

[54] **TEMPORARY POWER SUPPLY FOR A HEART-STIMULATING DEVICE**

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[58] Field of Search **128/419 P, 419 R, 128/421, 422; 307/64, 65, 66**

[56] **References Cited**
UNITED STATES PATENTS
3,620,220 11/1971 Murphy, Jr. 128/419 P

3,478,746 11/1969 Greatbatch 128/419 P
3,209,081 9/1965 Pucete et al. 128/419 P

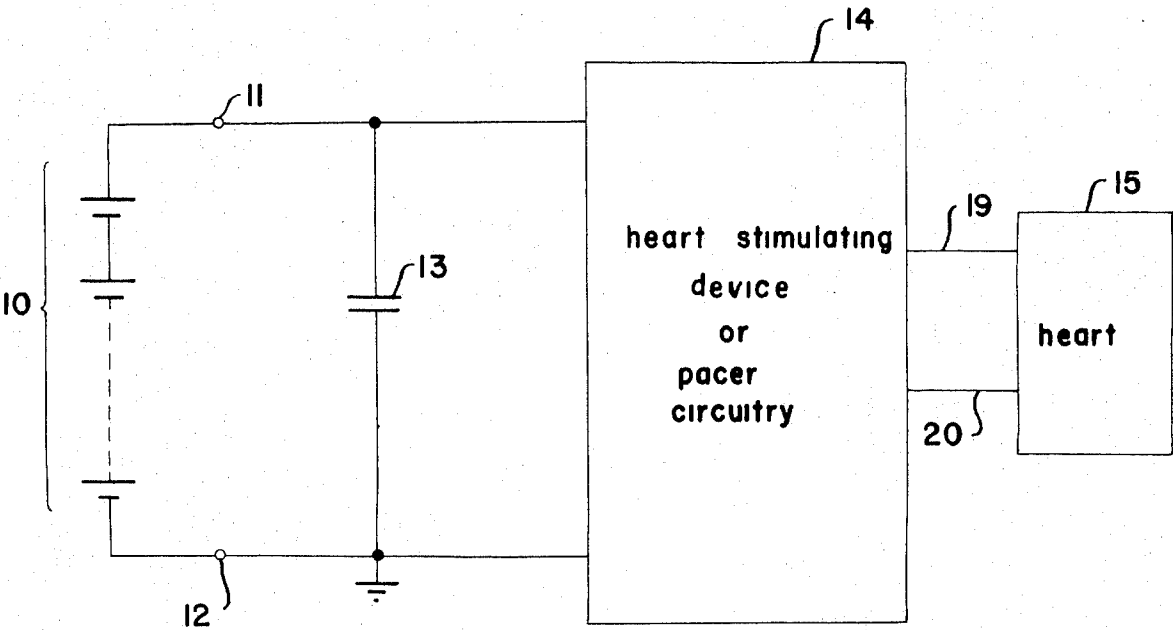
FOREIGN PATENTS OR APPLICATIONS
225,033 10/1959 Australia 128/419 R

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[57] **ABSTRACT**

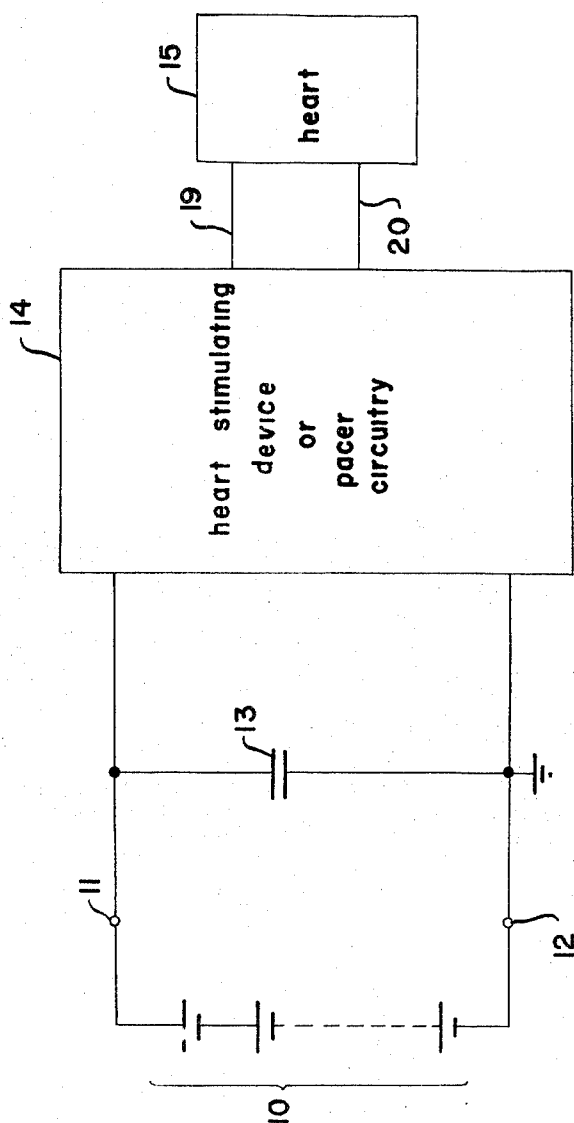
A temporary power supply for a heart-stimulating device. Apparatus is disclosed that provides temporary power to a battery-powered pacer during the time of battery replacement. In an illustrative embodiment of the invention, a capacitor circuit is used for this purpose.

3 Claims, 1 Drawing Figure



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TEMPORARY POWER SUPPLY FOR A HEART-STIMULATING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to electro-medical devices for stimulating physiological functions, and more particularly relates to apparatus for temporarily powering an external, battery-operated, heart-stimulating device during the time of battery interchange or replacement.

2. Description of Prior Art

Prior art relates to the electro-medical area of external heart pacing. A typical prior art heart-stimulating device is arranged external to a patient and electrodes are implanted within the patient in contact with the heart.

Ordinarily, the patient is hospitalized, and may be electrically connected to other monitoring, and/or stimulating electronic devices. There is a possibility, when several electronic devices are simultaneously connected to the same patient, that the patient may be accidentally electrically shocked. It is thus desirable to have the heart-stimulating device electrically isolated from the other power sources.

One way of isolating the heart-stimulator's power supply is to use a battery, and a battery normally is used in the prior art to supply power. This is plausible for several reasons including the fact that a heart-stimulating device typically does not draw a large amount of current. Thus batteries are operable for reasonable periods before replacement is necessary.

A problem arises in most prior art when the battery must be replaced. The patient being stimulated by this device is in most cases a seriously ill patient. His heart is ordinarily in an irritated and weakened condition. It is advantageous to the patient to have the pacing function maintained with as much continuity as possible. During the interchange of batteries, if the heart is being stimulated and if there is not means provided for maintaining power to the heart-stimulating device, the heart may stop beating. This can be dangerous to a heart that is already in a weakened and irritated condition.

In the past, battery-powered external pacers did not have a capability of maintaining power and hence pacing function during battery replacement. One battery was removed from the terminals supplying power to the pacer circuitry and then a fresh battery was inserted therefor. This resulted in loss of both power and possible pacing during the time of battery interchange. It also resulted in possible undesirable transient conditions when the new battery was inserted. The present invention solves this prior art problem.

The external heart-stimulating device is usually mounted on the patient himself, i.e.: on the patient's arm. Thus, for reasons of comfort and mobility, the heart-stimulating device is designed to be as small in physical size as is reasonably possible.

Certain prior art discloses a bulky device. The prior art utilizes a dual battery chamber. In this arrangement, a fresh battery can be inserted when the old battery is still in place. One disadvantage of this double battery system is that there is unused extra space available for the fresh battery. There is always one chamber that is usually empty. The present invention solves this problem. Also, the dual battery system requires a nurse to be specially trained in order to make proper use of the

system. For example, the nurse may erroneously remove the depleted battery prior to the inserting the fresh battery. This would result in the same interruption in pacer capability that is experienced in the above-described prior art.

By comparison, the present invention does not permit this adverse possibility to occur. Means for delivering power in the present invention to the pacer is an automatic feature and requires no special preparation. Immediately upon removal of the depleted battery, means for providing or maintaining power to the stimulating device automatically becomes operable.

SUMMARY OF THE INVENTION

The invention comprises a device that maintains power to heart-stimulating apparatus during the time of battery interchange. An illustrative embodiment includes a capacitor circuit in parallel with the battery supply. The battery supply may comprise a series of cells. The capacitor circuit is permanently connected to the heart-stimulating circuitry. The battery is electrically connected in parallel with the capacitor circuitry, but is physically removable. Upon removing the battery from the terminals in which it is connected, the capacitor acts as the power supply. The capacitor maintains sufficient voltage for an adequate amount of time, to allow the pacer to continue to be powered while the fresh battery is being readied for insertion into the available terminals. After insertion of the fresh battery, the capacitor is charged up to a new level established by the voltage level of the fresh battery. The capacitor maintains a level equal to the voltage of the fresh battery for the life of that battery. The capacitor again provides a simulated power supply function when the so-called fresh battery is depleted and replaced by yet another battery.

There are several advantages to our invention. For example, in addition to the advantage of the automatic nature of the device, a capacitor, such as that used in the present invention, is much smaller than a second battery chamber of the prior art, and therefore provides a much smaller overall package. This makes a more convenient adaptation to a patient's arm or other ambulatory place.

It is thus an object of the present invention to provide an improved external heart-stimulating device.

It is an additional object of the present invention to automatically provide power to the pacer continuously during battery replacement.

Other objects and advantages of the present invention will become apparent to one having reasonable skill in the art after referring to the detailed description of the appended drawing wherein:

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a schematic representation of an illustrative embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, pacer circuitry 14 is connected by electrodes 19 and 20 to heart 15 of a patient (not shown). The pacer circuitry is arranged to provide stimulation to heart 15, and in the case of a demand pacer, pacer circuitry 14 is arranged to sense a natural heartbeat and provide stimulation to heart 15 only in the absence of a natural heartbeat. Circuitry of this

type may be found in U.S. Pat. No. 3,528,428 assigned to the same assignee as that of the present invention, and the disclosure of U.S. Pat. 3,528,428 is incorporated herein by reference.

Battery 10, is a single battery or can be a plurality of single cells connected in series. It is in parallel connection with capacitor 13. The dashed line associated with battery 10 is intended to indicate that no fixed number of cells is necessary. (Battery 10 is sometimes referred to herein as batteries 10.) Terminals 11 and 12 represent a connection between permanent circuitry to the right of the terminals and the removable battery to the left of the terminals. Capacitor 13 is permanently connected with pacer circuitry 14. Terminals 11 and 12 are intended to indicate that batteries 10 can be easily removed and replaced by fresh batteries.

In FIG. 1 of the above incorporated-by-reference patent, the reader is referred to the junction between batteries 3 and 5 and the junction between batteries 5 and 7 which are used for certain biasing arrangements. In improved versions of this circuitry, these biasing requirements have been satisfied in other ways, thereby eliminating the need for individual cells. These improvements have been incorporated into a particular external pacer, so that a single battery suffices. However, other capacitors (not shown) can be arranged, if necessary, between a particular cell and ground to provide temporary biasing to various points in the pacer circuitry. This temporary biasing would be provided in a manner similar to the way in which capacitor 13 provides temporary power to the overall circuitry.

In operation, capacitor 13 senses voltage of battery 10. Upon removal of battery 10, capacitor 13, is charged up to the old battery voltage and provides temporary power to pacer circuitry 14. Typically, it takes 15 to 20 seconds to remove old battery 10 and replace it with a fresh one. For this amount of time, capacitor 13 will tend to discharge to a certain small extent. This may have an effect of changing the pacing rate in a small way—perhaps a 5 beats per minute variation. This is acceptable and is not ordinarily noticed by a pa-

tient being paced in this manner. Capacitor 13 in an illustrative embodiment is chosen to be in the neighborhood of 100 microfarads with 25 volts breakdown voltage. This is a typical size for the job required and is not large physically. Of course, larger or smaller sized capacitances can be used.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and the range of equivalency of the claims are therefore intended to be embraced therein.

We claim:

1. In an improved external heart-stimulating device which includes electrode means for connection to the heart of a patient, pulse generator means for generating heart stimulating impulses on said electrode means, at least one removable battery for powering said device, and non-removable battery-output terminals for conducting output from said at least one removable battery to said device, the improvement comprising capacitive means permanently connected to said battery-output terminals for charging in response to the voltage of said at least one removable battery, said capacitive means providing temporary voltage to said device initially at a final voltage level of said at least one removable battery when said at least one removable battery is removed, said capacitive means decreasing said temporary voltage from said final voltage level and maintaining said temporary voltage above a minimum voltage level during a predetermined time.

2. The improvement of claim 1 and wherein said at least one removable battery includes a plurality of single cells connected in series, where at least one cell of said plurality is removable.

3. The improvement of claim 1 and wherein said capacitive means is at least one capacitor.

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