

[54] **PORTABLE PACEMAKER PULSE COUNTER**

[72] Inventor: **Frederick Shlisky**, 253-31 61 Ave., Little Neck, N.Y. 11362

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[51] Int. Cl. **A61b 5/02**

[58] Field of Search ... **128/419 P, 2.06 R; 235/92 PC, 235/92 MT, 92 TC**

[56] **References Cited**

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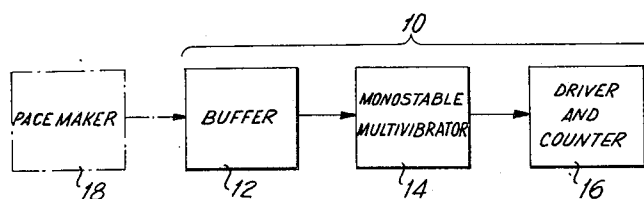
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Primary Examiner—Thomas A. Robinson
Assistant Examiner—Joseph M. Thesz, Jr.
Attorney—Steinberg & Blake

[57] **ABSTRACT**

A portable pacemaker pulse counter for recording the number of electrical impulses provided by a pacemaker. The pulse counter has a signal-receiving section for receiving a signal each time an electrical impulse is transmitted to the heart by the pacemaker, and the pulse counter also has a counting section for counting the number of signals received, these signals being transmitted to the counter through a transmission section. The above sections all are combined together into a small, miniaturized, light-weight unit small enough to be carried about comfortably on one's person in a pocket or the like.

8 Claims, 4 Drawing Figures



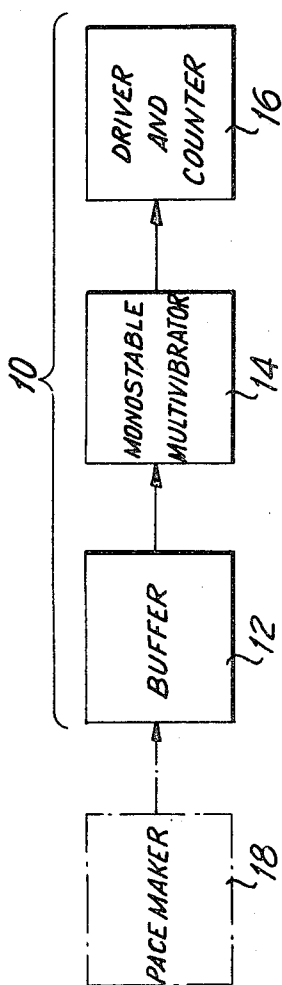


FIG. 1

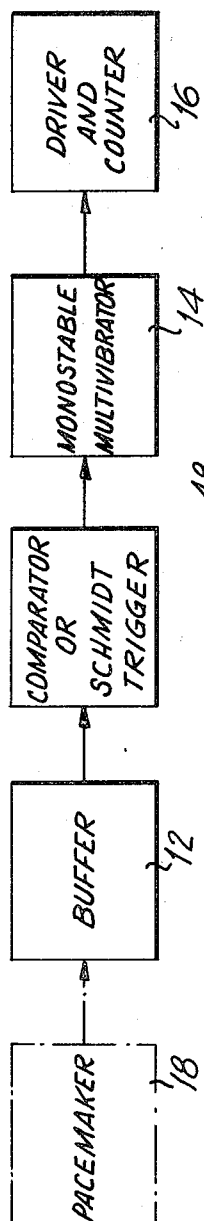


FIG. 2

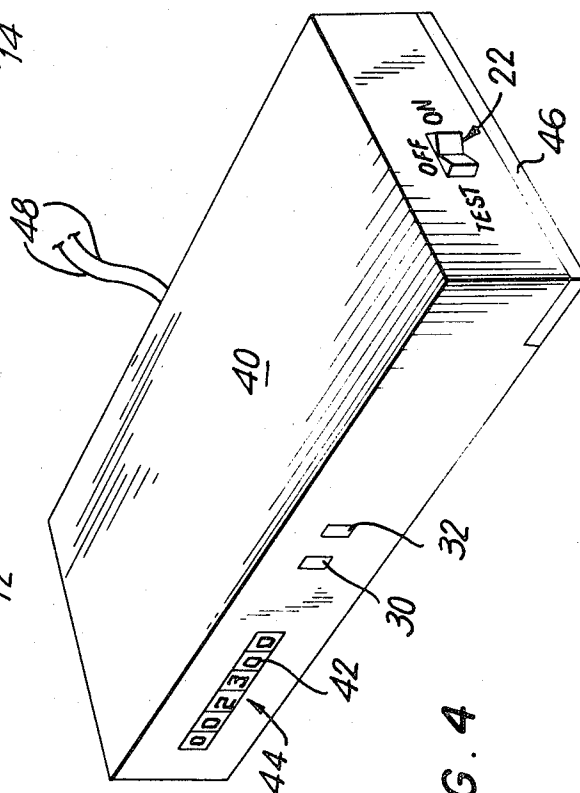


FIG. 4

INVENTOR.
FREDERICK SHLISKY

BY

Steinberg and Blake
ATTORNEYS

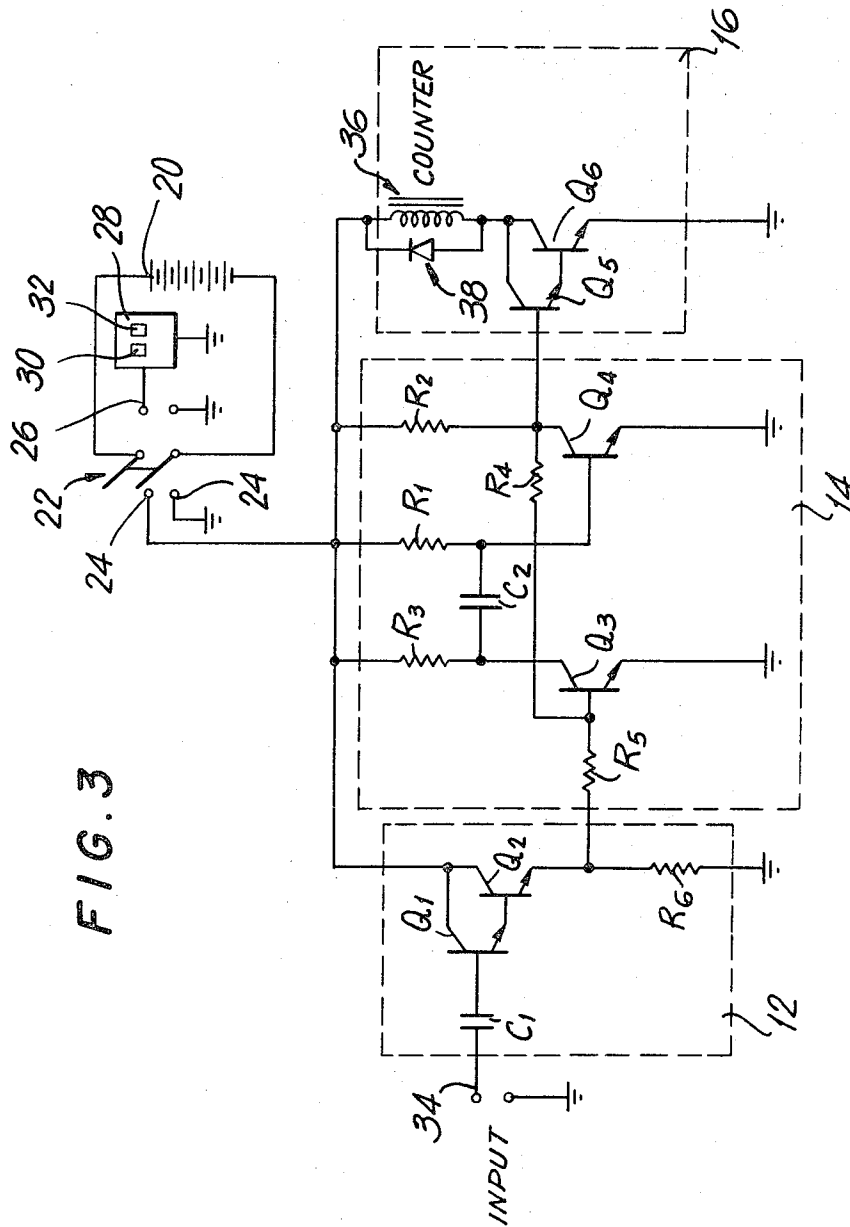


FIG. 3

INVENTOR.
FREDERICK SHLISKY

BY

Steinberg and Blake
ATTORNEYS

PORTABLE PACEMAKER PULSE COUNTER

BACKGROUND OF THE INVENTION

The present invention relates to devices for counting the number of electrical impulses transmitted by a pacemaker to the heart of an individual provided with a pacemaker.

As is well known, certain individuals who have problems in maintaining a proper heartbeat are required to have pacemakers which, as is well known, detect the rate at which the heart beats and automatically provides an electrical impulse to be delivered to the heart for stimulating the latter to increase the rate of heartbeat whenever required.

It is of the utmost importance when dealing with devices of this type to determine how many electrical impulses were delivered by the pacemaker to the heart. When a person provided with a pacemaker goes on about his normal daily activities, it is extremely difficult to count the number of electrical impulses, if any, provided by the pacemaker. This is a considerable drawback because physicians will in certain cases provide individuals with a pacemaker simply as a safety measure, without being absolutely certain as to whether or not a pacemaker is required. Thus, where there is some doubt, a physician will provide a patient with a pacemaker. If the individual who carries the pacemaker goes about his normal daily activities, it can well happen that the pacemaker never provides any electrical impulses, simply because it is not actually required, and the physician, as well as the individual, will never become aware of this fact.

Of course, this problem has been recognized, and attempts have been made to count the electrical impulses transmitted to the heart by the pacemaker. However, at the present time all of the known devices are heavy, bulky units which can only be attached to the pacemaker while the patient is in the hospital or at least very greatly confined and hampered in his activities, with the result that such devices are seldom used and even when used cannot possibly give the information which is required in connection with the operation of the pacemaker during those times when an individual goes about his normal daily activities.

SUMMARY OF THE INVENTION

It is accordingly a primary objective of the present invention to provide a construction which will avoid the above drawbacks.

In particular, it is an object of the invention to provide a pacemaker pulse counter which is small in size and light in weight, to an extent sufficient to be conveniently carried about on one's person while at the same time reliably recording the number of electrical impulses transmitted by a pacemaker to the heart.

Furthermore, it is an object of the invention to provide a pulse counter unit of this type with the capability of providing sufficient insulation to insure maximum safety to the patient.

Also, it is an object of the invention to provide a pulse counter which will not respond to false signals such as voltage generated by the body of the patient or coming from the heart itself.

Further object of the invention is to provide a unit of this type which will give an immediate, instantaneous indication to an attending physician, for example, of

the number of electrical impulses delivered by the pacemaker.

In addition, it is an object of the invention to provide a pulse counter of the above type which requires only an extremely small amount of energy.

In accordance with the invention the portable pacemaker pulse counter includes a signal-receiving means for receiving from a pacemaker a signal each time the pacemaker delivers an electrical impulse to the heart. A counter means is provided for counting the number of signals received by the signal-receiving means, and a signal-transmitting means is situated between and operatively connected with the signal-receiving means and the counter means for transmitting the signal, in a suitably modified form, from the signal-receiving means to the counter means. The latter three means are all combined together into a miniaturized unit which is small enough and light enough to be conveniently carried about on one's person in a pocket or the like.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a diagrammatic representation of the three basic stages of a miniaturized unit of the invention operatively connected with a pacemaker, shown in phantom lines, to receive a signal therefrom;

FIG. 2 shows the unit of FIG. 1 modified to receive an additional stage;

FIG. 3 is a wiring diagram of the unit of FIG. 1; and

FIG. 4 is a simplified schematic representation of the unit of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, the unit 10 indicated in FIG. 1 includes a buffer stage 12, a monostable multivibrator stage 14, and a driver-counter stage 16. The buffer stage 12 forms a signal-receiving means for receiving a signal from a pacemaker 18 indicated in phantom lines in FIG. 1. This pacemaker 18 will deliver a signal to the buffer stage 12 each time the pacemaker is called upon to transmit an electrical impulse to the heart. The signal-receiving means formed by the buffer stage 12 has its signal transmitted by a signal-transmitting means which is formed by the monostable multivibrator stage 14. The signal is received from the signal-transmitting means 14 by a counting means which is formed by the driver-counter stage 16.

As is apparent from FIG. 3 the stages 12, 14 and 16 form a transistorized circuit to which energy is delivered from a battery 20. The circuit includes a switch 22 which normally has an off position. The switch can be turned in one direction to connect the battery 20 with the contacts 24 in order to energize the transistorized circuit shown in FIG. 3. However, the switch 22 can be turned in an opposite direction to energize a battery-testing circuit 26 which includes a known testing assembly 28 having, for example, a green lamp 30 indicating that the battery 20 need not be changed and a red lamp 32 indicating that the battery 20 should be changed. Thus, from time to time the operator will turn the switch 22 into the position for energizing the testing means 28 so as to determine

whether or not it is necessary to change the battery 20 for a new battery. At other times, when the pulse counter unit 10 is to be operated the switch 22 will be in its opposite position closing and energizing the transistorized circuit of FIG. 3.

The buffer stage 12 which forms the signal-receiving means has the input 34 connected electrically with the pacemaker which is a demand type of pacemaker providing an electrical impulse whenever the pacemaker detects that the rate of the heartbeat has fallen below a given level. The pacemaker will then automatically transmit an electrical impulse to the heart to stimulate the heart to increase the heartbeat rate, and at this time the input 34 will receive a signal from the pacemaker. Thus, the input 34 forms an input means of the signal-receiving means for rendering the latter responsive to an electrical impulse of a pacemaker. The buffer stage 12 has a high input impedance to insure a good insulation of the pulse counter with respect to the pacemaker. The signal received by the stage 12 is transmitted by the signal-transmitting means 14 to the driver-counter stage 16. The stage 14 has the transistor Q_4 which is normally saturated and in the on condition where the collector voltage is zero. When a signal is received by capacitor C_1 transistors Q_1 and Q_2 become conducting and transistor Q_3 becomes saturated, while transistor Q_4 will terminate its saturated state and assumes an off condition. The voltage at the collector of transistor Q_4 will rise from zero volts (saturated) to 12 volts (off). This voltage will remain at 12 volts for a time period determined by the time constant R_1C_2 and then the collector voltage of transistor Q_4 will return to zero. In this manner the output voltage of transistor Q_4 is a positive pulse causing transistors Q_5 and Q_6 to become conducting, thus providing a current of sufficient strength to energize the electromagnet 36, located in the collector circuit of transistor Q_6 and momentarily energizing the counter for actuating a totalizer of well known construction. The diode 38 is provided to prevent a transient signal.

Thus, it will be seen that the buffer stage 12 provides a good insulation, by way of its high input impedance, between the pulse counter and the pacemaker, consequently achieving maximum safety for the patient. The buffer stage utilizes the blocking capacitor C_1 in the input circuit, allowing a pulse to pass but blocking any direct current. In this manner the patient is protected by possible harm in the extremely rare event of transistor breakdown.

The monostable multivibrator stage 14 functions to extend the time interval or pulse width of the input pulse from the pacemaker. It provides a single pulse output whenever there is a positive triggering pulse at the input. The output pulse width depends upon the minimum pulse width requirement of counter plus a small amount of safety factor to assure actuation of the counter.

Since the output from the monostable multivibrator stage is not of sufficient power to activate the counter, the circuitry includes the driver stage to boost the power to the value that will trigger the counter.

The above-described structure is designed to be triggered by pulses equal to or greater than a certain predetermined voltage level or threshold voltage. In

some cases it is desirable to have an adjustable threshold voltage, and for this purpose a comparator or Schmitt trigger stage may be situated between the buffer stage and the monostable multivibrator stage, as indicated in FIG. 2. This additional stage in the embodiment of FIG. 2 will provide a threshold voltage high enough to eliminate any false triggering due to unwanted signals including the EKG as well as the voltage generated by the body, but at the same time low enough to accept any signal put out by the pacemaker.

The Schmitt trigger of FIG. 2, when connected into the circuit of FIG. 3, would be situated in the conductor leading from the transistor Q_2 to the resistor R_5 , so as to be situated between the stages 12 and 14. Thus, the input to the Schmitt trigger would come from the transistor Q_2 while the output from the Schmitt trigger would be delivered to the resistor R_5 . Several resistors are provided in the circuit to adjust the operation thereof in accordance with the characteristics of the components.

The unit 10 of the invention is miniaturized and light enough to be carried about without any discomfort on one's person, as, for example, in a pocket or the like. This unit 10 as indicated in FIG. 4 may be of a generally rectangular configuration and may have a size which is approximately the size of a pocket-sized transistor radio. The outer housing 40 has a window 42 through which the numbered wheels of the totalizer 44 are visible. Thus, each time the electro-magnet of the counter is energized it will turn the units wheel through one increment, so that when the units wheel has turned through one complete revolution the next tens wheel will be turned through an increment displacing it from one digit to the next, and so on, in a well known manner. The switch 22 is conveniently situated at one end of the container 40. Moreover, the container 40 is provided with a removable lid 46 giving access to a battery compartment for the purpose of exchanging an old battery for a new battery. The red lamp 30 and green lamp 32 of the battery-testing means also visible from the exterior of the housing 40. The switch 22 coacts with suitable designations to indicate when it is in its intermediate off position or when it is in the on or test position as described above. Suitable leads 48 extend from the housing 40 to be removably connected in any suitable manner with the pacemaker.

It is thus apparent that with the structure of the invention a light, small pulse counter is provided which will count the electrical impulses of the pacemaker while the patient goes through his normal daily activities, thus making immediately apparent at the window 42 the number of electrical impulses required during the normal activity of the patient. Thus, it becomes unnecessary to make any allowances for the fact that the counting was made while the patient was necessarily confined and in an idle, unusually relaxed state. The patient can thus comfortably wear the unit of the invention and is free from bed confinement while being observed. The operation of the invention because it is a fully solid state device is extremely reliable. Since it is battery operated it need not be connected with any alternating current source and there is no danger of electrocution. The power consumption is at a minimum, so that the battery will have an extremely long operating life, and the same is true of the unit itself. It is possible,

when initially designing the unit, to provide it with a suitable threshold voltage, but by the use of the embodiment of FIG. 2 which includes the comparator stage, it is possible for the physician to provide any desired triggering sensitivity level in order to suit the needs of the patient and the physician.

What is claimed is:

1. A portable pacemaker pulse counter comprising a signal-receiving means for receiving a signal from a demand type of pacemaker each time the latter provides an electrical impulse, said signal-receiving means including an input means for constantly detecting over a long period of time during use of the pulse counter whether or not operation of the pacemaker occurs and for rendering said signal-receiving means responsive to an electrical impulse of a pacemaker, counting means for counting the total number of signals received by said signal-receiving means from the time the counting means starts operating till the time it stops operating, and transmission means situated between and operatively connected with said signal-receiving means and said counting means for transmitting a signal from said signal-receiving means to said counting means to be counted by the latter, all of said means together forming a miniaturized unit small enough and light enough to be comfortably carried about on one's person in a pocket or the like.

2. The combination of claim 1 and wherein all of said means form parts of a transistorized electrical circuit.

3. The combination of claim 2 and wherein a battery

is operatively connected with said circuit to provide energy therefor, said battery also forming part of said miniaturized unit.

4. The combination of claim 3 and wherein said signal-receiving means has during use of the pulse counter a connection to a pacemaker, said circuit including a buffer stage forming said signal-receiving means and insulating the miniaturized unit from a pacemaker connected thereto, a monostable multivibrator stage forming said signal-transmitting means, and a driver-counter stage forming said counting means for counting the signals received by said buffer stage.

5. The combination of claim 4 and wherein said buffer stage includes a high input impedance to be situated between the pacemaker and the miniaturized unit.

6. The combination of claim 4 and wherein a comparator stage is situated between the buffer stage and the monostable multivibrator stage for adjusting the threshold voltage of the pulses which provide signals to be transmitted to said driver-counter stage.

7. The combination of claim 3 and wherein a testing means is provided for testing the battery, and switch means for optionally connecting the battery either with the transistorized circuit or with the testing means.

8. The combination of claim 4 and wherein said driver-counter stage includes a totalizer for numerically totalizing the number of signals and rendering the total number of said signals immediately visible at the exterior of the miniaturized unit.

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