United States Patent

[11] 3,554,198

[72] Inventors **George Tatoian**
Williamsville;
Richard R. Ceier, East Aurora, N.Y.

[21] Appl. No. **658,478**
[22] Filed **Aug. 4, 1967**
[45] Patented **Jan. 12, 1971**

[73] Assignee **Cardiac Electronics, Inc.**
Clarence, N.Y.
a corporation of New York

[54] **PATIENT-ISOLATING CIRCUITRY FOR CARDIAC PACING DEVICE**
4 Claims, 2 Drawing Figs.

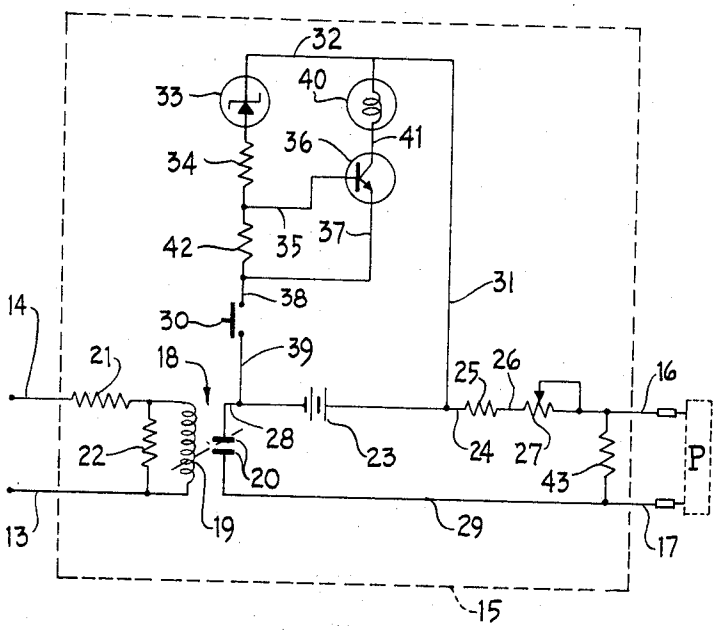
[52] **U.S. Cl.** **128/419,** 307/94
[51] **Int. Cl.** **A61n 1/36**
[50] **Field of Search** ..... 128/419, 421—423, 419P(Digests), 419D(Digests); 335/151, 152; 307/93, 94, 96, 100, 104

[56] **References Cited**
UNITED STATES PATENTS

3,109,430	11/1963	Tischler	128/422
3,135,264	6/1964	Tischler et al	128/423
3,215,794	11/1969	Zielinski	335/152
3,241,556	3/1966	Zacouto	128/421

Primary Examiner—William E. Kamm
Attorney—Summer, Weber & Gastel

ABSTRACT: A circuit for isolating a cardiac pulsing device from a periodic timing source to prevent stray voltages from being transmitted to a cardiac patient including a high speed relay having a solenoid in series with a resistor to form a primary circuit and the relay contacts in series with a battery to form a secondary circuit which provides the voltage for stimulating the heart of a cardiac patient, with the secondary circuit including variable resistor means for varying the voltage supplied to the patient and a built-in test circuit associated for periodically testing the battery to insure that it possesses sufficient voltage for providing adequate stimulation.



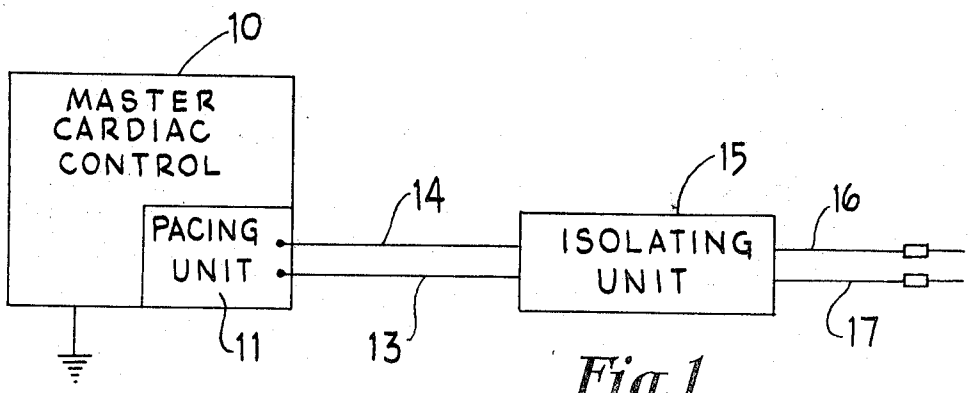


Fig. 1

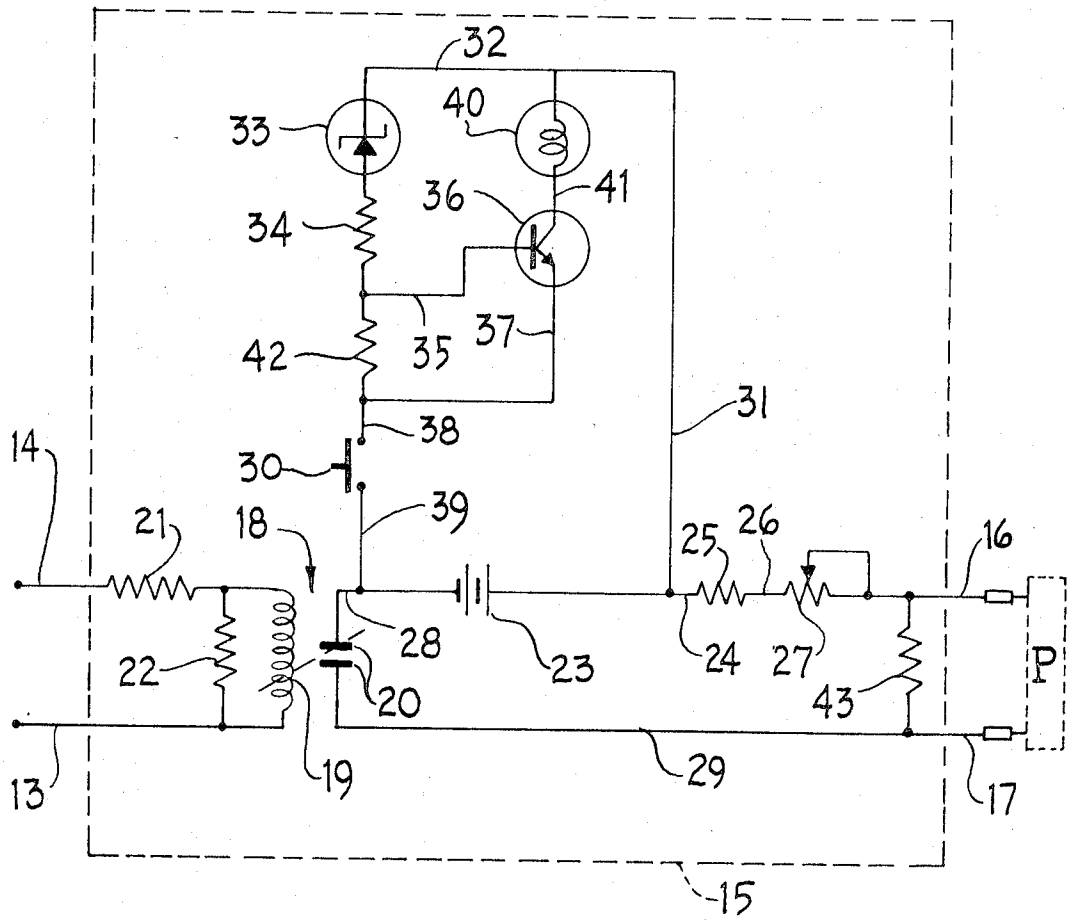


Fig. 2

INVENTOR.
GEORGE TATOIAN and
BY RICHARD R. CEIER
Joseph P. Gastel
ATTORNEY.

PATIENT-ISOLATING CIRCUITRY FOR CARDIAC PACING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to an improved device for pacing the heart of a cardiac patient while eliminating the possibility of applying stray voltages which might cause the heart to fibrillate.

By way of background, various cardiac pulsing devices are currently in use for pacing the heart of a cardiac patient from an external source by causing this source to provide periodically-timed voltage pulses which are transmitted to the patient. In the past, the pulsing device was susceptible of picking up 60-cycle stray voltages from stray electromagnetic and electrostatic fields, and these stray voltages could initiate fibrillation. These stray voltages originated from the equipment itself and from common ground loops inasmuch as the patient had to be connected to machine ground when he was being paced from an external pacing device. It is with an improved external pacing device which overcomes the foregoing shortcomings that the present invention is concerned.

SUMMARY OF THE INVENTION

It is accordingly one object of the present invention to provide an external pacing device for stimulating the heart of a cardiac patient, the external pacing device being completely electrically isolated from a timing device which triggers it thereby completely eliminating any possibility of fibrillation producing stray voltages in the timing device from being transmitted to the heart of the cardiac patient.

Another object of the present invention is to provide an improved external cardiac pacing device in which the pulses are transmitted through an isolating circuit substantially instantaneously without delay, thereby permitting the isolation of the two circuits without in any way delaying the signals to the patient.

A further object of the present invention is to provide an improved circuit for isolating a periodic timing source from a cardiac patient, the improved circuit providing a voltage to catheter leads from a battery source and including an unique battery testing circuit for insuring that the battery is of sufficient voltage to adequately perform its function. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

The improved circuit of the present invention utilizes a periodic timing source, such as an external pacing device, which is subject to stray electrical and electromagnetic voltages. The external pacing device drives a cardiac pulsing device while it is electrically isolated from the patient. Stray electrical or electromagnetic-induced voltages in the timing source are therefore isolated from the patient. The improved circuit comprises a primary circuit including the solenoid of a relay and a secondary circuit including the switch of the relay. The relay is of the fast-acting type which instantaneously transmits any pulse sensed in the primary circuit to the secondary circuit. The secondary circuit also includes a battery which is coupled to the heart of a patient by suitable electrical leads and the patient's heart will be stimulated by the battery as long as the switch is closed. The secondary circuit also includes a battery test circuit which can be used periodically to test the voltage of the battery to detect whether it still possesses sufficient voltage to perform its function adequately. The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the relationship between the improved isolating unit of the present invention and the master cardiac control which is utilized to provide a timing pulse; and

FIG. 2 is a schematic circuit diagram showing the improved isolating circuit of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 a master cardiac control **10** is shown which is utilized in its conventional manner for monitoring the heartbeat of a patient and performing other functions normally associated therewith including providing a visual indication of the patient's heartbeat on an oscilloscope or the like. Devices of this type are conventional in the field and a further description is not deemed necessary. Incorporated as a portion of master cardiac control **10** is a pacing unit **11** which is essentially an oscillator for providing periodic timed pulses which, through suitable leads **13** and **14**, are coupled to electrodes implanted in the heart of a patient and the timing pulses are utilized to periodically stimulate the heart and thus pace the heartbeat. Pacing unit **11** may be of any suitable conventional construction, and it is deemed that a detailed description of this particular unit is unnecessary.

As noted briefly above, if leads **13** and **14** are coupled directly to the patient, there is the distinct possibility that stray 60-cycle voltages produced by electrical and electromagnetic circuits within master cardiac control **10** and associated ground circuit may be transmitted to the patient. These 60-cycle voltages can induce fibrillation. Accordingly, in accordance with the present invention an isolating unit **15** is coupled to leads **13** and **14** extending from the pacing unit **11**. Isolating unit **15** completely electrically isolates pacing unit **11** from catheter leads **16** and **17** coupled to the heart of the patient, thereby completely preventing the stray voltages from being transmitted to the patient.

The isolating circuit **15** includes a fast-acting reed relay **18** consisting of a solenoid coil **19** wound about an highly evacuated envelope containing a pair of normally open contacts **20**. The reed relay is the type which can close contacts **20** within 0.0002 seconds after coil **19** is energized, thereby providing a substantially instantaneous response. In series with coil **19** is a resistor **21** which serves a plurality of functions. Firstly, it acts in combination with coil **19** to serve as a voltage divider and thus reduce the voltage on coil **19** so that external leads **13** and **14** can drive the isolating unit **15**. Furthermore, by virtue of the fact that resistance **21** is in series with coil **19**, there will be a speedup in the action of relay **18** thereby making it an ultraspeed relay and driving it many times as fast as it would normally be driven because the number of seconds required for operation of the relay is equal to L/R and therefore the greater the value of resistance **21**, the smaller will be the number of seconds required for relay **18** to operate. Coupled across coil **19** is a resistor **22**, across which the voltage of coil **19** is discharged when the voltage source to leads **13** and **14** opens to thereby provide a slow collapse.

Upon the closing of contacts **20** when there is a flow of current through coil **19**, a circuit will be completed to patient P from 9-volt battery **23** which is coupled across patient P by lead **24**, resistor **25**, lead **26**, variable resistor **27** and catheter lead **16**, on one side of the circuit, and on the other side by lead **28**, contacts **20**, lead **29** and catheter lead **17**. Resistors **25** and **27** are for the purpose of limiting the flow of current in the circuit to the patient and variable resistor **27** is essentially a potentiometer which varies the stimulation level to the patient's heart, this being calibrated for each particular patient, in accordance with his requirements.

It can readily be seen that there is complete isolation between the primary circuit in which solenoid coil **19** is located and the secondary circuit in which contacts **20** are located. Therefore, any stray voltages in the primary circuit cannot be communicated to the patient through the secondary circuit.

It will be appreciated that there must be an arrangement for testing the voltage of battery **23** to insure that adequate voltage is being supplied to the patient whenever the secondary circuit is established. To this end, a test circuit is provided for testing the voltage of the battery. This test circuit is established by closing of pushbutton **30**, and if the battery **23** can provide a voltage in excess of a predetermined amount, for example, 7.7 volts, there will be a flow of current from bat-

tery 23, through lead 24, lead 31, lead 32, Zener diode 33, resistance 34, lead 35, transistor 36, lead 37, lead 38, pushbutton 30 and lead 39 to battery 23. The flow of current from the base to the emitter of transistor 36 will cause a flow of current from lead 31 through lamp 40 and lead 41 to provide an indication that the battery 23 is in excess of the voltage required to trigger Zener diode 33 and flow through it and the resistance in series with it, namely, resistance 34 and the resistance provided by transistor 36, thereby showing that the battery possesses sufficient voltage to provide adequate cardiac stimulation. Resistor 42 in the circuit is merely for the purpose of discharging any leakage current which may collect on the base of transistor 36.

In the event that the battery 23 does not possess the minimum required voltage to trigger Zener diode 33, there will be no flow through the above-described circuit including Zener diode 33 and transistor 36 and thus there can be no flow through lamp 40 inasmuch as transistor 36 will not be energized. In this event, lamp 40 will not light up and it will be known that battery 23 does not have the required voltage for adequate cardiac stimulation and therefore must be replaced.

At this point it is to be noted that there is a resistor 43 coupled across catheter leads 16 and 17. This resistor is located in the circuit for external test purposes in testing and checking unit 15.

From the foregoing description it can readily be seen that the improved isolating unit of the present invention is manifestly capable of achieving the above enumerated objects and while preferred embodiments of the present invention have been disclosed, it will be appreciated that it is not limited thereto but may be otherwise embodied within the scope of the following claims.

We claim:

1. An isolating unit for utilizing a periodic timing source to drive a cardiac pulsing device while electrically isolating said pulsing device from said timing source to thereby prevent stray voltages from said timing source from being transmitted to a cardiac patient comprising a primary circuit including a solenoid, first lead means for coupling said solenoid to said timing source, a secondary circuit including a switch operable by said solenoid in response to the energization of said primary circuit by said periodic timing source, said switch being electrically isolated from said first circuit, a battery in said second circuit coupled to said switch, second lead means in said second circuit for effectively coupling said battery to a cardiac patient for applying an electric voltage to said patient on the closing of said switch whereby stray voltages in said timing source are not transmitted to said cardiac patient, said solenoid and switch means comprising a reed relay, and resistance means in series with said solenoid for speeding up the action of said relay.

2. A circuit as set forth in claim 1 including second resistance means coupled across said solenoid for discharging the voltage across said solenoid coil upon the termination of flow of current into said primary circuit.

3. An isolating unit for utilizing a periodic timing source to drive a cardiac pulsing device while electrically isolating said pulsing device from said timing source to thereby prevent stray voltages from said timing source from being transmitted to a cardiac patient comprising a primary circuit including a solenoid, first lead means for coupling said solenoid to said timing source, a secondary circuit including a switch operable by said solenoid in response to the energization of said primary circuit by said periodic timing source, said switch being electrically isolated from said first circuit, a battery in said second circuit coupled to said switch, second lead means in said second circuit for effectively coupling said battery to a cardiac patient for applying an electric voltage to said patient on the closing of said switch whereby stray voltages in said timing source are not transmitted to said cardiac patient, said solenoid and switch means comprising a reed relay, means for varying the amount of current flowing in said secondary circuit, a test circuit coupled across said battery for determining whether said battery voltage is in excess of a predetermined value to thereby assure the providing of sufficient voltage in said secondary circuit upon the closing of said switch means, and resistance means in series with said solenoid for speeding up the action of said relay.

4. A circuit as set forth in claim 3 including second resistance means coupled across said solenoid for discharging the voltage across said solenoid coil upon the termination of flow of current into said primary circuit.