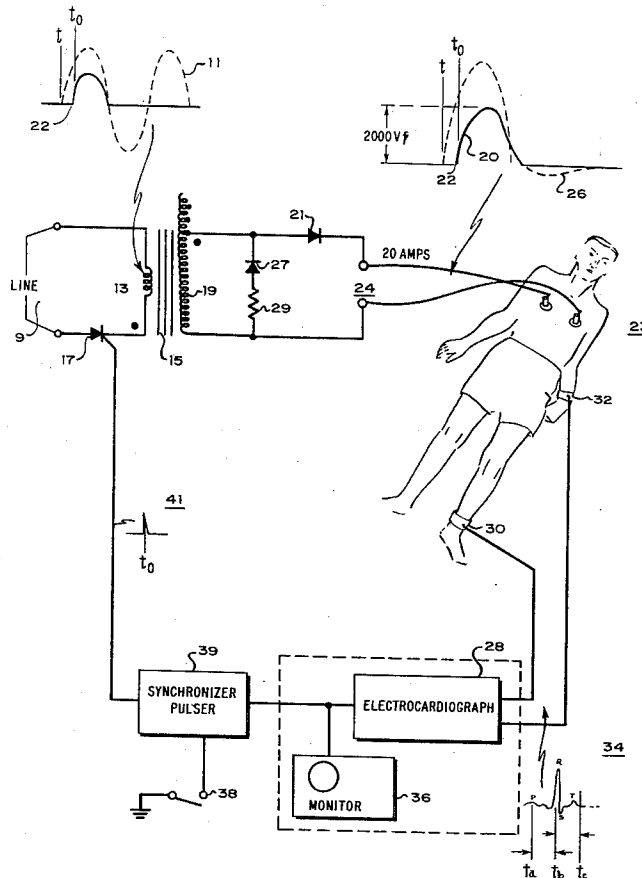


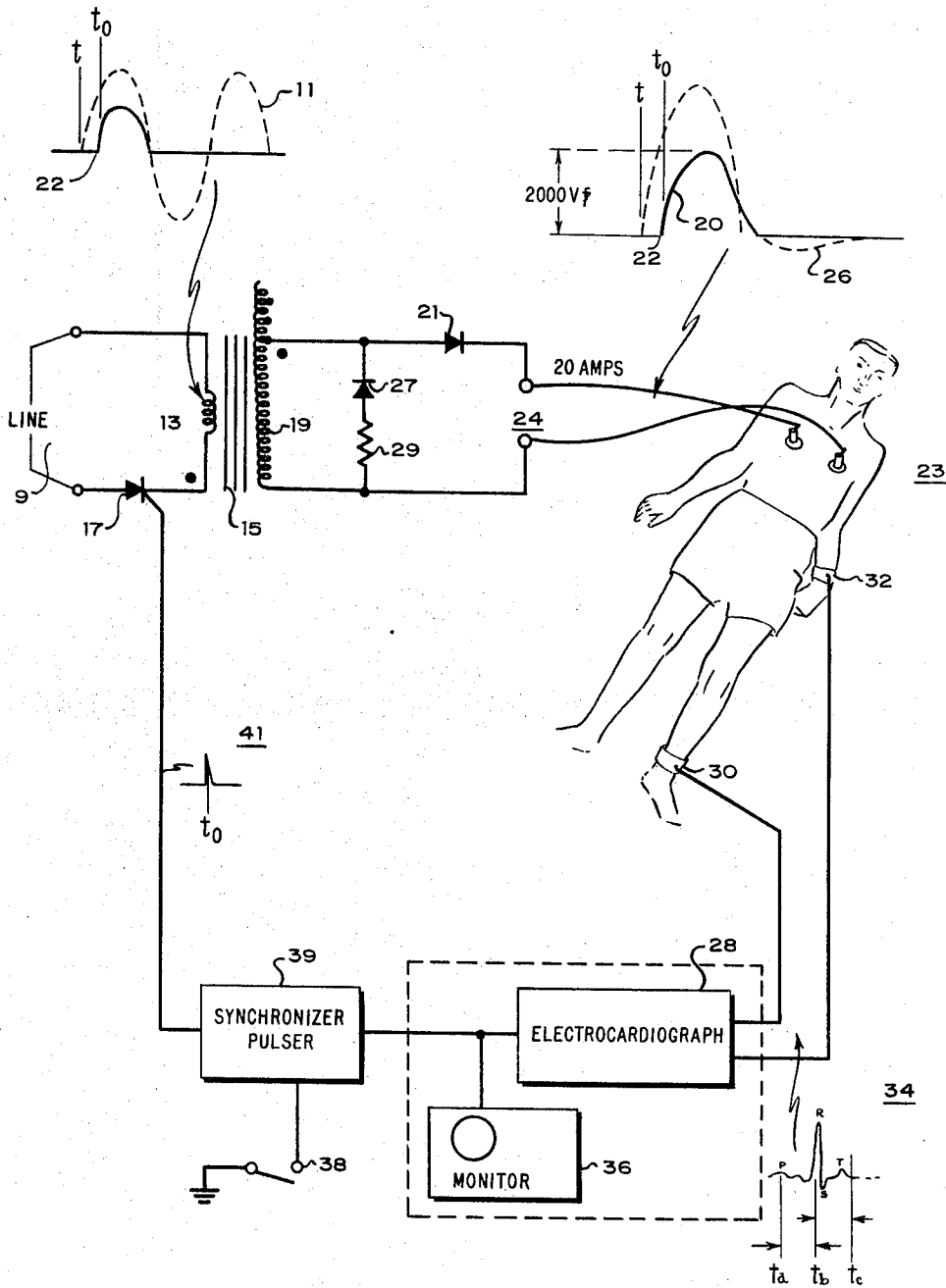
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[54] **DEFIBRILLATOR**
1 Claim, 1 Drawing Fig.
 [52] U.S. Cl..... **128/421**
 [51] Int. Cl..... **A61n 1/36**
 [50] Field of Search..... **128/419-**
—424, 419 (D)(digest)

ABSTRACT: A monopolar cardiac defibrillator obviates the need for bulky storage capacitors by operating directly from line signal to supply a high power-defibrillating pulse substantially as a half-wave portion of the line signal the defibrillating pulse is generated in timed relationship to a patient's electrocardiogram by activating a signal-controlled switch to apply a half wave of line signal to the defibrillator circuitry.





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DEFIBRILLATOR

BACKGROUND OF THE INVENTION

Conventional cardiac defibrillators commonly include a storage capacitor for storing a sufficient quantity of charge to supply to a patient a defibrillating pulse of about 2000 volts and 20 amperes for about 5 milliseconds. The physical size and weight of the storage capacitor is typically of the order of 1 cubic foot and several pounds and thus is not readily conductive to miniaturized packaging and convenient portability. Defibrillator apparatus of this type is described in the literature (See U.S. Pat. No. 3,236,239 issued on Feb. 22, 1966 to B. V. Berkovits). Also, the time required between defibrillating pulses to charge the storage capacitor of such conventional defibrillator apparatus prevents the delivery of several defibrillating pulses in rapid succession.

SUMMARY OF THE INVENTION

The present invention obviates the need for a storage capacitor to supply a high voltage, high current-defibrillating pulse by operating directly from a half-wave portion of applied line signal. Synchronization of the defibrillating pulse with the heart beat of a patient may be accomplished using conventional means coupled to a signal-controlled switch in the line signal circuit.

DESCRIPTION OF THE DRAWING

The drawing shows a schematic diagram and selected signal waveforms present in the defibrillator circuit of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, there is shown a line input 9 which may be connected to receive an alternating signal 11 from the power lines. The power line signal at input 9 is applied to the primary winding 13 of a step-up transformer 15 through a controlled rectifier 17 or other suitable signal-controlled switch. The voltage step-up ratio from the primary 13 to the secondary winding 19 of the transformer 15 may be as high as 30 to provide a secondary voltage as high as 2000 volts, even under conditions where the voltage applied to the primary may be as low as 60 volts at the peak of the half sine wave supplied to the primary winding 13. The pulse 20 of voltage produced on the secondary winding 19 when controlled rectifier 17 is conductive is applied to the patient 23 through diode 21, connecting cables 24 and the contact electrodes 25 suitably positioned on the chest of the patient 23. Typical peak values of the wave 20 applied to the patient 23 are about 2000 volts and 20 amps for about 5 to 10 milliseconds. The secondary winding 19 may include a plurality of taps to alter the turns ratio and provide selected values of secondary voltages and currents.

For power line frequency of 60 cycles, the pulse width of a half-wave is about 8 milliseconds. The portion of the line signal applied to the primary winding through the controlled rectifier 17 may be regulated simply by adjusting the electrical angle 22 at which the controlled rectifier 17 is rendered conductive. The inductance and resistance in the circuitry which supplies the defibrillating pulse 20 to the electrodes 25 smooths out transients upon turn-on of controlled rectifier 17 and causes a small amount of undershoot 26 in the defibrillating pulse 20. This undershoot portion of the waveform produces a reversal of pulse polarity which causes diode 21 to become nonconductive and which renders diode 27 conductive. The undershoot portion 26 is not applied to the patient but rather is dissipated in the resistor 29 which is serially connected with diode 27 across the secondary winding 19 of transformer 15.

It should be noted that the peak secondary current of about 20 amperes requires a peak primary current of several hundred amperes which must be supplied from the applied power

line signal. However, since the primary current of such high value flows from the power lines only during a portion of a half-wave period, and since the response time of fuses is typically equal to the period of a few cycles of line signal, the average power supplied to the circuit of the present invention during such response time is sufficiently low so that fuses in the supply lines are not blown. Thus, the transformer 15 may be relatively small in size with typically core dimensions of about 21×21 centimeters with a 7×7 centimeter cross section. The primary winding comprises wire of sufficiently large cross section to carry the high peak current and the number of primary turns with reference to the number of secondary turns is selected with due consideration for the fact that such high primary currents produce high line drops and thus that only about 60—70 volts may be available across the inputs 9 at the time peak current flows in the primary winding 13.

Conventional electrocardiographic apparatus 28 may be attached to the patient 23 using pickup electrodes 30, 32 suitably positioned on the patient to receive the electrocardial signals 34. The apparatus 28 may include a monitor 36 such as an oscilloscope or strip chart recorder which is connected to provide a continuous display of the patient's electrocardial signals 34.

In operation, it is desirable that defibrillating pulses be applied to the patients with nonfibrillating hearts during the period of the electrocardial signal waveform designated t_a to t_b and avoided during the period t_b to t_c . During the period t_a to t_b several cycles of the line signal occur and thus the controlled rectifier 17 may be rendered conductive during any one of these cycles occurring during this desirable period t_a to t_b . A synchronized pulser 39 responsive to the predominant QRS portion of the electrocardial signal may thus include a conventional monostable multivibrator or other suitable circuit for generating the conduction-initiating gate pulse 41 and may include transformer coupling to the gate electrode of controlled rectifier 17 so that true isolation of the patient 23 from line signal is preserved. The synchronized pulser 39 may also include conventional lockout circuitry for preventing gate pulses 41 from being generated during the undesirable period t_b to t_c .

It should be apparent that the present circuit may also be operated with a controlled rectifier in place of diode 21 where it is desirable to switch lower currents. However, the high secondary voltage presents some problems in biasing and insulating a trigger circuit for a controlled rectifier so connected, and also may require that another controlled rectifier connected in place of diode 27 be rendered conductive in the following half cycle to dissipate the undershoot portion 26 of the defibrillating pulse 20.

Therefore, the defibrillator circuit of the present invention obviates the need for a large and heavy storage capacitor by supplying to a patient a high power-defibrillating pulse derived directly from the power lines. The present circuit thus eliminates the requirement of charging time between defibrillating pulses and therefore permits several such pulses to be supplied to a patient in rapid succession.

We claim:

1. Monopolar defibrillator apparatus for applying an electrical signal to a mammalian subject, the apparatus comprising:
 - an input for receiving alternating signal from a source;
 - output means for applying an electrical signal to a subject;
 - a transformer having primary and secondary windings;
 - signal controllable switch means connecting the primary winding of said transformer to said input for applying a selected portion of a half cycle of alternating signal appearing at said input to said transformer in response to a control signal applied to said switch means;
 - circuit means connecting said secondary winding to said output means and including a first diode connected to conduct current in one direction to said output means from said secondary winding for signal therefrom of one polarity, and including a second diode and impedance means in series therewith for conducting current through

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said second diode and impedance means from said secondary winding for signal therefrom of the opposite polarity; and

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control means connected to said switch means to apply a control signal thereto at a selected time for applying said selected portion of alternating signal to said transformer.

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