United States Patent [19]

Panico

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[45] **Nov. 20, 1973**

[54] **DEFIBRILLATOR WITH FLASH TUBE SWITCH**

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[73] Assignee: **Health Systems, Inc.**, Woburn, Mass.

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

[21] Appl. No.: **208,870**

Related U.S. Application Data

[62] Division of Ser. No. 30,385, April 21, 1970, Pat. No. 3,723,887.

[52] **U.S. Cl.** ..... **128/419 D**

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

[58] **Field of Search** ..... 128/419 D, 419 R, 128/421, 423, 419 P; 315/208; 328/26

[56] **References Cited**

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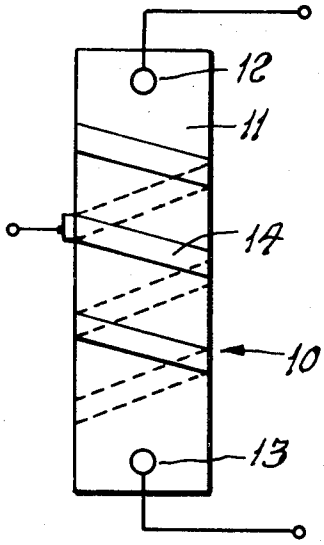
Primary Examiner—William E. Kamm

Attorney—Edward F. Costigan

[57] **ABSTRACT**

A defibrillator in which the patient contacting electrodes are coupled to a voltage source by a high speed, high energy switch system including a flash tube whose main electrodes are coupled in circuit with the patient contacting electrodes and whose control electrode is connected to a control switch.

6 Claims, 6 Drawing Figures



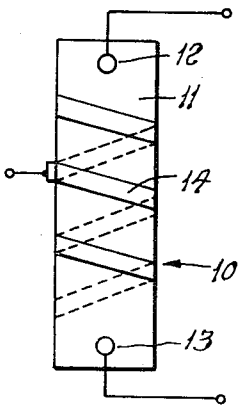


Fig. 1

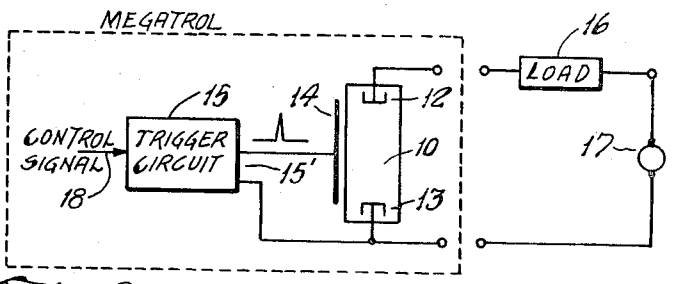


Fig. 2

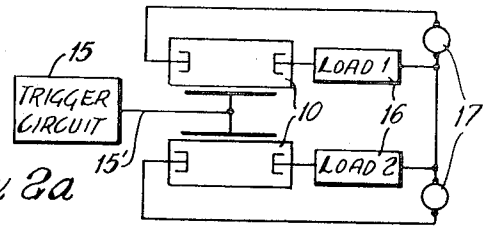


Fig. 2a

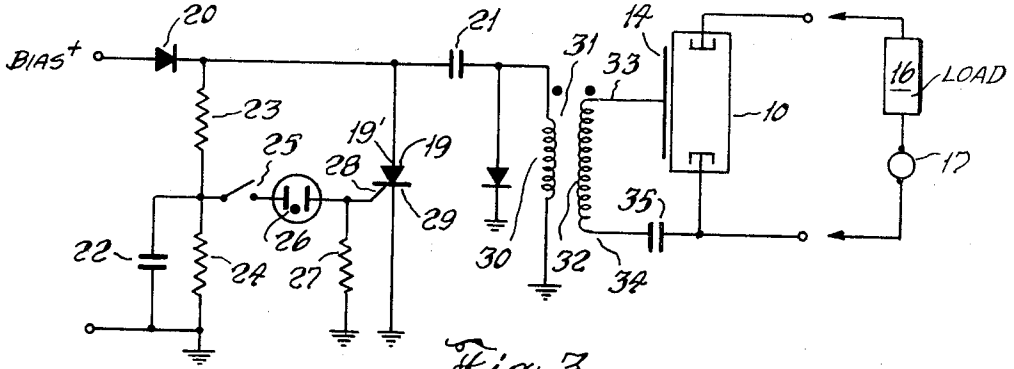


Fig. 3

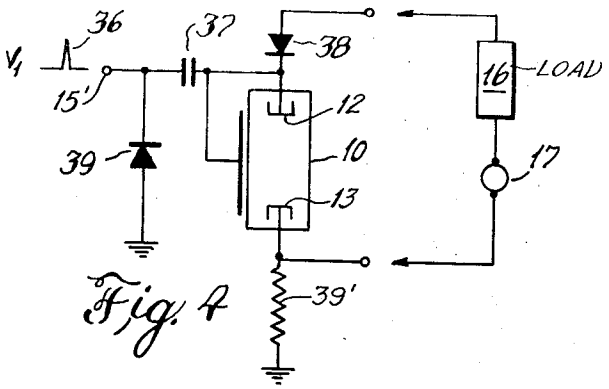


Fig. 4

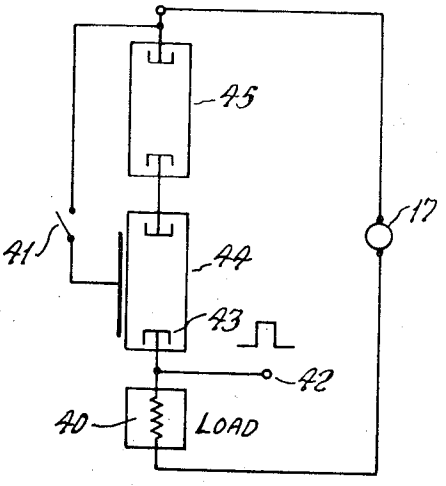


Fig. 5

DEFIBRILLATOR WITH FLASH TUBE SWITCH

REFERENCE TO PARENT APPLICATION

This is a division of application Ser. No. 30,385 filed Apr. 21, 1970 and now U.S. Pat. No. 3,723,887.

BACKGROUND OF THE INVENTION

2. FIELD OF THE INVENTION

The present invention relates to defibrillator with basic high speed, high energy capacity switches.

DESCRIPTION OF THE PRIOR ART

In the field of electronic and electrical switching it has been the general practice to employ a variety of special devices such as relays, contact switches, manual and remote, thyratrons, solid state elements such as silicon controlled rectifiers. Such devices have been found unsatisfactory in that they are limited in their current and voltage capacities and speed of operation. This is particularly true in the case of both the SCR, where limiting values of current and voltage exist due to the physical characteristics and the necessity of dissipating large heat accumulations, and for gas tubes such as the Thyratron where, although high currents can be accommodated, voltage and switching time limitations exist as well as the fact that the ignition and sustaining voltages are fixed parameters. These two devices, although extensively applied, are essentially unidirectional in conduction; thus they are not interchangeable for all applications with standard switch elements and do not have both switch terminals isolated. Relays and contact switches are clearly slow acting devices and subject to periodic breakdown when operating at high voltage and current. Moreover, none of these elements in and of themselves provide any secondary output or indicia of their operation, a useful output, where, a multifunction switch is necessary without additional elements or equipment. Those concerned with the development of switches and elements have long recognized the need for a high capacity, fast acting, bidirectional, and multipurpose switch. The present invention satisfies this requirement.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide a defibrillator with a switch that has all the advantages of similarly employed prior art devices and has none of the above described disadvantages. To attain this, the present invention provides a unique arrangement of a Xenon or Krypton flash tube whose main electrodes are connected in series with the load or line to be switched while a control pulse is applied between the control terminals thereof. One control terminal being any surface proximate the glass envelope of the tube which may be raised to the necessary ignition potential.

Still another object is to provide a defibrillator with a gaseous switch capable of operating over a plurality of ignition or firing potentials, while handling high level energy.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better under-stood by reference to the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective of a Xenon flash tube with a control electrode disposed thereon;

FIGS. **2** and **2***a* are block diagrams of embodiments made in accordance with the principle of this invention;

FIG. **3** is a schematic diagram of an embodiment of the instant invention;

FIGS. **4** and **5** illustrate novel trigger circuits for the switch;

FIG. **6** illustrates the switch used with a heart defibrillator circuit; and

In the illustrated embodiment of FIG. **1** a gas discharge tube **10** filled with Xenon or Krypton gas enclosed in a glass envelope **11** (or other suitable enclosure) has therein a pair of main discharge electrodes **12** and **13.** A control terminal or electrode **14** can assume a variety of shapes and positions since all that is necessary is to provide a short duration voltage across the gas to the main electrodes. This can be accomplished by affixing an electrical conductor proximate to or on the envelope **11.** Wrapping a wire therearound or an electrically conducting tape **14,** or a thin layer of conducting paint applied directly to the envelope, will provide sufficient potential to break down the gas and initiate the main discharge. The type of control element employed depends on the tube use so that where light emission is a factor, a wire or transparent tape is selected. It should be noted that as in most gaseous discharge tubes, a particular voltage between the main electrodes is required to sustain ignition or firing after the control terminal has activated or fired the tube. Recent developments in Xenon and Krypton flash tubes have included what can be generally termed as "doping." Various of these techniques have lead to the fabrication of a series of tubes which can sustain ignition at different currents and potentials. These parameters can be selectively determined in the manufacture of the tubes and, tubes can be obtained having sustaining voltages from approximately 300 volts to tens of thousands of volts. Tubes of this type are manufactured and available from the Xenon Corporation, Medford, Massachusetts and are fully described in their brochures on linear Xenon flash tubes designated as Novatron series **100, 200, 400** and **600.** By combining, with the Xenon discharge tube **10,** a source of ignition voltage and sufficient main electrode voltage the tube can be made to fire or ignite and emit a high light intensity very close to that of natural sunlight. In the embodiment of FIG. **2,** a trigger circuit **15** has its output **15'** connected between the control terminal **14** and one main electrode **13** while the two main electrodes are connected across the series combination of a load **16** and an electrical power source **17.** Many circuits are presently available to provide a relatively narrow pulse and any of these are suitable for the purpose of supplying ignition potential. For selective "firing" the trigger circuit must be activated and a control signal input **18** thereto has been shown. This control signal can be provided through the action of a manual or electronic switch. In operation, when the load **16** and power source **17** are connected across the Xenon tube and the trigger circuit **15** activated, the tube fires and conducts therethrough the load current. The trigger circuit which may include the control signal source and the Xenon discharge tube in combination comprise a switch module which will be

referred to hereinafter as the "Megatrol." In essence, the Megatrol is controlled in a manner similar to a relay or a silicon controlled rectifier. In order to close the main switch "contacts" a small amount of energy is applied to the control terminal permitting current to flow from the power supply through the load. As in the SCR, the main switch "contacts" reopen when the (voltage) current through the switch is insufficient to maintain conduction, but, unlike the SCR, current can flow in either direction (bidirectional). Once the Megatrol is extinguished it will not turn on again until the control terminal is activated. It is capable of controlling vast amounts of power through only minute control levels. For example, the Megatrol switch can easily hold off voltages in excess of 10,000 volts and conduct thousands of amperes while exhibiting an extremely high switching speed. FIG. 2*a* shows one possible multipole switch arrangement wherein another tube has been added to the module so that two or more loads can be simultaneously controlled.

An operative embodiment of the blocks of FIG. 2 is illustrated in FIG. 3 where a bias voltage is supplied to the anode 19' of an SCR 19 through a diode 20. Since the SCR 19 is "off" the bias voltage will cause capacitor 21 to charge to the desired level. Simultaneously capacitor 22 will be charged to a level established by the voltage divider comprising resistors 23 and 24. When switch 25 is closed the neon gas tube 26 will breakdown permitting current to flow through resistor 27 to ground and apply a voltage at the gate 28 of SCR 19 causing the SCR to short capacitor 21 to ground through its cathode 29. This discharges the capacitor and abruptly changes the voltage at the primary winding 30 of step-up transformer 31 which is coupled to the secondary 32 and provides a sufficient voltage pulse at the control terminal 14 to ignite the Xenon tube 10. The secondary has one end 33 thereof connected to the control terminal 14 and the other end 34 connected through capacitor 35 to one of the main Xenon electrodes. It has been found that this capacitor 35 in the secondary circuit provides proper operation, reliability and improved results. More important, the capacitor electrically isolates the switch terminals from the control circuitry. Once conducting the load current, the Xenon tube will continue conducting until it is extinguished by a decrease in (current) energy therethrough.

In certain applications and conditions the applied voltage V is insufficient to breakdown the tube and initiate ignition. Considering FIG. 4, a voltage pulse 36 is injected through capacitor 37 to the main electrode 12 thus applying a voltage $V + V_1$, which is sufficient to start ignition. Diode 38 blocks the positive pulse from the source of power while diode 39 absorbs the negative transient which passes through capacitor 37 when the tube switches "on." FIG. 5 indicates another novel trigger circuit wherein two discharge tubes are connected in series between the power source 17 and the load 40. A switch 41 is connected between the power source and a trigger input 42 to main electrode 43 of Xenon tube 44. With this switch 41 open no current will flow since the source voltage V is not great enough to breakdown both tubes 44 and 45 in series. However, when the switch is closed tube 44 will start conducting and will effectively lower its impedance so that the voltage across tube 45 will be sufficiently high to fire it and cause conduction in an avalanche mode. It should be noted that on conduction the voltage drop across tube 44 is practically zero due to the low conduction resistance.

In the heart defibrillator application of FIG. 6 the Megatrol 74 is used to control the energy output of the source 75 which can be adjusted to supply the required voltage and current for the particular patient. The Megatrol is disposed in the high voltage line 76 between the defibrillator paddle 77 and the source 75. A switch 78 carried by the insulated portion of the paddle handle is equivalent to switch 25 of FIG. 3 so as to control activation of the Megatrol and thereby the application of current to the patient's heart as controlled by the doctor administering the defibrillating energy. The circuit is completed by another electrode from source 75 to the patient.

It should be understood, of course, that the foregoing disclosure relates to only preferred embodiments of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

I claim

1. A heart defibrillator comprising:
a defibrillator paddle electrode;
an additional electrode for forming an electrical contact with a patient;
a source of electrical energy;
a high speed, high energy capacity switch connecting said paddle and patient contacting electrodes in circuit with the source of electrical energy comprising;
a gas filled bidirectional discharge flash tube having a pair of main electrodes and a control terminal for initiating the firing of said tube;
a trigger circuit for providing a high voltage pulse connected between said control terminal and one of said main electrodes;
means for activating said trigger circuit to provide said pulse, whereby when said paddle and patient contacting electrodes and said electrical energy source are connected in circuit with said main electrodes, said switch will control the energy therethrough.

2. The heart defibrillator as claimed in claim 1 in which said means for activating said trigger circuit is positioned at said paddle electrode.

3. A heart defibrillator comprising:
a defibrillator paddle electrode;
an additional electrode for forming an electrical contact with a patient;
a source of electrical energy;
a high speed, high energy capacity switch connecting said paddle and patient contacting electrodes in circuit with the source of electrical energy comprising:
a gas filled discharge flash tube having a pair of main electrodes and having a control terminal for initiating the firing of said tube;
a first diode;
said first diode being coupled in circuit with the paddle and patient contacting electrodes and energy source and the connection being coupled across said electrodes;
a high voltage pulse source;
means for actuating said pulse source coupled thereto;

means coupling said pulse source to said flash tube;
said coupling means comprising a capacitor having one side coupled to said pulse source and the other side coupled to one of said electrodes and to said terminal;
a second diode coupled to said pulse source;
a resistor coupling said diode to the other of said electrodes;
said first diode acting to block said pulse source from said energy source; and
said second diode acting to absorb transients from said capacitor when said tube switches on.

4. The heart defibrillator as claimed in claim **3** in which said means for activating said trigger circuit is positioned at said paddle eelectrode.

5. A heart defibrillator comprising:
a defibrillator paddle electrode;
an additional electrode for forming an electrical contact with a patient;
a source of electrical energy;
a high speed, high energy capacity switch connecting said paddle and patient contacting electrodes in circuit with the source of electrical energy comprising:
a gas filled discharge flash tube having a pair of main electrodes and a control terminal for initiating the firing of said tube;
a step-up transformer having a primary and a secondary winding coupled between said control terminal and one of said main electrodes;
a first diode;
a first capacitor;
a pair of bias terminals;
a first series loop having connected therein said bias terminals, said first diode, said first capacitor and said primary;
a pair of resistors forming a divider network connected between the junction of said first diode and said first capacitor and one of said bias terminals;
a second capacitor connected intermediate one of said pair of resistors and said one bias terminal;
a silicon controlled rectifier having a gate and its anode-cathode connected in parallel across said divider network;
a second switch;
a neon tube;
said second switch and said neon tube connected in series between said gate and the junction of said pair of resistors;
a third resistor connected intermediate said gate and said one bias terminal;
whereby when said paddle electrode and said patient contacting electrodes and source are connected in circuit with said main electrodes, said second switch will control the energy therethrough.

6. The heart defibrillator as claimed in claim **5** in which said second switch is positioned at said paddle electrode.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,773,050 Dated November 20, 1973

Inventor(s) Joseph J. Panico

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

Insert Figure 6 as part of Letters Patent.

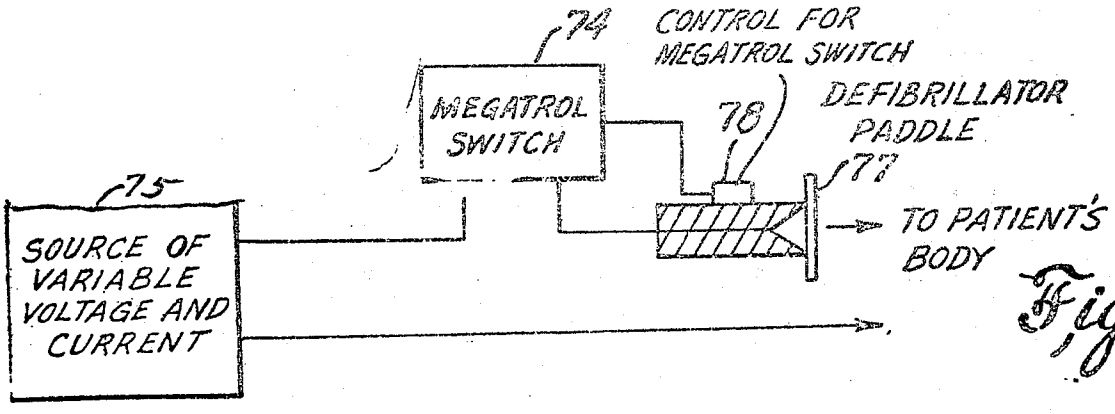


Fig. 6

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.