CLINICAL DEFIBRILLATORS

Defibrillator design has resulted from medical and physiologic research and advances in hardware technology. It is estimated that for each minute that elapses between onset of ventricular fibrillation and the first shock application, survival to leave hospital decreases by about 10%. The importance of rapid response led to development of portable, battery-operated defibrillators and more recently to automatic external defibrillators (AEDs) that enable emergency responders to defibrillate with minimal training.

All clinical defibrillators used today store energy in capacitors. Desirable capacitor specifications include small size, light weight, and capability to sustain several thousands of volts and many charge discharge cycles. Energy storage capacitors account for at least one pound and usually several pounds of defibrillator weight. Energy stored by the capacitor is calculated from:

$$W_s = \frac{1}{2} CE^2$$

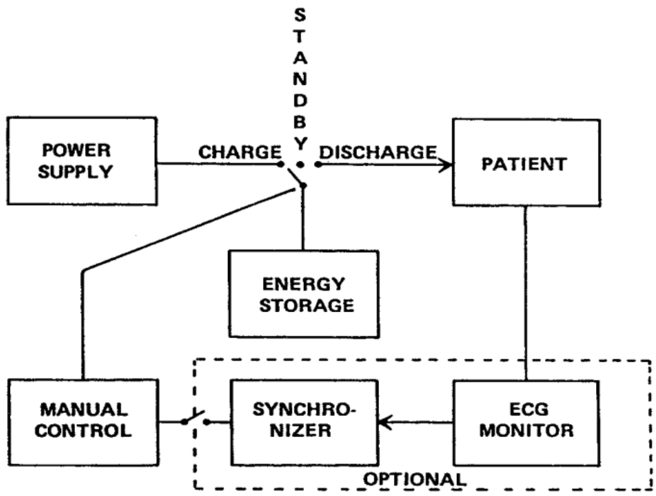

FIGURE 1: Block diagram of a typical defibrillator.

Where:

W_S = stored energy in joules,

C = capacitance in farads, and

E = voltage applied to the capacitor.

Delivered energy is expressed as:

$$W_d = W_S \times \left(\frac{R}{R_i + R} \right)$$

Where W_d = delivered energy, W_S = stored energy, R= subject resistance, and R_i = device resistance.

Figure (2) shows a block diagram for defibrillators. Most have a built-in monitor and synchronizer (dashed lines in Fig. 2). Built-in monitoring speeds up diagnosis of potentially fatal arrhythmias, especially when the ECG is monitored through the same electrodes that are used to apply the defibrillating shock.

The dc defibrillator device consists of several key modules, each of which controls a particular part of the machine and these units are**:**

1) Generating high voltages unit
2) Charge the battery unit
3) Output Unit
4) Control Unit
5) Electrodes

Generating high voltages unit

In this unit we need a relatively high voltage close to 7,000 volts and in order to get these voltages must design the following:

- **The oscillator**

This part very important in applications of switching power mode called this type oscillator UNSTABLE work for create the low frequency signals for operate the switching mode amplifier and work the oscillator in defibrillator circuits system in high-tension voltage unit. The oscillator generates a high frequency appropriate proportional with the work of the defibrillator device.

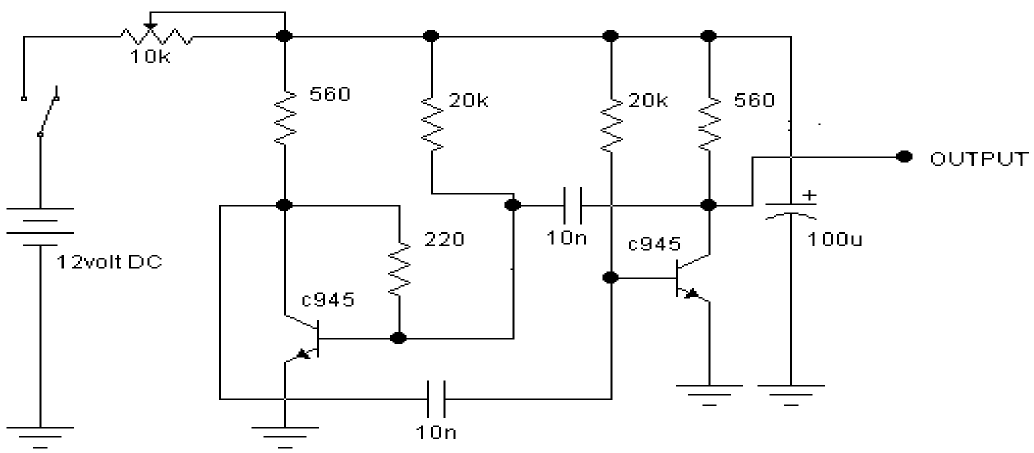

Figure (1) circuit diagram of oscillator

Use the variable resistance in oscillator for change in the intensity of the output, generate this circuit square wave signals with narrow pulses going to input of power amplifier to complete the switching mode power supply. The oscillator of principle work when TR1 is turn on then TR2 is turn off and when work TR2 then TR1 is turn off and the results output its square wave signals.

The parts of oscillator

1. Transistors use NPN transistors C945:

2. Capacitors (10nf and 100µf)

3. Variable resister (10kΩ).

4. Constant resisters (20kΩ , 560Ω and 220Ω)

1. **The power supply (charge unit):**

the consists of this unit is from step down transformer 220 to 14 volt ac , use the full wave rectifier and filter and used tow battery each one 6v, the type of the battery is Ni-Cad ,the circuit diagram in figure (2) the circuit of charge unit.

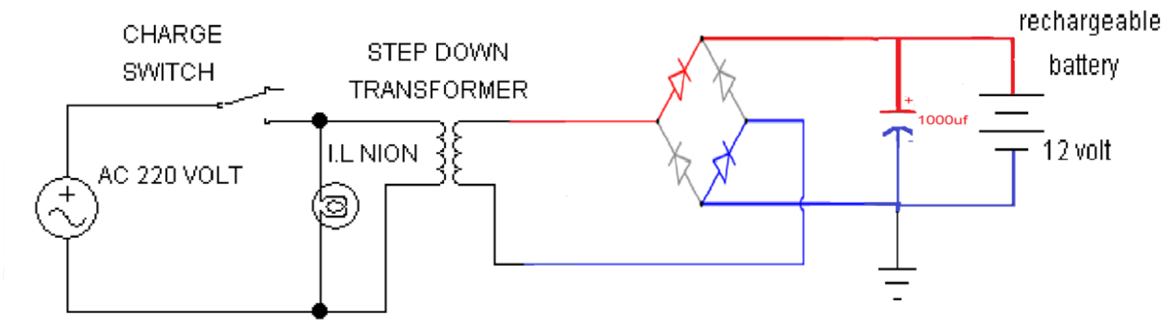

Figure (2) Circuit diagram of charge unit

The parts of the power supply:

1. **Step down transformer:**
   As a step-down unit, the transformer converts high-voltage, low-current power into low-voltage, high-current power. The Step down transformer that we use causes convert voltage from 220v ac to 12 volt ac.

2. **Neon lamp**: for indicator of operation of circuit.

3. Electrical bridge: used to rectify and convert ac signal to dc signal.

4. **Capacitor (1000 μf)**: used to correct the ripple in the output of the bridge to pure dc signal.

5-Electrical switch (on/off)

Switching power amplifier

Use the switching power amplifier for amplification signal from the oscillator and connect the output to solid transformer. We can design high voltage power supply by simple solid transformer low turns but give high quality and high efficiency in high voltage application.

Use in this circuit MOSFET power transistor and use some resister and capacitor and use fuse 4A for protection circuit. as shown in figure (3)

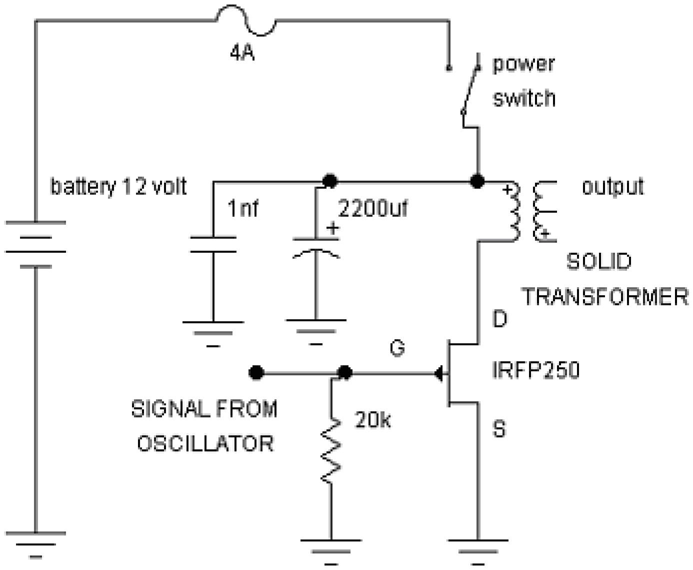

Figure (3) power amplifier

Main parts of switching amplifier

1. MOSFET power transistor IRFP250N P-channel
2. Resistance (20KΩ)
3. Capacitor (2200μf)
4. Power switch (on/off)
5. FUSE 4A: used for protection the circuit.
6. Step up transformer

2. The output and control circuit:

The control unit is working to provide two methods to control the discharge the device, first method normal (manual) and the second method automatic method for the first style manual, we can discharge the charge at any time this method is commonly used when the patient's heart stops entirely be given these charge as highest as possible and at any time until the heart muscle stimulated.

And for the trigger signal (control signal) it is generated from ECG graph synchronously with dc defibrillator so the ECG graph will give trigger signal in case of wave-shaped which used to stimulate the heart. Figure (5) illustrates the signal form the heart period of trigger signal.

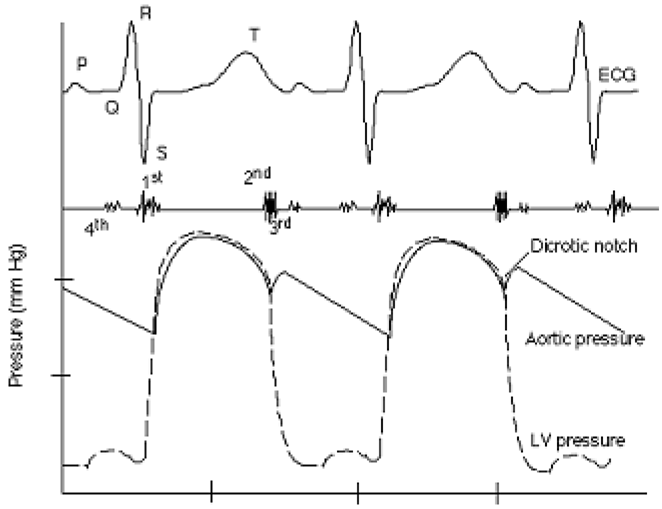

Figure (5)

This part start from secondary coil of solid transformer 270 turns for generated high voltage coil terminals use in this circuit special part because we use very high voltage and be careful when we use the device. The output connects to capacitors with series connection to give high voltage equal 7000 volt DC storage and going this voltage to controlled relay. The high voltage outputs from controlled relay go to the electrodes.

The equation of voltage capacitors is:

$\mathbf{V_{total} = vc_1 + vc_2 + vc_3}$ . . . . eq. (1)

Use some relay to work a circuit breaker and use the isolation for protect from the high voltage. This circuit in figure (4) the circuit designs with high efficiency because we use high-tension voltage and most be good design for safety.

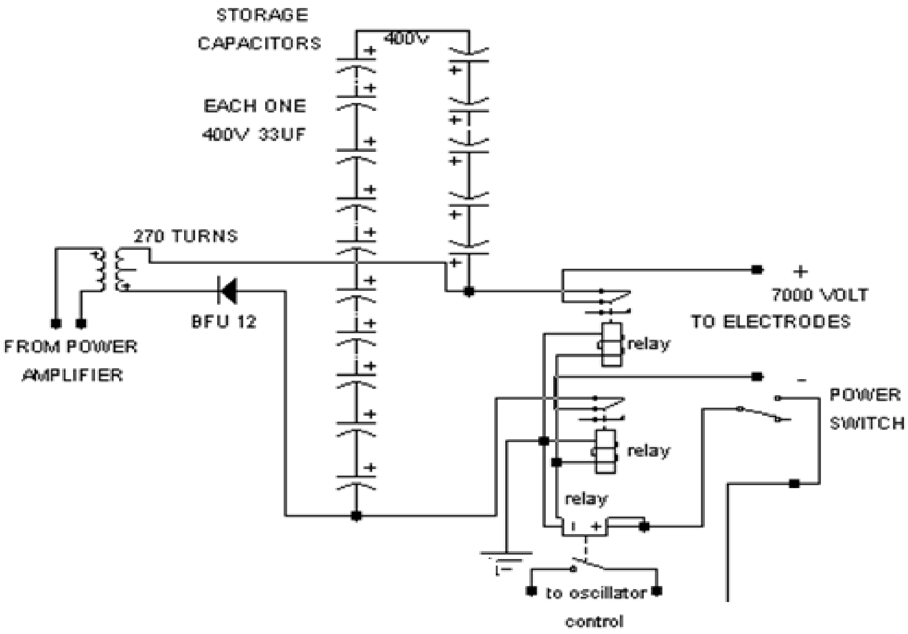

Figure (4) The output and control circuit

When work the dc-shock the voltage in output capacitors will increase due to the output voltage from switching mode amplifier to storage the high voltage.

ELECTRODE: There are many types of electrodes with different areas depending on the patient's condition, the pole is a plate of aluminum connecting in one of the high voltages terminals and due to the passage of voltages it had to be put very insulating material such as wood to isolate this plate of the hands of the physician and to electric spark does not occur catches the electrodes are designed several centimeters of wood for the safety of high electric.