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A New Technique for Constructing and Performance Analysis of Portable Use for Powered Medical Function

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May 2019

ACKNOWLEDGEMENT

First praise is to Almighty Allah for all his blessings for giving me patience and good health throughout the duration of fourth stage project during BSc stud which is entitled “**A New Technique for Constructing and Performance Analysis of Portable Use for Powered Medical Function”.**

We would like to express our gratitude to my supervisor Dr. Khalid G. Mohammed, and I appreciate his vast knowledge and skill in many areas (e.g., vision, ethics, interaction with participants), and his assistance in writing this dissertation. We thank Allah every time to help us for completing and implementing the project successfully.

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ABSTRACT

It is not a secret to anyone that the need for medical devices in Iraqi hospitals is increasing annually with the increase in the population percentage in Iraq at a reasonable rate of at least one million people, according to official statistics. This, of course, will lead to an increase in the demand for building hospitals and health centers. Increasing the civilian infrastructure in the field of community health will certainly require the import of a large number of medical devices from international companies at very high prices.

What is the best solution in order to preserve the minimum level of health care for the citizens of Iraq? The answer is to stimulate applied scientific research in the medical field. This is done by increasing the focus of our researchers in Iraqi universities in general and colleges of engineering, especially on innovation and the manufacture of medical devices based on the cheap raw materials that serve the purpose and available in the Iraqi market. We have found through the manufacture of the current device that understanding the basic working mechanism based on engineering laws in the fields of electrical and electronic power engineering helped greatly to accelerate the completion of the device within a period of no more than two months, knowing that the device was studied for the first time.

A device that reverses the Fibrillation of the heart Fibrillation causes the heart to stop pumping blood, leading to brain damage, is a treatment for life-threatening cardiac dysrhythmias, specifically ventricular fibrillation (VF) and non-perfusing ventricular tachycardia (VT). A defibrillator delivers a dose of electric current (often called a counter shock) to the heart. Although not fully understood, this would depolarize a large amount of the heart muscle, ending the dysrhythmia. Subsequently, the body's natural pacemaker in the sinoatrial node of the heart is able to re-establish normal sinus rhythm. In contrast to defibrillation, synchronized electrical cardioversion is an electrical shock delivered in synchrony to the cardiac cycle. Although the person may still be critically ill, cardioversion normally aims to end poorly perfusing cardiac dysrhythmias, such as supraventricular tachycardia. Defibrillators can be external, trans venous, or implanted (implantable cardioverter-defibrillator), depending on the type of device used or needed.[4] Some external units, known as automated external defibrillators (AEDs), automate the diagnosis of treatable rhythms, meaning that lay responders or bystanders are able to use them successfully with little or no training.

CHAPTER ONE
INTRODUCTION

Heart disease has become one of the most serious diseases of the present era. Cardiovascular diseases have become especially prevalent in the recent period and have become widespread throughout the world. , No one realized how dangerous it was to spread and began many suffer from and serious complications, and despite the great development in the field of medicine and progress, but heart disease has increased significantly in the past period and still according to statistics that have been conducted significantly late, in a For the last period that heart disease has increased in recent years by up to 60%, and the mortality rates caused by these diseases exceeded three million people annually, and heart disease has become common in the developed world the same degree of spread in the Third World countries, and all these statistics Increased the awareness of researchers and cardiologists of the seriousness of these diseases and the need to work to prevent the increase and spread in this manner. The spread and increase of heart disease is a state of great medical and scientific progress in the treatment of heart disease, there has been a major breakthrough in the field of treatments and tests of heart disease, where the tests of heart disease more advanced and developed before, heart tests now can detect heart disease The results of the tests are also very accurate and clear, and the rate of error is less than in the past. In addition, there was a great deal of confusion between the various heart diseases, and the results of the tests were often wrong, resulting in error in the diagnosis and treatment of the disease Lead to the patient's heart b And the development of the field of treatment and surgery of heart disease, where the drugs became more effective and efficient, and became heart surgery is also significantly advanced, and the results are better, open heart surgery has developed, and also emerged therapeutic catheter and diagnostic, which has become better for some patients at risk With complications in the open heart process. As for the technological and scientific development in the field of heart disease, the problem of arrhythmia was one of the biggest and most complex heart diseases. The patients suffering from this problem suffer from their illness. The treatment was difficult. There was treatment using electric shock. Sending strong electrical signals to the heart These signals reach the heart starts heartbeat in regularity, but soon start strikes in the

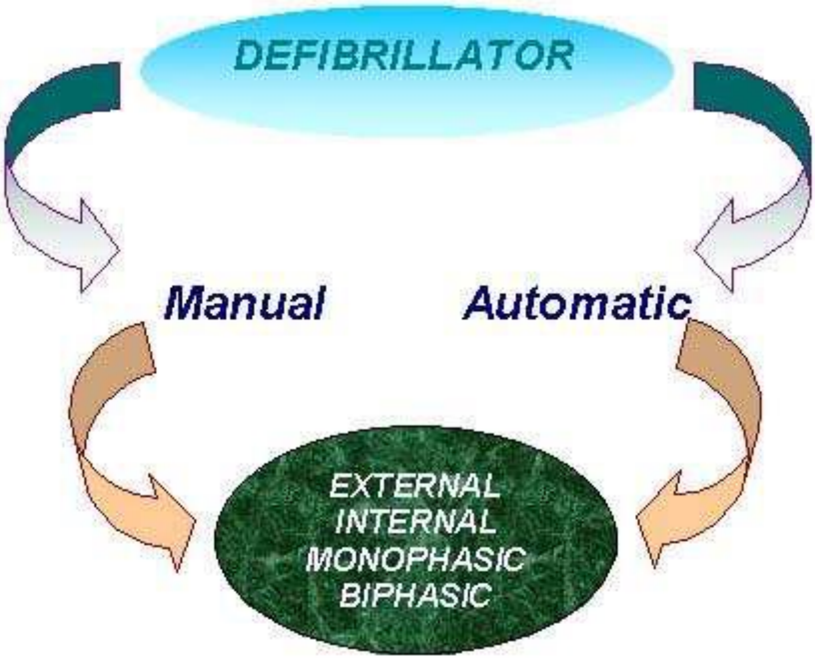
imbalance again, and the problem that irregular heartbeat may cause sudden cardiac arrest and death of the patient, so there was a need for better treatment for irregularity hit Heart. The pulse generator was used in the 1960s for the first time. It had a simple device with a battery and an electric circuit to produce normal pulse modulation. The new devices are more complex because they contain sensors, projectors and electric circuit sets specially developed with the advent of sophisticated microprocessors

1.1 Background

Defibrillators were first demonstrated in 1899 by Jean-Louis Prévost and Frédéric Batelli, two physiologists from University of Geneva, Switzerland. They discovered that small electrical shocks could induce ventricular fibrillation in dogs, and that larger charges would reverse the condition. In 1933, Dr. Albert Hyman, heart specialist at the Beth Davis Hospital of New York City and C. Henry Hyman, an electrical engineer, looking for an alternative to injecting powerful drugs directly into the heart, came up with an invention that used an electrical shock in place of drug injection. This invention was called the Hyman Otor where a hollow needle is used to pass an insulated wire to the heart area to deliver the electrical shock. The hollow steel needle acted as one end of the circuit and the tip of the insulated wire the other end. Whether the Hyman Otor was a success is unknown. The external defibrillator as known today was invented by Electrical Engineer William Kouwenhoven in 1930. William studied the relation between the electric shocks and its effects on human heart when he was a student at Johns Hopkins University School of Engineering. His studies helped him to invent a device for external jump start of the heart. He invented the defibrillator and tested on a dog, like Prévost and Batelli. The first use on a human was in 1947 by Claude Beck, professor of surgery at Case Western Reserve University. Beck's theory was that ventricular fibrillation often occurred in hearts which were fundamentally healthy, in his terms "Hearts that are too good to die", and that there must be a way of saving them. Beck first used the technique successfully on a 14-year-old boy who was being operated on for a congenital chest defect. The boy's chest was surgically opened, and manual cardiac massage was undertaken for 45 minutes until the arrival of the defibrillator. Beck used internal paddles on either side of the heart, along with procainamide, an antiarrhythmic drug, and achieved return of normal sinus rhythm.[citation needed[These early defibrillators used the alternating

current from a power socket, transformed from the 110–240 volts available in the line, up to between 300 and 1000 volts, to the exposed heart by way of "paddle" type electrodes. The technique was often ineffective in reverting VF while morphological studies showed damage to the cells of the heart muscle post mortem. The nature of the AC machine with a large transformer also made these units very hard to transport, and they tended to be large units on wheels.

1.2Type of Defibrillators



1.2.1- Manual external defibrillator

Manual external defibrillators require the expertise of a healthcare professional. They are used in conjunction with an electrocardiogram, which can be separate or built-in. A healthcare provider first diagnose the cardiac rhythm and then manually determine the voltage and timing for the electrical shock. These units are primarily found in hospitals and on some ambulances. For instance, every NHS ambulance in the United Kingdom is equipped with a manual defibrillator for use by the attending paramedics and technicians.[citation needed] In the United States, many advanced EMTs and all paramedics are trained to recognize lethal arrhythmias and deliver appropriate electrical therapy with a manual defibrillator when appropriate.[citation needed[

1.2.2- Manual internal defibrillator

Manual internal defibrillators delivers the shock through paddles placed directly on the heart. They are mostly used in the operating room and, in rare circumstances, in the emergency room during an open heart procedure.

1.2.3- Automated external defibrillator (AED)

Automated external defibrillators are designed for use by untrained or briefly trained laypersons. AEDs contain technology for analysis of heart rhythms. As a result, it does not require a trained health provider to determine whether or not a rhythm is shockable. By making these units publicly available, AEDs have improved outcomes for sudden out-of-hospital cardiac arrests. Trained health professionals have more limited use for AEDs than manual external defibrillators.[15]Recent studies show that AEDs does not improve outcome in patients with in-hospital cardiac arrests.[15][16] AEDs have set voltages and does not allow the operator to vary voltage according need. AEDs may also delay delivery of effective CPR. For diagnosis of rhythm, AEDs often require the stopping of chest compressions and rescue breathing. For these reasons, certain bodies, such as the European Resuscitation Council, recommend using manual external defibrillators over AEDs if manual external defibrillators are readily available. As early defibrillation can significantly improve VF out comes, AEDs have become publicly available in many easily accessible areas. AEDs have been incorporated into the algorithm for basic life support(BLS). Many first responders, such as firefighters, policemen, and security guards, are equipped with them. AEDs can be fully automatic or semi-automatic

A semi-automatic AED automatically diagnoses heart rhythms and determines if a shock is necessary. If a shock is advised, the user must then push a button to administer the shock. A fully automated AED automatically diagnoses the heart rhythm and advises the user to stand back while the shock is automatically given. Some types of AEDs come with advanced features, such as a manual override or an ECG display.

1.2.4. Implantable cardioverter-defibrillator

Also known as automatic internal cardiac defibrillator (AICD). These devices are implants, similar to pacemakers (and many can also perform the pacemaking function). They constantly monitor the patient's heart rhythm, and automatically administer shocks for various life-threatening arrhythmias, according to the device's

programming. Many modern devices can distinguish between ventricular fibrillation, ventricular tachycardia, and more benign arrhythmias like supraventricular tachycardia and atrial fibrillation. Some devices may attempt overdrive pacing prior to synchronised cardioversion. When the life-threatening arrhythmia is ventricular fibrillation, the device is programmed to proceed immediately to an unsynchronized shock.There are cases where the patient's ICD may fire constantly or inappropriately. This is considered a medical emergency, as it depletes the device's battery life, causes significant discomfort and anxiety to the patient, and in some cases may actually trigger life-threatening arrhythmias. Some emergency medical services personnel are now equipped with a ring magnet to place over the device, which effectively disables the shock function of the device while still allowing the pacemaker to function (if the device is so equipped). If the device is shocking frequently, but appropriately, EMS personnel may administer sedation.

1.2.5. Wearable cardioverter defibrillator

A wearable cardioverter defibrillator is a portable external defibrillator that can be worn by at-risk patients. The unit monitors the patient 24 hours a day and can automatically deliver a biphasic shock if VF or VT is detected. This device is mainly indicated in patients who are not immediate candidates for ICDs.

1.2.6. Internal defibrillator

A pair of electrodes used to defibrillate the heart during or after cardiac surgery such as a heart bypass.

1.3. Type of shocks

I have two types of shocks:

1-non synchronized or defibrillation

2-Synchronized or cardioversion

Differences between them non synchronized or defibrillation

1 - Asynchronous electric shock (meaning we determine the time of charge discharge) by pressing the deliver

2- High joule, it is usually starting with 200 Joule course for adults.

3 - Staringt with three consecutive shocks J200, 300 J. 360 J at least for the most .. and returned after the work of CPR for a minute did not change the clot

Either for synchronized or cardio version

1 - shock synchronized with the beginning of R wave .... to determine the time of discharge .. Click to unload but the device chooses the appropriate time to unload

2- Low joule Sometimes fifty or 100 joules

3. The patient should be given a dose of sedation and analgesic even if the patient is unaware of the need to give at least an analgesic.

4 - Giving one shock. Then can be returned single

Precautions to be taken before giving a shock

The Intubation set should be prepared next to the patient, oxygenated, and suction set before the shock

Note:

The device is in the case of synchronicazide, because the fragment is not expected to change because the fragment is already abnormal but waiting for the direction of R wave. If the shock was given during the T wave, the patient will be treated with 60 seconds. The electric shock device eek.gif the electric shock device eek.gif the electric shock device eek.gif to ventricular tachycardia, which is a fatal killer. This crime committed by many ignorant health care providers and bury the patient in their hands without knowing

Non-synchronized shock causes:

1 - Pulseless ventricular tachycardia.

2- Ventricular fibrillation.

Synchronized shock causes:

Unstable tachycardia is a group of arrhythmia, provided that it is accompanied by a decrease in blood pressure:

1-Atrial fibrillation <<<< AF

2. Atrial flutter

3-Ventricular tachycardia

4. Supra ventricular tachycardia <<< SVT

But if the pressure is normal, we should start by giving drugs such as digoxin, adenosine, or ibupotin, cheddar one, and when the pressure drops due to simultaneous shocks. The fatal mistake, which is repeated every day without censure.

1.4 Problem Statement

This device is available in the market, but at high prices and there is no maintenance for this device

1.5 Objectives

The purpose of the project is to manufacture a device that is affordable and meets the medical need and learn how to maintain this machine.

CHAPTER TWO

2.1 Principle

A high voltage electric current is applied to the Heart muscle either directly (Internal Defibrillator) through the open chest or indirectly (External Defibrillator) through the chest wall to terminate Ventricular Fibrillation as shown in figures 1 and 2.

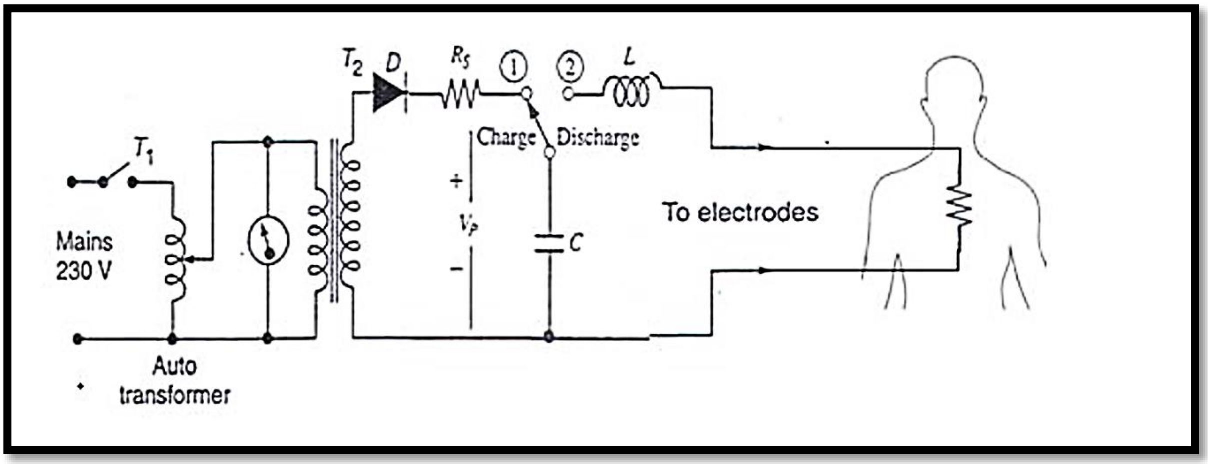


Figure 1: Electric Digram of the Apparatus.

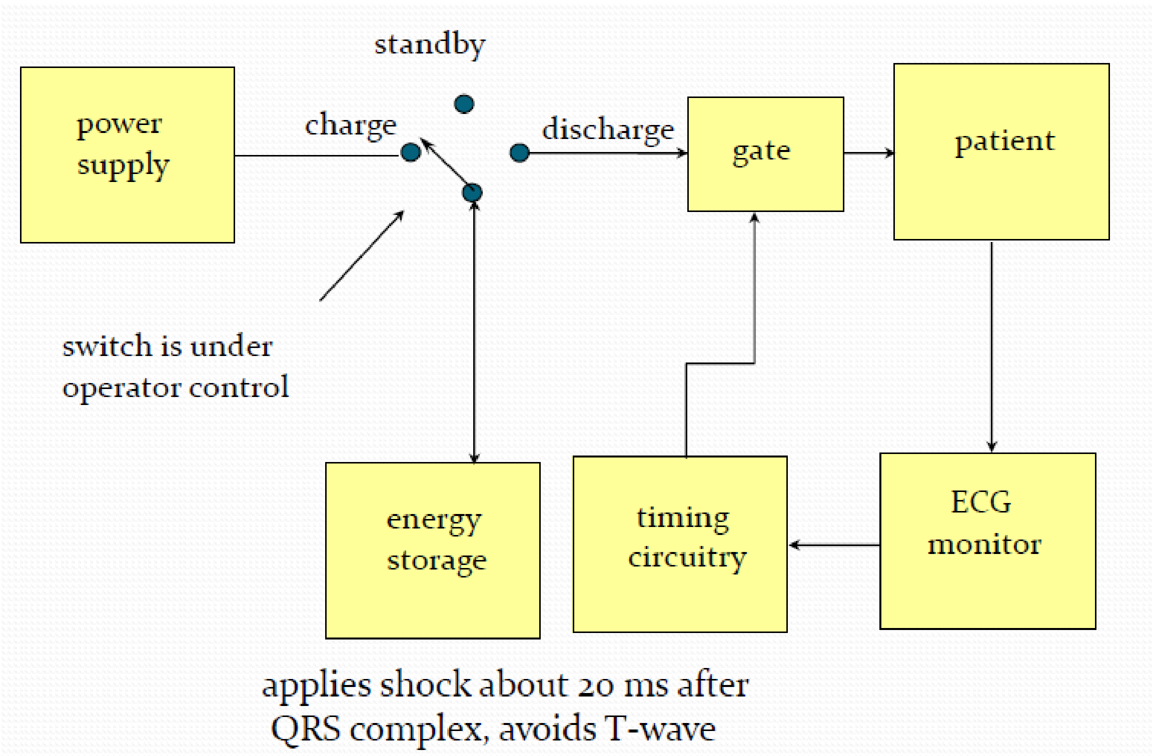


Figure 1: Power statges through the operation process of the apparatus.

• For each minute elapsing between onset of ventricular fibrillation and first defibrillation, survival decreases by 10%.

• Defibrillators should be portable, battery operated, small size.

• Energy in defibrillators usually stored in large capacitors.

• Total energy stored in capacitor:

$$W = 1/2CV^2 \tag{1}$$

Where V is the capacitor voltage.

2.2The basic components of the electric shock device

2.2.1 The machine consists of the following parts:

- ECG.
- High voltage.
- Power supply.
-Treatment Burdens.
-Motherboard.

2.2.2 Paddles

Equipped with an isolated hand and high on the conveyor surface so as not to cause electrical shock to the user of the device and also equipped with two keys to discharge and charging as shown in figures 3 and 4.

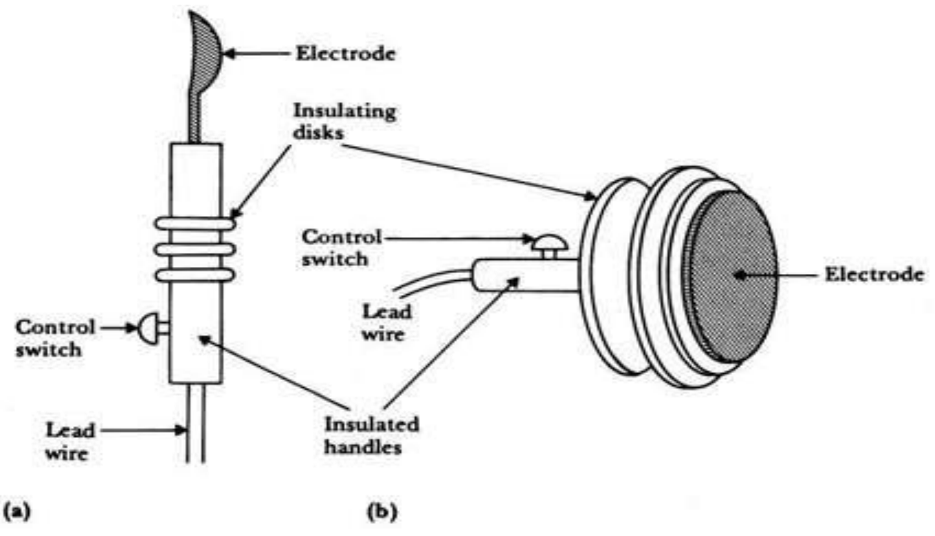


Figure 3: Electrodes used in defibrillator (a) a spoon shaped internal electrode that is applied directly to the heart. (b) a paddle type electrode applied against the anterior chest wall.

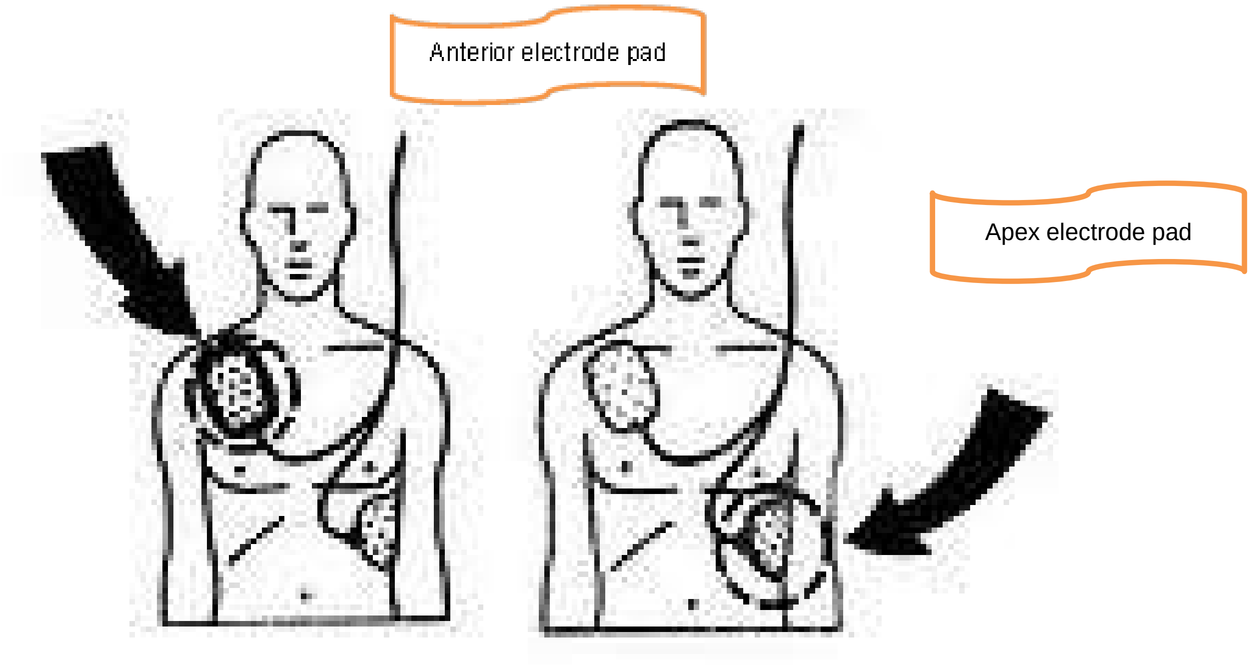


Figure 4: anterior –apex scheme of electrode placement.

2.2.3. Cable (ECG): to quote the heart signal

2.2.4. Control buttons :

-Power: Turn on the device.

-Selector switch: Selector switch, to set the power required for charging the capacitor and the power range between (0-360) Joules.

-Charge: It is used for charging capacitor.

-Synchronizer Synchronization: In order to synchronize the discharge of the charge with the ECG signal and specifically with the top of the threshold R, where the discharge wave is applied after the discovery of wave R and at the top.

-Discharge: A button placed on the paddle presses at the same time with its counterpart in the second paddle in order to discharge the charge across the patient's chest.

-Charge indicator light: Indicates that the capacitor has been charged and is ready for discharge and is located on the shock and on the control panel.

2.3 Electrical parts:

2.3.1-Transformer:

Transformer is a device in electrical engineering consisting of two separated windings wrapped around iron bars only a small distance. The electrical terminal is called the

primary coil, while the connected end is called the secondary name. The transformer is used to change the voltage value of the current power transmission system AC adapter where the adapter cannot operate in current systems. If the secondary voltage is less laborious, the transformer was less voltage. If the secondary voltage was higher than the primary voltage, the transformer was a voltage booster.

The principle of the work of the electric transformer is based on a law of electromagnetic induction that states that the value of the electrical force (electric voltage) is directly proportional to the rate of change of flow. Therefore, the transformer does not work in DC systems because the DC creates a static magnetic field, an electric voltage can then be generated by induction. This is one of the main reasons for the alternating current preference, which has no practical and economical method for converting the voltage value and the application of the law of Faraday as shown in figure 5.

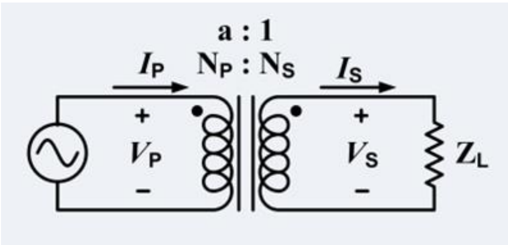


Figure 5: sketch of the simple transformer.

2.3.2-Choke coil

A choke, with two 20 mH windings and rated to handle 2 A. In electronics, a choke coil is an inductor used to block higher-frequency while passing direct current (DC) and lower-frequencies of alternating current (AC) in an electrical circuit. A choke usually consists of a coil of insulated wire often wound on a magnetic core, although some consist of a doughnut-shaped "bead" of ferrite material strung on a wire. The choke's impedance increases with frequency. Its low electrical resistance passes both AC and DC with little power loss, but its reactance limits the amount of AC passed.

The name comes from blocking—"choking"—high frequencies while passing low frequencies. It is a functional name; the name "choke" is used if an inductor is used for blocking or decoupling higher frequencies, but is simply called an "inductor" if used in electronic filters or tuned circuits. Inductors designed for use as chokes are

usually distinguished by not having the low-loss construction (high Q factor) required in inductors used in tuned circuits and filtering applications as shown in figure 6.

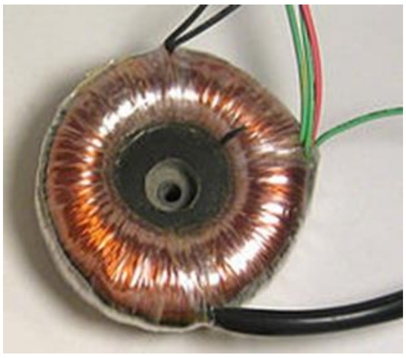


Figure 6: sketch of the choke toroid transformer.

2.3.3-Capacitor

Is one of the circuit components, a tool based electrical stores energy or electric charge for a period of time in the form of an electric field, consists of deliverers two sheets each carrying electric charge equal in magnitude and opposite in sign. And then use an electric charge or dissipate in time.

When installed in a circuit can unload the cargo stored in it momentarily, and can be re-charged. The capacitors manufactured with sheet metal thin electrically conductive placed on top of each, including layers of insulators or damage on each other to reduce the capacitor. Also called a condenser capacitance or dilated name as shown in figure 7.

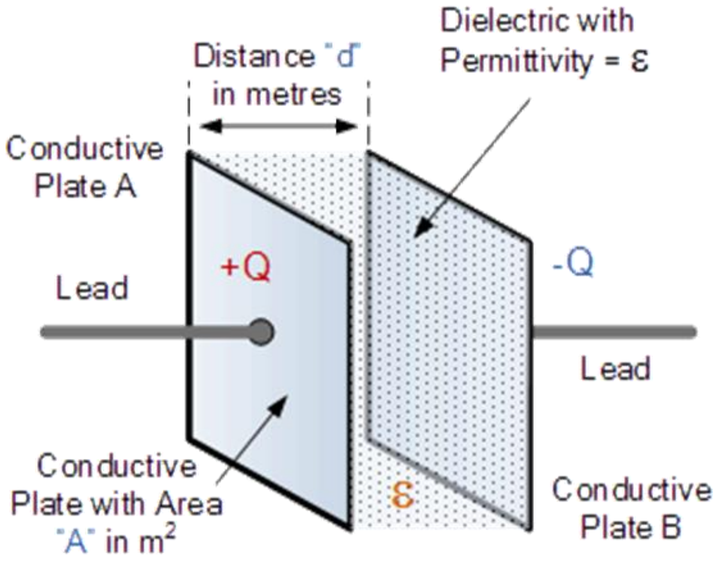


Figure 7: sketch of the electric capacitor.

The condenser is determined by the type of foam used in the industry. If the air is called the capacitor airways name, or if the plastic is plastic, or an intense mica, or ceramic capacitor, and so according to the type of article. If the chemical solution used as insulation equals intensive chemotherapy or electrolytic. More details is as shown in figure8.

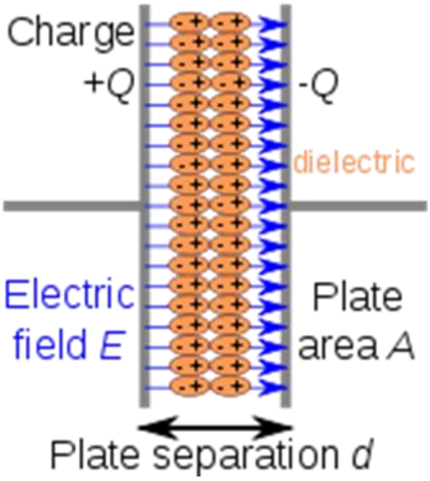


Figure 8: details inside the capacitor.

Isolate Tablet intensive charged in the generation of an electric field between the two causes. Negative charge -Q on the board and A positive charge + Q on the other board.

2.3.4-Battery

It is one of the most important so permanently that when power outages are ready to use and charged .Because if it is not charged it may lead to the death of the patient if I need the device at that time parts in the device, and it must be charged.

2.3.5 DC-Relay

An Electromechanical switch is called as Relay. It reacts as Automatic switch to control (just ON/OFF) large voltage load by using low voltage signal. We use DC (Direct Current) supply to Energize electromagnetic coil placed in relay so, it is referred as DC relay switch as shown in figure 9.

You know what happen when AC supply given to the coil, there will be varying magnetic field not suitable for constant switch (ON/OFF) operation that’s why here DC used.Relay Construction

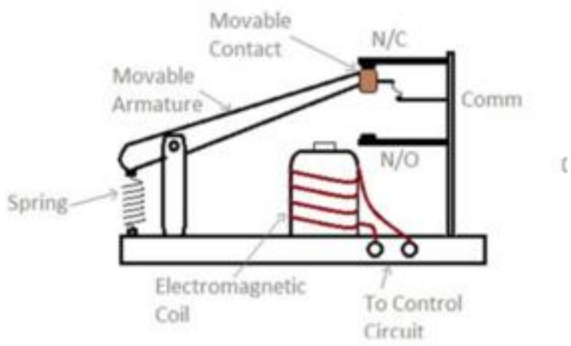


Figure 9: Relay Construction.

The Relay has Electromagnetic Coil turned around a metal piece this will reacts as magnet when coil gets energized. Movable Armature attached with spring exactly placed above the electromagnet setup and makes contact between common terminal and Normally closed contact (N/C), without any supply or zero input supply, this condition may be termed as normally open relay. When the coil get energized movable armature attracted by electromagnet and N/O contact becomes closed and N/C becomes open.

CHAPTER THREE
EXPERIMENTAL WORK & RESULTS

The specifications manufacture of the electrical components which are used in the of the implemented apparatus.

3.1. Electrical parts:

3.1.1. Transformer

V_{in} =115 volt

V_{out} =12 volt

3.1.2-Choke coil

Inductance (L) =36mH

Peak voltage =5.3KV

Resistance R=11.2Ω

3.1.3. Capacitor

Charging capacitor: the chargeable part of the charge required for the shock, 42 micro Farad capacitance, and maximum charge is 5000 volt, and maximum voltage used is 5200 volt.

3.1.4. Battery

It is one of the most important so permanently that when power outages are ready to use and charged .Because if it is not charged it may lead to the death of the patient if need to the device at that time parts in the device, and it must be charged.

3.1.5. DC-Relay

It acts as a switch to isolate the electronic circuit during discharge. The capacitor voltage is discharged from its total charge during the shortening process according to equation (2) and the value of the discharge current with time is based on the equation (3). The time of discharge can be represented by (4) while equation (5) determines the

energy stored in the capacitance. Table 1 highlights the calculated values of time, energy and voltage of capacitance during the charging and discharging process.

$$Vc=(1-e^{\frac{-t}{\mathrm{t}}}) \quad (2)$$

$$ic = \frac{E}{R}e^{\frac{-t}{\mathrm{t}}} \quad (3)$$

$$\mathrm{t}=RC \quad (4)$$

$$W = \frac{1}{2}Cv^2 \quad (5)$$

Table 1: the experimental values of charging time, energy absorbed and voltage of capacitance during the charging process.

Test No.	**Time charge (Seconds)**	**Energy (Joule)**	**Voltage (Volt)**
1	0.21	10	**800**
2	0.42	20	**1125**
3	0.63	30	**1325**
4	0.84	40	**1550**
5	1.05	50	**1750**
6	1.26	60	**1920**
7	1.47	70	**2125**
8	1.68	80	**2320**
9	1.89	90	**2525**
10	2.1	100	**2730**
11	2.31	110	**2935**
12	2.52	120	**3135**
13	2.73	130	**3340**
14	2.94	140	**3545**
15	3.15	150	**3750**
16	3.36	160	**3960**
17	3.57	170	**4165**
18	3.78	180	**4365**
19	3.99	190	**4570**
20	4.2	200	**4780**
21	4.41	210	**4990**

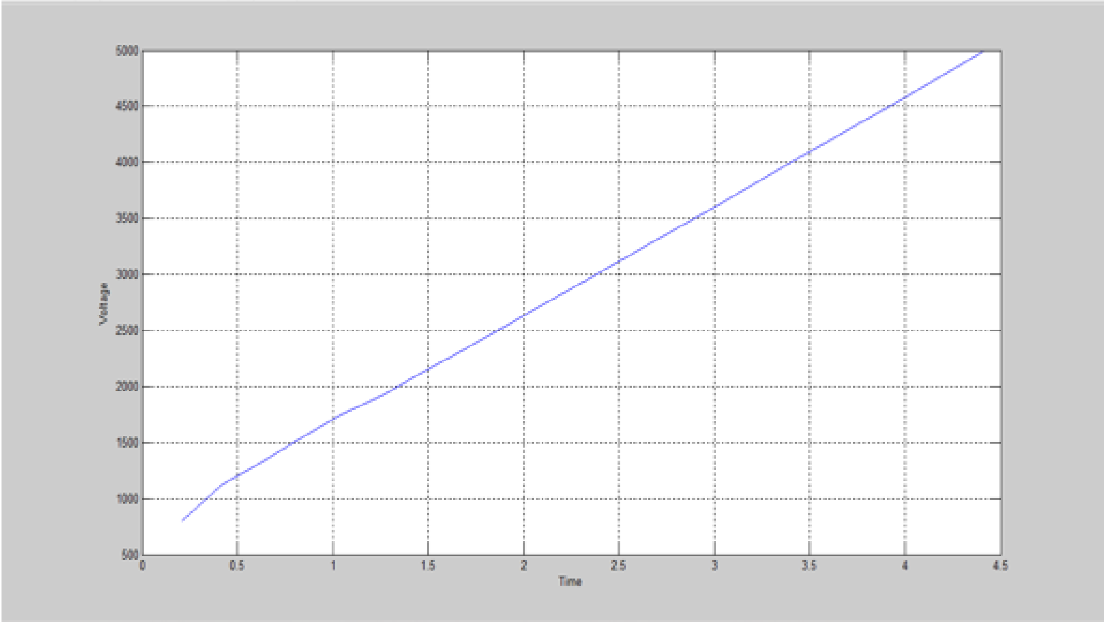


Figure 10: capacitance voltage increases when the time of charging rises up according to experimental recorded values.

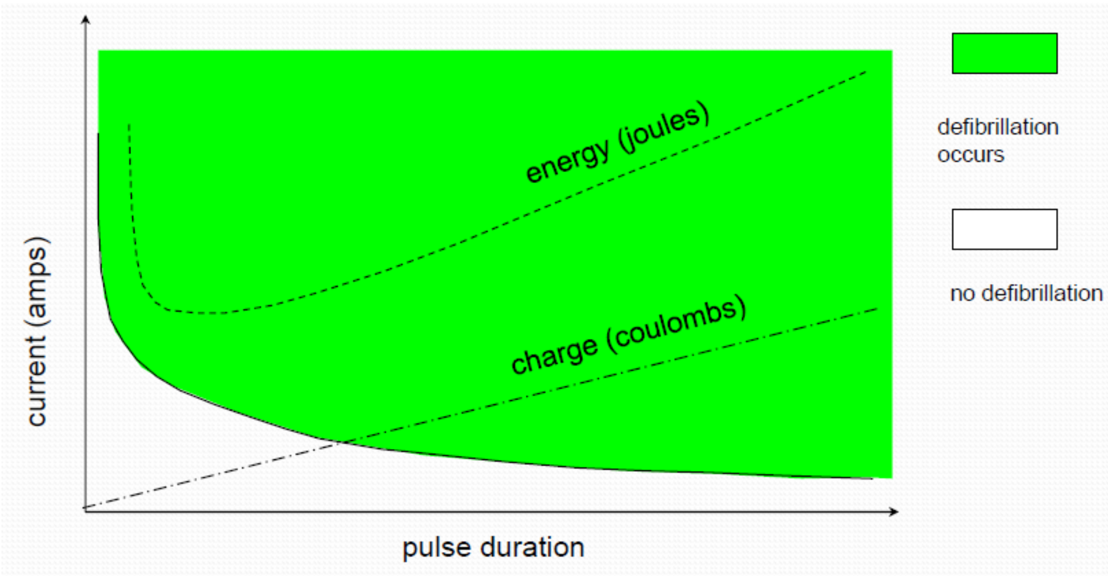


Figure 11: Performance of charging current by capacitor through the charging process.

Directions and notes should be taken in mind during using the apparatus for treating the patient:

• Minimum defibrillation energy occurs for pulse durations of 3 - 10 ms (for most pulse shapes).
• Pulse amplitude in tens of amperes (few thousand volts).
• Operator selects energy delivered: 50-360 joules, depends on
– Intrinsic characteristics of patient
– Patient "s disease
– Duration of arrhythmia
– Patient's age
– Type of arrhythmia (more energy required for vfib.)

CHAPTER FOUR

CONCLUSION

Through practical tests that were carried out on the device that was manufactured simulating the device imported by the international company, it was found that the electrical materials used, which were purchased from the Iraqi market, had the same specifications as the components in the imported device, almost at very reasonable prices. It was also found, based on the values in Table 1, that during a charging period of little more than 4 seconds only, the charging voltage increased from 800 volts to the maximum value of 5 kilovolts, which led to an increase in the stored energy in the capacitor from 10 joules to 210 joules. These practical values prove that the charging and discharging process required to be applied medically on the patient is very appropriate and actually mimics the specifications of the expensive imported device.

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