DESIGN AND CONSTRUCTION OF A MOBILE CELLPHONE CHARGER

By

OGBU, JERRY AUGUSTINE

2003/15424EE

A Thesis submitted to the Department of Electrical and Computer engineering in partial fulfilment for the award of Bachelor of Engineering (B.ENG.) Degree.

Federal University of Technology, Minna.

November, 2008.

DEDICATION

This project work is dedicated to God Almighty for all his blessings.

It is also dedicated to Pham Ogbu, O.T for all his moral and financial support during this project work.

DECLARATION

I, Ogbu Jerry Augustine, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

Ogbu, Jerry Augustine

....

(Name of student)

10th Nov, 2008.

(Signature and Date)

Mr. Michael David

....

(Name of Supervisor)

14/11/08

(Signature and Date)

Engr.Dr.Y.A.Adediran

....

(Name of H.O.D)

....

(Signature and Date)

....

(Name of External Supervisor)

....

(Signature and Date)

ACKNOWLEDGEMENT

My special appreciation goes to my Supervisor, Mr. Michael David for his constructive criticism and encouragement throughout the course of this work.

Also, my profound gratitude goes to the following people for their moral and financial support during the course of my studies, Pham Ogbu, O.T (Brother), Maryam Talatu Usman, and Kay (Boy).

ABSTRACT

The project is all about the design and construction of a portable, inexpensive mobile cellphone charger. The trends in mobile systems are to increase functionality for the user, increase battery life or power efficiency, increase interface quality and compatibility, and decrease weight and size of the system. The device is designed to charge different types of mobile cellphone batteries. The construction was achieved using IC 555 Timer as the main component for charging and monitoring the voltage level of the battery. The project was realised on a Portable Circuit Board using the components. The output voltage between 3.6V to 5.6V and a charging current of 180mA was obtained at the end by testing. Different mobile cellphone were connected at the output terminal using suitable adapters for the confirmation and testing of the work, which was justified.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.0 BRIEF INTRODUCTION OF MOBILE CELLPHONE

The telephone is one of the main means of communication used today. Throughout the world, the telephone provides people, businesses, governmental agencies and virtually all other entities with the capability to instantly communicate with each other. The telephone has evolved from just a device used for verbal/oral communication to a device that is used to transmit video and text messages. In addition, the actual telephone device has changed over time. Some of the original telephones comprised large bases with rotary dials and large hand held pieces through which a person would talk and listen. Today, some telephone designs are one-piece modules through which a person dials numbers, talks and listens. In addition, the communication networks that link different telephones together have also changed. Historically, a telephone network comprised a telephone connected to a central switching box/location. These switching locations were connected through a network of cables [6]. Many of these communication cables were large lines that contained many small communication wires that carried the telephone information. Today, telephone communications are much more sophisticated than the conventional telephone networks. The basic telephone network with a telephone being connected to a switching box does still exist. However, because of the variety of telephones that are in use, there are also other communication network configurations that include the basic telephone network and other communication means.

One main means of telephone communication today is the over air (wireless) communication. This wireless communication is accomplished through the use of a cellular telephone commonly known as a 'cellphone'. With this form of communication, there is no physical connection between an individual telephone and a communication switching location. Instead, the telephone communicates over air with a communication tower that directs the call to the desired location. Today, a typical telephone network comprises these communication towers and the conventional switching stations. A person can call a wireless telephone from a conventional telephone. The call will be routed to the conventional switching station. Once it is determined that the called number is a wireless telephone, the call is routed via communication from the switching station to the communication tower for that cellular telephone. The communication then routes the call to the identified number of the cellular telephone [7].

Hundreds of companies and research institutes in the US, Europe, and Japan are working on energy harvesting technology, and the industry is attracting millions of dollars in venture capital. But despite these considerable investments, progress in bringing this technology to market has been slow. Alternative power sources contribute only a fraction to worldwide power generation, and the load on the environment, much of it toxic, is still increasing. Billions of batteries are discarded every year. Researchers are deploying energy harvesting technology in architecture projects. The energy harvesting products include windup-powered radios, cellphones with chargers, magnetic force flashlights and laptops with huge batteries.

1.1 AIM AND OBJECTIVES OF THE PROJECT

The aims and objectives of the project is to design and construct a mobile cellphone charger that is:

- Capable of charging a battery inside a cellphone without removing it
- Capable of charging more than one type of cellphone
- Current limited voltage source that replenish the cellphone battery within two to three hours and
- Monitor as well as charges the cellphone and,
- Does not discharge the voltage in the cellphone battery when power supply goes off.

1.2 SCOPE OF THE STUDY

The scope of the project includes:

- It uses IC NE555 Timer as its main circuit chip
- The output voltage can be varied to suit different mobile cellphone batteries
- It is capable of charging different mobile cellphones with suitable adapters

CHAPTER TWO

LITERATURE REVIEW

2.0 A BRIEF HISTORY OF BATTERY

The earliest method of generating electricity occurred by creating a static charge. In 1660, ***Otto von Guericke*** constructed the first electrical machine that consisted of a large sulfur globe which, when rubbed and turned, attracted feathers and small pieces of paper. Guericke was able to prove that the sparks generated were truly electrical. The first suggested use of static electricity was the so-called "electric pistol". Invented by Alessandro Volta, an electrical wire was placed in a jar filled with methane gas. By sending an electrical spark through the wire, the jar would explode.

Timeline of Battery History

- **1748** - Benjamin Franklin first coined the term "battery" to describe an array of charged glass plates.
- **1780 to 1786** - Luigi Galvani demonstrated what we now understand to be the electrical basis of nerve impulses and provided the cornerstone of research for later inventors like Volta.
- **1800** - Alessandro Volta invented the voltaic pile and discovered the first practical method of generating electricity. Constructed alternating discs of zinc and copper with pieces of cardboard soaked in brine between the metals, the voltic pile produced electrical current. The metallic conducting arc was used to carry the

electricity over a greater distance. Alessandro Volta's voltaic pile was the first "wet cell battery" that produced a reliable, steady current of electricity.

- **1836** - Englishman, John F. Daniel invented the Daniel Cell that used two electrolytes: copper sulfate and zinc sulfate. The Daniel Cell was somewhat safer and less corrosive than the Volta cell.
- **1839** - William Robert Grove developed the first fuel cell, which produced electrical by combining hydrogen and oxygen.
- **1839 to 1842** - Inventors created improvements to batteries that used liquid electrodes to produce electricity. Bunsen (1842) and Grove (1839) invented the mo.ᵗ successful.
- **1859** - ɪ'ʳench inventor, Gaston Plante developed the first practical storage lead-acid battery ʰat could be recharged (secondary battery). This type of battery is primarily used in ˀars today.
- **1866** - French engiı.ˀer, Georges Leclanche patented the carbon-zinc wet cell battery called the Leclan ʰe cell. According to The History of Batteries: "George Leclanche's original cell wa assembled in a porous pot. The positive electrode consisted of crushed manganese dioxide with a little carbon mixed in. The negative pole was a zinc rod. The cathode was packed into the pot, and a carbon rod was inserted to act as a currency collector. The anode or zinc rod and the pot were then immersed in an ammonium chloride solution. The liquid acted as the electrolyte, readily seeping through the porous cup and making contact with the cathode material. The liquid acted as the electrolyte, readily seeping through the porous cup and making contact with the cathode material."

- **1868** - Twenty thousand of Georges Leclanche's cells were now being used with telegraph equipment.
- **1881** - J.A. Thiebaut patented the first battery with both the negative electrode and porous pot placed in a zinc cup.
- **1881** - Carl Gassner invented the first commercially successful dry cell battery (zinc-carbon cell).
- **1899** - Waldmar Jungner invented the first nickel-cadmium rechargeable battery.
- **1901** - Thomas Alva Edison invented the alkaline storage battery.
- **1949** - Lew Urry invented the small alkaline battery.
- **1954** - Gerald Pearson, Calvin Fuller and Daryl Chapin invented the first solar battery.

Battery, which is actually an electric cell, is a device that produces electricity from a chemical reaction. Strictly speaking, a battery consists of two or more cells connected in series or parallel, but the term is generally used for a single cell. A cell consists of a negative electrode; an electrolyte, which conducts ions; a separator, also an ion conductor; and a positive electrode. The electrolyte may be aqueous (composed of water) or nonaqueous (not composed of water), in liquid, paste, or solid form. When the cell is connected to an external load, or device to be powered, the negative electrode supplies a current of electrons that flow through the load and are accepted by the positive electrode. When the external load is removed the reaction ceases.

2.1 PRIMARY CELL

A primary battery is one that can convert its chemicals into electricity only once and then must be discarded. The most common form of primary cell is the Leclanché cell, invented by the French chemist Georges Leclanché in the 1860s. It is popularly called a dry cell or flashlight battery. The Leclanché cell in use today is very similar to the original invention. The electrolyte consists of a mixture of ammonium chloride and zinc chloride made into a paste. The negative electrode is made of zinc, as is the outside shell of the cell, and the positive electrode is a carbon rod surrounded by a mixture of carbon and manganese dioxide. The Leclanché cell produces about 1.5 V.

Another widely used primary cell is the zinc-mercuric-oxide cell, more commonly called a mercury battery. It can be made in the shape of a small flat disk and is used in this form in hearing aids, photoelectric cells, and electric wristwatches. The negative electrode consists of zinc, the positive electrode is of mercuric oxide, and the electrolyte is a solution of potassium hydroxide. The mercury battery produces about 1.34 V.

2.2 SECONDARY CELL

A secondary battery has electrodes that can be reconstituted by passing electricity back through it; also called a storage or rechargeable battery, it can be reused many times.

The storage battery, or secondary cell, which can be recharged by reversing the chemical reaction, was invented in 1859 by the French physicist

Gaston Planté. Planté's cell was a lead-acid battery, the type widely used today. The lead-acid battery, which consists of three or six cells connected in series, is used in automobiles, trucks, aircraft, and other vehicles. Its chief advantage is that it can deliver a strong current of electricity for starting an engine; however, it runs down quickly. The electrolyte is a dilute solution of sulphuric acid; the negative electrode consists of lead, and the positive electrode of lead dioxide. In operation, the negative lead electrode dissociates into free electrons and positive lead ions. The electrons travel through the external electric circuit, and the positive lead ions combine with the sulphate ions in the electrolyte to form lead sulphate. When the electrons re-enter the cell at the positive lead-dioxide electrode, another chemical reaction occurs. The lead dioxide combines with the hydrogen ions in the electrolyte and with the returning electrons to form water, releasing lead ions in the electrolyte to form additional lead sulphate.

A lead-acid storage cell runs down as the sulphuric acid gradually is converted into water and the electrodes are converted into lead sulphate. When the cell is being recharged, the chemical reactions described above are reversed until the chemicals have been restored to their original condition. A lead-acid battery has a useful life of about four years. It produces about 2 V per cell. Recently, lead batteries with useful lives of 50 to 70 years have been developed for special applications.

Another widely used secondary cell is the alkaline cell, or nickel-iron battery, developed by the American inventor Thomas Edison in the 1900s. The principle of operation is the same as in the lead-acid cell except that the negative electrode consists of iron, the positive electrode is of nickel oxide, and the electrolyte is a solution of potassium hydroxide. The nickel-iron cell has the disadvantage of giving off hydrogen gas during charging. This battery is used principally in heavy industry applications. The Edison battery has a useful life of approximately ten years and produces about 1.15 V.

Another alkaline cell similar to the Edison battery is the nickel-cadmium cell, or cadmium battery, in which the iron electrode is replaced by one consisting of cadmium. It also produces about 1.15 V, and its useful lifetime is about 25 years.

A number of new types of batteries have been designed for use in electric vehicles. Improved versions of conventional storage batteries have been developed for electric cars, but they still suffer the drawbacks of either short range, high expense, bulkiness, or environmental problems. Advanced batteries that show promise for use in electric vehicles include lithium-iron sulfide, zinc-chlorine, nickel metal hydride, and sodium-sulfur. The U.S. Advanced Battery Consortium (USABC), a consortium that includes the U.S. Department of Energy and the three major American automakers, was set up in 1991 to speed development of advanced storage batteries. Such batteries are also being developed by electric utilities to be used for "load levelling," to compensate for momentary system load fluctuations. Such battery modules could be installed close to sites of variable demand. They cause few environmental problems and occupy little space.

2.3 TYPES OF BATTERY

2.3.1 NICKEL-CADMIUM BATTERIES

Nickel-Cadmium has been the most common space battery since the 70's. They were used in all commercial communications satellites, in most earth arbiters, and in some space probes. They are generally a prismatic (resembling, or being a prism) design, and packaged very efficiently. This means that the batteries can be stored on the spacecraft in a very compact form, eliminating the need for extraneous space. They have been known to last for ten to twenty years in space. They are still in use in selected space applications, including small satellites and for missions that encounter very severe radiation environments.

This battery uses nickel oxide in its positive electrode (cathode), a cadmium compound in its negative electrode (anode), and potassium hydroxide solution as its electrolyte [5]. The Nickel Cadmium Battery is rechargeable, so it can cycle repeatedly. A nickel cadmium battery converts chemical energy to electrical energy upon discharge and converts electrical energy back to chemical energy upon recharge. In a fully discharged NiCd battery, the cathode contains nickel hydroxide [$Ni(OH)_2$] and cadmium hydroxide [$Cd(OH)_2$] in the anode. When the battery is charged, the chemical composition of the cathode is transformed and the nickel hydroxide changes to nickel oxyhydroxide [NiOOH]. In the anode, cadmium hydroxide is transformed to cadmium. As the battery is discharged, the process is reversed, as shown in the following formula.

$$Cd + 2H_2O + 2NiOOH \longrightarrow 2Ni(OH)_2 + Cd(OH)_2$$

Nickel cadmium is the most commonly used battery for Low Earth Orbit (LEO) missions. A spacecraft battery consists of series-connected cells, the number of which depends upon bus voltage requirements and output voltage of the individual cells.

2.3.2 NICKEL-HYDROGEN BATTERIES

The Nickel-Hydrogen battery is currently the most popular space battery. It can be considered a hybrid between the nickel-cadmium battery and the fuel cell. The cadmiuAm electrode was replaced with a hydrogen gas electrode. This battery is visually much different from the Nickel-Cadmium battery, because the cell is a pressure vessel, which must contain over one thousand pounds per square inch (psi) of hydrogen gas. It is significantly lighter than nickel-cadmium, but is more difficult to package, much like a crate of eggs. It is the longest-lived space battery yet built, with 10 to 20 year lifetimes being common. This battery is too expensive for commercial applications, and few terrestrial examples have been built.

Nickel-hydrogen batteries are sometimes confused with Nickel-Metal Hydride batteries, the batteries commonly found in cellphones and laptops. The nickel-metal hydride system is rarely used in space due to its limited life. Nickel-hydrogen, as well as nickel-cadmium batteries use the same electrolyte, a solution of potassium hydroxide, which is commonly called lye.

Incentives for developing nickel/metal hydride (Ni-MH) batteries comes from pressing health and environmental concerns to find replacements for the nickel/cadmium rechargeable batteries. Due to worker's safety requirements, processing of cadmium for batteries in the U.S. is already in the process of being phased out. Furthermore, environmental legislation for the 1990's and the 21st century will most likely make it imperative to curtail the use of cadmium in batteries for consumer use. In spite of these pressures, next to the lead-acid battery, the nickel/cadmium battery still has the largest share of the rechargeable battery market. Further incentives for researching hydrogen-based batteries comes from the general belief that hydrogen and electricity will displace and eventually replace a significant fraction of the energy-carrying contributions of fossil-fuel resources, becoming the foundation for a sustainable energy system based on renewable sources. Finally, there is considerable interest in the development of Ni-MH batteries for electric vehicles and hybrid vehicles.

The nickel/metal hydride battery operates in concentrated KOH (potassium hydroxide) electrolyte. The electrode reactions in a nickel/metal hydride battery are as follows:

Cathode (+): $NiOOH + H_2O + e^- Ni(OH)_2 + OH^-$ (1)

Anode (-): $(1/x)\ MH_x + OH^-\ (1/x)\ M + H_2O + e^-$ (2)

Overall: $(1/x)\ MH_x + NiOOH\ (1/x)\ M + Ni(OH)_2$ (3)

The KOH electrolyte can only transport the OH- ions and, to balance the charge transport, electrons must circulate through the external load. The nickel oxy-hydroxide electrode (equation 1) has been extensively researched and characterized, and its application has been widely demonstrated for both terrestrial and aerospace applications. Most of the current research in Ni/Metal Hydride batteries has involved improving the performance of the metal hydride anode. Specifically, this requires the development of a hydride electrode with the following characteristics: (1) long cycle life, (2) high capacity, (3) high rate of charge and discharge at constant voltage, and (4) retention capacity.

2.3.3 LITHIUM BATTERIES

These systems are different from all of the previously mentioned batteries, in that no water is used in the electrolyte. They use a non-aqueous electrolyte instead, which is composed of organic liquids and salts of lithium to provide ionic conductivity. This system has much higher cell voltages than the aqueous electrolyte systems. Without water, the evolution of hydrogen and oxygen gases is eliminated and cells can operate with much wider potentials. They also require a more complex assembly, as it must be done in a nearly perfectly dry atmosphere.

A number of non-rechargeable batteries were first developed with lithium metal as the anode. Commercial coin cells used for today's watch batteries are mostly lithium chemistry. These systems use a variety of cathode systems that are safe enough for consumer use. The cathodes are made of various materials, such as carbon monoflouride, copper oxide, or vanadium pentoxide. All solid cathode systems are limited in the discharge rate they will support.

To obtain a higher discharge rate, liquid cathode systems were developed. The electrolyte is reactive in these designs and reacts at the porous cathode, which provides catalytic sites and electrical current collection. Several examples of these systems include lithium-thionyl chloride and lithium-sulphur dioxide. These batteries are used in space and for military applications, as well as for emergency beacons on the ground. They are generally not available to the public because they are less safe than the solid cathode systems.

The rechargeable lithium battery field is a growing area for space, and the latest technology for space is the Lithium Ion battery. The high voltage lithium-ion cells are moving into space for short to moderate length missions. They are easy to package, and very light. In this system, the lithium metal anode is replaced with a carbon electrode which inserts lithium ions from the electrolyte, storing them in a solid solution phase. This configuration has improved safety over previous lithium rechargeable, and yet gives good rate capability.

The next step in lithium ion battery technology is believed to be the lithium polymer battery. This battery replaces the liquid electrolyte with either a gelled electrolyte or a true solid electrolyte. These batteries are supposed to be even lighter than lithium ion batteries, but there are currently no plans to fly this technology in space. It is also not commonly available in the commercial market, although it may be just around the corner.

In retrospect, we have come a long way since the leaky flashlight batteries of the sixties, when space flight was born. There is a wide range of solutions available to meet the many demands of space flight, 80 below zero to the high temperatures of a solar fly by. It is possible to handle massive radiation, decades of service, and loads reaching tens of kilowatts. There will be a continued evolution of this technology and a constant striving toward improved batteries.

2.3.4 SOLAR BATTERY

Solar batteries produce electricity by a photoelectric conversion process. The source of electricity is a photosensitive semi-conducting substance such as a silicon crystal to which impurities have been added. When the crystal is struck by light, electrons are dislodged from the surface of the crystal and migrate toward the opposite surface. There they are collected as a current of electricity. Solar batteries have very long lifetimes and are used chiefly in spacecraft as a source of electricity to operate the equipment aboard.

2.4 THEORITICAL BACKGROUND OF BATTERY CHARGERS.

2.4.1 CHARGING SYSTEM

In various installations, batteries are kept floating on the line and are so connected that they are being charged when load demands are light and automatically discharged during peak periods when load demands are heavy or when the usual power supply fails or is disconnected. In some oher installations, the battery is connected to the feeder circuit as and when desired, allowed to discharge to a certain point, then removed and re-charged for further requirements.

For batteries other than the 'floating' and 'system-governed' type, following two general methods (though there are some variations of these) are employed:

1). **Constant-Current System and**

2). **Constant-Voltage System**

2.4.1.0 CONSTANT-CURRENT SYSTEM

In this method, the charging current is kept constant by varying the supply voltage to overcome the increased back e.m.f. of cells. If a charging booster (which is just a shunt dynamo directly driven by a motor) is used, the current supplied by it can be kept constant by adjusting its excitations. If charged on a d.c. supply, the current is controlled by varying the rheostat connected in the circuit. The value of charging current should be so chosen that there would be no excessive current during final state of charging and, also, the cell temperature does not exceed 45^0C. This method takes a comparatively longer time but it is more efficient.[1]

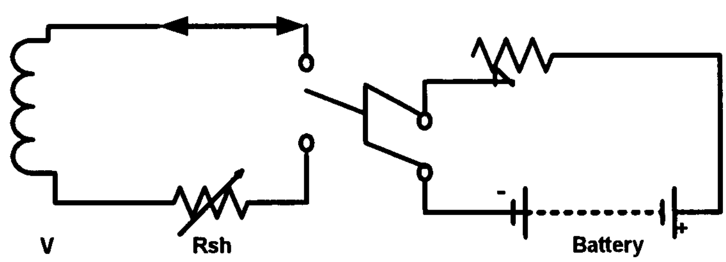


FIG. 2.0 Constant-Current System

2.4.1.1 CONSTANT-VOLTAGE SYSTEM

In this method, the voltage is kept constant but is results in vary large charging current in the beginning when the back e.m.f. of the cell is low and a small current when their back e.m.f. increases on being charged.

With this method, time of charging is almost reduced to half. It increases the capacity by approximately 20% by reducing the efficiency by 100% or 50%.

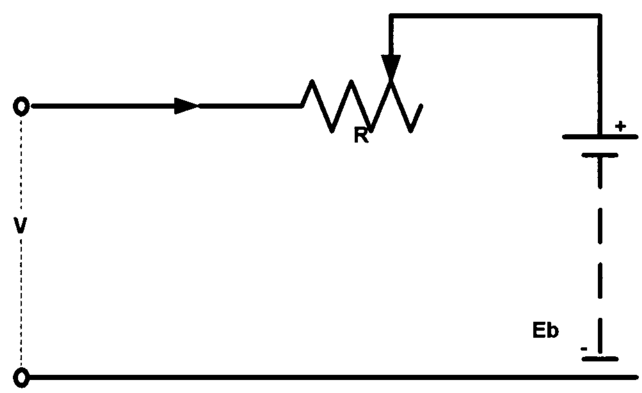


FIG. 2.1 Constant-Voltage System

When a secondary cell or a battery of such cells is being charged, then the e.m.f. of the cells acts in opposition the applied voltage. If V is the supply voltage which sends a charging current of I against the back e.m.f. Eb, then input power is VI but the power spent in overcoming the opposition is EbI. This power EbI is converted into the chemical energy which is stored in the cell. The charging current can be found from the following equation.

$$I = \frac{V - Eb}{R}$$, where

R = total circuit resistance including internal resistance of the battery.

I = charging current.

By varying R, the charging current can be kept constant throughout.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.0 DESIGNS

The design procedure of this project work is first knowing the basic charging requirements of cellphones, the charging voltage and the charging current whose critical statistical analysis forms the basis of this work. The table in the next subheading shows the different components of cellphone used in this project work to achieve the desired result.

3.0.1 LIST OF COMPONENTS USED

The following components were used to realize the complete design and implementation of the project. This is as seen from the table below.

Table 1: A List of Components Used With Their Values and Quantities

S/N	Component Name	Value	Quantity used
1	Transformer	9V	1
2	Capacitor	16V, 2200µF	1
3	Capacitor	0.001µF	1
4	Capacitor	0.01µF	1
5	Capacitor	25V, 4.7µF	1
6	Led	Orange	1
7	NE555 Timer		1

8	Variable Resistor	20K	2
9	Zener Diode	7.2V	1
10	Zener Diode	5.6V	1
11	Bridge Rectifier		1
12	Switch		1
13	Resistor	100Ω	2
14	Resistor	39Ω	1
15	Resistor	390Ω	1
16	Resistor	680Ω	1
17	Resistor	27K	1
18	Resistor	47K	1
19	Resistor	3.3K	1

3.0.2.1 ANALYSIS OF THE BLOCK DIAGRAM

The block diagram is a flow chart representation of different stages of the design of the project work. This can be segmented into the following:

1. Regulated Power Supply Unit
2. Reference Unit
3. Upper Limit Comparator
4. Lower Limit Comparator
5. Output unit

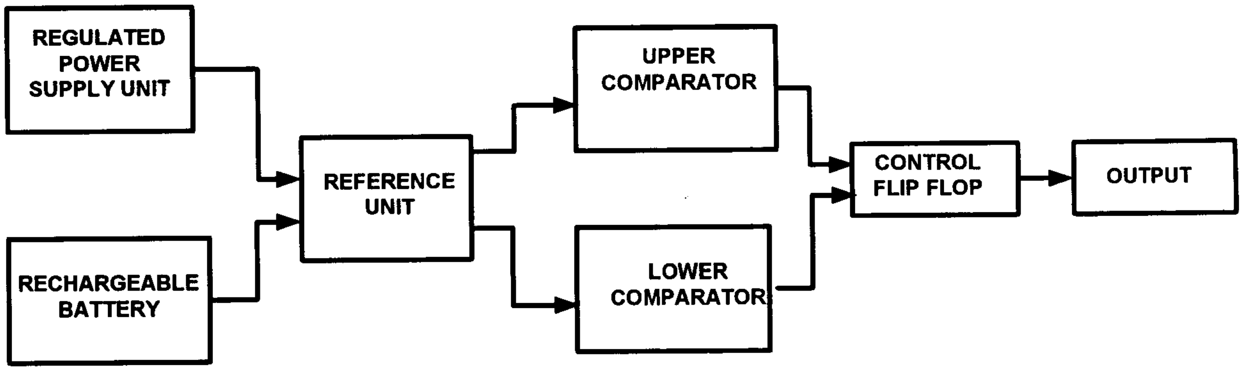


FIG.3.0 Block Diagram

3.0.3 REGULATED POWER SUPPLY

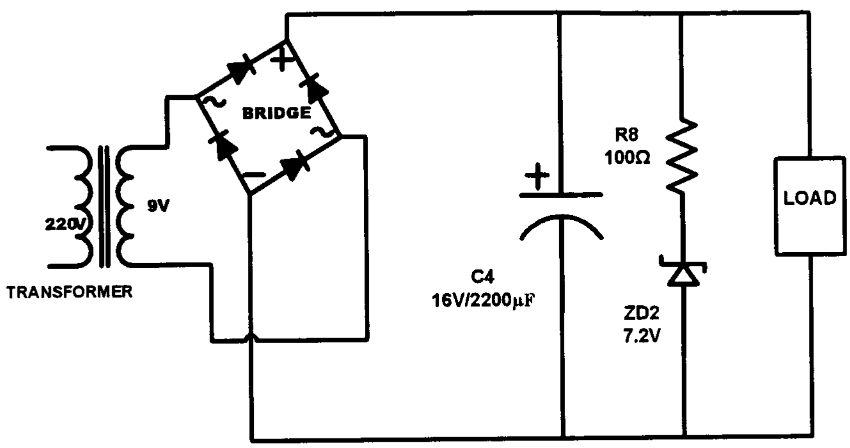


FIG. 3.1 Regulated Power Supply

Most of the electronics devices and circuits require a dc source for their operation. Regulated power supply is one whose terminal voltage remains constant irrespective of the amount of current drawn from it. This consists of a transformer, bridge rectifier, filter and Zener diode shunt regulator.

(1). Transformer (TX)

A 9V, 300mA transformer without centre tap was used to realize this work. The primary job of the transformer is either step up or (mostly) steps down the ac supply voltage to suit the requirement of the solid-state electronic devices and circuits fed by the dc power supply. It also provides isolation from the supply line-an important safety consideration [1].

(2). Bridge Rectifier (BR)

A bridge rectifier is a device inside a four terminal-case. It is also a circuit which employs one or more diodes to convert ac voltage into pulsating dc voltage. This was selected because of its high reliability, and no centre-tap transformer required.

(3). Filter (C4)

The function of this circuit element is to remove the fluctuations or pulsations (called ripples) present in the output voltage by the rectifier. In reality, no filter can give an output voltage as ripple-free as that of a dc battery but it approaches it so closely that the power supply performs as well.

(4). Voltage Regulator (ZD2)

The main function of the voltage regulator is to keep the terminal voltage of the dc supply constant even when the ac input voltage to the transformer varies or the load varies. In this design, a zener diode with series connected resistor (to limit over current and acts as a protective device) was used to achieve this, but it is impossible to get a 100% constant voltage but minor variations are acceptable for this job.

3.0.2.2 ANALYSIS OF THE MAIN CIRCUIT COMPONENTS

(1). Secondary Filter

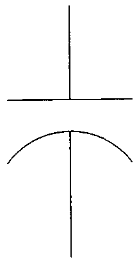


FIG 3.2 Secondary Filter

Ideally, the property of a capacitor is to oppose changes in voltage. Therefore, the 25V, 4.7μF capacitor was used to remove any possible trace of pulsating voltage from the regulated power supply.

(2). Voltage Sensor

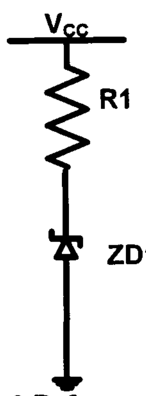


FIG. 3.3 Reference Voltage

A 5.6V Zener diode in series with 390Ω resistor (as a protective device) forms the voltage sensing unit. This provides a reference voltage for the upper comparator of the NE555 Timer and it is directly connected to the 2/3V point of the voltage divider network. The Zener diode provides a constant voltage for the load. The value of the resistor was calculated from the formula:

$$R = \frac{Vs - Vz}{Iz + Il}$$, where

Vs = Voltage Supply,

Vz = Voltage of the Zener diode,

Iz = Current of the Zener diode

$$R = \frac{12 - 5.6}{15 + 1} = \frac{6.4}{16E - 3} = 400\Omega$$

R = 400Ω.

Therefore, the 390Ω resistor was chosen because it is nearest and most likely substitute.

(3). NE555 TIMER IC

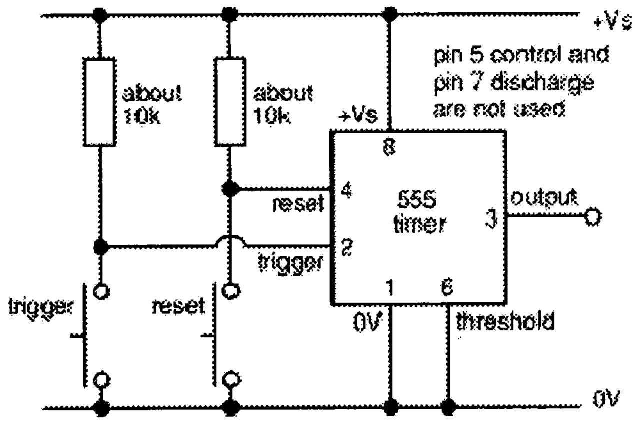


FIG 3.4 A Bistable 555 Timer Circuit

The 555 used is a Bistable (flip-flop) - a memory circuit.

The circuit is called a bistable because it is stable in two states: output high and output low. It is also known as a 'flip-flop' [8].

It has two inputs:

- Trigger (pin 2) makes the output high.
- Reset (pin 4) makes the output low.

(3). Upper Comparator of the 555 Time

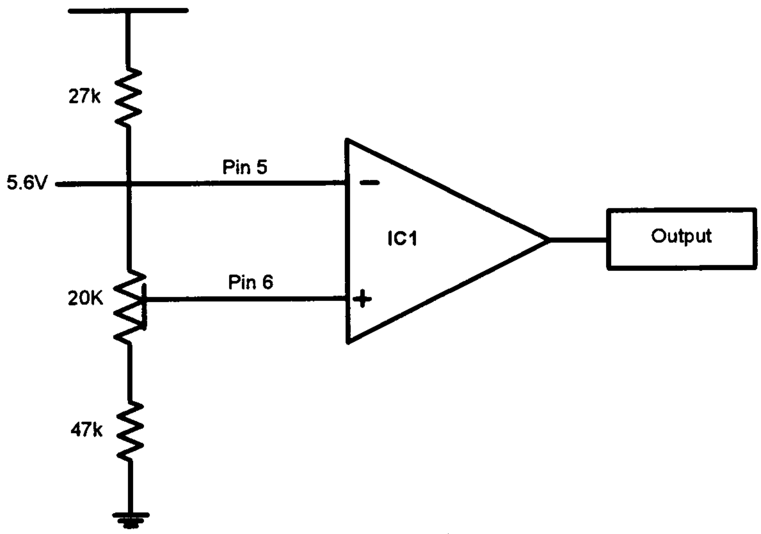


FIG. 3.5 Upper Comparator of the 555 Timer

The Op-Amp as part of the internal structure of the 555 timer forms the upper comparator circuit with the resistors connected as seen. The input voltage of the cellphone battery sets the flip flop by comparing it with the reference voltage provided by the zener diode. The voltage at pin was used to vary the threshold comparator's trip point above or below the 2/3 of the Vcc depending on the preset value of the 20K variable resistor.

The minimum input when the terminal voltage is 12V can be calculated from the voltage divider formula:

$$Vin = \frac{R1}{R1 + R2 + R3} \times 12 = \frac{27}{27 + 20 + 47} \times 12 = 3.45V$$

While the maximum is:

$$Vmax = \frac{R2}{R1 + R2 + R3}\ x\ 12 = \frac{47}{27 + 20 + 47}\ x\ 12 = 6V$$

The upper comparator reset the output end the charging process.

(4). Lower Comparator of the 555 Timer

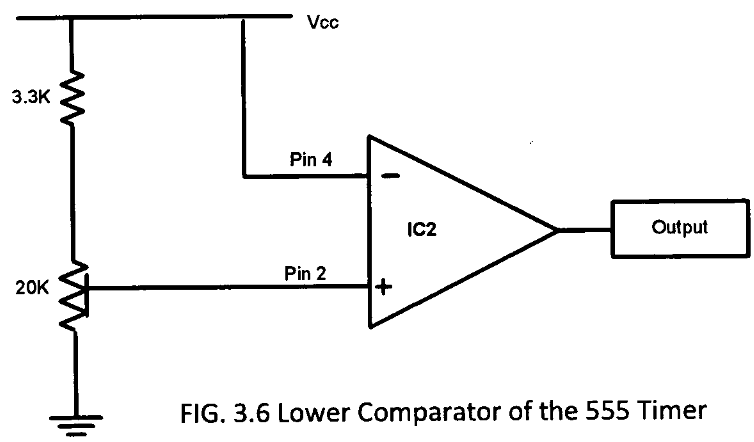


FIG. 3.6 Lower Comparator of the 555 Timer

When a discharged cellphone battery is connected across the charging terminals, then the output terminal voltage drops. Normally, the input through pin 6 of the upper comparator which senses the terminal voltage drops below the reference voltage of pin 5. The output when the reference pin 5 is higher is negative; hence the output has no effect on the flip flop. When the voltage has appreciated and has gone above the reference voltage, i.e. 6V, the output now becomes positive and reset the flip flop to zero.

The network above also senses the terminal voltage and compares it to ½ of the reference voltage. The lower comparator of the 555 timer and is calculated as below:

$$\frac{1}{2}\mathrm{Re}f = \frac{1}{2} \times 5.6V = 2.8V$$

Pin 2 can be varied using the 20K variable resistor from

$$0to\frac{20}{20+3.3}\times 12=\frac{20}{23.3}\times 12=10.3V$$

It senses the lower level of the voltage when the pin 2 input has dropped below 2.8V depending on the pre-set value. The flip flop is set, therefore, taking the output high. The lower comparator sets the circuit to commence the charging process.

(5). Light Emitting Diode Configuration

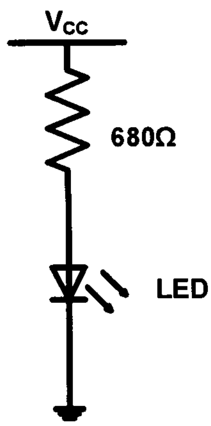


FIG 3.7 LED Configuration

An LED in series with a 680Ω resistor (to limit the current reaching the LED and acting as a protective device) is used to indicate the statue of each charging conditions for the output. The output is the normal 555 timer output which is approximately Vcc = 12V. But from lower comparator, Vout = 10.3V

$$R2=\frac{Vout-V(LED)}{I}=\frac{10.3-2}{15E-3}=553.3\Omega$$

R2 = 553.3Ω, and a 680Ω is chosen because it is nearest standard resistor value.

(6). Series Regulation

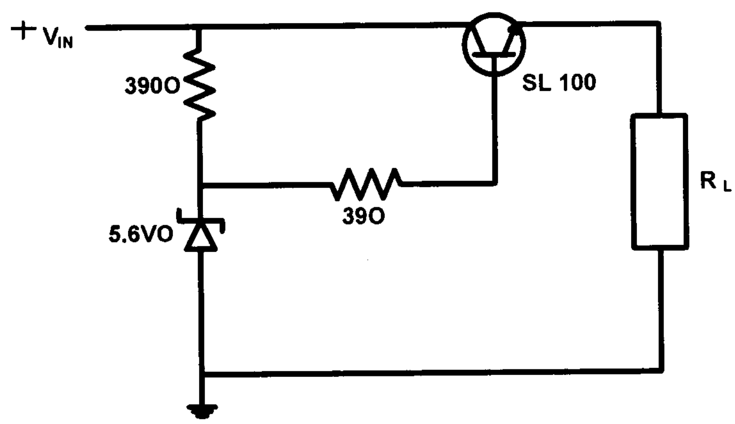


FIG. 3.8 Series Regulation Circuit

The series regulation involves the activities of both the transistor and the zener diode. The base voltage of the transistor is maintained at fixed value by the voltage drop across the zener. If the load current increases for some reason, there will be an increase in voltage cross the transistor, causing it to conduct harder and tending to maintain the output voltage at a constant value.

$$V_L = V_Z - V_{BE}$$

The load voltage for charging the battery is

$$V_L = 5.6 - 0.7 = 4.9V$$

This voltage (4.9V) is sufficient for charging cellphone battery whose charging voltage ranges from 4.7V to 5V.

3.1 IMPLEMENTATION

The construction of the project was done first by connecting component on each module on a Breadboard for test running and troubleshooting. The work was later carried out on a Project board or Vero board. This was achieved with the aid of soldering iron and lead. Each component or a number of component connected whether on the Breadboard or on the Vero board is being tested (to determine the voltage and current at the point) by the use of multi-meter [Appendix 1]. The entire work was later housed in a transparent plastic. An outlet was made for connecting the power supply, output, led indicator and the variable resistors [Appendix 2].

3.2 FUNCTION OF VARIOUS COMPONENT USED

(1). Resistors

(a). R1, R2, R3 and R7, are current limiting resistors. Current limiting resistor are series connected resistors inserted into a circuit to limit the current to the prescribed value.

(b). R4, R5 and R6, form a divider network for pin 2 and pin 6.

(c). VR1 and VR2 are resistors whose value can be varied either continuously or in steps. It sets the voltages needed by pin 2 and pin 6 to a predetermined level.

(2). Capacitor

(a). C1, this capacitor removes spikes generated in the circuit especially during switching operations which is carried out in the 555 time.

(b). C3, this capacitor is a smoothing capacitor. It removes any possible ac that is entering the main circuit. It also filters any possible glitch created by a standard 555 timer on supply when their output changes.

(3). Zener Diode

(a). ZD1, this zener diode provides pin 5 with reference voltage and regulated charging voltage due to varying current produced by the variable resistors. It also prevent current feedback.

(4). Transistor

(a). T1, the transistor is used to enhance the charging current.

(5). IC 555 Timer

(a). NE555, this IC is used to charge and monitor the voltage level of the battery.

CHAPTER FOUR

TESTING, RESULTS, AND DISCUSSION

4.0 TESTING

Testing started right from the point of acquiring and purchasing of components. Each component was tested by either checking for continuity using the multi-meter or by connecting it to the ac supply (in the case of the transformer) and checking the output reading.

Each module while on the Breadboard or on the Vero board was also tested for continuity or to get the desired output.

An external adapter was connected to the output terminal of the circuit so that mobile cellphone batteries can be charged without removing the battery.

The LED was tested initially by turning ON and OFF the switch contact.

4.1 RESULTS

Output voltage from the rectifier	= 8.6V
Output voltage from the regulator	= 7.2V
Voltage from the output of the circuit	= 3.6V to 5.6V
Circuit current rating	= 180mA

4.2 DISCUSSION OF RESULTS

Basically, the charger is a current-limited voltage source. Generally, cellphone battery packs requires 3.6V DC and 180 – 200mA current for charging. Theses usually contains three NiCd cells, each having 1.2V rating. Current of 100mA is sufficient for charging the cellphone battery at a slow rate. A 12V battery containing eight cells gives sufficient current (1.8A) to charge the battery connected across the output terminals. The circuit also monitors the voltage level of the battery. It automaticaly cuts off the charging process when its output terminal voltage increases above the predetermined voltage level.

Timer IC NE555 is used to charge and monitor the voltage level in the battery. Control voltage pin 5 of IC1 is provided with a reference voltage of 5.6V by zener diode ZD1. Threshold pin 6 is supplied with a voltage set by VR1 and trigger pin 2 is supplied with a voltage set by VR2.

When the discharged cellphone battery is connected to the circuit, the voltage given to trigger pin 2 of IC1 is below 1/3Vcc and hence the flip-flop in the IC is switched on to take output pin 3 high. When the battery is fully charged, the output terminal voltage increases the voltage at pin 2 of IC1 above the trigger point threshold. This switches off the flip-flop and the output goes low to terminate the charging process. Threshold pin 6 of IC1 is referenced at 2/3Vcc set by VR1. Transistor T1 is used to enhance the charging current. Value of R3 is critical in providing the required current for charging. With the given value of 39-ohm the charging current is around 180mA.

4.3 LIMITATIONS TO THE WORK

There are lots of shortcomings to the execution of this work. These ranges from the design stage to the final implementation. Some of these limitations include the following.

(1). Damage of components

Lots of the circuit component got damaged during the construction due to probably high voltage, high current or short circuitry.

(2). Identification problems

Identification of the component polarity was not as easy as it supposed to be as most of the components calibrations and signs were done wrongly by the manufactures.

(3). Construction

The actual construction of the project work posses more problem as most of the Vero board are not connected in series so as to ease the placement of components. The soldering lead also posse problem as much lead will cause short circuit, which makes the entire work to malfunction. Casing the project was not an easy task.

4.4 TROUBLESHOOTING

Most of the components were checked for continuity before using. It was discovered that most calibration made on the components for easy identification of polarity was done wrongly (say diode). It was found that most components conduct in both directions (say resistor). The multi-meter was used to determine the pin configuration of the transistor as mere looking at it did not yield desired result. IC holder was provided for the NE555 timer IC to avoid overheating, which may cause damage due to direct soldering of the pins to the Vero board.

CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSIONS

5.0 RECOMMENDATIONS

I highly recommend that engineering should keep on thinking on how to solve the immediate problem being faced by the masses and also with the view to making life easy by minimizing cost and delivery time.

Particularly for this work, it is most fantastic to include a digital display (but may involve the use of microcontroller chip and programming) so that the output voltage can be easily seen rather than imagined. I also recommend that this work should be made more compact so as to ease carrying (since one can travel with charger).

I highly recommend that engineering departments should start macro manufacturing of projects designed by the students with the view of motivating them.

5.1 CONCLUSIONS

At the end, the primary aim and objective of the project was achieved. That is, a portable, inexpensive cellphone charger capable of charging cellphone without removing the battery. Also, the charger is capable of charging different cellphone, within the range of two to three hours depending on the state of the battery before charging.

Finally, the charger is recommended for everybody's consumption (both private and commercial).

REFERENCES

[1]. Theraja B.L and Theraja A.K (2005), "Electrical Technology", S. Chand and Company Limited.

[2]. www.electronicsforu.com/circuitlab.asp

[3]. Daniel R. Tomal and David V. Godson (1999), "Principles and practice of Electrical and Electronics Troubleshooting", Published by TAB Boos Inc.

[4]. Shuler (2001), "Electronic Principles and Applications", Fifth Edition.

[5]. www.w3c.org/TR/1999/REC-html401-19991224/loose.dtd

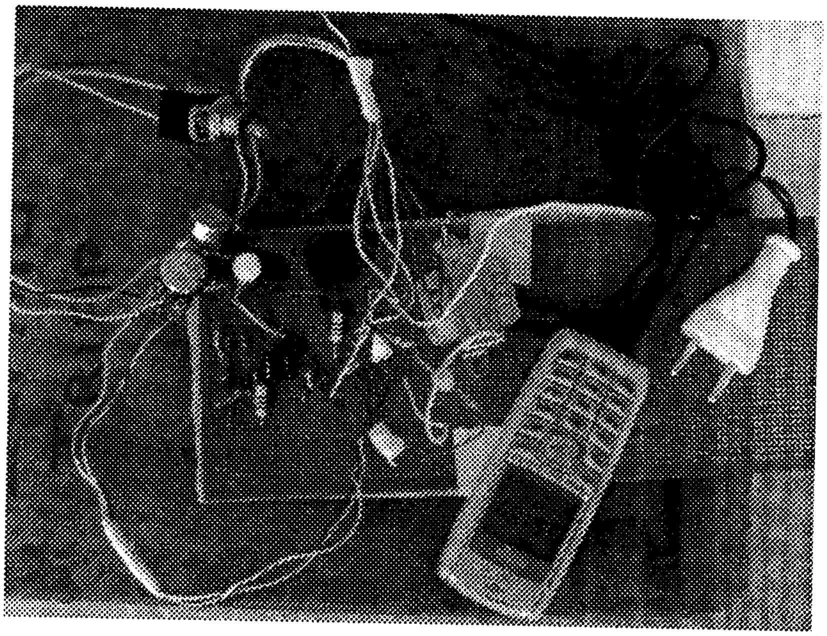
[6]. www.corrosion-doctors.org/Elements-Toxic/Elements.htm

[7]. Levinson, Paul, Cellphone: The Story of the World's Most Mobile Medium, and How It Has Transformed Everything, 2004 ISBN 1-4039-6041-0

[8]. Scherz, Paul, "Practical Electronics for Inventors," p.

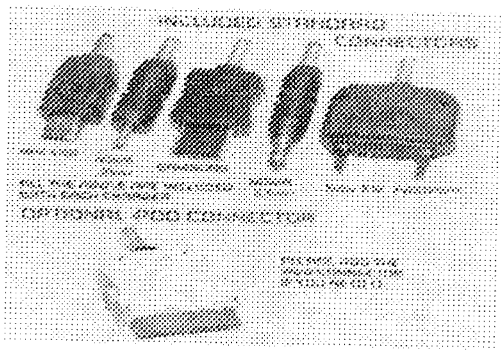
APPENDIX

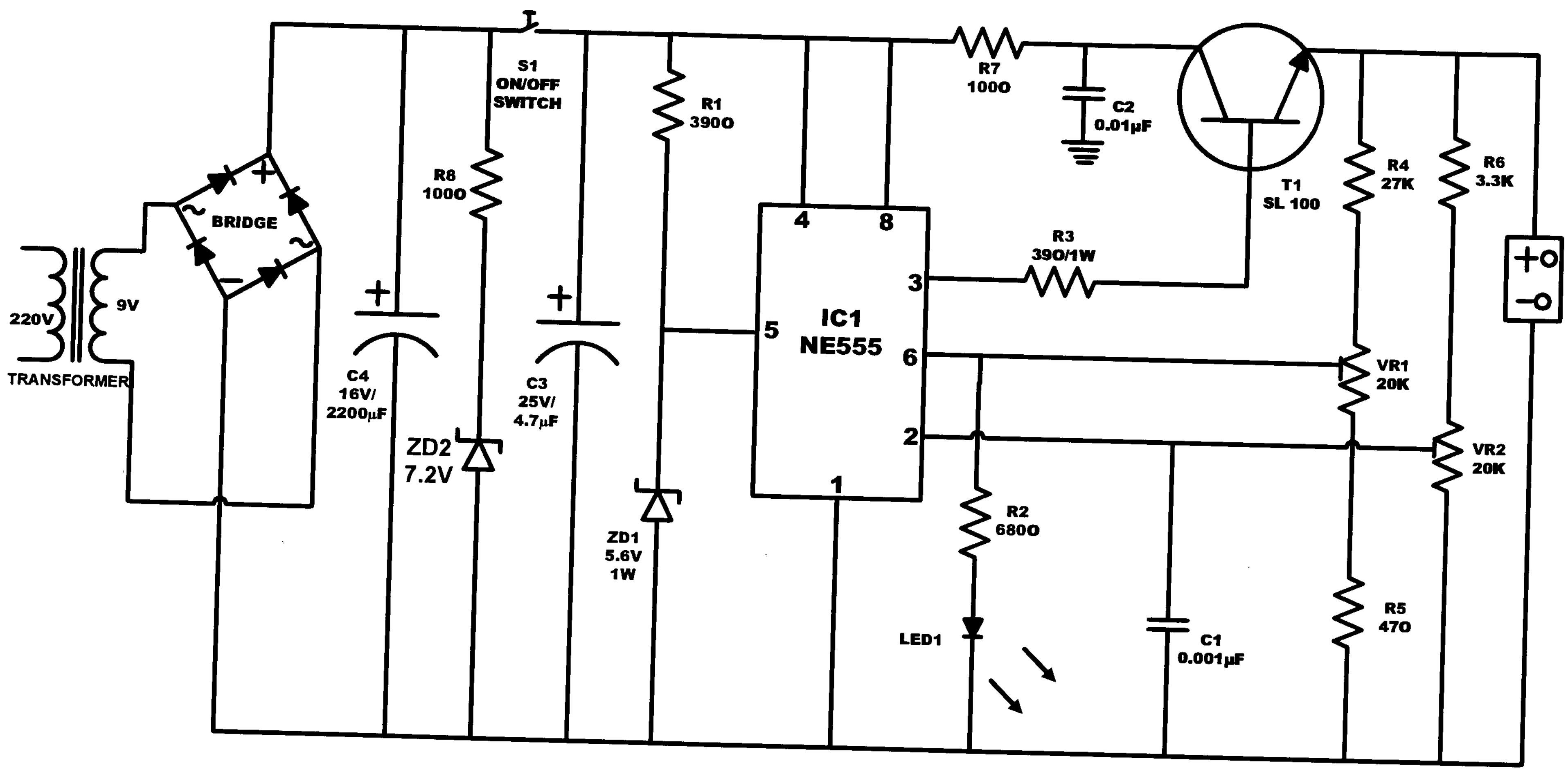
[1]. VERO BOARD WORK OF THE PROJECT



[2]. Connectors

The picture below show different types of connector that can be used as an adapter for charging mobile cellphone battery inside the cellphone.





COMPLETE CIRCUIT DIAGRAM OF CELLPHONE CHARGER