DESIGN AND CONSTRUCTION OF MOBILE CELLPHONE CHARGER

BY

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2000/9921EE

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A THESIS SUMMITTED TO THE ELECTRICAL/ COMPUTER ENGINEERING

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DEDICATION

This project is dedicated to Almighty God for taking me this far in the journey of life. Also, to my late father, Barrister Disu Sidiku, who set my feet upon a solid educational foundation. To my mother, from whose well of love and knowledge I draw my strength.

DECLARATION

I Mosunmola Bosede Sidiku, 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.

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Also indebted to, is my H.O.D, Engr Musa D. Addullahi and the entire staff of the Electrical department for their support in all aspects. God bless you all. To my mum and siblings: Olumide, Bankole, Ahmed, Buky, Yemi, Kemi, Segun, all from the Sidiku family, I love you all. Finally, my friends Jide Olumotanmi, Gbenga , Emily, Jossy, Lydia, David , Mathew , Emma. May God bless you all, AMEN.

ABSTRACT

The project is about the design and construction of a mobile cell phone charger. The device is designed to charge different brands of mobile phones knowing they have different power rating. The device has an ICNE555 timer which is responsible for charging and monitoring the voltage level of the battery which met the maximum requirement for the cell of the mobile to be charged.

The cell supplying the input voltage is backed up with a charging circuit so that it could be charged from the AC mains supply to regain its voltage capacity. The output of this device can be used to charge any mobile phone since it is variable.

This design will go a long way to help mobile phone users in the rural areas where there is no electricity and also in the cities when ever there is power failure because it gives mobile phones a special backup.

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CHAPTER ONE

1.0 INTRODUTION

Basically , Engineering is all about invention and making life convenient for living of mankind varying from provision of electricity, telecommunication to mention but a few and at affordable rates. Today even the smallest company can conduct global business with the right equipment. Laptop computers, cellular phones, two-way radio are no longer luxuries for top executives or mega companies, they are necessities enabling workers at every level to produce efficiently [5].

Since the invention of the TRANSISTOR in 1948, the size and power consumption if electronic equipment has drastically reduced. Many types of electronic equipment which have been operating on main supply were redesigned to operate on batteries brought life to the field of battery use in the society.

Batteries designed to power mobile equipment seldom perform to manufacturer's standards after the first few uses, a weakness that can render the best business tool in the world useless. Because of this increased use of mobile technology, rechargeable batteries have accounted for a larger share of the battery market in recent years and have become a multibillion dollar business.

Batteries are a dependent commodity, useless without chargers. Many chargers are so inefficient; they actually destroy the batteries slowly, or contribute to performance problems that have become the nemesis of portable convenience.

Charging of the cell phone battery is a big problem while traveling as power supply source is not generally accessible. If the cell phone is switched on continuously, its battery goes flat after a while making the cell phone useless, a fully charged battery become necessary especially when the distance from the nearest relay station increases. A way to replenish the lost of the cell phone battery during the time of operation brought the quest for a battery charger.

A well designed charger must be able to charger fast, ensure a long life and many circles before the battery become unserviceable.

This is what has led to the design of this project, a 12V mobile cell phone charger that provides the benefit of a conditioner. The ICNE555 timer monitors voltage and current levels as the cellphone battery is being charged, adjusting the charging algorithm to condition the battery through out the entire process.

When charging is complete, a light emitting diode (LED) illuminates and the charging halts automatically, delivering the battery in peak condition without overcharging. If the battery is left on the charger, the charger will maintain battery's voltage level using a proprietary process. This allows the batteries to be left on the charger indefinitely.

The cell phone charger would be compact and relatively cheap for every mobile cell phone owner to have at home and do away with the stress of looking for where to charge the phone while main supply fails, instead one can conveniently charge the phone anytime, anywhere, each time the charge level is low. This will saves cost.

1.1 OBJECTIVES OF THE PROJECT

This design work is aimed at designing a mobile cell phone charger suitable for charging any brand of mobile phones and purposely to solve the problem of phone charging faced by every phone users in the rural environment where there is no electrification or in an area where power supply is irregular.

This designed project work will tremendously assist mobile phone business operators in the rural area as well as in the cities because this charger would be ever ready and reliable, as long as the power source is giving out the required voltage, should it run down, it can be charged from the AC mains through the charging circuit designed for it.

1.2 CONTRAINTS OF THE DESIGN

The major constraints faced during this work were the mathematical representation, formulation and calculation of the value of various components used in this design which must be practically transferred into construction as meeting the purpose for which this project work was designed. It is also necessary to state here that a battery compatibility problem was encountered since the battery size required or fit for this project has to be custom made. During this design analysis, the following factors were considered.

- cost of design
- its suitability for the purpose of design
- ease of maintenance
- size and simplicity
- reliability and availability
- Modifications and efficiency.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 BATTERIES AND CHARGERS

Why the need for a charger?

To understand the reason why a charger is necessary, takes a glimpse into the history and working of a battery.

A battery is a combination of chemicals that are devoid of excess energy in their natural state. However, these chemicals are capable of storing and releasing energy through chemical reactions. Energy storing ions are generated by an influx of electrons. When they are released, electricity is generated, excess electrons are consumed and the battery slowly deteriorates to its natural state.

A battery consists of two electrodes, a positive anode and a negative cathode, with a porous separator in between. If the electrodes contact each other, the battery shorts out and becomes useless. The electrodes and separator exist in an electrolyte solution that has an initial concentration of ions that supports the chemical reaction rate and provide a medium for ion transport.

As battery is discharged, its internal electrochemical process results in transfer of ions from one electrode to the other through the electrolyte. When the battery is charged the process is reversed and the ions travel in the opposite direction. During this electrochemical process, each electrode goes through a chemical reaction that generates these ions at one electrode and consumes them at the opposite electrode. How well this process is carried out has an effect on the overall performance of the battery [5].

2.2 FACTORS AFFECTING BATTERY PERFORMANCE

2.2.1 EASE OF MOVEMENT OF IONS:

The chemical reaction rate at the electrode that is consuming ions is limited by the concentration of the ions at its surface. This concentration is related to how well the ions are able to move through the supporting electrolyte and separator. If the ion concentration across the surface of an electrode is uneven, the chemical reaction rate will not be uniform; leading to the development of dendrites; outgrowths of material from the electrode. Unchecked dendrites can eventually grow through the separator and the electrode can come into contact shorting out the battery. The charger addresses these problems by preventing dendrite build up and maintaining even ion concentration.

2.2.2 CRYSTAL STRUCTURE OF ELECTRODE:

Fine grain structure reduces internal resistance and increase the surface area. Under extended, low current condition the slower chemical reaction rate can cause the size of the crystals to increase reducing the surface area per unit of volume and causing a potential drop in overall battery capacity and an increase in internal resistance. This increase in internal resistance will result in lower battery capacity.

Until recently, emphasis was placed on the improvement and modification of batteries. Original equipment manufacturers (OEMs) want to replace their nickel cadmium (NiCd) batteries with lighter, higher- capacity, and most importantly, reliable battery. Battery research in recent years has developed nickel metal hydride (NimH) batteries, lithium-ion (Li-ion) batteries and a few other smaller players. However these improvements are not without drawback, high cost, short cycle life, limited power capabilities and, with NimH, a memory effect of its own.

In spite of the emergence of these new battery types offering increased power density, NiCd batteries still hold the ions share of the market and will continue to do so because of cost, potential life cycles and proven performers. Although it is true that they can demonstrate problems such as (1) memory effect which reduce charge capacity and cycle life with proper handling and charging, Nicd when not in use regularly developed dendrites (thin conductive crystals) causing internal short circuits and premature battery failure long before the 800 – 1000 charge/discharge cycles claimed by most vendors. Sometimes, this dendrites can be cleared by applying a brief high current charging pulse to individual cells but once dendrites have begun to form, they will typically reoccur thereafter. Secondly NiCd battery when not used regularly developed dendrites (thin conductive crystals) causing internal short circuit and premature battery failure, long before the 800-1000 charge/ discharge cycles claimed by most vendors sometimes this dendrites can be cleared by applying brief high current charging pulse to individual cells but once dendrites have begun to form, they will typically recur soon thereafter. NiCd can continue their role as the affordable, rechargeable workhorse. Chemical reaction of NiCd is:

$2NiO(OH) + Cd + 2H_2O - 2Ni(OH)_2 + Cd(OH)_2$

Li-ions are a type of rechargeable battery commonly used in consumer electronics. They are currently one of the most popular types of battery, with one of the best energy to weight ratio, no memory effect and a slow loss of charge when not in use. They can be dangerous if mistreated, however and unless care is taken they may have a shorter lifespan compare to other battery types. Li-ions are lighter, small and mobile and it does not suffer memory effect, it also has a low discharge rate.

A unique draw back of the Li-ion is that its lifespan is dependent upon aging from time of manufacturing (shelf life) regardless of weather it was charged and not just on the number of charge/discharge cycles. This makes Li-ions batteries not suitable for back up application compared to lead acid batteries. Li-ions batteries are not as durable as Nickel Metal hydrides or Nickel Cadmium designs and can be extremely dangerous if mistreated and they are usually more expensive [6].

$Li\ ½\ CoO2 + Li\ ½\ C_6 \quad ... \quad C6 + Li\ CoO2.$

Ironically, even though OEMs improve and release new products every year, little attention is paid to the charger. This "little companion box" that comes with this products may be the cause, and eventually the solution to many of this battery shortcomings.

For professional users of all portable products, dependable battery power is critical to staying on job. A suitable charger was developed in response to the frustration heard from the field. Public safety, government, military and utility professionals, service alike has asked for a solution to battery woes that hinder productivity and compromise safety. The charger was designed to provide a new technology that not only charges more efficiently and thus faster than other products but that provides a dependable, maximum capacity charge every time while extending battery life.

2.3 TRICKLE CHARGER

The standard OEM (Original Equipment Manufacturer) or consumer - priced battery charger is a constant current trickle charger. A trickle charger operates by delivering a steady, low level, positive current for as long as it is connected to a power supply. Ions are generated at one electrode in battery cell and must move to the other electrode. If the current is sustained over an extended period, the ions concentrate on one side and create polarization which causes heat generation, inadequate charging capacity and a shorter life for the battery.

This slow "overnight charger" relies upon the user to stop them when the battery has reached its maximum capacity. They generally charge battery fully in about ten hours. They are inexpensive and simple to design but they do not optimize the performance of the battery. In fact they actually contribute to premature disposal of the batteries. The low charge rate allows the chemical reaction to be localized on the electrode surface leading to dendrite growth. There is high likelihood of over charging and in case of NiCd and NimH, voltage depression or "memory effect".

Memory effect is the great "imposter" that causes premature dismiss of batteries. When NiCd batteries are recharged before they are fully discharged, electrodes passivate, decreasing the ability of the cells to accept a charge. When battery is repeatedly charged without being fully discharged, operating time and performance deteriorates and it appears to die before its time. Most electronic equipment will stop operating before the battery can reach a low enough per-cell voltage to recover the voltage depression, so few batteries are fully discharged before they are recharged.

Most OEMs upgrade fast chargers operate by increasing the constant current rate, charging the battery in only two or three hours. They either have rudimentary circuitry that terminates when the battery is fully charged or they decrease the charge current when the battery reaches a certain voltage, usually about 80% - 90% charged. However charging at a high constant current rate ignores the electrochemical process within the battery, which overtime causes significant deterioration, similar or worse than that caused by the trickle charger. The result is reduced capacity with each charge, untimely wear down and abbreviated life cycle for the battery [5].

2.4 PULSE CHARGER

Pulse-charging, introduced in the 1960s, was the first improvement to the constant-current trickle charge. Pulse charging operates on the principle of s urging power into the battery in pulses of electrical current. One second pulses of power are interspersed with rest periods lasting a fraction of a second, interrupting the pulse current gives ions a chance to diffuse and distribute more evenly throughout the battery and returns to normal levels routinely, thus reducing some of the negative effects of trickle charging. Although it was developed to address the chemical process of batteries, pulse charging still ignores the chemical reaction and physical phenomenon taking place in the battery. It provides short term fixes, i.e. charged batteries, but the costs are heavy, shortened battery life and shorter charged cycles which translates into inadequate power to support equipment for the recommended duration.

The second generation of pulse charging emerged in the1970s to counter the problem of recharging batteries that have not fully discharged. This method use only in selected commercial charger augments the rest period by adding a short negative discharge pulse interspersed with the positive charging pulse.

Podrazhansky, a Russian immigrant with a background in electrical and radio frequency engineering was busy searching for a solution to the problem plaguing his rechargeable batteries when he developed the DEW technology. Podrazhansky, advanced charger technology's vice president of research discovered that the negative discharge in pulse charging can cause negative effect in the reverse direction. Single, high magnitude negative pulse cause ion transportation problem in the negative direction as well as excessive discharge of the battery, which increases charge time. Podrazhansky found that applying even shorter, multiple, negative pu8lses with a higher magnitude eliminates charging problems and actually benefits battery chemistries. The higher magnitude discharge pulses are inherently focused in the area of dentrides and help to remove them. When allowed to build up, dendrites can short-circuit batteries electrodes. The brief high current rapidly balances the ion concentration and improves the crystalline structure of the electrodes. In NiCd batteries, the current momentarily pulls the battery voltage down, resulting in a reversal of voltage depression.

The improved balancing of ion concentration leads to an efficient charge process that enables higher charge currents, yielding the shortest charge times possible and actually conditioning batteries as they are charged, eliminating the need to discharge first.

In conclusion, the charger is designed to work in harmony with both electrochemical process and composition of batteries. The proven technology which can charge a NiCd cellular phone battery in as little as five minutes provides the break through in battery charging awaited by a mobile workforce[5].

CHAPTER THREE

3.0 STATISTICAL ANALYSIS OF CHARGING REQIREMENT OF VARIOUS BRANDS OF MOBILE PHONE

The basic charging requirements for the cell of mobile phones are the charging voltage and the charging current whose critical statistical analysis forms the basis of this work. This analysis represents the immediate first in the design procedures of the project work.

The table below shows the different brands of mobile phones and the specified charging requirement.

Table 3.1 shows charging requirement for brands of mobile phones.

Mobile phone brands	Charging voltage (V)	Charging currents (mA)
Nokia	3.7	335
Samsung	5.0	700
Bird	5.0	400
Sagem	4.5	400
Trium	5.7	550
Motorola	3.6	375
Nec	5.6	550
Ericson	3.7	355
Sony	5.0	500
SonyEricson	5.1	450
Philips	4.0	480
Supermaster	3.5	420
Sendor	5.0	300

Alcatel	3.6	400
Sharp	5.9	650
Siemen	5.0	420
LG	5.0	650
Panasonics	4.6	600

3.1 DESIGN ANALYSIS.

This chapter primarily deals with six major sections: (1) The power unit (2) voltage sensing unit (3) regulation unit (4) The Output unit (5) upper limit (6) lower limit.

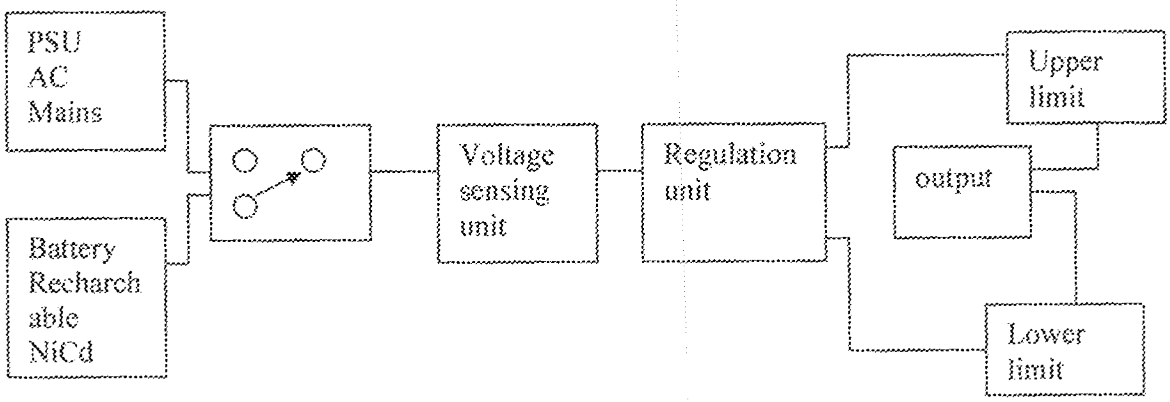


Fig. 3.1 CIRCUIT BLOCK DIAGRAMS

3.1.1 THE POWER UNIT

The power pack is just a unit in the system that is responsible for voltage conversions through the use of transformer, rectification, through the use of diodes and filtering through the use of capacitors.

Transformers could easily be defined as electrical device that is responsible for the conversion of energy from one level to the other at the frequencies (voltage transformer). There are other types of transformer for different purpose e.g. current transformer e.t.c. the voltage transformer could either be a step up or step down, depending on the turn ratio between its primary and secondary windings but for the purpose of this project, a step down transformer domestic type is used since the energy level is charged from a higher level to a lower level (220 – 12v), at the same frequency of 50hz.

The rectifying unit, consist of four diodes connected together to form a bridge rectifier and its work is to convert ac voltage from the transformer into a pulsating DC voltage. The reason behind choosing a bridge rectifier over the other type is that unlike in the other area, smaller transformer would be required for the same output because it utilizes the transformer output (secondary) continuously and no centre tap transformer is required

The filter circuitry performs the operation of removing the fluctuations or pulsating (ripples) that might be present in the output voltage from the rectifier. Though there has not been any filter that had been able to completely remove ripples associated with rectifier output, but it can be reduced to the minima and that is what the filter used in this project work has been able to achieve[1].

A typical circuit diagram of a power supply as used for this project work is shown below

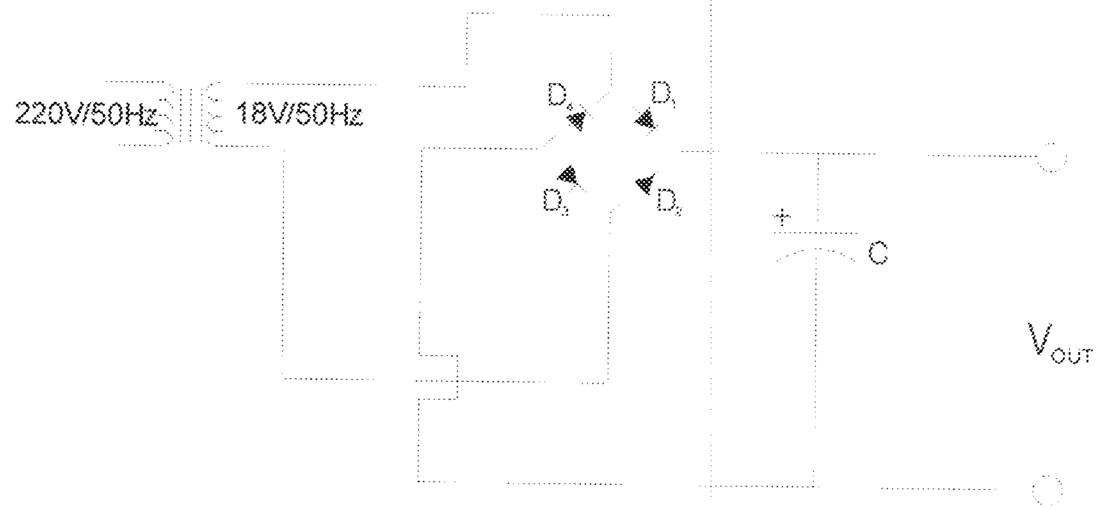


Figure 3.2 A TYPICAL POWER SUPPLY CIRCUIT

3.1.2 MODE OF OPERATION

When power is supplied to the primary of the transformer from the mains (PHCN) due to mutual `induction between the windings of the transformer (primary and secondary windings) on the same core, voltage is induced in the secondary and it is given as an output at the secondary winding. This output swings about a point, thereby having positive (+ve) and negative (-ve) half cycles. During the first positive half cycle, terminal T of the step down transformer secondary is more positive and terminal U is negative, thereby enabling diodes D1 and D3 to be forward biased and D2 , D4 are reversed hence current flows through point TABEFDCM it is as shown in fig 3.2.

During the first negative cycles, the secondary terminal U becomes more positive compared to T and so , diodes D2 and D4 are forward biased and diodes D1, D3 , becomes reversed biased. This time current flows through points UCBEFDT fig 3.3 it would be noticed that in both cases of half cycles the current flow through point

E and F thereby maintain constant charging to the capacitor, that it the capacitor is at maximum a.c.voltage. This in turn maintains constant flow of current in the circuit through both cycles.

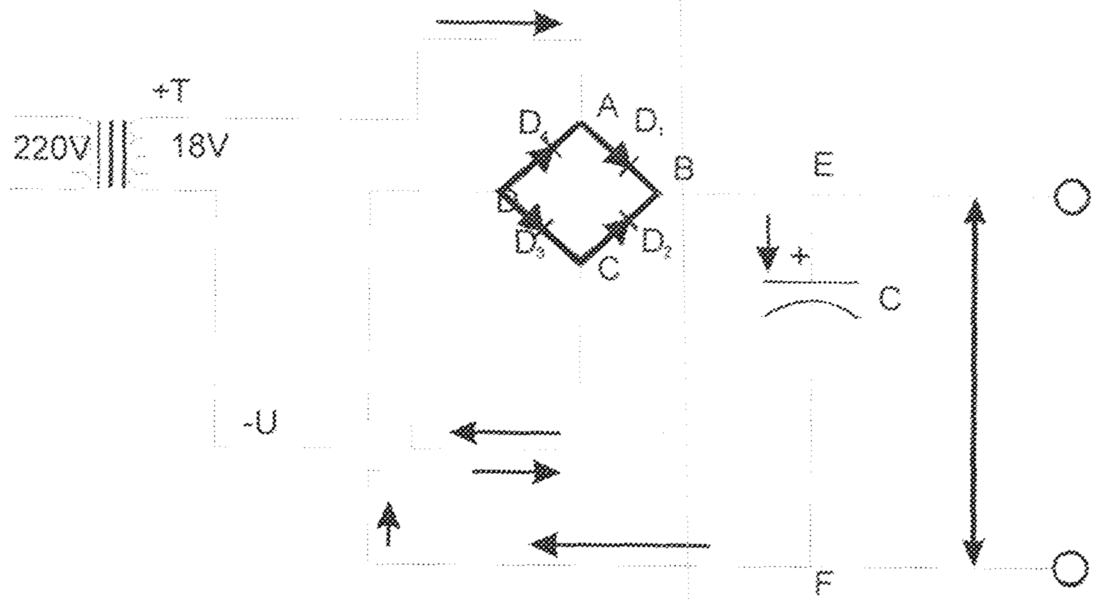


Fig 3.3 Current path during positive half cycle.

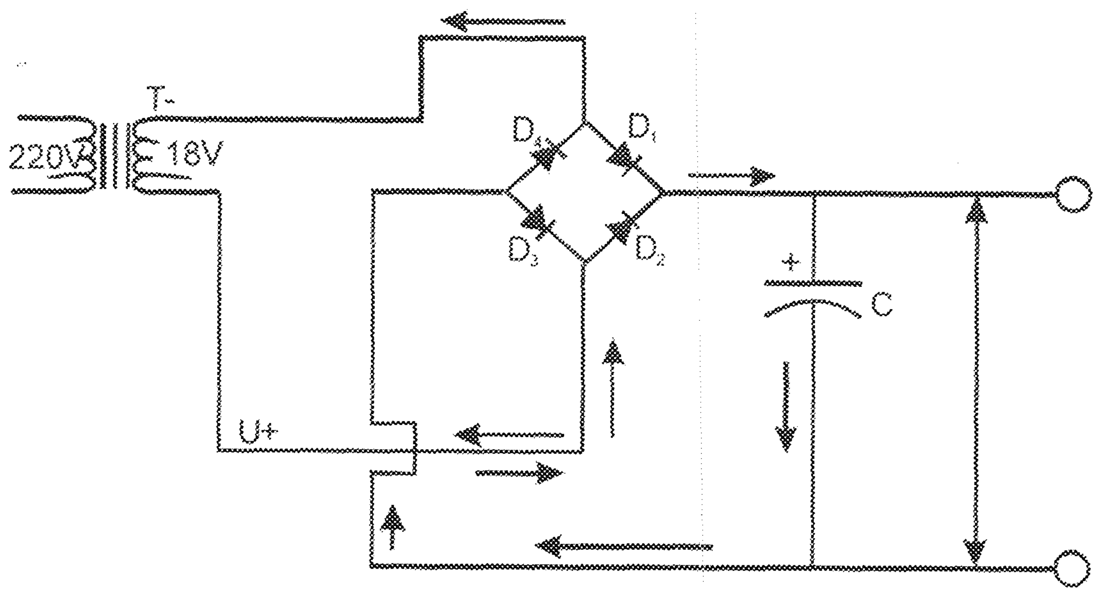


Fig 3.4 Current path during negative half cycle

In fig 3.4 above the various waveforms from the cathode ray oscilloscope is shown as follows:

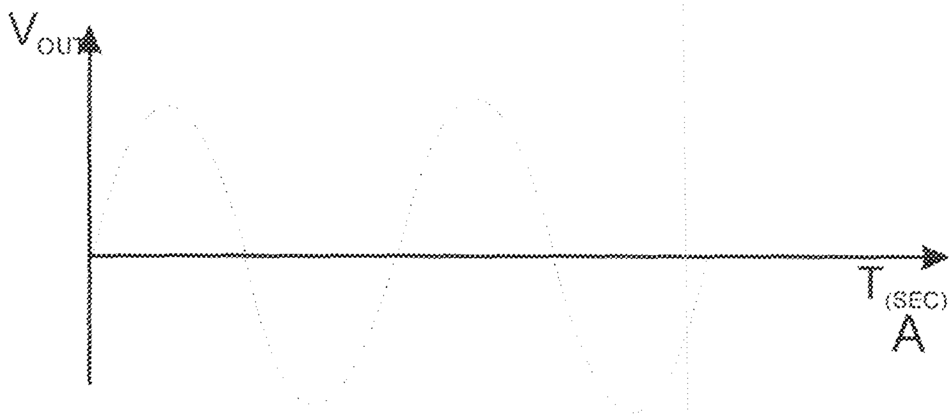
a. a.c waveform.

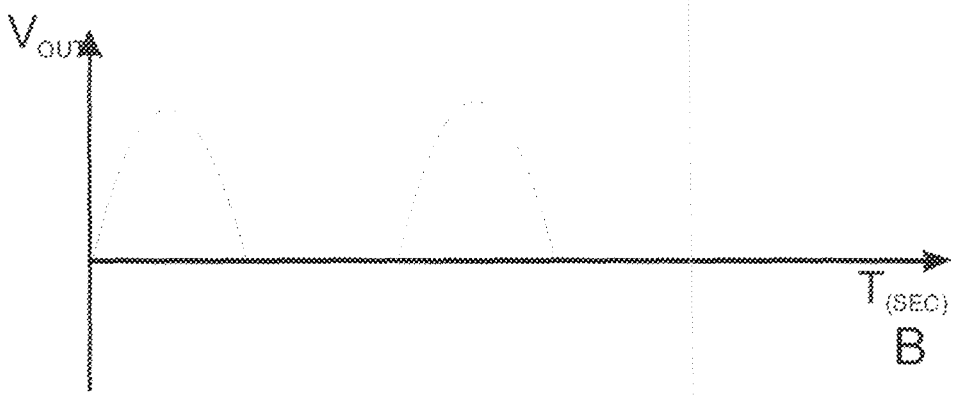
b. Positive half cycle waveform for diodes D1 and D3.

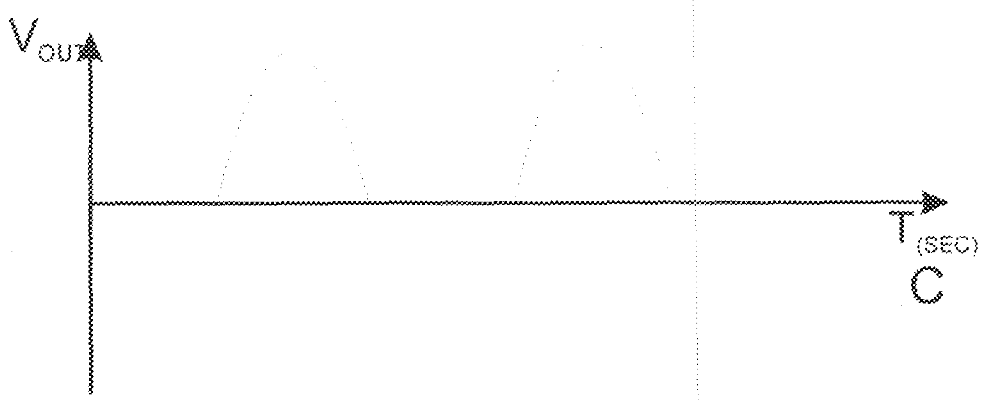
c. Negative half cycle waveform for diodes D2 and D4.

d. Waveform of the two combined.

e. Waveform across the capacitor.







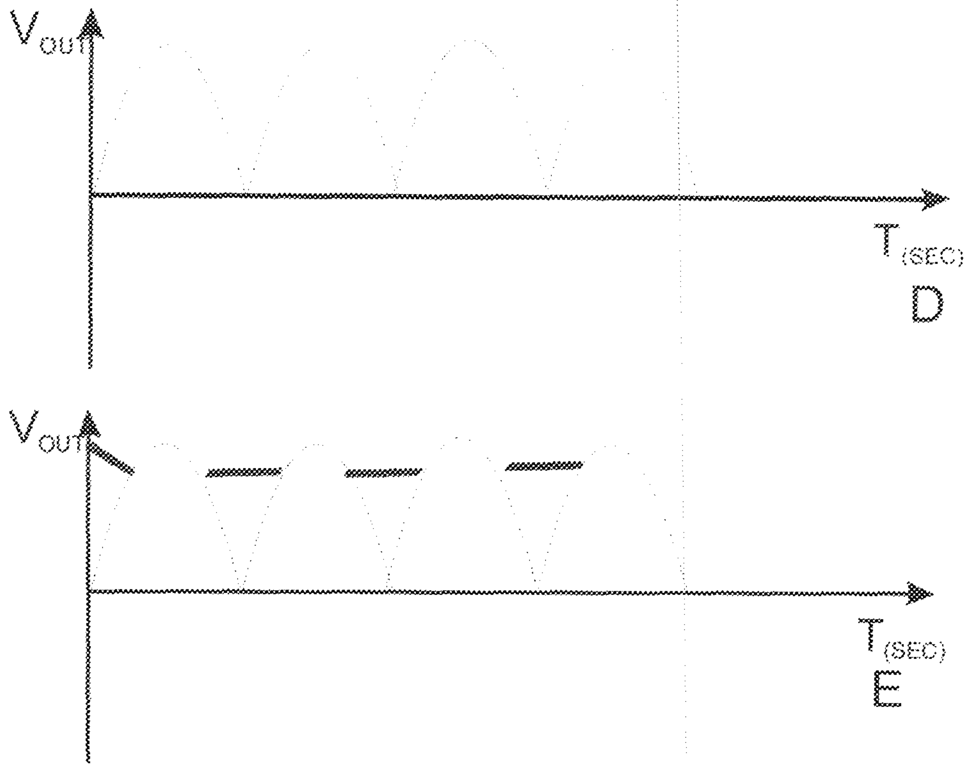


Fig 3.5 Waveform diagrams.

3.1.3 CALCULATION

Neglecting the losses in the coil, the *rms* value of the induced e.m.f. in the whole primary winding is equal to the product of the induced e.m.f and number of primary turns (N), i.e.

$E_1 = 4.44fN_1B * A$……………………………………………………………3.1

Similarly, the rms value of the induced emf in the secondary winding is equal to the product of the induced e.m.f. and the number of the secondary turns (N2), i.e.

$E_2 = 4.94fN_2 B * A$…………………………………………………………3.2

Thus, from these two equations, it can be deduced that

$\frac{E_2}{E_1} = \frac{N_2}{N_1} = k$……………………………………………3.3

Where E_1 = e.m.f induced in the primary winding.

E_2 = e.m.f. induced in the secondary winding.

f = frequency of operation.

N_1 = Number of turns of coil in the primary.

N_2 = Number of turns of coil in the secondary.

B = Maximum flux density.

k = voltage transformation ratio.

For this particular project $N_2 < N_1$, since a step down transformer whose transformation ratio is 12: 2: 1

Also, for an ideal transformer

Input power (VA) = Output power (VA)-------------------------3.4

Where,

I_1 = current in primary winding.

I_2 = current in secondary winding.

V_1 = voltage in primary winding.

V_2 = voltage in secondary

For the purpose of this project work, these are the parameters for the transformer used.

Primary voltage V_1 = 220V.

Secondary voltage V_2 = 12V.

Primary current = ?

Secondary current I_2 = 1.2A.

$$\frac{I_2}{I_1} = \frac{V_1}{V_2}$$

This gives

$$I_1 = \frac{I_2 V_2}{V_1}$$

$$\frac{(1.2 \times 12)}{220}$$

$= 0.0655A$

From the transformer, the output was connected to the bridge rectifier whose output is 0.89 times the r.m.s. voltage at the input.

Vrectified = 0.89r.m.s..........................3.5

3.1.4 FILTERS.

In choosing a capacitor for the purpose of filtering, two things are put into consideration, namely:

1. Voltage rating.
2. Capacitance value.

The purpose of filtering is to remove any pulsation ripples that are present in rectified voltage. The essence of this is to increase the usefulness of the rectified voltage by level ing out pulses and producing current at a steadier rate.

3.1.5 VOLTAGE RATING.

The reason for putting into consideration voltage rating in the selection of capacitors is to avoid charging up the capacitor with a voltage higher than the manufacturers rated voltage, and if this happens, the capacitor could explode which can be very hazardous.

In choosing a capacitor, it is always better to measure the output from the rectifier with a voltmeter on NO LOAD because at this point in time the maximum voltage is always across the terminals (rectifier). Whenever on load, there is always a drop in the voltage value. In the selection of a capacitor for a circuit, the voltage rating is given below

Voltage rating of capacitor = $\sqrt{2}$Vr.m.s. 3.6

For the purpose of this project work, the selected capacitor is 25V/1000microfarad, and the reason been that,

From the equation 2.7,

$Vc = \sqrt{2}\ Vr.m.s.$

$Vr.m.s = 21.5$

$Vc = \sqrt{2} \times 21.5$

$Vc = 30.4$

From this calculation the voltage value to be chosen is approximately 30V but in the various voltage ratings of a capacitor, the closet to this value is 25 and 35V and that was why 35V capacitor was chosen because 25V is lower in value.

3.1.6 CAPACITANCE VALUE.

Basically the property of capacitor is to oppose changes in voltage. It is therefore necessary to note that a bigger capacitance would tend to reduce the ripple magnitude increases Vdc towards the limiting value of Vip, thereby resulting in a better d.c. supply for the circuit [1].

3.1.7 VOLTAGE SENSING UNIT

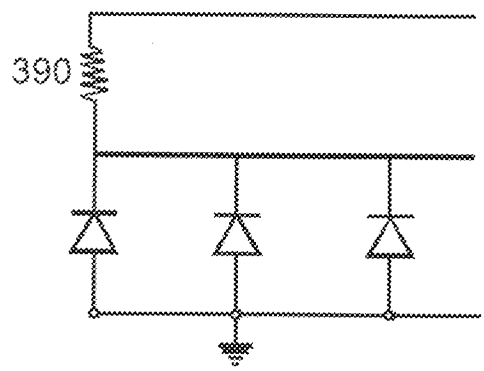


Fig 3.6 diagram for selection of different output voltages

The arrangement above is for the selection of different charging voltages for different products. ZD1, ZD2, ZD3, are different zener values that determine the output voltages for different product.

3.1.8 Voltage reference section:

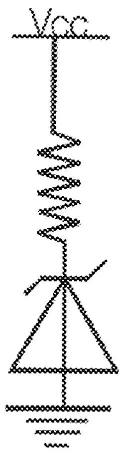


Fig 3.7 voltage reference diagram

This arrangement provides a reference voltage for the upper comparator of the 555 timer and is directly connected to the 2/3 v point of the voltage divider network. Zener diode as a voltage reference simply provides a roughly constant current, done with a resistor from a higher supply voltage forming the most primitive kind of regulated supply. The 5.6v Zener diode is used to achieve higher voltage. The current drawn by the 555 timer input is 1mA. The value of the resistor used is

$$R = \frac{Vs - V_D}{Iz + IL}$$

Where

Vs = voltage supply.

V_D = Diode Voltage.

Iz = Zener Current.

$$R = \frac{Vs - 5.6}{(15 + 1)\,mA} = \frac{6.4}{16\,(10^{-3})}$$

Resistor (R) = 400ohms.

390ohms value resistor is chosen and used because it is the nearest value to 400ohms in the market. R is connected in series with Zener diode so as to hold back excessive current or limit the current to a prescribed value and prevent the Zener diode from overheating

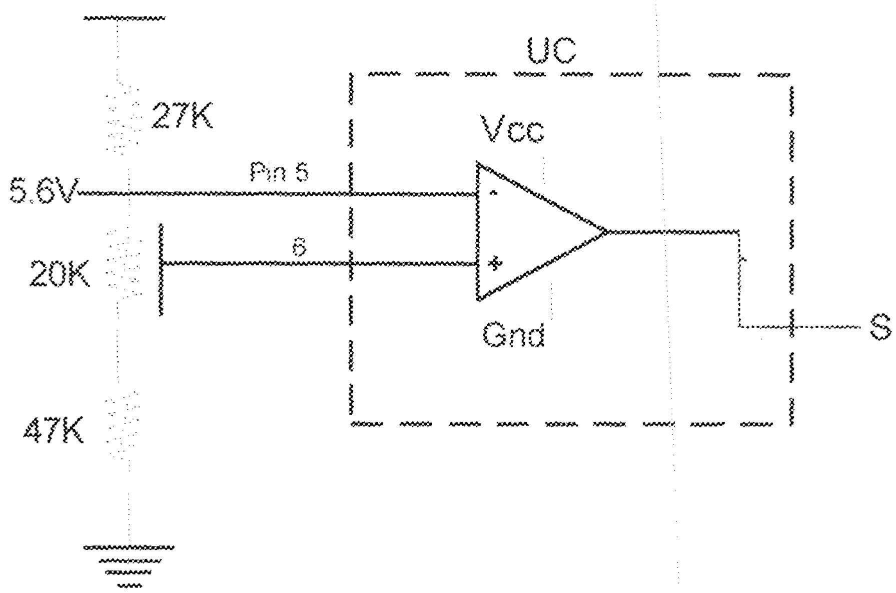


Fig 3.8 Diagram of the upper comparator of the 555 timer

From the diagram above the UC is the upper comparator of the internal structure of the 555 timer. The output sets the flip flop in the 555 timer. This arrangement senses the output terminal voltage of the battery and compares it with the reference voltage 5.6v. The voltage at Pin 5 makes it possible to vary the threshold comparator's trip point above or below the 2/3 of Vcc depending on the preset value of the 20k variable resistor.

The minimum input when the terminal voltage is 12v can be calculated based on the voltage divider theorem.

$$\frac{R_1}{R_1+R_2+R_3}$$

$$\frac{47}{27+47+20} \quad * \quad 12 \quad = \quad 3.5 \text{ v}$$

While the maximum is

$$\frac{47+20}{27+47+20} \quad * \quad 12 \text{ v} \quad = \quad 8.6 \text{ v.}$$

When a flat battery is connected across the charging terminals, then the output terminal voltage (of the battery charger) drops. Normally the input through Pin 6 of the upper comparator which senses the terminal voltage drops below the reference voltage of Pin5. The out when the reference Pin5 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. 8.6 v, the output now becomes positive and reset the flip flop to zero.

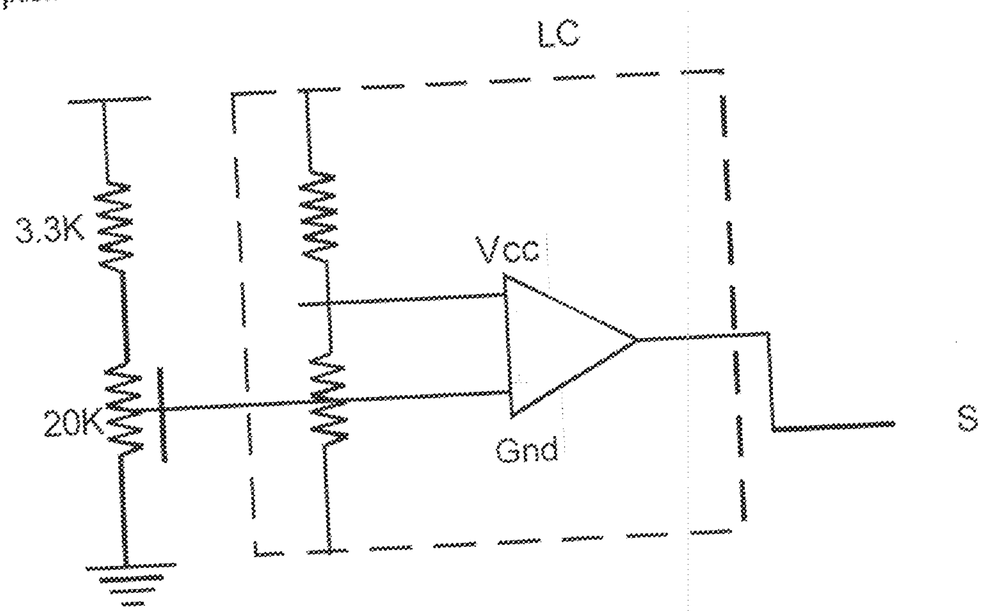


Fig 3.9 Diagram of the lower comparator of the 555 timer.

The network above also senses the terminal voltage and compares it to 1/2 of the reference voltage. The Lc is the lower comparator of the 555 timer.

½ ref = ½ * 5.6 v = 2.8 v.

Pin 2 can be varied through 20k variable resistor from

$$0 \text{ to } \frac{20}{20+3.3} * 12 = \frac{20}{23.3} * 12 = 10.3 \text{ v.}$$

It senses the lower level of the voltage when Pin 2 input has dropped below 2.8 v depending on the preset value or point. The flip flop is set, therefore, taking the output high.

In summary, the upper comparator reset the output to end the charging process while the lower comparator, sets the circuit to commence the charging process.

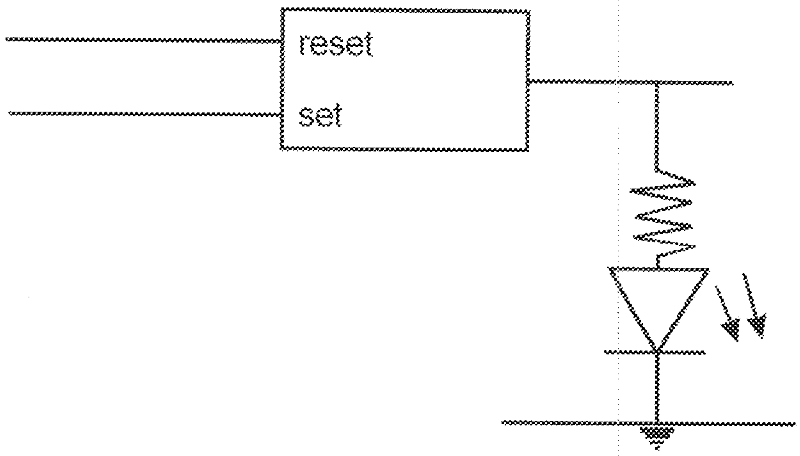


Fig 3.9.1 Connection of LED.

An LED must have a resistor connected in series to limit the current flowing through the LED otherwise, it will burn instantly. The output is the normal 555 timer output which is a approximately Vcc = 12,

Vout = 10.3 v.

$$R2 = \frac{Vout - VLED}{I}$$

$$\frac{10.3 - 2V}{20mA} = \frac{8.3}{15mA} = 553.3\Omega$$

A 680 resistor is chosen because it is the nearest standard resistor value. It is also chosen in order to increase the battery life.

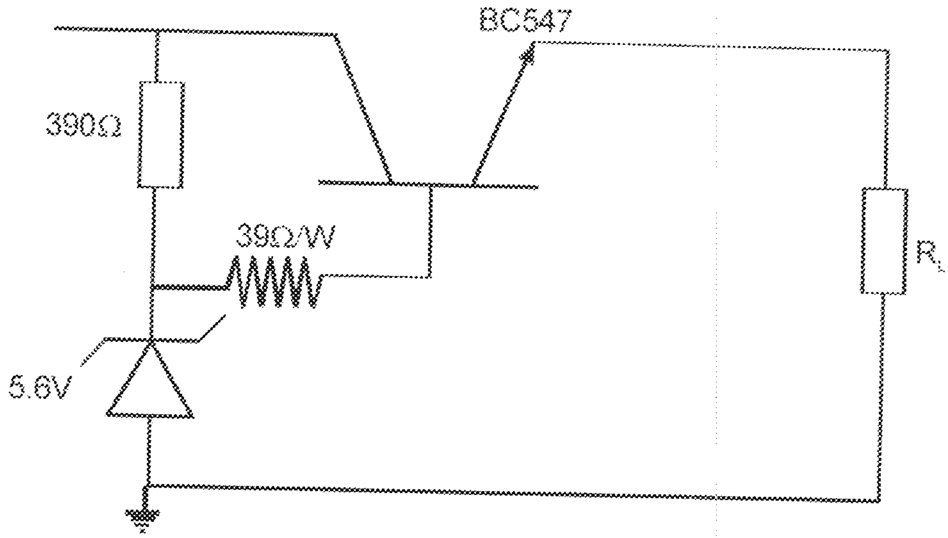


Fig 3.9.2 Series Regulation

The above is a series regulator. The base voltage is maintained at fixed voltage by the voltage drop across the Zener. If the load current increases for some reason, there will be an increase in voltage across 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 5.6 – 0.7 = 4.9v, where 0.7 is the V_{BE}. This voltage is sufficient to charge Nokia phone whose charging voltage is about 4.7. For other products like Motorola, Samsung and Sagem, the Zener is replaced with a suitable one. In this design, three voltages are apparent. These voltages include 4.2, 3.6 and 5.6 volts for products whose charging voltages are around these values.

3.1.9 MODE OF OPERATION

When a cell phone was connected across the output terminals; the lower and upper comparator of the IC senses the output terminal voltage of the battery and compares it with the reference voltages 5.6V, 4.2V, 3.6V provided by the reference Zener diode. The trigger input pin drops below 1/3Vcc (4V) depending on the preset value, thereby taking the output pin 3 high, at this point charging commences (The LED illuminates indicating that the battery is charging). When the voltage has appreciated and goes above 2/3 Vcc, the output becomes low and sets the flip flop to zero, thereby terminating the charging process (the LED goes off indicating that the charging process has ended). It should be noted here that after multi usage of the charger, the voltage goes low and may not charge effectively. The charger batteries would hence require charging. The charging process for mobile phone charger batteries follows a similar pattern. When the outlet of the mobile phone charger is connected to the A.C. mains, the transformer unit steps down the voltage from 220V to 12V which is suitable for charging the mobile charger batteries. The rectifying circuit of four diodes connected together to form a bridge rectifier, converts the A.C signal from the transformer into a pulsating D.C. voltage which charges the batteries. An LED illuminates, indicating that the battery is fully charged.

3.2.0 CONSTRUCTION

In the construction of the project, certain things were put into use such as breadboard /project board, which is usually a white rectangular kind of board with some tinning holes that conduct vertically and horizontally.

The essence of the breadboard is to assemble whatever the design is and carry out anything possible and ascertain the practicability of the project with necessary adjustment made before it is transfer to a Vero- board where soldering is finally being done.

Among other things used was the soldering iron for the purpose of soldering, lead suckers for sucking molten lead during the soldering. also used was a Vero board, onto which the individual components were mounted and soldered, It has both components and soldering parts. Other things used during the process of construction are pliers, side cutter, connecting wires e.t.c.

3.2.1 FUNCTIONS OF EACH COMPONENT USED IN THE CIRCUIT

Resistors (R_1, R_2, R_3, and R_7): are current limiting resistors. Current limiting resistors are series resistors inserted into a circuit to limit the current to the prescribed value [2].

RESISTOR R_1 (390 ohms) – is a current limiting resistor connected in series with a Zener diode. This is necessary to prevent the current from exceeding maximum allowable values which when surpassed, would cause the Zener diode to conduct excessively, thereby overheating. It simply holds back excessive current.

RESISTOR R_2 (680 ohms) – Resistor R_2 is also a limiting resistor connected in series with the LED to limit the current through the LED so as to avoid instant burn out of the LED.

RESISTOR R_3 (39 ohms) – resistor R_3 is critical in providing the required current for charging.

RESISTOR R_7 (100 ohms) – resistor R_7 limits the current flowing into the transistor. Uncontrolled current into the transistor can damage it.

RESISTORS R_4, R_5 R_6 (27k, 47k, 3.3k) – form a divider network for pin 2 and 6.

VARIABLE RESISTOR 1 and 2 (20k each) are resistors whose values can be varied either continuously or in steps. It sets the voltages needed by pin 2 and pin 6 to a predetermined level.

CAPACITOR C_2 (0.01μF) – capacitor C_2, removes spikes generated in the circuit especially during switching operations which is carried out in the 555 timer.

CAPACITOR C_3 (4.7μF, 25V) – capacitor C_3 is a smoothening capacitor. It removes any possible A.C. It also filters any possible glitch created by a standard 555 timer on supply when their output changes.

ZENER DIODE, ZD_1, ZD_2, ZD_3 (5.6, 4.2, 3.6) : the Zener diode provides pin 5 with reference voltage and regulated charge voltage due to varying current produced by the variable resistors. It also prevents back flow of current.

TRANSISTOR (BC 547) – the transistor is used to enhance the charging current.

IC NE 555 Timer – this is used to charge and monitor the voltage level the battery.

TRANSFORMER (Voltage transformer) – the transformer is used to step down a 220v voltage to 12v voltage.

BRIDGE RECTIFIER DIODE – the bridge rectifier convert the A.C signal into pulsating D.C voltages.

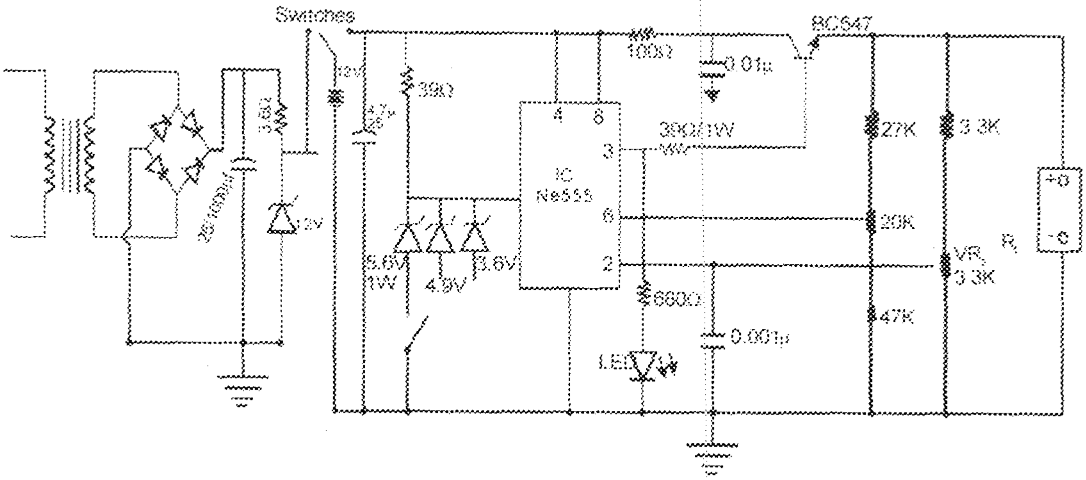


Fig 3.9.3 CIRCUIT DIAGRAM OF A MOBILE CELLPHONE CHARGE

CHAPTER FOUR

4.0 TESTING AND OBSERVATION

At the end of the whole construction of the project work, a cell phone battery was connected across the output terminal. When a cell phone battery was connected to the charger the LED turned on indicating that the battery is charging, and when the cell phone battery was fully charged, the LED went off.

Secondly, the rechargeable dry cell batteries of the mobile phone charger were recharged via A.C. mains. This was necessary, since it can be obviously deduced that the charger cannot continue to charge indefinitely. The mobile charger was plugged into the A.C. mains socket. This action switched off the LED indicator. After a while, say, 2-3 hours depending on the frequency of usage, the indicator comes on, signifying the battery is fully charged.

4.1 RESULTS

The following results were obtained at the end of the construction.

Output voltage from the rectifier- 14 V

Circuit current rating = 180mA

Circuit power rating = 2.16watts

Circuit current rating when Zener diode 1 is used = 1.00W

Circuit current rating when Zener diode 2 is used = 0.76W

Circuit current rating when Zener diode 3 is used = 0.65W

Transformer output = 12V

4.2 DISCUSSION OF RESULT

Comparing the expected result (theoretical) with the results obtained at the end of the work, there were some little differences which was not too much anyway. These differences might be due to tolerance value of the various components used which might not give the exact value.

4.3 TROUBLE SHOOTING

Troubleshooting can simply be defined as a process of identifying problems with a view to finding possible solutions to them. A problem can be described as a deviation from a standard, such as malfunctioning and inoperable products. When the cause of a problem has been identified, then the decision on how to repair it follows. One approach of troubleshooting is: define the problem, investigate the problem, analyze the information and determine the cause of the problem.

The ohmmeter is probably one of the most important in service. This meter is used in measuring continuity or resistance in a component or circuit. A component having continuity has resistance near zero while those having no continuity would read infinite. For the purpose of this circuit, the following components can be troubleshooted.

RESISTOR – The most common defects of resistors are physical cracking and charring. When excessive current and heat tend to increase the resistance, the resistor opens. A charred or discoloured resistor should be replaced since the resistor would often read well with an ohmmeter, but open under voltage in the circuit.

CAPACITORS – A capacitor below 25µF does not show readings on an ohmmeter. A near zero reading indicates a shorted capacitor. When checking the capacitor, place the leads of the ohmmeter across the leads of the capacitor. When this is done, the needle deflects upwards and slowly drops back down to near zero. Failure of needle deflection indicates a shorted capacitor. The following techniques can also be used in troubleshooting capacitors: Resistance measurement, capacitance measurement, spank test, bridging and substitution.

BATTERIES – The correct output voltage of a battery is very important. An excellent battery should exceed its rate value e.g. a new dry cell battery rated 1.5V d.c should measure between 1.5 to 1.6 V. On the other hand, weak batteries would read less than 1.5V.

TRANSISTORS – Are usually checked by either a transistor checker or by an ohmmeter. A too high reading indicates an open transistor while too low readings indicate shorted transistors.

IC NE 555 Timer- The first step in troubleshooting any IC is to use physical damages with or around it. Look for obvious problem areas such as corroded, defective or damaged pins, sockets or solder connections. The IC must be completely inserted in its socket and must be correctly positioned. Touch, is one of the techniques used in troubleshooting the IC so as to note its temperature. A hot IC is a good indication of a defective or shorted component. Most ICs should feel cool or warm to a touch. One could simply measure the voltage at each pin of the IC and compare the value with that of the manufacturers operating voltage. An incorrect voltage reading probably indicates a faulty IC. When a defective IC is found, replace with an exact replacement[3]

CHAPTER FIVE

5.0 RECOMMENDATION

Any project work is not an end to itself but a drawn of another invention, it is expected that others will continue from here. So, subsequent work on this subject should concentrate on modification of the circuit. Likewise digital display module could also be incorporated so that the output voltage could be displayed and reset to the required charging voltage of the mobile phone since the output is an adjustable one.

If this project is mass produced, cost of production would be greatly reduced. It is suggested that the school provides the means where by project work of this nature are commercially mass produced, this will make a good source of money.

5.1 CONCLUSION

From the whole work, though there were difficulties along the way, it could be concluded that the aim of the project was achieved, that is, a portable and inexpensive charger was constructed and the charger would charge a cell phone battery up within two to three hours of charging which is fairly O.K. and at a full charge the LED goes off.

It is thereby recommended for both private and commercial mobile phone users in both cities and rural areas.

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[2] STAN GIBILSCO eight edition (2001) 'The Illustrated Dictionary of Electronics', McGraw. Hill Companies.

[3] Daniel R Tomal and David V. Gedson (1999) 'Principles and Practice of Electrical and Electronics troubleshooting' published by TAB Boos Inc.

[4] Schuler (2001) 'Electronic Principles and Applications (fifth edition)

[5] www.freepatentonline.com

[6] www.springerlink.com

APPENDIX

COMPONENTS USED	QUANTITY USED.
LED	2
Zener diode	4
Resistors	
390Ω	1
100 Ω	1
680 Ω	1
39 Ω	1
27k Ω	1
47k Ω	1
3.3k Ω	1
20k Ω Variable Resistors	2
Capacitors	
0.01μF	1
0.001μF	1
4.7μF	1
IC NE 555 Timer	1
Transistor BC547	1
Switch	1
1.5 Volt Battery	8
Output Terminal	1
Transformer	1