# DESIGN AND CONSTRUCTION OF 500VA DC- AC INVERTER


BY

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG.) IN ELECTRICAL AND COMPUTER ENGINEERING .IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

MARCH, 2000

# DECLARATION

I, Sonaike Oluwaseun Paul, hereby solemnly declare that this project work "Design and Construction of a 500VA DC to AC Inverter/Charger is the result of my personal effort. It has never been presented elsewhere either wholly or in part for any degree or diploma.

All information derived from published work used in this project have been duly acknowledged.

.................................................... 24/03/2000 ..........

Signed. Sonaike O.P. DATE.

## CERTIFICATION

This is to certify that this project work was carried out by Sonaike Oluwaseun Paul in the Department of Electrical and Computer Engineering and it has been found to be adequate in scope and content in partial fulfillment for the award of Bachelor's degree in Electrical and computer Engineering (B. Eng).

........................................ 24/03/2000........................

MR. PAUL ATTAH DATE

(PROJECT SUPERVISOR)

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DR. Y.A. ADEDIRAN DATE

(HEAD OF DEPARTMENT)

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EXTERNAL SUPERVISOR DATE

# DEDICATION

To God who made the firmament, Who made the deepest sea, to him in whom I live and have ny being. To the God who put the stars in place, who gave his son to die for me. This project vork is dedicated to the Almighty God, the Ancient of Days, and to my parents, Pastor (Dr.) nd Mrs. P.O Sonaike.

## ACKNOWLEDGEMENT.

It is humanly impossible for one to remember all those who have contributed in one way or the other to one's success in an endeavour. For those whose names are not explicitly mentioned below, I crave your indulgence.

My sincere and heart felt thanks goes to my parents Pastor (Dr.) and Mrs. P.O Sonaike, Who Have been such wonderful Parents to me. I am so proud to have such wonderful parents, and words alone cannot express how grateful I am, thank you so much for your love.

I also want to appreciate my supervisor, Mr. Paul Attah , who despite his busy schedule made himself available when ever I needed his advice during the course of my project work.

My thanks also goes to Mr. and Mrs. Jide Okafor , Mr. and Mrs. Kolade Fagade, Mr. Tola Awosanya, Miss Iyabo Ogunremi,Mr. Segun Kolade and Mr. Sukanmi Osuporu, for their unflinching support and encouragement.

I am also grateful to the following people who offered their assistance in every area, Mr. Debola Ogunsina ,Mr. Lanre Idris, Mr. Kunle Osobu, and Engr. Abiodun Adekunle.

My appreciation also goes to my friends, Diran Olatunji, Wale Ajayi, Funsho Ajibola Folakunmi Ojemuyiwa, Wale Adeoye, Michael Ogundele, Shola Olarewaju, Femi Adegbola Muyiwa Adegunleye and Olumide Adenaiya ,who were a big encouragement during my stay in school.

My appreciation will not be complete without expressing my thanks to my best friend , Miss Olajumoke Ogunde , whose interest and words of encouragement were a source of inspiration during the course of my project work. And to my younger ones Tope , Kunle and Tolu Sonaike , I love you all.

# LIST OF FIGURE AND TABLES

## ABSTRACT

Due to the erratic nature of Electricity supply in Nigeria today and the high cost of procuring standly generating sets it became necessary to look for alternative methods of generating electricity for domestic use.

The Purpose of this work is to develop the d.c - a.c Inverter/ charger unit as an alternative to the use of generating sets because of its low cost and its maintenance free nature.

The components used in this design are locally available thereby making it possible to produce the Inverter /charger unit cheaply.

The inverter charger was designed using power Mosfets as the main inverter switching components and the switching signals were generated by a 555 timer Astable multivibrator. It is essentially a square wave Inverter. The Inverter/ charger can power loads up to 500VA from an ordinary 12 volts car battery.

# CHAPTER ONE

## 1.0 INTRODUCTION

Due to the unavailability of a constant supply of Electricity in Nigeria, coupled with the high cost of procuring standby generating sets, it became necessary to devise an alternative source of electricity that is cheap and Environment friendly.

An Inverter is a device that transforms a direct current input into an alternating current output. Inverters are powered by batteries which are a source of direct current

The concept of d.c - a.c inversion is not a new development, infact inverters have been employed in uninterruptible power supplies for computer protection and in motor control applications. The objective of this work however is to employ the d.c-a.c Inverter as an alternative source of electricity for household use and also for small scale power needs.

An inverter allows you to use equipment that run on alternating current on vehicles, since the inverter can be directly connected to the electrical system of the vehicle. This means that Television sets, Video cassette recorders and other appliances that run on a.c. can now be used in cars, Buses and trucks

The inverter/charger consists of two units viz. The inverter unit and the battery Charger unit.

### INVERTER UNIT

Fig. 1.1 shows the inverter in a very simple form. The input d.c. is converted into pulses by the pulse generator. The pulses are used to turn a set of Power Mosfets on and off.

The Mosfets are controllable switches i.e. their "on" and "off" states can be controlled. Other controllable switches that could also be used are the Bipolar junction Transistor (B.J.T.) and the Thyristor (silicon controlled rectifier). At the power stage is a step up Transformer which has enough power rating to power the load.

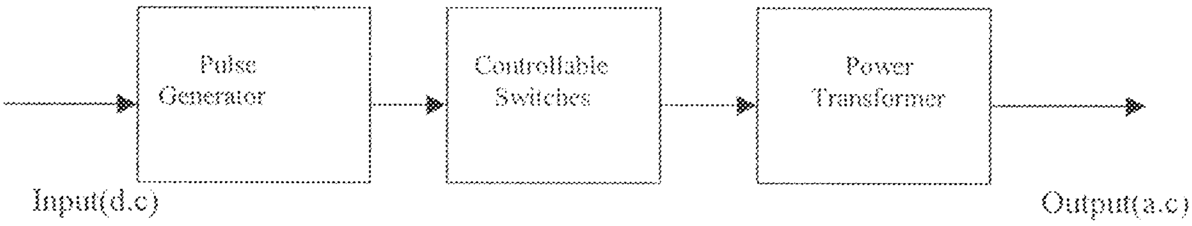


Fig 1.1 Schematic diagram of d.c - a.c Inverter

Voltage source inverters that are being employed are of three types.

1) **PULSE WIDTH MODULATED (PWM) INVERTERS:-**

In these inverters the input D.C is essentially constant in magnitude. The inverter therefore must control the magnitude and the frequency of the AC output voltages. This is achieved by pulse width modulation at the inverter switches. There are various schemes to pulse width modulate the switches in order to shape the output AC voltage to be as close to sine wave as possible.

2) **SQUARE WAVE INVERTERS**

In these inverters, the input d.c voltage is controlled in order to control the magnitude of the output a.c voltage and therefore the inverter has to control only the frequency of the output voltage. The output a.c voltage has a waveform similar to a square wave and hence are called square wave inverters .

3) **SINGLE -PHASE INVERTERS WITH VOLTAGE CANCELLATION**

In case of inverters with single- phase output, the inverter has to control the magnitude and the frequency of the inverter output even though the input to the is a constant d.c voltage and the inverter switches are not pulse width modulated (and hence the output voltage is like a square wave). These inverters combine the characteristics of the previous two inverters. Voltage cancellation technique work only with single-phase inverters and not with three phase systems.

## BATTERY CHARGING UNIT

The battery charging unit is shown in its simplest form in fig 1.2. the a.c. input has o be stepped down by a step down Transformer before it is rectified and filtered. The rectified output is passed through a voltage regulator and the regulated output can now be fed to the batteries for charging.

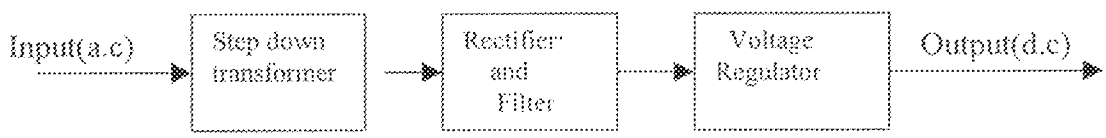


Fig 1.2 Schematic diagram of Battery Charger

Basically there are two methods of charging batteries which are:-

(1) Constant - current charging method

(2) Constant - voltage charging method

There are other methods which are also used, but they are modifications of the above mentioned methods

- Booster/high rate charging
- Trickle or slow rate charging
- Floating system

1) **CONSTANT CURRENT CHARGING**:- the battery charging takes place at a definite constant rate until no further rise in the specific gravity of the electrolyte take place.

2) **CONSTANT VOLTAGE CHARGING**:- it operates on the principle that as the battery nears its charge, the terminal voltage will increase with increase in opposition to charging current therefore a balanced potential occurs between the charger and the battery.

The method of charging employed in this project is the constant voltage charging method.

## 1.1 AIMS AND OBJECTIVES

The design of the Inverter/charger focuses on d.c - a.c Inversion using a readily available source of direct current, the battery. The design of the 500VA Inverter/Charger is quite simple and the electronic components employed for it's circuitry are readily available in the market.

The design takes into consideration the following:-

(1) Size and weight

(2) Output power

(3) Availability of components

(4) Overall cost

The Inverter/charger was designed to provide the following:

To provide freedom from noise , vibration and fumes of a generator, because it allows ou to obtain silent a.c. power without the need for a generator

*To provide adequate power for household appliances like TV, VCR, stereo and most small ppliances independently of the public electricity supply in areas in which the supply is not vailable , especially in the rural areas.

*To serve as a standby supply of electricity when there is mains failure

*To provide a cheap alternative to a standby generating set.

## 1.2 LITERATURE REVIEW.

Before the development of the d.c - a.c Inverter, there was no other way to obtain AC power other than from the mains supply or from standby generating sets. The mains supply in Nigeria is quite unreliable and generating sets are quite expensive to procure. The development of the d.c-a.c Inverter has therefore made it possible to obtain AC from batteries which are readily available.

The world's first high performance power Inverter was introduced in 1983 by Heart interface who has been a leader in Inverter /charger technology.

It was the first reasonably priced commercially marketed Inverter /Charger It was the first reasonable priced commercially marketed DC-AC power inverter.

In 1984 Heart Interface patented and introduced inverters utilizing Field effect transistors (ie. Mosfets -Metal Oxide Semi Conductor Field Effect Transistors). for the main power output devices . The use of Mosfets made the designs smaller because they are much smaller than Bipolar Junction transistors.

## 1.3 PROJECT OUTLINE

This write up centres around the design and construction of a 500VA DC-AC inverter/charger and it gives a step by step analysis of the design stages involved.

Chapter one, directly dwells on the concept at DC-AC inversion and the various methods used in achieving this.

Chapter two outlines the process of designing the inverter/charger system and the various levels that make up the complete system.

Chapter three deals with the process of Assembling the various component parts of the inventor/charger system and the testing of the design and also the analysis of the results obtained.

Chapter four gives the concluding remarks , recommendations and references.

# CHAPTER TWO

## 2.0 SYSTEM DESIGN

To make the construction of the inverter /Charger system,it was necessary to break down the complete system in to much simpler modules

## 2.1.0 COMPONENTS SELECTION

The major components employed in the design proces of the Inverter /charger include the following, Transistors:- BJTS and Mosfets, 555 Timer IC, voltage regulator IC and a number of resistors capacitors and diodes.

The electronic components were necessary to implement the various levels and units of the inverter/charger

## 2.1.1 317T - TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATOR

The 317T is an adjustable - terminal positive regulator capable of delivering a maximum current of 1.5A over a 1.2V to 37V output range. In addition to higher performance than fixed regulators, the 317T offers full overload protection available only in Ics. Included on the chip are current limit, thermal overload protection circuitry. Normally no capacitors are needed unlessthe device is situated far from an input filter capacitor in which case an input bypass is needed. An optimal output capacitor can be added to improve transient response.

The adjustment terminal can be bypassed to achieve very high input ripple rejection ratio which is difficult to achieve with standard 3- terminal regulators.

Besides replacing fixed regulators, the 317T is useful in a wide variety of other application since the regulator is floating and sees only the input to output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output voltage is not exceeded The 317T was used to control the magnitude of the d.c input in to the Inverter.

## 2.1.2 TLC 555 TIMER

The TLC 555 is a monolithic timing circuit fabricated using the CMOS process. Due to its high input impedance, it is capable of producing accurate time delay and oscillation using less expensive smaller timing capacitors.

The TLC 555 timer achieves both Monostable and Astable modes of operation. In addition a 50% duty cycle is possible by bypassing one of the Resistors with a signal diode.The Cmos process allows the TLC 555 to operate at frequencies up to 2MHz and be fully compatible with Cmos, TTL and Mos logic. It also provide a very low power consumption (Typically 1mW at $V_{cc}$=5V) over a wide range of supply voltage ranging from 2. Volts to 18 volts. Fig shows the 555 timer with its pin configurations.

The 555 timer was used as an astable multivibrator to generate square the pulses used in controlling the power Mosfets

## 2.1.3 VOLTAGE REGULATOR (78XX) SERIES)

This series of three terminal regulators are available with several fixed output voltages making them useful in a wide range of applications.

The voltages available allow these to be used in logic system instrumentation. This series allow over 1.5A load current to be supplied it adequate heat sink is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection is included to limit internal power dissipation. If internal power dissipation becomes too high for the heatsink provided, the thermal shutdown circuit takes over, preventing the IC from over heating. Common output regulated voltages are 5,6,12,15 and 24 volts.

## 2.14 POWER MOSFETS

The Inverter switching stage employs the power Mosfet for switching purposes. The Mosfet offers the designer a high speed, high power device with high gain, almost no storage time no thermal run away and inhibited breakdown characteristics.

The Mosfet is a majority carrier device, it is a voltage controlled device i.e. a voltage of specified limit must be applied between gate and source terminals in order to produce a current flow in the drain. Fig 2.12 shows the symbol of an N-channel enhancement mode Mosfet switch.

When the power Mosfet is used as a switch, the voltage drop between the drain and source terminal is proportional to the drain current, i.e the Power Mosfet is working in the constant resistance region and therefore it behaves essentially as a resistivity element, consequently, the on resistance of the power Mosfet is an important feature of merit because it determines the power loss for a given drain current.

In effect, drain current starts to flow after a threshold gate voltage has been applied. Beyond the threshold voltage , the relationship between the drain current and gate voltage is approximately equal.

In order to turn a Mosfet on, a gate- source voltage pulse is needed to deliver sufficient current to charge the input capacitor in the desired time. The input capacitor is the sum of capacitors formed by the metal oxide gate structure, from gate to drain ($C_{GD}$) and gate to source ($C_{GS}$) .

To turn off the Mosfet, since it is a majority carrier semiconductor device, it begins to turn off immediately upon the removal of the gate voltage and presents a very high impedance between drain and source, thus inhibiting any current flow. Fig 2.13. shows the terminal characteristics and load lines of the power Mosfet.

## 2.2 DETAILED DESIGN PROCEDURE

The inverter /charger system comprises of two main parts viz.:

(1) Battery charger module

(2) Inverter module

## 2.3 BATTERY CHARGING MODULE

The charging consists basically of a step down transformer whose output is rectified using a full wave bridge rectifier arrangement. Fig. 2.14. shows the circuit arrangement of a full wave bridge rectifier and it's associated wave forms.

For a full wave rectifier.

$V_L = 2\ V_{sm}$

Where

$V_L$ is the load voltage

$V_{SM}$ the max value of secondary voltage

$V_L = 16.5\ V$

$V_{SM} = V_L\sqrt{2}$

$V_{SM} = 16.5 x\sqrt{2}$

$= 25.9V$

The output of the rectifier is filtered and fed into a 15 volts regulator. This produced a constant output of 15V . The 7815 IC was used as the fixed voltage regulator.

The 7815 IC has a maximum rating of 1.5.A and it has to be mounted on Heatsinks to deliver it's maximum rated current.The MJ2955 Silicon N-P-N transistor was used to carry the load current from .To achieve this the MJ 2955 was connected in common base mode to the 7815 IC.

Assuming that a current of 100 mA flows into the voltage regulator, for load current greater than 100 mA the drop across the resistor turns on the current boosting out bound transistor ,limiting the current through the 7815 to 100mA but the output voltage is still maintained by the voltage regulator .

For a Bipolar junction transistor

$I_E = I_B + I_C$

Where $I_E$ = Emitter current

$I_B$ = Base current

$I_C$ = Collector current

The load current is 10A (supplied by the Transformer)

$I_B$ = Base current = 100mA

$I_C = I_E - I_B$

$I_C = 10 - 0.1$

$I_C = 9.99A$

So the load current can be delivered by the transistor. A current limiter was necessary to limit the current being drawn by the battery during the charging process.

Assuring that battery potential when weak is 11.5V v charge output voltage = 14v

Charger output current limit is = 8A

From Ohms law ,

$V = IR$

Assuming that a battery is at 11.5 volts

The charger output is 14 volts

Potential difference between charger and battery is

$V = (14 - 11.5) = 2.5$. volts

The value of limiting resistor was calculated as follows:

$R = V/I$

$2.5/8 = 0.3$ Ohms

Power dissipated by resistor

$P = I^2R = 8^2 \times 0.3$

$= 19.2W \approx 20W$

The battery charging circuit is shown in fig.2.15

## 2.4.0 INVERTER MODULE

The inverter unit can be divided into the following subunits

1) Inverter mode switch circuit
2) Pulse generator circuit
3) Inverter switching circuit
4) Output Power transformer

## 2.4.1 INVERTER MODE SWITCH

The section employs two NPN transistors and one PNP Transistors used as switches. This design eliminated the use of a relay to achieve switching between the inverter and charger units.

For a transistor to operate as switch, it must be operated in the saturation and cut off regions.

Figure 2.16 shows a typical BJT switch.

The collector current at saturation is given by $I_{c\,sat} = (V_{cc} - V_{sat})/R_C$

For the transistor to be in saturation $I_B$ must be $\leq 50\mu A$

$I_C = \beta I_B + I_{CEO}$

$I_{B\,sat} = (I_{C\,sat} - I_{CEO}) / \beta$

$I_b = (V_i - V_T) / R_B \geq I_{B\,sat}$

Where

$V_i$ = input voltage

$V_T$ = Threshold voltage (usually 0.7V)

$R_B \leq V_i - V_T$

The Inverter mode switch arraugment is shown is fig 2.17. When there is an input at $D_1$ to the base of Transistor $Q_1$ base current flows and $Q_1$ conducts, shutting out base current to the base of $Q_2$ by putting it's base at a zero potential. This turns $Q_2$ off and since current can not flow out of $Q_3$, the transistor $Q_3$ also is turned off.

Therefore since there is no input to the pulse generator, the inverter is off.

When the in to $D_1$ is removed $V_{cc}$ is dropped across $R_1$ and current flows to the base of $Q_2$ thereby turning it on and $Q_3$ is now on also, because base current can now flow out through it's base. Therefore the inverter comes on.

The input to $D_1$, is available when the inverter/charger is plugged to the mains and acts as battery charger.

## 2.4.2 PULSE GENERATOR CIRCUIT

The pulse generator was designed using a 555 timer Ic connected as an Astable multivibrator. Fig 2.18 shows the schematic diagram of a 555 timer Ic connected in an astable mode and the 'on' and 'off' nature of its output wave forms.

In the astable mode the frequency of oscillation can be calculated.

Let $t_{on}$ (the 'on' time of the 555) = 0.693 $(R_1+R_2)C$

Let $t_{off}$ (the off' time of the 555) = 0.693 $(R_2)C$

C is the Timing capacitor

It is apparent that the 'on' time must always exceed the 'off' time in this configuration unlesss $R_1$, has a very low resistence compared to $R_2$.

Therefore to make $t_{on} = t_{off}$ equal values were chosen for $R_1$. and $R_2$ and a Diode was connected across $R_2$

This now gives.

$T_{on} = 0.693\ R_1\ C$

$T_{off} = 0.693\ R_2\ C$

$T = t_{on} + t_{off}$

But $R_1 = R_2$

$T = (0.693 + 0.693)\ RC$

$T = 1.386$

$T \approx 1.4RC$

But $f = 1/T$

$f = 0.7/RC$

Assuming $R = 10k\Omega$

Frequency = 50 Hz

$50 = 0.7/10 \times 10^3 \times C$

$C = 0.7/(10 \times 10^3 \times 50) = 1.4\mu F$

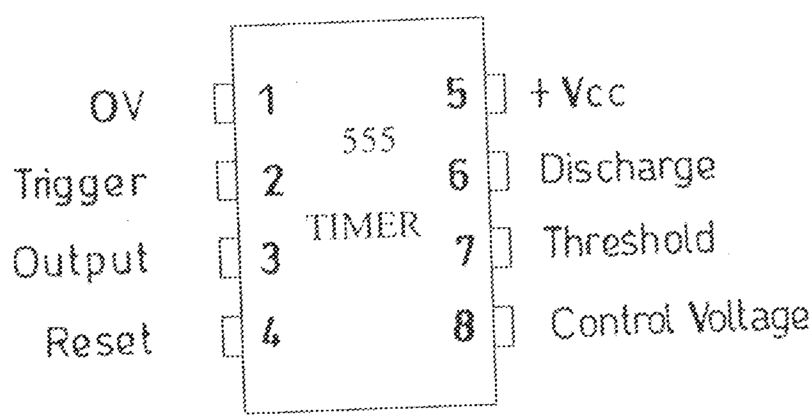


Fig 2.11 555 timer Ic

### 2.4.3 INVERTER SWITCHING CIRCUIT

This circuit employs six IRF540 Power mosfets connected in parallel. This allows for a sharing of the load current and provides more efficient power handling .The Mosfets are connected directly to the power transformer to make up the power stage

### 2.4.4 POWER TRANSFORMER

A transformer is a static or (stationary) piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. The voltage can be raised or lowered. but with a considerable drop in current. The transformer comprises of two windings. The primary and secondary windings.

The transformer used for the inverter/ charger is a step up transformer.

Let $N_1$, = No of turns in primary

$N_2$ = No at turn in secondary

$\phi_m$= Maximum flux in core in webers

= BmXA

$B_m$=maximum flux density in the core

A = area of the core

F= frequency of a.c. input in Hz

Since flux increases from its Zero value to maximum value $\phi_m$ in one quarter of the cycle i.e. 1/4 f second.

The average rate of charge of flux

= $\phi_m/0.25f$

= $4f\phi_m$ wb/s or Volt.

The rate of change of flux per turn means induced e.m.f. in volts.

Average e.m.f / turn $= 4f\phi_m$ Volt.

If $\phi$ varies sinusoidally them r.m.s. value of induceed e.m.f is obtained by multiplying the average value with form factor.

Form factor = r.m.s value = 1.11

r.m.s. value of e.m.f. / turn = $1.11 \times 4f\phi_m$ = $4.44f\phi_m$ Volt

Now r.m.s value of the induced e.m.f in the whole of primary winding.

= (induced e.m.f./turn) x No. of primary turns

$E_1 = 4.44fN_1\ \phi_m = 4.44fN_1\ B_m\ A.$ ............................................................ (i)

Similarly r.m.s value of the e.m.f induced in the secondary is

$E_2 = 4.44fN_2\ \phi_m = 4.44fN_2\ B_mA$ ............................................................ (ii)

From eqns. (i) and (ii) it can be seen that

$E_1/N_1 = E_2/N_2 = 4.44f\phi_m$

This means that the e.m.f to turns ration is the same in both the primary and secondary windings from egn (1) and (ii)

$E_2/E_1 = N_2/N_1 = K$

Where K is the voltage transformation ratio

Neglecting losses

Input power = Output power

$V_1I_1 = V_2 I_2$

or $I_2 / I_1 = V_1 / V_2 = 1/k$

Output of inverter/charger 500VA

Output voltage = 220V

$I_2$ (Secondary Current) = output power (VA)/Out put voltage

= 500/220 = 2.27A

$I_1$ (primary current) $= I_2 V_2/V_1 = 500/12$

$= 41.67A$

Assuming that due to losses that the peak voltage obtained during oscillation is less than the maximum of 12 volts, a 9 volt to 220 V step up transformer was used instead.

For the inverter output stage a 500VA, 9V to 22OV step up transformer was used. The complete inverter circuit is show in fig 2.20

### 2.4.5. COOLING SYSTEM:-

Due to the heat generated by the inverter operation, it be was necessary to cool the Mosfets by mounting on an aluminum heat sink. A 12v d.c brushless fan was mounted to draw out the heat produced in the Inverter and in the process draw in cool air through openings in the casing .

### 2.4.6 . STATUS INDICATOR

This consists of two light emitting Diodes connected to the inverter and charger circuits to indicate the mode in which the Inverter/charger is operating. The Green LED shows that the inverter/charger is in the battery charging mode. The orange LED comes on when the inverter/charger is in the inverter mode.

### 2.4.7 BATTERY

The battery provides the d.c input to the inverter. The capacity of a battery is the quantity of electricity which it can give out during a single discharge.

In other words it is defined as the product of the discharge current and discharge time. It is expressed in ampere hour (Ah). The Ah is the amount of power in amps that the battery can deliver over a specified period of time.

To increase the amp hour rating of batteries, battery banks can be created by connecting paralled connection of batteries. When batteries are connected in parallel the voltage of the battery bank is the same as that of each individual battery. The amp hour rating is equal to the sum of the amp hour ratings of each battery.

To calculate typical power requirement for a device connected to the inverter

For a 100W lamp

Battery voltage = 12V

Assuming an efficiency of 70%

Efficiency factor = 100/70 = 1.43

d.c amps = a.c Power /battery voltage

100/ 12 = 8.3A

Actual d.c amp = a.c amps x Efficiency factor

= 8.3. x 1.43

= 11.9A

If the lamp is run for 4 hours

amp hours consumed

= 4hrs x 11.9

= 47.6Ah

For the Inverter/charger to power the load given for the four- hour period, a 60Ah car battery is suitable

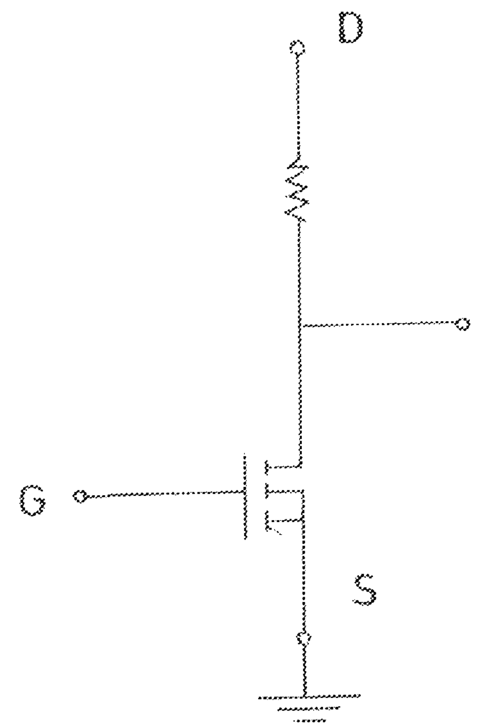


Fig 2.12 N-Channel Mode Mosfet Switch

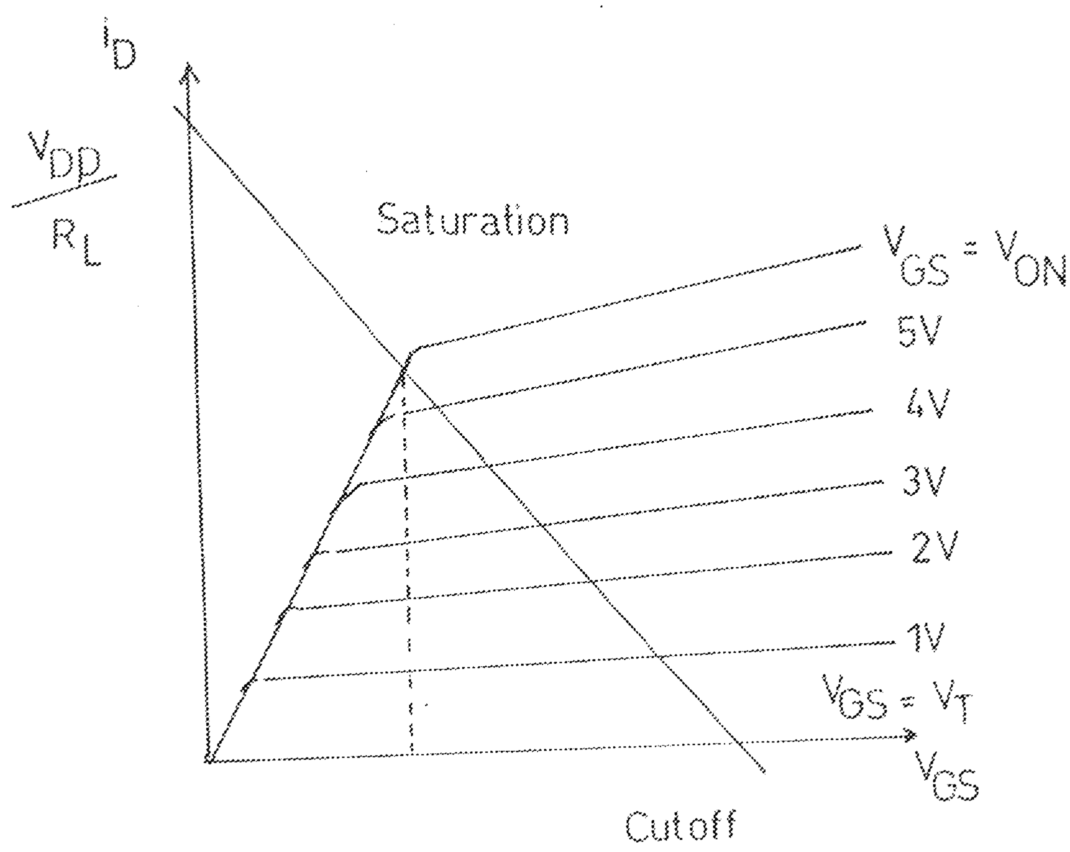


Fig 2. 13 Terminal Characteristics And Load Line Of Mosfet

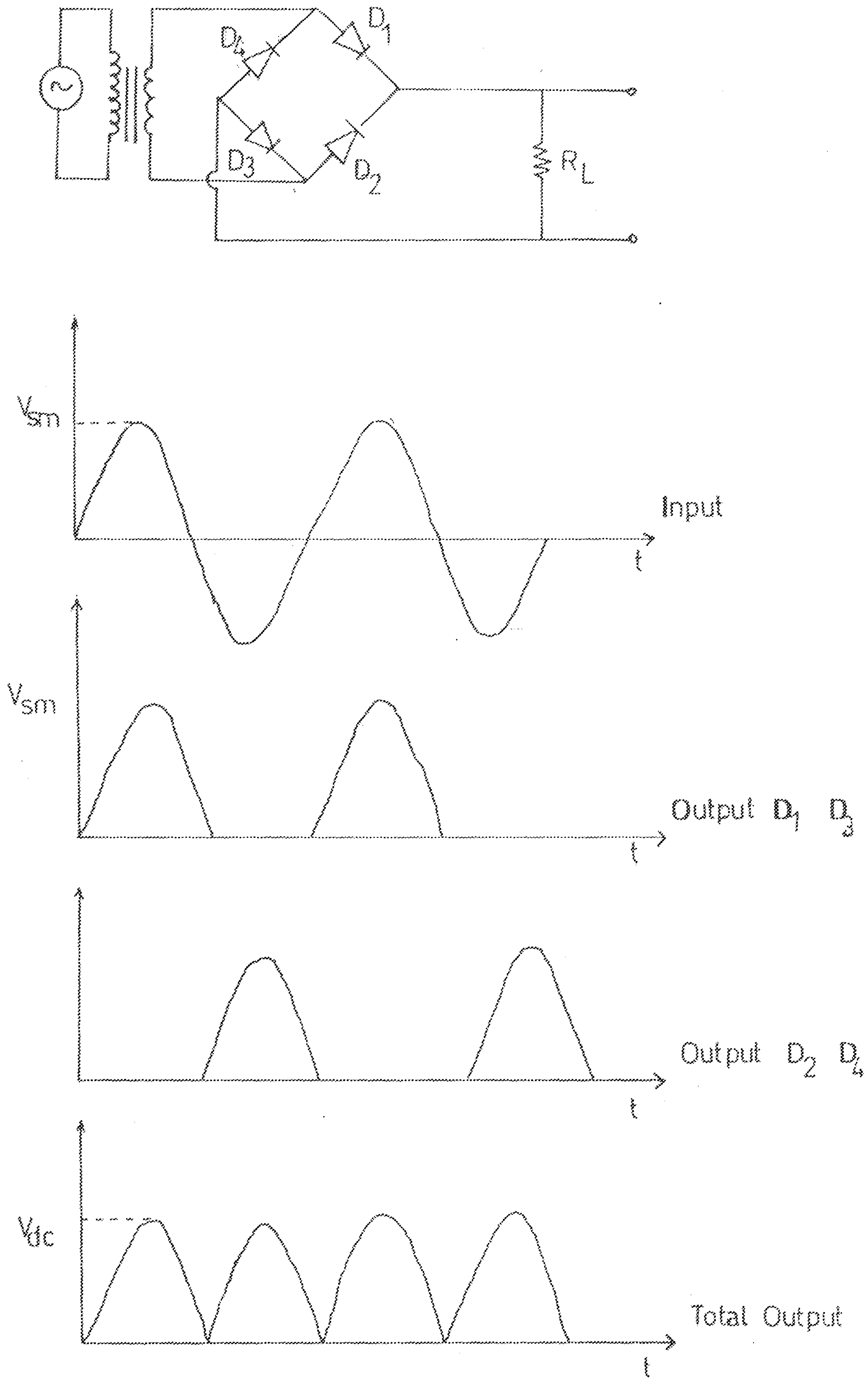


Fig 2.14 Fullwave Bridge Rectifier

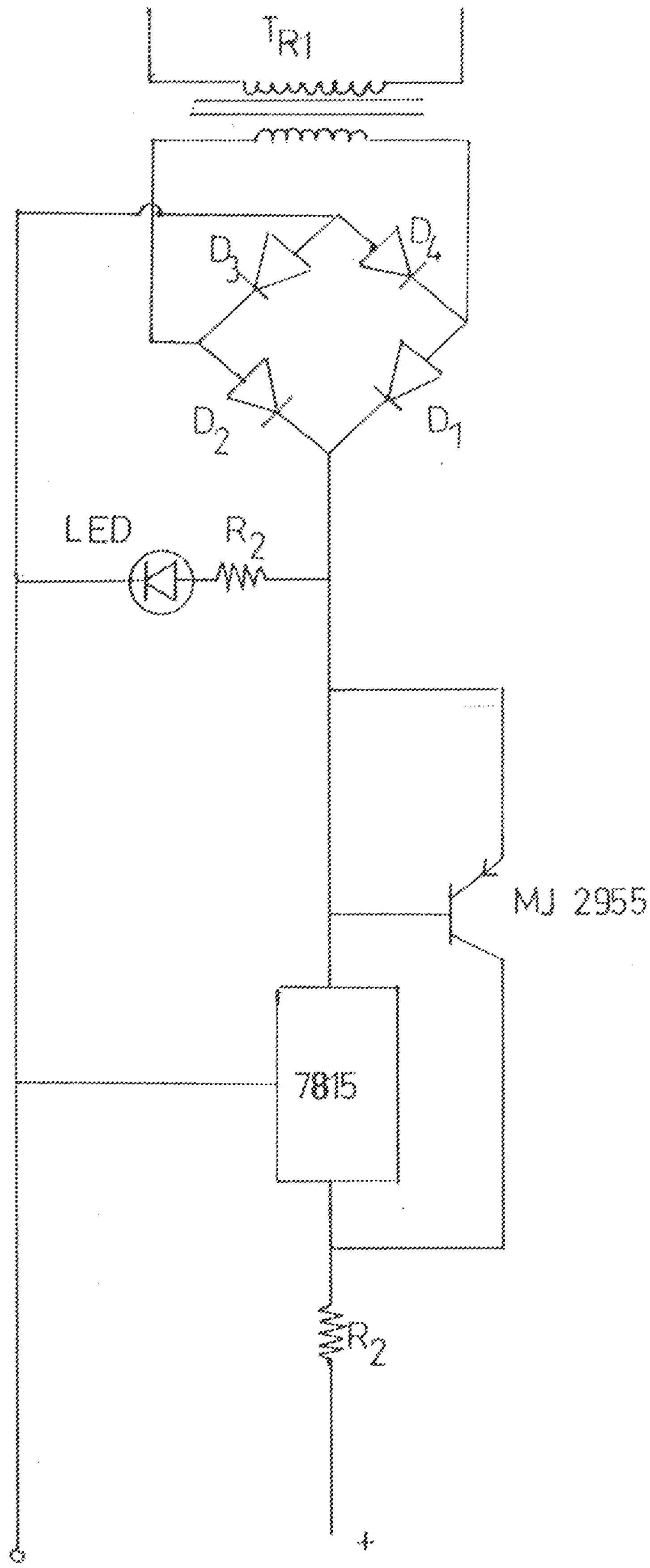


Fig 2.15 Battery Charger Circuit

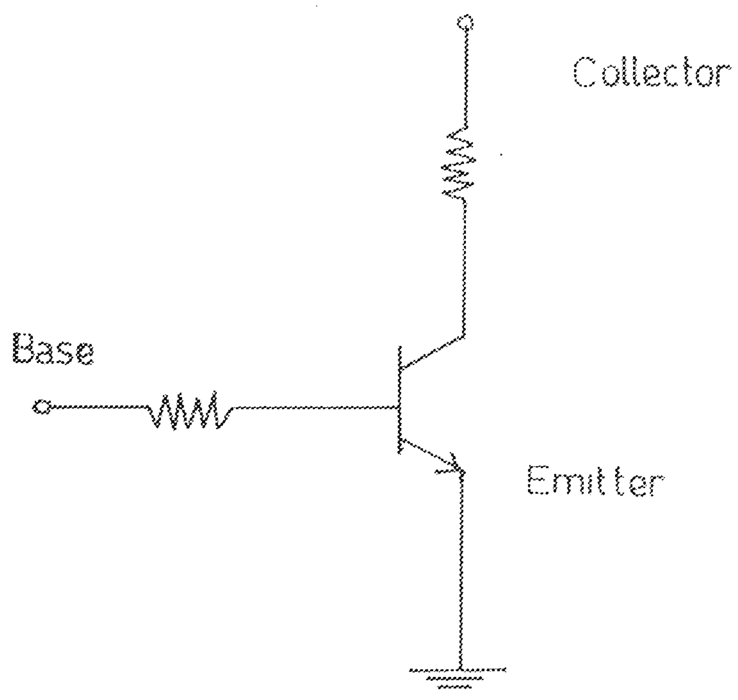


Fig 2.16 Typical BJT Switch

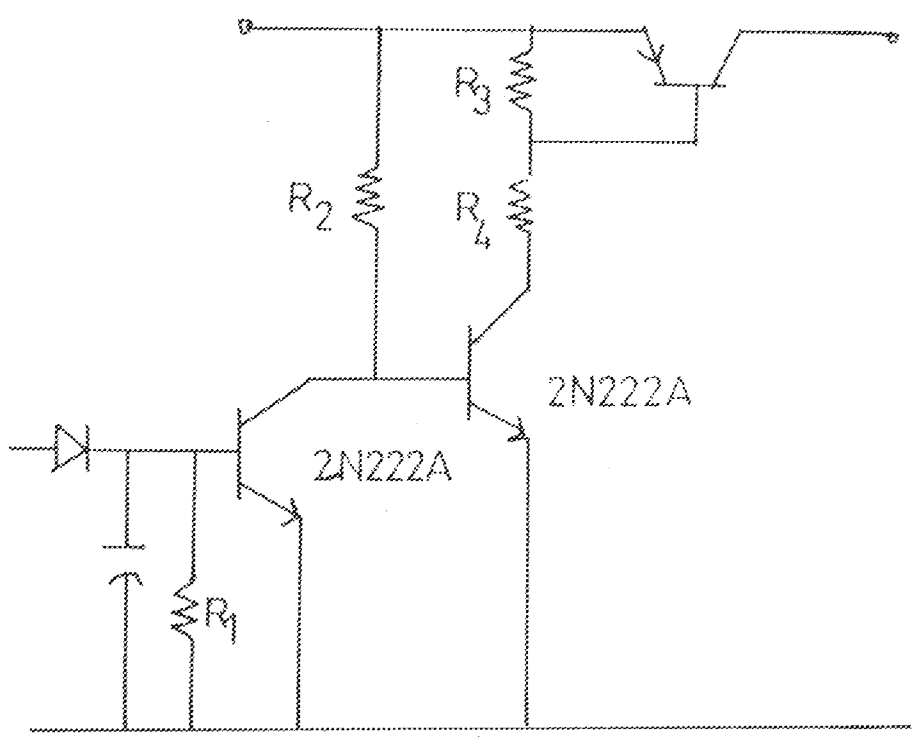


Fig 2.17 Inverter Mode Switch

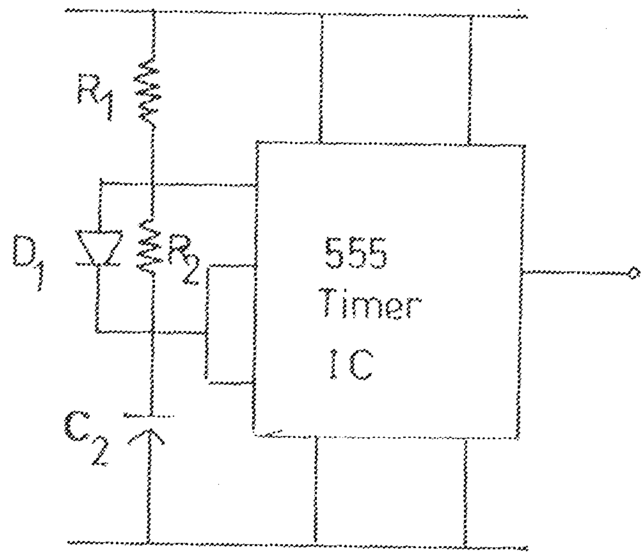


Fig 2.18 **555** Timer **IC** Astable Multivibrator

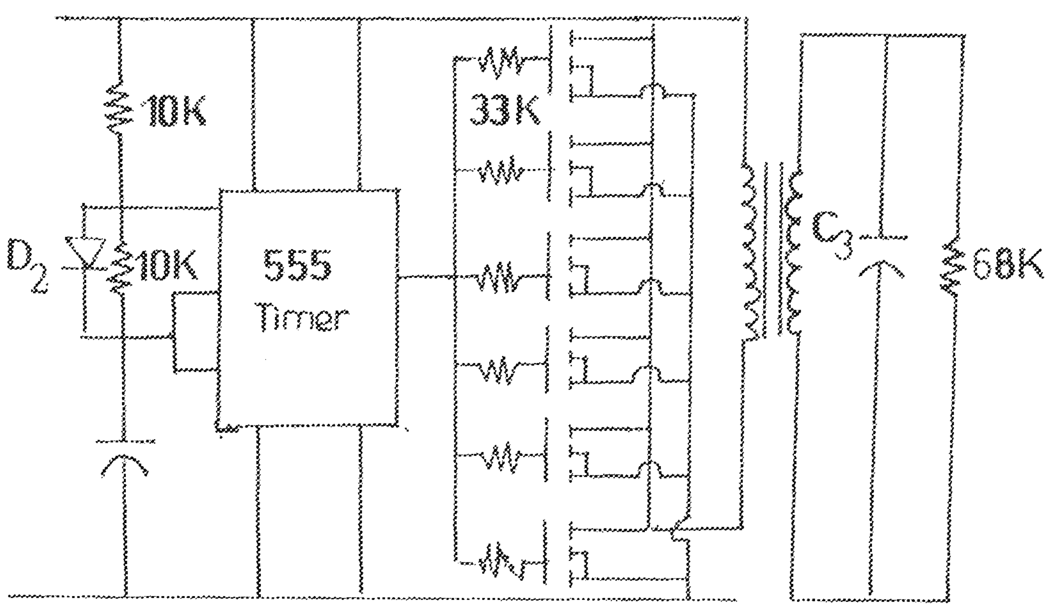


Fig 2.19 Inverter Circuit

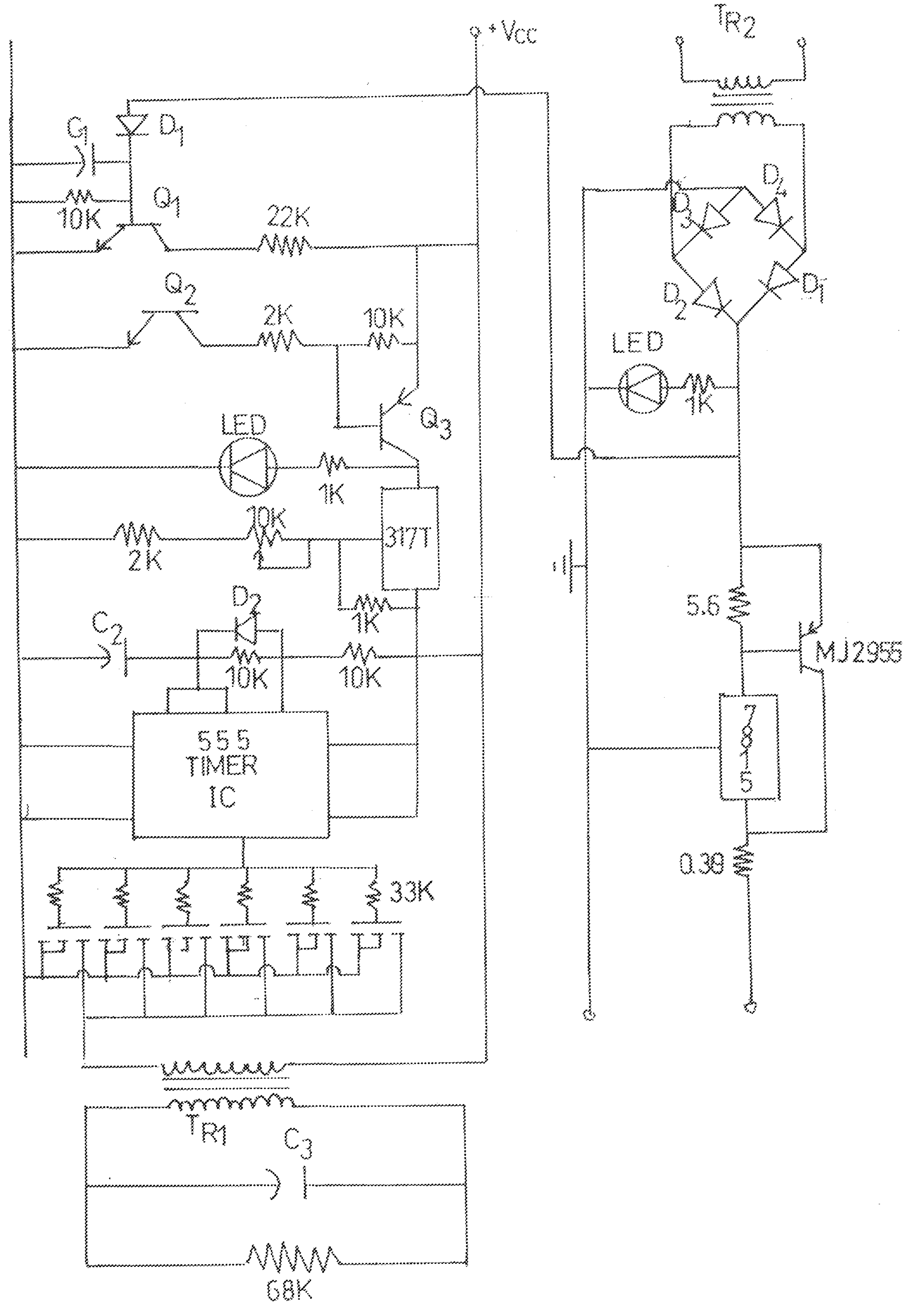


Fig 2.20 Complete Inverter Charger Circuit

# CHAPTER THREE

## 3.0 CONSTRUCTION PROCEDURE

The construction procedure involved first temporarily connecting the circuit components on a Bread board according to the circuit diagrams. The charger module was first connected and the output voltage was measured. The circuit was then transferred onto the Vero board.

The inverter module was also connected on the Breadboard and the output waveforms of the 555 timer was observed on the oscilloscope. The inverter/charger mode switch components, the pulse generator excluding the Power Mosfets were then soldered on to the vero board.

The holes for the cooling fan, transformers, indicator LEDS and other necessary perforations were made in the prefabricated metal casing. The strong metal case was necessary because of the heavy components of the inverter charger.

The Mosfets were then mounted on the Aluminium heat sink and screwed down. The connecting wires were then connected to the various points as indicated on the circuit diagram. The heat sink was necessary because of the heat dissipated by the power mosfets.

The components were finally assembled together in the metal casing and all wires were connected to the various parts. After all the parts were connected, a visual inspection was carried out to check all connections.

The complete Inverter /Charger is shown in fig 2.21

## 3.0 TESTING.

Having ensured that all the necessary connection were fully made, the inverter/charger was connected to a 12V 60Ah car battery. The output voltage was then measured. The variable resistor, $VR_1$ was adjusted until the output voltage was at 220V

Various loads were applied to the output of the inverter unit. Their respective power consumption is shown below:

Table 1.1 Power consumption of Appliances

| APPLIANCE | POWER CONSUMPTION (WATTS) |
|---|---|
| 21" colour Television | 100 |
| Video cassette recorder | 50 |
| Stereo player | 50 |
| Lamp | 100 |
| 14" colour television | 70 |
| personal computer and Hp DeskJet printer | 300 |

## 3.2 RESULTS

Since the Inverter was powered by a battery, it was necessary to consider the power consumed from the battery the fig 1.2 shows the power consumed by some appliances from the battery over a period of time

Table 2.3. Typical power consumption of appliances over 3 -hour period

| | | APPLIANCE RUN TIME/ AMP HOUR | | |
|---|---|---|---|---|
| APPLIANCE | TYPICAL WATTAGE | 1 HOUR | 2 HOURS | 3 HOURS |
| VCR | 50w | 6 | 12 | 35 |
| 21" Television | 100w | 12 | 23 | - |
| Stereo Deck | 50w | 6 | 12 | 35 |
| PC & printer | 300w | 35 | - | - |
| Lamp | 100w | 12 | 23 | - |

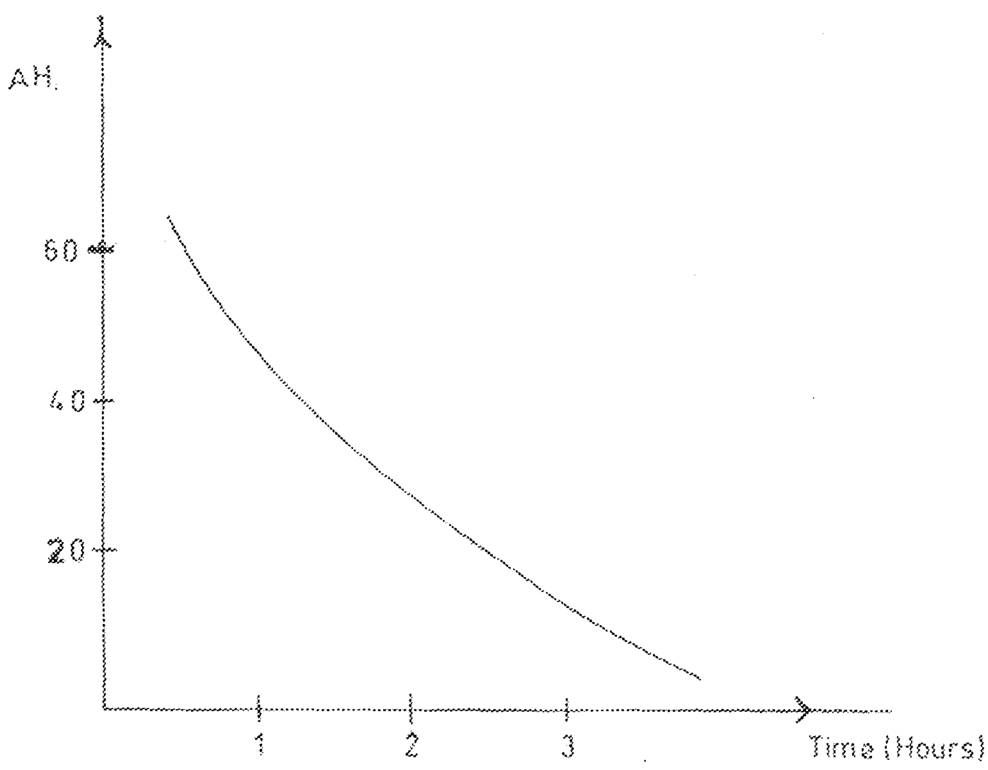


FIG 2.21 VARIATION OF BATTERY CHARGE DUE TO 50W LOAD ON INVERTER

# CHAPTER FOUR

## CONCLUSION

The aim of this project work has been to provide an alternative to the electricity mains supply to due to its erratic nature. The inverter /charger can power most household appliances for a period of time that is directly proportional to the amp hour rating of the batteries. The period for which the loads can be powered can be increased by increasing the battery bank size,but that would mean increasing the charging current needed to charge the batteries, otherwise it would take a very long time to charge the batteries. The Inverter /charger unit excluding the battery cost less than N5000. A typical car battery costs about N2,500 . this gives a total of N7,500. A small generator of the same capacity as the inverter costs between ₦34,000 to ₦ 40,000. Table 2.1 gives a list of components and there respective costs.

## RECOMMENDATIONS

For future improvements, I would recommend that the inverter/charge have feature like low battery shut down and pulse width modulation, which is a better method be used for inversion. The charger unit must be designed to be able to deliver up to 100amps or more as charging current, so that large battery banks can be quickly charged.

Deep cycle batteries which have relatively thick lead plates alloyed with antimony or calcium to make them harder, are better suited to deep discharge and use for inverters than Engine starting batteries. Engine starting batteries use a high number of very thin plates.

The resulting high surface area of the plates exposed to the electrolyte provides the capacity to produce the short bursts of high current necessary to start an Engine. They are rated in cold cranking Amps (CCA).

This number reflects the discharge load in amps which a new battery can deliver for 30 secs and maintain 1.2 volts per cell at 200 degrees. Engine starting batteries are not appropriate for inverter

The inverter /Charger can be made to be completely independent of Nepa by attaching Solar Panels to make a complete installation.

Table 1.3 Bill of materials

| Component | Qty | Price(₦) | Cost(₦) |
|---|---|---|---|
| 555 Timer Ic | 1 | 30 | 30 |
| 7815 Voltage Regulator | 1 | 50 | 50 |
| 10Kw Variable Resistor | 1 | 20 | 20 |
| IRF 540 Power Mosfets | 6 | 150 | 900 |
| 500W Power Transformer | 1 | 1,500 | 1,500 |
| 25A Bridge Rectifier | 1 | 100 | 100 |
| Signal Diodes | 3 | 10 | 30 |
| 1/8 Watt Resistor | 14 | 5 | 70 |
| 1.5μF Electrolytic Capacitors | 1 | 5 | 5 |
| 0.66μF Capacitor | 1 | 5 | 5 |
| LM 317T Adjustable voltage Regulator IC | 1 | 70 | 70 |
| N2222A N-P-N Transistor | 2 | 30 | 60 |
| TIP41 P-N-P Transistor | 1 | 20 | 20 |
| Aluminium Heat Sink | 1 | 200 | 200 |
| Prefabricated Metal Casing. | 1 | 500 | 500 |
| 12V Brushless Cooling Fan. With Metal Grille | 1 | 250 | 250 |
| Mj2955 N-P-N Power Transistor | 2 | 100 | 100 |
| Battery Clips | 2 | 100 | 100 |
| $3mm^2$ Cable | 2yrds | 80 | 160 |
| Light Emitting Diodes | 2 | 10 | 20 |
| Tenby 13A Socket | 1 | 150 | 150 |
| Mounting Screws | 20 | 100 | 100 |
| | | Total | 4,500 |

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