THE DESIGN AND CONSTRUCTION OF AUTOMATIC TIME SOUNDER

BY

ABDULMALIK IBRAHIM. O. REG NO 97/5886EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
SCHOOL OF
ENGINEERING AND ENGINEERING TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

AUGUST,2003

THE DESIGN AND CONTRUCTION OF TIME SOUNDER.

BY

ABDULMALIK IBRAHIM. O.

REG NO 97/5886EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE NIGERIA.

AUGUST 2003.

DECLARATION

I hereby declare that this project work was wholly and solely conducted by me under the supervision of Mr. S N RUMALA of the department of electrical and computer Engineering, federal university of technology, Minna.

.....

ABDULMALIK IBRAHIM. O.

.....

Date

CERTIFICATION

I certify that I have supervised, examined approved this project work which I have found to be adequate in scope and quality for the partial fulfillment of the award of Bachelor's Degree in Electrical and computer Engineering (B. Eng), Federal university of technology, Minna. Nigeria.

Mr S N RUMALA .....

Supervisor **Date and Sign**

ENGR. M .N Nwohu 28/4/09

Head of Department **Date and Sign**

.....

External Examiner **Date and Sign**

DEDICATION

This is dedicated to my ever caring and loving Mum, Dad, Sister, and Brother.

ACKNOWLEDGEMENT

Praise be to Allah Almighty, the lord of the universe and hereafter for His great comfort, guidance and protection all through my stay in Federal University of technology, Minna My gratitude to my supervisor Mr. S. N. Rumala for his keen interest, suggestion and intellectual through my project work.

I also extend my regards and appreciation to the head of Department of Electrical and Computer Engineering Dr. Adediran, Engineer M. D. Abdullahi, Engineer M. N. Nwohu present acting Head of Department as well as to the entire staff of the department and the University at large for their assistance and guidance during my stay with them in the Federal Universisty of Technology, Minna. I fervently wish to show my appreciation to Alhaji Ahmed Aliyu Garafini (Shettina Borgu), Mallam Hassan and Hussieni Osuwa and to all my brothers and sisters. Also to my beloved Mum and Dad whose Love, care and Support contributed to the successful completion of my school.

Special appreciation to Engr. Yahaya Otuoze, Engr. Wale Ajayi (wallexy), Miss Khadijat, Yemi Adekole, Engr. Elias Andy and all my friends who has made life so interesting during my stay in Federal University of Technology, Minna.

ABSTRACT

In this report, the design and construction of Automatic time sounder is presented. A 12 hour (quartz) clock with hourly chime or ringing is amplified with the aid of a design amplifier interphased with the input of a megaphone. A public address system (PAS) is incorporated into the design for public announcement. The system is power by a 12V DC power supply.

TABLE OF CONTENTS

CHAPTER ONE

CHAPTER TWO

CHAPTER THREE

CONTRUCTION, TESTING AND RESULT.

CHAPTER FOUR

CHAPTER ONE

1.0 INTRODUCTION

In all human endeavours, information is very important likewise their mode of dissemination is a vital tool in enlightening people. There are many ways of achieving this especially in a technological era as we have the entire world today. These and many other ways constitute a bridging gap between members of all social stratifications.

Today one of the most common reliable means of passing information to the general public in a particular location is the employment of public address system (PAS). This public address system sometimes comprises of megaphone which is a system combining units of electronic equipments, used to increase the magnitude of the sound of the voice, so that it can be heard at a desired distance. Microphones, amplifiers and loudspeakers are the major components that make up the megaphone.

In the course of this project design, much consideration is given to reliability and maintainability of the entire circuitry that make up the public address system. This reliable measure was achieved through a constant power supply from a battery, which remove the fear of power interruption. This is done by the system with a battery to give a better operation.

A charging system is designed, such that, when there is supply from the grid, charger charges the battery to give the battery a long lasting operational time. When there is no supply from the public power supply, the charging system in its in-active mode.

The diagram below shows the block representation of a typical megaphone with a clock chime output interphased to the megaphone for the public address system.

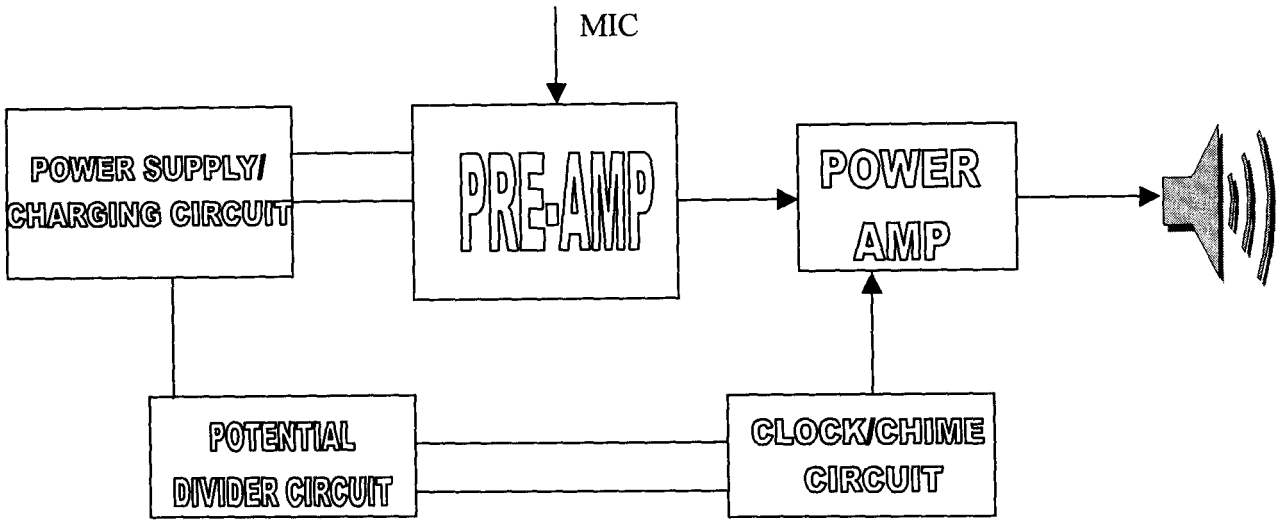

Fig 1.0 A BLOCK DIAGRAM OF THE SYSTEM

It is expected that after the construction of the megaphone, the output of the alarm wall clock interphase to the input of the megaphone, a very loud melody is heard at the speaker after every sixty minutes (one hour) when it is powered at its source. There are series of advantages listed below in automatic time sounder over other alarm clocks;

1. The alarming due to its amplification covers a very wide range of area, which gets people notified to be conscious of what to do.
2. Component tolerances are not critical
3. Fault tolerance system can easily be built
4 Automatic time sounders are highly reliable and they are constructed with electronic circuit that operate in only discrete state.

1.1 LITERATURE REVIEW

Since man earliest days, he has search for ways to make passage of time. Accuracy in specifying time is needed foe civil, industrial, and scientific purposes. Although defining time present a difficulty measuring it does not; it is the accurately measured physical quantity. A time measurement assigns a unique number to either an epoch, which specifies the moment when an instantaneous event occurs, in the sense of time of day, or a time interval, which is the duration of a continued event. The progress of any phenomenon makes up much of the subject matter of Astronomy, Physics, Chemistry, Geology, and Biology. The following section of this article treat time measurements based on manifestations of clocks which became timekeepers.

The following clocks listed below are some of the existing timekeepers: -

1.1.1 SHADOW CLOCK (SUN DIAL)

The first device for indicating the time of the day was the gnomon. It consists of a vertical stick or pillar; the length of the shadow that it cast gives an indication of the time of the day.

1.1.2 WATER CLOCK

Simple water clock were used to record time at night or when was observed. These were bucket – shape vessels from which water was allowed to escape by a small hole at the base.Uniform scales of the time were marked on the inside. At the end of the first, water filled to the brims would have falling to the first mark of the scale. The difficulty of regulating

the pressure of outflow of these clocks and the variation in viscosity of water, according to the temperature rendered them inaccurate.

1.1.2 THE WATCH

The mechanism of a modern watch's performance depends on the uniformity of the period of oscillation of the balance. The balance takes the form of wheel with a heavy rim; while the spring couple to it provides the restoring forgive. It possesses inertial, dependent on this mass and configuration.

1.1.3 MECHANICAL AND ELECTRICAL CLOCKS

The mechanism of a modern mechanical is as follow. The wheelwork of train of a clock is the series of moving machine part [gear] that transmits motion from a weight of spring to the minute and hour hands. The wheel and pinions must be made accurately, and the tooth was designed so that the transference of power takes place as steadily as possible.

In a master clock system, electricity is used to give direct impulse to the pendulum that in turn causes the clocks gear trains to move, or to lift a level after it has imparted an impulse to the pendulum after 60minutes eventually chime or rings if alarm is incorporated.

1.3.0 PROJECT OBJECTIVE/MOTIVATION

Over a long time, dissemination of information within the locality is very ineffective. In the olden days, the town criers are the only people that pass information to people but nowadays with the technological innovations a lot of means have been adopted but mostly ineffective, this project, the design and construction of the automatic time sounder with a public address system coupled in it, is to enable whoever concerned to make announcements to the entire public and make people be conscious of time within coverage area so that right things could be done at the right time.

CHAPTER TWO

2.0 SYSTEM DESIGN

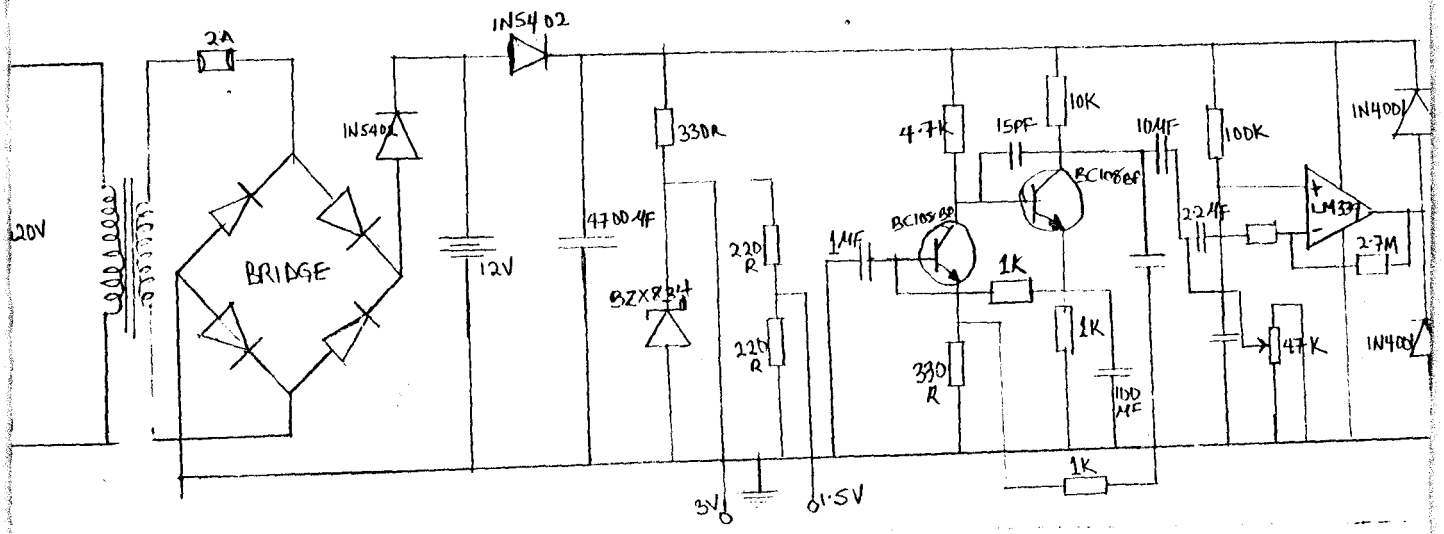

Fig. 2.0 The complete circuit diagram of automatic time sounder with a public address unit coupled to it.

2.1 INTRODUCTION

Before attempting the design of an electronic system, one must know exactly what the system is meant to do. Then on, to select the various devices and component to suit the different circuit of the system. Then design of the automatic time sounder with a public address unit coupled to it is concerned with the design of it different unit circuit, which are made up of the following:

1 Power supply unit

2 Pre-Amplifier unit.

3 Power Amplifier unit

The alarm clock and the microphone form the external devices of the system, but they are powered through a potential divider and Zener Voltage regulator circuit in the system.

Since the clock is used for time and timing is said to be a continuous process, the need for a stable power supply must be made available. This is the reason why the system is being powered by means of a lead-acid battery. The battery is kept on a continuous charging to avoid running down of the battery when discharging to the circuit. The charging unit, from an AC mean to a 15 220V/ 15V connected to a full wave bridge rectifier to the battery terminal to give it a continuous charging when the AC main is on. The pre-amplifier unit consists of the simple microphone pre-amplifier that interface the low frequency signal of the microphone into the power amplifier via the megaphone.

2.2 DESIGN OF POWER SUPPLY UNIT.

The diagram below shows the power supply circuit, its components and their functions.

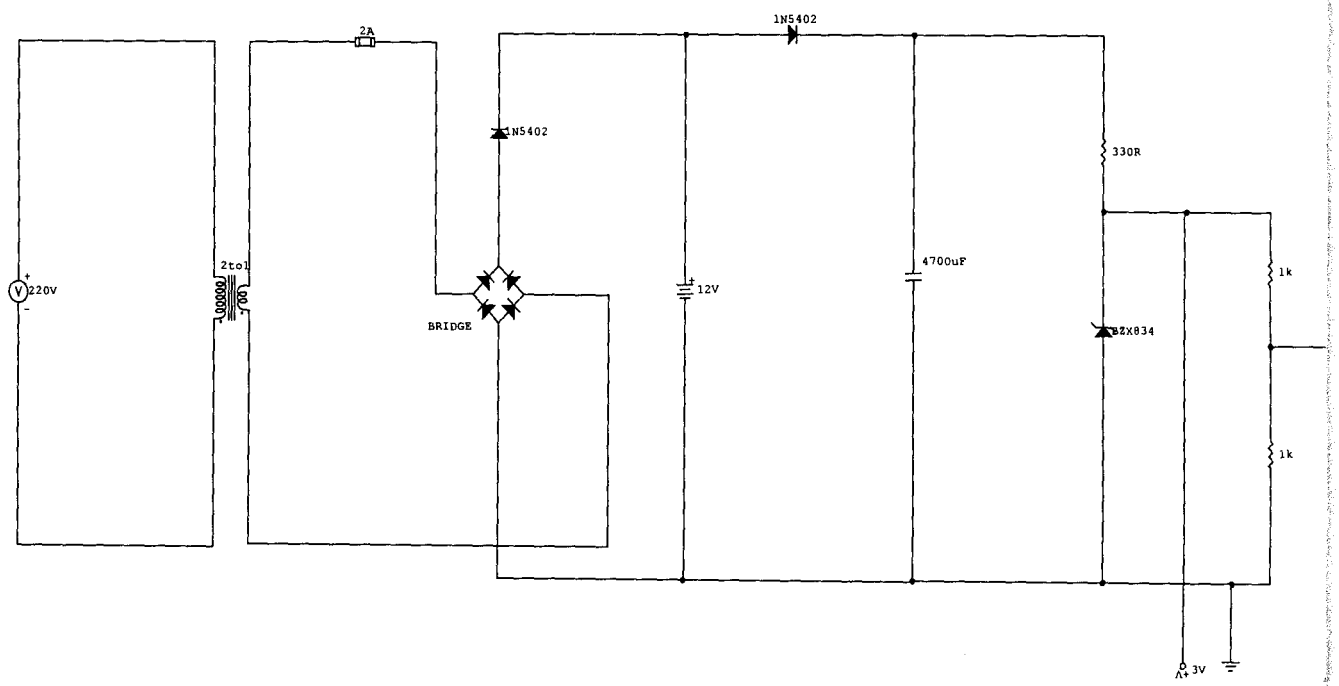

Fig 2.1 Power Supply Unit.

TRANSFORMER UNIT

Each component in the power supply circuit has been duly connected to enhance a steady range of signal processing and moreover for every stage in smoothing of signal unto a required signal to be transferred, each component plays its own role as it is shown below. A step down transformer is connected to the main alternating current (AC) in order to be able to step down the incoming AC signal into various component and the transformer is connected alongside with a switch enhance the flow of current whether it remain close or normally opened.

RECTIFIER STAGE

The waveform of the secondary voltage is alternating sinusoidal voltage. This is a voltage which changes polarity during a cycle i.e. it is positive in one half and negative in the other half, the output of the secondary terminal of the transformer assume a sinusoidal voltage $V = V_{max}\sin\omega t$. the rectifier stage converts this AC voltage to DC voltage. Bridge rectifier was used to achieve full wave rectification required from the supply unit.

FULL WAVE RECTIFIER

This is a more efficient arrangement in which secondary winding provide antiphase voltage to two diodes which conduct alternating current and provide an output voltage during each half cycle. The average value of output voltage is given by:

$V_{dc} = [2(V_{max} - V_D)/\pi$ volts

Where V_{max} = peak value of secondary voltage.

V_D = diode instantaneous voltage drop.

The amount of ripple is reduced here compared to the half wave rectifier circuit, but has the disadvantage of requiring two secondary winding, only one of which is used in any half cycle. Efficiency is relatively high.

FILTER STAGE

The main function of the filter is to minimize the ripple content of the rectifier output. Different filter circuit configuration exists among which are shunt capacitor filters, series

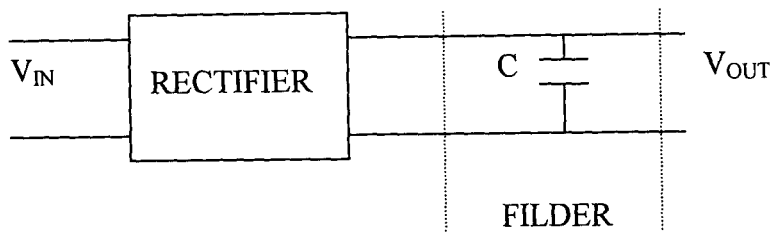

Fig 2.3 Shunt Capacitor Filter.

The total power needed in this project is +3 V D.C meant for the melody side of the clock, +1.5 V D.C for driving the clock's mechanism, and 12 V D.C for the amplifier and pre-amplifier unit of the system. The power supply unit consists of a transformer, a rectifier circuit, this is meant for the charging of the battery. The battery supply by-passed over a filter and the potential divider constitute the supply to the entire system distributed at different voltage range as mentioned above. The transformer is an already made 240V/15V ac step down of 200mA. The ac mains 240V is applied to the primary winding of the transformer T1 which step-down to 15V across the secondary winding. The full wave rectification of this 15V ac is achieved using a bridge of four rectifier diode, D1=D2=D3=d4= (IN5402).

The capacitor 4700uf 35v, which smoothens the ripple voltage from the rectifier circuit.

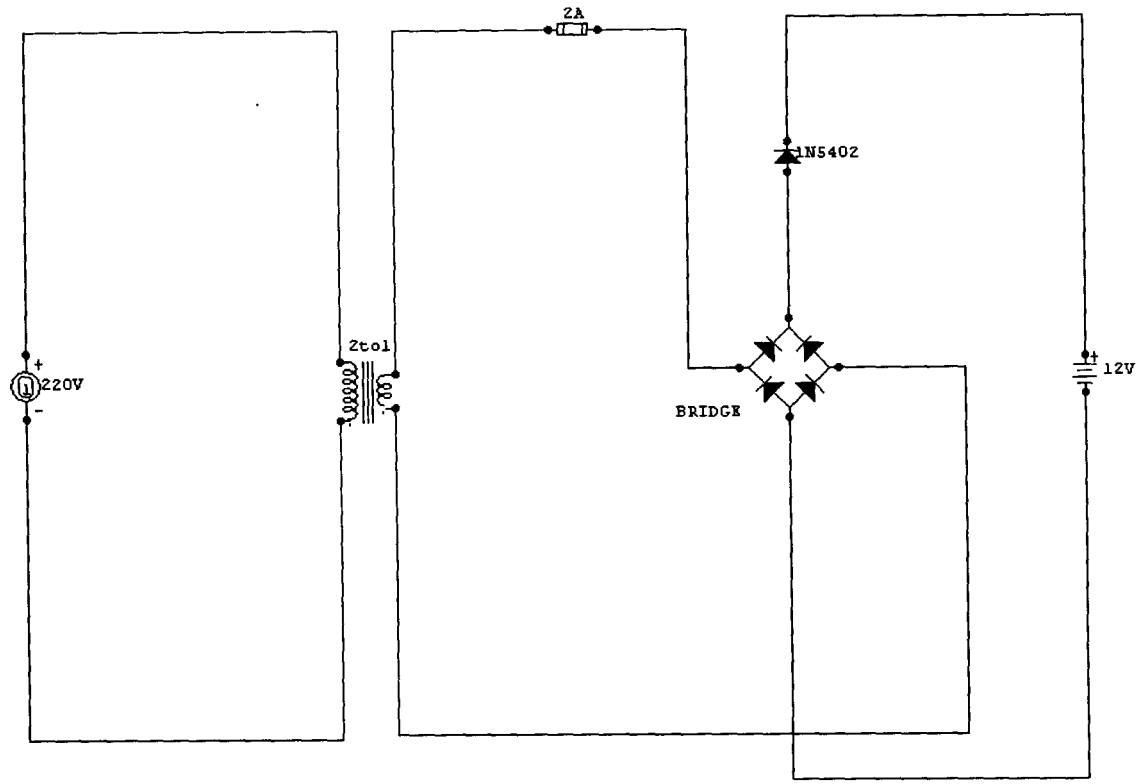

Fig 2.3 The charging circuit

Point A of transformer secondary is positive current flows in the direction of the arrows. When point B is Positive, current flows as in fig 1.2. Again, it is know that direct current is ment to flow in one direction, but in the case of charging a battery where a pulsating D.C is require to avoid the back flow of current from the battery which can easily destroy the battery a diode D5 (IN5402) is connected to allow the flow of current just in the specified direction to give the battery a continuous charging rather than excessive discharging.

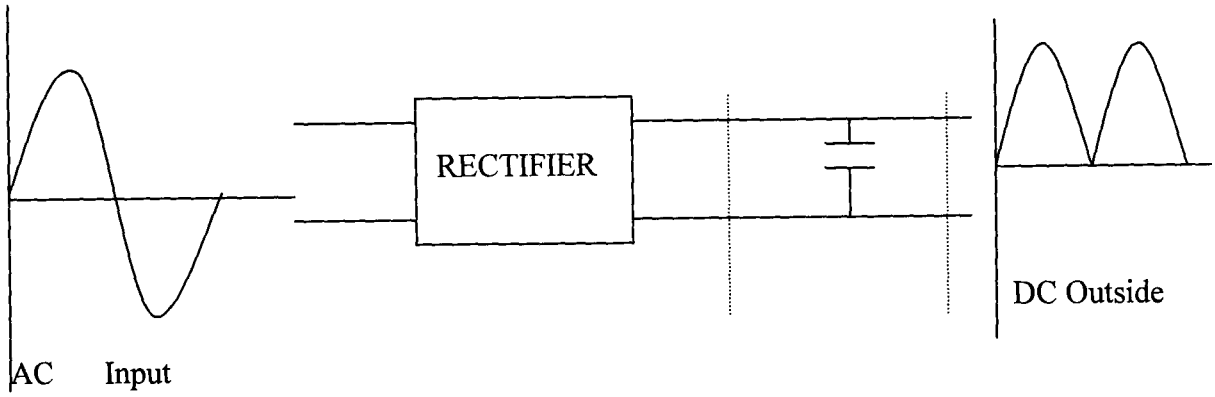

Fig2.4 The wave forms of Input and Output of full-wave diode rectifier.

A bridge rectifier operates on the principle that electric current flows through a junction of two dissimilar conducting material more readily in one direction than it does in the opposite direction. This is true because the resistance to current flow in one direction is low, while in the other directing it is high. Several amperes may flow in the direction of low resistance but only a few milliamperes in the direction of high resistance.

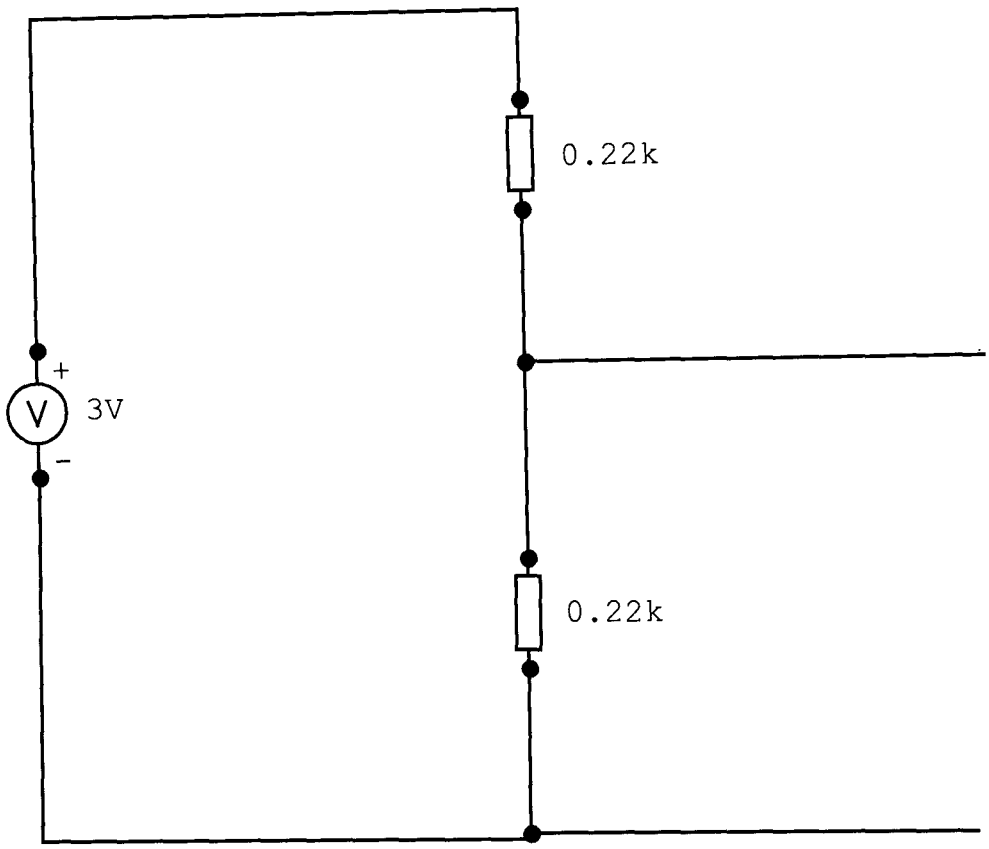

Fig 2.5. Voltage Divider

2.4 VOLTAGE DIVIDER DESIGN

Since this project requires different voltage rating at different unit of the circuit then the issue of a voltage divider come to play. A voltage divider is simply two resistors, across which voltage is applied, with the output being taken from the junction of the resistors. Since the same current must be flowing through both resistors (assuming the output is connected to a high impedance device), we V1/R1 = I = V2/R2. Hence V1/V2 = R1/R2 i.e. the voltage applied across the resistors is divided into two part according to the resistor values. If a single variable resistor is used for R1 and R2 then the output voltage can be varied, and this is the basis of the volume control. A 1.5V DC is require to power

the clock driving mechanism, and a 3 V DC is required to serve as voltage source for the ringing or melody unit of the alarm clock. 12V is fed directly to power pre-Amplifier and Amplifier unit from the 12V lead acid battery. To obtain this voltage a design of voltage divider is established to supply the D.C voltages to various units. To achieve this aim instead of using a voltage regulator, an electronic device that can be used as a voltage regulator is the ZENER DIODE, which is used in this project considering its I-V characteristics, are showed and explained below.

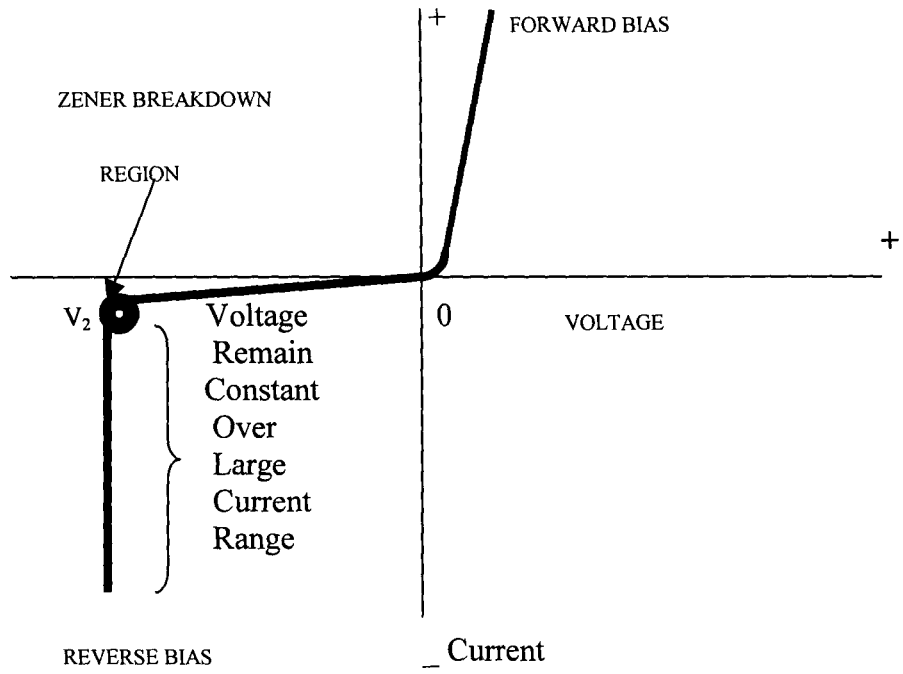

Fig 2.5. I-V characteristics of a zener diode.

When the Zener diode is revised based, a small reverse current flows to a point where the diode reaches the Zener breakdown rejoin, V_2. At this point the Zener diode is able to maintain a fairly constant voltage as the current varies over a certain range. Because of this, the diode provides excellent voltage regulation.

Although, the minimum approximated value of Rs was calculated as 200Ω, the series resistance was increase and instead 330Ω was used to avoid higher current and easy breakdown of the Zener diode.

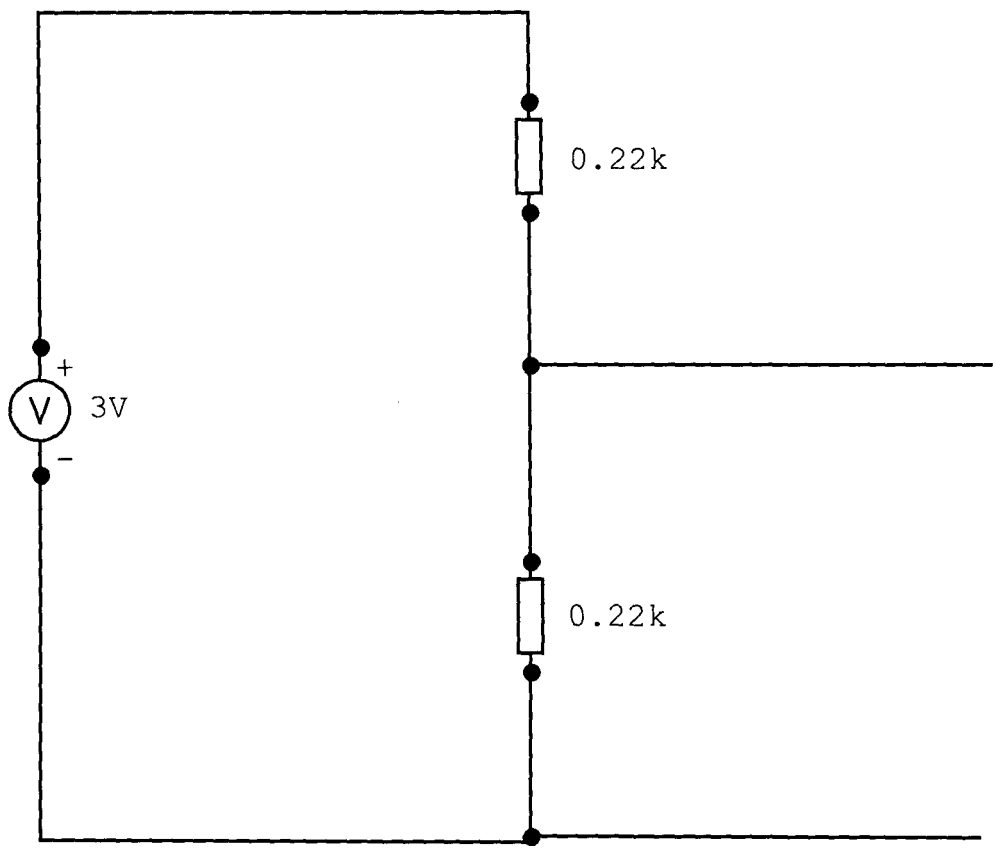

Fig 2.6 Voltage Divider Circuit.

Vs is 3v with the aid of the 3v breakdown Zener diode rating (BZX834)

Applying the voltage divider theorem

$$V_{out} = \left[\frac{R_1}{R_1+R_2}\right] Vs \qquad V_{out} = \left[\frac{220\Omega}{220+220}\right] 3\ V \qquad V_{out} = (0.5)\ 3\ V \qquad V_{out} = \underline{1.5V}$$

For current $I = \left[\frac{1.5}{220//220}\right]$ $\frac{1.5}{110}$ 0.00136A $\underline{13.6}$ mA

For this particular application, the value were chosen based on calculation. Considering a complete voltage step down circuit shown in the figure below.

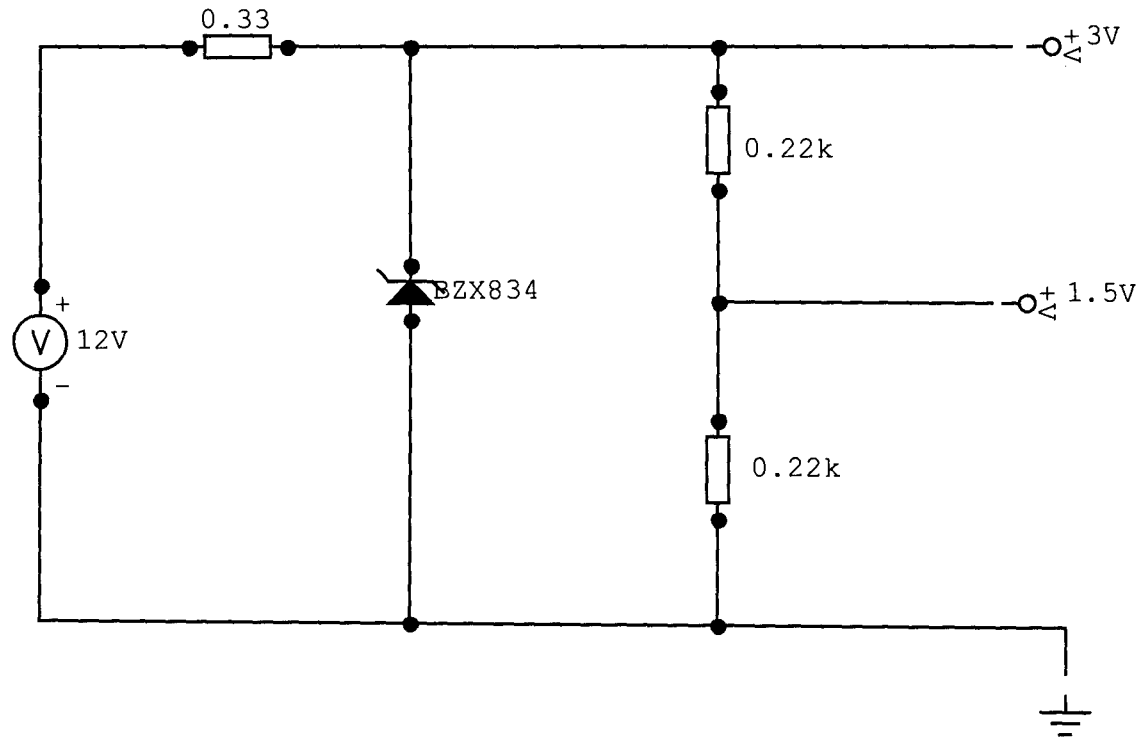

Figure 2.7 ZENER REGULATOR / VOLTAGE DIVIDER CIRCUIT

2.22 ZENER REGULATION CALCULATIONS

The series resistance is chosen based on the following calculation

$$Rs = \frac{V_s - V_z}{I} \quad \ldots\ldots(1)$$

Where R_s = series resistance for limiting zener diode current.

V_s = Voltage source

V_z = Zener Voltage

The following data are standard for the particular circuit in application

I_z = 20mA (minimum diode current)

I_L = 50mA (measured from the clock)

Now

$I = I_L + I_z \quad \ldots\ldots(2)$

= 50mA + 20mA = 70mA

Substitution all values into the equation

$$Rs = \frac{12 - 3.0}{70mA} = \frac{12 - 3.0}{70*10^{-3}} = 128.6\Omega$$

But $P_z < P_{zin}$ Power dissipated by the zener diode P_z must be less than maximum power rating of the zener diode. (P_{zin})

P_{zin} = 3000mW (from data book)

Since V_z = 3V

I = 70mA $P_z = V_z I$

$= 3*(70*10^{-3})$ $= \underline{210mW}$

Thus $P_z < P_{zin}$

Although the approximate value of Rs was calculated as 200Ω, the series resistance was increased and instead 330Ω, was used to avoid easy breakdown of the zener diode.

PREAMPLIFIER UNIT

The preamplifier unit is designed to match the level input signal from the microphone into the power amplifier. A typical application circuit used is shown in the figure below.

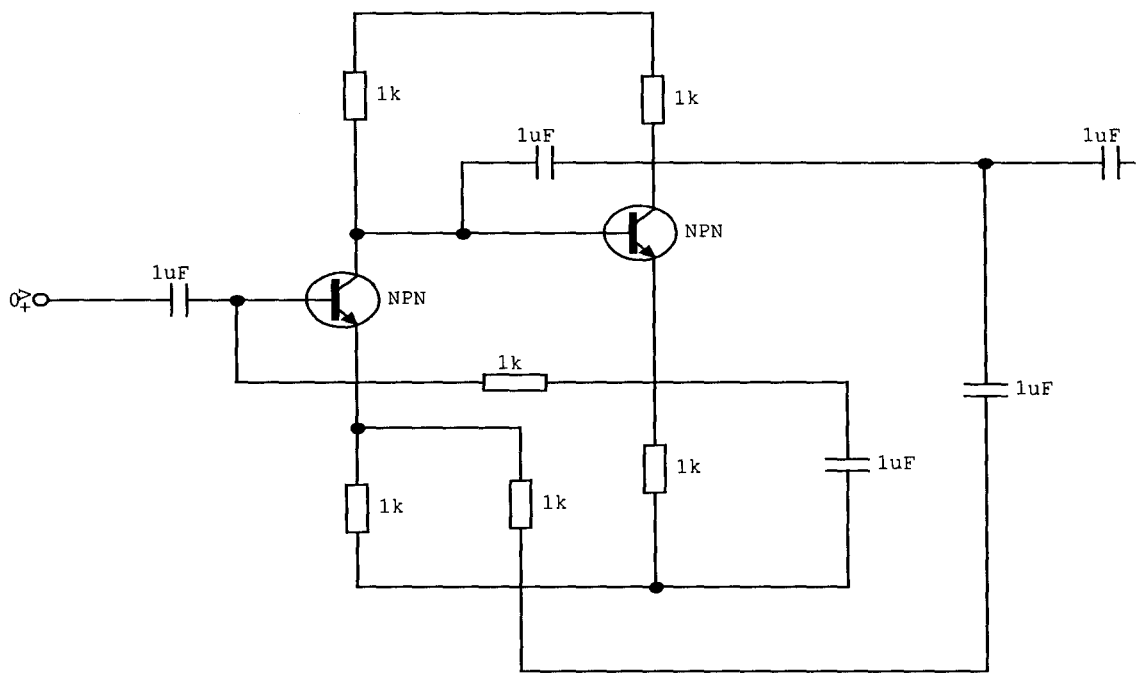

Fig 2.8 PRE – AMPLIFIER CIRCUIT

Gain of the pre amplifier is:

Av = 5.5k / 330

Av = 16.67

Microphone serving as a transducer to convert sound signal to its electrical signal equivalent. It was purchased from the market in which consideration was given to sensitivity and durability.

2.4 POWER AMPLIFIER UNIT

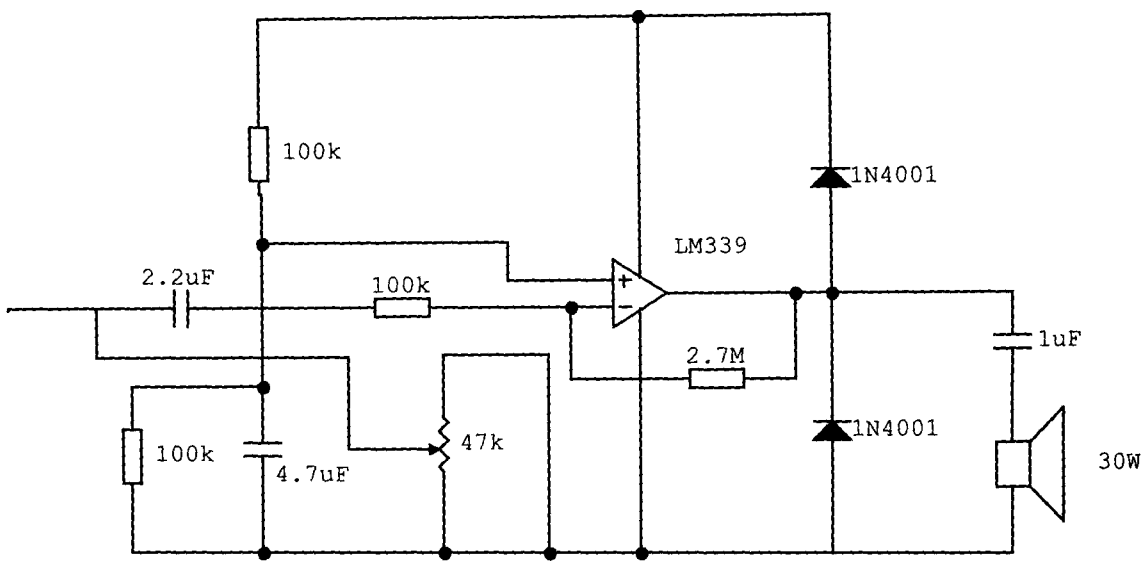

Fig 2.9 AMPLIFIER UNIT

This is the unit where the main purpose of the project took place. A power amplifier did it. The one chosen for this particular design is the TDA2006.

The TDA2006 is a monolithic integrated circuit in pentawatt package, intended for use as a low frequency amplifier. At 12V, d=10%, typically it provides 12W output on 4Ω load and 8W on 8Ω load.

It provides high output current and low harmonic distortion.

Among its characteristics that made it very suitable for use, are its incorporated original short circuit protection system comprising an arrangement for automatically limiting the dissipated power so as to keep the working point of the output transistors within their safe operating area.

A conventional thermal shut is also included.

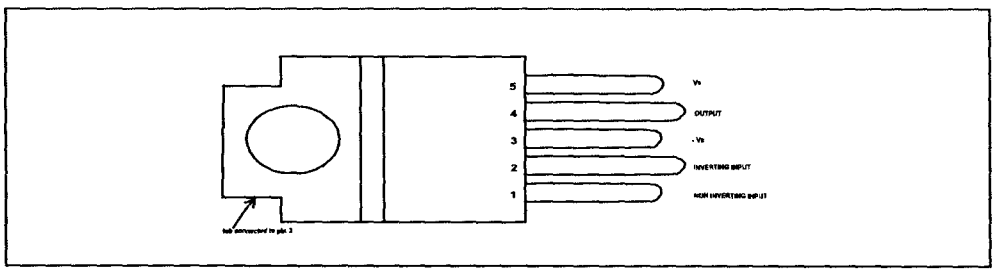

fig 1.9 PIN CONNECTION

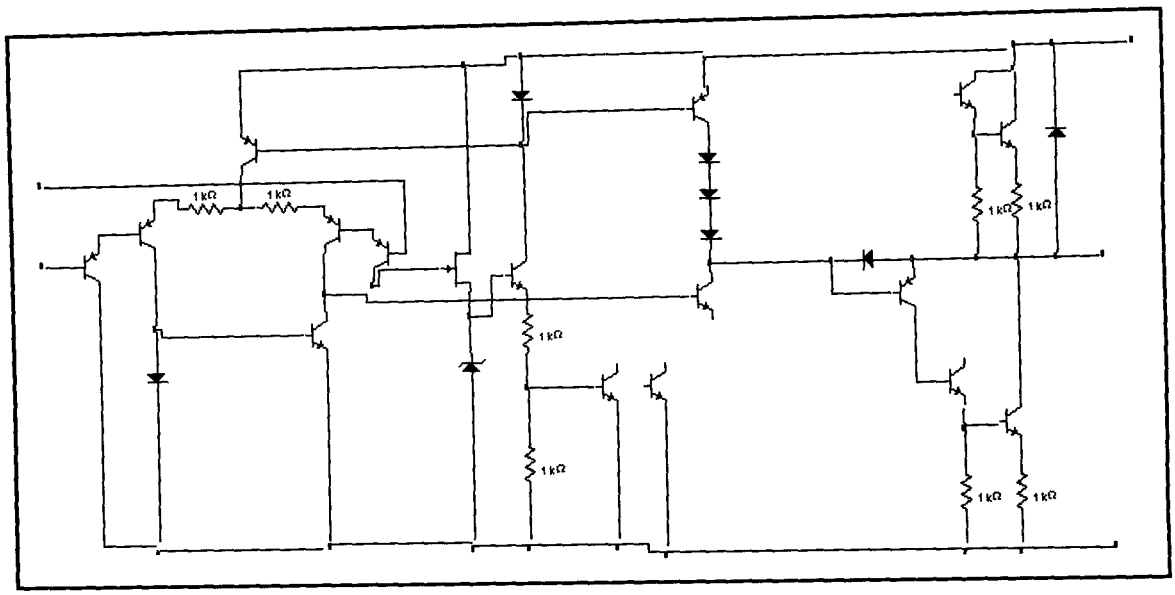

fig 1.10 INTERNAL CIRCUITRY OF TDA2006

The TDA2006 is specially designed to have the following absolute maximum ratings that serve as the guide in my application circuit.

SYMBOL	PARAMETER	VALUE	UNIT
Vs	Supply voltage	±15	V
Vi	Input voltage	Vs	
Vi	Differential input voltage	±12	V
Io	Output peak current (internally limited)	3	A
P_{tot}	Power dissipation at T_{case}=90 °C	20	W
T_{tsg},T_j	Storage and junction temperature	-40 to 150	°C

a) SHORT CIRCUIT PROTECTION

This, earlier mentioned, gives the TDA2006 its reliability characteristic.

It has an original circuit, which limits the current of the output transistors. Analyses have shown that the maximum output current is a function of the collector emitter voltage; hence the output transistors work within their safe operating area.

This function of TDA2006 can therefore be considered peak power limiting rather than simple current limiting. It reduces the possibility that the device gets damaged during an accidental short circuit from AC output to ground.

b) THERMAL SHUT DOWN

The presence of a thermal limiting circuit offers the following advantages:

i An overload on the output (even if it is permanent), or an above limit ambient temperature can be easily supported since the junction temperature (T_j) cannot be higher than 150 °C.

ii The heat sink can have a smaller factor of safety compared with that of a conventional circuit. There is no possibility of device damage due to high junction temperature.

If for any reason the junction temperature increases up to 150 °C, the thermal shut down simply reduces the power dissipation and the current consumption.

The maximum allowable power dissipation depends upon the size of the external heat sink (i.e its thermal resistance). Below is an illustration,

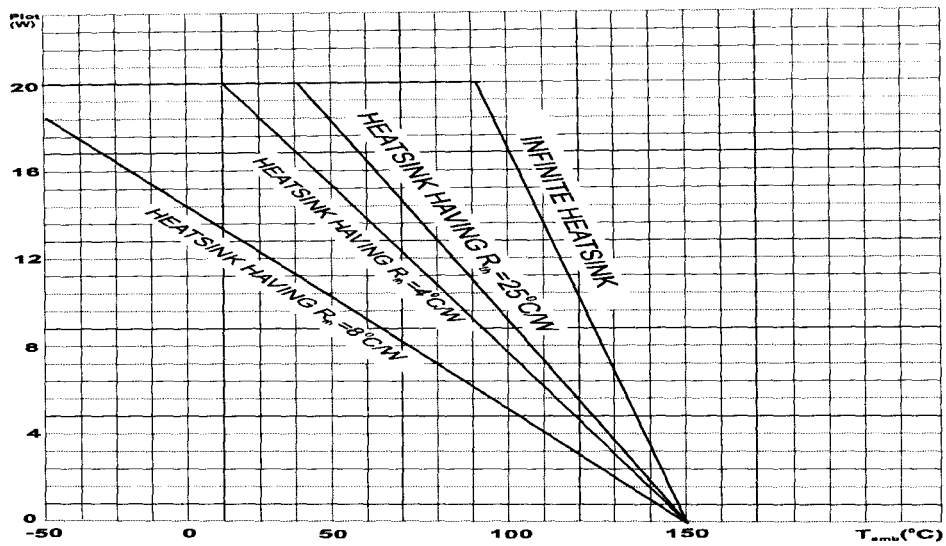

fig 1.11 MAXIMUM ALLOWABLE POWER DISSIPATION AGAINST AMBIENT TEMPERATURE

In this particular design, an application circuit was adopted to increase the gain to a desired level. The gain (A_v) is:

$A_v = 2.7M/100K$

$A_v = 27$

Lower cut-off frequency (f_{c1})

$f_{c1} = 1/2(3.142)R3C2$

$f_{c1} = 1/2\times3.142\times100k\times2.2\mu$

$f_{c1} = 0.72HZ$

Upper cut-off frequency (f_{c2})

$f_{c2} = 1/2(3.142)RLC3$

$f_{c2} = 1/2\times3.142\times8\times2200\mu$

$f_{c2} = 9.04HZ$

Each of the components in the configuration is serving a specific purpose, which cumulatively gave rise to the perfect functionality of the power amplifier.

C1 filters out noise and hum, which might otherwise be coupled from the non-inverting input.

C2 is the input DC decoupling, which block all the unwanted signals from the input point.

C3 serves in filtering out the unwanted DC signal from entering the speaker.

R1 and R2 form a potential divider that biases the non-inverting input to half the supply voltage. R3 is setting the closed loop gain and as well limiting the flow of current into the power amplifier.

R4 is for close loop gain setting.

D1 and D2 are to protect the device against output voltage spikes.

2.4 SPEAKER

This being the last unit in the system design is employed to convert the processed electrical signal from the power amplifier to acoustic signal.

It was professionally chosen from the market with specifications suitable for the project purpose.

SPECIFICATIONS:

Power rating: 30W(r.m.s), 45W(max)

Impedance: 8-ohm

Frequency response: 240-10KHZ

Dimension: 310 (285Lmm)

Weight: 1.98Kg

CHAPTER THREE

CONSTRUCTION, TESTING AND RESULT.

3.1 CONSTRUCTION

The construction of the circuit was first carried out on a breadboard. It was then tested for proper operation after being certified to be in other, it was then transferred to a Vero board.

A Vero board is a special kind of printed circuit board specially designed for practical operations. It has tiny holes, which are evenly spaced, through which components can be inserted and soldered. On one face of the board and copper striped and which run in rows such that all the component legs of a particular row are connected together. The legs of each component are pushed through the holes from the top of the board and are then soldered onto coppers strings under the board. The orientation of the components in the board is such that they are only a few millimeters above board.

After a firm attachment as been obtained, the excess wire are then cutoff, for neatness and uniformity using a long nose pliers or cuter. The verso board, which was used as the PCB, was splited into three different units this include the power supper unit, the preamp unit and the amplifier unit. The bridge rectifier arrangement shown in the circuit connected on the board with the output terminal going to the battery from charging process.The smoothing capacitor was then connected across the output of the battery. Also, jumpers were used to tap out the voltage sources for the clock and melody units.

The pre-amp circuit presented on a separate board is a transistor-based amplifier. Thus extreme precautions were taken to avoid damaging the transistors by heat. The connections of the components were spaced to avoid bridging.

The power amplifier unit was connected on a small piece of Vero Board located on a separate space. All the input and output channels are connected by means of jumpers linking out.

3.2 TEST AND OBSERVATION.

The resistors, capacitor and transistor were all tested using multi meter and were proved to be in perfect working condition on a breadboard. All the various components were first arranged according to the circuit diagram on the Vero board, it was tested by powering the clock and interphasing it to the constructed power amplifier unit and connected to the mega phone and a very louder output was heard from the megaphone.

CHAPTER FOUR

4.0 SUMMARY

The project in summary, we design and constructed a charging unit, a potential divider circuit, a pre-amplifier and power amplifier at the end of the construction, the pre-amplifier and the power amplifier are both fed with 12v form the source [battery]. A charging unit designed is to give the lead acid battery a constant continuous charging and a potential divider circuit with a zener regulator holds the voltage to it's voltage rating which is 3v and is fed to the alarming unit of the clock in the same potential divider with the aid of a parallel resistors connection a1.5v was achieved to feed the clock drive mechanism. A microphone is coupled to the pre-amplifier which convert the sound signal to an electrical signal and finally to the power amplifier which amplifies the final signal as sound through the megaphone.

It is expected that after every one hour the alarm is enabled automatically and sound or the melody is amplified through it's unit and heard over wide range of area at the megaphone. Microphone serves as source of input to the public address system couple.

4.2 RECOMMENDATION

The circuit is liable to modification, and more speakers can be connected so that wider range of area can benefit and being conscious of what the time is at a particular period.

REFERENCES

ELECTRICAL AND ELECTRONICS

BY HOWARD H. GERRISH / WILLIAM E. DUGGER

A TEXTBOOK OF ELECTRICAL TECHNOLOGY

BY B. L. THERAJA

A.K. THERAJA

MIKE, T "PRACTICAL DIGITAL ELECTRICAL" SECOND EDITION

MC GRAW-HILL BOOK COMPANY, NEW YORK,. (1988)

WWW.GOOGLE.COM

GOOGLE SERCH