A PROJECT REPORT

ON

DESIGN AND CONSTRUCTION

OF

A MEGAPHONE INTERFACED WITH CLOCK CHIME

BY

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IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B. ENG.) IN ELECTRICAL/COMPUTER ENGINEERING.

SUBMITTED TO

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SEPTEMBER, 2003.

CERTIFICATION

This is to certify that this project work was done by mahmoud A. abdullahi (97/5880EE), of the Department of Electrical Computer Engineering under strict supervision. It has been prepared in accordance with the specifications governing the presentation of a B. Eng. Degree in Electrical Computer Engineering, Federal University of Technology, Minna.

Supervisor
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date

H. O. D of Dept.

28/4/04
date

External Examiner

date

DECLARATION

I do hereby declare that this project work was wholly carried out by MAHMOUD ALFAH ABDULLAHI and three others, and has never been submitted to the Department of Electrical and Computer Engineering for the award of B. ENGR.

Mahmoud

DEDICATION

This project work is dedicated to my Dad ALHAJI ABDULLAHI MOHAMMED and my mum HAJIYA FATIMA ABDULLAHI for their immeasurable support, caring, love and understanding all the course of my life.

ACKNOWLEDGEMENT

In the name of ALLAH the most gracious who out of his will spare my life to this memorable day, may his peace and blessings be upon our prophet Muhammadu (S. A. W). I remain grateful to my parents who have giving me all I ever needed from birth to date especially my mum for been there all the times.

It is with gratitude and appreciation I wish to acknowledge the support and encouragement of my brothers atayi, kabiru,sule, hadi, tijjani, umar, nazif, suleman, aminu.A, aminu.B,and fatiu.

My sisters hauwa, maryam, maimuna, inna, mummy, amina, nafisa, sadiya, hadiza and mama. My step mums amarya and anti.

Also worthy of mention are my friends and colleagues in 500level in persons of takuma, taofeek, aliyu, abdulkadir, hafeez, baba, isah, jesus, ndagi, salka, a. a, ali, bello, shehu aminu, hadiza and all others too numerous to mention that have made my stay in f.u.t minna a fulfilling one.

People like kabiru, bullet, abdullahi ibrahim, yahaya, molar, murtala, danjuma, balatati can never be forgotten for their caring.

My mentor mohammed salihu (ENGR) for the positive way he affected my life.

Maimuna for her understanding and love.

Finally, my supervisor for his advice and encouragement and all the lecturers of my department.

ABSTRACT

The project as the name indicates is aim at designing and construction of a communication system, which is capable of notifying students in the campus what the time is and announcement of public information as well.

This is perfectly achieved with a 45W output speaker, which is fed by a designed amplifier system.

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CHAPTER ONE

1.0 INTRODUCTION

There is no doubt information dissemination is a vital tool in educating people .As such, different ways were developed to bridge the gap between one person and another who is in a distant place.

One and most common reliable means of passing information to the public within a confined Environment is the employment of MEGAPHONE.

This device 'MEGAPHONE' is a system combining units of electronic equipments, which serve the purpose of magnifying the sound of the voice, so that it can be heard at a considerable distance. Usually, microphones, Amplifiers and loudspeakers are found in it.

In the project design, much consideration is given to Availability and maintainability of the device 'MEGAPHONE'. This is done by the system with a battery to give it continues operational ability with or without NEPA supply.

A charging system is designed, such that, NEPA supply when available, charges the battery to give the battery a long lasting operational time.

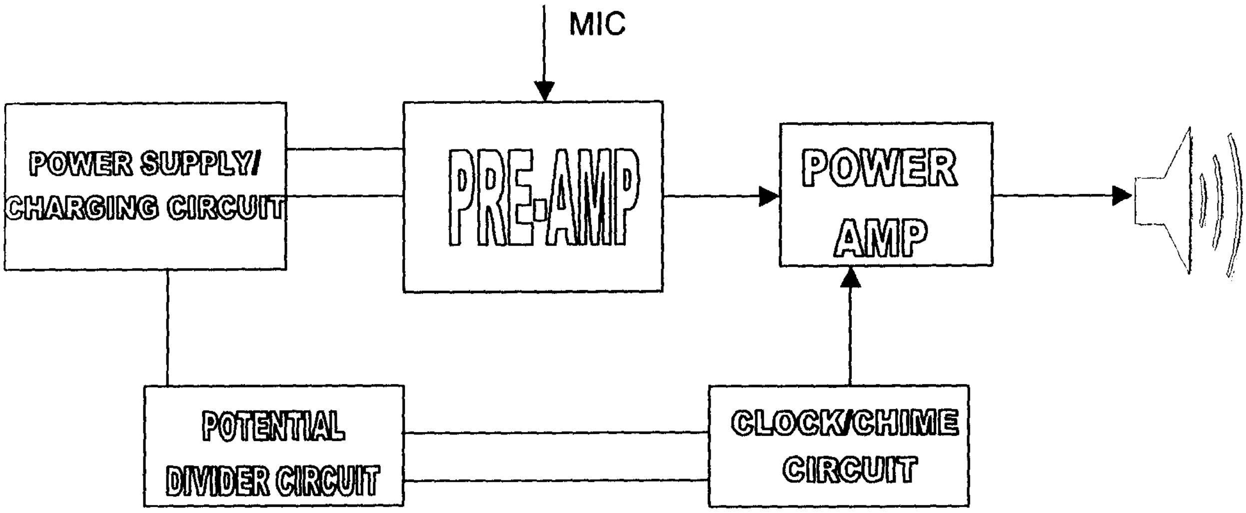

Fig 1.0 A BLOCK DIAGRAM OF THE SYSTEM

1.1 AIMS AND OBJECTIVES

Below are the aims and objectives of my project, to give a clear sense of purpose of my work.

a, To design an amplifier circuit capable of magnifying audio signal to cover the campus.

b, To interface the melody output of a clock with the input point of the amplifier.

C, To provide another input point on the amplifier to enable communication in cases of emergency or public information within the campus.

d, To power the whole system by a 12v lead acid battery via a voltage/current divider to different units of the system.

e, To economically use the 12v battery by making provision for charging the battery from NEPA supplied a.c mains.

1.2 MOTIVATION

The dare need to disseminate information within the campus has become almost indispensable by day. Then I decided to take up a challenge of bringing to an end this problem, which I wisely include the notification of what the time is around the campus.

1.3 PROJECT LAYOUT

The project comprises of five chapters.

Chapter one is the general introduction, which include block diagram, aims and objectives. Chapter two is the detailed design and analysis of each unit. Chapter three handles the construction description. Chapter four is the discussion of result and testing while chapter five finally take the recommendation and conclusion.

CHAPTER TWO

2.0 SYSTEM DESIGN

As stated in the previous chapter, the megaphone is made of different electrical units each serving a unique function.

These are:

2.1 POWER SUPPLY UNIT

As the name implies, this is a very essential part of the megaphone since it is which gives the megaphone operational ability.

This particular one was designed such that the incoming 220V-240V(50HZ) supply from the mains is stepped down to 15V,2A using a transformer of the given rating. In so doing, I employed the use of a fuse of 2A rating to protect the transformer from possible over-current.

The 15V at the secondary side of the transformer was fed to battery terminals via a full bridge rectifier and a switch. The bridge rectifier rectifies the supplied alternating signal into a pulsating d.c signal needed to charge the battery, and the switch provides a unidirectional flow to the battery to avoid discharging of the battery through the rectifier in the absence of a.c supply.

To make the power unit complete, a potential divider was designed to make adequate provision of supply to different units of the system consuming energy at different levels.

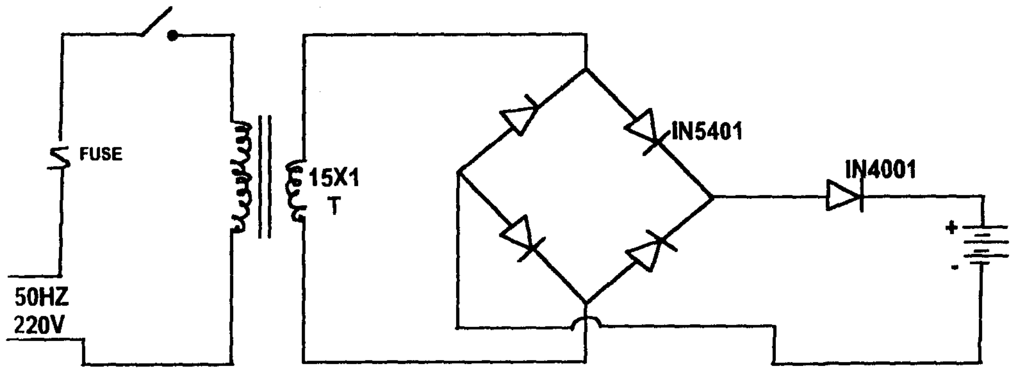

fig 1.1 CHARGING CIRCUIT

2.1.1 AT TRANSFORMER STAGE

The 220V taken by the primary side was dropped to 15V based on the coil number of turns arrangement.

$V2/V1=N2/N1$

$I1/I2=N2/N1$

There is no power loss during the transformation, and the primary and the secondary parameters are in phase.

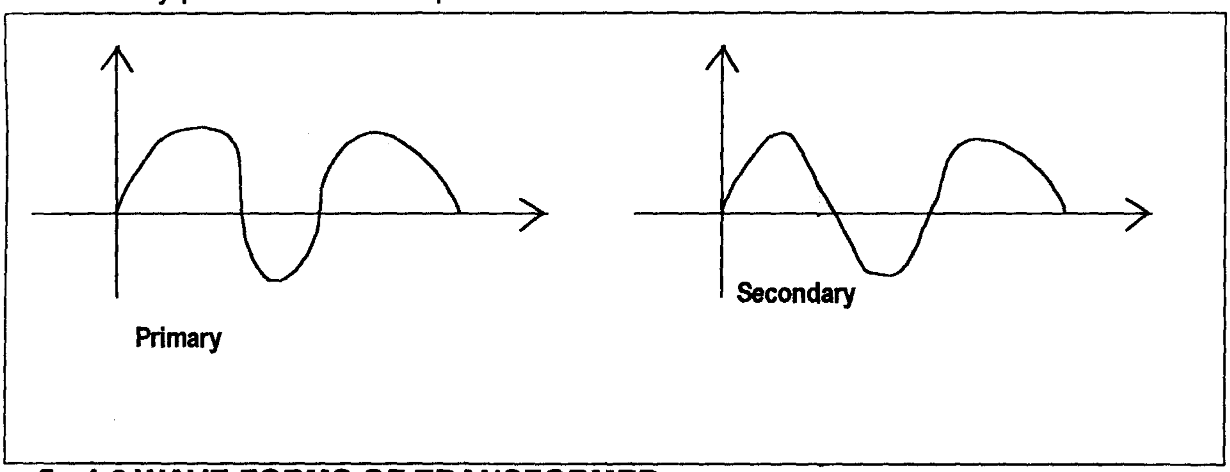

fig 1.2 WAVE FORMS OF TRANSFORMER

2.1.2 AT RECTIFIER STAGE

As observed that the wave of the transformer secondary voltage is alternating sinusoidal, and assumes a sinusoidal voltage V=VmaxSinwt, therefore the need for rectification, which will convert the a.c voltage to the desired d.c voltage.

A full bridge rectifier arrangement was used in which two diodes are conducting at any one circle. Thus, giving it a full wave output.

$I_{d.c}=0.367I_m$

$I_m=\sqrt{2}I_{r.m.s}$

Given $I_{r.m.s}=2A$

$I_m=2\times\sqrt{2}$

$I_m=2.83A$

$I_{d.c}=0.367\times2.83$

$I_{d.c}=1.8A$

$V_{d.c}=0.367V_m$

$V_m=\sqrt{2}V_{r.m.s}$

Given $V_{r.m.s}=15V$

$V_m=15\times\sqrt{2}$

$V_m=21.2V$

$V_{d.c}=0.367\times21.2$

$V_{d.c}=13.5V$

Since Vm =21.2, the diode must have a peak reverse volta

2Vm, i.e 42.4V. Hence, the choice of IN5401,which has peak reverse voltage (PRV) of 100V.

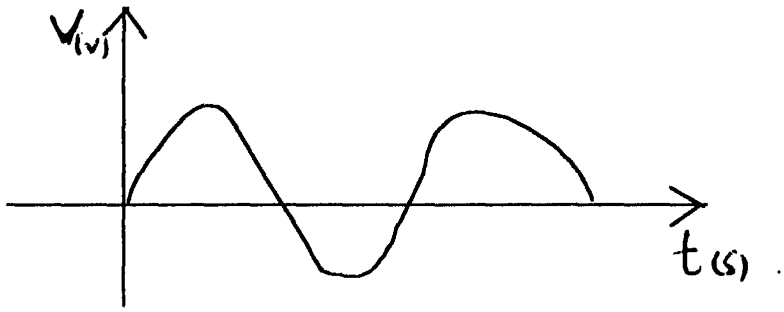

fig 1.3 INPUT WAVE TO RECTIFIER

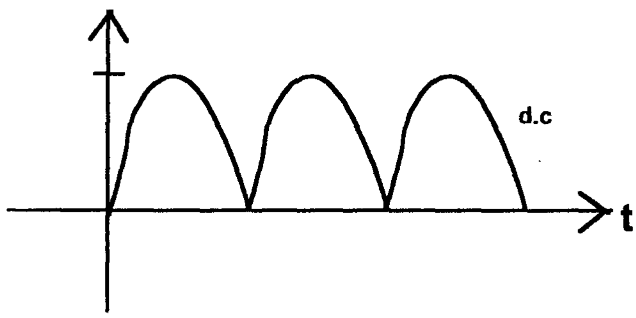

fig 1.4 RECTIFIED d.c VOLTAGE

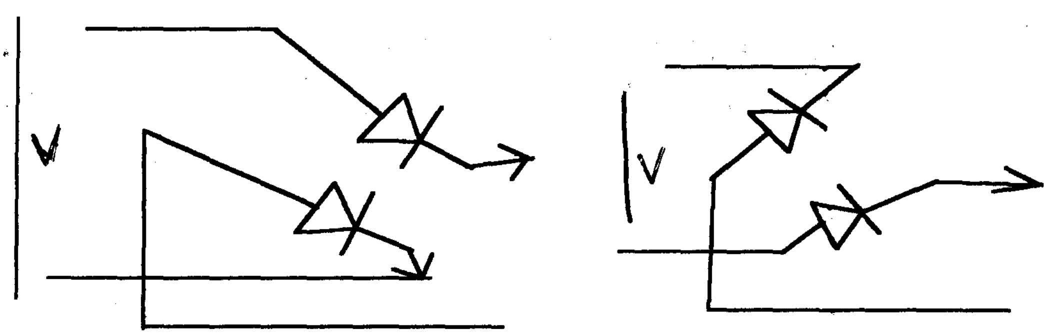

FIG 1.5 ACTIVE CIRCUITS DURING EACH HALF CIRCLE

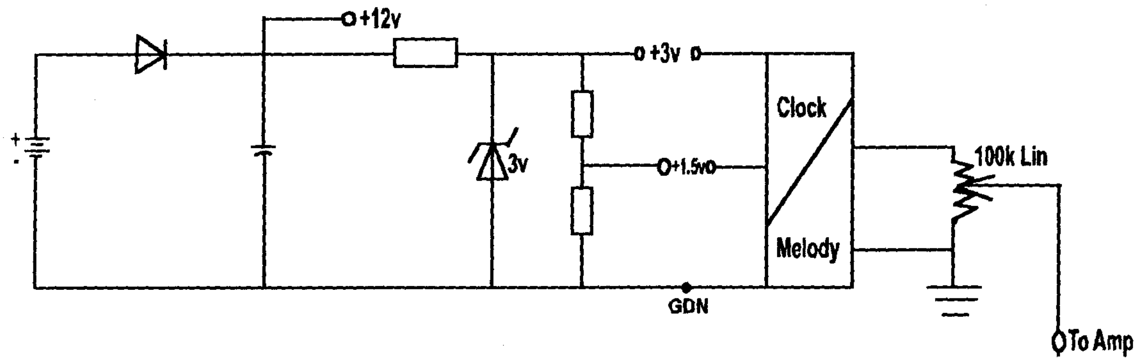

fig 1.6 VOLTAGE DIVIDER CIRCUIT

2.1.3 AT SMOOTHING STAGE

The 12V from the battery is a pulsating d.c through a switch to the filtering capacitor. It is desired that the ripple factor Y of the signal be reduced greatly. Choosing a 4700-µf capacitor;

$Y = Id.c/(4\sqrt{3}(fC)Vpk)$

$Id.c = 0.637Im = 18A$

$f = 100Hz$

$C = 4700µf$

$Vpk = 21.2V$

$Y = 0.026.$

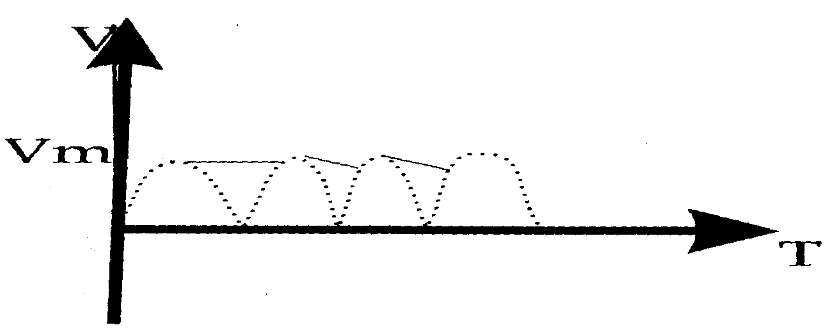

fig 1.7 SMOOTHENED RECTIFIED WAVE

2.1.4 AT VOLTAGE REGULATION STAGE

The 3V zener diode that appeared in the circuit diagram clips the voltage drop at 3V required to power the clock melody circuit even though there might be current variation due to battery running down below 12V.

The 200-OHM resistor was used to practically give the limit to which current can flow to the zener diode at a maximum supplied voltage.

The ensuing 3V from the zener diode is flowing with a forward current of 50mA into the clock melody, being the exact values needed to power the melody circuit.

$I = I_z + I_L$

$I_{L,MAX} = 50mA$

$I_{Z,MIN} = 20mA$

$I = 50+20$

$I = 70mA$

$V_S = 12-3$

$V_S = 9V$

$R_S = V_S / I$

$R_S = 128.57\Omega$

$R_S = 200\ \Omega$

$P_{Z,MAX} = 300mW$

$P_Z < P_{Z,MAX}$

$P_Z = IV_L$

$P_Z = 0.07 \times 3 = 210mA$

Since the power dissipated is less than maximum power, the zener diode will operate safely.

2.1.5 THE POTENTIAL DIVIDER STAGE

In powering the circuit, a potential divider was needed to give the values required.

$220 / (220+220) \times 3V = 1.5V$

$1.5V / (220//220)\ \Omega$

$= 0.013A$

0.010A is the rated current value flowing through the clock circuit.

2.1.6 CLOCK / MELODY

The clock was purchased from the market and used as a timer with an in-built chime. This was performed at hourly basis in different melodies for each. The only modification here, is the removal of the dry cell batteries and replacing them with the power supply from the designed power pack. As well, the interfacing of the melody circuit output with the input of a designed amplifier.

A variable resistor is used to control the input signal to the power amplifier from the melody circuit.

2.1.6 PRE AMPLIFICATION UNIT

In meeting the objectives of this project, it is necessary to employ this unit since the sound signal from an operator requires pre-amplification before further processing.

This was designed to couple the signal coming from a microphone with the power amplifier. It consists of arranging two transistors in cascade form to enable amplification to a minimal level that could be coupled to the power amplifier.

Below is the circuit:

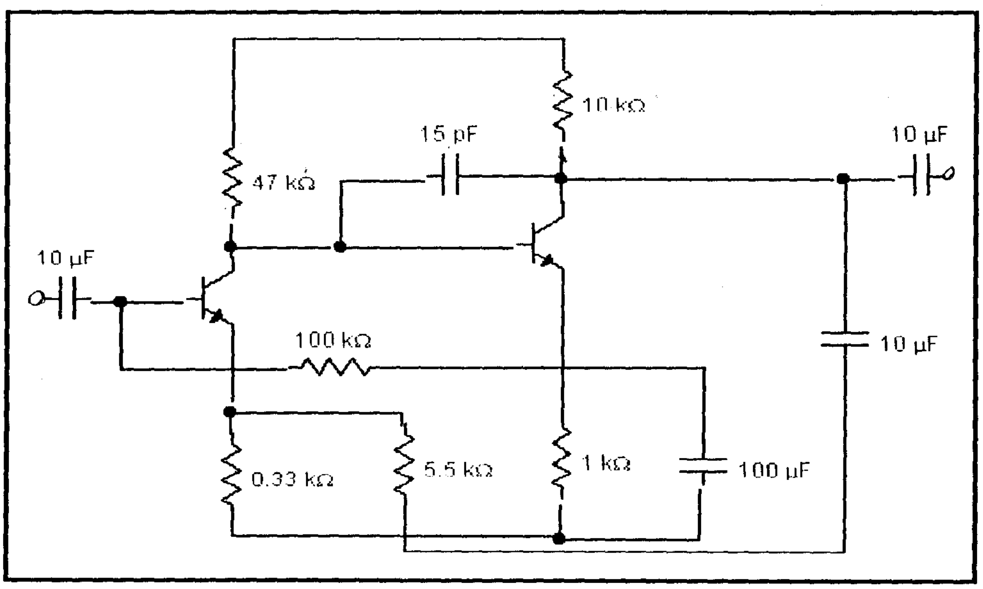

fig 1.8 PRE AMPLIFIER CIRCUIT

Gain of the pre amplifier is:

Av = 5.5k / 330

Av = 16.67

Input to the pre amplifier is done with the aid of microphone serving as 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.

2.3 POWER AMPLIFIER UNIT

This is the unit where the main purpose of the project took place. It was done by a power amplifier. The one choosen 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.

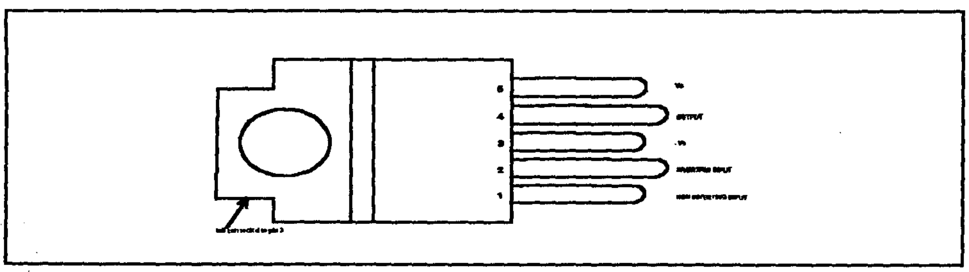

fig 1.9 PIN CONNECTION

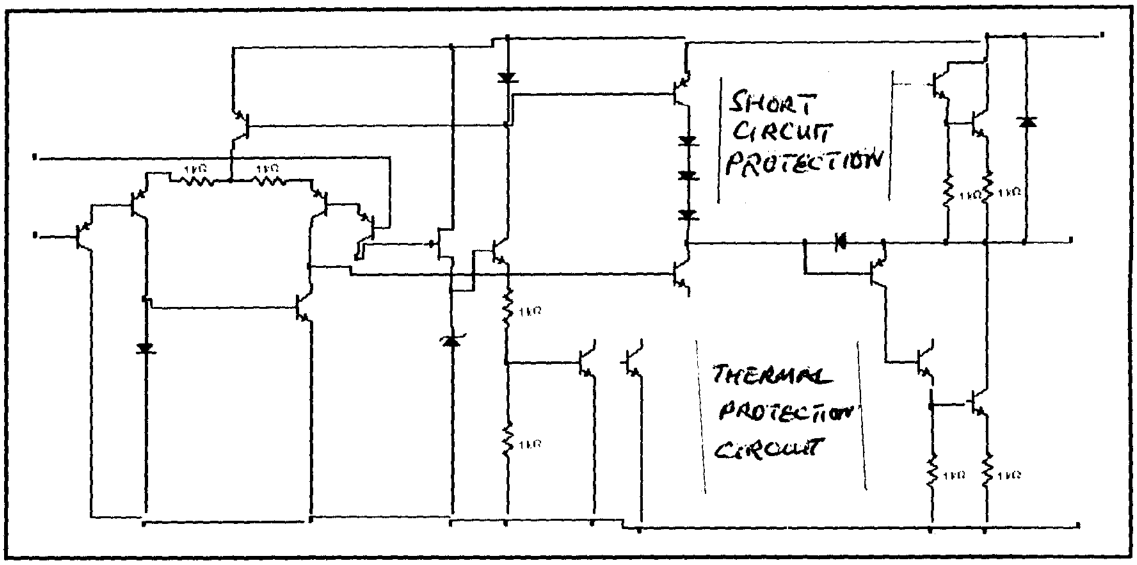

fig 1.10 INTERNAL CIRCUITRY OF TDA2006

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 a.c 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,

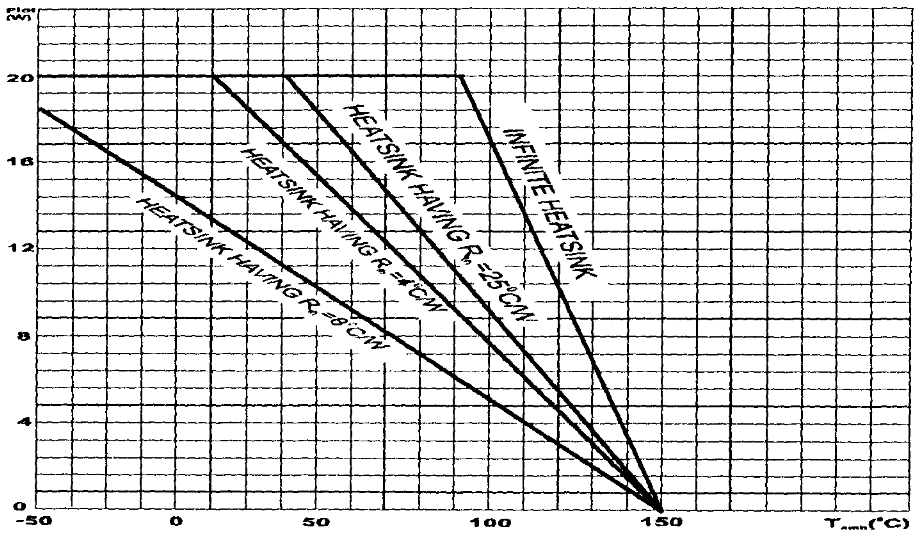

fig 1.11 MAXIMUM ALLOWABLE POWER DISSIPATION AGAINST AMBIENT TEMPERATURE

In this particular design, an application circuit was adopted to increase the gain to a desired level.

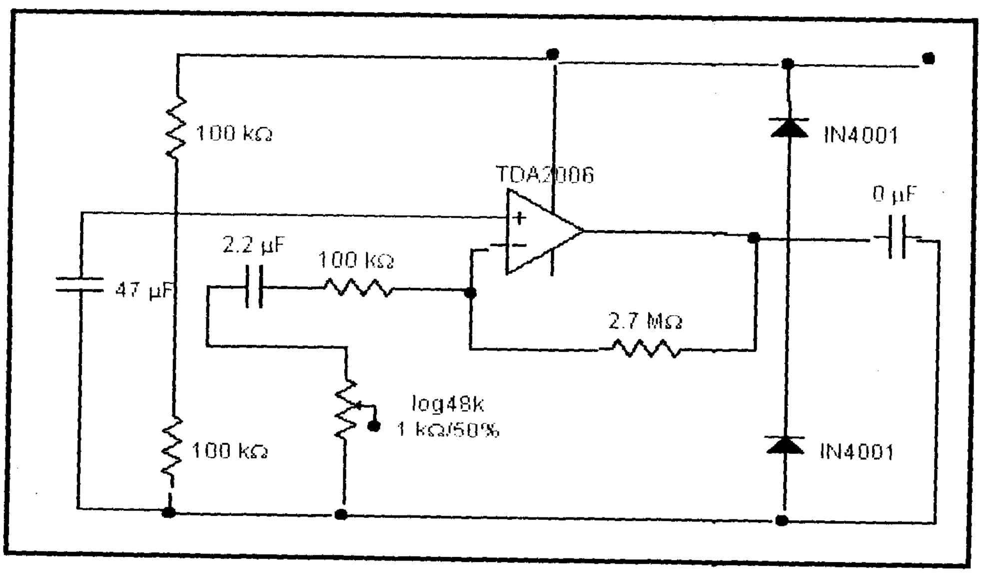

fig 1.12 CIRCUIT DIAGRAM OF POWER AMP

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 d.c decoupling, which block all the unwanted signals from the input point.

C3 serves in filtering out the unwanted d.c 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 choosen 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

Each component in the megaphone system was duly constructed and connected to enhance a steady range of signal processing and moreover, the transfer of signal from one stage to the other. Each unit is playing a vital role as below.

3.1 CONSTRUCTION OF THE COMPLETE SYSTEM

The transformer was connected to the a.c mains in other to step down the incoming 220-240V (50HZ) signal to constantly charge the battery connected across it.

A fuse and a switch are connected in between the a.c source and the transformer to protect the transformer from damaging in case of over current.

Though the current in both the primary and secondary sides of the transformer are sinusoidal, the battery needs a pulsating d.c signal for charging. Hence, the employment of a full wave bridge rectifier.

The signal from the rectifier was passed through a unidirectional device (diode), so that the battery doesn't discharge backward when NEPA supply goes off.

At the battery point, a supply was taken through a capacitor for smoothing to the potential divider circuit where the voltage is shared to the various circuits in the system.

The clock operation, melody circuit, pre-amp circuit and power-amp circuit require 1.5V/10mA, 3.0V/50mA, 12V, and 12V respectively for their operation.

The clock melody output was interfaced with the input of the main amplifier circuit, since it has an in-built pre amplifier while another separate pre amplifier was built and interfaced with the power amplification for sound signal coupling.

At the output of the power amplifier, a speaker was interfaced to convert the amplified electrical signal into their equivalent sound signals.

Recall, that incase of power failure, the charged battery discharges through the system and until NEPA restores the supply for recharging.

This is expressed in a simple flow diagram below:

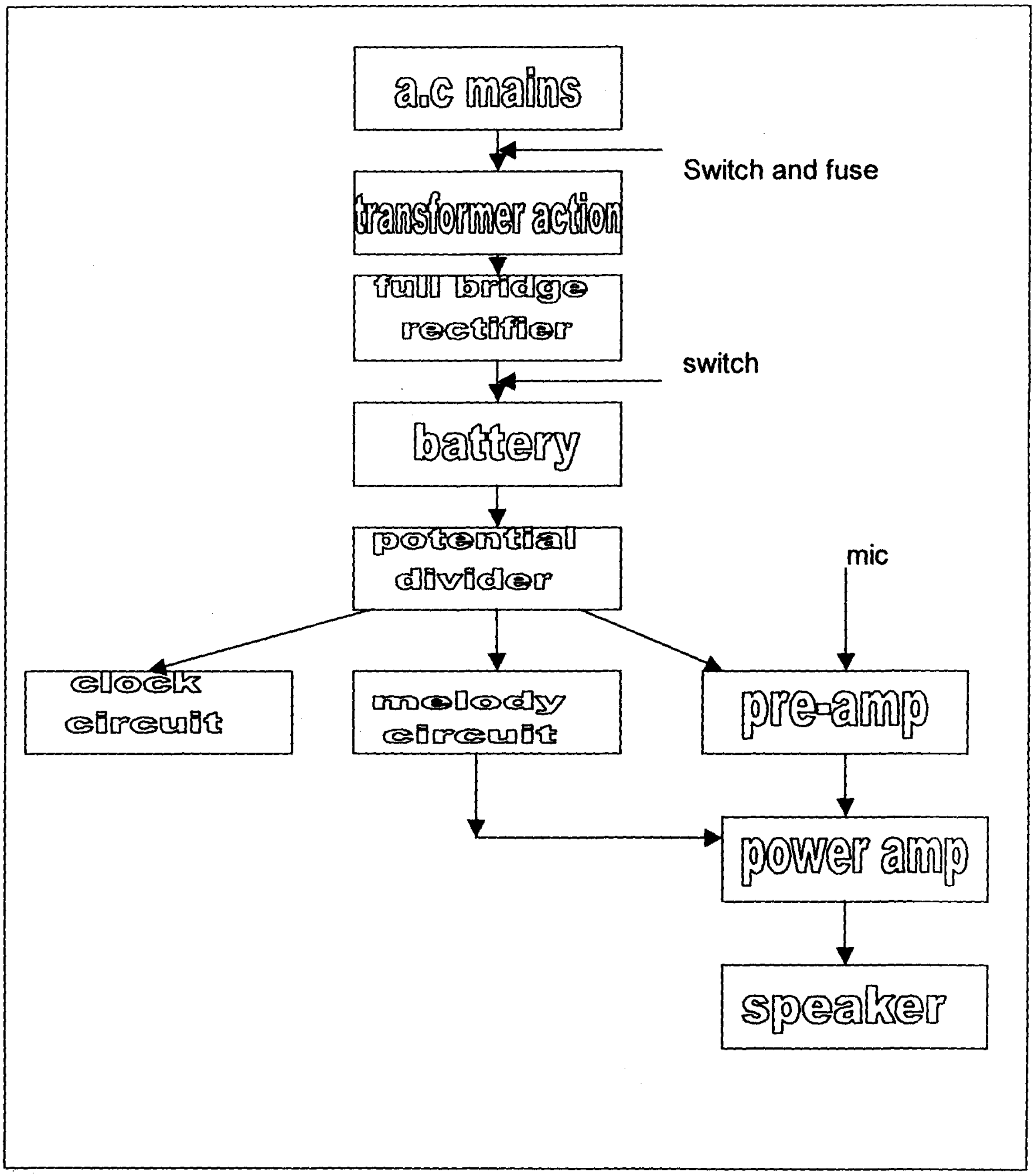

Fig 1.13 sequential operational flow of signal processing

3.2 COUPLING OF DIFFERENT COMPONENTS ON PRINTER CIRCUIT BOARD

The printer circuit board is tremendously important in almost all application areas of modern electronics. It provides a mechanical mounting for components.

The method used in coupling different components on the PCB is soldering, known as low melting point alloying of tin and lead used for making electrical and mechanical joints. This was done by dissolving unto solid surface the metal used rather than melting the surface of the PCB.

For a good coupling, some requirements were met during the exercise among which are:

a) The surface was properly checked for any layer of oxide.

b) A sequential layout system was adopted to give a neat and better coupling.

c) The surface to be soldered was also properly cleaned.

CHAPTER FOUR

4.1 TABULATION OF RESULT

SUB UNIT	SECTIONS	UNITS	VALUES
Power	transformer	V	220/15
	rectifier	V	21.2
	battery	V	12
	Ripple factor		0.026
Pre-amplifier	gain		16.67
Power amplifier	gain		27
	Lower cut-off freq.	Hz	0.72
	Upper cut-off freq.	Hz	9.04

4.2 DISCUSSION OF RESULT

The above results were obtained for a proper construction of the different units and it was noticed that even if the biasing voltage to the amplifier drops down below ±12V, it still perform function provided it did not come below ±6V.

It was observed that the 15V transformer helped very well in charging the battery at its giving voltage neither without allowing it to come short nor for the circuit to be disturbed.

4.3 TESTING

The circuit was first built on a solderless bread broad, which made it possible to make changes when the need arises, and made it easier to locate bugs. It was later transferred to the vero board where careful components soldering were done.

All components leads were kept at minimum to prevent accidental short circuit. The circuit was properly planned minimizing errors, and make trouble shooting afterwards.

The overall circuit layout was paralleled as much as possible. This is to make easy identification of each section by any person examining the circuit.

The entire circuit was housed in a metal case (compartment). The switch , the impedance selection to the power amplifier and pre- amplifier as well as the input to pre-amplifier were wired to the front side of the case to make them easily accessible to the user.

When all the soldering was over, the circuit was traced and retraced to ensure there was no short or open circuit anywhere, and the output of the power supply was carefully monitored for a proper overall throughput.

CHAPTER FIVE

5.1 RECOMMENDATION

Having done this project and tested working, I therefore recommend that the technology be adopted for use as, certainly it will find widespread acceptance due to its availability in times of performance and economy.

5.2 CONCLUSION

The aims ealier stated in chapter one were all satisfactorily attained. After testing the whole system, it was observed that a steady supply was there and as well a steady processing which gave the overall performance at a pre-desired level.

Reference:

1) principles of electrical engineering

(peyton z. peebles, jr.)

2) Hughes electrical technology

(I mckenzie smith)

3) encyclopedia britanica