DESIGN AND CONSTRUCTION OFA 35 WATTS AUDIO AMPLIFIER

BY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG) IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

NOVEMBER 2004

DECLARATION

I, OKON, EDWIN BASSEY hereby declare that this thesis presented for the degree of Bachelor of Engineering is an original work and has never been presented either wholly or partially for the award of diploma or degree in any other institution as far as I know.

The information derived from published works of others is acknowledged in the reference section.

DEDICATION

This piece of my work is dedicated to God Almighty, who has been my source of inspiration and guidance. Also to those who care for the poor and the poor in our society.

CERTIFICATION

This is to certify that this project "DESIGN AND CONSTRUCTION OF AN AUDIO AMPLIFIER" has been presented by Okon, Edwin Bassey of the department of Electrical/Computer Engineering, School of Engineering and Engineering Teclmology, Minna and that he has met the required standard acceptable by the above named department.

.... 7th Dec, 2004

PROJECT SUPERVISOR DATE

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.... 7/12/2004

HEAD OF DEPARTENT DATE

Engr. M.D. ABDULLAHI

....

EXTERNAL EXAMINER DATE

ACKNOWLEDGEMENT

Academic projects are entirely the results of people's aided effort and this is no exception. First, I am very grateful to Almighty God who in His infinite mercy made this dream to come true.

I wish to thank my humble supervisor **Engr Paul O. Attah** for his hard work towards the successful completion of this project. My profound gratitude goes to my Head of Department **Engr M.D. ABDULLAHI** and all the members of staff in Electrical/Computer Engineering Department who contributed in one way or the other towards achieving this success.

I am very grateful to my parents especially my mother **Chief (Mrs.) Winifred Okon** who single handedly brought my dream to a reality. May God continue to bless and protect you.

I am also indebted to my Uncle **Mr. Javis Archibong and family** who were always there for me both financially and moral encouragement. Thank you very much.

I shall remain ungrateful if I forget to say thanks to my brother **Michael**, and my sisters **Nkese and her husband Uncle Jay, Agatha** and especially **Mika** for her love and generosity. Aunty **Rosemary**, who is my Abuja mother, thanks for accepting me as a son. Finally, my thanks goes to my friends and colleagues such as **Roy** and **Tayo** (we were the three musketeers), **Okpala**, **Emeka**, **Uncle Zuby**, **Nta**, **Sunny boy**, **Shai man**, **Vicky**, **Nasiru**, **Uncle Alo**, **Abia**, **Funso**, **Ikie** and many others too numerous to mention, for their various forms of support and encouragement.

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ABSTRACT

This project is concerned with the design and implementation of an audio amplifier. It is simply a circuit that amplifies sound input using both the pre-amplifying stage and the power amplifying stage. The pre-amp builds up the weak signal so that it can be amplified by the power amp. The output is passed through the speaker. It is otherwise, a public address system. The performance after test, met the design specification though it is recommended that further work should be carried out on this project especially at the point of tapping the signal from the pre- amplifier to the power amplifier to see if a better sound output will be produced.

CHAPTER ONE

1.0 INTRODUCTION

Engineering design is the process of devising a system in order to meet a desired need. The basic mathematics and engineering sciences are applied to optimally convert the available resources inorder to meet a stated objective.

Therefore, this project is concerned with the design and implementation of an audio amplifier using a sound switch pre-amplifying circuit. The sound switch on it's own could be used to trigger any peripheral device connected to it, such as a photo flash when it is intended to take a photograph of an event which produces a sudden sound/noise or as a baby alarm. But in this case, an amplifying circuit is being connected inorder to amplify the sound input.

This is made possible when sound is produced. Therefore, sound could be described as the sensation received by the brain which comes through the ears, as a result of wave motion in the air, or any other transmitting medium set up by a vibrating body. The sound switch provides the user the ability to activate it and the span of time it will close, thereby preventing it from being triggered by normal conversation or background noise within a room.

This design has two important circuits; the sound activated circuit, and a power amplifying circuit. A microphone is used as a transducer of sound wave into electrical signals prior to their amplification. The circuit uses a 9v transformer which steps down the 220v from the mains. This transformer is connected to a rectifier and passes through a 9v regulator inorder to maintain a constant voltage supply.

1.1 OBJECTIVE

This work is aimed at producing an amplifier that will produce the same quality of sound as other amplifiers but with fewer components which are cheaper, as a result of the pre-amplifying circuit which is that of a sound activating switch.

1.2 GENERAL REVIEW OF THE AUDIO-AMPLIFIER CIRCUIT.

A sound activated pre-amplifier is commonly used for security purpose (burglary alarms in stores, private homes est)

It has two main components;

(a) The Auto-transformer for stepping down voltages, the rectifying diodes which converts alternating current to direct current and the capacitors which filters out the ripples.

(b) The relays which include transistors, capacitors, amplifier, microphone and the speaker

In the first stage which is the power supply unit, the transformer steps down the AC voltage from 220v to 9v, a rectifying diode connected to the transformer in which it's function is to convert the alternating current to a direct current .This is because the output of the transformer is alternating, it is therefore wise to convert it before applying the current to electronic circuits. This process is called RECTIFICATION. A full wave rectifier was used in this design. The unidirectional pulses obtained are passed through a filter and this filtering after rectification is called SMOOTHING.

The microphone acts as a transducer of sound wave into electrical signals before amplification. The resistors are used to provide resistance to current flow. The bulb shows that the circuit has been completed and also comes up whenever the input signal strength is increased.

The second stage of this design is the power amplifier which increases the strength of the electrical signal. The pre-amplifier builds the signal into a standard level before the power amplifier enlarges them millions of times into a level powerful enough to drive the elements of the speaker. The speaker is an indicator when the sound is up while the main switch is for protection

1.3 LITERATURE REVIEW

Man has always relied on his five senses to keep him informed about his environment. Of the five senses, hearing had a late arrival in the evolutionary process but has become the busiest. Our sense of hearing is always at work, and has become uniquely complex and timely tuned mechanism which we are trying now to understand. It is therefore not surprising that the sense of hearing and the nature of sound has captured the scientist interest.

Robert Boyles demonstrated in 1660 that sound needs a medium such as air through which it can travel. He hung a ringing alarm inside a glass jar and after removing air inside it, the ringing became inaudible. As at the seventeenth century, a French mathematician, Mersenne, measured the time it took for sound to be reflected over a known distance and thus calculated the speed to be 450m/s.Sound wave energy is quite small compare with that carried by ripple waves. For example, a single voice speaking softly produces a short distance away a sound intensity of about 0.1picowatt per square centimeter (10^-13 w/cm^2). This therefore shows how sensitive the ear must be to the energy changes caused by sound. This energy changes could be utilized in developing a switch to convert any perceptible sound by a transducer into electrical signal that will trigger a switching circuitry.

A switch is a device with only two conditions; open or close. It is any mechanical device by means of which two or more electrical conductors may be connected or disconnected. The simplest form consists of two strips of spring metal on which are mounted electrical contacts. A simple mechanical sound switch is shown in the figure below.

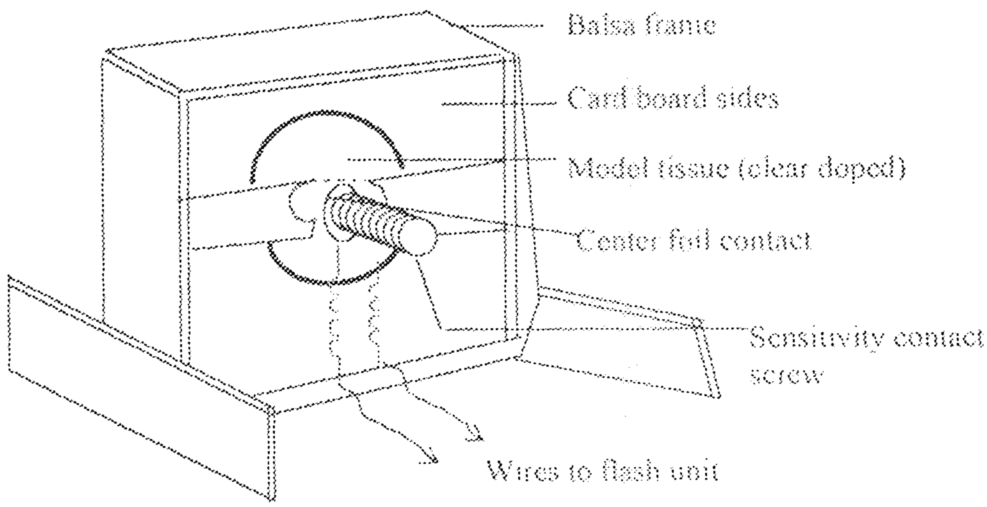


Fig 1 A simple Mechanical Sound Switch

Switches have been in use for a very long time. In 1837, W.F.Cooke, Wheatstone and Edwards Davy, all of U.K, invented the relay about the same time, though individually. The relay was employed in making telegraph signals from one point to another.

Communication is essential to mankind and from early history; various means have been used to provide communication at a distance. In a lecture titled, "the science of human communication", Wilbur Schamn noted that communication was a crossroad where many have passed but few have tarried. The first public communication through radio broadcast was in Nov 1920 in Pittsburgh, Pennsylvania when the KDKA station announced the Presidential election results.

Therefore modern day communication depends very much on amplification. This is evident from the fact that the commonest types of electronic devices used in communication are those covered by the term "AMPLIFIER". In telecommunication, we take a look at the amplifying properties of the thermionic valve which prior to this time, long distance telephony was limited to about 400 miles, picture telegraph was impracticable; broadcasting and television unthought-of.

With the invention of the three – electrode valve by Lee de Forest, it became possible to generate continuous oscillation on medium and short waves, and to modulate them by speech or other signals. Receivers of high sensitivity and high output power became possible because weak signals were strengthened and increased by the use of amplifiers thereby making broadcasting practicable.

The transistor came into being in the 1948 John Bardeen, Walter H. Brattain and Shockley of the Bell laboratory (U.S.A) found that simplification could be obtained by means of a third contact to the normal p-n contacts in germanium (Ge). This was termed a point contact "transistor'. Transistors came into very wide use because of its advantage of low voltage operation, low current consumption, extreme small size and high reliability.

CHAPTER TWO

2.0 CIRCUIT ANALYSIS

In the first part of the circuit are two transistors, one an NPN and the other a PNP transistors which work together to process the sound fed in by the microphone. The output from this transistors amplifier operates a two transistor switch on the second part when the microphone receives sound waves.

The output across the points X and Y as shown in the figure below consists of voltage changes, which is the amplified electrical signals, corresponding to the sound waves. The two resistors R_5 and R_8 are arranged as a voltage divider so that in a situation where there is no signal input to Tr_3, this transistor is just turned off. With this happening, it means that the base emitter voltage is close to 0.6v. The varying voltage is now impressed on the steady base voltage so that the voltage which appears at X goes above and below 0.6v as seen in the graph of Fig 2 below.

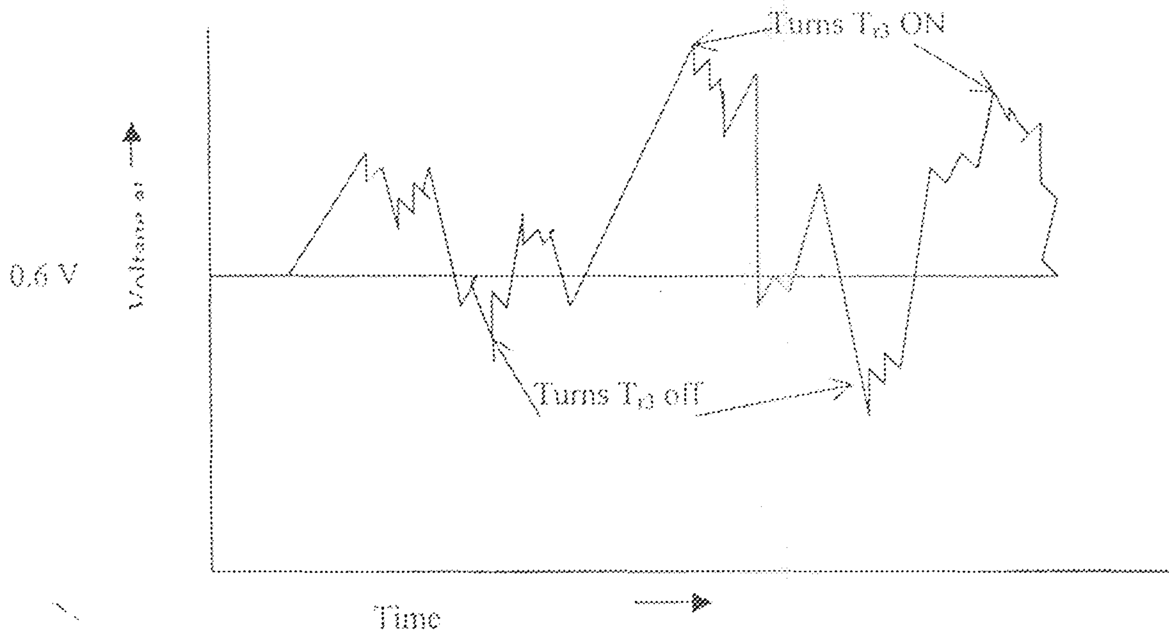


Fig 2. Signal variations from an amplifier.

It will be noticed that only those signal which drive the base to greater than 0.6v can switch on the transistor Tr3.

Transistor Tr_4 is a PnP transistor and R6 holds this transistor off. But when Tr_3 starts conducting, the current flowing through R_7 and R6 lowers the voltage at the base of Tr_4. with this, the transistor turns ON and the bulb lights. Capacitor C4 is in the circuit to keep Tr4 in the ON state a little longer than Tr_3; that is, though Tr_3 has turned off and C_4 has discharged completely while Tr_4 is conducting, there will still be current flow through the bulb (L_1) for a short time to enable C4 to charge up again through R_5.

In this design, when the supply to the circuit is ON, current flows through R_6 and the bulb comes ON for a short time and goes off. Then depending on the sound intensity, the bulb will come ON and off again. The electrical signal output from capacitor C3 in the pre – amplifier is fed into an OP – AMP (A TDA 2002) power amplifier circuit input whose function is to increase the electrical signal and also magnifies the output signal.

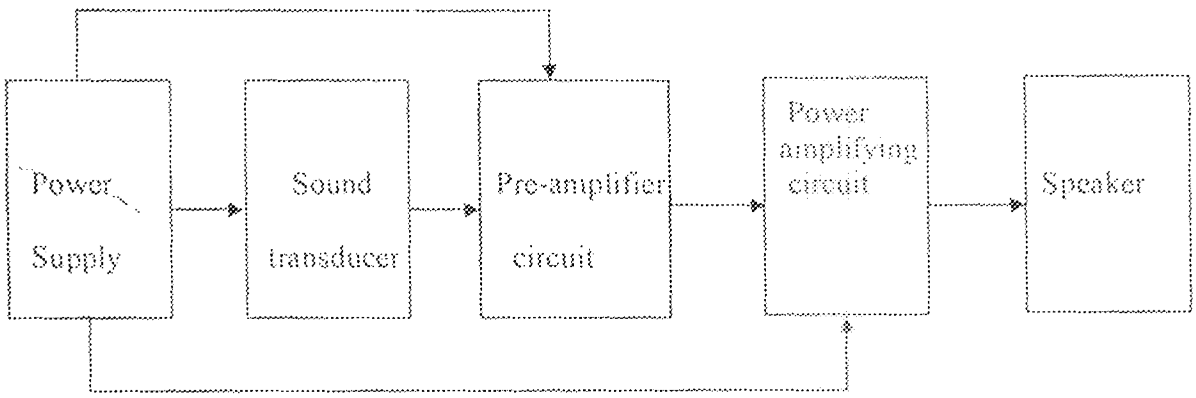


Fig 3 Generalized block diagram of the audio amplifier

2.1 POWER SUPPLIES AND VOLTAGE REGULATOR

All electronic circuits usually require a DC power supply that can maintain a fixed voltage while supplying enough current to drive a load. Batteries make good DC supply but their relatively small capacities make them impractical for driving high – current frequently used in circuits. An alternative solution is to take a 120 v AC, 60 Hz line voltage and convert it into a useable DC voltage. The trick to converting the AC line voltage into a useable (typically lower level) DC voltage is to first use a transformer to step down the AC voltage. After that, the transformed voltage is applied through a rectifier network to get rid of the negative swings (positive swings if you are designing a negative voltage supply). Since this design is based on a positive voltage supply, therefore once the negative swings are eliminated, a filter network is used to flatten out the rectified signal into a nearly flat DC voltage pattern as shown in the figure below.

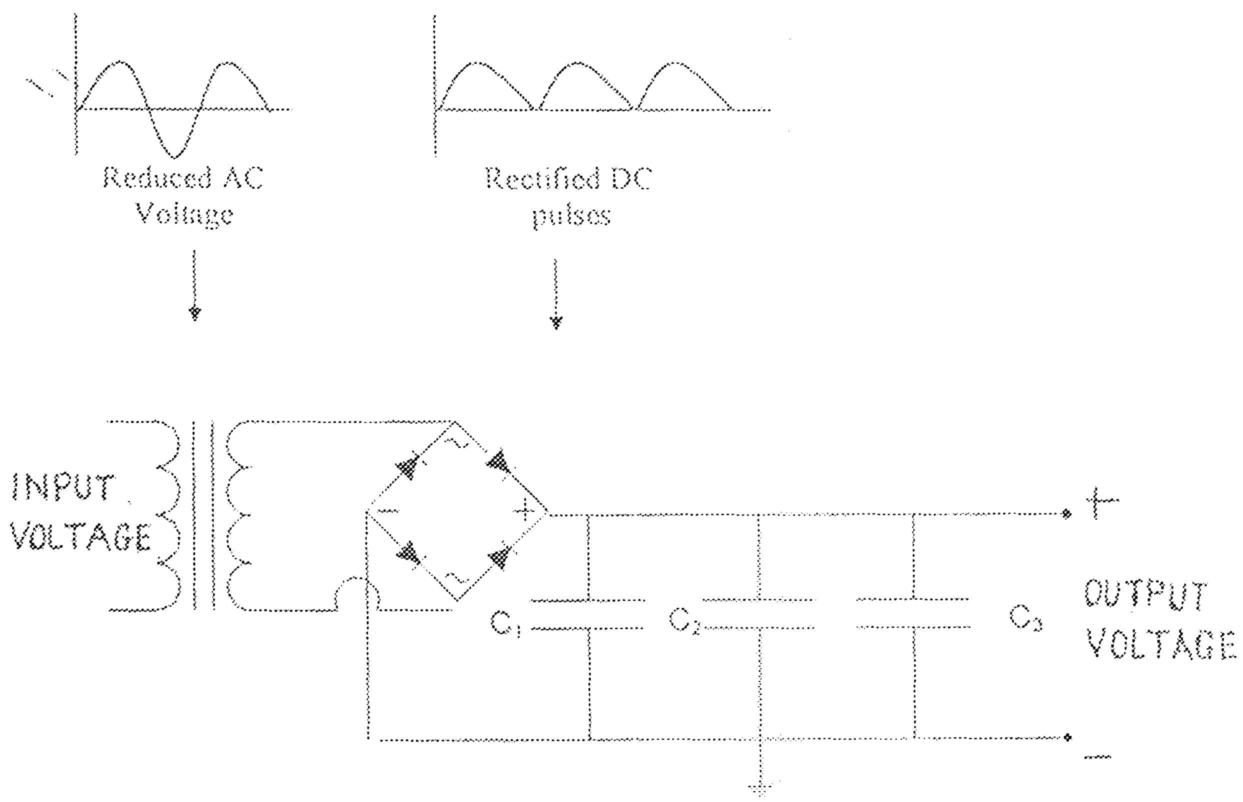


Fig 4 Unregulated power supply circuit

Now there is one problem with this supply - it is unregulated. This means that if there are any sudden surges within the AC input voltage (spikes, dips etc), these variations will be expressed at the supply's output and this can lead to improper operating characteristics (e.g. false triggering) and may destroy the IC's in the process. An unregulated supply also has a problem maintaining a constant output voltage as the load resistance changes.

A special component was used in this project to maintain a constant output. It's called a VOLTAGE REGULATOR. It was placed across the output of an unregulated supply to convert it into a regulated supply.

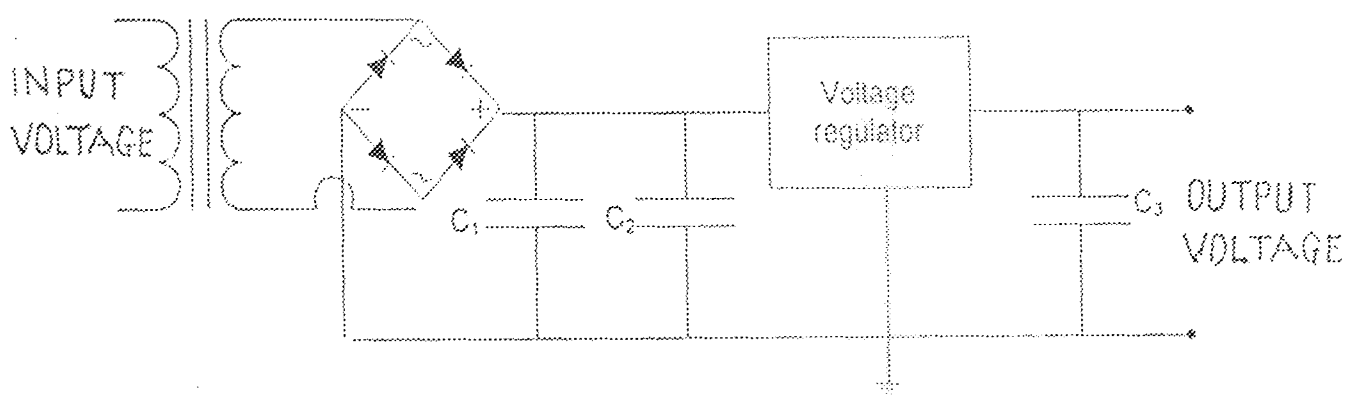


Fig 5 Regulated power supply circuit

A voltage regulator is therefore designed to automatically adjust the amount of current flowing through the load, so as to maintain a constant output voltage by comparing the supply's output with a fixed or programmed internal reference voltage. C3 is a bypass filter used to eliminate high frequency noise generated by the load.

A simple regulator consist of a sampling circuit, an error amplifier, a conduction element and a voltage reference element as seen in figure 6 below.

The regulator's sampling circuit (voltage divider) monitors the output voltage by feeding a sample voltage back to the error amplifier The reference voltage (zener diode) acts to maintain a constant reference voltage that is used by the error amplifier. The error amplifier compares the output sample voltage with the reference voltage and then generates an error voltage if there is any difference between the two. The error amplifier output is then fed to the current control element (transistor), which is used to control the load current.

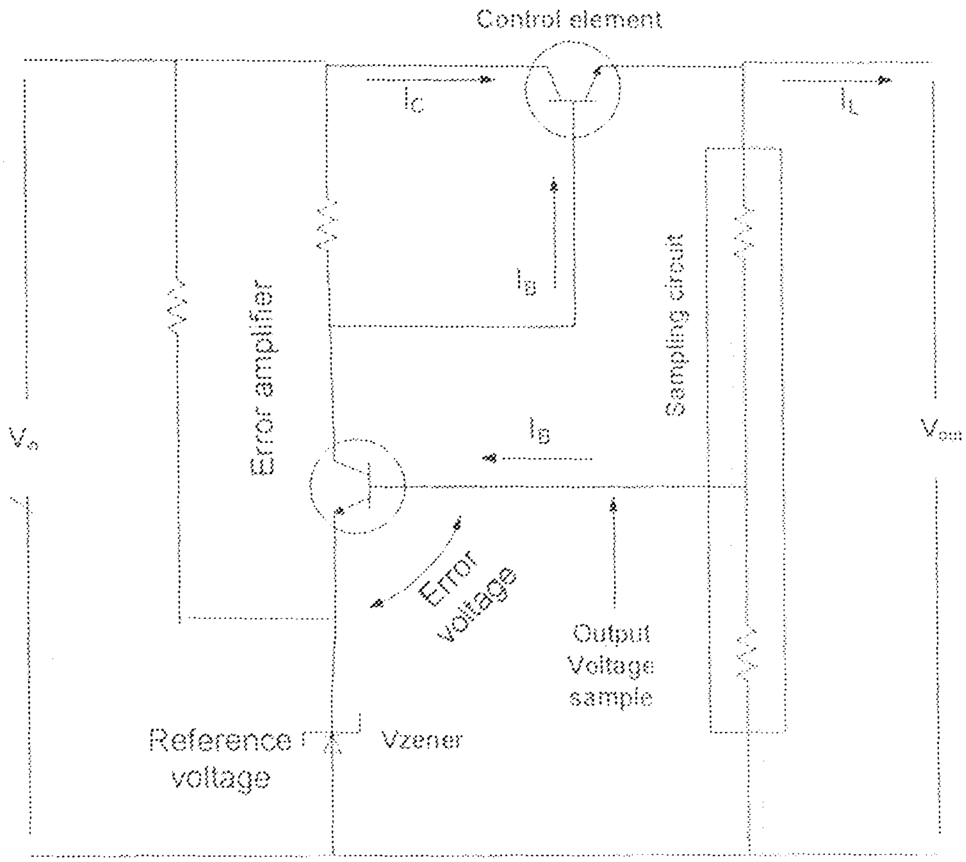


Fig 6 Internal circuit of a simple regulator

RIPPLE VOLTAGE

From the power supply circuit diagram, the rectifier diodes charges up the filter capacitor (C1) to the peak DC value, and between non – conducting cycles of the diodes, it discharges into the load resistor thus, creating a saw tooth wave form known as ripple voltage. The value of the ripple voltage is dependent on the load current, power supply frequency and capacitor value. That is,

$V = ½ FC$

Where V is the ripple voltage (nV)

F is the frequency of AC supply.

C is the smoothing capacitor value.

2.1.1 CAPACITOR FILTER

Recall that, the output of the full wave rectifier still contains both AC and DC components, and most electronic circuits/applications can't stand a high value of ripple. Therefore, further processing of the rectified output is necessary in order to remove the undesired AC components or reduce it to the barest minimum thus, producing a smoother waveform. This is achieved using a filter.

The voltage regulator will be unable to work correctly if the fullwave rectified waveform was applied directly to its input. This is due to the fact that the waveform is varying from Vmax to 0v and no regulator can provide a DC output when its input is approximately 0v.

The filter stores energy when the rectifier voltage is near Vmax, so that when the voltage falls, the filter gives back this energy to prevent the voltage from falling to 0v. There are four basic types of filter circuits namely.

(a) LC capacitor

(b) LC choke input filter

(c) Capacitor filter

(d) RC capacitor.

Of the four types, the most commonly used is the RC capacitor filter which is being used in the design of this project. It stores energy as charges

To measure the smoothness of the DC input from the filter, we use the ripple factor and the percent ripple given as:

Ripple factor = rms voltage / average DC

Percent ripple = ripple factor · 100

To get the rms voltage value, the ripple component of the waveform is passed through an rms meter and its average value will be indicated by the meter.

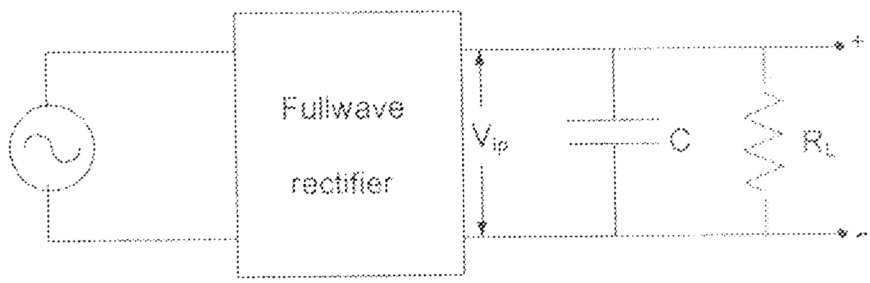


Fig 7 Circuit diagram of an RC capacitor filter

A capacitor connected directly across the load is shown above. It`s operation is to shut the ripple to the ground but leaves the DC to appear at the output when it is connected across the pulsating DC voltage.

2.2 TRANSFORMER REGULATION AND EFFICIENCY

Transformers are known for their efficiency especially when it comes to its work of converting AC voltages and current from one value to another. In practice, between 95% - 98% of efficiency may be achieved. The losses is due to heating effect of the transformer core; losses due to winding and flux leakage. Transformers have a VA rating which is simply given as the secondary voltage multiply by the secondary current. That is, a transformer rated as 20v, 1A will only measure 20 volts when it is delivering 1A.

2.2 RECTIFIERS

A Rectifier is said to be a device which converts alternating current into direct current by limiting or regulating the direction of current flow. That is, the sinusoidal voltages into a pulsating DC signal. For improved efficiency of operation, a fullwave rectifier was used in this design.

Rectification is said to be a process of changing alternating current to direct current. When a semi-conductor rectifier such as a junction diode is connected to an AC voltage, it is alternately biased forward and reverses in step with the AC voltage. This is shown in the figure below.

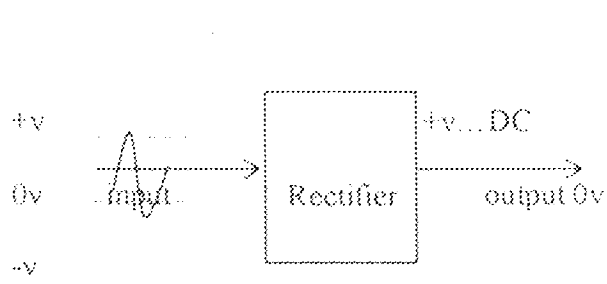


Fig 8 Rectification process

2.3.1 THE FULL WAVE RECTIFIER

With the aid of a transformer, the desired voltage in a rectifier can be provided. Step – up transformer is used for high voltage DC power supply, while step down is used for many solid state equipments for the application of voltages of 4v, 6v, 9v, 15v etc.

Therefore, a fullwave rectifier is one which is capable of converting an AC voltage into a pulsating DC voltage, using both half of the applied AC voltage. It uses four (4) diodes and is available in three distinct physical forms.

(a) four discrete diodes

(b) as part of an array of diodes in an IC

(c) One device inside a four terminal case.

For the purpose of this project, the one device inside a four terminal case rectifier was used.

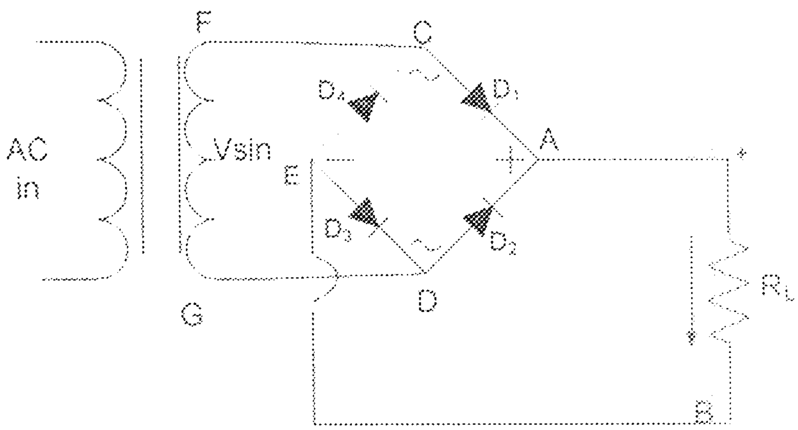
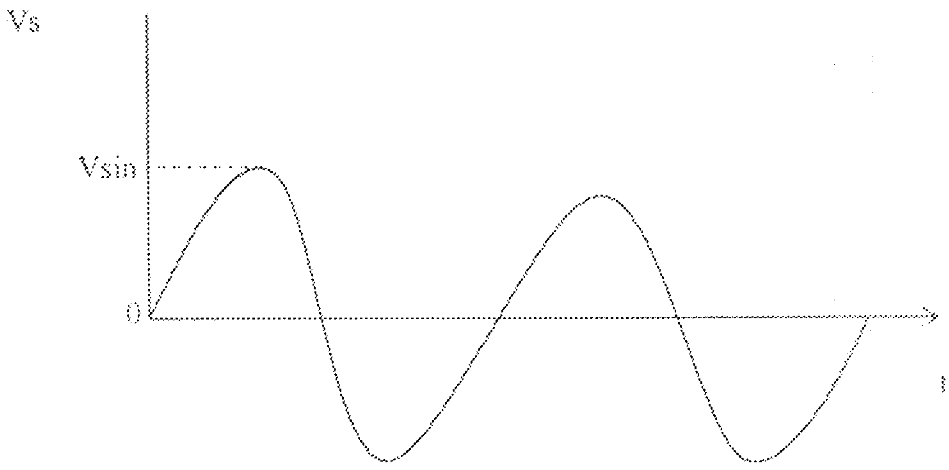
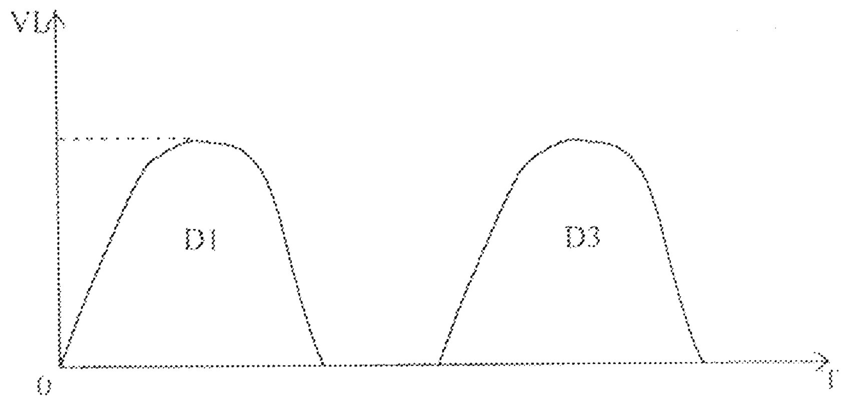


Fig 9 A Full wave rectifier circuit

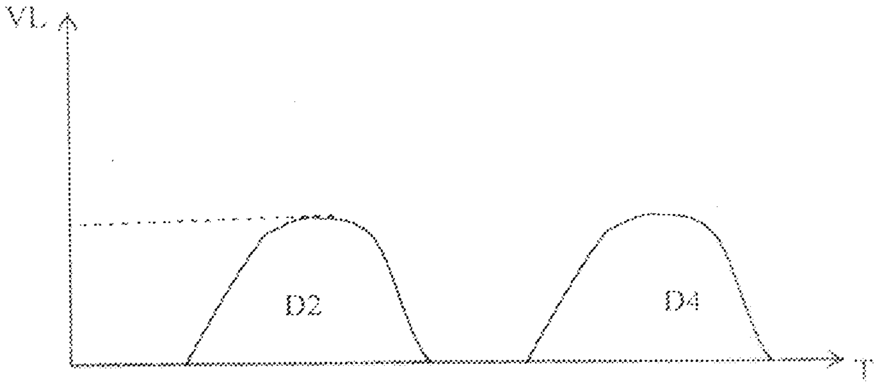
From the figure above, during the positive input, half cycle terminal F is positive and G is negative and diodes D1 and D3 becomes forward biased (ON), whereas D2 and D4 are reversed biased (off). Hence, current flows through FCABEDG producing a drop across RL. On the other hand, during the negative input half cycle, terminal G becomes positive and F negative. At this point, D2 and D4 are forward biased and D1 and D2 are reversed biased. Therefore, current flows through GDABECF. It's therefore normal that current keeps flowing through the load resistance RL in the same direction AB during both half cycles of the AC input supply. The output voltage across RL is shown below.



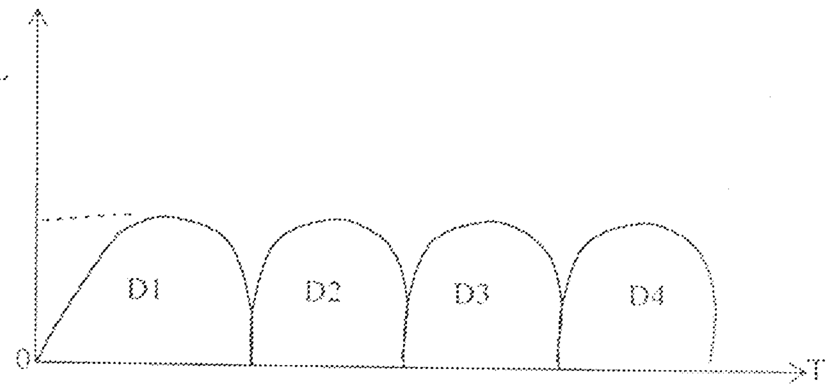
Input voltage



Output of D1 and D3



Output of D2 and D4



Total output

Fig 10. OUTPUT WAVEFORMS FROM THE RECTIFIER

2.4 APPLICATIONS OF COMPONENTS

Capacitors unlike batteries can drum large charges in a tiny fraction of seconds which is extremely dangerous. They are used in electronic circuits in different ways

(1) In combination with inductors, they make possible sharp filters for separating desired signals from background noise.

(2) They are used to eliminate ripples. If there are ripples in a DC voltage. This can be removed / reduced using a capacitor. It simply absorbs the spikes in the voltage.

(3) Capacitor can be used in blocking a direct current.

In the course of this project design, several capacitors where used to achieve different functions and results.

POWER SUPPLY SECTION

Capacitor C1 acts as a supply decoupling capacitor inorder to remove unwanted spikes which can generate unwanted electromagnetic radiation. It absorbs the spikes and keeps the Vcc level constant. C2 and C3 are used for blocking and bypass application to eliminate high frequency noise generation.

PRE-AMPLIFYING SECTION

Capacitor C1 is a filter. It stops the unwanted signal (noise) coming in from the surrounding environment so that it doesn't cause false triggering. C2 is a decoupling capacitor. it is used to decouple the AC signal from the resistor so that degeneration of the signal is avoided. C3 is for coupling of the signal to resistors R_5 and R_8 inorder to drive the lamp. C4 stores energy inorder to keep transistor Tr4 in the ON state a little longer than Tr3, so that current can still flow through the lamp (L1).

POWER AMPLIFYING SECTION

Capacitor C5 is for decoupling to prevent noise at switch ON and switch OFF. C6 is for ripple rejection, i.e. it removes ripple in the signal. C7 is a decoupling capacitor. It is connected directly across the Vcc to ground inorder to absorb distortion and keep the Vcc constant so that it prevents it from modulating the supply which in turn joins with the audio signal to produce a background noise which affects the production of the system. If this (C7) is faulty, two affects may occur;

(1) Open circuit and background noise

(2) It bypasses the Vcc from reaching the audio amplifier therefore; no sound will be produced at the speaker.

C8 is used to couple the signal to the load and also cut-off low frequency. C9 is used to maintain frequency stability inorder to prevent danger of oscillation.

TRANSISTORS

Transistors are used to amplifier current. It is mostly used in the circuits with resistors to convert the charging current to a charging voltage; so therefore, they are used to amplify voltage.

In this project, the transistors are used as an amplifier of sound signal and also as a switch. Therefore, Transistors Tr_1 and Tr_2 are in the circuit to amplify the sound being fed by the microphone. Tr_3 and Tr_4 acts as switch or drivers which amplifies the voltage inorder to drive ON the lamp.

2.5 TRANSDUCERS

A transducer is an electrical component / device which convert one form of energy into a corresponding electrical signal. The output of the transducer is a signal which passes through the amplifier for modification. It can also be a mechanical coupling design to amplify the variation in signal before it is applied to the electrical element.

In other words, they are devices which enable electronic systems to communicate with the outside world, e.g. a microphone changes sound into electrical signals, a loudspeaker does the opposite.

A transducer must be matched to the input of the system with which it is design to work. This means ensuring a maximum voltage transfer between the transducer and the system or vice versa.

TYPES OF TRANSDUCER

Transducers are generally grouped into two categories, namely:

(1) Generating transducer

(2) Modulating transducer

(1) Generating transducers: These are those types of transducers which produces a voltage that is proportional to the magnitude of the quantity (or proportional to a change in the quantity) being fed into a system. Therefore, the signal from a generating transducer must be fed into an amplifier before it is being used because it's usually of a very small signal of only a few millivolts. It includes thermoelectric, photoelectric and piezoelectric.

(2) Modulating transducers: These are those types which are capable of altering some of the electrical properties (e.g. resistance or capacitance) to convey the data being transferred (i.e., variation in the physical quantity being measured). Modulating transducers requires a stable reference voltage or frequency, and they are connected in an electrical circuit in such a way that it alters the voltage, frequency or phase of the reference to reflect the variations in the physical quantity. Its resulting signal is then amplified before being used

Examples of modulating transducers include variable resistance (thermistors for temperature, photocells or light- dependent resistors and potentiometers), variable capacitance or variable inductance (moving a core into a coil inorder to increase its inductance).

2.5.1 MICROPHONES

Microphones are transducers which detect sound signals and then produce a corresponding electrical image of sound, i.e. they produce a voltage / current which is proportional to the sound signal. The symbol for microphone is shown below.

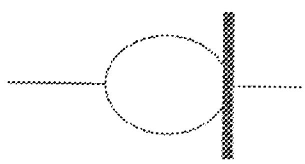


Fig 11.MICROPHONE SYMBOL

A good microphone should be able to respond to sounds in the audio frequency range (20Hz –to-20 kHz). Otherwise, the electrical signals it passes on for amplification and conversion back to sound by the output transducer (i.e. the speaker) will not be identical with the sound signals.

2.5.2 MICROPHONE SENSITIVITY RATING

Sensitivity is the measure of how much electrical output is produced by a given sound. Therefore microphone sensitivity rating tells how much electrical output (measures in thousands of volts/millivolts) a microphone produces for a certain sound pressure input. The most important factor in choosing a microphone is how its sound appears in the required application.

2.5.3 LINEARITY /DISTORTION AND FREQUENCY RESPONSE

Linearity has to do with the way in which the diaphragm of the microphone is made and mounted.

In frequency response, avoidance of flat frequency response has always been the main goal in this project because; this has been one of the major problems in designing an audio amplifier. This problem is mostly encountered with sounds originating behind the microphone.

2.5.4 TYPES OF MICROPHONES

The various types of microphones are:

(1) Dynamic microphone

(2) Carbon microphone

(3) Condenser microphone

(4) Capacitor microphone

Carbon microphone: It is the most widely used because of its sensitivity. It's principle of operation is based on a charge in capacitance when subjected to incident sound waves. It is used in telephones. A sound makes its diaphragm to vibrate and then varies the pressure on the carbon granules.

Dynamic microphone: It is also popularly used because of its good quality production, omni-directional properties (i.e. detection of sounds from all directions) and reasonable cost.

Capacitor microphone. This type is used in broadcasting studios, for public address systems and for concerts where the highest quality of sound is necessary. It is relatively free from non-linear distortion and has fairly uniform frequency response. It is also relatively cheap.

This microphone is the type used in the design of this project.

2.6 AUDIO AMPLIFIER

Audio amplifier which is the project all put together, is an electronics devices for increasing the strength of electrical signal. The pre –amplifier enlarges it millions of time into a current powerful enough to drive the speaker. It takes care of the frequency response, distortion, and protection of the output under faulty conditions, high efficiency and output loading.

The audio amplifier is also used for boosting Audio level from low power sound or other audio sources. It is called "Audio amplifier" in order to distinguish it (audio amplifier) from other amplifiers like DC amplifiers used for instrumentation application and from high-frequency amplifier used in radio frequency (RF).

2.7 TDA 2002 AUDIO IC

The TDA 2002 Audio IC is a five pin IC which has a circuit that enables it to withstand a voltage pulse train on pin 5, as shown below.

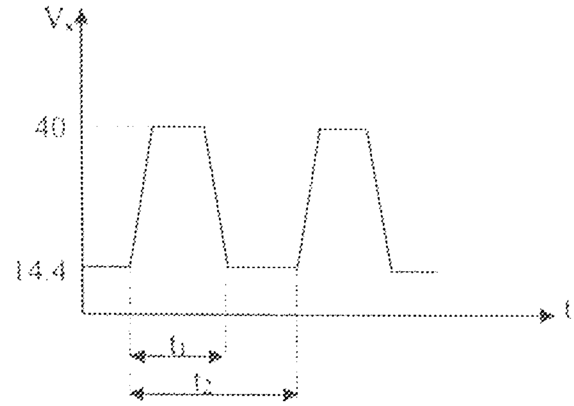


Fig12 VOLTAGE PULSE ON PIN 5

If the supply voltage peaks to more than 40v, then an LC filter must be inserted between the supply and the pin 5, in order to assure that the pulses at pin 5 will be held within the limits shown above.

A suggested LC network is shown below.

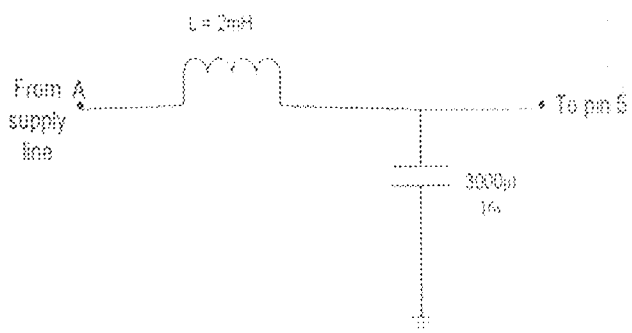


Fig13 SUGGESTED LC NETWORK

With this network, a train of pulses with amplitude up to 120v and width of 2m can be applied at point A. This type of protection is ON when the supply voltage (pulsed or DC) exceeds 18v for this reason, the maximum operating supply voltage is 18v.

2.8 AMPLIFIER SPECIFICATION

BANDWIDTH AND FREQUENCY

The bandwidth (BW) of any amplifier is said to be a given range of frequencies. (form a lower range to a higher range), over which the amplifier is able to deliver sufficient gain. The word "sufficient" here depends on the application since different applications have different ranges of frequency in which they operate. Audio frequency in hi-fidelity audio lies within 20Hz to 20 kHz would be required, though in some applications, 100 kHz is considered to be an audio frequency. In a telephone circuit, 300Hz is an adequate bandwidth.

GAIN

Gain is one of the constant characteristics of any amplifier. It is defined as the ratio of the output signal to the input signal. This gain falls into three categories namely: voltage gain (AV), current gain (AI) and power gain (AP).

Depending on the specification, AV and AI may be expressed as a simple ratio or as the Log to base 10 of the ratio:

$$AV = \frac{Vout}{Vin} \quad \text{or} \quad \text{.......................................} \quad \text{Eqn 2.1}$$

$$AV = 20Log_{10}\ Vout / (Vin) \quad \text{.......................................} \quad \text{Eqn 2.2}$$

If the log of the ratio is used, the result comes as dB (decibel).

For power gain (AP),

$$dB = 10Log\ Pout / Pin = \frac{10Log\ (Vout)\hat{}2 / Rout}{(Vin)\hat{}2 / Rin} \quad \text{..................} \quad \text{Eqn 2.3}$$

$$= 10Log\ R_{in} / R_{out} + 20\ Log\ V_{out} / V_{in} \quad \text{..................} \quad \text{Eqn 2.4}$$

GAIN BANDWIDTH (GBW): This is another property of an amplifier, and it's a constant. Therefore, if the amplifier is set to a gain of AV, then the bandwidth is given by

$$BW = GBW/AV \quad \text{.......................................} \quad \text{Eqn 2.5}$$

E.g. suppose the GBW is 200,000, at a gain of 30. Then the amplifier bandwidth will be

BW = 200000/30

= 6,666.7 Hz.

2.9 NOISE

Electrical noise is defined as any unwanted signal which is noticeable at the output of a system or at any part within the system. This is very common in communication receivers/systems. Therefore, it is very important to keep this unwanted signal at the barest minimum, otherwise the required output information may be fully or partially lost.

Noise is a source of error in both analogue and digital systems, though the digital system tolerates it better because signals appear in logic level 1 or logic level 0.

SOURCES OF NOISE

External Noise

This could be artificial / man- made sources of noise e.g. partial contact on switches. The spark gives off an electromagnetic radiated signal which is picked up by the system.

Another source of noise is interference from radio transmitters. This is known as second channel/image channel interference. Artificial sources can be minimized either by suppression at the source (i.e. preventing the spark at switch contact) or by filters.

There are natural sources of noise such as static noise from space and electrical discharges during thunder storms and lightening.

INTERNAL NOISE

(1) Noise in FET's

FET, a unipolar device is less noisy since only one type of charge carrier is used and only one current flows. The sources of noise here are:

(a) Short noise resulting from the charges in the small leakage current in the gate – to – source junction

(b) Flicker noise resulting from charges in the conductivity of the semiconductor material and the charges in its surface conductor

(c) Thermal agitation noise developed in the channel resistance of the device.

(2) Resistor noise produced by the random motion of free electrons in a conductor.

CHAPTER THREE

3.0 CIRCUIT DESIGN IMPLEMENTATION AND CONSTRUCTION

For the purpose of execution of this project work, the design specification of each component was adhered to strictly as specified by the reference/source. The construction includes a prototype on the temporal location (breadboard) and later, proper construction of the complete design on the veroboard.

To really implement this project, as well as operating and maintaining the system efficiently, a detailed understanding of the functions of all components in the circuit is very important and necessary, i.e. the transformer, the microphone, the capacitors, the resistors, transistors est.

3.1 COMPONENT LAYOUT AND CONNECTION

The various stages of the project were first assembled on a breadboard, testing for each stage was carried out before it was transferred to the veroboard. Again, stage by stage testing was done according to the block representation on the veroboard before they were soldered. Some precautions were taken while soldering, these are

(1) Proper contact was ensured before soldering and little but enough lead was used for the joints

(2) The temperature of the soldering iron was taken into consideration inorder to avoid it from being too hot which can damage the internal layout of the components being soldered.

3.2 DESIGN SPECIFICATION / CONSIDERATION

For the design of the project to be implemented, the various analyses of components in chapter two aided in choosing components inorder to yield optimum results. Hence efforts were made to choose components that met most of the design specification.

The following were adhered to, to meet the specification:

(1) The desired power output and voltage of the power supply so as to design a protective circuitry.

(2) The desired output frequency so as to determine an appropriate filter.

(3) The desired efficiency and regulation so as to choose the appropriate circuit configuration.

(4) Cost effectiveness.

With the above-mentioned points, the circuit configuration that met my requirements is shown in fig 14

3.3 CONSTRUCTION

The construction of the project was done in two stages: first, the components layouts, soldering of the components and secondly, coupling of the entire project to the casing.

In the first stage, the power supply was first soldered before the pre-amplifying section. This soldering was done on two verboards. The first veroboard contains the pre-amplifying circuit while the second contains the power supply and the power amplifying stage.

The second phase of the project construction is the casing of the project. A power pack case was used for the packaging. The case is design with perforation which makes it easier for the components to function well; also, an auxiliary socket was added for plugging of the load (microphone) into the system. A space for the switch was also made for easy control of the system. The base of the case was covered with a cardboard to prevent contact between the legs of the components and the metal surface of the case which could cause bridge in the circuit. The transformer was screwed onto the body of the casing to keep it in position.

3.4 PROBLEMS ENCOUNTERED

The first problem encountered was that of soldering of components on the veroboard. When they are too close to each other, soldering becomes difficult such that, if care is not taken, one will end up soldering two or more components together, thereby bridging the components. When this occurs, a pointed object is used to separate the components and also to clear the track of any linkage.

Secondly, it was noticed that when the speaker faces the microphone and at a close distance from the main circuit, it generates a sound which introduces noise on the amplifier output. This was avoided by positioning the speaker properly.

CHAPTER FOUR

4.0 CONCLUSION

The project which is the design and construction of an audio amplifier was done considering some factors such as availability of components and research materials, portability, compatibility, durability and most of all, economy and cost effectiveness due to the use of a sound activated switch circuit which is a cheaper form of a pre-amplifier.

The performance after test, met the design specifications though its operation will be dependent on the user who is open to human error such as overloading of the amplifier. It also depends on how well the soldering was done (because if a longer time is used to solder, the heat may damage the internal structure of the components without you the designer knowing).

The construction and packaging was done having in mind that maintenance and repairs must take place

This project has really exposed me to practical electronics, research in components and other electronic circuits. With these, the aims stated earlier are achieved. The audio amplifier has been design, constructed and tested. However, like every aspect of life, there is still room for improvement and further research on this project work

4.1 RECOMMENDATION

To acquire in-depth knowledge of design procedures, circuit analysis for design and construction, wide area of research and availability of research materials, students in the department should be given their project topics before going on their industrial training, with this, they stand to enter into the right sector for their training and also gather technical facts about their projects.

I also recommend further work on this project especially at the point of tapping the signal from the pre-amplifier to the power amplifier to see if a better sound output will be produced.

The department should employ more lecturers so that the number of students supervised by one lecturer will be reduced, with this, the potentials of both the lecturer and the students will be really manifested in their project work.

Finally, carefulness and patience should be the watch word because in situations of mistakes and faults while constructing, it takes patience to be able to trace back the circuit to its (fault) origin. Therefore one should not be discourage by them.

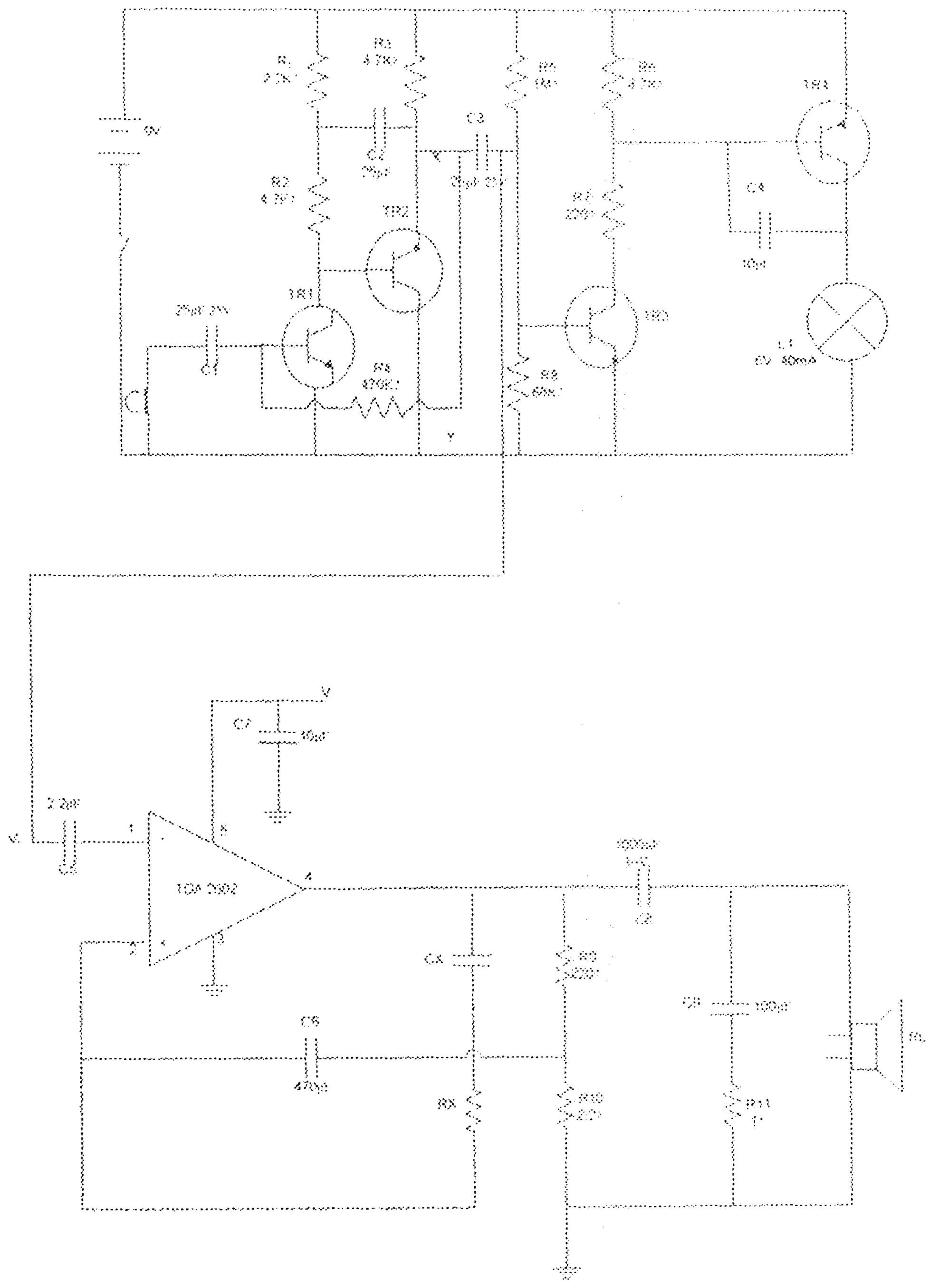


Fig 14: Complete circuit diagram of the Audio Amplifier

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4) CYRIL W. LANDER. Power Electronics (second edition)

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APPENDIX 1-LIST OF COMPONENTS USED

PRE- AMPLIFIER CIRCUIT

s/n	Description	Quantity
1	2.2kΩ Resistor	1
2	4.7kΩ Resistor	3
3	470kΩ Resistor	1
4	1MΩ Resistor	1
5	220Ω Resistor	1
6	68Ω Resistor	1
7	22uf 25v capacitor	3
8	10uf 10v capacitor	1
9	BC 108 transistor	2
10	BC 557 transistor	2

POWER –AMPLIFIER CIRCUIT

s/n	Description	Quantity
1	C1-2.2uf capacitor	1
2	C2-470uf capacitor	1
3	C3-10uf capacitor	1
4	C-4 1000uf capacitor	1
5	C-5 100uf capacitor	1
6	R-1 220Ω Resistor	1
7	R-2 2.2Ω Resistor	1
8	R-3 1Ω Resistor	1
9	TDA 2002 IC	1

POWER SUPPLY AND VOLTAGE REGULATING CIRCUIT

s/n	Description	Quantity
1	Transformer 9v	1
2	9v Regulator with heat sink	1
3	1000uf capacitor	1
4	0.33uf capacitor	1

5	0.2uf capacitor	1
6	9v Rectifier	1

OTHERS

s/n	Description	Quantity
1	Vero board	2
2	Connecting cables	½ yards
3	lamp (bulb) 6v	1
4	soldering lead	1 yard
5	turbo switch	1
6	cable plug	1
7	microphone	1
8	speaker 4Ω 35w	1