Design an Electronic Amplifier Circuit for Hearing Impaired

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ABSTRACT

Low-cost hearing aid device was designed and constructed to produce an amplified sound for people with hearing loss. A 3V DC was used as the power supply. The condenser microphone was used as input transducer to pick up sound from the environment for conversion to electrical signal, npn transistor (BC337) along with tow capacitors and three resistors were used as pre-amplifier.to amplify. The integrated circuit available in 8-pin mini chip package and specially designed for portable power amplification was used for the amplification function a 32 ohms ear phone was used as the output transducer to convert the amplified electricáksignals back to sound.

Chapter one
INTRODUCTION

1.1 INTRODUCTION

The human body is built in such a way that the organs compliment themselves to achieve common goals whether they are internal or externally fitted. The ones we see externally also have internal connections that make the human body function as a network. The absence or malfunctioning of any renders the operations of the body inefficient. While the malfunction of some may not be very noticeable, the eye, ear and throat are so vital that any fault in them is easily observable. The blind person needs a guide, the deaf while seeing does not comprehend or communicate with the environment freely and easily. The blind may not venture walking alone, however the deaf may but at a very high risk as only the danger seen can be avoided. Although, many events are noticed due to the sound made reaching to them. For instance, a vehicle that fails break can attract shout from passerby which when heard, could help them to react but the deaf will not and even when heard may not know the direction to move to avoid accident. There is absolute need for those living with hearing disabilities and already using some form of hearing aids to improve their hearing abilities so that they can walk freely in both streets and major roads without endangering their lives, especially getting involved in accidents. [1] Apart from that, hearing abilities of infants born with such disabilities also need to be improved, so that they can learn how to talk because, it is what they hear that prompts their response. There are conventional hearing aids that are already in existence but, have some shortcomings in terms of function and capacity. Although some have multiple channels which help in different frequency range, which can be adjusted with potentials but they are not electronically programmable. Also, the existing systems are powered by batteries that dissipate within short intervals. One can ask the question; for how long does the battery stay alive? So power consumption is one of the drawbacks of these conventional hearing aids / devices. One can remedy the effect of high power consumption by opting for digital hearing aids but what about the ability of the device to filter off noise such as loud automobile loud buzz, so that the user or patient would be able to operate in an open and noisy environment. It is understandable through observation that transmission range and noise plays a major role in determining the effectiveness of any form of hearing aid and the extent to which a patient hearing ability is improved. Hence, the need for a hearing aid that is adaptive which can intelligently increase or decrease the loudness of the acoustic signal within any type of environment, and at the same time adjusts the transmission range with respect to the source of the sound.

1.2 HISTORY OF HEARING AIDS

The ear trumpet was invented in the 17th century and is considered the first device used to help the hearing impaired. These trumpets came in a number of shapes and sizes and were made of everything from sheet iron to animal horns.

The next advancement did not appear until the late 18th century with the invention of the collapsible ear trumpet. Frederick C. Rein was the first to commercially produce these trumpets in 1800. In order to make the devices less noticeable, Rein created acoustic headbands, which hid the hearing devices within the user's hair.

The first hearing aid was designed thanks to Alexander Graham Bell's 1876 invention of the telephone, which included technology that could control the loudness, frequency and distortion of sounds.

The first electric hearing aid was invented in 1898 by Miller Reese Hutchison. His design used an electric current to amplify weak signals.

In 1913, the world was introduced to the first commercially manufactured hearing aids. These devices were cumbersome and not very portable. In the 1920s vacuum-tube hearing aids were produced; these tubes were able to turn speech into electric signals and then the signal itself was amplified.

The idea of miniaturization was ushered in with other technological advances spurred by WWII; this was crucial to the advancement of hearing aids. The transistor was invented in 1948. Transistors were able to replace the vacuum tubes in previous models of hearing aids and were smaller, needed less battery power and had less distortion.

The microprocessor and the multi-channel amplitude compression were created in the 1970s. The microprocessor brought miniaturization to a new level and the compression ushered in the use of digital technology.

2005 – Bluetooth wireless technology is introduced to hearing aids

Starkey Laboratories introduced the ELI device, enabling hearing aids to be compatible with Bluetooth-enabled mobile phones for the first time. Named by Time magazine as one of the best inventions of the year, the buzzing and interference mobile phones used to cause with hearing aids was eliminated as Bluetooth technology was used to route calls directly into the earpiece itself.

The device was designed to plug into the bottom of behind-the-ear hearing aids and route calls directly from the phone through ELI and into the aid. For users of other type of hearing aid, the ELI device could be work on a necklace and linked to the hearing aid via analog wireless.[2]

2010 – Widex releases the first hearing aid designed for babies

Widex released the BABY 440 hearing aid, the first digital aid specifically designed for babies. Set up to provide high quality sound to infants with minimal to moderate-severe hearing loss, the aid's miniature size and light but tough materials meant it fit comfortably and securely in small ears. [2]

2014 – GN ReSound launches the first Made-for-iPhone hearing aids

The ReSound LiNX and corresponding Beltone First were the world's first Made-for-iPhone (MFi) hearing aids. As well as being powerful enough to address 90% of hearing losses, the devices' MFi connectivity allowed direct streaming of sounds from iPhone, iPad and iPod products, allowing users to treat their aids are wireless headphones or to talk on the phone without the need for an intermediary device.

The ReSound Smart app designed to accompany the devices allowed users to set preferred volume levels and treble/bass settings for the audio streamed into their hearing aids, as well as use geotagging to adjust the aids' settings to the acoustics of frequently-visited places like home, work and favourite restaurants. The app also featured a geotagging function to help users locate their hearing aids if misplaced. [2]

2016 – IoT enabled hearing aids reach consumers

The Oticon Opn is the first Internet of Things (IoT) enabled hearing aid, which could be programmed to communicate directly with a range of connected devices such as doorbells, smoke detectors and baby alarms through its If This Then That (IFTTT) technology. This enables a sound such as a spoken notification or chime to be delivered through the hearing aids when these devices are triggered, ensuring the users' hearing loss doesn't mean they miss vital notifications from the devices.

The Opn does this using a patented dual communication system called TwinLink that combines binaural processing with streamer-free internet connectivity, without compromising battery life or physical size. [2]

2019 – Starkey launches sophisticated AI-powered health monitoring aid

The Livio AI hearing aid is the first ever to use integrated sensors and AI to monitor the user's health. Through the accompanying Thrive app, Livio AI hearing aids use accelerometers and gyroscopes to track the wearer's physical and mental health for an overall daily wellness score.

Ideal for elderly and frail aid users, these sensors can detect when a fall occurs and send a text message to up to three emergency contacts, using AI to detect what is an isn't within the normal range of motion for the user to avoid any false alarms. [2]

Chapter two

THEORETICAL PART

2.1 HEARING AID

A hearing aid is a device designed to improve hearing by making sound audible to a person with hearing loss. Hearing aids are classified as medical devices in most countries, and regulated by the respective regulations. Small audio amplifiers such as PSAPs or other plain sound reinforcing systems cannot be sold as "hearing aids".

Early devices, such as ear trumpets or ear horns,[3][4] were passive amplification cones designed to gather sound energy and direct it into the ear canal. Modern devices are computerised electroacoustic systems that transform environmental sound to make it audible, according to audiometrical and cognitive rules. Modern devices also utilize sophisticated digital signal processing to try and improve speech intelligibility and comfort for the user. Such signal processing includes feedback management, wide dynamic range compression, directionality, frequency lowering, and noise reduction.

Modern hearing aids require configuration to match the hearing loss, physical features, and lifestyle of the wearer. The hearing aid is fitted to the most recent audiogram and is programmed by frequency. This process is called "fitting" and is performed by a Doctor of Audiology, also called an audiologist (AuD), or by a Hearing Instrument Specialist (HIS). The amount of benefit a hearing aid delivers depends in large part on the quality of its fitting. Almost all hearing aids in use in the US are digital hearing aids.[5] Devices similar to hearing aids include the osseointegrated auditory prosthesis (formerly called the bone-anchored hearing aid) and cochlear implant.

2.2 USES

Hearing aids are used for a variety of pathologies including sensorineural hearing loss, conductive hearing loss, and single-sided deafness. Hearing aid candidacy is typically determined by a Doctor of Audiology, who will also fit the device based on the nature and degree of the hearing loss being treated. The amount of benefit experienced by the user of the hearing aid is multi-factorial, depending on the type, severity, and etiology of the hearing loss, the technology and fitting of the device, and on the motivation, personality, lifestyle, and overall health of the user.[6]

Hearing aids are incapable of truly correcting a hearing loss; they are an *aid* to make sounds more audible. The most common form of hearing loss for which hearing aids are sought is sensorineural, resulting from damage to the hair cells and synapses of the cochlea and auditory nerve. Sensorineural hearing loss reduces the sensitivity to sound, which a hearing aid can partially accommodate by making sound louder. Other decrements in auditory perception caused by sensorineural hearing loss, such as abnormal spectral and temporal processing, and which may negatively affect speech perception, are more difficult to compensate for using digital signal processing and in some cases may be exacerbated by the use of amplification.[7] Conductive hearing losses, which do not involve damage to the cochlea, tend to be better treated by hearing aids; the hearing aid is able to sufficiently amplify sound to account for the attenuation caused by the conductive component. Once the sound is able to reach the cochlea at normal or near-normal levels, the cochlea and auditory nerve are able to transmit signals to the brain normally.

Common issues with hearing aid fitting and use are the occlusion effect, loudness recruitment, and understanding speech in noise. Once a common problem, feedback is generally now well-controlled through the use of feedback management algorithms.

2.3 TYPES

There are many types of hearing aids (also known as hearing instruments), which vary in size, power and circuitry. Among the different sizes and models are:

Figure 2.1 Vacuum tube hearing aid, circa 1944

Figure 2.2 Transistor body-worn hearing aid

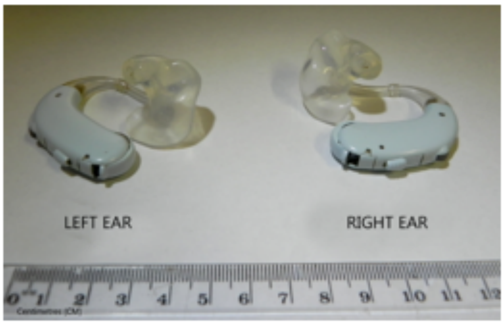

Figure 2.3 Pair of BTE hearing aids with earmolds.

Figure 2.4 Receiver-in-the-canal hearing aids

Figure 2.5 In-the-ear hearing aid

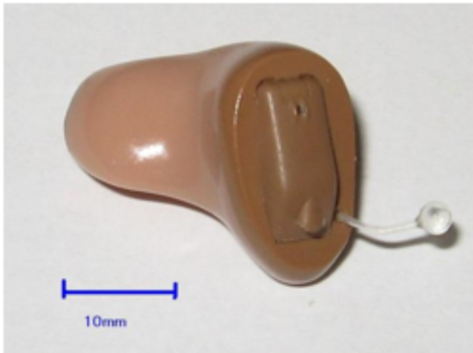

Figure 2.6 In-the-canal hearing aid

2.3.1 Body-worn

Body worn aids were the first portable electronic hearing aids, and were invented by Harvey Fletcher while working at Bell Laboratories Body aids consist of a case and an earmold, attached by a wire. The case contains the electronic amplifier components, controls and battery, while the earmold typically contains a miniature loudspeaker. The case is typically about the size of a pack of playing cards and is carried in a pocket or on a belt. Without the size constraints of smaller hearing devices, body worn aid designs can provide large amplification and long battery life at a lower cost. Body aids are still used in emerging markets because of their relatively low cost. [8]

2.3.2 Behind the ear

Behind the ear hearing aids are one of two major classes of hearing aids – Behind the ear (BTE) and In the ear (ITE). These two classes are distinguished by where the hearing aid is worn. BTE hearing aids consist of a case which hangs behind the pinna. The case is attached to an earmold or dome tip by a traditional tube, slim tube, or wire. The tube or wire courses from the superior-ventral portion of the pinna to the concha, where the ear mold or dome tip inserts into the external auditory canal. The case contains the electronics, controls, battery, and microphone(s). The loudspeaker, or receiver, may be housed in the case (traditional BTE) or in the earmold or dome tip (receiver-in-the-canal, or RIC). The RIC style of BTE hearing aid is often smaller than a traditional BTE and more commonly used in more active populations. [9]

BTEs are generally capable of providing more output and may therefore be indicated for more severe degrees of hearing loss. However, BTEs are very versatile and can be used for nearly any kind of hearing loss. BTEs come in a variety of sizes, ranging from a small, "mini BTE," to larger, ultra-power devices. Size typically depends on the output level needed, the location of the receiver, and the presence or absence of a telecoil. BTEs are durable, easy to repair, and often have controls and battery doors that are easier to manipulate. BTEs are also easily connected to assistive listening devices, such as FM systems and induction loops. BTEs are commonly worn by children who need a durable type of hearing aid. [8]

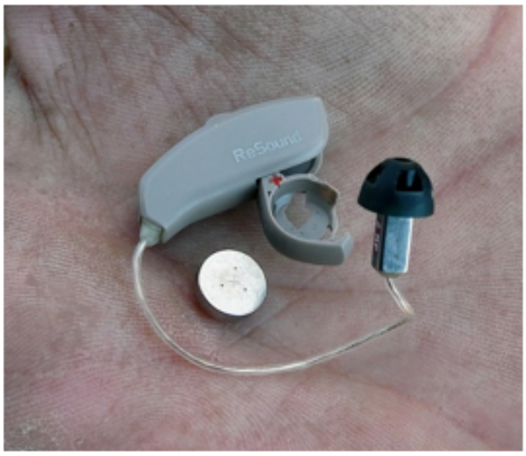

Figure2.7. A modern behind the ear hearing aid with a minicell battery

2.3.3 in the ear

In the ear aids (ITE) devices fit in the outer ear bowl (called the concha). Being larger, these are easier to insert and can hold extra features. [10] They are sometimes visible when standing face to face with someone. ITE hearing aids are custom made to fit each individual's ear. They can be used in mild to some severe hearing losses. Feedback, a squealing/whistling caused by sound (particularly high frequency sound) leaking and being amplified again, may be a problem for severe hearing losses. [11] Some modern circuits are able to provide feedback regulation or cancellation to assist with this. Venting may also cause feedback. A vent is a tube primarily placed to offer pressure equalization. However, different vent styles and sizes can be used to influence and prevent feedback. Traditionally, ITEs have not been recommended for young children because their fit could not be as easily modified as the earmold for a BTE, and thus the aid had to be replaced frequently as the child grew. However, there are new ITEs made from a silicone type material that mitigates the need for costly replacements. ITE hearing aids can be connected wirelessly to FM systems, for instance with a body-worn FM receiver with induction neck-loop which transmits the audio signal from the FM transmitter inductively to the telecoil inside the hearing instrument.

Figure 2.8 A person wearing in-the-ear hearing aid

2.3.4 Invisible in-canal hearing aid

Invisible in canal hearing aids (IIC) style of hearing aids fits inside the ear canal completely, leaving little to no trace of an installed hearing aid visible. This is because it fits deeper in the canal than other types, so that it is out of view even when looking directly into the ear bowl (concha). A comfortable fit is achieved because the shell of the aid is custom-made to the individual ear canal after taking a mold. Invisible hearing aid types use venting and their deep placement in the ear canal to give a more natural experience of hearing. Unlike other hearing aid types, with the IIC aid the majority of the ear is not blocked (occluded) by a large plastic shell. This means that sound can be collected more naturally by the shape of the ear, and can travel down into the ear canal as it would with unassisted hearing. Depending on their size, some models allow the wearer to use a mobile phone as a remote control to alter memory and volume settings, instead of taking the IIC out to do this. IIC types are most suitable for users up to middle age, but are not suitable for more elderly people. [12]

2.3.5 Eyeglass aids

During the late 1950s through 1970s, before in-the-ear aids became common (and in an era when thick-rimmed eyeglasses were popular), people who wore both glasses and hearing aids frequently chose a type of hearing aid that was built into the temple pieces of the spectacles. However, the combination of glasses and hearing aids was inflexible: the range of frame styles was limited, and the user had to wear both hearing aids and glasses at once or wear neither. Today, people who use both glasses and hearing aids can use in-the-ear types, or rest a BTE neatly alongside the arm of the glasses. There are still some specialized situations where hearing aids built into the frame of eyeglasses can be useful, such as when a person has hearing loss mainly in one ear: sound from a microphone on the "bad" side can be sent through the frame to the side with better hearing [13].

This can also be achieved by using CROS or bi-CROS style hearing aids, which are now wireless in sending sound to the better side.

2.4 HEARING AID APPLICATION

Hearing aid application (HAA) is a software which, being installed on a mobile computational platform, transforms it into a hearing aid.

The principle of HAA operation corresponds to the basic principles of operation of traditional hearing aids: the microphone receives an acoustic signal and converts it into a digital form. Sound amplification is achieved by the means of a mobile computational platform, in accordance with the degree and type of users hearing loss. The processed audio signal is transformed into audio signal and output to the user into the headphones/headset. Signal processing is implemented in real time.

Constructional features of mobile computational platforms imply preferred use of stereo headsets with two speakers, which allows carrying out binaural hearing correction for the left and right ear separately. HAA can work with both wired and wireless headsets and headphones. [14]

As a rule, HAA have several operation modes: setup mode and hearing aid mode. Setup mode involves the user passing an in situ-audiometry procedure, which determines the user's hearing characteristics. Hearing aid mode is a hearing correction system that corrects the user's hearing in accordance with user's hearing thresholds. HAA also incorporates background noise suppression and acoustic feedback suppression. [15]

The user can independently choose a formula to enhance the sound, as well as adjust the level of the desired amplification according to his subjective feelings.

HAA have several advantages (compared to traditional hearing aids):

- the large distance between the microphone and the speaker prevents the occurrence of acoustic feedback
- possibility to implement more convenient application control functions for people with poor motor skills
- using of various types of headphones and headsets
- it is possible to achieve the highest sound pressure level and get high sound quality (due to large speakers and a long battery life)
- resistant to ingress of earwax and moisture
- it is possible to use more complex audio signal processing algorithms and a higher sampling rate (because of capacious battery)
- software flexibility
- the set up HAA in simple cases does not require special equipment and qualifications
- HAA does not cause any psychological inconvenience
- the user does not need to purchase and carry any separate device

2.5 EVOLUTION OF HEARING AID APPLICATIONS

There are audio players designed specifically for the hard-of-hearing. These applications amplify the volume of the reproduced audio signal in accordance with user's hearing characteristics and acts as music volume amplifier and assistive hearing aid. The amplification algorithm works on the frequencies that the user hears worse, thus restoring natural hearing perception of the sound of music.[16]

Just as in hearing aid application, the player adjustment is based on the user's audiogram

There are also applications that do not only adapt the sound of music to the user's hearing but also include some hearing aid functions. Such types of applications include sound amplification mode in accordance with the user's hearing characteristics as well as noise suppression mode and the mode allowing to hear the surrounding sounds without pausing the music.

Also, some applications allow the hard-of-hearing watching the video and listening to the radio with comfort. Operational principles of these applications are similar to hearing aid application operational principles: the audio signal is amplified on the frequencies that the user hears worse.[17]

2.6 TECHNOLOGY

The first electrical hearing aid used the carbon microphone of the telephone and was introduced in 1896. The vacuum tube made electronic amplification possible, but early versions of amplified hearing aids were too heavy to carry around. Miniaturization of vacuum tubes lead to portable models, and after World War II, wearable models using miniature tubes. The transistor invented in 1948 was well suited to the hearing aid application due to low power and small size; hearing aids were an early adopter of transistors. The development of integrated circuits allowed further improvement of the capabilities of wearable aids, including implementation of digital signal processing techniques and programmability for the individual user's needs.[18]

2.7 PROCESSING

Every electronic hearing aid has at minimum a microphone, a loudspeaker (commonly called a receiver), a battery, and electronic circuitry. The electronic circuitry varies among devices, even if they are the same style. The circuitry falls into three categories based on the type of audio processing (analog or digital) and the type of control circuitry (adjustable or programmable). Hearing aid devices generally do not contain processors strong enough to process complex signal algorithms for sound source localization.[19]

2.8 ADVANTAGES OF HEARING AIDS

Aside from the primary benefit of improving overall hearing proficiency, wearing hearing aids offers the following advantages:[20]

- **Enhanced Directional Perception**

If you hear better in one ear you may find it difficult to locate where sounds are coming from because your usual perception is off due to the fact that you're receiving input of a decreased volume from one side while the other side is hearing frequencies loud and clear. If you have such problems with directional perception, hearing aids can correct this by balancing out your frequency levels in both ears. This is not only a convenience but also an added safety accessory because it can help you locate incoming objects, people, or vehicles during an unexpected accident, mishap, or collision.

- **Improved Conversational Comprehension**

Hearing aids do a good job of amplifying the starts, stops, and high-pitched sounds that are common in speech. People with hearing loss may find it difficult to distinguish sounds like "th" or "s" from one another, and whispering is especially challenging to comprehend. With hearing aids you'll be able to hear the "S" in the word "she" instead of mistaking it for the word "he" or "the." With an enhanced ability to comprehend speech in conversation you'll find yourself caught in fewer awkward social situations because you won't experience as many miscommunications.

- **Targeted Amplification of Specific Voices or Sounds You're Trying to Focus On**

Today's hearing aids can detect which voice you're trying to listen to and make it more pronounced. You can even have multiple profiles saved with each one containing set preferences for a specific type of environment. For example, you could have one preset programmed to match the acoustics in your living room, while another preset is set to cancel noise and clarify speech at your favorite restaurant. This feature simplifies the process of comprehending speakers in crowded environments while also streamlining environmental adjustments on-the-go.

- **Available in a Variety of Styles and Configurations**

There is a common misconception that hearing aids have to be ugly or easy-to-notice. Nowadays hearing aids come in a wide variety of styles and configurations, including super stealthy models like the Completely-in-Canal (CIC) or Behind-the-Ear (BTE) configurations, both of which do an excellent job of concealing the receiver so that it is not obvious to onlookers. Alternatively, there are also some quite stylish, yet more noticeable models that incorporate a broad range of colors, shapes, and custom molds for a sleeker appearance.

2.9 DISADVANTAGES OF HEARING AIDS

Of course most people would find fewer disadvantages to wearing hearing aids, as there really aren't that many, but of the potential shortcomings that do exist, the following are the most notable:[20]

- **High Price**

Yes, it is true that hearing aids can be costly, with a top-of-the-line brand new model costing about $2,000 per pair. However, some would argue that a couple thousand is a nominal price to pay when you consider how much you can improve your quality of life by having your hearing restored to comfortable levels.

- **Potential Discomfort**

If you choose the wrong configuration type or style, or the custom mould is not fitted properly, you could encounter some discomfort. However, this is usually an easy fix as a simple visit to your audiologist will get you on track with a more suitable model. Then there is also the potential for social discomfort when wearing the hearing aids in public, particularly if you're conscientious about letting other people know that you're wearing them.

- **Maintenance Issues**

Finally, keep in mind that you may have to perform maintenance on your hearing aids from time to time. This may include removing any built up ear wax from the casing. Fortunately, most hearing aids come with a cleaning kit and instructions on how to maintain the device.

2.10 BATTERIES

While there are some instances that a hearing aid uses a rechargeable battery or a long-life disposable battery, the majority of modern hearing aids use one of five standard button cell zinc–air batteries. (Older hearing aids often used mercury battery cells, but these cells have become banned in most countries today.) Modern hearing aid button cell types are typically referred to by their common number name or the color of their packaging.

They are typically loaded into the hearing aid via a rotating battery door, with the flat side (case) as the positive terminal (cathode) and the rounded side as the negative terminal (anode)

These batteries all operate from 1.35 to 1.45 volts.

The type of battery a specific hearing aid utilizes depends on the physical size allowable and the desired lifetime of the battery, which is in turn determined by the power draw of the hearing aid device. Typical battery lifetimes run between 1 and 14 days (assuming 16-hour days).[18]

Chapter three

EXPERIMENTAL PROCEDURE

3.1 SYSTEM DESCRIPTION AND DESIGN

The block diagram of the system is shown in Fig. 1 with the Power unit, input unit, amplifying unit and the output unit.

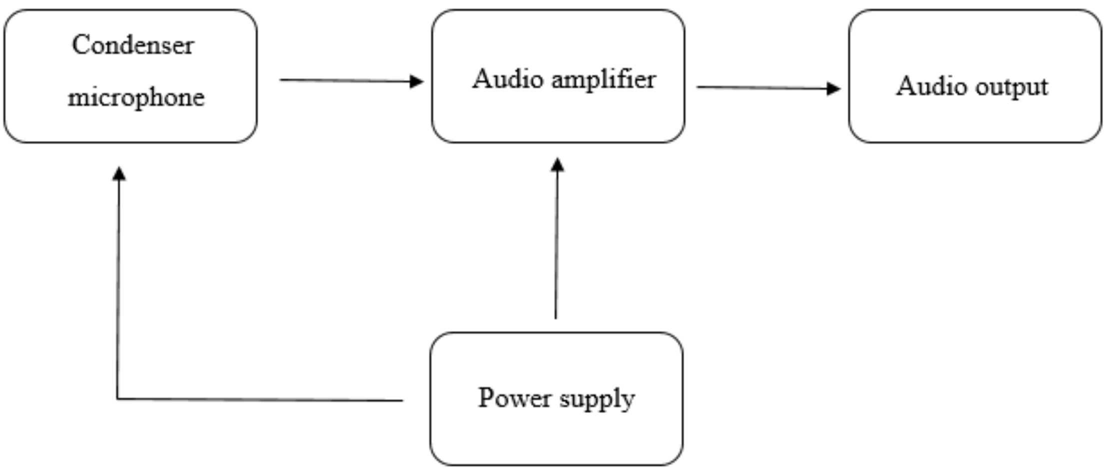

Figure 3.1Block diagram of hearing aid

3.1.1 Power supply unit

The entire circuit of hearing aid device designed in this paper consumes a very small amount of power within the range of 10 milliwatts. Furthermore, the voltage Requirement of every major component is within the range of 1.8 volts and 15 volts. Therefore, for portability, a 3V DC battery is used to power the circuit.

3.1.2 Pre-Amplifier Design

the sole function of this stage is to amplify the input sound from the microphone. Usually, the electrical signals produced by microphones are weak and faint hence the need to strengthen it by a pre-amplifier circuit.

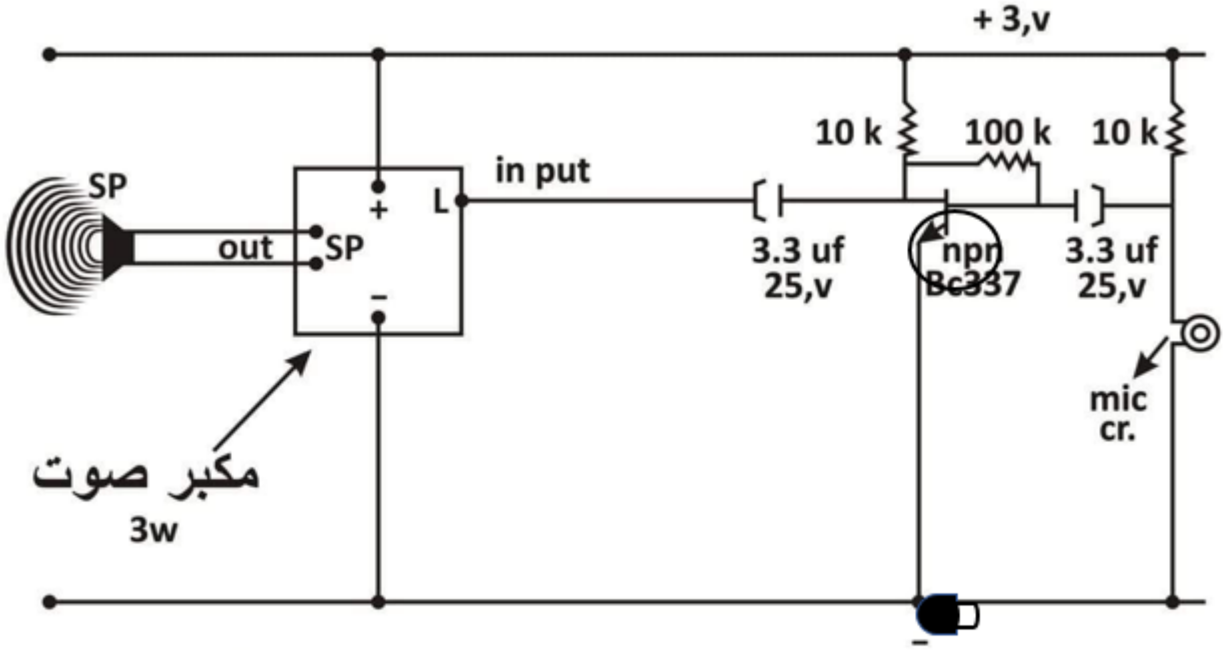

Figure 3.2 Electronic amplifier circuit

3.2 MATERIALS USED AND CONSTRUCTION

- **Resistor**

A two-ended electrical component that applies electrical resistance as an element in a circuit. The resistors limit the flow of electrical current, while at the same time they reduce the voltage levels within the electrical circuit [21]

Figure 3.3 Resistor

- **Amplifier**

is an electronic amplifier that amplifies low-power electronic audio signals such as the signal from radio receiver or electric guitar pickup to a level that is high enough for driving loudspeakers or headphones. Audio power amplifiers are found in all manner of sound systems including sound reinforcement, public address and home audio systems and musical instrument amplifiers. It is the final electronic stage in a typical audio playback chain before the signal is sent to the loudspeakers [22]

Figure 3.4 Amplifier

- **NPN transistor**

The transistor in which one p-type material is placed between two n-type materials is known as NPN transistor. The NPN transistor amplifies the weak signal enter into the base and produces strong amplify signals at the collector end. In NPN transistor, the direction of movement of an electron is from the emitter to collector region due to which the current constitutes in the transistor. Such type of transistor is mostly used in the circuit because their majority charge carriers are electrons which have high mobility as compared to holes [23]

The BC337 is an NPN transistor with a maximum gain of 630, commonly used in low power audio applications. It can also switch loads up to 45V and 800mA hence also used as general-purpose transistor [24]

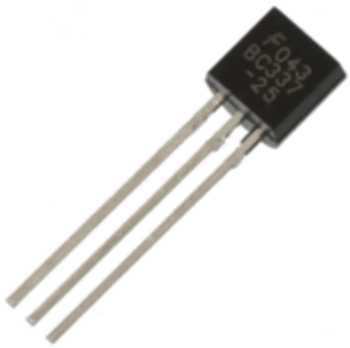

Figure 3.5 NPN transistor

- **Capacitor**

It is one of the components of electrical circuits, and it is a tool that stores electrical energy or electric charge for a period of time in the form of an electric field, consisting of two conductive plates, each carrying an electrical charge of equal magnitude and opposite in signal. Hence the electric charge is used up or dissipated in time [25]

Figure 3.6 Capacitor

3.3 TESTS

3.3.1 Frequency Response Test

After the construction of the amplifier stage, it was subjected to tests to determine its frequency response which indicates the range of frequencies for which the appliance is suitable. To do this, a signal generator was used to feed signals of fixed amplitude but varying frequency to the amplifier. The gain at each signal variation was found by using a double beam oscilloscope to measure and compare the output and input signals. The experimental set up is as shown in Fig. 7.

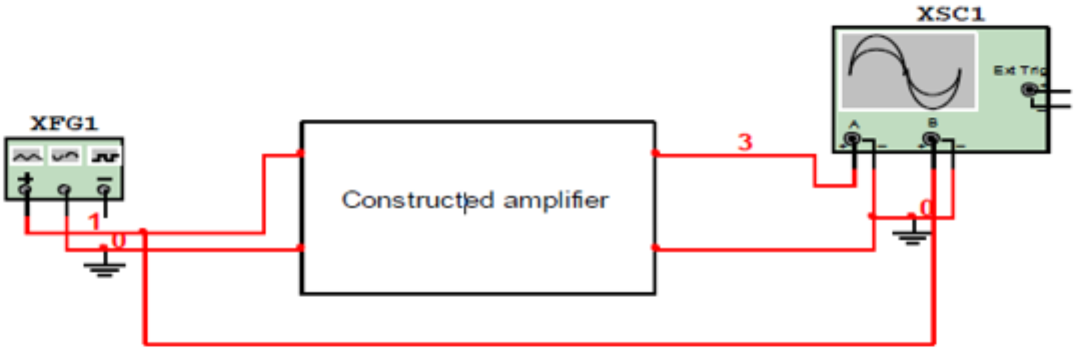

Figure 3.7 Set up to determine the frequency response of the amplifier

3.3.2 Test of Device on Deaf People

1) The device was tested on seven (7) people from Baghdad with various degrees of hearing problems. To conduct the test a tape recorder was placed at a distance from the patient. With the device placed on the ears, the sound on the player was adjusted to a level that he could just barely hear the sound. The hearing aid was then removed to see if they could still hear the sound. This process was repeated severally using different sounds of different frequencies and magnitude.

2) The above test was conducted on 3 completely deaf people

Chapter four

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Result of Test of Amplifier Gain against Frequency

The result of the test on the frequency response of the amplifier is tabulated in Table 1 and plotted in

Table 4.1 Measurement Amplifier

Input Frequency (f) Hz	Input voltage (Vin) mV	Output voltage (Vo)	Gain (VO/Vin)
0	20	9.8V	490
10	20	9.8V	490
50	20	9.8V	490
100	20	9.8V	490
500	20	9.8V	490
1000	20	9.8V	490
4000	20	9.8V	490
6000	20	9.8V	490
8000	20	9.8V	490
10000	20	8.4V	420
40000	20	5.2V	260
50000	20	3.0V	150
500000	20	300Mv	15
1000000	20	100mV	5

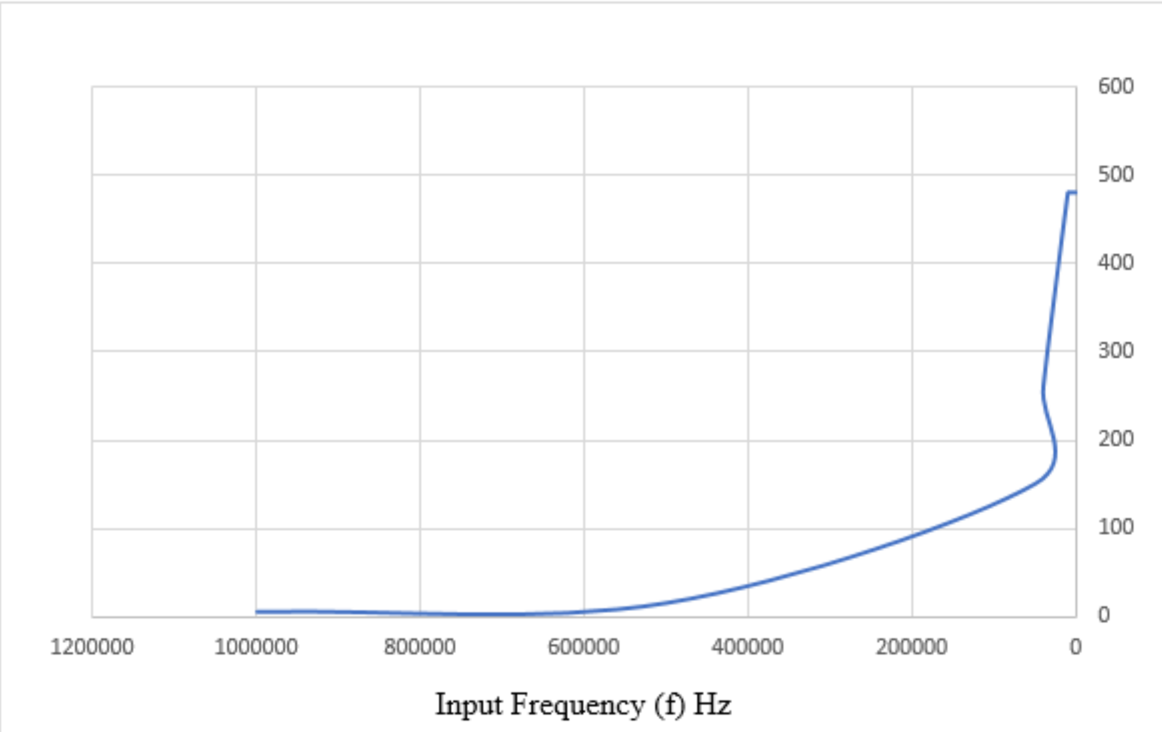

Figure 4.1 A plot of the frequency response of the amplifier

4.1.2 Result of Test on the Application of Device

The result of the response of those with partial deafness and those with complete deafness is tabulated in Table 2

Table 4.2 Response to use of hearing aid

Degree of deafness	**Response to use of hearing aid**
Partial deafness	Improvement in hearing
Complete deafness	No improvement in hearing

4.2 DISCUSSION

The frequency response curve of the amplifier showed that the amplify signals within the audio frequency domain. This means that the amplifier is useful for the purpose for which it is being designed. On the test of the final product on people with hearing impairment the result showed that there was significant improvement in their hearing ability in all the cases. The volume control was also found to be very useful as the user is able to control the level of signal he listens to. Signals that are two loud may course further damage to the ears.

It was realized that hearing aid device is in capable of truly correcting a hearing loss, but an aid to make sound more accessible. In situations where the primary auditory cortex does not receive regular stimulation, this part of the brain losses cells which process sound. As cell losses increases, the degree of hearing loss increases. When the loss of cell is not much, hearing aid can be of enormous importance.

4.3 CONCLUSION

The aim of this project was to design a system that pre-amplify an acoustic signal Picked up by a condenser microphone. The pre-amplified signal is then further amplified before being converted to sound by another transducer (speaker). The designed and constructed circuit was tested on different set of people with different degree of hearing problem. The final test showed that the device could prove very useful for people with partial hearing problems.

4.4 RECOMMENDATIONS

For further improvement, it is recommended that a wireless hearing aid device should be designed and constructed to reduce the weight. The casing of the hearing aid should be made up of more portable, qualitative and lighter plastic material so as to reduce the overall weight and size More care should be taken so as to avoid feedback signal between the microphone and the headphone which may result in noisy signal.

Chapter Five

SUGGESTIONS

5.1 SUGGESTIONS

- DESIGN AND CONSTRUCTION OF A LOW-COST HEARING AID.
- DIGITAL HEARING AID DESIGN.
- LOW NOISE AMPLIFIER DESIGN AND NOISE CANCELLATION FOR WIRELESS HEARING AIDS.

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