DESIGN AND CONSTRUCTION OF AM RADIO RECEIVER

BY

RAJAB HAYATUDEEN OGIRI.

2005/22033EE

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

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

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DEDICATION

This report is dedicated to Almighty Allah for His mercy and protection throughout my year of study, to my loving family of Alh. Muhammad Rajab Ogiri for their prayers and financial assistant rendered during my stay in school, May Allah guide them throughout their lives.

DECLARATION

I, Rajab Hayatudeen Ogiri. Declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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SIGNATURE AND DATE

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ABSTRACT

This report present the basic concept to the design and construction of an AM radio receiver that operates between the medium wave (MW) band of 530KHz to 1600KHz, the aim is achieved by receiving a radio wave from transmitting station through receiving antenna and then when through processes(such as amplifying, mixing, demodulating) and reproduces an audio sound at the loudspeaker output. the selectivity, sensitivity are high where as noise and distortion are low, the construction was tested and found working.

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CHAPTER ONE

1.0 INTRODUCTION

One important system used extensively in telecommunication is the broadcasting of information from source to destination; such a system can operate over space that connects the point (source) to all the different destinations or receiving point.

The idea of radio broadcasting can be extended to a wide audience and over much longer distance by using a radio transmitter to radiate the information through the transmitting channel for detection by a receiver anywhere within the range of the transmitted radio signal power.

1.1 MODULATION

The term modulation generally defined as the process by which a parameter (amplitude, frequency or phase) of a high frequency signal (carrier) is modified or varied in accordance with the instantaneous value of the message (modulating) signal. In this report, amplitude modulation will be discussed.

1.2 AMPLITUDE MODULATION (A.M)

A.M is a process whereby the amplitude of the carrier wave is varied in accordance with the modulating signal. In this case, the amplitude of the carrier signal is linearly in accordance with the instantaneous value of the modulating signal. In amplitude modulation, only the amplitude of the carrier wave is change in accordance with the intensity of the signal. However, the frequency of the modulated wave remains the same i.e carrier frequency.

Note the amplitude of both positive and negative half-cycles of carrier waves is change in accordance with the signal. For instance, when the signal is increasing in the positive sense, the amplitude of the carrier wave also increases. On the other hand, during negative half-cycles of the signal, the amplitude of carrier wave decreases. Amplitude modulation is done by electronic circuit called modulator.

The following points are worth noting in amplitude modulation:

(i) The amplitude of the carrier wave changes according to the intensity of the signal.

(ii) The amplitude variation of the carrier wave is at the signal frequency f_s.

(iii) The frequency of the amplitude modulated wave remains the same i.e. carrier frequency f_c.

1.3 A.M. RADIO RECEIVERS

A radio receiver is a device which reproduces the modulated or radio wave into sound waves, in some country like India, only amplitude modulation is used for radio transmission and reception. Therefore, such radio receivers are called A.M radio receivers in order to reproduce A.M wave into sound waves, every radio receiver must perform the following functions:

The receiving aerial must intercept a portion of the passing radio waves.

a. The radio receiver must select the desired radio wave from a number of radio waves intercepted by the receiving aerial. For this purpose parallel LC circuit is used. These circuits will select only that radio frequency which is resonant with them.

b. The selected radio wave must be amplified by the tuned frequency amplifiers.

c. The audio signal must be recovered from the amplified radio wave.

d. The audio signal must be amplified by the suitable number of audio-amplifiers.

f. The amplified audio signal should be fed to the speaker for sound reproduction.

1.4 TYPES OF A.M. RADIO RECEIVERS

A.M. radio receivers can be broadly classified into types viz., straight radio receiver and superhetrodyne radio receiver. The former was used in the early days of radio communication. However at present all radio receivers are superhetrodyne type.

1. Straight radio receiver; The aerial is receiving radio waves from different broadcasting stations. The desired radio wave is selected by the R.F. amplified which employs a tuned parallel circuit. The selected radio wave is amplified by the tune R.F amplifiers. The amplified radio wave is fed to the detector circuit. This circuit extracts audio signal from the radio wave. The output of the detector is the audio signal which is amplified by one or more stages of audio amplification. The amplified audio signal is fed to the speaker for sound reproduction.

2. Superhetrodyne receiver; the shortcomings of straight radio receiver were overcome by the invention of supeerhetrodyne receiver by Major Edwin H. Amstrong during the First World War. At present all the modern receivers utilises the superhetrodyne circuit. In this type of receiver, the selected radio frequency is converted to fixed lower value, called intermediate frequency(IF). This is achieved by a special electronic circuit called mixer circuit. There is a local oscillator in radio receiver itself. The oscillator produces high frequency waves. The selected Radio frequency is mixed with the high frequency wave by mixer circuit. In this process, beats are produced and the mixer produces a frequency equal to the difference between local oscillator and the radio wave frequency. As explained later, the circuit so designed that the oscillator always produces a frequency 455KHz above the selected radio

frequency. The mixer will always produce an intermediate frequency 455 KHz regardless of the station to which the receiver is tuned. For instance, if 60 KHz station is tuned, the local oscillator will produce frequency of 1055KHz. In superheterodyne principle. The selected radio frequency f_1 is mixed a frequency f_2 from a local oscillator. The output from the mixer is difference (i.e.f_2-f_1) and is always 455 KHz regardless of the station to which the receiver is tuned.

1.5 DIFFERENCE BETWEEN FM AND AM RECEIVERS

Both FM and AM employs superhetrodyne principle. However, the following are the point of difference between the two types of receivers:

(i) An FM receiver has two additional stages viz. Limiter and discriminator. which are quite different from AM receiver.

(ii) FM broadcasting signals lie in the frequency range between 88 and 108 MHz whereas AM broadcast signals lie in the frequency range from 530 KHz and 1600 KHz.

(iii) FM receivers are free from interference and this means that much weaker signal can be successfully handled.

(iv) FM bandwidth is about 200 KHz compared to 10 KHz bandwidth for AM.

(v) The IF for FM receivers is10.7 MHz whereas IF for AM receivers is 455 KHz.

1.6 OBJECTIVES

The major objective of this work is to design, construct and test a radio receiver that select the require radio station (frequency band) out of numerous modulated carriers reaching the receiving antenna, that is any signal within the medium wave (MW) band between 530KHz to 1600KHz.

1.7 METHODOLOGY

This project was achieved first of all with the circuit diagram simulation using mutism, when that was accomplished successfully then followed by temporary bread boarding and finally the permanent connection i.e. Vero boarding

1.8 SCOPE OF THE WORK

This is the design and construction of amplitude modulation radio receiver that uses D.C source of 9 volts supplied to the entire unit and receive any signal within the medium wave (MW) band between 530 KHz to 1600 KHz.

CHAPTER TWO

2.0 LITERATURE REVIEW/THEORETICAL BACKGROUND

The existence of radio wave was predicted long before it was actually discovered, the prediction was made in 1864 by James Clerk Maxwell, and he had improved electromagnetic waves existed, in 1887 by a German named Heinrich Hertz demonstrated these new waves by using spark gap equipment to transmit and receive radio or "Hertzian waves", as they were first called. The experiments were not followed up by Hertz. The practical applications of the wireless communication and remote control technology were implemented by Nikola Tesla.

The world's first radio receiver (thunderstorm register) was designed by Alexander Stepanovich Popov, and it was first seen at the All-Russia Exhibition 1896. He was the first to demonstrate the practical application of electromagnetic (radio) waves,[3] although he did not care to apply for a patent for his invention.

Device called a coherer became the basis for receiving radio signals. The first person to use the device to detect radio waves was a Frenchman named Edouard Branly, and Oliver Lodge popularised it when he gave a lecture in 1898 in honor of Hertz. Lodge also made improvements to the coherer. Many experimenters at the time believed that these new waves could be used to communicate over great distances and made significant improvements to both radio receiving and transmitting apparatus. In 1895 Marconi demonstrated the first viable radio system, leading to transatlantic radio communication in December 1901. The honor was later contested as he was found to be using equipment and designs of other experimenters that held the patents at that time.

Attempts began in the 1890s to develop a quantitative theory of information and to apply this measure to communication system, Guglieluro Marconi, the inventor of radio transmission began with code signals similar to the Morse code. He first sent radio waves through the air in 1895. By 1901, Marconi was able to send his wireless telegraph signal across the Atlantic Ocean.

In 1928, Hartley defined information rate of a communication system as the logarithm of the number of possible message that could be sent through the system, assuming that all messages were of the same format.

During world war II Norbert Wiener was largely responsible for the development of a general philosophy of communication and control called cybernetic, formalizing the concept that both desirable signals and undesirable signals (such as noise) could be defined in probabilistic terms as random processes. His work was well known to be initiated by the end of World War II but did not become readily available until 1948

Drawing on Wiener`s concepts and taking into account the effect of noise and message probabilities, C.E Shannon produced two classic papers in 1948. He introduced the concepts of entropy and channel capacity in communication systems and related them through the coding theorem. However Wiener and Shannon might be considered the discoverers of modern communication and information theory.

Furthermore, citizen band radio communication made it possible for motorists to exchange messages as they are driving in the same area. Public radio began in November 1920 when station KDKA in Pittsburgh Pennsylvania, broadcast the returns of presidential election.

2. 1 BLOCK DIAGRAM OF AN AM RADIO RECEIVER

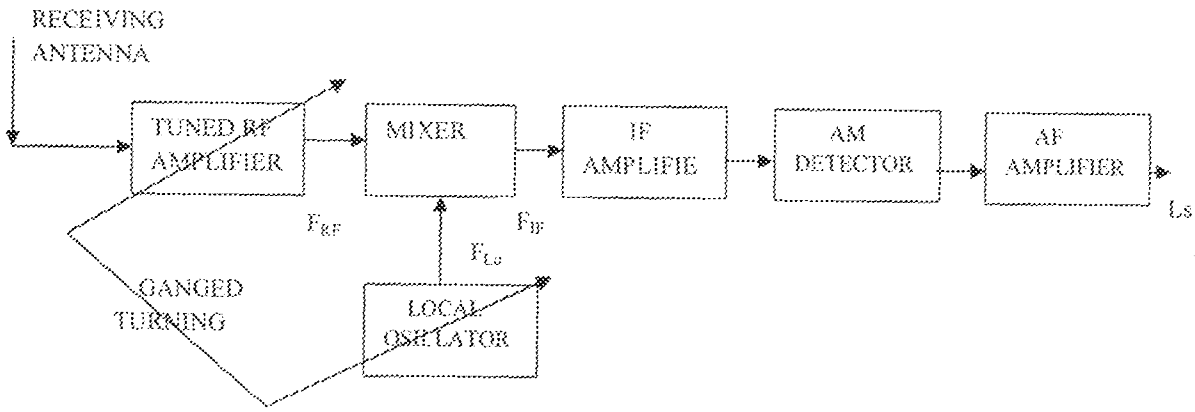


Fig 2.1

2.3 STAGES OF AN A.M RADIO RECEIVER

(i) R.F. amplifier stage; the R.F. amplifier stage uses a tuned parallel circuit L1C1 with a variable capacitor C1. The radio wave from various broadcasting stations are intercepted by the receiving aerial and are coupled to this stage. This stage selects the desired radio wave and raises the strength of the wave to desired level.

(ii) Mixer stage; the amplifier output of R.F. amplifier is to the mixer stage where it is combine with the output of the local oscillator. The two frequencies beat together and produced an intermediate frequency (IF). The intermediate frequency is the differences between the oscillator frequency and the radio frequency i.e.

I.F. = oscillator frequency – Radio frequency

(iii) Oscillator stage; The IF is always 455 KHz regardless of the frequency to which the receiver is tuned. The reason why the mixer will always produce 455KHz frequency above the radio frequency is that oscillator always produces 455 KHz above the selected frequency.

This is achieved by making C_3(oscillator stage) smaller than C_1(R.F stage) and C_2(mixer stage). By making C_3 smaller, oscillator will tuned to a higher frequency. In practise, the capacitance C_3 is designed to tune the oscillator to a frequency higher than the radio wave frequency by 455 KHz. this frequency difference (455 KHz) will always mainained because when C_1 and C_2 are varied, C_3 will also vary proportionally. It may be noted that in mixer stage, the carrier frequency is reduced. The IF still remains the audio signal.

(iv) I.F. amplifier stage; the output of mixer is always 455 KHz and is fed to fixed tuned I.F. amplifiers. These amplifiers are tuned to one frequency (i.e. 455 KHz) and render nice application.

(v) Detector stage; the output from the last amplifier stage is coupled t the detector stage. Here, the audio signal is extracted from the IF output. Usually, diode detector is used because of its low distortion and its excellent audio fidelity.

(vi) A.F. amplifier stage; the audio signal output of detector fied until it is sufficiently enough to drive the speaker. The speaker converts the audio signal into sound waves corresponding to the original sound at the broadcasting station.

2.4 REASONS FOR MODULATION

1. For channel assignment: each message is transmitted at a unique frequency band to avoid mix-up with other signals. This is why only one radio station is received within its coverage area without interference from another station.
2. To reduce noise and interference particularly at low frequencies.
3. For easy radiation and reception of signals by using practically realizable antenna sizes.

4. For multiplexing: so that several information can be transmitted through a single channel

5. To overcome requirement; e.g size and weight.

Two types of AM receiver configuration are possible:

(i) The tuned radio frequency receiver

(ii) The modern super heterodyne

2.5 FUNCTION AND BASIC PARAMETER OF A RECEIVER

The main function of a radio receiver are:

(i) To select the required radio receiver station (frequency band) out of the numerous modulated carriers reaching the receiving antenna.

(ii) To convert selected RF signal into AF signal

The following parameters must be taken into consideration in order to be able to access the quality of a radio receiver

(i) **SELECTIVITY:** This is the ability of a radio receiver to select the signal of be required radio station and reject the signal of unwanted adjacent station.

(ii) **SENSITIVITY:** Is the ability of a radio receiver to pick and reproduce weak signals. It is determined by the value of high frequency voltage which must be fed to the receiver input circuit in order too get normal output power.

(iii) **OUTPUT POWER:** Is the level or amount of audio frequency power that the stage of the receiver to the loudspeaker or earphones.

(iv) **OUTPUT VOLTAGE:** Is the level of output voltage range developed across the loudspeaker or earphones.

(v) **WAVELENGHT RANGE:** The wavelength range requirement of a radio receiver demands that the receiver must be capable of being tuned to any radio station within such range.

(vi) **QUALITY OF PRODUCTION:** This is determined by the level of distortion introduced by a radio receiver. The lower the distortion, the higher the quality of production

2.6 LIMITATIONS OF AMPLITUDE MODULATION

Although theoretically high effective, amplitude modulation suffers from the following drawbacks:

a. Noisy reception; in an AM wave, the signal is in AM variations of the carrier. Practically all the natural and manmade noises consist of the electronic amplitude disturbances. As a radio receiver cannot distinguish between amplitude variations that represent noise and those contain the desired signal, reception is generally noisy.

b. Low efficiency; in amplitude modulation, useful power is in the sidebands as they contain the signal. As discussed before, an AM has low sideband power. For example if modulation is 100%, the sideband power is only one-third of the total power of AM wave. Hence the efficiency is this type modulation is low.

c. Small operating range; due to low efficiency of amplitude modulation, transmitters employing this method have a small operating range i.e. that is messages cannot be transmitted over larger distances.

d. Lack of audio quality; this is distinct disadvantage of amplitude modulation. in order to attain high fidelity reception, all the audio frequencies up to 15KHz must both sidebands must be reproduced. But AM broadcasting stations are assigned bandwidth of only 10KHz to minimize the interference from the adjacent broadcasting stations this means that the highest modulating frequency can be 5KHz which is hardly sufficiently to reproduce the music properly.

2.7 RADIO FREQUENCY SPECTRUM

Radio frequency used by different communication systems extends from Very Low Frequency to Extra High Frequency as shown in the table below.

Frequency band	Classification	Application
Below 30 KHz	Very Low Frequency (VLF)	Long range navigation, sonar
30 KHz – 300 KHz	Low Frequency (LF) or Long Wave (LW)	Navigation aids, radio beacons
300 KHz – 3 MHz	Medium Frequency (MF) or Medium Wave (MW)	Maritime radio, direction finding, commercial AM broadcasting, coastguard communication.
3 MHz – 30 MHz	High Frequency (HF) or Short Wave (SW)	Telephone, facsimile, AM- SW radio broadcasting, search and rescue, aircraft communication and warships.
30 MHz - 300 MHz	Very High Frequency (VHF)	VHF television broadcast, FM radio, air traffic control, navigation aids.
300 MHz – 3 GHz	Ultra High Frequency (UHF)	UHF television broadcast, radar, satellite communication, altimeters, navigation aids.
3 GHz – 30 GHz	Super High Frequency (SHF)	Microwave links, mobile communication, radar.

Above 30 GHz	Extra High Frequency (EHF)	Railroad services, radar , landing system etc.

Table 2.7

CHAPTER THREE

3.0 DESIGN AND IMPLIMENTATION

3.1 RECEIVING ANTENNA: An antenna or aerial is an electrical conductor used either for radiating electromagnetic energy into space or for collecting electromagnetic energy from a space, or is a structure that couples the input of a receiver to the atmosphere. It converts electromagnetic waves into high-frequency current, quarter wave vertical (marconi) antenna was used because of its omni-directionality, it radiates equally in all direction.

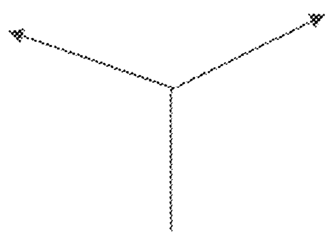


Fig 3.1 Structure of an antenna

3.2 TUNED CIRCUIT:

DESIGN FOR RESONANT TUNING CIRCUIT

Formulae

Bandwidth for A.M receivers 10KHz = BW

Quality factor = Q

Resonant frequency = f_r

$$BW = \frac{fr}{Q} \quad \ldots\ldots 1$$

The frequencies to be covered are 530KHz to 1600KHz, we have:

For f_r = 530KHz, $Q = \frac{fr}{BW} = \frac{530\times10^3}{10\times10^3}$

> Q = 53

But $\frac{XL}{Ri}$ = $\frac{wL}{Ri}$ = $\frac{2\pi fL}{Ri}$ 2

Therefore, 53 = $\frac{2\pi fL}{Ri}$

$$53 = \frac{2\pi \times 530 \times 1000 \times 400 \times 1000000}{Ri}$$

i.e. R = 25ohms

This is the effective or equivalent resistance of the tuned circuit.

At resonance, the formula relating L_2, C_2 and the tuned frequency is given by:

$$Fr = \frac{1}{2\pi\sqrt{LC}} \quad \text{..3}$$

Where fr = tuned in frequency

L = L_2 = inductance

C = C_2 capacitance

Fixing L_1 = 400μH

F_1 = 530KHz

F_2 = 1600KHz

Tank tuning ratio = $\frac{f2}{f1}$ = $\frac{1600}{530}$ = 3.02 : 1

The capacitance corresponding to L_1 = 400μH at frequency of 530KHz is :

$$C = \frac{1}{4\pi 2 f x f L} \quad \text{..4}$$

$$= \frac{1}{4\pi x \pi(530 x 1000)2 x (400 x 0.000001)}$$

$= \quad 225pF$

$C_1 \quad = \quad 225pF$

$$C_2 \quad = \quad \frac{1}{4\pi \times \pi(1600 \times 1000)2 \times (400 \times 0.000001)}$$

$= \quad 25 \times 10^{-12} \quad = \quad 25pF$

The tuned circuit comprises of radio frequency stage and oscillator stage.

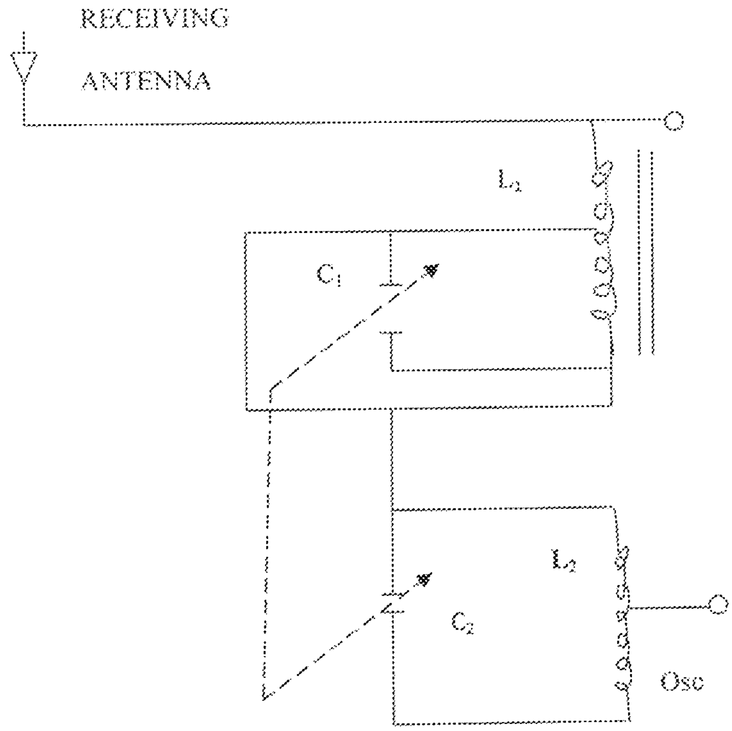


Fig. 3.2 Circuit diagram of the tuned circuit.

The RF signals was taken by the receiving antenna and fed to the tuned input circuit of the receiver. Another signal f_{LO} which is generated from the local oscillator gang tuned to select the required radio station and reject the unwanted ones.

The tuned circuit consists of the following components

3.2.1 Radio frequency stage: The R.F amplifier stage uses a tuned parallel circuit L1C1 with a variable capacitor C1. The radio wave from various broadcasting stations are intercepted by the receiving aerial and are coupled to this stage. This stage selects the desired radio wave and raises the strength of the wave to desired level.

3.2.2 Oscillator Stage: The IF is always 455 KHz regardless of the frequency to which the receiver is tuned. The reason why the mixer will always produce 455KHz frequency above the radio frequency is that oscillator always produces 455 KHz above the selected frequency. This is achieved by making C_3(oscillator stage) smaller than C_1(R.F stage) and C_2(mixer stage). By making C_3 smaller, oscillator will tuned to a higher frequency. In practise, the capacitance C_3 is designed to tune the oscillator to a frequency higher than than the radio wave frequency by 455 KHz. this frequency difference (455 KHz) will always maintained because when C_1 and C_2 are varied, C_3 will also vary proportionally. It may be noted that in mixer stage, the carrier frequency is reduced. The IF still remains the audio signal.

3.3 THE MIXER

3.3.1 Mixer stage: Mixer stage; the amplifier output of R.F amplifier is to the mixer stage where it is combine with the output of the local oscillator. The two frequencies beat together and produced an intermediate frequency (IF). The intermediate frequency is the differences between the oscillator frequency and the radio frequency i.e. I.F. = oscillator frequency – Radio frequency

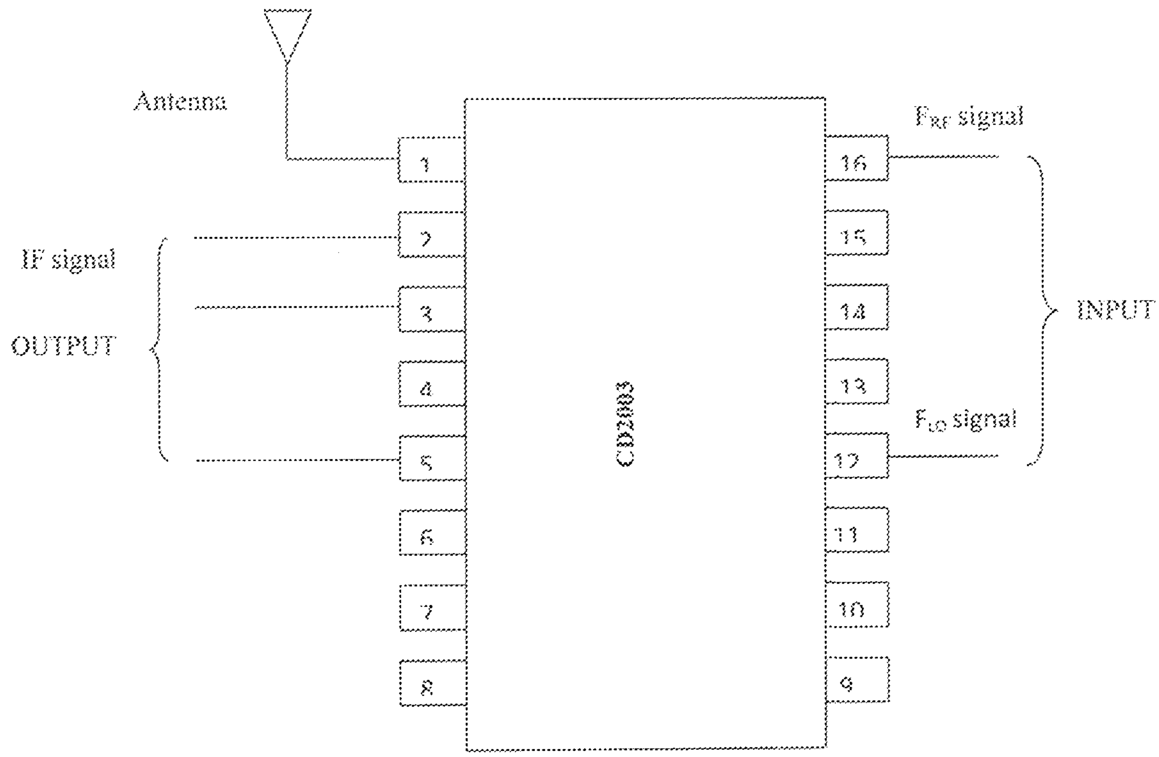


Fig. 3.3 Shows the pins configuration of the mixer (CD2003)

The amplified RF signal is coupled to the input of the mixer. The mixer beats together two frequency signals. The first input to the mixer is the amplified f_{RF} through pin 16 while the other input is from l a local oscillator signal of frequency f_{LO} through pin12 of the CD2003 IC as shown in the figure above.

3.4 THE INTERMEDIATE FREQUENCY.

3.4.1 **Intermediate Frequency Stage:** I.F. amplifier stage; the output of mixer is always 455 KHz and is fed to fixed tuned I.F. amplifiers. These amplifiers are tuned to one frequency (i.e. 455 KHz) and render nice application.

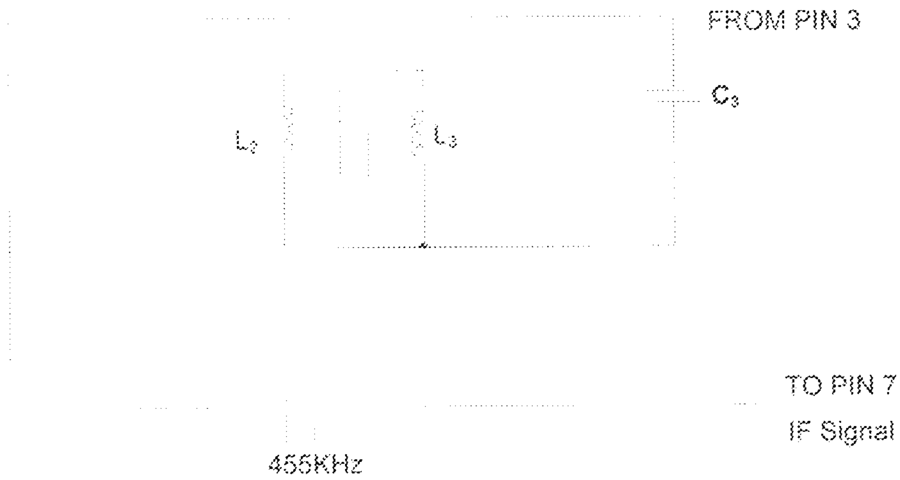


Fig. 3.4 The Structure of the IF Filtering circuit

The IF filtering circuit comprised of a tank circuit, a transformer and 455KHz IF crystal.

The tank circuit provides necessary selectivity and filter out unwanted signal.

The 455KHz IF crystal was used to ensure that the IF frequency is fixed at maximum stability, selectivity and sensitivity.

IF developed at the output of the mixer as indicated in fig 3.3 above, from the pin configuration above, pin2, pin3 and pin5 of the CD2003 (MIXER) give the output of frequency converter.

3.5 THE DETECTOR CIRCUIT3.5.1 Detector Stage: The output from the last amplifier stage is coupled t the detector stage. Here, the audio signal is extracted from the IF output. Usually, diode detector is used because of its low distortion and its excellent audio fidelity.

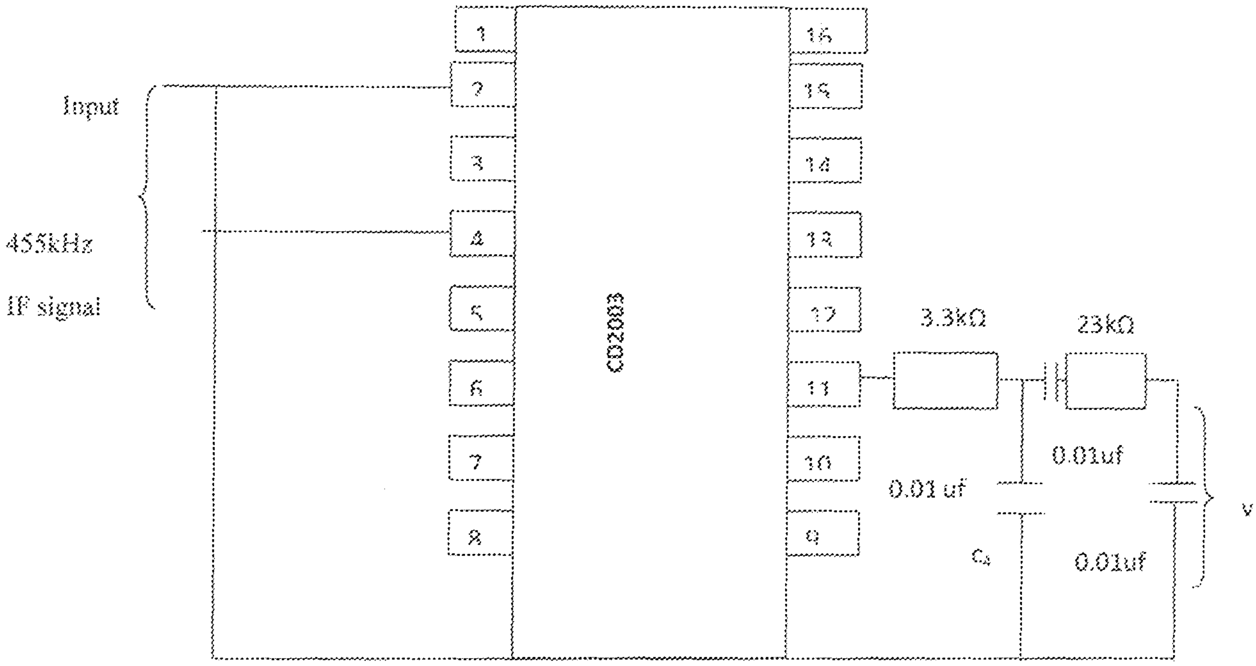


Fig.3.5(a) Detector Circuit

The amplified IF signal is fed into pin7 of the CD2003, IC for demodulation. The function of the demodulator is to separate the modulating (message) signal from the IF AM signal. That is, it converts IF AM signal to an audio frequency AF signal by removing the carrier content of the amplified IF signal. The detector used is an AM detector.

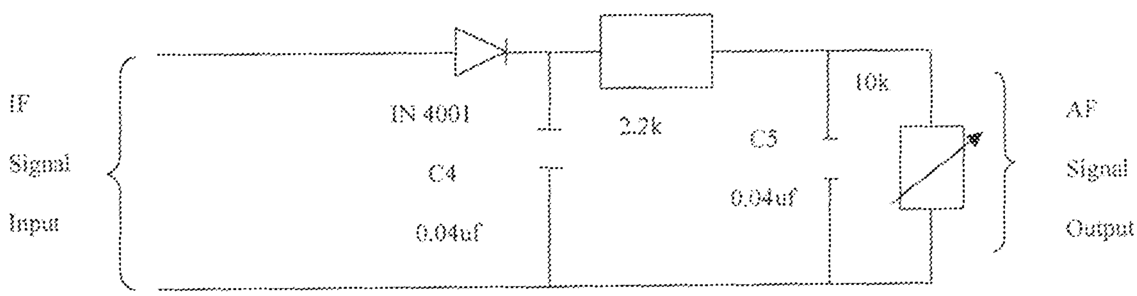


Fig 3.5(b) A simple diode detector

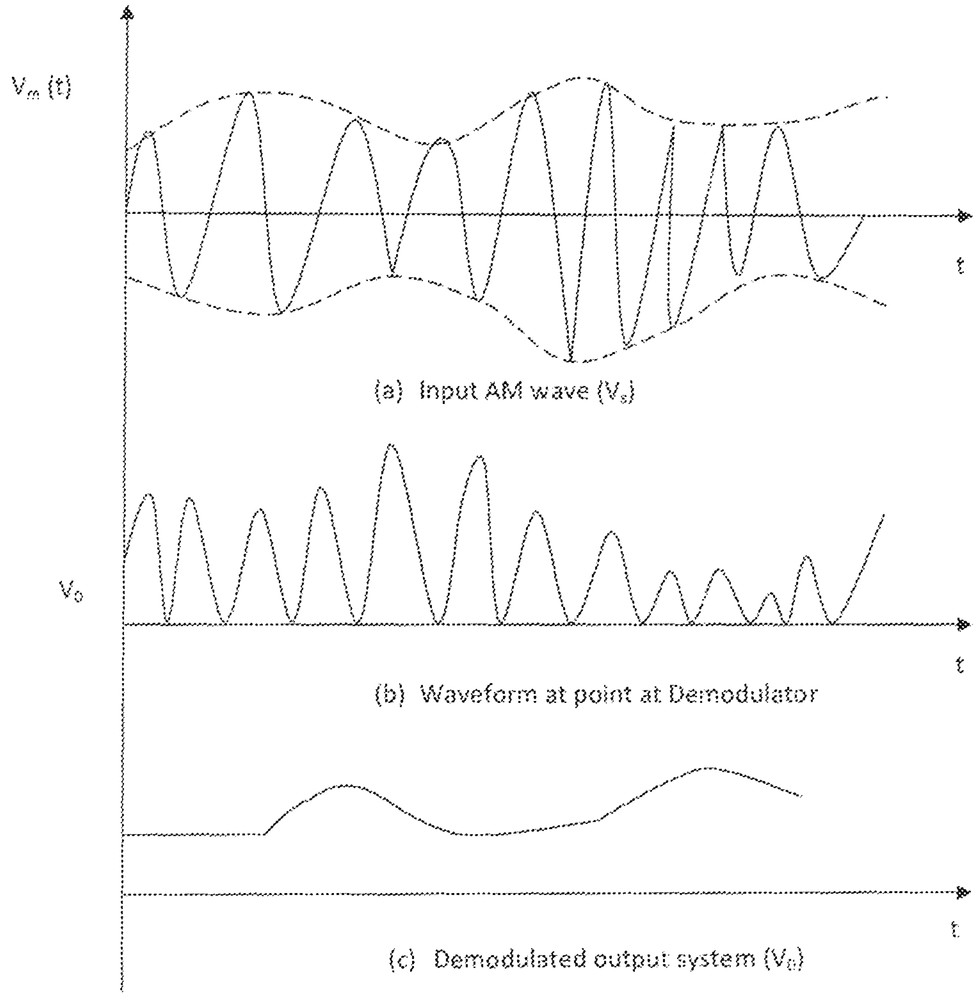


Fig. 3.6 Shows the input and output voltage waveforms for a simple diode detector displayed from an oscilloscope.

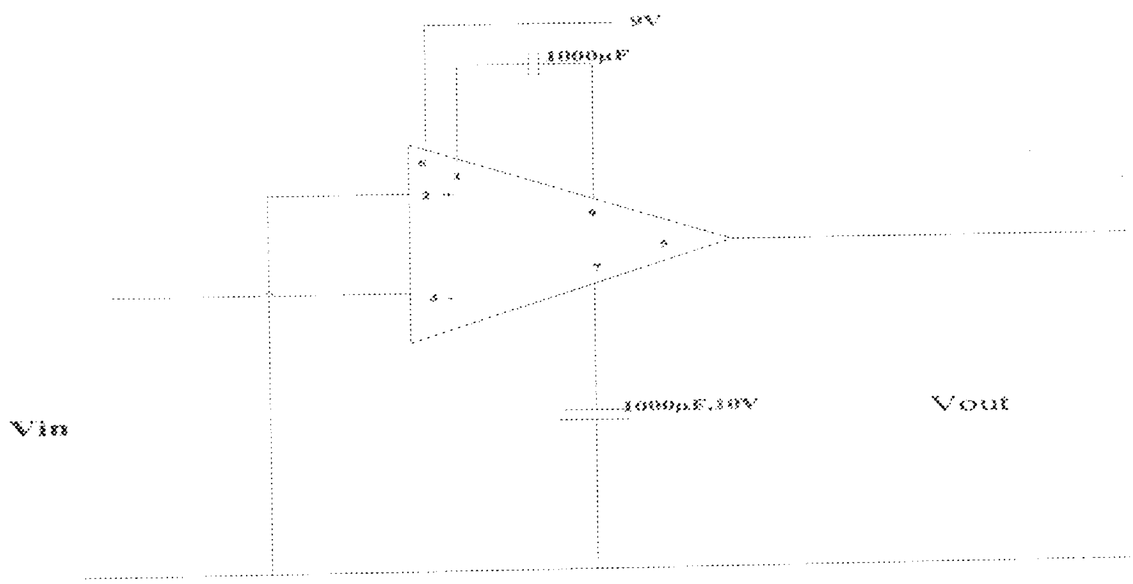
AM diode detectors operate in a similar way as a half wave rectifier shown in fig 3.6(b). During the positive half –cycles of AM wave input, diode D conduct and change C up to a potential almost equal to the peak value of the input signal. During the negative half-cycles the diode is cut off and C begins to discharge through R7. The result is the average V_O accurately for the small amount of ripples.

3.6 AUDIO FREQUENCY AMPLIFIER (AF AMPLIFIER)

3.6.1 Audio Frequency Stage: audio signal output of detector fied until it is sufficiently enough to drive the speaker. The speaker converts the audio signal into sound waves corresponding to the original sound at the broadcasting station.

The AF signal developed at the output of the detector is next amplified in the audio frequency amplifier. This increase the signal power of AF signal before power is finally fed to the wad speaker. The AF amplifier finally boosts the low frequency signal to a level high enough to drive the loudspeaker.

In this design, LM 386IC is used as an audio amplifier. The connections are shown in the circuit diagram below.



3.7 LOUDSPEAKER: The amplified AF signal is fed to the loudspeaker, which is a transducer.

Loudspeaker converts low frequency alternating current energy into sound wave(acoustic wave). The loudspeaker used in this design employ-moving coil or electromagnetic unit as illustrated in fig 3.68.

The audio signal is applied to the voice coil between magnetic pole pieces, which produces a radial magnetic field. The interaction between the varying magnetic field set up by the audio current in the voice coil and the static magnetic field makes the voice coil to oscillate along its own axis at the frequency of the applied audio signal. The oscillation of the coil radiates a sound from the diaphragm. The magnitude of the force on the coil is given by the expression.

$$F = BLI$$

Where F = Magnitude of force in Newton

B = Magnetic flux density within the air gap Webber

L = Length of the wire in the voice in Metre

I = Audio current flowing in the coil in Ampere.

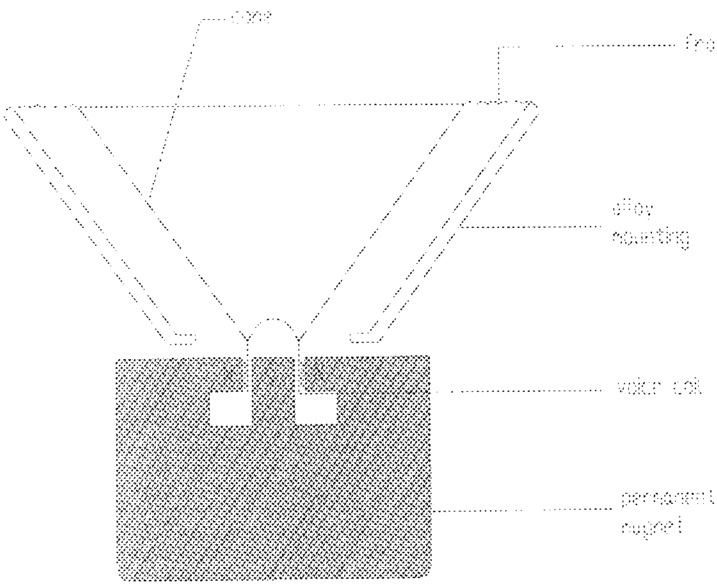
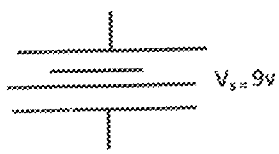


Fig 3.8 Structure of moving coil loudspeaker

3.8 POWER SUPPLY STAGE

Hi-watt BF 22 9V d.c battery for transistor radios with 0% mercury and 0% cadmium was used in this circuit as a power source to the entire unit.



3.9 PRINCIPLE OF OPERATION

(1) Let us assume that the incoming signal frequency is 1500KHz. It is amplified by the R.F amplifier.

(2) Next, it enters a mixer circuit which is so designed that it can conveniently combine two radio two radio frequencies, one fed into it by the R.F amplifier and the other by a local oscillator.

(3) The local oscillator is an R.F oscillator whose frequency of oscillator can be controlled by varying the capacitance of its capacitor. In fact the tuning capacitor of the oscillator is ganged with the turning capacitor of the input circuit so that the difference in the frequency of the selected signal and oscillator frequency is always constant. Usually, the difference is maintained at 455KHz. If signal frequency is 1500KHz, then oscillator frequency can be either 1,955 or 1045KHz. Let us suppose that it is 1,955 KHz. In fact, local oscillator frequency is always higher than the frequency of the incoming signal.

(4) When two alternating currents of these two different frequencies are combined in the mixer transistor, then phenomenon of beats is produced. In the present case, the beat frequency is 1955-1500 = 455KHz. Since this frequency is lower than the signal frequency but still above the range of audio frequencies, it is called IF.

(5) The 455KHz output of the mixer is then passed on to the IF amplifier which is fixed tuned to 455KHz frequency. In practice, one or more stages of IF amplification may be used.

(6) The output of IF amplifier is demodulated by a detector which provide the audio signal.

(7) This audio signal is amplified by the audio-frequency (AF) amplifier whose output is fed to the loudspeaker which reproduces the original sound.

3.10 COMPLETE CIRCUIT DIAGRAM

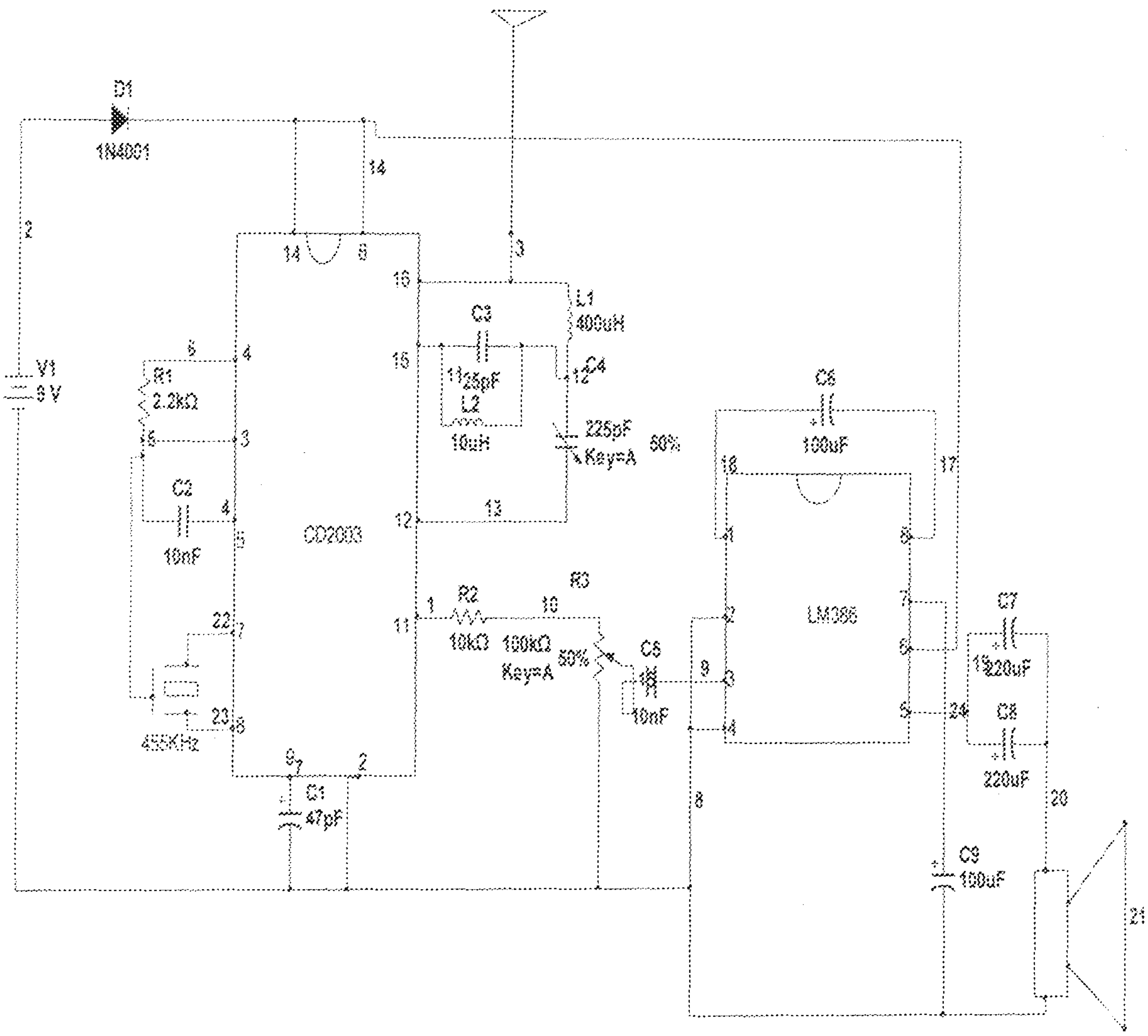


Fig. 3.10 Circuit Diagram

CHAPTER FOUR

4.0 TESTS, RESULTS AND DISCUSSION

4.1 CONSTRUCTION TOOLS AND EQUIPMENT

4.1.1 The electronic tools and equipments used in the course of the construction.

Soldering Iron: A modular soldering the iron with 40W heating element was used for soldering the components together. A very high voltage soldering iron will damage the electronic components.

Soldering Stand: This was used for keeping the soldering iron in a safe and upright position. The stand used is made up of metal and it is constructed so that the bit of the soldering iron does not touch any metallic or plastic materials.

Solder: Flux-core colder type was used for the soldering of the various electronic components.

Sponge: This was used for occasional cleaning of the soldering of the soldering bit when soldering. The sponge was always kept damp and used to wipe the soldering bit.

Lead-Sucker: This was used for sucking up molten solder. It also used to remove bad components out of the Vero Board.

Wire-cutters: Cutters were used to cut wires to required length and to tip off excess leg of electronic components after soldering.

Strippers: Wire strippers were used to scrip off the insulation from solid or stranded hook up wires.

Connecting Leads: These are wires used to connect all the components together in the circuit. For this project, solid wire was used because it is easy to soldered and disordered.

Digital Multimeter: This was used for quite a number of functions. It performs the following functions during the construction of the project.

1. It was used to test the continuity of each line on the Vero board.
2. It was used to know the terminals of the transistors used.
3. It was used to know the value of the colour-coded resistors, capacitors and inductor.
4. It was used also to know the voltage at each stage of the receiver.

CRT Oscilloscope: This was used to know the wave forms at the following stages.

i. RF stage
ii. Detector stage
iii. Output of the audio amplifier stage
iv. Power supply stage

Vero board: This allows permanent prototyping of an electronic design. The Vero board was pre-etched, therefore the various electronic components were simply soldered in place, using connecting leads (wires) and blade to make and break continuity respectively between them when necessary.

4.2 CONSTRUCTION DETAILS

Careful planning of the circuit simplifier wiring, minimizes errors and made troubleshooting easier. Over all circuit was connected in parallel so as to conform to the orderly schematic diagram of the circuit. The integrated circuit used in the design was positioned in the same direction for AF signal to flow and this made it easy to keep track of pin number during wiring and troubleshooting. The continuity on the Vero board was always cut with the aid of razor blade we necessary.

4.2.1 CONSTRUCTION OF THE POWER SUPPLY UNIT

The 9V D.C battery was used in this circuit as a power source to the entire unit

4.2.2 CONSTRUCTION OF THE RF COIL & 2.5Mh INDUCTOR

The RF coil was constructed by winding a very tinning wire round a ferrite rod as illustrated in fig. 2.63. As was indicated, L_1 = 30 turns and L_2 = 12 turns

Therefore, total number of turns = $L_1 + L_2$ = 42 turns. And very tin wire was wound on a ferrite rod of 2cm long. The construction is illustrated below. The thickness of he ferrite rod = 0.65m

4.2.3 CONSTRUCTION OF THE LM 386

The 8-pin IC socket that holds the LM 386 was first soldered. Soldering and breaking the continuity of the Vero board when necessary other components

CD2003IC was mounted in the same way as a 16-pins IC socket.

4.2.4 MOUNTING OF THE GANGED CAPACITOR

The ganged capacitor was mounted on the Vero board by drilling holes that connect the three legs of the ganged capacitor and the nub for tuning. Four holes were drilled and soldering made connections to

the required legs. The continuity was also made and breaks at strategic points on the Vero board.

Transistor, resistors, capacitors and diodes used were bought and inserted into the right point at various part of the Vero board. Test was made to confirm the polarity of some of the above components before final soldering.

4.2.5 PROJECT CASING.

The plastic casing was properly constructed and all the components were fixed at the appropriate positions

4.3 TESTING

Various tests were performed during the construction, at different stage, the project was tested to confirm if the waveform obtained conform to the target.

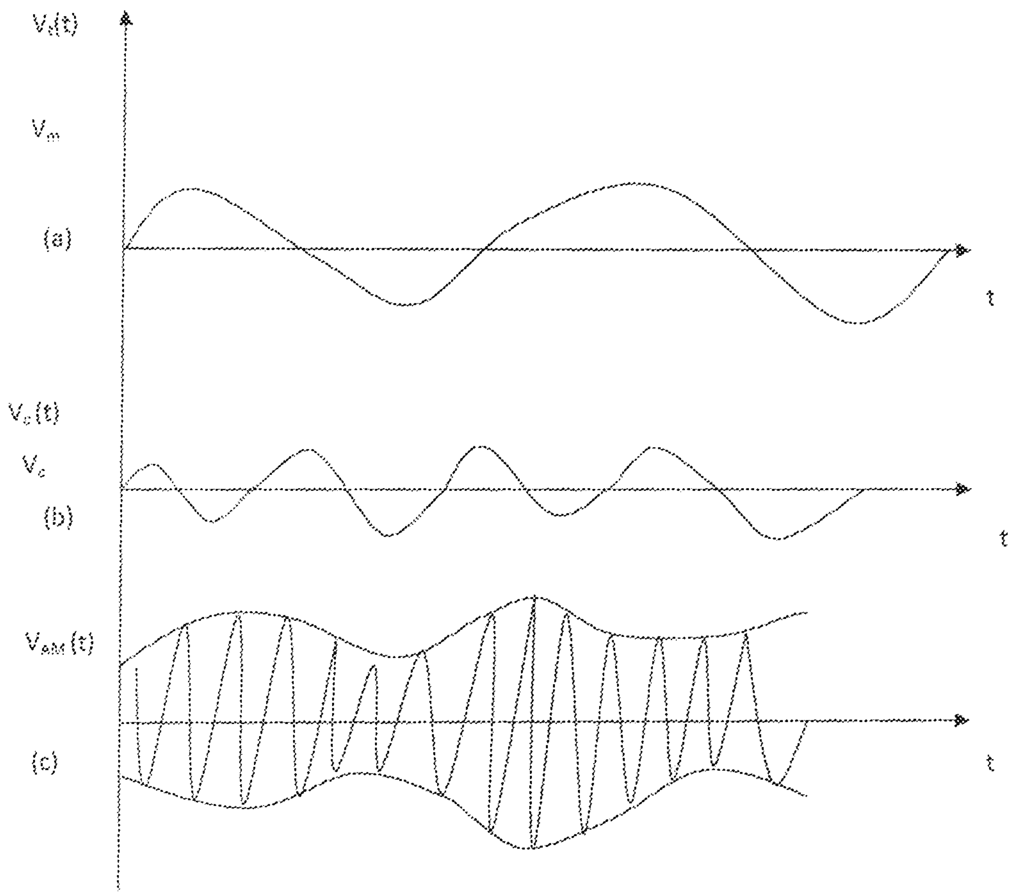


Fig 2.10 Construction of AM wave

(a) = modulating signal

(b) = carrier signal

(c) = AM wave

TEST	OBSERVATION	REMARK
RF Stage	The strength of the input RF signal increases	The wave form conform with the target
Detector Stage	The audio frequency signal was extracted	The wave form conform with the target
AF Stage	The audio frequency signal was amplified	The wave form conform with the target

Table 2.10

Also, at the end of construction, the project was tested and it is able to receive VOA, BBC. And Radio Nigeria Kaduna stations transmitting within the medium wave band of between 530KHz-1600KHz. The ability of the radio receiver to receives signal from the nearest AM station shows that the receiver works as was designed.

4.4 RESULT

From the tests performed above. I was able to achieve the following results:

1. The noise was minimal
2. The selectivity was high
3. The output power matched the input of the loudspeaker
4. The sensitivity is also high
5. The level of distortion is low

4.5 DISCUSSION OF RESULT

From the results obtained, it can be deduced that the quality of reproduction of the receiver is determined mainly by the level of distortion introduced by a radio receiver, Also, It was confirm that the lower the distortion, the higher the quality of reproduction. In this project, distortion was kept minimal by increasing the frequency-band passed by the receiver and detuning the resonant circuit from the carrier frequency.

CHAPTER FIVE

5.0 CONCLUSION

The design and construction of an AM radio receiver was successful. It gave an insight into quite a number of practical concepts in Electronics and Telecommunication Engineering. It enhances my skills and techniques in handling electronic tools and equipment.

The constructed AM receiver was able to pick, select radio station (frequency band) out of the numerous modulated carriers reaching the receiving antenna and convert IF into an AF signal. It receives V.O.A and B.B.C between 530KHz-1600KHz on medium-wave (MW) frequency band. It will be of great use to engineers, reporter, pressmen, motorists, students, traders, labourers, etc. For receiving messages, information or signals from an AM station transmitting within the medium wave (MW) frequency band.

5.1 RECOMMENDATION

1. The power supply unit can be both A.C (PHCN) and D.C (battery).This will give the receiver the chance to use any source in case of failure of one.
2. A display should be use for showing selected frequency when tuning.
3. A push-pull power amplifier can be connected to the output of the audio amplifier I.C used for a higher output power.

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