ELECTRONIC EAVESDROPPER

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DEDICATION

This project is dedicated to Almighty God and our Lord Jesus Christ, my brothers Mr. Sampson Amadi, Ernest Amadi, Bright Amadi, Martins Amadi, Stanley Gospel Amadi, my sister Mrs. Euphemia Okoroafor and to my parents Mr. & Mrs. Brendan Amadi who have contributed immensely to my moral, social and academic upbringing. May God bless you all, Amen.

DECLARATION

I, AMADI FRANKLIN, 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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ABSTRACT

Over the years, most especially in the military setup, it became necessary in electronic engineering to improve on monitory and hearing aid systems that is why the problem of hearing and amplifying a low audio signal message is studied. The input signal is as a result of a low volume conversation with the presence of noise.

Electronic Eavesdropper is a device used to intercept conversation between two or more people without the consent of any one of them.

The basic circuit of the Electronic Eavesdropper includes the Transmitter circuit which comprises of the input audio frequency amplifier stage, the transistor amplifier/ modulation stage, the oscillator stage, the output stage and the Receiver circuit.

The transmitter circuit is responsible for amplifying the low input audio signal message so as to solve the problem of low volume conversation, modulation of the amplified input signal, generation of FM carrier wave and conversation of FM carrier wave into electromagnetic waves for final onward transmission form the antenna into the atmosphere.

The receiver circuit is capable of selecting the wanted the signal from all the signals picked up by the aerial (Antenna) while rejecting all others, extracting the intelligence contained in the modulated signal and producing an audio frequency output of sufficient power to operate the loud speaker.

Finally, the transmitter circuit is operating at a carrier frequency of 4MHz (tested and analyzed) and the receiver circuit is receiving the transmitted modulated signal clearly at **92 MHZ** FM bands.

The reception distance for the transmitters is about 10 – 15 meters.

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CHAPTER ONE

INTRODUCTION

Earlier before the invention of radio communication, drums, signal fires, smoke signals, even mirror reflection signals played a crucial role in communication

With respect to electricity, communication can be defined as the sending, processing and receiving of information by electrical means. [1]

Besides, radio communication or wireless communication is a means of communication that relies on the use of electromagnetic waves propagated through the space at the speed of light.[2]

Electronic Bugging System can be defined as an electronic device used to intercept conversation (intelligence) without the consent of at least one of the participants.

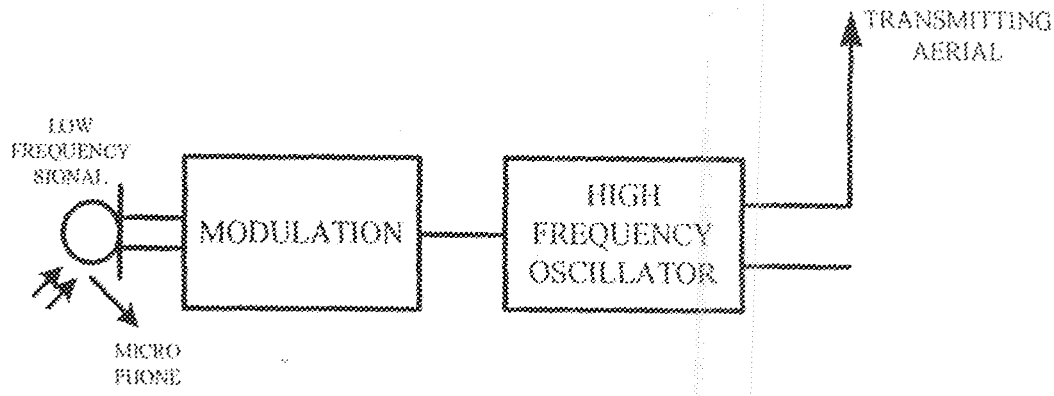
In radio communication, two things are of paramount importance:

i. The sending of message or Intelligence (signal)

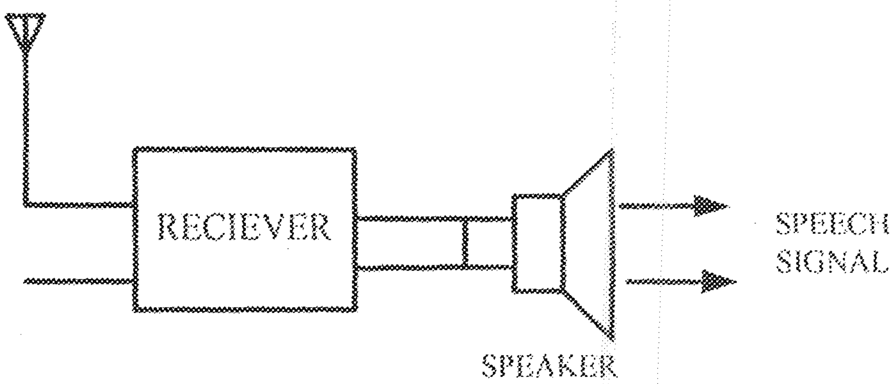
ii. Reception of the message signal.

In radio communication, the sending of message is done by the transmitter while the reception of the message signal sent is done by the radio receiver

A simplified diagram of Radio communication is shown in figure 1.0 and 1.1. We have the transmitter at the source and the receiver at the destination. [3]



Fig, 1.0 Radio Transmitter



Fig, 1.1 Radio Receiver

1.1 Aim of Project

The aim of this project is to produce a simple radio transmitter with a high input impedance and a radio receiver that is portable and capable of transmitting and receiving of intelligence on the commercial frequency modulation band of 88MHz to 108MHz.

1.2 Application of Electronic Eavesdropper

The placement of electronic eavesdropping device in homes, offices, companies, battlefields has become a useful phenomenon throughout the passing years. Besides, the use of these devices is legally prohibited in virtually all jurisdiction for commercial and private purposes.[4]

E.g. In some countries like the United States of America, the use of Eavesdropping devices were legally forbidden as way back as 1862. But today, electronic Eavesdropper, under the name of Electronic Surveillance is used for a variety of serious crimes subject to strict judicial control. This favours the police to use this method as an indispensable tool of effective police work in many cases; particularly in the investigation and disposal of crimes, sedition such as kidnapping.[4]

It also favours the military in checkmating the possibilities of coup plots and also used in the front line of battle areas.

1.3 Types/ Classification of Electronic Eavesdropper Device

Some types of electronic Eavesdropping devices in use are as follows:

1.3.1 Audio Amplifier type (wired)

This type of Eavesdropping device is normally used for short distances. This eavesdropper consists of two (2) stages; the input and the output stage. This device uses a microphone to convert sound energy being picked up into electrical pulses. The pulses are then passed on through a wire to another reproductive set where the pulses are then re - converted to sound. This type is used in TV, Radio stations etc. [4]

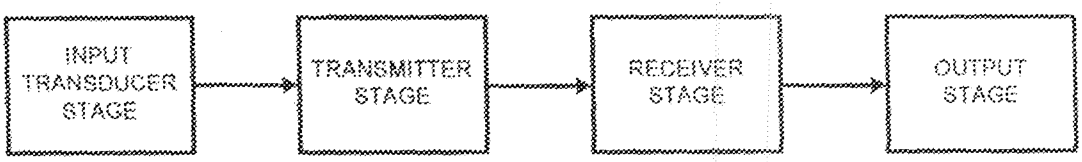


Fig.1.2: Block diagram of Audio amplifier Eavesdropper

1.3.2 Wireless (FM) Transmitter/ Receiver type

This type of eavesdropping device is also known as Bugging device, which makes use of a transmitter circuit to pick – up conversation which is then transmitted on to the receiver placed for distance away through the antenna. [4]

They are secretly placed in a room, office or in any location that is to be monitored.

In this type of eavesdropping device, the information source (signal) is spoken into the microphone which serves as a transducer. The transducer then converts the analog signal into electrical pulses that can be recognized by the transmitter. In the transmitter, the modulated signal is amplified to a level suitable to drive an antenna.

By the time the transmitted signal reaches its destination, the receiver demodulates and decodes the received waves, processes it and converts it to a form useful to a person.

Finally, electronic bugs take advantage of modern technology.

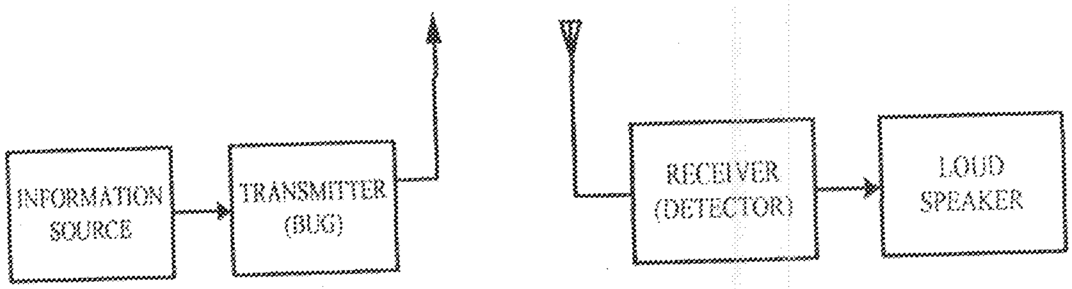


Fig.1.3: Block diagram of wireless Eavesdropper

1.3.3 The Ray – Gun Type

A ray – gun device is an electronic eavesdropping device that beams an object hundreds of meters away and can imperceptibly pick a conversation and return it to the man/ person at the listening post. In modern technology, the conversation is ordinarily carried by light beam or laser.[2]

1.3.4 The Radio signal interceptor

This type of eavesdropper is used in battle fields as an electronic support measure (ESM).

The primary function of the ESM is to search, intercept and monitor enemy radio signals.

The ESM sets are mounted with scanners and direction finding antennas.

The antennas are meant to cope with the wide range of frequencies from various enemy threat. [4]

1.4 Modulation

Modulation involves the process of placing or superimposing of information (intelligence) on a carrier wave at the transmitting signal end. The carrier wave by itself will not produce any intelligence at the loudspeaker of the radio receiver. The transmission of intelligence occurs when the modulating signal is superimposed on the carrier wave.

Modulation can be defined as the process of combining the low frequency signal (voice, music, etc) with a high frequency radio wave called the carrier wave together. [5].

The result of modulation process is a modulated carrier wave (signal) and a frequency shift.

Generally, carrier modulated sine wave may be represented by the equation

$$e = E_c \sin(\omega t + \phi)$$

where e = instantaneous value of the carrier modulated wave

E_c = maximum amplitude

ωt = angular velocity or angular frequency

ϕ = phase shift

Finally, varying any of E, ϕ, ω of the carrier wave signal by the modulation of signal give rise to amplitude, frequency and pulse modulation respectively.

1.4.1 Need for Modulation

Modulation process is employed in communication systems for the following reasons:

i. For channel assignment: Each message signal 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.

ii. To reduce noise and interference particularly at low frequency.

iii For easy radiation and reception of signals by using practically – realizable antenna size [6]. Besides, in order to radiate electromagnetic energy most efficiently,

The length of the transmitting antenna must be at least one quarter (1/4) of the signal wave length (λ). [5]

iv. For multiplexing so that several messages (signals) can be transmitted through the same signal channel.

v. To overcome equipment limitation e.g. size and weight.

1.4.2 Forms of modulation

There are two forms namely:

i. Analogue modulation

ii. Pulse or digital modulation

1.4.3 Analogue modulation

Analogue modulation refers to a category of modulation technique in which the carrier signals and the modulating signals are both analogue with respect to time.

1.4.4 Digital or Pulse modulation

In pulse modulation, however, the carrier is a pulse whose amplitude, phase (position or duration (width) or frequency is proportionately varied with respect to the instantaneous value of the continuous modulating signal. In order to achieve pulse modulation, it's necessary to sample the modulating signal so that the signal is used only during discrete time points.

Two main advantages of pulse (digital) modulation over analogue modulation are as follows:

i. Transmission and processing of discrete signals are easier

ii. The system consumes less power since only a sample is sent instead of the whole signal. [6]

With respect to this project, frequency modulation (FM) is of great importance.

1.5 Frequency Modulation (FM)

Frequency modulation is a modulation process in which the instantaneous frequency w(t) of the modulated wave is equal to the unmodulated carrier frequency w(c) plus a time – varying component that is directly proportional to the modulating signal Vm(t). [6]

FM can be represented by the expression

$V_{FM}(t) = VcCos(wct + \beta SinWmt)$

But,

$\beta = \Delta f / f_m$

$\Delta f = K_f V_m / 2\pi$

Where $V_{FM}(t)$ = FM modulated wave

V_C = Amplitude of the carrier (unmodulated)

w_c = Angular velocity of the unmodulated carrier wave.

β = Modulation index

Δf = frequency deviation

f_m = frequency of the modulating signal

K_f = frequency sensitivity of the modulator circuit

V_m = Amplitude of the modulated signal

w_m = Angular velocity of the modulated signal (wave)

1.5.1 Generation of FM wave

We have two methods of generating FM waves namely:

i. Indirect method

This method involves the process of connecting a frequency multiplier circuit to the output of the Armstrong circuit (Narrowband FM generator circuit). Fig. 1.4 shows the block diagram of indirect method of generating FM wave. [5]

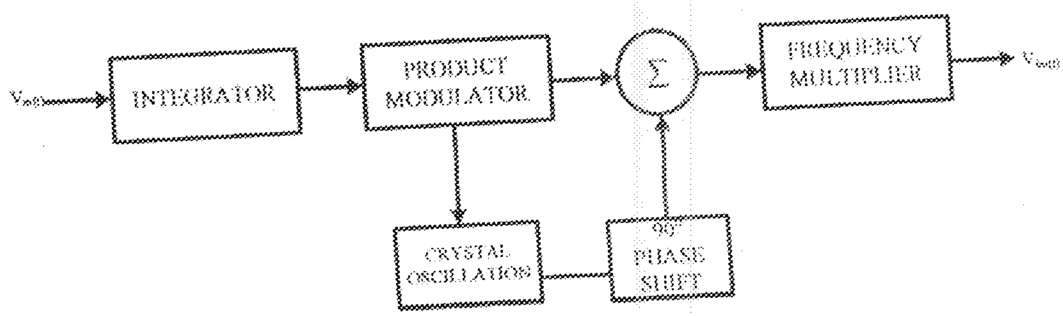


Fig. 1.4: Generation of FM wave (Indirect method)

i. Direct method

This method can be achieved by varying the frequency of the voltage controlled oscillator (VCO). Fig. 1.4 shows the block diagram of the method above

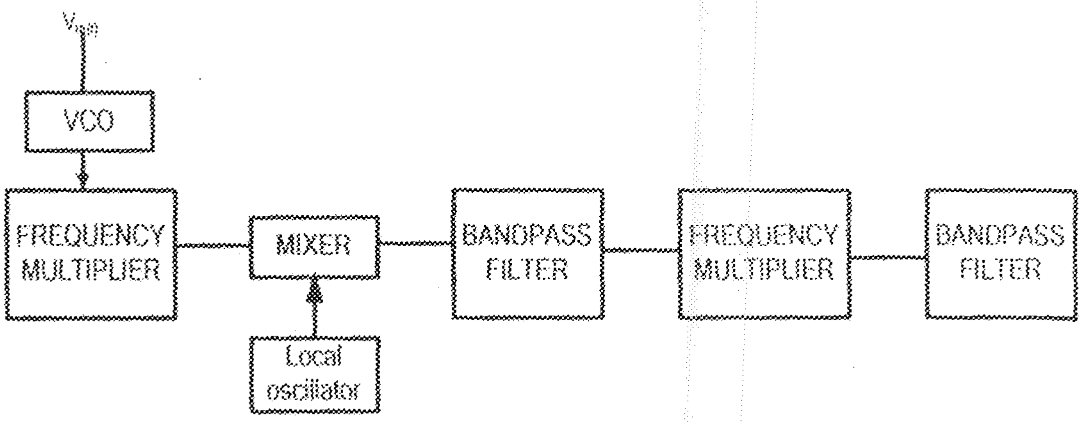


Fig. 1.4: Direct method of generating FM wave.

1.5.2: Demodulation of FM wave

Frequency demodulation is the process by which the original modulating wave is recovered from the FM wave. This process takes place at the receiving end. [6]

Demodulation of FM wave can be achieved by using

i. Frequency discrimination circuit

ii. Radio detector circuit

iii. Phase locked loop (PLL) circuit.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin of Radio communications

As far back as 1865, JC Maxwell predicted mathematically radio communications from the result of Faraday's and Christein Oersted – electrical and magnetic experiment. The laws deduced from the experiment were proven right in 1885 by Heinrich Hertz and by 1895, Marconi developed a practical radio transmitter. [7].

Edwin Armstrong (major), a great scientist born in Manhattan 1890 made an enormous contribution to the development of radio communications. In order to increase the sensitivity of the receiver, Armstrong hit on the idea of feeding the signal back to the amplified gain. The primitive value had a very low gain at radio frequency, He called this idea "REGENERATION".

In 1914 precisely, Major Edwin Armstrong invented super heterodyne receiver. In the super heterodyne receiver, each incoming frequency is tuned, amplified and then converted to an intermediate frequency (I.F.) by mixing it with a signal from an oscillator. [3]

Finally, with the invention of super heterodyne receiver, tuning has become easier because there are fewer variable tuned circuit, feedback is less of a menace because the signal (I.F.) is not at the same frequency with the input signal. It has also helped to reduce noise and interference. [8]

2.2 Radio Transmitter and Function

A radio transmitter is defined as an electrical device or system that uses electromagnetic energy for sending information through space. This information is sent as radio waves or electromagnetic waves. The transmitter actually modulates the information or message signal to be conveyed onto a carrier wave which is generated by the radio frequency oscillator and amplifies the waveform to the desired power level and delivers it to the transmitting aerial or antenna. [9]

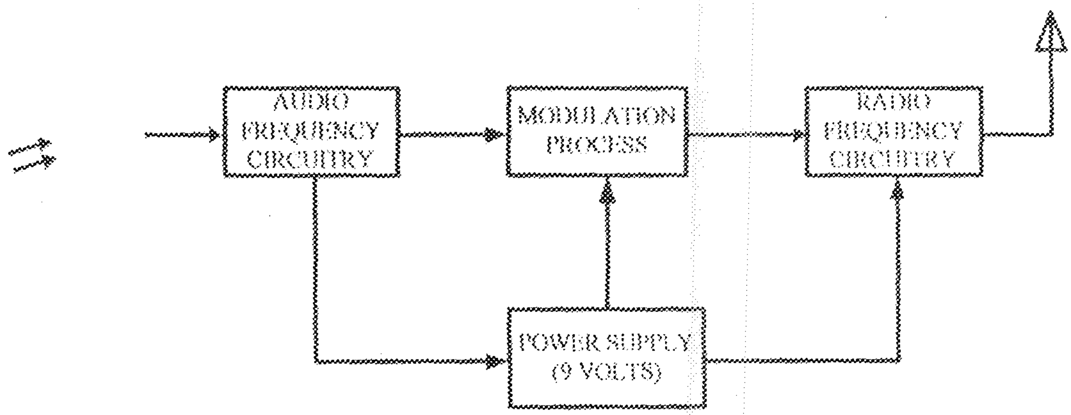


Fig. 2.0: Block diagram of a transmitter

2.2.1 Types of Transmitter

Radio transmitters are classified into two;

i Wide Band transmitter:

This type of transmitter is used for long range communication such as in military, marine, aircraft and amateur communication. They employ multimode modulation or function through single sided band modulation for transmission. [7]

ii. Narrow Band transmitter:

This type of transmitter employs frequency modulation or pulse amplitude modulation for transmission. They are used for short – distance communications.

2.2.2 Uses of Radio transmitters

i. Programme transmission/ broadcasting

It is important to note that the use of transmitters in broadcasting of programmes affords entertainment in form of music, drama, sport events and information through newscast, interviews and public service announcement.

ii. Two – way communication

iii. In the navigation of aircrafts, ships and missiles to their targets through the use of radar which is a specialized form of transmitter. [7]

iv. In data transmission.

2.3 Radio Receiver and Functions

A radio receiver is a device which picks up any desired radio frequency signal (i.e. modulated carrier signal) and receives from it the original modulating signal. [3]

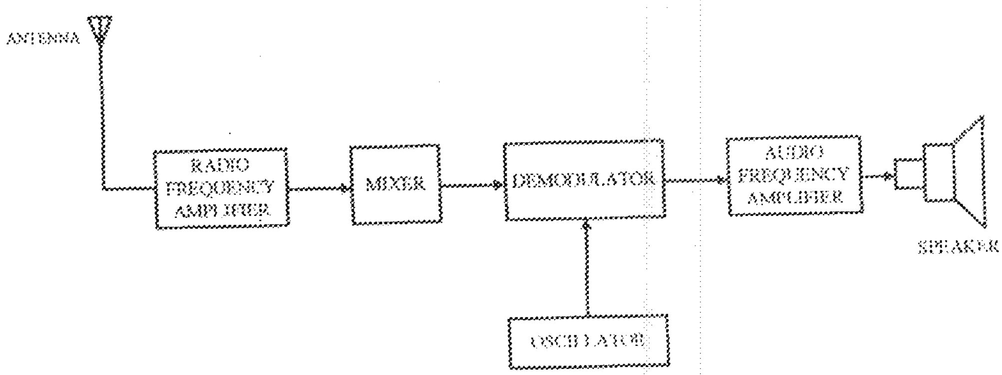


Fig. 2.1 Block diagram of a Receiver.

From the figure above, the mixer converts the incoming signals to a predetermined fixed intermediate frequency usually lower than the signal frequency. The mixer is required to obtain a new frequency by combining the signal frequency with that of the oscillator.

The demodulator demodulates the message being transmitted. (demodulation can be also be explained as the process of separating the RF wave from the AF wave.

The AF amplifier helps in amplifying the weak electrical signal from the transmitter to a level capable of driving the loudspeaker at the desired output sound level. [10]

2.3.1 Functions of Radio receiver

i. To select the wanted signal from all the signals picked up by the aerial while rejecting all others.

ii. To extract the intelligence contained in the modulated signal.

iii. To produce an audio frequency output of sufficient power is operate the loudspeaker or other receiving devices.

2.3.2 Classification of Radio receivers

Radio receivers may be classified according to the type of traffic they are designed to handle. Based on the operating techniques, radio receivers may be classified as:

i. Simple radio receiver

In this receiver type, selection is obtained by adjusting capacitor C_1 (in fig 2.2) to give resonance at the wanted signal frequency. The diode D_1 acts as a non – linear detector which helps in extracting the audio signal (plus a number of other components) which is passed through the earphones for conversion into sound.

The loudspeaker cannot be used because there is insufficient power. [10]

The audio frequency output power of the simple receiver can be increased if an audio frequency amplifier is used. Finally, simple radio receiver has a poor sensitivity and selectivity. [3]

ii. Tuned Radio frequency (TRF) radio receiver

In this type of receiver, amplification is the radio frequency amplifier stages and in the tuned circuit improves its selectivity and sensitivity.

iii. Super heterodyne radio receiver.

This is the commonly used receiver in these modern days. In a super heterodyne receiver, the wanted signal frequency is converted into a constant frequency known as the INTERMEDIATE FREQUENCY (I.F) at which most of the gains and the selectivity of the receiver is provided. [10]

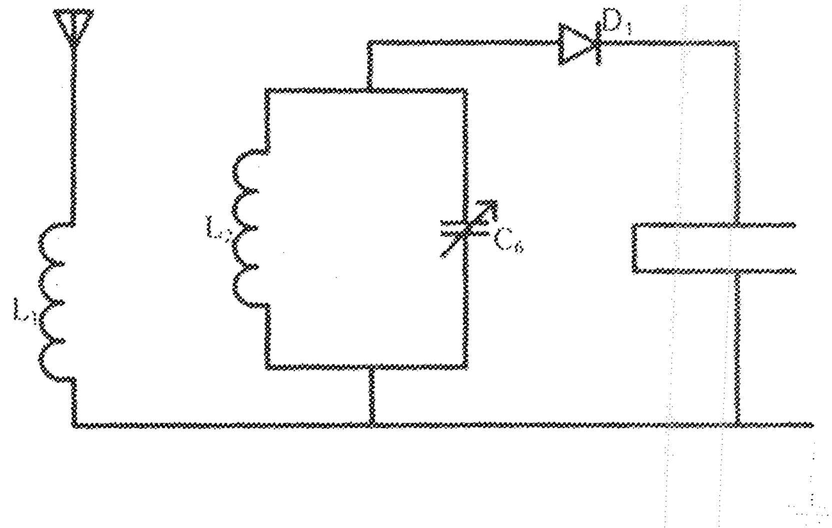


Fig. 2.2: Simple radio receiver

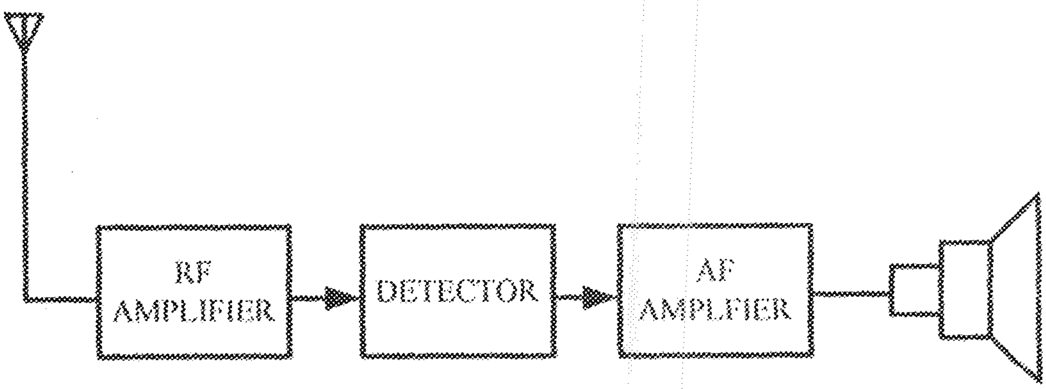


Fig. 2.3: Block diagram of tuned radio frequency receiver (TRF)

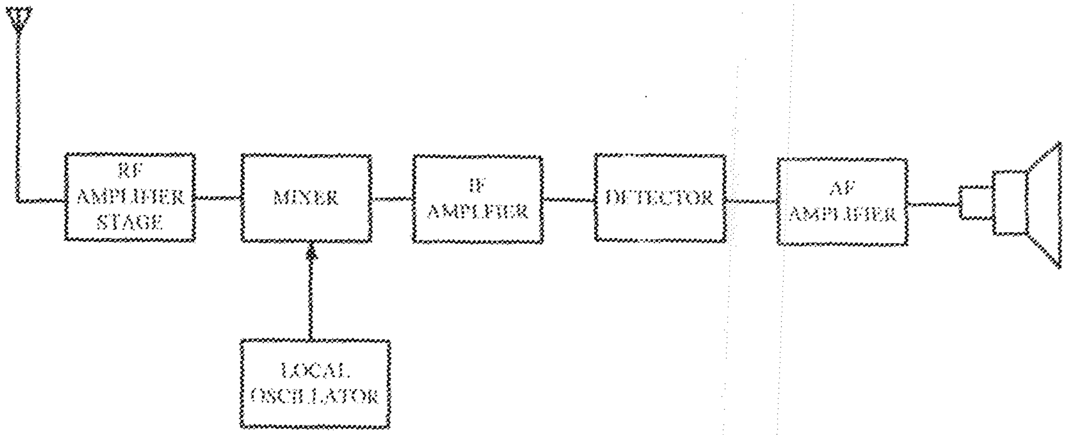


Fig. 2.4: Block diagram of a superheterodyne receiver

2.4 Comparison between AM and FM receivers

i. All transmitted power in FM receivers are useful whereas in AM, most of it is in the carrier waveform, which serves no useful purpose.

ii. It has a higher signal – to – noise (S/N) ratio than the AM receiver. This is because at VHF band, noise level is less and FM receivers use amplitude limiters to remove amplitude variations caused by noise.

iii. In FM receivers, there is hardly any adjacent interference due to "guard band" [5]

2.5 Disadvantage of FM receivers

i. It requires much wider channel (almost 7 to 15 times) as large as needed by AM receivers.

ii. It requires complex and expensive transmitting and receiving equipment.

iii. Since FM reception is limited to only line of sight, area of reception for FM is much smaller than for AM.

CHAPTER THREE

DESIGN ANALYSIS AND IMPLEMENTATION

3.1 Brief description of components.

The component employed in the construction work comprises an input terminal for input devices such as Dynamic microphone through which the input signal (speech,sound & music etc.) is fed into the system. Resistors for biasing the transistors[11],Capacitors which serves as coupling capacitors for blocking the flow of dc component from one stage to another [12],Transistor for the amplification of signal, An inductor in the tank circuit of the oscillator, and the antenna or the aerial which radiates or sends out the already modulated signal.[13]

Finally, variable capacitor is mainly used to vary the carrier frequency of the transmitter [15]

3.2 Design Requirement

Since the electronic eavesdropper is used for clandestine operations, both its circuits and components have to be miniaturized (especially the transmitter) as much as possible. Besides, for deception purposes, components or parts should be properly concealed and camouflaged especially the transmitter circuit.

Finally, to prevent damage, the components had to be secured to the outer case properly. The case of the device was designed to eliminate heat produced when in operation.[9]

3.3 Choice of Eavesdropper

For this project, the eavesdropper chosen is the wireless (FM) transmitter/ receiver type because the transmitter circuit has an input audio frequency amplifier stage which uses the microphone (dynamic) to pick up sound (signals).

Finally, its transmitting circuit takes advantage of modern technology.

3.4 Choice of Transmitter circuit

Since it is illegal in most countries to operate a transmitter without license, special care must be given to the transmitter circuit design operation. For this project, the transmitter circuit type chosen is the NARROW BAND TRANSMITTER TYPE used for short – distance communication.

3.5 Choice of Receiver circuit

For this project, SUPERHETERODYNE receiver is the chosen type because it has high selectivity (i.e. the ability to discriminate the unwanted signals from all the other signals picked up by the aerial) and thus it has an easy sensitivity. [3]

3.6 Design Analysis

An electronic eavesdropper as earlier discussed is made up of the transmitter circuit and the receiver circuit. Both the transmitter and the receiver circuit of this project are of simple design.

3.7 The Transmitter circuit.

The transmitter circuit consists of

i. The input audio frequency amplifier stage
ii. The transistor audio frequency amplifier stage (modulation stage)
iii. The oscillator stage.
iv. The output (antenna) stage.

3.7 The Transmitter circuit.

The transmitter circuit consists of

i. The input audio frequency amplifier stage

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iii. The oscillator stage.

iv. The output (antenna) stage.

3.7.1 The input Audio Frequency amplifier stage.

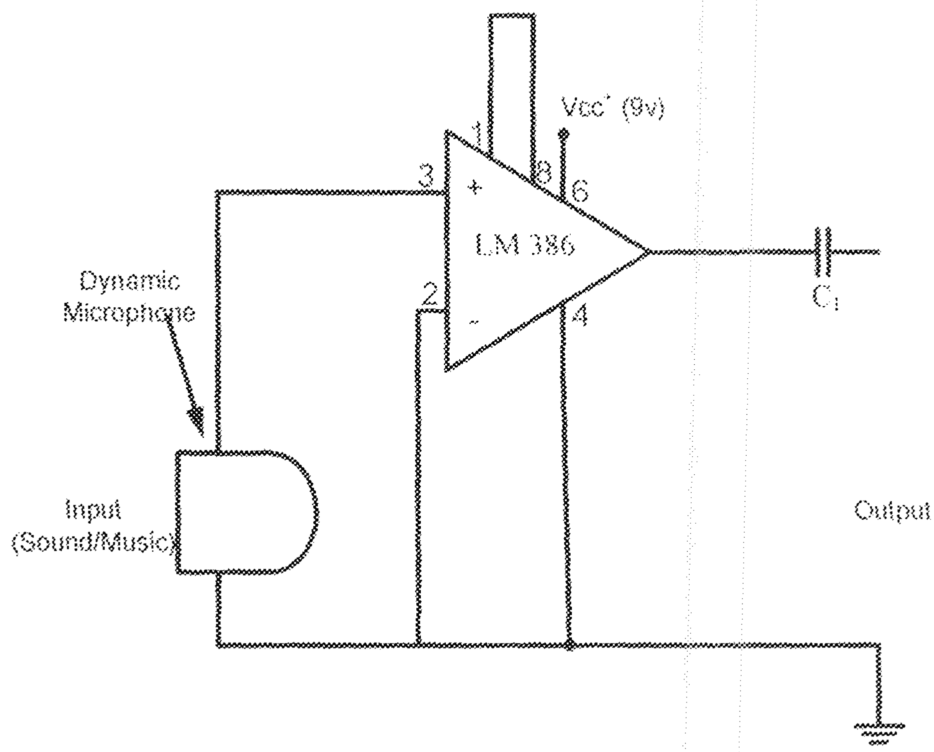

Fig. 3.0 Audio frequency amplifier circuit

The input audio frequency amplifier stage consists of IC LM386, capacitor C_1 (220μF). IC LM 386 is a dual – in – line integrated component that is designed mainly for low voltage amplification that will drive directly an 8Ω speaker. IC LM 386 has a gain fixed at 20dB (manufacturers specification) but it can be increased to 200dB (x10) by short circuiting pins 1 and 8 together as shown in figure 3.0.

At a gain of 200dB, the receiver speaker will be audible and capacitor C_1 is also blocking all d.c. current/ voltage from interfering with the transistor audio frequency amplifier stage. [16]

Calculations:

Gain (A) = V_{out} / V_{in}

Let Input voltage (V_{in}) = 10mV

Gain = 200dB

$V_{out} = AV_{in}$

$= 200 \times 10 \times 10^{-3}$

$= 2V$

3.7.2 The Transistor Audio frequency amplifier stage.

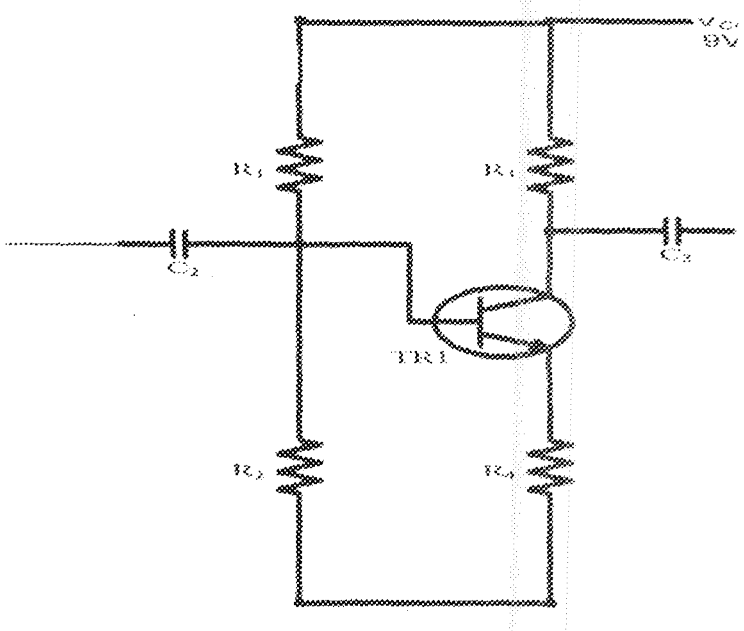

Fig. 3.1: Transistor audio frequency amplifier circuit.

In figure 3.1 above, C_2 couples the output of the audio frequency amplifier circuit to the base of the transistor 1 (TR1). Its function is to block the flow of d.c. current that would otherwise interfere with the bias conditions. [17]. R_1, R_2, R_4 are the biasing

The data sheet specification of BC 107 NPN transistor is shown below:

Table 3.0: The data sheet specification of BC 107 NPN transistor

TYPE NO	I_{MAX} (mA)	$V_{CEO(max)}$ (V)	P_{TOT} (mW)	hF_E	F_T (MHz)	$V_{BEO(max)}$ (V)
BC 107	100	45	360	110 – 450	250	0.7

$I_{C(max)}$ = maximum collector current

$V_{CEO(max)}$ = maximum collector – emitter voltage

$V_{BEO(max)}$ = maximum base – emitter voltage

P_{TOT} = maximum total power rating (V_{CE} x I_C)

hF_E = dc current gain

F_T = frequency of transmission

Calculations:

From figure 3.1,

$$V_B = (R_2/(R_1 + R_2))(V_{CC})$$

$$V_B = (15K \times 9) / (100 + 15)K$$

$$V_B = 1.174V$$

Where R_1 = 100K

R_2 = 15K

V_{CC} = 9V.

$R_B = R_1 // R_2 = R_1R_2 / R_1 + R_2$

R_B = 100K x 15K / (100 + 15)K

= 13043.48Ω

Voltage across the emitter resistor (V_E)

$V_E = V_B - V_{BE}$

but $V_{BE} = 0.7V$

$V_E = 1.174 - 0.7$

$V_E = 0.474V$

$V_E = 474mV$

$I_E = V_E / R_E$

but $R_E = R4 = 150\Omega$

$I_E = 0.474/ 150 = 0.00316$

$I_E = 3.16mA$

Recall that $I_C = I_E - I_B$ ………………(1)

$I_C = \beta I_B$ ………………………….(2)

Substituting 2 into 1 gives

$\beta I_B = I_E - I_B$

$\beta I_B + I_B = I_E$

$I_B (\beta + 1) = I_E$

$I_B = I_E / (\beta + 1)$

but β for BC 107 = 175

$I_B = 0.00316 / 17511$

$I_B = 0.000018$ A

$I_B = 0.018mA$

$I_C = I_E - I_B = 3.16 \times 10^{-3} - 0.018 \times 10^{-3} = 3.142mA$

Voltage at the collector (V_C)

$V_C = I_C R_C$ where $R_C = R_3 = 1K = R_L$

$V_C = 3.142 \times 10^{-3} \times 1 \times 10^3$

$V_C = 3.142V$

$V_{CE} = V_{CC} - I_C (R_L + R_E)$

$V_{CE} = V_{CC} - 3.142 \times 10^{-3} (1000 + 150)$

$V_{CE} = 9 - 3.613$

$V_{CE} = 5.387V$

Power output = P_{out}

$P_{out} = V_{CE} \times I_C$

$= 5.387 \times 3.142 \times 10\text{-}3 = 0.0169W.$

$= 16.9mW$

Power input = P_{in}

$P_{in} = I_B2R_B$

$= (0.018 \times 10\text{-}3)2 \times 13.043K$

$= 4.2 \times 10\text{-}6\ W$

r_i = input resistance of the amplifier

$r_i = VBE / IB = 0.7 / 0.018 \times 10^{-3}$

$= 39K\Omega$

r_o = output resistance of the amplifier

$r_o = VCE / IC$

$= 5.387 / 3.142 \times 10^{-3}$

$= 1714.5\Omega$

$= 5.387 / 3.142 \times 10^{-3}$

$= 1714.5\Omega$

3.7.3 The Oscillator Stage

An oscillator is basically an amplifier with an output but no external input. [18].

The oscillator used in this FM transmitter is the COLPITTS oscillator operating in the common base mode, (i.e. no d.c. returning collector resistor is employed) and the junction between capacitor (C_6 and C_7) in the tank circuit is not grounded.

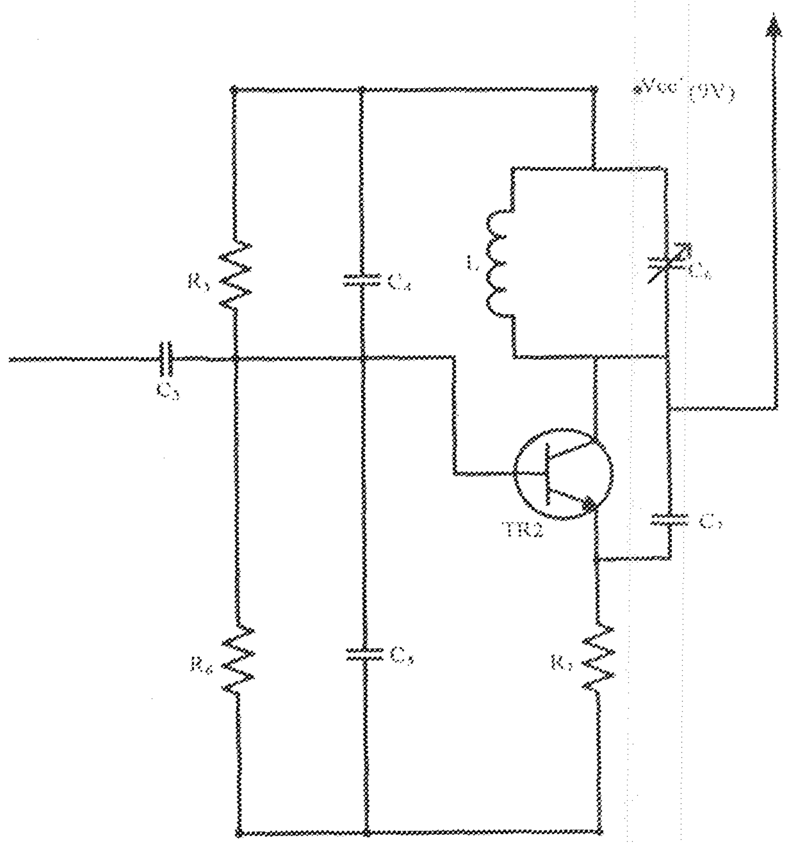

Fig. 3.2: Circuit diagram of COLPITT oscillator.

In figure 3.2, R_5, R_6, C_4 and C_5 are the FM carrier wave generator that generates the high frequency radio wave.

BC 140 (TR2), L, C_6, R_7 and C_7 form the colpitt oscillator tank circuit, responsible for the conversion of radio frequency wave into electromagnetic wave.

C_7 is used for radio decoupling process which helps to prevent the oscillator from acting as a receiver. R_7 is a swamping resistor that limits the flow of collector current. Finally, R_5, R_6, R_7 serves as biasing resistors which stabilize the base voltage and they are used to aid the oscillator operations [7].

Data sheet specification for transistor (TR 2) BC 140 NPN is shown below

Table 3.1: Data sheet specification for transistor (TR 2) BC 140 NPN

TYPE NO	P_{TOT} (W)	$I_{C(max)}$	V_{CEO}(V)	F_T(MHz)	hF_E	V_{BEO}(V)	SF
BC 140	0.85	1	80	250	175	0.7	10

Calculations:

Let open circuit voltage = V_{B2}

$$V_{B2} = (R6/(R6 + R5)) \times V_{CC}$$

$$= 15K \times 9/(15 + 10)K$$

$$V_{B2} = 5.4V$$

Voltage across R_7 = V_{R7}

$$V_{R7} = V_{B2} - V_{BE}$$

$$= (5.4 - 0.7)$$

$$V_{R7} = 4.7$$

The resistance at the base of the transistor (TR2) = R_{B2}

$$R_{B2} = R_5 // R_6$$

$$= R_5 R_6/(R_5 + R_6)$$

$$= 10K \times 15K/(10 + 15)K$$

$$= 6000\Omega$$

$$R_{B2} = 6K\Omega$$

SF = stability factor

$SF = R_{B2} / R_E = R_{B2} / R7 = 6000/ 470 = 12.8$

$I_E = V_{B2} / R_E$

$= 5.4 / 470 = 0.01A$

The carrier oscillating frequency = F

$F = 1/ 2\pi\sqrt{(LC_7)}$

where C_7 = 10pF

F = carrier frequency

$F = 1/ [(2 \times 3.142) \sqrt{(0.2 \times 10^{-6} \times 10 \times 10^{-2})}]$

$F = 1/ 8.886918026 \times 10^{-9}$

F = 113MHz.

But recall that L = r2n2 / (9r + 10d)

n2r2 = L(9r + 10d)

$n = \sqrt{[L (9r + 10d)/ r^2]}$

$n = \sqrt{[((0.2)(9 \times 0.5 + 10 \times 1.3)) / 0.5^2]}$

n = 3.74

n is approximately 4 turns

where L = inductance of coil (μH)

r = radius of coil (cm)

d = length of coil (cm)

n = number of turns

Note (L = 0.2μH, r = 0.5cm, d = 1.3cm)

3.7.4 The output stage.

The modulated signal going out of the transmitter is sent into the atmosphere as electromagnetic wave (radio wave) through the antenna (Telescopic)

3.8 The Receiver circuit

The receiver used in this project is a single IC (super heterodyne R – 803). It consists of the following: The RF amplifier, mixer, local oscillator, IF amplifier, limiter, detector, de – emphasis network, AF amplifier and speaker. [5]

3.8.1 Operation of the receiver

First and foremost, the transmitted modulated signal (incoming signal) on reaching the receiver is first amplified by the RF amplifier, next it enters a mixer circuit which is so designed that it can conveniently combine two radio frequencies. One fed into it by the RF oscillator whose frequency of oscillation can be controlled by varying the capacitance of its capacitor.

In fact, the local oscillator frequency is always higher than the frequency of the incoming signal. When two (2) currents of these two different frequencies are combined in the mixer transistor, the phenomenon called BEAT or Intermediate frequency (IF) is produced.

BEAT or Intermediate frequency is lower than the input signal frequency but it is still above the range of audio frequency.

The output of the mixer circuit is fed into the IF amplifier circuit. Besides IF signal amplification takes place here.

Thus, the output of the IF amplifier is fed into a limiter circuit. Its function is to remove all amplitude variation caused by noise from IF signal which might have crept into the FM signal. The limiter circuit is necessary for distortion – less demodulation.

The limiter output is fed into the detector circuit which provides the audio signal.

The audio signal passes through the DE – EMPHASIS network. This network reduces the amplitude of high frequencies in the audio signal which was earlier increased by the pre – emphasis network in the transmitting station.

It is also used to re – establish the "TONAL BALANCE" of the speech or sound (music) lost in the pre – emphasis network.

The output of the DE – EMPHASIS network is amplified by the AF amplifier whose output is fed to a loudspeaker which reproduces the original sound. [5]

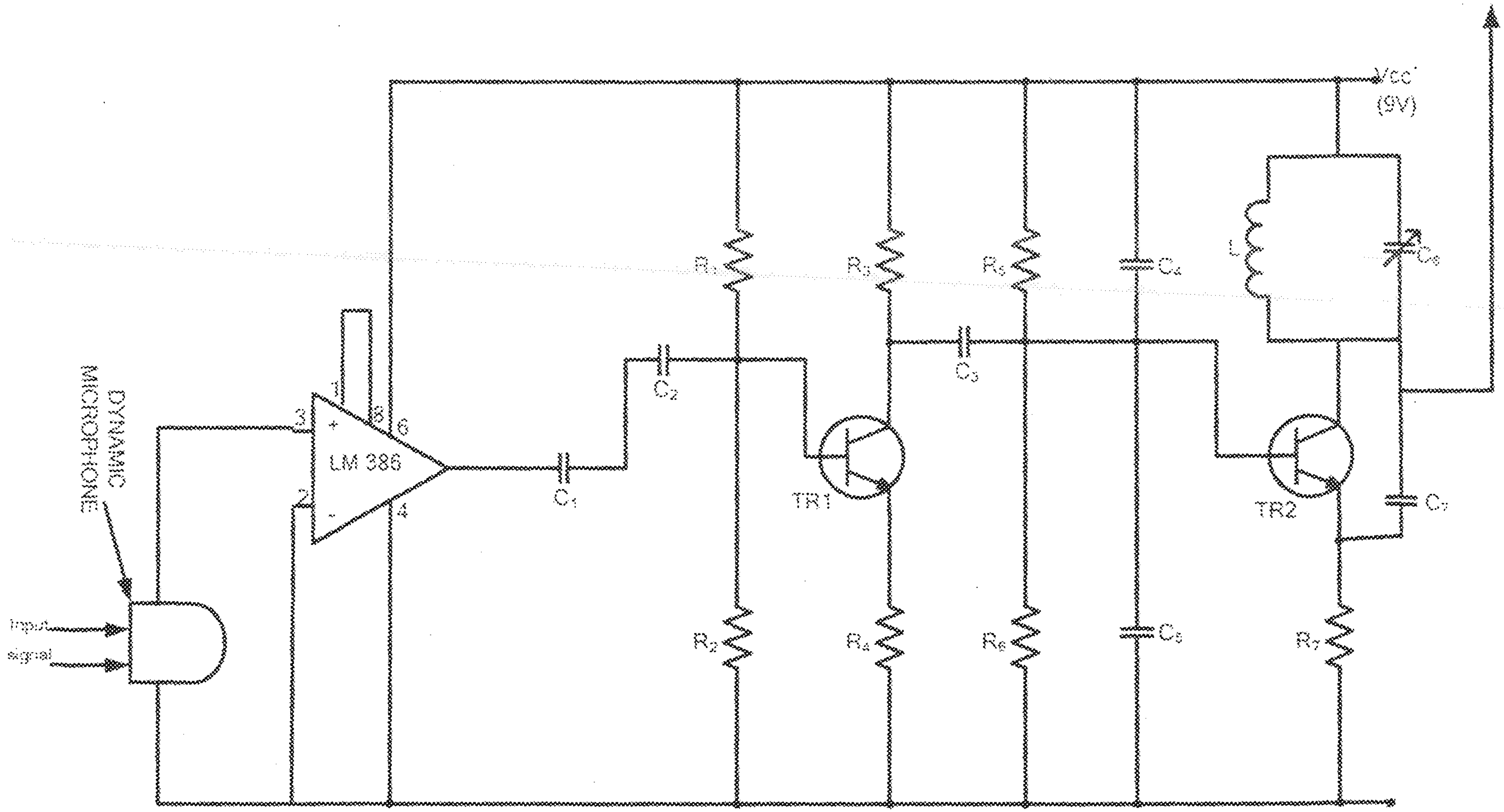

Fig. 3.3: Complete diagram of FM transmitter

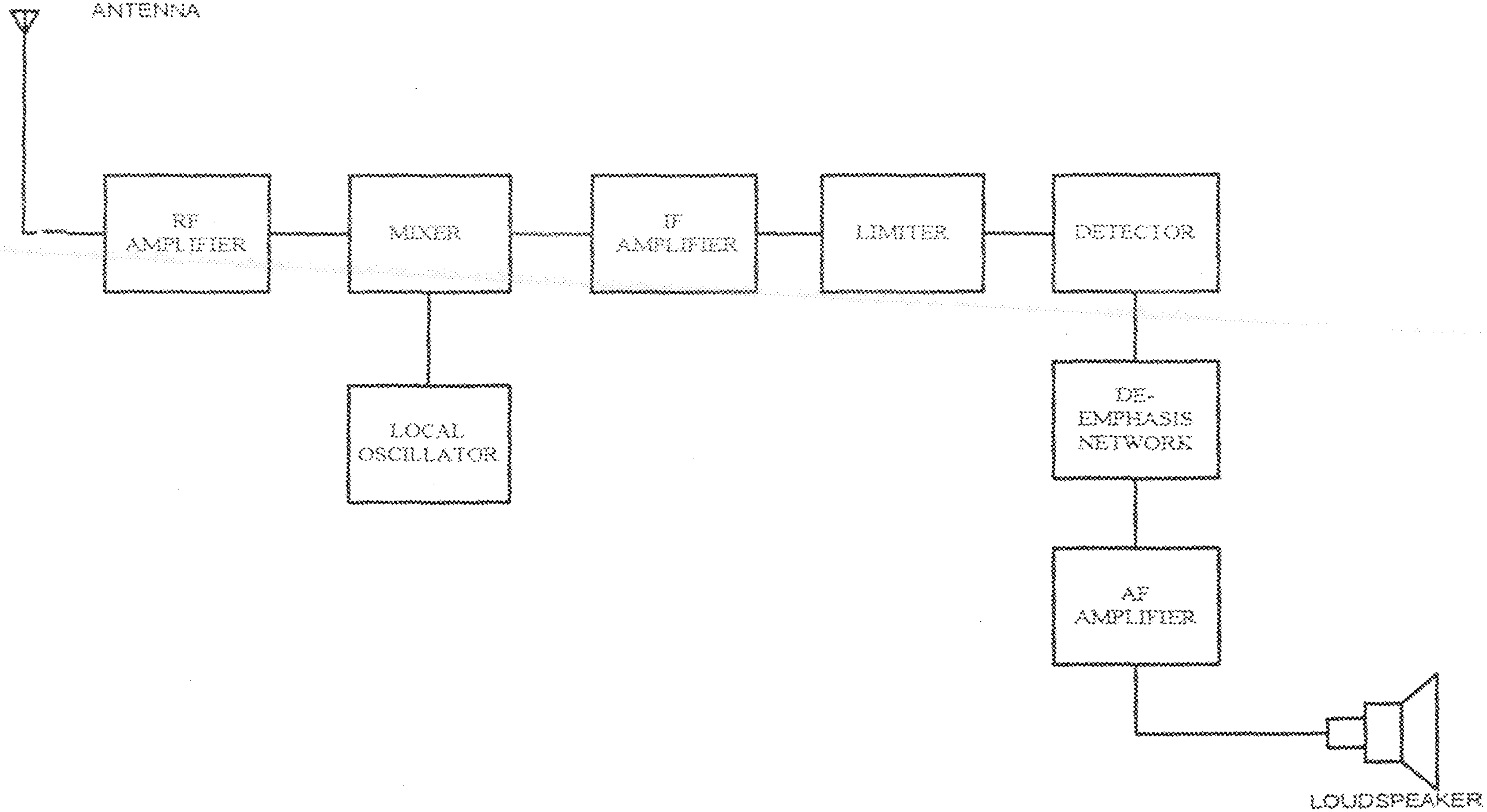

Fig. 3.4: Block diagram of the superheterodyne radio receiver tactful

COMPONENT LIST

Resistors		Capacitors	
R1	100K	C1	220μF
R2	15K	C2	4.7μF
R3	1K	C3	0.47μF
R4	150K	C4	2nF
R5	10K	C5	2nF
R6	15K	C6	22pF
R7	470Ω	C7	10pF

Inductor

L = 0.2μH

Transistors

TR1 BC 107 NPN

TR2 BC 140 NPN

Microphone

Dynamic Microphone

Antenna

Telescopic antenna (aerial)

ICs

LM 386

R – 803 (radio receiver)

CHAPTER FOUR

TEST, OBSERVATION AND RESULTS

The construction of this project needs a lot of practical experience in handling components using soldering iron and lead, proper wiring of the circuit on the breadboard and Vero board.

Also knowing how to use the laboratory equipment like the oscilloscope [OSC], multimeter, frequency meter is very essential.

First and foremost, after the construction of the FM transmitters (1 and 2), a super heterodyne radio receiver was tuned gently within the range of 88 – 108MHz FM band until a humming sound was heard and then the receiver locks (i.e. no more sound is heard) indicating that the receiver does receive the transmitted signal. Besides, all these took place after the adjustment of the variable capacitor in the colpitis oscillator circuit has been done.

When the transmitter was powered with 9V d.c. battery and music or sound was placed some distance away, the receiver received the transmitted modulated signal clearly at **92 MHZ** FM band and the reception distance is 10 – 15 meters away from the transmitter. While the transmitter and the receiver were still working, the carrier frequency of the transmitter was **4 MHz**. This value was measured through the frequency meter at the output of the colpitts tank circuit.

4.1 Discussion of Result

Although distortion in the form of electrical noise and line effect of other broadcasting stations with high power transmitter cannot be totally eliminated. But the aim of this project was still achieved as the transmitter is capable of picking up small sound and thus still capable of transmitting picked up sound up to 10 -30 meters away.

4.2 Precautions

While doing the constructions work, the following precautions were taken to ensure good production.

i. The use of a low – voltage soldering iron to ensure that sensitive components were not damaged by heat

ii. Ensuring of fine soldering by the use of thin and sharp solder

iii. Ensuring that all components used were compatible with 9V as the source voltage.

4.3 Difficulties Encountered

i. Knowing the exact value of the inductor that will fit into the colpitt tank (oscillator) circuit.

ii. Adjusting of the variable capacitor in the transmitter circuit was my biggest problem.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

A lot has been said and much work has been done concerning electronic eavesdropper as a device as far as this project is concerned both theoretically and practically.

Besides, a practical eavesdropper which is capable of transmitting intelligence at a carrier frequency of 4MHz when placed in a room, office, etc and receiving intelligence for 10 – 15meters has successfully been designed and constructed.

5.2 Recommendation

I strongly recommend that surface mounted devices (SMD) should be used instead of passive components (e.g. resistors and capacitors) so as to miniaturize the transmitter circuit and to enable the transmitter to transmit with a very high frequency and this of course will increase reception distance

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