DESIGN AND CONSTRUCTION OF A MULTI-USER INTERCOM TELEPHONE SYSTEM

BY

RAJI BASHIRU KOLAWOLE
98/7757EE

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

SEPTEMBER, 2003

CERTIFICATION

This is to certify that this project work was carried out by Raji Bashiru Kolawole (98/7757EE),for the award of bachelor of engineering of the federal university of technology, minna.

..... 21/10/03

SUPERVISOR DATE

Mr.Abraham Usman

..... 28/4/09

HEAD OF DEPARTMENT DATE

Engr. M.N. Nwohu

....

EXTERNAL EXAMINAL DATE

DECLARATION

I HEREBY DECLARE THAT THIS PROJECT WORK WAS PRESENTED BY ME, UNDER THE SUPERVISION OF MR. ABRAHAM USMAN DURING 2001/2002 ACADEMIC SESSION.

....

RAJI BASHIRU K. DATE

(98/7757EE)

DEDICATION

THIS PROJECT WORK IS DEDICATED TO GOD ALMIGHTY, JESUS CHRIST AND MY PARENTS, MR. AND MRS. YUSUF RAJI.

ACKNOWLEDGEMENT

Glory is to God Almighty for seeing me through all the trying periods. I use this medium to thank my supervisor, Mr. Abraham Usman for creating time for me in the aspect of supervising and support during the course of this project and to my wonderful head of department, Dr. Y.A Adediran and Engr. M.N. Nwohu for their numerous supports.

Big thanks also goes to my brotherly room mate, Mr. Alabi Ayodeji for his cooperation and level of understanding during our stay together, also to these people: Akintunde kayode, Akintunde Tolulope, Emmanuel Foluke, Abanji Isaac, Ukwuoma Pious, Otekalu Tolulope, Elijah Olakunle and host of others.

I will not but mention these people for their supports in all aspects of life, they include: Oluwole Mayokun, Awosika Timilehin, Ogunduyile Doyin, Olafeide Bridget, Oluwole Omotola, Solape, Victor, Ijilegan Adepeju, keye, Mrs. Oyewole Saidat, Adetokunbo Motiwa Evelyn, Owoseni carthy, Akindotuni Remi, Ayodeji Taye, R.S.K,Ogundipe Folake and Olanipekun Fatai.

Furthermore, my brothers and sisters played important roles toward the successful completion of my B. Eng. Degree, they are Fatai, Aanu, Biodun and Nike, thanks a lot.

Finally, I will like to appreciate the effort of my loving mother, who tried beyond expectation in molding my life to give a sound shape. God bless you, Mrs. Grace Raji.

I love you all and God bless.

Raji. B.K

ABSTRACT

It is known that the primary needs of man as regard communication with his immediate environment are of great importance; hence the work of design and construction of multi-user intercom telephone system came into being. The design and construction of a multi-user intercom is to provide the cheap and effective means of communication within a small location. It is achieved through the action of Relays at the exchange to achieve the aim of the design. When few buttons at the terminals are pressed the corresponding relays trip and conversation begins.

TABLE OF CONTENTS

CHAPTER ONE

1.0 INTRODUCTION

Communication can be defined as the process of sending, processing and receiving of signals, ideas and messages. In a world of constant production and competition, communication is vital to the biological survival of all living creatures. Recent studies, which have dealt with the range of animals' communication, have revealed that living creatures communicate by body movement, by making sounds to indicate danger or through speech making.

As man increased in wisdom and knowledge, his methods and needs of communication have also become more relevant and efficient. Effective communication is necessary, as it constitutes the backbone of social development.

1.1 THE INTERCOM IN COMMUNICATION

The intercom is a simple development utilizing telephone for the purpose of communication with people within a specific area. The design of an intercom is made to suit the need of the environment in which it is to be utilized with adequate considerations for future expansion.

The intercom can either be manually or automatically operated, the manually operated intercom requires the pressure of an operator at the master station to connect a caller to the point of call while the automatically operated intercom however, does not requires a master station or an operator to connect a caller to its point, as calls passed through the digital exchange with automatic operated switches. The rapid development of the communication in recent years has become one of the most interesting subjects of study in the world.

1.2 THE BELL'S MAGNETIC TELEPHONE

The bell's Magnetic Telephone comprises of three main parts namely: the transmitter, the receiver and a single connecting wire. The transmitter and the receiver, each contains a flexible metallic diaphragm and a horseshoe magnet with a wire coil. It generates the sound wire striking the diaphragm, which cause it to vibrate in the field of the magnet. The vibration generates electric current in the coil that varied in proportion to vibrations. There is a vibration in the strength of the receiving diaphragm that vibrates, thereby reproducing the original sound sent through the input devices.

1.3 LITERATURE REVIEW

The concept of communication between people came to existence by careful study of sound by Graham Bell, 1876. He developed a telephone using the same instrument as transmitter and a receiver. The experiment worked well as a receiver but less successful as a transmitter. Therefore, Thomas Alva Edison, 1877, used an improved transmitter, which exploited the properties of carbon transmitter. He discovered that as the contact area between the carbon granules was increased, there was a drop in the resistance of the circuit thereby leading to a momentary increase in current, which follows the corresponding changes in air pressure so that original sound can be effectively reproduced at the distant end.

In 1947, William Shelly, John Bardenen and Walter Brattain invented transistors. This enables the electronics revolution to emerge. In 1965, Charles Kuo came up with the theory that information could be carried using optical fibres, which enhance fast communications.

1.4 OBJECTIVE OF STUDY

The project was embarked upon so as to develop a cheap and efficient means of communication for our local establishments. Improvements were made on previous works carried out as manual connection between the caller and the called subscriber at the other end were improved by replacing it with an auto-exchange.

Also, more sophisticated designs were also analyzed and the excesses in then were expunged from this project. Past researches have been studied and improvement took place by replacing the LED at the hand set with tone generator circuits to alerts the called.

An intercom, which specifically suits the needs of a small establishment without being too expensive, is the focus of this project.

1.5 SCOPE OF STUDY

This project focuses on short distance transmission of information. The study of this project has been limited to only wire telephone transmission with a provision of three terminals. There is however the need effective communication in terms of using a wireless communication system.

1.6 PROJECT METHODOLOGY

This device operates when direct current is applied to the component parts. Basically, when one person lifts his handset and call the other, direct current (dc) flows through to the exchange without power conversion, then the tone generator circuit sounds at the terminal, the called picks up his handset, immediately the two relays of the caller and the called trip which allow communications between them.

1.7 JUSTIFICATION

Since, it is generally agreed that traveling over 500 meters to deliver just a simple message might be seen as an unnecessary waste of time, energy and risk involve in traveling. Simple communication system, cheap, affordable and easy to maintain will be a most welcome development.

The fact that it needs no master station to operate it eliminates the need for second operator. All these reasons have provide justification for which this project has been carried out.

CHAPTER TWO

2.0 THE TELEPHONE PRINCIPLE

The telephone system is made up of five major parts, which include: the transmitter, receiver, channel, exchange and cable. It also comprises of other peripheral parts such as alarms, switches and power source to power on the entire circuit. The mode of operation of a telephone system is based on the principle of electromagnetism being brought about through varying air pressure. Before a message can get to the receiving end from the source, the voice signal in form of a sound into a microphone, which will be converted into an electrical signal by the microphone, this electrical signal has to be converted back to a voice signal at the receiving end through the loudspeaker in the earpiece.

The block diagram of a modern communication system is shown below:

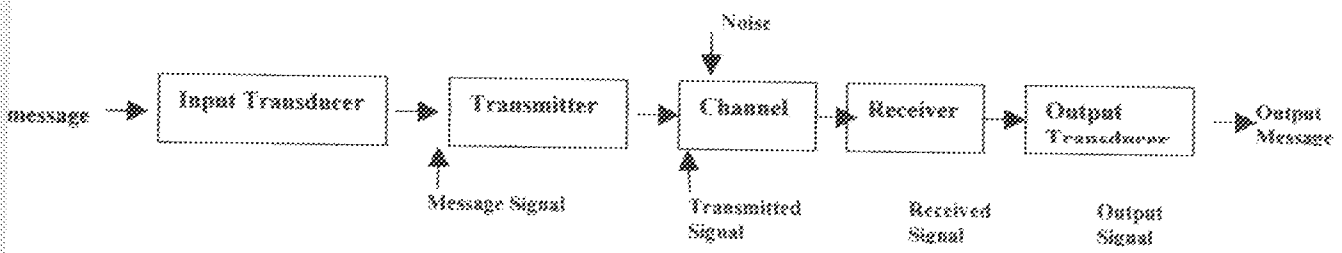


Fig. 2.0: Simple communication system.

INPUT TRANSDUCER

A transducer can be defined as a device that converts energy from one form into another. Here, the input transducer converts the sound waves in the frequency range of $300H_3$ to $3400H_3$ to electrical signal, which is sent through the wires to the transmitter. The typical input transducer device used in this project was the microphone.

2.2 TRANSMITTER

The transmitter does the function of coupling the message from the input transducer to the channel. Modulation is usually carried out at the transmitter, it is also capable of performing other functions as follows:- To reduce noise and interference, especially at low frequencies, for multiplexing, to overcome equipment limitations e.g. size, weight, for channel assignment, each message signal is transmitted at a unique frequency band to avoid mix-up with other signals.

2.3 CHANNEL

This forms the link between the transmitter and the receiver. There are different forms of channel, these include: underground or overhead cables, could also be wired or wireless channel.

The signal passing through the channels usually affected by degradation, which may be as a result of noise or interference, fading, therefore, the need for best available channel is of great importance in telecommunication technology.

2.4 RECEIVER

The receiver does the function of extracting and processing of the desired signal from various signals received at the output of the channel. The poor signals are amplified; received signal is also delayed to enhance matching with the message sent at the input. The receiver should be able to select well the desired signal and also reject well any unwanted signals, to increase its efficiency. The output transducer converts the received electrical signals from the receiver into the desired form by the user to enhance conformity with the message sent. The type of output transducer

used in this project is the loudspeaker. *(Adediran Y. A., 1977) Telecom Principles and Systems.*

2.5 OPERATIONAL AMPLIFIERS

Operational amplifiers are high gain input differential amplifiers. The name operational amplifier (op-amp) was derived from the fact that they can be used to perform mathematical operations such as addition, subtraction, differentiation, integration etc.

Op-amps were developed during World War II when they form the basis for analogue computers then used to solve very difficult differential equations involved in engineering design and the military strategies. All opamps are package in dual -in -line (DIL). A typical op-amp contains 24 transistors. The identification numbers associated with op-amps are: LM741, LM101, UA702, LM386 etc.

The standard circuit symbol for an op-amp is shown in fig 2.1 below:

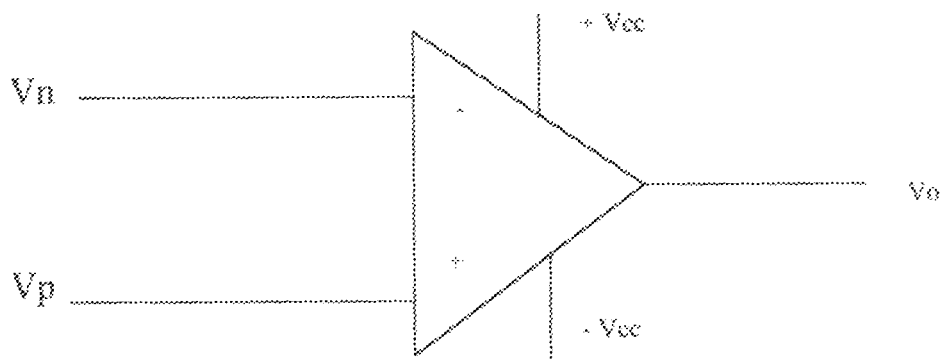


Fig 2.1 Operational Amplifier symbol.

The figure below shows the ideal operation of an amplifier;

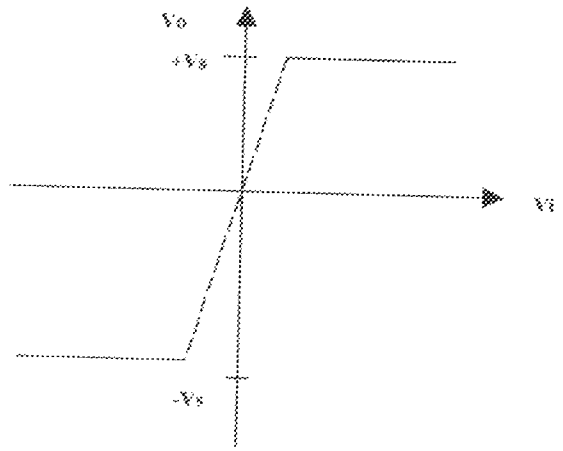


Fig. 2.2: Ideal transfer characteristics

From above diagram (fig 2.2), Vi represents the difference between the voltage available to the two inputs Vi+ and Vi-. If Vi is positive by small fraction, the output Vo is constant with positive value, which is having a magnitude slightly less than that of the voltage supply. Also, the negative values of Vi produce a constant output. To change Vo from one level to the other there must be a finite change in Vi, this is shown by the dotted line in the figure above. The characteristic equation that connects the three parameters Vo, Vi+ and Vi- is given as:

$$Vo = A (Vi+ - Vi-) \quad \ldots\ldots (1)$$

A, represent the gain of the amplifier, which is considerably large for amplifiers and infinite for ideal operational amplifiers. A, can be referred to as an open loop or gain without feedback of the amplifier. (Robert B.C.,1998 Electronics Principles and Applications).

2.5.1 INVERTING MODE OF AN AMPLIFIER

Inverting Mode of an Amplifier comprises of two resistors Ri (the input resistor) and Rf (the feedback resistor). The currents through the input and feedback resistors can be denoted by Ii and It respectively. For

the high input resistance of the amplifier, the current flowing through the inverting input is neglected, so:

$$Ii + It = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

From Ohm's law' i.e. I = V/R then,

$$\frac{Vi - V}{Ri} + \frac{Vo - V}{Rf} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Hence from equation (1);

$$Vo = -AV$$

Making V the subject of the relation, then

$$V = Vo/A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

By substituting for the value of V in equation (3);

$$\frac{Vi + \frac{Vo}{A}}{Ri} + \frac{Vo + \frac{Vo}{A}}{Rf} = 0 \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

When A is large, V tends to 0, and then the equation is

$$\frac{Vi}{Ri} + \frac{Vo}{Rf} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Making Vo the subject of the relation;

$$Vo = -\left(\frac{Rf}{Ri}\right) Vi \ldots\ldots\ldots \quad \ldots\ldots\ldots \quad \ldots\ldots(\; 7 \;)$$

This is the output voltage of the inverting operational amplifiers. The typical diagram is drawn below.

John C.C. Nelson 1995 Operational Amplifiers Circuits Analysis and Design

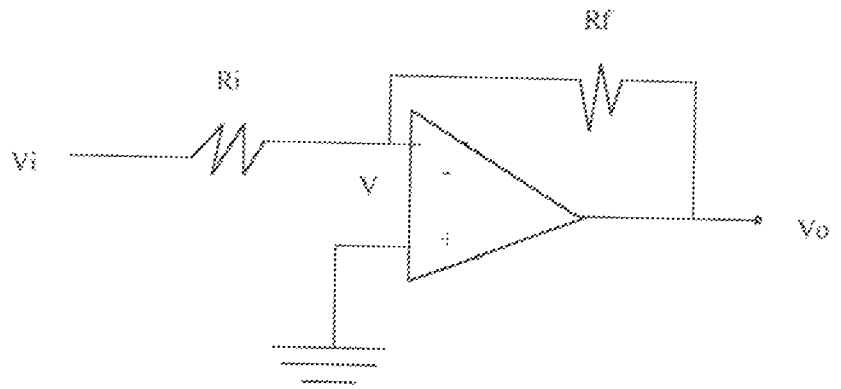


Fig. 2.3; inverting operational amplifier.

2.5.2 NON-INVERTING AMPLIFIER

In non-inverting amplifier, the signal is applied to the positive terminal while the circuit connection resistor Ri and Rf are still connected to the negative terminal, but only that the leg of the resistor Ri is connected to earth, this is shown in the figure 2.4 below:

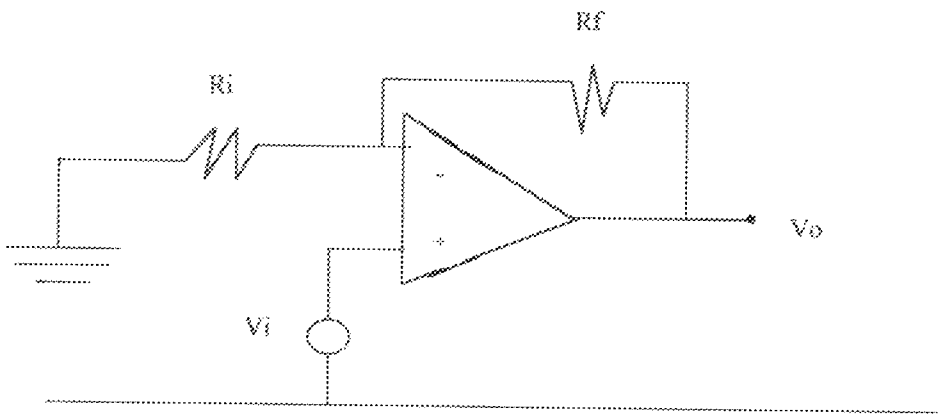


Fig. 2.4: Non-inverting operational amplifier.

In determining the output voltage, Vo of the non-inverting operational amplifier, the sign change associated with the inverting amplifier is definitely not required in non-inverting mode. Then the potential V- is thus:

$$V^- = \frac{(Ri)}{Ri + Rt} Vo \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

From equation (i).

$Vo = (vi^+ - vi^-) A$

Making $(vi^+ - vi -)$ the subject of the relation, then

$Vi^+ - vi^- = vo/A$ ……..(a)

But as the gain a tends to infinity, then

$Vi - vi = 0$

$Vi = vi$ ……..(10)

Substitute equation (10) in to equation (8);

$$Vi = \frac{(Ri)}{Ri+Rf} vo \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(11)$$

So, make vo the subject of the relations

$$Vo = \frac{(Ri+Rf)}{Ri} vi$$

$$Vo = \frac{(Ri + Rf)}{(Ri + Rf)} vi = (1 + \frac{Rf}{Ri}) vi \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

2.6 OSCILLATORS

An oscillator is an electronic circuit that produces a varying output signal from practically no input other than the DC source, an oscillator generates an AC Signal because of the frequencies involved. Oscillators are amplifiers having positive feedback.

2.6.1 CLASSIFICATION OF OSCILLATORS

- SINUSOIDAL OSCILLATORS: These generate sinusoidal waveform (or a close approximation to it)
- NON – SINUSOIDAL OSCILLATORS: The generated waveform is a non-sinusoidal. Such shape is square, saw-teeth rectangular, triangular etc. Multivibrators are responsible for such signals.

- OSCILLATORS GAS IONISATION: These are encountered in high power system, The basic requirement for oscillation in an oscillator is given by equation: BA $\leq$ 1. This is the Barkhausen criterion for oscillation.

Non sinusoidal oscillators are made use of in this project.

2.6.2 NON - SINUOSOIDAL OSCILLATOR

Multivibrators are basically oscillators whose output waveforms are non-sinusoidal. They can be realized using discrete components (transistor based) or via integrated circuits (ICS), using the 555 timer IC such as Operational Amplifiers.

2.6.3 THE 555 TIMER

This IC is so versatile that it has become an industry standard. It is given in schematic diagram below.

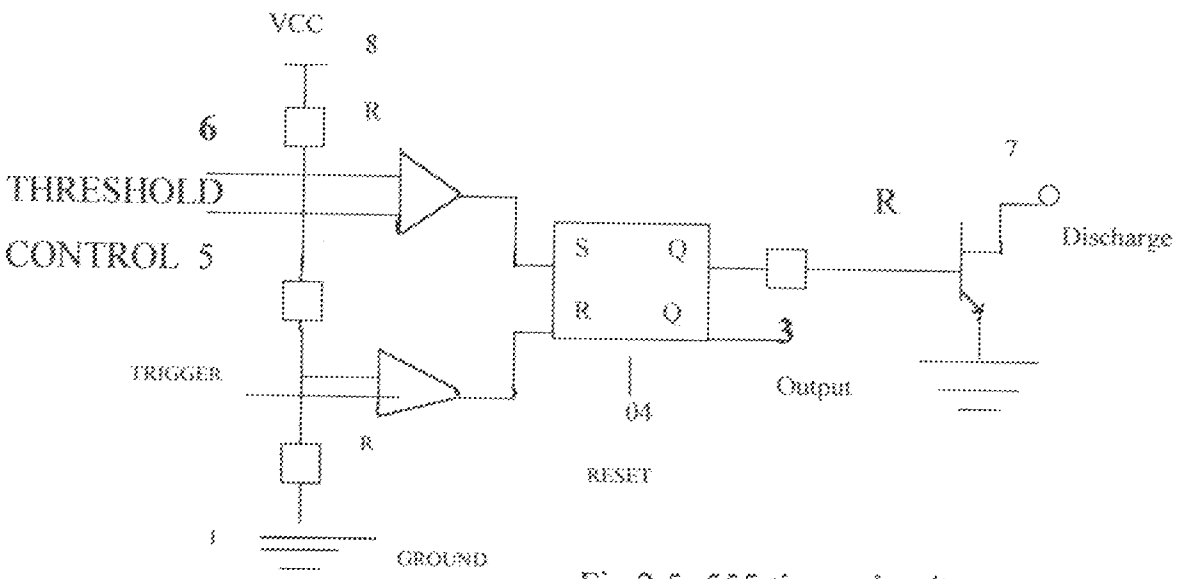


Fig 2.5: 555 timer circuit

The 555 timer IC will work with any supply voltage between 4.5V to 16v dc

Pin 1: Is the chip (IC) ground.

Pin 2: Is called the trigger, an inverting input to the lower comparator, which has a fixed voltage of +vcc/3. If the trigger-input voltage falls below 1/3 vcc, the operational amplifier goes high, causing the flip-flop to reset.

Pin 3: Is the output terminal, it is the complimentary or negated output from the

Flip-flop.

Pin 4: Is the external reset, if it is grounded, it prevents the entire IC from working. This feature can be used for on/off operation. In most applications, it is not used. So Pin 4 is often tied to the supply voltage.

Pin 5: Is the control pin. In most application, it is not used. The control voltage equals

$$+\frac{vcc}{3}$$

Pin 6: Is the threshold input, whenever the threshold voltage exceeds the control voltage the high output from the compararor would set the flop – flop.

Pin 7: Is connected to the collector of the discharge transistor. When connected to an external timing capacitor, a high Q from the flip-flop will saturate the transistor and so discharge the capacitor. When Q is low, the transistor opens and the capacitor can charge as previously discharged

Pin 8: Is the supply pin (between 4.5V to 16Vdc).

2.6.4 MONOSTABLE MULVIBRATORS.

This is stable in one condition or state. It is known as one – shot Multivibrators. Below in the schematic diagram of IC 555-monostable multivibrator.

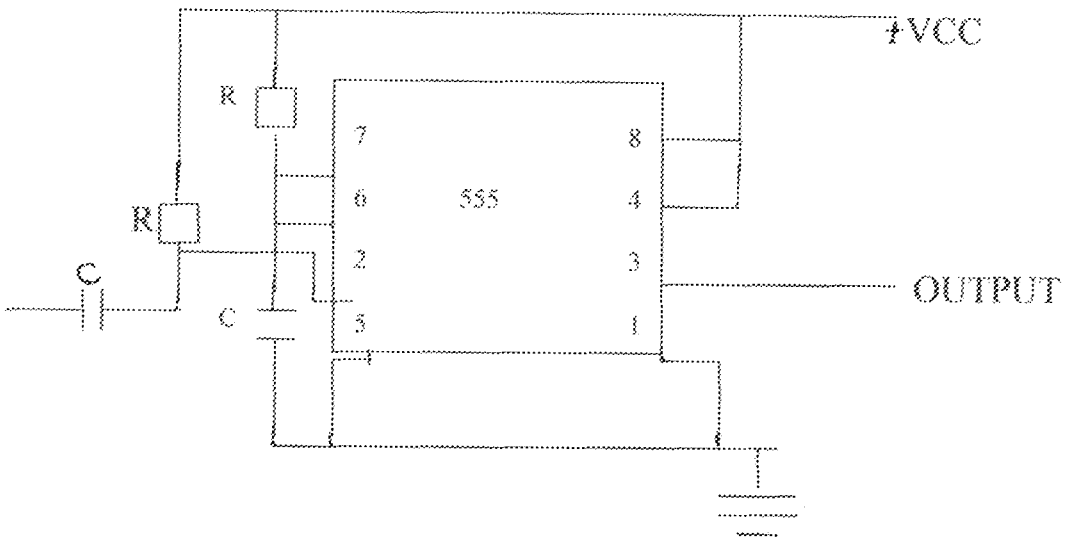


Fig 2.6 555 monostable Multivibrator.

Pulse width, W = 1.1RC

The monostable 555 operation produces a single pulse whose width is determined by the external R and C.

2.6.5. ASTABLE MULTIVIBRATORS

As an astable 555 timer – running Multivibrators because. It provide a continuos train of rectangular pulse.

The duty cycle defined by:

$$D = \frac{W}{T} \times 100\%$$

Depending on the value of resistors RA and RB, the duty cycle is between 50 and 100 percent.

Schematic diagram for the 555 Astable timer is shown below:

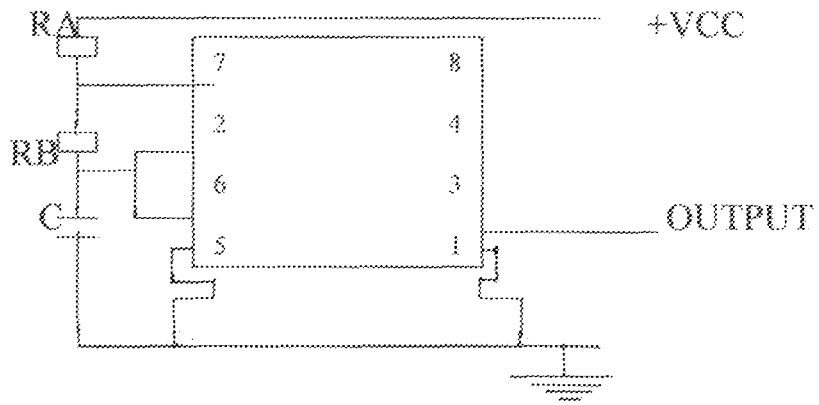


Fig 2.7: IC 555 based Astable Multivibrator

The output frequency is

$$F = \frac{1.44}{(RA+2RB)C}$$

and the duty cycle is,

$$D = \frac{RA + RB}{(RA + 2RB)} \times 100\%$$ *(Ahmed Et.Al1984 Analogue and digital Electronic for engineers)*

CHAPTER THREE

3.0 CIRCUIT DESIGN AND ANALYSIS

The aim of this project is to design a locally made cheap and portable intercom system for communication within a small area, privacy of conversation is guaranteed as the design is as simple as possible, the need for teleconferencing also available to enhance general discussion, it is easy on installation and promote expendability when necessary.

The system design layout of the project is to meet up with the specified aims are as follows:

Use of Hard wired system, implementation using a star confirmation in which the sets are connected to a common control unit, analogue and digital integrated circuits, maximum voltage of 12vdc, timer circuits for timing of call duration was 3 hrs, maximum current utilization of 250MA, operating temperature was

0C – 70^{0}C and output power of 10W

3.1 THE DESIGN MODE OF OPERATION

The system is basically divided into three stages namely,

- Selection Circuit: This is composed of 555-timer monostable multivibrator, handset with push – to stay switches, logic gates, the decoder and relays
- Decoding and Conditioning Circuit:- This composed of a 3-8 decoder that selects the signal from the handset when lifted up.
- Speech Part Circuit:- This is the combination of audio amplifier, bilateral switches and transducers (microphone and load speakers)

The three terminals of the project with each containing 555-timer, astable multivibrators, tone generators light emitting diodes, handset and push to stay switches.

Conversation can come up only between two terminals, unless its involves a teleconferencing where all the three terminals engage in a conversation. When the first caller to initiate a call is the terminal 1, he is capable of calling terminals 2 and 3. So when he lift up his handset H1, a high state is sent to a combinational logic circuit consisting of OR and AND gates and to the reset input of the terminal 2 and 3 of 555 timer monostable multivibrators, also a high input signal will be sent to the 3 – 8 decoder when he press switch 2 for instance, the signal then triggers the 555 timer astable multivibrators used as tone generator at terminal 2 to ring, output of the same astable multivibrator in also sent to a combinational logic circuit of an OR and AND gate which are connected to the relays RL1 AND RL2. However when handset H2 lifted up to receive a call, the 3-1 decoder then decodes the code which can be either 011, 101, 110,111. And it's corresponding decimal output line goes high and finally the relay RL1 and RL2 are triggered on so, the communication is enhanced between the terminals 1 and 2. The route of the communication is through the microphone of the handset H1 to the audio amplifier, to the bilateral switch and finally back to the audio amplifier with the load speaker of handset H2. The output of the other monostable multivibrators are tied to a NOR gate and connected as a feedback to the first and gate to avoid interruption while communication has been established. A one short monostbale multivibrator is used at the terminal to reset the decoder for one second to avoid residual calls.

3.2 DECODER CIRCUIT

Code conversation process is carried out by the decoder, it fetches the binary numbers from the output of the terminal handsets and decode it to corresponding decimal equivalent where only one output is high at a time. The CD 4028 3-8 decoder used in the design of this project has a truth table below.

H3	H2	HI	0	1	2	3	4	5	6	7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Fig 3.0: Truth table of a CD4028 3-8 Decoder.

3.3 IMPLIMETATION OF THE SWITCHING USING THE DECODER TRUTH TABLE

For 3-8 decoder to operate, the input to the decoder must at least be 2 high inputs which can be 011, 101, 110 or 111. So, when a caller at terminal 1 lifts up handset Hi to call a terminal 2 by simple pressing the switch S2, the tone generator circuit of terminal 2 begin to ring and immediately the called pick up his handset H2, a binary code 011 in sent to the input address of the decoder, then causes the decimal equivalent 3 to 50 high. The output pin 3 is connected to both relays RL1 and RL2 Via NOR and AND gates to avoid interference and to enhance conversation between the two relays. The truth table for both NOR and AND gates are illustrated below.

A	B	C	A+B+C	$\overline{A+B+C}$	ABC
0	0	0	0	1	0
0	0	1	1	0	0

0	1	0	1	0	0
0	1	1	1	0	0
1	0	0	1	0	0
1	0	1	1	0	0
1	1	0	1	0	0
1	1	1	1	0	1

Table 3.1. Truth table of NOR and AND gates.

3-4 THE SELECTION CIRCUIT

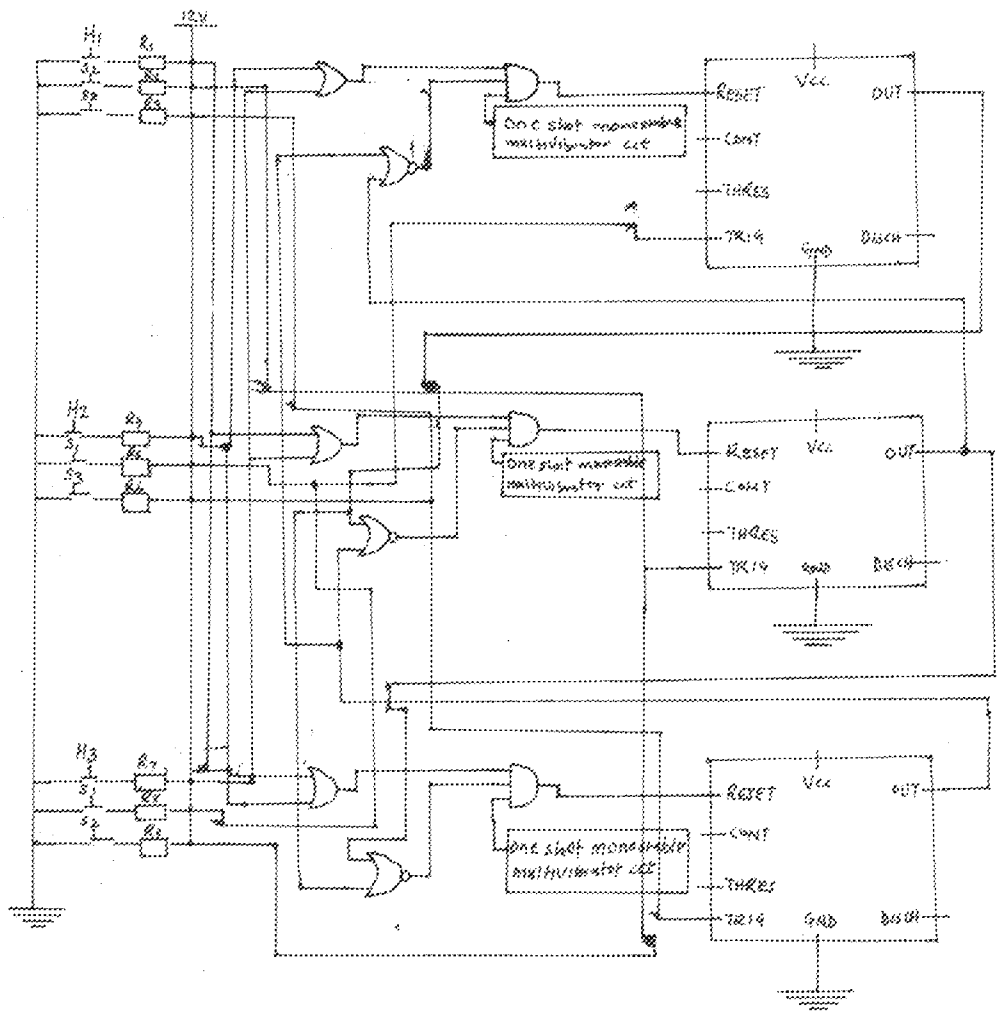


Fig 3.0: Selection circuit diagram.

3.41 ONE SHOT MONOSTABLE MULTIVIBRATOR CIRCUIT

The introduction of this circuit enhances the terminals, to be reset for 1 second so that only fresh calls are established whenever there is ringing.

The calculation for the duration of reset used was T=RC where R and C are resistor and capacitors respectively.

To obtain 1 second then R = 10MΩ, C = 100NF

Hence, T = RC

$= 10 \times 10^{6} \times 100 \times 10^{-9}$

= 1 second.

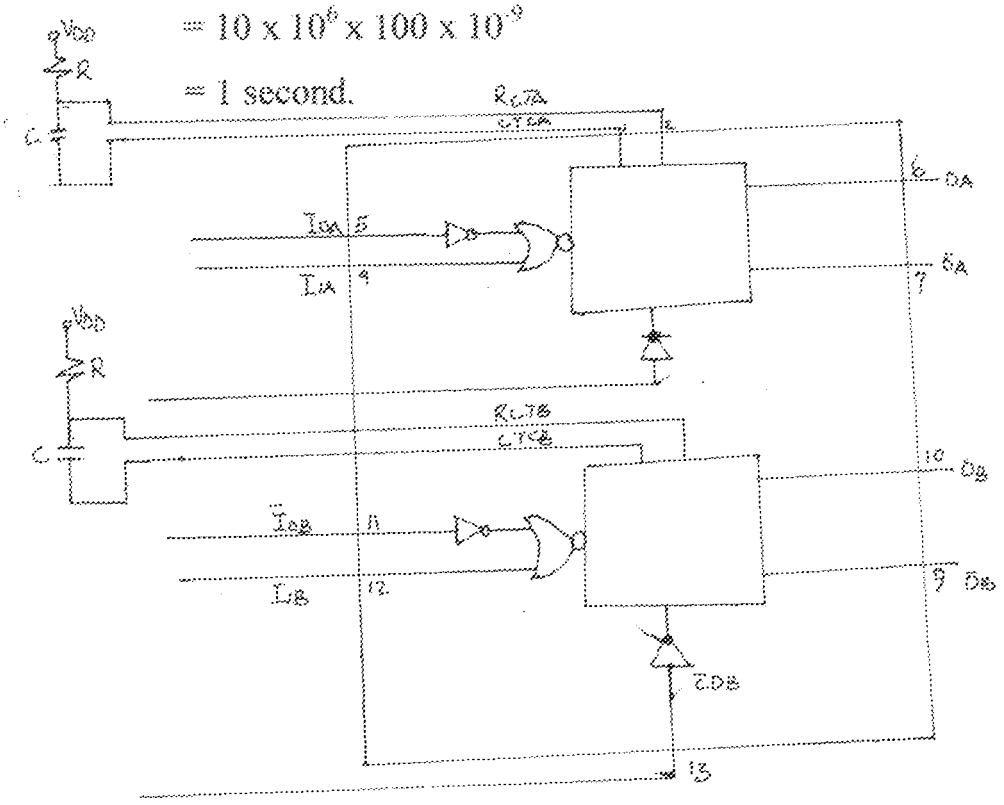


Fig 3.1: Connection of external terming components.

3.42 THE CALL PERIOD TIMER

The configuration of 555 timer monostable multivibrator gives the calling period of approximately 3 hrs. The connection is shown below:

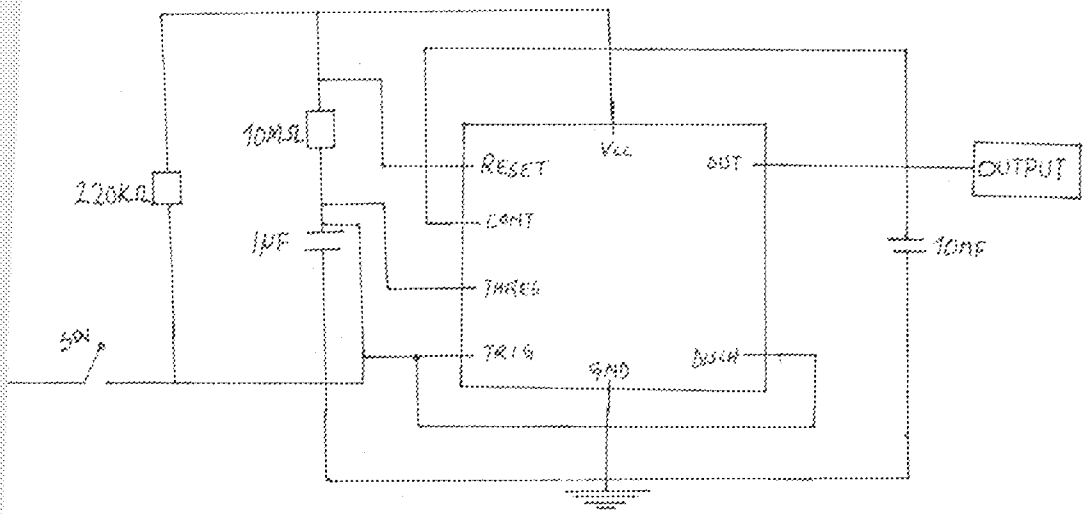


Fig 3.2 Call period timer circuit.

The determination of the pulse duration is by using the value of R = 10ML and C = 100UF to monostable multivibrators period equation, T = 1.1RC

$T = 1.1 \times 10 \text{ X } 10^{6} \times 100 \times 10^{-6} = 11000$ seconds

$T = \frac{11000}{360} = 3.056 \approx 3$ hrs.

3.4 THE SPEECH PATHCIRCUIT

The handset, the operational amplifier LM386, the Quad Bilateral switch CD4016A makes up the speech path circuit. The terminal is separated from each other by the relays, which usually remain open. The lifting of handset and the pressing of switches enable the decoder to convert the equivalent binary form to a decimal equivalent which will ensure communication between two relays. When the two relays are on, conversations begin through the mouthpiece and the earpiece of handset involved. LM386 operational amplifier was used to amplify the signals from bilateral switches so that loud and clear message can be received.

Below is the diagram illustrating the speech parts circuit of the design.

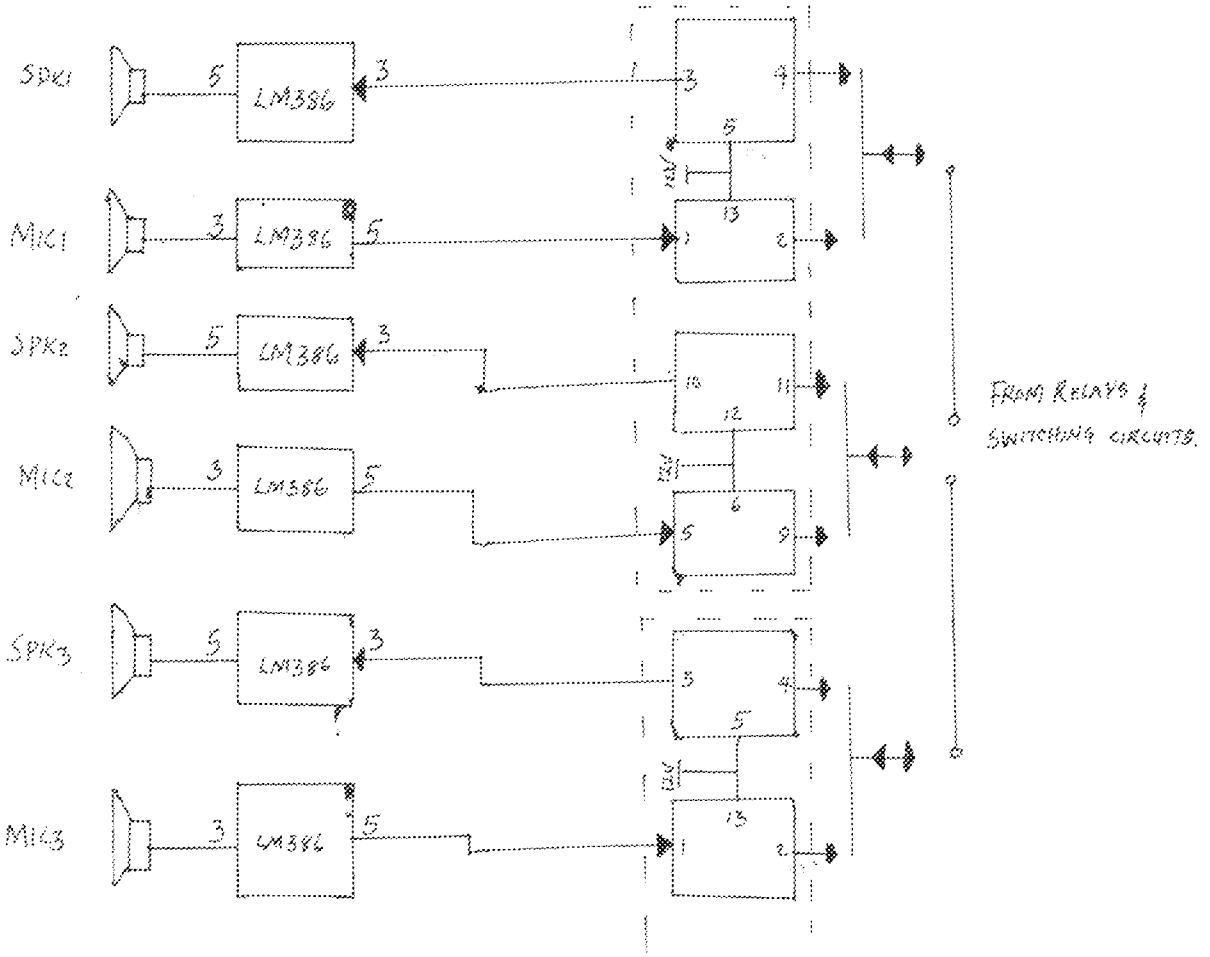


Fig 3.3: Speech Path Circuit

3.5 THE POWER SUPPLY UNIT

The power supply unit comprises of the 240VAC supply from mains being connected to a 240V/12V step down transformer. Bridge rectifiers are available to enhance rectification of the AC Voltage to DC Voltage, follow by filtering capacitor to a LM 7812 Voltage regulator to maintain 12VDC at output. A 5MA anti surge fuse in the transformer primary wandering provide protection for the circuit.

The diagram of the power supply unit is illustrated below:

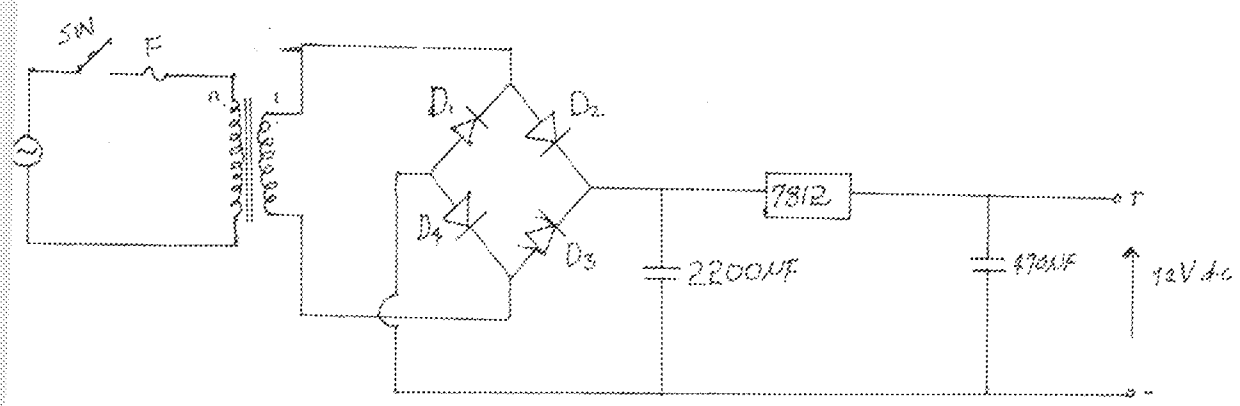


Fig 3.4: Power Supply Circuit

3.7 TONE GENERATOR CIRCUIT

555 Astable multivibrator was used to generate tone for the design. Astable multivibrator is a free running multivibrator. The frequency of operation was about 1.53HZ, This was achieved by using the formula for frequency in astable multivibrator, that is, frequency is 1.44/(R1+2R2) C where R1 = 220Ω, R2 = 470kZ and C = IUF. The output of the tone generator circuit is connecting to 80hm speaker.

To calculate the frequency now,

Frequency = $\frac{1.44}{(R1+2R2)\ C}$

$= \frac{1.44}{(220+2x470x10^{3})\ XW10^{-6}}$

$= 1.44$

$(220 + 940 \times 10^{3}) \times 1x\ 10^{-6}$

$= 1.53HZ$

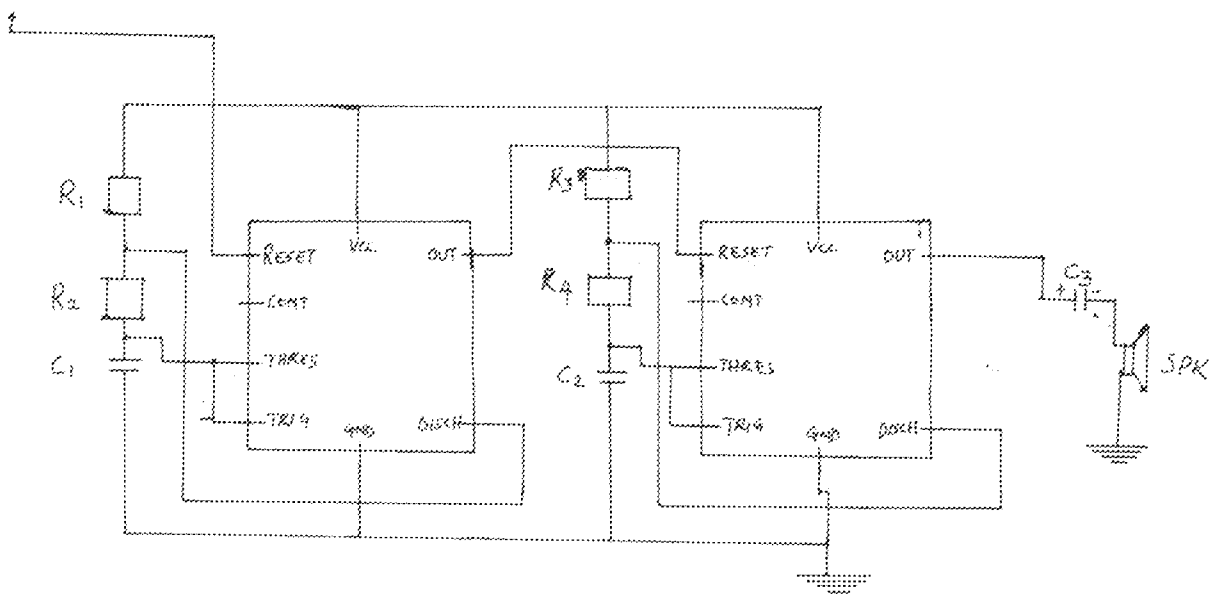
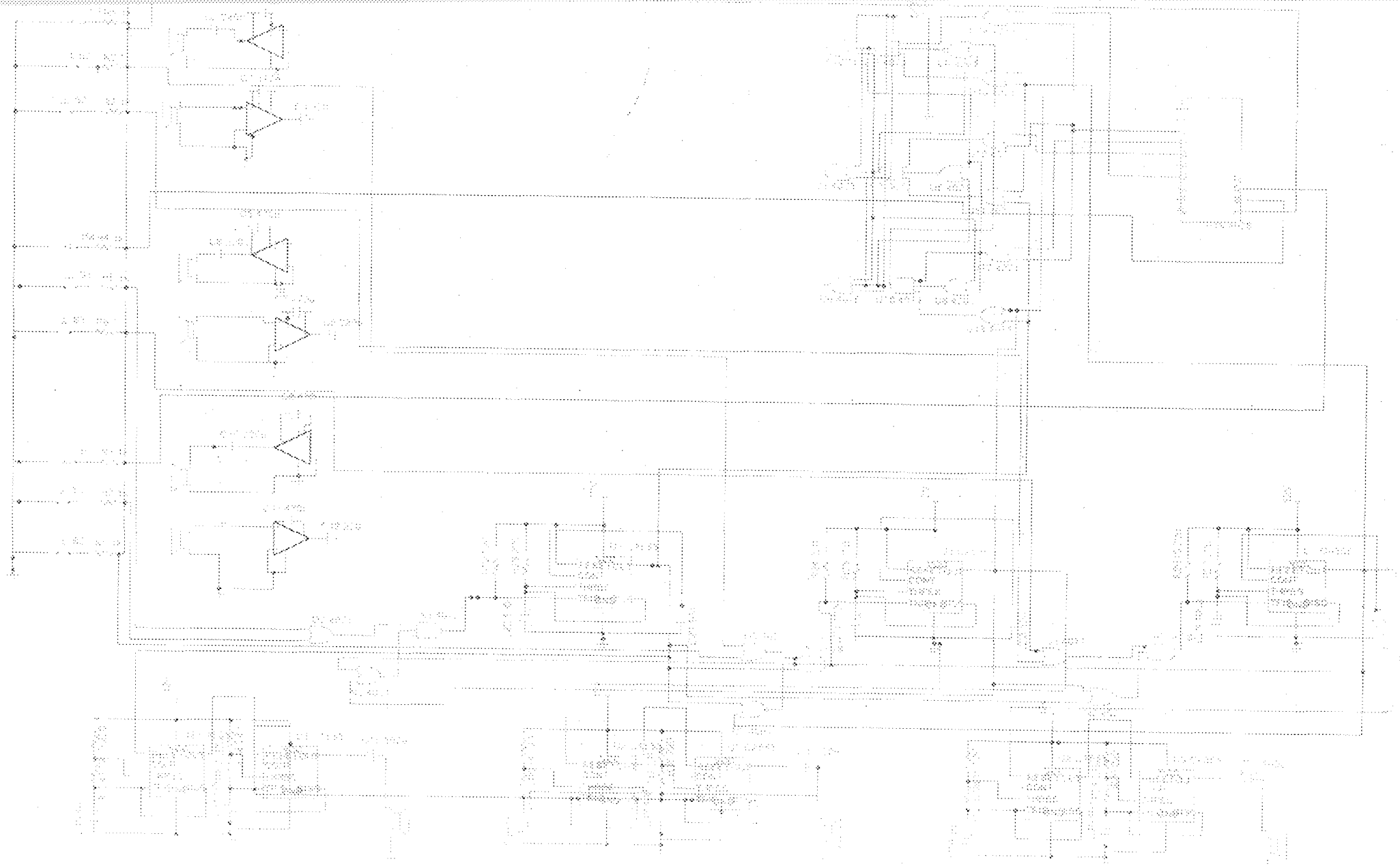


Fig 3.5: Tone Generator circuit



COMPLETE CIRCUIT DIAGRAM

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.0 CONSTRUCTION OF AMPLIFIER CIRCUIT

The design of the various circuits comprising the intercom system was tested using the specified components, and testing them on a breadboard, to ensure the workability of the design. When the system was certified to be working effectively, the component were then permanently fixed by soldering on a veroboard.

The component were fixed to the veroboard by placing each pin of the component in a separate hole, and then the pin will be soldered into the circuit via the use of the component socket. Soldering the component's sockets were done with great care to prevent the damage to the components. The tip of the soldering lead was used. The temperature of the solder was regulated to stall over heating and soldering techniques were applied.

4.1 CONSTRUCTION OF THE CASING

The choice of material used for the project was wood because of its lightweight and relative cheapness. The concept of conventional telephone casing was considered for the design of the project casing. The dimension of the casing was done with respect to size of the components and veroboard used. The casing was first designed on paper and modifications were made before the actual construction was made to ensure that the finished work was conformed to specifications.

The various components comprising the whole intercom system were puts together by fixing them in their appropriate places on the constructed wooden casing. The circuit board was screwed to hold it with the casing, these was done to enhance firm and neat work.

4.2 TESTING

Before any construction work of the system, each sub part of the device was simulated in electronic workbench software to know the workability of the parts.

Each subsystem was tested and the results are as follows:

- The bilateral switches were tested and coupled to ensure that they were able to switch voices when addressed.
- The switching circuits were tested on the breadboard.
- The signal and selection circuits were also tested.
- The amplifier circuits were tested to enhance high efficiency.
- The power supply units and tone generator were coupled and also tested.

After the general coupled of the different subsystems together, the device was tested and fully satisfied the specifications.

The following results were obtained.

SUBSYSTEM	PARAMETER TESTED	TEST EQUIPMENT	RESULTS
Tone generator	Output frequency	Electronic work bench simulation	1.53HZ
Amplifier circuit	Noise	12VDC supply and voice input signal	Satisfactory
Selection circuit	Pulse period	Electronic work bench simulation	3 hrs
Computer system	Range	Communication cable	Undetermined due to availability of lengthy cables
Power supply unit	Workability	Multimeter	Satisfactory

Table 4:1 Tests and result obtained.

4.3 PROBLEMS ENCOUNTERED

The problem encountered was radio interference but this was solved by making adjustments to the value of the resistors used to set gain at the pre-amplification stage. A lot of noise was received at the output of the circuit, due to the very high gain of the amplifier, then 47UF, 12V capacitor was used which reduced the effect of noise.

4.4 PRECAUTIONS:

A number of precautions were observed in the design and construction of this project. This was done to ensure the system worked efficiently. Some of the precautions include:

- Proper soldering techniques were applied, stray solders were carefully removed to avoid short-circuits and bridging.
- The values of circuit components were ensure to be very close to their calculated values.
- The vero board was cleaned to avoid any dust particle that could cause short circuits.
- Proper identification of components and their parts with values were made, from the time of purchase to the time of circuit constructions.
- All components were tested before soldering took place.

4.5 TELECONFERENCING

As mentioned earlier, there is a provision for teleconferencing facility in this project, only the master station can ignite the teleconference by pressing the teleconferencing switch which enhances the ringing of the entire three terminals along with the LED lights up.

Therefore, conversations among the terminals are achieved.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 CONCLUSION

The design and construction of a multi-user intercom telephone system as carried out in this project exercise has provided adequate information on the operation of the system.

After carrying out this work, I now understand better than ever before on the importance of telecommunication in the technological, social and economic development of our society. I was able to know the working principles and applications of general intercom systems.

5.1 LIMITATIONS:

Based on the scope of this project, it will improve the workability and efficiency of the system if the following measure are observed, these include:

i. The gain of the Amplifier circuit, LM386 was very low thus causing low amplification at the output, but by connecting a bypass capacitor across pin 1 and pin 8, the gain increased considerably.

ii. Another factor is the monetary aspect, as the most desired features of this project were slightly realized because of the financial constraints. The use of multiplexer switches are cascading must have been used instead of only one utilized.

iii. Longer cables enhance longer distance coverage since it is a wired intercom telephone system.

iv. The microprocessor-based system enhances multi access link in the system.

5.2 RECOMMENDATIONS

I will suggest that people who like to lay hand on this type of project as presented in this project should improve the work later. The areas where improvement could be done are as follows:

- The analogue exchange should replace by digital exchange unit.
- More sophisticated ICS should be used to promote efficiency.

This project is however recommended for use.

REFERENCES

Adediran Y.A (1997) Telecommunication principles and systems1st edition, Finom publishers, Minna, Nigeria.

Smith J.R.G (1997) Elementary Telecommunication practice.

Ahmed H. et al (1984) Analogue and digital electronics for engineers, Cambridge University press, England

Robert B.C (1998) Electronics principles and Applications.

Smale P.H (1992) Telecommunications system 2nd Edition, pitman publishing Limited, London, England.

John E.C Nelson (1995) Operational Amplifier circuit analysis and design

Brierlay H.G (1986) telecommunication Engineering Edward Arnold publishers' ltd. London, England.