DESIGN AND CONSTRUCTION OF A

TWO-WAY INTERCOM TELEPHONE SYSTEM

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Project submitted in partial fulfilment of the requirement for the award of the bachelor of Engineering {B.Eng.} degree in the department of Electrical and Computer Engineering, Federal University of Technology, Minna.

CERTIFICATION

This is to certify that this project was done by Baba Solomon (95/4627), of the department of electrical and computer engineering under the supervision of Mr. Paul O Attah, and has been prepared in accordance with the specifications governing the presentation of a B. Eng. degree in Electrical and computer Engineering, Federal University of Technology, Minna.

SUPERVISOR
MR. P.O ATTAH

DATE

H.O.D OF DEPARTMENT
DR Y.A ADEDIRAN

DATE

EXTERNAL EXAMINER

DATE

DEDICATION

To Jesus Christ the greatest influence upon me who has made living meaningful and rewarding

And

My Uncle and his wife Prof.& Mrs. J.M. Baba, thank you for co-orperationg with the purpose of God for my life. I love you dearly.

DECLARATION

I do hereby declare that this project work was wholly presented by me. Under the close supervision of Engr. P.O Attah during 1999/2000 academic session, and to the best of my knowledge it has never been presented elsewhere before .

BABA SOLOMON

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DATE

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I give God the glory for his steadfast love and support for me through all my happy and trying moments. My sincere appreciation goes to my supervisor Engr P. O. ATTAH for his assistance, patience and understanding and also for his sound advice leading to the completion of this project, and to my H.O.D, Engr. (Dr} Y.A Adediran for his concern and guidance in our academic work, and to my lecturers in the department, thank you all for your efforts.

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Finally special thanks goes to my late parents Mr. & Mrs. A. Phillip, though the times we spent together was short but the memories will forever linger in my heart.

ABSTRACT

The development of Telecommunication has reached or attained a climax with new methods that are effective and intelligent, however, the primary needs of a man as regards communication to communication with his immediate environment are of paramount importance.

The two-way intercommunication system has been developed with the purpose of providing a cheap but yet efficient means of communication in a relatively small society or establishment.

The system make use of NA741, LM386 amplifier which is primarily responsible for the amplification of the sent signal" acoustic signal". At the exchange, it also uses 4555B decoder, which activates one output at a time depending on the binary input. 4027B fllp flops (JK), 4081B AND gate, 4071B OR gate were all used at the exchange to realise the objective of the project.

The linking of the channels has been achieved with the use of button switches Via exchange automatically based on the various logic states of the truth table gotten from the state diagram which was reduced barely with the use of the common Min terms which gave high flexibility and fastness in the communication path.

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CHAPTER ONE

INTRODUCTION

Communication is the sending, processing and reception of signal using electrical means. The Information to be sent takes the form either of a written message, voice message or an electrical signal etc. A Communication system can be defined as a system of sending, transmitting, processing and receiving signals. The means of communication can be in the form of a radio link, optical fibre, and satellite and telephone network.

Telecommunication is therefore the transfer of information from one point to a distant one. It is the key ingredients of modern civilization. The prefix "Tele" is from the Ancient Greek word meaning "far".

It is therefore difficult to image what modern living would be like without ready access to reliable, economical and efficient means of communication. Therefore in the world of constant competition, communication expressiveness is vital to the biological survival of all living creatures. Recent studies about animal communication revealed that these creatures communicate by body movement or by making sound to indicate danger.

Sequel to the aforementioned, communication specialist all over the world are working towards developing systems and methods to handle the ever – increasing volume of information in the different spheres of our social lives. For example, scientist recently experimenting with fibre optics for use in communication systems have succeeded in transmitting 4 billion "bits" of information per second over a distance of 73 miles) that is 4 billion bits is equivalent of all information stored in the Encyclopedia Britannica. Isn't that incredible?

Everyone today is talking about the convergence of information and communication technology. What does this really mean? This basically means the growing tendency for both the information and communication technology to have a single identity element for example before a distinction used to be made between voice networks and data networks like the information super high- way (Internet) that can

Transmit voice, and voice networks that can transmit data. And in the future there will be just one network for all applications, regardless of whether voice, data or sound is being transmitted. In view of the advancing convergence of technology in the area of information and communication, a distinction no longer makes sense.

Therefore, communication is not just concerned with technology but it is primarily concerned with people and in the best analysis, any communication administration must be judged not by its equipment, but by how well it meets the need and aspirations of the people it serves. A feel of the advancement in the communication world can be felt when you make a call to a friend who is overseas, and the response sounds like he or she is next door thereby reducing the need for distant journeys, which involve high risk and cost.

But in the technological field, the continual research by communication engineers have been able to so far provide for the communication needs of our world with the use of optical fibres, coaxial- cables, power line carrier communication (PLCC), radio link and satellite transmission thereby actualizing the concept of the world as a global village.

1.1 BELL'S MAGNETIC TELEPHONE

The basic unit of bell's invention consisted of a transmitter, a receiver and a single wire. The transmitter and receiver were alike, each containing a flexible metallic (aluminum like) diaphragm and a horseshoe magnet with a wire coil. Sound waves striking the diaphragm caused it to vibrate in the field of the magnet. This vibration generated an electric current in the coil that varied in proportion with vibrations of the diaphragm. The current traveled through the wire to the receiving station where changes in the strength of the magnetic field were provided. This variation in magnetic field strength caused the receiving diaphragm to vibrate which reproduces the original sound.

1.2INTERNAL COMMUNICATION.

An intercom is a device, which allows normal conversation between people in a miniatursed environment, say of about five hundred meters. The intercom is a cheap and effective means of communicating within an office block, an organization or a parastatal. The design of the intercom system is made to suit the specific needs of the

environment in which it is to be utilized with adequate consideration for future expansion. It therefore plays the role of being the most efficient as well as the cheapest mode of internal communication, within an organization with it's name derived from the role it plays as a good means of internal communication.

However, with the rapid development of telecommunication in recent years, it has become one of the most interesting subject of study in the world. The simple design and implementation of the intercom makes it desirable and effective. It has the same operating principles as the telephone network system, the distinguishing factor being the type of transmitter employed in intercoms.

The intercom can either be manually or automatically operated. The manually operated intercom requires the presence of an operator at the master station to connect a caller to its port of call. However, the automatically operated one does not need a master station nor an operator to connect a caller to its port, as calls are passed through the digital exchange with automatic operated switches.

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 (the speaking part of the telephone) and a receiver (the listening part). But as a receiver, the experiment worked well for him but as a transmitter, it was less successful.

However, an improved transmitter, which exploited the properties of carbon transmitter, was used (Thomas Alva Edison, 1877). 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 intricate changes in air pressure so that original sound can be effectively reproduced at the distant end.

1.3.1 CATEGORIZATION OF TELEPHONE SYSTEM

Telephone system may be categorized by the nature of transmission used

(Ferral. G. Strember, 1952.)

1. SIMPLEX SYSTEM: - the system allows transmission in one direction at a time. . It provides communication in either direction alternatively in instances where transmission is unidirectional.

Figure 1.31 illustrates the simplex communication system.

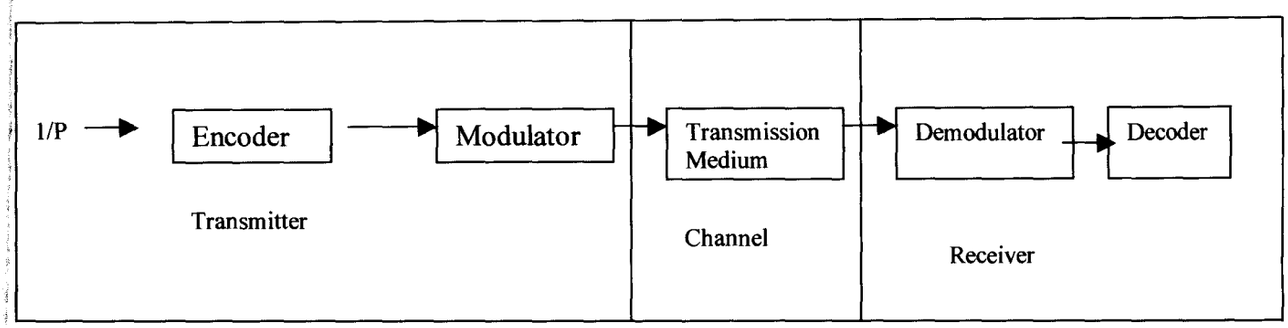

FIG.1.31 SIMPLEX COMM. SYSTEM

2. DUPLEX: - This allows simultaneous transmission in both directions – this is normally accomplished by using two separate circuits. One circuit for each direction although it is not economical because of duplication of facilities.

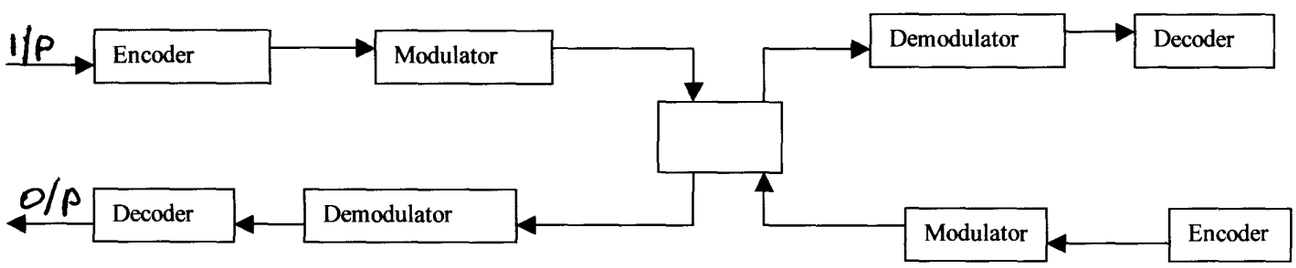

FIG. 1.312 DUPLEX COMM. SYSTEM

1.3.2 BASIC TELEPHONE SYSTEM

A simple two points telephone circuit uses a single pair of wires (or one wire with ground return) and two telephone sets of self-contained type. Each set is self-contained and does not use any control office equipment. This arrangement is illustrated in

1.4 OBJECTIVE OF STUDY

This study was carried out in order to develop a cheap, affordable and efficient means of communication for our local industries /organizations. Past works were studied and their defects such as manual connection between the caller and the called subscriber at the master station were corrected by replacing it with a digital exchange. Ringing tone circuit was also incorporated, as a replacement for the light emitting diode, which was used as an indicator when one, calls in similar past works.

1.5 SCOPE OF STUDY

This project focuses on transmission of information messages within a short distance. The study carried out in this project was limited to wired telephone transmission with a provision for 2- channel system, which will automatically operate, from one caller to the other.

There is therefore a need to cater for a greater communication in which wireless communication system will be more desirable. But the scope of this project specifies the design and construction of automatically operated 2 CHANNEL intercom telephone systems.

1.6 PROJECT METHODOLOGY

This device operates with direct current when the line is not locked on. Basically, when one person lift his handset and call the other, direct current flows through to the exchange with no power conversion and operate the combinational logic circuit of the bell of the called subscriber. As the called subscriber picks his handset, circuit current automatically seizes with A.C flowing through the Amplifiers due to the establishment of communication link between the two.

1.7 JUSTIFICATION

As it is considered a gross waste of time and resources to travel long distances just to deliver a simple but maybe significant message, it will also be a waste of time and resources to continually move from one section of an establishment to the other to deliver messages and information. A simple communication system, cheap, affordable and easy

to maintain, that adequately caters for the needs of a small establishment (especially) with a stringent budget will be needed in most growing organizations. An organization must maintain a high efficiency level and also try to keep over – head cost to a minimum so that this simple project can come in profitably.

The fact that it needs no master station to operate it eliminates the need for second operator. The design of an efficient system, which is affordable to most because it is inexpensive, will sufficiently cater for a small organization's needs, and which is also expandable provides the justification for this project.

CHAPTER TWO

THE TELEPHONE PRINCIPLE

Basically, the telephone comprises of transmitter, receiver and other several components such as gravity switches, the buzzer "alarm" induction coil, alternating current a.c source and the direct current source. The principles that govern the concept of the telephone are those of sound (varying air pressure) electricity and magnetism.

When a person speaks, sound is produced by puff of air from the vocal chord of the mouth. The changes in air pressure are caused by puffs due to vibration. However, for proper transmission of such messages through a long distance, modern communication systems were developed through research.

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

INPUTMESSAGE——▶ I/PTRANSDUCER▶TRANSMITTER —▶CHANNEL —▶ RECEIVER——▶O/P TRANSDUCER▶O/P MESSAGE.

2.10 INPUT TRANSDULER

A transducer is a device that converts energy from one form in to electrical energy

The input message, being in the form of sound waves in the frequency range of 0.3KHZ-3.4 KHZ is sent in to the transducer by means of acoustic signal from a person. The carbon microphone, which serves as input transducer here converts the intermediate waves to voltage variation, which is sent through the intermediate wires to the transmitter.

2.1.1 TRANSMITTER

The telephone – transmitter contains tiny particles of carbon the size of grains called carbon granules. They are closely held in small compartment between a piece of carbon which is cup-shaped and another piece which is dome-shaped with the aid of moving front electrode, which moves only when the diaphragm converges as a result of changes in air pressure, the carbon granules compresses thereby increasing their contact area which causes the resistance of the circuit to reduce thereby giving rise to a high flow of current. The carbon transmitter is carefully designed to ensure that the current follows

the intricate changes in air pressure so that original sound can be faithfully reproduced at the distant end. However, it is necessary that sound waves are passed through the transmitter for the following reasons.

(1) To reduce interference especially at low frequency

(2) To overcome equipment limitations e.g. weight and size

(3) For channel assignment i.e. each message signal is transmitted at a unique frequency band to avoid mix –up with other frequencies.

(4) For multiplexing.

2.1.2 THE CHANNEL

Channel is the medium through which the transmitted signal gets into the receiver. It may have many different forms ranging from the ground, underground or overhead cables, to sky and space. The transmitter can be either wireless (non wired) or non wireless (hard wired) to the receiver. A common characteristic of all channels is that the signal passing through them undergoes degradation which may result from noise or interferences, fading etc. because of it's peculiar adverse effect on the quality of the received signal, noise and their sources in communication systems are a separate topic which calls for more attention that is beyond the scope of this project.

2.1.3 RECEIVER

The receiver in a communication system extracts and processes the desired signal from the various signals received at the output of the channel. The desired signal is converted into a suitable form for the output transducer stage. This includes amplification of the reduced signal if the signal level is low (voltage or power). Demodulation occur at the receiver and a good characteristic of a good receiver is its ability to select the desired signal and reject any unwanted signal.

2.1.4 OUTPUT TRANSDUCER

This is a device that converts the electrical output signal of the receiver into the form desired by the user. For example, a loud speaker convert electrical signal to sound waves for the listener to hear, the cathode ray tube (CRT), meters and oscilloscopes are also examples of output transducer.

2.2 OPERATIONAL AMPLIFIER

The term "operational" refers to the fact that the amplifier can be used to perform mathematical operations, for example, additions (adding two voltages) subtraction, multiplication and division, integration and differentiation. The operational amplifier can be configured to perform the various operations by appropriate external circuitry (circuitry that is not part of the amplifier itself). This flexibility makes operational amplifiers very versatile and extremely useful. It is used in most control systems and is an essential component of analog computer (computer that perform mathematical operations using analog input signals).

It is the basic building block of electronic systems. The components consisting an amplifier have changed over the years base on the new technology but it is important to know how one amplifier will load another when they are connected together in series that is cascaded together.

Usually, the voltage amplification or power gain frequency response obtained with a single stage amplifier is not sufficient to meet the needs of a load device. Hence, two or more single stages of amplification are used to achieve greater voltage or current amplification. The output of one-stage serves as the input of the next stage as depicted in figure 2.2 below.

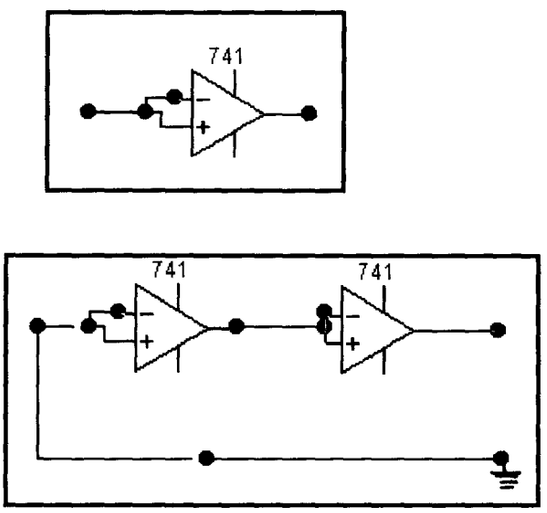

FIG.2.2 OPERATIONAL AMPLIFIER

From fig 2.2 the input R_1 is related to the output R_0 by a constant. The stage is said to have gain A (open loop gain) which is given by

$A = \frac{\text{amplifier output resistance}}{\text{Amplifier input resistance}} = R_0/R_i$

As the input increases, there will come a time when R_0 can not rise anymore due to limitations of the supply. Thus every amplifier will become non-linear for very large output demands.

2.2.1 THE INVERTING AMPLIFIER {PRE – AMPLIFIER STAGE}

This type of amplifier has the input signal into the negative (-) terminal with the positive terminal connected to the common rail or ground

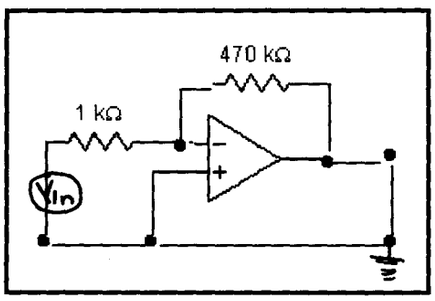

FIG.2.2.1 INVERTING AMPLIFIER

GAIN OF THE INVERTING AMPLIFIER

There are two gains in inverting amplifier

a. The open loop gain, which is got from manufacturer's specification.

(A) and usually in thousands.

b. The closed loop gain, which is got, from amplifier's calculation and it is usually very small so as to give high bandwidth with lesser distortion.

$V_f = \beta V_o$ ---- ---- (1)

$V_{in} = V_f + V_1$ --- -----(2)

Let β = fraction of output fed back to the input

Put (1) in (2)

$V_{in} = V_1 + \beta V_o$ ----- (3)

But from open loop,

-- V_{in} A = V_o ------(4)

A = - Vo/V_{in} -----(5)

Substituting (3) in (4)

V_o =-A {V_1 + βV_o}

V_o = - AV1 - βAv_o

V_o + βAv_o =- Av_1

Vo/V1 = A/1+βA ------ -------- (6)

But 1+ βA ≅ βA if A is large

:. V_o/V_1 = - A/βA = -1/β

But β = R1/R2

Vo/V1 = -1/R1/R2 = -R2/R1

A_{CL} = Vo/V1 = - R2/R1 ------ ----(7)

A = Y_O/V_{in}

From (7)

Vo/V1 = -A/1 +βA

Vo = (-A/1+ βA) V_1 ------ ---------- (8)

Put (8) in (5)

A = -V1/Vin {-A/1+βA}

Vin = + V1/A{A/1+ βA}

Vin = V1/1 +βA

V_{in} = input voltage to the amplifier

= V1/1 +βA

But from (5)

Vo = output voltage = -A Vin

The input current to the amplifier

Ii = V_1 – Vin/R1

2.2 GAIN OF THE NON – INVERTING OPERATIONAL AMPLIFIER

In this case, the input signal is applied to the positive terminal to the amplifier with the negative terminal (connected to the common rail.

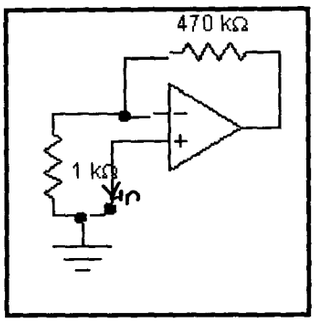

Fig 2.2.2 NON INVERTING AMPLIFIER

GAIN OF THE NON INVERTING AMPLIFIER

To complete gain of this configuration, note that $V_d = 0$

$$V(-) = V(+)$$

But $V(+) = V1 = V(-)$

$V(-) = \{R1/R1 + R2\}. Vo$ (voltage division)

Since $V(-) = V_1$

$\Rightarrow V1 = \{R1/R1 + R2\} Vo$

$A_{CL} = Vo/V1 = R1 + R2/R1 = 1 + R2/R1$

The above indicate that the output Vo is in phase with the source signal

2.2.3 THE FREQUENCY RESPONSE OF AN OPERATIONAL AMPLIFIER

The lower the gain of an operated amplifier, the wider the frequency bandwidth. Since the operational amplifier circuit is a dc amplifier, it amplifies signals down to dc (zero frequency), and the band width is simply referred to as f2. The expression for the closed loop cut-off frequency cab be seen as follows:

$F_2cl = \{1+ \beta A\} X f_2$ ----------(a)

But from equation (6)

$A_{CL} = Vo/V1 = - A/1+ \beta A$

$1+\beta A = A/A_{CL}$ _____(b)

Put (b) in (a)

$F_{2CL} = -A/A_{CL} \text{ X } f_2$

Where f_2cl = closed loop cut off frequency

F2 = open loop cut off frequency (usually gotten from manufacturer's data sheet.

A = open loop Amplifier gam.

Ad = closed loop Amplifier gam

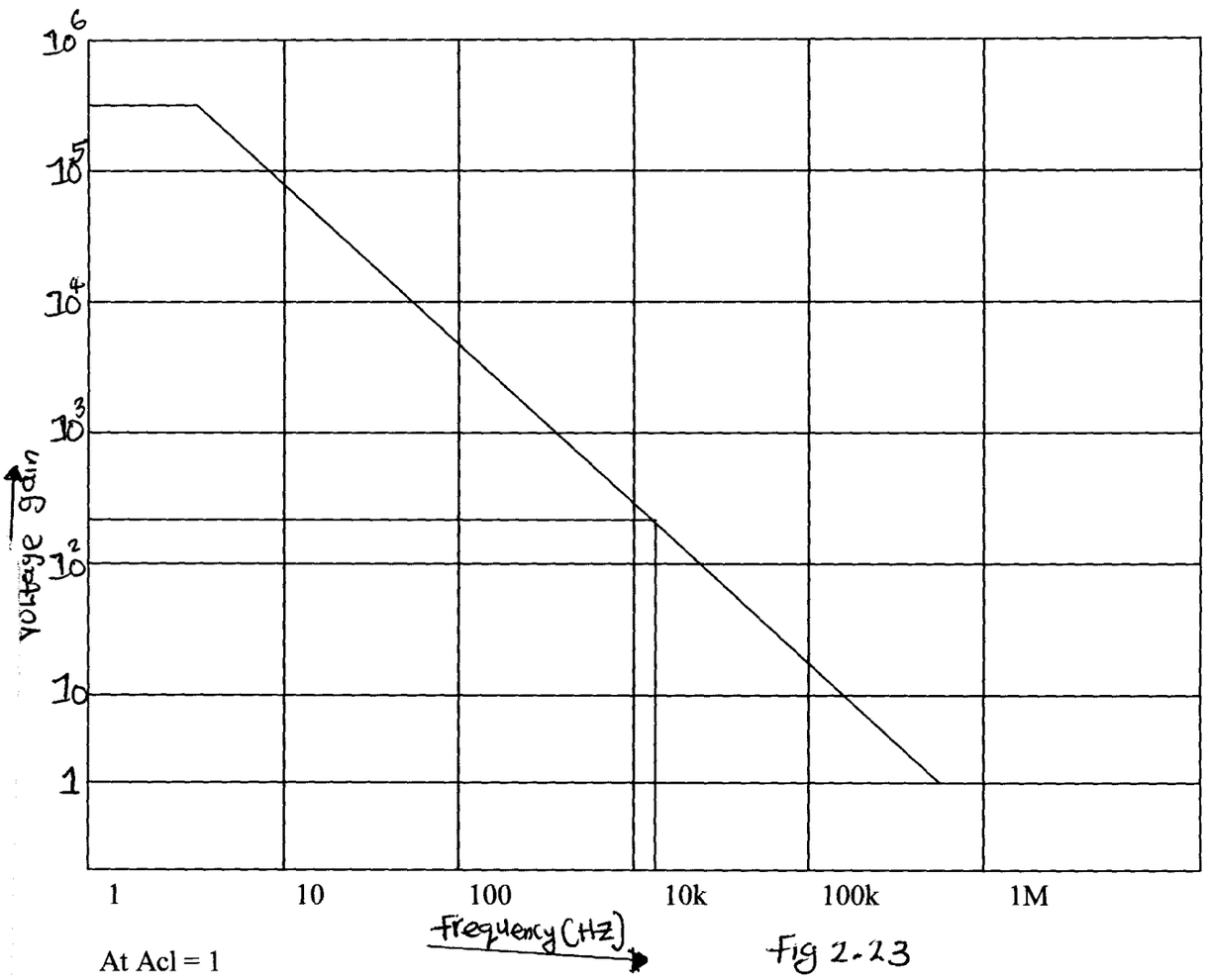

Fig 2.23

At Acl = 1

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-1} = 0.9\text{MHz}$

At Acl = 10

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-10} = 90\text{KHz}$

At Acl = 100

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-100} = 9KHz$

At Acl = 1000

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-1000} = 0.9KHz$

At Acl = 10,000

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-10,000} = 90Hz$

Acl = 100,000

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-100,000} = 9Hz$

At f2cl = 1Hz

$Acl = \frac{1.5 \times 10^5 \times 6}{1} = 9 \times 10^5$

However, from my design calculation

Acl = - 897.80

$F_2cl = \frac{-(1.5 \times 10^5) \times 6}{-897.80} = 1.002KHz$

The range of frequency for this project = (0.006 – 1.002) KHz

2.2.4 DISTORTION

Much like the bandwidth, distortion is improved or reduced as the closed loop gain is decreased. However, distortion can be defined as the deviation from the pure sine wave. For low Acl, distortion is minimal and as a result of this, the output signal is much closer to a sine wave form (assuming the input wave is a pure sine wave),in other words, the amplifier itself introduces less distortion if it gain is lower.

Mathematically, distortion improvement is a fraction of the ratio between the open loop and the closed loop gains.

$D_{cl} = D/1+A\beta$ ----------(d)

But from (6)

$Acl = -A/1 +\beta A$

$Acl = D/- A/A\beta = \frac{-Acl \times D}{A}$

Where Dcl = closed loop distortion of overall amplifier

D = open loop distortion of the internal amplifier

But Acl = - 897.8

A= 1.5 X105

$$Dcl = \frac{-(-897.8)}{1.5 \times 105} \times D$$

$$Dcl = \frac{897.8}{1.5 \times 105} D$$

$Dcl = 5.98533 \times 10^{-3} D$

$Dcl = 5.98533 \times 10^{-3} D$

Dcl = D/167.075

Thus there was 167.075:1 improvement.

167.075:1 improvement.

The above means that for an input of 167.075, the output will be 166.075 close to the input that is 1 out of it will be distorted.

CHAPTER THREE

3.0 CIRCUIT DESIGN

The working of the entire project depends on the circuit and hence the design of the circuit is in fact the main focus of this project. An understanding of the operation of an intercom telephone system, which is automatically operated, is necessary. Based on this understanding, state diagram was used to generate the truth table when satisfy the operation of the basic telephone system.

3.1 OPERATING PRINCIPLE OF THE PROJECT

There are two channels and an exchange, which serves as the control centre for the intercom system. Every one of the stations has a unit with an output transducer and signalling mode.

When the handset (H1) is lifted, a switch (soft touch switch or gravity switch) is released due to the removal of the weight of the handset from it, which then sends its state to high (+Vcc) at his station with the aid of pull up resistor. He then presses ON the control switch (A1), which provides a high voltage state to the combinational logic circuit and triggers the buzzer (B2) at the other unit station. The ringing of buzzer (B1} is varied by 555 timer T1 and 555 timer T2 with ON states being 3s and 0.45s and off state 2s and 0.2s.

However, when handset 2 (H2) and switch A2 are set to high states, the combinational logic circuit receives high Voltages State there by giving a binary equivalent to the address decoder 4555B. The decoder generates a corresponding output word whose output is high at a time thereby triggering the buzzer (B1). The ringing of the buzzer is also varied at a time using two 555 timers as used in the first unit station.

If the called subscriber lift up his handset to answer for his call, the sequential circuit designed with the use of decoders, flip-flops, And gates and OR gates automatically respond thereby giving a high state voltage (+Vcc) to the two amplifier circuit which lead to instant establishment of communication between the two units.

3.2 THE AMPLIFYING CIRCUIT

The amplifying circuit comprises of buffer amplifier and voltage amplifier. The

voltage amplifier amplifies the incoming low – level signal of about 2mv from the input transducer to a high level signal. The characteristics of the voltage amplifier (μ A 741) used is shown below

Input resistance = 2Ω

Input resistance = 75Ω

Supply voltage (min to max) 3V to15V

Recommended supply voltage 3V to 12V

Short circuit protection Yes

Storage temperature –650C to 150 C

Operating temperature OoC to 7Oc

The gain of the μA 741 amplifier was set by using two resistors R2 and R3 (logarithmic potentiometer) connected in series at the feedback

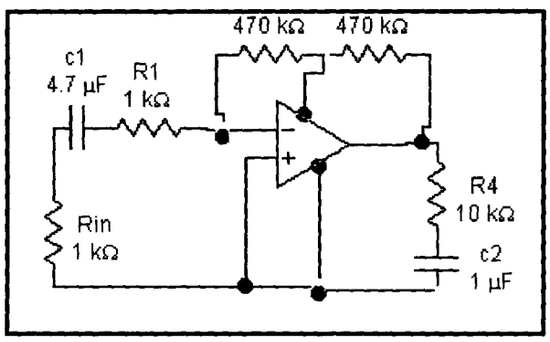

FIG. 3.2 VOLTAGE AMPLIFIER

With the value of R2 set at 470kΩ and VR3 at 470kΩ and the value of R1 set at 1Kn, the gain of the amplifier was calculated to give – 897.8

This value of gain was found to be the value, which gave an optimal yield, as gain values above this value gave a very distorted output. The logarithm potentiometer VR1 was used so that the gain can be easily varied. Resistance R4 was connected in series with capacitor C2 to stabilise the gain. The resistance R4 and capacitor C2's values were chosen to be 10kn and 1μf.

The resistance R1 is used as impedance matching that is match the input of the amplifier with the output of the carbon microphone. C1 serves to block all the D.C.

signals from entering the amplifier allowing only A.C signals.

Pin 7 of the amplifier was connected to the power supply Vcc with pin 4 connected to ground, while pin 3 of non-inverting amplifier was grounded.

The Lm 386 was the amplifier chosen for the buffer stage, that is power amplifier which has a gain >= 1. It also serves as isolation between the output load (receiver) and the amplified signal from μA 741. A 220μf capacitor was used at the output of the Lm 386 so as to couple the output signal with the load. And finally, an audio –transformer of unity turns ratio is used at output so as to eliminate all D.C. signals that might still be in the system so as to give a less distorted output at the receiver which was calculated to be ratio 167 to 1 improvement. The circuit is as shown in fig. 3.21

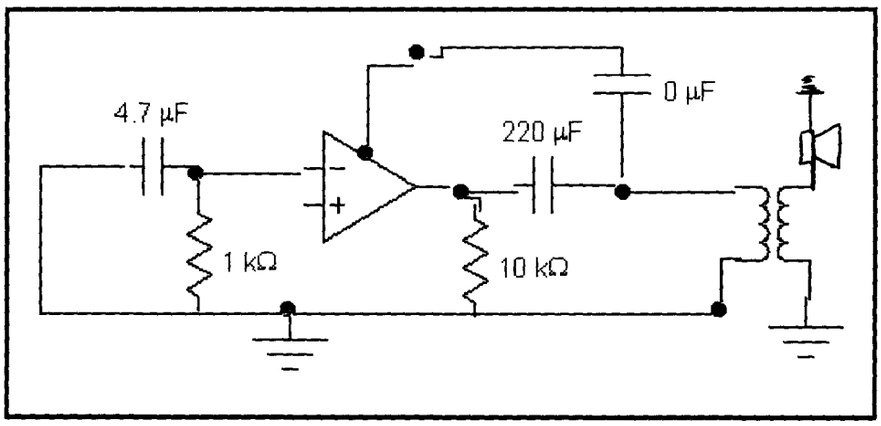

FIG 3.2 POWER AMPLIFIER

3.3 STATE DIAGRAM

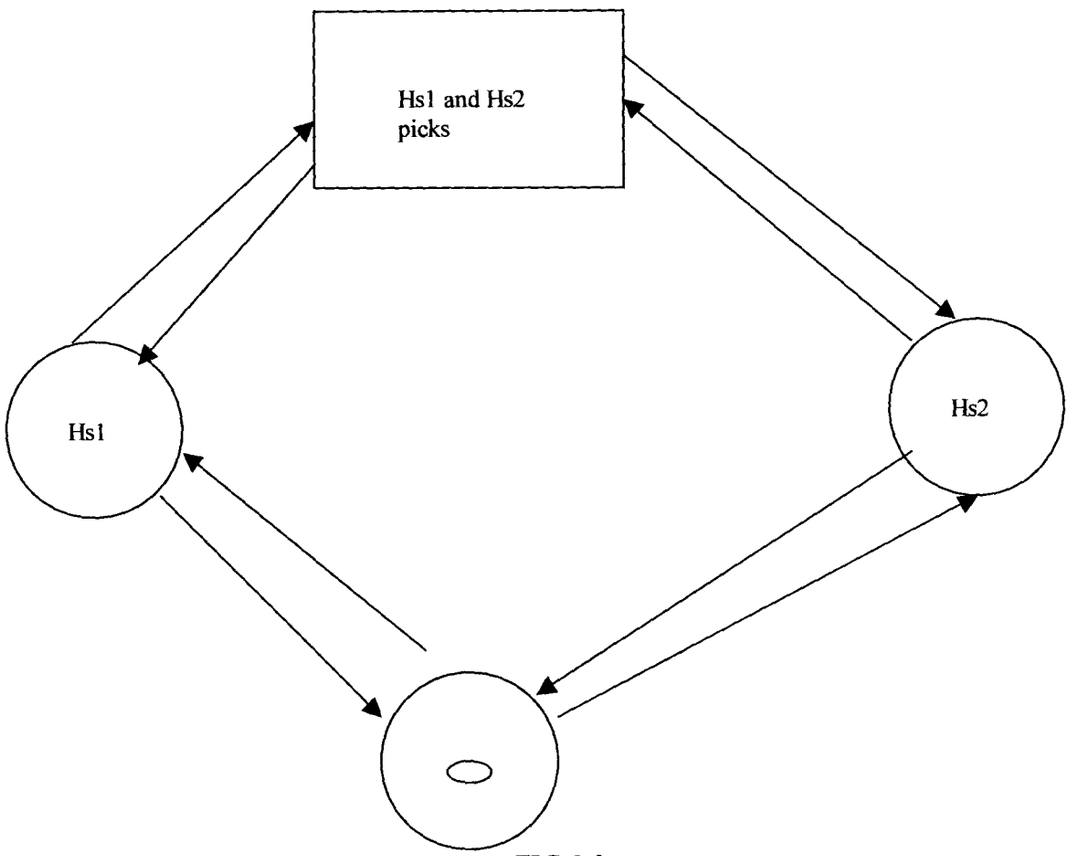

FIG.3.3

3.4 THE TRUTH TABLE TABLE 3.1

		Ff Present		Ff Next state						
H_1	H_2	Q_1	Q_2	Q_1	Q_2	J_1	K_1	J_2	K_2	O/P
0	0	0	0	0	0	0	X	0	X	0
1	0	0	0	1	0	1	X	0	X	0
0	1	0	0	0	1	0	X	1	X	0
1	1	1	0	1	1	X	0	1	X	1
0	0	1	0	0	0	X	1	0	X	0
1	1	0	1	1	1	1	X	X	0	1
0	0	0	1	0	0	0	X	X	1	0
1	0	1	1	1	0	X	0	X	1	0
0	1	1	1	0	1	X	1	X	0	0

THE LOGIC EQUATIONS

J1 = H1$\bar{H}$2 $\bar{Q}$1$\bar{Q}$2 + H1H2$\bar{Q}$1Q2

K1 = $\bar{H}$1$\bar{H}$2 Q1$\bar{Q}$2 + $\bar{H}$1H2Q1Q2

J2 = $\bar{H}$1H2 $\bar{Q}$1$\bar{Q}$2 + H1H2Q1$\bar{Q}$2

K2 = $\bar{H}$1$\bar{H}$2 $\bar{Q}$1Q2 + $\bar{H}$1H2Q1Q2

O/P = $H_1H_2Q_1\bar{Q}_2 + H_1H_2\bar{Q}_1Q_2$

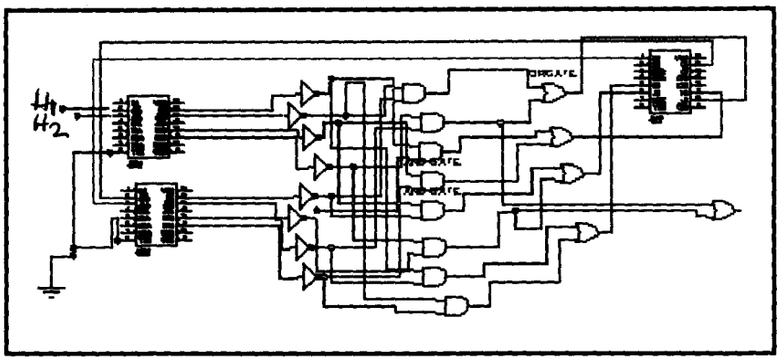

FIG. 3.40 EXCHANGE (SEQUENTIAL CIRCUIT)

3.5 THE RINBGING CIRCUIT

H2/A2	H1/A1	B1	B2
0	0	0	0
0	1	0	1
1	0	1	0
1	1	1	0

The logic equations

B1 = H1A1H2A2

B2 = H1A1H2A2

THE OVERALL CIRCUIT DIAGRAM

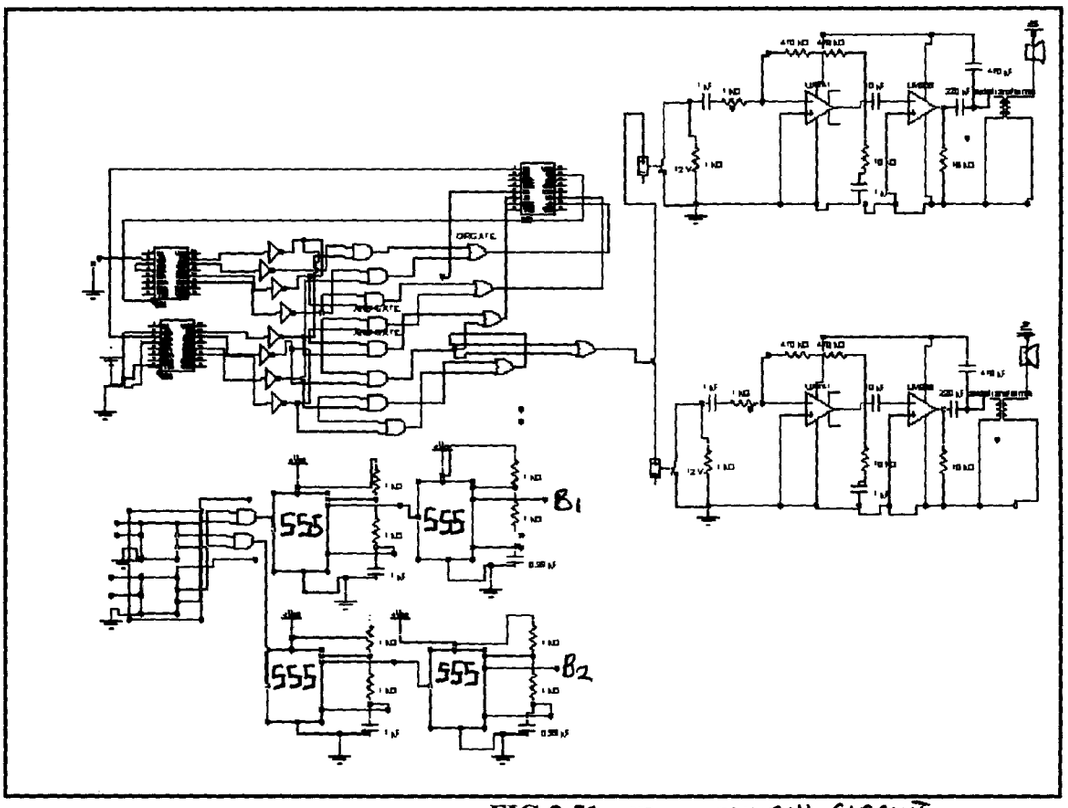

FIG.3.51 THE OVERALL CIRCUIT

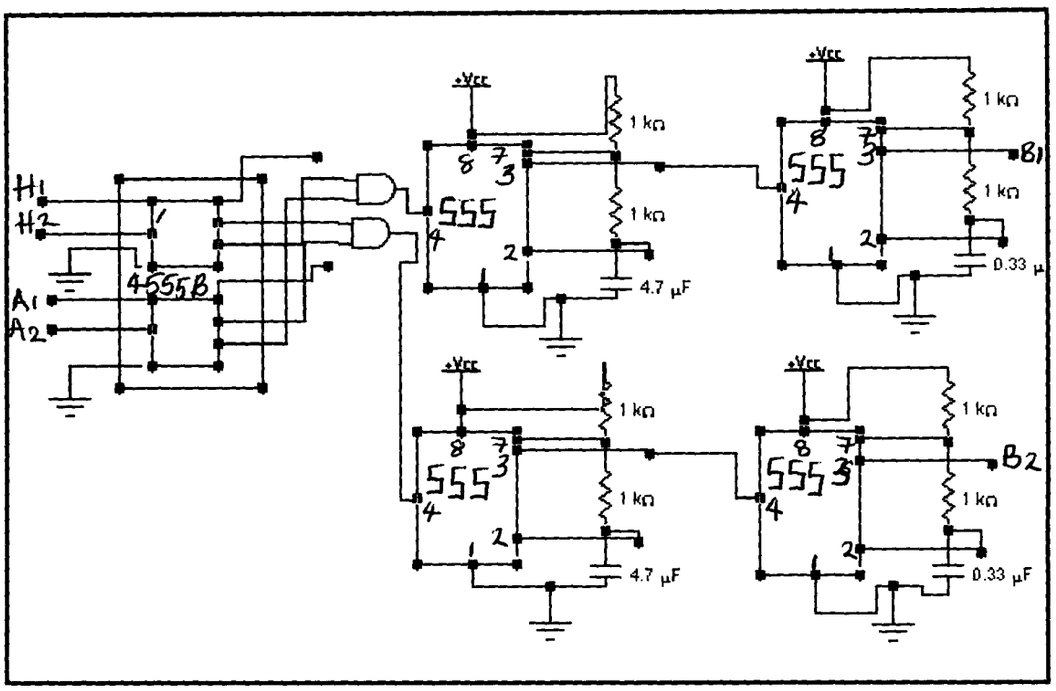

FIG 3.6 THE SIGNALLING CIRCUIT

3.6 THE SIGNALLING CIRCUIT

For the signalling in this project, buzzers were used on each channel's equipment to alert the channel of an incoming signal from the combinational logic circuit at the exchange. Another significant component of the signalling is the manual switch which ON and OFF normally with common contacts of the buzzers.

CHOICE OF CAPACITORS

This is a passive element, which is very essential in every circuit design. They combine with resistors to form the basis of nearly all the components in the circuit. They are used for waveform generation, blocking and bypass applications and as a filtering element.A capacitor is more complicated than a resistor, the current is not simply proportional to the voltage but rather to rate of change of voltage. They usually come in an amazing variety of shapes and sizes.

The basic construction of capacitor is simply two strips placed parallel to each other with an isolation between them usually called dielectric, when a common voltage is applied, it is found that the conductors charges up to the applied voltage. The values used in this project are 1μf, 0.47μ f, 100μf, and 220μf.

THE CHOICE OF RESISTORS

Resistors are many as their applications are. They are in many circuits i.e. as feed back in this project and in combination with capacitors, they establish time constant and act as filters. They are also used to reduce voltage by dissipating power to measure current and to discharge capacitors after power is removed.

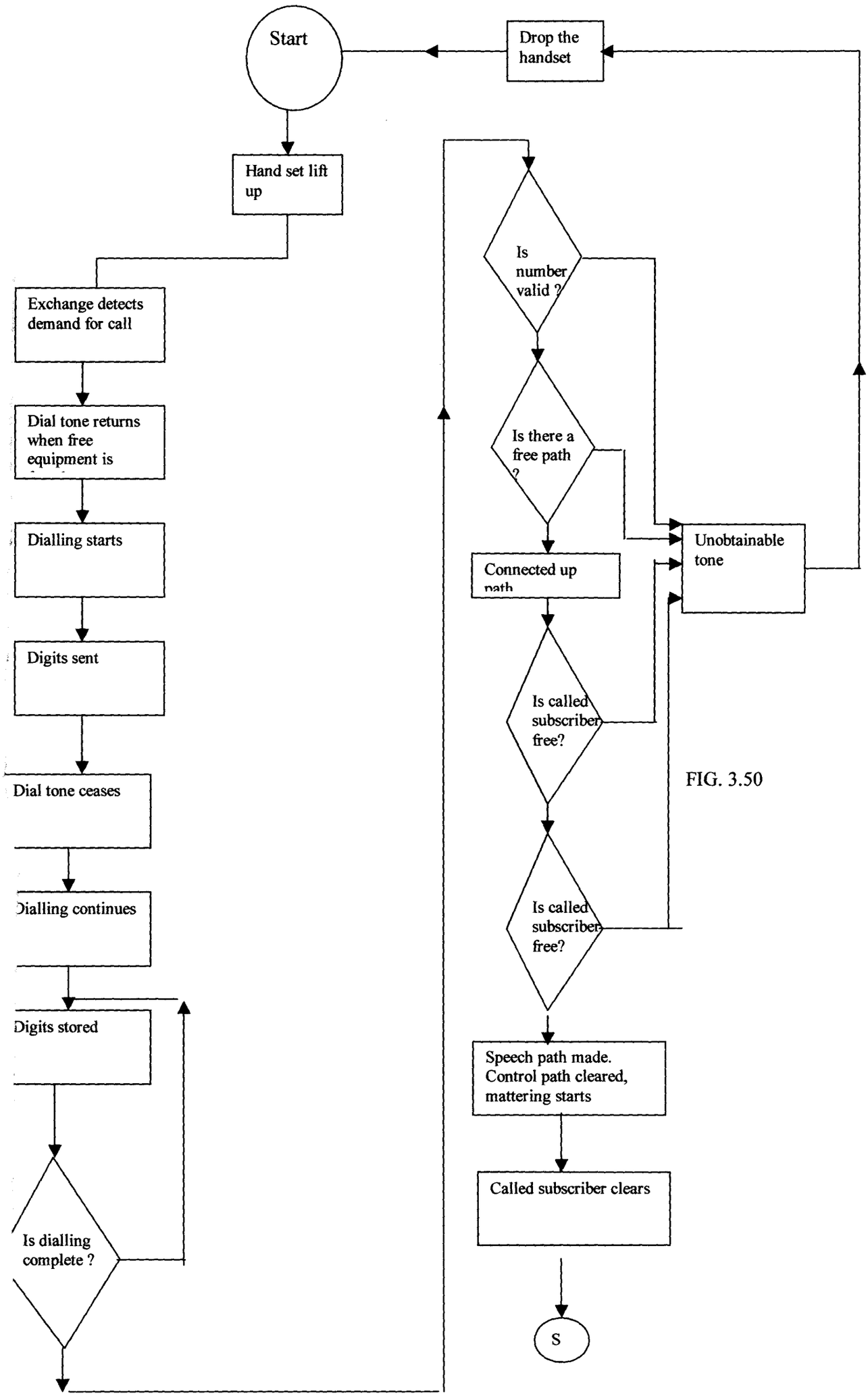

FIG. 3.50

Fig 3.5 - IHE_FLOWCHART 25

CHAPTER FOUR

LAYOUT AND CONSTRUCTION

This chapter is actually on bringing together the various parts in the proceeding chapters. An overview of the types of the materials used in the construction and general layout of the project design is seen. The complete assembly is also outlined.

4.1 CONSTRUCTION OF THE AMPLIFIER CIRCUIT

The design of the different circuits, which made up the intercom system, was tested using the components specified, and testing them on a breadboard to ensure full functionality of the design. When the components placed on bread –board were certified to be working, the components were then permanently fixed on the vero- board.

The vero-board is an insulator strip, comprising several parallel tracks of strips with small holes drilled along its length, giving a matrix format. The components were fixed to the vero-board by placing each of the pins of the components in a separate hole with the pin soldered into the hole in accordance with the circuit design. This ensures rigidity of the components. In the above, pins 4 and, 3 of μ A 741 were soldered to the ground, pin 2 to voltage input, pin 6 as the output and pin 7 connected straight to the +Vcc. In Lm 386, pins 2 and 4 were soldered to the ground, pin 3 to the voltage input, pin 6 straight to the +Vcc and pin 5 as the output. Uniformity of the arrangement of components with the tested design was ensured which eliminates the removal of components for the purpose of correction.

4.2CONSTRUCTION OF THE EXCHANGE

The design of the exchange based on the truth table got from the state diagram was tested on breadboard to ensure its workability before soldering.

555B decoders and 4027B flip flop have their pins 8 and 16 soldered to the ground and +Vcc. 4081B AND gate and 4071B OR gates also had their pins 7 and 14 soldered to the ground and +Vcc. The remaining pins were all soldered based on the IC cascading.

The bread –board proved to be very convenient, and played an integral role in the circuit design of this project, as theoretical designs were realised with ease and

Components were easily experimented. It was however noted that breadboard should not be used for circuits whose operating frequencies exceed 10MHZ.

4.3CONSTRUCTION OF CASING

The casing had similarities with the design of the conventional telephone. Plywood was chosen and was carefully designed to conform to the features of a conventional subscriber unit. The vero-board size determined the dimension of the casing.

Allowance was also made for opening the sets to make the system accessible for easy maintenance. The subscribers units are two in number, which made it a channel system. Spaces were also provided for the switches, cables and sound outlet.

Lastly, plywood was chosen for the casing because of its lightweight and availability. The vero-board was screwed approximately on the internal section of the constructed casing so as to avoid short-circuiting. The vero-board was first drilled through at appropriate points before the screwing was done. The switches were firmly tightened at various appropriate points on the casing.

4.4 PROBLEMS ENCOUTERED

A major set back in the design of the circuit came up in the use of the uA 741 amplifier at the pre – amplifier stage. A lot of noise was received at the output of the circuit due to the very high gain of this amplifier (20,000). A 470uf 16V capacitor was then used as the calculated value of the capacitor, which reduced the noise considerably.

4.5 PRECAUTIONS

Several precautions were taken in putting together this project. This was done to ensure the system working well with components not damaged in the process of construction so as to maintain a low cost of construction.

SOME OF THIS PRECAUTION ARE

1. The circuit diagram was followed during the breadboard and veroboard stages of the construction.
2. The values of the circuit components were ensured to be very closed to their calculated values.

3. The correct polarity of the components "ICs " used were correctly ascertained before soldering so as to prevent internal damages that may be caused to them
4. Screw drivers or any conduction substances that could bridge the legs of the I.C's were kept away from the immediate working table during soldering.

5. Proper soldering techniques were applied – stray solders were carefully removed to avoid short –circuits. High grade soldering lead was used with IC sockets so as to reduce ICs damage when heat of the soldering was high.

4.6 CABLING

0.5mm2 telephone cable was used through out the construction and realisation of this project. This is in accordance with the IEE regulation, which stipulate that the voltage drop across a particular conductor for load/ transmission carrier must not be greater than 2.5% of the nominal voltage.

That is VDL/1000 $\subseteq$ 2.5%

Where V = nominal voltage

D = voltage drop across the conductor

L = length of the conductor

4.7 TESTING

Most of the required testing had been performed during construction whereby the output of each stage was monitored and ascertained with necessary gain achieved viewed using oscilloscope and signal generator.

Also the circuit was simulated using electronic workbench software which is computer aided simulation software.

The final stage of testing was done when the project had finally been completed. This was achieved by making use of the two channels with the exchange.

The switching system was well tested and everything was found to be in perfect shape. The buzzers serve as the indicator to the called subscriber indicating that his attention was needed.

However, during the testing, it was noticed that noise was introduced at the channel that is the exchange when the system was powered at the exchange, but when powered at the unit the noise automatically cleared off the line

CHAPTER FIVE

5.0 CONCLUSION

This project gives an adequate explanation of a 2– channel automatically operated intercom system. It gives as insight to the operation of telephone system especially as related to intercom system. The intercom was tested and it performed creditably well as a prototype design. The objectives of this project were fully achieved, and the design and construction were realized.

Some things were observed during the testing and these include the difference between the theoretical and practical results. This intercom system is applicable in offices, homes, departmental store etc. This device is vastly used in both private and governmental establishment. It is currently being used in offices for instance it can be used as a means of communication between a boss and his secretary.

This work has accorded me the opportunity of knowing the great extent to which telecommunication has been developed, and I became familiar with their working principles and applications and also their limitations.

5.1 LIMITATIONS AND PROBLEMS ENCOUNTERED

(1) The gain of the Lm 386 was very low after bread boarding. But from micro-processor semiconductor data book, I discovered that the gain of the Lm 386 has been internally set to 2odB and to increase it to 2oodB, I had to connect a 10uf capacitor across pins 1 and 8 which was not in the original design .

(2) The design was also made using a 4n transducer but I discovered that on connecting them about in parallel, their total impedance become so low that it couldn't match the high impedance of the IC's. So I had to go and source for a 8n transducer so as to correct the problem but discovered that the 8n transducer can only be found in the olden days scraps, thus I went through some hardship before getting them which I used, so this limited my construction as I couldn't get up to the required nos. which I needed to use for my construction.

(3) The use of decoders "4555B" so as to reduce the complexity of the exchange also gave some problems due to the fact that it was not readily available thus I had to wait for a very long time before getting it.

5.2 ACHIEVEMENT

The construction of intercom system was fully achieved with the use of simple sequential and combinational logic circuit thereby making the principle of mechanical switching, at the master station useless. I was also able to incorporate tone generator (buzzer) which is varied at certain interval of time thereby making it obeying the international standards laid by telecommunication experts:- The system was designed to have a good quality, low noise output, by taking into consideration the gain and the feed back of the amplifiers.

5.3 RECOMMENDATIONS

The work that has been done here can still be worked upon again and improved on so as to make the system more efficient and compatible in line with modern trends. Some of the ways in which improvements can be made are:

1. The manually operated turn ON and turn OFF switch should be replaced with a thyristor switch such that you only turn ON the switch but the OFF state comes when there is a communication link which triggers the exchange automatically from Zero state to high state.

2. Exactly 2 input 4-output CMOS decoder should be used in place of dual-purpose 4555B decoder so as to reduce complexity and complication during soldering.

3. Extra care should be taken when mounting the components on the veroboard to avoid breakage of IC legs or in order words; IC bases should be used so as to avoid sudden damage of ICS.

5.4 SUMMARY

Communication is central to the human experience. It is an essential element in our society due to the ever increasing demand for it therefore working on this project was challenging, but it turned to be interesting and very enlightening. It was noted that the difference between the theoretical values and those practical values measured were partly due to human errors and approximations made in the values of the components.

5.5 REFERENCES

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