THE DEVELOPMENT OF AN IMPROVED AUTOMATIC TELEPHONE MESSAGE ACQUISITION SYSTEM

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(B.ENG.) DEGREE

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DECLARATION

I hereby declare that this design project report original work. To the best of my knowledge, it has never been presented in any symposium, seminar or elsewhere in any form for the award of diploma or degree.

So also I declare that this project report is based on findings conducted, information collected in pieces from different text books and from the project supervisor Engr. M.S AHMED.

--------------------------------- 21 - 02 - 2002

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CERTIFICATION

This is to certify that I have supervised , read and approved this project report, which I found adequate both in scope and quality for the partial fulfillment of the requirements for the award of bachelor of engineering (B.ENG) degree in Electrical/Computer Engineering.

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DEDICATION

I solemnly dedicate this project work to the loving memory of my beloved mother ALHAJA BILLY LAWAL, For the love shown to me during our short time together as mother and son.

More so I dedicate this project work to my father, Brothers and sisters for their immense support and contribution through this program

Finally to the first thing in my life Almighty Allah for making me a Muslim .

ACKNOWLEDGEMENT

My acknowledgement goes first to Almighty ALLAH for given me his sufficient grace, strength, knowledge and understanding through this program. My parents, whose unrelenting effort have contributed so much into my educational pursuit.

Having given thanks to Almighty ALLAH, I truly lack adequate words to put across my appreciation to my supervisor Engr. M.S. Ahmed for his encouragement, patience and trust, indeed I am greatly indebted to you sir.

I also use this opportunity to thank all my lecturers for the knowledge they have impacted on me.

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May Almighty Allah help and guide all of you in your future endeavors.

ABSTRACT

The automatic telephone message acquisition system is a device that works automatically with the position of the telephone handset. Whenever a telephone hand set is lifted (OFF HOOK.) the acquisition system is activated and it gives out a 6V as output voltage. Also when the telephone hand set is replaced, (ON HOOK.)The acquisition system is deactivated and it gives out a zero volt. as output voltage.

The system is made of thee different modules; they are the switching circuit the alternating and filter circuit and the recorder circuit.

When the telephone hand set is OFF- HOOK , the voltage that appears across the input terminals of the switching circuit is about 8 Volts, the voltage is far below the breakdown voltage of the Z_{D1} (zener diode) that has a Vz of 20V, therefore the transistor Q1is kept out of the circuit and the 9v battery takes over and produces a voltage output of about 6V or 3V depending on the selector switch position.

Likewise, if the telephone handset is ON- HOOK, the voltage to the input of the switching circuit is about 50V, this input saturates transistor Q1 and this keeps the switching circuit at off situation.

With the switching circuit activated the audio circuit allows the recorder to record both sides of the telephone conversation. The filter circuit is made of a band pass filter that extracts out the needed information for recording by the tape recorder that makes up the recorder circuit.

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`CHAPTER ONE

GENERAL INTRODUCTION

1.0 INTRODUCTION

Ever since the advent of the first system that renders answering services, that is, system that store telephone messages various other systems have been developed to perform similar functions, but the most common of such accessories is the answering machines, described by Brieley (1989). This device serves the purpose of transmitting a message to subscriber who calls an unattended telephone line, this unattended telephone line has attached to it a message storing device in which both pre-recorded message and caller's message are recorded on a magnetic tape or compact disc. The recording of unattended messages has always bring the work of the system (the telephone answering machine), but recent surge in the spy network and security advancement has brought about the need to record conversation between two or more people on the telephone network. .Most large cities in the world have secret telephone listening rooms, usually in the central telephone switching offices or in the main police station, but increasing need of the spy network require an eavesdropper to monitor a large amount of telephone lines, and simply to take note of any relevant information within the limited available time frame, and all this put together brought about tape recording telephone conversation when telephone line are in use. This saves time for the eavesdropper as he needs only check the tape periodically.

Devices that perform the task of documenting telephone messages are readily available in the market but also they are relatively expensive. The common automatic telephone message recorder is discussed by Povey (1985). In this work the electronic switch is activated by the OFF-HOOK state of the hand set any time the telephone is attended to, this in turn starts the tape recorder by supplying power to the recorder. Replacement of the hand set (ON-HOOK) is responded to by the switch to stop the recorder, by reducing the output voltage to zero volts, all these are achieved by a simple electronic network of switching transistors . The devise is high impedance d.c switch that isolate the recording controlled device from the telephone line in a relatively simple electronic circuitry. This unit rightly interfaces with most portable cassette recorders, with this configuration, both sides of the messages are stored in the recorder at minimum power utility.

The device is a simple electronic device, high reliability, functional and made up of relatively low cost components, this makes it relatively in expensive and economical for use and also for project work.

1.1 LITERATURE REVIEW.

There has been various works carried out on the development of telephone messages acquisition systems over the years. Work has been carried out on recording messages from unattended lines by answering machines , this was documented by Brieley H.G. In his book Telecommunications Engineering (1989). Also there has been work done on documentation of conversations on a telephone network, either by direct recording or transmitting and then recording.

Government and people have regularly listen in on both friends and enemies, in most countries of the world by keeping this system security in different locations.

The involvement of government and multi-national security agents has brought about the heavy investment of money in eavesdropping device production and research. And this has brought out very improved technology in the production of such systems. The most significant change has been the development of high quality miniature components that can be put together and makes this system work. This has continuously reduced the size of this systems.

The cost of production of this miniature components is taking its part on the overall cost of the system produced and this has made them unavailable to the masses but only available to the rich multi-national security networks over the globe.

The work on the development of a low priced version of this system had started over a given period of time and this involves the use of relatively cheap components to achieve the same objectives as the one produced from the miniature components circuit. There is presently a practically workable circuit with some deficiencies as described by

M.S.Ahmed in his paper titled Development of an Automatic Telephone Message Acquisition System (1999).

The project work is based on the improvement of this work from the present stage.

1.2 OBJECTIVE AND MOTIVATION OF PROJECT.

The development of an improved automatic telephone message acquisition system is to achieve accurate documentation of telephone messages when the need to document the conversation between two or more individuals, over the telephones network arrives.

Despite the fact that telephone massages acquisition systems are already in existence, the truth still remains that they are quite expensive and generally out of the reach of common man. Therefore the objective and motivation of this project is to develope telephone message acquisition system that can be designed using the available electronic circuitry that contains some quite cheap components and still get as close as possible to the level of efficiency of the existing systems.

With this design such system can be available and can easily be obtained by the general masses that requires their services. Just like the general saying "Engineers are there to make life easier" Therefore this project is to make life easier by bringing less expensive system into existence.

1.3 METHODOLOGY AND DESIGN CRITERIA.

The method used in the development of this system (project) and the design criteria considered has to do with the choice of components. Despite the apparent advantages of digital systems over analogue systems, analogue components were used in the realization of this project. The major things that were taking into consideration before choosing the analogue components were the availability and prices of components.

Majorly the objective of this project is to develop a system that is relatively cheap and of good efficiency when compared with the once available in the market.

Therefore in other not to defeat the primary objective of the project, the relatively cheap analogue components were used in the project design.

Also the entire system was broken into system modules, and the method adopted was to complete each module and finally assemble the entire project.

With the considerations, the entire project was carried out without much difficulty.

1.4 PROJECT OUTLINE.

This project write-up is a technical report based on the development and testing of Automatic Telephone Message and acquisition system.

The first chapter gives a general introduction of the project, the review of literature that was carried out, the project objective and motivation and the project methodology and design criteria.

The second chapter deals with the design and analysis, and it also involves calculations and determination of values of components used in the project.

The chapter also explains, the over all circuit operations in modular method.

The third chapter, gives an insight on the general construction techniques, the modular construction and testing of each module that makes up the overall system circuit.

This chapter also explains the sensitivity and accuracy of all other constructing equipment used during the project, also in the chapter are the results, analysis and discussion of result obtained after testing the system. The result obtained was presented in tabular form for clarity and simplicity.

The fourth and final chapter which happens to be the concluding chapter, deals with the conclusion and recommendation of future improvement of the system, and also the list of references.

CHAPTER TWO

DESIGN AND ANALYSIS

2.0. PRINCIPLES OF OPERATION

The improved automatic telephone message acquisition system works to record telephone messages during telephone conversations. The system is made up of the three major parts which are the switching circuits, the attenuation/filter circuit and finally the recorder circuit.

During the time when the telephone handset is placed in the cradle (ON-HOOK), the voltage across the telephone set is on the average of 50V and when the telephone handset is off the cradle (OFF-HOOK), The average voltage across the hand set terminal is 8V. The voltage across the telephone set is used to regulate the switching of the switching circuit and thereby determining when power is supplied to the recorder circuit.

Also voice message on the telephone terminal which is to be documented is modulated on a DC current .The attenuated voice signal is then filtered out of the signal by the use of a band pass filter.

The recorder circuit, which is made up of a tape recorder, and powered by the output of the switching circuit, then automatically records the output of the filter circuit. The telephone message is then documented on the tape in the recorder.

2.1 CIRCUIT DESIGN AND ANALYSIS

The switching operation for the system is done by a set of cascaded switching circuit consisting of two switching transistors and the third transistor acts as a current amplifier. For variety of applications, there are two output voltages at the output of the switching circuit, but one is to be selected by a switch. The first output is for 3 V recorder while the second is for 6 V recorder the voice signal is super imposed on a DC current from the telephone line. The DC is reduced to a lower proportion and a fraction of the audio signal is also extracted by using a band pass filter.

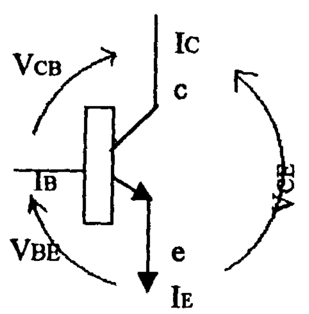
The combination of RLC filtering circuit for the loading of the telephone line is to reduce attenuation of voice signal and the filtering is to filter out the voice messages for recording.

2.1 SWITCHING CIRCUIT

The switching circuit of this system is performed by a set of cascade switching transistors.

The application to switching circuits represents one of the most important and wide spread use of silicon transistors. The circuit at rest remains in a well-defined state until it is switched to other states, the transition occurring instantaneously in an ideal circuit

In switching circuits, transistors are driven between two well-defined states, OFF and ON. Passage through the active region is not important except in determining the speed of switching. This OFF and ON stages are called saturation and cut-off stages respectively. Consider the figures shown below, fig 2.1.(a) shows the transistor in the NPN mode and fig 2.1 (b) and (c) summarizes the transistor characteristics.



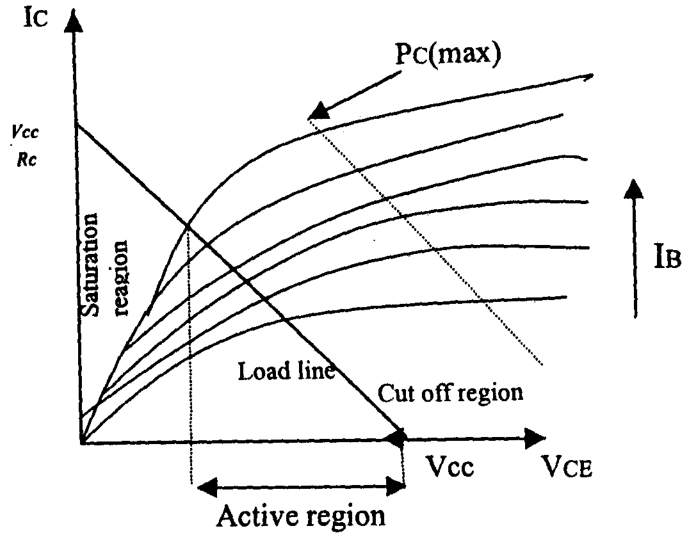
$I_E = I_C + I_B$

V_{CE} = collector Emitter Voltage.

V_{BE} = Base Emitter Voltage.

V_{CB} = collector Base Voltage.

Fig. 2.1(a) Transistor shown in N-P-N mode.



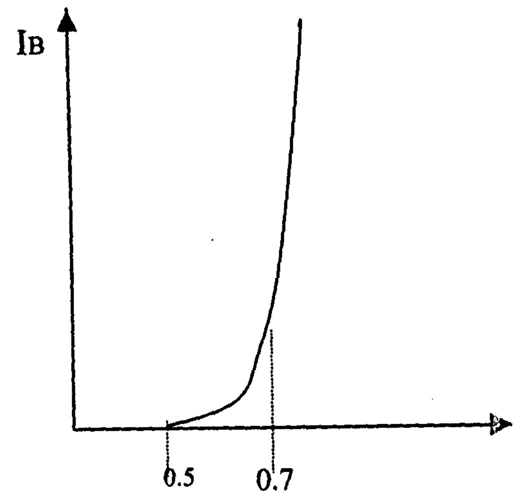


Fig.2.1 (b) Output characteristics with load line fig 2.1 (c) input characteristics

A plot of I_B versus VBE interrelates the two input parameter as the device input characteristics shown in fig 2. 1 (c)

The graphical relationship between the output parameters I_C and V_{CE} with I_B as control provides the output characteristics shown in figure 2.1b.The load line as it is called is a parameter that defines all the operation of a transistor given V_{CC} and R_C and its slope is $-1/R_C$.

Definition of parameters.

The fraction of emitter current appearing as collector current is given by the symbol ∝,

∝ = common base current gain of transistor.

Collector current / Emitter current = Ic / IE = ∝,

The ratio (β) of collector current to base current of a common emitter configuration can be determined by,

$$\frac{\text{Collector current}}{\text{Base current}} = \frac{I_C}{I_B} = \frac{\alpha}{1-\alpha} = \beta$$

when β = hFE

from IE=Ic + IB

but IB = (1- ∝)IE

$$\text{therefore } \beta = \frac{I_C}{I_E(1-\alpha)}$$

But $I_C = \alpha I_E$

$\beta = \alpha I_E / I_E(1-\alpha) = \alpha / (1-\alpha)$

β is termed the common – emitter current gain, that is input at the base, output at the collector.

For the analysis of the systems switching circuit, the system contains three transistors, two acting as switching transistor and the other acting as a current amplifier. The circuit of fig. 2.1.(d) below shows the switching circuit.

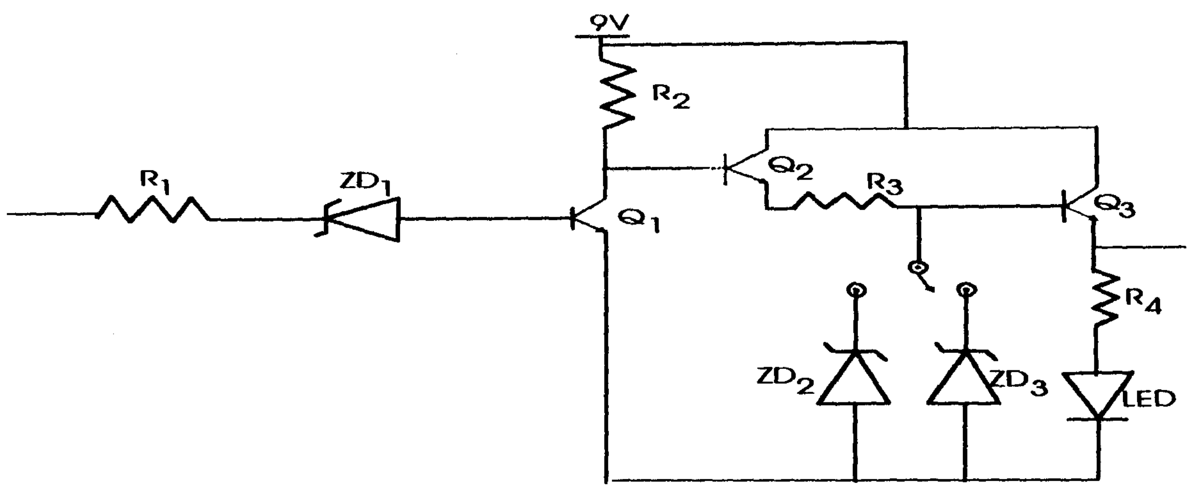


fig 2.1 (d) The switching circuit.

When the telephone hand set is ON-HOOK, the average voltage across the telephone terminal is 50V d.c. as measured.

The transistor Q1 has to be biased, therefore R1 allows some current just enough to saturate the transistor Q1.When the transistor Q1 gets saturated, the output voltage V_{CE1} becomes about zero volt, as can be seen from the output characteristics of transistor In fig 2 .1 (b). This voltage is transferred to the output of the circuit which in turn is zero and circuit stays off this implies that Q1 is ON, but VCE = VCE! sat = 0V and therefore Q2 is OFF.At OFF- HOOK, when the handset is lifted off the cradle, the voltage across Q1is below the breakdown voltage of zener diode, therefore no current flows and the voltage at node N is that due to supply (power) from the 9V d.c. battery which causes the transistor Q2 to conduct.

to conduct.. The resistor R2 between the 9V power supply and the base of transistor Q2 is to allow only about 0.7 V to be dropped at the base emitter junction of Q2 and therefore V_{BE} for Q2 is 0.7V. The resistor is also to ensure that the transistor is turned off with a reverse biased emitter junction.

The output voltage becomes the voltage of the selected Zener diode, while current is that amplified by the transistor Q3 enough for recorder operation.

The expected output voltage is 6V/3V , and current of 200mA. Minimum, input resistance of the recorder for a 6V option is given as Ro,

therefore Ro = Vo/Io

Ro = 6 / 200mA = 6 /. 0.2 = 30Ω

And from Io= $\beta 3 I_{B3}$, where Io = I_E.

Where β3 = 520 for Bc108 transistor,

I_{B3} = 0.2 / 520 = 0.385mA

Also the saturation base emitter voltage V_{BE} sat = 0.67 ≈ 0.7V

Therefore. $V_{z3} = 6 + 0.7 = 6.7$ V

From the analysis of the simple breakdown diode regulator which is a very simple shunt regulator in the form of a break down diode and current limiting resistor R_3, as shown in fig 2.1(e) below.

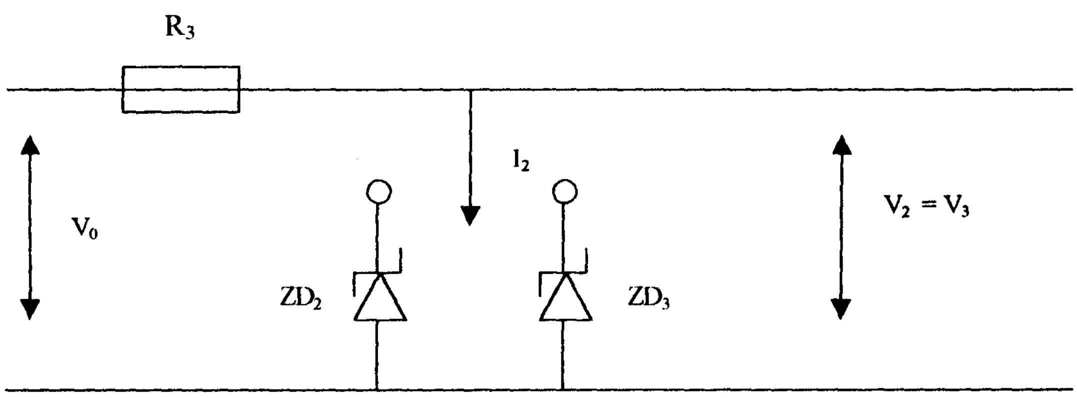


Fig 2.1 (e) Shunt regulator- (voltage).

For any particular chosen zener diode, the output voltage which happens to be the zener voltage of the device can be calculated.

For the ZD3, $V_{Z3} = 6 + 0.7 = 6.7$ V,

Hence a close value of 6.8 V zener diode is chosen for a 6 V while, 3.8 V zener diode is for 3V.

Most zener diodes on rated 300mw, thus for a 6.8 V diode, maximum input current can be determined.

$I_Z = p_Z / V_Z$

Therefore $I_Z = 0.3 / 6.8 = 44.1$ mA

But $I_Z$max can only occur at no load (when recorder is not connected) From the analysis of the regulator circuit. Therefore R_3 is the source resistance.

$I_Z(max) = V_K\, max - V_Z / R_3$

For the 9V battery supply;

$44.1mA = 9 - 6.8 / R_3$

$R_3 = 49.9\ \Omega\ = 50\Omega.$

The transistor Q3, that serves as a supply for the recorder is an emitter follower current amplifier, therefore the value of R_3 calculated which happens to be the minimum value of resistance for I_Z (max) of 44.1 mA is not necessary. Therefore, the minimum base current for saturation of transistor Q3 at output current of 200mA (at 6 v choice).

Thus;

$I_{E3} = I_{C3} = \beta_3 I_{B3}$

Therefore $I_{B3} = I_{C3} / \ \beta_3\ = 200mA / 520 = 0.385mA.$

Therefore at full load $I_{B3} = 0.385mA.$ and $I_{B2} = 0$

Then Q2 drops by V_{BE2} of 0.70V.

Thus, $V_K(max) = 9 - 0.70 = 8.30V.$

With V_K (max) as supply voltage.

$I_Z\ (max) = V_K\ (max) - V_Z / R3$

Therefore , $0.385mA = 8.30 - 6.8 / R3$

$R3 = 8.30 - 6.8 / 0.385\ *E\text{-}3 = 3.9\ K\Omega.$

The minimum base current for Q2 is I_{B2},

$I_{C2} / \beta_2 = I_{B3} + I_Z / \beta_2$

$I_{C2} = I_{B3} + I_Z = I_K = 0.385mA$.

$I_{B2} = 0.385mA / 520 = 0.74 uA$, $\beta 2 = 520$ for BC108.

This is the current applied to Q2 from Q1 and when off hook, Q1 is cut off.

At node K,

$I_K = I_{\beta 2} + I_{C1}$

$I_{C1} = I_{C1}$ (sat) $= 9V / R_L$ (off hook)

Thus , $I_{B2} = 0$

For off- hook, Q1 is off and $I_{C1} = 0$, because $I_{B1} = 0$.

At on hook $V_{CE1} = 0$ (saturation of Q1).

Therefore $I_{C1} = (Vdc - V_{BE}$ sat$) / R2$

R2 = (9V - 0.1) / Ic1 where $I_{C1} = I_{B2}$.

from analysis, R2 = 9V – 0.7 / 0.74uA = 11.2MΩ

but also, Ic (on) = Vcc – V_{CE}(sat) / R2

Max- current for the transistor BC 108 = 100mA

Therefore 0.1 = 9 – 0.25 / R2

0.1R2 = 8.75

R2 = 87.5Ω

But a value of R2 to provide saturation for the transistor Q2 is required, therefore the chosen value of R2 is 1000Ω.

I_{C1} sat = Vcc / R2 = 90mA

IB1 sat = 90mA / 520 = 0.0173mA, $\beta 1 = 520$ for BC108.

The zener diode ZD_1 is a 20v zener diode, therefore the resistor R1 is to protect the diode and set up the base current required for Saturation. Therefore R1 is required to drop (50v-20v), 30v.

$V_{R1} = 30V$

$30V = I_{B1} * R1$

R1 = 30 / 0.115mA = 260KΩ.

Because of large value of R1, the minimum value of required to set up minimum base current for saturation is chosen.

Therefore R1 = 100kΩ.

For a 40mA light emitting diode, (LED) .

R4 * 40mA = 6V (output voltage).

R4 = 6V / 40mA

R4 = 150Ω

THE SELECTOR CONNECTION.

The selector switch used in the system is used to select between the 6V and 3V output voltage as desired by the user of the circuit based on available recording set connected at the output of the terminals of the switching system.

The selector switch is a six terminal passive device that can be used to switch to any of the two desired level of voltage between the available range of 6V and 3 V .

The connection is based on terminals shown below on fig 2 (e)

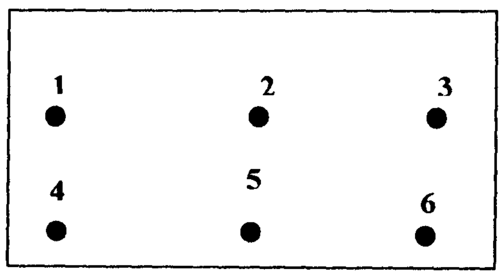


Figure 2(e) switch terminal as viewed from below.

During testing the selector was switched left (←) for testing of the terminals that reads to another.

The results obtained is as given below.

1 reads to 2

2 reads to 1

4 reads to 5

5 reads to 4

5 reads to 4

in summary, terminals 1 and 2 can be connected and so also is 4 and 5. Also the selector was switched right (⟶) for testing of the terminals, the results obtained is as given below.

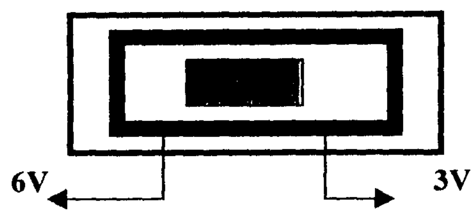
3 reads to 2

4 reads to 6

Also , in summary, terminals 2 and 3 can be connected and so also can terminals 5 and 6 be connected.

Finally with terminal 2 common to both sides of the selector, it can be used as a reference point and terminal 1 on one side and terminal 3 on the other side used together to select 6V and 3 V output for the circuit respectively.

The above explanation gives the theory behind the connection of the selector device.



2. 2 ATTENUATION / FILTER CIRCUIT

Sound attenuation is the reduction in amplitude of a sound wave as it propagates through a medium.

This circuit is to compensate for the loss and also filter out the voice signal between the designated frequency band.

As a signal is propagated along a transmission line, it will be attenuated , this attenuation is greater at higher frequency than lower frequencies.

The effect of line attenuation is therefore to reduce the amplitude of harmonics relative to the fundamental and make received sound seem unnatural.

A circuit known as equalizer is fitted to the receiving end of a line and is adjusted to have an attenuation frequency characteristics which is the inverse of the attenuation response of the line.

Whatever the type of cable used, the conductors must have some electrical resistance, furthermore, the insulating material used to separate the two conductors of a pair will have a value of insulation resistance, which will allow a very small current to flow between the conductors, instead of flowing along the conductors to the distant end.

Also, the insulation between the conductors form a capacitance which provide a conducting part between the conductors for alternating current. The conducting path becoming better as the frequency of the alternating current increases.

The capacitance also has the ability to store electrical energy. This capacitance path therefore prevents part of a. c information signal from traveling along the conductors to the distant end.

Energy is used to make the current flow against the resistance along the conductor and against the insulation resistance between the conductors. Energy is also used in charging and discharging the capacitance between the conductors. In the case of an information signal, the energy is extracted from the signal source, so energy available is gradually decreased as the signal travel along the line, and this is what we call attenuation.

If the line is long, the attenuation is large; eventually the signal energy available at the distant end is too small to operate a receiving transducer.

Since it is evident that attenuation is frequency dependant, then if the frequency range of the voice signal is specified, then a filter can be specified. In addition, voice signal is super imposed on a d. c current from the telephone line and the voice signal is an alternating electronic speech of frequency range 300-3400HZ.

This voice signal affected by attenuation as the frequency varies from the minimum to maximum, as shown in fig. 2.2 (a).

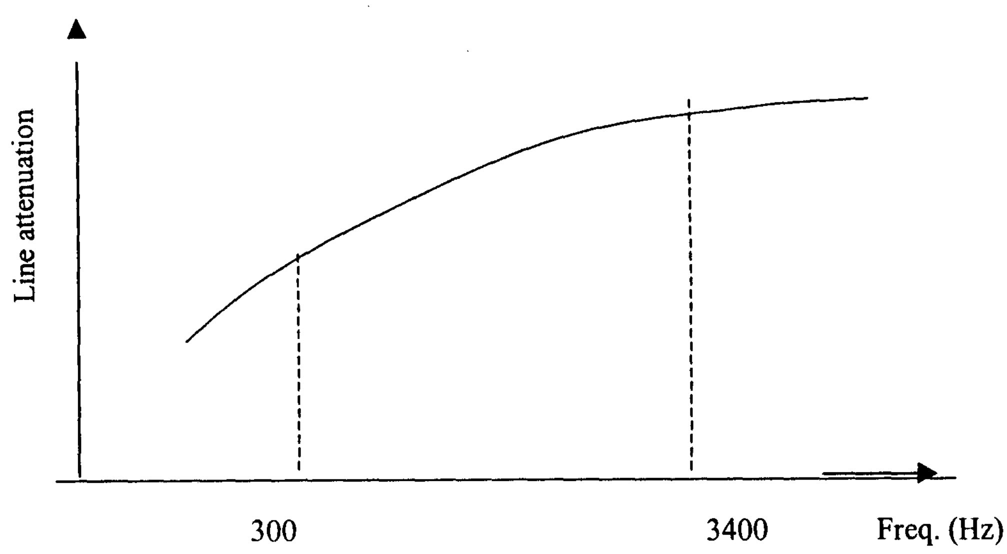


Fig.2.2(a) Attenuation Frequency characteristics.

Attenuation is minimized by increasing the average inductance per unit length, and this is the act called loading the line.

Therefore if a transmission line is loaded, attenuation is reduced.

Also, since the frequency range of the telephone signal is defined between 300HZ and 3400HZ , then band pass filter can be used to filter out the needed telephone message for recording by the output recorder.

FILTER DESIGN.

Since attenuation is minimized by increasing the average inductance per unit length of the transmission cable, and the range of frequencies is also affected. The simple RC filter produced by capacitor and resistor configuration can produce High pass or Low-pass gain characteristics, with 6dB/octave fall - off well beyond the -3dB point. By cascading high-pass and low-pass filters we can obtain a band-pass filter required for the project.

Often however, filter with flatter pass band and steeper skirts are needed, this happen when ever signals must be filtered from other interfering signals nearby in frequency.

From the ideas on operational amplifiers, we already know that simple cascading won't work, since each sections input impedance will load the previous section seriously, degrading the response.

But with buffers between each section (or by arranging to have each section of much higher impedance than the other one preceding it), it would seem possible. Nonetheless, the answer is no. Cascading RC filters do produce a steep ultimate fall off, but the knee of the curve of response versus frequency is sharpened. This point can be presented graphically by plotting graph of gain response (i.e. V_{OUT} / V_{IN}) Versus frequency for low pass filters constructed from 1 ,2, 4, 8, 16,and 32 identical RC sections, perfectly buffered. The graph is shown in figure 2.2 (b) below.

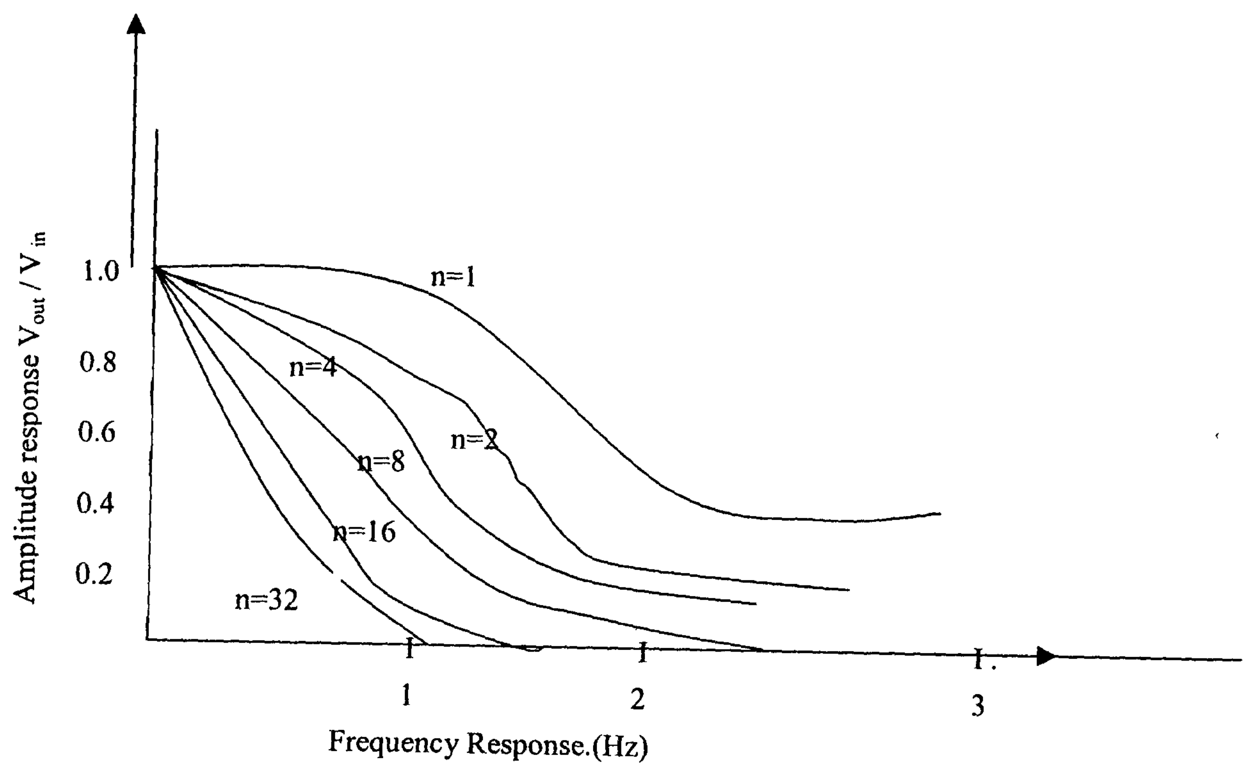


Fig 2.2 (b) Frequency response of multi section RC filters.

The graph shows the effect of cascading several RC sections, each with it's 3dB point at unit frequency. As more sections are added, the overall 3dB point is pushed downward in frequency, as it could have easily been predicted. Therefore, it is obvious that using a simple band pass filter will do more good than harm it has to offer to this system design. But in other to load the circuit input with an inductor value an RLC circuit will be more desirable to compensate for the attenuation in the circuit of the telephone.

Filters made this inductors, capacitors and resistor can have very sharp responses. By including inductors in circuit, it is possible to create filters with any desired flatness of pass band combined with sharpness of transition and steepness of tall off outside the band.

The only problem is that inductor as circuit elements frequently leave much to be desired. They are often bulky and expensive, and they depart from the ideal by being "lossy" i.e by having significant series resistance, as well as other 'pathologies" such as non linearity, distributed winding capacitance, and susceptibility to magnetic pick up of interference.

The most important thing that is needed now is a way to make inductor less filters with the characteristics of ideal RLC filters.

Invariably, what is required is make an active filter that possesses the characteristics of the RLC (passive) filter

By using OP-Amps as part of the filter design, it is possible to synthesize any RLC filter characteristic without using inductors. Such inductor less filters are known as Active Filters because of the inclusion of an active element (the amplifier).

Active filters can be used to make low-pass, high pass, band pass, and band reject filters, with a choice of filter types according to the important features of the response, e.g maximal flatness of pass-band, steepness of skirts, or uniformity of time delay versus frequency

CHARATERISTICS OF BAND PASS FILTERS.

The most obvious characteristic of a filter is it's gain versus frequency. The pass band is the region of frequency that are relatively unattenuated by the filter. Most often, the pass band is considered to extend to the 3dB point.

Cut-off frequency F_C. Is the end of the pass band, the response of the filter then drops off through a transition region also colorfully known as the skirt of filter's response, to a stop band, the region of significant attenuation.

The band pass filter will have two cut-off frequencies, one serving as the lower cut-off frequency (F_{C1}) and the other serving as the higher cut-off frequency (F_{C2}).

The frequency response of a standard band pass filter is presented graphically in figure 2.2(b) below.

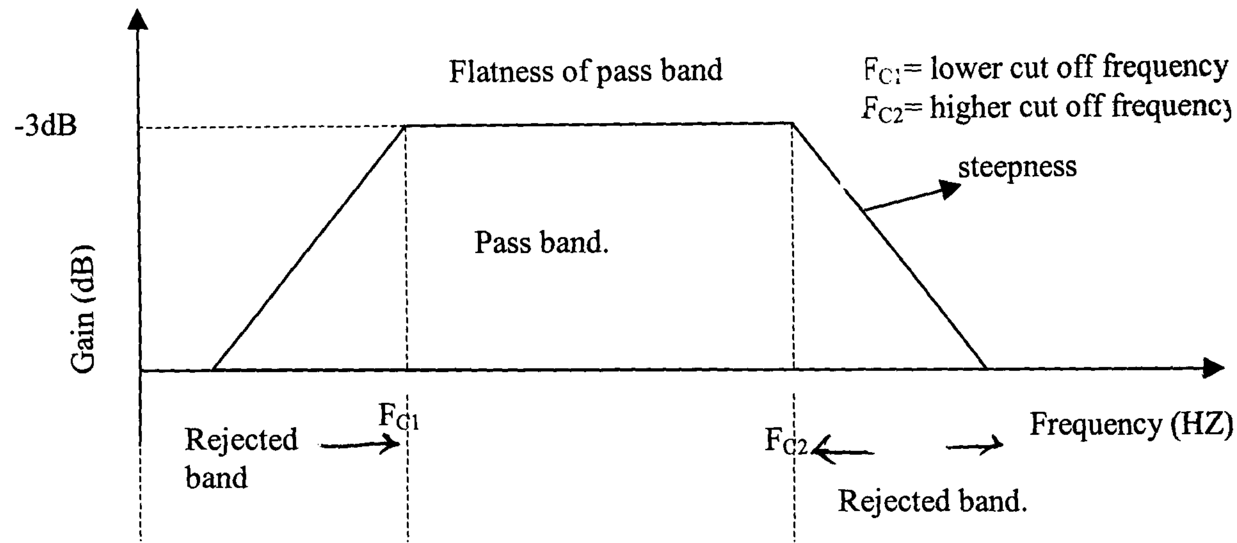


Fig. 2.2(b) Frequency Response of a band pass Filter.

In this system design, it is desired to filter out the telephone message and reject any otherwise that might attempt to distort the desired message to be recorded.

The telephone message is known to have a band width of 3100HZ.The upper and the lower cut-off frequencies for the telephone signal are given as F_{C1}=300HZ, F_{C2}=3400HZ, respectively. Therefore, it is desired to pass signals within 300HZ and 3400HZ and reject signals lower than 300HZ and higher than 3400HZ

Just like the way, then are so many ways of solving mathematical problems, so also there are many filter types with each designated to perform better in a particular area of application.

The ultimate is to choose the best design for the job.

The various types are given below, with their characteristics.

FILETR TYPE.	CHARATERISTIC.
Butter worth	Maximally flat pass band
Chebyshev	Steepest transition from pass Band to stop band.
Bessel	Maximally flat time delay.

The these filters are available in low-pass, high- pass and versions.

since in this system the aim is to get the telephone message out and records it on a magnetic tape ,we consider the Butter worth type.

BUTTER WORTH FILTERS

The butter worth filter produces the flattest pass band response, at the expense of steepness in the transition region from pass band to stop band. It's also has poor phase characteristics.

Butter worth filter trades off everything else for maximum flatness of response. It starts out extremely flat at zero frequency and bends over the cut off frequency fc (fc is usually the –3dB point). Butter worth filter in this application produces maximum flatness over the pass band and this produces the exact information needed to be recorded by the tape recorder connected to the output of the filter circuit.

Most importantly, In most applications, all that really matter is that the wiggles in the pass band response be kept less than some amount, say 1dB. This gives room for the faithful reproduction of the required telephone message.

The filter circuit used in this system is a single pole band passes filter to filter out the telephone message.

The design is given as follows;

Telephone message occupies the frequency range of 300Hz to 3400Hz, The filter circuit used in this system is a single pole band passes filter to filter out the telephone message.

The design is given as follows;

Telephone message occupies the frequency range of 300Hz to 3400Hz,

Therefore Band width = Higher frequency – Lower frequency

(Bandwidth) B = (3400-300) Hz = 3100 Hz.

Center frequency = rejected band (0-300Hz) + ½ band width

Center frequency = C.F = (300 + 1550) Hz = 1850 Hz

The resistor to be used in the filter circuit must have at most a tolerance range of 10%.

Using the electronic circuit design software to obtain the filter circuit. The following data were supplied,

1. Active filter design
2. Band pass filter
3. Resistor tolerance =10%
4. Center frequency =1850 Hz
5. Band width =3100 Hz

The circuit obtained is as given in the figure below.

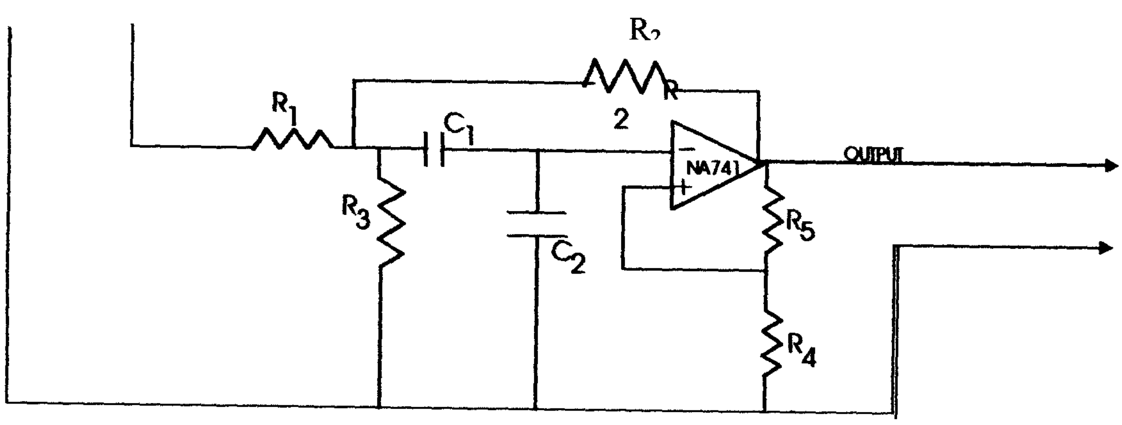


Figure 2.2(b) Band pass filter circuit.

The following sets of data were obtained for the component values. Two sets of values were obtained for two filters that will perform same operations.

SET 1.

C_1 =ln F	C.F =1850 Hz
C_2 = 0.5nF	B.W =3100 Hz
R_1 = 180k	Tolerance = 10%
R_2 = 56k	R_4 = 38k
R_3 =330k	R_5 =62k

SET 2

C_1 =10nF	R_4 =38k
C_2 =5nF	R_5 =62k
R_1 =18k	C.F =1850 hz
R_2 =6k	B.W =3100 Hz
R_3 =33k	Tolerance =10%

Because of availability the second set of components were used to implement the filter circuit.

The frequency response obtained for the band pass filter is given by the figure below,

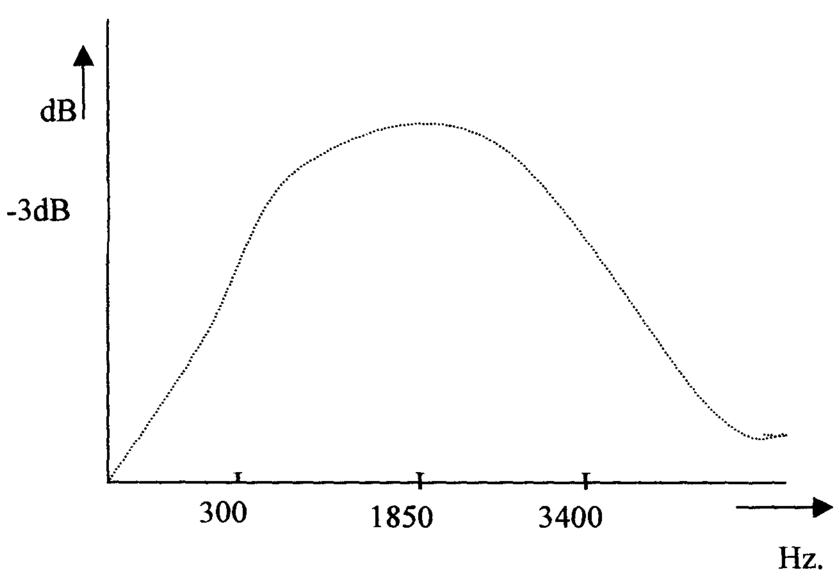


Fig. 2.2 ([illegible]) Frequency response of the band – pass filter.

2.3 RECORDER CIRCUIT

The recording module of the system is made up of mainly the type recording equipment, which records the acquired information, which happens to be the output of the filter circuit into a magnetic tape for storage. There are two main input to the recorder circuit, these are the output of the switching circuit and output of the attenuation / filter circuit these two inputs to the recorder circuit are what makes the recorder circuit to perform its function. The output of the switching circuit goes into the power section to supply power to the recorder and the out put from the attenuation circuit goes to the auxiliary section of the tape recorder for recording.

The play and record buttons of the tape recorder are permanently depressed and only requires activation by the switching circuit output.

When ever the telephone system is OFF-HOOK, for a 6V recorder system, a 6V output appears across the terminal of the recorder and this powers the recorder to initiate recording actions. The message received from the filter out put is then recorded on the magnetic tape in the recording equipment. Same procedure is applied if a 3V recorder is connected to the output of the switching circuit, only that the switch is used to select a 3V output in the circuit.

In-between the switching and the recorder circuit is an indicator lamp, used to indicate the on-off situation of the switching circuit. When the telephone set is OFF HOOK , the light emitting diode comes on by glowing and when the telephone set is ON HOOK , the light will not glow indicating an off situation for the switching circuit.

With the message recorded in the magnetic tape, it can then be stored or used for other purpose.

CHAPTER THREE

3.0 CONSTRUCTION AND TESTING

The construction and testing of the project work was carried out in modular form. The project was divided into modules and each module was constructed and tested during and after construction. . Matrix layout of component on paper was first used, that is the circuit diagram was first analyzed on paper and all design analysis was done to determine the values of the component required. With the values determined by calculations the the circuit was then transferred to the electronic work bench were the connection were made and simulations performed to see the response of the designed system to some of the predetermined input

The designed circuit responded as desired to the input signal at various values of the input signal. Also the filter circuit responded at the desired cut off frequencies, with the simulations having worked as desired, the physical components was latter transferred to the bread board for testing in order to make sure that the physical components works as desired. The various component of the system were developed one after another.

The components of the switching circuit were latter transferred Vero board and the circuit was constructed as that shown in fig 2.1 (d) testing was carried out for various values of the out put, that is for 3V and for 6V respectively. Permanent soldering was latter carried out on the component and the components were seriously protected from being damage by heat and were firmly soldered to the board.

Also of the attenuation / filter circuit were also mounted on the Vero board for permanent soldering.

After the modular construction and testing the circuit, each module was connected to the other to form the entire system. The point of connection was at the telephone handset terminal, the overall system was then connected to the telephone recorder circuit. The power section that happens to be the output of the switching circuit was connected through a jack terminal to the power input of the recorder system. In addition, the output of the filter circuit was connected to the microphone input of the recorder through a jack.

The entire system was later tested to record telephones message. The entire system was accomplished by using available circuit components that is, it was as built around relatively cheap components rather than the miniature components.

The list of components used and their respective values are presented in a tabular form as shown below in table 3.1.

TABLE 3.1 COMPONENTS AND VALUES

Designating parameter	Values of components
R1	100K
R2	1K
R3	50R
R4	150R
Q1	BC108
Q2	BC108
Q3	BC108
ZD1	20V Zener diode
ZD2	6.8V zener diode 1N5235
ZD3	3.9V zener diode.
LED	Red 200mA LED.
FILTER CIRCUIT.	
C1	10nf
C2	5nf
R1	18K
R1	6K
R3	33K
R4	38K

R5	62K
OP-AMP	UA741

3.2.1 RESULTS.

The results obtained from the system are presented in the tabular form below.

The tables are arranged according to how the tests were carried out. That is telephone terminal measurements were taken, also output of switching circuit were taken with recorder connected and also without the recorder connected across its terminals. Also measurement were taken at off hook and on hook situations

All together five tables are presented for the result. The tables are explained as follows.

For table 1. The values displayed are the telephone lines at ON-HOOK states of the handset. From the tables it can be seen that the output voltage of the telephone line at ON-HOOK was not stable. It ranges between 52V and 56.3V.And these range was maintained, but for accuracy the average values of 54V. Was taken after four different measurements were recorded.

In tables 2. The switching circuit input and output values at ON_HOOK are presented; these values are taken without the recorder connected at the output.

Also table 3. Presents the OFF -HOOK states of the handset, these values are the input and output values of the switching circuit also with the recorder disconnected

In both tables 2 and 3, the values were taken 4 times each in order to obtain an average value that can be reliable and present a true value both from the switching input and the switching circuit output.

Tables 4 and 5 are the values obtained with the recorder connected to the systems output. They represent the ON-HOOK and OFF-HOOK situations of the telephone respectively.

All the values in the tables were taken from the switching circuit selector positioned at the 6V.output part of the switch

All values in the tables were taken at least four times to avoid error in measurement.

TABLE 1. TELEPHONE LINES AND OUTPUT VALUES.

ON-HOOK			OFF-HOOK		
Voltage (V)	Current (mA)	Resistance (KΩ)	Voltage (V)	Current (mA)	Resistance (KΩ)
56.2	46.20	37.6	6.9	45.9	42.2
56.3	46.00	39.6	6.9	45.9	42.3
56.3	45.90	37.2	6.9	45.9	42.4
56.0	46.0	37.0	6.9	45.9	42.4

<u>TABLE 2</u> .SWITCHING SYSTEM INPUT, AND OUTPUT VALUES AT ON- H00K WITHOUT THE RECORDER. (From the workbench)

Input Voltage (V)	Current (mA)	Resistance (KΩ)	Output Voltage (V)	Current (mA)	Resistance (KΩ)
52.63	46.10	37.5	0.00	0.00	38
51.42	44.30	37.9	0.00	0.00	37
52.00	45.10	36.9	0.00	0.00	37
50.06	44.59	38	0.00	0.00	38.1

TABLE 3 SWITCHING SYSTEMS INPUT AND OUTPUT VALUES AT OFF-HOOK WITHOUT THE RECORDER

Input Voltage (V)	Current (mA)	Rssistance (KΩ)	Output Voltage (V)	Current (mA)	Ressistance (KΩ)
6.90	45.8	37	6.32	455	36.9
7.10	45.9	38	6.41	461	38
6.95	45.3	37	6.24	450	37
6.92	45.6	37.6	6.21	448	38.1

TABLE 4 SWITCHING CIRCUIT INPUT AND OUTPUT AT ON-HOOK WITH THE RECORDER

Input Voltage (V)	Current (mA)	Resistance (KΩ)	Output Voltage (V)	Current (mA)	Resistance (KΩ)
51.60	46.30	38.8	0.00	0.00	37.9
52.61	46.30	38	0.00	0.00	37
52.00	45.20	37.9	0.00	0.00	37.6
54.10	45.90	37	0.00	0.00	38

TABLE 5 SWITCHING SYSTEM INPUT AND OUTPUT AT OFF HOOK WITH THE RECORDER CONNECTED

Input Voltage (V)	Current (mA)	Rssistance (KΩ)	Output Voltage (V)	Current (mA)	Ressistance (KΩ)
7.60	46.30	37.8	6.34	459	38
7.64	46.41	37.9	6.35	463	37.8
7.41	45.92	37.2	6.21	444	37.8
7.52	46.00	38.2	6.21	456	38.9

3.3 DISCUSSION OF RESULT

From the results obtained and presented in the tables above, it is very evident that the switch work automatically in response to the situation of the telephone line, that is if it is ON HOOK or OFF HOOK. The output voltage of the circuit presents power to the recorder system.

The result presented above is based on the selector switch working at the 6V output voltage.

CHAPTER FOUR

CONCLUSION.

The device described above operates automatically. It turns on the storage system at specified input voltage from the switch at off-hook, when the handset is lifted and records the message on the line. The device turns off the acquisition system when the handset is replaced (ON-HOOK). The device records clearly both sides of the conversation of the telephone using magnetic tape as a storage material. The device at off hook is indicated by the glowing of the LED, which serves as indicator to indicate the situation of the recorder system.

4.2 RECOMMENDATION

With the telephone message acquisition system developed, the recording of the telephone message is done on the magnetic tape, in other to improve the capacity and sound quality of the recorded message, a much better recording material can be used to document the message. With the material documented on compact disc, this can be achieved.

Also micro soldering can be employed in order to reduce the size of the system and also much compact packaging can reduce the size (physical) of the storage system. The use of active filters and higher number of poles in filter type can be used to improve the filters frequency characteristics at cut - off

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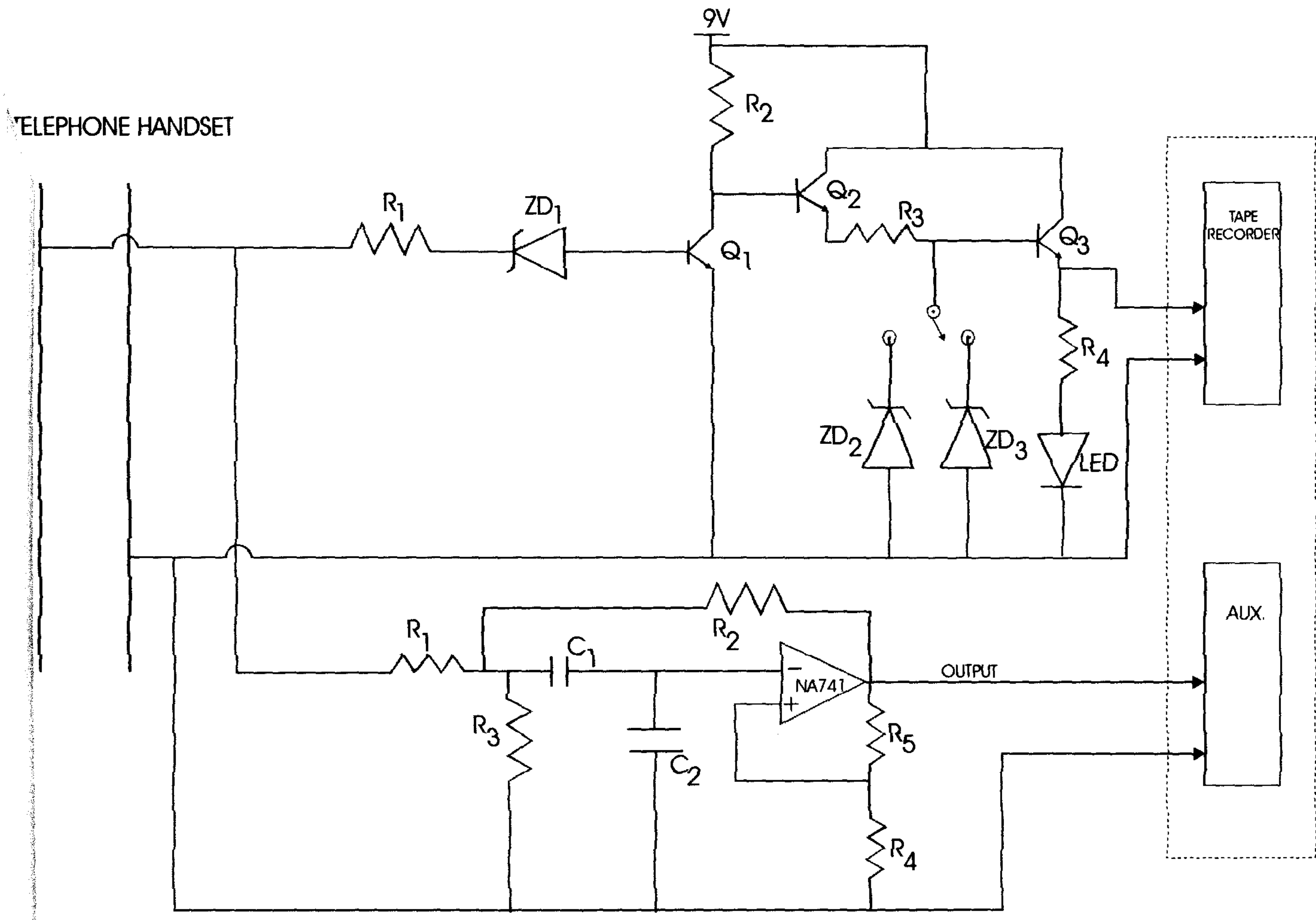
APPENDIX ONE.



CIRCUIT DIAGRAM.