DESIGN, CONSTRUCTION & TESTING

OF AN

INTRUDER/BURGLAR ALARM SYSTEM

BY

FAKOREDE ADEYEMI TUNDE 93/3576

IN PARTIAL FULFILLMENT OF THE AWARD OF
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CERTIFICATION

This is to certify that this project "Design of an Intruder/Burglar Alarm System" is the original work of Fakorede Adeyemi Tunde carried out wholly by him under the supervision of Eng. Y.A. Adediran and submitted to the Department of Electrical Engineering, Federal University of Technology, Minna.

1. Eng. Y.A. Adediran (Supervisor) — Date

2. Eng. Y.A. Adediran (Head of Department) — Date

3. External Examiner — 17/01/2001 Date

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CHAPTER FOUR

DEDICATION

To God be the glory. Firstly, I want to dedicate this project to the Almighty god, the Alfa, the Omega, the beginning and the end. It appeared it will never be, but today the table has turned around . Some people we started together fell by the way side, some never saw today and their dreams of appearing in the green and white (NYSC) uniform have been shattered. I am not rejoicing over them but praising God for his incalculable mercy.

Secondly, I want to dedicate this project to my father Mr E.I. Fakorede and my (weep not child) caring mother Mrs D.A. Fakorede whose effort to reach the level I am today will remain fresh in my memory for life.

Lastly, I am dedicating this project to Mr & Mrs Alabi in response to their financial support since the beginning of this adventure till date. God will bless you all and water your orchard (Amen).

ACKNOWLEDGEMENT

"This is the day the Lord has made, I will be glad and rejoice in it". I thank the Almighty God, for the great things he has done. It seemed as if it was not going to be but, today, it is obvious why I should be thankful.

My gratitude goes to my supervisor, and the H.O.D. Electrical and Computer Department (Engr. Y.A. Adediram) for being a father to me throughout the time of my project, his invaluable corrective effort is something I will live to remember. Also to all the entire lecturers of the Department of Electrical and Computer Engineering, who have been providing me with all the brain tools used to carry out this project right from inception into the department till date.

My sincere gratitude goes to my Father, Mr. E.I. Fakorede and my Priceless Mum, Mrs. D.A. Fakorede, for their love and support throughout my course. I cannot but extend my gratitude to my second father Mr. A.A. Alabi and my aunti Mrs. R.O. Alabi, for their financial support and parental guidance since I started this adventure.

My gratitude also goes to my many supporters that have one way or the other contributed immensely to my success today. I am very grateful and I pray that God Almighty will bless you more abundantly in return. People like Alj. Shehu, Eng. Gumel, Mr. Aderibigbe, Chief R. Dokpesi, Mr. Babatunde, Mr Ugoewe, Dr. Barrow Mr G.C. Ukamadu, Mr Taju Kareem Mr. Taju Armed, Mr Duduyemi, my dear brother (Taiwo Fakorede) and the rest I can't remember right now.

Also my gratitude goes to those who never wished me this success. They have always thought it was an illusion that can never come to pass. I will not but love to remember the challenges that you posed against me that have the other way

round turned me to a harder man today. I am very grateful for the imperative balance you made me realize was absent in my life. God will bless you for your effort.

ABSTRACT

Security of lives and properties as reflected in its name, is a means of assuring that lives and property are secured. This is the phenomenal index in which this project is based on.

The project describes the relativity between interference of a magnetic field and the normal condition of the field. It explains how interference can mark the end of normalcy and vice versa, Also the responses of the entire system to the two conditions are juxtaposed.

The system uses a dry-reed switch, which can be operated by a magnet. Moving the magnet away from the reed switch will cause the two contacts of the switch to open up, but bringing the field of the magnet close, will cause the two contacts to close up forming a link for a closed circuit. These two conditions form the logic behind this project. The system in turn responds to the first condition by producing a warning alarm, but to the latter, does not produce any sound alarm

Applying this electronic mechanism logically to the opening and closing of a door. The opening could then be related to moving the magnet away from the reed switch which causes the system to produce a warning note, and the closing related to moving the field of the magnet close to the reed switch, which in turn forces the system to be in its normal state and no warning note is produced.

This application is adopted for this project because of its two-way direct approach in analyzing the two states of the system (its either inclusion or no intrusion.) Other applications can behave funny sometimes, this is the reason for the precise control system applied.

AIMS AND OBJECTIVES

Immagine yourself all alone in the midnight busy watching a crucial football match on the screen of the T.V set in your bedroom, and the sudden moment of distraction came only when, the round edge of a cold black steel touched the back of your head, and a strange dreadful voice came from nowhere, saying "Your money or your life" I can't immagine how the shock absorbers in one's brain will recover from the sudden shock of that traumatic situation, which might cause stroke or even lead to death.

This project is aimed at pre-informing you on time of this kind of unimmaginable situations, say for instance, at the point of breaking in of the intruder. And of course, security organisations would have been informed in time either by phone or your alarm connected on line. This will at least assure your rescue or even prevent the intruder from coming near you, thereby saving lives and properties with a system fabricated from materials that are readily available with low cost of production.

Another objective is to design a system that almost half of the Nigerian population will be able to afford and maintain. This is achieved because the operation protocol involved is highly instinctive and reliability factor taken into consideration in designing the system.

CHAPTER ONE

1.1 INTRODUCTION

In a vast society like Nigeria where rate of crime is sky-rocketing everyday, it becomes necessary to device a system (electronic) that can monitor what is happening in your house or office complex when you are either not around or sleeping. Since any nature of intrusion is executed by human beings, bringing about the movement of something or his own body makes it feasible to device a system to detect either the presence of someone or the movement of what he must move to execute his plans.

There are many ways by which the presence of an unwelcome visitor or even a thief can be detected. Let us take it from the scratch with the simplest electrical circuit method using a tripwire. This wire need not be connected if its movement simply operates an alarm switch using a trip wire carrying a current which holds a relay on. If the fine wire is broken by an intruder, the relay de-energizes, thereby switching on an alarm via two of its contacts. This is the foundational principle upon which this project is built.

This project describes how, the breaking of a magnetic field between a magnet and a reed switch , which is logically synonymous to the opening of a door can operate an alarm.

Since a designer's consideration to the targeted users is always based on cost, sensitivity, efficiency, safety, reliability and availability this project is not lagging in taking all these factors into consideration.

In advanced countries, an alarm is triggered by noise inevitably produced by the intruder, which is sampled by sound compactors, or even his body unknowingly breaking an invisible infra-red beam. Another way is by fixing a hidden camera at the entrance of a building which gives a clear picture of who is coming on a screen connected to it inside.

Interestingly, some countries have established their own security networks, where a person can monitor all the nodes connected to a central hub, then informs the concerned organisations.

1.2 LITERATURE REVIEW

Scientists who say there are just three basic necessities of life might have made an ignorant mistake. If not, why are you feeding, sheltering and watering a life that is not secured? This is where Security of life comes to mind as the fourth necessity.

Security is the act that provides safety, freedom from danger and anxiety. It can also be seen as the precautions taken to protect lives and property. Fear of uncertainties tortures the cerebrum, once it dominates the brain, the way forward seems glooming. This could be as a result of overshooting of adrenaline, which causes dullness of the brain, stroke and eventually might lead to death.

Freedom, in the presence of food, shelter and water nurtures life in a faculty of emotionally relaxed, progressive environment. Without this, life turns to an untimely two way (ON-OFF) switch which is triggered once, then packs-off.There are three concepts that can be used to detect the presence or movement a person. These concepts are: The infra-red concept, the visual concept, the magnetic concept .The infra-red concept explains how a beam of light waves, sent from a transmitter to a receiver, can serve as a set-up for detection. The beam, when disturbed in any way, from being received by the receiver will cause a drop of input voltage. An integrated circuit (I.C) chip connected to compare this input voltage with a reference voltage, will sence this voltage drop, thereby, giving an output, which is used to trigger an alarm, or to drive a relay. This concept was not used because , the component required are not easily available in the market as would be needed for large production. The visual concept shows how a network, consisting of a high-spec camera and a detecting circuit,connected to a screen, is used to visualise the happenings of a particular place. This concept is not preferable because of the cost and availability of the devices involved. The magnetic concept used in this project is the simplest and the best concept for any designer, taking Nigeria as a case study. The easy availability of the components used and the simple operation protocol involved to operate this system are interesting. Nobody can tell what will happen this millennium to make life Y2K Compliant, Security must be taken seriously because of unseen dangers of seriously timed, ballistic explosions of this new millennium. To this effect, various principle are being used to device means of safeguarding lives and properties. All hands are on deck by, especially electrical designers to bail the world out of this timed mess.

1.3 METHODOLOGY

In designing a transistor radio, the designers took into consideration various signals of different frequencies landing on the receiving antenna at the same time, as a result of radiation into space. By means of a frequency discriminator, which might be in the form of a tuning circuit, these signals are detected. Hence, the frequency selection is proportional to the tuning effect made, which makes it possible to select a desired station from series of stations available, since the frequency ranges (bandwidths) are different. Other methods use subtractors which remove (filter off) other signals different from the selected one, particularly when digital signals are involved.

This project in its scope describes how the opening of a door can trigger an alarm. The system uses a dry-reed switch which is operated by a magnet. When the magnet is some distance away from the reed switch, the contacts of the switch open up, but moving the magnet close to the switch causes the contacts of the switch to close up, since one of the contacts is a magnetic material, and the other is not. The magnet is fixed inside the door frame, and the reed switch inside the jam of the door at the same level with the former. Once the door is closed against the jam, the contacts of the reed switch also close up and current flows from the positive terminal of the supply connected to the reed switch, pass through, and then back to the supply's negative terminal. This is the normal mode the system is designed to be always.

When the door is opened, the magnet becomes far away from the reed switch, this causes the reed switch contacts to open up, thereby, causing the flow of current to stop from the supply. At this stage, the alarm is energized mainly by an astable multivibrator coupled with a signal magnifier and a transducer (loud speaker). The sound energy produced from the loud-speaker due to conversion from electrical signal to sound signifies that the door has been opened.

If only one door in a house is equipped with this system, the aim of security of lives and property will not be achieved since the intruder can decide to enter through another door in the house. Interestingly, this project solves this uncertainty, by making the system compliant with multi-door purposes. The exact door can then be determined by checking the indicator display, This makes the security system a directional system.

The importance of this project comes to mind when the basic considerations of any objective designer is examined. These include, easy installation, easy operation protocol, availability of materials required, and easy diagnose of the section that might have been faulted whenever there is a fault on the circuit network. Another advantage is its independence from power failure since an alternative means is available to power the system.

CHAPTER TWO

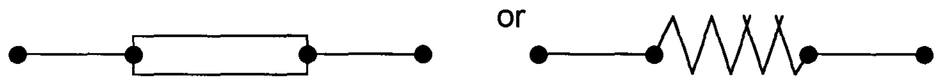
2.0 COMPONENTS DEFINITION

The intruder alarm system described in this project consists mainly of electrical, electronic and electro-mechanical devices/components, such as resistors, capacitors, inductors, diodes, transistors, to mention but few.

2.1 Resistor

A resistor is any element in an electric circuit that resists the flow of electric charge. They are mainly used to regulate voltages o other electrical and electronic components. A resistor rated 1Ω will allow one ampere of current through it when a potential difference of one volt is maintained across it.

Circuit Representation:-



(a) or

Fig. 1.1 (b)

Types of Resistors

(a) Linear Resistors - (those that obey Ohm's Law)

(b) Non-Linear Resistors – (do not obey Ohm's Law)

(c) Photo-Resistor – light sensitive and dependent resistor

(d) Thermistor – heat dependent resistor

(e) Voltage dependent Resistor

Only linear resistors are used in this project as represented above.

2.2 Capacitor

The energy storing property of an element in an electric field is called its capacitance. A capacitor is then an element that exhibits this storing property in an electric field. It consists of two conducting surfaces separated by an insulating medium. Capacitance is designated by C and measured in farads (F) or micro farads (mF) because of its small quantities.

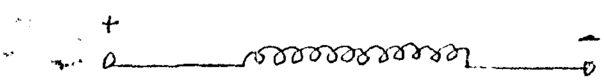
Circuit representation.

or

Fig.1.1 capacitor`s symbol

2.3 Inductor

An element that stores energy in a magnetic field is called an inductor. It is made of turns of wire. The ability of an element to exhibit this inductive property is called its self-inductance. This is measured in Henrys (H) and denoted by L, it is related to the voltage and current as V = L di/dt.



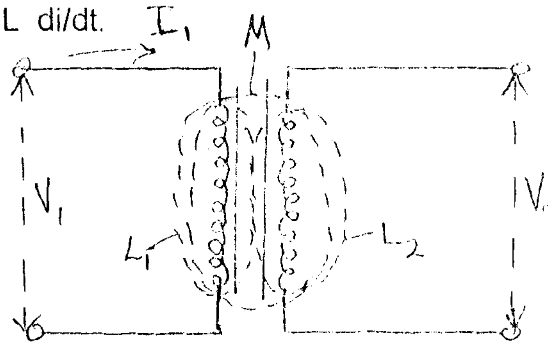
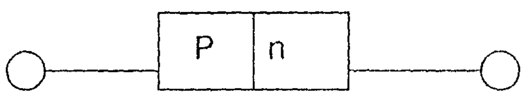


Fig.1.3 (a) Inductor`s simbol (b) Illustration of mutual inductance

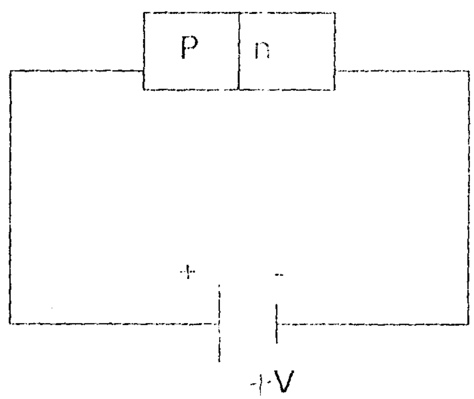
There is the possibility that current may be induced in other circuits linked by the field. Two circuits linked by the same magnetic field are said to be coupled to each other as in Fig. (1.3b) and is called the Mutual inductance, It is denoted by M, and has a mathematical relation as $V_2 = M\, di/dt$

2.3 Junction Diode

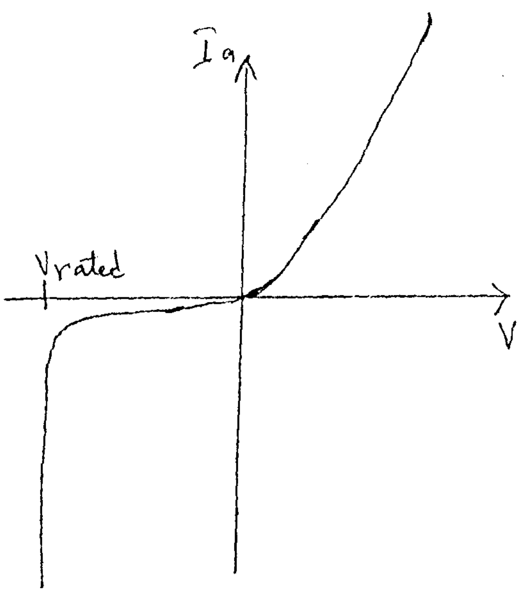
The fundamental building block upon which all semi-conductor devices are based is the p-n junction. The P layer has a greater concentration of holes and the n layer, greater concentration of electrons. The difference in concentration exhibits a gradient across the junction resulting in diffusion of carriers, which results in the production of immobile ions of opposite charge on each side of the junction. The region extending to both P and n regions is called the depletion region (space charge region); no mobile carrier exist in this region. The depletion region then establishes an electric field due to opposite in polarity of the two sides of the junction. The two effects of the field are the potential barrier and the drift current produced. The drift current causes holes to move from n to p. region and electrons from p to n region. In equilibrium, with no external circuit connected, no net current exists; the drift and diffusion components of current are equal and oppositely directed.



(a) Structure of a PN junction



(b) Forward bias



(d) V-i characteristics

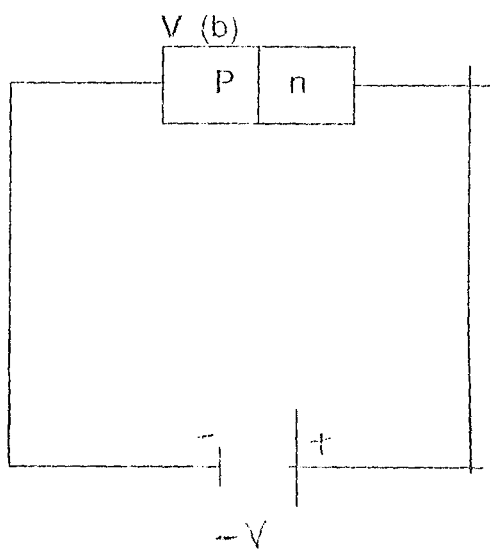


Fig.1.4 © Reverse bias

A diode is then a two-layer device of p.n junction as discussed.

Biasing of a Diode

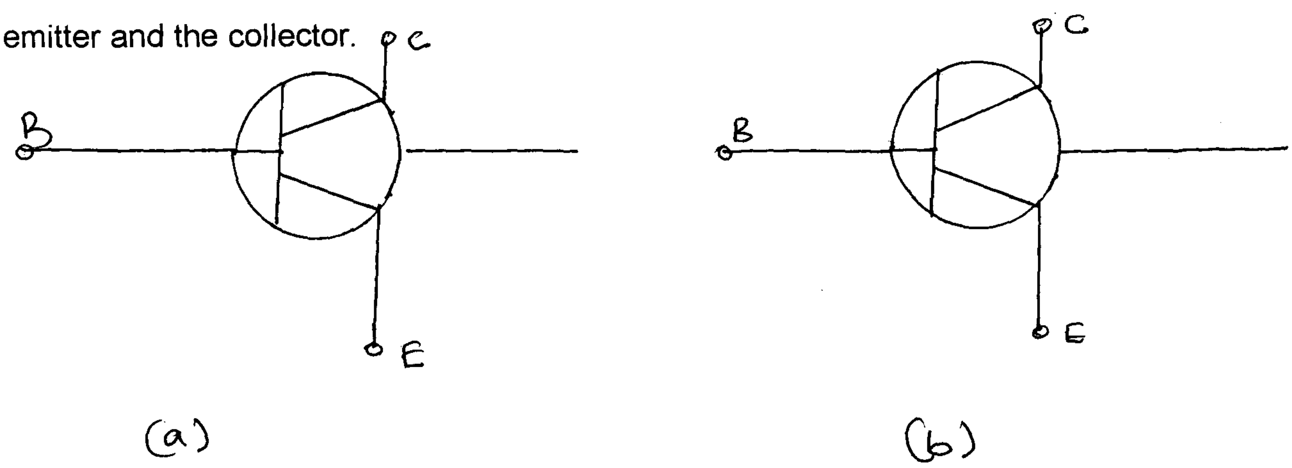
If an external circuit is connected as in Fig 1.4 (b) the voltage source V is the bias, when V=O the barrier is uneffected and the circuit behaves like an open circuited P-n junction. Positive values of V is called forward bias, the current increases because the barrier is reduced, when V is negative as in fig 1.4(c) it is called reverse bias, This increases the potential barrier and reduce the number of carriers at the boundary. Increasing the reverse bias does not affect the reverse current until breakdown occurs. Figure 1.4 (d) shows the V-i characteristic of a diode which explains the practical processes (step by step) of the output signal waveform produced.

(i) Application of Diodes

1. Diodes are mainly used as rectifiers (to convert a.c to d.c signal)
2. They are used in power regulation to clip voltages (Zener diode) and in clamping.
3. It can also be used as a switch due to its uni-directional nature.

2.5 Transistor

A transistor is a three-layer device which is formed of two pn- junctions. The representation in (a) below is a pnp transistor which of two p layers tapped as the emitter and collector terminals and the n-layer as the base terminal.Fig.1.5 (b) shows an npn transistor having both the collector and emitter terminals tapped at n-layer and the base as p-layer. The base is slightly doped compared to the emitter and the collector.



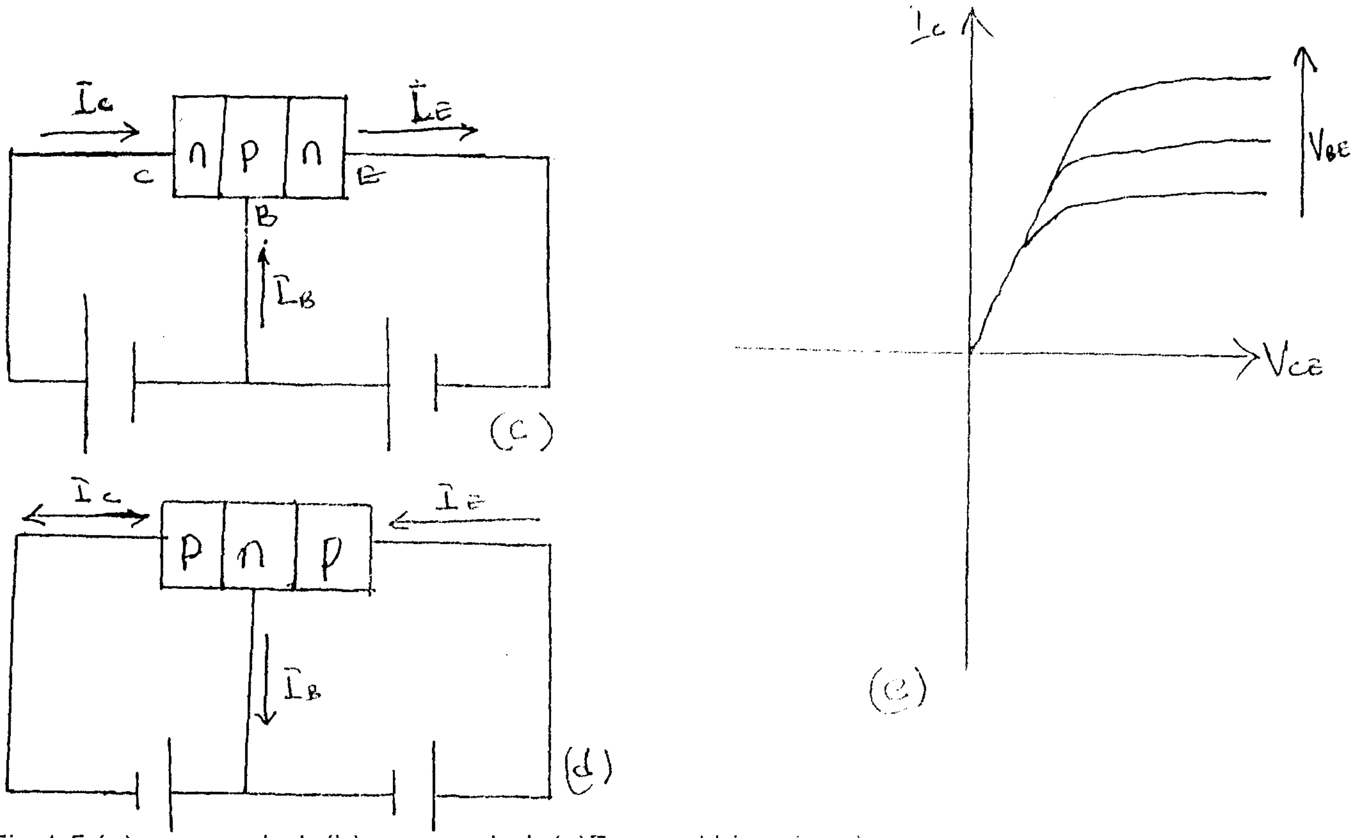


Fig.1.5 (a)npn symbol, (b)pnp symbol, (c)Forward bias (npn)
(d) Forward bias (pnp), (e)V-I characteristics.

2.6 **Relay Switch**

A basic relay consists of a coil, an iron core and a movable magnetic material usually an iron bar. It operates with the principle that a magnetic material, when placed within the field of an electromagnet, is attracted. The magnet as shown in Fig. 1.6 (a) is a temporary magnet that gains its magnetivity only when current flows through the coil, and losses it as current stops flowing. The iron rod is then attracted towards the terminal require

If a terminal A is fixed in between the upper E arm of the magnet and another terminal B at the side of the iron bar, the iron bar then becomes a two ways switch that switches to A (assuming ON) when current flows through the coil, and B (OFF) when current stops to flow. The effect of the attraction is usually controlled by fixing a control spring to the iron rod.

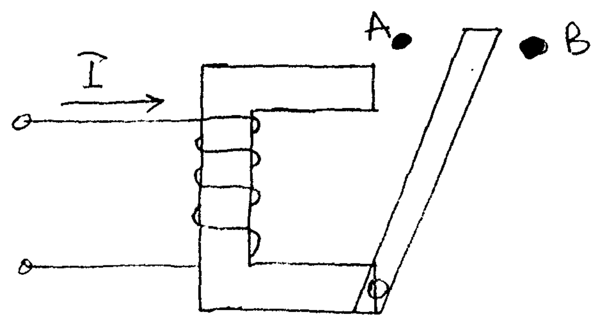
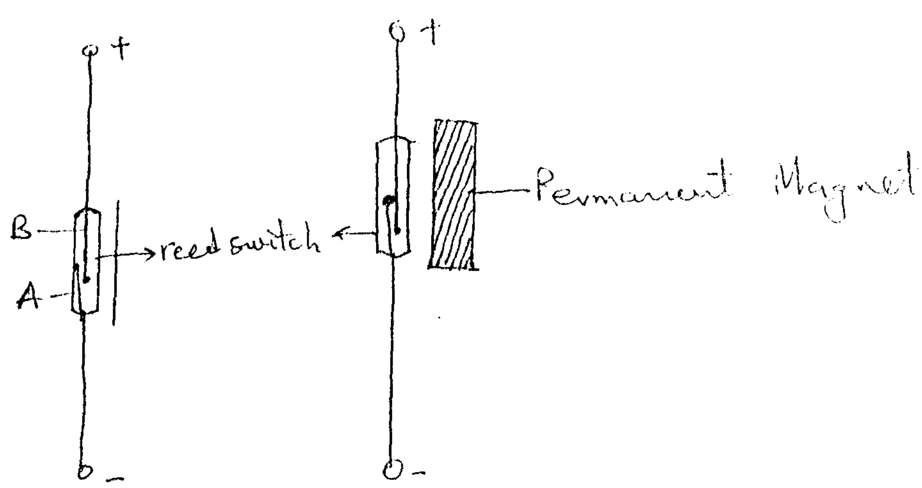


Fig.1.6 The relay switch

2.6 Reed Switch

A reed switch operates almost the same way as the relay switch. Terminal A, serving as the positive terminal, and B as the negative terminal. It operates with a bar magnet in close and far distances from it, serving as ON and OFF positions respectively. When the magnet is brought close, the contact close, thereby, allowing current to pass through, but moving it away from the reed switch, the contacts remain apart and disallowing current any passage to terminal B, thereby, behaving like an open circuit. This is achieved because the lower end of terminal A (Contact) is magnetic, while that of terminal B (contact) is non-magnetic.



Structural and circuit representation.
Fig. 1.7 The reed switch

2.8 Indicators

Indicators are light emitting diodes (LED), which emit light whenever current passes through them, their operation is the same as the junction diodes this is why they are called special diodes. They indicate when there is a flow of current through them by glowing.

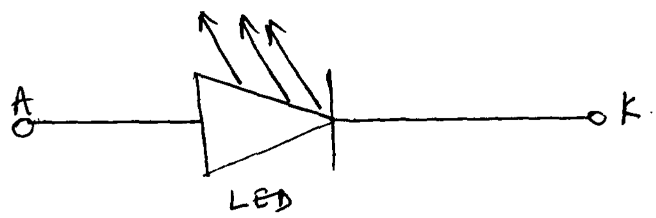


Fig.1.8 Circuit representation of a LED indicator

CHAPTER THREE

3.0 CIRCUIT DESIGN

An empirical representation of the design of this project is given in block diagrams below;

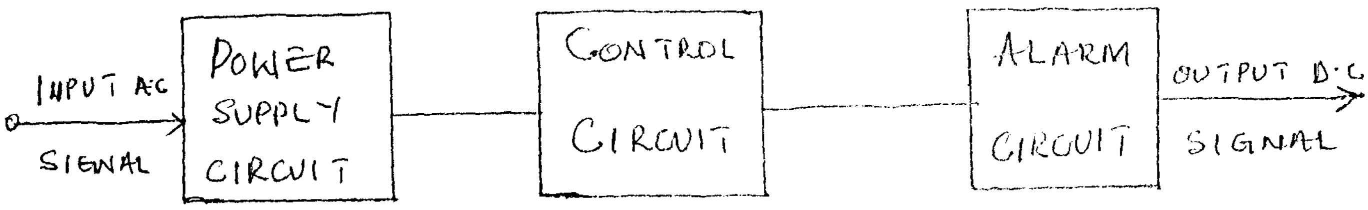


Fig 2.1 Project`s block diagram

The project is divided into three main parts;

(i) The power supply

(ii) The control circuit

(iii) The Alarm circuit

A more elaborate step-by-step design analysis is given in block diagram of Fig.2.2

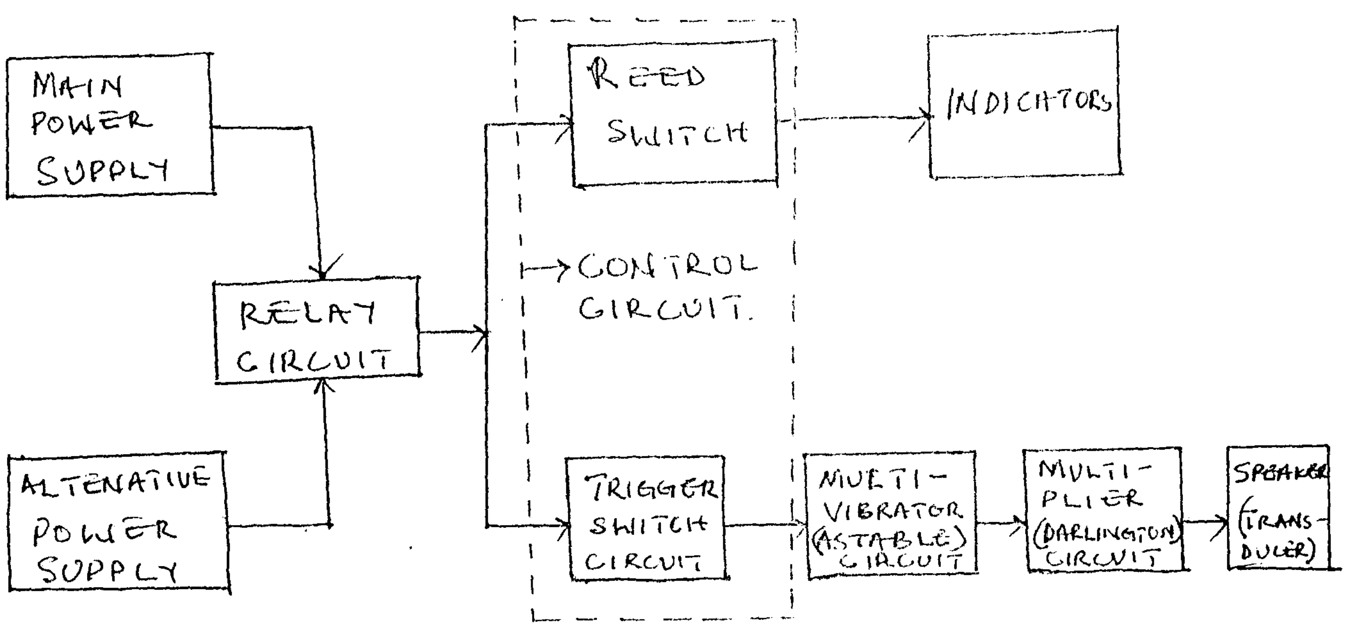


Fig. 2.2 Project`s step by step block diagram

The inclusion of the relay switch ensures constant power supply to the system. The speaker acts as a transducer, to convert the output d.c signal produced to sound energy. The indicators make it possible to locate at a glance, where exactly the alarm circuit has been interrupted (in case of intrusion) by lighting up, and the exact door intruded is read on the key-board

3.1 **The power supply Circuit**

This consists of two parts;

(a) The main power supply

(b) The alternative power supply

(a) The main power supply circuit.

There are four processes involved in this circuit, namely; stepping down of the 220V a.c supply to 12V a.c with a step down transformer, rectification of the 12V a.c to 12V d.c, smoothening of the 12V d.c output wave form and regulation of the smoothened output from 12V d.c to 9V d.c.

(1) Stepping down of the 220V a.c supply.

A step-down transformer of desired ratings is appropriate to achieve this. It is widely available commercially in a range of physical sizes, power ratings and electrical configurations designed for operation at a specific frequency (usually 50-60Hz). The circuit diagram of an ideal transformer is given in Fig. 2.3 (a)

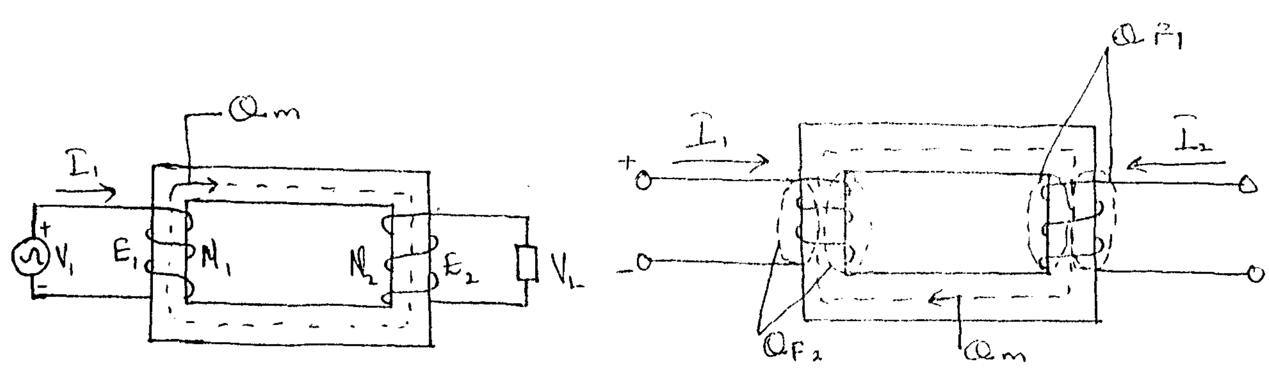


Fig.2.3 (a) An ideal transformer, (b) Practical transformer

Fig. 2.3 (b) shows schematically a practical transformer having two windings of N_1 and N_2 turns respectively on common magnetic field. There are ratings to be considered before selecting a transformer for this purpose, the ratings are;

(i) The voltage rating

(ii) The output current of the transformer

(iii) The power rating (Wattage or KVA)

(iv) The frequency of operation (usually 50-60Hz in Nigeria.)

(i) Rectification of the 12V a.c signal to 12V d.c

This can be achieved in two ways; (a) by using a diode for half wave rectification as in fig 2.2(a), and (b) using four diodes forming a bridge for full wave rectification or two diodes with the transformer tapped at the center. The bridge rectifier as shown in fig 2.2(b) is used for this design because of the required output signal, and availability of ordinary transformer unlike the center-tapped transformers.

(a) Half Wave Rectification

This consist of a linear diode fed by a sinusoidal voltage source as shown in fig 2.4 (a).

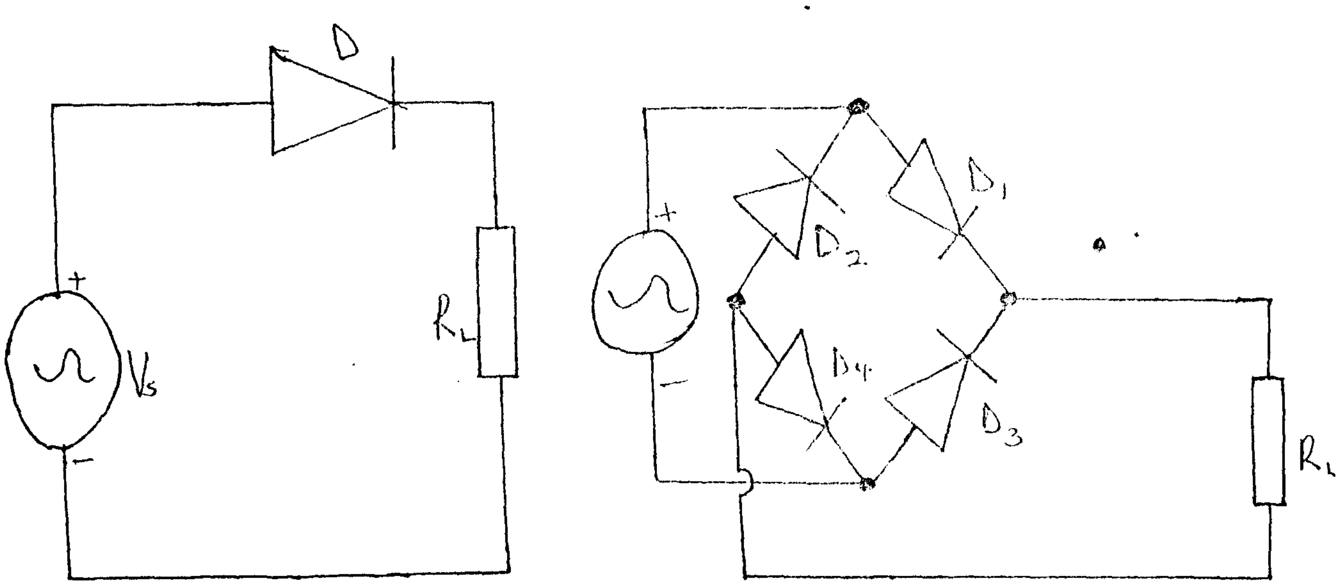


Fig 2.4 (a)Half wave rectifier, (b)Full wave bridge rectifier

Hence V_{dc} = $V_m/2\pi$ / sin Q d Q - - - (I)

Where Vm = Peak value of input voltage

Corresponding load current is V_{dc}/R_l

$\therefore I_{dc} = V_m/\pi R_L$ - - - (ii)

(a) Full wave Bridge Rectifier

The use of both phases of the input voltage which is the major short coming of half-wave rectification, can be achieved by using four diodes as shown in Fig. 2.4 (b). During the positive half cycle, diodes D_1 and■ D4 conduct, while D2 and D3 are OFF. Thus, the upper terminal of the load is connected to the upper terminal of the sources and the lower voltage follows the input voltage Vs. For the negative half-cycle, D2 and D3 conduct while D_1 and D4 go OFF. The upper terminal of the load voltage is connected to the lower terminal of the source, so that the load voltage follows the negative of the supply voltage (-Vs). The wave form is represented in fig 2.4 (c)

Hence V_{dc} = $\frac{1}{2\pi} \int_0^{2\pi} \sqrt{2}$ Vs sin wt d (wt)

= $\sqrt{2}$ Vs/π - - - (iv)

Since Vm = $\sqrt{2}$ Vs sin wt

I_{dc} = 2Vm/πRL - - - (v)

(ii) Smoothing of the 12v d.c output

(Ripple Filtering)

The rectified signal from the rectifier circuit considered above is not adequate because the output load voltage pulsates. In other words, the load voltage still has some a.c components in addition to the required d.c components. It is therefore necessary to modify the circuit to reduce the a.c components to the bearest minimum. This a.c component is called the ripple voltage, and its removal process is called ripple filtering. This is achieved by including a capacitor in fig. 2.5 (a)

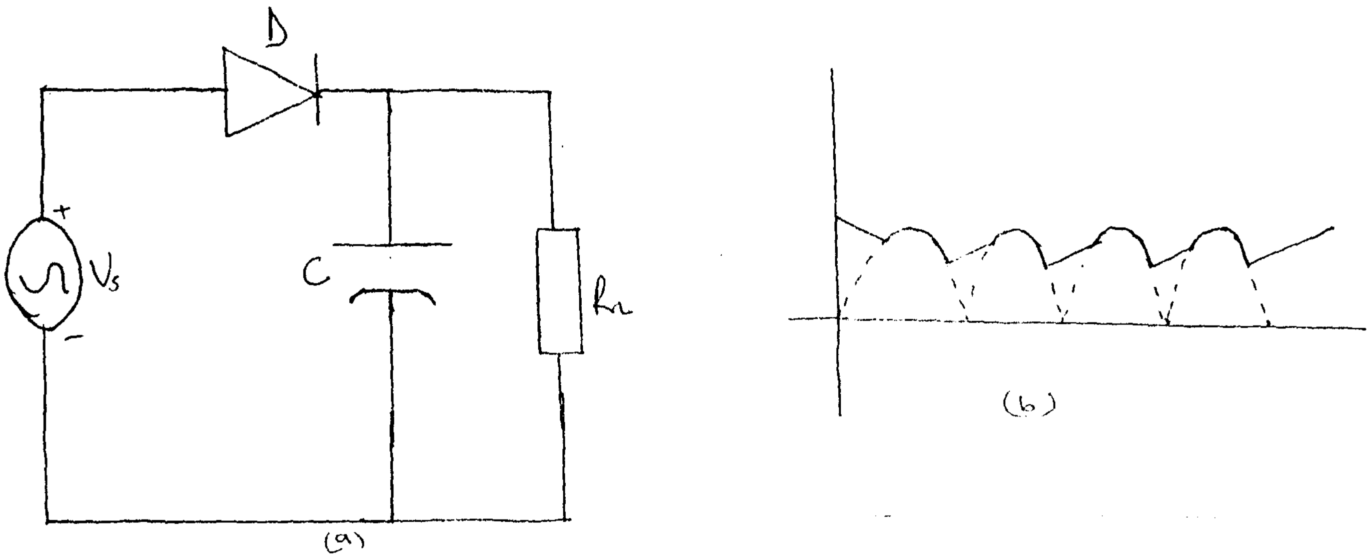


Fig.2.5(a)Capacitor filtering (b)Output waveform of the filte

The ripple voltage Vr can be determined by the value of the reservoir capacitor. The load current and the frequency determines the time over which the capacitor discharges. The output wave form of the filtered output is then given in fig 2.5 (b)

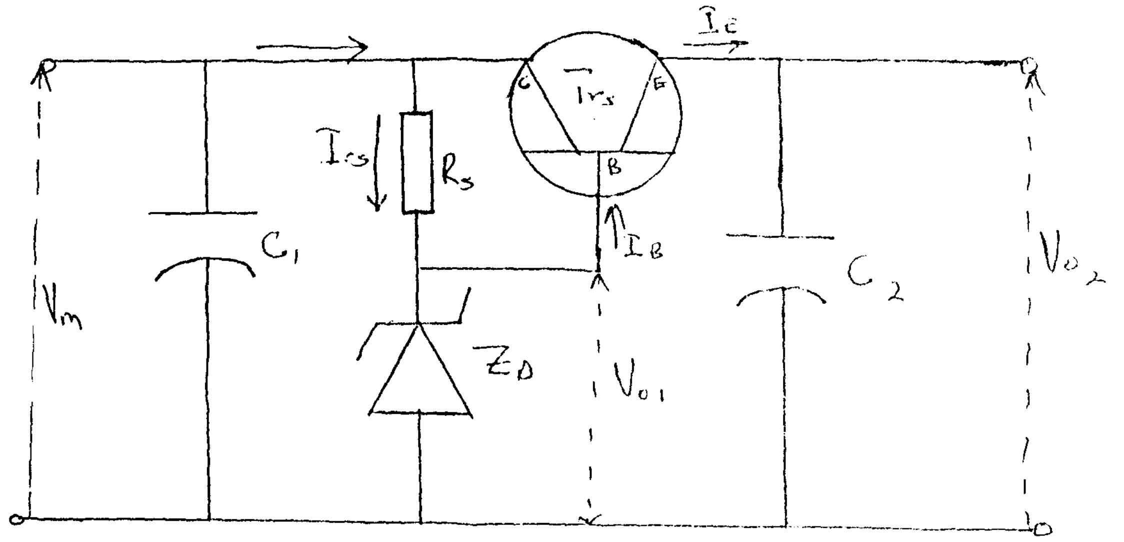


Fig 2.6 Regulating circuit

The circuit in Fig. 2.4 uses a transistor to isolate the R_s and D_1 circuit from the load circuit consisting of R_L. This way, the current through R_s and D_1 can be kept small.

Irs = Iz + Ib - - - eq (v)

Since the stabilizer is required to supply 50mA to the load at 9V, even though the input voltage may change between the limit of 13.6V and 11.2V. The output voltage level will always be clamped at 9V.

Since V1 is to be 9V, the zener diode to be used must be capable of giving the reference voltage of about 9.6V. A standard zener diode of 10V could be used, which clamp the base of the transistor at 10V and provide a stabilized output of about 9.4V.

(b) The Alternative Power Supply Circuit.

This can be in form of an accumulator. Though, not the aim of this project, it will be discussed briefly. It is available commercially. It works with the principle of electrolysis (i.e. Michael Faraday's theory) to convert chemical energy to electrical energy with dilute mineral acid as its electrolyte, and lead as electrodes. The advantage of a lead-acid accumulator here is its rechargeable quality. When the voltage available at its terminal is lower than required, charges are recycled back into the battery through a process called recharging. This is a suitable means of providing an alternative d.c. output signal to power the alarm circuit.

3.2 The Relay Switch.

The relay switch is an electro-mechanical control device that can alternate from the terminal of one source signal to the other, depending on the state of the driving signal. It is included in this project for this purpose, Its make and break action is very important to power supply system`s designs. It is available commercially depending on the sizes and desired operation to be performed. A typical relay switch is shown in Fig.1.6 of section 2.6.Having in mind its mode of operation as discussed. Terminal A representing the main supply and B, the alternative d.c. supply, the relay switch will switch to A only when current flows through its coil, and switch to B only when the current through the coil stops flowing.

3.3 The Control Circuit

This is divided into two parts;

(i) the reed switch circuit

(ii) The trigger circuit

(i) <u>The Reed Switch Circuit</u>

A reed switch is also electromechanical switching device that exhibits make and break action, with magnetic field dependency in a logical way. In Fig. 2.7(a),it has two contacts A and B wide apart by design. If contact A is connected to a signal source, the conduction will not affect contact B, but, any attempt to bring the magnetic field of a bar magnet close to it, attracts the magnetic end of A to close up with end B which is permanently fixed. Connecting A to a signal source this case and closing up the circuit will cause conduction round the circuit as represented in fig. 2.7(b). When the magnet is moved some distance away from the switch, the two contacts open again, since B is made of a non-magnetic material.

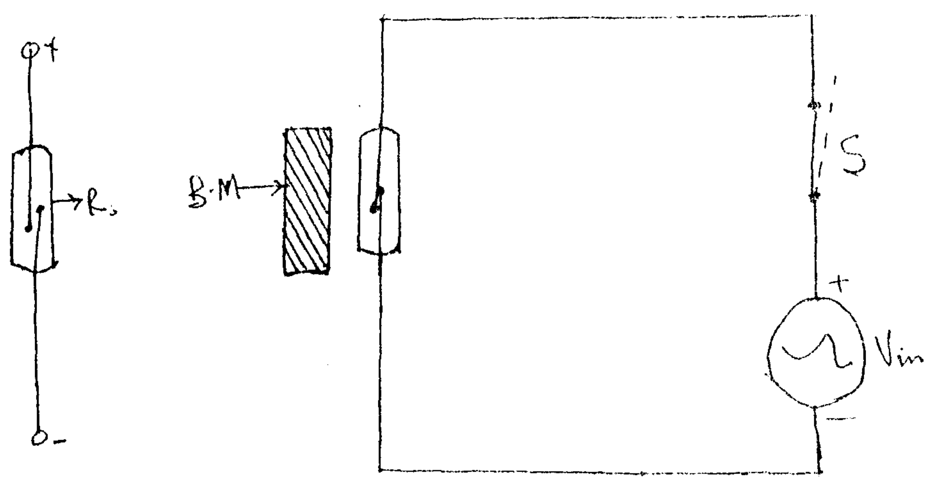
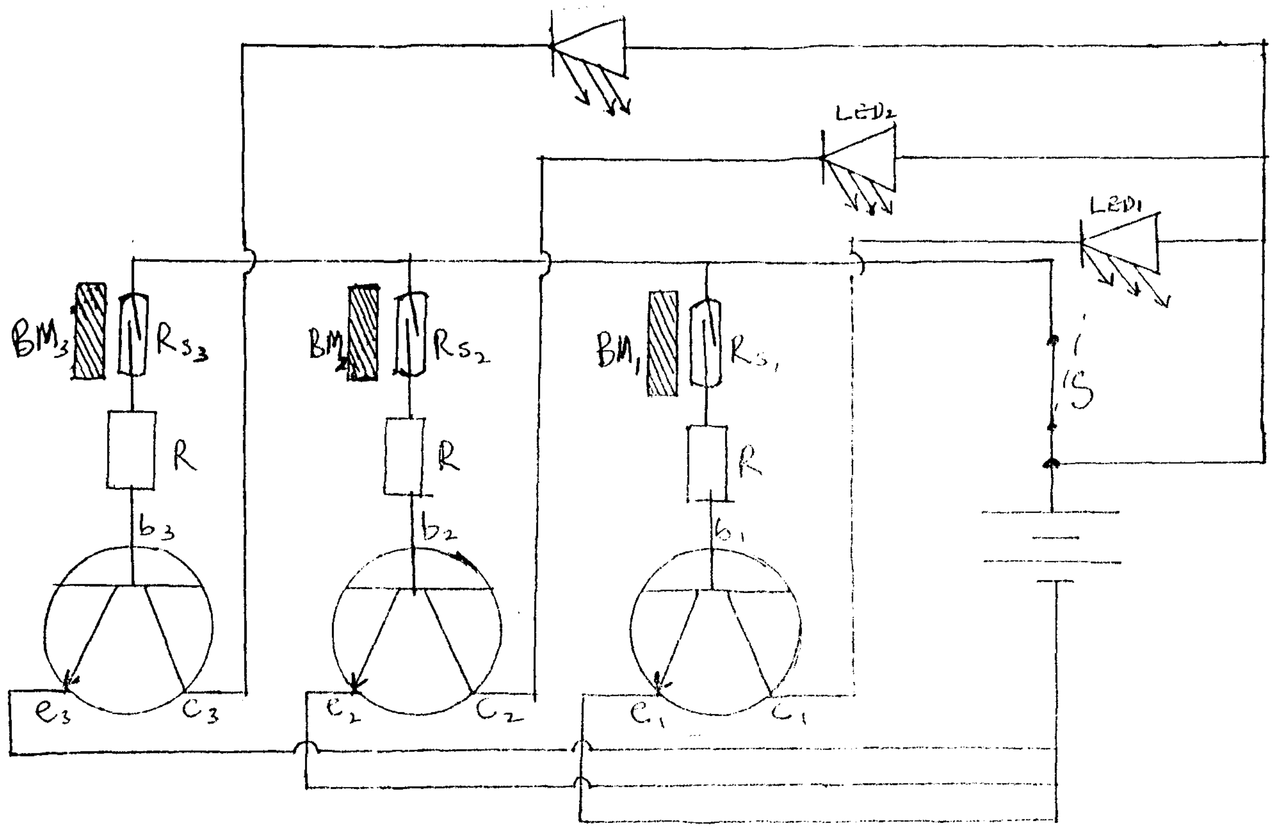


Fig. 2.7 (a) A reed switch (b) A reed switch in circuit with a bar magnet and S Closed.



(c) Transistorised reed switch circuit

In Fig. 2.7(b), current will flow through the resistor R and back to the negative terminal of the supply if and only if, the bar magnet is brought close to the reed switch and the switch S is closed. The Figures (a) and (b) are only suitable for one switch control. For a multi-switch control, a transistorized circuit as shown in fig. 2.7(c) is suitable, it shows a logical connection of the switches in parallel. This way, any required source signal leaving the battery, depending on the current required to enter the base of the transistor, will be divided into the three branches P, Q and R. This branch signal, having passed through the reed switch when a bar magnet is brought close to it ,will be regulated to suit the transistor by resistor R. Hence, the transistors are energized, drawing collector currents from the supply and producing the emitter currents which are connected back to the negative terminals of the supply. This connection will make each branched circuit to be independent (i.e. break in any branched circuit will not affect other branches). If the collector currents are connected to the cathodes of LED_1, LED_2 and LED_3 respectively and the anodes connected to the supply, the current drawn from the supply will cause the LED to glow, therefore indicating the flow of current.

(iii) The Trigger Circuit

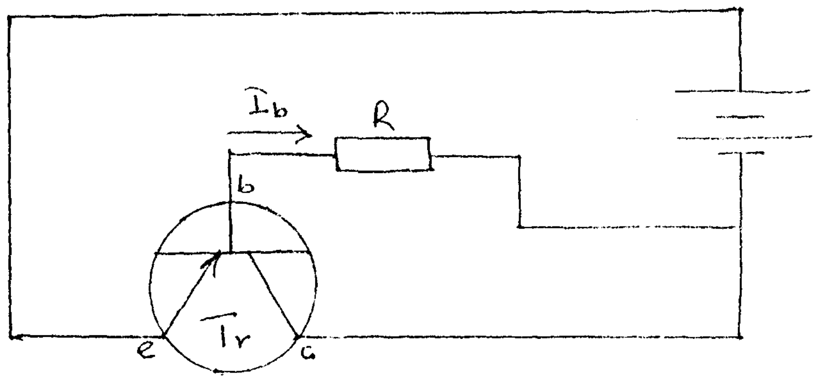


Fig. 2.8 (a).

This is mainly an electronic switch, It consists of a PNP transistor with base held negative in respect to the supply, and emitter positive. The transistor is hence energized, and the output is tapped at the collector terminal (remember no current will flow in the reverse bias even with supply very positive. This is shown in Fig. 2.8(a). To suit a multi-negative signal purpose, three transistors are used as in fig. 2.8(b) This way, negative signal from the supply can energize three transistors connected in parallel with each circuit independent.

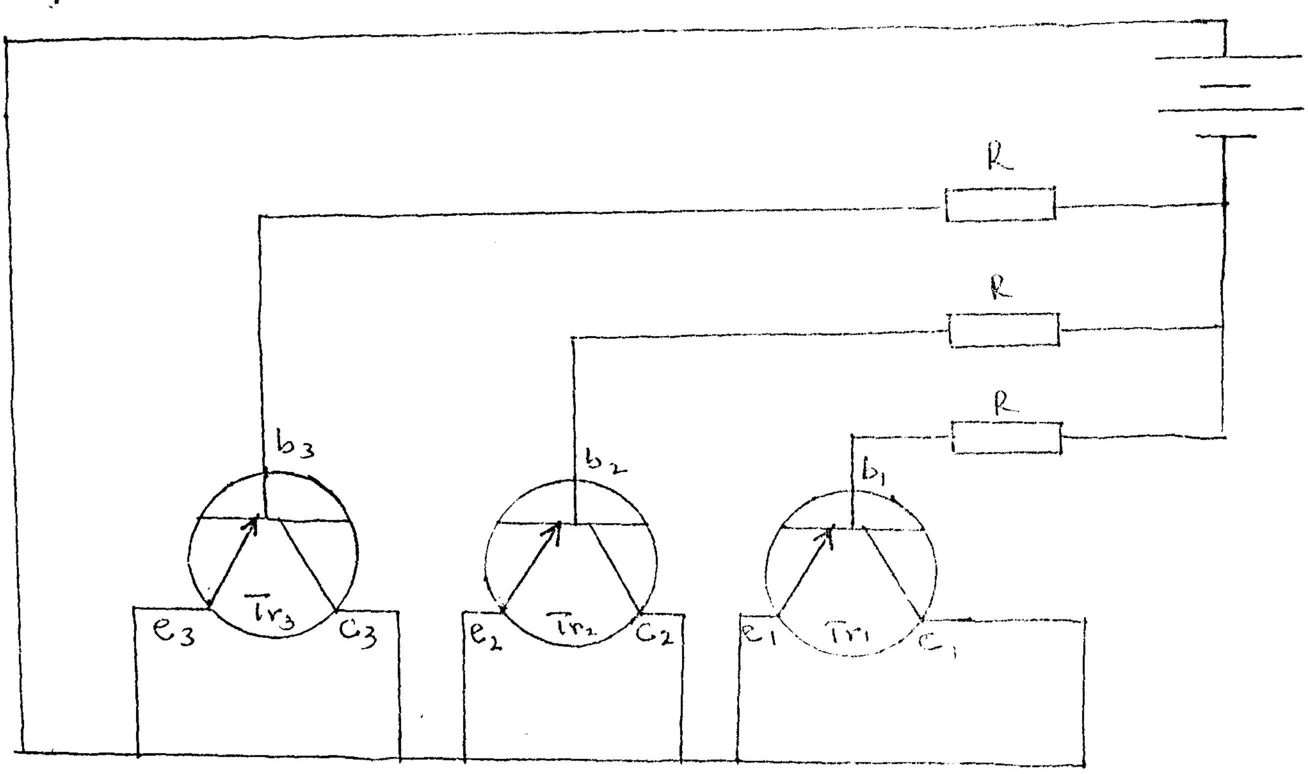


Fig.2.8(b) Multi-negative signal Trigger Circuit.

3.4 The Alarm Circuit.

This is divided into two parts:

(i) The Multivibrator Circuit.

(ii) The Multiplier Circuit

The circuit shown in fig. 2.9 shows schematically the connection of a multivibrator. Suppose that when the supply is switched on, Tr_1 begins to conduct, this causes a voltage drop across R_1 so that the voltage of the collector of Tr_1 begins to fall. This voltage change is transmitted by capacitor C_1 to the base of Tr_2, and begins to turn this transistor OFF. Now, if Tr_2 beings to turn OFF, its collector voltage rises and this rise is reflected via C_2 to the base of Tr_1, which is driven further on very rapidly, This process causes Tr_1 to saturate and Tr_2 to cut-off. This action, in which a change in one part of a circuit causes another part of the circuit to enhance the original change is known as regenerative action or positive feedback. It is the increasing current through Tr_1 which causes Tr_2 to cut off and hence enhance the turning on of Tr_1. The state with Tr_1 saturated and Tr_2 cut off cannot last as current flowing through R_3 begins to charge C_1 and hence, to increase the voltage at the base of Tr_2. Eventually Tr_1 is driven via C_2; the Tr_1 collector voltage rises via C_1 (which is now discharging through Tr_2); Tr_2 is driven to saturation; R_2 now experiences voltage drop and R_1 free. The cycle repeats itself at a rate determined by the time constants of C_1 and R_3, and C_2 and R_4. This circuit is called an astable mutlivibrator, the output can then be tapped at the collector of Tr_2.

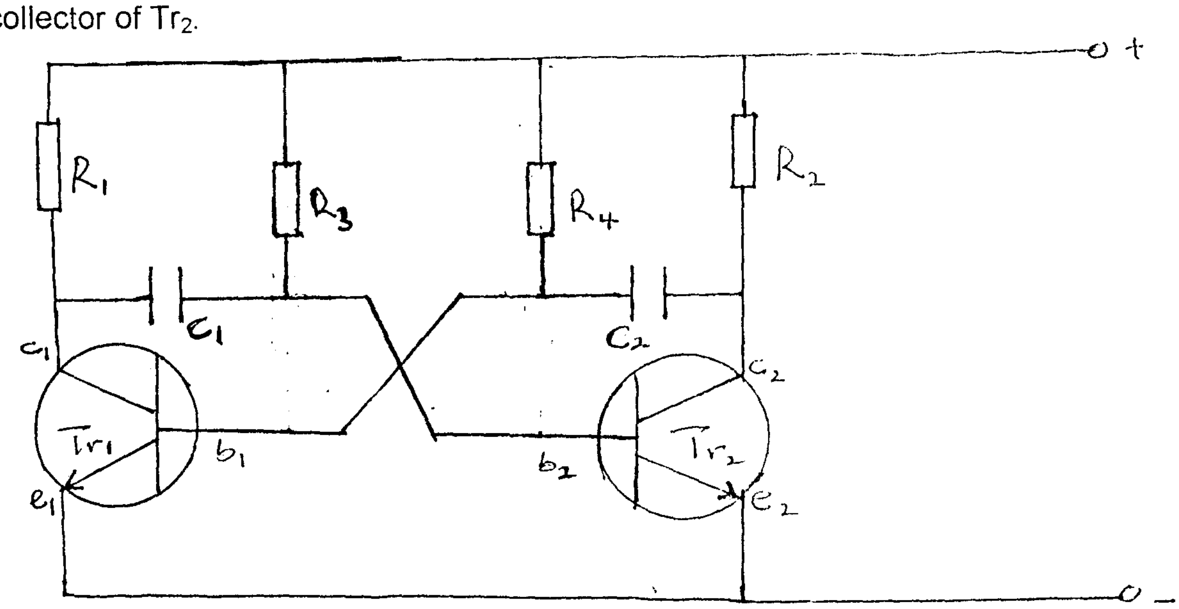


Fig. 2.9 The astable multivibrator circuit.

(ii) The Multiplier Circuit.

When an output signal is produced in electronics and it involves converting the output signal (electrical signal) to either heat or sound energy, the output signal is not always sufficient to drive the transducer required. This is why the circuit in fig. 3.0 is very crucial. The circuit can magnify the signal to 10 times the original signal or larger, depending on the current gain (hfe) of the transistors used. The emitter current of Tr1 is connected to the base of Tr_2 and hence, the base current of Tr_2. The emitter current of Tr_1 is almost the same as its collector current and of course, the base current of Tr_2 is much less than its emitter current. Therefore the collector of Tr_2 carries almost all the current that will drive the load R_l in the above circuit.

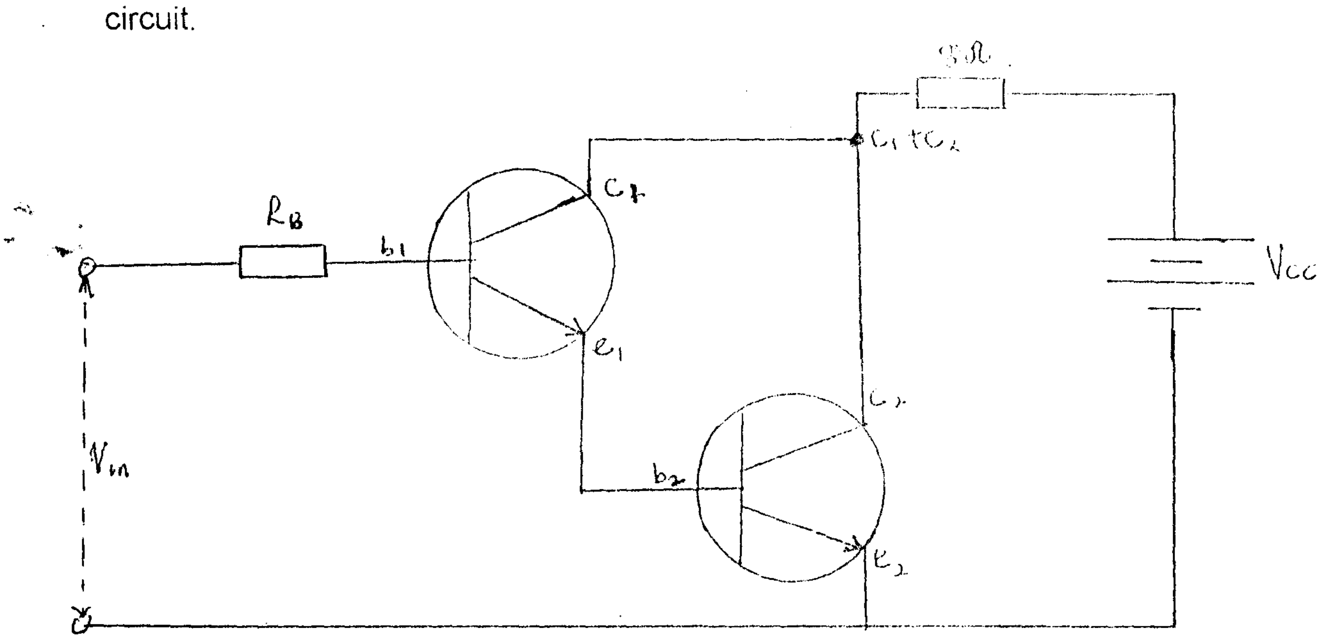


Fig. 3.0 The multiplier circuit

3.5 Construction of the Entire Circuit (Intruder Alarm System).

The construction of this project is made by logically and calculatively combining all the separate circuits earlier discussed to form a system, taking into consideration the aims of the project and reliability. The power supply is constructed in such a way that the output signal required to power the system

This is constructed on a vero board which is divided into three parts; the first for the power supply circuit, the second for the multivibrator and the multiplier circuit and the third for the control circuit. The construction was made based on the calculations from the design which make it possible to choose the values of all the components used for the circuit. These components, being readily available in the market, were all bought, except for the sample door which was constructed in a carpenter's shop. The fixing of all the components to the veroboard was done by soldering them into the appropriate holes according to the design. This was done with soldering lead and soldering tools. Long nose plier was used to protect the components from spoiling due to the heat generated while soldering. Long wires are used to connect the reed switches to the door and the board for ease of installation.

3.6 Operation of the Entire System.

When the switch S is closed, and the magnets M_1, M_2 and M_3 brought close to R_{sw1}, R_{SW2}, and R_{SW3}, power is supplied to the system and current flows and divide into branches A, B and C. Resistors R_A, R_B and R_C generate a base bias voltage to switch on Transistors Tr_1, Tr_2 and Tr_3 which have their base currents drawn from the supply. The collector currents are drawn from the supply too via the light emitting diodes LED_1, LED_2 and LED_3 which light, signifying normal operation of the circuit (no intrusion state). The emitter currents E_1, E_2, E_3 are then fed back into the negative terminal of the supply. When there is intrusion (e.g. at Door A), current stops flowing through branch A and Transistor Tr_1 goes off (no emitter current from Tr_1). The negative bias from the supply then switches on transistor Tr_4 and the output signal tapped at its collector, the supply acts as a closed switch, this allows the signal to enter the multibibrator section which is responsible for the generation of a warning note at a frequency depending on the value of R_9 and R_{10}. The output signal is then amplified in the Darlington pair multiplier which should be large enough to drive the 80Ω speaker. The intrusion sound is heard from the speaker since transistor Tr_1 is off no collector current flows through LED_1 from the supply, therefore LED_1 is off (no emission of light).

This indicates intrusion at Door A. Corresponding components set at work will follow the same process if door b or C is opened.

CALCULATIONS

Power Supply

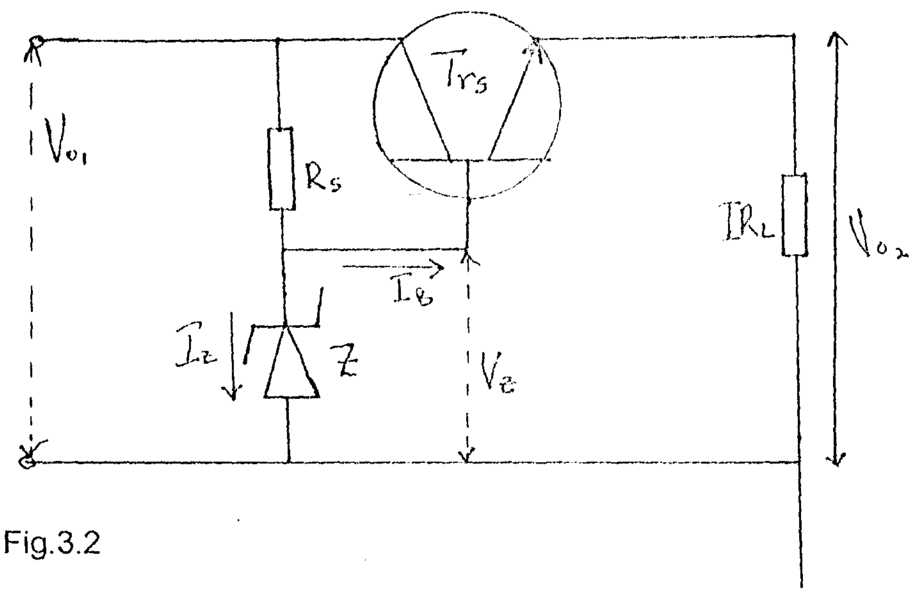


Fig.3.2

Vin = 220V

Vo_1 = 12V

Vo_2 = Vz-0.6 (for silicon Trs)

Since 9V is needed, Vz used = 10V

Vo_2 = (10- 0.6)V = 9.4V (stabilized output)

Since hfe for Trs = 100

I_B = IR1\hfe but IE is designed to be 50mA and since Ie $\approx$ Ic

$I_B = IR_1/hfe$

= 50mA/100 = 0.5mA

$\therefore$ current through Rs = (5+0.5)mA

based on the design so that current Iz is 5mA which is to times I_B.

Rs= (V_{01} (min) – Vz) / IRs

V_{o1} (min) = 11.2v

V_{01} (max) = 13.6v

Rs = (11.2 – 0.6)/50mA = 200 Ω

Minimum power dissipation of zd

$Pzd = VzIz = 10 \times 5mA = 50mW$.

Power dissipation in Rs.

$P = (V_{o1}\ (max) - Vz)\ IRs$

$= (13.6 - 10)\ 5.5mA$

$= 21.6mW$.

(i) Current and Voltage across the reed switch circuit.

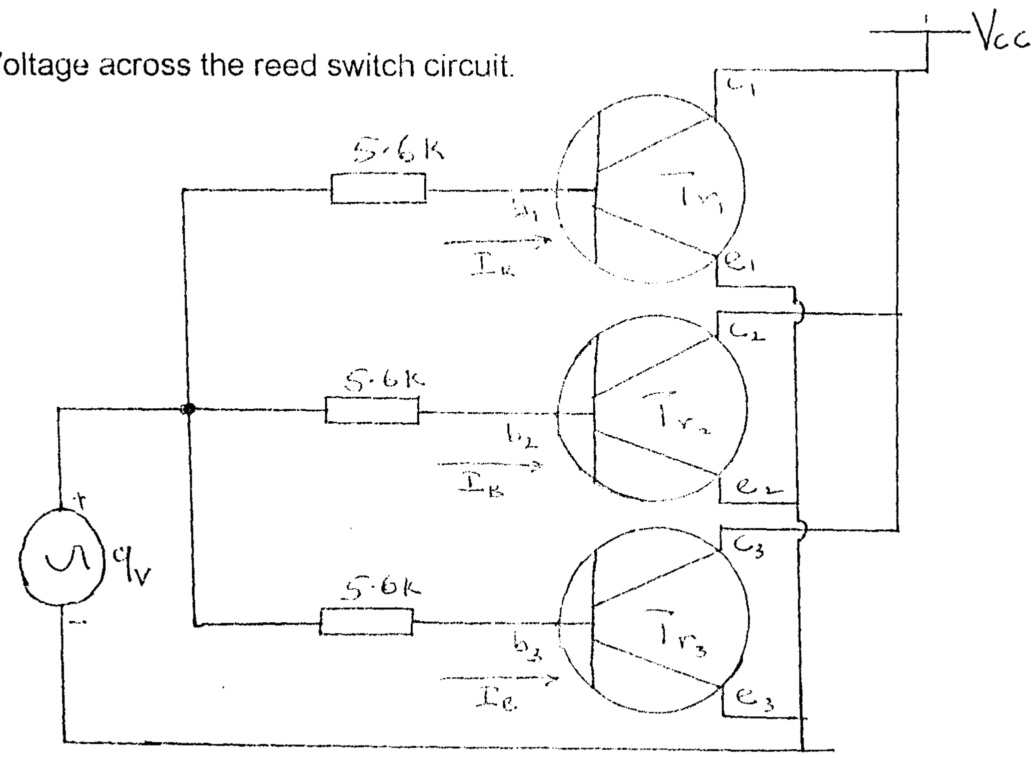


Fig. 3.3

When the reed switch is closed, (assuming no voltage drop at the LED).

Considering Tr1

$V_{CC} = V_{BB} + V_{BE}$, ($V_{BE} = 0.6v$ for silicon transistor)

$V_{CC} = V_S = IR + V_{BE}$

$9V = IR + 0.6V$

$IR = 9V - 0.6V = 8.4V$

: $V_{BB} = 8.4V$

Considering the three 5.6kΩ resistors in parallel

$R_T = (5.6k\Omega)^3 / (94.08k\Omega)^2 = 1.87k\Omega$

Total current through the three transistors

$I_T = V/R_T = 9/1.87k\Omega = 4.81 \times 10^{-3}A$

Base current through each transistor

$I_B = 4.81/3 \times 10^{-3} = 1.60mA$

: $I_{B1} = I_{B2} = I_{B3}$

$I_C = \beta I_B$

$= 100 \times 1.61mA$

$= 161mA$

$I_E = I_C + I_B$

$= 161mA + 1.61mA$

$= 162.61mA$

For the Trigger Circuit

Let us consider only one transistor since the assumption is based on intrusion of one door at a time.

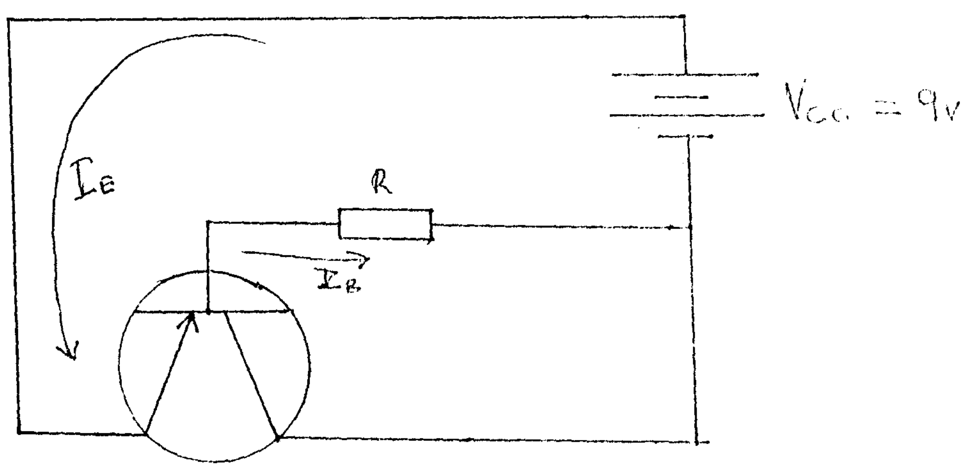


Fig.3.4

$I_B = -Vs/R \quad = \quad -9V/5.6 \times 10^3 = -1.61$ mA

(negative sign refers to the direction of flow)

$I_C \quad = \beta I_B \ = 100 \times 1.61$ mA

$= 161mA$

This is the current that will flow each time there is an intrusion, through the supply which is now acting as a closed circuit and to the multivibrator circuit.

<u>For the Multivibrator</u>

$R_T = 5.6 \,//\, 5.6$

$= 2.8k\Omega$

$I = Vc/R = 9V/2.8k\Omega = 3.21$ mA

This is the current through the multivitbrator and to any PNP transistor that is in trigger mode as emmiter current.

$I_C = I_E - I_B$

$= 3.21$ mA $- 1.61$ mA

$= 1.6$ mA.

At any point in time there is intrusion the output current at each collector of the multivibrator will be approximately

0.01mA (assumption)

for the magnifier circuit:

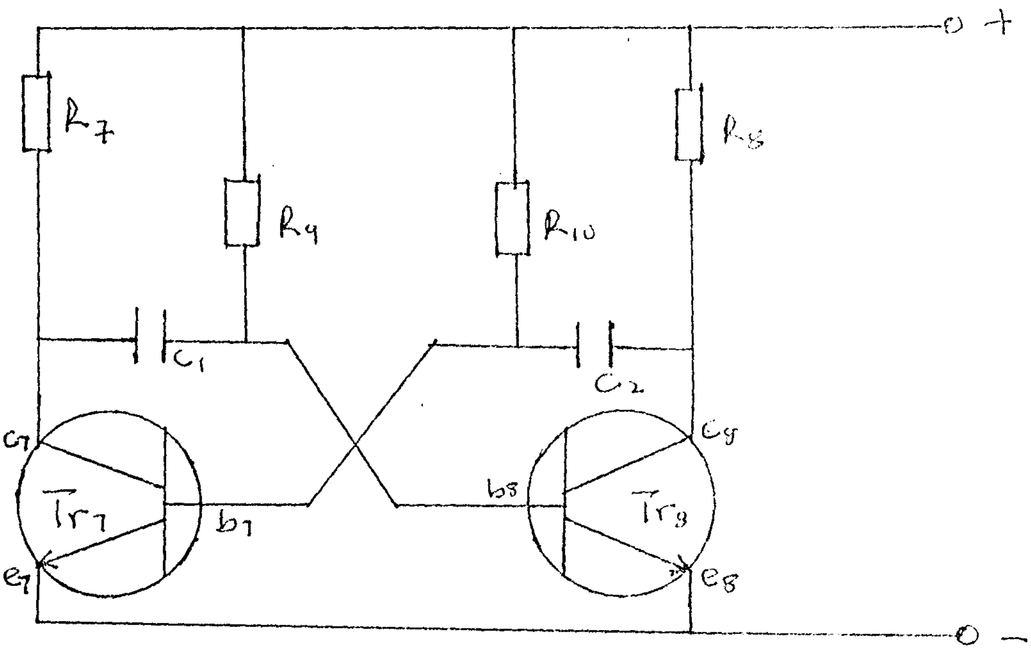


Fig.3.5

Since $V_{BB} = 8.4$v

And Vs still = 9V

$V_{B1} = 8.4$v

$I_{B1} = 0.01$mA

$I_{C1} = BI_{B1} = 100 \times 0.01$mA

$= 1.0$mA

(1.0+ 0.01) mA

E_1 = 1.01ma

$I_{B2} = I_{E1}$

$I_{C2} = BI_{B2}$ = 100 x 1.01mA

101 mA

∴ the maximum current that will operate the 80oc speaker will be

I = V/R = 9/80 = 0.1125A

= 112.5mA.

∴ 101 mA is within the range of permissible current.

Astable Multivibrator

$R_9 = R_{10}$

$C_1 = C_2$

ti/t2 = 1 (mark to space ratio)

f = 1/(t1 + t2)

∴ = 1/0.7c1R_9 + 0.7c2 R_{10}

= 1/1.4c1R_9 since $R_9 = R_{10}$ and $C_1 = C_2$

1/1.4x102x10-12x50x103

= 109/7140

=140100Hz

= 140.1KHz= Frequency of operation.

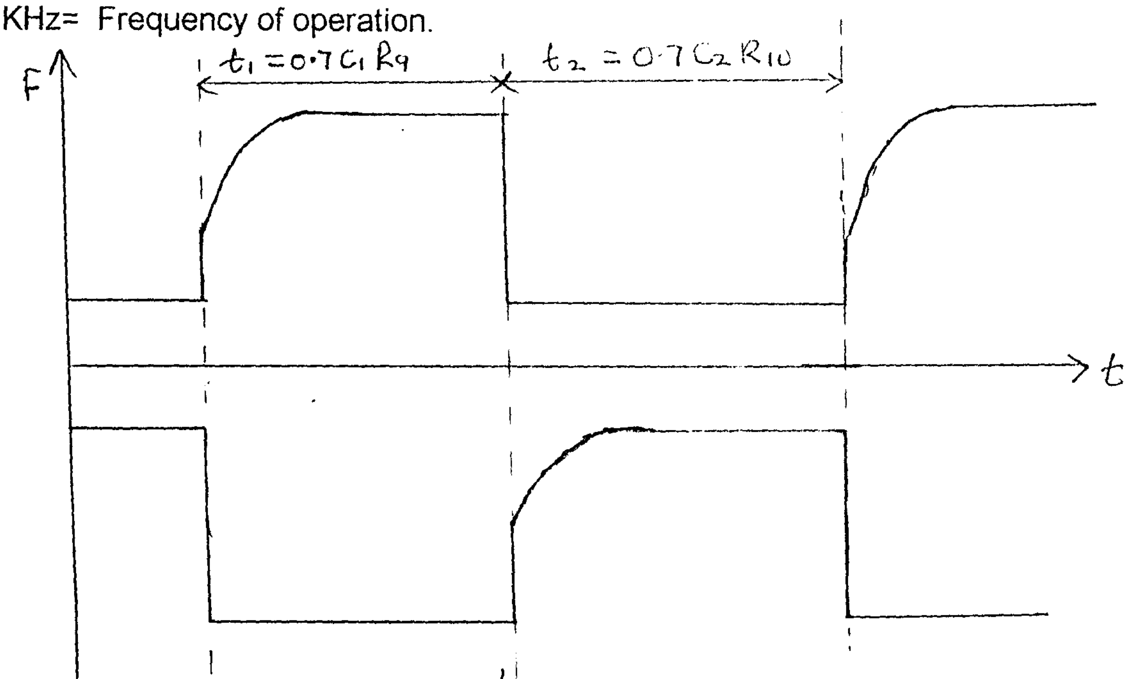


Fig. 3.2 Frequency/Time graph.

CHAPTER FOUR

4.1 TESTING AND OBSERVATIONS

The testing of the project was thoroughly performed. The circuits were first arranged on a bread board and the output waveforms examined on an oscilloscope. The circuit were then transferred onto a vero board after thorough testing. The output signal was further magnified to enhance the output current production.

It was observed that the output signal viewed on an oscilloscope gives a pulsed waveform, This suggests the vibration of the multi-vibrator. Reduction in the values of R_9 and R_{10} increases the frequency of the vibrating signal produced.This could be enhanced further by altering the values of C_1 and C_2.

Also, it is the condition of the reed switch that determine the switching effect of the multi-vibrator.

4.2 CONCLUSION

This project has been able to achieve (if not all) its main aims. First is to produce a vibrating signal that is controllable. Secondly, a system for a multi-door monitoring purpose using available materials or components to produce the required signal to ensure its low cost of production was produced.

And above all, creating a secured environment for lives and properties.

4.3 RECOMMENDATION.

The operation of this system can be further enhanced by using this vibrating signal to switch on another constant alarm producing circuit of higher frequency wit the use of ICs. This enhances the sound effect produced. Another recommendation is a way of digitalizing the output signal to fit in, in an Ethernet or a LAN (Local area network) to form a network.