DESIGN AND CONSTRUCTION OF AN INTRUDER ALARM DETECTOR WITH A CODE LOCK / TRAP DEVICE

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING IN PARTIAL FULFILLMENT FOR THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING (B.ENG) IN ELECTRICAL AND COMPUTER ENGINEERING OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

Dedication

I Dedicate this project to almighty god for being my guide throughout my research that has finally culminated in this feasible piece of work, may his grace continue to be my strength. (amen).

Declaration

I, **INYESE O. WILSON**, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology Minna.

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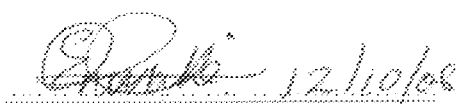
 (Signature and Date)	 (Signature and Date)
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(Signature and Date)	(Signature and Date)

Acknowledgement

With all honour and a deep sense of appreciation. My Gratitude Goes to Almighty God for his protection, guidance and his inspiration during and after the completion of this project work. My profound gratitude goes to my supervisor DR MRS. E.n Onwuka for her encouragement, timely and useful suggestions.

To my most esteemed and irreplaceable family, Rev. and Mrs. E.N.Inyese, my brothers (Francis, Innocent, Gideon), my lovely sisters (Ndidi and Mrs. N Aladegbola) and also not forgetting the family of Mr. S. J Aminu for their prayers, support and love you all are the best.

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Finally for all those who in different ways have been instrumental to my achievements, I remain forever grateful.

Abstract

This project (intruder alarm detector/trap device) is aimed at constructing a device that will trigger an alarm whenever an intruder tries to invade a secured area. This is achieved by using a code lock upon which a wrong code if entered, triggers an alarm which in turn trips a trap. This is necessitated by the fact that the rate of crimes has increased tremendously in our society today, which in turn has caused fear, tension and uneasiness in the hearts of most individuals as people with respect to property and life. Hence this is very useful because it provides a high state of security in our homes, offices, banks, industries and other places that require protection from intruders. The intruder alarm detector/trap device is constructed in such a way that it can be fitted to the doors of premises comfortably without any form of inconveniences.

This device is cheap and easy to operate and install it is therefore easily affordable.

Table of Contents

Dedication… ……i

Declaration… ……ii

Acknowledgement…… ……iii

Abstract… ……iv

List of figures…… ……v

List of tables …… ……vi

Chapter One…… ……1

1.0 General Introduction…… ……1

1.1 Project Description…… ……1

1.2 Aims and Objective … ……3

Chapter Two ……4

2.0 Literature Review …… ……4

2.1 The Infrared Method …… ……4

2.2 The Visual Method …… ……5

2.3 The Magnetic Method …… ……5

2.4 Mode of Operation … ……6

2.5 Brief History- On Automation …… ……6

2.6 Definition Of An Alarm System… …… 9

2.6.1 Alarm Detectors …… ……9

2.6.2 Alarm Indication …… ……9

2.7 Type of Alarm Systems …… ……10

2.7.1 Professional Burglar Alarm … ……10

2.7.2 Speed Limit Alarm 10

2.7.3 Industrial Alarm 11

2.7.4 Intruder Alarm Detector System 11

2.7.5 Anti- Theft Car Alarm 12

2.7.6 Refrigerator Door Alarm 12

Chapter Three 13

3.1 Circuit Design And Implementation 13

3.2 Project`s Modular Representation 13

3.3 Power/ Regulator Stage Design 14

3.4 Transformer 15

3.5

Diodes 15

3.5.1 Forward Bias 15

3.5.2 Reverse Bias 16

3.6 Capacitors 18

3.6.1 Determining the Capacitor C 19

3.7 Voltage Regulator 19

3.7.1 The Voltage Regulator Circuit 20

3.7.2 Alternative Source Of Power 21

3.8 Transistor 22

3.9 The 555 Timer 24

3.10 Control Circuit 26

3.10.1 Code Lock Device 26

3.10.2 7474 Dual D – Flip Flop 27

3.10.3 Operational Mode Of 7474 D – Flip Flop As Code Clock 28

3.11 Infrared 28

3.12 Sensor Circuit 30

3.12.1 The Transmitter Stage 30

3.12.2 The Receiver Stage 30

3.13 Voltage Comparator (LM 393) 30

3.14 Design Analysis Of Alarm Stage 34

3.15 The Oscillator Stage 34

3.15.1 Cmos Oscillator 35

3.16 Amplification / Alarm Stage 37

3.16.1 Alarm Unit 38

3.17 Trap Stage 38

Chapter Four 41

Implementation 41

4.1 Introduction 41

4.2 Casing Design 43

4.3 Tests 43

4.4 Result 43

Chapter Five 45

Conclusion and Recommendation 45

5.1 Conclusion 45

5.2 Recommendation 45

References 46

List of Figures

Fig. 3 Modular representation of an automatic intruder detector with a coding device..... 13

FIG 3.2 Block diagram of an automatic intruder alarm detector with a coding device. 13

FIG 3.3 Power supply unit..... 14

Fig 3.4 signal representation of the power supply unit 15

Fig.3.5 Transformer representation 15

Fig 3.6 Diode symbol and characteristics 16

Fig.3.7 Symbol of capacitor 18

Fig.3.8 IC Voltage regulator..... 20

Fig 3.9 Circuit diagram of switch relay 21

Fig 3.10 Transistor structures and symbols 23

Fig 3.11 Representation NPN & PNP biasin..... 24

Fig 3.12 Characteristic curves of biasing level 24

FIG 3.13 Astable mode 25

Fig 3.14 7474Dual - D – flip flop interconnections..... 26

Fig 3.15 Circuit representation of the code lock 28

Fig 3.16 Infrared emitter/detector circuit..... 29

Fig 3.17 Pin connection of LM 393..... 31

Fig 3.18 LM393 comparator (input/output) connection 31

Fig 3.19 Receiver unit in inverting stage 32

Fig 3.20 Receiver unit in non- inverting stage 33

Fig.3.21 Full receiver circuit unit..... 33

Fig 3.22 Circuit representation of alarm stage 34

Fig.3 23 Control enable/ clocking and amplification circuit 37

Fig3.24 Circuit of the trap timing duration 39

Fig 3.25 Gate symbol representation (ex-OR) 39

Fig 3.26 Circuit representation of the trap device..... 40

List of Table

TABLE 3.1 truth table..... 40

TABLE 4.1 component specification..... 41

TABLE 4.2 capacitor rating & type..... 42

TABLE 4.3 Diode rating... 42

CHAPTER ONE

Introduction

In rapidly increasing society like Nigeria where the rate of crime increases everyday, it becomes necessary to device a system (electronics) that can monitor what is happening in ones house or office premises (bank, research laboratory and industry). Since any form of intrusion is executed by human being, which brings about the movement of something or his own body. This makes it feasible to device a system (alarm) to detect the presence of someone intruding into the premises.

However there are many ways in which the presence of an intruder can be detected for instance a simple electrical circuit method of detecting the presence of an intruder using a trip wire [1], this wire need not be connected, if it moves it simply operates an alarm switch using a trip wire carrying a current which hold a relay in the ON state. If the fine wire is broken by an intruder, the relay de-energise thereby switching ON the alarm via two of its contact. This is the fundamental principle upon which this project is built.

1.1 Project Description

This project is design and construction of intruder detector. The operational principle is based on the breaking of a magnetic field around a magnet and reed switch, which is logically similar to how the opening of a door can trigger an alarm if the alarm was not deactivated before the door was opened. The purpose of designing this system is to achieve the targeted user desire which is most often based on it simplicity in terms of its operational mode, cost, sensitivity, efficiency, reliability, safety and availability. However, we shall try as much as possible to put some of these conditions, if not all into consideration.

In advanced countries, an alarm detector can be triggered by noise inevitably produced by the intruder or the body of the intruder breaking an infrared beam [1] Another way of detecting an intruder is by fixing a hidden camera at the entrance of a building which gives a clear picture of who is coming in on a screen connected to it

Interestingly, countries like Nigeria have devised there own security network where a person can monitor all the nodes connected to a central hub, then inform the concerned authority for necessary action to be taken immediately and these can be found mostly in the bank. The intruder detector/trap project is a more advanced method of intruder detection, in the case of the trip wire system an intruder can escape breaking the wire and this is a major set back. In the case of the visual detection method, a security officer or guard is expected to watch the area via the use of a screen (monitor), if the guard dozes off or is distracted, an intruder can secretly penetrate in, rendering the method unreliable. The magnetic intruder method uses a magnet on the door, if the intruder makes a hole through the door the alarm will be triggered and this is also a set back for this method.

The intruder detector/trap method overcomes the above set backs. First, it is embedded within a code-lock system, so if an authorized person enters the right code, the alarm and trap is deactivated, but if an unauthorized person breaks in either by braking the door or coming in through the window or ceiling the alarm and trap is still activated because the right codes was not keyed-in.

When the intruder steps into the vicinity, the infrared rays lined up in a zigzag manner is broken by the intruder (the intruder is very likely to break this infrared beam because it is placed everywhere) and this activate an alarm, which is only heard by the security guards at the security post, so even if the guard is asleep, the loud sound of the alarm will wake the guards, while the trap circuit is also activated to trap-in the

intruder, until when the security guards reaches the scene this will aid the security guards to apprehend the intruder knowing fully well that he/she cannot escape due to the trap. This shows advancement on all the above mentioned method of intruder detecor systems.

1.2 Aims and Objective

A common problem that occurs frequently is an intruder penetrating secretly into our homes, places of business and industries. This has result to insecurity in homes and industries and measure are being taken to avoid such attack. As a result of these the aim of this project is to design an **automatic intruder detector with a coding device/trap** while the objectives are as listed below:

- Employing security officers to guard homes and industries.
- Fencing and mounting of strong gates in homes and industries.
- Employing the use of wild and strong animals such as dog.
- Mounting of solid doors, windows and using of iron protectors at doors and windows
- Some homes and industries even go to the length of electrocuting their fence, gate and doors just to scare the intruder.

CHAPTER TWO

Literature Review

Scientists who say that there are just three necessities of life must have made an ignorant conclusion, because how can we feed, shelter, and protect a life that is not secured? This is why security of life is very important, as the fourth necessities which over ride the earlier assumption. [4]

Security is the act that provides safety, freedom from danger and anxiety, it can also be seen as the precaution taken to protect life and properties [3]. The fear of uncertainties tortures the cerebrum, once this dominates the brain the way forward seems to be uncertain. This could be as a result of overshooting of the adrenaline, which causes dullness of the brain, stroke and eventually might lead to death. [2]

Freedom in the presence of food, water and shelter nurtured life in an environment of emotionally relaxed atmosphere, progressive environment of which without this life will turn into an untimely two way (ON-OFF) switch channel which is triggered once then pack-off. However there are three (3) methods that can be used to detect the presence or movement of a person. These methods are as follows:

- The infrared method
- The visual method
- The magnetic method

2.1 The Infrared Method

This method explains and shows how a beam of light rays sent from a transmitter to a receiver can serve as a means of detecting the presence of an intruder. The beam when disturbed in any form from being incident on the receiver will cause a drop in the input voltage. An integrated circuit (IC) chip is connected to a comparator to compare this

voltage drop and once it goes below the reference voltage, it sends a high (1) and thereby given an output voltage respond which is used to trigger an alarm and also to drive a relay

2.2 The Visual Method

This shows a network consisting of a high speed surveillance camera and a detecting circuit is connected to a screen (monitor) which is used to visualize the event taking place at a particular location [5] This method is not preferable because of the cost of installation and the scarcity of the components involved in achieving this objective.

2.3 The Magnetic Method

This method is the simplest of the above mentioned methods, it 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 magnetic device is some distance away from the reed switch the contact short circuited thus making the switch to contact which in turn trigger an alarm connected to it using a buzzer to indicate that there is an intrusion at the security post. This method as not used because the components involved are not easily accessible and readily available in the market as would be needed to conveniently carry our this project work [4]

Therefore, the **infrared method** will be used in this project because it is the simplest method for any designer to adopt taking into cognizance a country like Nigeria as a major factor in terms of security, the availability of the components used and the simple operational protocol involved in its operation are interesting. Nobody can tell what will happen in this millennium to make life and the entire Nigeria population to be aware of the latest technological improvement on security (electronics)

Security must be taken seriously so as to guard against any unforeseen circumstances. Ballistic explosion of this millennium, putting in view the ugly incident that occurred here in Nigeria some years back i.e The bomb explosion that occurred in Lagos state on 27th of April, 2002 at Ikeja military cantonment [6]. To this effect, various principles have been put in place and developed as a way of safe guarding life and properties against such ugly incidents which then implies that all hands are on deck by the Electrical Engineer and their subordinate that will bail the world out from the fear and agony of danger.

2.4 Mode of Operation

This project describes how a network of infrared diodes can be used to detect and trigger an alarm and also release a trap at the same time. It uses an electronic code lock to open a restricted area (laboratory and military arsenal). If the right code are keyed-in, the entire security system is deactivated and the authorize person goes in without raising a false alarm at the security post and also the trap will remain intact The intruder detector/security system work on the bases of automation (which is a developed to extends the capacity of machines (electronics) to perform certain task normally done by human and to control sequence of operation without human aid) [3]

2.5 Brief History- On Automation

The central theme in all industrial developments during the last century has been automation. The first significant attempt on automation was assembly-line automation for the manufacture of automobile engines by Henry Ford in the early 1900. [11] Today, there are decision-support systems and communication tools available for automating marketing and sales processes, as well as the relationships with the suppliers. The motive in all these attempts is to automate processes in the supply chain, beginning with raw

material procurement and ending with delivery to the end consumer, with the primary goal of serving the customer more efficiently and effectively. Thus, automation efforts that first started on the factory floor have now spread to the entire supply chain. Technology is at the root of all these developments, sometimes causing drastic disruptions in the industry and creating revolutions.

There were second- and third-order effects of the automation on supply-chain processes. For example, Henry Ford's assembly automation brought the automobile within the reach of the middle class, and this has led to the creation of shopping malls outside city limits, well-paved roads and highways, and truck transportation. A whole set of other industries sprung up and thrived. for example, The Internet created another major shift, allowing people to shop from their homes, the need for delivery through multiple channels, and the coordination of returns. There are several different ways that one can describe the developments of the last century. Several historians and popular books have already done this [12]

Despite several economic and cultural changes, the main goal of manufacturing and supply-chain networks has remained the same, i.e., to procure raw materials and transform them into final products and deliver them to the global customer at the time and place specified by him or her in the presence of the other players in the market. Basically, this involves the automation of material, information, and financial flows, and relationships between businesses and customers. In a manufacturing supply-chain environment, there are several decisions to be made and facilities to be supervised and controlled. Significant efforts have also have gone into the automation of facilities such as warehouses and factory floors. Recent emphasis has been on automating and integrating intercompany material and information flows. [13]

Each of the industries cited above uses automated machines and equipment in all part of their manufacturing processes. As a result each industry has a concept of automation that fits a particular production need. Therefore, this project is based on **automatic intruder detector with a coding device/trap.**

This security system uses an infrared diode which transmits an infrared light at a given distance (place in zigzag manner) and when the beam of the infrared rays is broken, the trap activates and the photodiode resistance reduces. This in turns reduces the voltage at the receiver end and a voltage comparator is used to compare the voltage that is supposed to be transmitted to the photodiode from the infrared beam at the receiver end and if any reduction is sensed by photodiode, it sends a high(1) and thus triggers an alarm.However.this alarm is only heard by the security guards. so the intruder has no idea that he/she has been discovered .The trap is also released by the breaking of the beam, so the intruder will be trapped until the security guards comes around

The alarm remains **ON** till the security guard put it **OFF** at the entrance where the device is installed, this is designed in that manner so that the alarm will keep ringing till it is put **OFF** by the security guard on duty. The trap is released via the action of two motors, which are connected to a rod holding the trap in place on the roof. Once the motor is activated the rod is rolled off and the trap slides down, preventing the intruder from escaping the premises. This reduces the job of the security guard in apprehending the intruder because they do not need to look for the intruder, they will just go and pick him/her from where he is trapped

2.6 Definition Of An Alarm System

Systems, which operate a warning after the occurrence of an abnormal or dangerous condition, are usually Alarm systems. Alarm systems are used to signal undesirable or dangerous situation such as the presence of an intruder or the existence of an away condition in an industrial processing stages. Alarm systems are usually open loop control system. A basic alarm system contains two essential components: an alarm detector and an alarm indicator. Frequently, they are remote control systems, that is, the detector is located remote from the indicator.

2.6.1 Alarm Detectors

Alarm detectors are used to monitor a given situation to decide whether or not abnormal or dangerous conditions exist. The type of detector is determined by the particular application and by the nature of the physical quantity being detected.

2.6.2 Alarm Indication

Alarm indicators are used to translate the information from alarm detector into a warning signal when a predetermined limit is exceeded. The warning usually is accomplished by means of a visual or an audible signal. This signal can be as common place as the flashing light ringing bell that is often found at a rail road grade crossing.

2.7 Type of Alarm Systems

There are different types of alarm systems, in existence today; the function of each alarm depends on the system configuration and the purpose it's to serve

2.7.1 Professional Burglar Alarm

Joe Maurath said that using window foil that "break" a circuit, as the glass is broken, could use the professional type burglar alarm to protect window or glass area[]. It is an alarm that is triggered when the protective glass is broken. All protective door and window circuit must be normally closed and series connected so that an opening of any protective device will trigger the alarm. Once the alarm is triggered it can be turned off only by opening the master switch. The recommended power supply AC power 6VDC source.

2.7.2 Speed Limit Alarm

This is a wireless portable unit adaptable device, installed in the internal combustion engine of vehicles. This circuit has been designed to alert the vehicle driver that he has reached the maximum fixed speed limit (i.e. in a motor way). It eliminates the need to look at the tachometer and to be distracted from driving. There is a strict relation between engine RPM (revolution per minute) and vehicle speed .So this device controls RPM and start beeping and flash a LED (light emitting diode), once per seconds when maximum fixed speed is reached. Its outstanding feature lies in the fact on connection is required from the circuit to engine.

2.7.3 Industrial Alarm

This alarm comes in three versions as stated in RS book of October 1992 [6] The 12V dc GREY bell are affordable home security. This is ideal for use in security system and complies with the requirement of BS4737 intruder alarm system in buildings. The unit must be mounted within a bell enclosure when used in external environments of BS5839 fire detection alarm system in buildings. The 240Vac GREY bell is an extremely effective signaling unit for use in industrial environments. The design avoids the need for mechanical contacts resulting in greater reliability efficiency and longer operating life. All units may be ceiling or wall mounted, with flush or surface wiring and requires no final setting up adjustment. A chip hold the movement to a tough polycarbonate base, and a twist lock mechanism hold the going in position.

2.7.4 Intruder Alarm Detector System

The alarm detector system provides effective and affordable home security, whenever any unexpected guest approaches your property, this is triggered –ON. This Perimeter intrusion detector system alerts you of the presence of an intruder. It simply operates on the principle of a wireless technology. The system, consist of two Basic component, an infrared sensor detects the presence of the person, and then immediately via a 300MHZ radio signal to the receiver in the house which sound the Alarm. It has an exceptional range of up to 150feet. The sensor/transmitter is a special Military version. The sensor has an adjustable field of view with 30feet detection Limit and is powered by a 9volts battery. The receiver/ alarm unit is plugged into a Standard electrical outlet inside the house or at the security post as the case may be. Upon receipt ion of signal from the sensor to be receiver unit, this activates the alarm. The receiver has a volume control for the alarm and terminal board for connection of

An optional external siren. So it's based on the above analogy that this project built on, With an improvement on it by incorporating a trap device and it was therefore tagged **An automatic intruder alarm detector with o coding device/trap**

2.7.5 Anti- Theft Car Alarm

Electronic magazine of March, 1983 affirm that, the unit is mounted somewhere in the car where it will de difficult to find it and renoved. The switch under the Dashboard where the driver can reach it but were a thief will not easily find it. When the ignition is turned on with the switch closed, whether by using the key or by "hot" wiring the circuit will be activated.

2.7.6 Refrigerator Door Alarm

This system is so designed to indicate the state of a refrigerator door. This was Designed based on the light sensitivity received when the refrigerator door is opened. Today man people are conscious of the havoc caused by lack of preservation of foods a in some cases the items get spoiled when the refrigerator door is left opened for a long time. So this system will alert someone that the refrigerator door is not closed. It shows thus when it starts beeping after a preset time.

CHAPTER THREE

3.1 Circuit Design And Implementation

An empirical representation of the design of this project is given in block diagram and in modular representation below:

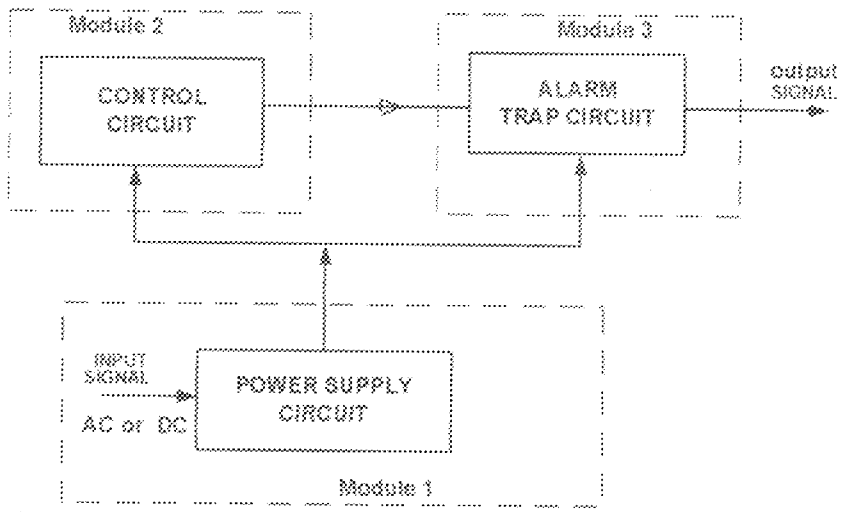


Fig. 3.1 modular representation of an automatic intruder detector with a coding device

3.2 Project's Modular Representation

This project is divided into three major modules

1. The power supply
2. The control circuit
3. The alarm circuit

A more elaborate step-by-step design analysis is given in the block diagram of fig 2

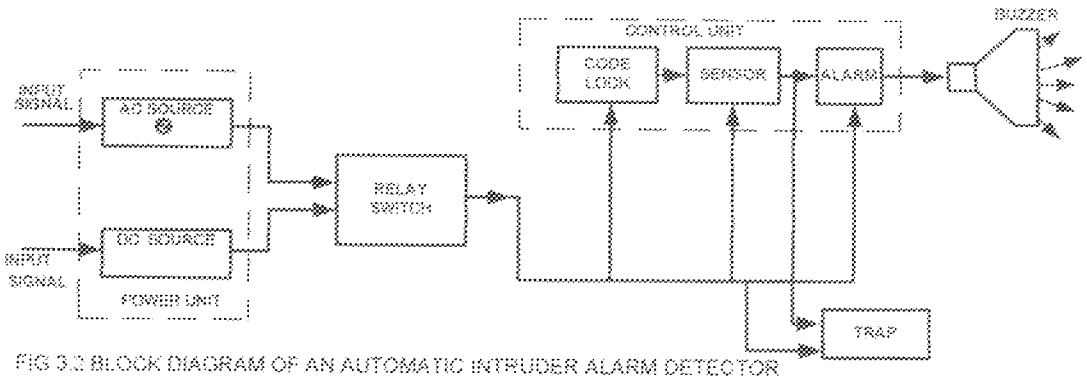


FIG 3.2 BLOCK DIAGRAM OF AN AUTOMATIC INTRUDER ALARM DETECTOR WITH A CODING DEVICE

The inclusion of the relay switch ensures constant power supply to the system. The buzzer acts as a transducer, to convert the output D.C. signal produced to sound energy

3.3 Power/ Regulator Stage Design

The input power to the system is 220V at 50Hz, which is stepped down to 12V through a step down transformer.

The stepped down 12V is still a.c. and need to be converted to D.C. required by the system. To achieve this, the rectifier section is used which comprises of four diodes. IC diode can be used or discrete diode as used in this design. Output from the full – wave rectifier diode contains ripples and needs to be smoothened further. The capacitor takes this voltage and charges during positive half of the signal and during negative half it discharges giving a continuous signal

Capacitors of higher values were used to give the required output. The capacitor of 4200μF was not found in the component market; hence I used a 14V, 330μF capacitor and set a compensating capacitor C_2 to be 100μF to compensate for the ripples not removed by330μF capacitor.

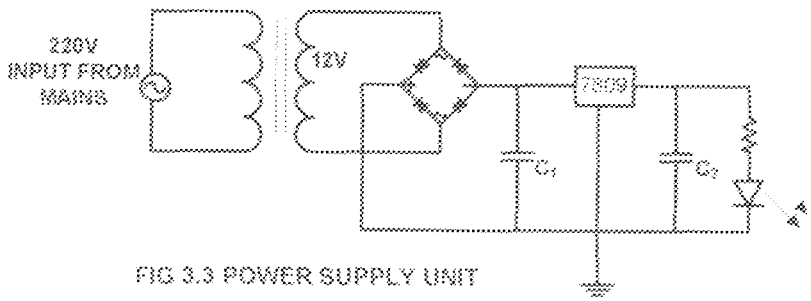
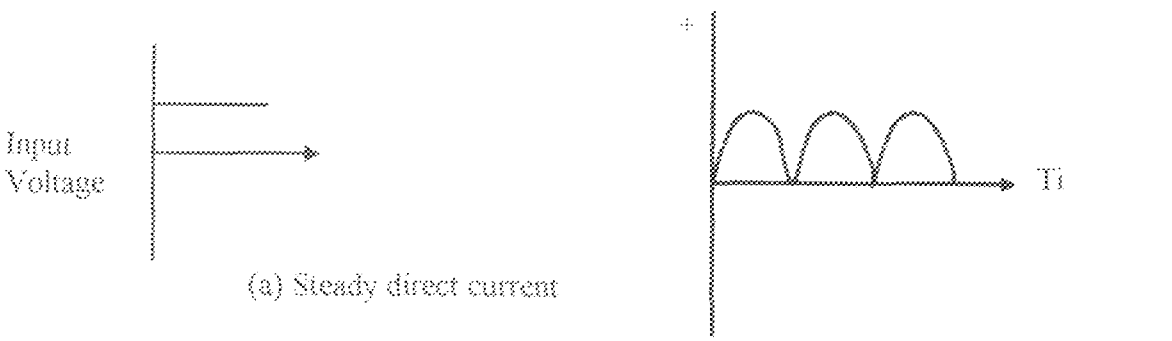


FIG 3.3 POWER SUPPLY UNIT



(a) Steady direct current

(b) Full wave rectification

Fig 3.4 signal representation of the power supply unit

3.4 Transformer

It is a device consisting of two closely coupled coils in which an a.c. signal applied to the primary appears across the secondary with a voltage transformer and current multiplication is inversely proportional to the turns' ratio [9]

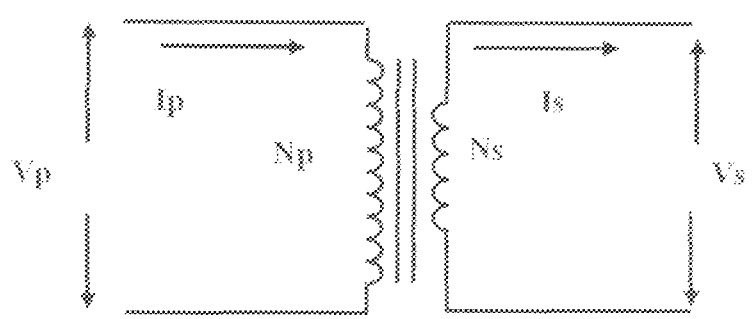


Fig 3.5 Transformer representation

N_S = Number of turns in secondary coil

N_P = Number of turns in primary coil

V_P = Primary terminal voltage

V_S = Secondary terminal voltage

I_S = Secondary Current

I_P = Primary Current

A transformer could be a step up transformer in which the input voltage is stepped up (increased) while at the output, voltage is stepped down (decreased) at the output. In this design, a step down transformer is used, since the entire voltage required by circuit is 9V

3.5 Diodes

A diode is made up of two pieces of semiconductor material joined together, one is p – type and other is n – type is the cathode. [7]

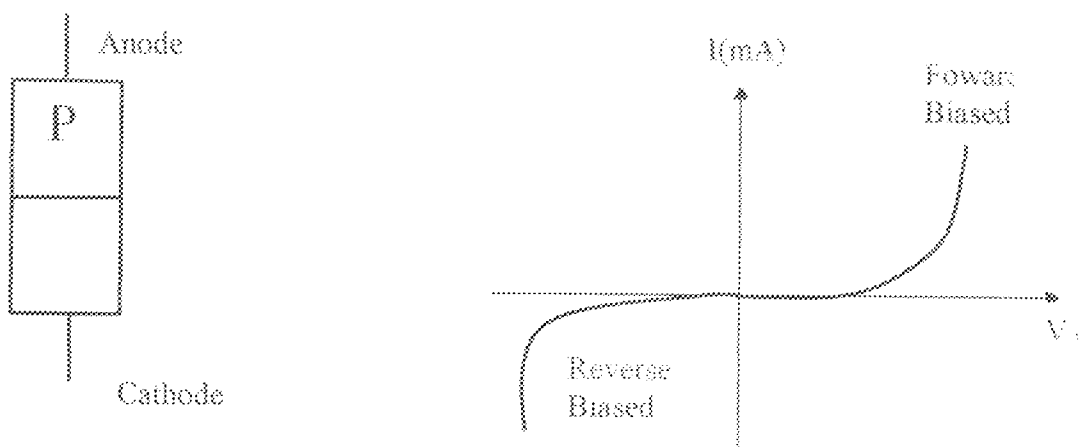


Fig. 3.6 Diode symbol and characteristics

The diode offer low resistance when forward biased and behaves almost like an insulator when reverse biased.

3.5.1 Forward Bias: When the diode is forward biased form zero voltage, hardly do any current flow because of the barrier voltage and once this is neutralized, current begins to flow. It can damage the diode if the voltage is increased beyond a certain safe value.

3.5.2 Reverse Bias: On reverse biasing the diode, majority carriers are blocked and only small current flows in the diode, but when the reverse bias voltage exceeds a certain value called "breakdown voltage", the leakage current sharply increases and may cause burnout (damage)

The analytical explanation of determining diodes characteristics.

Each silicon diode has a threshold voltage drop of 0.6V. So there are four rectifying diodes forming the full wave bridge. This will drop a voltage of 2.4V

Voltage required at output = 12V

Voltage dropped across diode = 2.4V

Total voltage left at output = 10.4V

Since the total voltage left is less than the reference voltage required by the circuit, therefore the total voltage will be 14.4 in order to obtain exactly 12V at the output after passing through the rectifying diode.

Therefore, peak voltage = 14.4V

The transformer gives r.m.s voltage. R.M.S. voltage is an a.c. voltage that will give an equivalent D.C. voltage with the same power output.

Recall $V_{r.m.s} = V_{peak} / \sqrt{2} = 14.4/1.4 = 10.286V$

The diode plays a very vital role in electronic system such as

(i) Rectification

(ii) As a switch

(iii) As an AND gate

However, in this design the diode is used as a rectifier.

3.6 Capacitors

Capacitors are made up of two parallel plates separated by an insulator called dielectric; the external leads are two metal plates. A flow of electrons force away an equal number of electrons form the positive plate. It is in effect, an electrical bucket that is filled and emptied by the reset of the circuit. For a perfect capacitor, no electricity flows across the gap and it has the property of Q = CV where

Q = charge stored in the capacitor

C = capacitance of the capacitor

V = voltage across the capacitor

Capacitors are devices that might be considered simply as frequency dependent resistors. They are used for

(i) Storing electricity

(ii) Waveform generation filtering

(iii) Blocking and bypass application

(iv) Integrators and differentiators

However, in this stage of the circuit design, the capacitor was used to reduce effects of ripples (i e. waveform generation filtering)

Taking the derivative of the defining equation above, we obtain

$I = CdV/dt$

A Farad is very large, so microfarads or picofarads are normally used as units of measure. Capacitors come in an amazing variety of shapes, sizes, and types viz mica, ceramic, polyester, porcelain, electrolytic e.t.c.

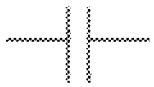


Fig.3.7 Symbol of capacitor

The capacitance of several capacitors in parallel is the sum of their individual capacitances i.e.

$C_t = C_1 + C_2 + C_3 + \text{-------} + C_n$

3.6.1 Determining the capacitor C

From $I = C\, dV/dt$,

Where I = maximum current in the circuit

I = 1A

If a ripple of 20% is obtained, then

dV = 20 x 12/100

= 2.4V

Then dt = 1/2F

F = frequency of a.c. voltage = 50Hz

Therefore, dt = 1/ (2 x 50)

= 1/ 100 = 0.01sec

3.7 Voltage Regulator

Line voltage at output at a power supply often fluctuates by as much as 10 – 20% causing the output voltage of the phasor to vary, the current drawn by the power supply load may have a wide range of values, in addition, the temperature may change. This affects and tends to change the output voltage

A regulator is normally connected between the filters and the load designed to maintain a nearly constant output voltage for anticipated variation in the input voltage, load current and temperature.

There are several regulation circuits used for power supply design, the IC voltage regulator and the series voltage regulator. [17]

The IC voltage regulator was used for this design for a fixed 9V output, the IC voltage regulator 7809 was used to obtain this output. The circuit diagram of the voltage regulator is as shown below.

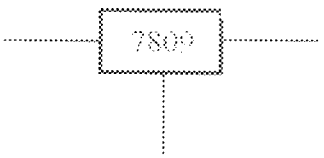


Fig.3.8 IC Voltage regulator

3.7.1 The Voltage Regulator Circuit

For the 9V output, the IC voltage regulator 7809 used to obtain this output. These include fairly simple, fixed voltage types of high quality precision regulators. These IC regulators have much improved performance as compared to those made from discrete components. The IC is a three terminal type. If an excess current, or overheating should occur, the IC will shut down to prevent any damage. The output voltage of a 7800 series is indicated by the last two figures in the device number. Thus 7809 IC provides an output voltage of 9V. And if the input voltage is below its required output voltage (i.e. below 9V), the regulator IC will simply act as a conductor. Now if the input voltage is greater than the output voltage by a factor of 4V and above, (i.e. 9V + 4V = 13V), the voltage regulator IC will start to heat up and eventually damage the IC after sometime. Hence we require an input voltage to be approximately at 12V.

Therefore, the power supply unit comprises of`

(1) Transformer used to step down the 220V to 12V

(2) Diode used for rectification

(3) Capacitors (electrolytic) used for smoothing the 220Va.c. to 12V d.c

(4) Voltage regulator

3.7.2 Alternative Source Of Power

Since the situation in Nigeria is such that power outages are very common, we will require an alternative source of power for this design i.e. A battery back up, so that if there is no power from the nation's power source, the battery will act instead.

This will entail using a relay to switch using its two terminals: "The normally closed (NC) and the normally open (NO)" The relay switches to its normally closed state when it is not powered and switches to its normally open state when it is powered. This characteristic feature of the relay is what is used in a UPS (uninterruptible power supply) and for this circuit`s power supply design. So when there is power, the relay switches to its NO state. The main power source is connected to NO pin, so the circuit is powered by the common pin of the relay which switches between NO and NC pins, so if there is no power, the common switches to the NC pin, the battery is connected to the NC pin so in either case the circuit is powered via the common pin which is either at V" or battery

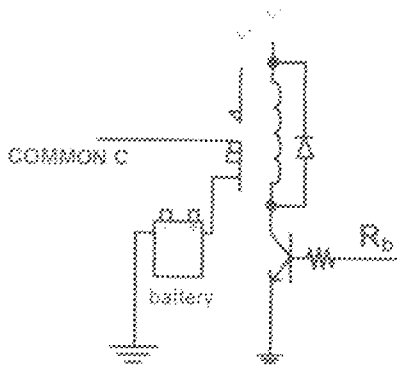


Fig 3.9 circuit diagram of switch relay

From the circuit above,

$V^{-} = I_C R_C + V_{CE}$

Since transistor is used as a switch, $V_{CE} = 0$

Therefore $I_C = V^{-} / R_C$ since $I_B = I_C / hFe$

Rc = Coil resistance

= 9V / 175 = 0.00693Ω

hFe = 175

Therefore $I_B = 0.00693 / 412$

$= 1.682 \times 10^{-5}$ A

$V_B = I_B R_B = V_{BE}$

Making R_B the subject of the formular,

$R_B = (V_E - V_{BE}) / I_B$ $V_{BE} = 0.6V$ (i.e. diode voltage)

$= (9 - 0.6) / 1.682 \times 10^{-5}$

$= 4.9 \times 10^{5}$ Ω

= 490 kΩ

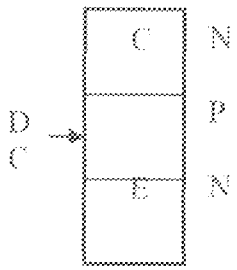
Preferred value of 500 kΩ is used

BC 337 (transistor)

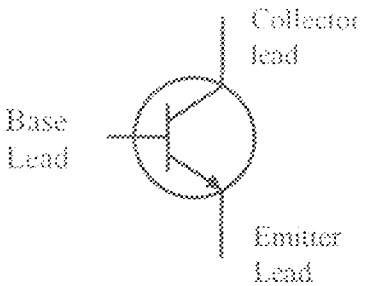
D_1 is to stop feedback current across the coil.

3.8 Transistor

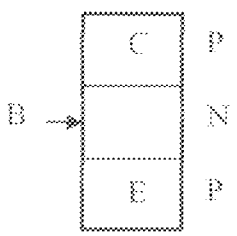
Transistors provide the power gain that is needed for most electronic applications. They also can provide voltage gain and current gain. For the purpose of this project, we will be concerned with Bipolar junction transistor (BJT) [9]. The transistor is bipolar because both holes and electrons will take part in the current flow through the device. The transistor regions as shown in the figure below are named emitter, base and collector. The N – type regions contain free electrons which are negative carriers. The P – type region contain free holes which are positive carriers.



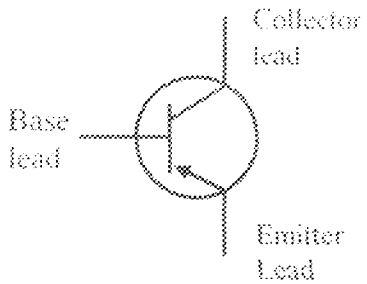
(a) NPN Structure: positive base region between two negative regions



(b) NPN schematic symbol



(c) PNP Structure: Negative base region between two positive regions



(d) PNP schematic symbol

Fig 3.10 Transistor structures and symbols

A transistor would be classified as an NPN transistor or PNP transistor. However, a transistor must be properly biased for it to function normally

The collector base junction must be reverse – biased for proper operation in an NPN transistor, the collector will have to be positive with respect to the base.

In a PNP transistor, the base – emitter junction must be forward biased, the collector will have to be negative with respect to the base [10]

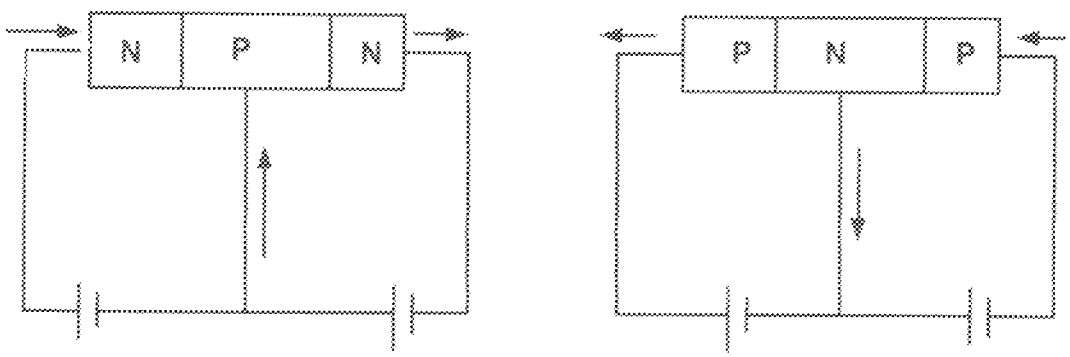


Fig 3.11 Representation NPN & PNP biasing

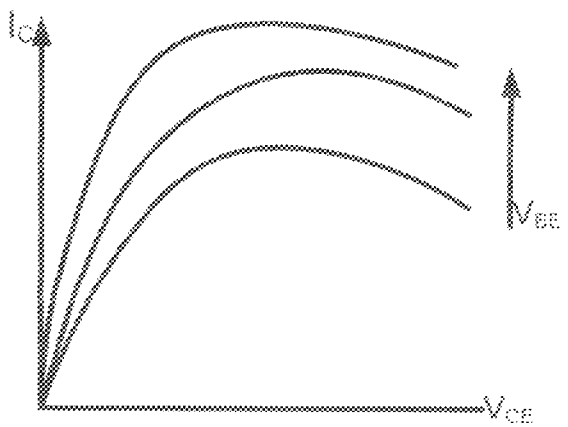


Fig 3.12 characteristic curves of biasing level

3.9 The 555 Timer

The NE555 IC TIMERS are very much common in design. For the purpose of this project, we shall be using the NE555timer in the 8-pin package. The 555timer provides stable time delay or free running oscillation. The timer-delay mode is RC-controlled by two external components. Timing from microseconds to hours is possibly depending on the desired output waveform Frequencies form less than $1H_Z$ to $500KH_Z$ with duty cycles from 16% to99% can be attained [7].

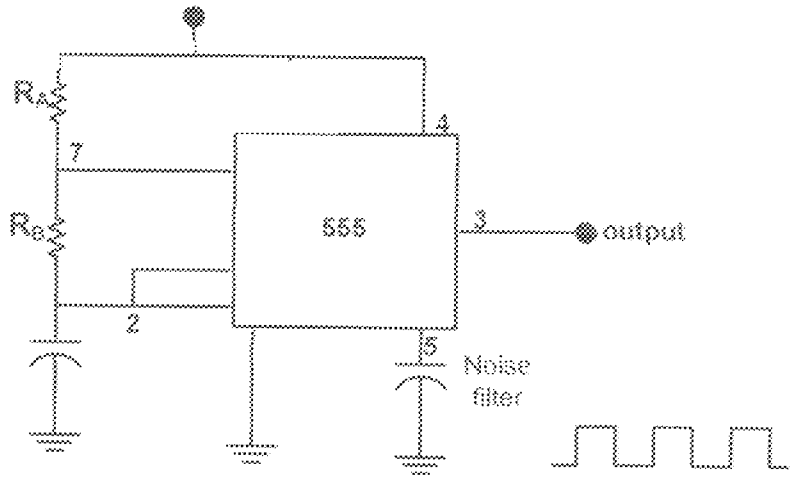


FIG 3.13 Astable mode

The output waveform is non symmetrical, the output frequency will be equal to the reciprocal of the total period or the output frequency can be found with

$Fo = 1.45/ (R_A+2R_B) C$

Assume that both timing resistors $R_A = R_B = 10k\Omega$ and that the timing capacitor,

$C = 0.1\mu F$

Therefore, $F_0 = 1.45/ (10 X 10^3)0.1 X 10^{-6}$

$= 483Hz$

The Duty Cycle D of a rectangular waveform is the percentage of time that the output is high. It can be formed by dividing the total period of the waveform into time that the

Output is higher. For the astable circuit, it obtained from,

$D = [(R_A + R_B) \times 100\%] / R_A + 2R_B$

Assuming two 10kΩ time resistors gives

$D = (10 \times 10^3 + 10 \times 10^3) / 10 \times 10^3 + 20 \times 10^3$

$= 66.7\%$

3.10 Control Circuit

The control circuit is made up of the code lock and the sensor. This controls the **trap** and the **alarm** system.

3.10.1 Code Lock Device

The code lock is necessary to deactivate the sensors when an authorized personnel inputs the right codes. So the trap and the alarm will be disabled

However, the code lock for this project is not presettable. This is because of the cost implication. To achieve a presettable code lock, a PIC (programmable integrated circuit) will be required. Therefore for the demonstration of this project, a 7474 IC dual – D – flip flop is used which is not presettable, the dual d – flip flop transfers the value of the data input to the output Q [8]

NB. A D - flip flop has tow outputs Q and $\overline{Q}$

Connection Diagram

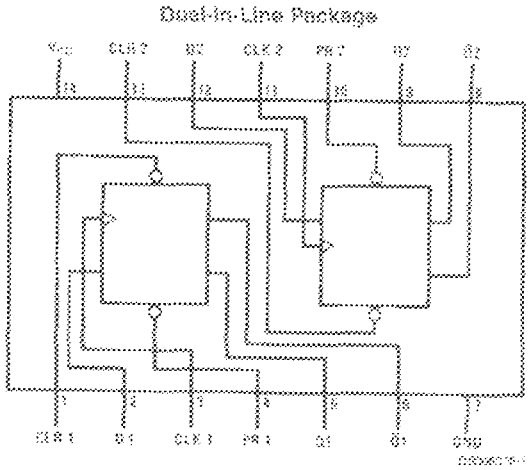


Fig 3.14 7474 dual - D – flip flop interconnections

3.10.2 7474 Dual D – Flip Flop

This device contains two independent positive – edge – triggered D flip – flops with complementary outputs. The information on the D input is accepted by the flip – flops on the positive going edge of the clock pulse. [14] The triggering occurs at a voltage level and is not directly related to the transition time of the rising edge of the clock pulse. The triggering occurs at a voltage level and is not directly related to the transition time of the rising edge of the clock. The data on the D input may be changed while the clock is low or high without affecting the outputs as long as the data setup and hold times are not violated. A low logic level on the preset or clear inputs will set or reset the outputs regardless of the logic levels of the other inputs.

Since the data present at D when there is a clock pulse at C_T is transferred to Q, then we can cascade four (4) 7474's ICs to achieve the code lock system. Although the clock input is level – sensitive, the positive transition of the clock pulse between the 0.8V and 2.0V

levels should be equal to or less than the clock to output delay time for reliable operation [8]

Inputs				Outputs	
PR	CLR	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H (Note 1)	H (Note 1)
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

H = High Logic Level
X = Either Low or High Logic Level
L = Low Logic Level
↑ = Positive-going transition of the clock.

3.10.3 Operational mode of 7474 D – flip flop as code clock

The first key sends the HIGH data at D_1 to Q_2 which is connected to another D_2 of a second 7474 D flip flop so when the second key is pressed, the HIGH logic of D2 is sent to Q3 and the Q3 output of this second 7474 is connected to the D3 input of a third 7474. So when the third key is pressed, the logic level on D3 is sent to the output Q4 and when the fourth key is pressed, the logic level on D3 is transferred to Q4. This is connected to the sensor through a Schmitt trigger. To disable the sensor, all other keys are sent to the RESET pins and never the wrong key is pressed, the 7474 automatically resets its pins to ogic level LOW.

Below is the circuit diagram.

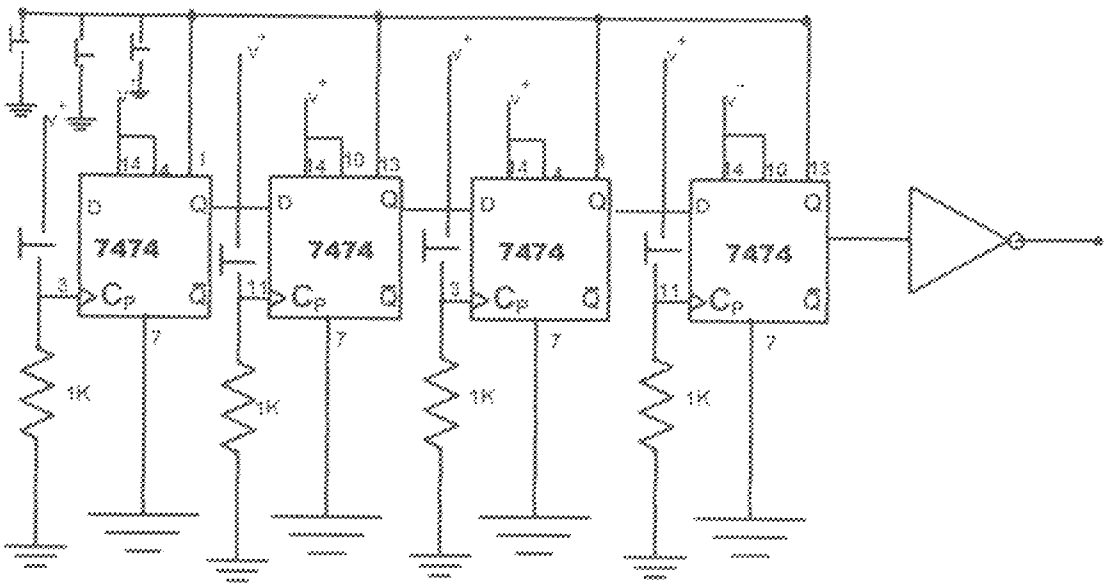


Fig 3.15 circuit repeseneation of the code lock

3.11 Infrared

Infrareds are invisible band of radiation at the lower end of the visible light spectrum. With the wavelength from 750nm to 1mm, infrared starts at the end of the microwave spectrum and ends at the beginning of visible light. Infrared transmission typically requires an unobstructed line of sight between transmitter and receiver.[15]

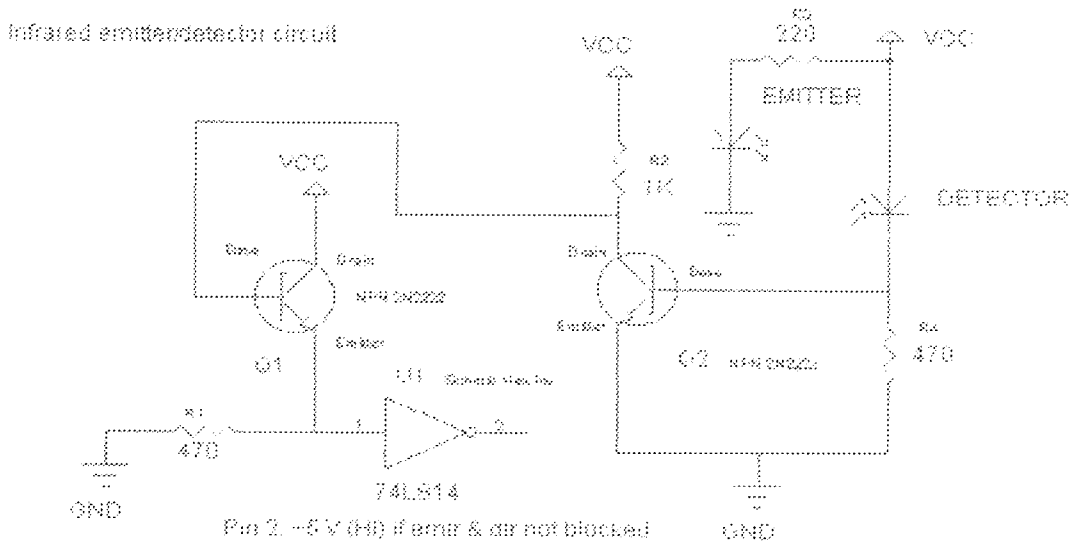


Fig 3.16 infrared emitter/detector circuit

Uses of Infrared

(1) Used in most audio and video remote

(2) Infrared transmission is also used for wireless connections between computer devices.

(3) Used a detectors

Therefore for this project purpose it will be used as a **detector**

3.12 Sensor Circuit

The sensor is used for this project is the infrared transmitter and the photodiode as the receiver.

3.12.1 The transmitter Stage:

This is made up of the infrared emitting diode which is forward biased through a 220Ω resistor to reduce the voltage across the diode, this transmitter emits infrared rays constantly so long as the anode voltage is positive with respect to the cathode

3.12.2 The Receiver Stage:

The receiver is a photodiode which senses continuous infrared rays from the transmitter. The photodiode resistance is low when it senses light rays from the transmitter and increases when there is no light rays from the transmitter.

This change in resistance of the photodiode is what is used to trigger an alarm and also used to activate the trap. However, the photodiode is connected to a voltage comparator (LM 393) of which the output at the comparator (LM 393) serves as a clock for a D – flip flop.

3.13 Voltage Comparator (Lm 393)

The LM393 series are dual independent precision voltage comparators capable of single or split supply operation. These devices are designed to permit a common mode range – to – group level with single supply operation. Input offset voltage specification as low as 2.0mV makes this device an excellent selection for many applications in consumer, automotive and industrial electronics.

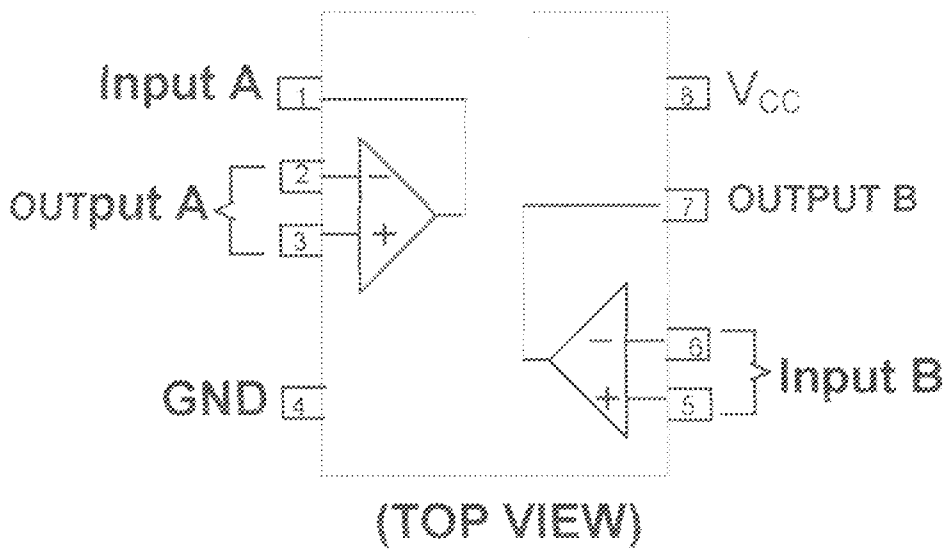


fig 3.17 pin connection of LM 393

Therefore, for the project, LM393 was used, where non – inverting input is pin 3 and the inverting input is pin 2 as represented in the diagram below

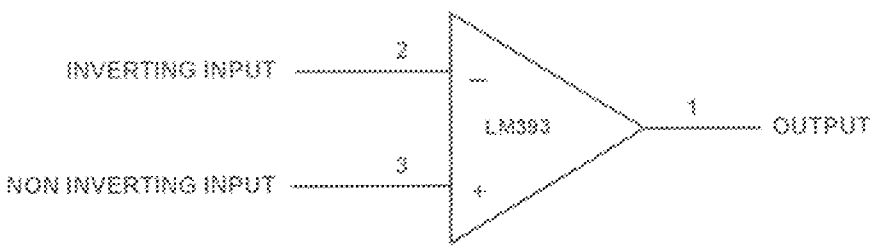


fig 3.18 LM393 comparator (input/output) connection.

The maximum resistance of a photodiode when its not sensing light is about 1MΩ. Therefore if a 1MΩ resistance is connected as the voltage divider with the comparator (LM393). Then when it is not sensing light, the voltage at the junction is 45V as shown in the diagram below

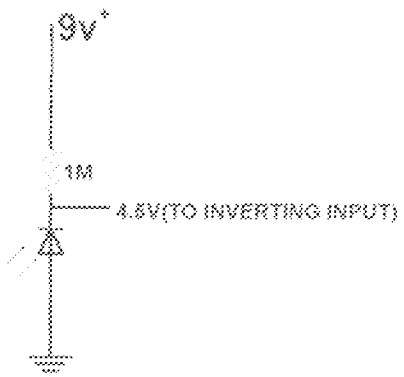


Fig 3.19 receiver unit in inverting stage

NB. The 4.5V serves as the inverting input signal so the non – inverting input has to be set to a preferred value lower than 4.5V (i.e. inverting input)

Assuming the voltage at the non – inverting input is 3V, applying voltage divider theorem

thus: $3 = \frac{9 \times R_1}{R_1 + 1K}$ (NB: 1KΩ ➔ pull – up resistor from datasheet)

$3\ (R_1 + 1K) = 9R_1$

$3R_1 + 3K = 9R_1$

$3K = 9R_1 - 3R_1$

$6R_1 = 3K$

$R_1 = \frac{3K}{6}$

$= \frac{3 \times 1000}{6}$

$= 500\Omega$

From value obtained, this allows the distance of the photodiode and infrared to be adjusted. so we used a preferred value of 4 7K preset resistor.

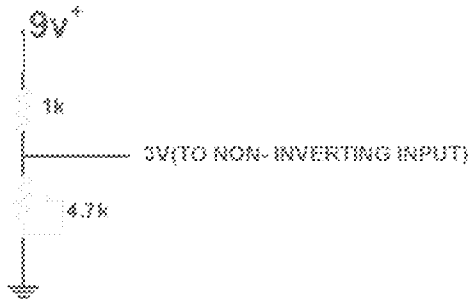


Fig 3.20 receiver unit in non- inverting stage

The diagram below shows a full receiver circuit

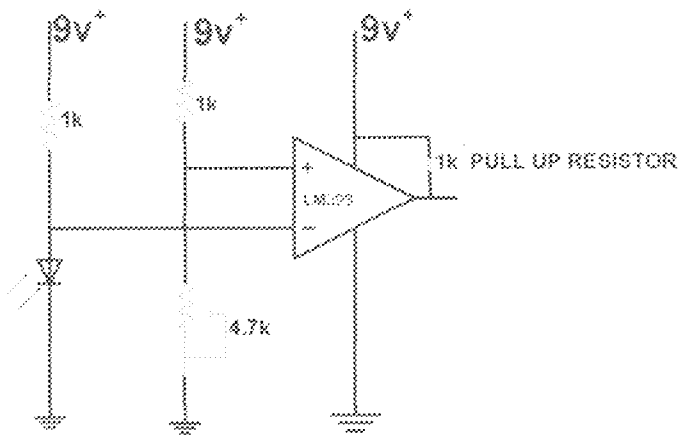


Fig3.21 full receiver circuit unit

3.14 Design Analysis of Alarm Stage.

The alarm comes ON when an intruder breaks the infrared beam, thus reducing the sensitivity of the photodiode which is connected to the 555 timer in an astable mode generating a frequency of 4.5Hz.

The RESET pi of the 555 timer (pin 4) is connected to the output of the Q output of the D flip flop (pin 6). The output of the comparator clocks the D – flip flop which cause it to toggle and Q becomes a HIGH logic and the alarm is triggered

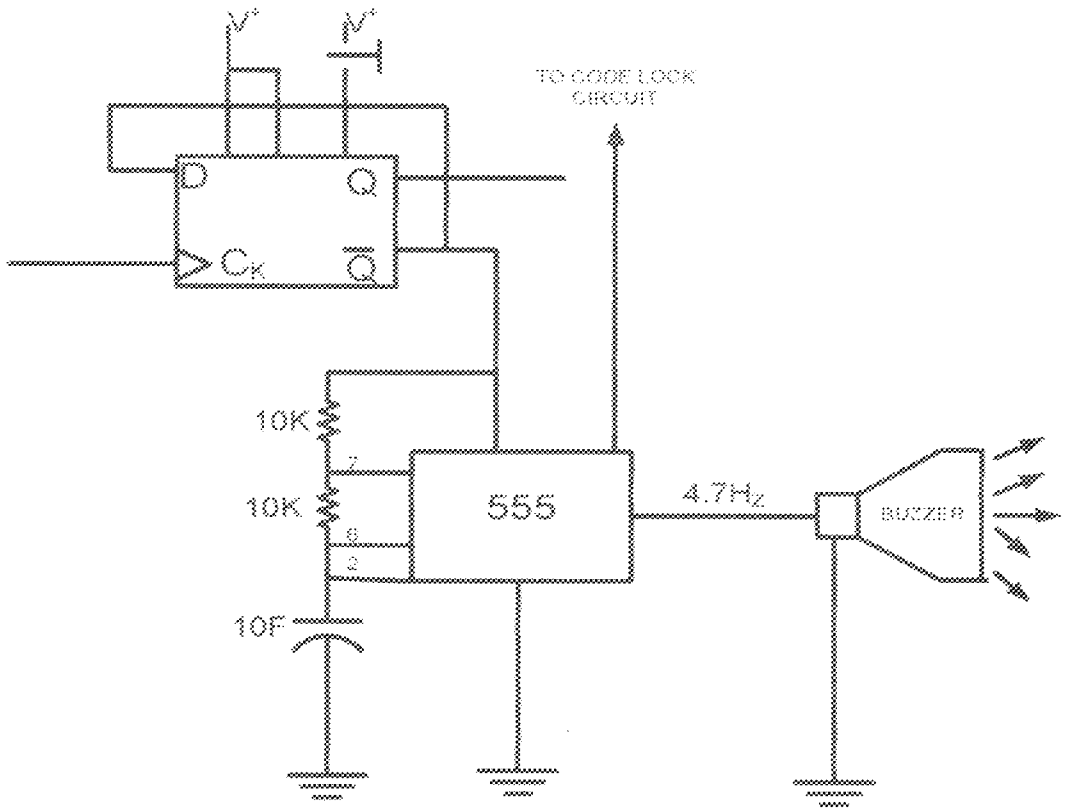


Fig 3.22 circuit representation of alarm stage

3.15 The Oscillator Stage:

With positive feedback, it is possible to build oscillators, circuits that generate or create an output signal with no external input signal. Positive feedback alternately drives the output into positive and negative saturation. The principle behind a relaxation oscillator is to let the charging and discharging of a capacitor determine the frequency of the output square wave.

To build an oscillator, an amplifier with positive feedback is required. The idea is to use the feedback signal in place of an input signal. If the loop gain and phase are correct, there will be an output signal even though there is no external input signal. In other words, an oscillator is an amplifier that has been modified by positive feedback to supply

its own input signal. This may sound like perpetual motion, and in a way it is. But it must be noted that an oscillator does not create energy. It only changes d.c. energy from the power supply to a.c. energy. There are various types of oscillators, under RC and LC families, namely:

1. Crystal oscillator
2. Wien – Bridge
3. Colpitts
4. Twin – T oscillators
5. Armstrong oscillators
6. Hartley
7. Clap oscillators.

3.15.1 Cmos Oscillator:

For this project, the CMOS oscillator was designed using the 4011B NAND gate. The CD4011BC quad NAND gate is monolithic Complementary MOS (CMOS) integrated circuits constructed with N – and P – channel enhancement mode transistors. It has equal source and sink current capabilities and conform to standard B series output drive. The devices also have buffered outputs, which improve transfer characteristics by providing very high gain.

All inputs are protected against static discharge with diodes V_{DD} and V_{SS}.

This project consists of two oscillators generating frequencies of

1. 10Hz used for clocking of the input signal from the detector stage.
2. 550Hz used for controlling the duration (period) of the alarm signal

For the 10Hz oscillator, the RC network dictates the frequency of this section, clocking is achieved when the high input from the detector stage clocks with a high input from the

oscillator stage. The 10Hz oscillator generates a square wave signal of high and low pulses, which is fed back into the input. The circuit remains dormant or inactive until a high pulse from the detector stage clocks with the high portion of the oscillator, thus triggering a high output form the second NAND gate connected, this triggers a high output form this stage, which is fed into the next stage, that is the 550Hz oscillator, which is analyzed later.

The frequency of this stage is thus derived.

The second oscillator, the 550Hz oscillator controls the alarm and it's duration or period of the alarm signal/ sound. This oscillator generates a square wave signal or pulse train consisting of high and low pulses (1's and 0's) and this is clocked with the high output (1's) from the pulse train causing the alarm to be triggered. The RC network dictates the period/ duration and that determines the turn – off of the alarm unit

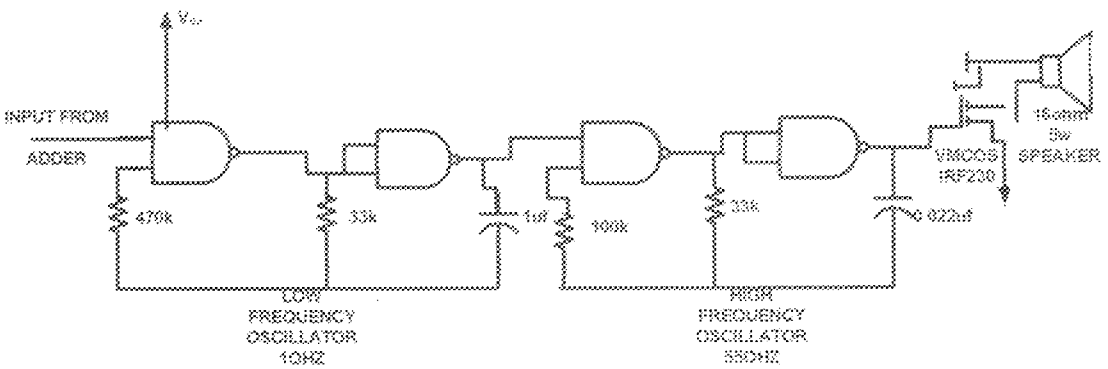


Fig:3.23 Control enable/ clocking and amplification circuit

3.16 Amplification / Alarm Stage:

This stage involves the use of an amplifier/ switch using a VMOS (Vertical Metal Oxide Semiconductor), this module amplifies the signal and controls the turn on and turn off, of the alarm speakers. The VMOS belongs to the family of MOSFETS (Metal –

Oxide Semiconductor Field Effect Transistors), which has three terminals namely source, gate and drain. Unlike in JFET, the gate is insulated from the channel. Because of this, gate current is extremely small whether the gate is positive or negative.

The structure of the VMOS is shown below, it is observed that it has two sources at the top. These are usually connected. Furthermore, the substrate now acts like the drain. When V_{GS} is greater than the threshold voltage, free electrons flow vertically downward from the two sources to the drain. Because the conducting channel is much wider along both sides of the V groove, the current can be much larger. The overall effect is an enhancement – type MOSFET that can handle much larger currents and voltages than a conventional MOSFET

Prior to the invention of the VMOS transistor, MOSFETs could not compete with the power ratings of large bipolar transistors. But now, VMOS offers a new type of MOSFET that is better than the bipolar transistor in many applications requiring high load power, including audio amplifier, RF amplifiers, switches and so on.

- It`s lack of thermal runaway
- It`s ability to be connected in parallel
- Faster switching speed
- It`s lack of storage time
- It`s ability to be interfaced with digital IC (such as CMOS, MOS or TTL) to high power loads

3.16.1 Alarm Unit:

This unit produces the audible sound which indicates that an intruder is within the immediate vicinity of one of the detector/ sensor units. It consists of a speaker connected in the audio generating stage

3.17 Trap Stage

This comprises of a monostable timer and a combinational logic circuit. The trap is released when the intruder steps in the vicinity without inputting the right code.

The output of the flip-flop in the code lock stage is used to power the monostable 555 timer, so that when the right codes are imputed the trap is deactivated, but if the codes are not correct or nothing is imputed at all the trap is active.

The monostable is set to time constant of 5s, and the output is fed to one of the inputs of an ex-OR gate, the other input of the ex-or gate is connected to the Q output of the flip. So when the codes is correct the output of the monostable is low and the Q output is low and the Q output is low, which involves the output of the ex-or low, but if the codes imputed is incorrect, the 555 timer will be activated and the Q output high, so when the intruder breaks the beams, it triggers the monostable which outputs a low, hence the two inputs of the ex-or is unidentical which makes the output high

The output of the ex-OR controls a DC motor, which rotates to the release the set trap.

The monostable configuration is shown below:

For 5sec we have

$C = 100uf$; from $T = wRC$ take $R = 47\Omega$(as prefer value)

$$\frac{5 * 10^{6}}{1.1 * 100}$$

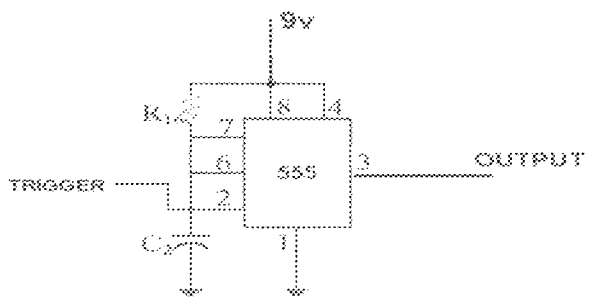


Fig3.24 circuit of the trap timing duration

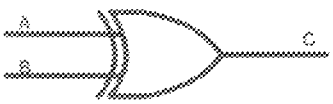


fig 3.25 gate symbol representation (ex-OR)

table 3.1 (truth table)

	INPUT	OUTPUT
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

The circuit diagram of the trap stage therefore is:

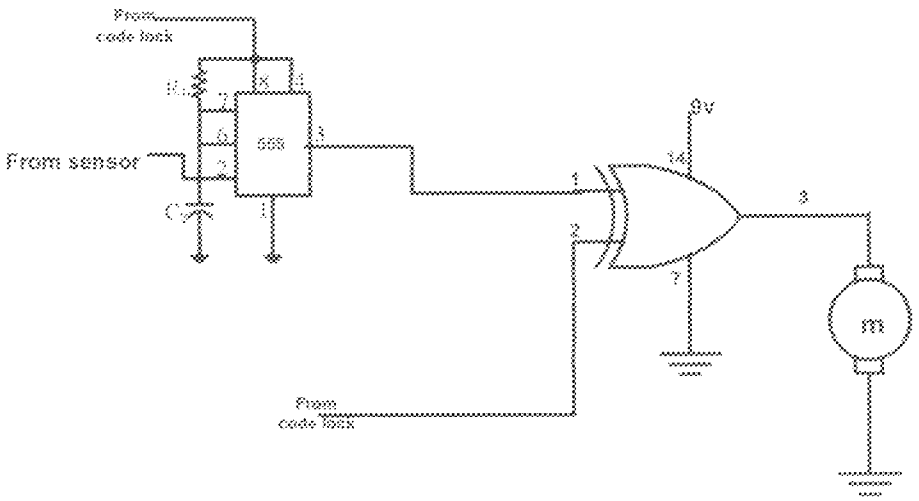
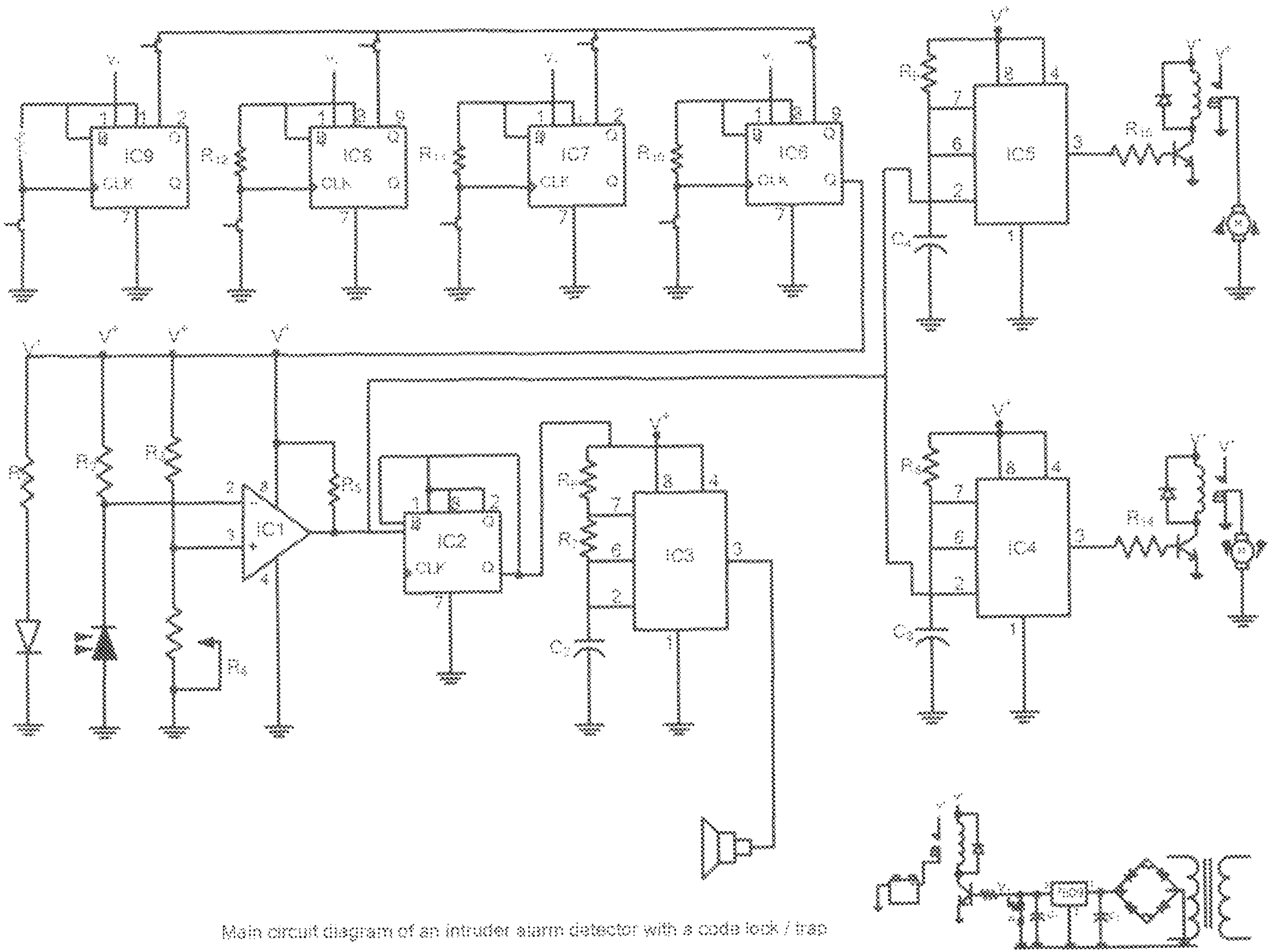


Fig 3.26 circuit representation of the trap device



Main circuit diagram of an intruder alarm detector with a code lock / trap

CHAPTER FOUR

Implementation

4.1 Introduction

This chapter gives a detailed summarizing of the methods that were used in assembling the different components that were chosen from the design calculation in chapter two to make a workable and functional unit

Table 4.1 below gives a summary of the various components used and their corresponding specification.

Table 4.1 Component specification

RESISTORS	VALUE (Ω)	POWER DESCRIPTION (W)	TOLERANCE (%)
R_1	10K	1/4	5
R_2	100K	1/4	5
R_3	1 K	1/4	5
R_4	1K	1/4	5
R_5	100K	1/4	5
R_6	1K	1/4	5
R-	100K	1/4	5
R_8	1K	1/4	5
R_9	1K	1/4	5
R_{10}	100K	1/4	5
R_{11}	2.2K	1/4	5
R_{12}	470K	1/4	5
R_{13}	33K	1/4	5
R_{14}	100K	1/4	5
R_{15}	33K	1/4	5
R_{16}	1000k	1/4	5

Table 4.2 capacitor rating & type

CAPACITORS	VALUE(μF)	TYPE
C_1	1000	ELECTROLYTIC
C_2	47	ELECTROLYTIC
C_3	0.043	CERAMIC
C_4	0.022	CERAMIC

Table 4.3 Diode rating

DIODES	VALUE
D1 – D4	IN 4007
D5 – D8	LED
D9	PHOTODIODE

The components were first mounted on the bread board and tested to ensure that the respective modules operate efficiently. After testing on the board, the components were then transferred to a vero-board and soldered on it.

The component layout of the vero-board is shown in Appendix A the transformer and the vero-boards were mounted on the base of plastic transparent casing to show a clear representation of all the internal circuitry devices used in the construction which was made possible through the use of connecting wires the wires not too clearly connected before soldering to reduce induced magnetic flux that could create unwanted ripples signals.

Care was taken to avoid or dry joints as well as too much heat to prevent damage of the components and circuit board.

The sensors were made to come out of the casing through connection of wires, same goes with the speaker

4.2 Casing Design

The casing is fabricated with a plastic transparent (passof 150 x 120 x 102 (mm) perforations that serves as outlet for the three sensors were made so that they could be placed on their required position, perforation was also made for the speaker unit. The casing was made portable so that it can be placed inconspicuously to avert easy detection by the intruder.

The main alarm bus should be kept in the security guards post and labeled to indicate where the alarm is coming from so that the alarm is easily heard by the guards on duty. The three sensor should be placed at the appropriate places that is; the dark sensor should be placed in a hidden corner with the photodiode sensing it to make the circuitry a closed loop and continuous. If an intruder goes in and thus breaking the continuity of the circuit this will trigger in input oscillator thereby causing the alarm to go on and also activate the closure of the trap door.

4.3 Tests

The testing of this project was carried out in two different phase i.e. the breadboard stage and the Vero board stage. However, the breadboard testing was done in order to ascertain that the whole work piece was to function properly on soldering permanently on the Vero board, of which a satisfactory result where obtained. Afterward, the final testing was done on the Vero board. After properly soldering, the following test were carried out on the various components in the following order,

(I) The power unit was tested and required voltage 12V was obtained as a supply voltage to the main circuit.

(II) The code lock pad was tested by inputting the right code which was confirmed on breaking the beam to be functioning properly.

(III.) On braking the beam, the Alarm was triggered, this confirmed that the infra red and photodiode where functioning properly.

(IV.) The trap device was tested okay after a step pulse of 5 seconds sent from the 555 timer delay set it activated.

(V.) The overall project was tested operational after all the above testing steps activate the alarm thus indicating intrusion.

4.4 Result

The following results were obtained after carrying out the various tests on the project.

- The 12V power was supplied to the main circuit.
- The code lock accepted the preset code value on inputting it.
- The infra red was deactivated on inputting the right code
- The Alarm was triggered when the beam was not deactivated as expected.
- The indicating signal shows that it's safe to enter, thusshowing that the alarm has been deactivated.
- The trap slide down indicating that an intrusion as occurred.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The intruder alarm detector with a code/trap system is a device that provides total
security, that is to say when there is an unauthorized person within a restricted area.
It has an incorporated 240v/12v transformer to make the system work under low voltage
This makes it versatile. Its major objective revolves around providing security to the
vicinity where the alarm is operational and the design specification were achieved during
the course of this project

5.2 Recommendation

As always, every functional system, even operating normally without faults has
imperfections in it design. It is the duty or design specialist to seek our these
imperfections and try to proffer solution to these problems in order to improve
systems efficient.

As in the case of the project, certain aspects of the system design can be imp
upon such areas

- The sensitivity of the burglar alarm sensors in order to mak
more responsive
- Trap lock motors can be made more faster by increasi
of the 555 timer.
- The stability of the system can be improve
susceptible to interference
- The use of a backup battery could be inc

- Indicators could be added in order to show which areas are or have been intruded upon. If the alarm is mass produced for use in a large areas or building.

The suggestion made can improve the system functionality and value.