DESIGN AND CONSTRUCTION

OF A

CAR HIJACK ALARM

BY

ADELEMI BUSAYO ADEWUMI

MATRIC NO 2000/9779EE

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

OCTOBER, 2006

DESIGN AND CONSTRUCTION

OF A

CAR HIJACK ALARM

BY

ADELEMI BUSAYO ADEWUMI

MATRIC NO 2000/9779EE

IN PARTIAL FULFILLMENT OF THE AWARD
OF BACHELOR OF ENGINEERING (B.ENG)
A PROJECT SUBMITTED TO THE
DEPARTMENT OF ELECTRICAL &
COMPUTER ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA,
NIGER STATE, NIGERIA

OCTOBER, 2006

DEDICATION

To God be the glory. Firstly, I want to dedicate this project to the Almighty God, the Alpha, the Omega, the beginning and the end.

Secondly, I want to dedicate this project to my father Mr. S.A Adelemi and my mother Mrs. R.T Adelemi whose effort to reach the level I am today will remain fresh in my memory for life.

DECLARATION

I. ADELEMI BUSAYO ADEWUMI, hereby declare that this thesis is an original work of mine, and that it has never been presented in any form for the award of Degree Certificate anywhere. All information obtained from published and unpublished works have been acknowledged.

ADELEMI .B. ADEWUMI SIGN/DATE

Engr. MUSA D. ABDULLAHI SIGN/DATE

SUPERVISOR

Engr. MUSA D. ABDULLAHI SIGN/DATE

HEAD OF DEPARTMENT

EXTERNAL EXAMINER SIGN/DATE

ACKNOWLEDGEMENT

"This is the day the Lord has made and I will be glad and rejoice in it". I thank the Almighty God for the great things he has done.

My gratitude goes to my supervisor, and the H.O.D. Electrical and Computer Department (Engr. **MUSA D. ABDULLAHI**), for his assistance, guidance, kindness, understanding and being accommodating throughout this period. May the Lord God Almighty continue to increase you in wisdom, knowledge and understanding. 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 parents **MR** and **MRS ADELEMI** for their love, encouragement and support throughout my course. May God bless you all. Amen

My gratitude also goes to the following people that have one way or the other contributed immensely. I am very grateful and I pray that God Almighty will bless you more abundantly in return. People like my dear brothers (**ADEWALE and TAYE ADELEMI**), my dear sister (**KEHINDE ADELEMI**) and to all my friends like **LAWRENCE UMEJI, KEHINDE ADEDIPE,** and special thanks to **IFY EKPUNOBI** for her love and support throughout my course.

ABSTRACT

This work describes a Car Hijack Alarm which is a circuit designed basically for the situation where a car hijacker forces the car driver from the vehicle. If any of the car doors is opened while the ignition is switched on, the circuit will trip. After a delay of a few minutes the alarm will sound and the car's engine will fail. When the alarm is tripped, the LED lights and the buzzer give a short beep. In the case where the car owner or driver unintentionally trips the alarm a reset button could be pushed within a specific time. This switches off the LED, indicating that the alarm has been reset.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

The first documented case of car theft was in 1896, only a decade after gas-powered cars were first introduced. Since then, cars have been a natural target for thieves. They are valuable, reasonably easy to resell and they having a built-in gateway system. As a result, car theft is a common occurrence, and it is getting more sophisticated by the day.[10]

In the light of this, it is not surprising that many car owners are willing to invest in alarm systems. Cars could be equipped with sophisticated electronic sensors, blaring sirens and remote-activated systems. In its simplest form, a car alarm is one or more sensors connected to some sort of siren.

Car security or alarm systems, like other alarm systems, are in two categories. They are the contact operated alarms and remote alarm systems. Contact operated alarms are alarm systems that are activated by opening or closing of a set of electrical switches or contacts, which could take the form of a pressure pad, simple push-button switch, etc.

These alarm systems are designed to operate with a loudspeaker, a buzzer, a siren or a relay which output can be used to operate any kind of audible warning device. The simplest contact alarm would have a switch on the driver's door, and it would be wired so that if someone opened the door the siren would start wailing. This could be implemented using a switch, couple of pieces of wires and a siren.

Remote alarm systems involve the transmission of trigger signals by either breaking an infrared or ultrasonic beam or a modulated radio frequency signal. A decoder at the receiver circuit decodes the received signal. This decoded signal is used to control the switching of the alarm system.

This work is targeted at designing a contact operated hijack alarm with a view to applying it in safeguarding of cars from hijackers. The alarm is activated by opening any car doors while the ignition is switched on. Once the door is opened under this condition, the circuit is triggered and the entire process, which involves a timing action, begins. A LED comes on and a buzzer gives a short beep. If the reset button is pushed, the LED will switch-off, indicating that the alarm has in fact reset. A failure to press the reset button within the specified period will cause the siren and buzzer to start sounding continuously. This allows for more time to reset the alarm before the engine fails.

Many car-theft incidences occur on highways. This circuit is designed to serve where a hijacker forces the car driver out of the vehicle while the ignition is active. The block diagram below summarizes the actions of the Car Hijack Alarm from the switch controlled stage through to the engine cut-out stage.

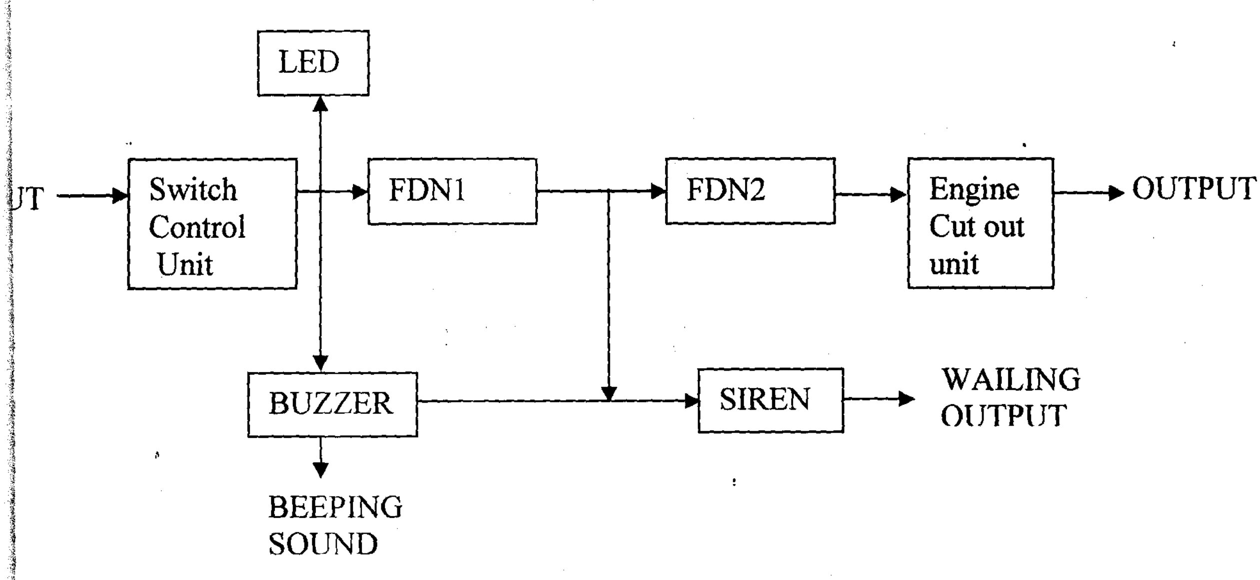


FIG. 1.1: BLOCK DIAGRAM OF THE CAR HIJACK ALARM

1.2 AIM AND OBJECTIVE

To design a car hijack alarm system with the added ability to stop a moving vehicle by causing the engine to fail. The alarm system should be such that immobilizes the vehicle, until the hijack alarm is reset.

1.3 MOTIVATION

The rate of car snatching on Nigeria highways and the ease with which culprits get away is alarming. A desire to see this reduced to a barest minimum, if not completely wiped out, serves as motivation.

Furthermore, the drive to reduce the resources spent on importing similar and more expensive products from without the country, thereby enhancing our foreign reserves, presents a strong motivation in the execution of this project.

CHAPTER 2

LITERATURE REVIEW/THEORETICAL BACKGROND

2.1 LITERATURE REVIEW

Way back in the old, people would rely on simple means to alert others of a breach in security. Little bells attached to a door that rang when it was opened, tin cans tied to a string across a pathway, and the likes served. One day, someone placed a large bell into a metal enclosure and placed four lantern batteries inside of it with a relay and mounted it to the outside of the building. From the enclosure, there were two sets of wires, one for the door contacts and the other for the key switch that turned the bell on and off. This technology is commonly referred to as a "local bell". Maintaining the batteries was one of major obstacles to its application.

This simple system used the relay to monitor the door contacts. The key switch was located outside, and the owner would close all of the doors and turn the key at right. If the doors were opened with the key switch on, the bell would ring. Closing the door would not stop the bell, only by turning the key could one silence it. The local bell uses a wiring scheme that latches the relay contact into an alarm condition. This was very popular for a while until people figured out that the bell could be yanked from the wall and quickly silenced. [8]

Development and discoveries through the years in the technologies of electronic component, like the resistors, diodes, transistors, capacitors, etc has also translated into technological growth in the construction of burglar alarms. Engineers had to use vacuum tubes before the transistors. Just as the transistor, the vacuum tube can switch electricity on or off, or amplify a current. But there were several reasons to replace the vacuum tube. It generates a lot of heat and has a tendency to burn out. Compared to the transistor, it is slow, big and bulky.

When the transistor was invented in 1947, it was considered a revolution. Small, fast, reliable and effective, it quickly replaced the vacuum tube. [4] Desirable electrical constructions became realizable. Most designs that had to be constructed on enormous surfaces could be done surfaces as small as a breadboard. This invention, among other developments also had a significant impact on construction of alarm systems.

Alarm design and circuitry has grown over the years, especially to meet with present-day demands. The technology has grown with a view to always be ahead of the ingenuity of burglars. From the manual ways that characterized the onset, most alarms are becoming automatic in operation, applying highly sensitive sensors. Electrically designed sound producers like buzzers, sirens, and loudspeakers have replaced horns and bells of old.

Digitalization has made room for smaller devices that could be kept out of the view of the burglar, unlike analogue components that could easily attract a burglar. Whatever alarm system design, present day realities are taken into cognizance.

Alarm circuits could be security alarms such as anti-theft or burglar alarms, fire or smoke detectors or instrumentation alarms such as metal detectors, clocks, digital phones, etc. Security alarms could be dual-tone or multi-tone as in siren and other hazard alarms.

Discrete electronic multivibrator circuits could be used to generate tones and such ones amplified to allow for loudness. An instrumentation alarm on the other hand gives beeping tones or a particular melody. The beeping of these alarm circuits are achieved using a buzzer. The buzzer has a built-in oscillator, which generates a signal of a particular frequency. The buzzer is activated once powered.

Over one hundred years ago, car alarms wouldn't have been thought necessary. At a time, cars were non-existent, and when they were eventually made, there was no much need for a security system, since cars stealing was not a problem. Events of 1896 and beyond changed all that. Cars became natural targeted for thieves being valuable, reasonably easy to resell and possessing a built-in getaway system. Some studies claim that a car gets broken into every twenty seconds in the United States. [10] Nigeria, and in fact, Minna and its environs have not been left out of cases of car theft.

As a result, alarms that formerly served other purposes have been diverted to serve for vehicular security as well. In some of the nations of the world, like in Europe, government policies are been made to ensure that car manufacturing industries provides security gadgets for the cars they produce.

Cars alarms must do more than producing sounds to alert car owners or security personnel, especially with the ingenuity of today's car snatchers, and the present imperfections in the Nigeria system with regards to security. Many car alarms of today are designed to alert car owners of any intrusion on their properties, that is, the car or car parts. Built-in motion detectors cause an alarm to sound once there is any detected movement. Such alarm circuits are connected so that opening either the door or the window of the car or making contact with its parts will trigger the circuit. Sensors come in handy here.

There are also car immobilizers, an improvement over the mere sound-producing types. Newer alarm circuits have immobilizers incorporated in them. This makes it impossible for an intruder unaware of the security facility to start the car. In some cases, once the door of the vehicle is opened, the circuit is triggered and, unless reset, the alarm will sound and the engine will fail. Only persons aware of the procedures for restarting such a grounded car can get it ignited again.

The car hijack alarm is designed to address cases of hijack. A hijacker could operate from inside or outside the vehicle. A car hijacker is one who is desperate to get away with a car after illegally seizing control of the car in transit. The car owner or the car driver is simply forced out of the car (if it is not a case of kidnap) without turning off the ignition. This action is utilized to trigger off the car hijack alarm, which eventually renders an ignorant hijacker unable to get away with the car.

Cost effectiveness. availability and reliability of components required to fabricate these alarms are other factors to consider. Technological breakthroughs have led to smaller, compact and cheaper electronic components. The car hijack alarm utilizes the simplest of components to give a much more desired result, rendering it cost effective. These components are readily available on electronic shelves, and they are equally reliable at regulated ratings.

2.2 CIRCUIT DESIGN AND ANALYSIS

The car hijack alarm is designed to secure both moving and packed vehicles. However, it is basically for the situation where a car hijacker forces the car driver from the vehicle, especially while the vehicle is in motion. If any of the car doors is opened while the ignition is switched on, the circuit will trip. After a delay of about 60 seconds the alarm will sound and the engine will fail.

2.3 PRINCIPLES OF OPERATION

The system depends on the opening of any of the car doors to operate. The opening of a door triggers the circuit. The circuit is directly powered from the car battery, and earthen is achieved through the interior light circuitry, which is designed to operate when any of the car door's is open. This makes it possible to link all the doors through a common means to the alarm circuit. This connection serves as the door switch of the alarm circuit.

The switch is OFF when all the doors are closed and ON when any of the doors is open. The car's ignition is connected to the circuit to serve as the circuit's ignition switch.

When a door is opened, while the ignition is switched on, the circuit is earthed through the door switch and the alarm is turned on. This is indicated by the LED lighting and the buzzer giving a short beep. Its length is determined by capacitor C3. In a situation where an authorized person unintentionally trips the circuit; these first indications are to alert such a person to the need to push the reset button. Once the reset button is pushed, the LED is switched off to indicate that the alarm has reset.

If the reset button is not pressed within about (3) minutes the relay RY1 will switch to active the siren and buzzer, which begin to sound continuously. This is primarily to attract the attention of security personnel like the police. Resistor R_7 and capacitor C_4 set the delay between the first and second sets of indications. In the case of an unintentional tripping of the circuit, these second indications also provide additional time to reset the alarm before the engine fails. Resistor R_{13} and capacitor C_6 provide a time delay of about one (1) minute between the time, the siren and buzzer begin to sound continuously and the time the relay RY2 de-energizes. The circuit is designed such that when the relay drops out the battery to ignition coil is disconnected causing the car engine to fail and the car to stop. The reset button will be placed where only authorized persons can locate it.

Turning off the ignition will cause RY2 to de-energize, resulting in a low standby current. This disables the car engine while the vehicle is parked. In order to reset the circuit, the ignition must be turned off or all the doors of the car closed before the reset button is pressed. While both the ignition is switched on and a door remains open the circuit will not reset.

2.4 THE POWER SUPPLY UNIT

Almost all electronic circuits or system require direct current for their operation. Direct current is obtained from dry cells, but this source of dc is unreliable for applications over a long time. A more reliable, convenient and economical source of power is the domestic alternating current supply, where alternating voltage (usually $240V_{rms}$) is converted to desired dc voltage. This is used in this project to replace the car battery, which is to be used when the hijack alarm is connected to a car.

2.41 THE TRANSFORMER

The transformer steps the domestic ac supply of about 240Vrms to the required voltage suitable for electronic devices. It consists of two closely coupled coils identified as the primary and secondary windings. An ac voltage applied to the primary (Vp) appears at the secondary (Vs) as a voltage multiplication inversely proportional to the turns ratio(K).

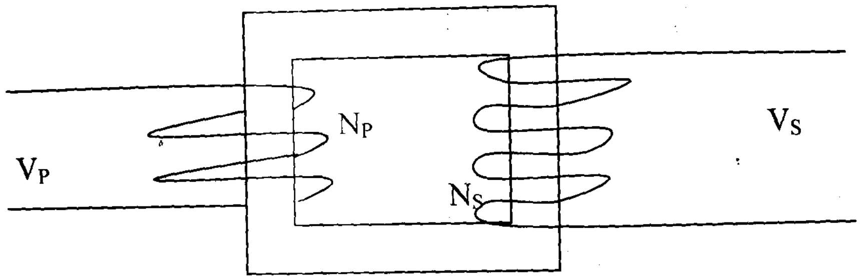


FIG. 2.1: THE TRANSFORMER

K= Vs/Vp= Ns/Np

Where K>1, the transformer is a step-up transformer, and when K<1, the transformer is a step-down type.

K = Voltage transformation ratio

Vp = Voltage applied at the primary

Vs = Voltage delivered at the secondary

Np = Number of turns in the primary

Ns = Number of turns in the secondary

A 15V step-down transformer was used for this project to meet the twelve volts (12V) required for the car hijack alarm.

2.42 THE RECTIFYING CIRCUIT

The rectification process employs diodes to convert alternating voltage to pulsating direct voltage. The circuit for achieving this is known as the rectifying circuit.

A full wave bridge rectifier was used for this project; it has fewer ripples and produces much output voltage.

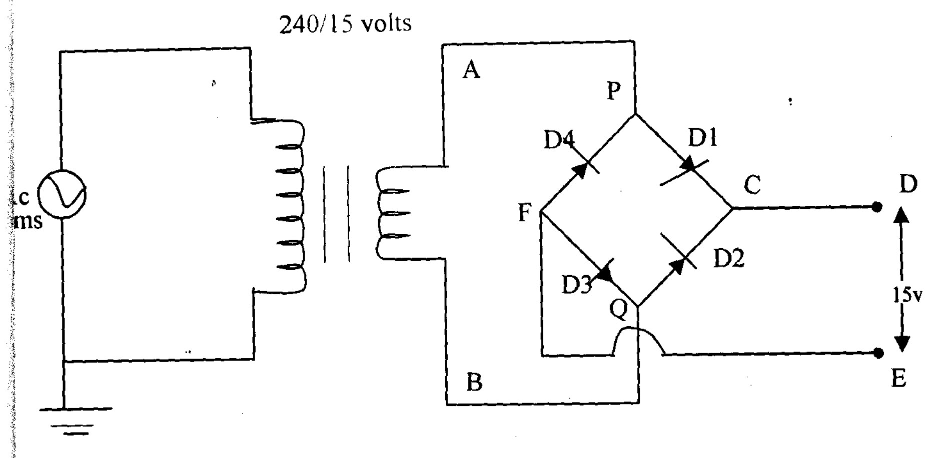


FIG. 2.2: CIRCUIT DIAGRAM OF THE FULL WAVE BRIDGE RECTIFIER

During the positive input half-cycle, terminal P of the secondary is positive, while Q is negative. Diodes D1 and D3 are forward-biased while D2 and D4 are reversed-biased. This allows current to flow through APCDEFQB producing a drop across the load connected across DE.

During the negative input half-cycle, terminal Q is positive, while P is negative. Diodes D2 and D4 are forward-biased, while D1 and D3 are reversed-biased, so that current flows through BQCDEFPA. Hence, current keeps flowing through the load in the same direction DE during both half-cycle of the ac input supply.

2.43 THE FILTERING CIRCUIT

This is required to remove the ripples that are present in the output voltage of the rectifier. The filtering is achieved by passing the rectified current through a capacitor. The capacitor is charged during the diode conduction period to the peak value and discharges through the load when the rectifier voltage falls below the peak value. The filter capacitor is chosen large enough to provide acceptably low ripple voltage. The capacitance of the capacitor is inversely proportional to the ripple gradient of the power supply.

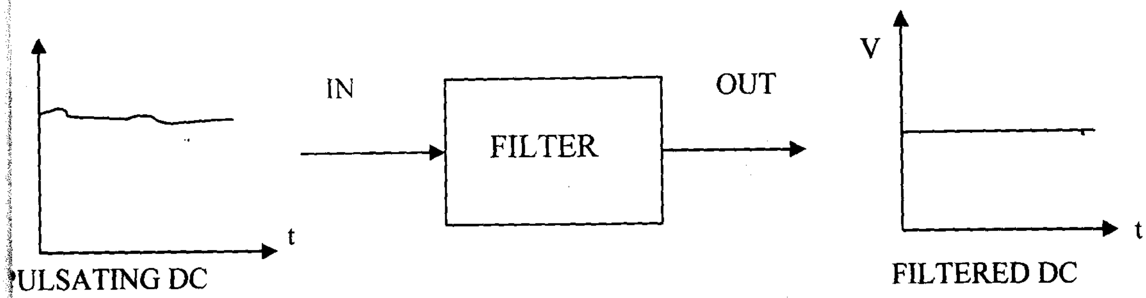


FIG. 2.3: DIAGRAM OF THE FILTER ACTION

2.44 THE VOLTAGE REGULATOR

Its main function is to keep the terminal voltage of the dc supply constant even when ac input voltage to the transformer or the load varies. A 7812 regulator was used to ensure a constant supply of twelve (12) volts to power the car hijacks alarm. A constant voltage is required to forestall damages to components making up the circuit.

The circuit diagram below gives a complete representation of the power supply system as applied in the construction of the car hijack alarm system.

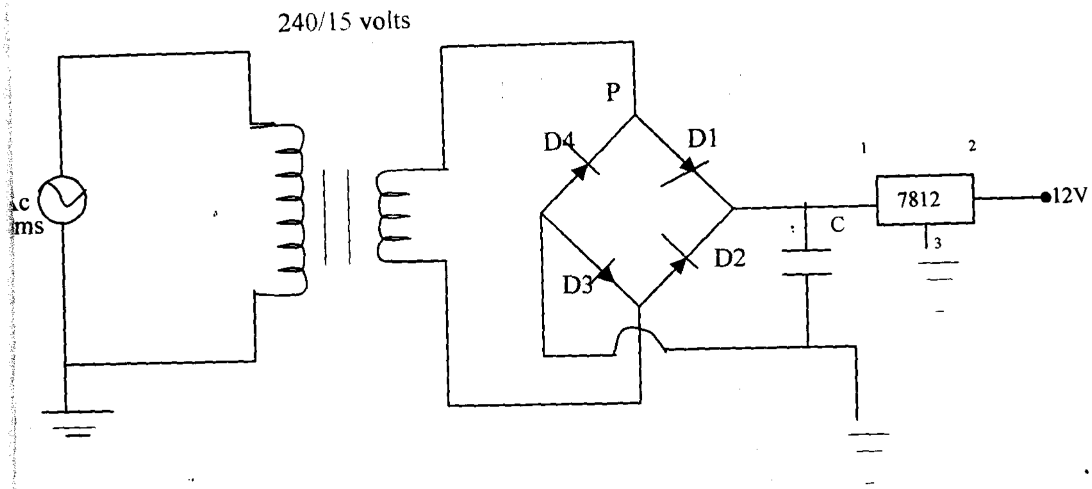


FIG. 2.4: CIRCUIT DIAGRAM OF THE POWER SUPPLY SYSTEM

2.5 THE SWITCH CONTROL UNIT

This comprises of the ignition switch, the door switch and the reset switch with protective diodes and capacitors. The ignition switch represents the key starter of a vehicle. It operates as a closed-circuit system, that is, it is normally closed. When it is switched off, the electric fan used to represent the car engine remains off. Once switched on, the fan almost immediately turns on to indicate the active or motion state of the vehicle.

The door switch represents the entire doors of a vehicle with all the doors commonly linked or the driver's door in the case where the car doors are not linked. It operates as an open-circuit system, that is, it is normally open. It is closed when the car doors connected to it are open, and open when the doors are closed. It triggers the alarm circuit when it is closed, begins a more convenient path for current to ground, thereby, causing the input at pin 1 of the quad 2-input NAND gate CMOSIC to be low (see circuit diagram of the car hijack alarm).

The reset switch is a push button. Its function is to drain every charge responsible for triggering the alarm to ground, thus, resetting the alarm. This is, however, possible only when the following procedure is observed.

To reset an already triggered alarm

(I) close all doors connected to the alarm circuit,

(II) turn off the car's ignition key starter, if the car's engine has already failed; otherwise, leave it on, and

(III) press the reset button, (Observe the LED turn off to indicate that the alarm has really reset).

OR

(I) turn off the car's ignition, and

(II) press the reset button and observe the LED turn off to indicate that the alarm has really reset.

2.6 THE ALARM UNIT

The alarm unit is made up of the Light Emitting Diode, LED, the buzzer, the siren, the Frequency Determining Network FDN 1, and switching transistors Q_1 and Q_2.

Before triggering, the low output from pin 3 of the CMOS IC cause the LED to remain dark, and transistor Q_1 is switched off, operating at cut-off. The low input of about zero volts at pin 8 and 9 of the CMOS IC result in a high output at pin 10. As a result, the base voltage of transistor Q_2 is about zero with respect to the source voltage and, thus, reverse-biasing the base-emitter junction of Q_2. Q_2 therefore operates at cut-off as an open switch.

Immediately the hijack alarm is triggered, pin 3 goes high. This causes the LED to light.. At the same time, transistor Q_1 is switched on, thereby, switching on the buzzer. The buzzer immediately gives a short beep. The length of the beep is determined by capacitor C_3.

Once pin 3 goes high, capacitor C_4 is charged through resistors R_7 and R_8, and there is a negligible voltage drop across pins 8 and 9. The low input voltage of about zero volts at pins 8 and 9 causes the output at pin 10 to remain high (about 12volts). When C_4 is fully charged, it acts as an open circuit. The input at pins 8 and 9 become high as a result, causing a low output (of about zero volts with respect to ground) at pin10.

The low output at pin 10 causes the base-emitter junction of transistor Q_2 to be forward biased, so that Q_2 operates in saturation. That is, Q_2 is switched on and, therefore, operates as a closed switched. The base voltage of the PNP transistor Q_2 is negative with respect to the source voltage. This switching action causes relay RY1 to switch, thereby, switching on the buzzer and the siren. The buzzer and the siren begin to sound continuously.

In soft saturation, a transistor is barely saturated; the base current is just enough to operate the transistor at the upper end of the load line. Soft saturation is not reliable in mass production because of the variation in β_{dc1}. A circuit using soft saturation can easily come out of saturation with temperature change or transistor replacement.

In hard saturation, the transistor has sufficient base current to be saturated under all operating conditions, to get hard saturation, a designer makes collector current at saturation, I_C, approximately 10 times the value of base current t saturation, I_B a ratio of

10:1 is low enough for almost any transistor to remain saturated despite temperature extremes, transistor replacement, supply voltage changes, etc. [3]

2.7 THE ENGINE CUT-OUT UNIT

This comprises of the relay RY2 and transistors Q_3 and Q_4, which form a pair. The Frequency Determining Network FDN 2 is also considered here.

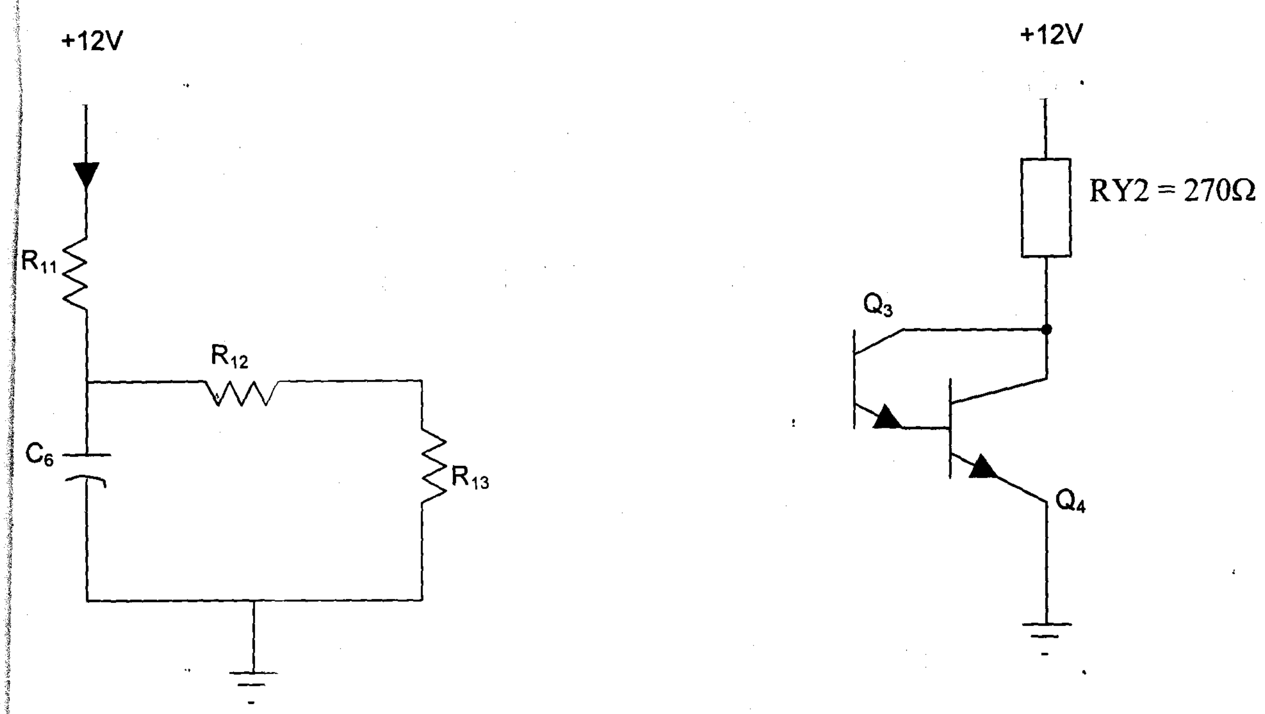


FIG. 2.5

Capacitor C_6 charges up through resistor R_{11}, while output at pin 10 is high. The magnitudes of R_{11} and C_6 were set to follow for a very short charging period; so that the Darlington pair switches on almost immediately the ignition is switched on. For a period of about 2s and with capacitor C_6 of capacitance 220μF, the resistor R_{11} will have the following value.

$T_3 = 0.693 R_{11} C_6$

$R_{11} = T3 / 0.693\ C_6$

$= 2 / (0.693 \times 220 \times 10^{-6})$

$= 13{,}118\Omega$

R_{11} was selected to be 10KΩ. When the output at pin 10 is low the capacitor discharges through resistors R_{12} and R_{13}, maintaining the ON state of the Darlington pair.

The collector current I_{C3} is given by:

$I_{C3} = V_{CC} / RY2$

$= 12 / 270$

$= 0.044A$

The corresponding base current I_{B3} is given as follows:

$I_{B3} = I_{C3} / \beta_{dc}^{2}$

Where β_{dc} = current gain for each transistors = 10

$I_{B3} = 0.044 / 10$

$= 0.00044A$

Also,

$I_{B3} = (V_{BB} - V_{BE}) / R_B$

Where $V_{BB} = [R_{13} / (R_{13} + R_{12})]\ V_{CC}$

And $R_B = R_{13} // R_{12}$

Maximum base current is produced when V_{BB} is maximum and, also, when R_B is minimum. In other words, the ratio of = R_{13} to R_{12} should be maximum I_{B3}.

Let R_{13}: R_{12} = 100:1

$V_{BB} = V_{CC}$ [100 / (100+1)]

= 11.88V

R_B was set at 10KΩ. As a result, values of 10KΩ and 1MΩ were used for R_{12} and R_{13}, respectively.

The discharge of capacitor C_6 is such that within about one minute, its output is Insufficient to keep the Darlington pair switched on. This turns off the car engine.

2.8 THE SIREN UNIT

The siren is made up of two oscillators, an IRF24 N-channel MOSFET and a loudspeaker. An oscillator may be defined as an electronic source of alternating current or voltage having sine, square or saw tooth or pulse shapes. It may alternatively be defined as a circuit which generates an ac output signal without requiring any externally applied input signal.

One of the oscillators is a low frequency oscillator, while the other is a high frequency type. The resistors and capacitors used in the design of the oscillators are chosen to ensure these low and high frequencies for the respective oscillators. The oscillators are non-sinusoidal.

The low frequency oscillator, F1, which is enabled by the 12Volts dc source, is used to enable the high frequency oscillator, F2. The output of F1 is fed into input enable input of F2. F2 is on active high operation, so that, when the output of F1 is low, F2 is disabled, and when F1 is high, F2 is enabled. The combinational operation of both oscillators makes it possible for the siren to pause between sounds in a continuous fashion once activated. A quad 2-input NAND gate CMOS IC is used in the design of the oscillators. The circuit diagram for the siren is as illustrated below.

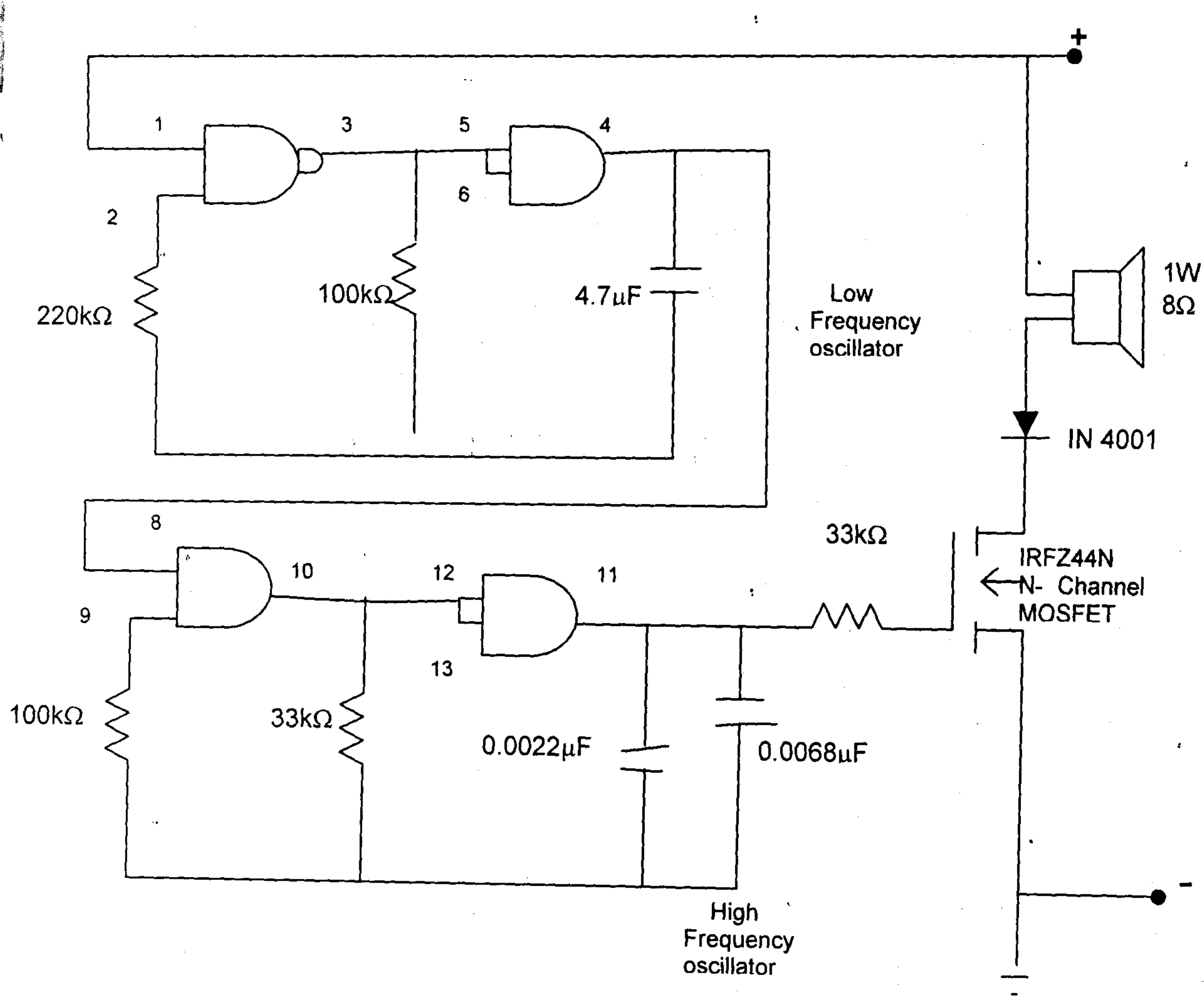


FIG. 2.6: CIRCUIT DIAGRAM OF THE SIREN

The MOSFET is used to switch on the speaker. It is switched on at every positive or high output of the high frequency oscillator. The MOSFET amplifiers the output to the speaker.

An IN4001 diode is placed between the MOSFET and the speaker to reduce the power fed to the speaker, thereby protecting it.

Below is a sketch of the waveforms for the two frequencies, F_1 and F_2, and the resultant output frequency, F, as fed into the speaker through the MOSFET.

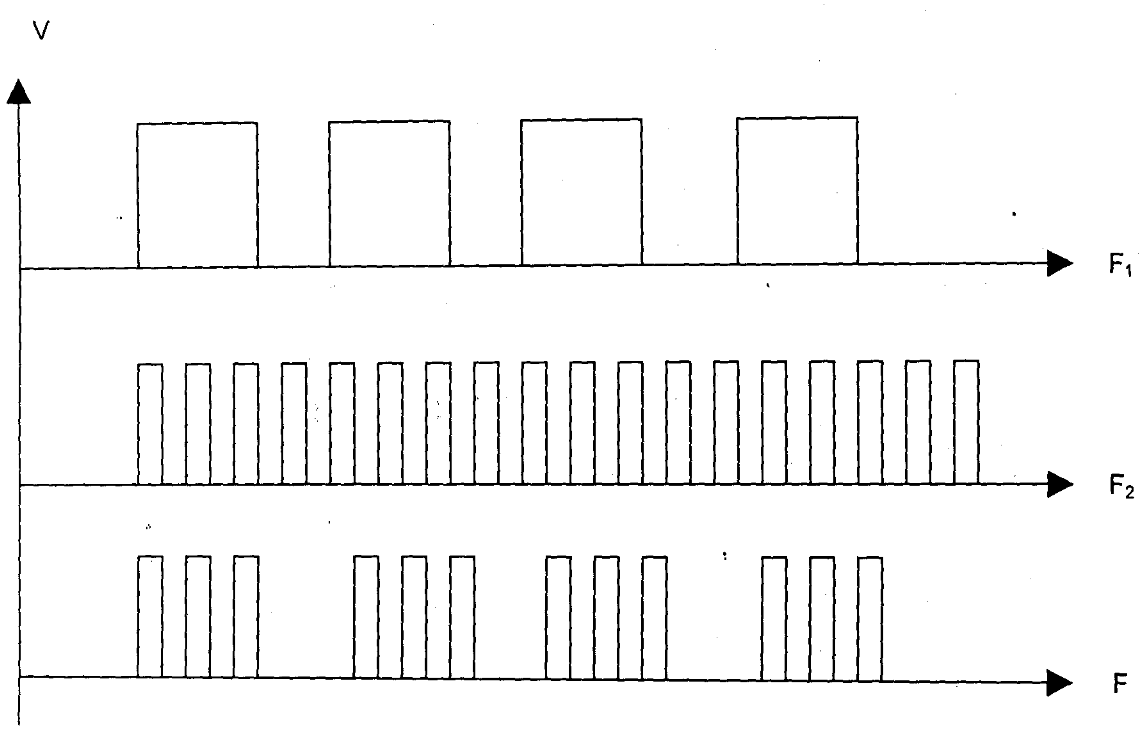


FIG. 2.7

The relationship between resistors R_1 and R_2 is given by

$2R_2 <= R_1 < 10R_2$

Below is a sketch of the NAND gate used in the design of the siren.

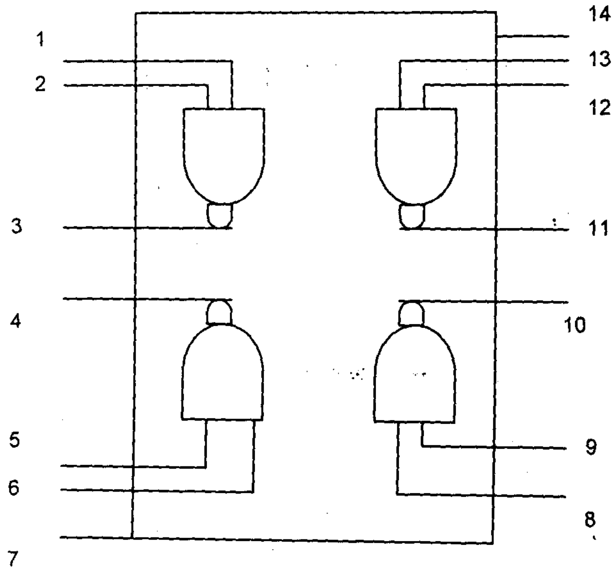


FIG. 2.8 QUAD 2-INPUT NAND GATE

CHAPTER 3

DESIGN AND IMPLEMENTATION

The work was first implemented on a computer system using the Multisim computer software package. On this package the entire circuit was designed around the CMOS 4001 IC, commencing from the switching section, through the time delay components to the relay-controlled sections. Relay RY2 was, however, not linked to a car engine. Rather, the switching behavior of the relay was simply observed as well as the behavior of other components such as Light Emitting Diode (LED), the buzzer, relay RY1 and the siren.

The physical implementation of the car hijack alarm was first done on a breadboard. The various components were assembled on the breadboard and extra connections both on and off the surface of the board were done by means of wires. An electric fan of approximate rating was used in place of the car engine to clearly observe the operation of relay RY2.

An alternative dc source producing the required twelve (12) volts was initially used in observing the behavior of the breadboard connections stage-by-stage before the power supply meant for the hijack alarm was built.

3.1 HARDWARE CONSTRUCTION

The entire system was broken into smaller units for easy and neat construction, convenient and troubleshooting. The various units are as follows:

(i) Power supply unit

(ii) Switching / triggering unit

(iii) Alarm circuit

(iv) The siren

(v) Engine cut-out unit

3.11 POWER SUPPLY UNIT

The power supply was built with a transformer first fitted to a wooden surface for stability. The primary winding of the transformer was connected to an ac plug. The secondary winding was connected to two terminals of the bridge rectifier, observing the manufacturers sign convention. An electrolytic capacitor was connected with the right polarity to the other two terminals of the rectifier. The positive terminal of the capacitor was subsequently linked by means of coupling wires to pin 1 of the 3-terminal regulator IC, while the negative terminal of the capacitor was grounded as well as pin 2 of the regulator, pin 3 of the regulator served as output.

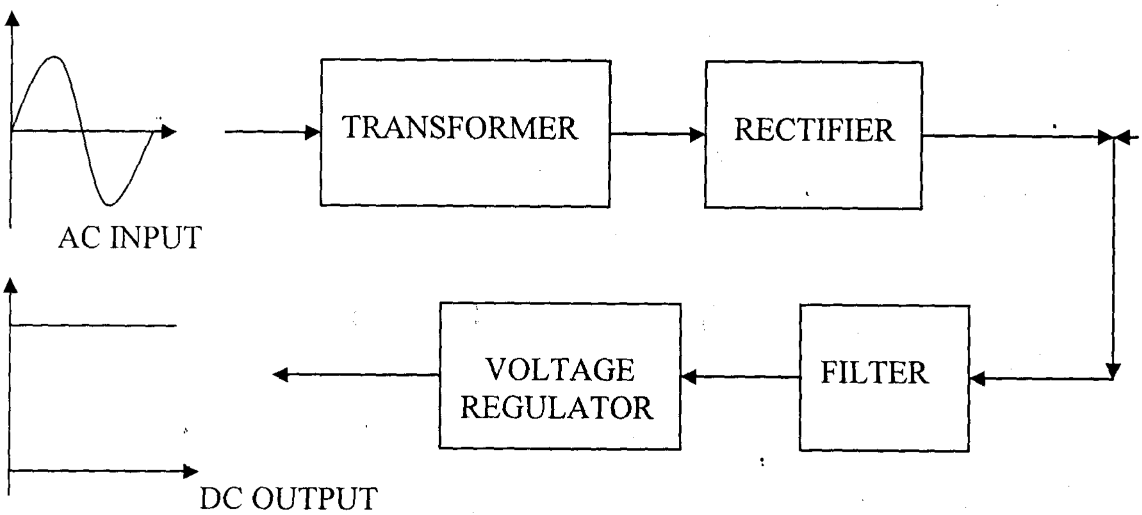


FIG 3.1. BLOCK DIAGRAM OF A REGULATED POWER SUPPLY UNIT

3.12 SWITCHING / TRIGGERING UNIT

Two push buttons were used, each to serve as the door switch and the ignition switch, respectively. They were constructed on a separate piece of Vero board with wire connections available for linkage with the main circuit. The ignition button was connected directly to the twelve (12) volt terminal of the dc supply, while the door switch was grounded. The reset button was also soldered to this unit. The LED was fitted close to the switches to allow for easier and quicker observation of the triggering as well as the resetting of the hijack alarm.

3.13 THE SIREN

A separate piece of Vero board was used in soldering together the components required for the siren. The quad 2-input NAND gate CMOS IC was not directly soldered to the board. Instead, an IC socket was first soldered to the board before the NAND gate IC was fitted to the socket. The quad 2-input NAND gate was used for both oscillators.

The resistors, capacitors and the MOSFET were also soldered to the Vero board and coupling wires were used to link their terminals as appropriate, taking into consideration the polarities of each terminal where necessary. Pin convention was also carefully observed for the NAND gate CMOS IC used.

A wire was then used to connect the high frequency oscillator of the circuit to the loudspeaker through the Drain terminal of the MOSFET. An IN4001 diode was connected between the drain of the MOSFET and the loudspeaker.

Two wire representing positive and negative terminals respectively were finally soldered to the power supply points of the siren and left hanging for subsequent connection to the alarm circuit.

3.14 ALARM CIRCUIT

This is the main circuit the alarm section of the system. An IC socket for the CMOS 4001 IC was neatly soldered into place on a Vero board followed by the capacitors, resistors, diodes and transistors under controlled use of the soldering iron to avoid damaging any of the components. Connection leads were used to link various components.

The buzzer was linked by means of wires to the Vero board. Relay RY1 was soldered to a separate piece of Vero board along side relay RY2, and RY1 was linked to the alarm circuit by means of wires. The siren was also fitted to the alarm circuit by means of wires. The siren and the buzzer were connected to the alarm circuit by means of wires to allow for easy fitting of both components to sections on the casing away from the alarm circuit.

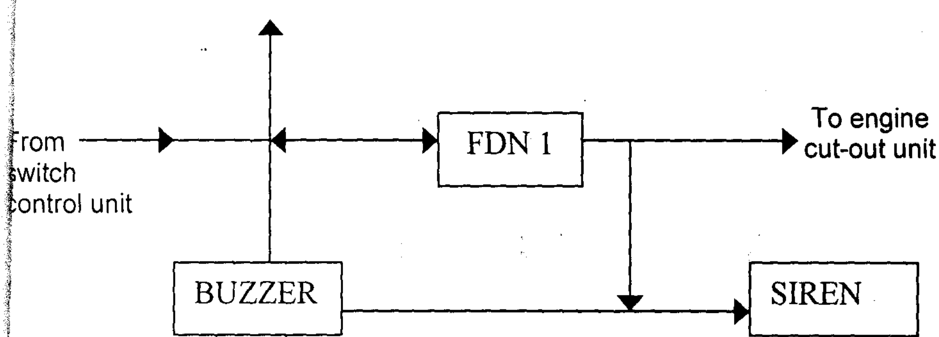


FIG 3.2 BLOCK DIAGRAM OF THE ALARM UNIT

3.15 ENGINE CUT-OUT UNIT

This is the final unit that is responsible for the eventual failure of the car engine. It is made up of diodes D8 and D9, resistors R11, R12 and R13, capacitors C6, transistors Q3 and Q4, which collectively form a Darlington pair, and relay RY2.

This unit was constricted on the available space of the Vero board of the alarm circuit, because of the close proximity in the interconnections between the alarm circuit and the engine cut-out unit. Wires were used to link relay RY2 on a different board to the cut-out circuit. The negative and second terminals of the delay time-determining components C6 and R13, respectively, were grounded. The emitter terminal of transistor Q4 was likewise grounded. Output wires from RY2 were left hanging freely, available for onward connections to a car's engine or an alternative appliance as used in this project.

3.2 COMPONENT LAYOUT

Below is a pictorial representation of the fabricated circuit for the car hijack alarm. It shows the layout of the various components constituting the hijack alarm and the units into which they were broken.

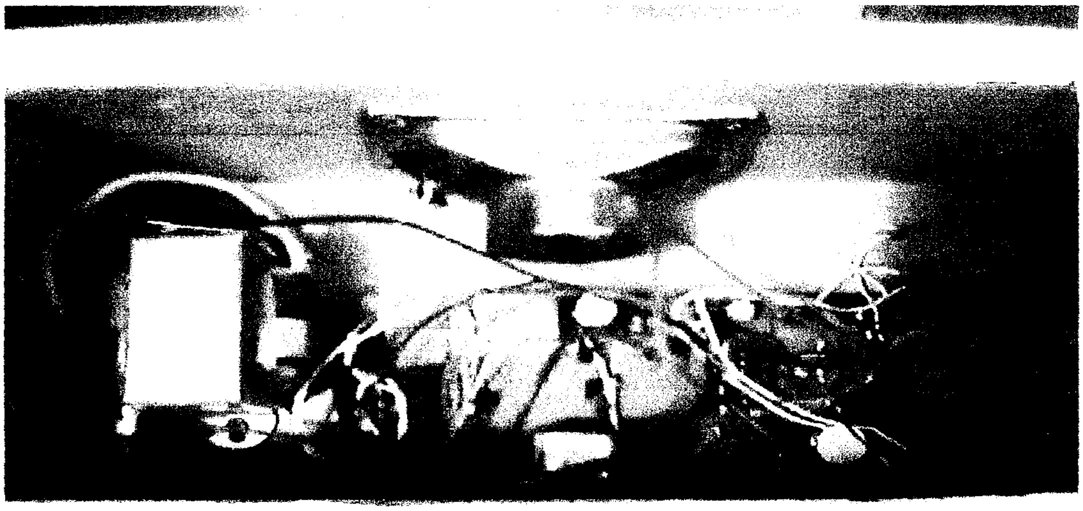


FIG. 3.3: A PICTORIAL REPRESENTATION OF THE CAR HIJACK ALARM CIRCUIT

During construction, the following were observed:

1. The CMOS 4001 was mounted on an IC socket already soldered to the Vero board to ease replacement when faulty.

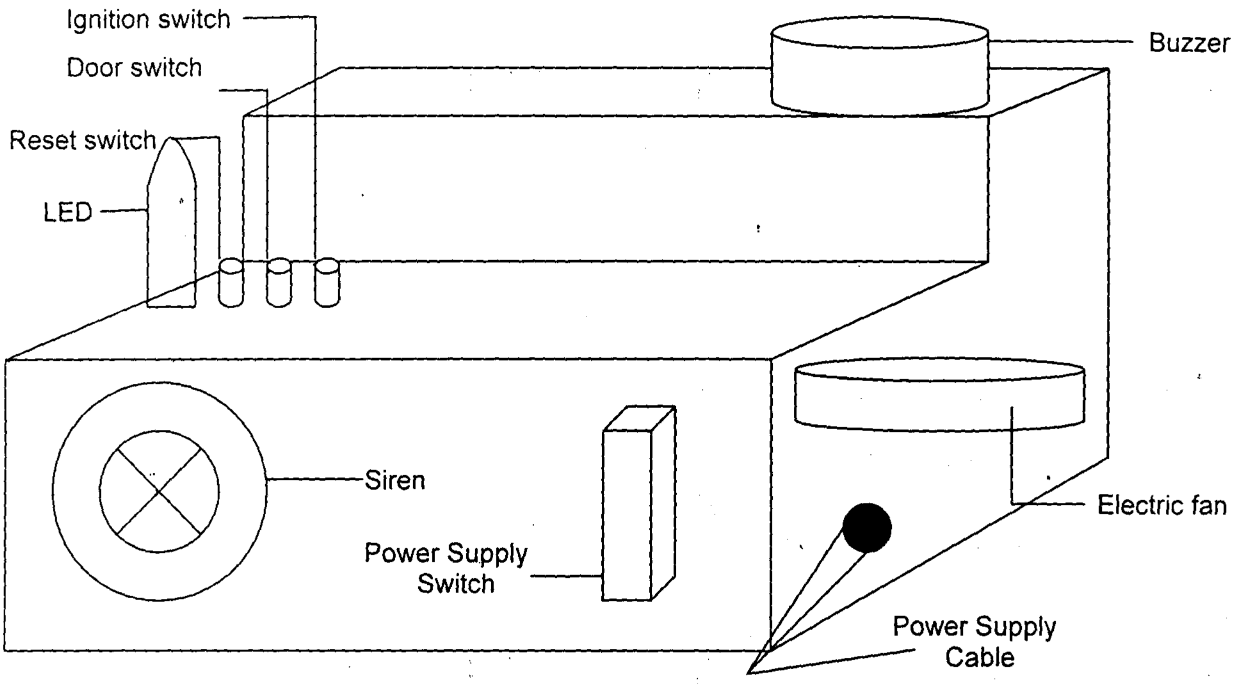
2. Interconnections were made through etching of the Vero board and the use of insulated copper wires connected at the underside of the Vero board, while the components were mounted on the top of the Vero board and soldered underneath. This was done to allow for ventilation, easy access and replacement of faulty components.

3. The leads of various components such as diodes, capacitors and resistors were reduced to prevent short circuit.

4. The entire circuit was generally designed and laid out with a view to simplifying wiring, avoiding error and making troubleshooting easier.

3.3 ENCASING

The constructed hardware was enclosed in a wooden box, being a prototype. The various units of the hardware were firmly fitted to the front and sides of the box. A sketch giving the position of the mounted components and units is shown below.



3.4 CONSTRUCTION TOOLS USED

The following construction tools were put to use during the modeling and constructions of the car hijack alarm.

(a) Soldering iron and lead: This was used in soldering the components to the Vero board.

(b) Wire cutter, pliers and blades: These were used in cutting wires to desired length and preparing insulated ends for soldering.

(c) Digital multimeter and oscilloscope: The digital multimeter was used to test for continuity in conducting paths and to measure voltages; currents and resistances of various components were also identified by means of the multimeter. The oscilloscope was used to test for various signals such as the output from the power supply and oscillators of the siren.

(d) Suction tube: It was used in removing unwanted de-soldered lead from soldering points.

3.5 OPERATION

When the ignition switch was put on, while the door switch was closed 9i.e. all the doors of the car open by implication), the torchlight bulb representing the car engine did not come on, indicating that the ignition will not start until all the doors are closed, that is, the door switch is open.

The bulb came on when the ignition was switched on after opening the door switch. With the ignition on, closing the door switch caused the LED to light and the buzzer to give a short beep as expected. Pressing the reset button before about three minutes elapsed caused the LED to go off. However, this only occurred when the door switch was re-opened. Failures to press the button within this time delay caused relay RY1 to switch, causing the buzzer and the siren to sound continuously.

At this point, pressing the reset switch with the door switch open caused the LED to turn off. Only a minute was available for this before relay RY2 switched and the torchlight bulb turned off to indicate the failure of the car engine. After this, the reset could only be done with either the ignition turned off or all the doors closed (or the door switched open) before pressing the reset button.

3.6 CALCULATIONS

3.61 DESIGN CALCULATIONS FOR THE VOLTAGE REGULATOR

The transformer use is a step-down transformer as stated earlier with output voltage at the secondary being 15Volts (root mean square value).

Let V_{rms} = root mean square value of secondary voltage

V_p = peak/maximum value of transformer secondary voltage, and

V_L = average dc value of load voltage.

$V_p = V_{rms} \sqrt{2}$

$V_{rms} = 15V$

$\therefore V_p = 15 X \sqrt{2}$

$= 21.213 \cong 21Volts$

The dc voltage drop across the load is given by

$V_L = 2Vp/J1$

$= 2 X 21/J1$

$= 13.4 \cong 13Volts$

This value of VL is regulated by the regulator to give the required 12Volts

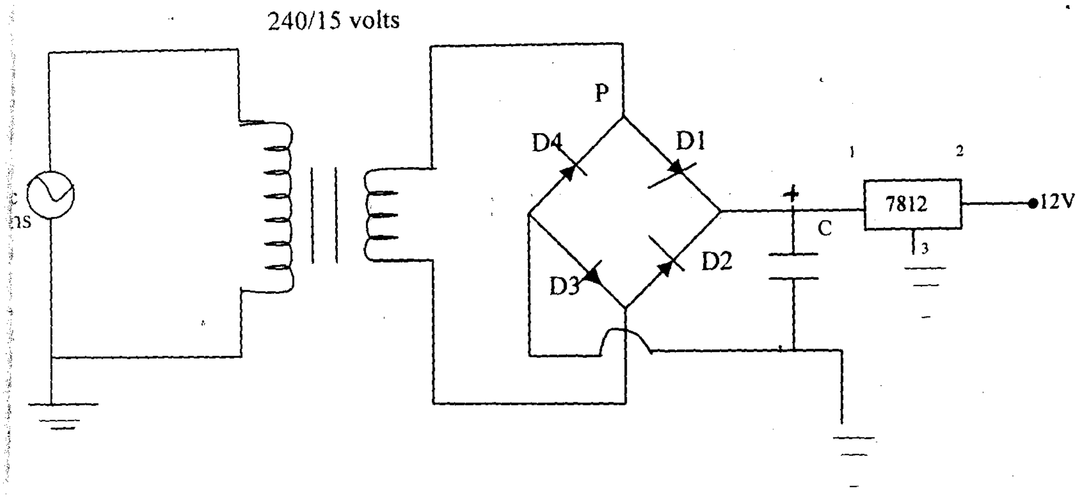


FIG. 3.61: CIRCUIT DIAGRAM OF THE POWER SUPPLY SYSTEM

3.62 DESIGN CALCULATIONS FOR THE ALARM UNIT

Consider transistor Q_1 as illustrated separately below.

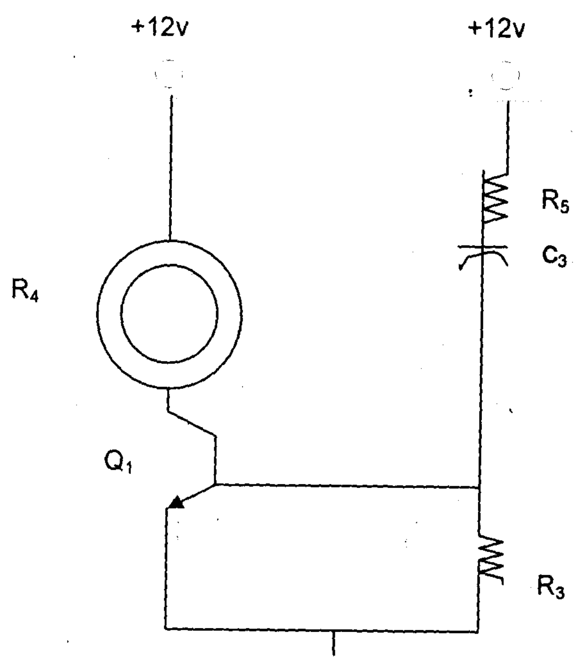


FIG.3.62

The collector current is given by

$I_{C1} = V_{CC}/R_L$

Where V_{CC} = supply voltage

R_L = resistance of the buzzer (approximately 2kΩ)

$\therefore \quad I_{C1} = 12/2000$

$= 0.006A = 6mA$

The minimum base current I_{B1} required to switch on the transistor Q_2 can be obtained as follows.

$I_{C1}/I_{B2} = \beta_{dc1}$

Where β_{dc1} = dc current gain

Therefore, $\beta_{dc1} = 10$

and $\quad I_{B1} = I_{C1}/\beta_{dc1}$

$= 0.006/10 = 0.0006A$

$= 0.6mA$

For a period T_1 much less than one (1) second, say 0.1s, and a capacitor C_3 of capacitance 10μF, the resistor R_5 will be obtained as follows.

$T_1 = 0.693R_5C_3$

$R_5 = T1/ 0.693C_3$

$= 0.1/ (0.693 \times 10 \times 10^{-6})$

$= 14{,}430\Omega$

A value of 10KΩ was selected for R_5. In order to maintain approximately the minimum base current, a base voltage of about 6v is required. R_3 was selected to be 10KΩ also. When output of pin 3 is high, capacitor C_4 is charged through resistors R_7 and R_8 in series with it. The period T2 it takes to charge fully is set at three (3) minutes. The combined resistance of R_7 and R_8 is given by

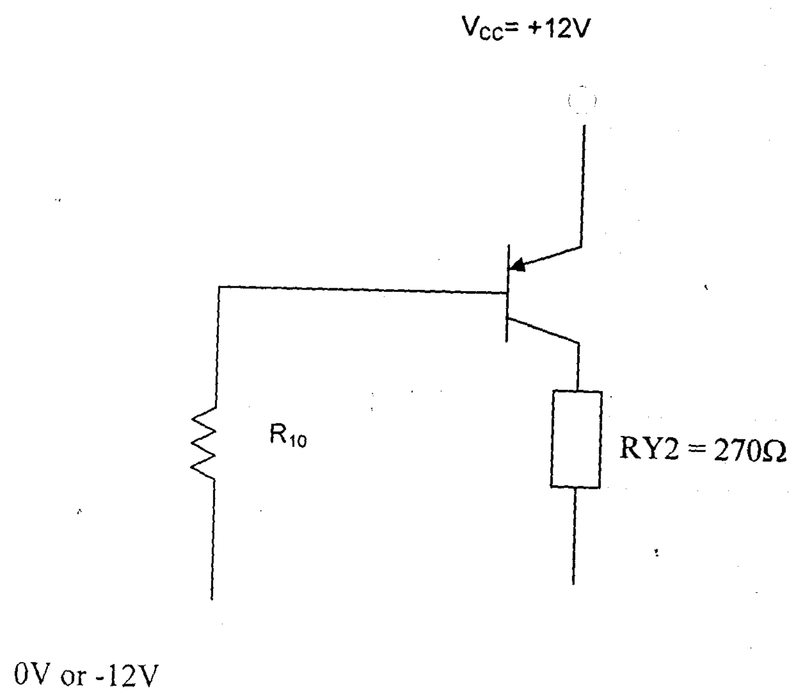
$$T2 = 0.693(R_7 + R_8)$$

$$(R_7 + R_8) = T2 / 0.693C_4$$

$$= 180 / (0.693 \times 220 \times 10^{-6})$$

$$= 1{,}180{,}638\Omega$$

Consider the circuit diagram of the car hijack alarm. The greater resistive value of 10MΩ was selected for R_7, while R_8 was made to have a value of 2200Ω. This was done to create a convenient path for capacitor C_4 to discharge when the hijack alarm is Let. Consider transistor Q_2 as illustrated in the FIG. 3.73 below



From FIG. 3.72, collector current I_{C2} is given by

$I_{C2} = V_{CC} / RY2$

$= 12 / 270$

$= 0.044A$

$= 44mA$

The base current I_{B2} is as follows:

$I_{C2} / I_{B2} = \beta_{DC2}$

Let $\beta_{DC2} = 10$

$\therefore I_{B2} = I_{C2} / \beta_{DC2}$

$= 0.044 / 10$

$= 0.0044A$

$= 4.4mA$

The value of resistor R_{10} can be obtained through the equation below.

$V_{in} - V_{BE} = R_{10}I_{B2}$

Where V_{BE} == base-emitter voltage = 0.7V (for silicon)

V_{in} = base input voltage

$\therefore R_{10} = (V_{in} - V_{BE}) / I_{B2}$

$= (12 - 0.7) / 0.0044$

$= 2,568\Omega$

A 2.2KΩ resistor was selected for R_{10}.

3.64 DESIGN CALCULATIONS FOR THE SIREN UNIT

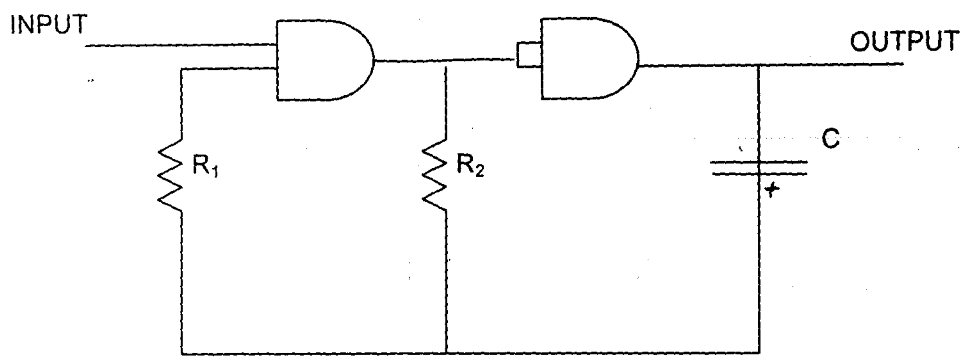


FIG. 3.64 DIAGRAM OF THE TYPICAL OSCILLATOR

The above circuit diagram represents the typical oscillator used in the design of the siren. The relationship for calculating the frequencies of both oscillators with respect to the circuit diagram above is as given.

F = frequency of the oscillator

R_2 = resistance of second resistor indicated by 2

C = capacitance of capacitor

The low frequency oscillator has frequency F_1 given by

$F_1 = 1.44 / (100 \times 10^3 \times 4.7 \times 10^{-6}) = 3.064\text{Hz}$

The frequency for the high frequency oscillator is given as

$F_2 = 1.44 / [33 \times 10^3 \times (0.0022 + 0.0068) \times 10^{-6}] = 4{,}848.5\text{Hz}$

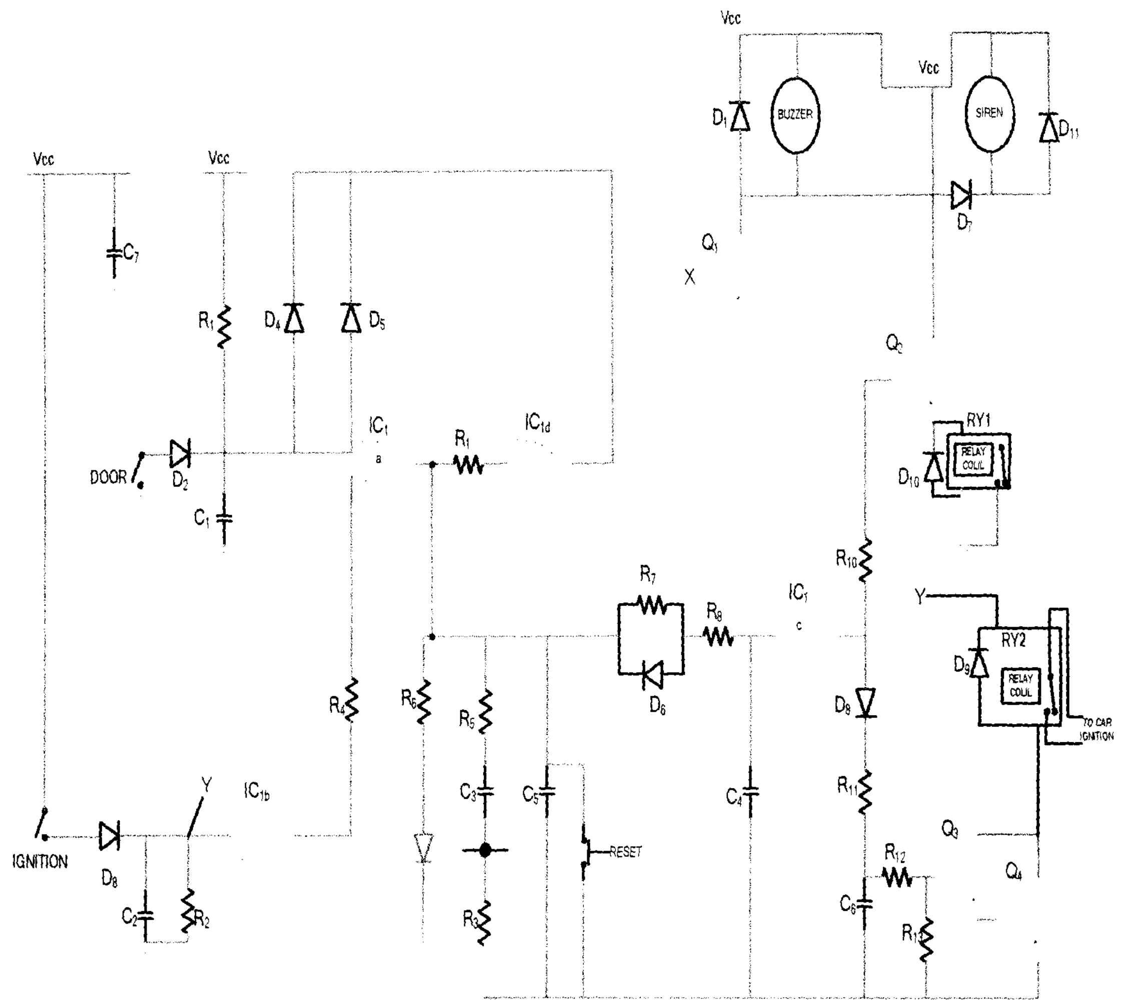


Fig 3.7 Circuit Diagram of A Car Hijack Alarm

KEY TO THE CAR HIJACK ALARM CIRCUIT DIAGRAM

DIODES:	D1 = D4 = D5 = D6 = D8 = D9 =D10 = D11 = 1N4148
	D2 = D3 = D7 = 1N4001
	Zenar Diode Z1 = 16V 1W
CAPACITORS:	C1 = C2 = C5 = C7 = 100nF
	C3 = 10µF 25V
	C4 = C6 = 220µF 25V
TRANSISTORS:	Q1 = Q3 = Q4 = BC 547 NPN
	Q2 = BC 557 PNP
RESISTORS:	R1 = R2 = R6 = R8 = R10 = 2.2KΩ
	R4 = R9 = 4.7KΩ
	R3 = R5 = R11 = R12 = 10KΩ
	R7 = R13 = 1MΩ
RELAYS:	RY1 = RY2 = 270Ω

CHAPTER 4

TESTS, RESULTS, AND DISCUSSION

4.1 TESTING

The digital multimeter was put to use at various stages and at the completion of the hardware construction in carrying out the following tests.

1. The continuity of copper wires used in the construction was tested from time to time.

2. The polarities of components were ascertained through testing with the multimeter.

3. The output voltage was observed and found to be within acceptable range, especially with regard to the power fluctuation from the national grid.

4. The output of the voltage regulator was measured and also found to be within acceptable range, approximately 12V

5. The switches and reset button were tested to ascertain their workability in the ON state, and non-conduction in the OFF state.

6. The overall operation of the hijack alarm circuit was tested, and the led, buzzer and siren effects as well as the relay actions noted.

4.2 FITTING THE HIJACK ALARM TO A CAR

The design architectures of a typical car make it easy to connect the hijack alarm to it. The car's ignition key starter replaces the ignition switch used in the prototype of the hijack alarm. One terminal of the key starter is connected to the ignition terminal of the alarm circuit, while the other terminal is connected to the power supply terminal of the alarm circuit. The circuitry of the internal lighting system connected to the doors of the car replaces the door switch of the alarm circuit as illustrated below.

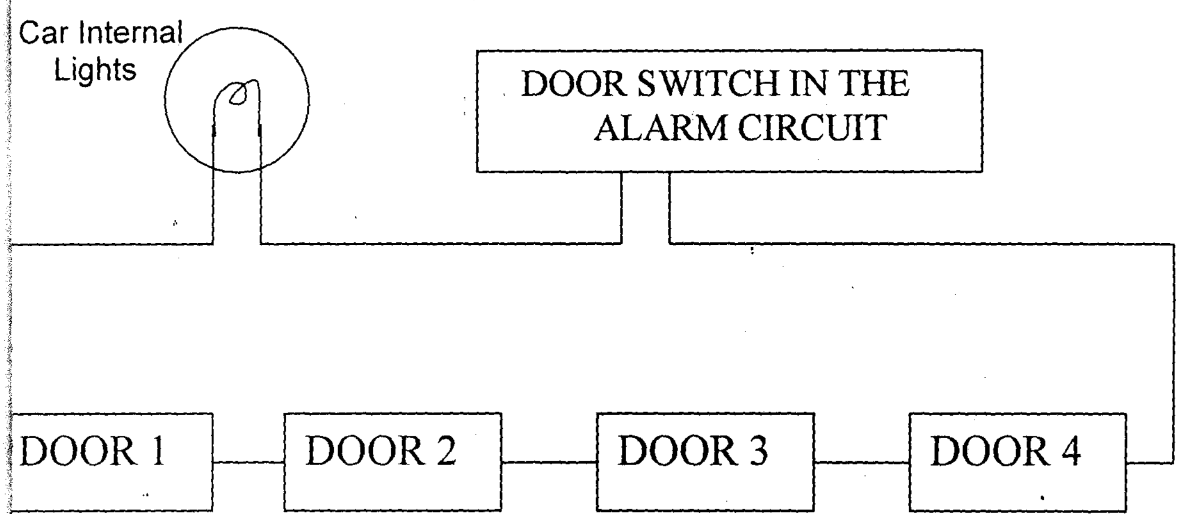


FIG. 4.1: SCHEMATIC OF THE CONNECTION OF THE DOORS OF A CAR TO THE HIJACK ALARM

Opening a door closes a switch and, thus, completes the circuit of the hijack alarm, triggering it. Closing a door opens the switch. Relay RY2 is the then used to switch on and off the car ignition. However, relay RY2 is not capable of doing this directly due to its current rating. The contacts of relay RY2 are too small to withstand the high current of the car's ignition coil. Rather, RY2 should be used to switch the coil of a larger relay suitable for automobiles. An IN4001 diode should be fitted across its coil to prevent damage to the CMOS IC. An approximate and simplified schematic of the fitting of the alarm to a car is given below.

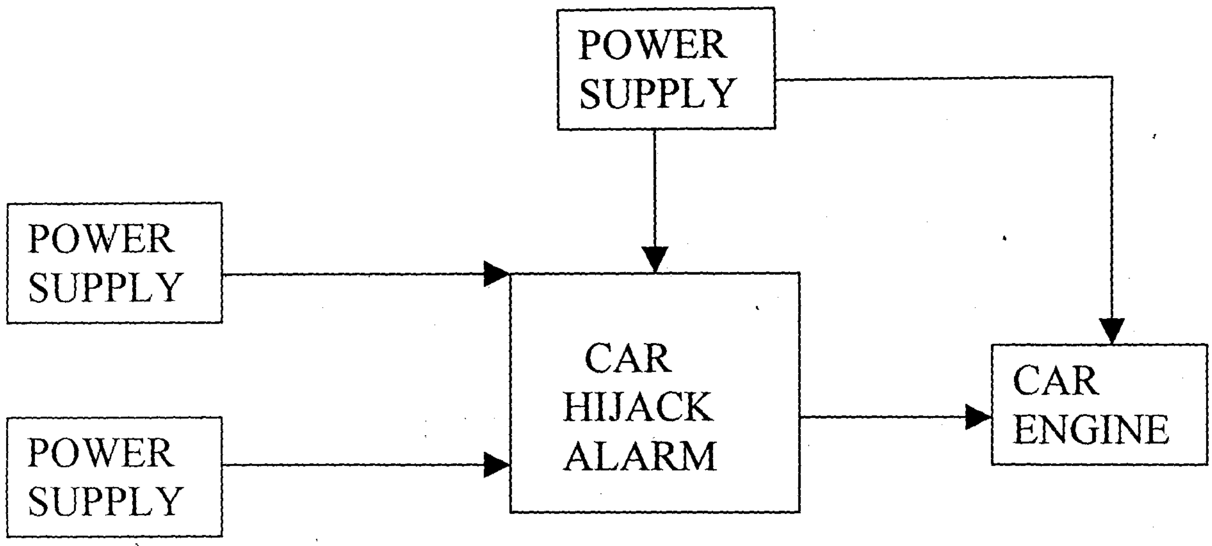


FIG. 4.2: A BLOCK SCHEMATIC OF THE FITTING OF THE HIJACK ALARM TO A CAR

4.3 DISCUSSION OF RESULT

The car hijack alarm always works on the principle of set, execute and reset mode as observed from the hardware tests carried out. A common voltage with magnitude of about twelve (12) volts is required throughout the circuit. Opening of any of the doors of the car while the ignition is switched on triggers the alarm circuit and what follows is evident in the coming on of the LED, the sounding of the buzzer and the siren, and the eventual failure of the car engine.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In conclusion, the objective of designing a car hijack alarm system that is cheaply affordable and able to prevent the hijacking of a car has been achieved as observed from the test carried out on the device.

However, emphasis is placed on the fact that this security system applies primarily to such hijack incidences as outlined in this work, and not to all incidences of car theft. It may not offer protection to a car while it is parked.

Also, emphasis is laid on the scope of protection offered by the car hijack alarm. This device is primarily capable of protecting the car only, especially during a hijack situation, when the ignition of the moving car on the highway is less likely to be switched off. The car owner or user must do more to secure him or her

5.2 RECOMMENDATION

The scope of this work leaves much room for greater improvement, mostly due to time constraint and limited resources. The circuit could be further enhanced to cater for a lot other needs in the car security. It could be made to also immobilize a car for as long as it is parked, by incorporating in it a distinct circuit for that purpose or it could be used along side other security gadgets.

Since disconnecting the hijack alarm circuit from its source of power will inactivate the alarm or cause it to automatically reset, if disconnected after engine failure, it is advisable that an alternative power source other than the car battery, which is quite visible, be used. If the car battery must be used, then the workmanship of an expert will be required in secretly linking the alarm circuit to the battery, and there has to be much dependence on the proper functioning of security personnel such as the police.

Therefore, for this work to be of utmost benefit to the general public, security personnel must adopt quick or timely and sustained response to such security alerts a posed by the hijack alarm. This will demand alertness and sensitivity on their part. It is expected that, once the alarm goes off, those in charge of road security will be alerted and will go after the hijacker. The engine cut-out is supposed to facilitate the speedy recovery of the vehicle.

The alarm system only offers protection to the car. Therefore, the car owner or driver must be smart in responding to situations during hijack operations as they arise. For instance, the driver should know that the discovery of the alarm system could provoke hijackers who may be armed. Therefore, once one is forced out of the car, one should do well to approach or contact security personnel immediately, both for ones safety and the safety of ones car.

Finally, the students of the department should be encouraged and motivated to take up challenges in the design and fabrication of various electrical and electronics circuits to meet the daily needs of the society right from at most their 200 level. The Student Work Experience Programme SWEP should be made more electrically inclined than it is presently to give the junior members of the department an early start in practical electronics, among other knowledge. This will further enhance student's output in the final year projects by increasing originality in work done and technical know-how.

REFERENCE

1. CHARLES A. HOLT, Electronics Circuits Digital and Analog, John Wiley & Sons, Inc. 1978; Pages 158, 210.

2. DONNALD P. LEACH, ALBERT PAUL MALVINO, Digital Principles and Applications (Fourth Edition), McGraw-Hill book Company, 1986; Pages 4, 5, 6.

3. ECG Master Replacement Guide (17^{th} Edition), Philips ECG;

4. History of the Integrated Circuit, e-museum, http://www.google.com/ .

5. LEN JONES, Basic Electronics for Tomorrow's World (Cambridge Low Price Edition), Cambridge University Press; Pages 138-146

6. PAULL E. GRAY, CAMPBELL L. SEARLE, Electronic Principles Physics, Model and Circuits, John Wiley & Sons, Inc 1969

7. RALPH J. SMITH, RICHARD C. DORF, Circuits, Devices and Systems (Fifth Edition), John Wiley & Sons, Inc. 1992; Pages 368-376, 394-401

8. STEVE FILIPPINI, A Brief History on the Security Alarm, Sound & Video Contractor http://www.google.com/

9. TOM HARRIS, How Burglar Alarm works, HowStuffWorks, Inc. http://Electronics.howstuffworks,com/alarm

10. TOM HARRIS, How Car Alarms work, HowStuffWorks, Inc. http://Electronics.howstuffworks,com/alarm

11. W. H. DENNIS, Electronic Components and System, Butterworth & Co (Publishers) Ltd, 1982; Pages 83-98

12. Microsoft Encarta Premium 2006, Alarm system