Touch-less Hand Dryer

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Dedication

I dedicated this project to the glory of Allah (Subhanahu-watalah) for making things possible and for keeping me alive up till this day.

I also would like to dedicate this project to my parents and family members who have always given me their unflinching and overwhelming support at all times.

DECLEARATION

I <u>KANI SALEH AMINU</u> declare that this project 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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Acknowledgement

I would like to extend my utmost gratitude to my parents for their emotional and financial support.

My supervisor Mr. M.E. Eronu for creating time to attend to his project students and guiding us on how best to go about our project and painstakingly correcting and enlightening us.

I would like to thank the Department of Electrical and Computer Engineering Department for giving us facilities in the Departments Lab and the Library, and also providing us with a booklet to guide us on how to write our project

ABSTRACT

This Project involves the construction of a Touch-less hand dryer which is used to minimize the risk of cross infection of diseases and germs. This was implemented using a latch which is set by the receiver unit to control a Fan and a Heater to operate for a given period of time using a time which resets the latch to switch the Heater ON or OFF pending the output of a comparator fed by a Heat Sensor.

At the end the receiver segment was a bit sensitive and the heat sensor found to be more accurate than Thermistors. The project is user control oriented as the Receiver sensitivity, the operating time duration and maximum heater temperature can be adjusted to the user's preference.

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CHAPTER ONE

INTRODUCTION

1.1 Introducing Touch-less Hand dryers.

A Touch less hand dryer is an automatic hand dryer, but Sensor not Button activated, (the circuit only comes on when the infra-red sensor has an input). That is, it senses a nearby hand then comes ON and also encompasses the automatic functions.

This is a more presentable and effective device in replacement for the old fashioned hand dryer since it allows users to dry their hands without touching anything (an ON or OFF button). Though they have been around for some time, but with increased concerns about cross-infection, facilities are installing more of them. Touch-less hand dryers use no waste paper, so there is no need for trash container in restroom or toilet. The device provides an amazing easy-to-use operation.

1.2 Objective of the Project.

The Towel is a common longstanding feature in toilets. It is mainly used to wipe water off wet hands or other parts of the body. In our modern world, its use is under threat.

Towels are unavoidable means of transmitting germs like Ecoli bacteria (man eating bacteria which causes ailments in the digestive tract), Flu (common Catarrh and Cough) and also some Skin diseases just to mention a few infections [1].

The Cost of using waste paper or Sterilizing Towels requires a huge budget on its own in order to maintain hygiene in public toilets.

The easiest alternative is the Touch-less hand dryer whose initial cost is affordable and mean between maintenance close to two years as stated by Organization of Hand Dryer Manufacturers in the U.S.A [3].

1.3 Scope of Project.

The basic idea is to operate a Fan and a Heater using a Hand detector receiver (photodiode), control unit (latch) to control whether both Fan and Heater are ON or OFF depending on the receiver input to the latch, let the unit be on for a specific period of time using a timer and also decide whether the Heater alone should be ON or OFF pending the input of a comparator fed by a heat sensor. Thus limiting the heater to a specified maximum temperature.

1.4 General Description of Project.

The project has 2 Heaters (Filaments) of 1Kilo-Watt each, an Axial Fan of 2500rpm with 12V d.c terminals, the Main circuitry which has a Timer(4060B), Control latch(4013B), Relay (12V d.c), LM35 sensor, 2 Comparators(LM339A), 12V and 5V Voltage Regulators and 240VA.C to 24V D.C step down Transformer. The other components are Diodes, resistors ,capacitors and transistors to be discussed in detail in **Chatpter 3**.

1.5 What makes this Touch-less Hand dryer Project different?

A more accurate thermostatic setup as the LM35 sensor is more efficient than using normal thermistor. The circuit goes OFF 20 seconds, after the infra-red beam was last reflected.

The more significant functions can be can regulated to the user's preference using variable resistors i.e the thermostatic setup reference temperature, the Sensitivity of the Receiver to determine range of distance of hand from the receiver for activation of the dryer, while the duration the Circuit operates can be adjusted by varying the capacitance value of the Capacitor attached to the timer.

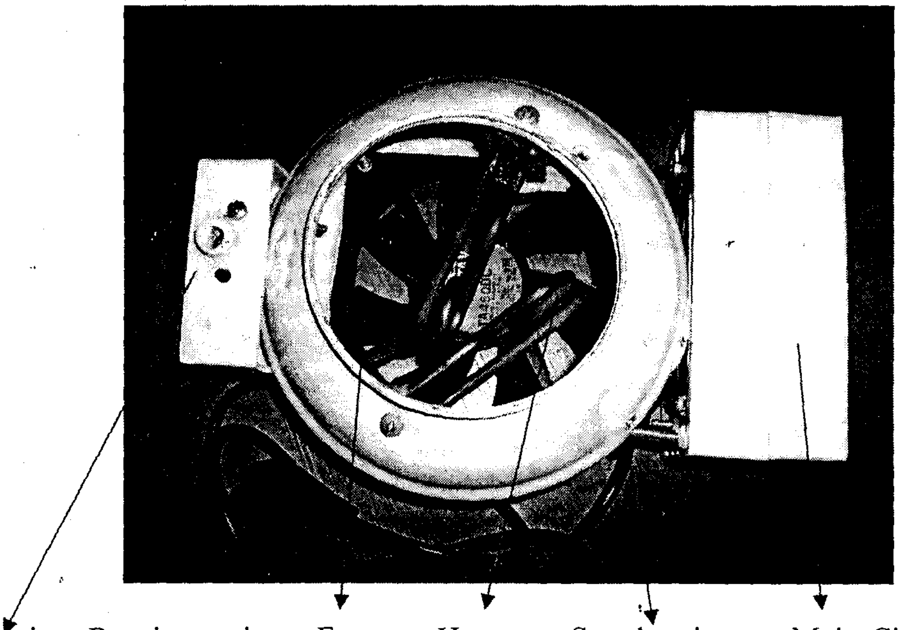


Fig 1.1 Touchless handrier Visible units

1.6 Project methodology

The project features an innovative design technique. The unit mainly holds a fan (blower), a heater (for heating the air to be blown), an electronic thermostat (for preventing over-heating effect), a timer to keep the entire circuit ON for a certain amount of time and more interestingly an infra-red electronic eye. A central logic control unit incorporates all the units together into a specific functional gang.

In addition, the infra-red electronic eye comprises of an infra-red transmitter and receiver. The transmitter emits a straight infra-red beam away from the receiving side so that whenever a hand is brought close to the eye, the transmitting beam is reflected to the infra-red receiver. The resulting signal at the receiver is the input of the whole circuit.

The leading signal is processed by a logic control unit. This unit is built up of integrated circuits. These circuits are designed to switch on both the air-blower and heater.

The air-blower forces air through a nozzle while the heater gets the air heated. The operation is quite digital in nature. This is because a timer is incorporated into the design to provide a specific operating time for the fan and heater. The timing helps reset or switch OFF the components whenever the dryer is left alone after use, thus the switching ON and OFF of the device is achieved without any physical contact with the device.

From experience of older designs, hearting is a common demerit. Therefore, a heat monitoring feature is added to the design. The leading circuit holds a linear temperature sensor and comparator-control circuit. The circuit alters the heating effect of the system by switching off the heater whenever the temperature of the blowing air is unacceptable. The sensor is attributed to precision, so there is no or little worry of temperature instability.

To add more weight, the design is all about simplicity. The involved electronic components are usually cheap and readily available. The resulting design is economic.

The foundation of the project is acquisition of relevant information. The design was set upon after gaining access to all the components data sheets. They were downloaded from the manufacturer's websites.

1.7 Limitations of Project

Financial limitations: More efficient components usually cost more than the common ones in the market, and the project was limited to a budget.

Availability: Some ideal components are not readily available in the market such as Hight temperature resistant plastic for casing and Energy Efficient Heaters.

Location of the Heater near the main circuitry meant that some components operations were slightly affected by temperature.

Inexperience on the part of the designer lead to some unsuitable decisions and mistakes that were unbecoming, but eventually, it was rectified and overcame.

Chapter Two

Literature Review

2.1 History and development of hand dryers

Hand driers possess one and the same history as hair driers. Even, the hair dryers have the features of hand dryers. They have the same basic of operation. The earliest dryers came from Iran. They were called blower dryer and mechanically operated [2]. A blow dryer is an electromechanical device designed to blow cool or hot air over wet or damp hair. in order to accelerate the evaporation of water particles and dry the hair. The usage of blow dryers also allows better controlling the shape of the hair in the process of styling, by accelerating and controlling the formation of temporary hydrogen bonds inside the hair. Blow dryers dominated around the end of the 19^{th} century being dependent on the heat generation and mechanical air flow in order to be effective. Hairstyles using blow dryers usually have volume and discipline, and can be further improved by the usage of brushes during drying to add tension, and usage of styling products. Before the development of blow drying, hairstyles tended to be stiff and lacking volume.

Due to the development in electronics, good commercially important dryers emerged in the later part of the 1950's, they were quite portable or small in size. They required little technical knowledge for necessary operation. The most interesting attachment was that it was affordable. Around this period hair dryers were adopted for hand drying application [3].

The early designs were manually operated through a push button, but with further invention and development in electronic devices, modern touch less hand dryers were made a possibility. The dryer is operated without any physical contact. Such designs provide éasy-to-use features along side minimizing disease infection commonly attributed to towel usage.

2.2 Types of Hand Drier

There are two major types of hand dryers, they are the hand operated and touch-less types. The hand operated involves manually switching ON and OFF of the hand dryer. This requires a toggle button that is pressed ON to activate the unit and a release to switch, to switch OFF the device. This type of hand drier is becoming old and out of use. The recent development in electronics brought about the easier operated "Touch less hand drier". The design involves an infra-red eye that responds to close objects or hands by switching on the heat blowing effect. This type of unit involves timing circuits to smoothen their operation. Also, its increasing popularity is due to the touch-less operation nature. It is believed that the chances of infection through the use of touch less hand dryers is minimal compared to other means of getting hands dried.

In addition, both types of dryers are incorporated with thermostat for heating regulation. This feature prevents over-heating.

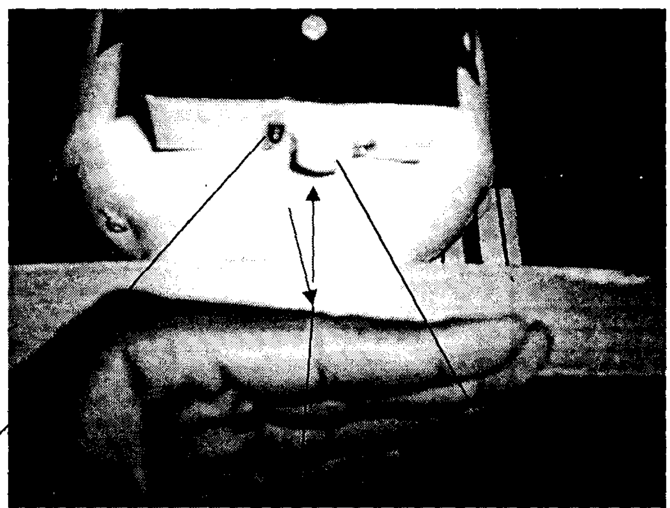
2.3 The Basic Principle of Operation of Touch-less Hand drier.

It is quite obvious that hair, cloth and hand dryers have similar principle of operation. There is always a heating filament or heater and an axial fan blower. These two devices are connected to the same control line but the operation of the heater is usually influenced by a thermostat circuit [5]. As earlier explained, the thermostat keeps the involved heating at a reasonable and acceptable temperature rânge. The reason is to avoid damaging the components on the circuit and prolong the heating elements life span.

Another part of the device is an infra-red eye, this leading unit helps in the control mechanism. It is the control input of the whole device. It activates the heat blowing effect by sensing a nearby hand, therefore it senses close objects for operation.

2.4 The Infra-red eye:

This unit involves an infra-red transmitter and receiver. The two devices are placed beside each other. The transmitter which is usually an infra-red emitting diode, emits straight infra-red signal away from the set-up. The signal is far out of the reach of the infra-red receiver, therefore the device is put at OFF mode.



LED Reflected Infra-red beam Receiver (Reverse biased photo-diode covered from external interference).

Fig 2.1 Infra-red eye with Reflected infra-red beam.

By reflection, the infra-red beam gets to the receiver. Whenever the signal gets to the infra-red receiver, the loads (heater and blower) are activated through a control logic unit connected to the infra-red eye. Infra-red radiation is always chosen for such application due to its visible nature. In fact infra-red radiation is electromagnetic radiation of a wavelength longer than that of visible light but shorter than that of microwave radiation. The name means “below red”, from the Latin word infra, “below”, and red being the colour of visible light of longest wavelength.

Infra-red eye is placed at the air outlet so that by putting hands towards this part the hand automatically gets the device working. Also a typical sensor range is 120mm. The infra-red electronic eye normally works with a timer control switching unit. It features auto time-out protection.

2.5 The blower

There are three main types of fans used for blowing air. The Axial, Centrifugal (also called radial) and Cross flow (also called tangential). The axial flow fan is commonly used for hand drier application. The Axial fans blow air across the axis of the fan, linearly hence their name. This is the most commonly used type of fan and it is used in a wide variety of applications ranging from small cooling fans for electronics to the giant fans used in wind tunnels. Small axial fans are used for hand dryers. They generally consist of a set of rotating blades that are placed in a protective housing that permits air to flow through. Also they are usually rotated by both A.C and D.C electric motors. Mostly the D.C type are used, which use low voltage typically 24V, 12V or 5V.

The brushless D.C motors are better due to the fact of related much less electromagnetic inference (EMI). An average power rating is 1/10 hp at 3450RPM. In most drier configuration the involved fan blows over a heating filament for resulting warm air [4].

2.6 The Heating Filament or Heater

In most related designs the involved heater is usually a close coiled nickel chrome wire rated at around 1-2.5 Kilo-Watts supported in mica former and provided with woven gals to cord support. An automatic safety cut-out prevents over heating. Modern designs substituted linear precision temperature sensor for usual thermistor for the most important element of the electronic thermostat. The reason is for a more accurate heating control mechanism.

CHAPTER THREE

DESIGN ANALYSIS

3.1 Circuit Analysis

The project can be divided into six main units. Each unit contribute to the overall operation of the circuit.

The involved units are:-

i) Infra-red eye/amplifier unit.

ii) Control logic unit.

iii) Motor switching unit.

iv) Heater switching unit.

v) Thermostat unit.

vi) Power unit.

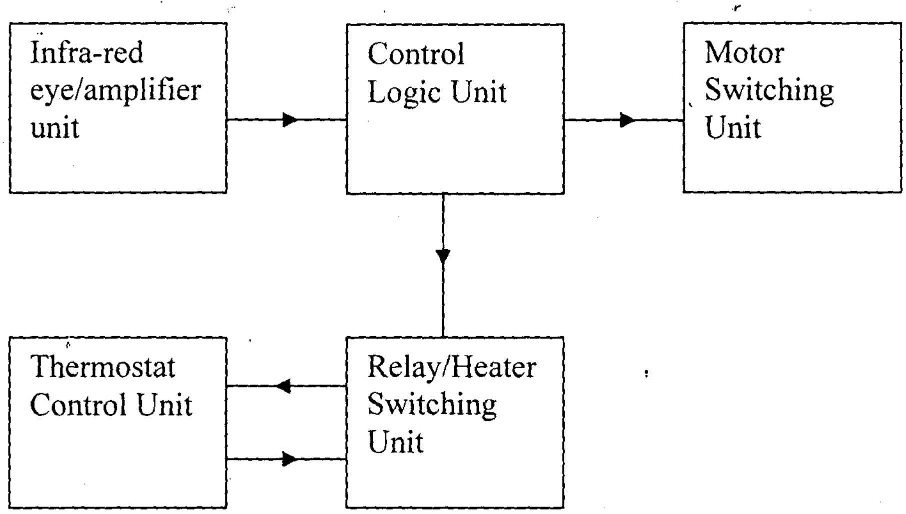


Fig 3.1 Block diagram of the Touch-less hand dryer

The input of the whole circuit is the infra-red eye. The output involves both the motor and relay-heater switching units. The logic control and thermostat control units do the coordination of the input with the output.

3.2 Power unit

The power unit supplies the both 5V and 12V for the circuit. A 24V output step down transformer with a current rating of 500mA is the input of this unit. Its output voltage of 24V A.C is rectified through a bridge rectifier. This is a full wave rectification process that involves four diodes. The bridge rectifiers connection allows two diodes to be forward biased while the other two are reverse biased during each half cycle of the input voltage. This results into the rectification of the involved A.C voltage [6]. The output is polarized into both positive and negative terminals. But, the expected component direct current nature of the output is not so. The output possesses an A.C characteristic which is required to be filtered out. To do this, a filter capacitor is incorporated into the output. The capacitor is usually from 100-3300µf. It is connected in parallel to the output. The result is a smooth or more direct current nature output.

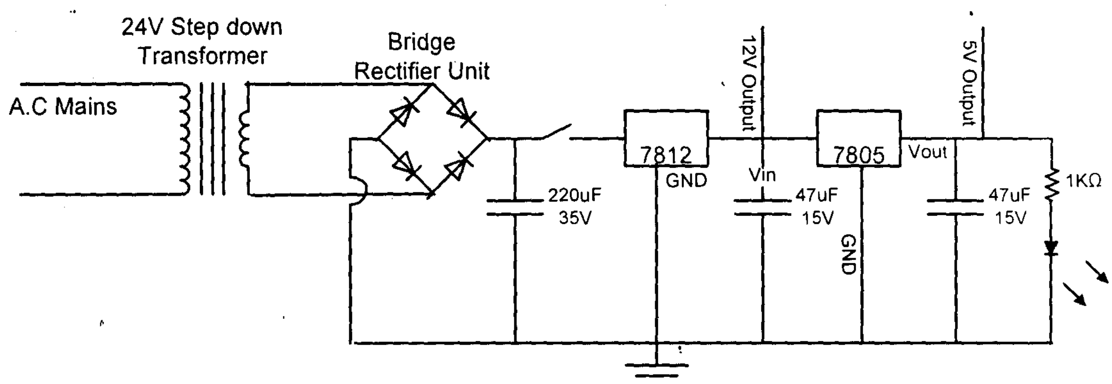


Fig 3.2 Bridge Rectifier unit.

Both 12V and 5V regulators are incorporated into the circuit. The 12V power supplies the output load involving the fan blower and heater switching. 5V power supplies the other components which are mainly integrated circuit. The regulators are connected in parallel to the roughly 24V power supply.

A power indicator circuit shows the presence of electric current flow in the circuit. The circuit involves both 1kΩ resistor and light Emitting Diode (LED). The circuit is connected to the 5V power supply.

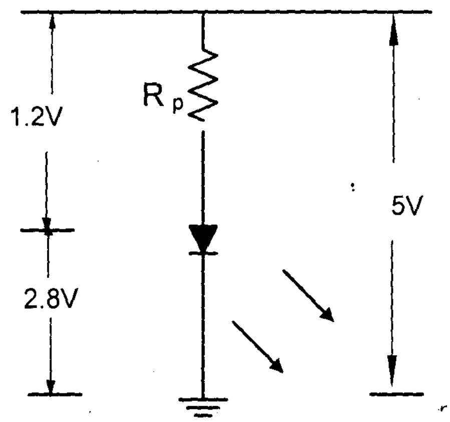


Fig 3.3 Voltage along LED

2.8V is expected across the LED; 2.2V across Rp. A typical electric current flow of 3mA is expected in the series circuit.

$Rp = 2.2 / (3x10^{-3}) = 733.33\Omega$

1kΩ is used in the circuit, 733Ω resistors are not quite readily available for purchase, therefore a 1kΩ is useable for a similar result. The only effect might be a dimmer light output which is not really significant.

3.3 Infrared eye unit

The main input of the device is the infra-red eye/amplifier unit. It is configured as a motion sensor. The unit operates mainly on infra-red signal. The motion sensing technique covers both infra-red transmitter and receiver. The infra-red transmitter generates a straight beam of infra-red. The receiver deals with the conversion of the infra-red energy into corresponding electric current. The involved electric current is usually weak. Therefore, it is strengthened through an amplifier.

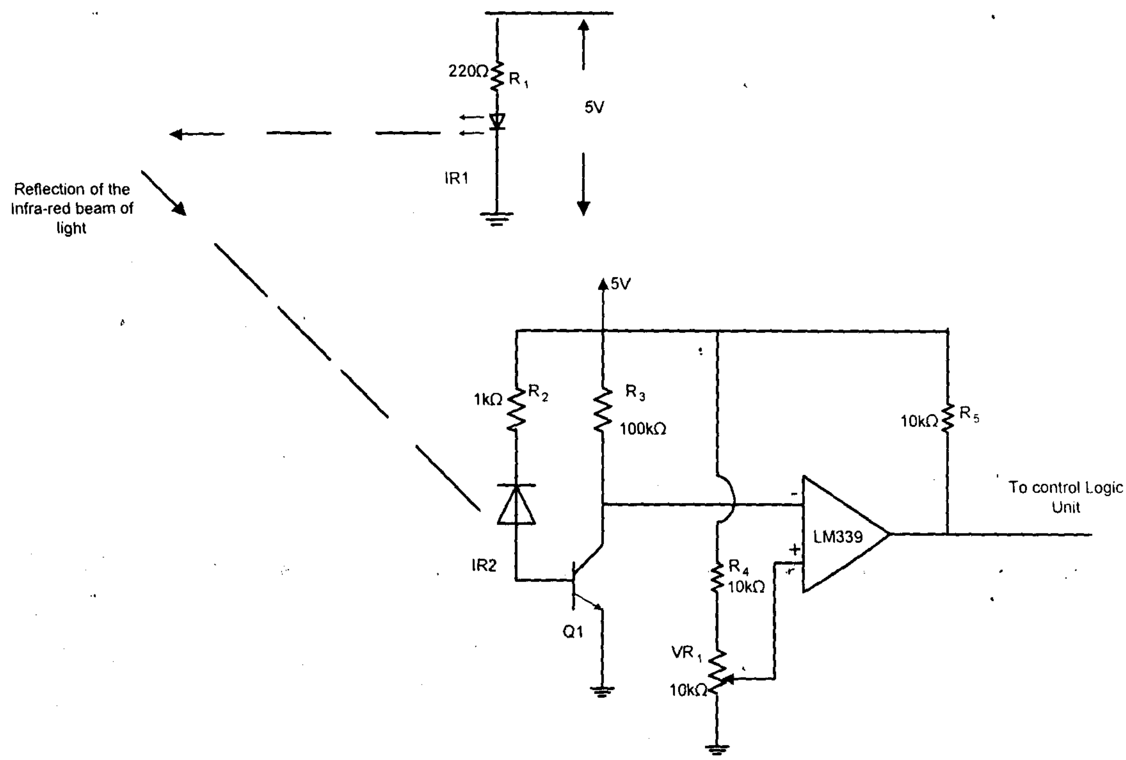


Fig 3.4 Infra-red eye amplifier unit

The infra-red transmitter circuit is designed using a 220Ω (R1) resistor and an infra-red emitting diode (IR1). The components are connected in series. The diode requires around 2.7V for normal operation. Therefore, a series resistor (220Ω) needs to hold the remaining 2.3V from the 5V supply of the circuit. A current of 10mA is expected through the circuit.

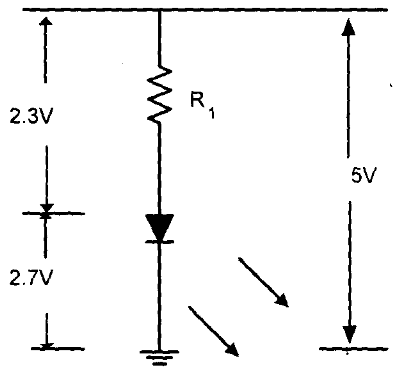


Fig 3.5 The infra-red LED setup.

R1 = 2.3 / (10 x 10^{-3}) = 230Ω

But 220Ω is used instead, as 220Ω is more readily available in the market than 230Ω. It still serves the same purpose.

The other section of the infra-red eye/amplifier unit is designed for the reception of the infra-red beam from the transmitter for control purpose.

An incorporated infra-red sensor (Reverse Biased Photo-Diode) converts infra-red energy into corresponding electric current. The degree of conversion is of direct proportionality. This is means, the more infra-red exposure of the sensor, the more corresponding output electric current. An evident attribute of the electric current from the infra-red sensor is very low strength.

Q1 which is 92JC945 NPN transistor, is connected to the infra-red sensor for significant amplification of the involved electric current. It is a common practice to put in series a 1kΩ resistor with the infra-red sensor. The resistance allows suitable current to flow through the device. The computation of the current through the base is quite complicated due to the fact that infra-red sensors are always reversed biased. Therefore, the estimation of such electric current flow is started from the transistor's collector and through the current gain of the transistor, the base current is known.

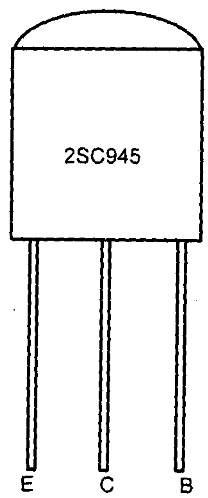
The very impedance of infra-red sensor necessitated a high resistance loading of the collector of the involved transistor. The high resistance is compatible with the expected low current of the base of the device. R3 the collector load is made 100kΩ. Therefore, for saturation, the transistor is expected to possess a collector current as estimated below

$I_c = V_{cc}/R3$............Eqn(3.1)   already $V_{cc} = 5V$, $R_3 = 100k\Omega$

$I_c = 5/100 \times 10^3 = 0.05mA$

$I_c = 0.05mA$

2SC945 NPN transistor is designed for low speed switching and audio amplification. It has a typical current gain of 100. It operates with a maximum collector current and voltage of 100mA and 50V respectively.



E = Emitter.   B = Base.   C = Collector.

Fig 3.6 The Pin Configuration of the 2SC945 Transistor

Therefore the base current of Q1 with Ic Value of 0.05mA is given below.

$I_B = I_c/h_{fe}$ ....Eqn(3.2)

$I_B = 0.05 \times 10^{-3} / 100.$

$I_B = 0.5\mu A.$

The expected electric current at the base is extremely small. It shows the high impedance nature of infra-red sensors. At least, the electric current is expected to completely saturate the involved transistor. But, this electric current is not always attained for sake of longer infra-red range or coverage.

The result is an incomplete zero state of the collector during expected saturation state. The fact is that, on infra-red detection the voltage of the collector drops close to zero voltage. When there is no infra-red detection, the collector of the transistor is relatively high.

The collector of the transistor is connected to the inverting input of an LM339 comparator. The non inverting side of the comparator is referenced or off-set through VR1 (a 10kΩ range variable resistor). The resistor is used for adjusting a particular voltage to the non-inverting input of the comparator.

The LM339 comparator follows one and the same principle of operation of conventional transistor. A single LM330 integrated circuit has four comparators [9].

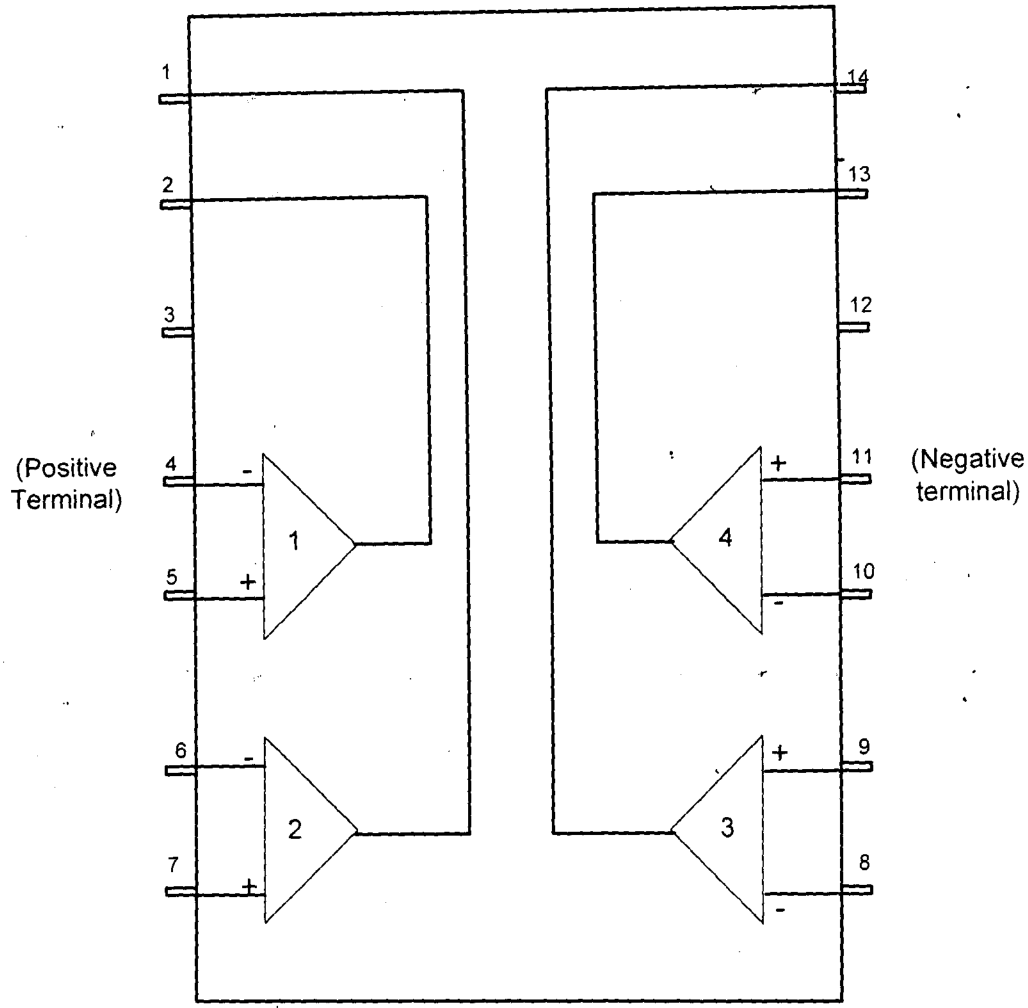


Fig 3.7 The Pin Assignment of the LM339

One of the four comparators is used in the circuit. A single comparator has two inputs and a single output. The output responds to the comparison of the two inputs. The output is in digital or logical nature. Whenever, the voltage at the non-inverting input (Vin (+)) is greater than that of the inverting side (Vin (-)), the output is always logic 0. but a reverse state of the inputs results in logic 1 outputs [9].

In the design, the non-inverting output (Vin (+)) is always at voltage value within the range 0-2.5V, but it is usually not adjusted at 0V. R4 and VR1 are of the same value (10kΩ), the voltage across them is 5V. Therefore it is quite evident that the voltage across each of the resistors is 2.5V.

The variable resistor, VR1, is always used to offset the comparator this is because of expected infra-red detection. The result at the non-inverting input won't be zero. Therefore, a comparator is required to rectify the result. VR1 is also used for adjusting the sensitivity of the sensor. A wide voltage off-set results into low input sensitivity, lower off-set voltage and give better sensitivity.

The circuit is designed in a manner that an obstacle reflects the infra-red radiation from the transmitter to the infra-red sensor. The output of the comparator changes from the logic 1 to 0. The high logic level is quite a necessary control signal.

3.4 Control logic unit

The control logic unit holds a 4013B latch and an automatic reset logic device involving the 4060B.

The unit controls the main operation of the device in response to the inputs condition.

The 4013B is a CMOS integrated circuit comprising of two latches. The internal devices work independently. In fact, the latches or flip-flops are D-type devices but they can easily be converted to SR devices [8].

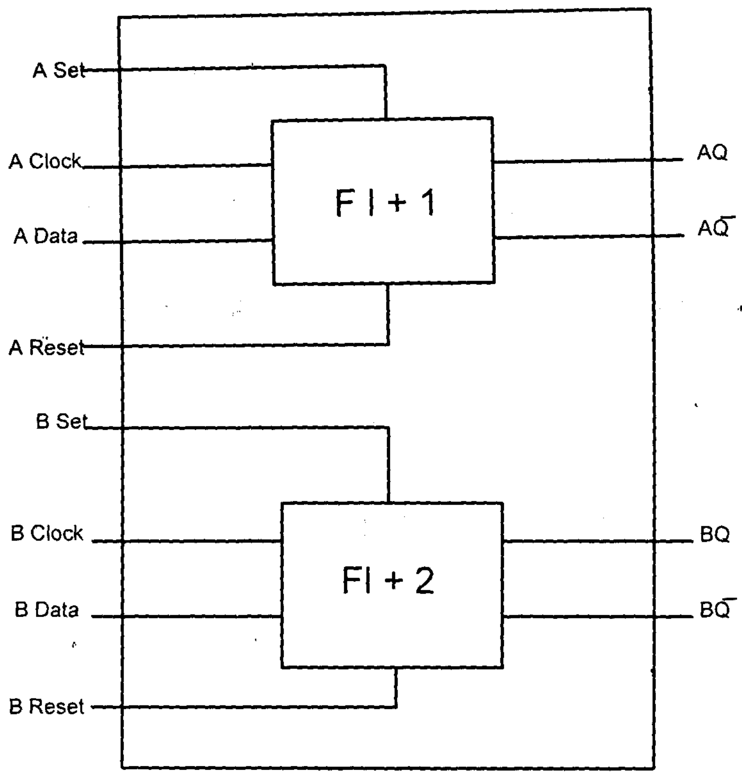


Fig 3.8 Functional diagram of the 4013B

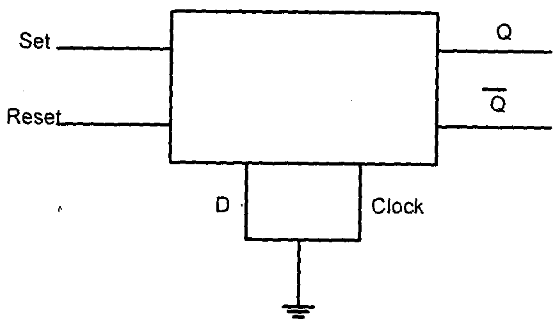


Fig 3.9 A single D-type device at SR configuration

An SR latch is incorporated into the design to hold control logic level for the purpose of motor and relay/heater switching.

The 4060B on the other hand is a CMOS oscillator. It is usually operated at the RC configuration. The device is quite a useful timing device. This is because it possesses ten frequency outputs. The frequencies are gotten from internal 14 stage division of a main frequency generator by an RC circuit.

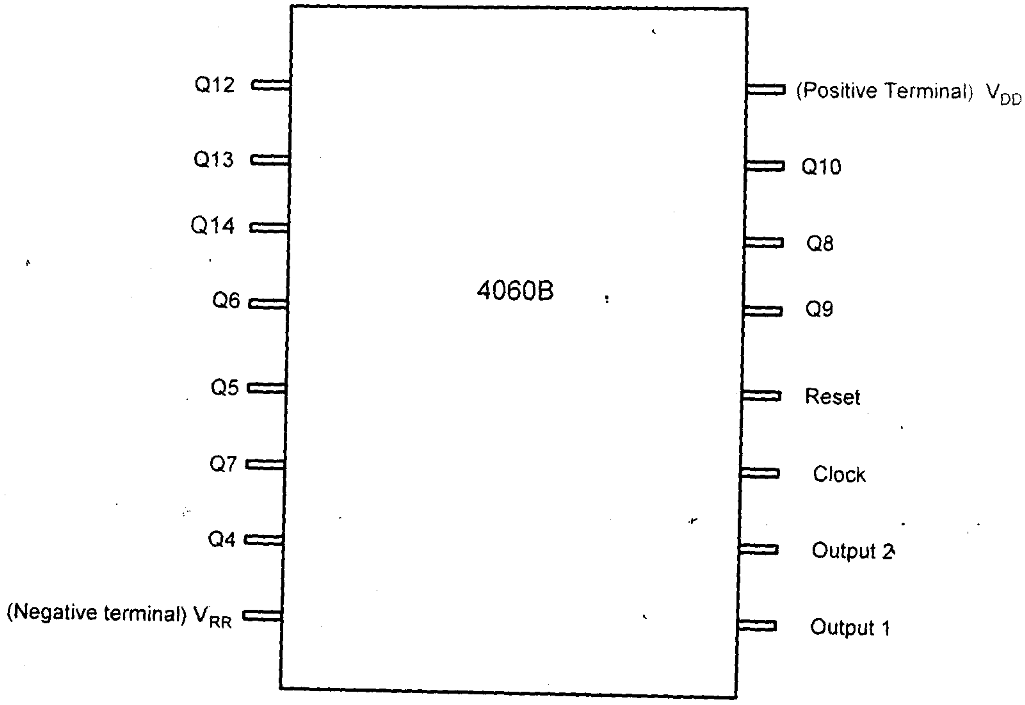


Fig 3.10 The pin Configuration of the 4060B.

Pin 12 of the device is used for device control. It is active high whenever the Pin is placed at logical 1, the device would not work. only at logical 0 would the 4060B integrated circuit be operational.

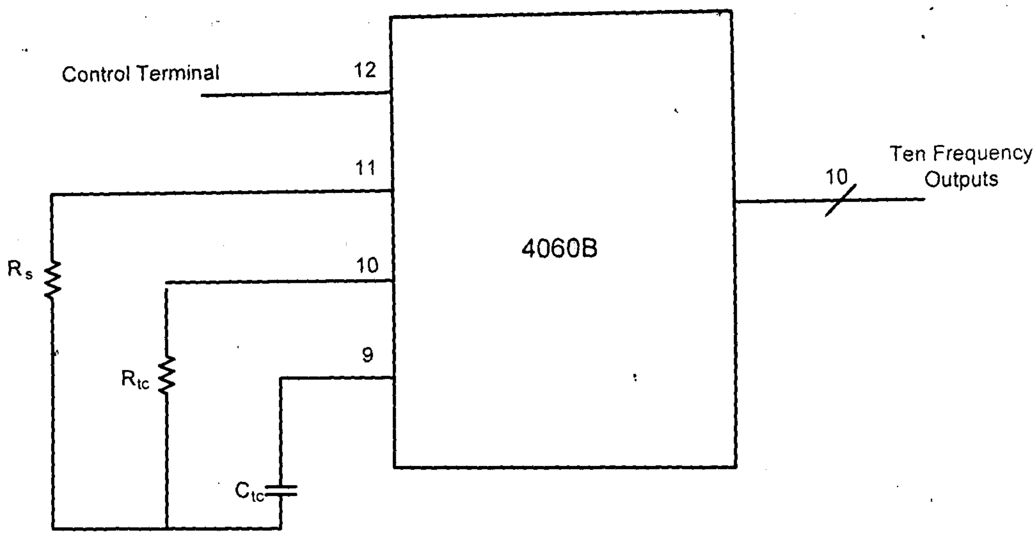


Fig 3.11 The RC configuration of the 4060B.

Rtc and Ctc are required for the devices Oscillation.

$10R_{tc} \geq R_s \geq 2R_{tc}$

The main frequency is given below

$F_m = 1/\ 2R_{tc}C_{tc}$ .... Eqn (3.3)

A given output from the device depends on the corresponding Q value.

$F_{Qx} = F_m/2^x$ ....Eqn(3.4)

x is the corresponding Q value of a particular output [11].

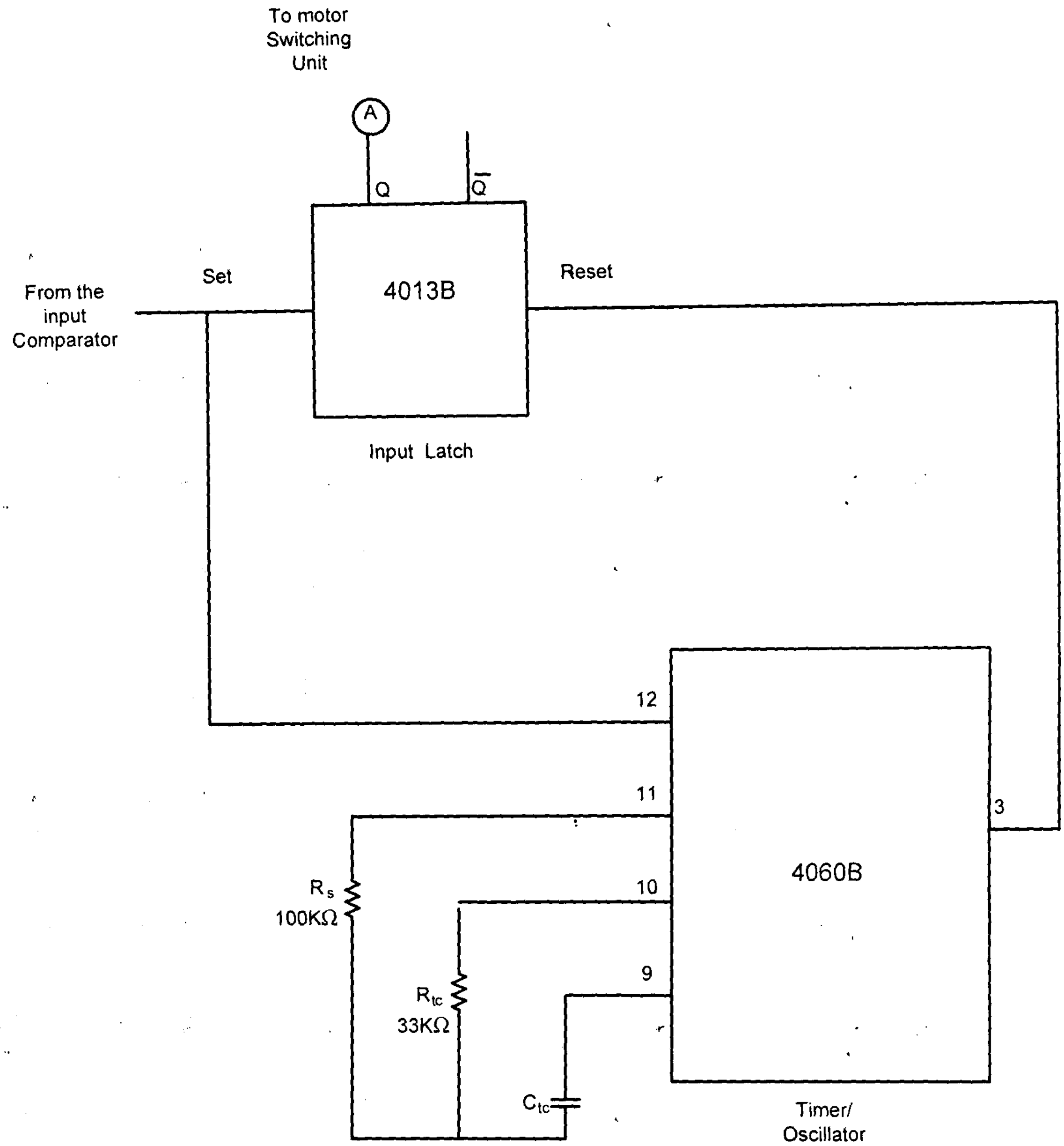


Fig 3.12 The control logic unit.

The time of oscillator (4060B) is required to reset the input latch after a delay. The result is a timed operation of the output. That is the in wired fan and heater work for a particular time before automatically switching off. Output of the input latch does the major control. It goes logical 1 a moment after the output of the input comparator is high logic level.

High lever of the 4060B simply results into disenabling mode. Whenever the high level signal changes low in response to no–infra-red condition, the timer starts working towards a time in which its output changes logical 1 in resetting the input latch. in response output changes from logical 1 to 0.

The output is designed to be ON for a specific time of roughly 23 seconds. The determining elements are Rs (100kΩ), Rtc (33kΩ) and Ctc by using the 4060B integrated circuit's formula from the manufacturer's data sheet the value of Ctc can be computed.

23 second timing is corresponding to the following frequency which is given below.

$T = 1/f$ ....Eqn(3.5)

$F_{tc} = 1/23x2 = 0.022Hz$

If the signal is expected at pin 3,

Therefore,

$0.022 = F_m/2^{14}$

$F_m = 2^{14} \times 0.422 = 360.5Hz$

$F_m = 1/\ (2.3 \times R_{tc} \times C_{tc})$.........Eqn(3.6)

$C_{tc} = 1\ /\ (2.3 \times R_{tc} \times\ F_m)$.........Eqn(3.7)

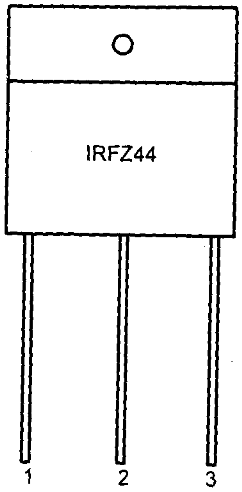
$C_{tc} = 1/\ (2.3 \times 33 \times 10^3 \times 360.5) = 3.65\text{x}10^{-8}F$

$C_{tc} = 0.035\mu F$

Ctc value of 0.047μF is used in the circuit therefore, the timing is expectedly slower due to increase in capacitance component of the oscillator and due to the inaccuracy of the involved formula.

3.5 Motor switching

The motor switching unit involves a MOSFET switching device namely the IRFZ44. This is a very high current switching transistor with a very low on state at about 0.01Ω. It has a maximum operating voltage of 55V.



1. Gate, 2. Drain, 3. Source

Fig 3.13 The Pin assignment of the IRFZ44

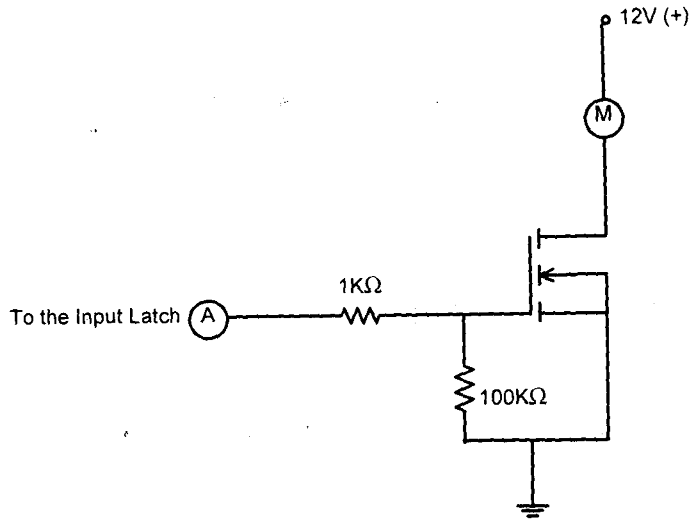


Fig 3.14 MOSFET for Motor switching

Metallic oxide semi-conductor field Effect Transistors (MOSFETs) are attributed to direct switching. As the gate is slightly positive, the source and drain are directly connected together with an extremely small resistance [12].

Therefore the MOSFET simply allows 12V power supply to the motor for operation. That is whenever the gate is relatively positive.

Terminal K is fed to the relay/heater switching unit for control purpose. Moreover the motor is representing an air blower.

3.6 Heater Switching Unit

This unit works with hand in hand with the motor switching unit. The unit responds to signal from the input control latch. The unit mainly comprises of a switching NPN transistor, 12V relay, and a heater.

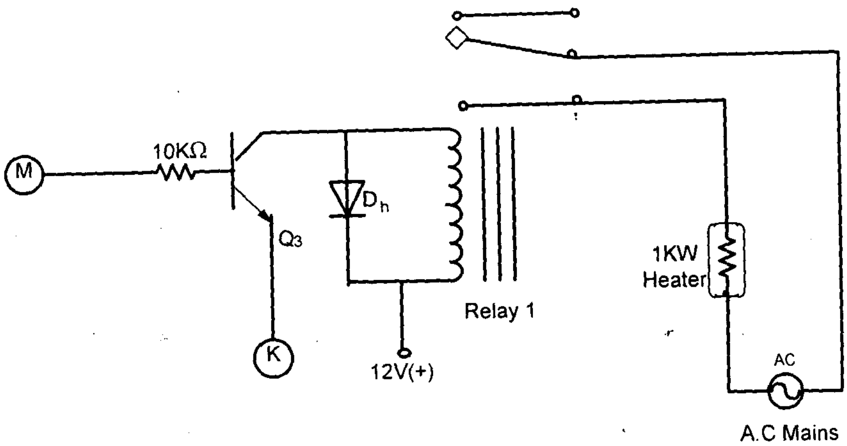


Fig 3.15 The heater switching unit

The IRFZ44 that was earlier explained does not only switch the motor but also Q3 (a new switching transistor). The initial condition of the base of the transistor is high logical level. Therefore, in making the emitter of the transistor negative, the corresponding relay is switched on. In other words, the transistor is saturated or in the on state.

The relay responds to the transistor's saturation. At the transistor's cutt-off state, terminal 1 of the relay is connected to 2, but during the saturation terminal 2 is disconnected from 1 and goes to 3. The initial switching condition of the relay disconnects the involved heater for the A.C mains supply, but during the transistor's saturation, the heater is supplied with electricity.

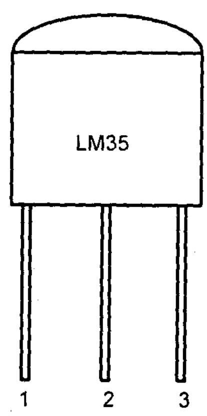
Terminal M links the heater switching unit to the thermostat unit which controls the heating. This feature is necessary because continuous operation or on state of the heater could lead to considerable circuit damage.

The thermostat control involved changes the initial high condition of terminal M low whenever the heating is hazardous.

In addition, the reversed biased diode across the inductive terminals of the relay is incorporated to conceal the effect of back E.M.F resulting from the period switching of the involved relay switch.

3.7 Thermostat unit

As earlier explained, the thermostat is incorporated into the circuit to regulate the involved heating. The thermostat is quite electronic and modern in nature, due to its precision and accurate response. The main electronic component in the circuit is an LM35 integrated circuit temperature sensor. It possesses three terminals. They are required for power supply. The other one produces an output voltage in response to temperature exposure. The terminal is based on a temperature –voltage relationship of $1^{o}c$ to 10mv [13]. Therefore, a temperature like $40^{o}c$ is corresponding to 400mV. In fact the temperature sensor is just an electronic thermometer. It works within a temperature range of 0 – $100^{o}c$.



1. Vin (Positive terminal) 2. Vout (Output voltage) 3. GND (negative terminal)

Fig 3.16 The Pin assignment of the LM35

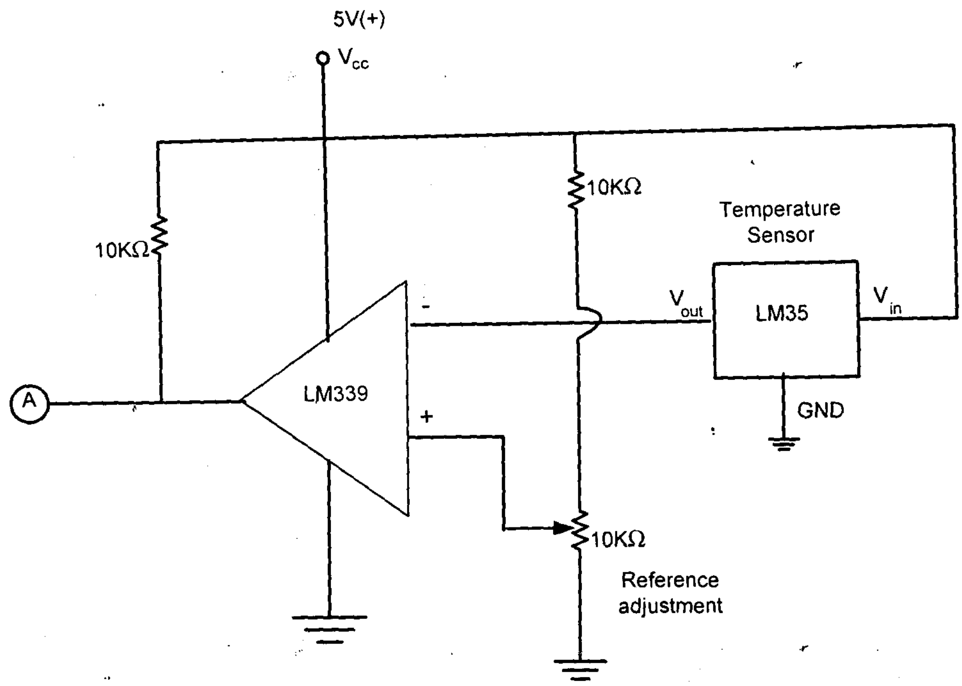


Fig. 3.17 The electronic thermostat Unit

The LM35 integrated circuit is connected to an LM339 device. The Output of the LM35 is connected to the inverting Output Vin (-). The non-inverting input Vin (+) is made as the reference. The corresponding voltage to a particular temperature can be asjust at the no-inverting input Vin(+). Whenever the voltage from the temperature sensor is going beyond the reference voltage, the output of the comparator changes from the initial logical 1 value to low 0. A relatively low voltage at the base of the relay switching transistor simply turns the relay off or heater disconnected from the power supply. This is despite the fact terminal K is relatively low. The reference voltage of the comparator is set at 600mv, corresponding to 60*c. therefore, whenever the air heating is going beyond 60*c the hear is switched off. The hearting starts again whenever the temperature is about dropping below 60*C. moreover the two 10kn resistor make a potential divider. It is quite obvious the voltage across each resistor is 2.5V.

This is simply how the heating of the device is regulated.

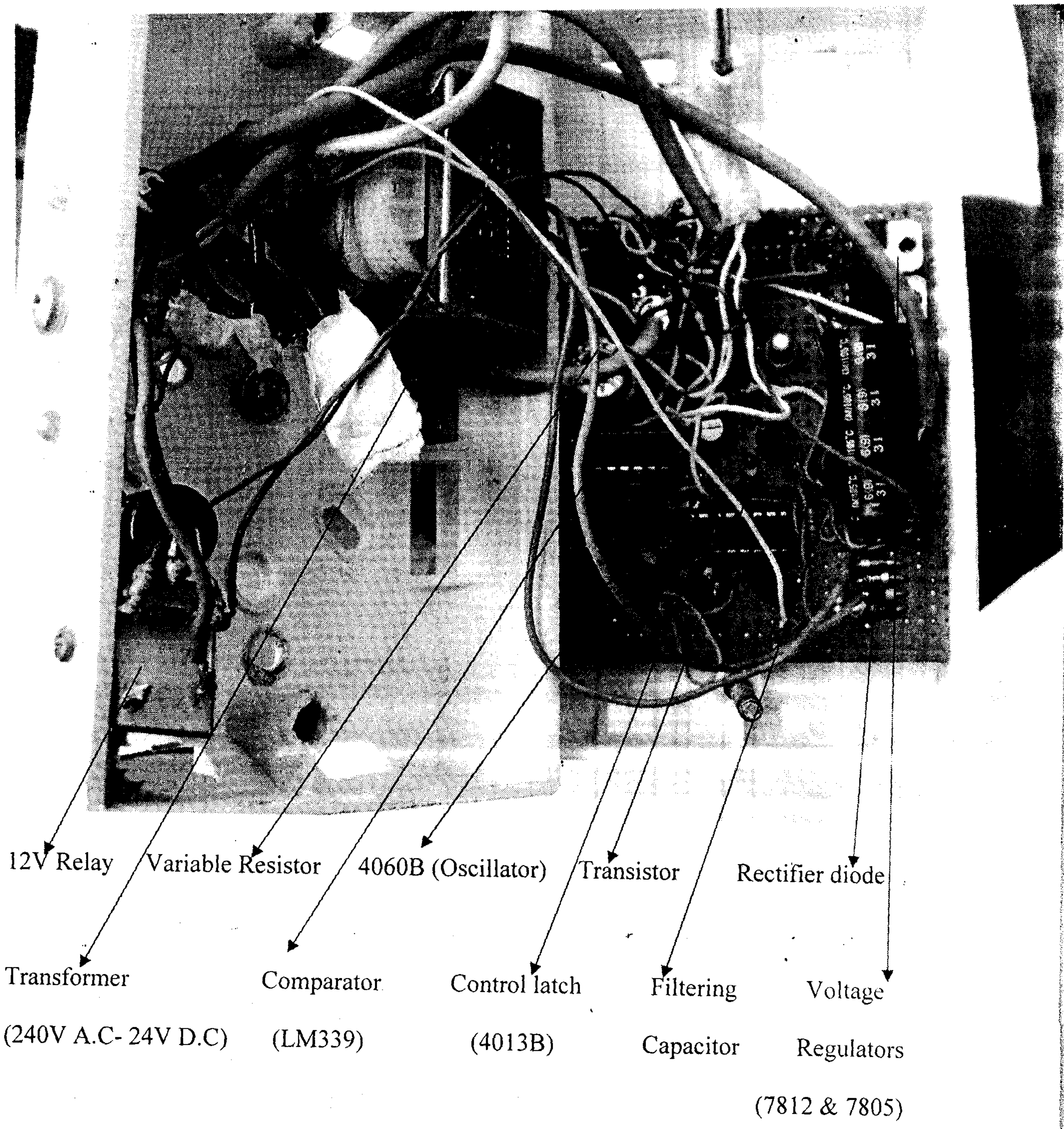


Fig 3.18 Picture of the Whole Circuit on a Vero-board.

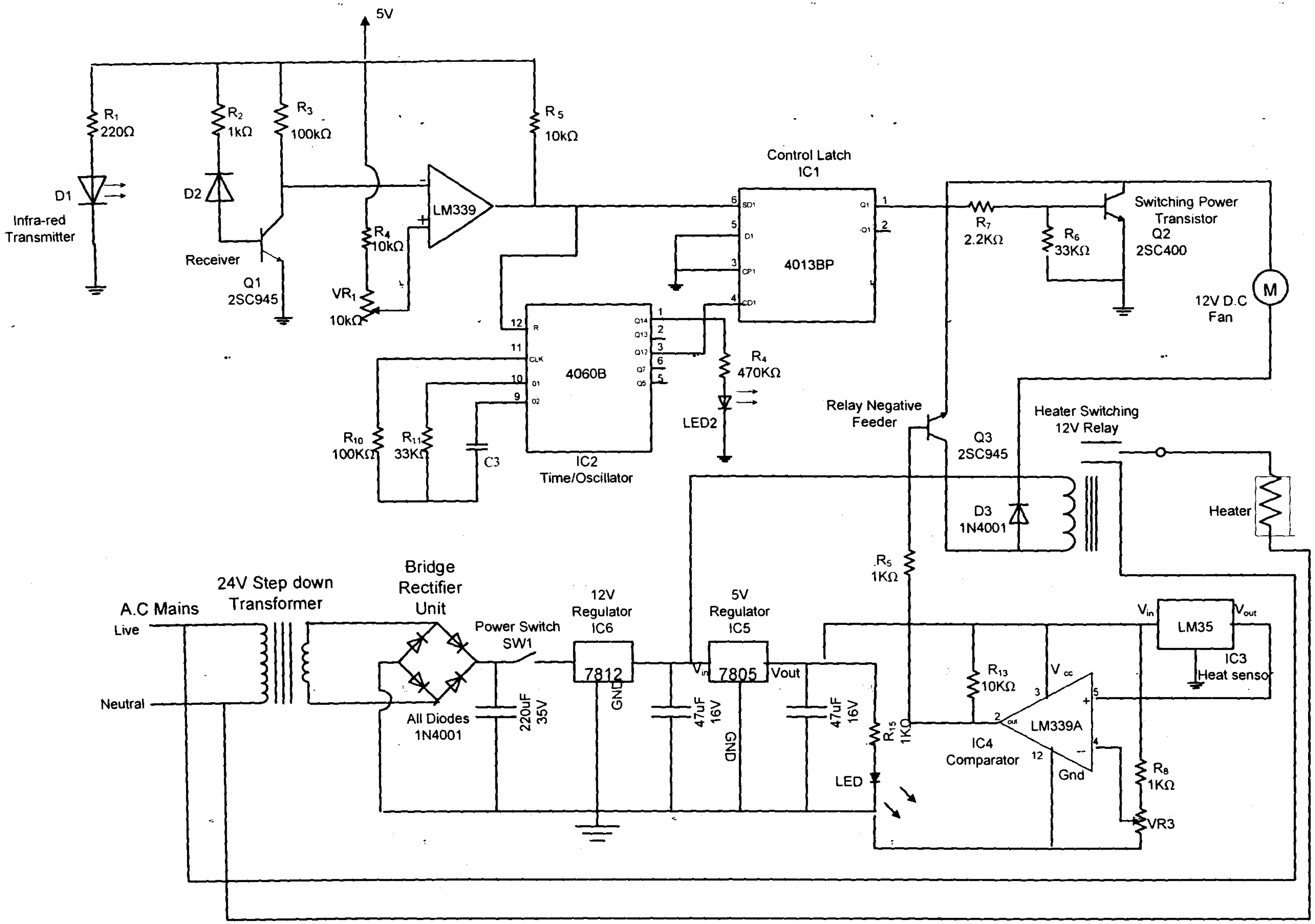


Fig 3.19 Complete Circuit Diagram of the Touchless Hand dryer

CHAPTER FOUR

CONSTRUCTION, TESTING AND DISCUSSION OF RESULTS

4.1 Construction

The construction was carried out in stages i.e. one unit after the other-using a breadboard where each section of the design was built and tested to give the required signal output. Practically all the components were transferred onto the Vero-board after the initial assembly and test using the bread board. Components prone to damage due to static charges and handling (the LM35 sensor and the MOSFET) were the last to be mounted.

They were fitted in integrated circuit holders but were not plugged into the holders until all the wiring was completed. Care was taken in the course of soldering to avoid short-circuiting. A number of link wires are needed and the capacitor checked for polarity before final soldering was carried out. The circuit set-up was tested again and then placed in a casing, where the Vero-board was screwed onto the casing.

A casing was constructed from a Double (13-15Amp) socket gang box and a Single (13-15Amp) socket gang box. The Single socket gang box was used for housing the Transmitter and receiver and the Double gang socket box to house the whole Main circuitry of device.

The main body was constructed from an old kettles metallic body to from a round truncated cylindrical shape. The fan was attached at the base of the container while the heater was attached at the other opening where the hot air is supposed to exit.

The whole body measures 27cm length and the cylindrical part alone has a diameter of 17.5cm. The truncated opening for hot air to pass is 10.6cm in diameter.

A proper cable rating of $2.5mm^2$ was used to supply power to the circuit because of the 2 heavy load Heaters of 1Kilo-Watt each [14].

(a) Length 27cm, (b) width 17.5cm, (c)Vent opening 10.6cm, (d) Height 7.5cm

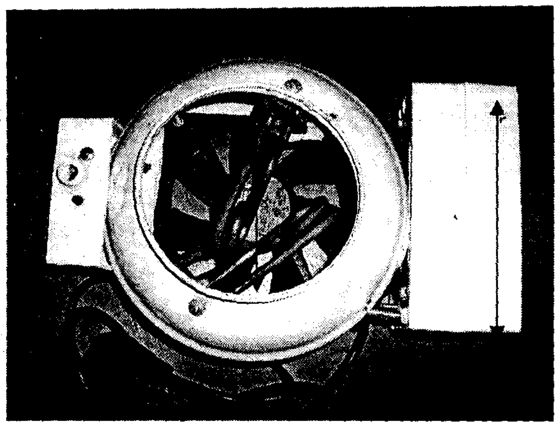


Fig 4.1 Dimensions

4.2 Testing

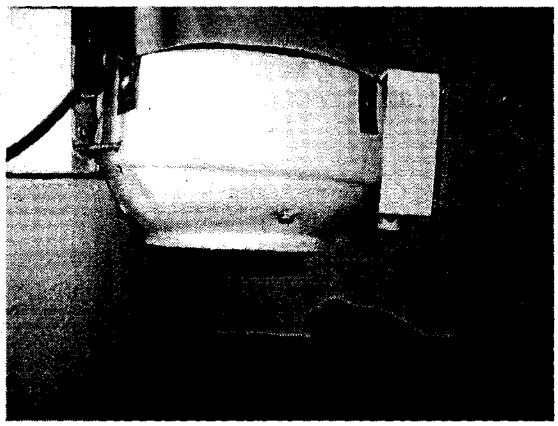


Fig 4.2 Illustration of operation

The equipments used for testing was a Digital and an Analogue multi-meter, a Clinical thermometer, a Stop Watch and a transparent ruler.

There are two LED pilot lamps for use indication, one for standby mode with power supplied (Red LED), and the other for when the circuit is operating (Blue LED).

A Voltage of 5V is referenced against a 10KΩ resistor and VR1 which are then connected to the non-inverting input of a Comparator (LM339A), thus when the inverting input is not as much as the voltage across VR1 (when the transistor is saturated and collector voltage Vcc is very low) the Comparator (LM339A) gives a high to trigger the control latch.

The value of VR1 is therefore directly proportion to the sensitivity (the effective distance range between the receiver and a hand reflecting a signal) of the Receiver. Therefore the distance range of the Receiver is set using VR1.

To achieve setting the temperature not to go beyond 60°C. 5V is referenced through a 1KΩ resistor and VR3. The VR3 is set such that voltage across it is 600mV, which fed to the non-inverting input of the Comparator2 (LM339A). Knowing the sensor produces 10mV per 1°C of temperature, at 60°C it will produce 600mV. When the sensor is attached to the inverting input of the Comparator so that when it produces voltage beyond 600mV, the comparator is low and the relay is triggered to switch OFF the heater.

The higher the value of VR3, the higher the Voltage across it. Hence the higher the maximum temperature of the Heater.

The Oscillator's (4060B) timing duration is determined by the capacitance value attached to Pin9 of the 4060B IC. This is given by the formula:

$C_{tc} = 1/(2.3 \times R_{tc} \times F_m)$...........Eqn (4.1)

Where $F_m = 2^{14}/T$ and T is the time duration in seconds you want the circuit to be ON.

And R_{tc} is a Resistance value attached to Pin10.

Hence $T = 2.3 \times R_{tc} \times C_{tc} \times 2^{14}$ ....Eqn (4.2)

4.3 Results

Outputs of all Logic IC's (Digital output) were measured when high and found to be 5V or some 4.99V.

Data concerning the relationship between the Value of VR1 and the Receiver range :

At all times a voltage of 5V is referenced across both VR1 and the 10KΩ resistor.

Table 4.1 Sensitivity of Receiver in terms of distance range and value of variable resistor VR1.

Voltage Across VR1 (in Volts)	Distance Range of the Receiver (in cm)	Voltage Across 10KΩ Resistor (in volts)	Resistance Value of VR1 (in -Kilo-Ohms)
2.50	6.20cm	2.50	10.00
1.50	9.70cm	3.50	4.29
1.00	Receiver becomes highly sensitive, even normal room light activates the circuit.	4.00	2.50

The receiver had to be shielded even for the 2.5V as a room with very high illumination will activate the circuit.

Using a clinical thermometer to monitor the switching efficiency of the thermostatic unit the maximum value recorded of the heating element was 58.55°C.

%Error = (60-58.55)/60 x 100% = 2.42%

The timing duration of operation of the circuit was 19 seconds instead of 23 seconds, the timing of the circuit might have been hindered by the resistance of the soldering joints of the two resistors and the capacitor attached to the Oscillator (4060B).

For the regulators, the voltage Output of the 12 regulator (7812) was 11.92V.

%Error = (11.92-12)/12 x 100% = -0.66%

The Output Voltage of the 5V regulator (7805) was 4.97V.

%Error = (4.97-5.00)/5 x 100% = -0.6%

4.4 Discussion of Results

For sensitivity of the receiver to kept under control, the value of the variable resistor should be > 2.5KΩ. The receiver is quite sensitive to light and should be shielded from all sources of light apart from the path for reflection of the infra-red beam.

The timing delay might have been hindered by both the resistance of the joints due to soldering or due to high temperature generated by the Heater and the Circuit components. The error in temperature of Heater when switching occurs (Relays switches OFF the heater) might have occurred because of the use of a clinical thermometer instead of the user of a more accurate thermometer using more sensitive metals with higher temperature resistance gradient. i.e Nickel is more sensitive than the Mercury in Clinical thermometers [7].

The error in Voltage across the Regulators is mostly due to power fluctuations by PHCN. As such two multi-meters, an Analogue and a Digital multi-meter were both used to ascertain the values for sure.

CHAPTER FIVE

Conclusion And Recommendation.

5.1 Conclusion

The original idea behind this project is the design and construction of a prototype touch less hand dryer which is infra-red sensor activated, temperature regulated and timer controlled.

Heating of the element was restricted to a range of 0-60^{0}C by the thermostatic setup to keep temperature safe for the human hands, the circuitry, wiring and even for the heating elements to have a longer life span.

A Step down transformer of 240 A.C to 24 D.C was used instead of 240 A.C to 12 D.C so that in case of power supply fluctuations within the IEE approved rate + or - 5% the outputs of the 12V regulator (7812) and 5V regulator (7805) will compensate effectively for power the fluctuation.

The wiring is so simple very little can go wrong provided all of the components are correctly positioned and well soldered. Time was spent checking for dry joints, solder bridges and incorrect component positions and values before applying power. Also, it is tasking getting the collector, emitter and the base of the transistor, which is gotten from data book. Usually the terminals of each component or IC have to be carefully studied before connections are made and it should be as indicated in the manufacturer's data sheets.

The design is relatively simple and automated; the detection in the heating environment of the sensor is through thermo-ionic emission. Hence, it can be conveniently used in many applications for heating monitoring functions.

The comparator output for the Relay switch actuation signal was found to be satisfactory.

5.2 Recommendations

A more efficient heating element and a Non metallic casing using a special high temperature tolerant plastic should be used in future. The heating element used in standard Hand dryers consumes much less energy while producing a large amount of heat. The current heating elements used might not last too long.

An infra-red setup which is a lot more accurate than the one used in this project should be adopted.

The use of Touch-less hand dryers will go a long way in curtailing the spread of infections and its use should be taken seriously.

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DESIGN AND CONSTRUCTION OF AN AUTOMATIC CAR THEFT ALARM

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FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN ELECTRICAL & COMPUTER ENGINEERING.

NOVEMBER, 2004

DECLARATION

I want to state here that this project was carried out by me, Mr. Harrisen N. Chubu under the supervision of Engr. M. S. Ahmed and has been presented and approved for the award of Bachelor of Engineering, (Electrical/Computer Engineering.)

CERTIFICATION

This is to certify that this project titled "Design and construction of an Automatic Car Theft Alarm" was carried out by Chubu Nabem Harrisen under the supervision of Engr M. S.Ahmed and submitted to Electrical & Computer Engineering Department, Federal University of Technology, Minna for the award of bachelor of Engineering (B. Eng.) Degree in Electrical & Computer Engineering.

---------------------- 8/12/04
Engr M.S. Ahmed — Date
Supervisor's Name/ signature

---------------------- 8/12/2004
Engr M.D. Abdullahi — Date
Head of Department's Name/ signature

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External Examiner's Name/ signature — Date

DEDICATION

From the depth of my heart and total reverence I dedicate this work of mine to he who gave all the success of my career, the LORD GOD Almighty.

And also to my Mum Mrs. C.T. Chubu and my father, Mr. Fassam Chubu (R.I.P.) with love.

ACKNOWLEDGEMENT

First and foremost, I sincerely commend the efforts of my Mum, Mrs. C. T. Chubu for making sure that I have success through my academic struggle. I thank God for giving her the strength to see me through.

In the execution of this project, I have been extremely fortunate in having the strength, support and encouragement of a host of people who are: Mr. Thomas Ayongul, Mr. & Mrs. Samuel Gbinde, Prof. David Iornem.

The indebtedness, which accumulated in the process of this work cannot be adequately expressed.

My profound gratitude goes to my H. O. D. Engr. Mohammed Abdullahi and my Supervisor Engr. M. S. Ahmed whose academic advice has contributed immensely to the success of this work.

No author can succeed without the encouragement and patience of his family. In this regard, I am particularly grateful to my brothers, Aodofa, Tyona, Tyodoo, Lutor, Sughtor and Deve. And also to my sisters Hembadoon, Demmem, Ngufan and Mvena. Not forgetting the great pillars behind this success, my grand parents, Mrs. Nyiekula Daymnyor and Mrs. Iyoughkper Chubu.

ABSTRACT

Criminology studies providing statistical data on societal crime show that the phenomenon has been increasing geometrically. Burglary and theft cases especially, have remained relevant despite pragmatic efforts by lawmakers, enforcement agencies and organizations to curb it. This critical state of insecurity coupled with the inadequacies of security measures adopted in recent time posses momental challenges to control system engineering. In recognition of the aforementioned truth, here is a supplementary or somewhat complementary security system known as "AN AUTOMATIC CAR THEFT ALARM" designed and controlled for the purpose of checkmating car burglary or theft. The uniqueness of this particular project design is that though the topic boldly indicate the concept of an alarm, it does just a little more than producing alarming sound notes. The idea of feedback control is intelligently employed diversifying the scope of the project. This design is a juxtaposition of carefully selected electrical and electronics devices and components. It is reliable, effective, cheap and therefore suitable for real time utility for car security.

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CHAPTER ONE

1.0 INTRODUCTION

The general state of insecurity and the prevailing nature of seemingly uncontrollable cases of burglary or theft have generated notable endless anxiety in people. This inbuilt fear is due to huge financial and material losses often incurred by victims an sometimes people paying the supreme price with their dear lives.

In Nigeria, crime has been on a steady increase throughout the country, particularly in urban settlements and cities where the population is dense and hence there is competition and other serious challenges for survival.

Long and short-term strategies have been adopted by man based on either individual or collective efforts through logistics, enforcement and penalty to ensure the safety of lives and property.

Most of these strategic efforts do not effectively checkmate the adaptive skill tendencies and capabilities f the intruder. As a result of these inadequacies of manual and mechanical measures adopted by man in crime prevention, the application of automatic electronic systems have assumed an alternative and strategic role in anti-crime crusade.

1.1 SCOPE OF WORK

This project is therefore a modest attempt to design and articulate a workable and virtually automated car theft alarm.

The alarm system depends on some actuators, which provides the required electronic signals to activate it. At some strategic areas of choice, for example car doors, boots, bonnets etc connections are made to detect the presence of an intruder. The connection provides an actuating signal, which undergo the system's design control before finally casing the alarm to trigger into action.

The alarm is designed to be capable of giving an output pulse of between 0.5 to 1 second internal. The system has an initial time delay of 10 seconds before the alarm could be activated.

It is pertinent to state here that the initial time delay is designed to be useful only when the car user is disembarking from his car, it is not useful on reentry. Another time delay of relatively shorter period of about 3 seconds, than the initial time delay is also included in the system's design to take adequate care of the r-entry condition. A unique feature of this alarm system is that there is an arrangement by method of feedback signal, such that as soon as the alarm becomes fully energized, usually by the fully off mode of the car ignition switch, the power-switching device disengages supply to the car ignition switch. Any attempt therefore to start the car by the intruder cannot yield fruitful result. This design therefore presents an extra-ordinary protective advantage in addition to the perceived normal function of alerting the car owner.

Power supply to the alarm system is derived from the car's electrical system. That is to say the alarm should be capable of operating with a 10– 12 volts D.C. supply, which is also the capacity of the car battery. This alarm system is portable and can be installed in a hidden place in the car.

CHAPTER TWO

2.0 DEVELOPMENT OF SYSTEM BLOCK DIAGRAM

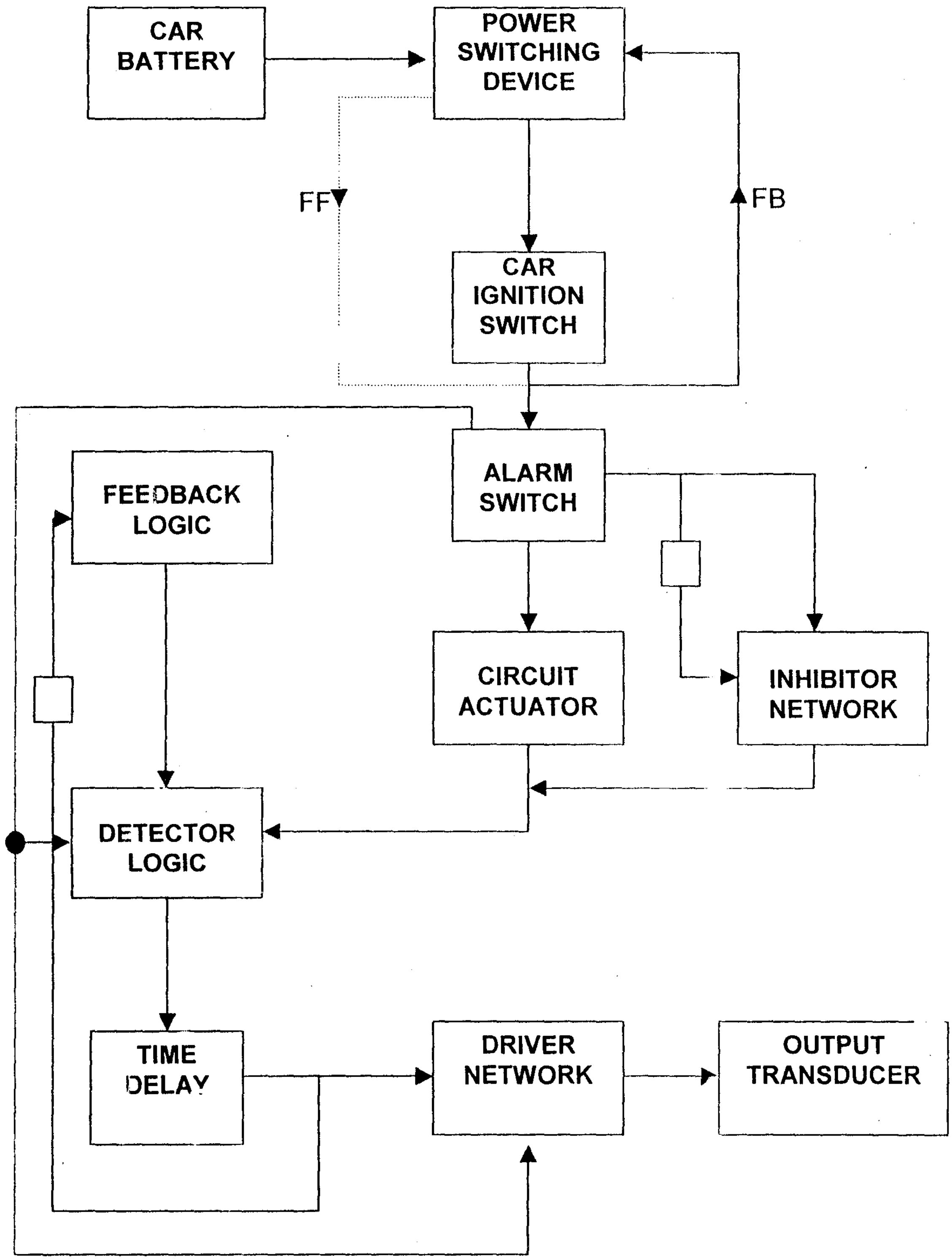

Figure 2.0: Block Diagram Of Automatic Car Theft Alarm

2.1 INTRODUCITON

This design as illustrated by the entire block diagram is made up of several units/parts that are inter-connected for the purpose of achieving the desired objective. The several parts are put together in the system's block diagram of figure 2.0. It consists of power supply (power switching device, car ignition switch, alarm switch), circuit actuator, inhibitor network, circuit (detector logic, feedback logic) tim delay, driver circuit and final output transducer, i.e. speaker.

2.2 POWER SUPPLY

The most common source of power in cars and other automobiles is the D.C. battery. In this section, we shall be concerned with the discussion of the vital components that make up of the power supply segment of this project. As it can be seen in the block diagram of figure 2.0, the power supply consists of such components as car battery, power switching device, car ignition switch and alarm switch.

2.2.1 POWER SWITCHING DEVICE

Figure 2.1 shows the schematic circuit of te automatic car theft alarm.

The power-switching device is formed by a relay labeled RLY1 and diode D_2. Its operation is such that the terminal a1 is connected to the car battery and is linked to the car ignition switch (IGN) via terminal

b_2. But as soon as the ignition key is turned to the off position (I_{off}), current flows through diode (D_2) and switch (Sw1) to the power distribution point e. In the process a signal F_1 is fedback to the relay RLY1. Once the relay is energized, it switches from $a_1 - b_2$ to $a_1 - b_1$. As a result of this switching action, the ignition switch is by-passed, since terminal b_1 is connected ahead of diode (D_2). The behaviour of this switching brings to manifestation, one of the two vital characteristics of the alarm system meant to protect the car from vandalization or theft.

2.2.2 CAR IGNITION SWITCH

In figure 2.1, the car ignition switch is designed by IGN and has a diode (D_2) connected to its I_{off} terminal. The ignition switch, which uses a key for its operation has two states; the ON (I_{ON}) and OFF (I_{OFF}). The connection of the ignition switch as it appears to this system is such that the alarm is energized only when the ignition is off (I_{OFF}). It implies therefore that only when the car is off with respect to the ignition that the alarm system is poised to work

2.2.3 ALARM SWITCH

The alarm switch is simply a normal power switch that is found in electrical or electronics circuit. This switch enables the user of the car to put the alarm ON or OFF at anytime of choice. However, in the circuit arrangement, the switch is permanently ON, as long a th alarm is to perform its desired function. The switch is indicated on the schematic circuit diagram of figure 2.1 as SW_1. It is from this unit also that the rest of the alarm circuitry is powered through point e (e_1', e_1'', e_1''').

2.3.1 CIRCUIT ACTUATOR

The circuit actuator is a parallel arrangement of switches, which provide the intelligence signal that is meant to drive the alarm system. For the purpose of illustration, figure 3.3 shows an arrangement of switches in parallel to each other with common input and output terminals connected to a transistor switch.

The required output of terminal C to drive the alarm is logic low (0–voltages level), therefore the circuit arrangement acts as an inverter, such that a closure of any of the switches (logic high), results in a zero output (logic low). In a car, the opening of one of its doors results in the closure of a switch like the ones similar to SW_3, SW_4, SW_5, SW_6 and this design has been done in such a manner that will suit the standard provision for the car.

2.3.2 INHIBITOR NETWORK

The inhibitor network is mainly made up of a monostable multi-vibrator using an integrated circuit timer (555).

The schematic circuit diagram of figure 2.1 shows the 555 timer and its external connections, with Resistors R_1 and Capacitors C_1 connected to pins 7 and 6 as shown.

The input pin 2 is connected to switch SW_2 and to V_{cc} (ei). Pin 3 is the output and is connected to line C via a diode D_3. Switch SW_2 also work in a monostable mode, such that it is only stable in the state. It is such that it needs a push to come on it as soon as the push-force is removed, it returns to its off state.

The timer is actuated by the falling edge of trigger signal from SW_2. When the trigger input signal goes negative, it triggers the output as pins 3 to HIGH for a period determine by the values of resistors R_1 and Capacitor C_2.

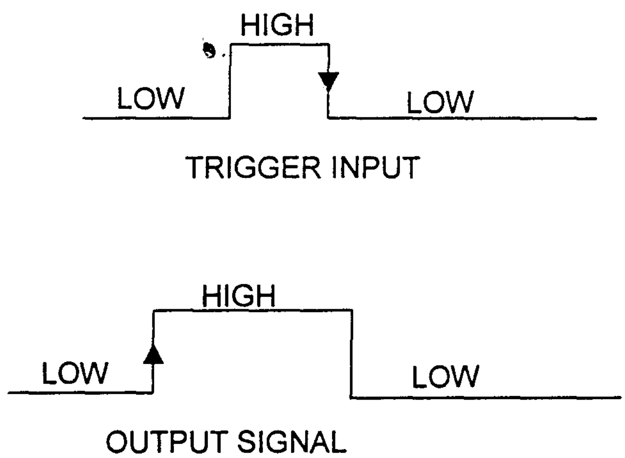

Figure 2.2: Input/Output Signals Of The Monstable (555)

Before the driver or owner of the car disembarks from the car, he needs and initial delay to stall the activation of the alarm. The inhibitor therefore initially prevents the alarm from blowing aloud by providing an alternative signal F_1 through D_3, when the owner himself opens any of the sensitive areas. However, this immunity is obtained only within an allowable period, in seconds as fixed by the design. It is assumed therefore that the car owner is aware of this maximum allowable time delay of the alarm circuit and should act urgently and also in anticipation of its expiration.

2.3.3 DETECTOR CIRCUIT

The detector circuit is an important unit of the alarm where relevant logical decisions are taken for the controlled operation of the entire alarm system. It consists of two similar logic gates, which are referred to as feedback logic and detector logic respectively, for the decision-making.

2.3.4 FEEDBACK LOGIC

This section of the alarm consists of a NAND gate ND_1, with an input F_2 through resistors R_4 and R_5 and another input V_{cc} (e1''') through resistors R_2 and R_1. The output of NAND gate is 4, which is also one of the inputs to ND_2. Once the ignition switch energizes, the alarm circuit the input Vcc (e_1''') HIGH while F_2 remains LOW. These systems of inputs cause the output L_1 to remain HIGH.

Vcc (e_1''')	F_2	L_1
1	0	1
1	1	0

Figure 2.3: Truth Table Of Nd_1

When any of the switches SW_3, SW_4, SW_5 and SW_6 is closed and the alarm begins to blow, it means that the relay RLY2 is energized and therefore F_2 goes HIGH. From the truth table of figure 2.3, it shows that when F_2 and Vcc (e_1''') are both HIGH, the output L_1 goes LOW. The use of the feedback F_2 is to cause ND_1 to go LOW so that any further change in the state of line C_1 cannot stop the alarm from sounding.

2.3.5 DETECTOR LOGIC

In the detector logic, the logic component and the characteristics function is basically the same as described in the feedback logic. This unit also has a NAND gate ND_2 with two input and one output. One of the inputs shown at line C through resistors R_{13} and R_{14} in figure 2.1 comes from the circuit actuator. While the second input L_1 comes from the output of the feedback logic gate ND_1.

C	L_1	L_2
1	0	1
0	1	1
0	0	1
1	1	0

Figure 2.4: Truth Table Of Nd_2

From figure 2.4, it can be seen that the output L_2 goes LOW only when the two inputs C and L_1 are both HIGH. The logic combination C(1) and L_1(0) represents the condition when a switch (door) is re-closed after having been opened. C(0) and L_1(1) represents the initial

ON state of the alarm when a switch (door) is opened. Another combination C(0) and L_1(0) shows a situation when a switch (door) is closed and the relay RLY2 is energized to provide the feedback signal F_2 for ND_1. In essence, the output L_2 of ND_2 is used to drive the relay RLKY2 through a transistor Q_1.

2.3.6 TIME DELAY

The function of either monostable or astable flip-flops are available in integrated circuits known as timers. External components have to be provided to determine the desired times which can be selected from a few microseconds to several minutes. Other external connections are used to select free running (a stable) or one-shot (monostable) oscillator modes and an additional input may be provided to allow voltage control of the time periods.

A combination of resistors and capacitors also yield an initial timing effect whose output does not oscillate, provided the magnitudes of th voltage of the input are steadily maintained. The characteristics of this simple resistor and capacitor combination is suitable for the time delay objective of this security system and therefore it is used.

Figure 2.1 shows a parallel connection of resistor R_6 and capacitor C_2 as the time delay component. Suitable values of R_6 and C_2 are selected to give timing period of about 3 seconds.

2.3.7 SWITCHING RELAY FOR DRIVER NETWORK

With an aid of a switching transistor Q_1 with biasing resistors R_7 and R_8, couple to a relay RLY2, the relay is energized. By the delayed incident signal L_2, the transistor is switched on and therefore the relay can function. Power is then conducted from Vcc (ei) through the relay to the driver network and also provides one of the inputs F_2 to the feedback logic gate.

2.3.8 DRIVER NETWORK

This segment of the theft alarm circuit consists of an astable multi-vibrator and a Darlington pair.

This network is very important because it produces the needed oscillatory signals, which drive the output transducer (speaker).

2.4 ASTABLE MULTI-VIBRATOR

Astable Multi-vibrators are free running rectangular wave generators. They may be made up of transistors, logic gates or operational amplifiers, each having applications in different circumstances. Alternatively, integrated circuit timers like the 555 may be connected in an astable mode.

Figure 2.1 of the schematic circuit diagram shows a 555 timer with two resistors R_9 and R_{10} and capacitor C_3 connected to pin 7 and pin 6. A voltage V_{10} at pins 4 and 8 activates he multi-vibrator, while output is obtained at pin 3.

2.5 DARLINGTON PAIR

The Darlington pair is an arrangement where the emitter of one transistor Q_2 is directly connected to the base of another transistor Q_3 as shown in figure 2.1.

The emitter current from Q_2 is the base current for the second transistor Q_3. Darlington pair offers enough current gain for the speaker.

The speaker transduces the signal from the astable multi-vibrator to audible sound

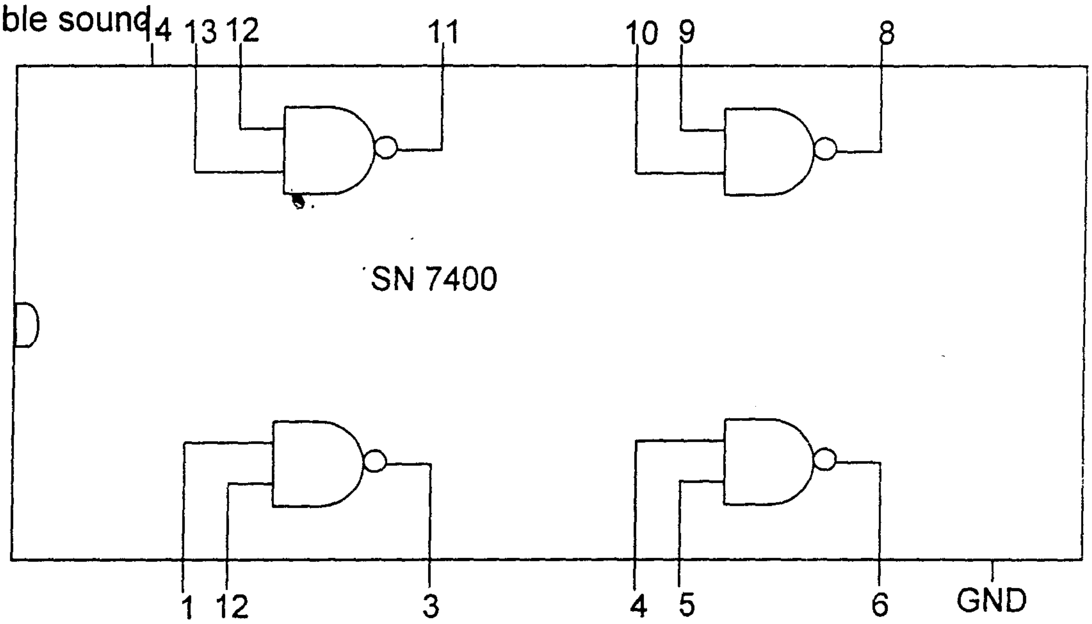

Figure 2.5: The Pin Connection of SN7400 Integrated Circuit.

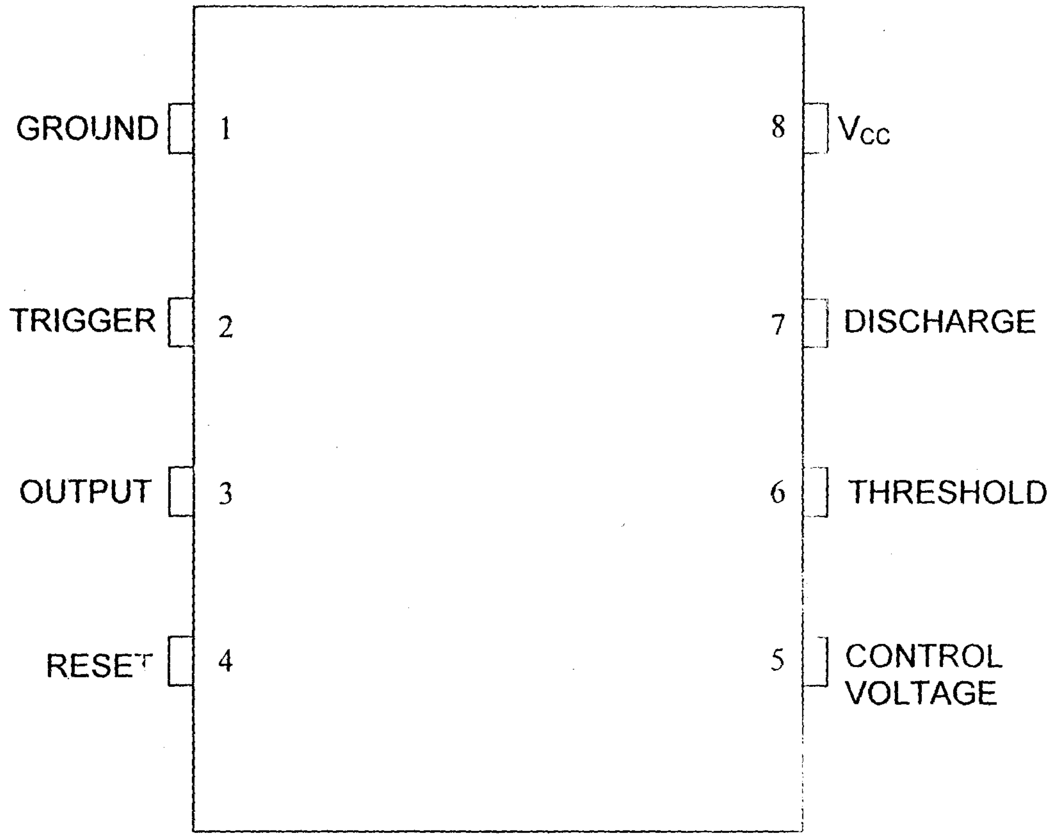

Figure 2.6: Pin Connection of NE555 N Timer

CHAPTER THREE

3.0 DESIGN AND ANALYSIS

3.1 INTRODUCTION

In this chapter, the design and analysis of various stages are carried out. The chapter also provides an explicit and comprehensive analysis, assumptions and specification adopted in designing the system. The simple arrangement and design strategies adcpted will make troubleshooting easy. The values of all the components used in each stage are compiled at the end of chapter four for quick reference.

3.2.1 POWER SWITCHING DEVICE

Switching devices are those devices that provides ON and OFF states at their outputs depending on certain input conditions. Some switching devices allow or provide the opportunity of an alternative source of power supply. Power switching devices are made of metallic and semiconductor materials and they provide utility options, depending on the objectives of such a device in an electronic or electrical circuit.

Examples like Thyristor, bipolar junction transistors and relays are very common in circuits.

Figure 3.0 shows a schematic representation of the relay used in the circuit of the alarm.

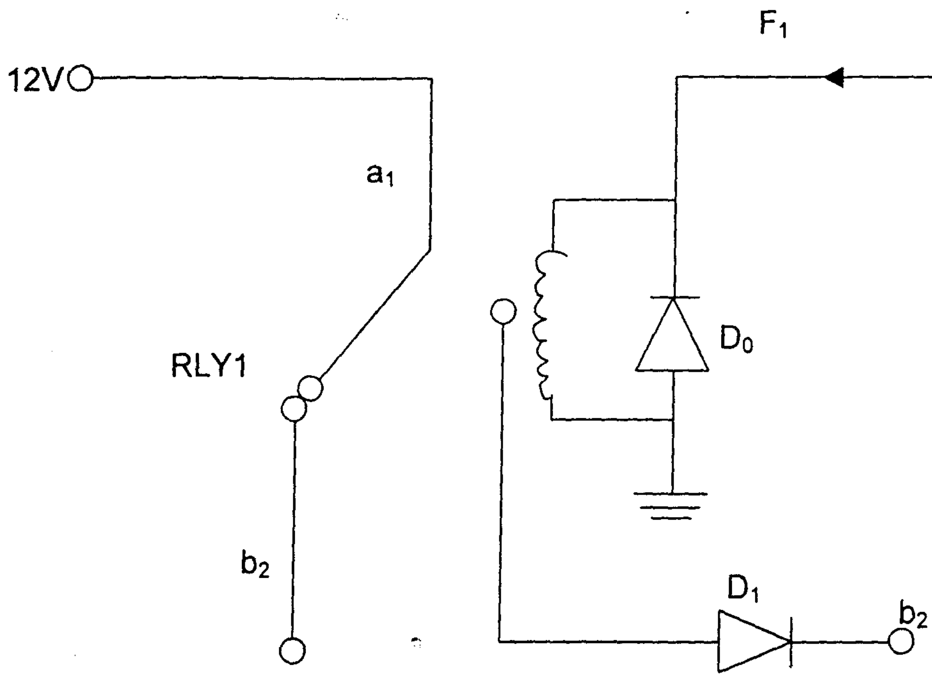

Figure 3.0: Power Switching Devices Circuit

3.2.2 CAR IGNITION SWITCH

The car ignition switch is an enabling circuit devices that provides the ON and OFF alternatives for the owner of the car. Without this switch, is may not be possible to start the car and move it from rest. Ignition switches are operated by keys, which are modeled to suit the design of a slot on the acceptor unit in the circuit or simply button, which can be pressed in and out. It may also be made of a slide system, which can be pushed vertically or horizontally, depending on its position and orientation in the ignition circuit. Figure 3.1 represents the ignition switch. The connection of the ignition switch as it applies to the design is such that the alarm system is on only when the car is off.

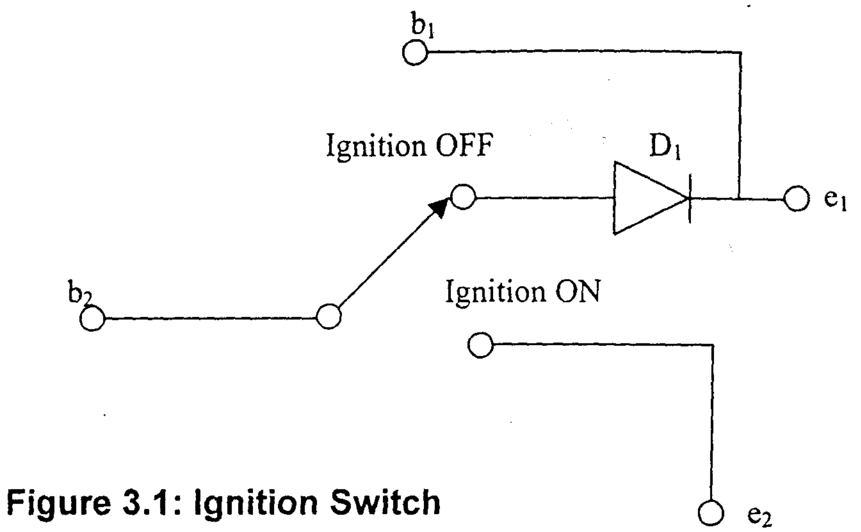

Figure 3.1: Ignition Switch

3.2.3 ALARM SWITCH

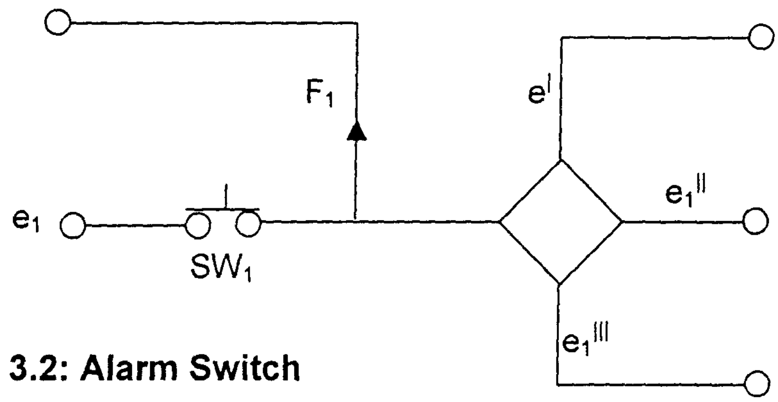

Figure 3.2: Alarm Switch

The alarm switch denoted by SW_1 in figure 3.2 is a normal switch that is common to electrical and electronic designs. It enables the user of the car to put the alarm ON and OFF at anytime of choice. The rest of the alarm circuitry is powered from this unit vis-à-vis terminals e_1^{I}, e_1^{II} and e_1^{III}.

3.3 CIRCUIT ACTUATOR

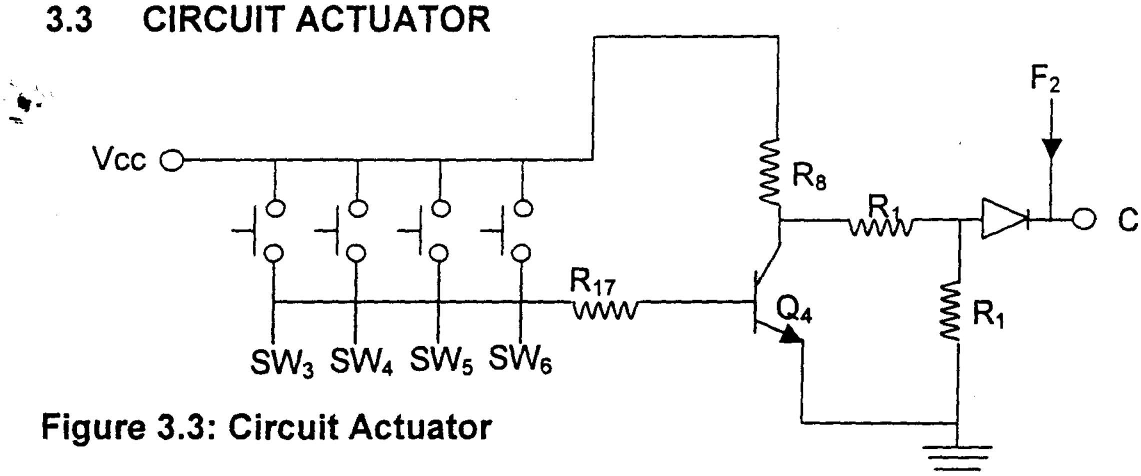

Figure 3.3: Circuit Actuator

To find the correct biasing resistance to Q_4, the arrangement in figure 3.3 can be modeled as shown in figure 3.31

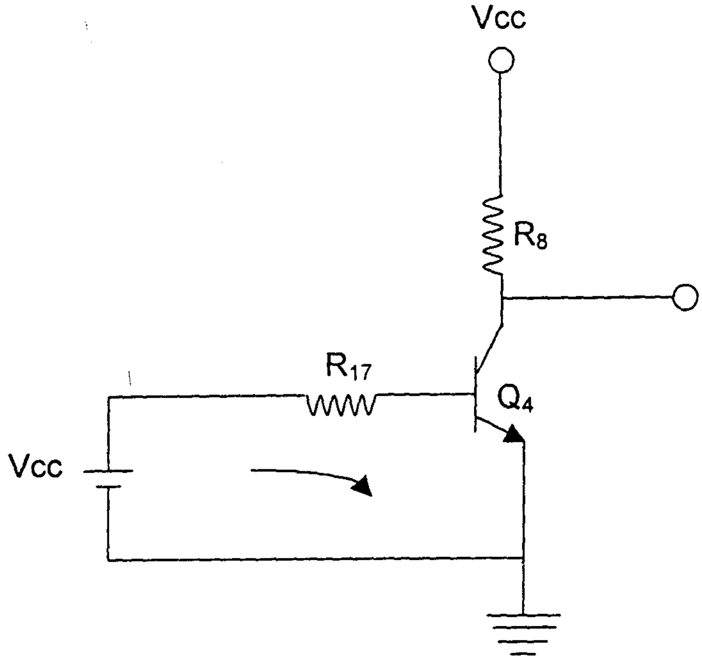

Figure 3.3.1

The loop voltage shown by the arc in figure 3.31 can be expressed as $Vcc - I_B R_{17} - V_{BE} = 0$ 27

Using transistor as a switch implies operating it in the saturation mode.

The relation $\beta I_B \geq Ic$ therefore holds.

Let $R_8 = 100\Omega$

$\therefore Ic = \frac{Vcc}{R_8}$

$= \frac{12}{100}$

$= 0.12A$

for $\beta = 50$

$50\ I_B = \geq 0.12A$

$I_B \geq \frac{0.12A}{50}$

$\geq 0.0024A$

$I_B = \geq 2.4mA$

$\therefore R_B = \frac{Vcc - V_{BE}}{I_B}$

Where

$Vcc = 12V$, $V_{BE} = 0.8$

$I_B = 1.24mA$

$R_B = \frac{12 - 0.8}{2.4 \times 10^{-3}}$

$= \frac{11.2 \times 10^3}{2.4}$

$= 4.6k \ = 5k$

From the actuator circuit of figure 3.3, the input signal voltage V_{ei} is 11.3V instead of exactly 12V. This voltage takes into consideration the 0.7V drop across the unidirectional diodes D_1 and D_2 depending on the supply terminals of either b_1 or b_2 at a given time.

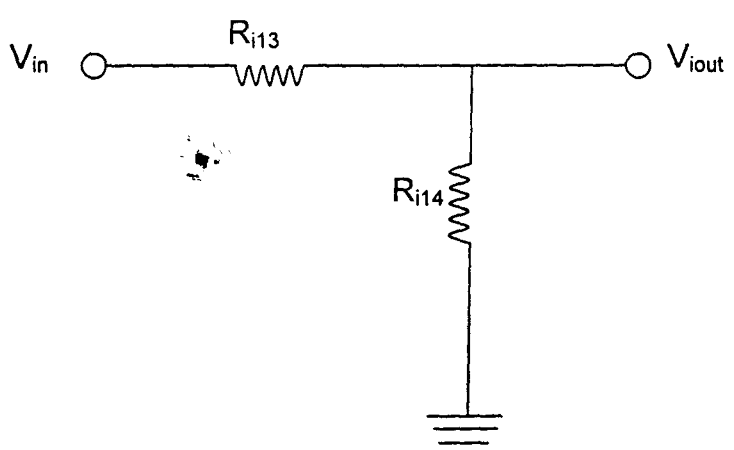

Figure 3.3.2

Let $Ve_1'' = V_{in}$

The required output V_c in figure 3.3 is 5V, hence diode D_4 is again considered in computing the output of the voltage divider R_{13}/R_{14}

$$V_{out} = V_{in} \cdot \frac{R_{14}}{R_{14} + R_{13}} \qquad (1)$$

For $V_{in} = 11.3V$

$V_{out} = 5.7V$

Let $R_{14} = 10k$

Hence $5.7 = \dfrac{11.3 \times 10}{10 + R_{13}}$

$57 + 5.7R_{13} = 113 \qquad (2)$

$R_{13} = \dfrac{113 - 57}{5.7} = 9.83k\ (10k)$

3.4 INHIBITOR CIRCIUT

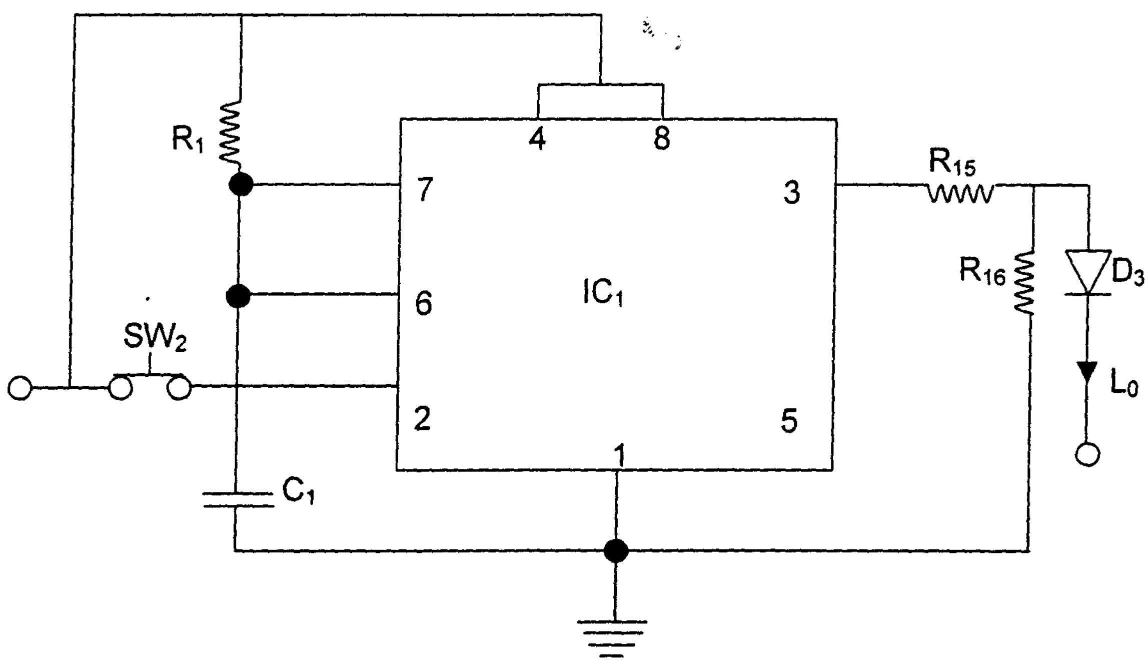

Figure 3.4: Inhibitor Circuit

The inhibitor circuit triggers when a negative going pulse applied to pin 2 of figure 3.4 reaches 1/3Vcc. The trigger pulse must be narrower than the desired output pulse. Once triggered, the output remains set until the charge time of the circuit configuration has elapsed, even if triggered again during this period.

3.4.1 DESIGN CONSIDERATION

Timing of the output of the inhibitor network is given by the relationship, $td = T = 1.1C_1R_1$ (td = time delay) for time delay of 10 seconds

$\Rightarrow 10 = 1.1C_1R_1 \ldots. (3)$

let $C_1 = 47\mu f$

$10 = 1.1 \times 47 \times 10^{-6} \times R_1$

$$\frac{10}{1.1 \times 47 \times 10^{-6}} = R_1$$

$$R_1 = \frac{10 \times 10^6}{1.1 \times 47}$$

$$= \frac{10^4 \times 10^3}{51.7}$$

$$= 193 \times 10^3$$

$R_1 = 193k\ (200k)$

To obtain the required 5v input to the logic gate ND_2 ($1/4IC_3$), a voltage divider in figure 4.1 is used.

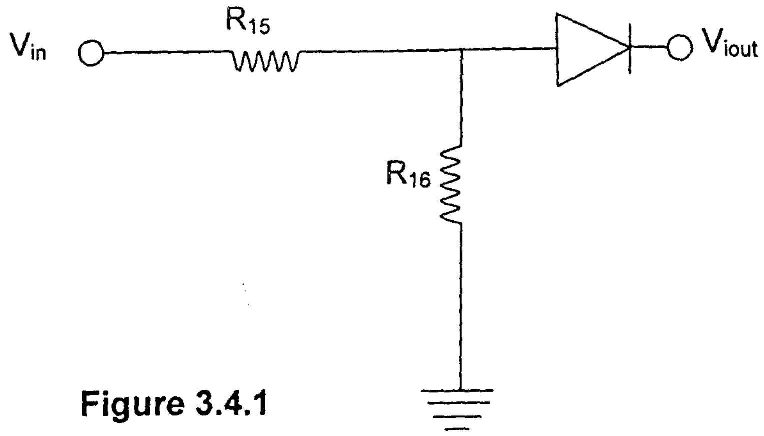

Figure 3.4.1

The output of the 555 timer (IC_1) is (Vcc – 1.7)

$\therefore V_{in} = V_{cc} - 17$ (4)

$= 11.3 - 1.7$

$= 9.6V$

Required output V_{out} is 5.7V

$$V_{out} = V_{in} \frac{R_{10}}{R_{15} + R_{16}} \qquad (5)$$

$$5.7 = 9.6 \frac{R_{10}}{R_{15} + R_{16}}$$

Let R_{16} = 10k

$$\Rightarrow 5.7 = \frac{9.6x10}{10 + R_{15}}$$

$57 + 57R_{15} = 96$

$$R_{15} = \frac{96 - 57}{5.7}$$

R_{15} = 6.8k

3.5 DETECTOR CIRCUIT

The detector circuit is an important unit of the alarm where relevant logical decisions are taken for the controlled operation of the entire alarm system. It consists of two similar logic gates contained in

IC_3, they are referred to as feedback logic and detector logic respectively.

3.5.1 FEEDBACK LOGIC

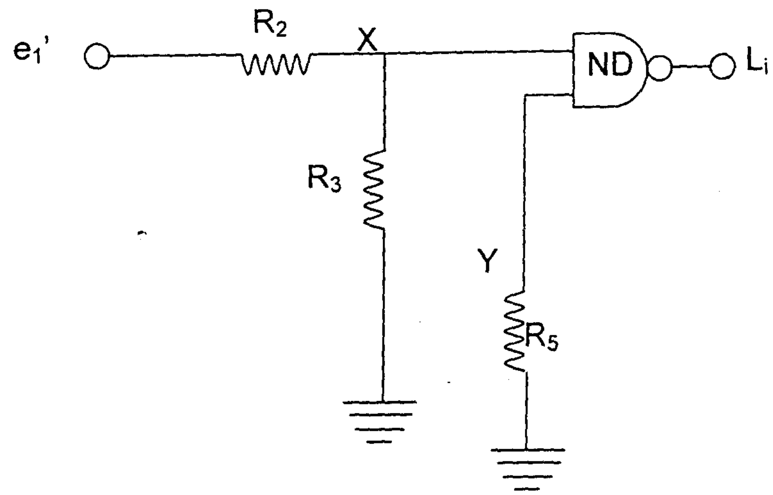

Figure 3.5: Feedback Logic

Let the dual inputs to the logic gate ND_1 ($1/4IC_3$) be X and Y as denoted in figure 5.0 at the two modes. The needed input to the logic gate are 5V respectively. And the voltage at terminals F_2 and e_1''' are also the same. Therefore resistor pairs R_2/R_3 and R_4/R_5 will be the same. Considering node X

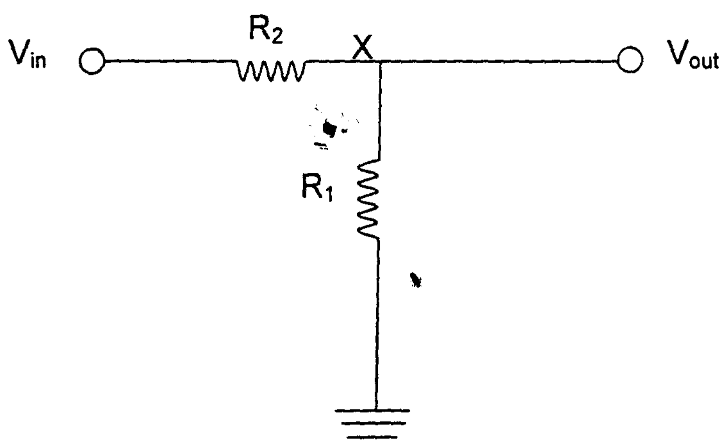

Figure 3.5.1

$$V_{out} = V_X \frac{V_{in1} R_3}{R_3 + R_2} \quad (6) \quad (V_{in} = V_{e1''})$$

Where

$V_{out} = 5V$, $V_{in} = 11.3V$

Let $R_3 = 10k$

$$\Rightarrow 5 = 11.3x \frac{10}{10 + R_2}$$

$50 + 5R_2 = 113$

$$R_2 = \frac{113 - 50}{5}$$

$R_2 = 12.6k$ (12k)

Hence $R_4 = 12.6k$ (12k)

$R_5 = 10k$ (10k)

For node Y, since the resistor pairs have been established to be the same.

3.5.2 DETECTOR LOGIC

The detector logic components of this circuit have no external components attached to it, which would require some analysis. Inputs to it are obtained directly from ND_1 and IC_1 via D_3.

3.6 TIME DELAY

Time delay as it is called is a component of the alarm system, which offers some impedance to the flow of signals in the remaining part of the circuit after it. The delay is constrained by a specified design period using selected components values and their configuration or arrangement. Details have been discussed in chapter two.

3.6.1 DESIGN CONSIDERATION

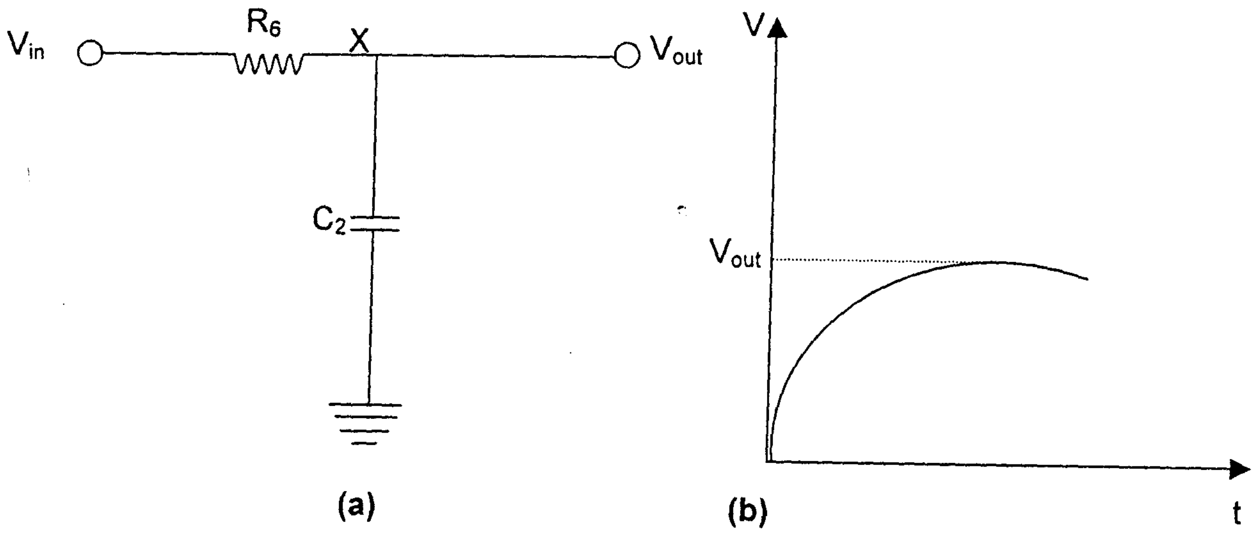

Figure 3.6: Time Delay Circuit

From figure 3.10,

$$\Rightarrow \frac{V_{in} - V_{out}}{R_6} = C_2 \frac{d}{dt} V_{out} \qquad (7)$$

$$V_{in} - V_{out} = R_6 C_2 \frac{d}{dt} V_{out}$$

$V_{in}(s) - V_{out}(s) = SR_6C_2V_{out}(s)$ *[Laplace Transform]*

$V_{in}(s) \quad = SR_6C_2V_{out}(s) + V_{out}(s)$

$\qquad = (SR_6C_2 + 1)V_{out}(s)$

$$\frac{V_{out}(s)}{V_{in}} = \frac{1}{SR_6C_2 + 1} \text{..........}(8)$$

From input voltage $V_{in}(s) = \frac{V_{in}}{s}$ (a step function)

$$\Rightarrow V_{out}(s) = V_{in}\left[\frac{1}{s}.\frac{1}{SR_6C_2+1}\right]$$

$$V_{out}(s) = \frac{V_{in}}{SR_6C_2}\left[\frac{1}{s+\frac{1}{R_6}C_2}\right] \qquad (9)$$

By partial fraction method,

$$\frac{1}{s}\left[\frac{1}{s+\frac{1}{R_6C_2}}\right] = \frac{A}{s}+\left[\frac{B}{s+\frac{1}{R_6C_2}}\right]$$

$$\Rightarrow 1 = A(s+1/R_6C_2)+BS \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$$A = A = \frac{1}{s+\frac{1}{R_6C_2}}/s=0=R_6C_2$$

$$B = \frac{1}{s}/s = -1/R_6C_2 = -R_6C_2$$

$$\therefore V_{out}(s) = \frac{V_{in}}{R_6C_2}\left[\frac{R_6C_2}{s}-\frac{R_6C_2}{s+\frac{1}{R_6C_2}}\right]$$

$$\frac{V_{in}}{R_6C_2}R_6C_2\left[\frac{1}{s}-1/2+\frac{1}{R_6C_2}\right]$$

$$= V_{in}\left[\frac{1}{s}-1/s+\frac{1}{R_6C_2}\right]$$

$$V_{out}(t) = V_{in}(t)\left[1-e^{\frac{-1}{R_6C_2}t}\right] \text{ (inverse Laplace Transform)}$$

$$V_{out}(t) = V_{in}(t)\left[1-e^{\frac{-1}{R_6C_2}t}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Expressing equation (11) in terms of the delay 't',

$$\Rightarrow \frac{V_{out}(t)}{V_{in}(t)} = 1 - e^{\frac{-1}{R_6C_2}t}$$

$$e^{\frac{-1}{R_6C_2}t} = 1 - \frac{V_{out}(t)}{V_{in}(t)}$$

$$-\frac{t}{R_6C_2} = \ln\left[1 - \frac{V_{out}(t)}{V_{in}(t)}\right]$$

delay $t = R_6C_2 \ln\left[1 - \frac{V_{out}(t)}{V_{in}(t)}\right]$ ....(12)

For $V_{in}(t)$ = 5V and time delay (td) t = 3 seconds

Assuming $V_{out}(t)$ = 3V

∴ the ratio of $V_{out}(t)$ to $V_{in}(t)$ = 3/5 = 0.6

$\Rightarrow V_{out}(t) = 0.6V_{in}(t)$ .... (13)

Hence $3 = R_6C_2 in\left[1 - \frac{0.6V_{in}(t)}{V_{in}(t)}\right]$

$3 = -R_6C_2\ln 0.4$ .... (13)

Let C_4 = 47μf (47μf)

From equation (13),

$3 = -R_6 \times 47 \times 10^{-6} ln 0.4$

$$R_6 = \frac{3}{47 \times 10^{-6} \times \ln 0.96}$$

$$= +\frac{3 \times 10^6}{43.07}$$

R_6 = 69.67k (68k)

3.7 SWITCHING RELAY

The switching relay has preceding translator switch Q_1, which has biasing resistors R_7 and R_8 as shown in figure 7.0. The relay RLY_2 is energized by V_{cc}(ei) when the transistor switch is biased by an incident signal L_2. Power is then conducted from Vcc(ei) through the relay RLY_2 to the driver network and also provides one of the inputs F_2 to the feedback logic gate.

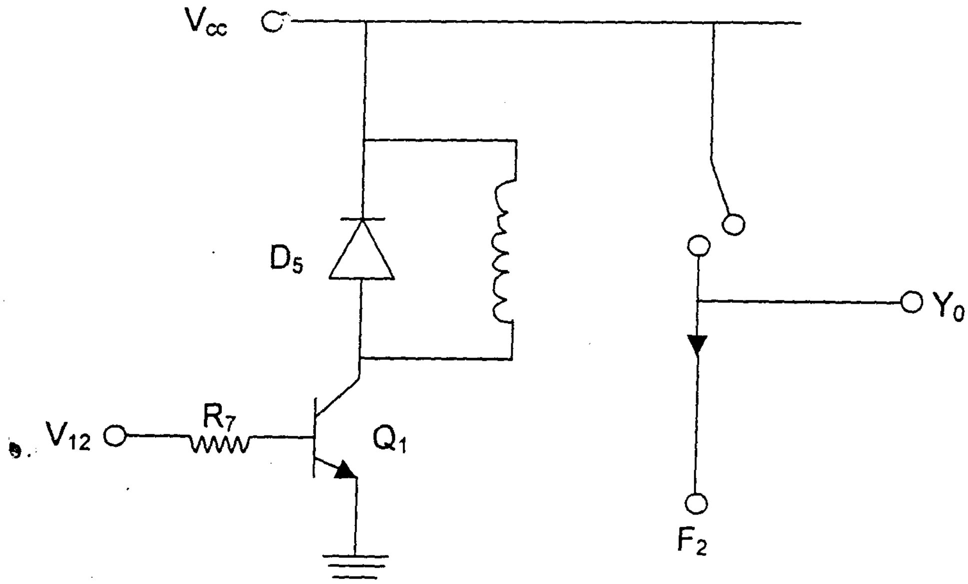

Figure 3.7: Switching Relay

3.7.1 DESIGN CONSIDERATION

To find the correct biasing resistance to Q_1, the figure 3.7.1 using the Venin's Theorem.

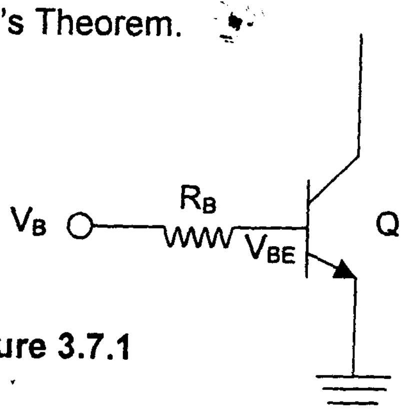

Figure 3.7.1

The loop voltage shown by the arc in figure 3.7.1 can be expressed as $V_B - I_B R_B - V_{BE} = 0$ .... (15)

Using transistor as a switch implies operating it in the saturation mode.

The relationship $\beta I_B \geq I_C$ (16) therefore holds. Where β = current gain of transistor I_B and I_C = base and collector current respectively.

Relay resistance = 419Ω

Vcc is gain as (12 – 0.7)V = 11.3V

For $I_C = \frac{V_{CC}}{Rr}$ (Rr = Resistance of relay)

$$\Rightarrow I_C = \frac{11.3}{419} = 0.02696\text{A} = 26.96\text{mA}$$

For β = 50,

$50 I_B \geq 27$mA (equation (16))

$$I_B \geq \frac{27}{50} mA$$

$I_B \geq 0.54$mA

From $V_B - I_B R_B - V_{BE} = 0$ (equation (15))

$$R_B = \frac{V_B - V_{BE}}{I_B} \quad \text{.....................................(17)}$$

Where V_B = 3V, V_{BE} = 0.7, I_B = 1mA

$$\Rightarrow R_7 = R_B = \frac{3-0.7}{1\times10^{-3}}$$

$= 2.3 \times 10^3$

= 2.3k (2.3k)

3.8 DRIVER NETWORK

This component of the alarm circuit consists of an astable multi-vibrator and a Darlington pair. This network is very important because it produces the needed harmonics, which drive the output transducer (speaker).

3.8.1 ASTABLE MULTI-VIBRATOR

Figure 8 shows the 555 timer (IC2) with its external configuration, which serve as the astable multi-vibrator. The following sub-figures (8.11) and (8.12) illustrate both the charging and discharging time for 555 timer astable and its output waveform respectively.

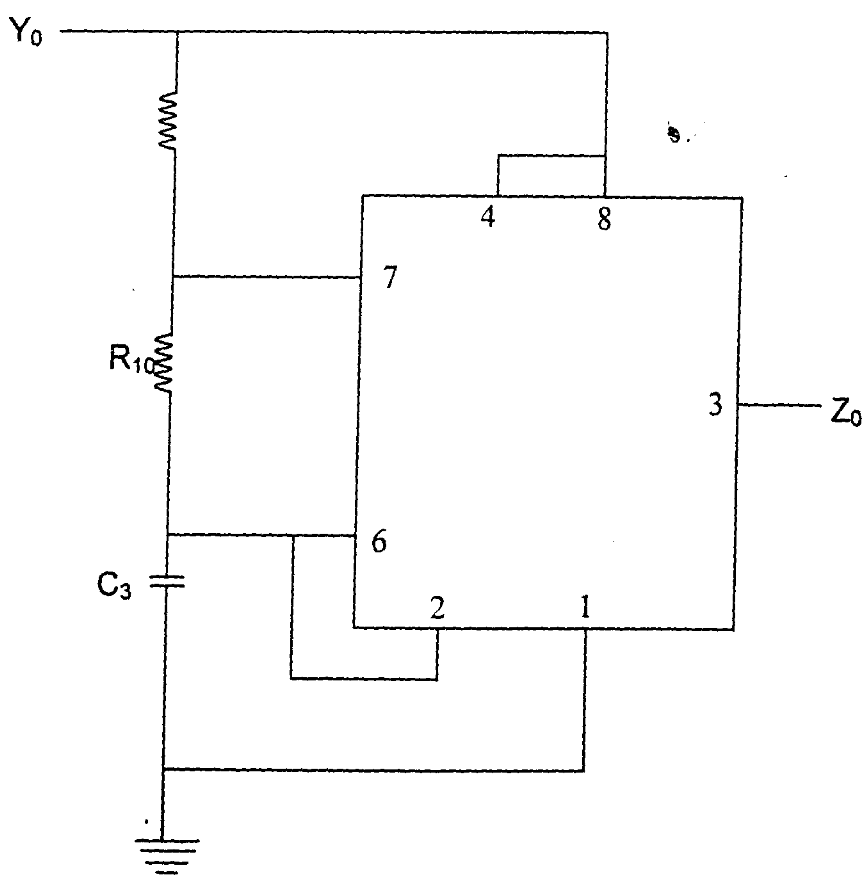

Figure 3.8: Astable Multi-Vibrator

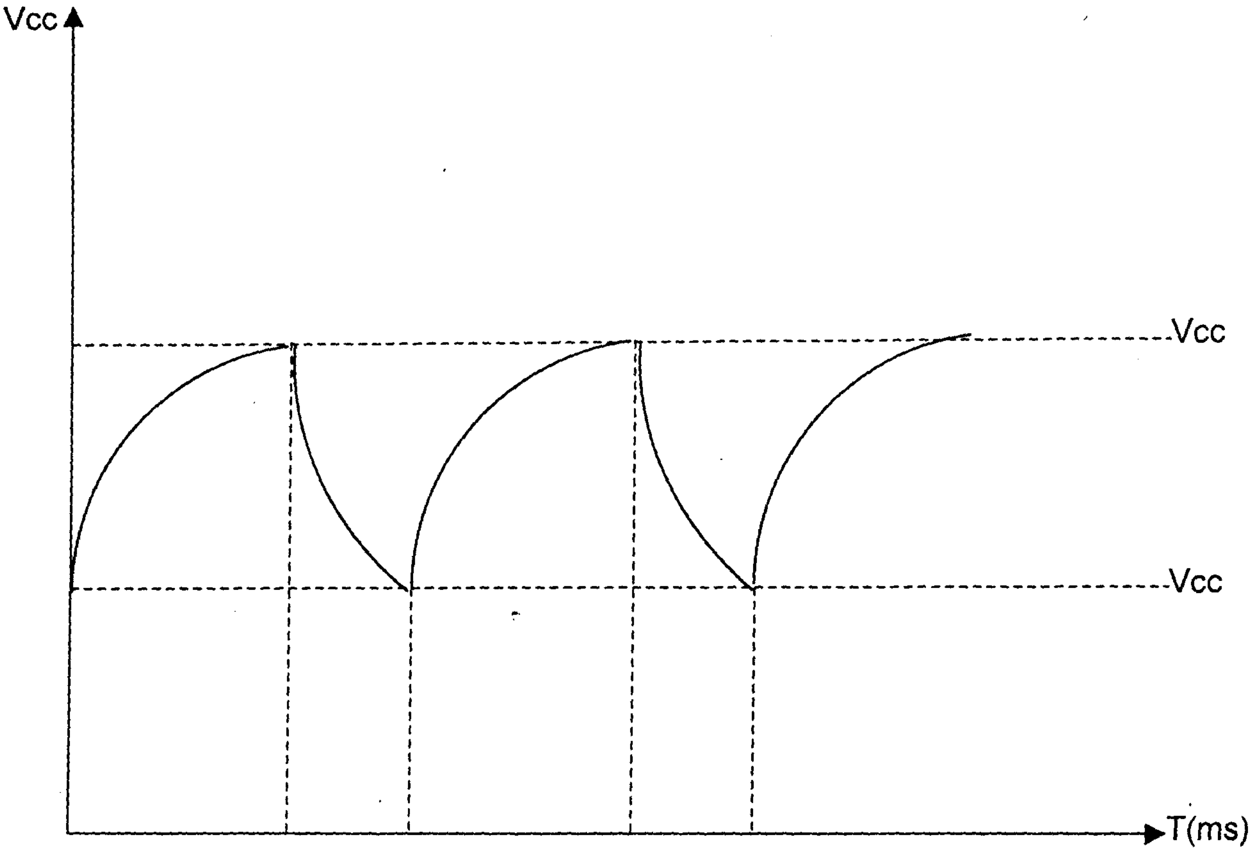

Figure 3.9(A): Charging And Discharging Time For 555 Timer Astable

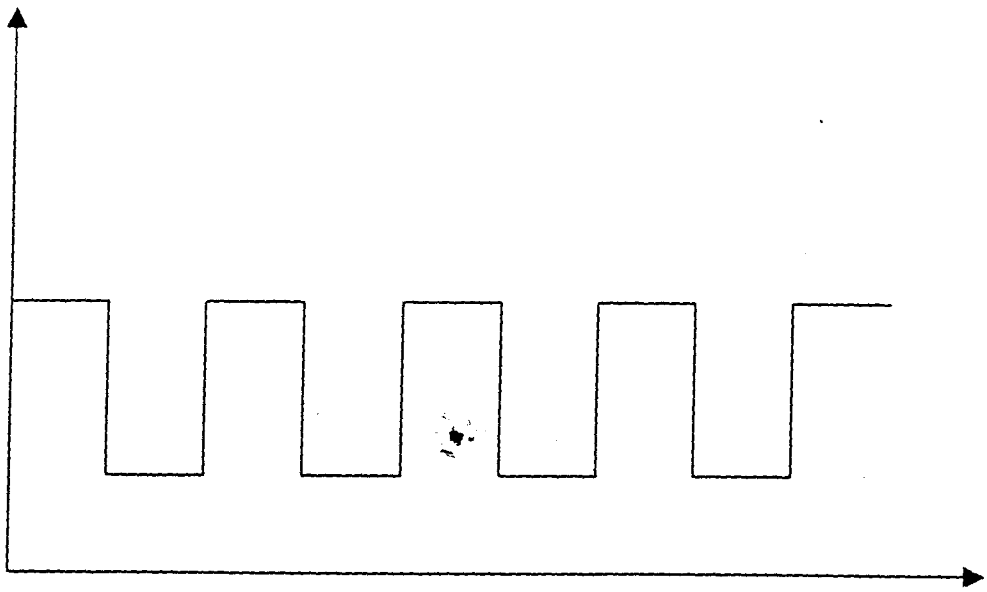

Figure 3.9(B): Waveform Of A 555 Timer Astable

DESIGN CONSIDERATION

Let the frequency of oscillation = 1khz

From $F = \frac{1}{T}$

Total period $T = \frac{1}{F}$

$= \frac{1}{1000}$

$= 10^{-3}$sec

Taking a mark/space ratio of 3:1

T_1 (mark or charge time = ¼ o T

T_2 (space of discharge time) = ¼ of T

$T_1 = ¾ \times 10^{-3}$

$= 0.75 \times 10^{-3}$sec

$T_2 = ¼ \times 10^{-3}$

$= 0.25 \times 10^{-3}$

Hence from $T_1 = 0.6993 (R_9 + R_{10})C_3$ (mark time) (19)

Let $C_3 = 0.01\mu fR_{10} = 51k$

$\Rightarrow 0.75 \times 10^{-3} = 0.693 (R_6 + 51000) \times 0.01 \times 10^{-6}$

$(R_9 + 51000)0.00069 \times 10^{-6} = 0.75 \times 10^{-3}$

$R_9 + 51000 = 0.75 \times 10^{-3}$

$0.693 \ \ 10^{-3}$

$R_9 = 1.08 \times 105 - 51000$

$= 108000 - 561000 \qquad = 57000$

$R_9 = 57k$ (56k)

3.8.2 DARLINGTON PAIR

The Darlington pair is an arrangement where the emitter of one transistor Q_2 is directly connected to the base of another transistor Q_3 as shown in figure 3.10. Darlington pair offers enough current gain for the speaker.

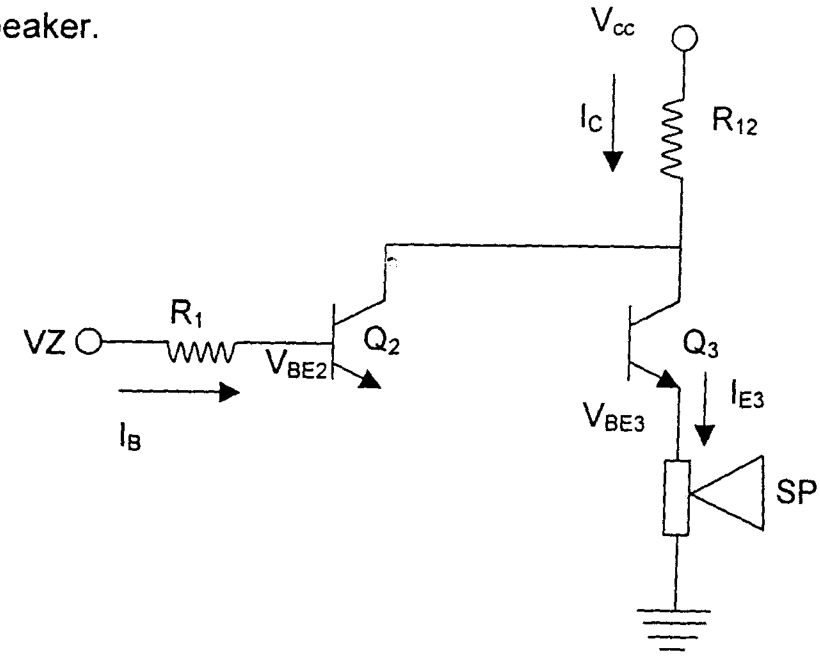

Figure 3.10: Darlington Pai And Speaker

DESIGN CONSIDERATION

Specification of speaker (SP); 2 watts, 16ohms

$P = I_0^2 R_L$ (20) (for current drawn by SP R_L = SP resistance, P=power)

$$I_0 = \sqrt{\frac{P}{R_L}} \quad \text{........................} \quad (21)$$

$$\Rightarrow I_0 = \sqrt{\frac{2}{16}} = 0.354A(r.m.s.)$$

$0.354 \times \sqrt{2} \quad = 0.5A$

The Darlington pair is expected therefore to produce an I_{E3} of 0.5A

$$\Rightarrow I_{E3} \approx I_C = 0.5A$$

From figure 3.10

$V_{cc} = I_C R_{12} + I_C R_{SP}$ (12) RSP = Resistance of SP)

Hence, $R_{12} = \frac{V_{CC} - I_C R_{SP}}{I_C}$

Where $V_{CC} = 11.3V$, $R_{SP} = 16\Omega$, $I_C = 0.5A$

$\frac{11.3 - 0.5 \times 6}{0.5}$

$R_{12} = \frac{3.3}{0.5}$

$R_{12} = 6.6\Omega\ (6.8\Omega)$

$$V_{SP} = \sqrt{P_{SP} R_{SP}} \qquad (23) \left[P_{SP} = \frac{V_{SP}}{R_{SP}} \right]$$

$V_{SP} = \sqrt{2 \times 16}$ ($P_{SP} = 2$ watts, $R_{SP} = 16\Omega$)

$= 5.66V$

Also from figure 9.0

$V_Z = 2V_{BE} + V_{SP}$ (24) ($2V_{BE} = V_{BE2} + V_{BE3}$, $V_{BE2} = V_{BE3}$)

$V_Z = 2 \times 0.7 + 5.66$

$= 7.06V$

For Darlington Pair,

$I_C \leq I_B \beta^2$ .... (25)

$$I_B \geq \frac{I_C}{\beta^2} = \frac{0.5}{50^2} = 2 \times 10^{-4} A$$

$V_Z = I_B R_{11}$ .... (26)

$$R_{11} = \frac{V_Z}{I_B} = \frac{7.06}{2 \times 10^{-4}} = 35.3k \quad (36)$$

CHAPTER FOUR

4.0 CONSTRUCTION AND TESTING ON BREAD BOARD

4.1 INTRODUCTION

During construction and testing on breadboard, many upsets were encountered. Though the initial circuit of the alarm seemed feasible, it was however not completely realized due to the non-ideal and probably deviant characteristic behavior of general solid-state electronics components, when they are connected in a circuit. Therefore adjustment, additions and subtraction were effected on certain areas that needed improvement.

4.2 POWER SWITCHING DEVICE

The design arrangement of the switching device in figure 3.0 could not work as desired, when ever the relay was powered from the source, and instead of the relay to make at once, the common terminal would be oscillating between the normally closed and the normally open terminals. After a close examination, it was notice that because of the relay was supplied from terminal b2, before terminal a1 would make terminal b1, somewhere half way between b2 and b1 the coil is de-energized and terminal a1 falls back to b2. since a1 is the main supply, when it reconnects to b2 the coil is re-energized, a1 tends toward b1 and half way it falls back again.

The overall consequence of this effect is the r4elay could not make permanently. The only solution immediately available was to supply the coil from the source through a thyrsistor (SCR) as in figure 4.1.

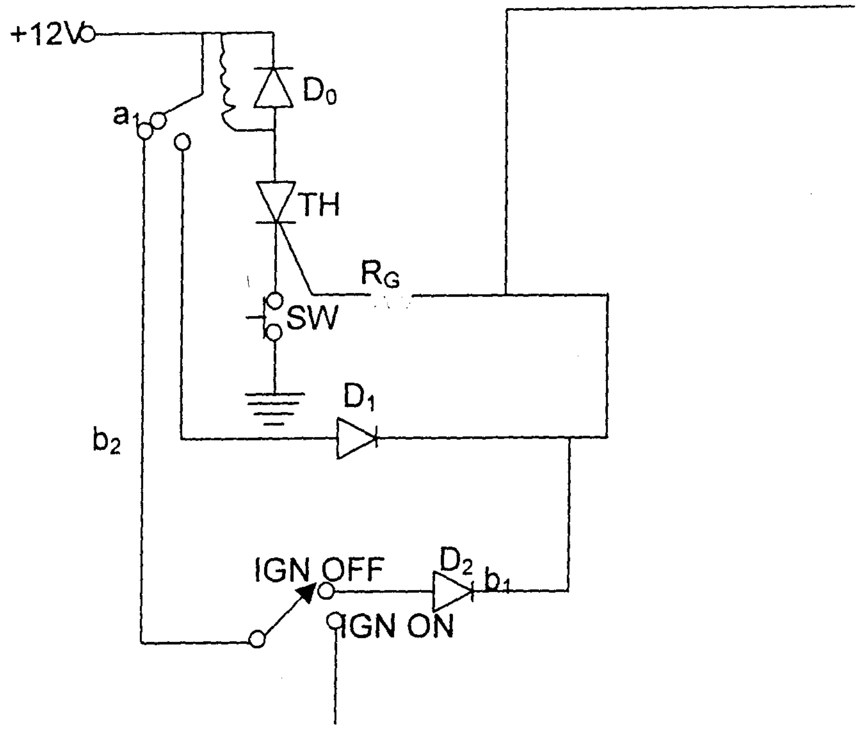

Figure 4.1: Power Switching Device

4.3 DETECTOR CIRCUIT

The detector logic comprises the two NAND gates circuit as visible in figure 3.5, a single chip integrated circuit (IC3) known as 7400 is utilized to achieved this circuit. The logic levels for this IC are OV and +5V for low and high respectively.

However, when the IC was connected in the circuit via a Vcc of +5V, the unfed input pins of the used gates where measured to be at a voltage level of +1.5v asOppposede to 0v. the grouse of this behavior is that TTL chip considers a voltage range of +1.5 and+5v as a logic High.

To overcome this challenge several auxiliary connections were made to change the 1.5v level to a 0v level. Finally, success came sprawling when the circuit in figure 4.2 was connected to several auxiliary connections were made to change the 1.5v level to a 0v level. Finally, success came sparkling when the circuit in figure was connected to the various input of the used gates. Therefore the voltage level achieved for the logic low was 0.5volts.

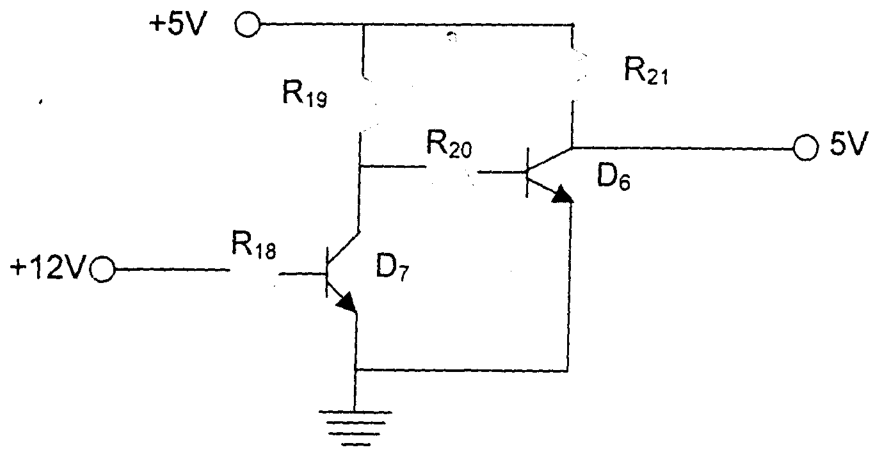

Figure 4.2: Logic Input Stabilizer

4.4 INHIBITOR NETWORK

The alarm circuit shown in figure 2.1, which was used for analysis in chapter three contains a 555- timer chip with external configuration to give a mono-stable switch. When it was connected on breadboard as analysis, it did not give the anticipated output. The 555-timer chip IC1 was therefore replaced with an RC-transistor network as clearly shown in figure 4.3

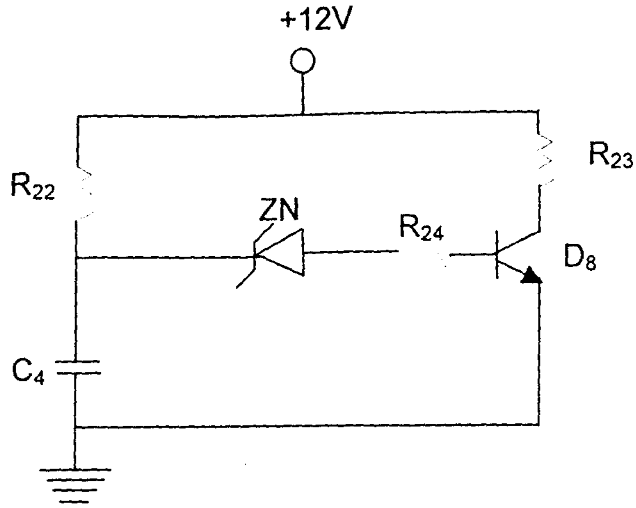

Figure 4.3: Inhibitor Network

As the expectation was from the 555 timer mono-stable, the resistor-capacitor-transistor network is also suppose to produce an output signal of up to Vcc for a period of 10 seconds after which the output goes low.

4.5 CONSTRUCTION ON VERO BOARD

Construction on Vero board generally entails transferring all the components of the entire automatic car theft alarm system used in construction on the breadboard, to Vero board. The components are mounted in their respective circuit positions and then soldered rigidly unto the Vero board. Continuous strip Vero board was used all components mounted on it were linked where necessary and the original continuous lines of the Vero board were "cut" when necessary to ensure discontinuity manual soldering processes were carried out using soldering iron. Some amount of soldering lead was usually applied to the top of the soldering iron to create the bridge effect.

4.6 PACKING

Packing is the assembling of the motherboard switches and other conveniences of the alarm system in a desired orientation in a casing.

The mode of casing and the material selected for it is a question, which depends on the designer's choice and cost. Initial dimensioning of the parts for the construction of the casing, boring or drilling of small diameter slots for switches and power source mainly, were carried out. A hole was also drilled on the back face of the casing was also extension of the actuator circuit to the doors switch of the car

For proper finishing and durability, the Vero board was screwed tightly to the floor of the casing. He overall essence of this well orchestrated packing procedure is for cease of maintenance, stability and repair of the system.

4.7 TESTING

The designed constructed and packed project was "test run" several times, varying the various input parameters. It was discovered at the end of the "test run" that project is highly efficient and reliable. The system proved to be sensitive to its designed input parameters like the opening of the door etc.

The final complete circuit diagram of the 'Automatic Car Theft Alarm" arrived at after construction on breadboard is shown in figure 4.4

CHAPTER FIVE

5.1 INTRODUCTION

The objectives of this chapter is to give a brief and genuine summary of the entire project especially all that pertains to the achieved objective of the construction aspect. The success of the project paved way for improvement on the work that has already been done. This particular project will help to improve the reliability and sensitivity of alarms. All possible areas of application of the project work are also given with the systems reliability though not quantitatively evaluated.

5.2 CONCLUSION

The automatic car theft alarm displayed good margins of efficiency and sensitivity in detecting the presence of an intruder. Its workability is guaranteed judging from the test conducted.

The efficiency of the alarm was not compromised for shape, size and cost. Component parts of this project work are locally available and relatively cheap.

The project is commercially valuable when cost of purchasing imported alarm systems and the inconveniences of keeping close watch on packed cars, pausing owner restiveness, with written instruction the instrument can be easily installed and used by a layman.

Repair work can be carried out on the project by changing faulty components and effectively soldering them into position where faulty ones were removed.

NO USER SERVICEABLE PART – so only experts are to work on it. Apart from car, the project can be useful in residential homes, banks and supermarkets and also in the control of industrial processes, for signally errors of over-voltages derived from pure electrical systems or mechanical and chemical processes. In case of other than pure electrical and electronics, transducers are used to convert such signals to electrical quantities.

5.3 SUGGESTION FOR FURTHER WORK

This project can be further improved in the following ways:

i. The output transducer (speaker) may be connected to output of the oscillator (Astable multi-vibrator) circuit through a power amplifier to improve on the magnitude of the sound output.

ii. A touch sensor can be added as another actuator circuit to the "Detector Circuit" of the alarm system. This touch sensor may be connected to the entire body of the car or only to some selected areas of interest.

iii. The design can be made to be highly efficient and luxuriantly convenient by incorporating a remote control in it. This remote control will permit the operation of the alarm system from a given distance away from the car.

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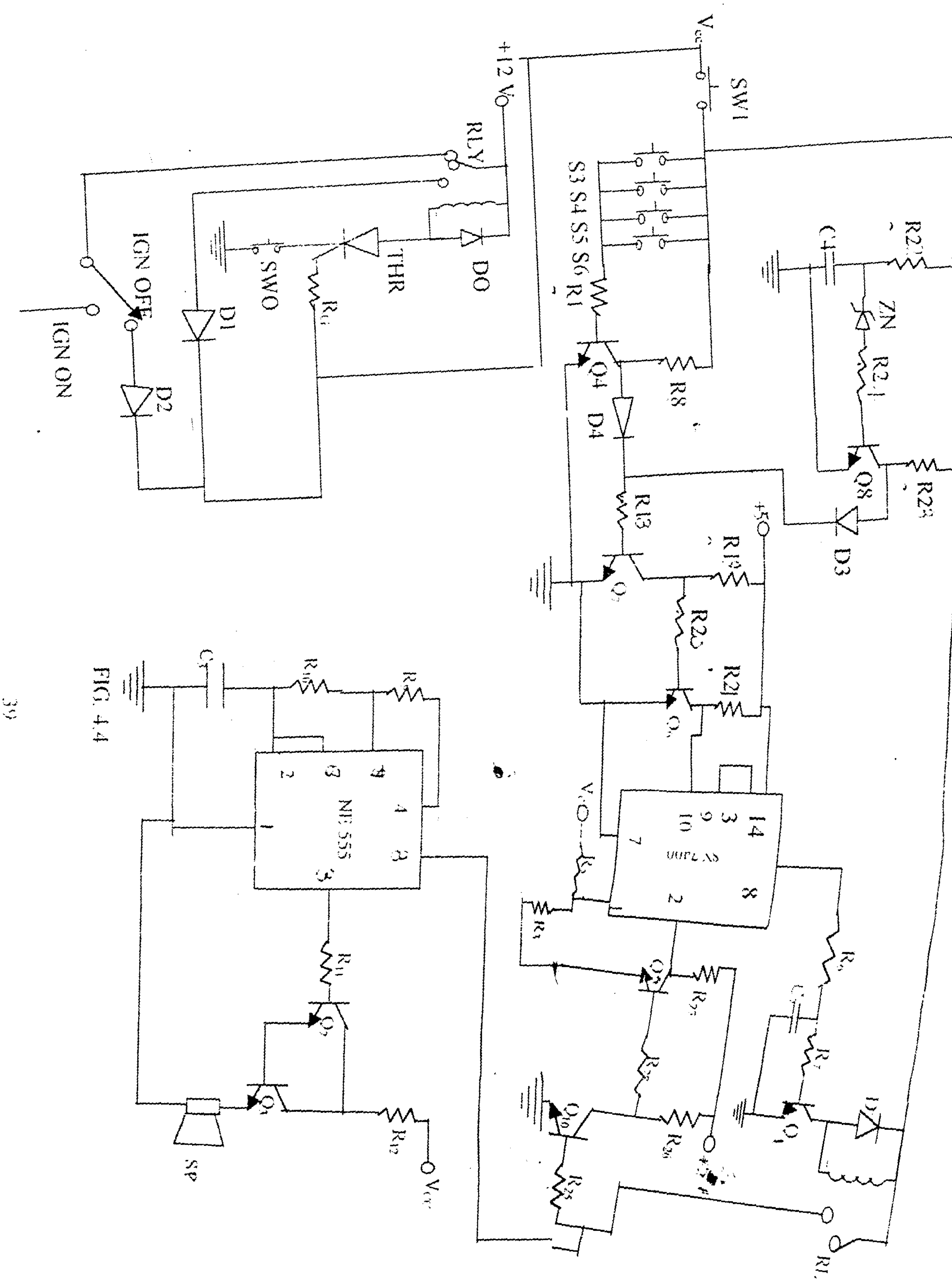

FIG. 4.4

COMPLETE CIRCUIT DIAGRA AUTOMATIC THEFT ALAF

Components List

Components	Value
Relay (1,2)RLY	12v, 10A
Signal Diodes D_0, D_1, D_2, D_3, D_4	
SPEAKER	8Ω 0.5w
CAR Ignition switch	IGN
IC_2	NE 555
C_2	4 7μf
C_3	0.01μf
R_2	12kΩ
R_3, R_G, R_{18}, R_{25}, R_{17}	10k
R_9	56k
R_{10}	51k
IC_3	SN7400
R_7, R_{21}, R_{27}	1k
R_6	68k
R_{12}, R_{23}, R_8	100Ω
Q_1	BC 547
Q_2, Q_3	BC 546
THYRISTOR (SCR)	BT 151
R_{20}, R_{28}	1.5k
R_{19}, R_{26}, R_{24}	330Ω
Q_6, Q_7, Q_9, Q_{10}	BC 945
Q_8	C 4204
C_4	100μf
R_{22}	180k
ZENER DIODE	ZN
R_1	200k
R_{15}	6.8
R_{16}, R_5, R_{13}, R_{14}	10k
R_4	12k
C_1	47μf
IC_1	NE 555
~~C_1, R_1, R_{15}, R_{16}, R_4,~~ R_5	

Figure 4.5