# DESIGN AND CONSTRUCTION OF INFRA – RED ALARM SYSTEM

BY

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*(93/3476)*

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE.

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

MARCH, 2000.

# CERTIFICATION

This is to certify that this project titled Design and construction of Infra-red Alarm system, was carried out by Abodunrin Olufunmilayo Samson under the supervision of Mr Paul Attah and submitted to Electrical and Computer Engineering Department, Federal University of Technology, Minna in partial fufillment of the requirements for the award of Barchelor of Engineering (B.ENG) degree in Electrical and Computer Engineering.

Mr. Paul Attah — 24/03/2000

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Head of Department — Sign & Date

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External Examiner — Sign & Date

## DECLARATION

I hereby declare that this project is the result of my own handwork and research which has never been presented by anybody. It was conducted under the supervision of Mr. Paul Attah in the Department of Electrical/Computer Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria.

ABODUNRIN, O. SAMSON — 23/03/2000

93/3476 — SIGN & DATE

# DEDICATION

This work is dedicated to the Almighty God and to my parents, Mr Gideon Olayinka Abodunrin and Mrs Esther Oyefunke Abodunrin who have seen to the fulfillment of my dream in life.

## ACKNOWLEDGMENT

My thank goes to the Almighty God, for sparing my life till this present moment and for his grace given to me to complete this work successfully my profound gratitude goes to Mr. Paul Attah a dynamic, hardworking,

Intelligent and God-fearing person, who has been my supervisor throughout the course of this project. I appreciate his expertise, patience, guidance and assistance throughout the period of supervising me on this project.

I also express my sincere gratitude to the Head of Electrical/Computer engineering Department of Federal University of Technology Minna,

Dr (ENGR) Y. A. Adediran.

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I would like to appreciate the words of encouragement from my brothers and sisters which has been a fire power in achieving a laudable success in this project.

Finally, I give my profound gratitude to my lovely friend, Miss Bosede Omowumi Ogunsola who stood by me throughout the period of my course.

## LIST OF ABBREVIATION/SYMBOLS

| | |
|---|---|
| Vrms/Irms | Instantaneous values of voltage/current |
| Vm/Im | Maximum voltage/current |
| Vdc/Idc | Dc output voltage/current |
| Vcc | Based voltage supply |
| Vbe | Base-emitter voltage |
| Vin/Vout | Input/output voltage |
| Bdv | Breakdown voltage |
| PIV | peak - inverse voltage |
| Δv | peak - to - peak ripple voltage |
| Il/Id | Load current/diode current |
| Ic(sat) | saturation collector current |
| hFE | D.C Current gain |
| hFE(sat) | Forward, current, transfer ratio at saturation |
| Po | Power output |
| Rl | Load resistor |
| C | Capacitor |
| f | Frequency |
| γ | Overdrive factor |
| μF | Micro farad |
| NC/NO | Normally closed/Normally opened |
| LED | Light Emitting Diode |
| $T_1$ | Transformer 1 |
| IC | Integrated circuit |
| Tr | Transistor |
| UJT | Unjunction transistor |
| SPKR | Speaker |

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# CHAPTER ONE

## GENERAL INTRODUCTION

## 1.1 INTRODUCTION

As this time it is possible that your home or business is under surveillance by professional burglar and date is set for the job. This could take place in the dead of night on a weekend when you are away.

All the buglar must do is learn the daily habits of you and your family and wait until the ideal oppotunity occurs.

By taking the proper preventive method to reduce the chances of your property being burglarized is to install a good burglar alarm system and let it be known that such a system exists.

All alarm systems no matter how complex, might be broken down into four basic sections. The infrared pulse generator emitting the infrared radiation, sensors, control unit, power supply and the alarm indicator.

Some current applications of infrared system are:

MILITARY: Military fire control at night or during the day when vision isdiminished due to fog, smoke or haze. Detection and tracking of ships, aircraft, missiles, surface vehicles and personnel, submarine detection and range finding.

MEDICAL: Early detection and identification of cancer, obstacle detection for the blind, location of blockage in a vein and early diagnosis of incipient stroke.

SCIENTIFIC: Satellite and space communication. Environmental survey and control, detection of life and vegetation on other planets and measurement of lunar and planetary temperature.

INDUSTRIAL: Aircraft landing aid and traffic counting forest fire detection and natural resource detection.

## 1.2 AIMS AND OBJECTIVES

The aim of this project is to design and construct a multipurpose movement detector which will be able to form the basis of all sorts of burglar alarms and automatic controllers.

It will work either as a single interrupted beam alarm over substantial distances or will directly detect moving objects or persons by measuring changes in the level of reflected infrared over shorter distances. It is intended that the project will be insensitive to ordinary visible light.

## 1.3 METHODOLOGY

Each of the stages was designed separately (i.e. modular approach method,). This project was bult using integrated circuits (I.C.) And discrete components.

The design is composed of four basic sections, the infrared pulse generator, sensors, control unit, power supply and the alarm indicator.

The circuit diagram of the transmitter is a standard 555 astable circuit having the values of the timing components ($R_3$, $R_4$, And $C_3$) chosen to give a suitable operating frequency. The output waveform of the 555 astable was connected to the emitter diode, connected between the output of the 555 astable was connected to the emitter diode, connected between the output of the IC, and the Positive supply rails

The next (fig. 1) is the circuit diagram of the receiver (detector). The detector diode ($D_5$) is coupled to receive transmitted signal filtered by $R_5$ and $C_4$. At the receiver circuit is the amplifier which is a simple two – stage common emitter type capacitively coupled. The output of the amplifier was rectified and smoothened by $D_6$, $D_7$,$C_9$ and $R_{12}$. The Schmitt trigger is based on $IC_2$. $R_{14}$ was incorporated to provide hysteresis and to obtain desired sensitivity (a compromise between these two qualities being maintained)

The output of the comparator ($IC_2$) was coupled to the timer circuit. The timer circuit employed is a 555 timer IC which has a monostable operation. The timing components are $R_{16}$ and $C_{12}$. Fig. 1. The relay is a 12V, 400Ω relay (RLA $_2$). The making of the relay depends on the timer circuit.

The normally open, NO terminal of the relay feeds the alarm circuit. Two oscillator were used at the alarm circuit. The unijunction oscillator and the astable multivibrator. The output of the unijunction oscillator was coupled to the base of one of the transistor of the astable multivibrator. The output of the two oscillators was coupled to a speaker through an impedance matching transistor.

## 1.4 LITERATURE REVIEW

Sir William Herschel in 1800 discovered infrared radiation when he worked for the Royal Navy. He geerated the radiation by vibration and rotation of the atom and molecules within some materials at temperature above absolute zero that is O°k or -273 $^{\circ}$c

Herschel referred to the new portion of the spectrum by such names as "invisible rays" "radiant heat", "dark heat", and "the rays that occasion heat".

In the recent years, there has been an increasing emphasis on the research design, development and deployment on various infrared devices and systems for military application at night or during the day when vision is diminished by fog, haze, smoke or dust.

During World War 1 an infrared system could detect aircraft, at a distance of 1.6km and a person at a distance of 300m.

Many sensitive infrared detectors, such as photo-detector and image converters were developed during World War II. In the late 50's, the side winder and falcon heat - seeking infrared guided missiles were developed.

Furthermore, infrared techniques became applicable to the altitude stabilization of space vehicles, measurement for planetary temperature, earth mapping and early detection of cancer.

The fundamental work on infrared thermal imaging systems was contributed by many dedicated scientist and engineers, such as Hudson, Jones and Johnson.

## 1.5 PROJECT OUTLINE

The design is such that objects are detected as they pass between the emitter and sensor devices (figr-1). They are placed in short distance apart depending on the range are want to cover.

The emitted signal is the form of infrared pulses and the generator is an oscillator, which pulses at infrared LED.

The sensor unit consist of infrared detector diode feeding a very high gain amplifier.

The control unit read the condition of the sensor circuit and determine if current is flowing or not. The control unit detect the loss of current flow and produce an alarm output.

A simple alternating current power supply is used to power the inferred alarm system. A 12V battery can still be used as a stand by supply.

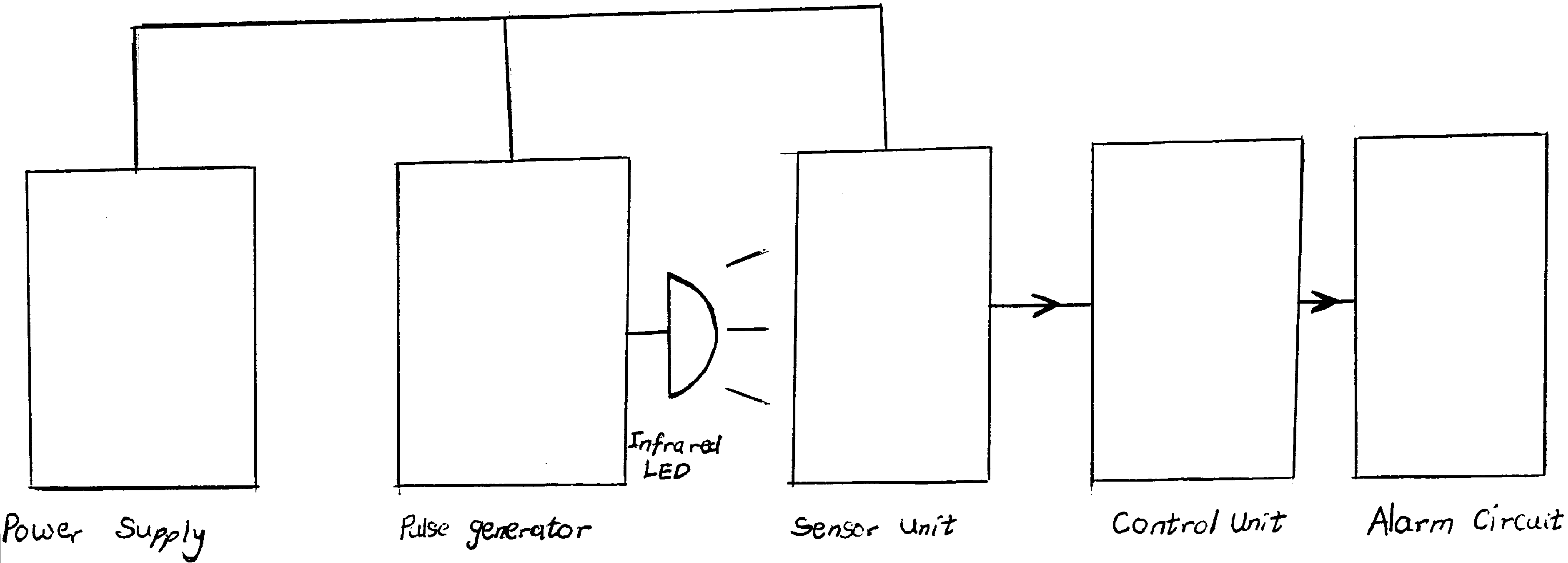



Fig 1.1 Block diagram of Infrared alarm System

# CHAPTER TWO

## SYSTEM DESIGN

### 2.1 POWER SUPPLY

#### i. METHOD OF RECTIFIATION:

A full-wave rectifier network with center tap transformer was employed to:

- obtain a higher dc voltage output since

  $Vdc = 2Vm/\pi$ and $Idc = 2Im./\pi$

- Increase the peak inverse voltage (PIV).

PIV is the maximum voltage that can be applied in the reverse direction without breakdown ( through the rectifying diodes)

$PIV = 2Vm$ , $(PIV = Vm$ for half – wave )

#### ii Transformer selection

$Po = Vdc \times Idc$

$= 2Vm/\pi \quad x\ 2Im/\pi$

$= \quad 2\sqrt{2}\,Vrms/\pi\ x\, 2\sqrt{2}\,Irms/\pi$

$= 2\sqrt{2}\,Vrms/\pi,\ x\, 2\sqrt{2}/\pi x Vrms/R$

$= 8Vrms^2/\pi^2 R$

therefore $Vrms = \sqrt{Po\pi^2 R/8}$

for this project,

Po is 15W, Rl 8Ω

Vrms = $\sqrt{15 x \pi^2 8 / 8}$

≈ 12.167V

= 12V

therefore a transformer of 240V : 12V was chosen

iii **diodes rating**

Voltage rating: the maximum voltage, which occurs across the diode in the reverse direction, peak inverse voltage (PIV) must be less than the breakdown voltage of the diode if it is not to conduct appreciably in the reverse direction.

for a full-wave,

PIV = 2 Vm

Vm = $\sqrt{2}$ Vrms

= $\sqrt{2}$ x 12

= 16.197V

Vm ≈17V

Therefore PIV = 2 x 17

= 34V

the breakdown voltage must be greater than PIV (Bdv > PIV)

Therefore diodes of breakdown voltage of 50V (>34) are desirable.

Current rating:

$Idc = 2Im/\pi$

$= 2\sqrt{2}/\pi \times Vrms/R$

$= 2\sqrt{2} \times 12/8\pi$

$= 1.35A$

Idc = the mean load current

Therefore a diode of current rating of 1.5A was chosen.

From the E.C.G. data book IN5391 diode satisfy the requirements.

iv. **CAPACITOR SELECTION**

voltage rating:

capacitor voltage, Vc rating > $\sqrt{2}$ Vrms

$\sqrt{2} \times 12 = 16.97V$ ( $\sqrt{2}$ Vrms)

$Vc \geq \sqrt{2}$ 2 Vrms

$Vc \geq 16.97V$

Therefore a capacitor of voltage rating of 25V was chosen.

Capacitance rating:

$\Delta V \approx Vm/2fRC$

$\Delta V \propto 1/C$

If a peak – to – peak ripple voltage of not more than 10V is to be tolerated

$10 = 12\sqrt{2}/(2 \times 50 \times 8 \times C)$

$C = 12\sqrt{2}/8000$

$= 2121\ \mu F$

therefore a capacitor of 2200μF capacitance was chosen

v **ZENER DIODE AND LIMITING RESISTOR, RS**

a varying load: fixed supply voltage

Rs = (Vin – Vout)/ (Idmax + Ilmin ) ....................(1)

Rs = (Vin - Vout)/(Idmin + Ilmax ) ....................(2)

b. varying supply voltage, fixed load

Rs = (Vin min - Vout) /(Idmin - Il ) ..................(3)

Rs = (Vin max - Vout)/(Idmax + IL) ...................(4)

Using equation (1) above,

Vin = 14.7V

Vout = 12V

Id = 6 mA

Therefore Rs = (14.7 – 12)/0.006

= 450Ω

the preferred value of Rs = 470Ω

vi **Protective fuse**

current rating:current rating of fuse should be higher than the mean load current (I dc)

Idc = 0.63Im

= 1.35

therefore a fuse of 1.5A was used. (See fig.2.1)

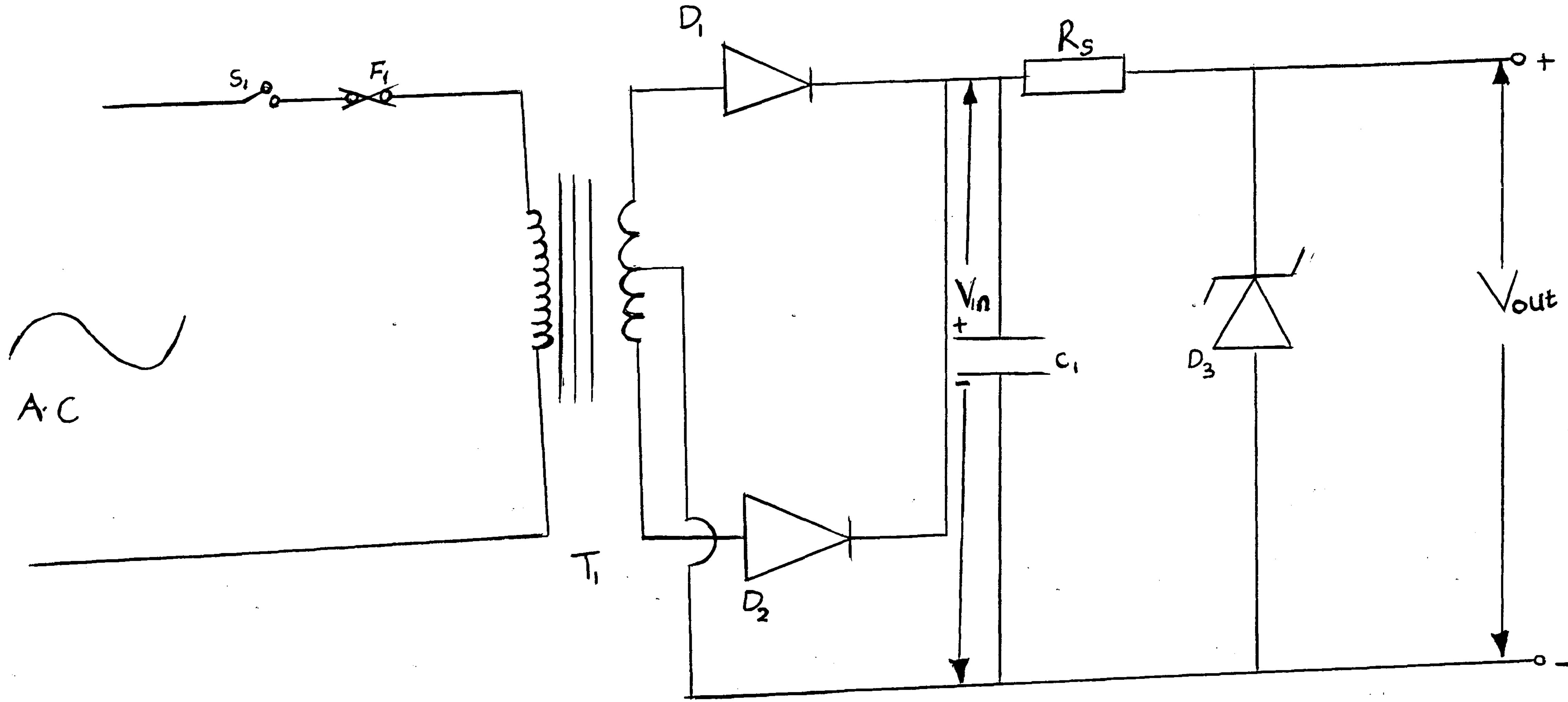



Fig II.1

Power supply Circuit

## 2.2 THE PULSE GENERATOR STAGE

The pulse generator is figure 2.2(a) a standard 555 astable circuit having the values of the timing components (R3, R4, and C4) chosen to give a suitable operating frequency.

The frequency, f, of the pulses produced by the astable is given by

$f = 1/(t1 + t2)$ HZ.

With the mark period three times longer than the space timer so that the emitter diode is only pulsed on for 25% of the time fig 2.2(b). This was done to keep the average current consumption of the circuit down to a reasonable level. Fig 2.2(a) and 2.2(b)

From the above:

LED on = R4 C3

LED off = (R3 + R4 ) C3

LED off : Led on = 3:1

(R3 + R4 ) C3 : R4 C3 = 3:1

(R3 + R4)/R4 = 3/1

R3 = 2R4

From f = 1/(t1 + t2 ) Hz

And t = R4 C3 , t2 = (R3 + R4 ) C3

f = 1/(R4 C3 + (R3 + R4 )C3 } Hz

= 1/(R3 + 2R4 )C3 Hz

but R 3 = 2R4

therefore f = 1/{2R4 + 2R4)C3}

= 1/(4R4 C2) Hz

$f \propto \; 1/R4$ (with 1/4C3 constant)

with a frequency of 10KHz and a capacitance of 10n F

$10 \times 10^3 = 1/(4R4 \times 10 \times 10^{-9})$

therefore R4 = 2.5K

The preferred value of R4 is 10K (for maximum adjustment)

Since R3 = 2R4,

R3 = 2(2.5) K

= 5K

preferred valued of R3 is 20K .

D4 is an LED (TIL 38) with the following parameters:

Maximum forward voltage, VF = 1.5V

Dc forward current, IF = 150mA

Therefore R2 = ( Vcc – VF)/IF

$= (12 - 1.5)/150 \times 10^{-3}$

= 70 Ω

the preferred value is 56Ω

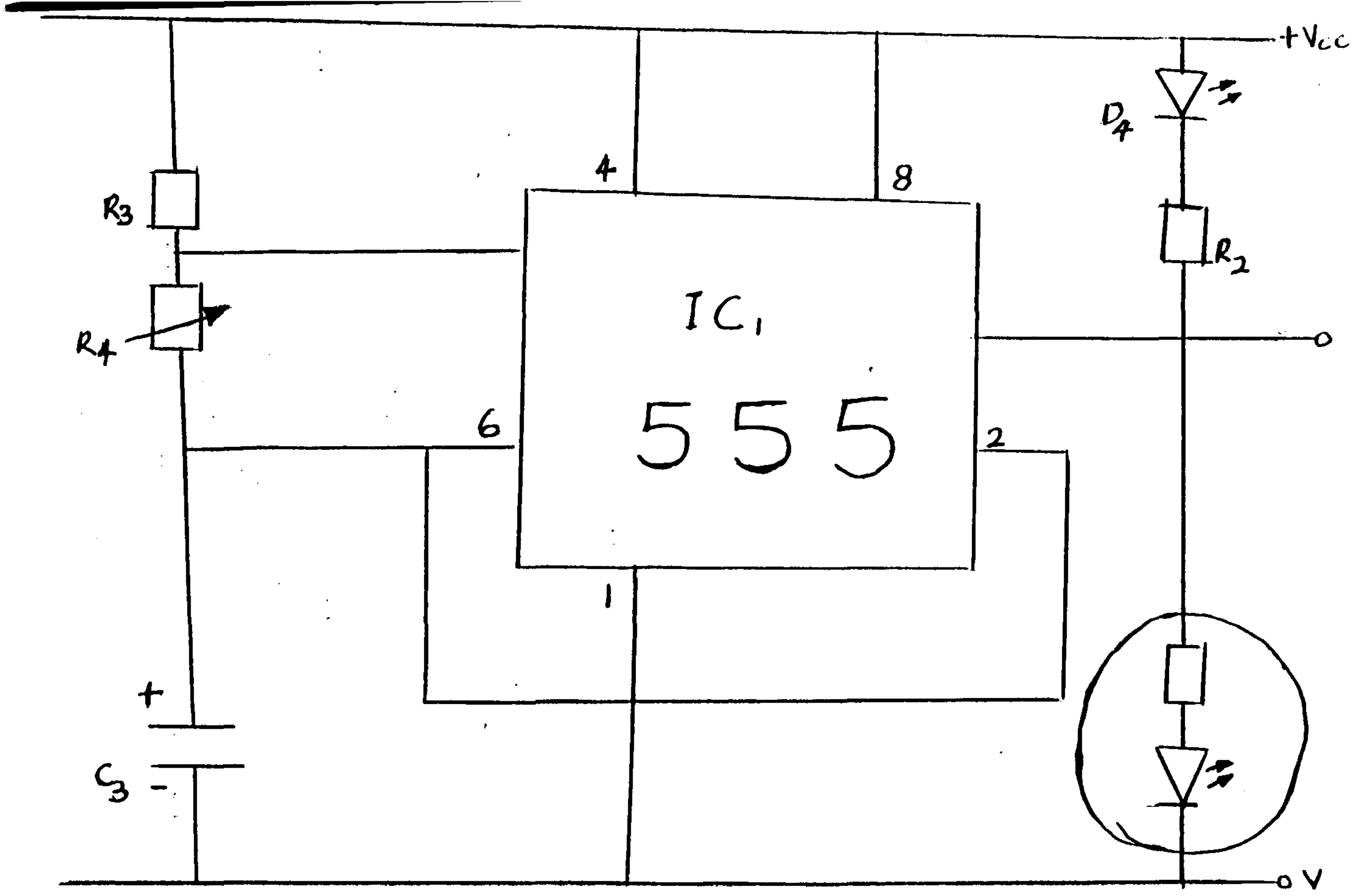



Fig 2.2(a) The Pulse generator Circuit

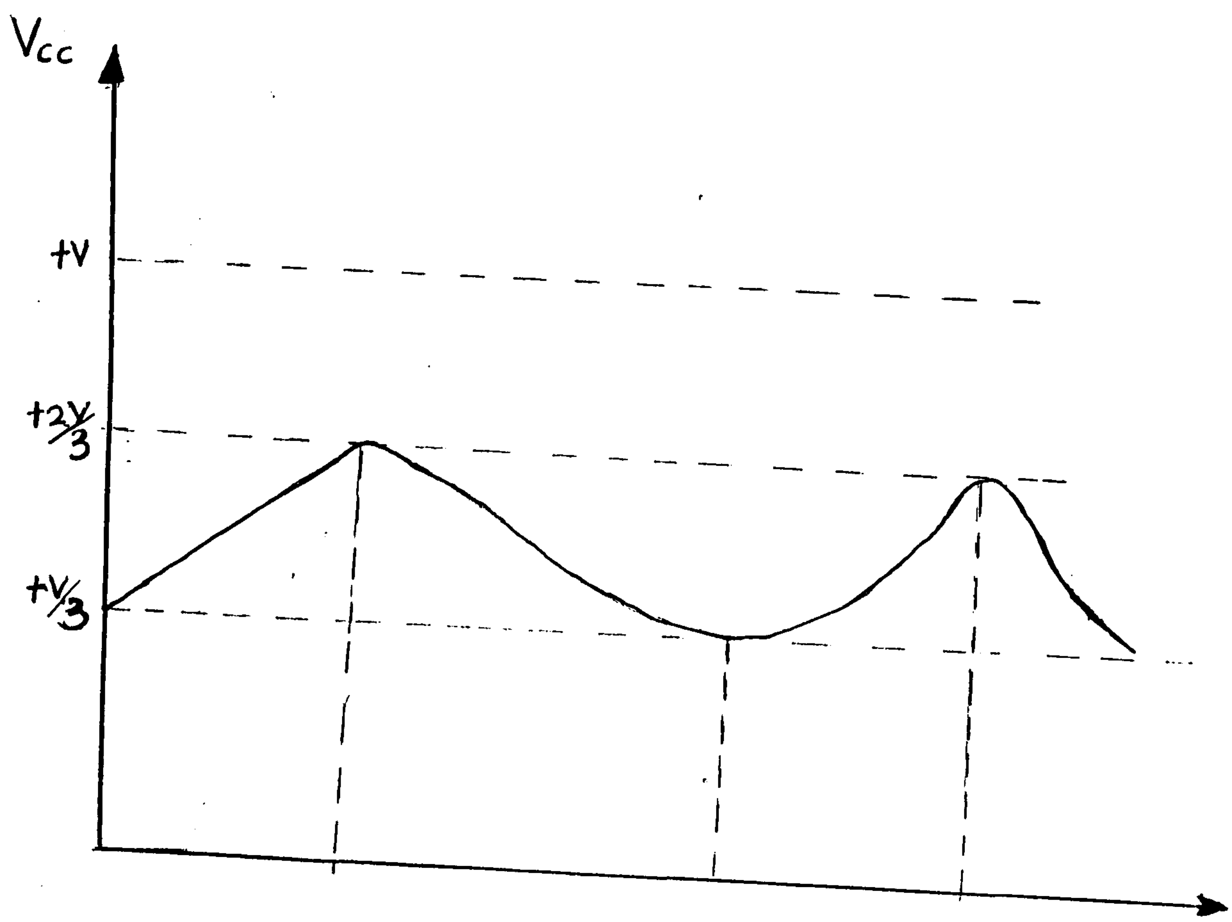



Fig 2-2(b)

## 2.3 AMPLIFIER STAGE

For the transistor to be used as amplifier, the following were done.

- Bias at the mid-point of transistor operation
- Collector resistor, Rc and base resistor, Rb were included
- A transistor of high gain, hFE were chosen
- Base resistor value used was very high

Since high input resistance implies small base current and this together with high hFE increases the sensitivity of the transistor figure 2.3

Capacitor C5 was included to the block d.c (component of the signal into the transistor.

A voltage – shunt feedback technique was used. That is voltage (as output) fed back as current. R6 (R7 & R9) provided base – current bias for the two transistors. They also act as feedback elements figure 1.

Refer to figure 5

To bias to the center of the dc load line, that is, for the output voltage at the collector to be Vcc/2,

Vcc/2 icRc

Vcc = 2icRc ..................(i)

Loop equation gives Vcc/2 = ibRb + Vbe

Neglecting Vbe, we have Vcc = 2ibRb in ..........(ii)

Equating (i) and (ii)

2icRc = 2ibRb

Rb = icRc/ib

But ic/ib = hFE

Therefore Rb ≈ hFE Rc

From 2icRc = Vcc,

Rc = Vcc/2ic

for Tr1 and T2 (BC10 9C) ;

Ic max = o.1 amps

hFE = 400

Rc = 12/2(0.1)

= 60Ω

the preferred value of R6 is 68Ω

power rating of Rc, PRc

PRc = $I^2$ Rc

= $(0.^2)$ x 68

= 0.68W

≈ 1W

therefore the preferred value of Rc is 68Ω , 1W

from Rb ≈ hFERc

Rb = 400 x 68

= 272000Ω

The preferred value of Rb = 30 K

Power rating = 1/4W

Therefore the value of Rb = 30K , 1/4W

**The value of the capacitor, C5**

$Xc << rin$

$Xc$ = reactance of the capacitor

$rin$ = input resistance

If $Xc = 10\% \, rin$

$Xc = 1/2\pi fC$

$1/2\pi fC = 10/100 rin$

From the circuit: fig. 11

$Vcc = Ib(Rc + Rb) + Ic\,Rc + Vbe$

$rin = Rc + Rb$

$Rb >> Rc$

$rin \approx Rb$

Therefore $rin \approx 30K$

$1/2\pi fC = 10/(100 \times 30{,}000)$

$C = 1/(100\pi \times 3000)$ $\{f = 50Hz, \pi = 3.142\}$

$= 1.06 \times 10^{-6}$

The preferred value of C5 = 1 μF

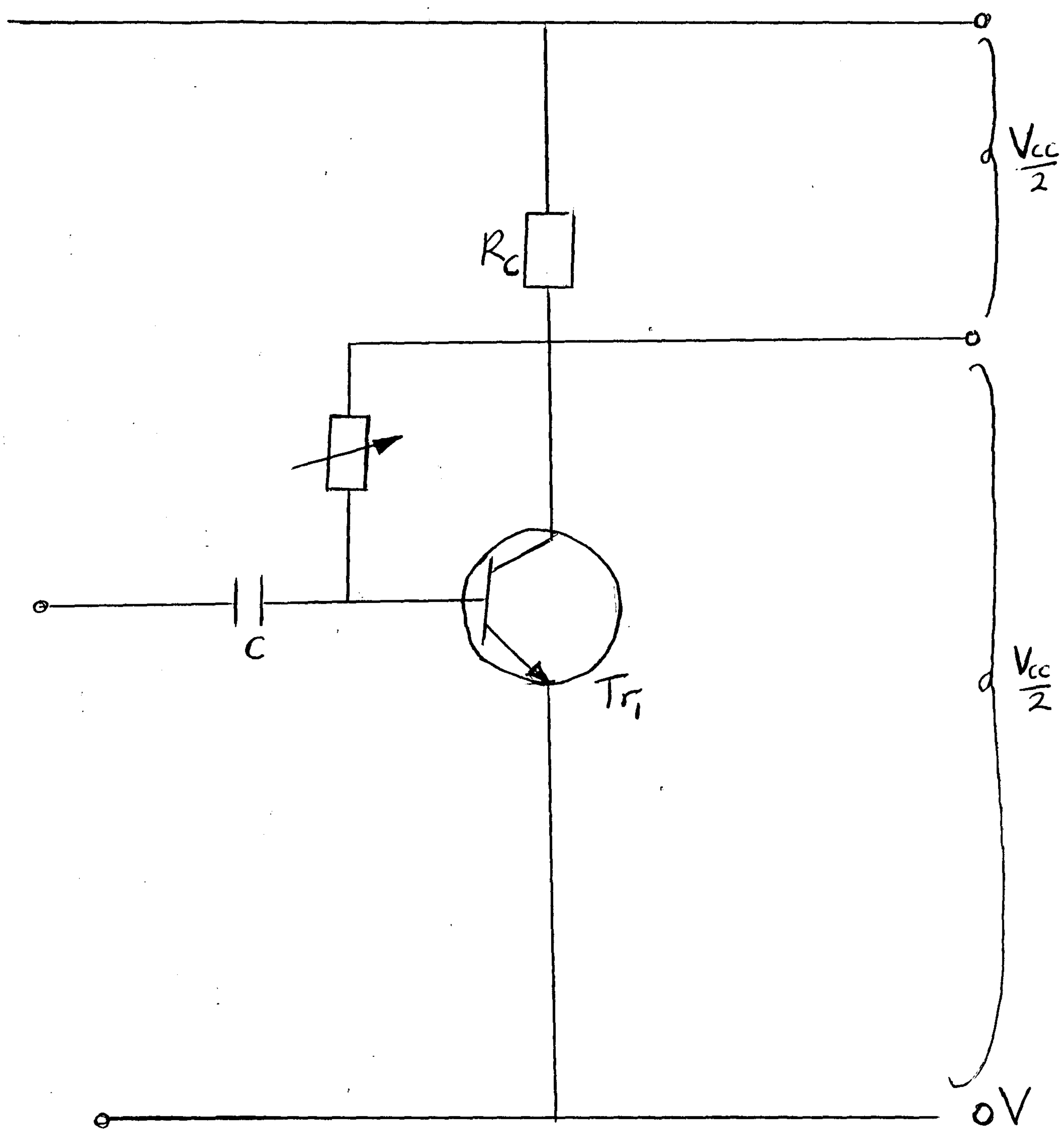



Fig 2·3 Biasing a Transistor at the Q-Point

## 2.4 THE SCHMITT TRIGGER (COMPARATOR)

The Schmitt trigger is a circuit that will produce sharp rectangular pulses. It is used to know which of two signals is larger, or to know when a given signal exceeds a pre – determined value. It may also be used in wave shaping applications. For example, various periodic waveforms such as sinusoid and triangular waveforms may be converted to square wave or pulse trains.

Schmitt trigger makes use of positive feedback. The effect of the feedback resistor in the circuit is to have two thresholds which eliminates multiple triggering. Also, the positive feedback ensures a rapid output transition regardless of the speed of the input waveform. The input of a Schmitt trigger depends on both the effect voltage and on its recent history.

This effect is called hysteresis fig. 2.5.

Comparators are examples of non – linear circuits. The two op – amp input voltages may have completely different values because of the absence of negative feedback.

The divider network consisting of R1 and R2 astablizes a voltage at the non – inverting input terminal proportional to the output voltage. The magnitude of the voltage across R2 in Fig 2.4 will be defined as threshold (triggering) voltage, $V_T$

$V_T$ = R2 V(sat)/( R1 + R2)

By choosing an appropriate value of $V_T$, one can minimize the effect of noise at the transition points.

The transition points corresponds to the input voltage becoming more positive than $V_T$ in one direction and becoming more negative than $-V_T$ in the opposite direction.

If the output lies at the positive saturation limit V positive, $V_T$ will be positive and equal to

$V+ = R2/(R1 + R2)\ Vpos$

Applying a Vin greater than R2/(R1 +R2) $V_{pos}$ to the negative terminal causes ($V_{+}$, -V-) to become negative, in turn forcing $V_{out}$ to its negative saturation limit of $V_{neg}$ If Vin is returned to Zero, however, $V_{out}$ will remain negative at $V_{neg}$ eg, with

$V_{+} = R_2/(R_1 + R_2)\ V_{neg}$.

Now, consider fig 8a

With $V_2 < V_1, V_o = +V_o$

$V_1 = V_o - R_2/(R_1 + R_2)\ Vcc$ ..............(1)

With $V_2 > V_1, V_0 = -Vo$

$V_2 = V_o + R_2/(R_1 + R_2)\ Vcc$ ...........(ii)

The width of the hysteresis band $V_2 - V_1$ ($V_H$)

Is easily controlled by adjusting $R_2$

$V_H = V_2 - V_1 = V_0 + R_2\ Vcc/(R_1 + R_2) - \{ (V_0 - R_2\ Vcc/(R_1 + R_2)) \}$

Therefore $V_H = 2R_2\ Vcc/(R_1 + R_2)$

For a symmetrical square wave:

$V_1 = -V_2$

$= - R_2/(R_1 + R_2)\ Vcc$

Design Procedure

Consider fig 2.5

1. R* (variable resistor) was used as a resistive divider to put the threshold at

approximately the right voltage. Figure 2.5

2. The (positive) feedback resistor R was chosen to produce the required hysteresis figure 2.6(b)

Now with the power supply voltage at Vpos

(ie + 12V = Vsat)

$V_{in} = R_2/(R_1 + R_2)$ Vpos

For a faster transition, the reference voltage (or threshold) must be as small as possible.

Thus reference voltage of 0.5V was chosen.

$V_T = R_2/(R_1 + R_2)$ Vpos

$0.5 = R2/(R1 + R2) \times 12$

$R_2/(R_1 + R_2) = 0.5/12$

At $R_1$ = IM

$R_2/(1000 + R_2) = 0.0416$

$R_2 = 41.67K$

The preferred value of $R_2 = 47K\Omega$

($R_2 \equiv R_{13}$ in the complete circuit diagram) figure 1 .

The schmitt trigger has a bistable characteristic. In other words it has two stable states. These states are the positive saturated state whereby the output drives (V+ -V-) in the positive direction and when Vout and (V+ -V-) are both negative.

Where (V+ -V-) are power supplies.

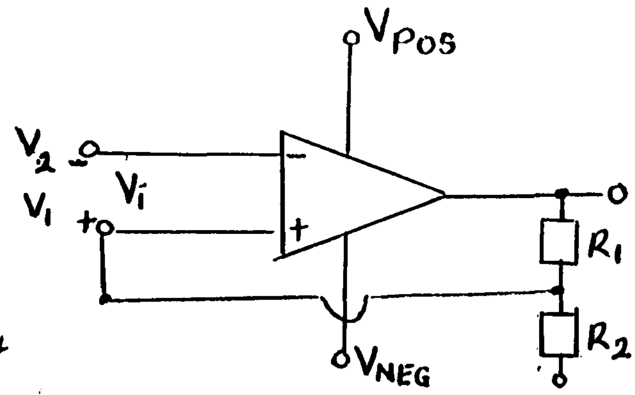



Fig .2.4

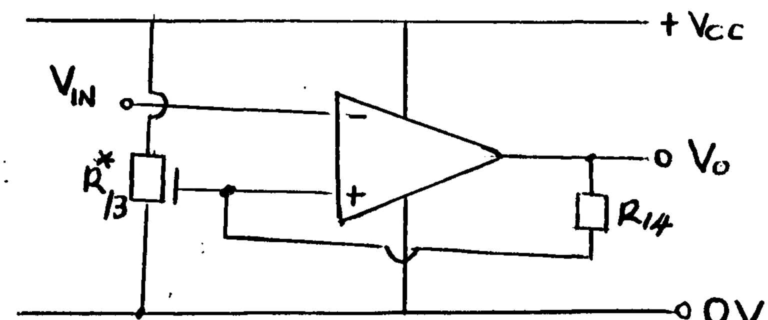



Fig .2.5

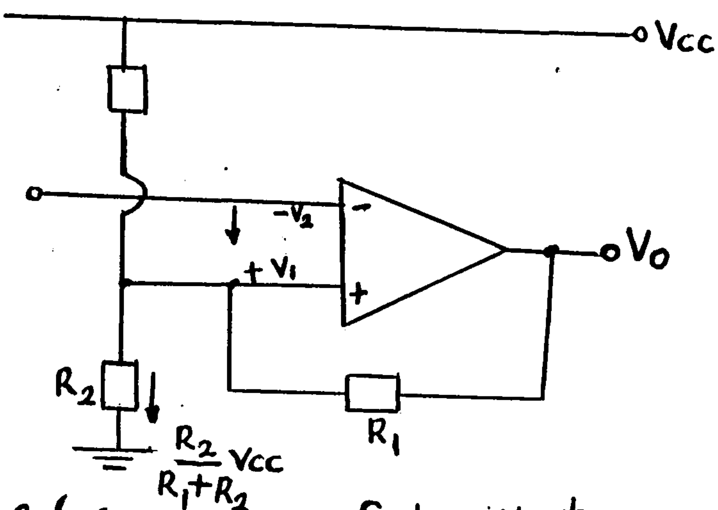
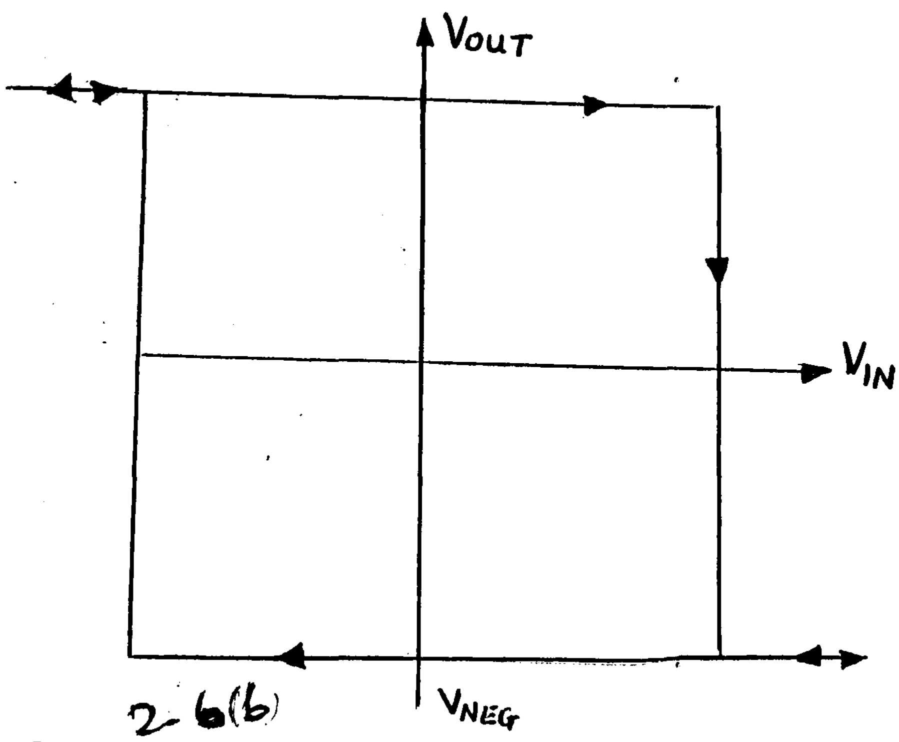



Fig.: 2.6(a) Schmitt trigger circuits




2-6(b)

Fig. Plot of Vout Versus VIN for the Schmitt trigger

## 2.5(A) TIMER CIRCUIT

The 555timer circuit is designed to switch on a device for a pre – set period of time and then switch it off..

A signal through pin 2 of the 555 timer makes pin 3 which was at 0 volts goes to $+V_{cc}$ and the relay2 energizes. The relay then remains on for the period determined by the timing components $R_{16}$ and $C_{12}$ .Figure 9a.

It then turns off that is pin 3 goes back to 0 volts. The circuit of this type has a monostable operation. Fig 9(b).

Delay time, t is given by

$t = 1.1\ RC\ s$

$t \propto R\ (1.1C = \text{constant})$

With $t = 5$ s, and $C = 10\ \mu F$

$5 = 1.1 \times 10 \times 10^{-6} R$

$R = 454.5\ K$

The preferred value of R16 = 470K

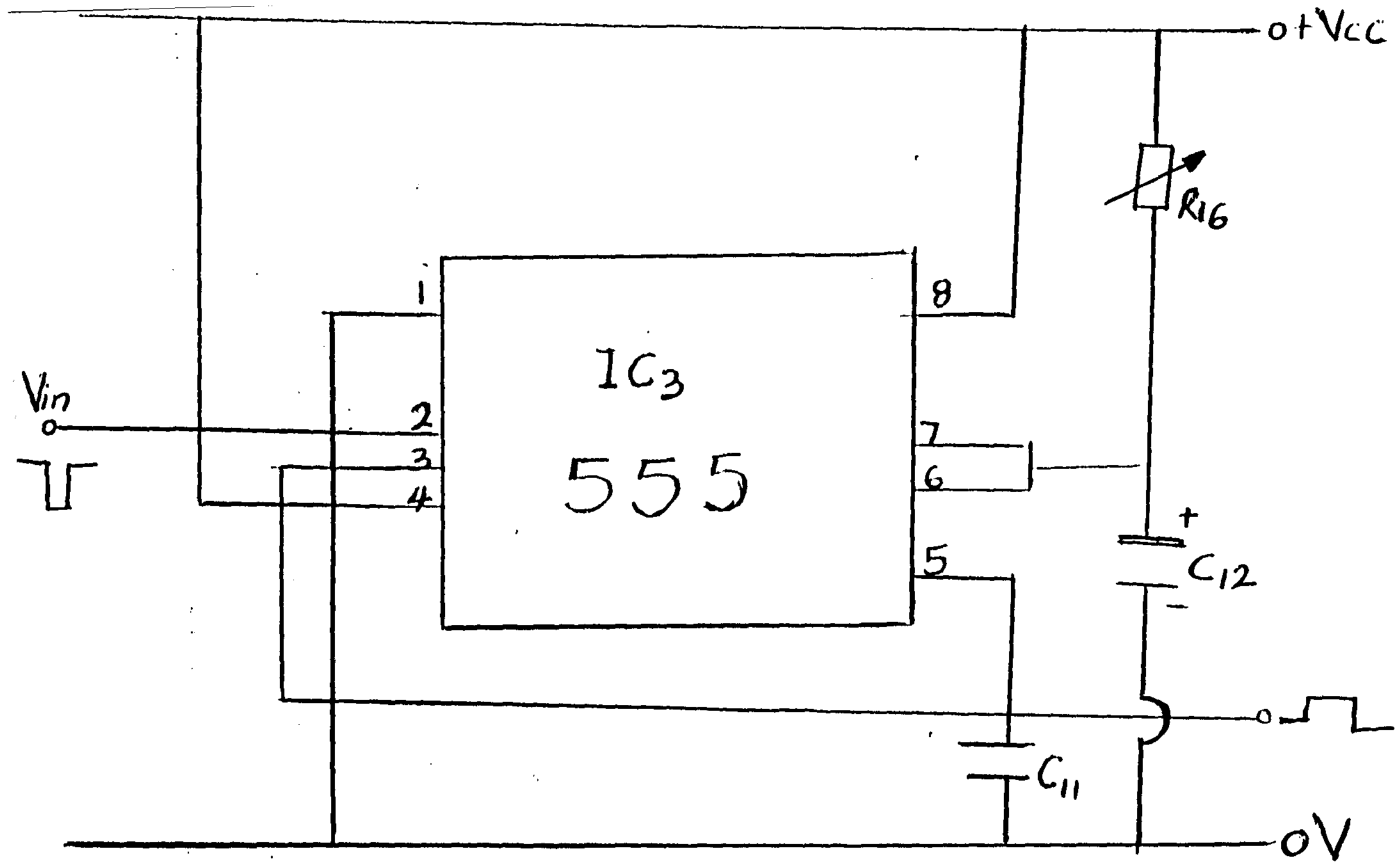



Fig. 2.7(a) Timer circuit

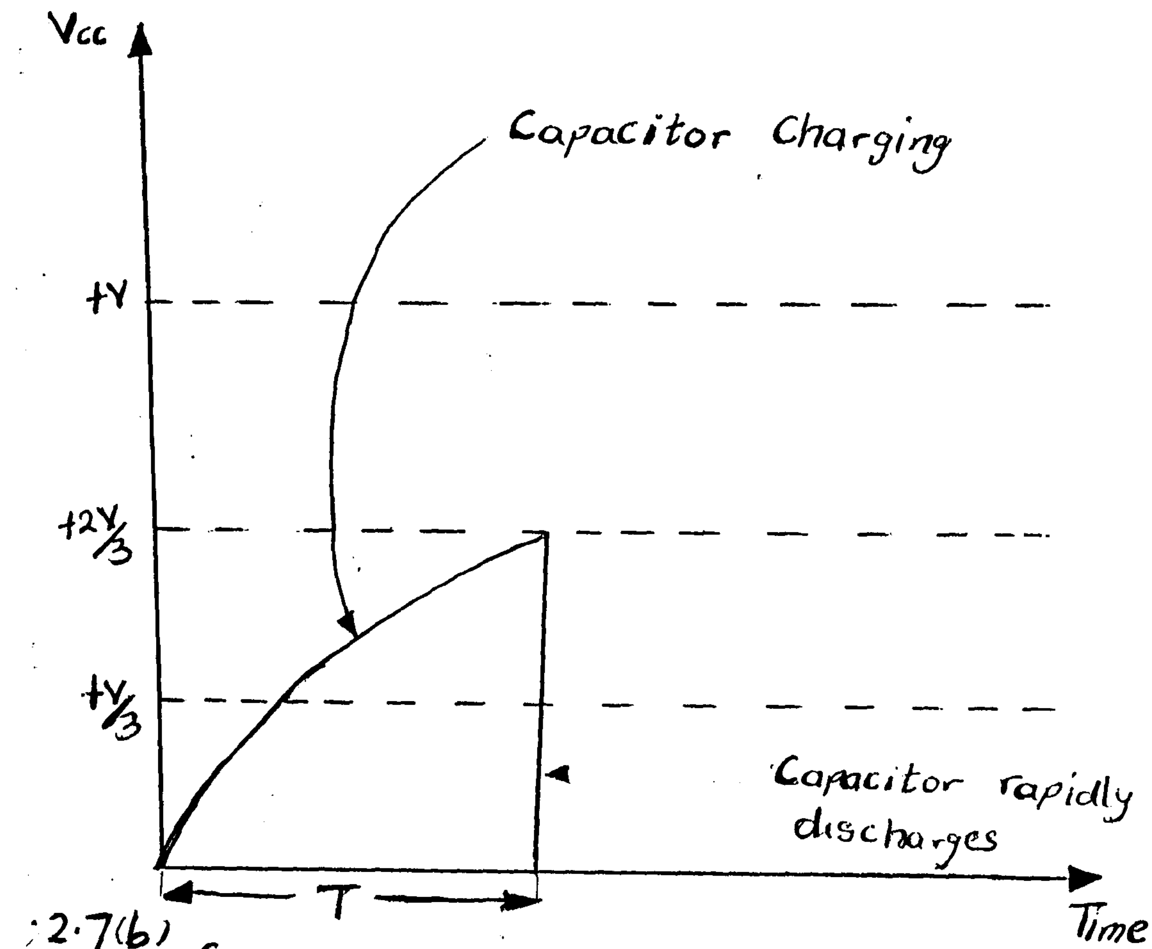



Fig :2.7(b) Capacitor charge and discharge curve for 555 Monostable function.

## 2.5(B) RELAY AND THE DRIVER

The output from the 555 timer ($IC_3$) is not enough to switch the relay, hence the incorporation of the transistor switch

Ib = Ic(sat)/hFE (sat)

Ib is the current just needed to switch on the transistor

To improve the switching time and to ensure that the circuit is driven hard into saturation, an overdrive factor, $\gamma$ , is normally introduced, so that Ib is given by

Ib = $\gamma$Ic(sat)/hFE(sat)

For sufficient overdrive, $\gamma$ lies between 2 and 5

Rb = (Vbb – Vbe)/Ib

For $Tr_3$, (D400) the parameters are:

Ic (max) = 1 ampere

hFE = 120

For the relay of 12V, 400Ω ,

Relay current, Ir = 12/400

Therefore Ir = 0.03A

for effective making of the relay,

Ic = Ir (i.e collector current = relay current)

$\gamma$Ic = Ib/hFe

Ib = $\gamma$Ic/hFE

Ib = 3(0.03)/120($\gamma$ = 3)

Therefore, Ib = 0.75 mA

Vbb = voltage (output) form the 555 timer

Vbb = 7V

Vb {Vbb Vbe}/Ib

= 7 – 0.6/(0.75 x $10^{-3}$ )

= 8.5 K

preferred value of Rb = 10KΩ ,

power rating of Rb is = $(0.75 x 10^{-3})^2 x\ 10000 \approx \frac{1}{4}$ w

preferred value of $R_{17}$ = 10kΩ, ¼ w.

Refer to fig. 2.8

D9 is a freewheeling diode (overswing limiting diode). When inductive loads are switched off by semi conductor devices, the inductance sweeps the collector/emitter (or anode/cathode) voltage to a greater value than the supply. This could cause avalanche breakdown which eventually leads to the failure of the device. It is usual therefore in such circuits where this problem is likely to arise to include an overswing limiting diode (Fig2.8).

Current rating of D9 > load current

Breakdown voltage > $12\sqrt{2}$

Current rating of D9 = 2A (>1.3A)

Voltage rating of D9 = 100V (> $12\sqrt{2}$ )

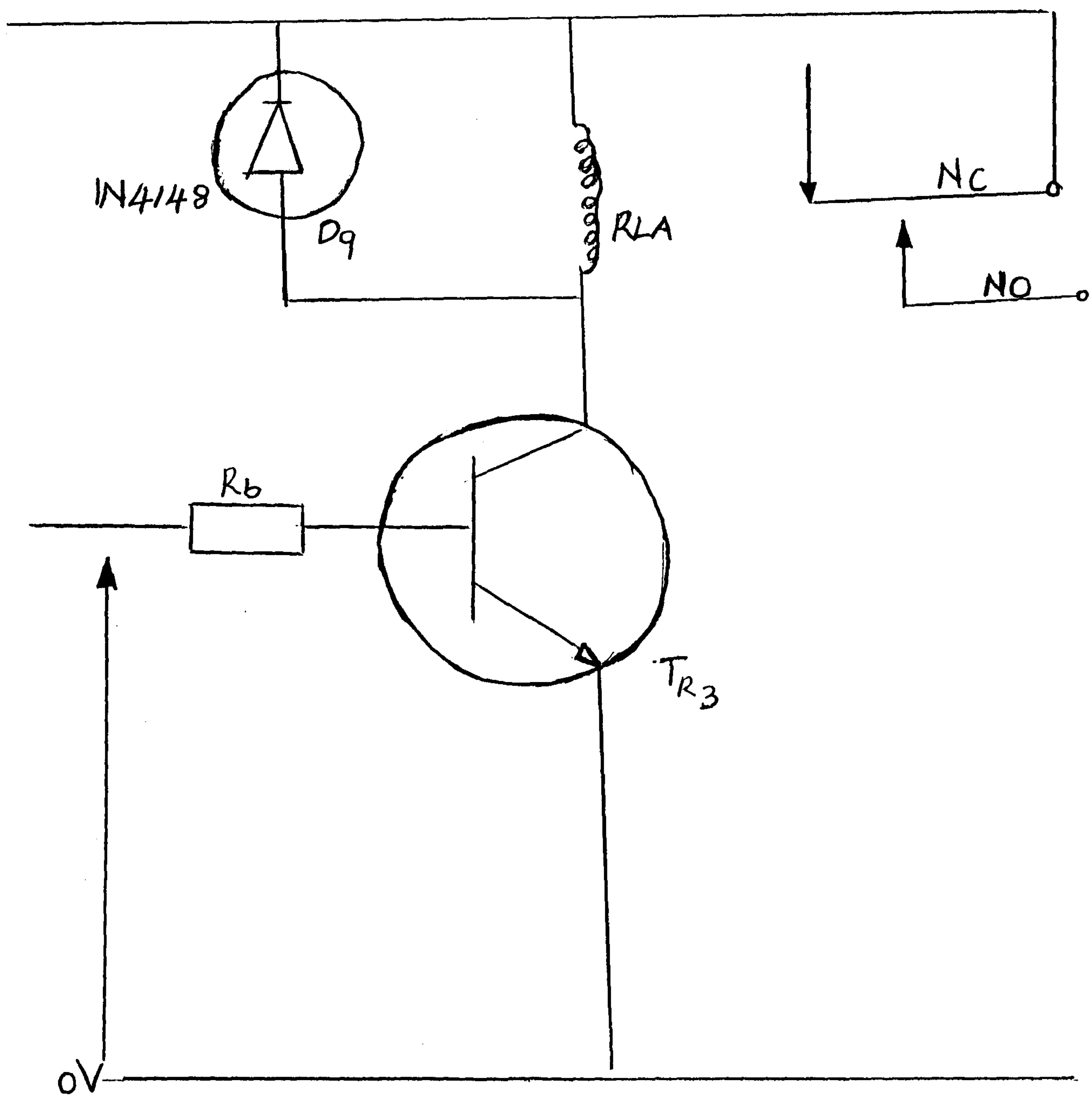



Fig 2.8 Transistor switch.

## 2.6 ALARM CIRCUIT

The circuit bonded by ABCDE is the circuit (fig2.9(a)) is a unijunction oscillator. It modulates the basic oscillator circuit. The UJT figure 2.9 (b) adds and subtracts base current from Tr4. The current modulation causes the frequency of the multivibrator to shift from a low to a high frequency then turns off momentarily and repeats the cycle over and over again.

The output of the multivibrator Figure 2.9c is direct –coupled through R24 to the base of the power transistor Tr6. The current pulse at the base of Tr6 is sufficient to drive the collector to saturation, thereby connecting the supply voltage across the speaker.

The frequency of the UJT is given by

$f \approx 1/(RT\ CT\ In\ (1/1-\eta)\ \}$ HZ

Where $\eta = R1/(R1 + R2)$ Vcc

For symmetry of pulse, R1 = R2

$\eta = R1/2R1$

$= 1/2$

therefore $f = 1/(RT\ CT\ In\ 2)$

with CT = 4.7μf, 25V

$f \alpha 1/RT\ CT$

with RT = 33K

f = 0.1075 Hz

Refer to fig 10(b)

Transistor Tr4 and Tr5 perform as a free – running multivibrator otherwise called an astable multivribrator.

Ic (sat) = P{Vcc – Vce(sat)}/Rc

Rc = {Vcc - Vce(sat)}/Ic(sat)

Tr 4 = Tr5 = 2N3638 PNP transistor

hFE = 180

For switching circuit, the transistors must operate in the saturation region (i.e fully ON) required value of base current, Ib is given by

Ib = Ic (Unloaded) + fan – out current.

Fan – out current is the current that must be available to drive eternal loads.

Choosing an over drive factor of 3 to ensure that the current is driven hard into saturation

$\gamma$Ib = Ic (sat)/hFE(sat)

Ic(sat) = 30 mA

= 3(30 x 10 )/180

therefore Ib = 0.5mA

from the circuit fig 10, the loop equation gives:

Vcc = Vbe + IbRb

IbRb = Vcc – Vbe

Rb = (12 – 0.6)/(0.5 x 10)

Therefore Rb = 22.8 K

Therefore Rb = 22K

The frequency of operation is given by

1/f = (C1 R1 + C2 R2) log

f = 1/{0.693(C1 R1 + C2 R2) }

= 1/(0.7C1 R1 + C2 R2)

f = 1/(t1 +t2) Hz    t1 = 0.7C1 R1

t2 = 0.7C2 R2

If R1 C1 = R2 C2, then

f = 1/1.4R1 C1 or 1/1.4R2 C2

C1 = 1/1.4R1f    R1 = R2 = Rb

C1 = C2 =C

C = 1/1.4Rbf

f = 1/1.4C Rb

f $\alpha$ 1/CRb

Fixing the value of C at 0.1 µF

$f \alpha \quad 1/Rb \qquad C = 0.1 \times 10^{-6} F$

$Rb = 22k$

Therefore $f = 1/(1.4 \times 0.1 \times 10^{-6} \times 22 \times 10^{3})$

Therefore f = 324.5.68.Hz

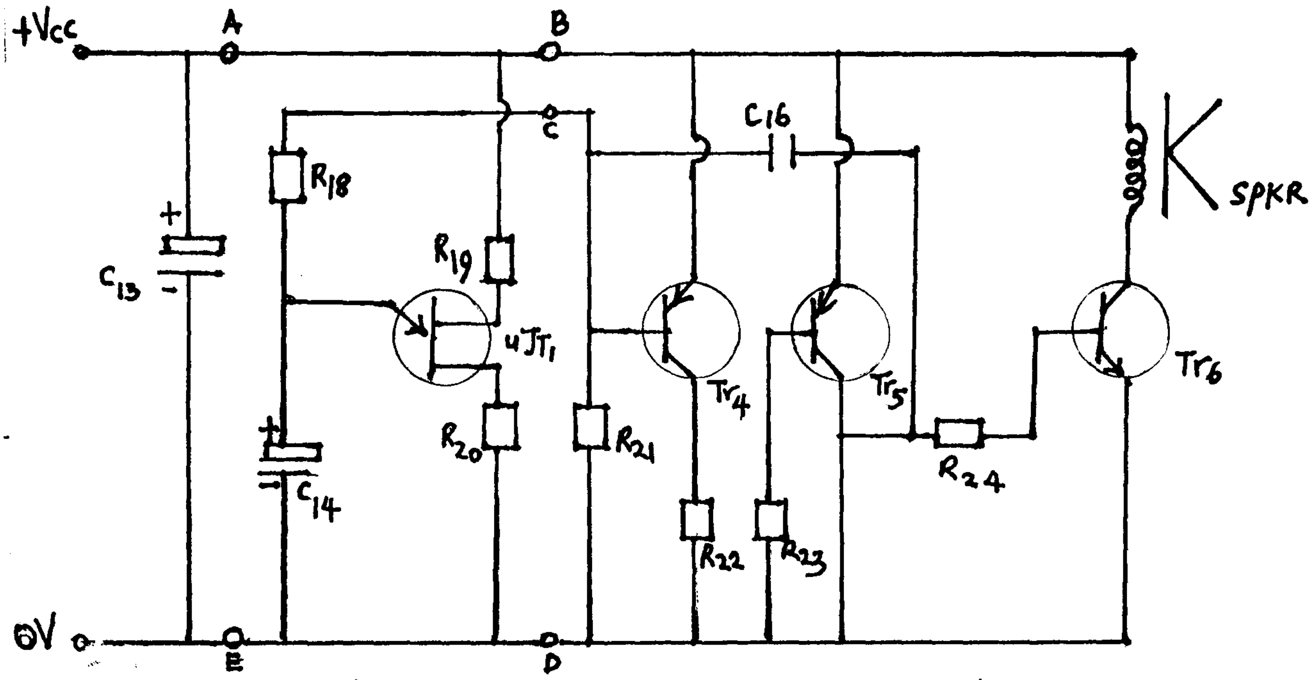



FIG 2.9 (a) THE COMPLETE CIRCUIT OF ALARM SOUNDER.

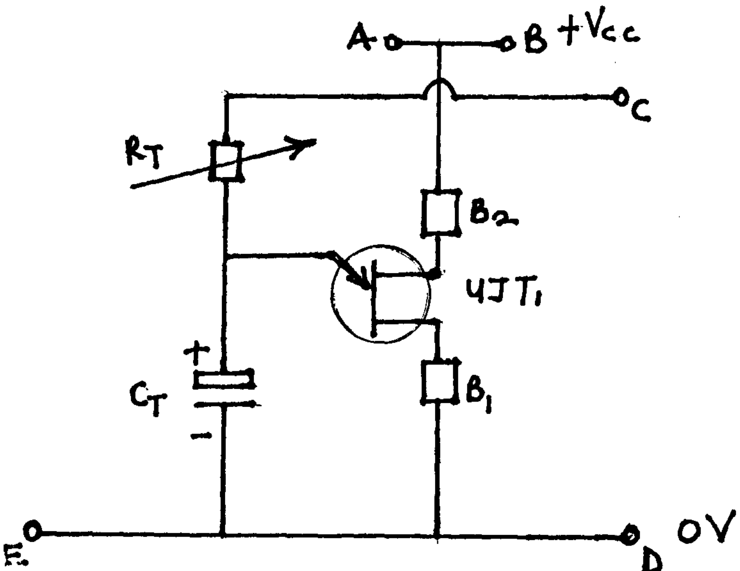



FIG 2.9 (b) UNIJUNCTION OSCILLATOR

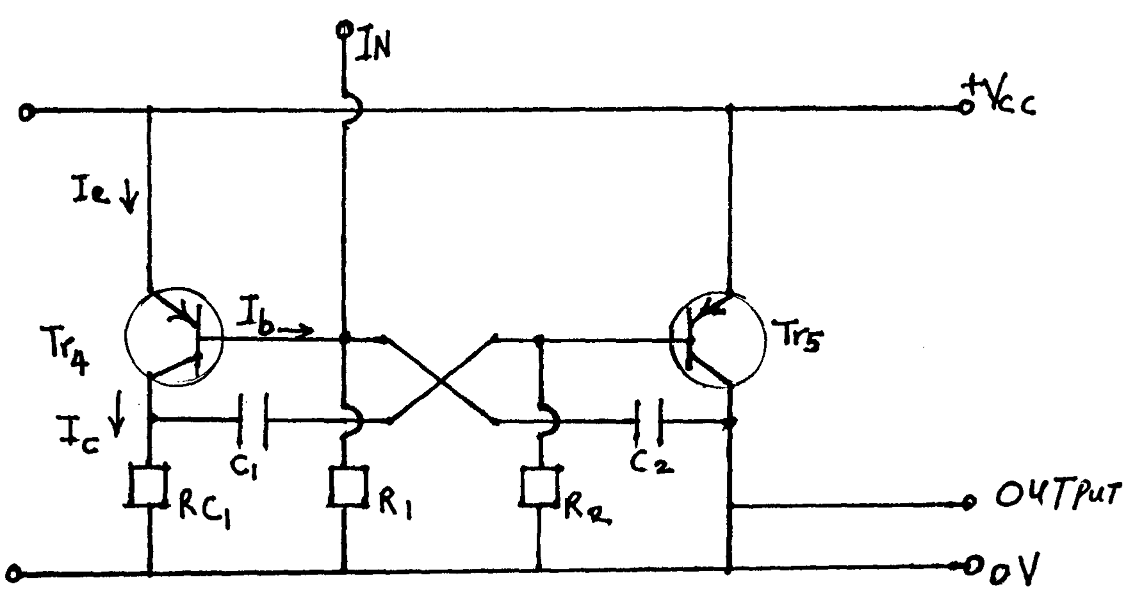



FIG 2.9 (C) ASTABLE MULTIVIBRATOR.

## CHAPTER THREE

## CONSTRUCTION; TESTING AND RESULTS

### 3.1 CONSTRUCTION

The project was constructed based on the design. Each of the stages was constructed and tested separately before coupling.

The components stated in the design were used and the methods were followed

### 3.2 TESTING OF THE ALARM CIRCUIT

Values of frequencies were obtained for corresponding values of the base resistor, Rb

TABLE 1.1 Result of alarm circuit

| **Base Resistor, Rb (K )** | **Frequency Of Operation (In Hz)** |
|---|---|
| 10 | 700 |
| 15 | 475 |
| 20 | 350 |
| 25 | 280 |
| 30 | 230 |
| 35 | 200 |

The value of capacitance, C was fixed at 0.1 μF

Frequency of operation is inversely proportional to the base resistor, Rb

$f = 1/1.4 \times C \times Rb$

## 3.3 TESTING OF TIMER CIRCUIT

Various values of time in seconds were obtained for corresponding values of the timing resistor with the value of capacitor fixed at $C = 10\mu F$

**Table 1.2 of result for timer circuit**

| Timing Resistor (K ) | Time Of Operation (Seconds) |
|---|---|
| 100 | 1 |
| 15 | 1.5 |
| 200 | 2 |
| 250 | 2.5 |
| 300 | 3 |
| 350 | 3.5 |
| 400 | 4 |

$t \alpha R$ ( i.e time of operation is directly proportional to the timing resistor)

t = 1.1. CR

## 3.4 TESTING OF THE INFRARED ALARM SYSTEM

The circuit was tested in broad day light and the performance was satisfactory.

It was also discovered that total darkness does not favour the performance of the circuit

Table 1..3 **Sensitivity of the infrared alarm system**

| **Nature of object** | **range** |
|---|---|
| Large object | 150 – 300mm |
| Small object | 25 mm |
| Very small object | Not detected |
| Large and highly Reflective object | 150 – 500mm |

## 3.5 LIST OF COMPONENTS USED

RESISTORS (1/4w)

| | | |
|---|---|---|
| R1 | = | 470Ω |
| R2 | = | 56Ω |
| R3 | = | 20Ω |
| R4 | = | 10Ω (variable) |
| R5 | = | 68Ω |
| R6 | = | 12Ω |
| R7 | = | 30Ω |
| R8 | = | 68Ω |
| R9 | = | 30Ω |
| R10 | = | 68Ω |
| R11 | = | 12Ω |
| R12 | = | 39Ω |
| R13 | = | 47Ω (variable) |
| R14 | = | 1MΩ |
| R15 | = | 10Ω |
| R16 | = | 470Ω |
| R17 | = | 10Ω |
| R18 | = | 33Ω |
| R19 | = | 100Ω |
| R20 | = | 100Ω |
| R21 | = | 22Ω |
| R22 | = | 22Ω |
| R23 | = | 22Ω |
| R24 | = | 47Ω |

TRANSISTORS

| | | |
|---|---|---|
| $Tr1$ | = | BC1096 |
| $Tr_2$ | = | BC1096 |
| $Tr_3$ | = | D400 |
| $Tr_4$ | = | 2N3638 |
| $Tr_5$ | = | MJE3055 |
| $Tr_6$ | = | 2N3638 |
| UJT | = | 2N2646 |

DIODES

| | | |
|---|---|---|
| $D_1$ | = | IN5391 |
| $D_2$ | = | IN5391 |
| $D_3$ | = | 12V Zener diode |
| $D_4$ | = | TIL 38 |
| $D_5$ | = | TIL 100 |
| $D_6$ | = | OA 91 |
| $D_7$ | = | OA 91 |
| $D_8$ | = | IN 4148 |
| $D_9$ | = | IN 4148 |

CAPACITORS

| | | |
|---|---|---|
| $C_1$ | = | 2200µf ELECTROLYTIC, 25v |
| $C_2$ | = | 2.2µf, 50v Electrolytic |
| $C_3$ | = | 10nF creamic |
| $C_4$ | = | 2.2µF, 50v electrolytic |
| $C_5$ | = | 1µF ceramic |
| $C_6$ | = | 1pF ceramic |
| $C_7$ | = | 22pF ceramic |
| $C_8$ | = | 1µF |
| $C_9$ | = | 1pF |
| $C_{10}$ | = | 100µF, 16v electrolytic |
| $C_{11}$ | = | 10nF |
| $C_{12}$ | = | 10µF |
| $C_{13}$ | = | 50µF, 25v electrolytic |
| $C_{14}$ | = | 4.7µF. 25v electrolytic |
| $C_{15}$ | = | 0.1µF cermic |
| $C_{16}$ | = | 0.1µF ceramic. |

REPLAYS

| | | |
|---|---|---|
| RLA1 | = | 6V, 4088Ω |
| RLA2 | = | 12V, 400Ω |

ICS

| | | |
|---|---|---|
| $IC_1$ | = | 555Timer |
| $IC_2$ | = | CA3140E |
| $IC_3$ | = | 555Timer |
| S1 | = | Toggle |
| F1 | = | Fuse 1 A |
| T1 | = | 240/12v center tapped transformer |
| SPKR | = | speaker, 15W, 8Ω |

# CHAPTER FOUR

# CONCLUSION AND RECOMMENDATION

## 4.1 CONCLUSION

Form the table of results for alarm circuit, it could be seen that the frequency of operation of the alarm circuit, $f \propto 1/.Rb$.

Also, from the table of result for the timer circuit, timing operation, $t \propto R$, where R is the value of timing resistor. That is the time of operation is directly proportional to the timing resistor.

From the general outcome of the testing of the infrared alarm system, it could be seen that the amount of the infrared energy emitted depends on the nature of the body and the wavelenght of the radiation. This agrees with planck's law.

Planck's Law:

$$W(\lambda) = C1\ \lambda^{-5}\ C_1\lambda^{-5}(e^{c2/\lambda T} - 1)^{-1} W / cm^2 / \mu m$$

$W(\lambda)$ =energy of radiation it shows that the Electron emerge with a kinetic energy increases directly with the frequency of the light

Where $C1 = 2\ \pi\ hc^2 = 3.7415 \times 10^4$ W. $(\mu m)^4 / cm^2$

$h = 6.6256 \times 10^{-34}$ W. $s^2$ is Planck's constant

$c = 3 \times 10^{10}$ cm/s is the velocity of light in vacuum

$\lambda$ = wavelength in micrometers

T = absolute temperature in degree Kelvin

Therefore, the objectives of the project were achieved.

## 4.3 REFERENCES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