DESIGN AND CONSTRUCTION OF SMOKE / FIRE DETECTOR ALARM SYSTEM

BY

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93 / 3577

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

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CERTIFICATION

This is to certify that this project titled Design and Construction of Smoke/Fire Detector Alarm System was carried out by Faloseyi D. Olusegun (93/3577) under the supervision of Engr. A. O. Aduloju and submitted to Electrical and Computer Engineering Department, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of Bachelor of Engineering (B. ENG) degree in Electrical and Computer Engineering.

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DECLARATION

I, FALOSEYI DANIEL OLUSEGUN, hereby declare that the project work is an original concept wholly designed and constructed by me, under supervision and guidance of my supervisor, Engr. A.O. ADULOJU of the Department of Electrical and Computer Engineering Federal University of Technology, Minna.

SIGN..................

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DEDICATION

This work is specially dedicated to God Almighty and to my dear parents Mr & Mrs E.O. Falosheyi. Also to my sisters Miss Omodolapo Faloseyi, Miss Olubukola Faloseyi, Olubunmi Faloseyi, Olufunmilola Faloseyi and Temidayo Faloseyi.

FALOSEYI OLUSEGUN

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ABSTRACT

The design and construction of fire and smoke alarm system is described in this project. The project is intended to produce an audible alarm tone in an 8 ohms (Ω) audio speaker.

This project report is intended to produce two outputs, which depend solely upon the temperature of the sensor device (thermistor) and the high resistance of the photoresistor sensor due to the blocking of light by smoke. The thermistor here is fully immersed in water (hot water). As the temperature of the thermistor increases, its resistance decreases, thereby causing it to approach the set trip value of the variable resistor.

When the thermistor resistance becomes less than the set value of the variable resistor or when the photoresistor resistance becomes higher than the set trip value of the variable resistor the comparator output switches to a high output state which are both at low frequencies. The audio oscillators are free run.

The output of the comparator (i.e from the two Op – Amp) are used to drive the two relays respectively. The signal from the relay circuit is fed into the alarm circuit which comprises a 556 multivibrator that is used to supply signal to the 8 ohms (Ω) loudspeaker which eventually produces an audible alarm.

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CHAPTER ONE

1.0 INTRODUCTION / LITERATURE REVIEW

1.1 INTRODUCTION

Security is paramount to life and is essential to every man. The fear of losing one's life or properties to armed robbers, flood or fire is in man's heart. Many security devices had been developed to protect lives and properties. Engineers had worked day and night to provide different security systems. Alarm system is one of such systems and it is designed to send information to users in the form of audio or visual signals immediately it senses danger. As part of industrial and domestic safety regulations, it is necessary to install one or two electrical protective devices in buildings and factories. The fire / smoke detector alarm is one of such units which detects visible smoke and fire and announces their presence through an alarm system.

The need for a smoke / fire detector emanates from the rampant fire disaster happening in our offices, industries or residential places and so on from time to time. Fire disaster as a result of electrical hazards (cable sparkling, generator explosion, gas explosion, petroleum explosion e.t.c) could have been averted were it that fire / smoke detector are installed in all these public places Also, the installation of such a device saves the huge amount of money that is always spent on the renovation of burnt projects, and which can be used on some other visible projects.

The system is designed in a way that when it senses any smoke from such a dangerous situation, it is connected to voltage level corresponding to the magnitude of the smoke. But if the smoke level is not enough to cause voltage more than the reference or threshold voltage the alarm will not come on. This is to say that any smoke like cigarette smoke will not cause any triggering that can make the voltage level exceed the threshold or reference voltage.

Furthermore, the system is designed such that if any fire or smoke situation is detected, and the source of the smoke had been extinguished, the alarm will stop immediately the smoke disappears. However, it is pertinent to note that the fire / smoke detector does not prevent this non – conforming situation but to announce its occurrence.

With fire / smoke detecting units installed in public and residential buildings, the rate of loss of lives and properties will surely reduce drastically, since it will provide users with an early warning that can save lives and properties.

1.2 PROJECT OBJECTIVES AND MOTIVATION

The aim of this project focuses on the construction of fire / smoke detector alarm system. A little design on each circuit part is essential but the detailed design analysis of the whole circuit is not required. Therefore, the aim and objective of this project are to construct a circuit that should be able to detect a temperature rise over the environment and also to sense the presence of smoke. It should be able to blow an audible alarm, which help in fire out break before it grows into uncontrollable proportions.

Also, the project design work is also suitable to provide a smoke alarm detector in places where there is constant electric power supply.

1.3 METHODOLOGY

The method employed in this project work is where the input of the system which is smoke/fire chamber comes first to provide the necessary signal to actuate the system. Therefore, no smoke or fire no output. The circuit is designed such that the input light source is ON permanently to supply the required light beam. When a detector senses enough smoke, the conductivity of the sensor changes, thereby increasing or decreasing its output current. This change in current is then amplified by an amplifier and its output is fed into a comparator. A relay is connected to serve as a remote current – controlled switch, which is an electromagnetic device. The alarm circuit is powered separately and has a 556 multivibrator which triggers when a certain predetermined voltage level is exceeded. This is to say that the system does not recognize the presences of just any level of smoke, it recognizes only fair thick smoke, which should be able to produce voltage level above the reference.

A device is usually incorporated which resets the fire / smoke detectors alarm immediately the smoke or fire escapes. Moreover, provision is made for sensing open circuit or short circuit faults.

However, the growth in number of smoke / fire detector alarm systems has also meant that the number of unwanted or false alarm has increased to a point where people do not necessarily believe a fire alarm when it sounds. There are many reasons for this false alarm. This includes poor maintenance of the system and bad initial fire engineering in locating the detector.

1.4 LITERATURE REVIEW OF SMOKE / FIRE ALARM SYSTEM

In its simplest form, a system to detect the growth of smoke or fire automatically can save lives and properties by allowing early remedial action. However, one major problem with most systems is the false alarm which can erode confidence in the smoke / fire detector alarm system. Modern fire security industries had indeed, through years of research programs and extensive funding have now improved significantly the smoke / fire detector alarm system. The integrated circuits, popularly called IC's, are used in this modern day circuits. These chips are designed for different functions, but can be used for a customized work in one's design as long as the chip configuration and parameters are known.

Other active devices such as transistors, and diodes can also be used along with some passive electronics elements such as resistors, capacitors and inductors to achieve this same circuit.

Automatic smoke / fire detection system had been in use since that great fire of London in 1667. Since that time nearly all the physical methods of dealing with fires had been applied. However, the most commonly used methods are still the detection of smoke or heat.

1.4.1 DETECTOR AND SENSOR

In the smoke or fire security industry, the term SENSOR is used for a device that gives a signal related to the quantity of heat, smoke or flame present whereas a DETECTOR changes it's state at the present level of smoke or heat. A sensor can also be referred to as an input transducer through which the presence of a stimulus can be identified. The stimulus can either be smoke, heat, flame or ionized gases. The physical characteristic of the stimulus is now converted to electrical signals (current, voltage or resistance) which can be amplified and then detected. Moreover, detectors are basically sensors with a present trigger point. There are different types of sensors and detectors, ranging from a simple resistive conductor to a very complicated circuit. Devices such as thermistors, photodiodes, photoresistor, solar cells, bimetallic strips, comparators, phase – sensitive detectors, temperature sensors, heat detectors e.t.c have been useful in the designs and the constructions of security or an alarm system.

1.5 PROJECT OUTLINE

The fire / smoke detector is a very important instrument that is useful in detecting fire out break. This thesis outlines the design procedures and techniques involved in the smoke detector.

Chapter One examines the general introduction into the project as a whole, it gives first hand information about the project. The chapter introduces the fire / smoke detector, give the literature review and the objectives which the project is designed to achieve.

Chapter Two discusses the steps involved in the system design. It gives information about the operating principle of the smoke alarm, the system block diagram that make up the smoke / fire detector and the considerations involved in choosing the ICs used for the project.

Chapter Three covers the details involved in the construction and testing of the project. It explains how the various components were soldered on the veroboard and how the device was tested.

Finally,Chapter Four talks about the discussion of results, conclusions reached and recommendations.

1.5.1 LOCATION TO AVOID UNWANTED ALARM

Smoke / fire detector is designed for indoor use only. Cigarette smoking will not set off the alarm under normal conditions unless the smoke is blown directly into the unit. Improper locations near kitchen, bathroom, fire place or garage may cause unwanted alarms due to concentrated high levels of humidity and products of combustion.

It should not be located near heating and cooling vents. One should avoid locating humidity respectively. The fire / smoke alarm should be placed on the ceiling but not near machines that can produce smoke or too much heat as stated above in both residential and office or industrial uses.

Normally, smoke chamber may be more than one depending on where it is to be installed.

CHAPTER TWO

2.0 SYSTEM DESIGN

2.1 OPERATION

In the block diagram in Fig 2.1, the smoke and the temperature heat chambers are made the first stage. In the fire chamber, a transducer, which is a thermistor, is used as a detector. The thermistor is an example of heat detector and it is based on detecting fire or temperature rise on an environment in this work. In the presence of fire, there will be heat, which causes changes in temperature in the environment. The thermistor is then used to sense and detect the rise in temperature. Also, the smoke chamber is made up of a light source and a photoresistor, which acts as the transducer.

In the presence of smoke at the chamber, the beam of light falls on the baffle to be diffused thereby making the beam to strike the surface or window of the photoresistor. This is possible because smoke particles are heavy enough to deflect light passing the screen and on to the photoresistor. This principle is known as Photoscatter .

When this beam strikes the photoresistor or the thermistor detects any change in temperature in the environment, a very small current which is almost proportional to the intensity of the light, flows and this is amplified by using a special type of integrated circuit called LF 353N IC which has two operational amplifier inside it. So, one of the operational amplifier, is responsible for amplification of the smoke detector while the heat detector is amplified by the other operational amplifier. The amplified signal is then converted into voltage by the feedback resistors R_1 and R_2, across the cathode of the photoresistor and the output of the amplifier.

The voltage comparator is used to mark the instant when an arbitrary waveform or signal (voltage or current) from the amplified IC (LF 353N) attains some predetermined or reference levels selected by adjustable resistor connected to the inverting terminal of the IC.

Relay circuit is incorporated in the project design, which is electromagnetic in nature. In this project work two of its kind is used, one for controlling the smoke chamber, while the other is for the fire / heat chamber. The relay switches ON in the presence of smoke or heat and it triggers OFF in the absence of smoke or heat. The of a low voltage, low current circuit and since it is a magnetic switch, a flash light cell is used to energize the electromagnetic which is controlled by the switch. Diodes are placed before the coil of the relay in order to prevent back electromagnetic force.

The output from the comparator will now trigger the multivibrator which is 556 dual timer. The multivibrator which is referred to as the alarm circuit is powered separately and the control circuit is also powered separately in order to have the required power to make the alarm sound properly well without using any audio amplifier. The 556 Dual timer works as astable at both ways i.e. free – running multivibrator. The astable multivibrator provides the frequency of oscillation to operate the loudspeaker.

The output from the astable produces an alarm signal through an 8 ohm (Ω) loud speaker.

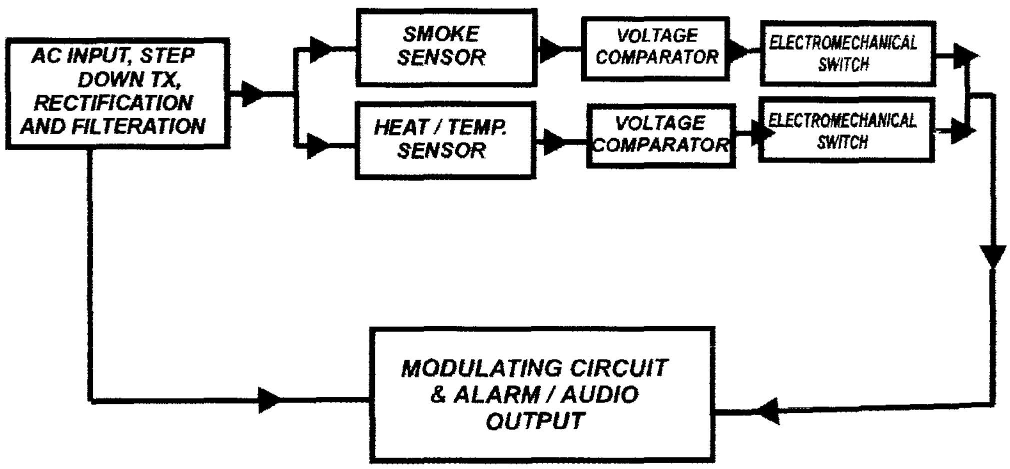

Fig 2:1 **BLOCK DIAGRAM SMOKE / FIRE DETECTOR**

2:2 SMOKE CHAMBER

This is a stage that actually detects the input, which is the smoke. The arrangement is as shown in fig 2.2. It comprises a photoresistor and a light source, arranged in such a way that a baffle or an opaque material is placed between them. Under no – smoke condition, light from the source will not reach the photoresistor due to the screen and the non – reflective nature of the interior. The presence of smoke in the chamber would allow some light reflection to reach the photoresistor. The smoke will diffuse the beam so that light strikes the photoresistor. As it is depicted in Fig 2.2, the smoke particles are very heavy enough to cause deflection of light past the screen and on the photoresistor.

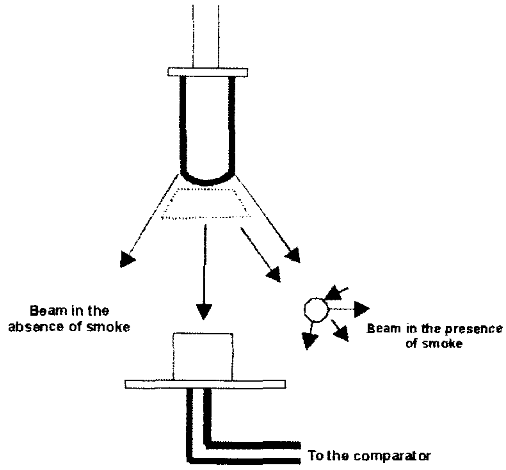

Fig. 2:2 ARRANGEMENT OF THE SMOKE CHAMBER

2.2.1 PHOTORESISTOR

The photoresistor, sometimes called a photoconductive cell, is a two terminal device whose resistance decreases in the presence of light.

When the light falls on a PN- junction of the devices, however, the photons, whose energies exceed the energy gap of a semi conductor produce additional charge carriers (holes and electrons) which is almost proportional to the intensity of the light. These newly created free carriers have no appreciable effect on the majority carrier concentration. Photoresistors are operated in the reverse- biased condition. If the reverse biased junction is illuminated, the current varies almost linearly with the light flux.

The dark current of a photoresistor is low and essentially the same as normal reverse saturation current of a typical resistor. The action of reversed forces makes the newly created holes moves toward the cathode and electrons towards anode. The net effect is the large increase in the reverse current.

In typical photoresistor, the increase in the reverse current is almost directly related to light intensity. The typical set of characteristics and symbols are shown in Fig. 2.3 and 2.4

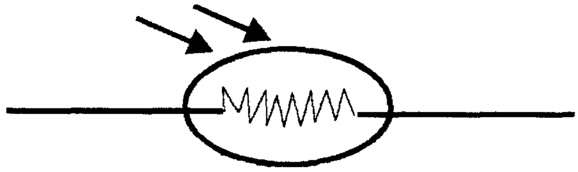

Fig 2.3 Symbol of a photoresistor

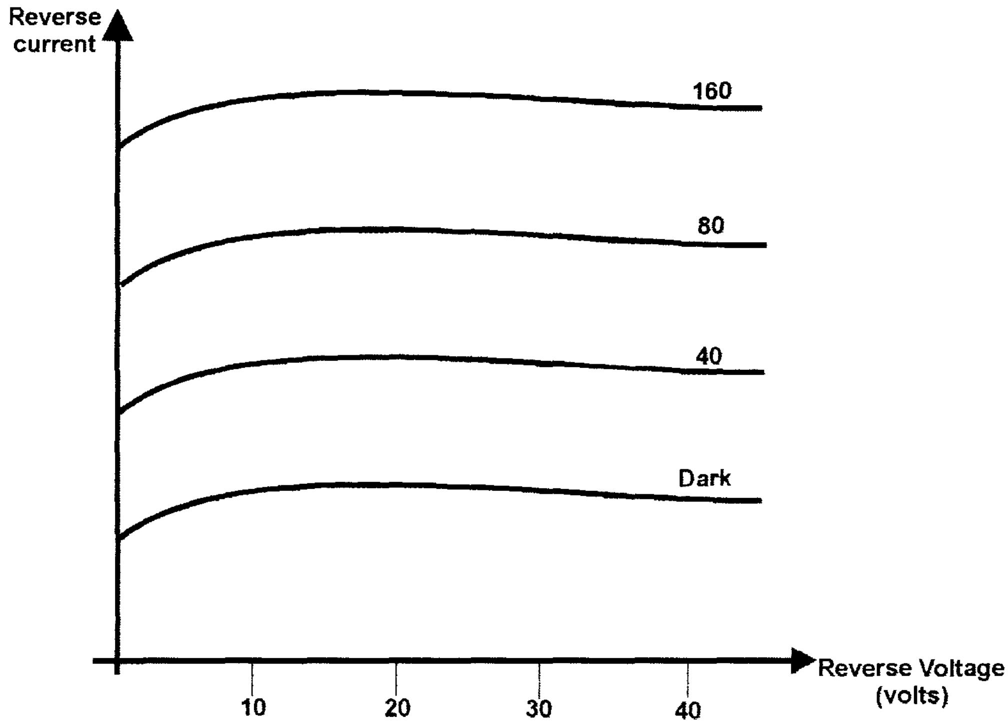

Fig 2:4 **Characteristics of Photoresistor reverse current to the light intensity**

2.2.2 NEON LIGHT SOURCE

A neon light source is a diode that will emit light when forward-biased. Neon light is often used as displays to communicate information to equipment operators.

The input neon light is permanently ON to provide steady sources of illumination. The project is designed in a way that very small current is drained; therefore, it can be ON for any length of time.

Neon light is made of semiconductor emit light in the infrared region (wavelength = 905mml, the neon light has light illumination as its output).

Therefore, the emitted light can be made variable. A reflector is placed at the back of the neon light to converge the rays into a thin concentrated beam.

The current I_D flowing through the neon light is given by:

$$I_D = \frac{V_c - V_d}{R_d}$$

Where:

V_c = supply voltage

V_d =forward voltage drop across the neon light.

R_d =current limiting resistor.

2.3 FIRE CHAMBER

This is the stage where the temperature heat changes is actually detected. There is a wide range of heat detectors, but the principle of operation, that of temperature rise, remains the same for each.

Detectors, which use thermocouple and solid state detectors (thermistor), use electrical principles to operate an alarm.

In this project work the temperature transducer used is thermistor which is shown in the circuit diagram.

2.3.1 THERMISTOR

An inexpensive temperature traducer of the resistance thermometer type is the thermistor. It is make from sintered mixtures of metal oxides and has semiconductor characteristics. Those used for measurement of temperature (as opposed to detection of temperature change) have a negative temperature coefficient. This means that an increase in temperature causes a reduction in the resistance of the device. One problem with thermistors is the extreme non – linearity of their characteristic but they are very sensitive indeed and very fast acting.

In this project work the thermistor detects the changes in temperature heat of the environment and senses it occurrence.

2.4 PHOTORESISTOR AND THERMISTOR AMPLIFIER

The amplifier employed for this purpose is LF 353N dual in nature, which is an 8 -pin JFET operational amplifier. It is biased through a stabilized and filtered 12volt-dc supply. However, it can take between the range of + 5V to + 18V dc supply. Other Op –

amps family that can be used for this purpose are LM 355, LF 315N and LF 356B. The advantages of using LF 353N as the amplifier include:

(i) high input impedance

(ii) low noise amplifier i.e. it has better thermal stability.

(iii) less current consumption

(iv) stability at high temperature

(v) faster frequency response

(vi) high voltage gain i.e. the voltage generated at the output of the ICs is sufficient and powerful enough to drive the relay.

The current produced by the photoresistor and thermistor is fed to the amplifier and it is converted to voltage by the resistors R_1 and R_2 to the output. The amplifier also acts as a current – to – voltage converter.

For all Op – amps, there will be very small bias current flowing into the inverting and non – inverting input terminals. For FET input op – amps, these bias currents are so small that their effect upon any voltage offset can be neglected. The circuit diagram of the photoresistor and thermistor amplifier is as shown in fig 2.5 and the block diagram of the IC, is shown in fig 2.6. The current from the amplifier is converted to voltage and amplified to the comparator.

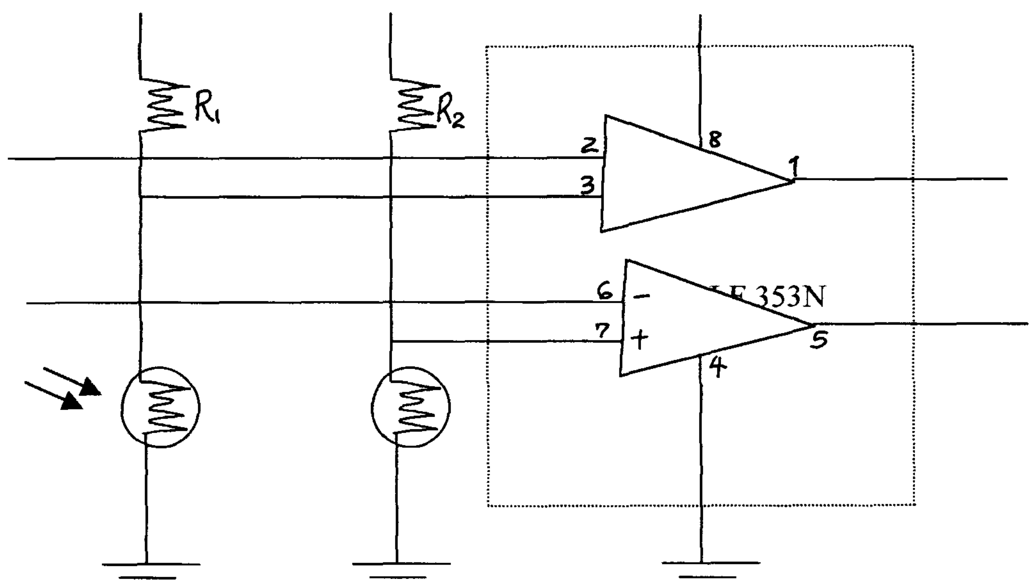

Fig 2:5 Basic circuit of the LF 353N amplifier

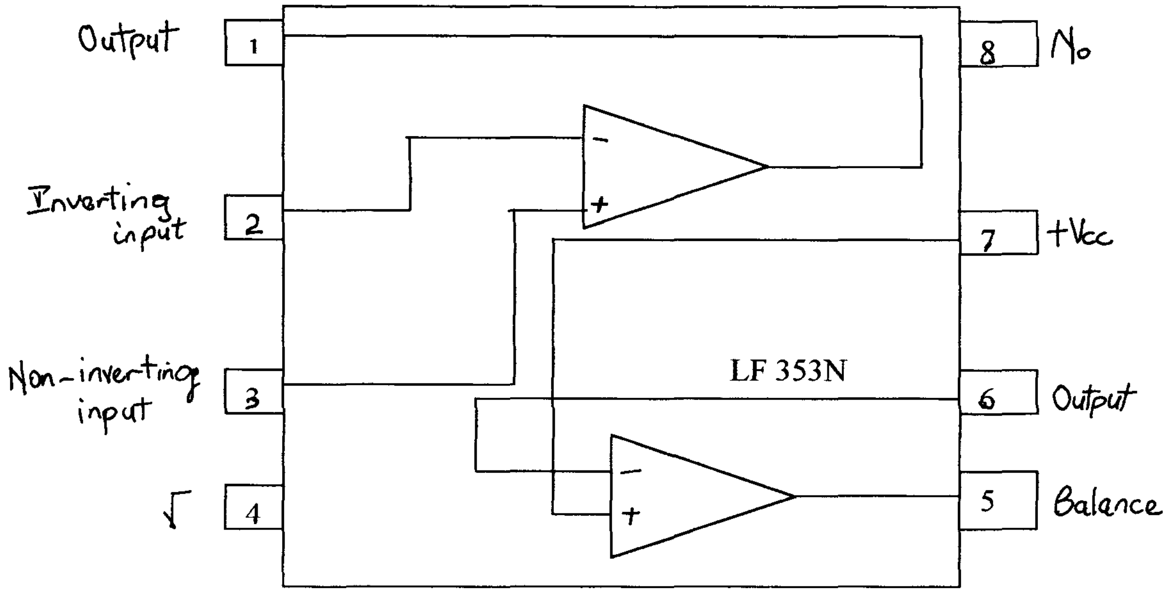

Fig 2.6 Block Diagram of LF 353 N amplifier

2.5 COMPARATOR

The function of a comparator is to compare two voltages A and B. If A>B, the comparator output will remain at one voltage level, if B>A, then the output will be at a second level. Thus if B is changing relative to A starting at a lower value and increasing, as the level of B passes that of A, the output level will switch. This relationship is shown in the transfer characteristic in Fig 2.7

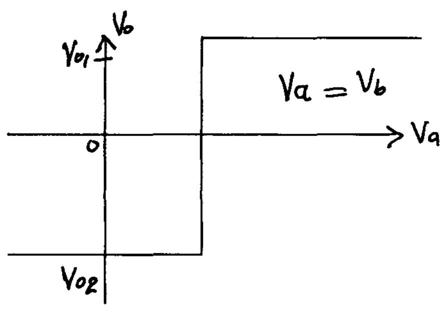

Fig 2.7 **The transfer Characteristic of a Comparator**

In this case, V_B is a reference level and Va. varies between negative and positive values compared with V_B. Two arbitrary output levels V_{O1} and V_{O2} are shown in the figure above. In practice, positive, negative or zero reference levels can be used and output levels can be chosen to interface with logic circuitry such as TTL or CMOS are required.

The resistor VR1 and VR2 are connected to the operational amplifier, which are employed to select the reference voltage. The resistors have two adjusting sliding contacts that function as an adjustable voltage divider.

The comparator circuit is used to mark the instant when arbitrary signal (voltage or current) attains the reference level that has been selected by the resistor. The comparator may be a sharp pulse which occurs when signal and reference are equal.

Here, the simplest form of comparator, which is a high gain differential amplifier made with an operational amplifier, is used. It is designed such that the operational amplifier goes positive or negative saturation according to the difference of the input voltages.

An Op – amps can be used as a comparator but in spite of this, there are still some special integrated circuit that are designed to be a comparator. Examples are LM311, LM306, LM393, NE527,TLC 372 and LF353. They are all designed for very fast response.

In the design of this project, IC LF 353N is used because of its high input impedance, also the amplifier is a low noise, which maintains its stability at high temperature.

2.6 RELAY

A relay could be generally defined as a remote current – controlled switch. Relays are mainly electromagnet with sets of contacts. A d.c relay consists mainly of sets of contacts (Normally closed (N.C), and Normally open (N.O) a coil would on soft iron core. The winding and core are made up the magnetic circuit of the relay.

The relay used in this project design is a d.c relay which acts more or less like a switch. This is applicable here because of its ability to control large current through its contacts. When the switch is closed current flowing in the coil creates a magnetic field, which pulls the contact together. But, when the switch is open, this stops the flow of current in the coil, which in turn causes the magnetic field to decay.

CONTROL CIRCUIT

The control circuit is made up of low noise junction field effect Integrated Circuit wired as voltage comparator. The Integrated Circuit has two operational amplifier (Op – amp) inside it (dual JFET IC) and each of them controls the smoke and fire / heat signal. This IC has a very high gain so that the use of amplifying circuit at the output of the Op – amp to drive the relay is not necessary.

A linear potentiometer is used to produce reference voltage (Vref) to the Operational amplifier, thereby making the Vref to be adjustable to individual user taste and based on environmental condition at a particular time.

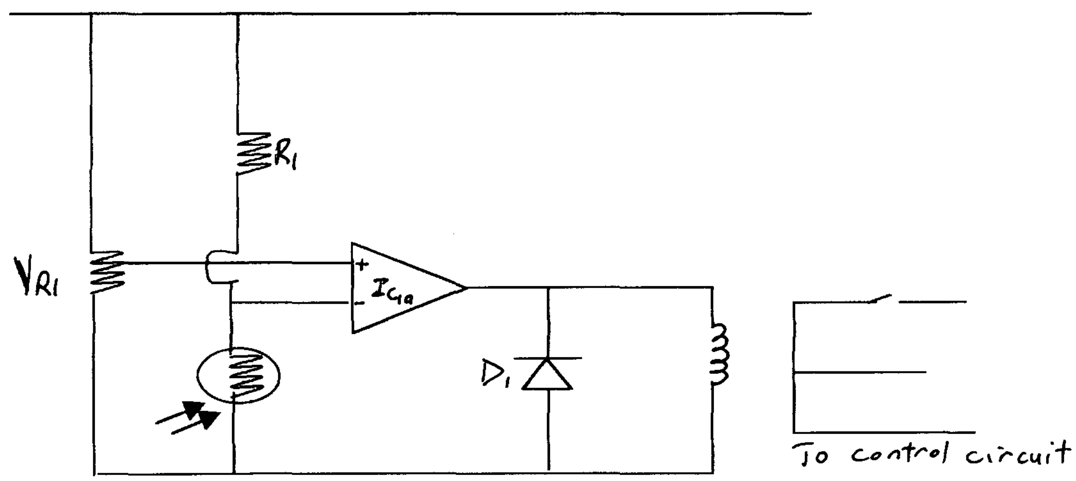

Fig 2:5.1 SMOKE COMPARATOR

The photoresistor has dark resistance of: 15kΩ

The photoresistor has light resistance of: 900Ω

The Vref is adjusted through V_{R1} and has the reference voltage ranging from 0 –Vcc

Assuming V_{R1} is adjusted to A

Using voltage divider theorem

$$\text{The voltage at A} = \frac{A \times Vcc}{V_{R1}}$$

A variable resistor reading is 20k and the voltage that power the circuit is 12V

$$\therefore \quad \text{Voltage at A} = \frac{12A\ V}{20} = 0.6\ AV$$

Assuming A is adjusted to 5Ω

$$\therefore \quad \text{Voltage at A} = 0.6 \times 5 = 3.0V$$

Since we want a significant voltage at the inverting input of the Op – amp (i.e. 50% at Vcc). Therefore, we want the voltage at inverting input to be 0.50Vcc when the photoresistor is at dark temperature.

$\therefore$ Vin (inverting voltage) $= 0.5Vcc = \frac{R_1 \times V_{cc}}{R_1 + R_{ph}}$

$$0.50 \times 12 = \frac{12 R_1}{R_2 + 15}$$

$$6.0 = \frac{12R_1}{R_1 + 15}$$

$$6.0 \ (R_1 + 15) = 12R_1$$

$$6.0R_1 + 90 = 12R_1$$

$$12R_1 - 6.0R_1 = 90$$

$$6.0R_1 = 90$$

$$R_1 = \frac{90}{6}$$

$$R_1 = 15k\Omega$$

$\therefore$ We use a resistor of $15k\Omega$

At dark resistance : - $V_{in} = (0.5 \times Vcc)V$

$= 0.5 \times 12$

$= 6V$

At light resistance : - $Vin = \frac{R_{PH} \text{ at light} \times Vcc}{R_{PH} \text{ at light} + R_1}$

$$\frac{900 \times 12}{1500 + 900}$$

$$\frac{10800}{15900}$$

$$= 0.679V$$

$Vo = A\,(Vref - Vin)$

$A = 10^5$ (manufacturer data book)

E. C. G book.

$Vo = A\,(Vref - Vin)$

$Vo = 10^5 (Vref - Vin)$

At dark resistance

$Vo = 10^5 (Vref - 6.0v)$

At light resistnace

$$Vo_{light} = 10^{5}(Vref - 0.679v)$$

And for relay to be driven Vref > Vin however

Vref is the same throughout the temperature variation.

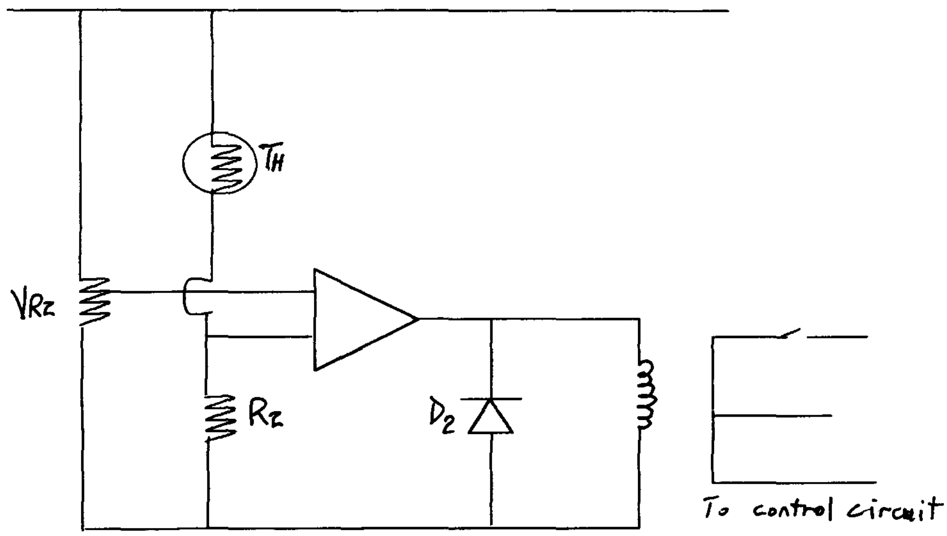

Fig 2:5.2 FIRE COMPARATOR

The thermistor cold resistance : 1.86kΩ at room temperature.

The thermistor warm resistance : 320Ω at 100° C

The Vref is adjusted through V_{R2} and has the reference voltage ranging from 0 – Vcc

Assuming V_{R2} was adjusted to B

Using voltage divider theorem

$$\text{The voltage at B} = \frac{B \times Vcc}{V_{R2}}$$

A variable resistor reading is 20k and the voltage that power the circuit is 12v

$$\therefore \quad \text{Voltage at B} = \frac{12B}{20} V = 0.6\,BV$$

Assuming B is adjusted to 6V

$$\therefore \quad V \text{ at } B = 0.6 \times 6$$

$$= 3.6V$$

Since we want a significant voltage at the inverting input of the Op – amp (i.e. 45% of Vcc) The voltage at inverting input is taken to be 0.45Vcc when the thermistor is a room temperature.

$$\therefore \quad Vin = 0.45Vcc = R_2 \times Vcc$$

$$0.45 \times 12 = \frac{12R_2}{R_2 + 1.86}$$

$5.4 (R_2 + 1.86) = 12R_2$

$5.4R_2 + 10.044 = 12R_2$

$$R_2 = \frac{10.044 \text{ k}\Omega}{6.6}$$

$R_2 = 1.52K\Omega$

$\therefore$ We use a resistor of $1.50K\Omega$

At room temperature: $-Vin = (0.45 \times Vcc)V$

$(0.45 \times 12)V$

$= 5.4V$

At $100^{\circ}C$ $$-Vin = \frac{R_{TH} \text{ at } 100^{\circ}c \times Vcc}{R_{TH} \text{ at } 100^{\circ}c + R_1}$$

$$Vin = \frac{320 \times 12}{1500 + 320} \qquad \frac{284}{182}$$

$-Vin$ at $100^{\circ}C = 2.10V$

$Vo = A(Vref - Vin)$

$A = 10^5$ (Manufacture data book)

$Vo = 10^5(Vref - Vin)$

$\therefore$ At Room temp

$V_{OR} = 10^5 (Vref - 5.4v)$

At $100^{\circ}C$

$Vo_{100^{\circ}c} = 10^5 (Vref - 2.10)$

$\therefore$ $Vref > Vin$ before the relay could be driven

2.7 MULTIVIBRATOR CIRCUIT

The multivibrator circuit consists of two 555 timers IC incorporated in one IC called 556 Dual timer. It is designed together in such a way that the two ICs work hand in hand. This is an oscillator that contains two linear inverters coupled in such a way that the output of one provides the input for the other. The essence of having this unit in the design is to provide the necessary oscillation to drive the loudspeaker, since loudspeaker operates on an alternating signal.

There are several types of multivibrator circuits, they are monostable (oneshot), astable (free running) and bistable multivibrators. But for the purpose of this project, two astable multivibrators are employed.

The 556 Dual timer can also be used to generate single pulse of arbitrary width, as a bunch of other things. The output goes HIGH (near Vcc) when the 556 Dual timer receives a TRIGGER input, and it stays there until the THRESHOLD input is driven, at which time the output goes LOW (near ground) and the DISCHARGE transistor is turned ON. The TRIGGER input is activated by an input level below 1/3 Vcc, and THRESHOLD is activated by an input level above 2/3 Vcc

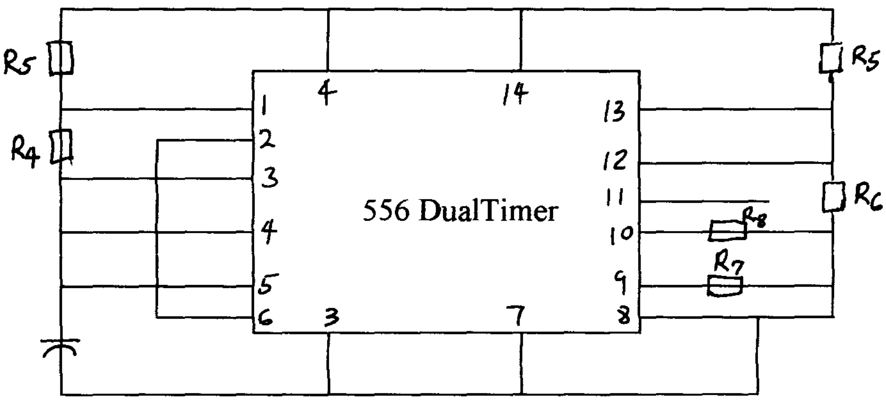

Fig 2:8 Basic circuit of the two Astable connection using a dual 556 Timer.

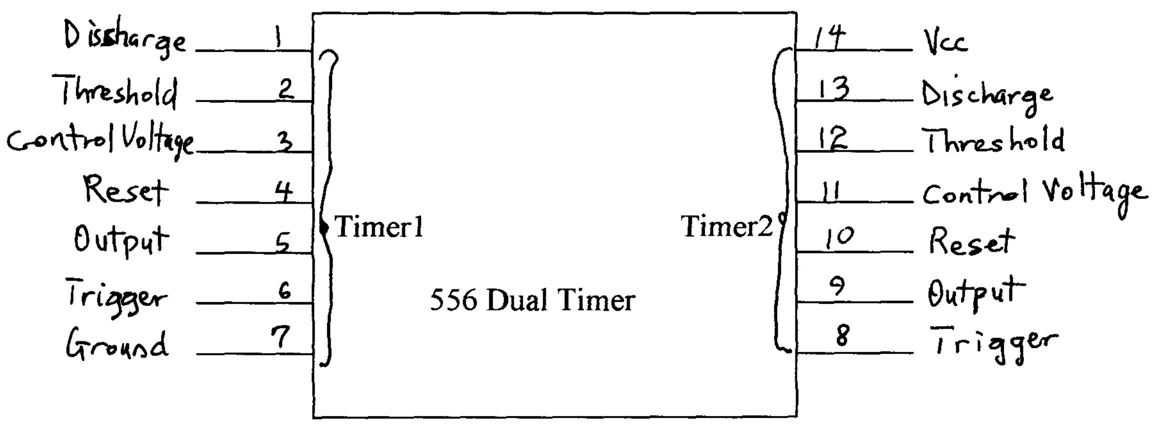

Fig 2:9 **TIMER PIN – OUT DIAGRAM**

2.7.1 ASTABLE (FREE – RUNNING) MULTIVIBRATOR

This is a free – running rectangular wave generator. None of the states is stable, that is, it has two quasistable states. This is so because the output remains in one of these states for a time T_1 and then abruptly changes to second state for a time T_2 and the cycle of period $T = T_1 + T_2$ repeats.

As stated earlier, a dual 556 timer is used as astable circuit at both sides of the timer. The advantages of using 556 dual timer are that

(a) It can withstand higher temperature

(b) It saves space

(c) It is cheaper than buying two 555 timers

For the basic astable circuit IC_3 pins 2 and 6 are connected together so that the circuit will trigger each timing cycle, thereby functioning as the an oscillation frequency is independent of Vcc.

The total time required to complete a charge and discharge cycle is

$$T = T_1 + T_2$$

$$T = 0.693\ (Ra + 2R_b)$$

Seconds and the frequency of oscillation is 1/T, so that

$$f = \frac{1.44}{C_4(Ra + 2R_b)}$$

The duty cycle, which is defined as the ON time as a percentage of the total cycle time, is given in this case by the ratio

$$\text{Duty ratio} = \frac{R_b}{R_a + 2R_b}$$

MULTIVIBRATOR

Modulator

R_3, R_4 & C_3 determine the T_{on} and T_{off}

$T_{on} = 0.693\ (R_3 + R_4)\ C_3$

$T_{off} = 0.693\ R_4\ C_3$

Total time $= T_{on} + T_{off}$

We want the ton to be for 0.2 seconds

$T = 0.693\ (R_3 + R_4)C_3$

We choose an electrolytic capacitor of 3.3μ F, 25V Resistor (R_4) is also chosen to be 100kΩ

$0.2 = 0.693\ (R_3 + 100k)\ 3.3\times10^{-6}$

$R_3 \approx 22.2k\Omega$

For $T_{off} = 0.693\ R4\ C3$

$T_{off} = (0.693 \times 100k\Omega \times 3.3\times10^{-6})S$

$T_{off} = 0.2$ seconds

$f = \frac{1}{T_{total}} \quad \frac{1}{0.4} = 2.5Hz$

Duty ratio= $\frac{R_4}{R_3 + 2R_4}$

$= \frac{100k}{2{,}2k + 2\ (100k\Omega)} \quad \frac{100}{202.2} = 0.49$

≈ 0.5

For the multivibrator that determine the audio out put

$T_{on} = 0.693\ (R_5 + R_6)\ C4$ - (i)

$T_{off} = 0.693\ (R_6)\ C_4$ - (ii)

Let the Toff be ½ ((0.5) of Ton

$T_{on} = 0.693\ (5k\Omega + 5k\Omega)\ 0.1 \times 10^{-6}$

$T_{on} = 0.693\ (10k\Omega)\ 0.\ 1\times10^{-6}$

$T_{on} = 0.7ms$

$T_{off} = 0.35ms$

Choose resistor of $5k\Omega$

$0.35 \times 10 = 0.693 \times 5 \times 10^{3} \times C_4$

$C_4 = 1 \times 10^{-7}\mu$

$C_4 \quad 0.1\mu F$

$T_{on} = 0.7 \times 10^{-6} = 0.693\ (R_4 + 5k\Omega)\ 0.1 \times 10^{-6}$

$R_4 \approx 5k\Omega$

R_8 limits the current to voltage control input

R_7 limits the current to the speaker.

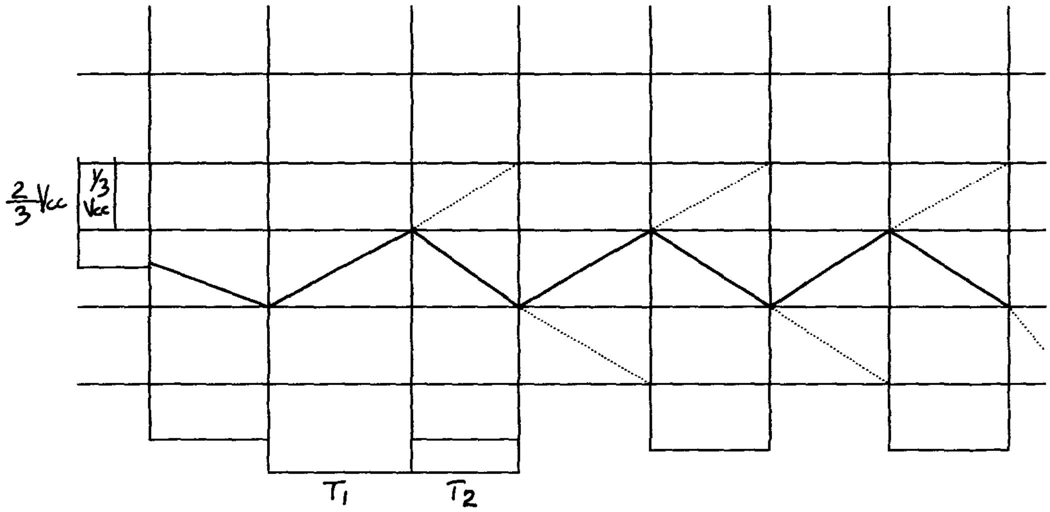

Fig 2:10 **Graphical Illustration of an Astable Multivibrator**

Therefore, as R_b decreases, the duty cycle approaches zero and as R_b increases, the duty cycle approaches 50%. This can be illustrated graphically as shown in Fig 2:10

2.8 OTHER COMPONENTS

2.8.1 LOUDSPEAKER

This is a transducer that converts electrical signal to sound energy. It is the final unit of any sound reproducer.

Loudspeaker uses a coil and diaphragm arrangement in which a small coil is fixed at the centre of a diaphragm that is free to move in an annular gap. A strong magnetic field produced by either a permanent magnet or electromagnet is applied across the gap. The audio signal from the audio amplifier is the input of the coil (known as speech coil) which has an alternating current causing it to move in the magnetic field as a result electromagnetic induction. The diaphragm is thus caused to vibrate at the same frequency as the alternating current and sound waves are produced by it.

2.8.2 RESISTORS

Resistors are devices that limit the flow of electrical current. They are used as potential dividers between points in circuits and also used to achieve protection or control in circuits.

2.8.3 CAPACITORS

These are used to store electrical energy and block the flow of direct current while passing alternating current. They are used in association with resistors as time constants in this design.

2.8.4 POTENTIOMETER

This is a three – terminal rheostat or resistor with one or more adjustable sliding contacts that functions as an adjustable voltage divider. But for the purpose of this project, it is used as an adjustable voltage divider, it is used to select the reference or threshold voltage going to the comparator.

CHAPTER FOUR

4.0 CONCLUSION / RECOMMENDATION

4.1 RECOMMENDATIONS

During the course of testing this project, it was observed that the efficiency is higher during night than daytime, this is because there would be more illumination in this time than the daytime. Since LED glows better in darkness than in any other conditions, this will aid the deflection of the beam towards the window of the photoresistor. Moreover it works best in doors due to stray ac field elsewhere.

Furthermore, the distance at which the photoresistor is placed to LED also determines the sensitivity of the photoresistor. The distance of the baffle to the photoresistor also matters. It also contributes to the fast response of the photoresistor. An LF 353N IC was used because it is a low noise amplifier, that is, it makes thermal noise insignificant.It also has high voltage gain. The voltage generated at the output of the IC is sufficient and powerful enough to drive the relay.

Lastly, it was observed that the output of the smoke detector goes "ON" for as long as there are still some particles of smoke test in the smoke chamber, but it goes "OFF" immediately there is no more smoke present.

It is therefore recommended that every home, industry and office should be compelled to install fire/smoke detecting units to avert any unforeseen danger of fire which might cause loss of lives and properties.

From the experience obtained during the course of this project, the limitations and problems encountered have constrained me to recommend as follows: -

1. Project topics should be given to students early enough to allow for adequate preparation.
2. Companies and establishments should be consulted for possible sponsorship of various projects.
3. Practical should be given more time in school and consumable items made available

4.3 **REFERENCES**

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CHAPTER THREE

3.0 CONSTRUCTION, TESTING AND RESULTS

3.1 BREADBOARD AND VEROBOARD CONSTRUCTION

The component assembly of this project is straightforward and should carefully follow the layout designed for the project work. The assembly of components is divided into two stages. The first stage was experimental which involves mounting of the components on the breadboard, while the second stage was the actual construction, which involves soldering on the veroboard.

After undergoing the first stage, necessary adjustments were made to the circuit so as to meet the specification and the standard required. After all the stages on the breadboard of construction have gone through testing and found working perfectly, we then proceed to the second stage of component assembly where each stage mounted on breadboard was transferred on to the veroboard, after which soldering takes place immediately.

3.2 SOLDERING TECHNIQUES

Components are connected together in circuits by soldered joints. Solder is basically an alloy of lead and tin, the proportions varying according to the application for electronic work (as the constructed power supply). A mixture of 60 percent tin and 40 percent lead is used. If solder is heated to the melting point and applied to a variety of different metals, it will amalgamate with the surface to provide a joint with high electrical conductivity and mechanical strength.

The prime requirement in soldering is cleanliness both of soldering iron and work – component leads, tags, veroboard etc. Cleanliness means absence, not only of dirt and grease, but of oxidation on metal surfaces. Visibly corroded component lead must be scrapped using pliers, side – cutters or knife blade to discourage further oxidation, by melting a coating of solder on to them.

For keeping the soldering iron bi-face clean, frequent wiping on a damp sponge is all that is required once the bit has been tinned.

3.3 CONSTRUCTION

The component parts of the design are coupled together to make up a unit of fire/smoke detector alarm system. There are smoke chamber, fire chamber, comparator circuit, relay and multiribrator circuit. As shown in fig.2.1

There was a little deviation from the designed values when construction work was carried out. However, the smoke and fire chamber was made into an enclosure and safety precaution on the photoresistor and thermistor was taken in consideration. The photoresistor and LED were aligned such that the light from the LED does not fell directly on to the photoresistor except by deflection by the smoke. The thermistor was placed in the position where the temperature heat difference could be easily noticed. Also, a relay circuit is incorporated which serves as a switch control to the entire circuit.

3.4 TESTING

After the components have been mounted on the breadboard and proper safety precautions carried out, the system was powered from the 12V-dc supply.

Oscilloscope and multimeter (digital) were connected to various stages and readings were compared and found to be similar.

Smoke was prepared and placed some distance to the chamber and there was audible sound from the loudspeaker. The alarm will stop immediately the smoke is cleared.

For the fire chamber, test was also carried taking the hours of tests per day in six hours and this was subjected to test for four different days.

	DAY 1, TEMP. AT TRIGGER ^{o}C	DAY 2, TEMP. ^{o}C	DAY 3, TEMP. ^{o}C	DAY 4, TEMP. ^{o}C
1^{ST} HOUR	65	62	65	60
2^{ND} HOUR	60	60	60	60
3^{RD} HOUR	60	55	60	60
4^{TH} HOUR	60	55	58	55
5^{TH} HOUR	58	53	55	55
6^{TH} HOUR	55	58	55	55

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3. Practical should be given more time in school and consumable items made available

4. More technical books on Engineering should be made available in the library to facilitate students research work on Engineering.

4.2 CONCLUSION

The project is designed and constructed to detect every type of smoke and (multipurpose) this is unlike the imported ones, which are made only for a particular type of smoke and fire. It can be used anywhere both at home and industries. It has the advantage of simplicity, and the use of variable threshold will permit flexibility when the system is produced for use.

The system was designed and constructed with a view to making it commercially viable. But if the project could be improved and produced enmasse, it would surely be more effective and efficient than the ones already in market.

The ups and downs, the author has gone through during the period of design and construction have made him to learn a lot things in the field of electronic engineering and most especially in the behaviour of transducers like photoresistor, thermistor and light emitting diode in relation to light. However, the knowledge acquired in the usage of Integrated circuits (ICs) especially with respect to their response and flexibility cannot be ignored. It can therefore be improved upon by the addition of more ICs for the audio output. It is my wish however to see this project improved upon and marketed one day.

In conclusion, the aim and objectives of this project was realised despite the limitations and some problems encountered.