DESIGN AND CONSTRUCTION

OF

MULTIPLE FIRE ALARM SYSTEM

BY

USMAN MOHAMMED BABA

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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DEDICATION

This project is dedicated to the glory of Almighty ALLAH and to my beloved parents MALLAM ABUBAKAR USMAN WACIN, MALLAMA AISHATU ABDULMALIK AND MALLAMA AISHATU ABUBAKAR for their care and support throughout my academic pursuit in F.U.T minna.

DECLARATION

I Usman Mohammed baba declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the federal university of technology minna.

Usman Mohammed baba

(Name of student)

....

(Signature and date)

Mr. J.A Ajiboye

(Supervisor)

....

(Signature and date)

Eng'r M.D Abdullah

(HOD)

....

(Signature and date)

....

(External supervisor)

....

(Signature and date)

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Finally, I thank GOD for seeing me through the years.

ABSTRACT

The design and construction of multiple fire and smoke alarm system is described in this project. It is intended to produce an audible alarm tone in an 8 ohm audio speaker and also LED display.

This project is intended to produce two outputs, which depend solely upon the temperature of the sensor device (thermistor) and the high resistance of the LDR sensor due to the blocking of light by smoke.

When the thermistor resistance becomes less than the set value of the variable resistor or when the LDR becomes higher than the set value, the comparator output swiches to a high output state which are both at high frequency. The audio oscillators are free running.

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 of two 555 timers which are used to supply signal to the 8 ohms loudspeaker which eventually produces an audio alarm with LED display indicating whether it is the smoke or temperature that is posing the danger

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CHAPTER ONE

1.0 INTRODUCTION ON ALARM SYSTEMS

An Alarm is a device that warns or signal, while a system is a group of objects, components or units combined to form a whole functional unit collectively an alarm system is a combination of devices that work together to alert one of a dangerous or unfavorable situation, ensures security and provide certain information when required.

Alarm systems in buildings, serves to protect the building, its equipments and its occupant from impending disaster and as such may as well be one of the most important systems in the building. They serve as round the clock watch dogs against fire, heat and burglary as well as monitor various parameters such as pressure, temperature liquid levels e.t.c.

Alarm systems are usually open loop control system. A basic alarm system consists of two essential components: an alarm detector and an Alarm indicator. Frequently, they are remote control systems, that is, the detector is located remotely from the indicator.

1.1 ALARM DETECTORS

Alarm detectors are used to monitor a given situation and provide the information required to decide whether or not an abnormal or dangerous condition exists.

1.2 ALARM INDICATORS

Alarm indicators are used to translate the information from alarm detectors into a warning signal when a pre- determined limit is exceeded. The warning usually is accomplish by means of visual or audible signal. Those signal can be as commonplace as the flashing light and ringing bell that are often found at a railroad grade crossing.

1.3 INTRODUCTION TO FIRE DETECTION SYSTEMS

In fire detection, smoke detectors and Heat detectors are both used. Smoke detectors are effective in sensing fires. In their early stages. Heat detectors require high temperature before they respond and therefore react very slowly to fire.

1.4 HEAT DETECTION

Heat detectors are the oldest type of automatic fire detection devices. They are the least expensive fire detectors and have the least false alarm rate of all fire detectors, heat detectors are best suited for fire detection in small confined spaces.

1.5 SMOKE DETECTION

Smoke detectors provide faster detection time and higher false alarm rates due to their increased sensitivity. Devices such as photoelectric cells and ionization detectors.

The photoelectric detectors respond quickly to smoldering fires while ionization detectors respond quickly to flaming fast burning fires. Smoke detectors are very effective for life saving applications. Smoke detectors should be used in areas where life safety and fast response time is paramount. Smoke detectors can operate within seconds of fire ionization. Smoke detectors are very effective for life saving applications, but are more difficult to locate, in that air current, which might affect the direction of smoke flow, must be taken into consideration. The ionization detector responds more quickly to flaming fast burning fires. A radioactive element inside the chambers and makes it a conductor of electricity. Any smoke entering the detector slows or blocks the current and the circuit is closed.

1.6 ALARM UNIT

It cannot be over emphasized that the detection and communication systems must fully be integrated. Each fire that is detected should be immediately reported through the audio output of the speaker. The position of the fire can be known through the audio output and also the video out put of the LEDS, as the sound of position 1 is different from that of position 2 and the LEDS will change from green to red indicating where the danger is.

1.7 SCOPE OF WORK

Multiple fire alarm networks are a device that senses the presence of fire in a room when the temperature of the room rises to or above the preset value and also the presence of smoke in the room. When the presence of smoke and fire is established, the system triggers an alarm, which is through the speakers.

The multiple fire alarm network comprises of three different units, specifically design for storey buildings or for different rooms in a building. Each unit of the system comprises of smoke detector, heat detector and the Alarm indicator and detectors built using thermistors, (temperature dependant resistor), light dependant resistors, integrated circuits, light emitting diodes to indicate the presence of danger, which are coupled in order to achieve the desired performance.

In case of fire out break for instance, were it is used in storey building, the floor where the danger is can be identified by the audio sound, since each floor has its own tune frequency or by the change from green to Red of the video signal.

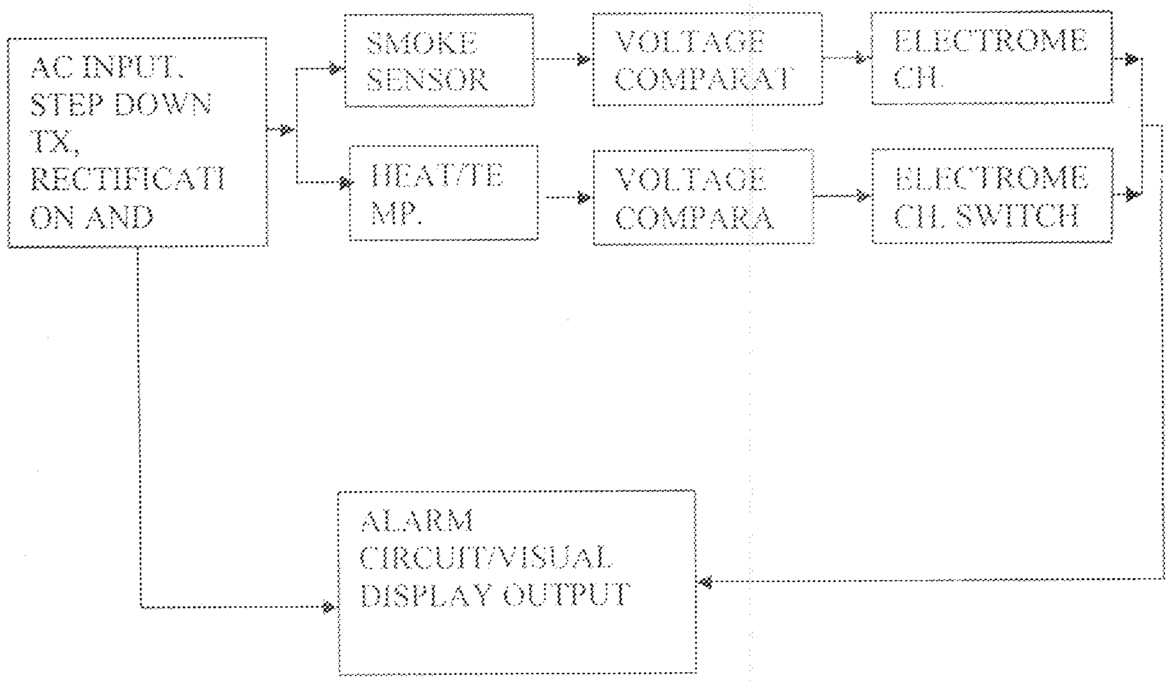


Fig 1.0 Block diagram of fire alarm system

1.8 MOTIVATION

Design of this type of system is very essential in storey buildings, for ware house and it can also be for machines (the heat sensor part of it). The fire alarm can sense both heat and smoke, the presence of any triggers an alarm and the video display.

1.9 AIMS AND OBJECTIVES

The aims and objectives of this project is to show that the system is a fire alarm system for buildings which the sensor can be kept in different locations.

1.1.0 METHODOLOGY

The method employed in this project work is where the input of the system, which is fire/smoke, comes first to provide the necessary signal to activate the system. Therefore, no smoke or fire no input. 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. An amplifier then amplifies this change in current and its output is fed to a comparator. A relay is connected to serve as remote current – controlled switch, which is an electromagnetic device.

1.1.1 LOCATION TO AVOID UNWANTED ALARM

Smoke/Fire detector is designed for indoor use. Cigarette will not set off the alarm under normal condition unless the smoke is blown directly into the unit. Improper location near kitchen, bathroom, fireplace or garage may cause unwanted alarm due to concentrated high level of humidity and products of combustion.

It should not be located near heating and cooling vents, one should avoid locating it where the normal temperature and humidity exceeds 4°C to 38 °C and 85% relative humidity respectively. The fire/smoke unit should be placed in the ceiling but not near machines that can produce smoke or too much heat.

CHAPTER TWO

2.0 LITERATURE REVIEW

At the beginning of the 20th century, the threat of fire outbreak existed, in both cities and towns.

As a result, ways of preventing and fighting fire were invented, and the efficiency of these methods increased through the century. Until recent years, the prime method of preventing injury and death in building was by shielding the occupants from the fires flame and heat. The smoke and toxic gases from fire were causing more death than the direct effects of the flame and heat. Authorities attributed the problem to the increasing use of plastics. The toxic gases given off during the thermal decomposition of the new plastic materials were far more deadly than those given off by the traditional materials. Today 80% of deaths in building fires are cause by smoke inhalation. A few breaths of some toxic gases will completely immobilize a person, with death following. In a matter of minutes, the victims were death before the fire ever reaches them.

In the industrial sector where safety is the watchword, heat sensing alarm system is a necessity. Scientist observed that heat was fluid called caloric that flowed from hot bodies to cold bodies. Modern ideas explain heat and temperature in terms of motion of molecules of substances. For the purpose of this project, we shall restrict ourselves to early detection and communication of fire outbreak. The need for a smoke/fire detector emanates from rampant fire disaster happening in our offices, industries or residential places and so on from time to time. Fire disasters as a result of electrical hazards (cable sparkling, generator explosion, gas explosion, petroleum explosion etc) could have been aviated were it that fire/smoke detector are installed in all these public places also, the installation of such a device serves 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.

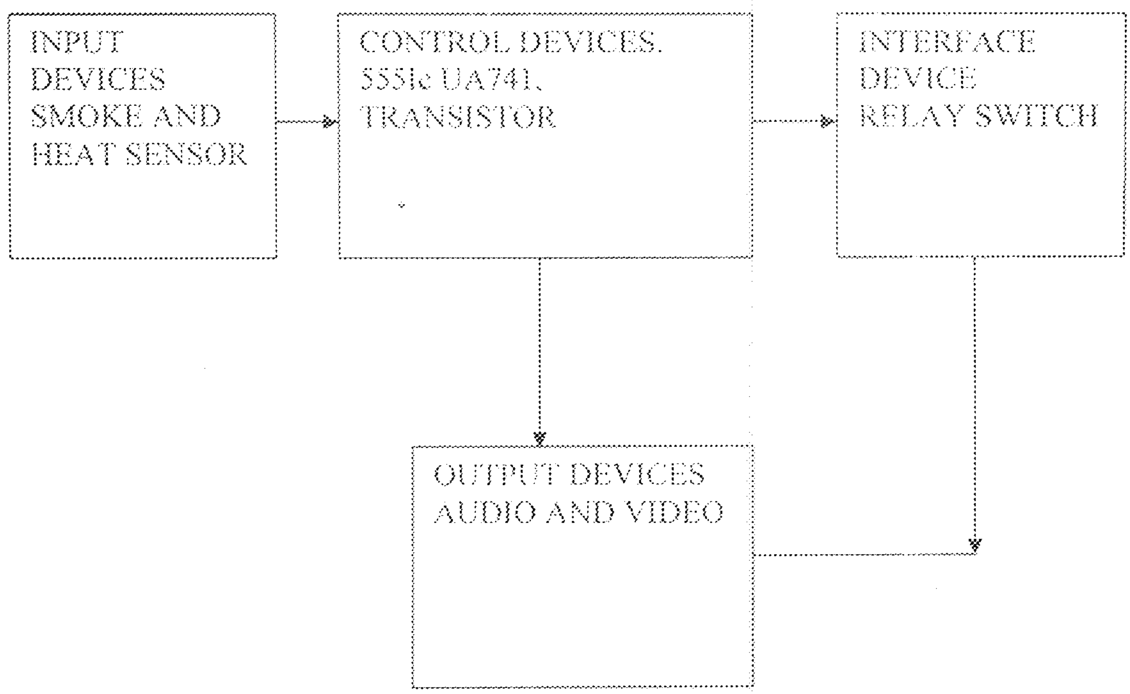
However it is pertinent to note that the fire/smoke detector does not prevent this non-conforming situation but announce its occurrence.

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

CHAPTER THREE

3.0 SYSTEM DESIGN

The design of the fire alarm can be divided into four building blocks, namely: Input, control, Interface and Output devices respectively. The block diagram is as shown in fig 3.0 below



Figs 3.0 BLOCK DIAGRAM OF FIRE ALARM

3.1 POWER SUPPLY UNIT

Power supply unit is an electrical circuit that supplies the device with electrical energy. It can either be battery or rectified A.C. The term power in this context is used to refer to the complete circuitry, which performs the conversion from A.C to D.C. including the transformer, which is normally used to isolate the d.c supply from a.c mains. To convert a.c to the required d.c, the circuit below was used.

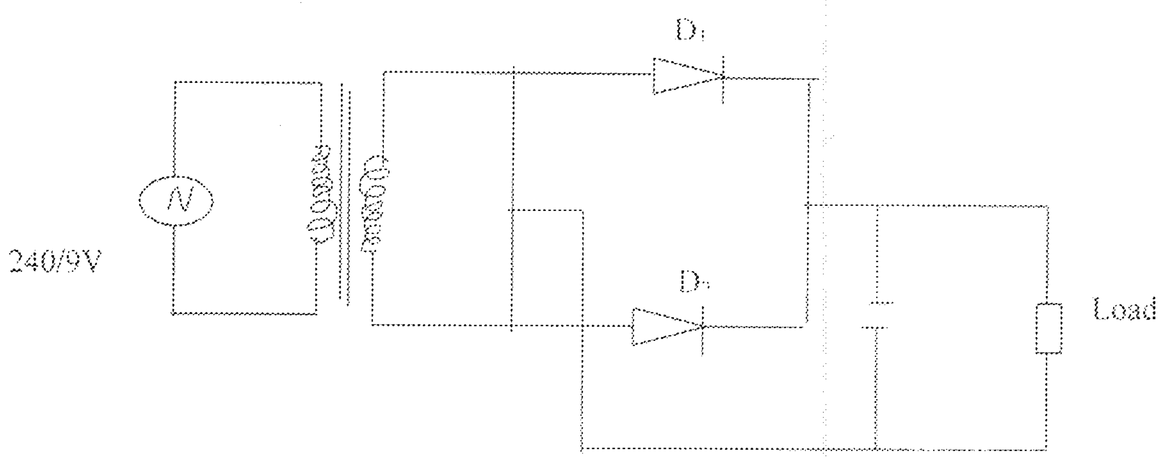


Fig 3.1 Full wave rectifier circuit

The circuit consists of a transformer (center tapped), two diodes and a filtering capacitor. The input to the circuit is an alternating current supply (A.C), which is stepped down from 240V to the required 9V to be used in the circuit. The diodes rectify the D.C and the capacitor across the output improves transient response and keeps the impedance low at high frequencies. The transformer steps down the voltage according to the ratio of its turns as shown below:

$V_1 / V_2 = N_1 . N_2 = K$ .... (3.0)

Where K is a constant known as transformer turning ratio.

The output voltage is given by:

$V_2 = N_1 V_1 / N_2$ .... (3.1)

The voltage will then serve as output to the rectifier.

The rectifier circuit consists of two diodes as shown above. During the positive half cycle, diode 1 is forward biased and is conducting since its P side more positive relative to the N side. At the same time diode 2 is reverse biased therefore experiences negative voltage in relative to the P side. During the negative half cycle Diode D_2 is forward bias and is conducting since the P side is more positive relative to the n side while Diode D_1 is reversed biased since the N side experiences negative voltage relative to the P side. In both cases, current keeps flowing through load R_1 in the same direction.

3.2 *RIPPLE FILTERING*

The ac component of the output voltage can be characterized in terms of the peak to peak ripple voltage. The ripple can be reduced by increasing the RC time constant, thereby decreasing the rate of decay of the load voltage and decreasing the duration of the conduction interval.

Capacitor value must be larger in order to present as small reactance as possible to the pulsating rectified d.c output and to store sufficient charge. so as to maintain current flow in the load during the period that the rectifier is not conducting. Capacitor of range 3300micro Farad is used in the construction of the project.

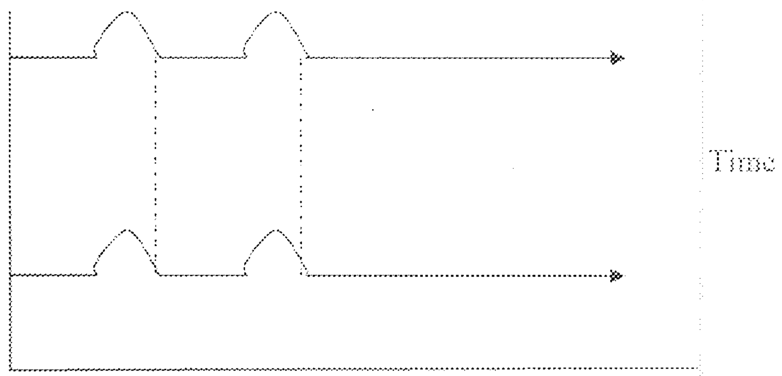


Fig 3.2 out put waveform of the filter

3.3 SMOKE SENSOR UNIT

This unit consists of a transistor. LDR, LED. UA741op amp and a relay.

3.4 LIGHT DEPENDANT RESISTOR (LDR)

Light energy falling on a semi conductor material such as cadmium sulphade, causes a change in resistance. The resistance of LDR in total darkness is about 10MΩ, in normal room lighting it falls to about 10KΩ and in bright sunlight about 100Ω, with the surface of LDR exposed to light, it can carry several milliamperes, an amount which could be sufficient to operate a relay.

3.5 LIGHT EMMITTING DIODES

It is a semi conductor device that converts electrical energy efficiently into visible light by electro luminescence at a forward biased pn junction.

3.6 UA741 OPERATIONAL AMPLIFIER

It is a solid-state integrated circuit that uses external feedback to control its function. It is one of the most versatile devices. The op.-amp here is used as a comparator. A comparator is a circuit that compares an input voltage with a reference voltage. The output of a comparator then indicates whether the input signal is either above or below the reference voltage.

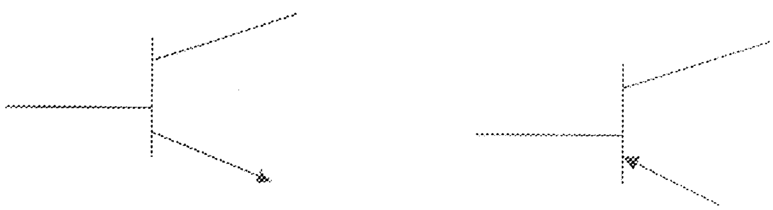
3.7 TRANSISTOR

Transistor was developed in 1948, the name was derived from its original title "transfer - transistor". Transistor is a three terminal device in which current flowing between two of its terminals can be controlled by signal on the third terminal. This facility means that a transistor has properties that enable it to be used as an electronic switch or an amplifier. There are many types of transistors available, but they can be effectively grouped into two:

- The bipolar junction transistor (BJT)
- The unipolar or field effect transistor (FET)

3.8 THE BIPOLAR JUNCTION TRANSISTOR (BJT)

This transistor is a current operated device. It is a three-layer semiconductor device that has three electrodes, the base, collector and emitter. There are two groups of this transistor N-P-N and P-N-P the names of the electrodes comes from the roles they play in the device operation. The Base controls the flows of electrons from emitter to collector. The collector collects the electrons the emitter emits electrons. However, to understand the simple operation of the device, it is only necessary to consider one of the charge carriers: electrons for n-p-n device holes for a p-n-p device. For an n-p-n transistor, the electron flows from the emitter region to the base region and . The arrow on the circuit symbols indicates the flow of conventional current through the device.



N-P-N P-N-P

Fig 3.3 circuit symbol

Fig 3.4 schematic diagram

The transistor in this case is used to amplify the output signal from the op- amp to activate the relay.

3.9 THE SMOKE DETECTING CIRCUIT

R_1 acts as a current limiter, which limits the current flowing through the LED. The resistance of the LDR (light dependant resistor) is light dependant, as such its resistance is determined by the intensity of light from the LED. In the absence of smoke the intensity of light from the LED will be high which results in a low potential drop across the LDR.

In the presence of smoke, light intensity from LED reduces due to obstruction from the smoke. This will lead to an increase in the resistance of the LDR and subsequently results in a rise in the voltage drop across the LDR the voltage of the inverting input of the op amps equal to the voltage drop across R_3 In the absence of smoke, the voltage drop across the LDR will be less than 6v. While the voltage drop across R_3 will be 6v.This will cause the output of the op- amp to be high. The output voltage will be equal to V_{cc}. In the presence of smoke, the voltage drop across the LDR will rise to above 6v, which will cause the output of the operational amplifier to go low. Mathematical calculations are shown in the circuit analysis of the smoke detecting circuit.

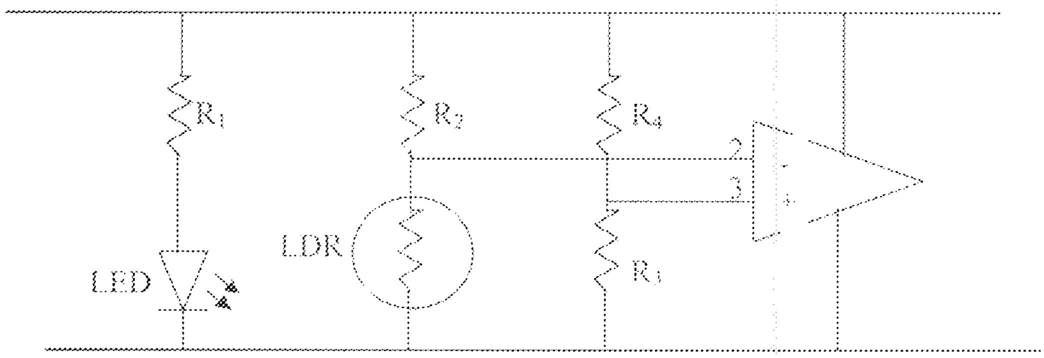


Fig 3.5 Circuit diagram of smoke detecting circuit

3.1.0 CIRCUIT ANALYSIS OF SMOKE DETECTING CIRCUIT

$V_{cc} = 9V$

$V_{LED} = 1.2V$

$I_{LED} = 20mA$

$R_1 = (9 - 1.2)\ V / 20mA = 390\Omega$

R_{LDR1} (Dark state) = 240KΩ

R_{LDR2} (Presence of LED without smoke) = 8Ω

R_{LDR3} (Presence of LED with smoke) = 124KΩ

$I_{Max\ (LDR)}$ occurs at R_{LDR2}

$I_{Min\ (LDR)}$ occurs at R_{LDR3}

$R_{2(Max)}$ occurs at $I_{MIN (LDR)}$

$R_2 = (V_{cc} * R_{LDR3}) / V_{LDR} - R_{LDR3}$

$R_3 = (9 * 124) / 6 - 124 = 620K\Omega$

For this project

$R_2 = 60K\Omega$

$R_3 = 10K\Omega$

$R_4 = 10K\Omega$

3.1.1 HEAT SENSOR UNIT

This unit consists of thermistor, transistor, relay and UA 741 op amp.

3.1.2 THERMISTOR

Is an input transistor (sensor), which converts temperature (heat) to resistance? It is made from a sintered mixture of the oxide of nickel, Zinc, Copper, and Manganese. They are of two types. PTC (Positive Temperature Coefficient) thermistors have high resistance when hot (about 1kΩ at 100^0 C) and low resistance when cold (about 100Ω at 20^0 C). The NTC (Negative Temperature Coefficient) thermistors (resistance decreasing as temperature increases).

3.1.3 UA 741- OPERATIONAL AMPLIFIER

Op- amplifier here works the same way as that of the smoke detector; they are used as comparators.

3.1.4 VOLTAGE COMPARATOR UNIT

The voltage comparator is a circuit that compares input signal V_{IN} with a reference voltage V_{REF}. When the input voltage exceeds the reference signal the output of the comparator, V_{OUT} changes from its value.

A voltage comparator exhibits a non- linear operational amplifier characteristic while a differential amplifier behaves linearly. A comparator is therefore a two input, one output voltage comparing devices that is capable of high input resistance and low output, while this may be taken as the definition of an operational amplifier, it should be noted that voltage comparison is just one of the areas of application of op- amps. A comparator performs the following functions:

- Detect two input voltages
- Provide an output that is one of two discrete states
- The differential voltage comparator is operated via dual power supply with a common ground, thus enabling the output to swing either to positive or negative with respect to the ground. Typically it gives a voltage gain A.

One input terminal is denoted negative, it gives an inverted output (i.e.) the inverting terminal and the other is denoted positive, which gives a non inverting output (i.e.)

the non inverting terminal, the output at the terminal is ideally zero. When identical signals are simultaneously applied to both inputs, since the two signals are concealed out by the differential out come of the amplifier, the out put of the circuit is proportional to the differential signal between the input and it is given by:

$$V_0 = A_0 V_{IN} - V_{REF}$$

A_0 = the open loop of the operational amplifier

V_{in} - the input signal at the non inverting signal

V_{ref} = the reference voltage at the inverting terminal

V_0 = the output voltage

3.1.5 THE HEAT DETECTING CIRCUIT

R_T is a positive temperature co-efficient thermistor, which means that its resistance increases as the temperature increases and vice- versa. In other words, whenever there is a rise in atmospheric temperature (probably due to a fire) the voltage drop across the thermistor will increase. Like in the case of op- amp (IC 1) in the smoke detecting circuit, the op- amp (IC 2) in the heat detecting circuit will have a voltage of 6V at its non-inverting input. Whenever the voltage at the inverting input is less than 6V, the output voltage of the op amp will be equal to V_{cc}. The voltage at the inverting input will be equal to the voltage drop across the resistor R_5. At normal room temperature, the voltage drop across resistor R_5 will be less than 6V. But whenever the temperature (ie room temperature) rises to above 50 degrees centigrade (probably due to the presence of fire) the voltage at the inverting input will rise to above 6V and will result in a low at the output of the op amp.

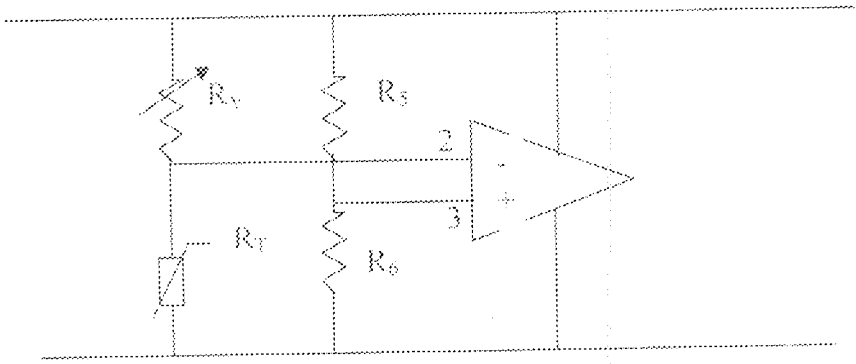


Fig3.6 Circuit diagram of heat detector

3.1.6 CIRCUIT ANALYSIS OF HEAT DETECTING CIRCUIT

$R_T = 900.667 - 1.333T$ (Where T is the absolute temperature in Kelvin)

At a temperature of 50^0C

$T = 273 + 50 = 323K$

$R_T = 900.667 - 1.333(323) = 470\Omega$

$V_{CC} = 9V$

$V_T = VCC - V_{R5}$ (V_{R5} is voltage drop across R_5)

$V_T = 9 - 6 = 3V$ (V_T is the voltage drop across the thermistor)

$I_T = V_T / R_T = 3/470 = 6.38$ mA (I_T is the current flowing through R_T)

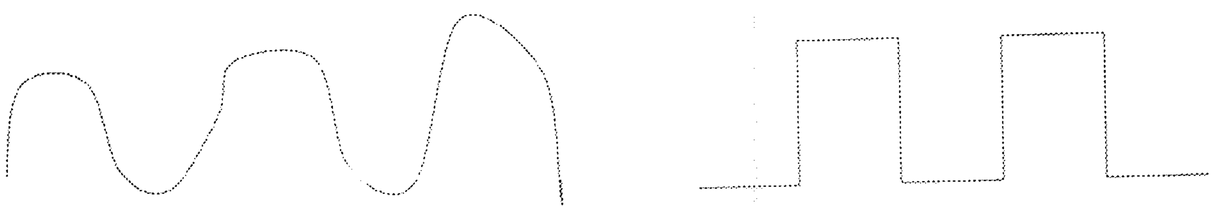
3.1.7 THE ALARM CIRCUIT UNIT

The alarm circuit is designed to give an audio alarm signal whenever the transducer (thermistors and photocells) detect the presence of fire and or smoke, apart from the LED indicators, the circuit comprises of 555 timers integrated circuits, which are both designed as astable multivibrator, one of the three non sinusoidal oscillator (an inverter)

3.1.8 OSCILLATOR

Oscillators are inverters, which convert d.c current to alternating current. Oscillators are divided into two types according to their output waveform

- Sinusoidal oscillator: this produces pure sine wave output
- Non- sinusoidal (relaxation) oscillator type: it produces pulse of rectangular waveform out put. They are also known as multivibrators.



a

b

Fig3.7 output waveform for both types of oscillators

3.1.9 TYPES OF NON-SINUISOIDAL OSCILLATORS

- The mono stable
- The Bistable
- The Astable- multi vibrators

3.2.0 MONO STABLE MULTI- VIBRATORS

The mono stable multi vibrator or (one shot) circuit produce a rectangular out put pulse in response to a trigger signal applied to its input. It is designed in such a way that out put pulse is only produced each time trigger pulse is applied.

3.2.1 BISTABLE MULTI- VIBRATOR

A Bistable multi- vibrator or Flip- Flop is a circuit having two stable states. This circuit will remain in one stable state until a trigger pulse is applied to switch the current to the other state. i.e. it remains in either state.

3.2.2 ASTABLE MULTI – VIBRATOR

This is the type employed in this project because of its advantage as a free running multi vibrator. It is a simple relaxation oscillator that produce square wave signal from two identical amplifier circuit connected in a closed loop. It has two unstable states and will continuously change from one to the other to generate a square wave.

3.2.3 555 TIMERS

The 555 timers IC is non-sinusoidal oscillator used to generate waveform. 555 timers IC comprises of two voltage comparators, a Flip Flop. Transistors and three resistors.

The comparators in the 555 timer IC are usually operational amplifiers that compare input voltage to the internal reference voltage, which are generated by an internal voltage divider chain of three 500 ohms resistors. The reference voltage provided are one third of V and two third of V, when the input voltage to either of the comparators is higher than the reference voltage of the comparator, the amplifier goes into saturation and produces an out put signal to trigger the Flip Flop which controls the output state of the timers. The pin out connections of 555 timer IC are shown in fig below 3.8

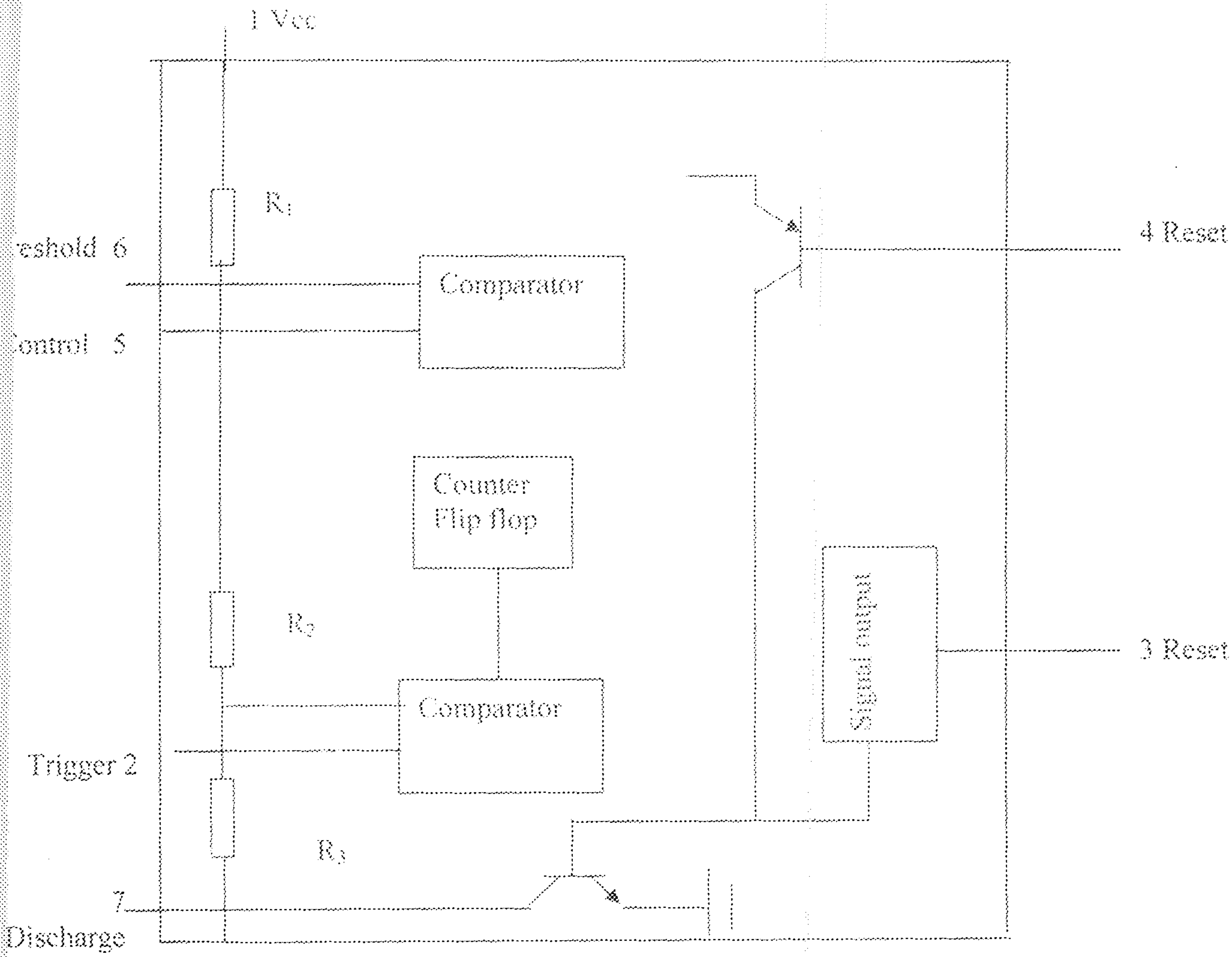


Fig 3.8 Internal circuitry of 555timer

Details regarding connections to be made to pins are as follows:

PIN1: This is the group pin and should be connected to the negative side of the supply voltage

PIN 2: This is the trigger input. A negative voltage pulse is applied to this pin when falling below one third of V_{CC} which causes the comparator out put to change state, the out put level then switches from low to high.

PIN 3: This is the out put pin and is capable of sinking or sourcing a load requiring up to 200mA and can drive TTL circuits. The out put voltage available is approximately V_{CC} = 1.7V.

PIN 4: This is the Reset pin. If used to reset the Flip Flop that controls the state of out put – pin 3. Reset is activated with a voltage level of between 0v and 0.4v and forces the output low regardless of the state of the other flip-flop inputs.

PIN 5: This is the control voltage: input voltage applied to this pin allows device terming variations, which is independent of the external terminal network. Control voltage may be varied from between 45% V_{CC} value in mono stable mode. In astable- mode the variation is from 1.7v to the full value of the supply voltage.

PIN 6: This is the threshold input. It resets the flip- flop and hence drives the out put low. if the applied voltage rises above third of the voltage applied to pin 8.

PIN 7: This is the discharge pin; it is connected to the collector of N- P- N transistors, while the emitter is grounded. Though when the transistor is turned ON, pin 7 is effectively grounded.

PIN 8: This is the power supply pin and is connected to positive side of the supply. The voltage applied may vary from 4.5v to 16v.

3.2.4 TWO TONE ALARM CIRCUIT

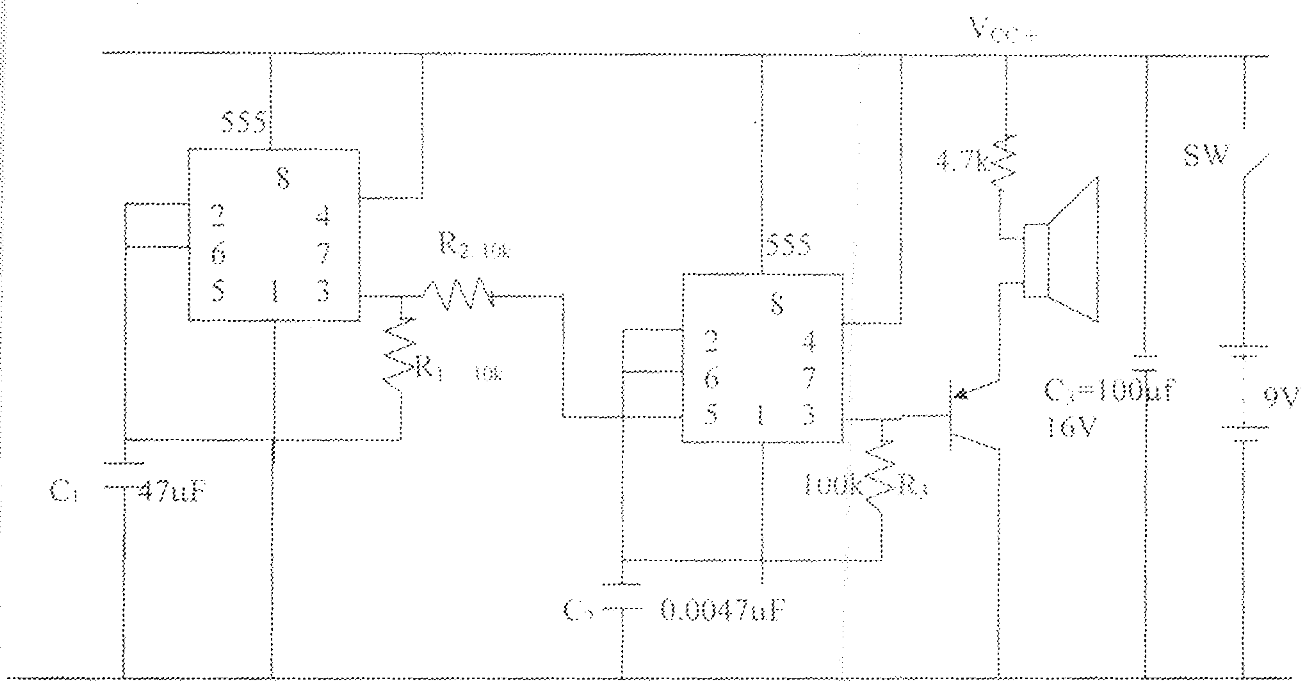


Fig 3.9 Two tone circuit diagram

Two tone generations is achieved by feeding the out put pin 3 of the first 555 timer to pin 5 of the second 555 timer, the first 555 timer generate a tone of low frequency while the second 555 timer generate a tone of high frequency. When C_1 is removed it becomes a single tone siren. To increase the duration of the siren, C_1 can increase, in value so as to increase the length of the hees and haws or vice versa

3.2.5 ASTABLE (FREE RUNNING) MULTI VIBRATOR

This is a free running rectangular wave generator. None of the state is stable, that is, it has two quasistables states. This is so because the out put remains in one of these state for a time T_1 and then abruptly changes to second state for a time T_2 and a cycle of period

$T = T_1 + T_2$ repeat.

As stated earlier, two 555 timer are used as astable circuit each.

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

The total time required completing a charge and discharge cycle is

$$T = T_1 + T_2$$

$$T = 0.692\ (R_a + 2\ R_b)$$

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

$$F = 1.44/C\ (R_a + 2\ R_b)$$

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

Duty Ratio = $R_b / R_a + 2 R_b$

3.2.6 MULTI VIBRATOR

Modulator

R_1, R_2 and C_1 determine the T_{ON} and T_{OFF}

$T_{ON} = 0.693 (R_1 + R_2) C1$

$T_{OFF} = 0.693 (R_2C_1)$

Total time = $T_{ON} + T_{OFF}$

We want the T_{ON} to be for 0.6 seconds

$T = 0.693 (R_1 + R_2)C_1$

We choose an electrolytic capacitor of 47 microfarad. 6v resistor (R_2) is also chosen to be 10kilo ohm

Therefore to determine R_1

$0.6 = 0.693 (R_1 + 10_k) 47 * 10^{-6}$

R_1 = 10kilo ohm

For $T_{OFF} = 0.693 R_2C_1$

$T_{OFF} = (0.693 * 10k\Omega * 47 * 10^{-6})$ S

T_{OFF} = 0.3Seconds

F = 1/ T_{otal} = 1/ 0.9 = 1.1Hz

Duty ratio = R_3 /(R_2 + 2 R_3) = 100k/ 10k + 2(10k) = 0.9

For the multi vibrator that determine the audio output T_{ON} = 0.693 (R_3) C_2

T_{OFF} = 0.693 (R_3) C_2

Let the T_{Off} be ½(0.5) of T_{ON}

T_{ON} = 0.693 (100k) 4.7nF

T_{ON} = 0.5

T_{OFF} = 0.25mS

R_4 limits the current to the speaker

3.2.7 LOUD SPEAKER

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 that is free to move in annular gap. A strong magnetic field produced by either a permanent magnet or electro magnet is applied across the gap.

The audio signal from the audio amplifier is the input of the coil (known as speech coil) that has an alternating current causing it to move in the magnetic field as a result of electromagnetic induction. The diaphragm is thus caused to vibrate at the same frequency as the alternating current and the sound waves produced by it.

3.2.8 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.

3.2.9 TRANSISTORS

Transistor in this circuit is used to amplify the signal to the speaker

3.3.0 CAPACITOR

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

3.3.1 POTENTIOMETER

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

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

4.0 COUPLING OF STAGES

As earlier stated in chapter two, the system is made of four building blocks namely:

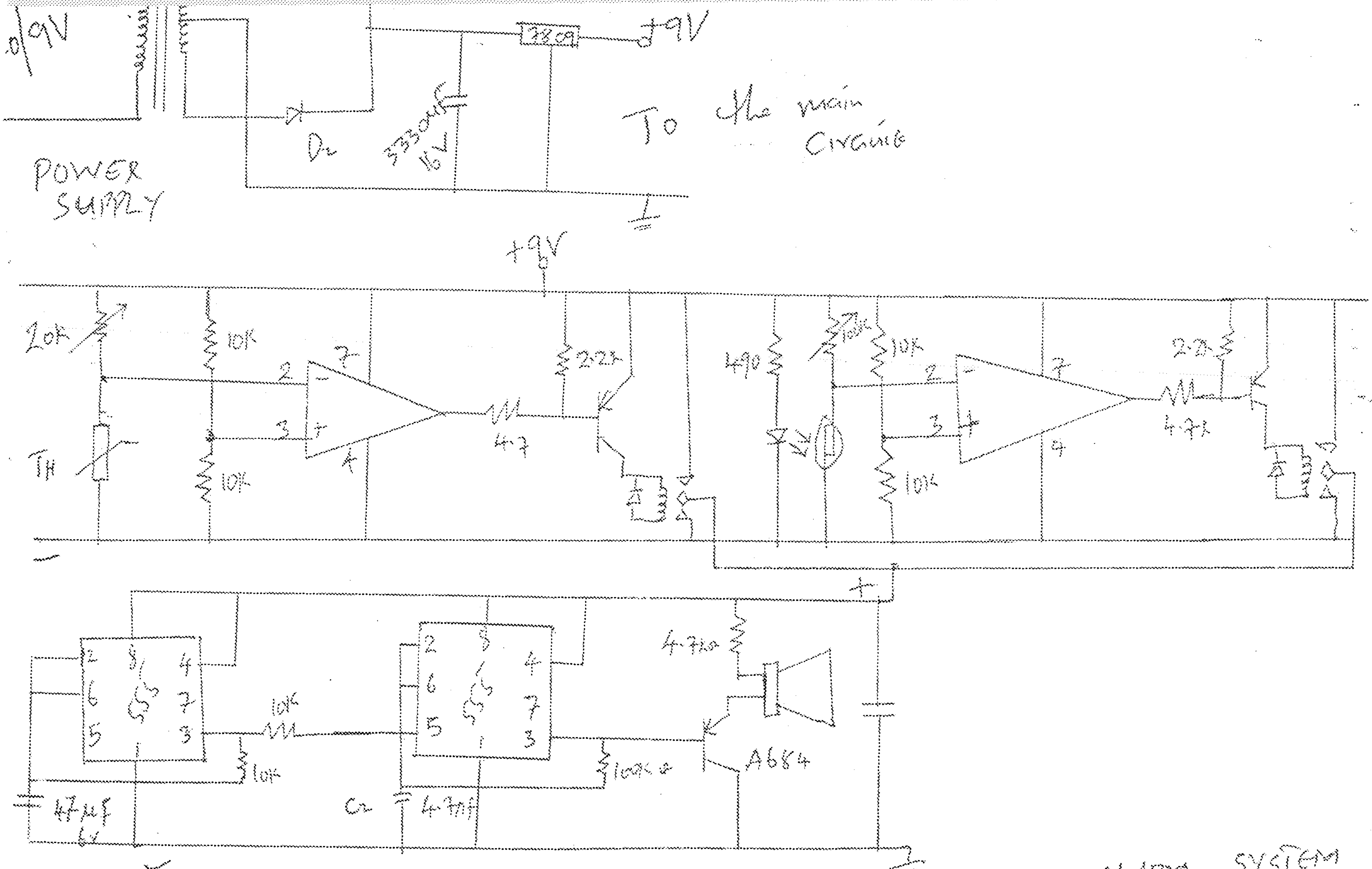
i. Input Device: Which includes transducers such as the thermistor (for heat detection) and the light dependant resistor (for smoke detection)

ii. Control Device: Which includes IC such as the 555 timer, UA 741 (op amp), Transistors?

iii. Interface Device: which includes the relay switch?

iv. Output Devices: which includes the speaker and the LED display

9V D.C, power supply, powered the system. The construction was first done on a breadboard and tested to have a satisfactory output, (i.e.) preliminary tests were carried out under induced alarm conditions and minor adjusments were made on the value of the resistors, until the system operated as expected. With satisfactory performance obtained, the components were transferred unto the Vero board and tested in stages.



COMPLETE CIRCUIT DIAGRAM OF FIRE ALARM SYSTEM

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

4.0 COUPLING OF STAGES

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9V D.C, power supply, powered the system. The construction was first done on a breadboard and tested to have a satisfactory output, (i.e.) preliminary tests were carried out under induced alarm conditions and minor adjustments were made on the value of the resistors, until the system operated as expected. With satisfactory performance obtained, the components were transferred unto the Vero board and tested in stages.

4.1 TESTING

After construction, tests were carried out to ensure that the circuit operates as designed. In the first stage of the test, output voltage of the power supply to circuit was measured to make sure it was 9v after, that the heat sensor unit was tested separately to if the relay will click as heat was applied to the thermistor, then that of the smoke sensor was also tested separately. Initially a single 240/9v step down transformer was used and it was realized that a single transformer will not be able to power the two circuits of both fire alarm system.

4.2 PACKAGING (CASING)

The complete unit was housed in a wooden case with the following dimensions.

Height = 25cm

Length = 30cm

Width = 20cm

Provisions were made for the power on and reset switch on the front face of the case. The speakers were mounted on the front face of the casing. At the back of the case, provisions were made for the AC power supply and the outlet for the transducers.

The Vero board was screwed on to a wooden base laid at the bottom of the wooden case.

CHAPTER FIVE

5.0 CONCLUSION

The design and construction of a fire/smoke alarm system with an audio alarm and video display had successfully been carried out as described. The demonstration of the detection of fire depends on the detection of heat and smoke by the thermistor and LDR respectively.

The primary objective of this project was to produce a prototype detector circuit that will detect the presence of smoke via the combination of the LED and LDR or an increase in the temperature of the environment beyond a given temperature through the thermistor and subsequently give an output. Either through the speaker (i.e. as audible tone) or through the LEDS those changes from colour from green to red signifying danger.

With regard to the detector, detailed block diagrams, schematic circuits and typical installation diagrams provided in addition to information about the waveforms and signals (voltages and current) at some strategic points in the circuit. This is to facility easier maintenance. Besides the demonstration units, the detector or transducer unit use very few components namely thermistor, light emitting diodes, light dependant resistor, operational amplifier (UA741) transistor, relay switch, capacitors, resistors, 555 IC timers and a 4ohms 8 watts speaker were used.

5.1 RECOMMENDATIONS

I will like to advise the department to expose the students to more practical works before embarking on final year project. This will ease the problem encountered during project design and construction

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

- project topics should be given to students early enough to allow for adequate preparation
- Companies and establishments should be consulted for possible sponsorship of various projects.
- practical should be given more time in school and consumable items made available

REFERENCES

[1] 'M C GAW- HILL ENCYCLOPEDIA OF SCIENCE AND TECHNILOGY (5th edition). Cambridge University press pp 16-23

[2] PAUL HORWITZ AND WINFIELD HILL, THE ART OF ELECTRONICS (2nd edition) (Cambridge university press) 1989 ISBN: 052149865, 11225 pp 7-19.

[3] D .G FINK, ELECTRONICS ENGINEERS; HANDBOOK Published in co-operation with IEE press published by CRC press Beaverton Oregon, (1996) ISBN 061250459 pp 34-39

[4] THERAJA B.L AND THERAJA A.K (1999, electrical technology S. CHAND and company LTD New Delhi, India 26-45

[5] ELECTRONICS SYSTEM AND COMPONENTS WH DENNIS (BUTTER WORTH SCIENTIFIC).

[6] LIONEL WARNES: ELECTRONIC AND ELECTRICAL ENGINEERING (PRINCIPLES AND PRACTICE) 2nd edition published by Macmillan press limited 1998 pp71- 81

[7] WILLIAM B.W: POWER ELECTRONICS, 2ndedition, published by Macmillan press limited, 1992 pp 16-22