DESIGN AND CONSTRUCTION OF A THREE ZONE SMOKE DETECTOR WITH AUDIO AND VISUAL ALERTS

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

According to a recent CNN (cable news network) report, fire disaster remains one of the greatest threats to human lives and properties. As the extensive use of electricity continue to be deployed, whereby almost every device now run on electric current, coupled with the ever changing global climate situation it is only normal to observe that the scope of fire accident as result of electrical faults and natural causes is also broadened.

Fortunately, this menace can be avoided and its attendant colossal loss slashed heavily. With efficient fire fighter system in place plus early warning techniques, the destruction of lives and properties by wild fire or fire accident as the case may be can be averted.

It has been observed that when fire outbreak at inception is reported, further escalation and possible out of control situation can be halted. The scope of the work introduced here is one that brings about such possibilities. The design and construction of fire alarm system with audio alert seeks to use cheap and available materials to detect unusual behavior of fire at its inception and make audio announcement before an out of control situation is reached. It is against this fact that is project (THREE ZONE SMOKE DETECTOR WITH AUDIO AND VISUAL ALERTS) is being undertaking.

In the view that this design will be capable of controlling three sensing terminals which if effectively positioned the security coverage of the building which it monitors will be greatly improved

The project use electronic sensing device called smoke detector or ionization detector installed in fire prone areas in our homes, offices, factories etc. to report unusual behavior of

fire or inrush of smoke to an electronic unit which in turn triggers an audio warning and at the same time indicating the zone(s) where the fire outbreak is taking place. The audio alarm continues to operate until it is deliberately switch off (reset) or until the fire is put out.

1.1 OBJECTIVES

The objective of the project "fire alarm system with audio alert" is highlighted bellow:

(1) To use affordable materials in constructing a device that will arm every household against the danger of out of control fire outbreak.

(2) To announce any inrush of smoke or ionization in a fire sensitive area.

1.2 AIM

The project "design and construction of three zone fire alarm system" is aimed at using simple techniques with low cost and low power consumption, to give an opportunity to a house, store, factory, office etc so that a fire disaster can be averted.

This is achieved by calling the attention of People around through audio alert to the area where an indiscriminate behavior of fire has been started and also to give people a chance of escaping to safety where necessary.

It is believed that an early audio warning system during a fire outbreak will give a second chance for control and rescue purposes; this is the intension of this project.

1.3 MOTIVATION

The menace of fire accident is always grievous and can bring untold hardship to human lives. Unforgettable instances are the great California fire of 1889 which history has never forgotten, the Jos girls' boarding school holocaust of early 2000, and of late the Australian wild fire of early 2009. The list goes on and on.

In every one of those instances mentioned above, human lives were tragically involved. These mishaps have no discrimination; it strikes anywhere and at anytime. However, in developed societies, it has become mandatory to have early warning scheme in form of smoke or ionization detectors installed in every fire prone areas of private or public facilities, this approach have worked magic because more than 70% of all fire outbreaks never reach their out of control state.

Back home in Nigeria, from the information I have gathered, by visiting areas where fire accidents have taken their toll, I found out that in all the cases there are no fire alarm or any form of detector in place to give warning in case of a fire accident. The side effects have been very costly. A regrettable instance is the fire accident that claimed the lives of two undergraduates mid last year, somewhere in the central district area of the FCT. It was said that the fire started in the kitchen area and spread to the sitting room and then to the bedroom where the victims were already asleep. Had there been some form of smoke detector in place, these poor victims may have had a second chance.

As a matter of fact, I became concerned when I discovered that the huge number of estate springing up in Abuja metropolis have no form of enforcement on this issue. Thousands of residential areas are constructed without any fire safety facilities.

I became motivated when I found out that with only a few thousand Naira, an alternative that can save lives and protect properties is viable. I was moved to do something that will negate the excuses of house or property owners who are either ignorant of the working of the importance of fire alarm system or simply that they are too expensive to have.

1.4 SCOPE AND LIMITATION

This project is designed to operate only on single phase A.C to D.C converter as power supply. If properly installed and the smoke detector is well positioned, the device is capable of sensing smoke inrush or outright fire outbreak and immediately trigger a siren. The area where fire has been started is indicated on the device panel.

However, the greatest limitation of this device is that it is not designed with a backup power supply unit. This means that once the mains supply is interrupted the device will no longer operate until power is restored again.

1.5 METHODOLOGY

As stated earlier one of the major target of this project is to offer a very cheap but efficient version of the most sophisticated fire alarms we see installed in facilities such as factories, offices, banks, laboratories and so on. These modern fire alarm devices with brand names such as Zeta, Gent, just to mention only a few are microcontroller based and are of course programmable. They are designed with some forms of intelligence to coordinate several numbers of smoke detectors and serve as central fire alarm monitoring system. They also have relatively large data bank for keeping information on the activities of the sensors interfaced with them. This information can be retrieved and analyzed at any time when

connected with a computer. These of course explained why they are expensive and require professional handling [3].

However, the method adopted in our own design is far simpler yet does relatively what the sophisticated version can do. The method adopted here is the "hardwire "type where no form of program is written into any microcomputer, with virtually no form of intelligence or memory for data bank.

Only a few logic gates wired in a simple format intended in such a way that once there is an output from the smoke detector (a situation that indicates fire outbreak), the logic circuit receives it as input signal and produced an output that is further amplified by a section called signal buffer. The siren is then triggered on via a thyristor by the output of the signal buffer. The siren continues to operate until it is either reset or the fire is put out.

1.6 REPORT ORGANISATION

In this project report, chapter one discuss the general introduction, the aims and objectives, motivation, scope and limitation, and methodology. Chapter two discuses the literature review, while chapter three is dedicated to show case the various design concept of each section of the device. Chapter four deals with construction and circuit development. The closing chapter five centers on conclusion, recommendation and reference[4].

CHAPTER TWO

LITERATURE REVIEW

A smoke detector is a device that senses the presence of smoke in a building and warns the occupants of presence of fire so they can fight it out or at least , enabling them to escape a fire before succumbing to smoke inhalation or burns[3]. Equipping a home with at least one smoke detector cuts in half the chances that the residents will die in a fire. In 1992 it was declared that a smoke detector alarm is one of the "30 Products that Changed Our Lives." Smoke detectors became widely available and affordable in the early 1970s. Prior to that date, fatalities from fires in the home averaged 10,000 per year, but by the early 1990s the figure dropped to fewer than 6,000 per year.

Two basic types of smoke detectors are currently manufactured for residential use. The PHOTOELECTRIC SMOKE DETECTOR uses an optical beam to search for smoke. When smoke particles cloud the beam, a photoelectric cell senses the decrease in light intensity and triggers an alarm. This type of detector reacts most quickly to smoldering fires that release relatively large amounts of smoke[6].

The second type of smoke detector, known as an IONIZATION CHAMBER SMOKE DETECTOR (ICSD), is quicker at sensing flaming fires that produce little smoke. It employs a radioactive material to ionize the air in a sensing chamber; the presence of smoke affects the flow of the ions between a pair of electrodes, which triggers the alarm. Between 80 and 90% of the smoke detectors in homes and offices in the advanced world are of this type. Although most residential models are self-contained units that operate on a 12-volt battery, construction codes in some parts of the world now require installations in new homes to be connected to the house wiring, with a battery backup in case of a power failure.

The typical ICSD radiation source emits alpha particles that strip electrons from the air molecules, creating positive oxygen and nitrogen ions. In the process, the electrons attach themselves to other air molecules, forming negative oxygen and nitrogen ions. Two oppositely charged electrodes within the sensing chamber attract the positive and negative ions, setting up a small flow of current in the air space between the electrodes. When smoke particles enter the chamber, they attract some of the ions, disrupting the current flow. A similar reference chamber is constructed so that no smoke particles can enter. The smoke detector constantly compares the current flow in the sensing chamber to the flow in the reference chamber; if a significant difference develops, an alarm is triggered[5].

Fire disaster being a major concern worldwide, for this reason; individually and in group efforts have been made to buffer the outcome of conflagration. Severally we have seen cases where fire has wiped out entire families as in the case of Gboko in Benue State in 1992 and groups such as prison inmate as in the case of Kiev in ukrane and even razing down completely business complexes as in the case of Nasarawa Shopping complex Jos Plateau state.

In advanced countries of Europe, walkway service lines ment to pump water over considerable distance at a high pressure to subdue fire are provided in most streets in their cities.

In less advanced countries, fire fighters use water with chemical diluted in them to subdue the fire. The fact remains that in these areas detection are usually done by means of human senses which in fact senses rather too late when the fire has gain ground. In most cases the fire consumes all in it way before it is put out. More often than not after the overall analysis, it is found that the claim made by fire, goes beyond the 70% of the structure engulfed. Which by every standard is a great loss, and a poor bargain.

Having established that fire cost so much as a master not timely discovered. It becomes imperative to put in place mechanism for early detection and signaling of fire outbreak before it gets out of hand. In some nations the prevention of it has been extensively being worked on and land mark results have come up nations that are at the forefront of this campaign include China, India and United State of America and so on.

It is part of the standard building plan to incorporate fire detection majors which are backed up with effective and efficient fire fighting officers in the locality. There by limiting the triumph of fire to a reasonably low level. Although, a loss is a loss.

Before this particular work student in the electrical departments worldwide have attempted to develop early warning mechanisms against fire but every attempt came with its limitations.

Some photolytic sensor, gives false alarm in dark environment due to increase resistance other sensors are too sensitive and leading to panics when the friendly smoke level is experienced.

While others are of low sensitivity that their detection is made when the fire is already beyond control which is a good as they not being there at all.

This work is being done, putting into account all the key area as the sensing device, the internal circuitry and the alarm system all of which are of high standing with limited failure rates. Another angel to this work is that it can effectively monitor three separate locations simultaneously. For a residential unit these locations will be kitchen, generator house and the store. Kitchen is a place where burning flame is on for at least eight hours. The generator house is a site of combustion of fuel (petrol and diesel majorly). Because of the heat generated, high possibility of faults that can lead to sparks and subsequently ignition of fire, it becomes a place of interest. The store is usually left with little activity or surveillance.

Hence if anything goes wrong it is hardly detected on time. Putting a sensor as a reporter of fire is very much in place.

In spite of the aforementioned efforts aimed at perfection, they are still much room for improvement. Since every work has got its scope and limitations.

CHAPTER THREE

DESIGN AND IMPLEMENTATION ANALYSIS

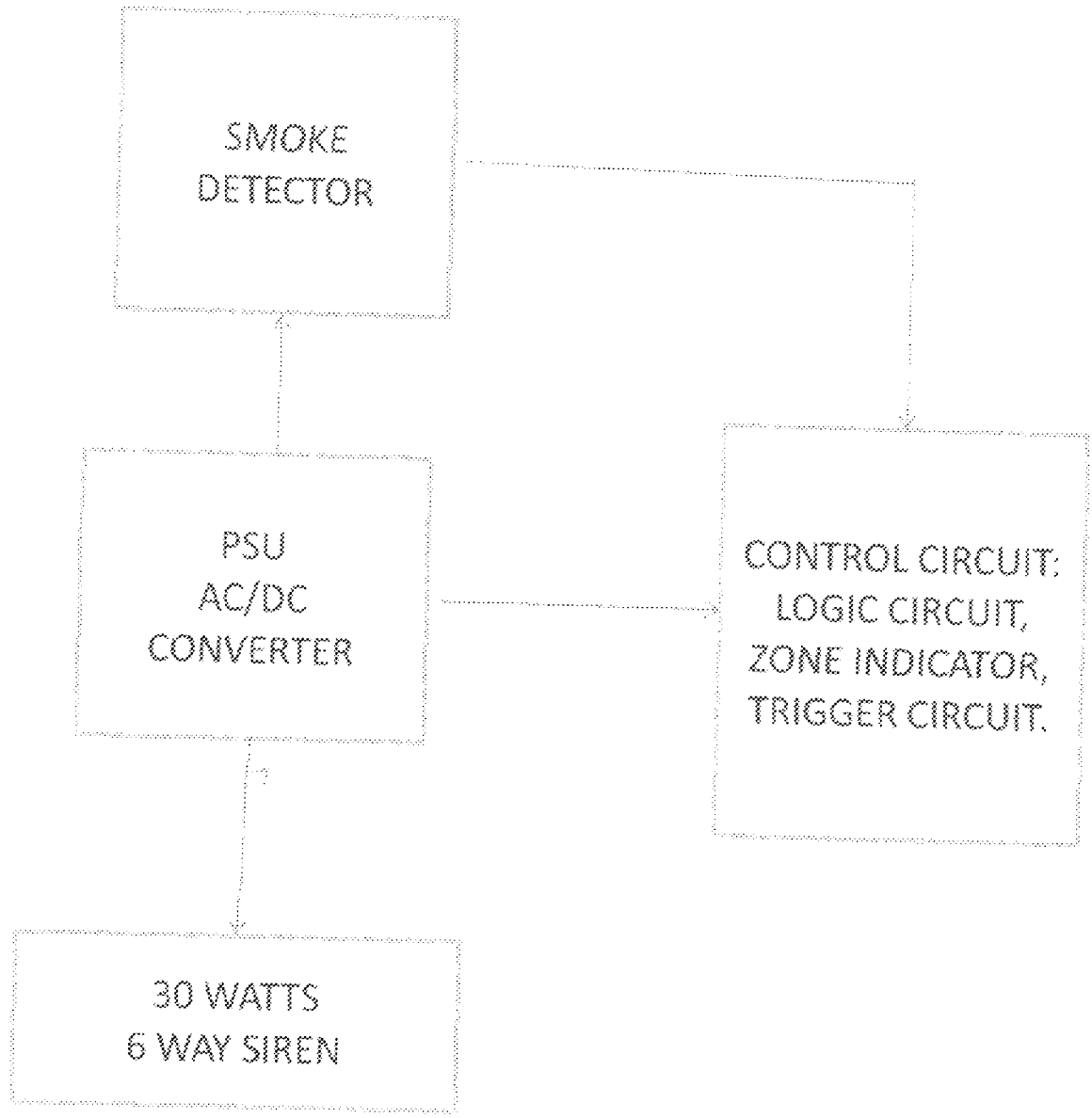

Fig. 3.1 Block Diagram Of A Three Zone Smoke Detector With Audio And Visual Alerts

The design concept of this project is based on the use of simple electronic principles that deals with how to put components together to achieve a working device. First a workable diagram of the circuit is sketched. Secondly, calculations on how to deduce the values of the various electronic components are carried out to figure what value of say, a resistor that can give the best results.

The principles for deduction and calculation are based on acceptable formulae used in electronic textbooks and related literatures. The designs also include analysis of logic gates and their truth table, and how the output of these logic circuits affects the working of our device. Detail explanation on various sections of the device during its design will be available in subsequent headings.

3.2 POWER SUPPLY

The components used in constructing the device are entirely electronic, thereby requiring a D.C power supply. The D.C power supply used to operate the various section of the unit is derived from an A.C/D.C converter. The converter unit is build around the following components.

1. A 500mA, 12v-0-12v step down transformer.
2. Two diodes for full wave rectification (IN4007)
3. Filter capacitors (2200μF@50v,10μF@50v)u
4. A 12v I.C voltage regulator (LM7812)

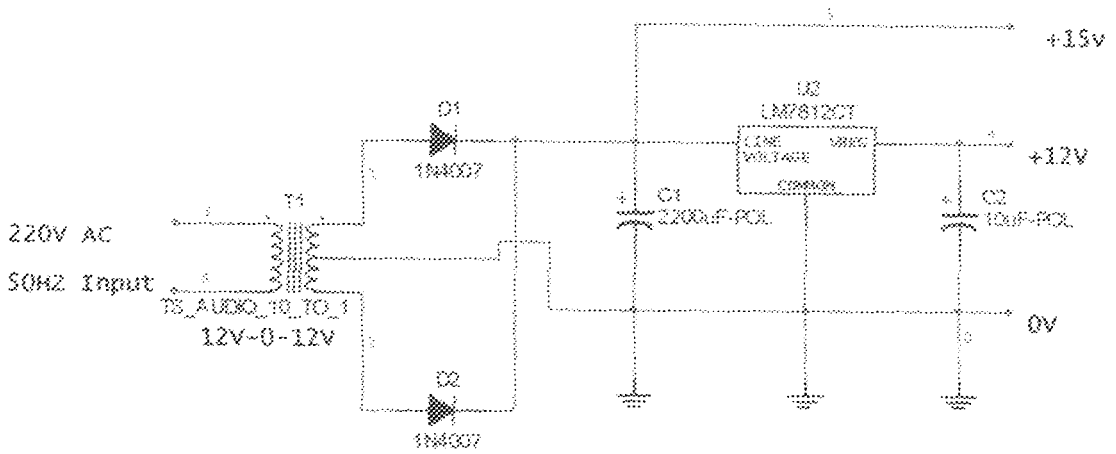

Fig. 3.2 power supply circuit

3.3 VOLTAGE RECTIFICATION

The circuit shown above is a demonstration of a full wave rectification using two rectifiers and a centre tap transformer, the resultant D.C voltage is further smoothened by a capacitive filter. Once the AC signal from output transformer passed through diodes it would become an uneven DC. A filtering section is used to smooth out this uneven DC signal.

The LM7812 is a fixed I.C voltage regulator. It offers a fairly good voltage regulation over a relatively varying input voltage for loads not requiring more than 1000mA.The nominal output 12voltage is used to feed the logic gates; CD4011, and smoke detector.

The centre tapped transformer and two diode full wave rectifiers method was employed, in order to maintain simplicity, low cost and circuit space management.

Traditionally this is implemented using four diodes (full wave bridge rectification) for our case we have chosen to use just two diodes and a centre tapped transformer to achieve this.

When W_1 is supplying D_1 it anode is positive so it conducts while D_2 has a negative anode which prevents it from conducting. This result in the load current flowing from the centre tapped transformer through the load and ending at D_1. In the second half cycle the polarities are switched the anode of D_1 is negative while that of D_2 is positive resulting in it conducting in the same way as D_1, the direction of load currents remain unchanged but here the load currents ends in D_2[1].

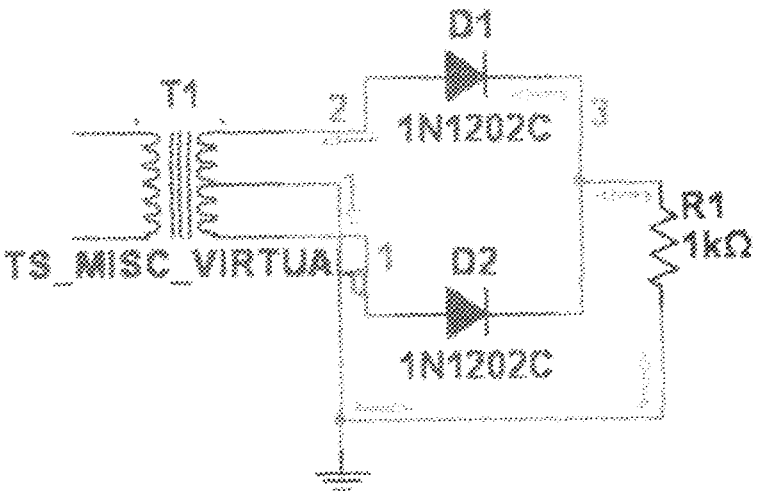

Fig. 3.3 Full wave rectification positive half-cycle

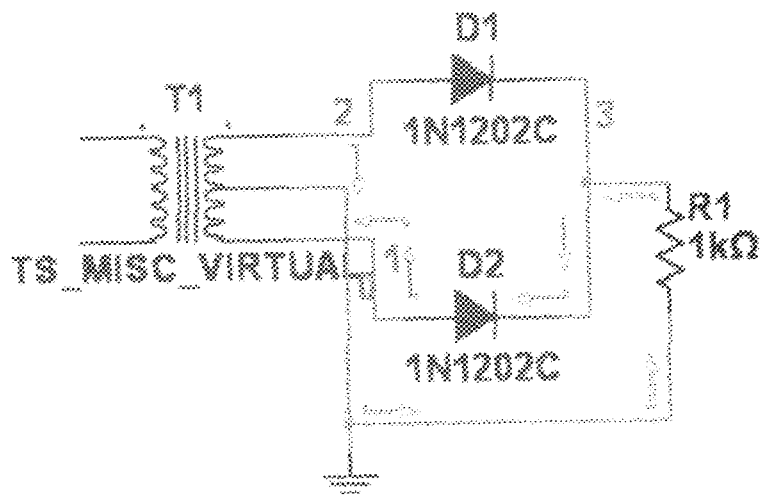

Fig. 3.4 showing full wave rectification negative half-cycle

circuit a certain timing constant or TC. This TC measures how fast the circuit responds to changes in the voltage level.

If the circuit has just the right timing constant, it can act to smooth the output voltage, and once the voltage leaves the filter stage, most of the variations or "ripple" should be removed. The AC has been converted into a smooth DC.

3.5 CAPACITOR VALUES

Usually, the filter includes one or more capacitors. The capacitors are placed between the DC line and ground. The value of the capacitors is chosen carefully to give the filter circuit a certain timing constant or TC. This TC measures how fast the circuit responds to changes in the voltage level.

If the circuit has just the right timing constant, it can act to smooth the output voltage, and once the voltage leaves the filter stage, most of the variations or "ripple" should be removed. The AC has been converted into a smooth DC.[2]

The value of the capacitor for filtration was deduced from the expression.

$Q = CV = It$ 3.2

$C = \frac{It}{V}$ 3.3

Where

C = smoothening capacitance across rectifier output

V = maximum allowable peak-peak AC ripple voltage

I = maximum load current.

t = period of the unsmoothed DC voltage.

$t = \frac{1}{f}$ = half wave rectifier……3.4

$t = \frac{1}{2 \times f}$ = full wave rectifier. … ……3.5

The amplitude of the DC output is given by the relation:

V_{DC} = 15.264V

15.264 – 12=3.264V.

The current required by our circuit is 0.5A

$$C = \frac{It}{V} = \frac{0.5 \times \frac{1}{2 \times 50}}{3.264} = 1.531 \times 10^{-3} = 1531 \mu F.$$

This is the minimum capacitance to maintain the regulation of 12V to feed the system circuitry. But a capacitance of value 2200μF was used instead to improve system performance the

The smoothed DC voltage was fed into a 7812 device to produce a regulated output voltage of 12V which was then fed to the different parts of system components.

3.6 VOLTAGE REGULATION AND POWER DISSIPATION IN LM7812

The supply voltage *Vi* to the LM7812 is approximately 15.0v. The output voltage *Vo* will be a fixed 12v and can supply current up to 1amp. Care must be taken when using a high

value for *Vi*. For example if *Vi* = 35v the output voltage of the LM7812 would be 12v, it means that regulator has 35-12=13v drop across it. If it is supplying a current of 0.8amps to a load, then the D.C power (volts *amperes) dissipated in the LM7812 is given as 13*0.8 =10.4 watts. The regulator will surely get hot and must need a heat sink to dissipate this heat.

Although the maximum allowable power dissipation for the LM7812 is about 15watts, it is strongly recommended that the regulator be operated at a lower input power rating so as to avoid eventual deterioration due to hot spot. Fortunately, our entire circuits require only just about half an amp (0.5A) even when the siren is operating.

To deduce the power dissipation in the LM7812

Vi = 15.264v

Vreg = 12.0v

Voltage drop across LM7812 = (15.264 -12.0) v =3.264v

D.C power dissipated =3.264*0.5=1.632watts

From the result of calculation shown above, the heat dissipation in the LM7812 is far lower than the nominal value; hence it is quite safe in this project to operate the voltage regulator without a heat sink.

3.7 LOGIC CIRCUITS

The logic circuit is build around a CD4011B; a quad 2-input NAND gate. The NAND gate is used because the logic level of its output from the truth table favours our design. The figure below shows the circuit symbol of a NAND gate and its truth table.

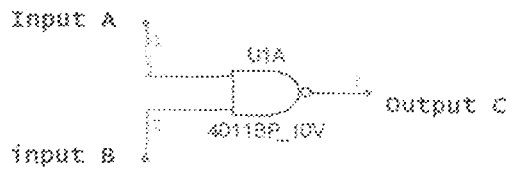

Fig. 3.5 Diagram of an NAND gate.

Table .3.6 showing the truth table of the CD4011 NAND gate.

Input A	Input B	Output C
0	0	1
0	1	1
1	0	1
1	1	0

(A) CIRCUIT DESCRIPTION

The signal output of the NAND logic gate as shown in the truth table above in fig (3.2a), gives a very useful hint in the design of the interface between the sensor and signal buffer.

From the truth table, it can be deduced that the only logic condition when the output C of the gate will be low, is when the two inputs A and B are all high (0). If at any point the two inputs have a dissimilar logic level, the output will be logic level (1) [1]

In our design, we concentrated on the condition whereby the output of the gate is low. This of course implies that both signals at the two inputs are high.

In the diagram shown below in fig3.2c a single gate has been selected to show how the above illustration is achieved.

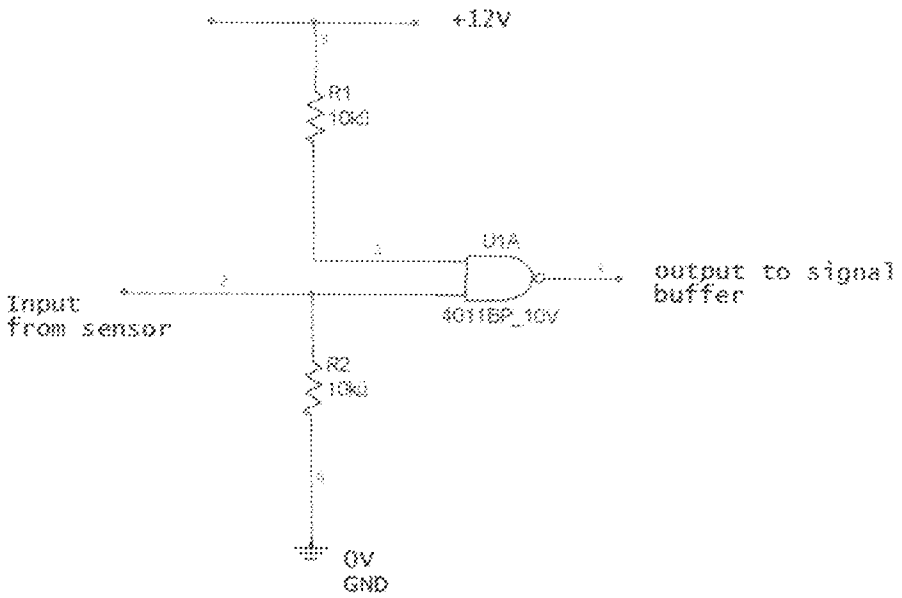

*Fig.*3.6 Single gate circuit interfacing the sensor and the signal buffer.

The two inputs of the gate have a 10kΩ resistor each. Input A has 10kΩ resistor connected to positive the D.C rail (VCC). This arrangement keeps input A at high logic level always. The 10kΩ resistor is called a pull up resistor. In the same way input B has 10kΩ resistor connected but this time to the ground to keep it at low logic level always. The 10kΩ resistor is known as pull down resistor. The pull down resistor also ensures that unless there is a positive signal from the sensor, input B should always be at low logic level. This arrangement is also known as anti floating, for instance in the absence of the pull down resistor, the input B may begin to float by assuming any logic level and cause the output of the gate to behave unpredictably. As long as input A is keep at a high logic level and input B remain low, the output of the gate will be at high logic level and this implies that the signal buffer must invert the signal to a low logic level to keep the siren deactivated.

However, as soon as input B becomes high due to a positive input signal from the sensor, (this is only possible when fire or smoke have been detected), the input combination for a low output logic level has been accomplished and the signal buffer in turn inverts the low logic to its input to become high logic level. At this point the trigger section is activated thereby turning on the alarm. A detail explanation on the function of the signal buffer will be available in subsequent sub-heading.

3.8 ZONE INDICATOR

(A) CIRCUIT DESCRIPTION

The zone indicator is a very simple circuit that shows the location where a smoke density or fire has been started. It consists of an LED and its current limiting resistor, connected directly to the output of the inverter or signal buffer. The LED is turned on whenever the output of the buffer is at a high logic level. This also indicates the location where the smoke sensor from a particular zone connected to the gate's input has detected the presence of fire or smoke.

The following analysis shows how the value of the limiting resistor was arrived at. The colour of the LED used for zone indicator is green; green was chosen because of its luminance and its easy attraction to the eye.

The green LED has a forward P-N junction voltage drop of approximately 2volts. And since it is only safe to operate LEDs with current source not exceeding 30mA, the following procedure for deducing a suitable limiting resistor is very important.

Using the relation $Rl = (Vs - Vf)/If$ 3.6

Where:

RL = limiting resistor for biasing the LED.

Vs = is the D.C supply voltage

Vf= is the forward voltage drop due to P-N junction resistance of the LED.

If = is the intended safe current allowed to operate the LED.

(B) DEDUCTIONS

Let

Vf = 2.0volts

Vs = 12volts

If = 30mA

Applying the relation shown above.

RL = (12-2)/30mA

= 10/0.03

= 333.33Ω

The effective resistance value for the limiting resistor is 333.33Ω, however the conventional resistance value of 330Ω is readily available than 333.33Ω; hence we decided to use a 330Ω resistor.

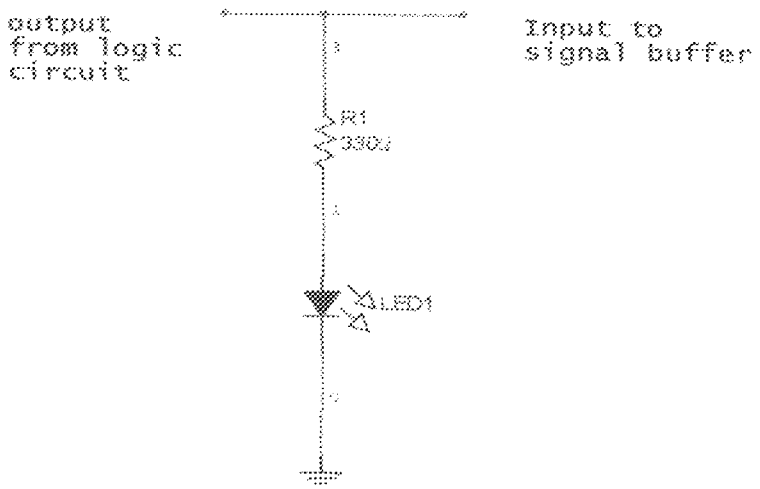

Fig 3.7 Diagram of Zone indicator.

3.9 SIGNAL BUFFER

(A) CIRCUIT DESCRIPTION

The output of the logic section will be at a low logic level when the smoke detector senses the presence of smoke or fire outbreak. At that point the zone indicator as well as the audible alarm (siren) will still remain off. The job of the signal buffer is to take the low logic level on the output of the logic section and invert it to a high level with the following properties:

(1) Ensure that the logic level of the signal from the zone indicator is an inverted version of what is replicated at the input of the trigger circuit.

(2) Obtain a regenerated signal level strong enough to turn on the thyristor in the trigger circuit.

The above listed points constitute the buffer concept of the buffer circuit. The buffer section is constructed using an NAND logic gate from CD4011B, a quad -2 input NAND logic gates.

The NAND logic gate presents a very suitable logic condition from its truth table that best describe its buffer property. The figure below shows the circuit symbol of a NAND logic gate and its truth table.

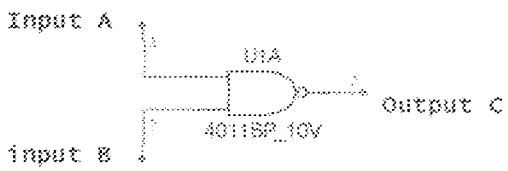

*Fig.*3.8 Symbol of an OR logic gate

Table. 3.8 Truth table of a NAND logic gate.

Input A	Input B	Output C
0	0	1
1	0	0
0	1	0
1	1	0

Fig 3.9 A signal buffer.

The two inputs A and B are bridge together in order to assume a common input logic level as shown in fig.3.4c. This means that a high input logic level will apply to both inputs simultaneously, as well as a low logic level.

Considering the output of the truth table of then NAND logic gate as shown in fig 3.4b, the output C is at low logic level under only one condition that is when both inputs are at high logic level. Inversely, the output becomes high when all inputs are low. This characteristic is the signal buffer property of the buffer section. In this design the signal buffer ensures that its output logic signal level is the inverted version of its input.

3.10 TRIGGER CIRCUIT

The trigger unit is an electronic circuit designed to turn on the siren (audio alarm) in the event of smoldering fire or outright fire outbreak. Once turned on, the trigger unit continues to power the siren until it is reset.

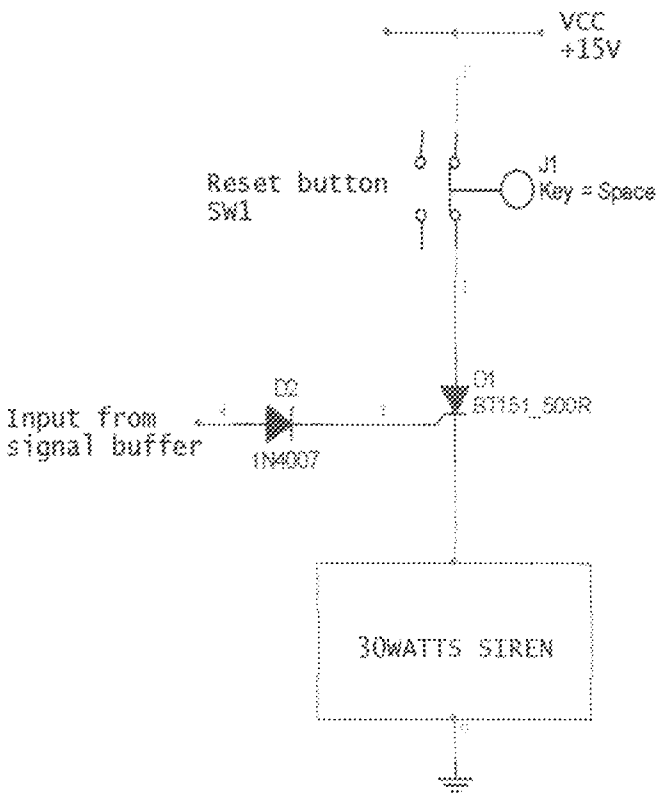

Fig 3.10 Trigger unit

(A) CIRCUIT DESCRIPTION

SCR FIRING

The SCR (silicon control rectifier) also known as thyristor is a very useful switching device in electronics. It is a rectifier with a third terminal for control purposes. Once the SCR is forward biased i.e. When the anode terminal is connected to the positive rail of a DC power supply and the cathode to the negative rail, the SCR will operate in its forward blocking mode thereby not conducting current from the anode to the cathode, as a normal rectifier would do.

However, when a short positive pulse is applied at the gate terminal with respect to ground, the forward blocking mode is removed and the device is turned on and conducts an

anode – cathode short circuit current, which is only limited by a load in its path. The application of positive pulse to the gate terminal of an SCR in order to turn it on is called firing.

Once the SCR is fired, it remains in its on state regardless of the gate's voltage level. As a matter of fact, even if the positive voltage that initially turned it on is removed, the SCR still continue to conduct. this situation is known as forward latching.

To turn off the SCR, the anode circuit must be interrupted. Although there are several ways of turning off an SCR, the anode circuit interruption is simpler and requires no separate turn off control circuit. This is the reason why the reset button is connected across the anode of the SCR in our design.

These features of the SCR play a very important role in the design of the trigger unit of this project. In our design, as soon as smoke or fire is detected and the signal buffer's output is a high logic level, the gate terminal of the SCR is powered. It turns on thus connecting the siren to power. The siren continues to give audible alert until the reset button is operated.[1]

In the circuit shown in fig.3.5a the diode IN4007 is inserted along the gate circuit to prevent any feedback from the anode of SCR during anode- cathode conduction into the logic circuits. The SCR is not fitted with any heat sink since it remains dormant at all times. It only begins to work when it is fired. Also, the nominal anode current capacity of SCR C106Y is about 4 amps, and since the siren can sink just about 1amps, it is only unnecessary to fit the SCR with a heat sink; after all we are aiming at cost effectiveness.

3.11 SMOKE DETECTORS

Smoke detectors have been recognized as very useful and desirable in providing an early warning of dangerous level of smoke. A smoke detector can warn of a smoldering fire

before any significant property damage occurs and before the occupants of the structure find themselves in grave danger.

When the output of such detectors goes into a mechanism fitted with an audio alert, they surely are a source of great remedy. Usually a visual indicator is included to show where the danger of fire outbreak is looming. Smoke detectors are commonly used to detect presence of smoke particles in the air by sensing light scattered from a light beam by smoke particles that infiltrate the smoke detector. Smoke detectors are typically mounted in various locations around houses and apartments building as high as possible due to the fact that heat and smoke rise is in upward direction, so that the higher up they are mounted, the earlier a fire may be detected. Smoke detectors are usually arranged in appropriate position of a building, and are coupled to a centralized fire monitoring unit installed in the building which provides electric power to the smoke detector. This is the sophisticated version of fire alarm system we talked about in the methodology earlier. They come with dozens of features and are intelligent. They are also expensive.

(A) HOW SMOKE DETECTORS WORK

Smoke detectors detect the presence of smoke particles as an early indication of fire. In general, smoke detectors are based on the principle of detecting smoke particles in the air. Typical smoke detectors function to sense smoke either by sensing atomic particles using an ionization detector or by sensing smoke particles using a photo detector process.
Generally, there are two major principles of smoke detection.

(1) Photo detector principle:

The photo detector type detectors, detects light beams scattered by smoke. Inside the detector there is a light source and a sensor, (photo detector) but they are positioned at right angle to one another i.e. at 90 degrees. In a normal situation, the light from the light source

shoots straight across the sensor without any interference. However, when smoke enters the chamber the smoke particle scatter the light and some amount of light hit the sensor (photo detector). If the sensor is wired to an electronic control unit like ours in this design, it could set off an alarm.

Photo electric smoke detectors are better at sensing smoke fires such as smoldering mattress, carpet, plastic etc.

(2) Ionization principle:

Ionization smoke detectors use an ionization chamber and a source of ionization radiation to detect smoke. This type of smoke detector is more common because it is inexpensive and better at detecting the smaller amount of smoke produced by flaming fires. Most ionization detectors use a radioactive material called Americium, which is a good source of alpha particles.

The ionization chamber of a smoke detector consists of two plates with a potential difference across them along with the radioactive source on one end. The alpha particles generated by the Americium have the following property: they ionize the oxygen and nitrogen atoms of the air in the chamber, due to ionization free electrons are attracted to the plate with a positive voltage, and the positive atom is attracted to the plate with negative voltage.

The electrons in the smoke detector sense the small amount of electric current constituted as a result of the electrons and ions movement towards the plates.

When smoke entered the ionization chamber, it disrupts the current flow as the smoke particles attach to the ions and neutralize them. The detector senses the drop in current flow between the plates and triggers an alarm.

While the performance and reliability of smoke detectors may vary, modern smoke detection is usually based on either ionization or a photoelectric detection technology. Both ionization

and photoelectric smoke detectors have proved to be useful in proving warnings of existence of fire.

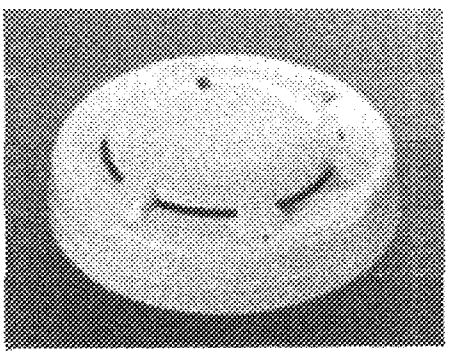

Plate 3.11 Outlook of a typical ICSD.

The major raw materials used in the construction of an ionisation smoke detector are poly-styrene plastic, small electronic alarm, a printer circuit board fitted with electronic components then a sensing and referensing chamber and a radio active sourse material.

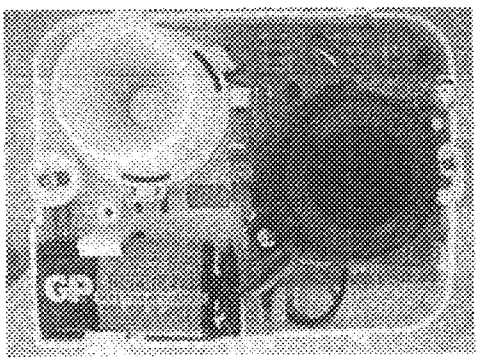

Plate 3.12 Internal of an ICSD.

3.12 AUDIO ALERT (SIREN)

The audio alert is a section that is equally important as every other part of the fire alarm system. It is the aspect that involve calling the attention of people to be aware of a possible fire outbreak.

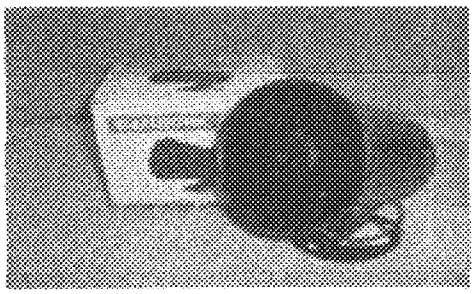

*Plate*3.13 A siren.

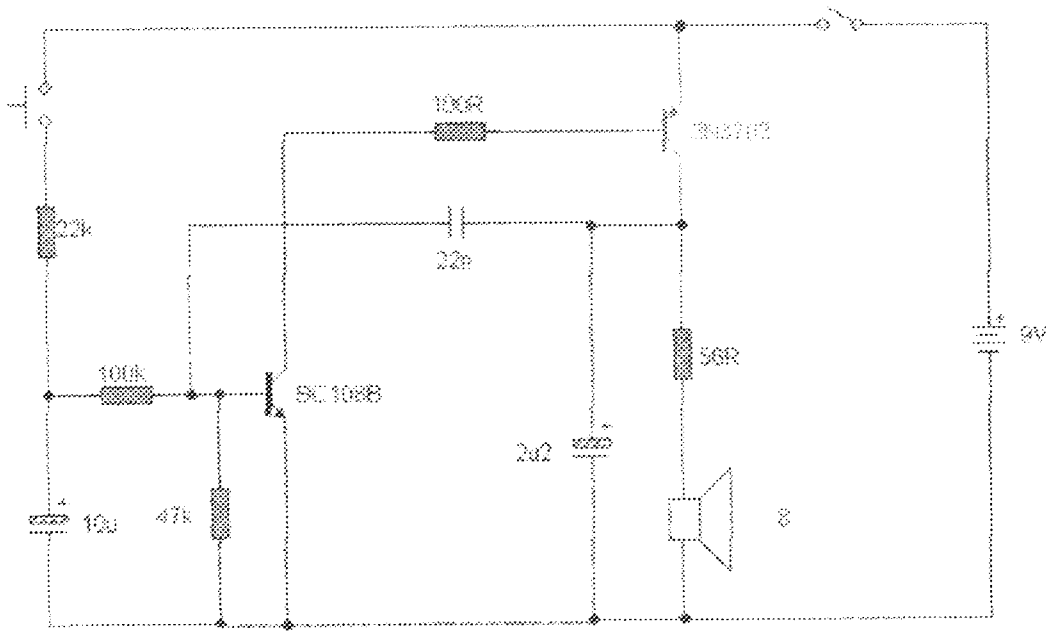

Fig. 3.14 Simple circuite diagram for a siren.

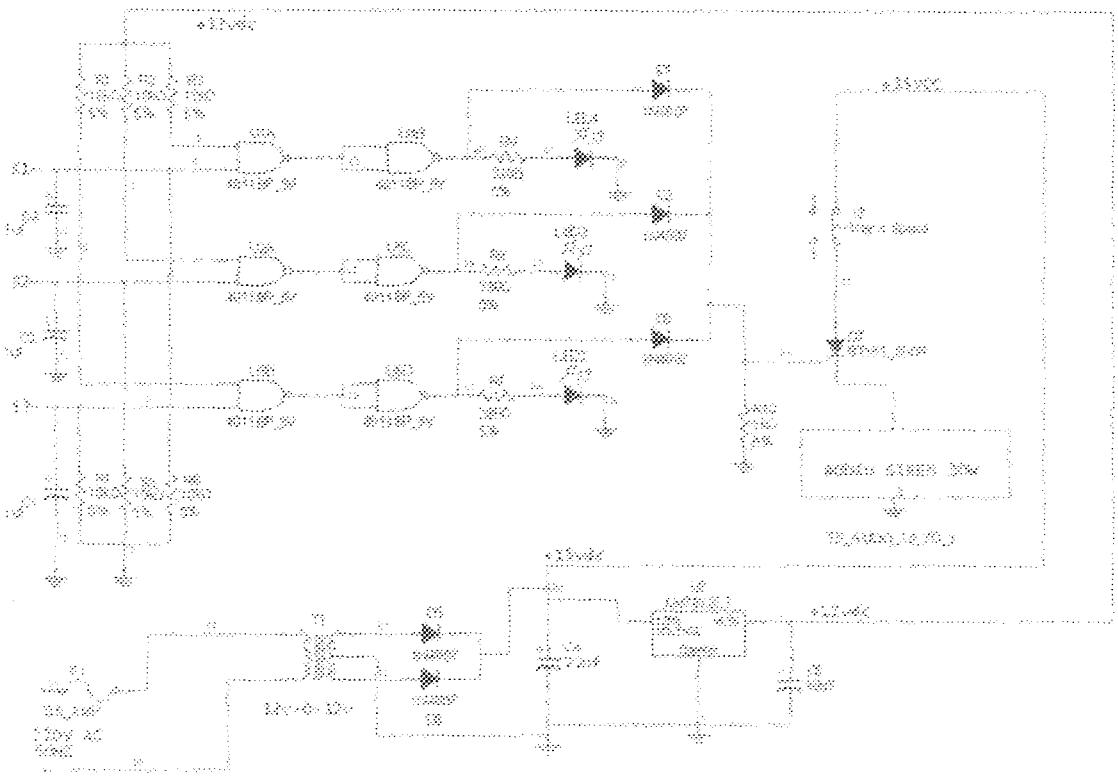

Fig. 3.15 A comprehensive circuit diagram for the Of A Three Zone Smoke Detector With Audio And Visual Alerts.

CHAPTER FOUR

4.1 CONSTRUCTION, TESTING AND RESULT.

A logical conceptualization of this project design follows by its construction and testing of its workability/functionality. This involves the technique hitherto proper understanding of the design stages acquiring adequate hardware components and minimizing the amount of components used. The compatibility of the component parts and proper interfacing for effective functionality is something to be well understood. The realization of an automatic temperature control is a procedural stages and implementation of the circuit on the breadboard. The workability must be such to be confirmed on breadboard after which the components are laid on the veroboard marking the second stage as soldering on the veroboard. And lastly the Vero boarded sample was encased to house the entire implemented or constructed circuit.

4.2 CONSTRUCTION:

The system construction was logically and inherently modularized into the following units:

i. Power supply

ii. DC amplifier

iii. Audio sounder.

The construction of the three zone smoke detector involves three stages:

i. Bread boarding

ii. Vero boarding

iii. Casing of the entire circuit.

4.2.1 BREADBOARDING STAGE:

This involves the activities whereby each of the components were carefully placed on the breadboard according to the signal flow as shown by the block diagram. While bread boarding the components, the continuity test was performed to ensure of effective signals flow. The perfect and tight connections were not uncommon to achieve high efficiency of the components placement and bread boarding.

4.2.2 SOLDERING STAGE:

The soldering stage was adequately done with careful placement on veroboard. This was done with the aid of soldering iron and lead as soldering materials. Enough care was taken here not to short circuit.

4.2.3 CASING STAGE:

The casing of the whole circuit is paramount as it prevents or serves as a house to the components of the system. In the course of construction, adequate aeration was taken into consideration to maintain proper ventilation to avoid localization of heat.

4.3 TESTING:

The most paramount part of any experiment is the testing of it to meet the targeted goals for which it was design.

4.4 LIMITATIONS:

The limitations to this project in the course of the experiment are as follows.

i. Substandard components resulting to unpredictable behaviors.

ii. The system design was without a backup power supply.

4.5 PRECAUTIONS:

i. It was ensured that calculations leading to the determination of electrical values were carried out with the correct formula.

ii. To avoid damage to the component as a result of over voltage a stabilizer was used at the initial stage.

iii. To ensure there was no damage to the component, they were handled with care.

iv. The bread board used for the initial construction was tested for proper functionality.

v. The component and jumper were placed at the appropriate point with utmost concentration.

vi. The soldering was done to ensure firm grip at same time not damaging the Vero-board.

vii. The casing was constructed so as to ensure a stable base for the work.

4.6 RESULTS:

The synchronization of the component parts (sensor, logic circuit, trigger system and ultimately alarm) was actualized whenever an unfriendly smoke level was observed. The alert (audio and visual) continued until the AC source is interrupted or the zone, free from smoke.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From the test result on this project, it is seen that it is a success as it fires on all alerts each time a smoke in-rush was observed, preventing a full scale fire which can only be, if the fire started and got established unchecked. These project brings to quick notice an evolving conflagration before it becomes over powering which is its primary objective. The edge of this particular project is that inspite of its low cost of construction, it is able to respond as promptly as the more sophisticated types. A is that a very good sensor was used along side simple and effective design but most importantly, it is made to monitor at the same time as much as three different locations. I conclude that if every house (residential, office building, ware house etc) were to have detection system as these the number of life and amount of property distroy by fire on a daily bases would be greatly reduce.

5.2 RECOMMENDATION

In life were made to be in constant contact with fire which can be inform of burning flame or other potential form (fuel that can be ignited by environmental conditions as heat and electrostatic, electricity which during a fault can result in outline flame and so on). Having know how vulnurable to this great and dengarous force, it becomes essentials to put in place mechanism to notify in an advent of it.

Against this back drop, I here by recommend the installation of smoke detector such as this in every building erracted to serve as a forewarner of a developing conflagration and making way for the possible necessary measures to fight it out while it is not yet well established.

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