DESIGN, CONSTRUCTION AND TESTING OF A SMOKE AND HEAT DETECTOR.

BY

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DECEMBER 2009

DECLARATION

I hereby declare that this project has been written by me and is a record of my own research work. It has not been partially or wholly presented in any previous application for a degree, diploma or any other form of certificate. All quotations and sources of information are duly acknowledged by means of references.

JERED A.ISHAKU

18th December, 2009.

DATE

CERTIFICATION

This is to certify that this project titled "heat and smoke detector" was carried out by JERED A. ISHAKU. It satisfy the regulations/standards governing the award of the degree of bachelor of Engineering and computer engineering department of the school

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09/03/10
DATE

DEDICATION

This work is dedicated to the most high God, who has been faithful all through,

My Parents Dcn. And Dcns Ishaku Paul Samu and to the memory of my late

Uncle, Mr Philip S. Bawa Bejih.

ACKNOWLEDGMENT

My profound and sincere gratitude goes to Almighty God for sparing my life and giving me the strength through my difficult times. My gratitude also goes to my dynamic project supervisor Mr Paul Abraham Attah for his intelligent contribution and correction of the project and fatherly advice throughout my stay in the school and especially during the period of this project. I am also acknowledging the great contribution of Mall. Mohammed for this effort in overseeing the work and making valuable suggestion towards the completion of the work. I must confess that it was a rare privilege to be your student.This project was sincerely made possible through the unending support from my parents Den and Dens Ishaku Paul Samu , my uncle Eng.Simon Bawa Bijeh and Mr Bitrus Usman who have laboured so much to see that I succeeded even when it seemed so difficult for them.

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Special thanks go to my dearest and caring friend Juliana Joshua for all her moral, financial support and advice all through this period, you have really blessed my life. To my brothers in the list ; Jonadab Ishaku, Julius Ishaku and Jeshrun Bawa Ishaku I am so greatful.

I cannot forget my colleagues that work so hard with me in spite of our "differences" to ensure that these works succeed. In the list are: Bima Mohammed, Ahmed D. Suleiman, Mr Ephraim. Mr Ted. And others too numerous to mention. Thank you all and god bless. (Amen)

ABSTRACT

This design and construction of a heat and smoke detector alarm is described in this Project. The project is intended to sound an alarm as soon as smoke and heat are Detected above a preset value, through the various sensors.

The project is expected to produce two output depends solely upon the temperature Sensor device the thermistor and the LDR (Light dependant resistor) .The thermistor Senses the heat while the LDR senses the smoke respectively, when they exceed their Known set value then an alarm is then triggered.

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CHAPTER ONE

INTRODUCTION

1.1 BRIEF HISTORY ABOUT THE PROJECT

Fire detectors are devices that sense the early stages of fire and sound a warning so that the occupants or inhabitants of those buildings may escape safely. They detect smoke and heat in a variety of ways. The two basic types of fire detectors are smoke detectors and heat detectors. A smoke detector transmits a signal to the control unit when the concentration of air-borne combustion products reaches a predetermined level. A heat detector transmits a similar signal when the temperature reaches a predetermined level or when there is an abnormality in the rate of temperature rise.

There are two principal types of smoke detectors: photoelectric and ionization. Photoelectric detectors are sensitive to the presence of ions, which are electrically charged particles produced by the chemical reactions that takes place during combustion. Both ionization and photoelectric detectors are effective. Which one is better in a given situation depends in the nature of the fire. Hot gases with few smoke particles are more readily detected by ionization smoke detectors, while photoelectric detectors are more sensitive to cooler smoke with large smoke particles.

The smoke detectors should not be confused with self-contained devices commonly used in apartment suits and houses that are technically refered to as smoke alarms – smoke alarms have a build-in audible alarm device in addition to a smoke sensor. Smoke alarms are intended to warn only the occupant in the room or suite which they are located. Smoke detectors in the other hand are connected to the building's fire alarm system and are designed to initiate an alarm signal to warn the occupants of the entire building. A heat detector, like smoke detectors, when actuated sends a signal to the

control unit to initiate an alarm throughout the building. This type of detector is not prone to false alarms although it is insensitive to smouldering fire of a low temperature.

Automatic sprinklers can perform the same function as a heat detector. A water system is installed so that when the fire alarm actual causes the sprinklers to operate to serve as a first aid control system. This form of fire detection has the advantage of automatically suppressing the fire (12)

1.2 SCOPE OF THE PROJECT

The scope of the project is to design a fire alarm with some complex features such as heat detector, smoke detector, loud speaker and provision for water sprinkler. However, they are usually much more complex when components such as fire detectors annuciator panels, telephones, control panels and pull boxes are included. (12)

The system designed and constructed enables the loudspeaker to produce the audible alarm signal.

1.3 THE NECESSITY OF THE PROJECT

The project became a necessity as a result of the alarming rise in the rate of fire outbreak in our homes these days. It is also a necessity for building codes. In the case of a new building, this is usually accomplished through the adoption of building regulations. In existing buildings, fire alarms systems may be required by municipal a provincial pre code provisions or by special provincial acts or municipal by-laws directed at specific classes of buildings, above all with aim at protecting life and properties.

1.4 METHODOLOGY ADOPTED IN THE PROJECT

The first approach here is to provide a description of each component used in the circuit in order to give a very clear understanding and intuitive findings for the design behaviour.

After physical insight has being obtained into the operation of the circuit then mathematics is applied in deriving the circuit parameters. The concluding steps include the construction, testing trouble-shooting and packaging of smoke and heat alarm system. This is followed by conclusion and recommendation. Each chapter is well defined with illustrations using block diagram and circuit diagrams provide where necessary. The project report is divided into five chapters, chapter one introduces the project, chapter two contains literature review, chapter three gives design and system operation project such as captioned diagrams, chapter four gives construction, testing and the result obtained; chapter fives gives the conclusion and recommendations, finally the material consulted are contained in the references.

1.5 CONSTRIANT TO THE PROJECT

The constraints of the project is that it is limited to the design and construction of smoke and heat detector, an alarm system, a provision for sprinklers and an alarm signal, but it cannot automatically engage equipment to pressurize stair ways to shut down re-circulation of air system.

1.6 OBJECTIVES OF THE STUDY

The project objectives is to design an efficient fire detection alarm that will be able to alert the occupants of an entire building as well as providing first aid sprinkling device (Not incorporated) in times of fire outbreak to save life and property damage. It may also perform other functions, for instance, the system can be designed to simultaneously alert the fire department by means of a direct or relayed signal where a response by the fire department is essential. This is particularly important in certain industrial establishments containing huge quantities of highly explosive materials were a fire can develop rapidly and in high building, hospital and nursing homes where evacuation

assistance may be designed to alert initially only the building staff before the general alarm is actuated.

1.7 ECONOMIC IMPORTANCE

The economic importance of this project design is to save cost. It cost ₦ 4,330 to design and construct a smoke and heat detecting system. This can be compared with research carried out at a security outlets shops. It was found that imported smoke detectors cost about ₦3,900 while imported heat detector cost ₦3,500. A single zone fire alarm panel cost ₦8,000 whereas the design and construction of smoke, heat detector and alarm system with provision for sprinkler cost relatively cheap compared to each single detecting system.

CHAPTER TWO

2.1 LITERATURE REVIEW

The design of heat and smoke detector dated back to the beginning of the 19th century when George Andrew Darby, an electrical engineer of 211 Bloomsbury street Birmingham, England, in 1902 patented the electrical heat-indicator and fire alarm. The devices indicated any change of temperature say between 38^{0}C to 50^{0}C in the apartment where it was fixed. The devices operated by closing an electrical circuit to sound an alarm if the temperature rose above the safe limit. The contact was made by bridging a gap with a conductor or allowing one plate to fall on another. This closing movement was caused simply by a block of butter which melted as the temperature rose, this early devices subsequently gave way to more modern fire alarm and eventually smoke alarm.

Another significant development occurred in the 1920's as a result of several resort fires which claimed many lives around the world. The leading members of Japan's insurance industry founded the Hochkiki Corporation in 1918. The Hochkiki corporation undertook the design, manufacture, installation and maintenance of fire alarm system and produced in excess of 3.5 million unit each year, the first mechanical manual (mm) style fire alarm system was installed in Japan by Hochkiki corporation.

In the 1960's the mechanical manual (mm) style fire alarm system was exported by Bangkok, Thailand, the manufacturing and testing facility was constructed in Machida which is a suburb of Tokyo. Also in 1969, British company electronic designed the first battery operated smoke alarm to receive UL (underwriters laboratory Inc) testing. During the 1970's as part of the Pittway Corporation, the smoke alarm division flourished. As a division of Pittway, British company electronics flourished. During the early 70's, intense product development produced a series of high quality and affordable battery and AC powered and system smoke alarm. British Electronics used these successes to enter

the new construction and mobile home market and increased its share of the commercial system smoke alarm market.

In 1974, Sears, Roebuck and Company put its name on British Company Electronics battery operated smoke alarms. The response was outstanding. The popularity of the sears alarm was so strong it prompted other manufacturers to enter the residential smoke detector market. In 1976, British company electronics introduced first Alert brand battery-operated residential smoke alarms. Consumers responded enthusiastically and sales of first Alert brand alarms become a major part of British Company Electronics total sales, by 1980, first Alert brand product had become the most recognized name in smoke detection. First Alert, together with BRIC brand alarm sold primarily to electrical contractors, combined to make British Company Electronics the leading manufacturer of residential alarms. The major contribution of British company electronics in the field of fire and smoke detectors as follows.

- Residential smoke, in 1967
- Residential carbon monoxide (CO) alarm, in 1993
- Combination smoke and Co alarm, in 1996
- Remote control Co alarm, in 2000
- Remote control smoke alarm, in 2001

In modern time, optical smoke and heat detector such as the one produced by C-Tec company, a British pre protection system Association, in corporate a pulsing LED. This is located in a Labyrinth within at hausing. The labyrinth is designed to exclude light from any external source. At an angle to the LED is a photo-diode which normally does not register the beam of light emitted by the LED. In the event of smoke entering the labyrinth the light pulse from the LED is scattered and registered by the photodiode. if the photo-diode, 'sees' smoke on the two following pulse, the detector changes to the

alarm state and It's LED illuminate. This detector is usually used for detecting fires from materials which produce large smoke particles such as PVC insulation, fabrics, furnishing etc.

The European standard categorized heat detector according to their response time and upper limits. Detectors are classified as being grade 1, 2 and 3 (from most normal applications) or arrange 1 and 2 (for high temperature environment). The fixed upper temperature for grade 1,2 and 3 or 60°C , 65°C and 75°C respectively and for ranges 1 and 2 they are 80°C and 100°C. All grades have a rate or rise element, but this differs according to the response time, grade 1 being the fastest in responding.

Heat detectors are normally used in areas where too much smoke is produced for the reliability of optical or lionization detectors (Public house, waiting rooms, etc) or in high temperature environment such as boiler house. An efficient heat and smoke detector should be able to detect fire from materials which produce small smoke particles such as PVC installations, fabrics, paper and wood. The latest innovation has been able to meet this requirement of efficiency in smoke and heat detectors.

CHAPTER THREE

3.1 DESIGN OVERVIEW

The circuit is designed to be simple and more economical, the requirement is made possible by the use of the transistor, transistor logic (TTL) Integrated circuit, such logic techniques is attributed to low power consumption high efficiency, high switching rate and released modern unit design incorporates the leading logic by the reasons of the early. The design holds 74Lsxx series TTL (Transistor Transistor Logic) for implementing logic design.

3.2 DESIGN OPERATION

This project is aimed at sensing fire and smoke especially in the aspect of fire hazards. This system gives an alert and also activates the switches (mechanical switch) that controls the pump meant to sprinkle water as first aid before the fire service arrives, to the place of fire outbreak. The system consist of the following units the power supply unit the sensor unit the comparator unit the control unit, the relay unit, as well as the alarm unit.

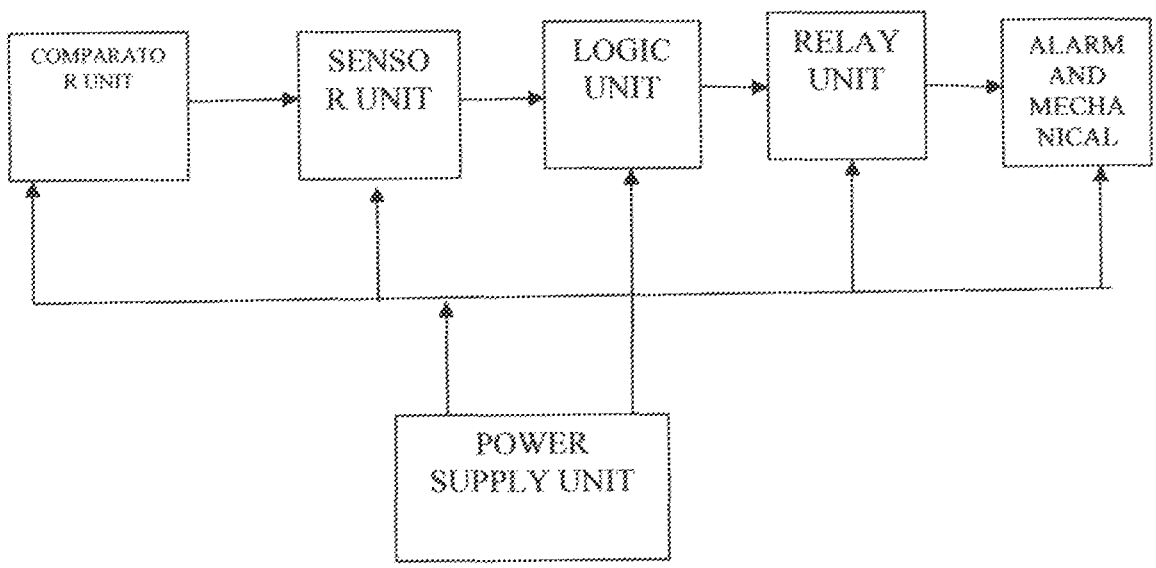


Figure 3.20 Block diagram of smoke and heat detector.

3.2.1 POWER SUPPLY UNIT

The main power supply come from the 230v/18v step down transformer, the output alternating current (AC) voltage is applied to the bridge type rectifier, Normally, the reactifier consist of the normal four-diode configuration. But in this respect a one chip rectifier is used. The ripple is then filtered by the 2200Ωf, 25v electrolytic capacitor. The voltage regulators 7815 regulate the voltage to 12v and the 7805 to 5v to suite the operation of the intended use.

The power circuit has a power switching which serves as power link to the other part of the circuit. A power indicator is connected along the supply line to indicate the status of the current flow in the circuit.

The indicator is a light emitting diode (LED) type it is connected in series with the 1kΩ resistor, the leading resistor serves as current limiting devices. It disallows damage to be done to the light emitting diode

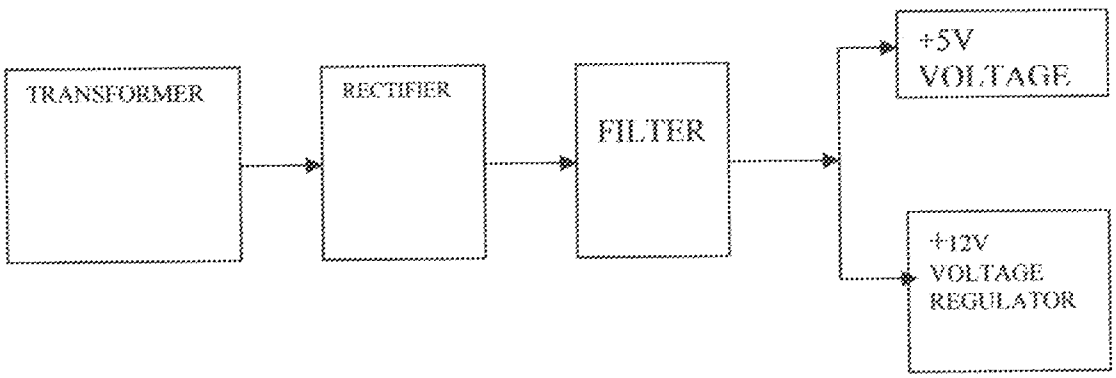


Fig 3.2.1 Block diagram of the power supply unit.

The input or supply voltage is single phase voltage obtained from the mains supply of PHCN with value of 230v, 50Hz.

3.2.1.1 THE TRANSFORMER SPECIFICATIONS

This is the stage of the power supply unit that involves the reduction of the AC voltage value to a lower value of 18v AC with the aid of 230v/18v transformer. The current rating is about 500mA, which is enough to drive the entire circuit. A transformer is an electrical device that provides physical relation between the 230v AC main and the rest part of t the circuit. The only link is by means of magnetic flux thus eliminating the risk of electric shock.

However, there exist basically two types of transformer which include: Step-up and the Step-down transformers. The step-down transformer is used and consist of two winding (coils) the primary winding and the secondary winding, this is shown in figure 3.2 below

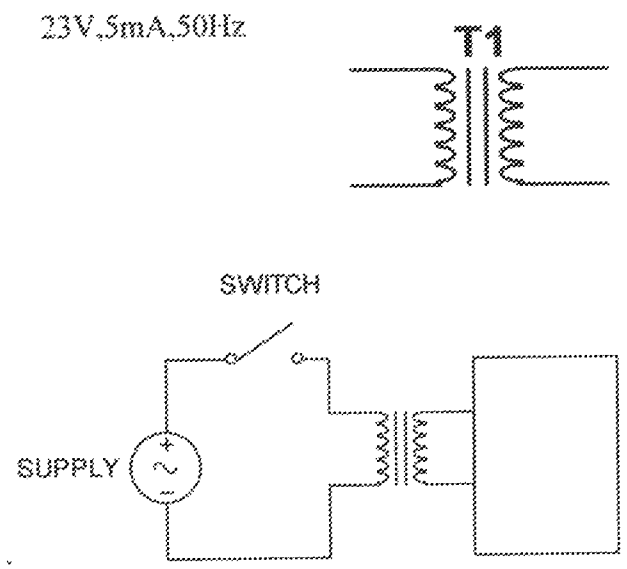
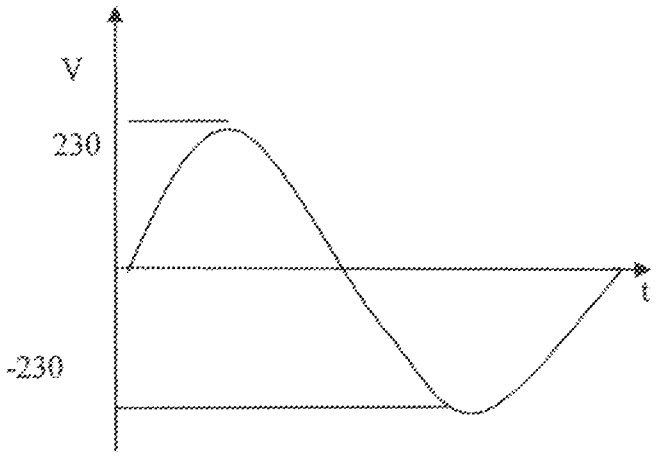


Figure 3.2.1.1 Transformer circuit symbol



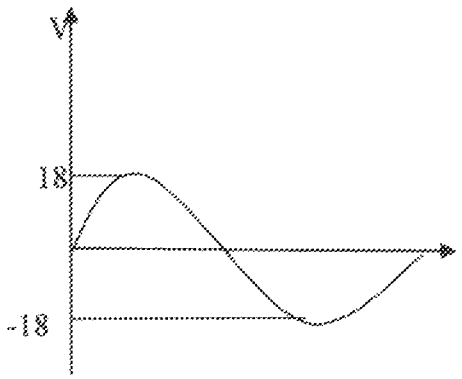


Figure 3.2.1.2 (a) input signal (b) output signal

The two figures above shows the waveform associated with the input and out of the transformer.

Below are the transformer date calculations.

V. (input) = 230v, V= (output) = 18v, I_2 = 500mA

Frequency f = 50Hz

The ratio of the primary voltage V_1 to the secondary voltage V_2 is equal to the turns ratio of the primary winding N_1 to the turns on the secondary winding N_2 of the transformer.

The primary and secondary voltage is related as follows.

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$\frac{230}{18} = 12.7 \cong 13$$

Turn ratio N_1:N_2

=13:1

The magneto motive force (MMF) =NI

$N_1 \times I_1 = N_2 \times I_2 = 13$ 3.20

N_1=Number of turn ratio on the primary of the transformer

N_2=Number of turn ratio on the secondary of the transformer

I_1=Primary current of the transformer

I_2=Secondary current of the transformer

$I_2 = 500mA = 0.5A$

$I_1=I_2/13=0.5/13=38Ma$

Power input (P_1) = power output (P_2)

$P_1=P_2$ 3.21

$I_1 \times V_1 = I_2 \times V_2$ 3.22

V_1=Primary side voltage of the transformer

V_2=Secondary side voltage of the transformer

38mA X 230= 8.74W.

3.2.1.2 THE RECTIFIER SPECIFICATIONS

From the output of the transformer, which is an AC signal is converted to DC signal with the aid of a rectifier circuit. The cheap rectifier is used.

The circuit achieves the aim of making current flow in one direction only (DC) irrespective of the positive and negative half-cycle of the input signal. The association wave forms are shown below.

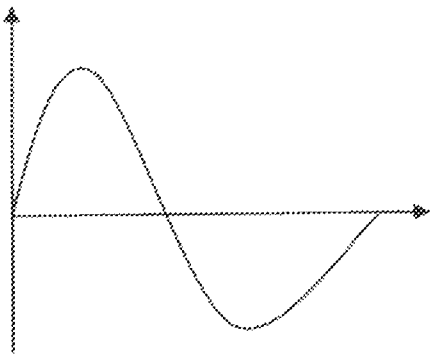
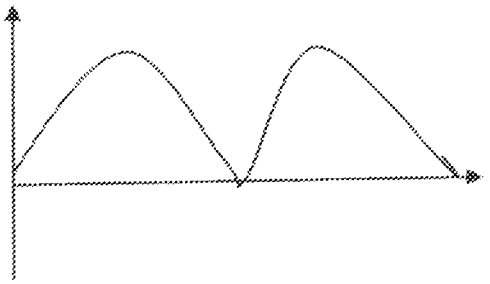


Fig.3.2.1.2(a) Input signal V_2



(b)Output rectified signal.

3.2.1.3 THE FILTER SPECIFICATION

The filter circuit forms a part of the power supply unit so as to minimize the ripples content of the rectifier output. The output voltage waveform of a rectifier is pulsating because it has both DC component and some AC component called ripple over this type of output signal is not good enough to drive electronic circuits. The filter circuits receives DC signal as an input and filter out and smoothens and the pulsations from the input.

There exist various types of filtering circuits but the simple capacitor filtering is adopted in the design where a large electrolytic capacitor (2200uf) is connected to the rectifier output. The shunt capacitor "bypasses" the AC signal present (ripples) and this effect makes the output to almost assume a pure DC level. The capacitor charges during the diode connection period to the peak value and when the input voltage falls below the

value, the capacitor discharges through the load so that the load receives almost steady voltage. Figure 3.2.1.3 shows the ripple gradient of the supply.

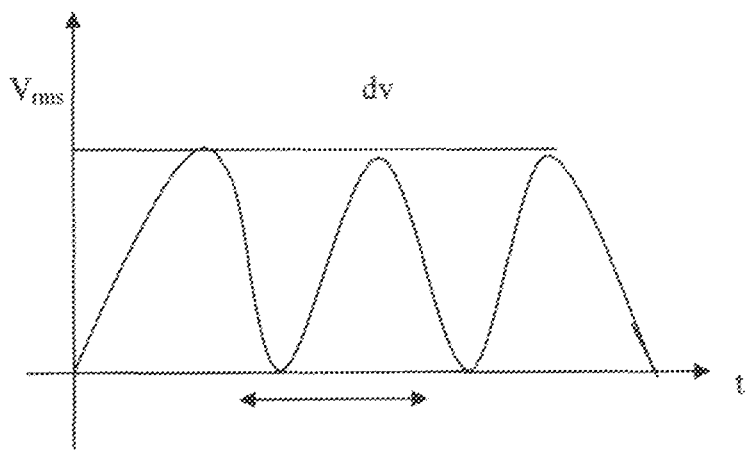


Fig 3.3 filtration.

ripple gradient waveform dv is the ripple voltage for dt, and that depends on the power supply frequency.

For rms voltage of 18volts (from transformer) But rectifier diode will eat up 1.4 during rectification, then we are left with 16.6v.Therefor

$$V_{peak} = 16.6 \times \sqrt{2}$$

$$= 23.48v$$

$$Q = IT = Cdv \quad \text{.....3.23}$$

Q=quantity of charge, I=current T=time, C=capacitance, dv=change in voltage.

Frequency from main power supply is 50Hz

$$\frac{1}{2}t = \frac{1}{2}f = \frac{1}{100} = 0.01$$

$$\frac{15}{100} \times 23.48 = 3.522$$

$$C = \frac{4}{3.522} \times 0.01 = 2840\mu f$$

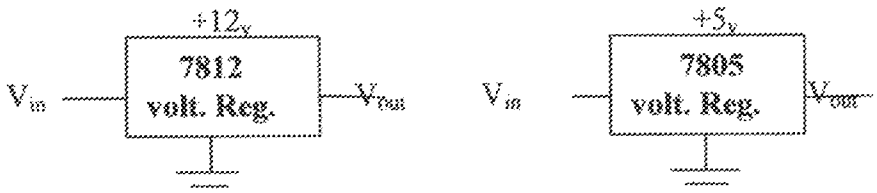
$$\approx 2200\mu f$$

A preferred value of 2200uf was employed for the rectification aspects of the power supply stage. C acts as filter capacitor and filters out or smoothens out the pulsations.

3.2.1.4 THE VOLTAGE REGULATOR

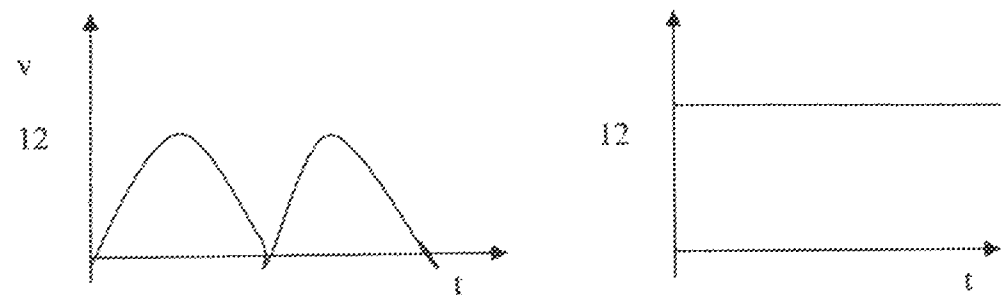
The voltage regulators are necessary for the project to regulate the amount of power supply to various unit on the project. The regulates used include the 7812 and the 7805 which maintain a constant voltage supply of 12v and 5v respectively regardless of the varying voltage of input or load change which can cause irregular supply. A voltage regulator is a circuit that holds an output voltage regulator is a circuit that holds a output voltage at a predetermined value regardless of the change on the normal input or change in the load impedance.

The voltage regulators are mostly in three terminal package; one input terminal, one output terminal and the ground terminal. The 7812 chip and 7805 chip supply the rated voltage of 12v & 5v respectively with a wide range of voltage input and variations in load current



(a) (b)

Figure 3.3.1.1 (a) and (b) shows regulator circuit.



(c) (d)

Figure 3.2.1.2(c) and (d) show input and output wave form for 7812, the same waveform is applicable to 7805 chip.

3.3 LED INDICATOR

The LED indicates power ON and it is connected in series with the current limiting resistor of 1kΩ

Fig 3.3 .1.3 LED circuit

By standard the current consumption of an LED is 10mA and the voltage rating for an LED is 2.3 volts. Taking the supply voltage to be 18v.Therefore,voltage

across the resistor for normal on –destructive flow is 18-2.3=15.7v,therefore the value of

$$R_1 = \frac{V_1}{I} \quad \text{.....3.24}$$

$$R_1 = \frac{15.7}{10 \times 10^{-3}} = 1.5k$$

A 1k is suitable for the 1570Ω

$$R = 1.5k + 1K\Omega$$

3.4 THE SENSOR CIRCUIT (THEMISTOR)

The thermistor used in this used in this project is a 15k negative temperature coefficient (NTC) thermistor, this device varies in resistance with varying temperature. There are two types of themistor the negative temperature coefficient (NTC)and the positive temperature coefficient. The resistance of the NTC themister decrease with increase in temperature. A factor considered on its implementation in the design circuiting. But the PTC type thermister do otherwise.

Figure. 3.4

From experiment it has been shown that at room temperature (i.e. 28°C) The resistance of the thermistor is about 11kΩ Assuming that at room temperature a divider network is needed to divide the voltage into two, that is V_1 = 6v

$$\frac{R}{R+TH} \times V_{cc} = V_1 \quad \text{.....3.25}$$

Where R = resistance

TH=thermistor

V=voltages

$$\frac{R}{R+11K} \times 12 = 6$$

$$6R+66=12R$$

$$66=12R-6R$$

$$66=6R$$

$$R=11K\Omega$$

But since 11kΩ was not available in market 15kΩ was chosen instead.

3.5 TEMPERATURE CONTROL

The temperature control arrangement is shown below, at which the alarm will alert

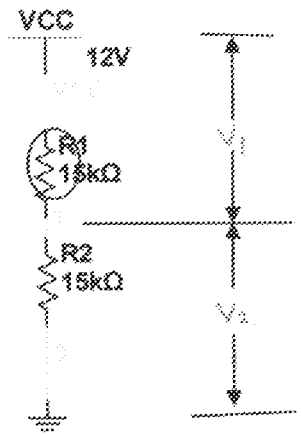
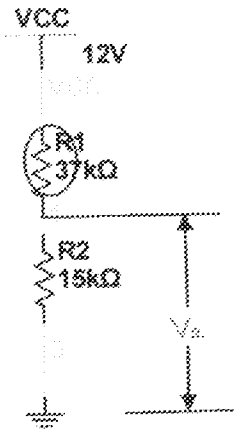


Fig. 3.5

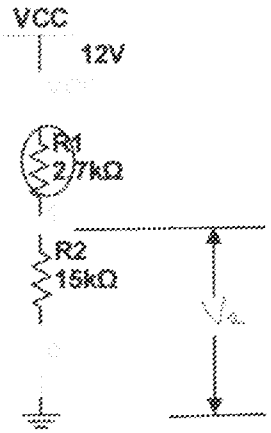
At room temperature V1 = 6v is expected, during the experiment that at 0°C the resistance of thermister is 37kΩ and at 100°C the resistance is 2.7kΩ

. . At 0°C



$$V_1 = \frac{15}{15 - 37} \times 12 = 3.5v$$

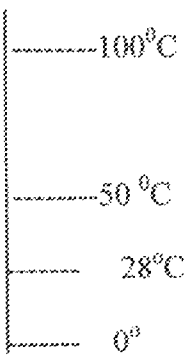
At 100°C

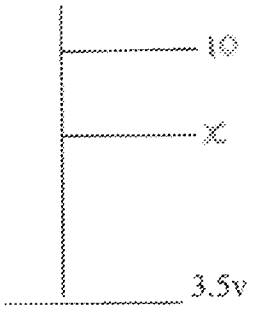


$$V_{in} = \frac{15}{15 - 2.7} \times 12 = 10.$$

3.5.0 CALIBRATION

From the analysis done, since the alert system is at 50°C then we have this calibration.





Therefore at 50°

$$\frac{50^{\circ}C - 0}{100 - 0} = \frac{x - 3.5}{10 - 3.5}$$

$$\frac{50}{100} = \frac{x - 3.5}{10 - 3.5}$$

50(10-3.5) =100(x-3.5)

$$X = \frac{65}{10}$$

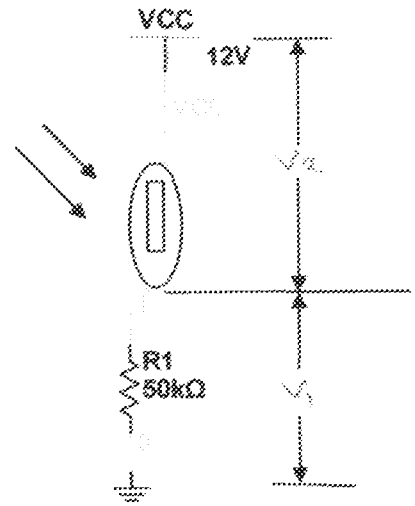
X= 6.8v

Finally from the calculation done it can be seen that the thermistor comparator at the non-inverting terminal is set to be 6.8v at 50°C.

3.5.1 THE LIGTH SENSOR (LDR)

The LDR (light dependent resistor) is very useful especially in the light/darkness sensing circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000000, when illuminated at light the resistance drops dramatically.

From the analysis the resistance of an LDR = 50k at ambient light it was used to create a voltage divider which divides voltage into two equal values as shown.



$$V_1 = V_{2=} \frac{1}{2} V_{CC}$$

$$V_1 = \frac{R_2}{R_1 + R_2} V_{CC}$$

$$\frac{1}{2} V_{CC} = \frac{R_1}{R_1 + R_2} \times V_{CC}$$

$$R_{1=50K\Omega}$$

$$R_{2=50K\Omega}$$

Hence when smoke comes over the LDR as a result of its opaque nature the resistance of the LDR increases so V_2 increase and V_1 reduces.

3.6 COMPARATOR

The comparator used is the Lm 324 (quad operational amplifier) it is made up of four operational amplifiers it has internally frequency compensated for unity gain large DC voltage gain 100db, wide power supply range, band width (unity gain) 1MHz (temperature compensation) wide power supply range, single supply 3v to 32v or dual supplies ± 15v to ±16v very low supply current drain (700mA) input common made voltage range includes voltage with large output voltage.

However, for this project 2/4 of the operational amplifier was used. The basic operation of the compartor is given below.

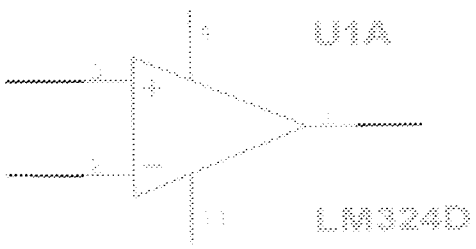


Fig. 3.6 Comparator citrcuit.

When Vin1 is greater than Vin2, Vout is high else it is low also, if Vin = V_{in2} then Vout is low.

3.7 THE SENSOR/COMPARATOR CIRCUIT

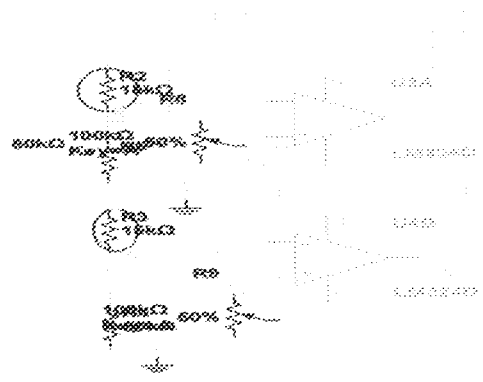


Figure 3.7 sensor and comparator circuit

From the circuit for the sensor and comparator reference voltage are set with the variable resistors. These are set above the voltage calculated to be at the inverting input (eg 6v) as the temperature increases the resistance reduce leading to reduction in the voltage level at the inverting input of comparator B it keeps reducing until it is below 6v then the output goes high.

As a result of smoke which is opaque the voltage at the inverting input of comparator A reduce as a result of increasing resistance of the LDR the voltage at inverting input reduces lower than that of the non-inverting input and the output goes high

3.8 CONTROL UNIT

The control unit is a single chip ic 74LS00 consisting of the AND gate which is done with the NAND gate, the NAND (NOT AND) gate is basically a NOT gate in series with AND gate, the circuitt realization are shown below.

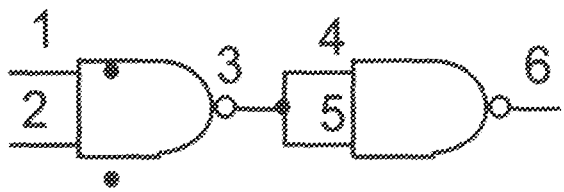


Figure 3.8 NAND Gate.

Table 3.8.The truth table for 74LS00.

A	B	C	D
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

Each input of A and B gives a corresponding out C and then D.

3.9 TRANSISTOR SWITCHING

Today's transistors are mostly the silicon types and are available in either NPN or the PNP type .Transistors is three terminal devices that comprises of an emitter, collector and the base. The common emitter is mostly used for most design because of its high state of stability. Transistor are also used for different purposes, it is used for switching, for radio frequency, for handling high voltages.

However, the transistor used for this project is BC547 and it is used for current amplification and also helps to provide the switching effect for the relays.

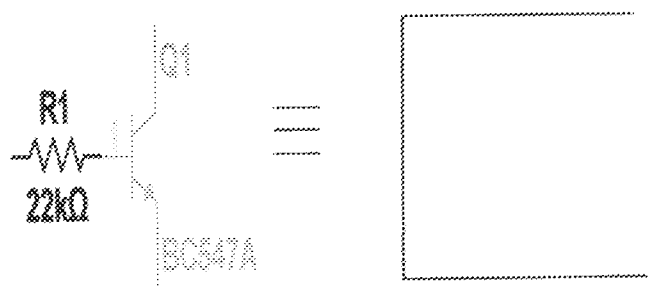


Fig 3.9 (a) conducting transistor

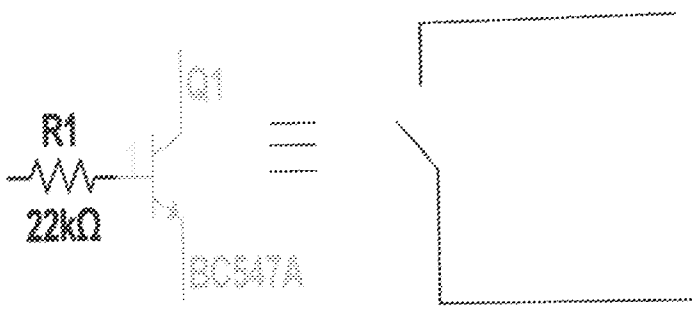


Fig 3.9 (b) Transistor not conducting

The conducting transistor is equivalent to a switch that ON and a transistor not conducting is equivalent to a switch that is OFF. When emitter of an NPN transistor is grounded (0Volts), no current flows from the base to the collector but when the base is forward biased a current the flows from the emitter to the collector the transistor is the said to be ON at this stage, it then energizes the relay coils to set ON the buzzer and the sprinkler switch.

$$V_{CC} = I_C R_C$$

For the BC547

$12v = I_C R_C$

But $R_C = 200\Omega$

$$\frac{12_V}{200} = I_C$$

$$I_C = \frac{0.\Omega}{\Omega}$$

$I_C = 0.06A$

But hfe=112

$$hfe = \frac{I_C}{I_B}$$

$I_b = \frac{0.6V}{112}$

$I_b = 0.0005357A$

$V_b = I_b R_b$

But $V_b = \frac{2}{3}(12v$

$\frac{2}{3} \times 12 = 8V$

$8 = I_b \times R_b$

$R_b = \frac{8}{0.0005357}$

$R_b = 15.43\Omega$

3.10 RELAY SWITCH

Method of switching current through a load, which requires isolation from this controlling circuit, involves the use of an electromechanical relay, this device offers a simple, low cost solution to the problem of maintaining adequate isolation between the controlling current and the AC main supply

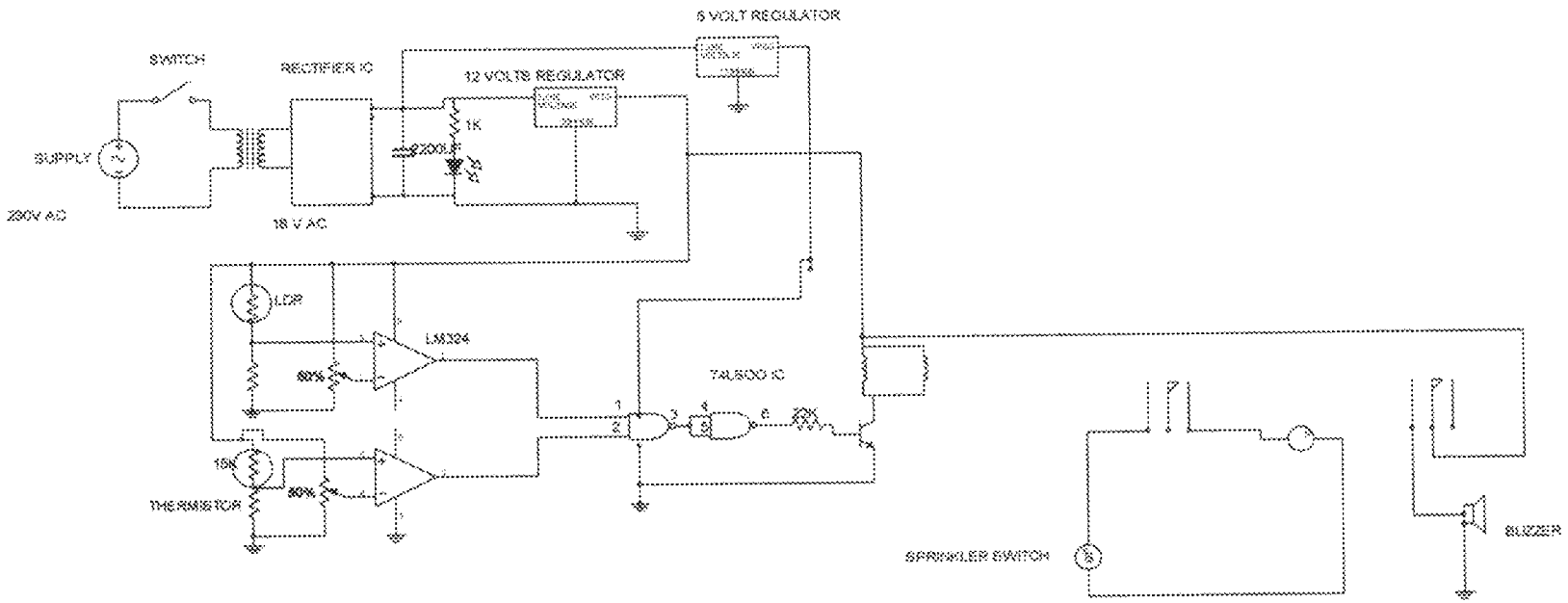
When the coils are energized a flues is set up in the relay care and the one gap. The relay operates as a switch in this project to switch on the buzzer and the mechanical switch the sprinkler automatically and simultaneously. A relay is normally closed position but opens when actuated while normally open relay closed when energized,

when energizing face is remove the spring actress returns the amative to its original state normally.

Before the coil is powered, the common is always on the contact called normally closed. However, when power is fed into the coil, the common is then moved to the normally open contact.

3.11 ALARM SYSTEM

In the circuit designed a buzzer of 12V to 18V DC volt was used as an alert sound to notify the occupant that there is a fire outbreak. This aids to occupant to evacuate the building while the fire goes high as well as all the fire service for assistance.



THE CIRCUIT DIAGRAM FOR SMOKE AND HEAT DETECTOR.

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

The circuit connection of the heat and smoke alarm system with sprinkler provision was carefully constructed with durability in mind.

4.1 ARRANGEMENT

Due to the encouraging assurance of the availability of the circuit design, the circuit construction was directly performed on the Vero board. This permanent connection of the components is carefully done with a moderately heated soldering iron. This is simply done to avoid heat destruction of the loading component. Also, the components are handled with care in order to avoid "static electricity effect or damage".

The power section is firstly implemented on the Vero board that was after the metallic surface of the board strictly scrapped with razor blade. The operation includes smooth and neat soldering of the leading component on the Vero board. Most times the surface of the board is covered with dirt that limits "metal to metal" soldering contact.

Moreover, the two sensor circuit where put on to the Vero board that was offer the power circuit is tested and working. The addition to circuit was independently tested. The errors of unclosed contact were detected and carefully bridge over. Also the alarm circuit was the next, the circuit was tested alone.

The sub-circuit wave inter connected, so that a whole new circuit was achieved. The circuit was set to meet the aims of the project by careful adjustment of the value of critical value components like the resistor and capacitor toward the output section of the device.

4.2 SOLDERING

Some soldering precautions taken are outlined below

1 Little but enough solder was applied to any joint to ensure proper contact of the component.

2 Care was taken to ensure proper soldering of each joint, so that the head of individual joint would not heat away

3 Heat sink was used to conduct heat away.

4 Made sure that the soldering iron temperature was not too high to prevent damage that could result from other heating.

4.3 DIFFICULTY ENCOUNTERED

Difficulty encountered during the construction of the project involved

- Unclosed connection which was bridged with a wire
- Short circuit that rises through de-soldering of concerned
- Readjustment or redesigning of the circuit to fit the real target

- Unavailability of some components which resulted in looking for best alternative
- Sensitivity of sensor hand to be increase as a result of insensitivity

4.4 TESTING

The smoke sensor is quite sensitive but the limitation is a false alarm when the sensor is highly illuminated with light, this effect is attributed to the light LDR. The error is minimized by proper shielding of the sensor.

The limitation of the heat sensor is merely the exposure to water or other conducting liquid. The liquid bridges the contact terminals of the device and result in a

false audio alarm triggering. The thermistor involved in the circuit is well placed and isolated.

4.5 SMOKE TEST

The test began with a lighted paper and the light was later put off in order for carbon mono-oxide a carbon dioxide (i.e. thick gas) to come out. The carbon dioxide was carefully directed to the smoke detector circuit whose resistance increases as the smoke gets thicker as the resistance increases to the known set value the alarm is then triggered ON.

The reason for this triggering of the alarm is as a result of smoke being released from the carbon mono-oxide or carbon dioxide which leads to the increase in the resistance of the LDR. the LDR is set to alarm at a certain resistance, hence when it is reached the alarm is then triggered.

4.6 HEAT TEST

A plug soldering iron was carefully placed on the thermistor when it was 37k for some moment. The thermister was subjected to the heat looming out from the iron until the temperature was 27000 ohms. At this temperature the alarm was triggered indicating the abnormality of the temperature.

4.7 DISCUSSION OF RESULT

It can be seen that the thermistor resistance once increases with increase in temperature. When heat is applied to the sensor, its` resistance changes from 50Ω-100Ω which increases the resistance value of the thermistor (say 27000Ω while the temperature is 50°C. At this temperature 50°C of the thermister, output voltage of 6.8v triggers an audio alarm circuit for some minutes until the set button is pressed and this clear the latch and the audio alarm is OFF

Likewise for the smoke test, when the smoke covered the surface of the LDR, the LDR's resistance increases as the smoke darkens as it exceeds the set value then it triggers ON the alarm until the set button is pressed and this clear the latch on the audio alarm is OFF

4.8 SYSTEM PACKAGING

The complete unit was housed in a wooden case, this is because it's readily available, cheaper and convenient to construct. The case is rectangular in shape. It's constructed in such a way that, there is enough at the top sides and front parts of the case, so that there is enough room for heat and smoke to enter into the chamber of the heat/smoke alarm system case.

Length = 17.8

Breath = 12.5

Height = 7.5

The total volume of the casing is

Volume = Length x Breath x Height

17.8 x 12.5 x 7.5=1668.75cm.

The power pack, the speaker, the socket outlet for sprinkler were all provided space in the casing, a provision was also made in the casing for AC and DC supply, for input transducers the Vero bard was mounted firmly on the base of the wooden case with nuts.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The design and construction of a heat and smoke detecting circuit through an alarm system has been carried out successfully. The demonstration of the detecting circuit followed the other of which, fire produce heat which is detected through the thermistor at a temperature 50^0C while the smoke is detected by the LDR (light dependent resistor)

Therefore, as far as the future of smoke and heat systems goes, there is something one can be sure of that is,it will continue to evolve the pressure to continue the development that is driven by professional detecting systems who continue the cat and mouse game of coming up with new ways and ideas to beat the latest technology.

5.2 RECOMMENDATION

Despite the high reliability of the design, some areas of the circuit or project can still be improved upon, so as to enhance its' performance, such improvement could include an increase in the sensitivity of the smoke and heat detector, and the use of high watt speaker and also the incorporation of the mechanical device that is the sprinkler in the provision made, to serve as first aid.

Instead of using only electricity to power the circuit a sealed backup acid battery and a charging circuit for the battery should be provided so as to provide an emergency supply to the alarm system in case of power failure from PHCN.

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