DESIGN AND CONSTRUCTION OF AN

INFRARED BURGLAR ALARM SYSTEM

By

DAUDA UMAR SULEIMAN
(96/5125 EE)

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY.

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,

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DECLARATION

I hereby declare that this thesis was wholly and solely written by Dauda U.S under the supervision of Engr P.Attah, Department Of Electrical And Computer Engineering, Federal University Of Technology, Minna.

DAUDA U.S
NAME

28/02/02
DATE & SIGN

CERTIFICATION

This is to certify that this work was carried out by Dauda Umar Suleiman of the Department Of Electrical and Computer Engineering, Federal University Of Technology Minna, Niger State, Nigeria.

....
Supervisor
(MR. P.O. ATTAH)

28/2/2002
Date

....
H.O.D.
(DR. Y.A. ADEDIRAN)

....
Date

....
External Examiner
(DR T.A AKINBULIRE)

....
Date

DEDICATION

I dedicate my entire write up to Almighty Allah for He (Allah) has made everything possible

ACKNOWLEDGEMENT

The writer wishes to express his profound gratitude to Almighty Allah Who made everything possible from the beginning to the end. He is also grateful to everyone who in one way or the other contributed one or two things to made this thesis what it is now especially his cousin Nma Abdulkadir.

Thank you all

ABSTRACT

The infrared burglar alarm system in this project is a detection system comprising of a transmitter and receiver both with infrared properties, an amplifier, few oscillators and a speaker. The transmitter and receiver are separated at a reasonable distance where the presence of an intruder can be detected when the beam is interrupted. When an intruder passes in between the transmitter and receiver, the receiver fails to the beam in which the output that is responsible for the audio output goes high. When an intruder passes in between the transmitter and the receiver, the infrared pulses are being interrupted thereby cutting off the pulses to the receiver. With this, the purpose of the sensor (a transducer) is not felt nor will there be conversion of pulses to electrical signal in voltage form.

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CHAPTER ONE

1.1 INTRODUCTION

In modern day security system, the burglar alarm security system has a number of important applications in homes and industries. They can be activated when light enters a normally dark area, such as the inside of a store room or a wall safe or can be used to sound when an intruder or object enters a prohibited area and breaks a projected light beam.

Burglar alarms may be designed to use an audible loudspeaker output, an alarm bell output, or a relay output than can be used to operate any kind of audio or visual warning device.

The infrared burglar alarm system comprises of source of infrared radiation used as a transmitter and a receiver consisting of a sensor sensitive to infrared rays, an amplifier and oscillators. The infrared beam between the transmitter and receiver is invisible. If the beam is interrupted, an alarm signal is produced. Figure 1.1 shows a block diagram of an infrared Burglar Alarm System.

Some current applications of infrared systems include:

SCIENTIFIC: Satellite and space communications, environmental survey and control, detection of life vegetation on other planets as measurement of lunar and planetary temperatures.

MEDICAL: Early detection and identification of cancer, obstacle detection for the blind, location of blockages in the vein and early diagnosis of incipient smoke

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

1.2 LITERATURE REVIEW

Infrared is the part of electromagnetic spectrum lying between the visible and microwave region. The region of the greatest practical importance for infrared instrumentation occurs between 2 and 5 micrometers (0.00008 and 0.00006 inches) in wavelength. The strongest absorption occurs of a specific characteristics wavelength for most organic and inorganic substances because the frequency of absorption band is determined by the position and configuration relationship of the vibration of atoms in a molecule. It has a wavelength longer than that of visible light rays

Infrared rays has approximate wavelength in meters between 8×10^{-7}m and 1×10^{-3}m and frequency between 3×10^{11} KHZ and 4×10^{14} KHZ.

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

In 1800 Sir William Herschel discovered infrared radiation. Then he referred to it as "invisible rays", "radiant heat", "dark heat" and "the ray that occasion heat". Sir William Herschel found that the heating effect increased as he moved the thermometer toward the red from the blue end of the electromagnetic spectrum.

Photocells, photographic films, or other detectors of light sometimes show the presence of light when none is visible to the eye. Heat radiation is a form of light known as infrared radiation. About one-third of the radiation that reaches us from the sun is heat radiation; most of the rest is visible light.

It is always noted that ruled surface like a photograph record reflects light of different colours in different directions followed by orange, yellow, green, blue and violet in order as the directions change. By using appropriate detectors, it can be seen that the visible light from a mercury lamp is always deviated into the region beyond the violet and the light from a hot iron goes at the other region of the spectrum, "below" the red. The names ultraviolet and infrared mean "extreme violet" and "beneath the red" respectively. Where visible light ends and invisible infrared and ultraviolet begin depends on the detector.

During world war I, an infrared search system could detect aircraft at a distance of 1.6km away and a person at a distance of 300m. Many sensitive infrared detectors such as photon detectors and image converter were developed during the world war II.

1.3 PROJECT OBJECTIVE/MOTIVATION

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

It will work as a single interrupted beam over a substantial distance and intended that the system will be insensitive to ordinary light and plain white paper.

I was encouraged to embarked on this project due to indiscriminate stealing when homes and safes are being burgled. Another factor was due to low cost and very high efficiency of most Burglar alarms.

1.4 PROJECT LAYOUT

The project layout presents the general write up of the project, which is divided into four chapters.

Chapter one is dealing with the general introduction of the infrared burglar system as regards its general physical operation. Some of the current applications of systems using infrared where also discussed.

Chapter two is a report on the basic operation of the system itself beginning from the transmitting stage (infrared transmitter), receiver, signal amplifier using operational amplifier, oscillator and the audio output. Other report on this chapter includes some basic function of components used in the project.

Chapter three discussed on the construction, testing and discussion of results obtained during calculation.

Chapter four talked on the recommendations and calculation base on the work done.

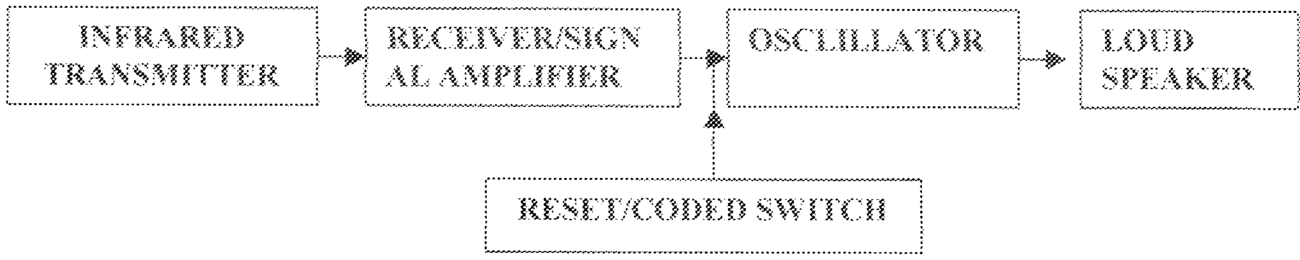

FIG. 1.1 BLOCK DIAGRAM OF INFRARED BURGLAR ALARM

CHAPTER TWO

SYSTEM DESIGN AND CALCULATIONS

2.1 INTRODUCTION:

The design of this system is to detect any intruder that interrupts the invisible infrared pulsed beam transmitted from the transmitter to the detector (receiver). The major use of the pulse is to enhance wider distance of transmission. The theory behind this design is that of emission of continues pulses of infrared beam.

2.2 INFRARED TRANSMITTER

A beam of infrared is produced by an infrared emitting diode (IRED) by feeding it with a pulse through the output of an oscillator. The integrated circuit used was a TC4069UBP NOT gate containing six NOT gate with fourteen pin-outs. The integrated circuit operates with a d.c supply of 5 – 18V.

The positive terminal of the d.c supply is connected to pin 14 and negative terminal to pin 7 (ground). Shown below is the infrared transmitter section of the alarm system.

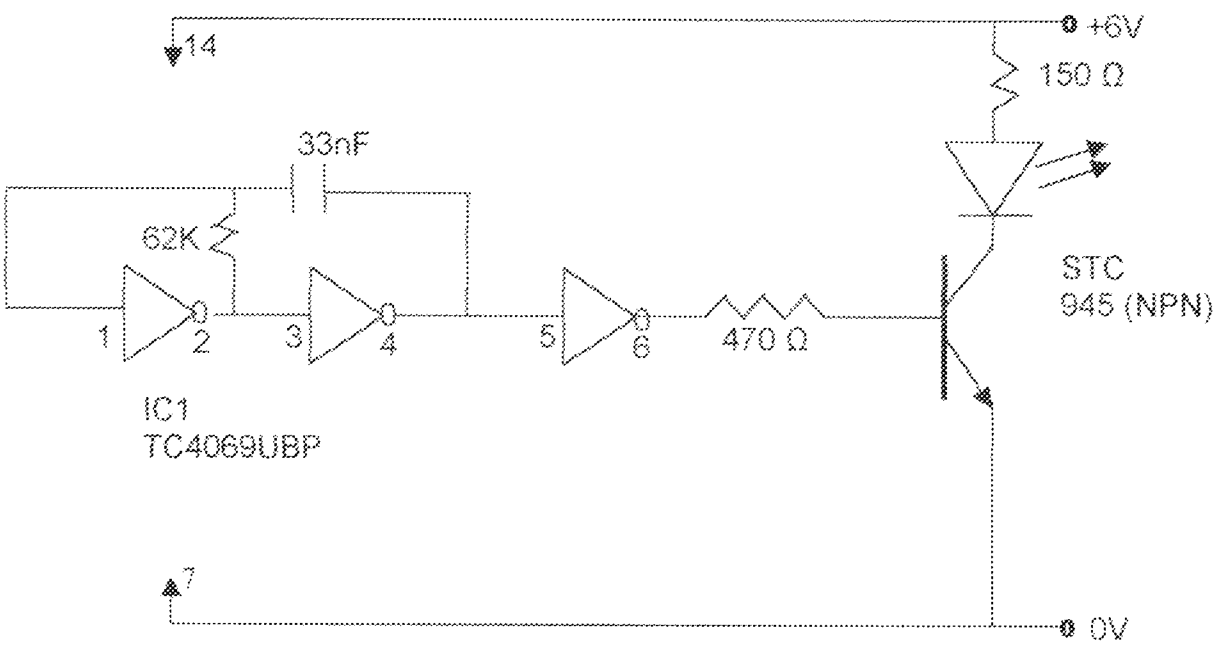

FIG. 2.2 (a) Infrared Transmitter

If the output from the first inverter is zero (0) then the input to the second inverter is also 0 and its output will be one (1). As the input to the first inverter is high and its output is low the 33nF capacitor will begin to discharge through the 62k, resistor with the result that the voltage across it fall. When it is low enough, the output of the first inverter will charge to high; this will be feed back to the input of the second inverter thus making its output low. The capacitor now begins to charge up through the resistor until the voltage across it high enough to cause the output of the first inverter to switch once again to low.

The continuous high and low pulse experienced at the output of the second inverter is also experienced at the output of the third inverter. This high pulse make the base-emitter junction forward bias, and a small current will flow in the forward direction from the base to the emitter. This current triggers the flow of a much larger current between the collector and emitter. And with this, the infrared – emitting diode emits a continuous pulse of invisible rays.

CALCULATION

When an infrared emitting diode is forward biased, it emits infrared rays. A series resistor was used to limit the current through the infrared diode.

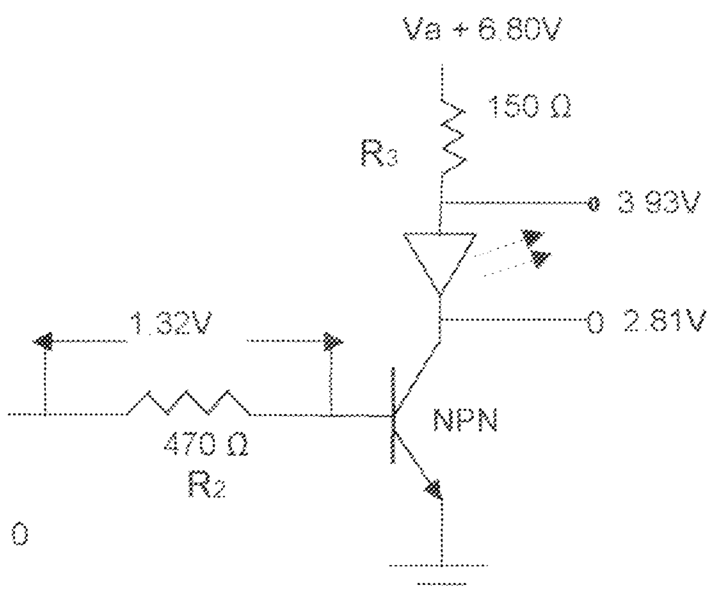

FIG. 2.2 (b) IRED On Mode

$$I_{IRED} = \frac{Vcc - V_{IRED}}{R_3} \quad \text{.......... (1)}$$

$$= \frac{6.80 - 1.12}{150}$$

= 38m A

Where

V_{ee} = Maximum collector voltage

V_{ILED} = Maximum voltage across light emitting diode

I_{ILED} = Maximum current through light emitting diode

A small current, (i.e. base current) that triggers a much larger across the collector – emitter junction can be calculated as;

$$I_B = \frac{1.32}{R_2} = \frac{1.32}{470} = 2.81mA.$$

Current through the 150 resistor is:

$$I_{R_3} = \frac{2.87}{150\Omega} = 19mA$$

The frequency at which the oscillator oscillates due to continuous high and low pulses experienced at the output of the third inverter is due to resistor-capacitor values and can be calculated as:

T_1 = CR .... (2)

C = 33nf

R = $62k\Omega$

$\therefore$ T = $33 \times 10^{-9} \times 62 \times 10^3$

T = 2.046m sec

$$f = \frac{1}{T} = 488.75 \simeq 489Hz$$

where T = period of oscillation.

f = Frequency of oscillation.

2.3 INFRARED SIGNAL RECEIVER

The receiver used is a PN junction diode that receives pulses of infrared rays. As the rays fall on its surface, it creates electrons pair at the PN junction, this induces current in the device. The diode is designed to operate when it is reversed bias so that the decrease in current is very small.

Once the beam is interrupted, the receiver converts the continuous pulses received into electrical signal (a transducer) in voltage form which serves as input signal to the operational amplifier. The amount of voltage at the input of the operational amplifier is directly proportional to the frequency of the continuous pulses received (i.e. equal to the frequency of the transmitted pulse).

The output of the receiver serves as an input to the inverting terminal of one of the LM324 operational amplifier.

When the beam is interrupted, the current that flows into the diode from cathode to anode is;

$$I = \frac{V_{R4}}{R_4} = \frac{2.59}{122 \times 10^3} = 0.021\text{mA}$$

FIG. 2.3 Infrared Receiver

where V_{R4} is the voltage across the R_4 resistor.

Due to the interruption of the beam, a current flows through the receiver (detector) via a capacitor to the inverting input of the amplifier.

2.4 SIGNAL AMPLIFIER.

For an effective amplification of the signal received from the detector, the KIA 324P operational amplifier was used. The amplifier has a very high voltage gain and high input impedance.

Two operational amplifier were used for the amplification purpose. The output of the first amplifier is connected to the non-inverting input of the second amplifier and the output of the second provides the final output. Shown below is the general signal amplifier connection.

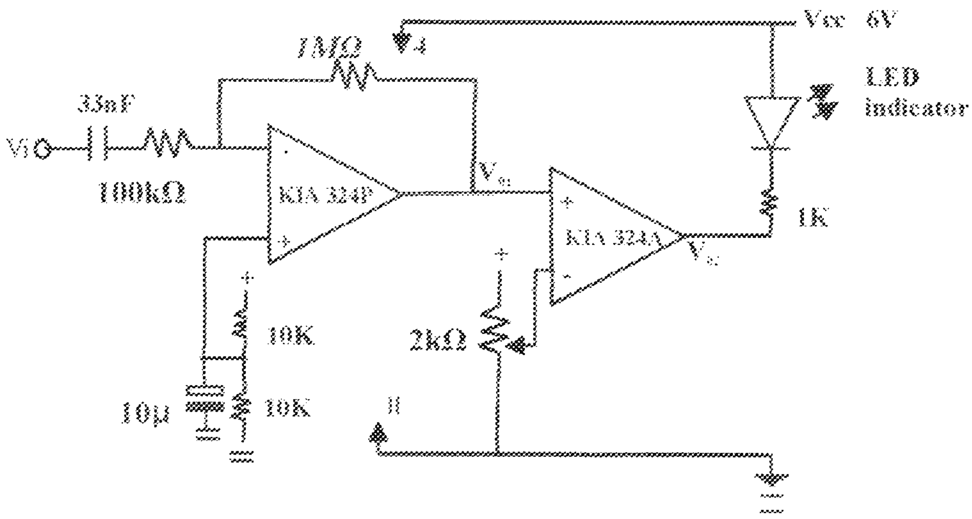

Fig. 2.4 (a) Signal Amplifier

The essential elements of the dc circuit of the first amplifier stage are show in fig 2.4 (b). The voltage divider consisting of two equal resistance of value establishes a dc voltage $V_B/2$ at the non-inverting operational amplifier input terminal. The operational amplifier functions as a voltage follower for this dc circuit, and thus the op-amp dc output is also $V_B/2$. The major function of the capacitor is to prevent the circuit from attempting to multiply the dc level by

$1 + \frac{Rf}{Ri}$ which cause saturation under most condition.

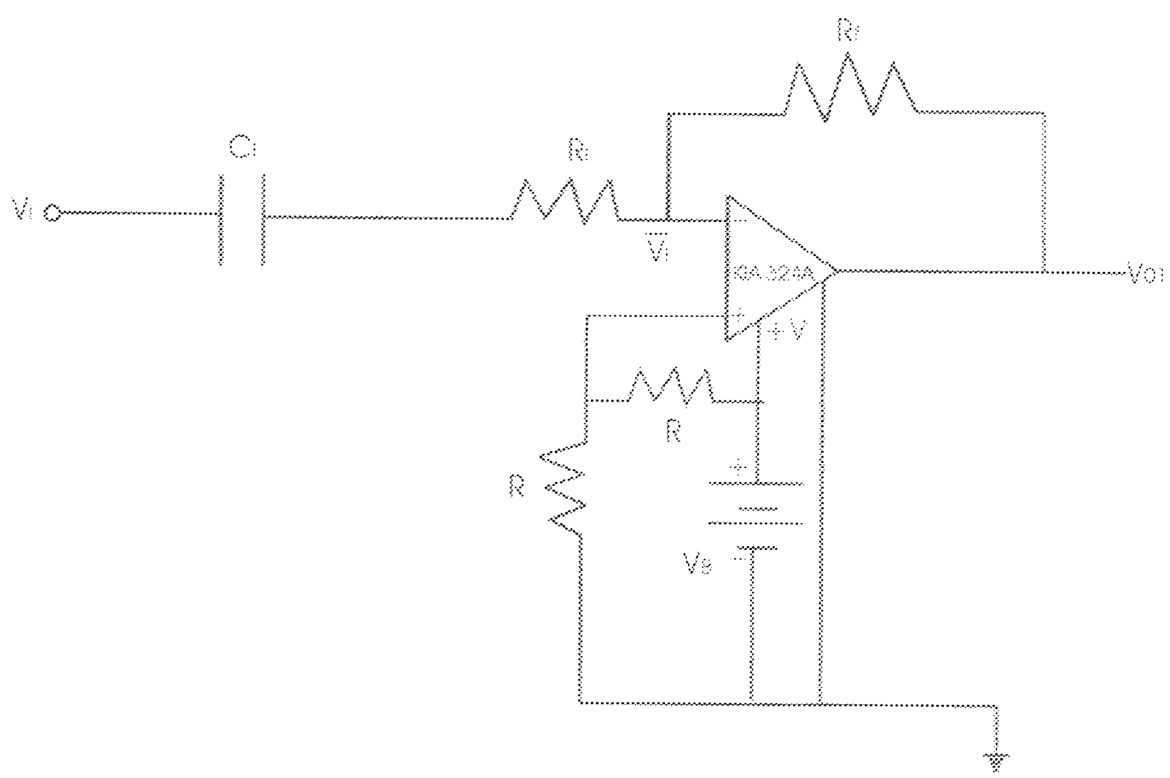

Fig. 2.4 (b) Inverting amplifier connection for first stage amplification

Input signal is coupled to the non-inverting input resistance Ri through the capacitance Ci. Such time-varying signal causes a signal current to flow alternately up and down through Rf, and the voltage at the inverting input terminal vary instantaneously about it's dc level. Feedback forces the op-amp output to vary directly proportional about its dc level. The resulting signal component at the first op-amp output is coupled to the non-inverting input terminal of the second op-amp.

The variable resistor connected to the inverting input of the second op-amp is so adjust to a fixed value so as to enhance the working capability of the alarm system. Thus, when the resistance is too low, then even before the beam interrupted is being interrupted, the alarm will be triggered into operation, and when the resistance is too high, interruption of the beam will have no effect on the system.

CALCULATIONS:

With respect to fig 2.4(b) Vi:

$$V_i = 3.41V$$

And the current flowing through the feedback resistor is calculated as;

$$I_f = \frac{V_{RF}}{R_f} \quad \ldots\ldots\ldots\ldots \ldots\ldots \ldots\ldots\ldots (3)$$

but V_{RF} = $\frac{V_B}{2} - Vc$

where V_B = $Vcc = 6V$

and Vi = 2.15V.

∴ I_f = $\frac{3 - 2.15}{1 \times 10^6}$

I_f = $0.85\mu A$.

The output voltage and the voltage of the voltage divider net is,

d.c level = $\frac{V_B}{2}$

d.c level= $\frac{6}{2}$

d.c level= 3V.

∴ V_{01} = 3V (negative).

From figure 2.4 (a), for the LED indicator to come on, a certain amount of current is expected to flow, and this can be calculated as;

V_{R10} = Voltage across 1k resistor

V_{R10} = 0.6V

∴ I_{R10} = $\frac{0.6}{1 \times 10^3}$

I_{R10} = 0.6mA.

The amount of current flowing through the light emitting diode indicator which is connected to the output of the second stage operational amplifier is same as the current flowing through the series resistor R_{10}. This can be calculate as;

I_{R10} = V_{R10} / R_{10} .... (4)

I_{R10} = $\frac{0.6}{1 \times 10^3}$

$I_{R10} = 0.6mA$

where V_{R10} = voltage across the R_{10} resistor.

Since current flows from higher to lower potential, and both the diode of D_4 and input of the inverter that lies between D_4 and D_5 are connected to $+V_{CC}$ through the resistor R_{11} to limit the amount of current flowing through D_4, then current through D_4 (ID_4) is;

$ID_4 = V_{R11} / R_{11}$ .... (5)

$$I_{D4} = \frac{0.77V}{22 \times 10^3 \cdot 2}$$

$I_{D4} = 0.035mA$

And with this, the output of the inverter becomes high (i.e. having a $+V_{CC}$ voltage).

At this point, the input of the first oscillator inverter is high and its output low, and the 4.7µF (C_6) capacitor begins to discharge through the 47KΩ (R_{12}) resistor with the result that the voltage across it falls. When it is low enough. The output of the first inverter will charge to high, this will be feedback to the input of the second inverter thus making its output low. The capacitor now begins to charge up through the resistor until the voltage across it is high enough to cause the output of the first inverter to switch once again to low. The continuous high and low states experience depends on the value of the capacitor and resistor used, which are the prime factors used in calculating the output frequency of the oscillator.

$T_2 = R_{12} C_6$ .... (6)

$$\text{and } f = \frac{1}{T}$$

$$= \frac{1}{R_{12} C_6}$$

$$= \frac{1}{47 \times 10^3 \times 47 \times 10^{-6}}$$

$\therefore \quad f = 4.53Hz$

where T = period in second, and

f = Frequency.

The diode D_6 after the oscillator output allows limiting amount of current through the resistor R_{13}. The charging and discharging time of capacitor C_7 depends on the time constant. The charging time depends on R_{13} and C_7 while discharging time depends on R_{14} and C_7. This was calculated as;

Charging time (Tc) = $R_{13}\,C_7$ .... (7)

Tc = $782 \times 100 \times 10^{-6}$

= 0.0782 sec. and

Discharging time (Td) = $R_{14}\,C_7$ .... (8)

= $22 \times 10^{3} \times 100 \times 10^{-6}$

= 2.2 sec.

The value of R_{14} used for the discharging time is higher than that of the charging time because small amount of current is expected to flow through the base to emitter region of both Q_2 and Q_3. For the transistor to function properly i.e making the collector: emitter forward bias, then a much higher current is expected to flow through the collector-emitter junction, there then putting the transistor in an operating state. Show below is a part of the section.

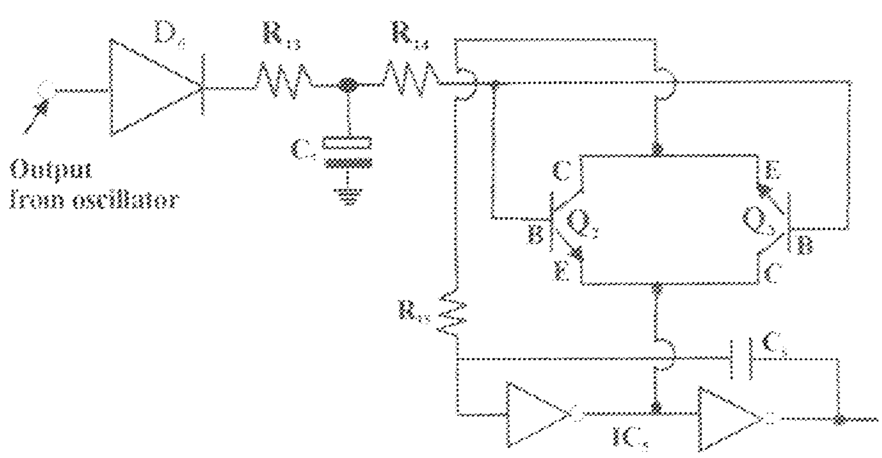

Fig. 2.4 (c) Section of the circuit.

A loudspeaker converts low-frequency alternating current energy into sound wave energy (acoustic waves). A good loudspeaker must not only be able to deliver high power audio output but must also faithfully reproduce sounds of different frequencies.

The audio signals is applied to the voice coil situated between magnetic poles pieces which produce a radial magnetic field. The interaction between the varying magnetic field set up by the audio current in the voice coil and the static constant magnetic field makes the voice coil to oscillate along its own axis at the

Fig 2.4(b): Inverting amplifier connected for first stage amplification

frequency of the applied audio signal, and this was the main reason why a capacitor was connected between the IC_5 output and the base of the Q_4 transistor. The oscillator, of the coil radiates a sound from the diaphragm.

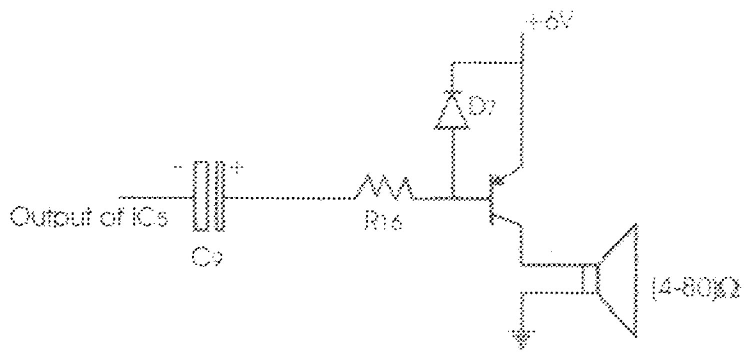

Fig. 2.4(d): Audio output

2.5 SWITCHES

The design encompasses three (3) switches. The first is the main power Switch, which is between the source positive supply and the conductor wise that supply positive voltage to the circuit. This can be put on or off by either closing or opening the line switch so as shown in figure 2.5. When on, it puts the circuit in its working state, but which solemnly depends on the other two switches.

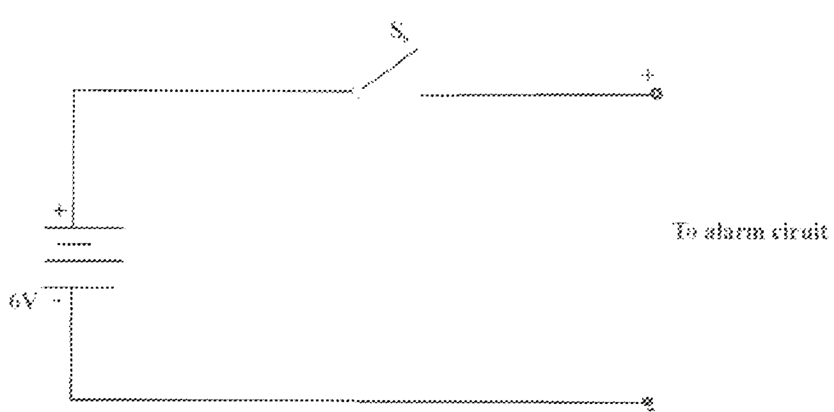

Fig. 2.5 (a) Main alarm switch

The second switch S_1 when closed allows current to flow to the clock (Ck) input of the JK master-slave flip-flop. The flip-flop is so connected to provide continuous change in the output Q and Q when ever a pulse is received at the clock input. This switch S_1 serves the purpose for security and economy such that when it is in an inactive state i.e Q low, automatically puts the input of the IC_4 how, there then the circuit inactive. Figure 2.5 (b) clarifies this.

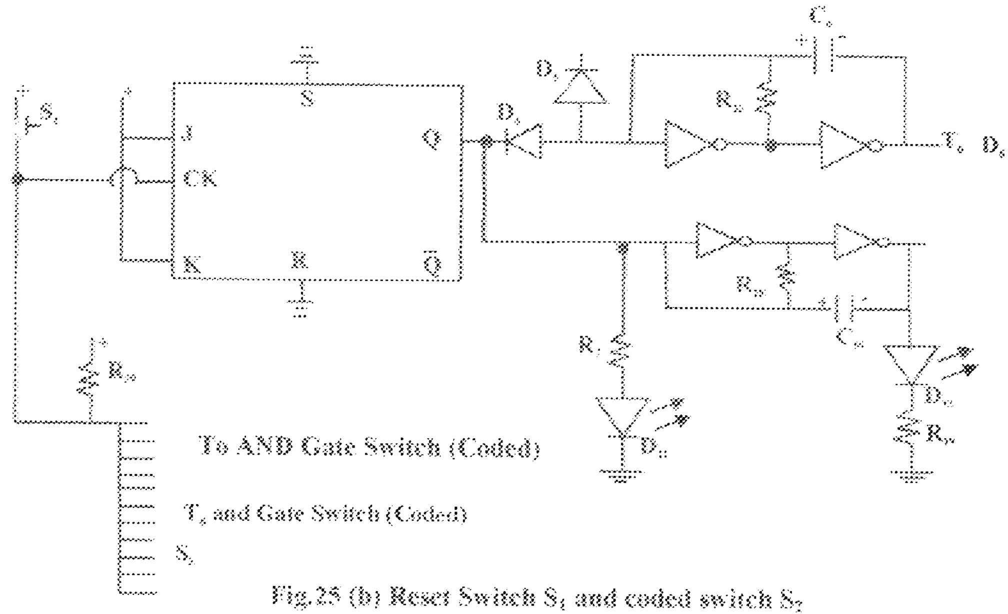

Fig.25 (b) Reset Switch S_1 and coded switch S_2

But when the output of Q becomes high, current fails to flow from the anode to cathode of D_8. This is because the cathode of D_8 is at a higher potential. This the provides for the high emitting diode (LED) indicator D_{11} to be on. The switch S_1 and LED D_{11} will be installed inside the house such that it can be switched on/off from inside the house with the help of D_{11} as an indicator.

The current flowing through the R_{17} resistor to D_{11} can be calculated as;'

$$I_{R17} = V_{R17} / R17$$
$$= 3.0 / 10 \times 10^3$$
$$= 0.3mA.$$

Which is the same current flowing through the LED D_{11}. Figure 2.5(b) show this.

The third switch S_3 is a coded switch, which will be outside the house, which serves the same switching effect purpose for the circuit as s_1. The LED D_{12} will also be outside the house to guide for the purpose of the visible indicator such that when on, indicates that the alarm is on and any attempt to break pulse the continuous ray will trigger the alarm on. So whenever the alarm is on i.e D_{12} on, the coded switch must be used to provide a pulse at the clock input of the flip-flop to switch the alarm off, if not an intruder will be detected. The principle and application of an AND gate was use for the switch S_2.

$f = 1 / t$ .... (9)

Where $t = R_{18} C_{12}$

$= 0.22secs$

$\therefore f = \frac{1}{0.22secs} = 4.55Hz$

And the current through the LED D_{12} is;

$I D_{12} = VR_{19}$

$= R_{19}$

$= \frac{1.32}{470}$

$= 2.8mA.$

2.6 POWER SUPPLY UNIT

This is a unit that serves to provide power to the circuit which can either be in d.c or a.c form. Power supply units can have additional circuitry to enable them maintain either a constant current or a constant voltage when supply a load. For the purpose of the project design, only D.C power supplying unit was considered due to inadequate supply of a-c from NEPA. But the design can still in cooperate the two types of supply at the same time but only one supply power to the system at a time.

ALTERNATING CURRENT – DIRECT CURRENT SWITCHING EFFECT

This alternating current – directed current switching effect is a circuit designed so as to produce a voltage at the out put at all time, i.e. either NEPA source or battery source.

The circuit comprised of a 12volts transformer connected to mains supply and supplying the alarm system and also a 6volts battery connected to the output of the power supply unit.

The transformer is in operation if there is an alternating current from mains, which leaves the 6volts battery un-operating. This is so because the cathode of Diode D_5 is at a higher potential than its anode and so current does not flow i.e and point 1 at higher potential than point 2. But the moment the potential at point 1 goes below that of 2, then the diode will be forward bias and that leaves the battery operation i.e. transformer un-operating. Therefore during the operation of the transformer, $V_1 > V_2$ and vice-versa in the case of the battery. The figure below clarifies this.

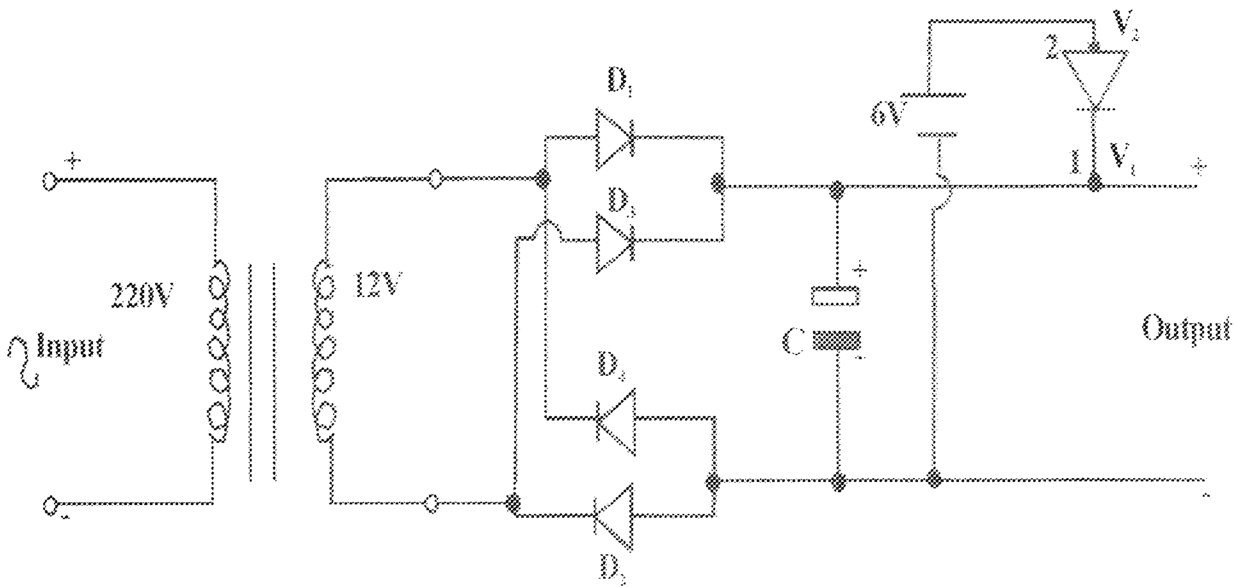

Fig. 2.7 Transformer-battery switching effect.

CHAPTER THREE

CONSTRUCTION, TESTING AND RESULTS

3.1 CONSTRUCTION

Every construction work takes place on a strip board and every construction work involves the soldering of the various components that make up the circuit. The strip boards have to be properly labeled before construction can begin.

SOLDERING

Soldering was performed with due regard to safety. It was carried out using a low voltage soldering iron, operated from a transformer connected to the mains.

A hot soldering iron is essential if good solder joints are to be produced. It is important to make the joint hot but not overheat, as overheating can cause damage to the components being soldered. The soldering iron was placed so that it touches both the lead to be soldered and the copper track on the strip board to which it was to be joined. After a few seconds, the solder was applied to the track; this then melt onto the track and flow up around the base of the lead forming a wedge. This steps was repeated for the soldering of each component leg(s).

Solder flow from cold to hot and therefore if the lead is cold no solder will flow around or the solder will form a blob. Similarly, if the track is cold, the solder will form a blob around the leg of the component. If the solder is not hot enough, then the blob form will be dull and this is referred to as a dry joint.

Apart from dry joints, another problem one avoided was solder bridges linking tracks. This normally happens when too much solder is applied to a joint and an adjacent track is heated at the same time as the joint, perhaps by using a soldering iron bit that is too large. This situation if not death with can cause a short-circuiting of adjacent tracks and this might lead to a fault in the circuit.

Breaking of tracks between the pins of the IC holders is very important, that if not done will short circuit or bridges the pins and this definitely will lead to malfunctioning of the IC and the circuit itself. This is applicable to all IC's used in the project construction.

3.2 TESTING

Having completed construction, the first thing that was done was to carry out a thorough test of the circuit This involves a number of different procedures ranging from visual check for faults, to using equipments such as meters (i.e voltmeter, ammeter etc).

If a fault is encountered, if is always very important to persist checking until fault if found. The circuit testing involves that of visual check power supply, a active components and passive components.

VISUAL CHECK – This was done before power was connected to the circuit and attention was paid to the following:

(a) To see it that all component were properly connected and the right way round (particularly transistors, diodes and electrolytic capacitors) in the circuit.

(b) That all wire links were located in the right places.

(c) That the power supply leads was properly positioned on the board and of the correct polarity

(d) That no solder bridges are made

(e) That no small pieces of copper fall between the track particularly at the edges of freshly out boards.

TESTING THE POWER SUPPLY – The above check would have ensure proper connections of the power supply (positive and negative) to the board and therefore all other test employ a means of testing for a voltage level. A voltmeter was used to trace the voltage supply to the appropriate points on the board/terminals directly connected to the power supply.

Test were also carried out on active and passive components using voltmeter e.g. if for instance a resistor is bad, then the potential at both terminals when measured will be the same i.e. no resistance is offered to the flow of current.

3.3 RESULTS

Results obtained for this thesis are those gotten from the analysis calculations and are sub-divided into three different parts.

a) TRANSMITTER

The frequency of transmission of the infrared pulses was calculated based on two factors i.e. the capacitance and resistance value of the astable multivibrator. The frequency is thus calculated as;

$f_1 \quad = 1 / T$

$= 1 / (R_1 C_1)$

$= 1 / (62E3 \times 33E\text{-}9)$

$= 489$ Hz

The audio output frequency is directly proportional to the transmitter frequency and therefore is the same as f1.

For the design to work for a wider distance between the transmitter and receiver, then the transmitting frequency have to be increased by a factor of the capacitance or resistance.

b) AMPLIFIER

The KIA 324 op-amp used has a gain of 10, and this lead to the choice of R_5 and R resistors

Gain of amplifier (KIA 324) $= R_f / R_i$

$= R_5 / R$

$= 1E6 / 100E3$

$= 10$

c) OSCILLATOR

The other two astable multivibrator used is configured using IC_4 and IC_5 of which is expected to deliver a frequency of 4.53 H_z each. The two frequencies are thus calculated as;

$f_4 = f_5 = 1 / (R_{15}C_{10}) = 1 / (R_{12}C_8)$

$= 1 / (47E3 \times 4.7E\text{-}6)$

=4.53 Hz

3.4 DISCUSSION OF RESULTS

All the results obtained from this work are in line with the design and construction of the Automatic Burglar Alarm System.

The transmitter stage of the circuit was expected to operate successively at a frequency of 500± 5 Hz with regards to the receiver choice. That prompts the use of the 62k resistor and 33nF capacitor to obtain the value.

At the receiver stage, the continuous pulses received from the transmitter must be converted into electrical signal at the same frequency as that of the transmitter. The amount of voltage at the input of the Op amp (receiver) must be directly proportional to the frequency of the transmitter. Also the potential at the second LM324 output must be equal to the potential at the LED D_3 cathode terminal for the LED to come on.

The frequency received at the speaker input was in conjunction with what was expected and that prompted the use of IC_5 which is being driven by the two (2) transistor Q_2 and Q_3 for continuous supply of frequency at the required Hz.

CHAPTER FOUR

RECOMMENDATION AND CONCLUSION

4.1 CONCLUSION

It can be seen from the foregoing report that the design of an infrared burglar alarm system just like any other system require careful planning and implementation.

In this project design, the use of an astable multivibrator was used for the generation of the alarm and flasher signals. It was due to the logic 1 and 0 at the output of the oscillator and of which the time constant/frequency are the primary factors considered that led to its use. The invisible pulses generated at the transmitter output make it very impossible for the intruder to know the location of the system nor know were the beam originates from, and this also make it almost impossible for the system to be fooled

With regards to the detector, a detail block and schematic circuit of both sections and entire system is provided in addition to information about the signals (voltage and current) at some strategic point in the circuit to facilitate easy understanding and maintenance.

There is a need only for few spare parts and thus very low cost required to implement the detector unit.

4.2 RECOMMENDATION

The design is recommended for use in our homes and safes at a maximum distance of 1.5 meters. For cases where longer distance is required between the transmitter and receiver, then the frequency of transmission can be increased by either increasing the frequency of transmission or using a receiver with a higher sensitivity.

Since this design can still be improved on, it will serve as a guide for who so ever is interesting in higher sensitivity and lower rate of false alarm. Thus it is hoped that this will lead us to the solution of high rate of life and property insecurity in the country today

4.3 SUGGESTION

One very important suggestion to make is this, that the department should try as much as possible to always give project topics to student before they go on industrial training (IT) so as to make them have a broader view / knowledge on there project life.

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APPENDIX