DESIGN AND CONSTRUCTION OF A DUAL HOME SECURITY ALARM SYSTEM

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DEDICATION

I dedicate this work to God Almighty, the dispenser of all knowledge, wisdom, divine understanding, the giver of good health and all the good things of life. The one who saw me through this programme.

DECLARATION

I Quadri Oluwabunmi Nimota, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This home security system is created to protect homeowners from intruders. The prototype that is created can be easily be installed and operated. The sensors could be placed throughout the house at all possible entryways such as windows and doors. Those attempting to enter the house while the system is on will either interfere with the beam and trip the alarm or make a sound while trying to enter the house or cut through the burglary doors or windows and consequently set off the alarm.

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CHAPTER ONE

1.1 INTRODUCTION

With home security becoming more accepted and utilized across the country, before installing any type of system the limitation of such security system must be understood. One of the most common is the wireless infrared home security system which can be connected quickly and easy and without the need to run cables between the camera and the recorder or monitor.

A wireless infrared home security system can be used at driveway entrances and as area-wide surveillance. By the nature of the infrared technology that makes it useful in covering large areas, its use to transmit signals is non-existent. For most uses in a wireless infrared home security system there is a transmitter that sends out an infrared beam to a receiver. If the beam is broken, the receiver opens a loop, kept closed by receipt of the beam, and activates an alarm. [1]

This technology makes infrared an ideal solution for covering a room with a single device. Many alarm systems use infrared detectors on large rooms with numerous windows to cover the interior of the room instead of separate devices for each door and window. A wireless infrared home security system can cover much more area with a single device than most wired devices.

Due to the fact that an infrared beam flows in a straight line and cannot go through walls or people, the use of a wireless infrared home security system is limited. Think about the remote control on the television and how it cannot work through the kids or around walls. The same limitations exist in a wireless infrared home security system. They work well when covering a wide area, but cannot be used to send signals to a receiver unless they can establish and maintain a direct line of sight between the transmitter and receiver. [2]

While the individual units can be hidden inside walls, there has to be a hole through which the signal passes. In a darkened room the red beam origination point can be readily identified. Although the beams used in a wireless infrared home security system may be wide, a narrow band trips the alarm when it is broken. In most cases a perpetrator can skirt the visible origination of the beam and work their way past the beam. [2]

This effectively allows some burglars to circumvent the entire alarm system. That is why most people use components of a wireless infrared home security system in conjunction with other types of devices to insure full and adequate property coverage.

1.2 AIM AND OBJECTIVE

The aim of this project is to add an element of security to the average household. The idea is to scare away potential intruders by sounding an alarm while they attempt to enter a house equipped with this system. This system is intended to be very precise and sensitive while cost effective.

1.3 ABOUT THE PROJECT

The project is on the design and construction of a dual home security alarm system. This security system is an indoor system and is mostly suitable for use in residential homes for safeguarding valuables. It is also suitable for use in jewelry stores, artifacts in museums and also for safeguarding paintings, sculpture in art galleries.

The principle of operation of the system is very simple but effective.

1.3.1 INFRARED SENSOR

An infrared transmitter projects a beam of infrared energy to the receiver. When the intruder moves through the beam, a circuit in the receiver is being broken, thereby triggering the alarm.

1.3.2 SOUND SENSOR

A condenser microphone is used to pick up any minut sound made by the intruder either his footstep or a slight sound of his equipment, thereby triggering the alarm.

CHAPTER TWO

LITERATURE REVIEW

2.1 MOTION DETECTOR

Motion Detector is a type of electronic security device that senses movement and usually triggers an alarm. Many types of motion detectors can sense motion in total darkness, without an intruder becoming aware that an alarm has been triggered.

Motion detectors are an important part of most burglar alarm systems. They help alert security personnel, especially in situations where no obvious break-in has occurred. For instance, if an intruder steals a key to gain access to a protected site or hides within the site during normal business hours, the intruder's entrance or presence could go unnoticed. A motion detector will detect the intruder's movements as soon as he or she walks or otherwise moves within the area protected by the detector.

Motion detectors usually protect indoor areas, where conditions can be more closely controlled. Detectors for use in homes usually detect movement in spaces about 11 m × 11 m (35 ft × 35 ft) in area. Detectors for large warehouses can protect areas with dimensions as large as 24 m × 37 m (80 ft × 120 ft). Buildings with valuable or important assets, such as museums, also use motion detectors to detect break-ins at vulnerable points. Such points include walls, doors, windows, skylights, and even air ducts. Special motion detectors can protect the inside of exhibit cases where items such as diamonds are displayed. Others can be focused to a narrow area of coverage, somewhat like a curtain, that is projected in front of a painting to detect even the slightest touch.

2.2 HISTORICAL BACKGROUND

The existence of an infrared radiation has been since 1800, which was discovered by Sir William Hershel. Then he referred to it as “invisible ray”, “radiant ray” and rays that occasion heat. Sir Williams found out that the heating effect increased as he moved a thermometer towards the red from the blue end of the electromagnetic spectrum.

The electromagnetic spectrum shows that visible light in a thin band at the center exceeding from the shortest violet wavelength of 3800nm (0.38μm) to the longest violet wavelength of 770nm (0.77μm). The infrared band extends from the red end of the visible band to 1mm, the shortest wavelength of the radio frequency of band.

Infrared is considered to be heat radiation, but technically it is not. It is produced by such varied resources as candles, fires, incandescent light. There is one disadvantage to using infrared security systems, and that is that they require a direct line of sight. These beams cannot pass through walls, or people. This limits the effectiveness of such a system in certain situations. [3] TV remotes cannot work through walls, and your alarm will be working on exactly the same principle. These cannot be used to send signals to a control unit because they are so unreliable.

It is possible to conceal the units inside walls however you must leave a hole so that the infrared beam can pass through. It's very easy for burglars to identify where this light is coming from if you are using visible light sensors. This allows the intruder to avoid the beam quite easily.

2.3 A PHOTO-INFRARED MOTION SENSOR (BURGLAR ALARM DETECTION POINT)

Burglar (or intrusion), fire and safety alarms are all electronic today. Sensors are connected to a control unit via a low-voltage hardwire or narrowband RF signal which is used to interact with a response device. The most common security sensors indicate the opening of a door or window or detect motion via passive infrared (PIR). New construction systems are predominately hardwired for economy. Retrofit installations often use wireless systems for a more economical and quicker install. Some systems serve a single purpose of burglary or fire protection. Combination systems provide both fire and intrusion protection. Sophistication ranges from small, self-contained noisemakers, to complicated, multi-zoned systems with color-coded computer monitor outputs. Many of these concepts also apply to portable alarms for protecting cars, trucks or other vehicles and their contents

Burglar alarms are sometimes referred to as alarm systems, Burglar alarms (or perimeter detection systems, Perimeter protection, intrusion detection systems and many more terms for the same thing) are divided to two main fields: home burglar alarms and industrial burglar and perimeter intrusion detection.

2.3.1 Home burglar alarms

Home burglar alarms are often systems assembled from inexpensive infrared detectors that the home owner or the security contractor will install in front of all the windows and doors in the house. These infrared sensors are designed for indoor use only and should not be used outside. The cost of installing outdoor sensors is higher and false alarm prone. A more complete home alarm also includes magnetic sensors on the doors and windows. These sensors will alarm the system when a door or window is opened. These sensors do not protect against glass breakage, but additional glass break detectors can also be used. The sensors are connected to a control panel that is operated by a keypad. The control panel processes intrusion signals and rings sirens and/or communicates to a monitoring service which then calls the owner and/or police department. This is the basic form of home alarm system.

2.3.2 Industrial perimeter intrusion detection systems

In the field of industrial security systems, the methodology of protection is quite different. First is to detect, second to delay and third to alarm. Industrial alarm systems are designed as an integration of several sensor systems. The most important for big facilities would be the outer fence on which a sensor is placed. It would detect and delay the intruders before they even reach the building itself> As described below, there are a number of different fence mounted sensors, each with its own pros and cons. Other than the fence mounted sensors, there are also buried perimeter sensors that can be put on top of a wall or buried underground to create a hidden defense line. This only allows the security system to detect an intruder, but does not delay them. Another choice for detecting is Closed Circuit Television (CCTV). A guard can watch the screens or video motion detection software act the part. In any case CCTV is ineffective as a standalone sensor because it's affected by weather conditions as cameras cannot see in heavy fog, rain and snow. The last line of protection is the building itself. It can be protected by infrared sensors, microwave sensors, smart locks and magnetic door sensors.

MOTION DETECTOR TECHNOLOGIES

These types of sensors are designed for indoor use. Outdoor use would not be advised due to false alarm vulnerability and weather durability.

2.3.3.1 Passive Infrared Detectors

The passive infrared detector (PIR) is one of the most common detectors found in household and small business environments because it offers affordable and reliable functionality. The term *passive* means the detector is able to function without the need to generate and radiate its own energy (unlike ultrasonic and microwave volumetric intrusion detectors that are "active" in operation). PIRs are able to distinguish if an infrared emitting object is present by first learning the ambient temperature of the monitored space and then detecting a change in the temperature caused by the presence of an object. Using the principle of differentiation, which is a check of presence or non-presence, PIRs verify if an intruder or object is actually there. Creating individual zones of detection where each zone comprises one or more layers can achieve differentiation. Between the zones there are areas of no sensitivity (dead zones) that are used by the sensor for comparison.

2.3.3.2 Ultrasonic Detectors

Using frequencies between 25 kHz and 75 kHz, these active detectors transmit ultrasonic sound waves that are inaudible to humans. The Doppler shift principle is the underlying method of operation, in which a change in frequency is detected due to object motion. This is caused when a moving object changes the frequency of sound waves around it. Two conditions must occur to successfully detect a Doppler shift event:

a) There must be motion of an object either towards or away from the receiver.

b) The motion of the object must cause a change in the ultrasonic frequency to the receiver relative to the transmitting frequency.

The ultrasonic detector operates by the transmitter emitting an ultrasonic signal into the area to be protected. The sound waves are reflected by solid objects (such as the surrounding floor, walls and ceiling) and then detected by the receiver. Because ultrasonic waves are transmitted through air, then hard-surfaced objects tend to reflect most of the ultrasonic energy, while soft surfaces tend to absorb most energy. When the surfaces are stationary, the frequency of the waves detected by the receiver will be equal to the transmitted frequency. However, a change in frequency will occur as a result of the Doppler principle, when a person or object is moving towards or away from the detector. Such an event initiates an alarm signal. This technology is considered obsolete by many alarm professionals, and is not actively installed.

2.3.3.2 Microwave Detectors

This device emits microwaves from a transmitter and detects microwaves at a receiver, either through reflection or reduction in beam intensity. The transmitter and receiver are usually combined inside a single housing (monostatic) for indoor applications, and separate housings (bistatic) for outdoor applications. By generating energy in the microwave region of the electromagnetic spectrum, detector operates as an active volumetric device that responds to:

a) A Doppler shift frequency change.

b) A frequency phase shift.

c) A motion causing reduction in received energy.

2.3.3.3Photo-Electric

Photoelectric beam systems detect the presence of an intruder by transmitting visible or infra red light beams across an area, where these beams maybe obstructed. To improve the detection surface area, the beams are often employed in stacks of two or more. However, if an intruder is aware of the technology's presence, it can be avoided. The technology can be an effective long-range detection system, if installed in stacks of three or more where the transmitters and receivers are staggered to create a fence-like barrier. Systems are available for both internal and external applications. To prevent a clandestine attack using a secondary light source being used to hold the detector in a 'sealed' condition whilst an intruder passes through, most systems use and detect a modulated light source

2.3.3.4 Glass Break Detectors

The glass break detector may be used for internal perimeter building protection. When glass breaks it generates sound in a wide band of frequencies. These can range from infrasonic, which is below 20 Hertz (Hz) and cannot be heard by the human ear, through the audio band from 20 Hz to 20 kHz which humans can hear, right up to ultrasonic, which is above 20 kHz and again cannot be heard. Glass break acoustic detectors are mounted in close proximity to the glass panes and listen for sound frequencies associated with glass breaking. Seismic glass break detectors are different in that they are installed on the glass pane. When glass breaks it produces specific shock frequencies which travel through the glass and often through the window frame and the surrounding walls and ceiling. Typically, the most intense frequencies generated are between 3 and 5 kHz, depending on the type of glass and the presence of a plastic interlayer. Seismic glass break

2.3.3.5 Microphonic Systems

Microphonic based systems vary in design but each is generally based on the detection of an intruder attempting to cut or climb over a chainwire fence. Usually the microphonic detection systems are installed as sensor cables attached to rigid chainwire fences, however some specialised versions of these systems can also be installed as buried systems underground. Depending on the version selected, it can be sensitive to different levels of noise or vibration. The system is based on coaxial sensor cable with the controller having the ability to differentiate between signals from the cable or chainwire being cut, an intruder climbing the fence, or bad weather conditions. The systems are designed to detect and analyse incoming electronic signals received from the sensor cable, and then to generate alarms from signals which exceed preset conditions. The systems have adjustable electronics to permit installers to change the sensitivity of the alarm detectors to the suit specific environmental conditions. The tuning of the system is usually accomplished during commissioning of the detection devices.

This is one of the principle used in the project construction.

Pros: very cheap, very simple configuration, easy to install.

Cons: some systems have a very high rate of false alarms because some of these sensors has sensitivity problems as they might be too sensitive.

Conclusion: If you need a fence mounted sensor and you are willing to add some more money for a reliable system go with the Vibration system.

Taut Wire Fence Systems

A taut wire perimeter security system is basically an independent screen of tensioned tripwires usually mounted on a fence or wall. Alternatively, the screen can be made so thick that there is no need for a supporting chainwire fence. These systems are designed to detect any physical attempt to penetrate the barrier. Taut wire systems can operate with a variety of switches or detectors that sense movement at each end of the tensioned wires. These switches or detectors can be a simple mechanical contact, static force transducer or an electronic strain gauge. Unwanted alarms caused by animals and birds can be avoided by adjusting the sensors to ignore objects that exert small amounts of pressure on the wires. It should be noted that this type of system is vulnerable to intruders digging under the fence. A concrete footing directly below the fence is installed to prevent this type of attack.

Pros: low rate of false alarms, very reliable sensors and high rate of detection.

Cons: Very expensive, complicated to install and old technology.

Conclusion: Very good but very expensive system that uses 20-year-old technology; these days there is no reason to choose taut wire over the other fence-mounted sensors.

2.3.4 System connections

The trigger signal from each sensor is transmitted to one or more control unit(s) either through wires or wireless means (radio, line carrier, infrared). Wired systems are convenient when sensors (such as smoke detectors) require power to operate correctly, however, they may be more costly to install. Entry-level wired systems utilize a Star network topology, where the panel is at the center logically, and all devices "home run" its wire back to the panel. More complex panels use a Bus network topology where the wire basically is a data loop around the perimeter of the facility, and has "drops" for the sensor devices which must include a unique device identifier integrated into the sensor device itself. Wired systems also have the advantage, if wired properly, of being tamper-evident. Wireless systems, on the other hand, often use battery-powered transmitters which are easier to install, but may reduce the reliability of the system if the sensors are not supervised, or if the batteries are not maintained. Depending on distance and construction materials, one or more wireless repeaters may be required to get the signal reliably back to the alarm panel. Hybrid systems utilize both wired and wireless sensors to achieve the benefits of both. Transmitters or sensors can also be connected through the premises electrical circuits to transmit coded signals to the control unit (line carrier). The control unit usually has a separate channel or zone for burglar and fire sensors, and better systems have a separate zone for every different sensor, as well as internal "trouble" indicators (mains power loss, low battery, wire broken, etc).

2.3.5 Alarm response

Depending upon the zone triggered, number and sequence of zones, time of day, and other factors, the monitoring center can automatically initiate various actions. They might be instructed to call the ambulance, fire department or police department immediately, or to first call the protected premises or property manager to try to determine if the alarm is genuine. They could also start calling a list of phone numbers provided by the customer to contact someone to go check on the protected premises. Some zones may trigger a call to the local heating oil company to go check on the system, or a call to the owner with details of which room may be getting flooded. Some alarm systems are tied to video surveillance systems so that current video of the intrusion area can be instantly displayed on a remote monitor, not to mention recorded.

The first video home security system was patented (patent #3,482,037) on December 2, 1969 to Marie Brown, an African American inventor. The system used television surveillance.

Access control and bypass codes

To be useful, an intrusion alarm system is deactivated or reconfigured when authorized personnel are present. Authorization may be indicated in any number of ways, often with keys or codes used at the control panel or a remote panel near an entry. High-security alarms may require multiple codes, or a fingerprint, badge, hand-geometry, retinal scan, encrypted response generator, and other means that are deemed sufficiently secure for the purpose.

Failed authorizations should result in an alarm or at least a timed lockout to prevent "experimenting" with possible codes. Some systems can be configured to permit deactivation of individual sensors or groups. Others can also be programmed to bypass or ignore individual sensors (once or multiple times) and leave the remainder of the system armed. This feature is useful for permitting a single door to be opened and closed before the alarm is armed, or to permit a person to leave, but not return. High-end systems allow multiple access codes, and may even permit them to be used only once, or on particular days, or only in combination with other users' codes (i.e., escorted). In any case, a remote monitoring center should arrange an oral code to be provided by an authorized person in case of false alarms, so the monitoring center can be assured that a further alarm response is unnecessary. As with access codes, there can also be a hierarchy of oral codes, say, for furnace repairperson to enter the kitchen and basement sensor areas but not the silver vault in the butler's pantry. There are also systems that permit a duress code to be entered and silence the local alarm, but still trigger the remote alarm to summon the police to a robbery.

Fire sensors can be "isolated", meaning that when triggered, they will not trigger the main alarm network. This is important when smoke and heat is intentionally produced. The owners of buildings can be fined for generating False alarms that waste the time of emergency personnel.

False / no alarms

System reliability can be a problem when it causes nuisance alarms, false alarms, or fails to alarm when called for. Nuisance alarms occur when an unintended event evokes an alarm status by an otherwise properly working alarm system. A false alarm also occurs when there is an alarm system malfunction that results in an alarm state. In all three circumstances, the source of the problem should be immediately found and fixed, so that responders will not lose confidence in the alarm reports. It is easier to know when there are false alarms, because the system is designed to react to that condition. Failure alarms are more troublesome because they usually require periodic testing to make sure the sensors are working and that the correct signals are getting through to the monitor. Some systems are designed to detect problems internally, such as low or dead batteries, loose connections, phone circuit trouble, etc. While earlier nuisance alarms could be set off by small disturbances, like insects or pets, newer model alarms have technology to measure the size/weight of the object causing the disturbance, and thus are able to decide how serious the threat is, which is especially useful in burglar alarms.

False-Alarm Reduction

Home and business owners can now choose a new type of keypad control panel designed to help reduce false alarms.

Based on a standard called CP-01-2000, developed by the American National Standards Institute (ANSI) and Security Industry Association (SIA)) , the new generation of keypad control panels takes aim at user error by building in extra precautions that minimize unwarranted dispatch of emergency responders.

Some of the features of CP-01 keypads include a progress annunciation function that emits a different sound during the last 10 seconds of delay, which hastens exit from the premises. Also, the exit time doubles if the user disables the pre-warning feature.

Other "rules" address failure to exit premises, which results in arming all zones in Stay Mode and a one-time, automatic restart of exit delay. However, if there is an exit error, an immediate local alarm will sound.

Cross zoning reduces alarms

Cross zoning is an innovative alarm-system strategy that does not require a new keypad. Using multiple sensors to monitor activity in one area, advanced software analyzes input from all the sources.

For example, if a motion detector trips in one area, the signal is recorded and the central-station monitor notifies the customer. A second alarm signal - received in an adjacent zone in close time proximity, is the confirmation the central-station monitor needs to request a dispatch immediately. This builds in increased protection and a failsafe should a door blow open or a bird rattle an exterior window.

Enhanced Call Verification

Enhanced Call Verification (ECV) helps reduce false dispatches while still protecting citizens. ECV requires central station personnel to attempt to verify the alarm activation by making a minimum of two phone calls to two different responsible party telephone numbers before dispatching law enforcement to the scene.

The first alarm-verification call goes to the location the alarm originated. If contact with a person is not made a second call is placed to a different number. The secondary number, best practices dictate*, should be to a telephone that is answered even after hours, preferably a cellular phone of a decision maker authorized to request or bypass emergency response.

In-the-field proof that ECV practices are the best solution for false-alarm reduction while maintaining the safety of taxpayers comes from the state of Florida. As of July 1, 2006, the implementation date of the nation's first statewide ECV law, the Palm Beach County Sheriff's Department reduced dispatches from 12,712 between October 2005 and December 2005 to 8,802 during the same period in 2006. Tennessee has also adopted EVC policies, as has Reno, Nevada policies among other municipalities including St. Louis, MO, Providence, RI, Bethlehem, PA and Golden, CO, among others.

Video verification

Video verification documents a change in local conditions by using cameras to record video signals or image snapshots. The source images can be sent over a communication link, usually an Internet protocol (IP) network, to the central station where monitors retrieve the images through proprietary software. The information is then relayed to law-enforcement and recorded to an event file, which can later be used as prosecution evidence.

An example of how this system works is when a passive infrared or other sensor is triggered a designated number of video frames from before and after the event is sent to the central station.

A second video solution can be incorporated into to a standard panel, which sends the central station an alarm. When a signal is received, a trained monitoring professional accesses the on-site digital video recorder (DVR) through an IP link to determine the cause of the activation. For this type of system, the camera input to the DVR reflects the alarm panel's zones and partitioning, which allows personnel to look for an alarm source in multiple areas. [4]

2.4 OTHER USES OF MOTION DETECTORS

Motion detectors have other uses besides for security. In manufacturing, electric eye detectors can count products on an assembly line, and perform other tasks that people would find tedious. Some dangerous machinery is equipped with active infrared or electric eye beams of light as a safety device. Should an operator's hand get dangerously close to the machinery, the beam is broken. The circuit is interrupted, and the machine shuts down. Garage doors with automatic door openers can be equipped with beams that sense a child under the door and stop the downward movement before the child is injured. Outdoor porch or patio lights fitted with motion detectors can be turned on automatically when motion is detected. One of the most common and convenient applications of motion detectors is found at modern grocery stores, where doors automatically open as customers enter and leave. [5]

2.5 THEORY OF SOUND

This project is also based on sound. The sound sensor picks up any slight sound that is transmitted from the wave.

2.5.1 SOUND WAVES

Sound waves are described as waves of compression and rarefaction in the air. This means that when sound waves travel past a fixed point, the atmosphere pressure travels slightly above and below the steady barometric pressure. But these fluctuations are far too rapid to be detected by a barometer. A device which can be used to detect this fluctuation at a very rapid rate was discovered named a microphone.

A microphone is a kind of extra sensitive barometer capable of detecting these rapid fluctuation in our pressure. This microphone transforms sound energy into electrical. They are important in communication systems and in instruments that measures sound and noise. The America inventor Alexander Graham Bell built the first microphone in 1876 when he constructed his telephone transmitter.[6]

There are several types of microphone that can be used to detect sound waves. These microphones can be velocity dependent, amplitude dependent and carbon microphones.

2.5.2 VELOCITY DEPENDENT MICROPHONE.

In these microphones, the output voltage is proportional to the velocity of vibration of the moving parts which in turn depends on the intensity of sound receiver. An example is the moving coil microphone.

2.5.3 AMPLITUDE DEPENDENT MICROPHONE.

In these microphones, the output potential difference is proportional to the amount by which the sound waves displace the moving part from its rest position. An example of these is condenser microphone (capacitor microphone) [6]. This is the type of microphone used in this project.

2.5.3.1 CONDENSER MICROPHONE

It has two thin metallic plate placed close to each other that serves as a capacitor. The back plate of the capacitor is fixed, and the front plate serves as the diaphragm. Sound waves alter the spacing between the plates changing the electrical capacitance between them.

An emf in series with a resistor is connected across the capacitor, the charging and discharging current produces a varying potential difference to be produced across the series resistor. The potential difference is amplified before passing out of the microphone. Capacitor microphones can be made very small and they are Uni-or-Omni-directional. An example is the electrets condenser microphone used in hearing aid, because of their exceptional high quality, this microphone are used in broadcasting, on stage and in public address system [6].

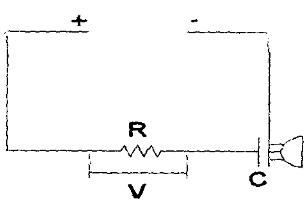


Figure 2.1
CONDENSER
MICROPHONE

2.3.4 CARBON MICROPHONE:

These consist of a fixed piece of carbon shaped in form of a cup, separated by a layer of carbon granules from another piece of carbon which is in the form of a dome and positioned at the bottom of a cone-shaped diaphragm. This type of carbon is free to move and vibrate when sound waves strike the diaphragm. Compression of the granules decreases its resistance, while a decrease in pressure leads to an increase in resistances. Carbon microphones are mostly used in the telephone system. The quality of carbon microphone is low.

CHAPTER THREE

DESIGN PROCEDURES AND OPERATION

3.0 DESIGN INTRODUCTION

It is paramount to know the scopes and approach in engineering design to achieve optimal and less cost of production of any appliances. The importance of this also helps in modification of product for better performance.

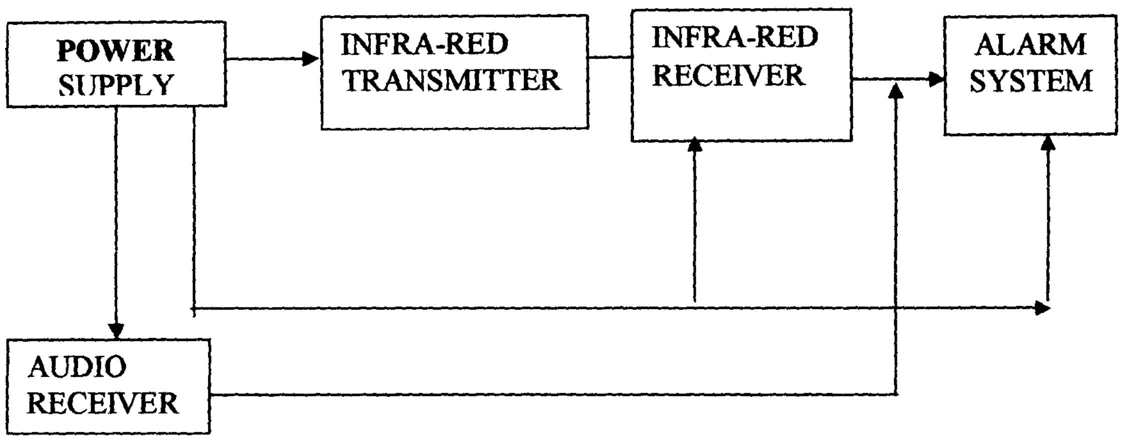


FIG 3.1 BLOCK DIAGRAM OF THE DUAL HOME SECURITY SYSTEM

3.1 GENERAL DESCRIPTION/OPERATION

The circuit power source is generated from an ac source via a transformer. The main power supply of ac 220v 50 Hz is stepped down by a transformer "220/12v" that is a transformer that takes input of 220v ac in its primary windings and produces output of 12v ac in the secondary windings. The low 12volts ac produced in the secondary windings is rectified by diodes D_1 –D_4 and filtered by 16v/1000µf capacitor before regulated by 7809 IC regulator that takes a considerable amount of dc voltage greater than 9v and produces 9v as a regulated output. The regulated 9v output is used to power the circuit.

The infrared transmitter operating in an astable mode sends the beam 38 kHz with the help of infrared lighting emitting diode to the receiver. The infrared receiver connected in a reversed biased mode conducts when it absorbs infrared beam thereby turning on transistor TR_1 (NPN) by providing its base current. The transistor TR_1 switches on the transistor TR_3 (PNP) by providing the appropriate negative base current. When these occurs, the latch configured 555 timer IC_1 PIN 2 which is the collector output of TR_3 is set as high state and its output pin 3 remains low.

Whenever the infrared beam from the transmitter is interrupted, the two transistors goes off and pin 2 of IC_1 goes low through 50kΩ variable resistor thereby setting the alarm system on by sending high signal to pin 4 of IC_2 .

The audio receiver also receives air pressure as a result of breaking made by the intruder to have his way into the secured place through the microphone. The small signal is amplified and fed into the trigger input of IC_3 which is configured as a latch. The output from the time sets the alarm on. The diodes D_5 and D_6 acts as a 2-input OR gate for the dual security system.

Power Supply

The block diagram for the power supply is shown in figure 3.1a below. This configuration allows the system to be plugged into any standard wall socket.

Figure 3.1a

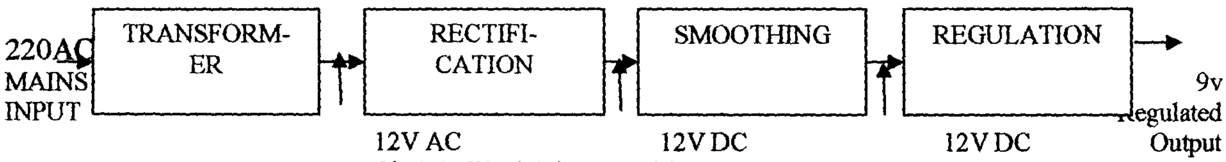


Fig 3.1a Block Diagram of the Power Supply

The circuit diagram for the power supply is shown in figure3.1b. An important characteristic of this diagram is the use of 7809 regulator chip. This chip provides the output that is needed to power the system properly.

3.1.1 TRANSMITTER MODULE AND DESIGN

This is one of the key parts of the circuit since it transmits invisible signal that makes the circuit work without the notice of the intruder.

The major components used for the transmitter are

a) 555 timer

b) Infrared light emitting diode

c) Transistor

3.1.2 Features of 555 timer.

Trigger input: when < $^1/_3$ Vs ('active low') this makes the output high (+Vs). It monitors the discharging of the timing

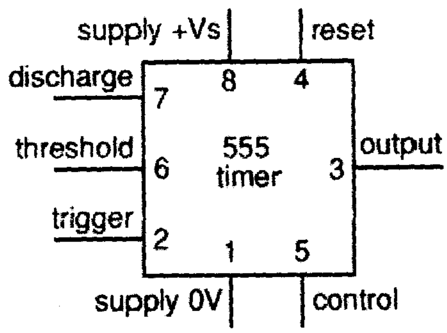


FIG 3.2 555 TIMER

capacitor in an astable circuit. It has a high input impedance > 2MΩ.

Threshold input: when > $^2/_3$ Vs ('active high') this makes the output low (0V)*. It monitors the charging of the timing capacitor in a stable and monostable circuits. It has a high input impedance > 10MΩ.

* providing the trigger input is > $^1/_3$ Vs, otherwise the trigger input will override the threshold input and hold the output high (+Vs).

Reset input: when less than about 0.7V ('active low') this makes the output low (0V), overriding other inputs. When not required it should be connected to +Vs. It has an input impedance of about 10kΩ.

Control input: this can be used to adjust the threshold voltage which is set internally to be $^2/_3$ Vs. Usually this function is not required and the control input is connected to 0V with a

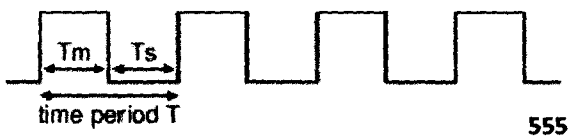
0.01 μF capacitor to eliminate electrical noise. It can be left unconnected if noise is not a problem.

The **discharge pin** is not an input, but it is listed here for convenience. It is connected to 0V when the timer output is low and is used to discharge the timing capacitor in astable and monostable circuits [7].

3.1.3 ASTABLE OPERATION

An astable circuit produces a "square wave", this is a digital waveform with sharp transitions between low (0V) and high ($+V_S$). The durations of the low and high states may be different. The circuit is called an astable because it is not stable in any state. The output is continually changing between "low" and "high".

With the output high ($+V_S$) the capacitor C1 is charged by current flowing through R1 and R2. The threshold trigger input monitors the capacitor voltage and when it reaches $2/3V_S$ (threshold voltage), the output becomes low and the discharge pin is connected to 0v. The capacitor now discharges with current flowing through R2 into the discharge pin. When the voltage falls to $1/3V_S$ (trigger voltage) the output becomes high again and the discharge pin is disconnected, allowing the capacitor to start charging again.



555 astable output, a square wave (Tm and Ts may be different)

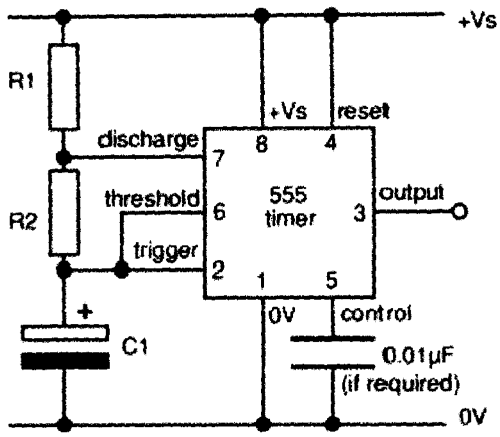


FIG 3.3 555 astable circuit

The time period (T) of the square wave is the time for one complete cycle, but it is usually better to consider frequency (f) which is the number of cycles per second.

$T = 0.7 \times (R1 + 2R2) \times C1 and\ f = {}^{1.4}/{(R1 + 2R2) \times C1}$

T = time period in seconds (s)

f = frequency in hertz (Hz)

R1 = resistance in ohms (Ω)

R2 = resistance in ohms (Ω)

C1 = capacitance in farads (F)

The time period can be split into two parts: **T = Tm + Ts**

Mark time (output high): **Tm = 0.7 × (R1 + R2) × C1**

Space time (output low): **Ts = 0.7 × R2 × C1**

Many circuits require Tm and Ts to be almost equal; this is achieved if R2 is much larger than R1.

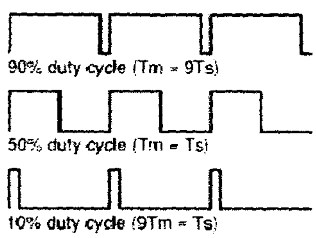
For a standard astable circuit Tm cannot be less than Ts, but this is not too restricting because the output can both sink and source current. For example an LED can be made to flash briefly with long gaps by connecting it (with its resistor) between +Vs and the output. This way the LED is on during Ts, so brief flashes are achieved with R1 larger than R2, making Ts short and Tm long. If Tm must be less than Ts, a diode can be added to the circuit as explained under duty cycle below. An astable can be used to provide the clock signal for circuits such as counters.

A low frequency astable (< 10Hz) can be used to flash an LED on and off; higher frequency flashes are too fast to be seen clearly. Driving a loudspeaker or piezo- transducer with a low frequency of less than 20Hz will produce a series of 'clicks' (one for each low/high transition) and this can be used to make a simple metronome.

An audio frequency astable (20Hz to 20 kHz) can be used to produce a sound from a loudspeaker or piezo transducer. The sound is suitable for buzzes and beeps. The natural (resonant) frequency of most piezo transducers is about 3 kHz and this will make them produce a particularly loud sound [8].

Duty cycle

The duty cycle of an astable circuit is the proportion of the complete cycle for which the output is high (the mark time). It is usually given as a percentage.



For a standard 555/556 astable circuit the mark time (Tm) must be greater than the space time (Ts), so the duty cycle must be at least 50%:

$$Duty\ cycle = {}^{Tm}\!/_{Tm + Ts} = {}^{R1 + R2}\!/_{R1 + 2R2}$$

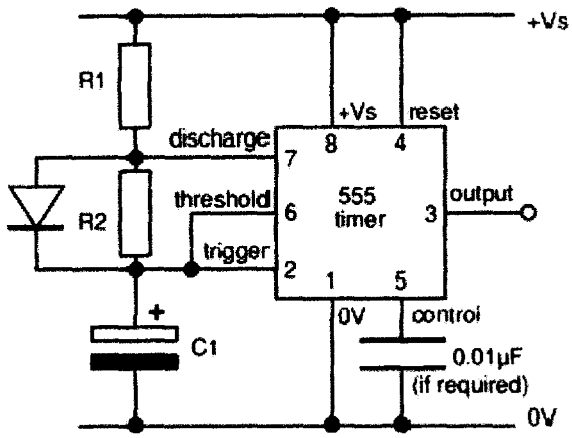


FIG 3.4 555 astable circuit with diode across R2

To achieve a duty cycle of less than 50% a diode can be added in parallel with R2 as shown in the diagram. This bypasses R2 during the charging (mark) part of the cycle so that Tm depends only on R1 and C1:

$$\text{Duty cycle with diode} = {}^{\text{Tm}}\!/_{\text{Tm} + \text{Ts}} = {}^{\text{R1}}\!/_{\text{R1} + \text{R2}}$$

Tm = 0.7 × R1 × C1 (ignoring 0.7V across diode)

Ts = 0.7 × R2 × C1 (unchanged)

3.2 TRANSMITTER MODULE

The transmitter is designed in astable mode to generate pulse at frequency of 38 kHz which most infrared sensors receivers. The frequency if operation is calculated as follows:

For astable multivibrator

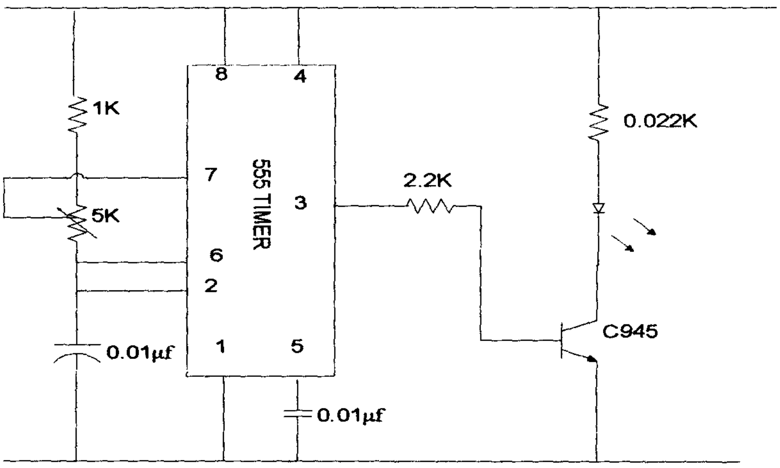


FIG 3.5 TRANSMITTER CIRCUIT

t_{high}=0.693 (R_A+R_B)C

But since a diode is connected across, R_B resistance is zero when capacitor is charging.

$\therefore t_{high}$=0.693 (R_A)C

During discharging period

t_{high}=0.693 (R_B)C

The period of the oscillation

$T = t_{high} + t_{low}$

$0.693(R_B)C + 0.693(R_A)C$

$0.693C\ (R_A + R_B)$

Frequency=1/T = 1/0.693 ($R_A + R_B$)

For frequency of 38 kHz

F= 1/T

$3800\text{Hz} = {}^{1}/_{\text{T}}$

T =1/3800 = 2.6315×10^{-5} sec

T= 2.6315×10^{-5} sec

Recalling

T=0.693 ($R_A + R_B$)

Substituting the values of T and C

C = 0.01μf, T= 2.6315×10^{-5} sec

$$2.6315 \times 10^{-5} = 0.693 \times 0.01 \times 10^{-6}\,(\text{R}_\text{A} + \text{R}_\text{B})$$

$$\text{R}_\text{A} + \text{R}_\text{B} = \frac{2.6315 \times 10^{-5}}{0.693 \times 0.01 \times 10^{-5}} = 3797.372\Omega$$

$$\text{R}_\text{A} + \text{R}_\text{B} = 3.7974\text{K}\Omega$$

Choosing $R_B = 1k\ \Omega$

$\therefore R_A = (3.7974 - 1)k\Omega$

=2.7974K

This is obtained by using 5kΩ variable resistor.

Duty cycle

D=$R_A/R_A + R_B$

$D = {}^{1}/_{3.7974} \times 100 = 26.33\%$

3.3 RECEIVER MODULE AND DESIGN

The switching circuit of the receiver comprises of transistor TR_1, TR_2 latch operated 555 timer IC_1

Considering TR_1,[10]

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

I_C = Collector current

I_B=Base current

ß=Current base

For a small signal transmitter, ß =100

For a short distance of 1 inch, the transmitter and receiver current across diodes is $10\mu A$.

$$\frac{I_{c1}}{I_{B1}} = \beta,$$

$$I_{c1} = I_{B1} \times \beta_1$$

$$I_{c1} = 10 \times 10^{-6} \times 100 = 0.001A$$

I_{c1}=1mA

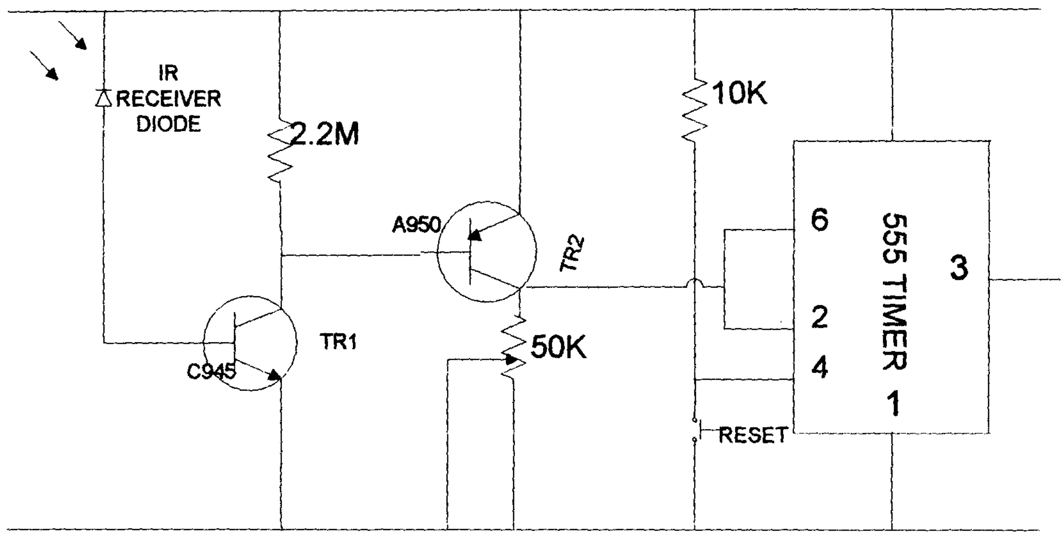


FIG. 3.6 RECEIVER CIRCUIT

Considering TR_2

$$\frac{I_{c2}}{I_{B2}} = \beta_2$$

$$\therefore \quad \beta_1 = \beta_2 = \beta$$

$$I_{c1} = I_{B2} = 1mA = 0.001A$$

$$I_{c2} = I_{B2} \times \beta_2 = 0.001 \times 100 = 0.1A$$

IC_2 keeps the trigger input of IC_1 high to avoid false triggering when the receiver receives the beam. When the transistor is off, the pulse is generated via $50k_{\Omega}$ variable resistor adjusted to 3.8k for better sensitivity.

3.4 ALARM MODULE AND DESIGN

The alarm is designed to generate a high audio output signal with low frequency of about 300 Hz-400 Hz for an astable mode multivibrator.

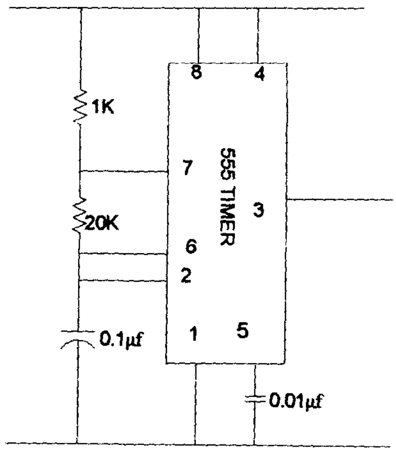


FIG 3.7 ALARM CIRCUIT.

$t_{high} = 0.693\ (R_A + R_B)C$

$t_{low} = 0.693\ (R_B)C$

$T = t_{high} + t_{low}$

For c=0.1 and R_A=1K

$t_{high} = 0.693\ (R_A + R_B)0.1 \times 10^{-6}$

$t_{high} = 0.693\ (1 + R_B)0.1 \times 10^{-6}$

$t_{high} = 6.93 \times 10^{-8}(1 + R_B)$

$t_{low} = 0.693\ (R_B)C$

$t_{low} = 0.693\ (R_B)0.1 \times 10^{-6}$

$t_{high} = 6.93 \times 10^{-8}(R_B)$

$T = t_{high} + t_{low}$

$t_{high} = 6.93 \times 10^{-8}(1 + R_B) + 6.93 \times 10^{-8}(R_B)$

$= 6.93 \times 10^{-8}\{(1 + R_B) + (R_B)\}$

$= 6.93 \times 10^{-8}(1 + 2R_B)$

At frequency of 350 Hz

$F=1/T$

$350=1/0.53\times10^{-5}(1+2R_B)6.93 \times 10^{-8}(1 + 2R_B)$

$6.93 \times 10^{-8}(1 + 2R_B) = \frac{1}{350}$

$(1 + 2R_B) = {}^{1}/_{6.93 \times 10^{-8} \times 350}$

$(1+2R_B)=4.122\times 10^{-4}$

$(2R_B) = 4.122 \times 10^{-4}$

$(R_B) = {}^{4.122 \times 10^{-4}}/_{2}$

$(R_B) = 20.6093 \times 10^{3}$

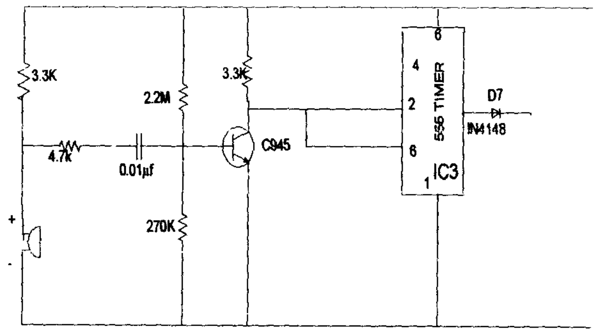
$=20.61K$

$\cong 20K\Omega$

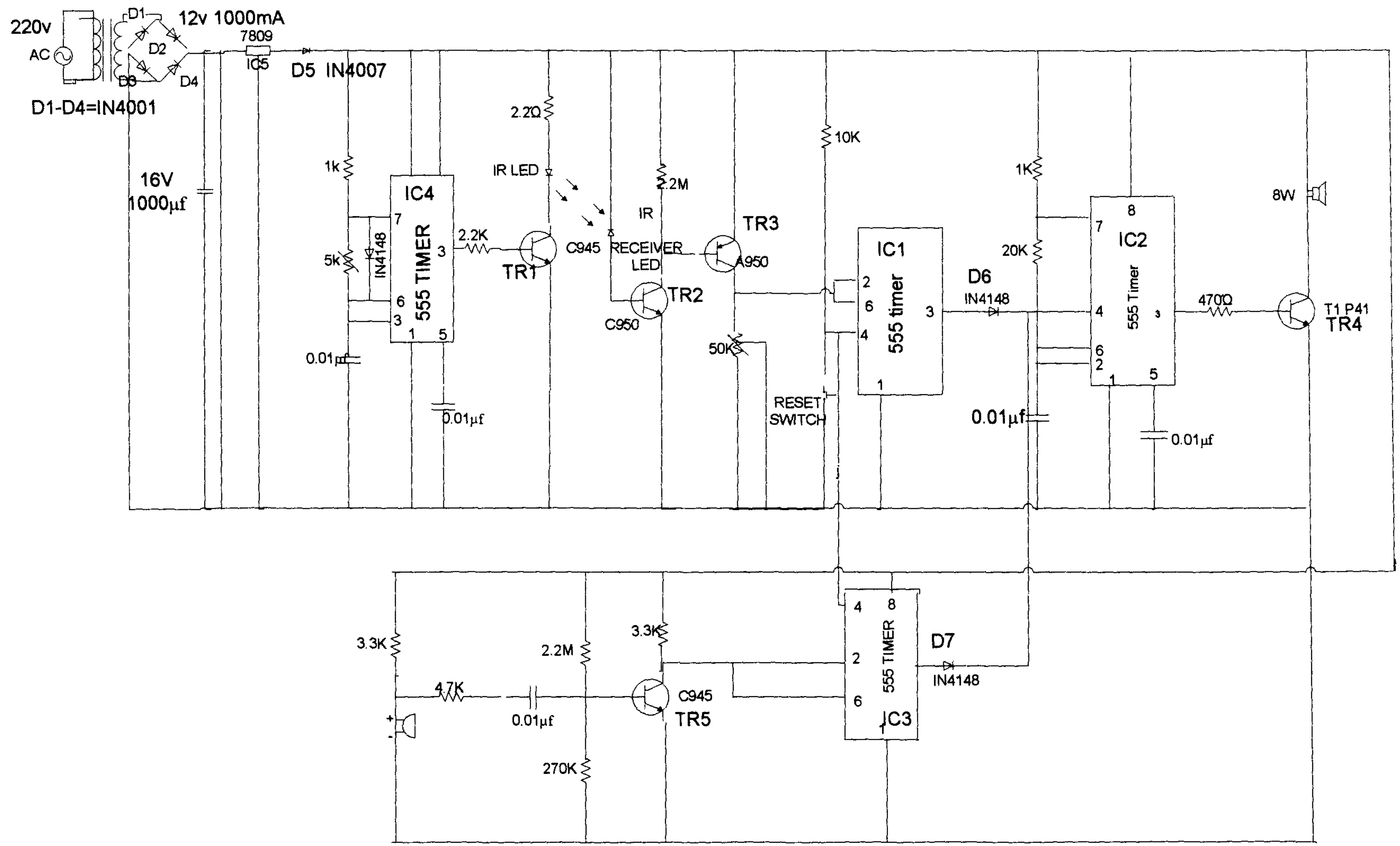
SOUND DETECTOR SYSTEM

It helps to detect and sound made by the intruder through the cutting of the door or the chain cables put on a fence then amplifies it to give an output.

Fig 3.8 Sound Detector System



THE COMPLETE CIRCUIT DIAGRAM



CHAPTER FOUR

TEST, RESULT AND DISCUSSION

4.1 TESTING AND RESULT OBTAINED

During the construction of this project, the voltage rectifier was first constructed and tested to determine the voltage valve with the use of a voltameter if it is the required 9v for the normal functionality of the circuit and this was achieved as the required voltage was gotten.

The next phase was the infrared transmitter and the receiver. The circuit constructed was powered, the output state of pin 3 of the 555timer was tested to know if the signal was been received but there was no signal receiver until there was an obstruction i.e. a cutting of the beam that was transmitted to the receiver. This confirms the workability of the infrared transmitter and receiver circuit.

The sound circuit system was also constructed and tested in order to know the sensitivity level of the electrets microphone. When powered and a little sound was made, there was an output received from the output of the 555 timer.

The alarm circuit was not left out. It was constructed and tested to determine and know if it is receiving signal from both the infrared circuit and the sound circuit.

The above steps of construction and test was first carried out on the breadboard, this is to give room for any adjustment and correction that has to do with the ICs and electrical material used.

When this was done, and all necessary tests confirmed, the construction was carried out on the Vero board. It was also tested while on the Vero board, this was to ensure that the soldering was done properly. But during the test it was discovered that the alarm circuit was not working, it was later found out that the 555 timer and a resistor was no longer working because the heat from the soldering iron has melted the pins. It was removed and replaced with a new one and carefully done.

Finally the casing was made and the prototype of my project was tested to make sure that it is working properly.

4.2 DISCUSSION OF RESULT.

The coming up of the alarm circuit as observed above, shows that either the intruder has passed through where the inferred circuit was installed and has cut the beam or the sound system has detected sound made by the intruder.

The alarm circuit can only be put off when the circuit is reset.

CHAPTER FIVE

5.1 CONCLUSION

The aim of this project has been achieved. It is to add to an element of security to the average household. The idea is to scare away potential intruders away by sounding an alarm while they attempt to enter a house equipped with this system.

5.2 RECOMMENDATION

After carrying out the project, the following recommendations were made:

- The security system could be powered using two sources, a power supply voltage and a charged battery where it acts as the power source when there is power failure.
- The possibility of reducing the numbers of ICs used in order to minimize cost.
- The possibility of using several infrared sensor will also ensure high security.

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