A PROJECT REPORT

ON

DESIGN AND CONSTRUCTION OF A MOSQUITO REPELLER WITH DUAL POWER SUPPLY

BY

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DEDICATION

I dedicate this project to my parents, MR. J.I. Itanyi, Mrs. S. itanyi and my brothers and sisters; Comfort, Siaka, Achenyo, Ojone, Dorcas, Eleojo, Benjamin and Victor.God bless you all.

ATTESTATION

I hereby certify that this work was carried out by Mr. Itanyi Julius Ocholi of the department of Electrical and Computer Engineering, Federal University of Technology, Minna.

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ACKNOWLEDGEMENT

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ABSRACT

This project is based on the development of a low intensity sound wave emitter which repels mosquitoes. The system is desired to generate ultrasonic sound of 40KHz.Use is made of a 555 timer to generate this sound (which is inaudible to human ears).

The system uses two types of power supply; the mains (AC) and the alternative power supply (which is a battery). So, it can work for a long time without unnecessary interruption.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 HISTORICAL BACKGROUND

The topic of the project is ''DESIGN AND CONSTRUCTION OF A MOSQUITO REPELLER WITH DUAL POWER SUPPLY'' This system is able to scare away mosquitoes which are the major cause of malaria.

Although there are many methods of mosquito control such as the cultural method, traps, and chemicals and so on, it has been observed that a very high frequency sound can be used to chase away mosquitoes, which means chasing malaria away. The circuit can be used at all seasons, any time and anywhere. It causes no discomfort to the user and the environment since the sound it produces is inaudible to human ears.

1.2 THE EFFECT OF MOSQUITOES

When an affected mosquito bites a healthy person, it introduces parasite and sporozites into the liver, which multiply into gametocyte. A mosquito picks this gametocyte when it bites an effected person, which develops in the stomach of the mosquito where they reproduce sexually to produce sporozoites. This migrates to its salivary gland and is eventually transmitted to a healthy person through its bites and thereby causing malaria. [6]

1.3 SYMTOMS OF MALARIA

Symptoms of Malaria includes cyclic occurrence of chills (violet shaking), fever shaking and head ache. These symptoms occur when the sporozoites destroy the red blood cells, causing toxins to be released into the blood stream. The secondary effect are mainly anemia, jaundice and enlargement of the spleen. [5]

1.4 CONTROL OF MALARIA

Malaria can be controlled by the use of insecticides which is the common way, but mosquitoes are becoming resistant to it and the use of it may result in respiratory diseases such as catarrh when inhaled for a long time. The circuit (mosquito repeller) was design to get rid of mosquitoes from our environment, not by killing them, but by keeping them away from biting us.

The mosquito repeller can be used anywhere within the range of five to ten meters radius at home, farmland and even camping ground. That is to say that it can be used for both indoor and outdoor purposes.

The circuit design consists of power supply (mains) alternative power supply (battery), voltage regulator IC, 555 timer ICs and the output sound wave. It makes use of full wave rectified AC supply which keeps the voltage constant all the time. The alternative power supply (i.e. battery) is connected to the normally closed end of a relay while the main power supply is connected to the normally opened end in order to ensure an automatic change over from mains to battery. The 555 timer generate square waves which drive the speaker to give an output.

CHAPTER TWO

2.0 LITERATURE REVIEW

Ten years ago, the World Health Organization (WHO) estimated that over 300 million cases of clinical malaria occur every year with 1.4 to 2.6 million resulting in death mainly among African children. Malaria is therefore a major disease with comparable impact with the World's major deceases. Diarrhea, acute respiratory infections AIDs and tuberculosis.

Between the 1940s and 1960s, malaria eradication was achieved in USA, U.S.S.R, southern Europe and most Carrie bin island mainly by vector control.

The vector of human malaria is the infected blood feeding female mosquitoes of the genus anopheles which transfer the parasite from one person to another. Male mosquitoes do not bite. The human, parasites multiply exponentially in the liver and then in the infected red blood cells. Mosquitoes inject parasites with a blood meal, the parasite undergoing another reproductive phase in the mosquito before being passed on to another human.

Malaria exists in 100 countries but it is mainly confined to poorer tropical areas of Africa, Asia and Latin America. More than 90% of malaria cases and the great majority of malaria deaths occur in tropical Africa.

Four species of the genus plasmodium infect human by entering the blood stream. These are falciparum, vavax, ovale and malariae. Plasmodium falciparum is the main cause of severe clinical malaria and death.

Other diseases caused by mosquitoes include mosquito born viral encephalitis, yellow fever and philariasis. Human cases of encephalitis ranges from mild to very severe illness that in a few cases can be fatal. Dengue is a viral disease transmitted from person to person by

mosquitoes and it is characterized by sudden onset of fever, nosebleeds and circulatory failure.

Although there are many methods of mosquito vector control; such as the cultural methods, physical attacks, spraying houses with residual insecticides, environmental management to minimize potential mosquitoes or to make aquatic sites unsuitable for the development of mosquito larvae and so on. However, it has been discovered that an ultrasonic sound emitter can repel mosquitoes. This can be used at all times and seasons.

The unit produced is capable of repelling affected blood feeding female mosquitoes of the genus anopheles which transfer the parasite of the genus plasmodium from one person to another

2.1 GENERATION OF ULTRASONIC WAVES

There are number of ways which ultrasonic sound can be generated. The methods to be employed depend on the power output necessary and the frequency range to be covered. Generators of mechanical types, such as turning forks and Galton's whistle can be used up to 10KHz. [7]

2.2 GALTON'S WHISTLE

In determine the limit of audibility Galton device a miniature organ pipe, there is a moveable plunger or reflector and its position can be varied by a means of a micrometer screw. By means of the length of the air column within the pipe, the pitch of a note can be varied. Edelman later designed a pipe which blow from an angular nozzle fitted with a screw to vary its distance from the edge of the pipe, by adjusting this distance, and the pressure of the air blast, the pipe is set into resonant vibration at a frequency corresponding to the length and diameter. Sounds of very high frequencies can thus be produced. [7]

2.3 APPLICATIONS OF ULTRASONICS

Some applications of ultrasonic include:

I. Medical uses:

in modern surgery, ultrasonic has a dominant role to play; it has been used for the treatment of arthritis and other similar diseases. The use of ultrasonic for measuring the rate of flow of blood has been suggested. Location of gull stone has been done with ultrasonic. [7]

II Chemical effects:

Many chemical changes take place in the presence of ultrasonic which in absence do not occur. Oxidation and ionic reaction occur more rapidly in the presence of ultrasonic. Both dispersion and coagulation effect take place more rapidly under irradiation and oscillations varying from 20-100KHz are rapidly used. [7]

III Heating by ultrasonic:

It is observed by early workers that even when ultrasonic energy is concentrated in various materials considerable amount of heat is produced, and there is definite ratio between the heat produced and ultrasonic energy absorbed. With the increase of frequency of ultrasonic wave, the heat generated is increased due to increased absorption. [7]

IV Ultrasonic flow detector:

In metals especially, there may arise the presence of foreign materials. There may be a crack in the body of the metal which is not visible to the naked eyes. The presence of this discontinuity may seriously hamper the concentration of metal

parts. Ultrasonic finds a very useful application in detecting this flow and irregularities. [7]

CHAPTER THREE

3.0 DESIGN AND IMPLEMENTATION

3.1 The Block Diagram

Fig 3.1 below is the block schematic of the pictorial model of the system.

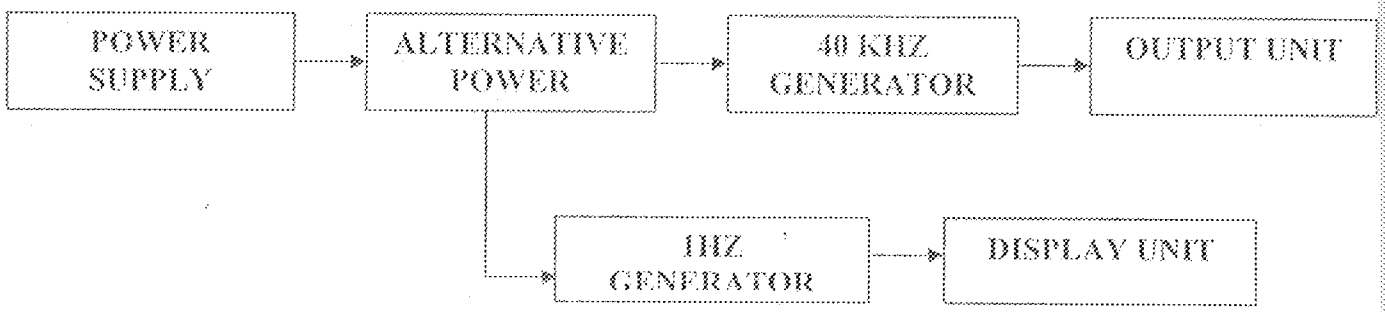

Fig. 3.1 pictorial model of an ultrasonic sound Emitter

Each block represents a major stage in the circuit of an ultrasonic sound emitter. These are, the power supply, the alternative power supply (battery), the 40 kHz generator, and the frequency output, the 0.1Hz generator and the display unit are to indicate whether the circuit is ON or OFF and to make the design more attractive.

3.1.1 POWER SUPPLY

It is known that the standard voltage supply in this country is 220 Volts, but the frequency generator (555 timers) circuit need only 9 volts supply. Hence the need for a step down transformer to step down 220 Volts to about 12Volts. So a 12Volts 1A transformer was used.

Now, the circuit needs to work with a direct current (dc). The direct current needed is obtained by connecting a silicon rectifying diode to the transformer's output as shown in the figure below

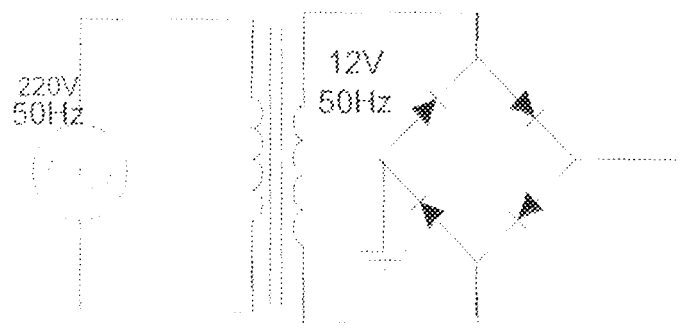

fig. 3.2 Main power supply of the system

The bridge rectifier used here is silicon chip with three legs like wire embedded in it. One of the legs is for the input A.C. supply from the mains, the second for the output DC supply while the remaining one is grounded. The input and output of the rectifier is as shown in Fig 3.2 above.

The current and voltage signal obtained as the output signal of Fig 3.2 will have replies. The remedy for this is to use electrolytic capacitor of high value of about 3000 μF (Filtering capacitor) which is capable of minimizing the replies. Compensating capacitor is used also to remove any ripple remaining.

Also, in this section, a voltage regulator IC (7809) is used to keep the voltage at 9V for the timer. The voltage regulator IC is being connected between the filtering capacity and the compensating capacitor. The IC (7809) has three legs and it is connected as shown in fig 3.3 below.

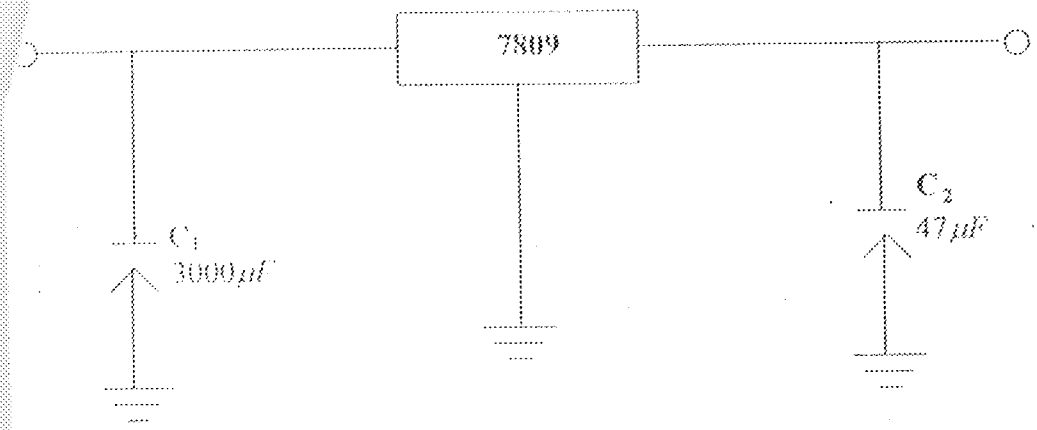

Fig 3.3 Filtering Capacitor and Voltage Regulator IC

3.1.2 ALTERNATIVE POWER SUPPLY AND RELAY

This section is connected in series with the main power supply. It constitutes the battery (9V), a relay, and a transistor (BC337). The battery is connected to the normally closed side of the relay, while the regulated 9V from the mains is connected to the normally open side to ensure automatic change over from the mains to the battery. When there is current from the AC mains, the coil of the relay becomes magnetized, hence, the armature is attracted and contact is made with the mains supply. When there is power failure, the coil becomes demagnetized, causing contact to return to the battery. The purpose of the LED connected through a resistor R_1 (330 Ohm) is to indicate when supply is coming from the mains (AC) or not and the colour is green.

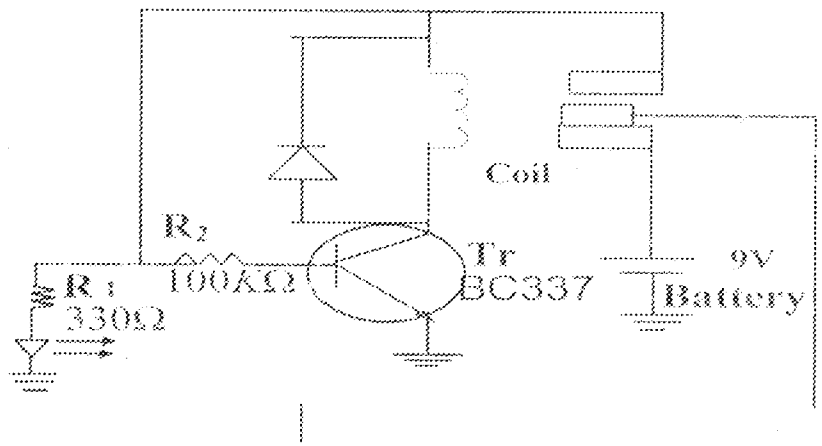

Fig 3.4 The Alternative Power Supply and the Relay

3.1.3 40KHZ FREQUENCY GENERATOR

The noise generator in this system is a 555 timer, biased in astable mode. The 555 timer when wired as an ultrasonic oscillator can generate a sweep square wave of about 40KHZ which can drive an 8 0hm speaker. To get a very accurate frequency, it is advised to use a low capacitor and also make sure that the resistor R_1 value is very small compared to the resistor R_2. Fig. 3.5 shows a 555 time wired as an ultrasonic Oscillator.

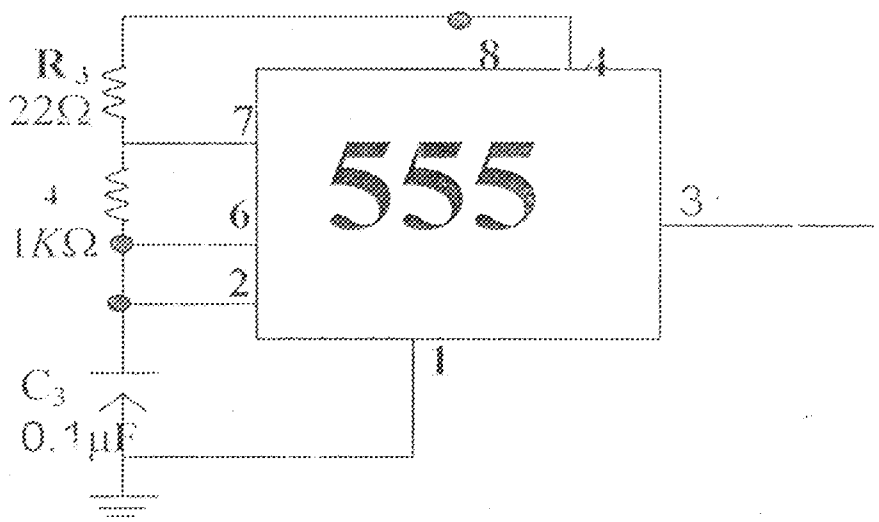

Fig 3.5 555 Timer as Ultrasonic Oscillator

3.1.4 THE OUTPUT OF THE SYSTEM

The square wave produced by the 555 timer (wired as ultrasonic wave producer) is passed through the 8 Ohm speaker. This speaker produces an ultrasonic sound of 40KHz which is of the same frequency with the sound produced by the male mosquitoes. This makes the female mosquitoes to stay away especially when they are pregnant and in search of food. This sound at 40KHz is not audible to human ears but can repel mosquitoes at a certain radius of 5 to 10 meters. The output of the system is as shown below;

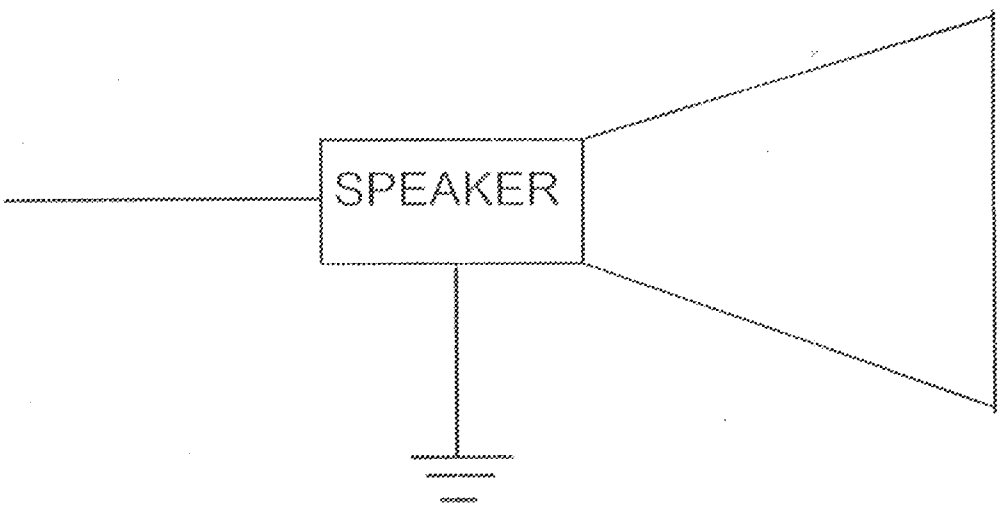

Fig 4.6 The Speaker as the output system

3.2 DESIGN CALCULATION

The value of (R_2) used in the oscillator (mosquito repeller) is one of the major parameters that can be altered to obtain the desired frequency.

The frequency required in this system from the 555 timer is 40 KHz. The frequency of oscillation (F) is given by:

$$F = \frac{1.44}{(R_1 + 2R_2)C} \quad \text{..... 3.2.1}$$

Period of oscillation is given by $T = \frac{1}{F}$ 3.2.2

Now, F=40 KHz

Assume R_1 = 22 Ohm.

$C = 0.1\ \mu F$

So that $40000 = \frac{1.44}{(22 + 2R_2)0.1 \times 10^{-6}}$

$0.088 + 0.008R_2 = 1.44$

$0.008R_2 = 1.44 - 0.088$

$R_2 = \frac{1.352}{0.008} = 169$ Ohm

A preset value of 1K Ohm is used for R_2

T = Period of oscillation

$T = \frac{1}{F} = \frac{1}{40 \times 10^3} = 2.5\mu s$

For the filter circuit.

Voltage from the secondary side of the transformer, V_s=12 Volts

Voltage from the primary side of the transformer, V_p=240 Volts

Voltage drop in the bridge rectifier, V_d = 0.6 Volt

Expected maximum current I = 1 Ampere

$V_{peak} = V_{rms}\sqrt{2}$

$V_{peak}=12*\sqrt{2}=16.97$ Volts

Frequency of Voltage, F = 50Hz

Also, $I=C\frac{dv}{dt}$ 3.2.3

Where, I = Maximum current

C = C_1- filtering capacitor

dv = ripple Voltage

dt = times between peaks of AC Voltage

Assuming 20% change in peaks of AC Voltage

dv = % ripple * peaks of AC Voltage

dv = 20% *16.97=3.40 Volts

$dt=\frac{1}{2}T=\frac{1}{2}*\frac{1}{F}=\frac{1}{2}*\frac{1}{50}=0.01S=10ms$

Substituting this value in equation (3.2.3),

$I=C_1*\frac{3.4}{0.01}$

$C_1=0.00294F=2940\mu F$

The preferred value of 3000 μF is used

C_2 is set to 47 μF (the range should be 10 to 100 μF)

ANALYSIS OF TRANSISTOR CIRCUIT

The transistor was constrained to work in the cut off region

$V_{CE}=0$

$V+=V_C+V_{CE}=I_CR_C+0$ 3.2.4

$I_C=\frac{V+}{R_C}=\frac{9}{400}=0.0225A$

The transistor BC337 HAS h_{fe} =250.

But $\beta = h_{fe} = \frac{I_C}{I_B}$ 3.2.5

$I_B = \frac{I_C}{h_{fe}} = \frac{0.0225}{250} = 0.00009A$

$V_B = I_B R_B + V_{BE}$ 3.2.6

$R_B = \frac{V_S - V_{BE}}{I_B} = \frac{9 - 0.6}{0.00009} = 9333.3\,Ohm$

R_B =93K Ohm =R_3

So, the preferred value of 100K Ohm is used.

3.3 DISPLAY UNIT

This module employs the CD4017 Johnson Decade counter. This counter has 10 decoded outputs, hence, its name the Decode counter, one output is high at a time. The output which is high at a given time depends on the clock pulse; each clock pulse changes the output logic sequentially.

$$F = \frac{1.44}{(R_1 + 2R_2)C}$$

$$1R_1 + 2R_2 = \frac{1.44 * 10^6}{1}$$

$$2R_2 = (1440000 - \frac{1000}{2})$$

= 719500 Ohm

R_2 = 719.5 K Ohm

The referred value of 1M Ohm is used.

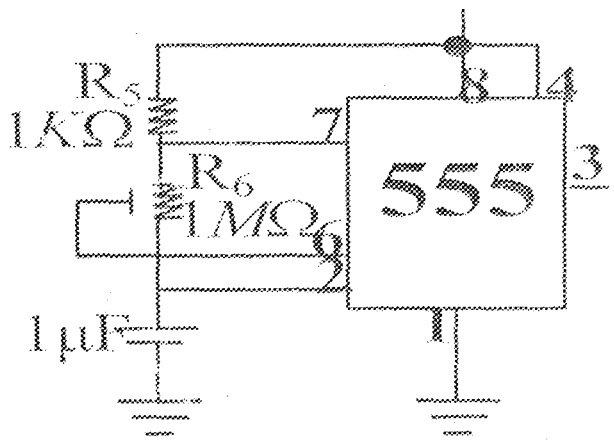

Fig 3.7 555 timer (1Hz generator)

For the display unit, each LED is connect to one decoded output, while the 5th decoded output is connected to the Reset of the Johnson counter, which resets the counter back 0, when the 5th output goes high.

The complete circuit of the display unit is as shown below.

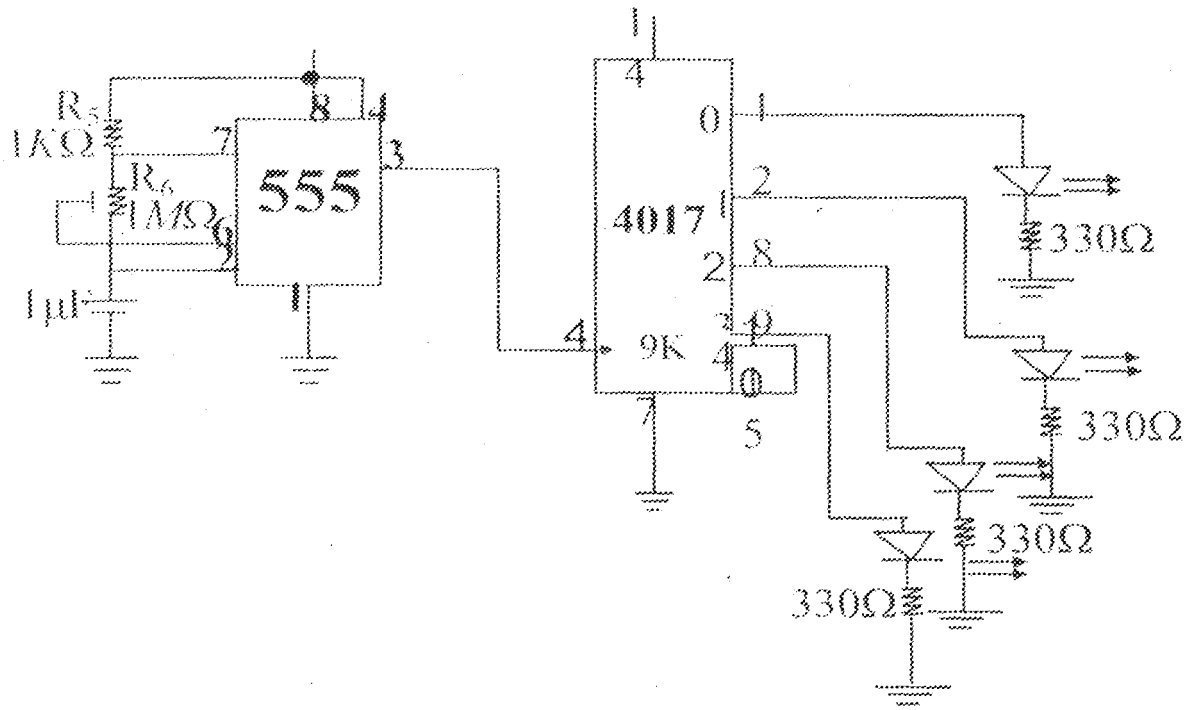

Fig 3.8 The 555 timer (1Hz) and the counter

The Fifth LED on the Display is the power LEG which indicate when the circuit is ON. The skated of the display is shown below.

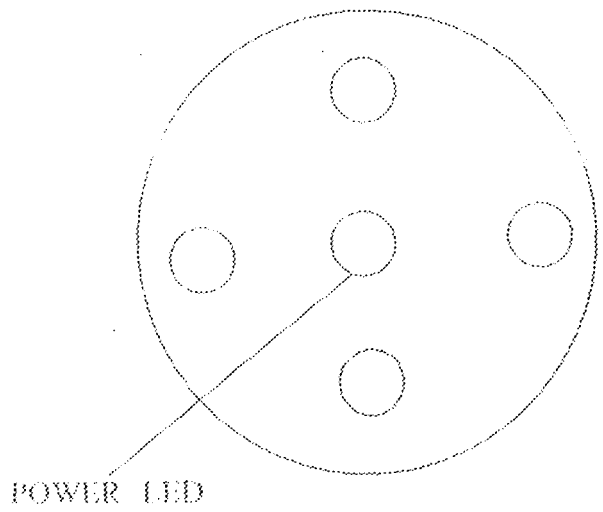

Fig 3.9 The Display LEDs

3.4 The Circuit Diagram

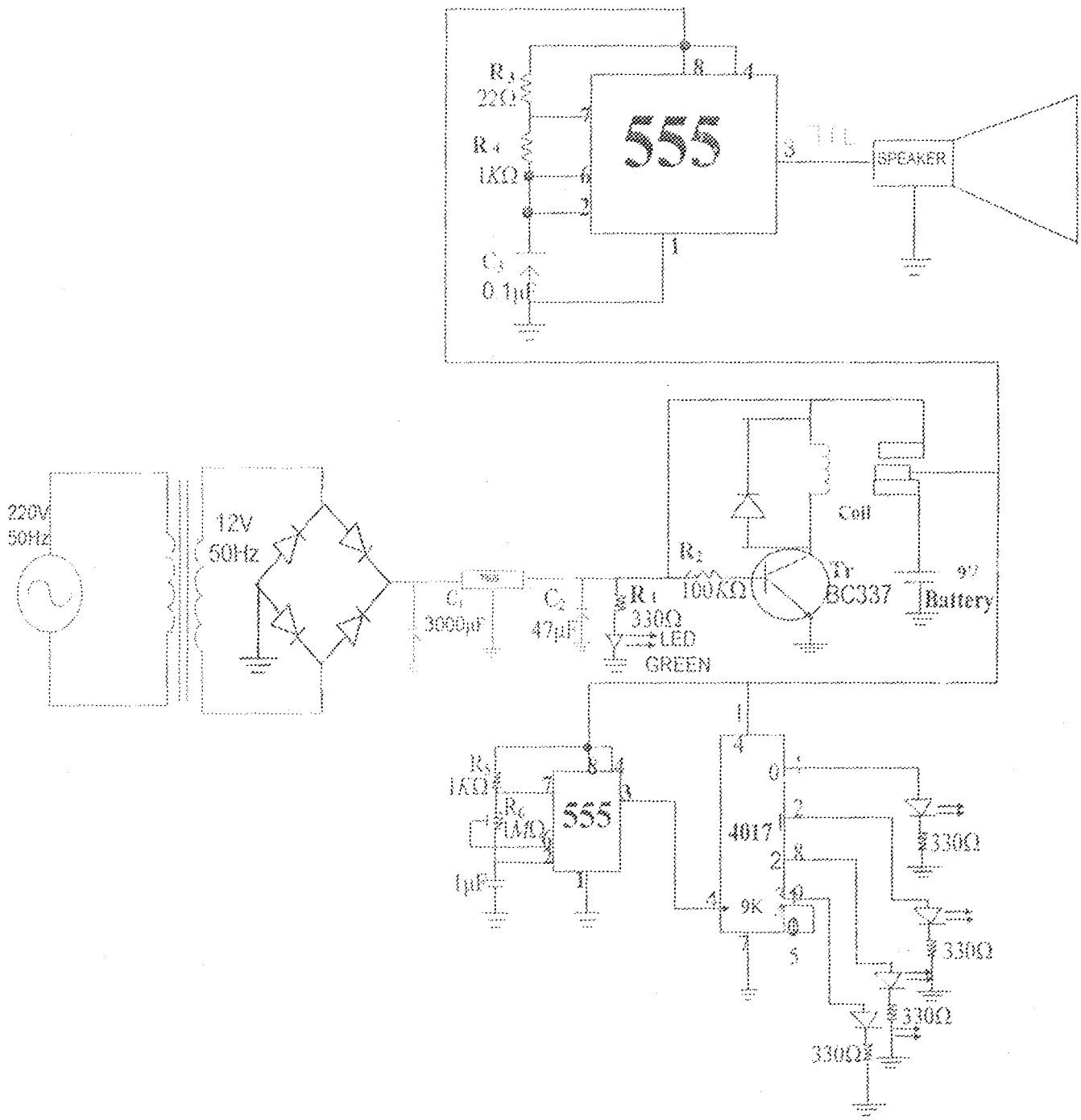

Fig 3.10 THE COMPLETE CIRCUIT DIAGRAM OF MOSQUITO REPELLER WITH DUAL POWER SUPPLY

3.5 FUNCTIONS OF COMPONENTS USED

(I) Transformer:

This is a static [or stationary] piece of apparatus by which electric power is transformed into electrical power of the same frequency in another circuit. It can raise or lower the voltage with corresponding increase in current. [1]

(II) Rectifier:

This employs one or more diodes to convert Ac voltage into pulsating DC voltage. The transformer connected to the rectifier supplies the rectifier with electrical isolation and alters Ac supply voltage. [1]

(III) Regulator IC:

The regulator IC has much improved performance; they have a number of built in features, current limiting, self protection against over temperature, remote control operation over a wide range of input voltage and feed back current. [2]

(IV) Zener diode:

This is used for voltage regulation and makes use of the breakdown property of diode when reverse-biased. The diode is designed to breakdown if the reverse current suddenly changes from a very small value to a very large value which is independent of the voltage.[1]

(V) Resistor:

These are used to limit the flow of current in a circuit. The limitation to this flow is called resistance which is measured in ohms. [3]

(VI) Variable resistor:

This is a type of resistor whose assistance value can be adjusted. [3]

(Capacitor).

These store electrical charges. Basically, it has two plates separated by an electrical insulation called dielectric. [4]

(VIII) Diodes:

This is arc semi conductor device which allow current to flow through them in only one direction. [6]

(IX) Loudspeaker:

A variable current passing through the coil of the speaker causes it to vibrate in and out of the pole pieces of the permanent magnet. The core when attached to the coil and therefore vibrate at the frequency, this in turn causes the surrounding air to vibrate and sound is produced. [8]

(X) Transistor:

This is an active component device that conducts current in one direction.

(XI) Light Emitting Diode:

This gives light when current passes through it in a forward direction. It is a transducer for changing electrical energy to light energy. It is made from semi conductor gallium Asenide phosphate.

(XII) 555 Timers IC:

The 555 timer IC is an IC that consists of equivalent of 20 transistors, 15 resistors, and 2 diodes, the number and configuration depending on the manufacturer. It is used in this circuit as frequency generator.

CHAPTER FOUR

4.0 TEST, RESULTS AND DISCUSSION

At this point, the various components bought were soldered on a Vero board as shown on the circuit diagram of figure 3.10. The soldering were done at intervals, that is stage by stage. Each stage was tested to see whether it gave the desired output.

The step down transformer was first mounted on the board connected to the mains and its output voltage was measured with multimeter. The output was found to be 12volts in AC form. This output voltage was fed into the silicon chip bridge rectifier which converts it into DC form at the same voltage level of 12volts. The green LED was soldered with resistor R1.

The DC-voltage obtained was fed through a filter circuit to remove the ripples in it. The electrolytic capacitor was soldered and its negative side grounded. Then the voltage regulator IC (7809) was connected and soldered followed by compensating capacitor C2 (47 μF) with its negative points grounded. The output of the voltage regulator IC was measured and found to be approximately 9 volts.

The output of the battery for the alternative power supply was measured to be 9 volts and soldered to the normally closed side of the relay, while the normally opened side was soldered with the mains supply. A transistor (BC337) which was constrained to work in the cut-of region, acting as a switch, was soldered to the coil of the relay while a diode was soldered across the coil in order to prevent back emf during the action of the relay. Power was supplied from the mains and the relay was found to be operating well.

The 555 timer was wired and soldered as shown in fig 3.5 and was fed with the 9volts through the output of the relay. The output of the 555 timer was measured and found to be a square wave of about 40KHz. This was fed into the 8ohm speaker through the output pin 3 of the 555 timer.

. The speaker produces an ultrasonic sound of 40KHz which is of the same frequency with the sound produced by the flapping of wings by male mosquitoes. This makes the female mosquitoes to stay away especially when they are pregnant and in search of food. This sound at 40KHz is not audible to human ears but can repel mosquitoes at a certain radius of 5 to 10 meters.

In addition, the display unit was soldered with the circuit in stages. The second 555 timer (1Hz generator) was soldered to the 9 volts supply from the relay output. Pin 1 of the timer was connected to the earth together with the negative side of the capacitor. The decade counter was soldered to the output of the 555 timer (1Hz generator). Each of the diodes are now soldered to the counter as shown in figure 3.8.

The output of each of the LED was found to produce light according to what was expected from the counter.

The variable resistor was used to control the speed of the counter.

The display unit makes it easy for one to know when the circuit is ON or OFF.

4.1.1 Test carried out after construction.

[i] Output frequency:

A frequency counter was used to test the output of the repeller circuit using pin 1 and pin 3 of the 555 timer and was found to be 40KHz.

[ii] Effect of mosquitoes (repeller action):

The circuit was tested in the room over the night and no mosquito could come near.

4.1.2 RESULT.

The frequency output was 40KHz after construction,and there was no audible sound produced by the speaker but the speaker was found to be vibrating.

4.1.3 CASE CONSTRUCTION

I. Type of casing: A glass casing was used to prevent the component being exposed to dust and to make it more portable.

II. Dimension: the dimension of the casing is 20cmx7cmx6cm

III. The diagram is as shown below

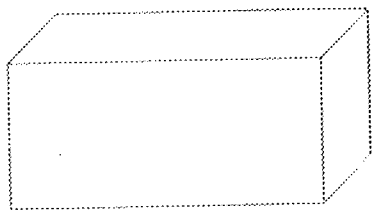

Fig 4.1 The glass casing

4.1.4 PROB LEM ENCOUNTERD

The construction was first done on a bread board and during testing; it was observed that the 555 timer IC became hot when it was used for a long time.

4.1.5 SOLUTION PREFERED

The casing should be made such that there would be enough ventilation to allow the circuit gets rid of excess heat.

This project has given me an insight into the application of 555 timers to generate sound frequency that scares away musquitoes. This sound was achieved by varying certain parameters in the circuits during design.

5.2 RECOMMENDATION

Although this project was designed to specifications, there are some things that can be incorporated into the design circuit. These are as follows:

i. The circuit may be incorporated with a small fan to make the circuit get rid of moisture that comes from the surrounding.

ii. A charger part may be incorporated so that the battery (alternative power supply) can be charged by the mains (AC power source) while the system is in operation.

[7] Lawrence .E. Kingsley, fundamental of Acoustics, professor of physics United states Naval post graduate school, Monterey, California, page 333-339.

[8] Chijioke .N, Insect and pest repeller, FUT Minna, 2004 page 15-22.

[9] Dr. Wenclaus Kilama, chairman malaria foundation international.
http://www.fightingmalaria.org.

[10] World Health Organization.
www.rbm.who.int/partnership/board/meetings/docs/strategy-rev.pdf.

[11] Charles schuler electronics, principles and applications, 5th Edition, page 56-58, 64-66.