Design and Construction of Automatic Electronics Hand Dryer

By

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Dedication

This Project is dedicated to the Almighty God, the author, and giver of life, my parents Mr and Mrs Abraham Donkoh.

Declaration

I Christian Ogbonna 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.

…………………………	………………………… 14112010
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Abstract

This Project presents the Design and Construction of Automatic Electronics hand-dryer. It contains timing circuit which comprises of the transmitter, the receiver and control unit. These help to reduce the duty cycle of the DC motor, thereby minimising the Power waste by bringing the motors into action only when a drying process is to take place and putting them off on standby mode.

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CHAPTER ONE

INTRODUCTION

In the world where Science and technology is improving almost every day, most of the present day work activities are not manually operated again. They are automatically carried out by themselves with the use of electronic components. This project, which is the Design and Construction of Automatic Electronics Hand-dryer, is another electronics project that steps further in the quest for the improvement of Man's living condition in both home and public places.

Automatic electronics hand-dryers have become as commonplace in public restrooms as sinks or mirrors. Most people do not think twice when they run their hands under the warm air for a second after washing up [18].

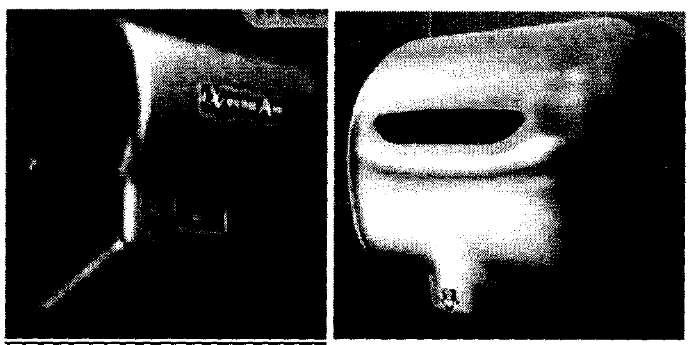

Figure 1.0 Samples of Automatic Electronics hand-dryers

Economic Benefits

Hand dryers have been popular with industries for their apparent economies. According to manufacturers, hand dryers can cut costs by as much as 90%, when compared to paper towels. They require very little maintenance compared to paper towels, which must be replaced, and the paper waste removed [16].

Environmental Benefits

Due to the reduction in litter and waste in comparison with paper towels, which cannot be recycled, hand dryers are also claimed to be better for the environment. One source claims that an average fast-food restaurant using paper towels, annually, results in 9 fully-grown trees being cut down, and 1,000 pounds (~450 kilograms) of landfill waste created, though many are often unaware of these consequences. Even before the paper towels are used, each ton has claimed 20,000 gallons (~76000 litres) of water in chemical cleansing [1].

Figure 1.1 littered environment

To make one ton of virgin paper consumes up to:

20,000 gallons of water

17 trees

384 gallons of oil

42 gallons of gasoline

It's estimated that hand dryers use 5% less energy than paper towels in the first year, and 20% less over five years [15].

A World Dryer study of 102 hand dryers installed in public schools in Topeka, Kansas, claimed an annual savings of 34.5 tons of solid waste, 690,000 gallons of water, and 587 trees; another World Dryer study of 153 hand dryers in the Iowa state capitol showed an annual savings of 10.5 tons of solid waste and 176 trees.

Health Benefits

Hand dryers promote sanitation as there is no water sloshed around and no drops of water carried from the wash basin to other areas on your premise. A touch-free and hands-off approach to using the hand dryers ensures personal hygiene [17].

1.2 Aims/Objectives

The aims and Objectives of this project are as follows:-

- To create Public awareness on the actual Energy Savings.
- To improve Personal Hygiene.
- To Save Paper Towel Costs.
- To reduce Environmental Pollution.

1.3 Methodology of the Project

The design involves the use of some specific electronic components such as infrared sensor and transmitter; transistors, capacitors, 555 timers, resistors etc.

The system uses infrared sensor which serves as an output and input to the transmitter and receiver unit. The maximum distance and total angle of view are important specifications needed in choosing a sensor.

1.4 Scope of the Project

The project involves the design and construction of Automatic Electronics Hand-dryer. It uses infrared sensor as a transmitter and a receiver, 555 timer for clock pulse generation and 7805 for voltage regulation.

1.5 Source of Materials

Materials were sourced from the Electrical and Computer Engineering Departmental library, from text books, previous final year project, lecture notes and numerous websites on the internet with the internet yielding the most valuable references.

Components and working tools were sourced locally from Minna and Lagos.

CHAPTER TWO

Literature review /Theoretical background

2.10 Historical Background

The sophistication and uses of electrical devices have increased dramatically. People rely on electrical devices for business, education, etc. Automatic Electronics Hand-dryer is one of the electrical devices popularly installed in public washroom, hotels and homes. Their popularity stems from their convenience and ease of use plus the huge cost savings opportunity. Ever since its invention in 1948, the hand dryer has continued a steady process of development and gaining widespread acceptance in the market [1]. There are mainly two types of hand dryers–button operated and automatic hand dryers controlled by an infra-red sensor. The push-button hand dryer runs on a timer. Both offer significant advantages over paper towels–the traditional alternative to hand dryers. New generation hand dryers are quiet and can dry hands in as few as 10 seconds [3]. They are available in a range of shapes and designs to fit in with any architectural environment, whether in an office, home or restaurant.

In 1993, Mitsubishi Electric introduced a new type of hand-dryer trademarked Jet Towel, with the concept of blowing jets of air to both sides of the hand, pushing the water off like a squeegee rather than evaporating it [9, 10].

In 2006, Dyson released their hand-dryer of the same design and concept as Mitsubishi's, the Dyson Airblade. Dyson claims that it dries hands in 10 seconds that it is more cost effective for energy usage than traditional hot air blower hand dryers, and is more environmentally friendly, saving 83% in energy in comparison to conventional hand dryers. Based on 200 uses a day for 365 days a year, the Airblade would cost £30 to operate for that full year [4].

U.S.-based Excel Dryer Ltd has also released a similar machine; XLerator, advertised as being 98% cheaper than paper towels, and more environmentally friendly. These machines are now commonly used in British supermarkets such as Tesco and Asda, replacing older once which are less efficient.

An American company, American dryer has developed a high speed hand dryer with a 10 second drying time. The eXtremeAir is more economical at a cost of $390 US. It works by blasting a user's hands with a stream of heated air at 185 MPH (≈300 km/h). This breaks up the surface tension of the water for quick removal and evaporation. It uses about 80% less energy than conventional hand dryers which require 2300 watts of electrical power for 30–40 seconds [5].

A number of studies have been conducted over the last four decades to investigate the effectiveness of hand drying systems in the context of skin hygiene [6]. The majority of these studies have concentrated on clinical and food science scenarios, and it is uncertain whether the stringent standards of hygiene required by these circumstances are equivalent to those required in general non-domestic situations, such as the use of a public washroom. Nonetheless, the data collected by these studies provide valuable insight into hygiene practices, and will provide a better understanding of the limitations of the various hand-drying mechanisms currently available.

With a strong focus on microbiological factors, most existing research on hand drying systems assumes that effective hand washing and drying should result in a quantitative reduction of micro-organisms on a subject's hands. However, the results obtained by separate studies are clearly disparate, and subsequent conclusions are at times contradictory [8].

More recent studies similarly concluded that there were no significant differences between use of paper towel, cloth towel and hot air hand drying systems. In their research, they allowed subjects to dry their hands under a hot-air dryer for 45 seconds, and subsequently declared that hot air hand drying was a suitable means of hand drying, and that there was 'no bacteriological reason to exclude them from clinical areas' [19]. In contrast, there are numerous research studies advocating that, from a microbiological perspective, the use of hot air hand dryers is inferior to other hand drying methods [13].

Believing that hand drying must meet two key requirements,

(a) The efficient removal of bacteria, and

(b) The prevention of transmission of bacteria to others,

In a later study, [14] builds on earlier research to assert that the dryer draws bacteria-rich air from its surrounding environment, and subsequently blows the bacteria out over the user, resulting in an increase in bacterial numbers on a person's hands. Suggesting that the relatively high humidity in washrooms provides a suitable environment for bacterial growth, Blackmore argues that not only are bacteria recirculated by the dryer's air currents, but that they can also be found inside the outlet nozzle [9].

In addition, the study conducted a survey of warm air hand dryers in 48 public washrooms, with the purpose of obtaining in situ data about dryer cycle times, exhaust air temperature, and humidity of the area surrounding the dryer, as well as confirming the presence of bacteria in dryer air streams and on the inside of the dryer outlet nozzle [10].

The results from the survey of dryers in both male and female washrooms in public houses revealed that bacteria could be cultivated from swabs collected from both the air stream and outlet nozzles, indicating that it is possible for bacterial to be blown out onto a person's hands [11].

Aside from Blackmore microbiological conclusions, which confirm previous findings, she also makes several additional observations. Firstly, the average temperature of the hot air is found to be 56°C, which is not high enough to cause bacterial death. The average cycle time of the various dryers was found to be 33 seconds – too short to kill bacteria, even if the exhaust temperature were increased. Lastly, Blackmore makes some interesting observations regarding the practicalities of dryer use in public areas. The short cycle time often means that more than one cycle is necessary to dry hands effectively. Also, with only one person able to use a dryer at any one time, people may grow impatient, and use alternative means of hand drying (clothes or handkerchief) or shake their hands to dry them, thereby increasing the risk of bacterial transfer, and defeating the purpose of hand washing [12].

In 1993, a team of researchers from the University of Westminster added to Blackmore's work on hand washing and drying habits under natural conditions [17]. The study observed that people rarely used hot air dryers long enough to ensure more than 55-65% dryness, and often completed the process by wiping their hands on clothing [13].

A recent Japanese study by went one step further in the investigation of warm air dryer efficiency, by examining the various behaviours that users engage in when using hand dryers. The study investigated the development of bacteria colonies on hands washed with bacterial soap, and then dried using warm air with and without ultraviolet light, while being rubbed or held stationary, or by paper towels [23].

A comparative analysis of the whole hand (palm and fingers) versus the fingertips indicated that warm air was more successful in reducing bacteria on the whole hand, while paper towel led to a greater reduction of bacteria on the fingertips, but not the whole hand [14].

2.20 Theoretical Background of the Project

This Project incorporates various theories and principle of Electronics; these are drawn from topics such as power electronics, physical electronics, integrated analogue circuit and electromechanical devices.

The "design and construction of automatic electronics hand dryer" can be divided or segmented into different circuits' modules namely;

- The transmitter circuit
- The sensor/receiver circuit
- Control circuit
- The power supply unit

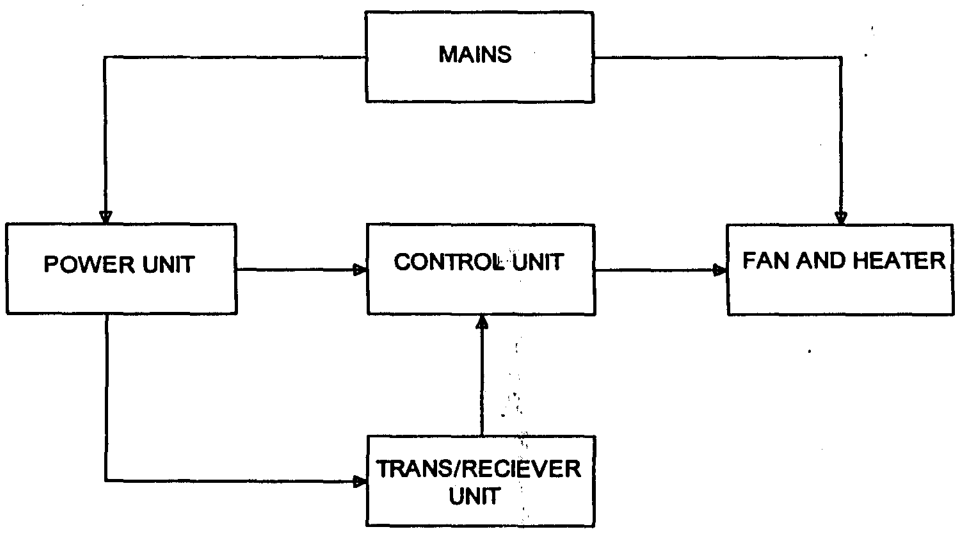

Figure 2.0 Block Diagram of an Automatic Electronics Hand-dryer

2.30 The Power Supply

Power supply is a basic requirement of every electronics system; power must be available for the electronics system to perform its specified duties, power supply can be in form of alternating current (AC) power supply or a direct current (DC) power supply. The power supply unit for the system was built using a 230/12V step down transformer full wave rectifier,1mF Capacitor for soothing of the signal output the bridge rectifier and a 12V 7805 Voltage regulator which makes sure the 12V Voltage required for triggering the relay is produced. For the alternating current power supply to become a direct current power supply, it must undergo some processes which are transformation, rectification, filtering and regulation.

The Power unit comprises of the followings;

- The transformer
- Bridge rectifier
- Capacitor
- Transistor NPN (7805)

2.40 The Transmitter/Receiver Unit

This is the portion of the system where the infrared beam originates. The transmitter is a light emitting diodes that emits light in the infrared region. It sends a continuous beam of signal with a bean angle of 40 degrees over a distance to the infrared sensor and maintains a constant link with the receivers. If this link is broken, the receiver which is always active low becomes active high. The infrared sensor operates at a frequency range of 32 KHz to 40 KHz. The infrared sensor is combined with a 555 timer operated in a monostable mode to produce a single rectangular pulse, whose amplitude, pulse width and wave shape depends upon the values of circuit components.

2.50 The Switching Unit

The Switching circuit is made up of a NPN transistors switch which is used to energize the relay. The transistor has two states, the ON and OFF state [25].

2.60 Electric Heating

An Electric heater is an electrical appliance that converts electrical energy into heat energy and this are commonly used in cooking, heating, boiling etc. The heating element inside every electric heater is simply an electrical resistor, and works on the principle of Joule heating: an electric current through a resistor converts electrical energy into heat energy [27].

2.70 The Infrared Sensor

This is another type of sensor which detects the presence or absence of an object. Infrared Sensors use a beam of infrared light to detect the object [24].

CHAPTER THREE

DESIGN AND IMPLEMENTATION

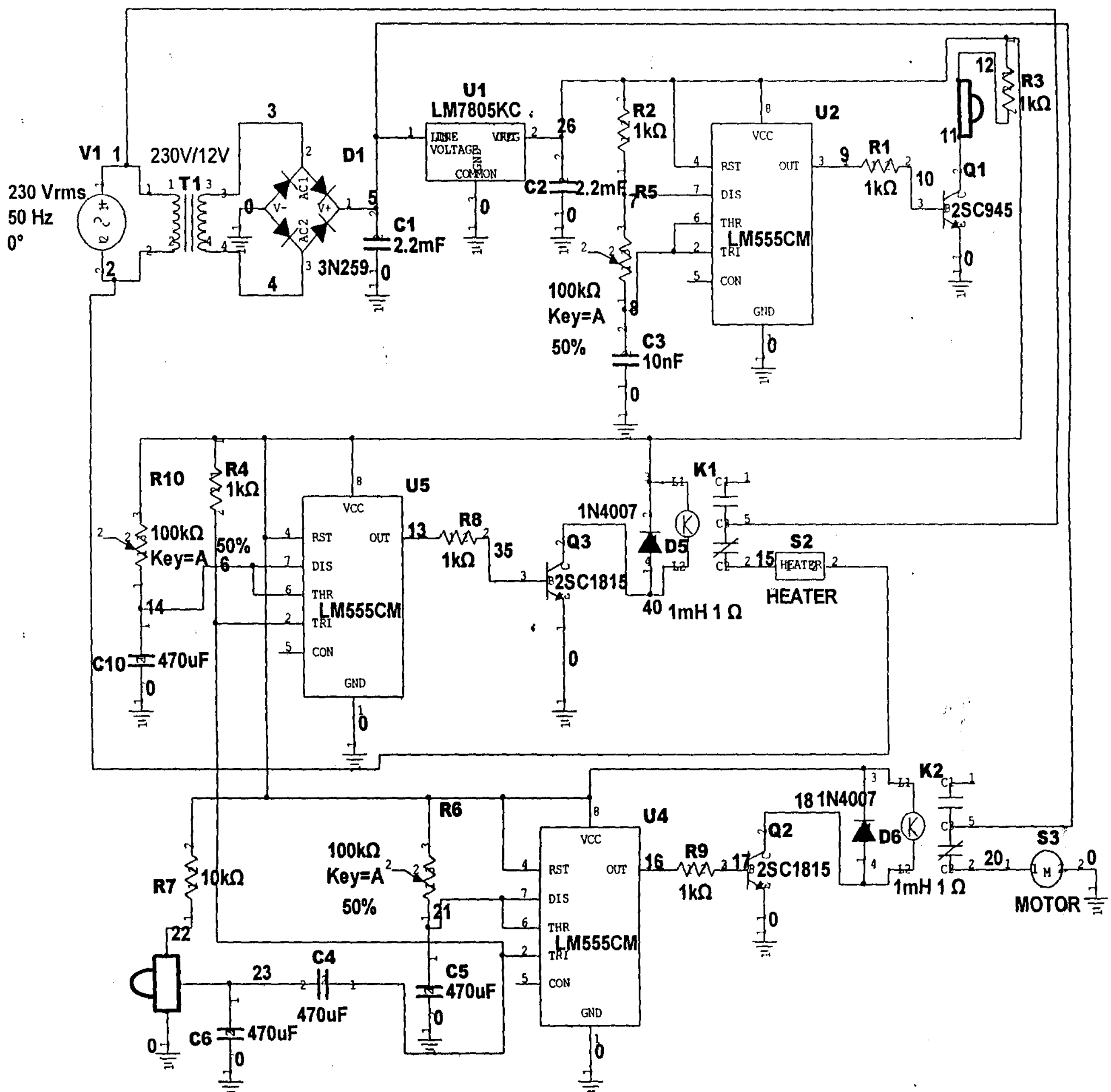

Figure3.0 Automatic Electronics Hand-Dryer Complete Circuit Diagram

3.1 Rectification

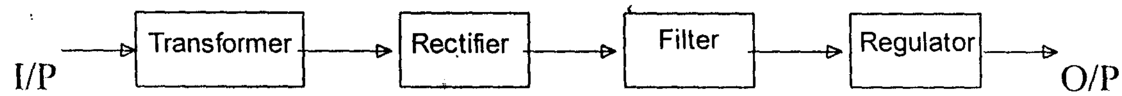

Figure 3.10 Block Diagram of the Power Supply Unit

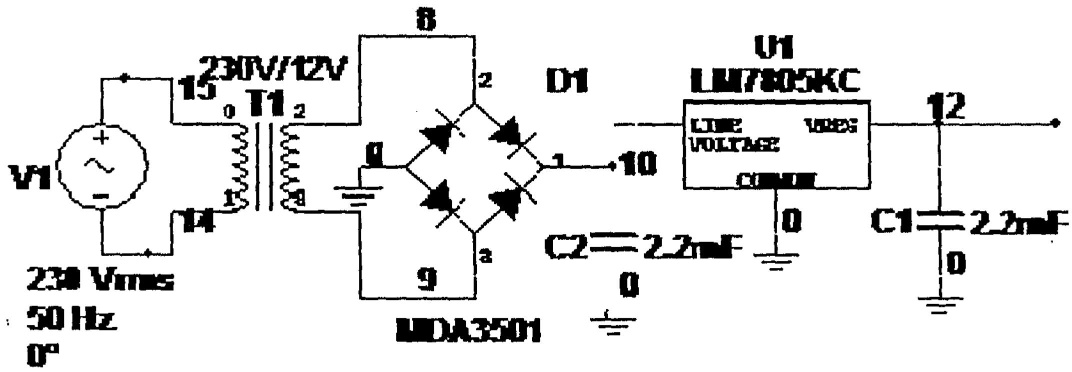

Figure 3.20 5VDC Power Supply Unit

This consists of a 230-12V 500mA Step down Transformer with a rectified output of 12V. This rectified output is smoothened by a 2200μF capacitor, the 7805 voltage regulator converts the 12V rectified filtered voltage to a voltage level of +5V which is used by the 555 timer circuit.

3.1.1 The Transformer Circuit

The first stage of the power supply unit design involves the stepping down of the 230V A.C mains to 12V volts A.C, with the aid of 230V/12V, 1A transformer. Transformer is an electrical device that provides physical isolation between the mains and the rest part of the circuit, the only link is through the means of magnetic flux, thus eliminating the risk of electric shock.

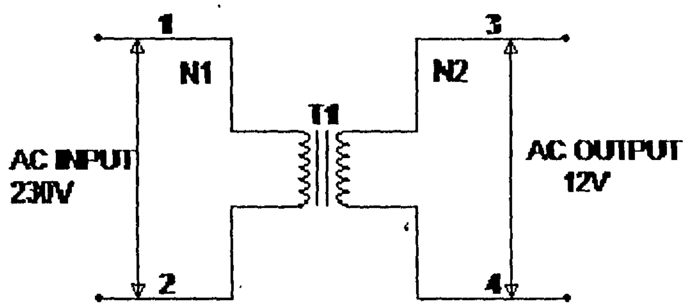

Figure 3.30 Transformer Circuit

It consists of two Coils, the primary winding and the secondary winding. The ratio of the primary Voltage V_1 to the secondary Voltage V_2 is equal to the turn's ratio of primary winding N_1 to that of secondary winding N_2.

i.e. $\frac{V1}{V2} = \frac{N1}{N2}$ .... (3.1)

From the transformer data $V_1 = 230V$, $V_2 = 12V$, $I_2 = 1A$, and the frequency of A .C mains supply is 50Hz. For ideal transformer

$$\frac{V1}{V2} = \frac{N1}{N2} = \frac{230}{12} = 19.17$$

Hence the turn ratio $N_1:N_2 = 19:1$

The magnetic motive force (mmf) = NI

$N_1I_1 = N_2I_2$... (3.2)

$$\frac{N1}{N2} = \frac{I2}{I1} = 19.17$$

But, $I_2 = 1A$

$\frac{I2}{I1} = 19$

$I_2 = 19I_1$

$I_1 = \frac{I2}{19} = \frac{1}{19} = 0.05A$

Power input (P_1) = Power output (P_2)

$I_1V_1 = I_2V_2$.. (3.3)

0.05 X 240 = 12W

3.1.2 The Rectification Circuit

The rectifier converts the 12V A.C Voltage from the secondary of the transformer into pulsating 12VDC. A full wave bridge rectifier circuit consists of four diodes arranged as shown in figure 3.40 below.

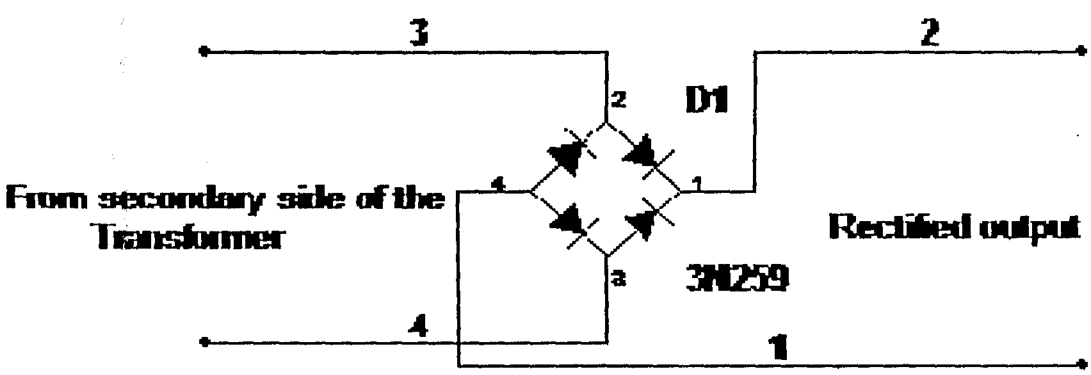

Figure 3.40 Full Wave Rectifier Circuit

During the positive half cycle of the voltage, diodes D_1 and D_4 are forward biased; therefore the load Voltage has the negative polarity on the left and the positive polarity on the right.

During the negative half cycle diodes D_2 and D_3 are forward biased, the same result is obtained since the load current is in the same direction, no matter which diodes are conducting.

The output voltage of the transformer secondary winding V_2 = 12Volts

$$V_2\,(peak) = V_2\sqrt{2} = 12 \text{ X } \sqrt{2} = 16.97V$$

The average DC Voltage V_{DC} across the rectifying terminal is given as

$$V_{DC} = \frac{2}{\pi} V_{2(peak)} \qquad (3.4)$$

$$V_{DC} = \frac{2}{\pi}(16.97) = 10.80V$$

3.20 The Filter Circuit

The DC Voltage from the rectifier is only suitable for limited applications such as charging batteries and running DC motors. Most electronic circuits require DC Voltage that is constant in value. A filter Capacitor is used to convert the full wave rectifier signal into a constant DC Voltage.

Capacitive filtering is adopted in this design where a large electrolytic capacitor was connected across the rectifier output. The Capacitor charges during the diode conduction period to the peak value and the rectifier Voltage falls below this value, the Capacitor discharges through the load so that the load receives steady DC Voltage [26].

The instantaneous Voltage at the input of the regulator must always exceed the dc output Voltage by a value that is typically up to 0.5V to 3V which is called minimum instantaneous input – Output Voltage. 7805 Voltage regulatorICs has an output Voltage of 5V at a load of 1A.

$V_{min} = V_{0reg} + \text{headroom}$ .... (3.5)

$= 5V + 2V$

$= 7V$

If assumed that the unregulated power supply that feeds the regulator has ripple voltage of

$\Delta V_0 = 2.3V$

Then, $\Delta V = \frac{1}{4CF}(\text{volt})$ .... (3.6)

Where F is the frequency of the supply (Hz)

I is in ampere

C is in farad

ΔV is the peak – to – peak ripple voltage, with an average value of $\frac{\Delta V}{2}$.

The average or mean dc voltage thus become,

$V_{dcFL}=V_{Lmin}+\frac{\Delta V}{2}$ .... (3.7)

For ripple voltage of 2.3V and load current of 1 ampere

$2.3 = \frac{1}{4C50}$ (from equation3.6)

C = 0.0022F

C = 2200μF

$V_{dcFL}= 14 + \frac{1}{2}(2.3)$ (from equation 3.7)

= 14+1.15 = 15.15V

This means that V_{dcFL}must be 15.15V at the very least.

3.30 The Timing Circuit

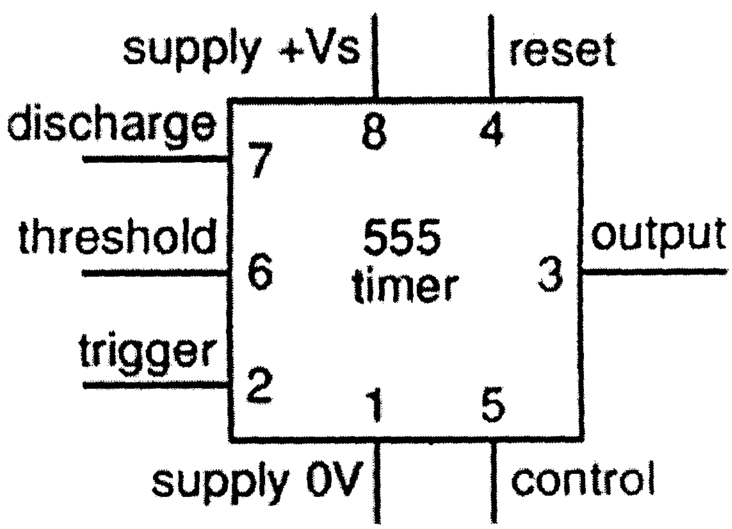

Figure 3.5 CircuitSymbol of 555 Timers

The timing Circuit comprises of the transmitter, the receiver and control unit. It helps to reduce the duty cycle of the DC motor, thereby minimising the power waste by bringing the motors into action only when a drying process is to take place and putting them off on standby mode. The major component of the circuit is a NE555 IC, which acts as timer and Oscillator Circuit. In this design, it has been connected in the astable and mono-stable mode, whose timing period is dependent on resistors.

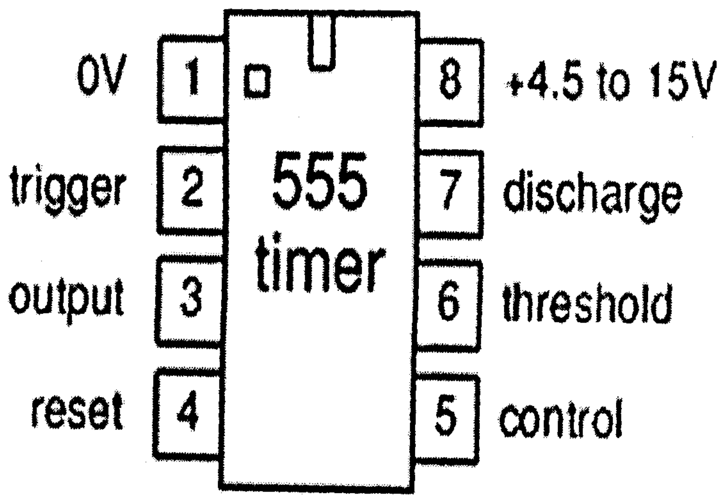

Figure 3.6 Actual PIN Arrangements of 555 Timer

The 555 can be used with a supply Voltage (Vs) in the range 4.5 to 15V (18V absolute maximum).

. The input and output pin functions are described briefly below:

- Astable - producing a square wave
- Monostable - producing a single pulse when triggered
- Bistable - a simple memory which can be set and reset
- Buffer - an inverting buffer (Schmitt trigger)

Inputs of 555

Trigger input (Pin 2): when less than $^1/_3$ Vs (active low) this makes the output high (+Vs). It monitors the discharging of the timing capacitor in an astable circuit. It has high input impedance greater than 2M**Ω**.

Threshold input (pin 6): when greater than $^2/_3$Vs (active high) this makes the output low (0V). It monitors the charging of the timing capacitor in astable and monosable circuits. It has high input impedance greater than 10M**Ω**.

Providing the trigger input is greater than $^1/_3$ Vs, otherwise the trigger input will override the threshold input and hold the output high (+Vs).

Reset input (Pin 4): 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 10k**Ω**.

Control input (Pin 5): 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 0.01μF capacitor to eliminate electrical noise. It can be left unconnected if noise is not a problem.

The discharge pin (Pin 7) is not an input, it is connected to 0V when the timer output is low and is used to discharge the timing Capacitor in Astable and Monostable circuits.

Output of 555

The Output of a standard 555 can sink and source up to 200mA. This is more than most ICs and it is sufficient to supply many output transducers directly, including LEDs (with a resistor in series), low current lamps, piezo transducers, loudspeakers (with a capacitor in series), relay coils (with diode protection) and some motors (with diode protection). The output voltage does not quite reach 0V and +Vs, especially if a large current is flowing.

The ability to both sink and source current means that two devices can be connected to the output so that one is ON when the output is LOW and the other is ON when the output is HIGH.

Relay Coils and other Inductive Loads

Like all ICs, the 555 must be protected from the brief high voltage 'spike' produced when an inductive load such as a relay coil is switched off. The standard protection diode must be connected 'backwards' across the relay coil.

However, the 555 require an extra diode connected in series with the coil to ensure that a small 'glitch' cannot be fed back into the IC. Without this extra diode Monostable circuits may re-trigger themselves as the coil is switched off. The coil current passes through the extra diode so it must be a 1N4001 or similar rectifier diode capable of passing the current a signal diode such as a 1N4148 is usually not suitable [27].

555 Astable

An Astable circuit produces a 'square wave'; this is a digital waveform with sharp transitions between low (0V) and high (+Vs). Note that the durations of the low and high states may bedifferent.

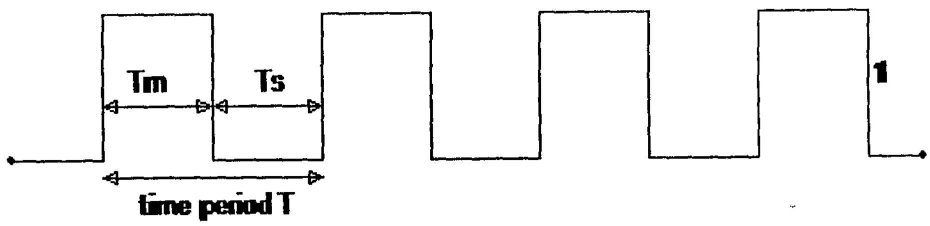

Figure 3.7 Astable Output

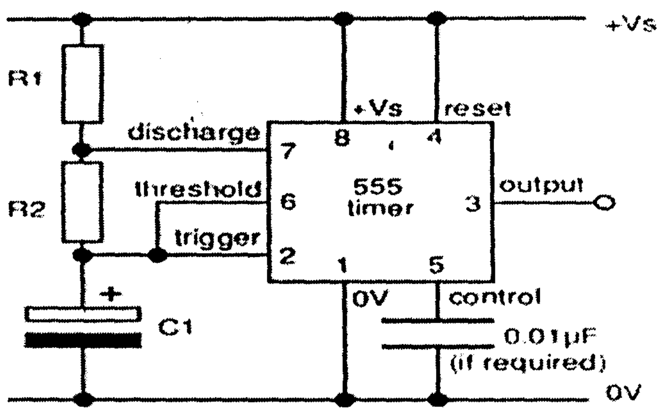

Figure 3.8 555 Astable Circuit

The Circuit is called an Astable because it is not stable in any state: the Output is continually changing between 'low' and 'high'.

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

$T = 0.7 X (R_1 + 2R_2) X C_1$ .... (3.8)

$$f = \frac{1.4}{(R1+2R2)\ X\ C1} \quad \text{(3.9)}$$

T = time period in seconds (s)

f = frequency in hertz (Hz)

R_1 = resistance in ohms (Ω)

R_2 = resistance in ohms (Ω)

C_1 = capacitance in farads (F)

The time period can be split into two parts: T = Tm + Ts .... (3.10)

Mark time (output high): $Tm = 0.7 \times (R_1 + R_2) \times C_1$ .... (3.11)

Space time (output low): $Ts = 0.7 \times R_2 \times C_1$ ....(3.12)

Many Circuits require Tm and Ts to be almost equal; this is achieved if R_2 is much larger than R_1.

Choosing R_1, R_2 and C_1

R_1 and R_2 were in the range 1k$\Omega$to 1MΩ. $C_1$was chosen first because capacitors are available in just a few values.

- C_1 was chosen first to suit the frequency range required (the table in chapter four was used as a guide).
- R_2 was chosen to give the frequency (f) required. R_1 was assumed to be much smaller than R_2 (so that Tm and Ts are almost equal), then:

$$R_2 = \frac{0.7}{F \mp XC1} \quad \text{(3.31)}$$

- R_1 was chosen to be about a tenth of R_2 (1k ohms min.) unless the mark time, Tm is expected to be significantly longer than the space time,Ts.

- Variable resistor was used to make R_2.
- If R_1 is variable it must have a fixed resistor of at least 1k ohms in series (this is not required for R_2 if it is variable).

AstableOperation

With the Output high (+Vs) the Capacitor C_1 is charged by current flowing through R_1 and R_2. The threshold and trigger inputs monitor the Capacitor Voltage and when it reaches $^2/_3$Vs (threshold voltage) the Output becomes low and the discharge pin is connected to 0V.

The Capacitor now discharges with current flowing through R_2 into the discharge pin. When the Voltage falls to $^1/_3$Vs (trigger voltage) the Output becomes high again and the discharge pin is disconnected, allowing the Capacitor to start charging again.

This cycle repeats continuously unless the reset input is connected to 0V which forces the Output low while reset is 0V.

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 AstableCircuit the mark time (Tm) must be greater than the space time (Ts), so the duty cycle must be at least 50%:

$$\text{Duty cycle} = \frac{Tm}{Tm+Ts} = \frac{R1+R2}{R1+2R2} \quad \text{(3.14)}$$

To Achieve a Duty Cycle of Less than 50%

A diode can be added in parallel with R_2 as shown in the diagram below. This bypasses R_2 during the charging (mark) part of the cycle so that Tm depends only on R_1 and C_1:

Tm = 0.7 × R1 × C1 (ignoring 0.7V across diode) .... (3.14)

Ts = 0.7 × R2 × C1 (unchanged) .... (3.15)

Duty cycle with diode $= \frac{Tm}{Tm+Ts} = \frac{R1}{R1+R2}$ .... (3.16)

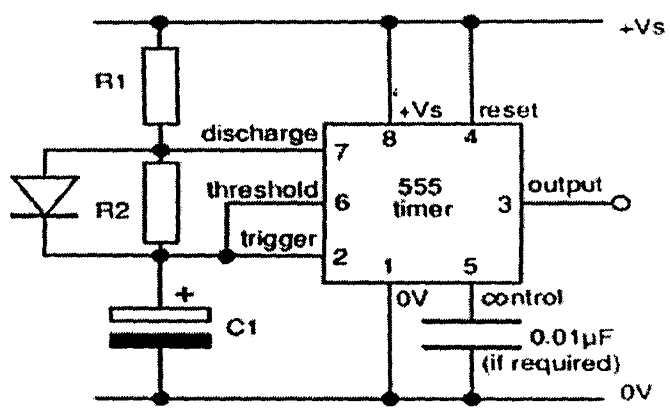

Figure 3.9555 Astable Circuits of Less than 50% Duty Cycle

555Monostable

A Monostable circuit produces a single output pulse when triggered. It is called a Monostable because it is stable in just one state: 'Output low'. The 'Output high' state is temporary.

The duration of the pulse is called the time period (T) and this is determined by resistor R1 and capacitor C1.

Time period, T = 1.1 X R_1 X C_1.. (3.17)

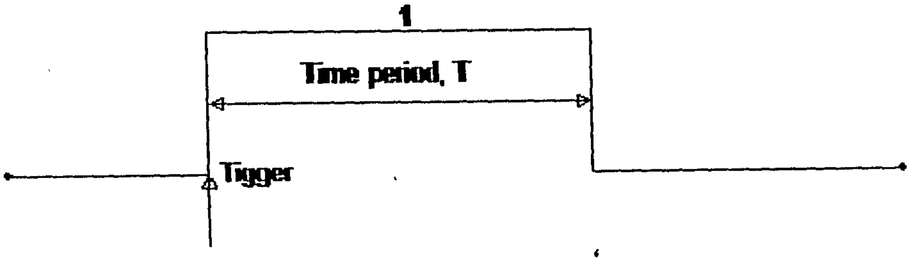

Figure 3.10555 Monostable Single Pulse Output

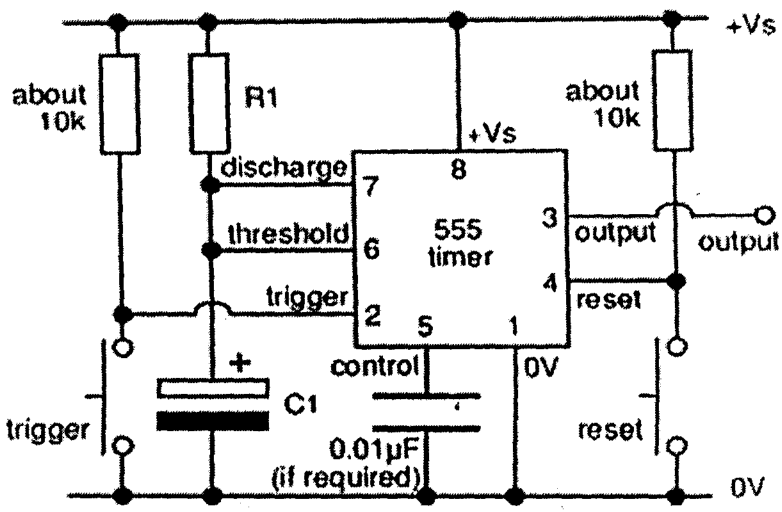

Figure 3.11555 Monostable Circuit with Manual Trigger

T = Time period in seconds (s)

R_1 = Resistance in ohms **(Ω)**

C_1 = Capacitance in farads (F)

The maximum reliable time period is about 10 minutes.

The Capacitor charges to $^2/_3$ = 67% so it is a bit longer than the time constant ($R_1 \times C_1$) which is the time taken to charge to 63%.

- C_1 was chosen first (reason; there are relatively few values available).

- R_1 was chosen to give the time period needed. R_1 should be in the range 1k**Ω** to 1M**Ω**, note fixed resistor of at least 1k**Ω** in series could be use, if R_1 is variable.
- Electrolytic capacitor values are not accurate; errors of at least 20% are common.
- Electrolytic capacitors leak charge which substantially increases the time period if a high value resistor is used.

For example the Timer Project should have a maximum time period of 266S (about 4½ minutes), but many electrolytic capacitors extend this to about 10 minutes!

MonostableOperation

The timing period is triggered (started) when the trigger input (555 pin 2) is less than $^1/_3$ Vs, this makes the output high (+Vs) and the capacitor C_1 starts to charge through resistor R_1. Once the time period has started, further trigger pulses are ignored.

The threshold input (555 pin 6) monitors the voltage across C_1 and when this reaches $^2/_3$ Vs the time period is over and the output becomes low. At the same time discharge (555 pin 7) is connected to 0V, discharging the capacitor ready for the next trigger.

The reset input (555 pin 4) overrides all other inputs and the timing may be cancelled at any time by connecting reset to 0V, this instantly makes the output low and discharges the capacitor. The reset pin is connected to +Vs if reset function is not required.

3.3.1 The Transmitter Circuit

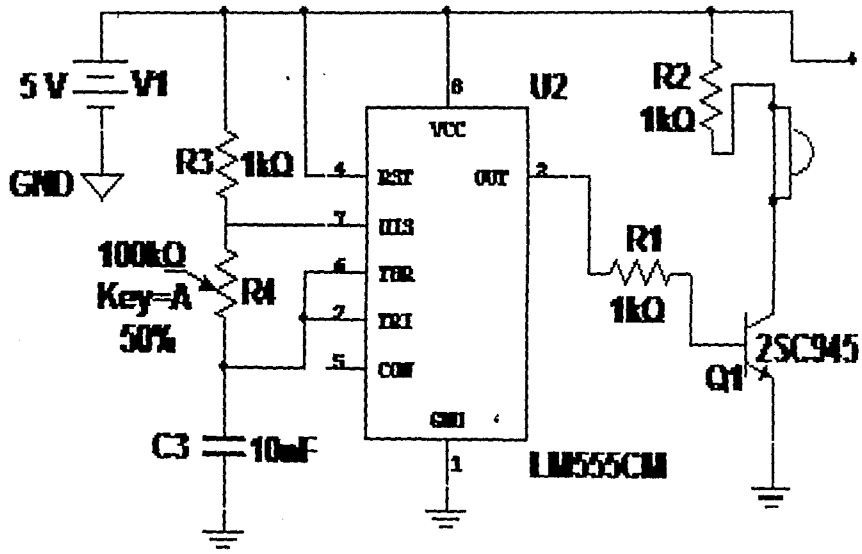

Figure 3.12 Transmitter Circuit

For this circuit, a duty cycle of 52%, a capacitor value $C_1 = 0.01\mu F$ and a resistor value

R_3 = 1K ohms were selected

From equation (3.14), Duty cycle = $\frac{Tm}{Tm+Ts} = \frac{R3+R4}{R3+2R4}$

$$0.52 = \frac{1K+R4}{1K+2R4}$$

$$520 + 1.04R_4 = 1K + R_4$$

$$480 = 0.04R_4,$$

$$R_4 = 12K\Omega$$

But 100K Ω variable was used instead.

$T = 0.7 \times (R_3 + 2R_4) \times C_1$(from equation 3.8)

$$T = 0.7 \times [1K\ 2(100K)] \times 0.01\mu F \ = 1.41mS$$

The frequency (f)

From equation (3.9) $\mathbf{f = \frac{1.4}{(R3+2R4) \times C1}}$

$$F = \frac{1.4}{[1+2(100)]K \times 0.01\mu} = 696.5Hz$$

R_2 is a current limiting resistor to the infrared sensor, whose supply voltage is 5volts.

$$I = \frac{Vs-Vd}{R2} \quad \text{..(3.18)}$$

Where V_s= Supply voltage

V_d= Voltage drop across the sensor

I = Current through the sensor

R_2 = Current limiting resistor

Let limit the current to 3mA;

And V_d= 2V

Then $R_2 = \frac{Vs-Vd}{I} = \frac{(5-2)V}{3mA} = 1K\mathbf{\Omega}$.

3.3.2 The Receiver Circuit

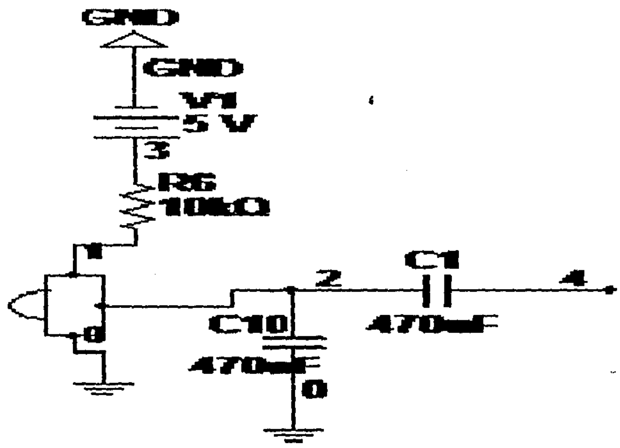

Figure3.13 Receiver Circuit

$R_6 = \frac{Vs-Vd}{I}$(From equation 3.18)

Let limit the current to 0.3mA,

$R_6 = \frac{5-2}{0.3m} = 10K\Omega$

3.3.3 The Control Circuit Unit

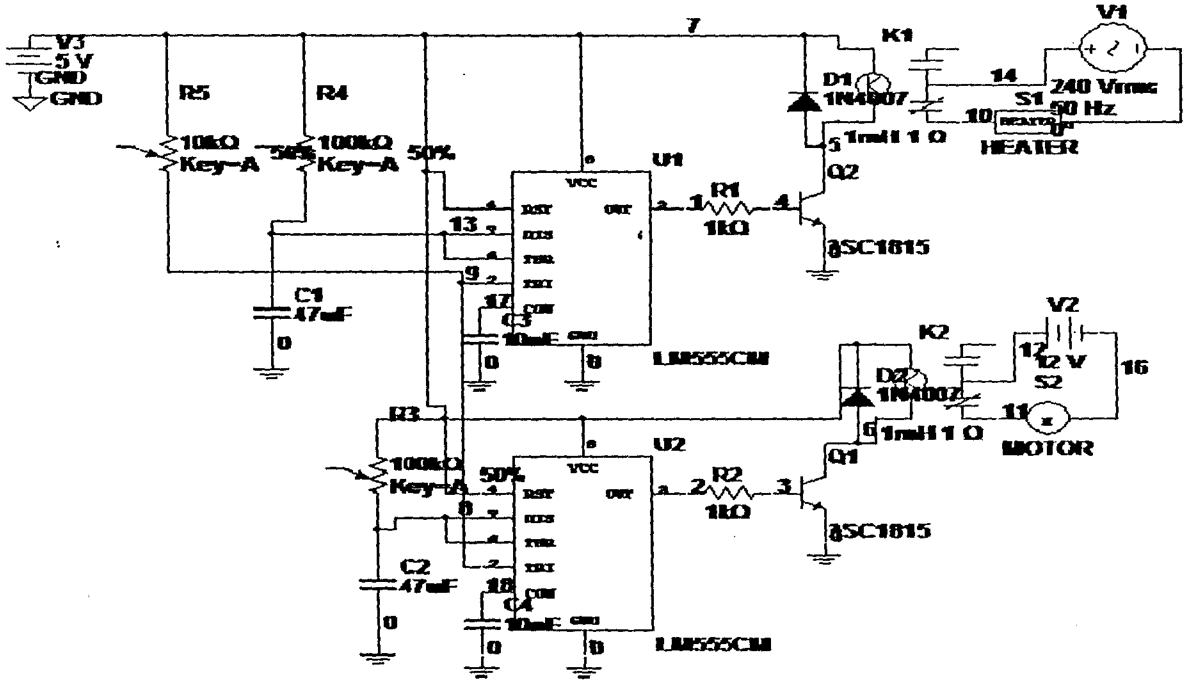

Figure 3.14 The Control Circuit Unit

Time period, $T = 1.1\ R_1 X\ C$ (From equation 3.17)

Where $C = C_1 = C_2$ and $R = R_3 = R_4$

Let $C = 47\mu F$, $T = 5sec$

Therefore, $T = 1.1\ X\ 47\mu\ X\ R$;

$$R = \frac{5}{1.1\ X\ 47\mu} \approx 100K\Omega$$

3.3.4Transistor Biasing

Transistors amplify current, for example they can be used to amplify the small output current from a logic IC so that it can operate a lamp, relay or other high current device. In many circuits a resistor is used to convert the changing current to a changing voltage, so the transistor is being used to amplify voltage.

A transistor may be used as a switch (either fully ON with maximum current, or fully OFF with no current) and as an amplifier (always partly on).

The relay coil has a resistance that serve as collector resistance of Q_1 and Q_2. The coil resistance of the 12V relay is 400Ω [29].

$I_{Csat} = \frac{Vcc}{Rc} = \frac{12}{400} = 30mA$

$\beta = 200$ type

Therefore, $I_{Bsat} = \frac{Icsat}{\beta} = \frac{30A}{200} = 150\mu A$

Required value of R_B;$R_B = \frac{Vcc-VBE}{IB} = \frac{12-0.6}{150\mu A} = 76K\Omega$ but 1K Ω was used.

D_6, D_7 are freewheelingdiode that prevents damage to Q_1 and Q_2 due to back emf from relay coils.

Heater

Power rating = 1000W, Voltage rating = 220/240VAC

Power = current (I) X Voltage (V)

Current (I) = $\frac{Power\ (P)}{Voltage\ (V)} = \frac{1000W}{220} = 4.54A$

Motor (Fan)

Current rating = 0.14A,

Voltage rating = 12VDC

Power = Current (I) X Voltage (V) = 12V X 0.14A = 1.68W

CHAPTER FOUR

TESTS, RESULTS AND DISCUSSION

Hardware and software portion of the project were separated to Units while developing the overall System. The Units includes: power Unit, control unit, Fan and heater Unit, and trans/receiver Unit. Building and testing smaller sections of the system made the project more manageable and increased efficiency by decreasing debugging time. The testing of the project started with the testing of the power supply Unit to ensure it could supply the required power to the circuit. The motor controller was tested next to ensure that it would rotate in the clockwise, anticlockwise as well as stop positions.

Table4.0 555 Astable Frequencies

555 ASTABLE FREQUENCIES			
C_1	R_2 = 10k ohms R_1 = 1k ohms	R_2 = 100k ohms R_1 = 10k ohms	R_2 = 1M ohms R_1 = 100k ohms
0.001µF	68kHz	6.8kHz	680Hz
0.01µF	6.8kHz	680Hz	68Hz
0.1µF	680Hz	68Hz	6.8Hz
1µF	68Hz	6.8Hz	0.68Hz
10µF	6.8Hz	0.68Hz (41 per min.)	0.068Hz (4 per min.)

The Circuit Diagram (some modules) was tested on the computer using software called multism. The result obtained for 555 Astable timer are shown on table4.0 above. Furthermore, breadboard was also used to ascertain the workability in accordance with the design.

Finally, the work was transferred to the permanent board called Veroboard for the final construction.

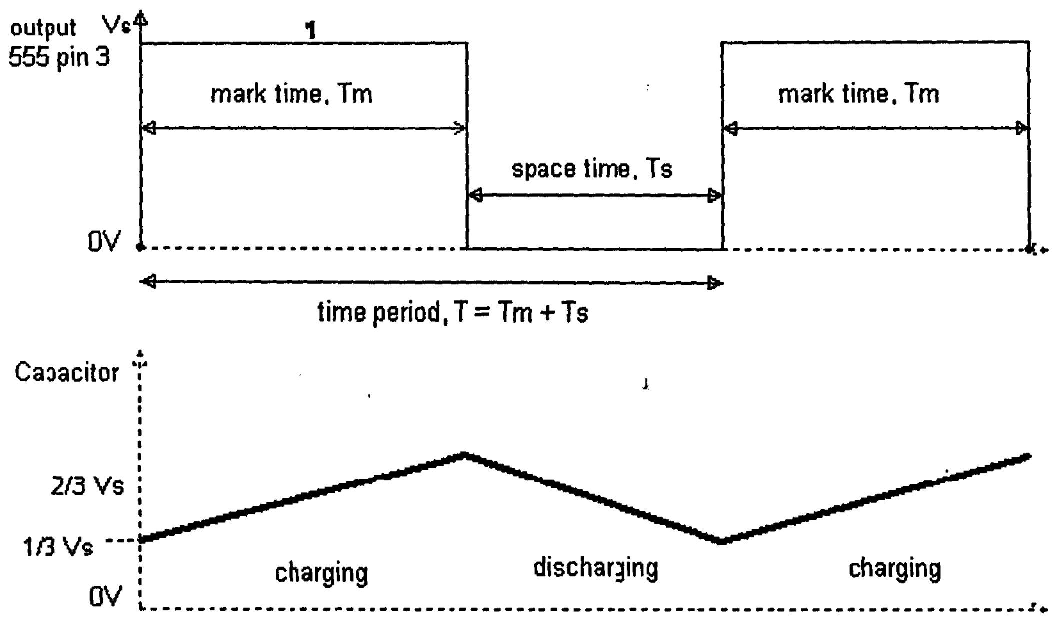

Figure 4.0 Charging and Discharging of Astable 555 Timer

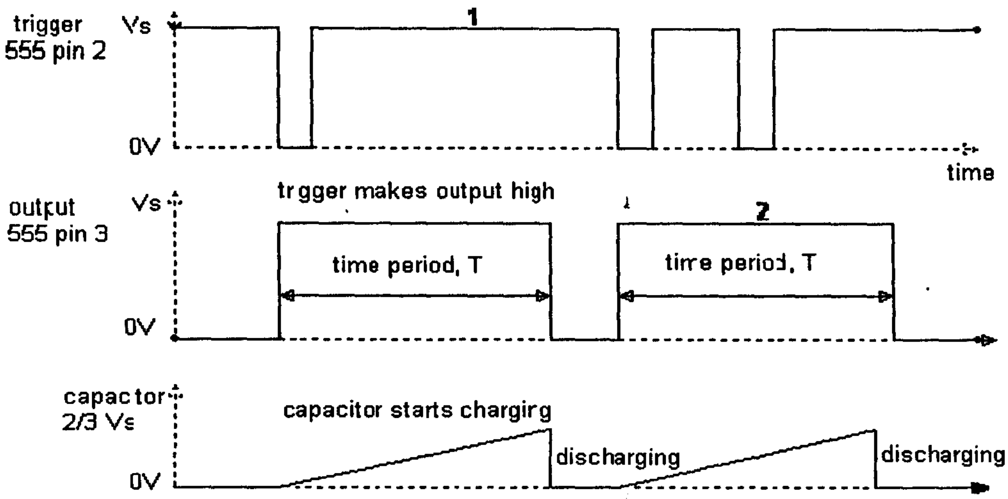

Figure 4.10 Charging and Discharging of 555 MonostableTimer

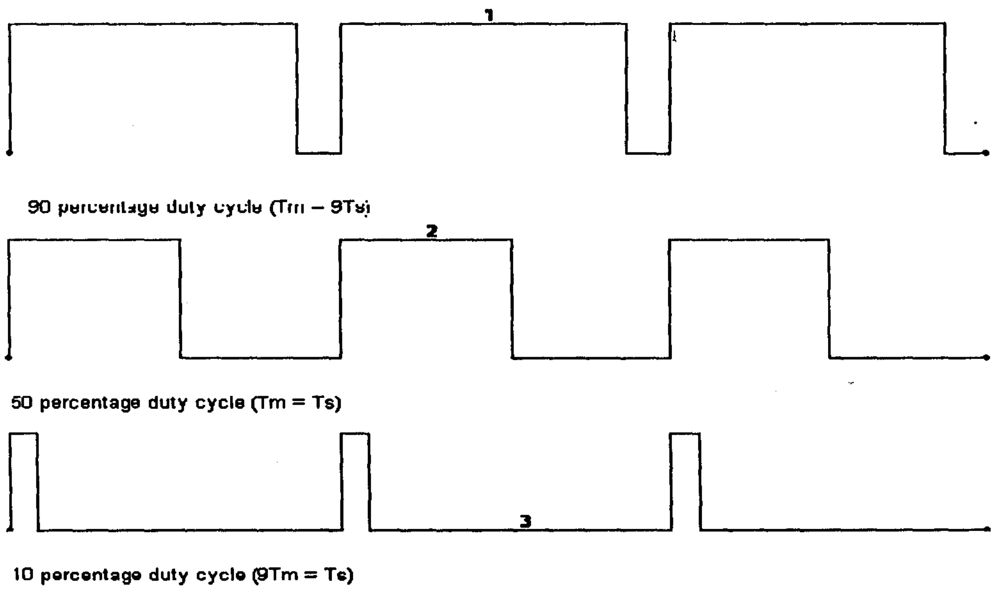

Figure 4.20 Different Duty Cycle and their Square Waves.

Result from Transformer Using Multimeter

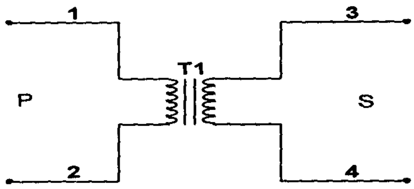

Figure 4.30 Transformer symbol

Table 4.10 Transformer results

P1	T1	P2	Output	Remark	S3	T1	S4	Output	Remark
1	-	1	1	Good	1	-	1	1	Good
1	1	-	1	Bad	1	1	-	0	Bad

Figure 4.40 Construction on Veroboard

Figure 4.50 Top View of the Project

Figure 4.60 Side View of the Project

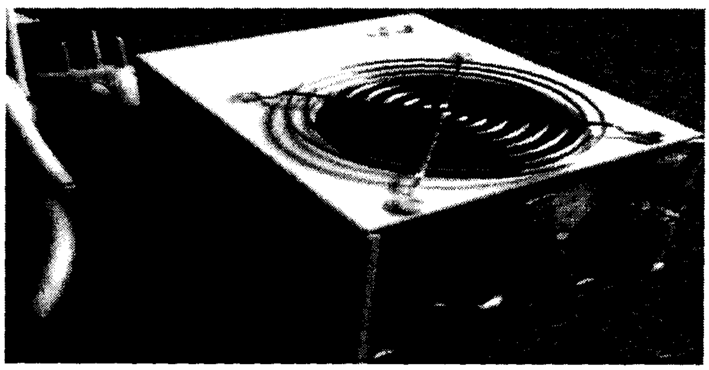

Figure 4.70 Completed Cased Project

4.10 Final Test of the Circuit

After the whole system unit (electrical and mechanical) had been coupled, the Automatic Electronics hand-dryer was tested as a functional unit and was found to be working.

4.20 Limitations

The difficulty in getting the exact components, leads to the use of its equivalent, which alter the actual result. That is, getting the correct heating element was a challenge.

The design does not incorporate antimicrobial treatment for hygiene and non-flammable material to prevent accidents.

It does not have inbuilt Self-disinfectant to generate ozone to clean and deodorize the environment where it is installed.

Even failure of power supply is a limitation to the device.

4.30 Maintenance

Maintenance can be defined simply as "continuing repair work": work that is done regularly to keep a machine, building or piece of equipment in good condition and working order.

An Automatic Electronics hand-dryer that incorporates an electric timing system for varying the required time of operation; faults of various kinds can occur within the System. There is the need to always keep the appliances on check.

The surfaces should be clean with clean cloth. Abrasives should not be used on it.
If damage occurs, the damage units should be removed and replaced.

4.40 Problem Encountered

- When the Project was first tested, the response from the system was not satisfactory; the sensor was not responding and there was no power at the Heater and Fan circuit which was rectified immediately.
- Construction of the Casing was very challenging.
- The initial stage of soldering on the Vero board was characterized by some minor mistakes, such as over flow of melting lead, which during the course of the work was overcome.

CHAPTER FIVE

CONCLUSION

From the testing and result obtained, it can be seen that the project presents a means of hand drying through the use of electrical device.

The Automatic Electronics hand-dryer system was able to trigger ON any time the sensor senses a beam across it.

All that is required is for the user to place his or her hand across the sensor and the system starts automatically and stops immediately the hand is removed.

This Project it is environmental friendly and of great economic importance because it does not contribute to the accumulation of waste products such as tissue papers, handkerchief, paper towel etc. It also promotes green revolution because the rates at which trees are cut for the manufacture of these papers are reduced as well as remove environmental degradation.

5.10 Recommendation

This Project has its limitations; the following presents possible improvement to increase its functionality, performance and dynamism. The

- Inclusion of alternative Power supply, such as solar energy etc.
- Inclusion of antimicrobial treatment for hygiene.
- Use of Microcontroller to reduce the complexity of the circuit.

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APPENDIX

LIST OF COMPONENTS AND PRICES

S/N	COMPONENTS DESCRIPTION	QUANTITY	RATE #	AMOUT #
1	TRANSFORMER 240/12V	1	200	200
2	MOTOR (FAN) 1.68W	1	1200	1200
3	DIODES	2	5	10
4	RESISTOR	7	10	70
5	VARIABLE RESISTORS	3	10	30
6	CAPACITOR	10	10	100
7	LIGHT EMITTING DIODE (LED)	2	10	20
8	IC 555 TIMER	3	50	150
9	TRASISTORS 2SC945	3	50	150
10	HEATER 240V 1000W	1	1500	1500
11	12VDC RELAYS	2	100	200
12	CONNECTING WIRE (YARD)	1	40	50
13	OUTPUT POWER SUPPLY JACK	1	150	150
14	POWER PLUG	1	100	100
15	PVC CASE	1	800	800
16	VERO BOARD	1	50	50
17	REGULATOR (7805)	1	50	50
18	SENSOR	2	150	300
19	240VAC RELAY	1	250	250
20	BRIDG RECTIFIER	1	100	100
21	MISCELLANEOUS	1	1000	1000
22	TOTAL			6480

APPENDIX: USER'S MANUAL

Automatic Electronics Hand Dryer

Plug in the Power Cable into ac main. Then turn ON the toggle switch to power the device. The power indicator (Red LED) glows, meaning that the device is now powered.

After the system has been powered on, wait for the initialization process to take place;

- Rotation of the motor for some seconds.

Place your hand close to the sensor.

The indicator (Green LED) glows, meaning that the heater and the motor are ON, thereby generating hot air which dries the hand within a limited time.