DESIGN AND CONSTRUCTION OF AN AUTOMATIC RAIN GAUGE

BY

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A FINAL YEAR PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE AWARD OF THE BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN ELECTRICAL AND COMPUTER ENGINEERING

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DEDICATION

This project as a humble contribution to the field of electrical Engineering, is dedicated to Almighty God for his grace and mercies upon my life.

I also dedicate this project to my late Mother, Maryamu Dauda Komo, for her undiluted love and care up to this stage of my life, before she was called to glory. May Her soul rest I peace with the Lord (AMEN).

DECLARATION

I, Komo, Haruna Dauda (2006/24408EE) hereby declare that this project was undertaken and written by me. It has not been presented before for any degree, diploma or certificate at any university or institution. The information derived from personal communications, published, and unpublished works were duly referenced in the text.

21/11/2011

Komo, Haruna Dauda

Student

Date

CERTIFICATION

This project entitled "The design and construction of an automatic rain gauge" by Komo, Haruna Dauda (2006/24408EE) under the supervision of Dr. E. N. ONWUKA, meets the regulations governing the award of the degree of Bachelor of Engineering (B. Eng.) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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Dr. E. N. ONWUKA Supervisor	Date
....	March 15, 2012
Engr. A. G. Raji (Head of Department)	Date
....	6/3/2012
External Examiner	Date

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I am most grateful to God almighty, who has made it a reality for me to complete my degree program.

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ABSTRACT

This is an improved automatic rain gauge from the former conventional one. The rain gauge is enhanced with a capacity to sense the certainty of rain fall using a rain sensing circuit, automatic opening and closure of the lid as the sensor detects certainty of rain fall using relays to configure for the bidirectional movement of the motor to activate the opening and the closure of the lid, taking the reading of the rain fall drop wise using seven segment display and its driver to achieve this. The automatic rain rauge, deactivate and closes the lid after the rain fall using information it gets from sensor (rain detecting sensor.). The automatic rain gauge has alternative power souce and an automatic change-over circuit to aid and supliment power outage.

TABLE OF CONTENT

CHAPTER THREE

CHAPTER FOUR

CHAPTER ONE

1.0 GENERAL INTRODUCTION

Technology has had immense impact on all aspect of our lives. Almost everything has been made easier, more convenient and much faster and efficient. The need for automated system has long been a civilized idea. This requires minimal efforts to accomplish a herculean task. From generation to generation devices are produced, developed until there is a dynamic revolution that causes it to be of immense significance to men. The main objectives being to control with the least human interface [4].

This really is true of nearly everything. Even the way the weather is measured and recorded has advanced dramatically over the years. Reading the rain fall measurement has never before been as easy as it is now, with the use of automatic rain gauge. You can find out how much rain has fallen from the comfort of your home throughout a storm, never having to go out in the rain.

Accurate knowledge of climatic and environmental changes is obligatory in our present day life and as a mechanism to having and setting a disaster-free environment/settlement. To this effect, some elements of climatic and environmental changes need to be studied and put under consideration such as precipitation (rain, dew, ice and hail.), drought, erosion, evaporation, wind, volcanic eruption etc [2].

Rain fall as the major and the most important element, needs to be studied, and quantity of rain fall of an area at a particular time recorded. This however calls for close study into the need to device a means of obtaining: stress-free, high efficiency, automatic and almost 100% accuracy in measuring the amount of rain fall of an area at a particular time.

1.1 AIMS AND OBJECTIVES

The aims and objectives of this project, is to design and construct an automatic rain gauge with the following functionalities:

i. Rain detection capability
ii. Very low power consumption
iii. High efficiency
iv. Display of measured result
v. Automatic deactivating capability after the rain fall.

1.2 METHODOLOGY.

In this project, the following methods were employed to archive the targets.

1.2.1 **RAIN DETECTION:** this was achieved using a circuit that switches "ON and "OFF" based on the amount of moisture content in the atmosphere (relative humidity) as its switch, which switches ON at high moisture content and switches OFF when the moisture content drops.

1.2.2 **WATER LEVEL CIRCUIT:** Water level detection circuit was used/employed, by incorporating the circuit in the container, to avoid overflow of the water, should the water full (out-sized) the container. Hence it triggers the circuit "ON" at certain level of the container to empty the water in the container.

1.2.3 **COUNTER:** This is employed to take note of every drop of water the container discharges. It was achieved by setting two conductors close to themselves which bridges (closes the circuit), when the water droplet drops on the conductors placed closed to each other.

1.3 SCOPE OF WORK.

The scope of this project ranges from the sensing capability of the rain gauge by the use of a rain sensor which is a metal probe that detects rain, based on relative humidity or rain drop on the probe, in cases of rain that comes unnoticed, its output is connected to a control oscillator which drives the motor that opens the lit of the container (gauge).

An up/down counter that counts the drop of water based on the drop of water falling on the probe, which in turn closes the circuit and counting the quantity of rain fall at a particular time. Then comes the display of the gotten result using a seven segment display.

1.4 SOURCE OF MATERIAL

Materials used for the project were sourced from the Local Electronics market in Minna. Construction of the project casing was also done locally. The knowledge of experienced

Electricians also aided in the completion of the design. Journals, textbooks and also the World Wide Web (internet) were helpful in sourcing information.

CHAPTER TWO

2.0 LITERATURE REVIEW

Until recently many researchers have shown interest in the field of coastal erosion and some of the environmental hazards and the resulting beach profiles [5]. They have carried out numerous laboratory experiments and field observations to illuminate the darkness of this field, their findings and inventions suggestion are reviewed here

2.1 HISTORICAL BACKGROUND.

The first known records of rain fall were kept by the ancient Greeks about 500BC. This was followed 100 years later by people in India using bowls to record the rain fall. The readings from these were correlated against expected growth and used as a basis for land taxes. In the Arthashastra used for example in Magadha, precise standards were set as to grain production. Each of the state store houses were equipped with a standardized rain gauge to classify land for taxation purposes [1, 5]. The first standardized rain gauge was invented in korea in 1441 during the reign of King Sejong the Great. There are some debate whether his son or one of his Scientists did the inventing.

Same size containers and rulers were kept throughout the entire country to help track rain fall, low crops, high taxes. The first Automatic rain gauge was invented in England in 1662 by Christopher wren. He calls it **"tipping bucket"** because it collects some amount of rain fall and tips it, emptying the content.

After their inventions [4, 5], so many people have done series of modification on their work taking us to about three reliable inventions.

2.1.1 PRINCIPLES OF OPERATION

Most rain gauges generally measure the precipitation in millimeters. The level of rainfall is sometimes reported as inches or centimeters.

Rain gauge amounts are read either manually or by AWS (Automatic Weather Station). The frequency of readings will depend on the requirements of the collection agency. Some countries will supplement the paid weather observer with a network of volunteers to obtain precipitation data and other types of weather conditions such as wind, hurricane etc. for sparsely populated areas [1].

In most cases the precipitation result is not retained, however some stations do submit rainfall result and snowfall for testing, which is done to obtain levels of pollutants.

This project has different principles of operation from the ones designed so far (Tipping bucket, for example, being the only automatic rain gauge designed). It has lit, to prevent sand particles and effects of the weather which as a result, causes error in the correct reading.

Unlike Tipping bucket, that employs the principle of "see saw" this project count uniform and standard water droplets from the outlet, which is based on carried experiment, to obtain a standardized droplets from the water outlets.

2.1.2 LIMITATIONS OF THE RAIN GAUGE.

a. Rain gauges have their limitations. Attempting to collect rain data in a hurricane can be nearly impossible and unreliable (even if the equipment survives) due to wind extremes.
b. Also, rain gauges only indicate rainfall in a localized area. For virtually any gauge, drops will stick to the sides or funnel of the collecting device, such that amounts are very slightly underestimated, and those of .01 inches or 0.25 mm may be recorded as a trace.
c. Another problem encountered is when the temperature is close to or below freezing. Rain may fall on the funnel and freeze or snow may collect in the gauge and not permit any subsequent rain to pass through.

Rain gauges should be placed in an open area where there are no obstructions, such as building or trees, to block the rain. This is also to prevent the water collected on the roofs of buildings or the leaves of trees from dripping into the rain gauge after a rain, resulting in inaccurate readings

2.2 TYPES OF RAIN GAUGE.

Types of rain gauges include :

i. Graduated Cylinders, (Standard Rain Gauge)
ii. Weighing Gauges,

iii. Tipping Bucket Gauges, and

iv. Simple Buried Pit Collectors

Each type has its advantages and disadvantages for collecting rain data.

2.2.1 Standard Rain Gauge

The standard rain gauge, developed around the start of the 20th century, consists of a funnel attached to a graduated cylinder (2 cm in diameter) that fits inside a larger outside container (20 cm in diameter and 50 cm tall). If the water overflows the inside graduated cylinder, the outside larger container will catch it. When measurements are taken, the height of the water in the small graduated cylinder is measured and the excess overflow in the large container is carefully poured into another graduated cylinder and measured to give the total rainfall. In most cases the cylinder is marked in "mm" and will measure up to 25 mm (0.98 in) of rainfall. Each horizontal line on the cylinder is 0.2 mm (0.007 in). The larger container collects any rainfall amounts over 25 mm that flows from a small hole near the top of the cylinder. A metal pipe is attached to the container and can be adjusted to ensure the rain gauge is level. This pipe then fits over a metal rod that has been placed in the ground [5].

2.2.2 WEIGHING PRECIPITATION GAUGE

A weighing-type precipitation gauge consists of a storage bin, which is weighed to record the mass. Certain models measure the mass using a pen on a rotating drum, or by using a vibrating wire attached to a data logger.

The weighing-type recording gauge may also contain a device to measure the quantity of chemicals contained in the location's atmosphere. This is extremely helpful for scientists studying the effects of greenhouse gases released into the atmosphere and their effects on the levels of the acid rain. Some Automated Surface Observing System (ASOS) units use an automated weighing gauge called the AWPAG (All Weather Precipitation Accumulation Gauge) [5].

a. Advantages of Weighing Precipitation Gauge

i. The advantages of this type of gauge over tipping buckets are that it does not underestimate intense rain,

ii. And it can measure other forms of precipitation, including rain, hail and snow.

b. Disadvantage of Weighing Precipitation Gauge

i. These gauges are, however, more expensive and

ii. Requires more maintenance than tipping bucket gauges.

2.2.3 Tipping Bucket Rain Gauge

(The interior of a tipping bucket rain gauge) The tipping bucket rain gauge consists of a funnel that collects and channels the precipitation into a small seesaw-like container. After an amount of precipitation equal to 0.2 mm (0.007 inch) falls, the lever tips, dumping the collected water and sending an electrical signal. The recorder consists of a pen mounted on an arm attached to a geared wheel that moves once with each signal sent from the collector. When the wheel turns the pen arm moves either up or down leaving a trace on the graph and at the same time making a loud click. Each jump of the arm is sometimes referred to as a 'click' in reference to the noise. The chart is measured in 10 minute periods (vertical lines) and 0.4 mm (0.015 in) (horizontal lines) and rotates once every 24 hours and is powered by a clockwork motor that must be manually wound [5].

a. Advantage of Tipping Bucket Rain Gauge

i. In the tipping bucket, the character of the rain (light, medium or heavy) may be easily obtained. Rainfall character is decided by the total amount of rain that has fallen in a set period (usually 1 hour) and by counting the number of 'clicks' in a 10 minute period the observer can decide the character of the rain. Correction algorithms can be applied to the data as an accepted method of correcting the data for high level rainfall intensity amounts.

ii. Modern tipping rain gauges consist of a plastic collector balanced over a pivot. When it tips, it actuates a switch (such as a reed switch) which is then electronically recorded or transmitted to a remote collection station.

Tipping gauges can also incorporate weighing gauges. In these gauges, a strain gauge is fixed to the collection bucket so that the exact rainfall can be read at any moment. Each time the collector tips, the strain gauge (weight sensor) is re-zeroed to null out any drift.

a. **Disadvantage of Tipping Bucket Rain Gauge**

The tipping bucket rain gauge is not as accurate as the standard rain gauge because the rainfall may stop before the lever has tipped.

i. When the next period of rain begins it may take no more than one or two drops to tip the lever. This would then indicate that 0.2 mm (0.007 in) has fallen when in fact only a minute amount has.
ii. Tipping buckets also tend to underestimate the amount of rainfall, particularly in snowfall and heavy rainfall events.

To measure the *water equivalent* of frozen precipitation, a tipping bucket may be heated to melt any ice and snow that is caught in its funnel. Without a heating mechanism, the funnel often becomes clogged during a frozen precipitation event, and thus no precipitation can be measured· Many Automated Surface Observing System (ASOS) units use heated tipping buckets to measure precipitation.

2.2.4 Optical Rain Gauge

These have a row of collection funnels. In an enclosed space below each is a laser diode and a photo transistor detector. When enough water is collected to make a single drop, it drips from the bottom, falling into the laser beam path. The sensor is set at right angles to the laser so that enough light is scattered to be detected as a sudden flash of light. The flashes from these photo detectors are then read and transmitted or recorded.

2.3 COMPERISON BETWEEN THE RAIN GAUGES

Of all the rain gauges mentioned above, it is only "Tipping Bucket that is automatic." The advantage of this project over the tipping bucket, is the counting of water drops instead of tipping it and the lit control ability of this project, gives it edge over tipping bucket, and tipping bucket is low in terms of its height, which gives room for error due to rain splash, unlike this project that is higher.

CHAPTER THREE

3.0 ELECTRONIC CIRCUIT DESIGN

Electrical and computer Engineering, deals with block diagram for better illustration and analysis of system(s)[12]. That is why this work is presented in block diagram as shown in the fig. 3.0

This project is made up of four distinguishable units viz: power supply unit (PSU), Sensing unit, Lit control unit and counting/display unit, as shown in the figure below.

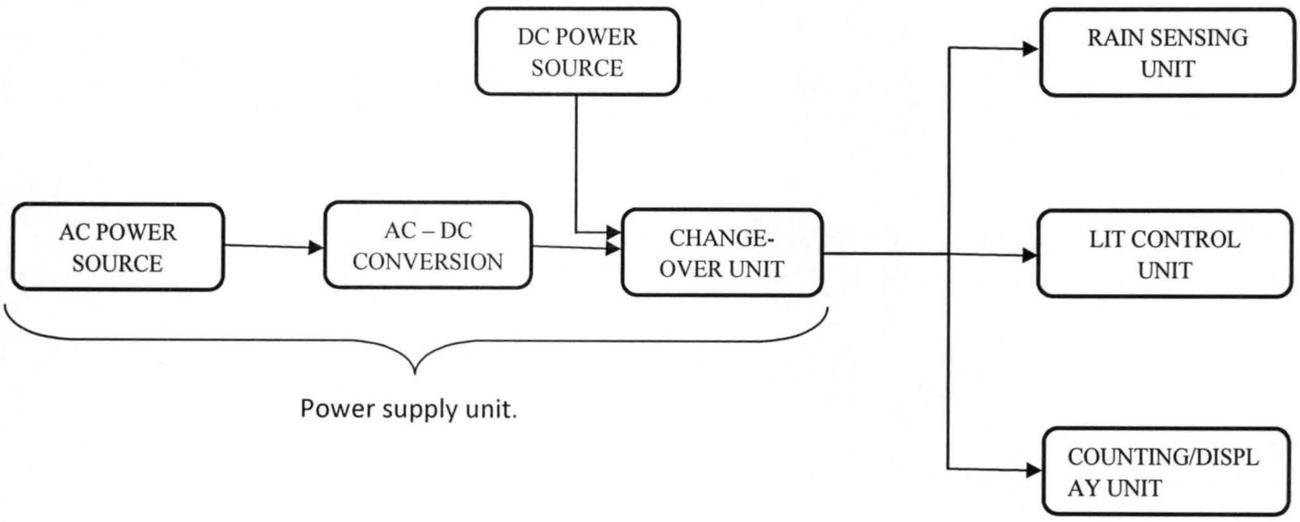


Fig. 3.0 Block diagram of an automatic rain gauge

3.1 ELECTRONICS COMPONENTS USED

a. Step down transformer

b. IC (4026)

c. Seven segment LED display

d. Motor

e. Variable resistor

f. Capacitor

g. Relay

h. Transistor.

3.2 POWER SUPPLY UNIT.

Power supply unit can be divided into four stages, namely: transformation stage, rectification stage, filtering stage and regulation stage. The circuit diagram of a typical power supply unit is shown below

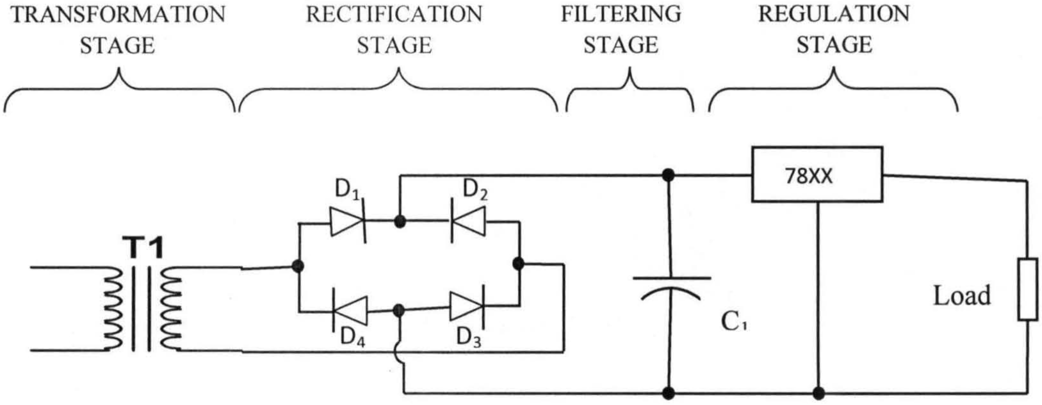


Fig. 3.1 Circuit diagram of power supply unit.

3.2.0 TRANSFORMATION STAGE

An ideal transformer is a lossless device with a primary winding and a secondary winding. The relationships between the input voltage and the output voltage and between the input current and the output current are given by two simple equations[11]. Fig. 3.2 shows an ideal transformer which has N_p turns of wire on its primary side and N_s turns on its secondary side, the relationship between the voltage $V_p(t)$ applied to the primary side of the transformer and the $V_s(t)$ produced on the secondary side is:

$$\frac{Vp(t)}{Vs(t)} = \frac{Np}{Ns} = \alpha$$

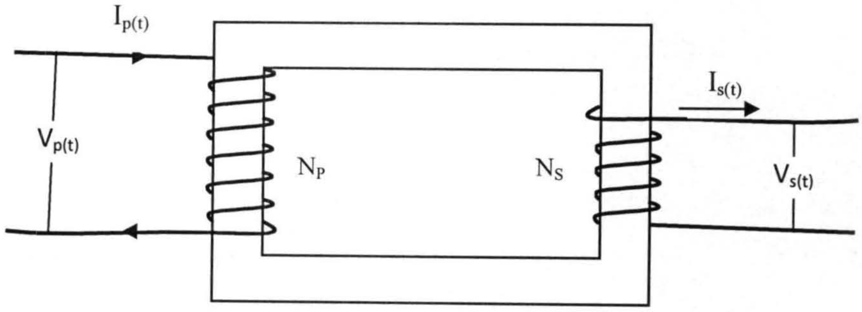


Fig. 3.2 Sketch of an ideal transformer

The relationship between the current $i_p(t)$ flowing into the primary side of the transformer and the current $i_s(t)$ flowing out of the secondary side of the transformer is

$$Np(t)\ ip(t) = Ns(t) is(t)$$

In terms of the phasor quantities, these equations are:

$$\frac{Vp(t)}{Vs(t)} = \alpha$$

And

$$\frac{Ip}{Is} = \frac{1}{\alpha}$$

$$\frac{Is}{Ip} = \alpha$$

Combining the 2 equations above, we have:

$$\frac{Vp(t)}{Vs(t)} = \alpha \text{ and}$$

$$\frac{Is}{Ip} = \alpha$$

$$\frac{Vp(t)}{Vs(t)} = \frac{Is}{Ip} \Rightarrow Vp(t)Ip = Vs(t)Is$$

Where

$V_P I_P$ is the input power (P_{in}) of the transformer and

$V_s I_s$ is the output power (P_{out}).

Since the functional unit of this project needs at least +12volts, a centre-tap transformer is used as follows:

$$V_p = 240volts$$

$$V_s = 12volts \text{ (centre-tap)}$$

$$I_s = 500mA = 0.5A$$

The turns ratio of this transformer is from:

$$\frac{Vp}{Vs} = \alpha$$

$$\alpha = \frac{Vp}{Vs} = \frac{240v}{24v} = 10 \Rightarrow$$

$$\boldsymbol{\alpha} = 10$$

It further gives;

$$\frac{Is}{Ip} = \alpha \Rightarrow$$

$$Ip = \frac{Is}{\alpha} = \frac{500mA}{10} = 50mA$$

$$I_p = 50\ m\ A = 0.050A$$

Input power

$P_{in} = V_pI_p \Rightarrow P_{in} = 240v \text{ X } 50mA = 12Watts$

3.2.1 RECTIFCATION STAGE

This is where power conversion takes place, from A.C power supply to D.C power supply, and this is done with the help of a bridge rectifier, using four diods. The bridge circuit illustrated in fig 3.3 below provides a full-wave D.C. output which requires four diodes[10].

Current directions in the full-wave bridge rectifier circuit are as follows for each half-cycle of the AC waveform:

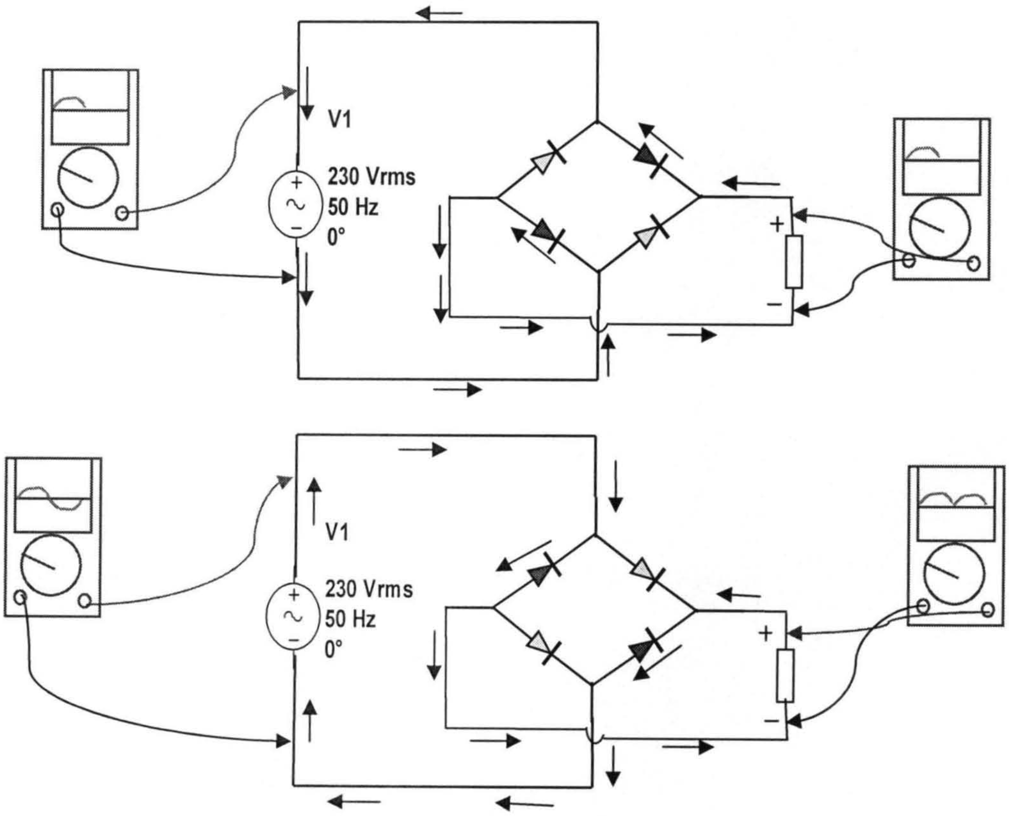


Fig. 3.3 Operation of a full-wave bridge rectifier, showing the direction of the current flow.

Because alternating current (A.C) supply voltages are typically specified, their root-mean-square (r.m.s) values to average values when working with rectifier circuit. Fig. 3.4 shows some measurements and conversion factors

$$V_{av}=\frac{2}{\pi}\, xV_p=0.637xV_p \ldots\ldots\ldots\ldots\ldots\ldots .3.8$$

$$V_{rms}=\frac{1}{\sqrt{2}}xV_p=0.707xV_p \ldots\ldots\ldots\ldots\ldots\ldots .3.9$$

Equation 3.9 gives

$$V_p = \frac{Vrms}{0.707}$$

Rearranging the right-hand side into the equation 3.8 gives

$$V_{av} = 0.637x\frac{Vrms}{0.707} = 0.9V_{rms} \ldots\ldots\ldots\ldots\ldots\ldots .3.10$$

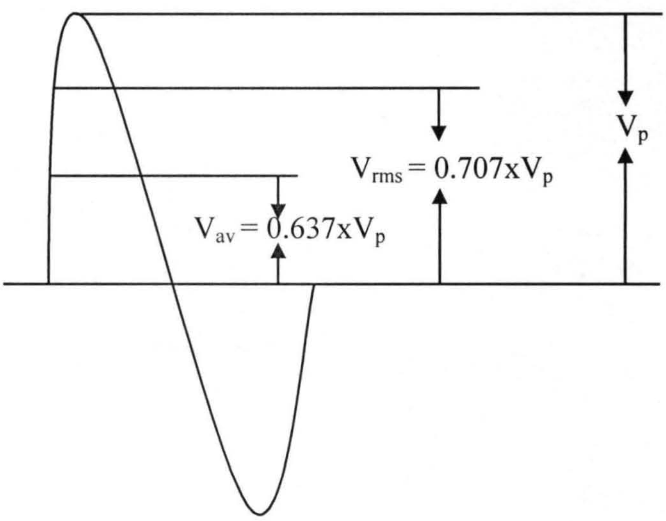


Fig. 3.4 Measurements and conversion factors

The output d.c voltage of the bridge rectifier circuit will be calculated as the average voltage V_{av} so from equation 3.10 above have.

$$V_{av} = 0.9xV_{rsm} \text{ where}$$

$$V_{rms} = V_s = 24\textit{volts.}$$

$$V_{av} = 0.9x24\textit{volts} = 21.6\textit{volts} \text{ which is the load voltage.}$$

3.2.2 FILTERING STAGE.

The most common technique used for filtering is a capacitor connected across the output. Fig. 3.5 shows a simple capacitor filter that has been added to a full-wave rectifier circuit. The voltage wave-form across the load resistor shows that the ripple has been greatly reduced by the addition of the capacitor, the effectiveness of a capacitor filter is determined by three factors[12]:

1. The size of the capacitor
2. The value of the load
3. The time between the pulsations.

These three factors are related by the formula

T = RxC

Where T = time in seconds(s)

R = resistance in Ohms (Ω)

C = capacitance in farad (F)

The choice of filter capacitor can be based on the following equation

$$C = \frac{i}{Vp-p} xT \quad \text{3.12}$$

Where

C = capacitance in farad (F)

i = the load current in amperes (A)

V_{p-p} = the peak-to-peak ripple in volts (V)

T = the period in second(s)

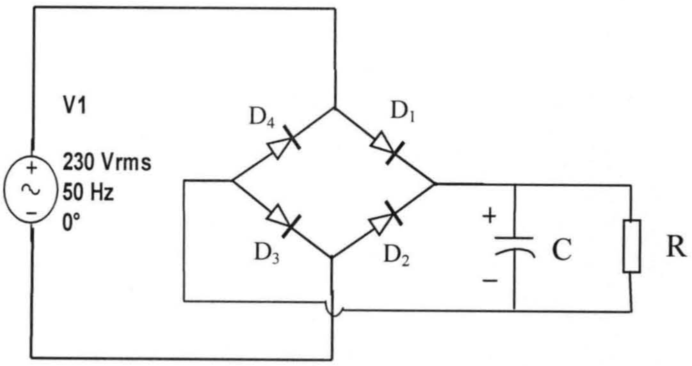


Fig. 3.5 a filtered bridge rectifier circuit

To get good filtering, large capacitor is used because it will take longer for the capacitor to discharge. If C is chosen to be 2200μF, for instance, the value of the ripple is thus calculated from the equation 3.12

$$C = \frac{i}{Vp-p} xT \Rightarrow V_{p\text{-}p} = \frac{i}{C} xT$$

Where i is the load current and this was found to be $i_{dc}=1A$

$$V_{p\text{-}p} = \frac{i}{C} xT \Rightarrow V_{p\text{-}p} = \frac{idc}{C} xT$$

$T = \frac{1}{f} = \frac{1}{2x50Hz}$, for full-wave rectification the ripple frequency is twice the input frequency.

$$T = \frac{1}{100Hz} = 0.01 seconds.\text{ hence}$$

$$V_{p\text{-}p} = \frac{i}{C} xT \Rightarrow V_{p\text{-}p} = \frac{1A}{2200\mu F} x0.01s = 4.545 volts.$$

Electrolytic capacitors are rated to work in d.c working voltage (dcWV or WVdc)

This voltage must not be exceeded.

3.2.3 REGULATION STAGE.

The regulation of a power supply is its ability to holds the power steady under conditions of changing load. Regulators can be elaborated circuits using integrated circuits some IC regulators such as the one used in this project, operate at affixed output voltage[10]. This is one of the reason for choosing it for this project.

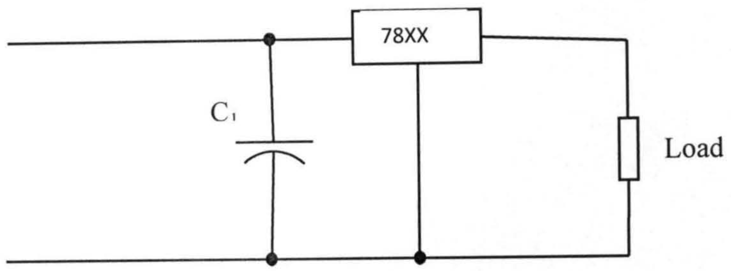


Fig. 3.6 circuit diagram showing voltage regulator.

3.3 RAINSENSING UNIT

The sensing unit, has to do with the ability of the project to sense the certainty of rain fall. The sensing unit involves two closely placed metallic conductors. Due to the ionic conductivity of water, electric current flows from one metallic probe to the other when bridged by water. The conduction is poor as compared to a metallic material that deals with electrons[11].

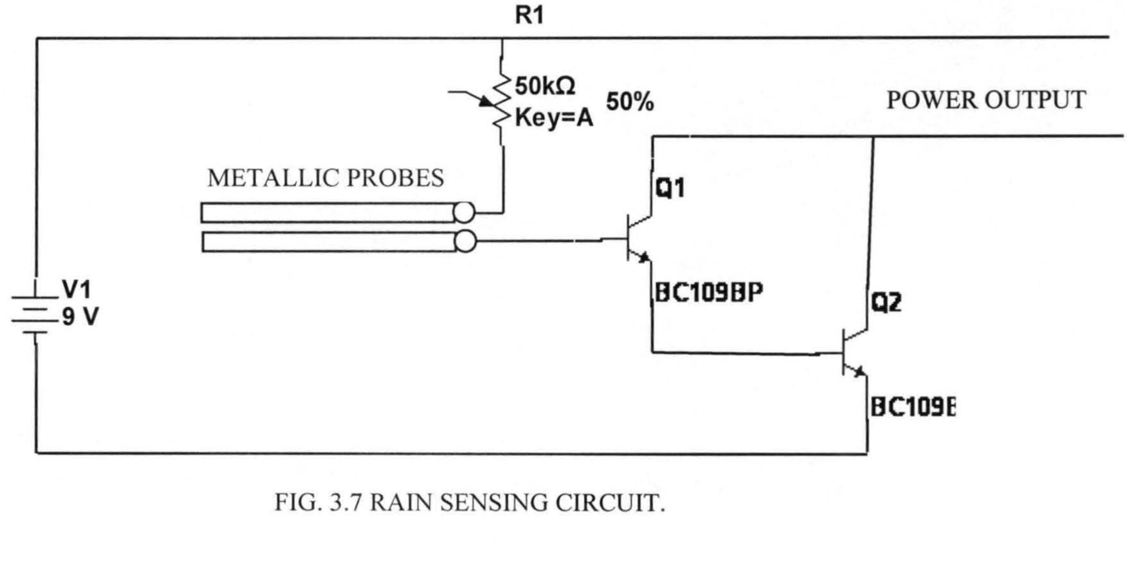


FIG. 3.7 RAIN SENSING CIRCUIT.

3.4 LID CONTROL UNIT

This controls the opening and closing of the rain in-let to the rain gauge. This was achieved using a d.c motor, interfaced with two relays, which controls the bidirectional configuration of the motor, which initiates the opening and the closure of the lid. Figure 3.8 shows a diagrammatic illustration of the lit control system.

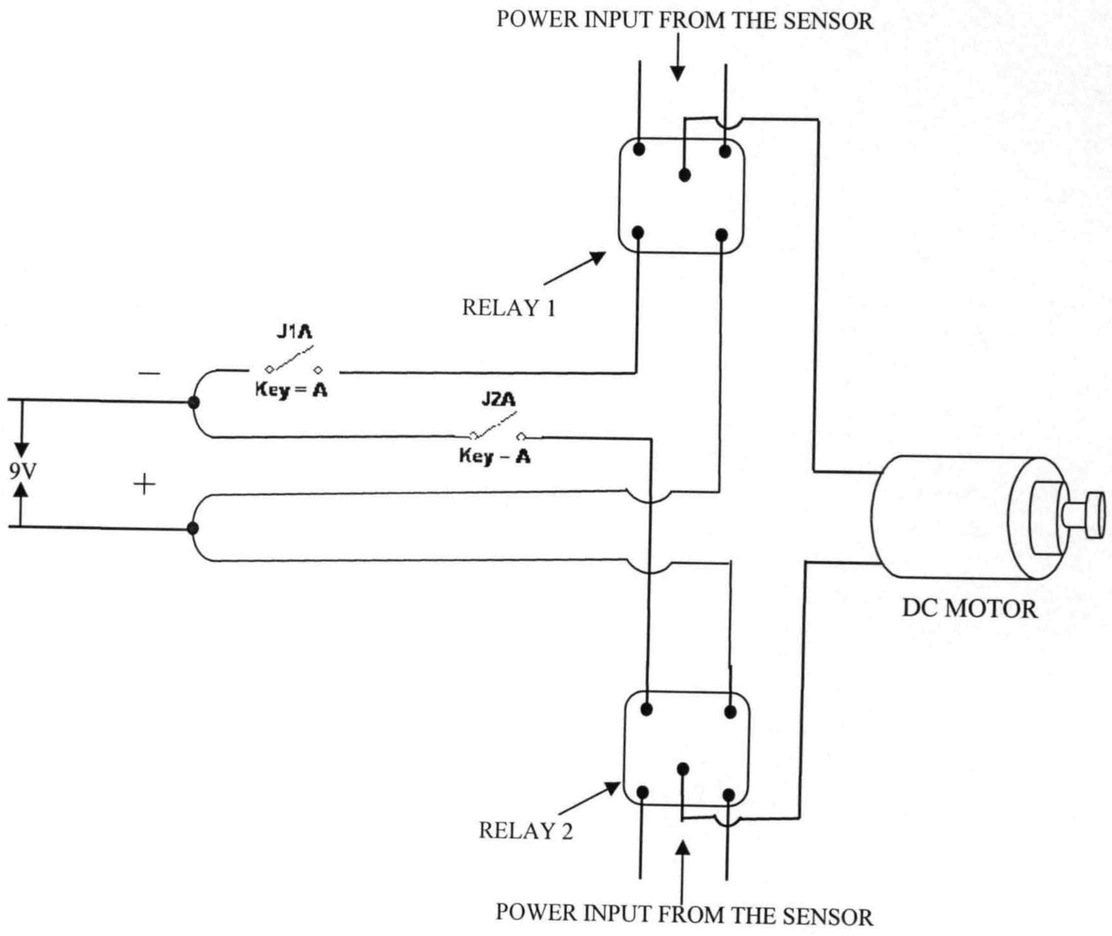


Fig. 3.8 LID CONTROL UNIT

3.5 COUNTING/DISPLAY UNIT

This unit comprise of two sub-units viz: counting and display unit. The counting unit is made of transistors (BC109) this is sensitive to water and is attached to a probe, which is the extension of the sensitivity of the project transistor. Below is the figure of the counting unit.

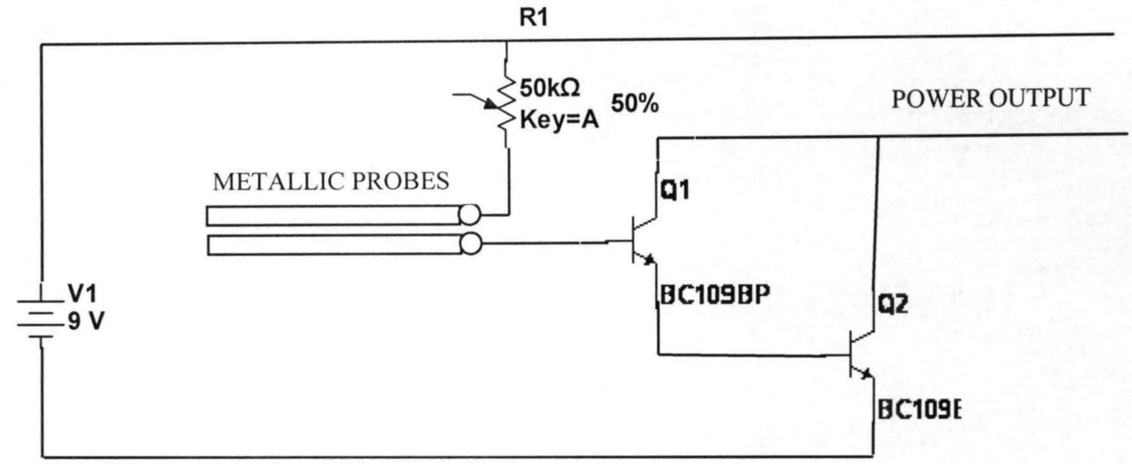


Fig. 3.9 COUNTING CIRCUIT.

3.5.1 DISPLAY UNIT

This is the unit that displays the read result, this was designed using a counting circuit and displaying the result on a seven segment, IC **HC4026B** was used to display the counts and store the results as well[8].

The **HCC4026B** (extended temperature range) and **HCF4026B/4033B** is monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package and plastic micro package. The **HCC4026B** consist of a 5-stage Johnson decade counter and an output decoder which converts the Johnson code to a 7-segment decoded output for driving one stage in a numerical display. These devices are particularly advantageous in display applications where low power dissipation and/or low package count are important. Inputs are CLOCK, RESET, & CLOCK INHIBIT ; common outputs are CARRY OUT and the seven decoded outputs (a, b, c, d, e, f, g). Additional inputs and outputs for the **HCC4026B** include DISPLAY ENABLEinput and DISPLAY ENABLE and UNGATED "CSEGMENT" outputs. A high RESET signal clears the decade counter to its zero count. The counter is advanced one count at the positive clock signal transition if the CLOCK INHIBIT signal is low. Counter advancement via the clock line is inhibited when the CLOCK INHIBIT signal is high. Antilock gating is provided on the JOHNSON counter, thus assuring proper counting sequence. The CARRY-OUT (Cout) signal completes one cycle every ten CLOCK INPUT cycles and is used to clock the succeeding decade directly in a multi-decade counting chain. The seven decoded outputs (a, b, c, d, e, f, g) illuminate the proper segments in a seven segment display device used for representing the decimal numbers 0 to 9. The 7-segment outputs go high on selection in the **HCC4026B** these outputs go high only when the DISPLAY ENABLE IN is high.

HCC4026B -When the DISPLAY ENABLE IN is low the seven decoded outputs are forced low regardless of the state of the counter. Activation of the display only when required results in significant power savings. This system also facilitates implementation of display-character multiplexing. The CARRY OUT and UNGATED "C-SEGMENT" signals are not gated by the DISPLAY ENABLE and therefore are available continuously. This feature is a requirement in implementation of certain divider functions such as divide-by-60 and divide-by-12.

Table 3.1 configuration if IC4026

Pin number	Name	Purpose
1	CLK	**Cl**oc**k** in
2	CI	**C**lock **i**nhibit - when low, clock pulses increment the seven-segment
3	DE	**D**isplay **e**nable - the chip outputs to the seven-segment when this is high (i.e. when it's low, the seven-segment is off) - useful to conserve battery life, for instance
4	DEO	**D**isplay **e**nable **o**ut - for chaining 4026s
5	CO	**C**arry **o**ut output - Is high when changing from 9 to 0. It provides an output at 1/10 of the clock frequency, to drive the clock input of another 4026 to provide multi-digit counting.
6	F	Output for the seven-segment's **F** input
7	G	Output for the seven-segment's **G** input
8	V_{DD}	The connection to the 0 V rail
9	D	Output for the seven-segment's **D** input
10	A	Output for the seven-segment's **A** input
11	E	Output for the seven-segment's **E** input
12	B	Output for the seven-segment's **B** input
13	C	Output for the seven-segment's **C** input
14	UCS	**U**ngated **C**-**s**egment - an output for the seven-segment's **C** input which is not affected by the **DE** input. This output is high unless the count is 2, when it goes low.
15	RST	**Reset** - resets all outputs to low when taken high
16	V_{SS}	The connection to the +9 V

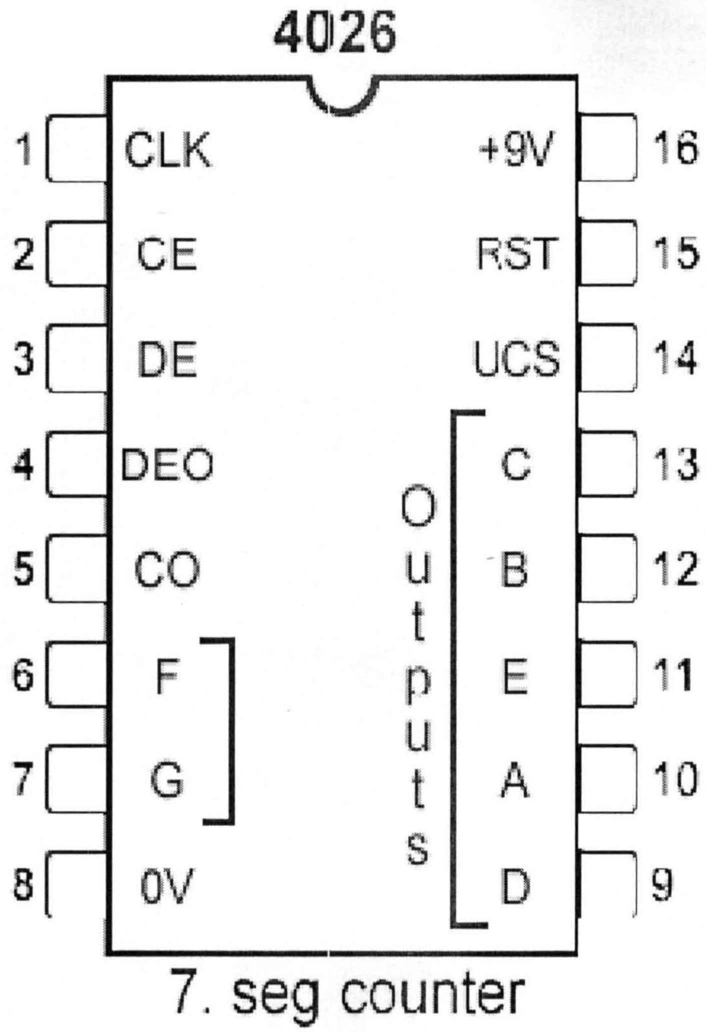


Fig. 3.10 pinout of LED Driver HCC4026B

Below is the circuit diagram of counting circuit, using two display, it was configured based on the pinout of the HCC4026B, as shown above.

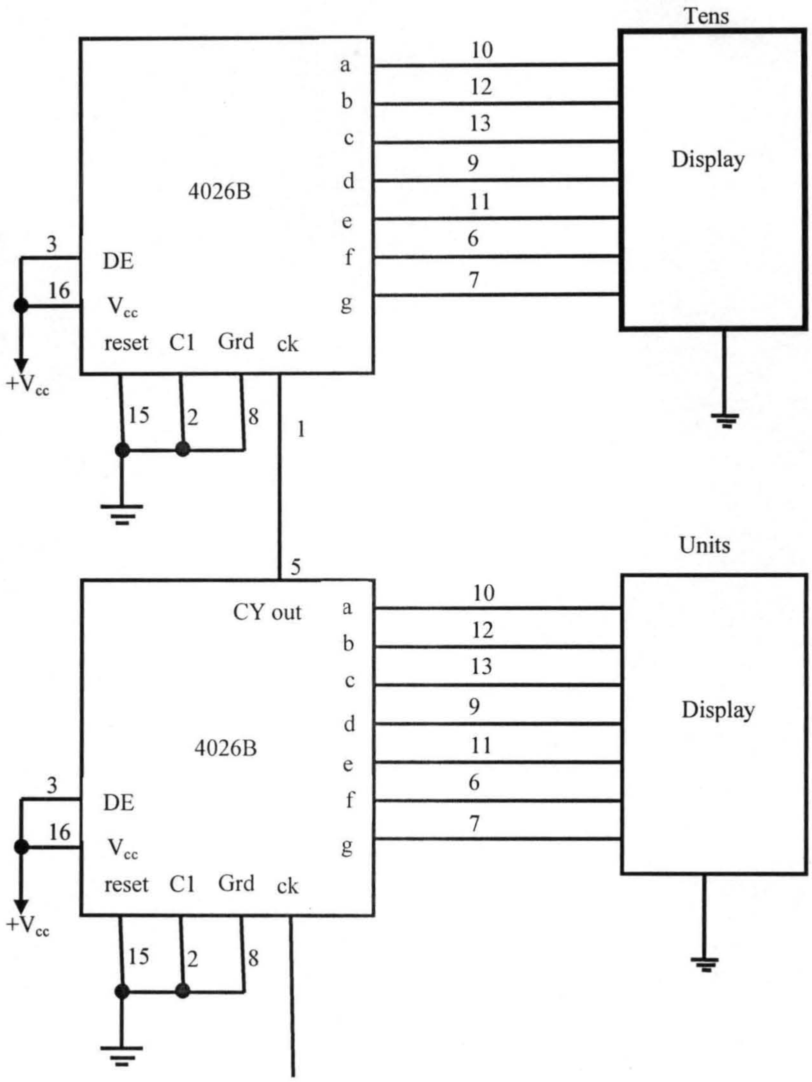


Fig 3.11 circuit diagram of the display unit.

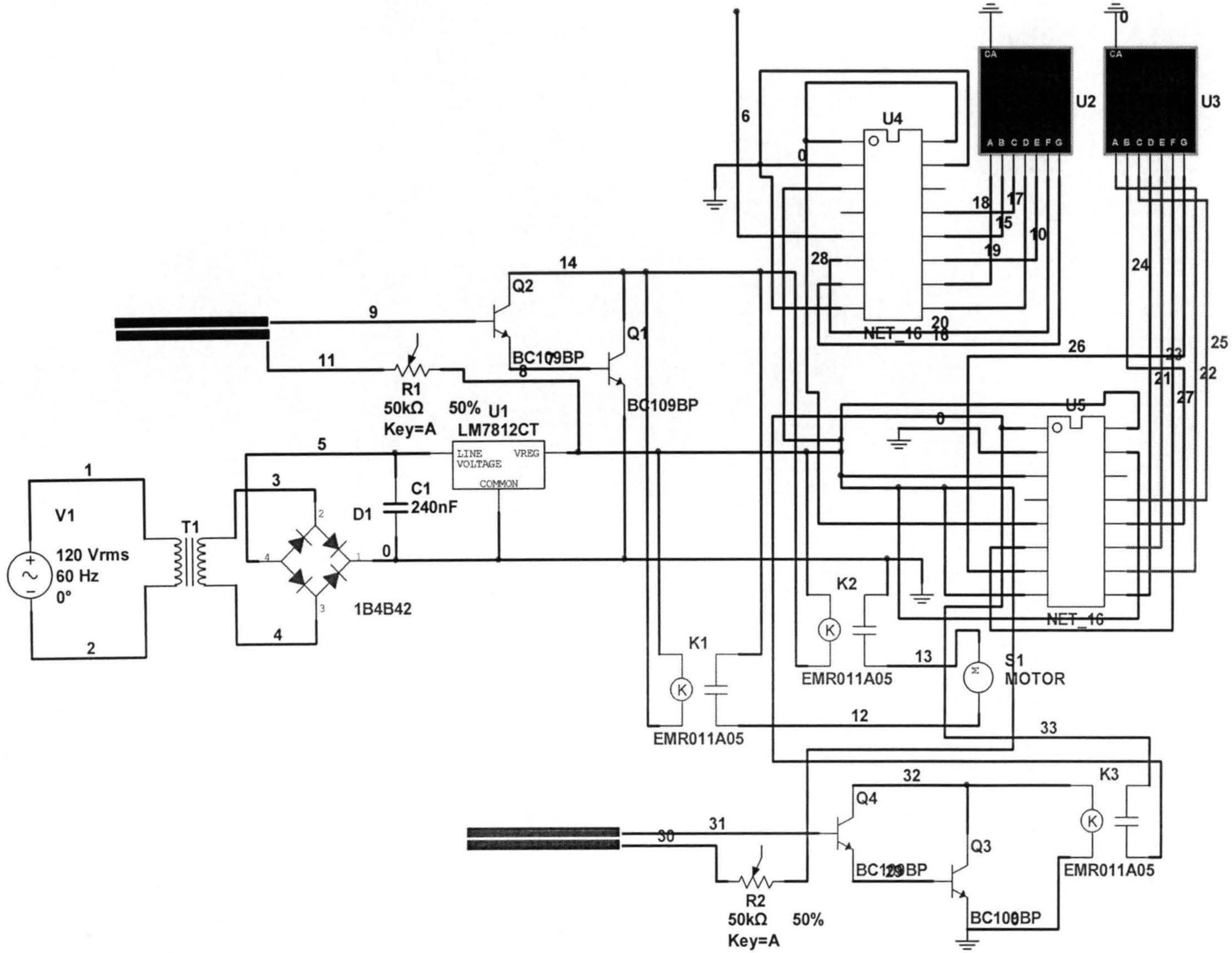


Fig 3.12 Complete circuit diagram

CHAPTER FOUR

4.0 TEST RESULT AND DISCUSION OF RESULT.

In design, the concept of reliability is of paramount importance. We need reliability to be sure of the viability and the level of confidence we have in our product and how our product will perform its intended duties or functions without failure. In the design and construction of the Automatic rain gauge, careful selection and purchase of components was done to enhance its reliability.

Each stage of the circuit was first built on a breadboard to check the practical workability of each stage. As soon as all was seen to be working, the whole work was then transferred on a Vero board and tests were carried out on it. When it was discovered that the whole project was working in a good condition, everything was then cased in a plastic glass

4.1 TEST AND MEASUREMENT

The project testing was done in three stages. The first stage of the test was the rain sensing sensitivity test. The sensitivity test was carried out by using steam to test the sensitivity and a drop of water as well. Some errors encountered were corrected before subjected to another phase of test. The process was repeated until errors were successfully removed; the second test (counting/display of the counts) was carried out after assembling of the components on the breadboard, after ensuring that the entire project worked effectively, the components were transferred to the Vero board and permanently soldered before the third phase of test and finally casing of the product was done. The respective results of the test carried out for different load requirements was visualized on the 2-digit seven segment display and tabulated respectively.

4.2 RESULTS OF TEST CARRIED OUT

The following are the results obtained from the several tests carried-out on the automatic rain gauge. The power supply is user friendly, in that the user decides which power source to use, and it saves the battery when there is power from the PHCN(when used in Nigeria).

Table 4.1 test of the droplets.

Number of Drops	Quantity in Litters.
4000 8000	1ltr 2ltr

Table 4.2 result of sensor sensitivity

Resistivity(killo Ohms.)	sensitivity
50	90%
100	70%
150	50%

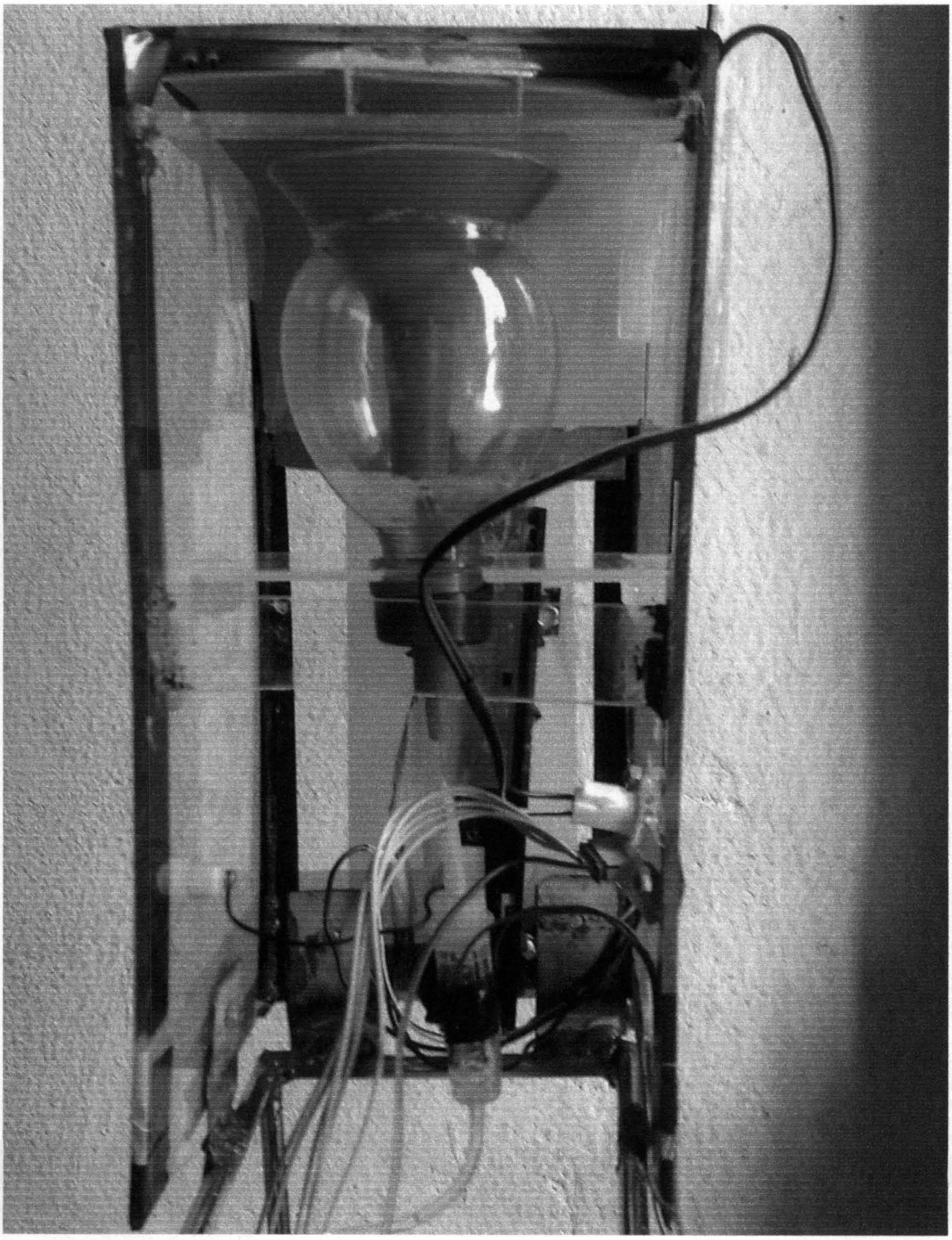
The above table shows the approximate number of water drops that makeup a litter, the user has to know this to enable him/her read it accurately.

4.3 DISCUSSION OF RESULTS

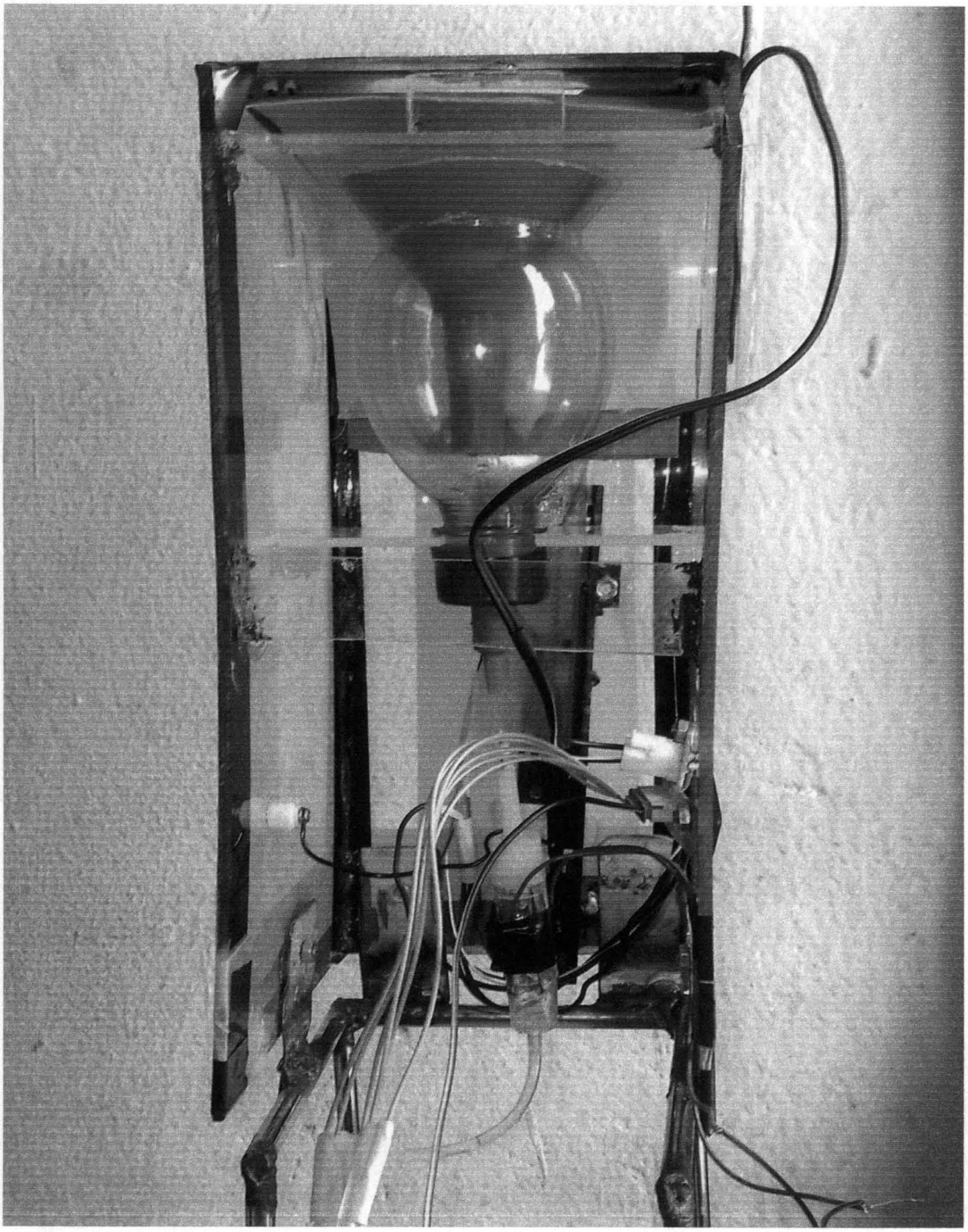
The results obtained from the test, was the outcome of the three stages of test subjected to.

The following precautions were adopted for enhanced safety:

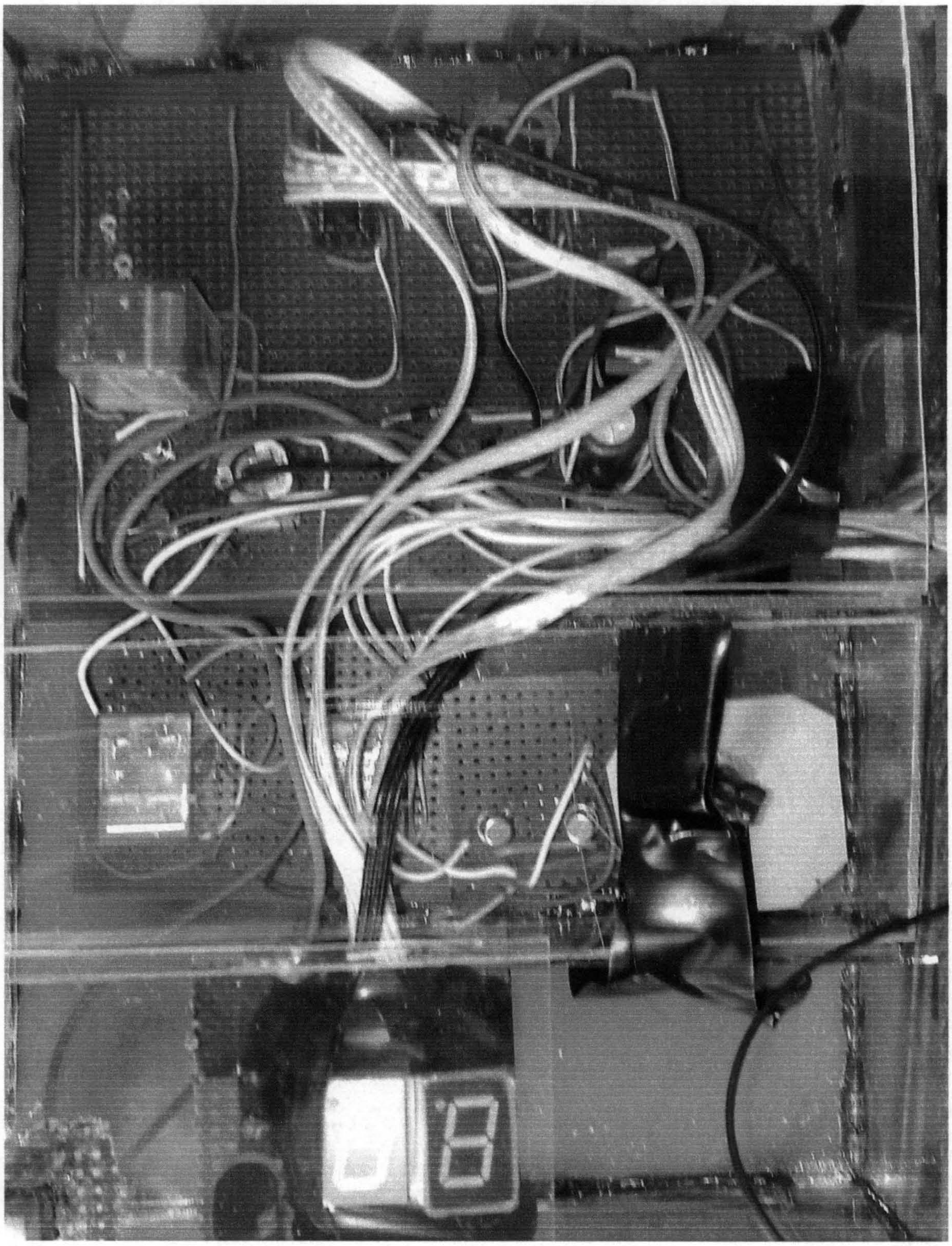
- An over-load function was provided to facilitate the protection of the delicate electrical appliances.
- A reset button is incorporated to reset the 2-digit 7 segment display to its zero state in case of error occurring.



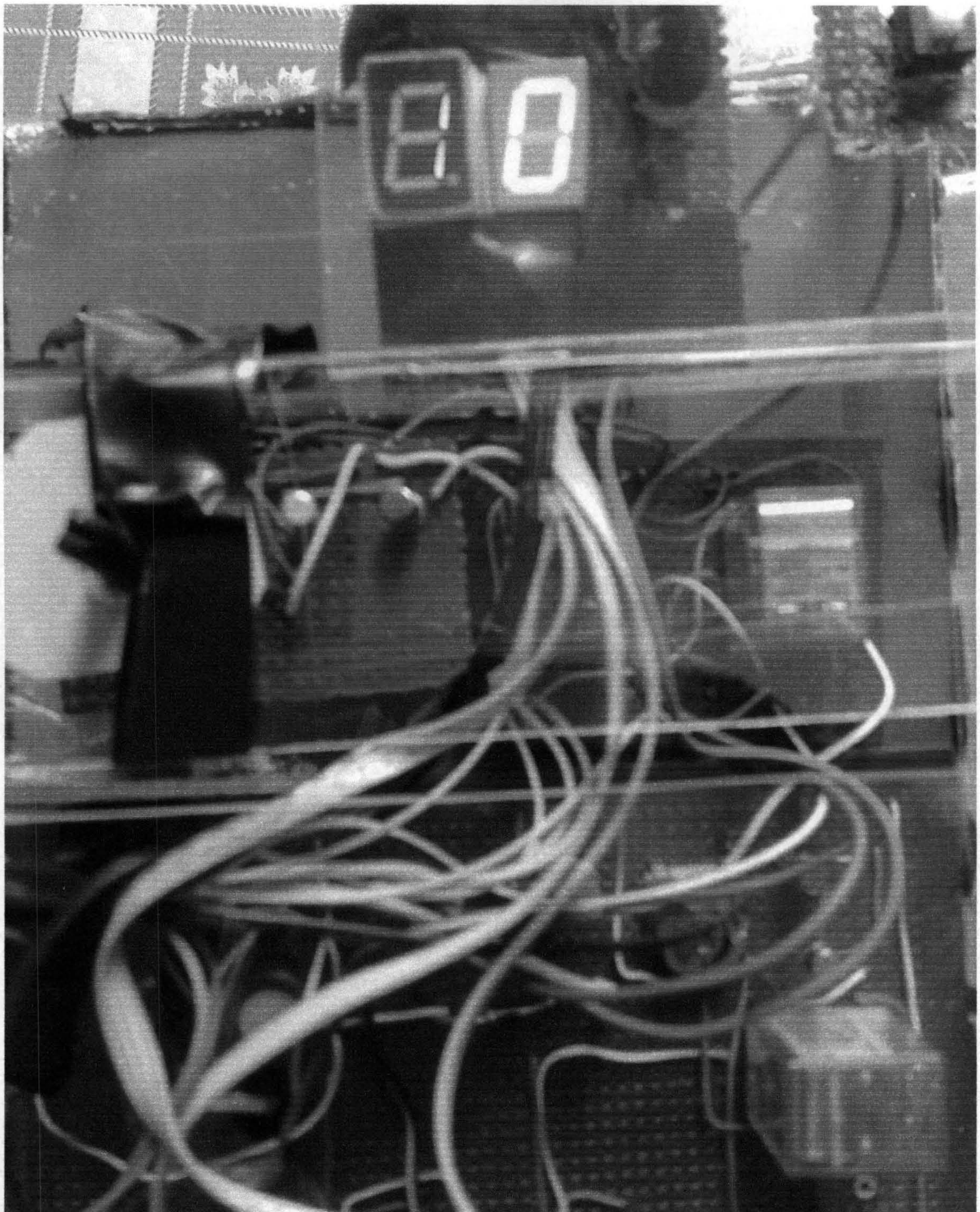
PICT. 3.1 Rain collecting unit.



PICT. 3.1 Rain collecting/counting unit.



PICT. 3.1 Rain result display unit.



PICT. 3.1 Rain result display unit. (active state).

CHAPTER FIVE

5.0 CONCLUSION

An automatic rain gauge has been designed and constructed. The prototype of the automatic rain gauge worked according to the specification and quite satisfactorily. The device is quite cheap, reliable and easy to operate. Whenever there is power outage, it reduces stress for manpower changeover.

The Automatic rain gauge is designed based on the rain sensing nature of Transistor BC109, which assist in the sensing aspect and the counting aspect.

The inclusion of a counting circuit into the system makes it such an intelligent one which is flexible and also user friendly, this is made possible by the use of HCC4026B (7 segment driver)

5.1 PROBLEMS FACED

Components to be used were hard to obtain. And during the bread board testing, the output obtained was not the desired output, this really caused much delay in the construction until it was found out that the IC HCC4026 bought, was not functioning well.

5.2 RECOMMENDATIONS

I recommend that prior preparation should be made as regards to the availability of design components, before embarking on the design, the operation of this project, is constraint to a maximum count of 99 drops of water on my design specifications. For future improvements/additions to this work, I recommend that more counting capability should be added to this, and a Microcontroller should be used instead to lessen the task of combining so many components to achieve a task.

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APENDICES

APENDIX A

Manual for the operation of the machine.

1. Position the rain collecting unit in an open place
2. Insert the antenna (rain sensing instrument) in it right position
3. Plug in the connection chord (cable) to the connecting receptacle, on the rain collecting unit.
4. Plug in the machine to the power supply source.
5. Turn ON the switch to start up the circuit.