DESIGN AND CONSTRUCTION OF ELECTRONICS WATERING MACHINE TRIGGERED BY THE MOISTURE CONTENT OF THE SOIL

BY

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(2007/2/26394EE)

ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

NOVEMBER, 2011

DEDICATION

I dedicate this project to my beloved parent and friends

DECLARATION

I Oyedele, kazeem adeola 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.

Oyedele .K.A
(Student)

Signature and Date

CERTIFICATION

This is to certify that this project titled "Design and Construction of an Electronics Watering Machine Triggered By The Moisture Content Of The Soil" was carried out by Oyedele Kazeem Adeola with matriculation number 2007/2/26394EE, and submitted to the Department of Electrical and Electronics Engineering, Federal University of Technology, Minna in partial fulfillment of the requirements for the award of Bachelor degree in Engineering (B. Eng.).

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(March 15, 2012)
Signature and Date

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External Examiner

6/3/2012
Signature and Date

ACKNOWLEDGEMENT

I will like to express deep appreciation to my project supervisor Mr. H.O. Ohize and Technical supervisor Mrs.E.A. Asindi for encouraging me to carry on with the project and also for his guidance throughout the period of research, design and construction.

Also I thank the entire staff and students of Electrical and Computer Engineering Department for the knowledge impacted.

This project isn't complete without mentioning the contribution of my parents Mr. and Mrs. Oyedele, and my brother Oyedele Taofeek and Mrs.Salaudeen for their financial and moral support. I cannot forget also Engr. Imhonlamhen, Lawal Hammed, Dada Oluwaseye, Aderibigbe Saheed, Adesina Olufemi, Akamo Lateef, Ogunsola Yaya, Alfa Nurudeen, Ogunseye Seun, Ndanusa Ibrahim, Peter Segun, Dada Abidemi, Muideen Bello, Oyedele Sheriff, Aminat Rabiu, Basit Aleemat, Ogunseye Funmilayo, Ajanaku Nurudeen, Rukayat, Kuburat, Seun and Samson.

I appreciate the interaction with my colleagues and friends during the course of the degree programme.

Above all my gratitude goes to God Almighty (Allah) for His Mercy, Grace and Favour over me.

ABSTRACT

The aim of this project is to activate an electronic watering pump (with perforated pipe outlet) by sending the variation of soil resistance between two metal probes spaced a known distance apart. It is well known that different types of soil have different conductivity in their dry state, and that humidity (amount of water) in the soil reduces the resistance per meter thus increasing its conductivity. Also, flowers grown in different soil types require different minimum amount of moisture to survive. The soil sensitivity subsection of the design uses two metal probes spaced apart in the soil. When the soil conductivity falls below a preset value for the soil and floriculture type, the electronics watering pump is activated and sprays the soil with water until the moisture content level desired is reached and hence the soil conductivity reaches a defined value. The Electronics watering machine featured in this project is an original design, equipped with a reservoir water level detector which detects low water level in the reservoir using the same principle of variation in resistance between two metal probes when in its dry and moist state.

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CHAPTER ONE

INTRODUCTION

1.0Background

The economic importance of dry season horticultural system cannot be over emphasized; therefore it is important to put in measures to ensure its effectiveness.

During the dry season, rainfall which is the major source of water becomes low and consequently insufficient for flower survival, which leaves the owner the choice of watering. Watering provides the way to ensure that flowers receive the appropriate amount of water in a timely fashion. The amount of water needed by a flower depends on the flower type, flower size and the weather condition which make it necessary to employ the use of appropriate watering system [8].

Major problems associated with the manual system of watering which include erosion, water logging and pure water distribution and management is greatly minimize with the use of electronics watering machine triggered by the moisture content of the soil system which ensures proper water distribution by the electrically controlled moisture sensor (probes), adequate water supply of water to flowers by its control knob and proper water management by the use of a reservoir water level detector.

1.1Objective

It is professional that single circuits are the best being that, they are easier to understand, implement and they develop less complication and are therefore easier to maintain.

This project takes into consideration, professionalism in electrical design by employing the use of a simple transistor connected in series circuit to solve practical problem.

As an undergraduate of electrical and computer engineering, the task of building an electronics watering machine which would both be professional and cost effective was embarked upon. This essentially required basic foundation in electrical engineering, in which I acknowledge contributions from various resources persons, whose ideas and suggestions brought to reality this project. (See acknowledgement). Consultations were also made to various material and these were duly referenced. (See references).

1.2 Project Report Layout

Chapter one gives a general introduction of the project and its constraints. Chapter two give a literature review on the economics of watering horticultural system, and answers questions on why the choice of technology in watering, what makes the electronics watering machine triggered by the moisture content of the soil a gardener best choice, the basic engineering concept of watering and the potential impact of improper watering system design. Chapter three highlights the circuit simulation and calculations done based on design and circuit simulation. Chapter four discusses on the construction, the electrical sub-system, mounting of components, design of casing and general precautions observed. Chapter five highlights the test and measurement carried out on the design and the basic fault diagnosis of the system, concludes the report stating the achievement and recommendation.

1.3 Sources of Components

In a relatively small town with few number of specialty electronic store, building an electronic circuit could be a lot more challenging than could be imagined; as the local available shops just might not have what you need. This results to choosing alternative equivalent guided by the use of data book.

However, materials used for this project were locally sourced.

1.4 Components list table

The unit of material (components) varies significantly depending on its application. The material and their applicable to this project are listed as follows.

Table 1.4 Component List Table

Material	**Unit**
Color Resistor	4
Variable Resistor	1
LED	1
Transistors	4
Buzzer	1
Vero board	1
Connection wires	1 yard
Screws	10
12V rechargeable battery	1

Bread board	1
Motor/ Sprayer module	1
Probes	2

1.5 Constraints

This project is just a model design, which makes everything to be designed in model size. Obtaining a motor module which would fit into the model design was the primary limiting factor in this design, as small motor module which could operate on a small D.C. voltage of between 9 and 12V were in limited market supply.

CHAPTER TWO

LITERATURE REVIEW

2.0 The Economics of Watered Horticultural System

Delicate garden floriculture needs to be taken care of whether someone is around or away for awhile. Finding the most economic method of water application is important to the manners of watered horticultural system as water is increasingly becoming a scarce and highly competitive resource due to population growth, industrial expansion, and recreational interest. This is the more reason why watering system with good water management should be employed.

An electronics watering is highly economical it is very simple to implement and the cost of production and maintenance is minimal compared to the manual watering system. Labour is very cheap as no special training is required to operate an electronics watering machine and energy is conserved.

In manual watering, the cost of watering is incremental most especially during the first watering due to the cost of energy and labour added to the cost of purchasing the equipment and its installation.

2.1 The Choice of Technology

Many of the watering systems which originated several thousand years ago in the East and Far East have continued without significant changes in their overall layout and methods of operation until the present time [2]. Some of the ancient methods of watering include the use if watering cans (manual water lifting) and mechanically operated systems using sprinklers and spray heads [4].

In recent time there have been various attempts in automation of watering. Some of the major attempts involved the use of valves operated by hand but with automatic closing through timing or volumetric mechanism (partial automation); valves with automatic opening and closing on non-sequential basis through programming or sensing devices [3].

Automatic sequential systems include, hydraulically operated systems the most common of which is diaphragm or piston valves also in the electrically operated systems where diaphragm or piston valves are controlled with a solenoid switch.

Non-sequential operated systems are fully automatic systems controls; electric or hydraulic valves which are operating independently of each other both in time and in quantity. Some of the attempts include soil moisture sensor for automation resistance blocks and rensionmeter, evaporimeter for automation [3].

The choice of technology depends largely on various factors, some of which are installation cost, maintenance cost, efficiency of equipment, downward compatibility and so on. The cost of installation and maintenance of the Electronics watering for dry season horticultural system is low as only the cost of installation of general farm mechanism is necessary, it is also highly efficient and downward compatible as it could be operated with earlier watering equipment. Generally the electronics watering is very convenient.

Subsequent chapters of this report, give more details and what makes the electronics watering for Dry Season Horticultural system meets the above criterion of technology choice.

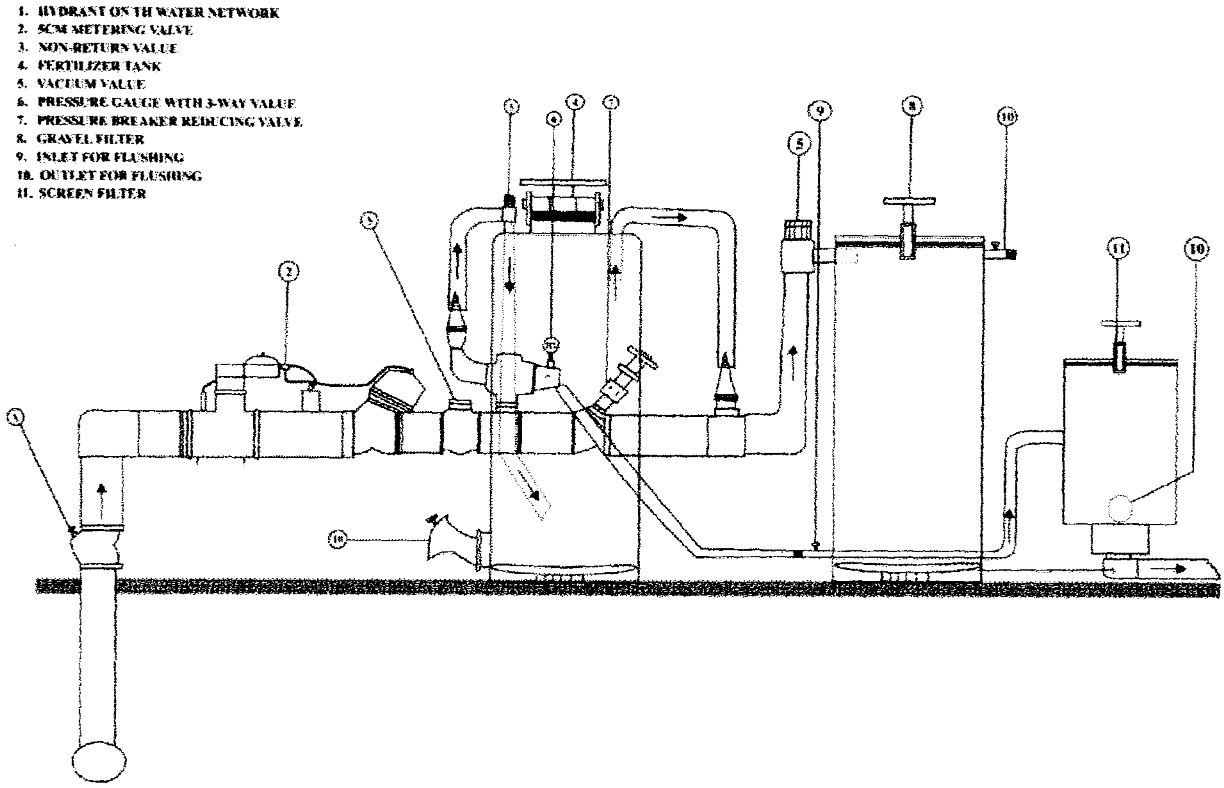


Fig 2.0 Example of an attempt of Automatic in Watering using valve (partial automation)

2.2 Electronics Watering in Dry Season Horticultural System

The electronics watering machine is an easy, improved and enhanced method of dry season watering. Understanding the various methods of watering is essential in the use of electronics watering machine so as to maximize flower survival. Regardless of the choice method, electronics watering machine could be employed. All that is necessary to operate the electronics watering machine is a source of water (reservoir) and the water distributor which depends on the method of watering adopted either surface watering or over head watering. Section 2.1 and 2.1 of this report gives insight as to factors to be considered when making a choice.

The water distributor (perforated pipe) is attached to the end of the pump; one of the probes goes to the reservoir while the other goes to the soil all of which are controlled by the circuit. The complete system can be said to be a negative feedback system whereby the pumping action is determined by the soil condition (either wet or dry) and preset valves depending on the soil and flower type [6].

2.3 Basic Engineering Concept

Apart from gravel and stones, the soil mineral particles are conventionally classified, on the basic of their equivalent spherical diameters, into size groups according to various grading systems. Thus the system adopted by the International Society of Soil Science (I.S.S.S.), divide them into coarse sand (2.0 – 0.2mm), fine sand (0.3 – 0.02mm), silt (0.02 – 0.002mm) and clay (<0.002mm).

The soil texture described in terms such as sand, sandy loam, silty loam, clay loam and clay – relates to the relative proportions of sand, silt and clay in the soil [7]. These influence the aggregate stability, permeability to air and water – holding capacity, ease of cultivation and consequently the soil resistance/conductance. A standard relation of these factors to the conductivity of the soil is yet to be determined; this is an issue open to both horticultural and electrical engineer to tackle for future improvement on the Design and Construction of an electronics watering machine triggered by moisture content of the soil for horticultural system.

2.3.1. The Concept of Flow

Water movement through soil is proportional to the product of the driving force and the conductivity of the soil for water. This movement, both liquid and vapor, can be expressed by the equation.

$Q = cDK$

Where Q = flow velocity

c = proportionality factor

D = driving force

K = conductivity of the medium

This relation holds true heat transfer and flow of electricity as well as for water movement.

2.3.2 Definition of Terms

The driving force:

The driving force in the case of water is a pressure gradient. Water moves from a position of high pressure of low pressure. This is true for saturated and unsaturated liquid flow and for vapor flow.

In the case of saturated flow the pressure gradient may be brought about by differences in hydrostatic head (gravity, "water seeks its own level"). This pressure gradient may also be brought about by mechanical force (pressure from weight on soil surface or swelling colloids)

In the case of unsaturated flow the pressure gradient is the sum of the difference in hydrostatic head and difference in soil-moisture tension.

The hydraulic conductivity:

The conductivity of soil for liquid water depends on the cross sectional area of the pores and on the size of the pores. In saturated flow the conductivity increases as the fourth power of the radius. In unsaturated flow the conductivity depends on the degree of saturation. The drier the soil, the smaller is its conductivity.

We can conclude from these statements that the hydraulic conductivity is no simple function of porosity. Although the conductivity of a very porous soil is generally higher than that of a less porous soil as far as saturated flow is concerned, this relationship may be reversed for unsaturated flow.

Generally the rate of saturated flow in soil of carious textures is in the sequence: sand > Loam > Clay

From the law of Darcy, the velocity of flow of a liquid through a porous medium is proportional to the force causing the flow and to the hydraulic conductivity of the medium. This can be expressed in several ways. The equation can be based on pressure gradient as the driving force:

$$Q = (cKAP) / L$$

Where Q = flow velocity (L^3T^{-1})

c = dimensionless proportionality constant

K = hydraulic conductivity ($ML^{-1}T$)

A = cross sectional area (L^2) of the porous medium

P = pressure gradient ($ML^{-1}T^{-2}$)

L = length of the porous medium

Or the equation can be based on the hydraulic on the hydraulic head gradient as the driving force:

$$V = Ki$$

Where V = flow rate ($L^{-1}T$)

K = hydraulic-head gradient (a dimensionless ratio)

i = hydraulic head gradient (a dimensionless ratio)

It is noted that the dimensions of the hydraulic conductivity depend on the form of the equation. The actual magnitude of the hydraulic gradient or the coefficient of permeability has to be determined for every case. It depends not only on the nature of the porous medium but also on the viscosity of the liquid.

CHAPTER THREE

SYSTEM DESCRIPTION AND DESIGN

3.0. System Overview

In circuit design as in most aspect of life, simplicity as opposed to complexity is the desired goal as it maximizes reliability, minimizes space, reduces realization cost and makes it easy to trouble shoot [8]. It is on the backdrop, an electronics watering machine was designed so as to meet required engineering standards [9].

The overview of the design concept is given of the logic table of Table 3.1

Table 3.1 Logic table showing an overview of the design concept

Soil condition	Reservoir water	Output of soil moisture sensor	Output of buzzer
Dry	High	High	Low
Dry	Low	High	High
Wet	High	Low	Low
Wet	Low	Low	Low

3.1. System Operation

The circuit operation is illustrated in the block schematic of fig 3:10 and in the flow chart of fig 3.1.1

The operation of the circuit can be divided into six main units; the power unit, the sensor unit consisting of the soil moisture detector and the low water level detector, resistance unit, the relay driver unit the pump activity indicator unit and the buzzer unit.

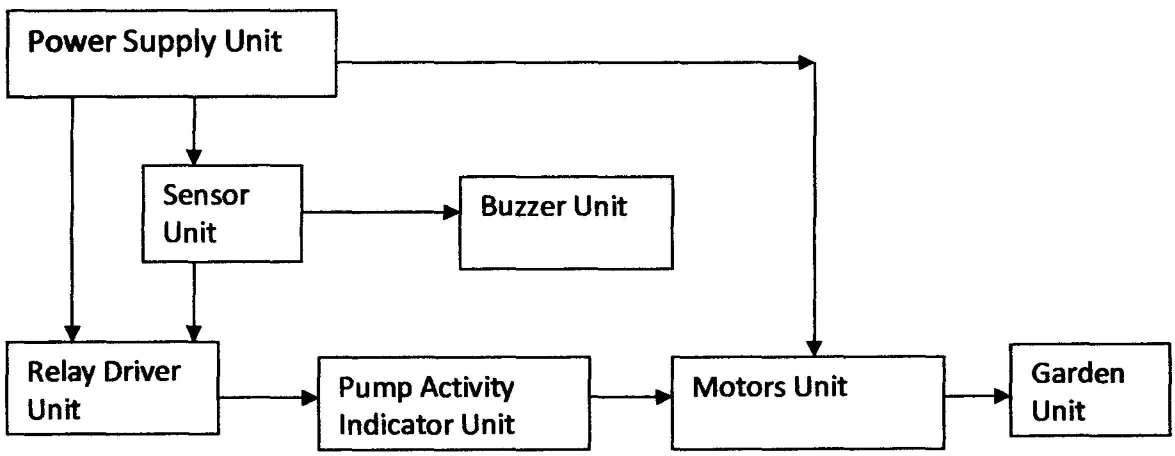


Fig 3.1.0 Block diagram of an electronics watering machine for Dry Season horticultural system

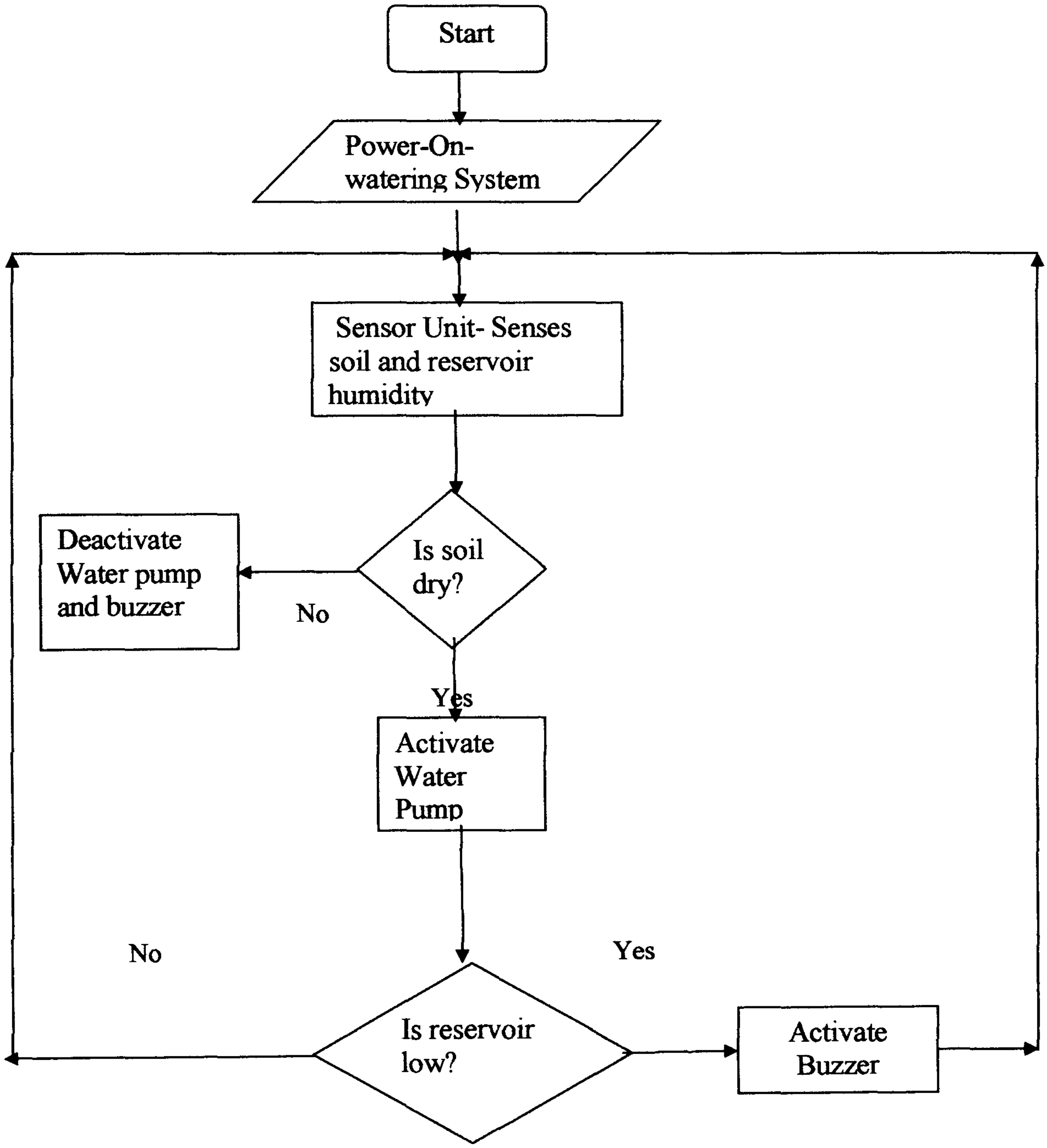


Fig. 3.1 flow chat of watering machine Operation

The sensitivity is setup at the resistor and base terminal. The probe, spaced apart in the soil, is connected to the variable resistor and base terminal with a voltage present for the datum soil type resistance.

Once the soil has reached sufficient moisture level as per calibration for soil type, the sensor circuit deactivates the pumping action of the sprayer motor.

3.2 Functional Units

The circuit has been sub divided into series of units, these units include:

- The power supply unit
- The sensor unit
- Relay driver unit
- Pump activity indicator unit
- Motor unit
- Buzzer unit

3.2.1 The Power Supply Unit

The Power supply unit of an electronics watering machine for Dry Season horticultural system uses a 12V D.C power supply. This is simply to make it compatible with the available 12V D.C. water motor.

3.2.2 The Sensor Unit

The sensor unit comprises a variable resistor and base terminal of transistor (BC109) that regulates the movement of the electrons via the aid of a probe connected to the output unit.

The design incorporates two sensing units, that is, the soil moisture detector and the reservoir low moisture detector. Four transistors were used on the circuit to achieve the sensitivity of circuit.

3.2.3 The Relay Driver Unit

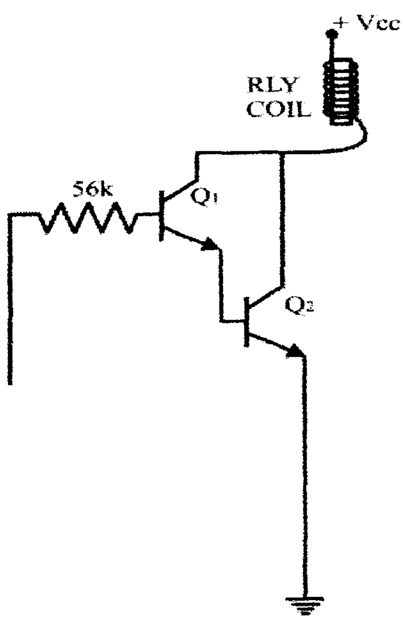


Fig. 3.4 Relay Driver Sub Circuitry

The transistors were connected in such a way that sensitivity from the base terminal of the transistor and the biased reaction of the second transistor emitter connected to the ground.

On this state we design such that the relay driver transistors Q are saturated to ensure maximum voltage drop across the relay, R_L

The relay chosen has a coil resistance R_L of 230Ω

Assume:

I_C is the current flowing in the collector of Q

I is the base current

V_b is the output voltage of the resistor. Driving transistor Q

V_{CC} is the supply voltage

V_{BE} is the base emitter voltage drop across Q

V_{CE} is the collector emitter voltage of Q at saturation

hFE is the D.C. current gain of saturated Q

then the following relation holds at saturation of Q

$V_{CC} = I_C \times R_L + V_{BE\,(Sat)}$ ....(a)

$V_b = I_b \times R_b + V_{BE}$ ....(b)

Now: $h_{FE} = {}^{I_c}/_{I_b}$ ....(c)

Based on experimental measurement on the test circuit,

The relay resistance, $R_L = 230\Omega$

$V_b \approx 10.7V$

And from the data book specification for the BC109 transistor used as Q

$V_{CE\,(Sat)} = 0.2V$; $V_{BE} = 0.7V$; $hFE \approx 285$

Substituting these values in equation eqn (a)

$$I_C = \frac{(12 - 0.2)}{230}$$

$I_C = 0.0513A$

Also from eqn (b)

$$I_b = \left(\frac{0.0513}{285}\right)A$$

$I_b = 0.00018A$

From eqn (b), $R_b = \frac{(V_b - V_{BE})}{I_b}$

Substitute values respectively

$$R_b = \left[\frac{(10.7 - 0.7)}{0.00018}\right]\Omega$$

$= 55.556K\Omega$

Viz $R_b \approx 56K\Omega$

3.2.4 Pump Activity Indicator Unit

The pump activity indicator consists of a light emitting diode (LED) connected to the collector of a BC109 transistor in series with relay coil RL. The LED lights whenever the voltage V_b goes high causing transistor Q1 and Q2 to be saturated.

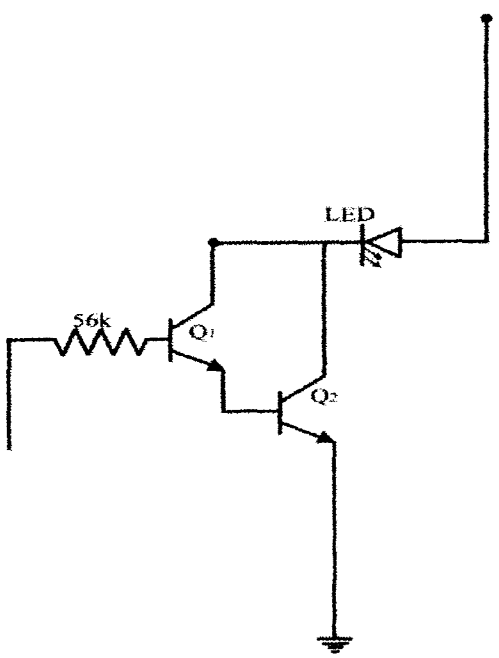


Fig. 3.5 Pump Activity indicator Unit

(In this state also, when the collector of transistor Q (fig. 3.4) goes high causing the relay, RL to switch on the motor pump motor).

When V_b goes low, the LED is deactivated indicating that pumping action has stopped.

We note that Pump Activity is a consequence of soil moisture level. When the soil moisture is high, the LED goes OFF while when the soil moisture is LOW the LED lights.

3.2.5 The Motor/Perforated Pipe Unit

The motor/perforated unit is a mechanical sub unit of the design controlled by the output of the previous sub units. The motor/perforated unit is the output with which the watering water reaches the garden flower. The motor of the water is activated by the relay RL (fig. 3.4)

3.2.6. Buzzer Unit

The buzzer unit indicates alerts on the state of the level of water in the reservoir. This unit is similar in design topology to the water motor activation unit. The buzzer is also controlled by the sensor unit feeding another resistor and base terminal of a transistor. When the output from the circuit goes high, indicating low reservoir water level, the buzzer is consequently activated. The buzzer is deactivated when the output of the circuit goes low indicating high reservoir water level.

3.3 Component Selection / Design Specifications

The designer of a circuit must have a working knowledge of the information of the various components. In addition, he must know the specification for the particular circuit to be designed; those specifications may take on various forms. For practical designs, information of the following type is necessary:

- Available power supply potential
- Operating and storage temperature range
- Cost, weight and size requirement
- Environmental conditions
- Sensitivity to parameter and supply voltage variation
- Input and output impedance levels
- Allowable current drain from power supply
- Noise and distortion
- Life expectancy

Components selected for use in an electronics watering machine for Dry Season horticultural system were guided by the above specification.

3.3.1 The Choice Of A BC109 Transistor

To design even the simplest transistor circuit requires that the designer use all available information including test data taken especially for the purpose, to create a circuit that satisfies the given specification.

The design of an electronics watering machine required a transistor type suitable for switching the relay activating the motor.

The choice of BC109 transistor was made based on the following criteria:

- BC109 is readily and cost effective
- BC109 is a silicon transistor which gives it the characteristics of larger energy gap resulting in a much lover lower leakage current (I_{CO}) and lower sensitivity to temperature extreme compared to Germanium Transistors
- It has medium current amplification factor
- It has high maximum collector – voltage ratings
- It has suitable physical size, and mounting dimensions.

3.3.3 The Choice of Minimum Wattage For Resistor Power Dissipation

From the circuit design simulations, the maximum power dissipated in any one resistor in the circuit is in the milli-Watt range. We chose resistors with minimum wattage rating of 1/2W to conveniently maintain stability in the circuit caused by unnecessary over heating of resistors. Also high stability metal-oxide film resistors are most readily available and cost effective.

3.3.4 The Choice Of The Relay

There are two main purposes of the relay,

- To enable a large current to be controlled by a small current. It is therefore a sensitive switch so that a small current change can control devices which use heavier currents, such as lamps, motors, solenoids, etc
- To enable the control circuit to be isolated from the controlled circuit.

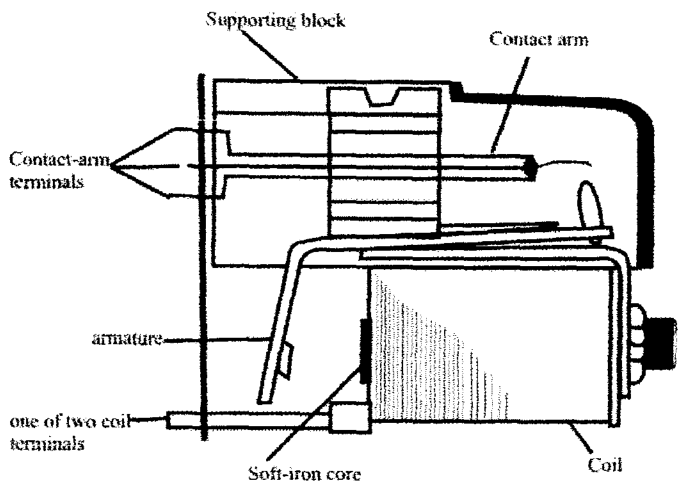


Fig. 3.7 The structure of a simple relay

For this design a 9V relay was chosen which has a minimum turn-on voltage of 6V. This ensures the relay is reliably switched on and off when activated by a near 12V D.C., source, with no latching.

3.3.5 The Choice Of A Buzzer

The buzzer is an electro magnetic device used to convert electrical energy to audio energy. It was chosen in the design so as to alert when the reservoir water level is low.

A piezo –electric buzzer was chosen because of its high impedance that ensures little current is drained from the battery when it is activated.

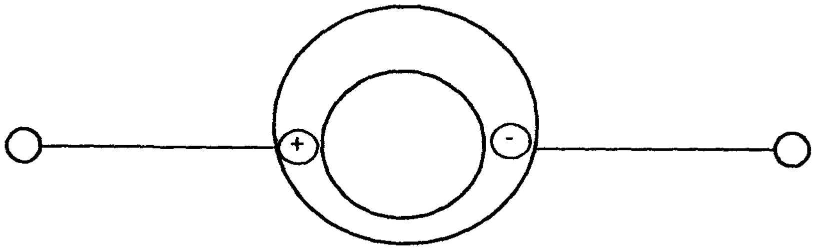


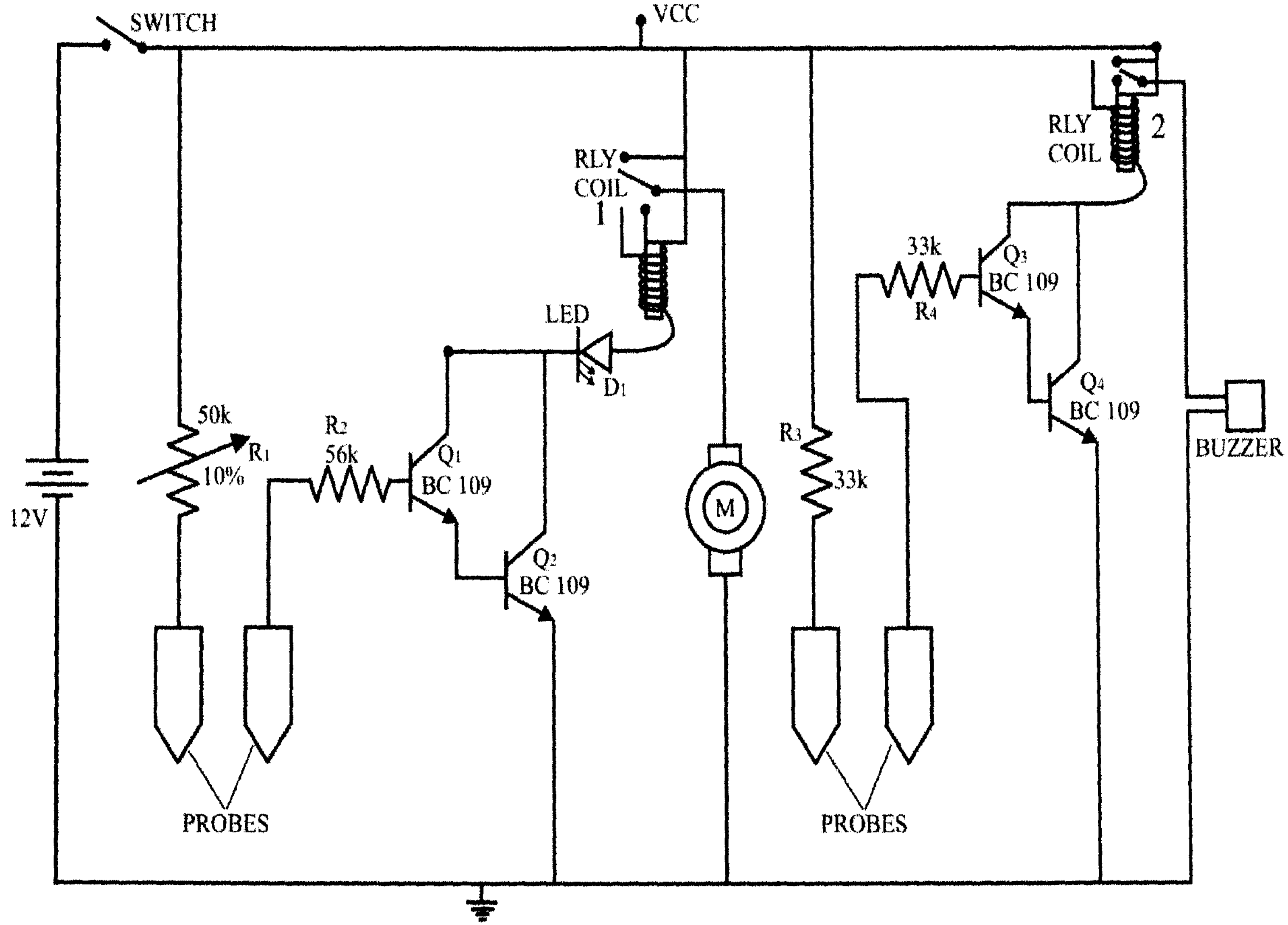
Fig. 3.8 Circuit symbol of a buzzer

3.4 Computer Based Simulation

Before a project is embarked upon, it is important to understand what is expected of its input – output functional behavior. A theoretical model of the circuit design (if such exist) can be useful in design planning and implementation.

Manual calculations based on theoretical models are tedious, often impossible for D.C. circuits consisting of non-linear elements, and gives only a rough estimate of input – output behavior. On the other hand, Computer Aided Design simulations with in-built component level characteristics are fast and give a good insight on how the circuit would behave in practice.

For this reason, simulation was carried out to predict the Electronics watering machine circuit input – output behavior using the proven and commercially available Electronic Computer Aided Design (ECAD) simulation programmed – Circuit Maker2000 [15]. Simulations were carried out using "what if" scenario which consequently helped to fix values for certain components – certain resistors in particular. Simulations were also carried out using the specified and derived component values to predict if the circuit would behave as envisaged.



<u>Electronics Watering Machine Triggered By The Moisture Content Of The SoilCircuit</u>

CHAPTER FOUR

CONSTRUCTION

4.0 Construction Overview

The overall construction was carried out in two phases – the electrical component mounting phase on Vero-board and the mounting of input-output sockets as well as the board on the casing.

The electrical component mounting phase involved the arrangement of various components on a 0.1inch pitch Vero-board guided by the circuit diagram while the casing design involved the building of a ventilated enclosure for mounting Vero-board, controls, indicators as well as sockets for various inputs and outputs.

4.1 Electrical Sub-System

The data book specification for the dimension of each component served as a guide in planning the layout of the electronic components on the Vero-board. The electrical components include resistors, transistors, potentiometer, Operation, rectifying, light emitting diode, relay, buzzer and switch.

4.2 Mounting Of Components

Almost all the components used in the electronic industry are equipped with leads allowing them to be mounted in suitable sockets or more frequently inserted into holes in a printed board then soldered in place [16].

A number of design rules were strictly applied the mounting of the various components of the Electronics watering machine on the Vero-board.

These include:

- Ensuring polarity is in the same direction
- Providing sufficient space around component to ease repair
- The use of solder to fit the component in place

4.3 Casing Design

Casing of an electrical system is important to ensure safety and neatness of design

The type of material to use depends on the characteristics of the electrical system in question.

In designing the casing for the Electronics watering machine, various factors were considered, some of which includes

- Concept of the design
- Application of design
- Material type
- Safety

- Cost

4.4 Safety Precaution Observed

Safety precautions were observed at various stages of the design to protect the operator and the circuit.

To protect the transistors against reverse voltage breakdown caused by back e.m.f. generated by inductive switching of the relays, free-wheeling diodes were inserted across the relay coils. Terminals to which voltage sources are fed or polarized components are connected were colour coded to prevent human error in connection.

Plastic casing was used to protect the operator from shock due to electrical leakage.

4.5 Overall Circuit Performance

The soil moisture sensor/water pumping and the reservoir water level sensor/buzzer were designed to concurrently function as subsystems of the Electronics watering for Dry Season Horticultural system. An overall circuitry and the following results were obtained:

- When the soil was dry and the reservoir water level high, the motor of the water pump with a perforated pipe outlet was activated, the activity indicator lighted and the buzzer was deactivated.
- When the soil was dry and the reservoir water level low, the motor the pump activity indicator was lighted buzzer was activated.
- When the soil was wet and the reservoir water level high, the motor pump and the buzzer were deactivated and the activity indicator off.

- When the soil was wet and the reservoir water level low, the motor pump and the buzzer were deactivated and the activity indicator off from the result summarized above, it can be concluded that the desired objective was achieved.

4.6 Basic Fault Diagnosis

Fault diagnosis requires the system view. There are all sorts of thing that can go wrong with a system like faulty power sources (including dead battery, bad connectors and loose connector, open cables and cables connected incorrectly, input signal missing, incorrectly set control, component failure etc

It is important to carry out preliminary visual inspection checking out for the following:

- Burned and discolored component
- Broken wires and component
- Cracked or burned circuit board
- Foreign object
- Bent transistors leads that may be touching including other non insulated leads as well
- Part falling out of socket or only partly seated
- Loose or partly seated connectors
- Leaking components especially battery and electrolytic capacitors
- The use of instruments such as multi meters can be used to test output voltage value and comparism made to the expected value to diagnose fault.

It is important to observe the operational guide for operating the Electronics watering machine to ensure its optimal life.

CHAPTER FIVE

CONCLUSION

5.1 Achievement

It was found that the Electronics watering for Dry Season horticultural system is an easy, effective, and economical method of watering.

The project also exposes ways in which the Series connection of transistors could be employed to solve practical engineering problems.

The system was made as flexible and cost effective as possible. It could therefore be mass produced at cheap cost.

5.2 Recommendation

For mass production and international purpose, it is recommended that the components be mounted on a printed circuit board. This would give greater reliability and aesthetic appeal. The design could also be made more commercially more attractive, by computerizing or configuring it to a micro controller which would in turn be interfaced with seven segment displays, to display in digital mode of the preset value and the outputs from the reservoir moisture detector and the soil moisture sensor.

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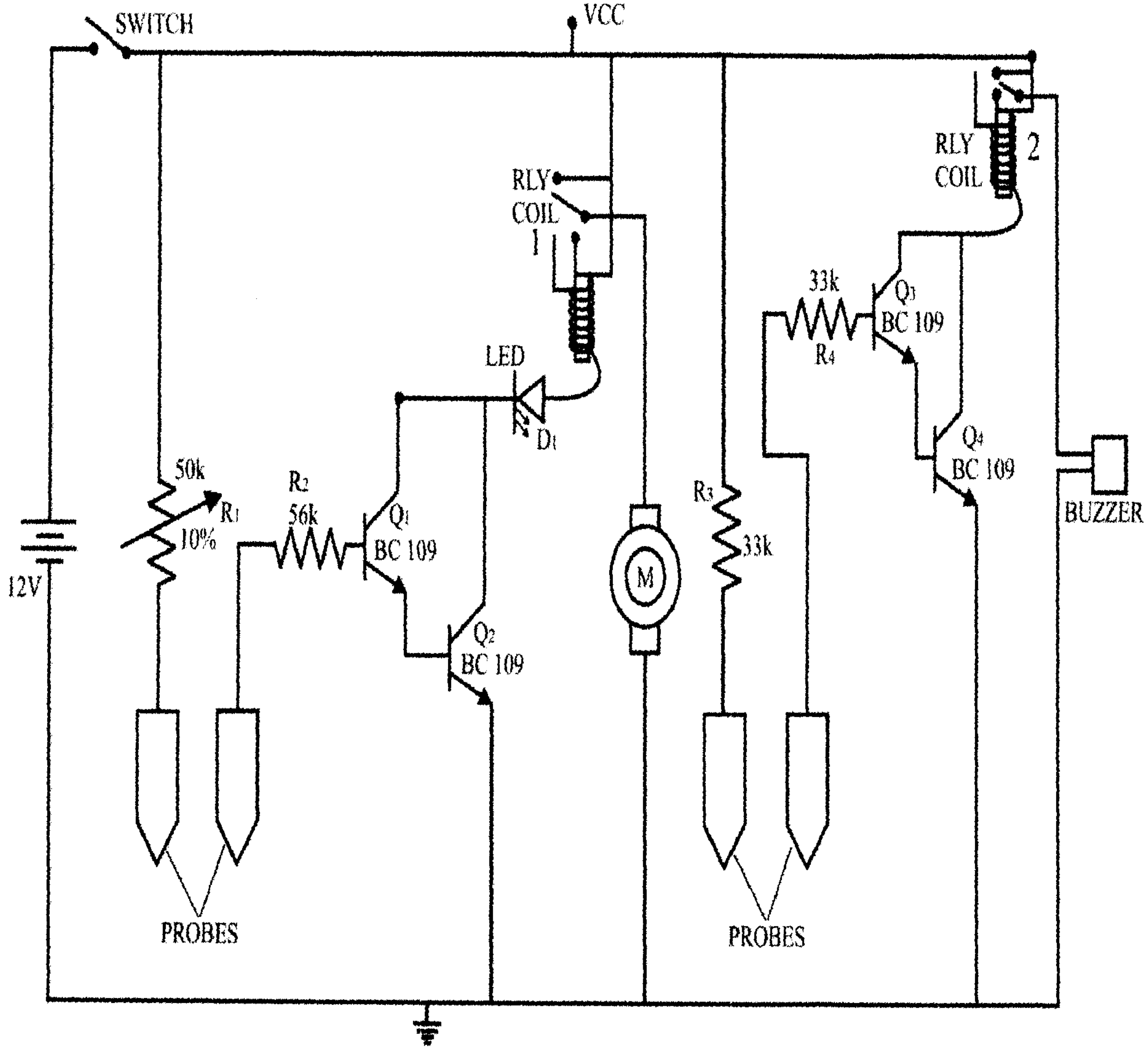
APPENDIX B



Electronics Watering Machine Triggered By The Moisture Content Of The SoilCircuit

The soil probe is then inserted into the soil spaced apart a known distance in the soil (depending on the datum soil) while the reservoir probe is inserted into the reservoir each, apart.

The Power Supply connectors are connected to their corresponding terminals in the correct polarity to the 12V battery. The circuit is the powered using the power switch.

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APPENDIX A

OPERATION MANUAL

Power switch: this is an ON, OFF switch used to activate or deactivate Electronics watering.

Reservoir probe terminal: this is the output terminal that connects the reservoir probes to the circuit.

Soil Probe terminals: this is an output terminal that connects the soil probes to the circuit.

Pump activity Indicator: this is a light emitting diode that indicates, pumping action.

Soil Moisture Sensitivity control: a potentiometer that is adjusted to increase to reduce the circuit sensitivity to soil moisture level detection.

12V Power Supply Terminals: this is an output terminal that connects a 12V D.C. Power supply to the circuit.

Motor Terminals: this is an output terminal that connects a 12V D.C. powered motor pump to the circuit.

Each probe is connected to its corresponding output terminal in its correct polarity.

The soil probe is then inserted into the soil spaced apart a known distance in the soil (depending on the datum soil) while the reservoir probe is inserted into the reservoir each, apart.

The Power Supply connectors are connected to their corresponding terminals in the correct polarity to the 12V battery. The circuit is the powered using the power switch.

APPENDIX A

OPERATION MANUAL

Power switch: this is an ON, OFF switch used to activate or deactivate electronics watering machine.

Reservoir probe terminal: this is the output terminal that connects the reservoir probes to the circuit.

Soil Probe terminals: this is an output terminal that connects the soil probes to the circuit.

Pump activity Indicator: this is a light emitting diode that indicates, pumping action.

Soil Moisture Sensitivity control: a potentiometer that is adjusted to increase to reduce the circuit sensitivity to soil moisture level detection.

12V Power Supply Terminals: this is an output terminal that connects a 12V D.C. Power supply to the circuit.

Motor Terminals: this is an output terminal that connects a 12V D.C. powered motor to the circuit.

Each probe is connected to its corresponding output terminal in its correct polarity.