DESIGN AND CONSTRUCTION OF DIGITAL WATER LEVEL DETECTOR

By

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DEDICATION

This project is dedicated to my beloved parents.

DECLARATION

I Lawal Muh'd Aminu declares that this work was done by me and never been
esent elsewhere for the award of a degree. I also hereby relinquish the copy right to
deral university of technology, minna

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(Signature and Date)   (Signature and Date)

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Lastly to my friends, colleagues and everyone that made this project possible.

ABSTRACT

The project involves the design and construction of a digital water level detector.

Detection of water level are within 25%, 50%, 75% and 100% of the entire volume of water.

Audible notification of this levels is effected through use of an alarm.

The benefit of this project among others is to avoid wastage as a result of spillage or overflow of water.

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CHAPTER ONE

1 INTRODUCTION

Production sector of the economy has advanced drastically in the use of technological method. Among these methods are the canning of food and bottling of drinks and all sort of liquid in general. Liquid are of particular interest due to the wonderful nature they posses.

Liquid refers to the state of matter where the atoms are not firmly held together but are also not so loose to the point of not having any force of attraction binding them. This important characteristic permits them to flow and take the shape of whatever container they are poured into.

Non – volatile liquid are of basic concern here and they include: water, soft drink, juice etc. all these requires pressure to flow effectively. Hence, the use of pumping machine by this sector of the economy is to meet the required flow for effective time management.

The installed pump in these industries and factories is to pump the liquid for storage and redistribution during the canning. Bottling processes requires an operator to monitor the liquid level in the tank which may be several meters above the ground level. As time goes on, the operator performance begins to deteriorate due to the monotonous nature of the job as well as the discouraging height at which the overhead tank is placed, thereby causing fatigue and boredom.

This performance deterioration causes inefficient and risk of having dry tank most of time which is not good for industrial processes because production have to be suspended and so capital is wasted due to what could have been avoided if only the level of the liquid in the tank or reservoir were known and controlled automatically.

This concern led to the conception of the idea of using logical circuit to produce a Digital water level detector with alarm system to indicate the level of water in a given vessel and also to trigger an alarm if the vessel is filled to its capacity and if the vessel is empty.

It indicate if water level is 25%, 50%, 75% and 100% capacity of water containing vessels by an arrangement of seven segment display with an alarm output. When the water-containing vessel is filled to its capacity (100%) and when it's empty (0%).

Water storage is a critical aspect of obtaining water security, so that water can be made available at all time, because the unavailable of water will cause discomfort and obstruction of industrial processes. At home, knowledge of water level is necessary so that domestic activity such as cooking, drinking, washing as well as bathing and other activities required to maintain cleanliness and personal hygiene do not become tedious or even impossible.

In industries, it is necessary to maintain certain minimum reserve of water in storage vessel to take care of erratic water supply from the public main supply, in other to avoid a sudden disruption of manufacturing process.

In hydro-power generating station where great quantity of water is stored in the Dam and used to drive turbine to generate electricity, the knowledge of the level of water in the dam is necessary so that the spill way can be open for excess water to flow out and in other to prevent the drawing of the dam.

Knowledge of the water level in a tank is necessary to prevent being taking unaware when the tank is empty as well as when the tank is full. Large volume of water is wasted due to the over flow of water in the tank as a result of in ability to know when the tank is full or any indication of the level of water in the tank.

The water level detector operates on the principle that the conductivity of water increases as the separation distance of the measuring probes increased, by supplying a reference voltage to the reference probe and placing the four probes horizontally at some distance apart from each other and also from the reference probes.

1.2   AIMS AND OBJECTIVE

The design and construction of water level detector is aimed at achieving the following goals.

1.   To enhance the efficiency of operation performance, by relieving the monotonous act of climbing to and fro the tank to determine the level of water.

2.   To avoid wastage of resources through spillage due to the tank overflow.

3. To provide a very efficient and simple method of knowing the level of water in a tank.

4. To put into practice, the various theories, laws and hypothesis learnt in school, such as Analogue electronic, Ohms law, Digital electronics, power electronics, laboratory practical at various levels, circuit theory and advance circuit technique among others.

PROJECT OUTLINE

CHAPTER ONE: This chapter gives a general introduction of the project, the aim and objective of project and the project outline.

CHAPTER TWO: This chapter covers the literature review that cover previous work done by different people on the subject, the theoretical background of the projects. This chapter also covers the principles of operation and also an in depth looks at various component and sub circuit that makes up the entire system.

CHAPTER THREE: This covers all the detail design and implementation, construction procedure employed to achieve the final product. It spans simulating circuit diagram on the computer system, bread board and soldering of the component on the Vero board, casing construction, construction precursions as well as the difficulties encountered in the course of the construction and circuit diagram of the various components.

CHAPTER FOUR: This chapter covers the testing procedure and difficulties encountered in the course of testing of the project, the result of the testing and its discussion.

CHAPTR FIVE: This chapter contains the conclusion drawn from the result of the testing with reference to the object and goals of the project. This chapter also contains the recommendation for further work on the project.

CHAPTER TWO

2.1 LITERATURE REVIEW

In order to obtain the level of a liquid, various methods have been employed in the time past starting from ancient "eyelevel" measurement where liquid is placed in a transparent container and the eye is placed at the line of best horizontality and at that point the measurement is taking as the level of liquid.

These however prone to a lot of error mostly arising from the observer. The need for a reliable method of the detecting the level and controlling the original flow therefore arises.

The earliest record of water measurement (detection) was the use of the float regulator machine in Greece in the period of 300 to 1 BC using feedback control. The water clock invented by Kleisibios used a float regulator to measure the level of water in the container on which a scale attached is used to take reading of time.

Russian Pulzunov I in 1765 invented the water level float regulator using feedback system, the float detect the water level and controls the valve that covers the water inlet in the boiler. [3]

The past 100 years have witnessed the emergence of various methods water level measurement (detection) as a result of the improvement in technology witnessed within this period. The ordinary dipstick is a simple device use for measuring liquid level.

It consists of a metal bar, on which a scale is etched, and fixed at a known position in liquid- containing vessel, removing the instrument from the vessel makes a level measurement and reading how far up the scale the liquid has wetted [1,16].

Measuring the level of a float on the surface of a liquid by means of a suitable transducer is another method of liquid level detection (measurement); the system using a potentiometer is very common and well known for monitoring the level of oil in motor vehicle fuel tanks; an alternate system is the float and tape gauge, where a tape is attached to a pulley situated vertically above the float and its other end a counterweight or a negative rate counter spring is attached, the amount of rotation of the pulley measured by either a synchrony or a potentiometer is proportional to the liquid level.

In the optical dipstick method, light from a source is reflected from a mirror and it passed round a chamfered end of the dipstick and enters a light detector after reflection by a second mirror, the instrument can be moved up and down its position is measure and hence the liquid level [1,3]

Pressure measuring devices used for water level measurement utilize the principle that the hydrostatic pressure due to a liquid is directly proportional to its depth and hence the level of its surface. In open topped vessels or covered ones that are vented to the atmosphere, the level of liquid is measured using an appropriate pressure transducer inserted at the bottom of the vessel. The liquid level is then relate to the measured pressure according to $h = p / pg$ where p = density of the liquid and g = acceleration due to gravity. [1,16]

Capacity devices are used for measuring liquid level in such application as measuring level in liquid metals (high Temperature), corrosion liquids (acids, e.t.c) and high-pressure devices. For non-conducting liquid (less than 0.1 micromho/Cm^3), two bare-meter capacitor plates in the form of concentric cylinders are immersed in the substance; the liquid behaves as a dielectric between the plates according to the depth of the liquid for conducting liquids, same method applies, but the capacitor plates are encapsulated in an insulating material, the dielectric effect of the insulator is put into consideration. The radiation method utilizes a radiation source and system location in a liquid filled tank. The absorption of both beta rays and gamma rays varies with the amount of liquid level. Caesium-137 is a gamma ray source which is commonly used for this purpose, the radiation level is measured by the detector. I is related to the length of liquid in the path x, according to the relation $I = Ioe^{-upx}$

Io = intensity of radiation received by the detector in the absence of any liquid.

U = mass absorption coefficient for the liquid.

P = mass density of the liquid.

The principle of vibration level sensor consists of two piezoelectric oscillators fixed to the inside of a hollow tube, which generates flexural vibrations in the tube at its resonant frequency. The resonated frequency of the tube varies according to the depth of its immersion in the liquid. A phase locked loop (PLL) circuit is used to track the change

in resonant frequency and adjust the excitation frequency applied to the tube by the peizo – electric oscillator. Liquid level measurement (detection) is therefore obtained in terms of the output frequency of the oscillator when the tube is resonating.

The ultrasonic level gauge principle uses energy from an ultrasonic source above the liquid reflected back from the liquid surface into an ultrasonic energy detector, measurement of time of flight allows the liquid level to be inferred. The Stevens ultrasonic level transmitter is a non-contact, solid state device for sensing water level in channels, lakes or streams for liquid to a data logger or other monitoring unit, analogue output can be configured normal or inversely proportional to the distance the target or water surface.

The Stevens submersible depth transmitter is a sensing device designed for water level measurement applications. Higher range units are used for ground water, storage tanks or other applications. Low range units are ideal for open channel flow application; a stainless steel pressure transducer is used as the primary sensing element, and it measures the water depth by pressure above the unit.

The improvement technology in the semiconductor industry led to the development of the operational amplifiers, operational amplifiers were developed initially for use in performing arithmetic operations such as addition, subtraction, multiplication and division. Later it was discovered that operational amplifiers could be used for other purpose other than performing arithmetic operation; one of such uses is as

a difference amplifier or differential amplifiers to amplify the voltage difference at its two inputs, as well as for comparison of voltages as a comparator, comparing a reference voltage with a varying voltage, without any feedback the operational amplifier is used as a comparator.

2.2 PRINCIPLE OF OPERATION

The water level detector works on the principle of conductivity of water, which increases with the increase in the separation of the conductive element that is the metal probes.

It consist of five probes with the first one as the reference probe connected to ground. As the water level increases they come in contact with the sensor. I.e., the probes voltage goes low in comparison with a reference voltage that is high and output of the comparator is low. As the water comes in contact with each probe, the level of water is displayed on a seven-segment display using logic circuit to achieve this.

2.3 THE POWER SUPPLY UNIT [2,7,9,10]

All electronic devices utilize a direct current (D.C) voltage source for operation. The main electricity supply is an alternating current at a voltage of 220V AC. A circuit is therefore required to step down this voltage to the required value as well as to convert it to direct current (D.C) voltage form required by electronic devices for operation.

Although batteries provide a cheaper source of direct current voltages, it cannot satisfy the amount of current drawn by most electronic devices for a long time as the battery is quickly drained and thus becomes inefficient, hence an A.C to D.C conversion is done by the power supply unit consisting of the transformer, a rectifier (bridge), a filter and a voltage regulator which function together to transform the alternating current (A.C) voltage supply from the mains into a regulated D.C supply as the output of the power supply unit.

Figure 2.0 shows a block diagram of the power supply unit.

A.C input → | Transformer | → | Rectifier | → | Filter | → | Regulator | → DC OUTPUT
220V/50Hz
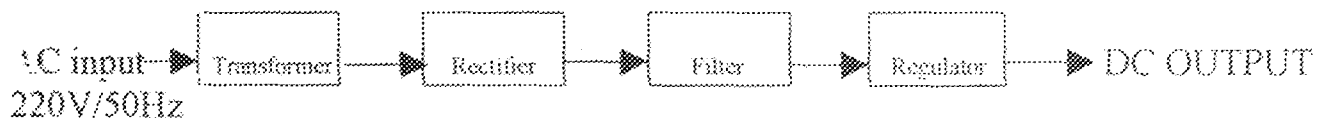
fig 1.0. POWER SUPPLY UNIT DIAGRAM

2.3.1 THE TRANSFORMER SPECIFICATIONS

The first stage of the power supply unit design involves the stepping down of the 240V A.C mains from the mains supply to about 12V A.C, with the aid of 240V/12V, 1000mA transformer whose current capacity is enough to drive the entire circuit. The transformer is an electrical device that provides physical insulation between the 240V A.C main and the rest part of the circuit; the only link is means of magnetic flux, thus eliminating the risk of electric shock.

It consists of two coils, the primary winding and the secondary winding.

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Figure 2.2 shows the circuit symbol of a transformer.

The ratio of the primary voltage V1 to the secondary voltage V2 is equal to the turns ratio or number of turns of the primary winding N1 to that of the secondary winding N2 of the transformer.
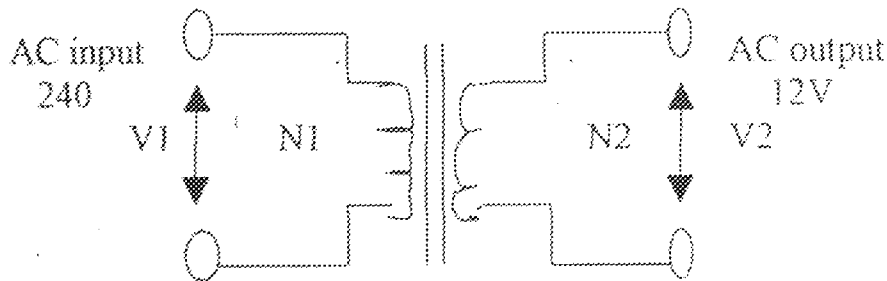
fig. 1.1 TRANSFORMER CIRCUIT SYMBOL

From the transformer data V1 = 240V, V2 = 12V, I2 = 1000mA = 1A, the frequency of the A.C main supply is 50Hz.

The primary and secondary voltage of an ideal transformer are related as follows:

$V1/V2 = N1/N2 = 240/12V = 20$

$\Rightarrow V1/V2 = N1/N2 = 240/12 = 20$

Hence the turns ratio N1 : N2 = 20 : 1

$\Rightarrow N1 : N2 = 20 : 1$

In an ideal transformer, the magneto motive force (mmf) = NI

$N1 / N2 = I1 / I2 = 20$

$I2 = 1000mA = 1A$

$I2 / I1 = 20 \Rightarrow I2 = 20I1$

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$I1 = I2 / 20 = 0.05A \Rightarrow I1 = 0.05I2$

Also in an ideal transformer,

Power input = power output

$P1 = P2 \Rightarrow P2 = P1$

$I1\ V1 = I2\ V2 = 0.05 \times 240 = 1000 \times 10^{-3} \times 12 = 12W$

THE RECTIFIER SPECIFICATIONS

The rectifier converts the 12V, A.C voltage from the secondary of the transformer into a pulsating D.C voltage and the process is called rectification. A full wave bridge rectifier circuit is used for the rectification. It consists of four IN 4001 diodes arranged as shown in the figure 2.3 below.
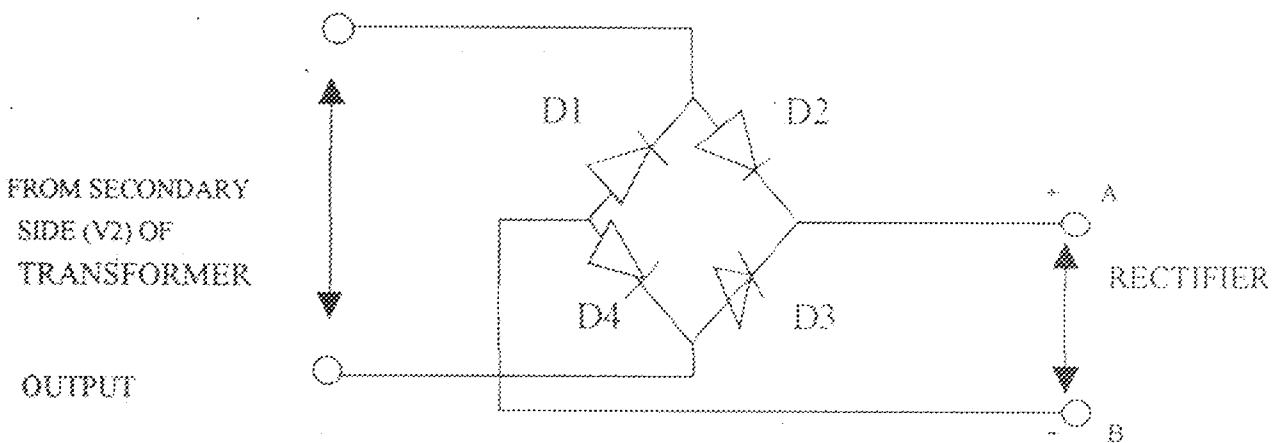

fig 1.2   FULL WAVE BRIDGE RECTIFIER CIRCUIT DIAGRAM

During the positive half cycle of the secondary voltage, diodes D2 and D3 are forward biased, therefore load voltage has negative polarity on the left and positive polarity on the right. During the negative half cycle diodes D1 and D4 are forward biased, on either half cycle the load voltage has the same polarity because the load current is in the same direction no matter which diodes are conducting. The full secondary voltage appears across the resistor; hence the bridge rectifier is better than the full wave rectifier.

The output voltage of the transformer winding $v2 = 12v$

$\Rightarrow$ V2 (peak) $= v2\sqrt{2} = 16.97v$

The average D.C voltage V d.c across terminal A B

V d.c $= (2/\pi)(16.97) = 0.6366 \times 16.97 = 10.80V$

2.3.2   THE FILTER SPECIFICATIONS

The filter circuit is to minimize the ripple content of the rectifier output. The output voltage waveform of a rectifier is pulsating. It has both D.C component and some A.C components called ripple, this type of output is not used for driving electronic circuits.

A circuit that converts a pulsating output from a rectifier into a steady D.C level is known as a filter because it filters out or smoothens out the pulsations in the output. Capacitive filtering is adopted in the design; where a large electrolytic capacitor is

connected to the rectifier output. The capacitor charges during the diode connection period to the peak value and when the rectifier voltage falls below this value, the capacitor discharges through the load so that the load receives almost steady voltage.

For a r.m.s (root mean square) voltage of 12V from the transformer secondary

$V2$ (peak) = r.m.s × $\sqrt{2}$ = $12\sqrt{2}$ = 16.97 volts.

Let the ripple voltage be 20% of this value, dv – 20% of 16.97 = 3.39

$1/C = dy/dt$ ....(2.1)

$C = dt/dv = 10ms/3.39$ (where dt = 10ms) = 2.9499×10^{-3} = 2949.9µF.

However, a preferred value (standard) value of 3300µF/50 Volts was used. The arrangement is shown in figure 2.4 below
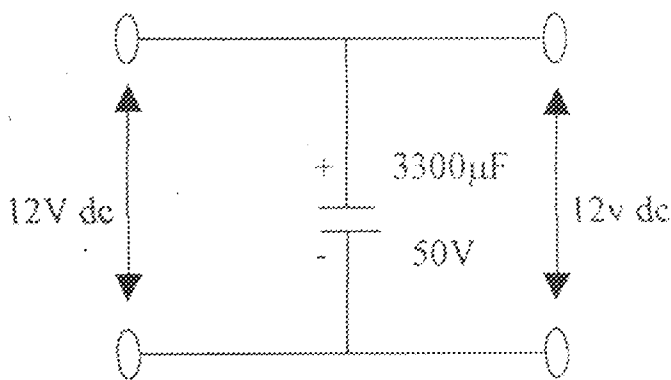

fig 1.3 FILTERING CAPACITOR CIRCUIT DIAGRAM

2.3.3 THE VOLTAGE REGULATOR CIRCUIT SPECIFICATIONS

The output voltage of the filter capacitor varies when the load current or the input voltage varies; this effect is undesirable. In an unregulated power supply, output voltage is never constant. The function of the voltage regulator is to reduce these varieties to

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Zero or least a minimum possible value.

A voltage regulator is a circuit that holds an output voltage at a predetermined value regardless of the change in normal input voltage or changes in load impedance. Voltage regulators mostly come in a three package.

They have one input terminal, one output terminal, and a ground terminal. A voltage regulator requires an input voltage at a minimum of 3 volts above the output voltage it is designed to deliver, hence the choice of a transformer of 12V at the secondary terminal for the use of a voltage regulator of 6 volts.

The LM 7806 voltage regulator was used. A capacitor of 0.01µF was connected at the output to filter off any ripples left on the supply line. Figure 2.5 is the complete circuit diagram of the power supply unit.
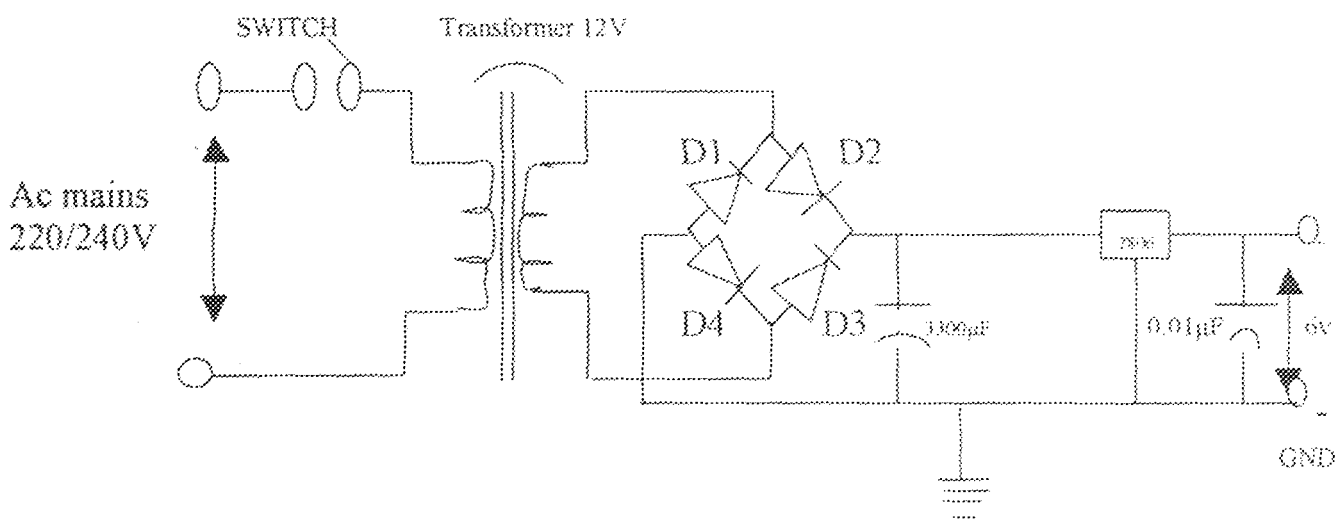

fig 1.4 POWER SUPPLY UNIT CIRCUIT DIAGRAM

2.4   THE WATER DECTECTION UNIT

This unit uses aluminum conductors as the probe to convert (transducer) the water level into electrical signal (D.C voltage).

It does this based on the principle that the conductivity of water, which increases with the increase in separation distance of the sensor, probes, from the reference probe. All aquae's solution conduct electricity to various degrees, the conductivity of liquids varies with temperature, volume and separation distance of the sensor (measuring) probes.

In the water detection unit the common or reference probe positioned at the bottom of the tank is connected to the reference voltage source, the 25% probe is positioned at the minimum. Desired water level in the tank 50% and 75% probe are placed at the appropriate desired water level and the 100% probe at the maximum desired water level of the tank.

2.5.1 AND GATE SPECIFICATIONS

This is a logical gate that gives a high O/P only if both inputs are high. The truth table and the logical symbol are shown below.

Table 1.0 TRUTH TABLE OF AN AND GATE

INPUT A	INPUT B	OUTPUT C
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

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A
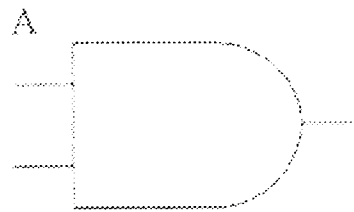
B   C = A.B
fig 1.5 AN AND GATE

As with other logic gate, AND gates are available with 3 or 4 (sometimes more)

input. A quad two input AND buffered b series gate 4081 (CMOS family) was used is

this project. The Boolean symbol for AND is a dot (.); this can be omitted, and usually is

"A AND B" is written A.B; or simply AB. From the truth table above, it indicates that

the output at logic level 1 (High) only when both input are simultaneously at logic level 1

(High) in other words the output is high if input A and B are both high. [17,18,19]

2.5.2   EXCLUSIVE OR GATE SPECIFICATIONS

This is a symmetric two input logic gate, its an interesting function although les

fundamental than AND and OR gates. The truth table and the logical symbol are shown

below.

Table 1.1 TRUTH TABLE OF AN EX-OR GATE

Input		Output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

A

B
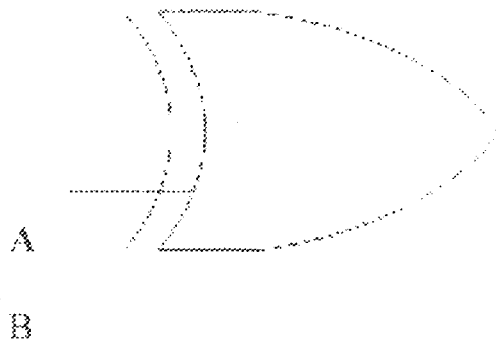
$$C = A (+) B = AB + BA$$

fig 1.6   AN EX-OR GATE

The output of an exclusive OR gate is HIGH only input one (not both inputs) is HIGH (it never have more than two inputs). The two input Quad Exclusive OR gates 7486 (T TL Ic family) are used in this project. The exclusive OR gate is identical with modulo – 2 addition of two bits.[17,18,19]

2.5.3   THE NOT GATE SPECIFICATIONS

This is a one input one-output logic gate; it's sometime called inverter. This is because it is capable of given the complement of the input as it's output. The Hex inverter (T TL Ic family) 7404 is use in this project. The Boolean symbol for NOT is a bar over the symbol, or sometime a prime symbol. "NOT A" is written $\bar{A}$, or A'. The truth table and logical symbol are shown below.[12,18,19]

A —————▷○—— B

fig 1.7   19
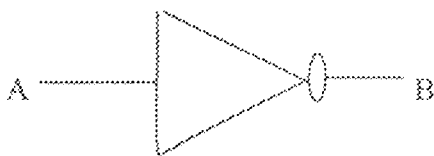
Table 1.2 TRUTH TABLE OF A NOT GATE

Input	Output
A	B
0	1
1	0

2.6 BCD TO 7 – SEGMENT DECODER SPECIFICATION

The BCD TO 7 – segment decoder used in designing this project is 7447A. It is an integrated circuit which accept a 4- bits BCD code input and produces the appropriate output for selection of the segment in a 7 – segment matrix display used for representing the decimal number 0 – 9.

The 7 output ($\bar{a}$, $\bar{b}$, $\bar{c}$, $\bar{d}$, $\bar{e}$, $\bar{f}$, $\bar{g}$) of the decoder select the corresponding segment in the matrix. The diagram is shown below [11,17]

fig 1.8 BCD TO SEGMENT DECORDER

2.7 DISPLAY UNIT SPECIFICATION

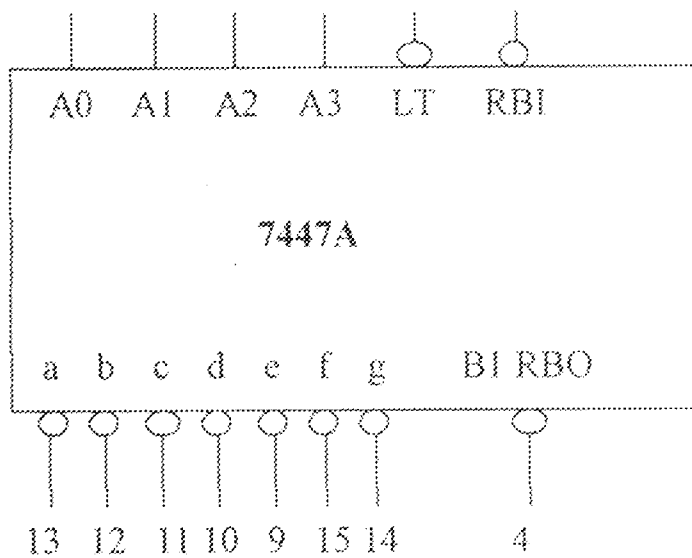The display unit used in displaying the result of the water level measured by this device in decimal form is the 7 – segment Display, which comes in form of an integrated circuit (IC).
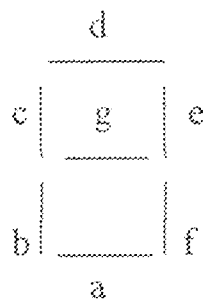

fig 1.9 SEVEN SEGMENT DISPLAY

A 7 –segment display circuit of seven rectangular LEDs, which can form the digit 0 – 9 as shown below.
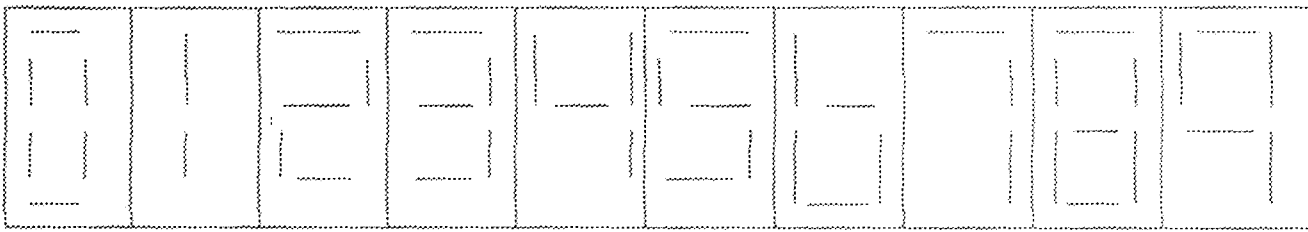
Fig 2.0 DISPLAY OF DECIMAL NUMBERS 0 - 9

They come in two types arrangement: common – cathode and common – anode. In common – cathode arrangement, all the cathode of the segment are tied together and connected to the ground while common – anode type, the anode of all the segments are connected together to vcc. A common Anode type of 7 – segment display was chosen for this device because it allows a BCD to 7 – segment decoder (which is readily available) with active low output to drive it.

Applying a low voltage to the cathode of the segment that are to be activated with each segment requiring 10 to 20mA to light it. [11,17]

2.8 THE COMPARATOR SPECIFICATION

A comparator circuit accepts input of linear voltage and provides a digital output that indicates when one input is less than or greater than the other.
A basic comparator circuit can be represented as follows:

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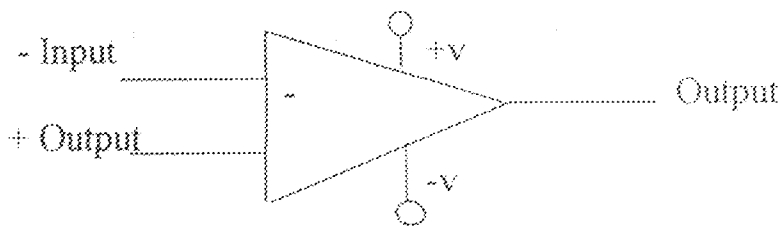
fig 2.1 CIRCUIT REPRSENTATION OF A COMPARATOR

The output is a digital signal that stays at a high voltage level when the non-inverting (+) input voltage is greater than the voltage at the inverting (-) input and switches to a lower voltage level when the non- inverting input voltage goes below the inverting input voltage.

In this project LM 339 IC quad comparator is used, it contains four independent voltage comparator circuits connected to external pins. Each comparator has inverting and non- inverting input and a single output.

The supply voltage applied to a pair of pins powers all four comparator.

The supplies circuit diagram is as follows: [11]
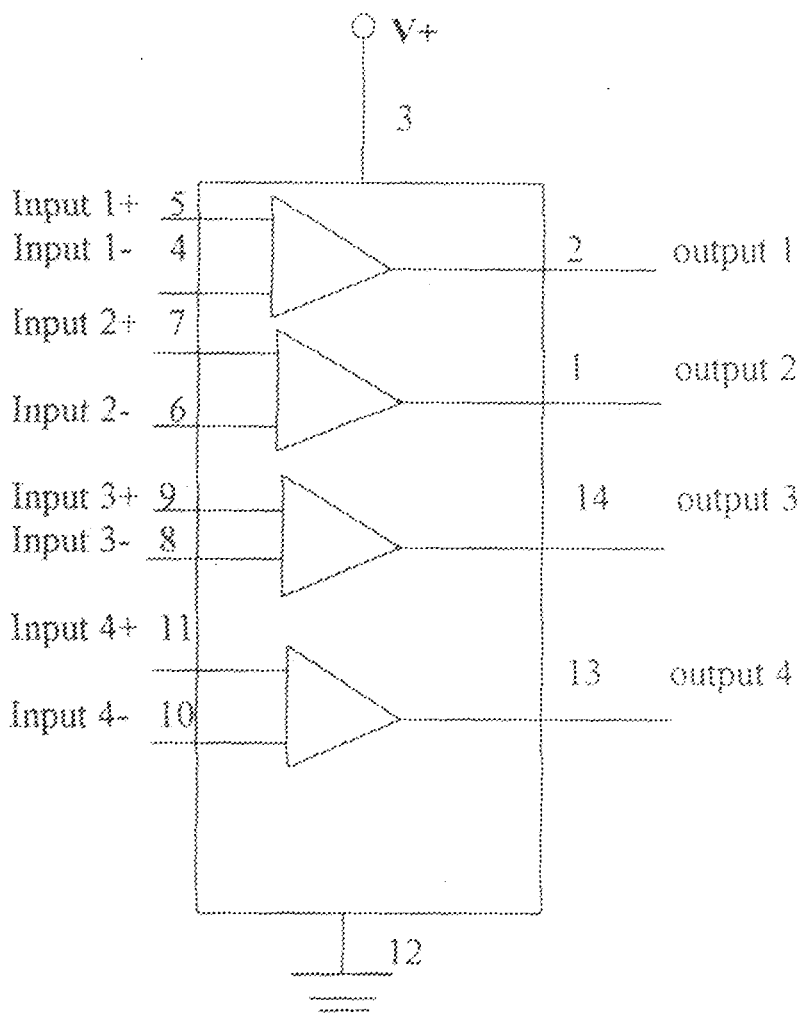
fig 2.2 INTERNAL CIRCUIT OF A QUAD COMPARATOR (LM 339) IC

2.9   THE 555 TIMERIC [555

This is a device that has gained popularity in recent time. It comes in an 8- bits

DIP package and can be set up in various modes. Its internal circuitry consists of; lower

comparator, upper comparator, internal flip –flop, discharge transistor and an output

driver.

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The lower comparator compares the voltage on its input with one – third (2/3) vcc. If its input is greater than 2/3vcc. It sets the flip – flop. Pin 5 controls or change the threshold voltage the upper comparator.

The internal flip – flop is set to saturate the discharge transistor and also cause the output driver to produce an output of 1. if the flip – flop is clear and discharge transistor is cut-off the output driver produces a 0 (zero) output. For the purpose of this experiment, an Astable mode was adopted. **The** circuit is as shown below. [11,12,17]

The block diagram of the 555 timer is as shown below:

fig 2.3   555 TIMER IC PIN REPRESENTION.

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2.10   DESIGN SEQUENCE OF THE ALARM CIRCUIT

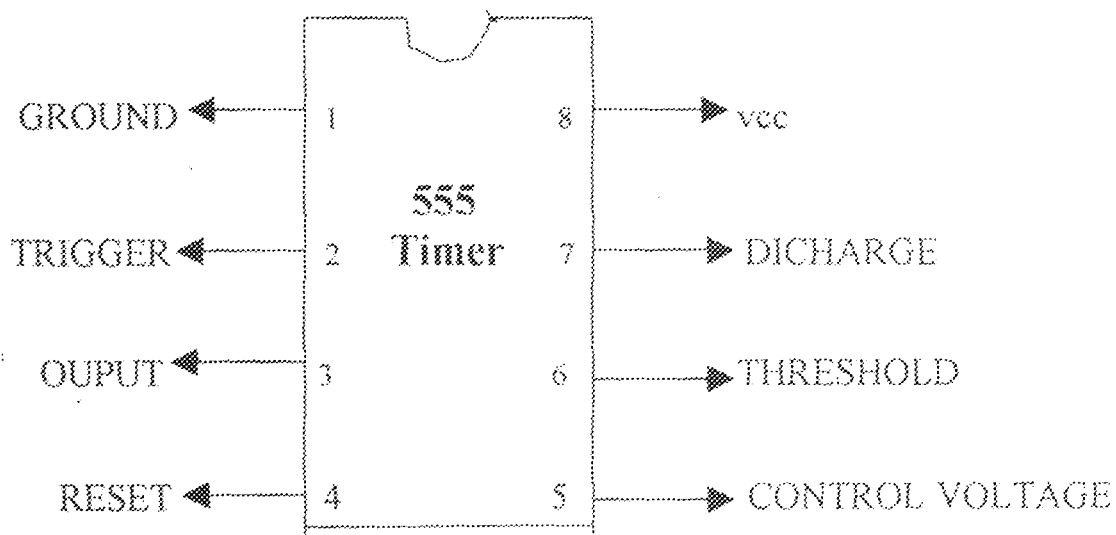This alarm circuit is design to produce an output frequency of 145.9Hz. To achieve this, a capacitor C1 of 1μF was chosen and it is connected in series to a resistor Rb of 4.7KΩ. The required mode of the 555 timers IC to be used is the astable mode of operation.

This mode of operation have a frequency,

f, given as; $f = 1.44/(Ra + 2Rb) \times C1.$ [11]

2.11   PRIORITY ENCODER SPECIFICATION

The name encoder is a circuit having up to 2^m main inputs and m outputs, such that when one input x_i is active, the m – bit binary pattern representing the number I appear on the output bus. Hence, an encoder generates the address i of an active line x_i, in contrast with a decoder, which uses the address I to active address line z_i. Since there is nothing to prevent the input line of an encoder from being activated simultaneously, encoding circuit is normally designed to respond to only one active signal. This is done by assigning priority values to the input line, and designing the encoder, usually called a priority encoder, so that only the address of the active input with the highest priority is generated at any time.

In this project, we used the 74184; it is an eight-bit priority encoder with a full compliment of data and control line. The output control line I denotes inactive inputs; it

is active (i = 0) whenever all the input data lines are inactive.[11,12,17]

i.e,

x = 11111111 and E = 0.

A second out line G is useful for increasing the encoder size. It is activated

(G = 0) only when there is at least one active input (implying that I = 1), and the encoder

is enabled (implying that E = 0).

Hence, we write G = I + E.

Inactive input I

Decoder X0 ──▶ 2^m   Encoder output

Input X1 ──▶   priority   m
               encoder   ──/──▶ Z1

X^m - 1 ──▶

E

(a)
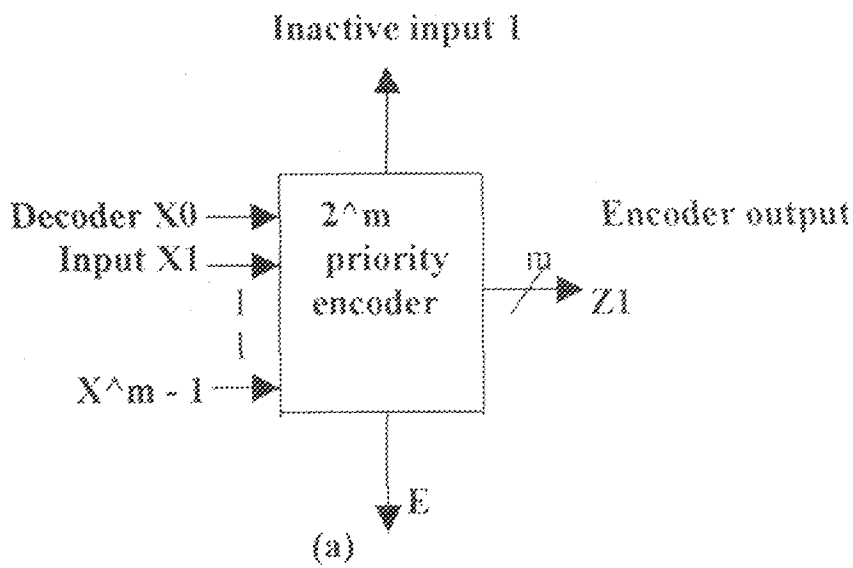
fig 2.4   BASIC DIAGRAM OF A INPUT 2^m PRIORITY ENCORDER
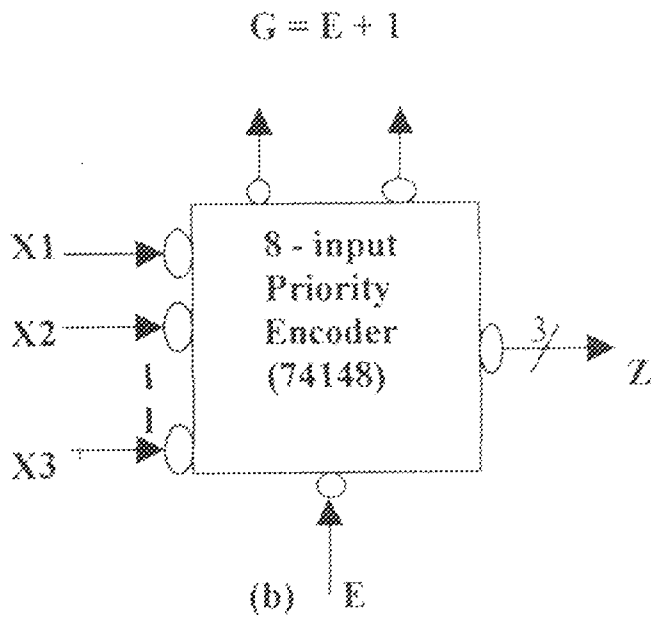
$$G = E + 1$$

(b)   E

fig 2.5   DIAGRAM OF 8 – BIT PRIORITY ENCORDER

CHAPTER THREE

3.1 CONSTRUCTION OF VOLTAGE COMPARATOR/SEVEN SEGMENT DISPLAY UNIT

These units were construction on a single Veroboard to avoid any likelihood of any broken connection and for easy troubleshooting.

The voltage comparator was constructed by connecting $1.2m\Omega$ to vcc and the other terminal to the non-inverting input. From the non-inverting input, a cable is connected to the probe. This is repeated for the other levels. Also, $2.2k\Omega$ resistor is connected to the V_{cc} and the other terminal to the inverting input and a $1k\Omega$ resistor is connected to the inverting input and other point to ground to create a fixed voltage potential at the inverting input of all the comparator, with this arrangement, the output of the comparator is high. A pull up resistor, $1k\Omega$ is connected to all the comparator to complete the circuit externally. As water come in contact with any of the probe, the output goes low for the next stage.

3.2   SEVEN SEGMENT DISPLAY

The seven segment display is used to display the output from the decoder. The seven segment display used is the common anode when the anode is connected to vcc via a limiting resistor. When the output of the decoder is low and connected to the display, the

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right binary equivalent (decimal) will be displayed.

3.3   CONSTRUCTION OF THE ALARM UNIT

The alarm unit was constructed on a veroboard, the 8-pin IC socket for the 555 timer. The 555 timer is power from the output of the exclusive OR gate 7486 which compares the output of pin 13 and 14 and output to the 555 timer. A buzzer is connected to the alarm circuit (555) timer to give the alarm signal when required.

3.4   CONSTRUCTION TOOLS AND MATERIALS

The tools and materials as well as instrument used during the construction of the project are briefly described below.

(i) THE CIRCUIT SIMULATION: The circuit diagram was tested on the computer using the multisim 7 software for the simulation, the output voltage required to illuminate each of the 7 – segment display was measure to know, if the value will be sufficient to illuminate the 7 – segment display, the waveform all these outputs was also viewed using probes.

The circuit diagram functioned as desired.

(ii) THE BREAD BOARD: The is a temporary board for circuit testing with tiny sockets that allows for electronic components (i.e. Resistors, capacitors, ICs e.t.c) to be easily plugged or removed freely without damaging the component.

The breadboard is meant for pre-construction testing of circuit and sub – circuit before the component are soldered on the Vero board.

(iii) THE ANALOG/DIGITAL MULTIMETER: These were devices (instruments) used for measurement of electrical quantities such as resistance, voltage and current.

They are also capable of being used to test circuit sections for continuity. The digital multimeter gives a digital output display of measured quantities, while analog meters gives an indication of the value of measured quantities on the scale. The value of which is read on the position of the pointer on the scale.

(iv) THE VERO BOARD: This is a perforated board on which electronic components can be inserted and soldered permanently.

It is used for permanent construction of the project prototype from the circuit diagram.

(v) THE WIRES AND CONNECTORS: Wires are used during the testing stage of the project on the breadboard to connect the component together as well as the the different sub – unit of the circuit, as well as during the soldering of the components on the Vero board. The type of wire used is the copper wire.

(vi) THE IC SOCKETS: This is a device used to hold IC socket is first soldered on the Vero board, before the IC chip is fixed on it, to prevent the heat of the soldering iron from destroying the IC, which is very sensitive to heat.

(vii) THE WIRE CUTTER AND STRIPPERS: These tools are used to cut wires to the desired size required before use, as well as to strip off insulation of the wire in

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(viii)other to expose the conductor for proper and neat soldering.

(ix) THE SOLDERING IRON: This is a low power heating element typically 40 watts. It provides the heat needed to melt the lead, so that it can be used for the connection of the components permanently on the Vero board. It is usually connected to the AC mains.

(x) THE SOLDERING LEAD: This is a metal (lead) wire of low melting point. It is used to electrically connect components and wires in the fixed position on the Vero board.

(xi) THE LEAD SUCKER: This is used to suck up excess molten lead from the Vero board to prevent short circuit (bridging) or under desirable electrical connections.

3.5 CONSTRUCTION DETAILS

The entire circuit was divided into different section for easy troubleshooting and construction, each of these units are soldered on different Vero boards.

3.5.1 CONSTRUCTION OF THE POWEER SUPPLY UNIT

A switch was connected to the primary of the 6V transformer for the control of the AC power supply to the transformer, the secondary of the transformer was then connected to the bridge rectifier circuit formed by connecting IN4001 diodes, the 3300µF/50V capacitor was then connected between the output of the bridge rectifier and the ground.

The input pin of the 6V voltage regulator was then connected to the output supply after the capacitor and the second (terminal) pin connected to the terminal, the output voltage was then obtained by connecting a wire to the third terminal of the voltage regulator. A 0.01μF was then connected on a continuous line on the Vero board, to obtain the 6V DC output voltage.

3.5.2 CONSTRUCTION OF THE WATER DETECTOR UNIT

The water detector unit was constructed using aluminum conductors, which were cut into four numbers of equal length. These were then positioned at different height level passing them through a hole at the height level made on a plastic container.

A connecting wire for the reference voltage was then connected ti the reference probe placed at the lowest level.

The 25%, 50%, 75% and 100% probes were then positioned passing them through the hole made in the plastic container at the desired levels. These four probes were then connected together to make electrical contact with each of these three probe.

3.6 CONSTRUCTION PRECAUTIONS

1. All soldered joints (points) were tested for continuity so as to avoid open circuits.

2. All the excess leads were removed to avoid bridge (short circuits) on the boards.

3. Polarities of the electrolytic capacitors properly checked to be correctly positioned before connecting (soldering) on the Vero board.

4. ICs were mounted on IC sockets to avoid overheating them during soldering

by soldering the IC socket first on the Vero board.

5. Excessive heating of the components was avoided so that they do not burn by making the soldering process to a component very brief.
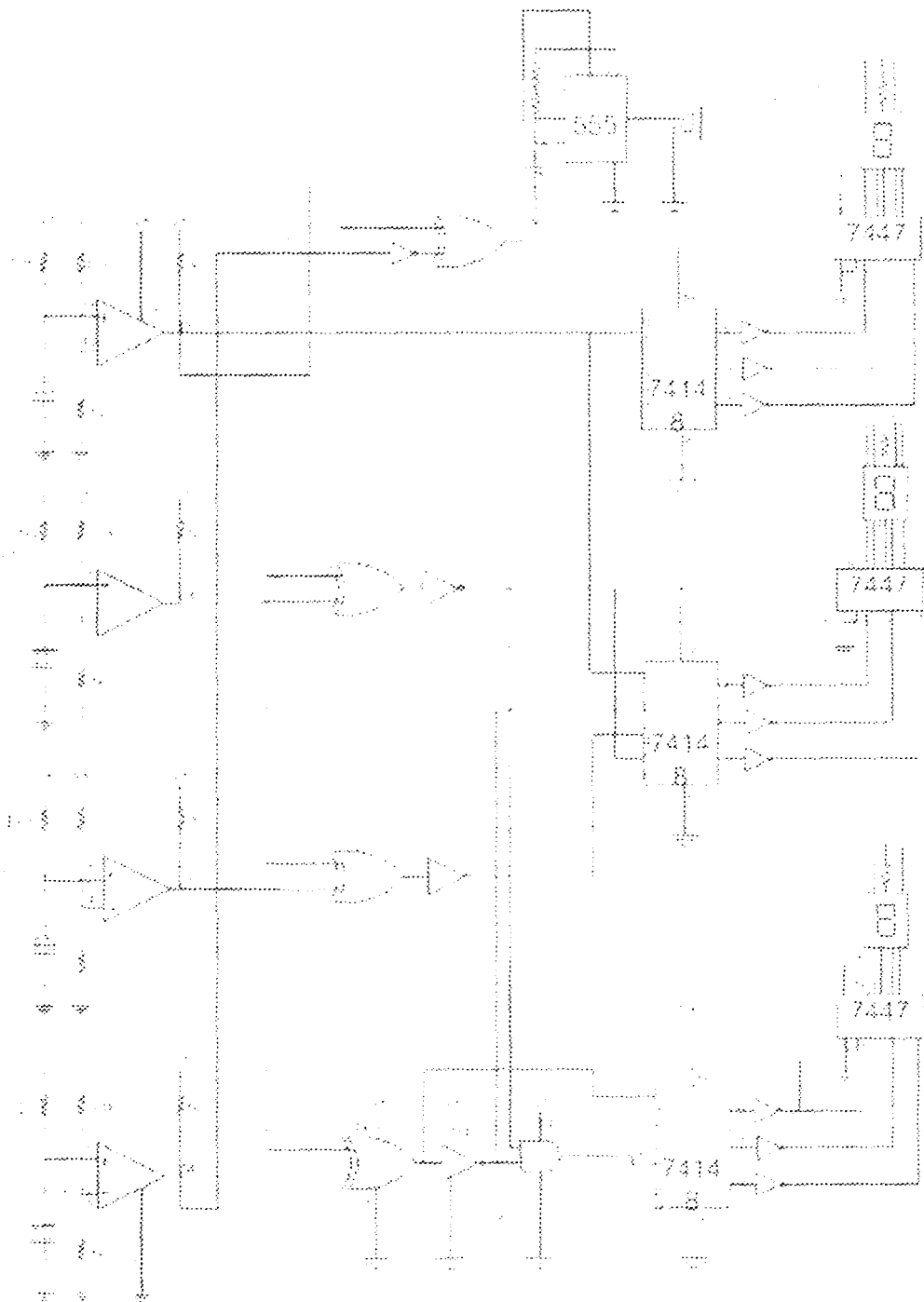
COMPREHENSIVE CIRCUIT DIAGRAM

CHAPTER FOUR

4.1   THE PROJECT TESTING

Measuring the output voltage after regulation tested the power supply unit, and it was found to be acceptable 6.1 volts. The entire circuit was then tested by inserting the probe into small container (CAN); water was then gradually poured into the container to increase the volume of water in the container, the 7 segment does not illuminate until the water just came in contact with the first probe. Then the 7 segment display 25%, and when the water reaches the second probe, it display 50%, when the water reach the third probe it display 75% and the water reach the forth probe it displays 100% the alarm was triggered on.

4.1.1   THE RESULT OF PROJECT TESTING

The result of the project testing was summarized in the table below for easy understanding and accessibility.   Table 1.4   7 - SEGMENT DISPLAY

WATER LEVEL	25%	50%	75%	100%	ALARM OUTPUT
BELOW FIRST PROBE	OFF	OFF	OFF	OFF	ON
AT THE FIRST PROBE	ON	OFF	OFF	OFF	OFF
AT THE SECOND PROBE	OFF	ON	OFF	OFF	OFF
AT THE THIRD PROBE	OFF	OFF	ON	OFF	OFF
AT THE FORTH PROBE	OFF	OFF	OFF	ON	ON

4.2 PROBLEMS ENCOUNTERED

(i) When the project was first tested, the response was not satisfactory, the probes were then positioned to be directly above the reference probe and the reference voltage to the reference probe was adjusted. On testing again, a satisfactory result was obtained with the 7 – segment display as expected and the alarm output being as desired.

(ii) The initial stage of soldering was characterized by some mistakes, such as overflow of molten lead burning of my finger with iron. But with time and together with the advise of my supervisor this difficulty was overcome.

4.3 PROJECT CASING

The project casing made of plastic, was carefully constructed to make provisions for the probes, and the buzzer, the power supply switch, LED indicator and seven segment display.

The casing is of dimension (2.1cm x 9cm x 9.5cm).

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

From the result of the tests carried out after the construction of the project, the water level detector was able to detect when the water in a tank is at a 25%, 50%, 75% and 100% of the tank, with an alarm output when water is at 0% and 100% of the capacity of the tank.

Hence, the aim of the project has been achieved. The components used in constructing the device are readily available.

The device will be useful in our homes, in the industries, hospitals, schools and dam sites to provide a knowledge of the water quantity available for use.

5.2 RECOMMENDATIONS

In the water level detector design and construction, 7 – segment display were used to indicate the level of water in a tank or storage vessel, this can be improved on by incorporating an Automatic pump using switching transistors and relays to switch on or off the water pump at 0% and 100% capacity of the tank, i.e to on the water pump when the water in the tank is at 0% of the tank capacity and off the water pump when the water in the tank is at 100% of the tank capacity.

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