DESIGN AND CONSTRUCTION OF A WEATHER ACTIVATED WINDOW

BY

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2000/9809EE

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILMENT OF THE REQUIEMENT FOR THE AWARD OF B.ENG. DEGREE.

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Dedication

I dedicate this project to the Almighty God for giving the grace to come this far and to the entire family of Wg Cdr and Mrs. Y.K Avong, thank you so much for making my stay in school a success.

Declaration

I, Avong Kambai Boman, 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.

Avong Kambai Boman — 07/10/06
(Student) — Date

Mr. M.S.N Rumala
(Supervisor) — Date

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(HOD) — Date

External Supervisor — Date

Acknowledgement

I wish to express my profound gratitude to the Almighty God for sparing my life to be able to do this project work.

I also wish to thank my supervisor, Mr. M.S.N Rumala for his assistance, constructive cricism, patience and understanding, who despite numerous tasks has found time to supervise every step of the work. My academic level adviser Mr. J.G Kolo and other staff of Electrical Engineering Department, I remain grateful for your effort.

My profound gratitude also goes to my friends Agbe, Zugwai, Ijachi, Solomon, Umanah, Dashe and the entire Big Brother House, love u guys. Altronics Inc thanks so much .Favor Danjuma....you will always be a sweetheart.

Abstract

The design and construction of a weather activated window is described in this project. The project is intended to respond to very harsh weather conditions such wind or rainfall and closes automatically. This is to prevent damage to furniture, electronics and every other household equipment. Comparators are connected to the wind and rain sensors to compare voltage with a set reference voltage. The control and logic unit receives this signal and provides the proper timing and control operation needed to drive the electromechanical motor responsible for closing the window.

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Chapter One

Introduction

1.1 General Introduction

The major benefit of technology to mankind is the ability to achieve a hard task with little labor input. Man's innovative spirit and need for elegance has always pushed him to the extreme trying to make things much more beautiful and easier to use. The quest for beauty and elegance has made today's architectural designs much more complex than they use to be in years past, thereby creating a need for complex household designs. Time is now greatly optimized through the development of electronics. Most industrial operations are now automated for ease and efficiency. Domestic automated appliances are making household activities faster, more accurate, more reliable and most of all safer. [11]. Through research and more study on automation, simple circuits can now perform better than previous complex circuits and also production cost reduced making them cheaper. Recent studies have also shown that 50% of the world's hazards on buildings and properties are caused by heavy wind pressure and rainfall. Small scale wind and rain also has a major devastating effect on household properties and windows are the gateways for such weather conditions [12]. It is a common practice to close windows during such harsh weather conditions and this is done manually. Manual closure is a disadvantage especially when the building has multiple floors. Therefore the need for maximum security against environmental hazards such as rain or wind to prevent damages to household appliances is a therefore needful. The design of this project ensures maximum security to properties against harsh weather conditions. A window fitted with this feature enjoys a touch less safe-window operation.

1.2 Methodology

The method employed in the design and construction of a weather activated window is based on the principle of conductivity of water and also the principle of electromagnetic induction. The water sensor unit and the wind sensor unit employ these methods respectively. Signals generated at the output of the sensors are compared by a comparator and a logic control unit which in turn drives a motor used to operate the window

1.3 Aims and Objectives

The project is aimed at the design and construction of a weather activated window, which responds to harsh weather conditions such as wind or rain for safety, and to prevent damage to properties.

1.4 Motivation

This project was motivated by the drive to solve one of the problems created by harsh weather conditions such as wind and rain, having in mind the need to make the design affordable considering the Economy and the purchasing power of the people.

1.5 Scope of the project

The scope of the project involves the use of a water sensor which is a metal probe that detects water and also a wind sensor. A fan is attached to the generator to produce the required mechanical rotation. Both outputs are connected to a control latch and a control oscillator which drives the motor that close the window.

1.6 Sources of materials used

Materials used for the project were sourced from the local electronics market in Minna. Construction of 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 also helpful in sourcing for information.

Chapter Two

Literature Review

2.1 Historical Background

A lot of people prefer wood shutters for their windows owing to its durability, classic look, and low-maintenance appeal. Windows have been a standard fixture on most historic buildings. It is a widespread belief that windows were first used in ancient Greece to give ventilation, protection, and light control in the hot environment. Those windows are believed to have been constructed with fixed louvers made from marble.

As time passed, the concept of windows went to the Mediterranean and eventually spread to nearby places. Wood soon replaced marble and designers developed movable louver shutters to control the amount of light and air that entered the room [8]. The general function of a window is to allow light and ventilation to come in. Louvered shutters can be closed to decrease the sun's heat while allowing for ventilation and privacy, should the need arise. When the louvers are pointed downwards, they can shed rainwater. Solid windows even protect homes from insect attacks. In medieval Europe, rectangular windows with solid shutters framed houses. These were closed with the use of a large iron bar for added protection and security. During the Tudor and Elizabethan times, the more expensive glass windows were used and were reserved for the upper half of window openings. Windows were still closed with solid shutters.

During the fifteenth century, hinged glazed sashes started replacing solid shutters, after which, interior shutters were used increasingly for decoration purposes. The early eighteenth-century England saw the emergence of window shutters and moldings as main decorative elements in small houses. The increasing use of wood construction in the Victorian period was followed by the popularity of using shutters outdoors. When Spain colonized the America, they brought shutters to the New World. Traditional shutters found in New England have their roots in England, where narrower louvers were used

It was not that long ago that motorized windows and doors were considered the sole preserve of theatres, cinemas and auditoriums. In recent years however, attitudes have changed. Electric doors and windows within the home are becoming increasingly popular with advancement in technology [13]. With the current boom in the construction of quality loft-style apartments and houses, it is not unusual to find several of such doors and windows in one area. To close or open these on a daily basis especially in a multi-storied building is tedious and impractical, leaving motorization an ideal solution.

In the early 90's, the Windows and Day lighting group, London, presented the concept for a "smart" highly efficient dynamic window that maximizes solar heat gain during the heating season and minimizes solar heat gain during the cooling season in residential buildings. The prototype dynamic window relies on an internal shade, which deploys automatically in response to solar radiation and temperature. This prototype was built at Lawrence Berkeley National Laboratory from commercially available "off-the-shelf" components. It is a stand-alone, standard-size product, so it can be easily installed in place of standard window products [14].

The prototype was constructed using a commercially available, three-layer, aluminum-clad wood window that contains a single pleated fabric shade between exterior double glazing and interior single glazing. The exterior double glazing encloses argon gas fill. The cavity side of the double glazing has a spectrally selective low-E coating, which was standard on the ready-made window that was used for the prototype but would not be appropriate for the final design because the spectrally selective coating limits the amount of solar heat gain through the window when the shade is open, thereby limiting the window's effectiveness for offsetting heating loads during the winter. The single glazing on the room side of the window unit has a durable high solar gain low-E coating (on the surface that faces the built-in shade). The single glazing is removable so that the shade can be accessed in case of malfunction. To the standard window with built-in shade, computerized controls, sensors, and a 12-volt direct current (D.C) motor to drive the shade was added. The computer electronics (a circuit board and chip and a real-time, Java-based microcontroller), sensors (including a digital thermometer and solar detector), and motor are embedded in the window head rail.

The computer employs a control algorithm that raises and lowers the shade in response to sunlight and temperature after the building occupant initially activates the shade for the day. For example, once the shade is opened manually by the occupant in the morning, it is raised and lowered automatically during the day in response to increasing and decreasing temperatures and solar radiation levels; in the evening, the shade is lowered in response to darkness. This schedule could be customized, and a button allows the occupant to override the product's current setting and raise or lower the shade at will. An example of a typical operation cycle in response to changing weather conditions during one day is as follows:

a) In the morning, the shade is down; the occupant pushes the override button, and the shade rises.

b) At mid-morning, direct solar radiation strikes the window, and outdoor temperatures are warmer than 78 degrees Fahrenheit (F); the shade automatically lowers.

c) In the afternoon, the temperature falls below 74 degrees F; the shade rises automatically (because solar gain through the window is unlikely to add to the interior cooling load under these weather conditions).

d) In the evening, darkness falls, and the shade automatically drops to provide privacy and nighttime insulation [14].

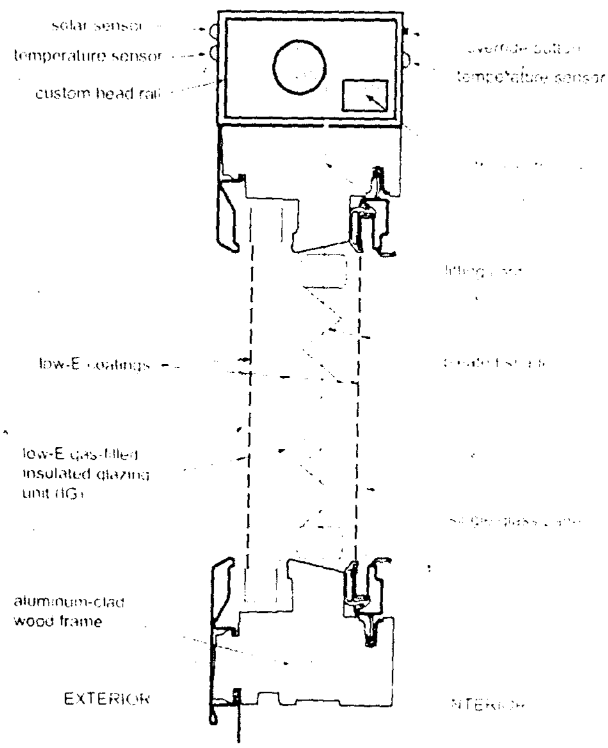

Fig2.1 Schematic of dynamic window.

Chapter Three

Design and Implementation

3.1 System Design and Analysis

The project design is categorized into the following sub-headings:

- Power Supply Unit
- Water Sensor Unit
- Wind Sensor Unit
- Comparator Unit
- Logic Control Unit
- Window (Load)Unit

3.1.1 Power Supply

Most electronic devices utilize a direct current (D.C) voltage supply for operation. The mains electricity supply in Nigeria is alternating current (A.C) at a voltage of 220V-240V and must be converted to a D.C supply of the required value. The use of batteries is an alternative power supply to the rectification process. However, it has some disadvantages which includes: limited life span-this results from the manner in which the internal resistance increases with age thereby deteriorating the battery. It cannot satisfy the amount of current used by most electronic devices for a long time as the battery is quickly drained and this becomes inefficient, hence an A.C to D.C conversion is done by the power supply unit to avoid these inadequacies of the battery.

The power supply unit consists of transformers, a bridge rectifier, a filter and a voltage regulator which all function together to transform the A.C voltage supply from the mains into a regulated D.C supply as the output of the power supply unit.

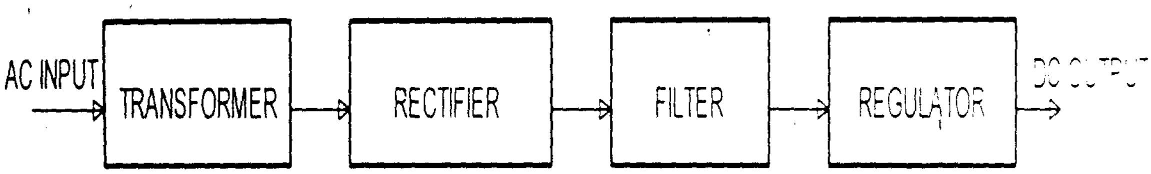

Fig 3.1.1Block diagram of the power supply unit

The input A.C supply voltage is a single phase voltage obtained from the mains supply of PHCN with a value of 220V, 50Hz.

3.1.1.1 The Transformer Specifications

This is the stage of the power supply unit that involves the reduction of the A.C voltage value to a lower value of 12V A.C with the aid of 240V/12V transformer. The current rating is about 500mA which is enough to drive the entire circuit. A transformer is an electrical device that produces physical relation between the 240V A.C main and the rest part of the circuit. The only link is by means of magnetic flux, thus eliminating the risk of electric shock [6].

There are basically two types of transformers, namely; step-up and step-down transformers. The step-down transformer is used and consists of two windings (coils), the primary winding and the secondary winding. Figure 3.2 shows the circuit symbol of a transformer.

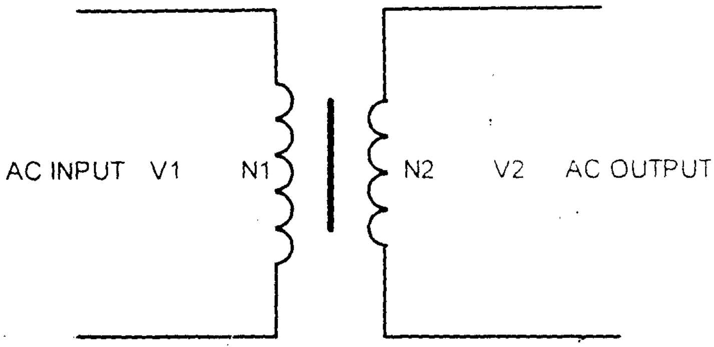

Fig 3.2 Step- down Transformer circuit symbol.

The transformer data is given as V_1 (input) = 240V

V_2 =12V.

I_2 = 500mA

Frequency f = 50Hz.

The ratio of the primary to the secondary voltage is equal to the turns ratio or number of turns of the primary winding N_1 that of the secondary winding N_2 of the transformer. The primary and the secondary voltages are related as follows:

$V_1/V_2=N_1/N_2$

=240V/12V

=20V

Turns ratio $N_1:N_2=20:1$

Magneto motive force (mmf)

$N_1 \times I_1=N_2 \times I_2$

$N_1/N_2=I_2/I_1=20$

I_2=500mA=0.5A

$I_1=I_2/20$

=0.5/20

=25mA

Also, power input =power output

$P_1=P_2$

$I_1 \times V_1 = I_2 \times V_2$

$25mA \times 240 = 6W$

3.1.1.2 The Rectifier Specifications

The output of the transformer (secondary terminal) which is an A.C signal is converted to D.C signal with the aid of a rectifier circuit but the full wave bridge rectifier circuit is used for this project. It consists of four 1N4001 diodes arranged as shown in figure 3.3 below.

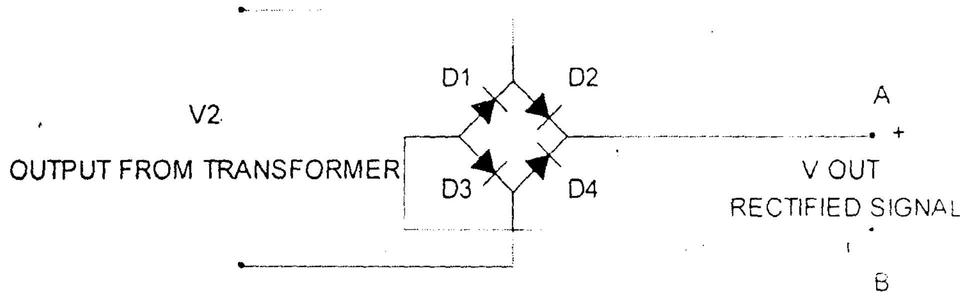

Fig 3.3 Full-wave rectifier circuit diagram.

During the positive half cycle of the secondary voltage, diodes D2 and D4 are forward biased, current flows through diode D2, terminal A, terminal B,(through a load connected at the output terminals), diode D4, during the negative half cycle of the input voltage V2, diodes D1 and D3 are forward biased and therefore, conducts current flowing through load connected across its terminals AB in the same direction as shown above (i.e. from point A to B).This circuit achieves the aim of making current flow in one direction only (D.C) irrespective of the positive and negative half-cycles of the input signal. The peak secondary voltage of a transformer V_{PS} with PIV greater than 67.88V is chosen.

3.1.1.3 The Filter Specifications

The filter circuit forms part of the power supply unit so as to minimize the ripple content of the rectifier output. The output voltage waveform of a rectifier pulsating because it has both D.C component and some A.C components called ripples and this type of output signal is not suitable for driving electronic circuits [2]. The filter circuit receives D.C signals as input and filters out or smoothens out the pulsations in the input. There are various types of filtering circuits but the simple capacitive filtering is adopted in the design; where a large electrolytic capacitor (2200μF) is connected to the rectifier output. The shunt capacitor bypasses A.C signal present and this effect makes the output to almost assume a pure D.C level. The capacitor charges during the diode connection period to the peak value and when the input voltage falls below the value, the capacitor discharges through the load so that the load receives almost steady voltage.

3.1.1.4 The Voltage Regulator

The introduction of a voltage regulator in the power supply unit is necessary to maintain a constant voltage supply of 12V regardless of the varying voltage of input or load change which can cause irregular supply. In other words, a voltage regulator is a [illegible] that holds an output voltage at a predetermined value regardless of the change in normal input or changes in load impedance.

Voltage regulators mostly come in a three terminal package: one input terminal, one output terminal, and a ground terminal. The 7805 voltage regulator IC chip is used to supply a steady 12V D.C to drive the system circuit. The 7805 chip supplies the rated voltage with a wide range of voltage input and variations in load current.

A 2200µF is connected at the output terminal of the regulator to filter any ripple left on the supply line. A power switch is used for opening and closing the circuit. A power indicator which is a light emitting diode shows that the circuit is active.

Fig 3.5 Power indicator diagram

For the rated voltage and current of the light emitting diode at 2.7V and 3mA respectively, the following calculations were made to obtain a rated value for resistance:

R=Voltage across the resistor/Current flowing through the resistor

R= V_{CC}-Voltage across the LED/Current flowing through the LED

$R=5-2.7/3\times10^{-3}$

R= 2300Ω

Figure 3.7 shows the filter/regulator circuit.

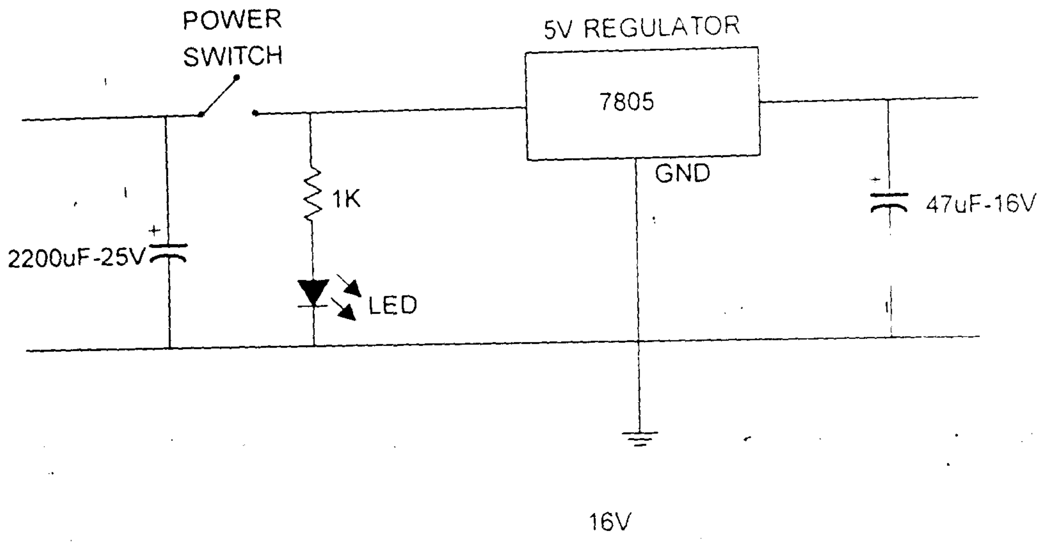

Fig 3.6 Filter/ regulator circuit.

3.1.2 Water Sensor Unit

The water sensor 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 metallic materials that deal with electrons.

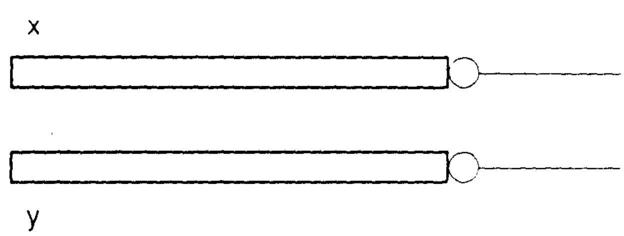

Fig 3.7 A simple illustration of metal probes.

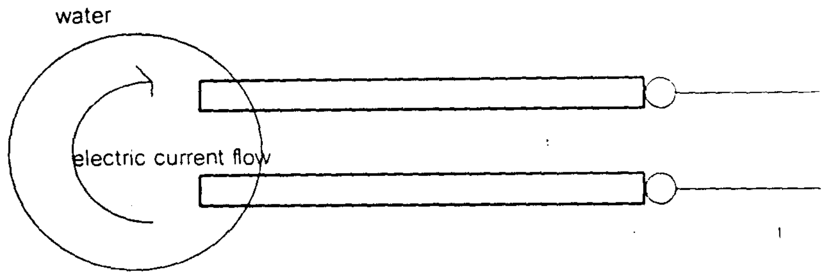

Fig 3.8 Electric current conduction through metals.

One of the terminals is usually placed at a relatively more positive voltage than the other which is usually connected to an amplifier to put the resulting voltage or signal workable. In this circuit, the water probe is connected to the non inverting input of the comparator. The configuration serves as an electronic detection of water.

3.1.3 **Wind Sensor Unit**

The wind sensor unit is designed to detect high air/wind pressure. High speed wind is at a very high pressure and serves as the input of the circuit. The circuit is designed to detect such high pressure wind capable of causing hazards and closes the window automatically. The wind sensor is a small D.C generator. Based on electromagnetic induction, electric current is generated in a coil that periodically cuts a magnetic field. The construction consists of a small fan connected to the D.C generator; wind speed is converted to mechanical energy that drives the D.C generator. The wind speed is directly proportional to the corresponding electric voltage at the output of the dc generator. The magnitude of the output voltage shows a direct relationship with the wind speed.

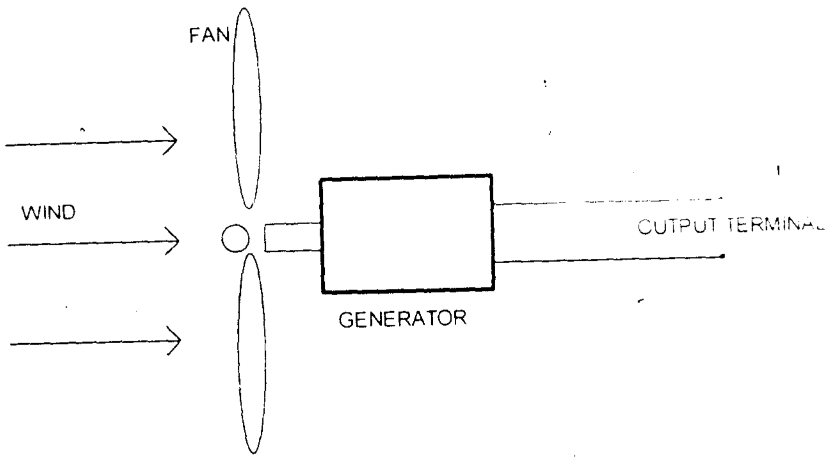

Fig 3.9 A simple illustration of the wind detector.

For better detection of critical wind speed, the output of the dc generator is connected to a comparator, the output of the comparator changes from logic 1 to 0 for leading detection.

3.1.4 Comparator Unit

The comparator is designed for use in level detection, low level sensing and memory applications in consumer, automotive and industrial applications. The unit is required for referencing or comparing the outputs from both water and wind sensors. The main reason is that a particular output value is responded to by the sensors. The technique allows a particular input signal level to be defined as being hazardous and the window close immediately.

The comparator in use is the LM 339 Integrated circuit. It holds four independent units of which two are used this particular circuit. Each unit has two inputs (inverting and non-inverting) and a single output. The output behaves in digital mode to the inputs. This terminal is either logical 1 or 0 depending on the condition of the inputs.

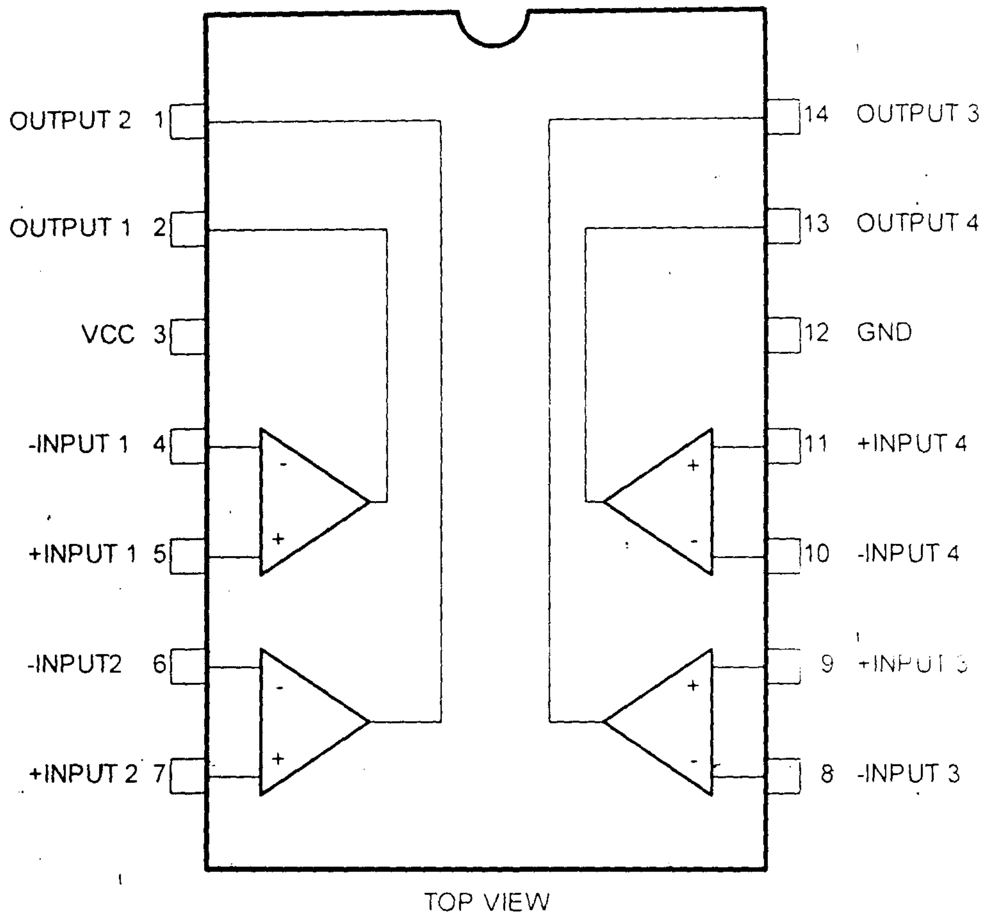

Fig 3.10 Pin arrangement of the LM339.

The output of each comparator is logical 1 whenever the voltage at the non- inverting input Vin (+) is greater than the voltage at the inverting input Vin (-). But the condition is different whenever the voltage at the non-inverting input Vin (+) is equal to or less than the voltage at the inverting input Vin (-). Two comparators are used in the design, one for each sensor. Their inverting inputs Vin (-) are reference points for a particular response.

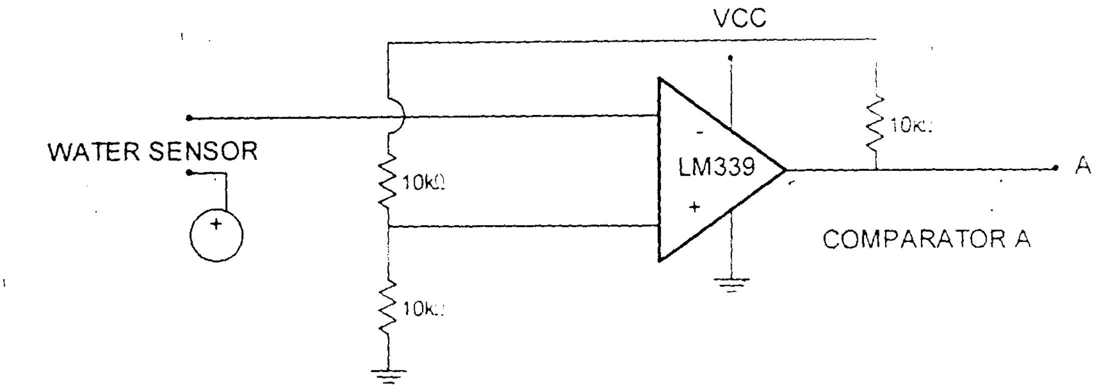

Fig 3.11 Comparator unit for the water sensor

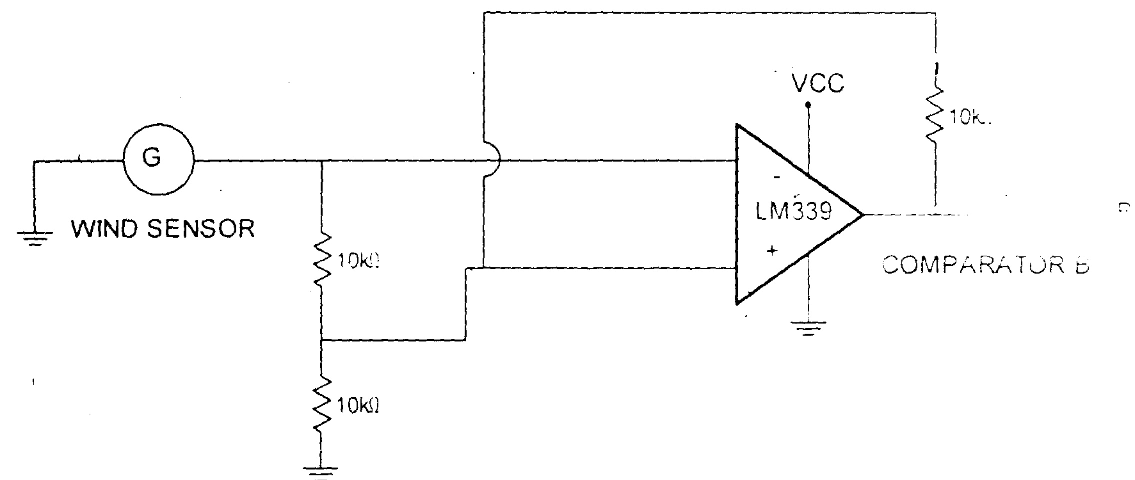

Fig 3.12 Comparator unit for the wind sensor.

The two comparators are referenced to 2.5 volts with two separate 10KΩ resistors forming a potential divider across the 5 volts V_{CC}.

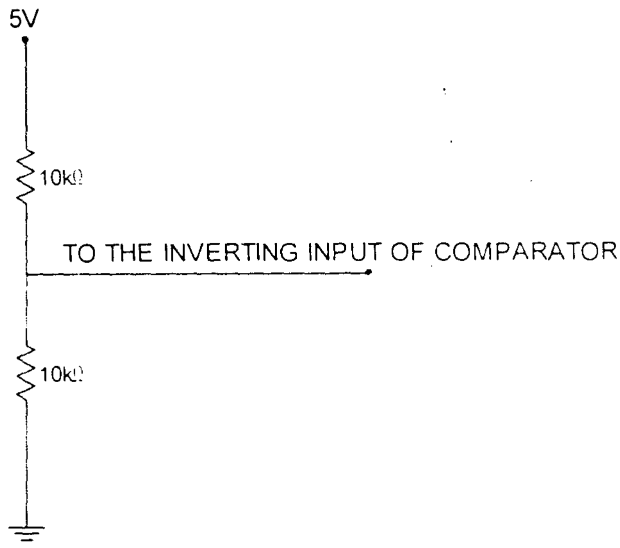

Fig 3.13 Potential divider at the inverting input of the comparator.

The voltage at the inputs put the initial output condition of the comparators at logical But detection of water and severe wind reverse the outputs logical to 1.this shows a particular non -inverting input Vin (+) is greater than the 2.5 volts reference at the other terminals. A 10 KΩ resistor is specified by the LM 339 Integrated circuit's data sheet for the output. The two outputs of the comparators are fed into a 2-input OR gate. The output of the gate is connected to the control logic unit.

In the design, the non inverting Vin (+) of the comparator in use is connected to the output of the in put transducer. The other input, the inverting input Vin (-) is required for referencing the comparator.

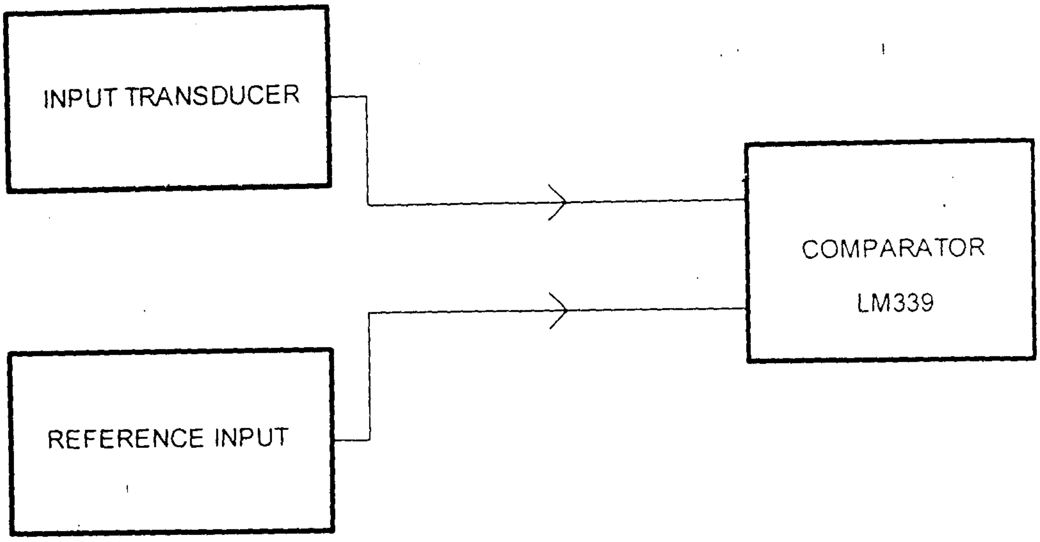

Fig 3.14 Block diagram of the comparator unit.

In the above diagram, the reference input is used to place the inverting input Vin (-) of the comparator to a particular voltage. The initial condition of the comparators output is at logical 0. This is because the reference voltage should be greater than the output from the input transducer. But at high vibration amplitude, the voltage at the non inverting input Vin (+) of the comparator is greater than that of the inverting side. The result is a high logical level at the output of the comparator to signify a critical vibration level. Through the reference input, the sensitivity of the setup can be altered.

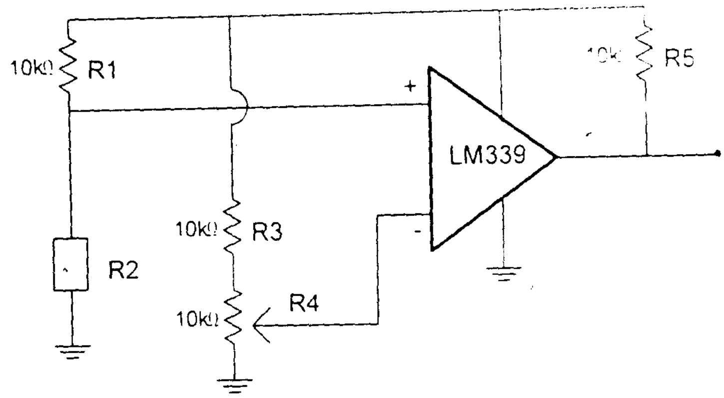

Fig 3.15 Comparator circuit.

From the above diagram, it can be seen that R3 and R4 are connected in series across the 5v power supply from the 7805 regulator. The resistors share the voltage. That is each has 2.5V. R4 is a variable resistor: its output can be varied within 0-2.5V range. Therefore, the inverting input Vin (-) of the comparator can only attain voltage within the range of 0-2.5V. At very low voltage the response of the device to vibration is very high. The reverse situation occurs at very high reference voltages.R1 also used in dropping the voltage across R2 (the input transducer).R5, 10 KΩ is specified by the LM 339 integrated circuits data sheet. It is required because the output of the comparator is an open collector.

3.1.5 Logic Control Unit

The control logic unit is designed to respond to logic output from the comparator. The main purpose of the circuit is to process the required signal needed to close the already opened window. Two integrated circuits are used in this unit namely the 4013B control latch and the 4060B oscillator/timer. They work together in performing a well coordinated operation at the output of the circuit.

3.1.5.1 **4013B Integrated Circuit**

The 4013B is designed with two identical, independent data-type flip-flops. Each flip-flop has independent data, set, reset, clock inputs and Q and $\bar{Q}$ outputs. The logic level present at the data input is transferred to the Q output during the positive-going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset respectively [10].

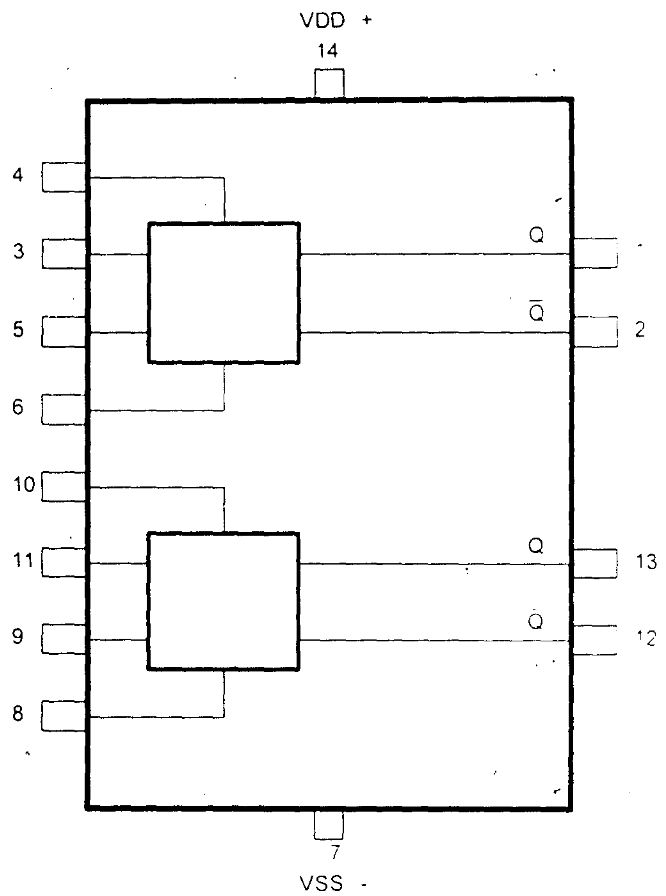

Fig 3.16 4013B Functional diagram.

Any of the input sensors carrying logic level 1 set the 7013B working through the data input pin shown above and the circuit is enabled allowing the motor ,at the output to function. Resetting is after a period of time with the aid of the 4060B oscillator timer and this disenables the circuit. This is to stop the motor ffom running continuously. Configuration of the integrated circuit is in the SR mode.

3.1.5.2 4060B Integrated Circuit

The timer used is the 4060B integrated circuit. It is a 14-stage binary ripple counter with on-chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator. The RC mode is a normal operational mode. Pin 10, 9 and 11 are used for this mode. Pin 12 requires low logical level for normal device operation. The reset function of the chip allows all outputs to be placed into the zero state and disables the oscillator. A negative transition on the oscillator will advance the oscillator to the next stage. The advantage of this feature is its multiple outputs and also generates stable output frequencies

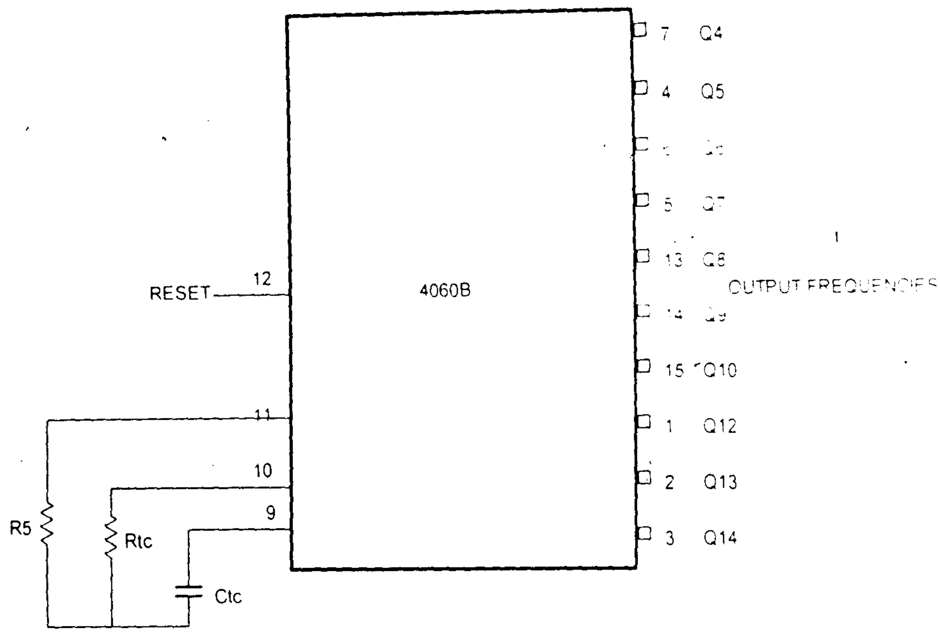

Fig 3.18 Functional diagram of the 4060B [9].

The following calculations show relationship between frequencies.

$F_M = 1/2.3 \times R_{tc} \times C_{tc}$ [9].

Typical values for the RC configuration are R_{tc}=33 KΩ, R5 = 100 KΩ, and C_{tc} = 0.001 μF

Substituting to find the value of Fm:

$F_M = 1/2.333\times10^{\wedge 3}\times0.001\times10^{\wedge -6}$

$Fm = 13.2\times10^{\wedge}3$

For any frequency output from the integrated circuit the relationship is given by:

$F_{QX} = Fm/2^X$

Only Pin 3 output is used by the 4060B and its frequency is given below.

$F_{14} = Fm/2^{14}$

$= 13.2\times10^3/2^{14}$

=0.8 Hz

Period of frequency=$T_{Q14} = 1/F_{14}$

=1/0.8

=0.125seconds.

This shows that the latch is reset automatically in 0.125seconds.

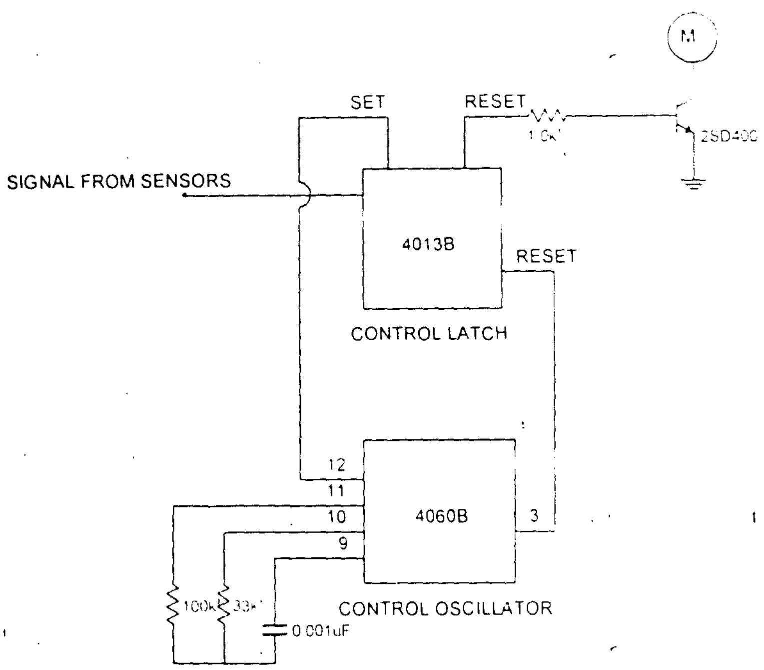

Fig 3.19 Logical control unit

When the set terminal of the control latch is at logical 1, the Q and $\overline{Q}$ outputs change to logical 1 and 0 respectively. Q is connected to pin 12 of the control oscillator. The terminal requires logical 0 for the control oscillator to be enabled. The Q output is connected to the base of a transistor. The transistor is attributed to 1000mAmaximum handling current. This makes it suitable for powering an electric D.C motor. The motor works when the Q terminal is at logic 1. But it is disenabled or cut-off when its base is at logical 0 and then the electric motor stops working.

The enabling of the control latch through its pin 12 allows the electric motor to work for a period of time by placing the reset input of the control latch at logical 1. Q and $\bar{Q}$ change to logical 0 and 1 respectively and this disenables the switching transistor and control oscillator.

3.1.5 **Window (Load) Unit**

The aim of the design is to move the window which is the load. This is achieved by building an auxiliary mechanical mechanism attached to the window primarily moved by an electric motor. When the circuit is activated as a result of an input signal the motor rotates. A small arm is connected to the rotating motor attached to the window making the window to close in a sliding motion. A transparent plastic glass is used in the construction of the window to ensure rigidity and lightness.

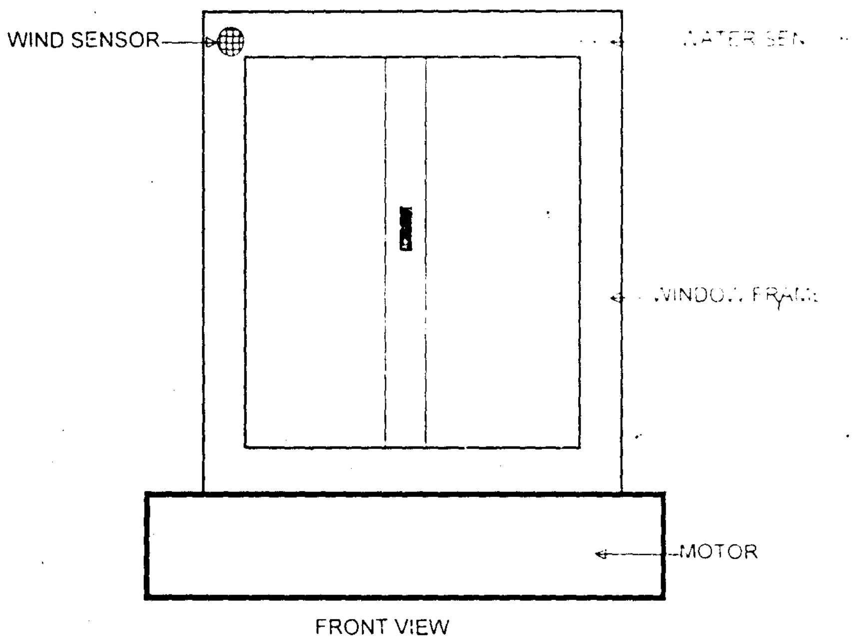

Fig 3.20 Window frame diagram

3.2 Circuit Diagram and Description

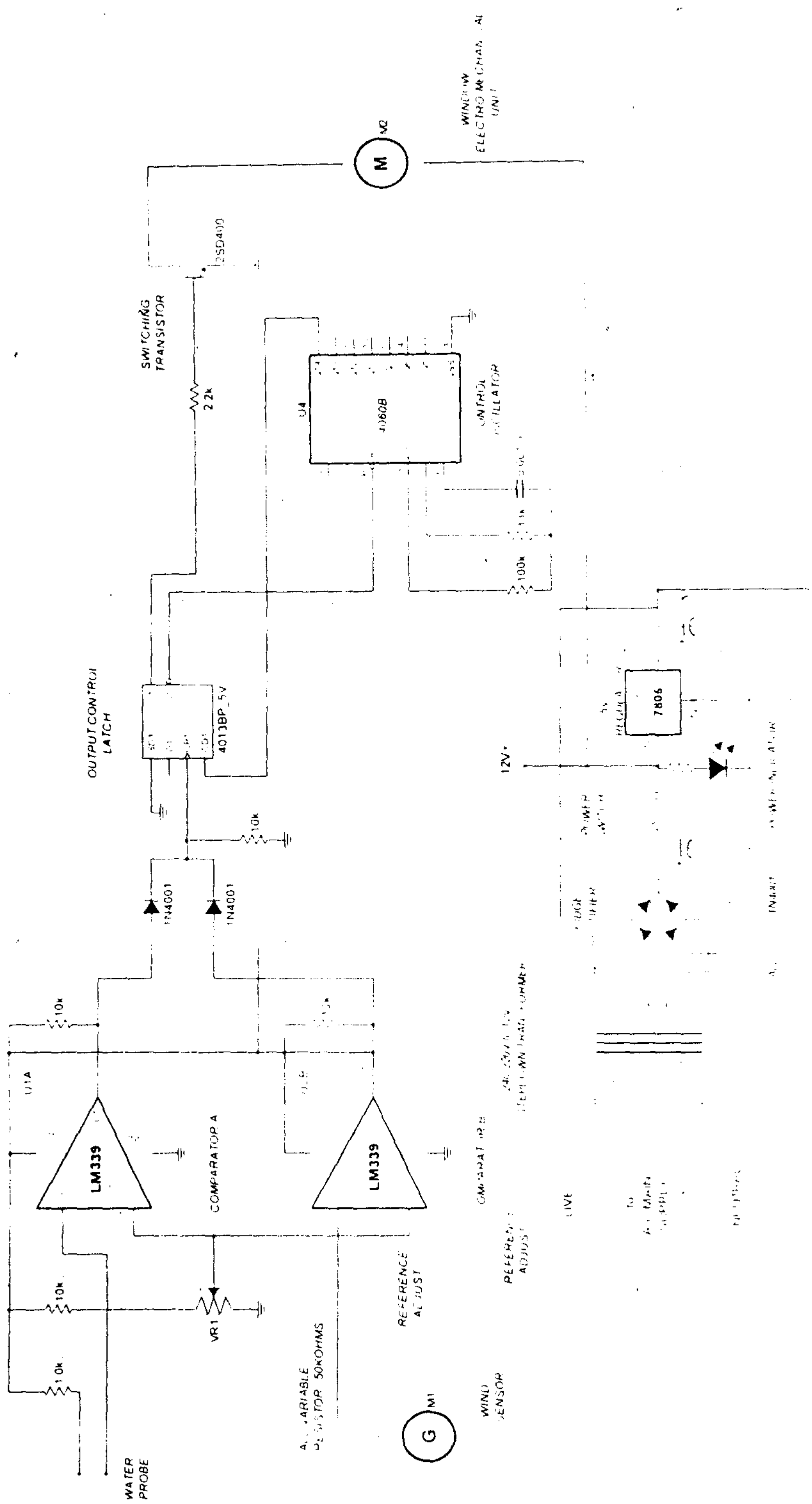

Fig 3.21 Circuit diagram of the weather activated window

Figure 3.20 shows the circuit details of the weather activated window. Power to the circuit is supplied by a full wave bridge rectifier unit. The 220-240V from the mains is stepped down to 12v by the step down transformer. The 12V is further filtered by the 2200μf capacitor and the voltage regulated steadily through the 7805 voltage regulator. Both LM339 comparators and integrated circuits are supplied 5V while the electric motor utilizes 12V.

The LM339 compares voltage from the wind and water sensor output with a reference voltage adjustable by the variable capacitor VR1. Both outputs are connected in parallel via a 10KΩ resistor to a single output which terminates at the input of the output control latch which is the set terminal. For a positive input from any of the sensors, the set terminal is at logical 1, output control latch is enabled, and this output is connected to the pin 12 of the 4060B control oscillator. The oscillator provides timing control of about 0.125 seconds after which the controls latch resets. Q is now at logic 0 and supply to the motor through the switching transistor is cut-off stopping the motor from operating

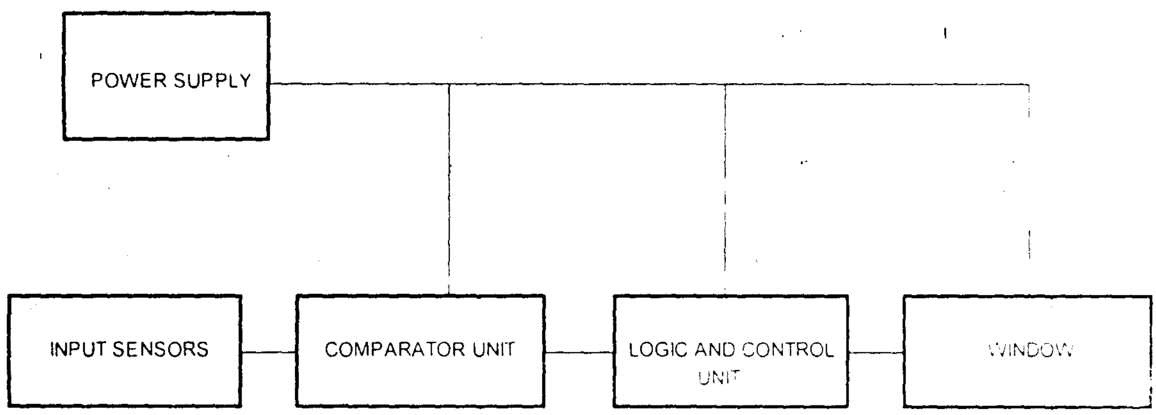

Fig 3.22 Block diagram of the weather activated window

Chapter Four

Construction and Results

4.1 Construction, Test and Results

The construction and testing of the weather activated window as analyzed and designed in the previous chapter is dealt with in this chapter. Each of the main building blocks is constructed and tested one after the other.

4.1.2 Construction

In the course of the construction of the project, some tools and materials were used. These include:

i. Breadboard: this is a board with connectivity along its horizontal lines and vertical lines (in some case). It was used primarily for temporal setting up of the design and to ascertain its working condition and hence further modification.

ii. Vero board: this is a perforated plastic board where the working circuit was finally mounted and soldered permanently.

iii. Soldering lead: this is a metal with low melting point. It was used to hold components and connecting wires in place on the Vero board.

iv. 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 components permanently on the Vero board. It is usually connected to the A.C mains.

v. Lead sucker: this is used to suck up excess molten lead from the Vero board to prevent short circuiting (bridging) or undesirable electrical connections.

vi. Multimeter: this is a multi functional device used for testing of continuity and measurement of voltages, currents and resistances in the course of the construction.

vii. Wires and connections: wires were used during the testing stage of the project on the breadboard to connect the components together as well as during the soldering of the components on the Vero board. Aluminum wires were used.

viii. Wire cutters/strippers: these tools were used to cut the wires to the desired size required before use, as well as to strip off insulation of the wire in other to expose the conductor for proper and neat soldering.

The circuit was first laid-out on the breadboard to observe its operational response and ensure that it is in line with the required objectives. Then it was dismantled.

The circuit was finally constructed on the Vero board starting with the power supply unit The components were inserted into the holes on the board properly to ensure that it was on the other side where the copper tracks are. All components and jumpers (connecting wires) were inserted in place before soldering. This was to permit better judgment on connection linkages between components. The connection between the components on different horizontal lines (potential) was carried out with the use of aluminum wires and a hole was made to break the horizontal lines continuity where it was needed or necessary.

To obtain a good soldering joint which is very important, it was ensured that the tip of the wire was in contact with the copper track, the wire to be soldered and the soldering lead. This soldering operation was carried out for a period of five seconds or less to prevent the components. The integrated circuits are very sensitive to heat, so they were protected by the use of IC sockets. These sockets were soldered to the board while the IC was inserted in place.

The entire circuit board and the transformer were housed in a plastic case which forms the window frame model. This was chosen because of it poor conductivity, readily available and relatively cheaper. The appropriate holes for the LED, sensors and power cable were drilled at various positions. Holes were also drilled to allow air flow for ventilation.

Various precautions were taken during the construction which includes:

i. All soldered joints were tested for continuity so as to avoid unnecessary open circuits

ii. All excess leads were removed to avoid "short circuits" on the board.

iii. Polarities of the electrolytic capacitor and LED were properly checked to be correctly positioned before soldering on the Vero board.

iv. IC sockets were used for the IC's to avoid overheating caused by soldering.

v. All components were properly soldered to the Vero board to avoid shorting of components leg.

vi. It was ensured that there was no power supply to the circuit while no reading is being taken to reduce power consumption.

4.1.3 Test and Results

After all the, components were arranged on the breadboard. they where tested to ensure the required output. The components and connecting wires which were soldered were tested for continuity using the continuity alarm tester of the multi-meter. The soldering joints were properly checked and errors detected were corrected by appropriate soldering and de-soldering actions.

At the end of the soldering operation. each unit was tested at every stage and the results obtained were adequate.

The modeled window was powered on and water sprinkled on the water sensor to simulate rainfall. immediately the window responded by closing. The wind was also simulated using a hair dryer to provide high pressure air. the window also responded immediately also to the wind pressure.

Chapter Five

Conclusion and Recommendation

5.1 Conclusion

From the results of the test carried out after the construction of the project, the water sensor and wind sensor were able to detect rainfall and harsh wind respectively. Hence the aim of the project has been achieved. The components used in constructing the device are readily available. The window constructed will be very useful in our homes, hospitals, industries, schools, hospitals e.t.c to provide better security against very harsh weather conditions.

5.2 Recommendation

In the construction of the project, the window is opened manually after it has been operated. This can be improved on by building an additional circuit allowing the window to open again at the touch of a button or remote control. A battery pack can be added as a backup in case of power failure.

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APPENDIX

LIST OF COMPONENTS

MC1 4060B Control oscillator [1]

CD 4013B Control latch [1]

2SD400 switching transistor [1]

7805 12V Regulator [1]

LM339 Comparator [2]

IN4001 Diodes [6]

5mm Red Led [1]

Capacitors:

- 2200µF-25 V [1]
- 47µF-16V 16ww PC electrolytic [1]
- 0.001µF Green cap [1]

Resistors:

- 100 KΩ [1]
- 50,KΩ Variable resistors [2]
- 33 KΩ [1]
- 22 KΩ [1]
- 10 KΩ [5]
- 1 KΩ [1]