Touch-less Hand Dryer

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DECLEARATION

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ABSTRACT

This Project involves the construction of a Touch-less hand dryer which is used to minimize the risk of cross infection of diseases and germs. This was implemented using a latch which is set by the receiver unit to control a Fan and a Heater to operate for a given period of time using a time which resets the latch to switch the Heater ON or OFF pending the output of a comparator fed by a Heat Sensor.

At the end the receiver segment was a bit sensitive and the heat sensor found to be more accurate than Thermistors. The project is user control oriented as the Receiver sensitivity, the operating time duration and maximum heater temperature can be adjusted to the user's preference.

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CHAPTER ONE

INTRODUCTION

1.1 Introducing Touch-less Hand dryers.

A Touch less hand dryer is an automatic hand dryer, but Sensor not Button activated. (the circuit only comes on when the infra-red sensor has an input). That is, it senses a nearby hand then comes ON and also encompasses the automatic functions.

This is a more presentable and effective device in replacement for the old fashioned hand dryer since it allows users to dry their hands without touching anything (an ON or OFF button). Though they have been around for some time, but with increased concerns about cross-infection, facilities are installing more of them. Touch-less hand dryers use no waste paper, so there is no need for trash container in restroom or toilet. The device provides an amazing easy-to-use operation.

1.2 Objective of the Project.

The Towel is a common longstanding feature in toilets. It is mainly used to wipe water off wet hands or other parts of the body. In our modern world, its use is under threat.

Towels are unavoidable means of transmitting germs like Ecoli bacteria (man eating bacteria which causes ailments in the digestive tract), Flu (common Catarrh and Cough) and also some Skin diseases just to mention a few infections [1].

The Cost of using waste paper or Sterilizing Towels requires a huge budget on its own in order to maintain hygiene in public toilets.

The easiest alternative is the Touch-less hand dryer whose initial cost is affordable and mean between maintenance close to two years as stated by Organization of Hand Dryer Manufacturers in the U.S.A [3].

1.3 Scope of Project.

The basic idea is to operate a Fan and a Heater using a Hand detector receiver (photodiode), control unit (latch) to control whether both Fan and Heater are ON or OFF depending on the receiver input to the latch, let the unit be on for a specific period of time using a timer and also decide whether the Heater alone should be ON or OFF pending the input of a comparator fed by a heat sensor. Thus limiting the heater to a specified maximum temperature.

1.4 General Description of Project.

The project has 2 Heaters (Filaments) of 1Kilo-Watt each, an Axial Fan of 2500rpm with 12V d.c terminals, the Main circuitry which has a Timer(4060B), Control latch(4013B), Relay (12V d.c), LM35 sensor, 2 Comparators(LM339A), 12V and 5V Voltage Regulators and 240VA.C to 24V D.C step down Transformer. The other components are Diodes, resistors ,capacitors and transistors to be discussed in detail in **Chatpter 3**.

1.5 What makes this Touch-less Hand dryer Project different?

A more accurate thermostatic setup as the LM35 sensor is more efficient than using normal thermistor. The circuit goes OFF 20 seconds after the infra-red beam was last reflected.

The more significant functions can be can regulated to the user's preference using variable resistors i.e the thermostatic setup reference temperature, the Sensitivity of the Receiver to determine range of distance of hand from the receiver for activation of the dryer, while the duration the Circuit operates can be adjusted by varying the capacitance value of the Capacitor attached to the timer.

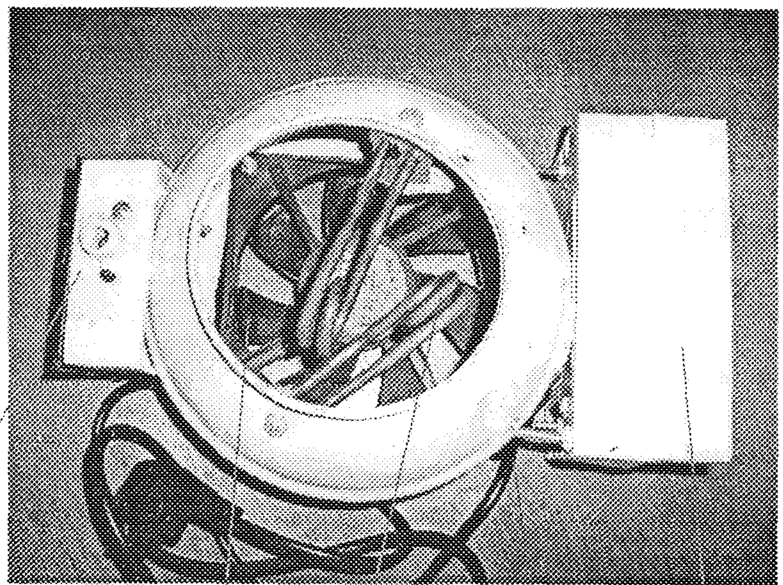


Fig 1.1 Touchless handrier Visible units

1.6 Project methodology

The project features an innovative design technique. The unit mainly holds a fan (blower), a heater (for heating the air to be blown), an electronic thermostat (for preventing over-heating effect), a timer to keep the entire circuit ON for a certain amount of time and more interestingly an infra-red electronic eye. A central logic control unit incorporates all the units together into a specific functional gang.

In addition, the infra-red electronic eye comprises of an infra-red transmitter and receiver. The transmitter emits a straight infra-red beam away from the receiving side so that whenever a hand is brought close to the eye, the transmitting beam is reflected to the infra-red receiver. The resulting signal at the receiver is the input of the whole circuit.

The leading signal is processed by a logic control unit. This unit is built up of integrated circuits. These circuits are designed to switch on both the air-blower and heater.

The air-blower forces air through a nozzle while the heater gets the air heated. The operation is quite digital in nature. This is because a timer is incorporated into the design to provide a specific operating time for the fan and heater. The timing helps reset or switch OFF the components whenever the dryer is left alone after use, thus the switching ON and OFF of the device is achieved without any physical contact with the device.

From experience of older designs, hearting is a common demerit. Therefore, a heat monitoring feature is added to the design. The leading circuit holds a linear temperature sensor and comparator-control circuit. The circuit alters the heating effect of the system by switching off the heater whenever the temperature of the blowing air is unacceptable. The sensor is attributed to precision, so there is no or little worry of temperature instability.

To add more weight, the design is all about simplicity. The involved electronic components are usually cheap and readily available. The resulting design is economic.

The foundation of the project is acquisition of relevant information. The design was set upon after gaining access to all the components data sheets. They were downloaded from the manufacturer's websites.

1.7 Limitations of Project

Financial limitations: More efficient components usually cost more than the common ones in the market, and the project was limited to a budget.

Availability: Some ideal components are not readily available in the market such as Hight temperature resistant plastic for casing and Energy Efficient Heaters.

Location of the Heater near the main circuitry meant that some components operations were slightly affected by temperature.

Inexperience on the part of the designer lead to some unsuitable decisions and mistakes that were unbecoming, but eventually, it was rectified and overcame.

Chapter Two

Literature Review

2.1 History and development of hand dryers

Hand driers possess one and the same history as hair driers. Even, the hair dryers have the features of hand dryers. They have the same basic of operation. The earliest dryers came from Iran. They were called blower dryer and mechanically operated [2]. A blow dryer is an electromechanical device designed to blow cool or hot air over wet or damp hair, in order to accelerate the evaporation of water particles and dry the hair. The usage of blow dryers also allows better controlling the shape of the hair in the process of styling, by accelerating and controlling the formation of temporary hydrogen bonds inside the hair. Blow dryers dominated around the end of the 19^{th} century being dependent on the heat generation and mechanical air flow in order to be effective. Hairstyles using blow dryers usually have volume and discipline, and can be further improved by the usage of brushes during drying to add tension, and usage of styling products. Before the development of blow drying, hairstyles tended to be stiff and lacking volume.

Due to the development in electronics, good commercially important dryers emerged in the later part of the 1950's, they were quite portable or small in size. They required little technical knowledge for necessary operation. The most interesting attachment was that it was affordable. Around this period hair dryers were adopted for hand drying application [3].

The early designs were manually operated through a push button, but with further invention and development in electronic devices, modern touch less hand dryers were made a possibility. The dryer is operated without any physical contact. Such designs provide easy-to-use features along side minimizing disease infection commonly attributed to towel usage.

2.2 Types of Hand Drier

There are two major types of hand dryers, they are the hand operated and touch-less types. The hand operated involves manually switching ON and OFF of the hand dryer. This requires a toggle button that is pressed ON to activate the unit and a release to switch, to switch OFF the device. This type of hand drier is becoming old and out of use. The recent development in electronics brought about the easier operated "Touch less hand drier". The design involves an infra-red eye that responds to close objects or hands by switching on the heat blowing effect. This type of unit involves timing circuits to smoothen their operation. Also, its increasing popularity is due to the touch-less operation nature. It is believed that the chances of infection through the use of touch less hand dryers is minimal compared to other means of getting hands dried.

In addition, both types of dryers are incorporated with thermostat for heating regulation. This feature prevents over-heating.

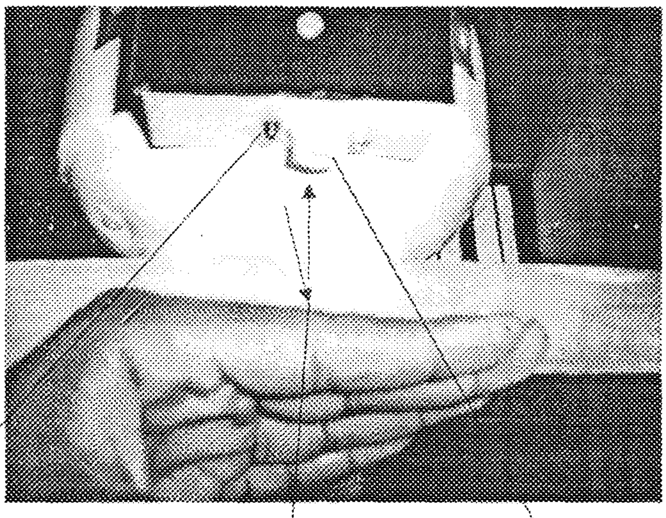
2.3 The Basic Principle of Operation of Touch-less Hand drier.

It is quite obvious that hair, cloth and hand dryers have similar principle of operation. There is always a heating filament or heater and an axial fan blower. These two devices are connected to the same control line but the operation of the heater is usually influenced by a thermostat circuit [5]. As earlier explained, the thermostat keeps the involved heating at a reasonable and acceptable temperature range. The reason is to avoid damaging the components on the circuit and prolong the heating elements life span.

Another part of the device is an infra-red eye, this leading unit helps in the control mechanism. It is the control input of the whole device. It activates the heat blowing effect by sensing a nearby hand, therefore it senses close objects for operation.

2.4 The Infra-red eye:

This unit involves an infra-red transmitter and receiver. The two devices are placed beside each other. The transmitter which is usually an infra-red emitting diode, emits straight infra-red signal away from the set-up. The signal is far out of the reach of the infra-red receiver, therefore the device is put at OFF mode.



LED Reflected infra-red beam Receiver (Reverse biased photo-diode covered from external interference).

Fig 2.1 Infra-red eye with Reflected infra-red beam.

By reflection, the infra-red beam gets to the receiver. Whenever the signal gets to the infra-red receiver, the loads (heater and blower) are activated through a control logic unit connected to the infra-red eye. Infra-red radiation is always chosen for such application due to its visible nature. In fact infra-red radiation is electromagnetic radiation of a wavelength longer than that of visible light but shorter than that of microwave radiation. The name means "below red", from the Latin word infra, "below", and red being the colour of visible light of longest wavelength.

Infra-red eye is placed at the air outlet so that by putting hands towards this part the hand automatically gets the device working. Also a typical sensor range is 120mm. The infra-red electronic eye normally works with a timer control switching unit. It features auto time-out protection.

2.5 The blower

There are three main types of fans used for blowing air. The Axial, Centrifugal (also called radial) and Cross flow (also called tangential). The axial flow fan is commonly used for hand drier application. The Axial fans blow air across the axis of the fan, linearly hence their name. This is the most commonly used type of fan and it is used in a wide variety of applications ranging from small cooling fans for electronics to the giant fans used in wind tunnels. Small axial fans are used for hand dryers. They generally consist of a set of rotating blades that are placed in a protective housing that permits air to flow through. Also they are usually rotated by both A.C and D.C electric motors. Mostly the D.C type are used, which use low voltage typically 24V, 12V or 5V.

The brushless D.C motors are better due to the fact of related much less electromagnetic inference (EMI). An average power rating is 1/10 hp at 3450RPM. In most drier configuration the involved fan blows over a heating filament for resulting warm air [4].

2.6 The Heating Filament or Heater

In most related designs the involved heater is usually a close coiled nickel chrome wire rated at around 1-2.5 Kilo-Watts supported in mica former and provided with woven gals to cord support. An automatic safety cut-out prevents over heating. Modern designs substituted linear precision temperature sensor for usual thermistor for the most important element of the electronic thermostat. The reason is for a more accurate heating control mechanism.

CHAPTER THREE

DESIGN ANALYSIS

3.1 Circuit Analysis

The project can be divided into six main units. Each unit contribute to the overall operation of the circuit.

The involved units are:-

i) Infra-red eye/amplifier unit.

ii) Control logic unit.

iii) Motor switching unit.

iv) Heater switching unit.

v) Thermostat unit.

vi) Power unit.

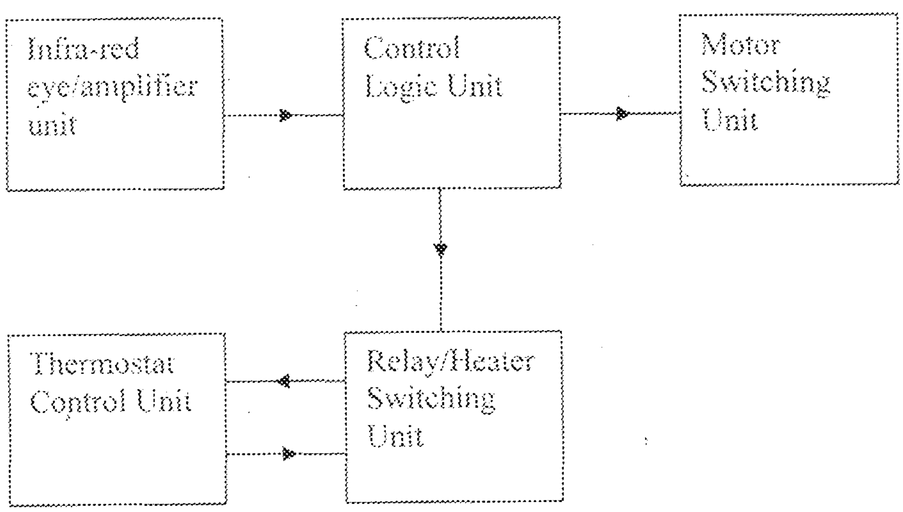


Fig 3.1 Block diagram of the Touch-less hand dryer

The input of the whole circuit is the infra-red eye. The output involves both the motor and relay-heater switching units. The logic control and thermostat control units do the coordination of the input with the output.

3.2 Power unit

The power unit supplies the both 5V and 12V for the circuit. A 24V output step down transformer with a current rating of 500mA is the input of this unit. Its output voltage of 24V A.C is rectified through a bridge rectifier. This is a full wave rectification process that involves four diodes. The bridge rectifiers connection allows two diodes to be forward biased while the other two are reverse biased during each half cycle of the input voltage. This results into the rectification of the involved A.C voltage [6]. The output is polarized into both positive and negative terminals. But, the expected component direct current nature of the output is not so. The output possesses an A.C characteristic which is required to be filtered out. To do this, a filter capacitor is incorporated into the output. The capacitor is usually from 100-3300µf. It is connected in parallel to the output. The result is a smooth or more direct current nature output.

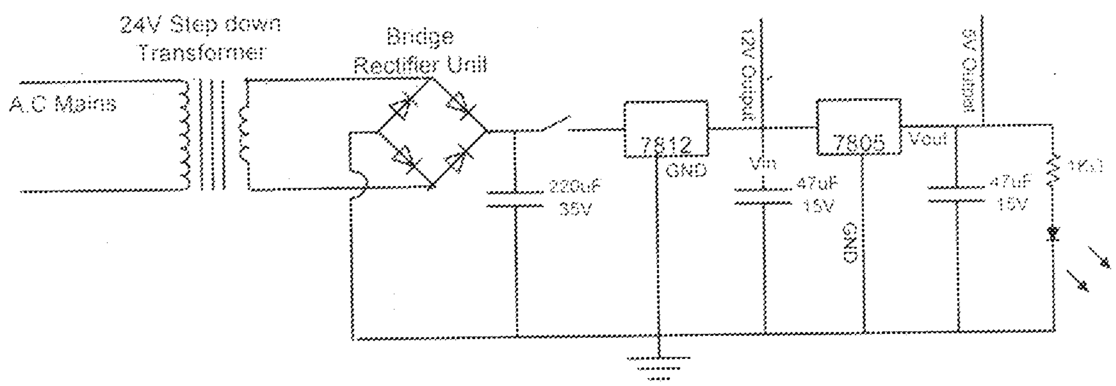


Fig 3.2 Bridge Rectifier unit.

Both 12V and 5V regulators are incorporated into the circuit. The 12V power supplies the output load involving the fan blower and heater switching. 5V power supplies the other components which are mainly integrated circuit. The regulators are connected in parallel to the roughly 24V power supply.

A power indicator circuit shows the presence of electric current flow in the circuit. The circuit involves both 1kΩ resistor and light Emitting Diode (LED). The circuit is connected to the 5V power supply.

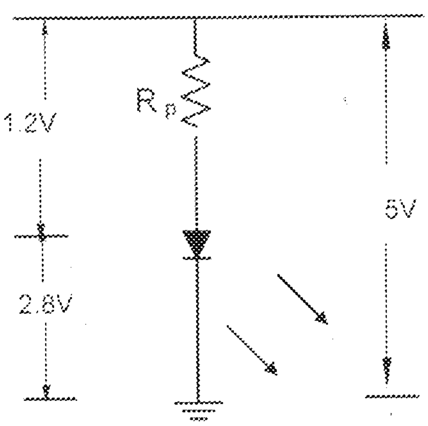


Fig 3.3 Voltage along LED

2.8V is expected across the LED; 2.2V across Rp. A typical electric current flow of 3mA is expected in the series circuit.

$R_p = 2.2 / (3\times10^{-3}) = 733.33\Omega$

1kΩ is used in the circuit, 733Ω resistors are not quite readily available for purchase, therefore a 1kΩ is useable for a similar result. The only effect might be a dimmer light output which is not really significant.

3.3 Infrared eye unit

The main input of the device is the infra-red eye/amplifier unit. It is configured as a motion sensor. The unit operates mainly on infra-red signal. The motion sensing technique, covers both infra-red transmitter and receiver. The infra-red transmitter generates a straight beam of infra-red. The receiver deals with the conversion of the infra-red energy into corresponding electric current. The involved electric current is usually weak. Therefore, it is strengthened through an amplifier.

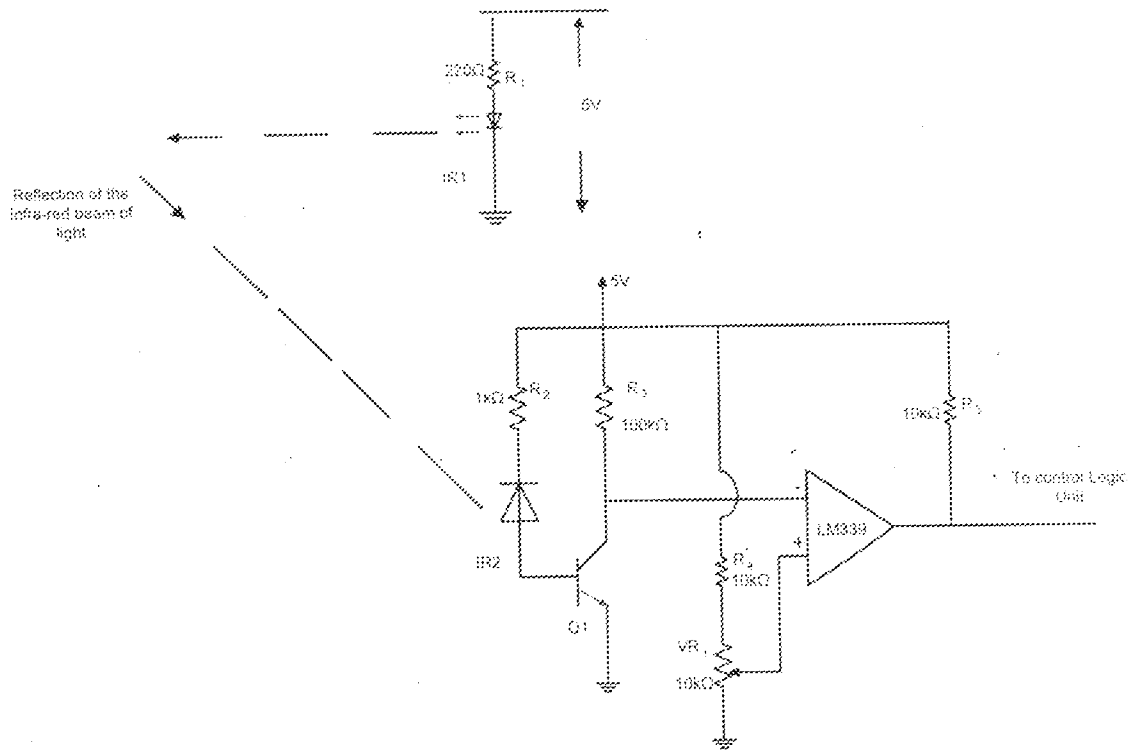


Fig 3.4 Infra-red eye amplifier unit

The infra-red transmitter circuit is designed using a 220Ω (R1) resistor and an infra-red emitting diode (IR1). The components are connected in series. The diode requires around 2.7V for normal operation. Therefore, a series resistor (220Ω) needs to hold the remaining 2.3V from the 5V supply of the circuit. A current of 10mA is expected through the circuit.

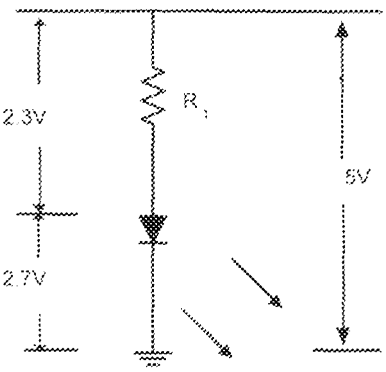


Fig 3.5 The infra-red LED setup

$R1 = 2.3 / (10 \times 10^{-3}) = 230\Omega$

But 220Ω is used instead, as 220Ω is more readily available in the market than 230Ω. It still serves the same purpose.

The other section of the infra-red eye/amplifier unit is designed for the reception of the infra-red beam from the transmitter for control purpose.

An incorporated infra-red sensor (Reverse Biased Photo-Diode) converts infra-red energy into corresponding electric current. The degree of conversion is of direct proportionality. This is means, the more infra-red exposure of the sensor, the more corresponding output electric current. An evident attribute of the electric current from the infra-red sensor is very low strength.

Q1 which is 92JC945 NPN transistor, is connected to the infra-red sensor for significant amplification of the involved electric current. It is a common practice to put in series a 1kΩ resistor with the infra-red sensor. The resistance allows suitable current to flow through the device. The computation of the current through the base is quite complicated due to the fact that infra-red sensors are always reversed biased. Therefore, the estimation of such electric current flow is started from the transistor's collector and through the current gain of the transistor, the base current is known.

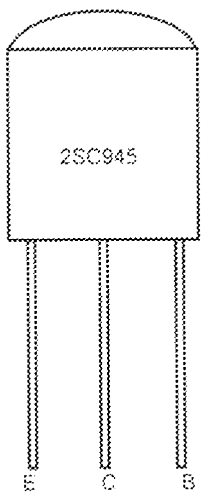
The very impedance of infra-red sensor necessitated a high resistance loading of the collector of the involved transistor. The high resistance is compatible with the expected low current of the base of the device. R3 the collector load is made 100kΩ. Therefore, for saturation, the transistor is expected to possess a collector current as estimated below

$I_c = V_{cc}/R3$. ....Eqn(3.1)   already $V_{cc} = 5V$, $R3 = 100k\Omega$

$I_c = 5/100 \times 10^3 = 0.05mA$

$I_c = 0.05mA$

2SC945 NPN transistor is designed for low speed switching and audio amplification. It has a typical current gain of 100. It operates with a maximum collector current and voltage of 100mA and 50V respectively.



E = Emitter. B = Base. C = Collector.

Fig 3.6 The Pin Configuration of the 2SC945 Transistor

Therefore the base current of Q1 with I_c Value of 0.05mA is given below.

$I_B = I_c/h_{fe}$ ....Eqn(3.2)

$I_B = 0.05 \times 10^{-3}/100$.

$I_B = 0.5\mu A$.

The expected electric current at the base is extremely small. It shows the high impedance nature of infra-red sensors. At least, the electric current is expected to completely saturate the involved transistor. But, this electric current is not always attained for sake of longer infra-red range or coverage.

The result is an incomplete zero state of the collector during expected saturation state. The fact is that, on infra-red detection the voltage of the collector drops close to zero voltage. When there is no infra-red detection, the collector of the transistor is relatively high.

The collector of the transistor is connected to the inverting input of an LM339 comparator. The non inverting side of the comparator is referenced or off-set through VR1 (a 10kΩ range variable resistor). The resistor is used for adjusting a particular voltage to the non-inverting input of the comparator.

The LM339 comparator follows one and the same principle of operation of conventional transistor. A single LM330 integrated circuit has four comparators [9].

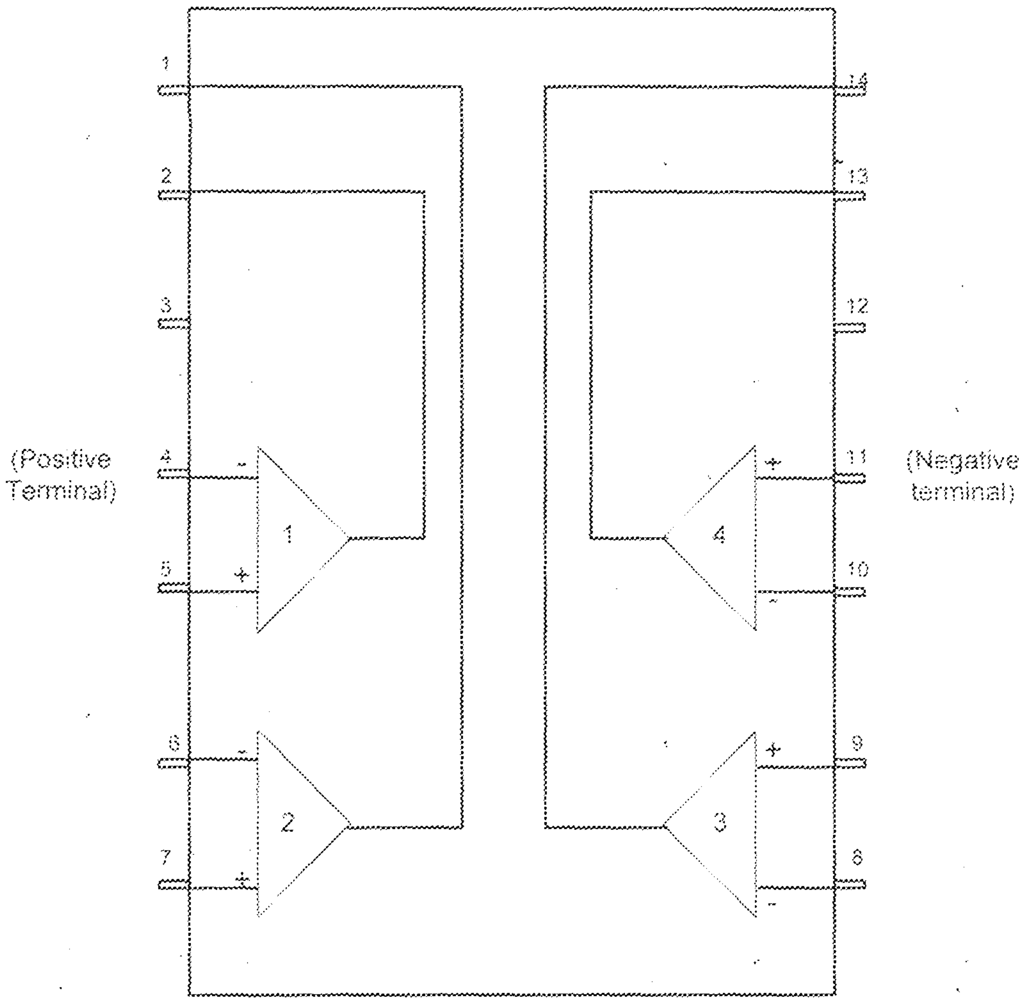


Fig 3.7 The Pin Assignment of the LM339

One of the four comparators is used in the circuit. A single comparator has two inputs and a single output. The output responds to the comparison of the two inputs. The output is in digital or logical nature. Whenever, the voltage at the non-inverting input (V_{in} (+)) is greater than that of the inverting side (V_{in} (-)), the output is always logic 0. but a reverse state of the inputs results in logic 1 outputs [9].

In the design, the non-inverting output (V_{in} (+)) is always at voltage value within the range 0-2.5V, but it is usually not adjusted at 0V. R4 and VR1 are of the same value (10kΩ), the voltage across them is 5V. Therefore it is quite evident that the voltage across each of the resistors is 2.5V.

The variable resistor, VR1, is always used to offset the comparator this is because of expected infra-red detection. The result at the non-inverting input won't be zero. Therefore, a comparator is required to rectify the result. VR1 is also used for adjusting the sensitivity of the sensor. A wide voltage off-set results into low input sensitivity, lower off-set voltage and give better sensitivity.

The circuit is designed in a manner that an obstacle reflects the infra-red radiation from the transmitter to the infra-red sensor. The output of the comparator changes from the logic 1 to 0. The high logic level is quite a necessary control signal.

3.4 Control logic unit

The control logic unit holds a 4013B latch and an automatic reset logic device involving the 4060B.

The unit controls the main operation of the device in response to the inputs condition.

The 4013B is a CMOS integrated circuit comprising of two latches. The internal devices work independently. In fact, the latches or flip-flops are D-type devices but they can easily be converted to SR devices [8].

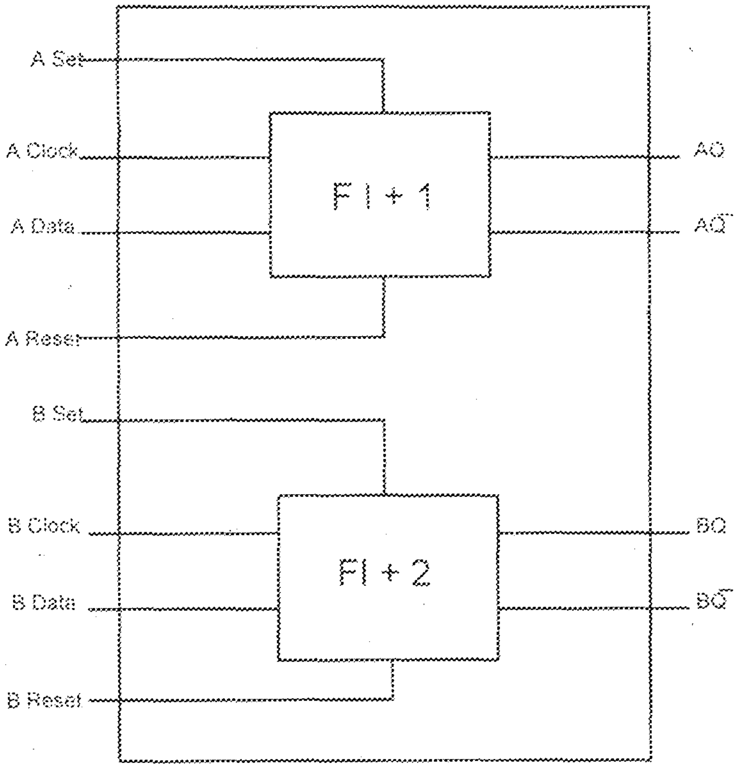


Fig 3.8 Functional diagram of the 4013B

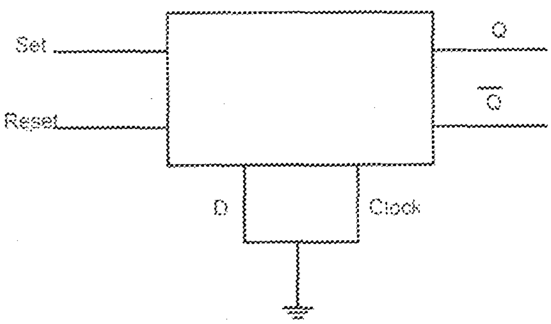


Fig 3.9 A single D-type device at SR configuration

An SR latch is incorporated into the design to hold control logic level for the purpose of motor and relay/heater switching.

The 4060B on the other hand is a CMOS oscillator. It is usually operated at the RC configuration. The device is quite a useful timing device. This is because it possesses ten frequency outputs. The frequencies are gotten from internal 14 stage division of a main frequency generator by an RC circuit.

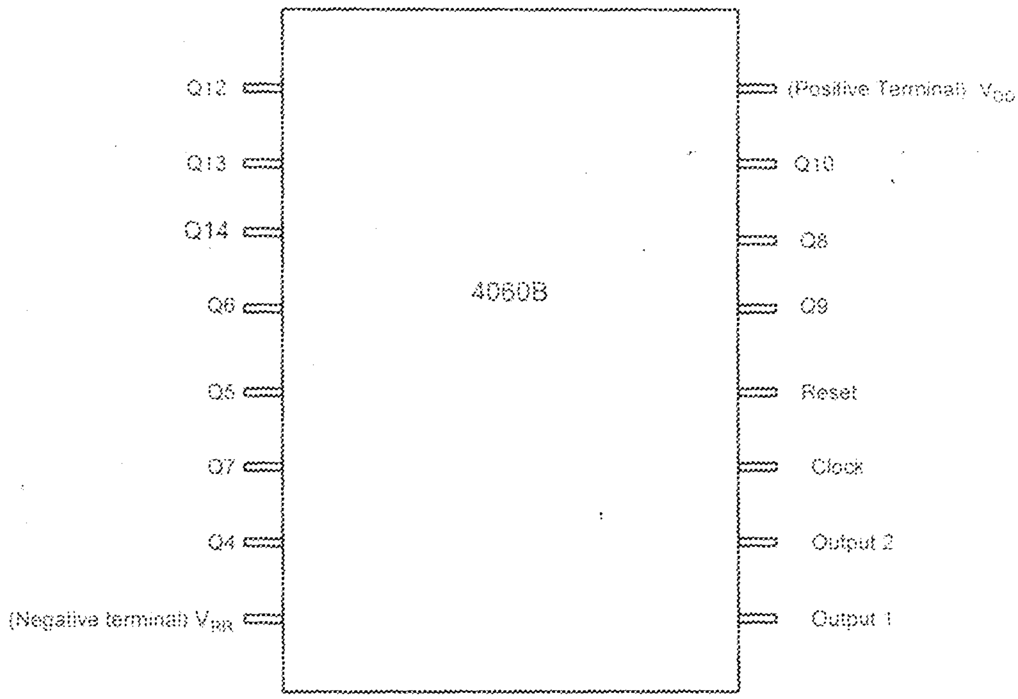


Fig 3.10 The pin Configuration of the 4060B.

Pin 12 of the device is used for device control. It is active high whenever the Pin is placed at logical 1, the device would not work. only at logical 0 would the 4060B integrated circuit be operational.

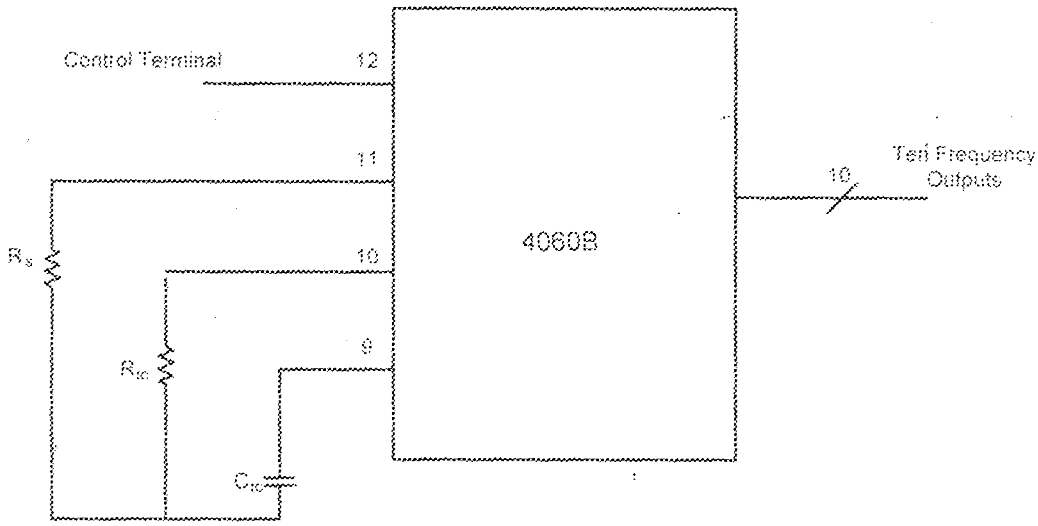


Fig 3.11 The RC configuration of the 4060B.

R_{tc} and C_{tc} are required for the devices Oscillation.

$10R_{tc} \geq R_s \geq 2R_{tc}$

The main frequency is given below

$F_m = 1/2R_{tc}C_{tc}$ ………….. Eqn (3.3)

A given output from the device depends on the corresponding Q value.

$F_{ox} = F_m/2^x$ ……….Eqn(3.4)

x is the corresponding Q value of a particular output [11].

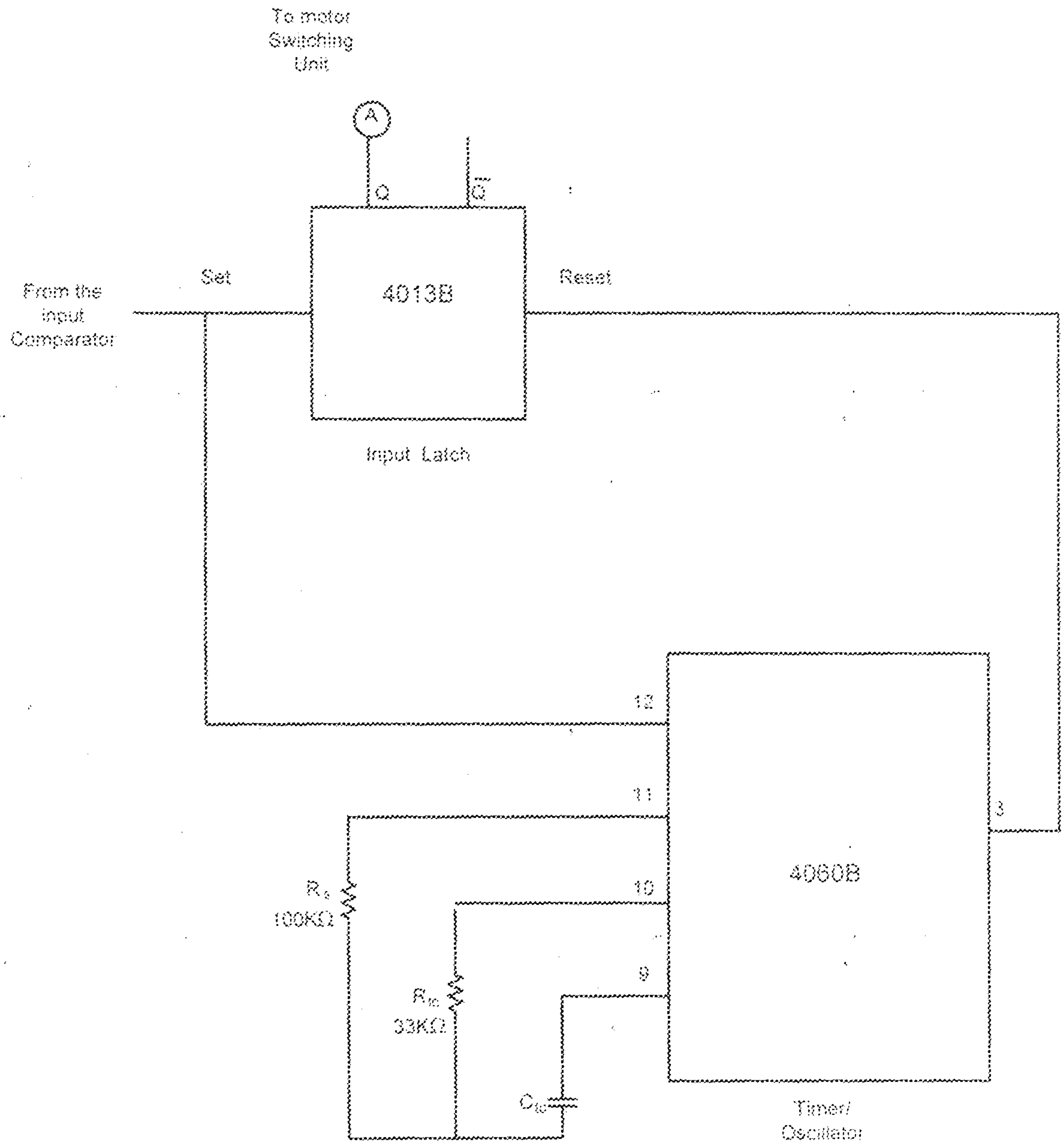


Fig 3.12 The control logic unit.

The time of oscillator (4060B) is required to reset the input latch after a delay. The result is a timed operation of the output. That is the in wired fan and heater work for a particular time before automatically switching off. Output of the input latch does the major control. It goes logical 1 a moment after the output of the input comparator is high logic level.

High lever of the 4060B simply results into disenabling mode. Whenever the high level signal changes low in response to no-infra-red condition, the timer starts working towards a time in which its output changes logical 1 in resetting the input latch. in response output changes from logical 1 to 0.

The output is designed to be ON for a specific time of roughly 23 seconds. The determining elements are Rs (100kΩ), R_{tc} (33kΩ) and C_{tc} by using the 4060B integrated circuit's formula from the manufacturer's data sheet the value of C_{tc} can be computed.

23 second timing is corresponding to the following frequency which is given below.

$T = 1/f$ ....Eqn(3.5)

$F_{tc} = 1/23x2 = 0.022Hz$

If the signal is expected at pin 3,

Therefore,

$0.022 = F_m/2^{14}$

$F_m = 2^{14} \times 0.422 = 360.5Hz$

$F_m = 1/ (2.3 \times R_{tc} \times C_{tc})$.........Eqn(3.6)

$C_{tc} = 1 / (2.3 \times R_{tc} \times F_m)$.. ....Eqn(3.7)

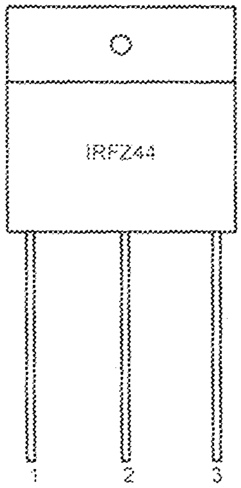
$C_{tc} = 1/(2.3 \times 33 \times 10^3 \times 360.5) = 3.65x10^{-8}F$

$C_{tc} = 0.035\mu F$

C_{tc} value of 0.047μF is used in the circuit therefore, the timing is expectedly slower due to increase in capacitance component of the oscillator and due to the inaccuracy of the involved formula.

3.5 Motor switching

The motor switching unit involves a MOSFET switching device namely the IRFZ44. This is a very high current switching transistor with a very low on state at about 0.01Ω. It has a maximum operating voltage of 55V.



1. Gate. 2. Drain. 3. Source

Fig 3.13 The Pin assignment of the IRFZ44

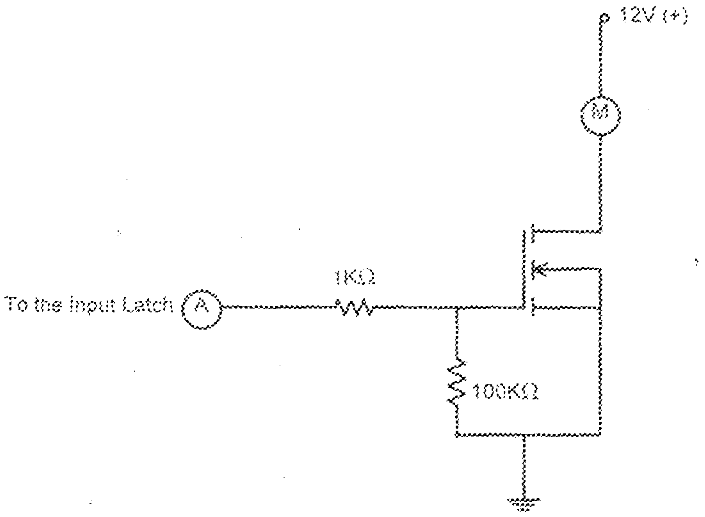


Fig 3.14 MOSFET for Motor switching

Metallic oxide semi-conductor field Effect Transistors (MOSFETs) are attributed to direct switching. As the gate is slightly positive, the source and drain are directly connected together with an extremely small resistance [12].

Therefore the MOSFET simply allows 12V power supply to the motor for operation. That is whenever the gate is relatively positive.

Terminal K is fed to the relay/heater switching unit for control purpose. Moreover the motor is representing an air blower.

3.6 Heater Switching Unit

This unit works with hand in hand with the motor switching unit. The unit responds to signal from the input control latch. The unit mainly comprises of a switching NPN transistor, 12V relay, and a heater.

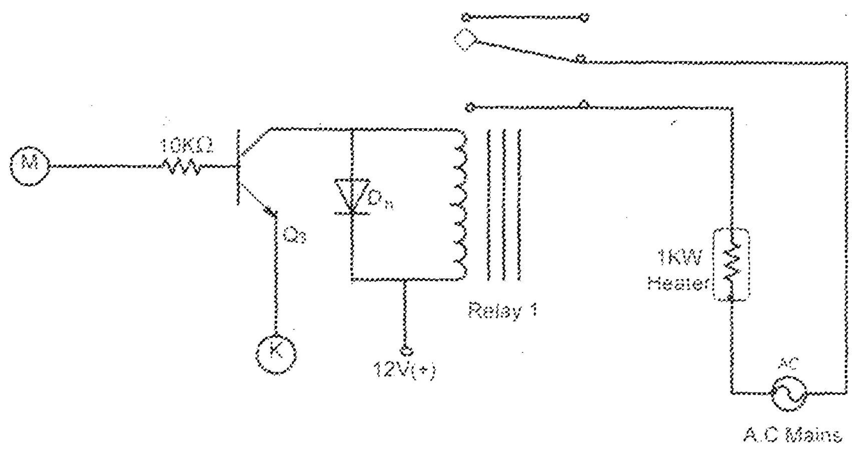


Fig 3.15 The heater switching unit

The IRFZ44 that was earlier explained does not only switch the motor but also Q3 (a new switching transistor). The initial condition of the base of the transistor is high logical level. Therefore, in making the emitter of the transistor negative, the corresponding relay is switched on. In other words, the transistor is saturated or in the on state.

The relay responds to the transistor's saturation. At the transistor's cutt-off state, terminal 1 of the relay is connected to 2, but during the saturation terminal 2 is disconnected from 1 and goes to 3. The initial switching condition of the relay disconnects the involved heater for the A.C mains supply, but during the transistor's saturation, the heater is supplied with electricity.

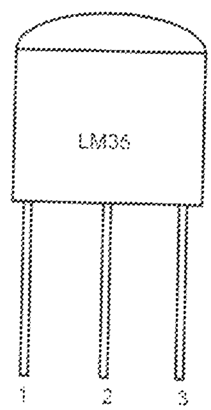
Terminal M links the heater switching unit to the thermostat unit which controls the heating. This feature is necessary because continuous operation or on state of the heater could lead to considerable circuit damage.

The thermostat control involved changes the initial high condition of terminal M low whenever the heating is hazardous.

In addition, the reversed biased diode across the inductive terminals of the relay is incorporated to conceal the effect of back E.M.F resulting from the period switching of the involved relay switch.

3.7 Thermostat unit

As earlier explained, the thermostat is incorporated into the circuit to regulate the involved heating. The thermostat is quite electronic and modern in nature, due to its precision and accurate response. The main electronic component in the circuit is an LM35 integrated circuit temperature sensor. It possesses three terminals. They are required for power supply. The other one produces an output voltage in response to temperature exposure. The terminal is based on a temperature –voltage relationship of $1^{o}c$ to 10mv [13]. Therefore, a temperature like $40^{o}c$ is corresponding to 400mV. In fact the temperature sensor is just an electronic thermometer. It works within a temperature range of 0 – $100^{o}c$.



1. Vin (Positive terminal) 2. Vout (Output voltage) 3. GND (negative terminal)

Fig 3.16 The Pin assignment of the LM35

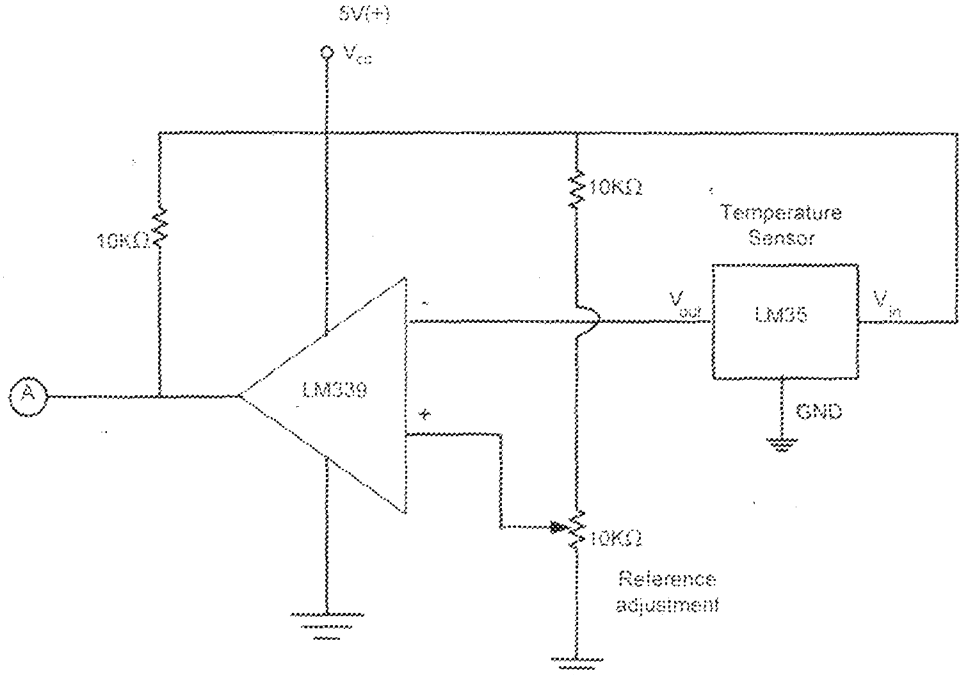


Fig. 3 17 The electronic thermostat Unit

The LM35 integrated circuit is connected to an LM339 device. The Output of the LM35 is connected to the inverting Output V_{in} (-). The non-inverting input V_{in} (+) is made as the reference. The corresponding voltage to a particular temperature can be asjust at the no-inverting input V_{in}(+). Whenever the voltage from the temperature sensor is going beyond the reference voltage, the output of the comparator changes from the initial logical 1 value to low 0. A relatively low voltage at the base of the relay switching transistor simply turns the relay off or heater disconnected from the power supply. This is despite the fact terminal K is relatively low. The reference voltage of the comparator is set at 600mv, corresponding to 60*c, therefore, whenever the air heating is going beyond 60*c the hear is switched off. The hearting starts again whenever the temperature is about dropping below 60*C. moreover the two 10kn resistor make a potential divider. It is quite obvious the voltage across each resistor is 2.5V.

This is simply how the heating of the device is regulated.

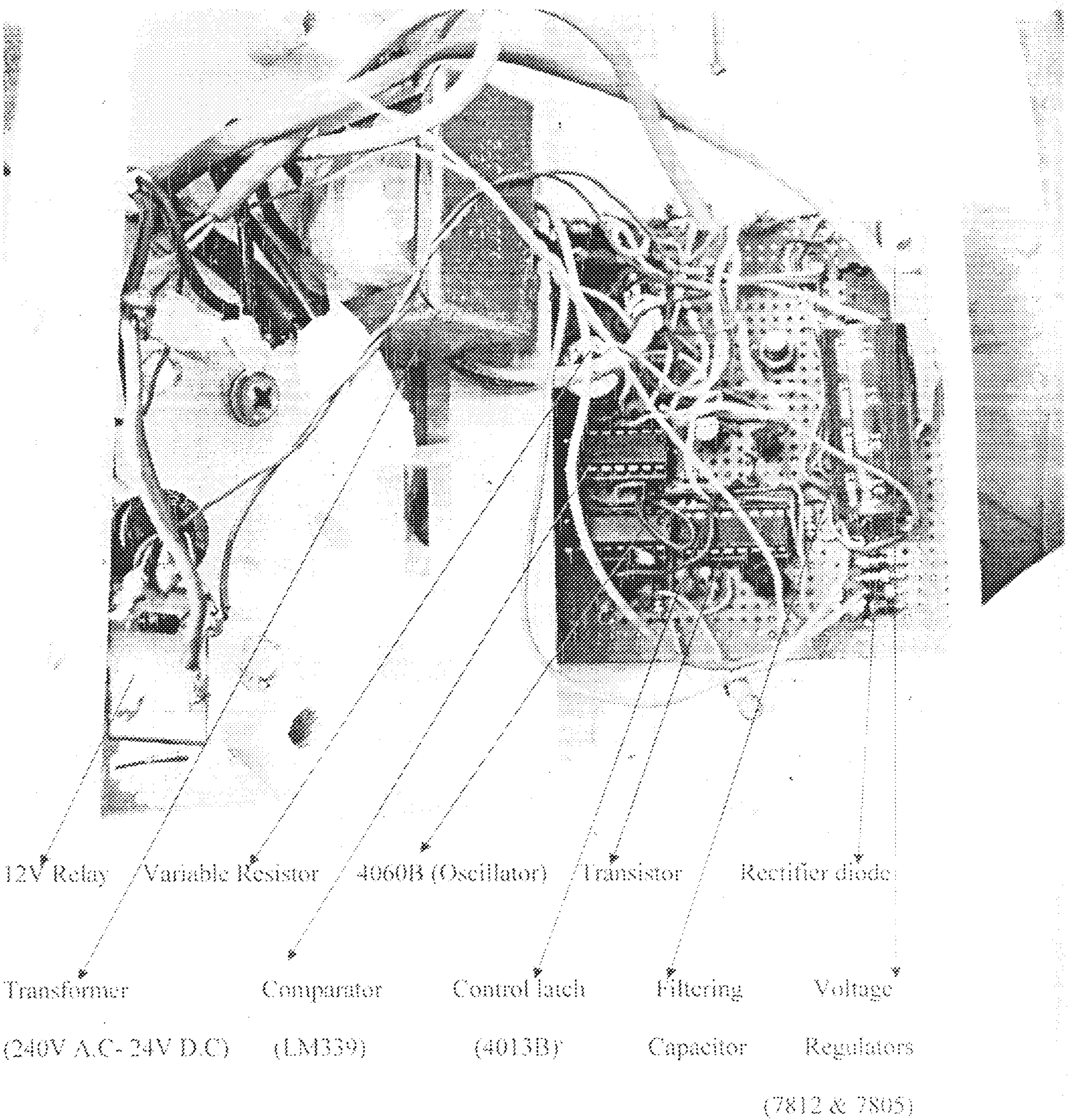


Fig 3.18 Picture of the Whole Circuit on a Vero-board.

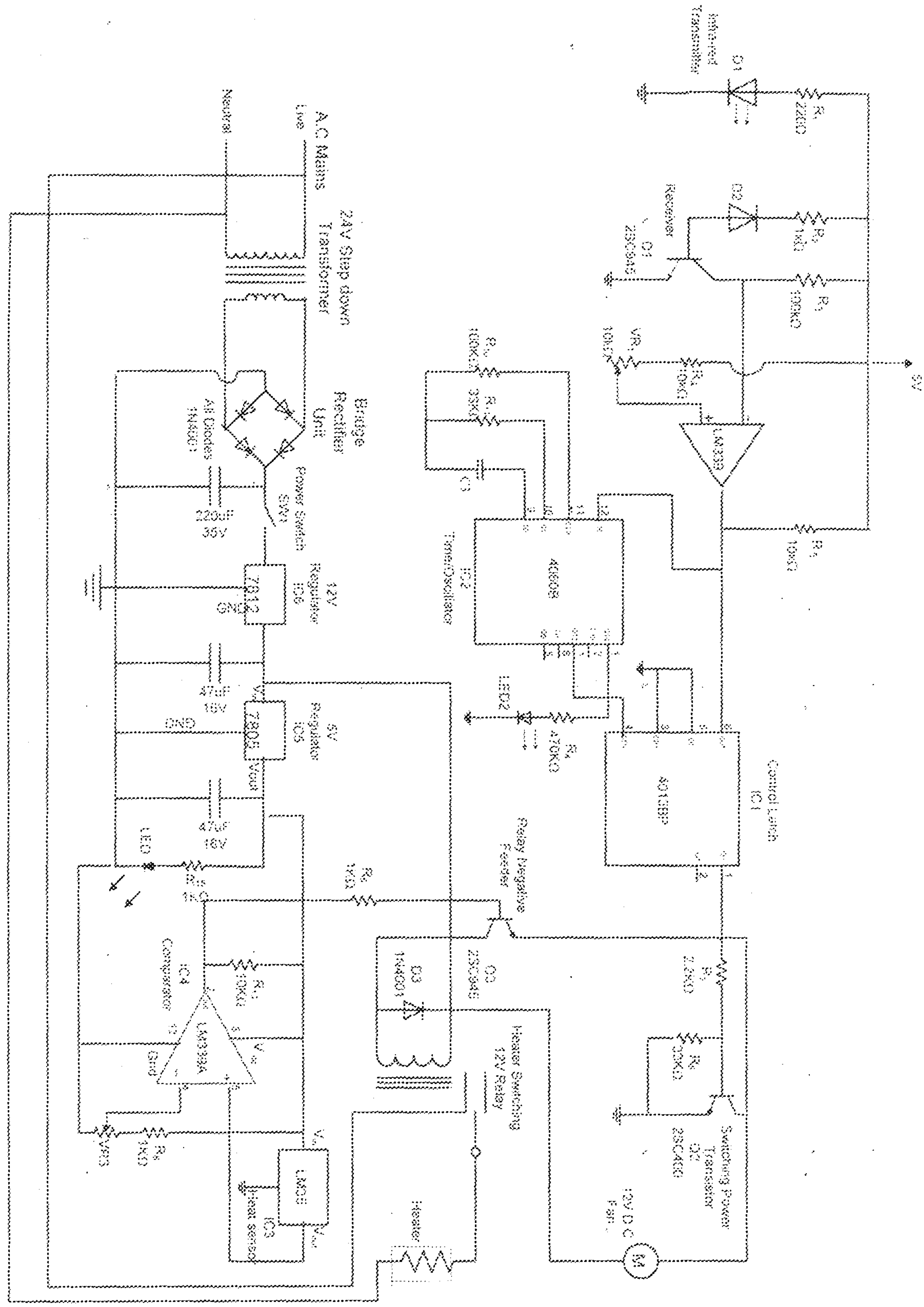


Fig 3.19 Complete Circuit Diagram of the Touchless Hand dryer

CHAPTER FOUR

CONSTRUCTION, TESTING AND DISCUSSION OF RESULTS

4.1 Construction

The construction was carried out in stages i.e. one unit after the other-using a breadboard where each section of the design was built and tested to give the required signal output. Practically all the components were transferred onto the Vero-board after the initial assembly and test using the bread board. Components prone to damage due to static charges and handling (the LM35 sensor and the MOSFET) were the last to be mounted.

They were fitted in integrated circuit holders but were not plugged into the holders until all the wiring was completed. Care was taken in the course of soldering to avoid short-circuiting. A number of link wires are needed and the capacitor checked for polarity before final soldering was carried out. The circuit set-up was tested again and then placed in a casing, where the Vero-board was screwed onto the casing.

A casing was constructed from a Double (13-15Amp) socket gang box and a Single (13-15Amp) socket gang box. The Single socket gang box was used for housing the Transmitter and receiver and the Double gang socket box to house the whole Main circuitry of device.

The main body was constructed from an old kettles metallic body to from a round truncated cylindrical shape. The fan was attached at the base of the container while the heater was attached at the other opening where the hot air is supposed to exit.

The whole body measures 27cm length and the cylindrical part alone has a diameter of 17.5cm. The truncated opening for hot air to pass is 10.6cm in diameter.

A proper cable rating of $2.5mm^2$ was used to supply power to the circuit because of the 2 heavy load Heaters of 1Kilo-Watt each [14].

(a) Length 27cm, (b) width 17.5cm, (c)Vent opening 10.6cm, (d) Height 7.5cm

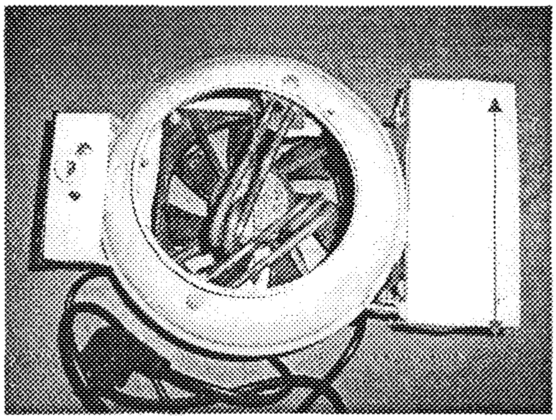


Fig 4.1 Dimensions

4.2 Testing

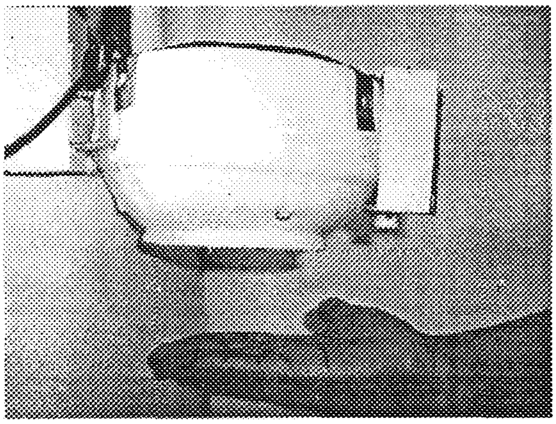


Fig 4.2 Illustration of operation

The equipments used for testing was a Digital and an Analogue multi-meter, a Clinical thermometer, a Stop Watch and a transparent ruler.

There are two LED pilot lamps for use indication, one for standby mode with power supplied (Red LED), and the other for when the circuit is operating (Blue LED).

A Voltage of 5V is referenced against a 10KΩ resistor and VR1 which are then connected to the non-inverting input of a Comparator (LM339A), thus when the inverting input is not as much as the voltage across VR1 (when the transistor is saturated and collector voltage Vcc is very low) the Comparator (LM339A) gives a high to trigger the control latch.

The value of VR1 is therefore directly proportion to the sensitivity (the effective distance range between the receiver and a hand reflecting a signal) of the Receiver. Therefore the distance range of the Receiver is set using VR1.

To achieve setting the temperature not to go beyond $60^{o}C$. 5V is referenced through a 1KΩ resistor and VR3. The VR3 is set such that voltage across it is 600mV, which fed to the non-inverting input of the Comparator2 (LM339A). Knowing the sensor produces 10mV per $1^{o}C$ of temperature, at $60^{o}C$ it will produce 600mV. When the sensor is attached to the inverting input of the Comparator so that when it produces voltage beyond 600mV, the comparator is low and the relay is triggered to switch OFF the heater.

The higher the value of VR3, the higher the Voltage across it. Hence the higher the maximum temperature of the Heater.

The Oscillator's (4060B) timing duration is determined by the capacitance value attached to Pin9 of the 4060B IC. This is given by the formula:

$C_{tc} = 1/(2.3 \times R_{tc} \times F_m)$............Eqn (4.1)

Where $F_m = 2^{14}/T$ and T is the time duration in seconds you want the circuit to be ON.

And R_{tc} is a Resistance value attached to Pin10.

Hence $T = 2.3 \times R_{tc} \times C_{tc} \times 2^{14}$.........Eqn (4.2)

4.3 Results

Outputs of all Logic IC's (Digital output) were measured when high and found to be 5V or some 4.99V.

Data concerning the relationship between the Value of VR1 and the Receiver range :

At all times a voltage of 5V is referenced across both VR1 and the 10KΩ resistor.

Table 4.1 Sensitivity of Receiver in terms of distance range and value of variable resistor VR1.

Voltage Across VR1 (in Volts)	Distance Range of the Receiver (in cm)	Voltage Across 10KΩ Resistor (in volts)	Resistance Value of VR1 (in -Kilo-Ohms)
2.50	6.20cm	2.50	10.00
1.50	9.70cm	3.50	4.29
1.00	Receiver becomes highly sensitive, even normal room light activates the circuit.	4.00	2.50

The receiver had to be shielded even for the 2.5V as a room with very high illumination will activate the circuit.

Using a clinical thermometer to monitor the switching efficiency of the thermostatic unit the maximum value recorded of the heating element was 58.55°C.

%Error = (60-58.55)/60 x 100% = 2.42%

The timing duration of operation of the circuit was 19 seconds instead of 23 seconds, the timing of the circuit might have been hindered by the resistance of the soldering joints of the two resistors and the capacitor attached to the Oscillator (4060B).

For the regulators, the voltage Output of the 12 regulator (7812) was 11.92V.

%Error = (11.92-12)/12 x 100% = -0.66%

The Output Voltage of the 5V regulator (7805) was 4.97V.

%Error = (4.97-5.00)/5 x 100% = -0.6%

4.4 Discussion of Results

For sensitivity of the receiver to kept under control, the value of the variable resistor should be > 2.5KΩ. The receiver is quite sensitive to light and should be shielded from all sources of light apart from the path for reflection of the infra-red beam.

The timing delay might have been hindered by both the resistance of the joints due to soldering or due to high temperature generated by the Heater and the Circuit components.

The error in temperature of Heater when switching occurs (Relays switches OFF the heater) might have occurred because of the use of a clinical thermometer instead of the user of a more accurate thermometer using more sensitive metals with higher temperature resistance gradient. i.e Nickel is more sensitive than the Mercury in Clinical thermometers [7].

The error in Voltage across the Regulators is mostly due to power fluctuations by PHCN. As such two multi-meters, an Analogue and a Digital multi-meter were both used to ascertain the values for sure.

CHAPTER FIVE

Conclusion And Recommendation.

5.1 Conclusion

The original idea behind this project is the design and construction of a prototype touch less hand dryer which is infra-red sensor activated, temperature regulated and timer controlled.

Heating of the element was restricted to a range of 0-60^{0}C by the thermostatic setup to keep temperature safe for the human hands, the circuitry, wiring and even for the heating elements to have a longer life span.

A Step down transformer of 240 A.C to 24 D.C was used instead of 240 A C to 12 D.C so that in case of power supply fluctuations within the IEE approved rate + or - 5% the outputs of the 12V regulator (7812) an 5V regulator (7805) will compensate effectively for power the fluctuation.

The wiring is so simple very little ca go wrong provided all of the components are orrectly positioned and well soldered.ime was spent checking for dry joints, solder idges and incorrect component positios d values before applying power. Also, it is sking getting the collector, emitter nd th se of the transistor, which is gotten from ta book. Usually the terminals of each c nent or IC have to be carefully studied fore connections are made and it should indicated in the manufacturer's data eets.

ne design is relatively simple and automate tection in the heating environment the sensor is through thermo-ionic emissic , it can be conveniently used in any applications for heating monitoring functi

The comparator output for the Relay switch actuation signal was found to be satisfactory.

5.2 Recommendations

A more efficient heating element and a Non metallic casing using a special high temperature tolerant plastic should be used in future. The heating element used in standard Hand dryers consumes much less energy while producing a large amount of heat. The current heating elements used might not last too long.

An infra-red setup which is a lot more accurate than the one used in this project should be adopted.

The use of Touch-less hand dryers will go a long way in curtailing the spread of infections and its use should be taken seriously.

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