DESIGN AND CONSTRUCTION OF AN AUTOMATIC HAND DRIER

BY

DANIEL .S. YISA

99/8419EE.

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELOR OF ENGINERING DEGREE (B.ENG) IN ELETRICAL COMPUTER ENGINEERING.

NOVEMBER, 2005.

DECLARATION

I sincerely declare that, this project work was carried out by me under the able supervision of Engr. M.A Saddiq of Electrical/Computer Engineering Department, Federal University of Technology Minna, Niger State.

....

Signature of student Date

CERTIFICATION

This is to certify that this project titled Design and Construction of Automatic Hand Drier was carried out by Yisa Daniel S. under the supervision of Engr. Saddiq and submitted to Electrical/ Computer Engineering Department, Federal University of Technology Minna, in partial fulfillment of requirements for the award of Bachelor of Engineering (B. Tech.) Degree in Electrical/Computer Engineering.

.....

Engr. Saddiq

(Project supervisor)

.....

Sign / Date

.....

Engr. M.D. Abdullahi

(Head of Department)

.....

Sign / Date

.....

External Examiner

.....

Sign / Date

ACKNOWLEDGMENT

All forms of blessing, favor assistance, guidance, and protection on me comes from my God. You are convent keeping God. Thank you for everything you have done for me.

My profound gratitude goes to my mother Mrs. D.G.Y, and my lovely brothers Engr Joseph Yisa Director Standard Aluminum LTD Abuja, and my lovely one Mary Jacob O. for being there for me, you are always been there for my support.

I will not forget my friends and course mates, especially Francis Baba for his assistance and contribution to the success of the work.

My thanks go to Engr. Kolo, Engr. U.A Usuman, Mr. Mathew Kolo for their assistance and advice towards my work was wonderful.

My big thanks go to my project supervisor, Engr. Sadidq for his assistance toward my work was wonderful.

To my head of department, Engr. M.D Abullahi and other lecturers in the department of Electrical and Computer Engineering for their immense contribution to this works.

DEDICATION

The project is dedicated first to the maker of heaven and the earth, the Almighty God and to my lovely mother Mrs. Deborah Yisa who take good care of me to make sure all need for the success of my study was granted.

ABSTRACT

The project is all about automatic hand drier. In which it is activated by blocking of an infrared with wet hand. It consists of four basic units namely, infra-red transmitter, signal detector unit, control unit and an output fan plus a heating filament. The transmitter and infra-red beam and signal detector unit response to any interruption of the beam for on ward transmission to the control unit. This unit response by activating the fan and heating element to dry up the hand.

The project have good factures compound to the traditional electronic methods such as low power consumption, low cost portability and efficient.

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CHAPTER ONE

1.0 INTRODUCTION

The project is based on the design of a touch less hand drier. The main concept is based on the use of the infra-red switching through modern solid-state electronic devices such as diode, transistor and complementary metallic semiconductors (CMOS) integrated circuits in activating a fan-motor circuit.

Dryers that allow users to dry their hands without touching anything have been in existence for along time, but with increased concerns about cross-infection, facilities are installing more of them.

Touch-less hand drier use no waste paper, so there no need for trash container where it is use. The device is designed with an input section embodying a infra-red control circuit, and the output holds a fan heater circuit. The input unit operates the output switching that is either "ON or OFF" the leading unit senses the breakage of infra-red transmitter-receiver link, so that the result is manipulated by a digital control unit which is directly connected to the output.

The circuit is design in a mode that whenever, the infra-red link is interrupted the fan-heater circuit is switched on and the device blows out hot air directed to dry the hands. And whenever the infra-red link is restored the fan-heater circuit is switched OFF.

The advantages of the infra-red no-touch control are now widely accepted. The drier switched ON without any long operation instruction for a new user. Moreover, the device is increasing used in the banks, hotels, hostels, restaurants e.t.c. It is mostly applicable for toilet use. Moreover, the design error is really minimized by component selection.

1.1 OBJECTIVE

The aim of the this project is based on the design and the construction of a touch less hand drier, the main concept is based on the used of infra-red switching through modern solid-state electonic devices such as diodes, transistors and complementary metallic semiconductor (CMOS) Integrated circuits in activating a fan motor circuit.

1.2 MERIT

In many public restrooms and restaurants, you can see the use of a "touch less" wall mounted hand dryer. These are activated by motion and allow you to begin drying your hand without having to press a button. Here is a brief hand dryer guide on the advantages to the touch free wall mounted hand dryer:

• Cleanliness: Touch less wall mounted hand dryers allow each person to share in the drying experience, without sharing the germs that they have on their hands before drying. An older wall mounted hand dryer would require each person to touch the exact same spot to get started, hardly the most sanitary of conditions.

• Timing – With the older wall mounted hand dryer, the air would last only as long as it was pre-programmed to when the button was pressed. Now, "touch free" wall mounted hand dryers will keep pumping that hot air out for as long as you keep moving your hand beneath it. This means no more having to race the clock to dry your hands. There are many other advantages to the new "touch less" wall mounted hand dryer. It is also use in the market for a wall mounted hand dryer for your business. it can also be use in the toilet to dry hand and most of the Government organisation and private companies make used of hand drier in their offices toilet to dry their hands after used.

DEMERIT

1) A more complex and compact integrated circuit can be used to contain altogether.
2) More set heating technique can be incorporated into the circuit for more efficiencies.
3) The circuit board can be printed for more easy in soldering.

CHAPTER TWO

2.0 LITERATURE REVIEW

Automatic hand drier that allow user to dry their hands without touching anything have been around since 1920, the first true hand drier come on the market, but it was extremely large and heave, and frequently overheated. Since then, thousands of patents have been issued for different hand dyer designs, but most of them only tweak the outside packaging of the hand dryer so that it looks more aesthetically appealing to you.

2.1 THE BASIC PRINCIPLE OF OPERATION OF TOUCHLESS HAND DIRER

The device incorporates three major parts. the infra-red control system, the electric motor and electric filament. the infra-red system is design for triggering on and off of the other parts. the design incorporates one infra-red transmitter and receiver the transmitter low energy infra-red ray or beam of a length strength for about 10cm. the infra-red receiver is at other opposite inline direction of the leading transmitter. The infra-red is usually a diode type in which the infra-red energy is changed or converted into corresponding electric current.

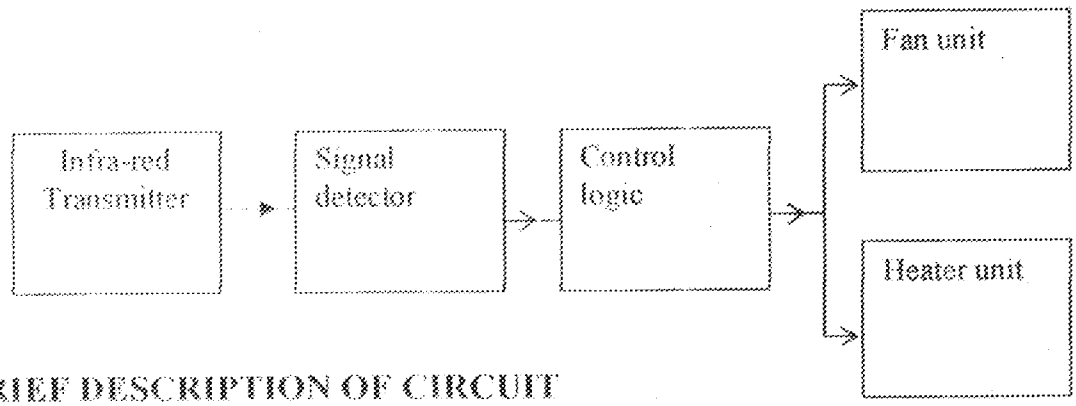
The device is connected to a amplifier which boast the strength of the current. the output from this amplifier is connected digital or logical circuit. the circuit to switch on and off both electric heating filament and fan or blower. the digital circuit switches on the device when ever the infra-red link between the transmitter and receiver is out or interrupted. And the switching is automatically reversed after about 10seconds.

2.2 INFRA-RED TRANSIMMITER:

This is a design which provide the source of output when input gate is high, when gate is low, the output is low a inversion of the output (out) is also availably which be used with a visible LEAD to insure the unit is operating properly. The intent of this design controlling and infra-red signal as outline in my application notes object dictation using pause infra-red. However, using these external free up the module and associated thermal for other application. It may be use with PICAXE' which do not have a module.

CHAPTER THREE

3.0 THE BLOCK DIAGRAM



3.1 BRIEF DESCRIPTION OF CIRCUIT

The circuit is attributed to a low power, simple and economical design and the use of modern and reliable electronic components is quit evident. Based on the target of designing a portable advices such as infrared emitting diode and receiver. And even complementary metallic oxide semiconductor (cmos) integrated circuit are used. They provide high degree of compactable, and reliability.

3 1 THE INFRARED TRANSMITTER AND RECEIVER.

The infrared transmitter is a diode type. It is design to transmit the invisible ray whenever it is moderate by forward biased with a simply of about 2.5v.

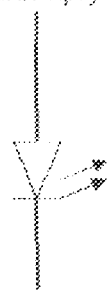
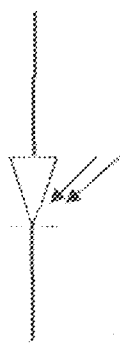


fig. 3.0 Simple for a infrared transmitter diode.

The infrared receiver is similar configuration. But it has a reverse mechanism of operation. The leading device produces corresponding electric current at it's terminals whenever limited biased in the circuit.



3.1 Symbol for a infrared receiver diode

3.2 THE OPERATION OF 4060B INTEGRATED CIRCUIT (IC)

The complementary metallic oxide semiconductor (CMSO) integrated circuit is designed to generate ten different frequency. It can be connected in both resistor – capacitor (Rc) or crystal ,ode. The easily is use in the circuit. The 4060B pin 11, 10, and 9 are attributed to the operation frequency. A specific value of resistor and capacitor are connected to respective pin.

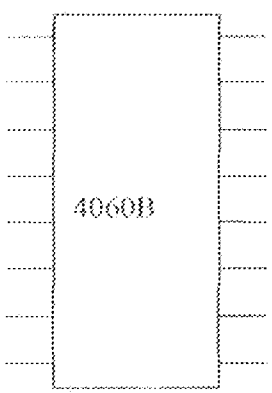
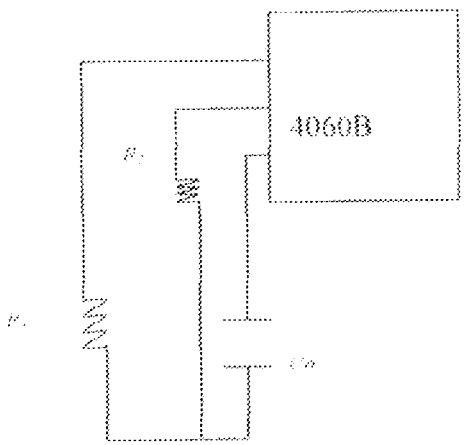


Fig. 3.2 4060 pin assignment



3.3 Fig. 3.3 4060B Oscillator Pin.

The value of R_2 and Co determine the frequency of operation of the integrated circuit. The relationship between R_1, R_2 and R_o. The frequency of F_o is operation $1/2.2R_2L_o$ and $10R_2 > R_1 > 2R_2$

The value of output from the frequency pin can be calculated by rising two with the value end Fo (the oscillating frequency) is derived by the value for instance, the frequency at pin 7 15

$K_{pin\ 7} = F_o/2^3$

The two is raised by four (4) between pin 7 15 Q4. this show that the frequency to has under go four divide by two action the pin 12 is used for control. When the high logical level is applied to the integrated circuit fail work or disenabled. Moreover a low logical level is needed at the pin for the device to be enabled. The leading pin is used for major control of the integrated circuit especially in time based compact and complex design application. The frequency of operation of the oscillator is

$F_o = 1/2.3RJo = 1/2. \times 33 \times 10^3 \times 0.001 \times 10^{-6}$

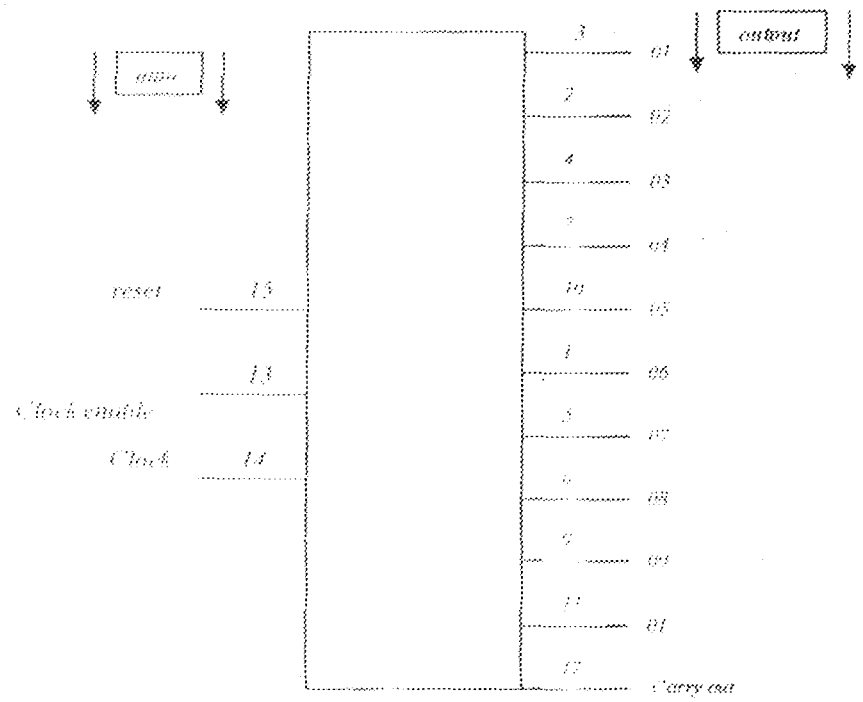
$= 13774.10Hz$

The data sheet defined the formula as not accurate so that frequency at pin3 is

$F_o/2^{11} = 13774.01/2^{11}$

3.4 THE OPERATION OF 4017B INTEGRATED CIRCUIT

It is also a complementary metallic oxide semiconductor (CMOS) integrated circuit and with ten output. The component is sometimes call a stepper. This is because logical 1 is forced to move along the output. For instance it moves from one output to be other for each clock trigger or pulse.



Functional diagram of 4017B

The outputs respond to the three major inputs. The reset pin 15 is designed to start the stepping allover again whenever logical 1 or HIGH. It is made low level logic at normal operation the pin 13 is the clock enable. And it requires a low level logic before the outputs can respond to the clock input or pulse. And pin 14 is the clock input in which the outputs respond. Both 4017B and 4060B can be used as digital timer as seen in the design.

3.5 OPERATING MECHINISM OF THE DEVICE

The input comer through or from the infrared circuit, especially the infrared sensor or receiver. Whenever the infra – red from he transmitter is in live with the receiver, the amplifier is output is low. The or at low voltage.

But wherever, the link is broken, the transistor's out put raise to high to the supply voltage of 9v the voltage is require to set the SR latch in which Q is the logical 1 and Q is low, the Q is connected to trigger on the transistor driving both the heater and fan.

And Q is design to enable the 4060B through it's pin 12 after this operation, the diode that is connected to pin 3 started to blink a ling with the corresponding pulse. Pulse at pin 1 of the 4060B is to clock the 4017B. in which after some time automatically reset back the SR flip flop, the operation change Q bank to a low logical level and Q to HIGH. And because pin 12 of the 4060Bis connected to Q of the 4013B.

A high logical level at the pin 12 disabled the integrated circuit. So that the condition returns back to normal. Whereby, the switching relays for both the heating filament and fan are triggered off. The relay circuit incorporate a diode that removes or eliminate sperks at the relay.

A relay is simply a electromechanical switch. It is designed for insulation switching. The transistor energize the relay and then switches on the power supply to the 500watts heater this is the same time the fan is on .

The fan blower air over the heater. And hot air is gives out. For the drying effect the gate and the base of the transistor and mosfet respectively are connected together so that both come on and off at the same time

3.6 THE OPERATION OF 7805 INTEGRATED CIRCUIT

The 7805 is a 3 terminal 1A positive voltage regulator in the 220ID PAK package and with several fixed output voltages making useful in a wide range of applications. Each type employ internal current limiting, terminal shutdown and safe operating area protector making it essentially in destruction. If adequate heat sinking is provided they can deliver over output current through designed primary as fixed voltage regulators

These devices can be used with external component to obtain adjustable voltage and circuit.

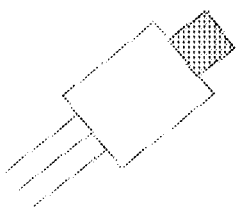


Fig. 3.4 1 Input 2 GND 3 output

3.7 THE OPERATION OF IR+244 MOSFET

The advance power MOSFETS from international Rectifier the 7805 consist of series of three terminal positive regulator are available in the package and with several fixed out put voltages, making them useful in a wide rang of application each time employ internal current limiting thermal shutdown and safe operation are protection making it essential in destructible if adequate heat sinking is provided they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external component to obtain adjustable voltage and current.

3.8 THE OPERATION OF MOSFET (224) INTEGRATED CIRCUIT

The N-Channel Mosfet (224) is to switch on the 12V fan (blower) the advanced power MOSFETS from processing techniques to achieve extremely low on – resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that power mosfets axe well known for provides the designer with an extremely efficiently and reliable device for use in the wide variety of applications.

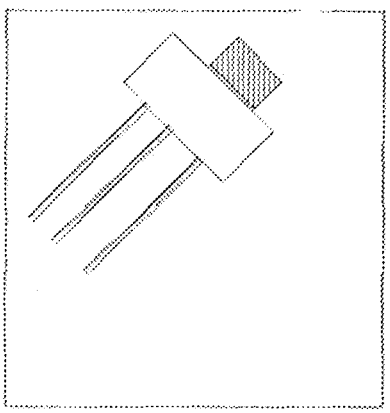


Fig 3.5

3.9 THE OPERATION OF 4013B INTEGRATED CIRCUIT

This is also the complimentary metallic oxide semiconductor (CMOS) integrated circuit. It is a dual D-large with both set and reset terminals. The device is use as a simple SR flip flop or large in the design. This is achieve by grounding both the clock and D input.

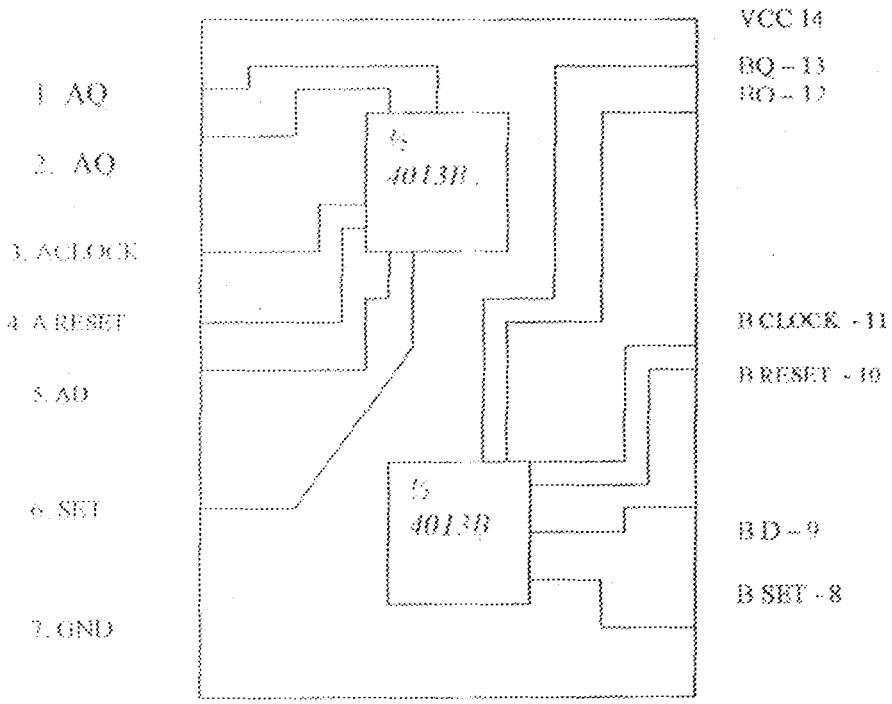


fig. 3.6 Pin assignment for 4013B

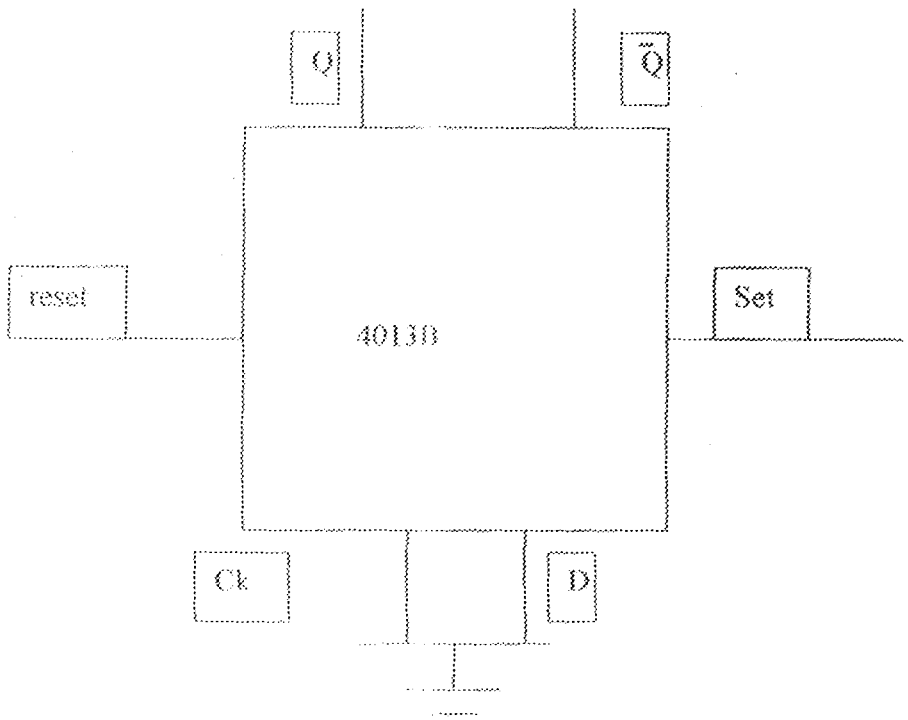


Fig. 3 7 connecting 4013B SR flip flop or large

S	R	O	Q
0	0	0	1
0	1	1	0
1	0	0	1

A simple truth table for a SR flip flop.

IT IS A NPN transistor with a current gain of about 100 it is also one of the most widely use transistor for switching application.

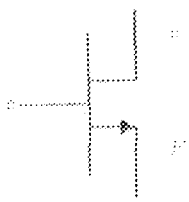


Fig. 3.8 25C945 NPN transistor

3.10 TRANSFORMER ACTION

A transformer can step up or step down voltage (step down in this case) according to the turns in ratio addition, the impedance connected to one side of the transformer can be made to appear either larger or smaller (step up or step down)at the other side of the transformer depending on the square of the transformer winding turns ratio A transformer is also applicable to transform current. As in this case of voltage transformation, the transformer can step up step down a voltage applied to the side directly as the ratio of the (or number of winding)on each the voltage transformation is given by,

$V_2/V_1 = N_2/N_1$

This is better clarified below under emf equation of a transformer

EMF EQUATION OF A TRANSFORMER

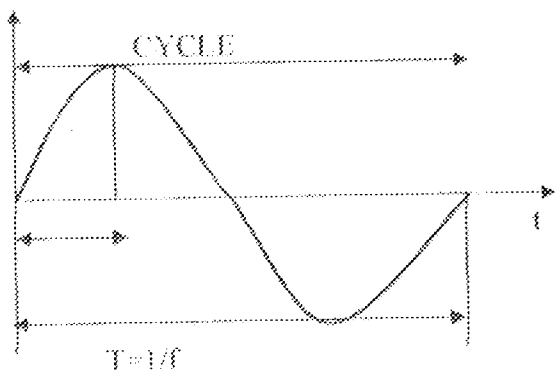


Fig.3.9 AC waveform

Let N_1 = Number of turns in the primary

N_2 = Number of turns in the secondary

ϕm = Maximum flu in core in webers

= Bm x A

= Where BM is the maximum magnetric flux and density A is the cross-sectional area.

= Frequency of AC inpot in Hertz

As shown in fig. 3. above, flox increases form its zero value to maximum ϕm in one qarter of the cylce.

Therefore,

Average rate of exhange of flux = $\phi m/ 1/4f) = 4f\phi m$ wb/s or v

Now , rate of change of flox unit tum means induced emf in volts

Therefore,

Average emf/ium = $4f\phi$ volt.

If flux ϕ varies (sinusoidally, then rms value of the induced emf is obtaned by multipying the average value with a form factor.

Form factor = rms value/ average value = 1.11

Therefore,

Rms value of emf/tum = 1.11 x $4f\phi m$ = 4.44 volt.

Now rms value of the induced emf in the whole primary winding

= (induced emf/tum) x No. primary turns

$$E_1 = 4.44fN_1 \phi m = 4.44N_2 BmA \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Similarly, rms value of the emf induced in secondary is

$$E_2 = 4.44fN_2\phi m = 4.44N_2Bm A \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

It is seen from (1) and (2) that $E_1/N_1 = 4.44f\phi m$

It means that emf/turn is the same in both the primary and the secondary windings. In an idela tranformer on no-load, $V_1 = E_1$ and $E_2 = V_2$, where V_1 is the terminal voltage.

Voltage transformation ratio (K) from equations (1) and (2), we get

This constant K is known as voltage transformation ratio.

i. If $N_2 > N_1$ i.e K> 1, then the trasnformer is called a step-up tramsformer

ii. If $N_2 < N_1$ i.e K < 1, then the transformer is known as step-up transformer

Again for an ideal transformer,

Input VA = output VA

$V_1I_1 = V_2I_2$ or $I_2/I_1 = V_2/V_1 = 1/K$

Hence currents are in the inverse ratio of the (voltage) trasnformation ratio.

RECTIFICATION

This is the conversion of AC (alternating current voltage) to DC (direct current voltage) still manfianing the magnitude (the voltage rating). Ethe DC level obtained from a sinusoidal input can be improved 100% usqing a process called full-wave rectification. This is achived by using doides in a bridwges configuration.

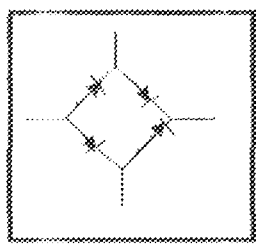


Fig. 4.0. Bridge rectifier

During the positive half cycle of the AC input sinusoidal voltage, diodes D2 and D3 conduct D1 and D4 are biased. So we have waveform like this.

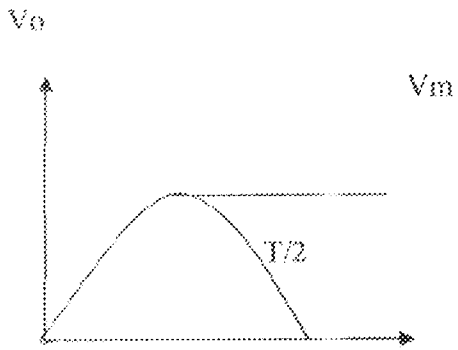


fig. 4.1 waveform of bridge rectifier in the positive half cycle

During the negative half cycle of the AC input sinusoidal voltage, diodes D1 and D4 conduct with D2 and D3 reverse biased. The illustrative waveform is

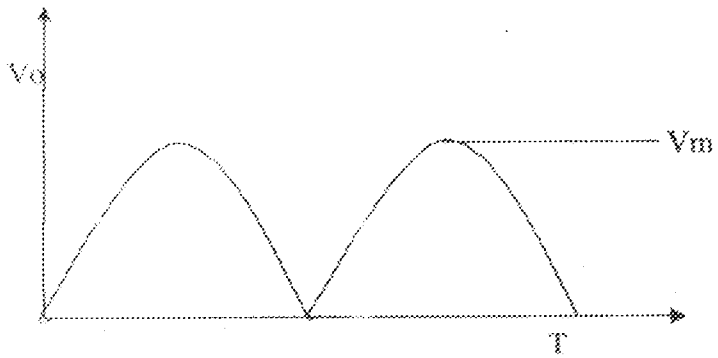


Fig. 4.2 waveform of bridge rectifier in the negative half cycle, One full cycle of the input and output voltages will appear as,

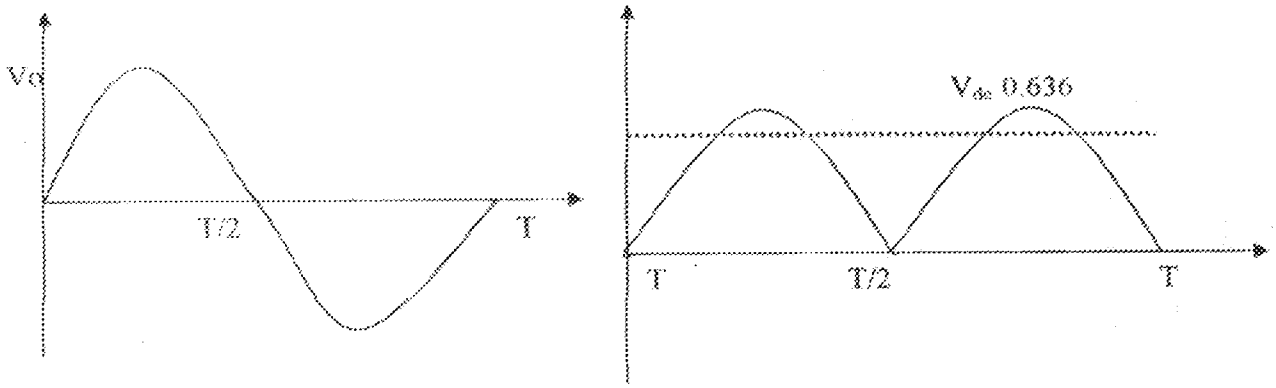


Fig. 4.3 Waveform of bridge rectifier in one full wave.

For a half-wave system, the output signal V_o has net positive area. The axis over a full period and average value is determined by,

Vdc half wave = 0.31Vm Where Vm = Vi sin wt

For a full-wave system, since the area above the axis for one wave is now twice that obtained for a half wave system, the DC has also been doubled and

Vdc fullwave = 2Vdc half wave

Vdc = 2(0.318Vm)

Vdc = 0.636

If silicon diodes (as applied to the project) rather than ideal diodes are employed, an application of kirchoff's voltage law around the conduction path would result in

Vi – Vt – Vo-Vt = 0

Where Vt is the hold voltage V0 is therefore

Vo max = Vm – 2Vt

And the peak value of the output voltage Vo is therefore

Vo max = Vm – 2Vt

For situation where Vm >>22Vt,

Vdc = 0.636 (Vm – 2Vt) can be applied for the average value with a relatively high level of accuracy.

The output of the full wave bridge rectifier is 12Vdc (unregulated).

The peak inverse voltage (PIV) is a significant factor to be considered in the choice of diodes for rectifiers, therefore, for each input diode,

Let transformer input voltage = 220Vac/ 50Hz

Transformer output voltage = 12v = Vrms

Let no load voltage = peak voltage (Vp)

Then,

Vm = Cpeak = √2 x Vrms

= √2 x 12

= √2 x 12

Vm = 16.79Vac

In choosing diodes, it should be considered that the maximum peak inverse voltage (PIV) that each diode has to sustain in when the anode is at negative peak of Vm (16.76 in this case) for full wave bridge rectifier.

Peak inverse voltage (PIV) rating of a diode is the maximum reverse bias potential that can be applied across it.

PIV≥ 16.79V with the use of 1N4001 diodes for the bridge network, the probability of diode breakdown is certainly zero because each 1N4001 diode has a high PIV of about 600v.

FILTERING

The rectified output waveform contains AC components called ripples. Filtering is done to remove these ripples and smoothen the DC voltage. The filtering is basically by a capacitor filter.

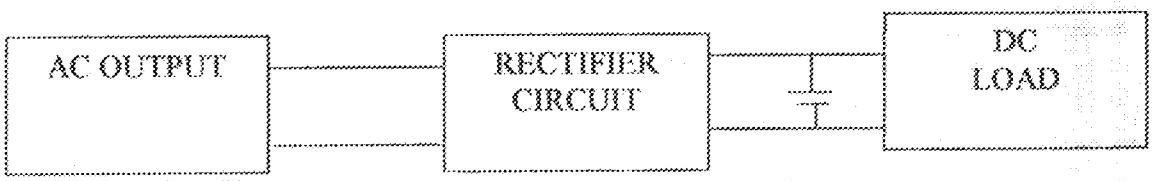


Fig 4.3 capacitor filter

The capacitor filter used is 2200UF (electrolytic capacitor). It changes up to the peak voltage and then discharges through the road (RL) preventing the voltage from falling rapidly. The filter capacitor is chosen large enough to provide acceptably low ripple voltage and make the discharge time constant R C much longer than the period of the

source waveform. As Rs is the DC load (fixed in value) only C can be chosen at will. By using a capacitor of large value

2 200 of 25v, a smooth waveform is achieved.

THE FILTERING ACTION

During the time the output voltage of the rectifier increases from ov to peak value Vm, the conducting diode (with reference to the bridge rectifier) at that charging time is very short (i.e high charging rate), the capacitor voltage will follow almost exactly the rectified waveform (Op curve in fig. 2.6 below). After charging to the peak value at point P, capacitor starts to discharged through the load R_l – the value of the capacitor should however be large (as it4 is in this project) that the discharge rate is slow (PQ curve). A point Q, the capacitor starts charging up again up to point K, and so on. The output waveform has less fluctuation (or ripple) than that without the capacitor

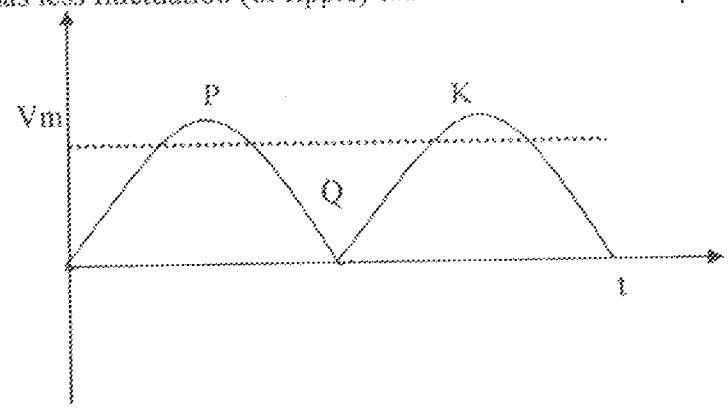


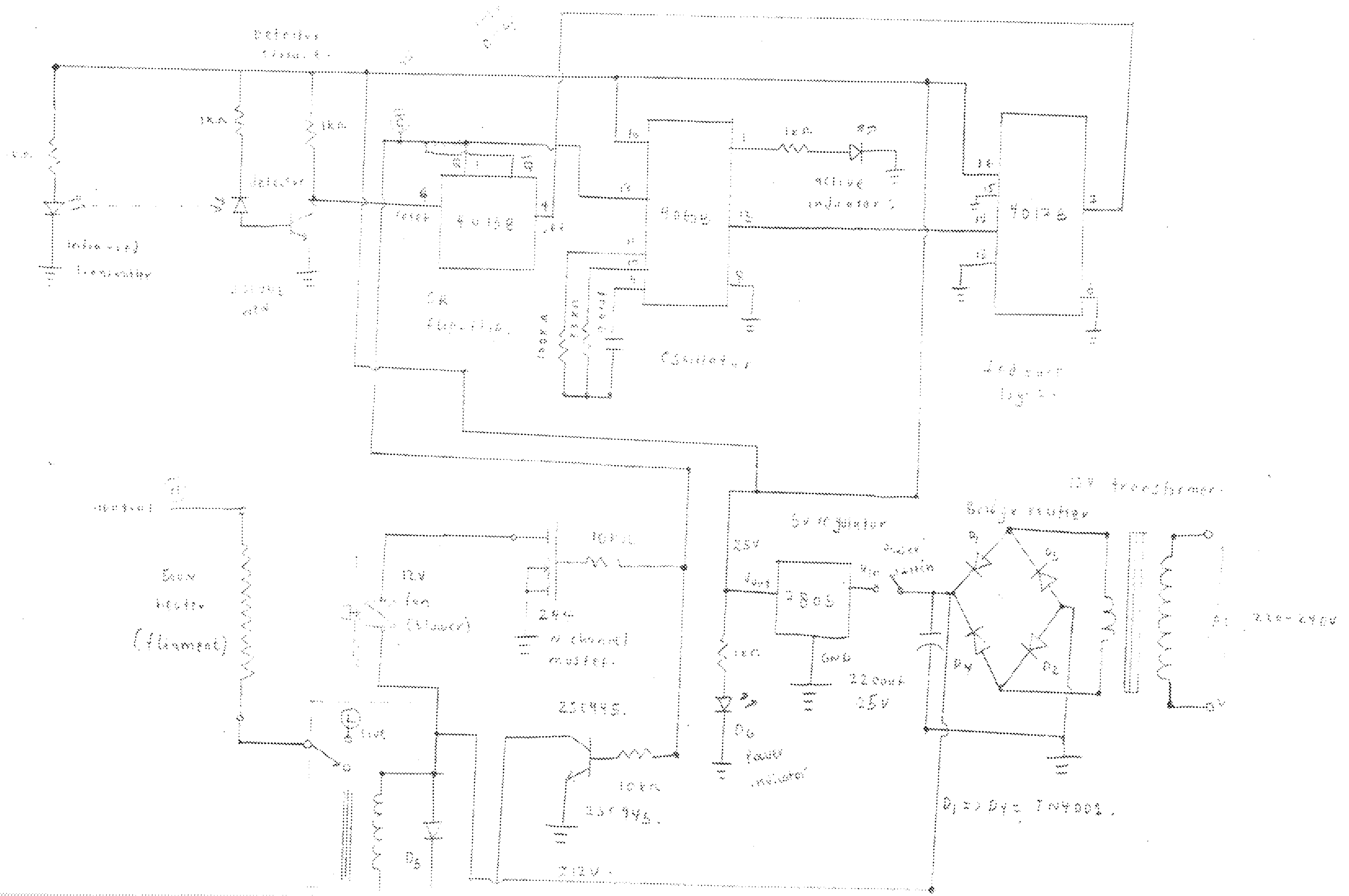
Fig. 4.4 Illustrating the effect of filtering capacitor

Voltage regulation is a vital factor in any circuit where IC's are embedded . voltage regulation is a measure of a circuit's ability to maintain constant output voltage. The output voltage of the power supply must therefore remain reasonably constant under a number of varying conditions, such as line voltage fluctuation.

In this project, regulator IC contains the circuiting for source, comparator, amplifier, control device and overload protection all in single IC. Although the internal construction

of the IC is somewhat different from the discrete voltage regulator circuits, the external operation is much the same. IC unit s provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. By inference, there are fixed voltage regulators, fixed negative voltage regulators, and adjustable voltage regulators.

Fixed positive voltage IC 7805 is used for this project with basic connection of a three terminal voltage regulator IC to a load as shown below.


Detector Circuit
1kΩ
detector
infra-red transmitter
CR flip-flop
4013B
4060B
oscillator
100kΩ
active indicator
4017B
12V transformer
Bridge rectifier
5V regulator
7805
GND
2200uF 25V
power switch
power indicator
D1 => D4 = IN4001.
10kΩ
12V fan (blower)
n channel mosfet
2SC945.
500W heater (filament)
D5
D6
+12V

CHAPTER FOUR

4.0 CONSTRUCTION

The project was constructed based on the design. Each of the stages were constructed and tested separately before coupling. The components stated in the design were used. Every construction work take place on a strip vireo board and every construction work involves the soldering of the various component that up the circuit. Soldering was perform with due regard to safety. It was carried at using a low voltage soldering iron, operated from a transformer connected to the mains.

The circuit board is enclosed in a casing and screwed tightly shut. The casing has holes for the power supply leads and connecting ware to sensors (relay infrared transmitter) and the contact (reset) switch.

4.1 TESTING

Having completed construction, the first thing that was done was to carry out a thorough test of the circuit. This involves a number of different procedure ranging from check for faults, using equipment such as meters (i.e. voltmeter ammeters).

Visual check, this was done before power was connected to the circuit and attention paid to the following;

i To see that all component were properly connected and the right way round (particularly transistors diode and capacitors) in the circuit.

ii That all wire link were located in right place.

iii That power supply leads were properly positioned on the board and of the correct polarity.

iv That no solder bridges are made (a solder bridge happens when too much solder is apply to a joint and adjacent track is heated at the same time at the joint, perhaps by using a soldering iron beat that is too large. This situation can cause a short circuiting of adjacent tracks and might lead to a fault circuit).

v That no small pieces of cupper fall between the track, particularly at the edges of freshly cut boards.

4.2 List of component

1. 4017B – stepper
2. 4060B - oscillator
3. 4013B – SR larch
4. 7805 – regulator
5. IRF244 – mosfet
6. 2sc945 NPN transistor
7. relay 12V
8. 220-240 transformer

4.3 PROBLEM – ENCOUNTER.

1. Problem of adjusting the infrared link
2. problem of getting some component like the electric fan
3. problem of short circuit during the cause of construction of the project.
4. problem of getting a suitable casing.

RESULT

After the design of the circuit, the construction was carefully executed to be in-line with the circuit diagram. After which a good inspection of the altogether hard ware was carried out. Moreover, the device was plugged and tested to see whether it goes along with the initial design. The test was carried out by placing of hands across the infra-red linkage. It resulted into the automatic switching on of both the fan heating filament. Also on was a blinking red light emitting diode. It indicates that the output on. And due to the manner the heater and air blower were placed a sense of hot air was fact on hand. The effect resulted into drying of the hand.. In addition, when the infrared contact was made by removal of hands, the output went off. The result shoed that through the breakage and restoration of the infra-red linkage the heater and blower can be controlled.

PRECAUTION

1. Every component is tested before apply into the design.
2. The components are connected base on manufacturer specification
3. The component are well spaced to avoid short circuit
4. The heat destruction of the component, is avoided by moderating the application of the heat during soldering.

CHAPTER FIVE

CONCLUSION

The circuit shows the extent of digital design technique. The use of complementary metallic oxide semiconductor (CMOS) reduced the power consumption of the unit to the minimum. The use of infra-red radiation is quite important in the circuit design. The electromagnetic wave makes the switching of the device relay to be wireless and it is important in the sense that the switching operation is not mechanical, but it is by placing an object between the coupling of the infra-red sensor. The circuit is a simple one.

RECOMMENDATION

1. The heating filament could be moderate by the use of very sensitive thermistor to avoid over heating.
2. Quality power electric fan could be used for better drying action.
3. The board circuit should be more organized and set.
4. The casing could be plastic so that it would be attractive.
5. The heating filament could be switch through silicon controlled rectifier (SCR) or other modern semiconductor device.

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BILL OF QUANTITY

Main components	Amount cost each	Quantity	Total Amount
1. 4013B	₦120	1	₦120
2. 4060B	₦120	1	₦120
3. 4017B	₦120	1	₦120
4. 7805	₦50	1	₦50
5. diodes	₦150	1	₦150
6. vero board	₦150	1	₦150
7. 1 kohms resistor	₦15	3	₦15
8. 33k ohms resistor	₦10	2	₦10
9. 2200µf capacitor	₦30	1	₦30
10. 220V/22V transformer	₦150	1	₦150
11. infra-red transmitter	₦10	1	₦10
12. infra-red receiver	₦10	1	₦10
13. casing	₦300	1	₦300
14. IRf244	₦150	1	₦150
15. fan	₦1,500	1	₦1,500
16. Heating filament	₦100	1	₦100
17. Lead	₦20	1	₦20
18. 12V relay	₦80	1	₦80
19. 2sc945 transistor	₦10	1	₦10
Total amount			₦3095