DESIGN AND CONSTRUCTION OF AUTOMATIC ROOM HEATER CONTROL

BY

OJELABI BUKOLA ADEREMI

2000/10943EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

OCTOBER, 2006

DESIGN AND CONSTRUCTION

OF

AUTOMATIC ROOM HEATER CONTROL

BY

OJELABI BUKOLA ADEREMI

REG NO: 2000/10943EE

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

Dedication

This project is dedicated to God the Father, the son and the Holy Spirit. The source of all things about my life.

Declaration

I, *Ojelabi Bukola Aderemi* 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 Federal University Of Technology Minna.

OJELABI B. ADEREMI
....
(Name Of Student)

....
(Signature And Date)

DR. E. N. ONWUKA
....
(Name Of Supervisor)

....
(Signature And Date)

ENGR M. D ABDULLAHI
....
(Name Of H.O.D)

....
(Signature And Date)

....
(Name Of External Examiner)

....
(Signature And Date)

Acknowledgement

My thanks firstly goes to God, my sustainer and my provider who had helped me to this work even making my carrier a success. Also I could not but remember the following personalities for their immense contributions to make my work and program a success.

However, my profound gratitude goes to all my lecturer in the department of Electrical/Computer Engineering, especially my supervisor Dr. E.N. Onwuka for her attention and helpful advice towards the completion of this work.

I am also very grateful to my parent Mr. J.M. and Mrs. Comfort Ojelabi and the children; Mrs. R.O. Onatunji, Mr. M.O. Ojelabi, Mrs. C.O Adigun, Mr. Toso Ojelabi, Mrs. L.F Olawoore, and Mr. Kunle Ojelabi for their support.

Also I could not but remember the following personalities for their immense contributions to make my work and program a success: Mr. Felix Onetunji, Engr. Afolabi Adigun, Mr. Timothy Olaawoore and Mr. Gbade Ojeleye, Mr. Musedic Adebayo Lawoya.

I am using this opportunity to say kudos to all my friends especially Emmanuel Omotoso, Folarin Oyetunju, Tayo Alao, Funsho Oduola, Wilson, Rufus Oloniyo, Ayobami Olabanji, Napoleon Idisi, Tayo Adeola. My thanks to all of you for your support and advice once again.

Abstract

This project presents the design and construction of automatic room heater control device. This device turns a room heater on or off with respect to the change in a set of temperature value. If the temperature of the room rises beyond a set value, this device is activated and it turns off the source of the room heater. However, if the room temp falls below the set value the device will turn on the heater. In other words, the device automatically controls the room temperature based on the preset value.

This device is very useful in Nigeria in the rainforest area during the rainy season and equally useful in Northern part of the country in harmattan period. The construction was tested and was found to perform reasonably well.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Historical Background

Generally, people find some weather condusive than the other which prompted the early men to look for diverse means of controlling temperature to having the desired temperature in their dwellings. In other words, the warmth and comfort needed were sought by different methods. The earliest heating system was the use of wood and charcoal which have many limitations and side effects. Stove and brazier were developed later for heating of dwellings by the ancient Roman which are still in use in some parts of the world today.

However as a result of limitation in the above methods, engineers came together and reasoned about the solution to the limitation of pollution that are caused by these means therefore chimney was employed to control the smoke and discharge it to the environment which is also harmful and causing environmental pollution, harmful to both plant and animals. Also depletion of ozone layer which lead to harzardous effects that is direct ultraviolet rays upon living[1,3]

All these limitations made engineers to sit down further to find a pollution – free way of heating a room to the warmth and comfort desired by man however automatic room heater came about which is capable of giving the desired warmth and comfort needed without the risk of harmful effect caused by the methods mentioned earlier. That is keeping the room to a desired temperature (controllability)

Also, in cold climate houses with their heating systems form dissipative system in spite of efforts to insulate such houses, to reduce heat losses to their exteriors, considerable heat is lost or dissipated; form them which can make their interiors uncomfortably cool or cold. Furthermore, the interior of the house must be maintained out of thermal equilibrium with its external surroundings for the sake of its inhabitants. In effect, domestic residences are oases of warmth in a sea of cold and the thermal gradient between the inside and outside is often quite steep. This can lead to problems such as condensation and uncomfortable droughts which, if left unaddressed, can cause structural damage to the property. This is why modern insulation techniques are required to reduce heat loss. In such a house, an automatic room heater is a device capable of giving the heat required when the house's interior falls below a set temperature, and automatically stopped when the set temperature is reached. Thus the automatic room heater controls the flow of energy into the room or houses that energy eventually being dissipated to the exterior.

The automatic room heater is a device designed by electrical method to give warmth required for human comfort in a room. As it is known that during the harmattan and rainy seasons, the room temperature always fall below the normal for human comfort. Therefore, the need for warmth for effectiveness and good health has necessitated the design of this unit. Also, change of environment may require having the device of this nature that is moving from a hot weather to a cold weather[11]

The unit converts electrical current into heat by means of heating element that emits radiant energy. The heating element might compose of metal alloy wire embedded in refractory insulation and encased in protective metal. If it is purposed for industrial use, a blower may be incorporated to convey the heat produced out of the unit and fan's blades are used to increase even distribution of heat in the room.

The device was designed purposefully for domestic heating particularly for the living room of dimensions (6mX4m). Its use could however be extended to central heating system or material processing in industries by simply altering some component parameters and increasing the capability and size of the unit to suit the desired purpose.

The unit also has sensing unit incorporated which comprises of thermistor input transducer that senses the temperature of the room and automatically trigger the heating element by solid state relay or component that controls the heating element, however current continues or ceases to flow through the heating element whenever the room temperature is below or above the critical temperature respectively. Seven segment display is incorporated to display the critical temperature.

Project Objectives

As it has been said, the project (automatic room heater) control is one of the problem – free room heater control which have higher reliability. It gives desired warmth and comfort needed in a room depending on the preset temperature (critical temperature) when incorporated with a heater. There are many other components that can be used to achieve these objectives. However, I chose this one based on the availability.

In summary, the automatic room heater control is designed to achieve the objectives itemized below:

- To design an efficient device that could be regulated to give desired warmth in a room.
- To design an efficient device (Room Heater Control) that automatically controls the temperature of a room.

- To show how efficient the aims could be achieved using very cheap discrete electronic components.
- To reduce the effect of condensation and uncomfortable draughts that can cause structural damage to the property in cold climate.

CHAPTER TWO

LITERATURE REVIEW/ THEORETICAL BACKGROUND

Heat Generation and Transfer

Heat in Physics is defined as energy in transit. Generally, heat is a form of energy associated with the motion of atoms, molecules and other particles which comprises matter. Heat can be created by chemical reaction (such as burning), nuclear reaction (such as fusion taking place inside the sun), electromagnetic dissipation (as in electric stores or heater), or mechanical dissipation (such as friction). Also heat can be transferred between objects by radiation, conduction and convection. The science of heat moving from one place to another is called Heat Transfer.

The area of interest here is thermoelectricity which is caused by the relationship between electrons, heat fluxes and electrical currents. Also the heat can only be radiated as a result of the movement of atoms and molecules in a material. Amount of emitted radiation increases with increasing temperature, a net transfer of energy from higher temperature to a lower result. There is no way we would talk on Heat without temperature therefore is defined as the measure of an object to spontaneously give up energy and is used to indicate the level of elementary motion associated with heat. Heat can only be transferred between objects or area within an object with different temperatures, and then only in the direction of the colder. In other words, Heat does not flow from a lower to a higher temperature unless another form of energy, work is also present[9].

Until the beginning of the 19th century, the effect of heat on the temperature of a body was explained by postulating the existence of an invisible substance or form of matter termed Calorie. Calorie in his theory states that a body at a higher temperature contains more calorie than one at a lower temperature; the former body loses some calorie to the latter body on contact, increasing temperature and decreasing temperature occurs in the bodies by transfer of heat. It is glaring that Caloric theory explained some phenomena of heat transfer but not fully experimented. Experimental evidence was presented by American born British Physicist Benjamin Thompson and it is said that heat was a form of energy. He published the results of his experiment in 1798[4]. There was no experiment of such until 1840, when Joule began his study of heat and other forms of energy. Joules measured the work done and the heat produced when water was churned in an apparatus he designed for the experiment. He also measured the work done and heat produced when oil was churned, when air was compressed, when water was forced through fine tubes and when cast iron level wheels were rotated one against the other. Always within the limits of experimental error, he found that the heat liberated was proportional to the mechanical work done and that the ratio of the two was the same in all types of experiment[2].

In other experiments, Joule measured the heat liberated by an electric current flowing through a resistance, at the same time he measured the work done in driving the dynamo which generated the current. He obtained about the same ratio for work done to heat liberated as in his direct experiments. However, this work linked the idea of heat, mechanical and electrical energy. He also showed that the heat produced by a current is related to the chemical energy used up, we can then say:

(a) Object gains energy when its temperature rises.

(b) Energy heat passes from a warm to a cold object if they are placed in contact.

(c) Also heat moves from higher temperature to lower.

In cold climates, houses with their heating systems form dissipative system in spite of efforts to insulate such houses to reduce heat losses to their exteriors considerably; heat is lost or dissipated, from them which can make their interiors uncomfortably cool or cold. Furthermore, the interior of the house must be maintained out of thermal equilibrium with its external surroundings for the sake of its inhabitants. In effect, domestic residences are oases of warmth in a sea of cold and the thermal gradient between the inside and outside is often quite steep. This can lead to problem such as condensation and uncomfortable draughts which if left unaddressed, can cause structural damage to the property. This is why modern insulation techniques are required to reduce heat loss. In such a house, an automatic room heater is a device capable of giving the heat required when the house`s interior falls below a set temperature.

By common knowledge, the term heat has been used in connection with the warmth or hotness, of surrounding objects. The concept that warm objects "contain heat" is not uncommon. During its 350 year development, the science of thermodynamics has established a physical quantity named temperature to quantify the level of "warmth" whereas heat (also improperly called heat change) was defined as a transient form of energy that quantifies the spontaneous transfer of internal energy due to a temperature difference (or gradient). The SI unit for heat is the joule; an alternative unit still in use in the U.S and other countries is the British thermal unit B.t.u.

The earliest heating system was the use of wood and charcoal which was later replaced by stove and brazier because of limitations and side effects of pollution and other hazardous effects on living. These limitations made engineers to sit down to find a pollution – free way of heating room to the warmth and comfort desired by man however automatic room heater came about which is capable of giving the desired warmth and comfort needed without the risk of harmful effect causing by the methods mentioned earlier that is keeping the room at a desired temperature (controllability).

CHAPTER THREE

DESIGN AND IMPLEMENTATION

Introduction

This project was designed with available components in order to reduce the cost and still achieve the aim to which it was designed. It has high efficiency. The block diagram in figure 3.1 below shows detail about layout of each stage which are explained further in this chapter.

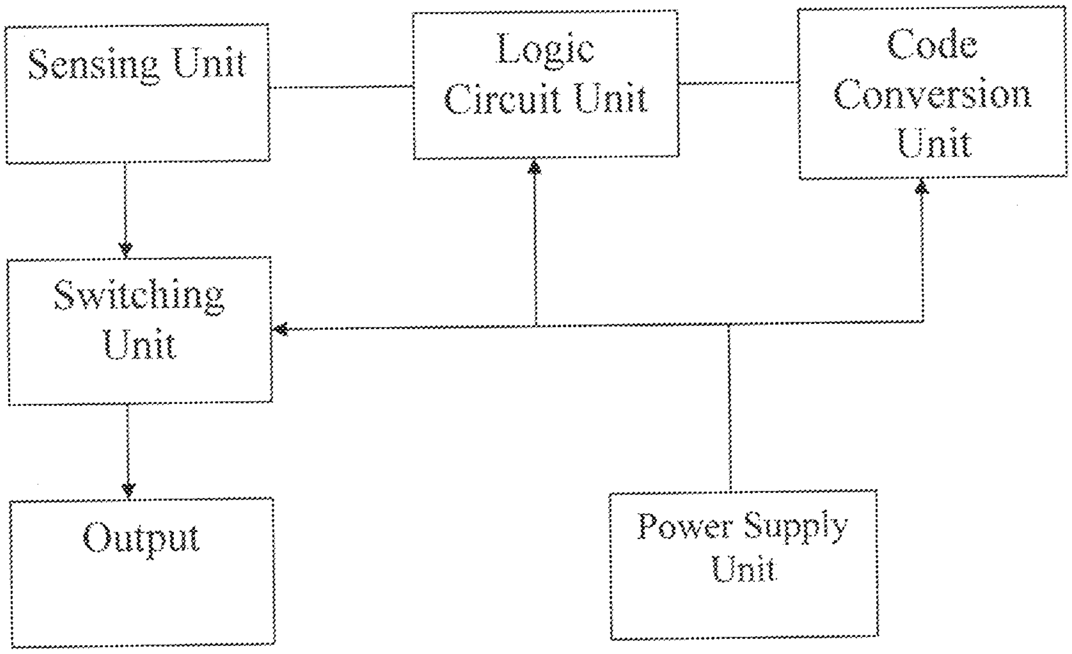
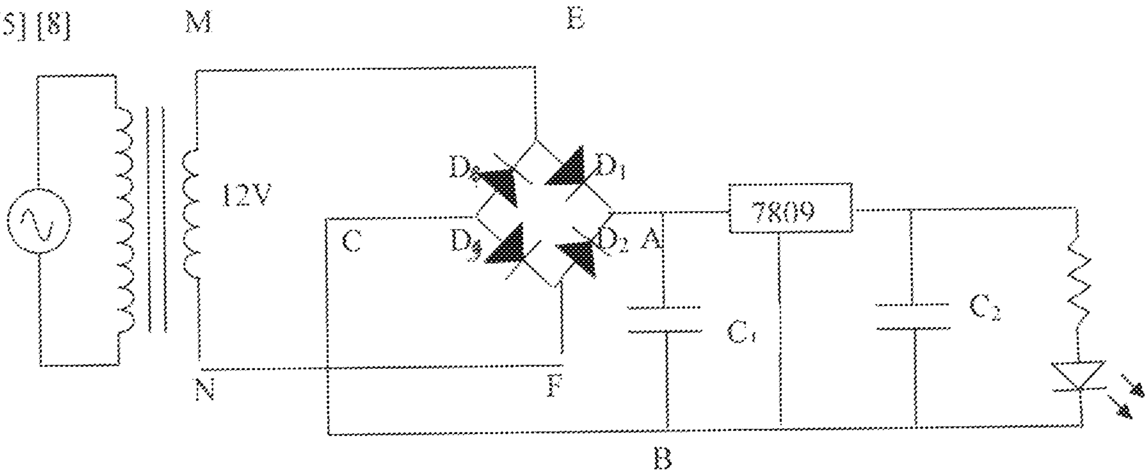


Fig 3.1 Block diagram of Automatic Room Heater Control

Power Supply Unit

Power supply unit increases or reduces the main voltage and then converts it from a.c to steady d.c so that it can be used in a range of electronic circuits. It can have additional circuitry to enable them to maintain either a constant current or a constant voltage when supplying a load.

The basic components of power supply unit used for this project consists of a transformer, a full-wave rectifier, a smoothing circuit and a stabilized voltage circuit or a stabilized current circuit . the circuit diagram of the arrangement are shown below in Fig. 3.2. [5] [8]



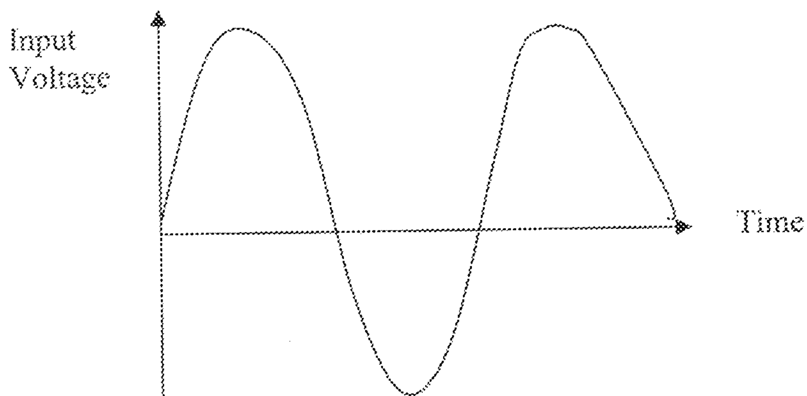


Fig 3.2 the circuit diagram of a power supply unit.

1 Brief Description Of The Components Of The Supply Unit

(i) Full wave rectifier np2s used in this project which is suitable rectifier useful in power electronic equipment or circuits. This is because it is stable and does not fluctuate at main frequency 50Hz. Actually, rectification is the process of converting alternating current, a.c to direct current, d.c. it is used in power supply units for producing low-power d.c from the mains 220V supply.

(ii) Transformer is a static (or stationary) piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit. However, based on operation, there are two types of transformers thus:

(1) Step-Down transformer

(2) Step-Up transformer

The transformer used for this project is a step-down transformer which is used to step down the main voltage to a voltage needed by the electronic circuit.

(iii) Smoothing was achieved by using a capacitor which is invariably used to smooth out the fluctuation of the variation in voltage. The variation in voltage obtained from output of the rectifier is called ripple voltage and at the same time the voltage have to be regulated to voltage required to power or energize the circuits which necessitated the use of voltage regulator.

However, voltage regulator is very important in every electronic appliance. Just to keep the terminal voltage of d.c supply constant even when;

(i) a.c input voltage of the transformer varies(deviation from 220V are common) or

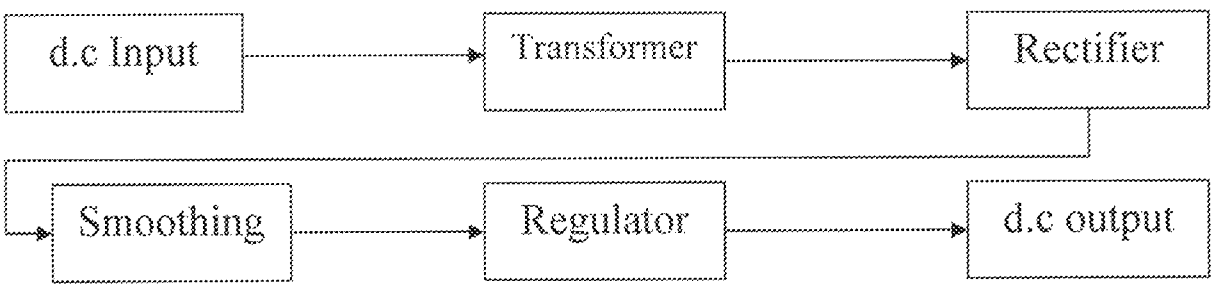
(ii) the load varies.

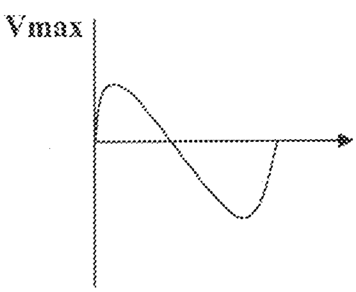
Usually, Zener diodes and transistors are used for voltage regulation purposes. again it is impossible to get 100% constant voltage but minor deviation are acceptable for most of the jobs.

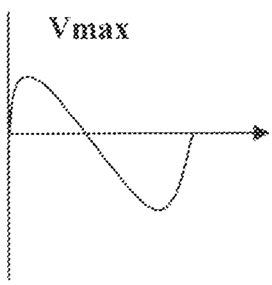
Mode Of Operation

During the positive half cycle of the a.c supply terminal M of the secondary transformer is positive(+ve) and N is negative as shown in Fig 3.1 above. Diodes D1 and D3 becomes forward biased(ON) whereas diodes D2 and D4 are reversed biased(OFF), hence current flow along the path MEABCFN thereby charging the capacitor C1 and to maintain value Vsm.

While during the negative (-ve) input half cycle of the a.c voltage, secondary terminal N of the transformer becomes positive and M negative, Diodes D2 and D4 are then forward biased (ON) and Diodes D_1 and D_3 are reversed biased (OFF), hence current flow along NFABCEM, charging capacitor C1 to maximum d.c voltage Vsm. current flow in the form through the circuit in both half cycle of a.c input supply thereby supplying a constant dc voltage to the voltage regulator and the compensating capacitor, C2. [6]







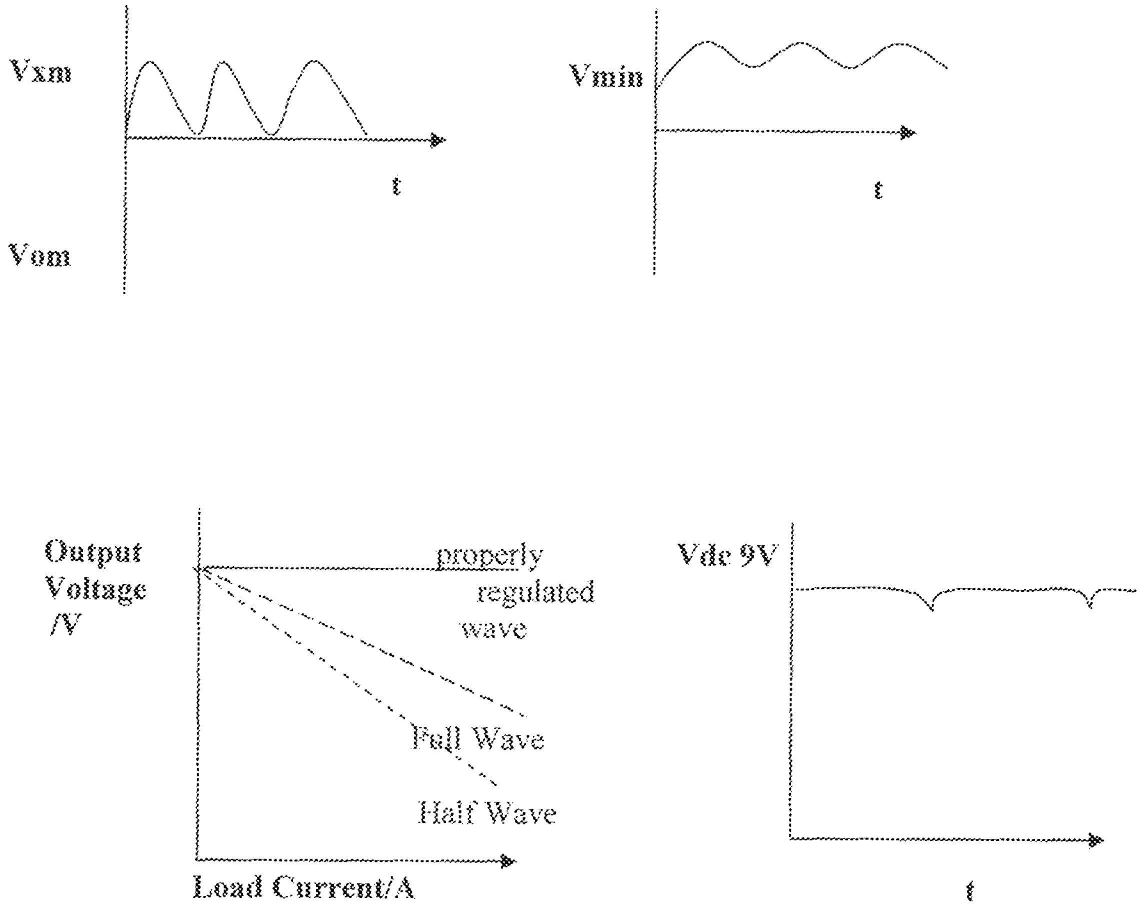


Fig 3.2 The Block diagram of the arrangement and the waveform [5]

Caculation

Design Specification for power supply unit.

Input voltage = 220v a.c mains

Supply voltage = 9V d.c

Maximum current = 1.00A

Using the formula below to find the capacitance of the filtering capacitor.

I/C = dv/dt

Where I = Peak output current

C = Capacitance

dv = ripple voltage

dt = change in time of ripple.

Normally ripple factor for full wave rectifier = 0.482 but of this rectification here, assuming ripple factor of 15%

Vrms = Root mean square voltage

Vp = Peak voltage.

For Vrms = 12V

$Vrms = Vp / \sqrt{2}$

$12 = Vp / \sqrt{2}$

$Vp = 12\sqrt{2} = 12 * 1.44$

Vp = 16.97V

Also, dv = 15/100 * Vp

= 15/100 * 16.97

dv = 2.55V

for frequency F = 50Hz

T = 1/f

= 1/50

For d.c

dt = ½ * 1/50 = 1/100

dt = 0.01s

dt = 10msec

for Current, I = 1A

$I/C = dv/dt$

$C = Idt/dv$

Having gotten other parameters therefore the capacitance, C of the capacitor used can be found here.

$C = (1*10 * 10^{-3}) / 2.55$

$= 0.003921.568$

$C = 3922*10^{-6}F$

$C = 3922\mu f$

This cannot be found in the market, hence the preferred value used is 3300µf

$C_1 = 3300\mu f$ for filtering

Compensating Capacitance $C_2 = 47\mu f - 100\mu f$ (fundamental range)

$C_2 = 100\mu f$

On transformer.

Neglecting the losses in the coil, the r.m.s value of the induced e.m.f in the whole primary winding is equal to the product of the induced e.m.f and number of primary turns (NI) i.e[6]

$E_1 = 4.44fN1BA$ eqn 3.1

Similarly , r.m.s value of the induced e.m.f in secondary wire is equal to the product of the induced e.m.f and number of secondary turns(n2) i.e

$E_2= 4.44fN_2BA$ eqn 3.2

Thus from equation 3.1 and 3.2

$E_2/E_1 = N_2/N_1 = K$ eqn 3.3

Where

E_1 = e.m.f induced in the primary winding

E_2 = e.m.f induced in the secondary winding

F = frequency of operation

N_1 = number of turns in primary winding

N_2 = number of turns in secondary winding

B = maximum flux density

A = cross sectional area of conductor

K = voltage transformation ratio.

For this project, $N_2 < N_1$, i.e transformer is a step-down transformer.

Again, for an ideal transformer

Therefore,

$V_1 * I_1 = V_2 * I_2$

$I_2/I_1 = V_1/V_2 = 1/K$

Where

I_1 = Current in primary winding

I_2 = Current in secondary winding

V_1 = Voltage in primary winding

V_2 = Voltage in secondary winding

In this design, a transformer with the following rating was used.

Primary Voltage, $V_1 = 220V$

Secondary Voltage, $V_2 = 12V$

Primary Current, $I_1 = ?$

Secondary Current, I_2 = 1000mA

From equation 3.5

$I_1 = (V_2 * I_2) / V_2$

$I_1 = (12 * 1000*10^{-3}) / 220$

$I_1 = 54.55*10^{-3}$

I_1 = 54.55mA

This gave an indication that the transformer used is a step-down type with rating 220V, 55mA / 12V, 1000mA

3 Sensing Unit

The sensing unit comprises of quad-comparator LM339, using one unit of the comparator and thermistor (NTC) negative temperature coefficient (the sensor)

.1 Brief Description Of The Components Of Sensing Unit

(i) A comparator circuit accepts input of linear voltages and provides a digital output that indicates when one input is less than or greater than the other. The comparator circuit together with thermistor is shown in fig 3.4 below for the comparison so that it will determine the high or low of the comparator output which will result to trigger action of the transistor and relay. The output is a digital signal that stays at a high voltage level when the non-inverting input voltage goes below the inverting input voltage.

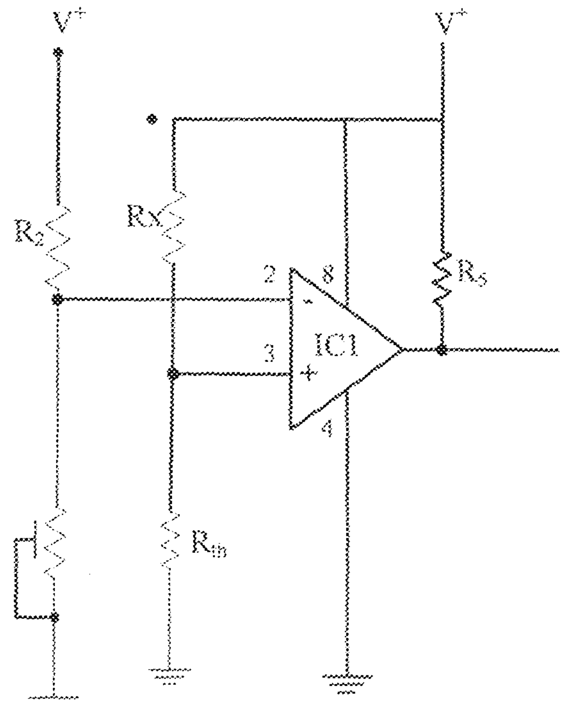


Fig 3.4 The circuit diagram of sensing unit(one unit comparator and thermistor)

Also, the other 3 comparator unit of the quad-comparator were used for calibration which fed seven segment display through logic circuits.

(ii) Thermistor

Thermistor is a transducer device that produces change in resistant as a result of temperature changes. It is a semiconductor device which behaves as a resistor with a high and negative temperature coefficient of resistance, sometimes as high as 6% per degree Celsius rise of temperature. It has high sensitivity and hence useful in precision temperature measurement, temperature control and temperature compensation especially in lower temp range of -100^0C to $+300^0C$.

The curve of thermistor behaviour with series of resistance is shown in fig 3.5.

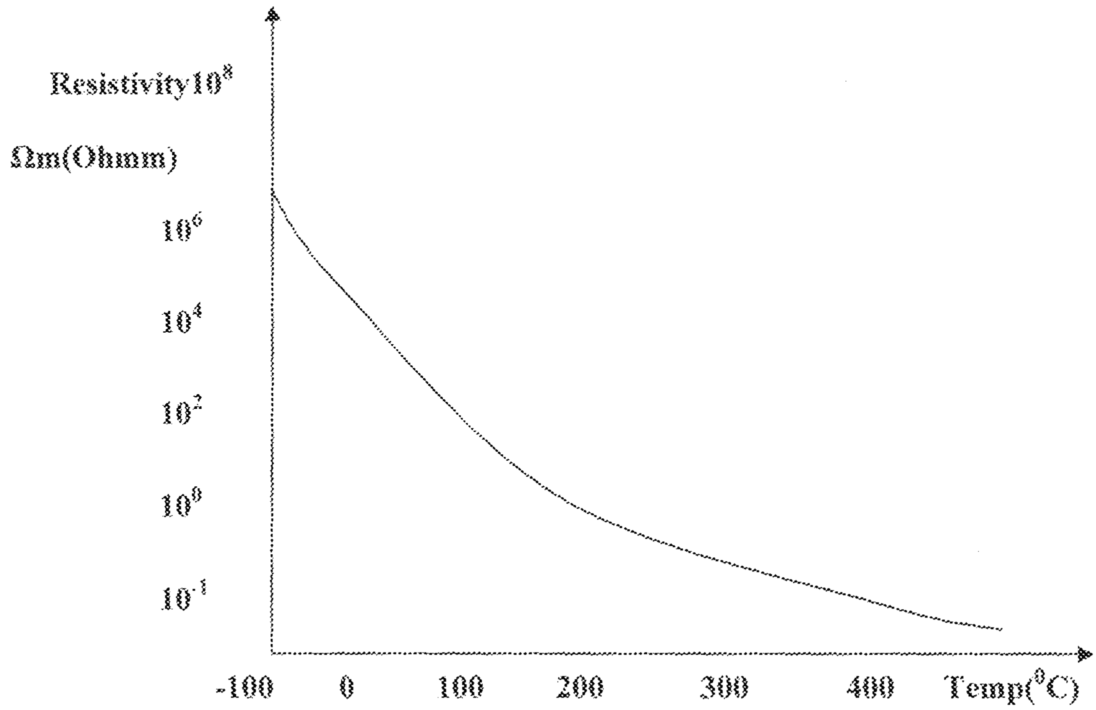


Fig 3.5 Resistivity against temperature curve of a typical thermistor

4 Calculation

To get resistance, Rx

Using voltage divider principle.

Resistance of the thermistor (R_{TH}) = 10k

at Pin8 assume a voltage of 8V

$V_{TH} = 8V$

$V_{TH} = R_{TH} / (Rx + R_{TH}) * 9$

$8 = 10k / (Rx + 10k) * 9$

$8(Rx + 10k) = 90k$

Rx + 10k = 90k/8

Rx = 90k/8 – 10k

Rx = 11.25k – 10k

Rx = 1.25k

Rx = 1k preferred value.

This result implies that 1k resistor can be used as Rx to get the desired result.

4 Switching Unit

Switching unit comprises of both transistor and relay(solid state relay). However, the transistor was connected in common emitter mode so as to obtain an amplified version of the input at the base across the transistor collector. Hence, this is shown in fig 3.6

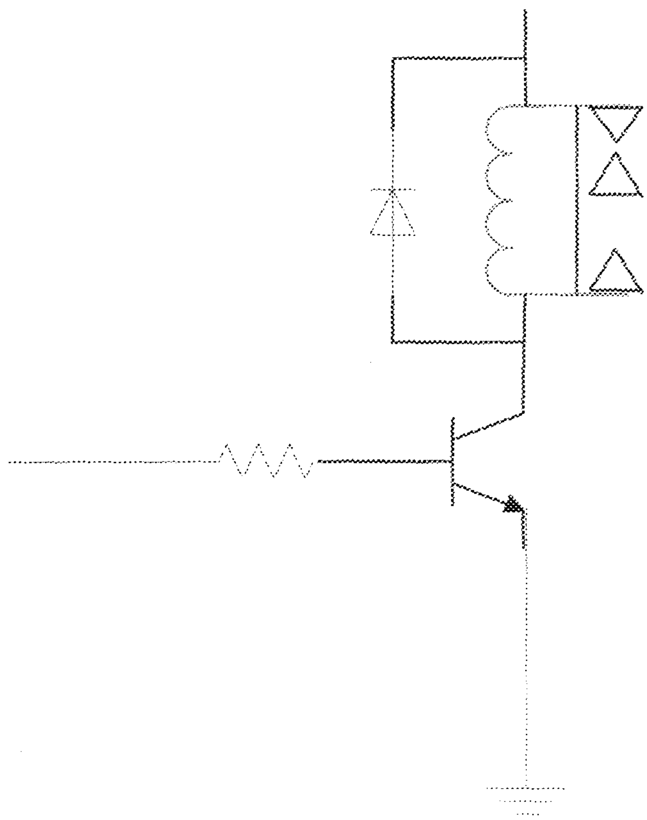


Fig. 3.6 Switching unit circuit diagram

4.1 Brief Description Of Transistor And Relay.

- Relay

A solid state relay is a mechanical switch used to switch other circuits on and off. It enables small current in one circuit to control a much larger current in another circuit or the simultaneous switching of more than one circuit also the contact are of three basic types Normally Open(NO), Normally Closed(NC) and Change-over(CO). in addition they can be Single Pole(SP) or Double Pole(DP).

It can also be said that relay is an electromagnetic device or a solid state device operated by varying the input which in turn is used to control other devices connected to its output. They form the simplest form of automatic switches in an electronic circuit. A relay consist basically of 2 parts;

(i) the coil

(ii) the magnetic switch.

- Common emitter Transistor used is NPN type which literally means that it is the emitter part or region of the transistor that is grounded. Also, it is very useful as switching device.

2 Mode Of Operation

The relay is activated when the base of the transistor is reversed biased which invariably allow current to flow through the relay, hence automatically trigger the load(heating element) for generation of heat. Also in another way round as soon as the base of the transistor is forward biased, the relay break the contact to the heating element therefore no flow of current. In other words, it means that Normally Open(NO) contact closes when the relay is activated while (NC) Normally closed contact opens and vice versa when activated.

3 **Calculation**

For gain, hfe = 400

From transistor equation

$R_B = (V_B - V_{BE}) / I_B$ eqn.(1)

$hfe = I_c / I_B$ eqn.(2)

$I_C = (V_{CC} - V_{CE}) / R_C$ eqn.(3)

Where

R_B = Base Resistance.

V_B = Base Voltage

I_B =Base Current

V_{BE} = Base Emitter Voltage

hfe = gain

I_C = Collector Current

R_C = Collector Resistance

V_{CC} = Collector Supply Voltage

V_{CE} = Collector Emitter Voltage.

Using transistor as switching it operates in the saturation and cut-off mode.

At saturation (ON-MODE)

$V_{CE} = 0$

From eqn(3)

$$I_C = (V_{CC} - 0) / R_C$$

$= V_{CC} / R_C$

$I_C = 12 / 300 = 0.04A$

$I_C = 0.04A$

Also, $hfe = I_C / I_B$

$I_B = I_C / hfe$

$I_B = 0.04 / 400$

$= 0.0001$

$I_B = 100\mu A$

Also, for $R_B = (V_B - V_{BE}) / I_B$ from eqn.(1)

For $V_B = 9V$

$I_B = 100\mu A$

$R_B = (9 - 0.6) / 100\mu A$

$= 8.4 / 100\mu A$

$R_B = 0.084*10^6.\Omega$

$R_B = 84K\Omega$

Hence $R_B = 47k\Omega$ as preferred value.

Logic Circuits Unit

Some logic gates were used in this project to get the set critical temperature displayed through seven segment display. Thus OR, AND and EX-OR gates. However, it is explained below the function they performed.[10]

.1 OR Gate Description.

The OR gate is called the any or all gate. The schematic in fig 3.5(a) shows the idea of the OR gate. The Lamp(Y) will glow when either switch A or switch B is closed. The Lamp will also glow when both switches A and B are closed. The Lamp(Y) will not glow when both switches A and B are open. The symbol is also shown in fig. 3.5(b)

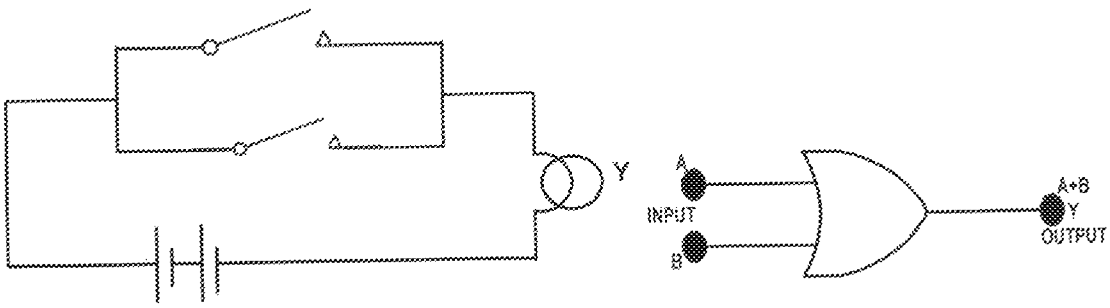


Fig.3.7 (a) OR circuit using switches. (b) OR-gate symbol.

5.2 NOT Gate Description

A NOT gate is also called an inverter. A NOT gate or inverter is an unusual gate. The NOT gate has only one input and one output[10]. The logic symbol for the inverter is shown in fig. 3.8 below.

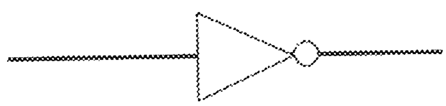


Fig 3.8 Logic symbol of an inverter.

3 The AND date Description.

The AND gate is called the "all or nothing" gate. The schematic in fig 3.7 shows the idea of the AND gate. The Lamp(Y) will light only when both input switches (A and B) are closed. The symbol of the gate is shown in fig3.9 (b) below:

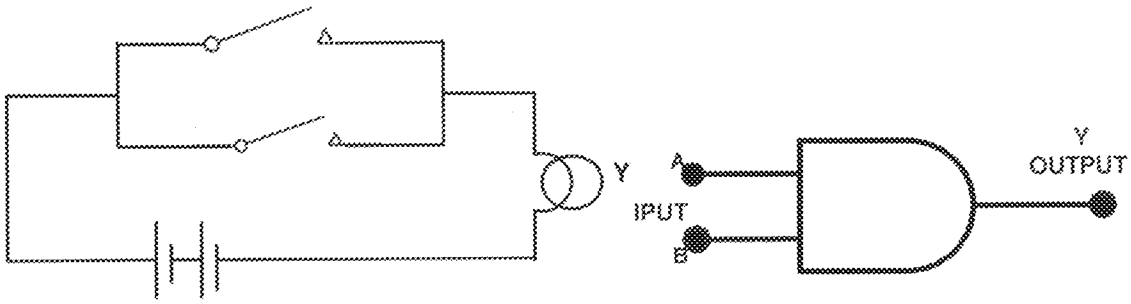


Fig. 3.9(a) AND circuit using switches. (b) AND gate symbol.

.5.4 **EX-OR Gate Description.**

The exclusive OR gate is referred to as "any but not all" gate. The XOR gate is enabled only when an odd number of 1's appear at the inputs. The Boolean expression therefore is

$$Y = A.\overline{B}+\overline{A}.B$$

For Y = Output A, B = inputs.

And the symbol is shown in fig 3.10 below:

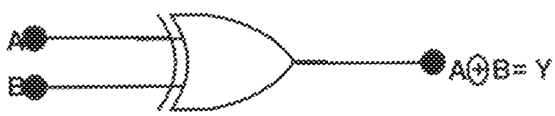


Fig 3.10 Standard logic symbol for the XOR gate. [6] [7]

3.6 Code Conversion Unit.

The display of number or codes which are easily understood according to the preset temperature or critical temperature necessitated the use of some code converters thus;

(i.) Encoder (Priority encoder)

(ii.) BCD to Seven Segment decoder/driver.

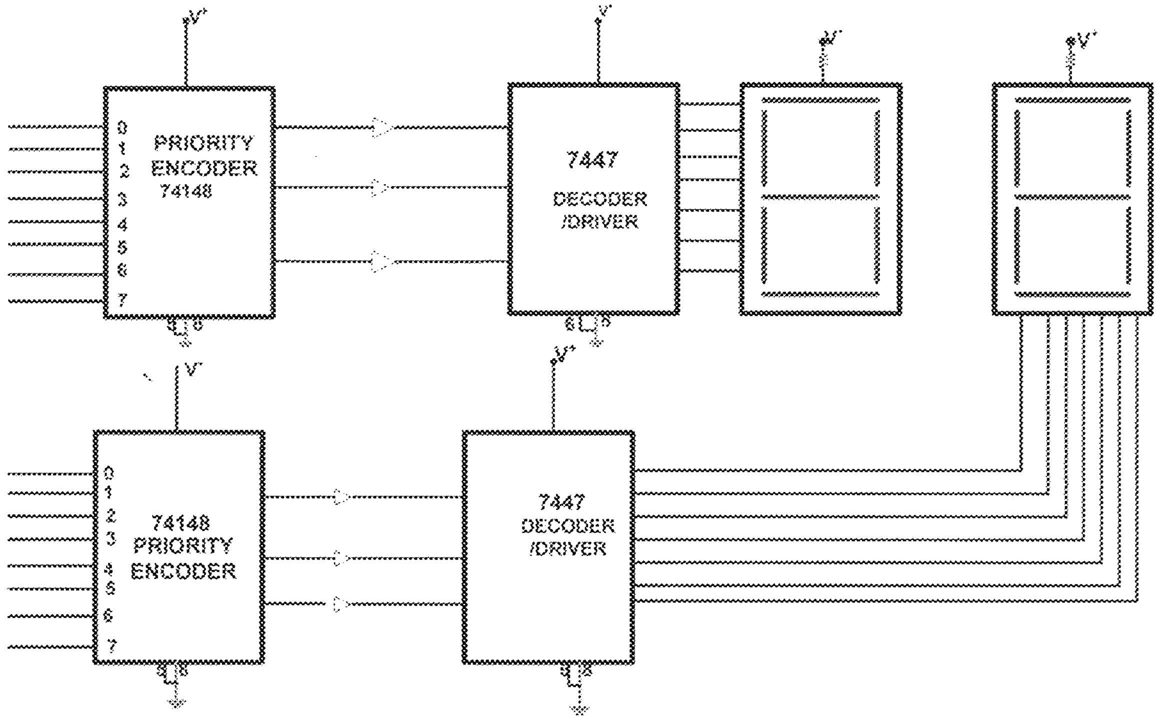


Fig. 3.11 The circuit of the code conversion unit.

.6.1 **74148 Priority Encoder.**

Encoders generally translates a decimal input to a BCD number, the encoder may have one active input which in turn produces a unique output and it is always active low which have been taken care of by logic circuit units and the output have to be inverted to get the required input to energise or feed the decoder/driver of the conversion unit.

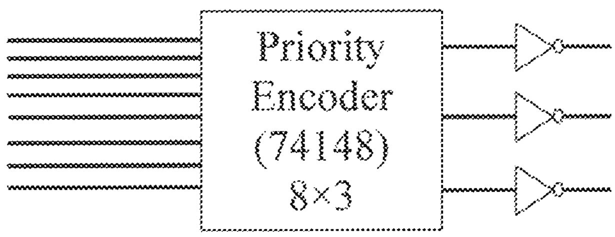


Fig. 3.12(a) Logic symbol of the priority encoder (8×3)

Table 3.1(b) Truth table for the 8×3 Priority Encoder.

	Inputs								Outputs			
Dec	0	1	2	3	4	5	6	7	A_2	A_1	A_0	0
0	H	H	H	H	H	H	H	H	H	H	H	0
7	X	X	X	X	X	X	X	L	L	L	L	7
6	X	X	X	X	X	X	L	H	L	L	H	6
5	X	X	X	X	X	L	H	H	L	H	L	5
4	X	X	X	X	L	H	H	H	L	H	H	4
3	X	X	X	L	H	H	H	H	H	L	L	3
2	X	X	L	H	H	H	H	H	H	L	H	2
1	X	L	H	H	H	H	H	H	H	H	L	1
0	L	H	H	H	H	H	H	H	H	H	H	0

From the truth table 3.1 above, it shows that the Priority Encoder gives priority to highest number in other words; it activates the highest number that has a low input. If a low were placed in input 7 and input 5 simultaneously, the output would be 111 for decimal 7. The encoder only activates the output of the highest order input number. Also,

H = highest Logic Level

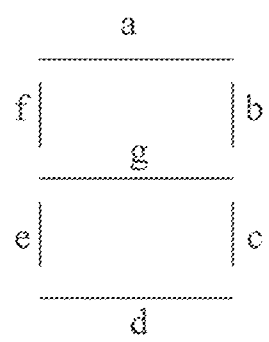
L = Low Logic Level

X = Irrelevant

3.6.2 BCD – to – Seven Segment Decoder/Driver.

A decoder may be thought of as the opposite of an encoder to reverse the process from the previous section there is to produce a decoder that translates from the BCD code to decimals. And a common task for digital circuit is to decode from machine language to decimal numbers. A common output device used to display is shown in fig. 3.12(a). the seven segment are labelled with letters from a through g. the first 10 displays representing decimal digits 0 through 9.

For instance if segments b and c light on the seven segment display, a decimal 1 appears. If segments a, b and c are lit, a decimal 7 appears and so forth. This is shown if fig. 3.13(a) below:



Also while considering TTL device 7447 BCD-to-Seven Segment decoder/driver. The input is a 3-bit BCD number, the BCD number is decoded, forming a Seven-Segment code that will light the appropriate segments on the LED display. The wiring of decoder and Seven-Segment LED display is shown in fig. 3.13(b) below:

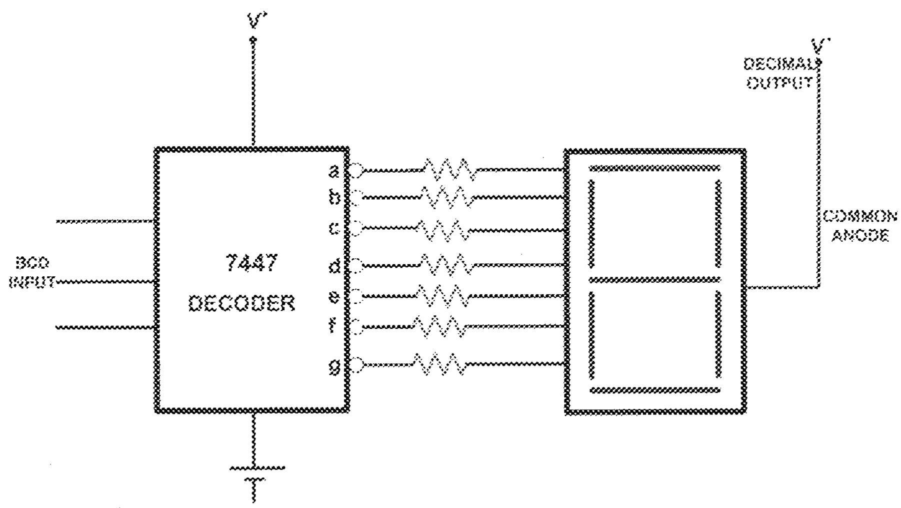


Fig. 3.13(b) Wiring of decoder and seven-segment LED display.

3.7 Output Unit

This stage consists of s heating element. Different types of alloys are used for various type of heating element which will also depend on the operating temperature. For this project, a constantan heating element [45%Ni, 55%Au] at 1120^{0}C was adopted.

Constantan was used because it posses some qualities of good heating element such as:

High Specific Resistance.

High Melting Temperature.

Low Temperature Coefficient of Resistance.

High Oxidizing Temperature.

Positive Temperature Coefficient of Resistance.

Mechanical Strength.

Ductility.

3.7.1 Mode Of Operation

By looking at the diagram in fig. 3.14 when the relay is triggered the terminals T1 and T2 is closed. The current will flow from the main supply through the heating element and heating up the room. But when the relay is not triggered T1 and T2 will remain open therefore a.c current ceases to flow through the heating element because the circuit is not completed.

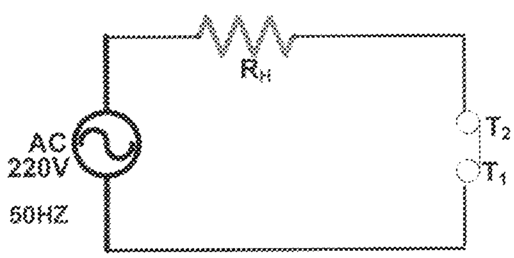


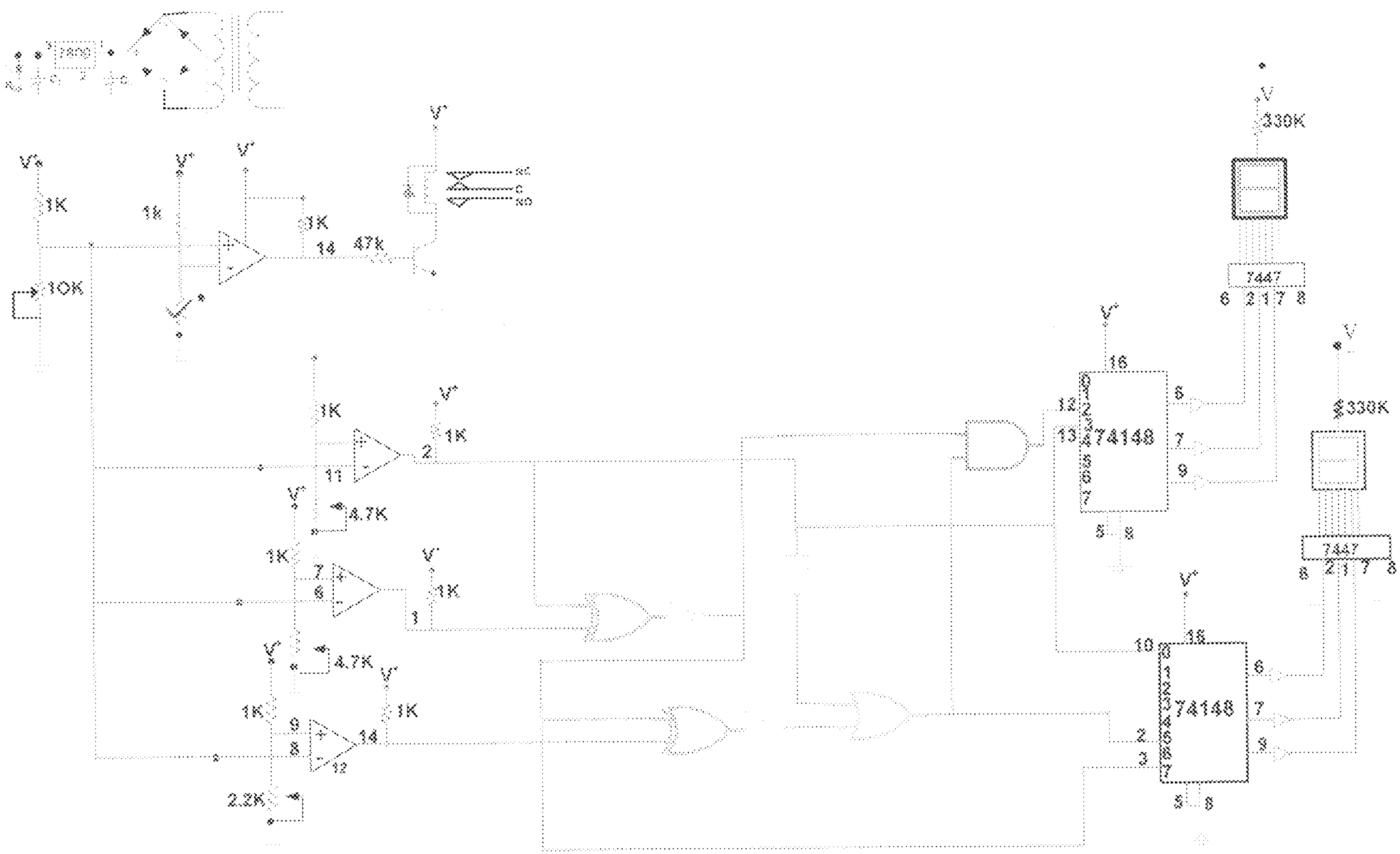
Fig.3.14 Output circuit diagram

.2 Principle Of Operation

When the room temperature is at the selected critical temperature, say, Tc = 30^0C, the heater continues heating the room, at the point, the reference voltage of the comparator at the non-inverting input is less than the voltage at the inverting input when the thermistor is connected. At the point the output voltage is low, the transistor is not biased hence the mains voltage to the heating element.

On the other hand when the room temperature has exceeded the critical temperature, voltage at the non-inverting input of the comparator is greater than the inverting input i.e. the thermistor resistance is low, the output is high which biased the transistor and the relay is energized which cut-off mains from the heating element, until the selected critical temperature is attained.

CIRCUIT DIAGRAM OF AN AUTOMATIC ROOM HEATER CONTROL



CHAPTER FOUR

TEST, RESULT AND DISCUSSION

4.1 Test

The physical realization of the project is very vital. The designer will see his or her work not just on paper but also as a finished hardware. After carrying out all the paper, design and analysis the project was implemented and tested to ensure its workability and was finally constructed to meet the desire specifications.

The process of testing and implementation involve the use of some test and measuring equipments stated below:

1. Bench power supply: This was used to supply voltage to the various stages of the circuit during the breadboard test before the power supply was soldered. Also during the soldering of the project, the power supply was still used to test various stages before they were finally soldered.
2. Digital multimeter: The digital multimeter basically measures voltage, resistance, continuity, current, frequency, temperature and transistor gain. The process of implementation of the design of the board required the measurement of parameters like, voltage, continuity, current and resistance values of the component and in some cases frequency measurement.
3. The digital multimeter was used to check the continuity of terminals in case of open circuit, resistance of resistors and gain of transistors in this project and also to test the various voltages levels during the testing and implementation.

REFERENCES

[1] H.C. Baeyer Van (1998). "Warmth Disperses and Frime passes". The history of heat new York.

[2] R. Siegel and Hohn R. Hwell. Thermal Daditun Heat Transfer Second Edition pp4

[3] Nelkon and Parker. Advance Level Physics 7th Edition pp 628

[4] www.commlinx.com

[5] Len Jones. Basic Electronics For Tomorrow's World pp 191, 79, 228

[6] B. L. and A.K. Theraja Electrical Technology. S. Chand and Company Ltd pp 1928, 1922, 1988

[7] R.L. Tokhem Theory and problems of Digital Principle pp 37, 40, 35, 54

[8] Paul Horowitz and W. Hill. The Art of Electronics, Cambridge University Press pp 47,48

[9] http://library.thinkquest.org/20031/history

[10] a.us/intruct/calderwoodD/digiogic/not.htm

[11] http://nas.cl.uh.edu/novotny/dsh5.htm