DESIGN AND CONSTRUCTION OF AN EGG INCUBATOR

BY

ABRAHAM PETER

(2003/15285EE)

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,

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

NOVEMBER, 2008.

DECLARATION

I hereby declare that this is my original project to the best of my knowledge has never been presented else where for the award of any degree or diploma.

Information derived from published and unpublished work of others has been duly acknowledged.

6/11/08

Abraham Peter Date

CERTIFICATION

This is to certify that I have supervised, read, considered and approved this research project report "Design and construction of an egg incubator" which I found adequate both in scope and quality for the partial fulfillment of the requirement for the award of Bachelor of Engineering (B. Eng) Degree in Electrical and Computer Engineering.

....	.......30/10/08.......
PROF. ORIA USIFO Project Supervisor	DATE
....	....
DR. Y. A. ADEDIRAN Head of Department	DATE
....	....
EXTERNAL SUPERVISOR	DATE

DEDICATION

This project is dedicated to the glory of God for his mercy and protection through out my stay in the university.And to my parents Mr. and Mrs. Abraham Anyebe for their love,care,and encouragement.And to my elder sister Mrs. Dorcas .B. Isah for her moral,and financial support she gave me throughout the duration of my study.

Finally to my late sister Mrs. Sarah .T. Abraham,may her gentle soul rest in perfect peace. "ADIEU BIG SISTER"

ACKNOWLEDGEMENT

This project was made possible by those whose contribution both financially and morally is worthy of note.

I wish to express my deep appreciation to my supervisor Prof. .O. Usifo of Electrical and Computer Engineering department for his encouragement,time and energy committed in going through this Thesis and Design work.My sincere appreciation also goes to the Head of Department Dr. .Y. A Adideran and the entire staff of Electrical and Computer Engineering Department.

Also my profound appreciation goes to my lovely parents Mr. and Mrs. Abraham Anyebe,my sweet sister Mrs. Dorcas .B. Isah for their financial support all through my university career,also to Mr. Sule Isah and to the Abraham's for their love,immence encouragement and consistent support.May the Lord Almighty replenish them all in Jesus Name (Amen).

I remain indepted to my friends,Abubakar .S. Abdul, Emmanuel .O. Agada, Igbafe Orikumhi, and Abubakar Yusuf who despite working on their own project took time to review this and offered their advise.

Finally,my deepest appreciation goes to the entire folks of Electrical and Computer Engineerig Department, 2007/2008 Graduate for their support.Especially the "upper house member"

Above all,i am grateful to Almighty God for granting me the previlledge to be alive and healthy,his love,care and protection over me throughtout my stay in Niger State.

ABSTRACT

The purpose of this project is to cause fertile egg/eggs to hatch into chicks by the application of heat synthetically. This thesis construction of a poultry incubator which has been design to achieve temperature and humidity of 37 and 70% respectively.

Heating of the chamber is achieved by the use of a 100Watts electric bulb installed inside the incubator with the aid of a screwed porcelain socket and humidity implemented by the use of saturated salt solution. The heat is however controlled by a transistor- relay switch circuit depending on voltage divider output compared by a comparator inttegrated circuit. The alarm circuitry was implemented by the use of integrated circuit (LM 358) consisting of a time delay circuit,oscillator circuit and driver/buzzer circuit.

Experimental results shows that the desired hatchability rate was obtained.

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CHAPTER ONE

INTRODUCTION

An incubator is an apparatus for hatching eggs by artificial warmth, and for rearing the new chicks until they can fend themselves. It means that eggs are kept warm at a constant temperature for a period of days after which the eggs hatch; this could be with birds, reptiles and some amphibians.

Food is, by far, the most significant way through which man receives energy for work and nutrient required for balancing all the metabolic activities that take place in and outside his body frame work. Protein, a cost of food nutrient is required for a progressive and coordinate health growth of body cells, maintenance of body metabolism, synthesis of disease fighting agent [antibiotics] within the body and so on. This brings to light the importance of protein in nutrition.

One major source of protein is egg which is produced by chicken and vice-verse. The natural rate of successful production of chick per year by an efficient mother hen is about sixteen(16).With a population close to a 100million and going by the present rate of poultry protein consumption ,it is estimate that Nigeria needs to produce 80million eggs per day and about 150million chick per year to meat its poultry protein demand. Natural production rate is obviously insufficient and hence an artificial means is sought to multiply rate of production in large folds .Only one option is inevitable in this regarded: production of more chicks is production of more eggs .Hence the essence of designing an incubator.

Incubation is an insulated enclosure in which temperature ,humidity and similar environmental factor be regulated at level optimal for growth or hatching for poultry, environmental simulation are enacted using the condition in the bottom of the mother hen as a guide .These conditions are maintains for 21-day incubating period.

Basically, these conditions are:

[1] Simulating the proper and favorable temperature {37^0C} in the enclosure.

[2] Ensuring adequate humidification of the enclosure {70% relative humidity}

[3] Methodology in egg turning.

[4] Efficient air circulation in the enclosure.

[5] Control and regulation of these factors.

The Chinese and Egyptians used incubation to hatch poultry eggs before the 3rd century AD. The essentially heated room with various sizes ,shapes and construction s Fire is used to provide the necessary heat ,temperature were estimated and regulated by an attendant ,who control the amount of heat by adjusting the fire and by opening or closing vent in the wall of the incubator .Eggs were place in layers either within baskets or on the floor and were turn by hand two(2) or three(3)times daily.

Modern, large and sufficient incubators are now used. Electricity has largely replaced oil as source of heat. Electric fan operating within chambers circulates the air, ensuring uniform temperature of 37.7°C. Humidity and temperature are controlled automatically. It is important that these two (2) factors be maintained at all times and at a uniform level throughout the incubation period. The air should contain approximately 70% relative humidity. Also eggs in most modern commercial incubators are turned automatically at least eight [8] times daily and at predetermined intervals Frequent turning prevents the developing embryo from sticking to the inner membrane of the shell. As many as 75, 000 eggs may be hatched at one time in most large commercial incubators. The broad range of modern incubators available can be divided into three (3) major classes, namely:

(1) Plywood incubator

(2) Cardboard incubator

(3) Still-air incubator

Individual incubator has an egg tray that holds the fertile eggs some few distances below the heat source (Electricity bulb) and above its base as well as hatching unit that produces the desired temperature for successful hatching. This heating is regulated by means of a thermostatic principle, i.e. immediately above the highest temperature, heat supply is cut-off automatically and vice verse. In addition to the heating unit and egg tray, the plywood incubator has two ventilation holes nears its base through which oxygen is supplies to the egg shell, while the embryo is developing.

1.1 CONDITIONS NECESSARY FOR INCUBATION

The fundamental conditions required for an incubating system and mode of implementation are discussed here. These condition are the parameters that avails in the bosom of the mother hen and implementations are based on result of researches to evolve a most efficient system are a reliable embryonic development of an egg. These parameters are

i Temperature

ii Humidity

iii Egg turning and positioning

iv Illumination

v Ventilation

Research findings on these factors and how they affect the developing egg embryo is presented.

1.1.1 TEMPERATURE

Research temperature studies are carried out on how it affects the development of the egg embryo and how it can be controlled or regulated over the twenty-one day incubating period.

FERE.C.H. [1] in1894 drew up a table showing different values of maintained temperature of an egg against an index of development (relative rate of embryonic development). This is shown in the table below.

Table 1.1 Temperature against index of development of an egg

Temperature (^{0}C)	34	35	36	37	38	39	40	41	42	43
Index of development	0.65	0.80	0.72	0.78	1.00	1.06	1.25	1.51	1.48	1.46

It was observed from the table that there is an increase in the rate of embryonic development up to 41^{0}C.Any temperature exceeding this value cause a condition of heat rigor and eventual death of the embryo. Also from the table it can be seen that the temperature for perfect development or efficient hatching is 38^{0}C.

B.M.FREEMAN and Margaret VINCE in 1974 found out that the optimum yield temperature is in fact 37.7^{0}c which is just a difference of 0.2^{0C} to that of FERE C.

Another Duo Lundy in 1969 [2] and Davenport in 1984 argued in different paper that for optimum hatchability, the temperature of the incubator should be varies. That is to say, the temperature should not be kept constant at 37.8^{0}C but be varied over the twenty-one day incubating period

1.1.2 HUMIDITY

The egg like all living things contains an amount of water. A fertilized egg contains 66% of water by weight. The relative humidity of the environment determines the rate of water loss from the egg. Successful outcome of incubation is highly dependent on level and stability of favorable humidity in the incubator. An inadequate humidification can lead to excessive water loss from the eggs and subsequent embryonic death.

Koch and Steinke in 1944 [3] and Chat lock in 1925 [reviewed in 1982 by Davenport] showed that the humidity outside the incubator was lower than the incubator inner chamber humidity. A relative humidity about 70% of environment is found favorable for perfect embryonic development. Also, excess humidity or too little moisture reduces hatchability, therefore resulting in wet soggy chicks, the latter causing some chicks to the shell.

1.1.3 EGG TURNING AND POSITIONING

Naturally, the mother turns her eggs around with her beak periodically; the eggs need to be turned around periodically, because if the eggs are left on one position, the York will stick to one side of the shell due to gravity. This is noticeable in boiled eggs when the yolk is not in the centre of the albumen

LANDANER C. [4] in 1961 proposes that the eggs should be turned N times a daily

Where $3 \leq N \leq 24$.

He asserts that adequate turning reduces mortality rate especially between days 5 to 16 and 19 to 21.

LANDANER. H. [5] in 1967 found out lack of turning or turning in one direction only causes a disruption of the clarion, rupture of the blood vessel and twisting of the chalazae. This is because when eggs are incubated with the small end upwards, there is an increase in embryonic malpositioning (the head is in the smaller end of the egg). This leads to a reduction in hatchability.

An egg is oval in shape. This necessitates it to be positioned horizontally and thus turned on its axis. Also due to the delicate shell, it should be carefully turned so that disruption of the clarion and / or breakage of the shell, dose not occurs. Pointing or sharp edge objects should not be used in turning the eggs to avoid accidental puncturing of the egg shell.

1 .1.4 ILLUMINATION

The effect of continuous light on the rate of development and time of hatching was reported in 1962 by SHUTZE and his colleagues [6] and was confirmed by LAVBER and SHUTZE (1964) [6]. It was discovered that illumination of the eggs throughout incubating period advances hatching by about 20 hours (almost a day) Hatching is advanced also but to a lesser extent when the incubator is illuminated for a single week. Illumination in the first week has alerter effect than the second or third week.
Siegel et al in 1969 [6] discovered that when the egg are illuminated throughout incubation, the total incubating period was reduced by as much as 30 hours but wit about 3/ reduction in hatchability.

Termini in 1967 [7] found that continuous exposure of eggs to light leads to depressed growth. In another report he put forward along with fox (Termini and Fox, 1967) [8] , control experiments were carried out, their findings contradicted that of Siegel et al and Shutze. Their experiment, they found hatchability efficiency to be greatly reduced in the light and hatching time to be delayed directly contradicting Shutze and Siegel.

Illuminating the incubator, therefore, has only the advantage of reducing the hatching time. The primary aim of the designer is to produce an incubator that will yield maximum hatchability and not minimal incubating period. It could then be logically concluded that continuous illumination is harmful to the egg fetus based on the above argument.

1.1.5 VENTILATION

Aeration of incubated eggs is another parameter worthy of consideration .Good and efficient ventilation of the incubator is necessary since developing egg fetus, like all living things respires.

According to Lundy in 1969 [8], oxygen content of the air should be about 21/ for maximum hatchability. This percentage content is just about that of normal air, thus necessitating the need for fresh air at all times in the incubator. He also stipulates that a carbon-dioxide level above 1/ result in a decrease in both hatchability and growth **rate of egg.** This suggests that used air should continuously be removed as fresher air is supplies to the incubator.

1.1.6 INSULATION

The principle of the incubating system should be based on the maintenance of a relatively constant and uniform temperature of the egg throughout the 21 days incubating period. Hence temperature supplies to the eggs must be conserved and regulated to avoid fluctuations of temperature, and to ensured maximum efficiency. Naturally, the mother her incubates using the heat of her body and insulates with her porous feather. It is therefore of utmost importance to lay the framework of the incubator to grand against environmental fluctuations such as temperature, humidity and so on.

1.1.7 ALARM

Assume the design capacity of the incubator is about 180 eggs whose total can be about three hundred Nair [#300]. The condition stipulated above has to be guarded against fluctuations so as to ensure maximum hatchability and security of the eggs. Electric power is utilized for heating supply. The failure of this or any other means of heat supply, without awareness of the incubator attendant can lead to loss of heat and subsequent death of egg fetus. This argument initiates the need to build an alarm.

1.2 AIMS / OBJECTIVES

1. To develop a simple, low cost device aimed at causing the prevailing financial difficulties faced by poultry farmers who intend going into the business of chick's production so as to meet the demand.

2. To reduces electricity cost which would have otherwise been high, if cooling or heating systems were left to operate always.

3. To stimulate the interest of upcoming students to take up topic, not only in relevant field of study [Elect/computer engineering] but also extending to other field.

4. To improve the efficiency of process that is highly temperature sensitive.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL BACKGROUND

The advent of modern day egg incubator has provided productivity, safety and time reduction, cost reduction and technological advancement to poultry industry. This design project is an improvement on earlier work carried out MRS OLANIPEKUN ROELYN [2003] and MR PAUL R.U. [2003] both of the same Electrical /Computer Engineering of the same institution. It is noted that most of the fundamental requirements of the incubation has been implemented by the latest work of MRS OLANIPEKUN R. However rigorous scrutiny of the implementation were carried out, thus, the major work done in this project are correction to the lapses found in such implementation and subsequent construction of the new modified operations as based on the fundamental requirements stated above.

This chapter gives the complete description of the various elements or modules used in the design of the egg incubator. The theoretical background of each element is extremely dealt with. The block diagram of an egg incubator is shown in figure 2.1 below.

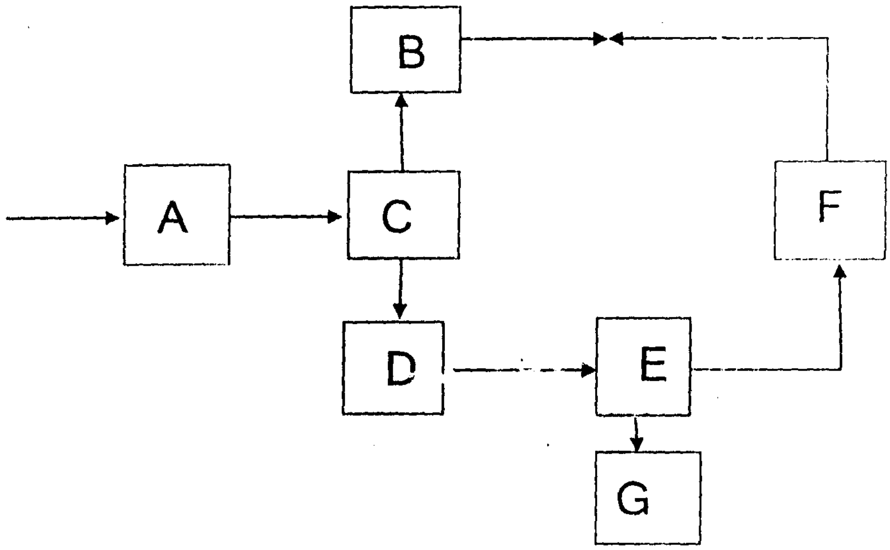

Figure 2.1: Block Diagram of an Egg Incubator Circuit.

A-power supply unit

B-sensor unit

C-voltage comparator op-Amp unit

D- Relay unit

E-switching unit

F-Heat unit

G-Alarm unit

2.2 POWER SUPPLY UNIT

The power supply unit is the house of the entire circuit of the egg incubator. Its output voltage (usually after rectification) is fed into the egg incubator and subsequently converted into heat energy. This is achieved when the temperature sensor unit (thermostat bridge) on receiving heat induced by the 100W turning system filament electric bulb, the thermostat [a transducer], converts the heat into voltage signal that drives the comparator unit meant to compare the voltage at the inverting and non-inverting into with respect to the reference voltage obtained by adjusting the variable resistor of the comparator unit.

Majority of electronic circuit uses direct current [DC] supply for operation and the covert ion of AC supply to DC can be achieved through the following laid down procedure.

2.2.1 TRANSFORMER STAGE

The transformer steps down the domestic AC supply of about 240Vrms to the required voltage suitable for electronic devices. It consist of two closely couple coil identified as the primary [Vp] appear at the secondary [Vs] as a voltage multiplication inversely proportional to the turns ratio[k].

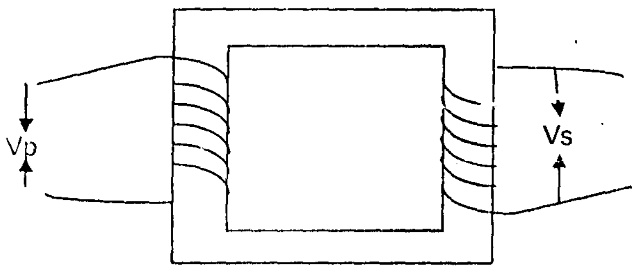

Fig 2.2 Diagram of a Transformer

The transformer is a step-down type

K=voltage transformer ratio

Vs=voltage supplied at the secondary coil

VP=voltage supplied at the primary coil

Ns=Number of turns in the secondary coil

Np=Number of turns in the primary coil

2.2.2 RECTIFICATION

The term rectification is defined as the process of changing pulsating AC voltage to DC voltage by eliminating the negative half cycle of the alternating. This is one of the simplest and most important applications of diodes. The simplest circuit of a rectifier is shown in figure 2.4 below. The AC symbol represents source of AC voltage, in electronic circuits, it is usually provided by the transformer, power from the AC power line. There are mainly three (3) types of rectifier circuit:

(1) Half-wave rectifier circuit

(2) Full-wave rectifier circuit

(3) Full-wave bridge circuit

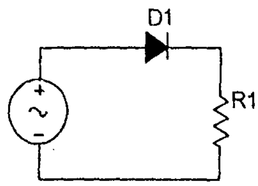

Fig 2.3a Half Wave Rectifier

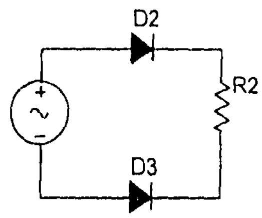

Fig 2.3b Full Wave Rectifier

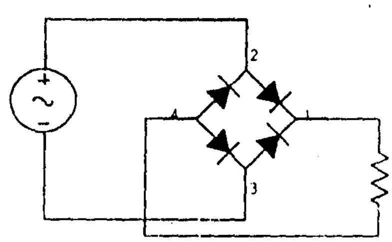

Fig 2.3c Full Wave Bridge Rectifier

In figure 2.4a, the circuit is called a half-wave rectifier because only half of the input wave form is used while figure 2.4b (full wave rectifier) the whole input wave form is used. The complete circuit diagram of a full wave bridge rectifier circuit is shown in figure 2.4d. It is connected to 240v, 50Hz mains.

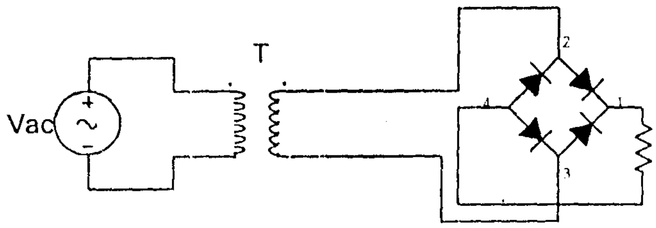

Fig 2.3d Complete Circuit Diagram of a Full Wave Bridge Rectifier

2.2.3 FILTERING AND SMOOTHING

The main function of a filter is to maximize the ripples content of the full wave bridge rectifier output. Efficient filtering can be achieved by using electrolytic capacitors. The input and output wave form of the filtering circuit is shown in figure 2.4

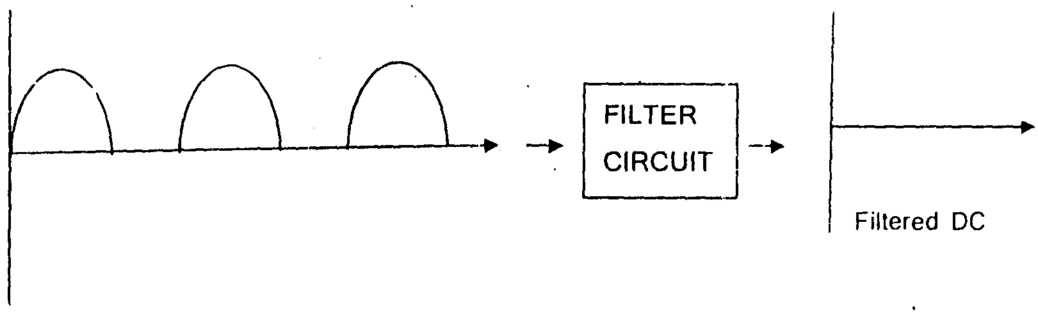

Fig. 2.4 Diagram of a Filter Function

2.1.4 VOLTAGE REGULATION

This stage is normally employed to eliminate excess voltage in the entire circuit and regulate it with specified power distribution within the incubator is shown in figure 2.5 below

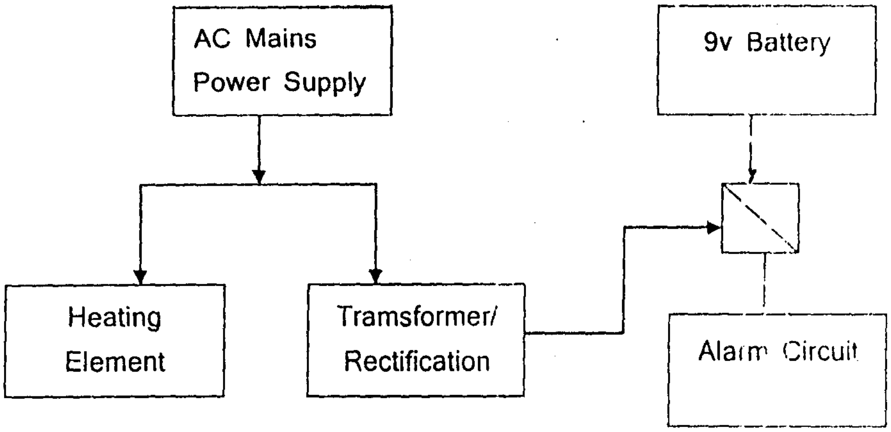

Figure 2.5: block diagram of power distribution in incubator

2.3 TRANSDUCER [Temperature Sensor Unit]

With the development of conventional air heating of the incubating chamber, the precise attainment of 37°C cannot be easily achieved because of device and environmental variation; hence control of this air temperature can be monitored. The recent vast increase in the development and use of electronic measuring systems, instrumentation engineers find it necessary to device a more efficient way of controlling this temperature variation and this is achieved electrically by utilizing an electronic sensor and an output transducer to the heating device.

Considering the role or function of the thermostat as a sensor, it is a semi conductor device that exhibits a negative coefficient of resistance with temperature typically in the neighborhood of -4%c. They are available in al sorts of packages, ranging from tiny glass beads to armored probes Thermostat intended for accurate temperature measurement typically have a resistance of few thousand ohms at room temperature. Their large coefficient of resistance change makes them easy to use, and they are inexpensive and stable, they are good choice for temperature measurement and control in the range of -50° C to +300° C. The circuit representation is shown

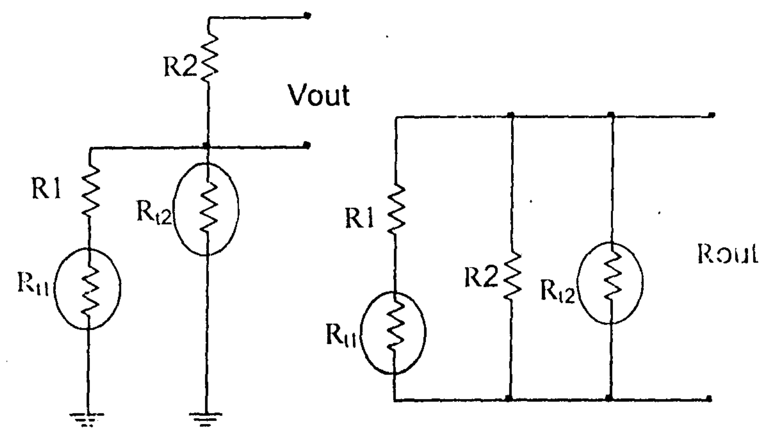

Fig 2.6 Circuit Diagram of aTransducer

2.4 TEMPERATURE/HEAT SOURCE [ELECTRIC BULB]

Light is a form of energy, an electromagnetic radiation whose wavelength is between approximately 100 and 200m. By strict definition only visible light can be considered as light and infra red or ultraviolet light is then termed radiation. The electric bulb is a resistive component that dissipates energy in the form of heat which is it used to warm the eggs in the incubator at a steady temperature between 99°F and 103° F

2.5 VOLTAGE COMPARATOR OP- AMP UNIT

Voltage comparator as the name implies, is a circuit that compare the magnitude of the two analogue signals (usually voltage) between the inverting and non-inverting logic output. It is similar to a differential amplifier operating in an open loop mode .However, because of high gain; the output is normally saturated in either high or low state depending upon the relative amplitude of the two input voltages. With this condition, the comparative provides a logic state output which is indicative of the amplitude relationship between two analogue signals. The circuit representation of a comparator is shown in figure 2.9 below.

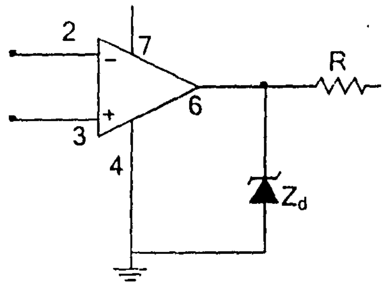

Fig 2.7 Comparator Circuit

2.6 SWITCHING UNIT

The switching circuit interfaces the entire system with the heat source inside the incubator Without this module the aim of this project (hatching of fertile egg into chicks) will not be achieved the comparator output voltage energizes the switching circuit through a parallel combination of resistors. The switching circuits regulate the heat supply inside the incubator.

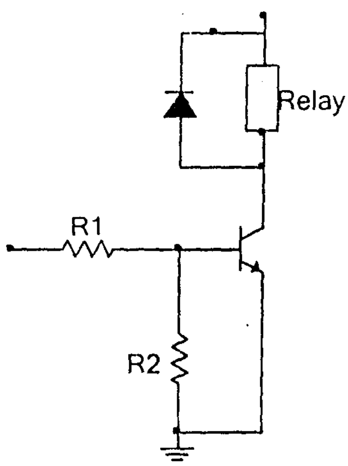

Figure 2.8: switching circuit of the egg incubator

CHAPTER THREE

DESIGN ANALYSIS

The invention of egg incubator has provides the poultry farmers high productivity, lesser time, cost reduction, low risk bearing safety in the production of poultry chicks. The chapter explains the electrical/electronic operations of the in incubating system. The electrical aspect deals with electrical power supply to the system electronic circuitry, the hearty element and the lighting bulb.

The electronic aspect explains how: control of various simulated factors and parameters of incubating system. It also explains the development and implantation of the alarm circuitry.

3.1 POWER SUPPLY

Power supply to the incubating system consists of 3 types:

(i) a 240v, 50 Hz AC single phase supply

(ii) a 12v DC regulated supply

(iii)a 9v battery supply.

The 240v, 50Hz Ac single is tapped from the mains by a plug/ socket fixture. The plug is connected to a cable connector via a 3-corre PVC sheeted PVC insulated cable. It is from the connector that the 100 watts heating element (electric bulb) derived their power through a relay switch. Also an internal lighting bulb is powered via a multiple pin spring loaded 2A 240v door switch. Finally, a 240/RV 20VA step-down transformer also receives 240v, 50Hz single phase supply from the mains

This transformer steps the 240v Ac down to a 12V (peak voltage) A back- up 9v battery is installed to supply the alarm circuit when there is mains failure. This is connected to the alarm circuit via the mains switch.

The block diagram of electric power distribution within the incubator is shown in figure 3.1

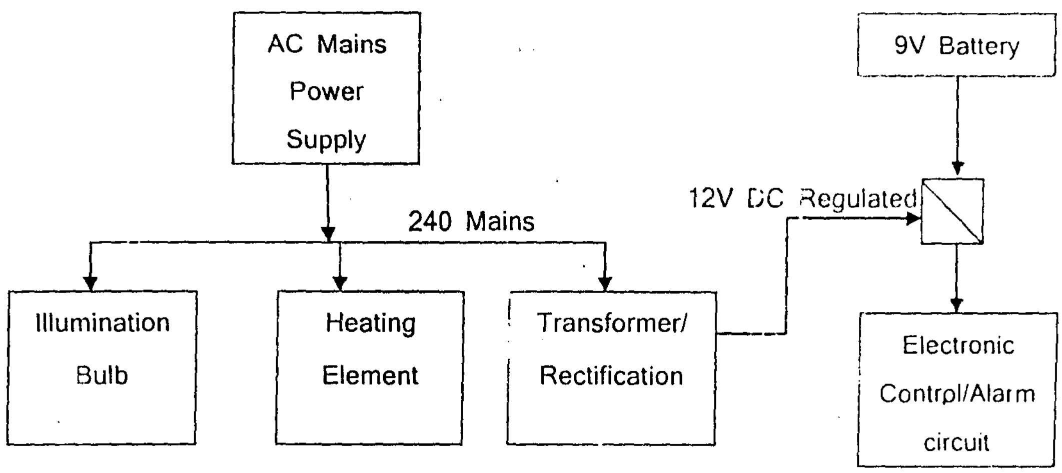

Fig 3.1 block diagram of power supply distribution in incubator

3.2 RECTIFICATION \ FILTERING

The term rectification is defined as the process of changing pulsating Ac voltage into Dc voltage by eliminating the negative half cycle of the alternating voltage. This project adopts the use of an integrated circuit (IC) full wave bridge rectifier.

The output of the bridge rectifier is fed across a 1000μf, 25v electrolytic capacitor for filtration and smoothening to maximize the ripple content at the full wave bridge rectifier output. The low ripple 12v dc is fed to a 12v voltage regulator IC (LS 7812). This is necessary since the mains voltage fluctuates and affects the bridge rectifier output. A led indicator stage is applied across the full wave bridge rectifier to indicate when there is power supply from the mains. The regulated 12v dc output feeds the electronic network.

The diagram of the rectification and regulated 12v dc supply network is shown in figure 3.2.

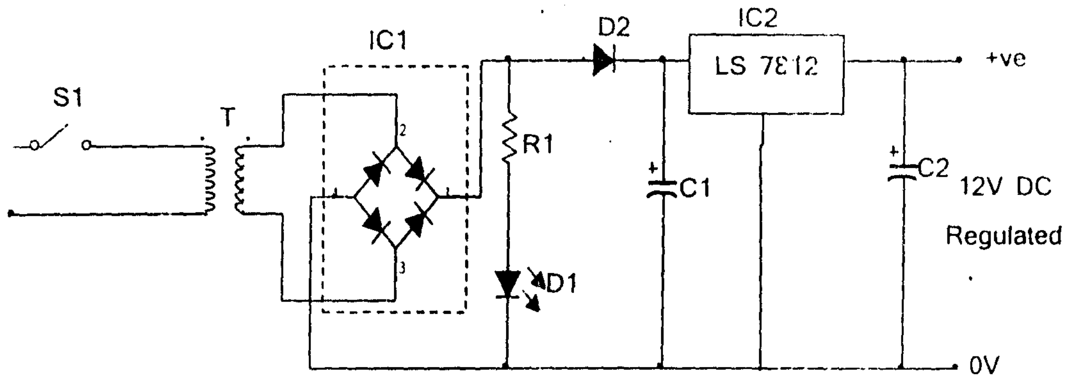

fig 3.2: 12v dc regulated power suppLy circuit design

CALCULATION (LED INDICATOR STAGE)

If we assume a 12v dc output from the bridge rectifier,

Than for the led indicator stage

$V_{cc} = I_d R_1 + V_0$ ----- -- ---- -- 1

Typical values of the led (green) are $V_o = 2.2v$ at I_d=20mA

$12 = 20 \times 10^{-3} R_1 + 2.2 =$

$20 \times 10^{-3} R_1 = 12 - 2.2$

$$R_1 = \frac{12 - 2.2}{20 \times 10^{-3}}$$

i.e. $R_1 = 490\Omega$

Preferred value of resistor R_1 = 470. The chosen value of capacitance can't be equal or greater than 1000 μf but with a voltage rating grater than twice the applied voltage

DESING SPECIFICATION

- Double pole single throw ON / OFF switch , S_1 240V, 3a
- Step down transformer , T 240v /12v ,20 VA
- Resistor R_1 , 470 Ω

- LED (green), D_1
- Electrolytic capacitor, C_1 1000 µf, 25v
- Full – wave bridge rectifier IC_1, 25v
- 12V voltage regulator, IC_2 LS 7812

3.3 TEMPERATURE REGULATION

With the development of conventional air heating of the incubating chamber, the precise attainment of 37 ^{0}C cannot be easily achieved because of the device and environment variation hence control of this our temperature can be monitored will not be practicable and result to inefficiency.

In this project, the feedback of air temperature is achieved electronically by utilizing an electronic sensor and an output transducer to the heating device.

3.31 TEMPERTURE SENSORS

There are many types of temperature sensors .The principles is based on utilizing the properties of materials which responds to temperature changes.

- Mercury – in –glass thermometer is the most common of temperature sensors. known to man. The sensitivity of this type of thermometer is very high and can be increased depending on the precision technology used in manufacture.

  Another type is a resistance – temperature detector (RTD)

  It is essentially a length of wire wound on a bobbin and housed in a protective sleeve

A cheaper method of temperature sensing is provided by the thermistor. It is a thermally sensitive semiconductor resistor formed from oxides of metals such as cobalt, manganese. There are of two (2) types;

(1) Positive temperature coefficient (PTC)

(2) Negative temperature coefficient (NTC)

In this project, a Negative temperature coefficient (NTC) thermistor is utilized because of availability, sensitivity, stability and range of temperature.

3.32 REGULATION / CONTROL CIRCUIT

The temperature regulation/ control circuit consist of three (3) stages – a difference bridge, a simple comparator circuit and a relay circuit. It is shown in figure 3.2 below

The difference bridge utilizes voltage divider network made up of resistors R2, R3 and R4 .Resistors R_3 andR_4 presents a constant reference voltage E_{ref} of $(R_4/R_3 + R_4) \times$ Vcc to the inverting input , pin 2 of the comparator stage. The other arm made of resistors R_2 and thermistor resistance Rt present a varying voltage, E_i of $(Rt/R_2+Rt) \times$ Vs to the non inverting input, pin 3. The comparator circuit consists of a 741 op- AMP The output of the comparator is connected to a transistor – relay switch. The transistor – relay switch is made of resistor biasing network, a PNP TRANSISTOR (BC 212L) with a relay connected to its collector arm to ground. The feedback thermistor resistance, Rt with Negative temperature coefficient (N.T.C) has Rt = 1.5k > R4 at room temperature. Thus $E_{ref} > E_i$ and the comparator stage is driven to Negative saturation, 0 volts. The transistor – relay is driven 'ON' and the relay becomes energized thus powering the heating element. The heating increases the temperature of the air and the feedback resistance decreases until $R_t \leq R4$ .At this point, $E_{ref} \geq E_i$ and the comparator output is driven to positive saturation, 13 volts. The transistor is driven to cut- off, the relay coil becomes de- energized thereby cutting off supply to the heating element.

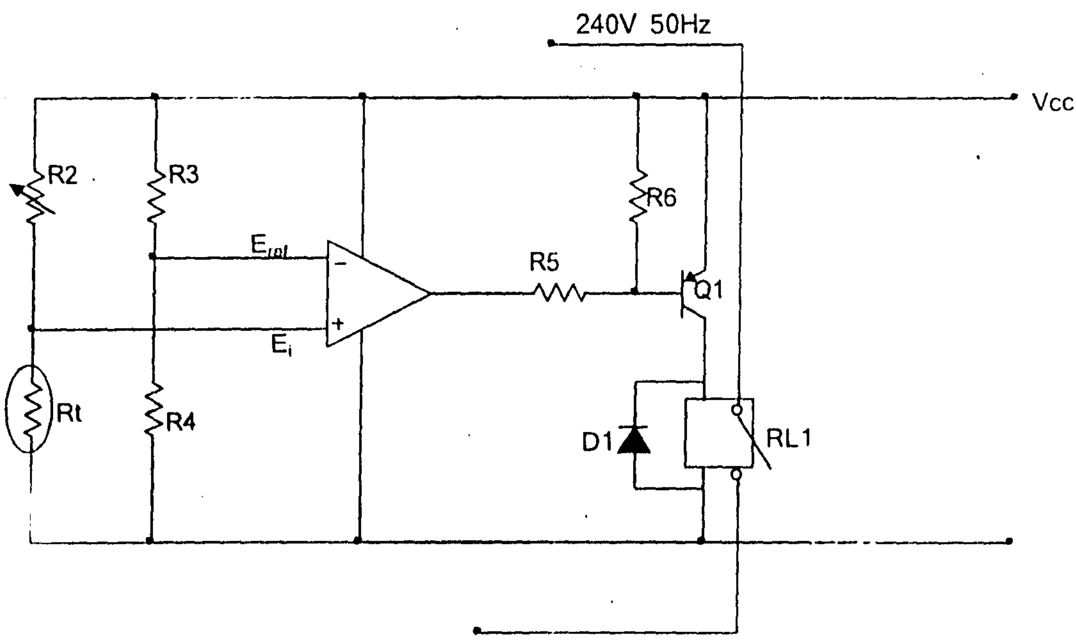

Figure 3.3 temperature control circuit

DESIGN CALCULATION

Thermistor resistance, Rt (37 ^{0}C) = 1.006k

Reference voltage Eref = $\frac{R_4}{R_3 + R_4} \times Vcc$

Choosing $R_3 = R_4 = 22\ K\Omega$ $\quad E_{ref} = \frac{22}{22+22} K\Omega \times 12V$

$E_{ref} = 6V$

For the switching circuit, $R_6 = 2.2K$, $R_5 = 4.7K$

RL = 400 when $V_i = 12v$, the transistor is bias such that VB = 0

This is adequate to cut –off i.e Vcc =12v

Vo = 0V

DESIGN SPECIFICATION

Resistor R3 = R4 = 22Ω

Variable resistor R2 = 1K Ω

Resistor R5 = 4.7 KΩ

R6 = 2.2 KΩ

Relay RL1 = 400Ω 12v

Diode D3 = IN 4001

Transistor, Q1 = BC 212L PNP

THEMISTOR Rc

Rc (25 °C) = 1.5 k + 10%, power dissipation =250 MW

Operating temperature range, -40 °C to 110 °C

3.4 MAINS FAILURE ALARM

The mains failure alarm was implemented by the use of an integrated circuit (LM 358). The circuit consist of a time delay,an oscillator and driver curcuit.

3.4.1 TIME DELAY CIRCUIT

The time delay goes high after a certain period of time to stop the oscillator.It is basically a comparator with a reference voltage at the negative terminal. Since R8 R9, the voltage at the negative terminal is 1/2Vcc which is supplied by the battery

$$V_2 = R_9/(R_8+R_9) \text{ X } Vcc = ½ Vcc$$

As the battery switches ON, the capacitor is charged through R7 Thus the voltage V_1 increases until it is greater than V_2 here by its output goes high. In this high state, the oscillator is inhibited because V'_3 is kept constant as a result of the first comparator's output voltage. The diode D_4 prevents any reverse voltage from the oscillator to the time delay. The charging voltage is given by

$$V_1=Vcc(1 - e^{-t/R7C3})$$

where t=delay time

when $V_1 > V_2$,the output is high

i.e $Vcc(1 - e^{-t/R7C3}) > V_2 = 1/2Vcc$

$$Vcc(1 - e^{-t/R7C3}) > 1/2Vcc$$

$$(1 - e^{-t/R7C3}) > 1/2$$

$$- e^{-t/R7C3} > -1/2$$

$$e^{-t/R7C3} < ½$$

taking ln of both sides

$$-t/R7C3 < loge(1/2)$$

$$-t < -0.693R7C3$$

choosing R7 = 22K, C3 = 1000F

$$t = 0.693 \times 22 \times 10^3 \times 1000 \times 10^{-6}$$

$$t = 0.693 \times 22 \times 1000 \times 10^{-3}$$

$$t = 15.246sec = 15sec$$

The time delay circuit is shoen in the figure below

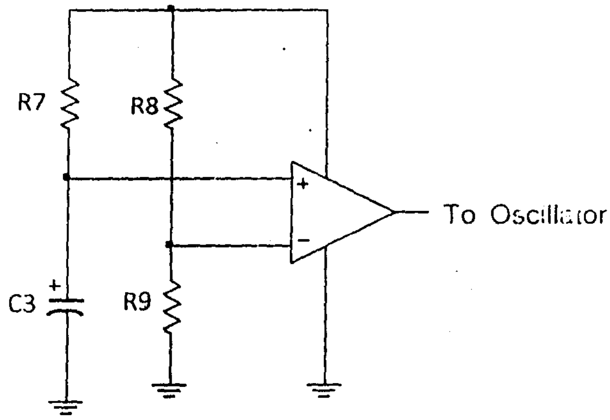

Fig. 3.5 Time delay Circuit

3.4.2 OSCILLATOR CIRCUIT

The osillator circuit is also a comparator circuit, the charging and discharging of capacitor C3 gives rise to oscillation. When the battery is switch ON, the oscillator starts oscillating, switching the buzzer through the driver, after a delay time(t), a high voltage value is introduced at V3 thus prevent the charging and discharging process of the oscillator. The period of oscillation is given by

$$T = 2R12C4\ln(2 + R10/R11)$$

choosing $R10 = R11 = 10K\Omega$

$R12 = 47K\Omega$, $C4 = 10\mu F$

$$T = 2 \times 47 \times 10^3 \times 10 \times 10^{-6} \ln(2 + 10000/10000)$$

$$T = 2 \times 47 \times 10 \times 10^{-3} \ln(3)$$

$$T = 1.033\text{sec} = 1\text{sec}$$

The osillator circuit diagram is shown below

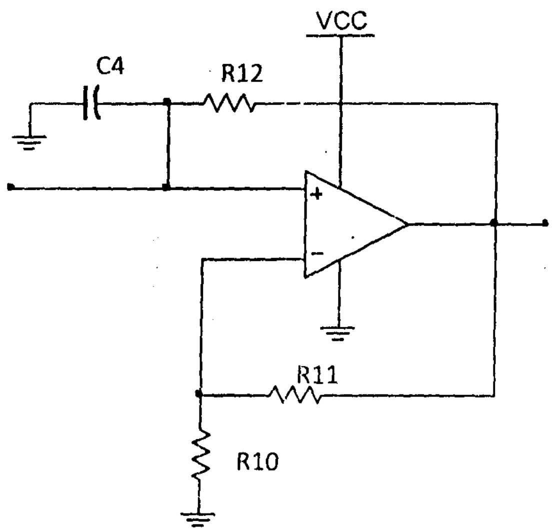

Fig. 3.6 Oscillator Circuit

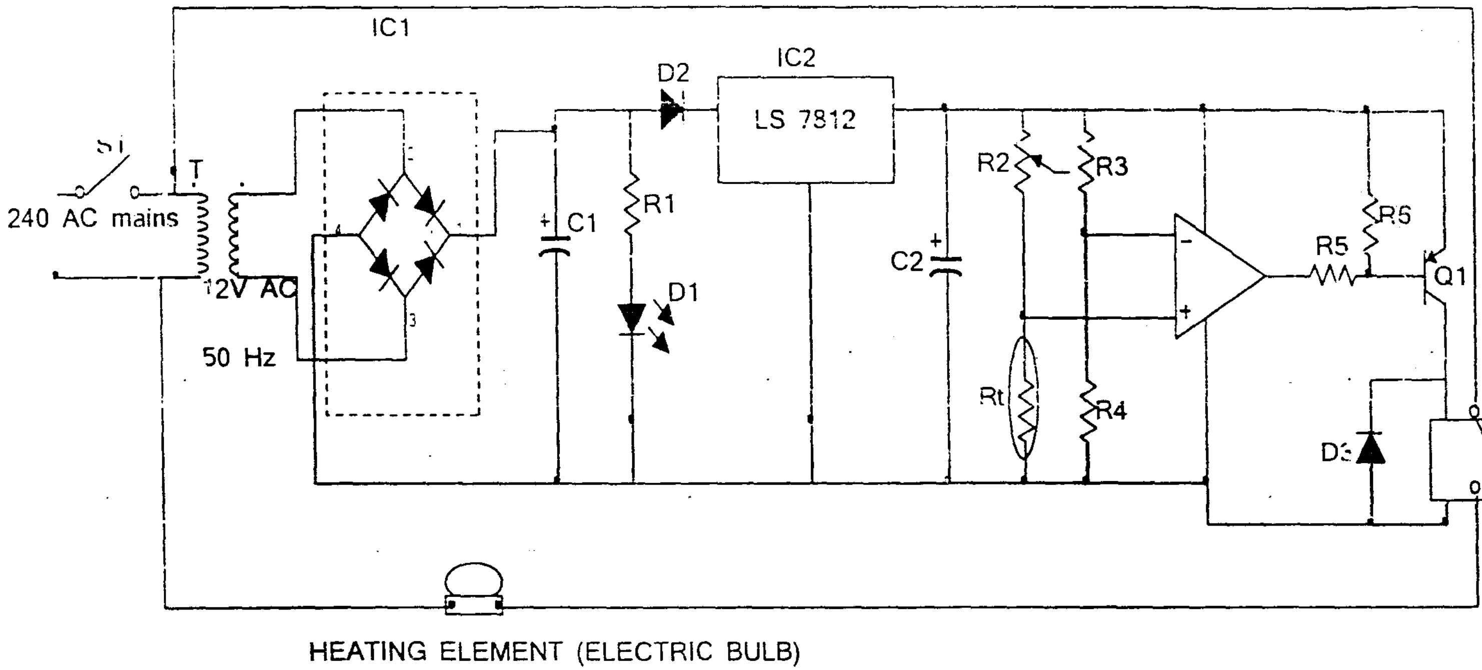

Fig. 3.7 COMPLETE CIRCUIT DIAGRAM OF AN EGG INCUBATOR

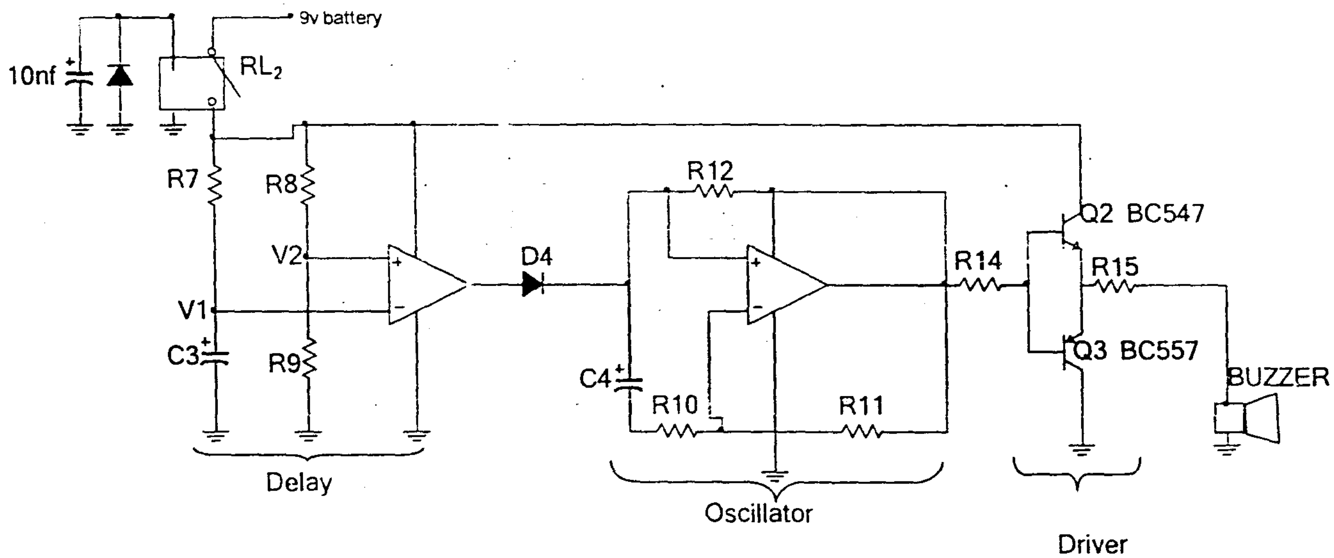

Fig 3.8 CIRCUIT DIAGRAM OF MAINS FAILURE ALARM

Table 3.1 Bill of Quantity and Cost Estimate

S/N	Description of items	Quantity	Unit Rate ₦: K	Total Amount ₦ : K
1	Resistors	20	10.00	200.00
2	Capacitors	10	70.00	700.00
3	Full-wave rectifier IC	1	30.00	30.00
4	LEDS	3	10.00	30.00
5	Diodes	15	5.00	75.00
6	Operational Amplifier IC	5	20.00	100.00
7	Voltage Regulator	1	70.00	70.00
8	IC Socket	3	25.00	75.00
9	Thermistor	1	200.00	2 00.00
10	12V Relay	3	80.00	240.00
11	Transistors	5	20.00	100.00
12	Connecting wires	2	30.00	60.00
13	Switch	1	70.00	70.00
14	9V Battery	2	80.00	160.00
15	Battery cap	1	50.00	50.00
16	12V Buzzer	1	200.00	200.00
17	Heating element Bulb	1	50.00	50.00
18	Electrical cable [1mm]	X5mm	30.00	150.00
19	Vero Board	1	50.00	50.00
20	Bread Board	1	350.00	350.00
21	240/24V Transformer	1	200.00	200.00
22	Soldering lead	2	30.00	60.00
23	Soldering Iron	1	150.00	150.00
24	Circulating fan	1	200.00	200.00
25	Casing			2000
26	Material cost Sub-total(ST_1)			5570.00

27	Transport of material , 5% of ST_1			2078.50
28	Sub-total$_2$ (ST_2)			5848.50
29	Labour,30% of ST_2			1754.55
30	Sub-total$_3$ (ST_3)			7603.05
31	Over head, 5% of ST_3			380.15
32	Sub-total$_4$ (ST_4)			7983.20
33	Profit 10% of ST_4			798.32
34	Sub-total (ST_5)			8781.52
35	Contingen cy, 5% of ST_5			439.08
36	Total cost of project			9220.60

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 CONSTRUCTION

The most important requisite for the development and manufacture of competitive products is the selection of the optimum combination of materials and process for the different component of the incubator project

In the hard ware construction, the overall system was broken down into modules for easy construction, testing and trouble shooting. Namely

- Power supply unit
- Voltage divider
- Voltage comparator unit
- Switching unit
- Heating source unit (Electric Bulb)
- Plywood Incubator.

MODULE 1: POWER SUPPLY UNIT

This module was built with a full-wave bridge rectifier integrated circuit as the first component on the Vero board. The bridge rectifier has four terminals denoted by the following symbol + ~ - such that the positive (+ve) terminal was connected to the supply line, Vcc, while the terminal with the Negative symbol (-ve) was connected to the ground, that is zero volt line. Meanwhile two centre terminal denoted by the symbol ~ was connected to the transformer output / secondary. Similarly, the capacitor (1000µf) was connected across the rectifier output as a filter consequently a voltage regulator (7812A) with its pin configuration identified was also connected across the resulting DC output to regulate the voltage. In order to reduce high voltage spike, another capacitor *(2200µf)* was connected across the regulator's output. With the transformer terminals identification, the primary was connected to the main supply (240vrms) and the secondary was connected to the circuit through the bridge rectifier.

MODULE 2: VOLTAGE DIVIDER UNIT

his module was built on the varo board immediately after the power supply unit. It comprises of resistors R2, R3, R4 and s thermistor with R3 and R4 presenting a constant reference voltage and variable resistor R2 and thermistor resistance Rt present a varying voltage to be compared. The thermistor senses the temperature / heat generated by the heat source (electric bulb) and transducers to voltage signal. It has two terminals with one connected to the ground and the other connected to the supply line through a resistor, a voltage divider network result. The thermistor was molted about 3 – 5cm away from the heat source without any electrical contact between them.

MODULE 3: VOLTAGE COMPARATOR UNIT

This module comprises of UA741C IC (integrated circuit) and a negative feedback resistor. The 741 IC was mounted on an IC socket soldered on the Vero board after identifying various pin configurations; the IC output pin was connected through a voltage divider network to the switching circuit. Meanwhile, the inverting and non-inverting input was connected to the voltage divider network (made up by the thermistor and the resistor) as well as the reference voltage, the resistor that stabilizes the output voltage require to drive the switch circuit on the non – inverting input, a variable resistor was connected to it through a combine resistors meant to hold the reference voltage at the desired voltage value so as to trigger the switching circuit

MODULE 4: SWITCHING UNIT

This module comprises a relay and a transistor. With the aid of digital multimeter, the emitter, base and collector of the transistor was identified, hence soldered on the Vero board this was accomplish with the identification of the relay pin configuration as N/O (Normally closed) and the relay coil was also checked to ensure efficient switching of the relay. And across the relay coil terminal, a diode (free – wheeling diode) was also connected in order to eliminate the sparking of the relay coil as avoiding back emf, which may be induce when the relay turns OFF.

MODULE 5: HEATING UNIT

This module constitutes a 100 watt electric bulb meant to induce heat inside the incubator thus causing the fertile eggs to hatch into chicks. At the set temperature, the electric bulb goes OFF and comes ON automatically and this was achieved with the aid of the switching unit, thus the temperature of the entire system is regulated.

MODULE 6; PLYWOOD INCUBATOR

This module was constructed with the following materials

1. Plywood
2. Glass
3. Cake pan
4. re mesh
5. Measuring tape
6. Nails
7. Hack saw
8. Sand paper
9. Evostic gum

With the aid of the hack saw and measuring tape, the required length, breadth and width of the incubator was cut accordingly.

CONSTRUCTION STEPS

- ✓ Using the measuring tape, measure the plywood to the required dimensions: height (16 inch), width (20 inch) and sawed with hacksaw.
- ✓ Assemble the plywood to form a rectangular shape.
- ✓ With the aid of the hammer and nail, join the assembled shape above in order to form a rigid structure.
- ✓ Haven form the rigid structure, using nails, two small piece of plywood (2mm thick diameter) and a hammer, fix the height peak and 5 inches above the base of the height. This should be done on both side of the rigid structure (inside).
- ✓ Using the measuring tape, the required dimension of the egg tray was also measured, sawed and assembled.
- ✓ To the assembled tray frame above, wire gauze was fixed permanently using nails at it's base, to form the egg tray
- ✓ The egg tray above was then placed in the egg – tray holder constructed inside the rigid structure above thus, the plywood incubator assumed the required shape.
- ✓ The glass after being measured to the required size, a cutting fluid (kerosene) was then applied on the marked pout to weaken the cohesive nature of the glass molecules.
- ✓ With slight pressure applied on the diamond cutter placed on the weakened spot of the glass, the cutter was hen dragged gently removing the unwanted part.
- ✓ The glass was then fixed on the assembled shape above thus a complete plywood incubator was constructed

4.2 TESTING OF CONSTRUCTION

After the completion of the construction, a careful hardware test of the completed circuits was carried out as follows:

STEP 1: Continuity of copper wire used in the construction using digital multi-meter

STEP 2: A digital multi-meter was aiso used to ascertain the absence of short-circuit between the supply line (+ve) and the ground (-ve)

STEP 3: Polarity of the power supply output was tested using a digital multi-meter to ensure adequate link to the incubator circuit as well as the identification of the reverse bias and forward bias of the diode use in the construction process.

STEP 4: The output voltage of the transformer (secondary output voltage) was observed and measure to be 12Vdc as required.

STEP 5: The variable resistor was set so that the relay turn switches ON and OFF, hence the heat source. By bringing the electric bulb closer to the thermistor after a few seconds the bulb turn OFF thus indicating that the set temperature of the incubator has been attained, and then switches ON after a few seconds thereby maintaining a steady temperature within the incubator.

CHAPTER FIVE

RECOMMENDATION AND CONCLUSION

5.1: CONCLUSION

The motive and objective of the project was realized as observed testing and operation proving that an "Egg incubator" can be constructed from the basic thermostatic principle, by the use of comparator circuit, switching circuit, voltage divider circuit. The low operating voltage, $12V_{dc}$ and low power consumption of the system allows for low temperature [99^0F to 103^0F] of the incubator, longer life, better maintenance, low overall cost in construction and operation thus resulting in high reliability of the system in egg hatching to produce chicks.

The egg tray design has made it possible to increase from incubating capacity of 40 eggs to about 90 eggs. This is as a result of efficient use of space.

The electronic control circuitry has been modified for improving functionalities and economic value. The logic of the mains failure alarm is greatly effective.

More so, an increased incubating capacity is a right step in the right direction in increasing the population of poultry birds and eggs with subsequent increase in our protein nutrition intake.

5.2 RECOMMENDATION

The project experience has put to test my previously acquired knowledge on a wide range of subject matter and related topics, with these experiences, my desire as on Electrical and computer Engineer is to fully integrate the discipline into other field such as medical sciences, Agricultural sciences as well as other engineering profession.

For effective production, it is recommended that materials selected for application in each unit of the incubator be of light weight and also have optimal performance value.

Although this design is for a poultry incubator, the basic features of regulated air temperature, insulation and humidity control can be extended to developing INFANT INCUBATORS. Difference in design feature will lie in the monitoring and regulation of air composition used in incubating.

Further more, up coming students should try in their endeavors to incorporate temperature digital readout so as to ensure the digital display of the incubator temperature.

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