A PROJECT REPORT

ON DESIGN AND CONSTRUCTION OF AN EGG INCUBATOR

BY

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97 / 6185 EE

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CERTIFICATION.

This is to certify that Paul Roland Umade carried out the design and construction of an egg incubator under the supervision of Engr (Dr.) Y.A. Adediran and submitted to the department of Electrical/Computer Engineering for the award of B.Eng. in Electrical and Computer Engineering, Federal University of Technology, Minna, Nigeria.

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SUPERVISOR.	**SIGN & DATE.**
ENGR. M. N. NWHOHU	7/4/84
HEAD OF DEPARTMENT	**SIGN & DATE.**
....	....
EXTERNALEXAMINER	**SIGN &DATE**

DEDICATION

I dedicated this project to my Lord Jesus Christ, through whom I have been receiving favour and mercies from God Almighty during my years of studies as an undergraduate.

ABSTRACT:

The purpose of this project is causing fertile egg/eggs to hatch into chicks by the application of heat synthetically. This heat is induced by a 60watt electric bulb installed inside the incubator with the aid of screwed porcelain socket. The heat is however, controlled by a Schmitt trigger through a switching circuit depending on voltage divider output.

ACKNOWLEDGEMENT.

Just like the psalmist said, "IF IT HAS NOT BEEN FOR THE LORD WHO HAS BEEN ON MY SIDE, WHERE WILL I HAVE BEEN".

My profound gratitude goes to my heavenly father, God Almighty, through Christ for His divine enabling grace upon my life during the course of my studies.

I am greatly indebted to my beloved mother, Kate, for her love that I can not quantify or express through this medium, may the Lord God Almighty in His infinite mercies and favours cause your great dreams and expectations upon my life be fulfilled in Jesus name, Amen!

However, the co-operation of my beloved and divinely linked friends, Engr. Sunday B. Anwansedo and Engr. Henry O. Ateri is highly commendable.

For in the multitude of counselors there is safety, i recognize and appreciate the concerned of my project supervisor in the person of Engr (Dr.) Y.A Adediran, former Head Of Department, Electrical and Computer Engineering, Federal University of Technology, Minna, Nigeria.

I also appreciate my father in the lord and his wife Pastor & Mrs. Fred Anwansedo whose sphere of contact sharpen me a great deal of success during the project.

Furthermore, I also registered my profound gratitude to people like Mr. Dickson O. Amromawvhe, Head of technical support, SSI-N (Shell Services International Nigeria) SPDC, Warri and Mr. Patrick O. Emoekabu, SSI-N commercial SPDC Warri, who in their endeavor supported financially in the course of this project as well as others who the rule of this game will permit me to mention. Finally, I appreciate the love and kindness of the Anwansedos'.

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CHAPTER 1

1.0 INTRODUCTION

The technology of incorporating sciences in the field of engineering has heralded the electrical and computer engineering age. For example, in the field of biomedical sciences (e.g. heart rate monitor, human incubator etc.), agricultural sciences (e.g. egg incubator). This technology is meant to provide the variety of functions required, especially in the field of agricultural sciences. Considering the egg incubator for example, a device designed and constructed based on the technical know-how in the field of electrical and computer engineering is meant to significantly alleviate the threat and difficulties imposed by consumers on farmers who intend taking chicks' production as one of their topmost priority. Incubator is an electrically operated machine meant to cause fertile eggs to hatch into chicks by the application of heat, usually created synthetically. The broad range of incubators available can be divided into three major classes namely; plywood incubator, cardboard incubator and still air incubator. Individual incubator has an egg tray that holds the fertile eggs some few distance below the heat source (electric bulb) and above its base, as well as heating unit that produces the desired temperature for successful hatching. This heating source is regulated by means of a thermostatic principle, ie, immediately above the highest temperature, heat supply is cut-off automatically and vice-versa. In addition to the heating unit and the egg tray, the plywood incubator has two ventilation holes near its base through oxygen is supplied to the eggs via the egg shell as well as an exhaust hole through which carbon-dioxide escapes via the egg shell, while the embryo is developing. Above all, the most fascinating, is how the embryo survives the developing

stage becoming chick at the end of the incubation. The avian egg is one of the finest foods. The yolk, white and the shell of the egg contain all of the proteins, fats, carbohydrates, minerals and vitamins necessary to the embryo during the 21-day incubation period. In other word, the embryo actually begins with the formation of egg within the hen's body. During the formation process, each yolk or ovum is contained in a thin membranous follicle. Blood vessels in the follicle carry nutrients to the developing yolk. When the yolk matures, the follicle ruptures along a line relatively free from blood vessels known as the STIGMA, and the yolk is released. The yolk is kept intact by the vitellin membrane surrounding it. Upon the release from the follicle the yolk drops into the body cavity. There the infundibulum, or funnel, engulfs the yolk and starts it on its on way down the oviduct. The oviduct is more than two feet long and is lined with glands that secrete the materials for the albumen, shell membranes, and the shell. Twenty-four hours or more are required from the time the yolk is released until the completed egg is laid. The fertilize egg is a highly complex reproductive cell and is potentially a small center of new life. The germinal disc from which new life develops is attached to the yolk of the egg. Surrounding and protecting the germ cell and yolk is the white or albumen consisting of several layers.

1.1 PROJECT OBJECTIVE / MOTIVATION.

The analysis of the aim and of this project" Design and Construction of an egg incubator" is;

i. **To develop a simple, low cost device aimed at easing the prevailing financial difficulties face by poultry farmers who intend going into the business of chicks' production so as to meet the demand in Nigeria rather than purchasing expensive incubator imported from oversea.**

ii. **To stimulate the interest of upcoming students to take-up research topic, not only in relevant field of study (Electrical and Computer Engineering), but also extending their arm of research to other field, say, Agriculture, the poultry farm in particular, thereby demonstrating the versatility of electrical and computer engineering as a discipline or a profession of great generality.**

iii. **To create an awareness and also make fellow students appreciate the versatility of Electrical and Computer engineering in relation to other field of engineering discipline (Mechanical engineering as in pneumatics) as well as in the field of sciences (Agricultural sciences as in egg incubator).**

1.2 PROJECT LAYOUT.

Chapter one introduces the project and reviews some of the related work done by other people.

Chapter two presents the detailed design/calculation of the egg incubator incorporating power supply unit (with an anti-surge); voltage divider unit (thermistor bridge), voltage comparator unit switching unit (comprise a relay and a transistor) as well as heat source (electric bulb). The chapter begins by discussing various sections that make up the project final design.

Chapter three is strictly concerned with the construction and testing of the project work. Also various equipment and components used in the construction of the hardware is included.

Chapter four discusses the result obtained and recommends ways to improve on the design. Inclusively, it also contains the final conclusion based on my research work and references.

1.3 LITERATURE REVIEW.

Early in the 17th century the concept of embryology made a little progress until the Renaissance, when Ulisse Aldvovandi, Volchet Coitor and Fabricus ab Aquapendente made original observation on the development of the chick. During the late 16th and early 17th centuries embryology emerged as a distinct scientific discipline. Concerned with anatomical description of the embryo, it was based on direct observation and coincided with the rise of mechanistic rationalism.

The breakaway from the ancient theories can be found in the work of the English biologist William Harvey, summarized in generatione animalium (1651). Harvey was an ardent disciple of the then-new method of studying the nature by direct observation and experiment. His embryological work became landmark in the history of the avian egg. He presented an extremely accurate description of chick development within the fertilized egg and correctly located the blastoderm as the site of origin of the embryo.

He, however, rejected spontaneous generation as well as two-seed and Aristotelian ideas of embryo formation of the avian egg. In what, is perhaps his most important achievement; he proposed that all animals are produced from eggs, which to him signified the product of fertilization.

Furthermore, an Italian physician Marcello Malpighi, using the newly invented microscope, and starting from Harvey's identification of the blastoderm as site of the origin of the chick, he was able to extend knowledge of chick morph genesis to include the first few hours of development. His treaties on the development of the chick, "De Ovo incubato De formatione pullin ovo, represent the pinnacle of the 17th century description of embryology. For the first time the neural groove, optic vesicles, somites, and the earliest blood vessels were described. Maipighi, influence by the fact he was

unable to observed an absolutely undeveloped fertilized egg, believed that the form of an embryo pre-exited in an un-incubated egg, unfolded and grew at different rates. Consequently, in 1672, the Dutch scientist Regnier De Braaf described in details the ovarian follicles of the mammals though, he mistakenly they were eggs and in 1677, the Dutch microscopist Anton Van leeuwenhoek announced the discovery of spermatozoa.

In relation to the above concept, early in the 18th century, the concept of pre-existence was transformed into preformationism; an interpretation of embryonic development as mere growth and manifestation of embryonic rudiments that were presents, but not delineated in the ovum

Or sperm before fertilization of the avian egg. Also, in the 17th century, the Dutch physician Jan Swamerdam had hardened a vitelin with alcohol and saw a completed form chick folded up within the shell. This observation led him to think that the avian egg contained preformed embryo. The preformationist maintained that there no true generation in nature, only growth of the preformed parts. Preformation took two forms: ovistic preformation, which posited the presence of preformed embryo in the avian egg and animalculist preformation; which located the miniature individual or homunculus, in the sperm. By the mid 18th century, ovistic preformation prevailed. The Swiss biologist Charlse Bonnet supported the preformation theory of encapsulation emboitement, were all life was said to result from an original creation at the beginning of time.

CHAPTER 2

DESIGN ANALYSIS

2.0 INTRODUCTION

The advent of the modern day egg incubator has provided productivity, safety, and time reduction; cost reduction and technological advancement to the poultry industry.

This chapter gives the complete description of the various elements or modules used in the design of the egg incubator. The theorical background of each element is extremely dealt with the block diagram of an egg incubator circuit is shown in fig. 2.0 below.

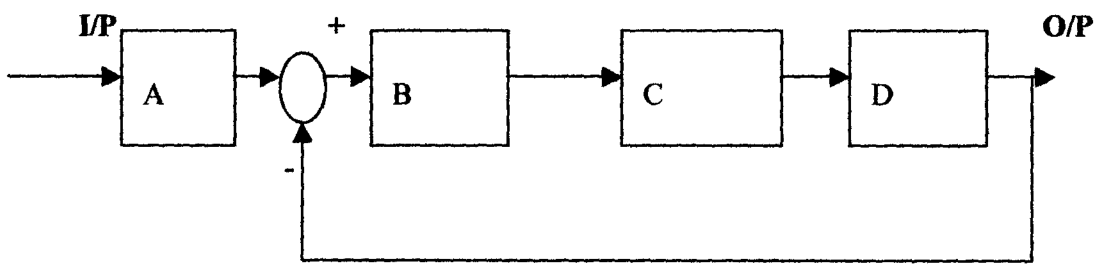


Fig 2.0 BLOCK DIAGRAM OF AN EGG INCUBATOR CIRCUIT.

A = Power supply unit

B = Voltage divider unit

C = Voltage comparator unit

D = Switching unit

The three subsystem of the incubator circuit are: voltage divider unit, comparator unit and the switching unit as illustrated in the block diagram above (fig. 2.1), it illustrate the process leading to hatching of the poultry fertilized egg into chick.

The power supply unit is the power house of the entire circuit of the egg incubator. Its output voltage (usually after rectification) is fed into the egg incubator circuit and subsequently converted into heat energy. This is achieved when the temperature sensor unit (thermistor bridge) on receiving heat induce by the electric bulb the thermistor (a transducer), converts the heat into voltage signal that drives the comparator unit meant to compare the voltage at the inverting and non-inverting input with respect to the reference voltage obtained by adjusting the potentiometer of the comparator unit. The output from the comparator unit drives the switching unit through a voltage divider network of 7.45kΩ and 1kΩ. The switching comprises of a transistor and relay to which the heat source is connected, with the heat induce by the heat equals the desired temperature of the egg incubator, the switching unit switches off the electric bulb and after a few seconds the temperature sensor through the comparator unit relates the signal to the switching unit once more, hence the process is repeated again and again, thus, the desired temperature for hatching is steady.

2.1 POWER SUPPLY UNIT

Majority of electronic circuit uses direct current (D.C) supply for operation and the conversion of an a.c supply can be achieved through the following laid down procedures.

The block diagram to illustrate this is shown in fig. 2.2 below.

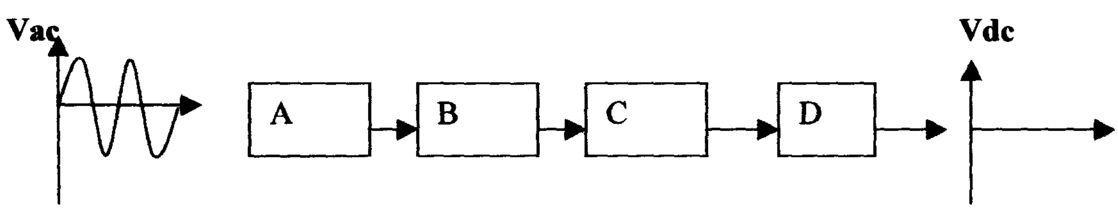


Fig 2.1 BLOCK DIAGRAM SHOWING THE STAGES OF A REGULATED POWER SUPPLY.

A = Transformer

B = Rectifier

C = Filter

D = Voltage regulator

2.11 TRANSFORMER.

. A 240Vr.m.s steps-down transformer is used to reduce the 240Vac from NEPA supply to 12v a.c, which is rectified to give the required d .c output voltage, 12Vdc.

2.12: RECTIFICATION.

The term rectification is defined as the process of changing pulsating a .c voltage to d .c voltage by eliminating the negative half-cycle of the alternating voltage. This project adopts the use of a full wave bridge rectifier because of its ability to produce the approximate varying and reference voltage.

The maximum instantaneous voltages between the terminals are:

$V_{max} = \sqrt{2} * V_{rms}$

The four diode in fig. 2.2 are arranged in a diamond configuration called full wave bridge rectifier.

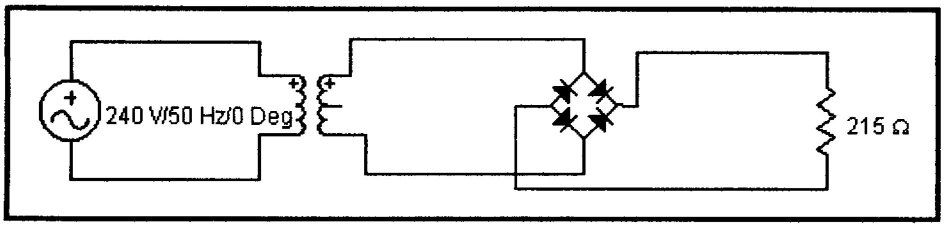


Fig. 2.2 RECTIFIER CIRCUIT (FULL WAVE BRIDGE RECTIFIER)

2.13 CALCULATION

The direct current voltage, Vd.c, is given by:

$V_{dc} = 2\ V_{max} / 3.142 = 0.636 V_{max}$. ....(i)

It must be noted that the PIV (peak inverse voltage) be greater than Vmax.

Also note that Vrms = 12V

From the expression; $V_{max}\sqrt{2} = V\ r\ m\ s$ .... (ii)

Therefore $V_{max} = Vr.m.s\sqrt{2}$

$= \sqrt{2} * 12 = 16.968V$.

Allowing a safety margin of 1.5, hence PIV = 1.5 * 16 968V = 25.5V

This value of the PIV (peak inverse voltage), 25.5V, prompted the need of selecting a 2A bridge rectifier with a maximum peak inverse voltage of 100V.

2.15 FILTERING CIRCUIT

The main function of a filter is to minimize the ripple contents at the full wave bridge rectifier output. The input and output waveform of the filter circuit is shown in fig 2.3.

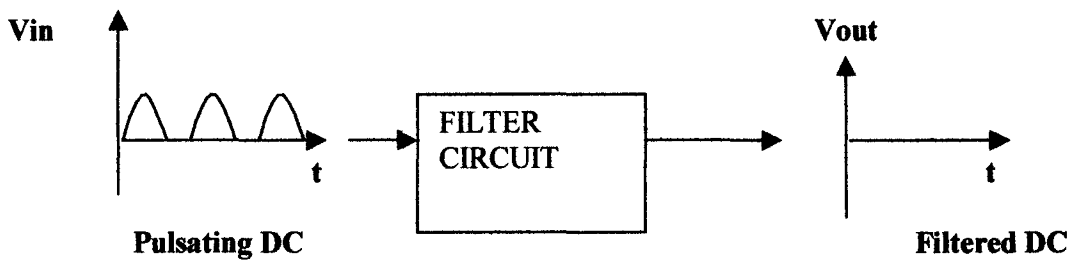


Fig. 2.3 DIAGRAM OF FILTER FUNCTION.

The electrolytic capacitor depends on its operation, the property of the device to charge up (i.e. store energy) during the conducting half cycle and discharge during the non-conducting

Half cycle. Fig 2.4 shows the input and output waveform to the shunt capacitor and the approximated ripple voltage.

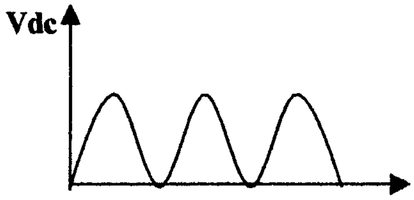


Fig. 2.4 (a) :INPUT WAVEFORM TO THE SHUNT CAPACITOR.

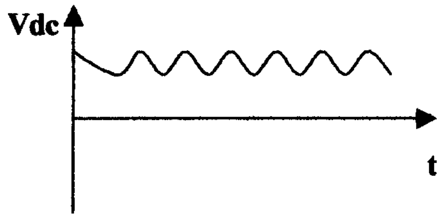


Fig. 2.4 (b) :OUTPUT WAVEFORM OF THE SHUNT CAPACITOR..

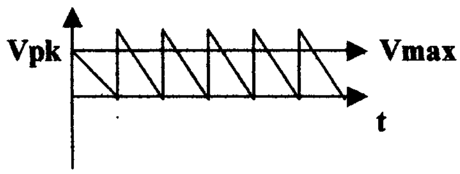


Fig. 2.4 (c): APPROXIMATED RIPPLE VOLTAGE.

The ripple voltage can be approximated by a triangular waveform, which has a peak to peak of Vr (p-p) and a period of Tr as in fig. 2.42(d) above. Considering the charge lost during the capacitor discharge as dq in time T is Idc* Tr

$Vr\ (p\text{-}p)=dq/c=I_{dc}*Tr/c$……………..(iii)

But, $I_{dc}=V_{dc}/R_l$; and $Tr=1/fr$……….(iv)

Substituting (iv) into (iii) we have;

$Vr\ (p\text{-}p)=dq/c=I_{dc}*Tr/c=V_{dc}/R_l*1/fr*1/c$……….(v)

But, $Vr.m.s=Vr\ (p\text{-}p)/2\sqrt{3}$……………………..(vi)

Substituting (v) into (vi) we have;

$Vr.m.s = V_{dc}/R_lfrc/2\sqrt{3}$………………………….(vii)

Knowing that the ratio of Vr.m.s to V_{dc} is denoted by a constant (gamma) and can be represented mathematically as;

$\gamma\ =Vr.m.s/V_{dc}=V_{dc}/2\sqrt{3}frCR_l/V_{dc}=1/2\sqrt{3}frCR_l$.

Note that for fullwave bridge rectifier fr=2f

Where fr is the ripple frequency and f is the line frequency (50Hz).

γ =1/2√3*2fCR$_l$=1/4√3fCR$_l$.

With γ kept at a minimum of 0.0386 and f=50Hz,C=? µF, Vmax. =16.968V

(From previous calculations), Vrms=12V, R$_l$=215Ω (Assumed load value).

But V_{max} =$I_{dc}R_l$. Therefore, R_l=V_{max}/I_{dc}.

Hence, γ =1/4√3fC[V_{max}. /I_{dc}] =I_{dc}/4√3fCVmax.

But from (i) above, V_{dc}=0.636Vmax. =0.636*16.968V=10.792V.

Therefore, I_{dc}=V_{dc}/R_l=10.792V/215Ω=0.05A.

Hence, γ = 0.05A / (4√3*50Hz*C*16.968V)

C = 0.05/0.0386*4√3*50Hz*16.968V = 0.000220381F

= 2.2 *10^{-4}F

But, 1µF = 10^{-6}F , therefore, 10^6 =1F. Thus, 2.2*10^{-4}*10^6µF=2.2*10^2µF =220µF. Here, 220µF, 25V rating was selected for the design.

2.16: VOLTAGE REGULATOR

In order to obtain the desired d .c voltage for the circuit operation, voltage regulator IC's are employed. In this project the voltage regulator used here is a 12v regulator IC (7812A).

2.17 ANTI-SURGE

Owing to the overhead high-tension cable, power supply from the generating station is susceptible to surge. This may be attributed to the falling of big trees on the high tension power line during storm, bird perching on the power line, which eventually result in short circuit fault, hence the supply of abnormal voltage. In most cases, the

consumer is affected in an area where the step down transformer has no fuse and as such, the fault current flows through the conductor (put in place of the fused). This faulty current then flow to the consumer electrical appliances and in the absence of anti-surge circuit was designed and constructed in order that, the voltage regulator and the appliance (load) be protected from any surge occurrence. The figure below depicts an anti-surge for the 12V power supply circuit and the incubator circuit.

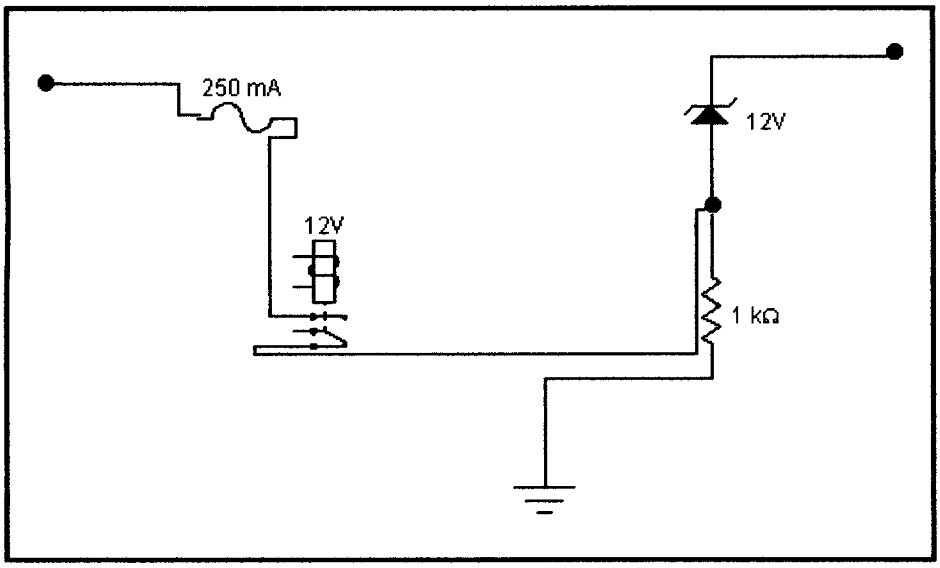


Fig. 2.5 SHOWS THE ANTI- SURGE CIRCUIT OF THE EGG INCUBATOR.

E = Anti-surge fuse

F = A relay

G = Zener diode

H = Resistor

2.6 TRANSDUCER (TEMPERATURE SENSOR)

The term "transducer" has been applied to variety of devices, including measuring instruments, acoustic-energy transmitters, signal converters and phonograph cartridges. With the recent vast increase in the development and use of electronic measuring systems, instrumentation engineers find it necessary to devise a more limited definition of transducer as a device for measuring purposes.

In accordance to this, the "instrument society of America" (ISA), published a standard definition in 1969, and defines transducer as a device, which provides a usable output in, responds to a specified measurand.

The "measurand" is a physical quantity, property or condition, which is measured, and the "output" is the electrical quantity (voltage signal) produced by a transducer, which is a function of the applied measurand.

Considering the function or the role of the thermistor in this project, in relation to the above definition, its measurand is the surface temperature induced by the electric bulb, while its output is the electrical quantity (voltage signal) to the comparator circuit (Pin 3 of 741 IC), which is a function of the applied surface temperature. In other words, the themistor can be regarded as a transducer used for measuring surface temperature to produce a usable output electrical signal required to energize the comparator. However, of its non –linear resistance versus temperature, it is employed where a short time constant is required.

Furthermore, the thermistor can also be regarded as an electrically conductive surface-temperature transducer and because of its size (small and flat shape it is not influence by convective heat transfer but only conductive heat transfer from the

measurand surface. The coating or covering on its surface minimizes the heat loss by radiation.

2.8 TEMPERATURE/HEAT SOURCE (ELECTRIC BULB)

Light is a form of light energy, an electromagnetic radiation whose wavelength is between approximately 100 and 0.01um. By strict definition only visible light (0.4 to 0.76um wavelength) can be considered as light and infra red or ultraviolet light is then termed radiation. The light spectrum in terms of wavelength frequency, photon energy and black body temperature. The light bulb (electric bulb) is a resistive component that dissipates energy in the form of heat, which is used to warm the eggs in the incubator at a steady temperature between 99^0F and 103^0F.

2.9 VOLTAGE DIVIDER

It is sometimes necessary to determine the voltage drop across any two or more resistor in series. It can be established that in such a case the voltage drop across a resistor with others is directly proportional to the value of that resistor. In this project a temperature using a simple voltage divider circuit that constitutes a thermistor and a resistor as shown in fig 2.6 formed heat dependent voltage circuit.

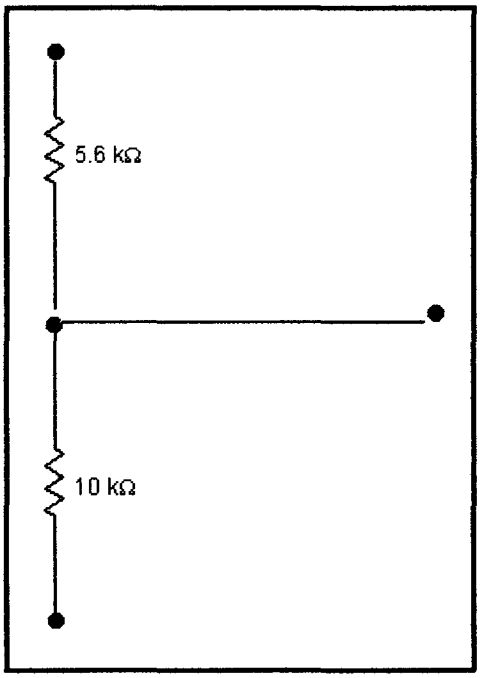


FIG 2.6 SHOWS THE VOLTAGE DIVIDER CIRCUIT OF THE EGG INCUBATOR.

R1 =5.6kΩ

R2 =10kΩ (Thermistor resistance before receiving heat)

Vout =Vcc*R2/ (R1+R2) kΩ

R2 = 5.6kΩ (on receiving heat)

Therefore, Vout =12V * 5.6k/(5.6+5.6) kΩ =67.2V/11.2kΩ = 6V.

This Vout (output voltage) value gives the required input voltage to energize the comparator circuit, which in turn energizes the switching circuit.

2.5 VOLTAGE COMPARATOR UNIT.

Comparator has the name implies is a circuit that compares the magnitude of two analogue signals (usually Voltage) between the inverting and non- inverting input and a logic output. It is similar to a differential amplifier operating in an open loop mode. However, because of its high gain, the output is normally saturated in either high or

low state depending upon the relative amplitude of the two input voltages. With these conditions, the computer provides a logic-state output, which is indicative of the amplitude relationship between two analogue signals. Fig. 2.7 shows the egg incubator comparator circuit.

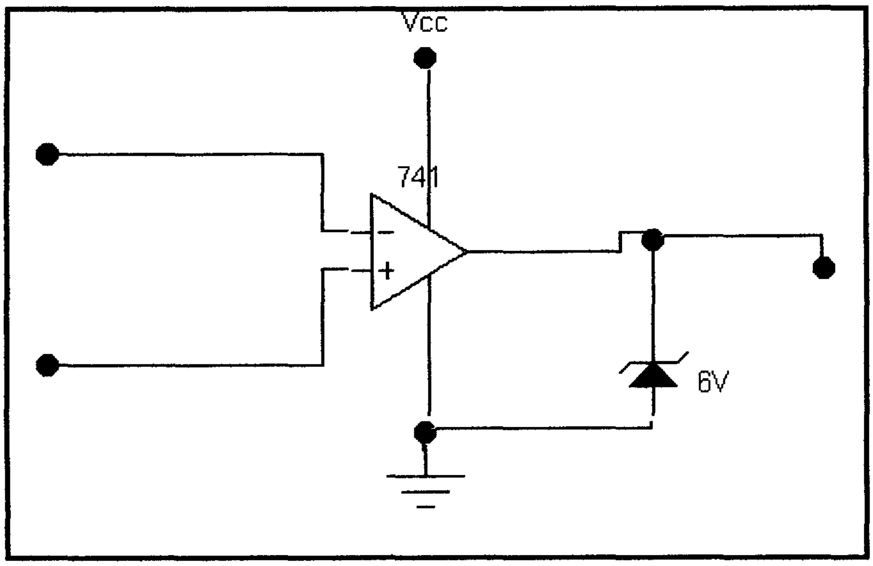


Fig 2.7 SHOWS THE COMPARATOR CIRCUIT OF THE EGG INCUBATOR.

2.6 SWITCHING CIRCUIT.

Switching means making, breaking or changing the connections in an electrical circuit. 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 eggs into chick) will not be achieved. The comparator output voltage, 6v, energizes the switching circuit through a parallel combination of R_b and R_g. The switching on receiving a voltage signal, energies the load (heat source) thus the switching circuit regulate the heat supply inside the incubator.

For this design a transistor and relay was used for the switching circuit. The choice of the transistor was based on its reliability, durability, responsiveness and cheapness. With the aid of the transistor switching, a relay can be turn On and Off by a small signal in the cut-off region (open) whereas the other level the transistor operate in the saturation region and act as a short circuit.

An NPN high speed switching transistor (2N2222) silicon type was used and was connected in the common emitter configuration with its collector output connected to the coil of the relay as shown in fig. 2.11. The small signal from the logic circuit (comparator circuit) will produce a higher switched output current or voltage at the collector output required to drive the relay coil, which inturn energizes the electric bulb.

DESINING THE SWITCHING CIRCUIT.

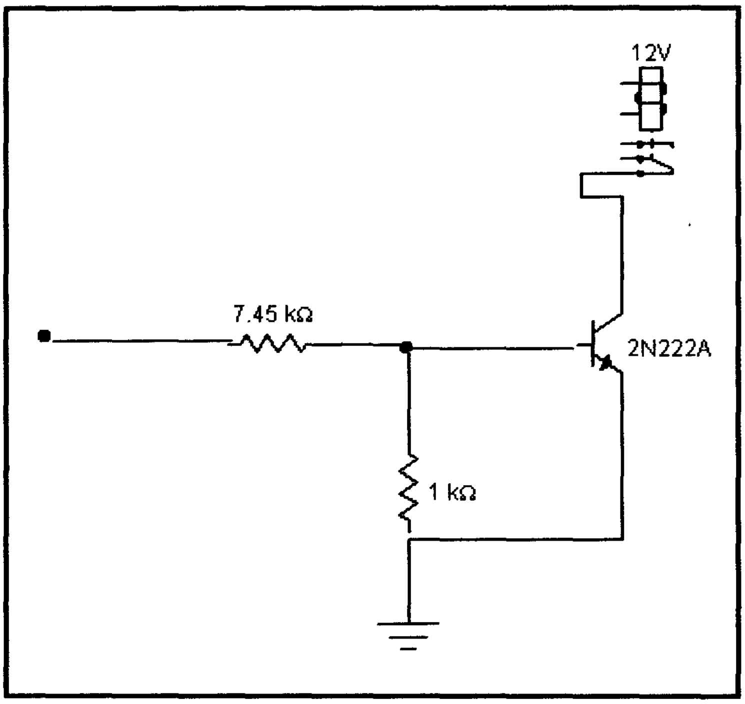


Fig 2.8 SHOWS THE SWITCHING CIRCUIT OF THE EGG INCUBATOR.

CHARACTERISTIC OF 2N2222A

I_{Bmax} = **0.02A**

I_{Cmax} =**0.8A**

V_{BE} = **0.6V**

β = **40**

Vcc =12V

V_{in} = **6 V**

R_{in} =**? KΩ (Input resistor)**

Rg =? KΩ (Base resistor wrt ground)

V_{BB} = **2V**

From the switching circuit, so by ohms law

$I_c = V_{cc} / R_l$, where R_l is the load (relay) resistance

And is given as 410Ω

Therefore $I_c = 12V / 410Ω = 0.029A$

Ignoring any leakage current, I_{CBO},

$I_{Bmin} = I_c / \beta = 0.029A / 40 = 0.000725A$.

The current through R_{in} necessary to ensure cut-off for an overdriven switch (by rule of thumb) equal to $2I_{Bmin}$, so $I_g = 2 * 0.000725A = 0.00145A$

Applying kirchoff voltage rule,

$I_g R_g = V_{BB} - V_{BE}$

$R_g = (V_{BB} - V_{BE}) / I_g$

$R_g = (2 - 0.6) V / 0.00145A = 965Ω = 0.965kΩ = 1kΩ$

Using kirchoffs voltage rule on the input with $I_B = I_{Bmin}$

$I_{in} R_{in} = V_{in} - V_{BE}$

$0.000725A\ R_{in} = (6 - 0.6) V$

Therefore, $Rin = 5.4V / 0.000725A = 7448Ω = 7.45kΩ$

2.7 MODE OF OPERATION

With the potentiometer adjusted to make the comparator output voltage at pin 6 fall near zero and the heat or temperature received from the heat source increases, the thermistor resistance falls causing the input voltage at pin three to fall which was initially at half the supply voltage (voltage divider network form by the thermistor and the resistor) as a result, the output voltage at pin 6 falls to near zero leaving the

transistor in the cut-off region and consequently the relay coil is not energized thus the light bulb remains in its off state. Contrarily, when the incubator temperature decreases the thermistor resistance increases causing the voltage at pin 3 to rise which inturn causes the output voltage at pin 6 to rise (swings towards the supply voltage), consequently causing the transistor to switch from its cut-off region to saturation region. Hence the relay coil is energized (activated) and the light bulb on receiving signal from the energized relay turn on to balance the drop in the incubator temperature.

CHAPTER 3

CONSTRUCTIONS AND TESTING

3.1 In the hardware construction, the overall system was broken down into modules for easy Construction, testing and trouble-shooting.

* **Power supply unit**
* **Voltage divider**
* **Voltage comparator unit**
* **Switching unit**
* **Heat Source unit [Electric Bulb]**
* **Plywood Incubator**
* **Wooden Candler**

MODULE 1: POWER SUPPLY UNIT

This Module was built with bridge rectifier as the first component on the Vero board. The bridge rectifier has four terminals denoted by the following symbol; + ~ - such that the positive terminal [+Ve] 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 center terminal denoted by the symbol ~. Was connected to the transformer out-put/secondary. Similarly, the capacitors (220µF) and (100nF) 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 D.C output to regulate the voltage. In order to reduce high voltage spike, another

220µFcapacitor was connected across the regulator's output. With the transformer terminals identified terminal with low as primary (the terminal with high resistance value) and secondary (the resistance value), the primary was then connected to the main supply (240Vrms) and the secondary was connected to circuit through the bridge rectifier.

MODULE 2: VOLTAGE DIVIDER UNIT

This module was built on the Vero board immediately after the power supply unit. It comprises of thermistor and resistor. The thermistor senses the temperature/heat generated by the heat Source (electric bulb) and transduces 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 mounted 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 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 requires to drive the switching circuit. On the non-inverting input a potentiometer 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 the collector of the transistor was identified, hence soldered on the Vero board this was accompanied with the identification of the relay pin configuration as N/O (Normally Open), N/C (Normally Close) 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 well as avoiding back e.m.f, which may be, induce when the relay turns off. With the aid of this module the control of the heating unit and hence the entire system.

MODULE 5: HEATING UNIT

This module constitute a 60 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 following material:

1. **Plywood**
2. **Glass**
3. **Cake Pan**
4. **Wire Mesh**
5. **Measuring Tape**

6. **Nail**
7. **Hack Saw**
8. **Sand paper**
9. **Evostic gum**

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

CONSTRUCTION STEPS ARE AS FOLLOWS

- **Using the measuring tape, measure the plywood to the required dimensions: height (11 1/2 -inch) and width (2 ½-inches) and sawed with hacksaw.**
- **Assembled the plywood to form a rectangular shape.**
- **With the aid of the hammer and nail, join the assembled 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 small piece of plywood 6 ½ -inches below 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 assembly above, a wire gauze was fixed permanently using nails at it's base. (egg-tray)**
- **The assembly above was then placed in the egg- tray holder constructed 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 point to weaken the cohesive nature of the glass molecules.**
- **With a slight pressure applied on the diamond cutter placed on the weakened spot of the glass, the cutter was then dragged gently thus removing the unwanted part.**
- **The glass was then fixed on the assembly obtained above thus a complete plywood incubator was constructed.**
- **The figure below shows the fully constructed plywood incubator diagrammatically**

MODULE 7:WOODEN CANDLER.

This module was constructed with the aid of a plywood cut to the desired dimension and finally assembled to form a square shape device. At the upper portion an egg-sized hole was drilled. This hole is meant to hold the egg/eggs while the ray from the electric bulb (usually on) installed inside the enclosure directly strikes the egg/eggs from underneath. With the aid of this module, one is able to identify and separate the fertile egg/eggs from the non-fertile egg/eggs, hence hatching is accomplished. This is usually carried-out on the 6^{th} and 18^{th} day of the egg/eggs stay inside the incubator. The overall process is called CANDLING.

MODULE 8 CALIBRATION

The selection of a thermometer for a particular purpose is governed by the temperature range to be covered, the precision required, the nature of the substance

whose temperature is to measured, the space available as well as the type of reading desired.

In this project , due to the small temperature range,99^{O}F to 103^{O}F , the mercury-in-glass thermometer because of its temperature range was employed for the calibration of the incubator temperature ,thus proper calibration at the desired temperature range .It must be noted that the potentiometer is the major component that plays the calibration role .

3.3 COMPONENT LAYOUT

The following was observed and carried out while constructing the hardware system.

- The LC was mounted the IC socket already soldered to the Vero-board to ease the replacement of any faulty IC in future.
- Interconnection was made through earthen of the Vero- board and the use of insulated copper wise connected at the bottom of the Vero- board. While the components were mounted on the top of the Vero- board and then soldered underneath, thus giving the component good layout and space to give room for trouble-shooting and replacement of faulty components.
- The long leads or legs of various components such as transistors, resistors and capacitors were reduce so as to prevent short circuit.
- Having made necessary connections and soldering on the Vero-board ,proper care was taken to avoid bridging/short circuit by thorough examination of the connection hole (line) and non-connecting hole (line). This was to ensure that the required current was supplied and proper connection between components.

3.4 CONSTRUCTION TOOL USED.

Most of the construction tool used during the modeling and hardware constructing are given below.

I. Project-board and insulated copper wires (used as jumpers): these components were used building part of the prototype model for test before the circuit was finally transferred to the Vero-board permanently.

II. Soldering iron and lead: A 60watt soldering and lead was used in the soldering of all components on the Vero-board.

III. Digital Multi-meter: This electronic device was used to carry out test on continuity between two lines. It was also employed in measuring voltage, resistor value and in determining the base, collector and emitter of the transistor as well as the N/O (normally open) and N/C (normally close) terminal of the relay in checking the relay coil during construction of the hardware.

IV. Precision Screw Driver: because of the various shape and size of this set of screw drivers, it was employed in regulating the variable resistor (potentiometer) so as to ensure the desired switching required

V. Lead Sucker: this was employed to remove molten lead while desoldering components from the Vero-board.

3.5 HARDWARE TESTING.

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

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

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

STEP 3:Polarity of the power supply out put 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 used in the construction of the hardware.

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

STEP 5: The potentiometer was set so that the relay turn switches ON and OFF, hence the heat source. By bring the electric bulb nearer the thermistor after a few seconds the bulb turns OFF thus indicating that the set temperature of the incubator has been attain, and then switches ON after a few seconds thereby maintaining a steady temperature within the incubator.

CHAPTER 4

DISCUSSION OF RESULT, CONCLUSION AND RECOMMENDATION

4.1 DISCUSSION OF RESULT

The result carried out after the circuit was simulated reveals that the system (egg Incubator), operates based on thermostatic principle. The system on receiving heat from the heat source (electric bulb) through its thermistor which transduces it into electrical signal and hence energizes a transistor which inturn drives/energizes a relay to activate the load (electric bulb) within a predetermine time interval thus maintaining a steady temperature(99^0F-103^0F) inside the incubator with subsequent successful hatching of the fertile egg.

The heat inside the incubator was measured based on the changes in the pulses at the comparator output. The interface between the incubator circuit and the heat/temperature source was performed here.

4.2 CONCLUSION.

The motive and objective of the project was realized as observed hardware testing and operation thus 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^OF to 103^OF] of the incubator, longer life, better maintenance, low overall cost in construction and operation thus resulting in high reliability of the system of the system in egg hatching to produce chick.

4.3 RECOMMENDATION.

My desire as an 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.

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

REFERENCES

Donald G. Fink and Christiansien [1982]: "Electronic Engineering handbook"

William D Stanley [1989]: "OP-AMP with linear I C"

Edward Hudges [1995]: " Electrical technology"

Paul Honowits and Winfield Hill [1995]: "Art of Electronics" {Cambridge}

M P Horsey: "Electronics in practice "

Prescribed Agricultural science for senior secondary school second edition by S A

Omoruyi, U X

Urhue, A A Akerobo.

Electrical Engineers Handbook; Electrical Power: Harold Pender.Ph.D ,Sc.D and

William A. Del

Mar FCGA.

BIBLIOGRAPHY

Charles W. Bodemff University of Washington school of medicine .

Arey, Lesile B; Developmental anatomy 7th ed [Sunder 1995]

Balinsky B. I. An introduction to embryology 3rd ed [sunder 1970]

Weiss Paul, principle of development: [Hafner pub.co.1969]

Watterson, Ray L and Sweeney, R; laboratory study of chick 2nd ed. [Burgest 1970]

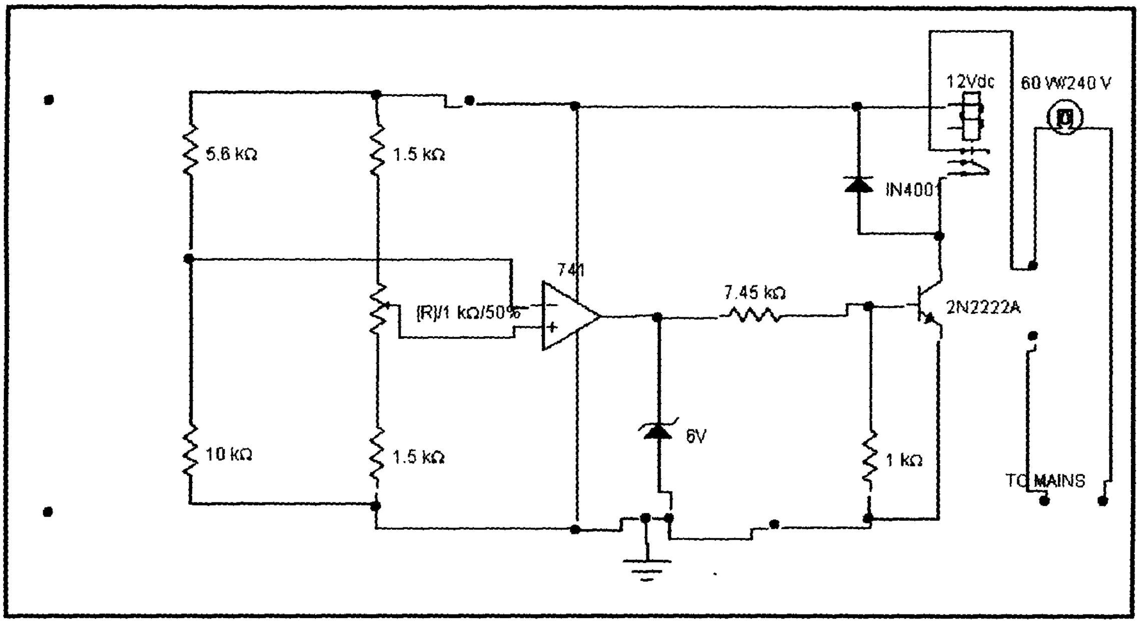
Rugh, Roberts and shettles, Landrum B : From conception of the avian eggNeedham,

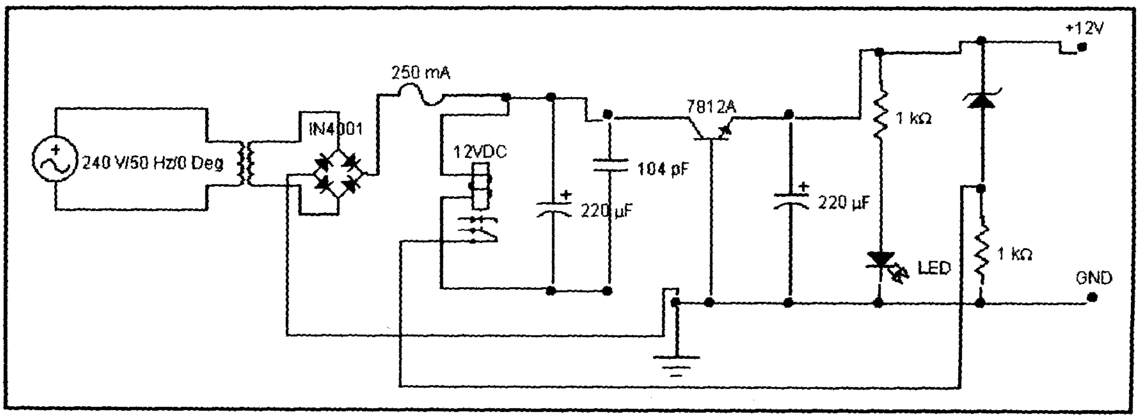
Joseph: A History of embryology of the avian egg 2nd ed. [Abeland –Schuman Ltd.19

Watterson, Ray L and Sweeney, R; laboratory study of chick 2nd ed. [Burgest 1970]

Rugh, Roberts and shettles, Landrum B : From conception of the avian egg.

Needham, Joseph: A History of embryology of the avian egg 2nd ed. [Abeland – Schuman Ltd.19





DIAGRAMS SHOWING A COMPLETE EGG INCUBATOR CIRCUIT.