DESIGN AND FABRICATION OF AN ELECTRICALLY OPERATED EGG INCUBATOR

BY

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

FEBRUARY, 2010

DECLARATION

I hereby declare that this project work is a record of a design and fabrication that was under taken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

18- 02 - 2010

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Date

CERTIFICATION

This project entitled "Design and Fabrication of an Electrically Operated Egg Incubator" by Animashaun Iyanda Murtala, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to Almighty Allah then to the greatest man ever lived on earth who said seeking knowledge is compulsory and that the most truthful name (one can bear) is the cultivator, Prophet Muhammad (Blessing and Peace be upon him). Also to my late Father Mallam Animashaun Abdus Salam whose fatherly love and caring can to be forgotten. May Allah grant him paradise (Amin).

More so, to my precious sprout, my beloved wife Mrs Basirah Abimbola Ojodu (Umm Nasir).

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for the time we shared together.May Alimghty Allah reward our good deeds in manifold

(Amin).

ABSTRACT

This project is a construction work to solve the need for an electrically operated egg incubator which has become very expensive because of high import duties incubator can be describe as a box – like insulated construction in which the environment conditions such as humidity, temperature e.t.c are controlled for the purpose of keeping the egg at a constant temperature range 37^0C to 39^0C for a period of 21days before hatching. The design and construction of the incubator was done using the materials available in our locality and local condition is also considered. It was motivated by the seal t construct an incubator which is relatively cheap in cost and maintenance. The incubator did not hatch due to irregular power supply. The functionality of the incubator was tested. It can be affirmed that the performance of the incubator based on the material and the ergonomics efficiency is on the average of about 70%. Incubator for large scale production can be constructed using the using procedure and to suppliment power failure an inverter should be built for the incubator.

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1.0 INTRODUCTION

1.1 Background to the Study

Incubation is the process in which eggs, bacteria, protozoa and other living organisms are kept under proper conditions for growth and development. Female birds usually carryout the incubation of their eggs by sitting on them. But machines called incubators may be used for the incubation of bird eggs as well as bacterial and human beings. Incubators maintain the proper temperature and proper humidity favorable to good development.

Incubator can therefore be defined or described as a machine that maintains conditions favorable for growth and development. Some types of incubators are used by hatcheries to hatch chicks from eggs, others are used in hospitals to maintain the lives of newborn or prematurely born babies. They all provide constant and adequate warmth and ventilation.

Incubation also known as hatching can be defined as a process of making an egg break open and produce a chick (young bird).However, hatchability is affected by a number of factors which can be classified as egg factors and environmental factors. It is important that the correct eggs are selected for incubation if acceptable levels of hatchability are to be achieved .All the eggs for hatching in the incubator should be of uniform weight and size as possible and have an average weight .Eggs which are more than 10percent smaller than the average may contain too small a yolk and therefore insufficient nutrient (Smith, 2006). However, an egg of little difference of say 1g lesser can be used. Eggs more than ten percent larger may be double yolked and if these are incubated they may prove to be infertile or produce deformed chicks. Incubation time is also affected by the size of eggs and if the range of egg size incubated is too wide, hatching may take place over too long a period. The eggs produced by birds in the second half of their first layer year and during the second laying year normally have the highest hatchability. Birds in their third and following laying years often produce a greater proportion of eggs which are either infertile or chick fail to breakout of shell (Smith, 2006).

The eggs should be candled to see whether they are sound. Eggs that are cracked should be discarded as cracked eggs loose water more quickly than non-cracked eggs and therefore these eggs will become desiccated before the end of incubation period and the eggs will fail to hatch. The eggs that are saved for incubation should be egg shaped, not long or round. Eggs that are very thin shelled should not be used.

For incubation to take place some important factors need to be considered. These factors include humidity of the environment, temperature and ventilation.

For instance keeping the eggs at a constant temperature range of 37^0C to 39^0C a period of 21days before hatching, (Iwena, 2008). Eggs can be incubated either naturally or artificially.

Natural Incubation

Local breeds of poultry are good incubators and good mothers. They should be provided with a straw nest .The hen continues to sit on a clutch of eggs laid by it until they hatch. This type of incubation is good for incubating small number of eggs, the capital outlay is small and there is no problem of power failure. The disadvantages of this include; the danger of pest, hatch time cannot be controlled, the mother hen must be available and it is not suitable for commercial operation because small number of eggs can be hatched at a time.

Artificial Incubation

Artificial incubation is carried out with incubators heated with fuels as diverse as paraffin (Kerosene), and electricity. For artificial incubator to function correctly, it must undergo the same conditions as that of the hen.

Artificial incubators though their initial and maintenance cost may be high, have great advantages because they can be used to incubate large number of eggs, it can be used at any time, there is no danger of pest, and the mother hen is not needed.

Incubator, according to obabu (2006) has broadly been classified into two,

(i) Still air incubator

(ii) Forced air incubator

Still-air incubators

These are small and may hold 20 to 100 eggs or more. They have no fan. What make air exchange are the three holes created on the incubator. A hole is created at the top and two at the bottom. Warm stale air escapes through the top hole and fresh air enters through the bottom holes. Air circulation is limited, so only one layers of egg can be incubated.

Force-air incubators

Unlike still-air have internal fans to circulate the air. Eggs are placed in stacks of tray, the capacities of these incubators are large. Most units have automatic equipment for turning the eggs and spray mist nozzles for holding proper humidity levels.

1.2 Statement of the Problems

-The high cost of imported incubators which make them unaffordable for the small scale farmers is a factor militating against adequate supply of poultry product.

-Using the natural method cannot also meet up with the demand for poultry product, hence there is a need to provide the small scale incubators that can be used by the families and small scale farmers.

1.3 Objectives of the Project

-To evaluate the performance of the prototype.

-To develop a low-cost electrically operated incubator using locally available materials

1.4 Justification of the Project

This will help develop simple devices aimed at easing the prevailing financial difficulties faced by poultry farmers who intend going into the business of chicken production so as to meet the demand in Nigeria rather than purchasing expensive imported one from oversea.

More so, the quest for Agricultural technology development is increasing everyday and the plan to feed the whole nation adequately is calling for improvement in the food production sections, especially protein, which is one of the essential items of food needs to be supplied in large quantity. Danmaraya (1993) said that the minimum protein requirement set by the Food and Agricultural Organization (FAO) is unlikely to be achieved anytime in the near future unless methods of lowering cost of food are introduced in livestock and poultry production by farmers. Hence, the need for this kind of project is one way of improving in the techniques of poultry product production in the country.

1.5 Scope of The Project

Generally, egg incubators are of various sizes base on whether one is producing on large scale or small scale. But for this project, a small size, which can perform the same function under the same condition, is required.

Although, the eggs of all domestic fowl can be hatched by the incubator, as long as it is within the room temperature (35-40°C), the project is designed mainly for the incubation of chicken eggs which takes 21 days to hatch at 37-39°C.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Origin and development of incubator

The development of the artificial incubators passed through stages and ages.

The early Egyptian incubators of some 3000 years ago were a series of mud - brick egg - ovens type, rooms built each side of a passageway all within a large mud brick building or hatchery. Thousands of eggs were placed in heaps on the floor of each incubator room. In the upper chamber of the room, there were shelves for low burning fires of straw, camel dung, or charcoal to provide radiant heat to the eggs below (Obabu, 2006).

The entrance to each incubator room from the passage way was through a small man hole. Temperature control was achieved through the strength of the fires, jute covers over the manholes and regular openings of vents in the roof of the ovens and passage way. Humidity was controlled by spreading damp jute over the eggs as necessary. The roof vents also allowed smoke and fumes from the fire to escape and provide some light (Martin, 2002).

The piles of eggs were rearranged and the eggs turned twice a day. The middle passage way also served as a warm brooding area for the chicks when they were hatched. The amazing thing about all this was that the temperature, humidity and ventilation were checked and controlled without using measuring devices or gauges nor were there any thermometer. They achieved all this by having the hatchery manger and the hatchery workers actually living inside the hatchery building (Martin, 2002).

2.2 The Development Electrical Incubator.

Most commercial chicken incubators are electrically heated to maintain a constant temperature of 39^0C or 39.5^0C. A system of fan circulates warm air through the eggs chambers and over the eggs. Incubators keep the relative humidity at about 60% to reduce the loss of water content from the eggs. Mechanical devices turn the eggs several times daily, turning all the eggs at the same time. Fresh air brought into the incubators keep the oxygen level at 21% (i.e the normal level of outside air). Large incubators hold up to 10,000 eggs, (Obabu 2006).

The break away from ancient theories was demonstrated by the of chick master (Ridlen, 1992). Chick master introduced a new control system fully compatible with their vision Data Acquisition system. The system contains an `ultra` which can be programmed using a high weight hand-remove unit. The unit displays full operating information including set point and permits easy adjustments of any of the control as condition warrant. The unit is user-friendly with an easily keypad and comfortable keys for rapid data entry .Set point security is provided by limiting access to the ultra control system. The system can be networked via their vision data acquisition system for remote, computer- based data exchange, system monitoring and diagnosis, remote programming and control (Obabu,2006).

The control cabinet for the ultra, containing the three electronic modules for control and diagnosis is mounted in a safe position on the top of the incubator. The vision Data acquisition system, which can link up to 160 machines to the central computer via the communication interface, now has a new software programme which provides the most current information on incubator performance .Chick master also introduced new SRQ roll-in incubators, key features of which are ergonomically designed buggies with two egg tray rows for easy handling by one person. (Obabu, 2006).

James also showed advances in hatchery management systems (Ridlen, 1992). He introduced Room sentry which expands the communications link and monitoring capabilities of their sentry control system. A temperature and humidity-sensing device can operate as a stand-alone unit or be directly connected to the central control via fibre optic connection. High and low temperature and humidity alarm ranges can be programmed into the unit. If it is connected on to a sentry display or hatch com monitor, the alarm set points can be remotely changed and recalibrated (Ridlen, 1992). He also developed a high temperature back up alarm system that provides a secondary method for monitoring high temperature in settlers and hatches, used in conjunction with other hatchery safeguards. It will enter into an alarm mode when it detects a high temperature or if a thermostat is removed from a circuit. James also introduced a hatchery disinfectant system, which includes an electric programmable controller with separate dual operation that precisely controls the application of disinfectants.

Further advances were shown in incubators. A completely hand-off hatching egg to chick is rapidly becoming a practical reality. Chick and shell separation is one key area where new system equipment highlights an important break through in automation and labour saving. Kuhl Corporation featured three models of capacity upgradable automatic chick and shell separators; manually hand-fed, hatchers tray fed for chicks and at capacities up to 1000 tray/hour. Electric or hydraulic driver options are offered (Obabu 2006).

Kaul also introduced a shorter, non- upgradable manually fed separator which was one of the most economical and lowest prices available. Kuhl also showed their range of automatic detachers with capacities up to 900 tray/hour, plastic chick box detachers, as well as washing machine for hatchers trays, buggies and hatching eggs (Obabu, 2006).

More so, the traumatic 360 made by Silfurtum was the world smallest egg tray making maching. Using recycled paper newsprint or paper boxes, the machine is design for on farm operation using unskilled labour. To start the operation, the operator connects water and electricity to the machine, which automatically makes pulp from the water paper. The operator then moves the mould into the pulp and up to the transfer mode. The second operator then put a pallet under the egg tray and the egg tray drops on the pallet. The operator can then repeat the circle. To dry the egg tray, the pallet is simply put outside where the sun will dry the tray in one or two hours or with the use of the dryer. Maintenance is simple as there is no complicated component. The pulping and moudling station is designed to reduce electrical consumption. The machine does not need any chemical for production, a big advantage especially for countries where import of goods is difficult (Obabu, 2006).

In a related development, Buckeye and Millan produce a'stream line' hatchers. The interior surfaces of these hatchers were constructed from stainless steel or other food-save material. The hatchers were designed to remove the hidden places where microbes can be grown. Production of the maximum number of top quality chicks depend upon the lowest level of contamination. The steam liner range of machine matches the sizes and capacities of the Buckeye series of hatchers and also can accommodates any popular types of hatching basket. This compatibility offers an opportunity for hatcheries whatever their past choice of incubator, to replace old hatchers with the new one. The easy –to-clean surface will help maximum production of quality sale-able chicks without the costly necessity of replacing existing setters.

The electrically operated egg incubator has a control circuit starting with supply stage and ends with switching stage (Salami, 2007).

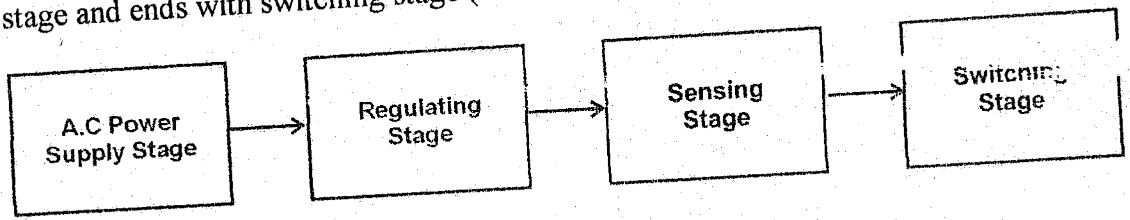


Fig.2.1 Block diagram of the control circuit of the egg incubator

2.3 Heat and Water Loss in Incubator

The thermal energetic of incubator have been modeled by Kashkin (1961), Kendeigh (1963) and Meijerhof (1993). A simple form of the model according to Obabu (2006) can be given as;

$T_{egg} = T_{inc} + (H_{emb} - H_{waterlost})/K.$

Where T_{egg} = temperature of the egg (^{0}C)

T_{inc} = temperature of incubator (^{0}C)

H_{emb} = heat production of embryo at a given moment of incubator (watts)

$H_{water\ lost}$ = heat loss from evaporative cooling (watts) and

K = thermal conductance of egg

These parameters are used because they are easier to measure than either heat transfer through radiation (H_{rad}) and convention (H_{conv}). Heat transfer through radiation is assumed to be small because all the surfaces within the machine will be at temperature close to (within approximately 1 to 2^0C of) the surface temperature of the egg. Kashin (1961) estimated that 40 to 45% of the total heat loss from a duck's eggs was by radiation, however, this estimate assumed that the total egg surface would be able to radiate heat to the surface of the incubation. In commercial incubators an egg will be surrounded by other eggs at the same temperature, and there is a reduction in the effective radiating surface of the egg (Kashin 1961). It is therefore assumed that the main transfer of heat occurs through convention.

The equation contain the term $H_{water\ loss}$ because egg continually lose water through incubation, typically amounting to 12% of the fresh egg weight between the onset of incubation and the start of piping (Nelson, 1991). The phase change from liquid water- to- water vapour requires heat approximately 580 cal/g of water loss (Schmidt, 1975). Embryo heat production can be measured directly, but Romijin and Lokhurst (1960) showed that it could be estimated by measuring oxygen consumption. Every liter of 0_2 consumed by the embryo is equivalent to the production of 4.69k cal of heat (Vleck, 1980).Typical 0_2 consumption of a chicken egg just before piping is 570ml/j (Vleck 1987). At the onset of incubation, H_{emb} is negligible and therefore $T_{egg} < T_{inc}$, because $H_{emb} < H_{water\ loss}$ (Nelson). However, at the end of incubation, $H_{emb} > H_{water\ loss}$ and therefore $T_{egg} > T_{inc}$. The thermal conductivity term k, used in the equation combines the thermal conductivity of the egg (k_{egg}) and the boundary layer of air around the egg (k_{air}). Sotherland et al. (1987) showed that the values of K_{air} is dependent on the air speed over the eggs and the relationship could be estimated as follow;

$K = (0.97\ U^{0.6})\ M^{0.53}$

Where U = air speed (centimeter per second)

M =egg mass (grams).

2.4 Egg Positioning

Eggs are spherical object with two ends (large and small ends). It could either be set in the incubator with the large end up or horizontal with the large end slightly elevated (Obabu, 2006). This enable the embryo to remain oriented in a proper position for hatching.

2.4.1 Egg Turning

Eggs must be turned 3-5 times daily during the incubation period. Do not turn eggs during the last 3days before hatching, because the embryos are moving into hatching, to maintain proper temperature and humidity.

In this incubator, using thread as a turner has replaced the turning by hand that we use to have. The angle of each turning is Turning prevents the embryo from sticking to the shell membranes when left in one position too long. The eggs should be carefully turned during the first week of incubation, because the developing embryo has delicate blood vessels that may rupture if shaken.

2.5 Candling

Candling is the term given to the process of using intense light sources to see the development of the embryo inside. Eggs can be candled on day 7,14 and 18 of the incubation period. However, if done improperly, candle can kill the embryo, (Obabu, 2006). An egg candler in this project is a small box made of plywood with a small flash light (bulb).

To candle with the flashlight, hold the light against an egg in a dark room. Part of the inside then becomes visible. A fresh egg appears clear with only a small air cell. After 5 days of incubation blood vessel should be visible if the eggs have a white shell. If the eggs have a brown shell, several more day of incubation may be required before blood vessels are visible. If development does not occur, the eggs may not be fertile, or there may be other serious incubation problems.

Incubated eggs are candled to determine whether they are fertile, and if fertile, to cheek the growth and development of the embryo. A small reddish area with blood vessels extending away from it will be visible in fertile eggs. This is the embryo floating around inside the egg, looking like a huge red spider. If the embryo dies the blood draw away from the embryo and forms what is called "blood ring". Observations at different stages of candling are shown below.

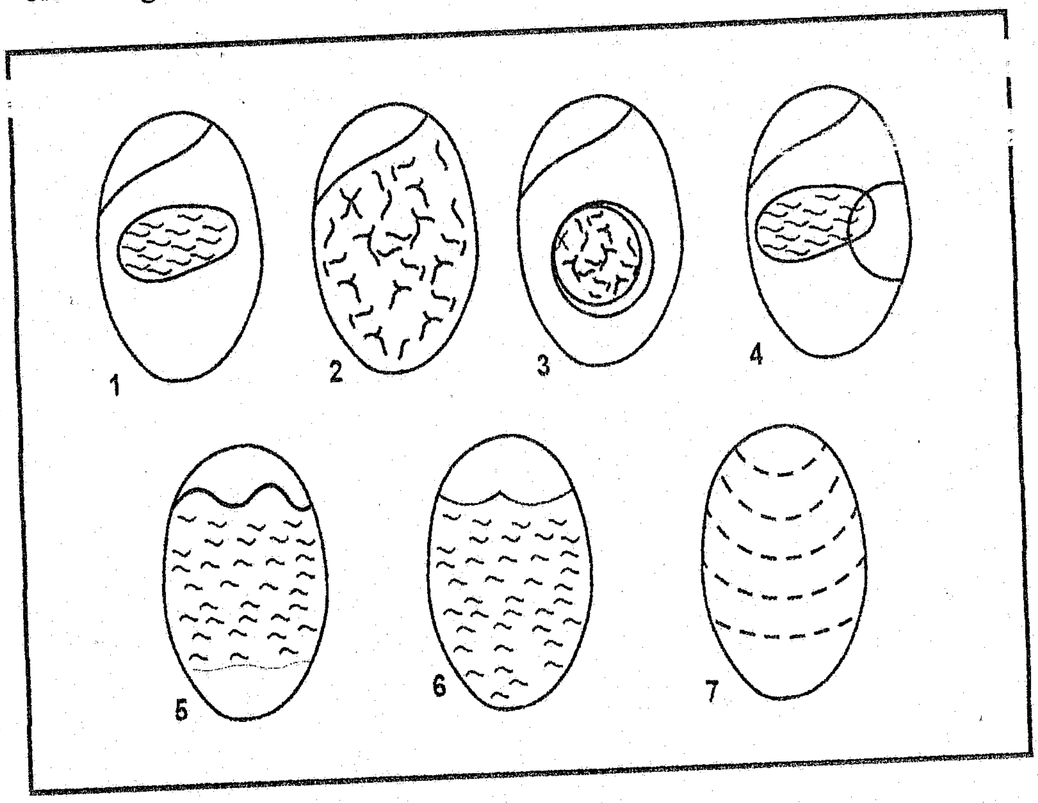


Fig 2.2 observation at different stages of Canlding

1. Clear when candled: Probably infertile (or very early death) when candled at 8days
2. Fertile with red blood vessels after 8days
3. Red or black staining :Early death when candled at 8days
4. Embryo with red blood ring:Early death when candled at 8days
5. Dark outline with ill defined detail:Late death (10-16days)
6. Live embryo with bid in air sack: This is due to hatch in 24-48 hour
7. Normal developmnt of the air pocket according to the number of days

Some of the trouble shooting measure for incubation is, Eggs clear, no blood ring, no embryonic development.

Probable cause: eggs held too long or held under improper condition of temperature and humilities.

Suggested corrective measure: eggs should be kept under proper temperature and humidity conditions and set within ten days after the date laid.

2.6 Ventilation of the Incubator

Eggs do respire. They take in oxygen and give out carbondioxide through the shell therefore the incubator is built with air vents to draw fresh air to the incubator and expel stale air and excess carbon dioxide. The holes are of the same dimension, so it is assumed that the rate at which air enters is the same as the rate at which it gets out. The vents are though not adjustable, they are designed to be adequate the entire hatching period.

2.6 Production of eggs for Incubation

The sexual reproduction (i.e mating) of producing hatching eggs in case of birds takes any of the following four forms

1. Mass mating
2. Stud mating
3. Pen mating
4. Artificial insemination

Mass mating

This is the most common method of mating used in poultry flocks, where several males are allowed to run with a flock of females. This method is used to obtain maximum number of hatching eggs (Iwena, 2008)

Stud mating

This is a method of mating one female with a male in a single pen. The female may be kept together but still be mated to different males. In this method there is possibility of mating more female to a single superior male, (Obabu, 2006)

Pen mating

This is a method where more than one male is not necessary because is a system of mating a pen of small flock of female with a single male, (Obabu, 2006)

Artificial Insemination: this method is used in unusual situation where other methods are not practicable. It makes it possible to mate birds that would normally never mate and birds of different sizes are also mated, (Iwena, 2008).

2.7 Incubation Requirement for Various Species of Fowl

Table 2.1 shows the incubation requirement of various species of fowl

Species	incubation Period (day)	temperature (F)	humidity (F)	do not turn after	humidity last 3 days
Chicken	21	100	84-86	18th day	90
Turkey	28	99	84-86	25th day	90
Duck	28	100	85-86	25th day	90
Muscovy Duck	35-37	100	85-86	25th day	90
Goose	28-34	99	86-88	25th day	90
Guinea Fowl	28	100	85-87	25th day	90
Pheasant	23-28	100	86-88	25th day	92
Peafowl	28-30	99	84-86	25th day	90
Bobwhite Quail	23-24	100	84-87	20th day	90
Pigeon	17	100	85-87	15th day	90

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Design Specification

Number of tray = 1

Capacity of the incubator =24eggs

Maximum major diameter of sampled eggs = 4.6 - 5.7cm

Maximum minor diameter of sampled eggs =3.0 - 4.0cm

Diameter of an egg hole = 4.7cm

Area occupied by an egg = 22.1cm^2

Clearance area = 12.48cm^2

3.1.1 Dimension of the Tray

Total area of eggs = 530.40cm^2

Length of the tray = 33cm

Breath of the tray = 19cm

Area of tray = 530.4cm^2

3.1.2 Dimension of the Incubator

Length of the incubator = 38cm

Breath of the incubator = 35cm

Height of the incubator = 44cm

Volume of the incubator = $0.058m^3$

3.1.3 Quantity of Heat for Incubation

The volume of the incubator = $0.058m^3$

Density of air at room temperature (35^0C) and normal atmospheric pressure (760mmHg) according to Isiaku (1998) is = $1.2kg/m^3$

C, the specific heat capacity of air = 0.24kj/kgk

Mass of air in the incubator = 0.0696kg

The required temperature for the incubator = 4k

Where 39^0C is the temperature of the incubator

35^0C is the room temperature

Quantity of heat required (Q) = 353632J

3.1.4 Electric power required

Power = 660 watts

3.2 Materials

The materials used in the fabrication of the plywood incubator includes;

- **Plywood** : Plywood obtain from mahogany timber is preferred and used because of its very low thermal conductivity compare to other common structural materials the effect of temperature on length of piece of timber is small and negligible (Isiaku, 1998).
- **Thermometer**: this is a device used to measure the temperature within the incubator.
- **Barometer**: this is a device incorporated to measure the atmospheric pressure.

- **Hygrometer**: this is used to measure the relative humanity.
- **Thermostat**: this is incorporated for regulating the temperature between two limit in a space heating. This closes the circuit whenever the temperatures of the heated air fall to 37^0C and opens as the temperature rises above 39^0C, invariably, this switches the heating device on and off as required.
- **Heating Device**: The heating device of the system is a tungsten filament and electric boiling ring.

Other materials include:

- **Water basin (stainless pan)**
- **Egg tray support**
- **Switch**
- **Glass**
- **Barometer**
- **Wet and dry bulb thermometer**
- **Avometer**
- **Light bulbs and lamp holders**
- **Water delivery system** (small rubber pipe)
- **Small water container**
- **Net**
- **Net egg tray**
- **Thread**
- **Hygrometer**

3.3 Procedures for the Fabrication

1. Make a rectangular box of length 38cm, breath 35cm and height 44cm

2. Make a hole of diameter 15cm at the top

3. Cover the hole with glass

4. Create a ventilation holes at both side, the diameter of the hole is about 1.5cm, the holes should be in three phases at each side. More so, create two holes of 1.5cm at both side of the base through which oxygen enters the incubator.

5. Create an exhaust hole at the side facing the door where carbondioxide pass through. The diameter of which is 1m.

6. Nail a point slightly above the tray where wet and dry bulb thermometer will be hanged. The thermometer must be visible through the glass of the door.

7. Nail another point beside thermometer where hygrometer must be visible through the door when hanged.

8. To the upper glass, gum the barometer with the inner part facing the glass.

9. The box should be above the ground at any convenient distance.

3.3.1 Fabrication of the Egg Tray

This tray serves two purposes, a setter and a hatcher. It is of length 33cm,breath 19 cm and a height of 7cm. It is surrounded at the bottom and sides by net. it has tray support at the bottom the distance between each support is 15cm along the breath, as shown in fig. 3.1.During the turning operation the movement of the egg tray in incubator is at the angle of 45^0

3.3.2 Fabrication of the Turner

Turner was made with two rectangular shaped wood positioned opposite to each other. On the top of the two wood is attached a rope as shown in

Fig 3.2 The Turner of the incubator

3.3.3 Fabrication of the Egg Candler

Though, there are three types of Candler which are Wooden, coffee can and improved Vu-graph Candler. (Obabu 2006), the one used in this construction is the wooden type. Materials used include, one proclaim socket, one 60watt bulb, 4 to 5 foot extension cord.

The procedures for fabrication are as follows:

1 .Make a rectangular box of length 19cm, breath 8cm, and height 8cm.

2. Drill a hole of about 2cm in diameter at one of the breath side of the box.

3. Drill a hole at the other side of the breath, where the extension cord can be attached to the socket.

4. Mount the proclaim socket at the breath of a small hole.

5. With the aid of a nail join the length(s), breath the upper and lower part together.

6. Screw in the light bulb

7. Hold the egg in front of the hole of observation.

The Circuit diagram showing the Electrically Controlled egg incubator is shown below

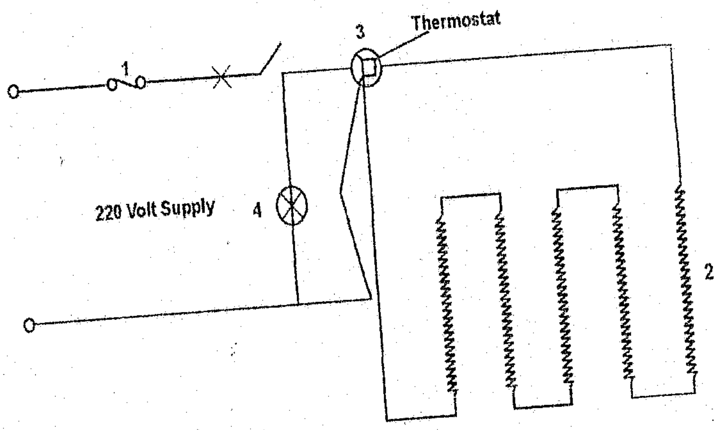


Fig 3.0 Circuit diagram of the incubator

1. The main switch
2. Tungsten resistance wire
3. Thermostat
4. Indication switch

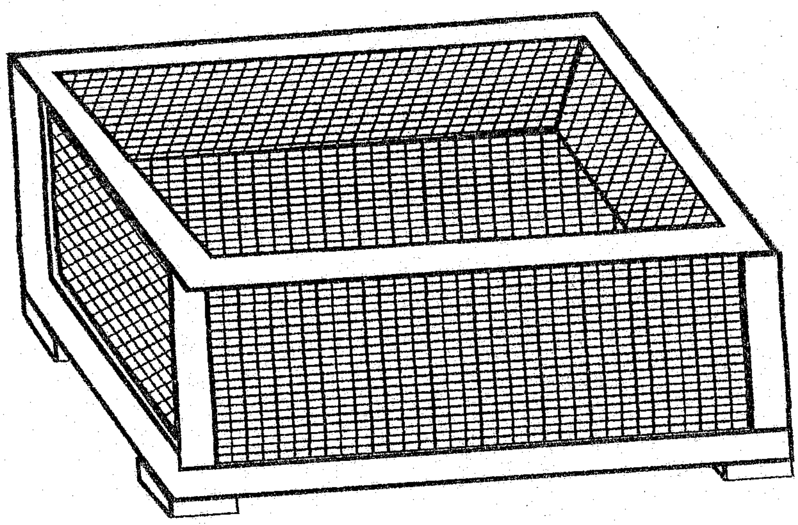


Fig 3.1 The incubator egg Tray

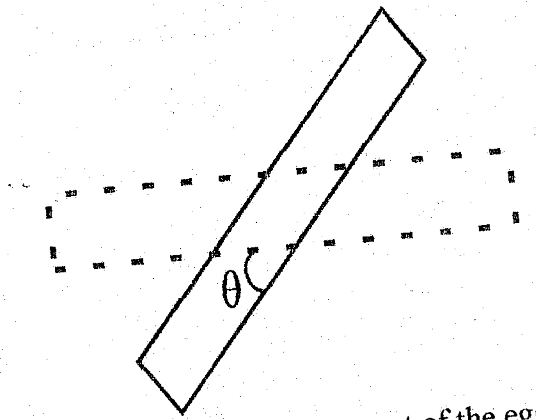


Fig. 3.2 Movement of the egg tray

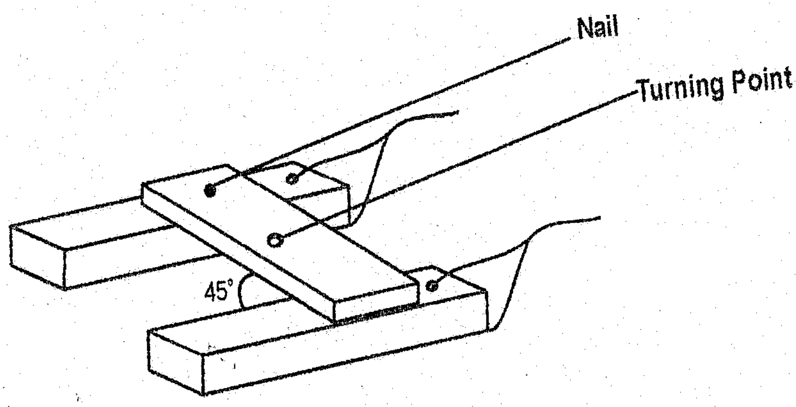


Fig 3.3 The Turner of the Incubator

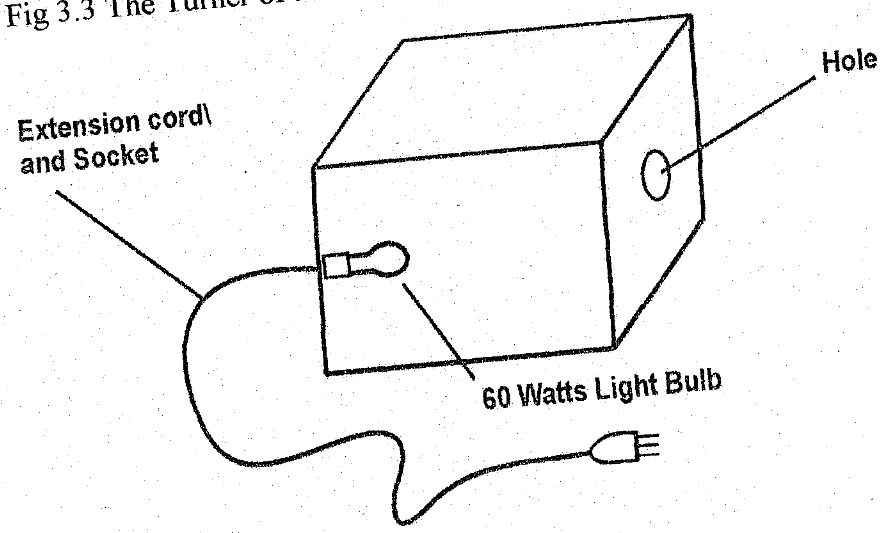
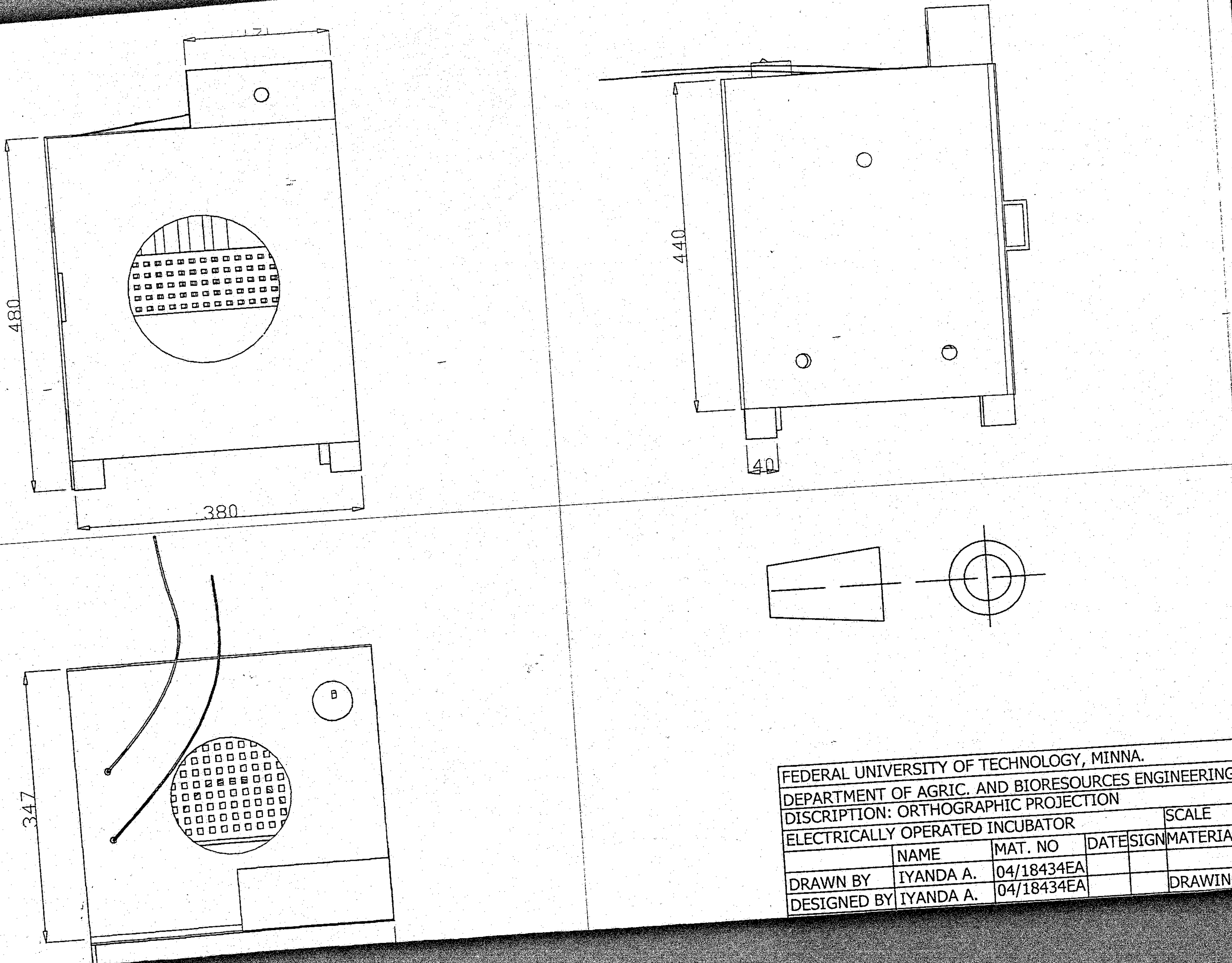


Fig 3.4 Incubator Candler



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ELECTRICALLY OPERATED INCUBATOR					MATERIAL
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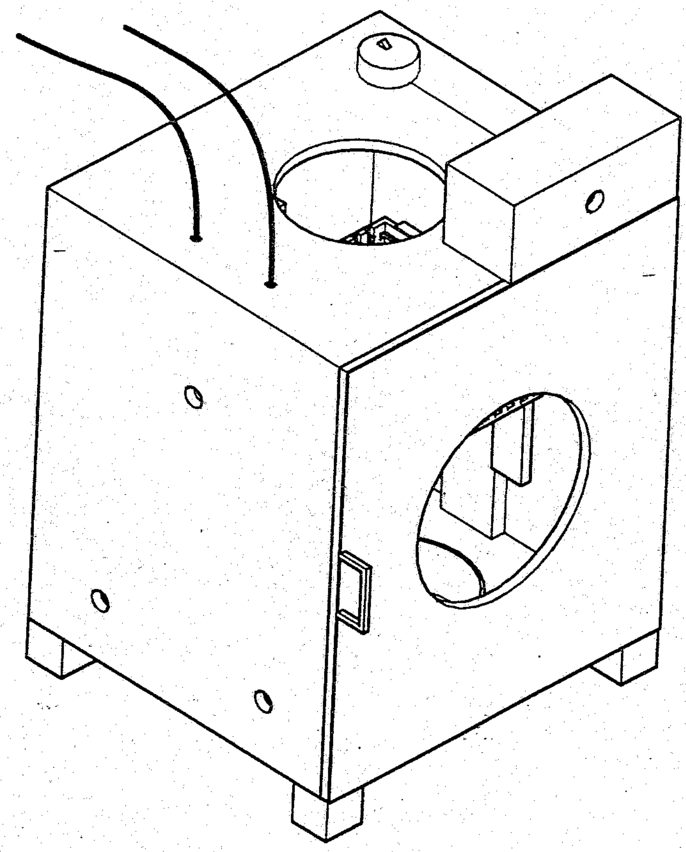
DESIGNED BY	IYANDA A.	04/18434EA			



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DISCRIPTION: ISOMETRIC DRAWING					
ELECTRICALLY OPERATED INCUBATOR					SCALE
	NAME	MAT. NO	DATE	SIGN	MATERIAL
DRAWN BY	IYANDA A.	04/18434EA			
DESIGNED BY	IYANDA A.	04/18434EA			DRAWING NO.1

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results of the relative humidity and temperature observed during the test are presented on Table 4.1

Table 4.1: Incubation Temperature and Relative Humidity

Day	Relative humidity (%)	Temperature ^0C
1	45.0	37.2
2	50.0	37.8
3	55.0	38.3
4	65.0	38.9
5	70.0	38.9

After the construction of the incubator, it was tested and the materials used worked properly.

Though, the eggs did not hatch due to power failure, the functionality of the egg incubator was tested.

Table 4.1 provides information about the thermometer and hygrometer reading for the incubation temperature and humidity respectively. It was observed that at a temperature of 37.2^0C, a relative humidity of 45%was measured. Though for the subsequent days the values vary, the values are still within the acceptable range for hatchability.

The table also shows that for better hatchability temperature and relative humidity of 37-39^{0}C and 50-70% is required respectively.

The tests were carried out with 10 eggs. The incubator was allowed to warm up to a temperature up to 37^{0}C before installing the eggs.

The eggs were placed in the tray with their broad end up and turning of eggs was done by tilting the tray for at least three times daily throughout the incubation period. The turning of eggs started from third to nineteen day of incubation period to prevent the embryo from adhering to the shell.

Dry and Wet bulb thermometer were placed in the incubator to determine the hotness and humidity.

Candling of the eggs was done and it was noticed that in each testing most eggs appeared clear without embryonic development only few with traces of blood that confirms fertilized eggs were present.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In Conclusion, the performance of the incubator based on material and Ergonomics efficiency is on the average of about 70%.

Also the fabrication of the egg incubator for large scale production will follow the same process and procedure. Hence, the use of electricity which is a cheap source of power will improve the production of Agricultural sector to a greater height.

5.2 Recommendations

1. High temperature alarm system should be included to indicate warning signal incase the temperature is above limit.

2. There should be provision by the school management for testing of a project of this type to solve the problem of power failure.

3. In the absence of recommendation 2, an inverter should be built to supplement the power failure.

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APPENDICES

Design Calculation

Capacity of the incubator = 24eggs

Number of tray = 1

Maximum major diameter of sampled eggs = 4.6 - 5.7cm

Maximum minor diameter of sampled eggs =3.0 - 4.0cm

Arranging the eggs along the minor axis (vertically) with the broad end up, average diameter of an egg is thus (3.0+4.0)/2 =3.5cm

Average radius of an egg = 3.5/2 = 1.75cm

Clearance of edges = 0.6cm

Radius of an egg hole = average radius + clearance

= (1.75 + 0.6) cm = 2.35cm

Diameter of an egg hole = 2 x radius

= 2 x 2.35 = 4.7cm

Area occupied by an egg = $(\text{Diameter of an egg})^2$

$(4.7)^2 = 22.1\text{cm}^2$

Clearance area = Area occupied - effective area

but effective area = $\prod r^2$

$=22.10 - (3.142 \times (1.75)^2)$

$= (22.10 - 9.62)\ \text{cm}^2$

$= 12.48\text{cm}^2$

Dimension of the Tray

Total area of eggs = area occupied by an egg X no of eggs

$= 22.10\text{cm}^2 \times 24 = 530.40\text{cm}^2$

Area of tray = $\frac{\text{Total area of eggs}}{\text{Number of tray}} = \frac{530.40}{1} = 530.4cm^2$

Length of the tray = 33cm

Breath of the tray = 19cm

Dimension of the Incubator

Length of the incubator = 38cm

Breath of the incubator = 35cm

Height of the incubator = 44cm

Volume of the incubator = 38x 35 x44 = 58.5 x 10cm

Volume, V= $0.058m^3$

Determination of Air Properties

Analysis of data shows that the average ambient air temperature of Niger State is 28.1^0C and average relative humidity of 75%. With these two known properties, other ambient properties can be determined using psychometric chart.

Specific volume of air $V_1 = 0.8776m^3$ /kg of dry air

Humidity ratio of air, W_1 = 0.0184 kg/kg of dry air

Specific enthalpy of air, h_1 = 75kj/kg of dry air

The recommended temperature and relative humidity for successful incubation is $37\text{-}39^0C$ and 60% respectively (Iwena, 2008). Hence,

The following air properties are obtained from Psychometrics chart.

Specific volume of air within the incubator, $V_2 = 0.9203m^3$/kg of a dry air

Specific enthalpy of air within the incubator, h_2 = 108kj/kg of dry air.

Humidity ratio of air within the incubator w_2 = 0.027kj/kg of dry air.

$$\text{Mass of air} = \frac{\text{Volume of the incubator}}{\text{Specific volume of air within the incubator}}$$

$$m = \frac{v_1}{v_2} = \frac{0.058m^3}{0.9209m^3/\text{kg of dry air}}$$

$m = 0.06298m^3$ of dry air

Where m = mass of air within the incubator.

Quantity of Heat

According to the first law of thermodynamics, and also according to Oria (2004) the quantity of heat, Q needed in a confined space is given as $Q = (m_1c_1 + m_2c_2)\ \theta$

where

Q = Quantity of heat

m_1 = Mass of air in the space

m_2 = Mass of the wood

c_1 = Specific heat capacity of air

c_2 = Specific heat capacity of wood

θ = Temperature change

To calculate the mass of air in the incubator

$$\text{Density of air in the incubator} = \frac{\text{Mass of air in the incubator}}{\text{Volume of the incubator}}$$

Therefore

Mass of air in the incubator = Density of air in the incubator X Volume of the incubator

The volume of the incubator = $0.058m^3$

Density of air at room temperature (35^0C) and normal atmospheric pressure (760mmHg) = $1.2kg/m^3$

Thus, mass of air in the incubator = 1.2 x 0.058 = 0.0696kg

To calculate the mass of wood (mahogany)

$$\text{Density of the wood used} = \frac{\text{Mass of the wood (mahogany)}}{\text{Volume of the incubator}}$$

Therefore

$$\text{Mass of wood (mahogany)} = \text{Density of air wood} \times \text{Volume of the incubator}$$

The volume of the incubator = $0.058m^3$

Density of the wood (mahogany) according to Olumuyiwa (2004) is $0.6 \times 10^3 kg/m^3$

Thus, mass of air in the incubator = $0.6 \times 10^3 \times 0.058 = 34.8kg$

Specific heat capacity of wood according to Isiaku (1998) is 0.24kj/kgk

And that of wood is 2.54kj/kgk

Where k = temperature change in degree Kelvin.

K is the difference between the temperature of the incubator and the normal room temperature= (39 +273)k – (35+273)k = 4k

Where 39^0C is the temperature of the incubator

35^0C is the room temperature

Substituting all the data into the equation $Q = (m_1c_1 + m_2c_2)\ \theta$

Q = (0.0668kg X 0.24 + 34.8 X 2.54) 4

= (0.016032 + 88.392) 4

= 353.632kj

= 353632j

Electrical power needed

Energy (joule)= power (watts) X time (seconds)

$$= \frac{353632}{536}$$

=659.7watts

Cost Analysis

Material cost: is the cost of purchasing the material

Labour cost: is the cost of time spent on construction and hatching. It is assume to be 15% of the material cost

Overhead cost: this involves money spent on transportation, photocopies of relevant materials, internet browning for information on the project

Assuming direct labour cost of material is 15%, then

Labour cost = 15/100 x 16,500 = #2475

Assuming Over head cost of 10% = 10/100 x 16,500 = 1650

Therefore the sum of fabrication is the sum of the material cost, labour and overhead cost. Total cost = 16500

2475

1650

#20,625

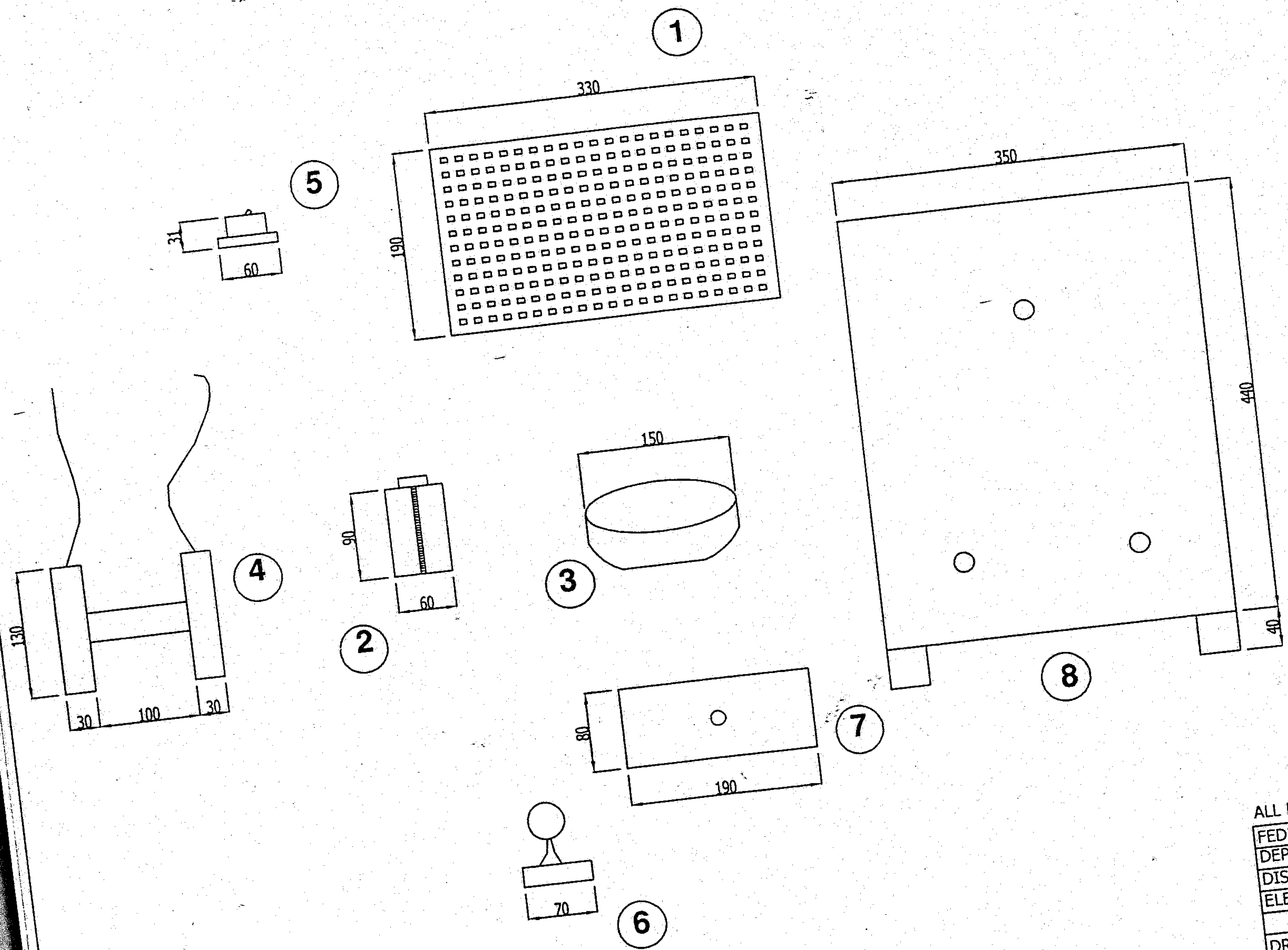
S/No	Material	Quantity	Unit price	Total (#)
1	Plywood	3	1500	4500
2	Thermostat	1	2800	2800
3	Bulbs (40watts)	4	40	160
4	Bulb (60watts)	1	40	40
5	Lamp holder	5	30	150
6	Paint	2	250	500
7	Brush	2	60	120
8	"2" by "2" wood	2	150	300
9	½ Nail	2kg	50	100
10	1" Nail	1kg	60	60
11	Net	1 yard	300	300
12	Humidifier	1	600	600
13	Wire	3yard	40	120
14	Clipps	1packet	40	40
15	Top bond glue	1 tin	250	250
16	Small screw	½ Pocket	100	100
17	Avometer	1	200	200
18	Dry &Wet bulb thermometer	1	2500	2500
19	Hygrometer	1	2500	2500
20	Electric Boiling Ring	1	100	100
21	Switches	2	50	100
22	Dimmer	1	250	250
23	Pilot Bulb	3	20	60
24	Glass	1	250	250
25	Fertile	10	40	40
				16,500

Over head cost = 1650

Table 4.2: Temperature and Relative Humidity of the Incubator for 24-Hours

Time, hr	Temperature, °C	Relative Humidity, %
1	37.2	45.0
2	37.2	45.0
3	37.8	50.0
4	37.2	45.0
5	37.8	50.0
6	37.8	50.0
7	38.3	55.0
8	38.9	70.0
9	38.9	70.0
10	38.6	65.0
11	38.3	55.0
12	38.3	55.0
13	37.8	50.0
14	37.8	50.0
15	37.8	50.0
16	37.8	50.0
17	37.8	50.0
18	37.8	50.0
19	37.2	45.0
20	37.8	50.0
21	37.8	50.0
22	37.8	50.0
23	37.2	45.0
24	37.2	45.0

The readings were taken every hour of the test, which started from 6am to 5am. Observations made showed that, the readings taken in the morning and in the night were almost the same while the readings increased slightly in the afternoon. This might be as a result of increase in the ambient temperature which affects the stability of the readings obtained.



S/N	DESCRIPTION	MATERIAL
1	EGG TRAY	WOOD
2	THERMOMETER	PLASTIC
3	WATER BASIN	STAINLESS STEEL
4	TURNER	WOOD
5	SWITCH	PLASTIC
6	40 WATTS BULB	GLASS
7	CANDLER	WOOD
8	FRAME	WOOD

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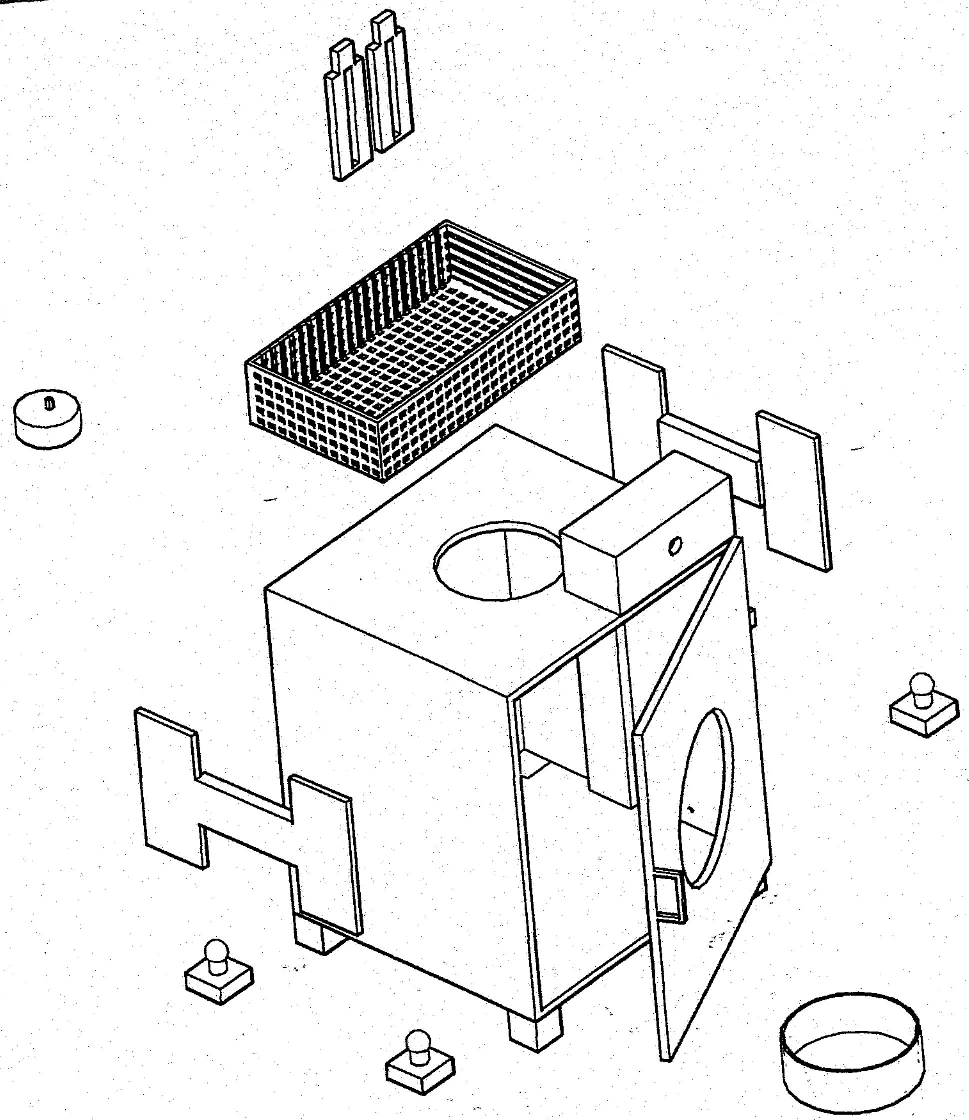
DESIGNED BY	IYANDA A.	04/18434EA			
CHECKED BY	ENGR. IDAH				



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