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DESIGN AND IMPLEMENTATION OF AUTOMATIC FIXED FACTORS EGG INCUBATOR

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Abstract: *Egg fertilization is one of the important factor to be consider when operating a poultry farm. Some eggs got spoiled when some factors such as temperature, humidity and egg turning. It is therefore necessary to have a system that can monitor and maintain constant factors in order to keep the eggs healthy with the use of a programmed microcontroller to activate the heater and put the fan in* ***OFF*** *position when the temperature is lower than the reference temperature and automatically put the heater* ***OFF*** *and the fan* ***ON*** *when the temperature wants to exceed the reference temperature putting the humidity inside the incubator into consideration. A well lagged rectangular box material is use in order to prevent surrounding air into the box.*

Key words: *Egg fertilization, poultry, microcontroller, automatic incubator, temperature and humidity.*

1. INTRODUCTION:

Egg fertilization is one of the important factor to be consider when operating a poultry farm. It is possible to hatch eggs at home without the mother chick seating on them. It takes 21-days to incubate these chicken eggs with the control of their temperature, humidity and turning of the eggs. Some eggs got spoiled when some factors such as temperature, humidity and egg turning are not maintained. It is therefore necessary to have a system that can monitor and maintain constant factors in order to keep the eggs healthy with the use of a programmed microcontroller to activate the heater and put the fan in OFF position when the temperature is lower than the reference temperature and automatically put the heater OFF and the fan ON when the temperature wants to exceed the reference temperature putting the humidity inside the incubator into consideration. A well lagged rectangular box material is use in order to prevent surrounding air into the box.

The fertilization of egg embryo remains the priority of any farmer since ~~hi~~s profits depend on that. This embryo when nurture well give birth to a chick. It is on this note that, it is paramount to manage a fertilized egg that can develop into a normal chick. The eggs required warmness either naturally or artificially as the case may be. The natural method required the bird to provide the warmness or the required temperature by sitting on the eggs in an open space [1] . The artificial incubator does the same function but in a large quantity of eggs even with a controlled humidity and ventilation to be fertilized for hatching. The heat needed by this incubator is usually provided by coil, oil, gas and electricity. The premature development of the embryos begins at temperatures above 72°F (22.2°C), [2]. Humidity of about 57% is maintained for small incubator at a temperature of $37^{\circ}C$, after 18-days, the humidity is increased to 70% while the temperature is reduced to $36^{\circ}C$ till the embryo is matured and hatched [3]. One important factor that should be consider is the position of the incubator for proper ventilation and work space for the incubator operator. Where eggs are not properly stored or kept longer than seven days before hatching them well becomes a problem. In it on record that the storage temperature be $12.5^{\circ}C$, lower temperature of say $-2^{\circ}C$ freezes the blastoderm, storage relative humidity be 80% to avert dehydration of eggs. Eggs that has been fouled in the nest should not be taken for incubation, but if need be, they should be scrap clean and not washed.

The sizes of incubator varies due to the market demand, despite the effectiveness of natural method over any other methods, it has the advantages of accommodating more eggs, hatch more baby chicks at any time when the need arises. This paper aimed at improving the number of chicks produced by the natural method; the numbers of newly hatched chicks that survive with the natural method are very low since they are exposed to disease, poor sanitary conditions and harsh weather, but the artificial method can solve those problems.

Most incubators are constructed using plywood in form of a rectangular box to retain the heat generated by various forms like the use of bulbs, charcoal or fire. Chinese and Egypt are two countries who are credited for applying artificial incubators. Chinese method of heat supply to the incubator is by burning charcoal to supply the heat while Egypt used fire in the place where the eggs are incubated.

Over the years, incubators have been refined and developed so they are almost completely automatic.

1.1 TYPES OF INCUBATOR

The two major types of artificial egg incubators are the still incubator and the forced draft incubator. The ***still air incubator*** presented in figure 1 consist of the following parts, namely Heating element, Thermostat, Egg tray for turning, thermometer to measure the air temperature, tray for water, a hygrometer for humidity measurement. The air circulates by convection. The heated air expands and rise to the top. The air flows in the incubator is determined by the amount of air outside the incubator box in order to maintain perfect air ventilation. Inside the incubator, the warm air moves towards the top so different temperatures will be recorded at different levels.

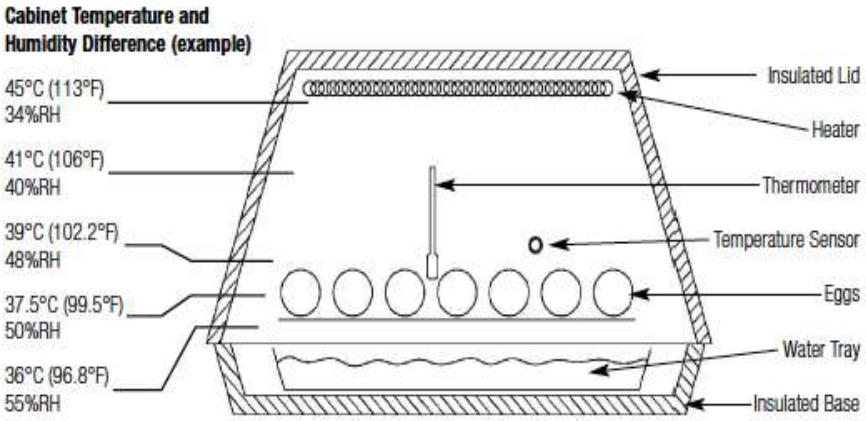

Fig: 1.0 Still Air Incubators [4]

The forced draft incubator presented in figure 1.1 aimed at controlling temperature gradient problem. Here uniform temperature is maintained with the application of fan which helps in circulating air allowing the temperature of the air around the egg to be constant. The humidity is measured using wet bulb thermometer. This kind maintain even temperature, humidity, and oxygen than still air incubator. This method decreases cracked, spoiled and premature eggs incubation.

Some of the factors that helps in affects the fertility of eggs are: temperature, humidity, turning of eggs, cleaning and culling, fumigation, storing time etc.

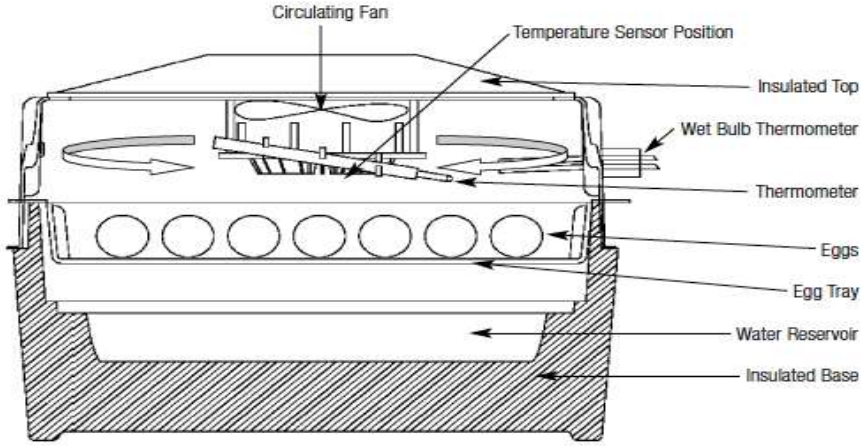

Fig 1.1: Forced Draft Incubator [4]

2. LITERATURE REVIEW:

Several researcher had ventured into finding solutions improve on the existing incubator. The function of egg incubator according [5] is to take over the animal job to incubate an egg until hatched. In his study, incubator was designed and tested in order to check its performance. The incubator consisted of a sun collector with a built-in thermal storage and incubating chamber of 100 eggs capacity. From the results, an average outlet collector temperature of 72.4˚C was obtained on the lowest solar radiation day and 51.8˚C was obtained on the lowest solar radiation day. The incubating chamber was maintained throughout the incubating period within a temperature range of 37˚C to 39.5˚C and relative humidity ranged from 58% to 71.5%. The percentage fertility and hatchability of the eggs was found to be 85% and 78.5% respectively. These values cannot be consistent in raining season while [6], researched on passive solar heating for poultry chick brooding in Nigeria. From the research, it was deduced that solar energy application was the most attractive option for a long energy supply in poultry production in dry season. When this method was compared with

the conventional one, It was found to be pollution free, user friendly and had low maintenance cost and energy but [7], worked on Internal Egg Temperature in Response to Pre-incubation warming in Broiler, Breeder and Turkey Eggs. From the study, warming rate potentials for small broiler breeder eggs (52 to 57g) was 0.0506kJ/min, large broiler breeder eggs (64 to 69g) was 0.0471kJ/min and turkey eggs (74 to 107g) was 0.0488kJ/min. It was also found that an increased in egg size decreased the rate of warming . The hypothesis was true for small broiler and large broiler breeder eggs. Furthermore, [8] developed an egg incubator, where he used Raspberry Pi to determine the farming precision. In their work , they found out that there were two elements of hardware designs which are mechanical and electronic; and the part three is comprised of software design. The software which was for this project was microcontroller pro software and proteus version 7.2 and this software shall be used to design the circuit to be produced on PCB board. Thermostat was also used to control the temperature inside the AEI thereby supported by light bulb for heating element air pump. This was designed to reduce the cost of other incubators in the market. [9] in their work where they design and develop infant incubator using a PID controller for multiple parameters control to adjust hotness, wetness, correct volume of oxygen inside a newborn baby incubator.

According to [10], Incubation refers to the process in which birds hatch their eggs which lead to the formation of embryo inside the egg. For incubation to be efficient, the temperature must remain constant over a specific period. The process of sitting on eggs to incubate in domesticated fowls is termed brooding while the attitudinal tendency to sit on a clutch of eggs by mother chicken is termed broody. These chickens start incubation after the last egg of the clutch thereby causing a concurrent hatching. But this process takes a long way; this is what leads to design and construction of a smart egg incubator which is cheap and easy to handle. The entire process of incubation lies in the Raspberry Pi microcontroller.

According to ATMEL AVR Design Contest 2006, there are prominent needs for egg incubators in the globe, because of many factors. A lover of birds can raised birds through artificial incubation.

Furthermore, in [11], proposed a system that integrates temperature, humidity and light to monitor hospital environment. An intelligent, integrated heat, light and humidity checking system with the use of an exposed normal technology, marketable channels and domestic matters which dynamically shows the ecological conditions. A foremost aim for this system is to have it designed and realized as price efficient as possible. The scheme allows an operator to input the wanted situations concerning an exact tolerant temperature, humidity and lighting dissemination. Looking at these researches there was something that is continuously mentioned and that is temperature, which is very expedient to the design of a temperature control system in an egg incubator, [12] on their part, designed a microcontroller based baby incubator using sensors where they PLC was programmed to monitor the heat surge through a liquid crystal display. In his work he was able to do a successful design and construction of a PIC control system. Going through series of researches, it was shown that the development of an automatic temperature system is not a smooth work.

3. MATERIALS AND METHOD:

3.1 Conceptual Framework

Figure 3 shows the block diagram of the incubator with temperature sensor interfacing with the microcontroller, and by monitoring the temperature of the vicinity. The microcontroller is programmed to regulate the temperature of the incubator

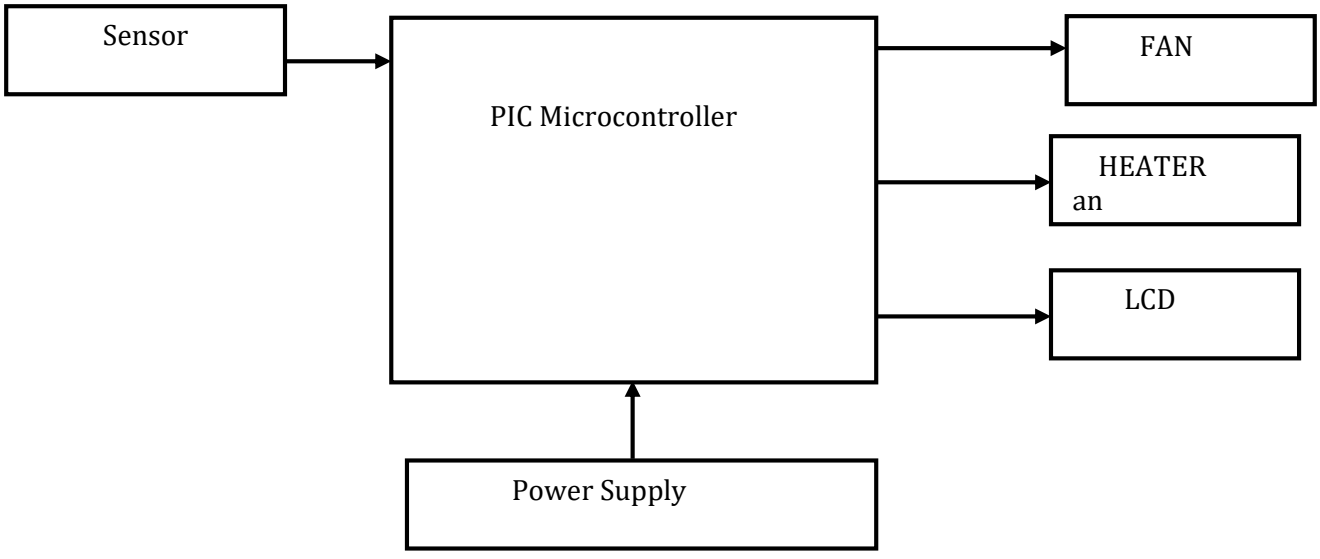

Fig 3.0: Block Diagram of Automatic fixed temperature egg Incubator system

FLOW CHART

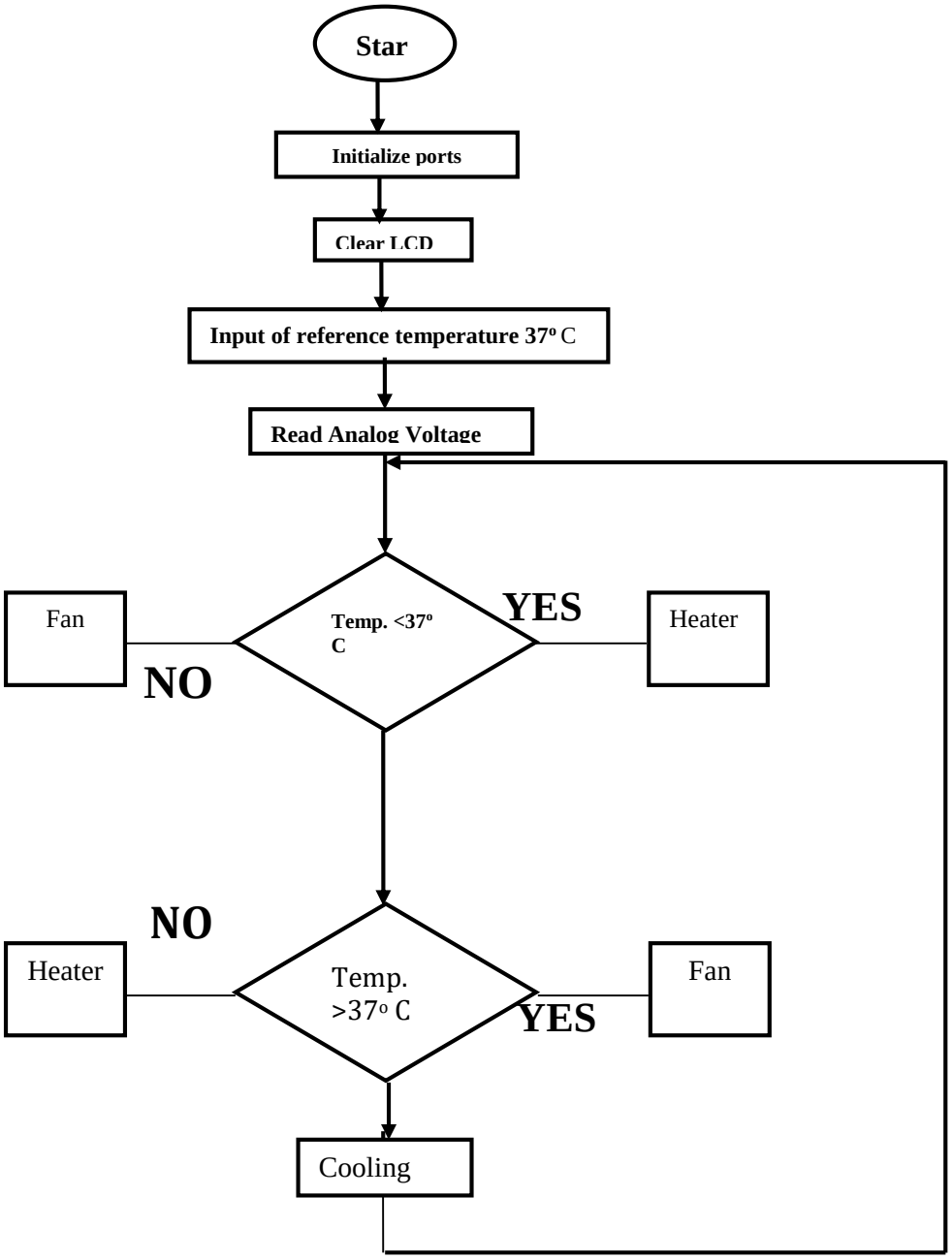

Fig 3.1: Flow chart of automatic egg incubator control system.

As the circuit is energized in figure 3.1, the ports of the controller are initialized and the LCD screen is cleared. The user is then prompt to input the desired temperature value. The microcontroller reads the temperature from the incubator chamber at every 10 seconds and compares it with the desired value. The heater is turned ON (1) the moment the temperature is lower than the reference temperature and OFF (0) as the temperature exceed the reference temperature, thereby activating the fan to ON. This process will continue at the required humidity of 58% until the eggs are ready for hatching.

4. ANALYSIS:

4.1 CIRCUIT DESIGN AND ANALYSIS

The power circuit:

Most components used for construction of electronics devices require DC power source, thus the need for a DC power supply is mandatory. Power supply shown in figure 4 is used for conversion of AC powers to an appropriate DC value. They are usually used in place of batteries. The power supply unit consist of step down transformer, AC to DC rectifier, 5V regulator and two filtering capacitors.

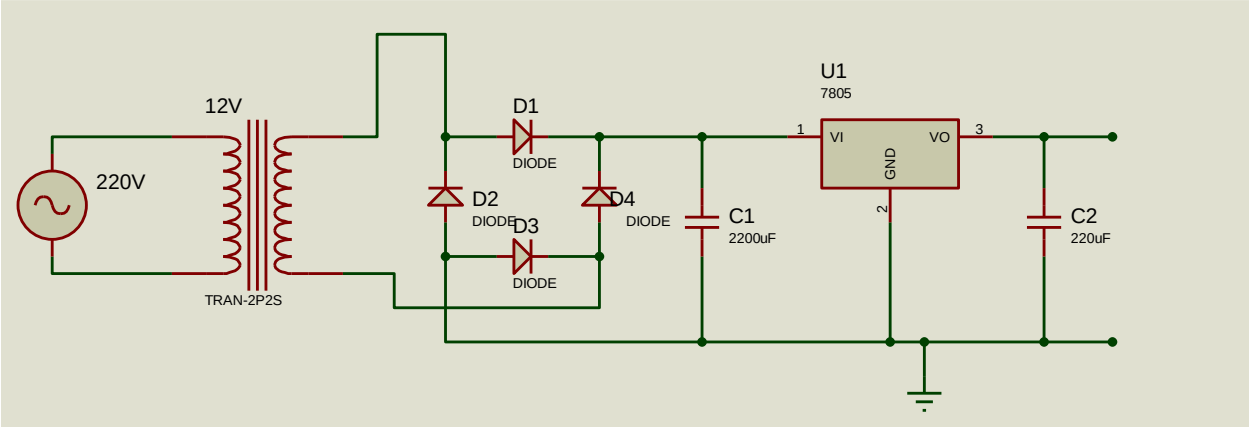

Fig 4.0: 5V DC Power Supply Circuit.

For a full wave rectifier,

$\gamma = \frac{I_{dc}}{4\sqrt{3}fCV}$……..1.0

Where,

γ = ripple factor which is chosen to be 4% for better performance

I_{dc} = 500mA (220/12V Transformer Current Rating)

f = 50Hz

V = 16V (Peak-Peak rectified Output Voltage of the Transformer)

From eqn 1.0

$C=C_1=\frac{I_{dc}}{4\sqrt{3}f\gamma V}$

$C_1=\frac{500\times10^{-3}}{4\sqrt{3\times50\times0.04\times16}}=\frac{0.5}{221.7025054}$ = 2.255×10^{-3} = 2255µF

Therefore,

C_1 = 2200µF

But our preferred value of C1 is 2200µF

C_2 = 10% 0f C1 = 220µF

Switching circuit

The switching circuit is shown in figure 5 composing of two relays which control the power supply into the heating element and the cooling element. The kind of transistor that activates the relay is NPN transistor. A base resistor is required to ensure perfect switching of the transistor, the collector resistance RC is the relay coil which is 400k

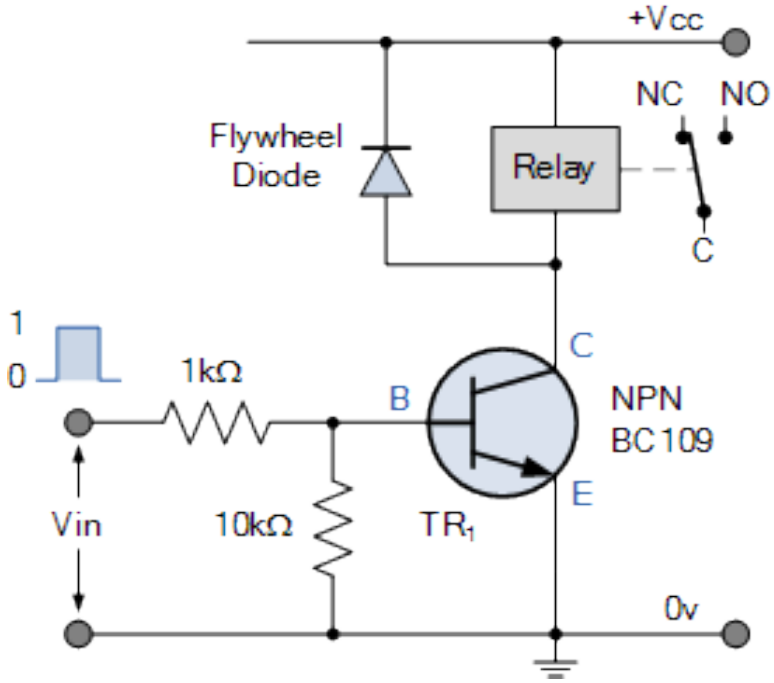

Figure 4.1: the switching circuit

SIMULATION MODEL

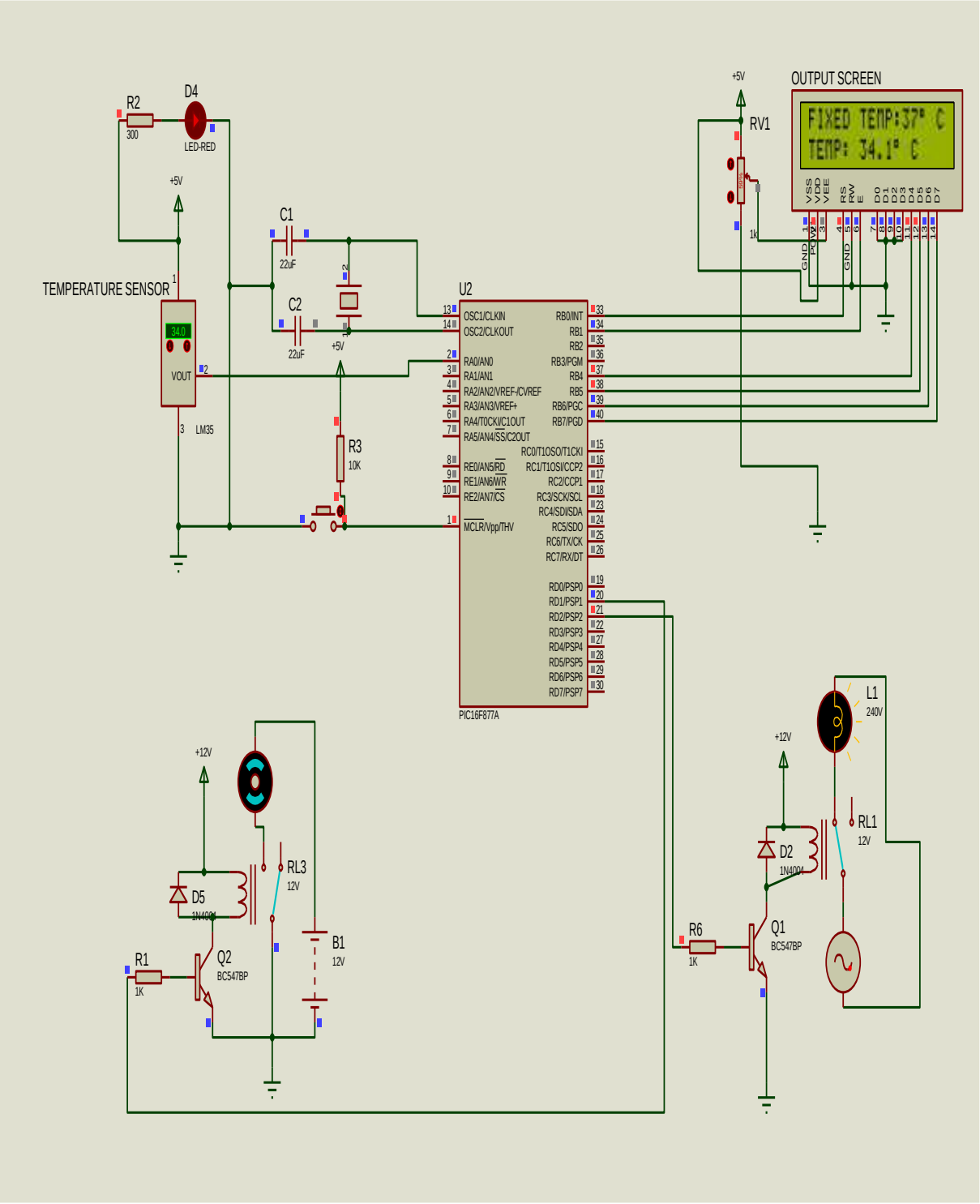

Fig 4.1: Circuit diagram of the system

5. CONSTRUCTION AND TESTING:

5.1 Construction

Construction involves two stages; first the components are mounted on the bread board as shown in figure 8 temporarily before transferring same to the Vero board permanently. The connection of the PIC16F877A Micro controller circuit was placed on the socket. The usage of IC socket helps in preventing the ICs from thermal damage due to excessive heat emanating from the soldering iron during soldering processes. The usage of the sockets also provides an ease for replacement in case any IC goes bad.

Figure 5.0: Constructed five tray egg incubator

5.2 Testing

The system entails various stages of circuits, every stage was checked and tested to ascertain proper connections and design specifications. Thereafter, continuity test was done on the entire system before powering it. When it was eventually powered, the desired results were achieved according to the stated objectives. Figure 8 showed the constructed incubator with all the openings seals in order not to allow any surrounding temperature. The upper case contains the control unit which actuate the heater and fan in the lower apartment which is design to accommodate the eggs when the need arises.

6. RESULTS AND DISCUSSION:

The main aim of the project as titled above was achieved, the temperature sensor (LM 35) which is coupled to Analogue to Digital Converter (ADC) senses the surrounding temperature and send it to ADC which converts it to microcontroller language for regulation of a constant temperature. As the process continue, the fan is ON when the temperature exceed the threshold temperature and OFF for the heater to ON when the temperature is low.

7. CONCLUSION:

From the implementation of the design, it is clear that the temperature of the eggs remain constant unlike the natural method where most times the mother chicken is not available to seat on the eggs. The constructed incubator can accommodate hundreds of eggs which the natural method is short of doing. Apart from that, the eggs fertilized well with little or no affected eggs.

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