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Improved Automatic Eggs' Turner Device for Effective Incubation

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ABSTRACT—*In natural means of incubation, the mother hen occasionally used her beak to turn her eggs twice to four times per day to avoid the embryo from sticking to the egg shell. In semi-artificial incubation, the eggs turning was done using hand to laterally keep the eggs horizontally four to six times per day. The natural way by the mother hen yield good result but is by far less than the number of chicks required worldwide. While the semi-artificial of eggs turning process using hands provided large number of chicks but transmitted diseases due to the direct contact to the eggs, is labor intensive and always leakage out the trapped head of incubation in the process of turning the eggs. This paper proposed an automatic eggs' turning device using a timing integrated circuit configured in an astable multi vibration mode of high time 1.8 ks, low time 1.5 ks and a duty circle of 50%. In every high time pin 3 of the timing circuit goes high and activated the relay which in turn switched a bi-directional DC motor that tilted the eggs at an angle of 45^0 in the clock wise direction and deactivated the relay which will resulted to the tilting of the egg trays in the anti-clock wise direction. Incubation efficiency was compared with the conventional incubator using hand turning and that with the proposed device, it resulted to hatchability of about 87% was achieved. The turning control was cost effective with the cost of only three thousand naira, in which the cost of production will drastically fall in mass production.*

KEYWORDS: bi-directional, egg, hatching, turning.

I. INTRODUCTION

Egg turning is usually done by the mother hen to enable the spray of even required temperature to the egg for development. The mother hen used its beak to turn the egg at some interval while laying on them [1]. The turning by the mother hen is efficient for embryo development and to avoid the sticking of the embryo to the egg's shell. The challenge of the conventional (mother hen) method is due to the production of small number of chicks, which are not enough to the demand. This challenge lead to the actualization of the artificial incubator, which produces large number of chicks at a time. Researchers proved that egg turning is crucial for a successful hatching apart from temperature and humidity control. The problem of egg turning in an artificial incubator is always a challenging control problem and hence this paper proposed a method for egg turning. The proposed techniques will turn all the eggs within an angle of 45^0 bi directional, this is to enable maintain the embryo at the center of the egg to prevent it from sticking [2].

Section II of this paper describes the design of the circuitry for the turning mechanism and the timing unit were mathematical analysis will be conducted. Section III provide the design and analysis of the eggs'–turner delay circuit, Testing results are shown in section II. Section V concludes on the presented results.

II. DESIGN AND ANALYSIS OF EGG TURNER MANIPULATOR

The egg turner manipulator shown in Figure I is a designaimed at frequent changing the polarity of the supply terminals of the bi-directional DC motor, which in turn tilts the eggs trays to an angle of 45^o [2]. The tilt angle will prevent the egg's embryo against sticking to the warm shell during incubation.

This was achieved by connecting the terminals namely 'A' and 'B' with the astable multivabrator relay's RL_A control terminals of Figure II. When RL_A is energized the terminals A and B will be connected and the energized RL_C and RL_D simultaneously. Now, the normal open of the relays (RL_C and RL_D) will both be closed, results in feeding the terminals 'a' and 'b' of the bidirectional DC motor with negative and positive supply from the standby battery respectively. This results in tilting the eggs' turner anticlockwise.

When RL_A is de-energized, terminals A and B will be open and will result to de-energize of RL_C and RL_D simultaneously. Now, the normal close of the relays (RL_C and RL_D) will both be closed, resulting in feeding the terminals 'a' and 'b' of the bidirectional DC motor with positive and negative supply from the standby battery respectively. This results to the tilting the eggs' tray in bi-directionmanner [3].

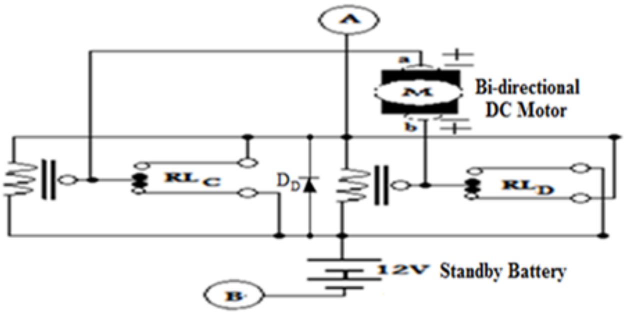

Figure I. Egg Turner Manipulator Circuit Diagram

A summary of the components required and used is shown in Table I.

Table I Egg Turner Manipulator Components

COMPONENT	CALCULATED VALUE	STANDARD VALUE
RL_C, RL_D	----------	12 V RELAY
D_D	----------	1N4001
BI-DIRECTION DC MOTOR	----------	12 V BI-DIRECTION MOTOR
BATTERY	----------	12 V

Relay 'RL_C and RL_D' are SPDT with 2 A at 220 V switch, coil voltage 12 V; coil resistance 200 Ω to 300 Ω was used.

III. DESIGN AND ANALYSIS OF EGGS' – TURNER DELAY CIRCUIT

The eggs' turner delay circuit is designed and implemented using the circuit diagram of Figure II.

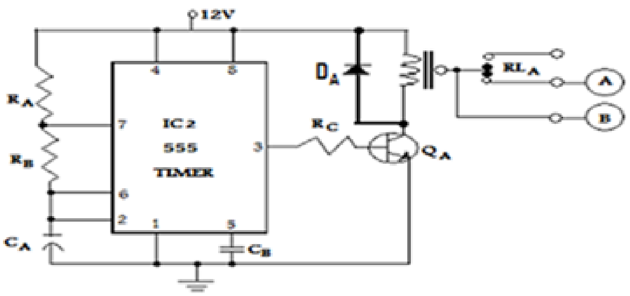

Figure II. Delay Circuit Diagram

Figure II was designed using an astable multivabrator by utilizing 555 IC. Efficient delays of 30 mins and 25 mins were chosen for the design oft_h (time high) and t_l (time low) respectively. The said period was selected to enable us to achieve a duty circle 'D' where D is approximately 55%, which leads toa pair of trays tilting per hour and 26 pairs of per day. The t_h and t_l can be computed by using equations (1) and (2) [4]:

$$t_h = 0.693(R_A + R_B)C_A (1)$$

$$t_l = 0.693(R_B C_A) (2)$$

Hence t_h is 30 mins = 1800 sand t_l is 25 mins = 1500 s and the capacitor C_A is selected as 3300 μF, 50 V. Using equation (2), the value of the resistor R_B is obtained as:

$$R_B = 787.09\ k\Omega$$

But standard value resistors of 680 kΩand 100 kΩresistors in series with ±10% tolarance are used.Using equation (1), the value of the resistor R_A is calculated as:

$$R_A = 131.2\ k\Omega$$

But a standard value of 130 kΩ with ±10% tolarance is used.

The period of oscillation 'T' can also be determined from equations (1) and (2), which yield the relationship in equation (3) [5]:

$$T = t_h + t_l = 0.693(R_A + 2R_B)C_A (3)$$

Hence, T = 55 mins = 3300 s

The frequency of oscillation 'f' of the timer was calculated using the relation in equation (4) [5]:

$$f = 1/T = \frac{1}{0.693(R_A + 2R_B)C_A} \quad (4)$$

Therefore, the frequency f = 260 μHz

The duty cycle $'D'$ as in equation (6) was derived from equations (1) and (3).

$$D = \left({}^{t_h}/_T\right) \text{ x } 100\% \quad (5)$$

$$\because D = (R_A + R_B/R_A + 2R_B) \text{ x } 100\% \quad (6)$$

Using equation (6), gives the duty cycle of:
D ≅ 55%.

The output of the timer IC at pin-3 is connected to the base of transistor Q_A through resistor R_C for further amplification. The transistor used is a general purpose NPN transistor with the following specifications:

Turn-on voltage$V_{BE} = 0.7$ V, Collector current $I_C =$ 450 mA, Power dissipation $P_D = 500$ mW.
Current gain factor $\beta = 250$. The part number of the transistor is BC548.

The base current of the transistor Q_A is obtained as follows [6]:

$$I_B = I_C/\beta (7)$$

Using equation (7) where I_B is 1.8 mA:

$$R_C = \frac{V_{CC} - V_{BE}}{I_B} \quad (8)$$

Using equation (8), the value of the resistor R_C is calculatedas:
$R_C = 6.2\ 8\ k\Omega$
But a standard value of 6.8 kΩ with ±10% tolarance is used.

A summary of the components required and used is shown in Table II.

Table II Eggs' - Turning Delay Components

Relay 'RL_A' is SPDT with 2A at 220V switch, coil voltage 12V; coil resistance 200Ω to 300 Ω was used.

RESULTS

The egg turner was implemented using the presented analysis. Standard component values were used in the

COMPONENT	CALCULATED VALUE (kΩ)	STANDARD VALUE
R_A	131.20	130 kΩ
R_B	787.09	780 kΩ
R_C	6.28	6.80 kΩ
C_A	----------	3300 µF, 50 V
QA	----------	C945

physical system. The egg turner was placed in an existing incubator (HEFINC840) of capacity 840 and it was found to provide egg tilting at an angle of 45^0 for each design delay. The same HEFINC840 and the same type and number of eggs were used but with manual (hand) egg turning. Hatchability was taking as the performance index of the two turning methods. Using the proposed turning method hatchability of 732 eggs were recorded and a failure of 108 eggs. While with the manual egg turning method hatchability of 4336 was recorded, and a failure of 404 eggs. Table III shows the comparison between the proposed automatic egg tilting system with the manual egg turning method.

Table III. Comparison of the Proposed and Manual Egg Turning Method

Proposed method Hatch success %	Proposed method Hatch failure %	Manual method Hatch success %	Manual method Hatch failure %
87	13	52	48

DESIGN OF THE EGG TURNING PARTS

The egg turning parts is made up of metal of different shapes (i.e. rectangular pipe, straight bar, flat sheet, angle bar and cylindrical rod) were used in building the turning frames. Figure III to Figure IV shows the major turning parts.

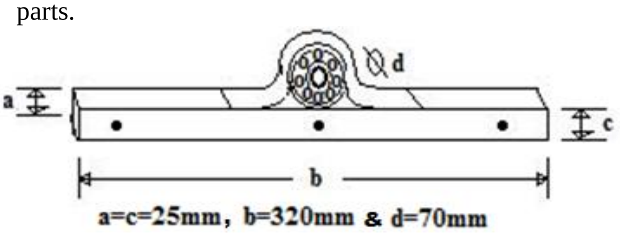

Figure III. Egg Turning Tray Pivot

Figure III is made up of rectangular pipe, straight bar and bearing all welded together to form pivoting part for the egg's turning tray. Three (3) holes were made on the rectangular pipe to ease fixing it on the wooding casing. Three (3) of its kind were made to support and permit free turning of the eggs' turning tray.

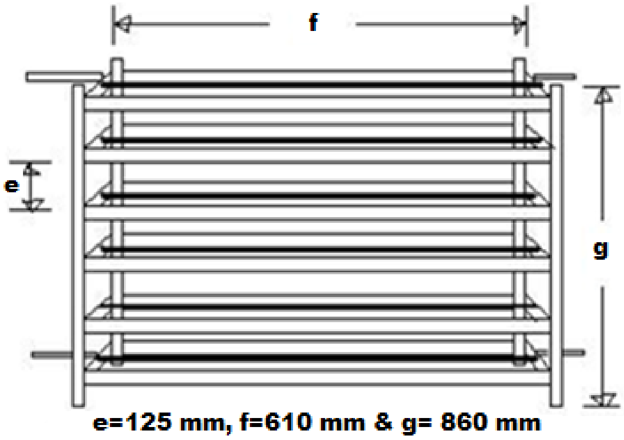

Figure IV. Egg Turning Shelve

Figure IV shows the egg turning device which was constructed using straight bar, rectangular bar, angle bar and cylindrical rod.

This mechanism was deliberately designed in such a way to freely tilt clockwise and counter clockwise. On completion of the design, the eggs' turning trays was found tilting smoothly at an angle of 45^0 in both directions without damaging any of the eggs. Such angular displacement was achieved using the equation (9) [3].

$$c = [\mathrm{Cos}\theta(a + b)] - a \qquad (9)$$

Wherea is the thickness of the bar used,b is the wideness between the two tray bars,c is the required gap between trays andθ is the angle of tilting required (45^0).

CONCLUSION

The proposed egg turning system was designed with an efficiency of 35% ahead of the manual egg turning method which is also porous to uneven turning and it can also transmit diseases to the eggs. Exactly egg tilting of 45^0 was achieved using the proposed method as against the manual turning which a random turning is administered. It can now be concluded that the proposed method of automatic egg turning at an angle of 45^0 in both directions is encourage to the used by the hatchers than the hand turning method.

REFERENCES

[1] A. B. Umar, K. Lawal, M. Mukhtar and M. S. Adamu "Construction of an Electrically-OperatedEgg Incubator" International Journal of Modern Engineering Sciences, vol. 5, issue 1, Florida, USA. p. 1-18, 2016

[2] A. Mohammad, M. J. Musa; K. Ahmad, S. Garba and M.D. Almustapha "Design and Performance of HEFINC840 Micro-controller Based Incubator" NIAE International Conference, Uyo 2013 University of Uyo, Nigeria. October 21-24, 2013, p. 685-692, 2013

[3] Z. N. Oriolowo; Z. Haruna; K.I. Ali; M. J. Musa; Tekanyi A. M. S. (2015) "Symbolic Modeling and Simulation of a Planar Seven-Body Mechanism using MapleSim" Zaria Journal of Electrical Engineering Technology, Department of Electrical and Computer Engineering, A. B. U. Zjeet Volume 1 & 2. No. 5/10-14

[4] U. F. Abdu-Aguye, S. Garba, M. J. Musa, K. Ahmad, and A.M.S. Tekanyi "Development of an Embedded Light Activated Remote for fan Regulator" Proceedings of Academia Industry Conference. Faculty of Engineering, Bayero University Kano 9th-11th December 2014.

[5] M. J. Musa; Y. M. Abdullah; M. J. Bello and J.A. Ignatius (2009) "Design and Construction of an Automatic Bird (Pest) Repeller" 3rd West Africa Society for Agricultural Engineering and 9th Nigerian Institute of Agricultural Engineering "Agricultural Technologies and the African Poverty Eradication Challenge" WASAE/ NIAEIFE 2009. 25th-29th January 2009. Pp.396-400

[6] K. Ahmed, Y. A. Sha'aba, M. J. Musa, A. S. Musa and A. M. S. Tekanyi "Design, Development and Reliability Assessment of four-in-one Electronics Security Assistant" 46TH Annual Conference of Science Association of Nigeria. ZAZZAU 2011.