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Development of A Debeaking Device for Poultry Birds

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Abstract: The development of a debeaking device (machine) for poultry birds for both small and medium scale poultry farmers has been undertaken. It is a dual purpose type that consists of a debeaking and cauterising mechanisms in which both processes are carried out in one single sequence in order to curb the act of cannibalism amongst poultry birds. The machine consists of a vertical, circular and solid column supported at the bottom end by a circular stepped metal base. Attached to the column are the cutting plate (fixed) and cutting blade (moveable). The cutting blade is carried by a mechanism (machine head) attached to the upper part of the supporting column. The test was carried out using one hundred (100) chicks of between five (5) and ten (10) days old in batches of ten (10). It took about an average of fifty (50) seconds to debeak each batch. This translates into the debeaking of one (1) chick in about five (5) seconds. A total of about seventy out of the one hundred chicks were effectively debeaked and cauterised while others were partially debeaked and cauterised, resulting in an efficiency of about 70%. From the result of the test, it is evident that the machine is quite effective for use in poultry.

Keywords: Debeaking, cauterisation, cutting plate, cutting blade.

Notation

W, P - combined weight of machine head and imposed load.

D - spring coil diameter.

d - wire diametr, column diameter.

C - spring rate.

T_{max} - maximum stress in spring.

σ - stress in column.

M - moment of lever arm.

I - second moment of area of cross – section of column.

A - cross – sectional area of column.

A_b - cross – sectional area of cutting blade.

P_{cr} - critical load.

μ - number of half waves.

E - Youngs modulus.

L - length of column.

τ_{maxb} - maximum stress in cutting blade.

1. Introduction

Debeaking, also known as trimming, is the partial removal of the beak of poultry, especially layer hens and turkeys although it may also be performed on quail and ducks [1]

Most commonly, the beak is shortened permanently, although growth can occur. Debeaking of poultry birds is practiced to prevent or minimise cannibalism amongst birds and, thereby, maximise profit [1, 2, 3].

Cannibalism is a problem that is associated with large poultry flocks where the birds kept in close confinement peck at neighbouring birds. This can result in significant mortality within the flocks when a wound is generated and could also cause a decrease in egg production as the pecked birds become stressed. This is a vice which is usually precipitated by some aspect of management or environment which the birds are subjected to. The behavioural problem of cannibalism in poultry industry can be problematic. Beak trimming is a preventive measure to reduce damage caused by injurious pecking such as cannibalism, feather pecking and vent pecking, and thereby improve livability [4, 5]

Amongst all the preventive measures against cannibalism (such as: avoidance of overcrowding, excessive heat and light e.t.c) the beak trimming approach is one of the most effective ways of reducing and checking cannibalism in poultry birds.

The term debeaking is used to denote the removal of beak by trimming process. In reality, only half or less the beak is removed. The trimming is usually done between 5 to 10 days old or between 1 day and six weeks of age [6, 7]. Laying hens and breeding flocks are debeaked sometimes again between 12 and 20 weeks of age. In recent practices, permanent beak trimming has become paramount using electrically heated blades in beak trimming machines. Hot blade machines are the

most common tool used today to trim beaks. Though, an electric soldering iron, cold blades, infrared and laser etc are other methods under investigation for the purpose of debeaking operation [5, 8]. Birds under backyard system are not to be debeaked [7]. Where beak trimming is carried out, it should, wherever possible, be restricted to beak tipping; that is the blunting of the beak to remove the sharp point which can be the cause of the most severe damage to other birds [9]

The aim of this work, therefore, is to design a beak trimming device that will effectively cut and cauterise the beak of poultry birds in order to curb the act of cannibalism amongst birds using an electric soldering iron as the heating element.

The objective is to provide a machine that will effectively trim the beak of poultry birds with little or no pain to the birds and to provide a beak trimming device which will include a heating element attached to the blades to cauterise the beak as it is trimmed. It requires temperature of 650-750 degree Celsius for 3 sec. For cold/mechanical method, beak is cut by scissor or clipper without cauterization [6, 10].

2. Design Analysis

The design of the various components of the machine was done within the elastic range of the materials used and, the failure load was based on the maximum shear stress theory. in relation to the yield stress ascribed, as mild steel was predominantly used while the cutting blade and cutting plate are of stainless steel. The assumptions made were to simplify the analysis of the various applied mathematical models.

Maximum shear stress induced in the spring wire is given as [11],

$$\frac{8WD}{\pi d^3} + \frac{4W}{\pi d^3} \quad (1)$$

$$= \frac{8WD}{\pi d^3}\left(1 + \frac{d}{2D}\right)$$

But,

$$C = \frac{D}{d} \text{ and } K_s = \left(1 + \frac{1}{2C}\right) \quad (2)$$

Substituting gives,

$$\tau_{max} = \frac{8WD}{\pi d^3}\left(1 + \frac{1}{2C}\right) \quad (3)$$

$$= K_s \times \frac{8WD}{\pi d^3} \quad (4)$$

The stress in the column is the combination of the direct stresses arising from the weight of the head and the imposed load and the bending stress also due to the imposed load on the lever arm. It is expressed as [11, 12],

$$\sigma = \frac{P}{A} + \frac{My}{I} \quad (5)$$

The critical or buckling load of the column, assuming a fixed – free end condition, is [13],

$$P_{CR} = \frac{\pi^2 EI}{(\mu l)^2} \quad (6)$$

$$= \frac{\pi^3 E d^4}{(\mu l)^2} \quad (7)$$

The maximum stress on the cutting blade is,

$$\tau_{maxb} = \frac{P_{CR}}{A_b} \quad (8)$$

2.1 Specifications

The following parameters/specifications were obtained from the selected materials and from the use of Equations 1 to 8.

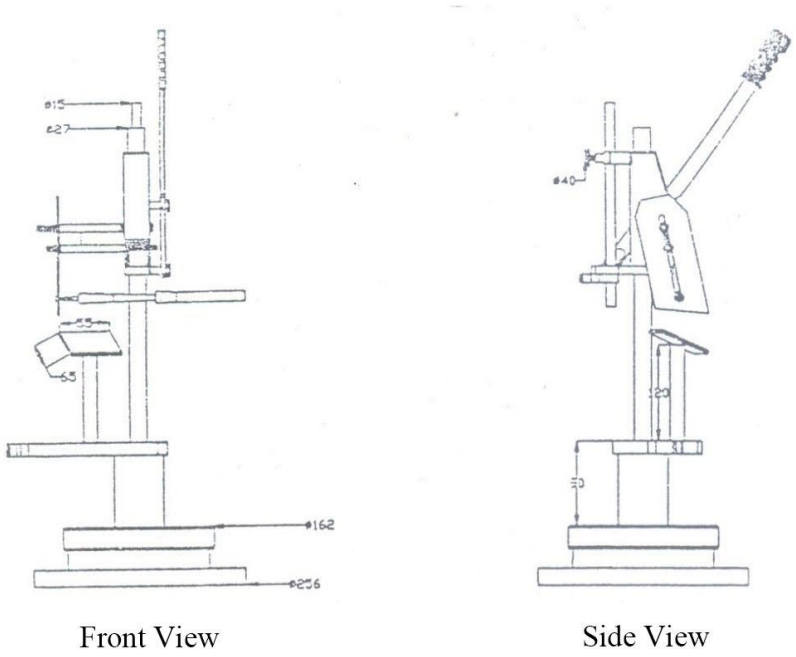
Maximum Stress in Spring (T_{max})	194 MN/m2
Stress in Column (σ)	76.58 MN/m^2
Cross-Sectional Area of Column (A)	3.14 m^2
Critical Load of Column (P_{cr})	452 kN
Length of Column (L)	0.3 m
Number of Half Waves (μ)	0.5
Cross-Sectional Area of Citting Blade (A_b)	1.5x10^{-4} m^2
Young's Modulus of Mild Steel (E)	207x10^{11} N/m^2

3. Construction and Testing

The various parts of the machine were assembled. The machine consists of a vertical, circular and solid column supported at the bottom end by a circular stepped metal base. Attached to the column are the cutting plate (fixed) and cutting blade (moveable) Figures 1 and 2. The cutting blade is carried by a mechanism (machine head) attached to the upper part of the supporting column. The mechanism also carries the heating element. The cutter and heating element assembly has provision for adjustment to accommodate varied sizes of birds. The mechanism comprises a lever, return spring and a stabilizing rod to ensure a smooth and effective trimming and cauterization of the beaks.

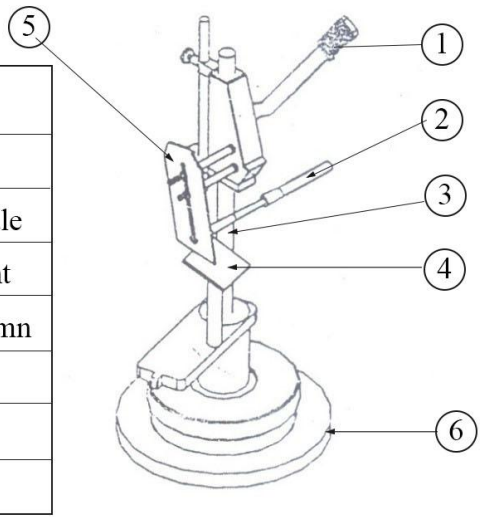
The test was carried out using one hundred (100) chicks of between 5 and 10 days old in batches of ten (10). The heating element is connected to a power

source to heat up the cutting blade. After the cutting blade has been heated to about 650^{0}C; the beak of the bird is placed between the cutting blade and the cutting plate. The cutting blade is now made to move and impose the cutting force on the beak by the mechanism lever. After the cutting action had been accomplished, the lever and cutting blade – heating element assembly are brought back to their previous positions, by the return spring, for the action to be repeated for another bird.



Front View Side View

Figure 1: Orthographic View of Machine



LEGEND	
S/N	PART NAME
1	Operating Handle
2	Heating Element
3	Supporting Column
4	Cutting plate
5	Cutting Blade
6	Base

Figure 2: Isometric View of Machine

4. Results and Discusion

Table 1 shows the results of the test carried out using one hundred (100) chicks of between 5 and 10 days old in batches of ten (10). It took about an average of about fifty (50) secs to debeak each batch. This translates into the debeaking of one (1) chick in about five (5) seconds as depicted in Table 1. And of the one hundred chicks that were debeaked, about seventy were effectively trimmed and cauterised, while others were partially trimmed and cauterised, thus, representing an efficiency of about 70%.

Table 1: Time taken to debeak one hundred chicks in batch of ten each.

Batch	No. of Chicks	Time Taken (sec)
1	10	47.35
2	10	46.42
3	10	45.70
4	10	46.61
5	10	47.26
6	10	46.55
7	10	47.55
8	10	46.65
9	10	47.73
10	10	45.37
Total Time Taken (sec)		**467.19**
Average Time Taken for Each Batch (sec)		**46.72**

5. Conclusion

The development and testing of a debeaking machine has been undertaken. The test was carried out using one hundred (100) chicks of between 5 and 10 days old in batches of ten (10) each. It took an average of about fifty (50) seconds to debeak each batch. This translates into the debeaking of one (1) chick in about five (5) second, which is in close agreement with literature value of about three (3) seconds per chick. A total of about seventy out of the one hundred chicks were effectively debeaked and cauterised while others were partially debeaked and cauterised, resulting in an efficiency of about 70%. From the result of the test, it is evident that the machine is quite effective for use in poultry.

However, it was observed that the heating element was not totally effective due to its location relative to the cutting blade which literally affected the rate of heat transfer, thereby, making it difficult to cut the beak at one fell swoop. It is of the view that if this problem is surmounted, the work rate of the machine will be significantly improved.

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