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Design and Fabrication of a Mosquito Repellent Coil Machine

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ABSTRACT

Various methods like pest killer spray, soap, oil is used to prevent mosquitoes from transmitting diseases to human but out of all the listed methods a mosquito repellent coil is the most popular germicidal because of its disinfectant properties. The objective of this project is to develop a simple mechanism for the production of a mosquito repellent coil making machine. This machine works on pulley - belt mechanism. Spring is used to regain initial position of the punch rod. Specially designed mold is used to make coils. The machine imprints the spiral coil shape into the mixed chemicals to be used and there by forms a mosquito repellent coil. The basic chemicals used are cow dung, fragrance, and engine oil also this production rate may vary depending upon the thickness of the mixed chemical. It was found to be effective and efficient at a speed of 950 rpm and the stamping operations occurs per 4 seconds immediately the machine is put on. This machine is less expensive compared to other mosquito coil producing machine and is durable and expected to last for 5 years.

INTRODUCTION

Mosquito, this a common name given to any two-winged insects. Mostly found from the tropics to the arctic circle and from lowlands to the peaks of high mountains. It was held that approximately 3500 species of mosquitoes are present in tropical and subtropical regions (Ghosh A et al., 2011). Mosquitoes are one of the most dangerous vectors which transmit parasites and pathogens impacting human life to a very great extent by spreading the deadly diseases like malaria, dengue, filariasis (Dr. Naresh et al., 2011). Only few vaccines to treat the virus caused by mosquito bites are available, the only exception is in the case of dengue researchers are yet to find a cure to the dengue virus (Farag et al. 2011). Various method like pest killer spray, soap, oil is used but out of all the listed method a mosquito repellent coil is the most popular germicidal because of its disinfectant properties, it's convenient to use without using a manual and lastly the major reason mosquito repellent coil is extremely used in developing countries is because it is cheap and accessible to the poor (Lawrence et al., 2004).Although, despite its potential benefit as a mosquito repellent, the mosquito coil may create unpleasant emissions, which constitute a potential source of indoor air pollution(Liu W et al., 2003).The most advantageous characteristic of mosquito repellent coil is that it's not hazardous to human health because the ingredient is finely arranged. For the progress of both the rural and urban society, the design, fabrication and usage of a mosquito repellent coil making machine plays big role along with a simple cost, it's an easy to handle repellent coil making machine. This can lead to improved financial and economic development of rural society, also encourage rural and the urban people to develop their small industries in other areas of manufacturing.

The major active ingredients of the mosquito coil are pyrethrins, containing for about 0.3–0.4% of the repellent coil mass (Lukwa et al., 1998).

The primary operation of a mosquito repellent coil making machine is the stamping operation as stated earlier. An automatic and Pad Printing Machining will be taken into consideration (D.S. Welkar et al., 2005). In this type of stamping machine, the machine uses the working principle of a microcontroller. The rubber stamping machine runs smoothly, faster and produce high quality stamping product using PLC with desired process sequence (Ravipothina et al., 2008). This works on automatic pneumatic stamping machine with the help of a transformer, air compressor, solenoid switches and microcontroller. The general purpose of this machine is to provide automatic pneumatic stamping machine with low power consumption, and effective performance. An environmental and cost analysis of stamping sheet metal parts. An automation unit was developed, so that the machine can easily be adopted in automated plant. It includes Geneva mechanism use for various machine process. The high pressure is achieved in this wheel and the crank reduce the fluctuation of pin, so the best output can be achieved (Aditya Kathar et al.,2017). In this machining process pneumatic control system is used. The general purpose of the present invention, which will be described subsequently in greater details, is to provide a portable automatic pneumatic stamping machine which has many advantages of the low power consumption and effective performance.

1.1. ACTIVE INGREDIENTS IN MOSQUITO REPELLENT COIL

The major active ingredients used in the production of mosquito repellent coil are pyrethrum, pyrethrins, allethrin, esbiothrin, meperfluthrin, butylated hydroxytoluene(BHT), piperonylbutoxide (PBO).

1.1.1. PYRETHRUM

Pyrethrum is a natural plant oil that occurs in the two species of pyrethrum daisy, Tanacetumcinerariifolium from the Dalmatian region and Tanacetumcoccineum of Persian origin. The insecticidal component, comprising pyrethrins, it's found in tiny oil-containing glands on the surface of the seed case in the flower head. It is an extremely effective insecticide, while it has been used for centuries against all manner of insect pests, is relatively harmless to mammals (R.A cloyd et al., 2004).

1.1.2. PYRETHRINS

The extract of the insecticidal chemicals in pyrethrum is called a pyrethrins. They are a mixture of six chemicals that are toxic to insects. Pyrethrins are commonly used to control mosquitoes, fleas, flies, moths, ants, and many other pests.

1.1.3. BUTYLATED-HYDROXYTOLUENE (BHT)

Butylated hydroxytoluene (BHT), are compounds also known as dibutylhydroxytoluene, it is a lipophilic organic compound, a chemically derivative of phenol, that is useful for its antioxidant properties. Butylated hydroxytoluene is an antioxidant due to its ability to hunt free radicals.

1.1.4. ALLETHRINS

The allethrins are a group of related synthetic compounds used in insecticides. They are synthetic pyrethroids, a synthetic form of a chemical found in the chrysanthemum flower. They were first synthesized in the United States by Milton S. Schechter in 1949.

1.1.5. PIPERONYL BUTOXIDE(PBO)

Piperonylbutoxide(PBO) is an organic compound used as a component of pesticide formulations. It is a waxy white solid and act as a synergist. That is, despite having no pesticidal activity of its own, it enhances the potency of certain pesticides such as carbamates, pyrethrins, pyrethroids, and rotenone. It is a semisynthetic derivative of safrole (Robert L et al., 2002).

1.2. HARMFUL EFFECTS AND BENEFITS OF MOSQUITO COIL

The mosquito repellent coil can lead to fire hazard. Their use as resulted in numerous accidental fires which has taken many life's and injured a lot of people. In 1999, a fire in a South Korean three-story dormitory caused the death of 23 people when a mosquito coil was left unattended to (Trumbull et al., 2000). The smoke emitted by a mosquito repellent coil during usage contains some carbonyl compounds with properties that can produce strong irritating effects on the upper respiratory tract (Chang et al.,1998).

1.3. TYPES OF MOSQUITO COIL MAKING MACHINE

The mosquito repellent coil making machines are divided into two types,
. Automatic mosquito repellent coil making machine
. Manually operated mosquito repellent coil making machine

1.3.1. AUTOMATIC OPERATED MOSQUITO REPELLENT COIL MAKING MACHINE

Automatic mosquito repellent coil making machine works on different power sources such as electrical motors, hydraulic systems, solar power source and gas emission. Fully automatic mosquito coil making machine adopts advanced systems such as the servo motor used by precise machine tool and big tonnage high speed hydraulic system. The major advantage of an automated mosquito repellent coil making machine is that it has a tight and reasonable structure, stable operation, precise positioning of chain and better permeability of mosquito repellent coil. These machine are mainly used for production in a minimal scale and can also be used for larger scale production. They are very costly compared to the manually operated mosquito repellent coil making machine, heavy and requires high maintenance and skilled labours.

1.3.2. MANUALLY OPERATED MOSQUITO REPELLENT COIL MAKING MACHINE

The need for manually operated mosquito repellent coil making machine arises for the development of small industries and rural settlement people, such where power supplies are not stable and the power shortages are frequent, this machine works on manual power and the size of these machines is feasible and can play a big role for upgrading of peoples financial as well as economic status. Manually operated mosquito repellent coil making machines work is done with simple and basic mechanism of spring and lever. Out of all the operational machine processes, only the stamping operation requires coil mold and other operations can be done separately. The manual effort needed to stamp one double coil operation is small compared to the lather machines and lies below average power in human biceps i.e. 75 watts.

2.0. MATERIALS AND METHODS

2.1. DESCRIPTION OF MACHINE COMPONENTS

FRAME: The main frame was constructed with mild steel sheets cut into sectioned shapes.
SHAFT: The shaft is a rotating machine element, its circular in cross section, and its used to transmit power from the electric motor through the belt to the punch rod. The following stresses induced in the shafts are:

i. **Shear stresses** which are due to the transmission of torque, torsional load
ii. **Bending stresses** are due to the forces acting upon the machine elements as a result of the pulley attached as well as the self-weight of the shaft.

PULLEY: It's designed to support the movement and change of direction of the belt and it's also used to transfer power between the shaft and the belt.
ELECTRIC MOTOR: The electric motor is a device that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motors magnetic field and the electric current in a wire winding to generate force in the form of rotation of a shaft.
BALL BEARING: The ball bearing is a rolling element bearing that uses balls to maintain the separation between the bearing races.

BELT: A belt is a loop of flexible material used to link two or more rotating shafts mechanically, often parallel. Belts may be used as a source of motion, to transmit power efficiently.

STAMPING SYSTEM: **The stamping system consist of spring, punch rod,coil mold cavity**, **and coil ejecting plate. The spring is**

used for both stamping stroke and return stroke.

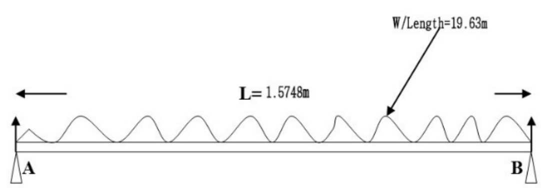
2.2. DESIGN ANALYSIS AND MATERIALS SELECTION

Fig 2.1isometric view of a mosquito repellent coil making machine

2.2.1. DESIGN ANALYSIS AND CALCULATIONS

Frame dimensions:

- Length of the frame (L)= 1574.8mm
- Breath of the frame (B)= 76 mm
- Height of the frame (H)= 914.4 mm
- Weight of the ball bearing=1.81437 kg
- Weight of the electric motor (1 hp) = 9.1kg
- Weight of other accessories= 20 kg
- Total weight on the bed=30.9144 kg
- The total weight can be assumed to be a Uniformly Directed Load DL loaded on a fixed beam
- Weight per length=30.9144/1.5748=19.63066kg/m



Directed load DL loaded on the fixed beam

Fig 2.2: Determination of reaction at point A and B

Calculations for the reactions at A and B

$\Sigma M = = -R\,L + wL$ (+ upwards) (1)

Reaction at A=30.9144/2=15.4572N

+ ↑ΣF = 0 = R + R − wL = 0 y Ay BY → R wL / 2 B ∴ = (+ upwards)

(2)

Reaction at B=30.9144/2=15.4572N

Calculation of Bending moment diagram for the fixed beam

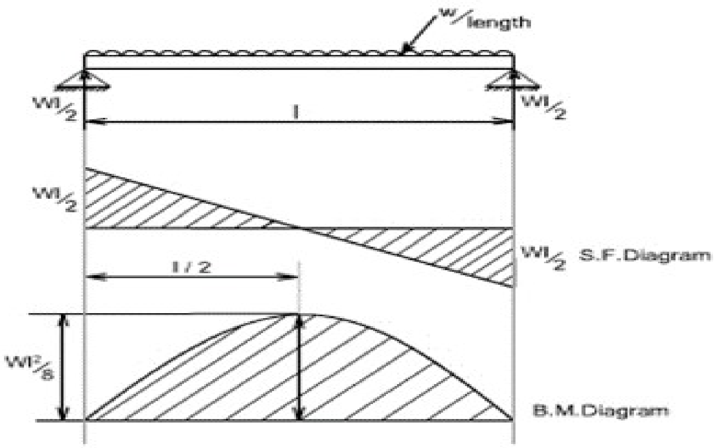


Figure 2.3: Bending moment diagram for Uniformly Distributed Load

Maximum moment (-) = MA=-WL/12=30.9144 x 1.5748/12= 4.057 Nm

Minimum moment =WL/24 at x=L/2=30.9144 x 1.5748/24= 2.0285 Nm

Since the obtained bending moment at the center and at the ends was within the permissible limits. Hence the design was safe.

Since the selected electric motor to be used is of 0.75Hp and it rotates at a speed of 1420 rpm, the minimum diameter of the pulley is 75mm according to IS: 2494-1974 and it will be selected for the electric motor pulley. Using standard equation, the diameter of the driven pulley can be determined as follows:

$d_1N_1=d_2N_2$ (3)

Parameters used

Where:

d_1 is the diameter of the driver pulley

d_2 is the unknown diameter of the driven pulley

d_1=75mm

d_2=?

From equation (3), d_2 can be obtained by:

$d_2 = \frac{(d1)(N1)}{(N2)}$ (4)

The machine is designed so that the speed of the shaft and the driven pulley is 50% of the natural speed of the system.

Therefore, speed of the larger pulley N_2

$$N_2 = \frac{50}{100} * 1420 = 710\text{rev/min}$$

$d_2 = \frac{1420 * 75}{710}$ = 150mm = 0.15m

$R = \frac{D}{2}$ = 75mm = 0.075m

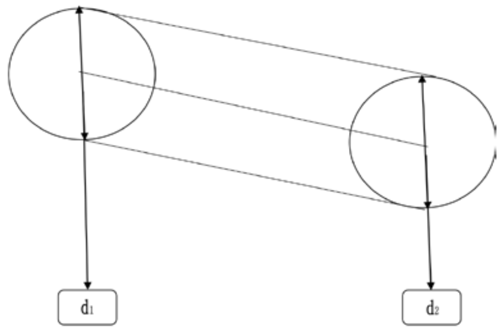


Fig. 2.4: Pulley diagram

DESIGN ANALYSIS FOR ELETRIC MOTOR

The electric motor serves as the power source and it also provides the drive for the machine. The electric motor, which is used to run the transmission belt, have a speed of 1420 rpm. Since the speed of the electric motor exceeds 100 rpm then, vibration will occur but a dimmer switch can be used as a regulator to reduce the speed of the electric motor. The power of the electric motor can be calculated as follows:

The machine is designed to use 3hp electric motor (1hp) electric motor
1hp = 746W
Torque transmitted by electric motor; it is given by:

$$T = \frac{P}{W} \quad (5)$$

P = Power transmitted by electric motor
ω= angular speed of the electric motor

$$\omega = \frac{2\pi N}{60} \quad (6)$$

N = Speed of rotation of the electric motor = 1420rev/min
Since 1hp electric motor is needed

1 hp = 746w

$$\omega = \frac{2*3.142*1420}{60} = 148.7\frac{\text{rads}}{\text{sec}}$$

$$T = \frac{P}{\omega} = \frac{746}{148.7} = 5.017\text{NM}$$

BELTS SIZE AND GRADE:

For a better performance of the machine, using relationship for speed ratios less than 3 the chosen Centre distance between the driver and driven pulley (centre M) can be determined.

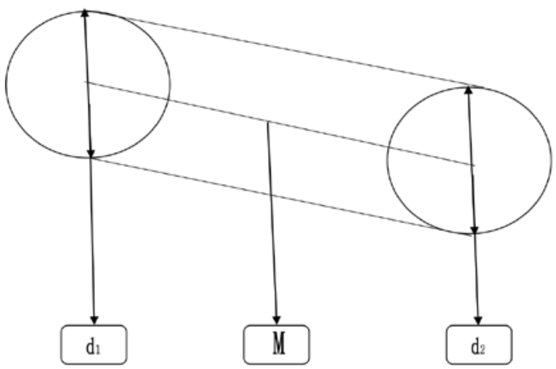


Fig. 2.5: Pulley and belt diagram (center M)

The above diagram simply illustrates the position of the two pulleys and the belt linking the two pulleys together indicating the position of the center M

$M = \frac{3d_1 + d_2}{2}$ (7)

$M = \frac{3(75)+(150)}{2} = 187.5mm$

The length of the belt can be calculated using

$L = \frac{\pi}{2}(d_1+d_2) + 2M + \frac{1}{4M}(d_1+d_2)^2$ (8)

$L = \frac{\pi}{2}(75 + 150) + 2\ (187.5) + \frac{1}{4\ (187.5)}(75 + 150)^2 =$ 796mm.

For Class A belts the inside length can be obtained by subtracting 36 from the pitch length.

The inside length=796-36=760mm

CROSS SECTIONAL AREA OF THE BELT

The angle of contact (θ) for both the driver and the driven pulley as to be calculated using this expression:

$sin\alpha = \frac{d_2 - d_1}{2M}$ (9)

$\alpha = \sin^{-1}\frac{d_2 - d_1}{2M}$

Where d_1 = 75 mm

d_2 = 150 mm

M = 187.5 mm,

$\alpha = \sin^{-1}\frac{150-75}{2(187.5)} = 11.537^o$

then angle of contact for the driver pulley will be as follows-

$\theta_1 = 180° - 2\alpha =$ (10)

$\theta_1 = 180° - 2(11.537^o) = 156.926^o$

In radians $156.926 \times \frac{\pi}{180} = 2.739\ rad$

And to determine the angle of contact for the driven pulley

$\theta_2 = 180° + 2(11.537^o) = 203.074°$ In radians

$203.074 \times \frac{\pi}{180} = 3.544\ rad$

Since both the driver and the driven pulleys selected are of the same material, the selected coefficient of friction will be same and this equal 0.30.

SHAFT DESIGN

Mass is given as the product of volume and density.
Volume of the circular plate = Area x length

Area = πr^2 (11)

= 3.142 x 133.35 = 418.99 mm^2

length = 266.7 mm

volume = area x length (12)

= 418.99 x 266.7

= 111,744.633 mm^3 = 1.117446 x 10^{-4} m^3

Mass = density x volume (13)

= 7850 x 1.117446x 10^{-4}= 0.8772 kg

Small cylinder attached to the circular plate

Volume of a cylinder = $\pi r^2 h$ (14)

Radius = 30.48 mm

Height = 91.44 mm

Volume = πx30.48^2 x 91 .44 = 266,879mm^3 = 2.6688 x 10^{-4} m^3

Mass = density x volume = 7850 x 2.6688 x 10^{-4} = 2.095 kg

Total mass of the cam = 2.095 kg + 0.8772 kg = 2.9722kg

This mass form a uniformly distributed load

= 2.9722 x 9.81 = 29.157 N

$\frac{29.157}{0.8}$ = 36.45 N/M

Calculating for the reaction we have,

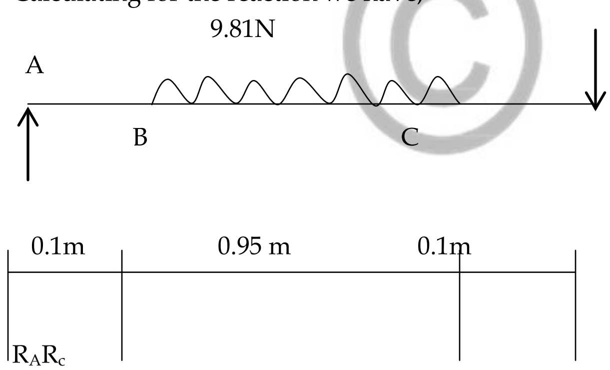


Figure 2.6: Bending Moment Reaction Diagram

Taking moment around C

1.05R_A + 9.81 x 0.1 = 29.157 x 0.475 (15)

R_A = 12.2558 N

Therefore, R_c is calculated as

Total load -R_A = (9.81 + 29.157) – 12.2558 = 26.7112 N

The maximum bending moment is determined for this design.

Bending moment

The bending moment at B

MB = 0.1 R_A

(16)

= 0.1 X 12.2558 = 1.226

The bending moment at C

MC = - (9.81 X 0.1) = -0.981 NM (17)

Referring to the shear force diagram at B, the shear force rises to 12.2558 NM, and then falls at mid-point. Hence the point P, at which it is Zero, is distant

$$= \frac{12.2558}{36.45} = 0.3362 \text{ from} B$$

At P considering forces to the left MP

$$12.2558(0.1 + 0.3362) - \frac{(36.45 \times 0.34 \times 0.34)}{2} = 3.239 \text{ N}$$

Recalling Tresca Theory of Failure

$$T_d = \frac{16}{d^3}(M^2 + T^2)^{\frac{1}{2}} \quad (18)$$

And introducing the fatigue factors

$$d^3 = \frac{16}{\pi \tau_s}(KbM^2 + KtT^2)^{\frac{1}{2}} \quad (19)$$

Where

D = diameter of the shaft

M = Maximum bending moment

T = Torque transmitted by the belt drive

T_d = Design shear stress

Horse power rating of the Electric motor

1 H.P = 746 W

Speed of the driven pulley is expected to 710 rpm

Ns = 710 rpm

Power = Torque x Angular velocity in rad/s

$$\text{P} = \text{TWW}$$

$$= {}^{\text{P}}/_{\text{W}} = \frac{746 \times 60}{2 \times \text{Ns}} = \frac{746 \times 60}{2 \times 710} = 31.52 \text{ NM} \quad (20)$$

To calculate the diameter from equation (19) we have

$$d^3 = \frac{16}{\pi \tau}[(1.5 \times 3.239)^2 + (1 \times 31.52)^2]^{\frac{1}{2}}$$

The shaft is design to have the maximum allowable shear stress of

$$\tau_s = 100 \ Mpa$$

Kb and Kt are Combine shock and fatigue factors for bending and torsion. The recommended value for Kt and Kb are 1.5 and 1.0 for steady loading (Khurmi 2005),

$$\frac{16}{3.142 * 100 \ mpa}\sqrt{(1.5 * 3.239)^2 + (1 * 31.52)^2}$$

$$d = 0.03823m3\text{m}$$

$$d = 38.23 \text{ mm} \quad (21)$$

DESIGN ANALYSIS FOR STAMPING SYSTEM

Stamping force required to stamp coils in one operation is

Stamping force = shear strength of material× perimeter of area to be stamped

F= % penetration × $\tau_s \times t \times L$ (22)

Where L=arc length of spiral

Arc length of spiral is given by-

Outer diameter of spiral is 145mm, i.e. coil outer diameter will be 145mm.

$$L=\int_0^n \sqrt{r^2 + (\frac{dr}{d\theta})^2 d\theta} \quad (23)$$

$$r = \alpha + \beta\theta \quad (24)$$

r = distance from the origin,

α= start point of the spiral,

β=affects distance between each arms.

The distance between each arm is

$$\frac{145-0}{4.25} = 34.12$$

$$\beta = \frac{34.12}{2\pi} = 5.43$$

n = end angle after 4.25 turns

$= 4.25 \times 2\pi = 8.5 \times \pi = 26.7035$

Now,

$r = 0 + 5.43\theta$

where the θ, thickness (t) = 0.0035m

shear strength (Ʈs) of the stock material = 0.01Mpa ;$^0/_0$penetration= 0.98 Therefore,

$$L=\int_0^{8.5\pi} \sqrt{(5.6172\theta)^2 + \frac{d}{d\theta}(5.6172\theta)^2}\, d\theta = 5{,}109.9\text{mm} \quad (25)$$

Stamping force =$^0/_0$penetration × Ʈs × t × L

$= 5.109.9 \times 0.01 \times 10^6 \times 0.98 \times 0.0035 = 175.27\text{N}$ (26)

Design of spring

A helical spring is used for our design. For spring design, following data is important.

Minimum load acting on spring due to mold weight is 40N

Maximum load acting on spring due to leverage is 175.27N

Wahl's stress factor=1.15(assume)

Spring material is carbon steel

Design factor of safety is 1.25

Allowable yield stress in shear = 840MPa

Endurance stress in shear = 323MPa

With reference of Design Data book for Machine element by

B.D. Shivalkar and Machine Design by R.S. Khurmi,

Spring Index C from Waal's stress factor,

From Khurmi

Shear stress factor

$$Ks = 1 + \frac{1}{2c} = 1.05 \quad (27)$$

Spring Wire diameter,

$$d = \frac{D}{C} \quad (28)$$

Shear stress factor

$$Ks = 1 + \frac{1}{2c} = 1.05$$

Mean load,

$$W_m = \frac{wmax + wmin}{2} = \frac{175.27+40}{2} = 107.635N \quad (29)$$

Variable load,

$$W_v = \frac{wmax - wmin}{2} = 67.635N \quad (30)$$

Mean shear stress,

$$\tau_M = K_S \text{ X } \frac{8Wm\, xD}{\pi \text{ x } d^2 \text{x } d} = 1.05 \text{ x } \frac{8 \text{ x } 107.635 \text{ x } dxc}{\pi \text{ x } d^2 \text{x } d} = \frac{2877.95}{d^2}$$

Variable shear stress,

$$\tau_v = K_S \text{ X } \frac{8Wv\, xD}{\pi \text{ x } d^2 \text{x } d} = 1.05 \text{ x } \frac{8 \text{ x } 67.635 \text{ x } dxc}{\pi \text{ x } d^2 \text{x } d} = \frac{1808.43}{d^2}$$

d = 2.5328 mm

For better long life, spring selected is SWG10 having standard wire diameter 2.5328 mm

D = 2.5328 X 10 =25.328mm

Design of punch or stamping rod

Length of punch rod

Critical load on punch is

$$P_r = \frac{\pi^2 EI}{4L^2} \quad (31)$$

Where, E = Elastic limit = 206GPa

$$I = \frac{\pi}{64} \text{ x } d^4 = \frac{\pi}{64} \text{X}18^4 = 5152.99 \text{ mm}^4 = 5.15299 \text{ x } 10^{-9} \text{ m}$$

L = length of punch rod

With reference of Design Data book for Machine element by B.D. Shivalkar the maximum critical load acting on rod is 29,102N

So the length of the punch rod can be obtained as follows:

$$29102 = \frac{\pi^2 206 \text{ x } 10^9 \text{x } 5.15299 \text{ x } 10 \text{ ^ } -9}{4L^2}$$

L = 0.3m = 300m

Maximum length = L_{max} from equation (31)we have

$$175.27 = \frac{\pi^2 206 \text{ x } 10^9 \text{x } 5.15299 \text{ x } 10 \text{ ^ } -9}{4Lmax^{\,2}}$$

Lmax = 3.865.71 m = 3865.71mm

L_{max} is the length of rod at which 175.27 N force is sufficient to start buckling, so length less than L_{max} should be safe in buckling.

2.2.2. MATERIALS SELECTION

The various materials used in the fabrication of an automated mosquito repellent coil making machineis listed below:

N	NAME	MATERIAL USED
1	Frame	Mild steel
2	shaft	Mild steel
3	spring	Mild steel sheet
4	Punch Rod	Mild steel
5	Pulley	Cast iron
6	Electric motor	Cast irons with windings
7	Bolts	Mild steel
8	Belts	Alloy rubber
9	Frame	Mild steel
10	Ball Bearings	Cast iron
11	Coil mold cavity	Casting
12	Coil Ejecting plate	Steel sheet
13	Damper	Rubber

2.1 FABRICATION OF THE MACHINE

Frame
The stand of the machine was fabricated with angular mild steel bar of cross section 305mm x 760mm. the angular mild steel bar was chosen because of its rigidity, availability and relatively cheap. A mild steel sheet of 5mm x 305mm x 760mm was brushed. The angular bar marked out shape. The cut out sheet was folded to the required shape.

Shaft
A mild steel bar of 35.8mm x 1000mm was mounted on the lathe chuck. Both ends were faced and then the rod turned into the designed diameter.

Punch rod
A rod which initial length was 12m was and diameter 5m was reduced into the desired shape using a lathe machine. This rod serves as the punch rod and the follower to the cam. Also the coil mold cavity is welded to this punch rod

Coil mold cavity
Mosquito coil mold die is made by casting into special shape having cavities for stamping coils. A steel rule die is used to make the coil mold cavity. Steel rule die is used for cutting material into shapes as desired.

3.0. RESULTS AND DISCUSSION

The machine imprints the spiral coil shape into the mixed chemicals to be used and there by forms a mosquito repellent coil. The basic chemicals used are cow dung, fragrance, and engine oil. The cow dung and the fragrance is mixed together on a rectangular plate which will serve as the ejecting place while a small quantity of engine oil is applied on the ejecting plate to make it slippery for easy removal of the formed shaped from the plate.

3.1. THE PERFORMANCE EVALUATION

The performance evaluation of this small-scale mosquito coil making machine is done by determining its efficiency with respect to existing mosquito repellent coil making machine. At a speed of 950 rpm the machine becomes more effective

S/N	Composition of the chemical used	Thickness (mm)	Time taken(seconds)	Efficiency (%)
1	Mixed Chemical used without fragrance	2.00	4	65
2	Mixed Chemical used with little fragrance	1.5	4	80
3	Mixed Chemical used with more fragrance	1	4	40

4.0. CONCLUSION

The mosquito repellent coil making machine was fabricated and tested. It was found to be effective and efficient at a speed of 950 rpm and the stamping operations occurs per 4 seconds immediately the machine is put on. Based on the construction materials selection and quality of fabrication work, the machine is durable and expected to last for 5 years. This machine is affordable since the cost of production is low about $150.

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