Design and Fabrication of Powerless Agerbatti Machine

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Abstract- *The design and fabrication of a low cost pedal operated incense-stick making machine to alleviate the labor intensive work associated with the production of bamboo-cored incense sticks is outlined in this paper. The machine is based on the mechanism of extruding the incense stick paste over the bamboo stick. The main components of this machine include a foot-pedal, a compound gear system, rack and pinion system and an extruder. As the paste used is of a semi-solid nature and a high force was needed for extrusiona suitable two-stage compound gear system and a foot-pedal was designed. The lever and gear system was designed ergonomically so that the applied force results in a minimal muscle fatigue for the operator.*

Keywords- incense stick making machine; gear ; rack and pinion; piston; cylinder; foot-pedal; ratchet ; extruder

I. INTRODUCTION

Incense sticks called agarbattis in India, are becoming internationally known as a ritual product used for spiritual purpose producing fragrance for aromatherapy and meditation. The agarbatti workers in rural areas lack efficient tools and education to develop better means of processing agarbattis. The current manual mixing processes are physically exhausting and time consuming. The incense sticks industry employs around half a million poor women. Thus, there is a need for design and fabrication of a manually operated machine for productions of quality incense stick. A machine that does not require any external power supply and has simple operation compact and affordable is to be designed for good production rates. Incense sticks industry is a 1800 crore industry India [1]. Every year more than 1000 billion sticks are produced and the market is growing at a rate of 7% per year. India exports close to Rs. 350 crore worth of incense sticks every year. There are about 5,000 incense companies in India which take raw un-perfumed sticks hand-rolled by approximately 200,000 women working part-time at home, apply their own brand of perfume, and package the sticks for sale. An experienced home-worker can produce 4,000 raw sticks a day. There are about 25 main companies, who together account for up to 30% the market, and around 500 of the companies, including a significant number of the main companies, are based in Bangalore [2]. The cost of an automatic incense-stick machine, pedal-driven machine, motor-driven semi-automatic machine, starts from INR 80000, INR 20000 and INR 32000 respectively.

II. MOTIVATION

The workers in the agarbatti industry face severe health hazards ranging from bruising of palm-skin to back-pain problems and are paid a pittance for such arduous work. A machine that will reduce the labour of incense-stick making is needed, as about 0.5 million women workers in India are involved in the industry [3]. Development of such a machine will not only aid these workers in making incense-sticks but will also provide livelihood opportunities for other poor women workers who are either unemployed or are involved in challenging and labour-intensive non-cottage industries. With such a machine they will be able to make more sticks in the same given time, eventually earning more money.

III. AIM AND OBJECTIVES

The aim of the project is to design a manually operated agarbatti making machine for micro enterprises in India focusing functionality, ergonomics and safety.

Objectives of the project are:

1. To collect data of existing designs through product study, visual design exploration, user study and market study.
2. To develop a simple mechanism to convert the manual input into force required to carry out the extrusion process for making the incense stick.
3. To design components of right sizes and material to make the machine strong and reliable at an affordable cost.
4. To design to make the machine compact and to attain a satisfactory rate of production.

IV. SCOPE

Scope of the project is confined to design and fabrication of an incense stick machine for the incense stick of

diameter of 3 mm and 6-7 inches in length. The production rate af machine will be 30 sticks per minute , the projects includes desing , fabrication , production of insences sticks and also inspect it.

V. DESIGN AND DEVELOPMENT

1. Market Survey

The currently available incense stick making machines in the Indian market are of manual, automatic and semi-automatic. Comparison of the three types of machine is shown in table 5.1.

Table 1. 5.1 Comparison of machines

Feature	**Manual**	**Semi-automatic**	**Fully automatic**
Electricity supply	Not required	Required	Required
Human effort	More	Less	Negligible
Electronic components	None	Less	More
Cost (in Rs.)	17,000	55,000	95,000
Production rate (no. of sticks/min)	30-60	180-200	250-300

2. Mechanism

The foot pedal actuates the ratchet and pinion which is on the same shaft of the first gear of the gear train. The second gear is co-axial with the pinion of the rack and pinion arrangement which drives the piston. The rack pressurizes the incense paste which is fed into the cylinder and pushes the paste into extrusion housing. The block diagram of the mechanism is shown in figure 5.1.

3. Prototype model and components

The prototype model is designed to transmit the force applied on the foot pedal to the piston in the cylinder which contains the agarbatti paste. This compressive force then causes the extrusion of the agarbatti stick. The prototype model has been shown in fig.5.2. The major components of the prototype model are:

1. Die kit
2. Extrusion housing
3. Cylinder and piston
4. Rack and pinion
5. Gear

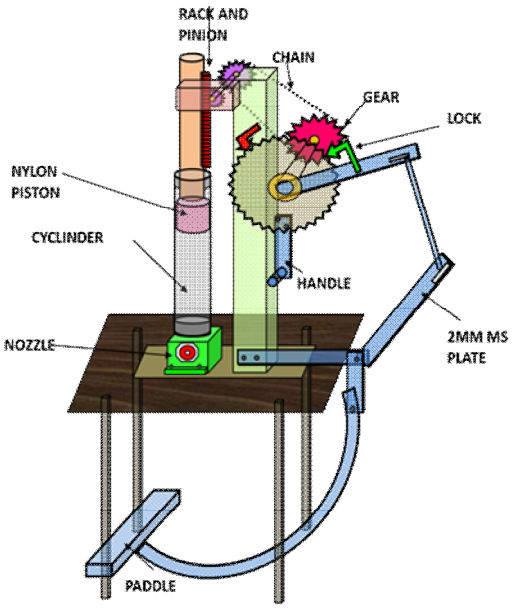

Figure 1. mechanism of system

4. Design Specifications

The following is the list of various parameters of the components that were designed:

Table 2. 5.2 Design summary tables

	Length (mm)	Diameter (mm)	Module (mm)	No. of teeth	Thickness (mm)
Rack	450	30	3	58	-
Pinion	-	40	3	14	50
Gear 1	-	81	3	20	20
Gear 2	-	135	3	80	20

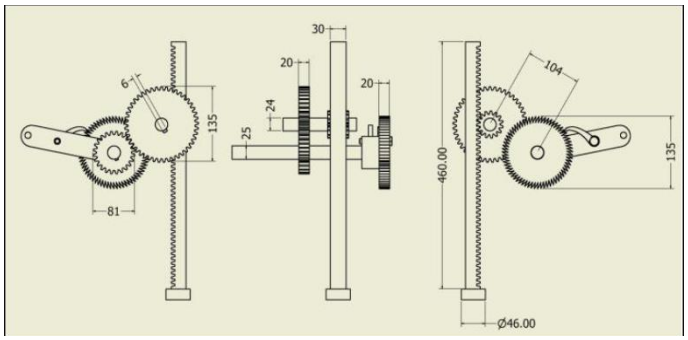

Figure 2. Transmission mechanism dimension specification


Figure 3. Side view of prototype


Figure 4. Front view of prototype

5. Design Specifications

A) Calculation of spur gear

Profile of the Gear is 20° full depth
∴ Number of teeth to avoid Interference=17
∴ Number of teeth on Pinion=20 teeth
∴,Number of teeth on Gear=20 x 4=80 teeth

1) DETERMINATION OF MODULE(PSG 8.13A) m≥

$$1.26\sqrt[3]{\frac{[M_t]}{y.[\sigma_b].\Psi_m.z}}$$

m=3mm

∴b=10 x 3=30mm

4) CHECKING FOR STATIC CONDITION (PSG 8.50)

By Lewis Equation, $F_s=\sigma_b.m.b.\ y_p$

F_s=175x3x30xπx0.1084

F_s=5363.6 N=5.36 KN

2. CHECKING FOR DYNAMIC LOADING

From PSG 8.50, $F_d=P_t.\ C_V$

But, $P_t=\frac{P}{V}=\frac{350}{0.251}$=1.394 KN

F_d=1.394x1.09=1.519 KN

∴ $F_d < F_s$

Hence,design is safe

3. CHECKING FOR WEAR STRENGTH(PSG 8.51)

$F_W=D_P$×Q×k×b

∴ F_W=6×1.667×8.794×3=263.8 kgf=2638.7 N

∴ F_W=2.638 KN

∴ $F_d < F_W$

∴ ***Design*** is safe.

Table 3. Tooth proportion

SR.NO	DESCRIPTION	PINION	GEAR
1	NO.OF TEETH	20	80
2	PRESSURE ANGLE	20° full depth	20° full depth
3	MODULE	3mm	3 mm
4	FACE WIDTH(b)	30 mm	30 mm

B) Calculation of welded joints

The maximum load which the frame can carry for transverse fillet weld is,

P = 0.707 x S x L x f_t

Where, S = Size of Weld=5mm, L=contact length = 50mm

$f_t = \frac{2000}{0.707 \times 5 \times 50}$

f_t =11.31 N/mm^2

Since,the calculated value of the tensile load is smaller than the permissible value as ft=56N/mm^2.
Hence,welded joint is safe.

C) Design of shaft

Only Torsonal stress will induced in the system

$\therefore M_b = 0$

$\therefore M_t = P_t \times D_p / 2$

$\therefore M_t = 1.394 \times 30$

$\therefore M_t$ =41.82 KN.mm

Now,ShaftMaterial=C-45

σ_{yt}=360N/mm^2

[ς]=36N/mm^2

For Key, [ς]=36×0.75=27 N/mm^2

Now, $M_t = \frac{\pi}{16} \times d_s^3 \times [\varsigma]$

VI. COST ANALYSIS

The total cost incurred for the project is shown below in the Table 6.1. The cost includes procurements of individual components as well as their fabrication cost

Table 4. the Queuing parameters of the system

Component	**Cost (Rs.)**
Extrusion housing	1500
Die	2000
Side plates	900
Gears	1500
Cylinder	500
Rack and pinion	850
Bearings	800
Shaft	500
Powder and sticks	400
Miscellaneous	2500
Total Cost	**11550**

VII. RESULT

The fabricated machine was found to work as expected with a production rate of 30 incense sticks per minute. Each refill of paste in the cylinder was observed to give up to 190 incense sticks, which is close to the theoretical value of 200.

VIII. CONCLUSION

It has been demonstrated that the mechanism developed makes good quality incense-sticks. The incense stick machine is cheaper than existing machines in the market, and the foot-pedal causes less fatigue so is easier to operate. The quality of incense-sticks, various cross-sectional shapes and length that can be produced by the machine cannot be otherwise achieved manually. It is felt that this incense stick machine can succeed as a viable product in India.

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