DOUBLE ROLLER COTTON GINNING MACHINE: ITS DRAWBACKS AND POSSIBLE MODIFICATIONS

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ABSTRACT

Detail design study revealed that present Double Roller (DR) Gin carries several drawbacks. In order to remove these drawbacks two conceptual modified models of DR gin were designed using Pro/ENGINEER software. Best design of modified DR gin found to be simple in operation, energy efficient, requires minimum operational cost, and consumes less spares. Saving in space requirement of the machine is observed to be 54 %. This modified design minimized lubricating points and application of grease. This design facilitates precise control over roller pressure. Machine manufacturing is very easy. This machine is very sturdy and operator friendly.

INTRODUCTION

Textiles constitute an important component of India's economy. Ginning is the first and most important mechanical process by which seed cotton is separated into lint (fibre) and seed and machine used for this separation is called as gin. There are mainly two types of gins (i) roller gins- most commonly used in India, Egypt, Uganda, Tanzania etc. and (ii) saw gins- extensively used in countries like USA, China, Australia, Uzbekistan etc.. Both type of gins are noted for certain advantages and disadvantages. The roller gin is used on high quality, fine fibred, extra-long staple cottons because of its tendencies to maintain fibre length and low nep levels as opposed to the adverse effects on these characteristics by the saw gins. Double roller (DR) gins are commonly used in rural India for ginning and producing about 2.8 million tonnes of lint [1]. In India about 50 000 DR gins are working in around 4000 ginning factories and there is demand of around 1500 DR gins every year towards new addition as well as replacement of old one. During

1700's some developments using roller principle followed and in 1840 Fones McCarthy invented single roller gin [2]. The British Middletone model of DR gin used 40 inches (1016mm) roller length while the American Foss model DR gin used 60 inches (1524mm) long roller [2]. Britishers introduced Middleton Double Roller gin manufactured by Platt Saco Lowell (UK) Ltd and Monforts M. Gladbach (Volkart) DR gin in India in the beginning of 20th Century. After India's independence Indian manufacturers have started manufacturing DR gins similar to Middletone DR gin and Monforts DR gin and major technological design modifications were not implemented for the improvement of the machine.

PRESENT DESIGN AND WORKING PRINCIPLE OF DOUBLE ROLLER GIN

It consists of two spirally grooved leather roller pressed against a fixed knife, are made to rotate at about 90-120 rpm. Two moving blades combined with seed grids constitutes a central assembly known as beater which oscillates by means of a crank or eccentric shaft, close to the fixed knife. When the seed cotton is fed to the machine in action, fibres adhere to the rough surface of the roller are carried in between the fixed knife and roller in such a way that the fibres are partially gripped between them. The oscillating knife beats the seed and separates the fibres. This process is repeated for number of times and due to push-pull-hit action the fibres are separated from the seed, carried forward on the roller and dropped out of machine. The ginned seeds drop down through the grid which is oscillating along with beater.

Drawbacks in Present Design of DR Gin

Detail design study revealed that present DR gin carries several drawbacks. One of the most important drawbacks is complicated power transmission system. It includes six planetary gears which not only oscillates beater at 960 oscillations per minute but also rotate the rollers at 95 rpm as shown in Fig. 1. Nineteen teeth gear is fitted on main shaft, which transmits the motion to the gear having 89 teeth so that it rotates with 205 rpm. Gear with 46 teeth is fitted on the same shaft on which gear with 89 teeth is fitted. This gear (with 46 teeth) is transmitting motion to helical gear having 99 teeth which rotates the leather roller (left hand side) at 95 rpm and in clockwise direction. To rotate right hand side roller, the drive is taken from matching gear having 46 teeth so that direction is changed i.e. (anticlockwise) and this gear then transmitting motion to helical gear having 99 teeth which rotates the leather roller (right hand side) at 95 rpm. This system requires about 20 kg grease or 18 litre lubricating oil per machine per season. This grease/oil due

to leakage fall on the floor surface, and damages the lint quality, which is considered as serious contamination worldwide.

Attachment Fig.1	
Fig. 1 Conventional Double Roller Gin	

In present design, 21 bearings of different sizes and types are used which makes the maintenance complicated and costly. Also lubrication points are more i.e. 18 in number (Swing lever 8 points, hub 1 point, wrist pin 1 point, gear side pipe 2 points, weight lever 4 points, beater shaft 2 points). Uniform pressure between fixed knife and roller plays an important role in quality and out put of the lint. In present design the roller is pressed against fixed knife with the help of hanging dead weights (total weight of 1158 N i.e. 324 N and 255 N/roller on gear box side and offside respectively) mounted on the weight lever of 495 mm in length. This method does not ensure uniform pressure between roller and fixed knife, occupies more space, and also makes it difficult to remove the roller for maintenance. Presently rollers are made of chrome composite leather washers and wear rate of roller is 0.02 mm/h of working (i.e. it has life of around 1200 working hours). Besides this in rainy season it has tendency to absorb water and get swelled to reduce the life of material further. Studies revealed that chromium particles generated during the process of ginning produce deleterious effect on the people working in the vicinity [3].

Theoretically energy required to remove 1 kg lint (fibres) varies between 1075 to 2775 joules but actual energy consumed by present DR is about 118000 joules/kg lint. This is about 60 to 120 times more. This poor energy utilization efficiency is mainly due to improper design of gearbox, unscientific way of applying pressure etc. Machine noise level is reasonably high (93 dB) due to the reciprocating action of beater and gearbox. Noise levels of 85 dB and above have shown to cause hearing impairment after prolonged

exposure [4]. Study conducted on commercial ginning factory for past three years revealed that spare parts repairs and replacements and maintenance cost including grease/oil per season was found to be around 25 % of the initial cost (Rs. 40 000) of the machine because of drawbacks mentioned as above.

POSSIBLE CONCEPTUAL DESIGN MODIFICATIONS AND EXPECTED IMPROVEMENTS

In order to remove drawbacks mentioned above, two conceptual modified models of DR Gins were designed using Pro/ENGINEER software and after detailed analysis, better design is used for actual fabrication.

First Conceptual Design

In first proposed conceptual design, arrangement of separate electric motors 1 hp each is provided to rotate both the roller. Two shaft mounted speed reducers are attached to both the leather rollers separately (Fig. 2).

Attachment Fig.1	

Fig. 2 First Conceptual Design

Power transmission from motor to shaft mounted speed reducer is achieved by pulley and V-belt arrangement. Separate electric motor of 1 hp is used for beater movement. Crankshaft with eccentric is used to convert rotatory motion of shaft into reciprocating

motion of beater shaft through oscillating head. The hanging weights used for applying pressure on roller against fixed knife are eliminated by providing push-pull and locking mechanism and attached to mainframe which is used to increase or decrease the roller pressure on the fixed knife. Split Coupling is provided for removing the roller for routine grooving and maintenance. The nut and screw mechanism to adjust the beater in respect of fixed knife is provided from the top of the side frames.

Second Conceptual Design

Second proposed conceptual design includes crankshaft with eccentric driven by electric motor, and flywheel with pulley & V-belt arrangement is provided to transmit power from electric motor to eccentric (Fig. 3) [5]. Power is supplied by 3 hp, 1440 rpm, 3 phase AC electric motor, which drives the main shaft at 960 rpm. This reduction in

Attachment Fig.1	Attachment Fig.1
Fig. 3 Power transmission from electric motor to main shaft	Fig. 4 Arrangement for change in direction and power transmission to roller

speed is achieved through a V-belt drive having a reduction of 1: 1.5. Reciprocating motion of beater (960 oscillations per minute) is obtained by using eccentric mounted directly on main shaft and other end of connecting rod is connected to beater shaft through oscillating head. Left hand side roller is rotated at 120 rpm in clockwise direction by a set of combination of timer or V-belt-Pulley arrangement in which drive is directly taken from main shaft. The reduction of speed from 960 rpm to120 rpm is achieved in

two stages. First stage reduction is through a V-belt drive having a reduction of 1: 4 and second stage reduction is through timer belt drive with a speed reduction of 1:2 (Fig. 4).

Idler is provided to timer/ V-belt to adjust the appropriate belt tension. Rpm of roller can be changed with change of pulley attached to roller shaft. Twenty degree full depth spur gear is mounted on main shaft. Number of teeth on gear is 60 [6]. The right hand side roller is rotated in opposite direction (i.e. in anticlockwise direction) to that of the left hand side roller. This change in direction is achieved by using identical matching gear to the gear fixed on main shaft so that rpm of both the rollers will remain same.

With this simple arrangement total planetary gearbox arrangement present in existing design is eliminated. This will also avoid the use of grease/oil and reduce the repairs and maintenance cost. Due to this modified design the number of bearing required shall be reduced from 21 to 18 only. The number of lubricating points shall also be reduced considerably.

The hanging weights used for applying pressure on roller against fixed knife are eliminated in present design by using spring loaded mechanism attached to main frame. Simple mechanism is designed for removing the roller for routine grooving and maintenance. This system is more scientific way of applying pressure uniformly and precisely on the roller and leads to more even wear-profile for rollers.

The alternate appropriate material for roller has been selected out of several materials tried in laboratory. Results of composition covering has so for given encouraging results as regard to quality and productivity of lint. The appropriate arrangement to the machine is designed to check the dust emitted during the process of ginning by way of providing proper dust arresters. Detail analysis on Pro/ENGINEER showed that this conceptual design found to be better, hence machine is fabricated. Complete gearbox design and fabricated machine is shown in Fig. 5.

Attachment Fig.1	

Fig. 5 Second Conceptual Design

PERFORMANCE EVALUATION

Performance of the machines was evaluated by ginning long staple Indian seed cotton variety named Surabhi having moisture content of 8.5 %. The ginning output of the second DR machine was found to 74 kg lint/h and fibre properties of lint viz. 2.5 % SL, UR, Mic, and Bt measured by High Volume Instrument (Uster 900) was observed to be 32.1 mm, 46 %, 3.4, 25 g/tex respectively. These results show that there was no damage to fibre properties of lint ginned on this machine. Electric power requirement of conceptual design is lower than the conventional machine. Electric current drawn during full load was found to be 5.3 A as against 8.63 A for conventional DR machine. This modified machine also requires less starting current of 14 A as against 25 A for conventional DR machine.

CONCLUSIONS

1. **The modified DR gin is simple in operation.**
2. **Machine manufacturing is very easy therefore cost of manufacturing is less.**
3. **This machine requires 30 % less energy than conventional DR.**
4. **Saving in space requirement of this machine is 54 %.**
5. **Lubricating points are less and grease is not required in the gearbox.**
6. **This machine facilitates precise control over roller pressure.**
7. **Machine requires less spares and therefore operational cost is minimum.**
8. **Cotton Quality is preserved during ginning operation.**
9. **This machine is very sturdy and operator friendly.**

NOMENCLATURE

A- Ampere; Bt- Bundle Tenacity, Maximum specific stress to rupture the fibres in g/tex; Mic – Fineness of fibre in Micronaire; SL- Span length, mm; UR- Uniformity Ratio in percentage.

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