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Research & Development of Cot Chamfering Machine

Prathamesh Kulkarni[1], Sagar Kshire[2], Shashank Patil[3],
Sachidanand Vishwakarma[4]

[1,2]*B.E. (Mech.), Department of Mechanical Engineering, GES's R.H.S. C.O.E., Nashik, Maharashtra, India.*
[3]*B.E. (Mech.), Department of Mechanical Engineering, S.I.E.R., Nashik, Maharashtra, India.*
[4]*B.E. (Mech.), Department of Mechanical Engineering, S.I.E.M., Nashik, Maharashtra, India.*

Abstract:*The objective of this paper is to deliver a predispose about an automated & system integrated machine named as 'Cot Chamfering Machine' with the help of the data obtained by thorough research and development techniques. The subsequent machine contributes to the precise delivery of sophisticated chamfering operation performed on a part named 'Rubber Cot', which is primarily used in textile industries. This prescriptive paper offers genuine concepts & overview of the research and development done on the respective machine along with the basic introduction about the same. The machine has the huge scope for development as it is being an automated & system integrated machine and the same has been portrayed in the following paper.*

Keywords: *Automation & System Integrated Machines, Chamfering, Rubber Cot, Special Purpose Machine*

I. Introduction

In most of the textile industries, the rubber cot is mainly used to support & carry the high velocity fibre/thread. Maintaining the quality of the thread is basically of paramount importance and it can be done so by the versatile rubber cot which performs consistently well - both in conventional and compact systems - spinning medium to fine cotton. The rubber cot is nothing but a small component consisting of the synthetic rubber covering on its outer diameter and aluminium core as it's inner diameter as shownbelow in the fig 1.1.

Fig. 1.1 Rubber cots with & without chamfer

This rubber cot is mounted on a high velocity rotating shaft and the fibre is made passed over it. While mounting any two circular components with respect to each other, in order to assure the proper inserting of one component over the other, a small chamfer is always provided on both sides of the component. Hence, the rubber cot is also required to be chamfered at its inner side i.e. aluminium side in order to have the proper insertion of the cot onto the shaft.

Now, being comparatively small and delicate component, the manual chamfering of every single rubber cot is a very arduous & hectic task for any operator and it is also having very minimal productivity. Having said that, due to manual operation and such monotonous task, there is however, no guarantee of the consistent good quality of operation and hence, there are higher chances of components being rejected as well. Considering everything as stated above, the manual chamfering of every single rubber cot may result in annual loss of the industry.

Owing to all the problems above, development of the automated & system integrated machine for the chamfering of rubber cots is the optimum solution as by which not only the quality of the operation will improve but the productivity will be increased as well, resulting in annual profit increment of the industry. The Cot Chamfering machine focuses on chamfering the rubber cots of various sizes simultaneously with the help of servo mechanism.

II. Objective

There are many ways to imply a chamfer on a hollow circular part. But the prime objective of this machine to provide chamfering operation on the rubber cot **'simultaneously'** on it's both ends. The cots used in the textile industries are not necessarily of same sizes i.e. they may have different diameters and lengths as per the required application. Imagine the exhaustive work if the operator were to perform the operation manually on all such varying size cots.To perform such simultaneous &effective chamfering on rubber cot with all such variations, hence the need of automated & system integrated machine.

III. Need for Simultaneous Operation

- To improve the quality of chamfer.
- To reduce the time required for the operation.
- To reduce the fatigue of the operator.
- To increase the productivity of the industry.

IV. Concept Drawing

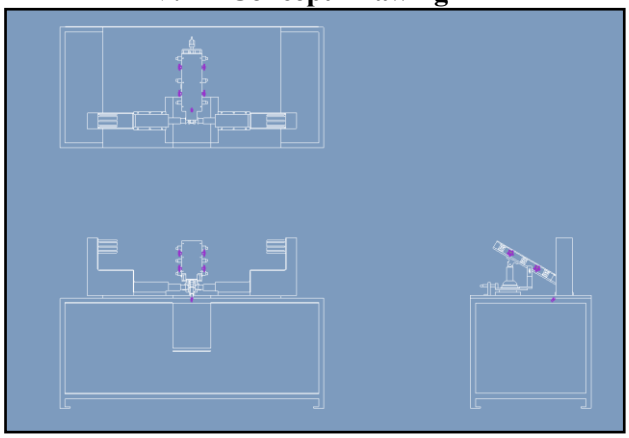

Fig. 4.1 Concept Drawing of the Cot Chamfering Machine

This is the entire concept drawing as shown in fig 4.1, consisting of base structure, base plate, two pneumatically operated spindle heads along with chamfering tools, Job Guiding Mechanism, X-Axis & Y-Axis Adjustment Mechanism, Job ejecting assembly etc.

V. Model Components

Following are the main components of cot chamfering machine -

1. Structure with Base Plate
2. Pneumatically Operated Spindle Heads with Chamfering Tools
3. Electric Control Panel
4. Job Ejection System

These are the basic components of the cot chamfering machine which were directly bought out and assembled on the machine, hence called as bought out components.

5.1 Structure with Base Plate -

The structure is composed of Mild Steel entirely and is powder coated in structured grain finish to achieve the required surface finish. The base plate is also comprised of Mild Steel having very smooth surface finish. In order to maintain the concentricity of both Spindle heads, the surface flatness of base plate is of critical issue and hence it is machined on VMC (Vertical Milling Machine). Four levelling pads are used to achieve the required level of flatness of the base plate & hence the machine.

5.2 Pneumatically Operated Spindle Heads with Chamfering Tools –

For precise required linear motion, the pneumatic control is finalized and hence the subsequent spindle head with pneumatically operated mechanism is used. The chamfering tool is manufactured externally as per requirement and then mounted on the spindle head to have required chamfering operation combined with precise linear motion.

The spindle head used is as shown in fig. 5.1& Different chamfering tools as in fig. 5.2

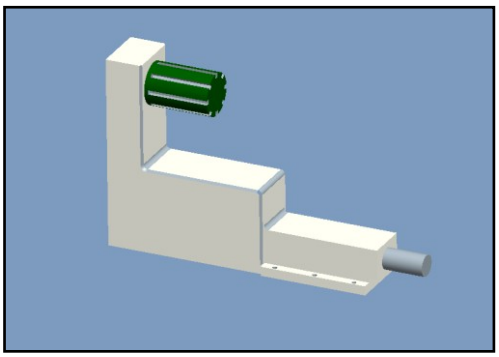

Fig. 5.1 Concept Drawing of Pneumatically Operated Spindle head

Fig. 5.2Sample Photograph of Different Chamfering Tools

Various types of Chamfering Tools like Micro chamfering tool, Universal chamfering tool, Precision chamfering tool etc. are tried with the spindle head to achieve the required operation.

5.3 Electric Control Panel -

For the machine to be completely system integrated, the electric control panel is a must and performs vital functions overall. Entire timing of the operation, precision & accuracy of the operation is controlled by the electric control panel.

This panel as shown in fig 5.3 is primarily consisted of following components –

1. PLC
2. Contactor
3. Over Load Relay
4. MCBs
5. Electric Drive
6. Main Power Switch
7. Terminal Block
8. SMPS etc.

Fig. 5.3 Actual Photograph of Electric Control Panel

5.4 Job Ejection Mechanism -

This job ejection mechanism is primarily required for the ejection of cot from the job holding fixture after the machining is done. As the job is not constrained in any way, the ejection mechanism doesn't require any complex pneumatic or hydraulic components. Just a simple and small pneumatic cylinder is sufficient enough to eject the job from the fixture. The cylinder is mounted with L bracket below the job holding fixture as shown in fig. 5.4

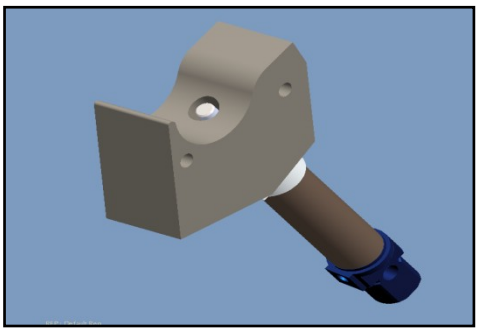

Fig. 5.4 Concept Drawing for Job ejection mechanism

VI. Development Phase of The Machine

1.1 Development of the mechanized concept –

The mechanized concept developed for the chamfering machine used the principle of vertical spindle operation.

Fig. 6.1 Actual Photograph of Cot Chamfering machine in primary phase of development

As shown in fig. 6.1, the operation is being done on the cot with the help of vertical pneumatically operated spindle head on one face only. This process used the mechanical stopper for the precise chamfering operation. However, the stopper was subjected to be changed every time the job dimensions changed along with the fixture. After that, the process consisted of operator fixing a job in the fixture and doing the operation on only one face at a time and then repeats the same procedure again for another face. This process was not very efficient when the time becomes a constraining factor. Not to mention the monotonousness of the process, the need of developing the machine for 'simultaneous' operation emerged.

1.2 Scope forDevelopment of Previous Concept –

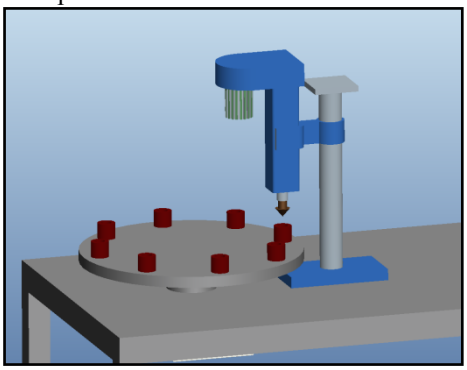

Fig. 6.2 Concept Drawing of Indexer Cot Chamfering Mechanism

In the previous concept, as shown in figure 6.1 the operation was done with the help of vertical pneumatic spindle head with mechanical stopper. However, in that mechanism, only one job was possible to do due constrained spindle head. Only Y-axis motion was allowed and there was no X-axis motion. Hence only one fixture was accommodated.

To overcome this situation, the idea of using an indexer plate with multiple job holding fixtures was implemented. As shown above in fig 6.2, this was one of the concepts for the automatic cot chamfering machine.

1.3 Development of Entirely Automated Machine –

This development phase purely consisted of improving the maneuverability of the machine i.e. providing more mechanism to accommodate any variations in the operation of the machine. In short, converting the hand operated machine to entirely automated machine. To take into account, the several issues while converting hand operated machine to automated machine, they are listed as follows –

1. Rubber cot auto feeding mechanism.
2. Job Holding fixture for different sized rubber cots.
3. X& Y-Axis Motion Mechanisms.

To overcome these critical issues, after thorough research and development, three effective solutions were devised which are interdependent on each other and are enlisted as –

Critical Issues	Possible Automated Solution
Rubber cot auto feeding mechanism.	Cot Guiding Chute.
Job Holding fixture for different sized rubber cots.	Different Fixtures.
X & Y Axis Motion Mechanisms.	Screw Jack & Slider Assembly.

Table 6.1 Critical issues & their possible solutions

6.2.1 Cot Guiding Chute -

This is nothing but a simple guiding assembly consisting of one base plate, two outer stationary plates and two sliding plates in between. The two sliding plates are held together with knobs & spring action and can be adjusted so that various sized cots can be entered easily.

As shown in fig. 6.3, the chute is kept inclined so that the rubber cots can slide/roll easily inside it and then at the machining end of chute, a job holding fixture is provided in which the cots would enter one by one and the chamfering operation is performed sequentially.

Fig. 6.3 Actual Photograph of Cot Guiding Chute

6.2.2 Job Holding Fixture -

The job holding fixture is supported by chute as well as one L Bracket below it which in turn supports/holds a pneumatic pencil cylinder. However, the fixture is limited as per one size of the job i.e. for different sizes, it is mandatory to manufacture different sized fixtures with their respective L Brackets. The pencil cylinder may remain same. The job holding fixture is as shown in fig. 6.4

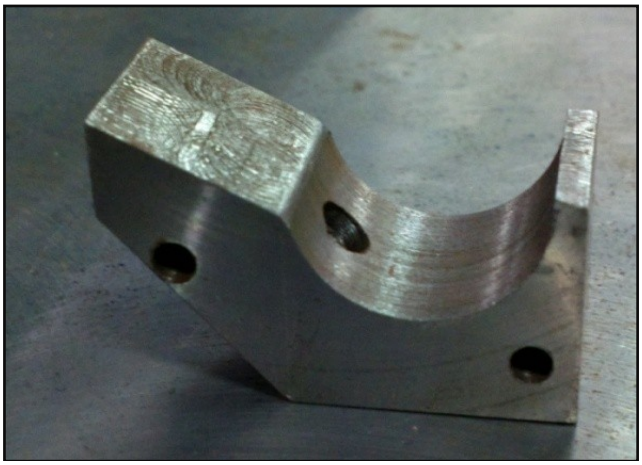

Fig. 6.4 Actual Photograph of Job Holding Fixture

6.2.3X & Y Axis Motion Mechanism –

For the rubber cot having largest size, it may be difficult to slide inside the chute which is earlier adjusted for the smaller sized cots. Hence, not only the inclination but the X-axis motion is also required to be adjusted. This X-axis motion mechanism can be achieved by either one simple bottle type screw jack, toggle screw jack, lead screws etc. As shown in fig. 6.5, a simple screw jack is used to support the chute as well as to increase the height of the chute; thereby one can adjust the required angle of inclination for the required size of the cot.

Fig. 6.5 Actual Photograph of Height Adjustment Mechanism

For Y-axis motion mechanism, when the angle of inclination of the guiding chute is changed, it is necessary to change its linear position as well to perfectly match the centers of job and two spindle heads. That means, the entire chute may either have to move forwards or backwards in Y-direction as per requirement. Hence, linear guide rails, horizontal lead screw, slider mechanism etc. can be provided to accommodate for any linear motion of the complete chute assembly. The Y-axis motion mechanism as shown in fig. 6.6 not only provides the means for linear motion but it also provides support for the screw jack assembly.

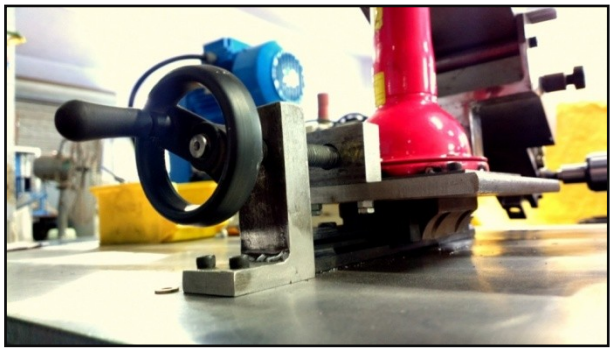

Fig. 6.6 Actual Photograph of Y-Axis Mechanism

This complete assembly is mounted on base plate in the direction perpendicular to that of motion of pneumatic spindle heads as shown in fig. 7.1

VII. Working of The Machine

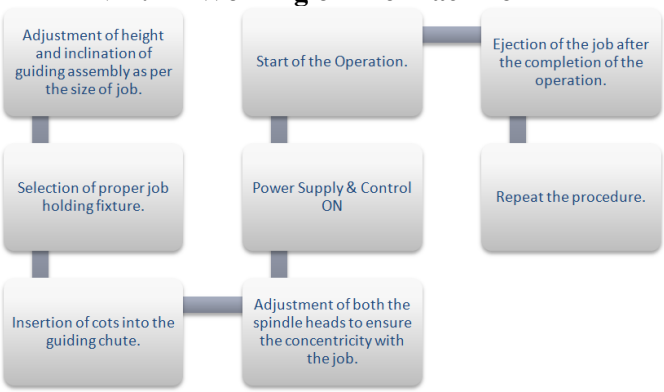

Fig. 7.1 Working of the Machine

VIII. Conclusion

From all the research, development and their implementation, it can be concluded that the precise and simultaneous chamfering operation on the rubber cot is achieved successfully by the automated & system integrated machine. The variations in the size of the rubber cot can easily be compensated but the key feature of such automated machine is that, the variations in the chamfer are also compensated without any hassle. The rubber cots, being disposable products, they are used in very high quantity throughout all the various textile industries. Hence, there is rapidly growing market for this machine in near future. This unique machine can also be used along with bowl feeder & conveyor assembly to achieve complete automatic loading of jobs in the cot guiding chute and hence, the objective of this project is thus fulfilled.

IX. Future Scope

This completely automated & system integrated machine once developed has a lot of scope for the future development when it comes to automating the entire manufacturing line in the industry. With the help of job feeding mechanisms, job carryout mechanisms & different sensors, the machine can be effectively used in any kind of chamfering operation on all different sized jobs. By providing some external & internal Poka-Yoke, machine may not need any operator to provide attention and hence, ultimately the productivity & quality of manufacturing will be drastically improved.

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