

**BUSITEMA UNIVERSITY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF TEXTILE AND GINNING ENGINEERING**

**DESIGN OF COILER MECHANISM FOR THE CARDING MACHINE IN  
THE TEXTILE LABORATORY OF BUSITEMA UNIVERSITY**

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## DEDICATION

This project is dedicated to my dear parents plus my elder sister for their selfless love and support they always offer me.

## DECLARATION

I NAKIYINGI MOURENE BU/UG/2009/80 hereby declare that this is my own and original project. It has never been done or submitted in by any other person in Busitema University or any other university or institution of higher learning.

Signed: .....  .....

Date: ..... 29/05/2013 .....



## APPROVAL


I hereby declare that this project of the title 'DESIGN OF COILER MECHANISM FOR THE CARDING MACHINE IN THE TEXTILE LABORATORY OF BUSITEMA UNIVERSITY' has been executed under my supervision and is ready for examination.

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## ABSTRACT

During fabric production, subsequent processes namely; spinning, weaving or knitting, wet processing and garmenting are followed. Spinning process has the blow, carding, draw frame, combing (optional), speed frame and finally ring frame for formation of yarn. Carding is known to be the heart of spinning since a fault in the carding process affects yarn quality. The purpose of carding is to; individualize fibres, eliminate impurities, reduce neps, eliminate of dust, and short fibres, blend fibres, orientate fibres and finally sliver formation.

On 17<sup>th</sup> January, 2013, Busitema University textile laboratory received various machines from WAGTECH, UK under the MSI Textile Engineering Project. Among these machines is a mini card (code 337A). This mini carding machine does not perform all the functions of carding; it is limited to web formation thus misses out on the formation of card sliver. The sliver is thus manually formed from the web by the machine operator using hands by folding. This makes the sliver formation process time consuming and exposes the sliver to numerous human errors related to foreign matter or imperfections formed during folding. This project therefore provided a solution to the above problems by introducing a coiler mechanism to the machine which continuously forms carded sliver.

The drum originally used to collect the web became irrelevant because the web was to be condensed by the coiler mechanism into sliver thus no more need for web collection. Therefore, the drum was thus to be unscrewed off the machine together with its drive. The components of the coiler mechanism were designed (basically size, shape and material selection). The components considered in this case included; gears for motion transfer, shafts, bearings, feed plate, trumpet, calendar rollers, coiler tube, coiler plate, card can, turn table and coiler post plus machine frame. The whole coiler mechanism was drawn and assembled using solid edge and 3-D AutoCAD 2007 as the design tools.

However, the project was too big because the mechanism had so many components. Also, literature on specific design of so many textile machinery parts is rare hence basic mechanical engineering design considerations were made.

Despite the challenges, the coiler mechanism for specifically the mini baling machine in the textile laboratory of Busitema University was successfully designed and with all the parts as mentioned earlier. The drive was picked from the doffer then given to the calendar rollers, coiler plate and turn table through gear drives with help of transmission shafts.

Recommendations have also been made to both the university and Textile engineers in Uganda. For the university to take up this project for implementation because of its advantages discussed in the report and for textile engineers to work hand in hand with mechanical engineers to start up textile machinery manufacture in Uganda so as to enable acquisition textile machinery at reduced costs since importation costs will be dogged.

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# 1. INTRODUCTION

## 1.1 Background

In textile manufacturing industries for fabric production, the following processes are generally subsequently followed namely; spinning, weaving or knitting, wet processing and garmenting. Spinning process has the blow room for opening and cleaning of fibres, carding for individualization of fibres and formation of card sliver, draw frame for alignment of fibres and removal of hooks from carding, combing (optional) for further alignment and blending, speed frame for formation of roving and finally ring frame for formation of yarn.

Carding is known to be the heart of spinning since a fault in the carding process affects yarn quality. The purpose of carding is to; open the flocks into individual fibres, clean or eliminate impurities, reduction of neps, elimination of dust, elimination of short fibres, fibre blending, fibre orientation or alignment and sliver formation.

The main parts and important regions of the carding machine are; feed plate which feeds the fibre lap to the feed roller. This then feeds the fibres to the licker-in. The licker-in has an under casing which carries out elimination of impurities before transfer of fibres to the cylinder. Above the cylinder are flats and between the cylinder and flats the following take place: opening of flocks to individual fibres, elimination of remaining impurities (trash particles), elimination of short fibres (neps also removed with short fibres), untangling the neps, dust removal and longitudinal orientation of the fibres. The main work of the card is individualization of fibres and it is done between the main cylinder and the flats only. By means of this fibre separation, it is possible to eliminate the fine dirt particles and dust. After the main carding action, the fibres on the cylinder wire points are carried around to the nearest point between the cylinder and the doffer hence web formation. The web then goes through the calendar rollers which then feed it to the coiler mechanism for sliver formation (Prof. A.R. Khare, 1999).

Uganda has some few textile manufacturing industries among which are; southern range Nyanza textiles in Jinja and Phoenix logistics in Kampala. These industries carry out all the above mentioned processes. There are no textile machinery manufacturing industries Uganda mainly because of the high technology required for the textile manufacturing processes and the high

## REFERENCES

1. Prof. A.R. Khare, 1999. Elements of carding and drawing. Textile Manufacturers departments, V.J.T.I, Mumbai-400019.
2. R.S Khurmi and J.K Gupta, 2006. A textbook of machine design (S.I Units) by Eurasia Publising House (PVT) Ltd, Ram Nagar, New Delhi- 110055.
3. Budynas-Nisbett, (2006). Shigley's Mechanical Engineering Design, eighth edition, by McGraw-Hill Primis.
4. <http://textilelibrary.wordpress.com>. (4/08/2011, 1:42:08). Card construction, setting and clothing
5. V.B. Bhandari (2007). Design of machine elements, second edition, ISBN-0-07-061141-6, 976-0-07-061141-2, published by NcGraw-Hill Company.
6. R. L. Norton, (1997). Machine Design; An Integrated Approach. (Einstein College of Engineering , Sir.C.V.Raman Nagar, Tirunelveli-12)
7. V.Tamilarasi (2004). Strength of Materials. (Lecture notes Prepared by Department of Civil Engineering).
8. E. J. HEARN(2000). Mechanics of Materials I; An Introduction to the Mechanics of Elastic and Plastic Deformation of Solids and Structural Materials. Third edition.
9. Joseph E. Shigley and Charles R. Mischke, (1996). Standard Handbook Of Machine Design, Second Edition.
10. J.D. Booker, M. Raines and K. G Swift, (2001). Designing capable and reliable products.
11. Micheal. F. Ashby, (1999). Material selection in Mechanical design, Second edition.
12. <http://textilelibrary.wordpress.com>, 28/02/2013
13. <http://asiancotton.com/files>
14. <http://www.freepatentsonline.com>