

ANALYSIS OF DESIGN ASPECTS OF TEXTILE WARPING: PART I: REVIEW OF LITERATURE

Prof. Ashwin Thakkar^{1*},

¹Head, Textile Technology Department, L. D. College of Engineering, Ahmedabad

Prof. (Dr.) Someshwar Bhattacharya²

² Dean, Faculty of Technology & Engineering, M.S. University of Baroda, Vadodara

Abstract Weaving is highly preferred method for formation of fabrics mainly for apparel purposes. Warping is an intermediate process for preparing warp for weaving process. There are many systems of warping but mainly two systems of warping viz. direct and indirect (or Sectional) are widely used. Both systems have their own set of application areas and are preferred for making particular varieties of fabrics. Much work has been done regarding process aspects of the process but not much work has been done to combine both applications into one system and thereby prepare beams which may contain any type of yarn. In this first part of a two-part series, analysis of process control parameters and their effect on reducing the production time will be discussed. Also an analysis of pros and cons of both systems will be carried out. In the second part of the series, various attempts which have made to offer solution towards reducing the capital investment and optimization of the process will be discussed.

Keywords Warping, Direct, Indirect, Creel, Beaming, Beam, Bobbin, Head Stock, Loom

1.0 Introduction

Weaving is one of three major methods of producing fabric. Woven fabrics are highly preferred for many of the apparel and home textile products and to some extent for technical textile products. Production of woven fabrics involves winding, warping, drawing-in and weaving processes apart from yarn spinning process. Yarn is packed in an individual form up to winding stage which means that the wound bobbin contains one yarn of very large length. This bobbin is useful for variety of end uses like as weft for shuttle and shuttleless loom, for knitting process etc.

The final woven fabric has several thousands of warp threads woven with weft yarn. The weft yarn is supplied directly on the loom. So producing a suitable system of supplying required number of warp threads wound for sufficient length on a suitable package is necessary to carry out the weaving process continuously. This task is done in two steps namely warping and sizing. The objective of the warping process is to convert the single yarn packages (last product of the winding process) into multi thread beam. The beam produced at the warping stage will have the several hundreds of warp yarns wound in the form of parallel sheet. The number of threads wound at a time will be decided by the creel used.

There are two most popular methods of carrying out the warping process as below: (Gandhi, 1999)

- i. Direct warping
- ii. Sectional warping

1.1 Direct warping

Direct warping is used mainly for producing beams containing mono colored warp threads. The machine comprises of two main elements namely the creel and the headstock. The process involves use of a creel where the given number of warp bobbins are mounted and from each bobbin the warp thread is taken forward up to head stock and then it is wound on a beam named warper's beam. Due to limitations of accommodating (Lord & Mohammed, 1982) a very large creel, the number of bobbins which can be taken will be limited to 1000 – 1200 only. This number is smaller than the requirement of several thousands of warp threads in the final woven fabric. So, there is one more process after direct warping for agglomerating few of the warper's beams to get the final beam suitable for use on the loom. This final beam is named weaver's beam. The process can be carried out through sizing operation where a coating of size film is applied on the final warp sheet. Alternatively the beams can be combined by a simple rebeaming process if the sizing is not required to be done.

The process of direct warping is simple but has limitation that only single colored warp can be used. Also the length of yarn to be wound per beam should be sufficiently large as the machine is running at speeds of more than 600 mpm. So direct warping is not a preferred choice for small length production. Warper's beams have the full width required finally but the number of threads are only few hundreds as mentioned earlier. So length of yarn wound on warper's beam can be very large. As many beams are to be combined at a later stage it is very

difficult to process warp yarns having patterns. Matching of the patterns will become highly complicated issue and in complex patterns will be impossible.

On the other hand the production of the system is very high so suitable and preferred for producing simple varieties at mass scale.

1.2 Sectional Warping

There are three main parts of this system: the creel, head stock and the beaming system. The creel is more or less same as that used in direct warping. Yarn is taken from creel and is brought up to the head stock in the form of a small width section. As the winding of the yarn takes place section by section, there is need to support the yarn sheet particularly when the flanges are not there. The head stock consists mainly of a one side conical shaped large drum. The angle of the cone can be fixed or variable depending on the manufacturer. Today most of the machines are sold with fixed cone angle. The yarn is mounted on the flat part of the conical drum. The width occupied by the yarn on drum will be exactly the width the same yarn will occupy on weaver's beam. As the drum starts rotating, the section of the yarn is wound on the drum and at the same time there is provision to traverse section of the yarn in such a way that shifting of the section occurs towards the raised conical part of the drum. After completion of winding of the required length, the yarn section is cut and the whole section is brought back to a point where second section will start. In similar way the winding of all the sections, as per requirement, will be carried out. So, in the end the entire yarn length is now stored on the drum. Now transferring the yarn stored on the drum to beam is carried out through a separate beaming device - an integral part of the machine. So process occurs as a two-step process.

In this system all the ends required finally will be wound on the beam so there is no need to agglomerate separate beams like direct warping. As all ends are to be accommodated on the drum, it is possible to use the system for warp having multi colored patterns. Again, as all ends have been transferred on the drum and later on on the beam, there is possibility of using the beam directly on the loom if sizing is not required to be done. Also the process will be highly preferred if small length of warp is to be processed.

On the other hand, the system has few problems like only small length of can be accommodated on the drum. So the final beam may not have very large length or many weaver's beams cannot be produced like direct warping. This system may not be suitable for mass production of simple varieties. This particular fact sometimes works in the benefit of weavers if the lot size is small. Cost of the machine is also comparatively very high and is justified only if there is sufficient requirement of suitable varieties. Lastly the machine is more complex in nature and fine-tuned calculations are required to be done to get the required characteristics of weaver's beam.

2. Literature Review

2.1 Process control parameters

As mentioned, warping is an intermediate process of converting a single package to multi-end beam. Though the process is of simple conversion, it is considered to be very essential because any flaw in the process will result as a defect in later on stage. Many papers have been published covering the effect of various process parameters on quality of beam. Some will be discussed here.

Dyer et.al. studied effect (Dyer, 1952) of various types of tensioners and concluded that compensating tensioners are not effective for use. Instead simple type of tensioner will give better result if the angle of wrap has been calculated properly for given warp yarn. According to Renner, the ever greater fluctuation of fashion trends, the wide variety in constantly smaller orders and the demand for shorter production times have affected warp preparation in the sense that it has accentuated the advantage of sectional warping over beam warping, as sectional warping produces warps of good quality. The sectional warping machines such as are available today. And the automatic winder on which packages with optimum run-off characteristics are formed, meet these requirement. Further improvements may be expected thanks to electronics and information technology (Renner, 1987). Scholze has stressed much on the quality of warp beam (Scholze, 1981) and has highlighted importance of selecting best possible warp beams to achieve higher and better output from a warping machine. The main points to be checked about quality of beam are smoothness and finish of the flanges, about the type of adapters, beam driving means in terms of fixing it on either warping machine or afterwards on sizing and loom. The aspects are to be considered separately for beams to be used for direct and indirect warping. Also beams to be used for spun and filament will have different quality parameters.

2.2 Design Parameters

Lonctaux H.J, Norton J.F and Griffis L.W. registered a patent from USA (Lonctaux, *et.al.*, 1935). This version is about sectional warping with claims of higher speed, improved control over threads and better braking mechanism. He also claimed that dividing plates with a small number of threads in a particular section can be an option. Possibility of adjusting the width between plates, in a small value, was effected by means of mechanical adjustments. Another relevant patent filed in 1961 was by Harris from Great Britain (Harris, 1960). The novel idea is about the modified design of the beam flanges and means of fixing flange onto barrel. Damage to the

yarn sometimes can occur because of rotations of flanges on to the barrel surface. Due to this sometimes scratches, cuts etc. happen on barrel surface and cause damage to some of the delicate yarns. Again damage may also occur due to lock nuts provided for fixing the flanges. Above problems are taken care of by providing new design which has teeth made on inside of flanges and barrel.

Also an important patent was registered by Erwin P. for Sulzer Brothers limited in 1978 in United States (Erwin, 1978). According to the claims made by him, the warp beam is multi-component and is made of at least two telescoping parts, with means for clamping, pressing the parts together radially from within the area of overlap. As shown in Fig 1, the clamping provided includes a wedge shaped plate pressed by means of a partially threaded spindle. This concept of beam is an extension of another patent filed by Scholze G. et.al. (Scholze, 1974) in 1974.

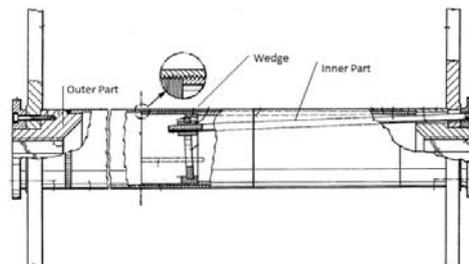


Fig. 1 Multi-component warp beam (Erwin, 1978)

Later on in 2003 a US patent was registered by Colson W.B. et.al. regarding a totally new concept of organizing the creel to be used for warping. As shown in fig. 2, the creel is arranged in a shape of circle. As per the discussion in the patent, this helps in maintaining an equal distance to be travelled by all threads while reaching the head stock and so the force required to pull the yarn will be same for all threads (Colson, et.al., 2003). A turn table that supports two or more beams is provided to facilitate the rapid switching of beams once one beam is full.

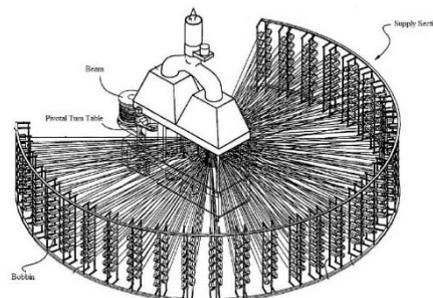


Fig. 2 Beam Winding Apparatus (Colson, 2003)

The invention by Agnihotri is about a design of an apparatus for warping high twist fine count yarn on a direct warper over a narrow width and then dyeing the same on a slasher dyeing machine. (Agnihotri, 2008) Use of narrow width beam permits better control over thread especially when higher tensions are to be applied. The pressure roller is also adjusted accordingly.

3.0 Summary

Many similar attempts have been carried out to make minor or major modifications in the current systems of direct and sectional warping machines. Most of the attempts were aimed at increasing productivity, providing ease of operation to workers, reducing the time required for creeling, providing novel means of inserting lease etc. Not many attempts have been made to provide a single system for the varieties of yarn i.e. mono colored and patterned. The work which will be presented here provides an attempt to unify both the systems in such a way that only one system will be used to warp any type of yarn.

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Unified Design of a Warper's Beam: A New Concept

Prof. Ashwin Thakkar¹, Prof. (Dr.) Someshwar Bhattacharya²

¹Head, Textile Technology, L. D. College of Engineering, Ahmedabad, India

Email: ashwin@ldce.ac.in

²Professor, Textile Engineering, Faculty of Technology & Engineering, M.S.U. of Baroda, Vadodara, India

Email: ssb_msu@yahoo.com

Abstract

Warping is an essential process for manufacturing woven fabrics. There are two systems mainly used for the same viz. Direct and Indirect. Both systems have their own set of applications. Users normally select either or both systems depending upon the requirements. While looking at the published literature, not many attempts are found which provide a single solution for warping all kinds of yarns. There are few attempts seen when patents are considered. Still it is not possible to provide the solution to the fullest. In this paper an attempt has been made to review some design modifications patented already. Also a totally new design concept has been attempted and the idea of the design for the same has been discussed. The new design offers an advantage of running both; mono colored as well as patterned warp to be used with the newly designed beam (Patent applied).

Keywords: Warping, Direct, Indirect, Creel, Beaming, Bobbin, Head Stock, Separator Plates, Drive

I. Introduction

There are mainly two systems of warping for preparing warp to manufacture woven fabrics^[1]. These systems are direct and indirect (or sectional). The former consists of preparing a full width warper's beam in one step but containing lesser number of threads, while the latter consists of preparing only one section at a time, many such sections making a full width weaver's beam^[2]. Users have their own set of application for either or both types of warping systems. The process of direct warping is simple but has limitation that only single colored warp can be used. Also the length of yarn to be wound per beam should be sufficiently large as the machine is running at speeds of more than 600 mpm. So direct warping is not a preferred choice for small length production. Warper's beams have the full width required finally but the number of threads are only few hundreds. As the number of threads are less, length of yarn wound on warper's beam can be very large. As many beams are to be combined at a later stage it is very difficult to process warp yarns having patterns^[3]. Matching of the patterns will become highly complicated issue and in complex patterns will be impossible. On the other hand the production of the system is very high so suitable and preferred for producing simple varieties at mass scale.

In sectional warping, all the ends required finally will be wound on the beam so there is no need to agglomerate separate beams like direct warping. As all ends are to be accommodated on the drum, it is possible to use the system for warp having multi colored patterns^[4]. Again as all ends have been transferred on the drum and later on the beam, there is possibility of using the beam directly on the loom if sizing is not required to be done. Also the process will be highly preferred if small length of warp is to be processed even if mono colored yarns are to be used.

On the other hand, the system has few problems like only small length of yarn can be accommodated on the drum. So the final beam may not have very large length or many weaver's beams cannot be produced like direct warping. This system may not be suitable for mass production of simple varieties. Cost of the machine is also comparatively higher and is justified only if there is sufficient requirement of suitable varieties. Lastly the machine is more complex in nature and fine-tuned calculations are required to be done to get the required quality characteristics of weaver's beam.

So, one can say that there is no single system which can provide solution to all types of yarns i.e. mono-colored and patterned warp. The articles published and the books written do not provide much insight in to the problem. But there are few attempts which have been made to provide solution to some extent in patent literature and the same have been discussed below.

II. Literature Review

Most of the books about weaving preparatory contain an account of process aspects and few talk about control of process parameters^[5, 6]. As far as the developments in the machinery is concerned one is required to go through the patent literature. There have been many attempts towards unifying both systems in to one but the machinery manufacturer and the textile goods producers still rely mainly on two main systems of warping. Following are the main areas where unified system may be focusing:

1. Possibility of running patterned warp on direct warping
2. Increasing the size of the creel for direct warping
3. Increasing the yarn content on drum of the sectional warping.

One interesting patent is based on conventional sectional warping but with a modification in the beaming process. Normally one beam is produced after the sectional warping process. As per the patent by Schmitz^[7] at least two beams

can be produced. The design is as shown in figure 1 below. While starting beaming process first beam is wound. After required length is wound on first, second beam is started. With this modification it is possible to produce multiple beams from one warping process. Rest of the features are usual with any standard sectional warping machine.

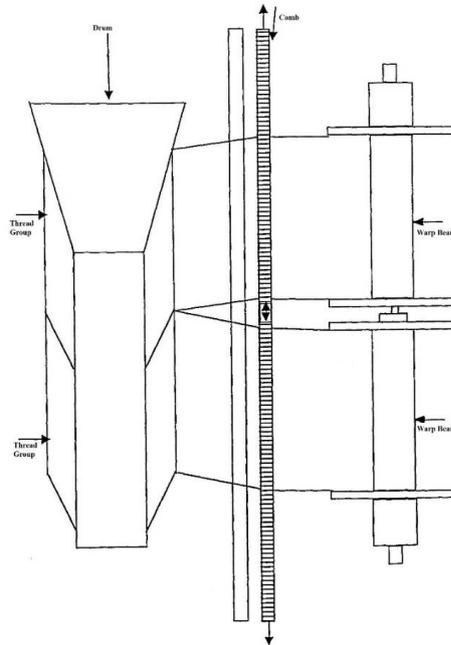


Fig. 1 Two beams from a sectional warping process [7]

Patent filed by Gaiser [8] is about the winding beams for Raschel knitting machine. Of course there is quite a great difference between a warping machines for warp knitting and for weaving but the idea of multiple beams can be adopted for weaving preparatory also. In his patent literature Gaiser has mentioned about following problems faced by warp knitting system at that point of time:

- (i) One beam or two beams only can be prepared with identical traverse. More than one beam with different traverse on the same beaming is not available.
- (ii) Tension variation between yarn creel and beam for different ends cannot be controlled positively.
- (iii) Occasional failure of stop motion, particularly when texturized yarns are used, occurs mainly because the yarn contains small amount of oil and oil deposit restricts operation of stop motion.

In the invention, multiple beam winding with individual adjustable traverse for each beam is disclosed. Tension adjustment is also possible. 15 to 140 ends can be wound on to three beams with width of the wound portion of the beam ranging from 190 cm to 330 cm or more. An arrangement of such a device is as shown in figure 2 below.

The idea has some limitation for use in weaving preparatory like there is only one end at a time or a group of ends which are wound and are traversed throughout the narrow beam. Such three beams are prepared. For weaving one needs many parallel ends to be wound adjacent to each other for a long length. But the idea can be explored further to adapt to weaving preparatory processes. There have not been many evidences whether this idea has been commercially applied by any warp knitting beam warping machine makers or it is further explored by other researchers.

One more patent was filed by Hiroshi and Shozo [9] regarding automatic switching of patterned warp on a sectional warping machine. They have tried to provide solution to the problem of reducing creeling time which is lapsed when running patterned warp. Also changing the creel at the end of the beam is a highly time consuming operation. Again first and the last sections of the beam require a different number of threads as selvedge threads will be included. Each position in the creel has a knotter attached to it. So as and when required, the knotter, operated by a motor and controller, can switch the yarn by carrying out the knotting operation.

Similarly there are many patents which have tried to identify some area of increasing the flexibility of either of the warping systems. All have ended up with totally a different problem or limitation due to which the technological adaptability was not realized.

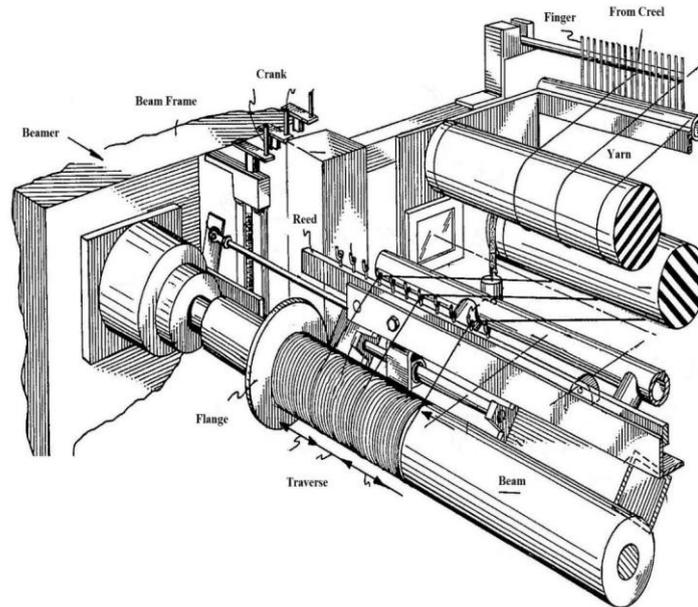


Fig. 2 Multiple beamer for Raschel Knitting [8]

III. Experimental Setup

As seen in earlier part there were few attempts which addressed the problem directly but not solving problem in total. The question of adjustment of section width is still not addressed anywhere. An attempt has been made by the authors of the paper to offer the solution to the problem by a novel design (Patent Applied) of a beam which is to be used on a direct warper and at the same time one will be able to wind the sections of the threads in a limited width like sectional warping. The manual model was prepared and was developed as three dimensional CAD model with the help of a dedicated mechanical design software. If one wants to prepare the beam containing mono-colored warp, then normal beam as used regularly on a direct warper is to be used. The novel designed beam (patent applied) is to be used when it is required to warp multicolor warp with complicated design.

IV. Unified Design of a Beam

Figure 3 below shows one such attempt aimed at providing the unified design of the beam. The assembly shows a normal warper beam with many modifications made. Both the flanges are same but the difference is that both (1 & 2) are movable on barrel. There are several separator plates (3) from left hand flange to the right side flange of the beam. The number of separator plates will depend upon the section width to be kept in the beam.

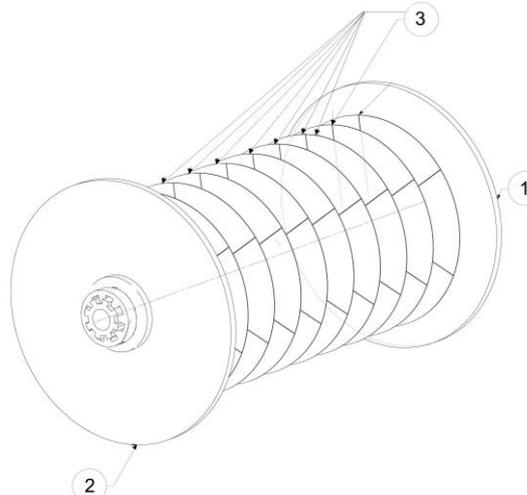


Fig. 3 Novel design of the Beam (patent applied)

V. Conclusion

So with the help of above mentioned design of the beam, it is possible to warp both types of warps i.e. mono colored or patterned. There are many adjustments required to be done but these are purely mechanical type and are easy to carry out. The investments in to both types of warping system can be done away with.

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