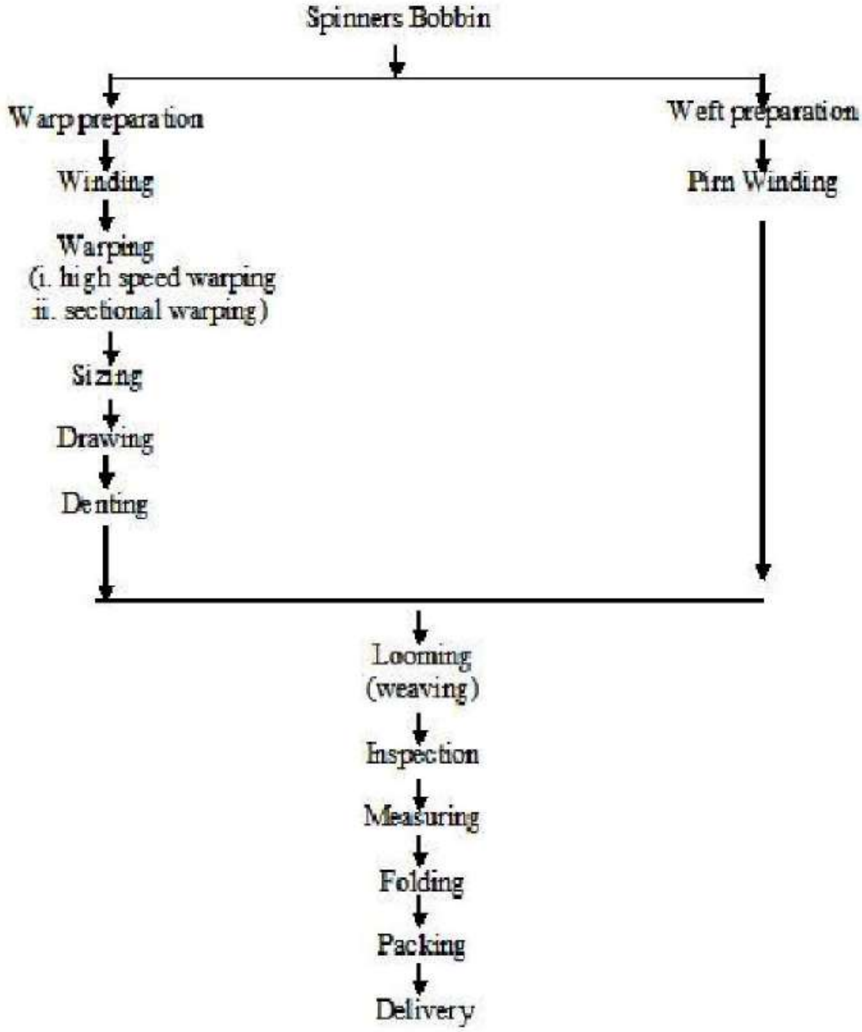
Introduction

Flow chart of weaving process



Definition of weaving

Weaving is the process by which a fabric is made by interlacement of two yarns. One is the warp yarn and the other is the weft yarn. The yarn which determines the length of fabric is the warp yarn. The weft yarn determines the fabric width.

Winding

Definition

The process of transferring yarn from small packages like hank, bobbing etc to a large package such as cones, pirns, cheese etc, containing considerable length of yarn is called winding.

Objects of Winding

Bobbin emptying operation

1. Make a continuous supply of yarn
2. Remove thick and thin places from the ring yarn
3. Remove weak places from the yarn
4. remove neps
5. remove knots
6. remove slabs

Requirements of a Winding Machine

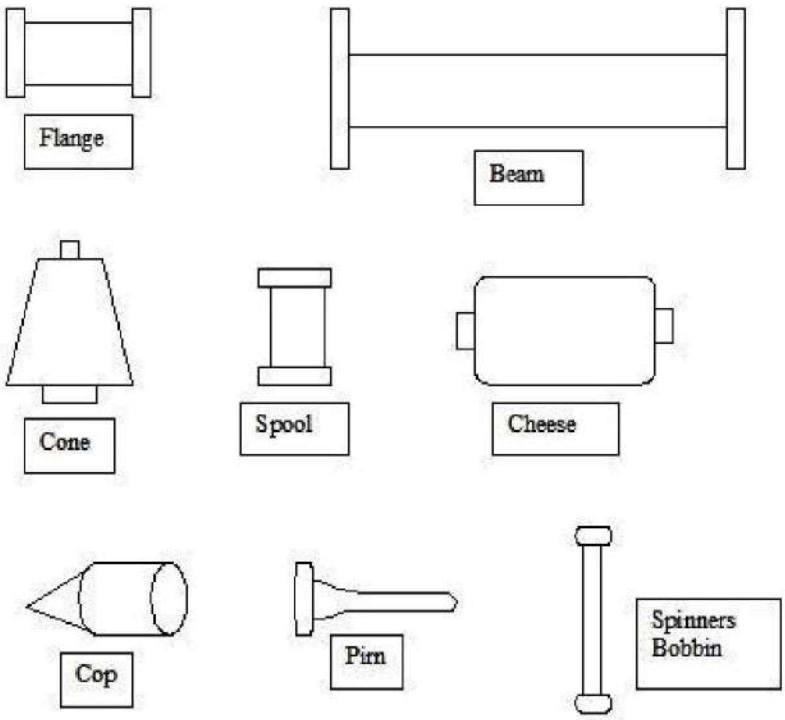
1. The faults should be reduced to an acceptable level
2. The yarn must not be damaged during winding
3. Winding should be carried out at high speed for higher productivity

4. The knots and splices should have sufficient strength and stability
5. The process should be economical
6. Winding package should not be too loose or tight.

Winding Parameter

1. winding plate speed (meter per minutes)
2. winding diameter (cm)
3. Traversing velocity (meter per minutes)
4. angle of winding (degree)
5. package velocity (meter per minutes)
6. net winding velocity (meter per minutes)

Types of Packages



Types of Winding in Packages

1. Parallel Winding
2. Non Parallel Winding
3. Cross Winding

Parallel Winding Package

In this type of winding the yarn is wound parallel to each other on package containing flanges on both sides. This type of winding does not require traversing guide.

Advantages of parallel winding

- Many yarns can be wound at the same time
- No need of traversing guide
- No change in yarn twist occurs
- The package is stable
- Side withdrawal is possible

Disadvantages of parallel winding

- Flanges are required
- Separate mechanism is required to unwind the yarn
- Over withdrawal is not possible

Examples: Beam, Flange

Non parallel Winding Package

This package contains one or more threads which are laid very nearly parallel to the layers already existing on the package.

Advantage of non parallel winding

- Flanges are not required
- Over withdrawal is possible
- No change in yarn twist occurs

Disadvantages of non parallel winding

- Side withdrawal is not possible
- The package is not stable
- Traversing machine is required

Example: Cop

Cross Winding Package

This type of package contains a single thread which is laid on the package at an appreciable helix angle so that the layers cross one another to give stability.

Advantages of cross winding

- Flange is not required
- Yarn package is very stable
- Over withdrawal is possible

Disadvantage of cross winding

- The yarn twist is changed during this winding
- Traversing mechanism is required

QUALITY AND TYPES OF KNOT

The yarn from one package can be knotted to that from another either manually. or by a hand knotter or by an automatic knotter. The quality of knot is very important for keeping the end breaks low at warping and weaving. Even if 10% of the knots tied on a winding machine were to slip out or cause a break, the results in warping and weaving can be disastrous. Control of quality of knots made in winding is important since the knots made in warping are very few. Besides slipping, a knot can cause end break because of

(i) its big size when it will cause serious obstruction as it passes through a heald eye or reed dent, and

(ii) its tail ends causing entanglements with neighbouring warp ends. In warp ing, a big knot can obstruct smooth unwinding and may cause a break. The important points to be checked in knot are :

 (a) resistance to slippage,

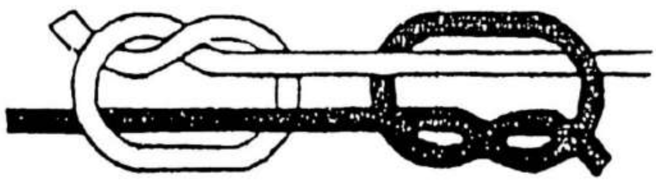
 (b) size of the knot, and

 (c) length of tail ends.

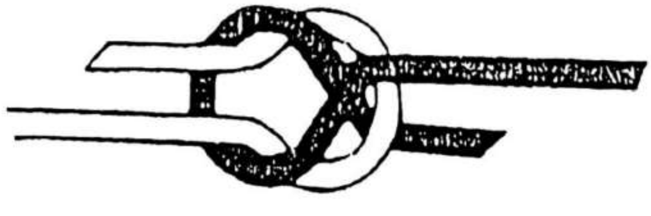
There are different types of knots used namely (i)Dog knot, (Fig 18.A)(ii)Fisherman's knot (Fig-18.B) and (iii)Weaver's knot (Fig-18.C). The Fisherman's knot, the Weaver's knot and the Dog knot rank in the decreasing order of resistance to slippage. In practice it is not at all convenient to tie the fishermna's knot by hand and it takes relatively long time to tie the weaver's knot in unsized yarn than in sized yarns. These knots can be tied easily with the help of special mechanical knotter. Use of such knotters also offer other advantages like uniformity of knot size and tail ends.

Fig - 18 DIFFERENT TYPES OF KNOTS

A DOG KNOT



B FISHER MAN'S KNOT



C WEAVER'S KNOT

For cotton yarns, the knotters that tie the weaver's knot are adequate. However, for polyester and other synthetic fibre blend yarns, where the knots have an inherent tendency to slip, the use of knotters that tie fisherman's knot will be very beneficial.

EFFECT OF KNOT ON SUBSEQUENT PROCESSING :

The main disadvantage of the knot is its bulkiness and length of tail ends. These two characteristics of the knot give trouble especially while passing through thread guides, tensioners, needles on knitting and tufting machines etc.

In high density woven fabrics, the knot size and tails interfere with the neighbouring ends, obstruct shed formation, strike against the reed and cause yarn breaks. The tail ends of these knots may entangle with adjacent ends to produce multiple breaks which may result in float formation.

On air jet weaving machines, knots are highly objectionable and lead to expensive stoppages and weaving faults. In warping, a big knot can obstruct smooth unwinding and may cause a break. Many knots come apart in weaving or cause holes in knitted fabrics. Finally, it causes bad appearance in the fabric and also gives problems in coating and raising the fabrics for special purpose.

SPLICING

Definition :

It is the process of joining of two yarns by fibre entanglement, ideally to produce a tailess joint of length and of similar diameter to the yarns, and therefore smaller than the knot which is the usual alternative.

Splicing is a better alternative to knots and is widely accepted. High speed shuttleless looms, for their efficient working, demand spliced yarn. It is the latest technique of joining two ends and is replacing knots at a faster rate as it overcomes the main disadvantage of the knot namely, its bulkiness and length of tail ends.

There is no difference in behaviour of spliced yarn in comparision to that of knotted yarn in warping and sizing process. In loomshed, the warp breaks for spliced yarn was found to be significantly lower than the same for knotted yarn. Hence, splicing would enhance the quantity and quality of production.

The splice structure consist of three distinct regions namely, twisting, wrapping and tucking/intermingling. Each of these splice elements contribute to the splice strength. Intermingling contributes the most to the strength and elongation of splice. The contribution of twisting is also significant to splice strength and elongation. Wrapping contributes the minimum to splice strength and elongation.

The spliced yarn has two important parameters namely splice appearance and splice strength. Standards have been established for judging the splice appearance. The splice appearance grade(SAG)permits qualitative evaluation of splicing appearance between 1 (excellant) to 7 (poor).

The spliced yarn strength, expressed as a parent yarn strength has been called Retained splice strength (RSS). The number of breaks on 'spliced joint' expressed as a percentage of total tests on spliced yarn has been called 'splice breaking ratio'(SBR). The SBR and RSS are found to be well related whereas SAG and RSS are not so.

It is necessary to monitor both the splice appearance and the splice strength of a spliced yarn to achieve better performance in subsequent processes. It is possible to characterise a splicer in terms of two important qualities of its product namely splice appearance and the strength of splice. In no case the splice appearance grade should be poorer than 4 and the strength 60% of RSS. The excellent splicer gives splices with SAG-3 and RSS 80%

One of the points against splicing is that the strength of the yarn at the splicing region is about 80% of the normal yarn.

Types of splicing :

1. Dry splicing - practiced for single spun yarns.
2. Wet splicing - practiced for double yarn.

Principles of splicing :

1. Pneumatic splicing
2. Electrostatic splicing
3. Mechanical splicing.

Characteristics of spliced yarn :

1. No bulkiness and tail ends at the joint.
2. The diameter at the spliced portion is 1.2 times the diameter of normal portion
3. The strength of spliced portion is 85% of the normal yarn which is quite sufficient to withstand weaving.

Advantages of splicing :

1. No thickening of the thread or only slight increase in its normal diameter (1.2d)
2. No great mass variation.
3. Visually spliced portion is not objectionable.
4. No mechanical obstruction by thread guides, tensioners etc.
5. In knitting, reduction in number of holes caused by knots.
6. It easily passes through the heald eye and reed dent in weaving and the needle of knitting machine.
7. Almost equal elasticity in splice joints as that of the parent yarn.
8. Gives significantly lower warp breaks in case of shuttleless weaving machine.
9. Poses no processing difficulties in case of coated and raised fabrics.

COMPARISION OF KNOTTED AND SPLICED YARN :

Sl. No	Knotted yarn	Spliced yarn
1.	Bulky and has tail ends at the joint	Not bulky and has no tail ends at the joint
2.	Diameter at the joint is 3 to 4 times that of single yarn	Diameter at the joint is 1.2 times that of normal yarn
3.	The strength at the knotted portion is more than that of normal yarn.	The strength at the spliced portion is only 80% of normal yarn.
4.	Great mass variation	No great mass variation.
5.	Visually objectionable	Visually not objectionable.
6.	Causes obstructions in subsequent processes	No mechanical obstructions in subsequent processes
7.	Lower elasticity at the joints	No loss in elasticity at the joints
8.	Causes more warp breaks in weaving	Significantly lower warp breaks in weaving.

Objectives of splicing :

i) To join two yarns by fibre entanglement, etc.

ii) To produce a tailless joint of short length.

iii) To produce a joint whose diameter is similar to that of normal yarn.

The spliced joint in short staple yarns has proved to be especially advantageous in the following areas of use: -

(i) In knotting, a reduction in the number of holes caused by knots.

(ii) With fabrics having a high warp density, no yarn breaks in the reed due to knots.

(iii) In coated fabric weaving, no difficulties in finishing.

(iv). With emery cloth, no pushing through the knots.

(v) With raised fabrics, no disturbances in the raising effect.

It is now possible to splics short staple yarns combed or carded, of cotton, man-made fibres and blends. According to the type of yarn and fabric, the yarn had to be joined either by a fisherman's knot or weaver's knot. The fisherman's knot is more durable but it is thicker than the weaver's knot. The spliced joint completely eliminates this problem. It is universally applicable and practically fault free. Even yarns which could hardly be joined with a fisherman's knot can be spliced effectively.

The Operation of the automatic splicer :

The two ends are joined by a jet of compressed air in such a way that the fibres are intensely mingled and twisted together. Duration and force of the air blast are tuned to the characteristics of the yarn. In this way a yarn joint is produced which complies with all demands of the subsequent processing in terms of appearance and strength.

The Splicing procedure has three processes in sequence :

(i) Opening of twist in the free yarn ends.

(ii) Intermingling of the fibres.

(iii) Joining of fibres

The spliced joint is then released and the winding head restarts immediately. .

CLASSIFICATION OF YARN FAULTS

Introduction

Quality has become a very important term in today's context. In today's competitive market, there is an ever increasing demand for better quality fabric. This demands excellent yarn quality. Besides meeting the traditional quality standards the yarn has to meet the standards in respect of yarn faults, hairiness, lea count CV, etc. Hence yarn producers are faced with an uphill task of meeting the international market demands if they are to survive the stiff competition.

Yarn faults

The most important quality requirement is that the yarn should have very few faults especially the objectionable ones. Controlling the faults is critical not only from the point of view of garment appearance but also from the fabric quality requirement for automated cutting of fabric during garment production. It is becoming imperative to produce defect free 100 m or even longer lengths of fabric to meet this latter requirement. Therefore for export of yarn and fabric it is of utmost importance to control, monitor and remove faults to meet the desired standards. This is true for both weaving as well as knitting yarns. Short and long thick places and long thin places are yarn faults that are critical not only in determining the appearance of a fabric but also the process performance. Every one is familiar with thick faults like slubs that greatly detract from the fabric appearance and adversely affect the weaving performance.

Yarn fault is an event that occurs rarely, say once in several thousand metres, and therefore cannot be tested by the Uster Evenness Tester. One of the most popular instruments for testing yarn faults is the Uster Classimat; another one is the Classifault. These instruments classify thick and thin faults in to several categories basing them on their length and cross-sectional area or mass. The classes of faults tested by these instruments are given in Table A and B.

Indian Scenario

The best cotton yarns (from non-EOUs) are able to match the Uster 50% standards in 20s and 30s carded yarns but not in combed 40s to 80s yarns. However, the best values achieved by the EOUs, shown in brackets in Table 2 match even the Uster 5% standards in every respect including long thin and thick faults.

In blend yarns the Indian situation is still worse. No mill is able to achieve the Uster 25% level in respect of total and objectionable faults; only one mill is able to come near this standard. Regarding long thin faults, no mill is able to match even the Uster 75% level.

Systems of yarn fault classification

There are two systems of yarn fault classification, namely,

a) Classimat system, and
b) Classifault system

The classimat system is shown in figure .1 below

Cross – sectional increase/

Decrease	+ 400	A4	B4	C4	D4		
	+ 250	A3	B3	C3	D3		
	+ 150	A2	B2	C2	D2		
	+ 10	A1	B1	C1	D1		
mean yarn						F	G

cross-section	+ 45					
	-30% -45%	H1	I1			
	-75	H2	I2			
Fault length (cm)	0.1	1	2	4	8	32

Figure 1 – Classimat system of fault classification

In this system of fault classification, the yarn faults are divided into length and thickness categories. The different classes of faults are A type, B type, C type, D type, F type, G type, H type and I type. Faults A to D types are divided into four levels and accordingly are known as A1, A2, A3, A4, B1..... B4, and so on. Faults H and I are known divided into two categories, namely H1 and H2, and I1 and I2. The faults A1, B1, C1, and D1 are known are those having a thickness of 100% of yarn diameter, and faults A2 .... D2 have thickness of 150% of yarn diameter, while faults A3 .... D3 have thickness of 250% of the yarn diameter and faults A4 ... D4 have a thickness of 400% of the yarn diameter. Faults F and G range between 45% to 100% the yarn diameter. While the faults A to G denote yarn faults that are thick and above the diameter of the yarn, faults H and I denote thin places, that is , lesser than the yarn diameter. The faults lengths of A class of faults range between 0.1 to 1 cm, while B class of faults range between 1 - 2 cms, C class of faults range between 2 - 4 cms, D class of faults range between 4 - 8 cms, and F and H class of faults range between 8 - 32 cms, while G and I class of faults are longer than 32 cms.

The classifault system is shown in figure 2

Cross sectional Increase/decrease							
+400%	A4	B4	C4	D4	E4		
+250%	A3	B3	C3	D3	E3		
+150%	A2	B2	C2	D2	E2		
+100%	A1	B1	C1	D1	E1		
+45%		F2		G2	H2	I2	J2
+30%		F1		G1	H1	I1	J1
Mean yarn 0%							
X- section -30%		K1		L1	H1		I1
-45%		K2		L2	H2		I2
-75%							
Fault length (cm)	0.1	1	2	4	8	9	25

Figure 2 – Classifault system of fault classification

The classifault is yet another system of yarn fault classification. In this system too the yarn faults are divided into length and thickness categories. Again the faults are divided into A , B , C , D , F, G , H, I, J and K types. Faults A to D types are divided into four levels and accordingly are known as A1, A2, A3, A4, B1..... B4, and so on. Faults H, I, J, K, and L are divided into two categories, namely H1 and H2, and I1 and I2 and so on. The faults A1, B1, C1, and D1 are known as those having a thickness of 100% of yarn diameter, and faults A2 .... D2 have thickness of 150% of yarn diameter, while faults A3 .... D3 have thickness of 250% of the yarn diameter and faults A4 ... D4 have a thickness of 400% of the yarn diameter. Faults F and G range between 45% to 100% the yarn diameter.. While the faults A to J denote yarn faults that are thick and above the diameter of the yarn, faults H, I, K and L denote thin places, that is , lesser than the yarn diameter. Class A faults range between 0.1 to 1cm, class B, F and K faults range between 1 - 2 cms, class C faults range between 2 - 4 cms, faults D,G and L range between 4 - 8 cms, class E and H faults range between 8 - 9 cms, class I faults range between 9 - 25 cms, and class J and I faults are longer than 25 cms.

Defects in Wound Packages

The main aspect of the quality of preparation in **winding** is the production of a fault free package that will unwind smoothly during warping. Some of these faults are caused by faulty machine settings while others are caused by incorrect work practice. Hence periodic checks on machine conditions, settings and proper supervision of operatives are necessary in order to minimize package faults. Some of the more commonly occurring package defects, their causes and remedies are given below

Types of wound packages defects in winding

The following are the important defects that commonly occur in wound packages:

Stitches on cone

This is due to improper laying out of ends onto the cone at reversal of yarn path. It causes more end breakages in the subsequent processes and also leads to excessive yarn waste.

Stitches on Cone

Sources

- Cone holders that are improperly set and are vibrating
- Tension brackets misaligned with winding drum
- Wrapping of coils of thread around the bottom of cone holder
- Traverse restrictors fixed at incorrect position

Corrective action

- Overhauling of cone winders to be done time to time
- Setting of cone holder and alignment of tension brackets with the drum to be done regularly

Ribboning or patterning

In this type of defect a ribbon like structure is formed on the circumference of the cone. It results in high level of slough off during unwinding, excessive yarn waste and uneven dye pick up in the case of dye packages.

Ribboning or Patterning

Sources

- Restriction in the rotation of the winding spindle
- Improper setting of cone holders
- Cam switch set improperly
- Loading of lint in the groove of builder cam

Corrective action

- Cone winders are to be overhauled periodically
- Anti patterning device is to be checked regularly
- Cone holders are to be properly lubricated so as to ensure their free movement

Soft package

It is caused due to abnormal softness of the structure of the package. In this case the overall density of the package is lower. It results in soft packages either at the base or at the nose of the cones.

Soft Package

Sources

- The winding spindle is not properly aligned to the improper alignment of winding spindle to winding drum
- The tension during unwinding is inadequate
- Loading of the cradle is insufficient

Corrective measures

- The tension during unwinding is to be kept between 6-8% of single yarn strength

- The pressure at the cradle is to be maintained at required level

Bell shaped cone

In this type of defect, the cones are tightly built at centre and appear in the shape of a bell. Such type of defect in the packages leads to excessive breaks during subsequent processes.

Bell shaped Cone

Sources

- The tension of yarn is high during winding
- Improper setting of cone holders with winding drum
- Paper cones being damaged at the middle

Corrective measures

- Cones are to be checked for quality during purchase
- The tension during unwinding is to be kept at required level

Nose bulging

It results in bulging of bunches of yarn at the nose of the cones. This leads to slough off during warping.

Nose bulging

Sources

- Setting of cone holders to winding drum is incorrect
- Periodical inspection of settings in machines

Corrective actions

- Avoiding use of damaged paper cones
- Tenters to be instructed to adopt correct work practices

Collapsed cone

In this type of defect, the structure of the package itself gets collapsed. This kind of defect in the packages cause excessive breaks during warping and tend to generate a high level of hard waste.

Collapsed Cone

Sources

- Use of poor or damaged cones
- Poor system of material handling
- Maintaining non optimum unwinding tension

Corrective actions

- Tenters to be trained on correct work practices
- Proper material handling devices such as cone transport trolleys to be used
- Cone inserts to be used for paper cones

Ring shaped cone

This defect results in the formation of ring shaped bulge across the cross section of the cone. It results in more end breaks in the subsequent processes and also causes slough off during unwinding.

Ring shaped Cone

Sources

- Incorrect setting of cone holder
- Wrong placement of tensioners in the tensioning assembly
- Traverse of yarn affected due to defects in the grooves of the drum

Corrective measures

- Due replacement of defective drums and stop motion wires to be ensured
- Periodic inspection of cone holder settings and tension assembly to be carried out

WARP WINDING

Introduction :

The winding process is the division between the group of process described as Spinning and those described as weaving. A manufacturer usually receives the supply grey warp yarn in the form of ring bobbins, mule cops or hanks. The first preparatory process to which it is subjected to is winding. The yarn obtained in any of the above forms contains such length of yarn that is incapable of keeping the next preparatory machine i.e., warping machine, running for a considerable length of time. This will necessiate frequent replenishment of supply packages which will reduce the efficiency and production of the machine to a considerable extent. Further. there will be abnormally high number of yarn breakages in warping and subsequent processes, particularly in weaving due to the presence of yarn imperfections which have not been removed. Also, the quality of the warp and the cloth produced from such yarns will be inferior, in addition to the low production and efficiency of the subsequent processes.

In an independant spinning mill, winding is a fast disappearing activity. Importance of winding has changed over the years from tube emptying activity to quality enhancing activity.

Can we eliminate winding?

It can be eliminated, if :-

i. sufficiently large packages could be produced at the spinning

ii. yarn with low imperfection incidences could be produced

iii. the primery packages could be used in both warping creels and on looms

This stage is fast approaching in case of open end yarn of count upto 20'.

Yarn consumption rate :

The yarn consumption rate for narrow width auto loom of 12 loom assigment is 3,60,000 meters / hour for a particular popplin variety. For the same variety, the consumption for wider width shuttleless weaving machines of 8 loom assignment is 15,00,000 meters / hour (i.e) the consumption has increased four fold. Also, the present loom assignment is 16 machines.

Hence, to maintain the loom assignment an acceptable efficiency level, we should ensure the following :-

i. Yarn should be spun with lower fault incidence.

ii. controlled selective clearing in winding with photoelectric clearing.

iii Every piecing should be spliced.

Objects of winding :

We know that the yarn package that comes from spinning is in the form of ring bobbin or hanks, which contains shorter length of yarn with inherent faults like thick places, thin places, neps etc. But, actually we require very long length of yarn for the subsequent process (i.e.) warping. Also the yarn should be fault free for better performance and quality cloth.

Hence, the objectives of winding is :-

i. to remove the objectionable yarn faults

ii. to produce a continuous long length of yarn

iii. to produce a suitable compact package that unwinds smoothly in the next process.

Methods of package driving and yarn takeup :

There are two methods of driving the wound package.

1. Precision winders or spindle winders
2. Drumwinders or frictional contact winders.

1. *Precision winders :*

In this, the spindle on which the package is mounted is positively driven. In most of the machines, the package run at a uniform speed throughout the build of the package. The number of coils per traverse remains constant at all winding diameters from empty to full cone. Hence, the rate of take-up keeps on increasing continuously as the diameter of the package builds up. This is advantageous for certain highly specialised applications. A constant take-up speed which is essential for good winding, is complicated and also expensive in this method.

2. *Drum winders :* -

Here, the drum is driven ~~positively~~ negatively and the package is driven by frictional contact with the drum. The package rpm decreases throughout the build of the package. The number of coils per traverse continuously decraese from empty to full cone. The drum winders give more or less constant winding speed throughout the build of the package. This is mechanically less complex and incorporates the rotary traverse also. This eliminates the reciprocating mass meant for separate traverse. This is the most common method of package driving and is used on most of the modern winding machines.

Comparision between Precision and Drum winders :

No.	Precision winders	Drum winders
1.	Package is positively driven (spindle)	Package is negatively driven by frictional contact.
2.	Package rpm remains constant from empty to full package.	Package rpm decreases continuously from empty to full package.
3.	The yarn take-up by the package continuously increases in proportion to its diameter.	The yarn take-up remains constant throughout the build of the package.
4.	The number of coils per traverse remains constant at all stages of package	The number of coils per traverse continuousely decreases as the package diameter increases.

5.	Constant yarn speed is difficult and expensive	Constant yarn speed is achieved easily.
6	Mechanically complicated	Not complicated
7.	Separate traverse mechanisam required	No separate traverse because of rotary traverse.
8.	Used only for specific purpose like synthetic filaments or costly staple yarn.	Most commonly used on all modern winding machines.
9.	Produces close wound package.	produces open wound package.

Methods of yarn traversing :

The yarn is to be traversed back and forth across the package to get uniform winding and the desired shape of the package. There are three methods of traversing yarns on to a package.

1. Reciprocating guide
2. Spirally slotted drum and
3. Propellar yarn laying system.

1. *Reciprocating guide :*

The yarn is traversed on the package by means of a separate thread guide which gets to and fro motion through a cam. This method can be used for both spindle driven and drum driven packages. The guide which is used to lead the yarn to the package is mounted on a swinging plate. This plate is parallel with the package surface and moves away from the package as its diameter increases. This is not suitable for high speed winders.

2. *Spirally slotted drum :*

In order to eliminate the traverse guide and its mechanical limitations for high speed winding, the drum itself is equipped with spiral / helical slots for yarn traverse. The drum does both the jobs of traversing the yarn and driving the package. Drums with different traverse can be used to build particular type of package. This method is used on all modern winding machines.

Angle of wind and package density :

Minimum package density is reached, when the winding angle is 90° or the two sets of threads, are perpendicular. Under these circumstances, maximum air gaps are produced between adjacent crossing yarns. This degree of porosity is not required. Even for packages meant for pressure dyeing 55° is normally adequate.

The most compact packages for warping and shuttleless weaving are normally wound with a winding angle of approximately 30°. As the winding angle changes from 30° to 55° there is normally a reduction in package density of about 20 to 25%.

Number of Winds or Turns :

The number of winds may be defined as the number of coils wound on the package for one stroke of the traverse guide or grooved drum. One stroke refers to the traverse of yarn from left hand side to right hand side or vice versa.

Example :

If the package makes 3 revolutions during the movement of the thread guide from one end of the package to the other, then the package is said to contain 3 winds.

Winds per Double Traverse :

When the drum or cam makes half-revolution the thread guide travels from one end to the other end of the package, which is one full stroke or traverse. When the drum or cam makes one full revolution, i.e., for every two strokes of the thread guide, the cam or drum makes one full revolution. If the number of wind is 3 for a single stroke, then for double stroke or traverse the package is said to contain 6 winds. This is defined as winds per double traverse.

TRAVERSE :

The coils wound on the package have to be laid throughout the surface of the package. This laying of material from one side to another side of a package is called **Traverse.**

The length in between the starting point and end point is called Traverse length.

Characteristics of winding drums :

Drums are normally made in 1.0, 1.5, 2.0, 2.5 and 3.0 scroll. This identifies the relationship between drum rotation and yarn traverse. On the 1.0 scroll, the yarn drum makes one revolution as the yarn makes one complete traverse and this gives maximum winding angle and minimum package density. The drum makes 2.5 revolutions to one complete traverse for the 2.5 scroll and this corresponds to minimum winiding angle and maximum package density. A range of combinations of traverse lengths and scroll turns will be required to cover all warping ,knitting and two-for-one twisting, but 125mm 2 scroll is generally suitable for most preparation and weaving applications, but not for knitting and two-for-one twisting.

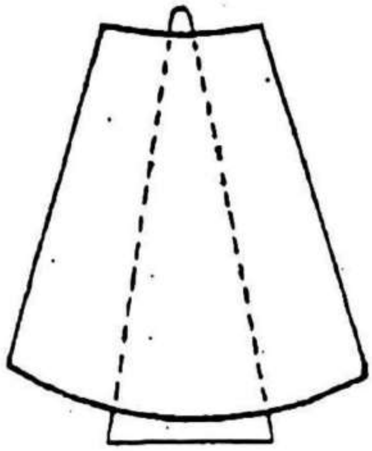
The foregoing applies only where the helix angle of the groove and the winding angle of yarn on the package are constant, which is the situation in drum winding.

FOSTER CONES OR TAPER CONES :

There is a greater tendency for the yarn to drag over the cone surface when the cone is full than when the cone has smaller diameter when the is being unwound. This is especially true when the yarn is moving at a relatively slow rate of speed as in knitting operation when the yarn guide is located close to the top of the cone. The dragging of the yarn on the package is most evident when the yarn is unwound from the base of the cone. Because of the above two conditions, the yarn does not balloon sufficiently to clear the surface of the package at the nose of the cone. This plucking action results in variation in yarn tension, This variation will affect stitch formation in knitting.

To overcome this effect , packages are produced with increased taper. This increased taper cone minimises yarn drag or plucking. This increased taper is achieved by making the traverse guide traverse more slowly when guiding the yarn on to the base of the cone than it does when it is at the nose. To overcome this effect, however, an accelerated package build is preferred where the conicity increases throughout the build of the package. The cone shell could be 5°57' and the final package 11°. This arrangement requires a helix angle which increases continuously from nose to base or by making the traverse guide travers more slowly on to the base of the cone than it does at the nose. Accelerated taper cones have concave noses and convex bases. They are generally described as Foster Cones and is shown in figure-3.

Fig - 3 FOSTER CONE

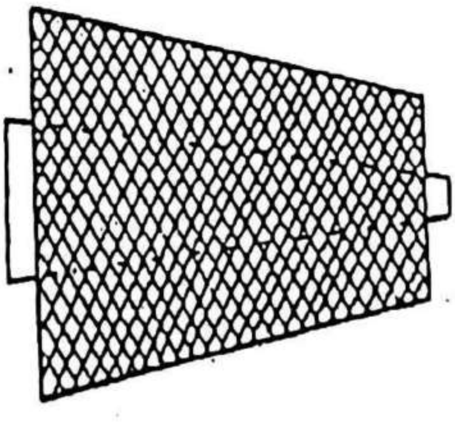


Types of Wind :

There are two types of winds generally used in cone and cheese winding namely, Open Wind and Close Wind.

Open Wind :

Fig - 4 OPEN WIND



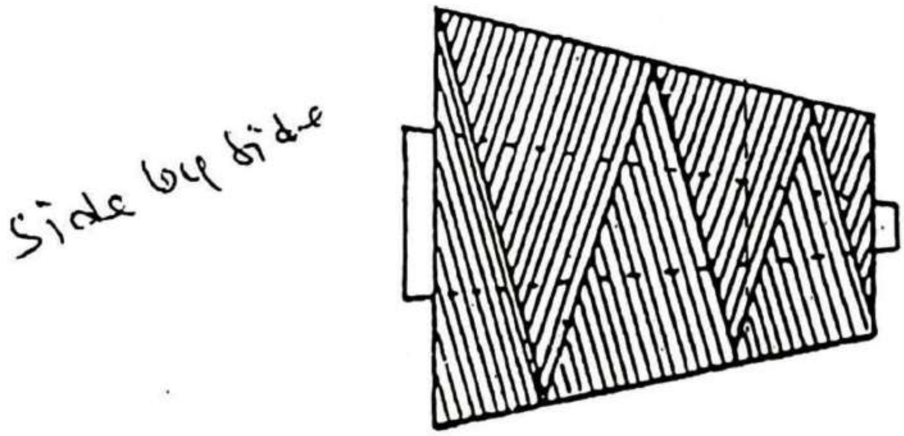
Dicemon

When the succeeding coils are laid widely on the preceding coils of the packae, to prevent diamonds or any patterns, this type of wind is called open or regular wind as shown in Fig-4. Such packages are suitable for high speed unwinding and is used for warping purposes and for preparing soft packages meant for dyeing. All the drum driven packages have open winding.

Close Wind :

When the successive series of winds on a package are laid closely side by side, a very compact package is formed as shown in Fig-5. Such closely wound packages are useful for sewing threads, filament and synthetic yarns required to be transported to a longer distance and should contain more quantity of yarn. This wind is also called as Universal wind or Diamond wind. It is not suitable very high speed nose unwinding because of sloughing off tendency. This package can be prepared only on precision winding machines.

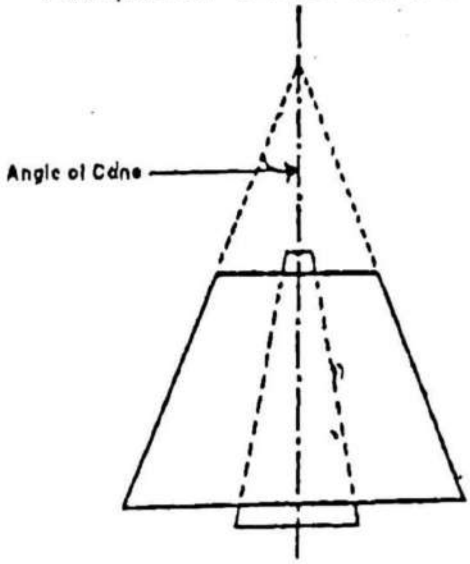
Fig - 5 CLOSE WIND



Angle of Cone or taper :

As the sides of the cone converges, it forms an angle and half of this angle is known as the angle of cone as shown in Fig-6. Usually the angle of cone or taper accepted are 4°20' to 9°15'

Fig - 6
ANGLE OF CONE OR TAPER



Conicity of package and its effects :

Packages are produced with different angle or conicity, ranging from 9° 15' to 2°. Latest packages are made with 2°, 4°20' and 5° 57' conicity. These packages have been found to be an ideal package for difficult weft insertion applications on projectile type weaving machines.

Shuttleless weft insertion systems require a variety of combinations of traverse, conicity and minimum diameter of core or cone shell, to deal satisfactorily with a range of yarns of different frictional properties and linear densities.

In case of shuttleless weaving, for linear densities finer than 30s Ne, a 'sunspool with 4° 20' conicity or a 80mm traverse cheese on a 105mm core are recommended. The 2° conicity 125mm traverse cone has also given excellent results between 30s Ne and 50sNe. 9°15' conicity, mainly meant for knitting, originated to assist free run-off of knitting elements. Now-a-days, this is being replaced by 5°57' conicity with a full package conicity of 11°. Massive slippage occurs on a 9°15' cone at the commencement of winding at the nose. From one third of the distance from the base, the slip starts increasing from this point to the limit of traverse at the nose where the slip is 57%. The corresponding slip for a 5° 57' cone is 16% and there is much less possibility of damage, particularly for fine spun or filament yarns.

A long traverse and large wound diameter are essential for large yarn content. But both of these produce higher yarn tension. The diameter effect can be countered by increasing package conicity. 5°57' is now becoming well established as the knitting and pirn winding conicity and is steadily penetrating into beam warping applications. Sloughing-off of fine yarns is very substantially reduced by the 5°57' angle of conicity. But for particularly difficult applications, a short traverse package with 4°20' conicity may be necessary.

Wound package requirement :

I. Shuttleless weaving machines :

These machines can impose severe restrictions on the yarn package depending on the characteristics of the weft insertion system(Dornier, Nuovepignone SMIT, kapps, somet, Giinne and SACM) and have low thread aceceleration-about 20% of that required for sulzer projectile weaving machinces. 4°20' cone can satisfy all types of yarns in all counts.

Projectile machinces and rapier machinces operating on the Gabler system have much more difficult insertion conditions. Sulzer system aecelerates weft from 0 to 1600 m/min in 0.007 secs. Latest generation of air jet machinces work at a weft insertion rate of 2200 - 2500 m/in.

II. Knitting :

No acceleration problems here as in weaving. The yarn take-off is steady and much slower. The unwinding rate is 250 m/min. Instead of 9°15' cone, 5°57' conicity with a full package conicity of 11° is rapidly coming into use in knitt ing (FOSTER CONES)

9°15' cone - slip at nose is 57%

5°57' cone - slip at nose is 16%. There is less possibility for damage, particulary in case of fine filament yarn in this cone.

All wound packages for knitting must be waxed. Degree of consistency of waxing influences yarn performance. Hence, positive wax applicator with uniform pressure is a must.

Reduce the winding speed, if wax applicator is used. Wax should not be applied at elevated temperrature and it should not disappeer into yarn.

iii. Beam & sectional warping :

The package should have substantial yarn content and must be capable of being unwound at speeds between 600-1200 m/min.5°57' conicity is steadily penetrating into beam warping applications replacing 4°20' conicity packages. Sloughing-off of fine yarn is considerably reduced by 5°57' conicity.

For difficult applications, a short treverse (85mm) package with 4°20' conicity can solve the problem.

Breakage rate :	0.25/million meter	- Excellent
	4.0/million meter	- disastrous

Certain amount of tension is necessary to be imparted to the yarn to produce a compact package and to enable the thin places in the yarn which are weak, to break. Following are the principle methods of giving tension to the yarn.

CONE WINDING :

Cone winding is also accomplished on the quick-traverse drum winding frame. In this case, the yarn is wound or formed into a cone-shaped mass instead of cheese shape. The empty tube is cone shaped and the yarn is built up to follow the same shape, arrangements being made in the fixing of the empty cone to ensure accuracy of action.

Cone winding is very often adapted for winding soft-spun hosiery yarns, and knitting machines are mostly adapted for knitting from cones in preference to cheeses. In the case of cones, the yarn can be drawn off from the small end of the cone with the minimum of drag or tension upon the yarn, thus ensuring as little stretching as possible.

General Features of High speed and Super speed winding machine :

There are a variety of high speed and super speed winding machines differing in principles, sometimes differing entirely from one another. In order to give a complete idea of the process to which the yarn is subjeoted on these machinces, they are being dealt with separately. Each machine, however, contains mainly the following important mechanisms or motions.

1. Creel.
2. Tensioner.
3. Balloon breakers or unwinding accelerators.
4. Clearer or Slub-catchers.
5. Traversing and yarn take-up.
6. Bobbin cradle.
7. Automatic thread stop motion.
8. Autimatic full bobbin stop motion.
9. Driving arrangement.
10. Anti - patterning device.

1. Creel :

Generally the supply package for winding machines are ring bobbins. They are placed below the drum on a horizontal rod extending along the length of the machine. There are a number of short pins, the angle of which can be adjusted to enable easy unwinding, fixed on the rod by means of brackets. The pins hold the bobbin in the upright position and unwinding of yarn takes place from the nose of the supply packages.

Some machines are fitted with a magazine type of creel. In this magazine, one supply package is in the winding position, and two further packages stand on the creel pegs of the magazine ready to be creeled. In this way, the continutity of winding is assured. In this type of magazine, spinning bobbins (ringcops), flanged bobbins and cone remnants can also be accomodated.

2. Tensioner :

Yarn Tensioning :

Tensioner should be used to eliminate weak places in yarns. The need for this practiece has been eliminateed by electronic yarn cleares. Any tension in excess of that necessery to give package stability, merely removes a proportion of the extensibility of the yarn. Capstan type tensioner is the simplest one.

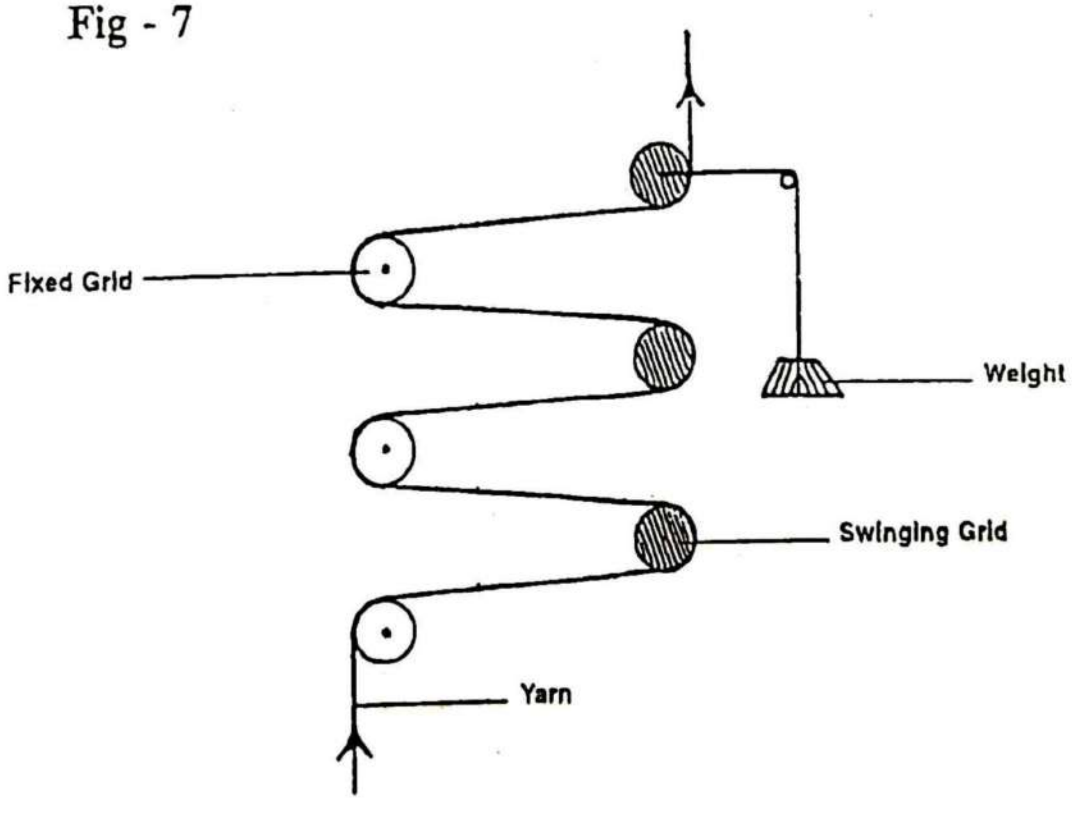
Different types of Tensioners

a. Deflecting the yarn path (Gate type Tensioner) :

The simplest method of increasing the yarn tension is to deflect the path of the yarn around a stationary single post or multiple posts. The tension is affected by the angle the yarn makes around the posts and the number of bends on its passage. This principle of deflection is applied in Gate type of tensioner or grid bar method shown in Fig-7. In this, the yarn passes between two series of grid bars; one series being fixed and the other swinging between these fixed grid bars.

GATE TYPE OF TENSIONER

Fig - 7



b. Disc Tension Device :

The yarn is made to pass between two steel discs, the upper disc usually rotating slowly to give a self cleaning action to prevent localised wear as shown in Fig-8. By increasing or decreasing the number of weight over the steel discs, the tension can be increased or decreased respectively.

In some methods, instead of putting weights over the discs, tension to the yarn is imparted by adjusting the pressure between these two discs with the help of a pressed spring as shown at **Figures** 8-A. One disc is fixed and the other is pressed on the former by the spring.

FIG - 8 DISC TENSION DEVICE

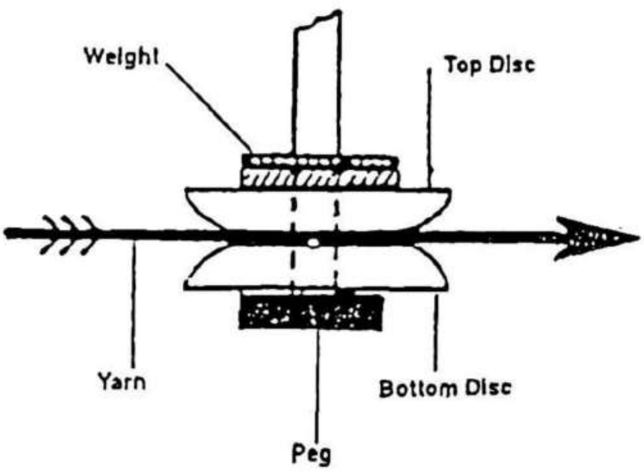
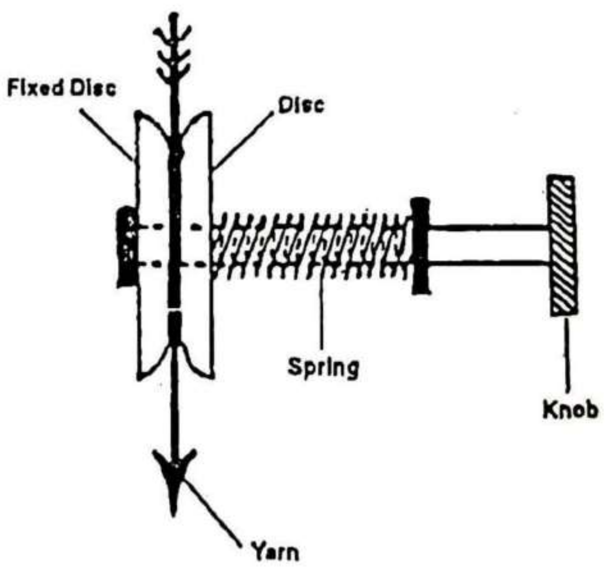


FIG - 8-A DISC TENSION DEVICE



c. Tension through speed : Tension ∝ [Speed]

On very high speed winding machine like **Barber Colman spooler,** generally no separate method is employed to impart tension to the yarn. This is so, because the tension is directly proportional to the square of the speed. Therefore, the very high speed is itself sufficient to give the required tension to the yarn.

d. *Tension control in Precision Winding (Compensating Tensioner) :*

In precision winding where the winding speed continuously increases in proportion to the diameter of the package, the tension will also rise along the build of the package. In order to counter balance the increase in yarn tension due to the increase in winding speed, suitable mechanisms are provided on these machines to gradually reduce the pressure on the yarn in the tensioning device. The tensioning device being generally of grid bar type on these machines, the presure on the yarn is gradually reduced with the help of a differential tension level which slightly opens the moveable grids as the package diameter increases.

For normal winding, generally the tension in running yarn should be around 10% of the single thread strength.

3. Balloon Breakers or Unwinding Accelerators :

The balloon breaker helps in reducing high tension by preventing a single balloon formation during unwinding of a bobbin and thus gives the possibility of winding faster without danger to the yarn. The simplest type of balloon breaker is a plain pin or peg placed 1" to 2" above the ring tube. The pin produces instability in the ballooning and so reduces yarn tension by forming multiple balloons. More sophisticated designs of balloon breakers are circular, triangular or square section tubes situated above the ring tube through which the yarn is threaded.

4. Yarn Clearing devices or Slub-catchers :

The tensioners used on high speed winding machines, to some extent, serve as clearers, as they remove the thin places, which are weak, present in the yarn. But they cannot arrest big knots and very thick places present in the yarn. For this purpose, the machine is usually provided with a slub-catcher, which removes big knots, snarls and abnormally thick places present in the yarn by passing the yarn through a narrow opening in a metal slit, serrateed blades or snick plates. They are broadly classified as (A) Mechanical type and (B) Electronic type. The working principle of different types of slub-catchers is given below.

A. Mechanical type of yarn Clearer :

i. Fixed Blade or Parallel Blade type :

This is the simplest type of slub - catcher in which the yarn is passed between two metal blades which are seperated by the gap. Thick places in the yarn gets jammed between the blades and cause the yarn to break. The opening of the gap depends upon i). the yarn diameter, ii). type of yarn (carded or combed) and iii). the degree of clearing required. For these slub-catchers, the normal clearance between the blades is about **1.5 to 2** times the yarn diameter for combed counts and about **2 to 2.5** times the yarn diameter for carded counts.

Fixed blade slub-catchers are of two types :

a. With fixed opening of the metal slit as showns in **Fig-9**. For different yarns, different blades have to be used.

b. Ajustable blade opening type as shown in **Fig-9.A**
The bottom blade is fixed and the top blade is adjusted with the help of a screw depending upon the yarn count.

FIG - 9 FIXED BLADE TYPE SLUB - CATCHERS

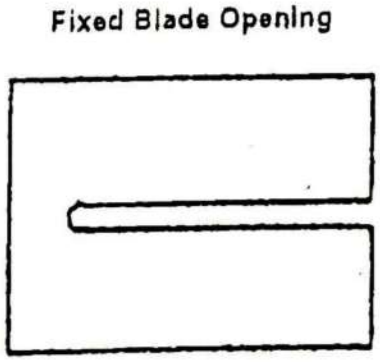
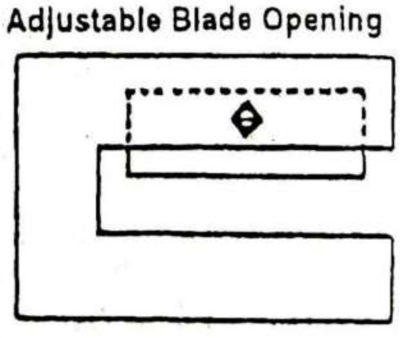


FIG - 9 A FIXED BLADE TYPE SLUB - CATCHERS

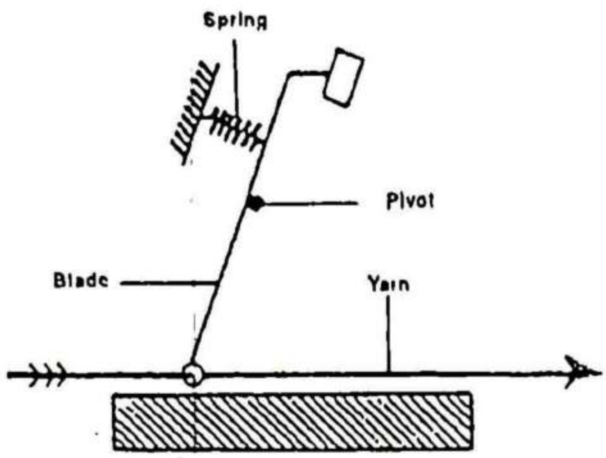


ii. Swinging blade type :

In these type of slub catchers, the yarn passes between a fixed platform and a pivoted blade which can swing along the runing yarn but remains in the position set for by spring action. Thick places in the yarn touch the blade which then is forced to swing along in the yarn direction. This closes the opening for the yarn to pass and thus the yarn gets broken. A side view of this type of slub catcher is shown in **Fig-10**.

FIG - 10 SWINGING BLADE TYPE
SLUB - CATCHERS

A (Side View)



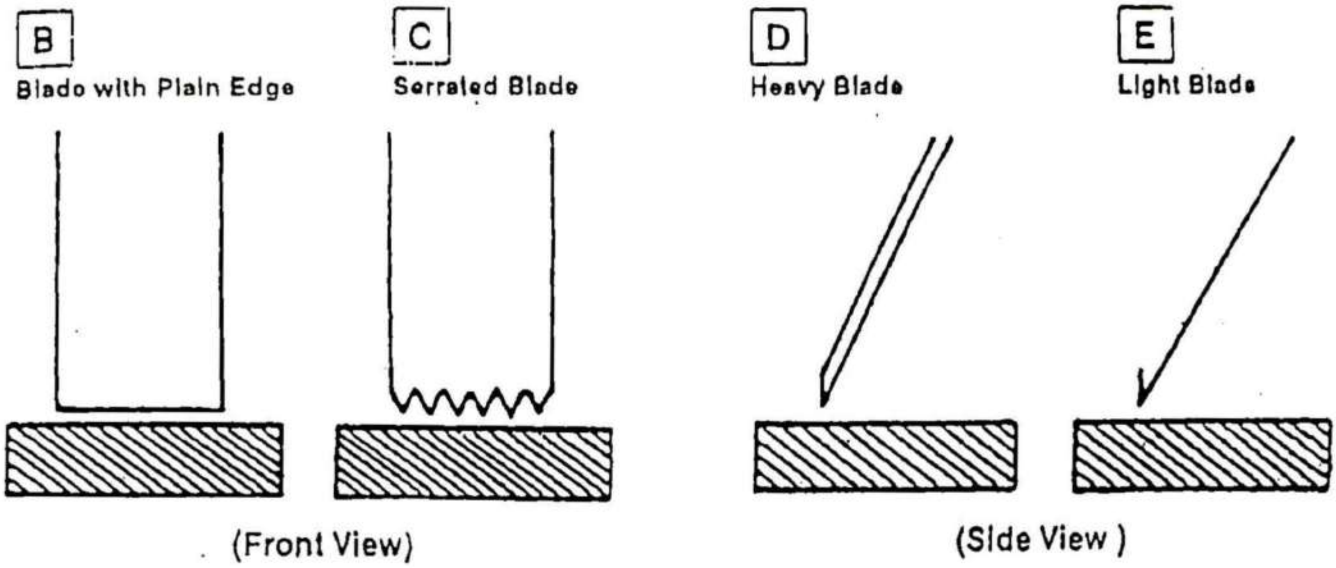
These slub catchers are more sensitive to break thick places than the fixed blade type and therefore, the blade settings for these are kept wider than for the fixed blade type.

If the blade is with plain edge as shown in Fig 10-B, the clearnce is generally 25% more than that for the fixed blade type. Micro slub-catches on Leesona Roto-coner winding machines are usually of this type. If the blade is serrated as shown in Figure 10-C the opening is kept still wider. For example, on Barber Colman winding machine the usual clearance for heavy serrated blades as shown in side view in Fig 10-D is about 3 to 3.3 times for combed yarns and about 3.5 to 4 times for carded yarns of the yarn diameter. For the light weight serrated blades as shown in the Fig 10-E the settings are about 4 to 5 times for combed yarn and 4.5 to 5.5 times for carded yarn.

The mechanical slub catchers are cheap, robust and easy to maintain. The main disadvantage, particularly of fixed blade type is that most of the slubs can get sqeeze and pass through the blades without breaking even at narrower settings. On the

FIG - 10 SWINGING BLADE TYPE SLUB CATCHERS

FIG - 10 SWINGING BLADE TYPE SLUB CATCHERS



B Clearance 25% More than fixed Blade type

C Clearance More than Plain Edge 25%

D Clearance 3 to 3.3 times for Combed Yarn
3.5 to 4 times for Carded Yarn

E Clearance 4 to 5 times for Combed Yarn
4.5 to 5.5 times for Carded Yarn

swinging serrated blade type of slub-catchers, the efficiency of removing slubs is comparatively better and can be further increased by narrowing the settings. However, this leads to a considerable increase in the number of undesirable yarn breaks. For majority of spun yarns, the swinging serrated blade type of slub catchers are quite adequate.

Electronic type of yarn clearers :

The electronic yarn clearers are most useful for superior quality fabrics which requires yarn to be completely free from the objectionable faults. On these yarn clearers, very high degree of yarn clearing can be achieved without causing any undesirable yarn breaks. These clearers can also be set for gauging the length of fault which cannot be done on the mechanical slub catchers.

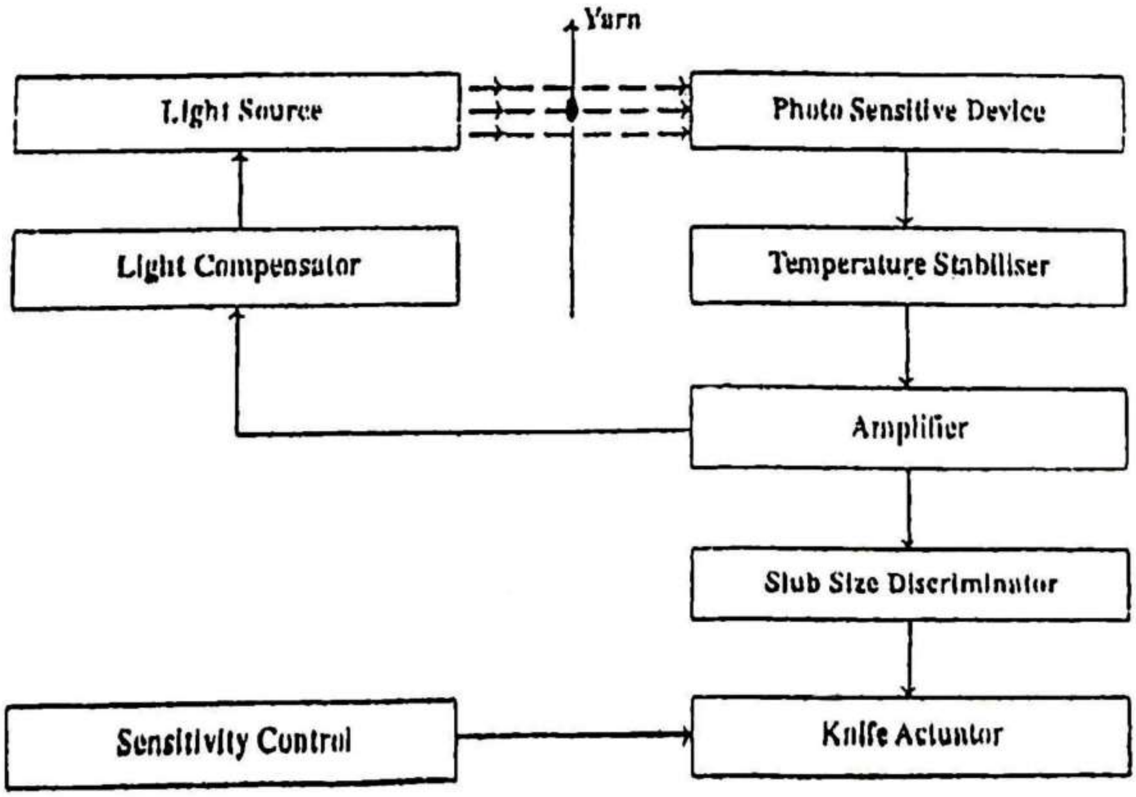
The principle of all the electronic clearers is a continuous measurment of the size of the running yarn by a gauging head. If a thick yarn or slub passes through the gauging head, it produces a signal which is amplified and in turn causes the yarn to be cut depending upon the settings used. On these clearers, there is no direct contact between the yarn and the gauging parts and hence yarn is not rubbed, which is an additional advantage over the mechanical slub catchers.

The electronic clearers have two principle methods of gauging.

i. Photo-electric Detection :

The system which is shown in the block diagram in **Fig-11** consists essentially of casting a shadow of the yarn on to a photo-electric surface. A change in yarn diameter causes a change in current through the photoelectric device. The signal is then passed to the discriminator, which takes into account both its length and its magnitude, and if these exceed certain preset limits, the signal is fed forward and actuate the knife. Some clearers have temperature stabilizers to compensate for any effects of temperature on sensitivity of the unit. Electronic clearers based on photo electric principle are (a) Peyerfil (British) (b) Optafil (Italian), (c) Optrinic (German), (d) Yran Spec (British), (e) Leopfe (Swiss), (f) New mark Linra (British).

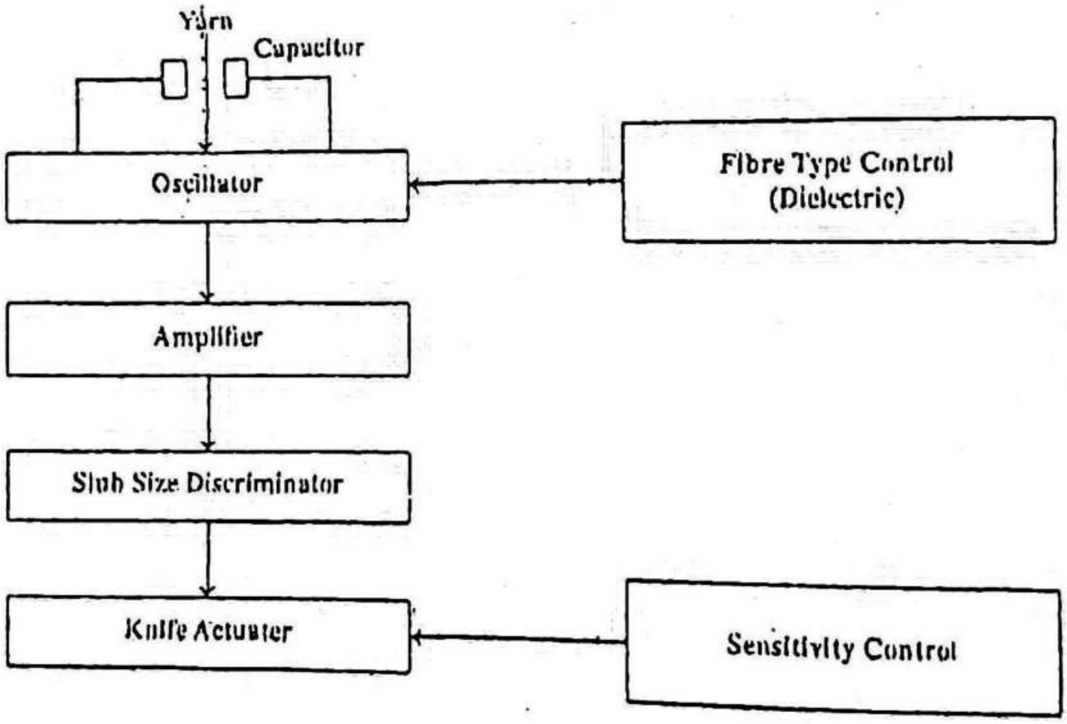
FIG - 11 BLOCK DIAGRAM OF PHOTO ELECTRIC CLEARER



ii. Capacitance Detection : [uster type yarn clearer)

In this system shown in block diagram in Fig 12, the gauging head consists essentially of two metal plates separated by a small gap and the yarn runs between the two plates. The plates and yarn form an electrical condenser and any change in the weight per unit length of the yarn, changes the capacity of the condenser. If a thick place passes through the clearer, the capacity is momentarily increased and this produces an electronic signal which is amplified and fed to the discriminator. The knife is actuated if the signal is sufficient to overcome the sensitivity control voltage.

FIG - 12 BLOCK DIAGRAM OF CAPACITANCE TYPE CLEARER



For these clearers the sensitivity control has to be set differently for yarn from different fibres.

Clearers based on capacitance princeple are :

a) Qualitex (Holland) and

b) Uster - Zellweger (Switzerland).

6 **Clearing Efficiency and Knot Factors :**

$$\text{Clearing Efficiency} = \frac{\text{Total no. of objectionable faults removed by the slub-catchers}}{\text{Total no. of objectionable faults present in the yarn before winding}} \times 100$$

$$\text{Knot Factor} = \frac{\text{Total no. of knots put to piece all breaks in yarn caused by slub-catcher}}{\text{Total no. of knots put to replace only objectionable faults from the yarn}}$$

$$\text{Quality Factor} = \frac{\text{Clearing Efficiency}}{\text{Knot factor}}$$

Quality Factor Should be equal to 100 for an ideal slub-catcher

In practice the following results are obtained from the slub-catchers :

S.No.	Type of slub - catchers	Clearing Efficiency	Knot factors	Quality factors
1.	Fixed blade types	Within 10%	2 - 3.5	3 - 5
2.	Oscillating non-serrated	Within 10%	2 - 3.5	3 - 5
3.	Oscillating serrated			
	(i) Light Blade	35%	1.5 - 2.0	17.5 - 20
	(ii) Heavy Blade	25%	1.5 - 2.0	12.5 - 17
4.	Electronic Clearer	upto 90%	1.5 or less	60 or more

Check theslub-catcher settings once in a shift or after every count change. Each slub-catcher should be calibrated once in 300 shifts for better results.

5. Traversing and yarn take-up :

Yarn take-up from the ring - tube is achieved either by frictional contact with driving roll or a positive spindle drive. The latter is both complicated and expensive to achieve a constant yarn speed, which is essential for good winding practice. All high speed winders adapt the negative friction drive as it is not only mechanically less complex but can incorporate the rotary traverse groove which lays the yarn onto the package. This also eliminates the reciprocating mass associated with separate traverse arrangements.

If yarn is laid in a groove in a cylinder which makes say two complete revolutions of the roll.in one traverse length of the cone, the number of yarn traverse between cone shoulder and base will countinuously decrease from commencement of winding on an empty cone shell to completion of winding of the full cone. In precision widing, the coils per traverse will be identical at all winding applications, but the great majority of spun yarns can be effectively wound with the rotary traverse.

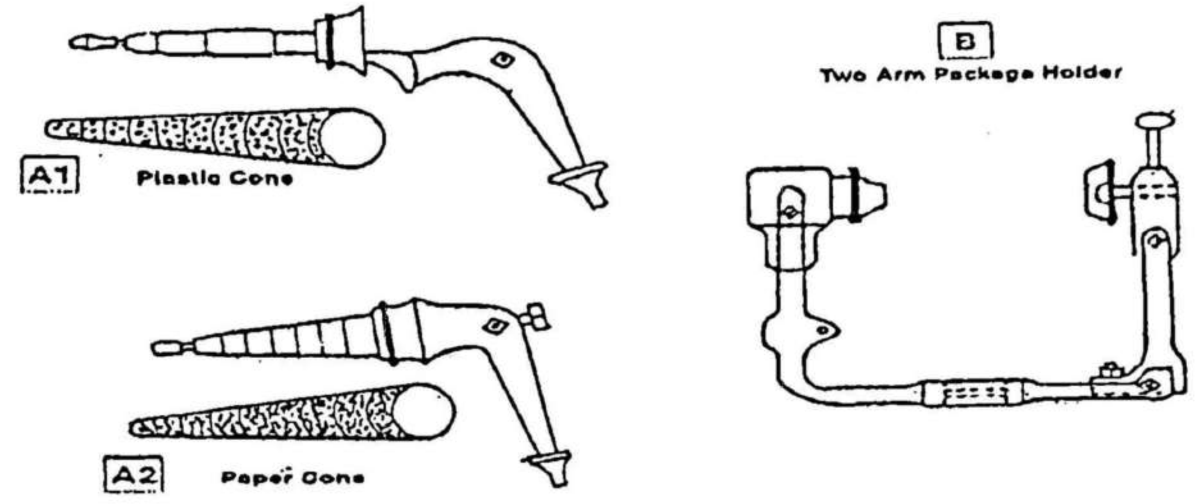
Take - up with regards to Z twist and S twist yarns in drum winding :

If a cone is wound on a cylinderical drum in a P machine i.e., with the cone base to the right or on a Q machine, i.e., with the cone base to the left, it will be obvious that at only one point between nose and base can it be driven without slip. Provided the package holder is correctly adjusted relative to the drive no damage occurs, but when winding fine yarns cutting at the nose is frequently associated with the application of excessive pressure. Methods of reducing this function either side of the drive point include slightly tapering the drum as on the schlafhorst model IKN or by including a free -wheeling loose shell on which the cone nose rests during winding. Reducing the angle of conicity from 9° 15' to 5° 57' reduces the nose slip from 57% to 16%. Cradles mounted in the P direction should be used for Z twist yarns and Q direction for S twist yarns. If the yarn is wound the other way, there is a strong possibility of package instability and sloughing off problems.

6. Bobbin Cradle :

The main object of the bobbin cradle is to hold the package while winding is in progress at such a highspeed. Some types such as the "one arm cone holder " can be used for building cones only and run on ball bearings ,wih expanding rubber rings for plastic or paper cones of the following conicity : 9° 15', 5° 57, 4°20' or 3° 30'. This type of holder is shown in line sketech in Fig 13-A.

Fig - 13 BOBBIN CRADLE OR TYPES OF PACKAGE HOLDERS



Another type of cradle is the "two arm package cradle" with ball bearing pivots for cylindrical or conical paper , plastic ,wooden, steel , wire spring or shrinking tubes or cones up to 4°20' taper. This type which is shown Fig 13-B can be used to wind cones or cheeses.

The winding positions can be started or stoped by easily accessible handles and buttons. The pressure of the take-up package against the traverse drum can be calibrated for each spindle. the pressure can be progressively increased or decreased as the package is wound. The package cradle is hydraulically damped to absorb any vibration which might disturb the yarn lay, and a coil spring compensates for increasing package weight so that constant pressure at the line of contact is maintained throughout the building of the package.

For winding dye packages, "Shogging motion and pressure compensation" device is provided. By this the amount of lateral package shogging can be adjusted. The progressive pressure compensation by means of counter weights is compensating the increaseing pressure of the growing dye package upon the traverse roll, thus performing a uniform density and a homegenous structure of the package.

7. Automatic broken thread stop motion :

This mechanism is provided to stop the winding operation when the yarn breaks or the supply package is exhasusted. On most of the machines thread is made to support a light feeler so that if no thread is present the feeler moves and contacts a notch or cam on a rocking shaft from which necessary force is obtained to disconnect the drive or lift the package from the driving drum.

A sketch of the broken thread stop motion mechanism employed in Barber Colman winding machine is shown in **Fig14.** A rod **F** which is free to rotate in clockwise direction due to the action of the spring **D** has at its bottom,feeler wires **C** and at top asupport plate **E.** The feeler wires **C** rest over the running yarn **B** which is held in position by grid bars **A.** when the yarn **B** breaks, the feeler wires become free to turn forward and thus rod **F** along with the plate **E** rotate in clockwise direction. A Long **U** - shaped wire **L** which is suspended to the outer side of the cheese holder arm fulcrum **G** and rests normally on

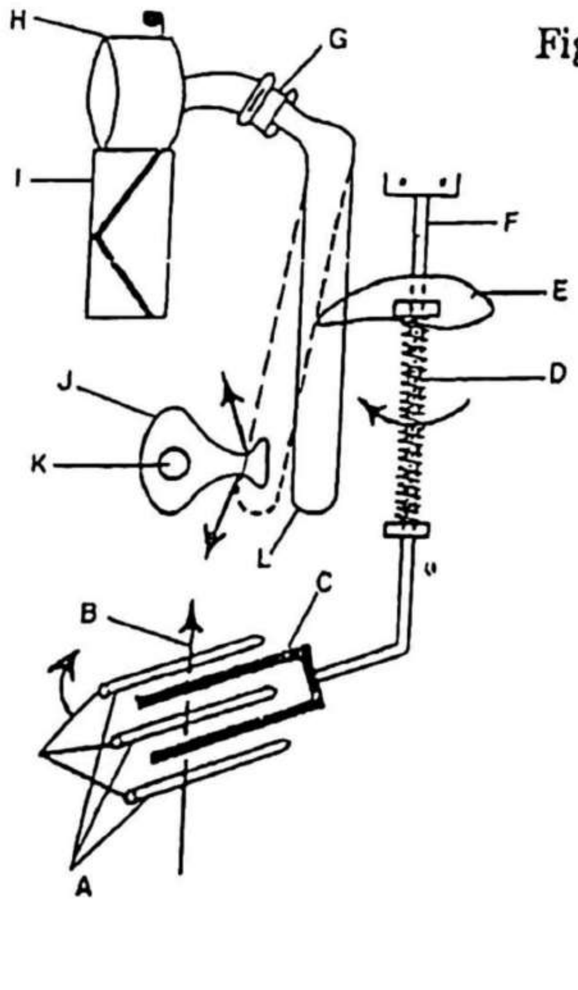


Fig - 14. AUTOMATIC BROKEN TREADS STOP MOTION

(Used in Barber Colman Winding Machine)

A. Grid Bars
B. Yarn
C. Feeler Wires
D. Spring
E. Support Plate
F. Rod
G. Cheese Holder Arm Fulcrum
H. Cheese
I. Drum
J. Rotating Camp
K. Rocking Shaft
L. Wire

a projection of the plate E on its (plates) rotation. On tilting, the wire L comes in the way of the permanently rotating cam J on the rocking shaft K and is thus pulled down ward. This causes the cheese H to lift from the drum I and fall on the forward side when the rod L is pulled to the bottom most position of the cam J movment. The wire L again goes out of the way of cam J when the cheese has been lifted from the drum.

8. Automatic full bobbin stop motion :

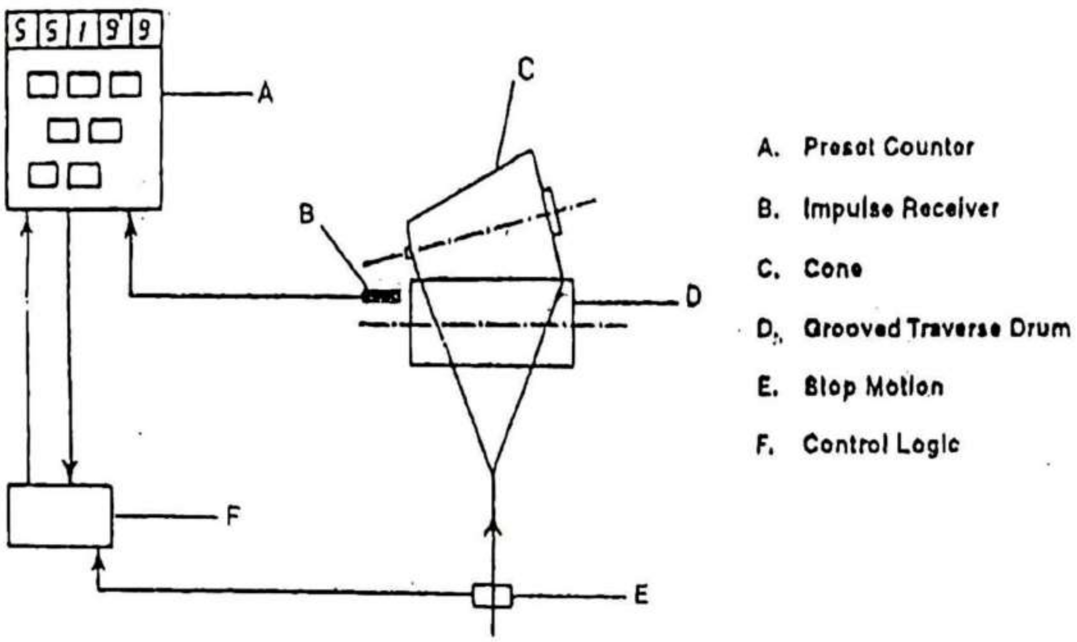
Some of the ordinary and all the automatic winding machines are provied with a mechanism to stop winding on the package which has been wound to a predetermined diameter or length. This helps in getting equal length of yarn and even diameter on all the packages, thus ensuring minimum waste at subsequent processes, particularly at warping and low rejection of packages if these are to be dyed. Instead of providing automatic stop motion, some machines have diameter indicators - usually a ring suspended over the package at a preset height. Touching of the ring by the package indicates correct diameter and thus helps the winder in doffing packages of uniform diameter.

Some manufacturers provide automatic stop motion with optical signal when the package diameter is reached. The wound package diameter is adjustable. Both broken thread stop motion and full bobbin stop motion are provided individully for each spindle of a winding machine.

Some manufacturers have a **Yarn length Counter** which measures the length of yarn by the number of drum rotations. Therefore, the yarn length to be wound on a package can be easily preset by the counter. This counter is coupled with the electronic yarn break detector which checks whether in fact the yarn is running. The counter registers only the actual yarn being wound on the package. Drum revolutions after yarn break are not counted. Each counter cater to 10 spindles, therefore, package of 5 different kinds of yarn length can be wound at a time on one machine of 50 drums.

The working principle is briefly explained in the **Fig15**. The electronic thread length device (MECON), is based on readings from the grooved drum revolution. Each

Fig - 15 LENGTH MEASURING DEVICE AND FULL PACKAGE STOP MOTION



revolution of the grooved drum corresponds to a certain length of yarn. At each winding position an electronic predetermined counter registers the rotation of the grooved drum. When an end breaks or runs out, the counting process is interrupted until the winding position is switched on again. When a predeterminted number value has been reached, the spindle will be stoped and indicated by a signal lamp. When production, is interrupted (Power failure), the predetermined number value, as well as the present value, are kept in a memory for a certain time.

9. Driving Arrangement :

The winding machines are usually drivien from individual motors, Which transmits motion to the winding shaft through either reduction gears or three stage pulleys. Each side of the machine may have separate motor, so that one may be run independently of the other. Push button control may be provided at one or both the ends of the machine to start or stop. The indivdual motors are usually three phase motors provided with automatic arrangement for breaking the circuit at regular intervals in order to alter the periodicity. A three stage pulley enables speed variation to be made according to the type of material worked without the necessity of altering any gearing.

WARPING

Introduction

The objective of warping is to convert a predetermined number of single end packages, such as cones or cheeses, into a sheet of yarn of specified length and width. The individual ends in the warp are uniformly spaced across its full width. The warp yarns comprise one of the systems of yarns .required to produce a woven fabric and also for warp knitting. The objective at warping, as erroneously considered by many, is not at all to remove yarn faults; the breaks due to these being only incidental.

The warping preparation can be classified into two basic systems

(1) Direct System **(2)** Indirect System.

In this system the warps are prepared by placing the individual yarn packages in a large frame called a creel. Each yarn is then threaded through its own tensioning and stop motion device and passes through guides to the front of the creel where they are brought together to form the warp sheet. The yarns are uniformly spaced by placing them into dents of an expanding comb of a reed before they are wound on a big double flanged bobbin known as 'Warper-Beam' or 'Back-Beam'. The expanding comb enables the width of the warp to be adjusted according to. the width between the warper-beam flanges- Since the capacity of the creel at warping is generally to run about 400 to 540 ends, the beams prepared at warping represent only a part of the total number of ends required in the loom warp. Loom warps are prepared by combining the ends of a number of warper-beams in subsequent process.

These are mainly two types of creels used for the beam warping machines **a**) V-Type of creel and (**b**) Rectangular Cree1. of these, 'v-creel is more widely used than the rectangular creel. V-creel consists of wooden or metal frame arranged in the shape of a V with its apex in line with the centre of the machine. This arrangement enables the ends to be withdrawn from the yarn packages without touching or getting entangled with one another while passing from the creel to the warp-beam. There are a number of upright shafts fitted at regular intervals on each arm of the V-shaped creel. Each vertical shalt has a number of pegs on which the yarn packages are creeled.

Examples of beam warping machines are described in the following sections :

Slow Speed Beam Warping

As shown in Figure 1, a linear sketch of a Slow Speed warping Machine. The supply packages for these machines are generally double flanged bobbins. Each bobbin is held' on the creel in a horizontal position by a wooden peg. The yarn is with drawn from the side of each bobbin which revolves on the peg supporting it. The creel is of V-shape. The sides of each vertical shaft facing the head stock are fitted with a round and smooth glass to prevent damage to the yarn from the rubbing action during its passage to the head stock of the machine.

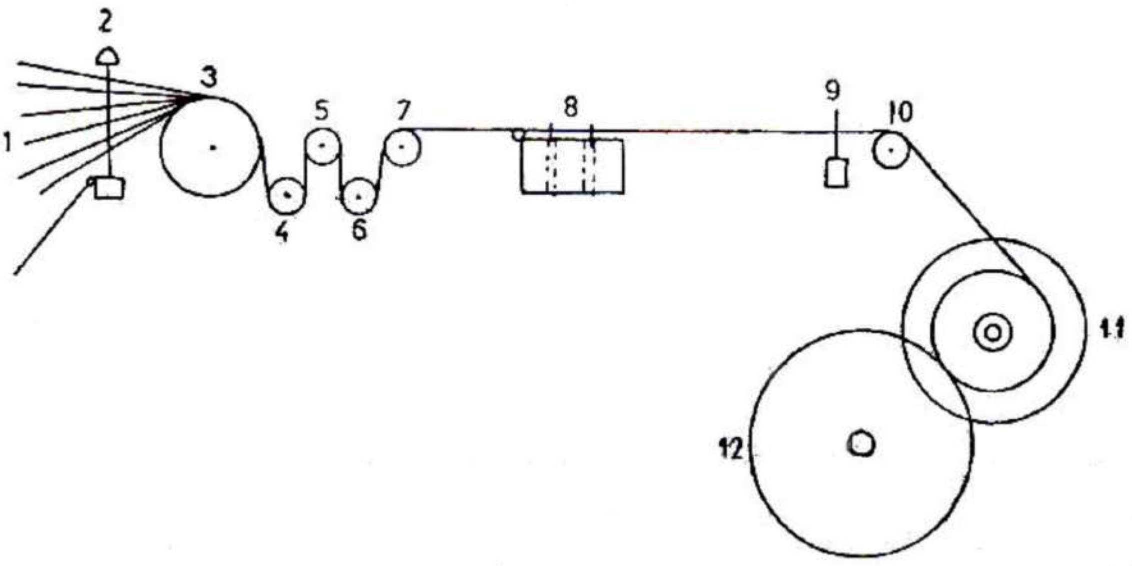


Fig. 1 : Yarn Passage on Slow Speed Warping' Machine

1. Yarn from Creel, **2.** Back Reed, **3.** Measuring Roller , **4, 6.** Falling Rollers,**5, 7, 10**. Guide Rollers, **8.** Drop Pins, **9.** Expanding Comb, **11 .** Warping Beam , **12.** Winding Drum.

The yarn from the creel is first of all passed separately through the dents of a back reed and then over a smooth roller called 'measuring roller' in a sheet form. The roller moves due to friction of the running yarn sheet at a surface speed equal to that of the warp sheet. The yarn sheet next passes under a pair of light seamless pipes termed as falling rollers', in between which is a guide roller. The falling rollers give slight tension to the warp due to their own weight. But the main function of these rollers is to keep the warp sheet taut in the case of machine stopping or warper turning the beam backward for finding a broken end. Each thread is now passed through ⋂ (inverted U) shaped drop pins which causes the machine to stop in case of an end break.

The yarn is then passed through' the dents of an expanding comb on to a guide roller from which it deflects downwards to wind on to a double flanged beam. The beam is held in position at both ends by two brackets and the inside beam pipe between the flanges, rests on a drum from which it receives the motion due to frictional conta0t. As the beam increase in diameter the arms of the bracket holding the beam pivots also rise accordingly. From the free end of the radial arm, weights are hung to apply pressure on the beam. This arrangement reduces bumping of the beam during warping and helps to get a compact beam.

These machines usually run at about I00 ypm. Higher speeds are not possible due to mechanical limitation. This is because the yarn un wounds from the side of the packages in the creel. Further, only small lengths (about 5,000 to 10,000 yards) can be taken on the flanged bobbins thereby prohibiting longer set lengths to be taken at warping. Therefore, these machines are used only for sorts where the set length is very small.

High Speed Beam Warping

To overcome the limitations o[slow speed warping on these machines, the supply package is either cone or cheese shape and from which the yarn is withdrawn from the nose. This, besides giving-higher unwinding speeds also keeps the unwinding tension low and more or less uniform. The supply package holds several times longer length of yarn than the flanged bobbin, there by making it possible to attain longer set-lengths and thus the machine can be run for a considerably long period without stopping it for the purpose of creeling.

The general design of these machines is similar to that of a slow speed warping machine except in some constructional details. Each supply package is mounted on the creel with its nose pointing outside and is provided with a tensioning device in front of it. The tensioner consists of porcelain casting having a pivot and two arms, one of which is provided with an eye.

A fibre washer is mounted freely on the pivot. The yarn from the supply package is passed successively through the eye of the porcelain arm, round the tension pivot and under the fibre washer. The amount of tensioner on the yarn depends upon the warp of it on the tension pin, weight of the washer and the warping speed.

The tension on the yarn should be just sufficient to keep it under control during unwinding. It should be around 10-14 grams for counts upto 36s and around 5-8 grams for counts finer than 36s. Some of these machines are also provided with 'magazine creel'. In this, provision is made in the creel to put one spare package for each running package.

The tail-end of the running package is tied with the starting end of the reserve package, so that when the running package is exhausted, the reserve one will start running. By the time the latter becomes exhausted, the formerly exhausted package will be replaced with a full package. In this way, an unlimited supply of yarn is obtained by the. use of a magazine creel and the stoppage due, to creeling is reduced practically to nil unless the count is to be changed. With magazine creel the amount of production is higher but at the same time the number of creel boys has to be increased.

With the system of unwinding from the nose, the over-running of yarn is avoided when the machine is stopped. In order to avoid burying of broken ends in the beam under the neighbouring, ends at high speeds, the machines are provided with a powerful and efficient brake which is automatically put into action as soon as the machine is stopped by the automatic thread stop motion. contrary to slow speed warping, on most of high speed warping machines the warp from guide roller passes to the bottom of the warping beam at its back, the movement of the beam being thus in opposite direction. With this method, finding of broken end is made easy by turning the beam in forward direction only and thus obviate the necessity of using any falling rollers.

On these machines no separate measuring roller is necessary and instead the winding drum itself acts for measuring the yarn length wound on to the beam.

Oscillating fans are also provided on some machines over the creel and warp stop motion to prevent accumulation of fluff, etc. All the revolving parts at the head stock are provided with ball bearings. The speeds of these machines are from 200 to about 450 ypm.

The high speed warping machines discussed above have movable beam bearings. Unlike these machines the Ruti high speed warping machine, has fixed bearin.gs for the beam and the driving drum is made to gradually recede as the beam increases in diameter. The main advantage of this system is to prevent jumping of the beam during warping.

Modern Super Speed Warping Machines

These machines have several improvements over the high speed machines to attain, winding speeds even upto 900 ypm, high production rates and improved The two following examples, are presently being used in the industry

(i) Barber-Colman Warper

The machine has a V-shape creel which is made up of a series of vertical bars, each carrying nine cheese holders or spindles. The upper and lower ends of the vertical bars are connected to endless sprocket chain running lengthwise of the creel and carrying a continuous series of cheese holders on both the sides of each creel section. The cheeses are held stationary and yarn pulled off over the end' When the cheeses on the outside of the creel are exhausted, a

small motor is started which causes the vertical bars to move the nearly empty cheeses from the outside to the inside of their respective creel sections.
This same movement brings the full cheeses from the inside of the creel to running position on the outside. Ends from cheeses are first laid into a special expanding comb to space them uniformly. The wires in the comb are divided into group of 9, the height of wires gradually increasing from first to the last in each group. The shortest one correspond, to the cheese at the bottom while the longest one corresponds to the cheese at the top of the column. There are as many groups of dents as the number of vertical bars in the creel. The ends from the nearest vertical bar to the head stock are taken in the centre group of comb dents and those from the last bars to the dents corresponding to beam selvedge's. This method of creeling help in doing this operation quickly and finding the broken ends easily.
As in other high speed warping machines, the warping beam in this case is also driven by frictional contact with a driving drum. The driving drum is made of metal. There is provision for gradually increasing the speed from a slow start to the full, otherwise there is possibility of the ends breaking due to the tension imparted to the yarn by the sudden pull of the warping beam running at such an enormous speed.
An indicator operated from a driving drum indicates on a dial, the length of warp wound on the warping beam. The winding stops automatically when a predetermined length. of yarn has been wound on the beam. The machine is A provided with automatic doffing mechanism for full beams.
There is a separate drop wire for each cheese in the creel. When an end breaks the corresponding drop wire falls and completes an electric circuit to magnetic relay in a control box mounted on the front of the creel. This relay when energized breaks the circuit to a magnet holding the brake disengaged and stops the rotation of the beam in time to prevent the broken end from being buried. When the beam rotation is stopped, kinks due to overrun yarn, are avoided by fall of the drop wires, assuming a leaning position which takes up any slack that may develop in yarn.
The machine can run upto 900 ypm. The tension on each of the running ends is low and uniform due to few parts coming in contact with the yarn. Air friction alone supplies the necessary tension to assure the winding of a smooth beam. Besides, there are anti-vibration devices for holding the beam firmly and with uniform pressure against the drum to achieve Uniform density of yarn throughout the winding.
(ii) Cocker BW40C Warper
While at B.C. Warping the beam is driven by frictional contact with the drum, in this machine the beam is driven instead through spindles which actually hold the beam journals. There is a pressure roll at the back of the beam which serves the function of controlling the yarn speed and warp density.
The braking action to the beam comes directly through the spindles. Therefore, this machine is very suitable for synthetic yarns which are very sensitive to abrasion.
The machine has a DC drive which provides a very gradual acceleration, placing minimum strain on the yarn in starting. With this type of drive, constant tension and speed control are obtained, through measuring of the revolution of the pressure roll by a Take generator system or a differential control unit which, in turn, re-controls trough a small hydraulic, transmission or pilot motor, the main motor speed.
The speeds at which the warper can run are selected by a rheostat on the warper and are generally designed to provide a 3-to-1 operating speed, i.e., a low speed of 200 ypm and any speed between that and 600 ypm. Speed ranges from 100 to 600 ypm are normally used.

Indirect System Or Sectional Warping

The fundamental difference between the direct and indirect systems of warping is that while the indirect system provides a means of making a loom warp on one machine, the direct system of warping requires two. Within the single machine operation of the indirect system, however, two steps are required to produce a loom wrap - (**a**) warping - preparing: of different sections, (**b**) beaming - rewinding-of the entire sections to the loom beam. This system of warping.is useful for ,short set-lengths and where generally the grey warp is not to be sized. With the introduction of modern sectional warping machines, this 'system is generally used for high twisted yarns and synthetic yarns.

The old type of sectional warping machines where each section is, prepared on a separate flangeless narrow width beam or cheese and then several of these are combined together side by side on a shaft for making a weavers beam by unwinding the sections, are nowadays not sectional warping machines have, however, found a superfine and synthetic mills. The general working sectional warping machines is given below:

Yarn from the creel is drawn through a lease reed and condensed into a guide reed to about the same number of ends per inch as required on the loom beam' The yarn sheet is wound on a drum or reel which is conical at one end. Winding for the first section is started at the base of the cone. During the warping process a slow continuous traverse is given to the guide reed towards the raised conical portion of the drum. Therefore, the yarn sheet is wound on the drum as shown in Figure 2. The second section is started from the empty space at the base of the cone just by the side of, the first section. Thus, a number of sections required to prepare for a particular loom beam are placed side by side. AII the sections have equal lengths. The cross-section of the warp on the drum is a perfect parallelogram.

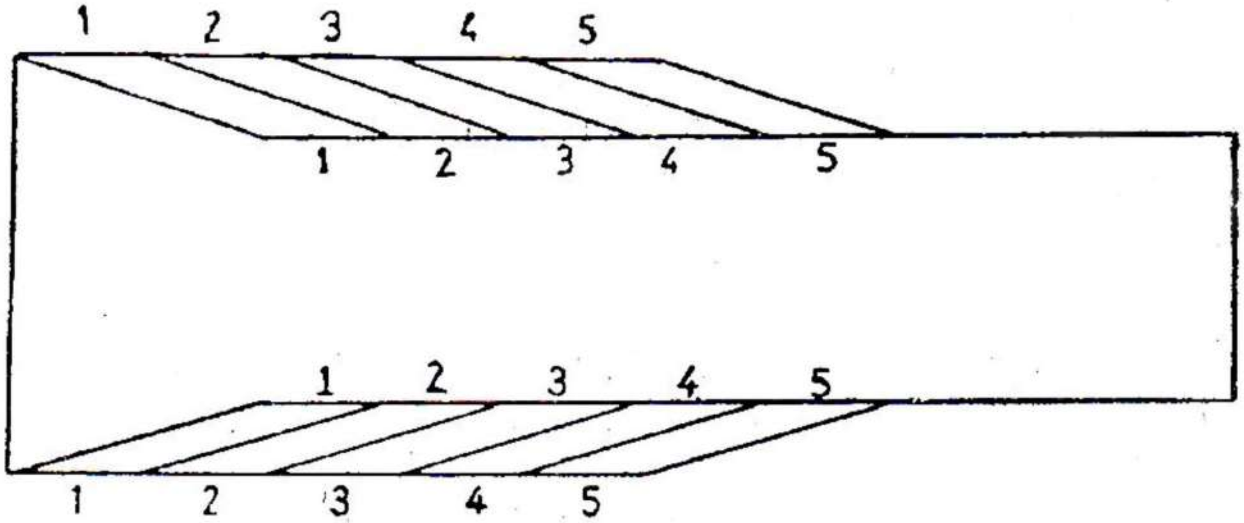


Fig – 2 Cross-Section of the Warp on the drum

After the warping operation is, complete, yarns section are taken together and wound on to a weavers beam at speed slower than that of warping.

Benninger sectional Warping

In industry this is one the most commonly used machines. It has a drum with 2.5 meters circumference. The cone located at, one of the drum consists of centrally adjustable elevators which can be raised to a height of 8" from the surface of, the drum to provide a full round cone. The elevator bars are 33.5" long. The height of the cone or the angle of inclination of cone can be varied according to the requirement of warp construction. The speed of traverse of the guide reed can also be varied as per requirements. The creel is of a rectangular shape and generally holds around 600 ends. Electric stop motion is provided at the front of the creel. The warping speed is infinitely variable within two ranges, each having a ratio of I :6, the two ranges are from 25 to 150 mpm and 135 to 800 mpm respectively. The speed selected depends on the quality of yarn, section density and warp length. For beaming, the speed can be varied from 30 to 200 mpm. An extra creel is generally provided to save the time of creeling. This is kept ready while the yarn runs from one creel.

Other Methods Of Warping

Mill Warping

This is the oldest method of warping cotton yarns. It is generally used for coloured sorts where varieties of small orders are dealt with. Warp yarn from the creel is wound in the form of a loose untwisted rope on a large revolving circular reel about a feet high and having a circumference of about l8 yards. In order to separate the ends in the rope form, an end and end lease is inserted during the start of the winding. With a slow traverse the yarn rope is wound spirally from one end to the other end of the reel. The ends are fixed on lease pegs at both the ends of the reel. The reel is next revolved in the opposite direction until the yarn in rope form reaches the place from where it started the first journey. In this way, to and fro winding is continued till the required number of journeys is completed. For example, if 2400 ends are required for the loom warp and the creel has a capacity of 300 ends, then 2400/300=8 journey will be required. The length of warp wound depends on the circumference of the reel and the number of wraps made during a journey. Usually the length of warp yarn is sufficient only for one beam. The yarn from the reel is removed and wound into a ball or chain form which can be bleached, dyed and sized and afterwards wound on to a weaver's beam.

Ball Warping

Warp yarns that are to be dyed, bleached, mercerized, or stripped can be made into ball warps. The yarn after it comes from the creed through the comb, goes through a guide and around a pulley and then: pass through a trumpet. This system draws the warp sheet down into a rope form as it is traversed and wound on to a core or tube s6t.in the. warper. since the cores that are used do not have heads and are much lighter then conventional beams,
the cost of shipping warp yarns in this form less expensive.

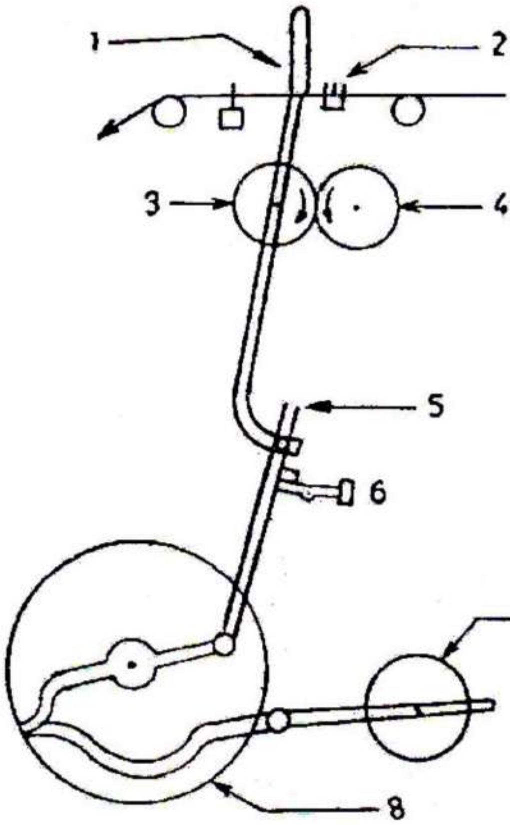
Thread Stop Motion And Brake

Thread stop motions are usually of two types –(**1**) Mechanical, and (**2**) Electrical

Mechanical Thread Stop Motion

The mechanical device most extensively used for thread stop motion on a beam warper is known as 'singleton' automatic thread stop motion. The working of this device is based on the falling wire between the nips of a pair of revolving rollers and thereby effecting a forward movement of one of these rollers, which throws the driving clutch out of gear through a lever arrangement.

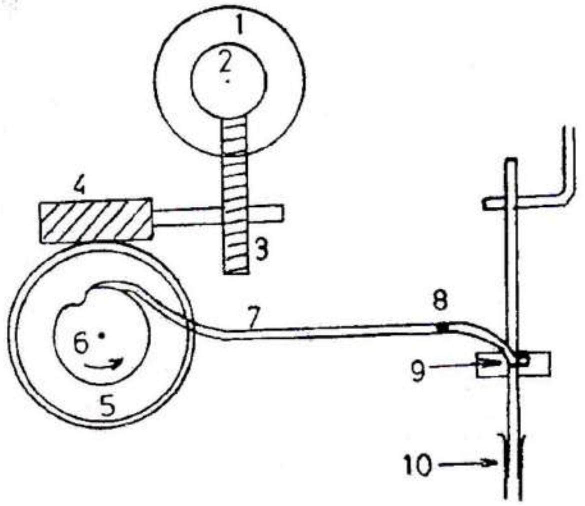
In shown in **Figure - 3** one of the rollers which is mounted on a fixed bearing receives its motion from the winding drum through shafts and levers. This roller through a gear drive at the other end drives another roller which is mounted on a movable bearing and hence can make lateral movements. on one end of this movable roller is a lever fulcrummed at a point above the roller. The lower end of this lever is in loose contact with a vertical trigger which in turn is connected with balance weight by means of lever arrangement. Normally the trigger is supported on a projection. No* when a yarn breaks, the pin supported on it falls. between the two moving rollers. The direction of the rotation o[the rollers is such that the pin is dragged down between the two and in the process the movable roller is pushed forward. Along with this, the lever also moves forward and this movement of the lever throws the trigger out from its support. This causes the friction clutch on the driving shaft to be thrown out of gear, simultaneously putting the drum brake into action so that the machine is stopped immediately. The balance weight which is attached to the lower part of the trigger assists in the performance of the above operation.



l. Lever Fulcrum
2. Drop Pins
3. Roller with Movable Bearing
4. Roller with Fixed Bearings
5. Vertical Trigger
6. Trigger Support
7. Balance Weight
8. Winding Drum

Fig – 3 Singleton's Automatic Thread Stop Motion

Electrical Thread Stop Motion
The principle of this motion has already been discussed under Barber- Colman Warper.
Measuring and Self - Stopping Motion
This motion is provided essentially to get equal length of warp on all the warper beams of a set. The measuring motions can be independent of self-stopping motion and are of various types, The length wound on to the beam can either be recorded through a measuring roller Which is driven by the running yarn or through the winding drum itself . One of the devices for self-stopping is described below **Figure 4**



1. Measuring Roller
2, 4. Single Worm
3. Worm Wheel
5. Wrap Wheel
6. Stepped Disc
7. Lever
8. Fulcrum of Lever
9. Support for Trigger
10. Trigger

Fig – 4 Measuring & Self-Stopping Motion

The measuring roller (**l**) at one end has a worm (**2**) worm which drives a wheel (**3**) on the shaft of the worm wheel there is worm (**4**) which transmits the motion to a wrap wheel (**5**) There is a stepped. disc (**6**) on the shaft of the wrap

wheel. Bent end of a fulcrum med lever (**7**) rests on this disc, while the other end of this lever is attached to an upright trigger (**10**) at the start the bent end of the lever rests on the depressed point or-the stepped disc. When the wheel completes one revolution the bent lever falls abruptly in the slot of the disc causing the trigger at the other end of the lever to be thrown out of its support. This causes the machine to be stopped by throwing the friction clutch on the driving shaft out of' gear or shifting the driving belt to loose pulley- Simultaneously brake is also applied to stop the machine immediately. The length of the yarn wound on the beam corresponds to one complete revolution of the wrap wheel. This length can be varied by changing the number of teeth of the worm wheel (**3**) and wrap wheel (**5**).
For knowing the length of wrap wound at any time a crock or counter is provided at the head stock. This device works either independently or in conjunction with the automatic stop motion' for stopping the machine when predetermined length of yarn has been wound on measuring motion usually provided on slow speed as shown in **Figure - 5.**

1. Measuring Roller
2, 3. Spur Gear
4. Worm
5. Worm Wheel
6. Dial
7. Pointer

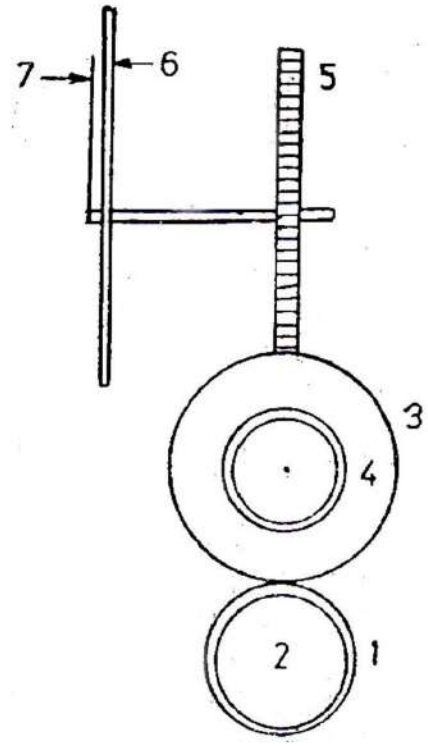


Fig – 5 Clock Measuring Roller

A wheel fitted on one end of the measuring roller drives through gears and worms a worm wheel on which a pointer is fitted by means of a small stud. This pointer indicates on a dial the length of yarn in yards wound on the warper beam. There is another small pointer which through gear connections makes only one revolution for. every 100 revolutions of large pointer. Thus up to 10,000 yards can be measured on the clock dial for one complete revolution of the small pointer.
On the high speed and super-high speed warping machines the length wound is recorded on a counter. The counter is driven through gears either by the measuring roller or the winding drum.

Speed And Production Norms For Warping Machines

The production rates at any warping machine will depend on machine speed, end break age rate, number of ends in the creel, set-length, incidence of creel changes and some other miscellaneous factors. Following table gives machine speeds and normal range of the production (for approx. 400 ends) for various types of warping machines:

Type of Warping	**Machine Speed (ypm)**	**Production per Shift of 8 Hours (In Yards)**
Slow speed warping	90-110	15000-20000
High speed warping	200-350	50000-75000
Super-speed warping	700	100000-150000
Modern Sectional Warping	200-350 (warping)	15000-25000
(For High twisted yarns)	50-120 (Beaming)	2500-3500

WEFT WINDING

Pirn winding/weft winding

With the advent of shuttleless looms, pirn winding is slowly ceasing to exist. However, as long as shuttle loom is there, weft winding or pirn winding is a must. There is no need of pirn for shuttleless looms as the cone or cheese package weighing approximately 2kg is fed as a weft package.

Objectives of rewinding the weft yarn:

1. To convert the cone or cheese (2kg)into a smaller package known as pirn(30gm) to make it fit into a shuttle.
2. To produce a compact pirn of required diameter and length.
3. To produce a pirn that unwinds smoothly without sloughing-off
4. To remove the yarn faults during rewinding

Two types of weft

Direct weft

straight from the ring frame, the yarn on pirn goes to weaving, yarn faults are not removed.
package may not be compact.

Rewound weft

Ring cop-cleared during winding. Then the cone or cheese is wound into a pirn. Package of required dia, length and compactness obtained.

Direct Weft :

Advantages;

(i) It is highly economical

(ii) No further processing of yarn after spinning.

Disadvantages:

(i) Quality of yarn wound on the pirn is limited.

(ii) Chances of sloughing off during weaving as the pirns have a tendency to be soft-built.

(iii) Yarn faults are not removed and hence it may result in weft breakages and loom stoppages.

Rewound weft :

Advantages :

(i) About 30% more yarn content which results in less number of pirns for a given length of cloth.

(ii) Compact and firm package and hence possibility of slough-off is very less.

(iii) Yarn faults are eliminated during winding.

(iv) Waste percentage is reduced.

(v) Quality of cloth is enhanced.

(vi) Exact positioning and size of bunch are ensured in case of auto pirns.

(vii) Work load of battery filler is reduced on autolooms.

Every spindle of an ordinary pirn winding can feed about 0.5 looms and an automatic pirn winding machine can feed 2 to 3 looms. The efficiency and quality of cloth produced are thus influenced by performance of pirn winding machines.

Points to be considered in winding department for Export quality yarn :

1 Electronic yarn clearers are to be preferred in place of mechanical yarn clearers for better clearing efficiency and low knot factor.

2 Splicers should be used instead of knotter for mending the yarns.

3 Waxing should be given to the yarn through a waxing device provided in the tensioner.

4. Tail end should be provided in each package to facilitate magazine creel in warping and knitting.

5. $5^{0}57'$ cones with velvet finish is to be preferred as it avoids slughing off of yarn.

6. Travelling blower should be provided on the winding machines to keep clean and neat.

7. Cone insert(Trident) is recommended to avoid damage of cones during trans porting and handling.

8. Cover each package with polythene bags. The packages are packed in carton covered with polythene sheets and strapped.

9 Experienced and quality conscious operatives are to be employed for this work.

Spindleless type of pirn winders :

SCHWEITER-HIGH SPEED, AUTOMATIC PIRN WINDER :

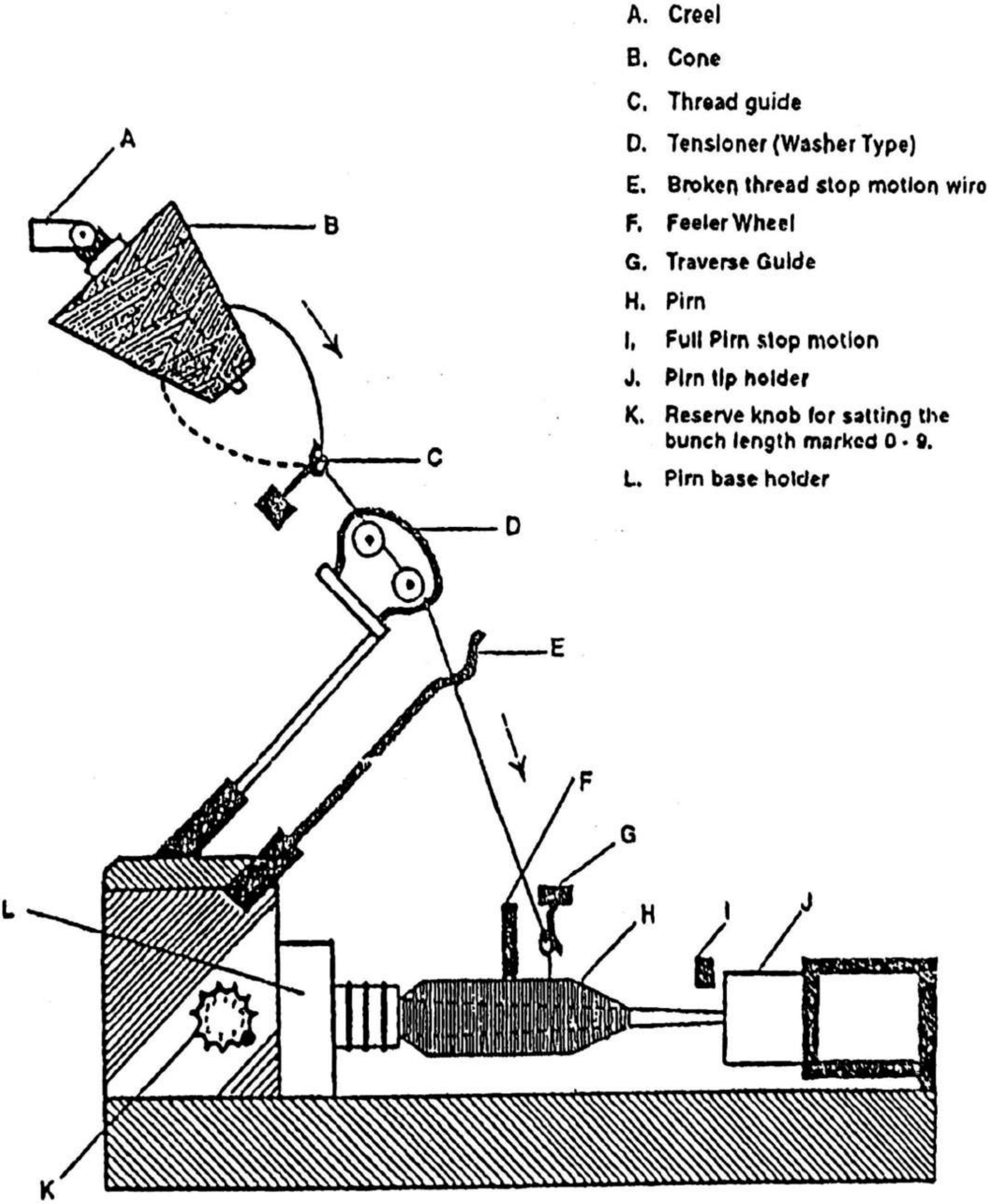
The passage of yarn through a Scheweiter automatic pirn winder is shown in the Figure-19, The machine is made by M/s. SCHWEITER LTD.. Switzerland. The supply package in the form of a cone is mounted in an inverted position at the top of the machine. There is a horizontal rod extending to the entire length of the machine. It holds a number of cone holders at regular intervals to hold the cones. The yarn from the cone is passed through a twin disc type tensioner. Two discs are arranged together by means of a pressure plate with a knob. The knob is graduated from 0 to 9. The tension on the yarn is adjusted by rotating the knob. For finer counts the tension on the yarn is less and for coarser counts the tension on the yarn is more. Higher the dial reading more is the tension and vice-versa.

The yarn is then passed over a broken thread stop motion wire, which stops the unit whenever an end breakage occurs or the supply package exhausts. Then, the material is passed through a thread guide which acts as a traverse guide and finally onto the pirn. The pirn is held axially in between two holders, one at the base and one at the tip. This arrangement eliminates the vibration of the pirns. Winding is carried out by rotating the pirn and traversing is carried out by traverse guide.

Fig - 19

SCHWEITER AUTOMATIC PIRN WINDING MACHINE

(Spindleless Type)



Working :

The majority of high-speed pirn winders is built and works on the unit principle. The work involved in doffing the full pirns, replacing it by an empty pirn and restarting are carried out automatically and systematically.

The machine consists of a number of units, each of which is self-contained and works independently of the other. All the units are driven by an electric motor. But this motor does not interfere with the individual units. Each unit receives its motion through a friction disc.

The traversing of yarn is carried out by the traverse guide, which is connected to a traversing mechanism. A feeler arrangement controls the diameter of the pirn by a setscrew. While starting, the feeler wheel is at the starting position of the pirn. After attaining the predetermined dia. the feeler wheel assemly mechanically moves forward to the tip of the pirn, so traversing is carried throughout the surface of the pirn. Here the layers are locked together and so a compact package can be produced.

As the pirn attains the predetermined length, the base holder goes backward and the doffing and donning of the full and empty pirn respectively, restarting of winding is carried out automatically.

A circular magazines accommodates a large number of empty pirn and can feed the empty pirn to the winding position, if required. This is effected by means of a chute and empty pirn carrier. Here the operator has to arrange the empty pirns on the circular magazine.

When an end breaks or supply package exhausts, the unit stops immediately by a broken thread stop motion. The operator has to take the ends from the cone and pirn and has to tie the ends by means of a hand knotter.

Various Adjustments on Schweiter auto Pirn Winding Machine :

1. *Traverse Length :*

The Traverse length is the length of material that is laid by a traverse guide for its one stroke i.e., from left hand side to right hand side of one stroke of traverse guide or thread guide. This length is adjusted by means of changing the distance, i.e., Height between the bow and traverse shaft. If the height is less that will give shorter traverse and if the height is more, it will give longer traverse. The length generally varies from 30 to 60 mm.

2. *Diameter of the pirn :*

Diameter of the pirn depends upon the shuttle width used in the loom. To get correct diameter. a setscrew is adjusted. To set the required diameter first the feeler wheel should be at the exact point where the winding is to begin.

Then the setting between the pirn and feeler wheel is adjusted by rotating the screw. If the screw is turned in the clockwise direction, the diameter will be more and if the screw is turned in the anti-clockwise direction the pirn diameter will be reduced.

3. *Length of pirn :*

By moving the tip holder away from the base holder or towards the base holder any length of pirn can be held by the two holders. One important setting here is, the stop-rod should be set according to the length of the material before starting the machine.

4. *Tension on the yarn :*

Tension is adjusted by means of a knob graduated from 0 to 9. For coarser counts the tension is more. If the knob shows higher reading, the pressure between the two discs is more. So the tension is more. For finer counts the tension imparted in the yarn is less and for this the lower number is used.

5. *Bunch Length :*

In auto looms during pirn change, a defect namely crack may occur. To avoid this defect, an extra length of material is wound at the base of the pirn. This bunch must be adjustable for yarn lengths to satisfy the requirement of loom with different reed space. The normal range is 5 to 15 meters. Where coarse yarn is involved for weaving in wide looms some provision is made for spreading the bunch. This length can be controlled by means of a knob which is graduated from 0 to 9. Higher the number means, bunch length is more.

6. *Spindle Speeds :*

Provision is made for changing the spindle speeds by changing the position of belt in the stepped pulleys to suit different types of yarn. Speeds of 12,000 R.P.M are now considered normal, but it must be recognized that the speed is limited to wind -or coils per traverse-as the reciprocation of traverse and not spindle speed is generally the design limitation. A speed of 12,000 may only be possible on some machines with a 13 wind but on another the same speed may be obtainable with a 10 wind. Winds are available in the range of 6 to 13 with intermediates, but on some machines 7 wind is standard. Traverse length is generally variable up to 6cm and as the normal relation between traverse 'T' and diameter 'D' is T=1.6D. This allows for pirns of 3.75cm, which is more than sufficient.

Elimination of the Battery Filler In Automatic Looms :

Due to increasing higher wages of the battery fillers, the machine manufacturers have devised means where by filling the battery by hand is eliminated.

Two methods have been developed which are not only applicable to new looms but can be fitted with minor modifications to many other looms. These systems are (a) Unifil loom winder and (b)Box or bobbin loaders.

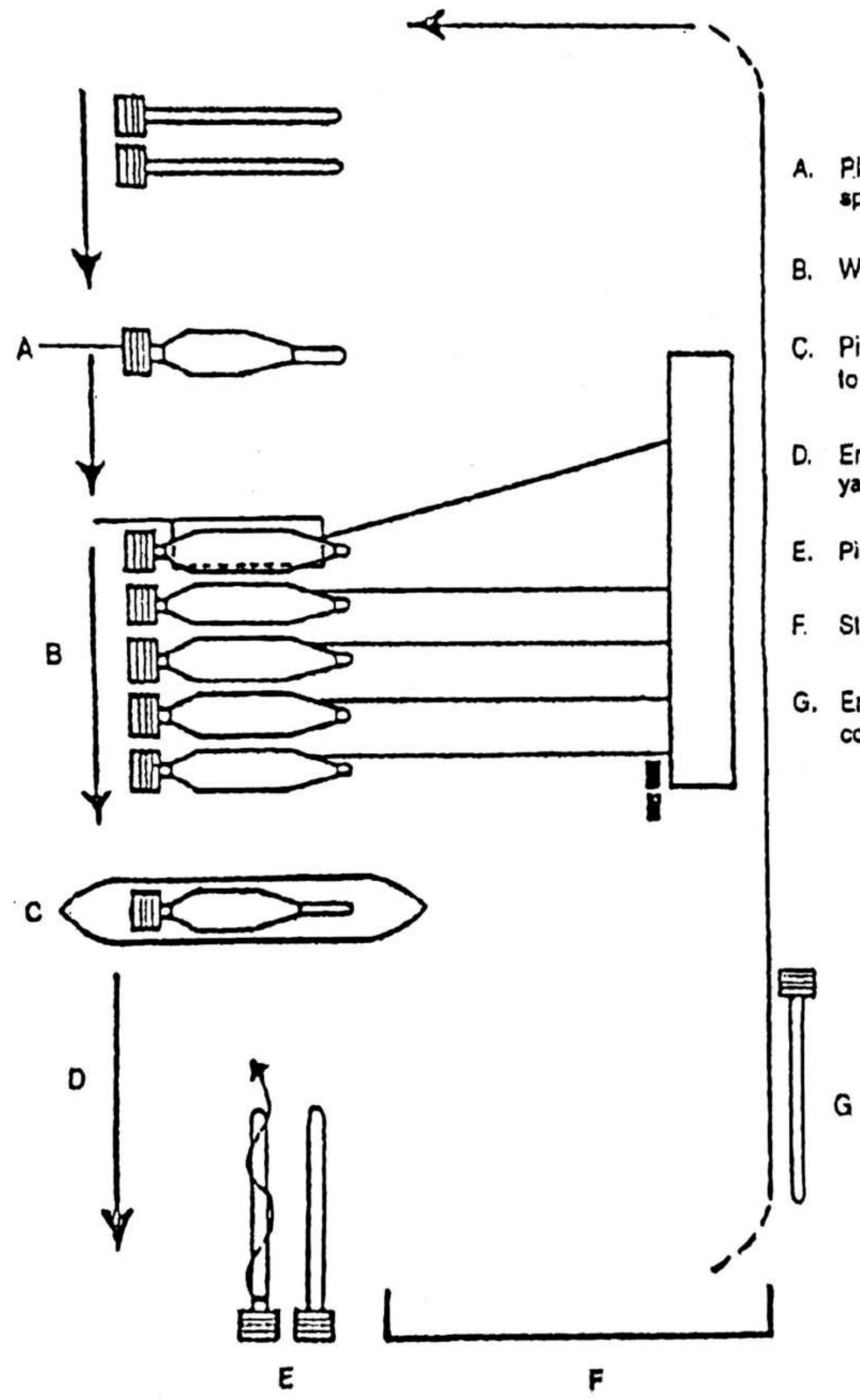
Unifil Loom Winder :

The Unifil Loom Winder is so designed as to be easily mounted on a loom and is of the spindleless type. A line sketch showing the process of winding, transferring, stripping and conveying of the pirn is shown in the figure-20.

Fig - 20

UNIFIL LOOM WINDER

(Spindleless Type)



A. Pirns wound from cone by the spindless type winder

B. Wound pirns fed to the magazine

C. Pirns transfered from magazine to shuttle.

D. Empty ejected pirns with remnant yarn transfered to stripper

E. Pirns stripped of remaining yarn

F. Stripped pirns picked by conveyer

G. Empty returned to winding unit by conveyer.

The pirns are wound from cones and are fed to the magazine from where they are replaced in the shuttle one by one, just as from the bobbin batteries. There is provision for controlling the diameter of the pirn to suit the shuttle and also adjust the length of traverse. The winding speed can be varied to suit different conditions.

As each pirn is completed, it is transferred.from the winder to a small magazine. The magazine holds small number of pirns-say 6. When the pirns are nearly exhausted the weft replenishing mechanism acts. The magazine replenishes full pirn into the shuttle and at the same time the empty pirn is ejected and passes to a stripping unit where the remaining yarn of bunch is removed. After stripping, the pirns are carried by a conveyor belt to the winding unit. The belt is tied with magnets to which the rings in the pirn adhere. In the winding unit, winding is done as in an automatic winder and the same operation is repeated.

The main advantage of the Unifil Loom Winder is the elimination of manual battery filling. Separate pirn winders are not required; hence separate pirn winding department is also not required, which leads to saving in labour and very high cost of initial expenditure on capital investment. The restriotion to a few bobbins to a loom 14 are sufficient to maintain the winding head-loom battery-bobbin stripper sequence operating correctly, can be a great advantage.

Being localized to one machine with Unifil, the damaged pirn is very rapidly traced and eliminated. There is also a considerable economy in investment in pirns, as some 400 pirns per loom are normally essential to sustain the supply of weft between the pirn winding departments and loom shed. There can be no doubt that waste can be reduced and fabric quality improved in comparison with conventionally pirned weft woven in rotary battery looms. Quality improves as a result of more uniform tension, less handling. Waste is reduced by eliminating back winds of uncertain length and the widest loom to which the pirn may be directed. There are no part-filled bobbins-a product of some fully automatic pirn winding machines-and soiling or staining due to mishandling or dropping in battery fillings is eliminated.

The maintenance of this type of winder is also important and therefore separate trained staff is required. However, in our country this winder has not yet been fully accepted probably owing to its high cost and maintenance.

Box or Bobbin Loader :

The Box Loader is another parallel development, the pirn winding spindle applying a nose bunch or **tip bunch** as well as the usual base reverse bunch to permit bobbin change without broken picks. The pirns are delivered to a box loader devise attached to the loom, which lifts the pirns out of the boxes and transfers them to the loom battery. The nose bunches are removed by the loom mechanism and held as the battery retaining end, during bobbin transfer. The Fischer AL.V. Bobbin Loader is one example of this type, which is used in the industry.

Layer locking device :

This device provides a differential binding motion which locks the layers of yarn during pirn winding. The locking of layers is achieved by slightly altering the wind being advanced the relative and restarted from the original positions on successive yarn layers. This helps to improve pirn stability which is vital especially for filament yarns.

When layer locking was used on a 7" pirn winding 140 denier acetate yarn, the minimum tension for stability in the loom came down from 36 to 26gm. In case of 150 denier viscose yarn on the same 7" pirn the minimum tension for stability fell from 62gm to 50gm.

By having this device in pirn winding, a better cohesion or grip is achieved for yarn coils with reduced tension to the yarn. The sloughing off of yarn during unwinding from the pirns is eliminated.

Bunch in a pirn :

Bunch is an extra length of yarn say 5 to 15 meters of yarn or 2 to 3 pick lengths

Empty pirns :

These are made of wood, metal, plastic or paper material and are used in a multitude of sizes depending upon the size of shuttles used on looms. Size of pirn is denoted in terms of lift of pirn and diameter at base and tip of the pirn. The profile of the pirn also varies and it can be classsified in three major categories, namely,

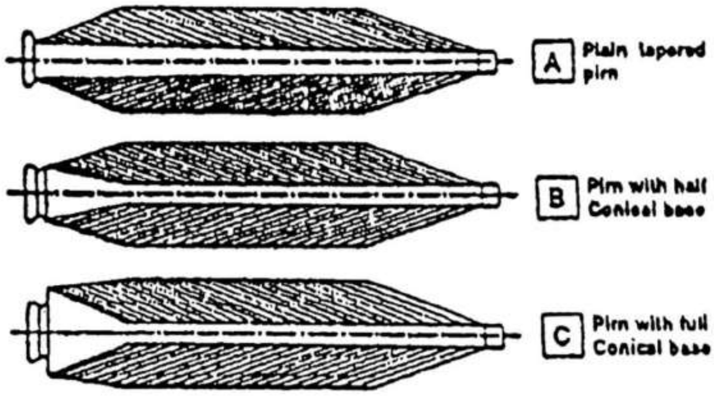
a) Plain tapered pirn.

b) Pirn with half conical base, and

c) Pirn with full conical base

These are illustrated in the **Figure-23-A,B and C**, respectively. Another important point to be considered is the **gripping** power of a pirn surface. Basically, it depends upon the material of pirn and finish given, if any, to the surface of the pirn. It can also be changed artificially by providing a number of grooves on the pirn surface.

Fig - 23
PROFILE OF PIRNS



The commonly used type of grooves are :

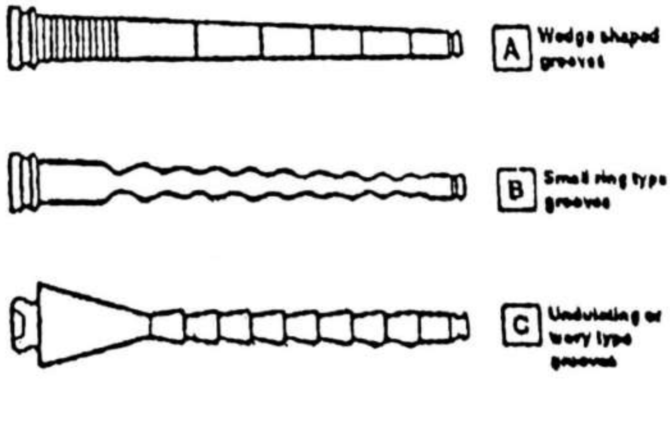
a) Scale or wedge shaped grooves.

b) Small ring type grooves, and

c) Undulating or wavy type grooves

as illustrated in figure-24-A,B and C, respectively.

Fig - 24
PROFILE OF PIRNS



Plain Taper Prins :

These prins are in common use for practically all types of yarn. These are specially suitable for automatic looms which have sliding type of weft feelers. The only disadvantage of plain tapered pirns is that there is an abrupt rise in tension when unwinding from the base of pirns. There are also short term fluctuation in tension during unwinding from nose and shoulder of the chase. However, the abrupt rise in tension during unwinding of the last few coils is more troublesome as it leads to more weft breaks. It is also a source of shiners in the case of filament weft yarns.

Half conical and full Conical Base Pirns :

The disadvantage of plain tapered pirn can be overcome by providing half conical or full concial base to the pirn, The unwinding tension is more or less the same as that for the plain tapered pirn in the initial stages of unwinding. But there is no abrupt rise in tension when unwinding the last few coils. That is, variations in tension during unwinding of the pirn are reduced. However, this advantage is accompained by increased tendency of the last few coils to slough-off from the conical base; the tendency to slough-off being much in the case of smooth filament yarns. Use of these pirns is therefore, limited to coarse and hairy yarns. If these pirns are to be used for fine yarns, it is advisable to use higher winding-on tension and more number of grooves on the conical base of pirns.

Pirns with scale type of grooves :

In these type of pirns, the possibility of sloughing-off is totally eliminated on account of the increasing diameter of scale or wedge in the forward direction. However, there is always danger of smooth filament yarns slipping on the edge of the scale and getting trapped in the bottom wedge. This type of groove is therefore mostly used in the case of spun yarns.

Pirns with Ring type of grooves :

Small ring type of grooves do not have any such draw backs as in scale type grooves, and are good enough to provide necessary gripping power to the pirn surface. These are therefore much preferred in the industry.

Pirns with wavy type of grooves :

The wavy type of grooves incorporates the features of the scale type of groove without any sudden change in diameter. It also ensures complete absence of ring type of grooves. However, it has not become popular in the industry. Smooth, grooveless pirns are recommended for zero twist filament yarns.

Basic Factors Affecting the unwinding performance of pirns :

Some of the important characteristics of full pirns are :

Full pirn diameter, chase length, chase angle, length of initial taper, number of winds and compactness. These are the basic factors affecting the unwinding performance of pirns.

The important aspects to be remembered are :

1. The normal pirn winding tension should not exceed 12-14% of the single thread strength of yarn.
2. Winding should begin at a distance of 2 mm from the butt end, while it should stop at about 3 to 10 mm from the tip of the pirn.
3. Chase length should be such as to give a chase angle of about 10-18° in the case of spun yarns and about 6-10° in the case of filament yarns.
4. In the case of plain tapered pirns, initial taper should be equal to the chase length.
5. In the case of conical base pirns, chase length should be equal to the length of conical base.
6. The number of winds should usually be around seven.
7. Filament yarns have profound tendency to slough-off. Similarly, tendency to slough-off is more for a pirn build having more number of winds, shorter chase length, greater cone angle, etc., In such cases, it is better to employ a layer locking system to achieve good pirn stability.

Package Faults in Pirn Winding :

Faults in pirn are often due to improper selection of winding parameters, improper machinery maintenance and fuulty operator practices. These faults not only affect loom performance, but also influence fabric quality.

The probable causes for different package faults are :

Missing bunch :

In pirns meant for automatic looms, when there is no bunch formation at the start of winding of a pirn, it is known as missing bunch. The causes are :

a) Bunch forming mechanism not working properly,

b) Improper control over the yarn at the start of winding

c) Incidence of an end break during bunch formation.

Bunch failures due to the first two causes do not normally lead to machine stoppages while the last, bring the spindle to a standstill and call for operator attention.

It is not generally possible to check the presence or otherwise of bunch on auto-pirns, as the bunch is usually covered up by succeeding yarn layers.

A random check at the start of winding of the pirns can, however, be conducted to get an idea of the incidence of missing bunch. An observation round in the auto-loomshed will also be helpful in this regard.

Improper Starting :

Normally a distance of 2 mm is kept from the butt end of pirns while starting a fresh pirn. Improper setting of the building mechanism alters the starting point and influences the yarn content of pirn. So also, improper starting causes shifting of position of the bunch and, in turn, affects functioning of the weft feeler mechanism on the auto-looms.

Soft build :

Compactness of pirn is solely dependent on yarn tension as there is no other pressure applying device. Soft pirns are produced if lowering of yarn tension takes place on account of clogging of tension discs with fluff or due to improper threading of yarn through the tension assembly. Apart from giving lower yarn content,.soft pirns are also prone to slough-off during weaving. Moreover, such pirns can also easily get damaged during handling and transport,

Uneven diameter/Ridgy surface :

Variations in yarn tension during winding, jerky movement of feeler disc and improper mending practices followed by operator are some of the causes of uneven/ ridgy pirn surface. It leads to variations in yarn content besides sloughing-off and en-tanglement during unwinding.

The operator should not start winding on the same position of pirn after mending an end break. He should always push back the feeler disc to the required extent before starting the spindle. This will ensure evenness of pirn surface.

Over-filled pirns :

Generally, yarn is wound onto a pirn upto a distance of 8 to 10 mm from the tip of the pirn. Faulty adjustment and improper functioning of full pirn stop motion lead to winding of yarn beyond this point and result in over-filled pirns. Such pirns are prone to slough-off during handling and give rise to increased hard waste.

Over-filling of pirns may also be in terms of bigger pirn diameter. This arises on account of improper setting of the building mechanism. Over-filled pirns cannot fit into the shuttle and are to be unwound. In the case of automatic looms, there is a danger of damaging the pirn changing mechanism, the shuttle and the pirn itself if the pirn is not able to fit into the shuttle during transfer.

Defective initial taper :

The initial taper of pirn is dependent on the dimensions of tapered profile plate. The length of initial taper should be 1:1 ratio of traverse length to the length of initial taper of pirn for satisfactory results. A shorter taper gives profound tendency of slough-ing-off during unwinding while a longer taper reduces the yarn content of pirn.

Absence of layer locking :

A layer locking device displaces longitudinally the normal length of traverse, the wind being advanced and retarded from the original position on successive traverses.

With this, there is more binding between adjacent yarn layers and hence pirns become more stable. Wearing out of this mechanism and improper settings may give rise to absence of layer locking. This will be reflected in an increase in the sloughing-off tendency of pirns on looms, especially in the case of fine counts and filament yarns.

Count mix-up :

Yarns of different counts may get mixed-up during pirn winding on account of negligence and give rise to weft-way defect in fabric. Frequent checks for markings on supply packages would be helpful in controlling this fault.

Shade variation :

Shade variations in pirns are due to differential dyeing of wound packages and ultimately lead to weft bars in fabric. This can be avoided if proper precautions are taken in winding and dyeing of dye-packages. However, this is beyond the purview of the pirn winding department. The only way to avoid weft bar formation is to seperate pirns according to light, dark and normal shades and use them seperately.

Difference between weft and warp winding :

Weft	Warp
1. Feeder package is very much larger than the delivered package	Delivered package is very much larger than the supply package.
2. 2kg supply cone delivers approximately 30gm pirn.	80-100gm supply package delivers 2 kgpackages.
3. Delivered package is automated.	Feeder package is automated.
4. Yarn winding speed of 825 mpm or special speed of 12000rpm.	Yarn take up speed is 1200 to 1500 mpm.
5. On a 30gm delivered pirn of 24' count, running time per pirn is 1.5mts	On a 100gm supply ring bobbin of 24' count, the running time may be around 3 mts.

Anti-patterning Device:

Patterning or Ribboning:-

When coils of yarn on successive double traverse are laid exactly on top of each other, a defect known as patterning or ribboning occurs.

When the yarn piles into a ribbon, a knuckle is usually formed at each end of the package. Subsequently when the yarn is drawn off from the package, it will be caught at this knuckle at the rear end of the package and the yarn will break frequently. Such packages when dyed, may also lead to uneven shades.

When this ribboning occurs?

(i) Precision winding:-

$$\frac{\text{package revolution}}{\text{traverse cam revolution}}$$

(ii) Drum winding

$$\frac{\text{package revolution}}{\text{revolution of the drum for a double traverse}}$$

is an exact whole number

This type of package is not suitable in the subsequent processes, if the yarn is to be drawn off over the end of the package.

How to avoid ribboning?

In case of precision winding, a gain mechanism is used to progressively displace the position of yarn coils.

Anti-patterning device in Precision Winder :

In precision winding to avoid formation of ribbon, the speed ratio of the cam to the winding spindle is kept slightly greater or less than a whole number by an amount termed **gain**. With this, the position of yarn cols on successive double traverse is progressively displaced. For drum driven packages where a separate reciprocating thread guide is used to traverse the yarn, ribbons are prevented by constantly varying either the speed of the driving drum or the cam which acutates the thread guide. The mechanism for varying the speed is usually referred to as **ribbon breaker,** and it is usually applied to the cam shaft rather than to the drum shaft. The ribbon breaker varies the speed of the cam shaft, either by using a V-belt drive with variable pitch sheave or by the use of a compound gear mechanism. Thus, when a package reaches a diameter where ribbon is formed, the varying speed of the thread guide will avoid the formation of these ribbons.

Anti-Patterning device in Drum Winder :

On a drum winder with rotary traverse, where the yarn is guided onto the package by helical grooves incorporated in the driving drum itself, it is obvious that the method of breaking ribbons has to be different from the methods described above. On such machines a method depending upon the **skid principle is used.** The mechanism consists of a switch in the power line leading to drum driving motors. The switch is operated by a cam which is driven by a separate motor known as 'Pilot Motor'. The cam interrupts the power to drum motors for an instant, about **30-35 times per minute,** by opening and closing the switch.

When the switch opens, the power is cut to the drum motors for an instant, the drum shaft begins to slow down, and then when the switch closes the circuit, the motors quickly pull down the drum shaft back to normal operating speed. This sudden increase in speed causes the package to slip or skid on the driving drums. This sliding action is very slight but is sufficient to change the lay of yarn on the package and prevent one wrap from winding on top of the preceding wraps at those package diameters where ribbons are formed. This method of breaking ribbons is applied on machines like Leesona Roto-coner, Schlafhorst, Auto-coner, etc.

On some machines with rotary traverse like Barber Colman winder and Schlafhorst BKN winder, instead of using skid principle the drum used is much bigger in diameter than even that of the full package. In such cases the number of package revolutions are always less than one for each revolution of the drum, and thus the necessary condition for ribbon formation is eliminated.

MURATA'S PRECISION CONE AND CREESE'WINDER TYPE 50B

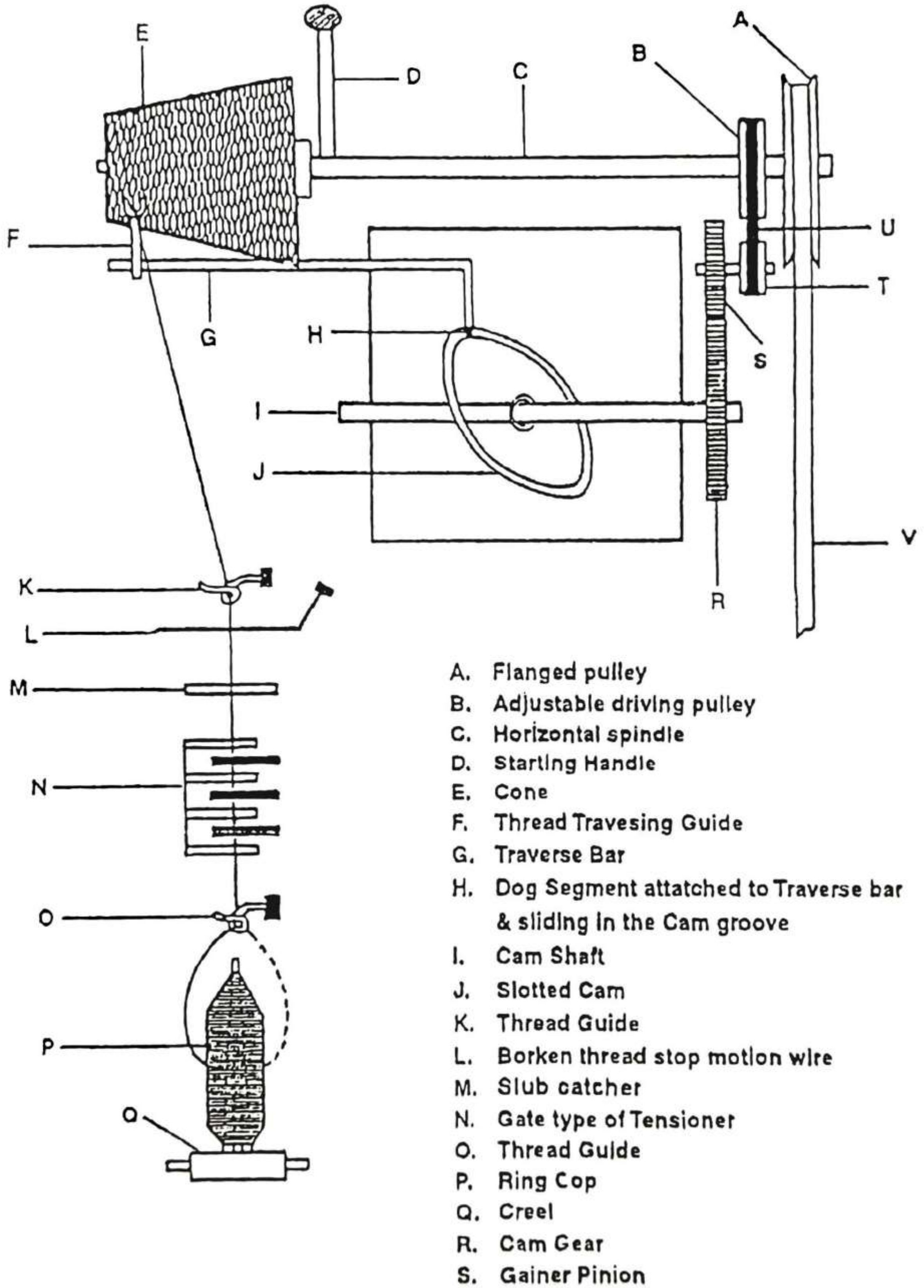
A Precision Winder is one in which there is a constant ratio between the speed of the spindle which carries the package being wound and the speed of the traversing mechanism.

This winder has the capability for winding nearly all types of yarn, for example, cotton, rayon, synthetic, spun rayon, linen etc. which are to be used in warping, dyeing, knitting, doubling, etc. Besides fineness, quality of the yarns do not offer any difficulty in winding on this machine. Even fine denier nylon can be wound on it without encountering any practical difficulty. The types of wind that can be produced on this machine are close wind and open wind. The number of winds obtainable ranges from 1 ½ to 4.

This winder winds yarn from any type of supply packages like ring cops, cakes (rayon, nylon), and hanks. Different type precision packages such as straight cones, pine-apple cones, parallel tubes and dye tube can be wound on this machine.

The passage of material through the important parts of the machine is shown in the figure-16 . The yarn from the supply packages, on its way to the traverse guide F passes through a gate type of tensioner N. The tension to which the running yarn is subjected can, therefore, be easily adjusted according to requirements. The machine is provided with a thread stop motion L which stops it in the event of yarn breakage or exhaustion .

The traverse guide consists of a steel roller plated with chromium which is a hard metal. As such, it will prevent wear to a very great extent. Besides, the co-efficient of friction on the chromium plated surface is rather low. Furthermore, it will make the guide rust proof. The traverse bar G to which the guide is attached, makes to and fro movement through a guide H (dog segment) provided with self-oiling arrangement. The important parts of the traverse motion are fully enclosed to prevent accumulation of dust and down which may hinder its correct functioning. The slotted cam J is fully fig - 16 MURATA PRECISION CONE AND CHEESE WINDER - TYPE - 50B



A. Flanged pulley
B. Adjustable driving pulley
C. Horizontal spindle
D. Starting Handle
E. Cone
F. Thread Travesing Guide
G. Traverse Bar
H. Dog Segment attatched to Traverse bar & sliding in the Cam groove
I. Cam Shaft
J. Slotted Cam
K. Thread Guide
L. Borken thread stop motion wire
M. Slub catcher
N. Gate type of Tensioner
O. Thread Guide
P. Ring Cop
Q. Creel
R. Cam Gear
S. Gainer Pinion
T. Wind Pulley
U. Endless Blet
V. Belt connected to Motor pulley

enclosed in an oil box to keep it lubricated all the time by the splash of the oil. The locking lever provided on the machine, being separated from the dog segment, do not produce any wavy mark on the surface of the winding package when it is restarted after piecing up a broken yarn. The setting of the dog segment permits fine adjustments. Consequently, the winding prressure can be regulated with precision according to requirements. The tapering of the cone can be regulated to the desired extent by means of an indicator device provided on the machine.

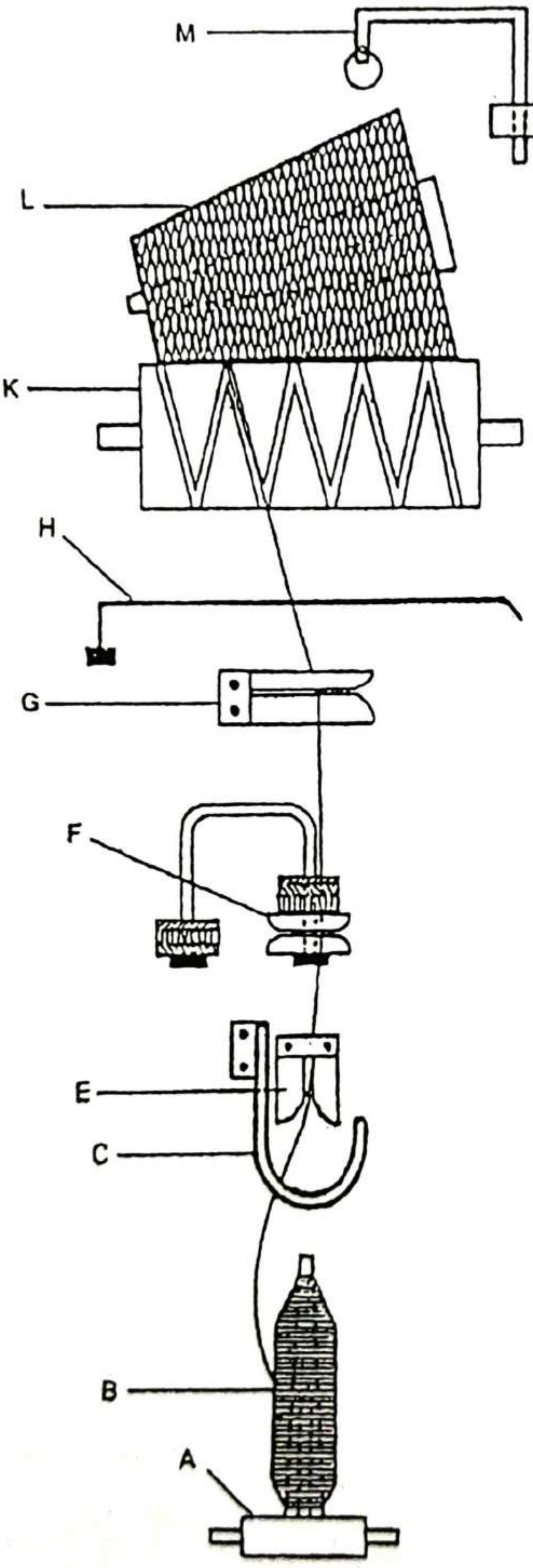
The winding speed of the machine can be adjusted from 200 to 400 yards per minute to suit yarns of different qualities and counts. The machine is driven by an individual motor. The power required for a machine having 12 spindles is 1 horse power. Such a machine will be 4 meters wide and 16 meters long. The various arrangements described above enables the machine to wind with varying characteristics. Although, it is specially designed for processing delicate man-made fibres like nylon, terylene, etc. the machine can be employed for fine cotton yarns where the conditions are favourable for its use.

Roto-coner No.44: High speed warp winding machine :

This machine is made by M/s. Universal winding co., England. The winding and traversing of the yarn is done at the same time and therefore the machine is called Rotary traverse drum winding machine. This machine is suitable for the winding of hosiery and warping cones, the standard length of traverse being 6 inches although for very coarse yarns a still longer traverse has been employed.

The grooved driving roll consists of 9 cuts or grooves from left to right and back again. The main object of these grooves is just to guide the yarn onto the package by suitable traverse motion. Each package require a separate drum and a series of drums are mounted on a horizontal shaft driven from a motor. The speed of the drum is 750 R.P.M. A line sketch of the passage of material through the machine is shown in **Fig-17.**

Fig - 17 ROTO - CONER NO. 44 HIGH SPEED WINDING MACHINE



A. Creel

B. Ring Cop

C. Balloon breaker

E. Thread guide

F. Tensioner (Washer Type)

G. Slub - Catcher

H. Broken thread stop.motion wire

K. Grooved winding drum

L. Cone

M. Full package indicator

Passage of yarn through the machine:

The supply packages usually ring bobbins B are mounted in an upright position on the creel, which extends the entire length of the machine on either side of it. The yarn from each supply bobbin is drawn through a thread guide E and then in between two metal washers of a tensioner F Of course, there is a balloon breaker in between the cop and the thread guide to break the balloon formation, thereby avoiding breakage of yarns due to excessive tension. The tensioning device consists of a pair of metal washers fitted loosely on a short spihdle. The amount of tension given to the yarn will depend on the weight of these washers, count of yarn etc. Generally for the coarse count, the amount of tension given to the yarn is 299 grains, for medium counts the tension will be 100 grains and for fine counts the tension will be 55 grains.

The yarn from the tensioner, passes between the serrated blades of a slub-catcher G , which arrests slubs, neps, snarls, thick places, etc. present in the yarn. The slub-catcher can be set according to the counts of the yarn wound. For a coarser count of yarn, double slub-catchers is used. For rotoconer generally micro-set slub-catchers is used. The setting will depend on the count of the yarn. For carded yarn, the clearance in the slub-catchers will be three times the diameter of the yarn and for combed yarn the setting will be 1.5 times the diameter of the yarn. The yarn from the slub-catcher passes over the broken thread stop motion wire H and then over the grooved winding drum K. The grooved drums are mounted at regular intervals on winding drum shaft which are provided with ball bearings. The number of drums per machine may be 20 to 120. Each shaft is driven by a separate motor so that the drums on any one side can be run independent of those on the other side.

The function of the grooved winding drum is two fold. It winds the yarn on the cone, and at the same time gives a traverse movement to the yarn. The grooves on the surface of the drum, guide the yarn which is always in these grooves and moves in the same direction as the latter.

Each winding drum has a separate broken thread stop motion. When an end breaks or the yarn in the supply bobbin becomes exhausted the cone automatically rises off the winding drum. Practically each winding drum with its tensioner, slub-catcher and broken thread stop motion, forms one winding unit.

The machine is further fitted with a conveyer, one on each side. The conveyer carries empty supply bobbins and deposits them into a suitable contanier kept at the end of the machine.

Duties of an operative in Roto-coner No.44 High speed winding machine :

1). The operator removes the empty supply package and inserts a full bobbin on the peg.

2). The operator picks up the end from the new supply bobbin and passes it through the thread guide, tensioner, slub-catcher and then through the broken thread stop motion wire.

3). He finds the ends from the cone end and knots it with the end of the supply package by using hand knotter.

4) Then he lowers carefully the cone over the revolving winding drum and winding starts.

5). When the package is full, it automatically lifts up(if the machine is fitted with an automatic full bobbin stop motion). Then he removes the full cone from the cone holder and inserts an empty paper cone or wooden cone, winds 3 or 4 rounds of yarn over the cone and lowers the cone holder carefully over the revolving winding drum and winding starts.

6). Above all he has to keep a constant watch for broken ends, exhausted supply packages and full cones and in the event of the any of the above mentioned cases, he has to perform the duties already explained.

Automatic Cone and Cheese Winding :

The automatic high speed and super speed machines used for this process carry out automatically most of the operations which are performed manually on the ordinary high speed and super speed machine and thereby eliminating human element as far as practicable. The automatic devices provided on these machines automatically detect the exhausted supply bobbin and replace it with a fresh bobbin after throwing away the empty one onto a conveyor belt for depositing in a container or sorting table. It sucks the cheese and bobbin ends for knotting or splicing, piece up both bobbin and cheese end together. It shears the protroding cheese and bobbin ends after knotting, and re-starts winding as soon as shearing of the ends have been completed. It measures the size of each winding package and throw it out of action when full. It restarts winding when an empty cone or cheese starter has been manualy or mechanically mounted in place of a full cone or cheese, and piecing up as well as shearing of the ends have been done automatically.

The winder is left with a few operations, namely filling the magazine or reserve holders with fresh supply bobbins, removing full winding packages and replacing the latter with empty cones or starters, as the case may be. All these manual operations are simple in nature and could therefore, be attented by even an unskilled operative. In certain types of machines the winder attends to the above operations while sitting comfortably on a chair, while the machine performs all the work automatically.

Features of Automatic/Fully automatic winding machines :

1. Automatic location and retie of all broken ends/exhausted bobbins.
2. Automatic feeding of full ring bobbin and removal of empty ring bobbins.
3. Automatic suction of both ends and joining them automatically by knotter/ splicer.
4. Automatic restarting of the winding head after mending.
5. Automatic broken thread stop motion to stop winding / lift the package from winding drum.

6. Automatic full bobbin stop motion.
7. Automatic doffing of full package and replacing with empty cone/ cheese.
8. Automatic winding of a reserve for magazining the wound package where it is necessary.
9. Automatic feeding of ring tubes from a hopper.
10. Automatic distribution of ring tube to winding position.
11. Automatic preparation of ring tubes for winding.
12. Automatic waxing of yarn, if necessary.

BABER COLMAN AUTOMATIC SPOOLER (Cheese Winding)

(Type C)

This is a super speed automatic machine made by Messrs. Barber Colman co., U.S.A. It winds packages ideally suited to warping, twisting, doubling, dyeing, quilling and back-winding. The traversing groove in the winding drum produces a package that is 84.13mm(35/16 inches) wide, with diameter upto 222.25mm (8 3/4 inches) being controlled by the traveller. Machines can be equipped to handle wood or paper bobbins.

The machine possesses a number of outstanding features which are intended for reducing the winder's work as well as the cost of winding. Besides, yarn of practically uniform quality, with most of its original elasticity retained, is obtained on this machine.

Description:

The supply packages consist of ring bobbins. Each bobbin is fitted on a skewer which holds it in a vertical position, so as to enable unwinding of yarn to take place from the end of the supply package. The yarn from the supply bobbin passes through a thread eye which is situated at a distance of about 1½" over the tip of the bobbin. The skewer should hold the bobbin, in line with the thread eye as otherwise, it will cause skewer failure. For each running supply bobbin, there is one reserve full bobbin which is fitted by the side of the former. In the event of breakage or exhaustion of yarn on the active bobbin it will be automatically ejected from the bobbin holder and dropped onto a conveyer for carrying it to a sorting table located at one end of the machine. The reserve bobbin will now automatically assume the position of the active bobbin practically without any loss of production. The empty skewer can then be filled with a full bobbin by the operative. The end of the yarn of this reserve bobbin is normally fitted into a thread clamp situated over it.

The yarn from each active supply package passes through the snick plate(slub-catcher). As the yarn passes between the snick plate blades, foreign impurities adhering to the yarn, soft thick places and gouts etc., are removed without damaging the yarn.

The yarn next passes through the broken thread stop motion which acts automatically in the event of an end breaking. When the thread breaks or supply package exhausts, it will cause the corresponding cheese to be lifted out of contact with the winding drum.

The yarn from the thread stop motion passes onto a grooved winding drum and then onto the spool. The winding drum rotates at a terrific speed and the spool receives its motion due to frictional contact with the former. The grooves on the drum also act as a traverse guide to the yarn, which traverses in the grooves during winding.

Winding Cheese for Dyeing :

When dyeing in the cheese form is to be resorted to, the cheeses are wound on perforated stainless steel dye sleeves. The dyed cheeses can be used directly on the Barber Colman superspeed warping machine. This is a great advantage in this system. The dye cheeses are soft in the centre and hard at the sides. This enables level dyeing to be obtained, because penetration of dye liquor will be more uniform in such cheeses. No special adjustment is normally required for this change over, except that it has been sometimes found desirable to reduce the winding speeed and use a lighter presser lever spring for obtaining a soft cheese.

Traveller :

The most important feature of this machine is the way in which the broken thread is automaticallly detected and knotted. The operations are performed by a mechanism called Traveller which also performs several other jobs automatically. The traveller moves on a rail situated at the top of the machine which is usually double sided having rounded ends. It is driven by a seperate electric motor. The following mechanism and motions are fitted on the traveller and work in conjunction with the latter:

i) A device for measurng the size of the cheeses, i.e. for finding out whether the latter has attained its full size or not.

ii) A thread detector which is brought automatically in contact with the running yarn as the traveller moves, with a view to finding whether the yarn on the corresponding cheese is broken, in which case the detector will cause lifting of the cheese out of contact of the windig drum. The cheese. will also be thrown out of contact of the winding drum when it has attained the predeter mined size.

iii) Cheese end suction device for finding out broken end on the cheese and carrying it to the automatic knotter.

iv) Knotter suction device.

v) Bobbin end clamp and cheese end clamp for holding bobbin end and cheese end respectively, for tyeing up.

vi) Automatic knotter for tying the broken end of the cheese and clamped end of the reserve bobbin together. It ties a weaver's knot.

vii) Cheese end shearer and bobbin end shearer for cutting the end of the cheese and corresponding end of the reserve bobbin respectively.

The movement of the traveller is so syncronised, that by the time the yarns on one set of active bobbins are exhausted, it will pass once round all the cheeses. The traveller in its passage round the machine will measure the diameter of the cheeses and also detect the exhausted bobbins and broken ends. If the cheese is full, the traveller simply passes onto the next cheese, leaving the reserve full bobbins as an indication to the operative that the full cheese requires replenishment with a starter. But if a traveller meets any broken end or a bobbin which has been exhausted, it will automatically throw the corresponding cheese out of contact of the winding drum and will also draw the end of the broken yarn from the cheese by pneumatic suction. The end will then be automatically knotted together with the end of the reserve bobbin, which has been collected from the clamp by forward movement of the traveller. The operative follows up the traveller, putting the reserve bobbins in position, fixes the ends in the respective clamps, removes full cheeses and mounts a starter on each cheese holder.

It is possible to produce cheeses of four diferent sizes i.e. one size on each quarter of the machine by making necessary adjustments on the traveller. It is also possible to wind yarns of four different qualities or counts on the machine at the same time. The adjustments required on the traveller for this do not take more than a few minutes.

The full cheeses are arranged on tridents. Tridents are placed on a truck which moves on rails running around the winding machine and extending upto creel of the warping machine. A trident provides 15 cheeses, i.e. 3 rows and 5 cheeses in each .

The machine is provided with a suction cleaning arrangement for removing lint from the points where it is actually formed e.g. bobbin pockets, winding drums etc., as otherwise it will float in the air, deposit on the machne or carried with the yarn wound on the cheese. The arrangement also removes extraneous matters, such as particles of broken seed, leaf, etc., which are loosened and drop down from the running yarn.

The provision of suction cleaning arrangement necessitates additional expenditure and maintenance cost. But the advantages derived from its use will off set the aforesaid disadvantages. The arrangement reduces work involved in sweeping the floor and cleaning the machine. It also conduces to a cleaner atmosphere in the winding room. This will have beneficial effect on the output and quality of the product obtained on this automatic spooler.

ABBOT AUTOMAT!C CONE AND CHEESE WINDING MACHINE

(Travelling spindle Principle)

In this winding machine the winding is cariied out as the spindle units travel around the machine and knotting unit is placed at one end and centre of the machine. The cone or cheese in each unit is rotated by frictional contact with the highly polished steel rollers.

DESCRIPTION

The yarn passes successively through a thread guide, gate type tensioner, slubcatcher, over stop motion wire, through the traverse guide and finally onto the cone. A number of such winding units are attached to a travelling chain which is supported at each end by sprockets and receives its motion through a speed reducer. It is situated at the upper part of the machine and is made to travel around the machine by rollers in contact with steel angle rails. In doing so the chain carries the winding units around the machine along with it.

The winding package in each unit is rotated by the frictional contact with the winding roller. Guiding of the yarn on the winding package is done by a traverse guide made of light alloy steel. The traverse guide in turn is actuated by a traverse cam which runs in oil contained in a dust proof box. The traverse cam is made of hardened steel and is driven by cork tyres in contact with the winding roller.

Automatic Knotting Head :

This consists of the following arrangements or mechanisms :

(i) A rotary or revolving magazine fitted at one end of the main frame of the winding machine holds the supply bobbins and automatically replenishes the empty bobbins of the winding units with full bobbins as the units pass this point during their travel.

ii) *Air Suction Arrangements :*

A motor driven fan provides the necessary vaccuum to the air suction arrangement. This arrangement sucks the end from each supply bobbin and presents it to the suction centre which holds the end in the knotting position. The end from the correponding winding package is also sucked by this arrangement and led to the automatic knotter for knotting.

(iii) Knotting Head :

It is fitted with a clutch which is brought into operation by the moving winding units as they pass this point. Here the end of each supply bobbin is tied with that of the corresponding winding package by the automatic knotter.

The process of winding is carried out on this machine in the following manner:

The operator sits at one end of the machine where the rotary magazine is located. The latter is kept filled up with supply bobbins with the end of each being guided by the operative to the suction circle which holds the end so that eventually it can be tied with the broken end on the relevent cone. The magazine revolves around an automatic knotting head and air suction arrangement. Since the winding units are travelling around the machine they will be continuously passing in front of the operative. The rate at which the travelling units travel depend mainly on the speed at which the operative can replenish the magazine with supply bobbins and present the ends to the suction arrangement.

Normally the speed of the travelling spindles, the rate of winding and the number of spindles per machine is fixed in such a manner that each bobbin gets exhausted by the time the relevant winding units comes back before the magazine for replenishment in each round. When a supply bobbin is exhausted, it is automatically taken off from the supporting spindle and dropped down onto a conveyor. All the winding packages are full at the same time. Therefore, when the indicator indicates that they have attained the predetermined size, all of them can be doffed at one time from either end of the machine.

Capacity of the Machine :

The machine can be used for various kind of yarns such as cotton, worsted, spun rayon, etc. and arranged for wide variety of bobbins and yarn, with a few changes and specification. Winding speed is limited to a certain extent according to the length of yarn and unit travelling speed, but on general it is 500-800 Y.P.M. and 600-650 Y.P.M. is an ordinary speed.

AUTO CONERS :

Introduction : Three degrees of automation are clearly discernable.

Stage 1 is the minimum to satisfy the description fully automatic winder, and includes automatic location and re-tie of all broken ends, automatic feeding of full ring tubes and removal of empties.

Stage 2 of automation became economical, the automatic doffing of the full package and replacement with an empty cone, including automatic winding of a reserve for magazining where required.

Stage 3 of automation eliminated the largest residual element in the winders work-cycle, preparing ring tube by removing the back-wind and locking it in the tube. Automatic feeding from a hopper, preparation of each ring tube and distribution to the winding positions virtually completed the automation of the process. It is inevitable that increasing automation is associated with reduced flexibility, and this is particularly serious in textile manufacturing where fashion produces constant change, and even the basic constructions incur changes of constituent yarns. Under these conditions the fully automated highly specialised machine is a high risk investment.

Two machines of the fully automatic class will be described here: one is the Schlafhorst autoconer which is typical of the stationary winding unit and travelling knotter group with a knotter ratio of 1 : 10, and the Uniconer which is typical of the machines with a knotter ratio of1:1.

THE SCHLAFHORST AUTOCONER RM.

The machines are built in units of 10 winding positions but erected in units of 5 with common head-end, service blower, and continuous tracks for the bobbin hozes. Each machine has a knotter which travels across the machine until such time as there is a broken end to re-tie or an expended or exhausted ring tube to eject and tie-in a replacement. The knotter takes 5 seconds for a single traverse of the 10 spindles and the time to lock into position on a spindle, and the time to service it and recommence search is 5 seconds/ The servicing frequency is high, and adequate for all but the coarsest low quality yarns with run off times of say 3 minutes and 2 clearing breaks per tube. Under these conditions winding efficiency would collapse to 60% and it would be essential to run a second knotter carriage so that each knotter could service 5 spindles. It will be found under optimum clearing rates it is generaly possible to maintain efficiency above 70% which is regarded as the economic limit.

The magazine holding 5 ring tubes is ergonomically designed so that the unwound yarn end can be released and is aspirated into a suction tube where it is securely held. As a bobbin exhausts, the magazine is indexed and a full tube is released from the magazine and located in the winding position, the yarn end on the package is located and tied to the end on the newly fed tube, the wound package being restored to the winding position. Normally a fisherman's knot is tied for security, but weaver's knots can be tied if so requirec, and are to be preferred for knitting applications. After the knot is made an electronic knot tester EKP checks for defective knots.

The yarn tract is through the unwinding accelerator, tension device, clearing unit,. stop motion, and onto rotary traverse drum. The package cradle is hydraulically damped to absorb any vibrations which might disturb the yarn lay, and a coil spring compensates for increasing package weight so that a constant pressure at the line of contact is mainted throughout the building of the package.

The cleanliness of the machine is maintained by a overhead travelling blower and a suction unit located, under the unwinding position, which collectively maintain, a downward flow of air through the machine. The winding performance is continuously monitored by a knot and tube change counter on each knotting carriage. Thus the clearing breaks per kg. can be consistently compared with the clearing limits set for the yarn being wound. If the clearing indication showed more knots had been tied for each bobbin fed, something is obviously wrong with either the yarn or the clearer setting on the machine.

Automatic waxing, automatic doffing, chopper feed and bobbin preparation and delivery of the prepared tubes to the winding units or service from a separate bobbin preparation unit are all extensions in automation applied to the basic machine.

Uniconer :(one Knotter for each winding head)

The chief advantage of individual knotter per head is increased production since the head does not have to wait in turn for the knotter. Besides there is ease of replacement of knotter without stopping all the heads.

Examples of this type of machines are :

a) Uniconer-Leesona(American)

b) Barcomatic-Barber colman(American)

c) Mecomat-Mettler(Switzerland),and

d) Savio RSA-Savio(Italian)

Besides automatic knotting, on most moderr automatic winding machines there are provisions for :

i) Automatic feeding and creeling of ring tubes.

ii) Knotting of the broken end from the supply package

iii) Automatic replacement of an exhausted ring tube by a fresh one

iv) Automatic doffing of full package and restart after doffing, and

v) Systems are also available for autonmatic conveyance of bobbins from ring frame department to winding machines and transfer of empties back to ring frames.

The automatic winders are not suited for(i)flax or jute yarns which are usually stated to be too extensible for the knotter, and (ii) for very coarse yarns due to difficulties in cutting these.

The supply packages for automatic winding is limited to ring frame bobbins only.

The SAVIO RAS 15 Fully Automatic Cone Winder :

This machine is built with 56 units in line with a knotter head for each winding position. It has a circular magazine holding five tubes. The yarn track is fairly straight from tube nose through balloon breaker, yarn tension unit, automatic waxer and clearer, and onto the rotary traverse drum. The fisherman's knot is normally tied but knotters are available to tie weaver's knot also. Knot control consists of a mechanical device for detecting oversize or tangled knots, a device to rectify incomplete servicing of knot tails, and an electronic spindle clearer. The makers claim that each spindle set up is identical due to centralised control of yarn tension on waxing unit, bobbin cradle counter-weight, package clutch, slip knot control and winding speed.

The rotary traverse drum and the package holder are independently breaked to eliminate any draft between drum and package, which is known to damage synthetic fibres with low fusion point. The drum itself is cast iron which is held to be responsible for the high winding speed of 1500 m/min. on polyester yarn and blends, 750m/min. being considered the maximum prudent for a bakelite drum.

Automatic package doffing including provision of a yarn reserve is standard equipment on the RAS 15, and full automation with hopper feeder, bobbin preparation and automatic feeding to the winding positions is supplied with RAS 15 CL. All automatic machines incorporate blowing and suction nozzles to keep important parts of the assembly free from dust, seed, fly, etc.

On these machines if the yarn breaks at the neck of the ring tube and end cannot be found by suction, the tube is rejected and a fresh tube is tied-in. The rejected tube is recreeled by the operative. If the end is not found from the winding package, most winders make upto 4 attempts before the winding head stops. All these machines have warning systems that inform the operative for his attention to the stopped head.

Advantages and Disadvantages of Non-automatic and Automatic Cone and Cheese winding Machines :

1) The automatic high speed and super speed winding machines used for winding cones and cheeses does most of the operations automatically and cuts down to a practical minimum the various operations which a winder has to perform manually on a non-automatic winder. For example : knotting of broken end, replacement of full supply packages, doffing of full packages,etc.

2) The elimination of human element will help to improve the quality of work attained on the automatic winding machines because non-uniformity, careless ness, etc. are the defects of human elements which are avoided by the use of these automatic winding machines.

3) The quality of yarn wound in automatic winders is also better as most of the impurities and defects in the yarn will have been removed and the yarn wound under uniform tension through out by using improved type of tensioners and slub-catchers.

4) In the automatic winders replacements of supply bobbins and the doffing of full packages and donning with empty tube, cone or starter is done automatically, whereas, this work is carried out by the operative in non-automatic winders.

5) In automatic winders, knotting is done automatically In non-automatic wind ers, this knotting operation is done manually, Moreover, the knot produced by the automatic knotter is superior than the manual knot.

6) When compared to non-automatic winders, the initial cost of the automatic winders is high. But this will be repaid in due course because the production is high and the quality of the package is superior.

7) In automatic winding machines like theB.C. Spooler, travelling spindle wind ers like Murata, Abbot, Holt's, the yarn breakage is attended by a knotter which is either stationary or, one or two knotters looking after 10 or 15 spindles each. The disadvantage in both the cases is that when an end breaks or a supply bobbin exhausts, that particular winding unit will be out of production

until the knotter comes to the winding unit or the winding unit comes to the knotter as the case may be, As such, much time is taken to attend the unit, so the efficiency of the machine goes down. But in the latest types of winders like Uniconer, Savio RAS 15, Murata No.7-11, Mach Coners, etc. each unit is supplied with a knotter or splicer, so practically there is no delay in knotting. So the production and efficiency goes up alongwith the initial cost of the machine.

Warping

In weaving preparation, an introduction to the preparation processes for both warp and weft yarn prior to the weaving process, figure 1.

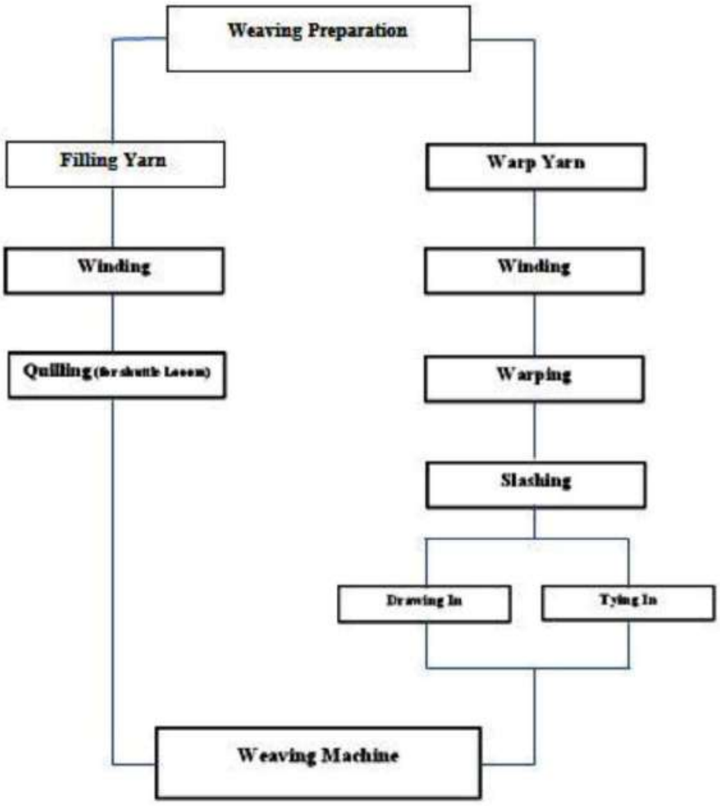


Fig (1): Warp and weft preparation

In this part we will discuss the warping process and its types and stages. Warping is defined as the process aimed to prepare the weaver's beam with a certain number of yarns with a certain length at a certain density to be set up on the weaving machine.

Warping has the following operations:

1.A certain number of warp yarns are wound at a desired length.
2.Arrange the warp yarns according to the required design and colours.
3.Produce the weaver's beam with the needed density, length, arrangement and number.

The weaver beam might contain thousands of yarns, which is always higher than the capacity of the creel, thus the beam cannot be wound directly from the creels to the weaver's beam in a single operation. For this warping process has two phases; phase 1, when the yarns are unwound from the cones to an intermediate carrier till the required number is achieved. Phase 2 takes place to rewind all the yarns simultaneously from the carrier to the weaver's beam. Depending on the intermediate carrier there are two different types of warping.

1.Sectional / Dresser Warping: where the yarns are wound into a conical drum.
2.Direct / Beam Warping: where the carriers are preparatory beam warping.

All warping machines have the same parts, creels, headstock and control devices.

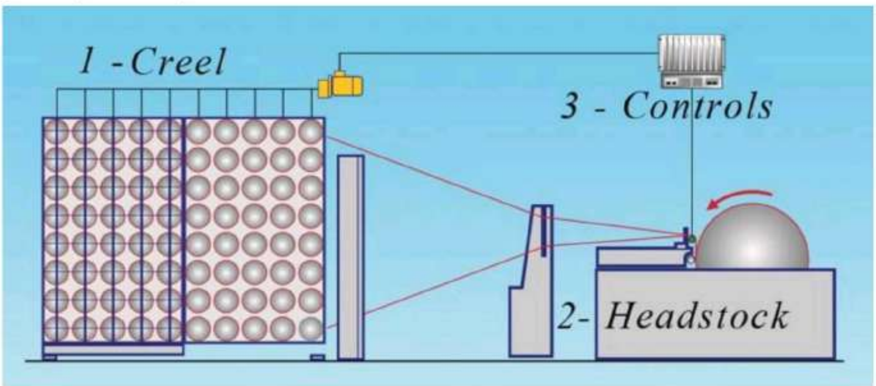


Figure (2): Shows a warping machine

Creels

They are the metallic frames, where the yarn cones are fitted / organized to be fed to the intermediate carrier. The creels are usually fitted with sensors for yarn tension and yarn breakage. The creel capacity is an indication of the number of the cone fitted on it, it is parameter that determines the number of section of beams. The capacity usually between 800 - 1200 cones.

Different designs of creels are available to overcome the problems of consuming time and space. **Figures 3, 4, 5** and **6** shows different types of creels with their advantages.

Figure (3): Mobile creel,
This creel is formed by trolleys that can be fitted in the creels, which save time and space.

Figure (4): Magazine creel,
This type of creels are used when similar types of warps are needed to be prepared. Two cones are used, one operating and one as reserve.

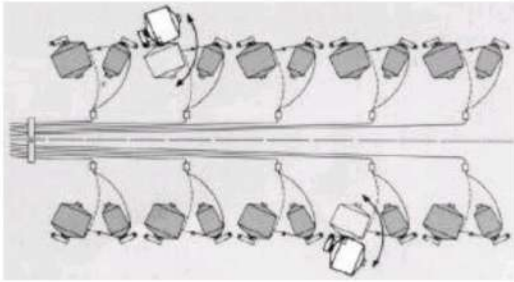


Figure (5): Swivel frame creel,
Similar to the mobile creel, this type consists of trolly parts that can be turned from one side to other side when the first one finish. When one side is operation the other side can be fitted with cones.

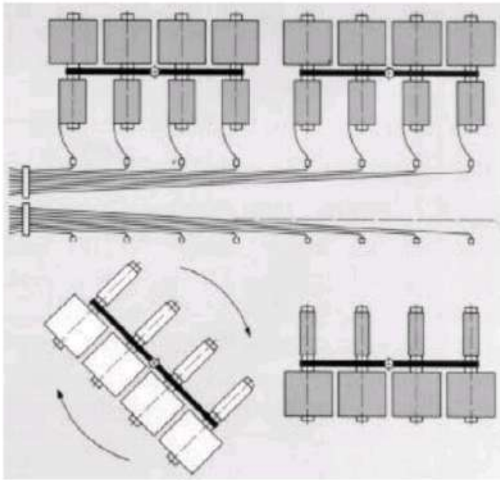
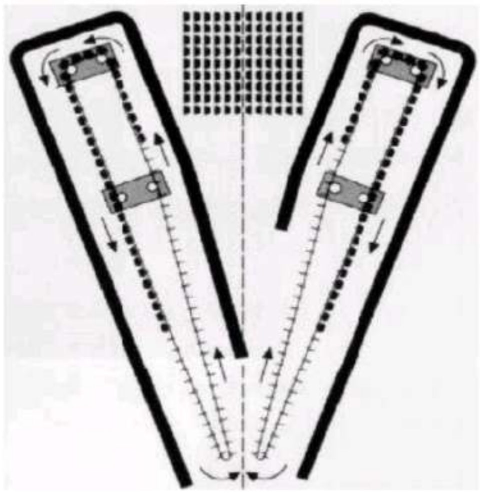


Figure (6): V-shaped creel,
In this creels the cones are fitted on endless chain, one side of the chain is operating while the other can be fitted with cones. When the operating side finished the chain rotates to bring the other side to the front to be operated. This creel reduces the tension on the yarns and produces uniform tension across the beam.
Some references say that creels are independent of the warping system, but others say that parallel creels used for sectional and direct warping and the V-shaped creels are used for direct warping because it allows high speed productivity.



Headstock
The winding process requires extra attention to tension of the yarns and the headstock is equipped with precision direct drive, advanced electronics, smooth doffing and programmable breaks. Also measuring roller connected to control devices.
In the sectional warping, the headstock consists of the drum, trolly, warping carriage, leasing device and beam carrying chuck, figure 7. 1 is the drum, 2 the leasing device that splits the layers of the yarns to separate them for later processes, 3 is carriage bearing, a is the expandable comb that

control the section width and position the section on the drum, b is the guide and metering roller, which measure the tension on the and give the feed back to the pressure control on the creel and c is the leveling roller to carry out winding at low tension and have a compact winding. the carriage feed the yarns to the drum in the conical shape with its traverse motion. The carriage also move with every new section, the creel has to move to keep the threads perpendicular to the drum.

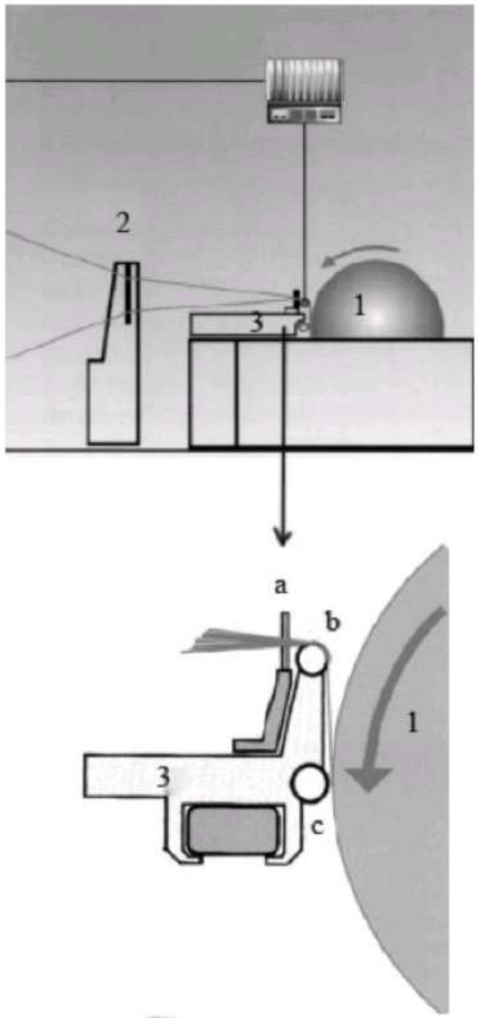


Figure (7): The head in the sectional warping machine,

The headstock for the direct warping is simpler than the previous one, figure 8. It consists of expanding comb, pressure roll and beam. The expanding comb is a zigzag comb place the yarns at the required width and order. The pressure roll works to ensure a cylindrical beam. The beam, figure 9, is where the yarns are wound onto.

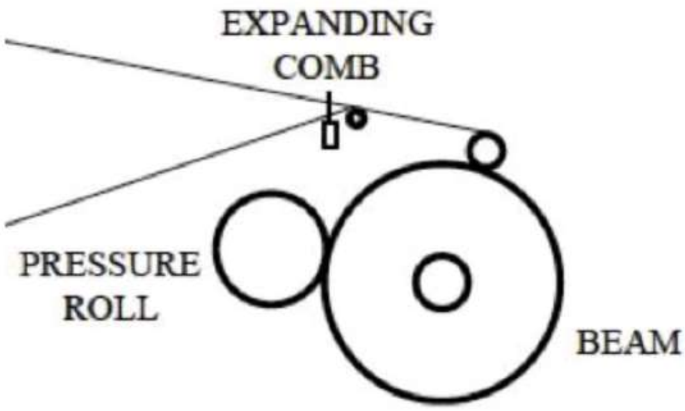


Figure (8): The head on the direct warping machine,

Figure (9): Beams

Controls

As mentioned earlier the tension should be applied equally and fully controlled during the warping process. The control devices are to ensure this. Beside the controls the exist on the headstocks, the creel has a control over the tension for single yarns, figure 10. The disc tensioner apply tension on the yarns, the new tensions can be controlled separately by mean of aerodynamic and connected to the main machine computer.

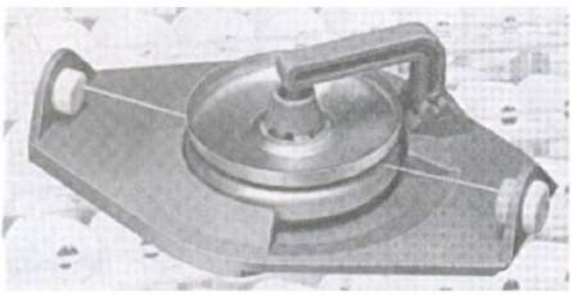
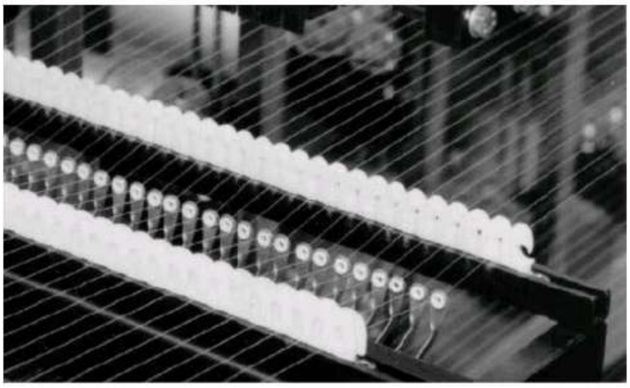


Figure (10): Yarn disc tensioner,

Also the yarn break sensors, figure 11, to stop the machine when there is a yarn break.

Figure (11): Yarn break sensors,



Warping Calculations
Sectional Warping
The conical shape dresser or drum is the mark of this type of warping. See figure below.

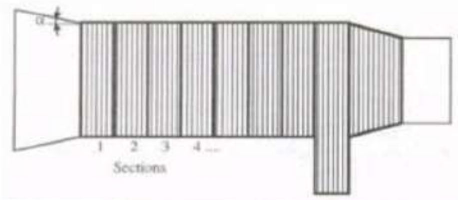
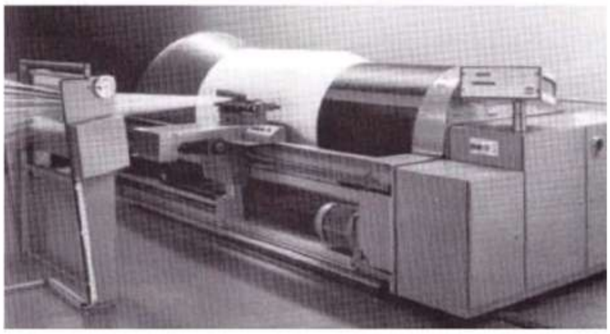


Figure (12): The sectional warping,
As mentioned before, the warping process here is carried out by parallel sections in certain sequence on the conical drum. This method is cost effective for short and striped warps. The warping speed is up to 800 m/min.

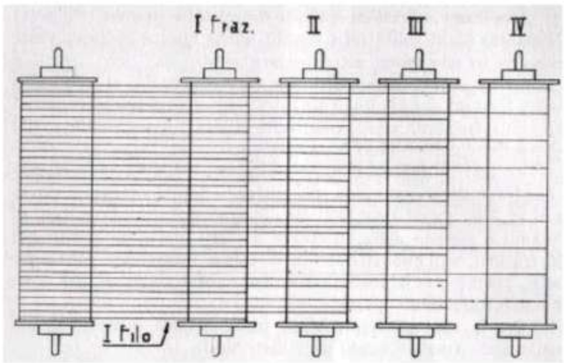


$$Section\ number = \frac{Total\ number\ of\ warp\ threads}{Creel\ loading\ capacity}$$

If this equation did not produce a correct number then the number of sections is adjusted to a bigger corrected one with a change in the total number of the yarns being warped.

$$Section\ width = \frac{Reed\ width}{Number\ of\ section}$$

As soon as all the section are being wound, the on the dresser, the second phase to produce the weaver's beam starts. The sections are unwound from the drum to the beam at the same time, this process is called beaming.



Direct Warping
This warping is done on two separate stages, first to wind the yarns onto beams, then unwind these beams and wind the yarns on the weavers beam as described below. The speed in this type is 1200 m/min.
Figure (13): Beaming,

$$Beam\ number = \frac{Total\ number\ of\ warp\ threads}{Creel\ loading\ capacity}$$

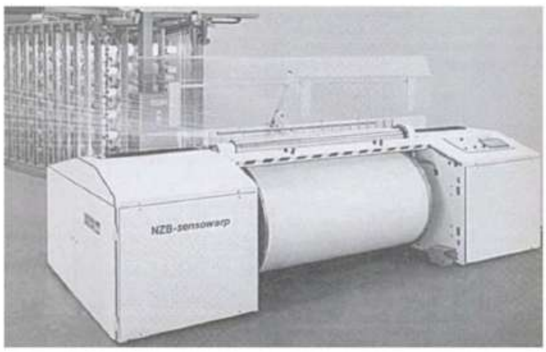
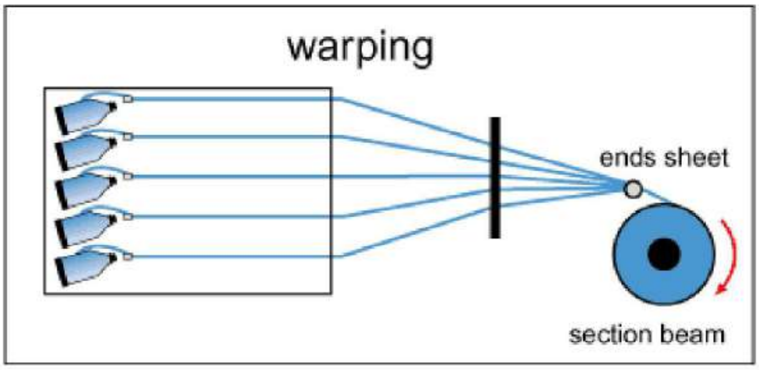


Figure (14): Direct warping,
There are other types of warping and different warping calculations in regard with calculation and carrying out the warping process it self.

Warping/Beaming

In many cases, the first textile operation is the preparation of the lengthwise ends system (warp or beamed yarns) of the textile structure by warping or beaming operations.



Description of the process

There are several basic methods used to produce beamed yarns/strands:

- **Direct warping:** Used mostly for electronic applications. A large and predetermined number of ends pulled from a creel are wound onto a large spool (beam) and placed on a warper to produce section beams. Then a predetermined number of them are assembled on a slasher to generate a loom beam, which will be used in the next processing step. During the slashing operation, a secondary sizing is applied to the ends in order to enhance their abrasion resistance. Some applications don't require the slashing operation; section beams can be used directly in the next textile process or a determined number can be assembled on a beamer to make up a loom beam.
- **Sectional warping:** A sheet of ends, pulled from a limited number of packages, is placed on a creel and wound onto the cylinder of the sectional warping machine in order to build a section. When the required amount of warp end sheets necessary to achieve the desired fabric width have been completed and placed side by side, all of the sections are rewound directly on a beam, creating the loom beam.
- **Warping sizing:** A predetermined number of ends pulled from a creel are directly slashed and wound onto a beam. Then the slashed section beams are assembled together on a beamer to produce the loom beams.

Some applications using warp ends don't utilize beams. Instead, the textile process is directly fed from a creel.

Warping Machines

Super Speed Drum Driven Warping Machine

Beam Compactness-mechanical manual

General Features:

- Sturdy frame & wall structure for vibration free working.
- Twin Disc type brake system for quick stop.
- Dynamically balanced drum for smooth working at high speed.
- Dynamically balanced light weighted measuring guide roller.
- Dynamically balanced machine pulley.
- Hydraulic power pack with standard components.
- Angular Contact bearing for beam pressure device.
- Drive with Crompton /ABB A.C. motor.
- AC Frequency inverter Drive of standard make.
- Logic stick for easy & Fault free working.
- Photo electronic rays sensor as beam guard for full safety of warper.
- All components including nuts & bolts are used of standard make.

- Machine look & design made architecturally as well as user friendly.
- Operating panel is made warper friendly with special design.
- Simple designs with high technology for better performance.

Technical Specifications:

Machine speed --- 50 mpm to 700mpm

Machine width available---- 60.5",63.5",68.5",72.5",78.5",54.5"or 1550mm,1600mm,1750mm, 1 850mm, 2000mm,2400mm

Workable Dia --- 22" - 24" - 26" - 28" -30 " or 560mm, 610mm, 660mm, 710mm, 760mm

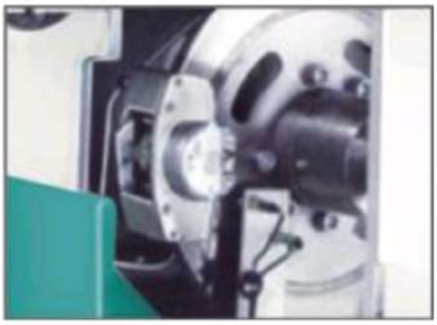
Workable barrel Dia ---- 8"/200mm, 10"/250mm, 12"/300mm

Shaft Dia Available ---- 1.25"(32mm) or 1.5"(38mm)

Motor HP According to machine size ---- 3 HP to 10 HP

Stop Motion ---- Electro mechanical System fitted on head stock

Beam Compactness-hydraulic automatic



Breake near chuck **Quick big disc brake** **Self centering & firm grip by chuck**

Sturdy wall & frame structural design for vibration free smooth working. Machine is designed with ergonomics to get high productivity with highest quality of warp beams with ease operations.

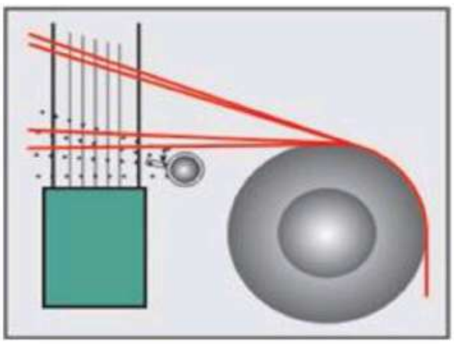
It Means:

- Short braking distance.
- Full automatic beam doffing & donning.
- Full thread guidance.
- No crossed ends as expanding zig zag comb with adjustable movements.
- Warp beams with perfect cylindrical & even surface.
- Smooth fabric bonded hylum pressing drum with kick back system.
- Toothed chuck ensure exact centering & perfect grip of the warp beam.
- Precise electronic length measuring device.

- Automatic fluff guard Screen.
- Auto Air blow system to clean the comb.
- Data management for easy repeatability of any product.
- Remote diagnosis through net.
- Mechanical safety guard with operating switches & additional light ray barriers for safety of the operator.
- Touch screen operating panel with operator friendly graphics for input, output of process data.
- Fluff & Dust extraction device.
- Static Eliminator.
- Oiling device.
- Dye beam device.
- Yarn storage device.
- Yarn tensioning roller nip device.
- Taping Device.

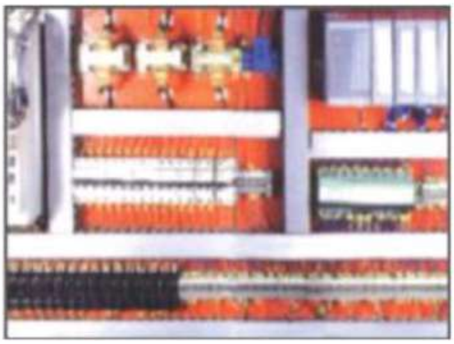
Technical Specifications:

Working Width	1400mm to 2400 mm
Flange Diameter	800mm to 1400mm
Max. Mechanical Speed	1200mpm
Max Warping Speed	1000mpm
Drive	AC Invertor servo drive
Controls	PLC base controls
Motor(Kw)	15kw to 22kw
Pressure Drum Roller	Rubber coated /hylum type
Brakes	Quick hydrualic type



Auto air blow

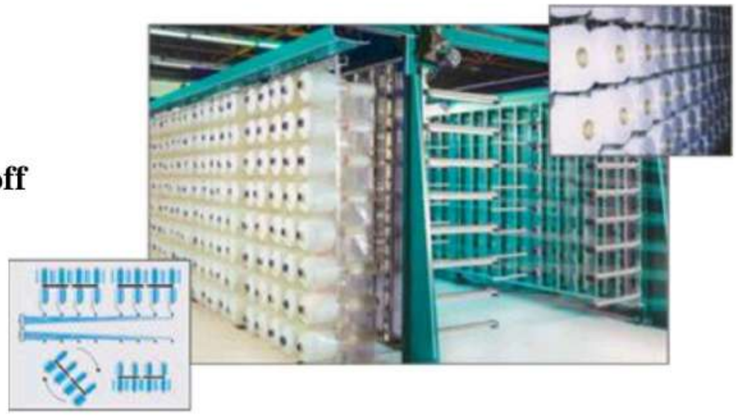
Easy denting & most parallel



Plc base, AC drive

Warping Creel to Suit the product

'H' Creel with swivel trolley, inward draw off



More Productivity

- Fast, easy creeling with less handling of the yarn packages.
- Quick self threading eyelets, stop motions & passage of yarn.
- Suitable vertical - horizontal pitch.
- Magazine creels are available.

User Friendly

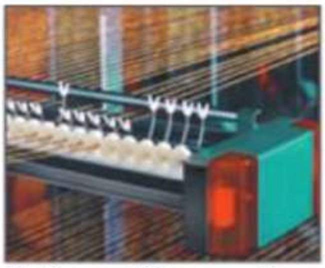
- End break easily located.
- Universal cheese /cone holders.
- Suitable number of package tiers.
- Inward / outward draw off designs.
- Single / less handling of the yarn packages.

Better Quality

- Centrally & individual tension controls for uniform tension.
- Stop motion reaction time is less than 0.1 second.
- Anti snarling device.
- Anti ballooning device.
- Integrated/ over head suction & blower cleaning system.

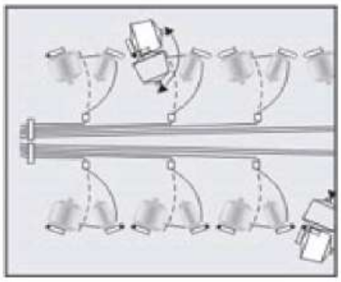
Electrical Stop Motions

Photo optic Stop Motions

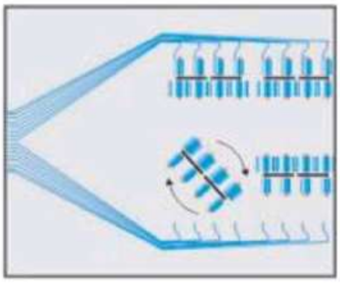


Universal Stop motion

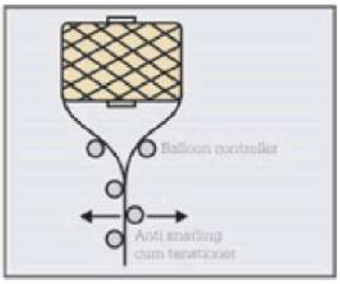
IntelligentStop Motion



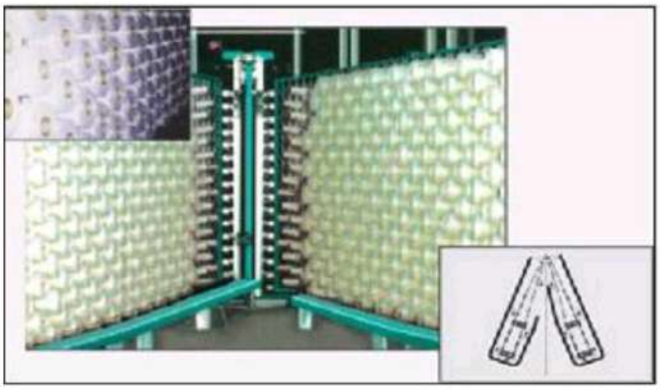
Magazine Creel



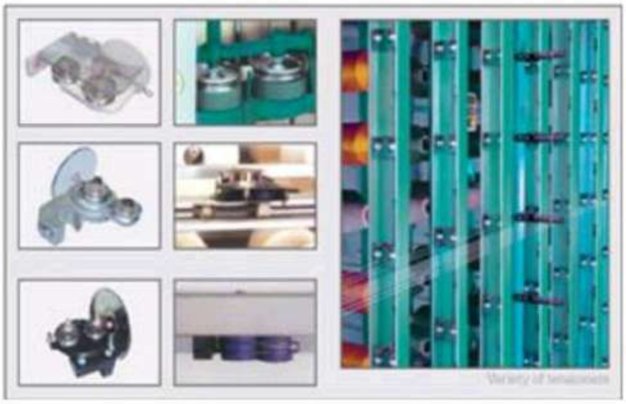
Out Word Draw Off



Balloon Snarl, Tension Controller



'V' creel with 360° rotation package holders



Variety of tensioners

What is Warping Creel:

Warping Creel is an arrangement where packages are placed on pegs for warping purpose. Single threads are taken from the packages passed through a tensioner, a guide and then on the front winding head. Function is to place all the threads in a sheet form so that whenever a thread breaks it can be easily traced out. It may be either of the rectangular type or "V" shape. Packages may be stationary or moving. It may be a simple creel or a magazine creel. It is build up of staves that are held vertically by top and bottom boards. The creel is so designed that staves are fixed in a certain order at a given distance and at an angle that yarn goes straight without entangling with the adjacent threads. The number of packages in a warping creel must be decided on the economic merit of any given situation with warper's bobbin its capacity is from 400 –600 packages; while with cones and cheeses the range is wider, i.e., 600 — 1000 packages. In deciding about creel size, weight of **yarn** on supply packages, floor space available and number of beams required must all be considered.

Warp Preparation | Common Steps Involved in Warp Yarn Preparation

Common Steps Involved in Warp Preparation:

The object of warp preparation is to transfer yarn from the spinner's package to a weaver's beam that can be placed behind a loom ready for weaving. A weaver's beam usually contains several thousand ends and for a variety of reasons, it can seldom be made in one operation. It is usual to divide the **warp preparation process** onto four sections:

Warp preparation

1. Warp Winding: The main functions of warp winding are to rewind the yarns from the spinning frame or texturing machine in a long continuous length to suit later processes. This is a process to wind the yarns into a suitable package size and shape, and also to take out imperfections such as slubs, weak places, leaves, neps and dirt, which are always present in yarn as delivered from the **spinning frame**. The winding machines for warp preparation can be classified as follows:

A. Drum winder: The yarn package (cheese or cone) is frictionally driven by using a driving drum or roll. Either a cam traverse or a grooved roller makes the yarn traverse motion. Due to the surface driving of the yarn package, the yarn speed is always constant, independent of the package diameter.

B. Precision winder: This is a precise-traverse winder using a yarn guide, which is controlled by means of a traverse cam or a grooved roller. The yarn package is driven positively by using a spindle. Therefore, the yarn speed is increased according to the package diameter if the spindle speed is constant. This type of winder is used for continuous filament yarns that are unsuitable for frictional winding methods like the drum winder.

2. Warping (Beaming): The purpose of **warping** is to arrange threads in long length, parallel to one another as preparatory to further processing. The primary operation of warp-making in which ends withdrawn from a warping creel, evenly spaced in sheet form, are wounded onto a beam (known as warper's beam) to substantial length. There are two warping methods, i.e. direct beaming and sectional warping.

A. Direct warping/beaming: This is the winding of total number of warp ends in full width in a single operation from creeled bobbin. Direct beaming /warping is used for long runs of greige fabric and simple patterns where the amount of coloured yarn involved is less than about 15 percent of the total.

B. Sectional warping: This is a method of preparing a warp beam consisting in i) winding a warp in sections on a reel/drum and ii) beaming-off the complete warp from the reel onto a warp beam. Sectional warping is used to produce warp beam for Yarn dyed fabric.

3. Sizing/Slashing: Sizing means the operation of applying a special solution (known as size solution) to warp yarns to strengthen, smoothen and lubricate them. In machine sizing a warp is transferred from a warp beam to a loom beam. The procedure is as follows:

- Warp in sheet form is withdrawn form a warp beam is passed through a sow-box and the squeezing rollers of a sizing machine. Application of size solution by immersion or by contact with a partially immersed roller, and penetration of the yarn by the size solution occur at this stage. The sizing agents generally used are PVA (Polyvinyl alcohol), Starch, Acrylic esters, CMC (Carboxymethyl cellulose), Wax etc.
- The warp is dried by hot air or by contact with steam-heated cylinders en route to the loom beam.

4. Looming: Looming covers the processes involved in warp preparation after sizing upto setting them to loom. During slashing, the exact number of warp yarns required in fabric is wound onto the loom (or weaver's) beam. The warp ends are then passed through the drop wires of the warp stop motion, the heddles of the harness frames and the dents at the reed. This can be achieved by drawing -in or tying-in, the choice depending upon whether or not the new warp is different from the warp already on the loom. The processes are as follows:

Drawing-in: The process of drawing every warp end through its drop wire, heddle eye and reed dent can be performed manually or by means of automatic machines. In both case, a length of warp yarn, just enough to reach to the other side of the frame, is unwound. Leasing (i.e. selecting warp) of the warp at this stage simplifies the separation of the yarns. Then they are threaded through drop-wires, heddle eyes and reed dents. The automatic drawing machine can handle the leasing-in and drawing-in process in single operation.

Tying-in: When fabric of a particular type is being mass-produced, the new warp beams will be identical with the exhausted beams on the looms. Therefore, if every end on the new beam is tied to its corresponding end on the old beam, the drawing-in process can be omitted. Tying-in may be done by means of a small portable machine on the loom or as a separate operation away from the loom.

Beam Warping Machine | Working Principle of Beam Warping Machine
Beam Warping Machine
The latest beam beam **warping machines** have a very simple design, which results in higher speed & consequently in output increase.
Main Parts Beam Warping Machine:

Beam warping machine

- Creel
- Expanding comb
- Pressure roller
- Beam

Working Principle of Beam Warping Machine:
In **beam warping**, the yarns are withdrawn from the single-end yarn packages on the creel & directly wound on a beam. Direct warping is used in two ways:

1. Beam warping can be used to directly produce the weaver's beam in a single operation. This is especially suitable for strong yarns that do not require sizing such as continuous filaments & when the number of warp ends on the warp beam is relatively small. This is also called direct beaming.
2. Beam warping is used to make smaller intermediate beams called warper's beams. These smaller beams are combined later at the sizing stage to produce the weaver's beam. This process is called beaming. Therefore, for if the weaver's beam contains 10,000 warp ends, hen there would be-say – 10 warper's beams of 1,000 ends each. If this weaver's were to be made an one stage, the creel would have to have 10,000 yarn yarn packages, which is impossible to manage.

How to Improve Beam Warping Process
Beam **warping** process is the most progressive process ensuring a high quality of produced warps & high efficiency. In cotton weaving, beam warping is mostly used.

1. Better uniformity in the tension of individual yarns are the provision of adjusting the tension of separate groups of warp yarns over the height of the warping creel.
2. Enlarging the mass of bobbins & warping beam winding.
3. Increased number of **bobbins** when warping yarn of low linear density & a greater number of yarns in the warp.
4. Improved shape of winding on the warping beams & uniformity of the specific density of winding.
5. Higher accuracy in warp measuring & reduction of wastes caused by irregular unwinding of warps from the beams at sizing.
6. Compensation of warp tension at starting & stopping of the machine & slow running at starting a new warping beam.
7. Increase of labour productivity in warping by partial or full automation of bobbin change.

Defects/Faults and Remedies of Warping

Warping means, **winding** of warp yarns onto a beam usually in preparation for slashing, **weaving**, or warp knitting. It is also called Beaming. When warping operation is done some defects occur as well as other operations. Now we will discuss faults and it's remedies of warping.

Defects & Remedies of Warping

1. Lapped end

Cause:

The broken end of yarn is not tied to the end on the warp beam & overlaps the adjoining yarn. The beam is not properly brake & the signal hook fails to operate.

Remedies:

- Tying the broken end to the end on the warp beam.
- Proper signal hook.

Piecing

Cause:

One broken end is pieced to another yarn end on the warping beam.

Remedies:

- By proper joining.

Soft ends on the warping beam

Cause:

Breakage of a group of ends & piecing them in bundle or by lapping. This defect is caused by the careless of the operator.

Remedies:

- Careful operation.
- Broken end should be piece up properly.

4. Incorrect form of build

Cause:

Caused by non uniform spreading of ends in the guide reed & its improper setting & conical winding in case of non uniform pressure of the warping beam.

Remedies:

- Uniform spreading of ends.
- Appropriate setting.

5. Slacks & irregular yarn tension

Cause:

It happens due to any one of these reasons- improper threading of the yarn into the tension devices, ejection of yarn from under the disc of the yarn **tensioning device**, or yarn tension devices of poor quality.

Remedies:

- Proper threading of tension device.
- Good quality of tension device.

6. Broken ends on the beam

Cause:

A group of ends is broken & tied as a brunch or worked-in with overlapping.

Remedies:

- Broken ends should be removed.

7. Conical winding on the beam

Cause:

It occurs due to incorrect load applied by the pressure roller.

Remedies:

- Correct load applied.

8. Improper length of warping

Cause:
It is due to malfunction of the counter & the brakes of the measuring device & warp beams.
Remedies:

- Good measuring device.

Define Warping | Flow Chart of Warping | Requirements of Warping | Faults of Warping
Warping
Warping is the parallel winding of yarn from cone or cheese package on to a warp beam. The operation of winding warp yarns onto a beam usually in preparation for **slashing**, weaving, or **warp knitting**. Also called warping.

<u>Flow Chart of Warping:</u>

Creel
↓
Control system
↓
Reed
↓
Measuring Roller
↓
Winding on a roller or beam
↓
Direct Warping...Sectional Warping

Requirements of Warping
To produce a quality beam suitable for the following must be accomplished:

1. The individual ends of the sheet should be spaced uniformly across its full width.
2. All the ends in the sheet should be wound at almost uniform tension.
3. The density of wound yarn beam should be uniform across the width & from start to end of **winding** the sheet.
4. The yarn breakage during warping should be as minimum as possible.
5. Density of the beam should be controlled not by increasing yarn tension but by adjusting the pressure roller on the beam in case of spindle driven beam.
6. The yarn should not get damaged during warping; this can happen if the drum surface is not smooth &/or the parts in the yarn path have cut marks.
7. The yarn sheet or the beam should not have faults, such as missing ends, cross ends, slack ends, fluff or wild yarn, high variation in tension between ends, damaged flanges etc. that will cause end break or defects at subsequent process.
8. Warping should not impair the physical & mechanical properties of the yarn.
9. The production rate of warping should be as high as possible.
10. A predetermined warping length should be observed.

Faults of Warping

1. Warp off centre of the beam
2. Ridge or uneven warp beam
3. Cress ends
4. Snarl is the warp
5. Missing ends
6. Unequal length of warp
7. Hard beam
8. Unequal size or weight of package

High Speed/Beam/Direct Warping | Sectional Warping | Differences Between Sectional and High Speed Warping

High Speed Warping:

High speed warping also called Beam warping/Direct **warping.** In high speed warping the yarn is wound parallel on the warping beam. All the yarns are wound at once and simple flanged beam is used. It is a very high speed process and is used for making fabric of single colour.

Flow Chart of High Speed Warping

Creel
↓
Beam for **sizing**
↓
Weaver's Beam

Features of High Speed Warping

1. It is used to make common fabrics in large quantities
2. It is used to produce weavers beam from single yarn
3. The production is high
4. Large amount of yarn is required to produce a weavers beam
5. Sizing is done
6. Simple flanged beam is used and drums are not required

Sectional Warping

In sectional **warping** equal length of yarn is first wound in small sections or sheets on a drum. Then from the drum it is transferred to the beam. By this process we directly get the weavers beam. This is a two stage method and is used for making fancy fabrics.

Flow Chart of Sectional Warping:

Creel
↓
Drum
↓
Beam (Weaver's Beam)

Working Principle of Sectional Warping:

1. Sectional warping is used for short runs especially for fancy pattern fabrics.
2. In this case sections of the warp which may contain up to 1000 ends are first wound onto a drum tapered with a given cone angle.
3. So cross wound sections are combined on the drum & thus each layer of warp contains the same number of ends on the drum.
4. Then the warp threads altogether are transferred onto a weavers beam by unwinding the drum.
5. In this method the warp threads are not necessarily processed in **sizing**.

Features of Sectional Warping

1. This is suitable for making checked, stripped or other fancy fabric.
2. We directly obtain weaver's beam from this process
3. As sizing is not done, so multi-ply yarns or yarns which do not require sizing are used
4. Small amount of yarn is required to produce the weaver's beam
5. Sectional warping is used to produce a warp beam with a greater member if ends
6. The production is less in sectional warping
7. The yarn tension is less uniform
8. It is less efficient than high speed warping

Differences Between Sectional and High Speed Warping

High Speed Warping	**Sectional Warping**
1. Beam **warping** is used for long runs of grey fabrics & simple pattern.	1. Sectional warping is used for short runs especially for fancy pattern fabrics.
2. The amount of coloured yarn is less than 15% of the total.	2. Greater amount of coloured yarn is used.
3. High production.	3. Low production.
4. Large amount of yarn required.	4. Small amount of yarn required.
5. Single yarn is used.	5. Twisted yarn is used.
6. Less expensive.	6. More expensive.
7. It is most widely used for cotton, linen, woollen & worsted yarn.	7. It is most widely used for silk & synthetic yarn.
8. Uniform tension of yarn.	8. Less uniform tension of yarn.
9. Weavers beam is produced after sizing.	9. Weavers beam is produced after warping.
10. Creel capacity is more.	10. Creel capacity is less.
11. Beam warping is more widely used.	11. Sectional warping is not widely used.

MODULE - 4

SIZING

INTRODUCTON

For the preparation of warp made up of single yarn, for subsequent weaving, sizing is an important process which can 'make' or 'mar' the weaving performance. One high speed sizing machine can control the working of 100 to 150 looms, depending on the coarseness or fineness of the yarn and the size add-on. One sized beam on a loom lasts for two to four weeks, One can, therefore, imagine the extent of the effect of a neglected sizing process on the working of a weaving shed. If the sized beam is not properly prepared, then there is no escape but to weave a faulty fabric or to get the beam cut and redrawn till the satisfactory portion of the sized beam is reached. Any experienced weaving technologist will therefore spend a major portion of his allotted time in invigilating the sizing operation. Though the sizing process employs only a few machines and a few operatives, compared to those in the other preparatory and weaving departments, modern warp sizing has become a complex and exceedingly manipulative operation.

THE SCOPE OF THE STUDY OF SIZING

Basically the object of sizing is to 'prepare' the warp which can stand the stresses and strains during the weaving operation, may be, on a handloom or a power loom or a modern shuttleless weaving machine. Thus the fundamental purpose of imparting weavability to the sheet of warp yarn has remained unchanged though numerous developments have taken place in the variety of fibres, their blends in yarn composition, sizing ingredients, methods of application, control of the sizing process and altogether new techniques of sizing. And so will it remain, unless the technique of weaving itself changes fundamentally or we find fibres which make yarn which can withstand the stresses and friction on the loom without any external protective applications.

Though principally the sizing operation has to serve the specific purpose of protecting the warp against breakages for only a limited time interval until the sheet is converted into cloth.

THE WARP UNDER STRESS

The primary object of 'warp preparation', i.e. warp winding, warping, sizing and drawing- in, is to produce a warp sheet that will weave a quality fabric with maximum loom efficiency. The commonly accepted criterion of judging the weavability is the warp end-breakage rate, particularly the breaks of the inexplicable type. Such types of breaks are generally due to the various stresses that are imposed on the warp, sometimes suddenly, during the process of weaving. While the warp sheet proceeds from the loom beam to the cloth fell the stresses are developed because of –

1. Stretching of the warp yarn due to opposite forces acting on account of let-off (particularly, negative let-off) motion and take-up motion playing a tug-of-war between them,

2. Dynamic stresses having maximum values developed, followed by minimum ones in quick succession due to the shedding operation, about 200 times a minute when the looms run at that speed.

3. Chafing or abrasive forces acting on a warp sheet lying on the race board of a sley during the quick passage of the wooden surfaced shuttle, from box to box during picking.

4. Rubbing action of the heald eyes, drop-wires, friction of the reed wires and in the case of dense warp sets, the friction between adjacent ends, during the movement of the warp yarn from the beam to the feel of the cloth,

5. Momentary impact forces acting on warp sheet during beating-up of the weft to the feel of the cloth.

All these primary and secondary operations of a running loom keep the warp constantly under stress. In addition to these stresses, there is a possible 'secondary' abrasion in the unsized yarn, caused by the movements of the fibres relative to each other, as frequently occurs in the blended yarns of cotton and man-made fibres due to differences in the frictional properties of the component fibres in the yarn.

THE SIZE TO THE RESCUE

In order to protect the warp against all such stresses, strains and abrasive forces that are acting on the yarn, which may result in yarn breakages, the yarn is impregnated with a paste, mainly composed of adhesives and lubricants or softeners, with a view to imparting to the warp yarn increased tensile strength, better fibre-lay and resistance to abrasion. The size paste penetrates the structure of the yarn to an appreciable extent and increases the cohesion of the individual fibres in the yarn to avoid slippage or breakage. It also produces a thin film or coating on the surface of the yarn which shields the yarn against abrasive, chafing or rubbing forces acting during weaving operation. In the past there were, however, other purposes also served by sizing, such as imparting a particular feel stiffness appearance or increasing the weight, when the fabrics were marketed in grey state, calendared or otherwise and were sold on weight basis. Thus an ideal size should give the yarn increased tensile strength by the cementing action, should retain, as far as possible its intrinsic flexibility, should lay the protruding fibres along the yarn surface and should form a flexible film which should allow the yarn to take all the bending at the high speed of running of a loom, without damage to the size film.

THE SIZE MIXTURE/INGREDIENTS

INTRODUCTION

In the last Chapter, we have seen that, what the warp needs before it goes on to the loom is some strengthening and some surface coating. The higher strength is needed to enable the warp threads to withstand the tension and shocks they suffer on the loom. Flexibility of the warp will also play an important role in this respect because, high flexibility will increase the work needed for the rupture of the yarn due to the stresses on the loom. Therefore, substantial retention of the flexibility of the warp, while strengthening it, will also need our attention.

The coating or cover on the warp threads is needed to minimize the effect of friction. The various kinds of friction mentioned in the last chapter not only rub out the size from the threads and nullify the effect of sizing, but also cause the fibres of the yarn themselves to drop out and lead to the breakage of the yarn. The cover on the yarn aims at minimizing this effect. The cover or coating is also meant to smoothen out the yarn surface to make the yarn evenly thick. This minimizes the yarn damage due to the thick places on the yarn wearing out the adjacent yarn or the thin places getting worn out themselves due to friction between neighboring threads. The main ingredient in the size mixture has to accomplish these twin objects of sizing. However, besides the main objects, there are some incidental necessary requirements arising out of the presence of the main ingredient and some other ingredients are therefore necessary besides the main one. Thirdly, the minor aims of sizing like giving the warps certain feel, weight, appearance, etc., which are no more valid in the present day practice of sizing, may require the addition of other minor ingredients.

ADHESIVES

Binding property:

While the breakages due to the tension and the shocks can be minimized by increasing the tensile strength of the warp threads (while retaining the flexibility), the breakages due to frictional effects can be reduced by making the yarn-surface smooth and uniform. These twin ends are to be met by the process of sizing of the warp threads, i.e. adding certain materials to the warp threads which will adhere to the yarn through the weaving process and will increase its strength and make the yarn smooth and uniform. The strength can only be increased by binding the different fibres together, so that they present a united body which will better, resist the breaking effect of the tension and the shocks. In short the sizing material should be a binder, something that adheres to the fibres and brings about better cohesion between them. Such a substance is called an adhesive.

Viscosity:

However, this adhesive must be used in a thick enough form, i.e. in the form of a viscous paste which forms a thick enough coating on the outside surface of the yarn, so that it.

(a) Lays the fibre ends on the body of the yarn to prevent them from jutting out of the yarn, and

(b) Form a uniform and smooth coat to minimize the friction effect of rubbing. Incidentally this coat must also be tough enough, so that it is not worn away by the severe rubbing it receives during weaving.

This adhesive has the adhesion property on account of the large number of attracting groups (polar groups) it has on its molecule. It will make a viscous paste because it has a high molecular weight, it is a polymer substance. It may be a natural material like starch or gelatin or may be a synthetic polymer like polyvinyl alcohol or a modified natural polymer like carboxymethyl cellulose.

SOFTENERS

Softening: But an adhesive is not alone enough for sizing. Most of the adhesives on drying form a him which is rigid and inflexible. This would make the yarn rigid and inflexible too. During shedding, therefore, the him and along with it the yarn would tend to break, instead of bending or elongating due to the bending forces or tensions on the loom. To correct this rigidity a softener is required. Such a softening agent is generally an oil, or a fat or a substance made from either of these. A softener itself has a flexible molecule and it breaks the continuity of the adhesive film and makes the film more flexible. A softener does not contribute to the weaving efficiency directly, but adds to the usefulness of the adhesive by overcoming a drawback of the adhesive. Therefore, while an adhesive is an essential ingredient of a sizing mixture a softener is necessary ingredient, although not in all cases.

Smoothening:

In addition to softening the adhesive film, softeners usually play another role also. This is to smoothen the outer surface of the film so that it causes less friction when it rubs against adjacent threads or against parts of the loom. This is called the lubricating effect and plays an important role in minimizing the warp breaks due to friction, as well as, in minimizing the wearing out and dropping off of the adhesive film during weaving. Softeners usually possess both these properties, viz., that of softening and that of smoothening, but not necessarily to the same extent. Some materials may be better softeners than lubricators and vice versa.

ANTISEPTICS

Another drawback of the natural adhesives is that they are also food materials and therefore they give rise to the growth of micro-organisms, particularly in warm and humid atmospheres. These micro-organisms then cause bad smell and coloured stains to be formed on the warp threads. In the long run they may even attack the substance of the fibres of the warp threads itself and the threads may get tendered. To prevent this substance is required which will prevent the growth of micro-organisms on the adhesive film. Such a substance is called a preservative or any antiseptic. Certain inorganic salts or organic compounds act as antiseptics or preservatives. They are necessary particularly when natural adhesives are used.

OTHER INGREDIENTS

Weighting agents:

Apart from facilitating weaving and increasing the efficiency of weaving, another aim of sizing, although a minor one, is to make the cloth more attractive and thus more saleable. This aspect is valid when the cloth is to be sold in the grey condition only. Since nowadays most cloths are sold in the bleached or dyed or printed and finished form, which necessitates the removal of the size, the size on its part, is not required to add to the attraction of the cloth at all. However, this aspect is still true in the case of a small percentage of the cloths which is sold grey even now. In their case, therefore, it is sought to add certain ingredients to the size mixture so that the sale value of the cloth is boosted up. Weighting agents are one such a type. Weighting agents merely serve to increase the weight and fullness of the cloth. This helps when the cloth is sold on the basis of its weight. Weighting agents, filling agents, fillers, weightening agents, etc., which are the other names by which they are also known, are usually cheap inorganic white powders like China clay, French chalk, Gypsum, Glauber salt, etc.

Blueing and brightening agents:

These substances correct the creamish greyness of the unbleached cotton cloth by adding a blue colouring matter to the size mixture, which being a complementary colour to the yellowish creamishness of the grey cloth, makes the cloth appear a neutral grey which gives the sensation of being whiter than the original. Fluorescent brightening agents are also used for the same purpose. Thus the appearance of the cloth to be sold in the grey condition only is made more attractive. Ultramarine blue, blue soluble dyes are the blueing agents and the well-known, old Tinopal-Ranipal-like substances are the fluorescent brightening agents used.

Deliquescent:

These are hygroscopic substances which attract moisture from the atmosphere and thus overcome the dryness of the warp. After sizing the warps are dried. Formerly this used to result in over-drying of the warp threads. Over-drying, i..e drying the warp so much that it contains less than its normal moisture, leads to making the warp threads weak, less flexible and therefore brittle and results in more warp breakages. It is not possible for the warps to regain the normal moisture during the weaving operation. Therefore to help the warps to do so hygroscopic substances like magnesium chloride, glycerol, etc., are added to the size mixture. Incidentally this may also help in increasing the weight of the cloth in the case of the grey sorts. Now that devices are available to control the drying to the required extent, the importance of the deliquescent has declined.

Antistatic agents, wetting agents, antifoaming agents:

These substances are usually required in the case of sizing of synthetic warps. Synthetic fibres being very hydrophobic (water-repellent) give rise to the formation of static electricity on them when they undergo some rubbing action. This static charge is troublesome in may respects. It spoils the finish of the cloth, causes fibres and yarns to repel one another and may even give rise to spark formation. Addition of antistatic agents to the size mixture is a very common practice to overcome this trouble. Many water-soluble surface-active agents serve as good antistatic agents, so also some hygroscopic substances.

Wetting agents are also required only in the sizing of water-repellent fibre warps which are difficult to be wetted by aqueous solutions of adhesives. They are not required for cotton or viscose rayon warp sizing.

When these antistatic agents or wetting agents are used, sometimes there is too much formation of foam. This is sometimes carried over to the drying cylinders too. To smother the foam, therefore, antifoaming agents, which are some oils like pine oil are added.

TECHNIQUES/CLASSIFICATION OF SIZING

INTRODUCTION

The purpose of sizing, viz. to coat the warp yarn with the adhesive so as to increase its strength and abrasion resistance and make it smooth and uniform can be achieved by various mechanical techniques of dipping the yarn in the adhesive pate and drying. The technique followed depends on the scale on which the warp yarn is required for weaving. When it is required on a small scale only and each small weaving establishment has to have its own sizing arrangement, the sizing of warp in the hank form, like hank dyeing or bleaching, is the method used. This is the method which our handloom weavers and small-scale power loom weavers follow mostly. This is obviously the simplest method of sizing.

Ball-warp sizing

Ball-warp sizing, also sometimes called chain warp sizing, is a slightly more advanced method, resorted to when sized warp on a slightly larger scale is required. This system is not much seen in our country, but was used particularly when separate spinning mills sold yarn as such without sizing or when the yarn was first bleached or dyed before making it ready for the weaver as a sized beam. Centralized sizing or sizing department of a slightly big weaving establishment used this method of sizing.

However, the most established practice of the day all over the world is tape sizing or slasher sizing. All our composite mills in the organized sector invariably use this method of sizing and even the power loom and handloom sectors get their warp beams sized through centralized sizing arrangements where this method is exclusively used because of its large scale operation and consequent economy.

HANK SIZING

As Said above, for small manufacturers in remote rural places, warp is generally available in hank form and such manufactures, therefore resort to hank sizing or hank bleaching or hank dyeing methods. The more productive but huge capacity and costlier machines are beyond their means and requirements. Hank bleaching and hank dyeing techniques are still quite common even in our composite mills, but hand sizing has all but died out because of the difficulties in the processing of the hanks in the viscous adhesive size pastes. Therefore even when hank sizing was more common, it was used only for pure or light sizing i.e. sizing in which the least number of ingredients are used and which is done only to improve the performance of the warp on the loom and not to increase the weight of the warp or give a particular finish to it.

The bleached and dyed warps are given only pure or light size. The yarn is first bleached and/or dyed in the hank form. It is then only partially dried. The damp yarn is in a better condition to absorb size. Many times therefore, the sizing used to be done as the last stage of bleaching or dyeing. In most cases the final wash after bleaching or dyeing used to contain the sizing ingredients and the bleached or dyed hanks after partial washing and a hard, uniform squeeze, used to be inserted in the last sizing bath and then squeezed. In some cases, in fact, where washings were not given after dyeing, towards the end of dyeing the dye-bath itself would be fortified with the sizing ingredients and the final state of dyeing would consist of both dyeing and sizing. Although this last mentioned practice is not to be recommended because of the lack of fastness of the dyeing, there should be no two opinions about its economic nature.

After this sizing the sized hanks are shaken, stretched and brushed in order to achieve a more thorough and uniform distribution of the size paste along the threads to make it smoother and to prevent the tendency of the yarn to stick together in a group. Obviously, this hand- operated method gives a very low rate of production. In the western countries some mechanization was achieved, as in the Cohen's hank sizing machine, which gave slightly higher rate of production. At present, however, hank sizing has become all but obsolete and can be seen only in some handloom centers in India.

BALL-WARP SIZING

In ball-warp sizing, the warp in the form of a loose rope is taken through a trough in which which the size paste is kept. The trough has a number of guide rollers over and under which the sliver of yarn passes. While so passing, the yarn bundle is spread out so that every end comes in contact with the size and gets soaked with it. At the end of the passage through the trough the yarn is squeezed through the nip of a pair of rollers. It then goes over a revolving winch and is deposited in a trolley below the winch. The yarn is afterwards dried.

This drying of the yarn is not continuous to the sizing operation. This is an advantage because this gives more scope for penetration of the size to the core of the yarn. The winding of the warp onto the beam also does not follow immediately after drying. This also gives an advantage because the dried yarn gets enough time to absorb moisture from the atmosphere and this gives it a peculiar mellow feel. A third advantage is that there is little tension during the sizing or drying. This preserves the extensibility of the yarn.

These advantages accrue from the separateness of the three stages of sizing, drying and beaming. This separateness of the three stages is itself the bane of this method, because it makes it too slow for modern requirements of high productivity and therefore it has also become obsolete. However, it is said that even now it should be very suitable for sizing short lengths.

TAPE OR SLASHER SIZING

What is tape or slasher sizing system?

As said earlier the tape or slasher sizing method is the one universally followed for large scale operations. This method may be described as one which comprises the operation of assembling of warp yarns of equal length in a parallel order in the form of a continuous sheet with the desired number of ends, application of a suitable size to the warp sheet, drying the sized warp sheet and winding dried warp sheet onto the weavre's beam. These functions of assembling the desired number of threads (ends) in a continuous sheet form, sizing, drying and beaming are to be supplemented by the ancillary functions of separating the ends, measuring the length of warp, marking into cut lengths and winding the warp of equal length to form the warp of a fabric. All these functions are to be performed by the tape or slasher sizing machine.

The three systems of drying:

Machines of the tape or slasher type comprise modifications of three distinctive types that are chiefly characterized by the method of drying the sized yarn. One type includes those machines which dry the yarn by passing it around and in direct contact with cylinders heated with steam, which are described merely as 'slasher' or 'tape' sizing machines. They are also called 'the cylinder' sizing machines to distinguish them from the other type which consists of those machines in which drying effected by hot dry air which directly comes in contact with the wet sized warp and carries away moisture from it by evaporation. Since the oldest slasher machines had cylinder drying arrangement, the mere term slasher of tape sizing machine usually indicates a cylinder drying system.

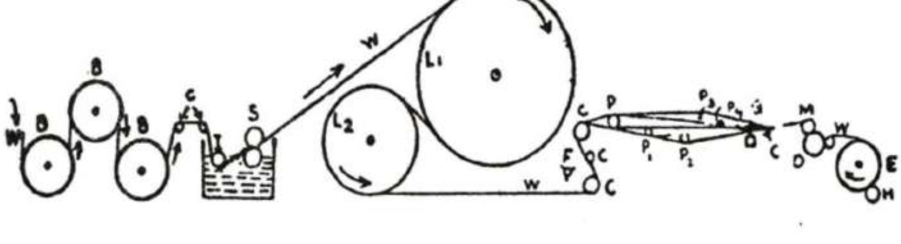
In the first type of machines the transmission of heat to the yarn is done from the steam through the cylinder surface by conduction. In the second type the heat transfer is carried out by free and forced convection of hot air over and through the warp sheet. The third system, viz. heat transfer by radiation is also there in some drying apparatus, but since such a system is very costly, such apparatus is used only exceptionally as additional drying and for special purposes like the preliminary drying of textured yarns, where infra-red radiators are used. It has been computed that the cost for equivalent drying capacity of a gas heated infra-red radiator is

about twice as much to run as that of a steam-heated cylinder. An electrically heated radiator is still more costly to run, costing three to four times as much to run as a steam-heated cylinder. Hot-air drying although less costly than radiation type drying, costs about 40% more than equivalent drying by heated cylinders (1).

Cylinder sizing machines further fall into two categories: Those employing only two large drying cylinders and those employing from five to thirteen small cylinders. The two cylinder machines were in common use all over the world until after the Second World War and it was in about the fifties that the hot-air drying machines made their way in many mills. However, during the sixties the multi cylinder drying systems made their appearance and the hot-air drying systems are now-a-days rarely seen except perhaps in the woolen, worsted and synthetic warp sizing machines, sometimes. The multi cylinder sizing machines have now been established all over the world, with certain modifications in the drying path of the warp yarns.

General description of a slasher sizing machine: A schematic drawing of a two-cylinder slasher is given in **Fig. 1.**

The yarn is wound on section beams in parallel order in the previous preparatory operation of warping. Usually each section beam contains about 500 to 600 warp threads, called ‘ends’. The section beams, called ‘the warper’s beams’ or simply as ‘back beams’, are placed in a stand called ‘creel’. The warp ends from each section beam are grouped and drawn forward, being passed under and over the other back beams, over and under the guide rollers and into the size box.



B : Back beams. W : Warp sheet. C : Carrier rollers. I : Immersion roller. S : Squeezing rollers. $L_1 L_2$: Large and small cylinders. F : Cooling fan. P, P_1, P_2, P_3, P_4, : Splitting rods. M : Measuring roller. D : Draw roller. E : Weaver's beam. G : Comb. H : Pressure roller.

Fig. 1: Two-cylinder sizing machine

The sheet of yarn is entered into the size paste, which is kept at near-boiling temperature by injecting steam directly into it through a perforated copper or galvanized iron steam pipe. The warp partially encircles an immersion roller while passing through the size paste and then passes into the nip formed by the 'size roller' and the 'squeeze roller'. Three is a minimum of one pair of these in a size box. The squeeze roller presses in the size paste into the yarn structure, presses out the external excess size and at the same time drags the warp sheet through the paste.

The yarn loaded with the wet size then passes through the section comprising the drying arrangement-either two cylinder or multi-cylinder or hot-air chamber-wherein the yarn is dried. Usually the drying is controlled to predetermined moisture content, thus avoiding over drying of the warp. The last cylinder of the cylinder range is usually kept cool so that the warp sheet is cooled when it leaves the drying range.

The next step is a split up the warp sheet by means of split rods, into as many sections as there are beams in the creel. The warp then passes through an 'expansion comb' which regulates its width and after passing between the nip of a 'drag roller' and a 'nip roller', is finally wound on a beam called the 'weaver's beam'. This front portion of the sizing machines consisting of the section after the drying range is called the 'head stock'. It combines numerous auxiliary devices such, full-speed and crawl speed devices, a length indicator, a measuring and cut marking motion and a pressing roller device to compress the yarn compactly on the weaver's beam. There has to be also a driving motion to rotate the weaver's beam at different rpm from the start to the end of the beam to accommodate the increasing circumference of the beam.

Thus, the sizing machine basically consists of three main parts:

- **(i)** Creel and size box forming the rear part.
- **(ii)** Drying arrangement in the middle and
- **(iii)** Head-stock to wind the sized yarn on the weaver's beam, forming the front part.

THE CREEL

THE PURPOSE AND TYPES OF CREELS

For the operation of sizing a set of back-beams containing a predetermined number of ends to be sized, is placed in stand made of cast iron frame work, called the creel. In the conventional sizing machine the creel was designed to accommodate back-beams of about 500 mm flanges. With the present trend of mass production to improve the efficiency of the operation, and consequent large packages, beam flanges of about 750 mm are quite common and accordingly, either new types of creel have been designed or old creels have been modified to suit the new requirements.

There are mainly three types of sizing creels in use:

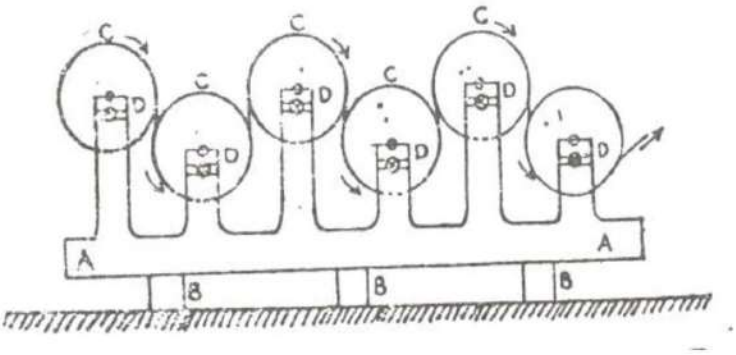
(i) Over-under (or staggering or zigzag creels), which are usually of horizontal type

(ii) vertical creels and

(iii) inclined creels. There are many modifications in each of the above three types.

OVER-UNDER CREEL

General description: **Fig. 2** shows this type of creel.



A: Cast iron sides. **B:** Adjustable feet. **C:** Back beams. **D:** Adjustable brackets.

Fig. 2.: Over-under creel.

It is so-called because of the serpentine path of the yarn that passes over the surface of the beams in the top tier of the creel and then passes under the beams in the bottom tier of the creel. The number of beams required for a particular set depends on the number of ends in the resultant fabric and the warping creel capacity. For general type of weaving normally 6 to 8 back-beams are placed in the creel. From a set of, say, six back beams the threads are withdrawn from the top side of the rear-most beam in the top row and passed underneath the second where they unite with threads that are withdrawn from the bottom side of that beam and so on until all the threads are gathered into one sheet of warp threads that pass over a guide roller when they are immersed in the near-boil size paste in the size box.

An advantage and a disadvantage: The advantage of the over-under creel is that such a creel in easy to load and unload. The horizontal position of the beams also provides easy supervision and access to any beam.

However, a disadvantage of this type of creel is that it is difficult to locate and cut the lapper exactly when a sheet of yarn consisting of the ends from a previous beam is running over the beam. The separate identity of ends from each beam is lost in assembling the ends from the last beam to the first beam in the form of a sheet. Incidentally it may be mentioned that this lapped portion of a broken thread in the shape of a ring round the beam or roller of any part of the sizing machine is called a lapper.

Another disadvantage of this type of creel is that since the warp sheets from the rearer back beams have to pass in contact with the beams in the front, they have to take part in the driving of the front beams and therefore share the tension due to this. This leads to the warp sheets from the rearer beams being put under greater tension than those from the beams ahead of them. This may lead to more breaks to the ends from the rearer back beams, unless steps are taken to reduce the tension considerably or equalize it throughout the combined warp sheet by other means.

VERTICAL CREEL

The vertical creel overcomes some of the problems encountered with an over-under or horizontal creel. This type of creel is also advantageous in mills where floor space is limited. The creel construction which supports the back beams needs to be very solid and sturdy.

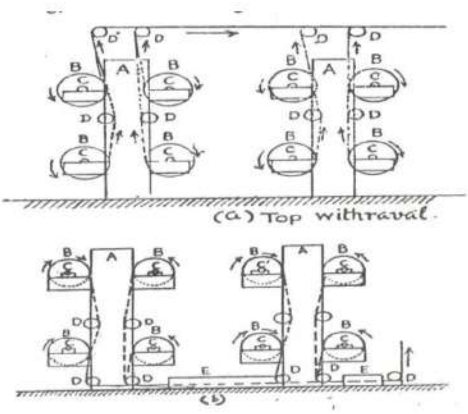


Fig. 3.: Vertical creel

Fig. 3. (a) and **(b)** show arrangements of this type of creel. The warp yarn may be drawn int a sheet form from the top of the creel as shown in Fig. 3. (a), or the warp sheet may run parallel and nearer to the flooring, as shown in Fig. 3. (b).

In both these arrangements a number of guide rolls, adjusting brackets, platforms etc. are needed, which makes this type of creel a bit cumbersome and unwieldy. Hence, though detection of a lapper is easier with this type of creel, it is relatively difficult to cut a lapper, particularly from the beams placed in the upper tiers of the creel.

INCLINED CREEL

Till one more variation in the creel design is used in which all the beams are kept in a creel in an inclined stand, whereby the beams will be positioned in an ascending order as shown in **Fig. 4. (a)** or in the descending order as shown in **Fig. 4. (b).**

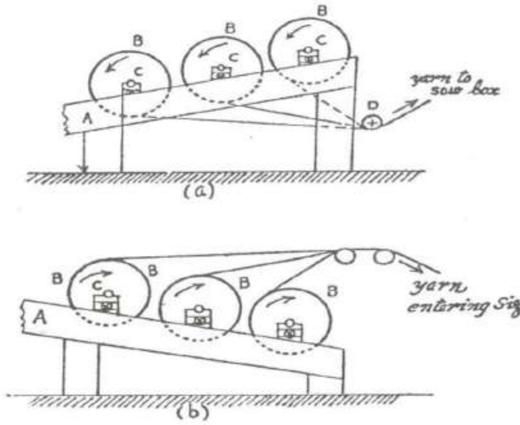


Fig. 4 : Inclined creels (a) ascending, (b) descending

In both these cases the individual guide rolls can be eliminated and only one front carrier roll will guide all the individual sheets into one combined sheet for presentation to the size box. Here also the detection of lappers is easier than in the horizontal type of under-over creel, but the removal of the lapper is more difficult because of the interference of the sheets of warp from the other beams. Unlike in the horizontal creel wherein the neighboring beams move in opposite directions, they do in the same direction in the vertical or the inclined creels to unwind the warp yarn.

OTHER VARIETIES OF CREELS

Equi tension creels: Some more variations in constructing the creel stands and positioning the beams are shown in **Figs. 5.**

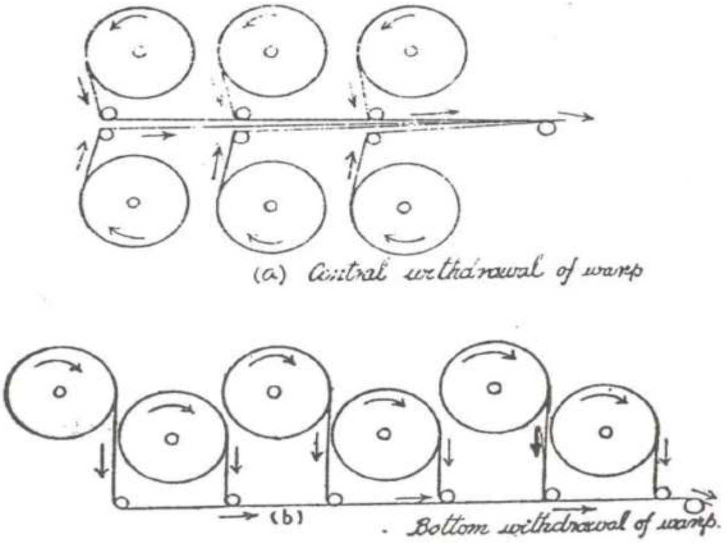


Fig. 5: A guide roller for each beam. Equi tension creels.

Most of these creels are capable of providing equal tension on all the ends coming from the various beams. Therefore they are called equi-tension creels as distinct from over-under creels.

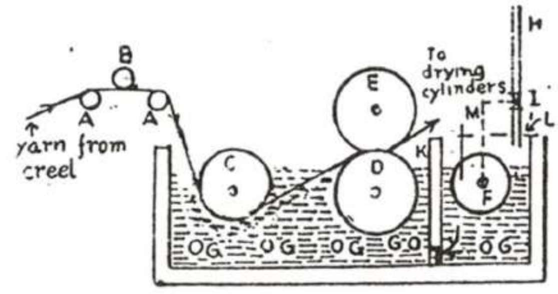
THE SIZE BOX

INTRODUCTIORN

The 'size-box', also known as the 'sow box' is the most important part of a sizing machine as most of the desired properties of the sized warp can be effectively controlled during the passage of the warp through the size box. The obvious purpose of the size box is to provide the size paste to be uniformly applied to each thread of the warp sheet as it passes through the paste in the size box. This simple-worded objective involves many issues, such as, proper penetration of the size paste into the yarn, formation of a uniform and smooth film of the size as a coating on the surface of each end and moreover maintaining all the desired properties of the size paste throughout the sizing operation of particular sort, to get uniform properties of the sized warp. All these require a meticulous control at the size box. Although these factors are also materially affected by the ingredients in the size paste and the method of its preparation which precedes the application at the size box and to a considerable extent by the drying method which succeeds the size box, the importance of the controlling devices at the size box should not be under-estimated.

Conventional size box: The design and construction of the size boxes depend on the type of warp yarn, its structure, type of the fabric to be manufactured etc.

The conventional type of size box shown in the figure below, which is used in the old two-cylinder sizing range is rectangular in shape and open at the top, except for the smaller compartment.



A : Guide rollers. B : Dancing roller. C : Immersion roller. D : Size roller. E : Squeeze roller. F : Float roller. G : Perforated steam pipes. H : Size feed pipe. I : Size feed valve. J : Slot in partition. K : Wooden partition. L : Lid. M : Air rent.

Fig. 6: Conventional size box.

Formerly it used to be fabricated out of wood and then sometimes lined in the inside with copper sheet. Latterly cast iron was the material of construction used. It can accommodate 225 liters of the size paste. The box is divided into two compartments, a smaller one at the front end and a slightly larger one at the rear end. The two compartments are separated by a partition with a small rectangular opening at the bottom for the size mixture to flow from one to the other compartment. The smaller compartment which is usually fitted with a lid to prevent evaporation of water from the size paste acts as a storage or reserve compartment to which the size paste is supplied from the storage beck of the size mixture through a feed pipe. The float roller shown into figure is meant to keep constant the level of the size mixture in the size box, which it does by means of its connection to a valve in the feed pipe. The float roller is simply a hollow copper tubing and due to its light weight compared to its volume, floats on the surface of the size mixture. It is provided with an air tube to prevent collapse due to fall in temperature.

The rear compartment contains an immersion roller which can be raised or lowered by means of a rack-an-pinion arrangement. The warp sheet passes into the size mixture from the guide rollers and then goes around the lower half of the immersion roller. By raising or lowering the immersion roller the length of the path of the warp sheet through the size mixture can be decreased or increased, respectively, as desired. This controls the size pick-up by the warp, longer length of the path giving higher pick-up and vice versa, as required.

The yarn then passes over to the size roller, which formerly used to be a copper roller, but nowadays is made of stainless steel. On the top of the size roller rests the squeeze roller. The yarn passes out through the nip between the size roller and the squeeze roller and gets squeezed. The squeeze gives the penetration of the size into the yarn interstices and also expels out the excess of the size from the surface of the yarn to leave an uniform smooth film on it.

SIZE PASTE PREPERATION

Equipment's for cooking and storing are pressure cooker, storage beck, pipeline and homogenizer (Optional)

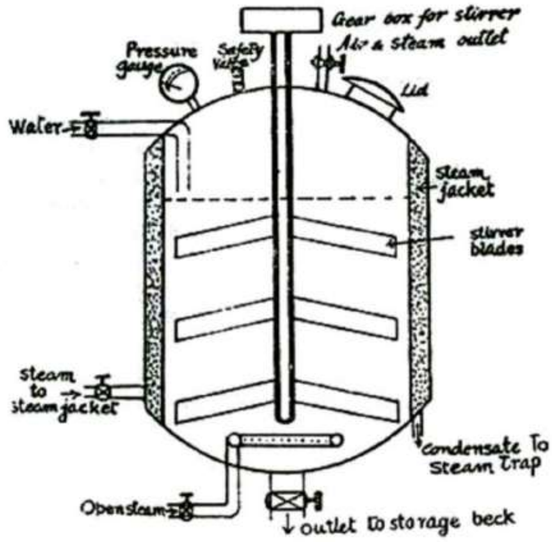
Gelatinizing process: Proper and uniform distribution of starch in the paste is the prime consideration. Starch has to be gelatinized and this require high temperature and also to maintain viscosity of paste stable. Process consist of boiling starch till its granules burst and dissolve in water by keeping viscosity stable, for this continuous stirring of paste and supply of steam is required. After size paste formed stop the process.

Concentration of paste: In order to get uniform size film on the warp, the concentration of the size paste, i.e. the weights of the various ingredients used per unit volume of the size paste, must remain constant.

PRESSURE COOKERS

Pressure cookers are also used on account of the reduction in cooking time and steam consumption that their use entails. A common pressure cooker is a cylindrical, steam-jacketed vessel of about 1.25 m outer diameter and 1.25 to 1.5 m in height. The cooker is provided with a stirrer, which rotates at 40 to 60 rpm. On certain cookers there is a provision for two speeds, one, a slow one (15 to 20 rpm) and the other the normal (40 to 60 rpm.). A pressure gauge, a safety valve and inlet and outlet pipes for steam and water are incorporated as shown in the figure: The highest temperature can be controlled thermostatically.

Fig.1 Pressure cooker



For preparing the size paste water to the extent of 80% of the specified volume along with the adhesives is fed by opening the lid at the top. The stirrer is started and so also the live and jacketed steam. When boiling starts the lid is closed, live steam is stopped and the pressure is allowed to rise upto 1.5 bar. The cooking is carried out for 30 minutes at the highest temperature. When the size paste is ready, the heating is stopped, the pressure allowed to drop and then the mixture transferred to the storage tank. Here the lubricant and antiseptic etc. are added and the mixture boiled and then made up to the desired volume.

Storing becks: When the mixture is properly prepared it is not kept in the same beck waiting to be used on the sizing machine, but is transferred to another beck, called the storing beck and from this transported through pipes to the size box whenever required. The construction of the storing beck is similar to that of the cooking kettle, except that, since during the storage the size paste does not require to be vigorously stirred, the stirring arrangement consists of the simplest stirrer without any baffle plates or other devices which are meant for creating high turbulence. However also stirring is a necessity to avoid uneven cooling of the paste which would result in lump formation, due to the congealing property of the starch pastes. The stirrer speed is kept at about 15 to 20 rpm only and the temperature at about 60 to 700C. Violent agitation of the size paste has to be avoided as it reduces the consistency of the paste. The hot temperature is required again, to prevent the gelling of the paste. For this purpose a temperature higher than 60 to 700C is not necessary.

Here again, it is preferable to have closed steam pipes for heating, as otherwise the steam would get condensed in contact with the size paste and would cause continuous dilution of the paste. There is, of course, the danger of the size paste getting concentrated due to long heating with closed steam and that is why the heating is restricted to keep the paste just hot enough to avoid gelling.

Another peculiarity of the storage becks is that they are generally lagged from outside with asbestos sheets to avoid heat losses, if the period of storage happens to be long enough. This also results in savings in steam consumption.

CIRCULATING SYSTEM

An elaborate system of piping is required in the size mixing section. The fluids to be transported are: the size paste which is required to be transported from the cooking vessel to the storage beck and from both of these upto the size box in the sizing machine; water to the size cooking and storing vessels as well as to the size carrying pipe; steam to the size cooking as well as size storing becks, so also to the size carrying pipe and there are also sometimes solutions and suspensions which are added to the size mixing beck directly. Such are the solutions of CMC and P.V. alcohol. Some sizers prefer to prepare solutions of these adhesives separately and add them to the cooking vessel instead of adding dry powders. This avoids any chance of lump formation. Again, as said earlier China clay paste used to be separately made and added to the size paste in a hot condition. Other ingredients like softener emulsions, gums, gelatin etc. are also sometimes made into solutions separately and added to the size paste.

In connection with this pipe line system the following points need special attention:

(a) The piping should preferably be made of rustproof material like galvanized iron. Formerly even brass pipes were not uncommon, but now they would be too costly.

(b) There should be minimum length of pipe line from the size cooking or storing becks to the size boxes.

(c) There should be minimum sharp right angled bends in the pipe line.

(d) Size carrying pipe lines should be connected at regular intervals to the steam and water supply lines. The purpose is to enable the size pipe line to be blown to remove any congealed size. During the long intervals when the size is not flowing through the pipe line, as for example during week-ends, it gets solidified and may block further flow. At such eventualities water and steam are forcibly blown through the size pipe line to remove the blocks.

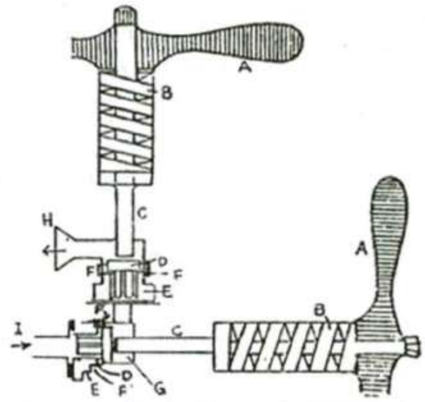
(e) The steam pipe lines should be amply lagged with asbestos-magnesia or plaster of Paris or fibre glass to prevent loss of heat, all the way from the boiler upto the kettles or the size pipe line. Similarly for the same reason the size pipe line should also be lagged. Heat losses can be considerably reduced, if attention is paid to the proper lagging of the steam and size pipe lines with the insulating materials, from time to time. This insulation of the pipe lines is a small investment which gives large dividends in the long run.

(f) The size circulating pipe should be provided with a strainer or filter before it enters the storing becks, so as to ensure that no foreign matter such as grit, trash, strings from sacking, lumps of congealed size, sand, pieces of chipped wood, etc. enter the size box. The strainers must be periodically cleaned.

HOMNOGENISERS

The homogenization process consists in bringing the mixture of starch and water to the gelatinizing temperature of the starch and thereafter forcing the paste through a microscopic orifice where forces of shear and turbulence come into play thereby breaking the swollen starch granules and forming a size paste in a shorter time than in the conventional open beck method. The process of homogenization is better explained with reference to Gaulin homogenizer. **(Fig. 2).**

Fig. 2: Gaulin homogenizer with two homogenizing valves.



A : Pressure adjusting handle. B : Homogenising valve spring. C : Valve rod. D : Homogenising valve. E : Valve seat. F : Impact rings. G : Pressure area. H : Outlet. I : Inlet.

The mixture of starch and water enters through an inlet from a pressure cylinder at a high pressure and is forced against the backside of the homogenizing valve. The very fine clearance between the valve and the valve seat starts the break-up of the particles. Reciprocating action of the plunger-type pump forces the slurry against the impact ring. The velocity is about 1600 m/sec. and the pressure between 150 and 250 bars. The pressure can be controlled by a hand-wheel which restricts the valve gap and the liquid is forced through by the pressure which is built-up.

The mixture is then discharged to an intermediate pressure area. Then a second homogenization is accomplished by a second homogenizing valve. Finally the homogenized paste is discharged at atmospheric pressure. At this stage again the release from a very high pressure to the lower atmospheric pressure causes an explosive reaction within the paste which, combined with the vehement dynamic impact results in further breakdown of the starch granules into more or less uniform minute particles.

MODULE - 5

DRYING EQUIPMENT

Importance of the drying operation: After the warp sheet has passed through the size paste and got squeezed through the nip of the squeezing rollers, it contains normally about 90 to 140% of its own weight of the wet size paste in it and the next operation is to drive out the water from the wet size, so that the yarn contains the dry size and only the natural moisture of the yarn and the size film. This drying of the wet, sized yarn is an important operations because not only the extent of drying has a great bearing on the physical properties of the yarn like its strength, flexibility, brittleness, plasticity etc. but the rate of drying determines the speed of the sizing machine and hence the rate of production of the sized yarn. Therefore the aim is to dry the warp in such a way that the good properties of the yarn like strength, flexibility etc. are retained as far as possible and the drying is accomplished in as short a time as possible, consistent with fuel economy. Particularly at present when the energy costs have gone sky high there is great need for economizing on the fuel consumption. Great efforts are therefore being made to find ways of economizing on the cost of drying.

Quantity of water to be evaporated: It is easy to see that the energy required for drying and therefore the cost of drying, as well as the rate of drying and therefore the rate of production of sized yarn will depend on the amount of water to be evaporated from the wet sized warp. This latter, in its turn, will depend on the concentration of solids in the sizing paste (a paste containing 5% solids will contain 95% water, while one containing 15% solids will contain 85% water) and the quantity of size paste contained in a unit weight of the sized yarn. For example, when the squeeze is 140%, that is, when 100 kg of the unsized warp carries with it 140 kg of the paste of, say, 10% concentration, there will be 126 kg of water to be removed during the drying operation for every 100 kg of unsized yarn.

Heat sensitivity of fibres: There is yet another factor, the heat sensitivity of the fibre of which the yarn is made. The synthetic fibres are thermoplastic (they soften on heating). Therefore the warps containing the thermoplastic fibres have to be dried at a relatively low temperature. Cotton is quite resistant to heat. Therefore a temperature not exceeding about 1500C for a short time is allowable for drying. But viscose rayon is a more delicate fibre, although not thermoplastic, and therefore a temperature exceeding 1200C is not desirable in its case. It should be remembered that wet fibres are more stretchable than dry ones and at high temperatures still more so.

Three basic methods: There are three basic methods of drying the warp on a sizing machine. They are the following –

(i) Conduction method in which heat is transferred to the yarn through the metallic surface of steam heated cylinders. This is the oldest and at present the most popular type of drying method attached to slashers. This is also the most efficient with respect to the energy required to dry the yarn.

(ii) Convection method in which hot air is circulated to dry the yarn as it passes through the drying chamber. The energy source for heating the air may be steam or electrical heaters. Fans and ducts are provided to circulate the hot air. The rate of exhausting the moisture-laden air is adjustable. In this method, unlike in the first mentioned method, the yarn is not much flattened.

(iii) Radiation method in which heat is transferred to yarn by direct radiation. It utilizes either tube-type or plate-type heaters. Energy is transmitted to the yarn by electromagnetic radiation, the heat waves, which directly impinge on the yarn and evaporate the water on it. Here also there is no flattening of the yarn, as there is no contact with hot metallic rollers or cylinders. It is generally recognized as the least efficient type of a dryer with respect to energy consumption, but is suitable for laboratory model sizing machines for experimental purposes or even sometimes on large scale machines where very quick drying is needed.

CYLINDER DRYING

Two-cylinder drying machine: This oldest type of machine used in some mills in India for cotton warp sizing. One of the two cylinders is a very large one with a diameter of about 1800 to 2100 mm (6 to 7 feet). The smaller one has a diameter of about 1200 to 1500 mm (4 to 5 feet). The yarn is led from the size box to the larger cylinder first and then is passed over the smaller cylinder for completion of drying.

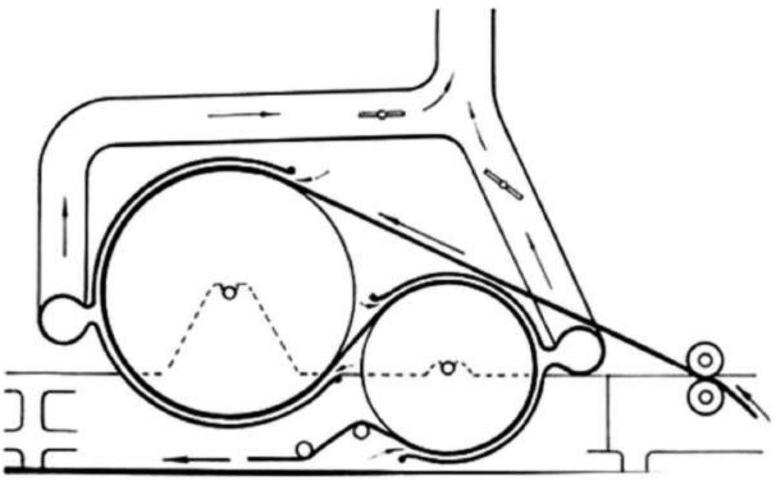


Fig. 7: Two cylinder drying range with Shirley hood.

As is well known, cylinder drying machines are very commonly used in the finishing of fabrics and have been acknowledged to be the most economical mode of drying, requiring only1.6 kg. or even less steam to evaporate 1 kg. of water from the textile. However, the peculiarity of the two-cylinder machine is the extra large cylinder on which the yarn is first passed. The purpose seems to be to avoid sticking of the size to at least the second cylinder. The warp ends on passing over the first cylinder surface of nearly 5 to 6 metre length is substantially dried and there is very little chance of the sticky size or the sticky yarn adhering to the second cylinder.

It is, however, said that during the long passage of the yarn over the first cylinder, when one side of the yarn surface is in contact with the hot surface of the cylinder continuously, there is much differential drying of the size film between the surface in contact and the opposite one. This leads to some shrinkage of the size film in contact with the cylinder surface. This shrinkage is also helped by this surface being the inner side of the curve being negotiated by the yarn. When the yarn passes on to the other smaller cylinder, the yarn curvature is reversed and the dried side of the film on the yarn becomes the outer stretched side and this sudden reversal is likely to crack the size film, now on the outer surface. Due to these cracks the size film is more likely to get powdered and form a fluff during the further passage of the yarn through the sizing machine or during weaving. This is said to be the main disadvantage of the two-cylinder drying machine.

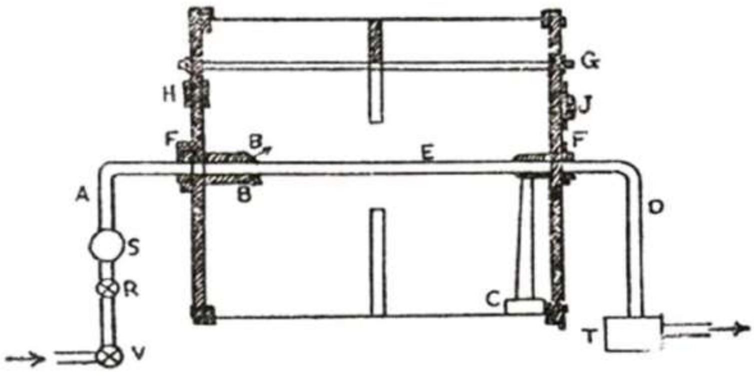
Another disadvantage of the two-cylinder drying system arise from the fact that in most cases the cylinders are not positively driven but are rotating by the friction of the sticky yarn which is continuously pulled over them. This results in much strain on the yarn and consequently much loss of flexibility as reflected in the loss of elongation at break. Elongation at break is, as is well known, the most important property of the yarn from the weaving point of view.

There are many other disadvantages like slow speed of drying and therefore of the sizing process as a whole. This is due to the fact that the largeness of the cylinder precludes the use of steam with high pressure. Very high pressure of the steam would be both uneconomical, as well as, unsafe for the large cylinder. Secondly, the large cylinders have large end plates too through which much heat is being lost. Thirdly, as said above, the sticking of the wet sized yarn to the cylinder surface cannot be wholly avoided.

Construction of the cylinders: Despite disadvantages mentioned above, the two cylinder drying system still persists in many mills. Besides, the modern multicylinder system also involves the use of cylinders. Therefore it is important to know some details of the construction of cylinders.

The cylinder consists of a hollow shell made of heavy copper sheet. The horizontal cylinder of about 1500 mm width has its two open ends covered up by end plates which are generally made from heavy thick cast iron. There is much loss of heat from the end plates. Therefore they have to be thick to minimize the loss. The figure below shows the section of a cylinder.

Fig. 8: Construction of a large drying cylinder.



A : Steam inlet pipe. B : Inlet ports for steam. C : Condensate bucket. D : Outlet pipe. E : Centre shaft. F : Ball bearings. G : Stay bars, H : Air valve. J : Man-hole cover. R : Reduction valve. S : Safety valve. T : Steam trap. V : Control valve.

Steam enters the cylinder through the center of one of the end-plates and passes out from the other. For the large cylinders of the sizing machine a high pressure steam is both uneconomical and unsafe. Therefore a pressure of 0.7 kg./cm2 (10 lbs./sq.in) is not exceeded. There is a safety valve on the steam pipe which ensures this. Steam enters into the cylinder through an ingenious entry system called doll-head which allows the cylinder shaft to rotate around the stationary entrance.

Inside the cylinder, the whole structure is held rigid by means of stay bars across the width along the periphery. Near th periphery, again, on one side there will be an air outlet to let out air at the start of the machine. It is kept open in the beginning and the steam is let in while the cylinder is run without any yarn passing over it. This allows the condensed and accumulated water to pass out from the other end into the steam trap and the air to pass out from the air valve.

Air and condensate removal: The initial step of removing air and condensed water is very important. Condensed water does not have the latest heat of steam. Therefore even at equal temperature it has very much less heat content. The air, on the other hand is a bad conductor of heat. The steam will push the air near the periphery, i.e. near the inside cylinder surface and the heat transfer will be very much affected by this. Again if steam contains air the partial pressure of air will be utterly useless from the point of view of heating. This means that the pressure shown on the gauge will be too high for the actual temperature of the steam + air mixture. For example, if the gauge pressure is 1.4 kg/cm2 and if the temperature of pure saturated steam of this pressure is 1220C, the temperature of steam + air mixture of the same pressure will be corresponding to the partial pressure of the steam only. Therefore it is necessary to get rid of air and condensed water from the cylinder. During long stoppages when steam is not passing through the cylinders, these two accumulate in it. While starting therefore the first task is to run the cylinder with the air vent open and the steam running in until the steam comes continuously out of the air vent.

The air vent has also another use. During the stoppages it is kept open so that when the steam inside condenses, air rushes in. If it were not so, the condensing steam would have caused partial vacuum inside and the cylinder would have got deformed by implosion.

To expel condensed water there is an arrangement of buckets inside the cylinders. Three buckets are placed at a distance of 1200 angle from one another and staggered through the width which is divided into three compartments by means of baffles. The bucket when it reaches the bottom gathers the water and passes it into the next compartment. The last bucket passes the water into the central outlet at the other end. Some manufacturers provide a spiral baffle arrangement for the same purpose.

The central outlet on the other side, thus, passes out the steam and condensed water. This is led to the steam trap, whose function is to allow water to pass out but stop the steam from passing out, thus saving the steam from being wasted. The condensed water is usually collected and used either for boiler feed or in making the size paste.

Three should preferably be a steam trap for each cylinder. This is said to be because if a single steam trap is provided at the end of the common condensate pipe, the first cylinder which comes in contact with the wet yarn will inevitably produce large amount of condensate and from the others much steam will also come out with a small amount of condensate. This excess of steam is likely to impede the condensate flow through the steam trap. In the case of an individual steam trap for each of the cylinders, whether in a two-cylinder or a multi-cylinder drying system, the condensate is discharged successfully without any hindrance, irrespective of the pressure of the steam and the volume of the condensate.

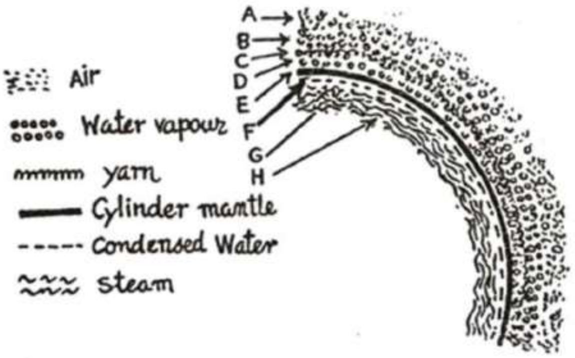
Thus it should be clear that the successful running of the drying cylinder system depends on the quality of the steam, condensate removal and removal of air. There is accumulation of condensate in the steam pipes too at the lower levels. Provision must be made to remove this condensate also before the steam flow starts.

Mechanism of cylinder drying: When the wet, cool sized yarn is passed over the steam- heated cylinder, the saturated steam in contact with the cylinder surface inside the cylinder cools and condenses, forming water which has less heat content and therefore slows down further heating of the cylinder surface. If there is air contaminating the steam it impedes the transmission of heat because of its low heat conductivity. It is said that if the steam contains

1% air, it reduces heat transmission by about 11%.

Outside the cylinder surface, as the hot surface heats up the lower surface of the yarn next to it, water evaporates and there is created a thin layer of water vapour between the cylinder surface and the yarn. Similarly, when the moisture on the other side of the yarn evaporates, the vapour formed forms a thin layer on it. Both these vapour layers resist further evaporation of the moisture in the yarn. These layers are illustrated in the figure hereunder:

Fig. 9: Possible boundary layers formed during drying of yarn on cylinders



A : Air mixed with vapour. B : Vapour layer. C : Yarn. D : Vapour cushion. E : Cylinder mantle. F : Condensate. G : Air pockets. H : Steam.

It should be now clear why it is important to remove condensed water through the steam trap and air through air vent. Air removal is now-a-days done automatically and continuously while the machine is running.

The outer vapour layer is removed by a vigorous air blast around the surface of the cylinders. The thickness of the vapour layer between the warp and the cylinder surface can be eliminated or at least minimized by increasing the tension on the yarn. The following figures for moisture evaporation rate illustrate this point (3):

Tension in warp sheet (N)	330	410	589
Kg of water evaporated/min.	1.9	2.3	3.0

Since there is no other apparent reason for the increased rate of drying with increase in tension, it can be assumed that the intervening vapour layer is getting minimized with increase in tension thus facilitating the heat transfer.

HOT AIR DRYING

General considerations: It may be surprising but true that hot air drying of warps was introduced in the early forties of this century to overcome the disadvantages of two-cylinder drying system before the multi-cylinder ranges were adopted. Here hot air is circulated in a chamber through which the warp sheet is passed to evaporate out the moisture from the sized, wet yarn. Here the air carries the heat needed for the evaporation and also carries away the vapours formed.

In a way heat transmission can be said to be better in hot air drying because the hot air comes in contact with the yarn on all sides, unlike hot cylinder surfaces. Another plus point is that in air drying the temperature and moisture content of the drying air can be adjusted to suit the properties of the yarn, by not only regulating the extent of heating the air but also admixing the fresh air with the moisture-laden exhausted air and the risk of over drying can be avoided. Again since the exhausted air is hot enough some heat reutilization is also achieved. Air-dried yarns are also less rigid, therefore it was said that less softener would be needed in the size mixture, than when cylinder drying is used.

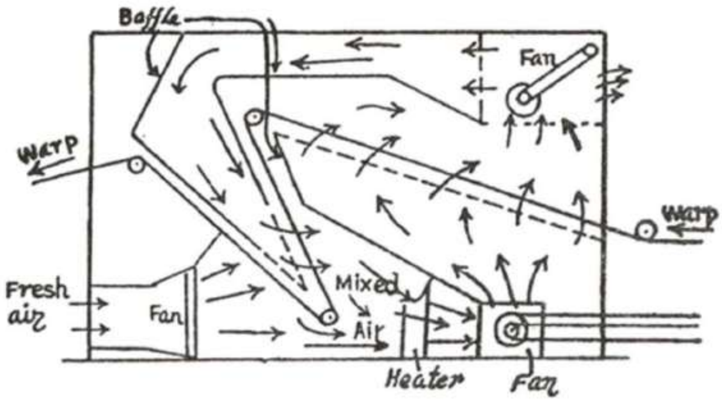
If the yarn is initially suddenly heated with dry, hot air, a crust of rigid dry film of size would form on the outside which would prevent the passing out of vapours of moisture from the inside of the yarn. The vapours would therefore accumulate in the inside of the yarn only and subsequently would burst open the crust surrounding it. This would crack the film and also the yarn with it. Therefore damp, hot air chambers were designed.

Another peculiarity and an advantage of the hot air drying is that since the drying is done in closed, well insulated chambers, the atmosphere surrounding the chamber is more comfortable, being less hot and less humid than in the case of cylinder drying. However, the main drawback of the hot air drying system is that it requires more steam (assuming that steam is used for heating the air) to dry the yarn (2.2 kg of steam per kg. of water evaporated) than the cylinder drying system (1.6 kg).

Hot air chambers also take much more space than the cylinders even in the multi- cylinder range.

Another serious problem with hot air drying is the curling and rolling of the yarn inside the dryer. This is caused by the air currents and the long lengths of the free hanging yarns and uncontrolled yarn tension. Removal of lappers inside the chamber is a difficult task for obvious reasons. For all these reasons the multi-cylinder drying system has relegated the hot air chambers to the background. In India some mills have even converted their machines from hot air drying to multi-cylinder drying.

Fig. 10: Hot air dryer



RADIATION DRYING

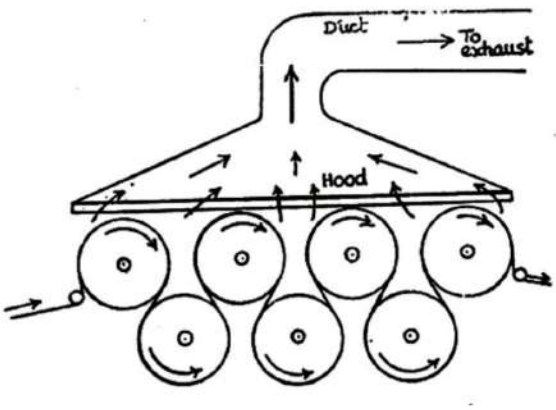
Infra red rays have been used for the last two decades for the drying of sized yarns, but being a very costly process, only as complementary to the main drying process. As a means of transmitting heat energy radiation has certain attractive features. It is applied by direct, linear propagation without any heat carrying medium like air or metal surface. It tends itself to instantaneous control. The equipment size is small and process time cycle may be short. The rate of drying depends on the intensity of radiation, surface absorptivity, temperature, humidity and velocity of air.

The strategy used in the case of irradiation method should be to irradiate for a short time followed by a period to allow evaporation of moisture and diffusion of inner moisture to the surface. In this way the material is only slightly warmed up and the usual crust formation does not impede the migration of moisture from inner to the outer surface. To achieve this the warp is made to travel alternately through irradiated and non-irradiated zones of the drying chamber. The electrically activated radiation banks are placed above the sized yarn so that the infra red radiation dries the damp yarn travelling underneath. For quick removal of vapour, air circulation is necessary. Fans are therefore provided in the chamber. Radiation drying is not in general use because of high initial investment and high power consumption. But it is sometimes used to give quick drying as is required for pre-drying of textured filament yarns.

MULTICYLINDER DRYER

Number of cylinders used 5 to 13, each cylinder smaller as compare to conventional, it is giving higher pressure and runs for higher speed, positively driven no tension on yarn, size on wet warp after sizing is bound to stick to the cylinder , affecting heat transfer and smoothness of cylinder, yarn may get damaged or lappers may formed. Therefore to avoid this first two cylinders are coated with Teflon (Polytetrafluorethylene). Smaller cylinder is having greater accuracy in surface and proper drying takes place. This system preserves elongation at break.

Fig. 11: Multicylinder dryer with hood



Moisture its importance and control: Over dried warp is likely to be rigid, less strong and brittle. It takes long time to absorb moisture from the atmosphere. Physical properties of yarn get affected.

Un dried yarn is one which has moisture more than its natural regain. It is also potential risk. It gives rise to mildew formation. It results in sticking of ends with neighboring one. To control the moisture content, one has to vary speed of sizing machine by which drying efficiency changes. Conventional method is to check physical by hand moisture of warp sheet.

In modern checking is done by capacitance method.

Stretch its importance and control:

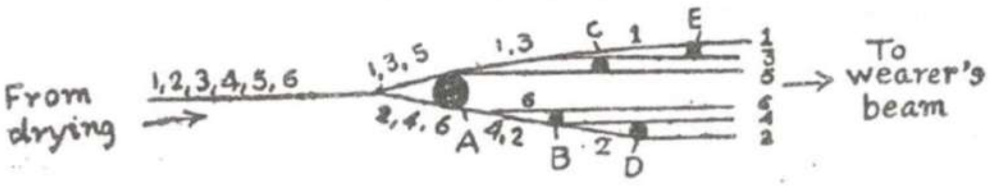
Weavability of the yarns mainly depends on the mechanical properties of the yarn like strength, elongation at break etc. Uniform strength and retention of the flexibility of the yarns are the two most important objectives to be attained during warping and sizing. Tensile forces acting on the yarn axis during weaving create tension which first causes stretch and results in rupture/breakage, if tension developed is high. Preservation of natural flexibility of the yarn is therefore essential. There is requirement of certain amount of tension during sizing to keep ends straight, uniform spacing and uniform tension to carry sizing effectively also unwind the weaver beam properly. Stretch gives increase in length of the yarn, greater stretch more is loss of elongation at break affecting breakage rate at weaving. To control stretch speeds of various elements of size box, drag roller and winding is to be controlled.

HEAD-STOCK

Following are the elements of the headstock of sizing.

Dry splitting, Comb, Drag roller, Winding, Beam pressing & measuring and marking motion

Dry splitting: After drying the warp sheet passes round guide rollers and emerges in a form in which many of the individual threads are stuck together due to the thin size film forming bridges between neighboring warp ends. This is very undesirable because this would hamper clear shed formation during weaving. Therefore it is very necessary to separate them completely before the sheet is wound on the weaver's beam. The separation would also facilitate the tracing of broken ends and missing ends and straightening of the warp sheet without cross or migrating ends, as they are on the warper's beam.

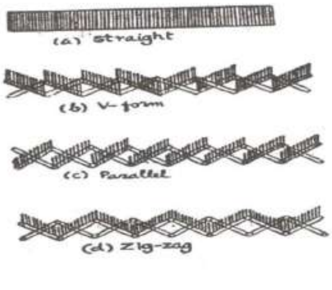


A. B. C, D, E : Lease rods. 1, 2, 3, 4, 5, 6 : Warp sheets.

Fig.1: Dry splitting

The purpose and the mode of use of the comb: As said above, the main purpose of the comb or wraith is to bring the sheet of ends together to the width of the weaver's beam between the flanges and to space the ends evenly over the full width available for each beam. This comb is similar to the one seen on a warping machine. Several types of slasher combs are used, but essentially each consists of a large number of this straight steel needle, set in a base. The base may be regulated so as to change the distance between the needles, the adjustment generally being made by means of a hand wheel.

Fig. 2 Comb



Drag roller: Also known as the draw roller or the delivery roller, the drag roller plays an important role in the sizing machine. It controls the tension on the warp ends and therefore determines the stretch on them, which in its turn determine the residual elongation at break. The draw roller constitutes an isolated nip for the warp sheet in conjunction with two heavy chrome-plated nip rollers, which are driven by means of frictional contact with the former. The first nip roller, i..e the one towards the rear end, is also a measuring roller on most machines. The drag roller is positively driven from the main motor and from this roller motions are transmitted to all other moving parts, particularly in the case of the older two-cylinder sizing machine. The production of the sizing machine is calculated on the basis of the draw roller speed.

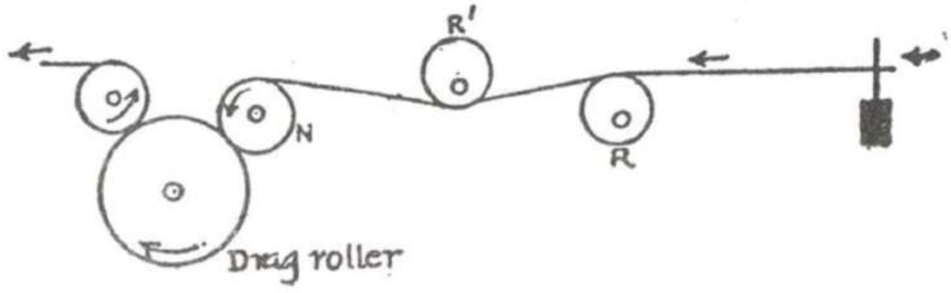
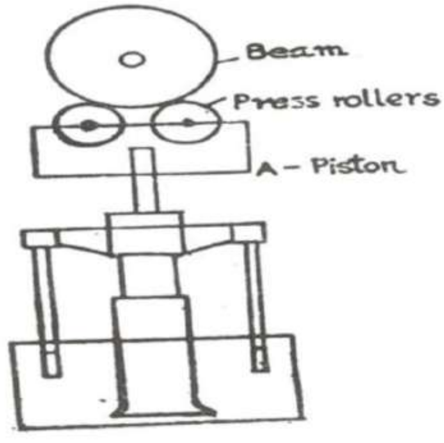


Fig 3: Drag roller

Hydraulic beam pressing: An example of hydraulic beam pressing motion as used on Zell sizing machine is illustrated in the figure below.

The pressure is controlled by means of an oil pressed piston A, which presses a pair of rollers vertically below against the beam. The pressure rollers are running on conical bowls as in the mechanical pressing motion. The outer ends of these rollers are made of laminated plastic to prevent damage to the flanges. The oil pressure needed comes from a hydraulic pump which is driven by a flanged motor and stops automatically once the machine si stopped. The pressure can be adjusted over a wide range. On this machine there is a provision to lift the beam, when it is full, bay raising the pressure, so that beam holding shafts are relieved of the load and may be doffed easily.

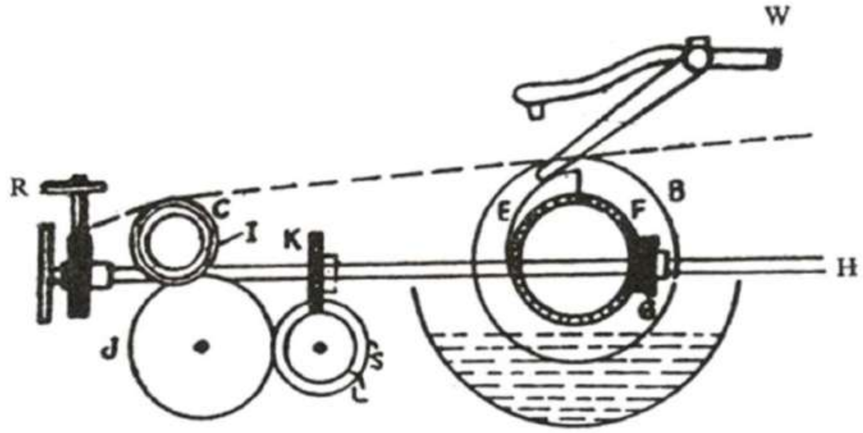
Fig. 4: Beam pressing motion



Measuring & marking motion: Majority of fabrics are sold in the market in pieces, known as cuts, of length depending upon the type of fabric and the choice of the customer. Similarly on certain fabrics like dhotis, towels etc. cross borders are to be inserted manually on the loom during weaving after a certain length. There is, therefore, a need of a method by which a weaver can know exactly at what place a fabric is to be cut during doffing or where exactly a heading is to be inserted. Provision is, therefore, made on sizing machines whereby the lengths of warp per piece are measured and marked in an easily recognizable manner, while at the same time, the total number of pieces wound on the weaver's beam is also recorded. This also helps in maintaining the production of sizing machines and also to calculate the beam count i.e. the apparent linear density of the sized yarn on the beam.

Usually one mark is inserted at the end of each piece length, but in certain fabrics like dhotis and sarees, which are sold in pairs, an extra cut mark of the same colour or a different colour is put on the intermediate cut marks. Various systems are available in which the only manual setting necessary is at the start of a new beam.

Fig. 5 Measuring and marking motion



B : Color wheel. C : Nip roller. E : Stepped cam. F & G : Bevel wheels. I : Measuring roller wheel. J : Carrier wheel. K : Worm wheel. L : Worm. S : Stud wheel. W : Weight. H : Shaft. R : Dial.

Calculations

Example 1: A machine is sizing a warp with 2500 ends, the count of the warp yarn being 20 tex. The percentage of size put on the warp is 15 % on the weight of the latter. If the calculated production of the sizing machine is 120 mt/min and its efficiency is 75 %. Calculate the following.

1) Calculate production per day of 8 hours in meters.

2) Actual length of yarn sized.

3) Actual weight of unsized warp.

4) Actual weight of the sized warp.

Given: Number of ends 2500, 20 tex yarn, size put 20%, speed 120 mt/min, efficiency 75%

1) Actual production (meters/8 hours)

=120*60*8*0.75 =43200 mtrs warp sheet.

2) Actual length of yarn sized

=43200*2500= 108000000 mtrs/8 hours.

3) Actual weight of unsized warp Tex=wt in gms/ length in km

Wt in kg= length in mtr * tex/ 1000*100

=108000000*20/1000*1000=2160 kg/8 hours.

4) Weight of sized warp in kg

=2160+ 2160*15/100

=2160(1+15/100) = 2484 kg.

Example 2: Actual production of modern slasher/sizing is 42000 mtr/day of 8 hrs. If slasher runs with a speed of 125 mtr / minute, calculate the efficiency.

Actual production/ hr in mtrs =42000/8 =5250 mtr/hr

Calculate production/ hr in mtrs=125*6= 7500 mtr/hr

Efficiency %= Actual/Calculated * 100

= 5250/7500 = 70%

SIZING

Important Process of Weaving Preparation

Textile Sizing:

Textile Sizing is one of the most important operations in weaving preparation. After **winding and warping** process yarn is sized during beam preparation. Sizing is the process of applying a protective adhesive coating on the surface of the yarn, so that the warp yarn can withstand against the weaving forces. Another way, sizing is an application of size and lubricants to the warp yarns. Sizing is called Sizing is used to protect the warp from the rigours of weaving. The size is a film-forming polymer such as starch and is applied from a solution. Sizing gives a protective coating on yarn surface to tolerate the friction on **loom machine**. As a result yarn breakage and yarn rupture will reduce during weaving process. So sizing is called heart of weaving.

Objectives of sizing:

To improve weave ability of warp yarn by making it smoother, stronger, and more resistant to abrasion against various machine parts.

An optimal size recipe, which guarantees a process safe work-ability and a good weaving behaviour.

Sizing ingredients and its function:

Ingredients	Name	Function
Adhesive	Starch, PVA, CMC, CMS, PES	To make warp yarn more strong, elastic.
Lubricating agent	Tallow, Japan wax, Linseed oil, Coconut oil, Palm oil	To increase smoothness, slippery/flexibility and reduce friction.
Antiseptic	Salicylic acid, Zinc chloride, Phenol	To save the yarn from various micro organism like mildew.
Deliquescent	Glycerin, Ca & Mg chloride	To absorb moisture from air for preventing excessive drying of yarn.
Tinting agent	Blue	To reduce yellowness and to increase brightness.
Anti foaming agent	Benzene, pyridine	To remove foam from sizing mixture.
Wetting agents	China clay, Sodium phosphate	To increase size exhaust with uniform distribution.

Typical sizing recipe:

Water = 85% , Total sizing ingredients = 15%

Sizing ingredients

For Light Sizing	For Medium Sizing	For Heavy Sizing
Flour – 100 lbs **Wax – 5 lbs** **Tallow – 4 lbs**	Flour – 100 lbs Clay – 34 lbs Tallow – 15 lbs MgCl2 – 1 gallon ZnCl2 – ½ gallon	Flour – 100 lbs Clay – 134 lbs Tallow – 14 lbs MgCl2 – 5 gallon ZnCl2 – 2 gallon

Modern sizing process:

Textile Sizing is a very important process to get a good strength, flexible and smooth yarn, which is suitable for modern **loom** and in particular nowadays, as faster and faster machine is used and quality is required at the highest level.

A saying from the old said "a well prepared and sized warp is already half fabric". A good sizing machine is equipped with every device able to ensure good control levels on tension, elongation, temperature, squeezing etc but they must also be able to choose the necessary parameters according to the items to be processed, their physical-chemical composition and also to choose those that are most suitable for that processing and for the following **operations of desizing** and dressing.

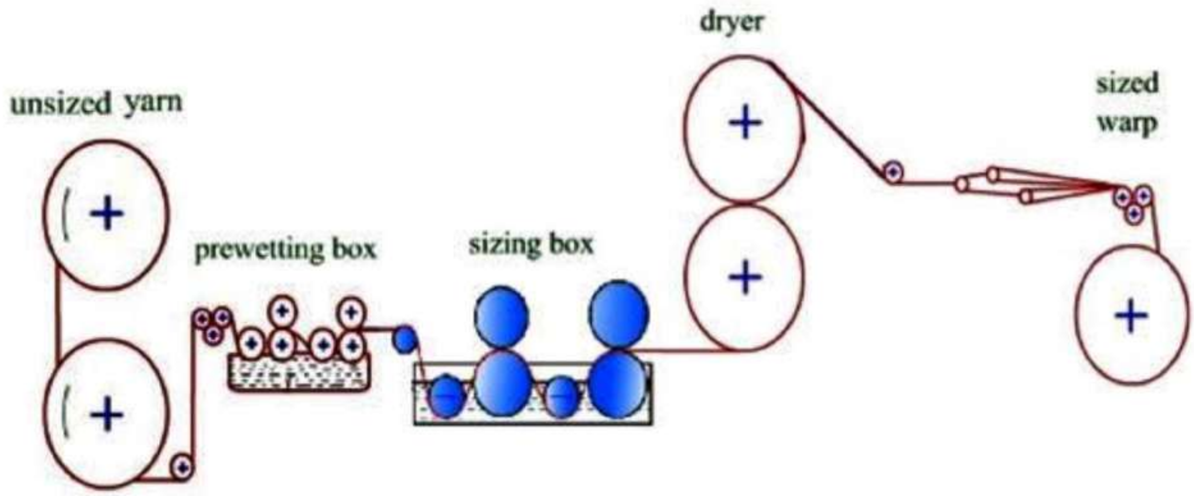


Fig: Modern sizing process

The warps were then moved to chambers with some return cylinders where they were dried with hot air (the most modern machines were equipped with copper drying cylinders heated by steam), then they were crabbed on beams going to the loom.

Effect of sizing on yarn properties:

Name of the properties	Property change after sizing
Yarn strength	Increase yarn strength
Elongation	Reduce elongation
Flexibility	Reduce flexibility
Frictional properties	Reduce frictional properties
Smoothness	Increase smoothness
Absorbency	Reduce absorbency
Weight of yarn	Increase weight of yarn
Hairiness	Reduce hairiness

Image courtesy: http://nptel.ac.in,

Process Flow Chart of Sizing

Sizing is the process of applying protective adhesive coating on the yarn surface. So that the warp yarn can withstand against the weaving forces. Another way, sizing is an application of size and lubricants to the warp yarns. This is the most important segment of weaving preparatory process. Because sizing has direct influence on the weaving efficiency. It is used to protect the warp from the rigours of weaving.

Sizing: The Heart of Weaving

Fig: Sizing of warp yarn

The size is a film-forming polymer such as starch and is applied from a solution. Better the quality of sizing higher the weaving efficiency & vice versa. In fact without sizing, in most of the cases it is almost impossible to run the weaving process. Moreover in case of towel manufacturing rotor (open end) & low twisted yarns are mostly used. There fore sizing should be done very precisely for **towel manufacturing.**

Flow Chart For Sizing of Warp Yarn:

Size Cooking
↓
Creeling
↓
Yarn Feeding
↓
Sizing (in show box)
↓
Drying
↓
Leasing
↓
Denting
↓
Empty Beam Feeding & M/C Running
↓
Ends Cutting
↓
Doffing

Requirements of Sizing | Factors Considered Before the Selection of Size Ingredients | Name of Some Natural & Synthetic Sizing Agents

Requirements of Sizing

In order to ensure good technological properties of sized warps, the following requirements should be met in size:

1. Sized warp must be sufficiently strong, smooth & elastic.
2. The **sizing process** must ensure the application of the required amount of size on the yarn or the required size regain.
3. The tension of the warp yarns at sizing must be regular & constant during all the time of warp unwinding from the warping beams.
4. Yarn stretch & loss in elongation should be within admitted limits.
5. The package, i.e the weavers beam produced must have a cylindrical shape, the necessary winding density & the yarn length.
6. The sizing process must be efficient, economical & must ensure the production of high quality sized warp.

Factors Considered Before the Selection of Size Ingredients

Before selecting the size ingredients the following factors must be considered:

1. It must be Non-degrading to the yarn.
2. It must be compatibility with equipment.
3. It must be easily removal, if necessary.
4. Provides good fabric characteristics if not removed.
5. Least amount of dusting-off during **weaving.**
6. Cost of the **size ingredients** must be less.
7. It should not modify the tone of coloured warps.
8. No skimming tendency.
9. Easily prepared.
10. Lack of odour.
11. No beam blocking.
12. Compatible with other ingredients.
13. Neutral pH. **14**. Insensitive to high heat. **15.** Rapid drying.

Name of Some Natural & Synthetic Sizing Agents

Natural sizing agents:

Natural sizing agents are based on natural substances & their derivatives.

- **Starch & starch derivatives:** native starch, degradation starch & chemical modified starch products.
- **Cellulosic derivatives:** carboxymethylcellulose (CMC), methylcellulose & oxyethylcellulose.
- **Protein-based starch:** glue, gelatin, albumen

Synthetic sizing agents:

- Polyacrylates
- Modified polyester
- Polyvinyl alcohols (PVA)
- Styrol/maleic acid copolymers

SIZING

Objects of Sizing / Types of sizing / Properties of Size Ingredients / Disadvantages of Sizing

Sizing:

Size is a gelatinous film forming substance in solution or dispersion form, applied normally to warp yarns. It can sometimes be applied to weft yarns. **Sizing** is the process of applying the size material on yarn. A generic term for compounds that are applied to warp yarn to bind the fibre together and stiffen the yarn to provide abrasion resistance during weaving. Starch, gelatin, oil, wax, and manufactured polymers such as polyvinyl alcohol, polystyrene, polyacrylic acid, and polyacetates are employed. The process of applying sizing compounds. The process of weighing sample lengths of yarn to determine the count. Now **automation is used in sizing operation.**

Fig: Yarn sizing

Objects of Sizing:

1. To protect the yarn from abrasion
2. To improve the breaking strength of the yarn
3. To increase smoothness of yarn
4. To increase yarn elasticity
5. To decrease hairiness
6. To decrease the generation of static electricity

Types of Sizing:

1. **Pure sizing:** when the size pick up % is about 3 – 10 % it is called pure sizing.
2. **Light sizing:** when the size pick up % is about 11 -16% it is called light sizing.
3. **Medium sizing:** when the size pick up % is about 17 – 40 % it is called medium sizing.
4. **Heavy sizing:** when the size pick up % is above 40 % then it is called heavy sizing.

Disadvantages of Sizing:

- Cost of land and machine is high
- Requires lot of labours
- Requires utility like gas, electricity etc and their cost is high

- Cost of ingredients
- The process is long and it takes time
- There is a risk of degradation of yarn
- The yarn diameter is increased
- Requires robust loom
- It increases yarn stiffness
- The fabric needs to be desized before use
- Need knowledge and information about the size ingredients
- There is a risk of pollution
- Sizing changes the shade of coloured yarn
- 100% size material cannot be removed
- Size material presence leads to uneven dying

Properties of Size Ingredients / Size Ingredients and Their Functions
Size and Sizing:
Size is a coating with a gelatinous or other substance to add strength or stiffness or to reduce absorbency. **Sizing** is the process of applying the size material on yarn.

Size Ingredients

Properties of Size Ingredients

- Ease of preparation
- Uniform viscosity
- Absence of prolonged congealing and kenning at application temperature
- pH control
- Absence of foaming properties
- Absence of prolonged tackiness
- Compatibility with other components of the size
- Stability towards decomposition
- Ease of desizing

Size Ingredients and their functions
Adhesive: Example: maize, wheat, corn, potato, sago, PVC, PVA, CMC
Function: It increases yarn strength and abrasion resistance
Lubricant: Example: mineral oil, linseed oil, tallow, Japan was, cotton oil
Function: Increases yarn smoothness and elasticity
Antiseptic agent: Example: $ZnCl2$, Phenol, carboxylic acid, synthetic acid
Function: It helps to store the yarn without being damaged and it also gives protection from bacteria or fungus.

Deliquescent agent: Example: MgCl2, glycerine
Function: It prevents brittleness of size and helps to keep the standard moisture regain by not allowing water to enter or exit the fibre.
Weighting agent: Example: china clay, French chalk
Function: It increases the weight of the yarn
Wetting agent: Example: MgCl2
Function: Helps to wet the yarn instantaneously
Tinting agent: Example: Blue
Function: It helps o increase the brightness of yarn
Antifoaming agent: Example: Benzene, Pyridine
Function: It prevents the formation of foam

Properties of a Good Sizing Material / Sizing Chemicals and Their Importance

Sizing is a complementary operation which is carried out on warps formed by spun yarns with insufficient tenacity or by continuous filament yarns with zero twist. In general, when sizing is necessary, the yarn is beam warped, therefore all beams corresponding to the beams are fed, as soon as **warping** is completed, to the sizing machine where they are assembled. Sizing consists of impregnating the yarn with particular substances which form on the yarn surface a film with the aim of improving yarn smoothness and tenacity during the subsequent weaving stage. Thanks to its improved tenacity and elasticity, the yarn can stand without problems the tensions and the rubbing caused by **weaving.**

Sizing chemicals for textile

Sizing Chemicals & Their Importance:
Film forming materials:

Starch is the oldest film forming material used in sizing of **cellulosic fibres**. It is also the most widely used in the world due to its low cost and ease of availability. In Pakistan, mostly maize starch is used, whereas, potato starch is more popular in Europe.

PVA is the second largest film former used in sizing. It is mostly used on synthetic yarns such as polyester and poly/cotton blends. PVA coating is strong, abrasion resistant and can easily be desized in hot water. Its strength is greater than starch and also more flexible than most standard starches. PVA is less prone to setup in the size box compared to starches. PVA can form foam in the size box which is controlled with a deformer. PVA may be too strong for some sizing applications. In this case, some weaker film forming polymers such as starch are added to modify the mixture, which also reduces the cost, since PVA is more expensive than starch.

The most widely used size materials are starch and PVA. However, other size materials have been developed and used for specific purposes. Carboxymethyl cellulose (CMC) is produced from wood pulp and cotton lint and has good adhesion to cotton.

Polyacrylic acid based sizes (polyacrylates and polyacrylamides) are used to size hydrophobic fibers and their blends such as nylon, acrylics, polyester, etc because of their good bonding.

Properties of a Good Sizing Material:

1. Environmentally safe. **2.** Good film former. **3.** Reasonable use economics.

4. Penetration of yarn bundle. **5.** Elasticity. **6.** Good film flexibility. **7.** Good specific adhesion. **8.** Good frictional properties. **9.** Transparency. **10.** Bacterial resistance. **11.** Reasonable strength. **12.** Controllable viscosity. **13.** Water soluble or water dispersible. **14.** Good hygroscopicity characteristics.

15. Uniformity. **16.** Clean split at bust rods. **17.** Improves weaving efficiencies.

18. No effect on drying. **19.** Reasonable extensibility. **20.** Recoverable and reusable, **21.** Low static propensity. **22.** No skimming tendency. **23.** Easily removed. **24.** Easily prepared. **25.** Lack of odour. **26.** No beam blocking.

27. Compatible with other ingredients. **28.** Good **abrasion resistance.**

29. Neutral pH. **30.** High fold endurance. **31.** Insensitive to high heat. 32. Low BOD. **33.** No build up on dry cans. **34.** Reduced shedding. **35.** Rapid drying.

36. No re-deposition of size, **37.** Insensitive to changes in relative humidity.

Techniques of Warp Yarn Sizing

Introduction of Sizing:

Sizing is the process of applying protective adhesive coating on the yarn surface. This is the most important segment of weaving preparatory process. The old adage that sizing is the heart of weaving still holds good today. This statement is all the more important in today's environment when loom speeds have increased tenfold from those used in shuttle looms. The weaving process depends upon a complexity of factors which include the material characteristics, the **sizing ingredients**, the sizing operation, and the yarn parameters.

Techniques of Warp Yarn Sizing:

Sizing machine can be classified according to the method of drying as follows:

Conventional Aqueous Sizing:

Double Cylinder Sizing: This consists of only two drying cylinder or two sow box arrangement which leads to more energy consumption.

Multi Cylinder Sizing: This consists of more than one sow box and several groups of drying cylinders. This is suitable for densely spaced yarns. Warp yarns are dried separately by separate drying arrangement. This is also suitable for dyeing and sizing together resulting in saving of wastes.

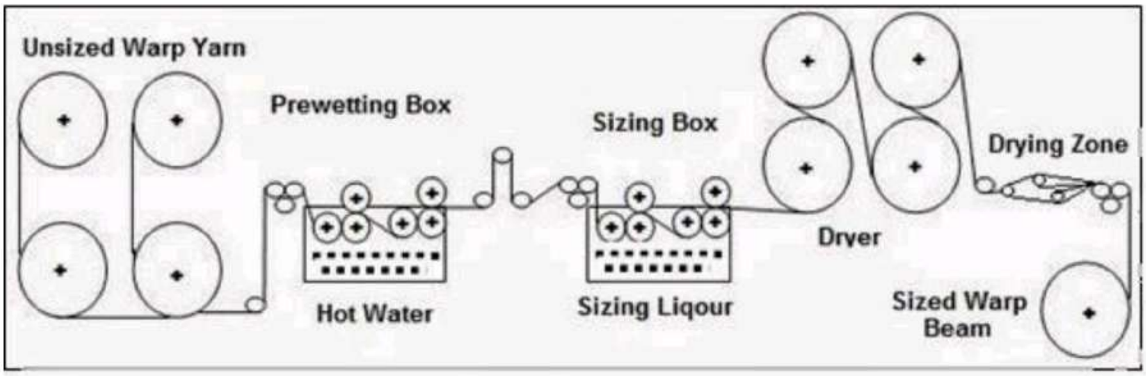


Fig - 1: Conventional Sizing Machine

Non-Conventional Sizing:

Dry Sizing: This is carried out by spraying dry size powder on the warp sheet and the size powder is thought to be fixed in the warp yarn due to electrostatic force of attraction. This process ensures the reduction of cost of raw material and reduction of pollution.

Solvent Sizing: Sizing is accomplished by using a non-aqueous organic solvent as the treatment media instead of water. Chlorinated hydrogen is mostly used as solvent and 1/10 th of energy is required to evaporate solvent.

Hot melt Sizing: Suitable for high speed weaving e.g. shuttle fewer looms where there is risk of yarn hairiness. Sizing is done in the warping machine by having a special arrangement called size applicator. The size is kept in cake form where the warp is kept pressed.

Foam Sizing: Here the solvent is replaced by water. Foam of size is used which must possess liquor, a gas, mechanical energy and thermal energy. Thus 70% energy is saved and production is increased.

Blend Sizing: Manmade fibers are more sensitive to heat and tension. However successful size will result better performance than 100% cotton. In order to perform well blend sizing needs both machinery as well as operational requirements.

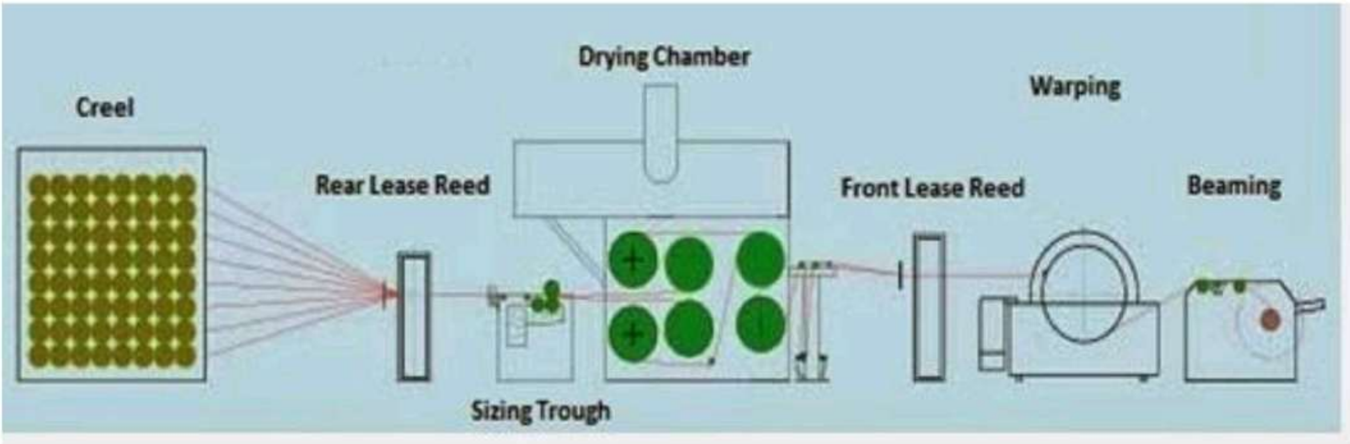


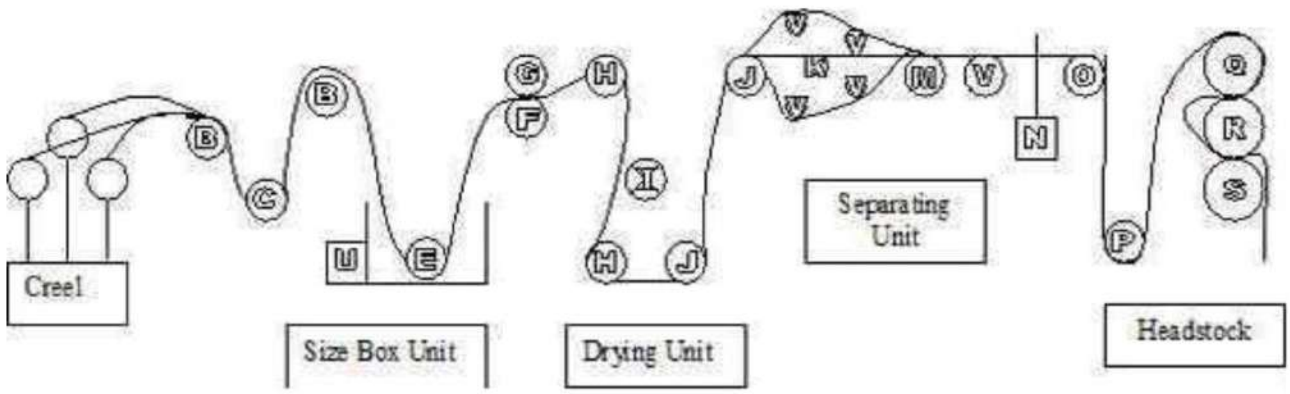
Fig - 2: Non-Conventional Sizing Machine

Slasher Sizing Machine / Main Parts of Slasher Sizing Machine

Slasher Sizing Machine: This is the most used sizing process. About all types of yarns can be sized by slazer **sizing process.** In this process the warp is passed through a size liquor bath then through a separating unit and cooling unit.

The Slasher Sizing Machine consists of the following seven units:

1. Back beam unit, **2.** Sizing unit, **3.** Drying unit, **4.** Cooling unit, **5.** Dividing unit/Separating unit. **6.** Measuring and marking unit **7.** Beaming unit



Slasher Sizing Machine

Main Parts of Slasher Sizing Machine:

B = guide bar, **C** = Tension roller, **E** = Emersion roller, **F** = sizing roller, **G** = squeeze Roller, **H** = Drying cylinder, **I** = cooling fan, **J** = guide bar, **K, L** = lease rods, **M** = colouring bowl, **N** = wraith, **O** = measuring roller, **P** = tension roller, **Q** = Nipper roller, **R** = warp beam, **S** = Pressure roller, **U** = reserve box, **V** = marking roller

Shirley Automatic Size Box: To maintain constant concentration the ordinary size box can't do it. That's why the **Shirley automatic size box** has been introduced with us.

Purpose of Shirley Automatic size box: In the size box **Shirley automatic size box** maintain constant level of size solution and also maintain constant concentration per volume.

Construction of Shirley Automatic size box: To immerse warp yarn into liquor and squeezing roller to control size takes up% the Shirley automatic size box consists of an immersion roller. To control size liquor there are also a water pipe and also to control concentration there are a size solution pipe.

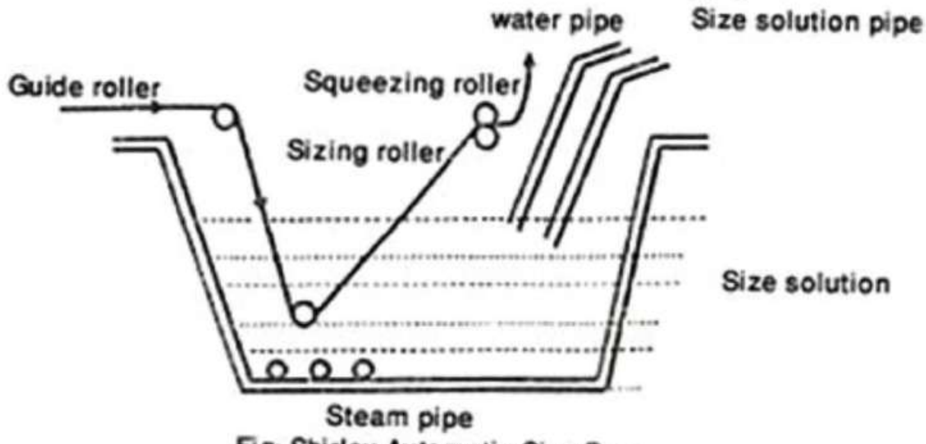


Fig: Shirley Automatic Size Box

Mechanism of Sizing: The mechanism of sizing is described below,
1. Through water pipe and size solution pipe, required amount of water and size liquor solution are added respectively.
2. To maintain the concentration when the concentration is more then just add water.
3. To maintain the concentration when the concentrations is less then just add size solution.
4. Via guide roller the yarn sheet is feed to the immersion roller and come out through the sizing roller and squeezing roller.
5. By the pressure of squeezing roller the yarn take up% is controlled.

Sizing Machine: The sizing machine can be divided into four main zones as shown in **Figure 1.** The zones are

Creel zone, Size box zone, Drying zone.

Headstock zone

The creel zone contains large number of warper's beam which can be arranged in different fashion depending on the design of the creel. Individual warp sheet emerging from warper's beam are merged together to form the final warp sheet which passes through the size box. During the passage through the size box, the warp sheet picks up size paste and holds a part of the paste after squeezing. Then the wet warp sheet passes through the drying zone and wound on the weavers beam.

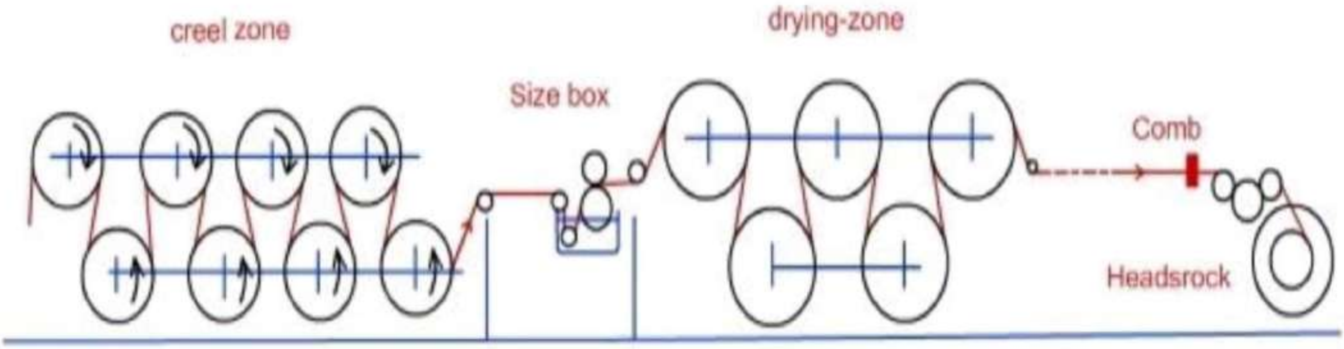


Figure 1: Zones of a sizing machine

Creel Zone

The creel zone of a sizing machine can have following types of design:

Over and under creel (**Figure 2 and 3**)

Equi-tension creel (**Figure 4**)

Vertical creel (**Figure 5**)

Inclined creel

Figure 2: Over and under creel

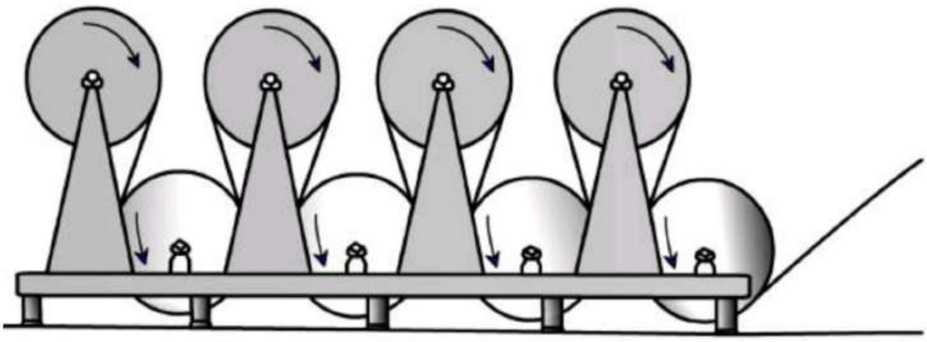
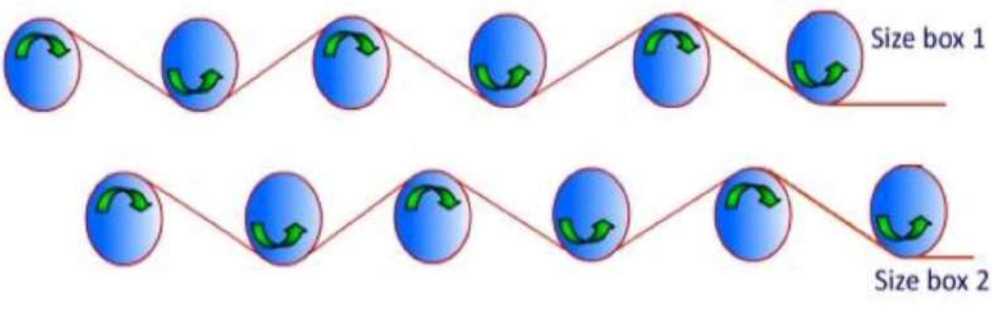


Figure 3: Over and under creel for two size boxes



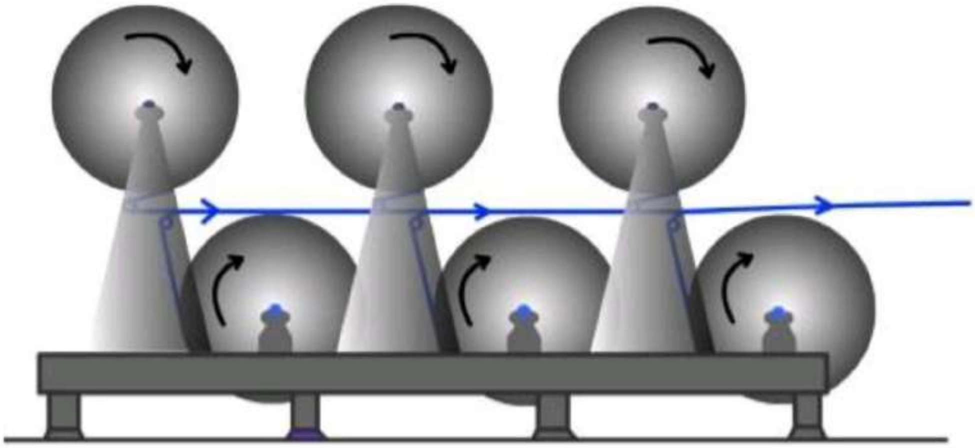


Figure 4: Equi-tension creel

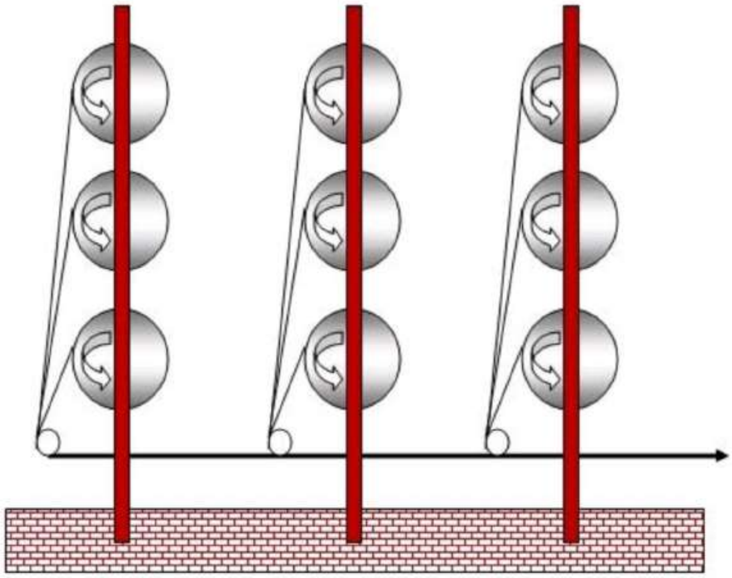


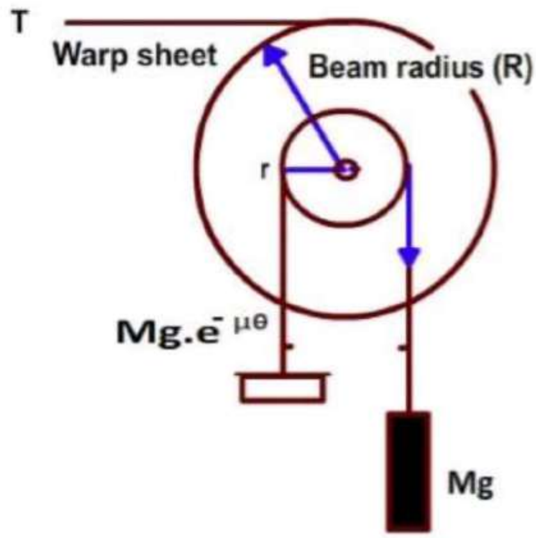
Figure 5: Vertical creel

In case of over and under creel (**Figure 2**), the warper's beams are arranged in two rows, having different heights, in an alternate manner. The warp sheet coming out from the rearmost beam passes under the second beam and over the third beam and so on. The individual warp sheets coming out from beams are merged together to form the final warp sheet. The warp sheet coming from the rearmost beam definitely experiences more tension and stretch than the warp sheet coming from the beam located nearest to the size box. The problem is partially mitigated when two creels are used one for each of the two size boxes as shown in **Figure 3.** If there are twelve beams then six beams are mounted on creel one and remaining six beams are mounted on creel two reducing the over and under movement of the warp sheet.

In case of equi-tension creel (**Figure 4**) the pattern of movement of warp sheet is completely different than that of over and under creel. In equi-tension creel, warp sheet does not move over and under any beam. One small guide rollers provided with every beam which deflects the warp sheet towards the proper

path. Here, the warp sheets are subjected to equal tension and stretch irrespective of the position of the warper's beam.
Another improvement in this direction has been implemented in the inclined creel. Here the height of the beam changes based on its position so that a constant inclination can be maintained in the path of the warp sheet.
All the designs, which have been discussed till now, requires considerable amount of floor space. This can be solved if vertical creels are used. In vertical creels, the beams are stacked vertically as shown in **Figure 5.**
It is very important to maintain adequate and uniform tension in the warp sheet during the entire sizing process. However, as the sizing process continues, the radius of the warper's beam reduces. Therefore, it is required to adjust the warp tension by adjusting either the dead weight suspended with the rope passing over the ruffles of the warper's beam (**Figure 6**) or by controlling the pneumatic pressure applied on the bearing region of warper's beam.

Figure 6: Warp tension control by dead weight system



From the balance of moment the following equation can be formulated.

$$T.R = 2T_2 \times r\left(1 - e^{-\mu\theta}\right)$$

$$or\ T.R = 2 \times Mg \times r\left(1 - e^{-\mu\theta}\right)$$

where **T** is the warp tension, **R** is the radius of warper's beam, **T2** is the tension in the tight side of the rope, **r** is the ruffle radius, **μ** is the coefficient of friction between the rope and the ruffle, **θ** is the angle of wrap (in radian) of the rope over the ruffle, **M** is the mass of suspended element and **g** is acceleration due to gravity.
In sizing process, the allowable stretch is 1-1.5% for cotton and polyester yarns. The stretch can be higher (3-5%) for viscose and acrylic yarns.

Size Box Zone

This is the zone where the warp sheet is immersed into the size paste and then squeezed under high pressure so that uniform coating of size film forms over the yarn surface. The process of immersion is called 'dip' and the process of squeezing by means of a pair of squeezing rollers is called 'nip'. The size box can have different number combinations of 'dip' and 'nip' to meet the requirement of various yarns. For filament yarns 'one dip and one nip' is preferred (**Figure 7**) where as for spun yarns made from staple fibres 'two dip and two nip' is advisable (**Figure 8**).

Two dip and two nip process allows grater time for immersion of yarns within the size paste and thus this process forms more uniform coating of size film. When the yarns are squeezed by the first pair of squeeze rollers, yarns become compressed. When the yarns come out of the nip of squeezing rollers, they try to regain their original arrangement and therefore an inward pressure is created which causes more penetration of size materials within the yarn structure.

Figure 7: One dip one nip size box

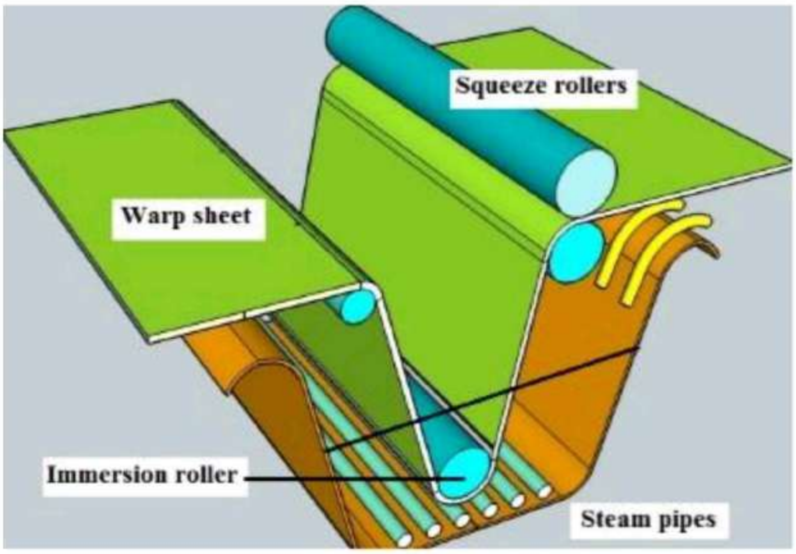
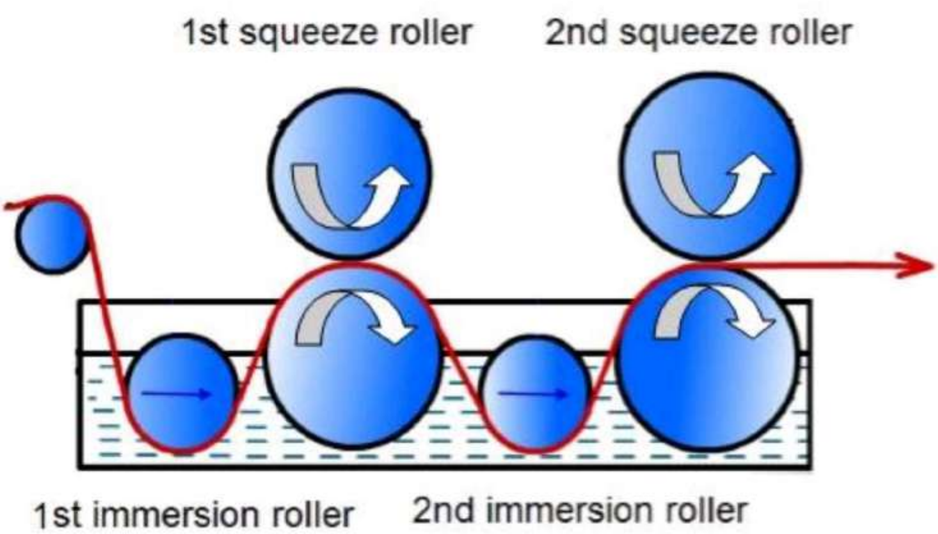


Figure 8: Two dip two nip size box



Important Parameters

The wet pick-up by the warp sheet is influenced by the following parameters:

i. Viscosity of Size Paste

Viscosity of a fluid indicates its resistance against the flow. The viscosity of the size paste is mainly influenced by the concentration (solid content) and temperature of size paste. Higher concentration implies higher viscosity. Viscosity of size paste reduces with the increase of temperature. The wet pick-up generally increases with the increase in viscosity. Viscosity also determines the penetration of size paste within the yarn structure. If more penetration is desired then viscosity should be lowered and vise versa. For bulky yarns, penetration is relatively easy and therefore higher viscosity may be preferred.

Viscosity of size paste can be measured by Zahn cup. It is a stainless steel cup with a small hole at the centre of the bottom of the cup. A long handle attached to the sides of the cup. There are five cup specifications, labelled Zahn cup #**N**, where **N** is the number from one through five. Large number cup sizes are used when viscosity is high, while low number cup sizes are used when viscosity is low. To determine the viscosity, the cup is dipped and completely filled with the size paste. After lifting the cup out of the paste the user measures the time until the paste streaming out of it breaks up, this is the corresponding 'efflux time'. Viscosity of the paste is calculated from the efflux time using standard formulae.

ii. Squeezing Pressure

The squeeze pressure forces out the excess paste picked up by the warp sheet. Besides, the pressure distributes the paste uniformly over the yarn surface and causes size penetration within the yarn structure. Higher squeeze pressure reduces the wet pick-up and add-on% (**Figure 9**)

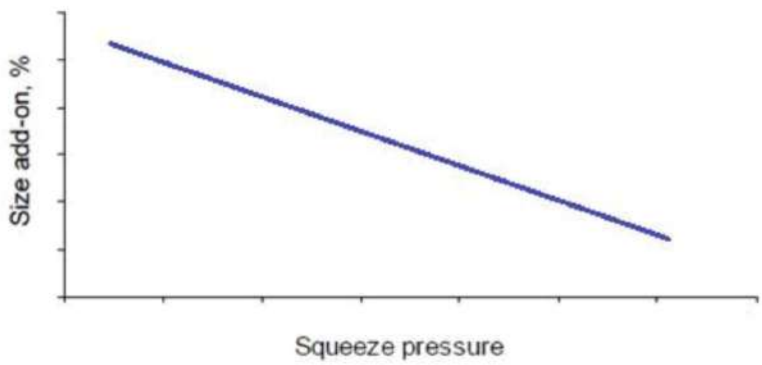


Figure 9: Effect of squeeze pressure on size add-on %

The effect of high pressure squeezing during sizing was investigated by Hari et al. [3]. It was found that for the same level of size add-on%, the high pressure squeezing facilitates better penetration of size within the yarn structure. However, the thickness of coating outside the yarn periphery reduces at high pressure squeezing. This reduces the dropping of size during weaving. The comparison of the size coating and penetration at high and low squeezing pressure is presented in **Table 1.**

Table 1: Comparison between high and low pressure squeezing

Pressure	**Size coating (film thickness)**	**Size penetration**
High	Low	High
Low	High	Low

Though there was no significant difference in the tensile properties of yarns sizes using high and low pressure, the weaveability of the former was much better than the latter.

iii. Hardness of Top Squeeze Roll

The bottom squeezing roller is made up of stainless steel. The top squeezing roller is having a metallic core part which is covered with synthetic material. If the hardness of the top roller is low, then there will be flattening of the roller. Thus the contact area increases which effectively reduces the pressure acting at the nip zone. Therefore, the size pick-up increases. In contrast, harder rollers give sharper nip and lower wet pick-up. The shore hardness of the top roller is around 45°.

iv. Thickness of Synthetic Rubber on the Top Roller

If the thickness of synthetic rubber cover on the top roller is greater, then the extent of flattening is more. This will reduce the nip pressure and thus the wet pick-up will increase.

v. Position of Immersion Roller

The position of the immersion roller within the size box is adjustable. If the height of immersion roller is lowered then the residence time of the warp sheet within the size paste increases. This will lead to the increase in wet pick-up if other factors are constant.

vi. Speed of Sizing

Speed of sizing also influences the wet pick-up by the warp sheet.

Higher speed reduces the residence time of the yarn within the paste which should reduce the wet pick-up.

Higher speed increases the drag force between the warp sheet and size paste which should induce more flow of paste with the warp sheet.

Higher speed reduces the time of squeezing which should increase the wet pick-up.

The speed of sizing will influence the wet pick-up based on the preponderance of the aforesaid factors. In modern sizing machine, the practical speed can be around 100 m/min. Though machine manufactures claim that the speed can be as high as 150 m/min.

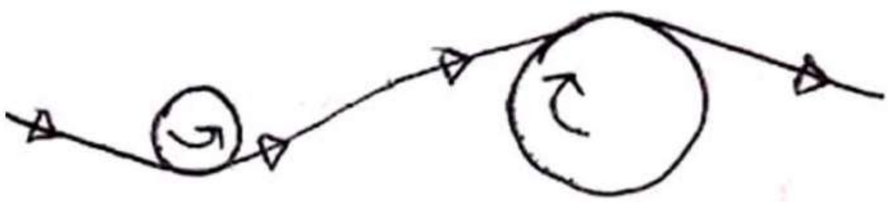
Drying | Drying Systems Used in Sizing | Cylinder Drying / Hot Air Drying / Infrared Drying / Combined Drying

Drying is a mass transfer process consisting of the removal of water or another solvent by evaporation from a solid, semi-solid or liquid. This process is often used as a final production step before selling or packaging products. In **sizing**, drying is necessary to bring the sized material hard.

1. Cylinder Drying: In this type of m/c, drying is done by passing over hot cylinders.

a) Two Cylinder Drying:

1. In this drying process, two copper cylinder are used in which one cylinder is large diameter & other is small comparatively.
2. Firstly warp sheet is passed below the small cylinder & then over the bigger one.
3. The yarn is dried while traveling through the circumstances of the cylinder.



Two Cylinder Drying

Advantages:

Simple process & cheap.

1. Less risky.
2. Temp. uniform.
3. Almost uniform drying.

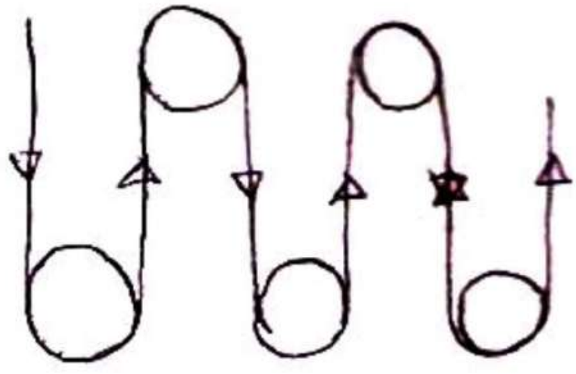
Disadvantages:

Slow process.

1. Drying efficiency is low.
2. Irregular drying.
3. Due to sticky property of cylinder uneven drying.

(b) Multi Cylinder Drying:

1. In this type of m/c, the drying unit consists of 5 to 7 or 11 cylinders having same diameter are used.
2. All cylinders may be steel cylinders or first two cylinders are Teflon coated & rest of are steel cylinder.
3. The cylinders are heated by passing steam.
4. Heat in initial cylinder is low & gradually increases when moved towards final cylinder.
5. If large amount of heat is given to the initial, the sized may be backed.
6. If finer yarn is used, then no need to use excess cylinder.



Multi Cylinder Drying

Advantages:
High speed process.

1. Uniform drying.
2. Non- sticky so smooth drying.
3. Drying efficiency high.
4. Less time required.

Disadvantages:
For high viscosity, stick properly may observed.

1. For friction, yarn hairiness.
2. Shinning effect.
3. Yarn shape may hamper.
4. Possibility of yarn flatten.

2. Hot Air Drying:

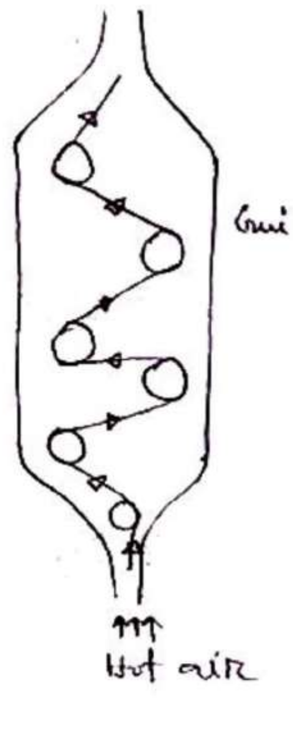
- In this m/c, the drying unit is a closed chamber containing a number of guide rollers through warp yarn.
- Hot air blown into the chamber causing the moisture in the yarn to evaporate.
- Exhaustion should be used to throw away the moisture.
- If moisture remains inside the chamber it may condense & again fall on the yarn.
- Hot air should be continuously passed through the chamber, so the process becomes somewhat costly.

Advantages:
Regular drying.

1. Not shinning effect.
2. Non-sticky property.
3. High speed drying.

Disadvantages:
Costly process.

1. For closed chamber, reqd more time.
2. Less suitable for fine yarn.
3. Difficult to maintain temperature.



Hot Air Drying

3. Infrared Drying:

- In this machine, the heating chamber consists of a plate which is constantly heated by gas flame.
- The warp sheet is passed over the plate & dried in the process.
- When gas flames are not used, then electronic plate may be used.
- Arrangement should be made to through out the moisture removed from the yarn. This m/c is not used signally.

Advantages:

No shining effect.

1. Drying efficiency high.

Disadvantages:

Yarn may burn.

1. Higher cost.
2. Difficult to maintain uniform heating.
3. Risk of accident.

4. Combined Drying:

- In this type of m/c, preheating is done as cylinder drying method.
- And final drying is done by hot air drying method or infrared drying method.

Advantages:

Regular drying.

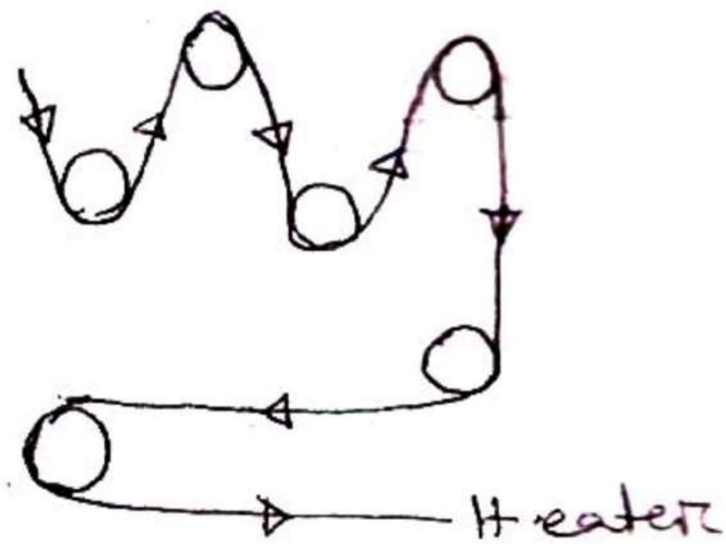
1. Drying efficiency high.
2. Speedy process.

Disadvantages:

Shinning effect.

1. High cost.

Infrared Drying



Parameters of the Process Control of Yarn Sizing

Sizing of Warp Yarn:

The **sizing of yarn** absolutely essential to render it weavable; without sizing the end breakage rate of warp, particularly in the case of single yarns, is so high that weaving becomes impossible. The objective of sizing, however, sizing cannot be looked upon as a process that improves the basic quality of yarn. The fact is that by endowing the yarn with abrasion resistance, proper sizing bring out the full potential of a yarn to weave. A properly sized yarn should have adequate improvement in abrasion resistance, indirectly indicated by the increase in tensile strength, minimum loss of extensibility and required amount of moisture. For satisfactory weaving the quality of the beam also important; the beam should be firm and it should not have excessive missing ends, crossed ends, taped ends (sticky ends) etc., so that it unwind smoothly in the loom shed.

We also want that in the sized yarn there should be:

- Some increase in tensile strength in the yarn
- Minimum loss of extensibility in yarn (about 4.4-4.6% elongation at break is required for cotton)
- Required moisture content (8-10% of cotton)
- Good quality of sized beam (neither too soft nor too firm + free from yarn defects)
- Good productivity and efficiency
- Reduced Cost

Some Important Parameters for the Process Control of Sizing:

Process Control in Sizing:

The process control program in sizing should, therefore, comprise of the following aspects:

1. Selecting the correct size recipe and size pick -up level.

2. Ensuring correct ratio of size paste.

3. Control of the followings:

- Size pick up
- Stretch
- Moisture content
- Quality of beam
- Machine speed
- Machine efficiency
- A method to calculate the expected level of productivity

Effects of Sizing on Yarn Properties:

The following properties of yarn are affected by sizing:

- Yarn elasticity decreases.
- Yarn strength increases.
- **Hairiness** of yarn increases.
- **Flexibility of yarn decreases.**
- Smoothness of yarn increases.

- Irregularity of yarn decreases.
- Yarn diameter increases.
- Yarn weight increases.

Factor on which Sizing Recipe depends on:

- Composition of yarn
- Yarn count
- Total no. of ends
- Weight of yarn

Factors Influencing Size Pick up%

Viscosity of size paste in size box: Any variation in the concentration or temperature alters the viscosity of the paste which in turn affects both the level of size pick up and extent of penetration. Initially as the viscosity increases, the size pick-up also increases. But as the viscosity increases beyond a point, the size pick up is reduced.

Squeezing pressure and condition of squeezing nip: The squeezing pressure determines the extent of penetration of the size paste between the fibers of the yarn and also of the removal of excess size paste and hence the level of the size pick up.

Speed of the sizing machine: Other **sizing** conditions remaining unchanged, the size pick up increases with increasing sizing speed and vice versa. This is because the time available to squeeze the surplus size from the yarn is less at high speeds.

Depth of immersion roller in size paste: the depth of immersion roller in the paste determines the duration for which the yarn remains immersed in the paste. This duration in turn influences both the level of size pick up and the extent of size penetration.

Level of size paste in the size box: Variation in the level of size paste is an important source of size pick-up variations both within and between beams.

Density of ends: When the density of ends is high, difficulties are encountered in obtaining adequate and uniform size penetration. Therefore size pick up may vary at these fabrics.

Yarn tension: In case of higher tension during sizing the set of warp yarns encounter a stretch of comparatively higher tension and thus the set of yarn increases in length. If this increase is too high then the elongation property of the yarn will be decreased. So the yarn will face comparatively higher breakage in subsequent processes. On the other hand lower yarn tension leads to uneven sizing. So the yarn tension must be optimal.

Yarn twist: In case of high twisted yarn penetration time should be increased in order to obtain the optimal pick up %.

Dia. of the yarns: Yarn with greater dia consumes higher size paste. Therefore, the higher the dia of yarn, the higher the pickup will be added.

Size Take-Up% | Factors Affecting on Size Take-Up Percentage
What is Size Take-Up Percentage?

Size take-up percentage is the amount of sized materials added on the **warp yarn** surface, which is expressed as percentage.

Fig: Sizing machine used in weaving sector

Size take-up (%) = (Weight of sized warp yarn - Weight of un-sized warp yarn)/ Weight of un-sized warp yarn × 100%.

Key Factors of Size Take-Up Percentage:

There are some key factors of size take-up percentage, which are pointed out in the below:

1. Warp tension,
2. Yarn characteristics,
3. Wet ability,
4. Nature of roller covering,
5. Roller weight,
6. Preparation condition,
7. Yarn count or Linear density,
8. Ends per inch (EPI),
9. **Fibre characteristics**,
10. Size concentration,
11. Uniformity of yarn,
12. Roller diameter,
13. Running speed,
14. Size ingredients.

All the above factors of size take-up percentage have explained in the following:

1. Warp tension:

If warp yarn tension is higher then size take-up percentage will be lower.

2. Yarn characteristics:

If yarn hairiness is higher then size take-up% will be higher but if yarn surface is rough then size take-up percentage will be increases.

3. Wet ability:
If wet ability is higher then size take-up% will be higher due to absorption.
4. Nature of roller covering:
If sized roller surface is soft and rough then size take-up% will be increased.
5. Roller weight:
If squeezing roller weight is higher then size take-up% will be lower due to penetration.
6. Preparation condition:
The shape of size ingredients or sizing materials should be uniform.
7. Yarn count or Linear density:
In case of finer yarn, size take-up% will be lower and in case of coarser yarn, size take-up percentage will be higher.
8. Ends per inch (EPI):
If ends per inch(EPI) is higher then size take-up% will be higher due to density of yarn in warp sheet.
9. Fibre characteristics:
In case of mature fibre, size take-up% will be lower due to small lumen and in case of immature fibre, size take-up percentage will be higher due to big lumen.
10. Size concentration:
If size concentration is higher then size take-up% will be higher.
11. Uniformity of yarn:
In case of uniform warp yarn, size take-up% will be lower and in case of un-uniform yarn, size take-up% will be higher.
12. Roller diameter:
If squeezing roller diameter is higher then size take-up% will be higher and vice-versa.
13. Running speed:
If running speed of machine is higher then size take-up percentage will be lower due to very short time for yarn penetration.
14. Size ingredients:
Size take-up percentage varies depending on the **types of size ingredients**.

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Sizing Control points, sizing defects

Control of Yarn Stretch

During sizing, the yarns are under tension, this results in a slight permanent stretch in the yarn. It leads to a decrease in extensibility or elongation at break of the sized yarn, which leads to more breakage at the loom shed.

The various zones of stretch control on modern sizing machines are:

1. Creel zone: start- last warper beam, end-Dry nip

2. Wet Zone; Start- dry nip, end- first drying cylinder

3. Drying Zone: start- first drying cylinder, end- last drying cylinder

5. Splitting Zone: start-last drying cylinder, end- drag roll

6. Winding Zone: start- drag roll, end- loom beam

Control of Stretch in Creel Zone

The creel stretch on the existing type of sizing machines has to be controlled manually. The yarn tension in the creel zone increases gradually with reduction in diameter of the warper's beam. To counter this, the tightening of the beam is required to be adjusted suitably as the sizing progresses.

Control of Stretch in the Wet Zone

The control of stretch in this zone can be done with the help of 'positive dry nip'. On multi cylinder sizing machines, stretch can be controlled by synchronising the PIV gear during the cylinders with that driving he finishing squeeze roller in the wet zone.

Control of Moisture in sized yarns

A moisture control of 8-10% should be maintained in the sized cotton yarns. With excessive drying, the size film becomes brittle and harsh.

Very high moisture content is also undesirable because it makes the size films soft and the yarn sticky.

Quality of Sized Beams

A satisfactory weaver's beam should unwind well on the loom. These are some of the important package faults:

1. Density of sized beams: A loosely packed weaver's beam does not work well. The density is mainly influenced by two factors:

a. Effectiveness of the friction clutch or the DC drive

b. Effectiveness of the bream pressing motion.

2. Broken ends, missing ends, crossed ends, sticky ends

The major sources of all these faults are
a. Lappers
b. Invisible breaks during sizing
A lapper is an accumulation of layers of yarn on the warper's beam.
Those end breaks during sizing that do not form lappers are called invisible breaks.
Both lappers and invisible breaks result in missing and broken ends in the sized beams.
Crossed Ends- these are formed during weaving whenever the leading end is not available in the appropriate place on the beam, and, therefore, the weaver has to knot the trailing end to an end that is far away. This happens because in some cases the leading end of an invisible break migrates to a distant place.
Sticky ends - These are caused when broken ends from the warper's beam migrate to the yarn of another warper's beam.
In order to control these faults, it is necessary to control the incidence of lappers and invisible breaks.

Factors affecting lappers:
- End breakage rate at warping
- Efficiency of warp stop motion at warping
- Condition of beam flanges (warper's)

Factors affecting invisible breaks
- High stretch at sizing
- weak places in the yarn

Defective selvedge's
There are two types of defective selvedge's that cause more difficulty in unwinding during weaving than the ends of the beam of the beam. These are:
1. Sunken selvedge's
2. Bulging selvedge's
These defects can be controlled by
a. correctly setting the expandable comb at the headstock
b. Using the correct size of beam pressing roller so that it reaches both the beam flanges.
c. Ensuring that beam flanges are true.

Formation of ridges on the Beam
Ridges on the beam are formed when the ends that are taken in one dent of the comb do not spread out. To minimise the fault the eccentric dancing rollers at the headstock should be adjusted properly.

Sizing Faults | Causes of Sizing Faults
Sizing Defects:
After applying **sizing process** in warp yarn, different types of changes occurred such as increase frictional resistance, flexibility, smoothness etc. During completing this process, several defects are produced which are deeply discussed in this article.

Faults of Sizing:
There are different types of sizing faults arise in sizing process of **weaving technology**, which are pointed out in the below:

1. Uneven sizing,
2. Hard sizing,
3. Sandy warp,
4. Size spots,
5. Shinnery,
6. Size dropping,
7. Ridge beam,
8. Improper drying,
9. Size stitching,
10. Repeating warp streaks.

All the above sizing faults have explained in the following:
1. Uneven Sizing:
Causes of Uneven Sizing:

- Its arise due or under or over **sizing** process,
- Its arise because of under or over concentration of size liquor.

2. Hard Sizing:
Causes of Hard sizing: When **sizing ingredients** applied to much in the warp yarn then size becomes too much hard which ultimately causes of hard sizing.
3. Sandy Warp:
Causes of Sandy Warp: This type of fault produced due to grind or crushed the size material perfectly.
4. Size Spots:
Causes of Size Spots: During sizing process in **warp yarn,** size ingredients must be added gradually into the chemical mixing tank for perfect mixing of chemical. It if it's not happened there, then this **type of fault** is produced.

5. Shinnery:

Causes of Shinnery: This type of defects produced because of the friction between drying cylinder and warp yarn.

6. Size Dropping:

Cause of Size Dropping: This types of defects should be removed as soon as possible which is produced due to not optimum the viscosity of sizing solution.

7. Ridge Beam:

Causes of Ridge Beam: Ridge beam faults of sizing is produced due to unequal distribution of yarn wraith during sizing process.

8. Improper Drying:

Causes of Improper Drying: Here, in case of over drying, hard **sizing** defects produced and in case of over drying, bacteria formed. As a result, yarn breakage occurred here.

9. Size Stitching:

Causes of Size Stitching: When **drying** will not perfect after completing sizing process, then this type of faults produced.

10. Repeating Warp Streaks:

Causes of Repeating Warp Streaks: Repeating warp streaks defects are produced because of improper tension in the pre-beam.

Sizing Faults | Causes of Faults of Sizing

Causes of Faults of Sizing:

Under slashed Warps:

Causes: Due to insufficient size concentration

- Improper size feed to the size box
- Variable size level
- Dilution of size
- Strong squeezing of warp

Over slashed Warps:

Causes: Due to insufficient splitting of starch at size preparation

- Weak squeezing
- Too deep immersion of the warp into the size box

Sticky Warps:

Causes: High **sizing** speed

- Low drying temperature

Over Dried Warps:

Causes: Low sizing speed

- Long stoppage of machine during sizing
- Very high temperature in the drying section

Gum Spots and Smears:

Causes: Splashes of size get on the squeezed warp

- Bad stirring of starch at preparation
- Improper coating of felts on the squeezing rollers

Non Uniform Size Regains:
Causes: Irregular heating of the size in the box
- Dilution of the size with live steam
- Non uniform pressure of squeezing rollers

Crossed and Lost Ends:
Causes: Lease rods are set too far apart
- Broken ends are improperly pieced up
- Bad **warping**

Improper Build of Beam:
Causes: Incorrect spreading of yarn ends in the reed dents

Incorrect Warp Length:
Causes: Disarrangement of the measuring and marking mechanism
- Improper adjustment of measuring and marking mechanism

Dirt Stains in Warp:
Causes: The size boxes and machine metal parts are dirty
- The size is cooked in non-galvanized iron kettles.

Shinnery:
Causes: Due to the friction between the yarn and drying cylinder

Sandy Warp:
Causes: Due to not crushed or grind the size material

Hard Sizing:
Causes: Excessive application of size material

Size Dropping:
Causes: Due to not optimum viscosity of the size solution

Uneven Sizing:
Causes: Due to over and under sizing

Technological Changes Due to Sizing Process

Due to applying **sizing process** in warp yarn, the following changes have done: **1.** Abrasion resistance increases, **2.** Elasticity increases, **3.** Breaking strength increases, **4.** Extension decreases, **5.** Hairiness decreases, **6.** Stiffness increases, **7.** Yarn diameter increases, **8.** Electrostatic charge decreases, **9.** Frictional resistance increases.

All the above technological changes have explained in the below:

1. Abrasion resistance increases: After completing sizing process in warp yarn, the gap among fibres are filled with size and coating on the outer side of the warp yarn takes place.

2. Elasticity increases: As extensibility of the sized yarn reduces, more forces have to apply to extent the warp yarn. As a result, elasticity increases in warp yarn after completing **sizing** process.

3. Breaking strength increases: During sizing, adhesive material creates bonding between fibre to fibres which ultimately increases the breaking strength of yarn. As a result, bout 20-40% breaking strength increases of the fibre here.

4. Extension decreases: During sizing, the gap among the fibres is filled with **sizing materials**. As a result, the slippage among the fibres of yarn does not occur too easy, which ultimately decrease in extension.

5. Hairiness decreases: During sizing process, protruding hairs of warp yarn fixed with the yarn end, which ultimately the causes of decreasing **yarn hairiness**.

6. Stiffness increases: Pliability or flexibility of warp yarn is reduced after completing sizing process which ultimately increase yarn stiffness.

7. Yarn diameter increases:

Sizing means coating adhesive on the outer surface of the warp yarn. As a result, yarn diameter increases.

8. Electrostatic charge decreases: During sizing process, electrostatic charge is formed due to the friction among roller and warp yarn. In sizing process, size materials contain moisture which ultimately reduces electrostatic charge.

9. Frictional resistance increases:

During sizing process, size materials makes outer surface of the warp yarn very smooth which ultimately reduces frictional resistance.

Drawing in and Denting

Looming: Looming covers the processes involved in warp preparation after sizing upto setting them to loom. During slashing, the exact number of warp yarns required in fabric is wound onto the loom (or weaver's) beam. The warp ends are then passed through the drop wires of the warp stop motion, the heddles of the harness frames and the dents at the reed. This can be achieved by drawing -in or tying-in, the choice depending upon whether or not the new warp is different from the warp already on the loom. The processes are as follows:

Drafting: It is the process of passing the warp yarn into the heald eye of heald frame is called drafting.

Fig: Drafting

- Drafting is known as the selection of heald frames or harness for individual warp threads according to design.
- Drawing in – to pull the warp threads through heald eye of the heald wires.

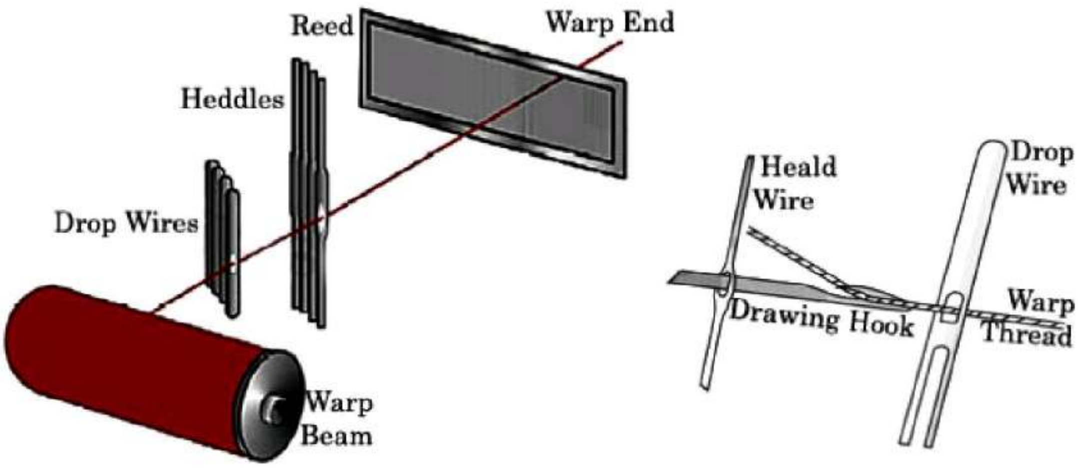
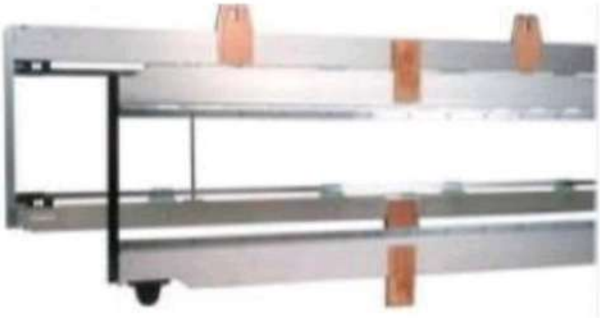


Fig: Schematic Diagram of Drawing in

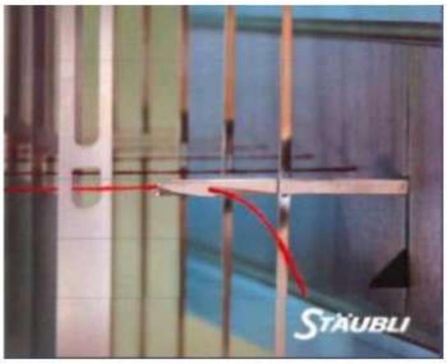
Drawing-in: The process of drawing every warp end through its drop wire, heddle eye and reed dent can be performed manually or by means of automatic machines. In both case, a length of warp yarn, just enough to reach to the other side of the frame, is unwound. Leasing (i.e. selecting warp) of the warp at this stage simplifies the separation of the yarns. Then they are threaded through drop-wires, heddle eyes and reed dents. The automatic drawing machine can handle the leasing-in and drawing-in process in single operation.

Healds & Frames



Before the weavers beam is mounted on the loom each end is threaded through a heald eye and the reed.it is also supports a drop wire.

- To pass the warp threads through the hole of the drop wire is known as pinning.



- If a single warp breaks drop wire will drop. As a result machine will stop instantly to avoid end missing.

Threading of Heddles

A **heddle** is an integral part of a **loom.** Each thread in the **warp** passes through a heddle. which is used to separate the warp threads for the passage of the **weft.** The typical heddle is made of cord or wire, and is suspended on a shaft of a **loom**. Each heddle has an eye in the centre where the warp is threaded through. As there is one heddle for each thread of the warp, there can be near a thousand heddles used for fine or wide warps. A hand woven tea-towel will generally have between 300 and 400 warp threads, and thus use that many heddles.

Fig: Heddles

Fig: Threading of Heddles

Drawing: It is the process of passing the warp into the drop wire is called drawing.

Denting: It is the process of passing warp yarn into reed is called denting.

Drawing threads through dent with hook

Knotting/Tying-in:

The tail end of the warp from the exhausted warp beam is tied to the beginning of the new warp is called knotting/tying-in.

The condition of knotting- Be easy to tie

There is no variation of count of yarn.

Warp number of new beam must be equal or less than from the exhausted warp beam.

Fig: Knotting or Tying-in:

Tying-in: When fabric of a particular type is being mass-produced, the new warp beams will be identical with the exhausted beams on the looms. Therefore, if every end on the new beam is tied to its corresponding end on the old beam, the drawing-in process can be omitted. Tying-in may be done by means of a small portable machine on the loom or as a separate operation away from the loom.

Gaiting: It is the process of setting drawing, drafting, denting in loom is called gaiting.

AUTOMATION IN WARPING AND SIZING PROCESS

Automation in Warping Process:

Other typical features of a modern sectional wrapper are:

- Feeler roller to apply material specific pressure to obtain exact cylindrical warp build-up;
- Lease and **sizing** band magazines
- Constant warp tension over the full warp width;
- Automatic section positioning with photo-optical section width measurement;
- Pneumatic stop brakes;
- Warp tension regulation for uniform build-up; and
- Automatic warp beam loading, doffing and chucking.
- Head stocks are equipped with advanced design features such as precision direct drive, advanced electronics, smooth doffing and programmable breaking
- Stop motion sensors are used when yarn breaks.
- Automatic creel movement
- Yarn length measuring devices are used to measure the warp yarn length.

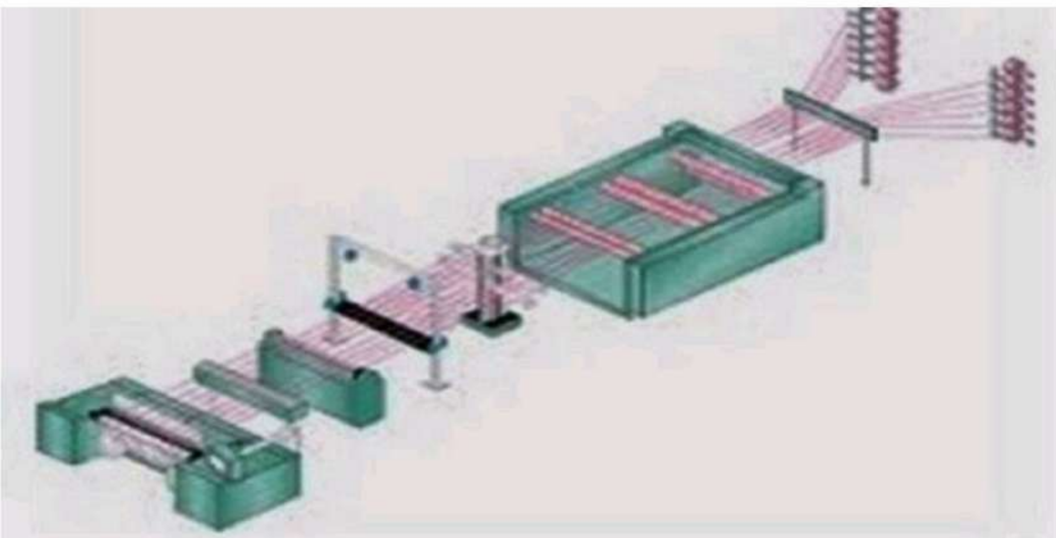


Figure : Automation in warping process

Automation in Sizing Process:

Sizing machine control systems provide a tool for management to insure that all warps are sized identically under standard operating conditions. These monitoring and control capabilities can be included in a computer network of a weaving mill. For years **knitting machine** manufacturers have been making excellent use of electronics to provide machines that are more automatic and versatile and many refinements of these advances have been made. These automatic machines are already 'islands of automation' that can be incorporated into a CIM network. **Automated weaving plants** are on the drawing boards. None is yet in operation but should be a reality within a few years. The six production steps **winding**, **warping**, **sizing**, weaving inspection and packing include 16 points of automation. Of these, 12 deal with materials handling or transport. Only four applications deal with automating the machine operations themselves. This includes automated process control on the slasher of

- Automation on creel zone by pneumatic cylinder
- Control the tension of yarn by sensors or pendulum roller
- Control the temperature and level of size paste in size box
- Control the temperature and level of size paste in size cooker
- In drying zone, control the temperature
- Control the percentage of moisture content by sensor
- Control the headstock system

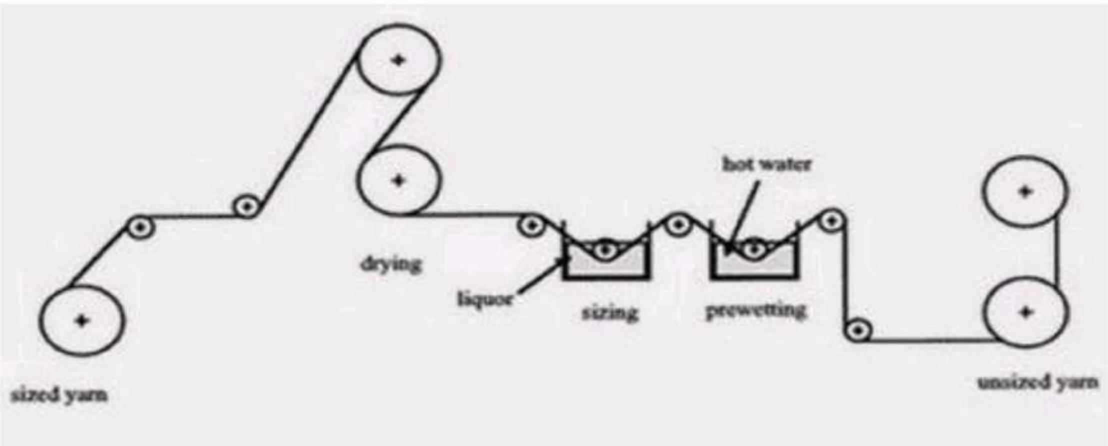


Figure: Automation in sizing process