Textile:

A textile was originally a woven fabric, but the terms textile and the plural textiles are now also applied to fibers, filaments and yarns, natural and manufactured and most products for which these are a principal raw material.

Reason for clothing

1. Modesty.
2. Adornment
3. Protection against adverse climate condition
4. Identification
5. Aristocracy

Fabric:

Fabric or Cloth**: Fabric is a kind of basic textile material that can be produced by interlacing, interloping or networking of natural or artificial yarn or fibres & produce a supple (flexible) sheet material**.

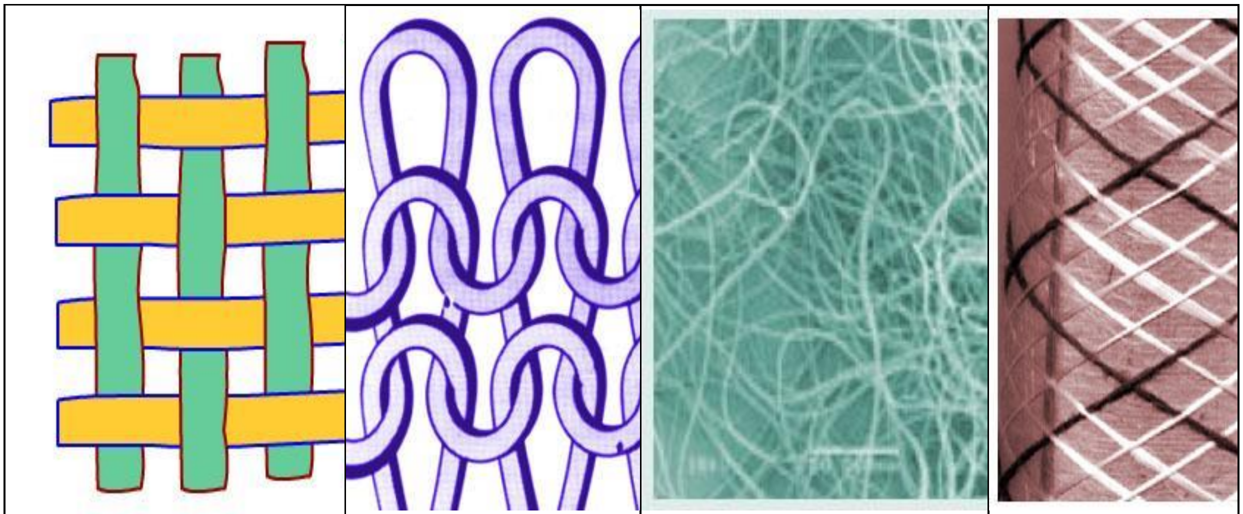
Types of fabric:

Generally four types of fabric are produced namely-

1. *Woven fabric*
2. *Knitted fabric*
3. *Non-woven Fabric.*
4. *Braided fabric*

End uses of Fabric:-

1. ***Apparel Fabric**: T-shirts, suits, shirts etc.*
2. ***Home furnishing**: Curtain, bed-sheets, cushion cover, mattress etc.*
3. ***Technical Textiles**: Geotextiles, belts, car seat, seat belts, air bag etc.*



Woven	***Knitted***	***Nonwoven***	***Braided***

Figure 1.1: Fabrics produced by different technologies

Historical Background of Weaving:-

1. *In the earliest primitive civilizations, the threads used for weaving were very coarse (probably vines or creepers). In general, therefore, the cloth produced was also crude and coarse.*
2. *There is evidence that the Egyptians made woven fabrics over 6000 years ago.*
3. *It is believed that in prehistoric times, lake dwellers in Europe made nets from twisted threads.*
4. *Silk became economically important in China over 4000 years ago under Emperor Huang Ti and it is said that his Empress invented the loom.*
5. *Cotton was imported to England in 1303.*
6. *In 1407 The Merchant Adventures Company had the monopoly to export cloth to continental Europe. Then weaving was a cottage industry.*
7. *In 1733 John Kay invented the fly-shuttle which enabled filling (weft) to be inserted more rapidly.*
8. *In 1785 Cartwright invented the power loom.*
9. *In 1790 Samuel Crompton produced the mule. The production of yarn now began to outstrip the production of cloth by the loom.*
10. *By the early 1800s, looms were made of cast iron and were driven by steam power.*
11. *In 1831 nearly 1,00,000 looms were running in the north of England. The looms were similar to the shuttle looms we see today.*
12. *In 1870 the automatic shuttle loom was invented which was called the Dickinson loom*
13. *From 1920 there were a lot of improvements in winding and warping of yarns of all kinds. Although actual processes remain unchanged, the machines are completely different.*
14. *In 1939 World War II interrupted the progress of weaving.*
15. *In 1945 after the World War II, the textile industry began to adopt shift working with all its economic advantages.*
16. *From 1942 the faster and more efficient shuttleless Sulzer looms were introduced.*
17. *Production of rapier and airjet weaving machines started in 1972 and 1975 respectively.*
18. *Today a Projectile loom can insert 1050 picks per minute and Rapier loom can insert 700 picks per minute.*
19. *While by water jet loom can insert 1000 picks per minute and air-jet loom can insert 1200 picks per minute.*

Flow chart of Textile processing

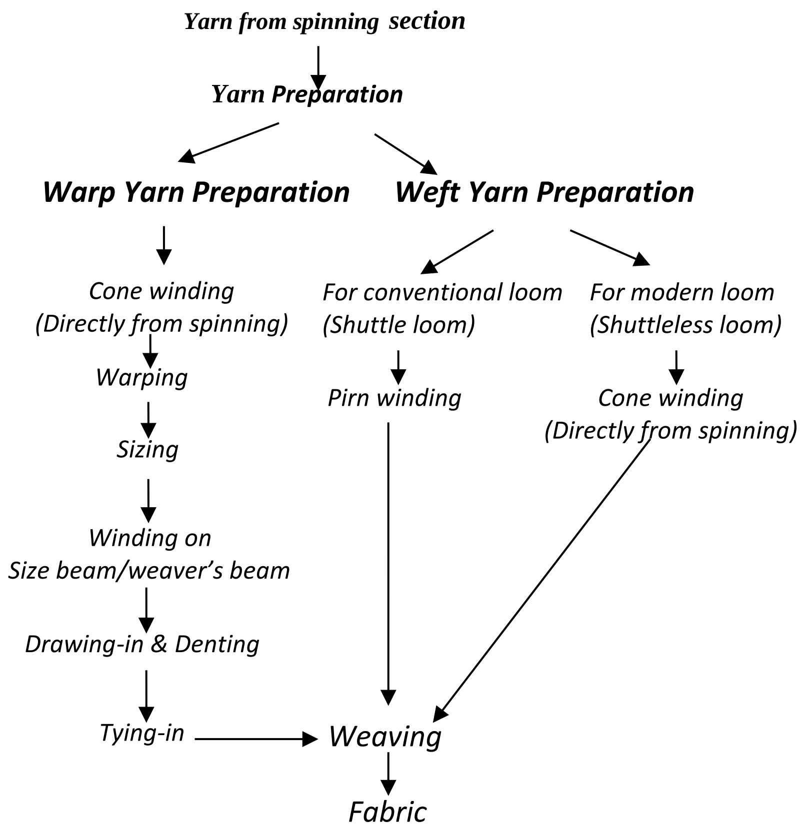
Input/ Raw material		Processing step		Output
Textile Fibres	→	*Yarn Manufacturing (Spinning Mill)*	→	*Yarn*
		↓		
Yarn	→	*Fabric Manufacturing (Weaving/Knitting Industry)*	→	*Grey Fabrics*
		↓		
Grey Fabrics	→	*Wet Processing (Dyeing, Printing & Finishing Industry)*	→	*Finished Fabrics*
		↓		
Finished Fabrics	→	*Garment Manufacturing (Garment Industry)*	→	*Garments*

Weaving:

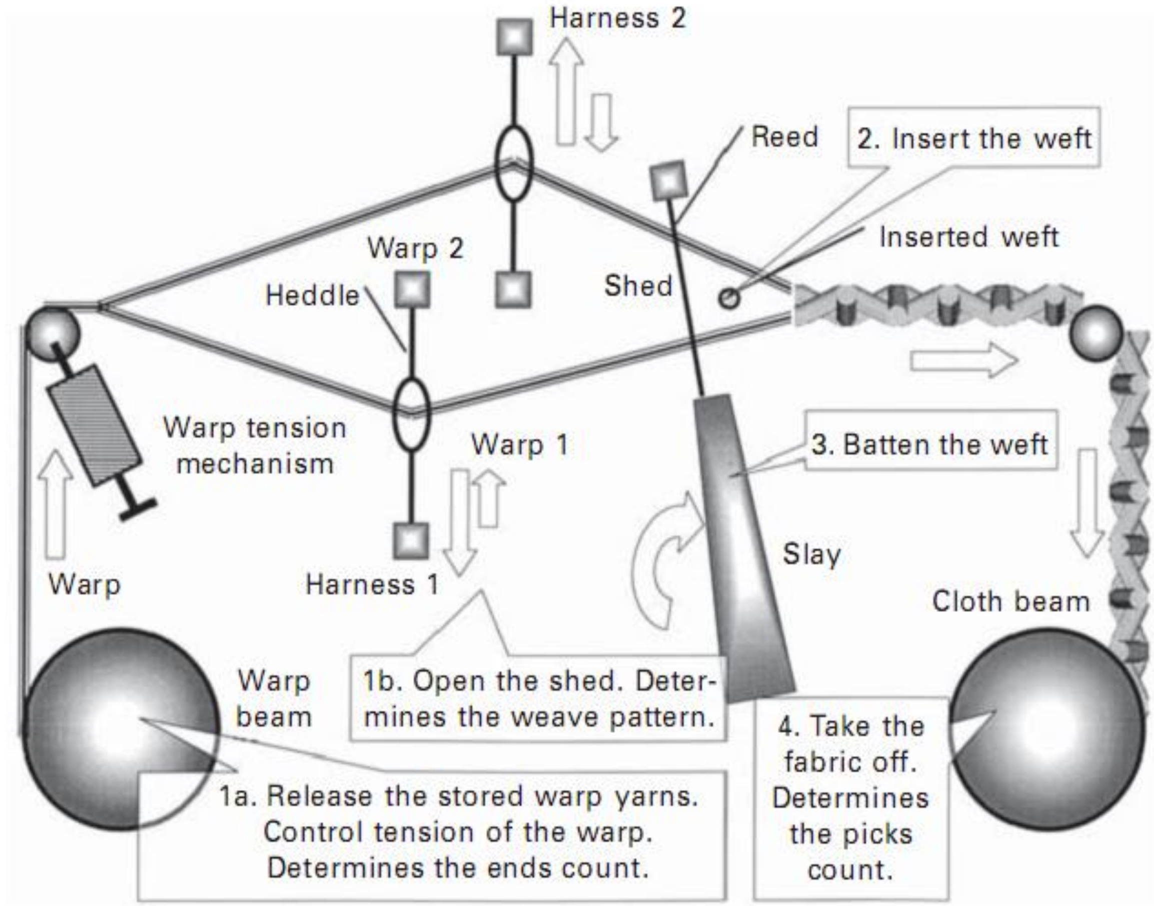
WEAVING

1. Weaving is the intersection of two sets of straight threads/yarns (warp and weft), which cross and interweave/interlace at right angles (90^0) to each other.
2. The threads which lie along the length of the fabric are termed **warp yarns**, while those which lie across the width are termed **weft yarns**.
3. Other names for warp threads are **ends** and for weft thread are **picks**.
4. Weft threads are frequently referred to as **filling**.
5. Woven fabric is produced by interlacing warp and weft. The warp lies along the length of the fabric whereas the weft lies across the width.

Process Flow Chart of Weaving



Introduction to Weaving Preparation



Causes of yarn preparation for weaving:-

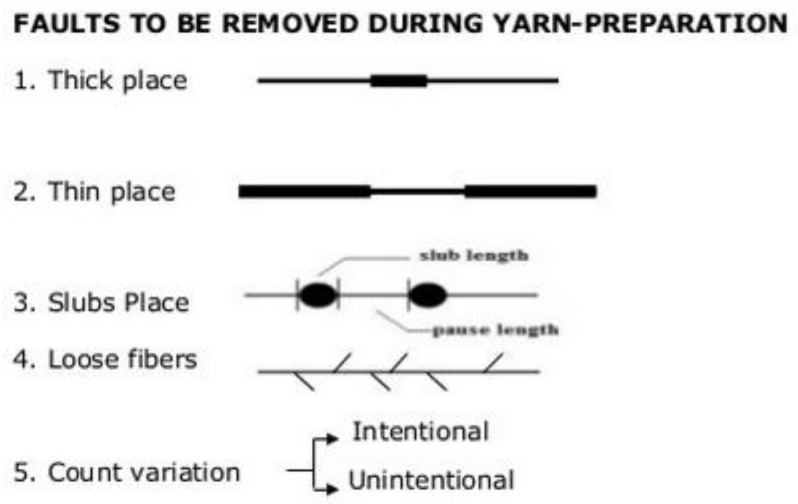
1. *To clear the faults those are commonly found in yarn from spinning.*
2. *To obtain yarn package of predetermined length.*
3. *To obtain a convenient form of yarn package that can be used in weaving. i.e. Weavers' beam for warp yarn and pirn for weft yarn.*
4. *To obtain higher efficiency during weaving.*

The stages involved in warp preparation are:

(a) Winding from spinner's package to cones.
(b) Winding from cones to warp. (i.e. Warping)
(c) Application of size material to warp (i.e. sizing)
(d) Drawing-in and denting or tying-in.

Importance of yarn preparation for weaving:

1. *Yarn from spinning contains thin spots. These are usually weak spots which may break during weaving. So, it is essential to remove them and replace them with standard knots.*
2. *Spinning bobbins contains small amount of yarn. It cannot be used as creel packages for warping as it will decrease the efficiency of warping.*
3. *The shape of the yarn package from spinning is not suitable for high speed warping.*
4. *Sometimes yarn from spinning contains thick places and neps. These should be cleared as they will affect the fabric quality.*
5. *The spinning yarn is hairy. These hairs will entangle with heald eye and dent of the reed. For this reason the yarn will break frequently. The hairiness of yarn is reduced by sizing process.*
6. *As the warp yarn has to go through tension so, without sizing, spinner's yarn cannot be used directly used in weaving as it has less elasticity.*
7. *We need to wind the pirn which can be used in a shuttle.*



<u>The essential features of a good warp are as follows:</u>

1. *The yarn must be uniform, clean and as free from knots as possible.*
2. *The yarn must be sufficiently strong to withstand the stress and friction of weaving without excessive end breakage.*
3. *Knots should be of standard type and size, enabling them to pass easily through the heddles and reeds of the loom.*
4. *The warp must be uniformly sized and the amount of size added must be sufficient to protect the yarn from abrasion at the heddles and reed so as to prevent the formation of a hairy surface on the warp surface.*
5. *The ends of the warp must be parallel and each must be wound on to the loom beam at an even and equal tension.*
6. *Each warp end must be of the correct length and there should be no broken end therein.*

Winding

Winding:

This is the process of transfer yarns from ring, bobbin, hanks etc. into a convenient form of package containing considerably long length of yarn. This simple transfer of yarn from one package (bobbin) to another package (cone, spool, pirn) is called winding.

Important Definitions in Winding

Wind: *It is the number of revolutions made by the package (i.e. number of coils wound on the package) during the time taken by the yarn guide to make a traverse in one direction (say from left to right) across the package.*

Angle of wind (θ) : *It is the angle made by the yarn with the sides of the package (**Figure 2.3**). If surface and traverse speeds are V_s and V_t respectively, then*

$$\tan\theta = \frac{V_t}{V_s}$$

Coil angle (α) : *It is the angle made by the yarn with the axis of the package (**Figure 2.3**). The coil angle and angle of wind are complementary angles as they add up to 90°.*

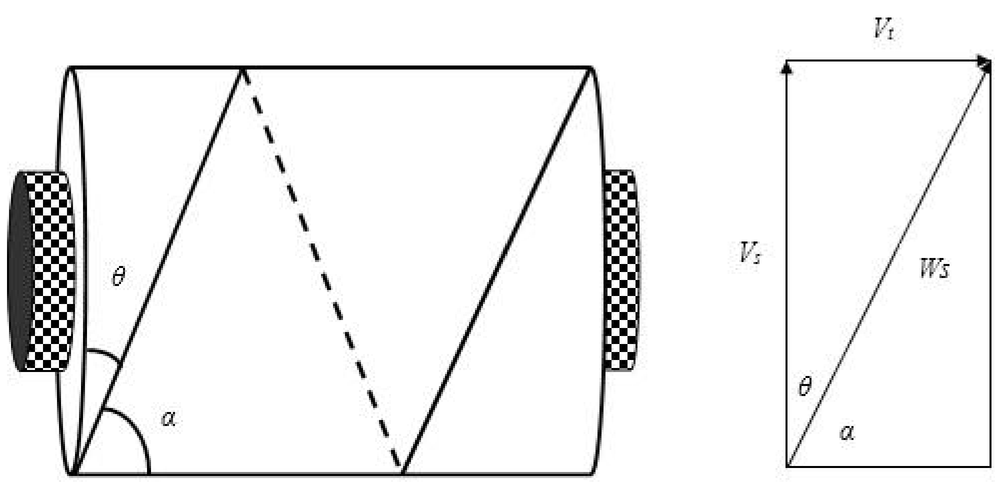


Figure 2.3: Angle of wind and coil angle

Objectives of winding

1. *To transfer the yarn from the spinner's package onto a convenient form of packages which will facilitate weaving or the next process of yarn preparation.*
2. *To have the desired length of yarn on the package.*
3. *To remove yarn fault and improve quality.*
4. *To empty spinners' bobbin so that it can be used again.*
5. *To improve the efficiency of the machine for the next process.*
6. *To make quality fabric.*

Input and out-put of winding:-

Input – Yarn (Spinner's bobbins, hanks)

Output –Yarn (Large cones, cheese, pirn, spool etc)

Types of yarn package:

a) Cone, (for warp yarn)

b) Cheese (for warp yarn),

c) Spool (for silk, jute warp yarn)

d) Pirn(for cotton weft yarn),

e) Cop (for jute weft yarn)

f) Beam

g) Flanged bobbin.

Types of winding

There are various systems of winding. Some are given below:

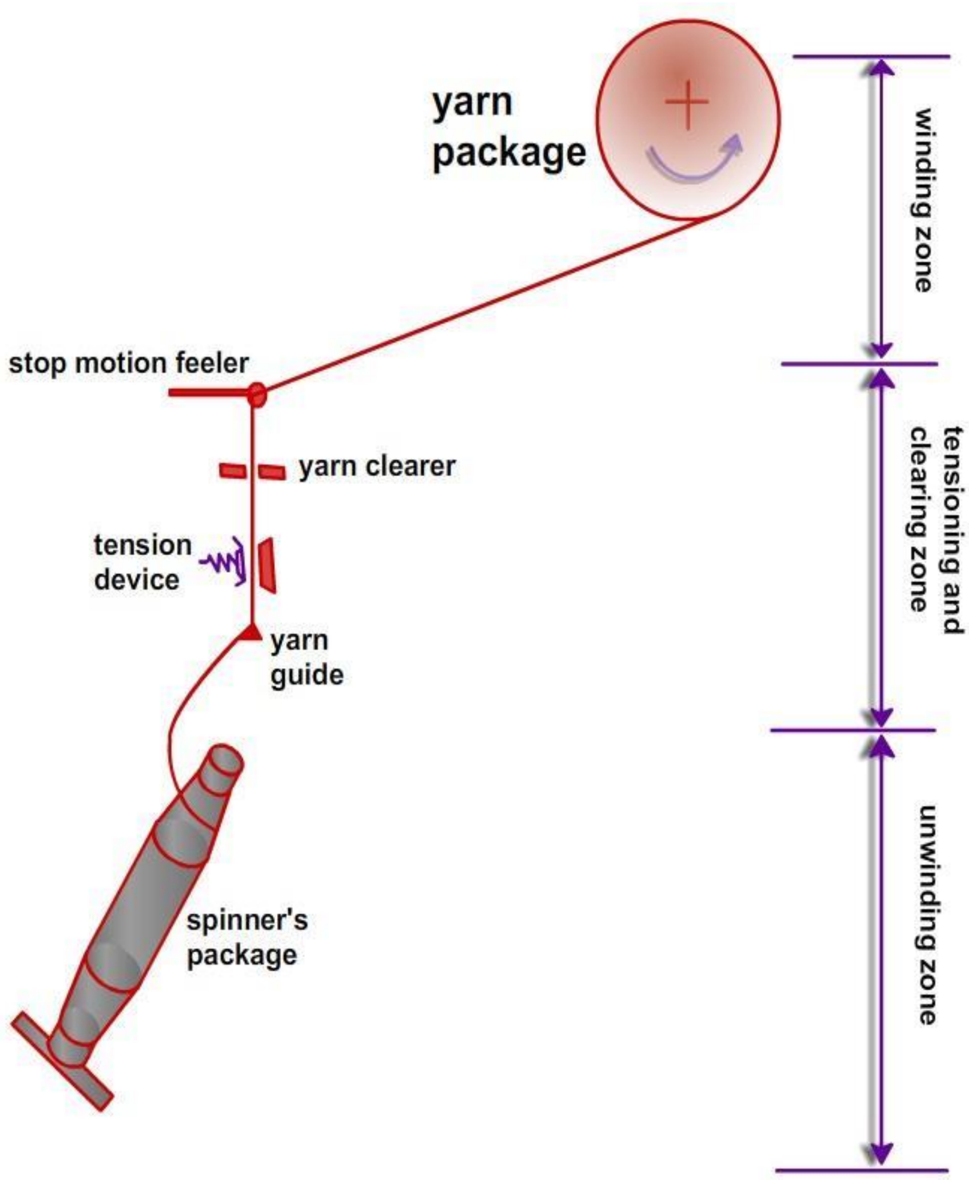
1. *According to density:*
   - *a. Precision winding.*
   - *b. Non-precision winding.*
2. *According to type of package:*
   - *a. Cone winding package.*
   - *b. Pirn winding package.*
   - *c. Flanged bobbin winding package.*
   - *d. Cheese winding package.*
   - *e. Cop winding package.*
3. *According the build of the package:*
   - *a. Parallel winding.*
   - *b. Near- parallel winding.*
   - *c. Cross-winding.*
4. *According to the methods of drive:*
   - *a. Positive or direct drive.*
   - *b. Negative or friction or indirect drive.*
5. *According to Features of automation:*

a. Conventional winding.
b. Modern winding

Winding Machine

Figure 2.4 *depicts the simplified view of a winding machine. It has three main zones.*

- *Uniwinding zone*
- *Yarn tensioning and clearing zone*
- *Winding zone*

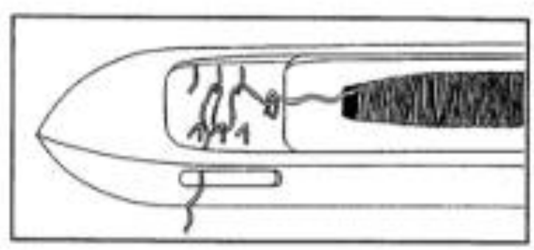


Winding requirements

1. *The fault level in the yarn must be reduced to an acceptable level.*
2. *The yarn must not be damaged in any way in the winding process.*
3. *The yarn must be wound in such a way as to permit unwinding in the following processes with a minimum of difficulty at the required speeds.*
4. *The package size, shape and build must be the most technologically suitable for the particular end use.*
5. *The package size should be controlled to meet the particular economic requirements.*
6. *The winding operation must be geared to give the best possible economic performance of the whole process of fabric manufacture.*

Types of Package Winding:

1.Parallel winding. e.g- a) Warp beam,
b) Weavers beam.
2. Near parallel winding. e.g-,
a) Cop,
b) Flanged bobbin.
3. Cross-winding. e.g- a) Cheese,
b)Cone,
c)Spool.



Shuttle with pirn

Yarn packages

1. ***Parallel wound package:***
   This package comprises many yarns laid parallel to one another as in a warp beam.
   It is necessary to have a flanged package.
   Example: Warper's Beam, Weaver's Beam

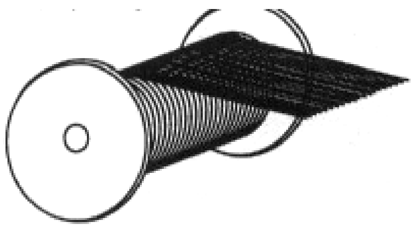


Fig: Parallel wound

Advantages:

a) *Many yarns can be wound at a time.*
b) *More yarn density in the winding package*
c) *Side withdrawal is possible.*
d) *During unwinding no change of twist*
e) *During winding no need to traversing*

Disadvantages:

a) *Need flanged packages*
b) *Need separate mechanism during unwinding*
c) *Over withdrawal is not possible*

2. ***Near Parallel wound package:***
   This package comprises one or more yarns which are laid very nearly parallel to the layers already existing on the package on the package.
   Example: Pirn, cop
   Advantages:

a) *Normally no need of flanged package*
b) *Over withdrawal is possible*
c) *The package is comparatively stable.*

Disadvantages:

a) Side withdrawal is not possible
b) During winding need traversing mechanism
c) During unwinding twist may be changed.

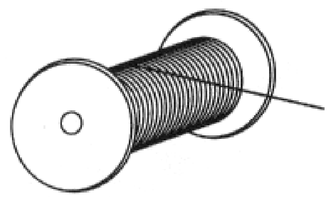


Fig: Near parallel wound

3. ***Cross wound package:***
This type usually consists of a single yarn which is laid on the package at an appreciable helix angle. So that the layers cross one another and give stability.
Example: Cone, cheese, spool etc
Advantages:
a) Package stable due to cross wound.
b) Over withdrawal
c) During unwinding no need of separate mechanism

Disadvantages:

a) The amount of yarn in the package is less due to low density
b) Twist will be changed during unwinding.

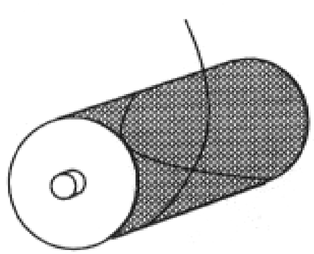


fig: Cross wound package

Precision Winding

In this type of winding successive coils of yarn are laid parallel or near parallel to each other. Hence a very dense package is formed which contains maximum yarn in a given volume (Warp Beam, Cop, Bobbin)

Non-Precision Winding

This type of winding is the package which consists of a single thread which is laid on the package at appreciable helix angle so that the layer s cross one another and give stability. For example- Cone, Cheese.

Difference between Precision & Non Precision Winding

Precision winding	***Non precision winding***
1. No. of coils remain constant from the first layer up to the full diameter of package.	*1. No. of coils per traverse of yarn guide decrease with increase in package diameter.*
2. No air gaps.	*2. Air gaps is found here.*
3. Winding angle is 90 °	*3. Winding angle is less than 80 °*
4. Bobbin can be wound by 1 or more yarn.	*4. Bobbin can be wound by only one yarn.*
5. Less stable package.	*5. More stable package.*
6. Flanged bobbin is needed.	*6. Flanged bobbin is not needed.*
7. Yarn tension is relatively more at the time of winding.	*7. Yarn tension is relatively less at the time of winding.*
8. Yarn package density is more.	*8. Yarn density is less in the package.*
9. Yarn coil is arranged in the parallel or near parallel.	*9. Yarn coil is arranged in traversal.*
10. Yarn withdrawal from the package takes more time & it is relatively difficult.	*10. Yarn withdrawal from the package takes less time & it is comparatively less difficult.*

Methods of driving

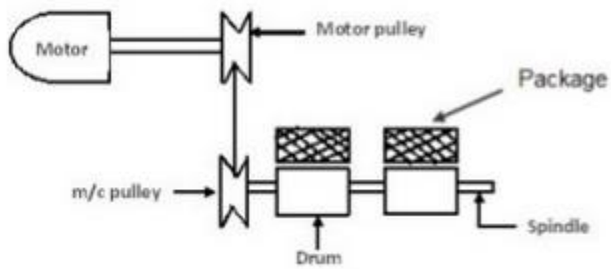
There are three types of package driving system

1. Surface contact driving(indirect system)

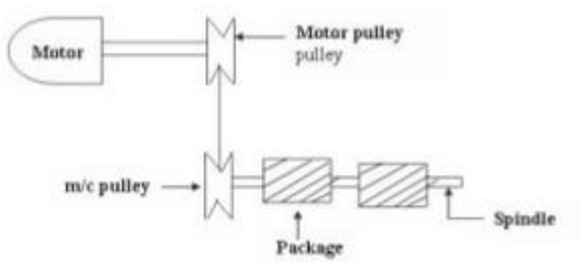
2. Directly package driving at constant speed

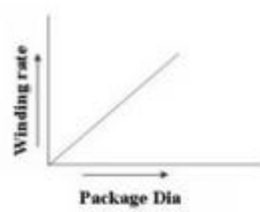
3. Directly package driving at variable speed

Surface contact driving: *In this system the yarn package is placed with a surface contact of a drum. The drum is driven by a motor & some gear. When it rotates the package also rotate in reverse direction. This gives a constant surface speed to the package & the yarn is taken up at an approximately constant speed. Here the speed of drum is not changed, so the winding rate will not be changed.*



2. ***Directly package driving at constant speed****: In this system the yarn package is placed on a spindle. The spindle is driven by a motor & some gear. So the package gets constant angular speed. Here the yarn take up rate is proportional to package dia*





3. Directly package driving at variable speed: *In this system the package is directly driven at variable angular speed to give constant yarn speed. Here the package speed is inversely proportional to package dia/radius*

I.e. Package speed $\propto \frac{1}{\text{Package radius}}$

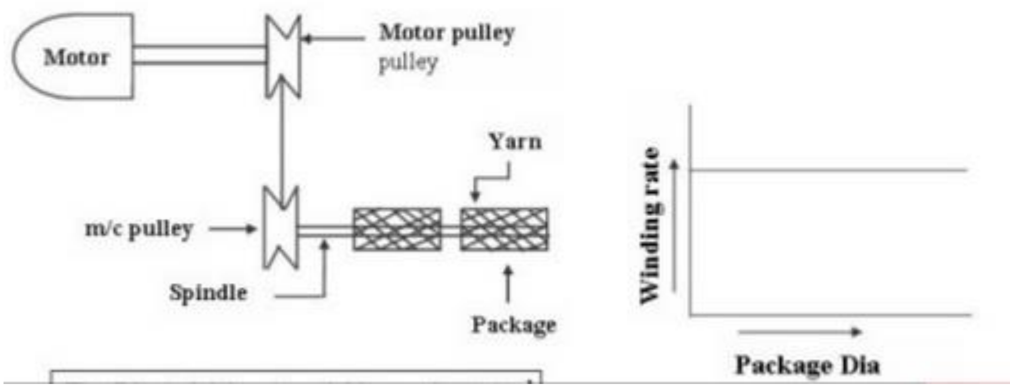


Fig: *directly package driving at variable speed*

Yarn withdrawal

The unwinding process of yarn from package is called yarn withdrawal. There are two ways in which a yarn package may be unwound:

1. *Side withdrawal*
2. *Over end withdrawal/over withdrawal*

Side Withdrawal

In side withdrawal, the spool must rotate in order for the yarn to be removed.

Advantages:

- *The yarn does not rotate upon withdrawal.*
- *The yarn twists remain constant.*

Disadvantages:

- *At high winding speeds, due to inertia, the rotation of the spool may lead to tension variations in the yarn.*
- *This process is costlier for practical use.*
- *High speed impairs the stability of the package.*

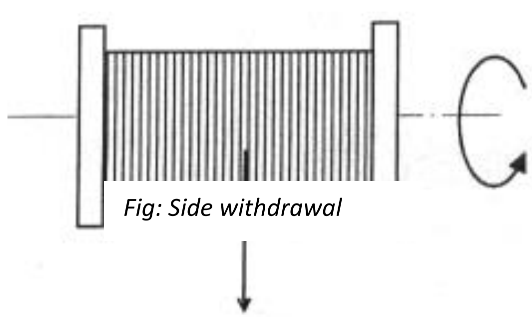


Fig: Side withdrawal

Over-end withdrawal:

This method is simplest & most common method of yarn withdrawal. The yarn is to take away along a line which roughly coincides with the axis of the package. Using this technique it is not necessary to rotate the package. It is used in circumstances where high winding speeds are required, such as in high speed beaming & the removal of yarn from weft ***packages.***

Advantages:

- *Very high rates of yarn withdrawal.*
- *Not so expensive.*

- *Not necessary to rotate the package.*
- *Flanged is not required.*

Disadvantages:

- *Problem of Balloon formation.*
- *There is a chance of one turn twist in the yarn.*

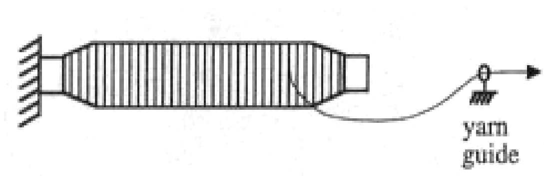


Fig: Over-end withdrawal

Auxiliary Function of Winding

Creeling *is the placement of full packages in position ready to be unwound as part of the transfer operations. An alternative meaning is the removal of the exhausted packages & their replacement with full ones.*

Piecing:
Piecing is the finding & connecting of the ends on the packages. The connection between the ends can be made by knotting adhesion or welding but the former is by far the most common. Such connections are required whenever an end breaks or when a creeling operation has been completed.

Doffing:

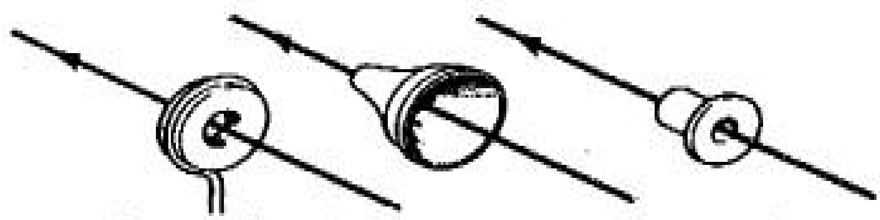
Doffing is the removal of newly wound packages & the replacement of these by empty packages which will receive yarn during the transfer process. It will be noted that creel packages are emptied as the packages to be doffed are filled.

Yarn Guide

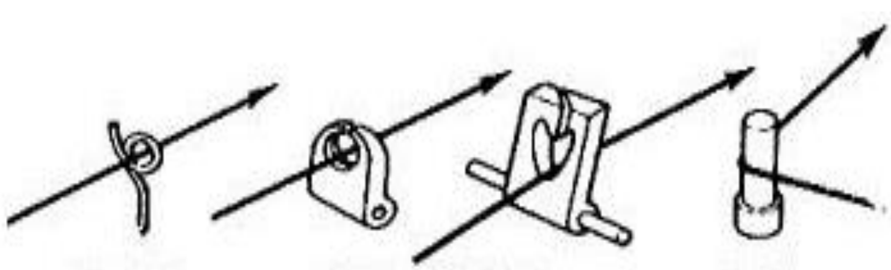
In winding or unwinding, it is necessary to control the yarn path. For controlling the yarn path, yarn guide is used.

There are mainly two types of yarn guide:

1. *A yarn end is required for threading*
    - *Takes extra time in threading*
    - *Low production*
    - *More friction*



2. *A yarn end is not required for threading*
    - *Easy threading*
    - *High production*



Tension device

T he tension device maintains a proper tension in the yarn to achieve a uniform package density. It also serves as a detector for excessively weak spots in the yarn that break under the added tension induced by the tension device.

Effects of tension on yarn and yarn package:

Too high tension:

- *Can damage the yarn*

- *Increase breakage rate of yarn*
- *Change elongation properties of yarn*
- *Can change molecular structure of yarn (incase of man-made fibre) which affects the dye ability; and causes random variations in color shading.*
- *Can lead to hard yarn package.*

Too low tension:

- *Can lead to unstable packages which will not unwind cleanly.*
- *Loosely wound package have tendency to "slough off".*

Types of Tensioning Device

Tensioning device can be classified in 2 ways as follows-

1. Depending on the type of the working member acting on the yarn.
2. According to the working principle.

Depending on the type of the working member acting on the yarn the tensioning devices are the following types:

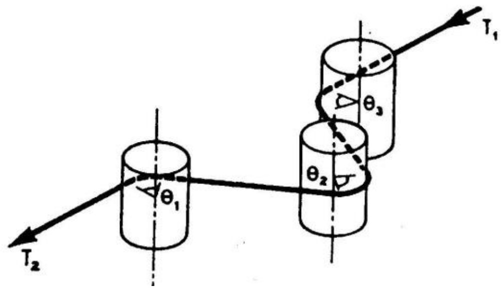
- *Ball type.*
- *Washer type.*
- *Disc type.*
- *Roller type.*
- *Comb type.*
- *Two zone type.*

According to the working principle the tensioning devices are the following types:

1. Capstan tensioner.
2. Additive tensioner.
3. Combined tensioner.
4. Automatic tensioner.

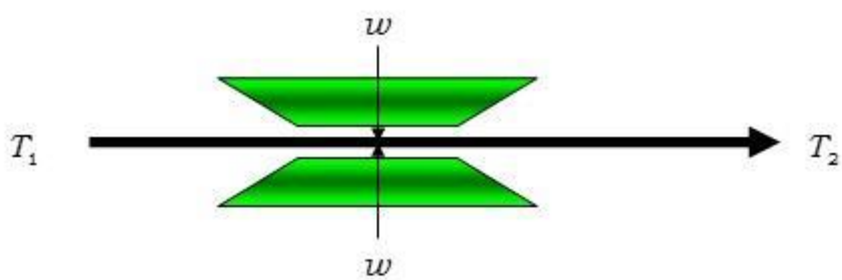
1) Capstan tensioner

The output tension depends on the input tension(T_1), coefficient of friction between the yarn and the post(μ) and the total angle of warp(θ)



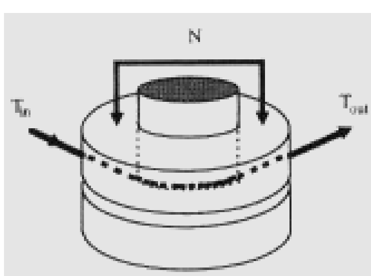
Additive tensioner

In this system, a dead weight or spring is used to apply a normal force (F) to change the tension.



2) *Combined tensioner*

This is the most common type, which consists of at least a disc and capstan type tensioner. Tension is changed by normal force and warp angle.



3) *Automatic tensioner*

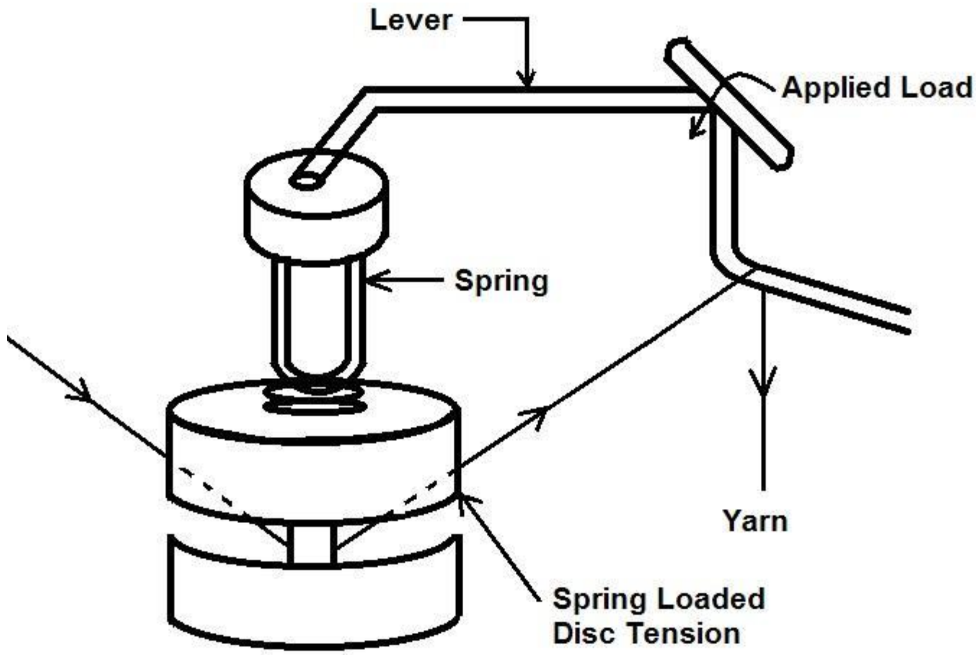


Fig: Automatic Disc Tensioner

FACTORS INFLUENCES FOR SELECTION OF TENSIONER

1. *The device must be reliable to control uniformly in tension.*
2. *It must be easily threaded.*
3. *It must neither introduce nor magnifies tension variation.*
4. *It must not introduce differences in twist.*
5. *It must not be affected by wear.*
6. *It must not be affected by the presence of oil and dirt.*
7. *It must not encourage the collection dirt and lint.*
8. *It must be capable of easy cleaning.*
9. *It must be inexpensive or cheap.*
10. *The operating surfaces must be smooth.*
11. *It must not cause damage for yarn.*

Winding efficiency depends on the following factors

- ***Spindle or drum speed:*** *the higher the speed the more is the winding efficiency*
- ***Yarn Count:*** *yarn count is proportional to winding efficiency*
- ***Yarn quality:*** *if yarn quality increases then winding efficiency increases*
- ***Worker efficiency:*** *the more efficient the work is the more efficient the winding will be.*
- ***Humidity:*** *humidity is reciprocal or inversely proportional to winding efficiency.*
- ***Work load per worker:*** *If the work load on each worker is less then efficiency of winding will be more.*
- ***Maintenance and over hauling:*** *if the maintenance and over hauling of the machine is not correct then efficiency of winding will decrease.*
- ***Power failure:*** *if power failure rate increases the winding efficiency will decrease.*
- ***Creeling time:*** *the more the creeling time the less is the efficiency.*
- ***Doffing time:*** *the more the doffing time the less is the efficiency.*
- ***Capacity utilization:*** *when capacity utilization decreases then efficiency decreases.*

Reasons for lower efficiency

- *power failure*
- *less skilled labor*
- *labor unrest*
- *shortage of machine parts and raw materials*
- *strike*
- *maintenance problems*