CHAPTER - 5

WEAVING

Weaving is a process in which two sets of yarn warp and weft are interlaced with each other at right angle. This is being done in looms. One set of threads are wrapped parallel in flanged beams called weavers beam and weft threads are directly inserted with

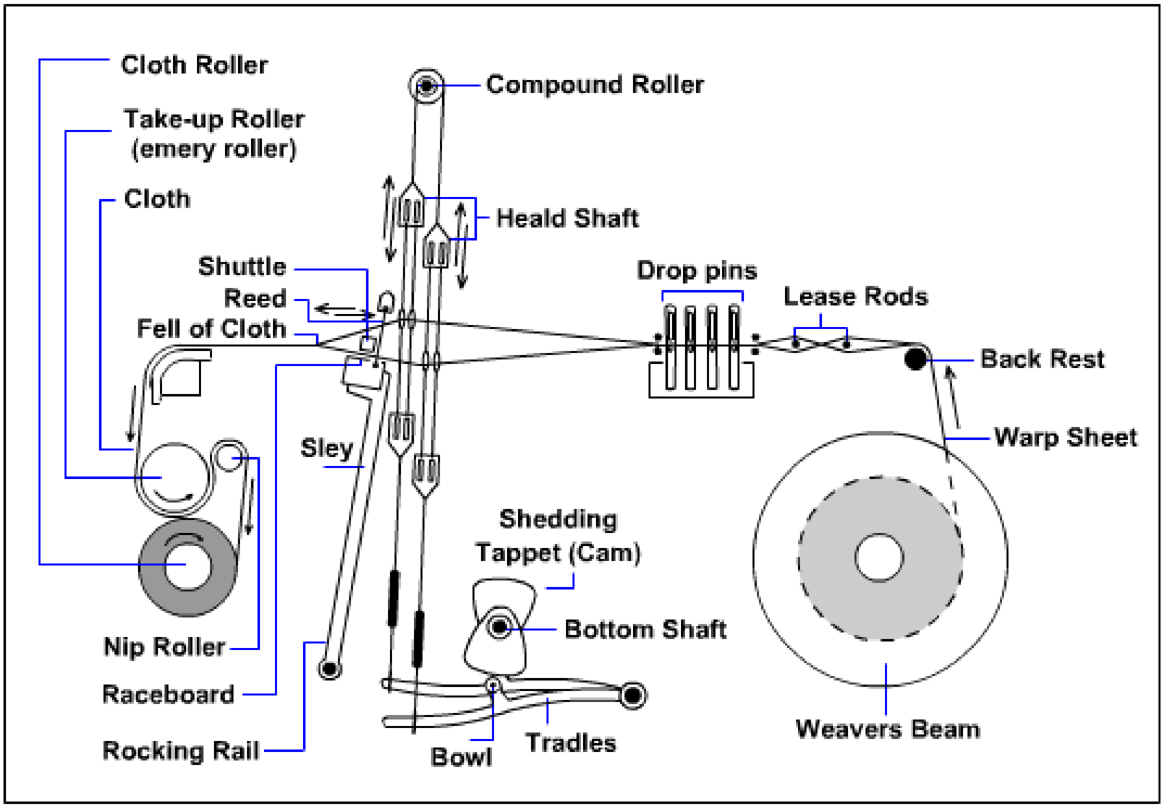

Figure 14 – Shedding machanism

the help of a carrier called **shuttle** in the case of ordinary/automatic loom and in shuttle-less loom with the help of **projectile** / **rapier** / **air-jets** / **water-jets** etc. Number of threads per weaver beam can be around 10000 depending on width (panha) of the fabric & ends/inch and/or as per parameters of cloth required. Warp beam is loaded on loom at rear side and is unwound at desired speed. Each and every warp yarn then passes through **drop pins** of the mechanism called warp stop motion to detect individual yarn breakage and then through set of **healds** to split or divide in to two layers called **shedding mechanism** to obtain various weaving patterns and finally through **reed** to keep uniform & parallel distribution of the warp yarn through out the width of cloth. Between two layers of warp yarn, weft yarn is inserted from one end to the other end and weft yarn is taken nearer to the fell of the cloth by the reed; which is called **beat up**.

5.1. Weaving Principles

The main cycle of operation of a loom has remained unchanged from the time the first loom was designed. In a simple loom, for producing plain cloth, the warp is supplied to the loom as a sheet of threads wound on to a roller called **'Weaver's beam'.** The warp sheet is approximately as wider as the reed space for the cloth being woven and this unwinds from the beam over the back rest and then through the lease rods, which separate the warp yarn individually. The warp threads then pass through the eyes in the **Heald wires of the Heald Shafts**. The heald frames **(Heald Shafts)** are raised and lowered to form an angular tunnel of threads called a **Shed.** The warp threads are guided between the wires of a closed comb called a **Reed**. The reed is secured in a frame called a **Sley**, which reciprocates forwards and backwards.

The farthest forward positions attained by sley and reed is known as the **beat up** position or the **fell of the cloth** that is the point where the warp and weft are finally interlaced to form cloth. Interlacement of warp and weft is effected by laying a yarn technically known as **Pick** of weft from the shuttle or by other means. The reed then beats up the pick and heald shafts change positions ready for the insertion of the next pick. This is the brief outline of a cycle of operation of a powerloom. The above cycle of operation on a powerloom are controlled by different type of elementary functions such as Primary motions, Secondary motions and auxiliary motions. The Modern Shuttle-less Looms are also on the same principle but with the technological innovations suitable to match the speed of the machine.

a) Primary motions:

i) Shedding motion:

Shedding separates the warp threads normally into two layers for the insertion of a pick. The function of shedding mechanism is to raise and lower the heald frames (Harness frames / shafts), which carry a group of warp ends. This process enables to make an opening for insertion of weft yarn for every pick, so that the warp & weft yarn will be interlaced as per the design / weave. There are three kinds of shedding mechanism namely **Tappet, Dobby & Jacquard**. Different shedding motions are designed on four different principles, namely open shed, semi open shed and bottom closed shed and centre closed shed.

ii) Picking motion:

Picking motion inserts a pick (weft) from one side to the other side. In conventional looms, pick is inserted with the help of a shuttle through the shed opened by the shedding mechanism i.e. between the two layers of warp sheet. The mechanical force applied to the shuttle is through the picking mechanism, which carries the weft from one end to other. This force is generated with the help of the picking tappet (a cam with nose bit) having a special profile. In short, the above system give a heavy hammering to the shuttle tip with the help of a picker connected to the picking stick. In modern looms wooden shuttle has been replaced with innovative weft insertion systems.

iii) Beat up motion:

The function of beat up mechanism is to push the weft thread that has been inserted across the warp threads in a shed, up to the fell of cloth. Fell of cloth is the position of the last pick in the cloth woven on the loom. The beating-up of the weft to the fell of cloth is carried out by the reed, which is fixed on the sley by means of a reed cap. In short, Beat up forces the newly inserted pick of weft up to a line of woven fabric called the fell of the cloth.

b) Secondary motions

i) Take-up motion:

Take-up motion pulls/winds the fabric from the area at a constant rate that is determined the required pick density. It means after the beat up of the weft, woven cloth is drawn away from the reed at the regular rate with the help of emery roller and this rate is decided by the number of picks (picks per inch / picks per centimetre). In conventional looms a set of seven / five gear wheels and a ratchet wheel are used. Reciprocating motion of the sley is transmitted into a rotary motion of the emery roller; finally draw the cloth for every pick at a uniform speed. In modern looms lot of modifications are made for more precise winding system and / or electronically driven separate motors are used in synchronization with the let off motion of the loom and as per the picks per inch required.

ii) Let-off motion:

Let-off (warp control) controls the amount of warp delivered and maintains the regional tension of the warp during weaving. There are three kinds of let-off motions namely **Negative Let off, Semi Positive Let Off, and Positive Let Off** (either Mechanical or Electrical Drive). The negative let off motion is working under the principle of friction. Frequently the weaver has to adjust the weight of the let off motion to control the warp tension of the weavers' beam, which has got a direct relation on warp breakage. Although it is very common in ordinary powerloom, if due care is not taken the cloth quality deteriorates. Even picks per inch throughout the length of the cloth will not be uniform. In semi positive let-off motion the attention of weaver to adjust the tension of the warp sheet is reduced to the large extent as the mechanism itself takes care of it.

In positive let off motion a mechanical feeler senses the diameter of the warp beam and regulates the speed of unwinding of the warp beam and also maintains uniform warp tension. The principle of electronic let off is the same as the positive let off motion where the unwinding is being done by independent servomotor duly controlled by electronic warp tension monitoring sensors. The added advantage of this system is having a full control on the warp tension during weaving which will reduce the warp breakages on loom. These electronic let off motions are very costly and are used only in high-speed shuttle-less loom.

c) Auxiliary motions:

With the advent of powerloom, a various type motions are introduced, by which the loom is brought to an automatic stop to avoid various type of damages likely to be caused during the weaving. To update a Powerloom to produce reasonable quality of fabric, additional mechanisms have been added, known as ‘auxiliary motion’. Auxiliary motions are (1) warp stop motion, (2) weft stop motion (3) pick finding motion (4) Anti Crack motion (5) Reed safety motion (Loose Reed / Fast Reed) (6) Brake/clutch motion etc.

i) Warp stop motion

Warp stop motion detects warp (End) breaks and stop the loom preventing missing end in the cloth. There are two types of warp stop motions in use i.e. Mechanical & Electrical / Electronic. Each & every warp ends are drawn through an independent **drop pin**, which are suspended, on the yarn. These drop pins are arranged in four rows on a rail having a serrated (toothed) profile. This rail having two parts, one stationary, and other one having side ward (to and fro) motion.

As soon as end breaks, because of the gravity, the drop pin falls on the rail between toothed portion and the movement of the rail is arrested and activates the mechanism to stop the loom. In case of electronic warp stop motion, as and when the drop pin falls on the rail, the circuit is completed giving signal to stop the loom. An indicating lamp is provided on the loom to identify the loom so that the weaver can easily attend the end break and put the loom into motion.

ii) Weft stop motion

Weft stop motion detect weft breaks / missing picks and stop the loom to avoid crack in the cloth. In conventional loom it is known as weft fork motion where a fork feels the presence of weft yarn and in absence of weft yarn, loom stops. Development in electronics replaced the weft fork motion with an optical/electronic sensor, which detect not only the absence of pick but also a broken pick.

Note: The absence of the warp stop motion and weft fork motion in the loom will make the Loom to run with broken end/s or pick/s which will result in defective cloth.

iii) Pick finding motion

This motion stops the loom in the exact shed where the pick is not inserted or broken. Weaver can repair the broken weft and start the loom without causing a thick/thin place/double pick.

iv) Anti-Crack motion

This motion prevents cracks & starting marks on the fabric, whenever there is a weft break. Fell of the cloth goes back by 1- 2 picks, which prevents a thin place.

v) Reed safety motions

There are two-type of safety motions (i) Loose reed & (ii) Fast reed. It prevents massive breakage of a large number of threads when a shuttle is trapped in the shed. Loose reed motion is commonly used in a loom for weaving light and medium fabric and the fast reed motion is used on loom weaving dense fabric. In both the cases, the mechanism prevents the beating operation and avoid smash, i.e. broken ends.

vi) Brake mechanism

This motion stops the loom instantaneously as and when there is an indication of warp or weft break by warp/weft stop motion.

Note: Technological refinements have taken place on conventional/ automatic loom to improve productivity and quality of fabric. All these modifications and auxiliary devices fruitfully resulted in saving time and labour.

5.2. Different type of Weft Insertion System:

As described above there are many ways of inserting/carrying weft thread between two layers of warp, which is known as weft insertion. Weaving machines are categorised as per these mechanisms such as projectile weaving, rapier weaving, air jet weaving, water jet weaving, multi phase weaving under the classification of shuttle-less loom which are given below:

- **Shuttle**
  - ⇨ Shuttle Looms
  - ⇨ Shuttle change looms
  - ⇨ Pirn changing looms

- **Projectile / Gripper loom**

- **Rapier Looms**
  - ⇨ Rigid Rapier looms (middle transfer)
  - ⇨ Flexible Rapier looms (middle transfer)
- **Jet Loom**
  - ⇨ Air-jet looms.
  - ⇨ Water-jet looms.
- **Multi Phase/Multi Shed looms.**

5.3. Weft insertion Rates:

Type of weft insertion	Weft insertion Rates		
Conventional Shuttle	150	to	200 meters / minute
High speed Shuttle	350	to	450 meters / minute
Projectile	700	to	1300 meters / minute
Rapier	700	to	1300 meters / minute
Jet	1200	to	2500 meters / minute

5.4. BEST WEAVING PRACTICES

5.4.1. Warp Preparation:

Preparation of warp (winding, warping, sizing, drawing-in) is a key element in successful weaving of a fabric. This is very important especially for high capital-intensive high speed weaving machines. For getting optimum productivity with the modern weaving machines, the preparatory machines should also be modern, so that warp/weft breakages are kept very low.

5.4.2. Winding:

While clearing spun yarns, indiscriminate removal of thick places is not desirable, since at the time & the removal of each fault is replaced by weak spot, such as knots/splices etc. Splicing is preferable to knots as knots give away or give rise to multiple breaks in weaving heavy density fabric. In addition, tail ends of knots also come in the way of clear shed formation and can be a cause of multiple breaks. So only very thick place should be assessed, with respect to its length and diameter and objectionable faults should be removed. This is possible only with an electronic yarn clearer. Such yarn should be tested on **Uster Classimat**, which classifies faults into twenty-three categories based on reference length and yarn cross section. If conventional mechanical clearer is used then clearer setting should be widened by 20 to 30% than that recommended for cotton counts.

5.4.3. Warping:

Warping is the first process of assembling individual ends into a sheet. Errors at this stage will be compounded at sizing and weaving. The purpose of warping should be not to have cross ends and keep the number of breaks low. To achieve this we should ensure top quality yarn packages and the following.

- ⇨ All the threads to be wound with equal tension.
- ⇨ Precise creel alignment
- ⇨ Reliable creel-stop motions and efficient brake.
- ⇨ Minimise wobbling of warping beams
- ⇨ Even build up of yarn from one side to the other of warper beam.
- ⇨ Drop wires / guides should be free from burrs
- ⇨ For wider width looms, wider width warping machines are preferred.

5.4.4. Sizing:

During sizing, yarn density of warp sheet entering the size box should not be high to facilitate equal size covering at all ends and reduces broken ends/migration/sticky ends. Guidance will be as follows:

$$\frac{\text{No. of ends x yarn diameter in mm}}{\text{Warping width in mm.}} \times 0.5$$

When the number of ends exceeds the capacity of one size box, it is advisable to go in for double size box-sizing machines. Multiple size boxes permit reduction of available yarn space in the size box. This gives more complete encapsulation and fewer size bridges between adjacent ends. Sizing machines with pre-dryers/ Syncro4 permit wet split drying.

It is recommendable to use after waxing as it permits ease of shed opening. The stretch in sizing should not exceed 1.5% and the strength increase after sizing should be at least 25% (For cotton) with a corresponding loss in elongation not exceeding 25%. Control of size box temperature, and size level, hardness of rubber rollers, controlled drying cylinder temperature etc. play a significant role in producing a good sized beam.

5.4.5. Weft preparation:

Weft winding is an important process in weaving. If the weft package meant for shuttleless weaving is not properly prepared with uniform tension, and has improper packing density, problems will arise during unwinding of the package on the loom, such as Sloughing – off, Snarling, Excessive tension, Too many weft breaks etc.

In order to develop a weft package that will reduce these problems to a large extent, following points need to be considered:

- ⇨ In winding, winding elasticity of the yarn to be maintained. In any case the tension in cone winding should not exceed 10-15% of single thread strength.
- ⇨ Preferably the RH (Relative Humidity) in the winding department should be 60-65%.
- ⇨ Compact hard package will work well, in the shuttle less looms. Package hardness can also be achieved by increasing cradle pressure.
- ⇨ 150 mm traverse and $5^{0}15$” or $9^{0}15^{”}$ conicity are recommended for course or fine counts respectively.
- ⇨ Transfer tails should be accurately positioned on the cone and its length should be uniform.
- ⇨ Patterning must be minimized and weak spots in the yarn removed.
- ⇨ Knot / splice testers are a good deterrent to avoid breakage due to slipknots / spliced joints.

Note: Electronic clearers in winding are to be preferred for preparing weft for shuttleless looms.