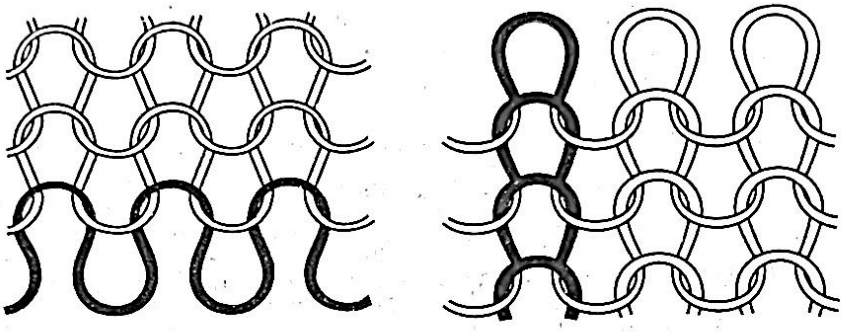
II. KNITTING

Knitting is another method of clothing construction, which is being widely used in garment manufacturing technology. It is the second most frequently used method first being the weaving. Originally, the knitted fabrics were hand-made and were used only for hosiery and inner garments but their wrinkle resistance, stretchability and comfortably close- fitting property has made them popular for sportswear and other outerwear apparel also. Today, a wide range of machine-knitted fabrics is available not only as hosiery garments, innerwear, sweaters, slacks, suits and coats etc. but also as rugs and other home furnishing articles.

Technique used for knitting :

Knitting is the construction of a fabric by forming the yarn into interconnecting loops, which hang one upon the other. The fabric may be constructed by machine or hand, from a single yarn that runs across the fabric or from a group of yarns that run length-wise. Crocheting is the simplest form of knitting in which a chain of loops is produced from a single thread by means of a hook. A knitting machine has a

number of such hooks that are evenly spaced, the spacing being proportional to the size of the stitch. The length-wise rows of interlocking loops are called wales and the rows running crosswise are called courses (Fig 4.22). Wales are similar to warp and courses to weft in weaving. The number of wales and courses per square inch of knitted fabric is called the **Gauge**. It determines the density of the fabric. The higher the number, the finer the fabric. All other factors of yarn and knit type being equal, the fabric that has more wales in it, is more rigid and stable in width and the fabric with more courses in it is more rigid and stable in length.



A. Courses B. Wales

Fig. 4.22. Courses and Wales

The quality of knitted fabric is affected by quality of the needles also. The thickness, length and the closeness of needles in the knitting machine affects the appearance, texture and durability of the knitted fabric.

Comparison of knitting and weaving techniques

Knitting	Weaving
1. Knitting is done by interlocking the loops.	Weaving is done by interlacing the yarns.
2. A single thread is used to form the loops.	At least two sets of yarns are used – warp and filling.
3. Knitted fabrics are quite stretchable. They can stretch in any direction to fit the body comfortably and provide more room for movement.	Stretchability is very less that also in diagonal direction (bias).
4. Knitted fabrics provide warmth because of insulation provided by air entrapped in them, because of construction technique.	Warmth is due to the inherent property of the fibre e.g. wool. Weave does not provide any warmth.
5. Knitted fabrics are not wind proof unless heavily napped. Thus they are porous and provide breathing comfort during body movements.	Due to the compactness in construction, woven fabrics are less porous and do not provide much breathing comfort.
6. Knitted fabrics are very absorbent, light in weight and wrinkle resistant.	Absorbency and wrinkle resistance are not due to the weave but due to the fibre characteristics and finish.
7. Knitted fabric tend to shrink unless gone through special shrink-proof processes.	Woven fabrics do not shrink unless stretched.
8. Some knitted fabrics tend to lose their shape and sag.	Woven fabrics retain their shape and do not sag easily.

Knitting	Weaving
9. In knitted fabrics, a single loop if broken will start a run and spoil the whole fabric.	In woven fabrics, yarns are not interconnected. Hence such a problem does not arise.
10. Designs can be changed very rapidly therefore, changed fashion demands can be met quickly.	Special looms are to be designed for a new weave therefore, changes cannot be very quick.
11. Knitting is faster than weaving. Plain knitting is up to 5 times faster.	Weaving is comparatively slow.

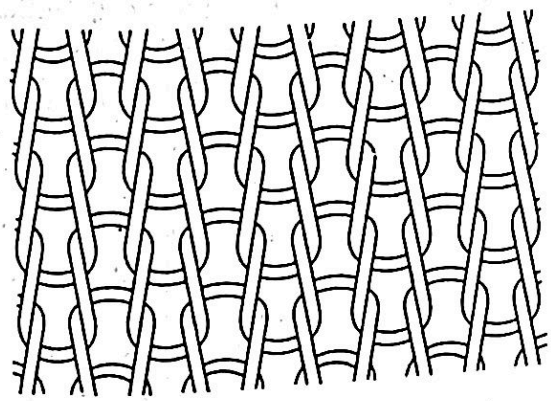
Knitted techniques are mainly of two types :

1. Weft-knitting – in which one continuous yarn forms courses across the fabric.
2. Warp-knitting – in which series of yarns form wales in the length-wise direction of the fabric.

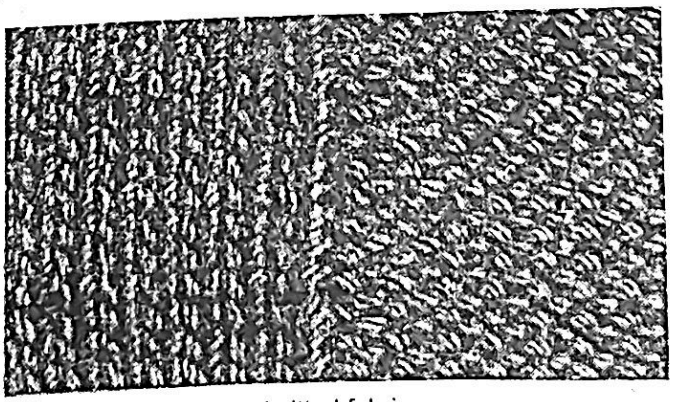
1. Weft knitting : Weft knitting is so called because just one yarn forms continuous rows of loops in the horizontal direction as weft in weaving. The hand method of knitting is weft knitting. On a knitting machine, the individual yarn is fed to one or more needles at a time. There are three fundamental stitches in weft knitting :

(i) Plain knit stitch
(ii) Purl stitch
(iii) Rib stitch

(i) Plain knit stitch : The plain knit is the basic form of knitting in which a loop is drawn through the front of the previous one. It can be produced in flat-knit or circular form. The flat-knit is also called the jersey stitch. In this, the knitting is done on a flat-bed knitting machine which has a row of hooked needles arranged at an even distance in a linear position on the needle plate. These needles move up turn by turn to accept the yarn from the yarn feed thus forming one row of loops on each passage. Since all the needles of such a machine face one way, all the loops produced also face in one direction and the fabric has a distinct smooth surfaced at the face and interlocking rows of opposing half circles at the back (Fig 4.23). A circular knitting machine is used for making circular or tubular fabrics and is more efficient as compared to flat knitting machine.



Yarn layout



Plain knitted fabric

Fig. 4.23. Plain knit stitch

Plain-knit fabrics have great stretch and are comfortable to wear but they may sag at areas of greater pressure and also have the tendency to curl towards back from the sides and towards the face from the top. If a yarn is broken in the plain-knit, the broken loop will drop downwards and a vertical run will

form. This happens more with filament yarns. However, textured and staple yarns provide some resistance to runs due to their rough texture and better cohesiveness.

Plain-knit produces light weight fabrics with single or plied yarns. Many variations can be created in plain-knit such as stripes (vertical as well as horizontal), multi-coloured designs, raised designs and pile effects. Some variations of plain-knit are :

- **Tuck-stitch :** It is a variation of plain stitch to create raised designs, which impart lofty appearance and softness to the fabric. The tuck stitch is made when the needles receives a new yarn while still holding its former loop, thus forming two loops at a time. More loops can also be formed. These loops are then casted off and knitted. Bobbles in a pattern are made using tuck stitch (Fig 4.24).

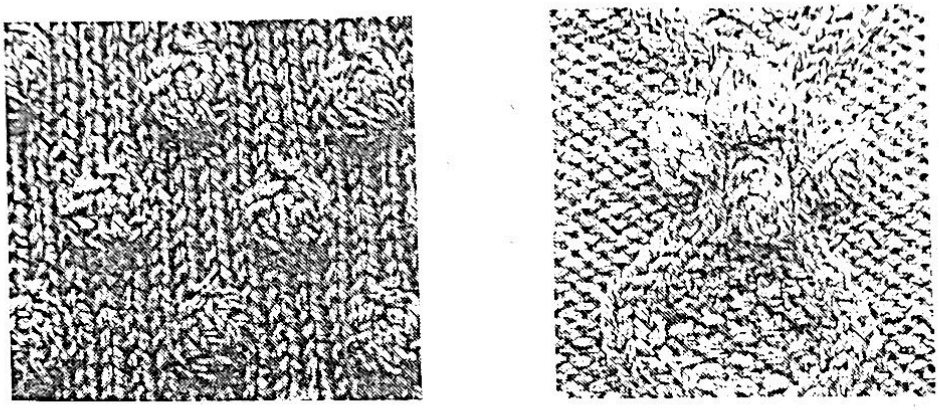


Fig. 4.24. Tuck stitch or Bobbles – A Raised Plain Knit Stitch

- **The miss or float stitch :** It is another variation created when one or more needles do not move to knit the yarn. No loop is formed and the yarn floats at the back. The miss stitch is used while knitting coloured designs.

  Pile effects : These are created by fleece, high pile, terry and velour knits. Depending upon the type of construction these are used for fur fabrics, rugs and fashion apparel fabrics.

Plain knit fabrics stretch more width wise as compared to length. These are used for inner wear, gloves, hosiery and sweaters. The problem with plain knit is that if a stitch is broken, it will start a run and spoil the fabric.

(ii) **Purl-stitch :** Purl stitch is a basic stitch in which a loop is drawn through the back of the previous one. This construction is also called links-and-links stitch after the German word 'links' which means on the left. It is also made on flat-bed or circular machines but the needles used have hooks on both the ends (Fig 4.25) as they draw loops alternatively to the front of the fabric in one course

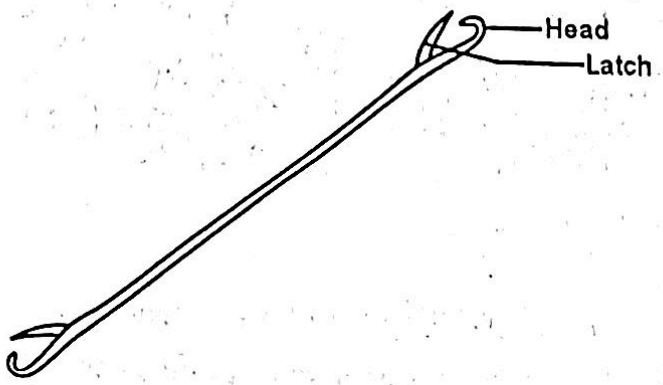


Fig. 4 25. A double-latch needle used for Purl stitch

and to the back of the fabric in next course. The use of double hook needles enables ready changeover to include flat and rib stitches during fabric construction which makes it possible to produce patterns resembling the hand knitted ones. The fabric looks the same on both sides and resembles the back of the plain knit (Fig 26). Like the plain knit purl knit also has the tendency to run up and down if the loop is broken but purl-knit fabrics do not curl at the edges.

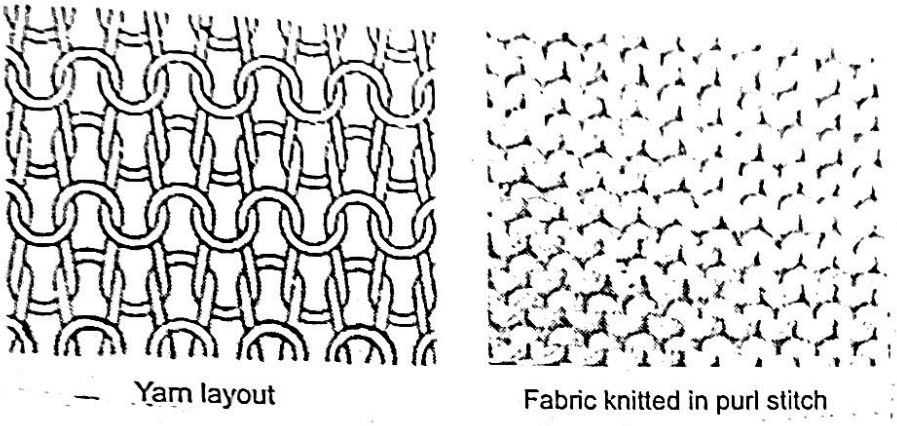


Fig. 4.26. Purl stitch

It is a slower and costlier technique and produces heavy or bulky effect. As the purl stitch has excellent lengthwise as well as some crosswise stretch, it is widely used for infant's and children's wear.

(iii) **Rib-stitch :** Rib-stitch fabrics look alike on the face and the back side because their construction has alternating length-wise rows of plain and purl stitches (Fig 4.27). They are produced on a flat rib machine or a circular rib machine. In the flat rib machine, two sets of needles are placed opposite each other in an inverted V position at 45° to the horizontal surface. In circular rib machine, one set of needles is placed vertically in the cylinder and the other horizontally on a dial. One set of needles pulls the loops to the front and the other to the back of the fabric. Rib stitches can be 1 × 1, 2 × 2, 2 × 1, 3 × 1 and so on. A combination of 1 × 1 and 2 × 2 is called **accordian rib.**

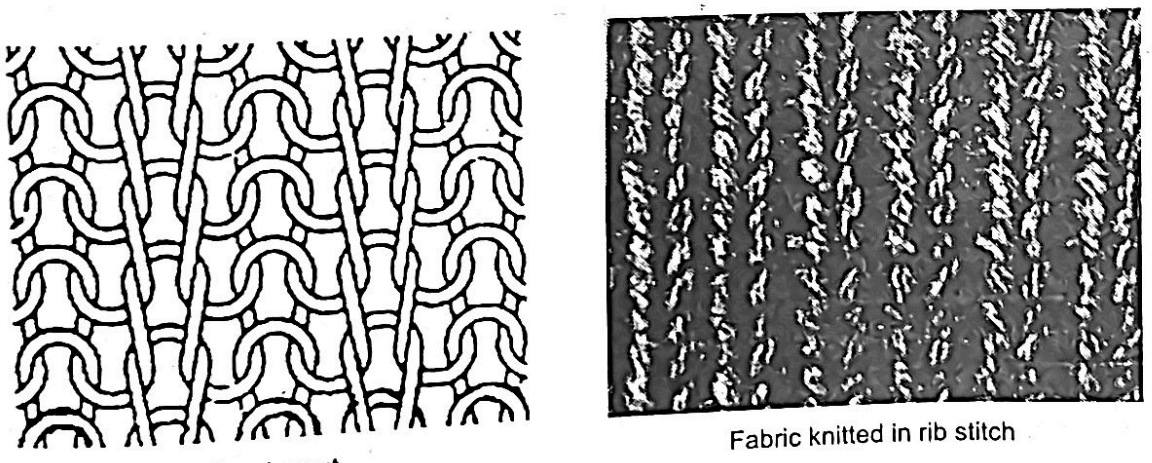
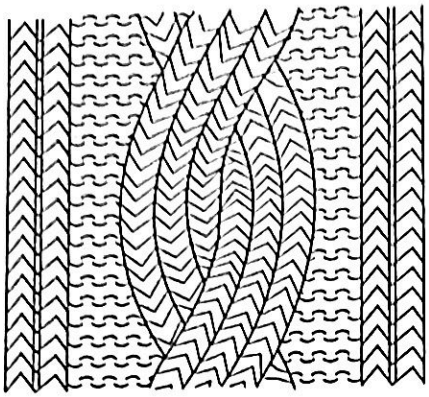
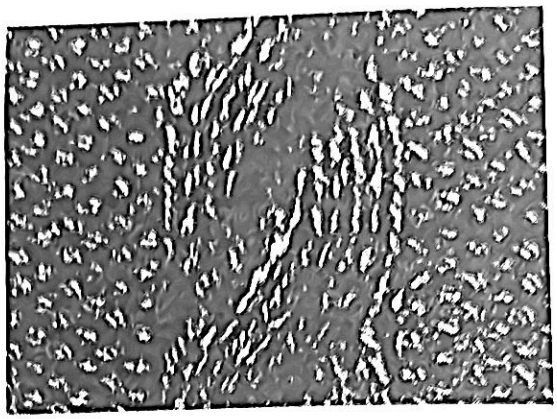


Fig. 4.27. Rib stitch

Variations – Horizontal as well as vertical stripes can be knitted. Full cardigan stitch, half cardigan stitch, interlock stitch, cable stitch (Fig 4.28), double-knit (Fig 4.29) stitch are some other variations. Double-knit fabrics are more stable and have limited stretching capacity.

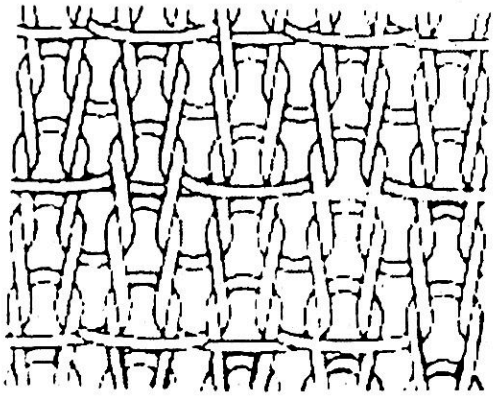


Yarn layout

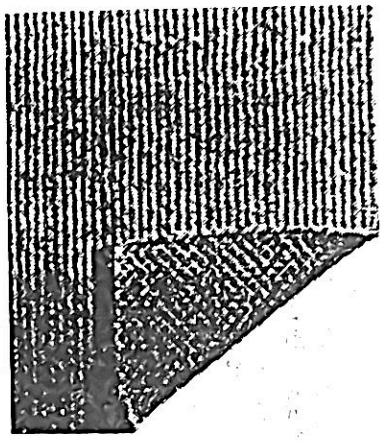


Fabric knitted in cable stitch

Fig. 4.28. Cable stitch – A variation of Purl stitch



Yarn layout



A double knit fabric

Fig. 4.29. Double-knit stitch – variation of Purl stitch

Rib construction is costlier as it requires greater amount of yarn. The rate of production is slow but the rib construction does not curl on edges and lies flat. If a yarn breaks, it will cause a run downward only. However, double knit fabrics do not run. Widthwise elasticity is excellent in rib stitch especially in 2x2 structure. Due to this character, it is extensively used in wrist bands of sleeves, waist bands of garments, for finishing neck lines, for inner wear and socks. Interlock stitch and double-knit stitch are used in sportswear, slacks, women's suits and dresses, men's suits etc. cable stitch is popular in outerwear especially sweaters.

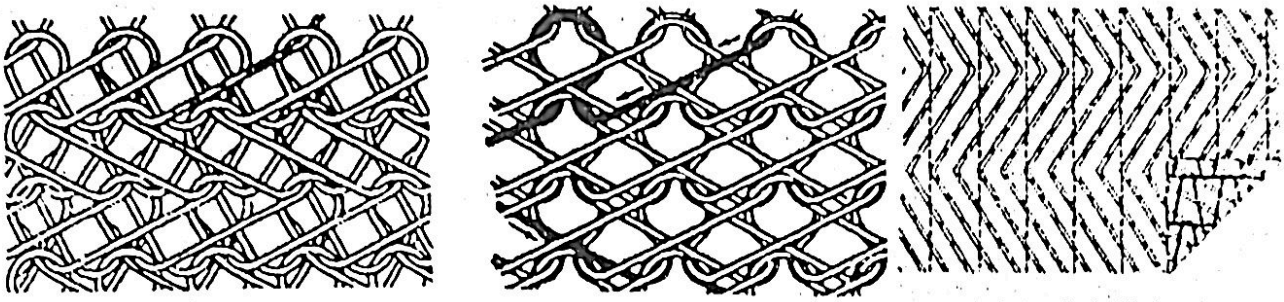
2. Warp Knitting : Warp knit is the innovative product produced by complex knitting machines. Warp knitting differs from weft knitting basically in that each needle loops its own thread. In weft knitting a single yarn goes past each needle turn by turn across the fabric. In a warp knitting each needle has its own yarn, which goes the length of the fabric. The needles produce parallel rows of loops simultaneously that are interlocked in a zig zag pattern. If each needle performs its loop forming cycle each time with its own yarn then there will be a large number of unconnected crocheted chains. If the yarn after forming a loop on one needle is passed on its adjoining needle, then the crocheted chains will join to form a fabric. The stitches on the face of the fabric appear vertical but at a slight angle and the stitches at the back appear horizontally as floats at a slight angle. These floats are called laps, which are characteristic of warp knits.

In warp knitting all the needles work together thus a full row is completed in time that is taken by one needle to complete its loop forming cycle. Thus warp knitting is very productive with speed as much

as fifty lakh stitches per minute or more. Secondly, only filament yarns are used for warp knitting which are easy-slip and trouble-free yarns which further improves knitting efficiency.

Warp knit fabrics have many advantages over weft knits. These are smooth, sheer, wrinkle and shrinkage resistant, strong and abrasion resistant fabrics. They do not run and are less susceptible to snagging. Quality, stitching, texture, compactness are better than weft knits. A wide range of fabrics from sheer lingerie to bulky sweaters, even piles and Jacquard designs are produced by warp knitting. There are seven types of warp-knitting. These are tricot, Milanese, simplex, raschel, ketten-raschel, crochet and weft-insertion warp-knit.

(i) **Tricot Knit :** The tricot knit machine has one or more warp beams mounted above it. Each set of yarns from a warp beam is fed to a row of needles arranged across the width of the machine and is controlled by yarn guide set in a guide bar which is also laid across the machine. As one guide bar is used for each set of warp yarns, the number of guide bars will be same as the number of warps beams. Thus the terms one-bar tricot (Fig 4.30A), two-bar tricot etc. are used. The greater the number of bars, the greater is the design flexibility. Highly uniform filament or textured yarns are used to get maximum efficiency and high speed.



A. Tricot stitch B. Milanese stitch C. Rashel stitch

Fig. 4.30. Some types of warp knitting

Tricot fabrics are porous and allow passage of air and moisture hence, are comfortable to wear. They are soft, wrinkle resistant, with good drape, abrasion resistant, reasonably elastic and do not run or fray. Hence, these are used for wide variety of garments such as lingerie, sleepwear, blouses, shirts, slacks and other outerwear. Some other variations of tricot knit are plain tricot, satin tricot, mesh-effect tricot, clipped dot tricot (with dot pattern) and napped tricot.

(ii) **Milanese knit :** Milanese knit fabrics resemble tricot in appearance though the technique used is different. It can be identified by the fine rib on the face and a diagonal pattern on the back (Fig 4.30B). Milanese fabrics are knitted from filament yarns and are light in weight. They are superior to tricot in smoothness, elasticity, uniformity and tear resistance but are very costly.

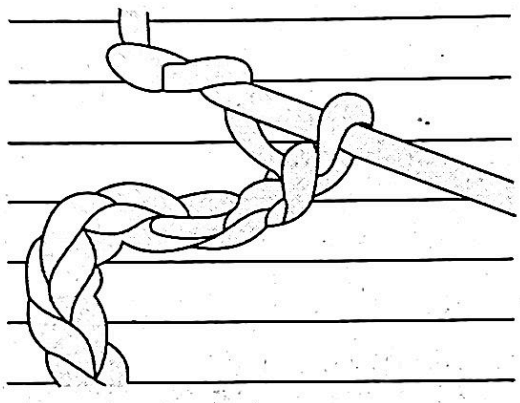
(iii) **Simplex knit :** Simplex fabrics are knitted on a machine which is like two tricot machines arranged back to back, hence the fabric also looks like a double-faced tricot. Simplex fabrics are made of fine yarns but are somewhat dense and thick. They may be napped to obtain a soft suede-like finish. Simplex fabrics are used for gloves, hand bags, sports wear etc.

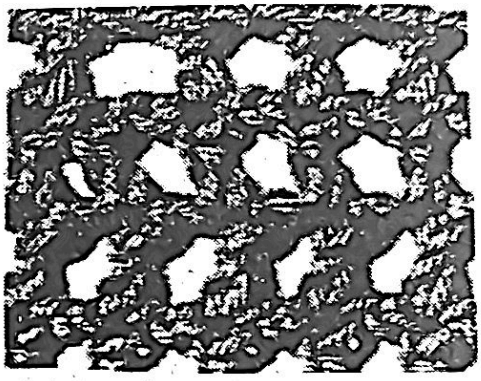
(iv) **Raschel knit :** Raschel fabrics are different from tricot fabrics in that these are made in heavy yarns and have intricate, lace like patterns (Fig 4.30C) while tricot fabrics are made of fine yarns and have simple geometrical patterns. Machines used for knitting these fabrics have two to forty-eight guide bars indicating that wide variety of fabrics can be produced with these machines. Raschel machines are very versatile and can knit every type of yarn, made of any type of fibre including metallic and glass and in any form staple, filament or novelty.

Raschel fabrics range from laces to power nets for foundation garments to such pile fabrics as carpets.

(v) **Ketten Raschel Knit :** This knit is also called chain raschel. It is a variation of tricot knit in which raised pattern effects can also be achieved. The fabric is fine with superior elasticity and cover.

(vi) **Crochet :** This is a basic stitch, which is used in hand-crochet work using a pillar chain (Fig 4.31). Wide variety of fabrics ranging from nets and laces to bed spreads can be constructed from this stitch.

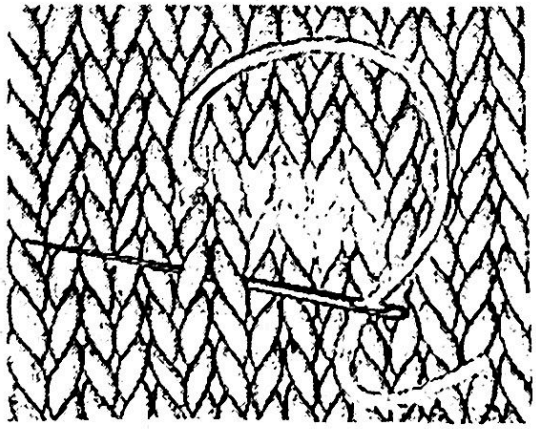




Crochet knitting

Fig. 4.31. Pillar chain of crochet work

(vii) **Weft-insertion warp knit :** Insertion knitting is a modification of knitting construction in which extra sets of yarns are woven into the knitted loops (Fig 4.32). The extra yarns provide greater stability and reduce stretchability. Weft-insertion warp knit is formed by interlacing a set of weft yarns crosswise into a warp-knit structure. The weft yarn dominates the appearance of the fabric and provides versatility because it can be of spun, slub or textured yarns, which can also impart colour, variety and pattern. Fabric stability is obtained in the width. Warp yarns can be inserted to weft knit fabrics also.



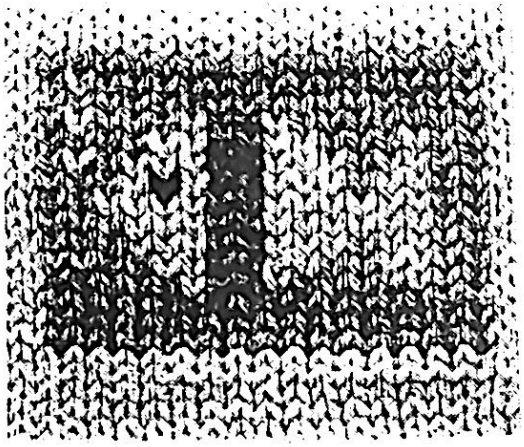


Fig. 4.32. Weft insertion warp knit

(viii) **Jacquard knitting :** Jacquard mechanism can be incorporated in both weft and warp knitting to produce multi-coloured designs. The Jacquard punched card technique used in weaving can also be adapted to knitting. Cards control the needles that are to be dropped or lifted to produce the pattern.

etc. They are used in [illegible]

V. KNOTTING

Knotting technique is being used since ages to secure the ends of a woven fabric in a decorative way i.e. to create a lacy edge. Now it is also worked separately to make household articles and is also attached to garments and other items as a trimming. The ornamental knotting technique is known as **Macrame'**. Macrame' fringes were used in Arabia as early as the thirteenth century. From there the art of macrame' spread to other countries very quickly through the sailors who bartered the articles knotted by them in other countries.

Macrame' is a craft of threads, cords or ropes which are knotted together in different ways to form various designs and patterns.

Materials required :

The material used for Macrame' is not very expensive and is easily available. The basic requirement is a variety of cords for working and to use as fillers.

1. **Cords :** Two sets of cords are used for knotting –

   (i) **Working cords** - The cords that are used to tie the knots.

   (ii) **Filler or mounting cords** – The centre cords around which the working cords are tied.

The cords should be strong enough to withstand the abrasion caused by repeated knotting and should not be too elastic. Natural fibre cords made of cotton, linen and jute are most commonly used as these are readily available, knot easily, have the required length, are in a variety of weights and colours and can also be dyed.

Jute is not colourfast therefore, should not be used for articles of outdoor use. Knitting yarns are not suitable as these are too elastic. Silk cords produce beautiful knots but are expensive and not always easy to obtain. Synthetic fibre cords made of acrylic and polyester are also suitable as they knot easily, are weather resistant, are available in bright colours and can be dyed. Nylon and rayon being silky, are difficult to use as they slip during knotting, Synthetic fibres when combined with natural fibres, provide added strength and durability to a cord.

Plied cords : Cords can be formed by twisting tightly together several lengths of filaments. Each filament length is called a ply. A three-ply cord consists of three separate filament lengths twisted together. The size of the cord is given by its diameter. Some cords are also made of braided filaments.

2. **Other supplies :** Very few materials are required for knotting (Fig 4.34). These are –

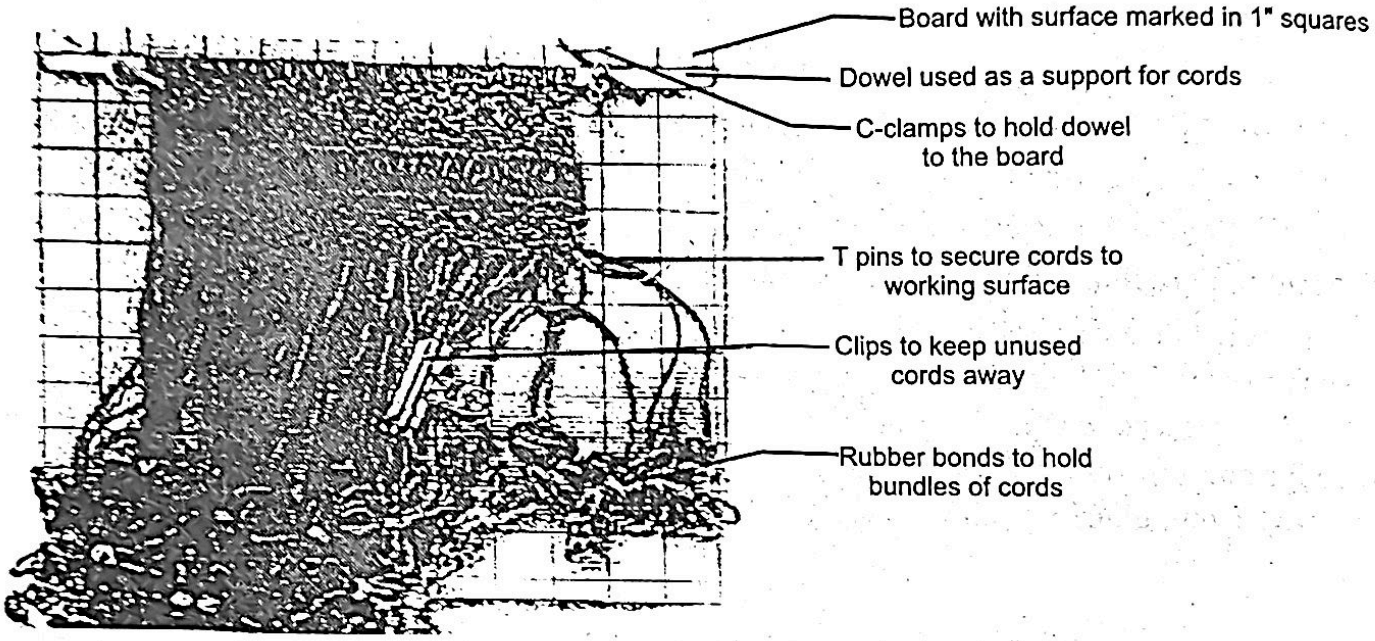


Fig. 4.34. Materials required for knotting

(i) **Knotting Board -** A knotting board is required to provide flat surface for working. The board should be thick enough to provide support and porous enough to insert pins in it. To keep the cords and knots even, the board should be covered with paper marked in one inch squares.

(ii) **Dowel or filler cord** – A support is required to mount the knotting cords so that these can be tied under tension. It can be a dowel, cord, a ring or a belt buckle. A stretcher frame can also be used as a support.

(iii) **C- clamp** – These are used to hold dowel to the knotting board.

(iv) **Pins** – Pins are required to hold cords to the board. These include T-pins, U-pins, Push pins etc.

(v) **Clips -** Clips are required to hold the cords that are not being used and keep them aside the working area.

(vi) **Scissors** – To cut the cords.

(vii) **Beads and rings** – To make the work attractive.

Estimating the length of cord required : Though it is difficult to estimate the exact length of cord required for a particular work, generally the work can be started using the individual cords seven to eight

times in length of the finished piece. This means that when the cords are folded and mounted, each working cord will be 3½ to 4 times longer then the finished piece. The required length may vary with the design and the tightness of the knots. A design with more number of knots will require a greater length of cords as compared to the one with more areas of floating cords i.e. cords without knots. Tightly tied knots require more cord length as compared to loosely tied knots.

Estimating the number of cords required : The number of cords required for a work depends upon the width of the article to be prepared and the thickness of the cords. Therefore, it is better to lay strands side by side till they measure one inch. Count the number in one inch and multiply it with measurement of the width of the article in inches i.e. if four strands laid side by side measure one inch then a piece that is ten inches wide will require forty cords when folded or tied to the mounted cord. The number will be actually twenty lengths of cords.

Techniques to Form Some Common Knots

Some commonly knots used in knotting are lark's head knot, lark's head sennit, double half hitch, square knot, square knot sennit, overhand knot, basket knot, Josphine knot, Cavandoli work etc.

1.Lark's head knot : It is a mounting knot used to tie the knotting cords to the dowel or the support. It is also called a slip knot. To tie the lark's head knot (Fig 4.35), fold the cord in half to form a loop in front of the dowel (A), carry the loop back and under the dowel (B), put two ends through the loop (C) and tighten it (D). For reverse lark's head knot, place the loop behind the dowel (A), bring loop down in front of the dowel (B), pull the two ends through the loop (C) and tighten them (D). It is also called reverse slip knot.

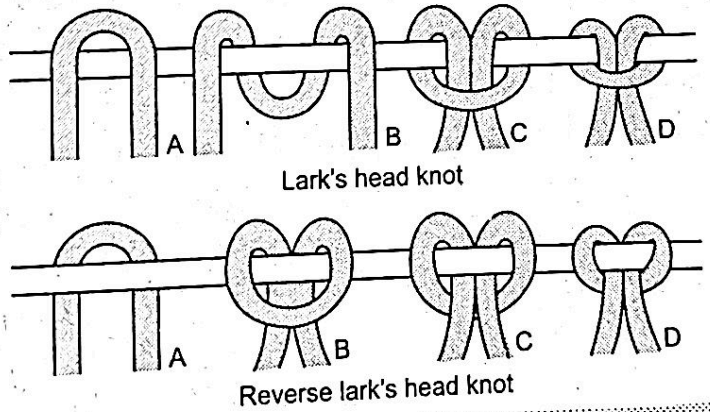


Fig. 4.35. To make Lark's head knot and Reverse Lark's head knot

2.Lark's head sennit : It is a chain of lark's head knots worked vertically. To make it (Fig 4.36), bring knotting cord over anchor cord (the cord around which the knots are tied) then around and behind it, then through the space between the two (A). Then bring the knotting cord under the anchor cord, around and in front of it and down through the space between knotting and anchor cords (B). Tighten the knots and repeat.

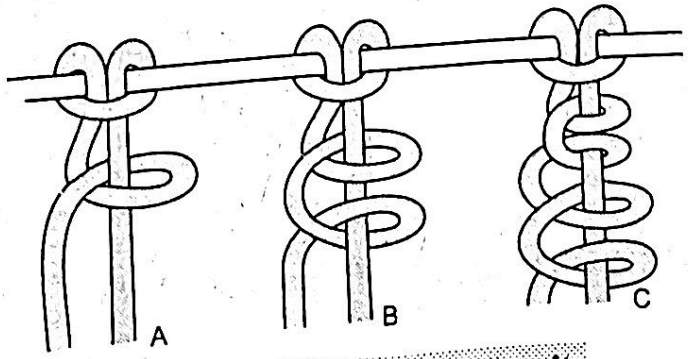


Fig. 4.36. Lark's head sennit

3. Double half hitch : The double half hitch is a basic knot and is also called the clove hitch. It is formed by knotting two half hitches one after the other. The half hitch is rarely used alone, though it can be added to the double half hitch to form triple half hitch. The double half hitch requires two cords; one to be used as knotting cord and the other as the holding cord, which is held taut during the knotting process. To make a half hitch, hold the knotting cord behind the holding cord, bring it under the holding cord then up and over it. Bring the end through the loop (A) and tighten the knot (B). To form it a double half hitch (Fig 4.37), again bring the knotting cord up and over the holding cord, put the end through the loop formed by the knotting cord (C) and pull to form a tight knot (D).

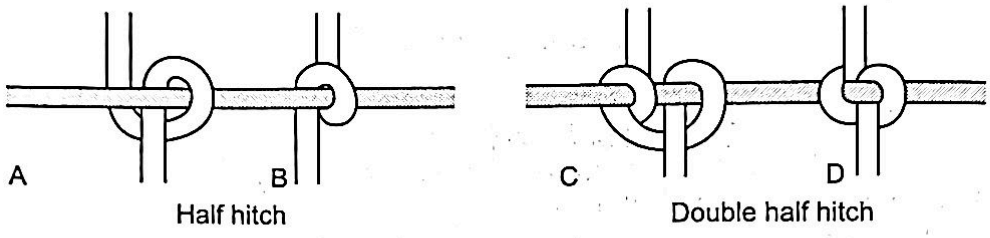


Fig. 4.37. The Double Half Hitch

The double half hitch is tied in straight lines vertically, horizontally or diagonally according to the position of the holding cord. To make a horizontal line, place the left cord in the horizontal position across the other cords in the row. Tie a double half hitch with the second cord on the left. Then tie a similar knot with each of the cords across the row. After knotting the last cord, turn the holding cord in the opposite direction and work from right to left (Fig 4.38A.). To make the diagonal lines, place the holding cord diagonally and make a double half hitch with each cord (Fig 4.38B). Vertical half hitch knot is a variation of the double half hitch, in which the holding cord becomes the knotting cord and each of the knotting cord becomes a holding cord (Fig 4.39A). Rows of double half hitches can be combines to form many designs such as diamonds, crosses, zig-zag etc. (Fig 4.39B).

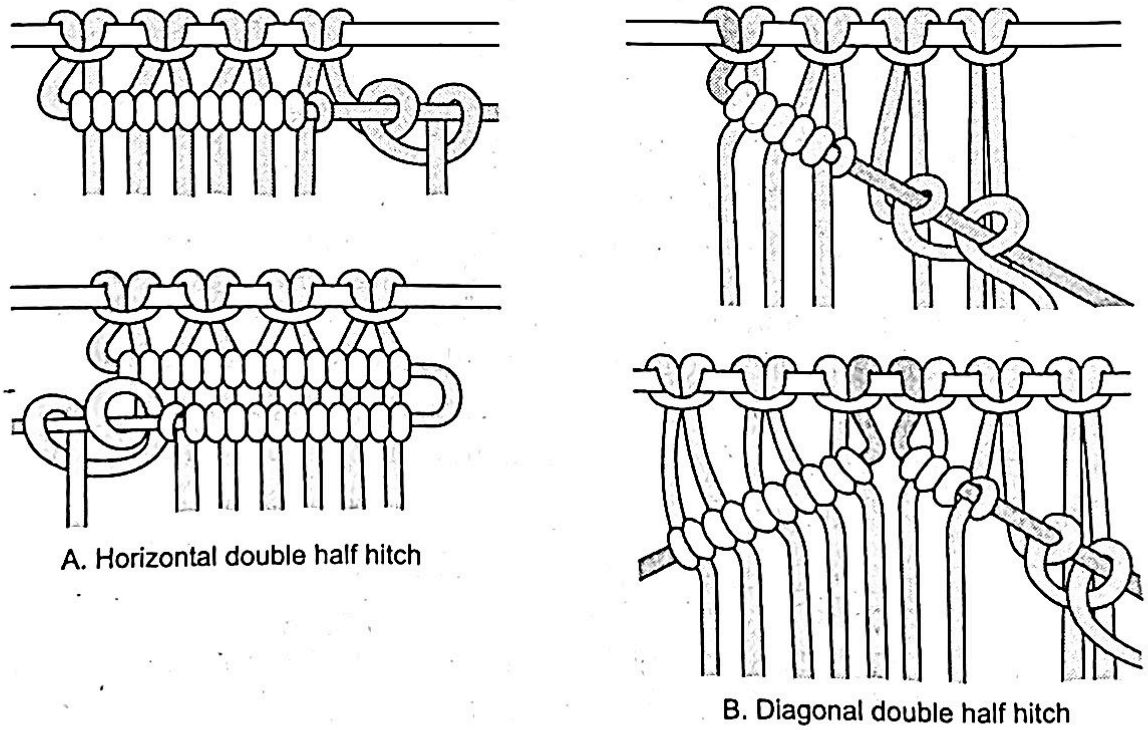
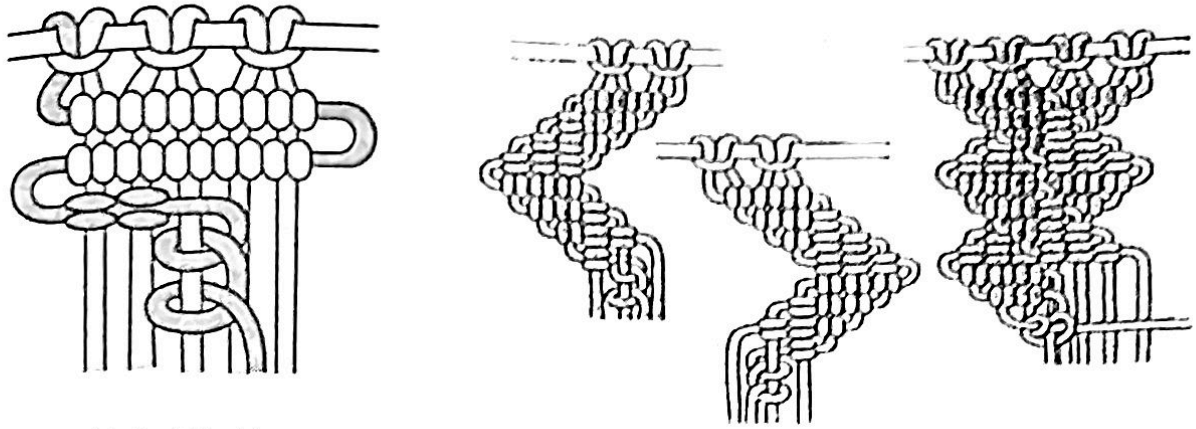


Fig. 4.38. Using double half hitch in design

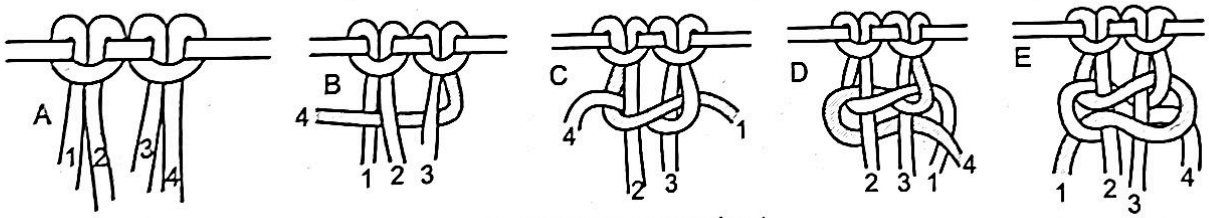


A. Vertical Double Half Hitch

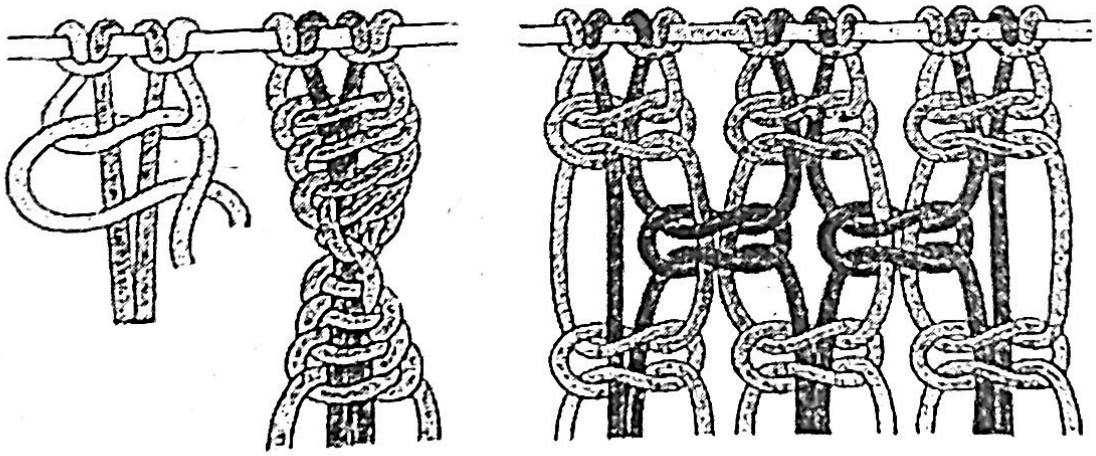
B. Double half hitches joined to make designs

Fig. 4.39. Half hitch designs

4. Square knots : The square knot is also a fundamental knot which is tied with four cords. The two inside cords are anchor cords, the two outer cords are knotting cords. To make a square knot, number the knots from left to right 1 to 4. Bring cord 4 under the two centre cords and over cord 1 (Fig 4.40A). Then bring cord 1 over the two centre cords and up through the loop made by cord 4. Keeping cord 2 and 3 taut, pull on tightly cord 1 and 4 to make the first half of the knot. For second half, being cord 4 under the two centre cords and over cord 1. Bring cord 1 over the two centre cords and through the loop made by cord 4. Pull on tightly cord 1 and 4 to complete the knot. A square knot lies flat.



A. Making a square knot



B. Half square knot sennit

C. Alternating square knot

Fig. 4.40. Making Square knots

5. Half square knot sennit (chain) : Tie only the first half of the square knot and loop on the left side only. If half square knot is tied tightly, it will twist around itself after tying about four knots. This will form a spiral. If the knots are tied with the right cord the chain will twist in the opposite direction (Fig 4.40B).

The square knots can be alternated by exchanging the knotting cords and anchor cords in succeeding rows of square knots (Fig 4.40C). For the first row make a basic square knot with each group of four cords. For the second row, leave aside row 1 and 2 and make a square knot using cords 3 and 4 and the cords 1 and 2 of the adjacent set. The third row repeats the first row. Alternating square knots if widely spaced, give a lace like appearance, if tied close together, they form a solid texture.

6. Overhand knot : The overhand knot is the simplest knot used in knotting. The knot requires only one cord. To make it, make a loop and bring the end of the cord through it (A). Pull to tighten the loop. Overhand knot can also be tied with the filler cord (B) or intertwined. To make the intertwining overhand knot, tie an overhand knot with one cord. Before pulling it tight, slip the second cord through the loop and tie an overhand knot with it. Pull both the knots tight (Fig 4.41).

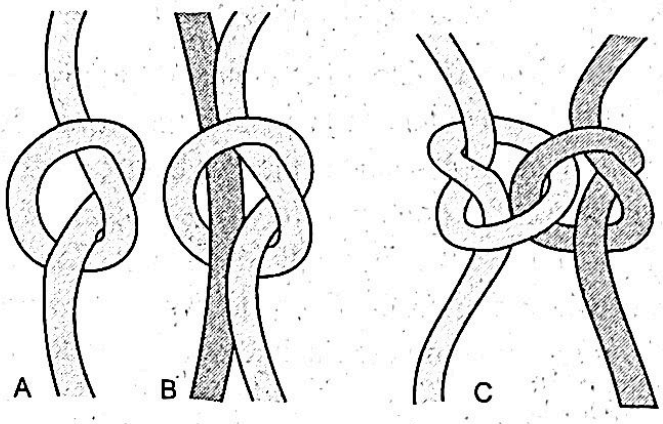


Fig. 4.41. Making an overhand knot

7. Basket knot : Basket knot is made by using two cords. Cord 1 cord is passed over the cord 2 towards right and then behind to the left. Cord 2 in then folded upwards behind cord 1 and again brought forward through the loop formed by cord 1 while passing over cord 2. Cord 1 is again passed over cord 2 on one side and below it on the other thus forming a square shaped knot as shown in Fig 4.42.

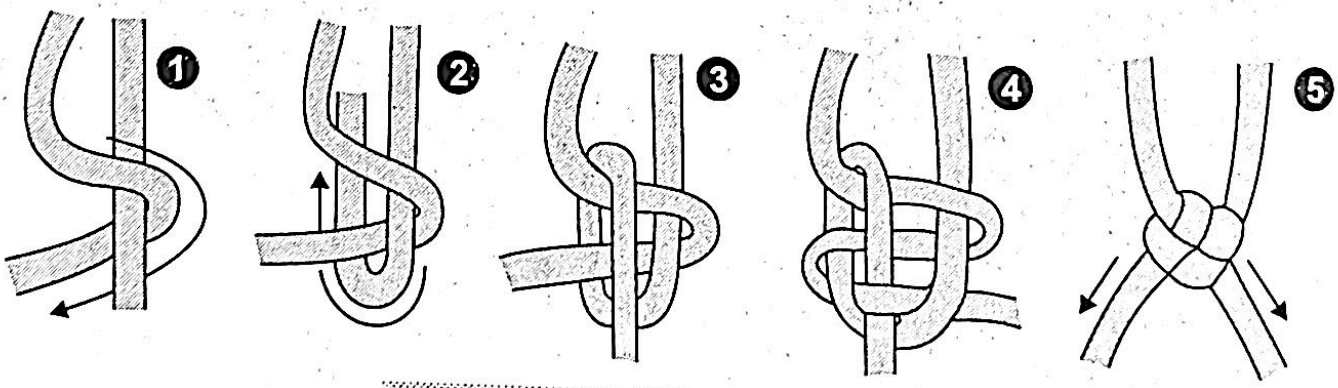
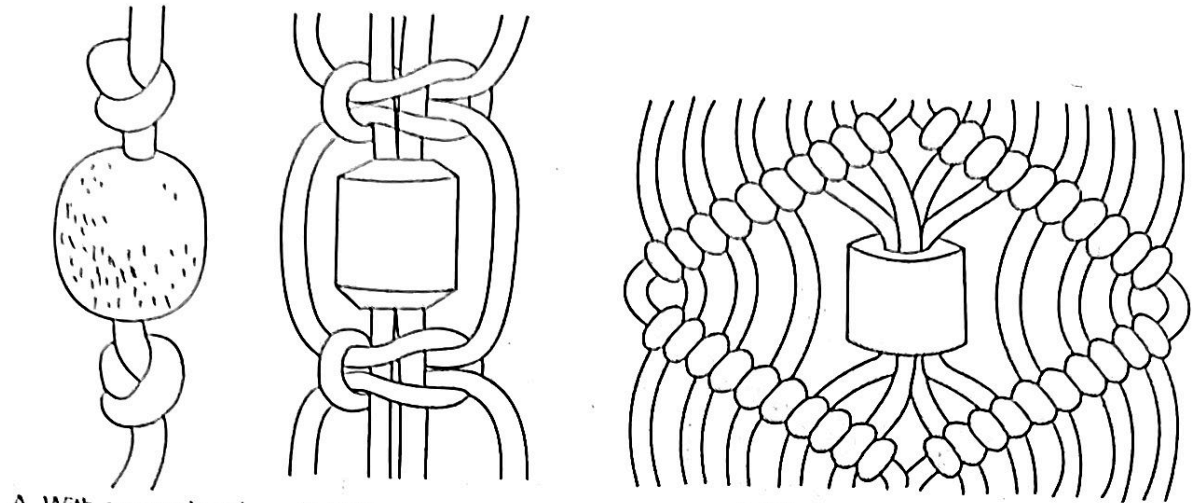


Fig. 4.42. Making a Basket knot

8. Josphine knot : Josphine knot is also known as Carrick bend. Mount two cords at midpoint so that there become four working cords. Make a loop with the left cords placing the working end under the beginning end (A). Then place the right cords on top of the loop that was formed with the left cords. Bring the ends of the right cords under the ends of the left cords (B). The right cords are woven over and under the other cords going from the upper left to the lower right (C). Put cord ends to make loops even and tighten the knot (Fig 4.43).



A. With an overhand knot B. With a square knot C. With double half hitches

Fig. 4.46. Adding beads with knots

Uses : Knotting is used to make many utility and decorative articles. Utility articles such as laces, fringes, bags, chairs, Baby swings, bottle racks, napkin holders, cutlery holders, pot holders, Magazine holders etc. and decorative articles such as curtains, wall hangings etc.

IMPORTANT QUESTIONS

SUBJECTIVE QUESTIONS

1. Define weaving. Explain basket and twill weave.
2. Explain bonding and felting.
3. What is a loom? Explain the equipment and steps involved in plain weaving.
4. Explain the steps involved in the manufacture of felted fabric.

SHORT QUESTIONS

1. Write about following
   (i) Harness (ii) Plain weave fabrics (iii) Fulling (iv) Properties of bonded fabrics
2. Fill in the blanks :
   (i) _____, _____, _____ and _____ are the methods of fabric construction.
   (ii) _____ is s process of interlacement of warp and weft.
   (iii) Woven fabrics are made of two sets of yarns known as _____ and _____ yarns.
   (iv) Two types of simple weaves are _____ and _____.
   (v) A fabric structure formed by interconnecting loops is a _____.
   (vi) Felt is not suitable for clothing because of its low _____.
   (vii) _____ force is used to bind the fabrics in felt.
   (viii) Non-woven fabrics are of two types _____ and _____.
   (ix) Knotting technique of fabric construction is known as _____.

Ans. (i) weaving, knitting, bonding, felting (ii) weaving (iii) warp and weft (iv) basket weave, twill weave (v) knitted fabric (vi) tensile strength (vii) frictional (viii) durable, disposable (ix) Macrame'

IV. BONDING

Bonded fabrics are non-woven fabrics in which techniques other than interlacing are employed for adhering the fibres to each other. The fibres may be held together by some mechanical, chemical, thermal or solvent means or their combination. Felted fabrics are also non-woven fabrics but bonding is different from felting in the sense that in felting frictional force is used as bonding agent while in bonding other techniques of bonding the fibres are to be applied. The history of non-woven fabrics dates back to early 1930s however, the invention of new types of binders recently has led to a greater interest in the development of this technique.

Manufacturing Process :

Any fibre that will not melt due to heat used during processing can be used. The fibres include cotton, wool, rayon, acetate, nylon, polyester, acrylic, polypropylene etc. Cotton or viscose rayon alone or in combination form the base of most non-woven fabrics. Very short and waste fibres can also be used but longer fibres produce stronger fabrics. Two techniques are used for bonding fibres :

(i) Thermoplastic fibres such as cellulose acetate are combined with cotton and heated to soften the thermoplastic fibres which fuse over and around the other fibres. As the fibres cool, these are held firmly together. The resulting product resembles cloth or paper.

(ii) In another process a binder is used in the form of a melt, solution or emulsion. Rubber latex, synthetic-resin emulsions and water soluble derivatives of cellulose are some of the binders used.

The steps involved in the manufacture of bonded fabrics are :

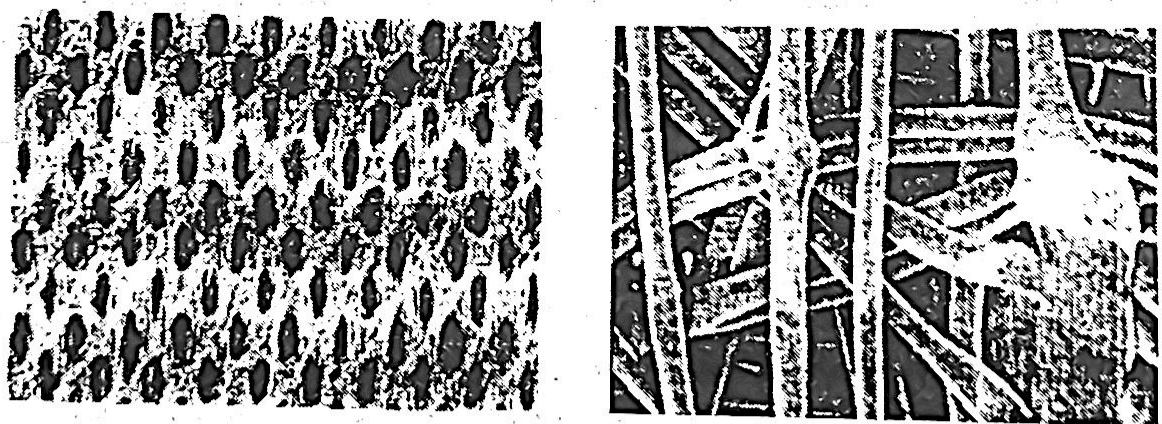
1. **Cleaning :** The fibres are cleaned and impurities are separated.
2. **Web formation :** A non-woven fabric is basically a web of fibres held together in some way. The web may be of staple fibres or filaments.
   (i) **Webs from staple fibres :** Carding is used to make multi-layered webs from staple fibres. In a carded web the fibres are aligned more or less parallel to each other. Thin webs of parallel fibres may be **parallel-laid,** i.e. in the same direction, **cross-laid** or **random-laid.**

The parallel laid web has high length-wise strength but low cross-wise strength. These webs are produced for disposable products. Cross -aid web has greater cross-wise strength but is costly to produce. To form the **random-laid web**, loose fibres are blown on to a rotating perforated vacuum drum. Randomly laid webs are very uniform. **High-velocity sprayed** web is used for thermoplastic fibres in which fibres are first sprayed and then heat and pressure are applied to fuse them. **Wet-lay web** is based on paper making technique in which fibres are mixed with certain chemicals, processed through beaters and pulpers and then passed on to a wire screen. Excess moisture is drawn off leaving a web, which is then compressed.

(ii) **Webs from filaments :** Filaments can also be tangled together to form the webs. Freshly extruded filaments are allowed to drop in curls and spirals on a moving belt which may contain patterns outlined in pins. The filaments arrange themselves around the pins and form attractive patterns. Thermoplastic filament fibres are heated sufficiently to fuse together to form a strong fabric suitable for curtains, tablecloths etc.

3. **Bonding the web :** Several methods are used for bonding the fibres in the web to form fabrics.

(i) **Resin Bonding :** If the fibres are absorbent, the web is saturated by spraying with or immersing in a bath containing suitable bonding agent (Fig 4.33A). It is then compressed between two rollers to squeeze out excess liquid. The web is then dried and heat-cured at a temperature of 93-204°C depending upon the material used.



A. Adhesive bonding in cellulose wiper–adhesive applied in dark stripes

B. Melt bonding in thermoplastic fibres

Fig. 4.33. Techniques of Bonding Fibres

(ii) **Latex foam bonding :** Latex foam may be used for bonding the fibres into non-woven fabrics. Latex may be applied to the web of fibres by pressure-spreading, spraying or by using some other technique.

(iii) **Heat bonding :** When a web of thermoplastic fibres or filaments is heated, the fibres soften into each other at many points. At the points where fibres cross over each other, rigid joints are formed (Fig 4.33B) in the non woven fabric which make the heat bonded fabrics stiff.

(iv) **Stitch bonding :** Webs may also be given extra strength by stitching them through with yarns. Thermoplastic yarns may be used to stitch laminated webs together. The application of heat softens and shrinks the thread which bonds the web structure, making it more compact. Such structures are more flexible and less paper-like than heat-bonded or adhesive-bonded fabrics.

4. **Finishing non-woven fabrics :** Only limited finishing techniques can be applied to non-woven fabrics. Dyeing is done after the fabric is formed. Calendering can be done for smoothness, embossing for textured effects, printing may also be done. Softness may be added for better feel.

Properties of non-woven/bonded fabrics :

Properties of non-woven fabrics are variable depending upon the fibres used and technique applied to form the web as well as for bonding.

(i) Their appearance can be paper-like, felt-like or like woven fabrics.

(ii) They may be soft to touch and resilient or hard, stiff and very little pliable.

(iii) They may be thin as tissue paper or many times thicker.

(iv) They may be transparent or opaque.

(v) They may be highly porous or impermeable.

(vi) Their tensile strength may be very low to very high

(vii) They may have a good drape or no drape at all.

(viii) They may be easy to wash or not washable at all.

Uses of non-woven/bonded fabrics :

Non woven fabrics are of two types – durable and disposable. Durable non-woven are used for apparel such as caps, interlinings, interfacing, for home furnishings such as draperies, furniture upholstery, mattress padding, carpet backing, for industrial purposes such as filters, insulation etc. Disposable non-woven are for one-time use only but some can be laundered and reused e.g. dust cloths, cellulose wipers etc. They are used in diapers, sanitary napkins, surgical and industrial masks, bandages and towels.

III. FELTING

Making cloth from loose fibres is the oldest technique of fabric construction. The primitive nomadic tribes matted the wool fibre into a compact mass to use it as tents, saddle bags and other articles because wool is the one natural fibre that possesses a special property of being formed directly into a compact mass having strength and durability. The construction of a fabric from loose wool fibres without any interlacing is known as **felting.**

Felt as defined by the Felt Association Inc.(1944) " **is a fibrous material which is built up of interlocked wool fibres by mechanical and chemical action, moisture and heat**".

The felting property of wool is due to the scaly structure on the surface of the fibre and its crimpy nature as well as the ease with which it can be deformed and recover from deformation. The primary mechanism of felting is abrasion. As the individual fibres get rubbed together the scales entangle in one another interlock and the whole thing shrinks in an irreversible way to make a mat that can't be separated. Wetting the surface makes it easy for the scales to soften and swell up. For this purpose, wetting alternately with hot and cold water ('shocking') works the best. If the pressure is applied or the fibre is agitated in a moist condition, it tends to turn to the root end. The presence of alkalies increases the ease of movement.

Thus felting is caused by the ability of the wool fibre to coil up on itself, interlock and shrink when subjected to heat, moisture and pressure (friction and agitation also). This results in the formation of a compact fabric which is strong enough to withstand considerable pulling out. Fibres without such frictional properties of wool can also form felts though they need more direct external force to tangle the fibres.

The Felting Process :

Today, specially designed machinery is used to form the felt. Wool used for felting consists principally of fleece wool though reprocessed or reused wool can also be used.

(i) **Sorting and grading :** Wool is graded according to fineness, colour and strength.

(ii) **Scouring :** Wool is then scoured with hot alkali solution. The remaining burrs and vegetable matter are dissolved by treating it with a weak solution of sulphuric acid and then subject it to heat. Vegetable matter that turns into carbon is crushed by heavy rollers and removed by dusting machines.

(iii) **Carding :** The cleaned fibres of different qualities are mixed or blended to obtain the desired quality. The mixed stock is then carded to complete the cleaning and disentangle and straighten the fibres thoroughly. In the wool felting process, two carding operations are carried out to make the fibres parallel and of even thickness in the form of a fine web. Several webs may be built up to form a sufficient amount of weight or thickness. Care has to be taken that webs do not break or have weak areas. The thin webs of fibres are deposited on to a circulating belt on which these are arranged one upon the other to form a soft fluffy 'batt' which is ½ to 2 inches thick. The batt is then cut and the edges trimmed to uniform size. Batts are usually 37 metres long, 60 to 90 inches wide and weigh between 8 to 23 kg.

(iv) **Felting :** After being trimmed, the batts are first rolled, then moistened evenly with warm water and placed between two heavy plates, the top one vibrates. The pressure combined with moisture and heat interlocks and entangles the fibres. Two to twelve batts are pressed together, the number depending upon the type of article desired. The machinery is automatically controlled so that it stops when the desired thickness and hardness of the felt are reached. After processing, the batts are allowed to drain off and cool for about 24 hours.

(v) **Fulling :** The next process is fulling. It consists of first dampening the felt with a suitable lubricant which may be soap, soda solution or sulphuric acid and then shrinking it by rotating it in bowls where wooden hammers compress and release the material. The lubricant helps to produce and control the shrinkage. Fulling time varies from five minutes to half an hour. The longer the felt is fulled, the firmer it will be, but if this operation is continued too long, it may spoil the quality of the felt.

(vi) **Final processing and drying :** The felt is then neutralized, scoured, rinsed and dried. Drying is done by passing it through wringers, then by centrifuging. Finally, it is stretched to the desired width in flames where the temperature is 150°-275°C, depending upon the type of the felt.

(vii) **Pressing :** Soft and medium felts are given a broad cloth finish by shearing, firm felts are smoothened with sand paper. Cylinder presses are used for pressing thin felt while heavy steam-heated plates are necessary for pressing thick, firm felt.

(viii) After pressing the felt is folded or rolled and placed in box-like machine with curved ends and hammers hanging from a shaft. These hammers swing back and forth, push, pound and roll the felt until it acquires proper thickness, firmness, length and width.

(ix) **Cleaning and dyeing :** The felt is now passed through a washing machine equipped with heavy rollers and is thoroughly cleaned. If the felt is to be finished in a natural colour, then it goes to the dryer. If some colour is to be applied, then it is dyed and then dried.

(x) **Finishing :** The fine qualities of felt are passed through a shearing machine where all loose ends of fibres are cut from the surface. Then it is pressed with steam-heated heavy rotary pressing machine, which gives it a smooth lustrous finish. Felts may also be stiffened, brushed to raise a nap, given water-repellent finish, flame-proofed or moth proofed depending upon their use.

Types of Felt :

Felt is of two types – Made from wool and from fur. These may be blended with other fibres also to provide variety.

(i) **Wool Felt :** In any blend at least half of the fibre should be wool as wool is the only fibre that has cohesiveness to produce this type of construction. Short staple fibres or noil are used for felt but finer the grade of staple used, stronger is the felt. Cotton, kapok, rayon etc. are also combined with wool but felts made from such blends are dull, with harder feel and rough texture. Acetate, nylon and acrylic are also blended with wool to produce cross dyeing colour effects, improve the drape and reduce the tendency to shrink.

(ii) **Fur Felt :** Fur felt is made from the fur of rabbit, beaver and muskrat, which has short fibres. For best quality of hats, beaver fur is used and muskrat fur is added for sheen. Fur felt is usually made from mixture of fibres in which fur contributes softness, smoothness, resilience and water repellency.

Properties of Felt :

(i) Felting is the inexpensive method of fabric construction in which short fibres can be used.

(ii) Felt does not have any threads therefore, it does not frail like many woven fabrics and does not ravel like knitted ones.

(iii) Felt has no warp or filling threads, thus it is simple to use in fabric construction.

(iv) No twisted yarns are used in felt and there is no interlacing. Hence felt has very little tensile strength and no stretchability.

(v) Felt has no elasticity and drapability.
(vi) Sewing is difficult and mended parts are clearly visible.
(vii) Felt can be cut in any shape.
(viii) It has good resilience and retains its shape unless subjected to undue tension.
(ix) Wool felt is highly thermal insulating. It provides warmth.
(x) It absorbs sound and shock and quite impervious to water.
(xi) Wool felt shrinks thus cannot be washed. It should only be dry-cleaned.

Uses of Felt :

Felt is not very suitable as clothing because of its low tensile strength but it is especially preferred for hats. Insulating and noise absorptive properties make it suitable for various industrial uses. Flexible felts are used for jackets, shirts, blazers, slippers, shoe – insoles etc. while thick fabrics are used for rugs, padding for tables and insulating materials. **Namdhas,** the embroidered felt throw rugs are the speciality of Kashmir.