Weekly Publication of

Cotton Association of India

COTTON STATISTICS & NEWS

Edited & Published by Amar Singh

2018-19 • No. 15 • 10th July, 2018 Published every Tuesday

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Journey of Cotton from Fibre to Yarn - Part II

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Introduction

The first part of this article depicted the processes involved upto the carding of fibres. The sequential processes from bale breaking to carding explained the flow of fibre preparation and refinement. The machines and devices involved found their true relevance in accomplishing their respective functions. The understanding of these processes and the mechanism involved in the creation of yarn therein are highlighted in this article which is a sequel to the earlier one.

GUEST COLUMN

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Combing

The greatest difference in the production of fine yarns, is due to the introduction of the combing process between the card and the draw frame. It is often customary to comb cottons of 1.5 inches in length and longer in order to produce fine, smooth and lustrous yarns. Here again, the fibres are cleaned, made parallel and separated from the shorter ones. Cotton is always carded even when intended for combing. All long cotton fibres contain a fair proportion of short fibres, which reduce the average value of the material for spinning purposes and extraction of these short fibres is done by the combing process.

Before cotton is combed, it is necessary to transform the carded sliver into comber laps of the correct width and uniform thickness, so that the combing may proceed efficiently. A sliver lap machine first transforms a number of carded slivers (14-24) into a lap by passing through rollers. Eighteen card slivers are run together to form a narrow uniform ribbon lap. In the ribbon lap machine, a number of superimposed laps are passed through pairs of rollers and drawn out, to be attenuated by the increasing speed of each pair of rollers. The amount of drafting is usually equal to the number of laps fed, as the main drafting is usually equal to the number of laps fed. The main object of the process is to form an even lap. Owing to the drafting action, the fibres tend to become parallel. Thus, the combing process involving nippers, combs and rollers to extract all the impurities and short fibres resulting in good spinning qualities. Thus, 20 to 30 percent extracts of the cotton is delivered from the card, adding to

the cost of the subsequent yarn, which is essential for high quality cottons. These very fine yarns are rarely needed. The great bulk of fine combed yarns range between 80s and 200s. The combing of cotton may be done on the Heilmann machine which is intermittent in action. The Nathsmith comb is an improvement over this machine and deal with shorter fibres of 1inch staple length.

Drawing

The sliver delivered from the card is very irregular in weight throughout its length and the fibres in the strand are badly crossed with each other. Drafting process is done to overcome these defects. Generally, six card slivers are fed together, and consequently the delivered strand is the same weight as one of the slivers fed to the machine. This folding together while not eliminating the defects of varying slivers, averages the differences and gives a more uniform strand. The folding and attenuating in repeated two, three, or four times and the machines are provided with the detector mechanism to stop the machines when a sliver fails to pass forward.

The continued drawing of fibres one over the other while attenuating the slivers, causes the fibres to take up a position parallel to each other. This arrangement is necessary before the fibres are twisted together, in order to obtain the most efficient yarn.

Fly Frame

The sliver delivered from the drawing frame consists of a rope of cotton fibres that have been cleaned, separated, strengthened and made parallel, and varying very little in weight along its length. The object of this fly frame process is to reduce this sliver gradually to a fine "rove" weighing ½ to 2 grains per yard ready for the final spinning. A series of fly frames are used usually three in number viz., slubber, intermediate and roving frames. The first named is fed with the draw frame sliver, and the roving frame delivers a "rove" ready for the spinning frame. During the operation the strand has become too thin to hold together by the natural cohesion of the fibre, so that a few turns of twist are inserted at each machine to hold it together. The softly twisted "rove" is then wound on a wooden bobbin of convenient size by a special mechanism.

Spinning

In its narrowest and restricted sense, spinning is the attenuating of twisted strands of fibres into a yarn or thread. In a slightly wider sense, the spinning process generally includes three basic processes which may be carried out by one machine. These three processes are the drawing of the roving to the required weight, the insertion of twist by a moving spindle and the winding of the twisted yarn into the bobbin. In the factory method of spinning, large numbers of spindles operate together in a frame. The three fundamental processes of spinning viz., attenuation, twisting and winding may be carried out by the different spinning methods described below. There are primarily five methods of spinning - 1. Flyer spinning. 2. Throwing 3. Cap spinning . 4. Ring spinning. 5. Mule spinning.

1. **Flyer Spinning:** The use of flyers and bobbins by Arkwright was the beginning of modern industrial spinning. This system is more common in Flax spinning. It is also employed for preparing rovings in cotton spinning. The spun yarn is wound on to the bobbin. When the bobbin is full of yarn it must be "doffed" or removed , so that it may be replaced by an empty bobbin. This causes the removal of the flyer which is one of the disadvantages of this type of spinning. The alternative name for the fly frame is throstle frame. The chief purpose of the flyer frames for rovings is to achieve drafting with the minimum twist for winding, as distinct from the insertion of twist in the spinning of strong yarns.

2. **Throwing:** A particular use of flyer and bobbin system of inserting twist is applied to yarns or filaments in which more twist is required or which have to be doubled together to form multiple yarns. It is largely used in the "throwing" of real silk filaments which enable the twisting of a number of fibres together. In actual throwing processes, a number of raw silk threads are cleaned by passing over a cloth-covered blade and wound together. The threads are first twisted, then doubled and then given the second twist or throwing proper. The threads are doubled and then thrown with about 2.5 to 7 turns per inch. The textile material to be twisted must already be in the form of a coherent and continuous thread.

3. **Cap Spinning:** This may be regarded as the precursor of the modern ring spinning but it is still used in the spinning of worsted yarns.

The spindle is fixed in the frame and the hollow cap shaped like an elongated bell is pushed on to the tapering tip of the spindle. Both cap and spindle remain stationary during the process. Cap spun yarns are generally full and hairy and so possess characteristic qualities. A disadvantage of this system of spinning lies in the fact that the cap must be removed before the full bobbin can be taken from the frame i.e. (doffed) and replaced by an empty bobbin.

4. **Ring Spinning:** The ring frame is probably responsible for most of the cotton spinning in the world with the exception of Great Britain where Mule spinning is still more prevalent. Ring spinning is also used for worsted yarns, dry flax and for doubling yarns of all materials.

5. **Mule Spinning:** The term "mule" indicates the hybrid nature of the mechanism as it combines some of the Hargreaves Spinning Jenny with the Arkwright's water frame. Mule spinning also attenuates the roving by drawing rollers, but the twist is inserted in the same manner similar to the old hand spinning wheel where the yarn was held at an angle to the spinning spindle. The revolving spindles impart a twist to the drawn stand resulting in the movement away from the drawing rollers. This produces a "stretch", or the length of the yarn, about 60 inches. When the drawing and twisting cease, the length of the spun yarn is wound automatically on the spindle in the form of a cop. Mule spinning is an intermittent operation and thus does not produce as rapidly as the ring frame which is a continuous spinner.

Doubling

In almost all the operations of cotton spinning, some combination or mixing of raw cotton, sliver or roving takes place to obtain uniformity, but the "doubling" refers to the twisting together of spun cotton yarns or of yarns spun from other material. Such combinations offer greater scope for a doubler with his materials than the spinner.

Strength, smoothness and novelty of appearance are obtained by variation in process and the doubler must be flexible in his operations to the changing requirements and conditions. Extra strength is given to single yarns by doubling with the correct amount of twist, without unduly increasing the thickness or diameter. This facilitates the use of the doubled yarn in the warp of Italians, alpaca, lenos, fustians, etc. Strength is naturally the chief requisite of sewing, netting, twine and heald yarns, whilst tyre fabrics, lace, embroidery and crochet yarns must have a greater strength than a single yarn of the same thickness could possibly give.

Variable Requirement of Yarn and Adjustments in the Process

When fine or high counts of yarns are to be spun, certain modifications are necessary in the spinning process. For the long staple cottons, certain alterations are needed in the opening, cleaning and attenuating operations. It is more difficult to remove impurities from the long fibred cotton due to their liability to entanglement. Also, greater care is to be executed while treating these long delicate fibres as compared to the short fibres. Adjustments in the processes before spinning with required variable speeds would satisfy the need for creating the required yarn. To obtain extra attenuation necessary to produce a finer roving for the final spinning frame, a fourth machine known as the "Jack Frame" is frequently employed, where the drawing rollers are specially designed to acquire a wider variation in the length of fibre, a characteristic feature in long staple cottons.

Folded Yarns

The yarn produced by a cotton, flax, wool or worsted spinner, is always a single yarn. But for many purposes it is necessary to have doubled yarns i.e., single yarns twisted together. This operation is accomplished by a branch of industry known as twisters and doublers. Single yarns may be doubled in two ways either twist against twist or twist on twist. The former one results in lustrous yarn, while twist on twist is generally used in the production of voile yarns and crepe yarns. These are hard, bare and winy threads having twist factors of 7 to 10. Twist against twist may reduce the twist of a single yarn. Twist factors of 4 to 6 are common with most folded yarns. Thus, doubling is not limited to two yarns or the same type of yarn. By using different tensions, counts and other factors, it is possible to create numerous fancy doubled yarns.

Sewing cottons are a special type of folded yarns. They are mostly folded in two stages, first twist on twist with a twist factor of about 4.5 followed by twist against with a factor of about

6.5 to balance the previous twisting. In most cases, the number by which the thread is sold, indicates the count of the thread after the first doubling. Thus, 6/60s is made from three threads of 2/120s count.

One of the earliest commercial sewing cotton was 3/30s i.e. 3 yarns of 30s single, equivalent to a single resultant count of 10s. The diameter of the yarn enabled it to be used with a certain type of needle eye, and hence to the resultant unit. In this manner 2/30, 3/30,4/30 and 6/30 actually contain 2 strands of 20s, 3 strands of 30s, 4 strands of 40s or 6 strands of 60 respectively; it is only with the 3 ply sewing cotton that the figure on the ticket or label represents the count of the original singles yarn. Individual manufacturers are rather prone to use their own system. Thus, there is no uniformity in practice.

The machinery involved in spinning processes are listed in Table 1.

Table 1. Machinery Used in Fibre Processing

Sr. No.	Name of the machine	Use
1	Mixing and Blowing Room	
1a	Bale Breaker	To break open the bales for loosening the fibres
2	Mixing (different bales of cotton)	
2a	Hopper Bale Opener	To break the lumps of cotton, loosen the fibres and remove impurities
2b	Hopper Feeders	Feeding the bales for moving the bales in the conveyor belt
3	Openers	
3a	Vertical Opener	To clean and deliver opened cotton (a pair of cage and lattice is involved)
3b	Exhaust Opener	Cotton is made into a lap or be subjected to a further opening by a bladed beater and then made into a lap
3c	Horizontal Opener	Abundant opening and cleaning surfaces
4	Scutcher	Opener with bladed beater or porcupine beater
5	Pedal Rollers (Piano motion)	Regulating the feed motion to regulate the length of the lap
6	Carding Machine	Besides opening and cleaning, it has provided two new ordered conditions of the cottons viz., a web and a raw form called a sliver.
7	Drawing Frames	Drawing action of the sliver and parallelisation of fibres and doubling process.
8	Combers	Combing number of slivers side by side
8a	Derby Doubler or Sliver Lap Machine	A number of slivers are passed through drawing rollers and made into very thin sheets
8b	Ribbon Lap Machine	Several thin sheets are combined to form a thick sheet which is then rolled up into a lap about 10 inches wide
8c	Can	Then these slivers are made into one sliver and wound on a can
9a	Flyer and Bobbin Frames	To reduce a thick sliver down to a very thin condition termed a roving (drawing process)
9b	Self Acting Mules	To revolve the spindle at a suitable speed to wind in the yarn in the form of cop (cardly spaced into) given to it by the shaper
10	Spinning	
10a	Movement of the carriage during spinning	To achieve gain in excess of surface speed (gain)
10b	Movement of Carriage by Winding (Drawing-Up, Scrolls)	Keeping the carriage under control by slow speed

10c	Spindle Drawing during Spinning	Spindle revolving at higher speed during twisting process
11	Ring Spinning	Spinning and winding are done at the same time creating a building motion
12	Driving the Spindles during Winding	An indirect method is used to revolve the spindles for winding on the twisted yarn that lies between the spindles and the rollers when the carriage has completed its actual run.
13	Shaper	Moving the copper faller wire (moving wire), produce widely spread coils on the cop and then gives a series of closely wound coils on the cop's surface
14	Winding Two methods, 1.Cone drum 2. Quadrant	To increase the capacity of the cop to contain large quantity of yarns. The final product of yarns wound in larger bobbins viz., pirns, paper tubes, etc and are ready for transporting to the cloth manufacturer.

The above mentioned processes were accomplished due to the continuity of inventions which occurred during the period when the importance of textiles were beginning to be recognised. They have been chronicled in Table 2 below.

Table 2. Inventions in the Cotton Industry

Sr. No.	Name of the inventor	Machine/Device	Year
1	Wyatt	Drawing Frame	1738
2	Lewis Paul	Card	1748
3	Lewis Paul	Doffing Comb Mechanism	1750
4	Hargreaves	Spinning Jenny	1764
5	Crompton	Mule	1779
6	Creighton	Scutcher	1797
7	Richard Roberts	Self Acting Mule and Ring Frame	1825
8	Holdsworth	Differential Motion	1830
9	Lord	Piano Feed Motion (pedal rollers)	1862

Summary

The accessories involved in the various process are essentially, rollers, drawers, travellers, Cards (wires, flats), revolving spindles, and finally bobbins. These components play a primary role in the functioning of the entire spinning processes.

In a nutshell, all the above processes (Table.1) shared by the respective machinery (Table 1) are involved in a cotton spinning mill. The cotton is changed from the slab masses of a bale to open fluffy cotton, then gathered together into a thick fleece and rolled up into a lap. This is opened out and spread into a long wide and very thin web which is so thin that it can be gathered together into a form of rope called sliver. The sliver is drawn out into a gradually decreasing thickness called a roving. This roving is ultimately drawn sufficiently fine that it can be twisted or spun into a yarn. The departments of the mill involved are usually as follows: Bale room, mixing room, scutching room (often called blowing room), card room and spinning room.

The recent innovations, to name a few viz., automated ring spinning, rotor spinning, compact spinning, airjet spinning and vortex spinning have taken the spinning world to great heights. Germany and Switzerland have recently sprung up as pioneers in textile machinery development with precision in automation. Thus a basic understanding of the spinning processes depicted here, will serve as a precursor for tracking the advancements in the growing spinning industry.

(The views expressed in this column are of the author and not that of Cotton Association of India)
