6. Drafting and Gilling of Fibrous Assemblies

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Learning objectives

On completion of this topic you should be able to:

- Explain the principles of roller drafting and the devices used to achieve this
- Define the terms associated with the drafting process and distinguish between calculated and actual drafts
- Describe the purposes and method of doubling
- Explain how periodic irregularities are introduced into slivers during roller drafting and pin drafting, and the factors that may influence this.
- Describe the various methods of controlling fibre in drafting
- Explain the purpose of autolevelling of slivers and the devices used for this process
- Describe the essential features of a gillbox, comparing the screw drive, chain gill and pinned roller mechanisms
- Explain the interaction of the faller pins with the front and back rollers to improve the fibre alignment and straightness in gilled slivers
- Outline how faller bar marks occur in gilled slivers

Key terms and concepts

Drafting, drawing, linear density, fibre extent, doubling, sliver irregularity, ratch, fibre control, apron, auto-levelling, gilling (pin drafter), faller, screw gill, chain gill, intersecting pin gillbox

Introduction to the topic

In wool yarn manufacture, an integrated series of operations is required to convert disorganised tufts of staple fibres into an organized twisted strand. Carding commences the process, but further steps are required before the yarn can be spun. The fibres are delivered to the next processing stage by a worsted and semiworsted card in the form of a sliver. This is a thick rope of fibres which are not well organised or aligned, with perhaps 20,000 – 30,000 fibres at each cross-section throughout its length. In comparison, yarns of 20 – 200 tex may have 50 to 500 fibres in their cross-section. To produce yarns of such counts, and with acceptable properties (strength, evenness, etc.) the fibres in a card sliver must be straightened, aligned and made parallel. This enables effective drafting so that the sliver count can be appropriately reduced (i.e. attenuated) to obtain the required yarn count during spinning.

Gilling improves the straightness and alignment of the fibres in a sliver, while drafting reduces its linear density (or count) by the desired amount. Both processes may be carried out by the same machine, a gillbox (or pin drafting machine), but drafting is also employed to attenuate slivers, tops and rovings in other spinning operations. For example, a worsted spinning frame uses roller drafting to reduce the linear density of a roving to enable a yarn of the required count to be spun.

The process of doubling, where multiple ends of sliver are fed in parallel into a gillbox, or other textile machines such as a comb, also produces excellent fibre blending. The drawing process is a combination of doubling and drafting.

The general references for this topic are Lawrence (2003) and Oxtoby (1987).

6.1 Drafting and doubling

Before considering gilling in detail, it is necessary to consider the various fibre manipulations that occur during gilling, in particular the principles of drafting, doubling and fibre control in gilling and other textile processes.

Drafting

A comprehensive theoretical treatment of drafting is given by Grosberg and Lype (1999).

Drafting is the process of drawing out (or *attenuating*) a fibrous assembly, such as a sliver, top or roving, to form a thinner strand of fibres (Lawrence 2003). The result is a longer, continuous strand of fibres with a lower linear density than before, i.e. with fewer fibres in the cross-section, and the fibres are straighter and more parallel. It is usual to specify the linear density of slivers and tops (or their mass per unit length, or their *count*) in kilotex. This unit of linear density is equivalent to grams per metre.

Drafting causes the fibres to slide past each other so that the fibrous assembly becomes longer and thinner. It does not significantly stretch the individual fibres; it merely rearranges their relative positions as they pass through the drafting zone between the two pairs of rollers.

Drafting is required at various stages of worsted and semiworsted yarn manufacture (i.e. gilling, combing and drawing). *Roller drafting* is performed by passing a sliver or roving between two pairs of driven rollers. The delivery (or front) rollers have a higher surface speed than the feed-in (or back) rollers.

The amount of draft produced in roller drafting is calculated from the ratio of the surface speeds or the ratio of the linear density of the input sliver(s) to the linear density of the output sliver. Figure 6.1 shows a simple example.

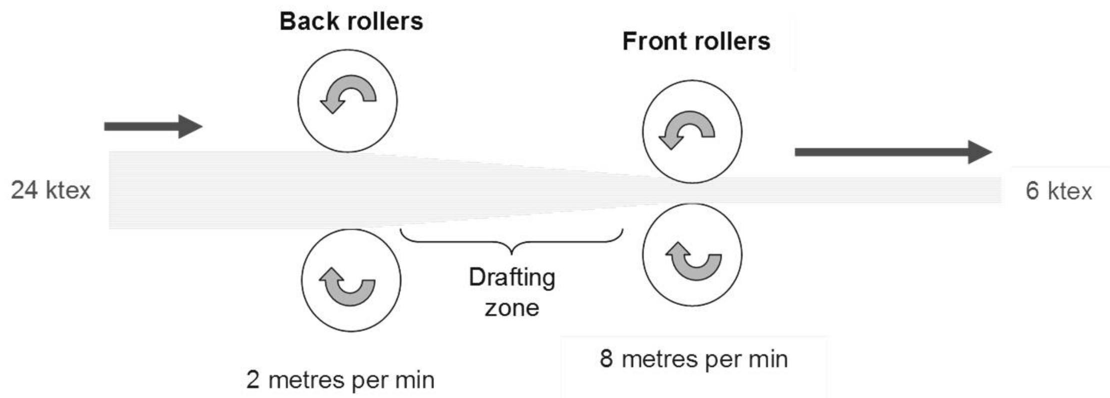

Figure 6.1 Simple roller drafting example. Source: Wood, 2006.

Using the surface speeds:

Draft = surface speed of front roller / surface speed of back roller

= 8 metres per minute / 2 metres per minute

= 4 (the front rollers are rotating 4 times faster than the back rollers)

Using the linear densities:

Draft = linear density of input sliver / linear density of output sliver

Since the draft = 4, and the linear of the input sliver is 24 ktex, the linear density of the output sliver is 6 ktex. It is thinner and longer by a factor of 4 than the input sliver.

Calculated and actual draft

The calculated draft D is derived from the machine settings, i.e. the roller speeds while the actual draft D' is the based on the ratio of the linear densities of the slivers. D' is usually less than the calculated draft D because of differences in fibre cohesion, recoverable fibre crimp and the elasticity of the sliver due to fibre entanglement and disorientation.

The ratio D'/D, which in the ideal case is 1, decreases with greater fibre entanglement in the feed sliver and increases at higher drafts. The ratio is usually in the range 0.85 – 0.95.

The amount of draft employed in a particular situation depends on:

a) the design of the drafting zone
b) the fibre length distribution
c) the fibre extent (i.e. the distance it extends along the sliver, less than its length of the fibre is crimped or hooked)
d) the disposition of hooked fibres, and
e) the linear density of the input material.

Figure 6.2 defines the terms 'fibre extent' and hooked fibres.

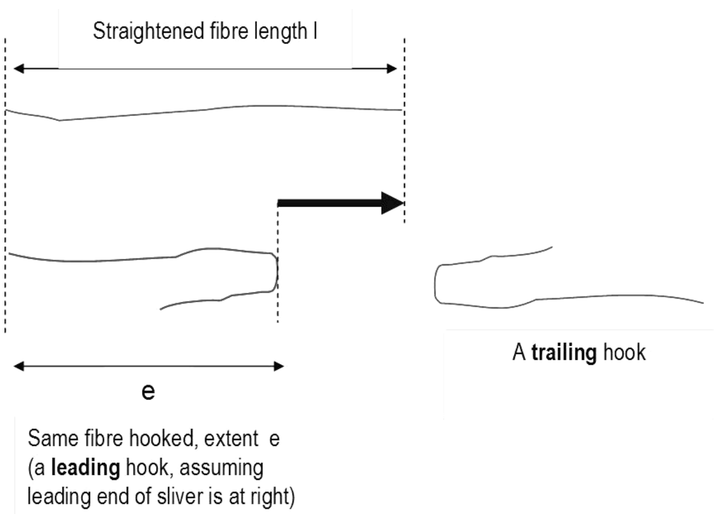

Figure 6.2 Hooked fibres in sliver. Source: Wood, 2006.

The general relationship between the irregularity of a product (i.e. variation in its mass per unit length) and the draft used to produce it is shown in Figure 6.3. The graph shows that there is an optimum range of drafts for a given fibre or given machine. As a general rule, more draft can be applied to longer fibres, to fibres with a low coefficient of variation of fibre length, or when fibres have a majority of trailing hooks.

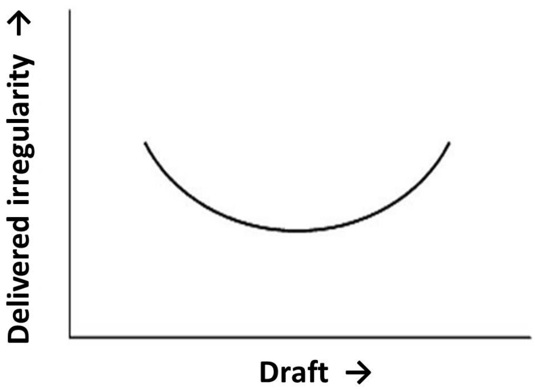

Figure 6.3 Relationship between draft and irregularity. Source: Wood, 2006.

Doubling

Doubling is the feeding of two or more ends of sliver or roving side-by-side into a drafting zone so that they are combined together and are delivered as one strand. The purpose of doubling is to promote regularity, fibre mixing and fibre alignment, as well as to maximize machine productivity.

In the example illustrated in Figure 6.1, the input sliver could be:
- a single 24 ktex sliver, or
- two 12 ktex slivers, or
- three 8 ktex slivers, or
- four 6 ktex slivers, etc.

The number of doublings is often matched to the draft, i.e. feeding in four ends of 6ktex sliver is fed into a drafting unit, which is set to a draft of four. In this case a 6 ktex sliver will be produced. On the other hand, if the draft exceeds the number of doublings, the result will be a reduction in sliver count. For example, if the draft above was increased to 6, the output sliver would have a count of 4 ktex (a reduction from 6 ktex).

There are three possible relationships between doubling and drafts:
1. doublings > draft
2. doublings = drafts
3. doubling < drafts

The first of these is only used where mixing is of prime importance.

The second is used where mixing is important but an increased sliver thickness is to be avoided. Under this arrangement the delivered sliver is the same count as the each of the individual ends fed into the drafting zone. Hence repeated drafts may be applied to improve fibre alignment without a reduction in sliver thickness.

The third arrangement is used to obtain a reduction in linear density (i.e. count). The rate of reduction depends on the ratio draft/doublings. This ratio is frequently increased towards the latter part of the preparations for worsted ring spinning.

Doubling and sliver count variation

The Law of Doubling says that the variation in linear density of the combined sliver CV_c will be the average of the variation of the n individual slivers $(CV_i)_{av}$, divided by the square root of the number of slivers being combined, i.e.:

$$CV_c = (CV_i)_{av} / \sqrt{n}$$

Some of the thick spots in a sliver may coincide with thin spots in other slivers, so the overall variation in linear density will decrease if more than one sliver is being drafted. Another way of looking at this effect is that after doubling the number of fibres increases in the sliver cross-section, which improves the evenness of the doubled material.

In general the coefficient of variation of the linear density of the combined slivers is less than that of each individual sliver. However, doublings cannot be relied upon to eliminate the effects of periodic thickness variations, i.e. variations which repeat at regular intervals.

The short-term irregularity of a yarn is not greatly affected by the number of doublings used in the drawing processes which precede spinning. Autolevelling has provided an alternative means of controlling irregularity; however the use of doublings is still important because current autolevelling devices cannot correct short term irregularities.

The reduction in sliver variation due to the Law of Doubling is limited by another effect – the Law of Addition. Each drafting operation adds variation in sliver linear density because it reduces the number of fibres in the sliver (or roving) cross-section and adds other drafting defects. This can be expressed by the formula:

$$CV^2(\text{out}) = CV^2(\text{in}) + CV^2(\text{added})$$

The variation in the linear density of the final sliver CV(out) will be increased because the drafting action adds variation. The amount of variation added (CV(added)) is a function of the drafting device and is different for each type.

Irregular drafting of slivers

(a) The effect of ratch setting

The distance between the contact points ('nips') of the back rollers and front rollers is called the *ratch*. Under normal conditions, any fibres extending longer than the ratch will be held by both the back and front rollers at the same time and therefore may be stretched and broken. Hence the ratch should not be set much closer than the length of the longest fibre which is not to be broken. If the ratch is set too close, the front rollers may deliver small undrafted tufts of fibres.

Floating fibres lie between the front and back rollers without being held in the nip of either. They are not under positive control – for their movement through the drafting zone they depend upon their chance contacts with other fibres. Because it is not possible to control floating fibres, variations in the thickness of the delivered sliver will inevitably arise – this is usually called *irregularity* or its reciprocal, *evenness*.

A greater variation in fibre length will lead to an increased number of floating fibres, and hence greater sliver irregularity. The main problem in roller drafting is to develop some form of control over the floating fibres. Better fibre control permits high drafts, and thereby reduces the number of operations required to provide a given reduction in sliver thickness.

An increase in the ratch will increase the proportion of floating fibres in the drafting zone, but this does not necessarily lead to greater irregularity in the product.

(b) Drafting waves

'Perfect' drafting, which preserves the original random fibre arrangement in a sliver, is unattainable because of the lack of positive control of the floating fibres. These are acted on by frictional forces due to contact with other fibres that are moving at speeds between those of the back rollers and the front rollers. It is on these frictional forces that the motion of each floating fibre depends.

In practice drafting is not ideal, and irregular drafting can occur from machine factors and fibre factors. Mechanical or electrical defects in the machinery can lead to variation in the nip position, or rollers can change speed intermittently or regularly. Rollers may be eccentric or out of shape. Another cause may be slippage between fibres and rollers, poor fibre alignment and the presence of short fibres.

Some fibres released from the back rollers tend to accelerate before they reach the front roller nip – short fibres tend to arrive in bunches, forming a thick place. When such a thick place arrives at the front rollers, a greater force is required to draft it and so the following portion between the rollers is drafted to a greater extent. A thin place is thus formed by the premature movement forward of some fibres. When this thin place subsequently reaches the front rollers the drafting force decreases, the movement of the fibres is delayed and so the thin place will be followed by another thick place, and so on.

Irregularities of this sort, called drafting waves, are quite repetitive (i.e. quasi-periodic) and are independent of any imperfections of the drafting machinery. The factors determining the irregularity in single zone drafting are:

- the size of the draft
- the count of the input material
- multiple inputs (doubling)
- roller or drafting zone setting
- the degree of parallelism, length and fineness in the input sliver.

(c) Machine defects

(1) Eccentric rollers
Roller eccentricity (where the axis of rotation is off-centre) will cause the nip of a roller to fluctuate in position, and this alternately lengthens and shortens the drafting zones. Usually the effect of such movement of the back roller nip line is negligible, but it is of much greater significance with the front roller pair.

The number of fibre leading ends nipped by the front rollers will vary in a regularly repeated manner, resulting in thick and thin places in the drafted material. The forward movement of the nip line increases the spacing between the fibre ends to produce the thin places, and the backward movement produces the opposite. This gives a periodic variation with a wavelength equal to the roller circumference. These variations are readily identified by the spectrograph function on the Uster Evenness Tester.

The eccentricity of the bottom roller is more of a problem than eccentricity of the top roller. This is because the bottom roller is directly driven so that as well as introducing the nip movement the roller surface speed will also fluctuate regularly. The result is a periodic fault with a larger amplitude than would be cause by an eccentric top roller.

(2) Roller slip
Roller slip may occur either at the back or front roller pair. Since the bottom rollers are directly driven, these are more likely to slip. The bottom rollers drive the top rollers and the fibre beards. If there is insufficient pressure at a roller nip, the bottom roller slips by and does not impart the correct surface speed to the fibre beard and the top roller. Changes to the top roller speed, caused by bottom roller slip, will introduce irregularities into the output sliver. It is obvious that the thicker the fibre beard between the rollers the greater is the chance of bottom roller slip. This problem is therefore associated with inputs of high linear densities.

Periodic changes in the speeds of bottom rollers, causing periodic variations can result from faults in the drive system and worn bearings.

6.2 Methods of fibre control in drafting

Drafting waves may be minimised by increasing the effective control over the movement of short fibres. This may achieved by the application of suitable additives to increase inter-fibre friction.

Alternatively, control of short fibres may be achieved by applying pressure to fibres in the drafting zone using an ‘apron’, or using pins.

Pin control

This method is based on the fact that if pins penetrate through an already tensioned sliver, the pressure between the fibres will be increased. Pin control helps to minimise fibre entanglement and nep formation, particularly with fine fibres. The amount of inter-fibre and fibre/pin pressure will depend on the length, thickness and population density of the pins, as well as the count and fibre density of the sliver being processed.

Pin control has been widely used in the processing of relatively long fibres such as jute, flax and worsted wool. The development of high speed gill boxes has led to the widespread use of pin control in the worsted and semiworsted industries. Gilling is discussed in more detail later in this topic.

Direct pressure control

Applying lateral pressure to a fibrous assembly such as a sliver increases inter-fibre friction while still permitting fibre slippage. This can be done with a variety of devices.

In the **carrier and tumbler** device (Figure 6.4), positively driven carriers support the fibres while a set of heavy tumblers rest on the materials and rotate by surface contact. The tumbler mass and its distance from the front rollers may be adjusted to alter the degree of control. Maximum drafts of around 10 are possible.

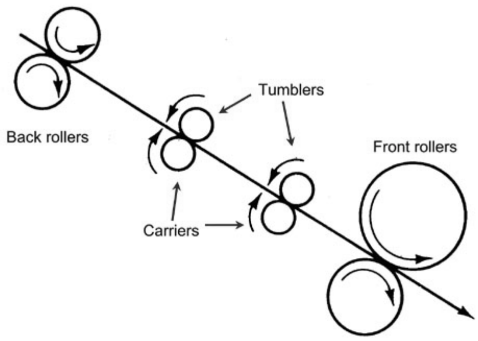

Figure 6.4 Drafting assisted by tumbler and carrier rollers. Source: Wood, 2006.

In the **apron and tumbler** device (Figure 6.5), the positively driven apron provides continuous support for the fibres. The tumbler ends are located in slots which make it easy to alter the distance of the tumblers from the front rollers. Drafts from 15 – 25 are possible with this system.

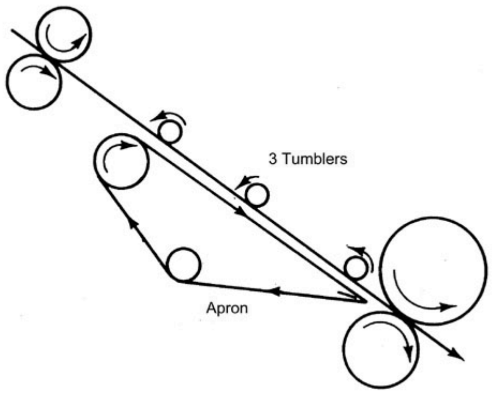

Figure 6.5 Drafting assisted by tumbler rollers and apron. Source: Wood, 2006.

The **double apron** device for fibre control is probably the most efficient method for frame spinning and it is widely used in worsted ring spinning (Figure 6.6). The aprons are made from synthetic, rubber-like laminates which offer a long working life, strength and resistance to fibre additives.

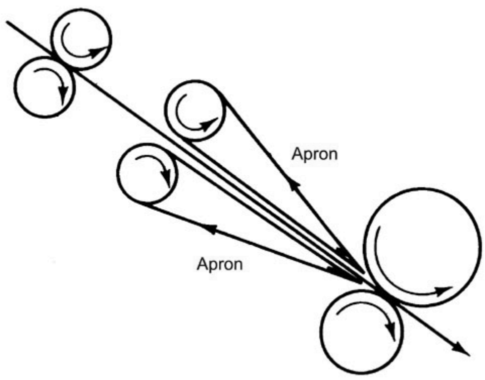

Figure 6.6 Drafting assisted by pair of aprons. Source: Wood, 2006.

The double aprons do not control fibre movement effectively when processing thick slivers, so that they are restricted to use in roving and spinning operations. The fibres are lightly compressed between two positively-driven aprons which have both pressure and speed adjustment. A close setting between the front end of the aprons and the front roller nip is possible because the aprons can be guided round stationary tension bars without the danger of fibre lapping. This reduces the number of uncontrolled floating fibres and therefore permits higher drafts than the previously described methods. Drafts in the range 10-40 may be used. Only a small draft of 1.1 – 1.3 is applied between the back rollers and the aprons. The main drafting zone is between the aprons and the front rollers.

The **Amblerdraft** (Figure 6.7) is highly versatile, being suitable for worsted drawing of fine and crossbred wools, man-made fibres and blends. This is because a wide range of adjustments is provided. The unit consists of two pairs of positively-driven rollers with the two nip points set at a fixed distance of 50 mm apart. However, the unit as a whole may be moved to alter the distance between the front rollers and the small tension rollers from 38 mm to 90 mm. The larger pair of rollers is scratch-fluted and the top tongued roller fits into the groove of the bottom roller, so the material is compressed into a rectangular cross-sectional shape.

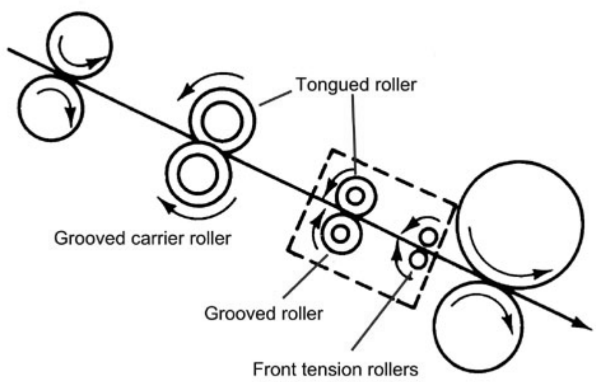

Figure 6.7 Amblerdraft system. Source: Wood, 2006.

6.3 Auto-levelling

The objective of an autoleveller device is to measure sliver thickness variations entering a drafting device and then continuously alter the draft applied to sliver accordingly to reduce these variations. More draft is applied to thick places and less draft to thin places, with the result that the sliver delivered is less irregular than it otherwise would have been.

Besides an improvement in the appearance of the sliver, autolevelling can also contribute to better production efficiency, fewer end-breaks in subsequent processes and less waste. A schematic diagram of an autoleveller control system is shown in Figure 6.8.

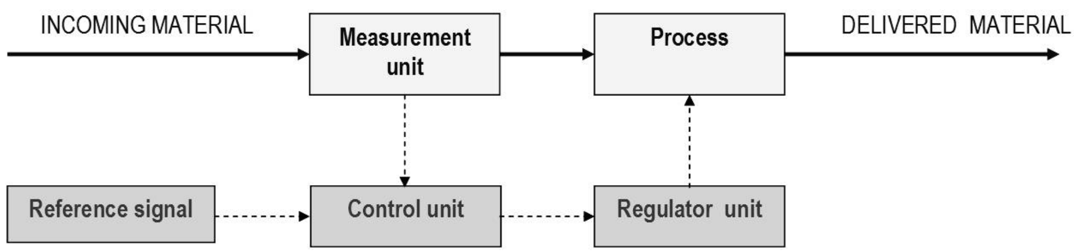

Figure 6.8 Open loop autoleveller control system. Source: Wood, 2006.

The traditional mechanical autoleveller (Figure 6.9) compresses the input sliver(s) between tongue and grooved measuring rollers, and variation in the sliver thickness causes the spacing between the two rollers to vary. This thickness variability is transmitted to movable rods on a memory wheel. After the required delay to allow the sliver to move forward to the feed rollers, the position of the rods is mechanically transmitted to a speed variator. This alters the position of a belt on cone pulleys, thus controlling the feeding speed of the sliver. The correction range is +/- 20%.

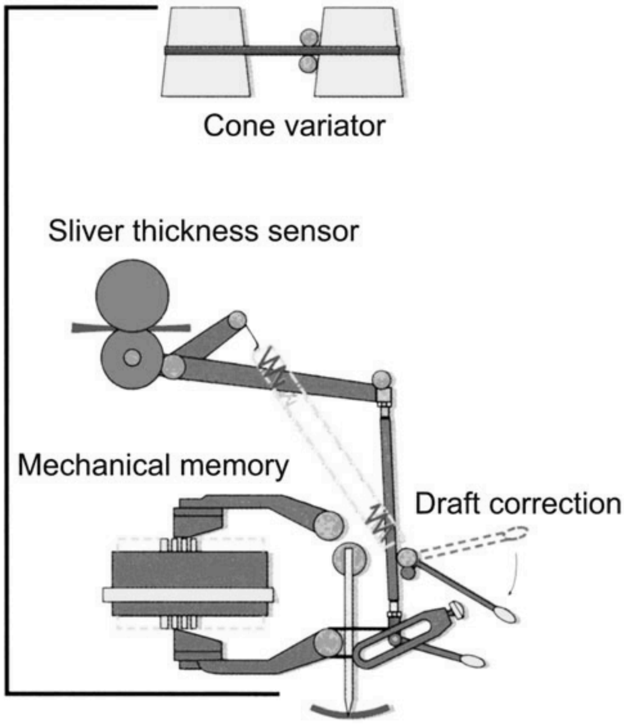

Figure 6.9 Autoleveller mechanism. Source: Sant'Andrea Novara.

Figure 6.10 is a schematic diagram of a cone variator in an autoleveller unit.

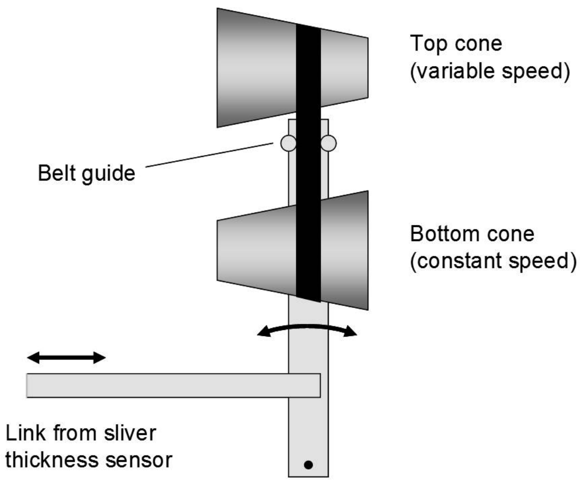

Figure 6.10 Mechanical speed variation device for autolevelling. Source: Wood, 2006.

Fully electronic autolevelling systems are also available – a version manufactured by Schlumberger for its GC15 Chain Gill is shown in Figure 6.11. Here, a computer uses the signal from a sliver thickness sensor, to speed up or slow down the front rollers, thereby compensating by an increase or decrease in draft for a thick or thin place in the sliver.

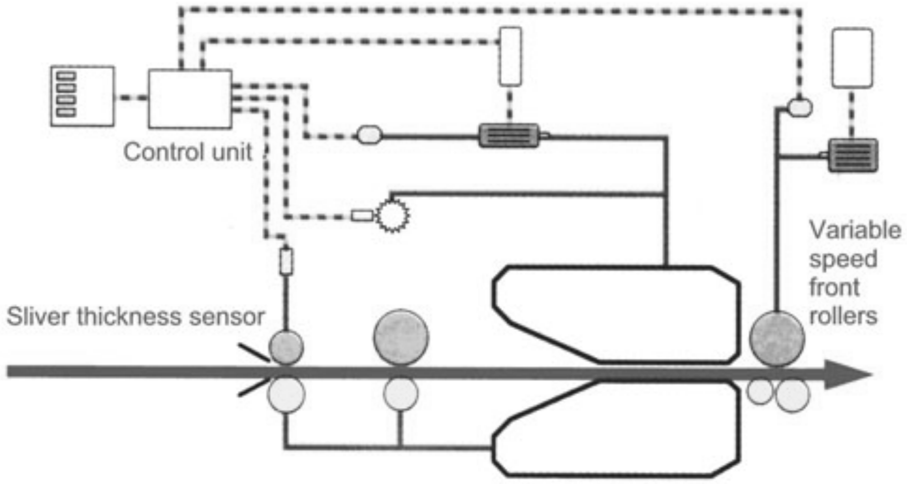

Figure 6.11 Electronic autolevelling system. Source: NCS Schlumberger.

6.4 Gilling mechanisms

In worsted top making the card sliver is subjected to a number of preparatory gilling or pin-drafting operations prior to combing, in order to straighten and improve the parallelisation of the fibres, to provide further mixing and to reduce the fluctuations in linear density of the sliver. These steps are called *preparer gilling*.

Further gilling steps, called *finisher gilling,* also occur after combing, to give a highly uniform sliver called *top*. Combing aligns the leading ends of the fibres, which adversely affects the sliver cohesion and subsequent processing. One of the main objectives of finisher gilling is to again randomize the leading fibre ends by drafting. Finisher gilling also provides further blending, straightening and aligning of the fibres, and the addition of moisture and oil, to produce a top of the required linear density and evenness. The first finisher operation generally involves up to 30 doublings and drafts between 5 and 10, while the second operation involves only 4 or 5 doublings.

Gilling plays a similar role in the preparation of semiworsted card sliver for spinning.

The essential parts of a gill box (or pin drafter) are shown in Figure 6.12.

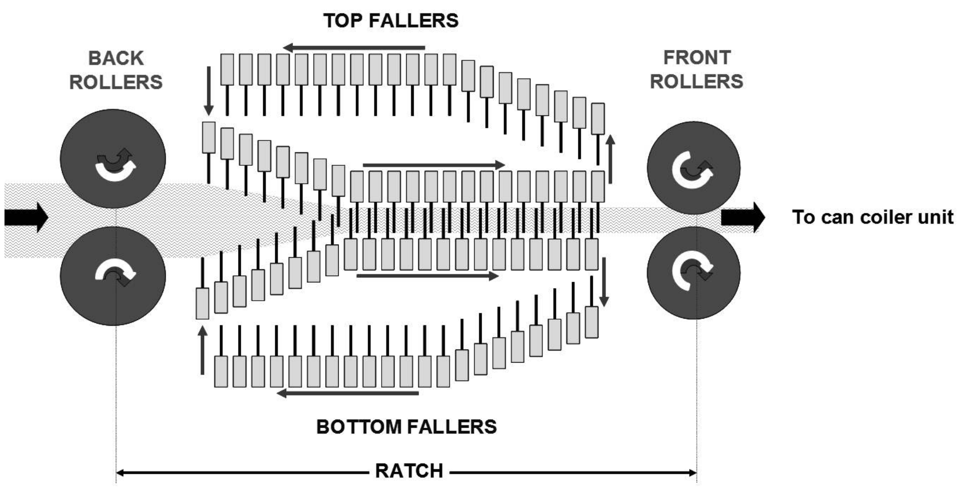

Figure 6.12 Principles of a gillbox (screw-driver fallers). Source: Wood, 2006.

The fallers are metal bars with up to about 100 sharp steel pins projecting from their working surfaces and equally spaced along the length of the bars (Figure 6.13). The pins may be round or flat; round pins are more robust but flat pins give better fibre control. This is because for the same number per unit length they have a larger free space within which a greater number of fibres can be held. The faller lengths are parallel to the nip lines of the front and back roller and penetrate the sliver vertically.

Figure 6.13 A gillbox faller. Source: Wood, 2006.

Gill boxes can be equipped with either mechanical or electronic autolevellers (see later) and can also be fitted with spraying devices. Adding moisture during high speed gilling is important to achieve the desired regain for subsequent processing. A lubricant (0.1-0.3%) may also be sprayed onto the sliver during the first or second gilling operations to assist in maintaining (or increasing) regain, minimizing static effects and modifying the fibre-to-fibre cohesion. Integrated suction and blowing systems keep the heads clean.

The gilling action

A number of slivers (doublings) pass between the back rollers (or feed rollers), merge into one sliver and are progressively penetrated and held between pins mounted on the fallers. Upper and lower sets of intersecting fallers move forward towards the front rollers (or delivery rollers) at a slightly higher linear speed than the surface speed of the back rollers. This speed difference applies a tension to the sliver.

At the end of its travel each faller is withdrawn and transported back to the starting point where it gradually re-penetrates the fibres as it moves forward again. The front rollers operate at a faster surface speed than the back rollers so the sliver is drafted to produce a sliver of the required linear density. Typical drafts of 5 – 15 are used.

The length of the drafting zone, the distance between the nip lines of the front and back rollers, is called the *ratch*. The shortest distance of a line of pines from the back roller nip line is called the *back ratch* while the *front ratch* is the closest distance of a line of pins to the front roller nip line. The group of fallers penetrating the sliver between the back and front rollers is often referred to as a *bed of fallers*. The total ratch is set so that the longest fibre in the back beard (the fibres nipped by the back roller) does not extend beyond half the distance of the faller bed.

During the drafting action, each faller moves from near the back rollers towards the front rollers at a speed of around 5% faster than the back roller surface speed. Consequently, the pins gently comb the back beard and this assists in minimising the effects of sliver extension, the removal of hooks leading into the faller bed, and the straightening and aligning of fibres.

Fibres released by the back rollers are transported by the fallers to the front roller nip line where, once nipped, the sliver is fully drafted. The large different between the surface speed of the front roller and the fallers is very effective in straightening and removing trailing fibre hooks. Pulling fibres from between the pins gives far more straightening than does combing the fibres with pins.

Although the back ratch draft gives only a small amount of straightening, it is still important. If the draft in this zone is too high, the combing action of the faller pins may result in fibre breakage, and irregularities may occur because of the uncontrolled motion of the short lengths of broken fibres.

On the other hand, if the draft in the back ratch drafting zone is too low, the fibres may not be sufficiently extended to remove their natural crimp. The drafting force in the front ratch zone then reaches a level that is sufficient to break fibres, owing to the greater frictional resistance caused by the crimp retained by the fibres.

The pins are used in fibre control in that they assist in maintaining inter-fibre friction. This function, in conjunction with their restrictive effect, minimises any forward, out-of-turn movement not gripped by the front rollers. In addition, the fibres being withdrawn have their trailing ends combed by the pins, greatly accelerating the straightening and parallelisation action.

Figure 6.14 shows the actions of the faller pins and front rollers in straightening a fibre that is hooked at its trailing end. Because the surface speed of the front rollers is much higher than the speed at which the faller advances, the fibre is drawn through the teeth of the faller and it is thus straightened.

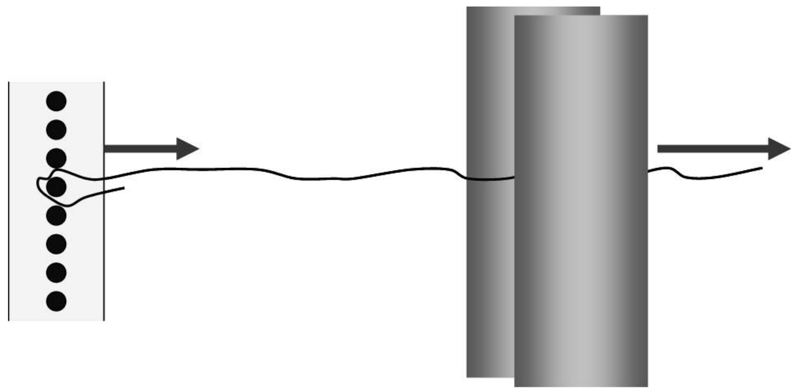

Figure 6.14 Removal of a trailing hook in a fibre. Source: Wood, 2006.

In order to provide straightening on both ends of a fibre a reversal of the direction of drafting is required in the next process (e.g. the second gilling step). Reversal of sliver direction is achieved simply by coiling the sliver into a can and then uncoiling the sliver from the top of the can at the next stage. This means that the leading hooks remaining after the first gilling step become trailing hooks at the second gilling step.

Since trailing hooks cause less fibre breakage in combing, ideally the hooks that remain after gilling should be trailing hooks. This will be achieved if there is an odd number of gilling operations between carding and combing. Three gillings are normally carried out before combing.

Increasing the pin densities in later gilling steps provides a progressive straightening and parallelisation. The initial gilling steps have lower pin densities to reduce the severity of the action so that fibre breakage is minimised.

Faller transport mechanisms

The traditional mechanism for the faller motion has been to mount the ends of the fallers in the grooves of two rotating screws. At the end of its travel towards the front roller, rotating cams knock the faller on to another pair of rotating screws with a coarser pitch. These screws quickly return the faller to its starting position, where it is mechanically re-positioned on the original screws. The screw gill mechanism has two major limitations:

1) A speed limitation is associated with the screw traversing mechanism and the speed of disengaging the faller bars, and

2) There is an environmental problem of excessive noise.

While for many years the upper speed limit for screw gills was considered to be around 1,500 faller drops per minutes, speeds of up to 2,500 drop per minute are now possible. This corresponds to about 22 metres per minute input.

The development of other gilling mechanisms has increased input speeds to around 75 metres per minute, and with production rates of 750 kg/hour. Fewer screw gills are manufactured now, with the main mechanism being the chain gill, where the fallers are attached to a pair of driven chains (Figure 6.15).

At the sides of the machines the faller ends are arranged to run in tracks which determine the faller orientation. Impact forces on fallers are greatly reduced (in comparison with screw gills), permitting much higher faller speeds. Faller speeds equivalent to 5000 faller drops per minute are possible, and chain gills operate at up to 4 times the production rate of traditional screw gills.

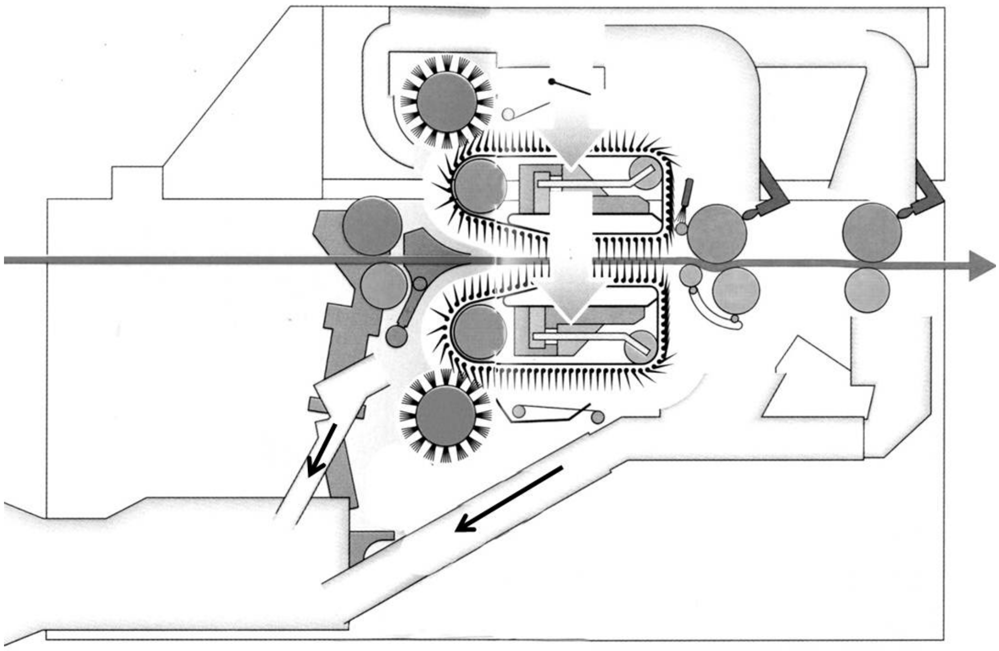

Figure 6.15 Chain gill showing dust removal system. Source: NCS Schlumberger.

Other alternatives to screw-driven fallers include rotating pinned cylinders (Figure 6.16). However, this system has a difficulty in obtaining a short enough distance between the pins and the nip of the front roller. For fibres shorter than about 55 mm mean fibre length, a screw gill box is preferred. Chain gills are favoured for longer fibres, when higher production rates are possible. They have largely replaced screw gills in semiworsted carpet yarn production.

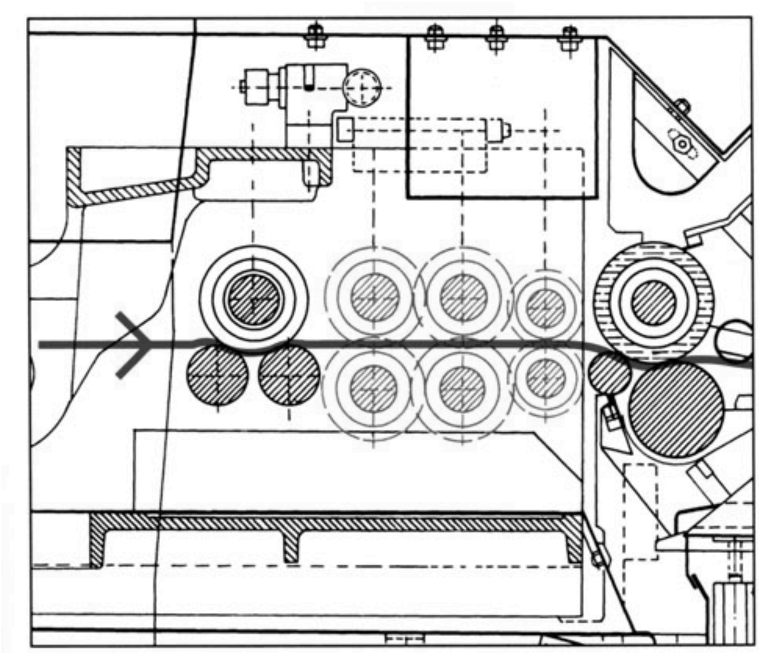

Figure 6.16 Intersecting pinned roller gillbox. Source: Sant'Andrea Novara.

6.5 Periodic irregularities in gilling

Gilled slivers are subject to the same periodic faults as occur in roller drafting, but the presence of the pinned fallers introduces further opportunities for periodic faults to occur.

With pin control, fibres that are released by the back rollers are compressed between lines of adjacent pins and therefore become constrained to move at the faller speed until they are nipped and accelerated by the front rollers. However, as fallers move within reach of the front rollers they lose some control of the fibres and the front bed (fibres nipped by the front roller) is then able to pull some un-nipped fibres forward. Also, as the front-most faller is removed from the faller bed, it may disturb the motion of fibre ends and cause a periodic fault known as *faller bar marks* in the output sliver.

The wavelength of the periodic fault present in a sliver equals the product of the draft and the distance between successive lines of faller pins (the *pitch* of the fallers). The amplitude of faller bar markings increases with short fibre content, the size of the front ratch and, most importantly, the level of draft. The effect of faller bar markings on yarn quality is diminished when a repeat drafting passage is used; the associated reverse feed of the sliver is beneficial.

It is clear from the above that the interaction between fibre and pin strongly influences the quality of the drafted sliver. As a general rule, the distribution of the fibre mass between the pins must be as uniform as possible, to maintain constant friction and drafting forces. The cleanliness and irregularity of the input sliver are therefore important factors. Impurities and thin and thin places in the feed sliver will alter the fibre packing densities between the pins, which, if too high can cause fibre breakage and if too low, a pronounced drafting wave. Finer fibres should be processed with a narrower pin spacing, which prevents the entry of impurities. The optimal input count of the doubled slivers is directly related to their fibre fineness, i.e. fineness in microns = count in ktex, 19 μm = 19 ktex.

Readings

The following readings are available on the web learning management system:

1. Wool Science Review, 1954a, 'The Scientist Looks at the Wool Industry: Drawing - Part 1,' *Wool Science Review,* vol. 12, p.3.
2. Wool Science Review, 1954b, 'The Scientist Looks at the Wool Industry: Drawing - Part 2,' *Wool Science Review,* vol. 13, p.3.

Summary

In wool yarn manufacture, an integrated series of operations is required to convert disorganized tufts of staple fibres into an organized, twisted strand. Carding commences the sequence, but further mechanical processes are required before the yarn can be spun. While the slubbing delivered by a woollen card require no preparation for spinning, the sliver produced by a worsted or semiworsted card must (a) have the fibre alignment substantially improved, and (b) be reduced significantly in linear density before a yarn can be spun.

The processes which manipulate the fibres in a sliver are gilling and drafting respectively, and are mostly carried out in a single machine, a gillbox. This topic outlines the principles of the drafting process, the effect of doubling on the homogeneity and evenness of the product, and typical systems to produce adequate fibre control in drafting. Gilling mechanisms are also described.

References

Grosberg, P. and Lype, C. Yarn Production – Theoretical Aspects, in: *Textile Institute,* ISBN 1870372034.

Lawrence, C.A. 2003, *Fundamentals of Spun Yarn Technology*, CRC Press, ISBN 1-56676-821-7.

NCS Schlumberger, GC 15 Chain Gill, product marketing brochure, NCS Schlumberger.

Oxtoby, E. 1987, *Spun Yarn Technology*, Butterworths, ISBN 0-408-01464-4.

Sant' Andrea Novara, SN Intersecting Single Head Drawing Frame, product information brochure, Sant' Andrea Novara.

Glossary of terms

Apron	A small continuous belt, open used to control fibres in a drafting zone
Autoleveller	An automatic device fitted to machines to improve the evenness of the output material. This is achieved by continuously monitoring the linear density and if necessary, changing the draft to compensate for any deviation from a pre-set value
Back rollers	The feed rollers to a drafting device
Carrier	Small driven rollers that assist fibre control in a drafting zone
Count (linear density)	The mass per unit length of a continuous strand of fibres (slubbing, sliver, roving, yarn)
Doubling	Feeding multiple ends of sliver (doublings) into a machine for drafting into a single end
Draft	To reduce the linear density of a sliver or roving by enabling the individual fibres to slip relative to each other (drawing); the ratio of the linear densities before and after drawing
Drafting (attenuating)	The process of reducing the linear density of a sliver or roving, often using two pairs of rollers rotating at different speeds (roller drafting)
Drafting zone	The region between the two pairs of drafting rollers where drafting occurs
Drafting wave	A periodic fault in sliver caused by inadequate control of fibres in the drafting process
Drawing	The sliver operation combining doubling and drafting
Fallers (or faller bars)	The pinned steel bars employed in the control of fibres between the drafting rollers in a gillbox
Faller bed	The parallel assembly of fallers in contact with the sliver in a gillbox
Fibre extent	The distance between the extremities of a fibre – for a hooked fibre this will be much less than the fibre length
Floating fibres	Fibres in the drafting zone that are not in contact with either the back or front rollers
Front rollers	The rollers that deliver the drafted sliver or roving
Gilling (or pin drafting)	A method drafting where the direction of the fibres relative to each other in a sliver is controlled by pins
Hook	A U-shaped configuration of a fibre
Irregularity	Variation in linear density along a sliver, roving or yarn
Nep	A tiny knot of entangled fibres

Nip	The line of contact between a pair of rollers, and the sliver passing between them
Ratch	The distance between the nips of two pairs of rollers in a roller drafting system
Tumbler	Smaller rollers that assist fibre control in the drafting zone