CHAPTER SEVEN

Drawing

THE functions of the drawing stages are (1) Drafting the finisher card sliver to a count suitable for feeding the spinning frames; (2) Reduction of weight irregularities by doubling; (3) Straightening the fibres and laying them along the sliver axis so that when they come to be spun on the spinning frame they will be evenly drafted and twisted to form an acceptable yarn.

DRAFTING

To examine the behaviour of the fibres during drafting, the simplest case will be considered first, where there are two sets of rollers involved—a feed pair and a drawing pair. The jute sliver enters the machine through the nip of the feed or retaining rollers and then passes forward to the drawing rollers. Because of the greater linear speed of the latter, the material becomes drafted, the exact amount of drafting being determined by the relative surface speeds of the two sets of rollers. The distance between the two sets of rollers, the reach, is longer than the fibre being drafted; if it were not so then a number of fibres would be gripped by both sets of rollers at the same time and be broken. As a result of this comparatively long distance there is always a large number of fibres which are gripped neither by the retaining rollers nor the drawing rollers. These are called 'floating' fibres. For ideal drafting each fibre should move with the same speed as the back rollers until their leading ends enter the nip of the drawing rollers. Under these conditions the fibre tips in the drafted sliver would be Dx inches apart if the draft on the frame was D and the tips were x inches apart in the entrant sliver. In practice, however, a floating fibre is held *in situ* by entanglement with its neighbours and inter-fibre frictional forces. When a long fibre has its tip gripped by the drawing rollers it immediately accelerates to the speed of these rollers and, because of this fibre entanglement and inter-fibre friction, some of the short fibres lying alongside will be dragged forward and prematurely drafted. This process is cumulative so that a clump of short fibres is drafted too soon, producing a thick place in the sliver. Moreover, this action causes a deficiency of floating fibres in the drafting zone with the result that a thin place follows on after a thick place. Such a cycle is repeated as more floating fibres are fed through the nip of the retaining rollers.

This is a simplified picture of drafting with only two sets of rollers but it should be sufficient to show that if no attempt is made to control the movement of the floating fibres the resulting sliver will be highly irregular. In jute drawing frames short fibre control is obtained by means of moving sheets of pins which carry the sliver up to the nip of the drafting rollers. The pins provide sufficient restraint to stop most of the short fibres being drafted prematurely but at the same time do not interfere with the normal processes of drafting near the nip of the drawing rollers. These types of drawing frames are known as gill-drawings and the pins as gill-pins.

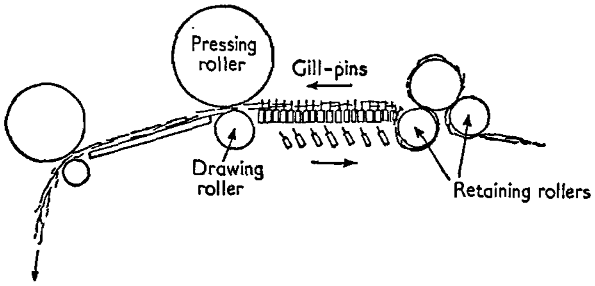

Figure 7.1. General outline of a drawing frame

Figure 7.1 shows the general lay-out of the drafting mechanism of a jute drawing frame. The slivers enter the machine between the retaining rollers and a self-weighted jockey-roller and then meet the gill-pins. The gill-pins are carried on a series of faller-bars which move in the direction indicated by the arrows. As the sliver leaves the nip of the back rollers a faller-bar with its sharp pins strikes upwards into it and the fibres are impaled on the gill-pins. The faller-bars move forward as a sheet and carry the sliver to the front of the machine. When the faller-bars are close to the drawing rollers they drop out of the sliver and travel back underneath the sliver in preparation for another strike upwards. The relative surface speed of the drawing and retaining rollers determines the draft in the normal manner. The linear speed of the gill-pins is a few per cent higher than that of the retaining rollers so that when the sliver is held between the retaining rollers and the pins that have just struck into it, it is under slight tension and the next row of pins can penetrate the sliver more easily. It is essential that the sliver rides within the pins otherwise control over the short fibres will be lost; if the sliver lies on top of the pins it is equivalent to drafting with only two sets of rollers and no draft control mechanism there at all. The sliver will ride on top of the pins when the lead between the retaining roller and the faller-bars is too low, or when the weight of the sliver is too great for the machine, or when the pins are blunt and hooked at their tips instead of being keen and sharp. The first essential of good draft control is good pinning.

Ideally, the pins should accompany the sliver right up to the nip of the drawing rollers so that even the very shortest fibres are controlled until the last minute but because of the dimensions of the bars and the

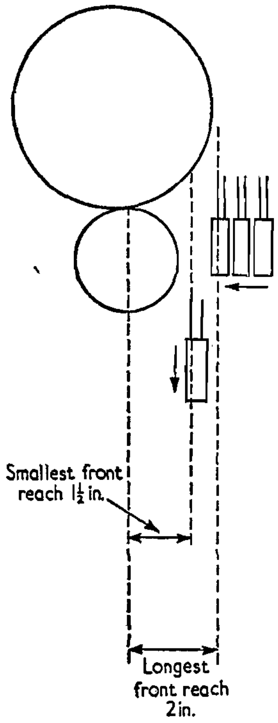

Figure 7.2. Drawing frame front reach

rollers this is not possible and there is a gap with no fibre control at all just at the most critical zone in the whole drafting area. Figure 7.2 shows how the distance between the point at which the faller-bars must drop out and the drawing roller is determined by the drawing roller diameter and the thickness of the faller-bar. While the machine is running, this distance, the front reach, varies between two extremes depending on the pitch of the faller-bars. For instance, in Figure 7.2, if the diameter of the drawing roller is $2\frac{1}{2}$ in. then the pins on the faller-bar may not be able to approach nearer than, say $1\frac{1}{2}$ in. to the nip of the drawing rollers. This means that there is always at least $1\frac{1}{2}$ in. of uncontrolled sliver. In the Figure, one bar has just dropped out of the sliver and therefore if the pitch of the pins is, say, $\frac{1}{2}$ in. then this uncontrolled length is now increased to 2 in. $(1\frac{1}{2}+\frac{1}{2})$. The result of this variable distance front reach is to allow uncontrolled drafting and, with a material like jute where there are many extremely short fibres in the sliver, the formation of what may be termed faller-bar drafting waves, or more simply faller-bar slubs. ('Slub' is a general term used to denote a thick clump of fibres in a sliver or a yarn.)

Figure 7.3 shows the fibre length distribution of a jute finisher card sliver placed alongside the drafting zone of a first drawing frame and

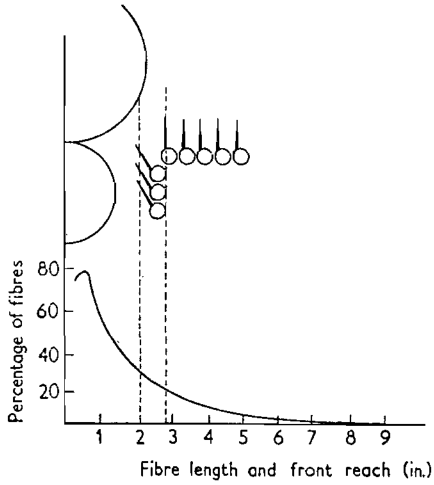

Figure 7.3. Number of finisher card slivers shorter than the front reach on a push-bar first drawing frame

the high proportion of fibres which are shorter than the front reach will be seen. Naturally, the more short fibre present in a sliver the more fibre movement will occur in the front reach and the more pronounced the faller-bar slubs will be.

The wavelength of the faller-bar slubs can be found from the product of the draft and the pitch of the faller-bars, e.g. with a draft of 4 and fallers $\frac{3}{8}$ in. apart, the faller-bar wavelength will be $1\frac{1}{2}$ in. Figure 7.4 shows sliver irregularity charts obtained from a testing machine which 'weighs' a continuous length of sliver electronically; in this test each alternate faller-bar was deliberately removed to illustrate the effect of the front reach. The weight profile of the sliver shows

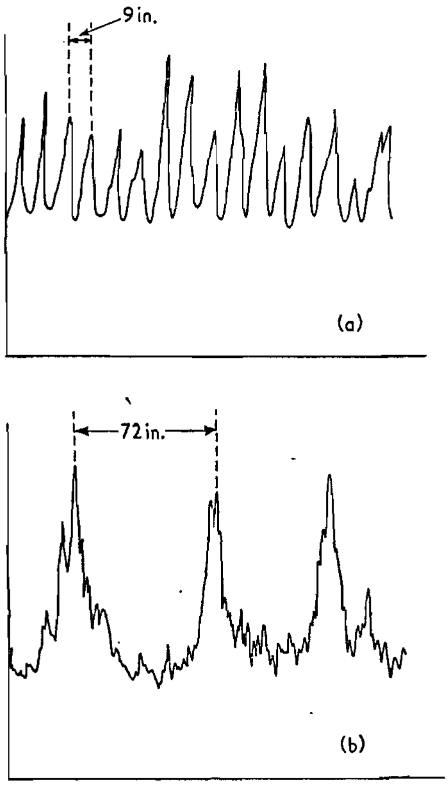

Figure 7.4. Faller-bar slubs in sliver and yarn:
(a) *Weight profile of sliver when alternate faller-bars are removed;*
(b) *Weight profile of yarn spun from above sliver at a draft of 8*

the accentuated faller-bar slub and the yarn trace shows that the slubs are carried forward to the finished yarn.

Faller-bar slubs cannot be eliminated entirely but they can be kept small by working with the correct density of pinning. As the sliver progresses through the drawing stages and its count becomes smaller then the gill-pins require to become finer and more closely-set, as is shown by Table 7.1

TABLE 7.1. DRAWING FRAME PINNINGS

	First push-bar	*Intermediate spiral*	*Finisher spiral*
Faller pitch (in.)	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{8}$
Pins/inch on bar	2	5	8
Rows of pins on bar	1	2	1
Width of gill (in.)	6	5	$3\frac{3}{4}$
Pin w.g.	13	15	15
Length of pins (in.)	$1\frac{1}{8}$	1	$\frac{7}{8}$

Drafting, therefore, is closely connected with sliver regularity and because of the variability of fibre length found in jute slivers and the imperfections of the draft control mechanisms each drafting operation increases the amount of irregularity present. This it does in two ways. If the entrant sliver contains a weight irregularity with a wave-length of 4 in. and it is drafted 4 times, then the delivered sliver will have an irregularity with a wave-length of $4 \times 4 = 16$ in. In addition, the action of drafting will have imposed further irregularities on the material and while the basic wave-length may be 16 in. there will be minor irregularities added to it. Thus, as the sliver progresses through the drawing stages its irregularity pattern becomes more and more complex and it is the function of doubling to try to reduce this complexity as far as possible.

DOUBLING

In jute slivers the count varies from place to place along the length of each strand and there are also differences in the general count level from one sliver to another. These differences in count fall into a definite pattern which can be defined statistically by the Normal

Distribution. If one took a length of sliver and cut it up into sections of, say, 1 ft and weighed them, one would find that the distribution of count followed a bell-shaped pattern (it would require a large number of tests to arrive at a smooth curve but even about 100 results show the general pattern). Figure 7.5 (a) shows the type of result obtained from such a test.

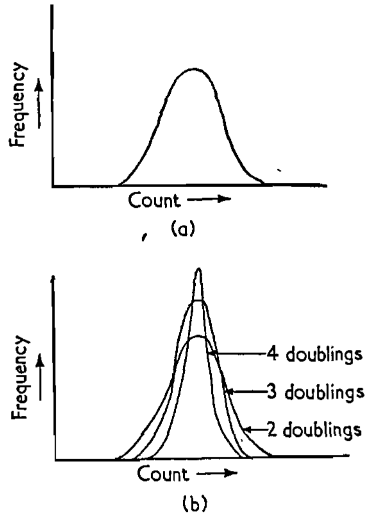

Figure 7.5. Reduction of count variability by doubling

If one takes two or more such slivers whose weight varies according to the normal distribution and doubles them together then the variation in the count of the product is always less than that of the individuals. The amount by which the variation falls depends upon how many slivers are doubled together, in fact the variation falls according to the square root of the number of doublings. Figure 7.5 (b) shows the distribution of count after 2, 3, or 4 slivers have been doubled together (the narrower and taller the bell-shape, the better and more uniform is the sliver). Doubling, it may be seen, is highly advantageous, but it should not be forgotten that to reduce the count of the material drafting must predominate over doubling and that drafting increases the variability of weight. Therefore, as the material passes over the drawing stages there are the two conflicting influences at work; doubling leading to a greater uniformity of weight and drafting leading to greater irregularity of weight.

Doubling may be carried out by placing two or more slivers together at the feed end of the machine and entering them on to one set of gill-pins or by uniting the slivers as they emerge from the nip of the drawing rollers in which case there is only one sliver on each set of pins in the drafting zone. The former situation holds for the lighter counts of sliver at the last drawing passage but in the earlier ones only one sliver can be accommodated on the pins and doubling takes place at the front of the machine. There is, however, another reason for doubling at the front of the machine and this is connected with the faller-bar slubs. In Figure 7.6 the plan view of a first drawing frame

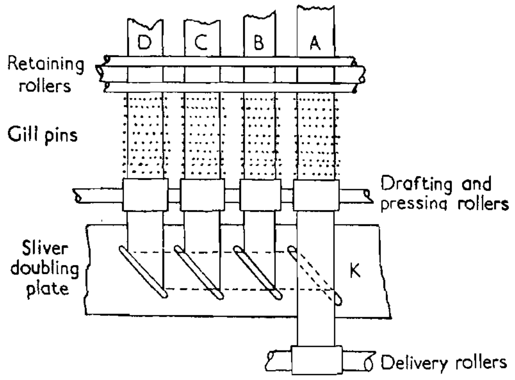

Figure 7.6. 4–1 doubling on the sliver doubling plate

with four doublings has been shown. After the individual slivers have been drafted they are doubled together on a plate between the drawing rollers and the delivery rollers called the sliver doubling plate. This is a cast iron plate roughly 1 in. in section running across the front of the machine. Slots with rounded edges are cut in the plate at an angle of 45 degrees to the line of the frame, through which the slivers can pass so as to change their direction. In the set of four doublings one sliver comes straight out of the drawing nip towards the delivery rollers but the other three are turned through 45 degrees and pass along the back of the plate to another 45 degrees slot. When they pass through this second slot they are laid down on top of one another and are now travelling toward the delivery rollers. The four doubled slivers now pass through the delivery nip where they are consolidated into one sliver and leave the machine.

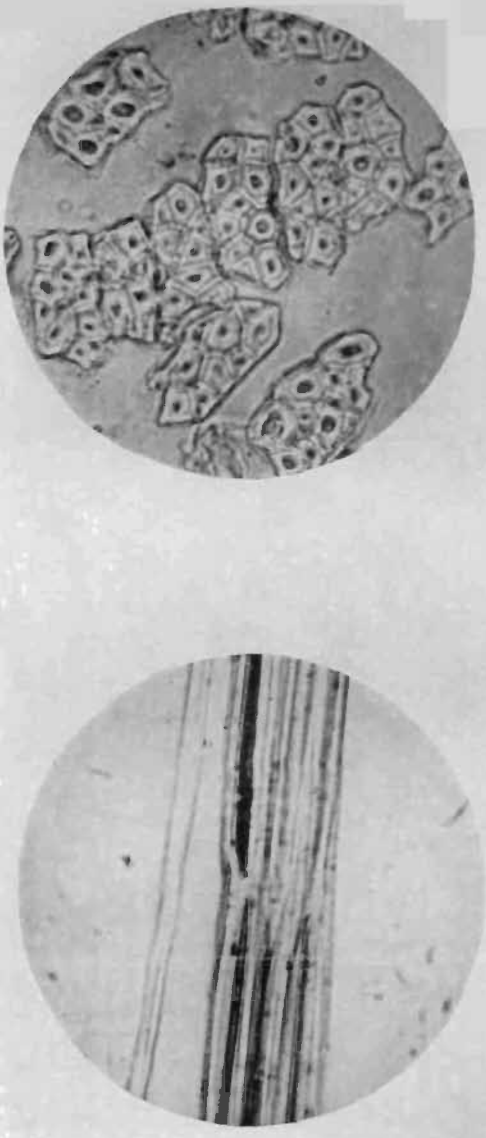

Plate I. Transverse and longitudinal view of fibre

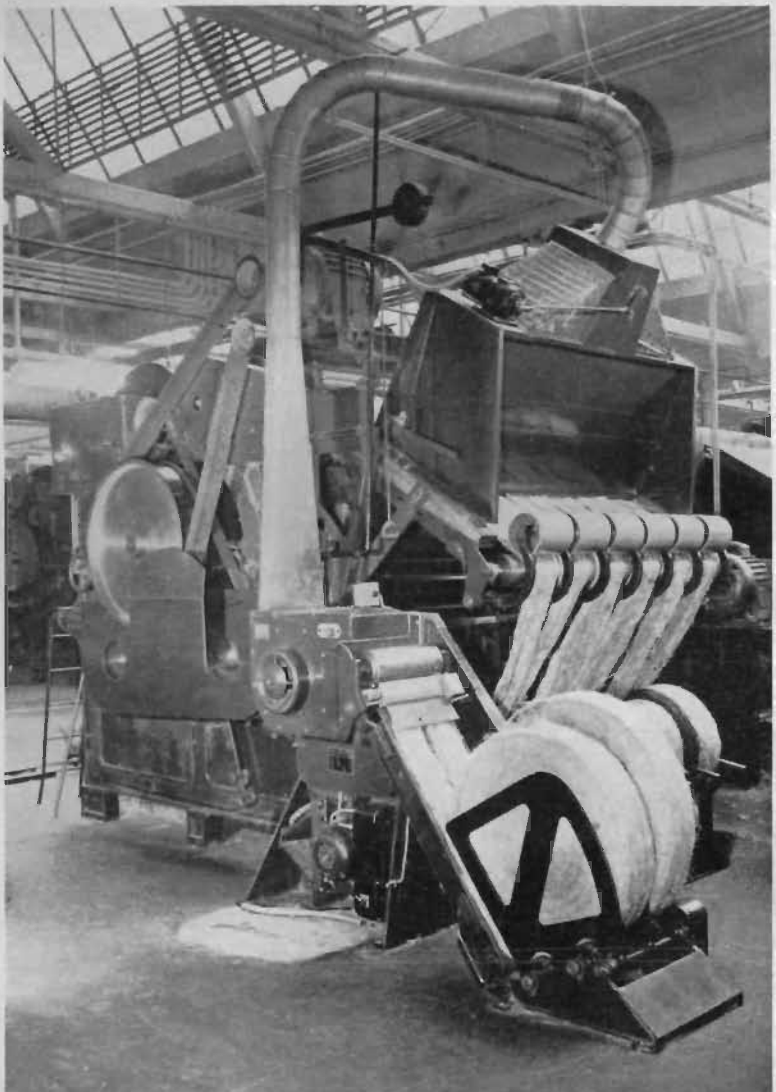

Plate II. Root cuttings sliver dispersal unit

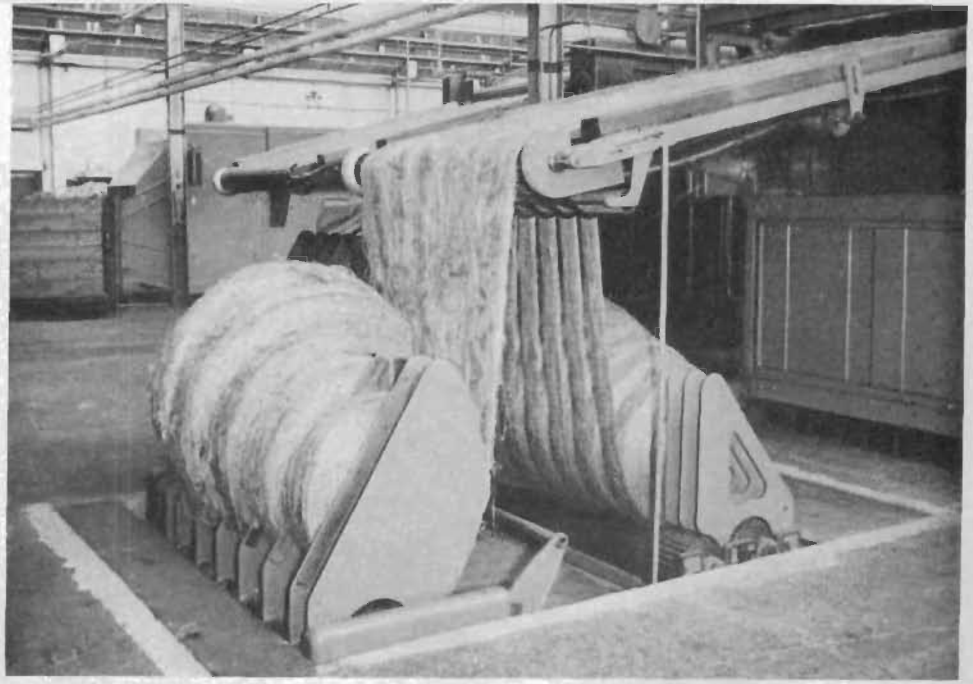

Plate III. Dual creel for blending long jute and cuttings sliver

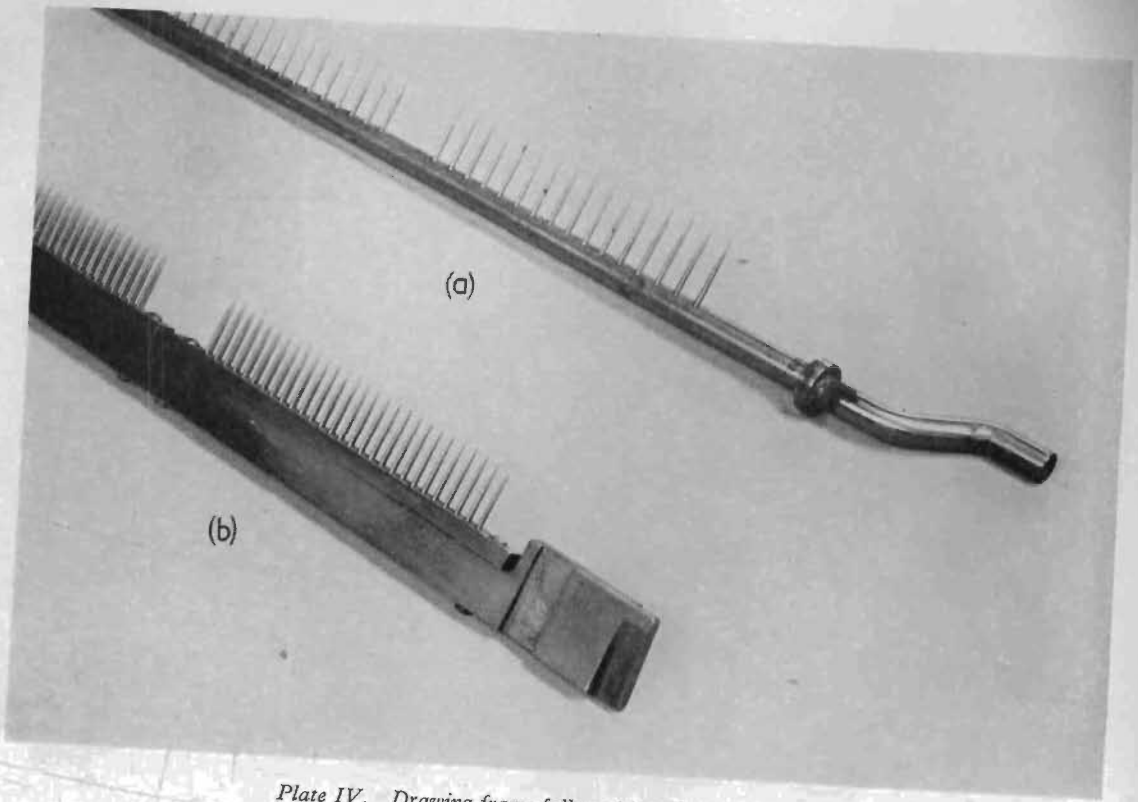

Plate IV. Drawing frame fallers: (a) *push-bar,* (b) *spiral*

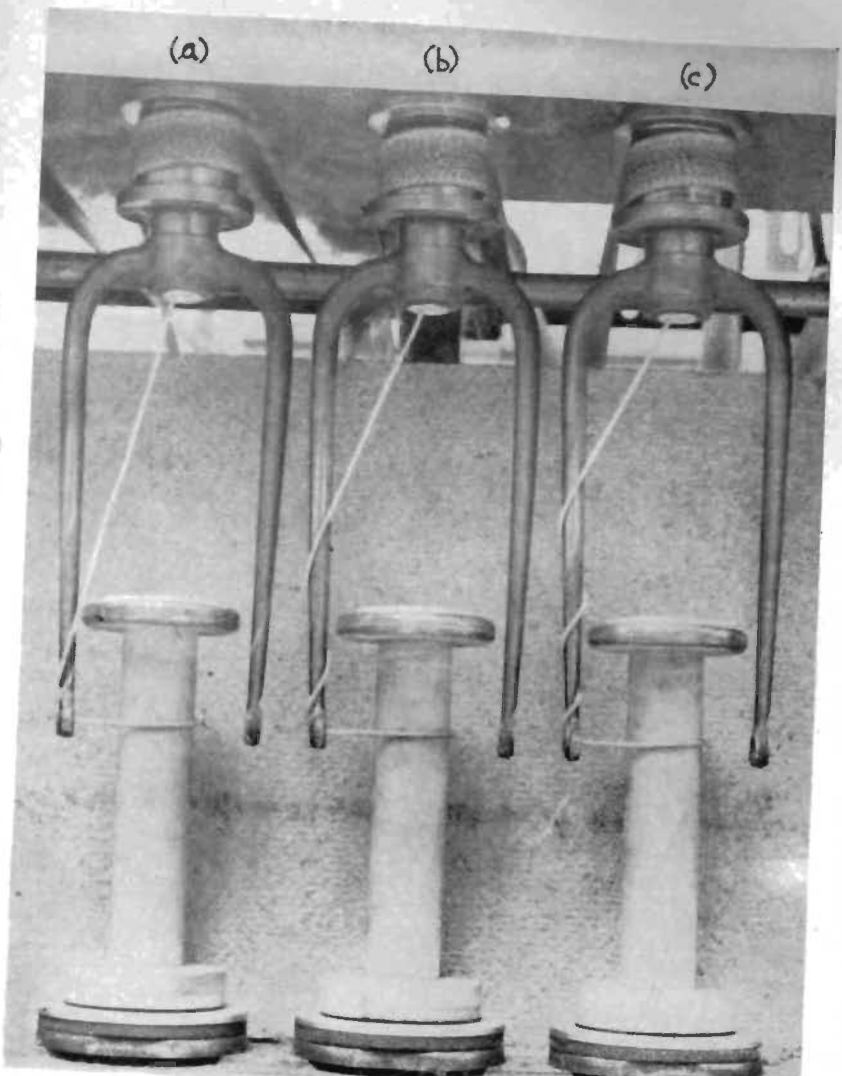

Plate V. Methods of leading yarn on to the bobbin

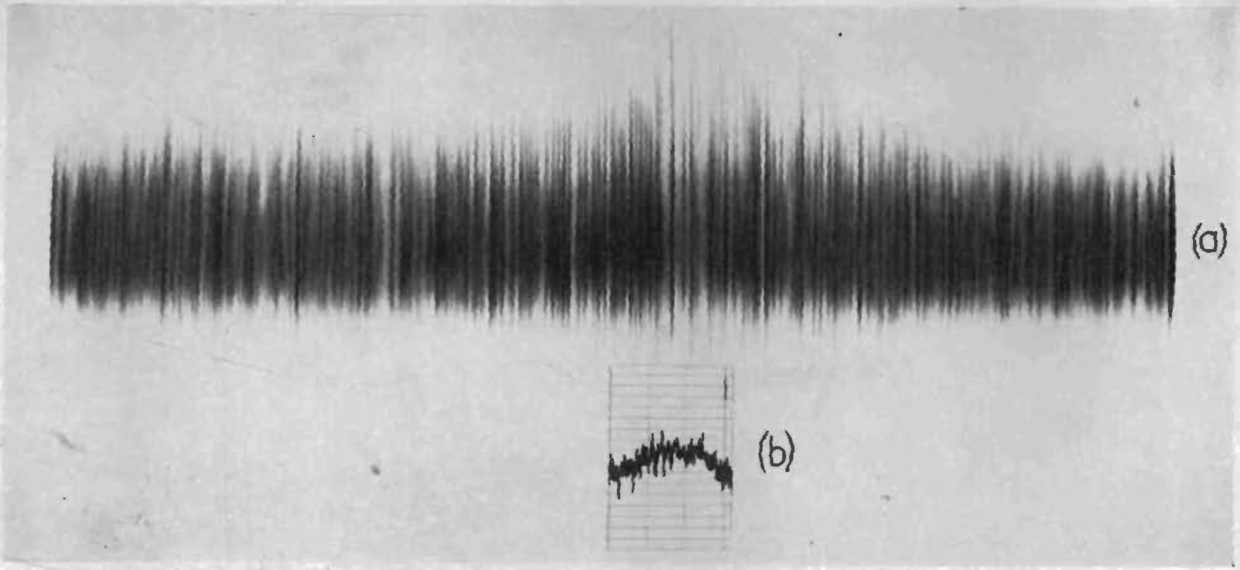

Plate VI. *Spindle vibration and its associated tension peaks:*
(a) *Spindle vibration;* (b) *Tension trace*

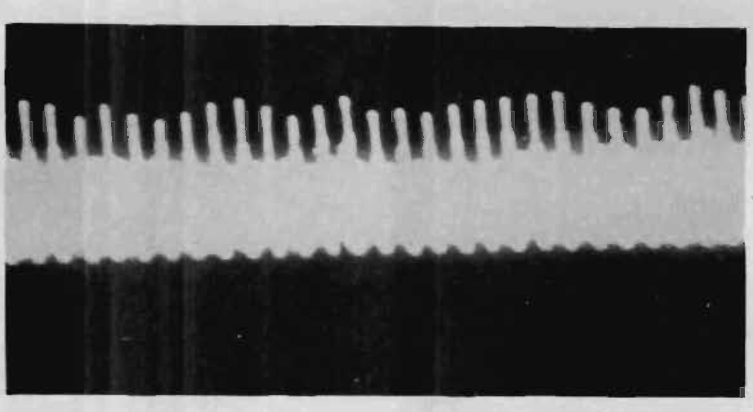

Plate VII. Transmitted tension pulses due to tape joint

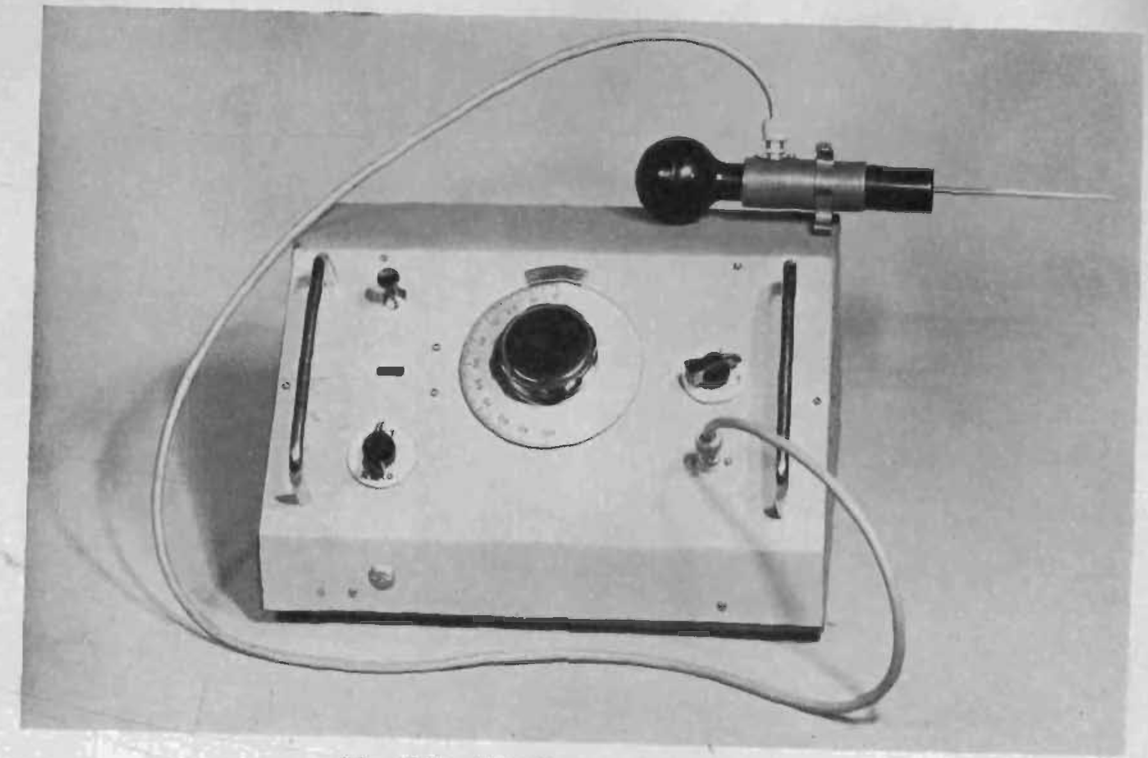

Plate VIII. B.J.T.R.A. Probe Moisture Meter

In order to examine the working of the doubling plate it will be assumed that the sliver entering the drawing frame has been perfectly uniform. As the four slivers traverse the gill-sheet they are held in the same way and when the faller-bars drop out of the sliver a faller-bar slub appears in each at exactly the same point. There are now four slivers with identical wave-forms issuing from the drafting nip, peak with peak, trough with trough, in perfect phase. Ultimately, from the sliver paths on the doubling plate, these four slivers are going to be placed one on top of the other in a four-layer sandwich. If all the peaks in the slivers coincide then the resulting sliver will be extremely irregular but if peaks can be made to fall alongside troughs then a more uniform product will result. The combination of the sliver doubling plate design, the draft, and the pitch of the faller-bars decides which of these conditions will prevail.

A numerical example will perhaps help to clarify this statement. Consider the doubling plate shown in Figure 7.6, and suppose that the four slivers are issuing from the drawing rollers with a faller-bar slub wave-length of 2 in. (this could arise from a faller pitch of $\frac{1}{2}$ in. and a draft of 4 on the frame). The slivers unite as a point K. Sliver A has a path length of 8 in. and since the wave-length is 2 in. there will be $8/2=4$ complete waves in this length of sliver. Sliver B has a path length of 16 in. in which there will be 8 complete waves, C has a path of 24 in. with 12 waves in it, and D has a path of 32 in. containing 16 waves. Thus at the uniting point, K, the four slivers will come together with the peaks of each wave-length coincident and the resulting sliver will be more irregular than either sliver A, B, C, or D.

If, on the other hand, the wave-length is $2\frac{1}{2}$ in. (resulting from a faller pitch of $\frac{1}{2}$ in. and a draft of 5) sliver A will have $8/2{\cdot}5=3{\cdot}2$ waves, sliver B 6·4 waves, C 9·6 waves, and D 12·8 waves. At the point K the peaks of the waves will be 0·2, 0·4, 0·6, and 0·8 wave-lengths apart and this will have the effect of producing a more regular sliver in which the ill-effects of the faller-bar slubs have been reduced to a minimum.

The faller-bar pitch and the path length on the doubling plate are fixed by the machine designer and the only variable left under the control of the producer is the draft. When the draft is changed the faller-bar slub wave-length is altered and hence the number of wave-lengths on the sliver doubling plate is changed, as in the example above. If the pitch of the slots in the doubling plate is P, the faller bar pitch p, and the draft d, then for any number of doublings the 'worst' draft, i.e. that one leading to peak-on-peak doubling, is given by,

$$d = \frac{P}{np}$$

where n is any whole number.

For two or more doublings, the 'best' draft, i.e. giving peak-on-trough doubling, is given by

$$d = \frac{P}{(n+\frac{1}{2})p}$$

and for three doublings

$$d = \frac{P}{(n+\frac{1}{3})p}$$

The implication of these relationships is important, for once the number of doublings has been chosen, the choice of drafts available is fixed by the design of the doubling plate. Certain drafts will produce more irregular material than others simply because they impose peak-on-peak doubling on the sliver instead of peak-on-trough doubling.

The practical results of working with a 'good' draft on a drawing frame may be illustrated by the following yarn test figures obtained when the second (intermediate) drawing frame was run at the draft which laid peaks and troughs together and another which superimposed the peaks on peaks.

	'Best' draft	*'Worst' draft*
Count (tex)	520	520
Tenacity (g/tex)	13·4	11·7
Minimum tenacity (g/tex)	8·0	6·0
Short term weight irregularity (per cent)	20·0	22·0

There is a difference in the average tenacities but the important practical value in a yarn is the strength of its weakest point and in this test the minimum tenacity (allowing for the normal variations in yarn strength) was some 33 per cent higher when the 'best' draft was used. Though this was a laboratory-scale trial similar results have been found in normal mill conditions and clearly the benefits accruing from the proper choice of draft are well worth seeking.

TYPES OF DRAWING FRAME

Jute drawing frames are divided into two types, depending on the mechanism used to propel the faller-bars.

(1) *Push-bar.* In this class, the fallers have specially cranked ends which run in slides on the machine frame. The fallers are driven by a large carrier wheel at the back of the machine. The earlier models had collars on each faller-bar which bore against each other but in modern frames the bars bear across the full width, the bar behind pushing the bar in front—hence the name.

(2) *Spiral.* In this method of faller-bar propulsion there are two spiral screws on each side, one set directly above the other. The ends of each faller-bar are cut to fit into the grooves on the spiral so that as the screws rotate they drive the faller-bars along. As each faller comes to the end of the top screw it is knocked down on to the bottom one by a cam on the top screw, springs holding it steady as as it falls into the grooves of the bottom screw. The bottom spiral is more coarsely pitched than the top one so that the faller-bars are returned quickly to the back of the machine ready to be lifted by cams on the bottom screw up into the spirals of the top screw. By having a coarse spiral on the bottom fewer bars are needed to complete the gill sheet.

PUSH-BAR MACHINES

Figure 7.7 shows one type of push-bar drawing frame, and the cranked end of one of the faller-bars is illustrated in Plate IV (a). Each bar is cranked only at one end and the carrier wheel has half as many teeth as there are faller-bars, alternate bars being driven from opposite sides of the machine.

In addition to being driven round the machine the bars must present

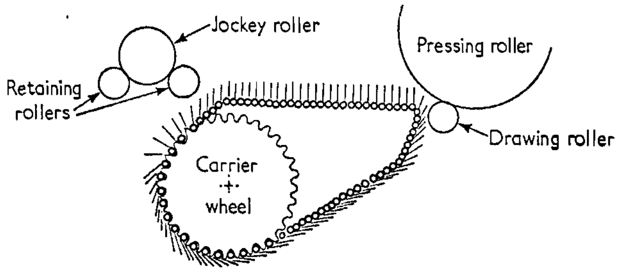

Figure 7.7. Push-bar frame

their pins to the sliver in as advantageous a manner as possible. This requires that the pins shall enter the sliver cleanly and show little tendency to lift the material on their points rather than pierce it, and that they shall leave the sliver without drawing down loose fibres. To achieve these functions there are tracks for guiding the bars in their course around the machine. The first of these is the guide track which keeps the faller bars in the correct position as they travel round. The other tracks, the pin control tracks, ensure that the pins enter and leave the sliver in the desired manner. When the pins are about to enter the sliver the pin control tracks, by virtue of their position relative to the guide tracks, act on the cranks in such a manner that the pins are swung into a vertical position, ready for a clean strike into the sliver. At the draft end of the machine the pin control tracks force the bars to change their orientation so that the pins fall freely from the sliver by swinging forward.

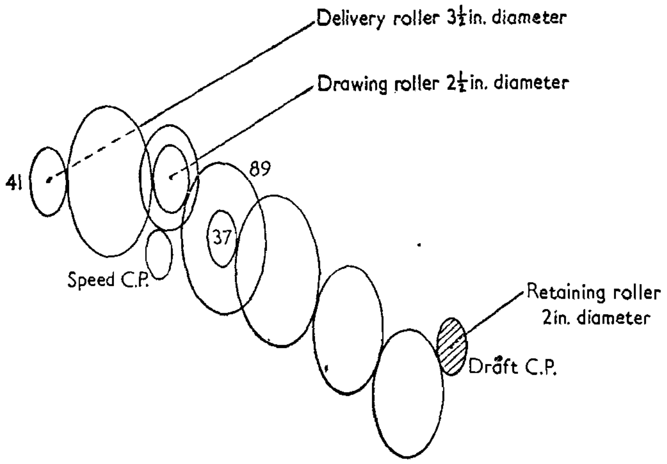

Figure 7.8. Draft gearing in a push-bar drawing frame

Figure 7.8 shows a diagram of the draft and delivery gearing of a push-bar drawing frame. For illustration, the method of calculating the draft constant is shown:

$$\frac{1}{2\text{ in.}} \times \frac{\text{c.p.}}{37} \times \frac{89}{41} \times \frac{3\frac{1}{2}\text{ in.}}{1} = 0{\cdot}1 \times \text{c.p.}$$

i.e. draft $= 0{\cdot}1 \times$ draft change pinion

Similarly, the lead of the delivery rollers is calculated by working from the slower roller forward to the faster roller and then expressing the lead of the latter as a percentage

$$\frac{1}{2\tfrac{1}{2}\text{ in.}} \times \frac{30}{41} \times \frac{3\tfrac{1}{2}\text{ in.}}{1} = 1{\cdot}0244$$

i.e. the faller lead is 2·44 per cent

SPIRAL DRAWING FRAMES

Plate IV (b) shows one end of a faller-bar from a spiral drawing frame and the screws which carry it are illustrated in Figure 7.9. Modern spiral frames are all double-thread or triple-thread, i.e. there are two

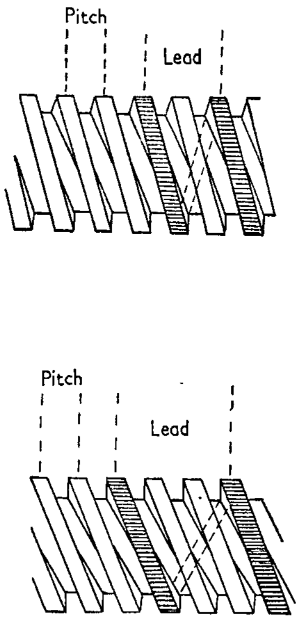

Figure 7.9. Double- and triple-thread screws for spiral drawings. (a) *Double-thread, one revolution of screws moves fallers a distance equal to the lead, i.e., 2 × pitch;* (b) *Triple-thread, one revolution of screw moves faller a distance equal to the lead, i.e., 3 × pitch*

or three complete spirals cut in each screw. The length of one complete spiral is the lead and the distance between adjacent spirals, the pitch.

$$\text{Faller-bar speed} = \text{r.p.m. of screw} \times \text{lead}$$
$$\text{Lead} = \text{number of screws} \times \text{pitch}$$

Early models of spiral frames had single-thread screws and the introduction of the double- and triple-thread has allowed faller-bar speeds to be greatly increased, as the limiting factor in a spiral frame is the rate at which the fallers can be dropped out of and lifted into the sliver. If the speed is increased above 200 drops per minute with a single thread spiral the bars begin to jump, pin badly, and the wear and tear is high, but with double screws faller drops of about 400 per minute are possible and with triple screws about 650.

The general lay-out of a spiral drawing frame was shown in Figure 7.1.

On this type of frame the pins are usually carried on brass gill-stocks which are riveted on to the bar. These make for easy pin renewal.

COMPARISON OF PUSH-BAR AND SPIRAL MACHINES

The following Table gives a condensed comparison between the two types of drawing frames.

Push-bar	*Spiral*
Faller drops up to 850/min	Double screw up to 400 drops/min
	Triple screw up to 650 drops/min
Faller-bar lead over retaining rollers 4–10 per cent	Faller-bar lead $1\frac{1}{2}$–$4\frac{1}{2}$ per cent
Quiet running	Noisy
Tends to clog with dirt	Self cleaning because of the jerk at each drop
Pinning good with modern types	Pinning excellent
Laps occasionally, especially with light slivers	Seldom laps

Since the object of any industrial process is to achieve a high production rate at an acceptable quality level as economically as possible it is desirable to be able to run machinery at high speeds. The highest speeds at which gill drawing frames can be operated is given by the equation

$$f = \frac{v}{pd}$$

where f is the number of faller drops per minute, v is the delivery speed per minute, and d is the machine draft.

In practice there is an upper limit to f, the faller drops per minute, imposed by two factors. The first of these is the ability of the fallers, as machine components, to withstand the forces involved in their propulsion without excessive amounts of wear and tear, the second factor is the ability of the gill-pins to strike into the sliver and control fibre movement during drafting. With regard to the mechanical aspects the fallers on spiral drawing frames, with their sudden drop-out at the drawing rollers and their rise at the feed rollers are subjected to greater strains than those of push-bar machines and for this reason cannot achieve such high speeds as the push-bar types. The pitch of the faller-bars is closely related to the maximum speed of the gill-sheet, for the smaller the pitch p, the finer must be the bars, pins, screws, etc., and the more expensive the mechanism becomes. There is obviously a lower

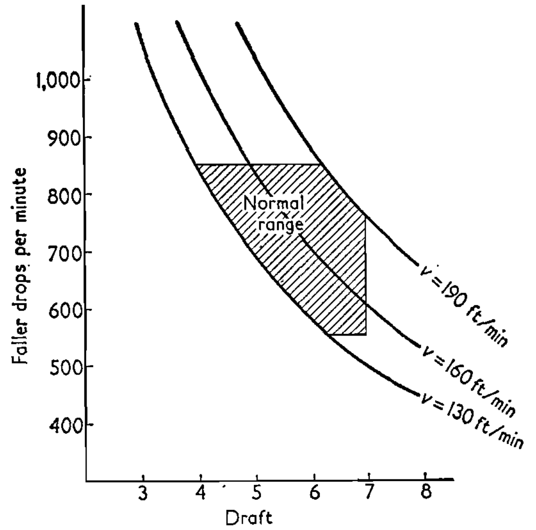

Figure 7.10. Effect of drawing draft and delivery speed on faller drops per minute. Sacking weft, 1st push-bar frame $f = v/dp$

limit beyond which the materials used and the manner of construction become so refined that the cost becomes prohibitive. On jute frames the faller bar pitch is between $\frac{3}{4}$ and $\frac{3}{8}$ in. and, as far as the user is concerned, this can be regarded as being fixed by the machine designer. Control over the number of faller drops per minute, therefore, devolves on making adjustments to the speed of the whole machine by a series of speed pinions on the main drive and selecting a suitable draft. Figure 7.10 shows how draft and delivery speed combine to give a series of different faller drops per minute on a sacking weft push-bar first drawing frame. In this case if it is desired to work at the upper limit of faller drops for this type of machine (850 per minute) and the faller pitch is 0·5 in., then,

$$v = 425d \text{ in./min}$$

and if the draft is changed at any time the delivery speed should be altered also to ensure that this relationship holds and the machine is run at its maximum speed compatible with freedom from mechanical trouble and correct pinning of the sliver.

DRAWING SYSTEMS

The common arrangement for hessian qualities is to have three drawing passages over a first push-bar, a second (or intermediate) double-thread spiral, and a finisher triple-thread spiral drawing. A double-

TABLE 7.2. EXAMPLES OF DRAWING SYSTEMS. ALL SLIVER COUNTS IN LB/100 YD

	(1)	(2)	(3)	(4)	(5)
Finisher card sliver count	14·0	15·0	16·0	9·0	18·0
First drawing draft	4·7	4·0	3·5	4·6	5·0
First drawing sliver count	12·0	15·0	9·1	5·9	7·2
Intermediate drawing draft	7·0	6·5	6·0	—	—
Intermediate drawing sliver count	5·2	4·6	4·5	—	—
Finisher drawing draft	10·0	9·0	9·0	10·0	7·5
Finisher drawing sliver count	1·04	1·02	1·0	1·18	1·90

Key:

(1) Hessian system, 4-3-2 Doublings, three drawing passages.
(2) Hessian system, 4-2-2 Doublings, three drawing passages.
(3) Hessian system, 2-3-2 Doublings, three drawing passages.
(4) Hessian system, 3-2 Doublings, two drawing passage.
(5) Sacking Weft system, 2-2 Doublings, two drawing passages.

thread spiral frame may be used as a first drawing where better quality work is desired but its speed and production are not so high as those of a push-bar and so more machines are required to handle the same quantity of fibre.

Certain hessian and sacking warp systems have only two drawings, working in conjunction with a drawing head on the finisher card to reduce the sliver count. Sacking weft systems have only two drawing passages in order to keep the manufacturing costs as low as possible.

Table 7.2 shows examples of several drawing systems with different numbers of doublings at the first and intermediate drawing stages.

From the data in Table 7.2 it is possible to analyse these systems from the point of view of the number of doublings and the stages at which most mixing occurs. The number of doublings in a system is found by *multiplying* together the doublings at each stage, e.g. 4 doublings at the first, 3 at the intermediate, and 2 at the finisher drawing frames gives a total of $4 \times 3 \times 2 = 24$ doublings. If the net draft at each stage is calculated, i.e. (machine draft)/(doublings), then the closer this is to 1 the more mixing and evening out of irregularities is occurring.

TABLE 7.3

	Drawing systems				
	(1)	(2)	(3)	(4)	(5)
Total number of doublings	24	16	12	6	4
Net draft at first drawings	1·17	1·00	1·75	1·50	2·50
Net draft at intermediate drawings	2·31	3·33	2·00	—	—
Net draft at finisher drawings	5·0	4·6	4·5	7·5	3·8

Notice that in the hessian systems the first drawing net draft is between 1 and 2, indicating that this stage is used primarily as a doubling stage. Most of the attenuation occurs at the final drawing stage. The number of drawing stages adopted depends upon the count and quality range to be spun, the nature of the raw material, the efficiency of the draft control mechanisms and, of course, process cost and labour requirements. If heavy sacking yarns are to be made then a two-drawing system will be chosen but if 4–6 lb/sp yarn of top quality is required then 4 drawing passages will be needed since high quality demands many doublings and short drafts. The shorter the drafts and the more doublings there are, the costlier is the process and, as so often happens in industry, a compromise must be reached between the demands of quality, production, and cost.

CRIMPED SLIVER

As the count of the sliver is reduced in its passage through the drawing stages it becomes more and more fragile until, by the time it emerges at the finisher drawing delivery, it is in so tenuous a form that it is impossible to handle at all and, indeed, is so weak that it would not carry up the back of the spinning frames. To overcome this, the sliver is crimped, or waved, to give a certain amount of cohesion to the strand. In some drawing systems the sliver at the first and intermediate drawing frames is crimped but all systems use crimped finisher drawing sliver. Figure 7.11 shows a crimping box attached

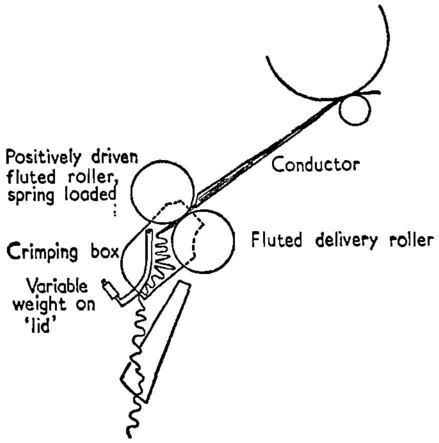

Figure 7.11. Crimping box attachment on a finisher drawing frame

to the delivery of a finisher drawing frame. The sliver leaves the nip of the drafting rollers and passes down the sliver plate into the nip of a pair of fluted delivery rollers, the upper one of the pair being spring-loaded and positively driven through a wide-pitch gear from the lower one. The sliver is driven into the box where it meets a metal finger or lid hanging down into the box. The finger impedes the motion of the sliver and the box quickly fills, when more sliver enters at the back the lid of the box is forced up by the mass of sliver inside the box and the sliver at the front of the box can come out; this, of course, is a continuous process, although the delivery of the crimped sliver is not steady and the sliver spurts out at an irregular rate from second to second. During its sojourn in the box the fibres in the sliver become 'concertinad' and take on a permanent crimp or wave. The length of time any particular piece of sliver remains in the crimping box can be regulated by means of small weights which can be added to the finger, a heavy weight requiring a greater mass of sliver in the box to lift it up and, hence, developing greater crimp in the fibres.

SLIVER PACKING

First and intermediate drawing sliver may be packed in rolls on roll-formers similar to those found on cards or, alternatively, in cans. It may be mentioned that if the sliver at either of these frames is crimped then it must be put into cans—the action of roll-forming would remove most of the crimp. The sliver from the finisher drawing frame is always fed into cans. Common can dimensions are

First drawing	18 in. dia. × 40 in. tall.
Second drawing	14 in. dia. × 40 in. tall.
Finisher drawing	12 in. dia. × 40 in. tall.

In order that the sliver may be packed neatly in the cans and as great a packing density as possible achieved the cans rest on can-turning plates at the front of the machine. These are simply carrier plates which revolve through almost 360 degrees in one direction and then reverse, the cyclic motion coiling the sliver neatly in the can. In addition to these can-turning plates there are a series of can-tramping arms, one for each delivery on the frame. These carry expanded metal 'feet' at their bottom ends, the feet projecting into the cans. As the trampers move up and down they pack the sliver down into the can and allow greater quantities to be inserted.

Automatic stop motions are an essential part of any machine which is meant to have a high output and the minimum of supervision. Jute drawing frames are fitted with a variety of stop motions which will cut off the power supply to the motor if a feed sliver breaks or a lap builds up at the feed or delivery. These devices not only prevent bad sliver being made when, for instance, a feed sliver breaks, but prevent accidental damage to the machine. Another device incorporated to avoid damage to the gill-sheet is the pitch-pin. This is a pin which passes through two flanges on the back-shaft of the machine. The pin, in effect, acts as a coupling between the flanges, transmitting motion from one to the other. If a sudden load is thrown on the faller-bars, perhaps by sliver lapping or choking somewhere, then the pin fractures and the drive to the faller-bars is stopped and damage avoided. It is obvious that the correct type of pin must be used and if a makeshift one is put in which is too strong then the whole object of the safety mechanism is defeated.

CALCULATIONS

The calculations required at the drawing passages are confined chiefly to those concerning sliver count and machine performance. A full set of machine performance calculations will be shown for an intermediate drawing frame of the double-thread spiral variety, Figure 7.12 showing the relevant gearing.

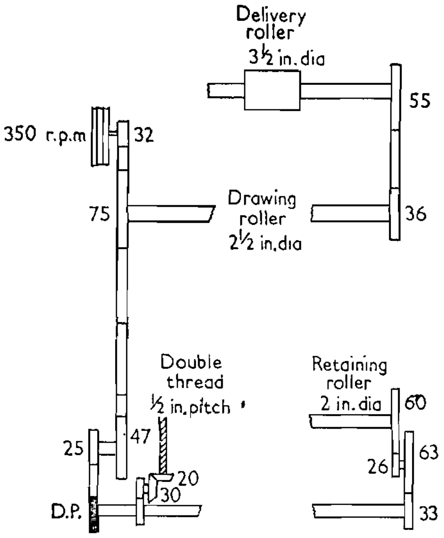

Figure 7.12. Spiral 2nd drawing frame gearing

Drawing roller surface speed:

$$350 \times \frac{32}{75} \times 2{\cdot}25 \times 3{\cdot}14 = 1{,}055 \text{ in./min}$$

Delivery roller surface speed:

$$350 \times \frac{32}{75} \times \frac{36}{55} \times 3{\cdot}5 \times 3{\cdot}14 = 1{,}074 \text{ in./min}$$

Retaining roller surface speed:

$$350\times\frac{32}{47}\times\frac{25}{\text{c.p.}}\times\frac{33}{63}\times\frac{26}{60}\times 2{\cdot}0\times 3{\cdot}14=\frac{8{,}496}{\text{c.p.}}$$

Faller-bar surface speed:

$$350\times\frac{32}{47}\times\frac{25}{\text{c.p.}}\times\frac{30}{20}\times 0{\cdot}5\times 2=\frac{8{,}960}{\text{c.p.}}$$

Faller drops:

$$350\times\frac{32}{47}\times\frac{25}{\text{c.p.}}\times\frac{30}{20}\times 2=\frac{17{,}920}{\text{c.p.}}$$

Draft constant:

$$\frac{1}{2\text{ in.}}\times\frac{60}{26}\times\frac{63}{33}\times\frac{\text{c.p.}}{25}\times\frac{47}{75}\times 2{\cdot}5\text{ in.}=\text{c.p.}\times 0{\cdot}138$$

i.e. draft = draft change pinion $\times\, 0{\cdot}138$

Lead of delivery over drawing rollers:

$$\frac{1}{3{\cdot}5\text{ in.}}\times\frac{55}{36}\times 2{\cdot}5\text{ in.}=1{\cdot}018\text{, i.e. }1{\cdot}8\text{ per cent}$$

Lead of fallers over retaining rollers:

$$\frac{1}{2\text{ in.}\times\pi}\times\frac{60}{26}\times\frac{63}{33}\times\frac{30}{20}\times 2\times 0{\cdot}5\text{ in.}=1{\cdot}052\text{, i.e. }5{\cdot}2\text{ per cent}$$

DEVELOPMENTS IN DRAWING FRAMES

Much attention has been given in recent years to the possibility designing a machine which could take account of the irregularit in the sliver as it enters the drawing frame and, by acting on the irregularities by means of a variable draft, produce a regular sliver at the delivery end. That is to say, thick pieces of sliver would be drafted more than thin pieces and the net result would be a greatly improved sliver as far as count regularity is concerned. The first commercially available machine for this was the Raper Autoleveller for worsted slivers and since then many manufacturers have marketed machines for the same purpose. None of these, however, are suitable for jute slivers because of the large variations in weight which are present. In all these machines the drafting mechanism is virtually unchanged, except that an independent variable-speed drive is provided for the drawing rollers; where they differ is in the method adopted for detecting the variations in the feed sliver weight and converting these variations into signals which will be used to control the speed of the drawing rollers. Figure 7.13 illustrates the general principle in such a frame, developed at the B.J.T.R.A.

The sliver passes between one of the normal retaining rollers and another pivoted, counter-balanced roller and, as the bulk of the sliver between the rollers varies, the pivoted detecting roller moves up and down. In this manner the detecting roller follows the weight profile

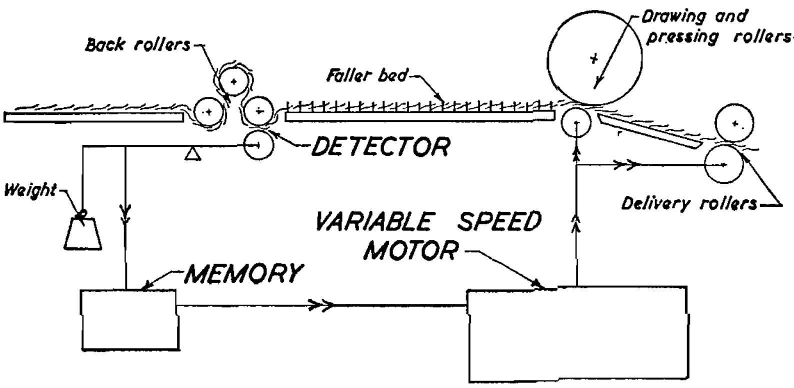

Figure 7.13. Variable draft drawing frame

of the sliver. The variable draft will ultimately operate on the signals put out by the pivoted rollers—increasing the draft when a thick section of sliver enters the frame and decreasing it for thin sections. On the drawing frame, however, there is inevitably a slight time-lag between the time of measuring the sliver thickness at the back of the frame and the proper time for drafting that particular piece of sliver. In order to store the weight profile of the sliver a 'memory' is required which collects the information from the detecting rollers about the variations in sliver count, stores this information for a certain time, and then transmits it to the variable speed motor so that the latter can act at the proper time. B.J.T.R.A. hold British Patent 889,969 for such a device. By using such a machine considerable improvements can be made on the long-term regularity of the material but, inevitably, the machine is more costly than conventional fixed-draft frames.