CHAPTER SIX

Carding

THE primary function of the cards is to convert the reeds of jute into a uniform supply of fibrous material which can then be drafted and finally twisted into yarn. It is perhaps at the cards that the most dramatic change in the appearance of the jute is seen; when it is passing into the breaker card the reeds from the stems of the plants can easily be identified and the whole feed is coarse and uneven, but by the time the jute has passed through the breaker and finisher cards it has been transformed into a thin web of separate fibres emerging as a fleece which is then condensed into a sliver. Besides this essential task, the cards begin the work of weight reduction by drafting and weight levelling by doubling.

Like the batching process, the carding system in use depends upon the class of fibre being worked and, in general, two methods are adopted, one for long jute and one for short material. In practice this reduces to one method for hessian and sacking warp yarns and another for sacking weft yarns, the former comprising two carding passages and the latter three. Jute and its allied fibres are invariably carded on roller and clearer type cards based on those used in the flax trade. The heart of the machine is a large cylinder 4–5 ft in diameter and covered with small pins set at an angle to its surface. Arranged round the periphery of this main cylinder are complementary pairs of smaller rollers clad also with pins, these rollers being known as the workers and strippers. The pins of the worker are set to work against those of the main cylinder whereas the stripper pins are set in the same direction as the cylinder pins (see Figure 6.1). As the cylinder, workers, and strippers rotate, their pins split and open the jute which is passing between them. On a breaker card there are usually only two pairs of workers and strippers but finisher cards commonly are made with four or five pairs. Another pinned roller is required at the delivery of the machine to pluck the carded fibre from the pins of the main cylinder and pass it to the delivery rollers, this roller being known as the doffer from its function of doffing the fibre from the cylinder.

Jute cards are classified according to the direction in which the cylinder pins are travelling when they meet the jute for the first time

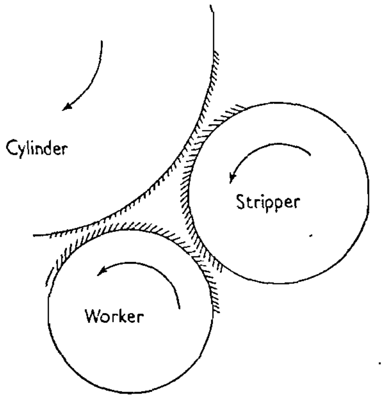

Figure 6.1. Worker/stripper/cylinder pin action

at the feed side of the machine and according to the amount of the main cylinder circumference which is utilized.

Upstriking, i.e. the pins of the cylinder approach the feed from underneath and strike up into the jute.

Downstriking, i.e. the cylinder pins approach the feed from the top and strike down into the fibre.

Half-circular, i.e. the jute travels half-way round the cylinder in its journey from the feed to the delivery and thus the feed and delivery are approximately 180 degrees apart.

Full-circular, i.e. the feed and delivery are almost side by side and the jute travels through nearly 360 degrees inside the machine.

Breaker cards are commonly downstriking and half-circular, and finishers, downstriking and full-circular. Upstrikers are mainly used to card low-grade material of short length for if this kind of fibre is handled on a downstriker card there tends to be a large amount of short fibre dropped beneath the machine. If the card is upstriking this material is held in with the bulk of the jute. With this type of card the sliver tends to be specky and dirty because of the accumulation of short fibre plus all the small pieces of bark and stick which would otherwise have fallen underneath the machine.

CARDING SYSTEM

Hessian yarns are given two carding passages, the breaker card handling 500–800 lb/hr and the finisher 350–450 lb/hr. The breaker card is fed from spreader rolls and the finisher card from breaker rolls. Between the two machines there is an effective draft of 3–4 to reduce the heavy spreader sliver to a count suitable for the first drawing stage.

Sacking warp material is given two carding passages over breakers and finishers which are similar to hessian-type cards, but the method of feeding the breaker differs. The jute for this grade of yarn is usually passed over the softener and it is converted to a continuous sliver at the breaker card instead of at the preceding stage as in the case of the hessian qualities. Just as the spreader is fed by a dollop of a certain weight to a pre-determined clock length, so the breaker is dollop-fed by hand. The breaker clock length, however, is only about 12 or 15 yd and the dollop weighs about 35 lb. The jute is taken from the conditioning site to the breaker cards where dollop-weighers make up bundles of fibre, equal in weight to half the dollop, which are then placed evenly on the card feed sheet by the breaker feeder at such a rate that the half-dollop is fed in half of one revolution of the gear-driven pointer at the top of the feed sheet. If, for example the clock length is 11·5 yd, the dollop 38 lb, and the card draft 17, then the delivered sliver count will be

$$\frac{38 \times 100}{11{\cdot}5 \times 17} = 19{\cdot}5 \text{ lb/100 yd}$$

When sacking weft is being prepared an extra carding machine is used to convert the bale ropes, yarn, and cloth waste used for this quality into a fleece or tow before mixing it with root cuttings and some long jute at the sacking weft breaker card. This machine is known as a teaser or waste breaker card and consists of a cylinder, two worker/stripper pairs, and a doffer, all clad with strong, coarsely set pins. The waste material is fed by hand to the teaser and the delivered fleece is allowed to fall to the floor or into bags. At the sacking weft breaker card, this tow is weighed out in the required proportions and mixed with the root cuttings and low marks of long jute which form the rest of the batch for this yarn. From the breakers the sliver passes to the sacking weft finishers which again are more sturdily pinned than hessian finishers and can be more heavily loaded, having a production rate of about 700 lb/hr.

THE JUTE BREAKER CARD

The breaker card is a particularly important machine in the jute processing system for it is here that the very basis of yarn quality, the average fibre length and fineness, is determined. Breakers are usually half-circular and downstriking and have two pairs of workers and strippers, Figure 6.2 showing a sketch of one such machine.

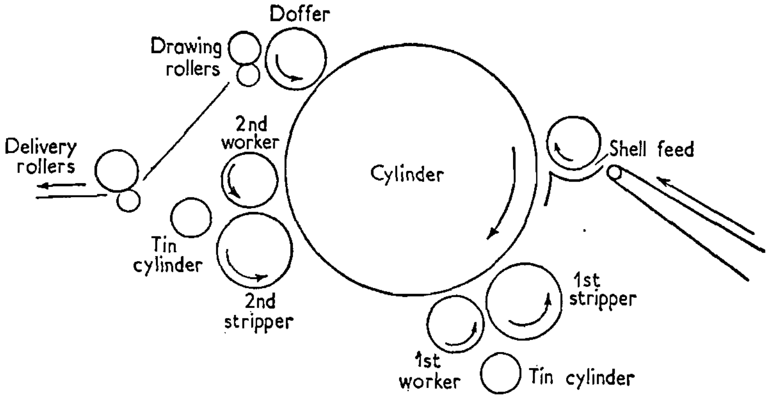

Figure 6.2. Two-pair downstriker breaker card

The carding action of converting the reeds into a fibrous fleece is not easy to examine since the machine must be enclosed with shrouding while it is running but, nevertheless, a full understanding of the process is essential. The description that follows refers particularly to a hessian breaker card but the same principles apply for sacking cards.

The rolls of spreader sliver, 6–8 in number, are fed on to the feed sheet from a creel at floor level and the material passes up towards the feed rollers of the breaker. The jute then enters the machine through what is known as a 'shell' feed. This consists of a pinned feed roller with backward-facing pins and a cast iron shell which is shaped to follow the circumference of both the feed roller and the main cylinder and forms a sharp edge between the two curvatures over which the jute must pass. The jute enters the space between the pinned feed roller and the shell and travels towards the swiftly moving pins of the main cylinder. When the leading ends of the reeds meet these fast-moving pins (which strike down into the jute because of the angle at which they are set in the cylinder and the direction of cylinder rotation) they are split, opened out, and converted into a fibrous 'beard', which hangs down between the lower part of the shell and the cylinder. More jute is fed forward and the beard becomes longer and the reeds are opened progressively. The longer the jute which is fed into the breaker the longer is this beard and to accommodate long reeds the first stripper is set 4 or 5 ft away from the shell; if this were not done there would be a danger that the reeds would become trapped between the pins of the 1st stripper and the cylinder and be pulled rapidly into the card without being sufficiently opened. While this combing, splitting, and opening is going on at the shell feed, the backward-facing pins of the feed roller exert a grip on the reeds and, ideally, each part should receive the same carding action. Unfortunately this does not always happen in practice. The feed roller pins can only exert a restraining influence on the jute provided there is enough bulk of material between them and the shell and if the incoming supply of fibre is not maintained then the jute which is between the roller and the shell will be pulled rapidly into the card over the shell edge and will not receive its fair share of carding—this action is known as 'gulping' the sliver. On breakers fed from spreader sliver the material normally enters the machine crop end first and if a thin section of spreader sliver comes along then gulping may occur and the root end will be dragged past the shell. Since it is important that this part of the reed should be carded properly, this constitutes a source of poor quality. If, on the other hand, the card is being fed by hand on the dollop system, as for sacking grades, the stricks are fed up the feed sheet root end first and this part will almost always receive the necessary degree of carding at the shell. When gulping occurs it is the lighter crop end which misses the combing action at the shell.

The clearances between the shell and the feed roller, the shell and the cylinder, and the feed roller and the cylinder can be altered to give a selection of operating conditions. These settings can have a considerable bearing upon the average fibre length in the card sliver and since it is axiomatic that as long a fibre length as possible is desired, the shell settings assume considerable importance. In general, any adjustment which exposes the jute to prolonged combing at the shell will reduce the fibre length, though naturally sufficient time must elapse to allow the essential opening, splitting, and cleaning to be achieved. Alterations in the combing time come about through changes in the rate of fibre feed. For example, if the fibre is fed at 8 ft/min, then each inch of the reed will pass over the shell edge in $\frac{1}{96}$ min, but if the feed rate is altered to 16 ft/min, then each inch will pass over the shell in $\frac{1}{192}$ min, i.e. half the time. Like the spreader, the breaker card is a constant delivery speed machine and when the draft is changed it is the feed speed that is altered, thus changes in the length of time the jute is exposed to combing will arise from changes in the card draft. Table 6.1 shows the results of tests made to find the effect of different breaker card drafts on the average fibre length.

TABLE 6.1. EFFECT OF BREAKER DRAFT ON FIBRE LENGTH

Draft	*Feed speed (ft/min)*	*Average fibre length (in.)*	
		Jute A	*Jute B*
24	8·1	2·4	2·7
18	11·2	2·6	2·7
12	16·3	2·7	2·9

Clearly, the greater the draft the more fibre breakage takes place at the shell and as the quality of the yarn depends *critically* upon fibre length it might be thought that a substantial improvement in the process would be obtained by using low breaker drafts. Unfortunately, undesirable side-effects come into operation when the breaker draft is low; for instance, if the same count of spreader sliver is used then a heavy breaker card sliver is made and this throws a heavy load on the finisher card and the drawing frames. Alternatively, the same count of breaker sliver could be made but this would be accompanied by a drop in production and more breaker cards would be required to put through the same tonnage of jute. As in so many cases, a compromise must be reached between acceptable quality levels and the demands of production.

The other important variable is the clearance between the shell and the feeder roller. The greater the distance between the two the lighter is the grip on the jute and the more easily is it dragged into the card by the cylinder pins. This has the same effect as reducing the time of combing, i.e. less breakage occurs. Table 6.2 gives a summary of the results of an experiment where two shell/feed-roller settings were used and the yarn properties examined.

The jute processed with the closer shell setting had a shorter average fibre length and poorer yarn properties. However, it cannot be deduced from this that the wider the feed/shell setting the better will be the quality of the yarn since there must be sufficient restraining

TABLE 6.2. EFFECT OF SHELL SETTING ON YARN QUALITY

Yarn properties	*Shell/feed-roller clearance* $\frac{3}{8}$ in.	$\frac{1}{2}$ in.
Count (lb/sp.)	7·9	7·9
Breaking load (lb)	7·2	7·5
Coefficient of variation of breaking load (per cent)	18·3	17·9
Calculated minimum strength (lb)	3·2	3·5

action at the feed to hold back the jute and allow enough time for the cylinder pins to do their work.

While dealing with the shell feed it is convenient to consider the effect of the physical properties of the jute on the fibre length obtained. It has been said already that the cylinder pins strike strongly into the projecting reeds at the edge of the shell and in so doing comb, split, and open the fibre complexes into more or less single units. As may be imagined the force exerted on the jute to achieve this function is considerable and therefore any fibre which is weak and 'brittle' would not be able to withstand this rigorous treatment as much as a strong fibre with some 'give' in it. These terms 'brittle' and 'give' are more correctly replaced by 'inextensible' and 'more extensible'; that is to say, a fibre which cannot be extended much without breaking has a low resistance to sudden impulsive loads and another which can extend more before it breaks will be better able to withstand such forces. Thus it is this property of extensibility which is important in a fibre in regard to its ability to be carded into a fibrous mass while retaining a good average fibre length. It will be recalled that, when the grading of raw jute was dealt with, one of the factors characterizing a good quality jute was good elasticity; now it can be seen that this has a very important bearing on the standard of the yarn which can be spun from it. Table 6.1 shows two fibre lengths obtained from the same conditions on the breaker card from two grades of jute, the better grade, B, having a higher extensibility, suffered less fibre breakage than the poorer grade.

In the early attempts to spin jute at the beginning of the nineteenth century it was only the line fibre which could be hand-spun into yarns at all—line fibre being the longer fibre extracted by a combing process from the bulk of fibre. With jute this meant that there was only a small quantity of line usable, leaving large amounts of tow containing very short fibres which could not be worked into yarn. One or two trials were undertaken in which jute was passed over a flax card but the average fibre length was so low that nothing could be done with the material and, besides, the dust and waste was excessive. It was not until batching was found to have a beneficial effect that the commercial exploitation of jute could begin. Unknowingly, the pioneers of jute spinning had conferred upon the fibre that very property which permits the mechanical carding of jute to be carried out successfully—increased extensibility. Batched jute has a higher extension at break than unbatched jute and, as a result, withstands the fierce action at the shell feed better and excessive fibre breakage is avoided. The difference in fibre length obtained with batched and unbatched jute is small but even a change of $\frac{1}{4}$ in. in the average can have an extremely large effect in the yarn, a lesser fibre length increasing the variability markedly. Since the working strength of a yarn is the strength of its weakest point, this results in a much inferior yarn.

From the preceding paragraphs it will be apparent that the carding action at the shell feed is one of great importance as it is here that the average fibre length is largely decided, but despite the robust operation at the shell all the reeds are not split and opened by the time the jute has passed completely into the card and further carding is required; this is carried out by the combination of the workers and strippers. The essential feature of the carding operation at the workers and strippers is one of combing, teasing, and splitting as the fibre is transferred first from the cylinder to the worker, then from the worker to the stripper and finally from the stripper back on to the cylinder. As the pins of the stripper point in the same direction as those on the cylinder the bulk of the jute descending on the cylinder passes between the cylinder and the stripper though there is a certain amount of build-up where the two rollers meet. The jute then comes in contact with the backward-facing pins of the worker and as the surface speed of this roller is very low compared with that of the cylinder (30 ft/min compared with 2,500 ft/min) the fibres are arrested by the worker pins. Those fibres which are firmly held by the cylinder pins pass underneath the worker and continue until they meet the next worker/stripper pair, but the remainder are pulled away from the cylinder pins by the worker pins. There is no clear-cut transition from one set of pins to the other but rather an indefinite fleecy mass forms in which the longer fibres are tugged between and round pins, and the shorter fibres dragged through longer ones still anchored in the cylinder pins. This fibre entanglement and inter-fibre movement continues the splitting and opening work begun at the shell and, in addition, much of the hard, barky particles adhering to the fibres are knocked off. The fibres do not lie as a uniform fleece on the pins of the worker, some being held by the pins but the greater majority resting quite lightly on the top of the pins. It will be appreciated that inside the shrouding of the card air currents and eddies are set up by the rapidly rotating cylinder; these tend to blow the fibres into a fleecy conglomeration on the workers and strippers. This fibre mass continues round the worker until it comes under the influence of the stripper where the pins, by virtue of their direction and greater surface speed, lift the upper layers of the fibre mass off the worker pins, splitting and opening it as they do so. The more firmly held fibres pass round the workers again until they meet the faster-moving cylinder pins and the cycle is repeated. Once the bulk of the fibre has been transferred from the worker to the stripper it continues round on the stripper until it meets the cylinder where it is removed from the stripper by the cylinder pins working back-to-back with the stripper pins. In this way the fibre networks are gradually split into a fibrous mass and, in addition, there is some degree of mixing inside the card as some of the material is held back and deposited on top of fresh. Indeed, it is possible for a bunch of fibres to travel several times round the worker/stripper pair before it passes on with the cylinder.

After leaving the second worker/stripper pair the jute meets the doffer whose function is to strip the jute off the cylinder and pass it to the nip of the drawing rollers and so out of the machine. Its action is similar to that of a worker, its pins plucking the fibre away from the cylinder surface. Ideally, the doffer should remove all the jute from the main cylinder so that the latter can approach the shell feed with clean pins ready for the maximum amount of carding but this seldom happens and some fibres evade the doffer's action and travel round with the cylinder. Most of the jute, however, is caught by the doffer and moves round with it until it meets the drawing rollers. These normally have about twice the linear speed of the doffer. The fibre is caught as a thin tenuous web in the nip of the drawing rollers and the doffer pins, by virtue of their downward movement relative to the drawing rollers, give up the fibre smoothly. The web emerges from the drawing nip and passes down a V- or U-shaped sheetmetal condenser at the foot of which is an opening which the jute passes through to form a sliver. Once through this hole it passes between two delivery rollers, the top one of the pair being heavy enough to compress the jute into a compact sliver.

Mention must be made of two other rollers found on the breaker card—the tin rollers. These are light hollow rollers situated at each worker/stripper pair (see Figure 6.2) for the purpose of reducing the amount of fall-out below the card. As the fibre fleece is travelling round with the workers and strippers it stands proud from the surface and there is a tendency for the long fibres to fall out of this fibrous mass. The tin rollers prevent this by containing the mass without interfering with the essential operations in any way.

Facilities are available to alter the clearances between the workers, strippers, and cylinder pins and to change the speed of the workers and strippers relative to the cylinder, but these settings or speeds do not appear to be critical. In tests where the worker speed was changed from 27 ft/min, to 111 ft/min, there was no alteration in the average fibre length or the physical properties of the yarn. This is perhaps not surprising, for it is not the roller's absolute speed that matters but rather its speed relative to that of the cylinder. When the cylinder has a linear speed of 2,500 ft/min and the worker's speed is 27 ft/min, the relative speed of the two is $2{,}500 - 27 = 2{,}473$ ft/min; increasing the worker surface speed to 111 ft/min only alters the relative speed to 2,389 ft/min, i.e. increasing the speed of the worker by a factor of around 4 changes the relative carding speed by only 3·4 per cent.

In the preceding paragraphs the impression may have been given that the pins of the rollers are carrying large quantities of fibre but this is not the case. It is interesting to calculate the weight of fibre on each square foot of the rollers of a breaker card, taking an average throughput of 12 lb/min, average roller surface speeds, and assuming that the cylinder carries fibre only over two-thirds of its surface, the feed roller carries fibre over one-third of its surface, and the doffer, over two-thirds. (These assumptions lead to the highest density of fibre on the rollers being calculated.)

Roller	*Loading* (lb/ft^2)
Feed	0·671
Cylinder	0·001
Workers	0·050
Strippers	0·005
Doffer	0·022

The figures illustrate how the jute is transformed from a thick heavy layer of reeds at the feed, travelling at perhaps 9 ft/min, to a thin web on the cylinder, travelling at about 40 m.p.h., and give one some indication of the forces applied to the fibres.

THE FINISHER CARD

Figure 6.3 shows the layout of a finisher card suitable for hessian, carpet, and sacking warp yarns. The machine is designated 4½ pair, from the number of pairs of workers and strippers; full circular, from the fact that most of the cylinder surface is usefully employed in carding; double doffer, from the two doffers; and down-striking.

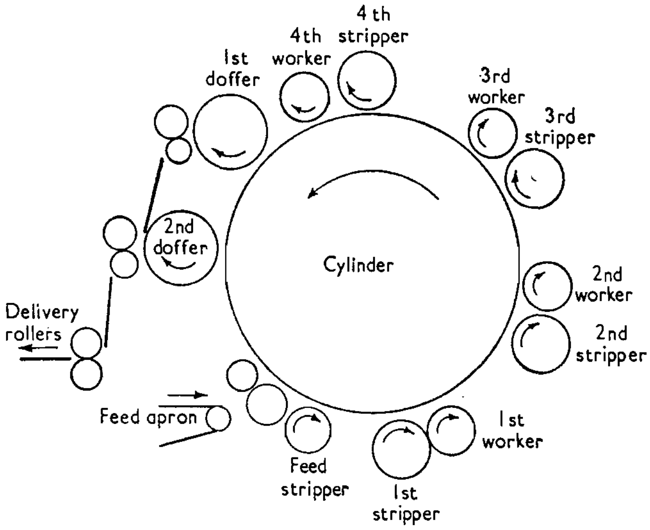

Figure 6.3. 4½-pair full-circular finisher card

The rollers and the cylinder are pinned in the same manner as the breaker card, but because the jute is in a more open state by the time it reaches the finisher the pins are somewhat finer and set closer together. The commonest type of feed arrangement is the 'pinned plain', i.e. the feed roller is clothed with pins but the roller immediately above it is not. The pinned plain feed is met with universally on hessian and carpet quality cards and very often on sacking warp cards. Two other types of feed are met with, the 'shell' feed and the 'double-pinned' feed. The shell feed is similar to that on the breaker with the shell set about $\frac{1}{4}$ in. from the feed roller; this feed is associated with heavy card loadings and is usually confined to sacking weft cards. In the double-pinned feed the sliver passes between two pinned rollers; with this method only light card loadings are possible.

The action of the workers and strippers in the finisher is the same as in the breaker, and the finisher, therefore, continues the work of weight reduction by drafting, reducing weight irregularities by doubling, splitting the fibre networks, and cleaning.

When good quality fibre is being worked most of the fibre complexes are opened sufficiently at the breaker and the finisher's usefulness lies in drafting and doubling; but when low grade, dirty jute is being carded the finisher does much to open the material and remove bark and stick.

The settings of the various rollers can be varied and the speeds altered by changing speed pinions and pulleys in the drive. The clearances and speeds do not appear to be critical since tests where the worker speed was altered progressively from 30 to 97 ft/min for poor and good jute showed that there was no effect on either the spinning performance or the yarn quality, and others where the roller settings were changed by factors of almost 3 indicated that there was only a slight advantage to be gained from using the maker's recommended settings. If, however, the card is overloaded, there is a deterioration in sliver quality as shown by poorer spinning performance and low yarn quality. Too great a load in the card forces the fibres on to the pins which cannot then exercise their proper functions and the essential splitting of the fibre complexes ceases and long aggregations of fibre pass forward into the drawing stages and yarn. These may be seen at the finisher card delivery when the fleece is passing down the conductor which, incidentally, is a good place to examine the fibre from the point of view of the effectiveness of carding.

FINISHER CARD DRAWING-HEADS

At the delivery of a finisher card there may be a short drawing-head attachment comprising a pair of feed rollers, a short lattice of pinned bars and a pair of delivery rollers. The sliver enters the feed roller nip and then passes forward on to the moving pinned sheet. The pins are intended to pierce the sliver and control fibre movement as the material approaches the delivery rollers. On the drawing-head there is a draft of about 2 and the head functions mainly as count reducer for systems having only two drawing passages. In addition, the drawing head straightens the fibres somewhat and orients them parallel to the axis of the sliver. The major disadvantages in drawing-heads are associated with the speed at which they must run. Since high speed is necessary, the pinned lattice must be of the push-bar variety and even this must be run at such a speed that mechanical wear and tear is high and the pins cannot pierce the sliver correctly so that very often it rides on top of the pins instead of within them and uncontrolled fibre movement occurs.

CARD PINNING

The card pins are set in staves or lags which are screwed to the rollers, the staves being curved to match the rollers and extending across the roller face. The pins are set at an angle to the surface of the staves and are arranged in rows both horizontally and circumferentially, the latter rows being staggered by half the pin pitch so that when the surface of the roller is examined the pins appear in a diamond formation. For hessian cards the pins are set in beech-wood staves but for cards designed to handle harsh material the staves are metal.

The density of pinning becomes greater as the material being carded becomes finer. That is to say, finisher card pinning is finer than breaker card pinning, hessian pinning finer than sacking, and so on.

To maintain efficient carding the pins must be kept sharp. The points become blunted with use and grooves develop in the sides of the pins as a result of the fibres being pulled round them; collections of fibre may gather in these grooves to be released as small tight balls or 'neps' which persist through to the yarn. A regular scheme of pin renewal is required, the frequency depending on the class of fibre being worked, harsh fibre being particularly hard on the pins. It is customary to renew half the cylinder staves at a time and some indication of the intervals at which this should be done is given below.

Hessian and sacking warp grades of fibre

Breakers	800 hr
Finishers	2,500 hr

Sacking weft grades of fibre

Breakers (waste)	400 hr
Breakers	700 hr
Finishers	2,000 hr

Worker pins should last for roughly 2 years and stripper pins about 3 years on two-shift working.

TABLE 6.3. TYPICAL CARD PINNINGS

Roller	*Pins per square inch*					*Pin angles (degrees)*
	Breakers			*Finishers*		
	Waste	*Sack. weft*	*Sack. warp & hessian*	*Sack. weft*	*Sack. warp & hessian*	
Cylinder	2·5	2·5	3	7	10	70–75
Feed	3	4	4	6	9	50–60
Workers	4	4	5	5	10–16†	30–35
Strippers	4	5	5	5	8–16†	35–40
Doffers	4	5	6	6	12–18†	30–40

† Pinning becomes progressively finer as the delivery is approached.

BREAKER AND FINISHER CARD OPERATING DATA

While individual machinery makers and manufacturers vary slightly among themselves in technical detail, Tables 6.4 and 6.5 represent typical conditions.

TABLE 6.4. CARD SPEEDS

	Breaker	*Finisher*
Cylinder	2,400–2,700 ft/min	2,400–2,800 ft/min
Feed roller	9–14	10–15
Workers	35–50	30–40
Strippers	300–500	300–500
Doffer	75–95	75–100
Drawing Rollers	150–200	150–200

TABLE 6.5. DRAFTS, DOUBLINGS, AND SLIVER COUNTS AT THE CARDS

	Drafts	*Doublings*	*Counts*	
			lb/ 100yd	*ktex*
Hessian breaker	10–20	6–8	18–20	90–100
finisher	10–15	10–12	13–18	65–90
Sacking breaker	10–18	—	18–26	90–130
finisher	12–18	8–10	14–18	70–90

SLIVER PACKAGES

Breaker and finisher card sliver is usually delivered in rolls though certain systems still use cans at the finisher delivery. Roll-forming seldom gives much trouble, the main faults being extremely soft or extremely hard rolls which will not unwind properly at the next stage in the process.

Soft rolls may be due to insufficient pressure on the roll-former, dry sliver, or a low lead between the delivery roller of the card and the roll-former itself. Hard rolls, conversely, arise from too high a pressure on the roll-former, a high lead, and high moisture in the sliver (a defect accompanying the last-mentioned factor would probably be lapping at the drawing roller, i.e. sliver wrapping itself round the roller instead of passing cleanly through the nip).

The roll-former lead over the delivery of the cards varies with the position of the roll-forming mechanism. For convenience in the layout of the carding machines in the space that is available it is sometimes necessary to lead the sliver from the card at the side, front, or rear. This can be done simply by passing the sliver round guides, plates, etc., and, in the rear delivery case, carrying the sliver to the back of the machine by a short conveyor belt acting in conjunction with a guide plate. At all times it is necessary to have the sliver under a slight tension so that there is no danger of the sliver going slack and fouling the delivery. The lead required is of the order

3 per cent for breaker cards.
5 per cent for finishers (front delivery).
13 per cent for finishers (rear delivery).

SPECIAL CARDING SYSTEMS FOR ROOT CUTTINGS AND SIMILAR MATERIAL

In recent years two special ranges of cards have been developed for handling root cuttings and similar material with a view to giving the fibre a thorough carding and distributing it as evenly as possible among better class jute so that the cheaper grade material can be used successfully as a diluent and permit a reduction in the cost of the batch to be made.

(1) *The Fraser system.* This range of machinery consists of two cards, specially designed to suit the nature of the raw material, and ancillary equipment for blending and mixing. The cuttings are taken from their maturing stalls and dollop fed to a lattice feeder similar to that used for feeding the softener (see Figure 5.13). The lattice feeder distributes the cuttings evenly on the feed sheet of the first card, the J1, which acts as a breaker for the cuttings. When cuttings are being processed the usual shell feed does not exercise sufficient control over the short fibre and it tends to gulp into the card instead of being restrained to allow the cylinder pins to do their work; this results in incomplete opening of the cuttings and an inferior sliver, full of hard bark and root. The J1, however, has a large-diameter pinned roller and a concentric feed-control plate which permits a more positive grip to be imposed on the cuttings, ensuring that no uncarded material passes forward. The cuttings are carded and delivered as rolls. The J1 card has a capacity of around 600 lb/hr.

Following the J1 card is an intermediate card, called the J3, which is fed with several J1 rolls and acts as a mixer for the cuttings besides continuing the work of splitting, opening, and cleaning. Like the J1, it delivers its sliver in rolls, but at a slightly lower rate—about 500 lb/hr.

It is at the next stage that the cuttings are intimately blended with long jute. This is done by an attachment to an ordinary shell-feed breaker card called the Sliver Dispersal Unit (S.D.U.) (Plate II). The S.D.U. is situated at the side of the breaker feed sheet with two rolls of J3 sliver sitting in its creel. The cuttings slivers enter the S.D.U. where they meet a drum carrying a series of beater bars which act simultaneously as choppers and blowers by tearing sections of sliver off the roll as it is being fed and blowing the fibres up a chute, mixing the jute into an expanded fibrous mass as they do so. The chute leads to the top of the breaker card feed sheet where an oscillating blade distributes the fibre uniformly on top of the long jute. From the breaker the material progresses to a finisher card in the usual manner, thus the cuttings receive a total of four cardings in their passage from the maturing stalls to the drawing stages.

The J1 card feeder distributes the cuttings evenly over the feed sheet allowing maximum opening and splitting to be effected in the card. This even feed rate allows the feed to be fast and permits the use of finer pinning than usual. It has been found that dense, short pinning on all the rollers may be used and remain clean despite the nature of the raw material.

TABLE 6.6. PIN DENSITIES

	Pins per square in.	
	J1	*J3*
Cylinder	8	10
Feed roller	5	6·4
Strippers	5	8
Workers	5	8
Doffer	5	5

The speeds of the rollers are much the same as those of hessian cards with the exception of the workers which are rather faster and the J1 feed which runs at about 50 ft/min.

A typical system employs three J1 cards and four J3 cards to produce 2,000 lb of material per hour. The J1 has a feed sliver weight of about 100 lb/100 yd and operates at a draft of 4. The J3 is fed by eleven doublings of J1 sliver and produces sliver of about 17 lb/100 yd.

(2) *The Mackie system.* Once the cuttings have matured they are placed in a hopper feeder attached to the 1st (or teaser) card. The hopper bin can hold 250 lb of root cuttings or mixtures of cuttings, bale ropes, and mill wastes; from the bin the fibre passes on to a moving lattice equipped with rotary beaters to knock off excess. The lattice carries it to an electrical weighing point where the material is weighed automatically and dumped on a second lattice at a rate adjusted to the card input speed to give the desired count of sliver at the delivery. This second lattice spreads the fibre on the feed sheet in such a manner that a uniform distribution of jute is presented to the

card pins. The card itself is a 2½ pair machine clad with coarse pins and functions as a sliver former and initiates the break-down of the hard, rooty material. The card delivers into rolls ready for the 2nd (or intermediate) card.

The 2nd card is a 5½ pair, pinned plain feed machine which is fed with 11 rolls of 1st card sliver and has a capacity of 450 lb/hr. The material is given a further opening and cleaning treatment in this card and it emerges from it in a suitable form for blending with long jute or passing directly to the drawing stages for sacking weft. If it is to be blended with long jute the sliver rolls are placed in a special dual creel which has positions for the cuttings rolls and the long jute rolls (Plate III). Blending may be carried out at either the hessian breaker card or the finisher card; if at the latter the poorer degree of blending must be accepted. The cuttings sliver is presented to the

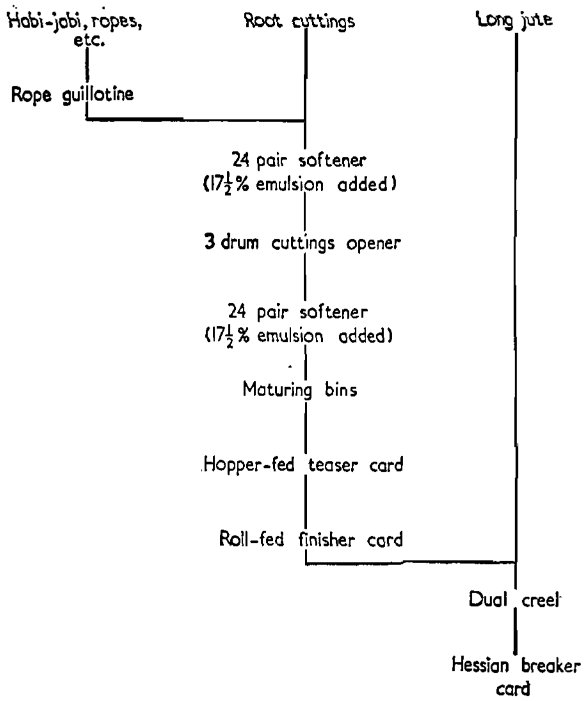

Figure 6.4. Flowsheet for blending cuttings and long jute on the Mackie system

feed sheet at regular intervals across its width and superimposed on the long jute slivers. In this way an intimate blend can be achieved.

The use of these special ranges of machinery permits a more regular product to be made from low grade material. This has enabled an extension of the scope of blending to reduce the batch cost and, as such, represents an important contribution to processing economics.

Figure 6.4 shows one possible arrangement for mixing low-grade material with long jute.

CARDING CALCULATIONS

These are of a simpler nature than those required for the spreader, being confined chiefly to draft, count, and speed. The following three are typical of those met with in practice.

(1) Eight ends of 300 ktex spreader sliver are fed to a breaker with a draft constant of 500 which has a draft change pinion of 28 fitted. If the feed speed is 3 m/min find the card production in an 8 hr day when it runs at 80 per cent efficiency, and the deliver sliver count when there is a moisture and waste loss of 6 per cent of the input weight. The sliver is delivered by a roll-former which has a 4 per cent lead over the delivery rollers of the card.

Draft on the card $= \frac{500}{28}$

$= 17{\cdot}85$

Delivery speed of card $= 3 \times 17{\cdot}85$

$= 53{\cdot}5$ m/min

Therefore, roll former delivery speed $= 53{\cdot}5 \times 1{\cdot}04$

$= 55{\cdot}6$ m/min

Daily delivery $= 55{\cdot}6 \times 60 \times 8 \times 0{\cdot}8$

$= 21400$ m

Sliver count at roll former $= \frac{300 \times 8 \times 0{\cdot}94}{17{\cdot}85 \times 1{\cdot}04}$

$= 121{\cdot}5$ ktex

Daily production $= \frac{121{\cdot}5 \times 21400}{1000}$

$= 2600$ kg

(2) It is necessary to produce breaker card sliver at a count of *18 lb/100 yd. What dollop weight must be used to meet the following conditions?*

Draft constant	440
Draft pinion	30
Feed sheet roller	7 in. diameter
Feed sheet roller	24·5 revolutions per clock revolution

Moisture and waste loss 3·5 per cent

In 1 revolution of the clock the feed sheet travels

$$\frac{24{\cdot}5 \times 7 \times 3{\cdot}1416 \text{ yd}}{36} = 14{\cdot}95 \text{ yd}$$

i.e. the clock length is 14·95 yd

$$\frac{\text{Dollop} \times 100}{\text{Clock length} \times \text{draft}} = \text{Delivered sliver (lb/100 yd)}$$

$$\text{Draft} = \frac{440}{30} = 14{\cdot}7$$

Hence, ignoring losses for the moment,

$$\text{Dollop weight} = \frac{18 \times 15 \times 14{\cdot}7}{100}$$

$$= 39{\cdot}7 \text{ lb}$$

To allow for losses this must be increased by 1·035,

Correct dollop weight = 41 lb

(3) The cylinder of a finisher card rotates at 180 r.p.m. Find its linear speed when its radius is 24 in. The feed roller travels at $\frac{1}{200}$ of the cylinder speed, the doffer at $\frac{1}{40}$ of the cylinder speed and at half the speed of the delivery rollers. Find the card draft.

Cylinder surface speed $= \dfrac{180 \times 2 \times 3{\cdot}1416 \times 24}{12}$

$= 2290$ ft/min

Therefore, feed roller surface speed $= \dfrac{2290}{200}$

$= 11{\cdot}45$ ft/min

Similarly, doffer surface speed $= 57{\cdot}3$ ft/min

Therefore, delivery speed $= 57{\cdot}3 \times 2$

$= 114{\cdot}6$ ft/min

Machine draft $= \dfrac{114{\cdot}6}{11{\cdot}45}$

$= 10$