CHAPTER ELEVEN

Winding

AS WINDING can be regarded as the first stage in weaving preparation, this chapter will deal only with the main points of the operation. After the yarn has been taken off the spinning frame it is transferred to one of three types of package—spools, cones, or cops. Although, as has been mentioned, these form the first preparatory stages for weaving, the winding department comes under the jurisdiction of the spinner. This it does as a matter of convenience. If the spinner sold his output on bobbins then he would require large stocks of empty bobbins to meet his own requirements and to allow for lateness or non-return from his customers. The spinner therefore winds packages which are suitable for direct sale.

The particular type of package on which the yarn will be wound depends on the yarn's end-use. Warp yarn will be wound on spools or cones; weft on cops, spools, or cones.

SPOOL AND CONE WINDING

In this operation the yarn from a number of spinning bobbins is tied head-to-tail to form a long continuous length of yarn which is wound on a wooden or paper centre. Spools are cylindrical and cones are, as their name suggests, conical. Both packages are without flanges and the yarn is built into a stable formation by winding it at a suitable angle. Spools are commonly 8–10 in. across the face and up to 10 in. in diameter. Cones, designed for over-end yarn removal, may be up to 15 in. in diameter with a 10 in. traverse, holding 45 lb of yarn. Cones generally have a taper of about 10 degrees though greater and lesser angles are found.

Two types of spool or cone may be made—open wound or precision wound. The first, and commoner, of these is made on a machine with a driving drum against which the package rotates through surface contact. As the drum has a fixed speed, it follows that the yarn winding speed is likewise fixed. The yarn may be traversed by means of guides set in a traverse-bar running along the machine; the bar being moved to and fro by a cam. Alternatively, the yarn may run in a helical groove cut in the driving drum itself, the yarn being led through the groove and traversed and wound by the one drum motion.

In drawn-winding the driving principle is straightforward and as the spool diameter increases, the spool r.p.m. decreases to give a constant surface speed. A cone, however, with its varying diameters does not behave in such a simple manner. There is only one point on the cone where the surface speed equals that of the drum. Towards the nose the drum travels faster than the cone and towards the base the cone surface speed is higher than the drum's, see Figure 11.1.

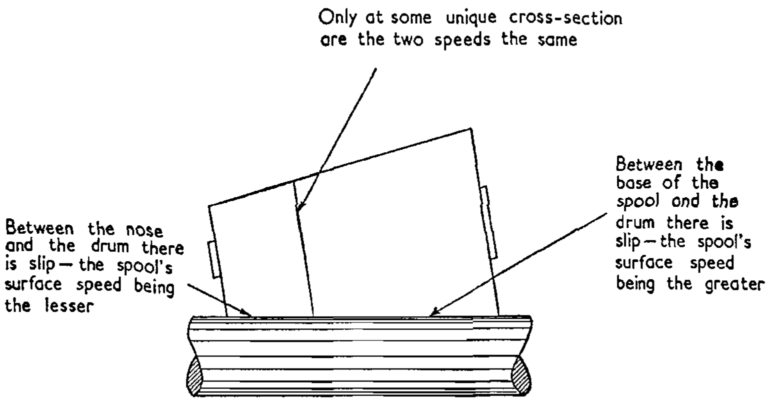

Figure 11.1. Slip encountered when driving a conical spool on a drum-type machine

Since the surface speed of the cone is

$$S = 2\pi fr$$

where f is the cone's rate of revolution and r is its radius, it follows that the surface speed varies from the nose to the base of the package and can only equal the driving drum's at one particular point. Some slip must therefore occur between the cone and the drum.

Open-wound packages have the yarn laid in a relatively open manner, successive layers criss-crossing with the previous in an irregular pattern. Precision spools or cones do not show this irregularity but have the yarns laid contiguously leaving very little free air-space between them. This leads to a very hard, dense package.

Precision winding is achieved by laying a definite number of spirals of yarn on in one traverse of the guide. Precision packages are wound on a machine which has a driven spindle on which the wooden or paper centre is mounted. The traverse guide is driven from the spindle at a certain 'winding ratio', i.e. the number of spindle revolutions to one traverse. If the winding ratio is 3 then three complete spirals will be wrapped round the package in each guide traverse. Note that if the winding ratio is a whole number or a half-number successive layers would be built exactly on top of previous ones and the fault known as ribboning would arise. The yarns would simply build up a spiral band bearing no resemblance to the desired product. To avoid this a slight lead, or gain, is given to the traverse cam-drive so that the yarn is laid in the fashion shown in Figure 11.2.

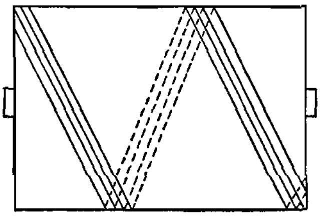

Figure 11.2. Precision-wound spool

COP-WINDING

For flat looms cops vary in diameter from 1½ to 2 in. and in length from 10 to 12 in. while for circular looms they measure up to 3⅛ in. in diameter and 17¾ in. in length. The cop is formed by winding the yarn on a bare spindle which is then withdrawn when the desired length of cop has been wound.

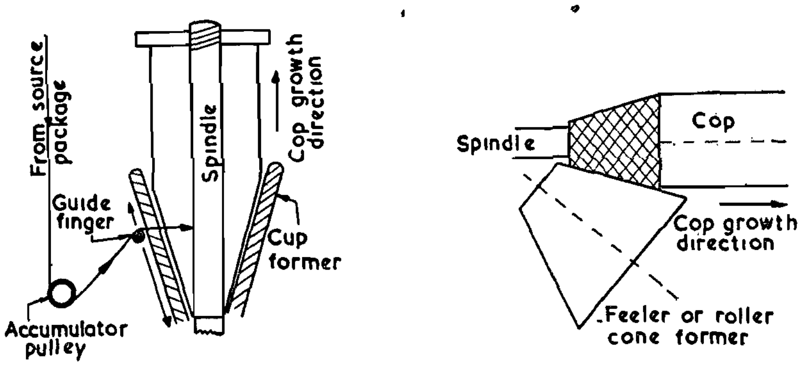

Figure 11.3. Cop-winding methods

The unit of the cop machine consists basically of a rotating spindle, a traverse guide and a nose-forming roller or cup, Figure 11.3.

The guide traverses back and forth, laying the yarn round the spindle in a wide spiral—winding ratios of 1·6–4·8 are found. At the start of cop formation the yarn builds a miniature open-wound spool until it comes in contact with the nose-forming roller or cup. The taper of the nose-forming member decides the nose angle on the cop, for jute yarn this is usually between 15 and 18 degrees for flat loom cops and about 22 degrees for circular loom cops. The cop continues to grow until a stop-motion, set to produce the required cop length, stops the spindle. The cop is doffed by withdrawing the spindle.

To increase the diameter of the cop a longer traverse stroke is used and *vice versa.* To give good unwinding the nose length is made at least $\frac{1}{8}$ in. greater than the diameter.

Depending on the design of the machine the spindles may be mounted horizontally or vertically. Modern machines run at 1,500–3,000 r.p.m. and have automatic doffing and re-starting. To capitalize on the high efficiencies of modern cop machines, the supply yarn is either on spools, cones, or tag-end bobbins, i.e. bobbins in which the first end on the bobbin is led to the outside of the full bobbin so that it may be tied to the tail-end of the next. Older machines have vertical hand-doffed spindles running at 1,000 r.p.m. and are fed from individual bobbins.

PRODUCTION ASPECTS OF WINDING

There are between 500 and 1,000 yd of yarn on a spinning bobbin. This means that the winder must tie at least one knot every 500–1,000 yd (there will be others to repair breaks but these are relatively infrequent and will be ignored for simplicity's sake as there are only about 2 per 10,000 yd of yarn). The winding machine's output is closely related to the winder's work-load, which in turn is intimately bound up with tying knots between bobbins.

Consider a drum-type spool machine running at 180 yd/min with a fresh bobbin waiting on each of its 40 spindles. If the bobbins hold 900 yd of yarn, each will be wound in 5 min. The winder starts 1, moves to 2 and starts it, moves to 3, and so on. If the winder can start bobbins at 10 sec intervals then it takes

$$40 \times 10 = 400 \text{ sec } (6{\cdot}67 \text{ min})$$

to work along the whole machine. By this time bobbin 1 will have wound, run out, and been idle for 100 sec (400 − 300), bobbin 2 has been idle for 90 sec (400 − 310), bobbin 3 for 80 sec (400 − 320), etc., up to bobbin 11 which is just finishing as bobbin 40 begins. The total lost time from bobbins 1 to 11 is 550 sec (9·18 min).

If now the speed of the machine is increased to 300 yd/min each bobbin will be wound in 3 min. A similar calculation shows that the lost time is now 2,330 sec (38·8 min). In both cases the net winding speed is

$$\frac{40 \times 900}{6{\cdot}68} = 135 \text{ yd/min}$$

At the slower speed this corresponds to an efficiency of 76 per cent but at the higher speed the efficiency is only 45 per cent. It must be remembered that efficiency or winding speed in themselves mean little —it is the combination of them both which determines output.

This presents a very simple picture of the more complicated practical case but should be sufficient to show that machine efficiencies, machine speeds, and output must be studied carefully if successful operation is to be achieved.

Just as material flow played its part in earlier operations the numbers of winding spindles, their speeds, and their efficiencies must be related to the spinning production.

For example, a mill has 20 spinning frames on 8 lb warp (4,000 r.p.m., 4 t.p.i.), 10 frames on 8 lb weft (3,900 r.p.m., 3·8 t.p.i.), 12 frames on 10 lb weft (3,700 r.p.m., 3·6 t.p.i.) and 4 on 11 lb weft (3,700 r.p.m., 3·5 t.p.i.); all the frames have 100 spindles. Spools are wound at 210 yd/min at 70 per cent efficiency, cops at 50 yd/min at 80 per cent from spools. How many warp and weft spindles are required?

Spin output at 90 per cent efficiency.

$$\text{Warp:} \quad \frac{20 \times 4000 \times 90 \times 100}{100 \times 4 \times 36} = 50000 \text{ yd/min}$$

$$\text{8's weft:} \quad \frac{10 \times 3900 \times 90 \times 100}{100 \times 3{\cdot}8 \times 36} = 25600$$

$$\text{10's weft:} \quad \frac{12 \times 3700 \times 90 \times 100}{100 \times 3{\cdot}6 \times 36} = 30850$$

$$\text{11's weft:} \quad \frac{4 \times 3700 \times 90 \times 100}{100 \times 3{\cdot}5 \times 36} = 10570$$

$$\text{Total:} \quad 117020 \text{ yd/min}$$

All this yarn must be wound into spools at an effective speed of

$$\frac{210 \times 70}{100} = 147 \text{ yd/min}$$

Spooling spindles required

$$\frac{117020}{147} = 795$$

Total weft spin output 67,020 yd/min.

Effective weft winding speed

$$\frac{50 \times 80}{100} = 40 \text{ yd/min}$$

Cop spindles required

$$\frac{67020}{40} = 1676$$

WINDING FAULTS

A not uncommon difficulty with cops is wrong diameter or variations in diameter. For automatic weaving it is particularly important that cops should be of the correct size otherwise faulty loading will result at the loom. Short-nosed cops can cause loops and snarls in the cloth when the cop breaks down in the shuttle. If the moisture regain varies widely then irregular cloth widths will result, for experience shows that cops with high moisture regains give narrower cloth than those with lower regains.

Spools may exhibit 'cobwebbing', Figure 11.4, where the yarn has passed over the end of the spool.

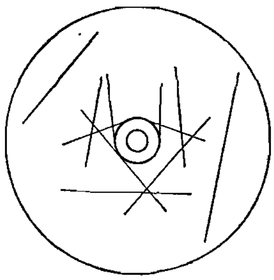

Figure 11.4. End view of a 'cob-webbed' spool

When these spools are unwound the yarn breaks as each trailing cobweb jerks the spool. If this is occurring on all spools from one bank of spindles it indicates a worn cam or badly positioned traverse bar. On individual spools the trouble may be due to a worn or slack guide or wrong positioning of the spool relative to the traverse guide.

TWIST CHANGES AT WINDING

If yarn is drawn off the side of a bobbin, spool, or cone no twist change takes place, but if it is drawn over-end from these packages or from a cop then the twist per unit length in the yarn is changed. The size of the change depends on the length of yarn in each spiral on the package. For instance, if one complete spiral of yarn on a spool is 12 in. long then over-end removal will change the yarn twist by 1 turn in 12 in., i.e. 0·083 t.p.i. Notice that the shorter the length of the spiral the greater is the twist change. Thus in a cop where the length of each complete spiral of yarn may be only $3\frac{1}{2}$ in. the twist change would be 0·29 t.p.i. The general level of twist change in cops is about 0·25 t.p.i.

The direction of unwinding, clockwise or anticlockwise, determines whether the twist change will be positive or negative, i.e. whether extra twist will be put into the yarn or taken out of the yarn. As almost all jute yarns are spun with Z-twist only this case will be considered (if S-twist yarn is used then the effects are the opposite, gains become losses and *vice versa*). If, when viewed from the end over which the yarn is drawn, the yarn moves in an anticlockwise direction then twist is taken out. If, on the other hand, the yarn rotates clockwise then twist is added.