

Woollen Carding

The woollen carding process is designed to open the fibre tufts into individual fibres and blend them together again into a fibre web. This web is then split into many parallel strips that are rubbed into condensed slubbings, yarn-like threads but twistless and therefore lacking strength. These slubbings, the equivalent of the rovings of worsted or cotton spinning, are taken to the woollen spinning frame on long bobbins and spun into yarns for knitting or weaving. The overall process is therefore short and the quality of the card web determines the quality of the slubbings and of the yarn spun from them.

The woollen carding process differs from the worsted process in that the card has many more sections because it is required to perform much more intimate mixing and blending than the worsted. Woollen cards usually have four or five sections, each with a main cylinder (the "swift") and workers and strippers arranged around them, an intermediate doffer links the sections. The woollen card also uses in its later sections "flexible" card clothing rather than rigid "metallic" wire. This flexible wire allows a high point density and helps to open up neps formed in the earlier carding parts. Much more lubricant is used in woollen processing than in worsted, around 4% compared to 0.5%. This to preserve fibre length through the long card, to reduce static electricity, and to help with condensing at the rubbers.

Input to the woollen card is usually by a weighing-hopper feed. Because any density variations at the input will generally appear uncorrected in the yarn, modern woollen cards use accurate weighing systems, whether weigh pans, roller-weigh systems or weigh-plate systems. Some also use secondary corrective systems such as Servolap which adjusts the feed rate according to a nuclear or X-ray measurement of the batt being fed into the card. The measurement, whether, weigh-system or X-ray then also controls the feed roller speed to provide a constant average feed rate of fibre.

The card-clothing gets progressively finer closer to the output. Many different combinations of clothing densities and types are chosen by carding engineers according to the fibres to be processed, which are often highly varied, and their training and beliefs. The main rule followed is that finer clothing (higher point densities) are required for the processing of finer fibres. Other than that, different factories processing identical fibre blends can operate with completely different complex (and secret) recipes to produce the same quality product.

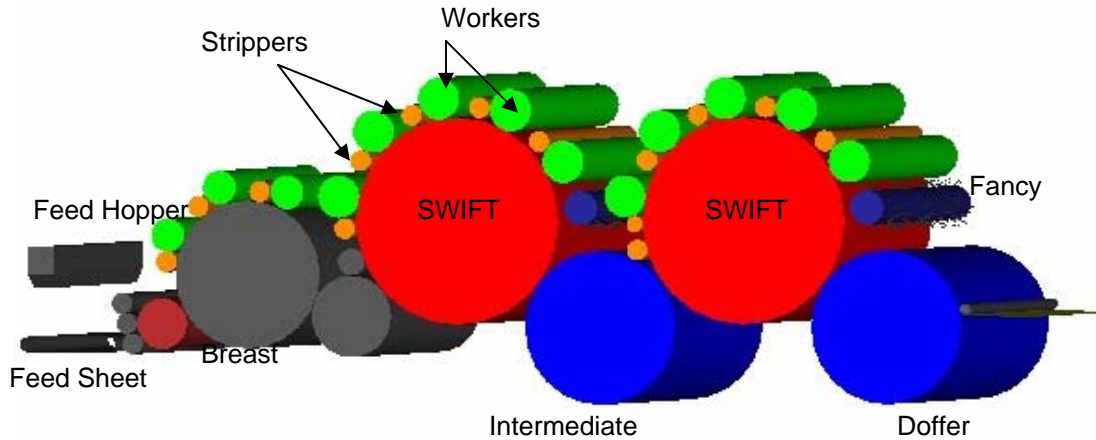


Figure 1. Schematic diagram of the input section of typical Woollen card.

The card operates by separating fibres and fibre tufts between rotating rollers covered in card clothing. The clothing or “wire” has many fine points like a wire brush that catch the fibres. In the diagram of Figure 1, the Breast and Swift rotate clockwise while the workers rotate anticlockwise and many times more slowly than the main cylinder. The teeth of the Swift wire face forward while the teeth of the worker wire faces backwards and so the speed difference and wire direction means the Swift and workers work point-to-point.

Fibre on the Swift is separated at the worker-Swift interaction, some fibre passes to the worker and some fibre stays on the swift. The fibre on the worker goes around relatively slowly towards the stripper. The stripper returns the fibre to the swift, the fibre is split again at the worker and the process repeats with a time delay determined by the worker speed and size. In this way the fibres are separated and blended. The effect is also to smooth out density fluctuations. If all the workers were run at exactly the same speed then, because the swift is running much faster than them, they would always return the same fibre to the swift at the almost the same time. This would mean that a coloured tuft, say, or a fibre density fluctuation, would be reinforced by the worker action laying the fault back onto itself repeatedly. For this reason workers are usually driven by sprockets of diminishing size so that they have different speeds.

A similar separation occurs at the doffers where some fibre is transferred to the output and the rest is recycled around the Swift. Thus most of the fibre is remixed many times in the machine direction before leaving each carding section. Weight control systems and the smoothing action of the card cannot however correct for cross-wise density variations at the feed. Because the transfer of fibre, and hence the blending and smoothing action, always occurs in the card's machine direction there is no cross-wise mixing within a card section.

The card is therefore usually split into "forepart" and "finisher" sections, linked with a cross-lapping device that takes the web produced by the forepart, condenses it and lays it across the input of the finisher section as shown for example in Figure 2. This ensures mixing across the card and so improves blending of the different fibre types introduced as tufts at the feed section. It also provides smoothing of cross-wise density variations that occur at the input to the card. The correct operation of the cross-lapping device is crucial to the evenness of the web produced and hence crucial to yarn quality. Any fluctuations occurring at the cross-lapper due to poor overlaying of the slivers will only be partially smoothed out by the finisher section.

After the forepart the cross-lapper then lays these well mixed longitudinal stripes across the finisher section which then mixes them again. The cross-lapping action also turn long scale-length variations that were along the machine into short term variations across the machine, the finisher section can then smooth out these short term variations but it has little impact on long scale-length fluctuations.

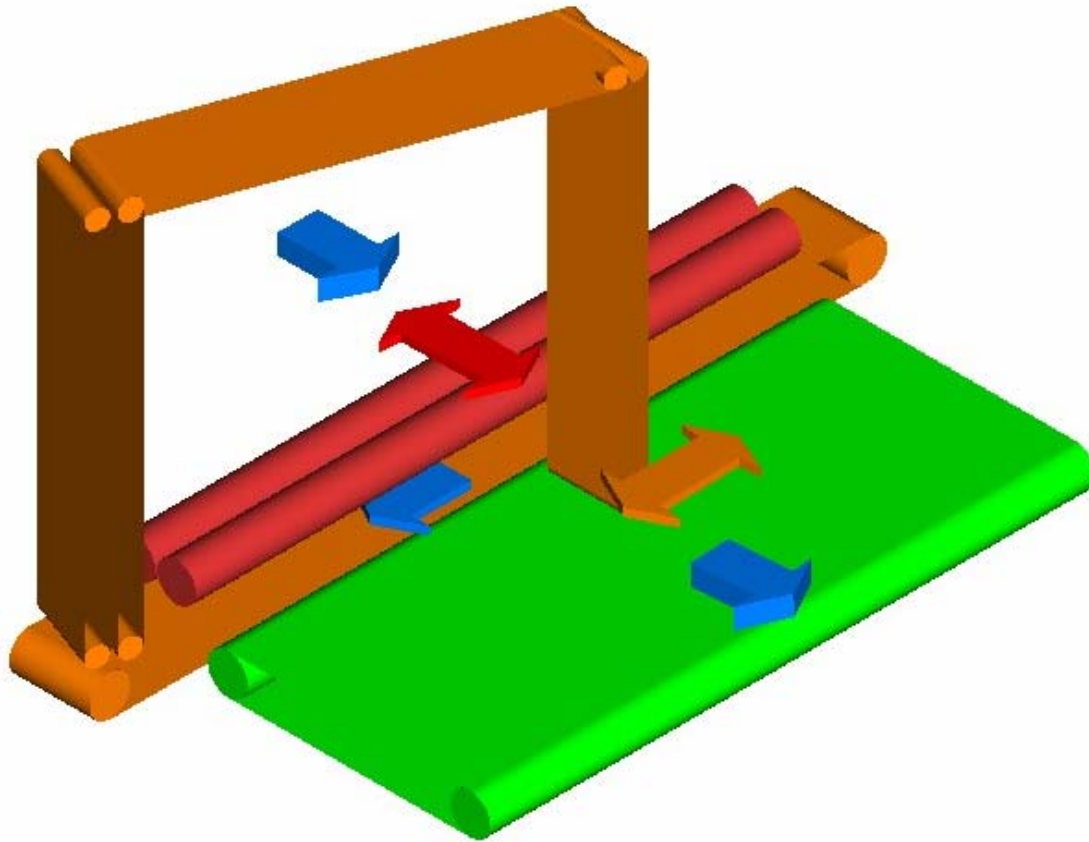


Figure 2. Woollen card Cross-Feed

The finisher section is similar to the two swifts of the forepart but has finer wire on rollers more closely set together. Sometimes the forepart produces a nep but the finisher can open the nep to give a clean web. Higher fibre loading in the working areas of the card, i.e. the worker-swift and swift-doffer interactions generally means more nep and poorer web clarity. More recycling around the swift and workers means better blending and opening but also gives higher card loading. Hence lower productivity is used if higher blending is needed so that the card loading is not excessive while recycling within the card can be high.

The fancy roller is positioned just before the doffer and runs in the same direction and slightly faster than the swift to lift the fibre embedded in the swift closer to the surface. This increases the efficiency of fibre transfer to the doffer reduces recycling. It also helps reduce the amount of fibre that becomes permanently embedded in the swift and that has to be periodically removed by "fettling". The fancy is clothed with long flexible wire that is set to slightly penetrate the swift wire.

The final web from the finisher section is fed into a tape condenser. The tape condenser splits the web into many narrow webs and feeds them to rubbing

aprons that are oscillating transversely to the machine direction while simultaneously rolling forward to carry the slubbings to the output. The rubbing action on the webs rolls them into lightly felted slubbings strong enough to be wound up and taken to spinning. At the feed section of the tape condenser alternate tapes trap the web against an upper or lower calender roller. As the tapes travel forward half go upwards and half go downwards so that the web is torn into thin continuous strips. These are usually fed into one of four sets of rubbing aprons such that each slubbing is separated by the width of four tapes. The tape width, and hence number of tapes across the card, is determined by the count range that is desired to be spun. Narrow tapes for fine counts and wider tapes for heavier counts. Fine count cards have tapes around 10mm wide and spin down to 40Nm or 20tex at the extreme, while medium counts of 150tex would have around 14mm tapes. Machinery manufacturers provide tables to advise on choice of tape width. In order to increase production rate, double and even triple rubbing sections are sometimes used.

After rubbing the slubbings are wound up onto bobbins via a surface drum. The surface drum keeps the speed constant whatever size the package has grown to. The bobbins are removed "doffed" when full and the condenser "creeled" with empty packages. The width of the bobbins is chosen to allow them to be handled easily if manual handling is required. For automatic systems larger packages can be used. The diameter of packages is limited because the slubbings are soft and cannot be wound tightly.