Fibre to fabric

Gary Robinson

Wool industry consultant

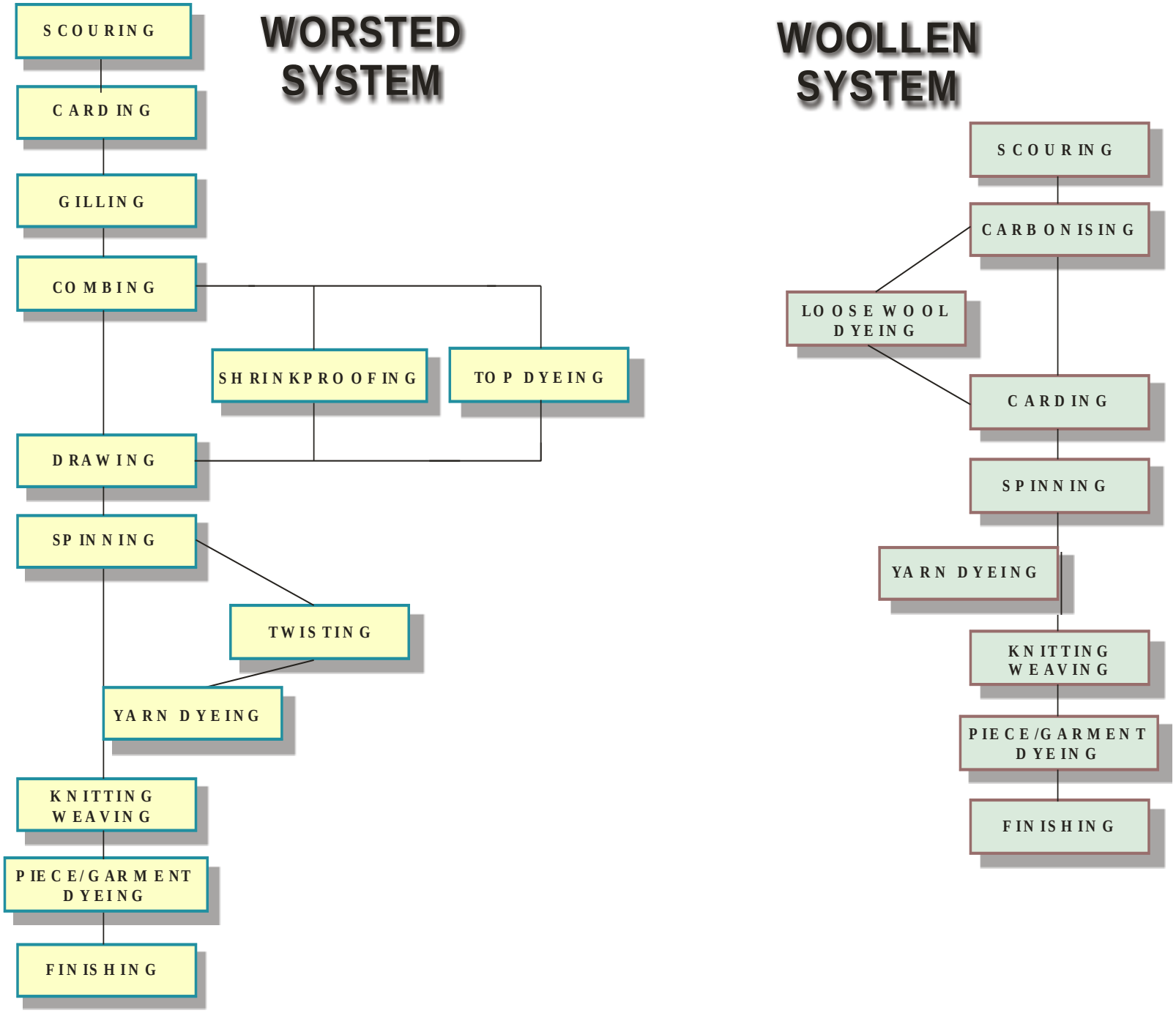
The transformation of raw wool to fabric

Zegna

Photograph courtesy of AWI.

Some issues for wool processing

- The random limit to fibre control
- Controlling fibres in drafting
- Fibre entanglement
- Fibre damage

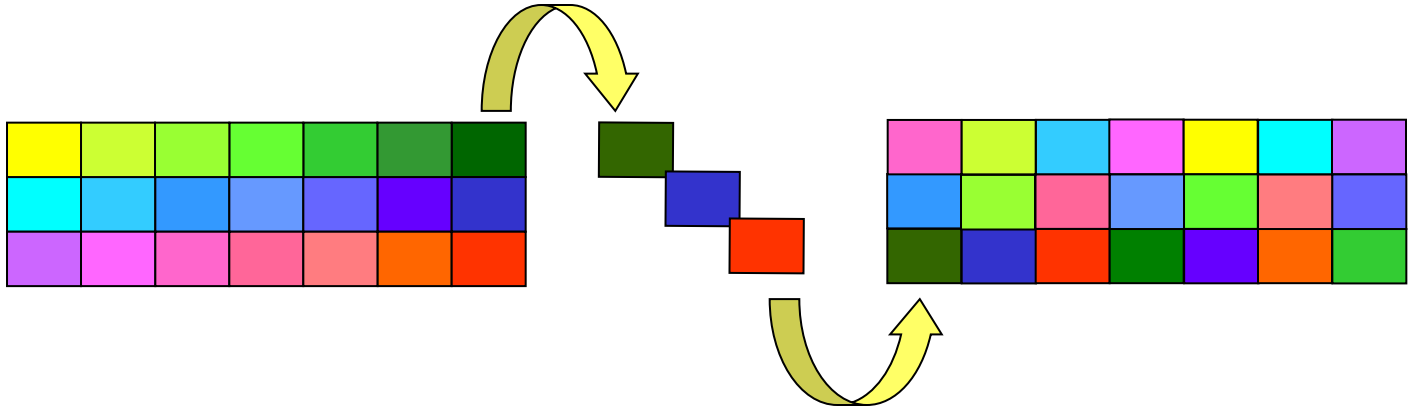

WORSTED SYSTEM
SCOURING
CARDING
GILLING
COMBING
SHRINKPROOFING
TOP DYEING
DRAWING
SPINNING
TWISTING
YARN DYEING
KNITTING WEAVING
PIECE/GARMENT DYEING
FINISHING
WOOLLEN SYSTEM
SCOURING
CARBONISING
LOOSE WOOL DYEING
CARDING
SPINNING
YARN DYEING
KNITTING WEAVING
PIECE/GARMENT DYEING
FINISHING

The woollen system

If it's got two ends you can make a yarn from it.

Inputs to the woollen system can include lambs wool, combed wool, dyed wool, carbonised wool, locks, crutchings, pulled rags, other animal fibres, vegetable fibres and feathers … anything with two ends.

Principle of blending



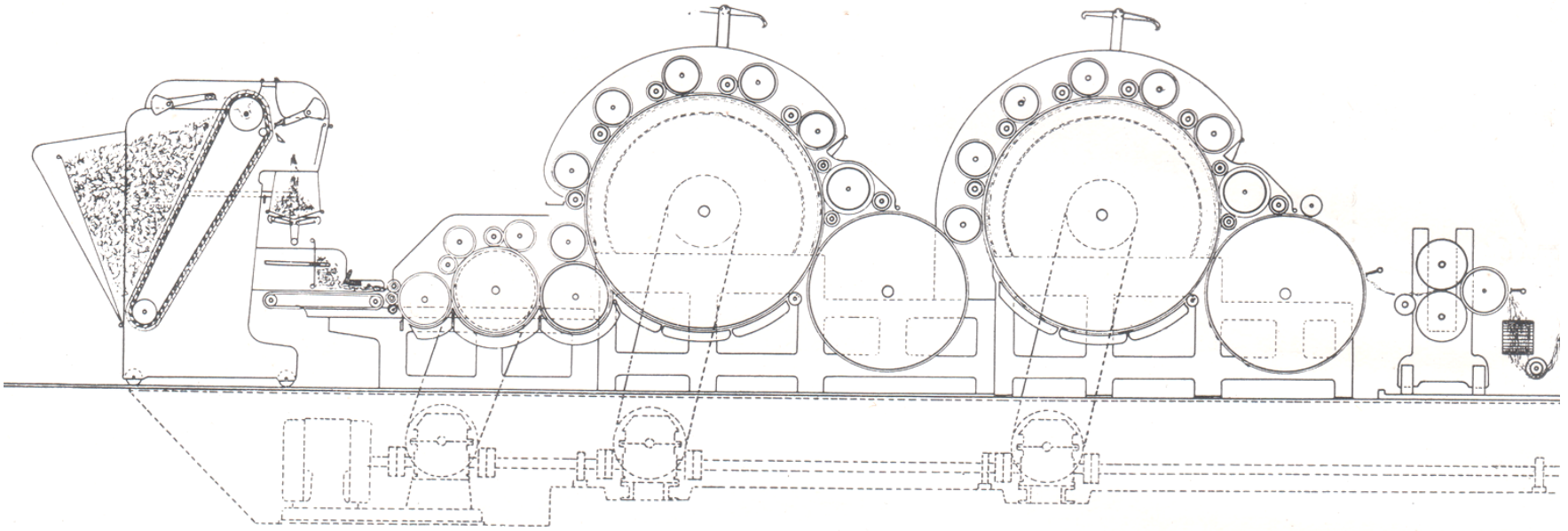
- Horizontal layers
- Vertical cuts

- Horizontal deposition
- Mixing of wool
- Greater uniformity of blend
- Ideal: all wool together

Woollen carding

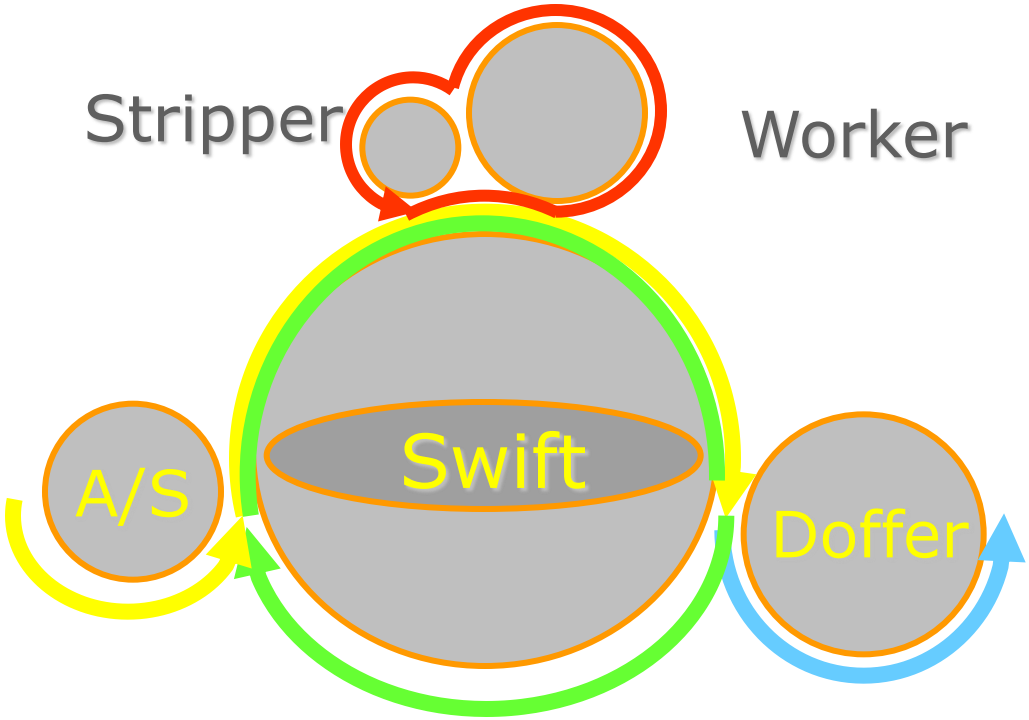
Source: Octir

Woollen spinning scribbler section



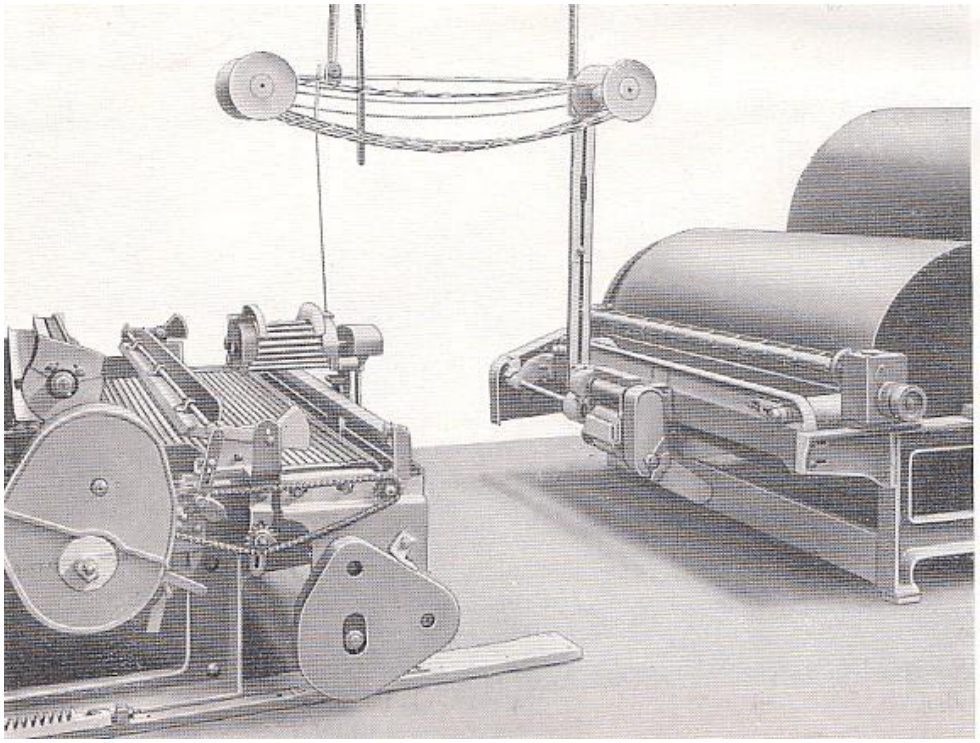
Source: William Tatham Ltd

Fibre flows in carding



Woollen spinning
Scotch feed web rotation

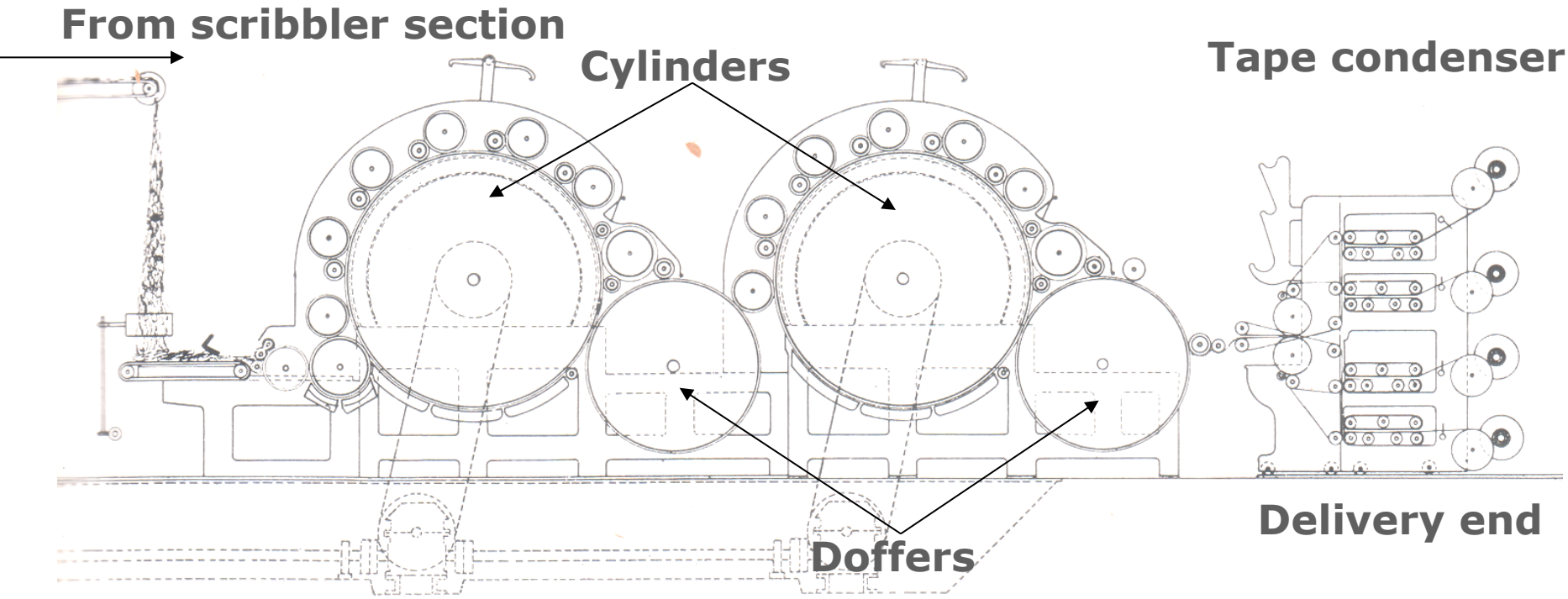
To carder



From scribbler

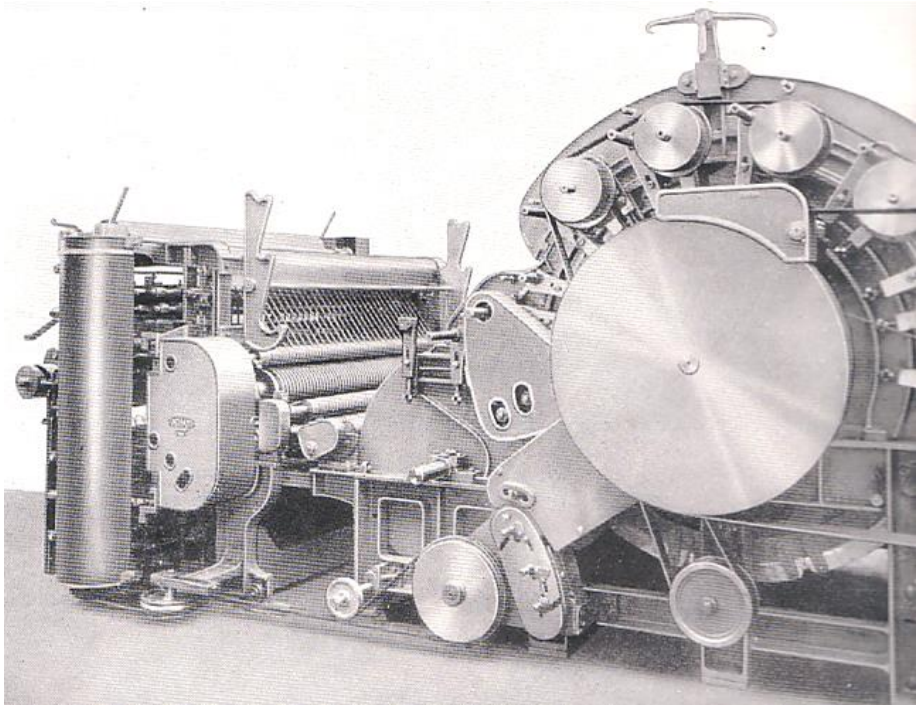
Source: William Tatham Ltd.

Woollen spinning
Carder section with condenser



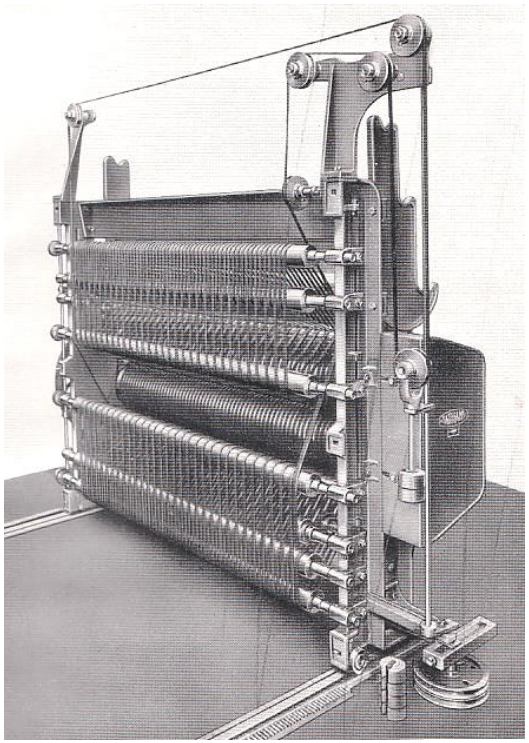
Source: William Tatham Ltd.

Woollen card
Delivery and condenser section

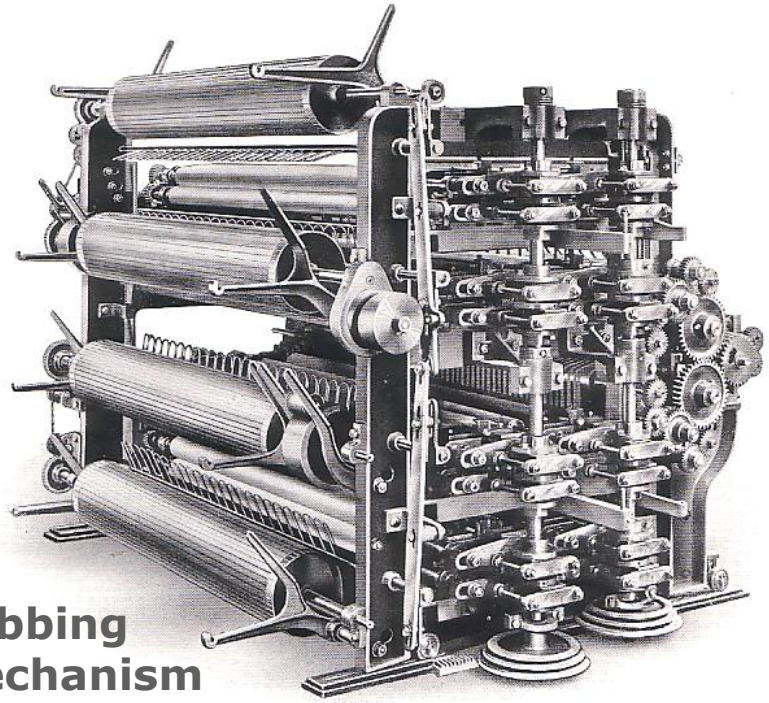


Source: William Tatham Ltd.

Woollen spinning
Condenser section



Tapes

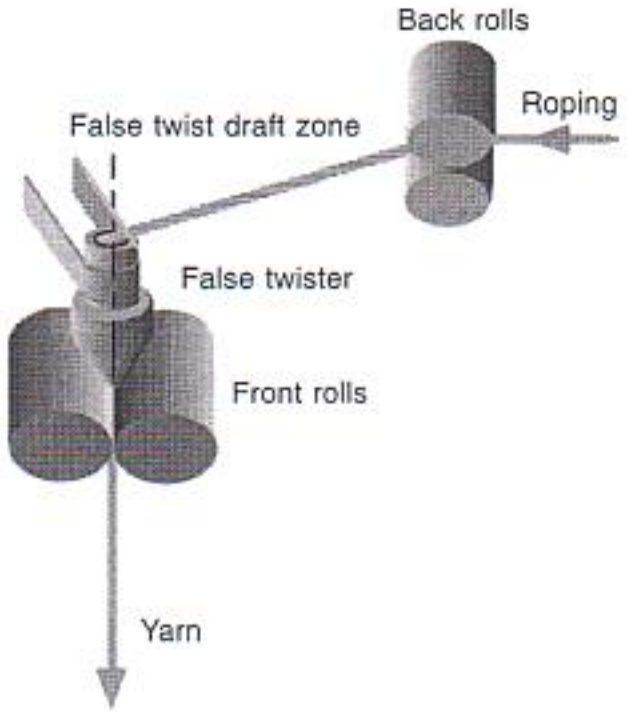


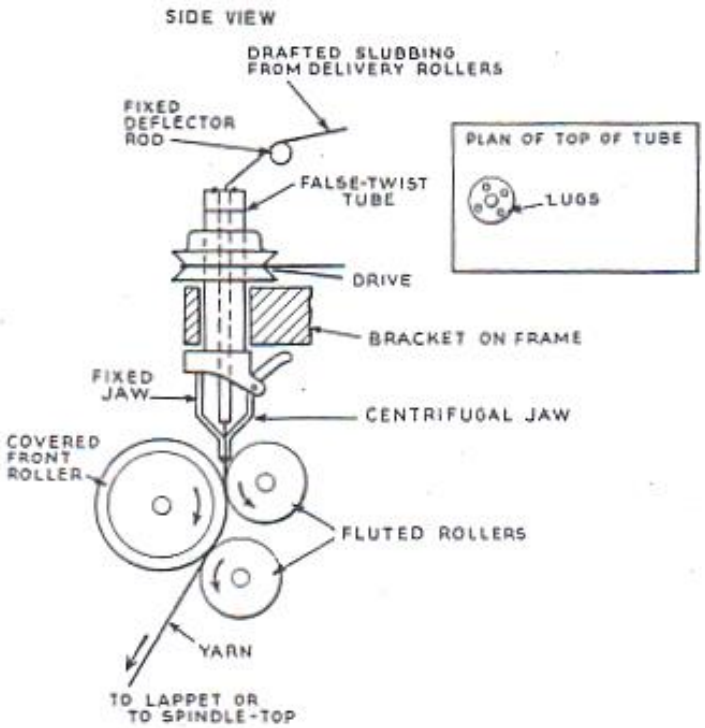
Rubbing mechanism

Source: William Tatham Ltd.


OCTIR
OCTIR

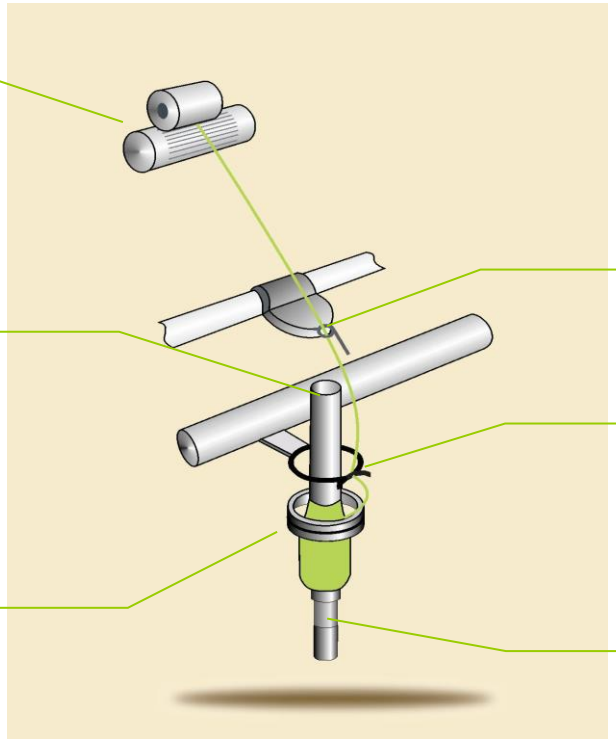
Woollen spinning
Draft against twist





Source: Murata Machines Ltd.

Ring spinning



The worsted system

The TEAM 3 equation

$$H = 0.43L + 0.35S + 1.38D - 0.15M - 0.45V - 0.59CVD - 0.32CVL + 21.8$$

H = Hauteur or mean fibre length in the top

L = Staple Length

D = Fibre Diameter

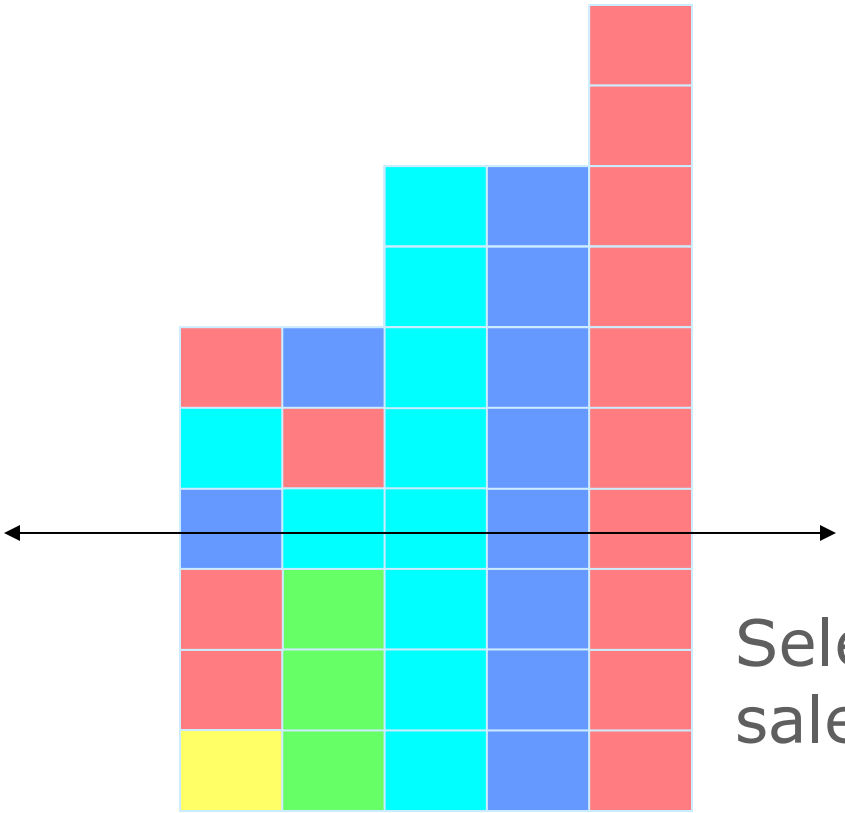
M = %Midbreaks

V = Vegetable Matter Content

CVD = CV Diameter

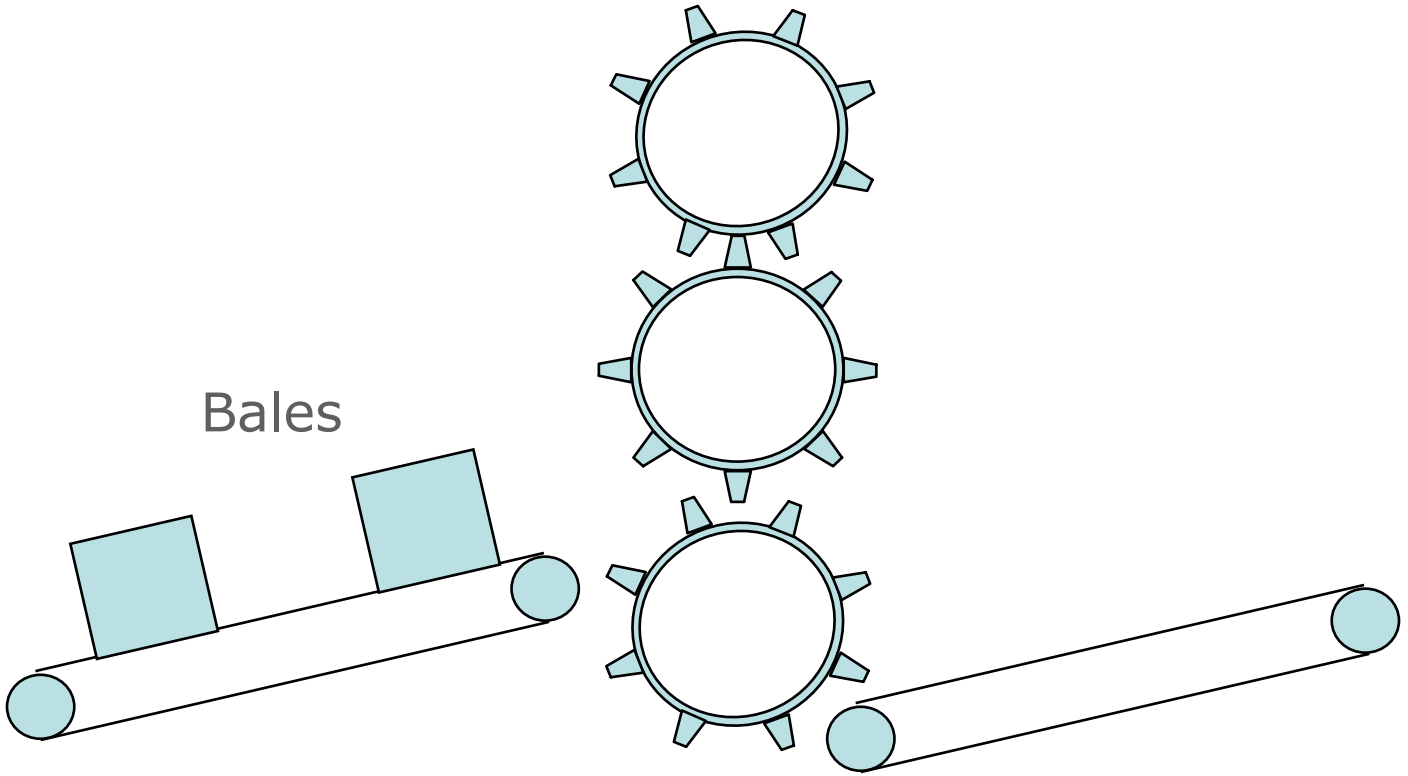
CV = CV Length

Blending procedure for greasy wool

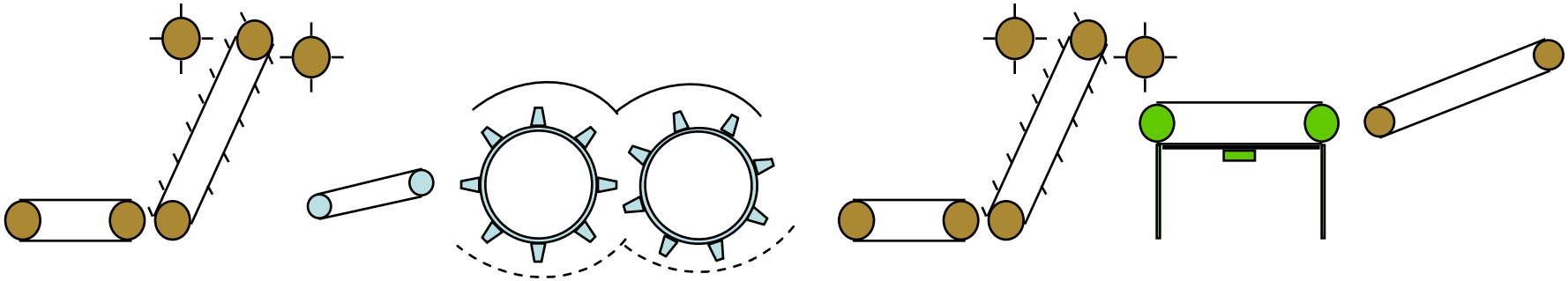


Selection across sale lots

Bale breaker



Opening of Australian wool



Brattice feed hopper

Double drum opener

Brattice feed hopper

Weigh belt

Scour

Contaminants in raw wool

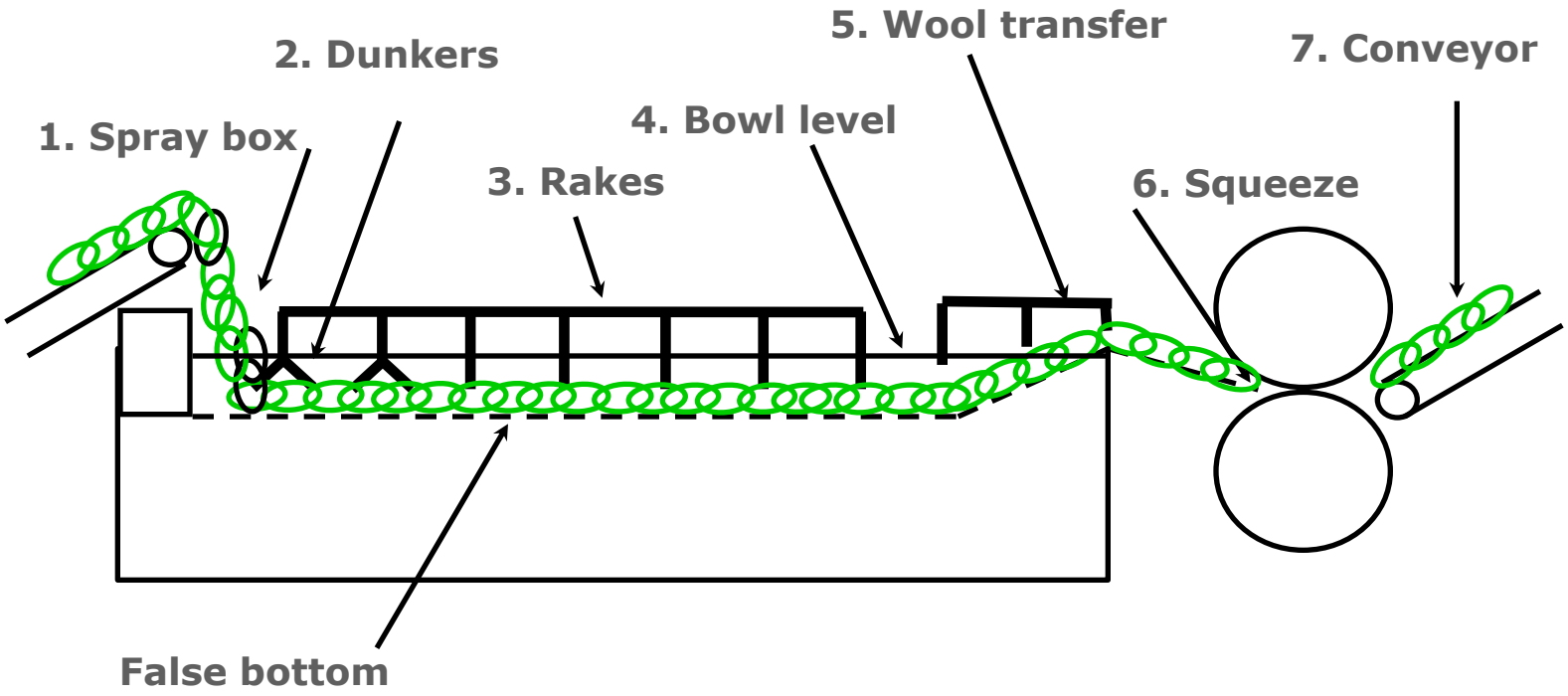
- Wool wax 10%
- Dirt 10%
- Suint 5%

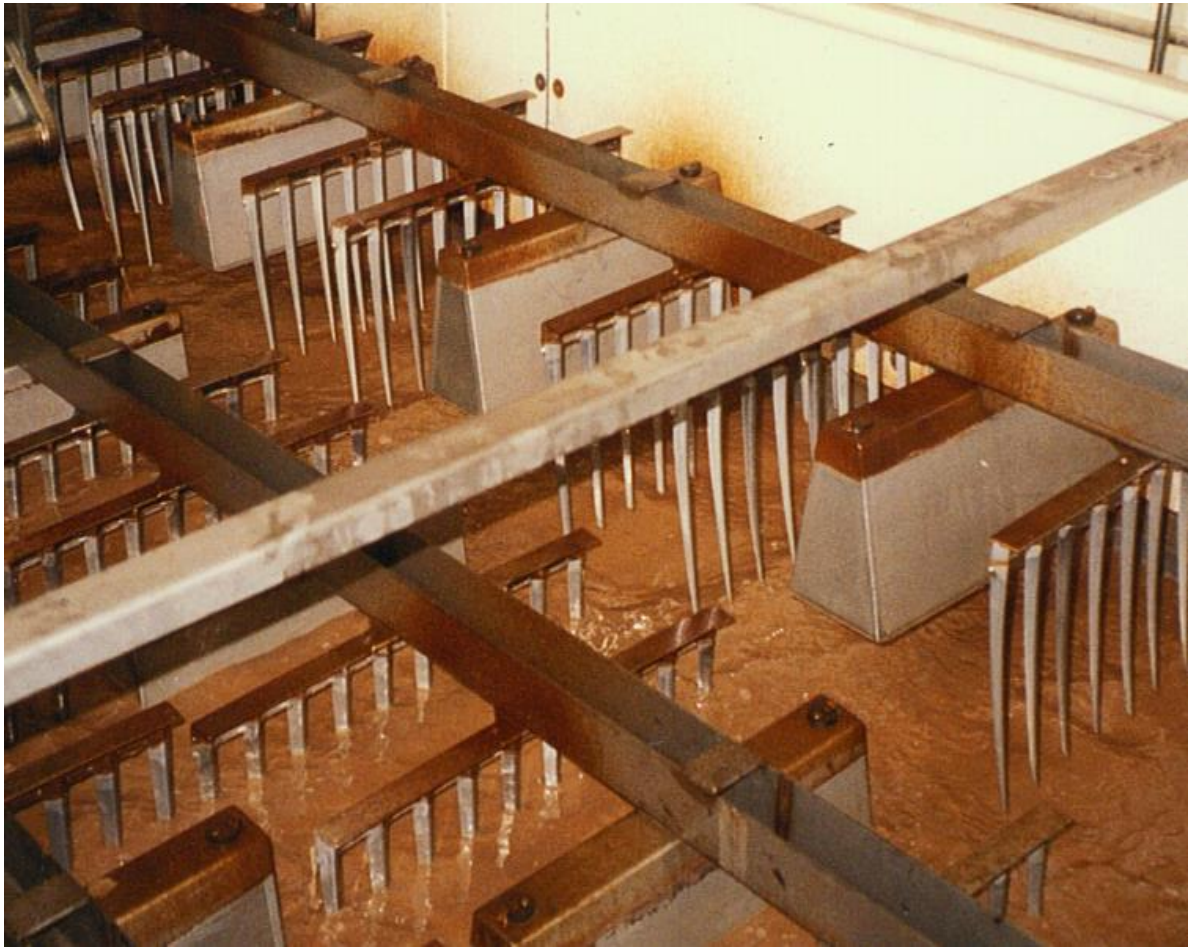
Burr

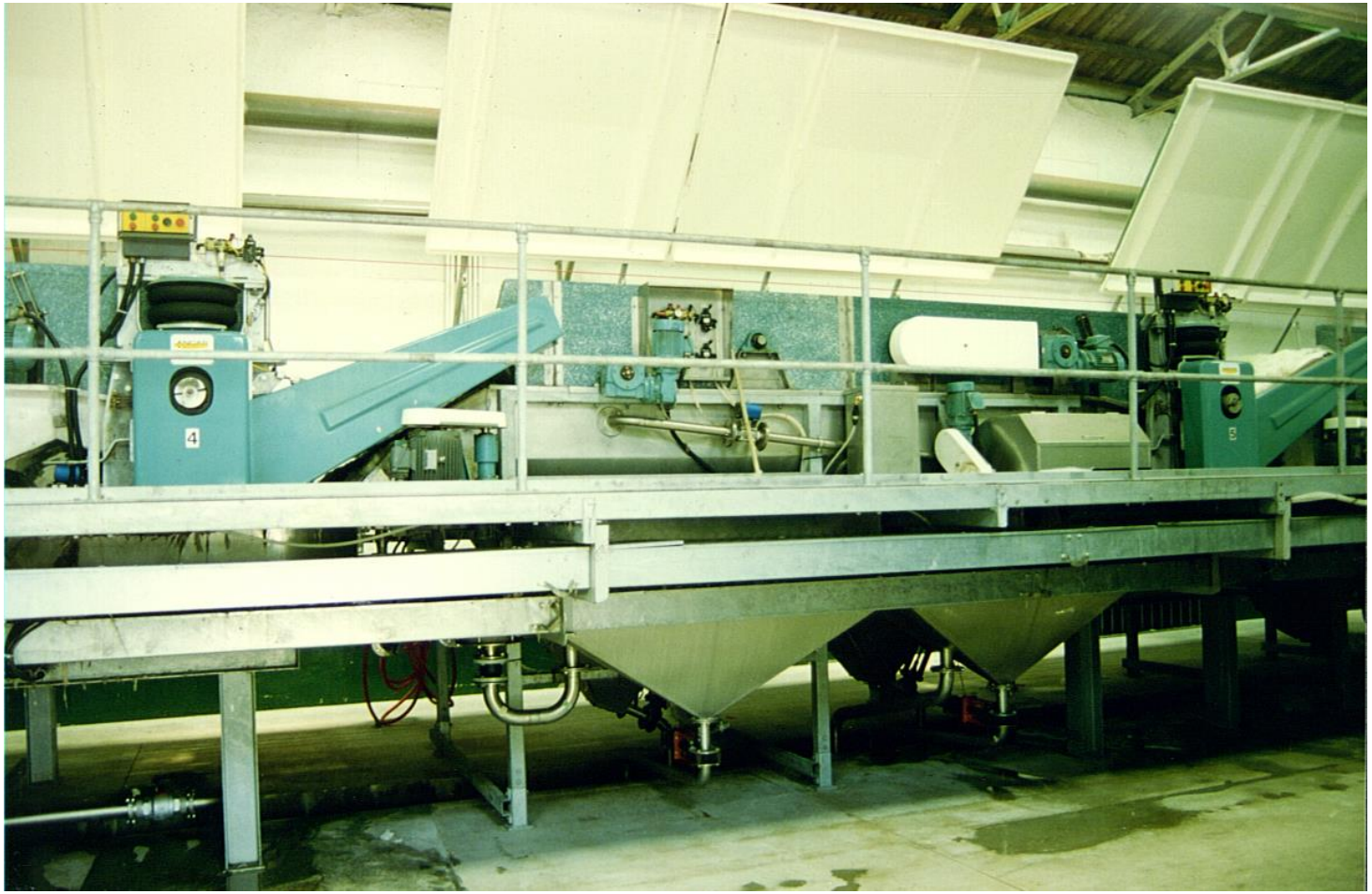
Seed and shive

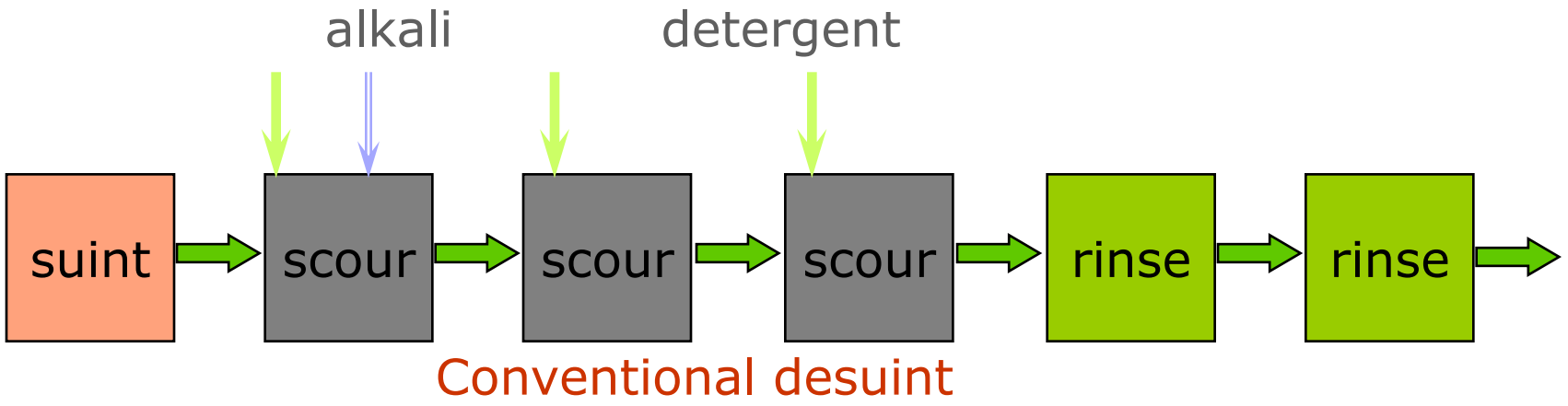
Hardheads

Typical wool scour

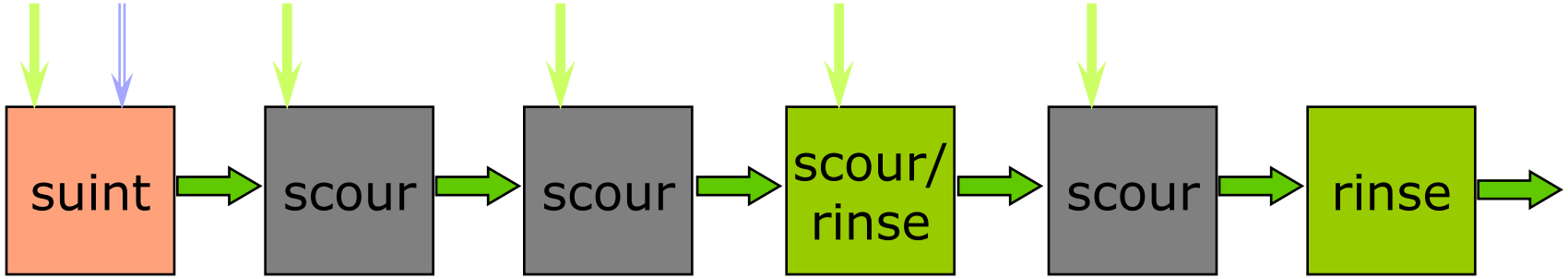





4

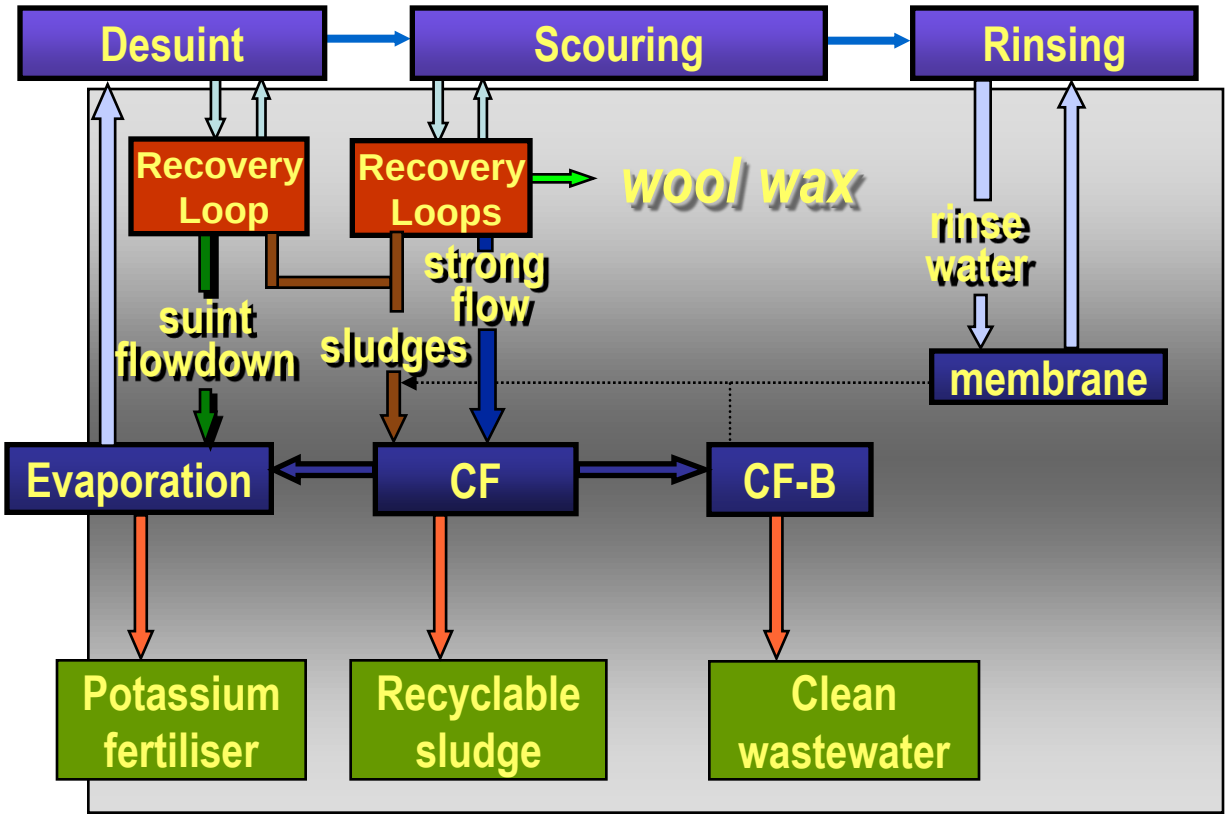


Conventional desuint

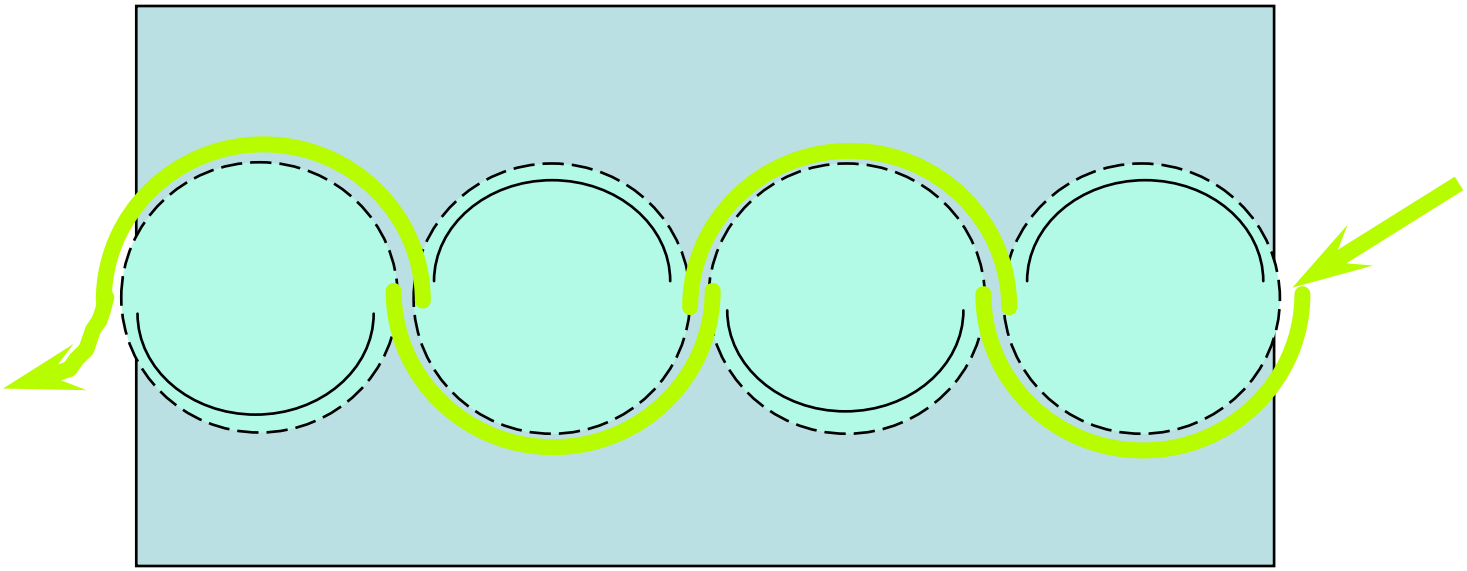


Siroscour

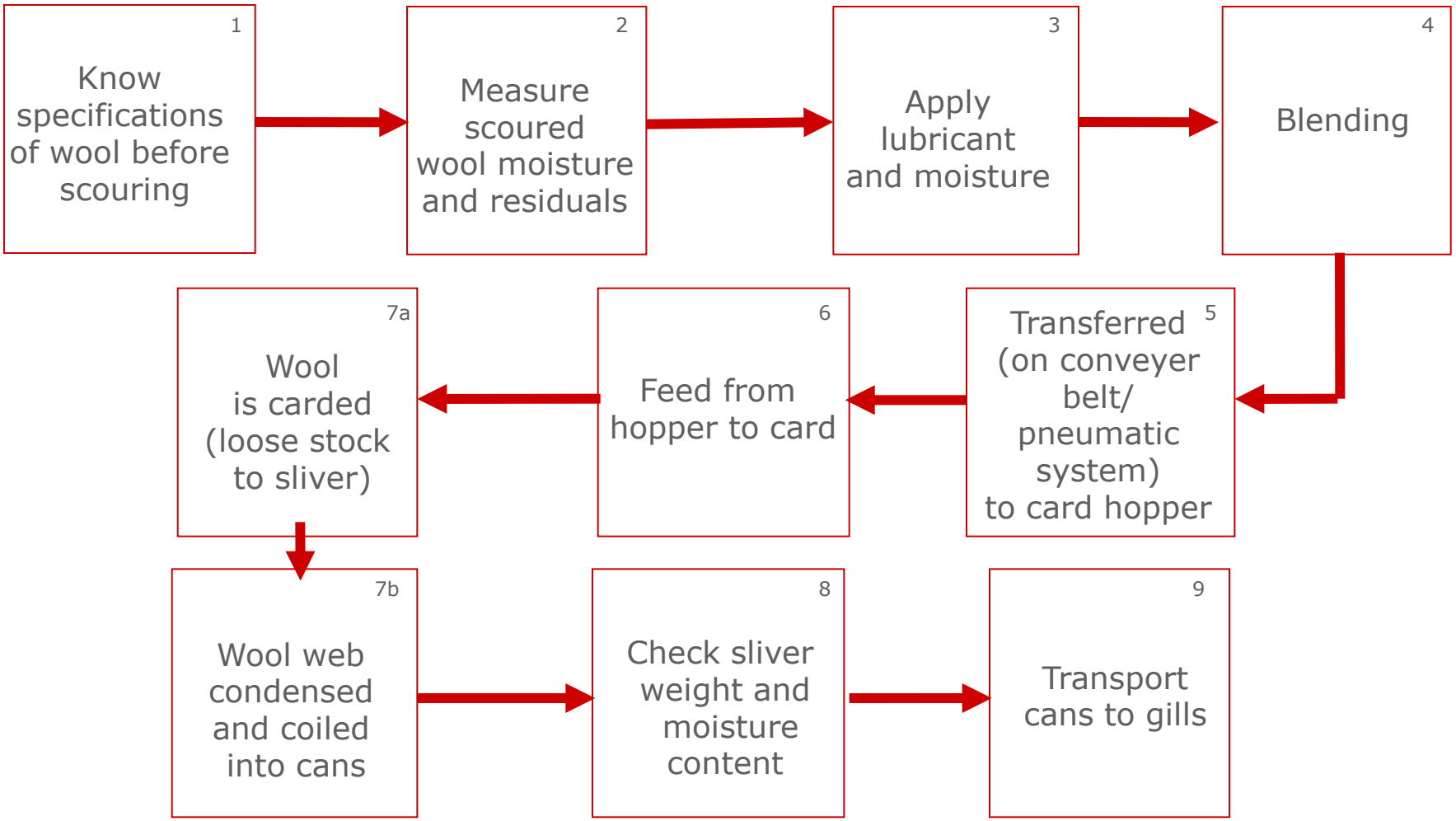
Sirolan - SWIMS



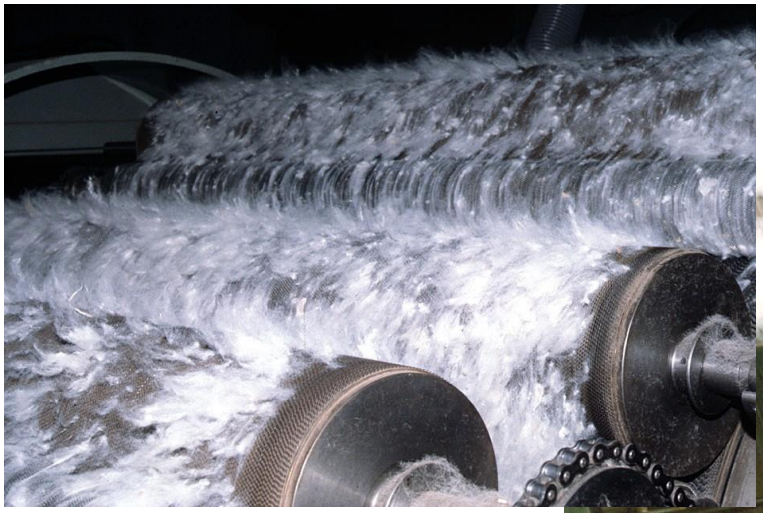
Drum dryer

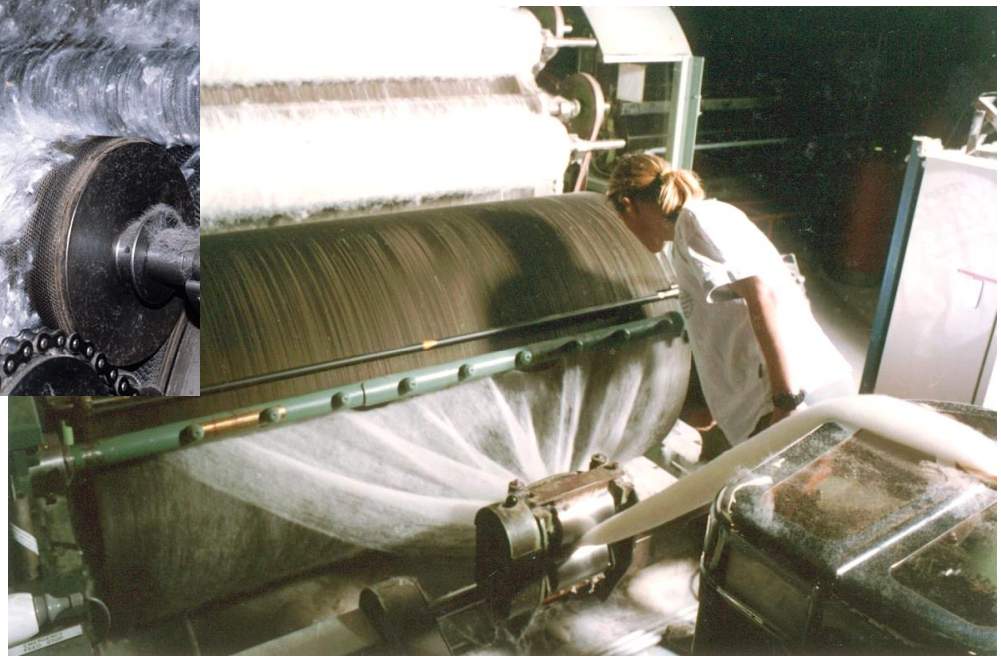


Topmaking

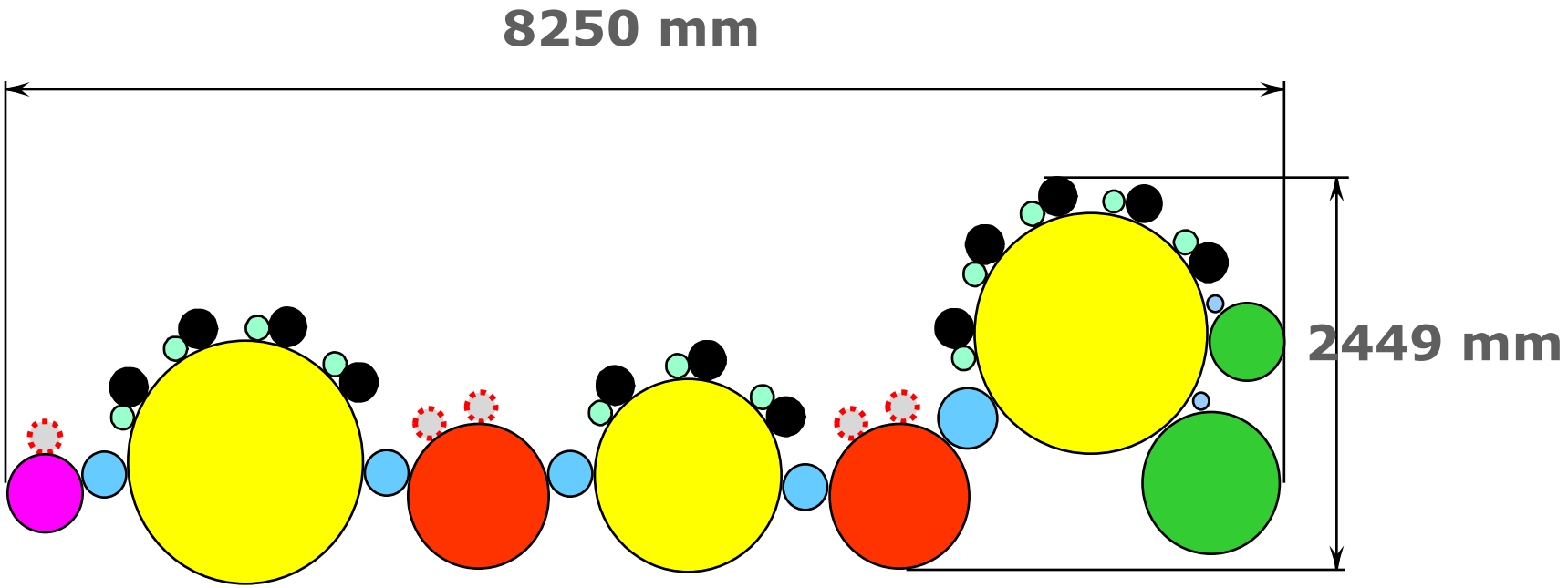

1
Know specifications of wool before scouring
2
Measure scoured wool moisture and residuals
3
Apply lubricant and moisture
4
Blending
5
Transferred (on conveyer belt/ pneumatic system) to card hopper
6
Feed from hopper to card
7a
Wool is carded (loose stock to sliver)
7b
Wool web condensed and coiled into cans
8
Check sliver weight and moisture content
9
Transport cans to gills

Carding



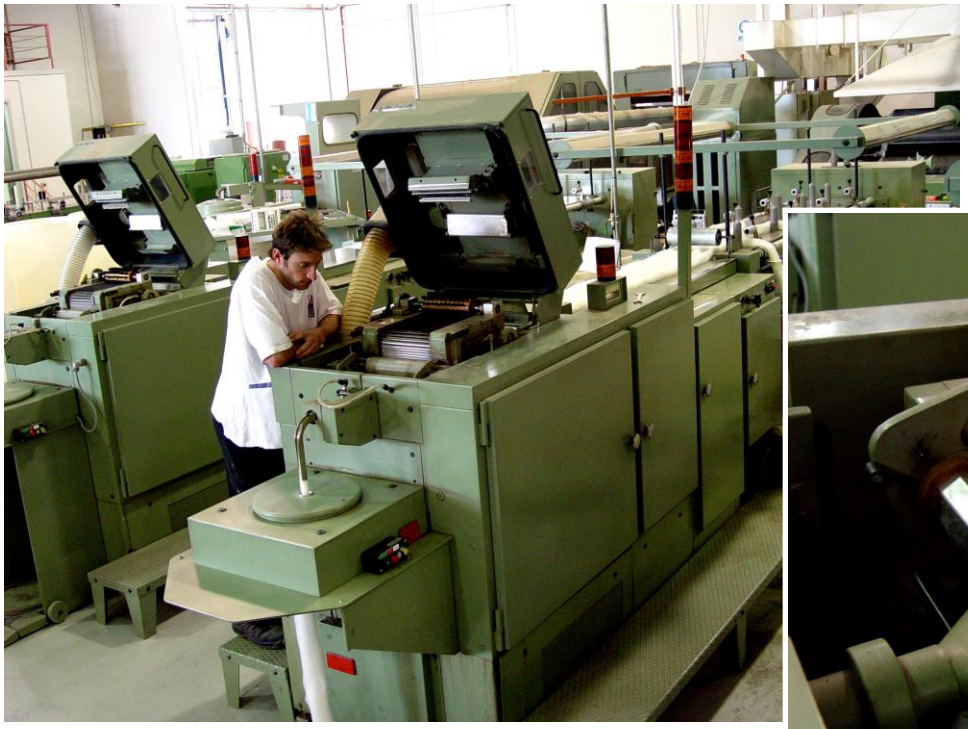


Worsted carding - the Thibeau CA7 card

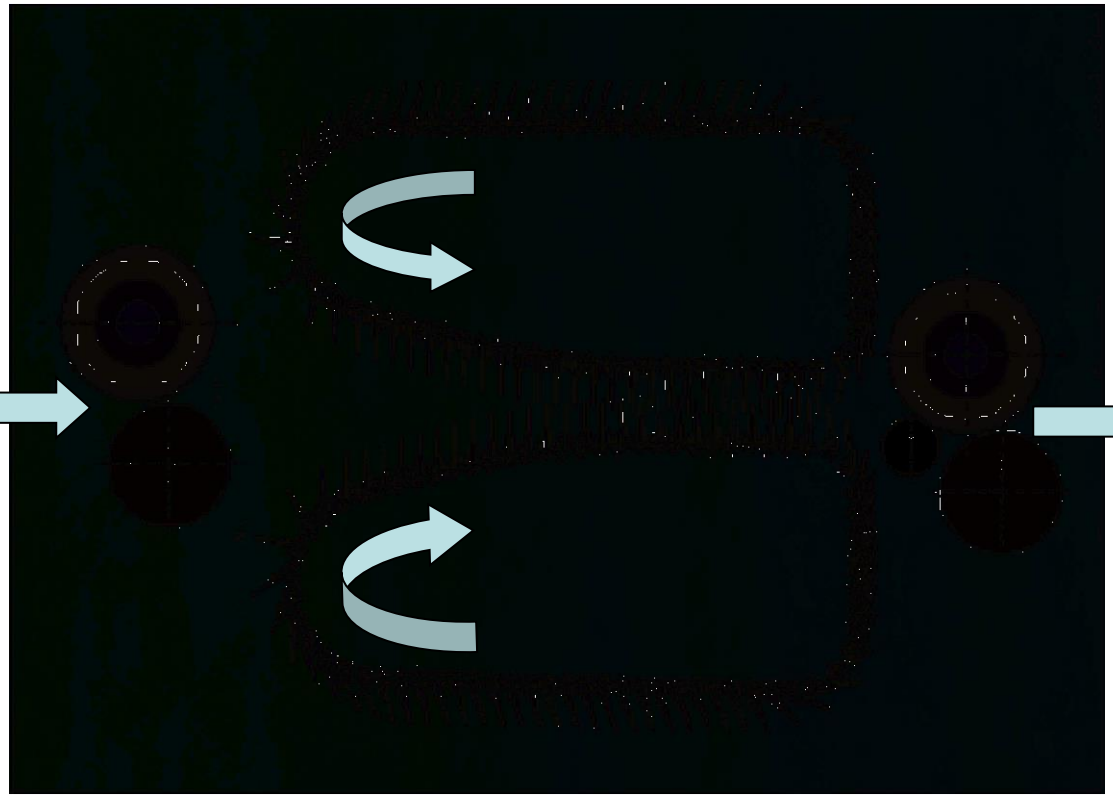


Worsted carding

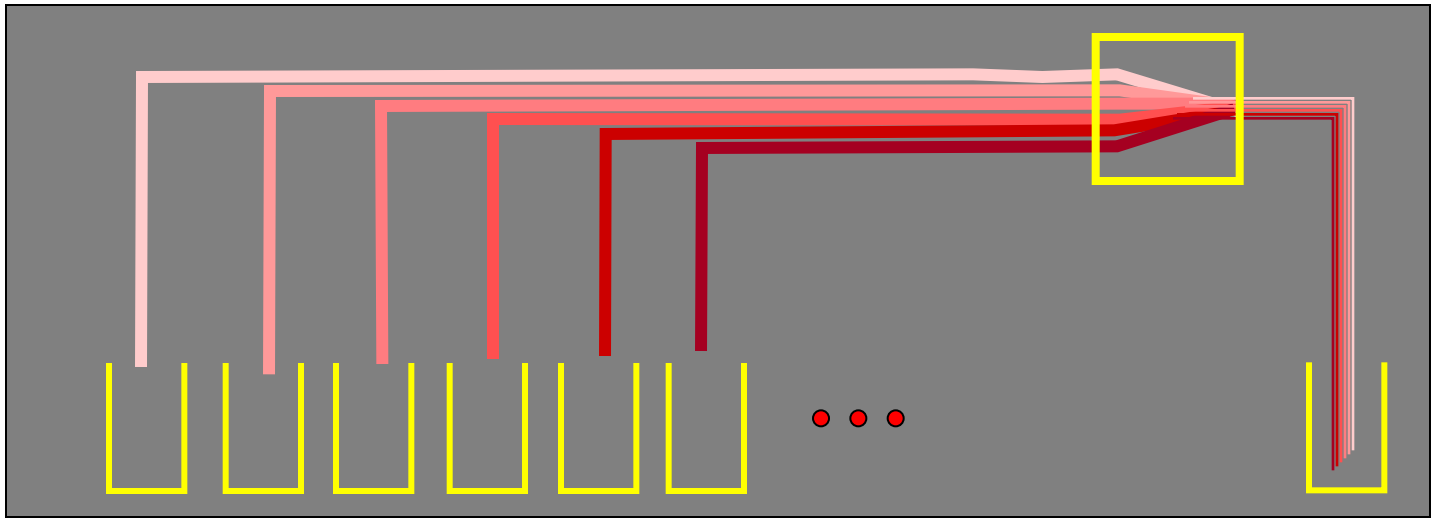
Gilling



Gilling



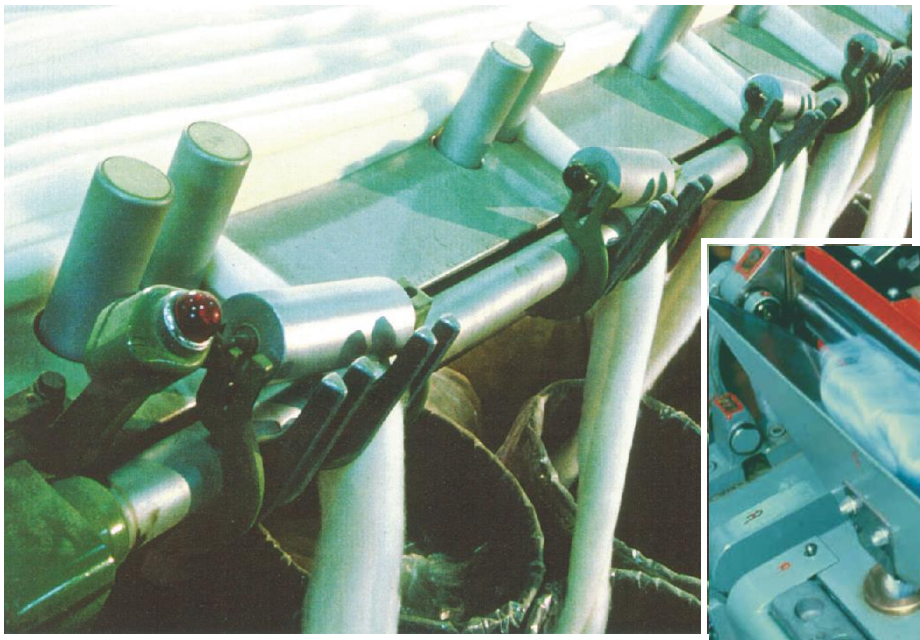
Blending in gilling and combing

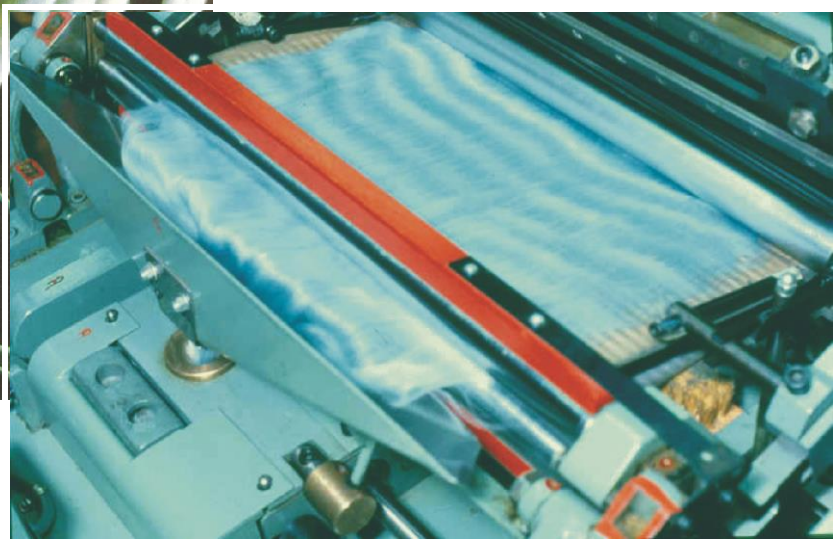


Gilling: 6 cans x 70 kg = 420 kg ⇒ 4% lot

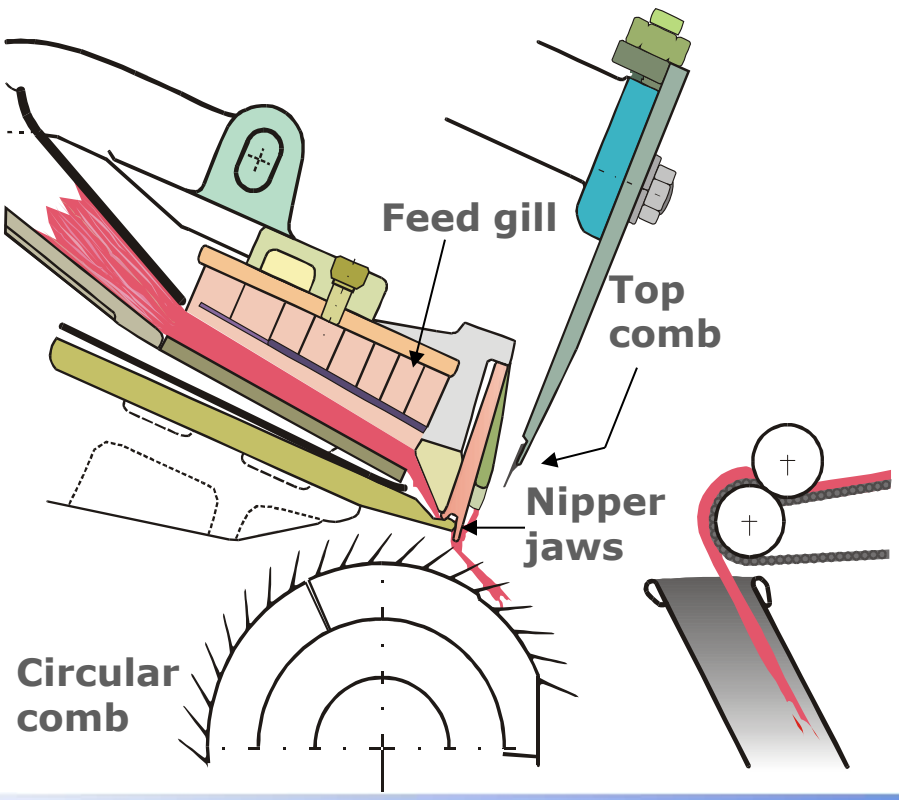
Combing: 20 bobbins x 50 kg = 1000 kg ⇒ 10% lot

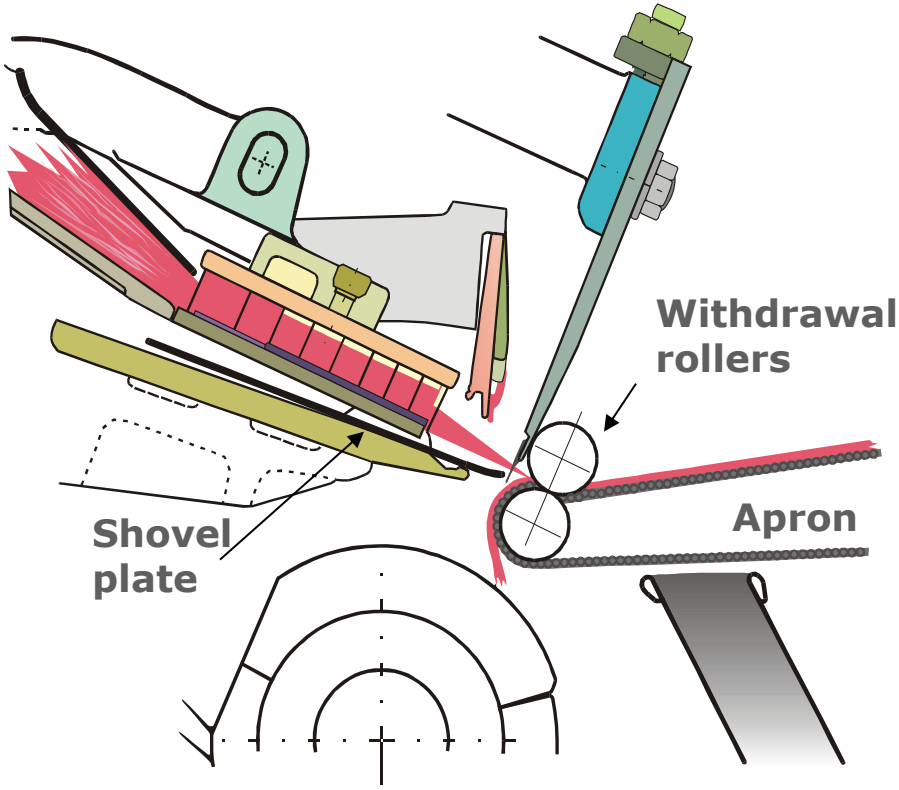
Combing



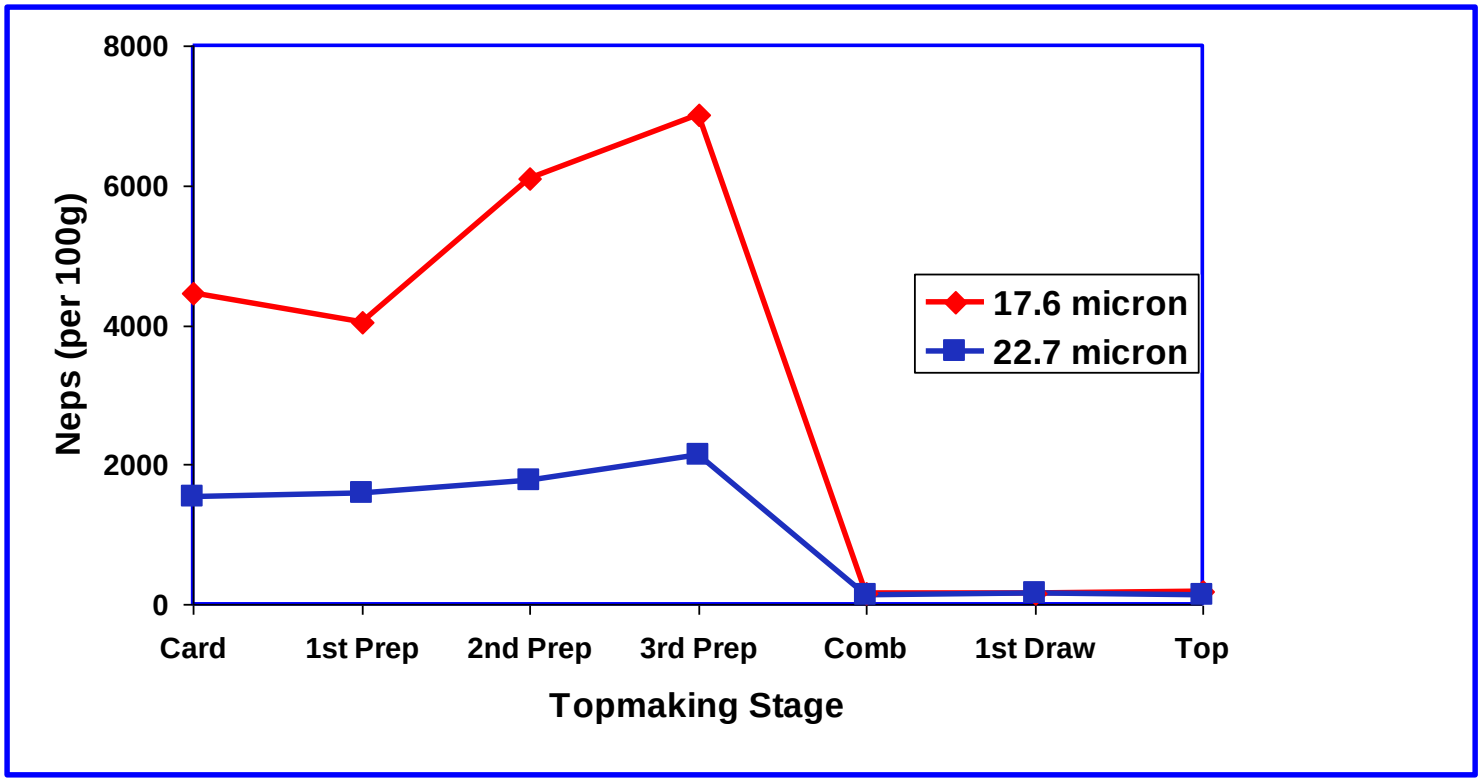


The combing cycle



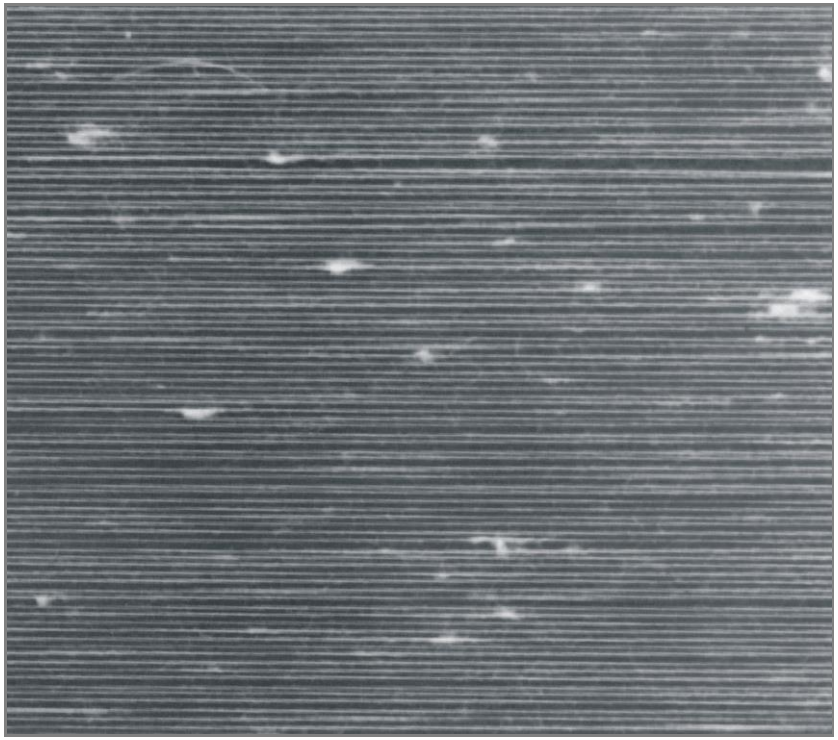


Nep generation during topmaking



The role of combing

Combed yarn



Uncombed yarn

Combing

- The final filter can be set to selectively remove short fibre.
- Removes majority of neps.
- Removes majority of remaining VM.
- Straightens/aligns fibres.
- Adjustments critical to suit wool (diameter and length).

Top making

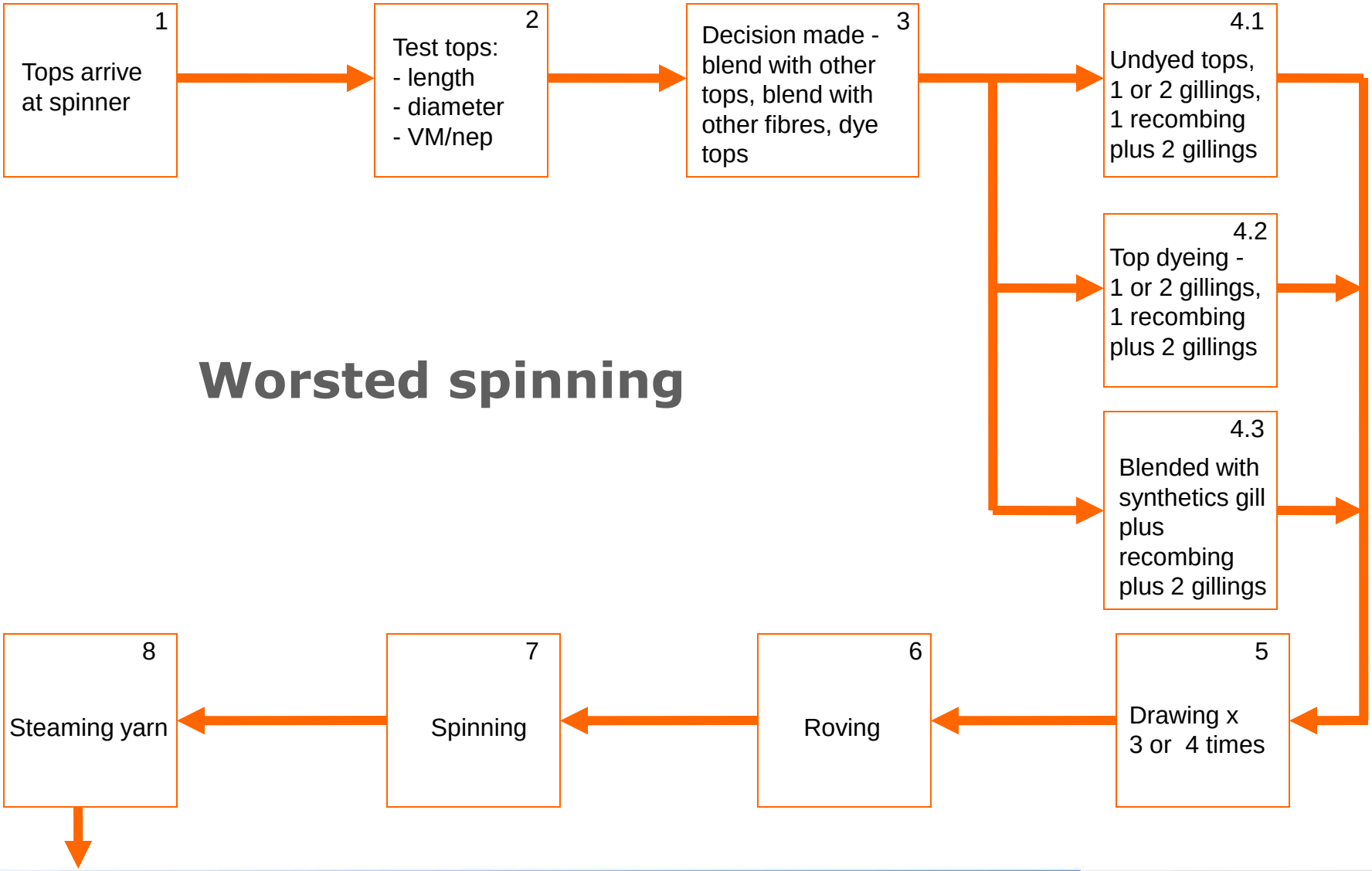
- Typically two post-comb gilling passages.
- Improve sliver cohesion.
- Improve sliver evenness (weight per unit length).
- Randomise fibre ends.
- Adjust moisture content.
- Produce top – raw material for spinner.

Topmaking as a blending process

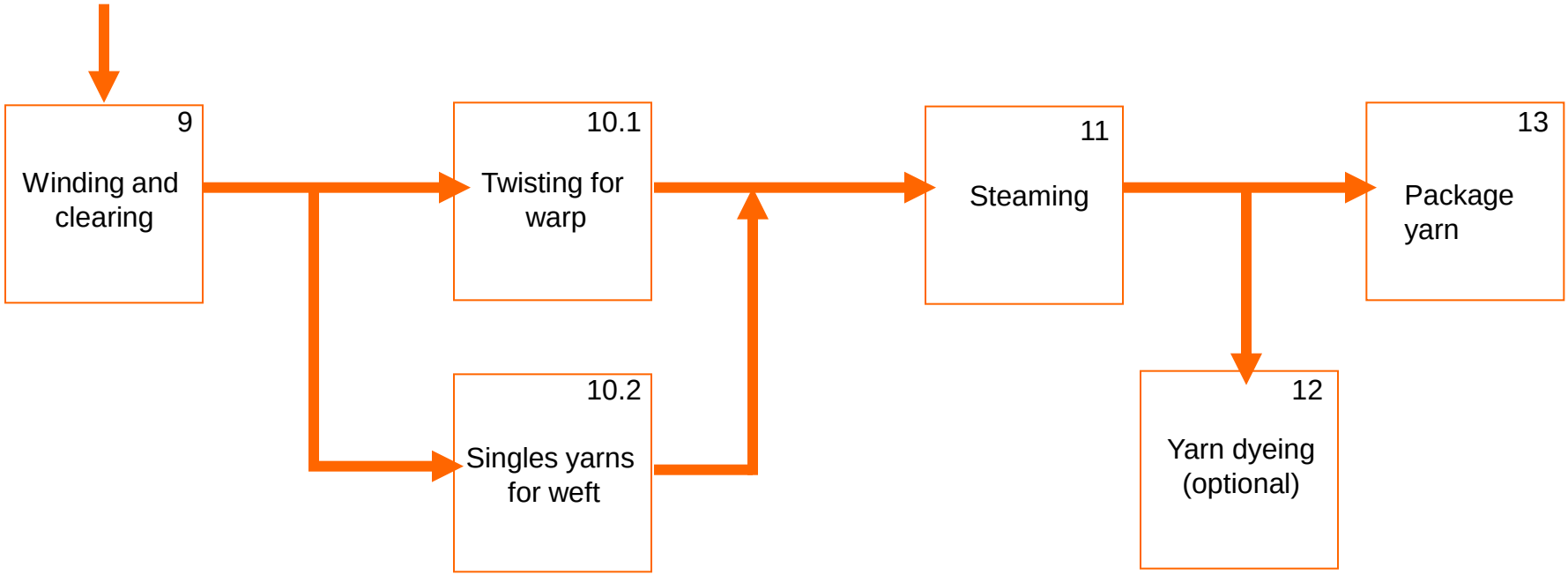
Stage	Doublings per stage	Total doublings
Preparer gilling	6	6
Second gilling	6	36
Third gilling	6	216
Combing	20	4320
Finisher 1	6	25920
Finisher 2 (top)	6	155520

Worsted spinning

Worsted spinning



Worsted spinning



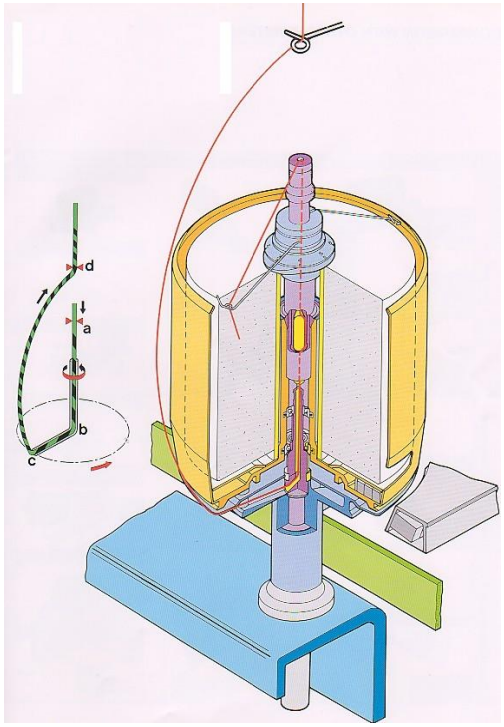
Worsted spinning

Worsted spinning
Steaming and winding

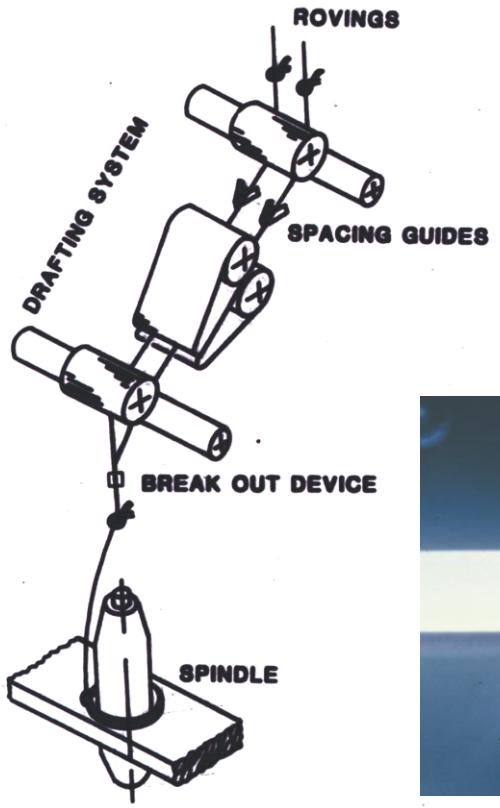
Yarn twisting

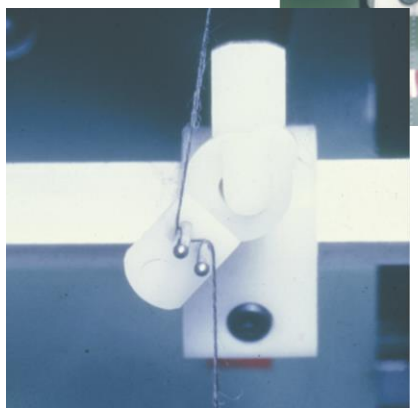
Assembly winding

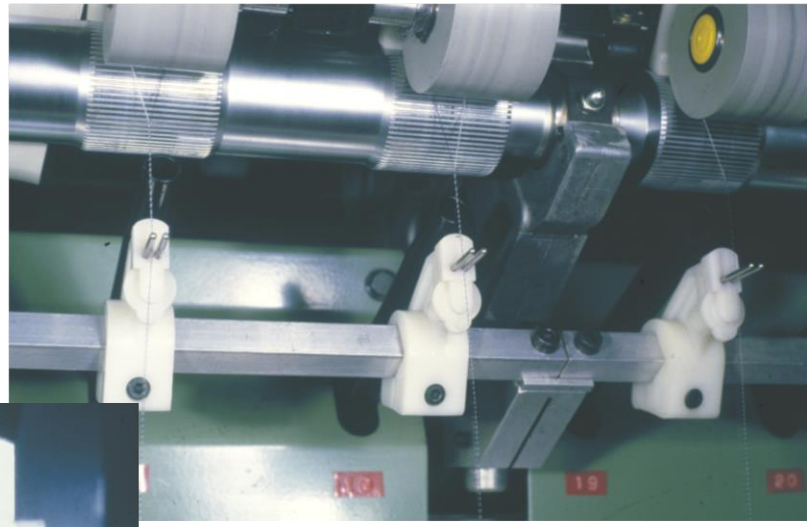
Two-for-one twisting



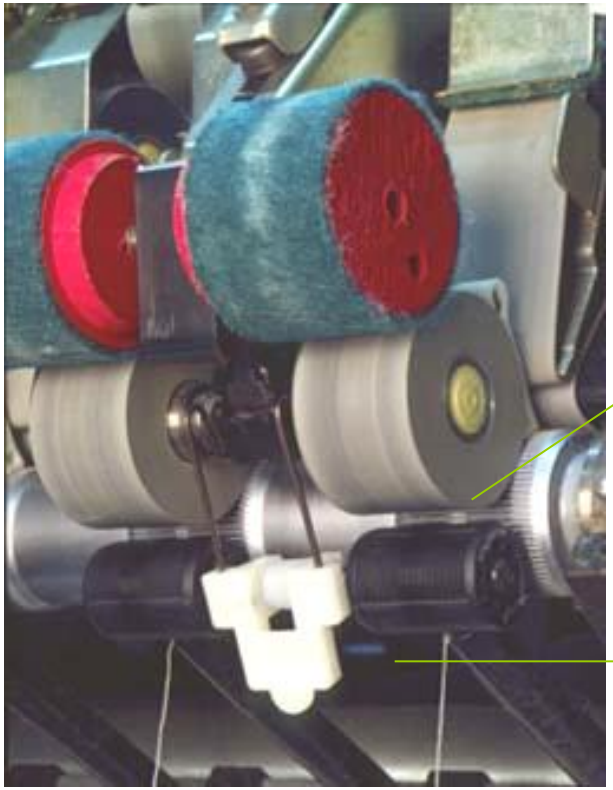
Sirospun


ROVINGS
DRAFTING SYSTEM
SPACING GUIDES
BREAK OUT DEVICE
SPINDLE





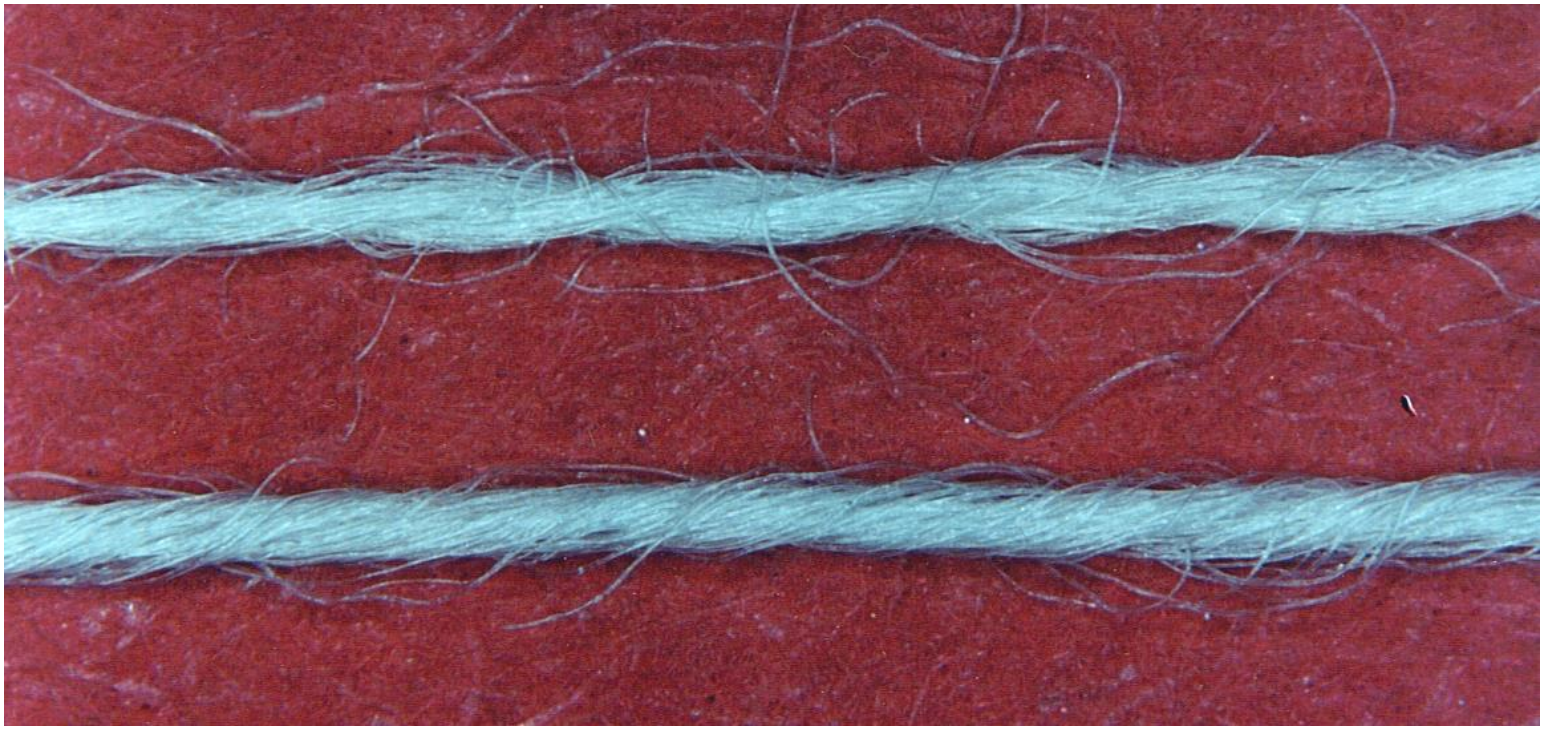
Solospun



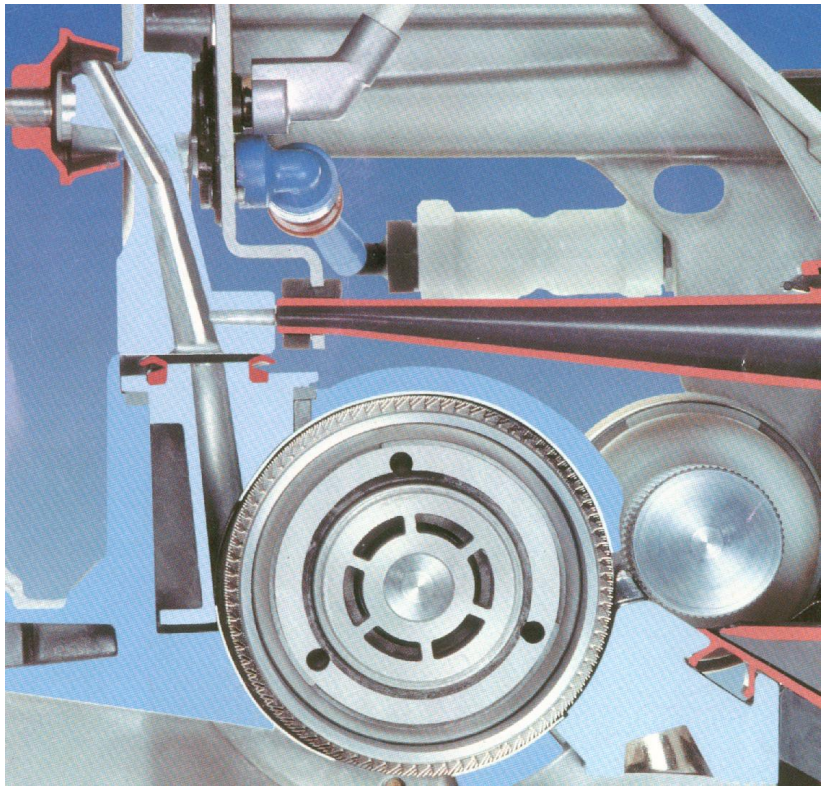
Solospun rollers

Weavable singles yarn

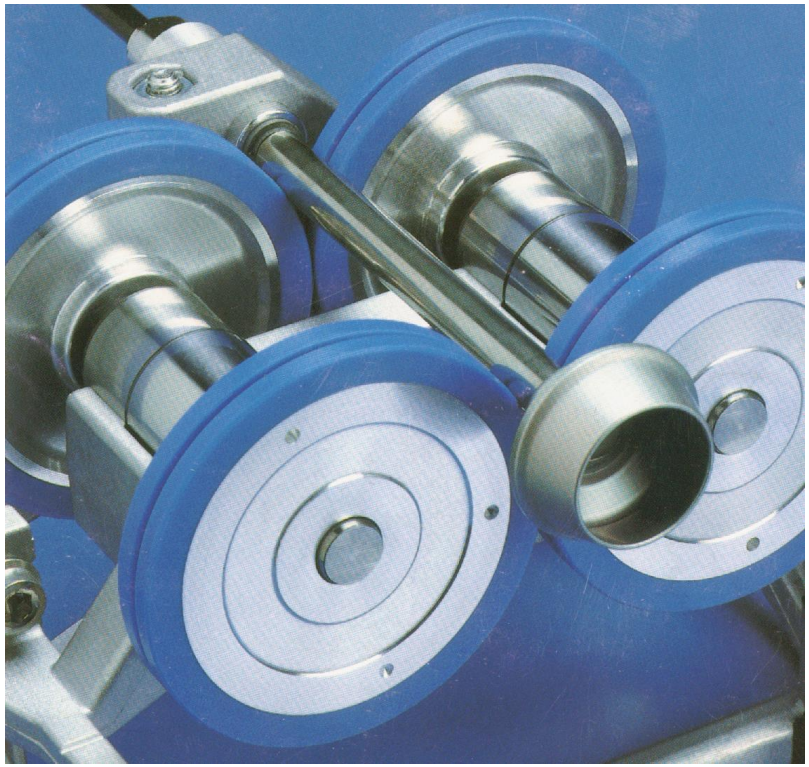
Solospun – comparison with two-fold



OE spinning layout
Rieter system



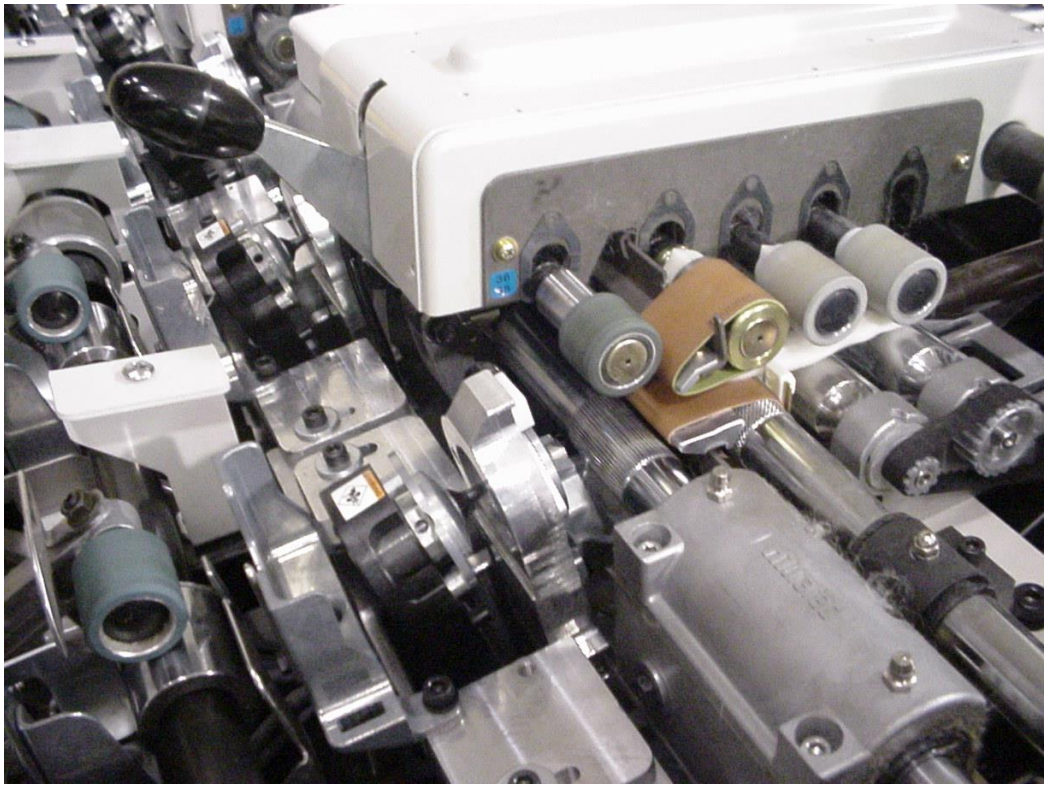
OE rotor and drive
Rieter system



Open-end characteristics

- Very high twist insertion: ~ 200,000 min-1.
- High production speed: 500 m/min.
- High production rate: 10 g/min/station.
- Yarn not as good as ring spun → used for sheeting, not high quality fabrics.
- Problem with yarn structure is the presence of ‘fasciated fibres’ giving the yarn a ‘harsh’ hand.

Murata Vortex Spinning
Drafting and Twist Insertion



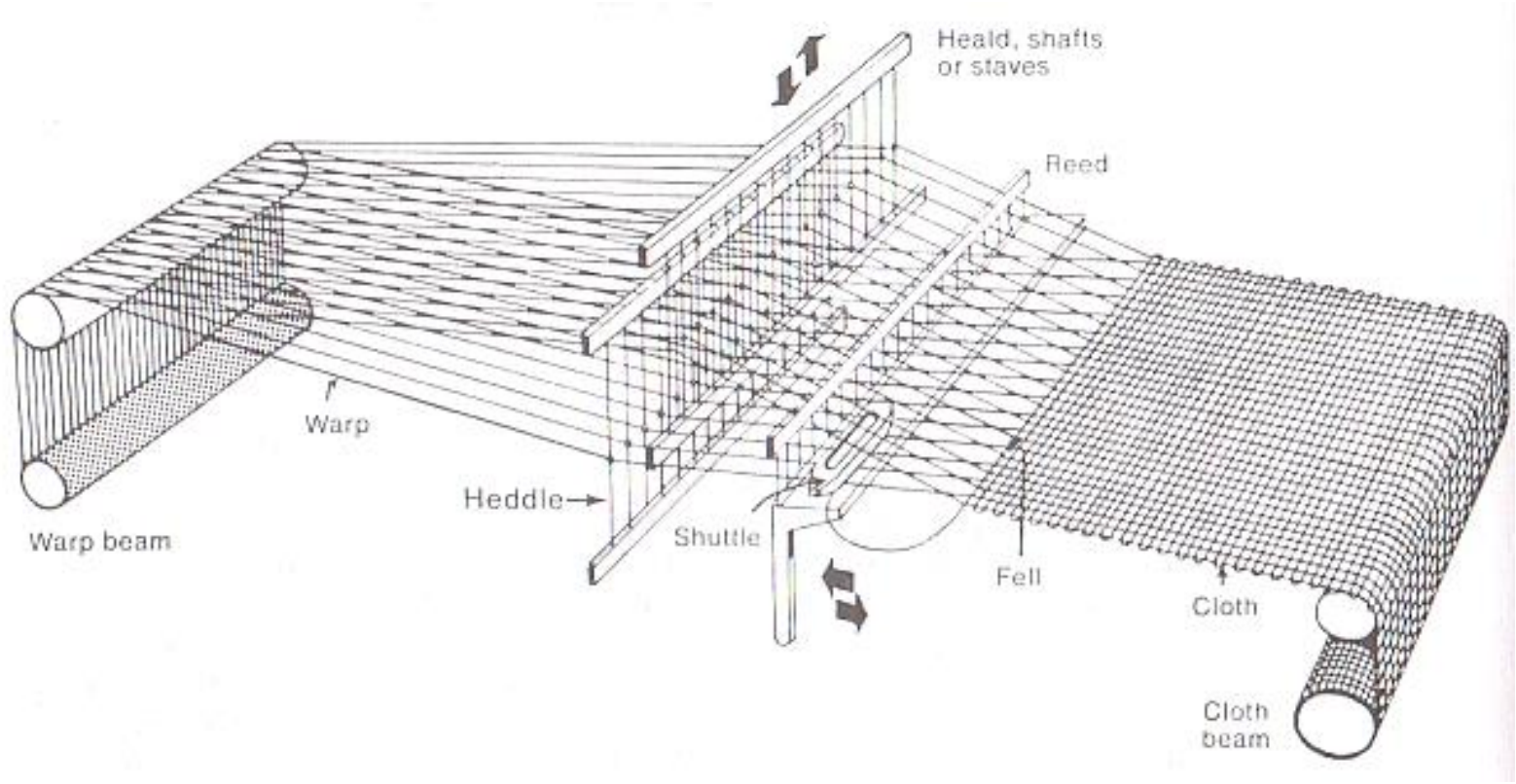
Spinning system comparisons

- Ring.
- Open-end (OE).
- Air Vortex and Air Jet (false twist process).

Spinning System	Ring Long	Ring Short	Rotor	MJS†	MVS‡
Spindles (million)	16	166	7.6	0.25	0.26
Delivery (m/min)	20	20	250	300	400
World Prod Rate (tonnes/min)	6.4	66.4	38	1.5	2.1

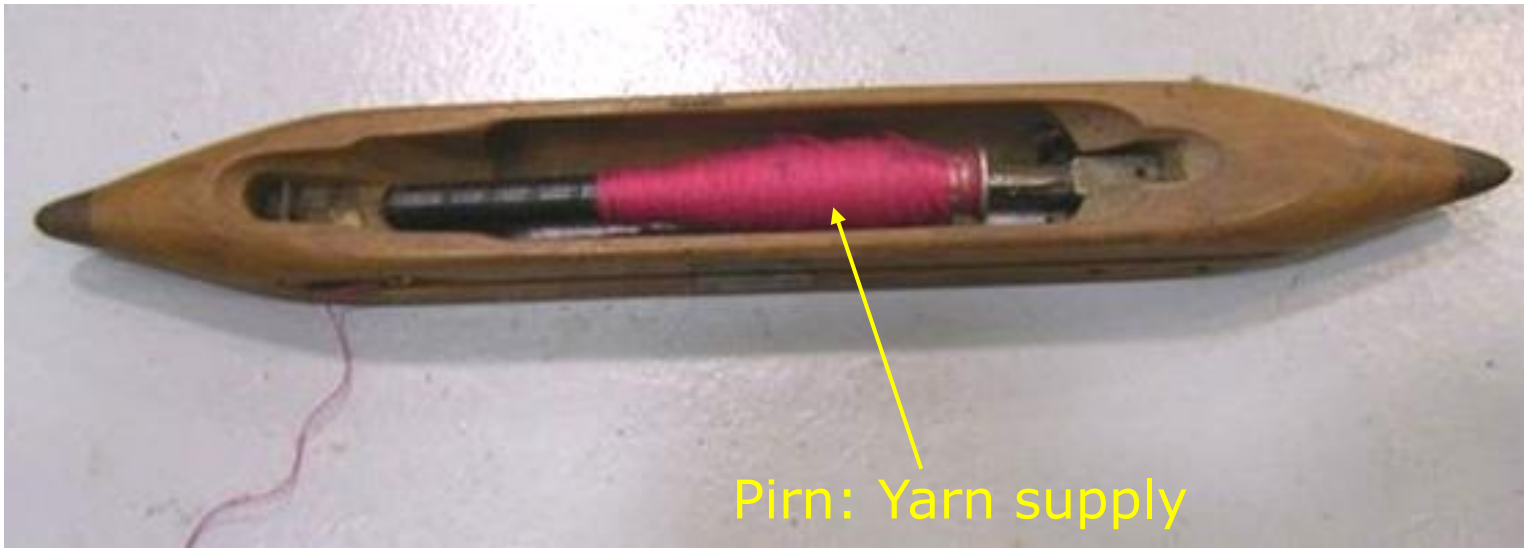
† **Murata Jet Spun** ‡ **Murata Vortex Spun**

Principles of weaving

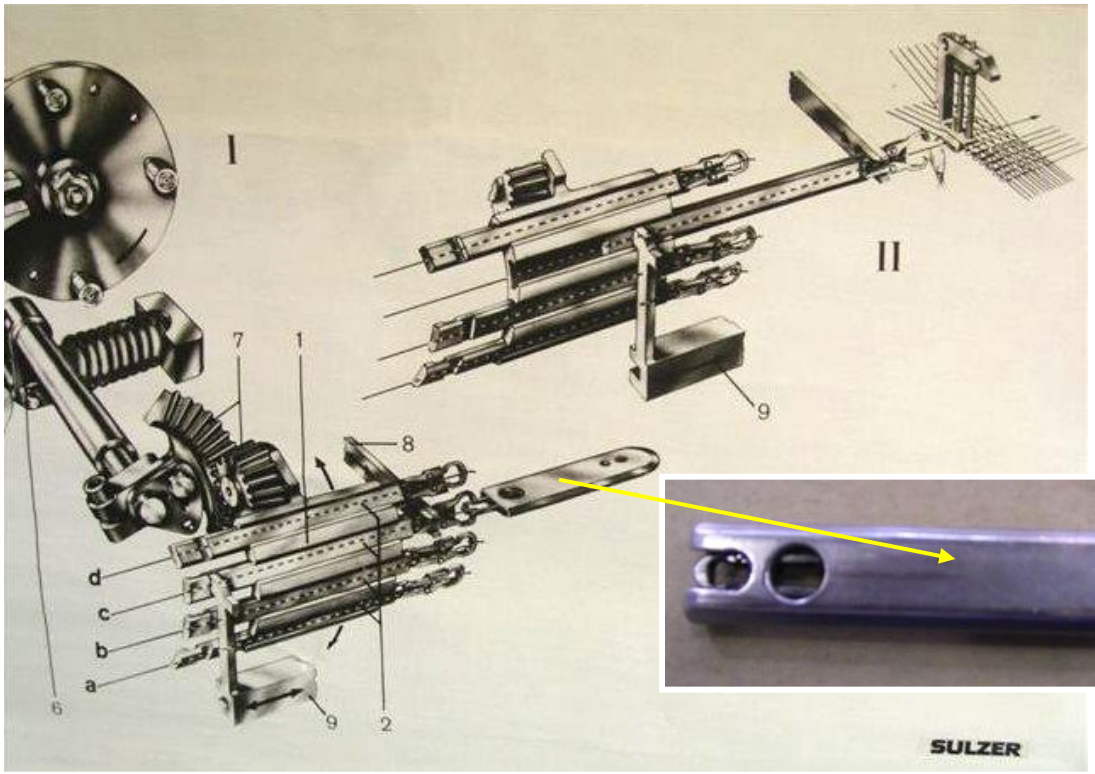


Weft insertion

Shuttle with pirn



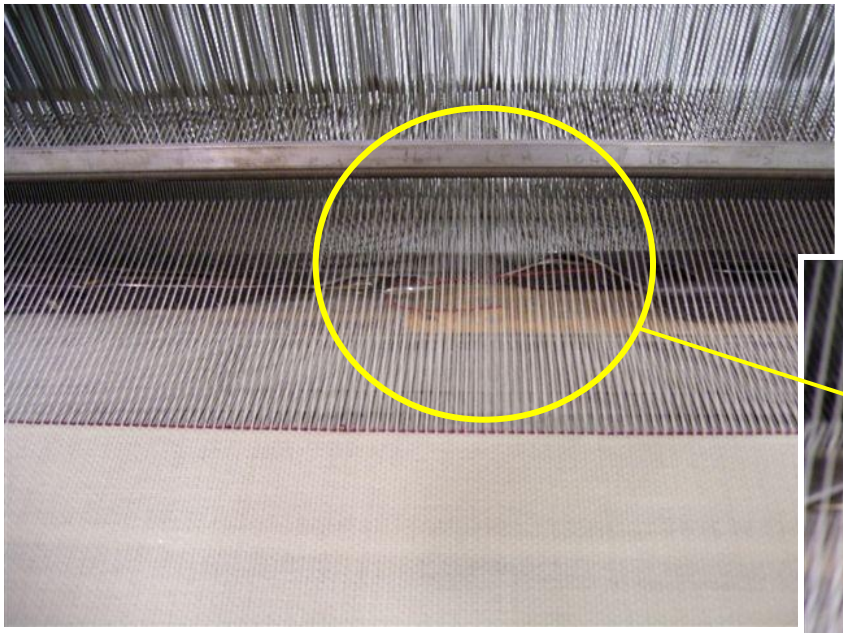
Weft insertion



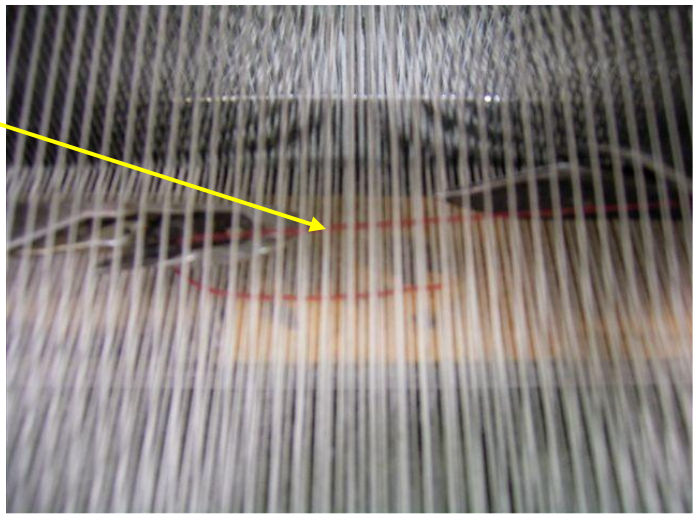
Projectile –
Sulzer system

Weft insertion

Rapier system

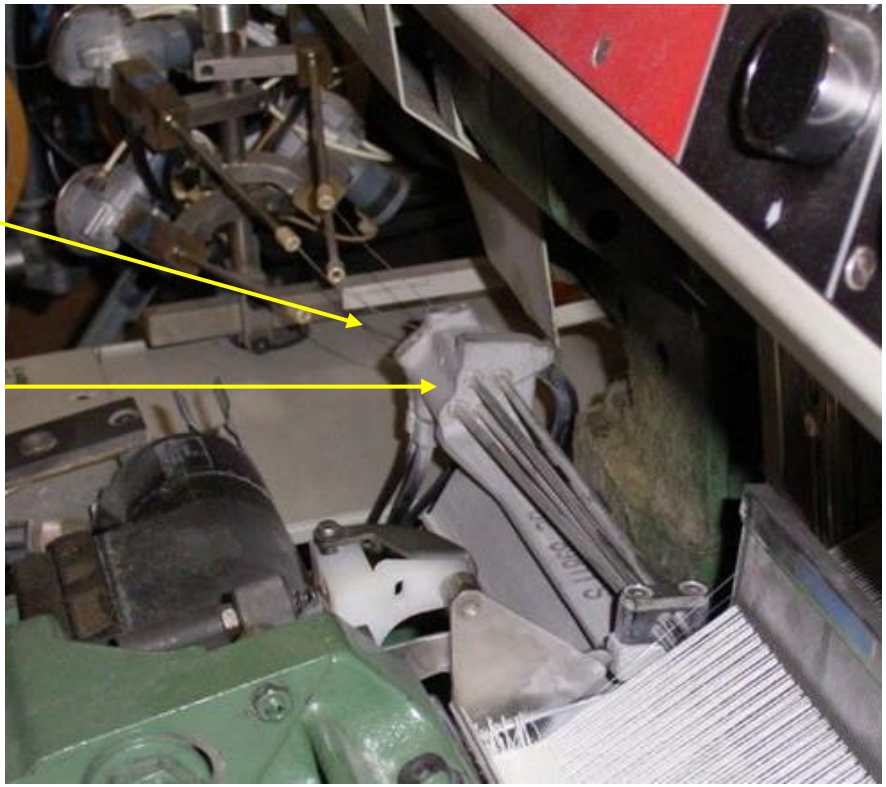


Yarn transfer



Weft insertion

Air-jet



Weft yarn supply

Weft yarns

Weft yarn accumulators (6)

Weaving speeds

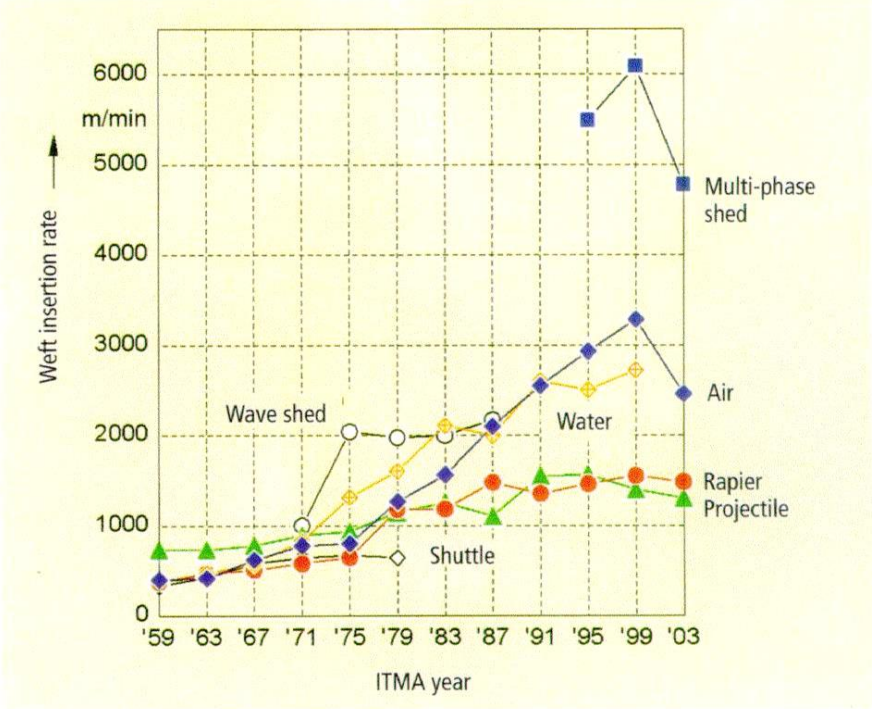
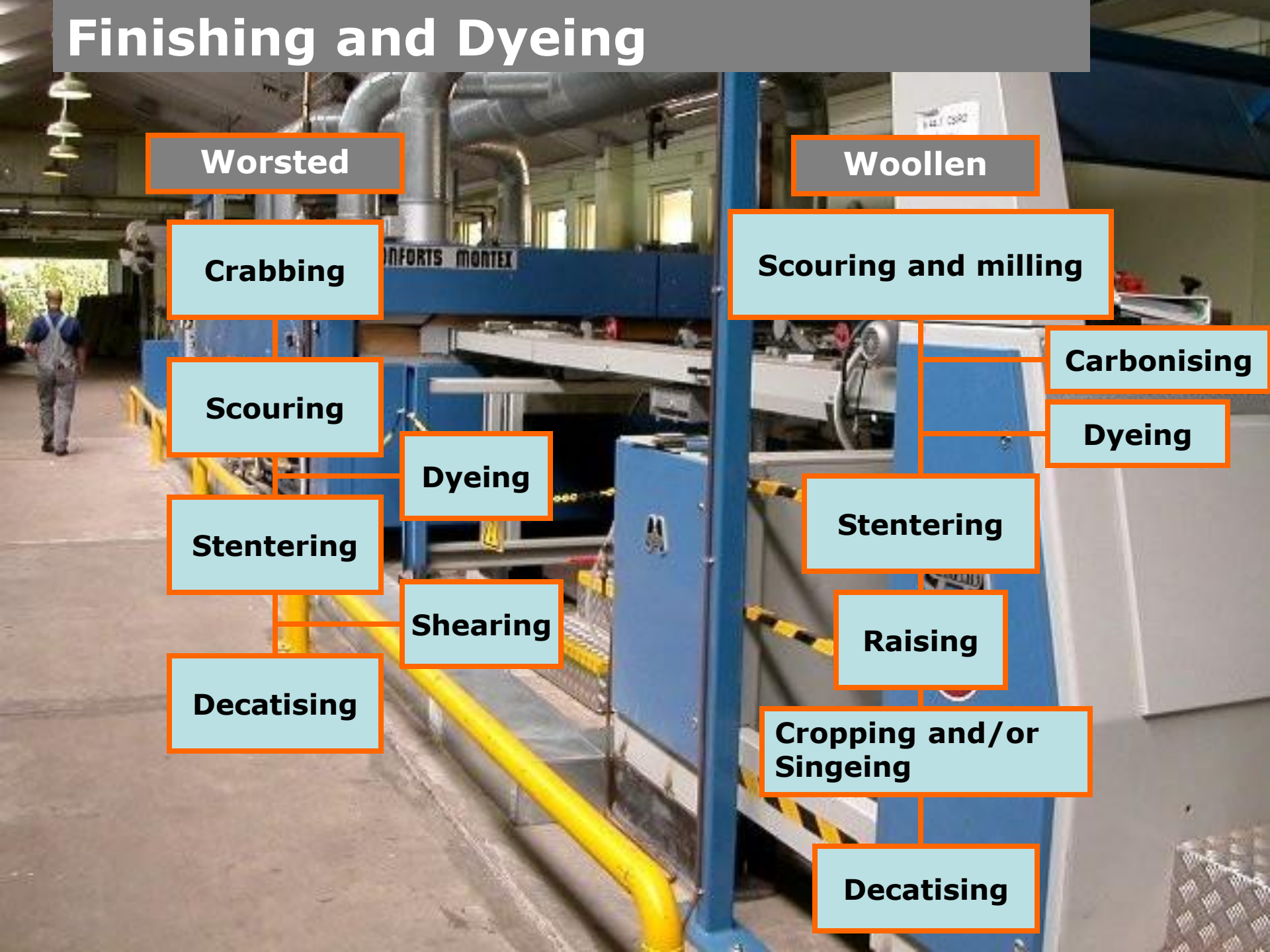


Fig. 1: Weaving machine exhibition performance. For the first time in the history of ITMA, weaving machine weft insertion speeds remained behind those of the preceding ITMA.
Illustration: ITV

Finishing and Dyeing



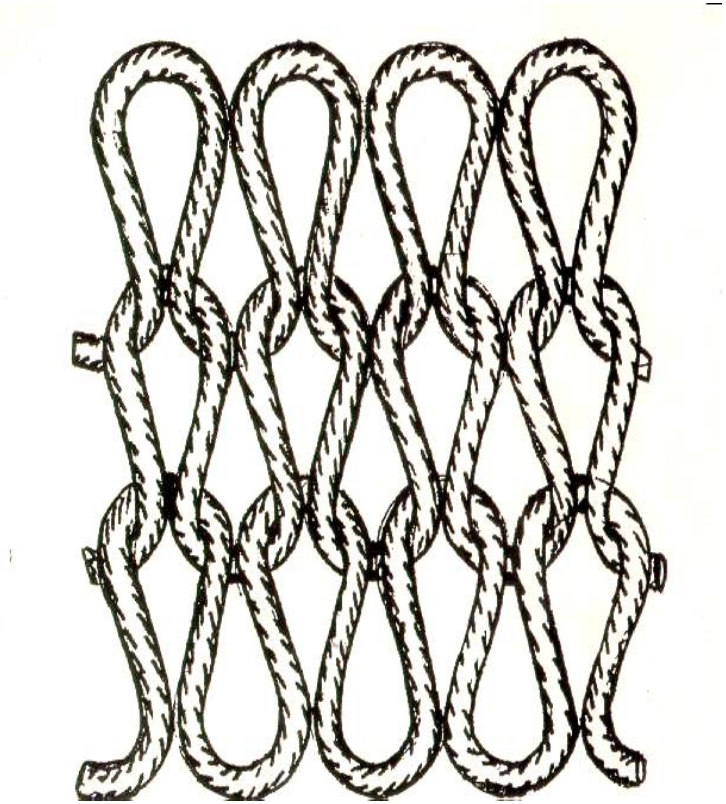
Worsted

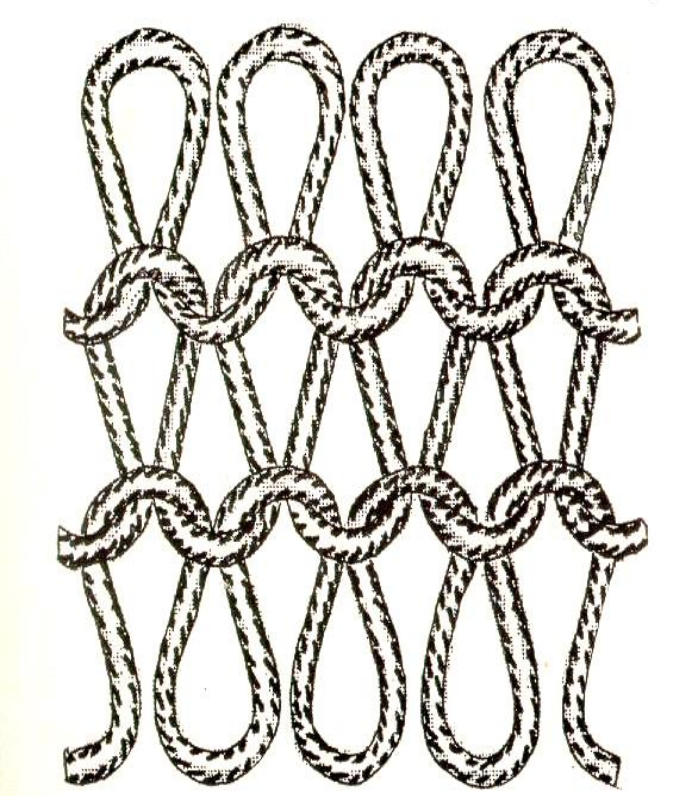
- Crabbing
- Scouring
- Dyeing
- Stentering
- Shearing
- Decatising

Woollen

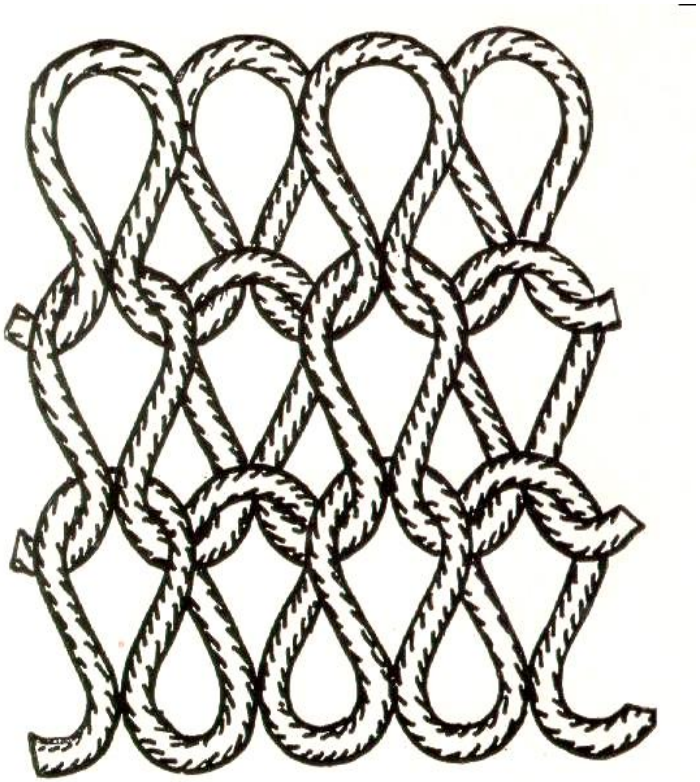
- Scouring and milling
- Carbonising
- Dyeing
- Stentering
- Raising
- Cropping and/or Singeing
- Decatising

Plain weft knit fabric



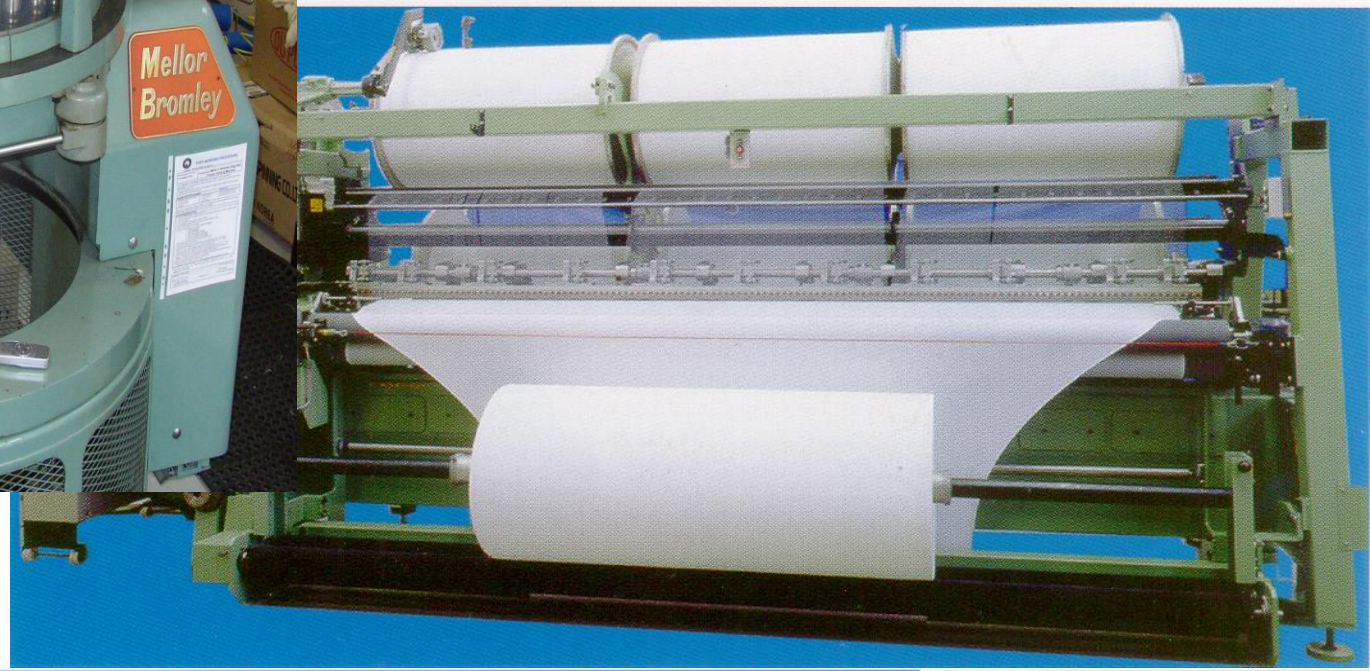


Weft knit rib knit or 1x1 rib

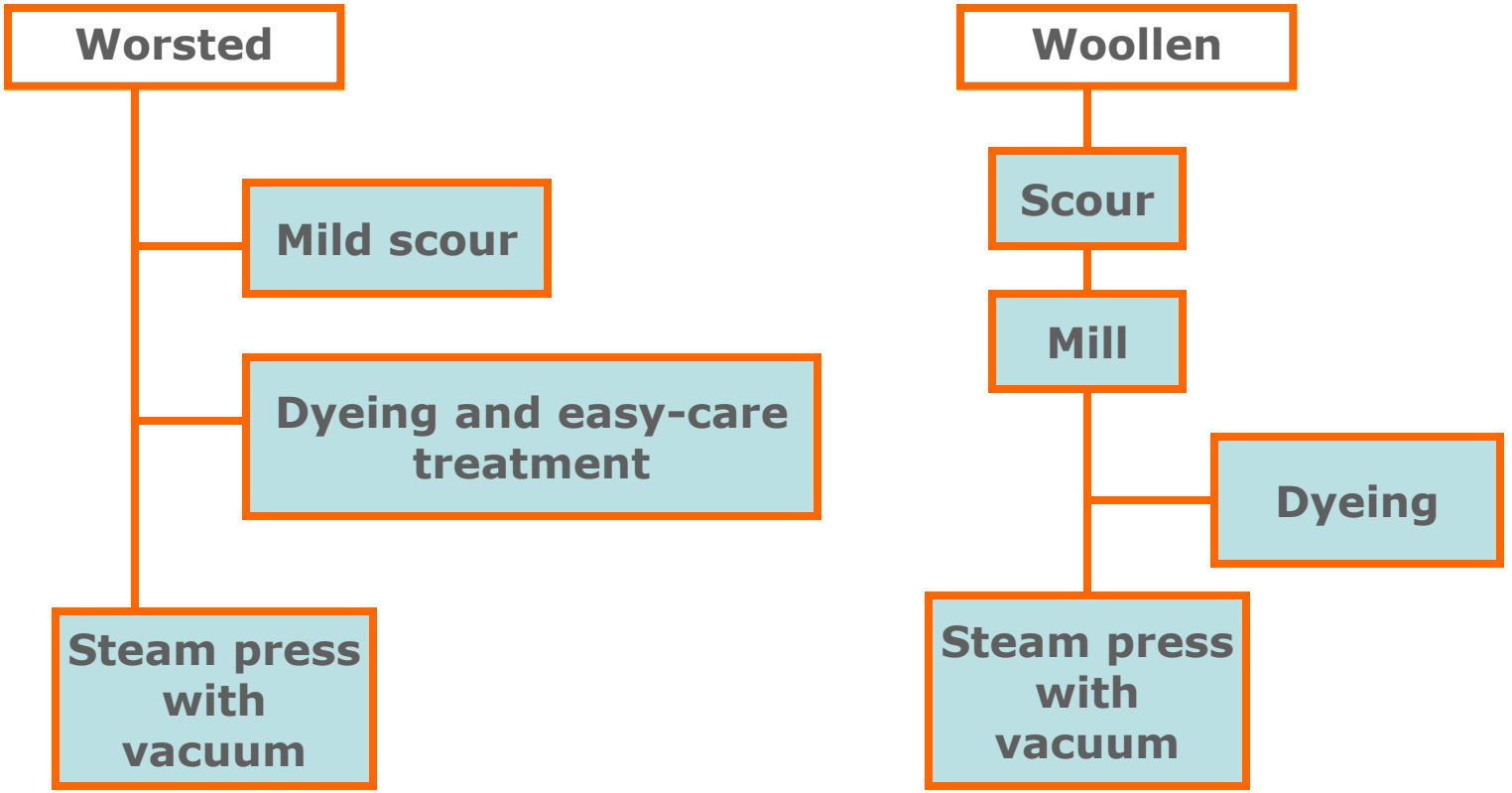


Circular knitting

Warp knitting



Finishing of knitwear



The miracle of transformation

- Many steps, often unique to wool.
- Batch processes are common.
- Productivity often relatively low.
- Specification and measurement essential.
- R&D important for product and process.
- Wool fabrics are unique and highly desirable.