

Fibre to fabric

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Wool industry consultant

The transformation of raw wool to fabric





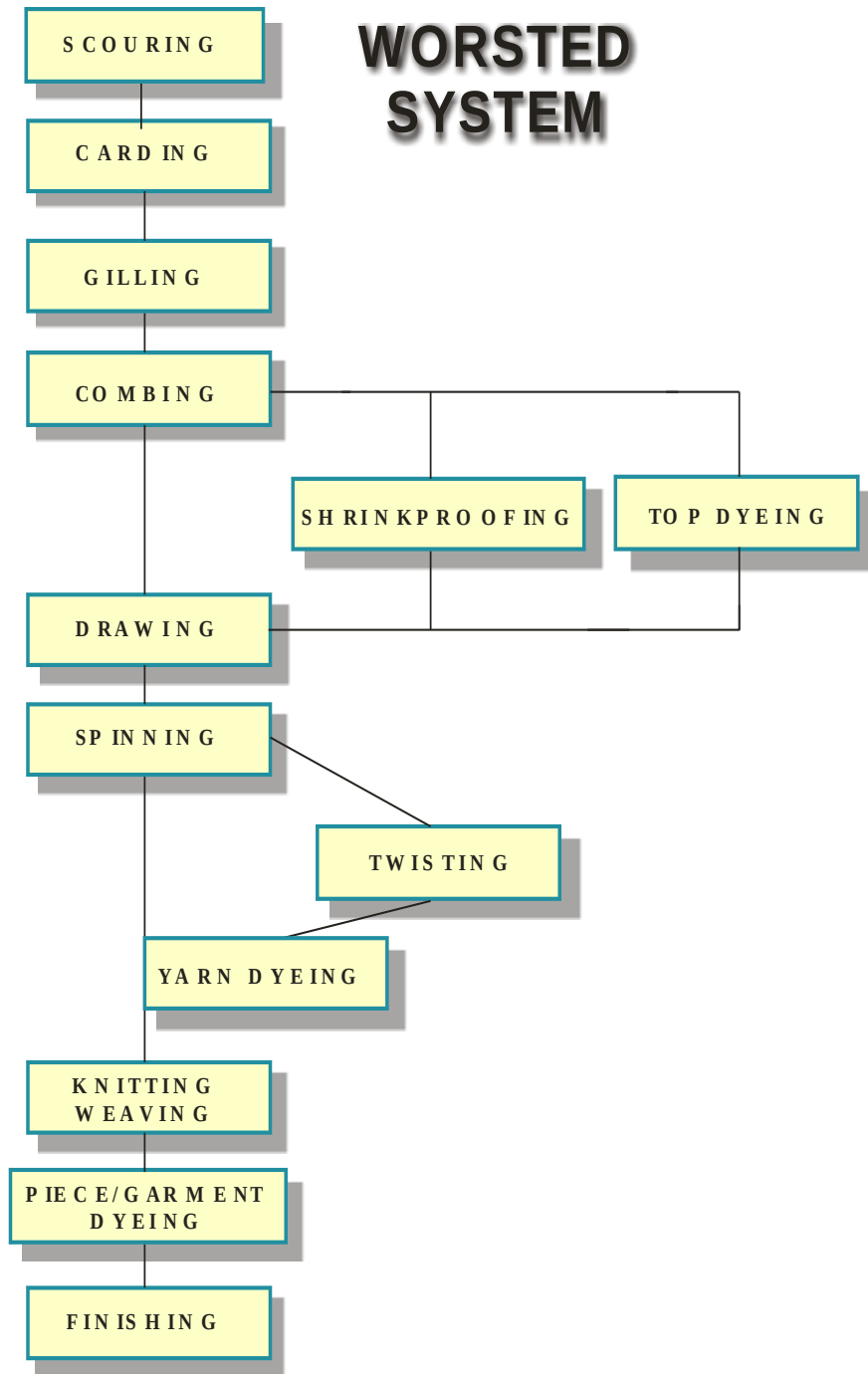
Zegna

Photograph courtesy of AWI.

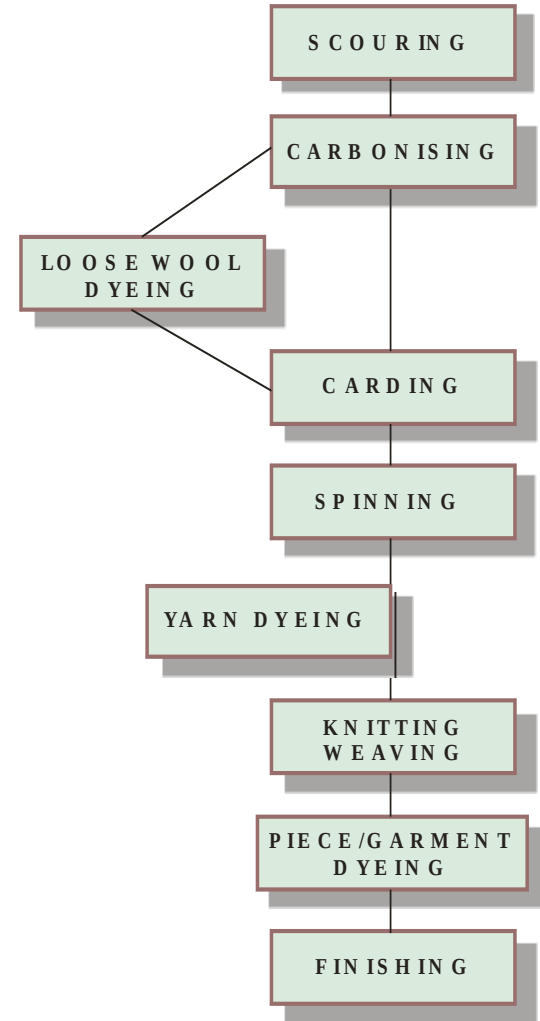
Some issues for wool processing

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

WORSTED SYSTEM



WOOLLEN SYSTEM

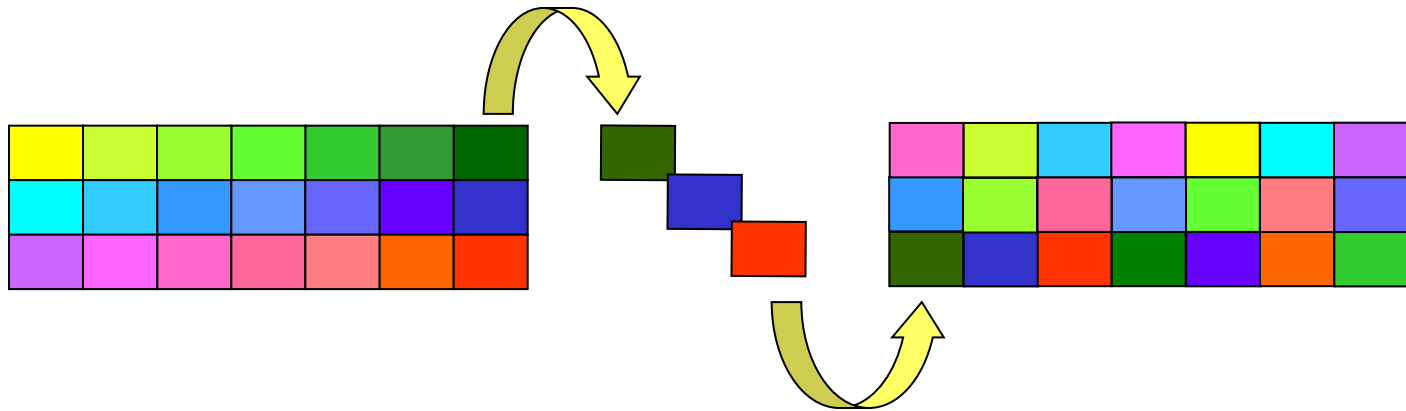


The woollen system

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



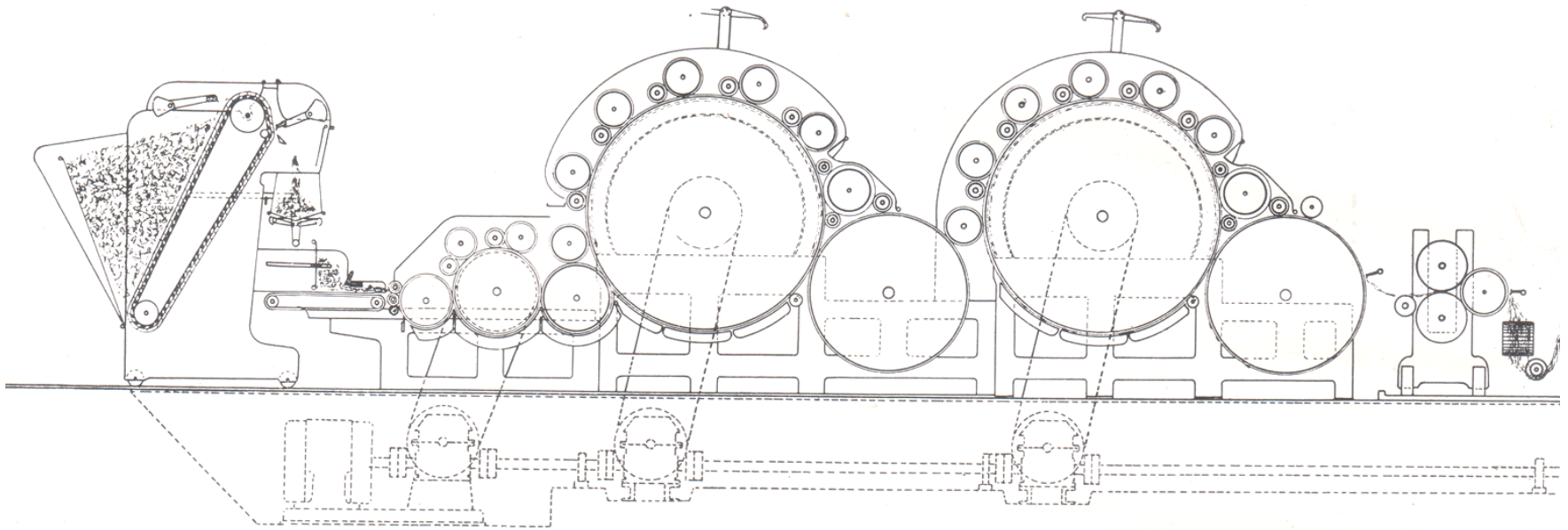
- Horizontal layers
- Vertical cuts
- Horizontal deposition
- Mixing of wool
- Greater uniformity of blend
- Ideal: all wool together

Woollen carding



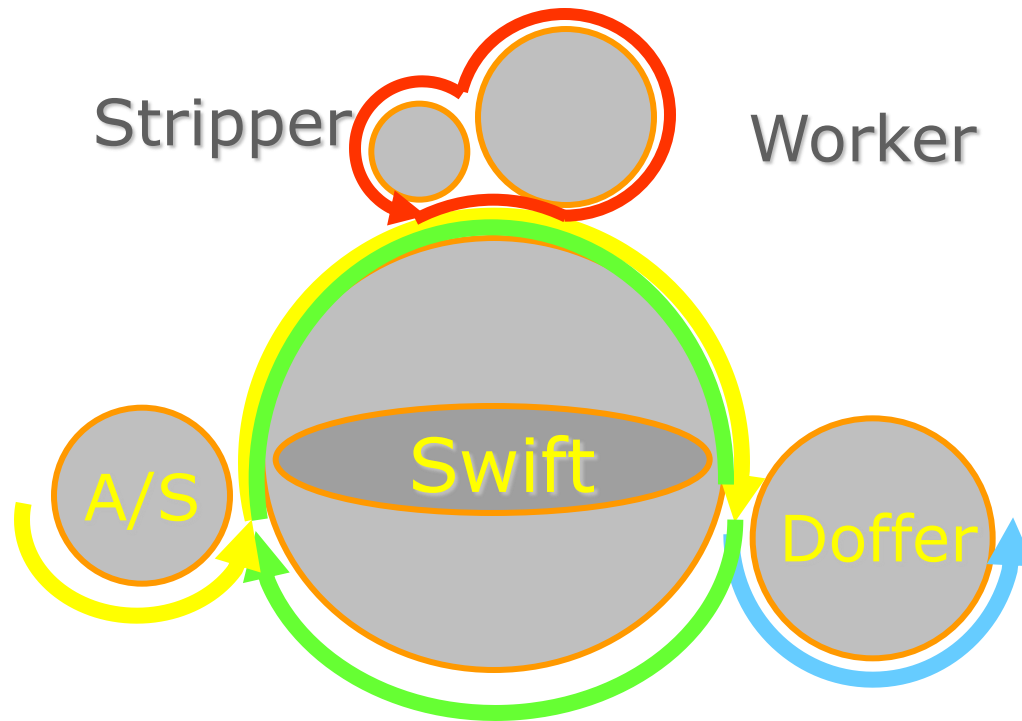
Source: Octir

Woollen spinning scribbler section



Source: William Tatham Ltd

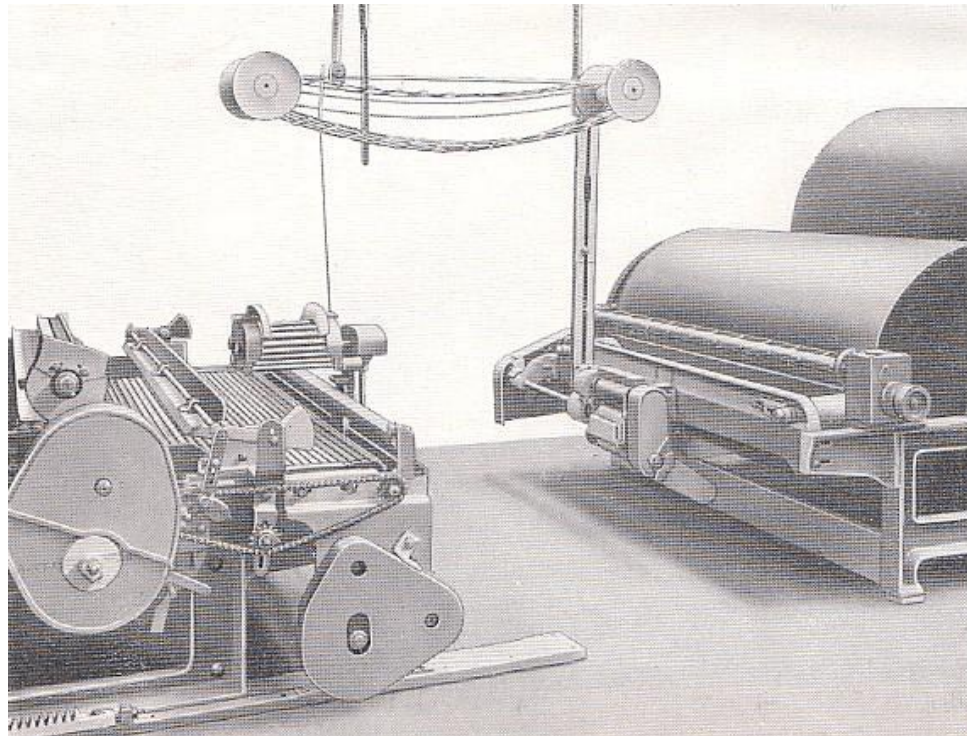
Fibre flows in carding



Woollen spinning

Scotch feed web rotation

To
carder

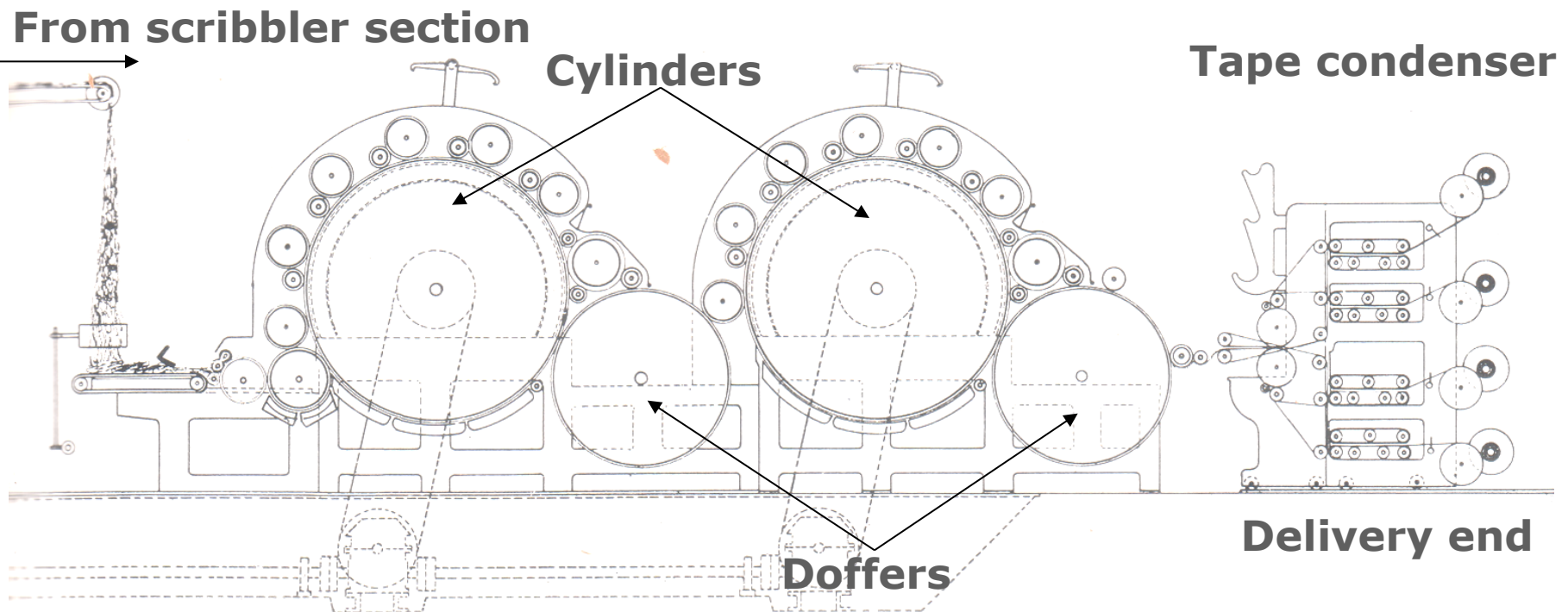


From
scribbler

Source: William Tatham Ltd.

Woollen spinning

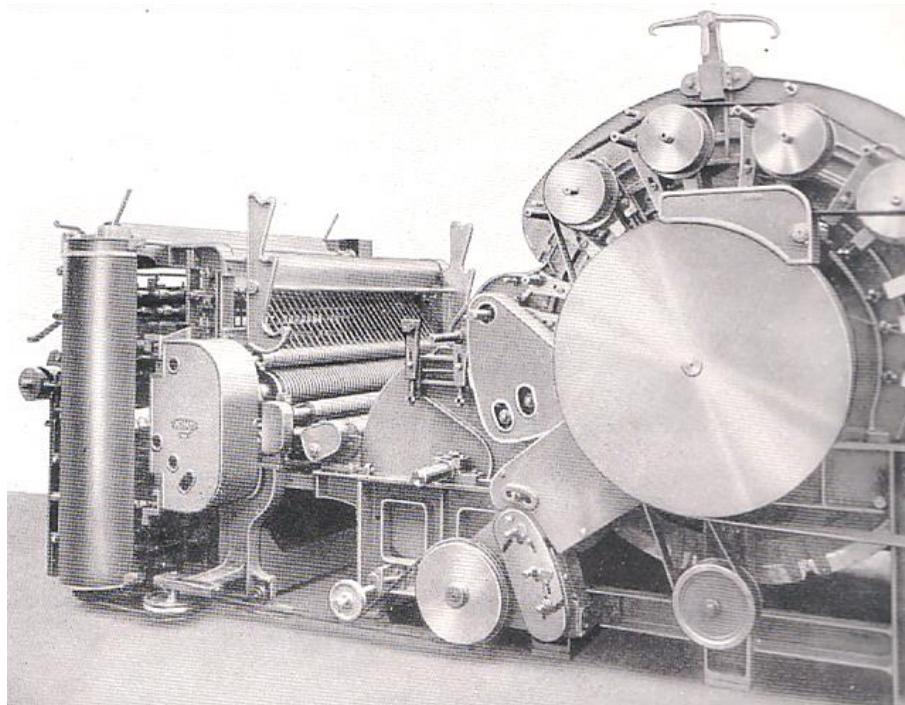
Carder section with condenser



Source: William Tatham Ltd.

Woollen card

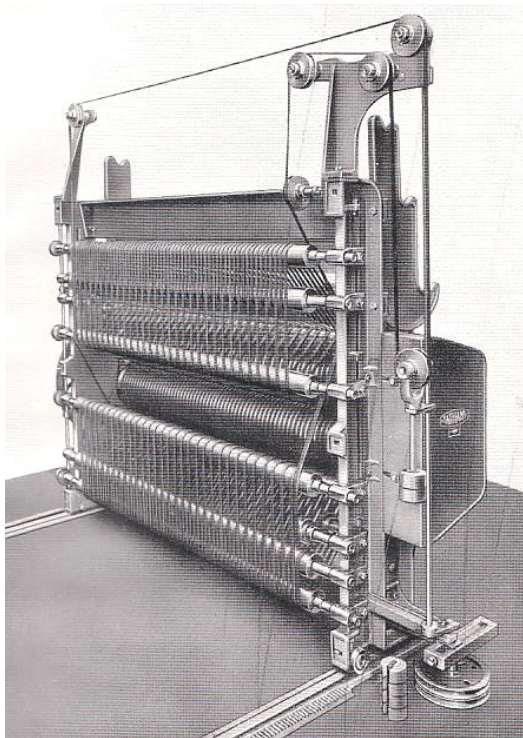
Delivery and condenser section



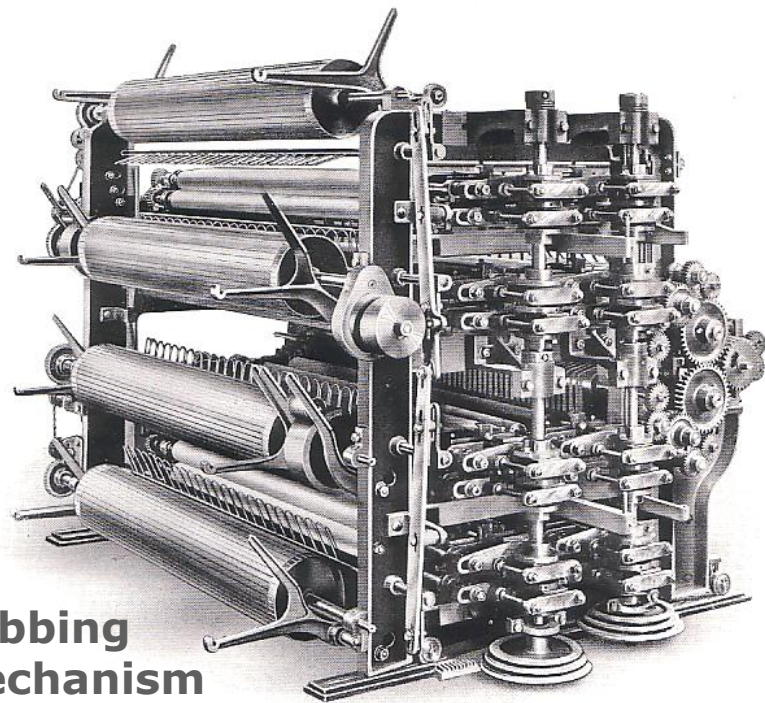
Source: William Tatham Ltd.

Woollen spinning

Condenser section



Tapes



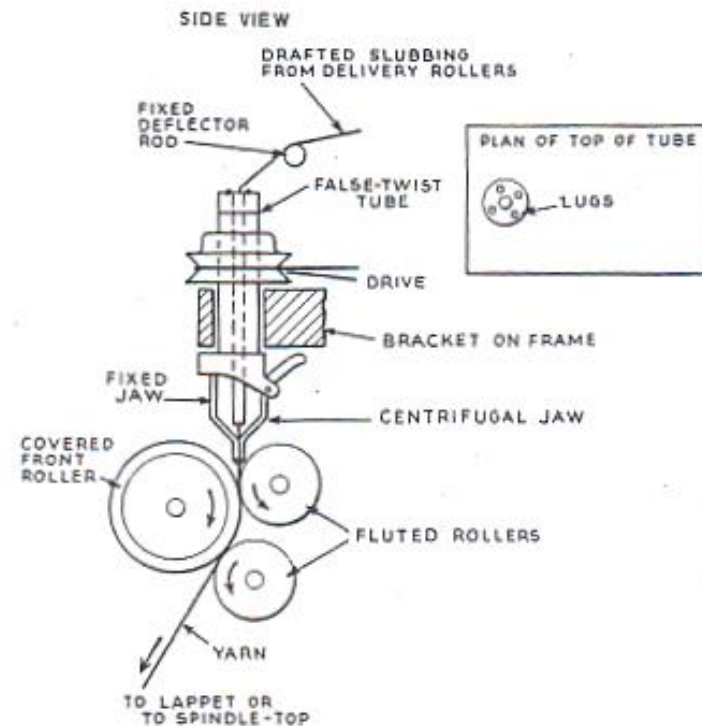
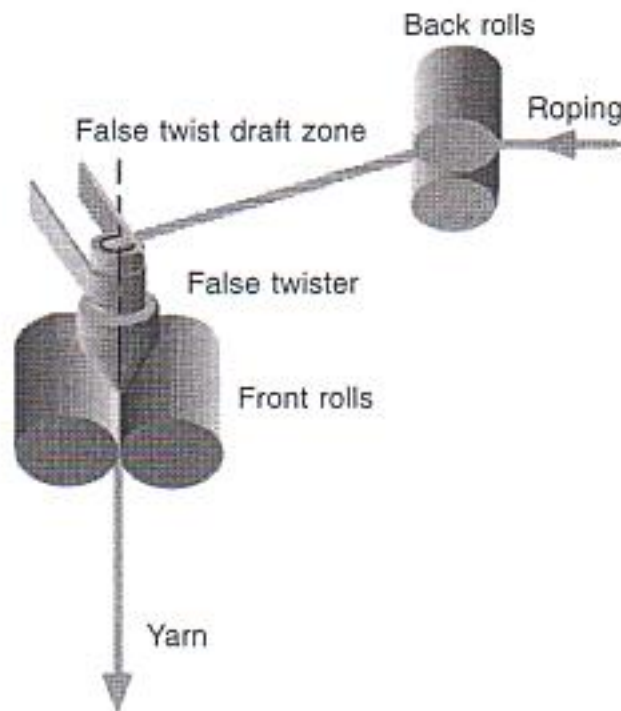
**Rubbing
mechanism**

Source: William Tatham Ltd.



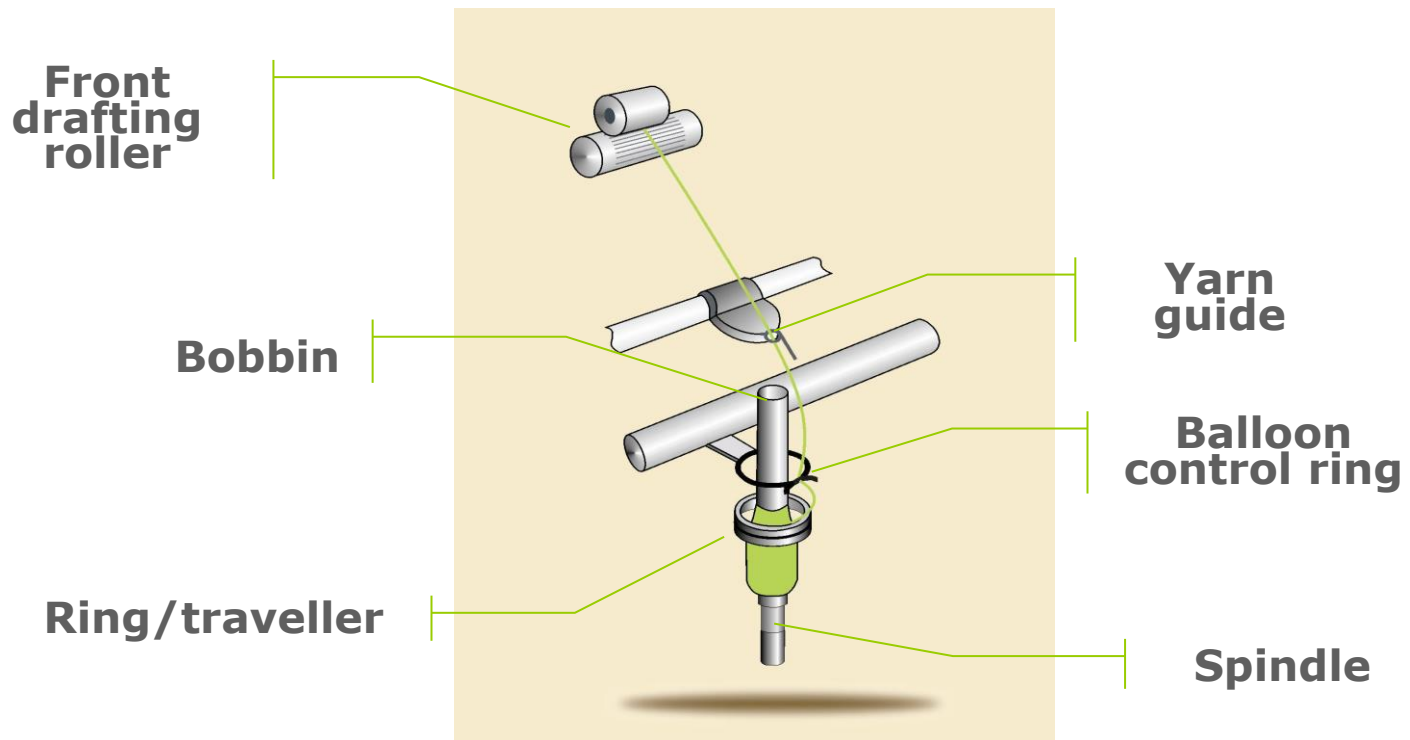
Woollen spinning

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

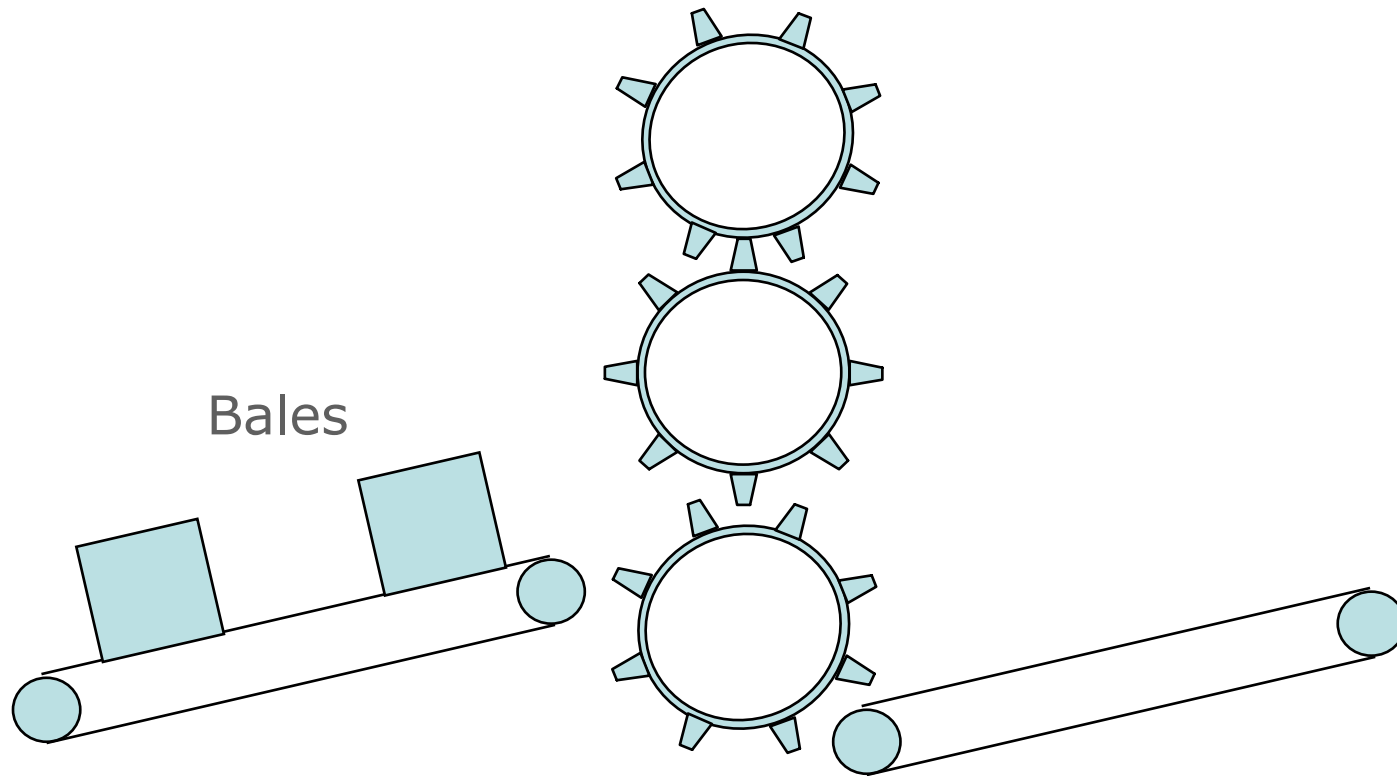
CVD = CV Diameter

CV = CV Length

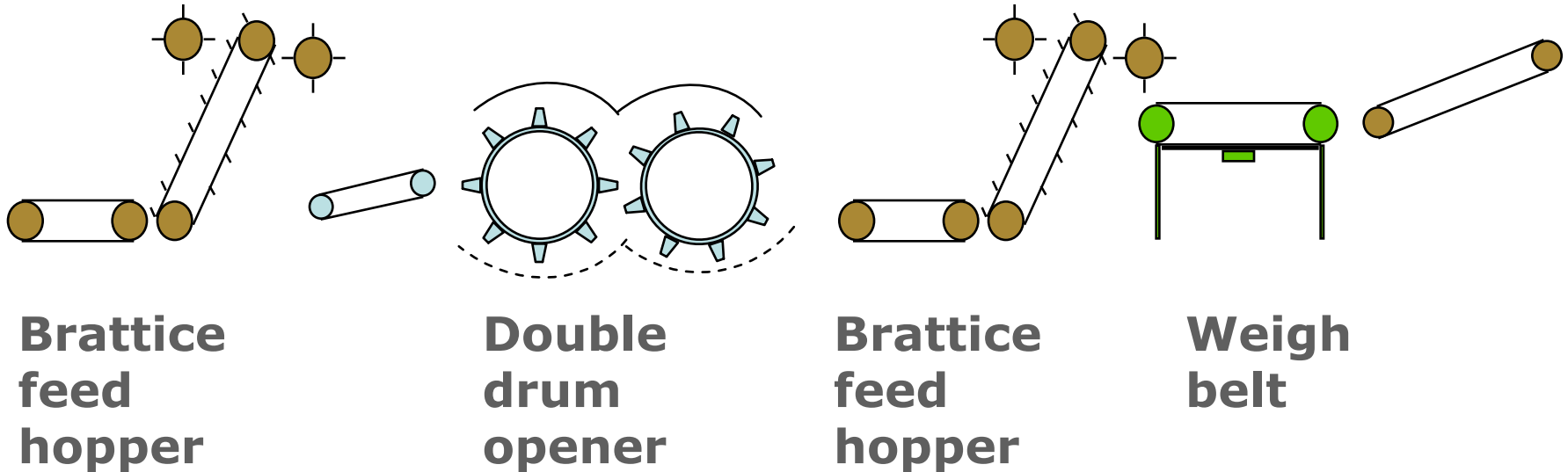
Blending procedure for greasy wool



Bale breaker



Opening of Australian wool



Scour



Contaminants in raw wool

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



Burr

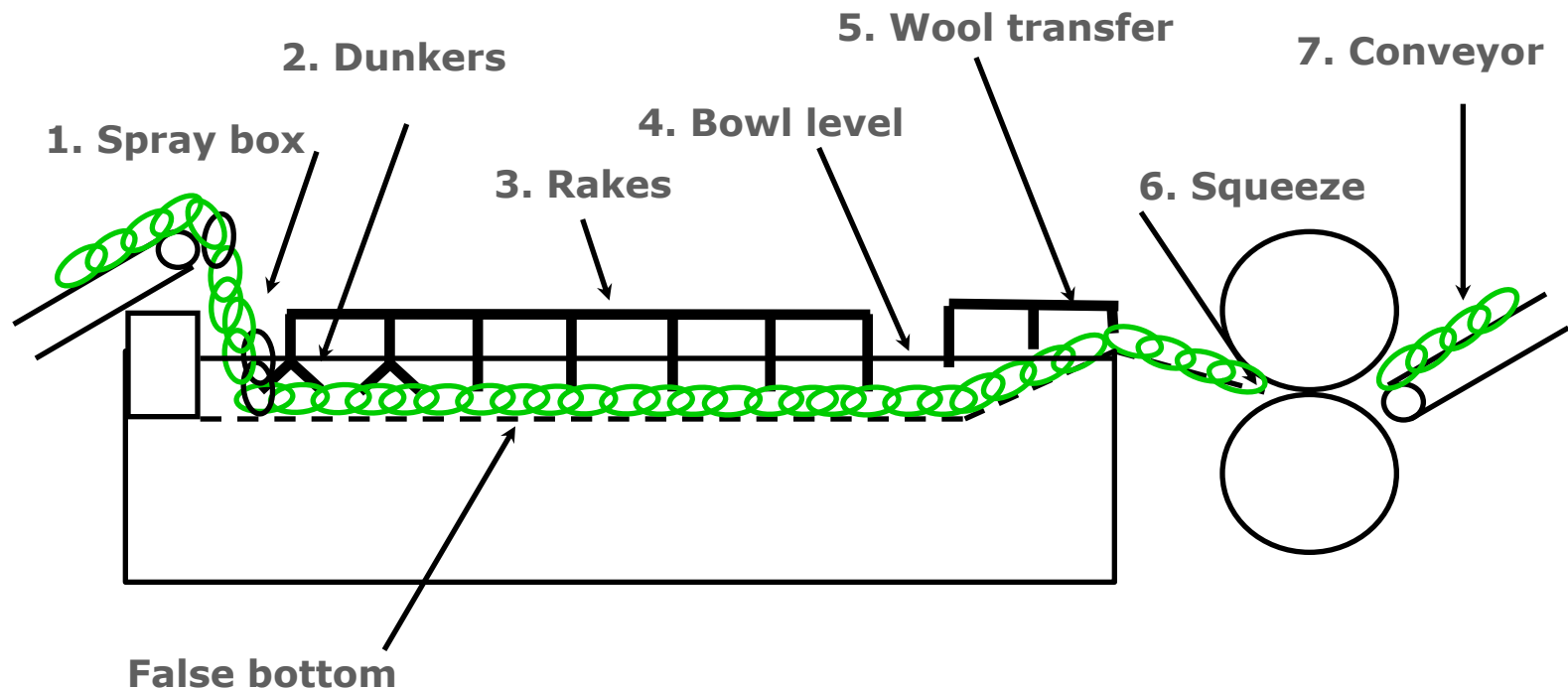


Seed and shive

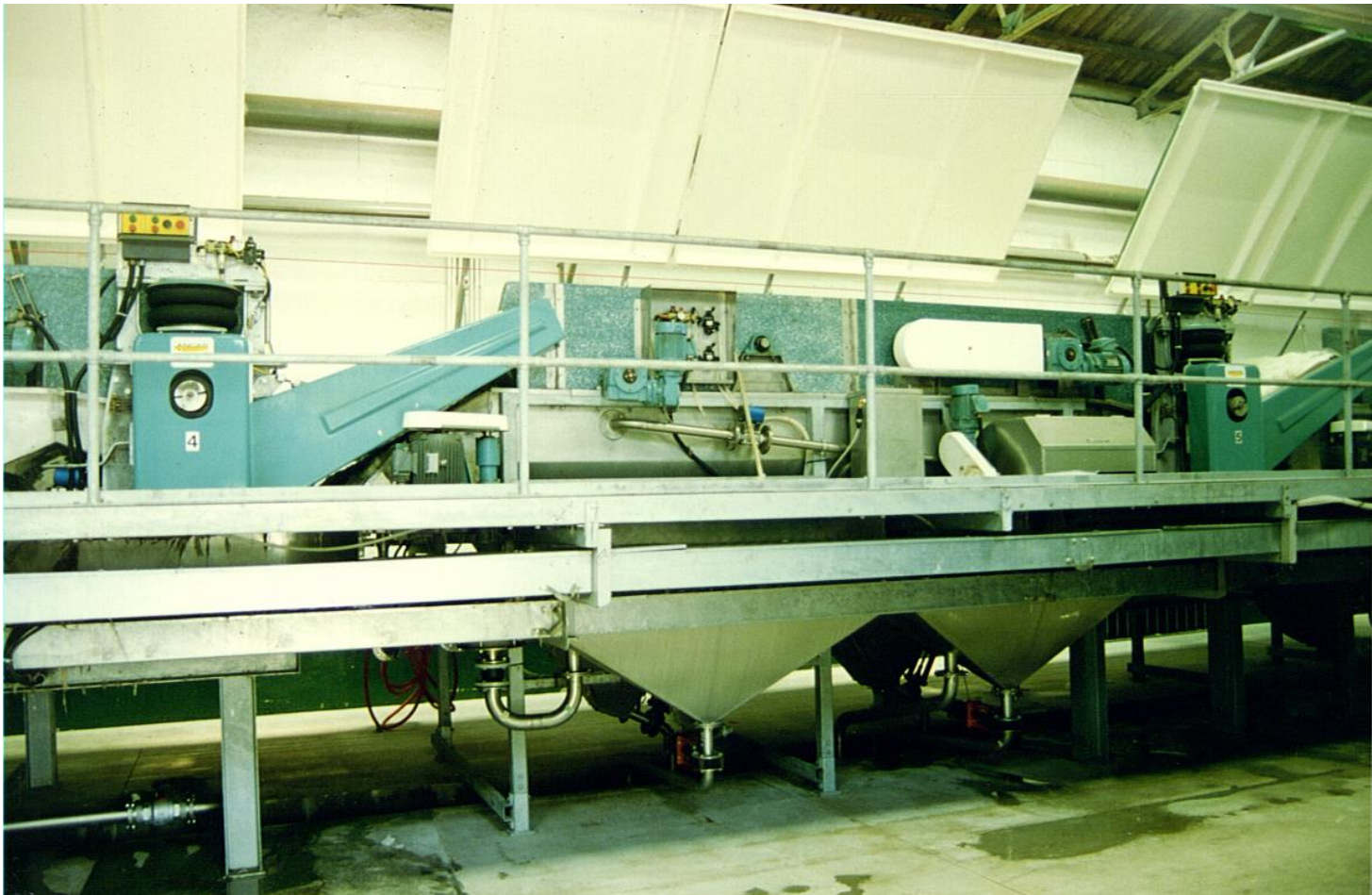


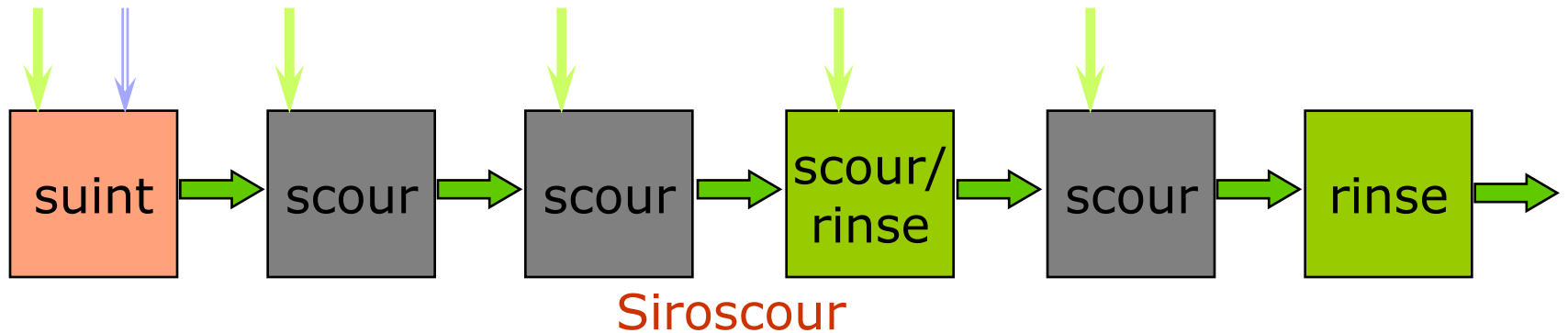
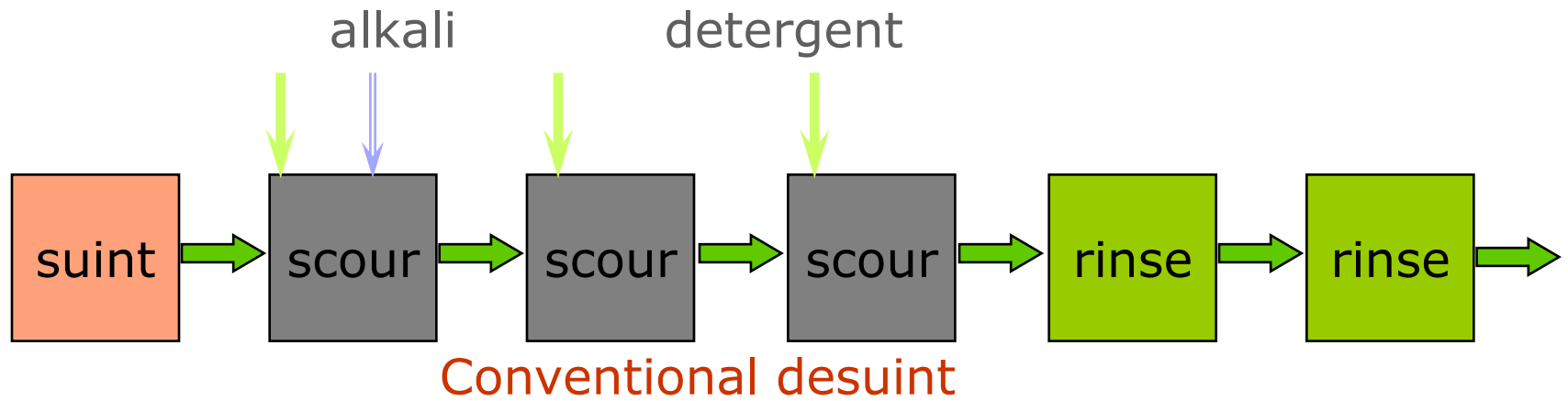
Hardheads

Typical wool scour

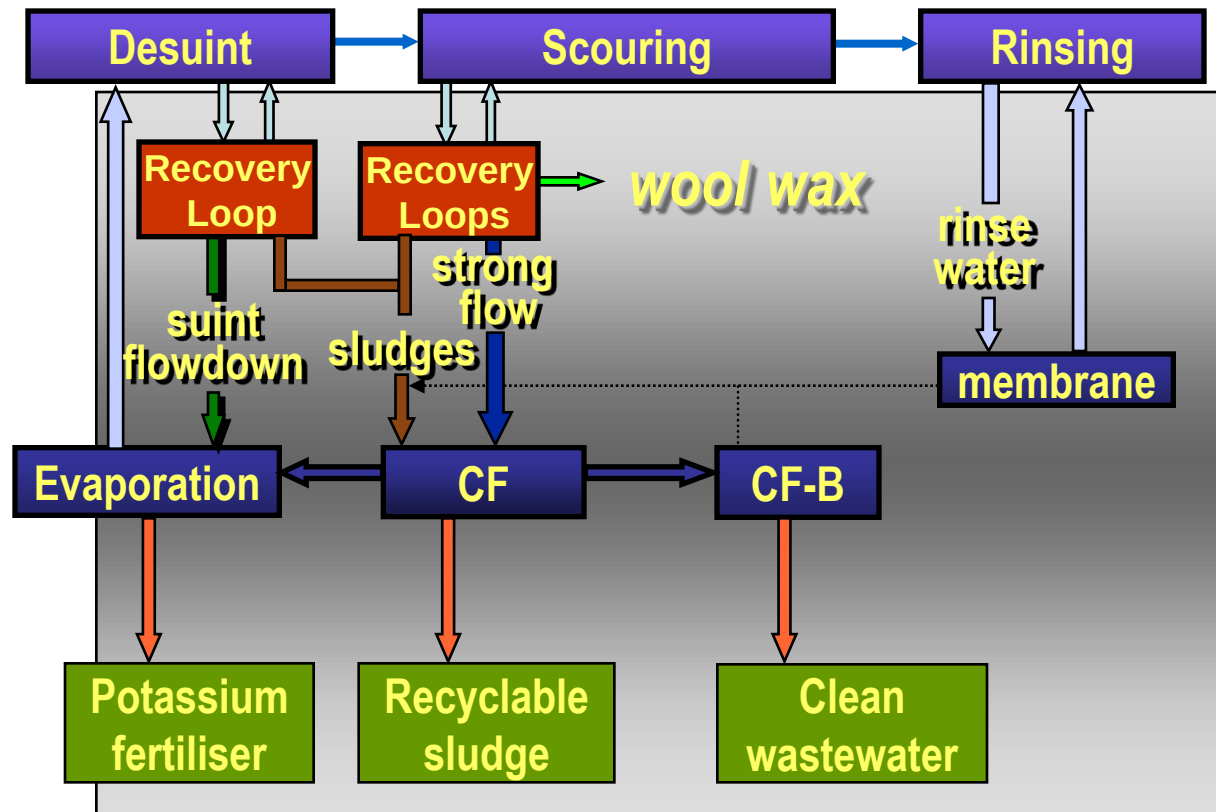




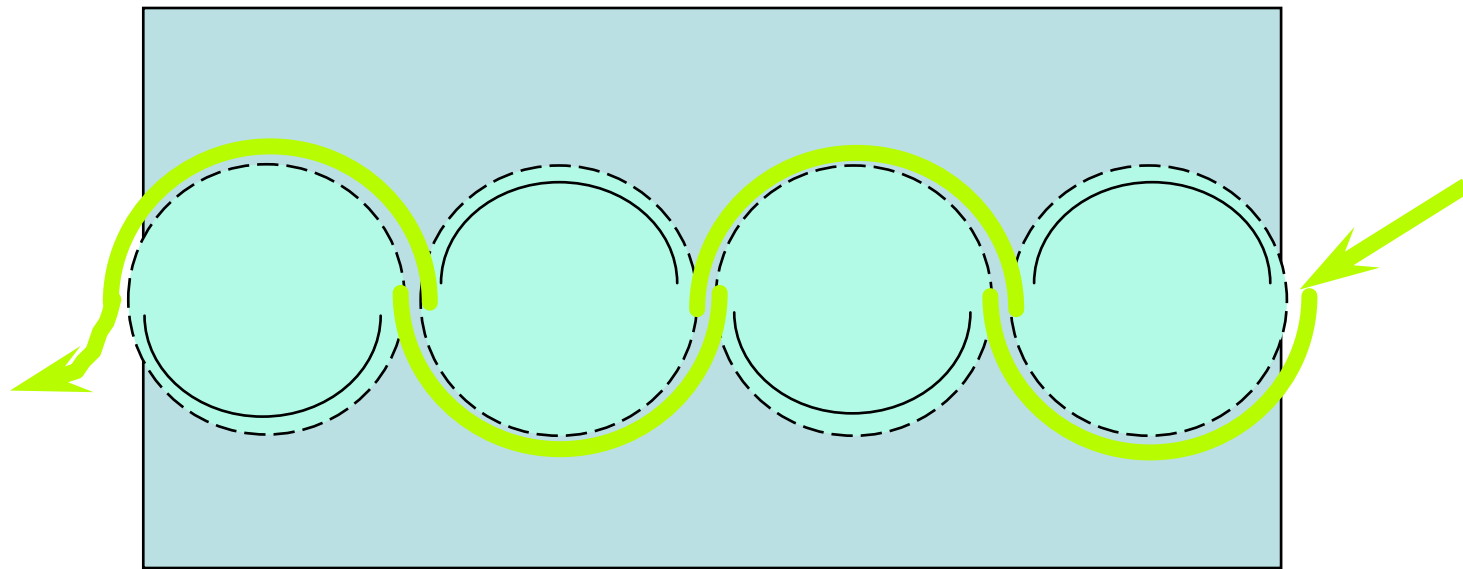




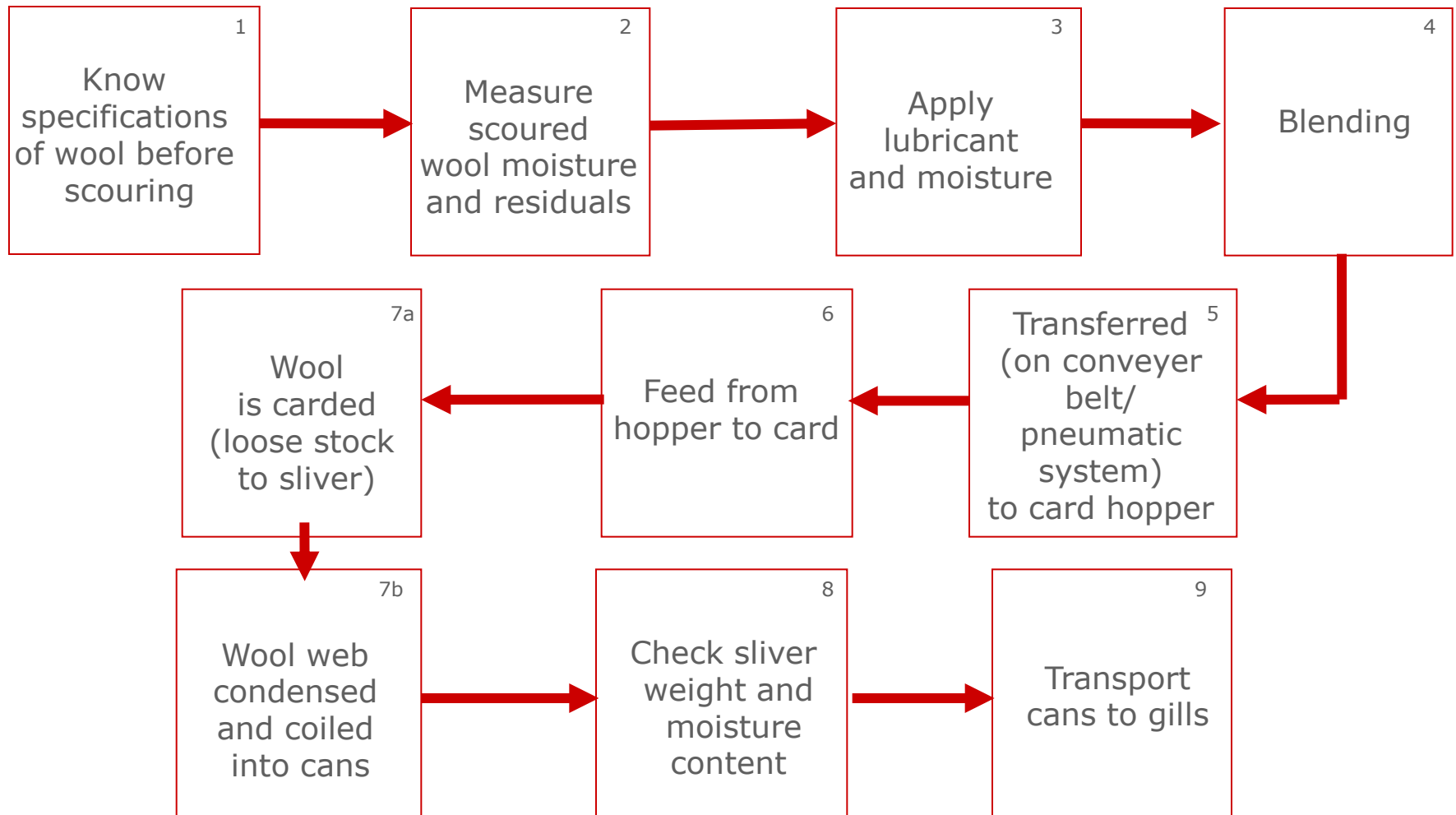
Sirolan - SWIMS



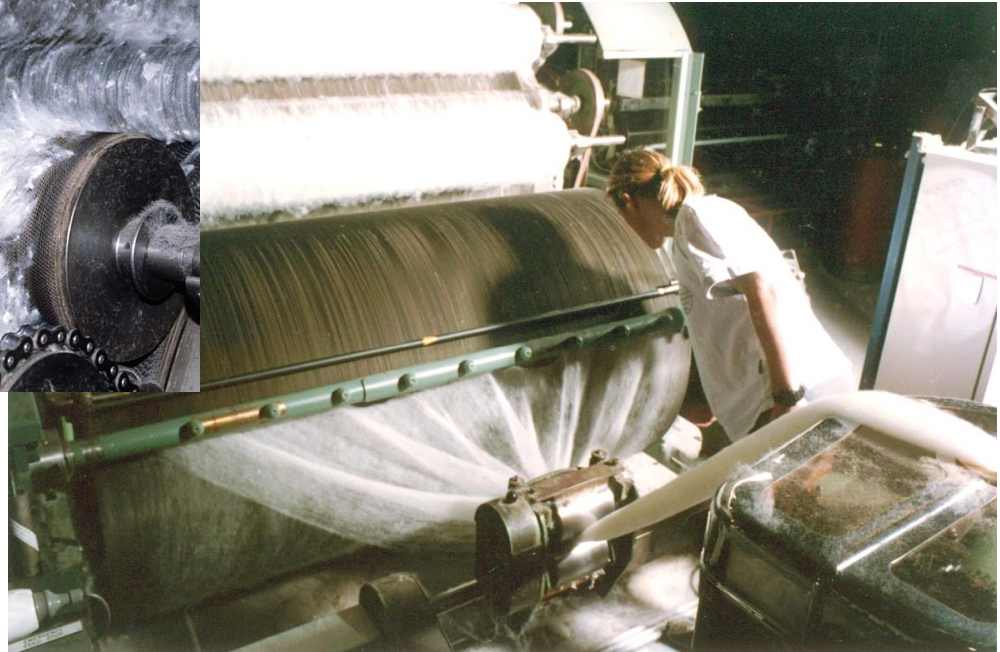
Drum dryer



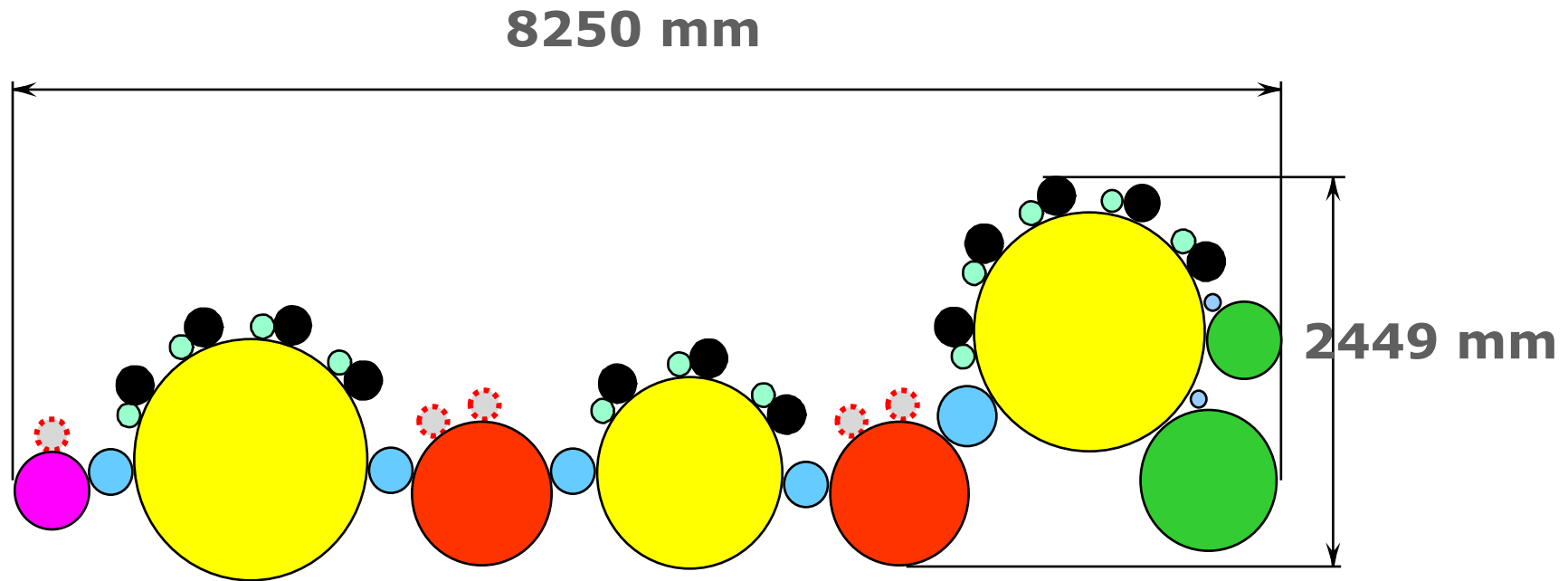
Topmaking



Carding



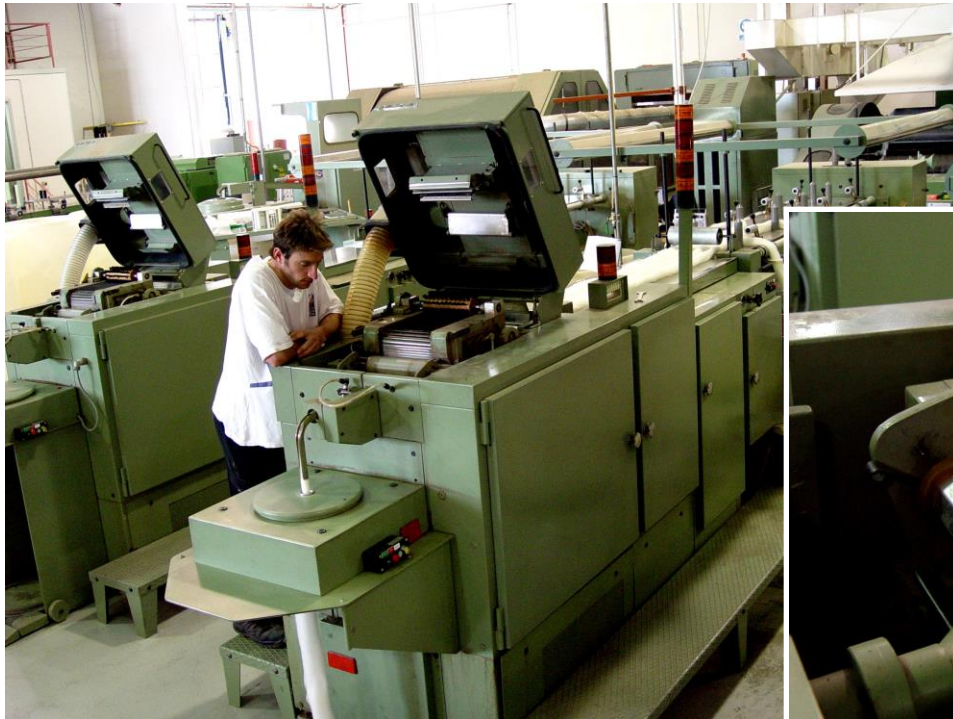
Worsted carding - the Thibeau CA7 card



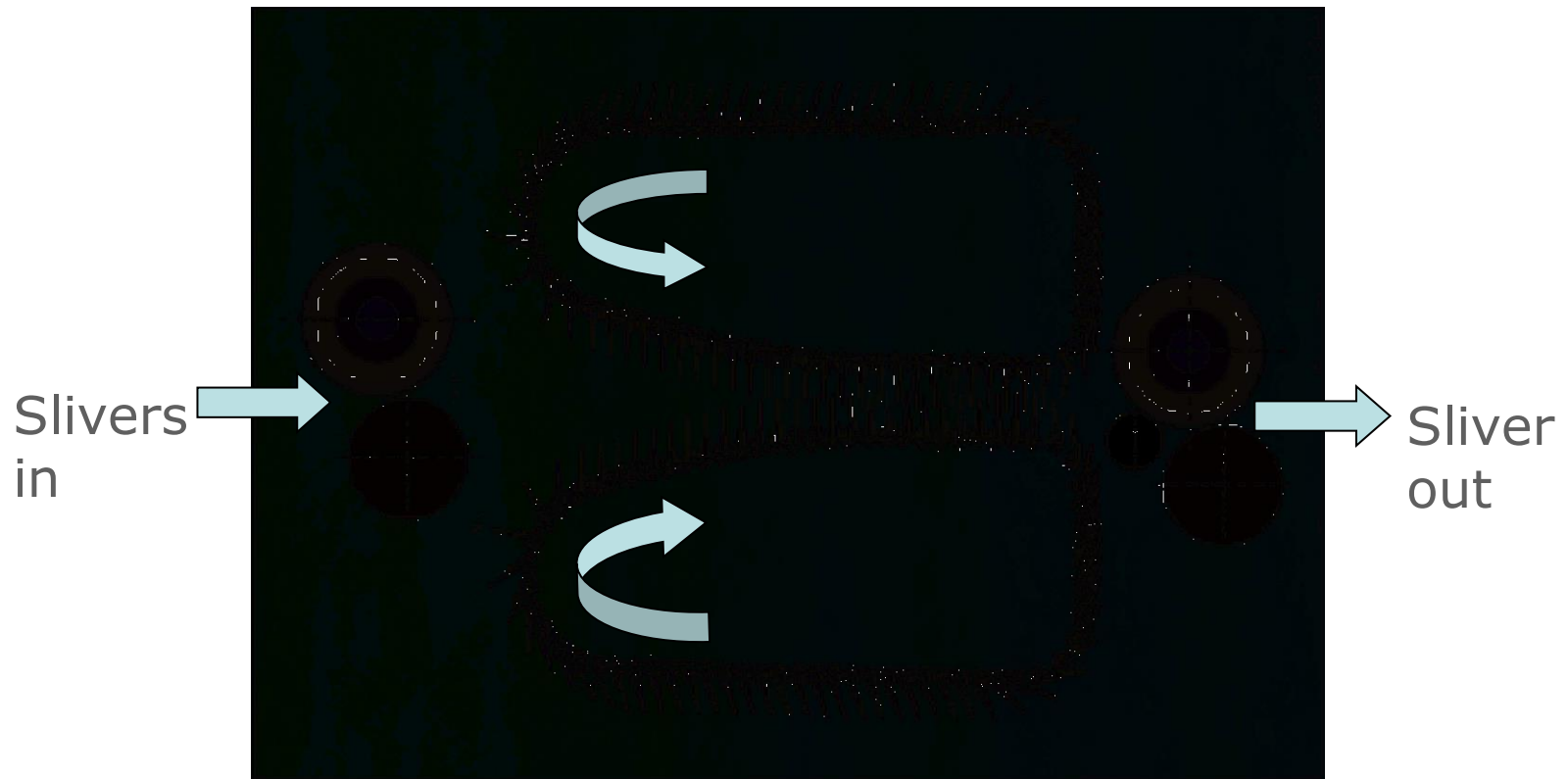
Worsted carding



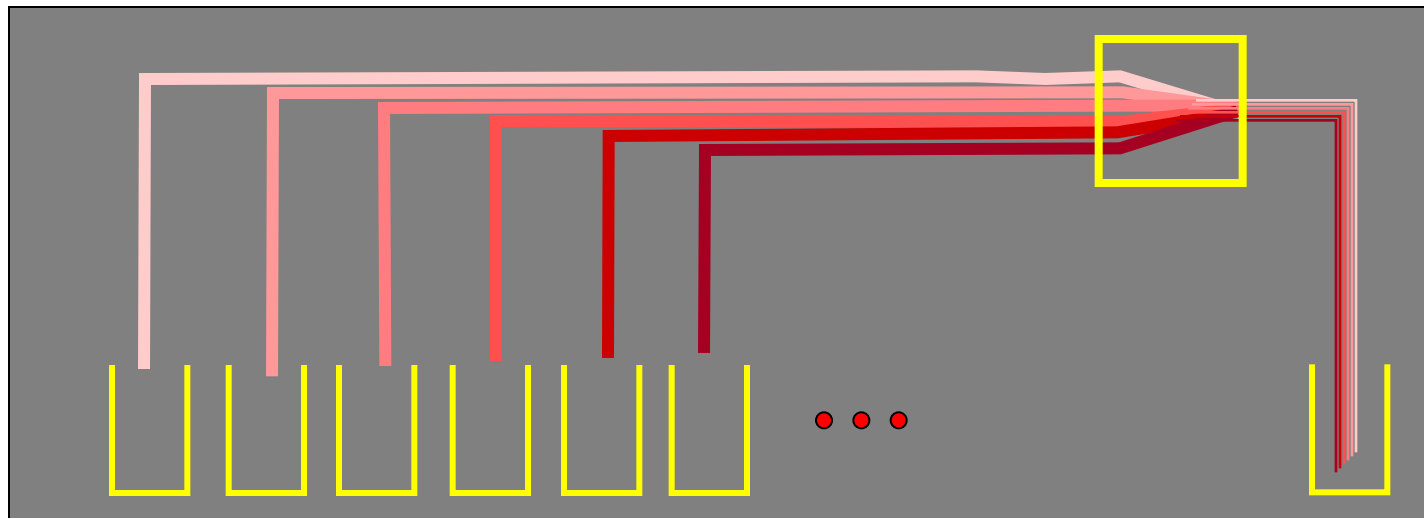
Gilling



Gilling



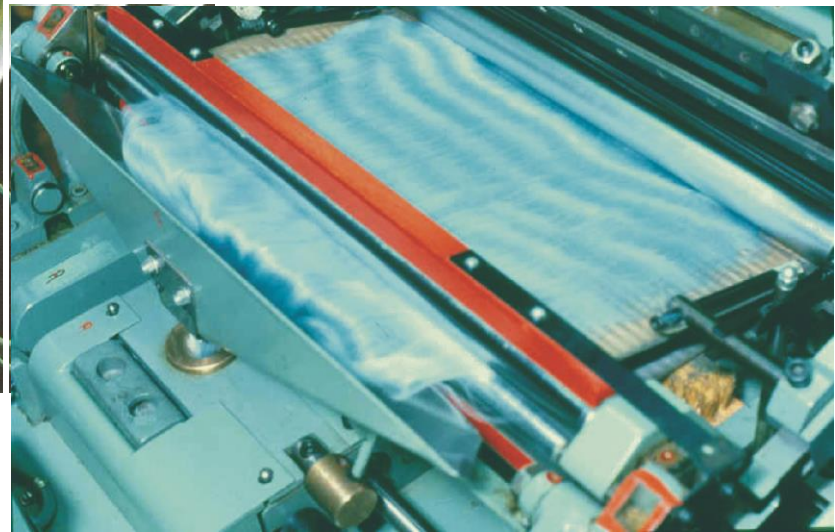
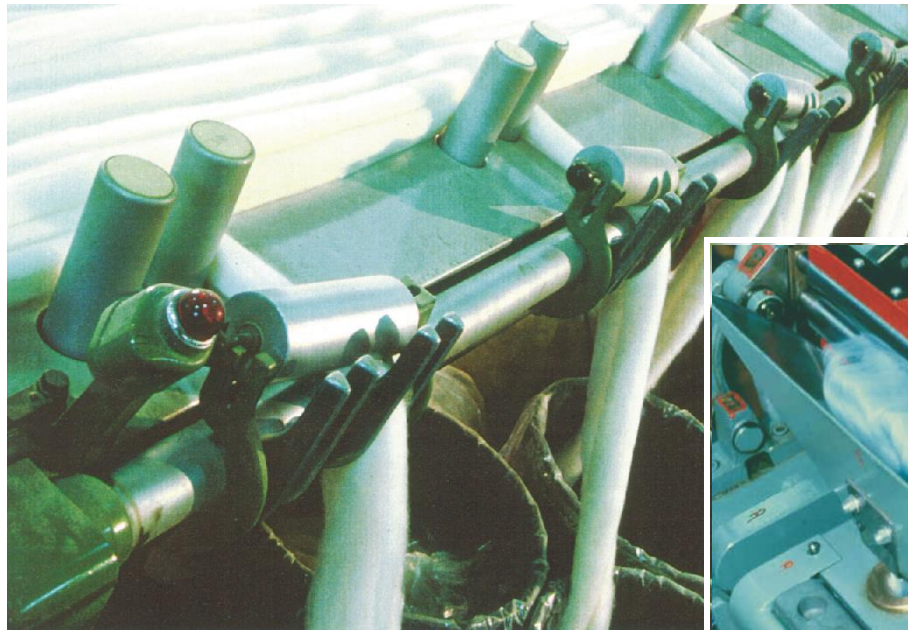
Blending in gilling and combing



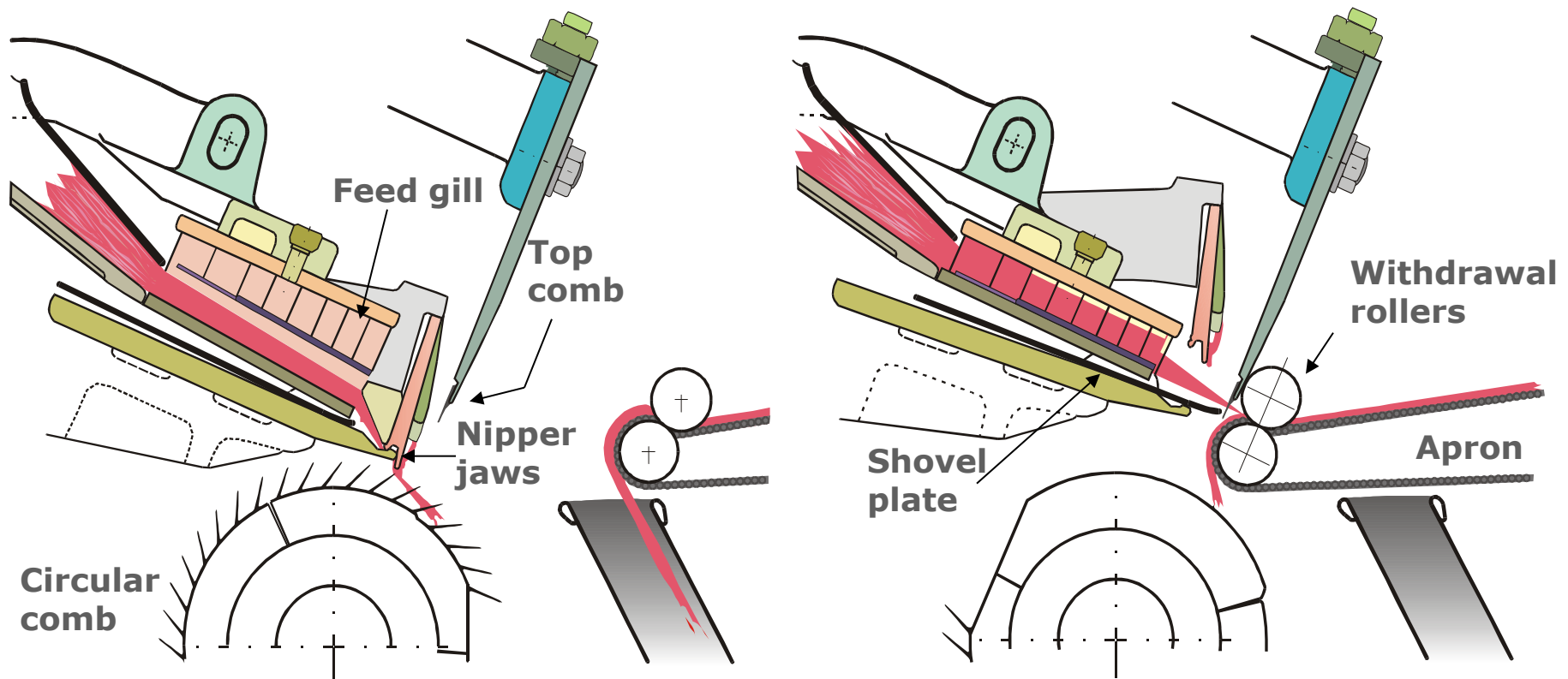
Gilling: 6 cans x 70 kg = 420 kg $\Rightarrow$ 4% lot

Combing: 20 bobbins x 50 kg = 1000 kg $\Rightarrow$ 10% lot

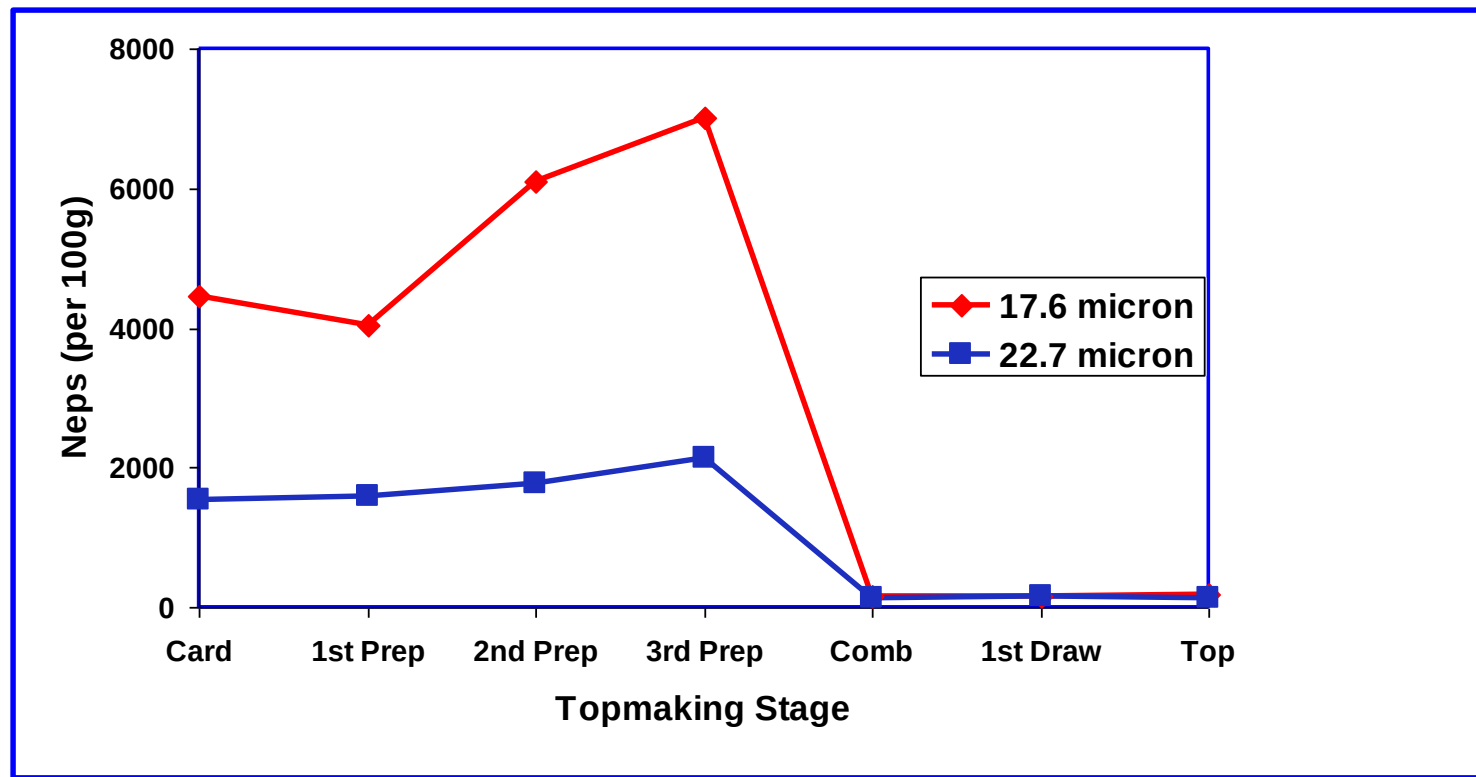
Combing



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

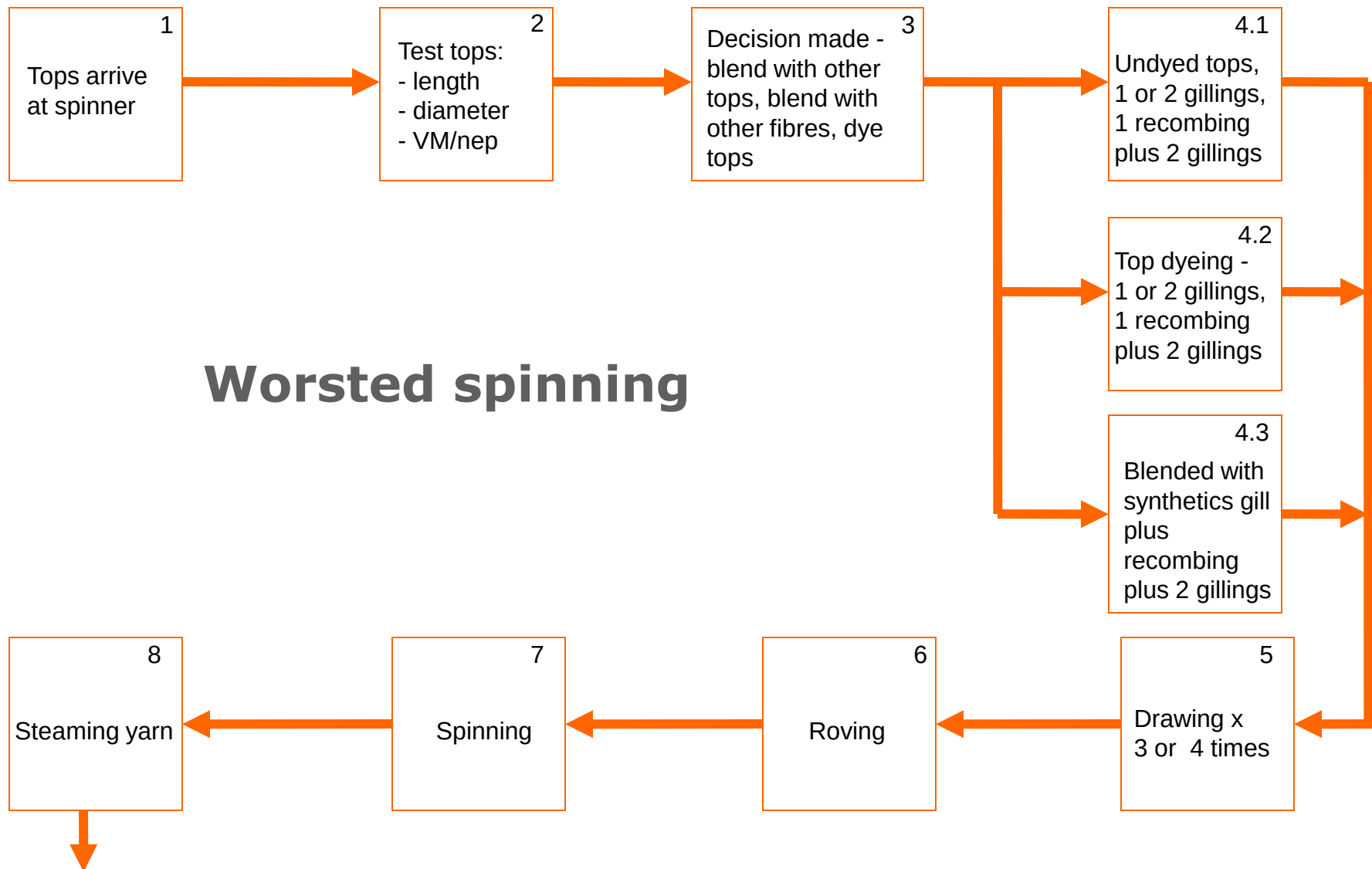
- Typically two post-comb gilling passages.
- Improve sliver cohesion.
- Improve sliver evenness (weight per unit length).
- Randomise fibre ends.
- Adjust moisture content.
- Produce top – raw material for spinner.

Topmaking as a blending process

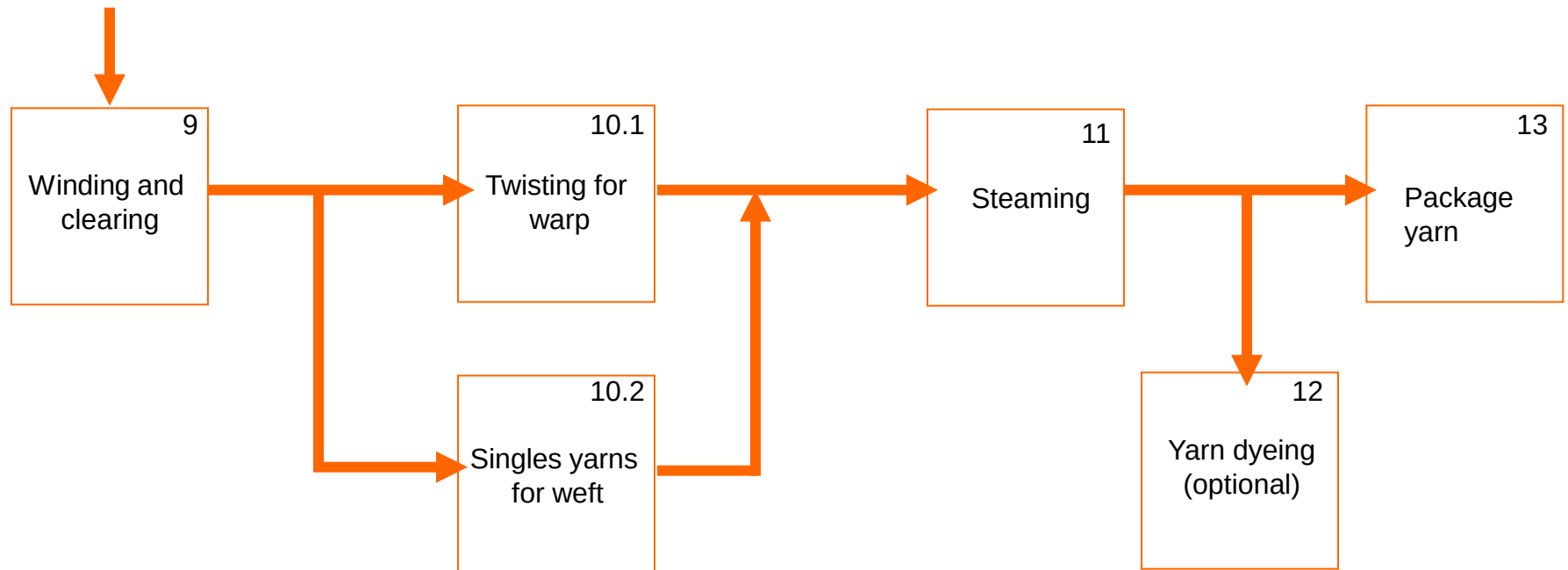
Stage	Doublings per stage	Total doublings
Preparer gilling	6	6
Second gilling	6	36
Third gilling	6	216
Combing	20	4320
Finisher 1	6	25920
Finisher 2 (top)	6	155520

Worsted spinning





Worsted spinning



Worsted spinning



Worsted spinning

Steaming and winding

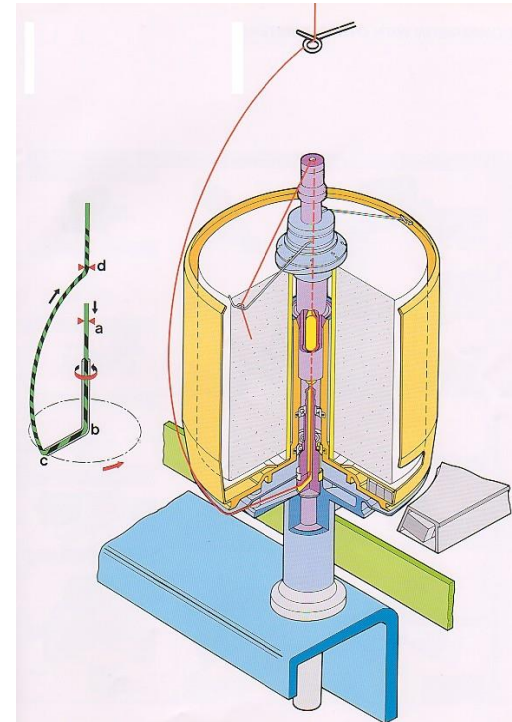


Yarn twisting

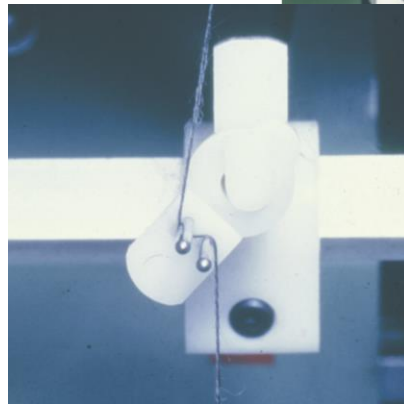
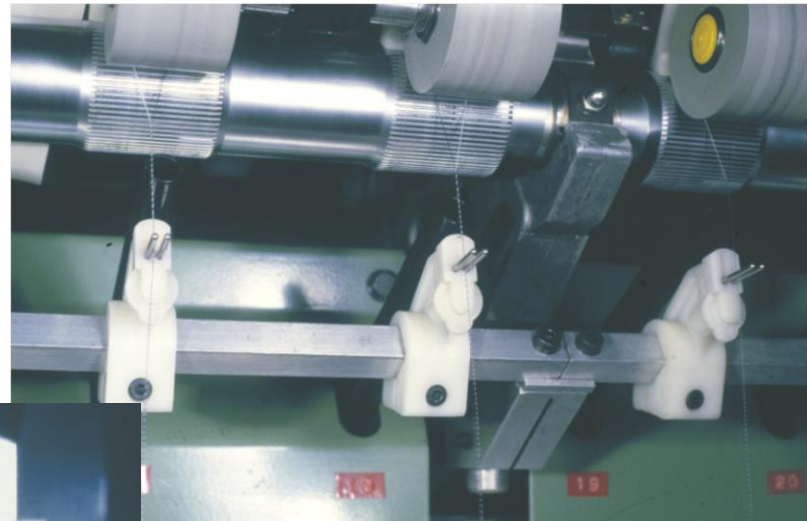
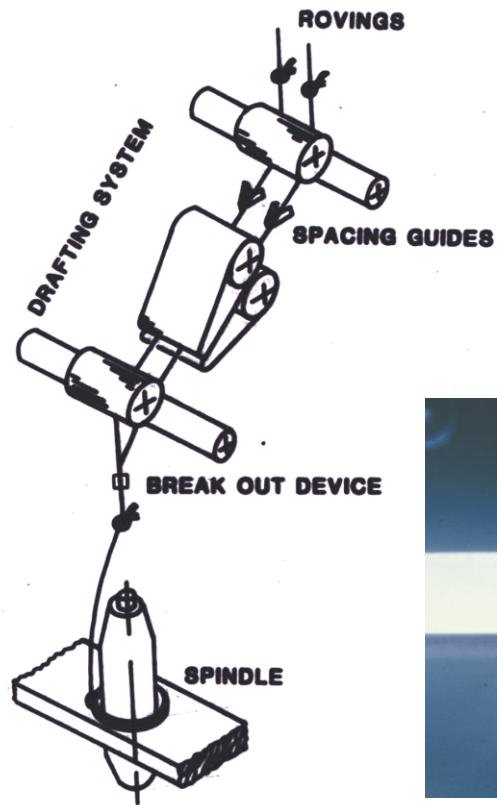
Assembly winding



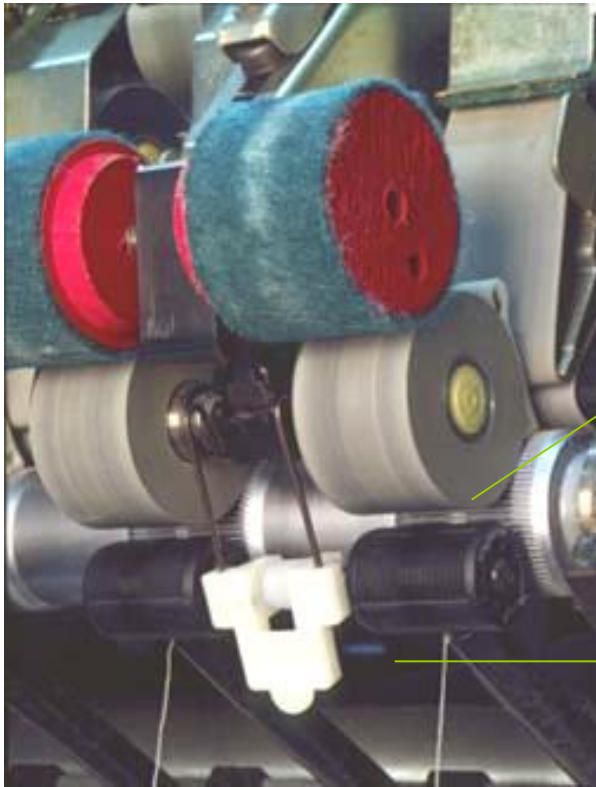
Two-for-one twisting



Sirospun



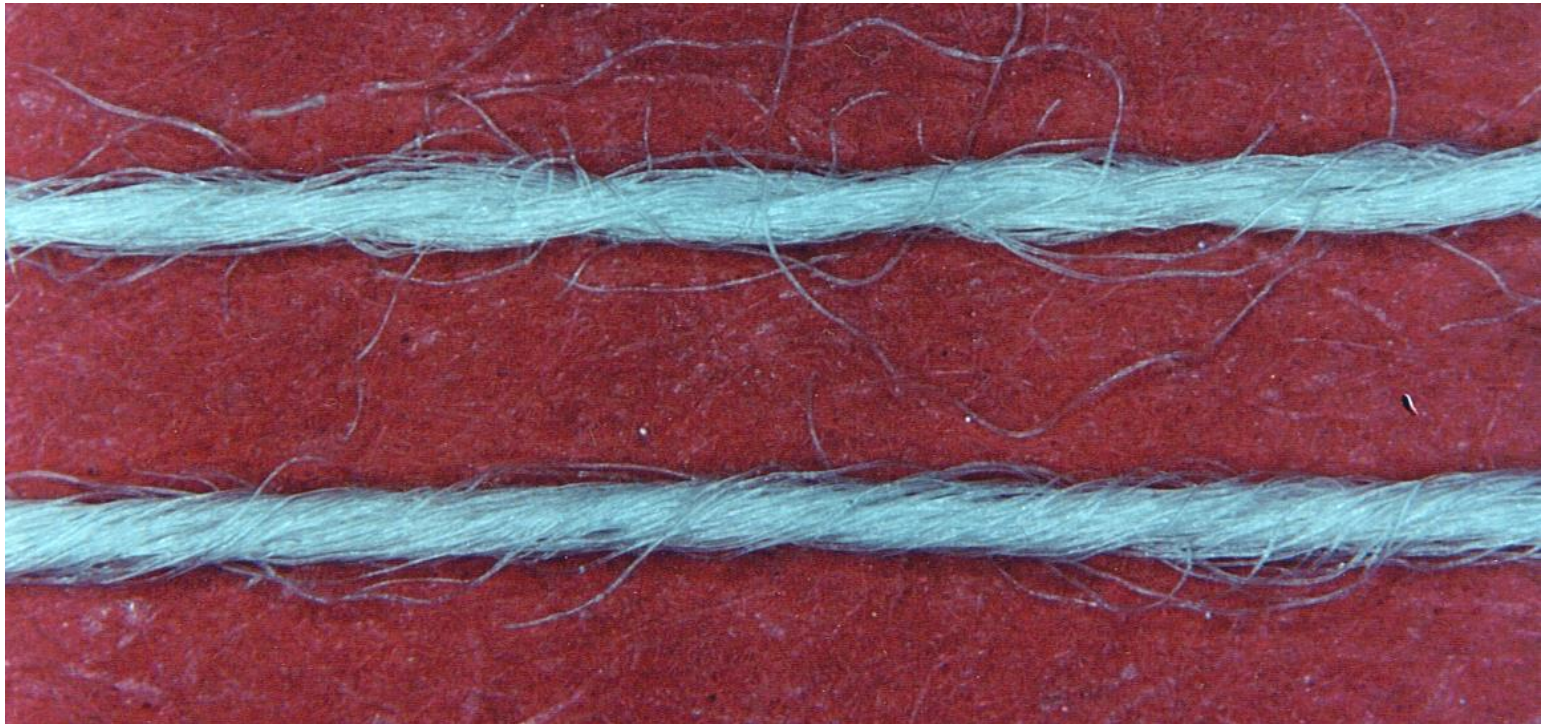
Solospun



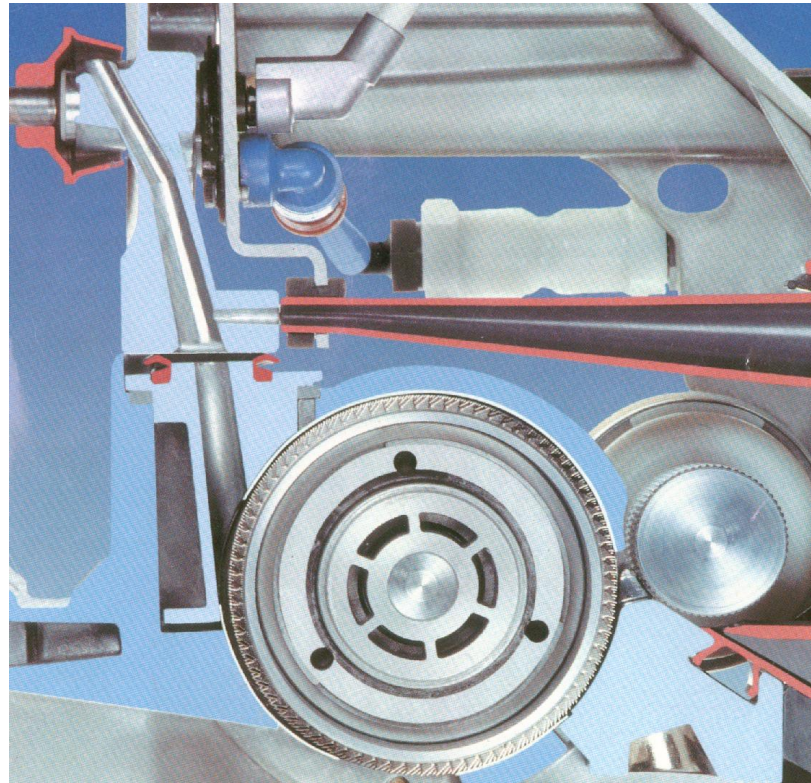
**Solospun
rollers**

**Weavable
singles yarn**

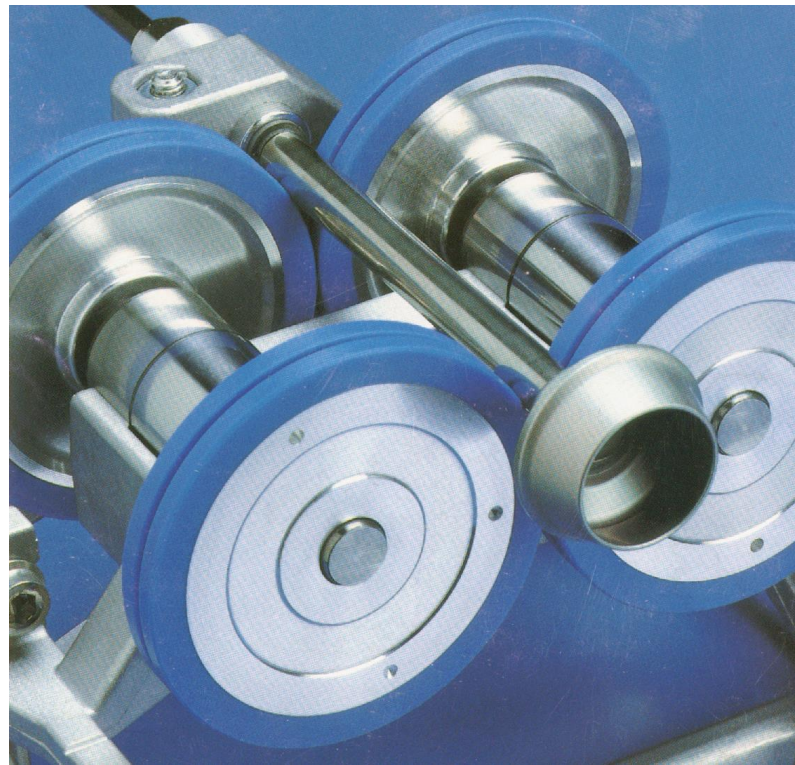
Solospun – comparison with two-fold



OE spinning layout Rieter system



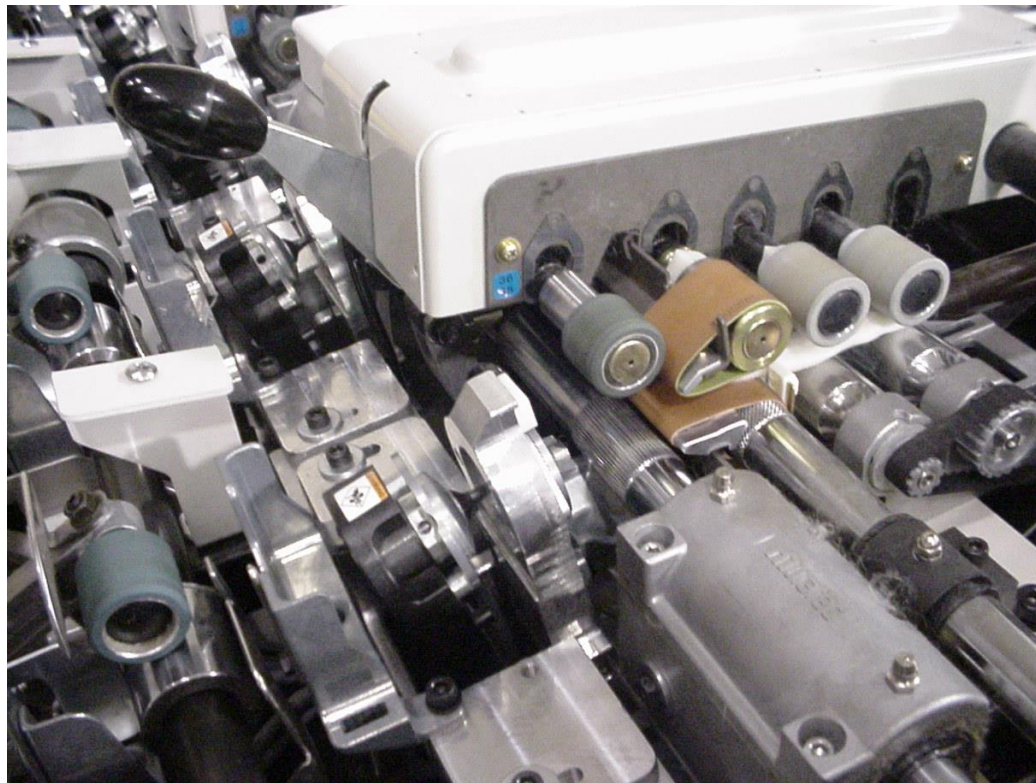
OE rotor and drive Rieter system



Open-end characteristics

- Very high twist insertion: $\sim 200,000 \text{ min}^{-1}$.
- High production speed: 500 m/min.
- High production rate: 10 g/min/station.
- Yarn not as good as ring spun $\rightarrow$ 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

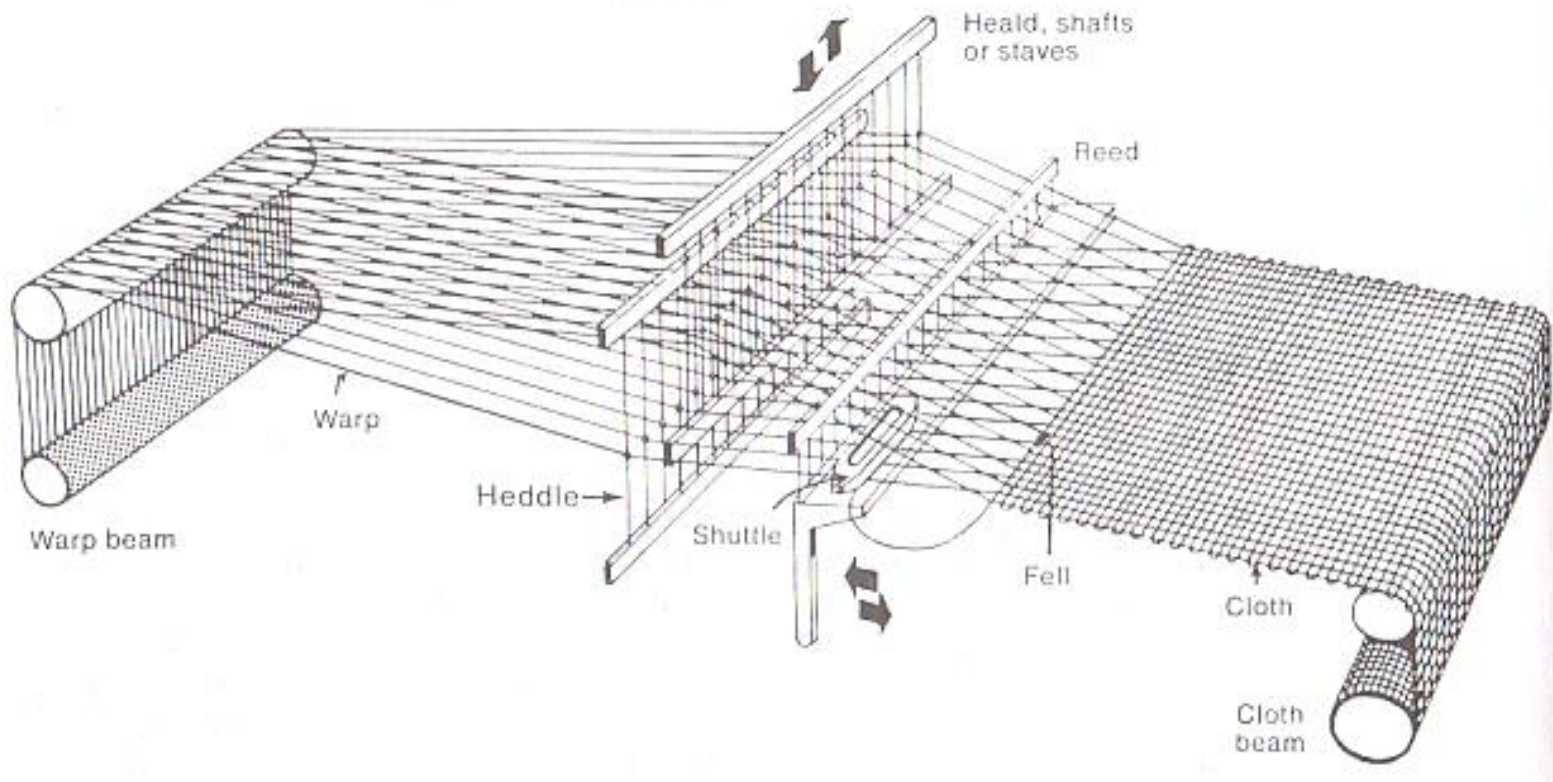
- Ring.
- Open-end (OE).
- Air Vortex and Air Jet (false twist process).

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

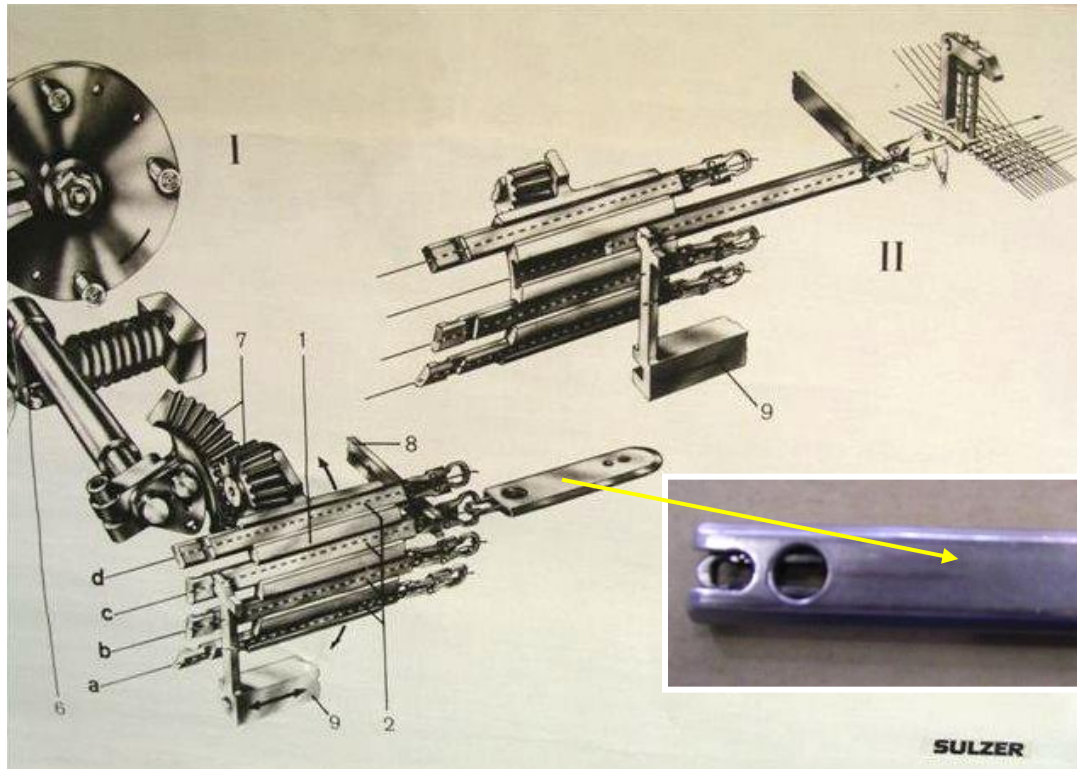


Weft insertion

Shuttle with pirn



Weft insertion



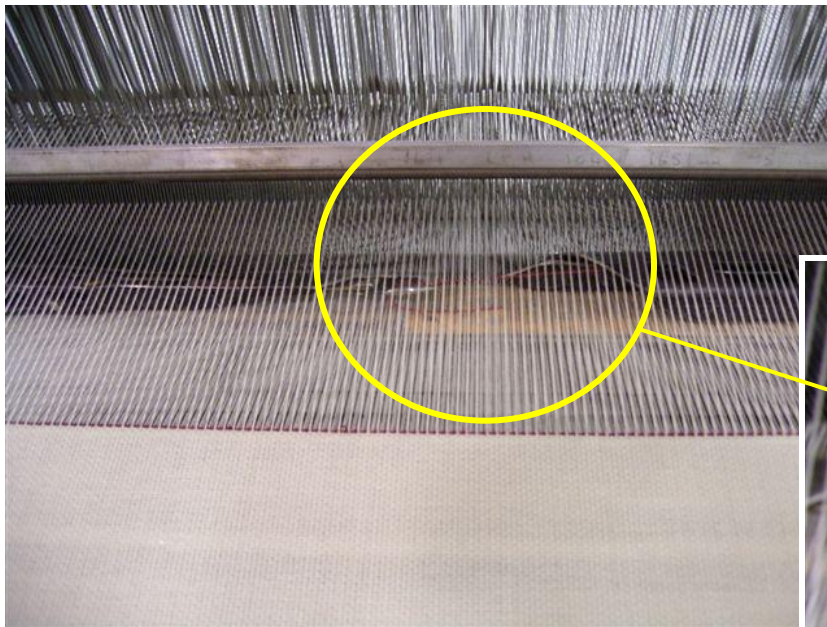
Projectile –
Sulzer system

Weft insertion

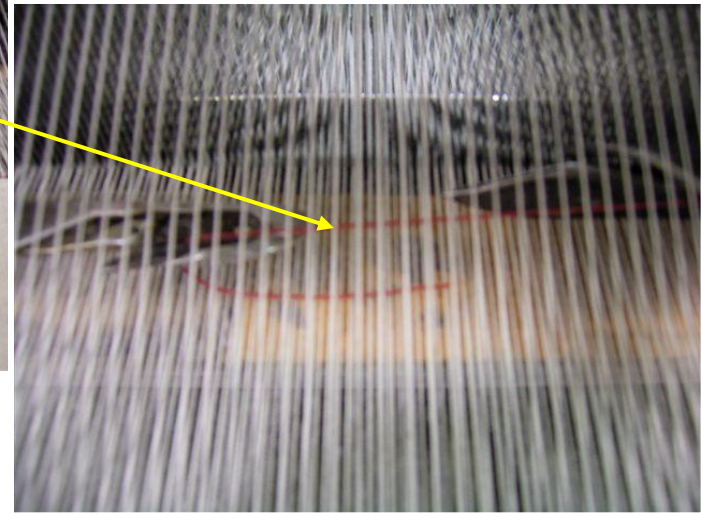


Projectile

Rapier system



Yarn transfer

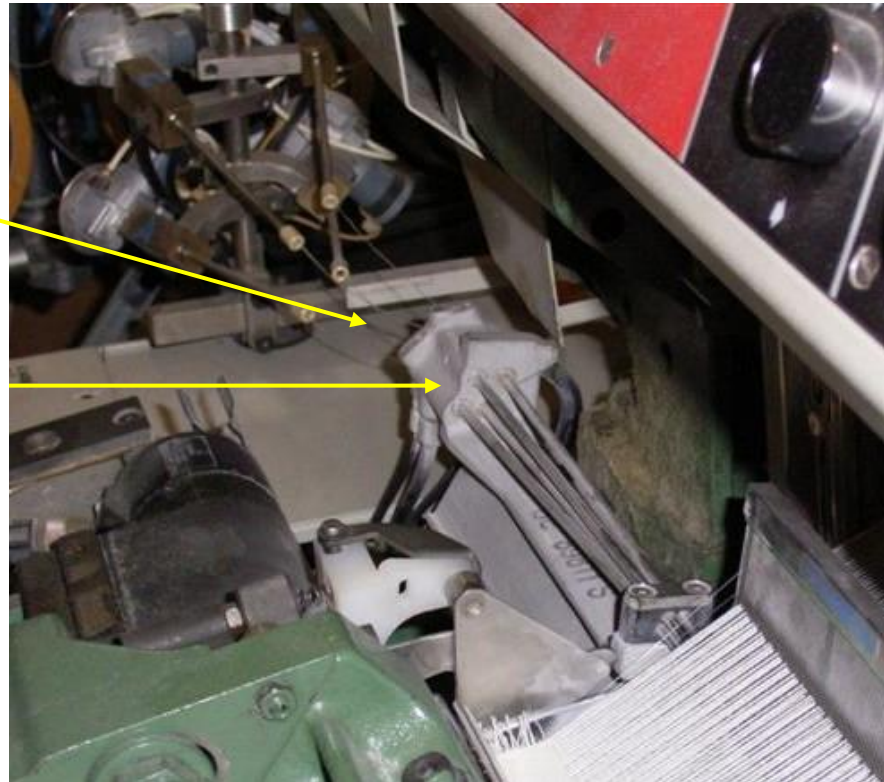


Weft insertion

Air-jet

Weft yarns

Primary air jet



Weft yarn supply



Weft yarns

**Weft yarn
accumulators (6)**

Weaving speeds

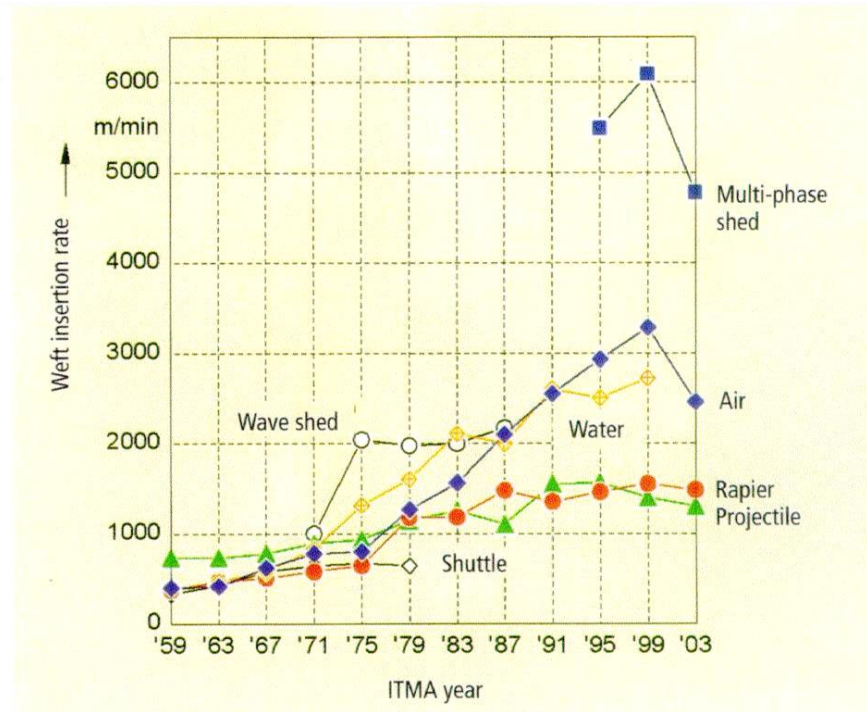


Fig. 1: Weaving machine exhibition performance. For the first time in the history of ITMA, weaving machine weft insertion speeds remained behind those of the preceding ITMA.

Illustration: ITV

Finishing and Dyeing

Worsted

Crabbing

Scouring

Stentering

Decatising

Dyeing

Shearing

Woollen

Scouring and milling

Carbonising

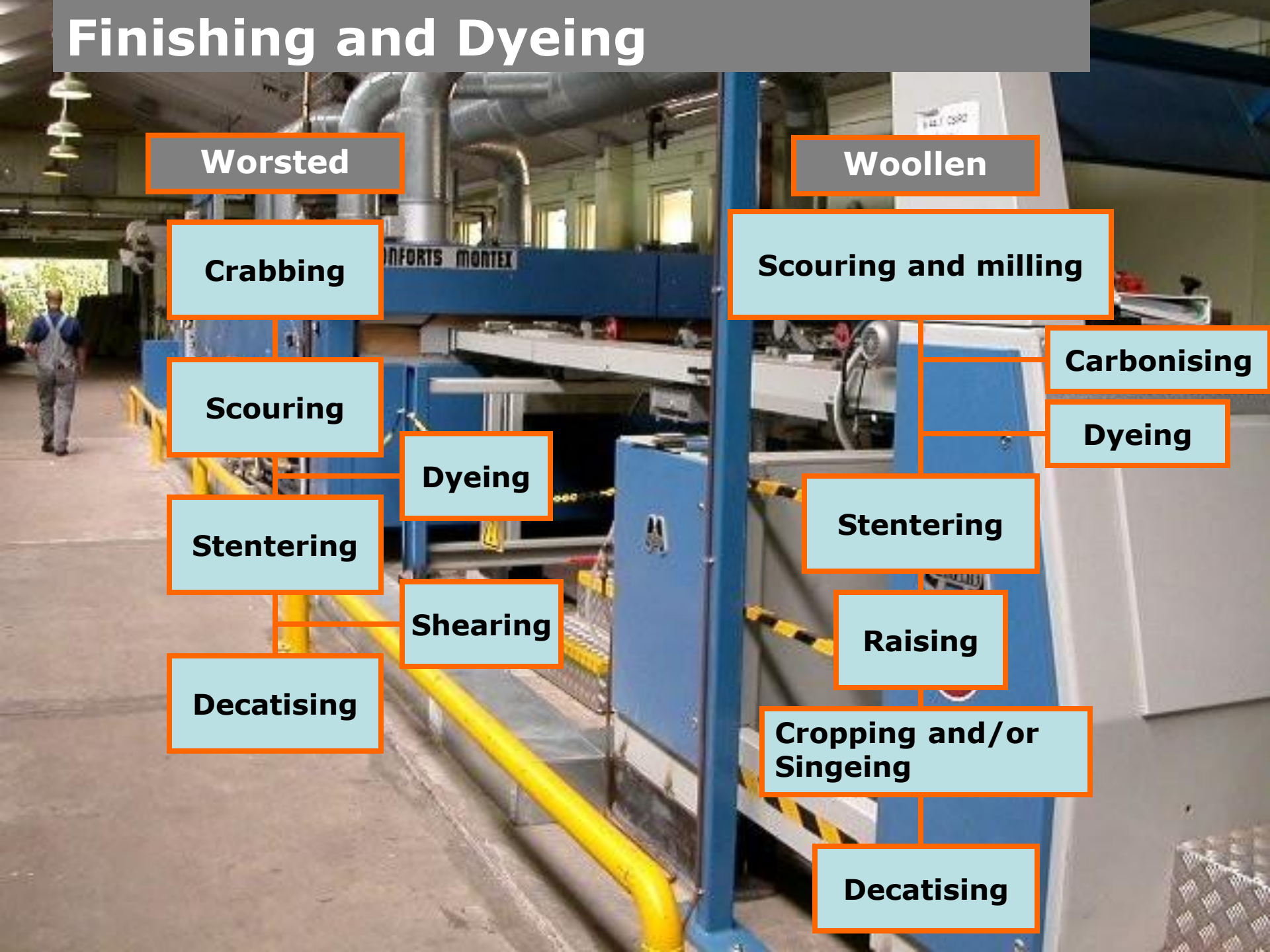
Dyeing

Stentering

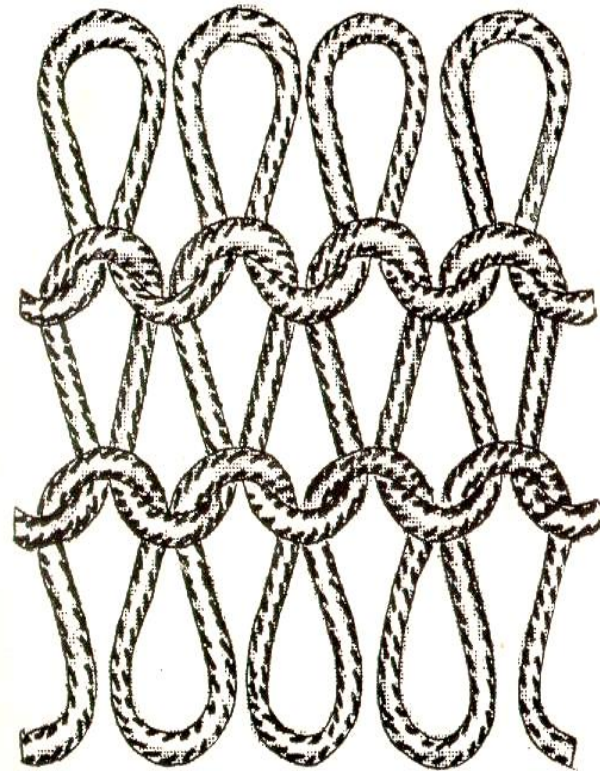
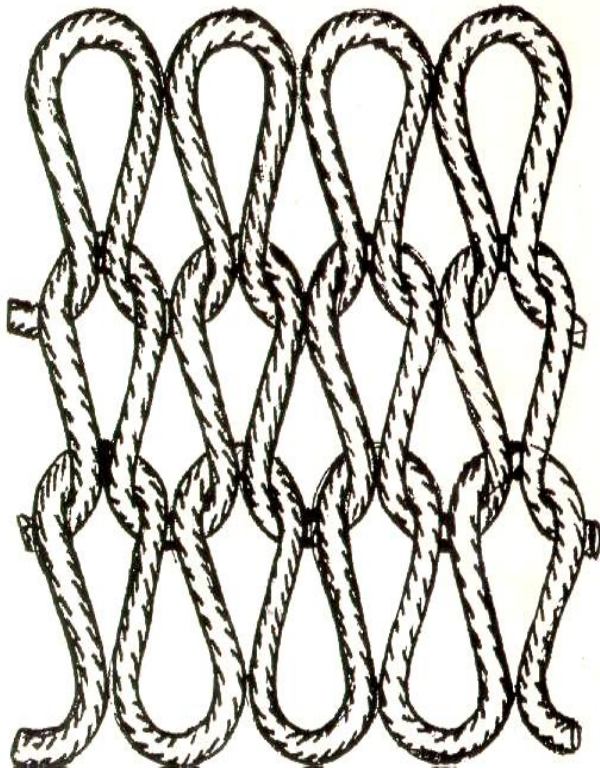
Raising

**Cropping and/or
Singeing**

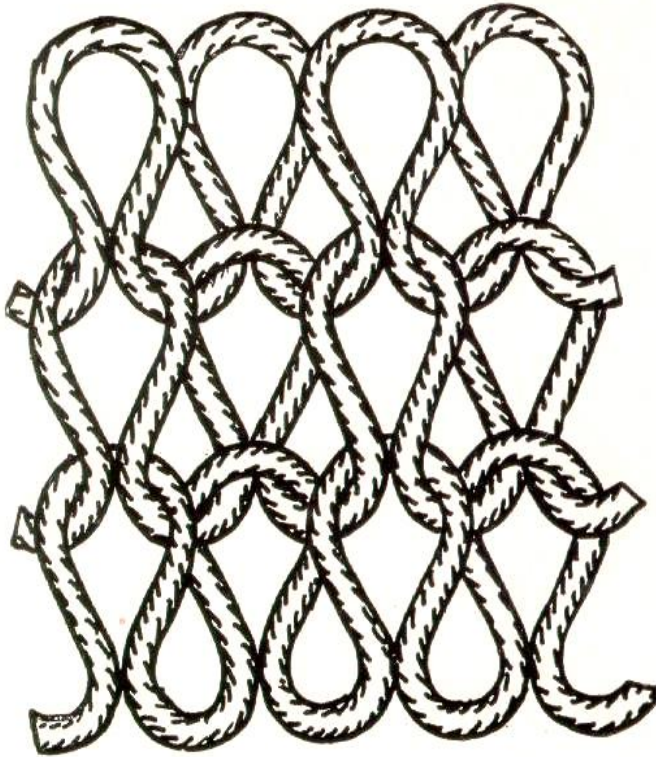
Decatising



Plain weft knit fabric



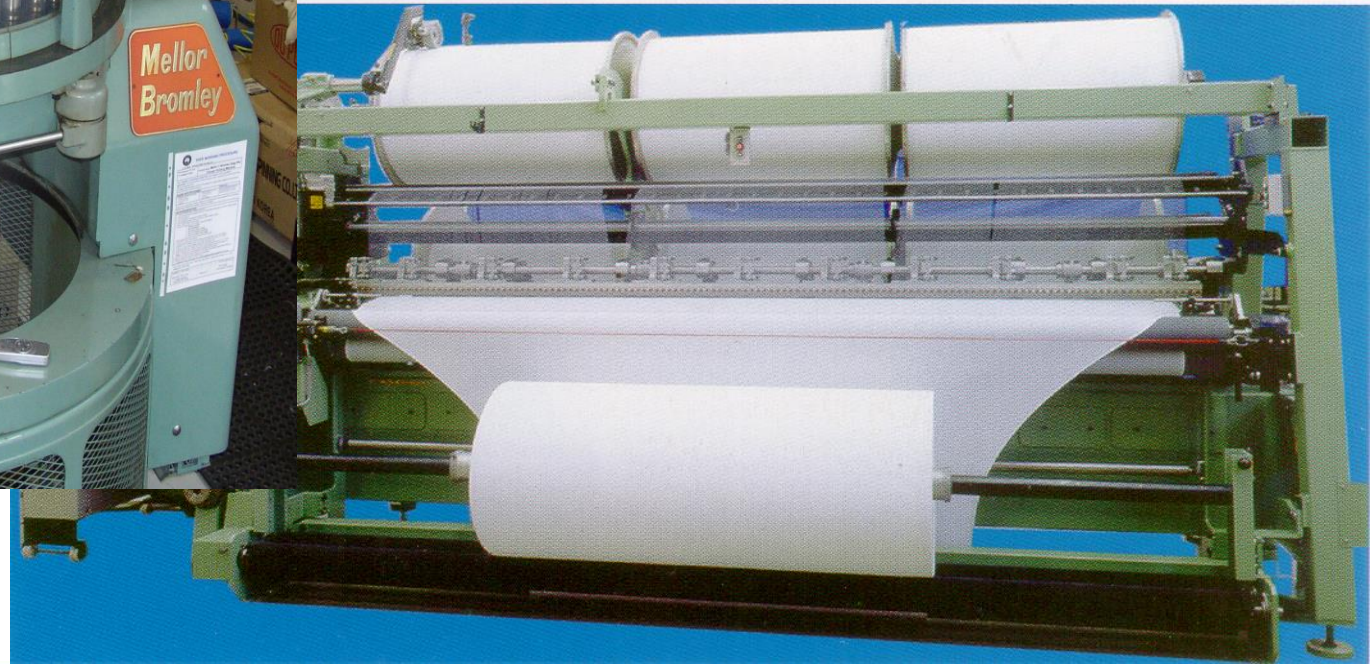
Weft knit rib knit or 1x1 rib



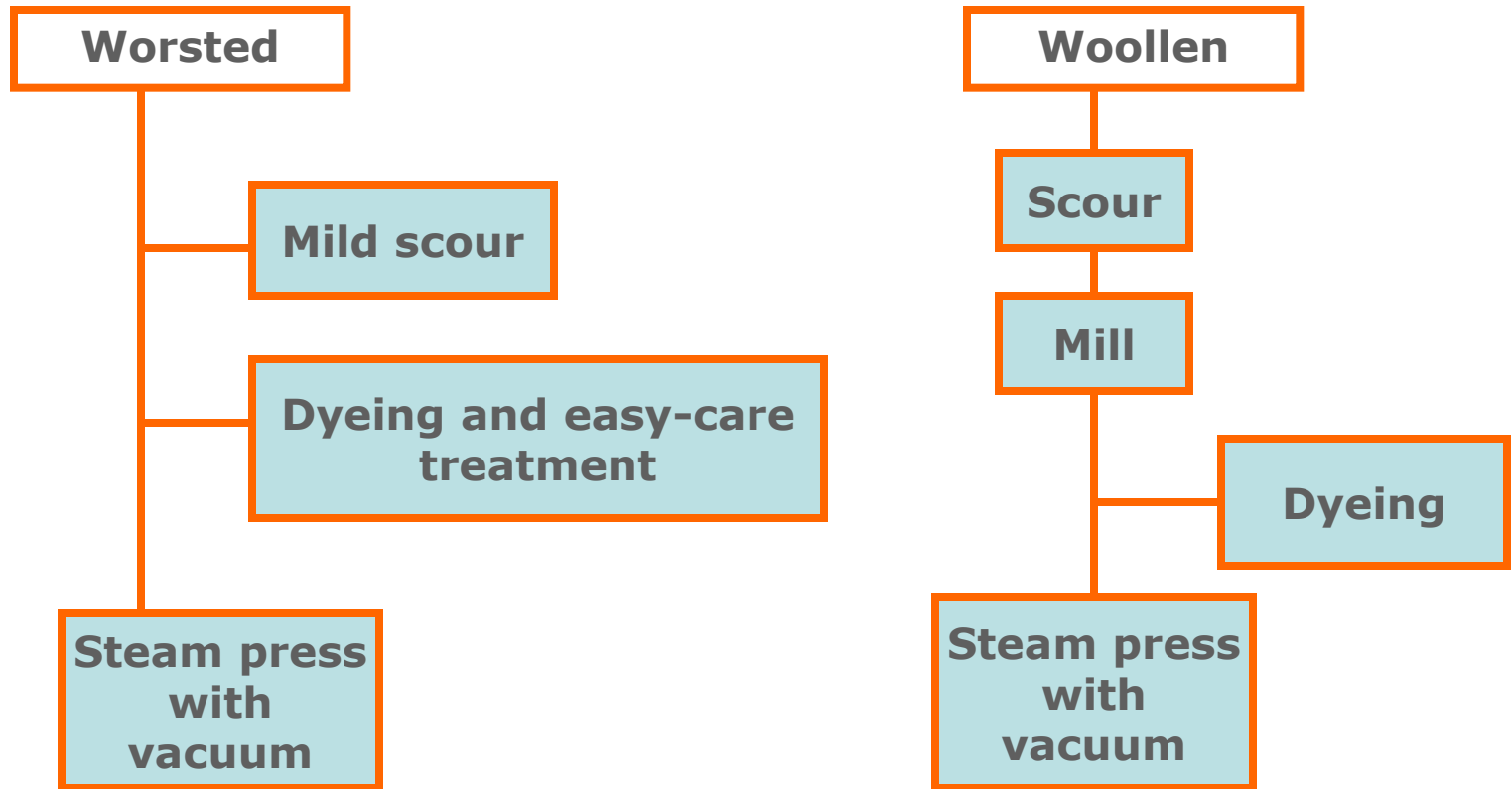
Circular knitting



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.