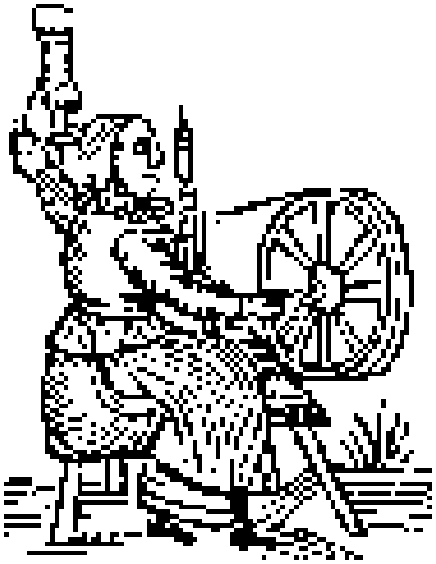
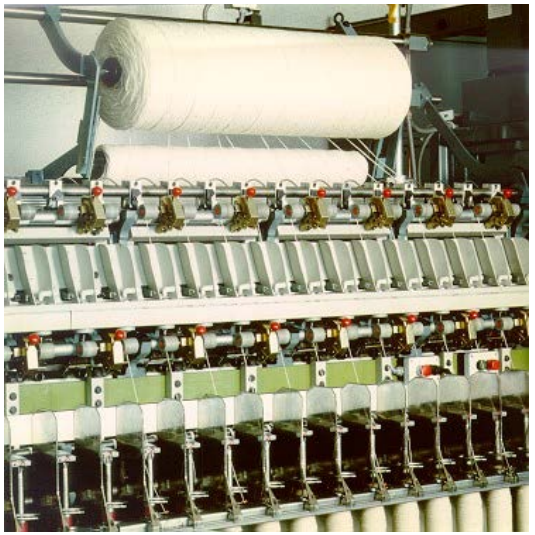
Wool spinning





Ing. Eva Moučková, Ph.D.

Department of Textile Technologies

Dividing of spinning mill, yarn characterization

Technological equipment of wool spinning mill corresponds to processed fibres and produced type of yarn. Spinning mills can be divided into:

- woollen spinning mills
- worsted spinning mills
- semi-worsted spinning mills
- spinning mill of non-conventional technology

Woollen yarns are produced from shorter fibres. Yarns are thicker (50 – 170 tex), hairy, fluffy, less even. They are used on fleece, tweed, woollen cloth, furnishing fabrics, carpets, etc.

Worsted yarns are fine (12,5 – 80 tex), even, smooth. They are used for production of suiting, knitting yarns, dresswear.

Semi-worsted yarns are produced usually from 100% chemical fibres. They have middle count (68 – 100 tex). Yarns are used on blanket, plush, furnishing fabric, carpet, etc.

Yarn characterization

Rotor yarns are spun usually from chemical fibres. Yarn fineness is between fineness of woollen and worsted yarn (20 – 170 tex). They are even. They are used for upholstery and furnishing fabric.

Yarns spun with non-conventional systems (for example yarn Dref, Repco, etc.) has properties given by the spinning system. These properties predetermine yarns for specific utilization.

Waste (vigogne) yarns are made from a waste (usually cotton), secondary textile raw materials. They are spun by woollen technology. They are coarser (84 – 2000 tex), less even. They are used on dust-cloth, wash-cloth.

Fibres processed in the woollen, worsted and semi-worsted spinning mills

Wool fibres, chemical fibres – viscose, polyester, polypropylene, polyacrylonitrile, secondary textile raw material

Wool fibre

- Natural animal fibre usually obtained by shearing sheep

1) Merino wool

a) Australian (Aie) – high quality, only for worsted yarn

b) South-American (JAS) - less fineness compare to Australian, higher elasticity

c) South African (JAJ) – fine, good felting property – used for felt products

2) Crossbred wool

- From New Zealand, South America
- Worse quality compared with merino wool

3) Coarse wool

Chemical fibres

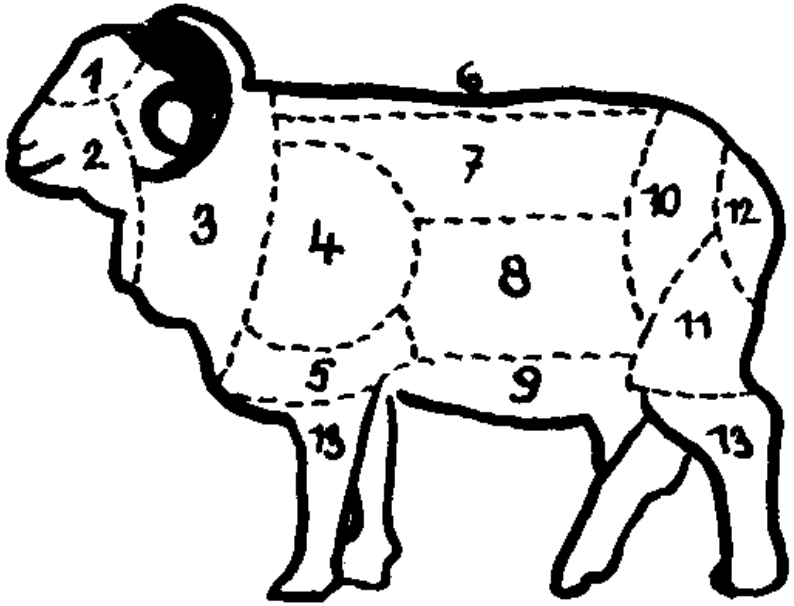
- They are processed chemical fibres adapted with length and fineness to wool fibres. There are especially: viscose, polyester and polyacrylonitrile fibres.
- Fibres are processed either in form of staple fibres or in form of tows.
- Tow of continuous filaments is processed by means of a **converter** technology.
- These fibres can be spun separately or can be blended with wool or among each other.

Secondary textile raw materials

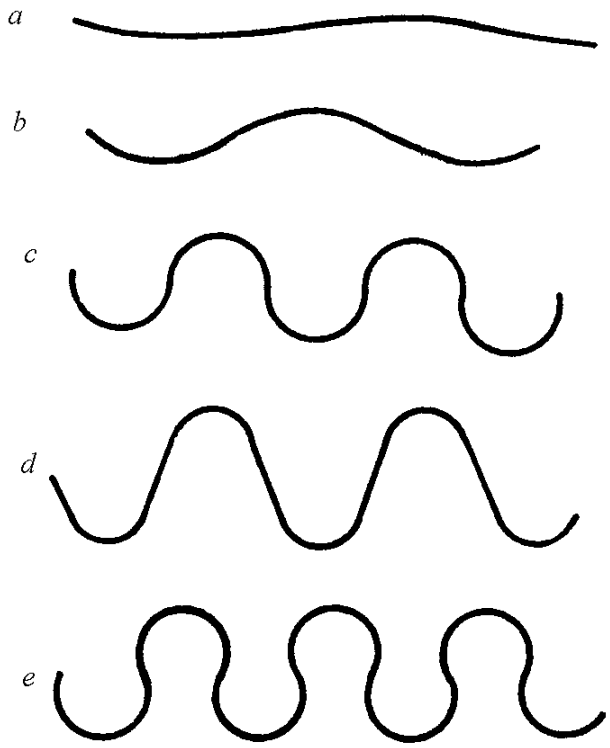
- These raw materials are obtained by means of processing waste textiles (noils from the combers or ragged and defibered technological waste from clothing industry.
- There are spun by woollen technology.

Main characteristics of wool

- Wool from sheep fleece is sorted into grades according to its quality – especially according to length, fineness, colour, crimpiness, evenness, degree of pollution, etc.

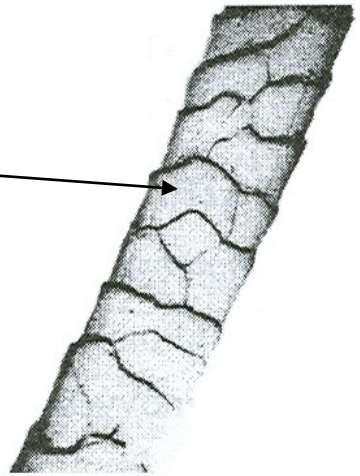


- Wool of the best quality is on sheep's hips and shoulder blades (4, 5, 7, 8).



Various degrees of wool crimpiness

Important wool fibre characteristics:



Surface of wool fibre is formed with scales.

Wool fibre fineness

- Usually expressed as a diameter of wool fibre in μm
- Average value: merino wool: 16 – 24 μm
  crossbred: 25 - 35 μm
  coarse wool: more than 35 μm

Wool fibre length

- Average value: merino wool for worsted yarn: ca 60 mm, max 100-150 mm
  crossbread wool: 80mm, max 180 – 200 mm

Wool fibre fineness is related to its length, crimpiness, handle. Finer wool is shorter, coarse wool is longer. Wool crimpines is important property in the case of merino wools (fine wool is more crimped than coarse wool). Some crimping contributes to good wool spinnability. Too high crimpiness of fine wool fibres used for the production of fine worsted yarns must be eliminated - by means of finishing tops - backwashing.

Structure of wool fibre influences lustre. Coarse wools are more lustrous compared with fine wool.
Wool fibre has white colour. Yellowish and greyish tint means lower wool quality.

Wool fibre elasticity favourably influences utility value of final textile. Elasticity also influences wool felting.

Evenness of wool fibre thickness is a very important property, which shows itself in yarn mass irregularity:

$$CV_{lim} = \frac{100}{\sqrt{n}} \sqrt{1 + 0{,}0004\, v_d^2}$$

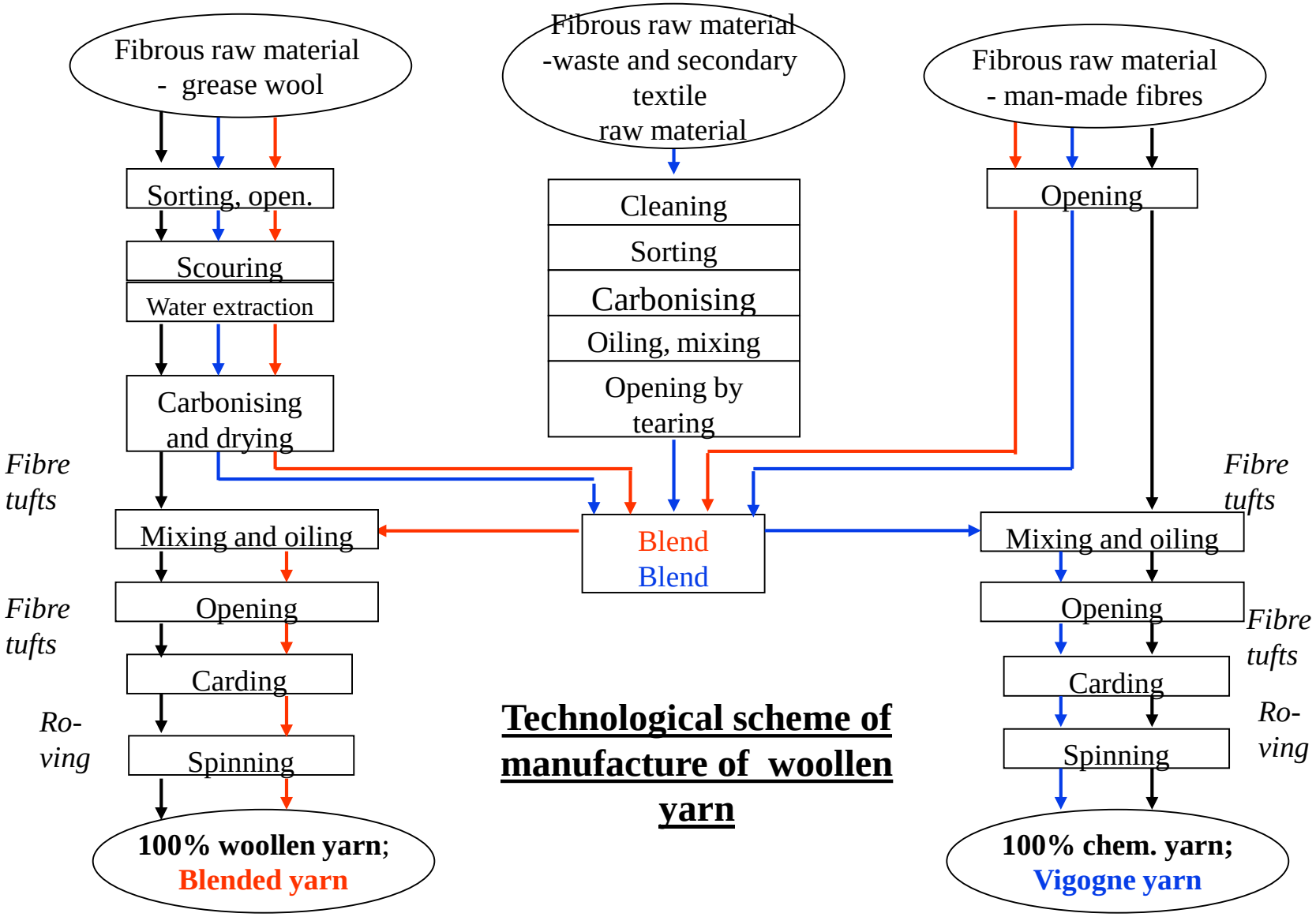
CV_{lim}.. ... limiting square mass yarn irregularity [%]
n … ….. average number of fibres in the yarn cross-section
v_d ……. coefficient of fibre diameter (20-28 % for wool fineness 19 –31 μm)

The most important **fibre characteristics** for **spinning** process are **fibre length** and **fineness**.

Impurities in wool fibres

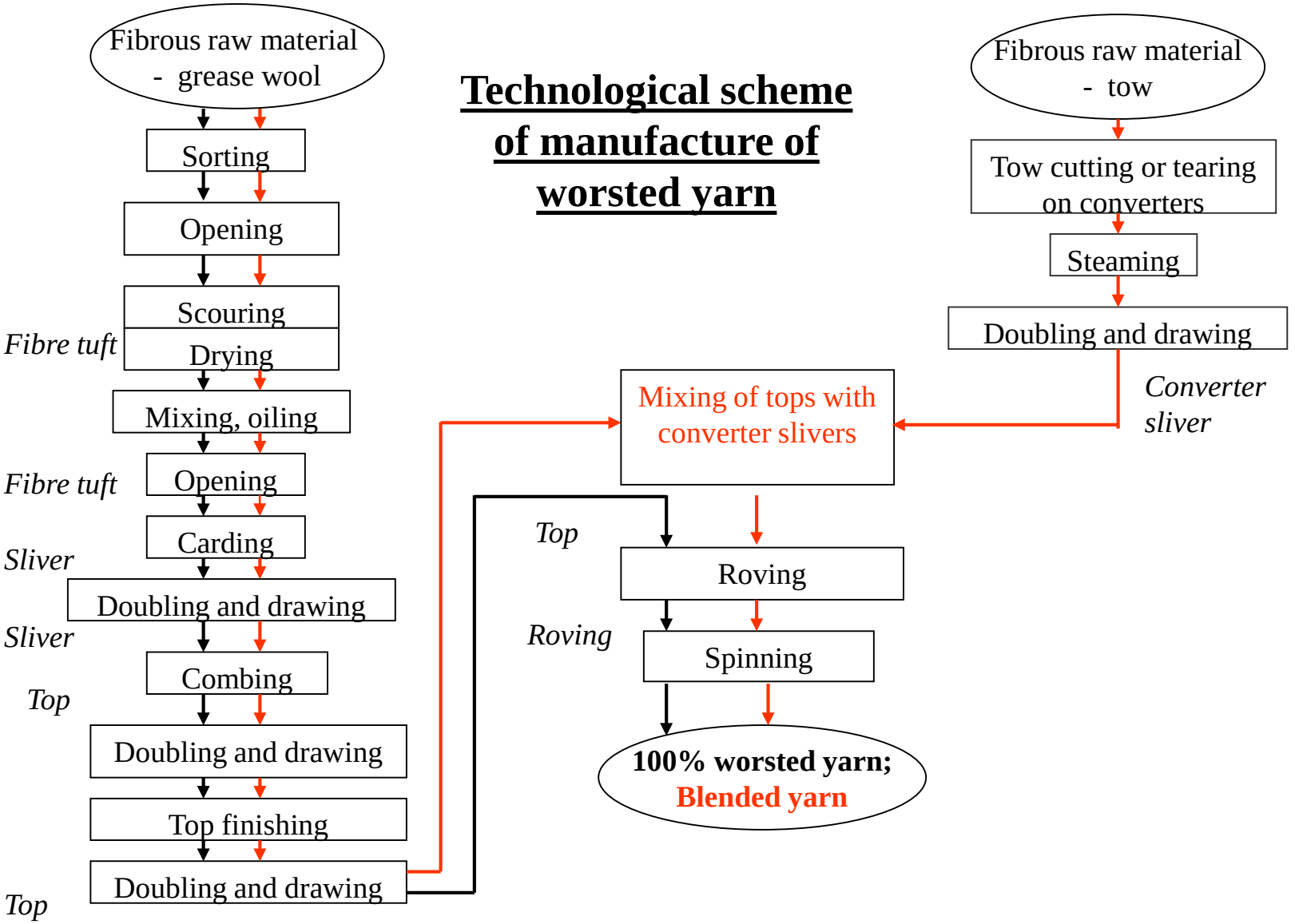
- **Wool grease, sheep's suint and carbamide (urea) –** are removed by means of scouring; the lanolin is obtained from the wool grease
- **Vegetable impurities (burrs)** – are removed either mechanically - **de-burring and combing** (worsted technology) or chemically – **carbonising** (woollen technology)
- **Inorganic impurities (sand, dust)** – are eliminated during scouring (washing)

Content of impurities in wool is various, finer wool is more polluted.

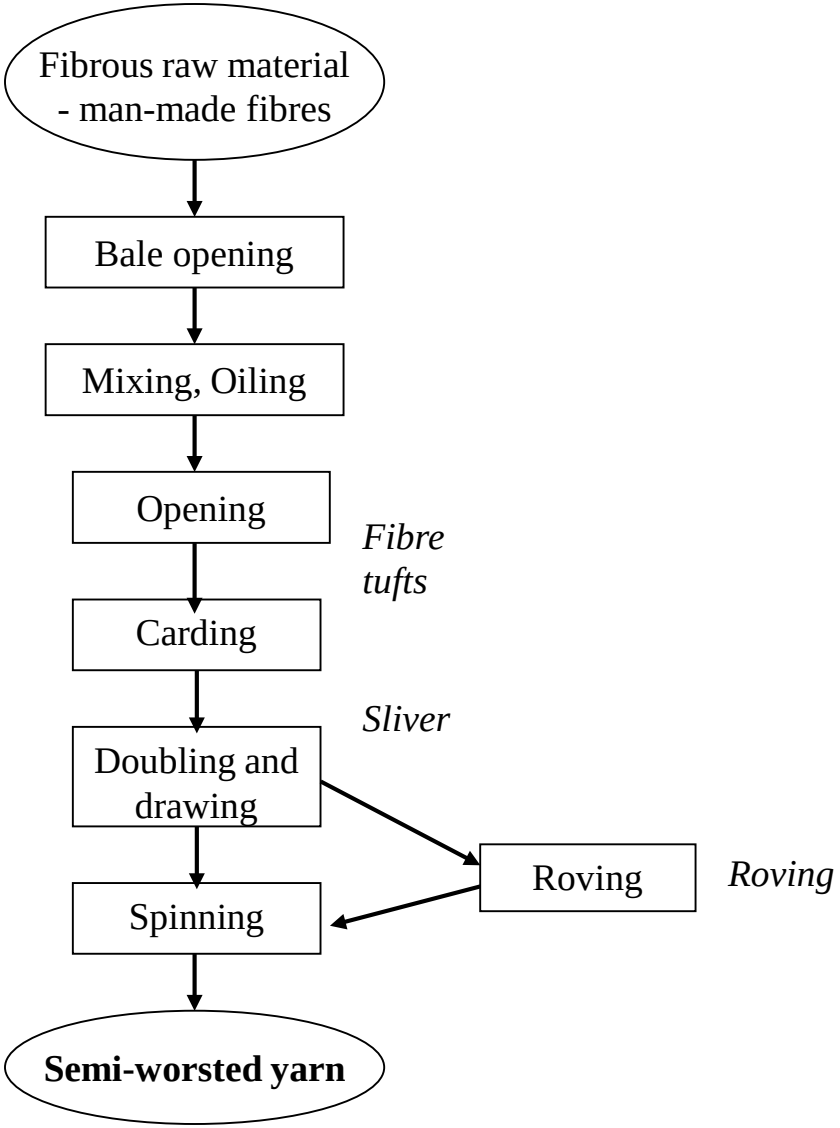


Technological scheme of manufacture of woollen yarn

Technological scheme of manufacture of worsted yarn



Technological scheme of manufacture of semi-worsted yarn



Wool fibre pre-processing

Wool fibre pre-processing includes these operations:

Sorting, classifying, grading
Opening
Cleaning - scouring + carbonising (woollen sp. system)
scouring + then de-burring on the roller card (worsted sp. system)
Drying
Opening, mixing, oiling

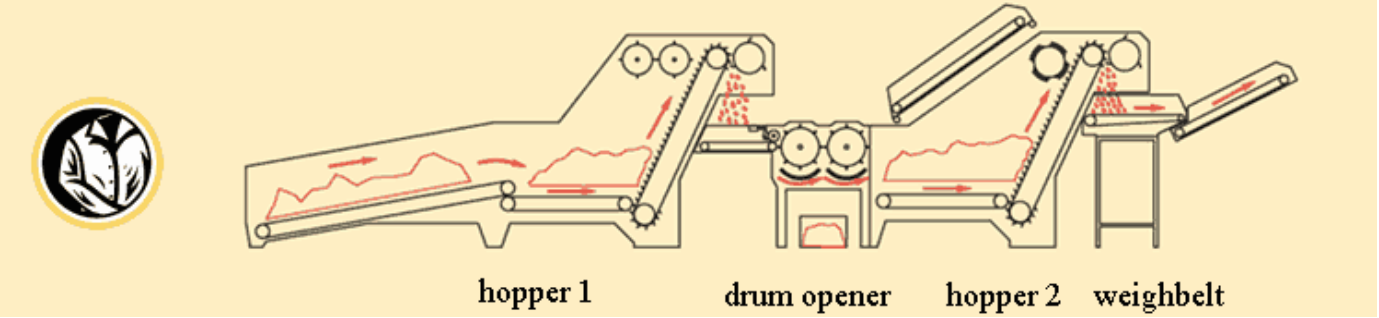
Unlike cotton fibre preparation, mechanical and chemical processes are used for wool fibre cleaning.

Sorting, Classifying, Grading

- Individual parts of the wool fleece are separated according to specified quality (usually by **hand**, rarely it can be done by a machine – only coarse wool) .
- **Hand sorting** - a fleece is spread out on the perforated table, a worker tears individual parts and gives them into the baskets according to their quality – usually there are 3-8 classes for worsted yarn and 2-5 classes for woollen yarn.
- Sorted wool is checked, weighed and deposited in the special boxes according to spinning lot.

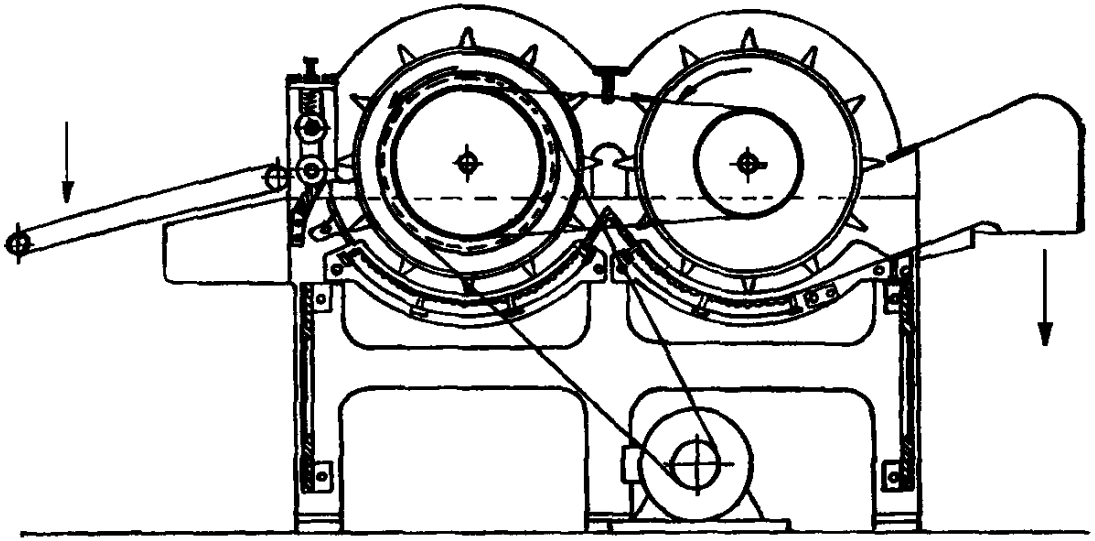
Opening

– Opening large fibre tufts into smaller. It is realized by means of the opening machine or special bale openers.

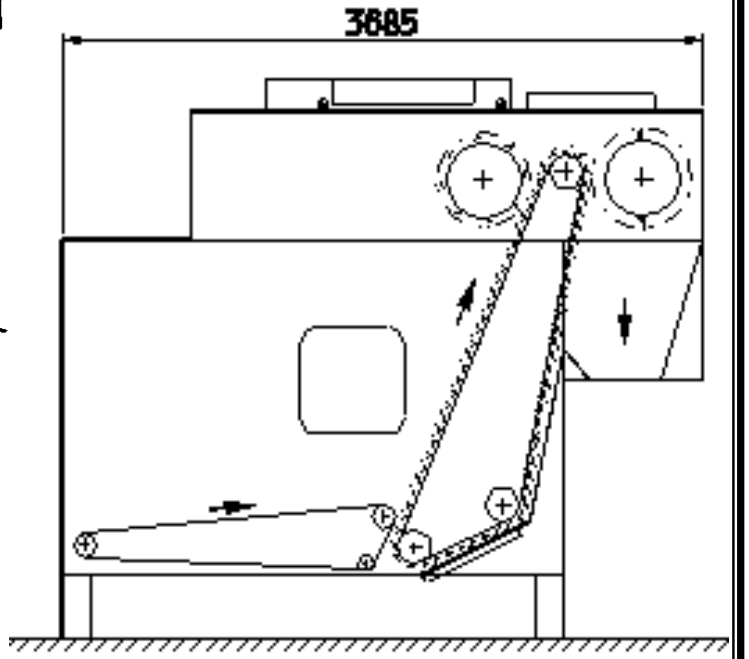


Drum opener with hopper feeders – Andar

Opening machine



Double-drum opener



Bale opener TEMAFA

Cleaning

- Removing impurities

As wool fibres contain different impurities compared with cotton (wool grease, sheep's suint) that is not possible to remove mechanically, the chemical cleaning must be done. Wool cleaning includes ***scouring (washing)*** and ***de-burring.***

a) Scouring

- Elimination of all mineral impurities (dust, sand) and sheep's suint; vegetable impurities and wool grease are removed partially - wool grease is extracted to the defined limit (0.5-1 %) to next processing be possible. Without grease the wool fibre is fragile and might break during following processes.

Scouring: solvent scouring

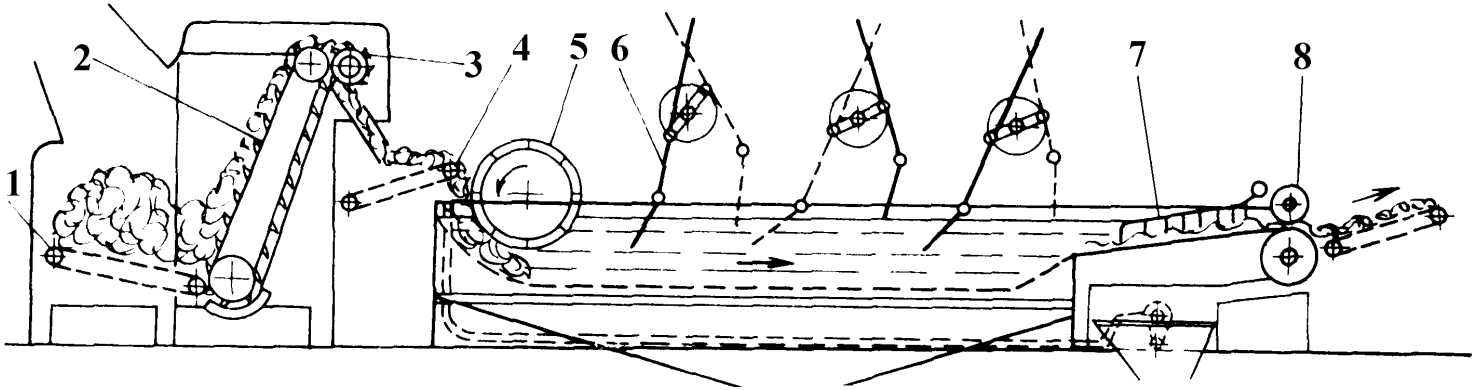
emulsion scouring – the most widely used

Emulsion scouring

- It is realized on the scouring machine called a leviathan. It is a set of scouring bowls (4-5). Bowls contain scouring liquor. There is usually done:

- Soaking (1st bowl)
- Main washing (2nd - 4th bowl)
- Rinsing (5th bowl)

- Between each two bowls there are squeeze rollers to squeeze out the excess liquor.



1 – loading belt; 2 – spiked lattice; 3 – stripping roll; 4 – feed belt; 5 – ducker; 6 – conveying rake; 7 – elevator; 8 – squeeze rollers

Scheme of first scouring bowl of the machine LEVIATHAN

Emulsion scouring

The wool is fed from a hopper into the first bowl, a rotary immersion drum (a ducker) immerses the wool. Wetted-out wool is then moved slowly forward, toward opposite end of bowl by a set of rakes. The pressure rollers at the delivery end of each bowl squeeze the liquor from the wool.

- Counter-flow washing system is applied there – clear water is fed into the last bowl and flows counter the direction of travel of the wool.
- There is used an alkali washing – the alkali + soap are a detergent. Alkali concentration + temperature of scouring liquor is very important.
- Temperature of scouring liquor depends on sort of wool, type of bowl, speed of wool motion in the bowl, content of impurities, type of scouring detergent.
- Water temperature, amount of scouring agent and wash time usually decreases from the first bowl to the last.
- After scouring the wool fibre should keep its strength, elasticity and colour. The wool must not be felted.

Wool scouring yield, called a rendement, is in the range of 50 – 75 %.

b) Burr extraction

It is removing vegetable impurities (burrs), which are contained in wool
It can be done: 1) **chemically** – carbonising
2) **mechanically**

Carbonising

Carbonising is done during manufacture of **woollen yarn**!

a) dry carbonising – for rest of wool or waste material

b) **wet carbonising**: - principle:

1) immersion of wool in a bowl containing sulphuric acid (H_2SO_4)
2) wool drying (t = 70 – 80 °C)
3) wool baking (t = 95 – 120 °C) ⇒ to carbonise vegetable matter
(transformation of cellulose on the hydrocellulose – it is brittle, it can be removed by crushing)
4) crushing
5) shaking
6) neutralization
7) rinsing
8) drying

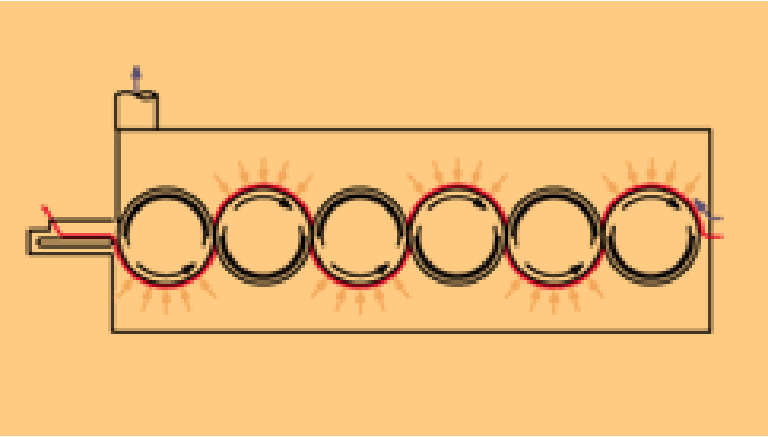
Mechanical deburring

It is done **in worsted technology**!
It is realized on the carding machine by means of de-burring device (Morel's de-burring device, Harmel's burr crasher). Removing of vegetable matter can be done also during combing.

Drying

- After scouring and carbonising the wool contains high amount of water (60-80 %). It is necessary to decrease moisture in the wool on target value of 17 % at the exit of dryer.
- Wool drying by means of the drying machine is based on ability of drying air to receive water

Drying machine:
- Suction drum dryer
- Conveyor dryer



Drum drying machine (by Andar)

Opening + blending + oiling

The tasks:

- Opening fibre flocks into smaller
- Fibre blending is done for many reasons:
  - To produce uniform product – to obtain consistent yarn properties (mechanical properties, less yarn mass irregularity, uniformity of count as well as colour or shade).
  - To reduce production costs.
  - To enhance specific properties.
- Oiling is done to fibres to be soft and elastic and to improve its spinning qualities.

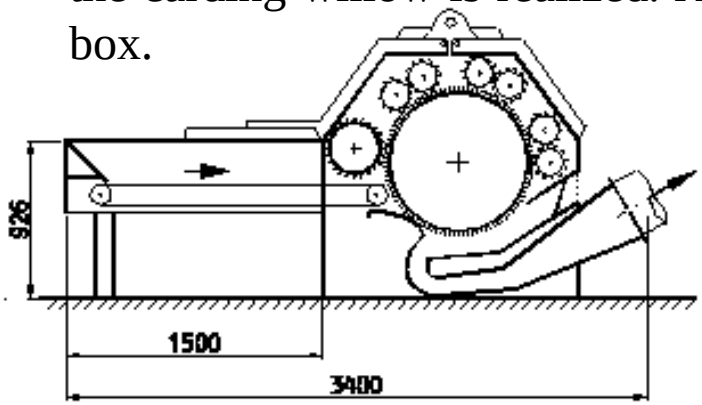
It is realized by the opening, blending and oiling line. The line consists of opening machines and blending boxes.

Small wool tufts are pneumatically transported from the opening machine to the blending box. Blending box has usually a cyclone placed on the roof plate. It spreads fibre tufts of each component on the floor of the box. A sandwich is formed. A lubricant necessary for next processing is uniformly applied between each layer. As soon as the box is full, material is vertically taken-off from this box and transported to the carding machine or it can be opened again.

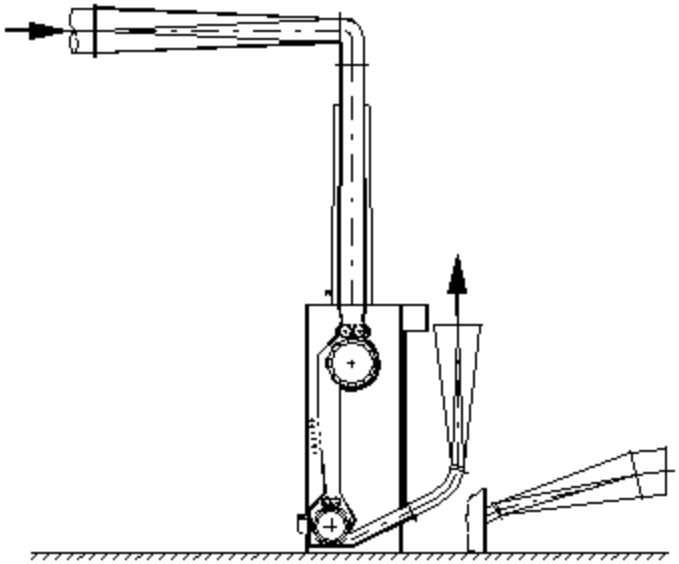
Opening + blending + oiling

- These lines have various compositions.

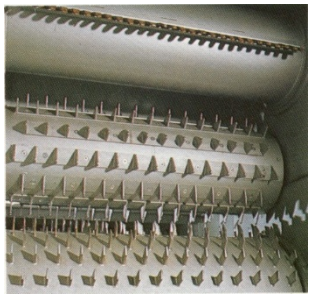
Older type – a sandwich is created by hand on the floor of blending room, each layer is oiled and then the material is vertically taken-off and opening by means of the carding willow is realized. After that the material is transported to the blending box.



Carding willow TEMAFA



Fine opener TEMAFA



Roller clothing

The blend is prepared in view of:

1) Yarn utilization
   a) For manufacture of woven fabric for suits and dress
   b) For knitting and knitted fabric
   c) For carpet manufacturing
   d) For special production

2) Physio-mechanical properties of yarn and method of spinning

3) Character of final product

4) Colour effect and goods appearance
   a) Goods produced from grey blend
   b) Goods produced from varicoloured blend (melangue)
   c) Goods piece-dyed
   d) Produced from colour yarn

5) Price

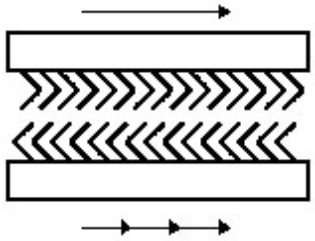
Carding

The tasks of the carding:

- Opening fibre flocks into individual fibres
- Elimination of impurities
- Elimination of dust
- Elimination of short fibres (un-spinable)
- Disentangling of neps
- Fibre blending
- Creating partial longitudinal orientation of the fibres
- Formation of supply product for following machine (sliver, roving)

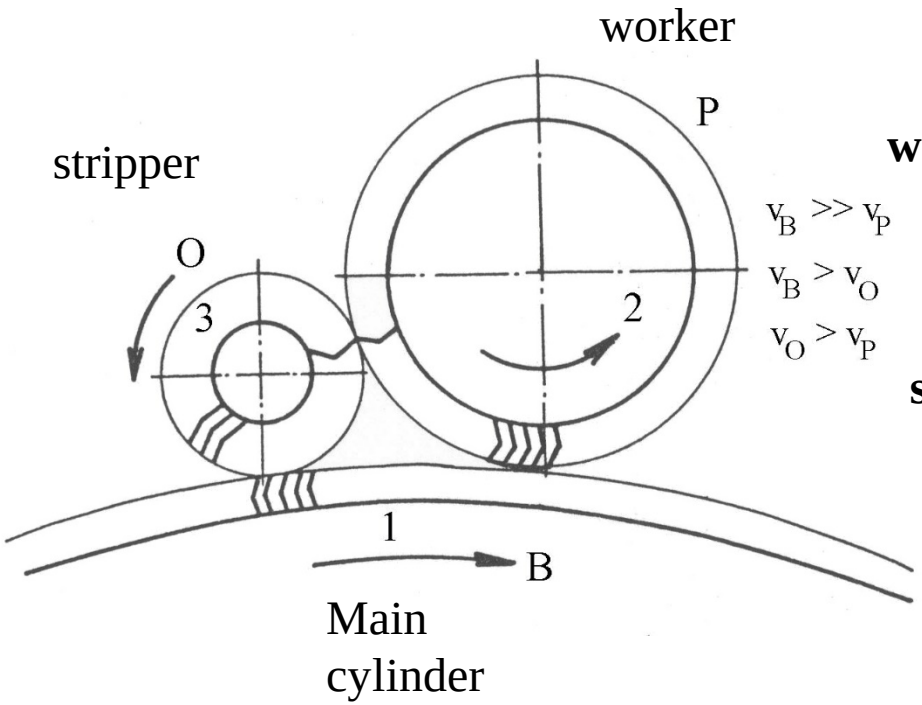
Principle of carding:

– Two saw-teeth (or small wire hooks) clothing are oppositely disposed. Both clothing move at different speed. One of them is fast (very fast). Second one is very slow. Points of super-fast clothing pull individual fibres from flocks. Opening flocks into fibres is realized. Fibres are straightened simultaneously. Short fibres press into slow clothing, which must be cleaned.

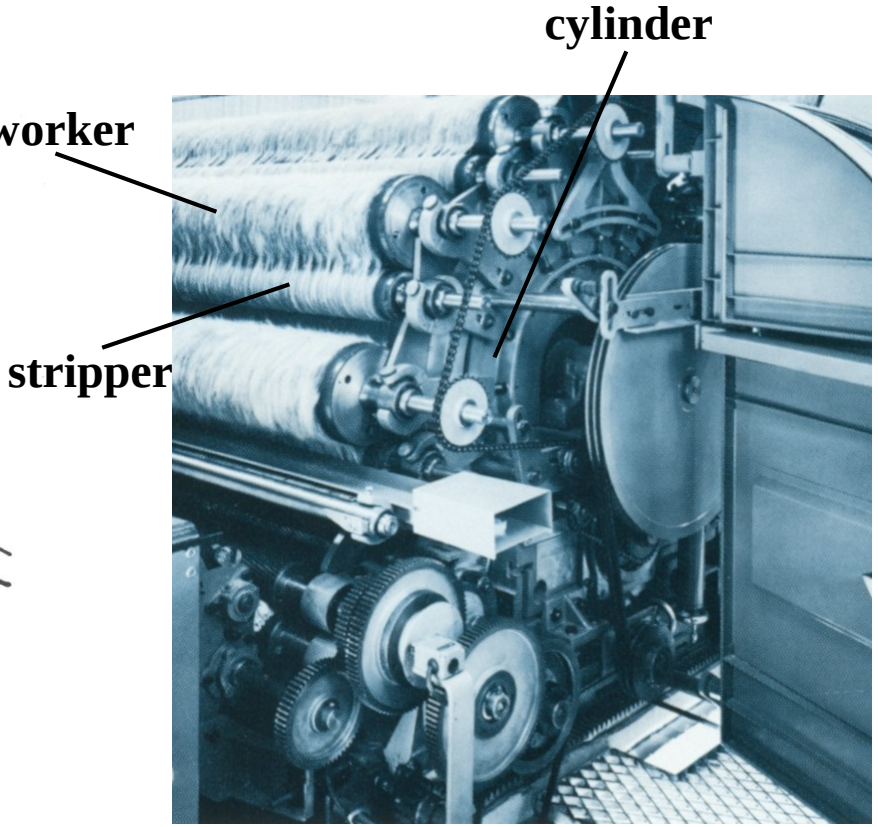


Roller carding machine

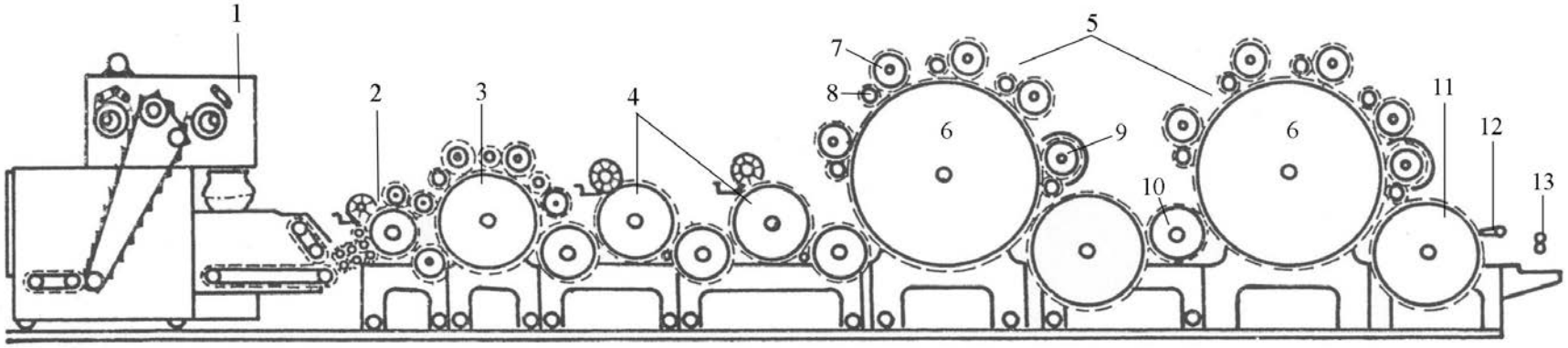
– Used for long fibres (wool, bast fibre, woollen type of man-made fibre)
- Woollen card, worsted card, semi-worsted card



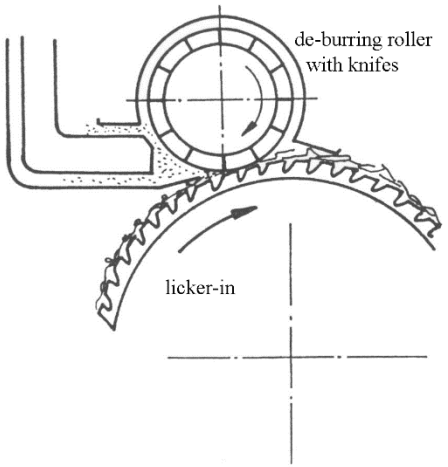
Carding zone



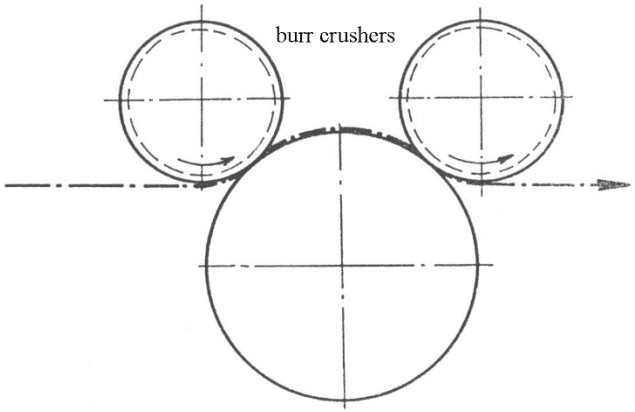
Roller carding machine for worsted spinning system



1 ... weighing hopper feeder
2 ... cleaning arrangements with entry rollers
3 ... breast apparatus
4 ... de-burring device
5 ... double cylinder roller card
6 ... main cylinder
7 ... worker
8 ... stripper
9 ... fancy roller
10 ... transfer roller
11 ... doffer
12 ... doffing comb
13 ... condensing rollers

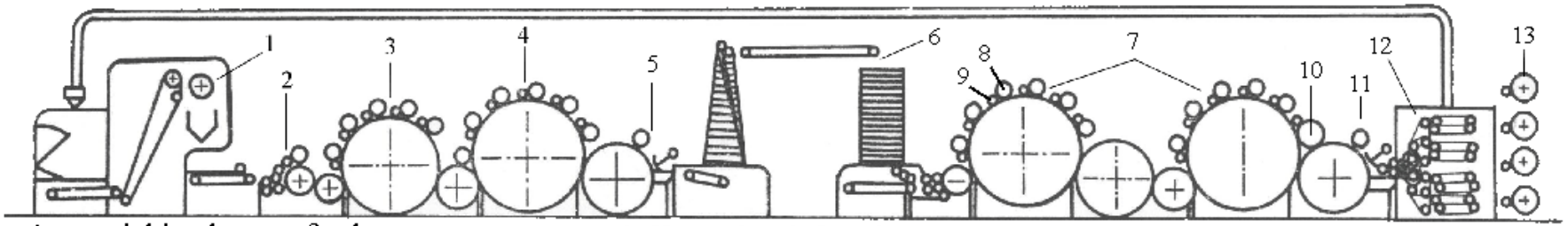


Morel's deburring device

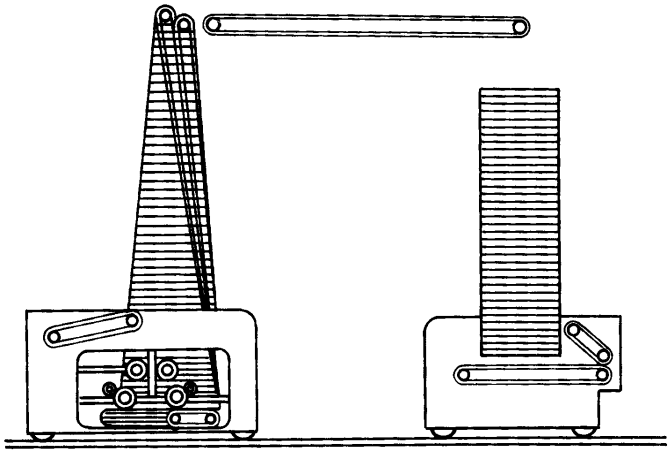


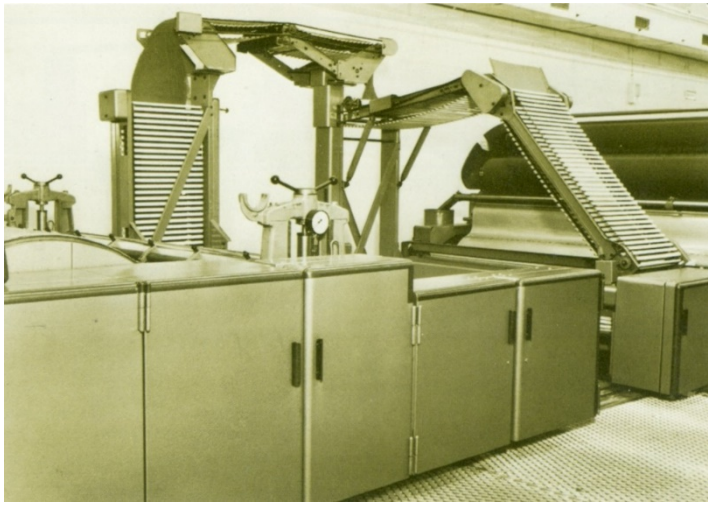
Harmel's crushing device

Roller carding machine for woollen spinning system



1 ... weighing hopper feeder
2 ... feeding and cleaning arrangement
3 ... breast apparatus
4 ... single roller card
5 ... doffer and web forming
6 ... band conveyor
7 .. double cylinder roller card
8 ... worker
9 ... stripper
10 ... fancy roller
11 ... doffer and web forming
12 ... tape divider
13 ... roving creel

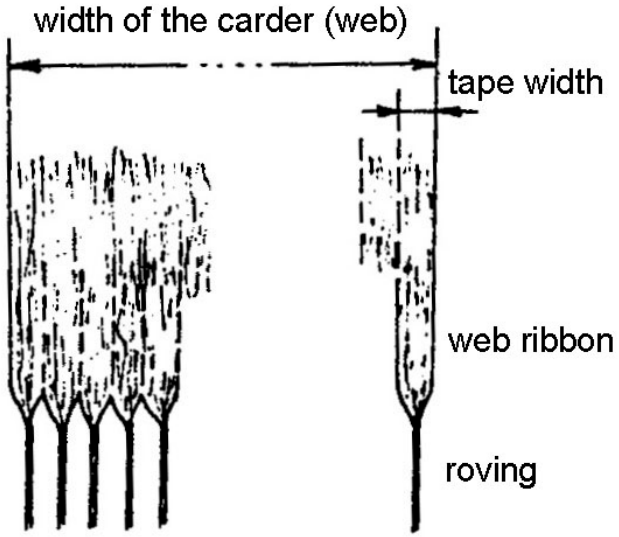


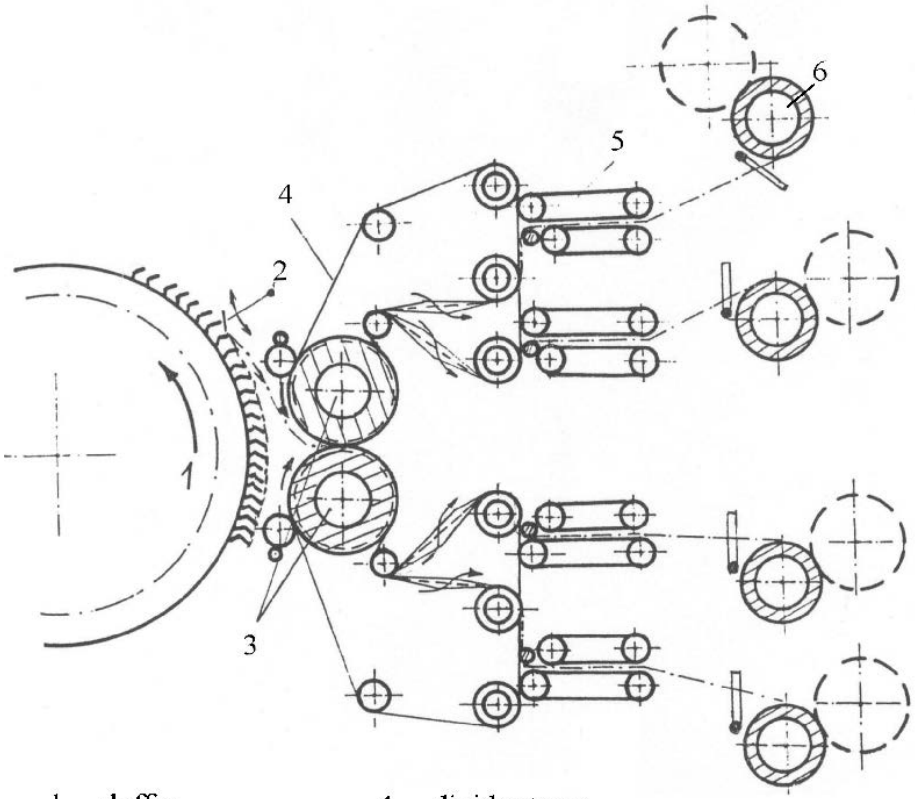


Band conveyor

Roller carding machine for woollen spinning system – web dividing

The principle of web dividing: Web passes between dividing rollers with tapes that divides a web into narrow ribbons. Then they are transported to rubbing aprons, between them they are strengthened by false twist (rounding).

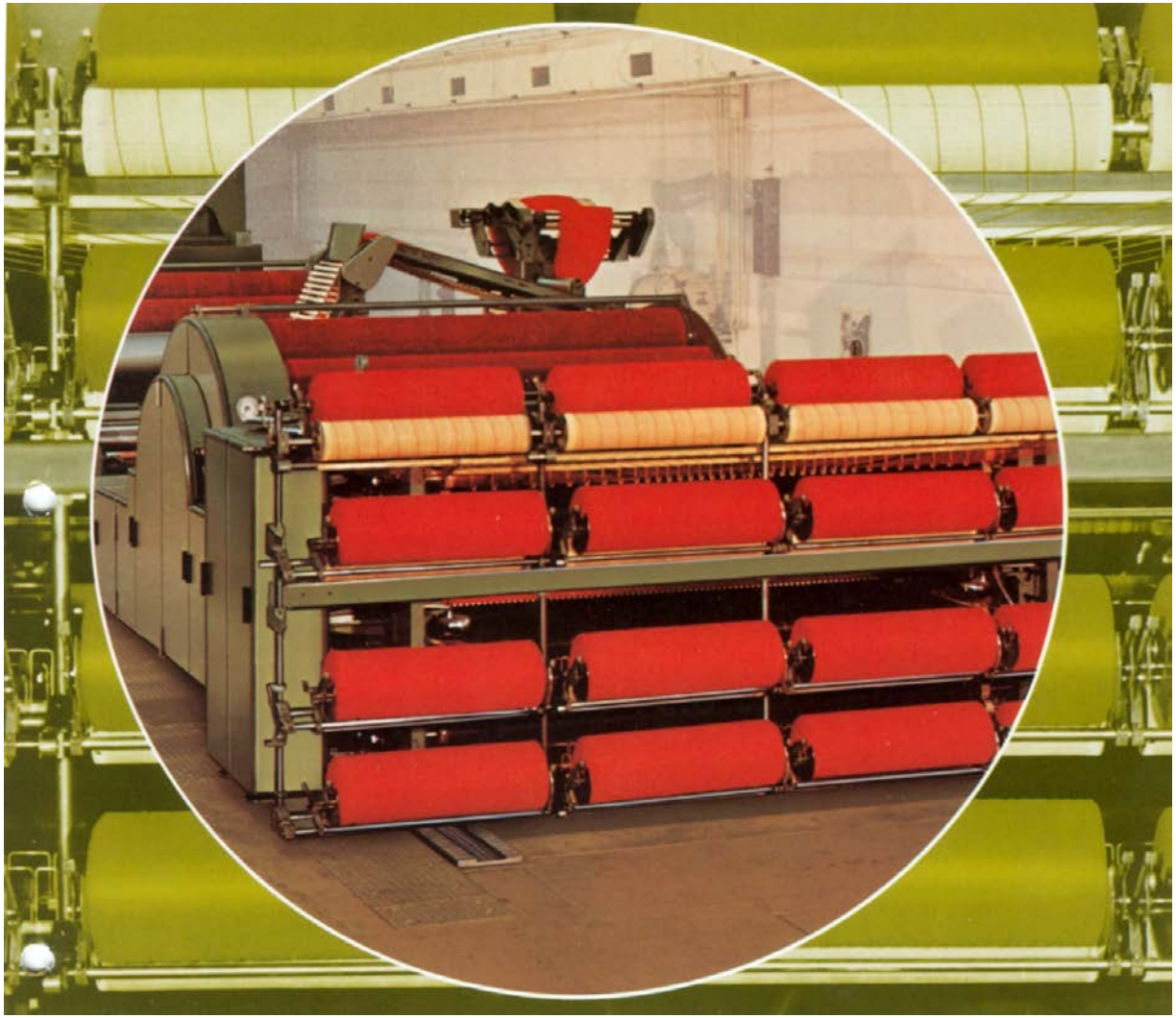




1 ... doffer
2 ... doffing comb
3 ... dividing rollers
4 ... divider tapes
5 ... rubbing aprons
6 ... winding rollers

Shallow groove tape divider with roving creel

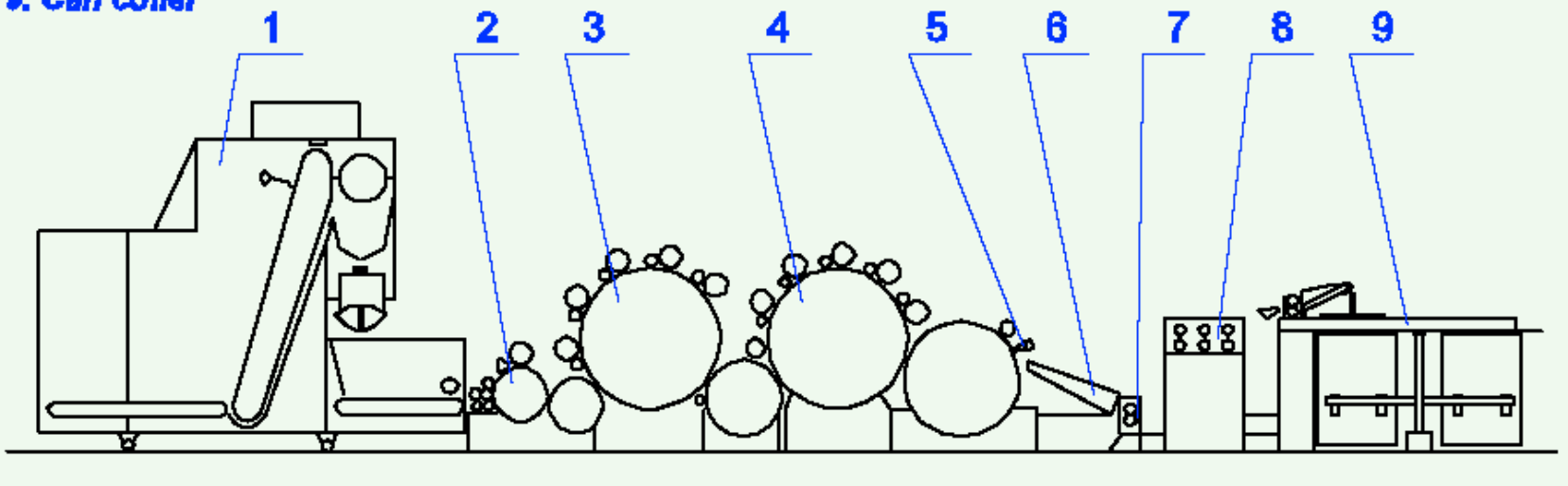
Roller carding machine for woollen spinning system – web dividing



Tape divider with roving creel (Befama)

Roller carding machine for semi-worsted spinning system

1. Weighing hopper feeder
2. Feeding and cleaning arrangement
3. Breast apparatus
4. Roller card
5. Doffing comb
6. Forming sheet
7. Condensing rollers
8. Silver drawing arrangement
9. Can coiler

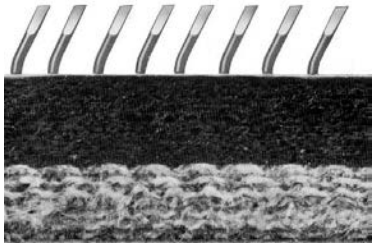


Schema of carding set for semi-worsted system (BEFAMA)

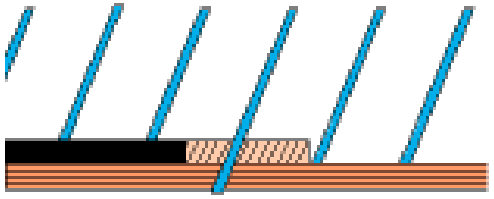
Roller card clothing

- For good work of card clothing it is important: inclination of saw-teeth (or wires), point density (number of points per area 100 mm^2), distance between each clothing (setting- 0.01 – 0.1 mm).

a) **wire (elastic)** – used for worker, stripper, fancy roller



Wire clothing - by Honneger



Wire clothing of fancy roller - by J.Holdsworth

Roller card clothing

b) **metallic (saw-teeth):** used for licker-in, cylinder, doffer

Main cylinder

Opening roller
Feeding roller
Breast apparatus

Worker

Worker on 2nd main cylinder

Transfer roller

Stripper

Doffer

Stripping roller – behind doffer

Morrel's deburring roller

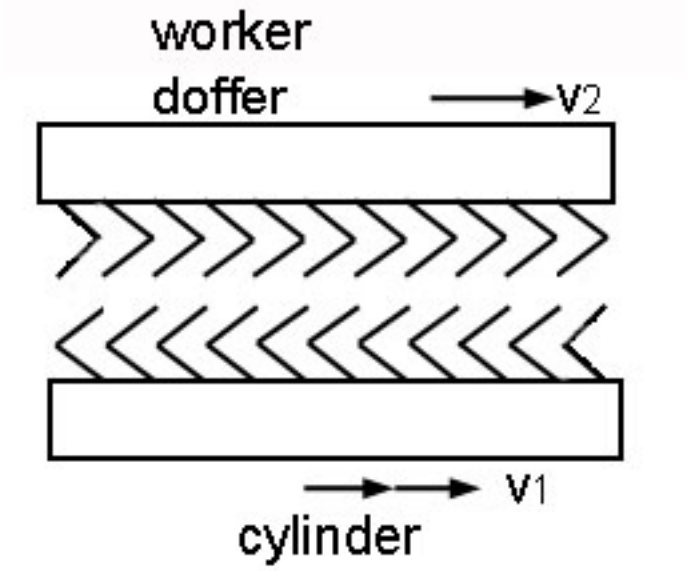
Card clothing of individual rollers of roller carding machine - woollen type - by Graf

Clothing arrangements

- the carding disposition ; - the doffing disposition; - the stripping disposition

Carding disposition

Typical clothing arrangement between:
Main cylinder – worker
Main cylinder – doffer



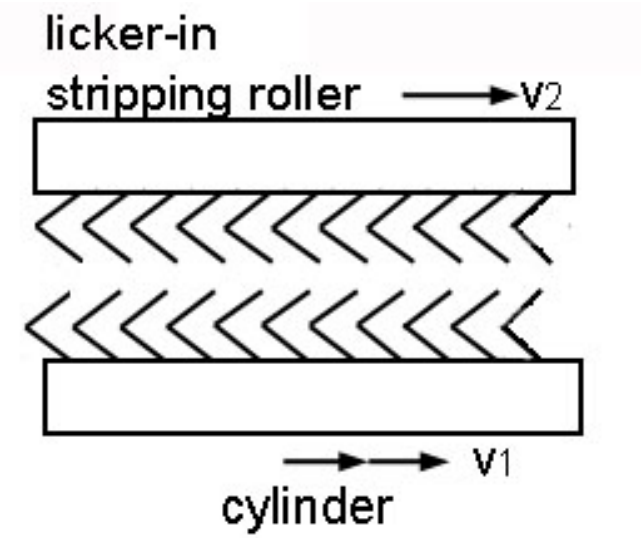
Conditions:

- The hooks (teeth in case of metallic clothing) of two neighbouring clothing are oppositely directed
- v_1 must be greater then v_2 or v_2 must be in the opposite direction to v_1 - fibres are drawn apart, are separated and aligned.

Doffing disposition

- It means card clothing interaction between:

licker-in - main cylinder ;
stripper– worker;
main cylinder – stripper ;
doffer – doffing comb



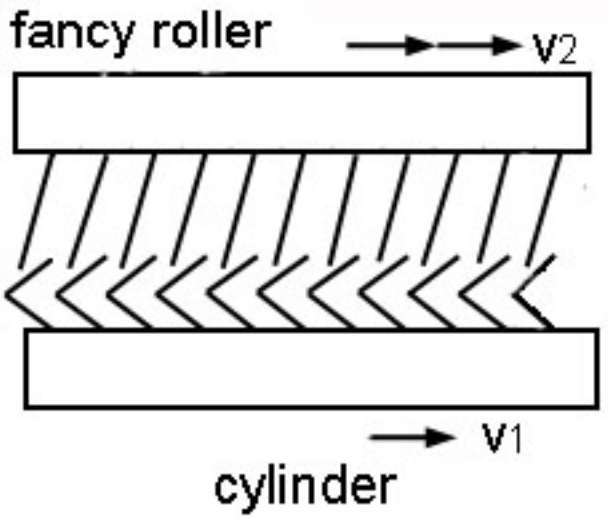
Conditions:

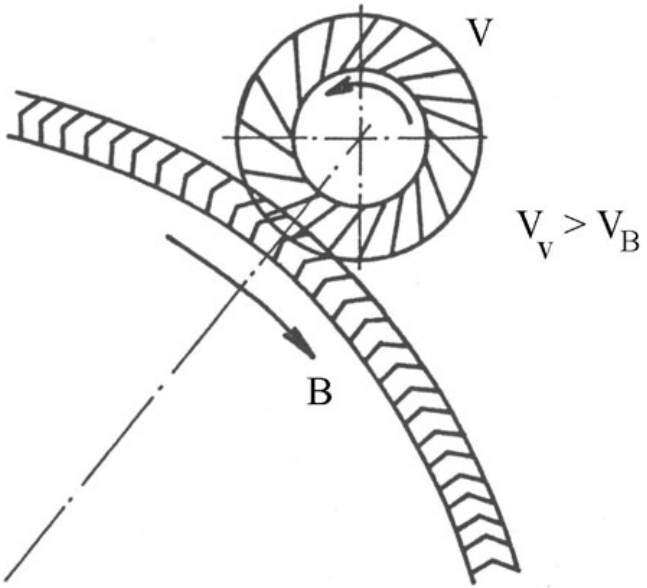
- The hooks (teeth in case of metallic clothing) of two neighbouring clothing extend in the same direction.
- v_1 must be greater then v_2 (feed clothing)

Stripping disposition

- Arrangement of clothing between the main cylinder (B) and the fancy roller (V)

The fancy roller – has long elastic wires without hooks. It lifts up fibres that are pressed in the main cylinder clothing onto its surface and prepare them for doffing.





Doubling and Drawing

Tasks of the drawing:

- Fibre straightening, parallelising
- Gradually attenuation of fibrous strand (refinement)
- Fibre blending (by means of sliver doubling which is realized together with drawing)
- Equalizing of mass unevenness by means of doubling (drawing itself is a source of irregularity)

Drawing machine

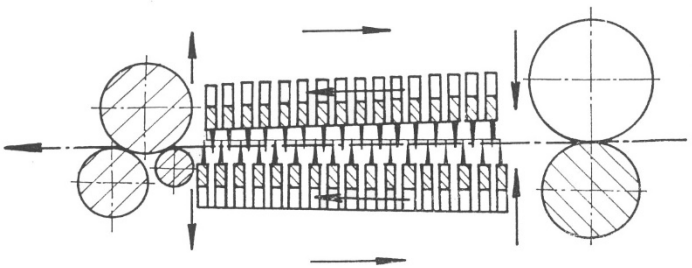
Supply product: several slivers - fed into the drawing machine together (doubling).
Output product: sliver

Drawing is usually done in **passages**, it means, several drawing machines (2-3) are arranged in a row and sliver is progressively processed with each machine.

Drafting arrangement of drawing frame for wool

Pin (gill) drafting system – used for long-staple fibres (wool, woollen type of man-made fibres)

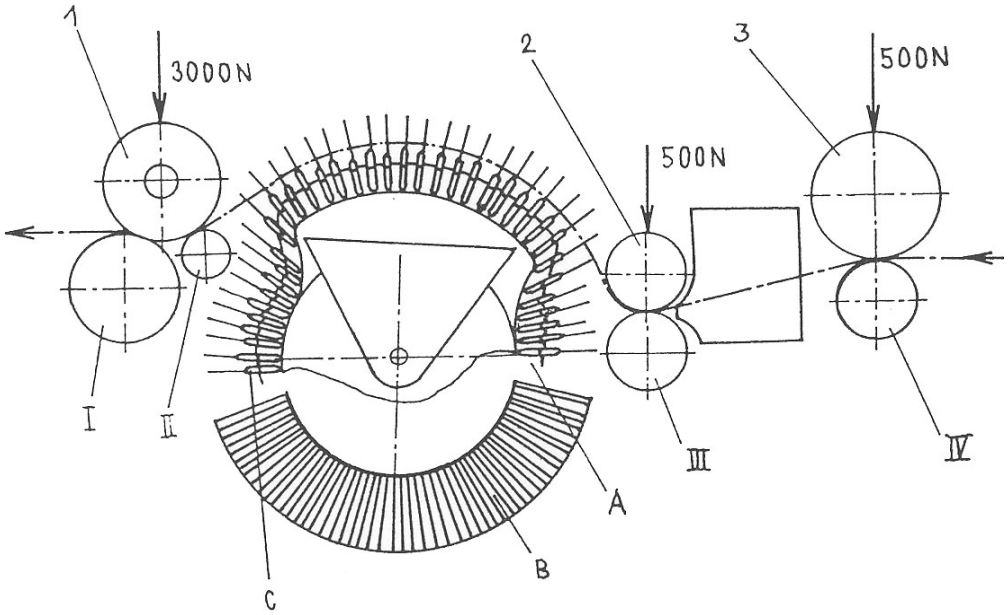
- Consists of feeding rollers, delivery rollers and set of gill bars moving between pairs of rollers
- One-gill (the machine called a GILL-BOX)
- Two-gill (the machine called an INTERSECTING)
- Due to gills fibres are guided between feeding and delivery rollers
- Speed of gills is slightly higher than speed of feeding rollers
- Gilled drafting arrangement differs from each other by its construction according to way of gills motion.



Drafting arrangement of drawing frame for wool

Motion of gills

1) **Gill bars** are fitted into the **groove of roller**. The roller rotates with gills. This type was used in the worsted spinning technology.

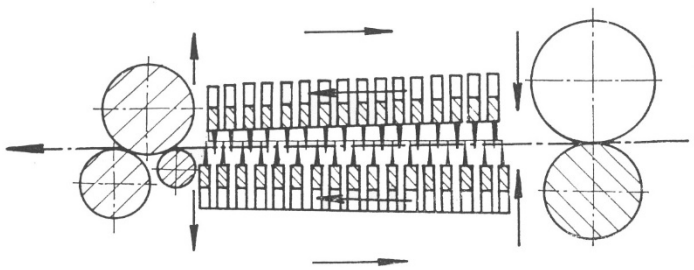


Drafting arrangement with gills carried with grooved roller A.. stationary guiding groove of gills bar; B … rotating disc groove; C … gill bar

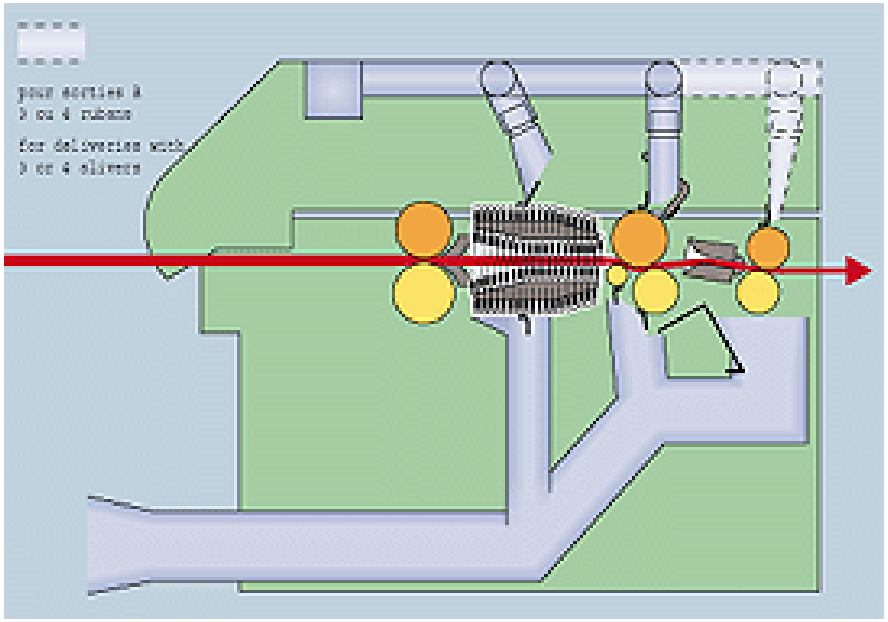
Drafting arrangement of drawing frame for wool

Motion of gills

2. **Gill bars are guided** by means of **endless screws**
   - Mechanism is very noisy, has low speed but has one advantage: precise leading of gill bars as well as fibres.
   - Used in semi-worsted spinning technology.



Two-gill drafting arrangement (Intersecting) with endless screws



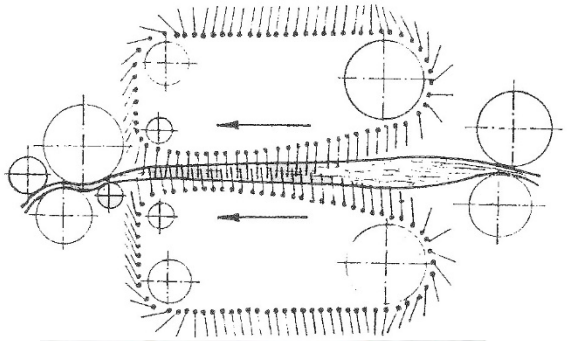
GN Intersecting (two-gill drafting arrangement with endless screws) - by NSC

Drafting arrangement of drawing frame for wool

Motion of gills

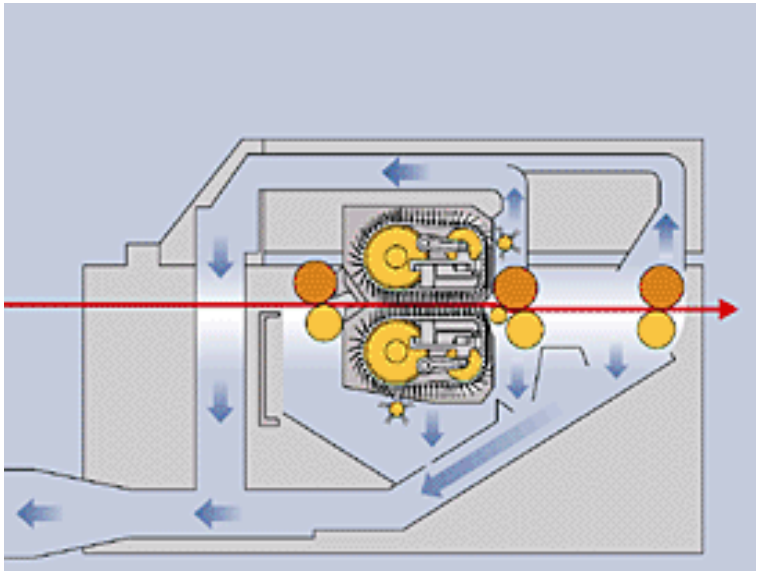
3. **Gill bars are connected with a chain** into moving endless band (sometimes called a **chain gills**).

- Widely used, especially in worsted spinning technology.
- An advantage: fibres are led and controlled more accurately than in the case of drafting mechanisms with groove rollers.



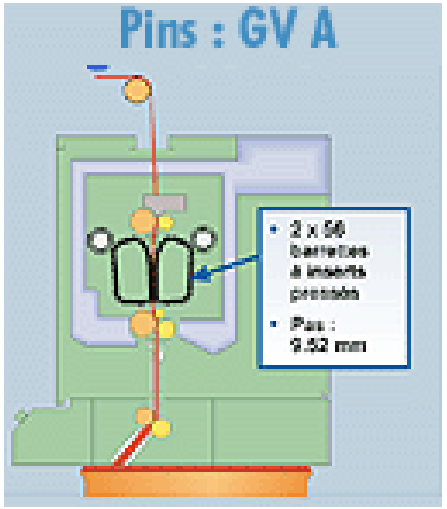
Two-gill drafting arrangement, gills guided with chain

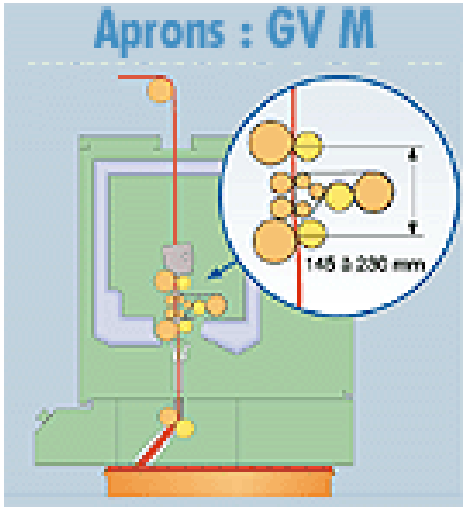
Two-gill drafting arrangement, gills guided with chain and bars

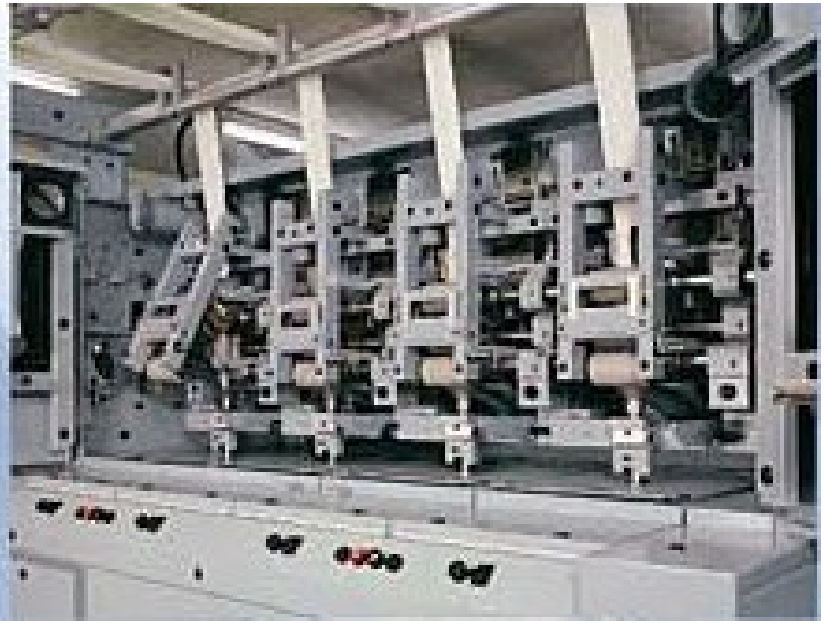


Chain gills GC – by NSC

Modern drafting arrangement of draw frame for wooll by NSC





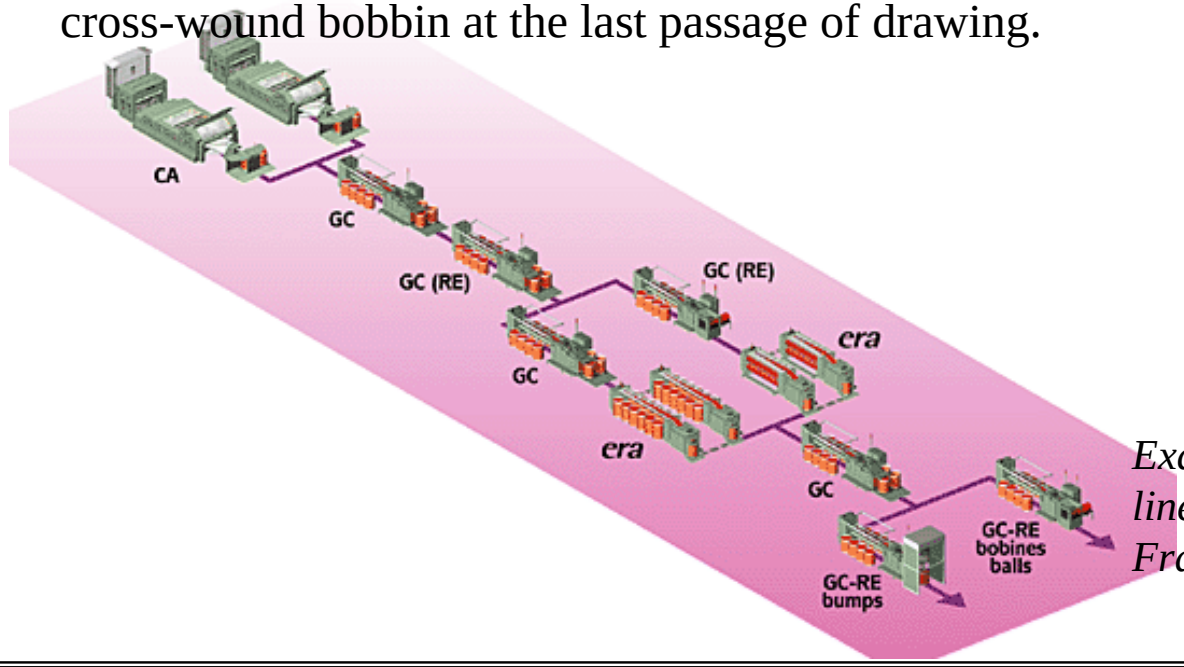


Preparation for wool combing

Tasks of the preparation for combing

- To form a suitably supply package for a combing machine. Cotton spinning technology – a sliver lap; worsted spinning technology - slivers.
- To straighten and parallelising fibres into longitudinal direction
- To improve mass regularity, to attenuate slivers and with doubling to blend fibres

Realization: several passages of double gill frame (drawing frame with chain gill drawing arrangement) usually with autolevellers. The sliver is usually wound on a cross-wound bobbin at the last passage of drawing.



CA … worsted cards
era … combing machine
GC … chain gills

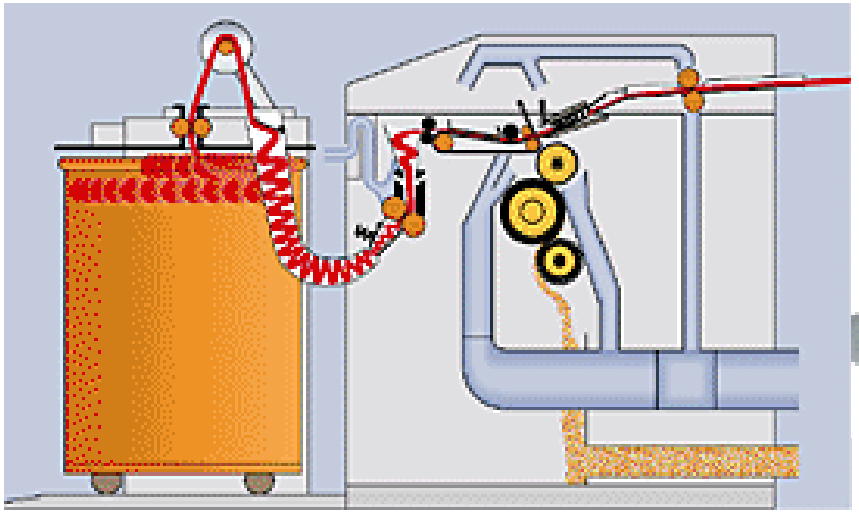
Example of carding and combing line for wool type fibres (by NSC - France)

Combing

The tasks:
- to eliminate precisely pre-determined quantity of short fibres
- to remove impurities, neps
- to straighten fibres and get parallel alignment to them
- to form longitudinal fibrous product – a combed sliver = a top

Realization: by the **combing machine,** periodically working

Comber for wool type fibres

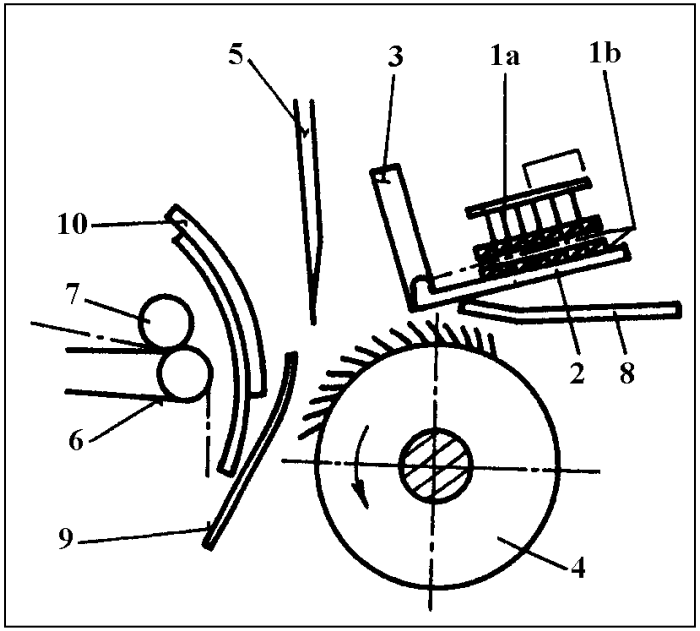


Wool comber- scheme by NSC

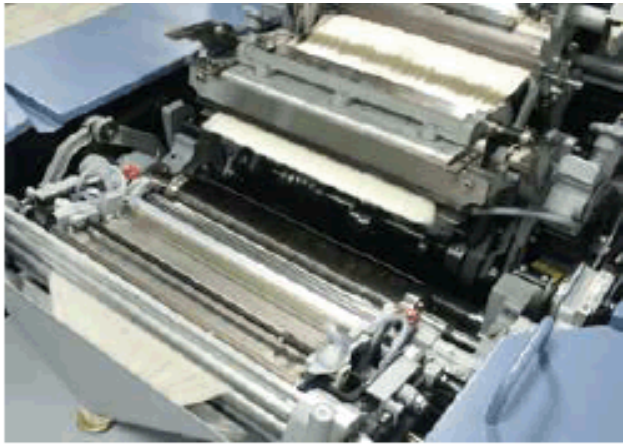
Wool comber - photo by NSC

Comber for wool type fibres

This comber has:
- 1 combing head
- stationary nippers (3)
- combing drum (4)
- feeding device – spiked plate (1a) with a grid (1b)
- supporting sheet (8)
- top comb (5)
- movable detaching device, it consists of leather band (6) and upper pressure roller (7)
- breaking hammers (9, 10)



2 phases of combing :
1) Fibre combing and preparation for detaching
2) Detaching

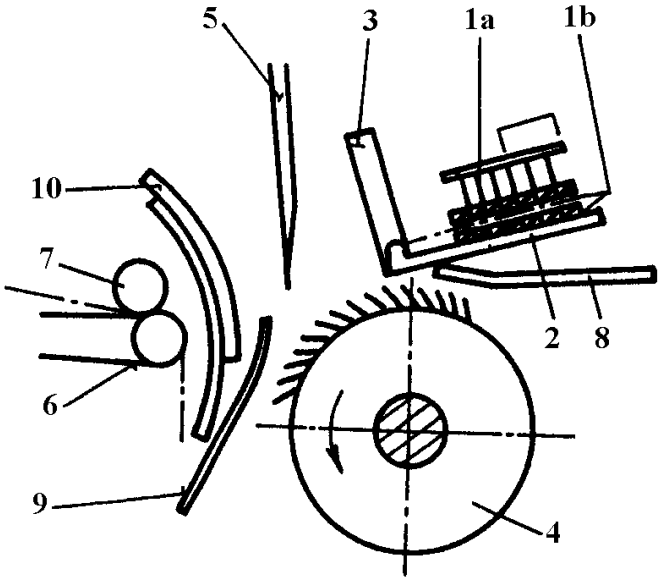


Detail of combing head – by NSC

Phases of wool combing

1st phase – Combing and preparation for detaching

- During this phase the nippers are closed and grip the fibre fringes, which is combed by the combing drum.
- The top comb is in its top position during combing.
- The supporting sheet is in its right position and the feeding device (the feeding spiked plate and the feeding grid) is being prepared for next feeding.
- The detaching device is in its left position and realizes back feeding (returns the part of the lap combed before).
- The upper breaking hammer protects the part of lap combed before against negative influences of the pins on the comb.



1a .. feeding pinned plate
1b... feeding grid
2 … bottom nipper
3 … upper nipper
4 … combing drum
5 … top comb
6 … detaching roller encircled by combing leather
7 … detaching upper pressure roller
8 … supporting sheets
9 … lower breaking hammer
10 .. upper breaking hammer

Phases of wool combing

2nd phase – Detaching

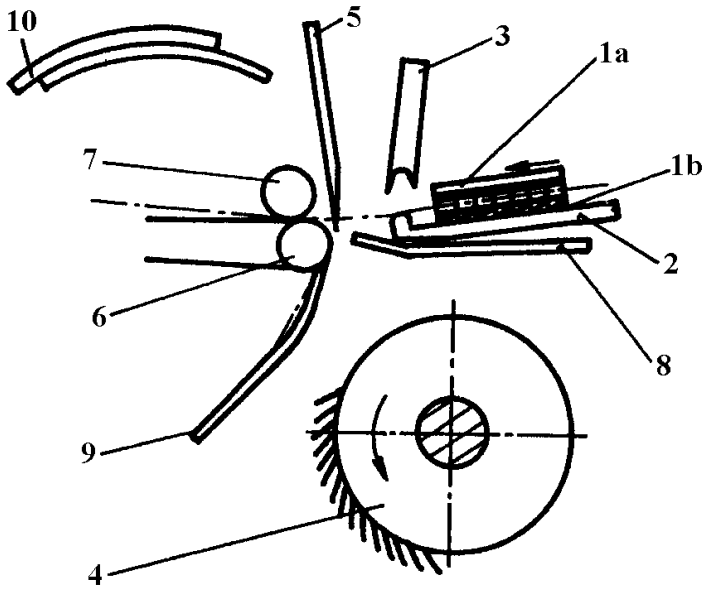
- While the nippers are opening, the detaching device is moving to the right (towards nippers).

- The upper breaking hammer goes up and bottom breaking hammer folds the fibrous fringe to the bottom part of the detaching device.

- The supporting sheet is shifting to the left position and leads combed fibres to the nip line of detaching device.

- The laps are joined.

- While the detaching device delivers the fibrous product, the top comb declines to fibrous material and combs the part of fibres which was gripped between the nippers. The feeding device feeds a new bit of lap. The detaching device is finishing its movement. The lap is detached. The detaching is finished, when upper breaking hammer falls down.



1a .. feeding pinned plate
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5 … top comb
6 … detaching roller encircled by combing leather
7 … detaching upper pressure roller
8 … supporting sheets
9 … lower breaking hammer
10 .. upper breaking hammer

Feeding, combing and detaching are intermittent functions, so the sheet from the detaching roller is also intermittent. In order to obtain a continuous web from the comber, fibre fringes are laid on the top of each other in the same way as roofting tiles. This process is called ”piecing”. This is a distinct source of fault in the operation of rectilinear combing. The sliver produces in this way exhibits a periodic variation. So subsequent doubling and drawing is necessary to eliminate this periodical irregularity.

The chain gills are used for doubling and drawing. Usually 2 passages are used.

Top finishing

In this phase of worsted spinning system a **top finishing** is included. This operation consists of **dyeing** and **backwashing of tops**.

Fine, very crimped merino wool is processed by worsted spinning technology. For production of fine yarn it is necessary to align crimps (by backwashing). Sometimes the tops are dyed in this phase.

During **top backwashing** the slivers are washed with lubrication bath, squeezed and dryed. These finished tops must be re-combed for elimination of neps and entangled fibres. Operation recombing includes: preparation for combing, combing as well as doubling and drawing after combing.

Tow to top converter

Previously, man-made fibres had come to the worsted spinning mill as staple fibres pressed into the bales. They were processed by classical way – opening, carding, drawing – blending of slivers from man-made fibres with wooll tops. It was uneconomical and complicated. Therefore the tow-to-top converter was developed.

The tasks of the converter: to cut or to stretch-break input product – a tow (a strand of continuous filaments – PL, PA, PP, VI) into fibres with length like wool: 80-150 mm and to form a sliver from these staple fibres.

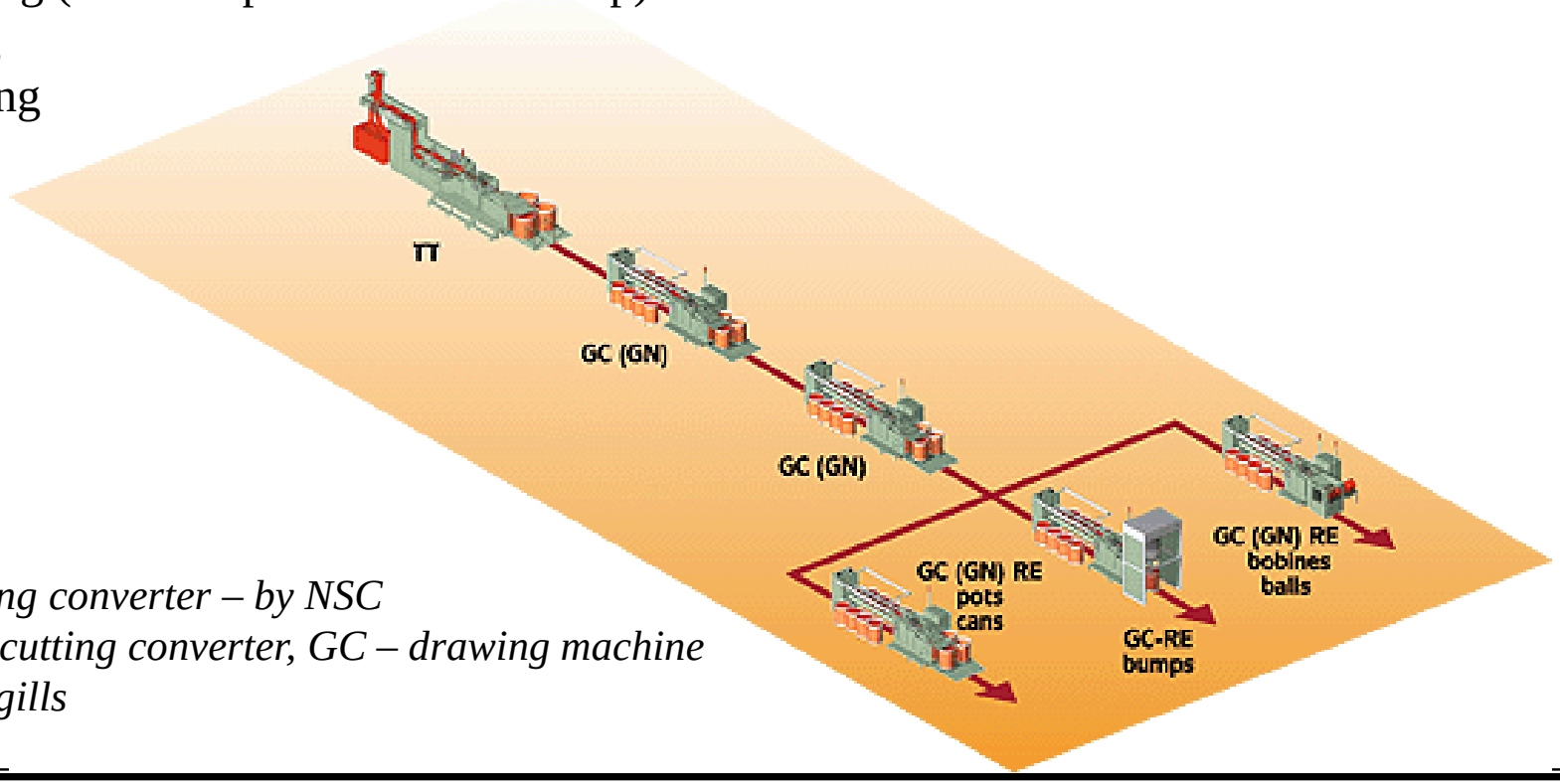
Tow and top

Tow to top converter

Utilization – in the worsted spinning mills

Technology of yarn manufacture with using of tow-to-top converter

- tow processing on the converter (event. with steaming- fibres are stabilized)
- drawing
- blending (for example with worsted top)
- roving
- spinning



Crush cutting converter – by NSC
TT – crush cutting converter, GC – drawing machine with chain gills

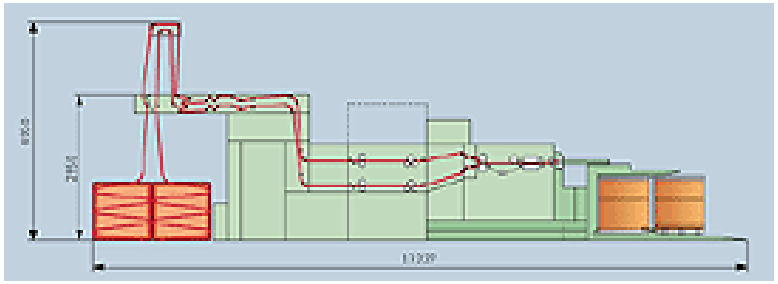
Type of tow to top converter

- Crush cutting converters
- Stretch breaking converters

Crush cutting converter

- **Principle:** crush of fibres between cutting roller and smooth bottom roller

- **Disadvantage:** fibre ends melt and splice together, the re-combing is necessary



Crush-cutting converter 911 by Seydel

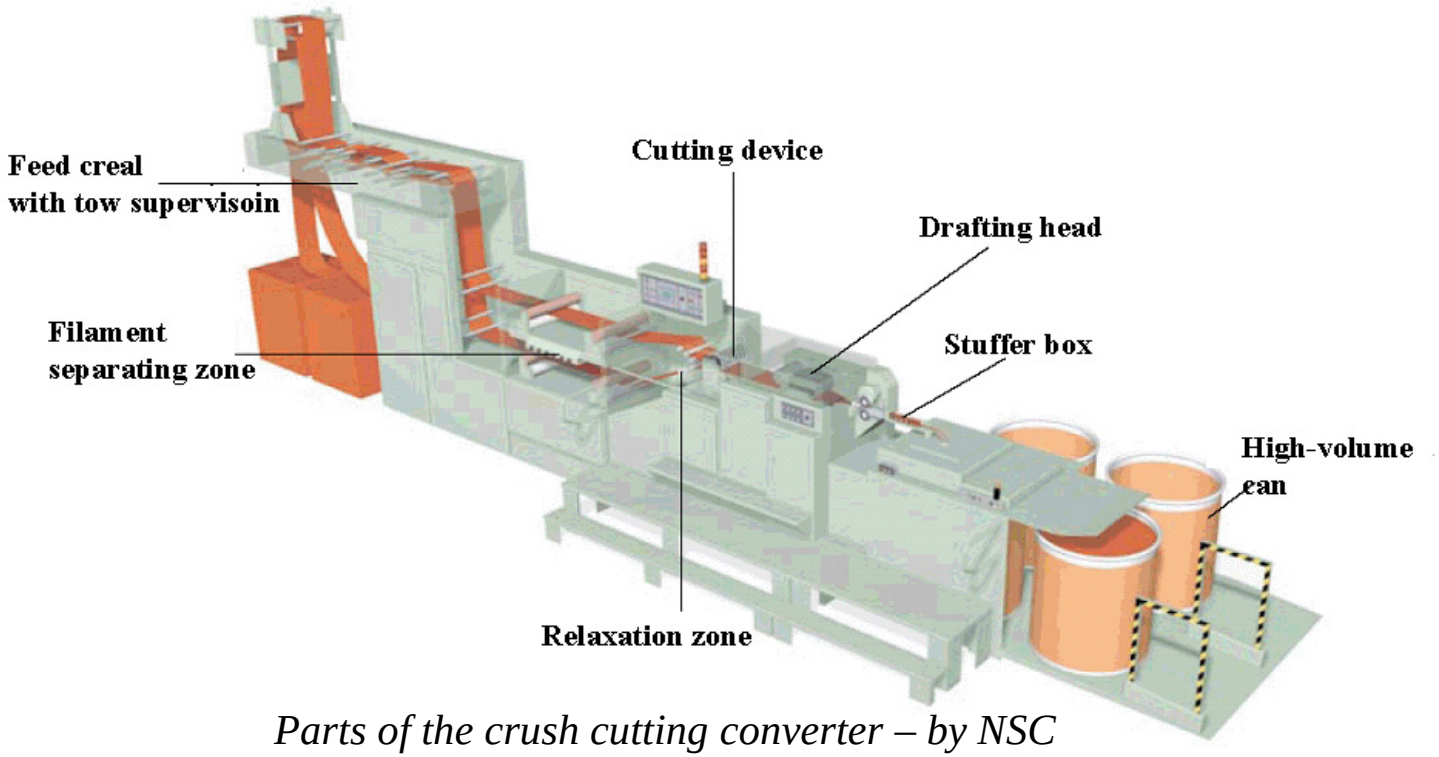
Advantages of the crush cutting converter:

a) Originate properties of man-made fibres are kept (for example elasticity, crimp, resistance, dyebility, etc.)

b) Relatively accurate check of fibre length. The possibility of rectangular staple diagram, triangle, respective staple diagram like triangle

c) The possibility of quick change of cut length and sliver fineness

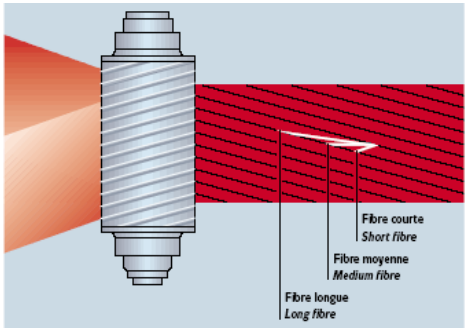
d) Wide range of cut length



Parts of the crush cutting converter – by NSC

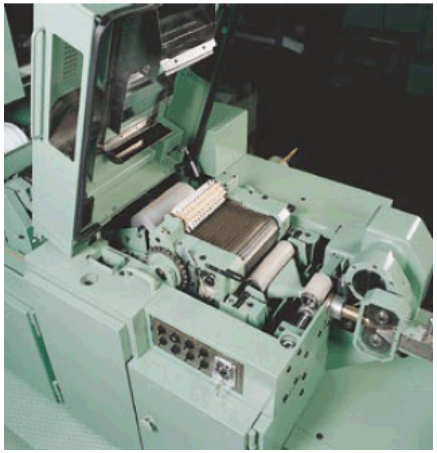
Main parts and equipments of crush cutting converter

- 2 rollers – top **cutting roller** with spiral cutting edge, **bottom roller** – smooth steel

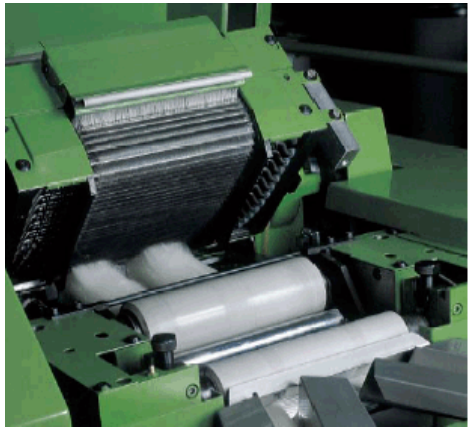


Scheme and photo of crush cutting converter – by NSC

- pin drafting mechanism



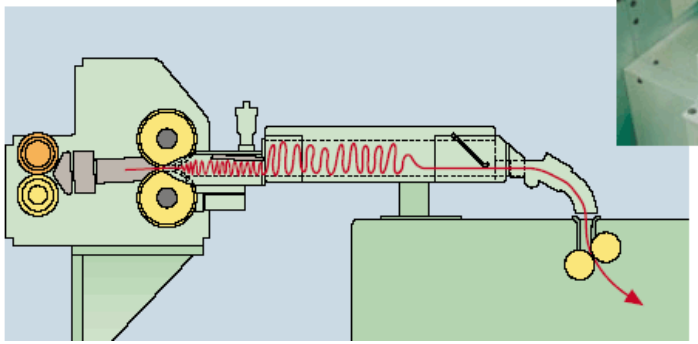
Pin drafting head of TT12 converter - by NSC



Drafting head of 911 converter by Seydel

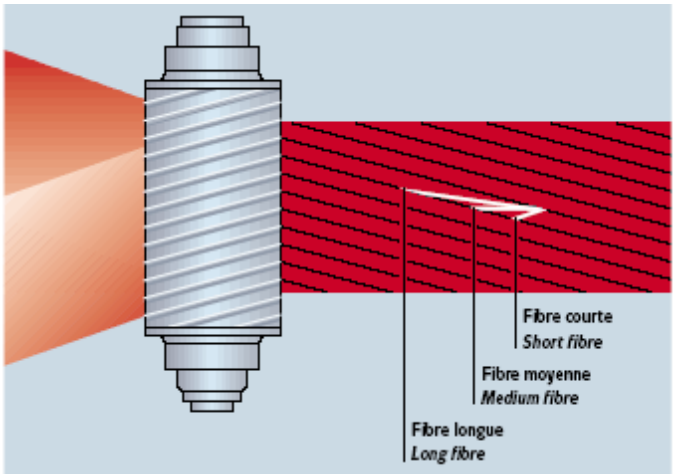
Main parts and equipments of crush cutting converter

- the stuffer box for fibre crimping



Stuffer box of converter TT12 by NSC

Variability of fibre length is achieved by means of a special device, which changes the angle of tow fed to the cutting roller.



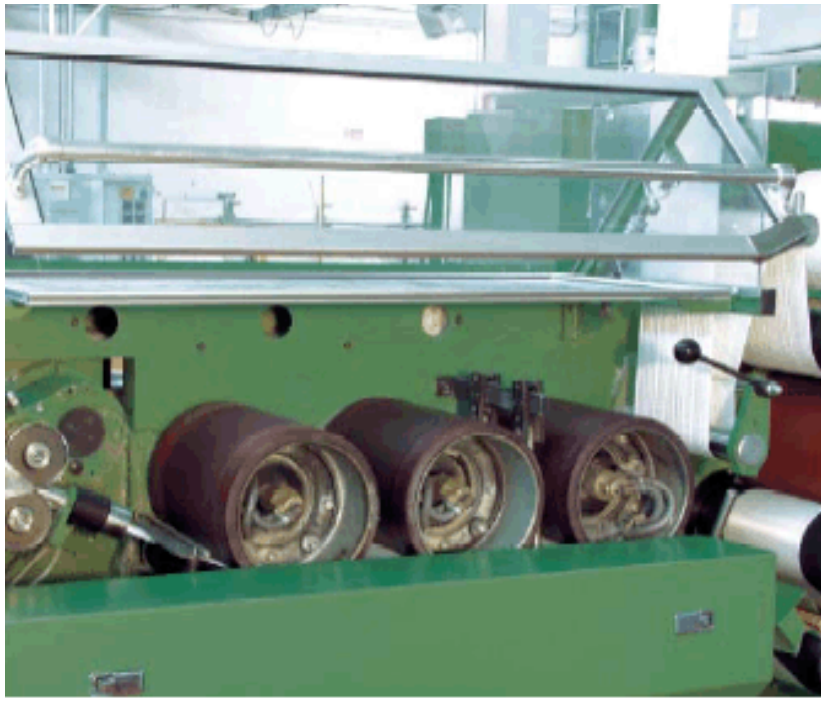
Feeding of tow to the cutting roller (by Seydel)

Stretch-breaking converter

Principle: the tow is gradually stretched between rollers till breakage

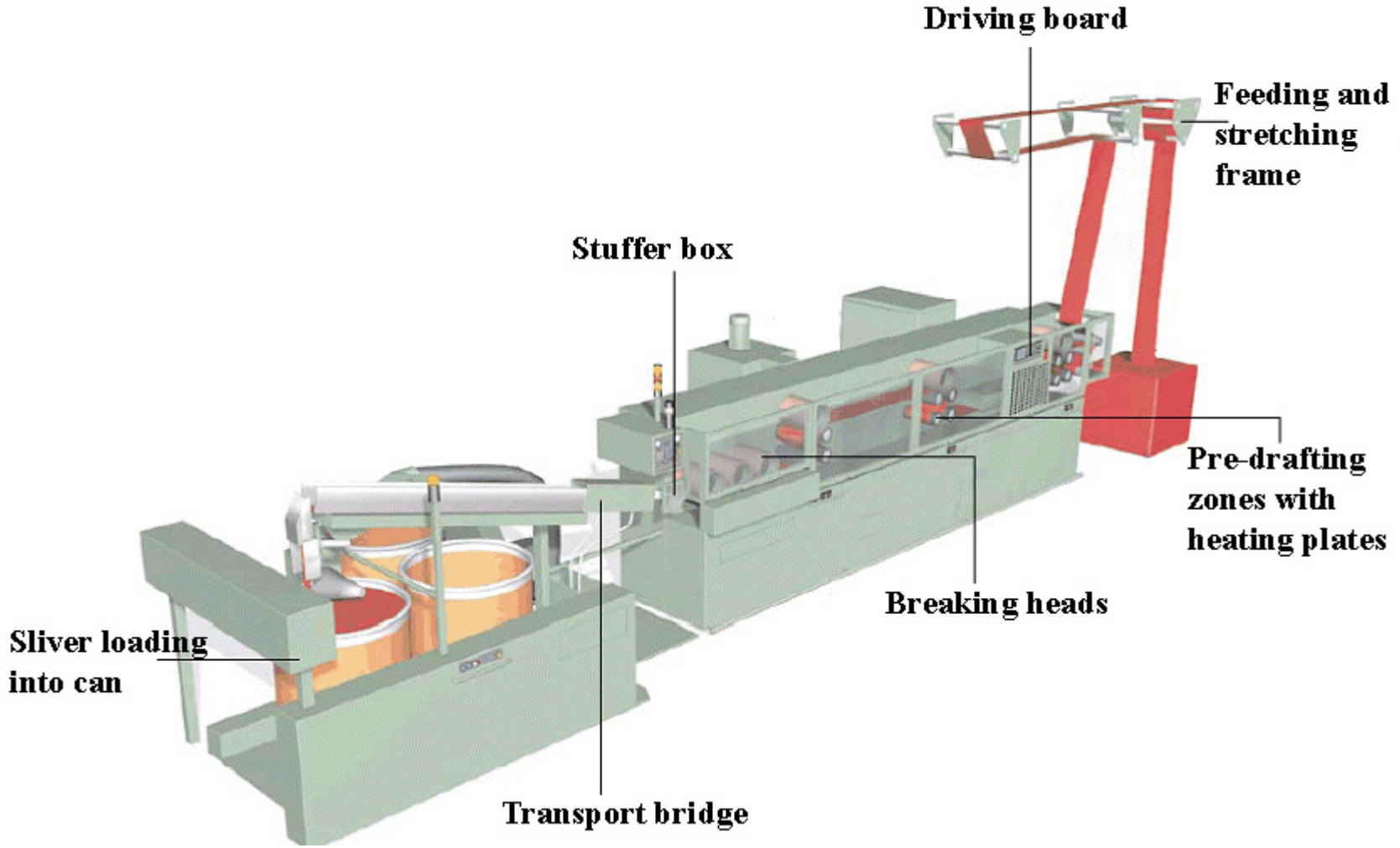
Realization: fibres pass through min. two pairs of rollers. The difference between their speed in % is higher than fibre breaking elongation. The fibre breakage occurs in its thinnest place in section between roller nip lines.

There are used several pairs of rollers (stretching, breaking and tearing zones) in order to fibres breakage could not happen at once and fibres could not be extremely stressed.



Breaking head of the Stretch-Break converter 873 – by Seydel

Stretch-breaking converters

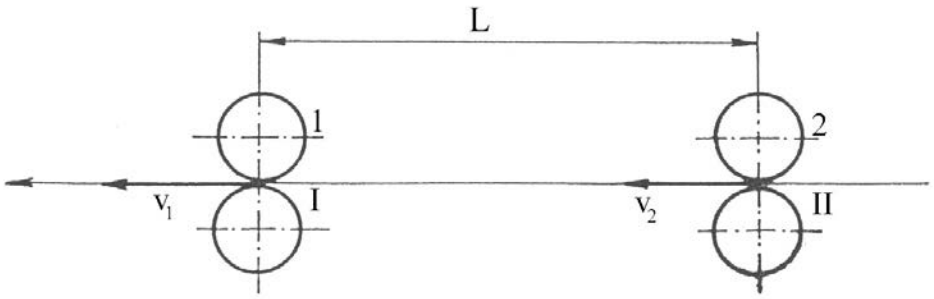


Parts of the stretch breaking converter TT11 – by NSC

Stretch-breaking converters

Stretch breaking converters 873 by Seydel

Stretch-breaking converters



The breakage of fibre (fibre length) is influenced by:
- rollers setting
- draft ratio
- fibre breaking elongation
- straightening and parallelisation of fibres in the tow

Advantages:
- high purity of converter top
- the possibility of manufacture of bulk yarns with selected fibre shrinkage (PAN tow) thanks to heating device
- machine universality - adaptability to various type of man-made fibres
- top re-combing is not necessary
- better mass evenness
- higher tenacity
- higher spinning limit
- higher bulkiness

} of resultant yarn

Stretch-breaking converters

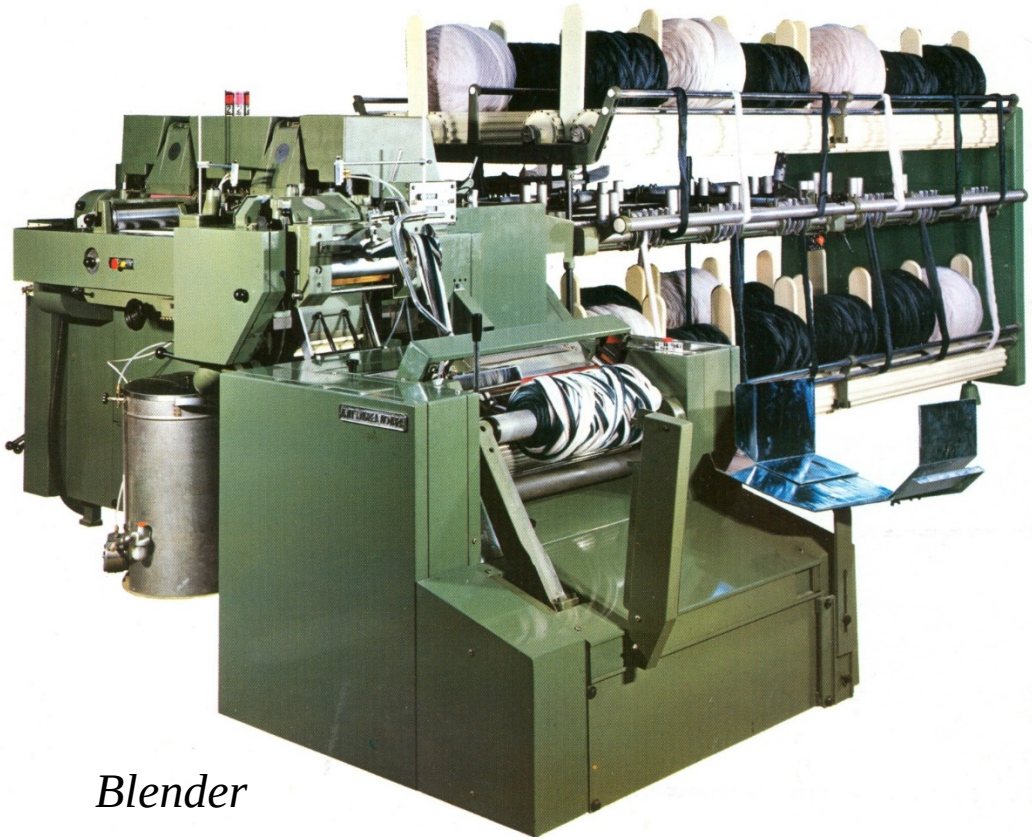
Disadvantage:

- The critical tension occurs during fibre breakage, it causes deformation of fibres and a change of their original properties (decreasing fibre thickness and breaking elongation, increasing fibre shrinkage during relaxation) ⇒ the steaming is necessary – fibres are fixed
- Deformation (internal stress) must be released in order fibre would not shrink
- It is necessary to use supply tow with lower breaking elongation (higher elongation = uneven breaking). The tow must contain a preparation – in order antistatic charge would not rise (it causes lapping of fibres on working device and low sliding – it is a problem during drafting).

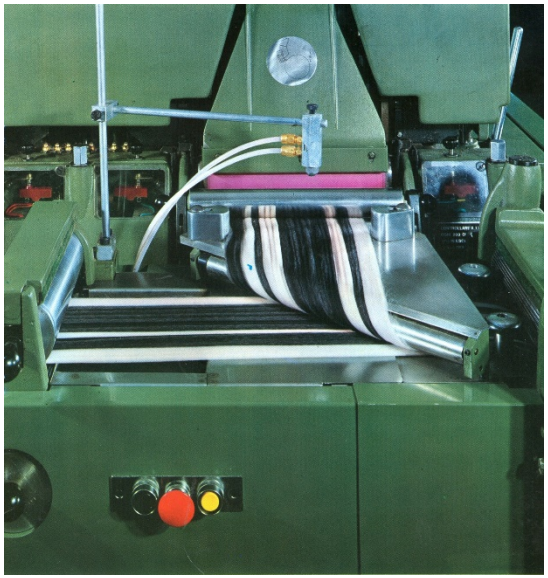
- Sometimes a prism with sharp or blunt edges is inserted between pair of breaking rollers. The prism rotates and its edges disturb fibres. Then fibre breaks at this place.

Top blending

Most of worsted yarns are produced as a mixture, it means blend of wool and chemical fibres. Before roving the tops are blended in requested ratio or with regard to colour. It is done on the blender – a mixing gill box.



Blender



Blender – detail

ROVING

In the woollen spinning mills technological operation roving is realized on the carding machine by means of the tape divider. Hence the individual operation roving is omitted in the technological process.

In the worsted spinning mill the rovings are produced into max. 4 passages of the draw frame, where the first machine has an autoleveller. The tops are gradually attenuated and equalized there. On the last machine the roving is obtained. The last machine is either the finisher or the flyer frame. In the case of the finisher the roving is rounded, in the case of the flyer frame the roving is slightly twisted.

This set of machines is called as a **roving assortment**.

In the semi- worsted spinning mill roving is either realized on the flyer frame or can be omitted.

Finisher

- It is the drawing frame enabling high draft, it is finished by rubbing aprons.
- Doubling is usually 1.

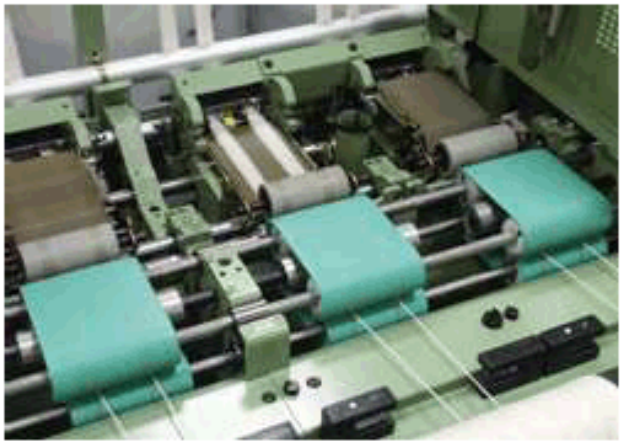
Supply product - a top (combed sliver)
Output product – the roving with false twist, double wound on the bobbin with cross winding

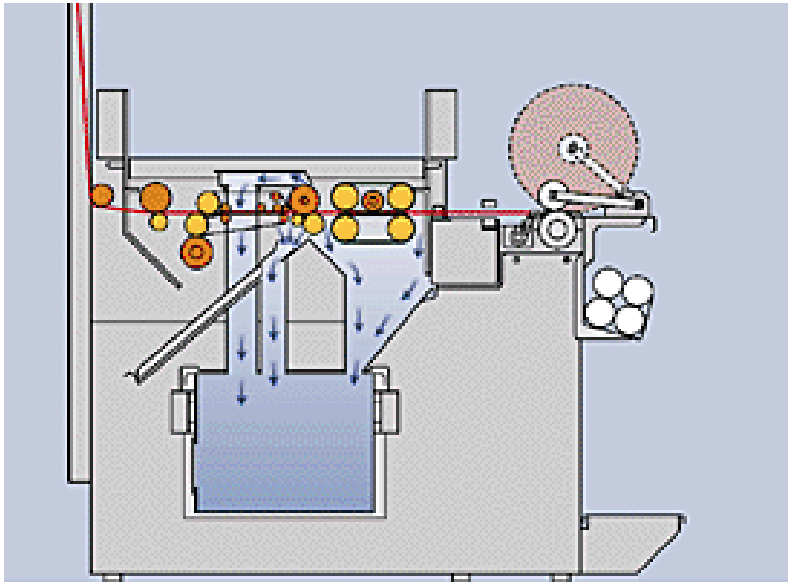
The main aims:
1) To attenaute sliver into fine strand by draft
2) To strengthen drawn fibrous strand – by false twist
3) To wind the roving onto a bobbin

Roving bobbins as an output from the finisher (by NSC)

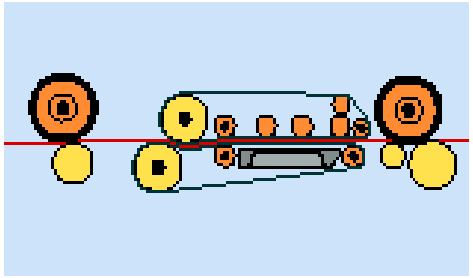
There are two types of the finisher: horizontal and vertical.

Horizontal finisher

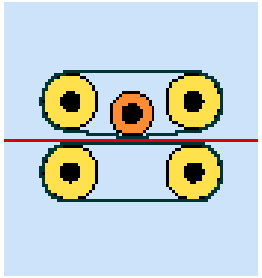




Horizontal finisher FM – by nsc



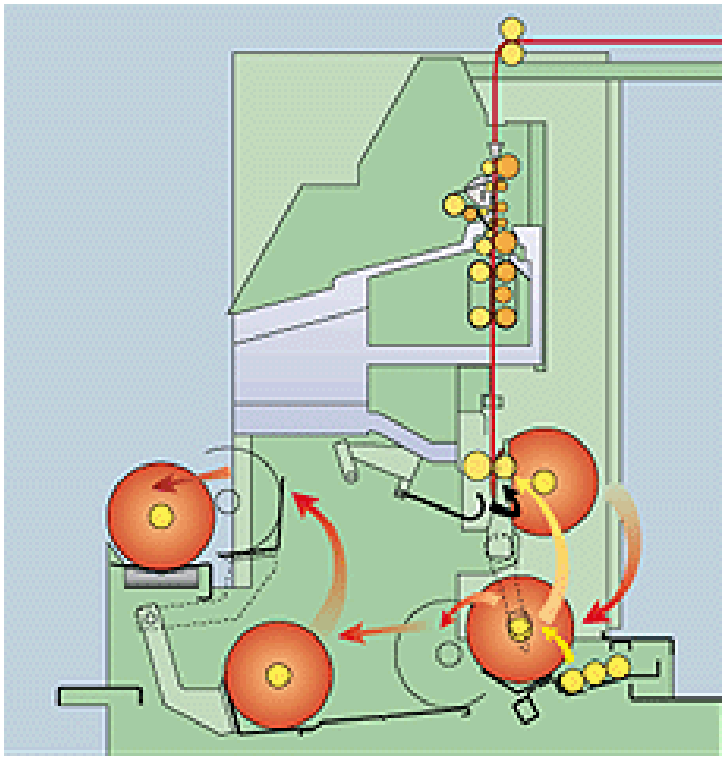
drafting device



rubbing aprons

Drafting system of FM 20 – double apron (scheme by NSC)

Vertical finisher



Vertical finisher FMV 40 – by NSC

Flyer frame

The main aims:
1) To attenaute sliver into fine strand by draft
2) To strengthen drawn fibrous strand – by true twist
3) To wind the roving onto a bobbin

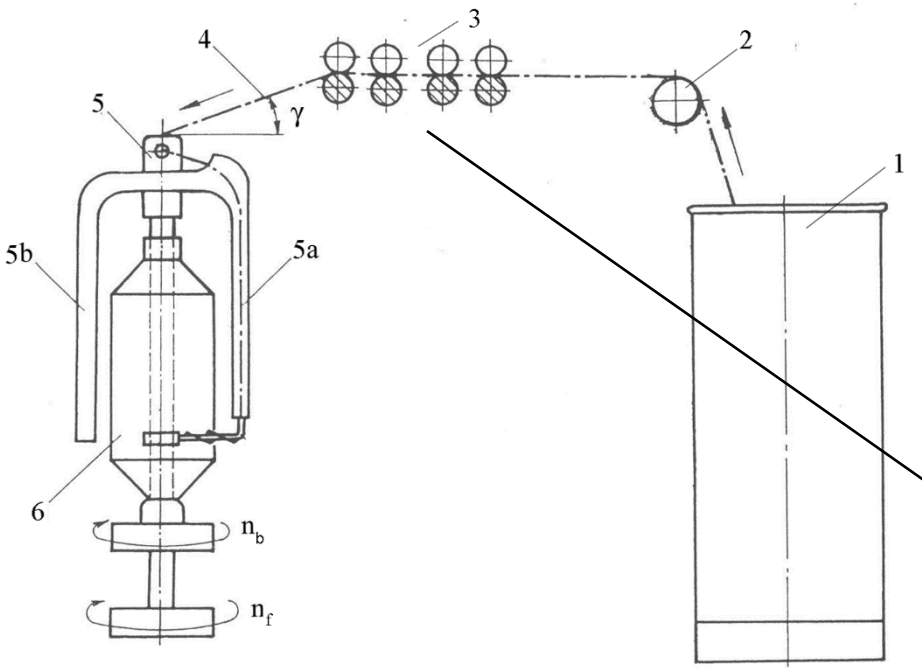
Supply product: a top from the draw frame
Output product: a roving wound on bobbin

Compare with the flyer frame used in the cotton spinning mill, this flyer frame is larger, it has larger drafting arrangement and higher roving bobbin.

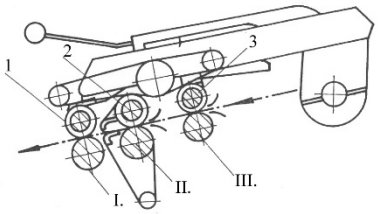
Flyer frame BM20 - by NSC

Flyer frame

Machine main parts: - feeding device - rollers
- drafting system
- twisting device – flyer
- winding device – flyer, roving bobbin, bobbin rail



1… can
2 … feeding roller
3 … drafting system (5-20)
4 … roving
5 … flyer 5a) hollow flyer leg
5b) full flyer leg
6 … roving bobbin
n_b … revolutions of bobbin
n_f … revolution of flyer



Flyer frame - scheme

Flyer frame

Twisting and winding devices are connected ⇒ twisting and winding are realized together. **Twisting device** – the flyer – inserts true twist. Each flyer revolution creates one turn in the roving.

Twist per unit length of roving depends on both the delivery speed and flyer speed.

Twist [tpm] = Flyer revolutions [rpm]/ Delivery speed [m/min]

Winding is realized by the flyer (it feeds roving to the bobbin) + by the bobbin (it is set on the bobbin rail, roving winds on bobbin) + by the bobbin rail (conveys roving along the bobbin).

The bobbin and the flyer are driven separately.

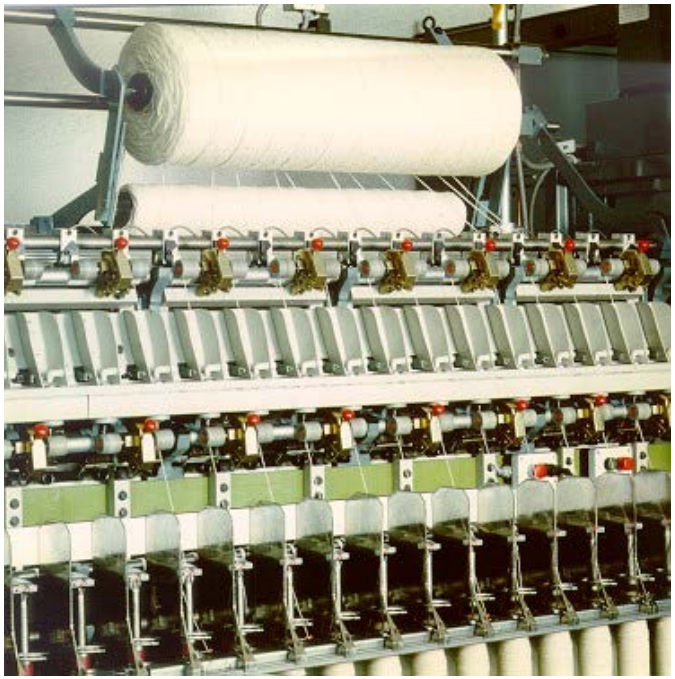
Condition for package forming - bobbin revolutions ≠ flyer revolutions

To form a package, the layer must be laid side-by-side. For that the lay-on point must move continually. The shift of the winding point is realized by moving of the bobbin rail. The bobbin rail moves up and down continuously, so that the coils are wound closely and parallel to one another. After each layer the lift of bobbin rail must be continuously reduced to form a tapered ends of bobbin.

Ring spinning frame

The tasks of the ring spinning frame:

- To draw the roving until required fineness is achieved
- To impart strength to the fibrous strand - by inserting twist
- To wind up the twisted strand (yarn) in a form suitable for storage, transportation and further processing – a cop



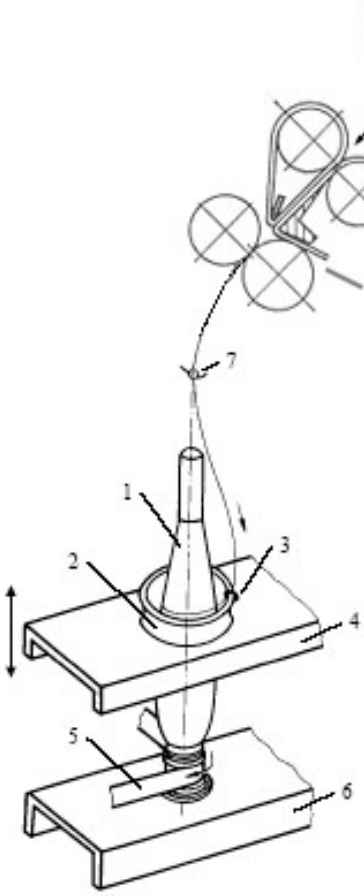
Ring spinning machine for woollen system

Ring spinning frame for worsted system

Ring spinning frame

In principle, the ring spinning frame consists of three basic mechanisms:
- Drafting mechanism
- Consolidation (strengthening) mechanism
- Winding and package forming mechanism

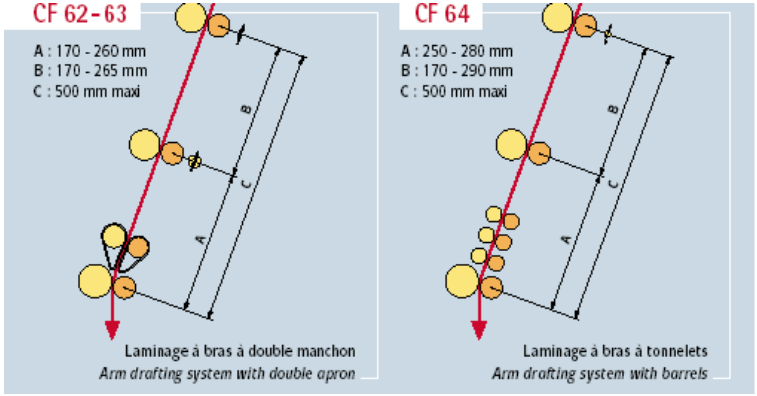
The drafting arrangement attenuates the fibre strand down to the desirable yarn count. The consolidation mechanism provides inter-fibre cohesive forces (twist insertion) to hold the fibres together in the yarn. Twist is inserted to the fibres by a traveller rotation around the ring flange. The driving mechanism of the traveller is the spindle, which carries the yarn bobbin (a cop). The traveller circling around the ring is elicited from rotation of spindle by means of yarn draught. Yarn passes through the thread guide and as well as the traveller, rotates together with the traveller and winds on the cop tube. Yarn winding is performed simultaneously with twisting. The difference in the speed between spindle and traveller causes the yarn winding on the package (a cop). In order to the cop be formed, the ring rail strokes upward and downward together with shifting up



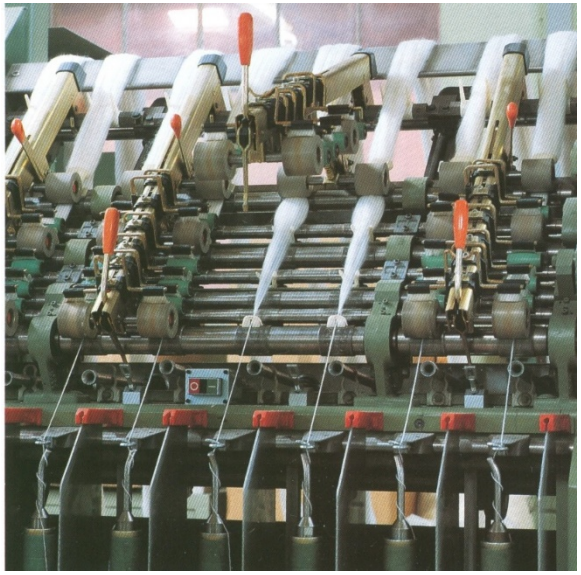
1 … spindle with cop
2 … ring
3 … traveller
4 … ring rail
5 … driving belt
6 … spindle rail
7 … thread guide
8 … drafting arrangement

Drafting arrangement for worsted and semi-worsted ring sp. frame

- Rollers drafting system with 2 aprons or with barrels (NSC)



Scheme of drafting system - ring spinning machine for semi-worsted spinning system by NSC



Drafting device for semi-worsted sp. system by NSC

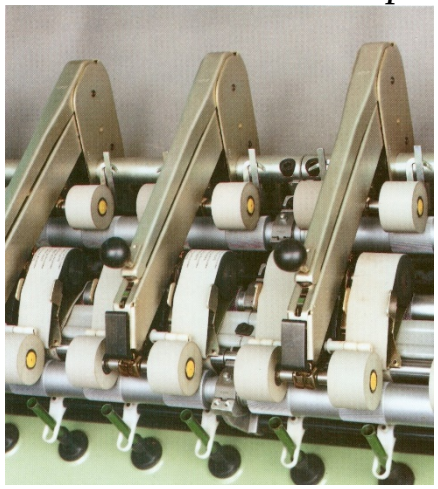


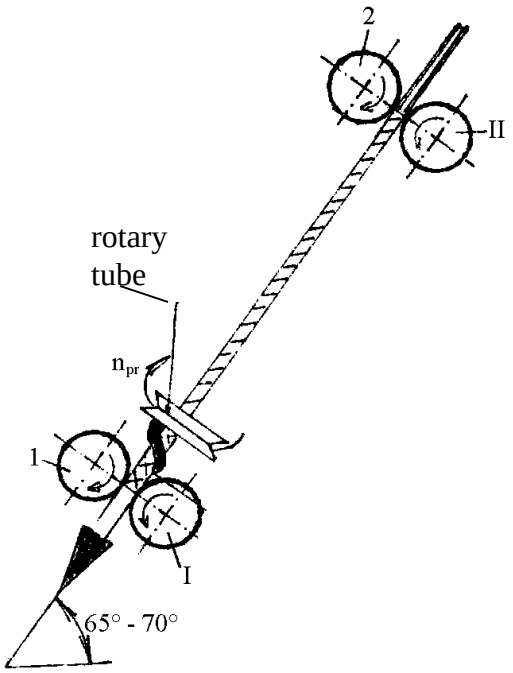
Photo of drafting system of ring spinning machine CF60 for worsted spinning system by NSC

b) Drafting arrangement for woollen spinning system

- There are 1zone drafting systems:

1) Drafting system with twisting tube -

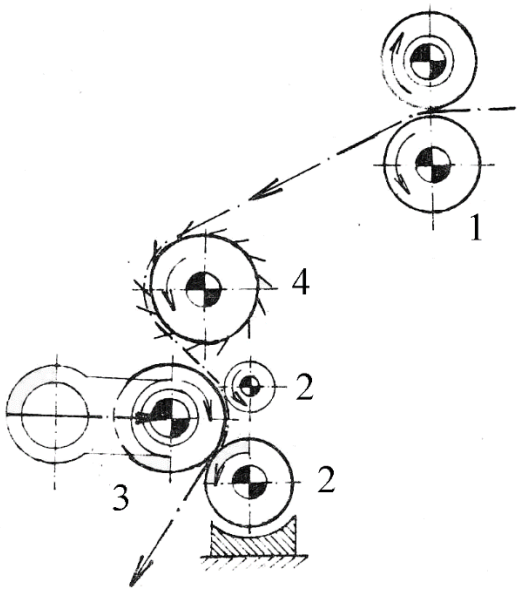
A rotary tube is set in the drafting system between pairs of rollers near delivery rollers. It turns and strengthens the roving with false twist – in order roving is drawn without breakage. Also improvement of roving irregularity is done, because less twist per meter is inserted into the thick places. Therefore they are less strengthened and follow-up drawing is higher compared with thin places.



A rotary tube in the drafting arrangement of ring spinning machine for woollen system

Drafting arrangement for woollen spinning system

2) Drafting system with needle roller

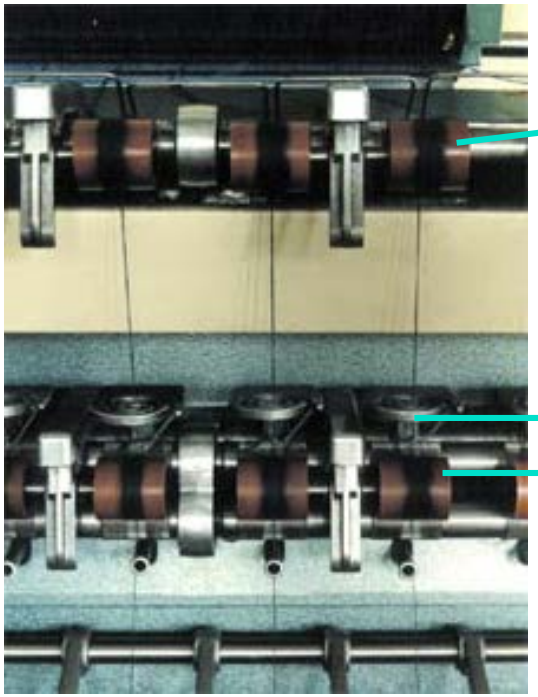


1 … feeding roller
2 … delivery bottom roller
3 … feeding bottom roller
4 … needle roller

Drafting arrangement with pinned roller

3) Drafting system with spiral

- Spiral inserts false twist into the roving



1 … feeding roller
2 .. spiral
3 … delivery roller

Drafting system of ring spinning machine for woollen system – PG5A Befama

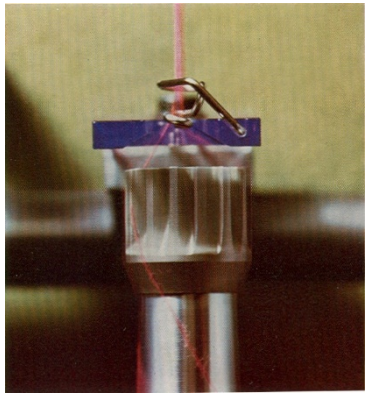
Traveller of the ring spinning machine for wool fibres

- It circles about the ring, its movement is caused by yarn draught (yarn drags a traveller)
- It participates in twisting and conducts yarn during winding

J travellers – by Bräcker

HZ travellers – by Bräcker

Spindle of the ring spinning machine for woollen sp. system



Crown spindle – detail (woollen yarn)

Obvyklé jemnosti délkových vlákenných útvarů

	Jemnost *T*	
	Cotton	Wool
Fibrous layer -web (input for card)	(650 – 950) ktex	(650 – 950) ktex
Carded sliver	(4,9 – 10) ktex	(20 - 40) ktex
Drawn sliver	(4 – 6,5) ktex	(5 - 40) ktex
Combed sliver	(3,7 - 6) ktex	Zpravidla 18 ktex (15 - 35) ktex
Sliver lap	(70 – 80) ktex	Nepoužívá se
Roving	(220 - 980) tex	(500 - 1000) tex – wollen sp.. (500- 650) tex – worsted sp.
Yarn	(4 – 100) tex	(10 – 200) tex

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