TXL 222: Yarn Manufacture II

3 Credits

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Marks Distribution

Minor:	**40**
Quiz (Best of 2):	**20**
Major:	**40**

Attendance Policy

▪ Minimum Attendance	: 75%
▪ Attendance less than 75%	: One grade down
▪ Late attendance	: Will be marked as absent after attendance has been already registered.
▪ Attendance more than 95%	: 5 bonus marks will be added to the full marks

Course Outline (Lecture)

Combing:

- ✓ Sequence of operation in a rectilinear comber
- ✓ Preparation of fibre assembly for combing
- ✓ Noil theory
- ✓ Process and Quality related factors
- ✓ Function of various components
- ✓ Recent developments

Course Outline (Lecture)

Roving Frame:

- Basic functions and construction of a roving frame
- Functions and design aspects of various components
- Principle of flyer twisting
- Package formation and building mechanism
- Automation and recent developments

Course Outline (Lecture)

Ring Frame:

- ✓ Basic functions and construction
- ✓ Design aspects of various components
- ✓ Twisting by ring/traveller arrangement
- ✓ Package formation and building motion
- ✓ Spinning geometry
- ✓ Recent developments and automation

Reference Materials

- ✓ A Practical Guide to Combing and Drawing, Short-staple Spinning Series (Volume 3), By W. Klein
- ✓ Fundamentals of Spun Yarn Technology By Carl A Lawrence
- ✓ Handbook of Yarn Production-Technology, Science and Economics By Peter R. Lord
- ✓ Spun Yarn Technology By Eric Oxtoby
- ✓ Advances in Yarn Spinning Technology, Edited by Carl Lawrence

COMBING

Introduction to Combing

Combed Cotton Clothing

- ✓ Soft
- ✓ Smooth
- ✓ Lustrous
- ✓ Appealing appearance
- ✓ Vibrant colour
- ✓ Superior drapability

Expensive

An additional process in the spinning line

Spinning Process Flowchart

Blow room
(Opening, cleaning, mixing, blending)

→

Carding
(Disentanglement & cleaning)

→

Drawframe
(Parallelization, straightening & reducing mass variation)

→

Combing
(Removal of short fibres and neps)

↓

Roving Frame
(Reduction in mass per unit length)

↓

Spinning
(Ring, rotor, vortex, air-jet spinning)

←

Winding
(Fault removal & packaging)

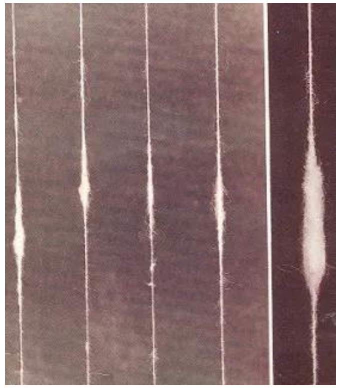
←

Plying
(Plied yarn)

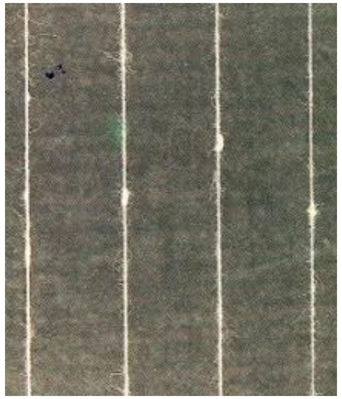
Introduction to Combing

Functions of Combing Operation

- ❑ Removal of short fibres (pre-determined quantity)
- ❑ Removal of remaining impurities
- ❑ Removal of neps and slubs
- ❑ Straightening and parallelization of fibres
- ❑ Improves evenness of slivers



Slubs

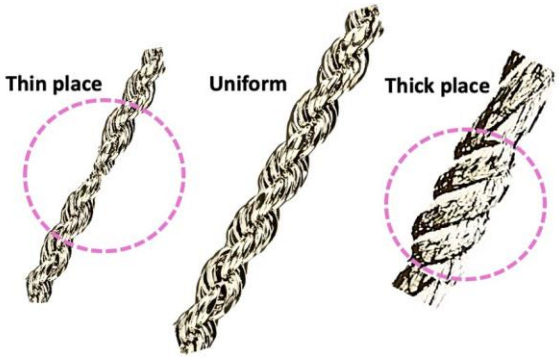


Neps

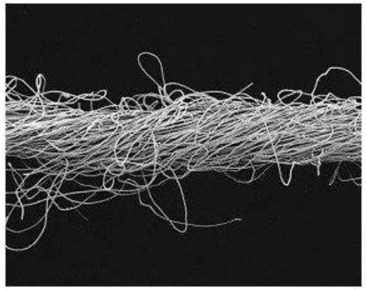
Introduction to Combing

Why to remove short fibres??

- ✓ Short fibres lead to thick and thin places (i.e., unevenness) in the final yarn.



- ✓ Result in the generation of fibre flies: contaminates surrounding atmosphere and machines.



- ✓ Increase hairiness of yarns.

- ✓ Short fibres are less mature: lead to barre effect in dyed fabric.

- ✓ Removal of short fibres improves fibre staple length

- ✓ Removal of short fibres improves strength of yarn. How??

Staple Length

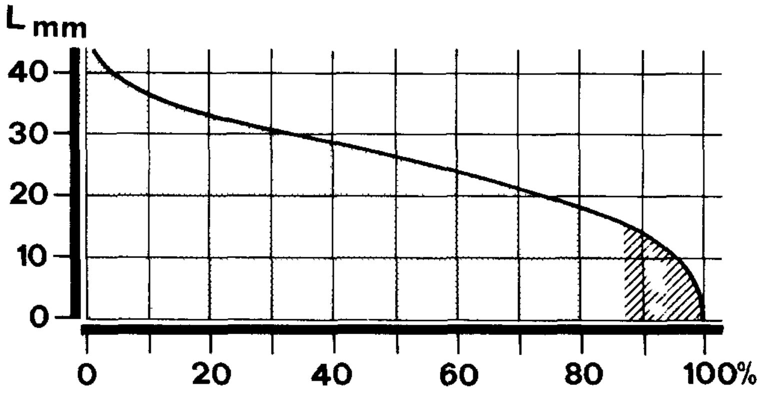
Cotton Fibre Staple Length

Type of fibre	Length (mm)
Short	Less than 20.6
Medium	20.6 to 25.4
Medium Long	26.2 to 27.8
Long	28.6 to 33.3
Extra Long	More than 34.9

Effect of Combing on Staple Length

Fibre Staple Diagram

The diagram obtained when the fibres in a tuft are arranged next to each other with their ends aligned and sorted according to length in a coordinate system.



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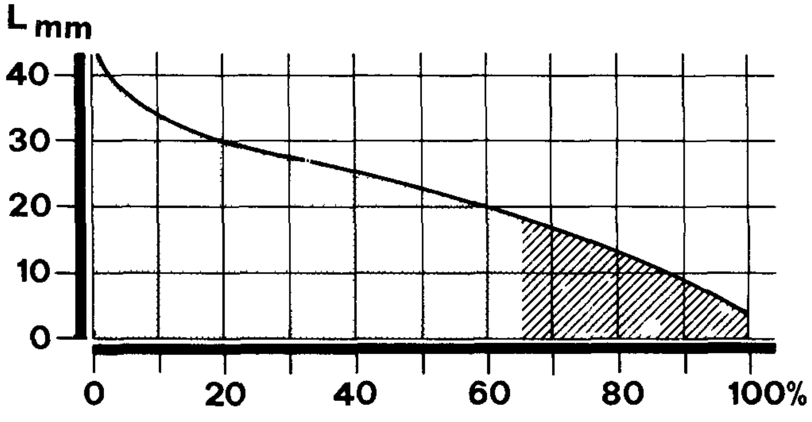

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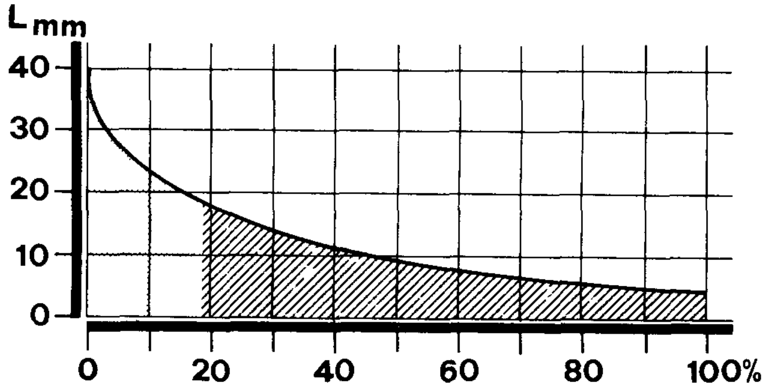
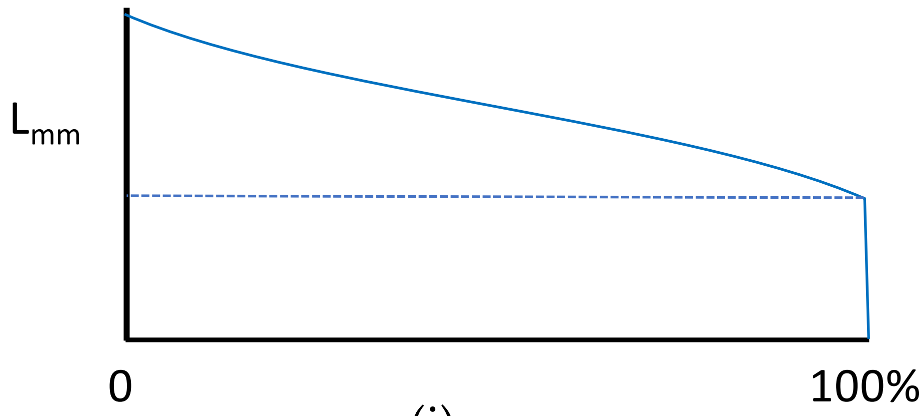


c

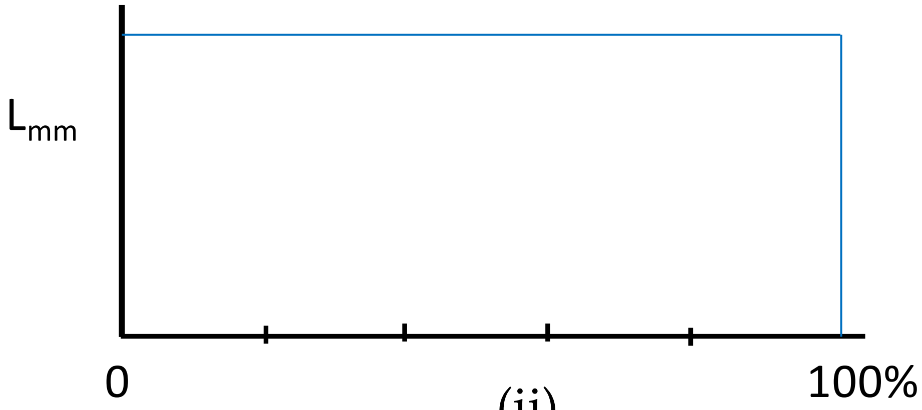
Staple diagram of cotton fibre: (a) Before combing, (b) after combing, (c) noil

Effect of Combing on Staple Length

How will be the staple diagrams if (i) all short fibres are removed and (ii) all fibres have equal length?



(i)



(ii)

Introduction to Combing

What is the purpose of combing operation?

To make the final yarn

- ✓ Cleaner
- ✓ Smoother
- ✓ Improved appearance
- ✓ More uniform
- ✓ Stronger
- ✓ Finer
- ✓ Softer

Comber Noil

Material rejected by the comber is known as "Noil".

$$\text{Noil}\,(\%) = \frac{Mass\ of\ noil}{(Mass\ of\ combed\ sliver + Mass\ of\ noil)} \times 100$$

Count range (tex)	Noil%	Yarn Type
7.5 -10	Less than 5	Scratch combed (upgrading)
7.5 -10	5-10	Semi-combed
6-7.5	10-18	Ordinary combed
5-6	More than 18	Super combed

Types of Application

Long Staple Combing Mills	Medium Staple	Short to Medium Staple
➢ Superior, expensive cotton of high strength. ➢ Low % of short fibres and trash ➢ Fine to very fine yarn ➢ Top quality ➢ Noil % is high(~ 25%) ➢ Lower production rate	▪ Medium quality cotton yarn with medium grade cotton ▪ Medium to fine count ▪ Good quality and economic production cost ▪ Average noil % (12-18%) ▪ High production rate.	✓ Same raw materials as that for carded yarn ✓ High production rate ✓ Lower noil % (6-14%) ✓ Technologically simpler ✓ Widely used in practice

Types of comber

- ✓ **Rectilinear comber** (short staple fibres)
- ✓ **Circular comber** (English worsted fibres)
- ✓ **Rotary comber** (Schappe spun yarns)
- ✓ **Hackling machine** (Bast fibres)

- ❑ **The short staple spinning mills use only the rectilinear comber.**
- ❑ Single sided m/c with 8 heads (almost all manufacturers)
- ❑ Double sided m/c with 12 heads (6+6)

Basic Elements of a Rectilinear Comber

Feeding elements:

- Consists of a feed plate and feed roll.
- To feed the comber lap in a series of short length.

Nipper plate:

- Grips the fibers as a means of holding long fibers
- Short fibers, neps and trash are removed.

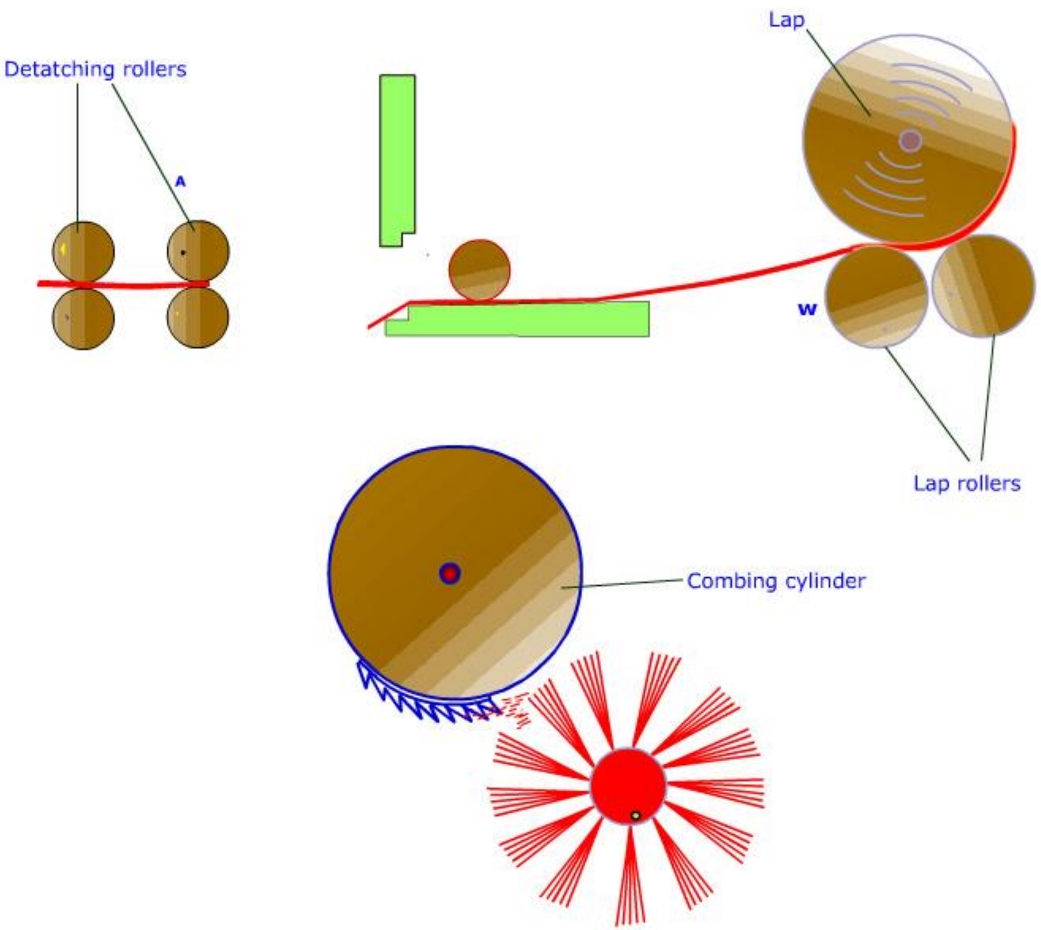
Combing system:

Consists of two combs:

- rotating bottom circular comb
- top comb completes the function of bottom comb

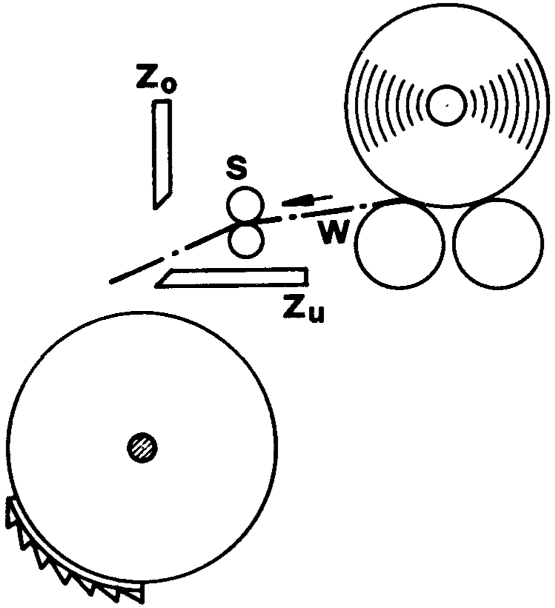
Detaching roller:-

- Two pairs of gripping rolls
- Rotate forward and backward in intermittent fashion



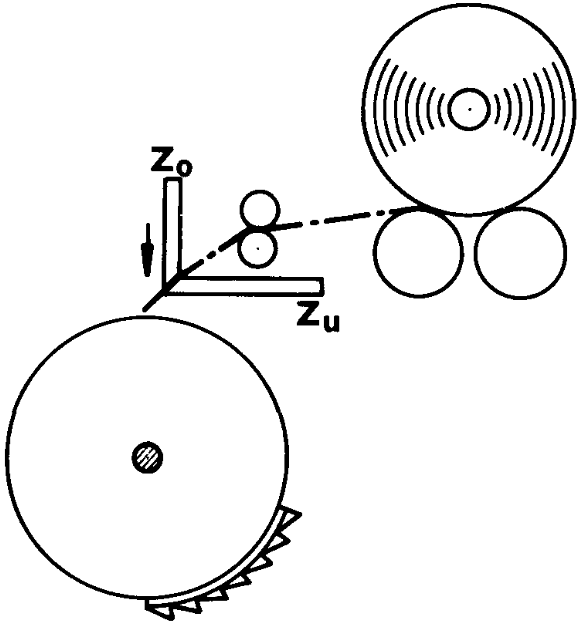
Operation of a Rectilinear Comber

Feeding



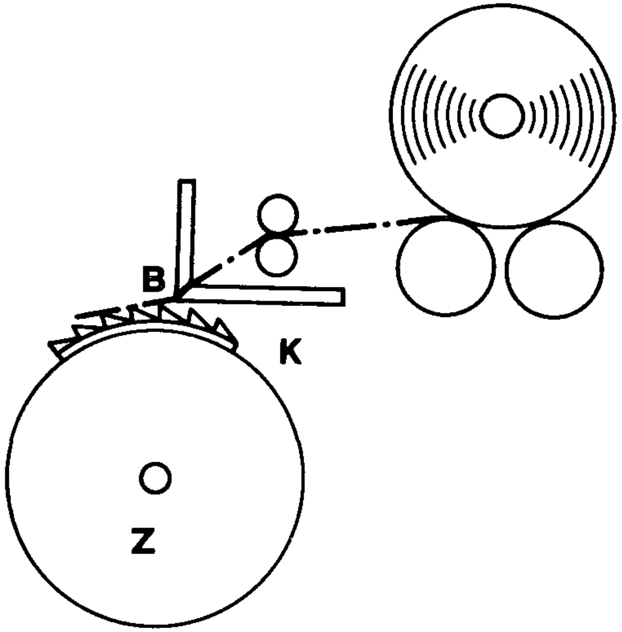
- Feed rollers 'S' move the lap sheet 'W' forward
- The nippers(Z_0 and Z_u) are held open.

Nipping



- The upper nipper plate Z_0 lowered on to cushion plate Z_u
- Fibres clamped between them.

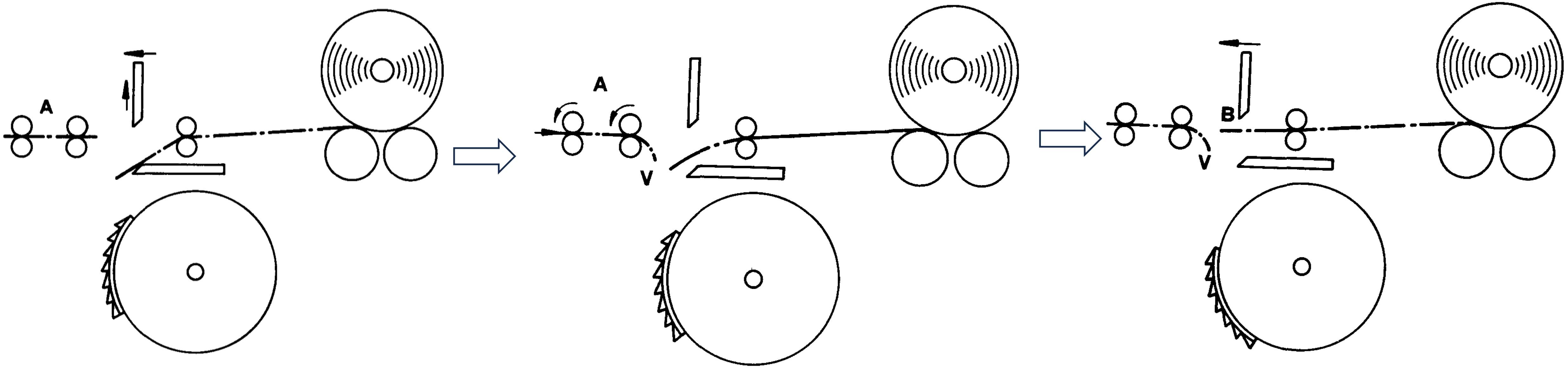
Rotary combing



- The cylinder combing segment (k) mounted on cylinder (z) combs the fibre fringe (B)
- Carry away anything not held by nippers.

Operation of a Rectilinear Comber

Nippers forward | **Web Return** | **Piecing**



Nippers forward

- The nippers open again.
- Nippers move towards detaching rollers (A).

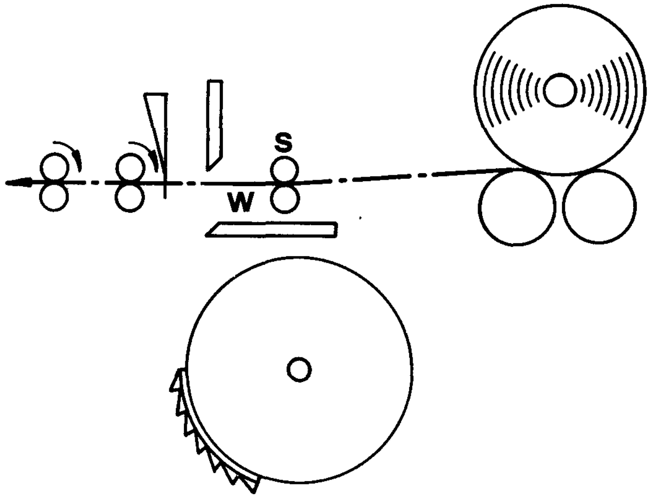
Web Return

- The detaching rollers return.
- Part of previously drawn web (V) returns back.

Piecing

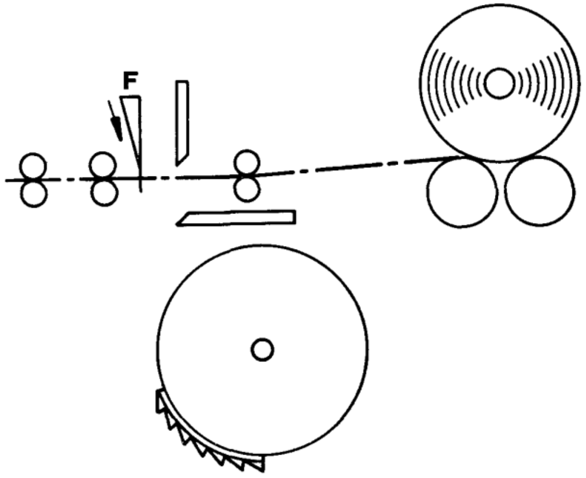
- During forward movement of nippers, the projected fiber fringe B is placed on web V.

Detaching



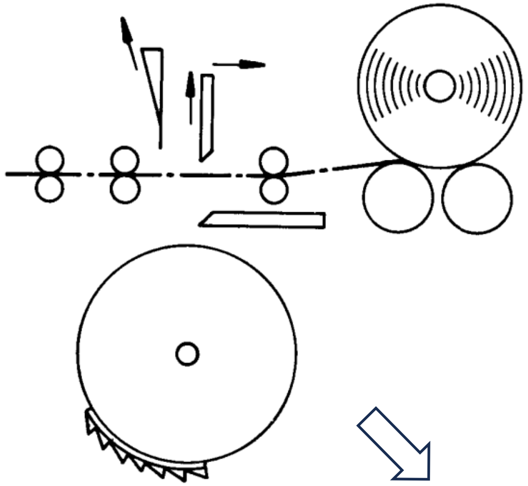
- Detaching rollers rotate forward
- Draw the clamped fibres out of the sheet 'W' held past by the feed rollers 'S'
- No up-down movement of top Comb. Penetration is due to detaching.

Combing by top comb

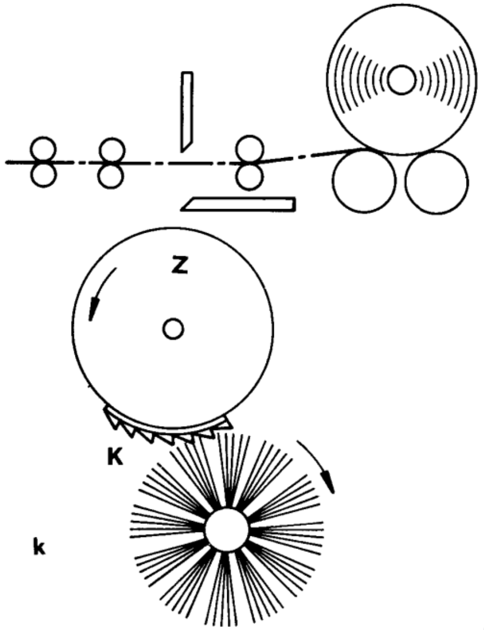


- Before the start of detaching, top comb 'F' comes in to action
- Single row of needles penetrates into the fibres fringe
- Trailing part of the fringe 'W' is combed

Returns of nipper assembly

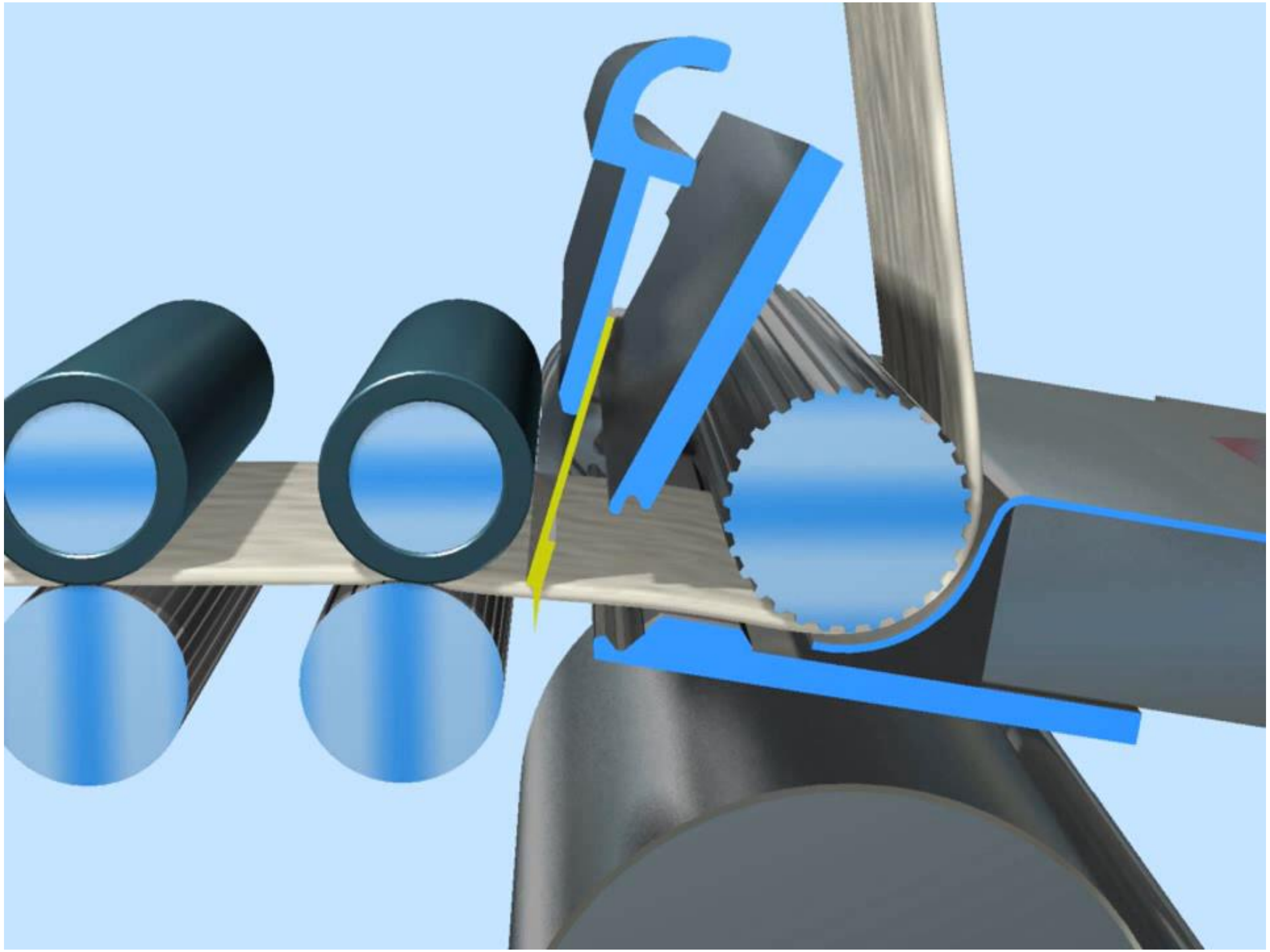


- Nipper assembly returns
- Nippers open for the next feed
- Top comb withdraws



- Combing cylinder rotates
- Brush roller stripes the combing segment

Operation of a Rectilinear Comber



Fibre Movement Through Combing Zone

NN1: Nipper action line

CC1: Line of action of cylinder comb

TT1: Line of action of Top Comb

AA1: Detaching roller nip

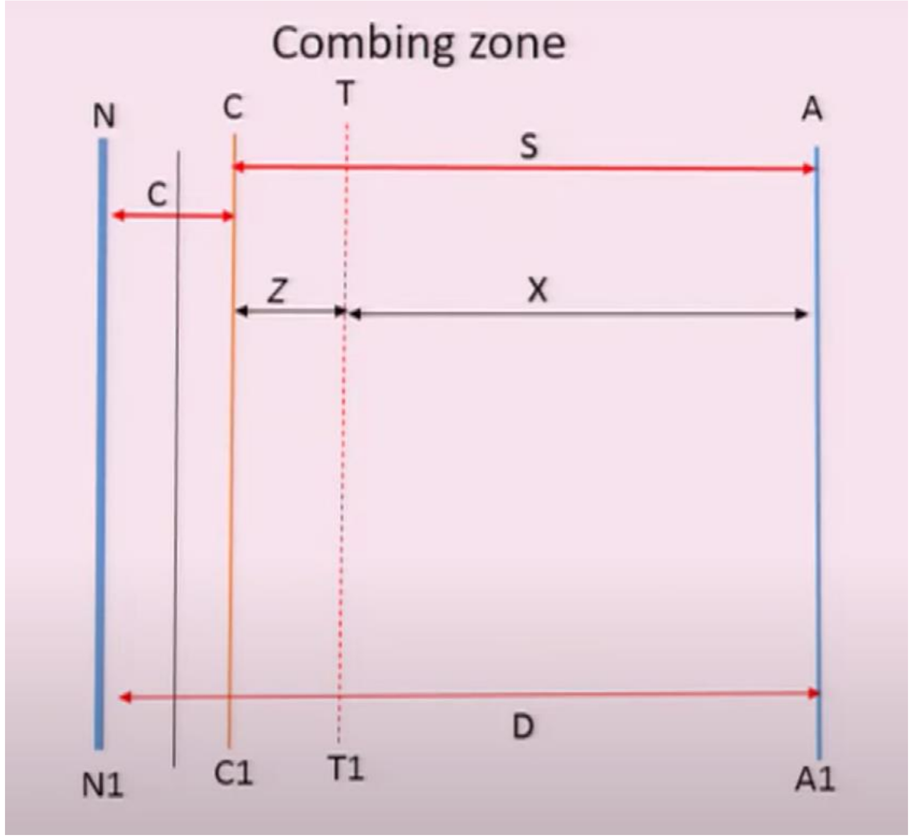
D: Detachment distance

S: Fringe length combed by cylinder comb.

C: Fringe length not combed by cylinder comb.

X: Distance between top comb and detaching roller nip.

Z: Overlapped length combed by both cylinder comb and top comb.



Fibre Movement Through Combing Zone

Assumption: All fibres are straight and parallel

f: Feed/nip

1st Cycle: A fibre arrives at the combing zone

b: Part of fibre projecting out

2nd Cycle:

b1: Projected out length combed by cylinder comb

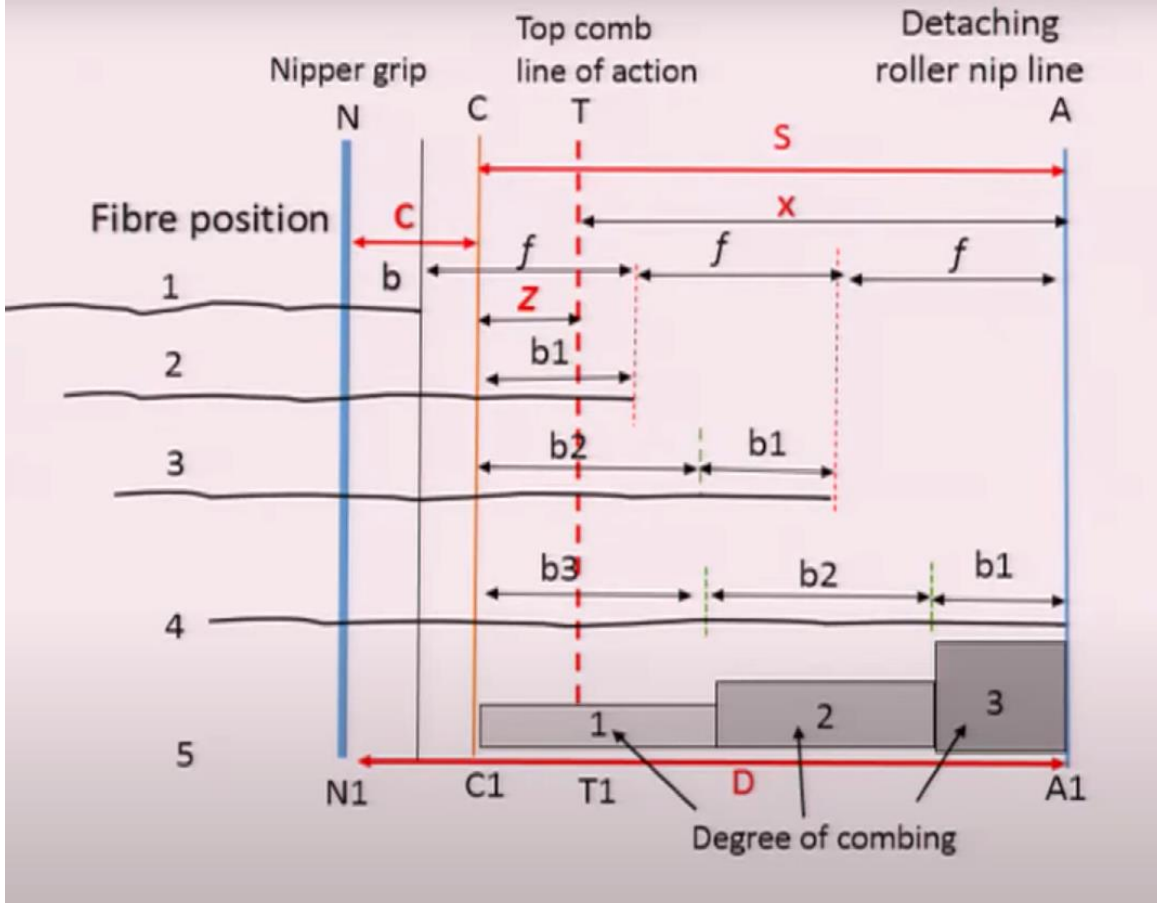
3rd Cycle:

b1 part gets combed twice and b2 once

4th Cycle:

b1 part gets combed thrice, b2 twice and b3 once

5th Cycle: Fibre is detached from fringe by detaching roller

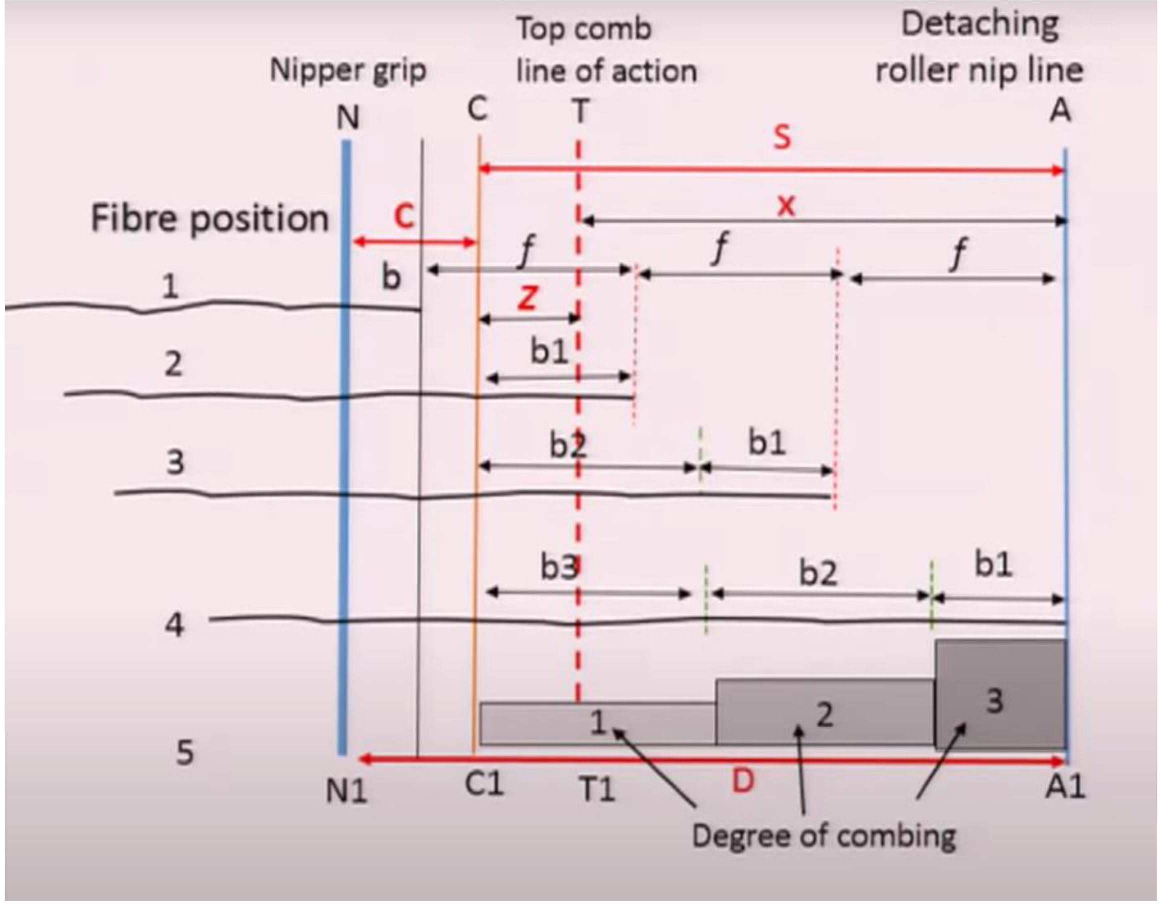


Degree of Combing

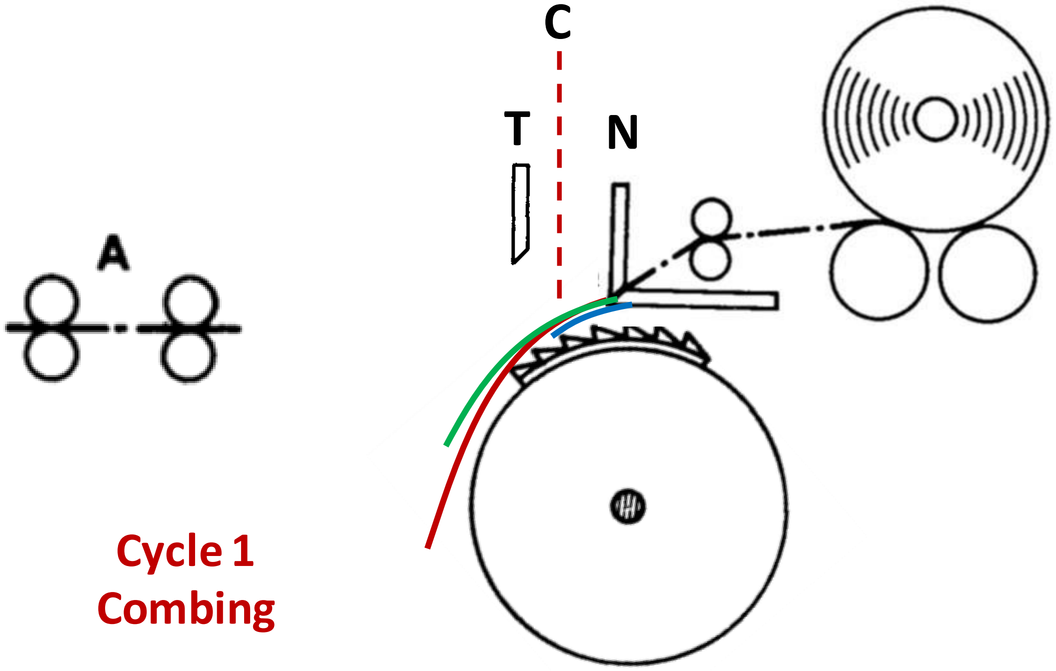
$$\text{Overlap Zone} = Z = D - (c + x)$$

Degree of combing (DC) is the number of times a fibre end gets combed while passing through the combing zone.

$$DC = \frac{(D - C)}{f} = \frac{S}{f}$$

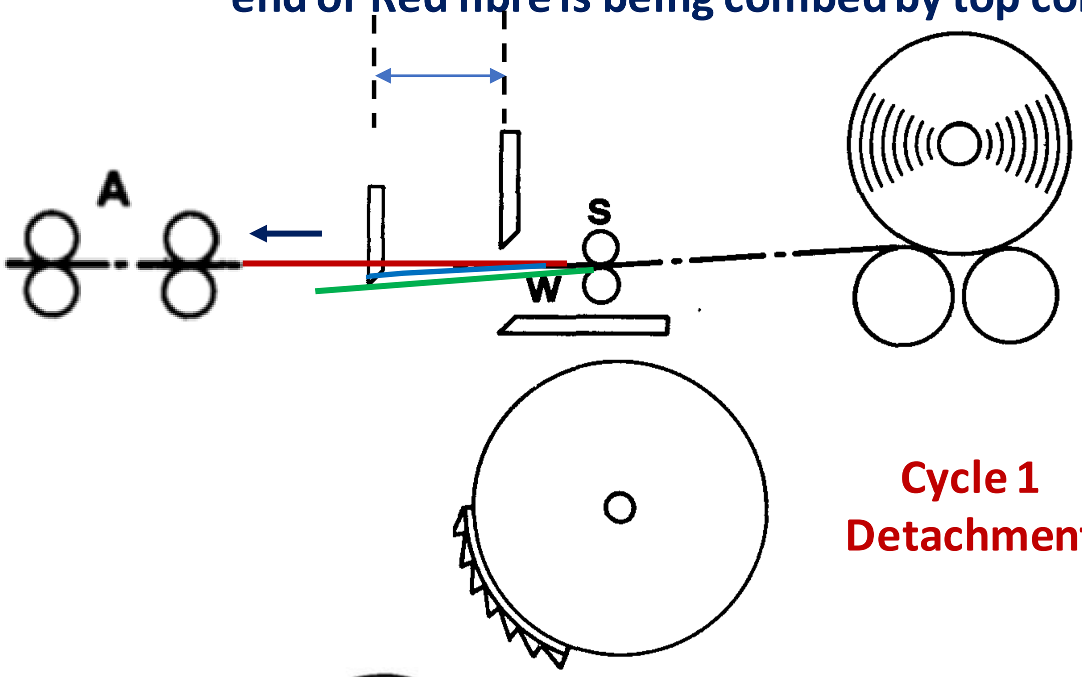


Red and Green fibres are being combed by cylinder comb. Blue fibre did not reach the cylinder comb.

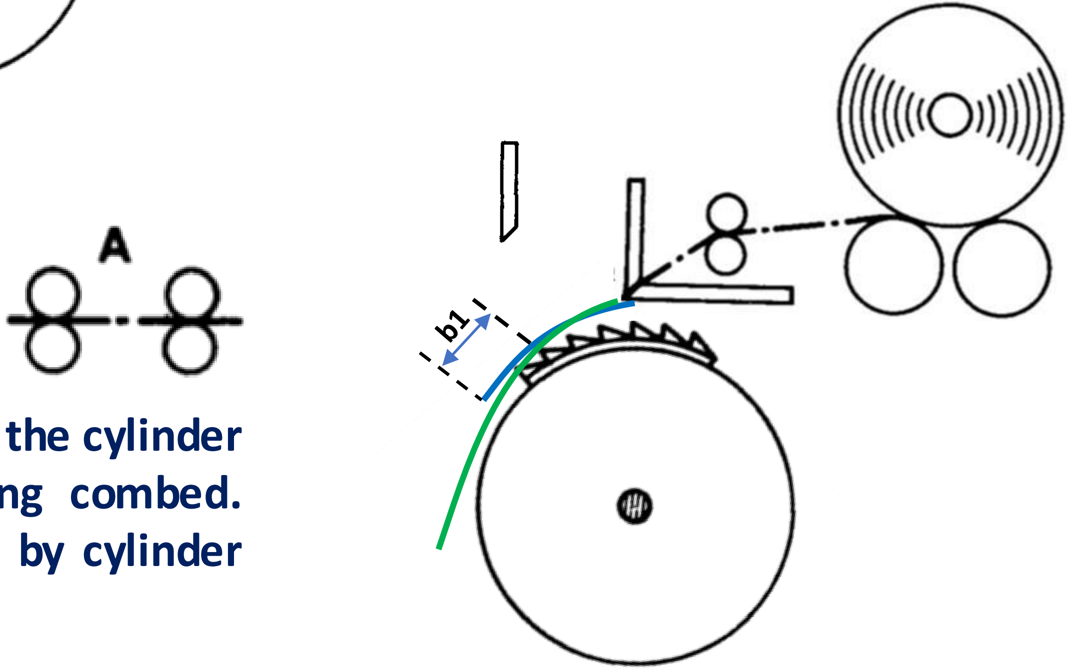


Cycle 1
Combing

Red fibre is being detached and the trailing end of Red fibre is being combed by top comb.



Cycle 1
Detachment

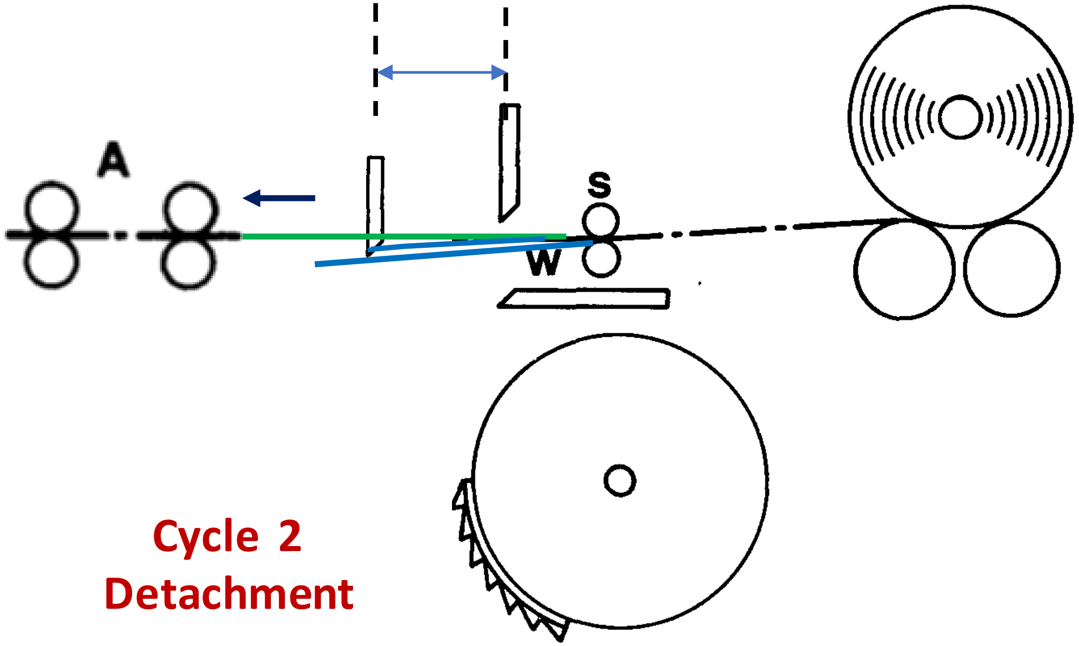


Cycle 2
Combing

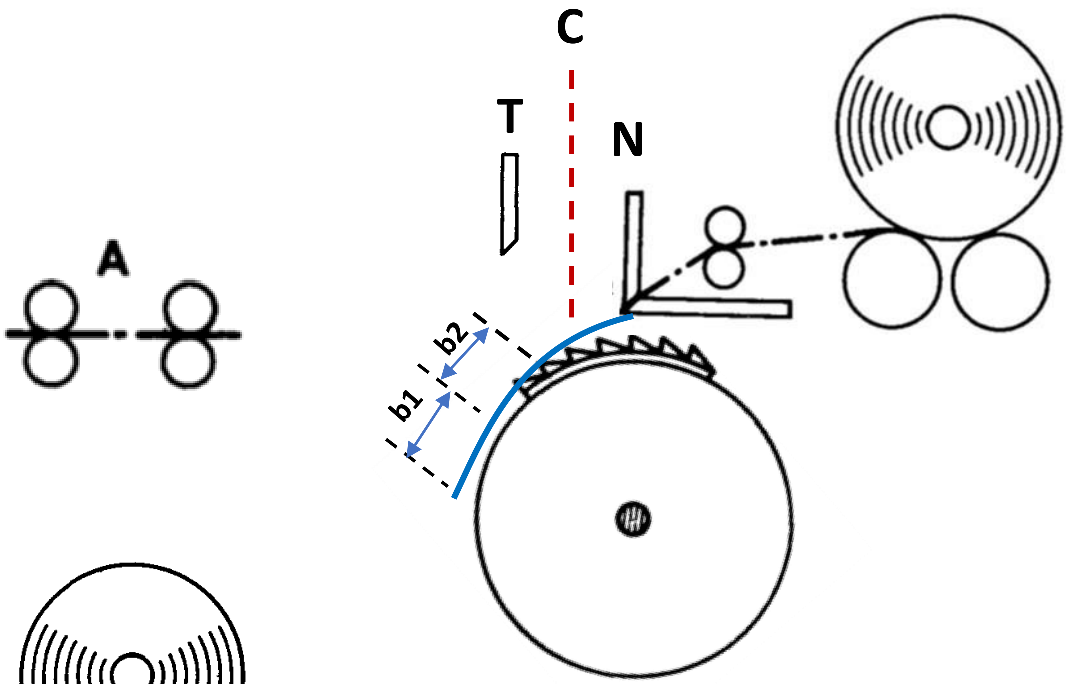
Due to feeding, Blue fibre reached the cylinder comb and the length b1 is being combed. Green fibre is also being combed by cylinder comb.

Green fibre is being detached and the trailing end of Green fibre is being combed by top comb.

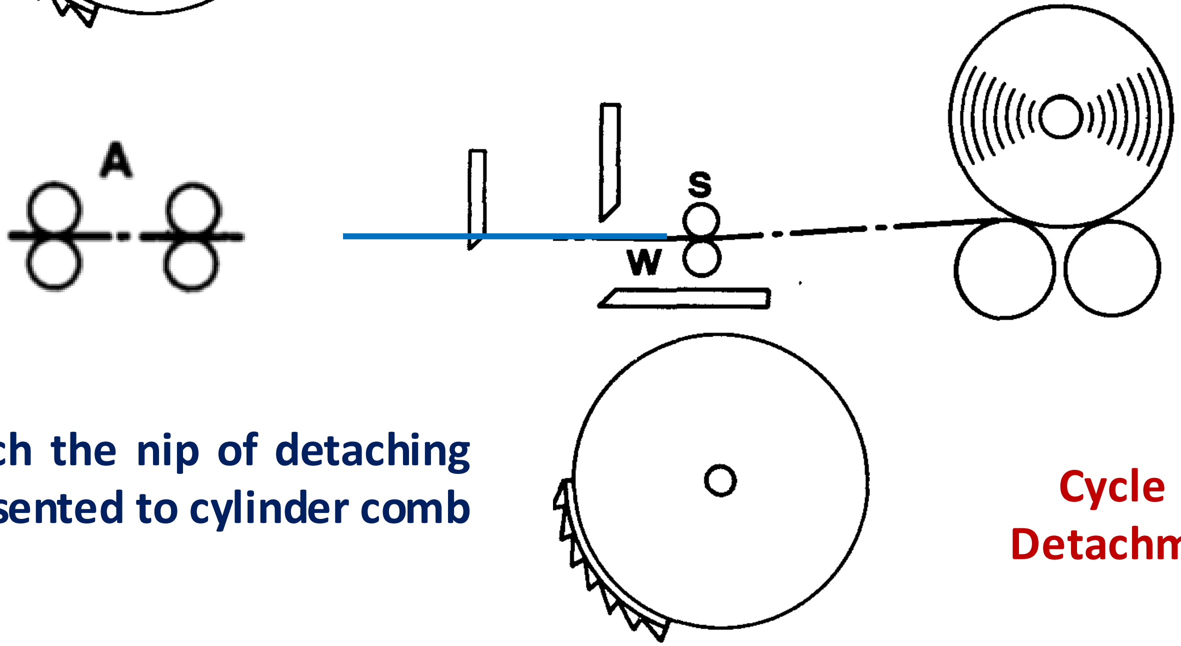
Due to feeding, new length b2 will be presented to cylinder comb. Length b1 will be combed again.



Cycle 2
Detachment

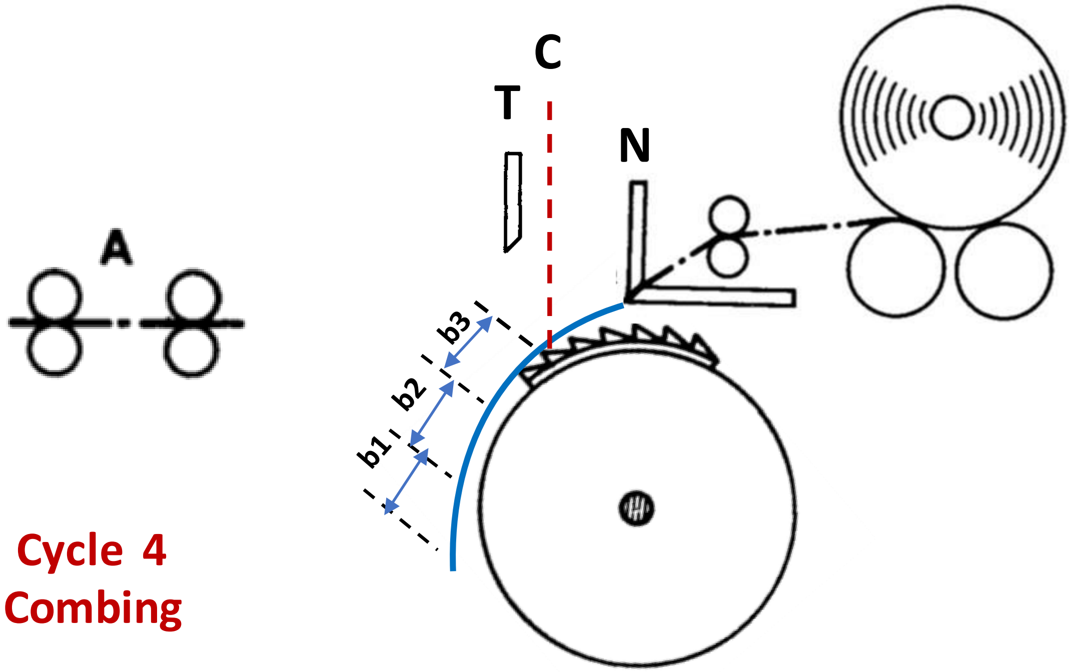


Cycle 3
Combing



Cycle 3
Detachment

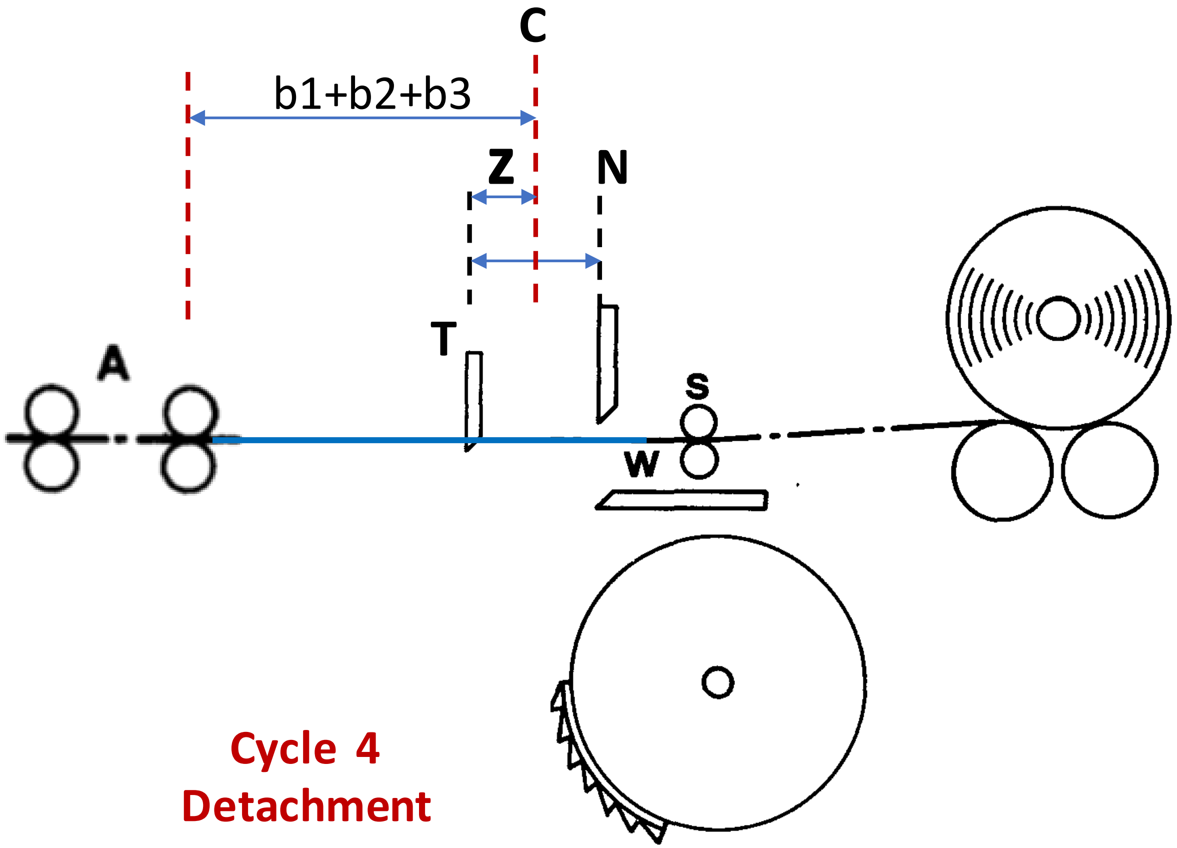
Blue fibre did not reach the nip of detaching roller. So, it will be presented to cylinder comb again in the next cycle.



Cycle 4
Combing

Due to feeding, new length b3 will be presented to cylinder comb and combed. Length b1 and b2 will be combed again.

Blue fibre is being detached and the trailing end of Blue fibre is being combed by top comb.



Cycle 4
Detachment

In the overlapping zone, 'Z' the fibre is combed by both cylinder and top comb.

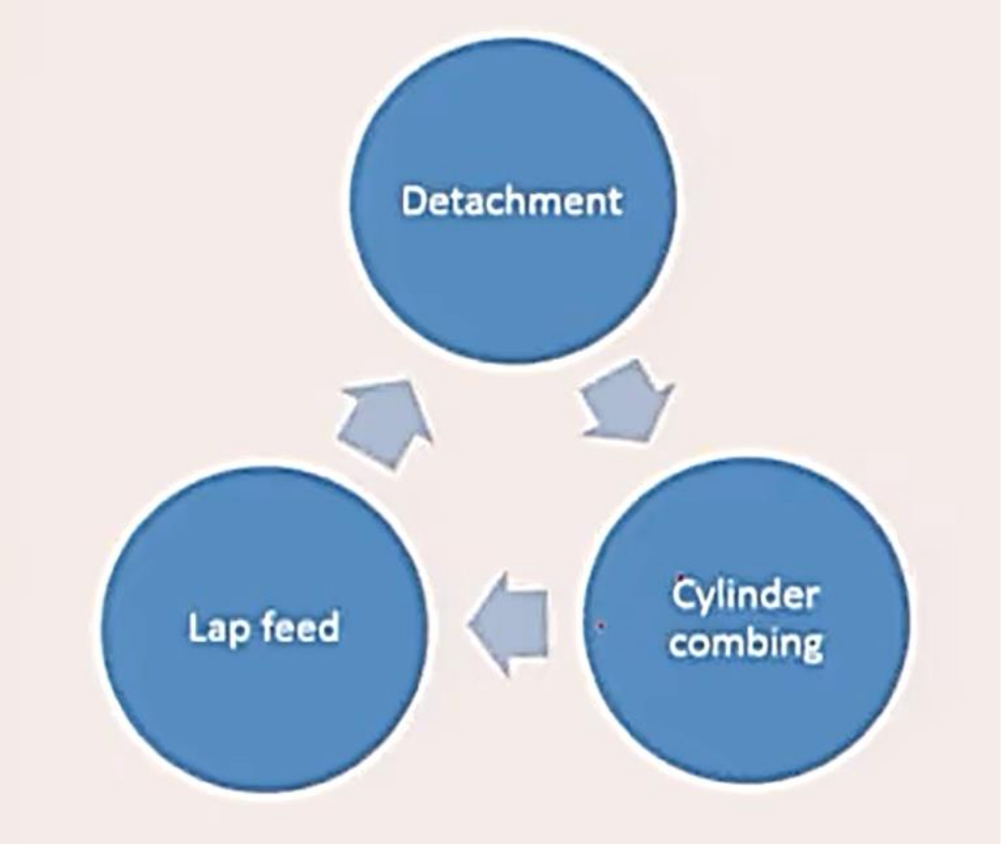
Conclusions?

- ✓ A fibre is subjected to different degrees of combing while passing through the combing zone.
- ✓ The intensity of cylinder combing reduces from leading to trailing end.
- ✓ Some portions of the fibres are combed by both cylinder and top comb.
- ✓ The trailing part of the fibre is combed by only top comb.

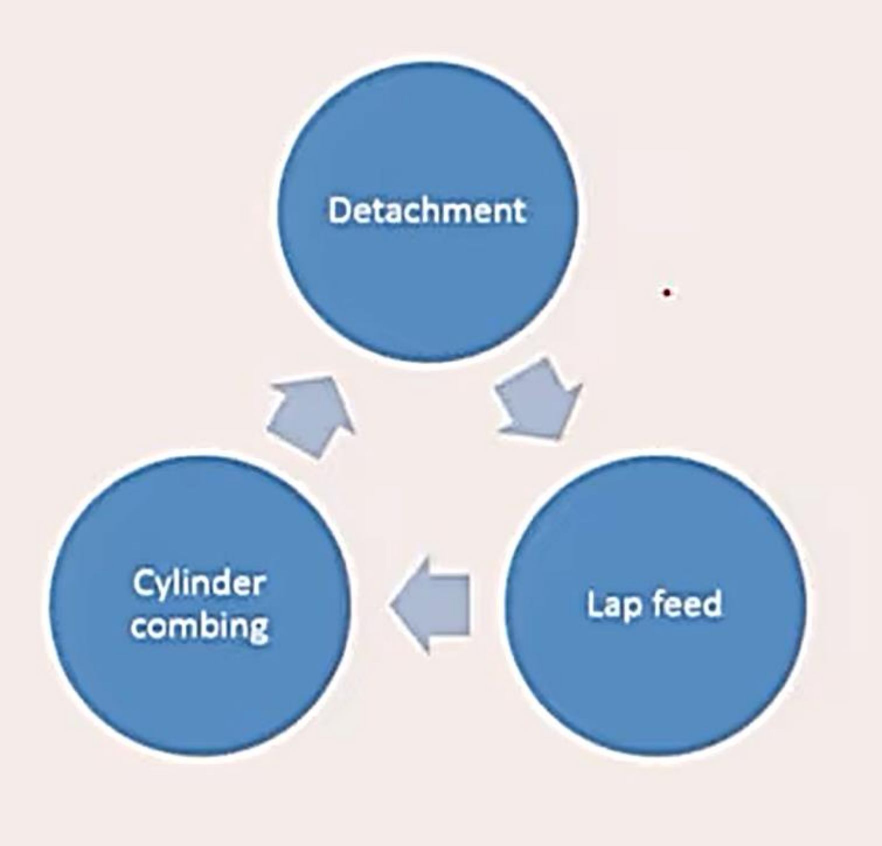
Types of Feeding

Forward Feed: Feeding occurs during forward movement of nippers

Backward Feed: Feeding occurs during backward movement of nippers



FDC

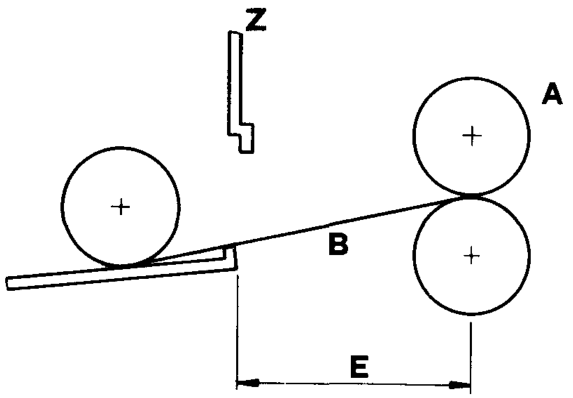


FCD

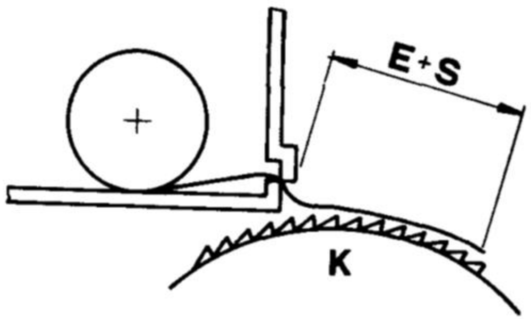
Estimation of Noil%

Backword Feed

Z– nippers
A – detaching rollers
B – fibre fringe protruding from nippers
E – detachment setting
S – Feed length

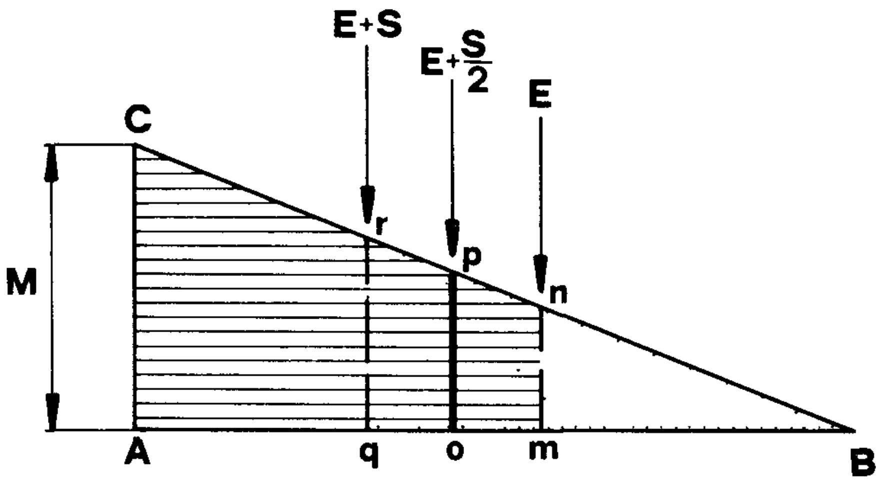


Detaching



Cylinder Combing

- Detaching rollers draw off all fibres longer than E.
- Fibres of length < E and not gripped by detaching rollers and will be retained by top comb
- Fibres shorter than 'E+S' are carried away to noil by cylinder comb, fibres > E+S go to combed sliver

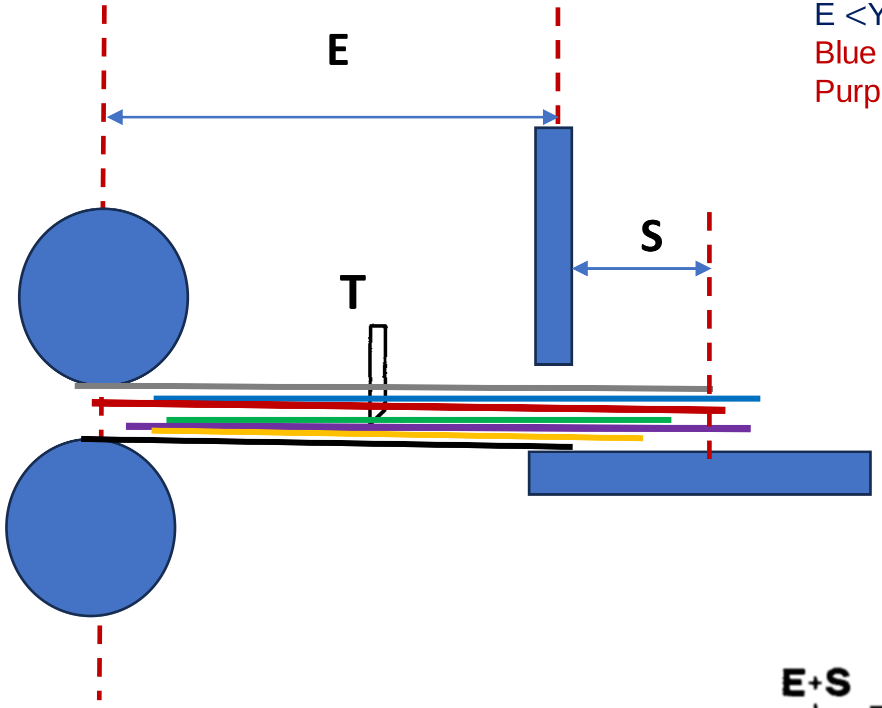


- During detachment: *All fibres to the left of 'm-n' should go to combed sliver.*
- During combing: *All fibres to the left of 'q-r' should go to combed sliver.*

Backward Feed

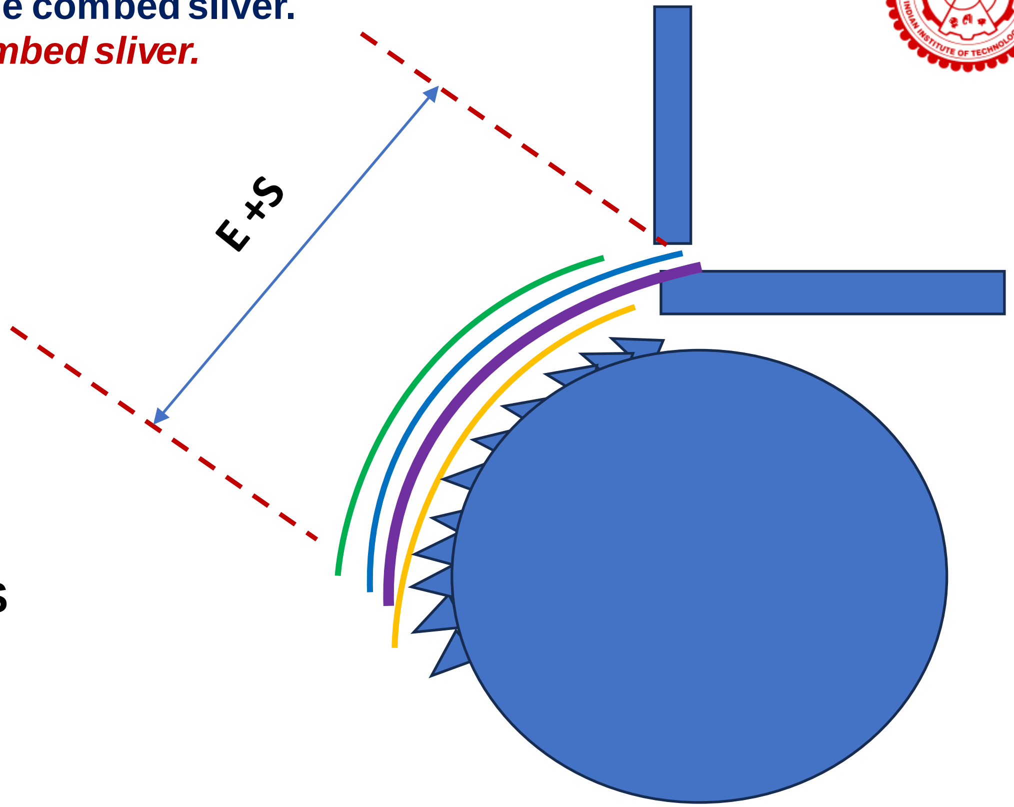
Fibres longer than E (if gripped by the detaching rollers) get detached and go to the combed sliver.

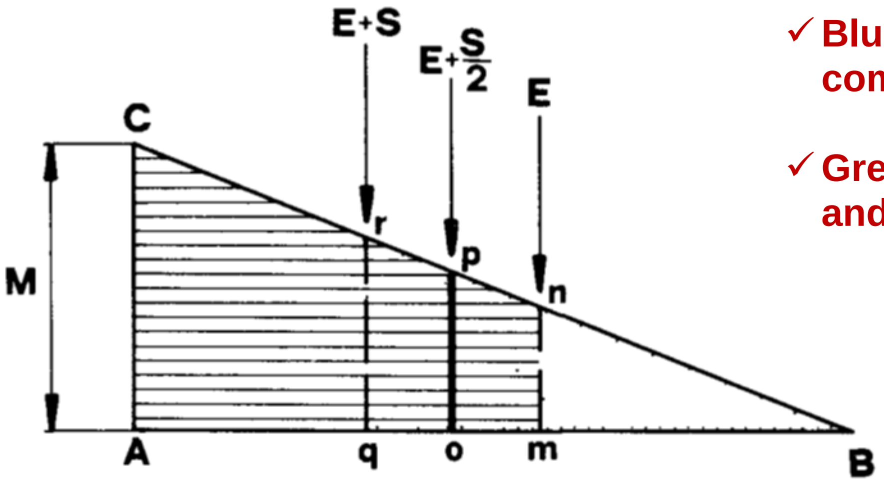
✓ ***Red, black and grey fibres are gripped by the detaching rollers and go to the combed sliver.***



E <Green fibre length < E+S
E <Yellow fibre length > E +S
Blue fibre length > E+S
Purple fibre length > E+S

After feeding fringe length becomes E+S





✓ **Blue and purple fibres having length >E+S will be nipped during combing and will remain in the combed fringe.**

✓ **Green and yellow fibres having length <E+S will not be nipped and will be removed by cylinder comb.**

$$\textit{Boundary Length} = E + \frac{S}{2}$$

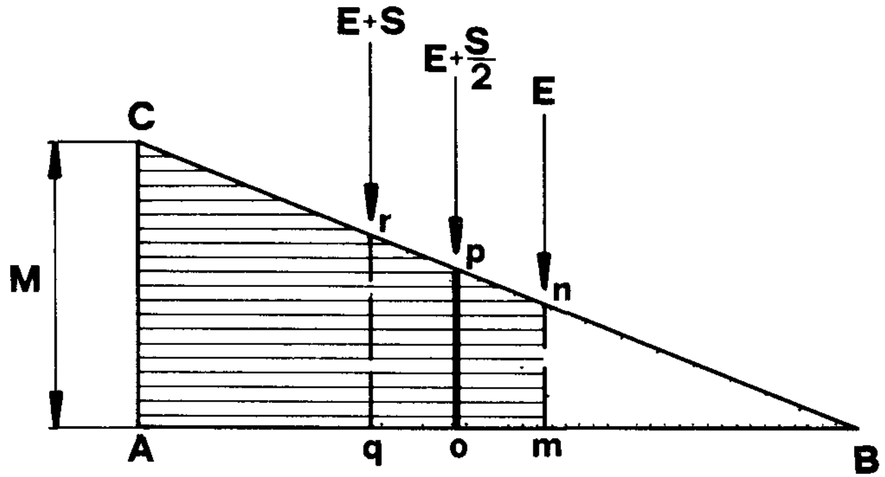
$$\textit{Noil} = P\,\% = \frac{\triangle oBp}{\triangle ABC} \times 100$$

$$= \frac{op^2}{AC^2} \times 100$$

$$= \frac{(E+\frac{S}{2})^2}{M^2} \times 100$$

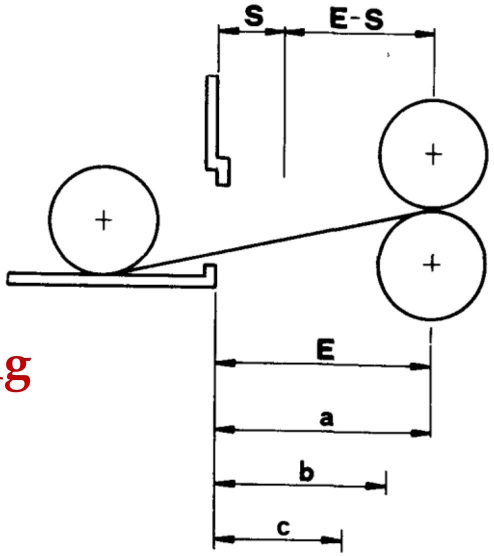
Noil increases when:

E and S increases

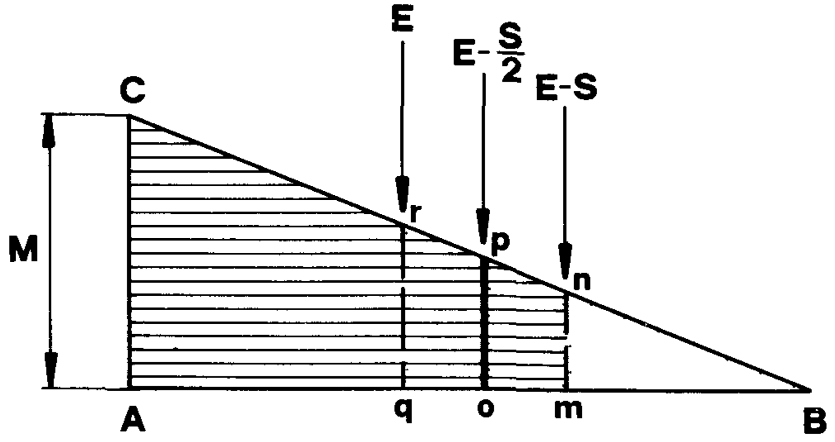


Staple diagram

Forward Feed



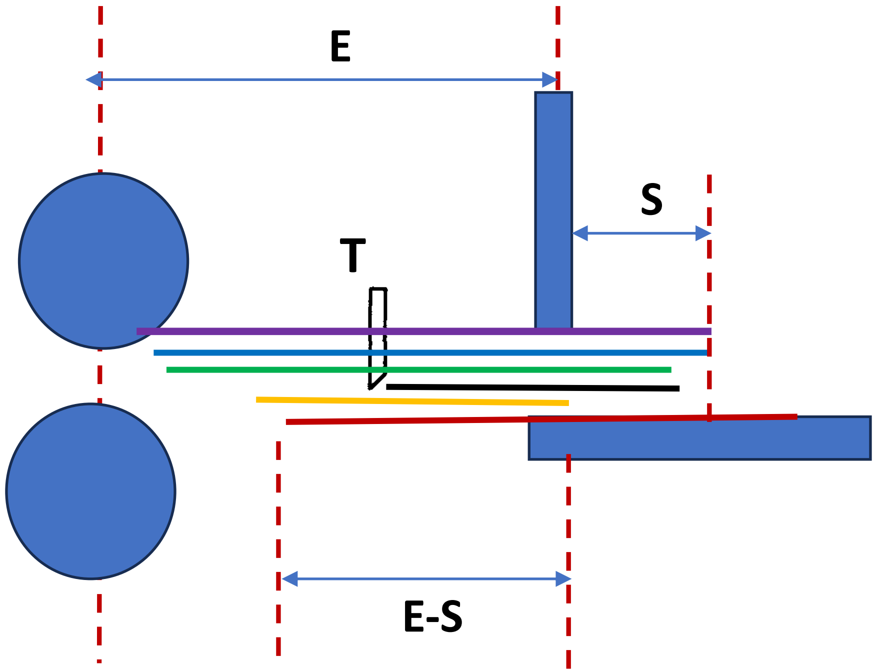
Detaching



Staple diagram

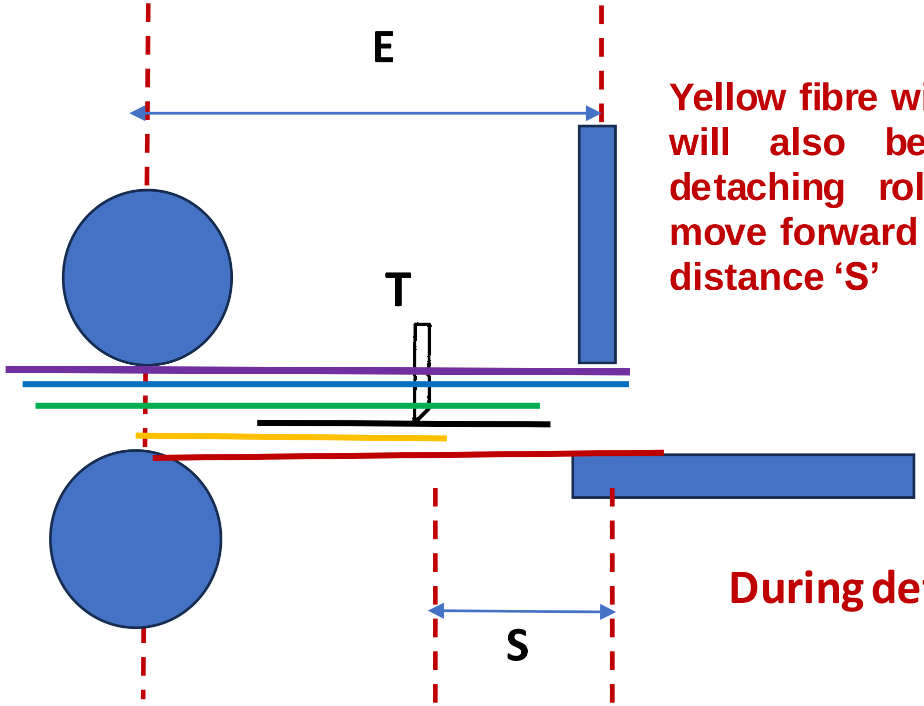
Noil% ?

Forward Feed



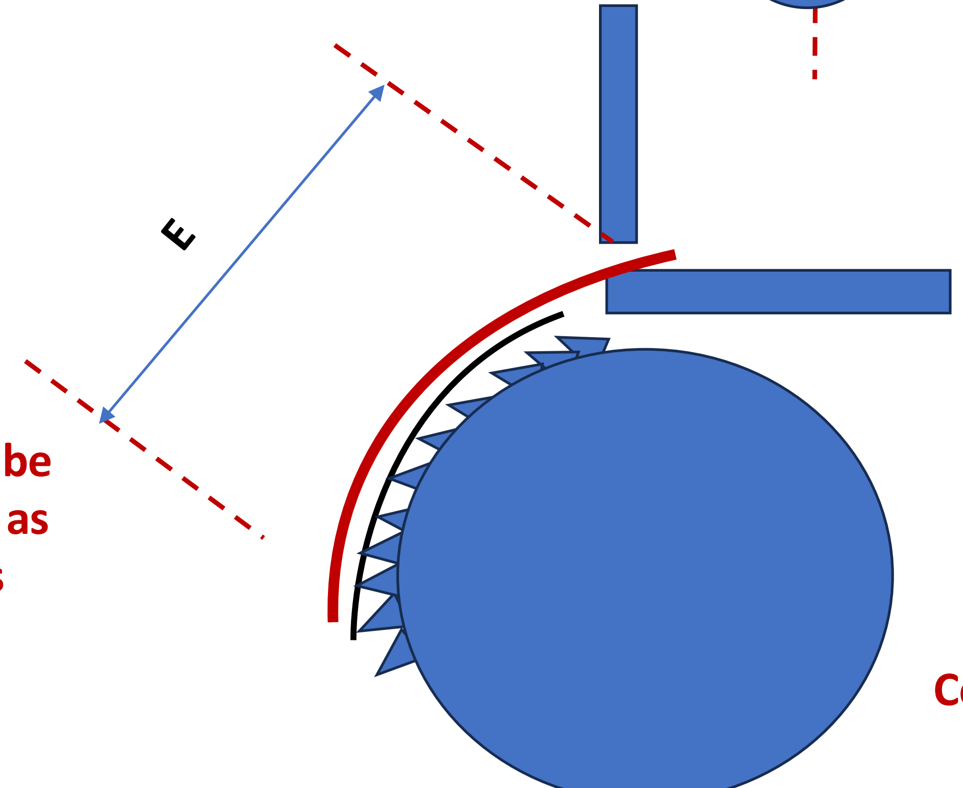
Before feeding

Feeding



Yellow fibre with length >E-S will also be gripped by detaching roller as it will move forward by the feeding distance 'S'

During detachment



Combing

- ✓ Black fibre with length < E will be removed by the cylinder comb as it is not gripped by the nippers

- ✓ Red fibre with length > E could not be detached and will be combed in the next cycle.
- ✓ Red fibre will not go to noil as it is gripped by the nippers.

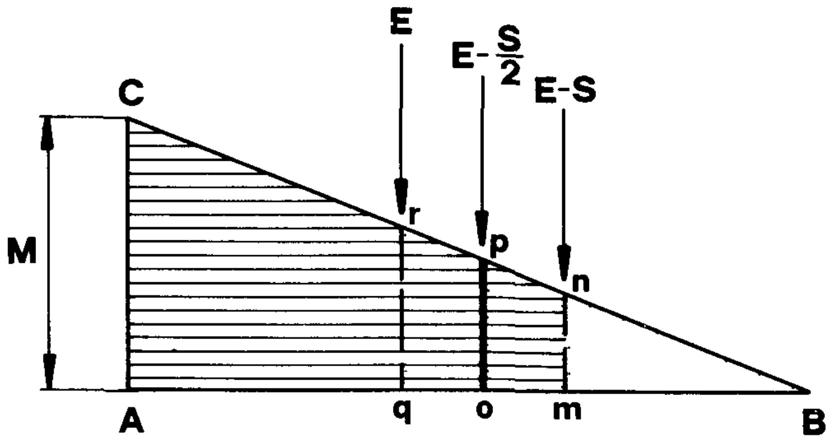
Forward Feed

$$\textit{Boundary Length} = E - \frac{S}{2}$$

$$\textbf{Noil} = P\,\% = \frac{\triangle oBp}{\triangle ABC} \times 100$$

$$= \frac{op^2}{AC^2} \times 100$$

$$= \frac{(E - \frac{S}{2})^2}{M^2} \times 100$$



Noil increases when:

E increases and S decreases

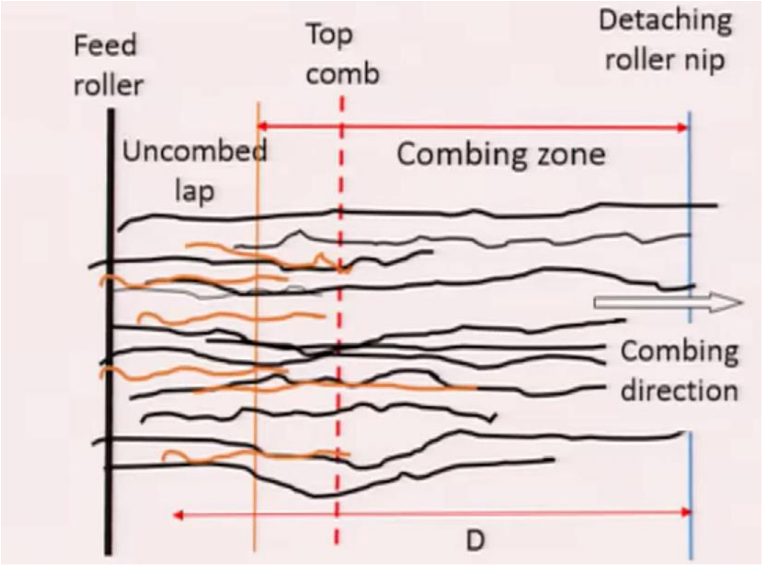
	Backword Feed	Forward Feed
Longest fibre going to noil?	E+S	E
Shortest fibre going to sliver?	E	E-S
Fibres definitely going to sliver?	Longer than E+S	Longer than E

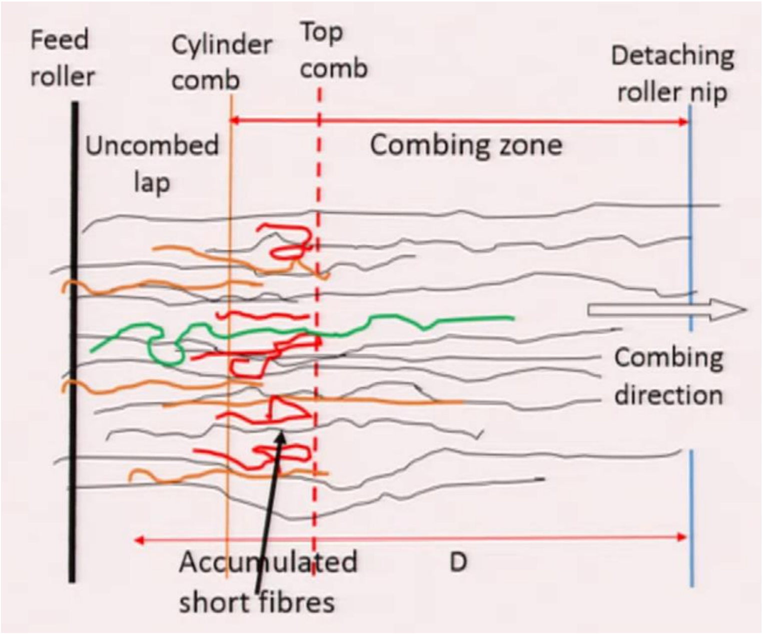
Mechanism of Noil Extraction

- **Trailing end of fibres will be deeply embedded within the uncombed fibres during detachment**

- **Detaching fibres will draw other free fibres which will accumulate behind the top comb.**

- ***Accumulated fibres will be removed by cylinder comb in the next cycle.***





Therefore, removal of short fibres does not take place merely due to action of cylinder comb, it occurs due to the action of the top comb needles.

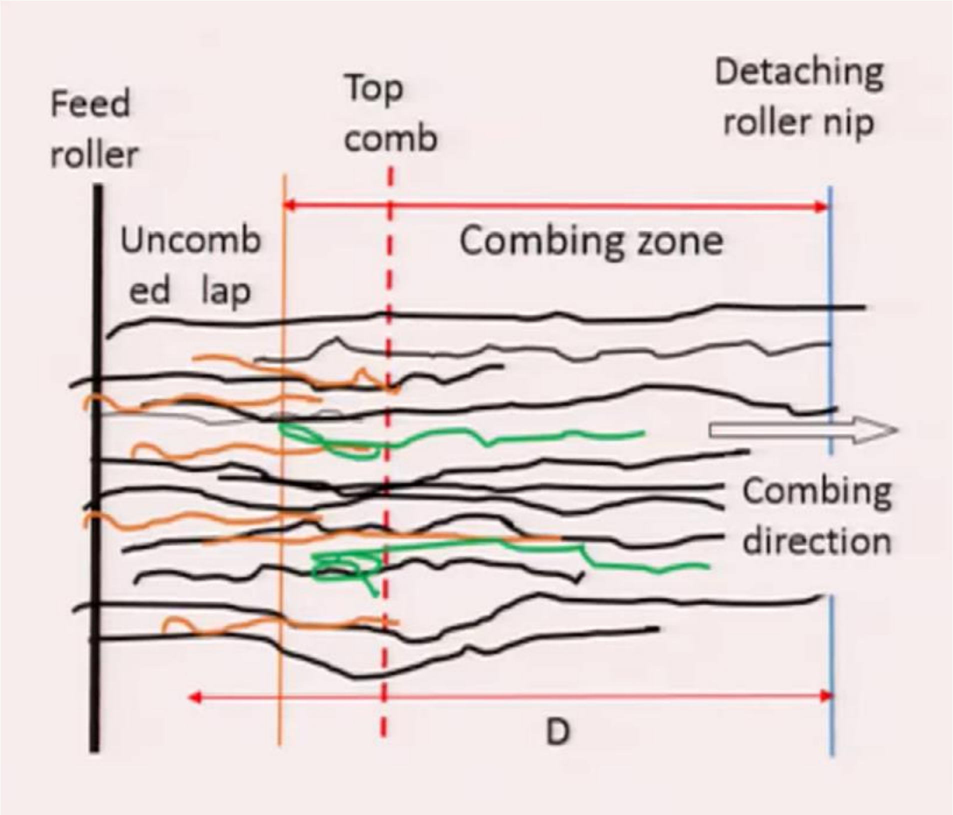
The major task of cylinder comb is to remove accumulated fibres behind the top comb.

Mechanism of Noil Extraction

✓ *Top comb accounts for about 80% of total waste removed by a comber.*

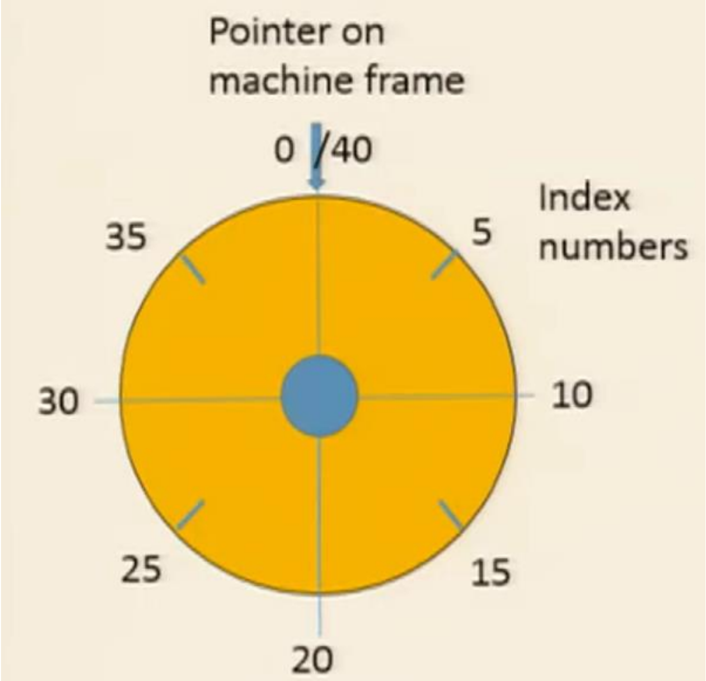
- Front end of long fibres remains undisturbed as it is held by the top comb needles.
- Back portion of the fibres is accelerated by other fibres being withdrawn and accumulate behind the top comb.

Some long fibres which are accumulated behind the top comb are also removed by the cylinder comb



Timing Diagram

- ✓ Index wheel facilitates setting of machine elements corresponding to various operations.
- ✓ Index wheel is mounted on the cylinder comb shaft.
- ✓ Index wheel has 40 marks on its periphery.
- ✓ Marks are read against a pointer on the machine frame.



Index Wheel

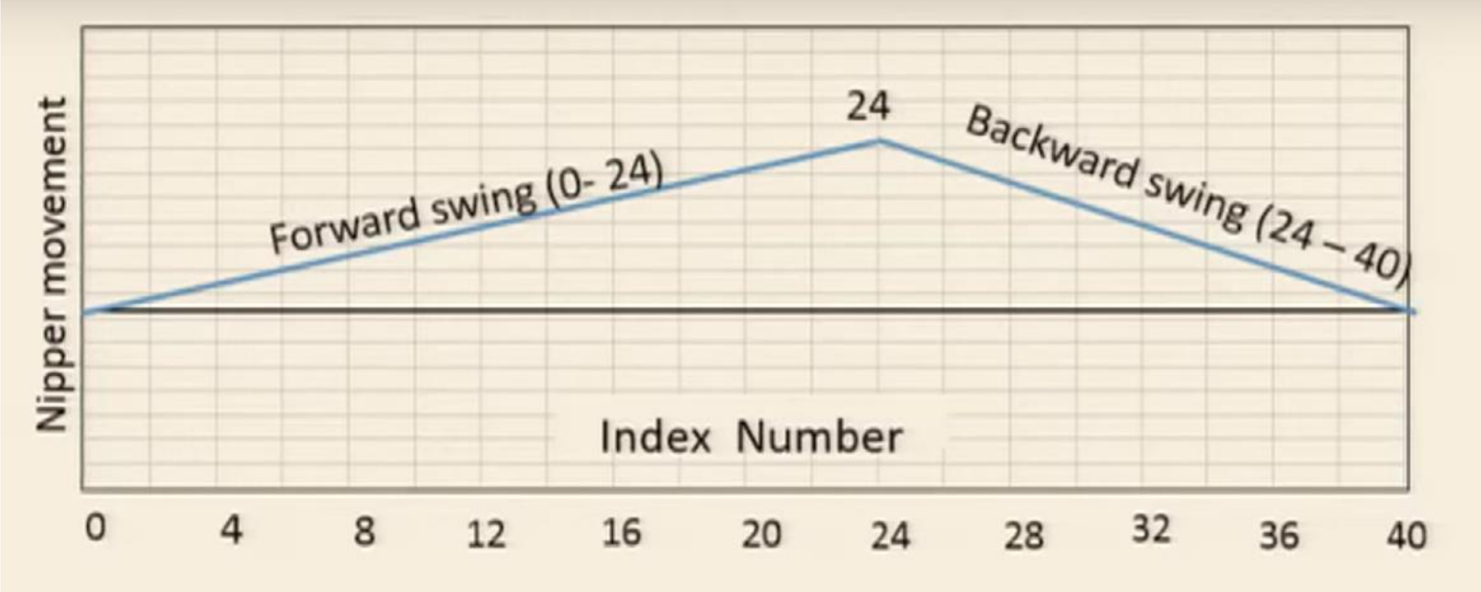
Timing Diagram

Timing for Nipper Oscillation

Nipper assembly has
- ✓ Back & forth oscillating movement
- ✓ Opening and closing movements

More time is given to nipper assembly for its forward journey. Why ?

Higher speed leads to more air drag on the fibre fringe resulting in buckling of fibres which affect piecing quality.



Forward: backword journey = 60:40

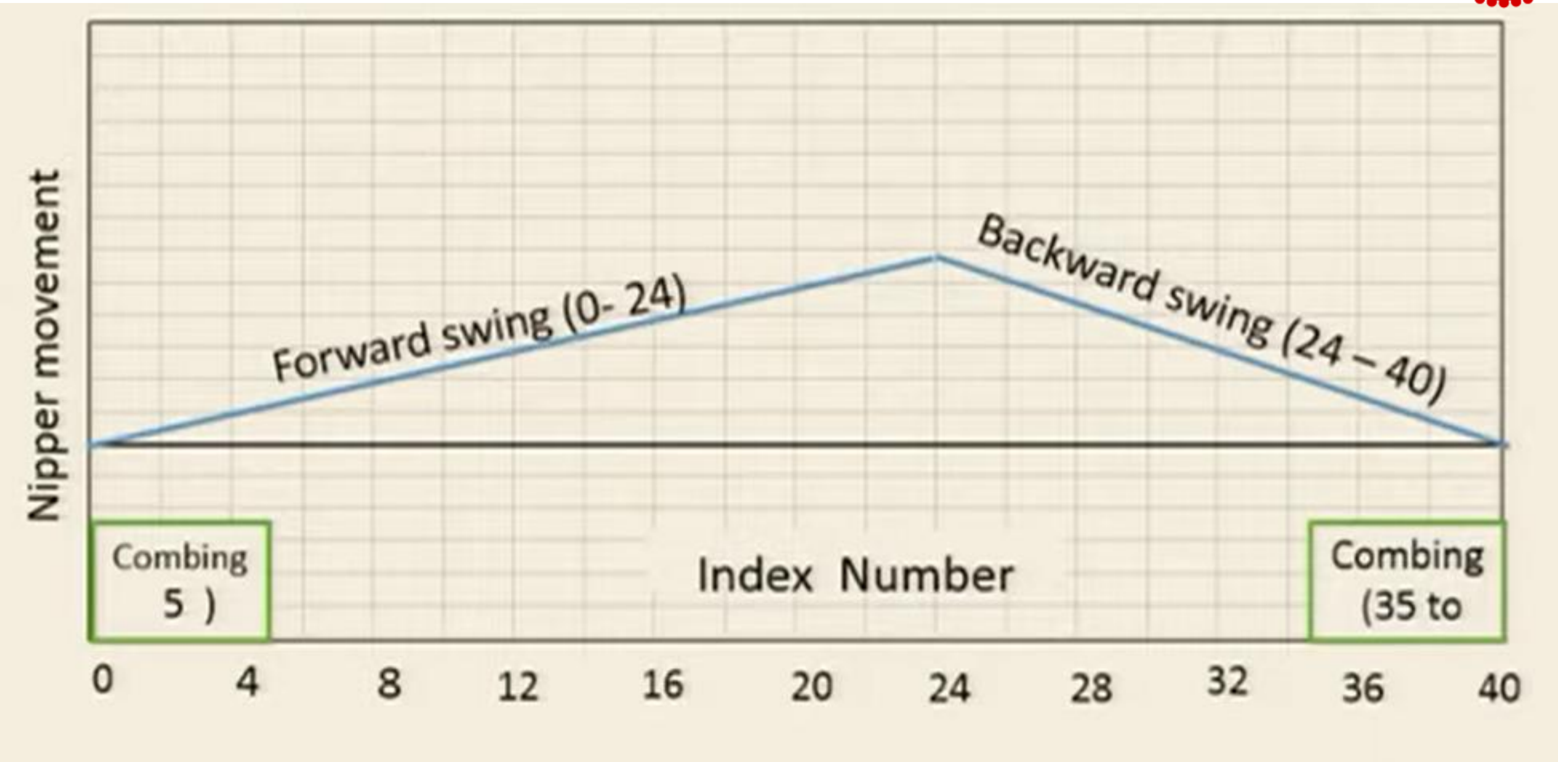
Forward journey: 40 × 0.6 = 24 Index numbers

Backword journey: 40 × 0.4 = 16 index numbers

Cylinder Combing

When cylinder combing should start?

When nipper assembly is farthest from the detaching roller.



- ✓ Cylinder combing is allotted ¼ th cycle time, i.e. 10 index number.

- ✓ So, ¼ th surface of cylinder comb is cover with combing needles.

Opening & closing of Nipper plates

When nipper plates should be closed?

Nipper plates should remain closed during cylinder combing.

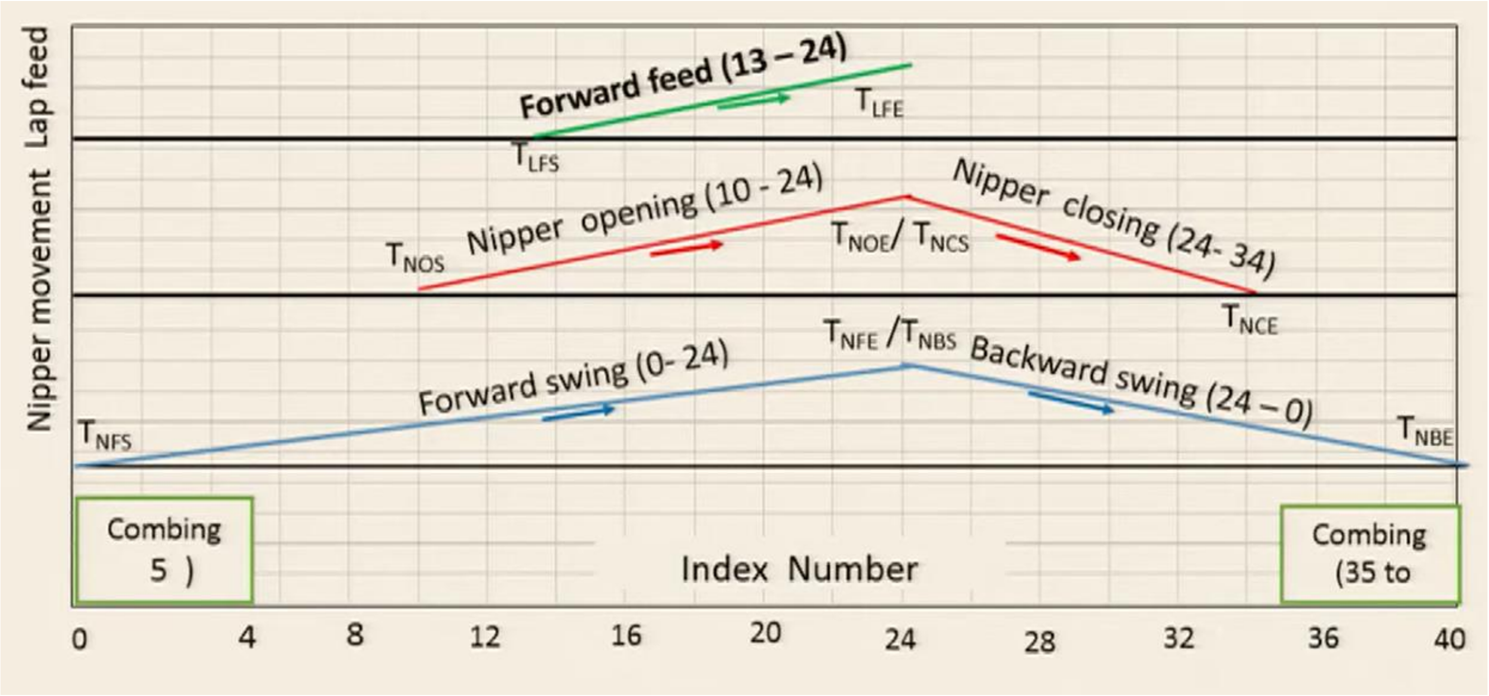
So, nipper assembly is remain closed for 10 + 4 (safety allowance) index numbers

So, the time available for opening and closing of nipper plates is (40-14), i.e., 26 index numbers.

Opening: closing = 60:40

Opening: 16 index numbers
Closing : 10 index numbers

Lap feed timing



Forward Feed:

Feeding should occur:

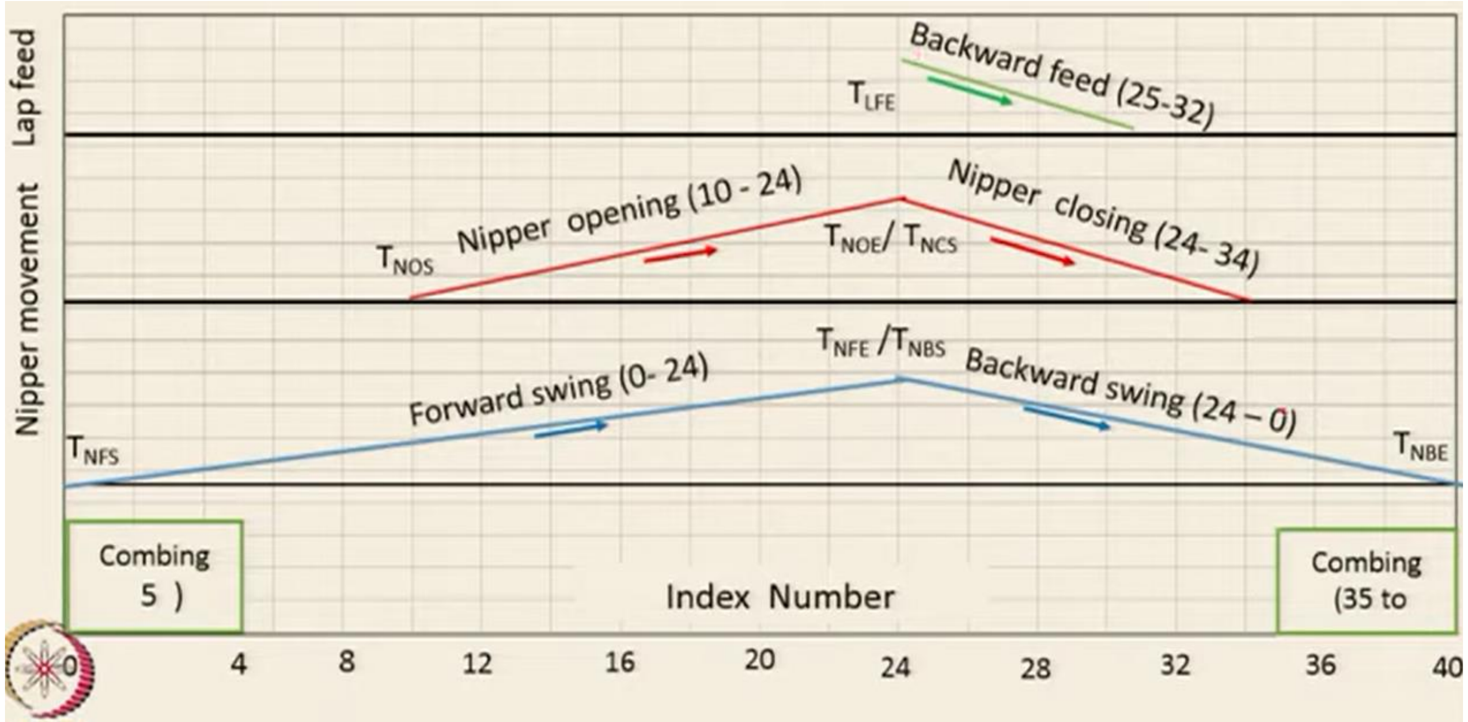
- ✓ During forward movement of nippers.
- ✓ When the nipper assembly remains open.
- ✓ After the cylinder combing is over.

Lap feed timing

Forward Feed:

Feeding should occur:

- ✓ During backward movement of nippers.
- ✓ When the nipper assembly remains open.
- ✓ Prior to start of the cylinder combing

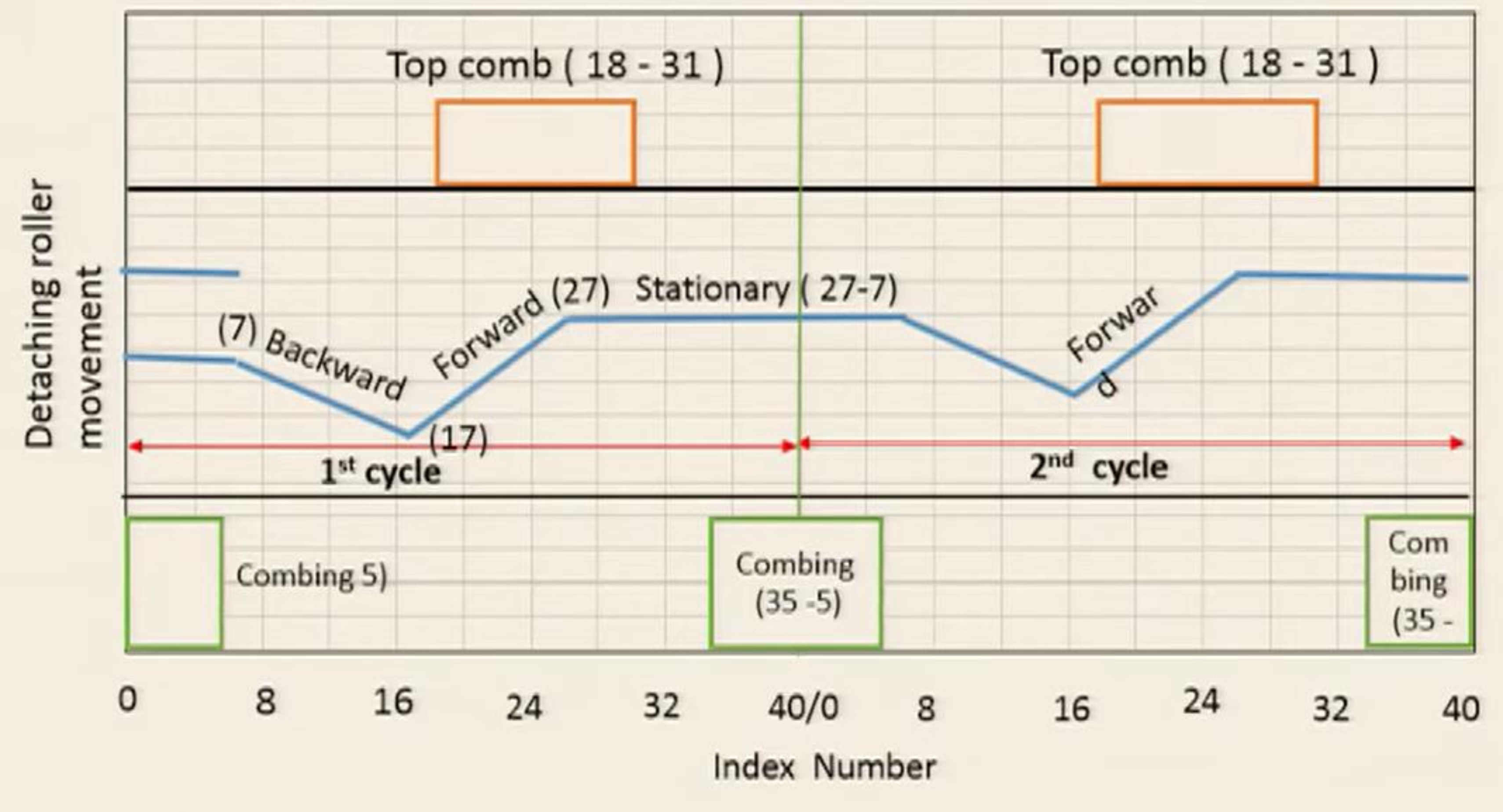


Detachment Roller Movement

Detachment should occur:

- ✓ During forward movement of nipper assembly
- ✓ After combing is over

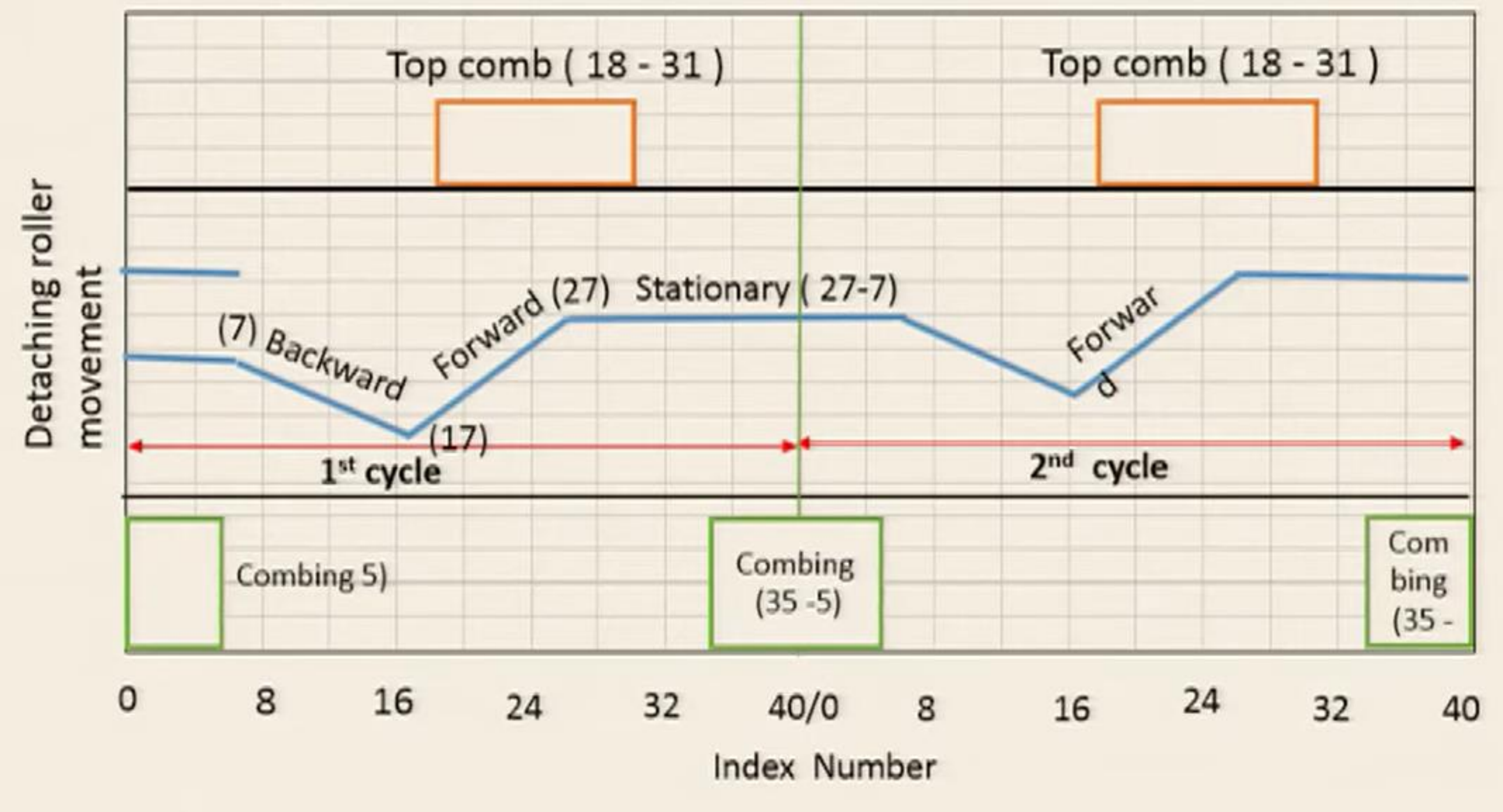
Detachment is allotted 20 index numbers and is equally divided for forward and backward movements.



Penetration of Top Comb

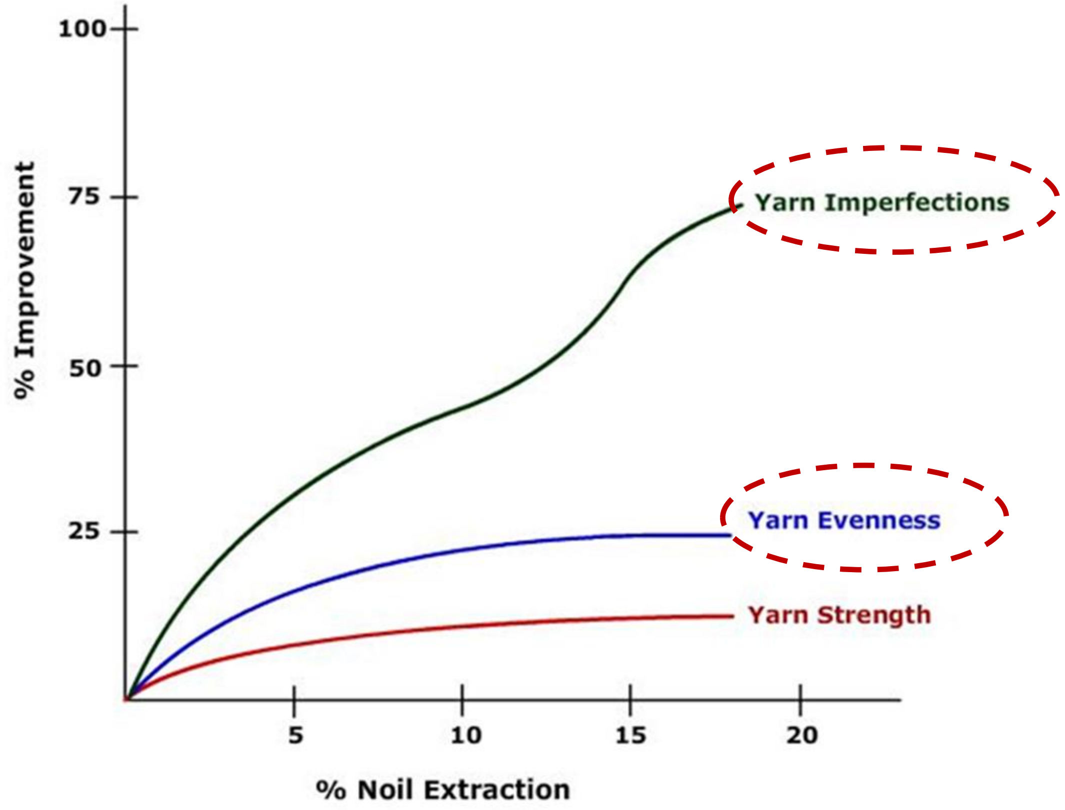
Top comb should penetrate

- ✓ When the detaching process has started
- ✓ When the front end of the fibre fringe has been gripped by detaching roller



Influence of Noil Extraction on Yarn Quality

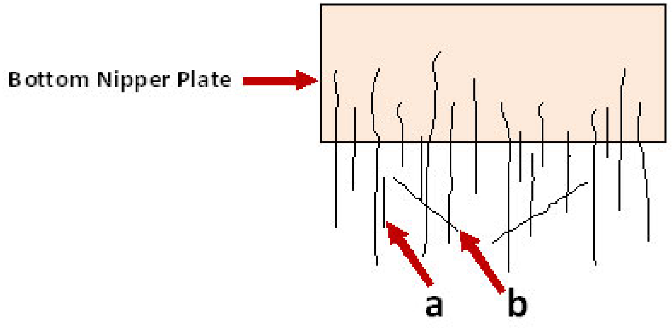
- ✓ **Increase in noil% leads to marginal improvements in yarn strength and evenness.**
- ✓ **Considerable improvement in yarn imperfections.**
- ✓ **The ends down rate in spinning mill decreases after combing until 20% noil.**



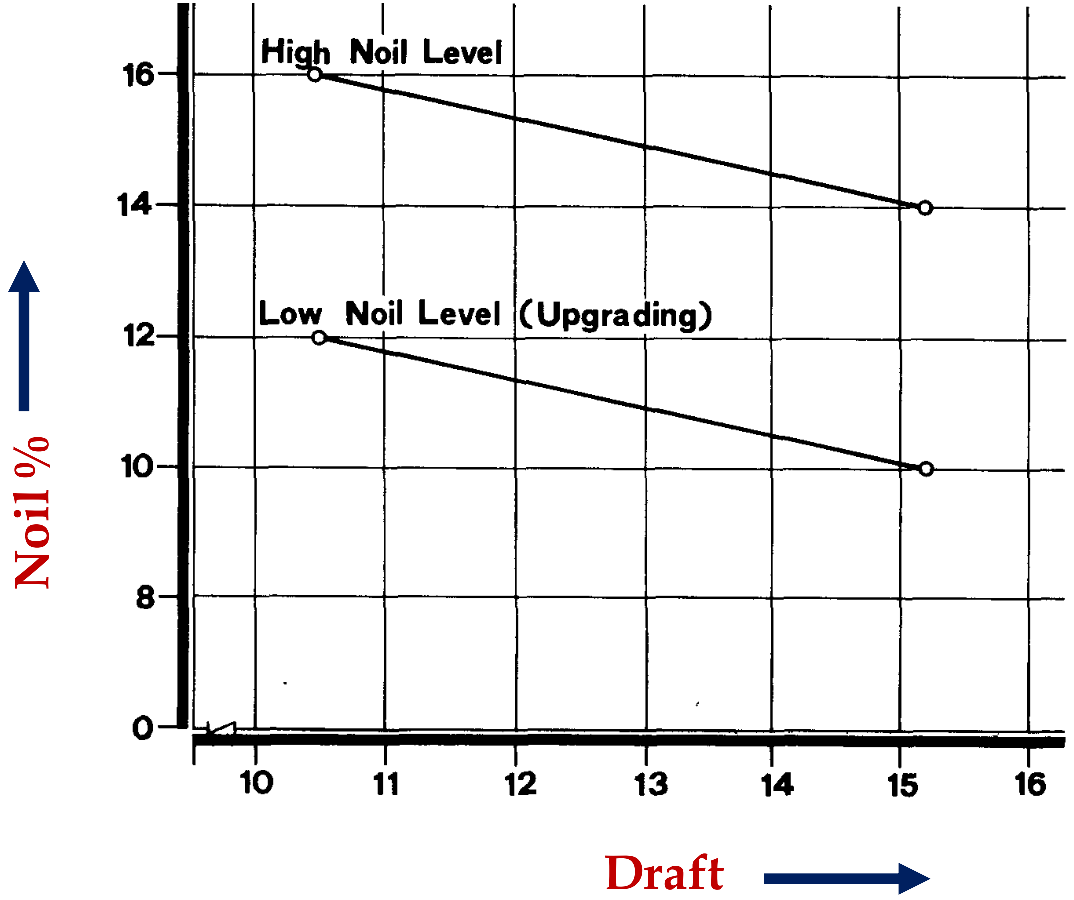
Parameters Influencing Combing Quality

Parallelization of Fibres

Too Low:



- ❑ Loss of longer fibres
- ❑ Cylinder combs pluck and tear the stock
- ❑ Carry away bunches of fibres
- ❑ Noil% increases



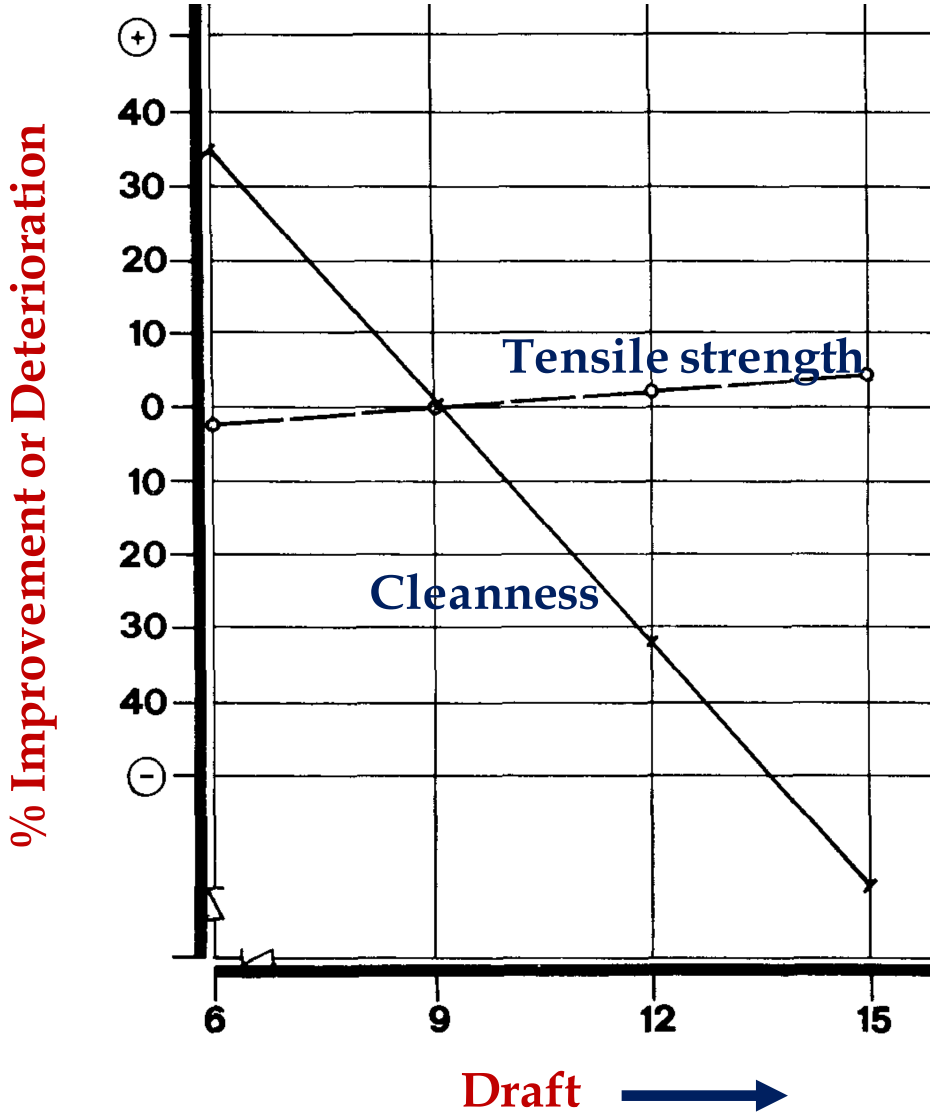
Noil % decreases with increase in draft Why?

Parameters Influencing Combing

Parallelization of Fibres

Too High:

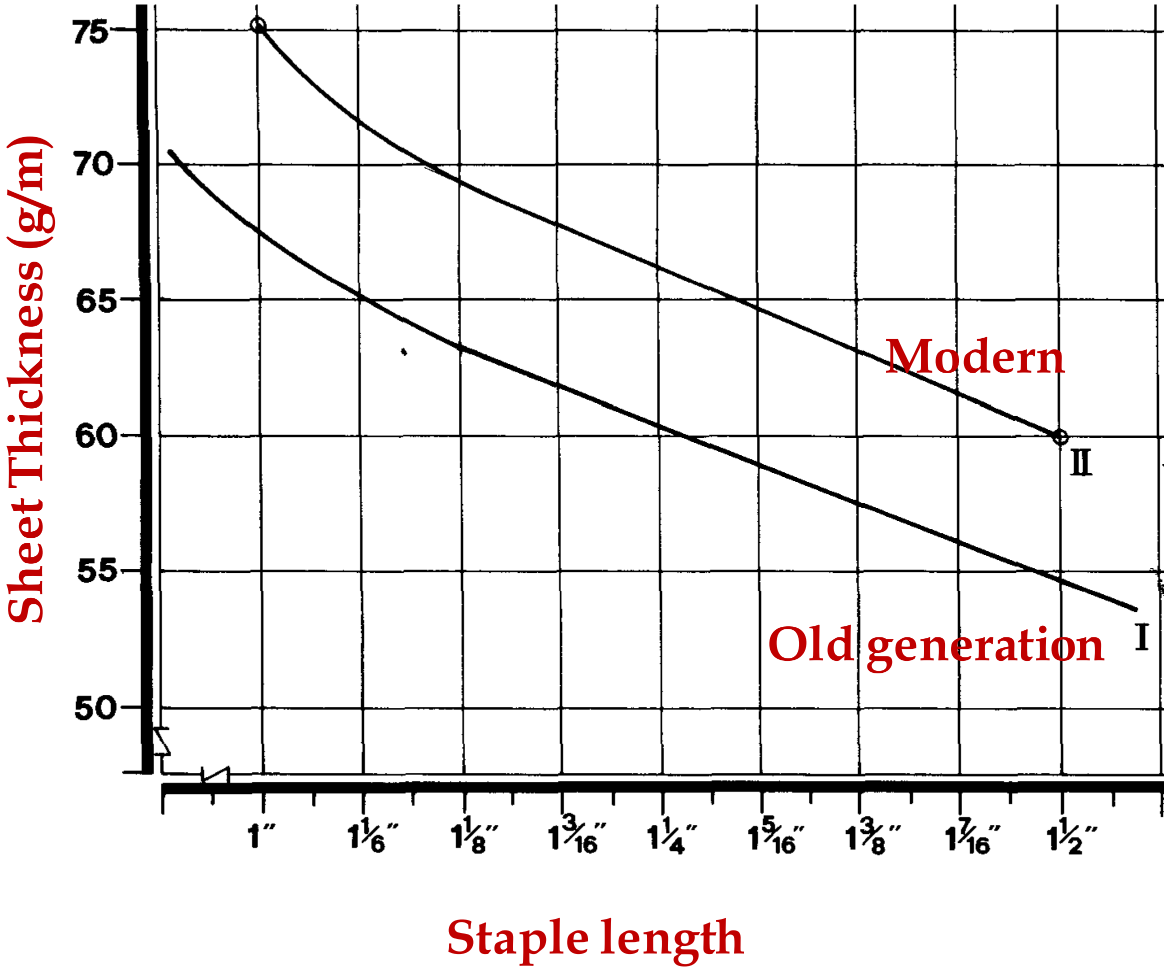
- Retaining power of the sheet strongly reduces
- It is no longer able to hold back the neps
- Self cleaning power reduces, i.e increased impurities
- Lap splitting
- Hairiness increases



Effect of sheet thickness

Higher sheet thickness leads to

- ✓ More self cleaning due to greater retaining power of fibers
- ✓ Better grip at nipper up to a certain level
- ✓ Higher productivity
- ✓ Increased load to the comb
- ✓ Uncontrolled combing
- ✓ Reduced overall quality



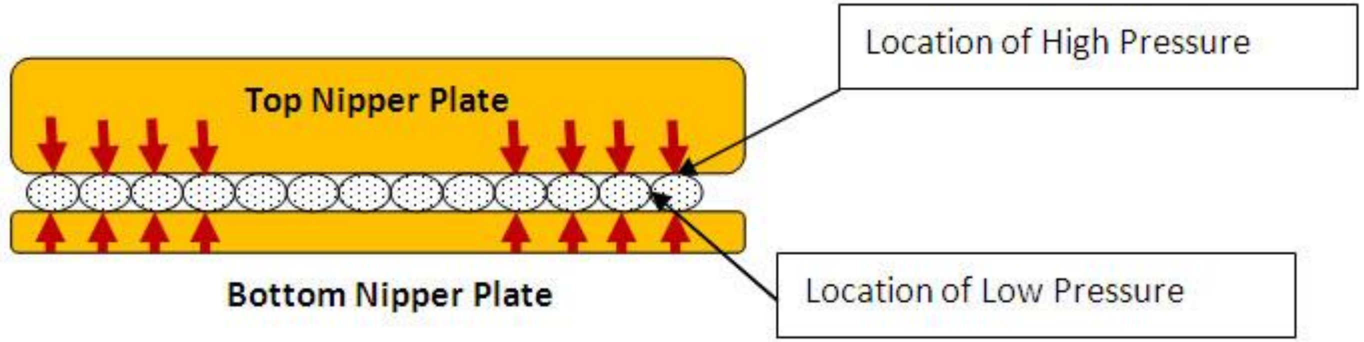
Sheet thickness should be lower for higher staple lengths.

Sheet Evenness

High Sheet Evenness:

- ✓ Uniform clamping
- ✓ Improved quality
- ✓ Less good fibre loss

Low Sheet Evenness:



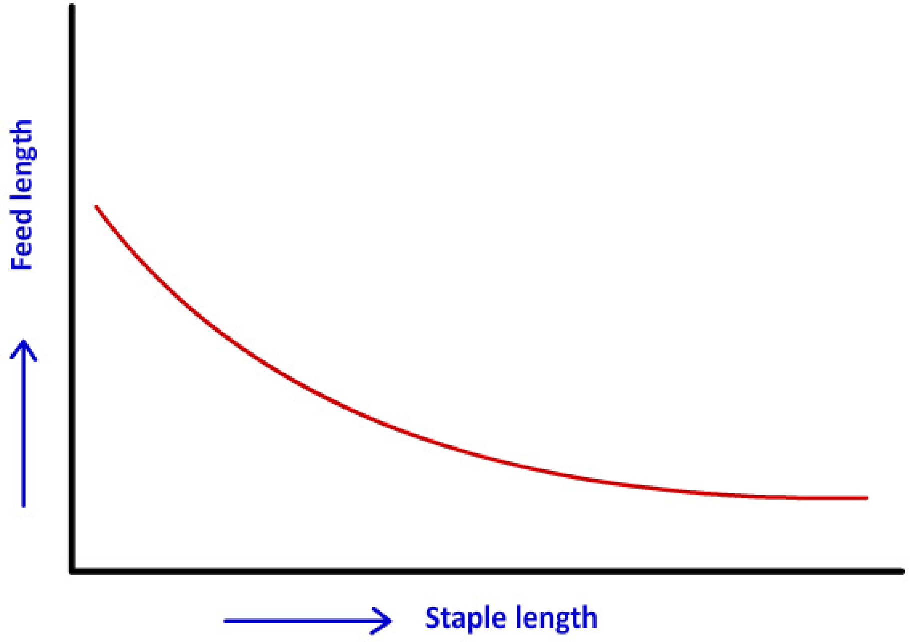
- Improper/uneven nipping (only on high pts.)
- Fibers could then be pulled out as clumps by cylinder combs

Effect of Feed Length & Detachment Setting

- High feed length leads to

  Higher production but inferior quality, especially cleanliness.

- **For better quality must be lower. Why?**
- Correlated with fibre length



Detachment Setting

Closest distance between the bite of nippers and nip line of detaching roll. Normal range ~ 15-25 mm.

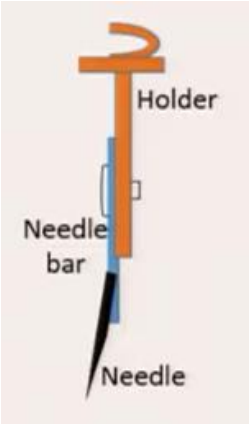
- **As detachment setting increases, noil % also increases. Why?**

Effect of Cylinder & Top Comb

Cylinder Comb

- Point density and fineness are as per raw material.
- **Cylinder combs with saw tooth or needles.**
- **Saw tooth: More robust than needles.**
- **Tooth/needle density varies in different rows. Why?**

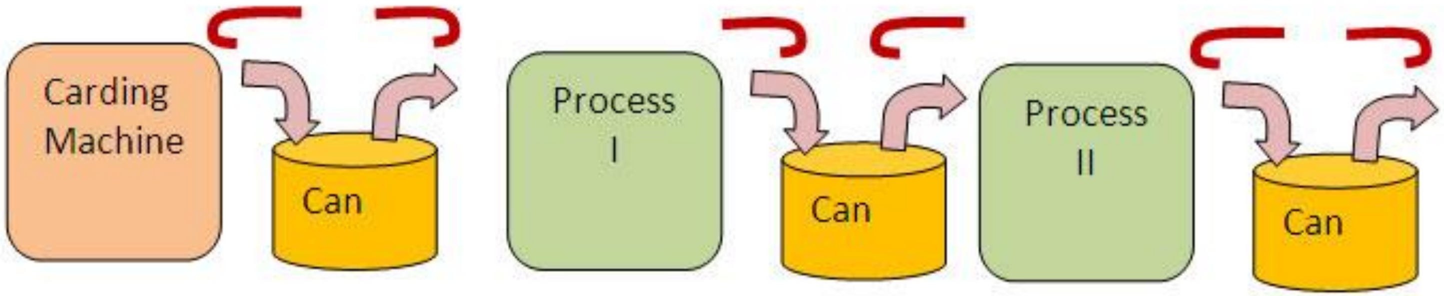
Top Comb



- **Higher no. of needles/cm leads to higher noil%. Why?**
- **As the depth of penetration increases noil % increases (by 0.5 mm, 2%)**
- **Very high depth of penetration disturbs fiber movement during piecing**

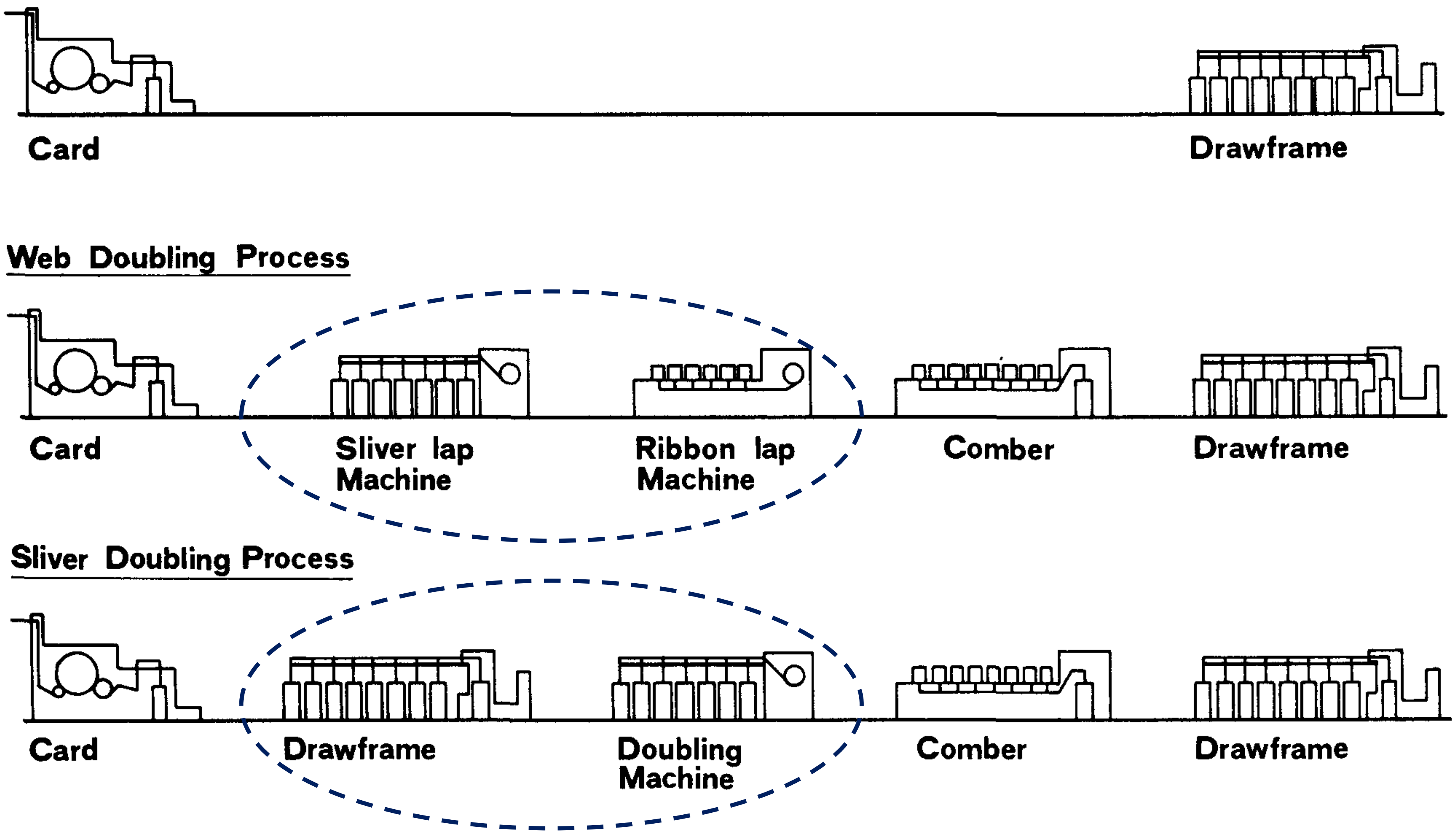
Disposition of Hooks

Fibres must be fed to the comber to present leading hooks



There should be even number of passages between card and comber.

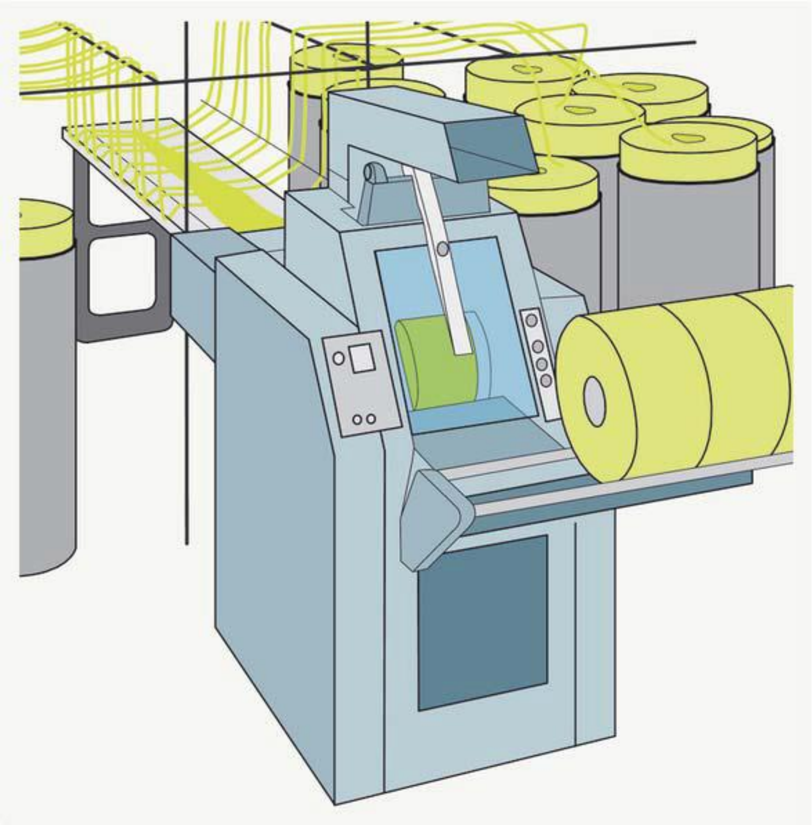
Preparation for Combing

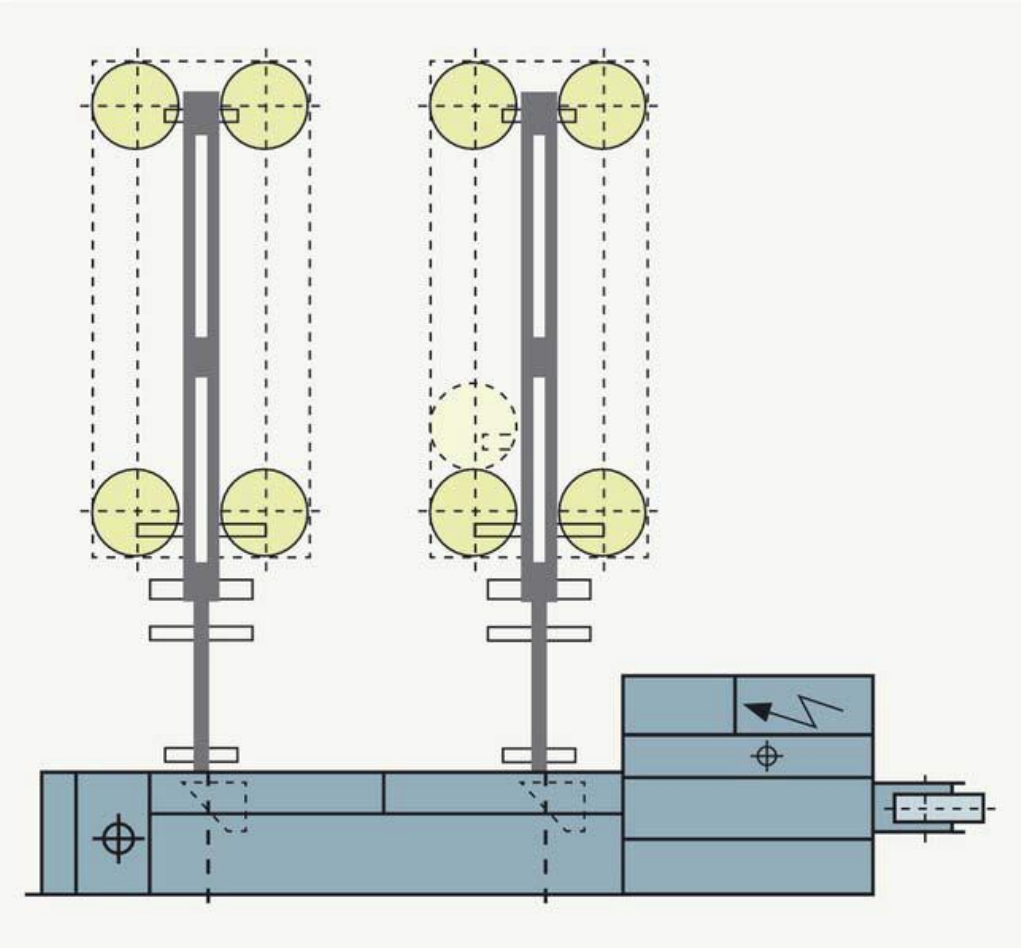


Carded yarn

Combed yarn

Sliver Lap Machine





2 Feed tables each containing 12 card slivers

↓

Guide Rollers

↓

Drafting system

↓

Deflecting plate

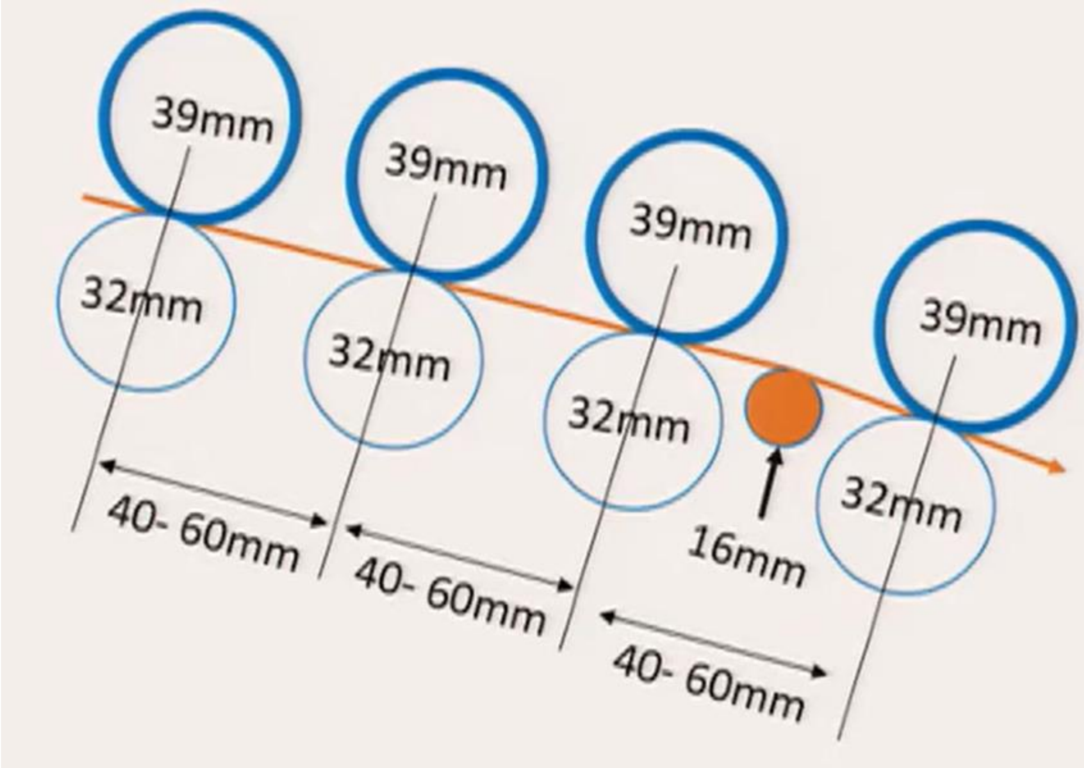
↓

Web Table

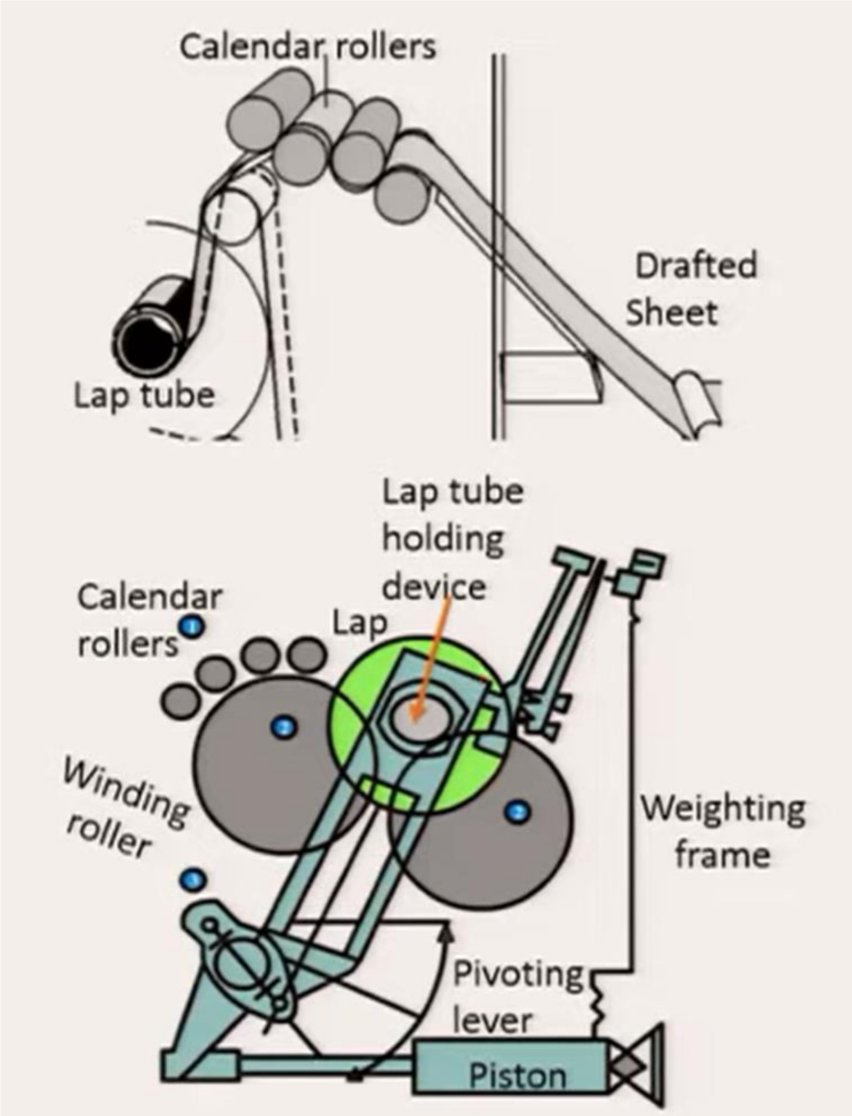
↓

Winding Assembly

Sliver Lap Machine



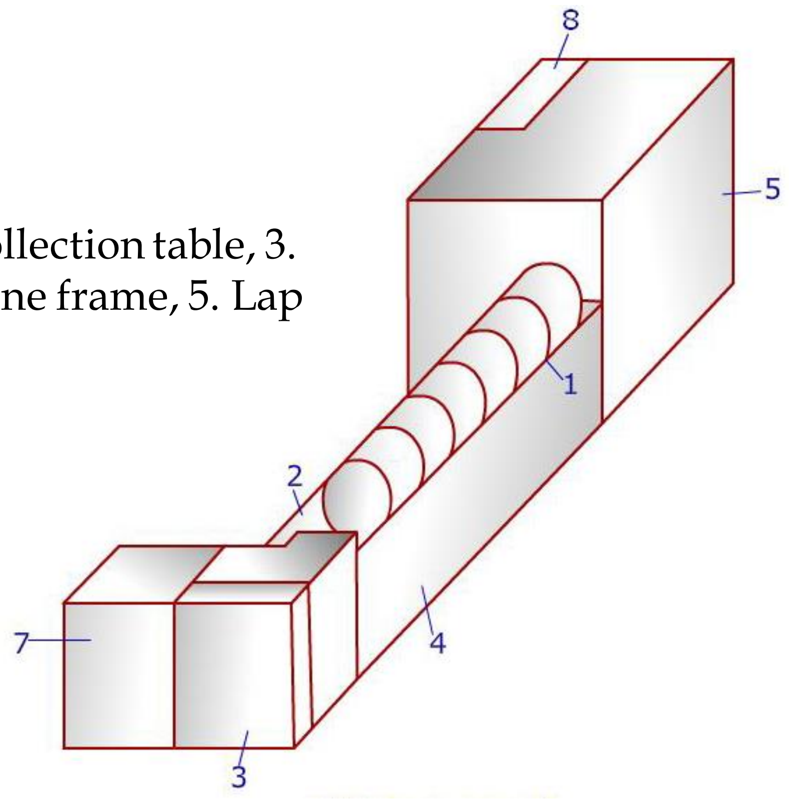
Drafting arrangement

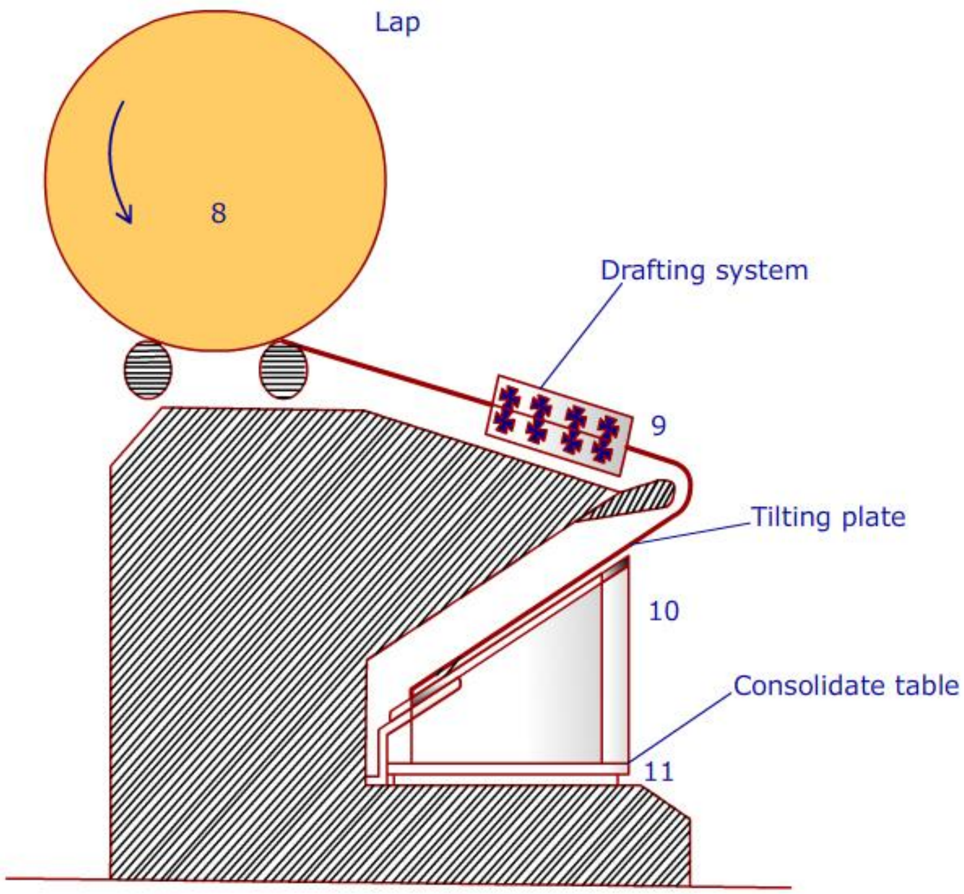


Winding Assembly

Ribbon Lap Machine

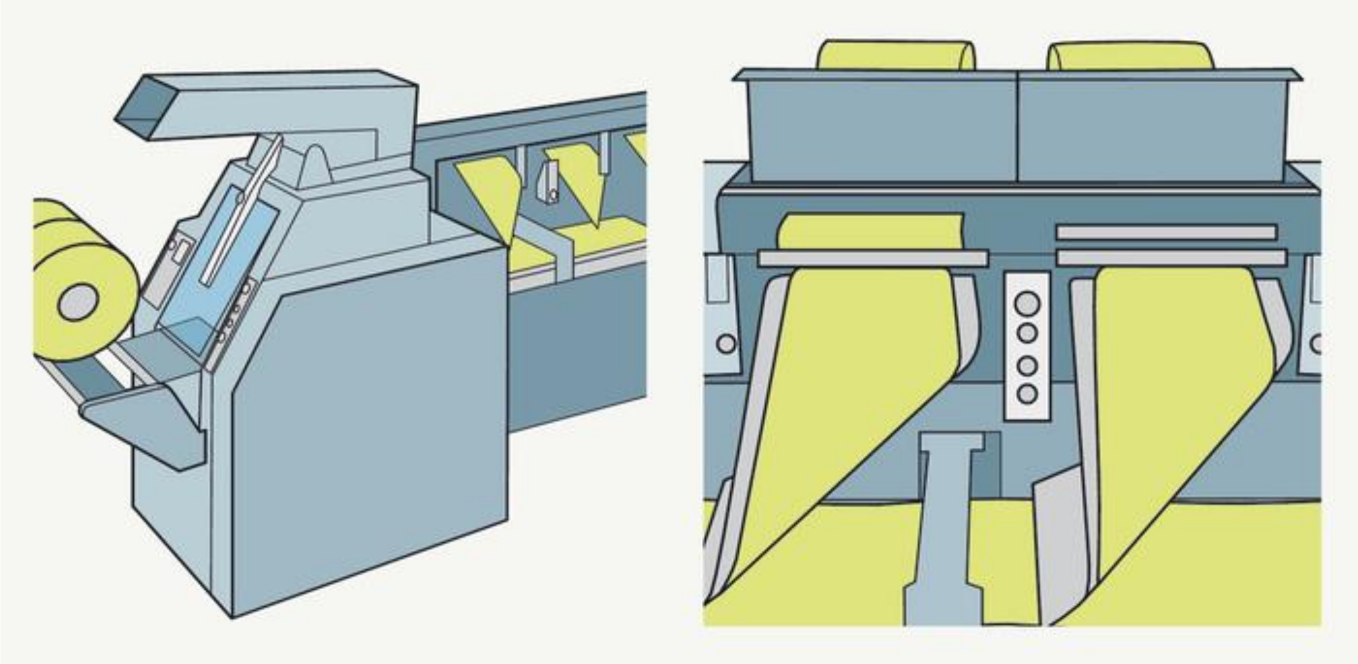
1. Laps, 2. Web collection table, 3. Gearing, 4. Machine frame, 5. Lap forming device





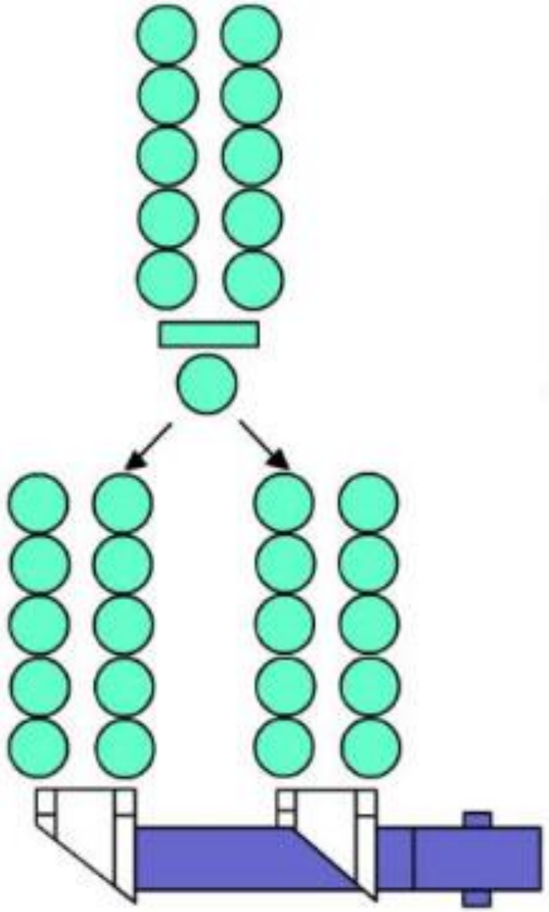
High evenness – 6 times web doubling in sandwich form

Ribbon Lap Machine



Sliver Doubling Machine

- Formation of lap directly from draw frame slivers
- Exactly same in design and operation as the Sliver Lap Machine
- Doubling: up to 32

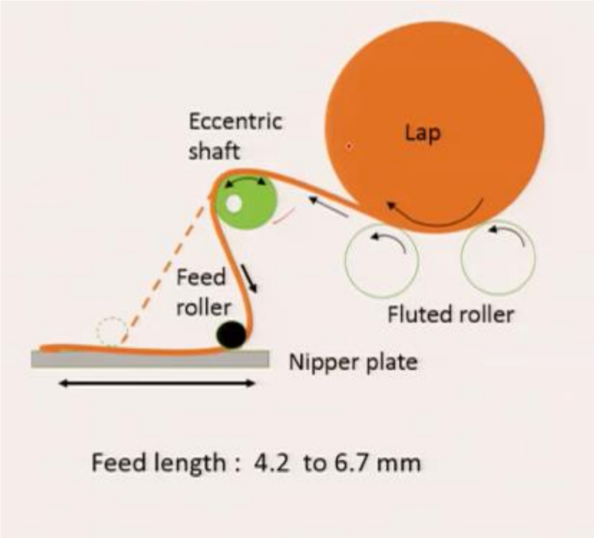


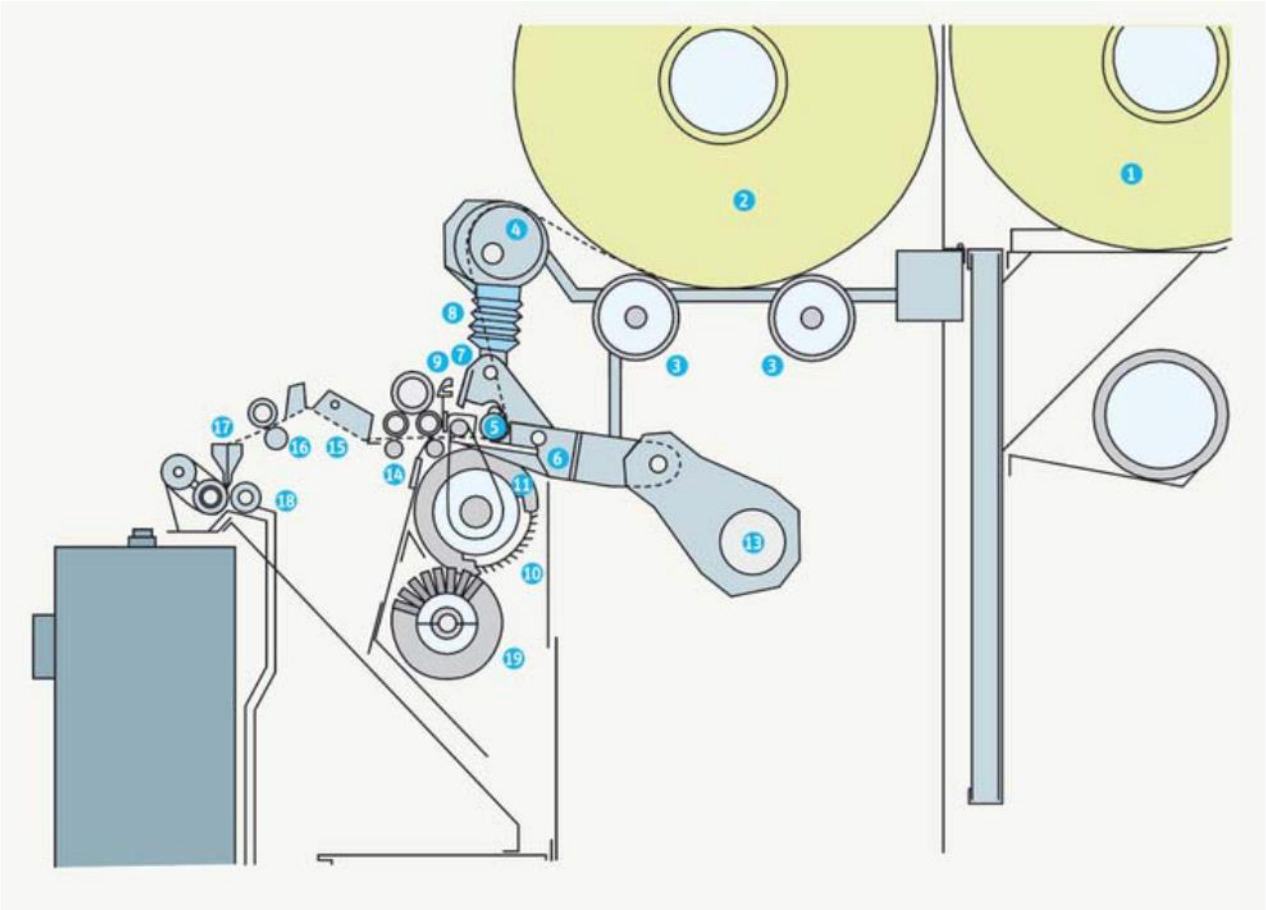
Silver Doubling

Feeding of Lap

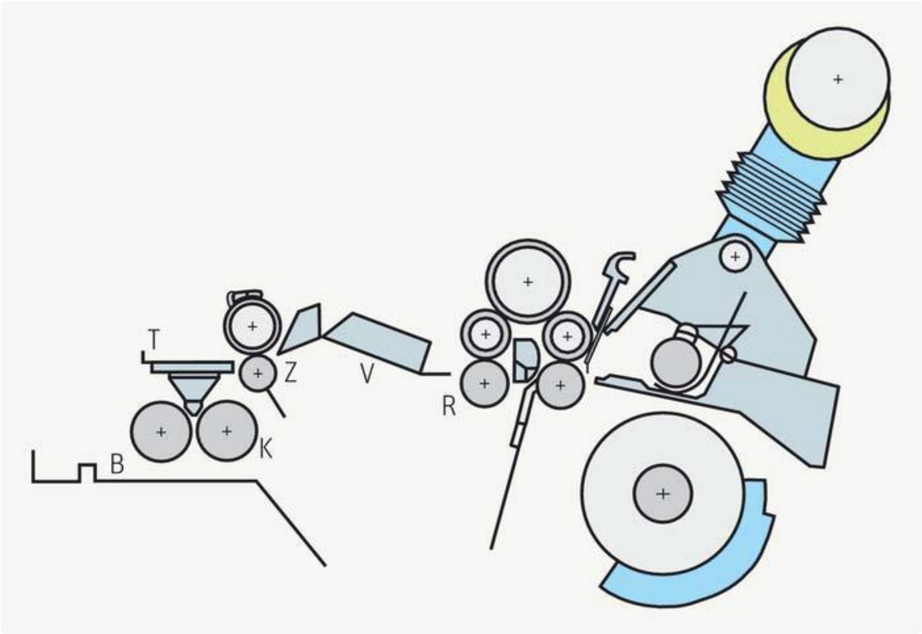
- Two fluted rollers (3) unroll the lap sheet from lap (2) –by surface contact.
- The eccentric shaft (4) between (3) and feed roller (5)
  - ✓ rotates intermittently with nipper cycle
  - ✓ rotates < full revolution.
  - ✓ forward and backward (clock and anti-clockwise)

Maintain tension and prevent false draft.

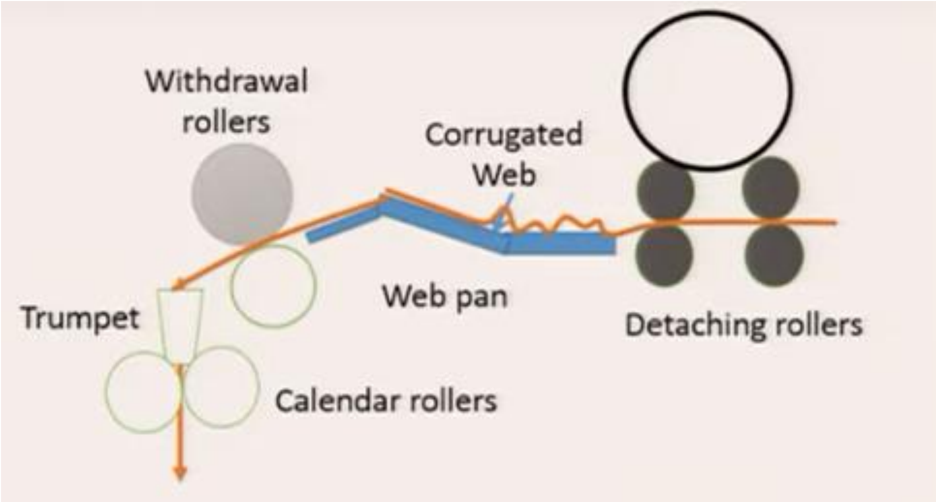




Web Delivery

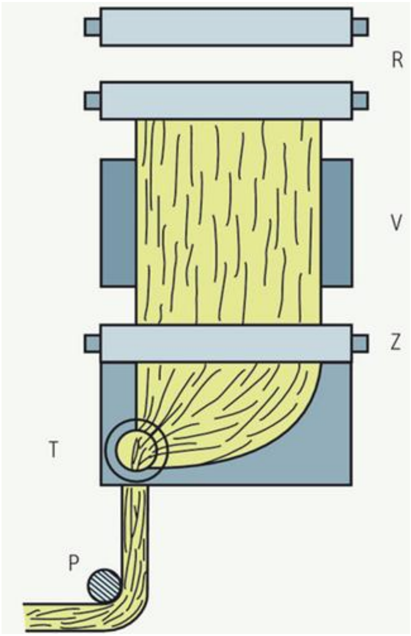


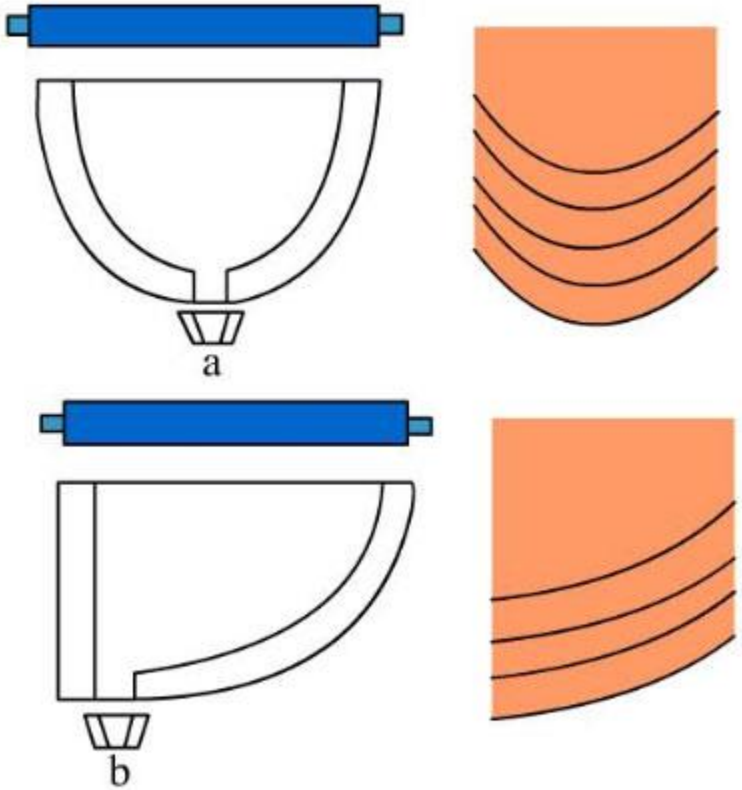
- Combed web (W) makes back-and-forth movement along with detaching roller (R).
- Web must be intact, So, a reserve of material should be there between (R) and withdrawing rolls (Z).
- Withdrawing rollers (Z) move unidirectionally
- Excess web forms a corrugated sheet on web pan (V) which acts as web reservoir.
- Web from (Z) is collected into a trumpet (T) and deposited on the sliver table (B) by calendar rollers (K) .



Web Collection

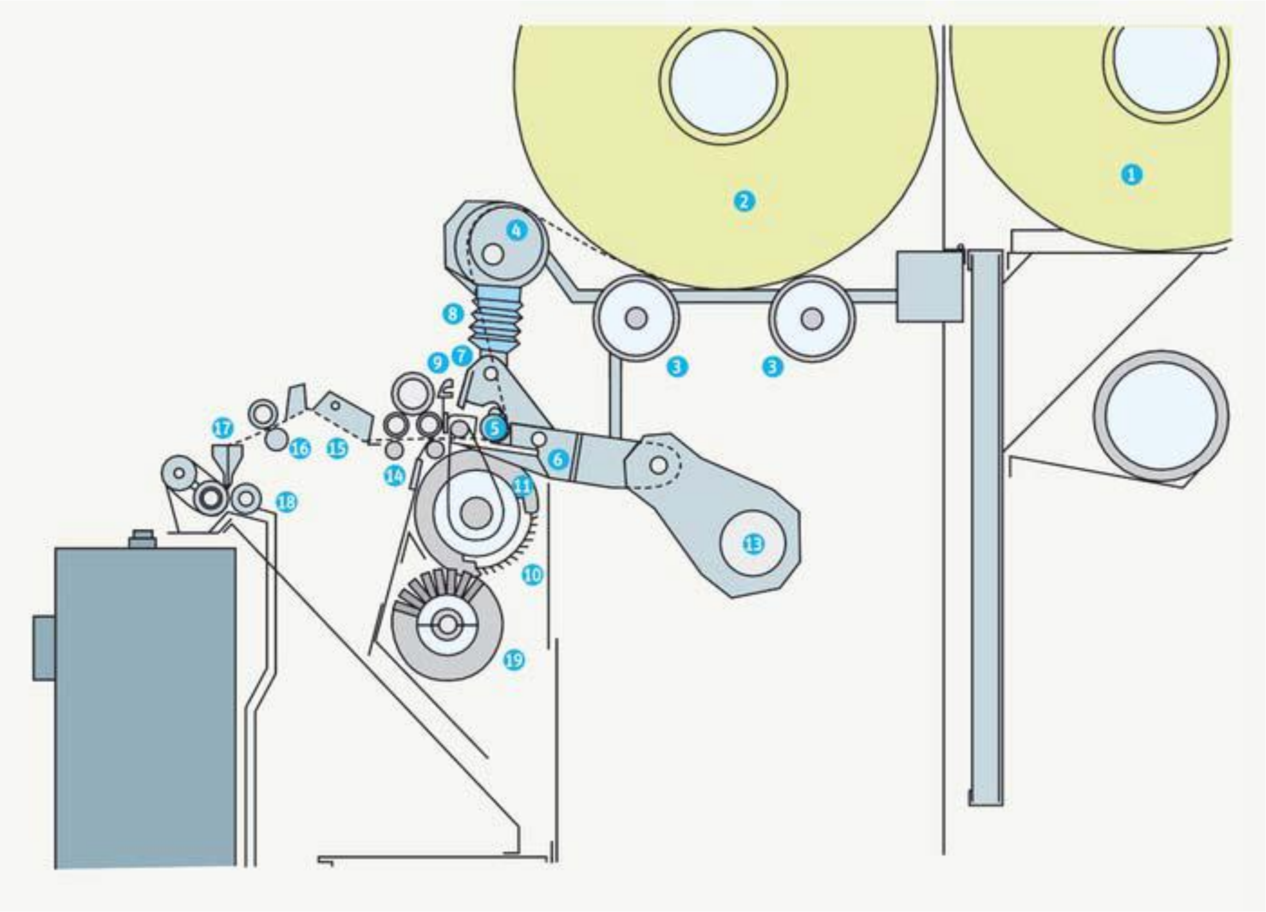
- Web is collected in the web pan
- Collected in centre-line (a): older m/c
- Collected in one - side (b): modern combers
- Piecing line forms curve in centre-line collection: piecing waves
- Piecing line forms diagonals in one-side collection:
    - ✓ Partial compensation of piecing waves.



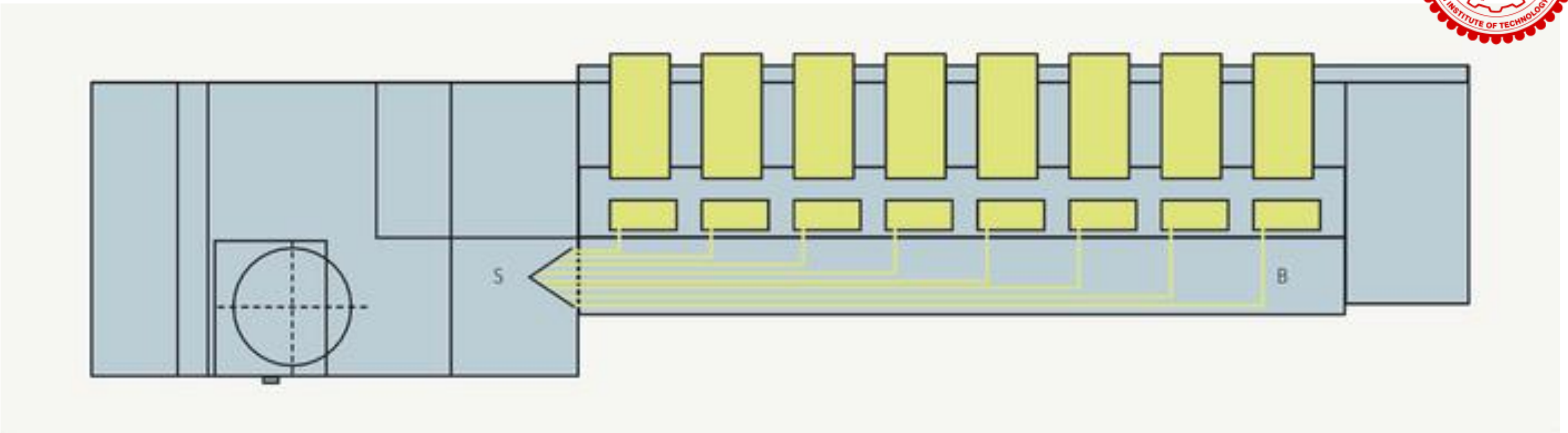


Sliver Formation

- Pieced web passes to a web pan (15) and then to a trumpet (17) via a lead-off roller
- Then to table rollers (18) which guide the formed sliver to transverse table.
- Doubling of individual slivers
- To drafting rollers
- Brush (19) cleans the cylinder comb (10) segment.



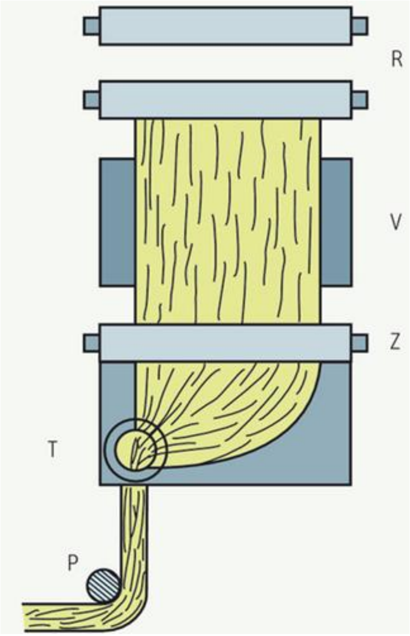
Sliver Formation



- Individual slivers from combing heads deflected through 90° to drafting arrangement

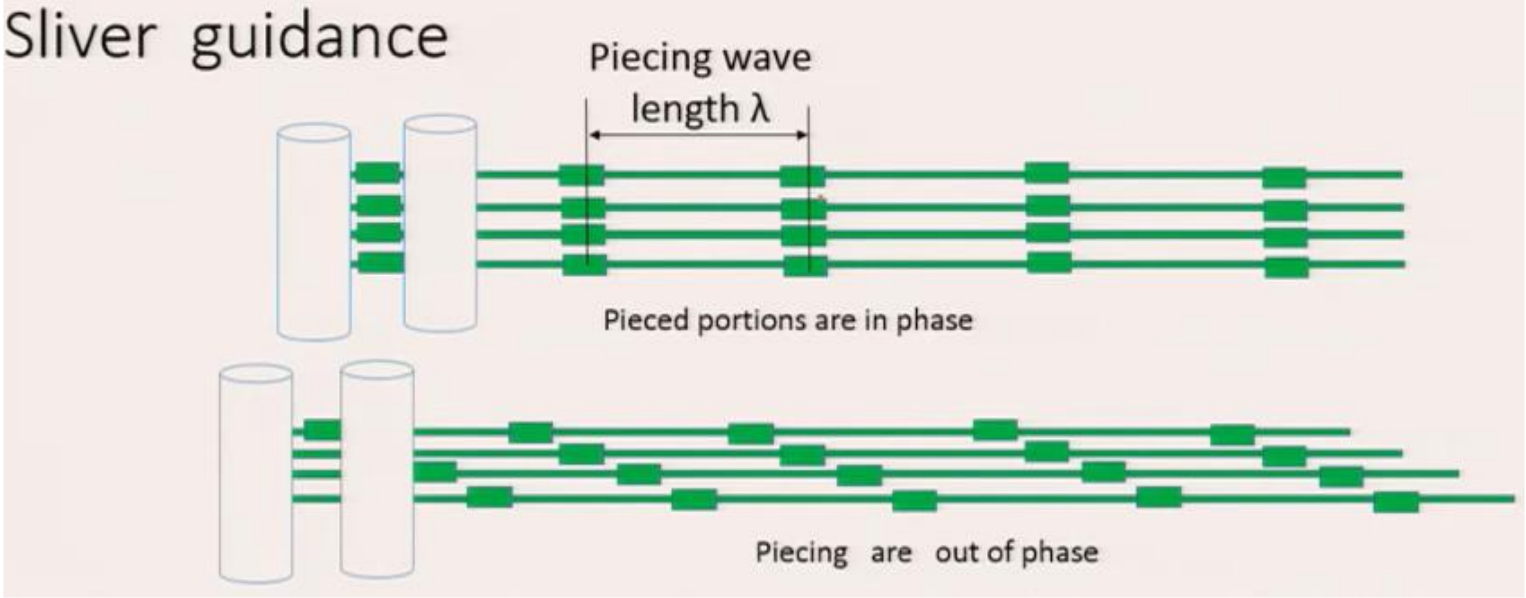
- 8 fold doubling

- For two delivery
  ~ 4 slivers/delivery



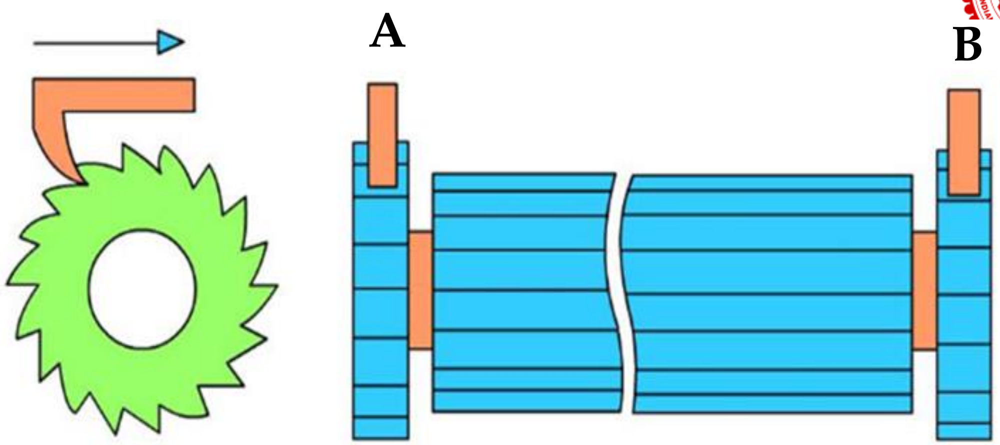
Sliver Formation

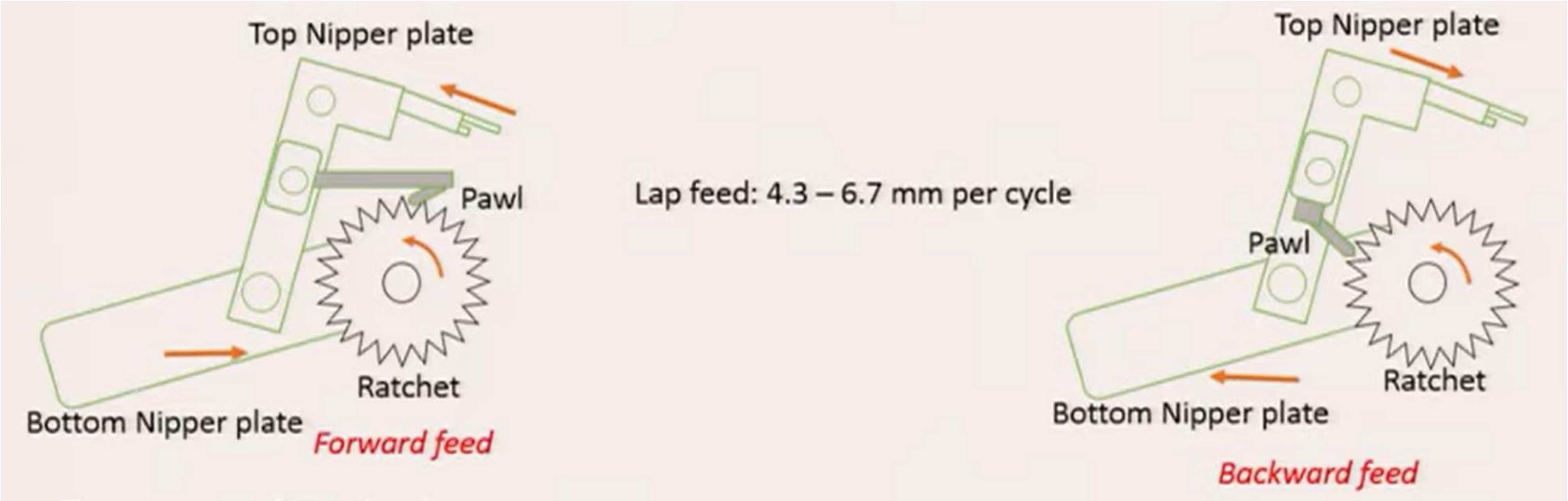
The distance between sliver trumpet and drafting rollers are adjusted by the deflecting volute to compensate the mass variation caused due to piecing wave.



Feeding of Lap

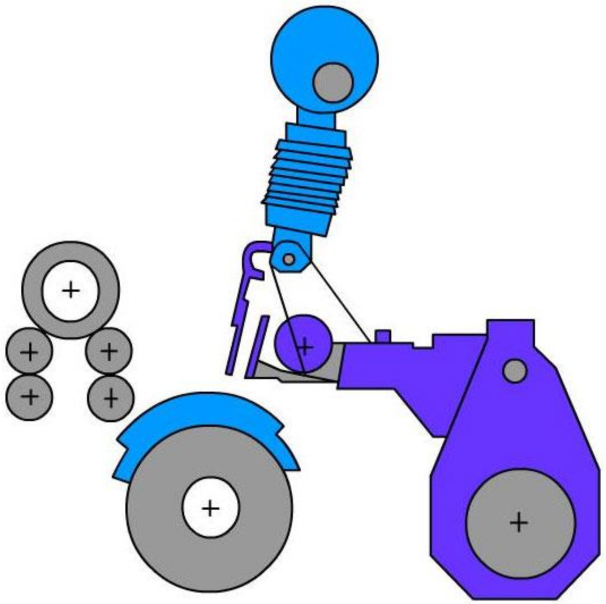
- The forward and backward feed selection: *by replacing the drive change gears A or B.*
- Feed cycle gets motion from relative movement of nippers through pawl arrangement

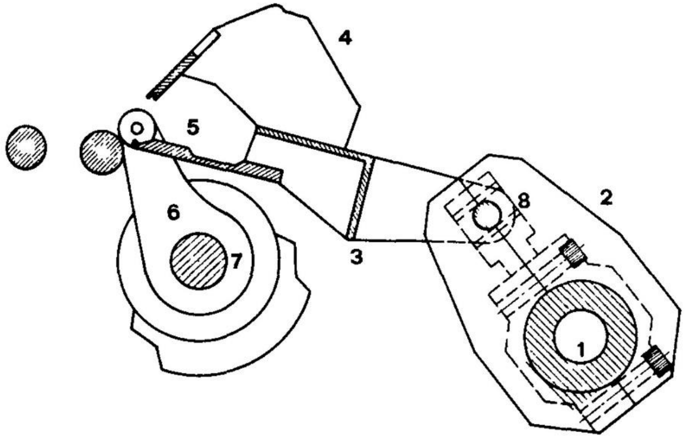




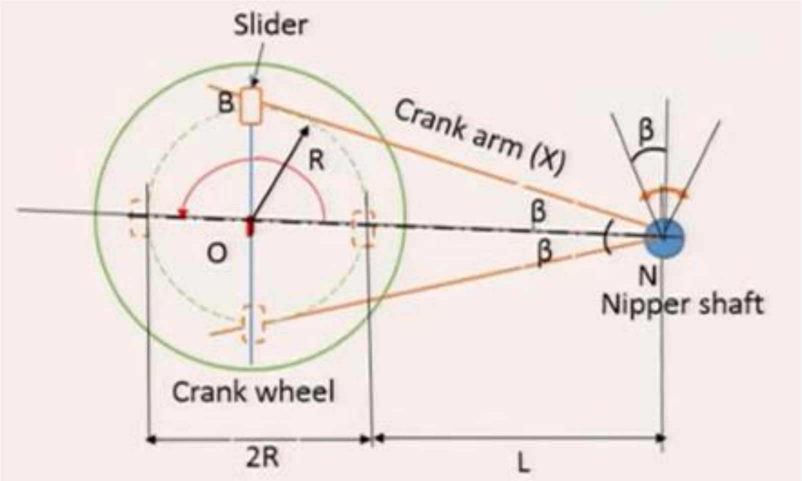
Movement of Nipper Assembly

- Lower nipper plate (5) is supported by two pivot levers (6) on left and right
- (6) is pivoted on axis (7), i.e. on cylinder comb axis: only for support
- Two swing arms (2)
  - ✓ connected at nipper shaft(1)
  - ✓ rotatable at(8)
- Shaft (1) rotates < full revolution.

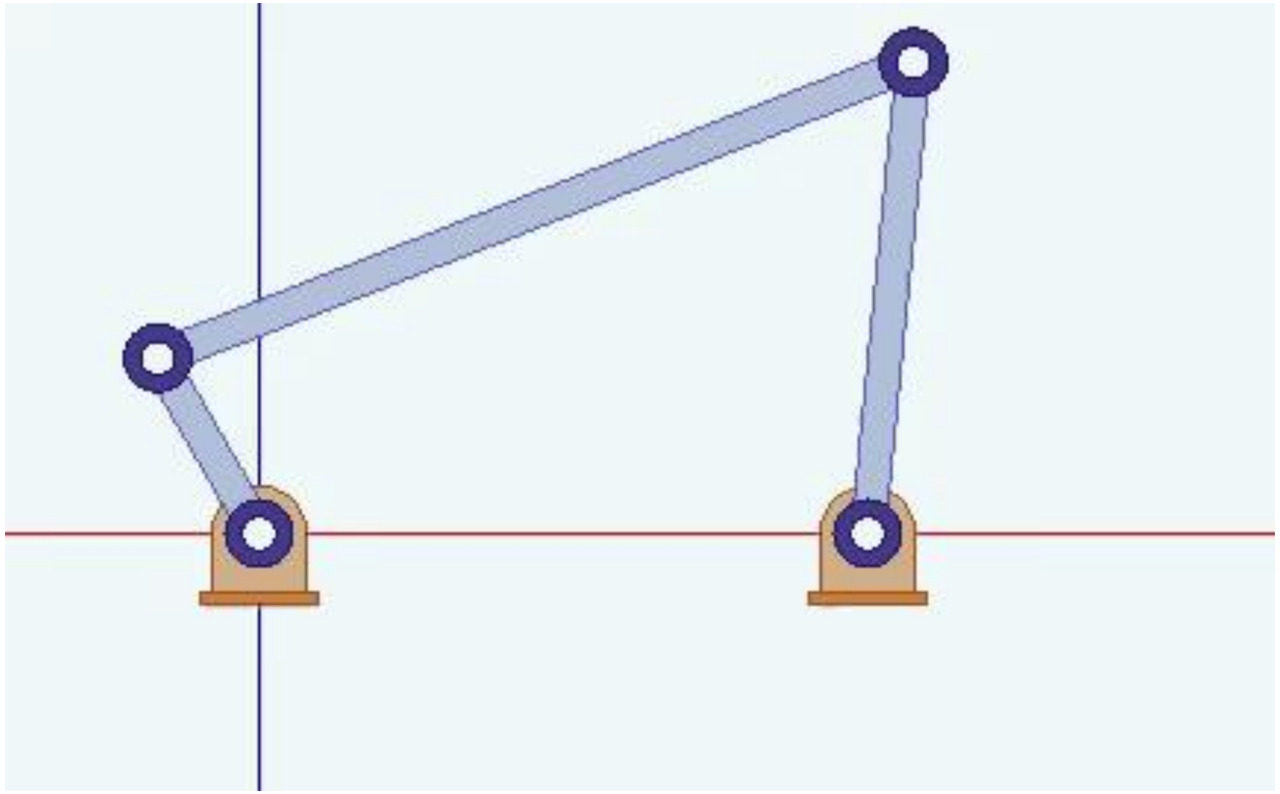




Crank slider mechanism

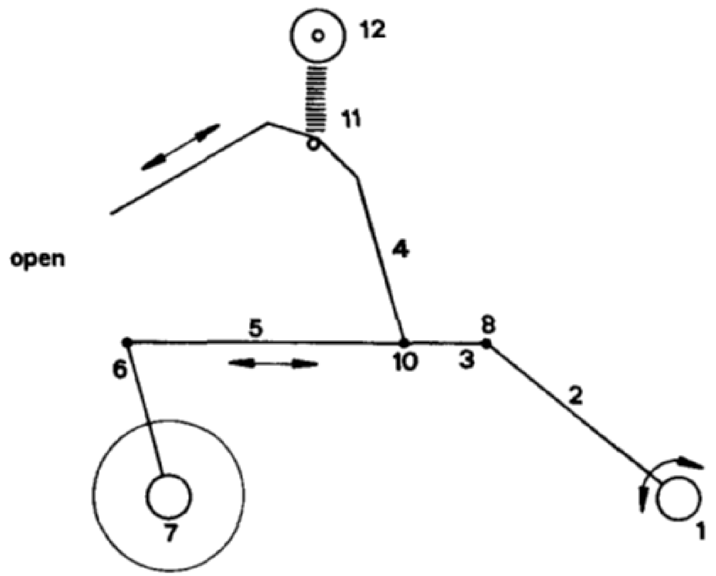


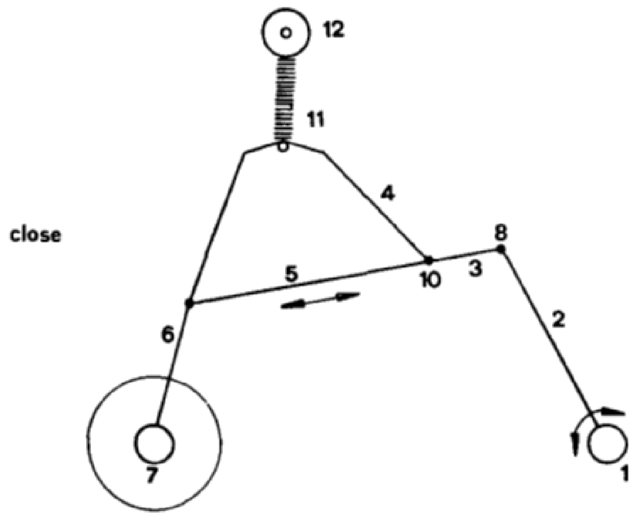
Crank Slider Mechanism



Movement of Nipper Assembly

- Nippers move forward up to detachment setting then withdraw
- Upper nipper
  - ✓ Suspended from(12)
  - ✓ Connected with bottom nipper at (10)
- As the nipper bite moves forward upper nipper raises and nippers open
- During backward movement, upper nipper moves downward and nippers close.
- Shaft (12) is eccentric to allow soft-closer.





Movement of Detaching Rollers

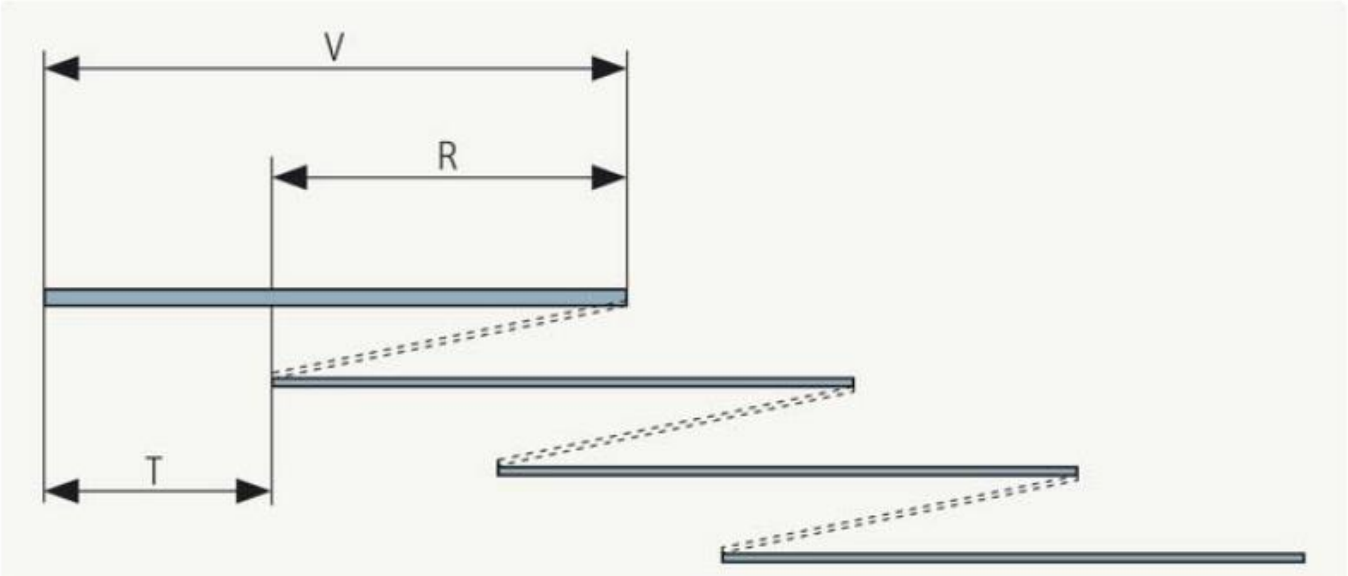
- ✓ After cylinder combing, detaching rollers feed back part of previously formed web (*R = 49.5mm*)

- ✓ Nippers swing forward and lay new web over it.

- ✓ Then detaching rollers rotate in forward direction

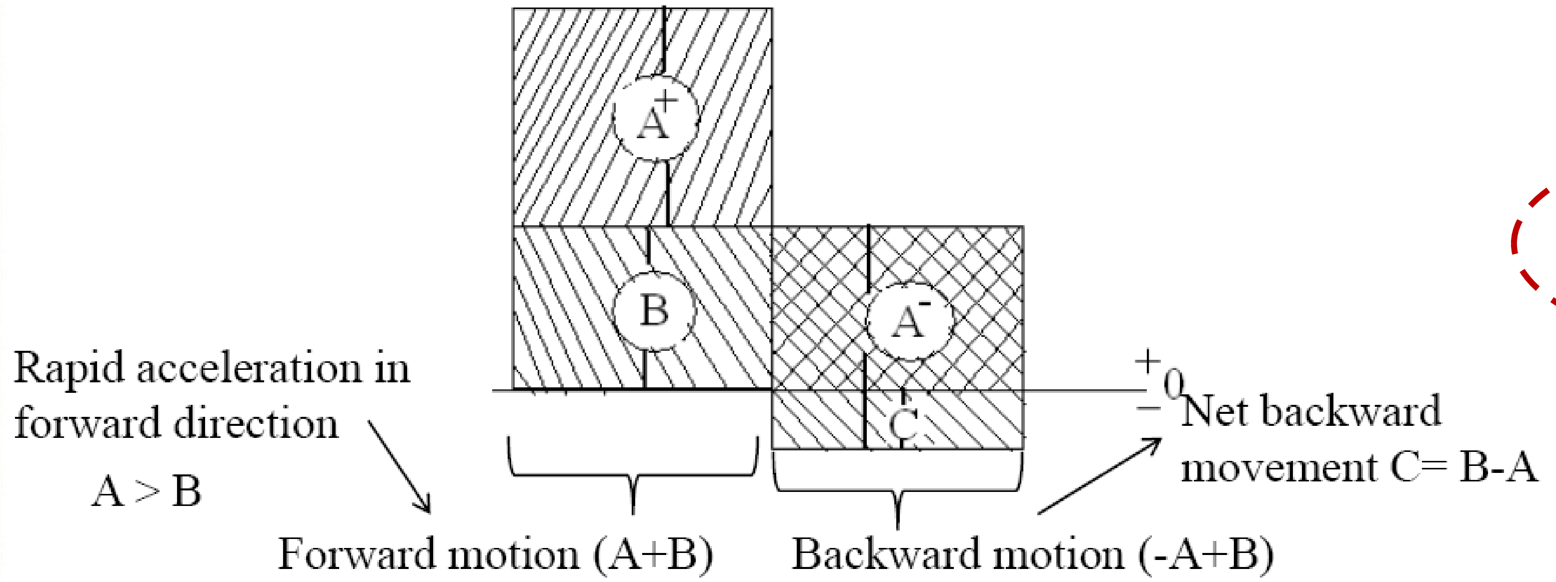
  Take new web through top comb and out of the lap sheet (*V=81mm*)

- ✓ Effective take off (T) = V-R = 31.5 mm per nip



Movement of Detaching Rollers

- ✓ Unequal movement is achieved by
  Intermittent rotation (±A) from ?? Nipper shaft
- ✓ **Superimposed** upon a constant basic rotation (B) generated from ?? Comb shaft Forward +ve



Differential Gear

There will be a net forward movement because speed (A+B)>(B-A)

Production of Comber

- No. of combing heads - H
- No. of deliveries - 1
- Nips /min - N
- Noil (%)- K
- Efficiency(%) -E
- Feed sheet(ktex) - G

S=lap feed mm/nip

E=efficiency(%)

A=tension draft between lap and feed roller

$$\textit{Comber Production in kg/hr} = \frac{N \times S \times G \times (100 - K) \times H \times E \times 60}{1000 \times 1000 \times A \times 100 \times 100}$$

Comber Numericals

Example

In a rectilinear cotton comber, processing cotton with 40 mm longest fibre length, the detachment setting and the feed length per combing cycle are 15 mm and 5mm respectively. Calculate the approximate change in noil% when the type of feed is changed from concurrent feed to counter feed.

ROVING FRAME

Why Roving Frame?

- Sliver has all the characteristics to form yarns
    - Clean
    - Parallel
- Expensive process of roving
- Liable to faults/defects
- Production cost

Draft needed to convert the sliver to yarn ~300-500

✓ Ring frame is not capable

✓ Transportation of d/f cans to ring frame & presentation to r/f

Solution

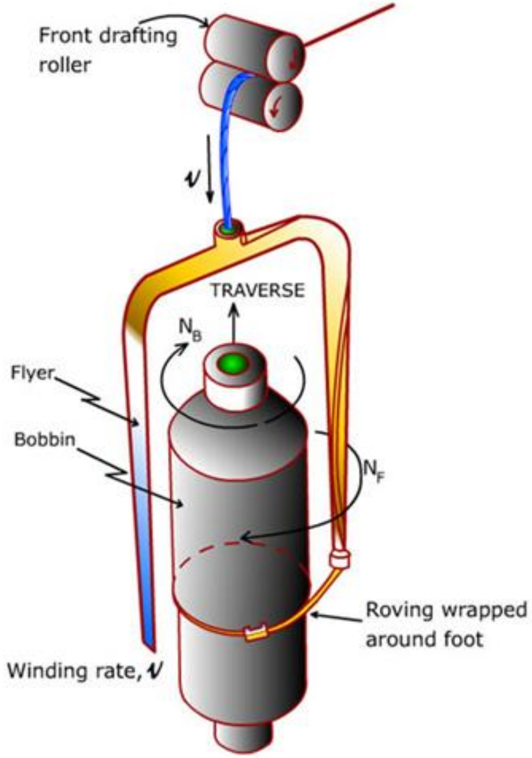
✓ With ring spinning technology

✓ With other spinning methods (modern spinning)

Without roving frame

Main Functions of Roving Frame:

- ✓ Attenuation of sliver
- ✓ Insertion of protective twist
- ✓ Winding of roving package
  - For transportation
  - Storage
  - Feed to ring spinning m/c



Complexity:

- Winding operation
- Spindle/flyer
- Cone drive/variable gear
- Differential gear
- Builder motion

Operation of Roving Frame:

D/F sliver is fed in large cans (1)

⇩

Transport rollers (2) forward them to drafting arrangement (3)

⇩

Drafting arrangement (3)

⇩

Sliver goes to flyer top (6) from the exist of the drafting arrangement

⇩

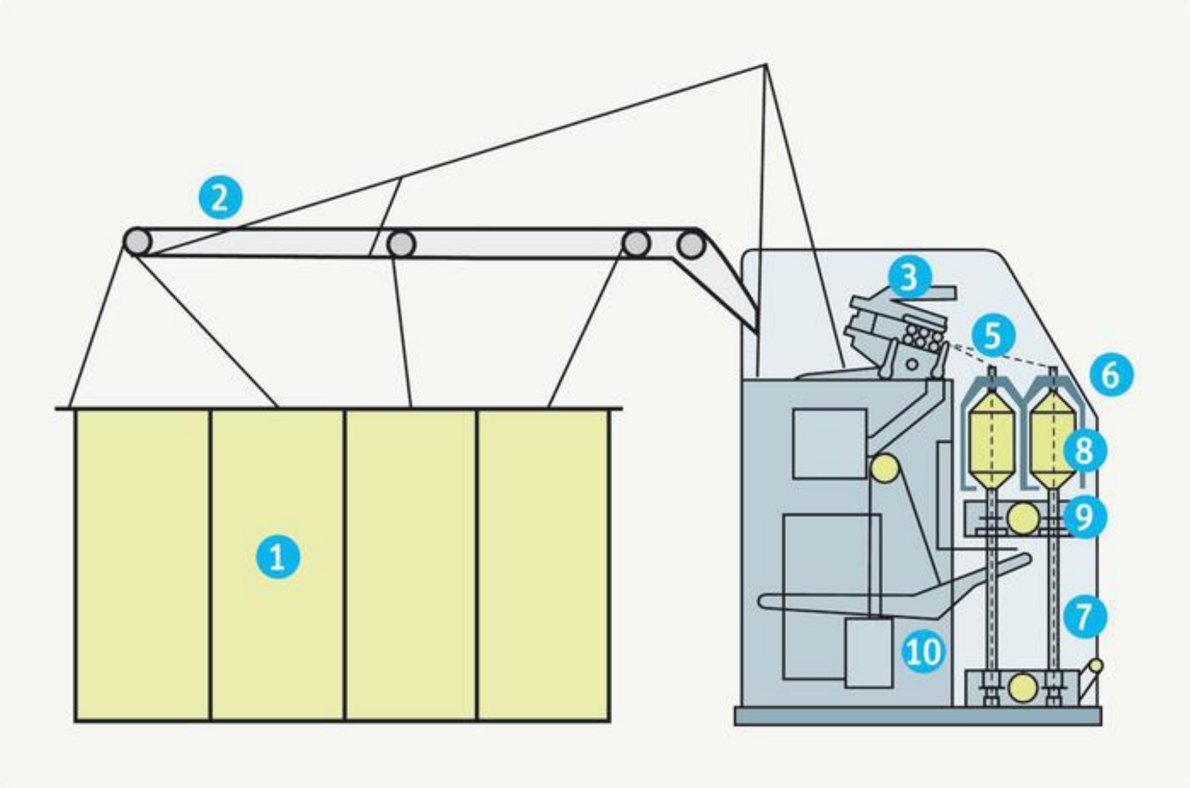
Hollow flyer leg

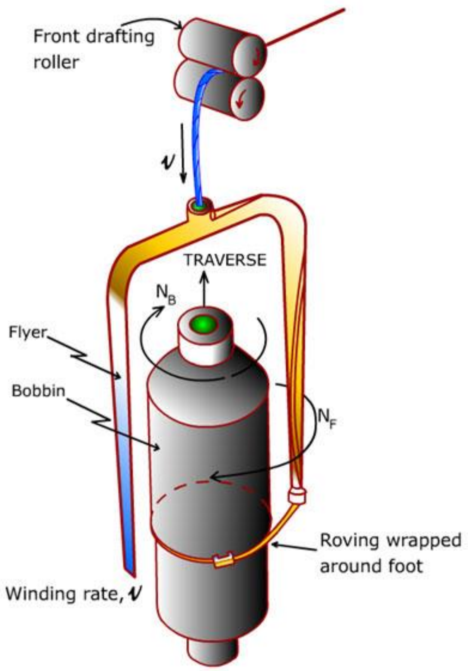
⇩

Pressure Arm

⇩

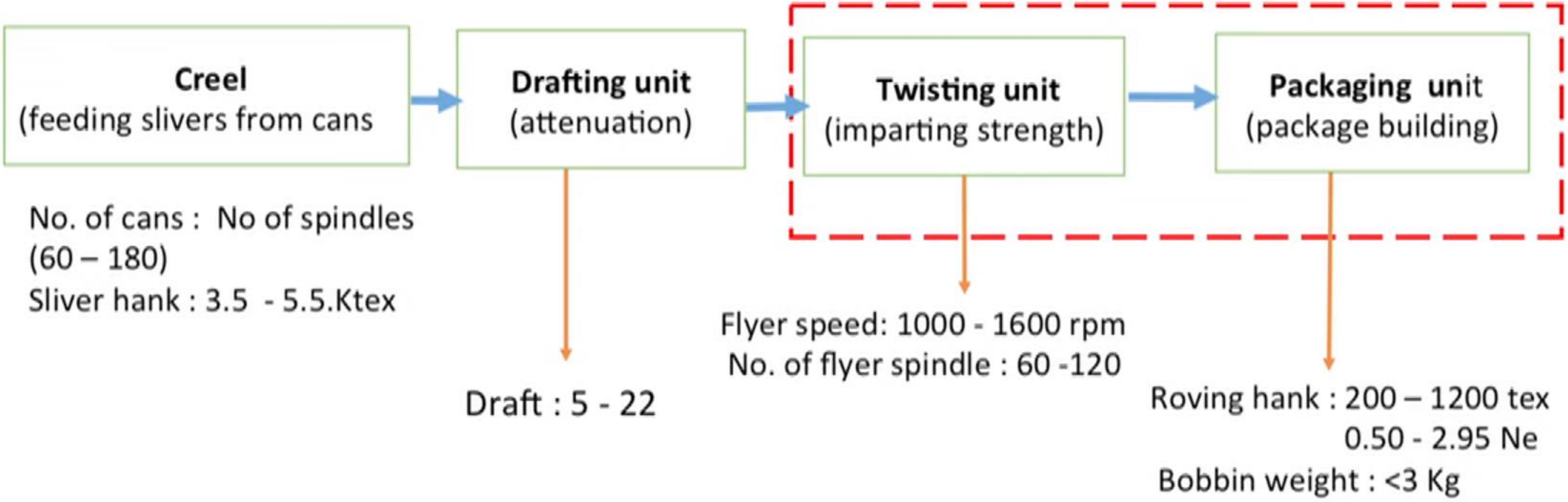
Bobbin (8)





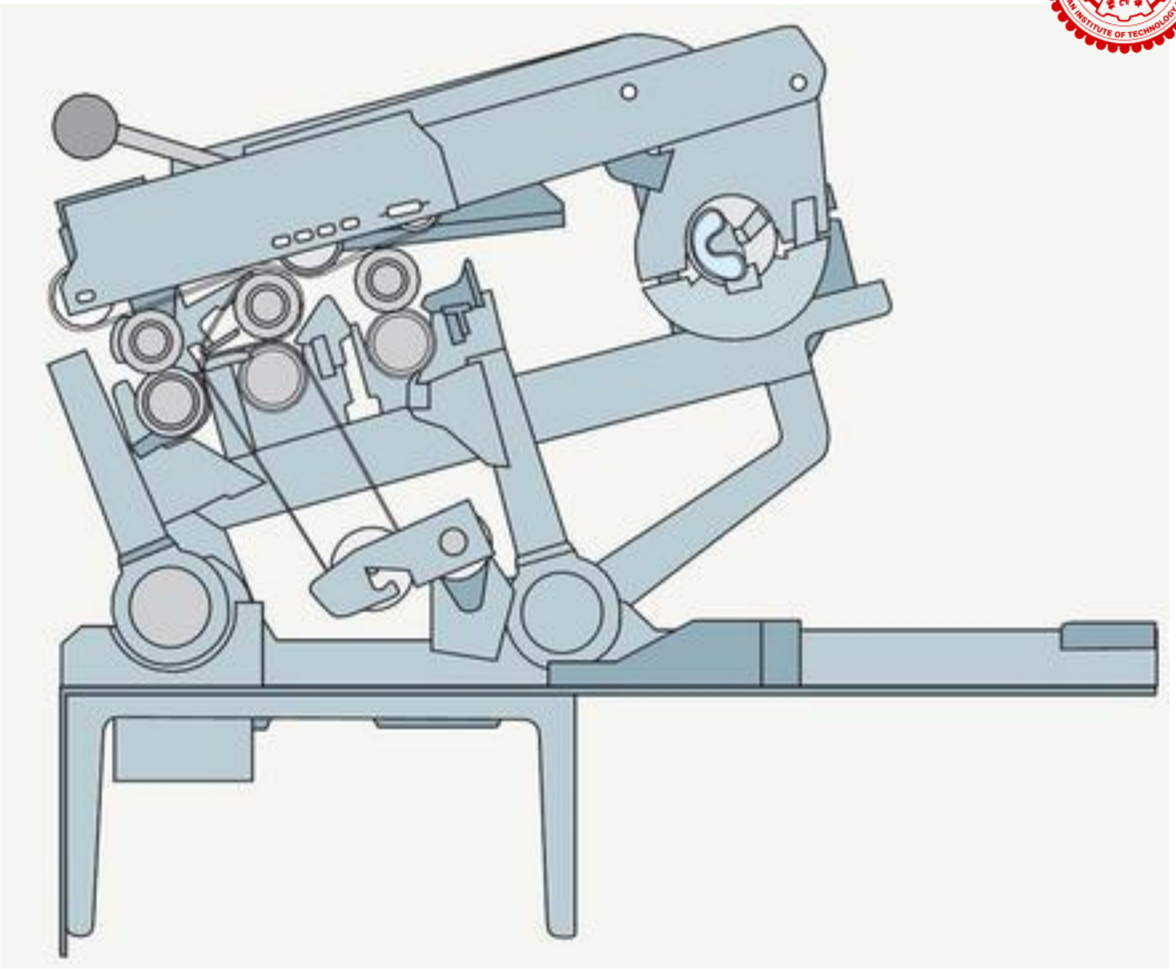
Flyer is fitted on rotating spindle (7)

Different Elements of Roving Frame:



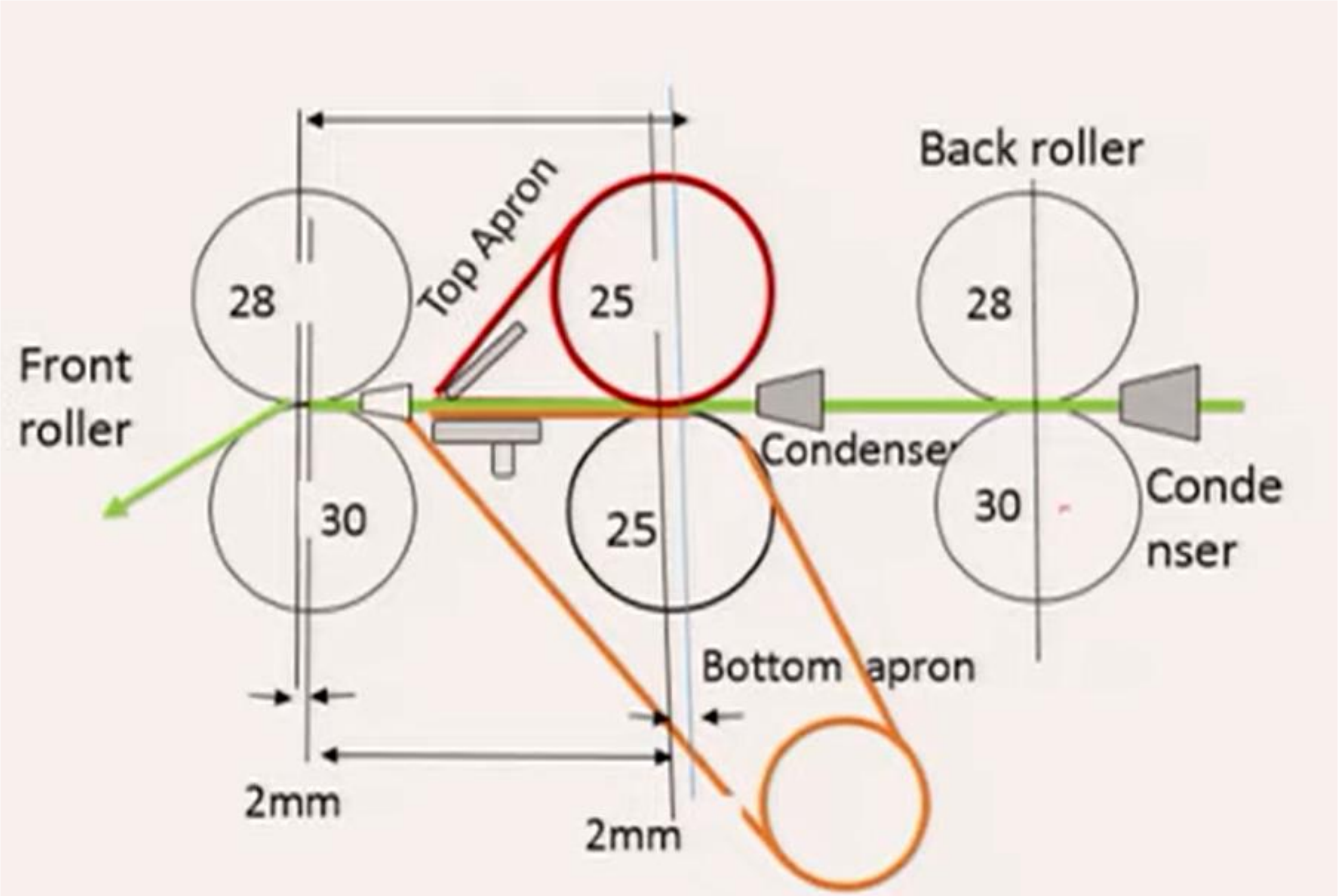
Attenuation of Sliver

- ✓ The apron arrangement
- ✓ Mainly double apron
- ✓ Only double apron enables draft of 20
  - Controlled fibre movement
- ✓ 3 rollers double apron ~ for low to medium draft
- ✓ 4 rollers double apron ~ for high draft
- ✓ Fluted bottom rollers and rubber coated pressure rollers (top rollers)



Drafting arrangement

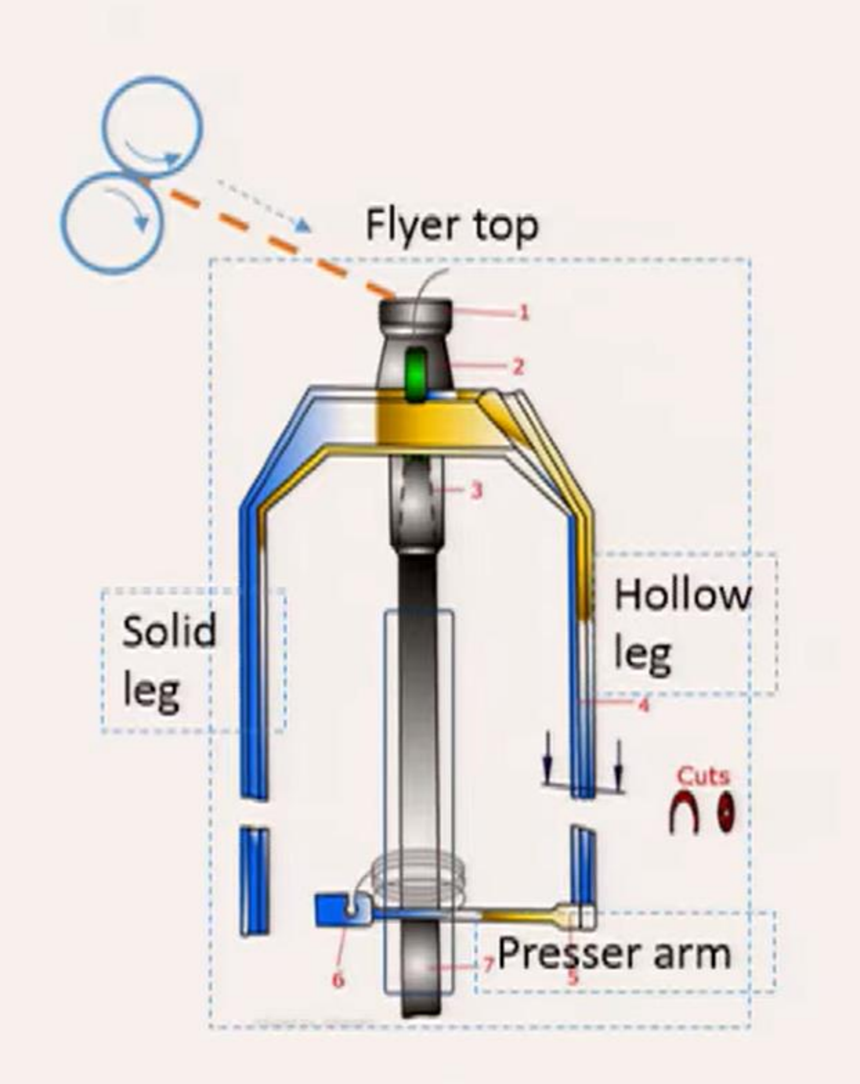
Drafting Arrangement:



Why is apron fitted in the main drafting zone?

What is the function of a condenser?

Twisting Element

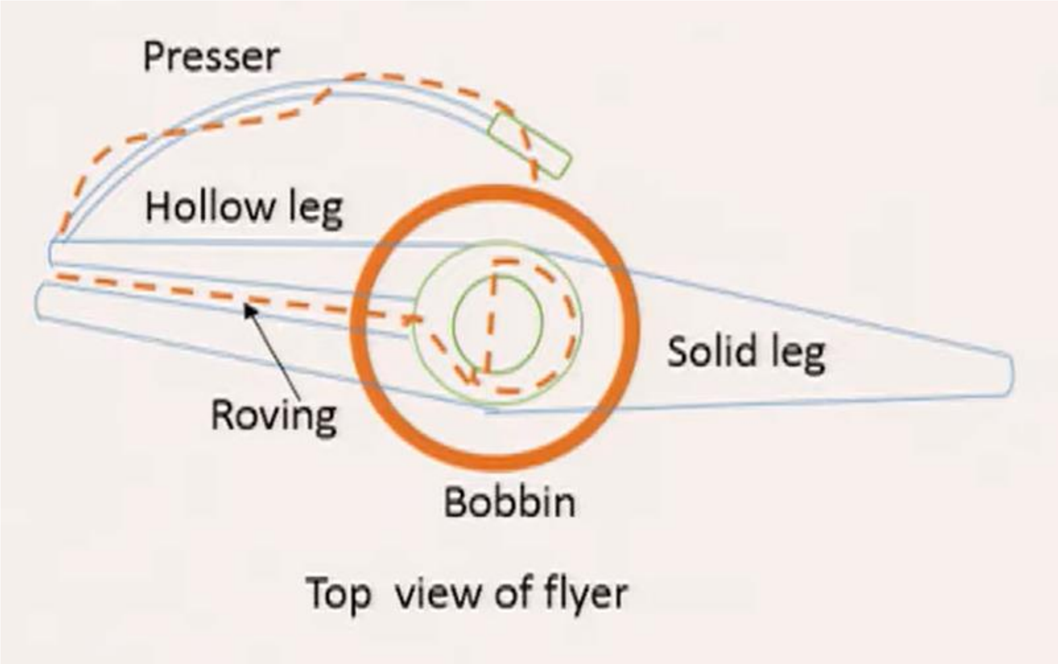


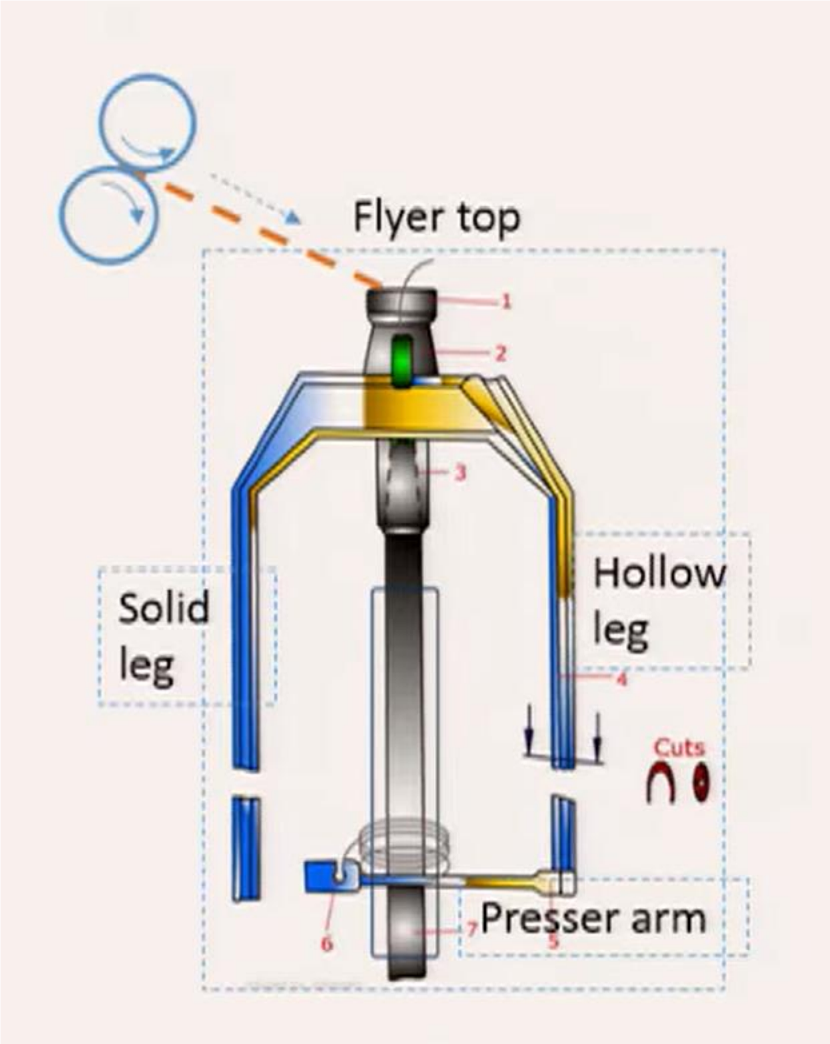
Flyer

What is the function of solid leg?

Solid leg balances the hollow leg to reduce vibrations.

Twisting Element





What is the function of hollow leg?

Hollow leg along with the pressure arm guides the roving from the flyer top to the bobbin and also ensures correct placement of the roving on the bobbin.

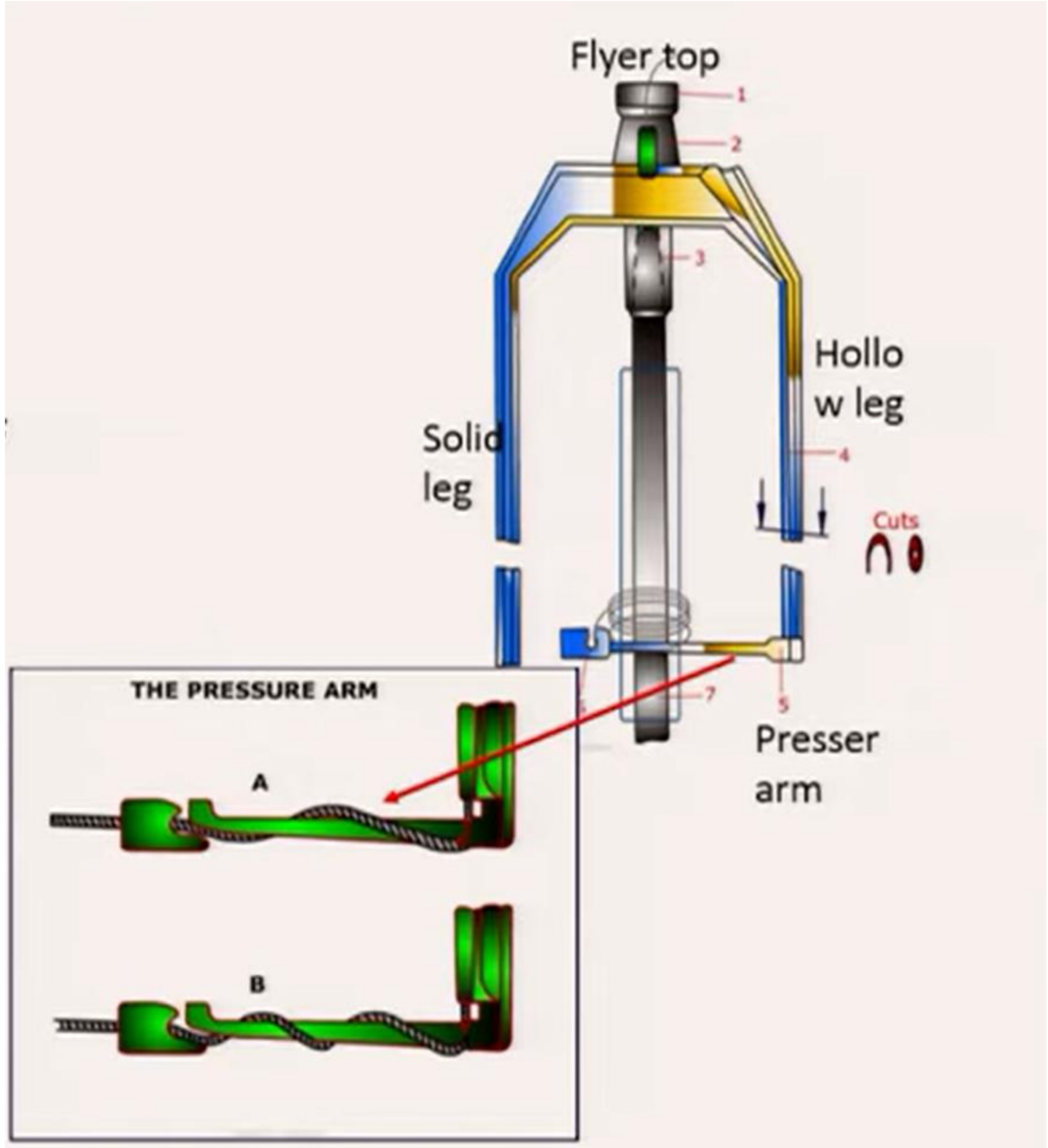
Hollow leg protects the roving from strong air current.

Twisting Element

Pressure Arm

- ✓ Guidance of roving to the bobbin
- ✓ Adjustment of roving tension by changing the no. of wraps around the pressure arm

    - Production of hard or soft package



How Roving is twisted?

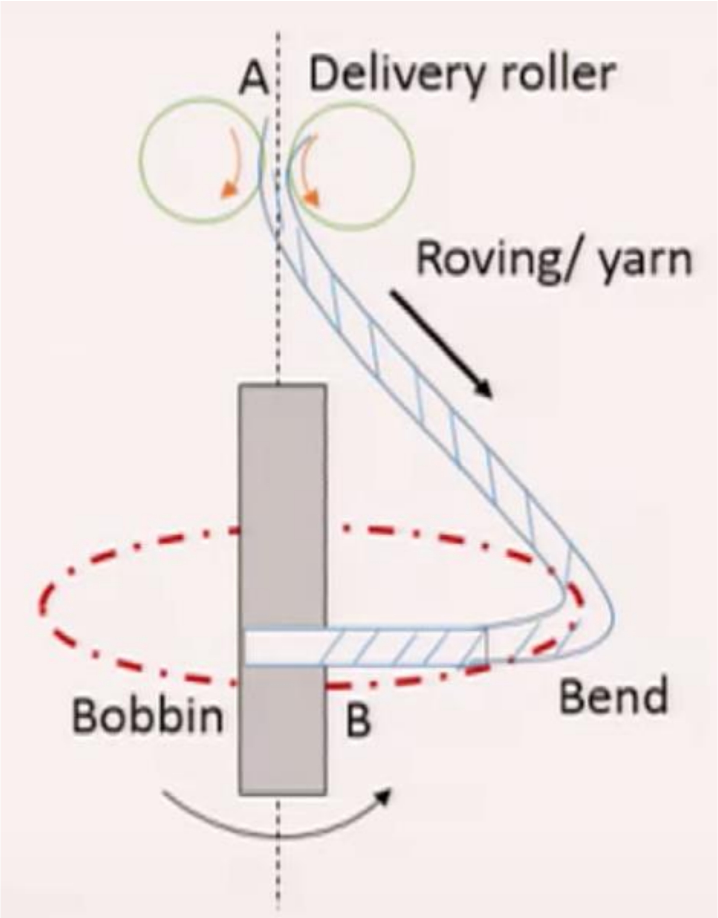
The loop rotates around the bobbin due to the rotation of bobbin/spindle

Twist develops in the loop between the bend and nip point

Developed twist flows beyond the bend into the roving

$$Twist = \frac{Rotational\ speed\ of\ flyer}{Develivery\ speed}$$

True twist



Problem: If twist in the roving is 1 turn per inch, roving delivery speed is 20 m/min, what will be the flyer speed?

Ans: 787 rpm

Why twisting elements of roving frame and ring frame are different?

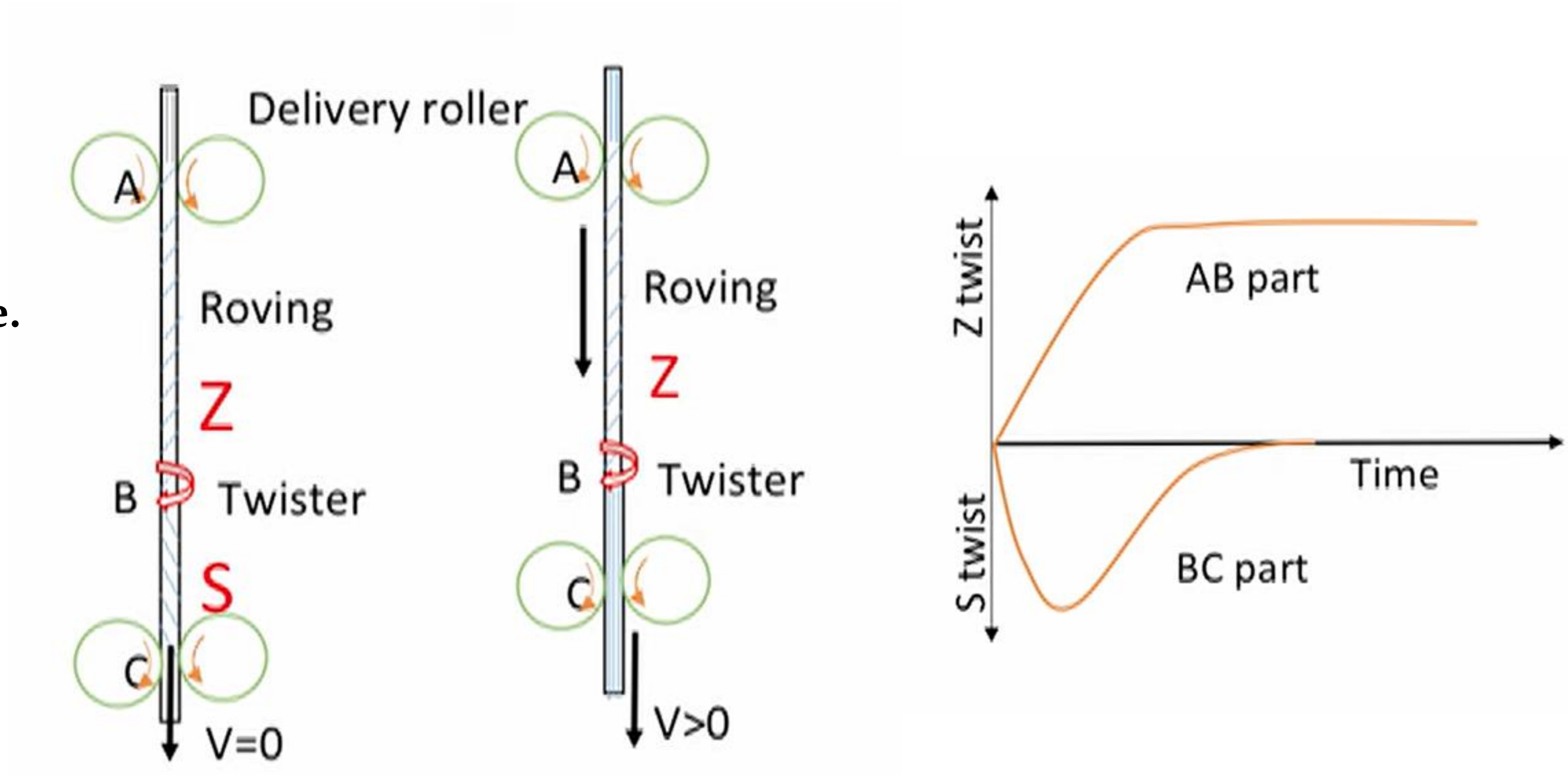
False Twist

AB zone receives Z twist and
BC zone receives S twist

As the yarn moves, Z twist in AB cancels S twist in BC zone.

The final yarn has no twist

The AB zone will have twist which is known as false twist



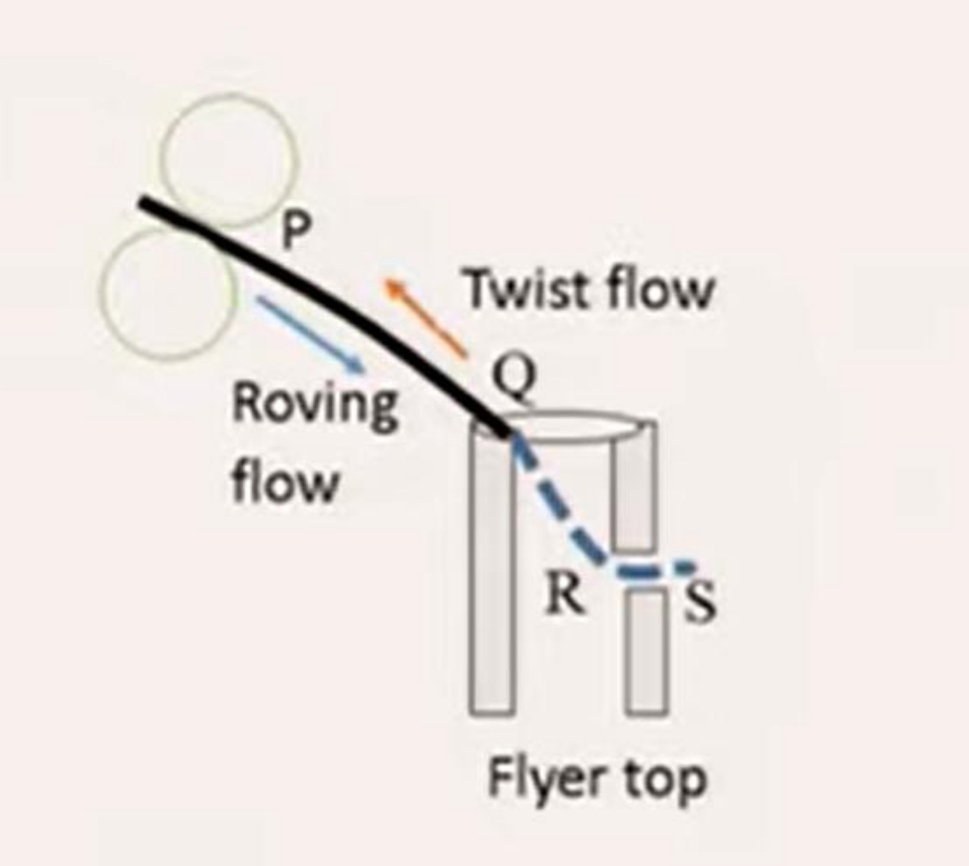
True Twisting Process

Twist originates in the region QR within the flyer top

When sufficient twist generates, it flows towards QP

Flow of twist depends on

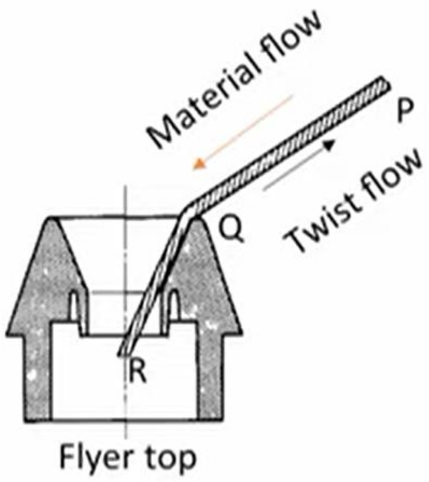
- ✓ Angle of wrap at the edge Q
- ✓ Pressure at point Q



False Twisting Process

Where and why false twist is generated ?

- ✓ At the flyer top due to rubbing of the roving

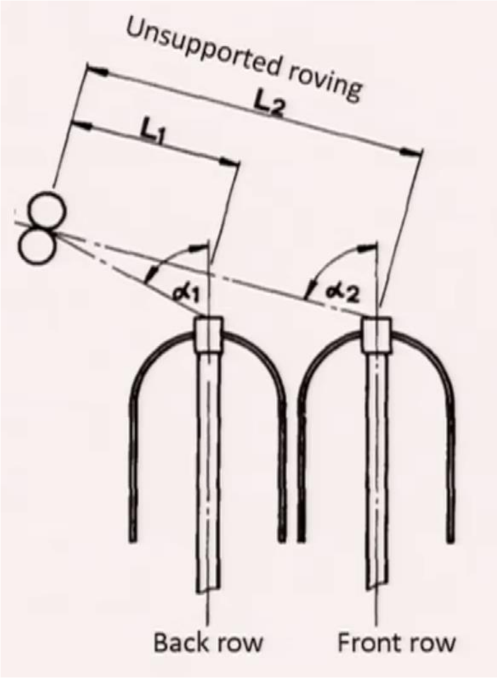


Benefits of false twist:

- ✓ Increase in strength of roving
- ✓ Less roving breakage

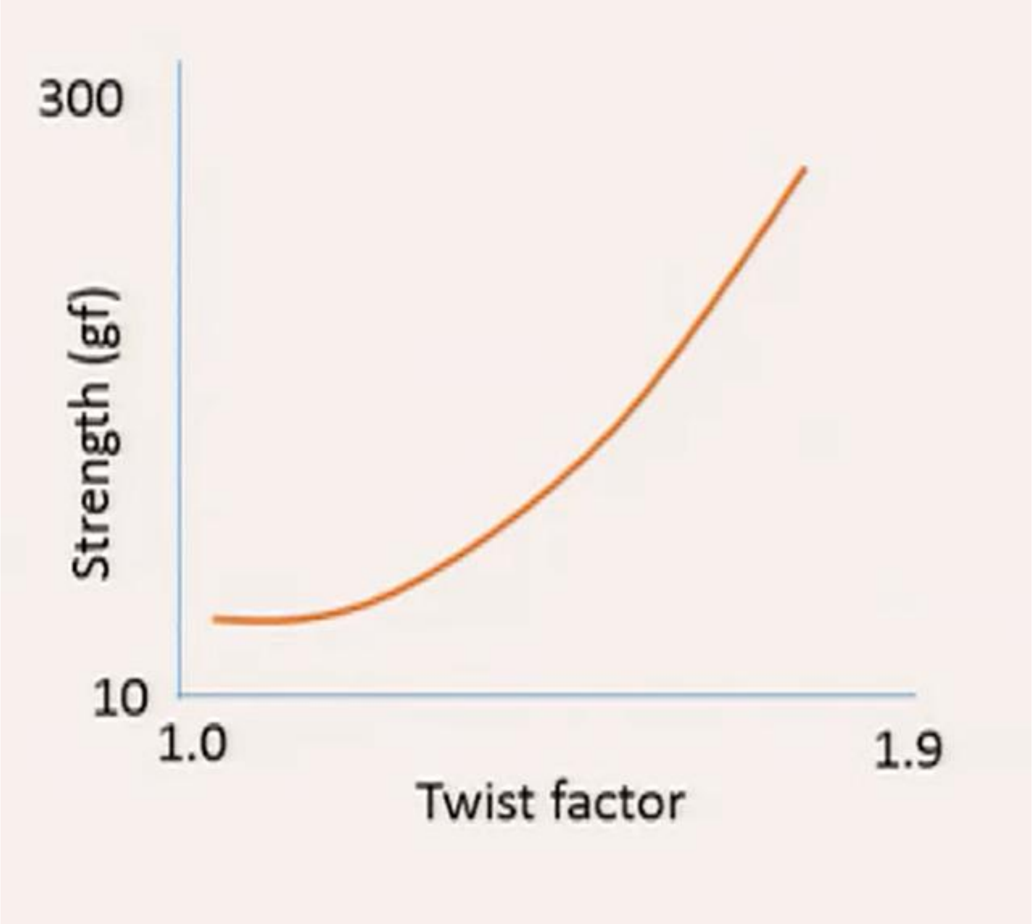
False twister

False twist in the front and back row is different as the angle of approach of roving to the flyer top is different.



How much twist needs to be inserted?

To make the roving strong enough for winding on the package without stretching or breaking



High Twist:

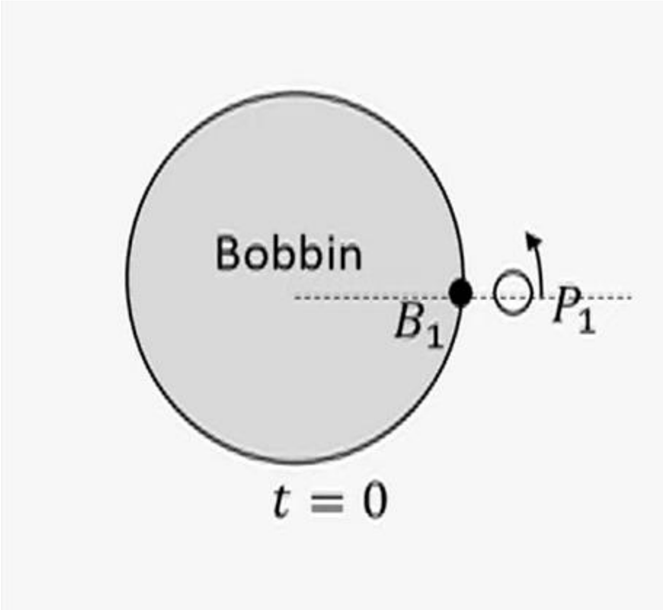
- ✓ Compact package formation at high production speed
- ✓ Problem in drafting at Ring frame

Winding

Winding is effected only when: **There exists a relative difference between bobbin and flyer speed**

Delivery Rate = Winding rate
=Winding speed × bobbin dia × Π
= $\Pi d_b \ |n_b - n_f|$

Calculate winding rate if twist in the roving is 1 turn per inch, roving delivery speed is 20 m/min, diameter of bare bobbin is 3 inch and (a) bobbin is stationary, (b) bobbin rotates at the same speed of flyer but in the opposite direction.



Ans. (a) Flyer speed = 787 rpm.
Winding rate =3.14*3*2.54*10^{-2}*787
= 188 m/min
Ans. (b) Winding rate =3.14*3*2.54*10^{-2}*(787+787)
= 377 m/min

Winding Possibilities

	Is winding possible ?	Is it acceptable?
Flyer rotates at the same speed of bobbin (same direction)	No	No
Flyer rotates at a higher speed than bobbin (same direction)	Yes	Yes, **Flyer Leading**
Flyer rotates but bobbin is stationary	Yes, but winding rate > delivery rate	No
Bobbin rotates at a higher speed than flyer (same direction)	Yes	Yes, **Bobbin Leading**
Bobbin rotates, but flyer is stationary	Yes, but no twist insertion	No
Flyer rotates in the opposite direction of bobbin	Possible, but winding rate >> delivery rate	No

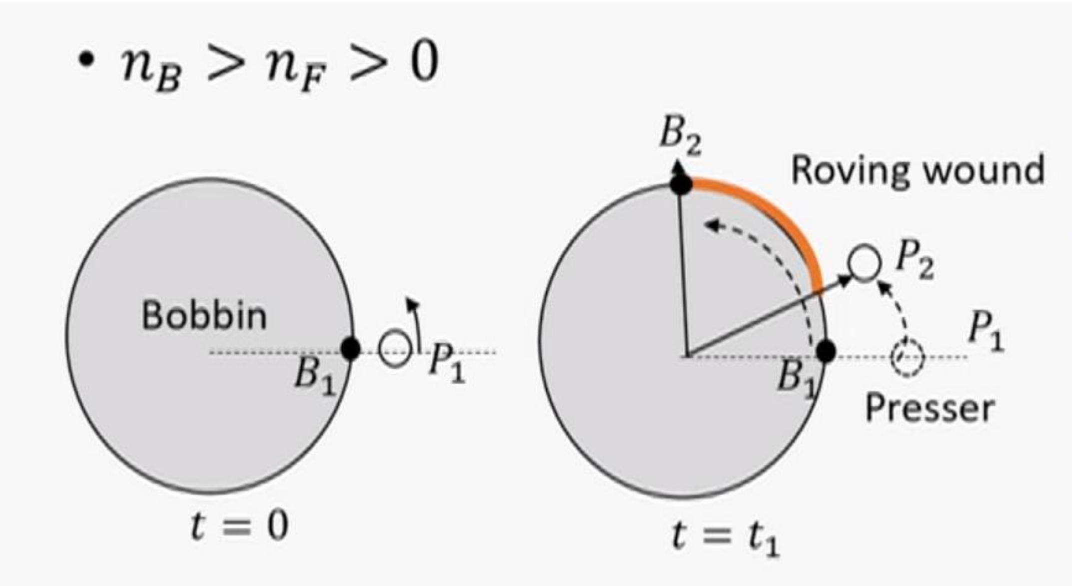
Bobbin leading:

$$v = \pi d_b (N_b - Nf)$$

$$N_b = N_f + \frac{D}{\pi d_b}$$

$$(N_b - N_f) \propto \frac{1}{d_b}$$

Where v = delivery Speed
d_b =bobbin diameter at a specific time



Why is flyer speed kept constant?

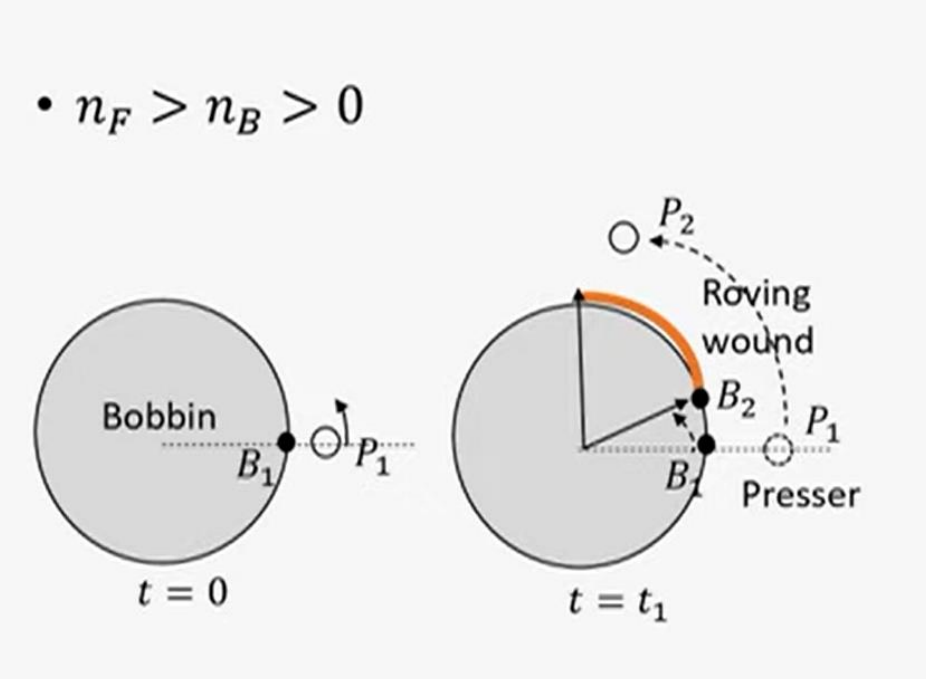
Owing to increase in bobbin diameter, the winding speed should decrease.
So, the bobbin speed should decrease as the winding progresses.

Flyer Leading

$$v=\pi db(N_f - N_b)$$

$$N_f = N_b - \frac{v}{\pi d_b}$$

$$(N_f - N_b) \propto \frac{1}{d_b}$$

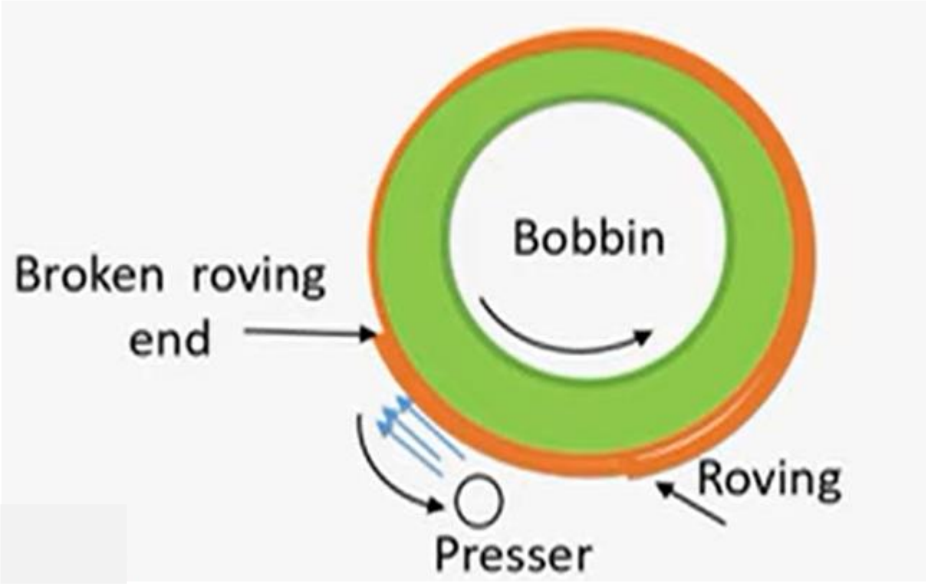


Owing to increase in bobbin diameter, the winding speed should decrease. So, the bobbin speed should be increased as the winding progresses.

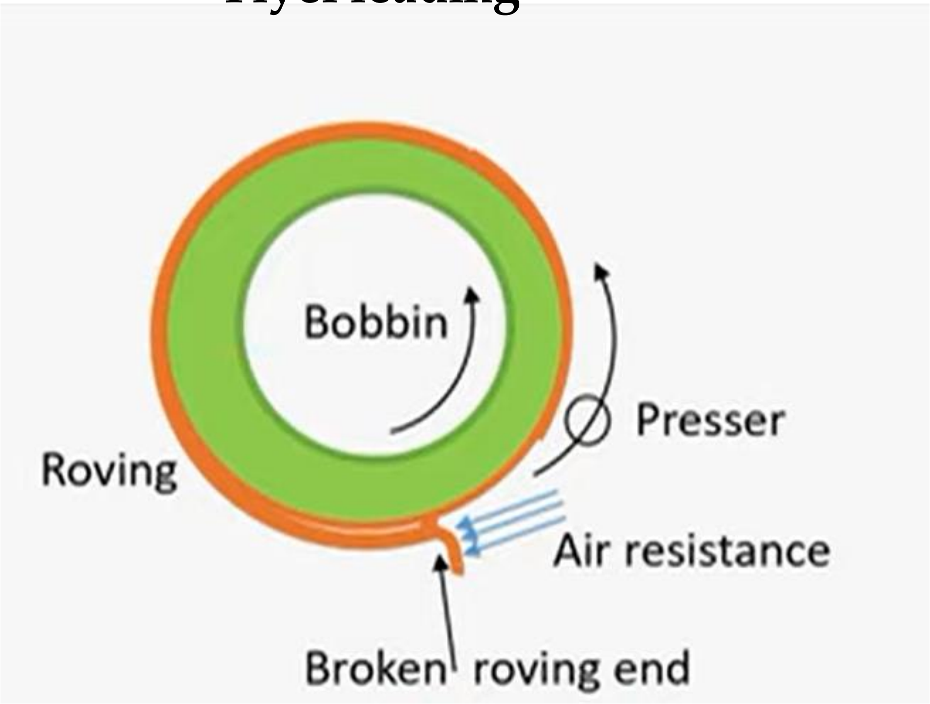
Less favourable in terms of energy consumption.

Bobbin Vs Flyer Leading

Bobbin leading



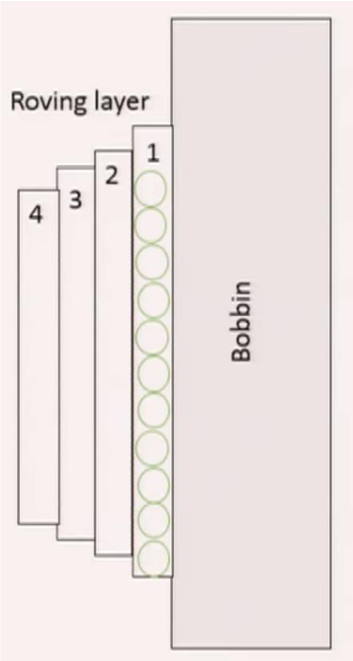
Flyer leading



- ✓ *After roving break, possibility of roving slough-off is higher in case of flyer leading frame.*
- ✓ Flyer leading frame leads to more roving breaks when the machine is switched on. Why ?

Bobbin Building

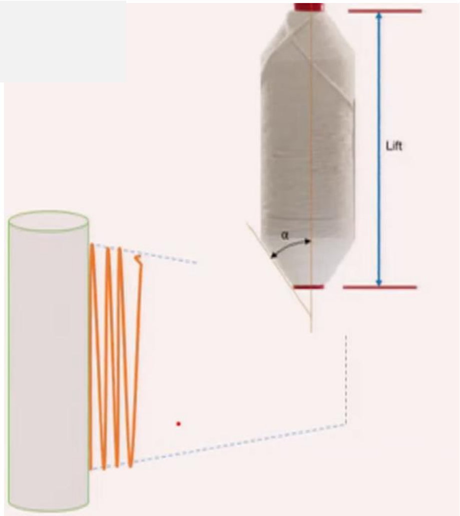
Operations involved in bobbin building



- ❑ Traversing roving laying point

  Traversing bobbin rail or Flyer?

- ❑ Shortening of traverse length after each layer
  - ✓Formation of conical package
  - ✓Prevent roving slough off during handling



- ❑ Progressive reduction of bobbin speed Why?

  To keep the winding rate constant.

- ❑ Progressive reduction in traverse speed

Traverse Rate of Bobbin Rail

Relation between traverse rate and bobbin diameter

$Delivery\ speed = v$

d_R *is the roving diameter*

$Length\ of\ roving\ delivered\ per\ min = v$

$Length\ of\ a\ coil = \pi d_b$

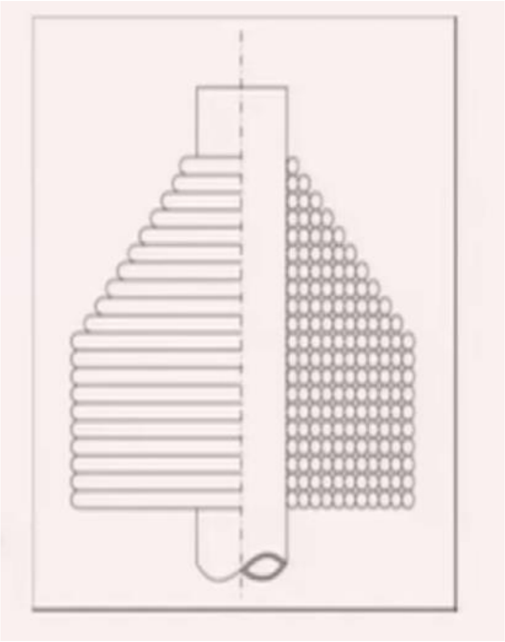
$$Number\ of\ coils\ laid\ onto\ the\ bobbin\ per\ \min(n) = \frac{v}{\pi d_b}$$

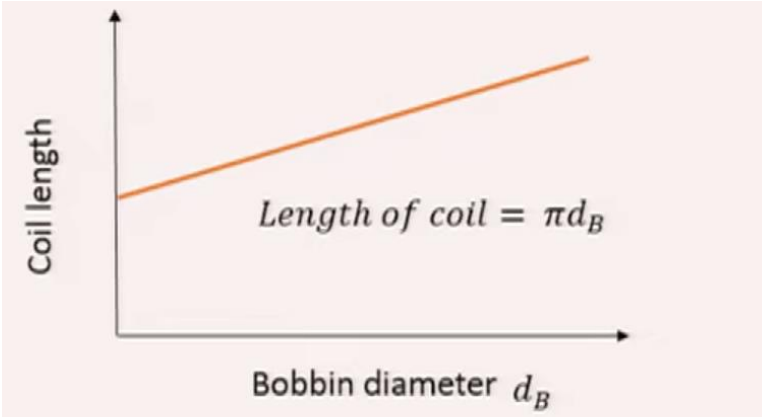
$$Distance\ moved\ by\ the\ bobbin\ rail\ per\ min = n \times dR$$

$$= \frac{v}{\pi d_b} \times d_R$$

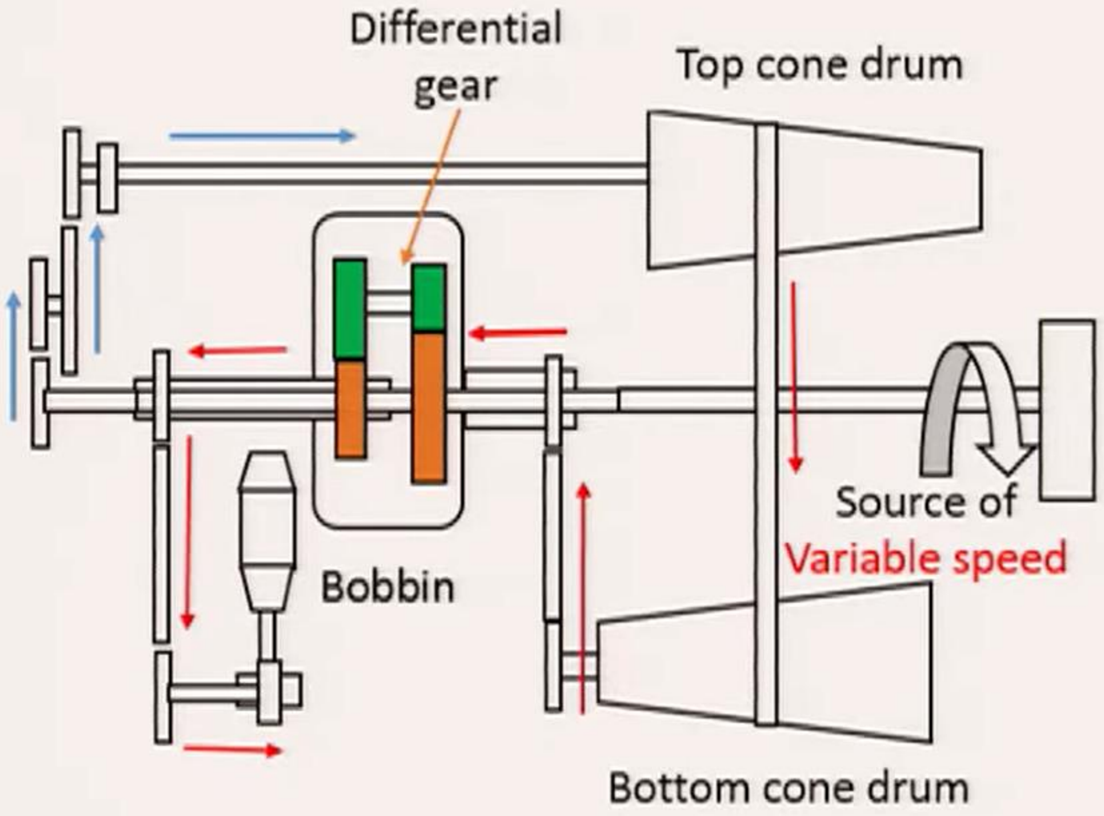
$$Traverse\ rate\ of\ bobbin\ rail \propto \frac{1}{d_b}$$

As the bobbin diameter increases, transverse rate needs to be decreased.





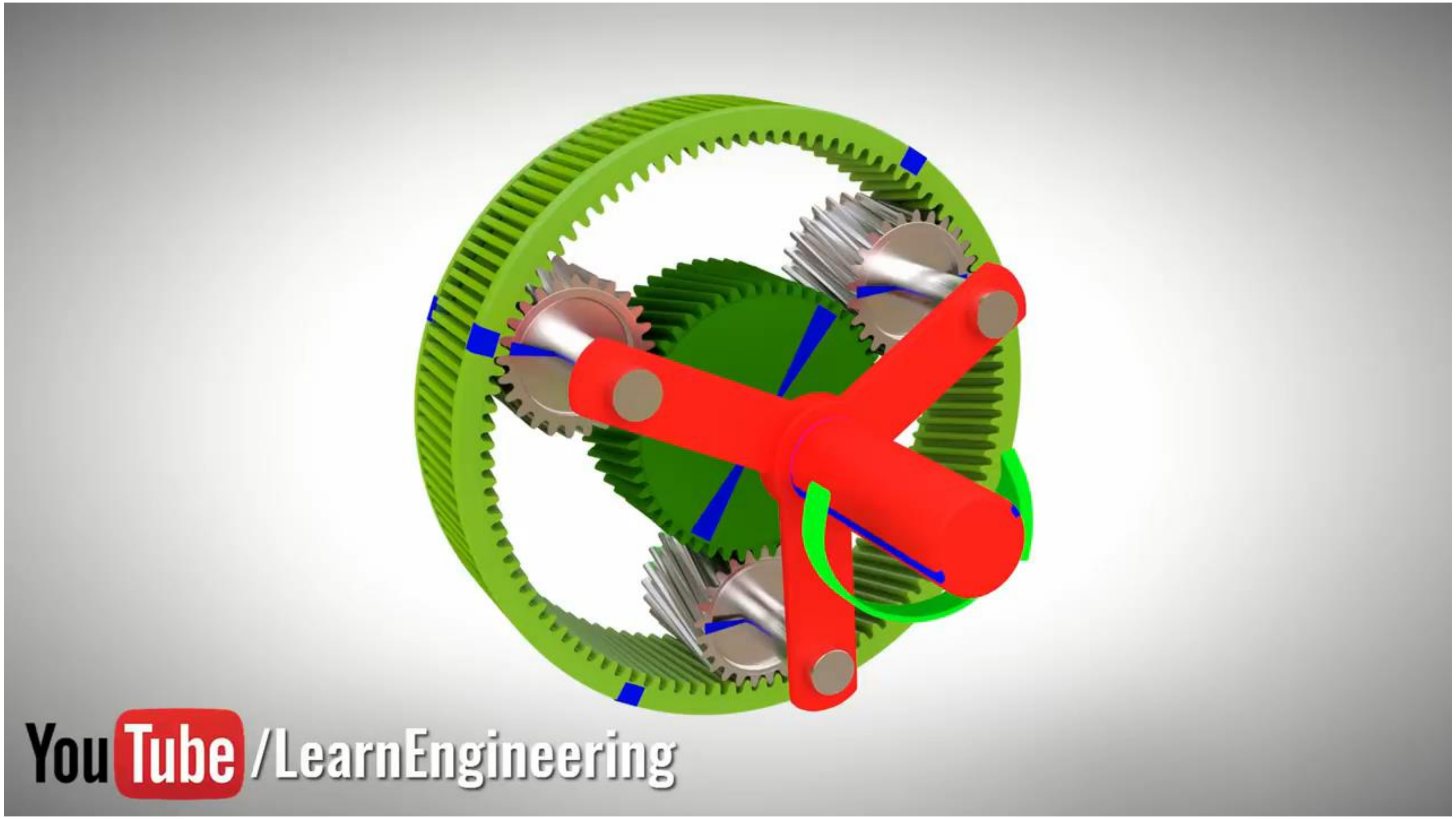
Bobbin Drive Mechanism



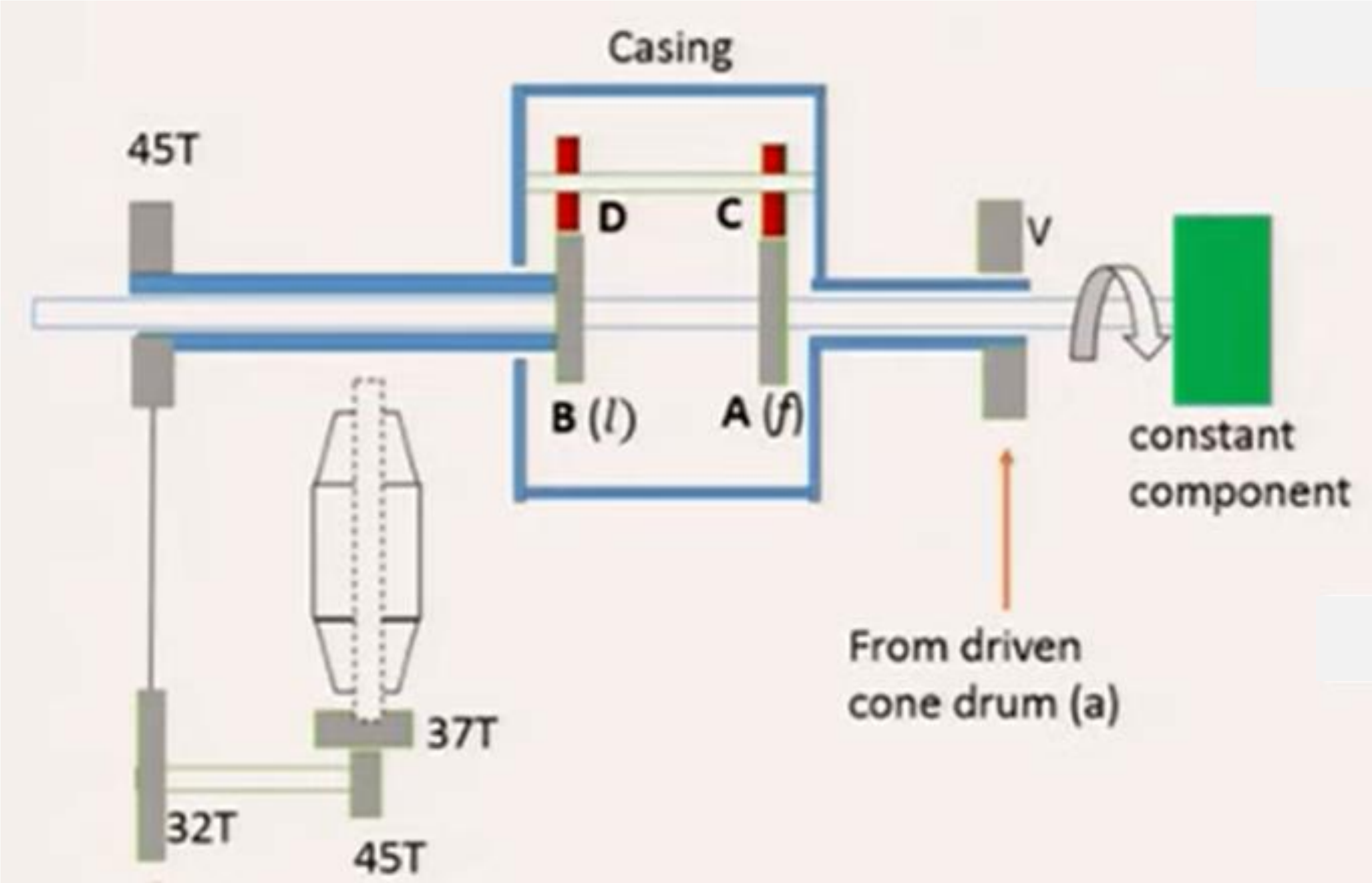
$$n_b = \frac{V}{\pi d_b} + n_f$$

$$(n_b - n_f) \propto \frac{1}{d_b}$$

Epicyclic Gear Box



Bobbin Speed Regulation



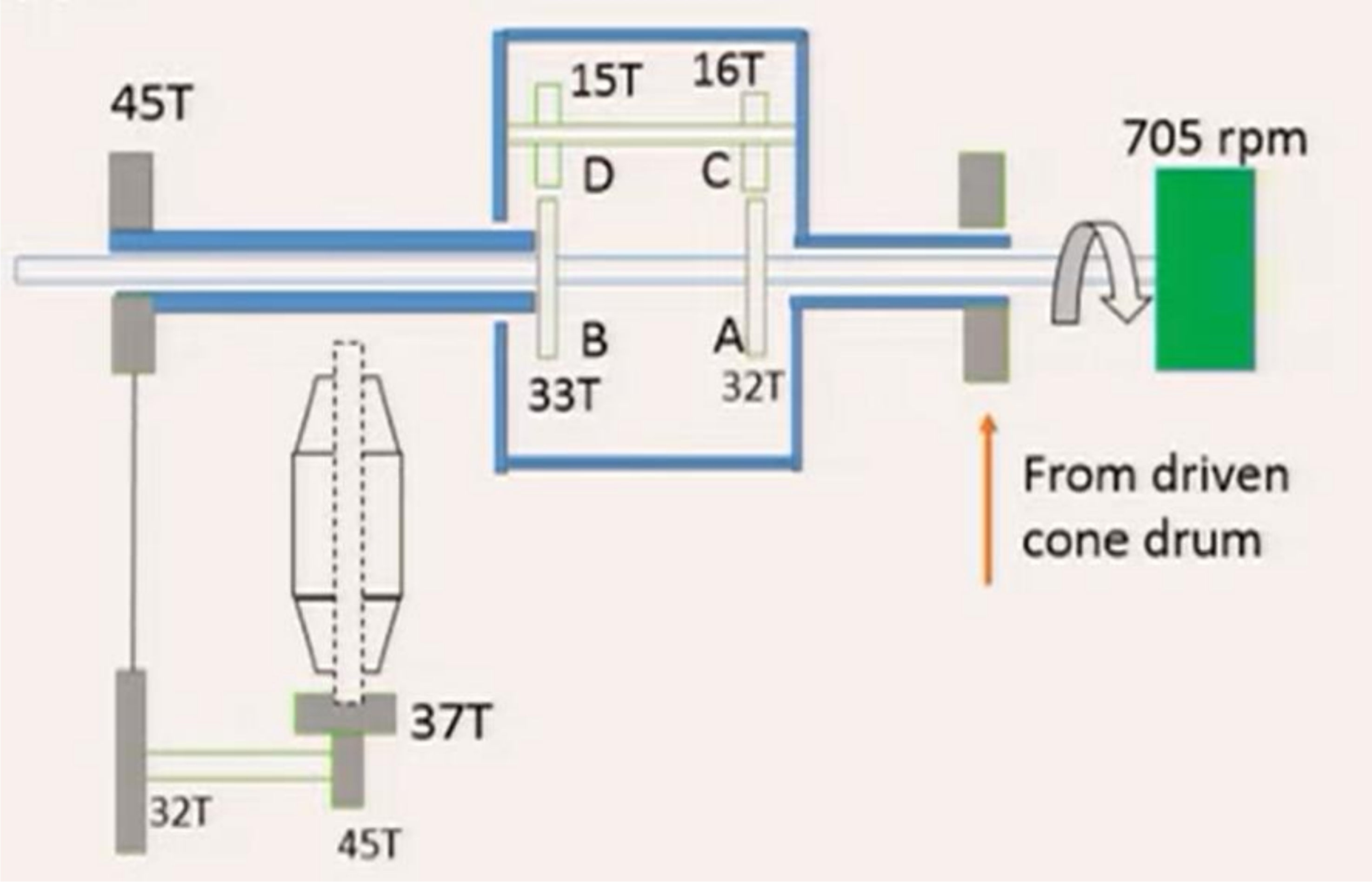
Epicyclic Ratio (e) $= \frac{A}{C} \times \frac{D}{B}$

Input gear speed = f
Output gear speed = l
Casing or arm speed = a

$$e = \frac{l-a}{f-a}$$

$$So, l = a + e(f-a)$$

Bobbin Speed Regulation



What will be the bobbin speed if the casing speed is 0 ?

Ans. 1096 rpm.

Bobbin Speed Regulation

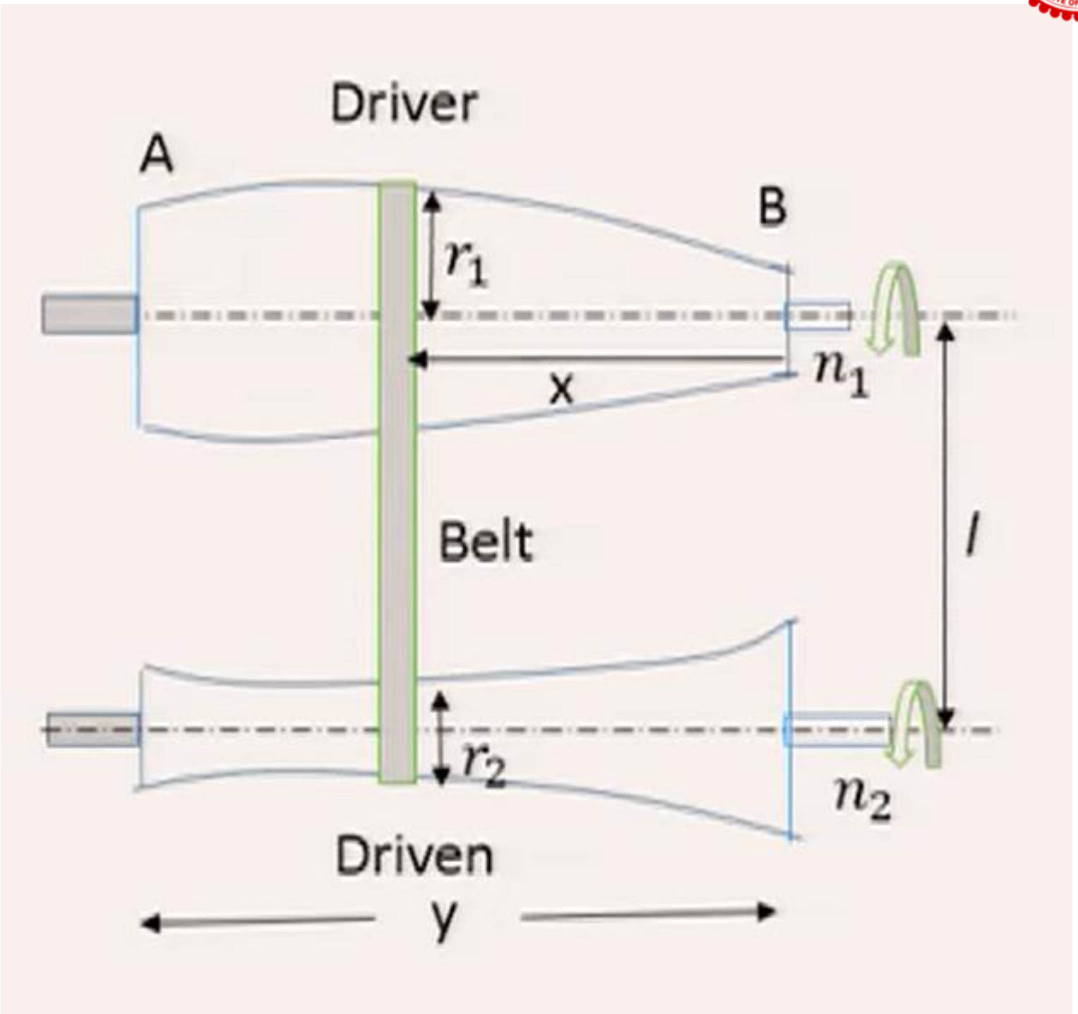
- ✓ The variable speed of the bobbin is obtained by using a pair of cone drum connected to a common belt drive.

- ✓ The driver drum runs at a constant speed.

- ✓ The belt is shifted continuously to change the diameter ratio.

- ✓ The driven drum speed changes depending upon the diameter ratio.

  - The speed of driven cone drum changes linearly



Bobbin Speed Regulation

Length of the belt should be constant.

Assuming the angle of wrap to be 180°

Length of the belt $= 2l + \Pi\,(r_1 + r_2)$

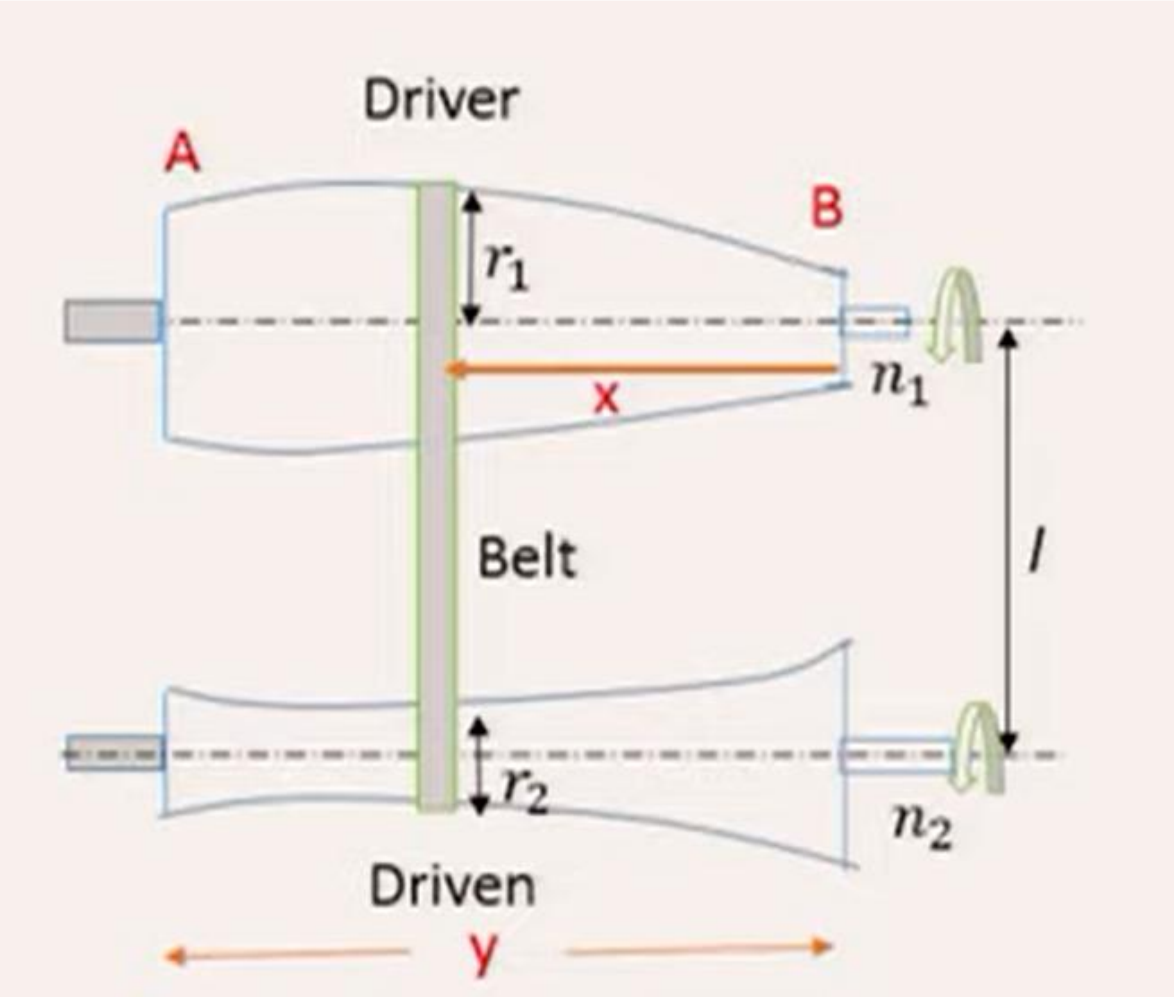
Relation between driver and driven cone drum speed

At any location of the belt, the surface speed of the cone drums is same.

So, $2\Pi\, r_1\, n_1 = 2\Pi\, r_2\, n_2$

$$n_2 = n_1\,(r_1 / r_2)$$
$$n_2 \propto (r_1 / r_2)$$

The speed of the driven cone drum varies linearly with the diameter ratio.



RING FRAME

Working Principle

Roving bobbins (1) are placed in creel holder(3)

↓

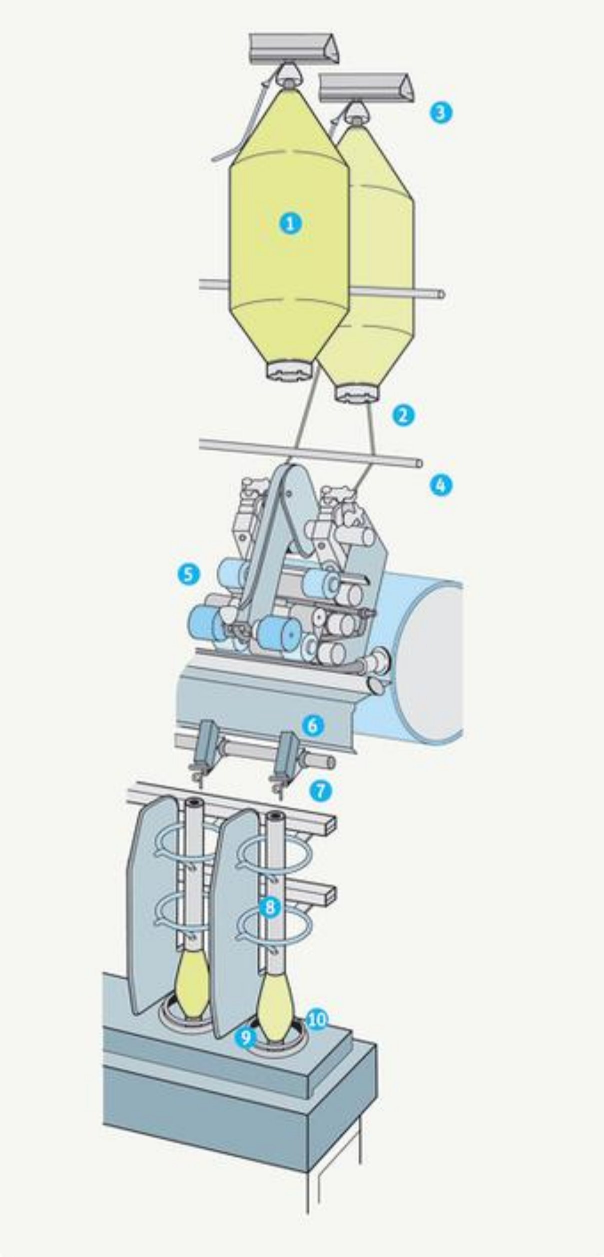
Roving (2) guided by guide rails(4) to drafting arrangement (5), inclined 45°-60°

↓

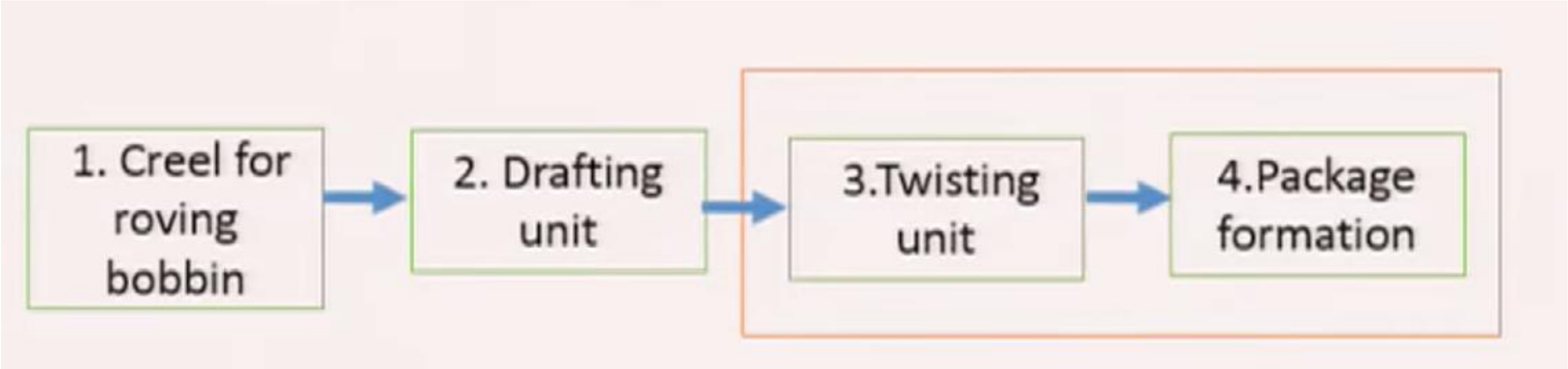
Fibre strands (6) from front roller get twisted by spindle (8)

↓

Spindle (8), traveller (9), ring (10) are required for twisting and winding



Working Principle

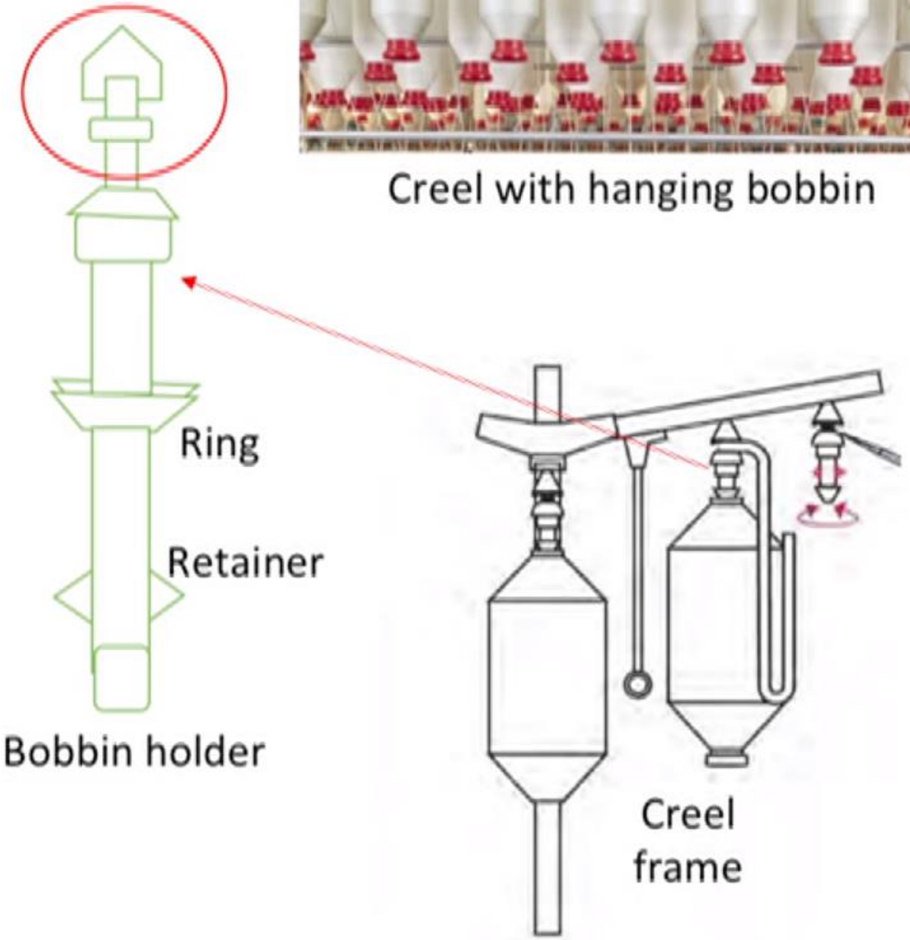


- ✓ **Feed Material:** Roving (200 -1200 Tex)
- ✓ **Output Material:** Yarn (5-100 Tex)
  Bobbin (Cop), 50-140 gm.
- ✓ **Draft:** 12-45
- ✓ **Spindle speed:** up to 25,000 rpm
- ✓ **No. of spindles:** 1980

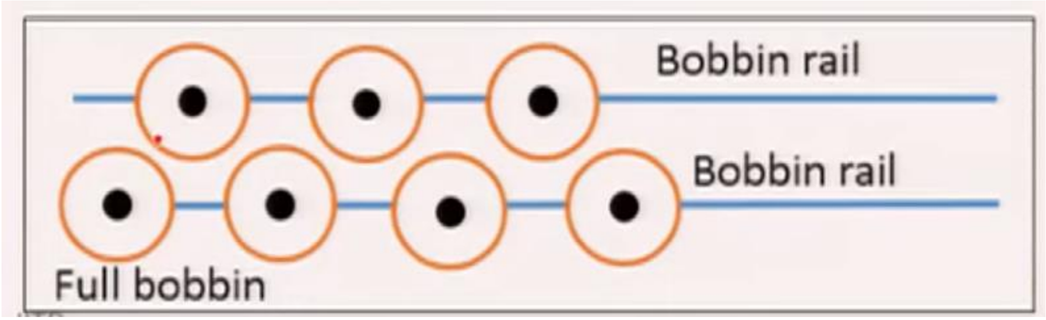
Creel Design

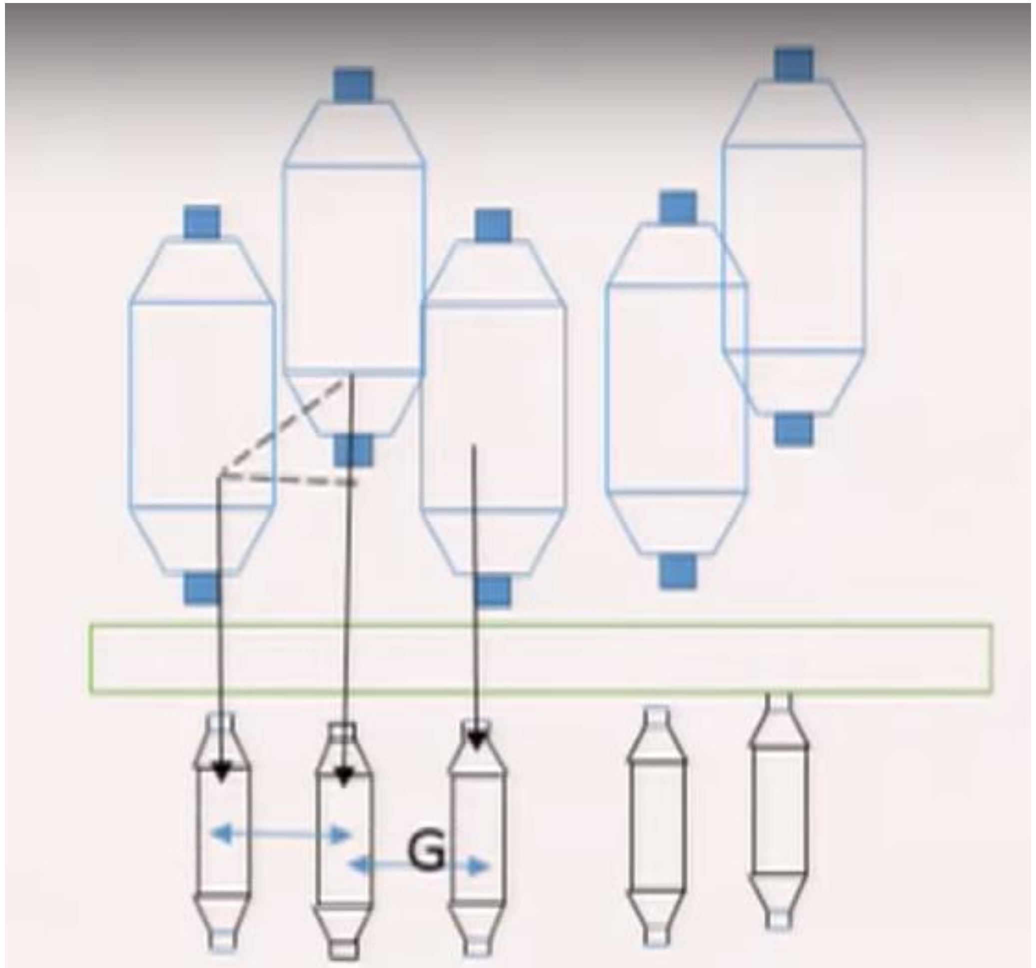
- ✓ Must accommodate a large number of roving bobbins
- ✓ Promote easy unwinding of roving without undue stretching
- ✓ Avoid interference with each other
- ✓ Easily accessible to the operators

Creel with hanging bobbin



Creel Design





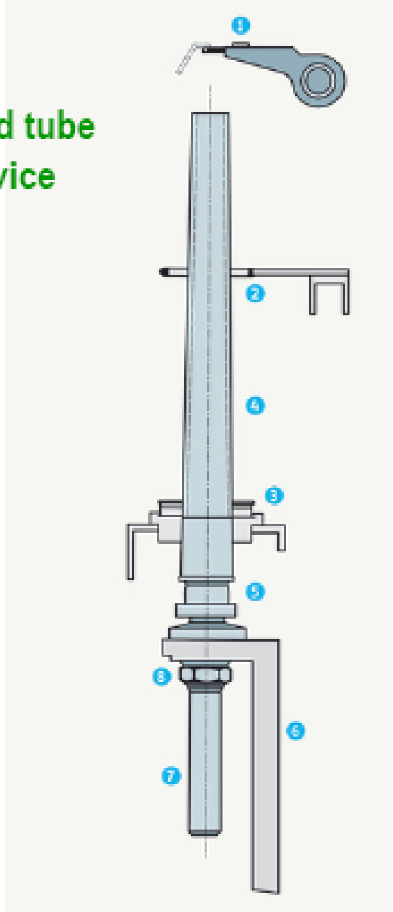
Bobbin holders are arranged in a staggered manner on the rails

Spindle

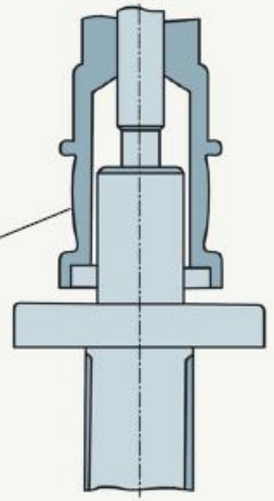
Two parts
- Upper part (4) ~ made of aluminum alloy and tapered
- Bolster (7)

Near upper end tube gripping device

- Bolster (7) is fixed to the frame (6) by a nut (8)
- Influence :
  - ✓ End breakage
  - ✓ Power consumption
  - ✓ Yarn quality

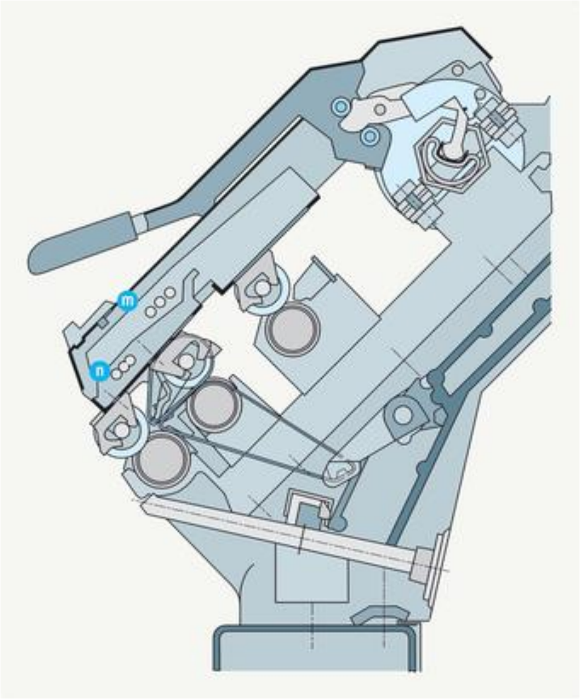


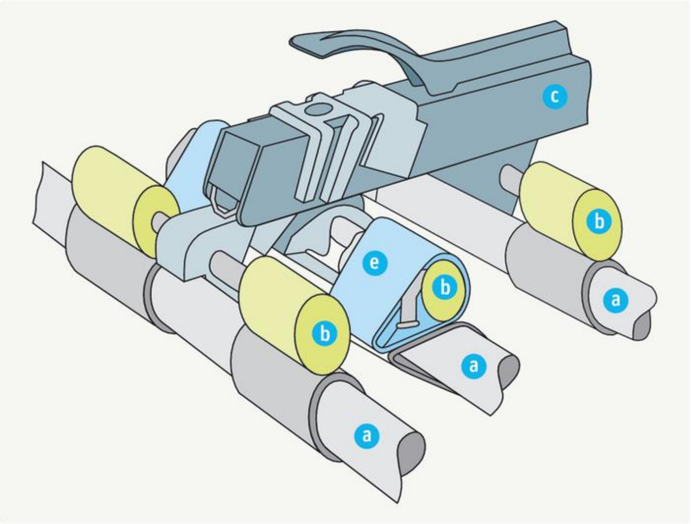
- ➤ Lower end of (4) is placed on the neck bearing in the bolster
- ➤ Driving tape rotates the spindle through bearing

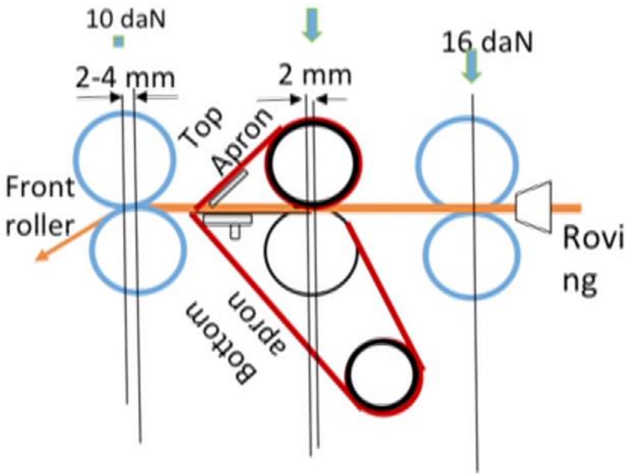


Drafting System

- 3/3 double apron
- 3 lower fluted steel rollers (a)
- Top rollers (b) - Carried in a pivoted weighting arm (c)
- Two aprons (e) guide the fibres

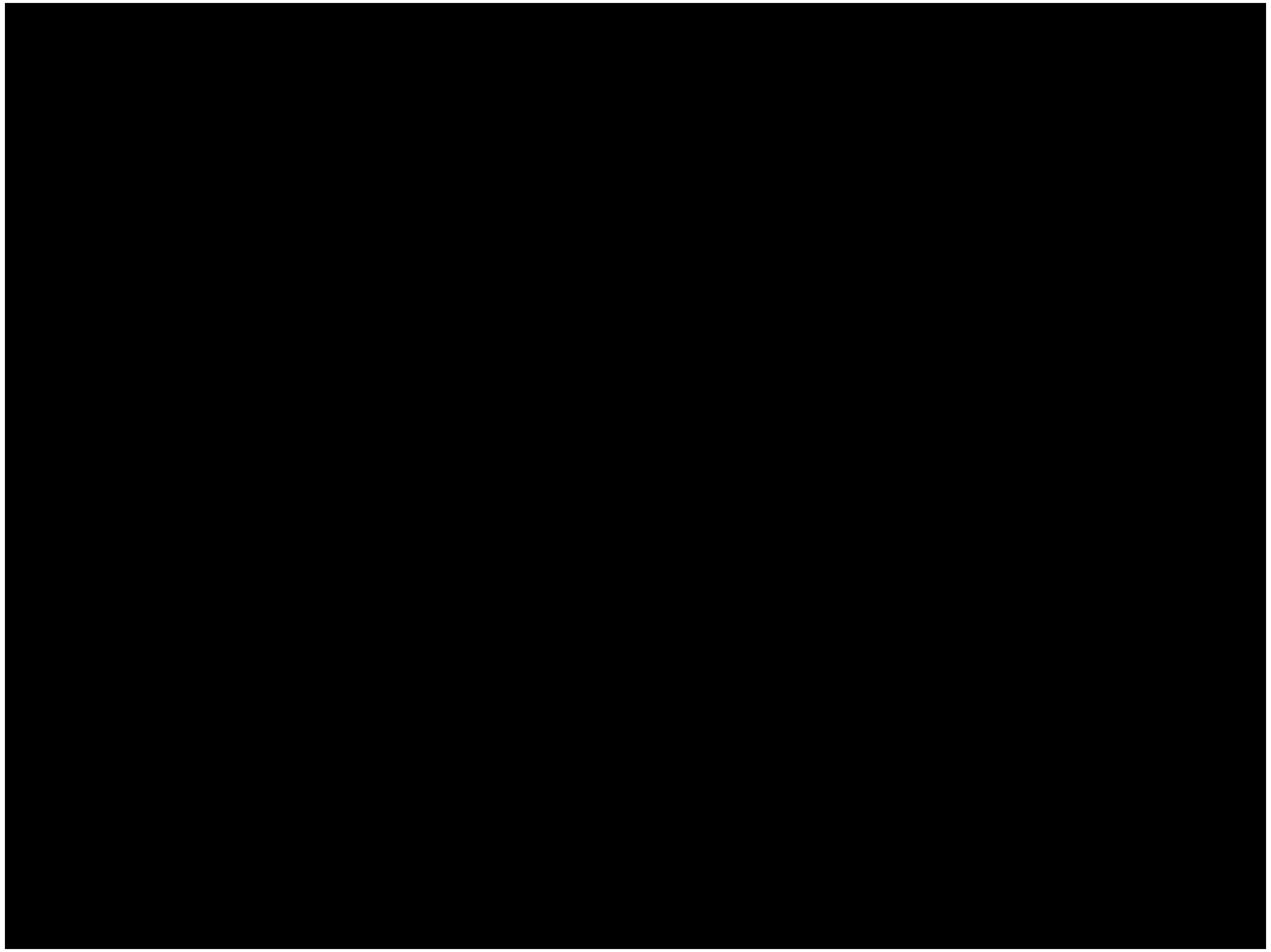






Working Principle

Ring Frame

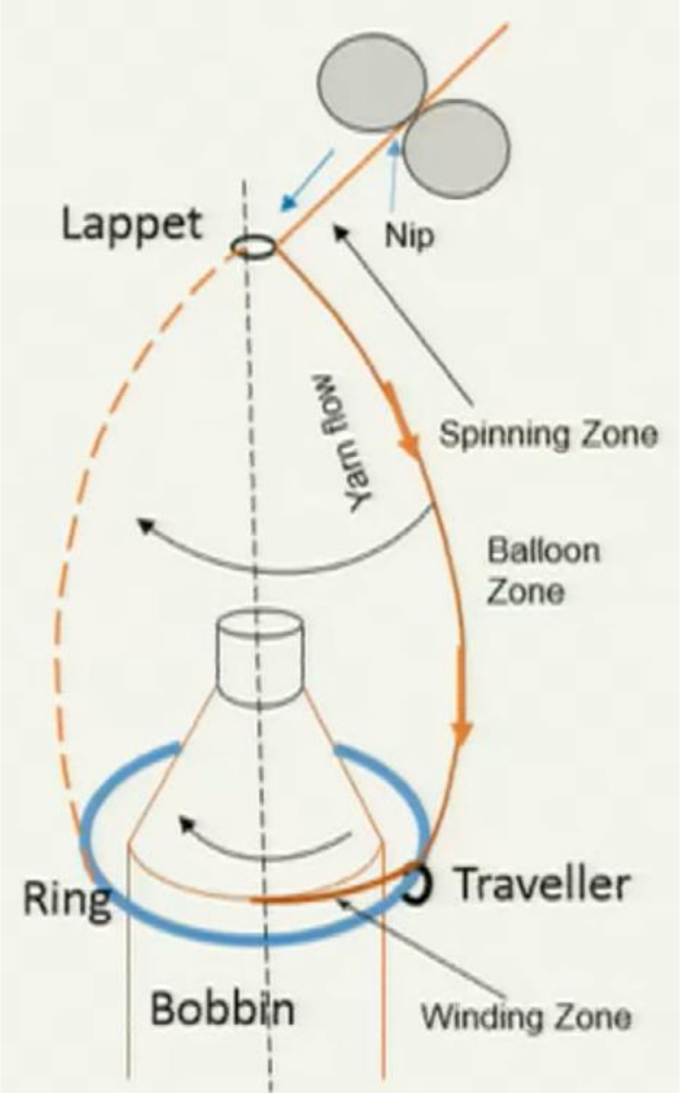


Twisting Principle

- ✓ Twisting and winding in ring frame occur simultaneously

  Consequence?

- ✓ Twisting occurs
  - Loop of yarn rotates around the bobbin axis.
  - The yarn turns around its own axis.



Twisting Principle

Why yarn balloon rotates?

Spindle and bobbin rotates at a high speed

⇩

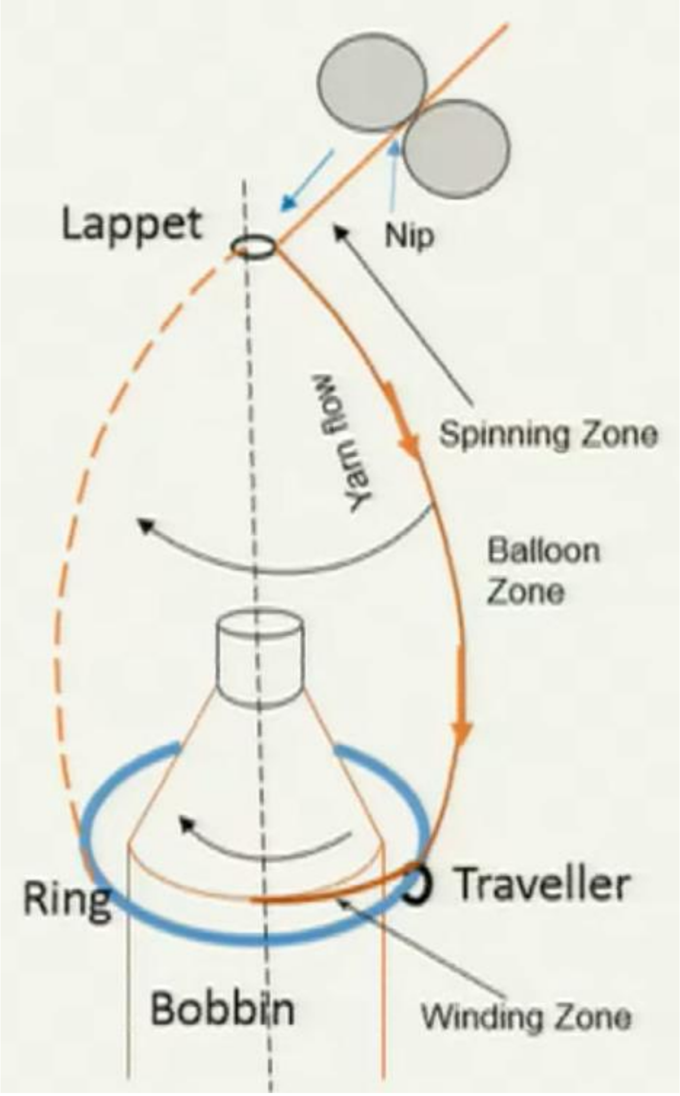
Yarn segment between bobbin and traveller gets dragged due to bobbin rotation

⇩

Traveller rotates on the ring which acts as a track

⇩

Yarn balloon rotates imparting twist in the yarn

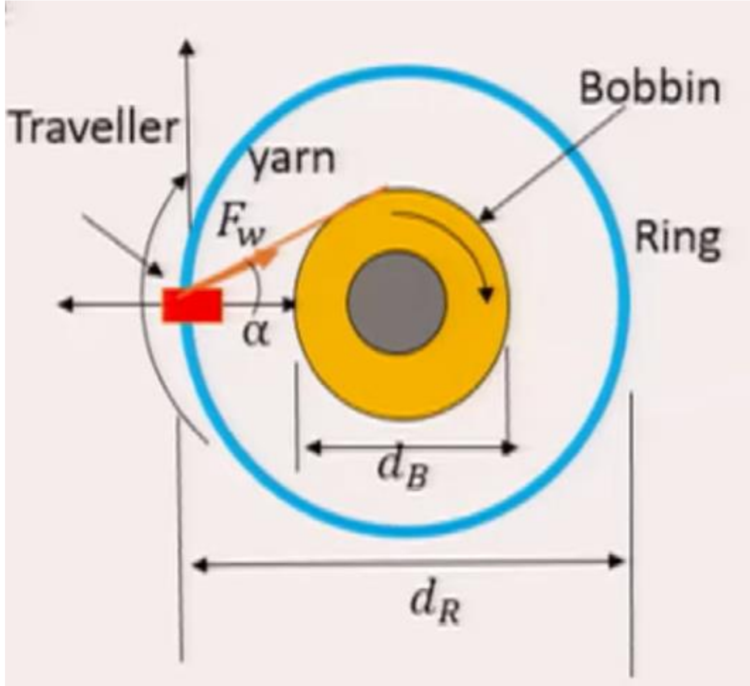


Twisting Principle

Why winding is possible?

A relative motion exists between bobbin and traveller.
Why?

- ✓ Due to friction between ring and traveller
- ✓ Continuous delivery of yarn



How is the relative speed maintained between bobbin and traveller?

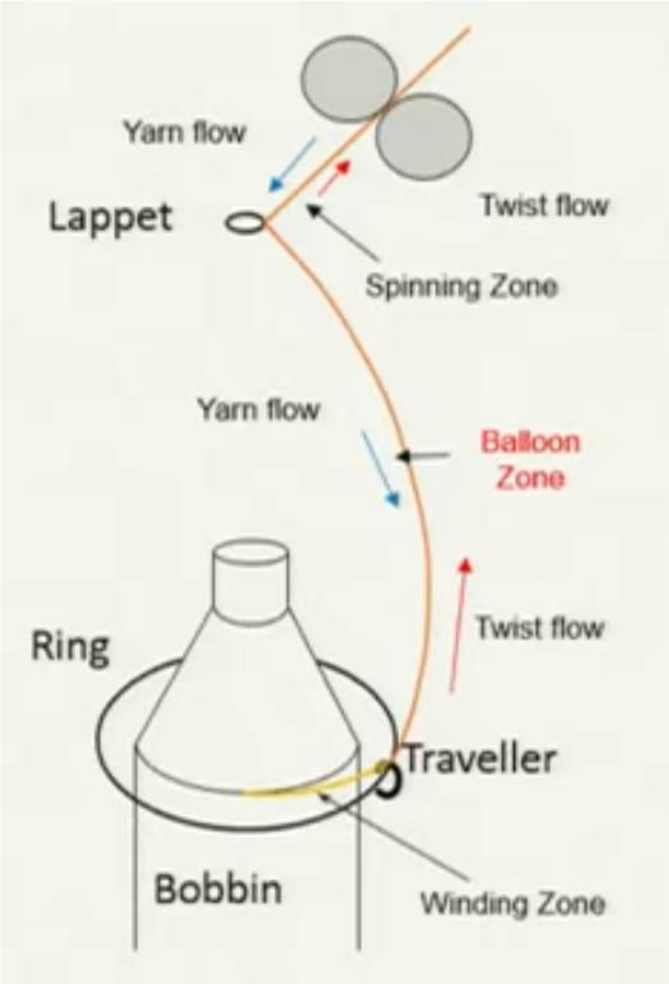
Automatically, self-adjusting

Twisting Principle

Twist generates in the **Balloon zone** and then flows to the **Spinning zone** and **Winding zone**

The flow of twist depends on the pressure at the yarn contact points at lappet guide and traveller.

$$\boldsymbol{Twist} = \frac{\boldsymbol{Traveller\ speed}}{\boldsymbol{Delivery\ speed}}$$



Winding Principle

Winding Rate = Yarn Delivery Speed

$$V = \pi D_b\,(nb - nT)$$

V: Delivery speed, D_b : bobbin dia, N_b: Bobbin speed, n_T: Traveller speed

As the bobbin diameter increases, traveller speed should increase.

What happens to twist?

Calculate the change in twist in turns per inch if the delivery speed of a ring frame is 15 m/min, spindle speed is 16,000 rpm and the diameters of full cop and bare tube are 46 mm and 25 mm, respectively?

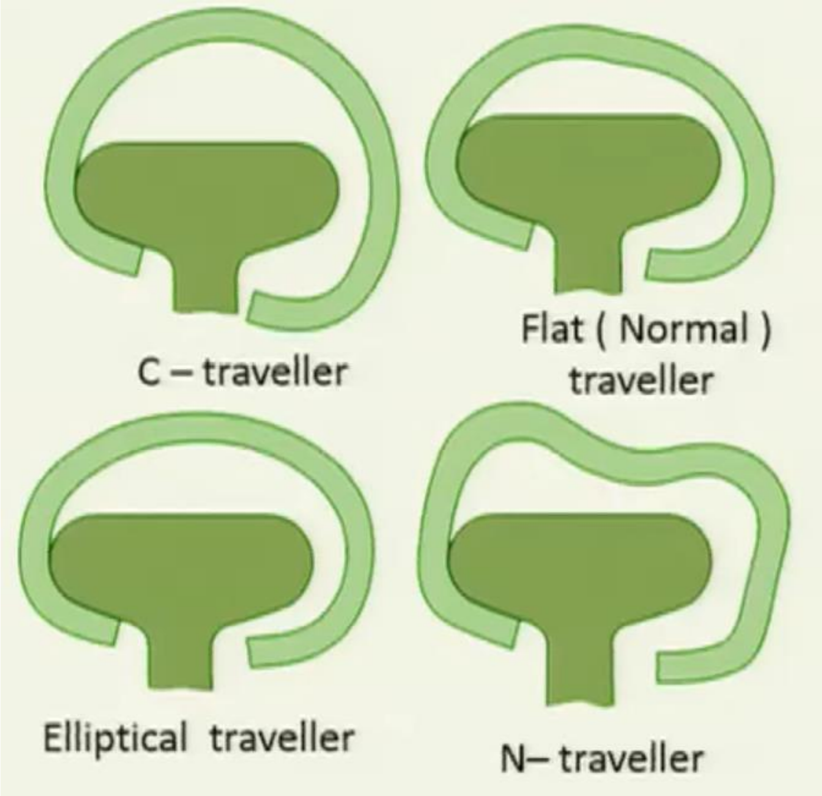
Ans:

Twist at the beginning: 26.8 turns per inch
Twist at the end: 26.9 turns per inch

Twist will not change significantly during cop building

Twisting Elements

Traveller



Traveller is subjected to high frictional heat generation

- ✓ High centrifugal force
- ✓ Very high contact pressure

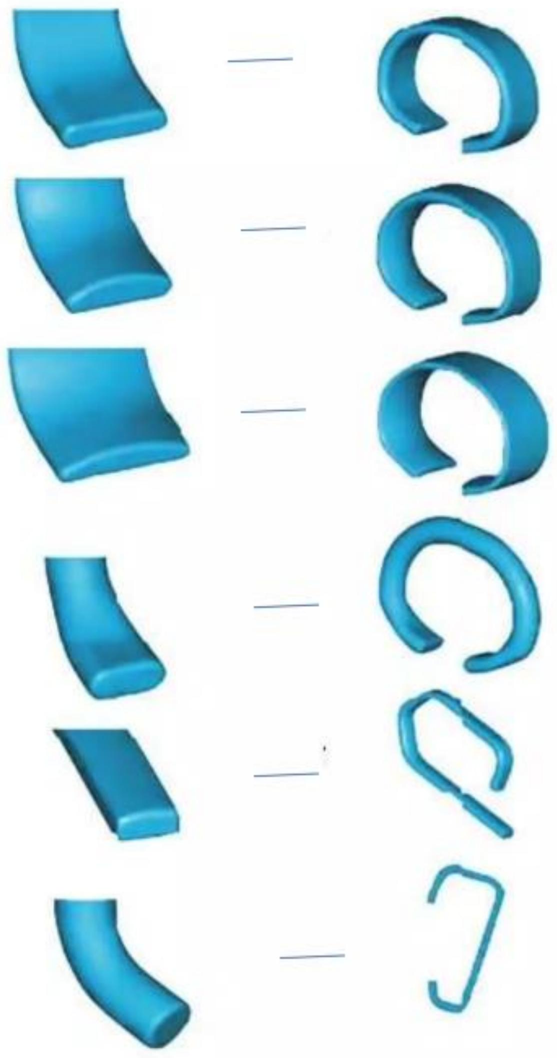
$$CF = m\frac{v^2}{R}$$

✓Temperature of traveller can go up to 300°C due to low mass

Traveller

Essential properties

- ✓ Low centre of gravity: smooth running
- ✓ Maximum contact area between ring and traveller
- ✓ Sufficient space for yarn passage
  - ❑ Influence hairiness
  - ❑ Melt spot formation for synthetic fibres
- ✓ Should generate less heat
- ✓ Should have excellent heat transfer property
- ✓ Wear resistant
- ✓ Low frictional co-efficient
- ✓ Less hardness than ring Why ?



Wire profile

Traveller Mass

$$CF = m\frac{v^2}{R}$$

Lower	Higher
Low Tension	High Tension
Soft Package	Hard Package
Less end breaks	Higher end breaks
Lower cop weight	Higher cop weight
Lower heat transfer to the ring	Higer heat transfer to the ring
Less stable running on the ring	Stable running without fluttering

Forces on Traveller (in Ring plane)

Winding tension F_w

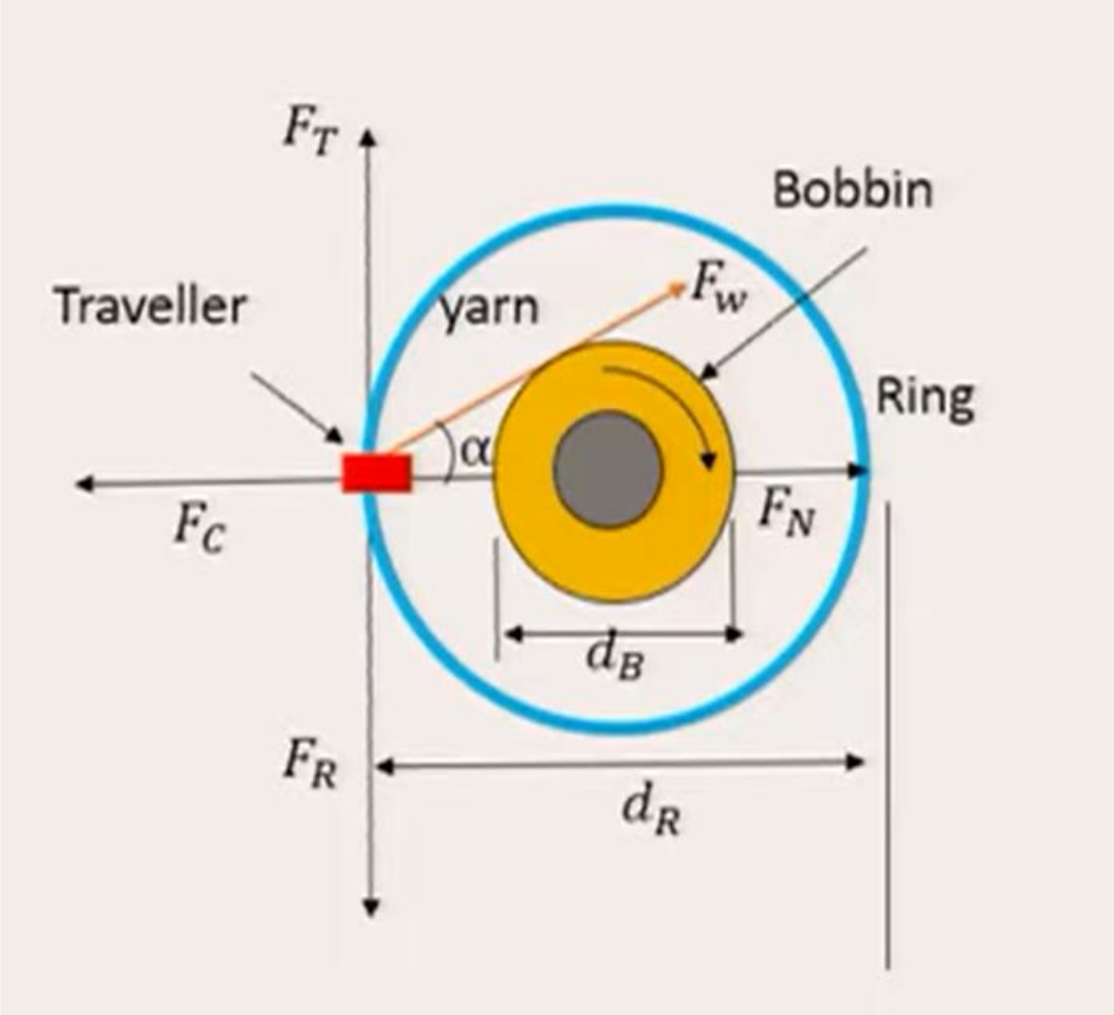
Due to:

- ✓ Ring traveller friction
- ✓ Yarn traveller friction
- ✓ Ballon rotation against air drag
- ✓ Yarn rotation against air drag

Frictional Force (F_R)

Centrifugal Force (F_C)

Normal Force (N)



Forces on Traveller (in Ring plane)

$F_T = F_w \,\text{Sin}\,\alpha$

$F_N = F_w \,\text{Cos}\,\alpha$

In equilibrium,

$F_T = F_R$

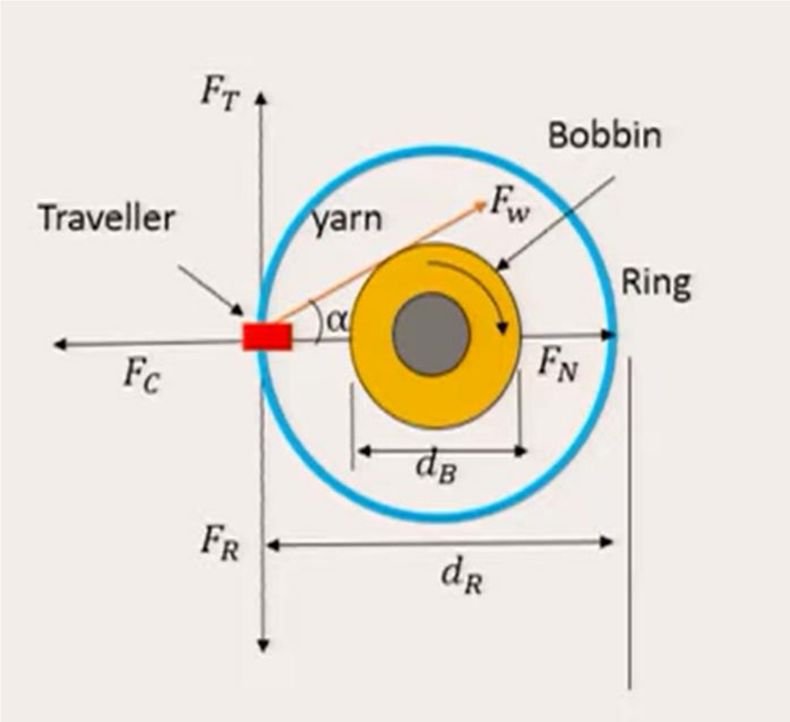
$Normal\ force\ N = F_C - F_N$

F_w **??**

$$\text{Sin}\,\alpha = \frac{OA}{OB} = \frac{r_B}{r_R} = \frac{d_B}{d_R}$$

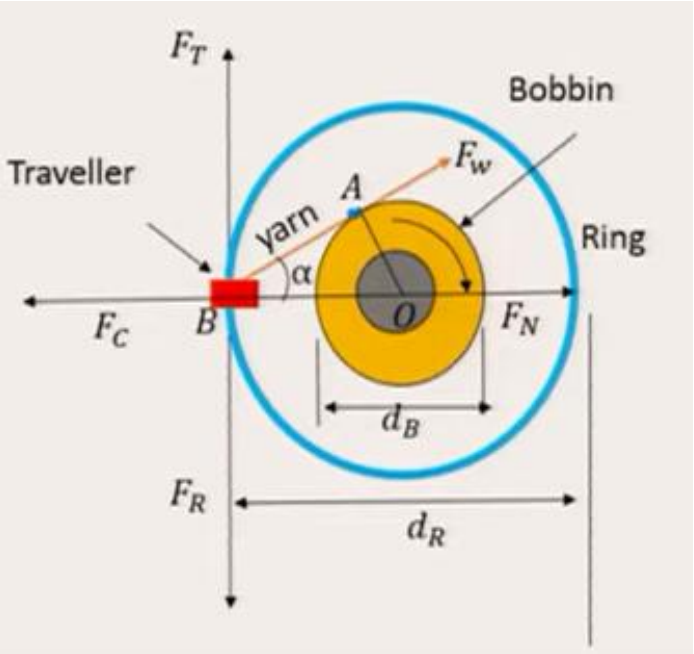
$$F_w = \frac{F_T}{\text{Sin}\,\alpha} = \frac{F_T}{d_B} \times d_R$$

$$F_w \propto \frac{1}{d_B}$$



$\alpha > 27°$

$d_B > 0.5\, d_R$



Forces on Traveller (in Ring plane)

What is relationship between winding tension and spindle speed?

$$F_C = m\frac{d_R}{2}\omega^2$$

Normal force on traveler $= F_C - F_N$

$$= m\frac{d_R}{2}\omega^2 - F_w \cos\alpha$$

$$F_R = \mu(F_C - F_N) = \mu\left(m\frac{d_R}{2}\omega^2 - F_w \cos\alpha\right)$$

Forces on Traveller (in Ring plane)

$$\boldsymbol{F_T = F_R}$$

$$F_w \sin\alpha = \mu\left(m\frac{d_R}{2}\omega^2 - F_w\cos\alpha\right)$$

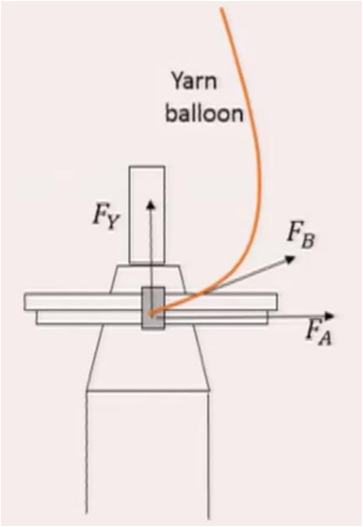
$$F_w \sin\alpha + \mu F_w \cos\alpha = \mu\, m\frac{d_R}{2}\omega^2$$

$$F_w \sin\alpha + \mu F_w \cos\alpha = \mu\, m\frac{d_R}{2}\omega^2$$

$$F_w \approx \frac{\mu m d_R \omega^2}{2\sin\alpha} = \frac{2\pi^2 \mu\, m\, d_R\, n_T^2}{\sin\alpha} \approx \frac{2\pi^2 \mu\, m\, d_R\, n_S^2}{\sin\alpha}$$

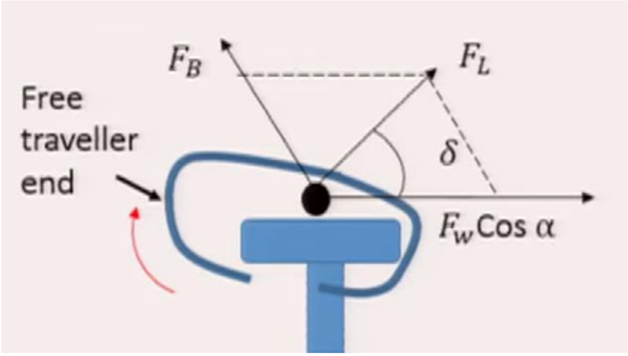
Change of Traveller Orientation

- ✓ **The balloon tension F_B acts at an angle.**
- ✓ **F_Y component presses the traveller upward against the ring.**



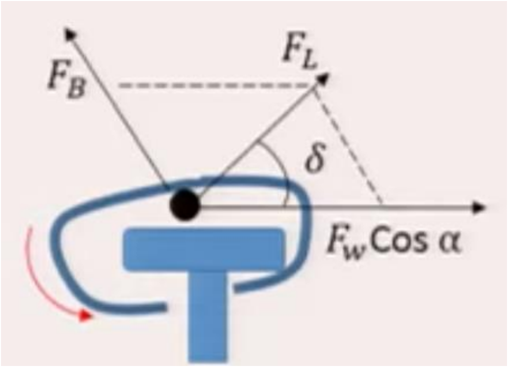
Traveller orientation at nose:

- Winding tension is high
- Free end of the traveller moves upward



Traveller orientation at shoulder

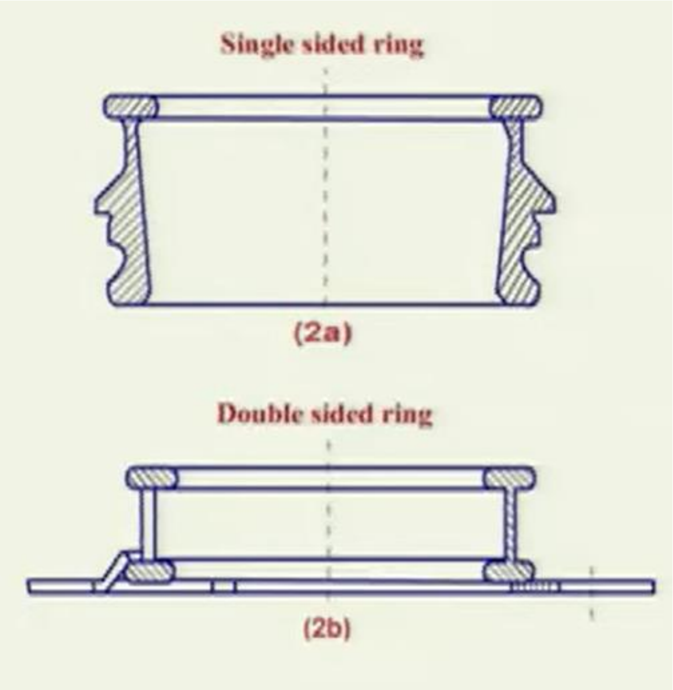
- Winding tension reduces
- Free end of the traveller moves downward



The traveller continuously changes its orientation during cop building.

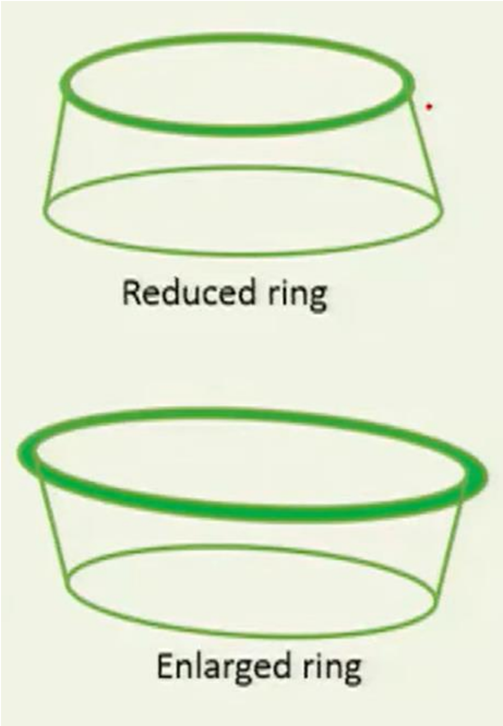
Ring

- ✓ Acts as the track for the travellers
- ✓ Internal diameter: 38 -54 mm
- ✓ Should have very high surface hardness and toughness
- ✓ Made of hardened steel, nitride steel, carbo-nitride steel
- ✓ Can be lubricated or non lubricated
- ✓ Can have single flange or double flange



Different Types of Ring

- ✓ **Reduced/Enlarged Ring:** The diameter of the flange is lower/higher than the lower part
- ✓ **Anti-wedge Ring:** has enlarged inner side flange and flattened upper side.
- ✓ **Low crown Ring**: has flattened upper surface.
- ✓ **SU Ring:** Large area of contact with the traveller



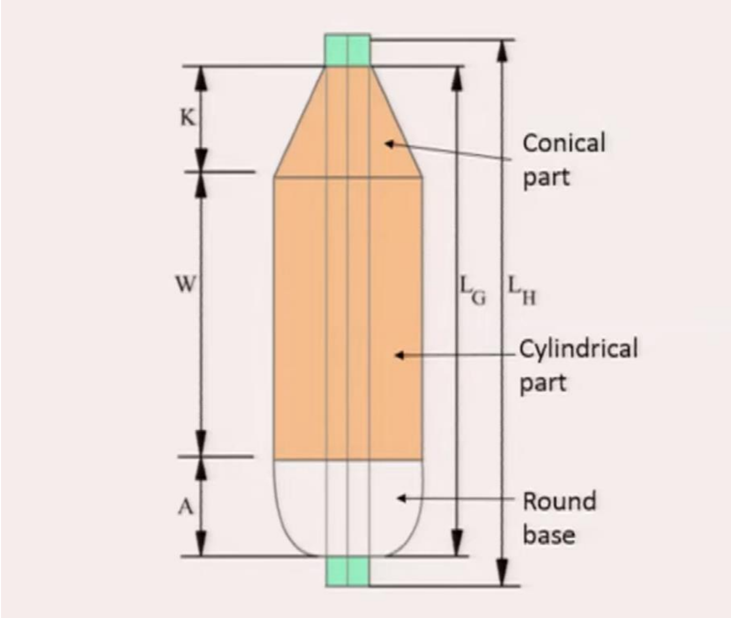
Anti-wedge Ring

SU Ring

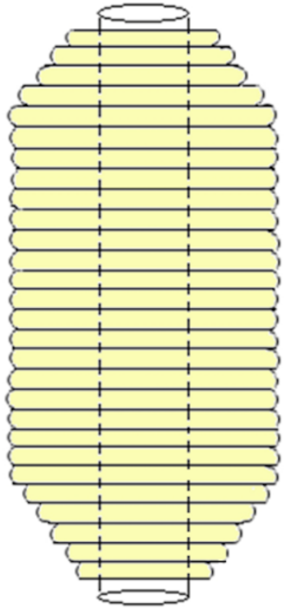
Low crown ring

S. Rana

Winding process: Bobbin Building



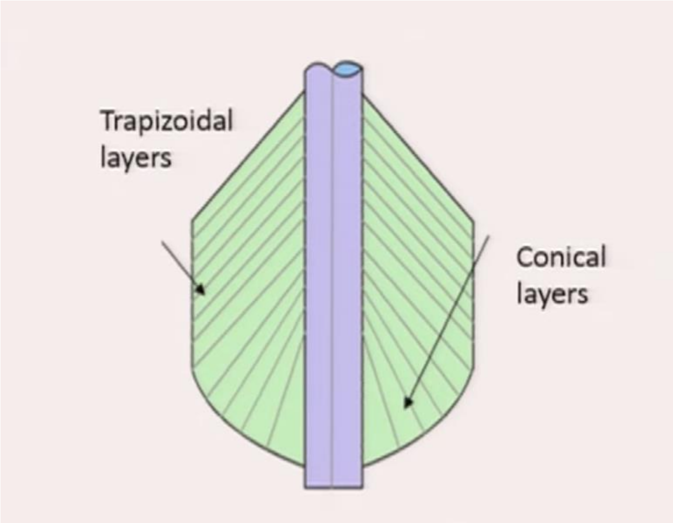
Ring Bobbin (cop)



Roving Bobbin

- Round base
- Cylindrical part
- Conical part

Winding process: Bobbin Building



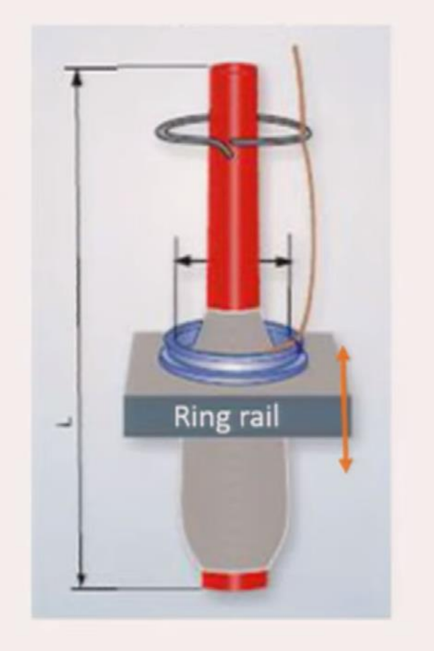
Yarn is deposited in the form of layers on the conical surface

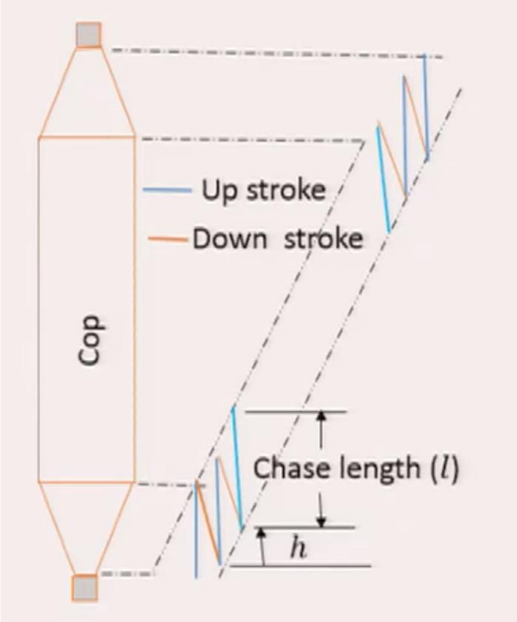
1st Phase: Formation of a conical layer (Base building)

2nd Phase: Deposition of layers on the conical surface

Nature of Ring rail movement

- ✓ Ring rail traverses up and sown in short strokes
- ✓ The cop is built from bottom to top by superimposing conical layers
- ✓ The conicity of the layers changes gradually and becomes constant





Nature of Ring rail Movement

Ring rail moves in short strokes, the stroke length is called chase length.

In each stroke, the downward movement is faster than the upward movement

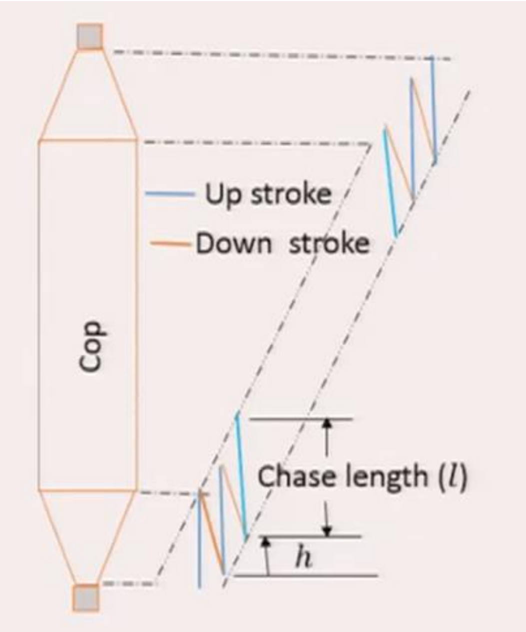
Winding coils are formed during slow rise of the ring rail

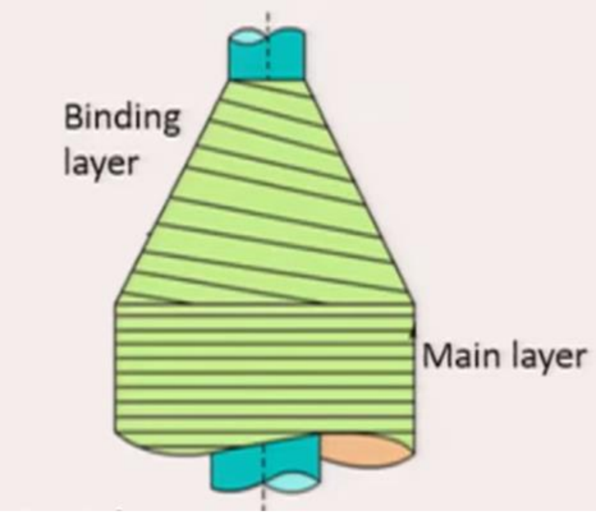
- ✓ Main cop filling coils
- ✓ Coils are close to each other

Binding coils are formed during fast lowering of ring rail

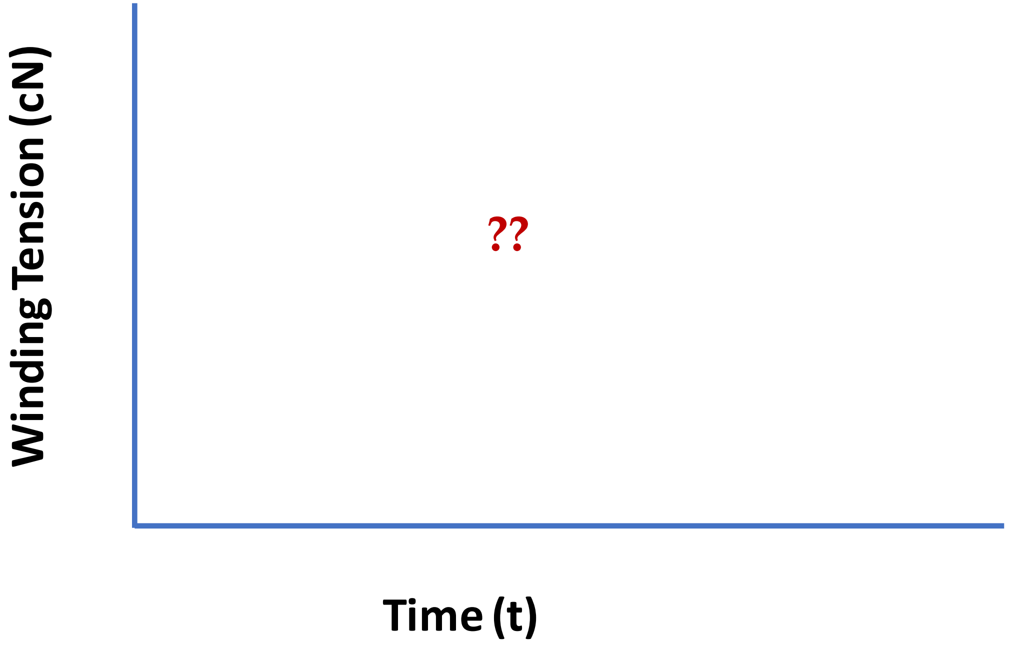
- ✓ Separated inclined coils
- ✓ Prevents sloughing-off of winding coils

After each layer formation (winding & binding coils), the starting point gradually moves upward.

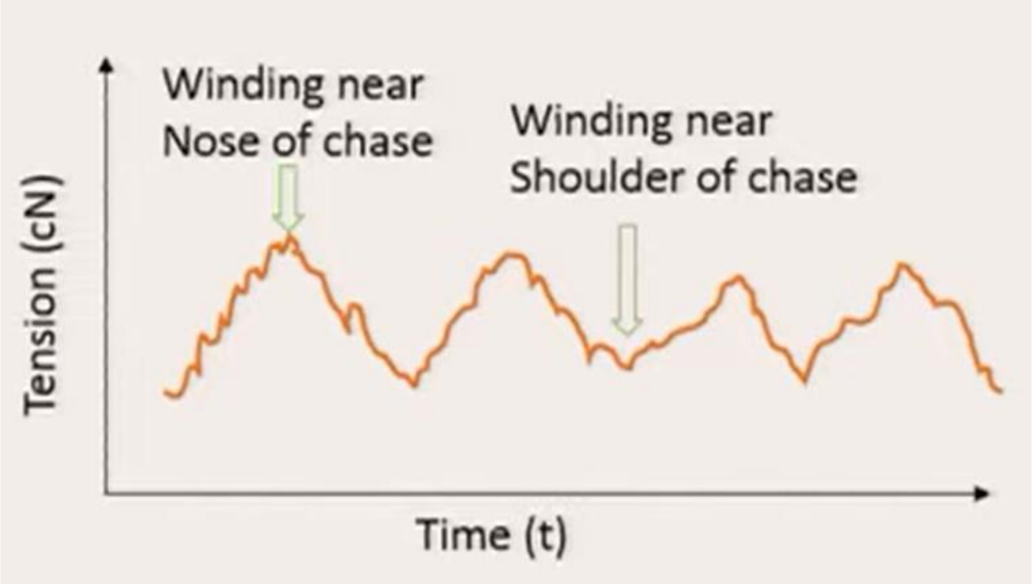




How winding tension varies during cop building?

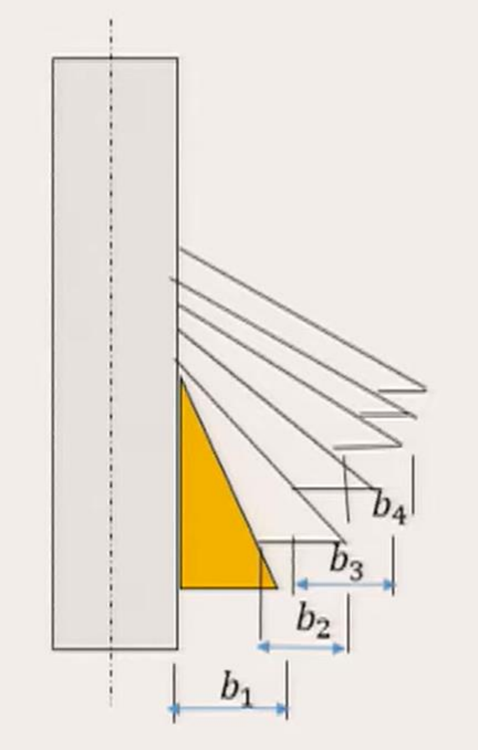


$$F_W \approx \frac{2\pi^2 \mu\, m\, d_R\, n_S^2}{\sin \alpha}$$



How to form the conical layers?

- Ring rail moves upward slowly with increasing speed
- Ring rail moves downward fast but with decreasing speed
- Ring rail spends more time at the base than at the nose



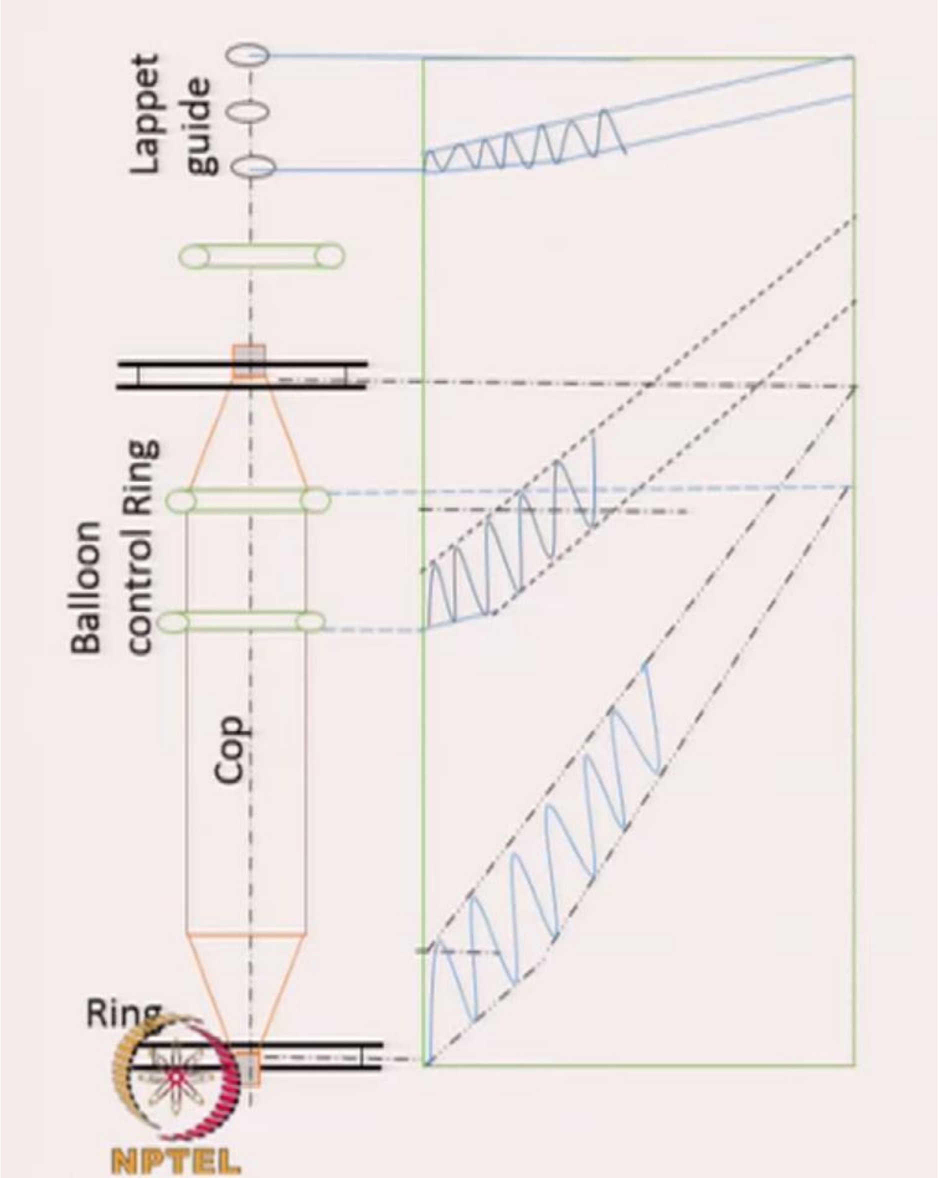
The thickness of the deposited layers will progressively decrease and at some stage, trapezia will become parallelogram. Why?

Ring rail Movement

Ring rail movement leads to change in the balloon size

✓ Leads to tension variation.

Ballon control ring and lappet guide perform similar motion, but with shorter strokes.



Building Motion

Rotation of cam leads to up and down movement of lever L and chain drum

⬇

The movement of lever L is transferred to ring rail via disc D1 mounted on shaft S

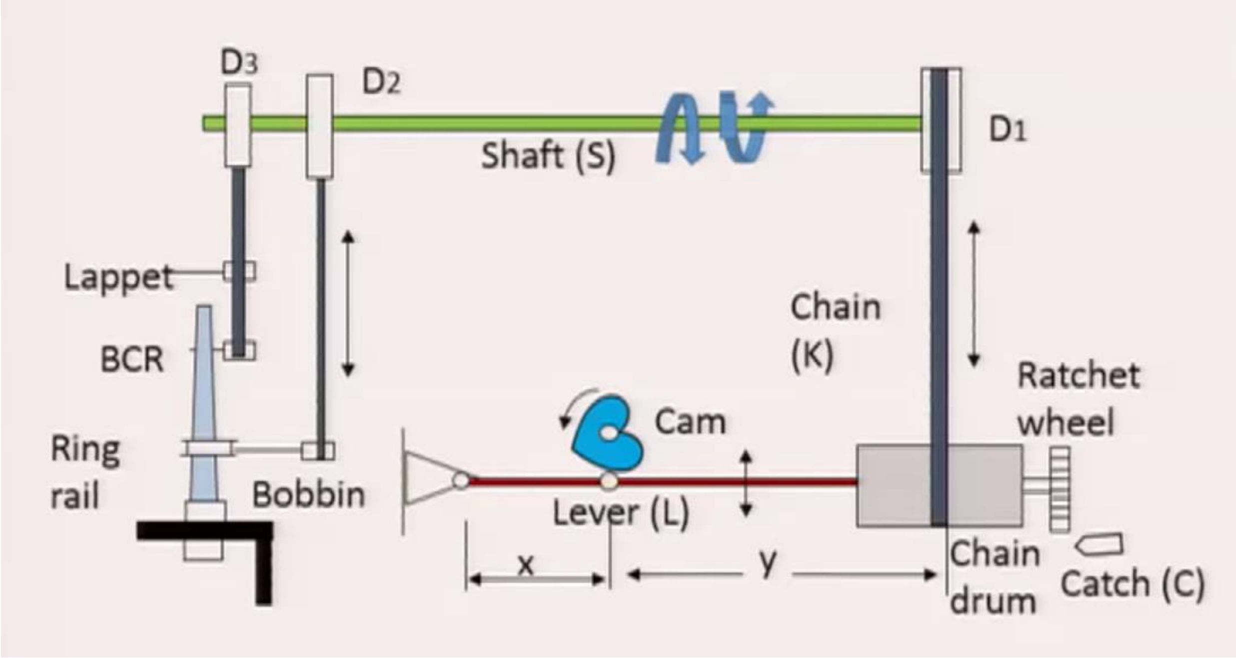
⬇

Each downward movement of chain drum leads to rotation of rachet wheel via a catch.

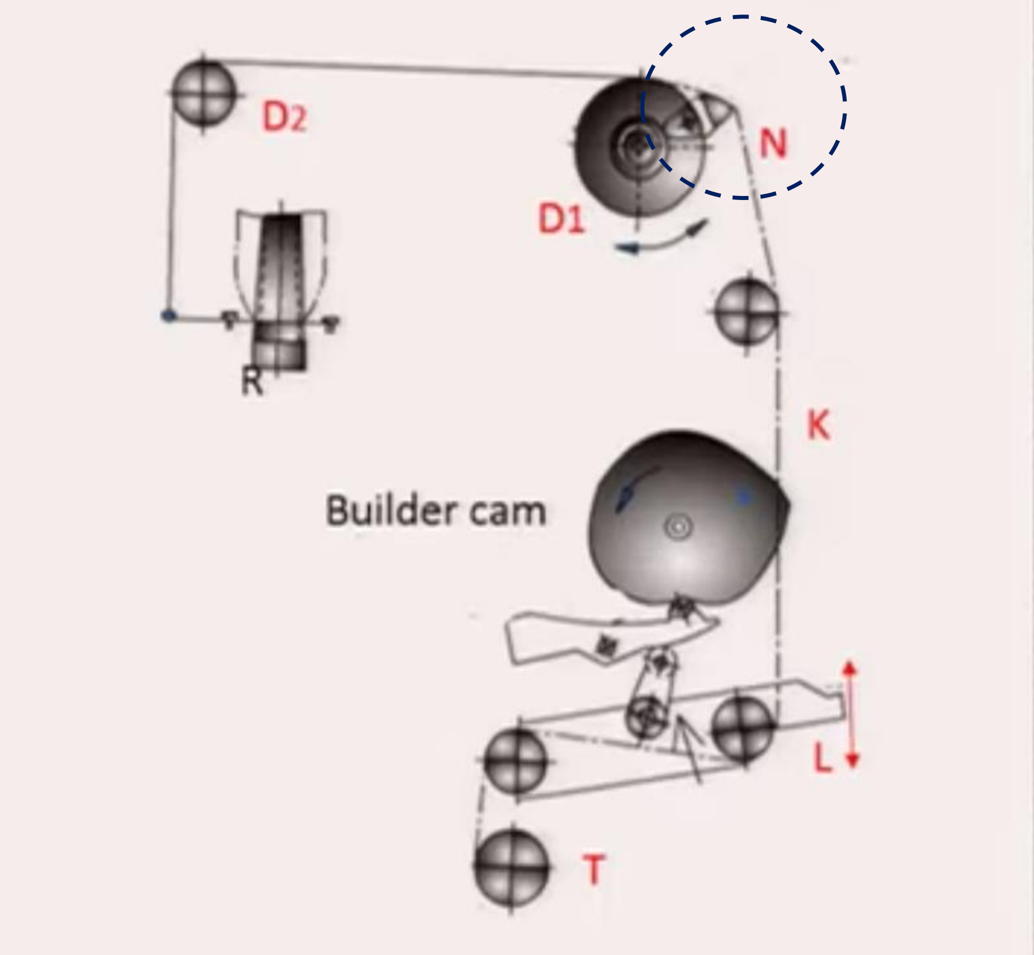
⬇

Rotation of rachet wheel causes shortening of chain length and rotation of disc D1

✓ Progressive lifting of ring rail position



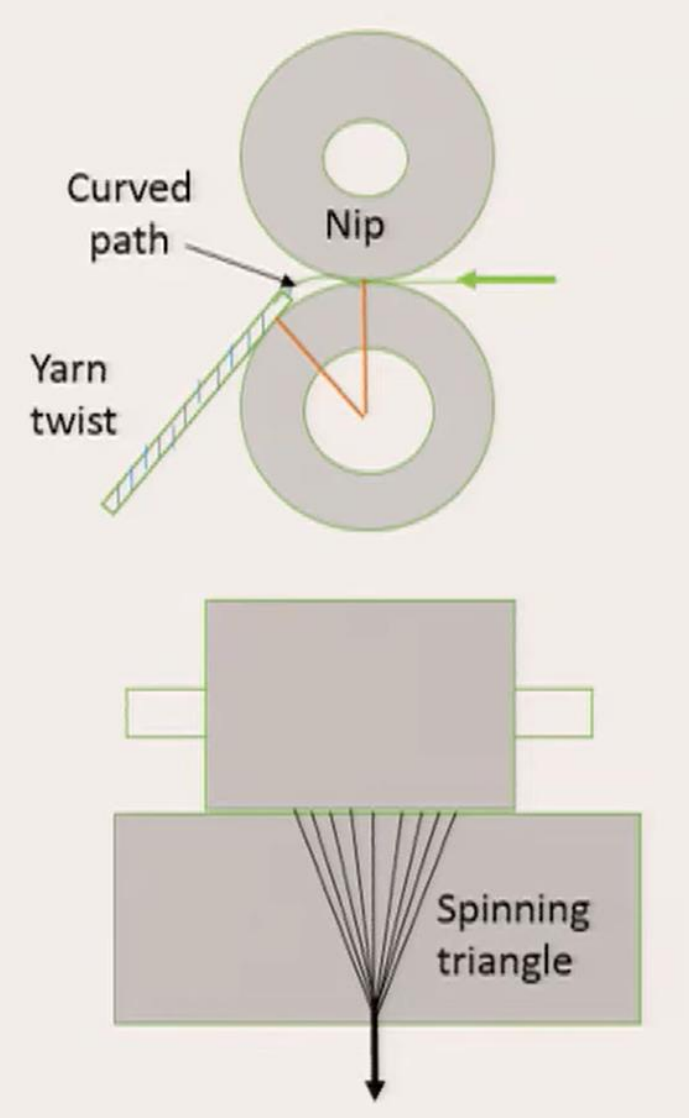
How to build the curved base?



- ✓ Due to the presence of a small cam N.
- ✓ The deflection of chain K at cam N leads to less transfer of upward movement to the ring rail

Spinning Triangle

- ✓ Twist generated in the balloon zone travels to the front roller nip
- ✓ Twist should flow as close to the front roller nip line.
- ✓ There exist a triangular bundle of fibres in front of nip line without any twist which is called spinning triangle.



Spinning Triangle

Short spinning triangle

✓Small weak zone

✓Fewer end breaks

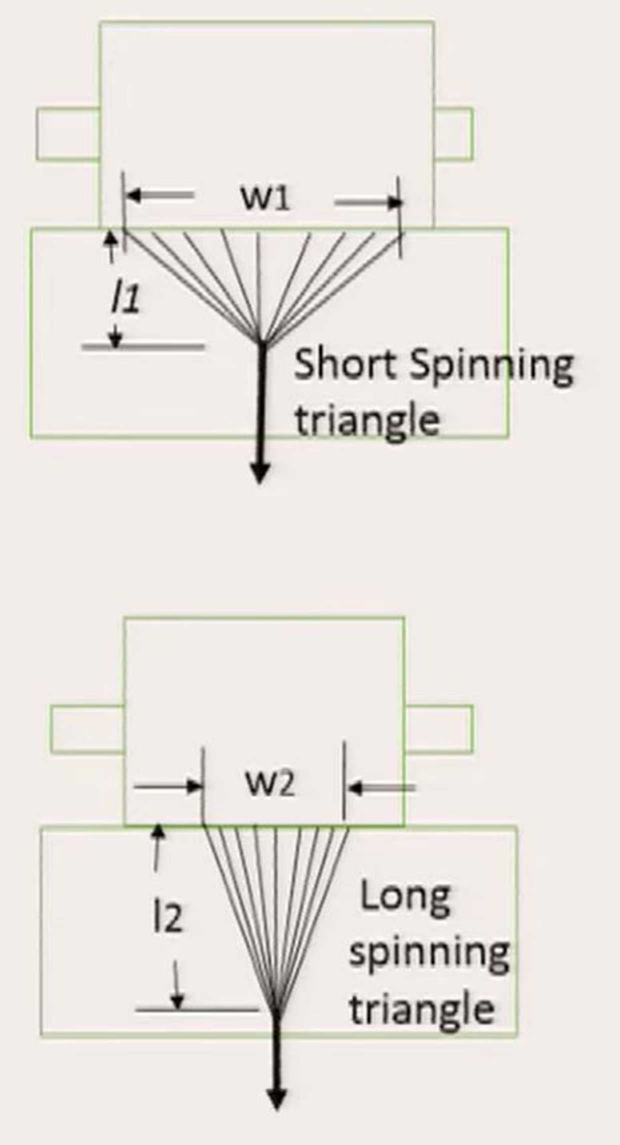
✓More fly generation

Long spinning triangle

✓Long weak zone

✓More end breaks

✓Less fly generation



Inclination of Drafting System

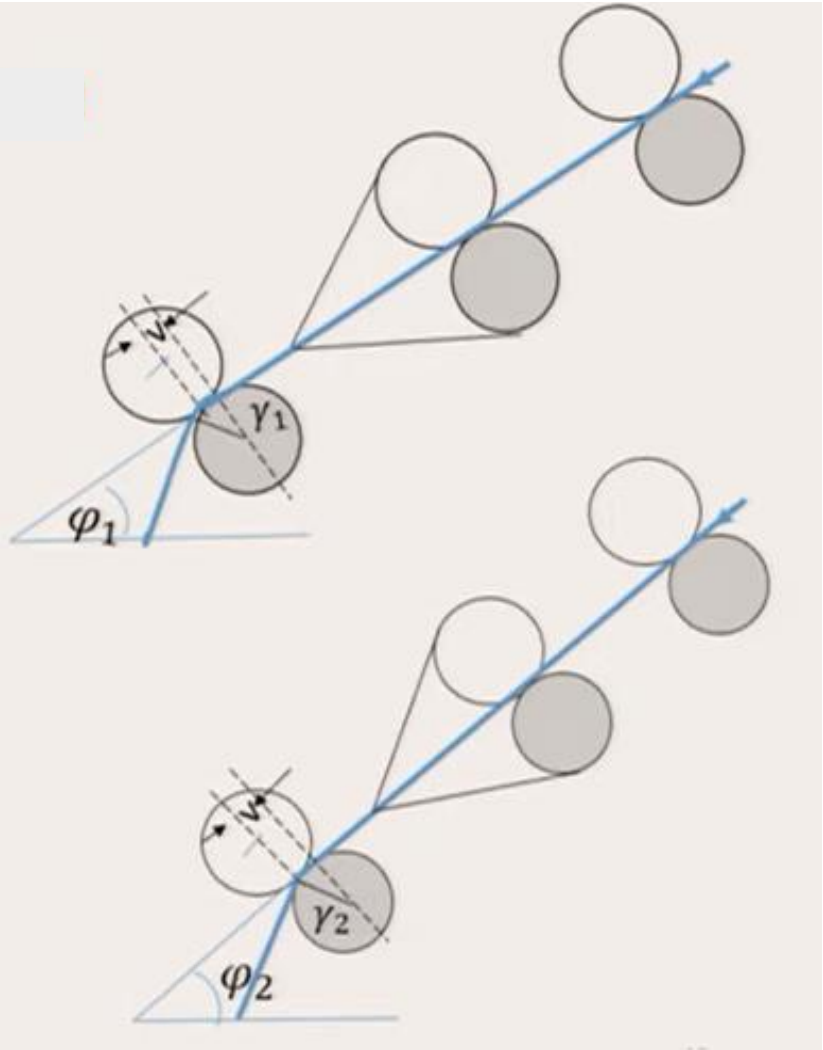
Low Inclination angle

- ✓ More deflection of fibres at bottom drafting roller
- ✓ Longer spinning triangle

High Inclination angle

- ✓ Less deflection of fibres at bottom drafting roller
- ✓ Shorter spinning triangle
- ✓ More machine height

Optimum inclination angle: 45 to 60°

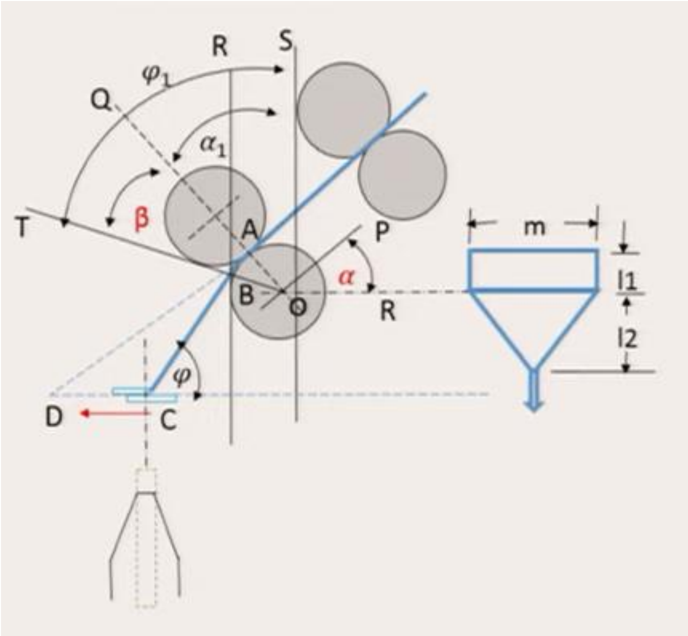


Spinning Triangle

Length of spinning triangle can be reduced

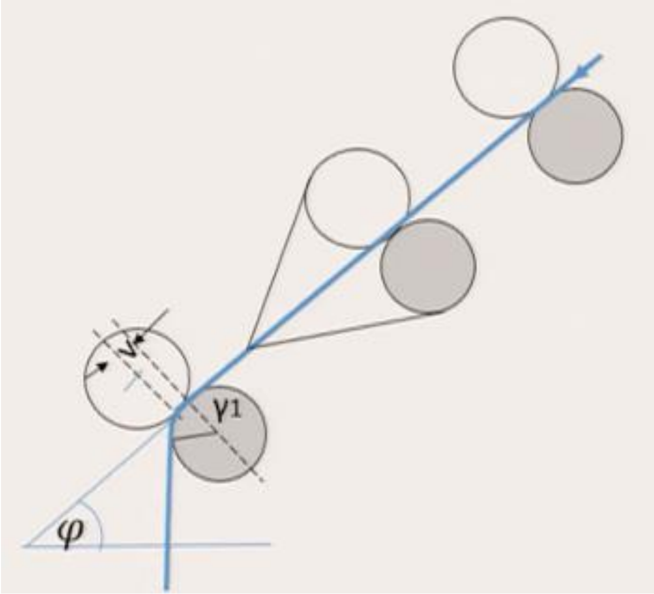
By reducing angle φ

- ✓ Can be achieved by moving the lappet guide from C to D.
- ✓ Leads to increase in the width of the machine



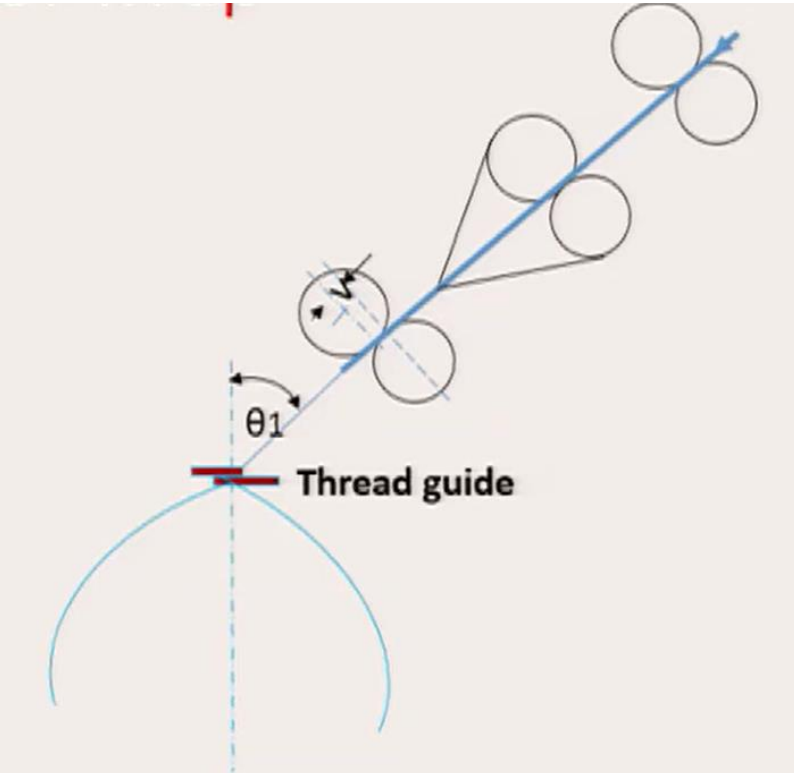
Roller overhang

- ✓ Top roller is offset 2-4 mm with respect to the bottom roller
- ✓ Leads to smooth running of top roller and shortening of spinning triangle



Thread guide

- ✓ Provides a braking effect to the tension generated during balloon rotation
- ✓ Absorbs impacts and vibration due to traveller rotation and air turbulence
- ✓ Restricts flow of twist to the spinning triangle



Ballon Height

Too high:

Leads to high tension variation between shoulder to nose
Ballon can collapse: BCR can help.

Cop height: ring diameter = 4.4 to 5.0: 1

New Spinning Methods

Ring spinning limitations

- Twisting and winding operations are combined
- Limited package size
- Limitation in productivity why?

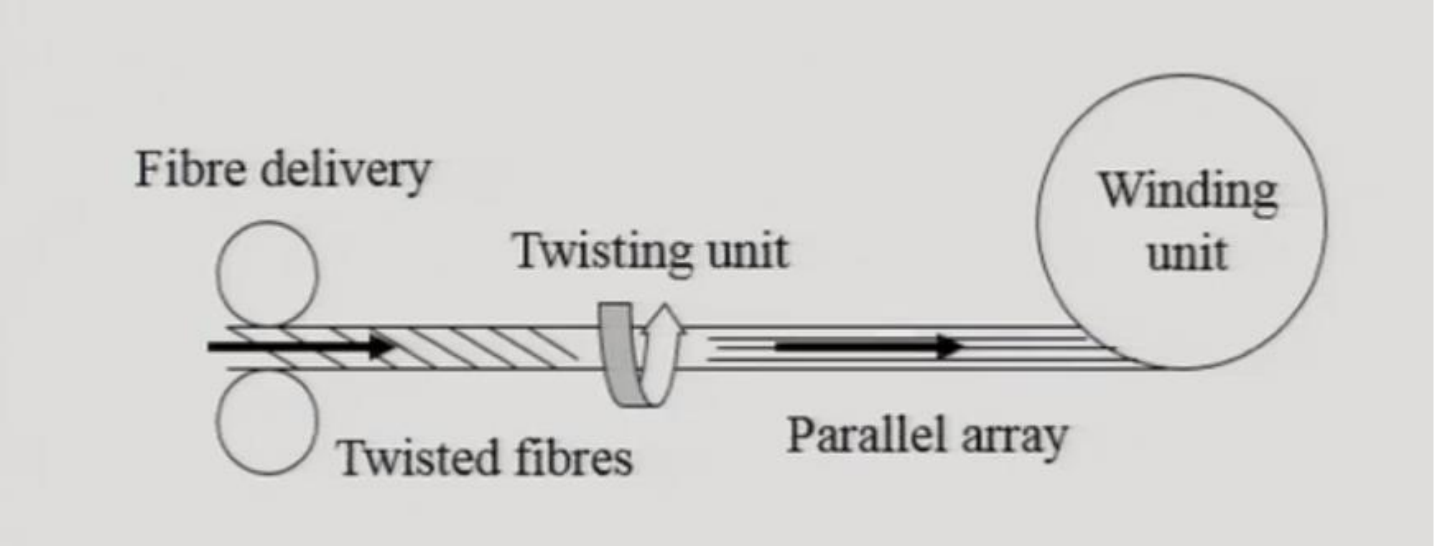
$$\textit{Delivery speed} = \frac{\textit{Traveller speed}}{\textit{Twist}}$$

The traveller speed is limited to 35 m/s in the mill condition

So, what is the solution ?

Twisting and winding mechanisms have to be separated

New Spinning Methods

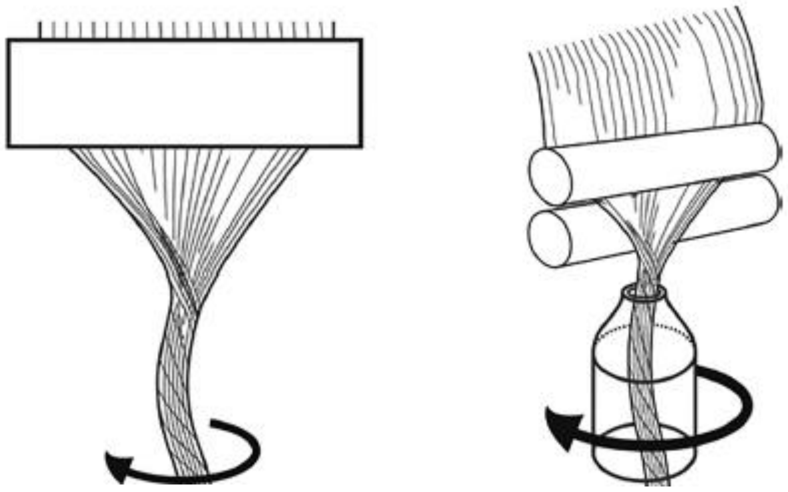


Separated Twisting and Winding Units

Is yarn formation possible?

NO. the twister will act as a false twister

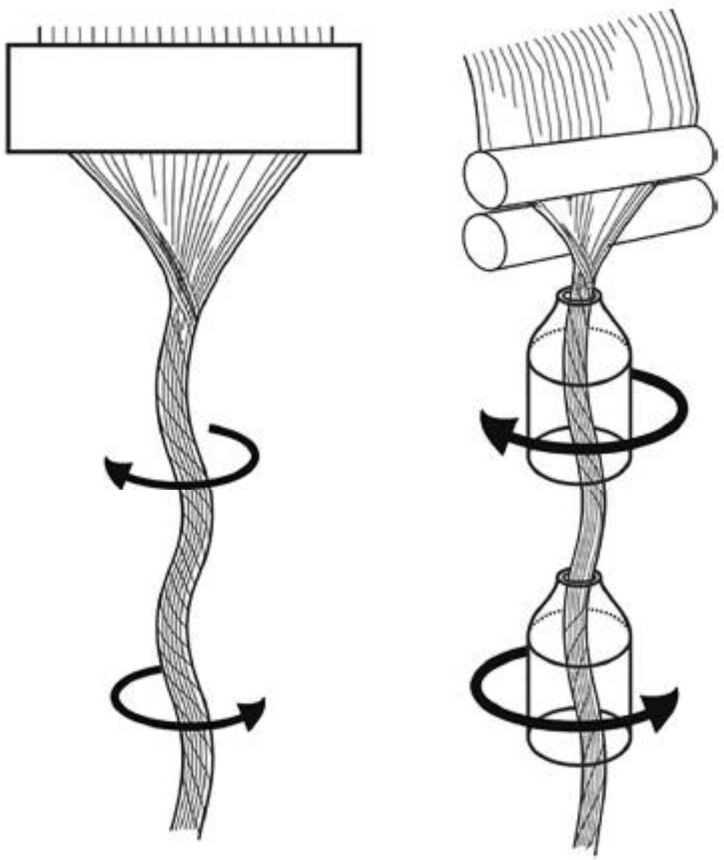
New Spinning Methods



Twisting with the help of an air- jet nozzle

- **False twist**
- **There will be no resultant twist**

Twisting using two air- jet nozzles



Air-jet Spinning

Jet 2 creates a high vortex, 10 lakh rpm at the rate of 2,50,000 turns/min.

↓

Twist runs close to the nip of front drafting rollers and will twist the core fibres

↓

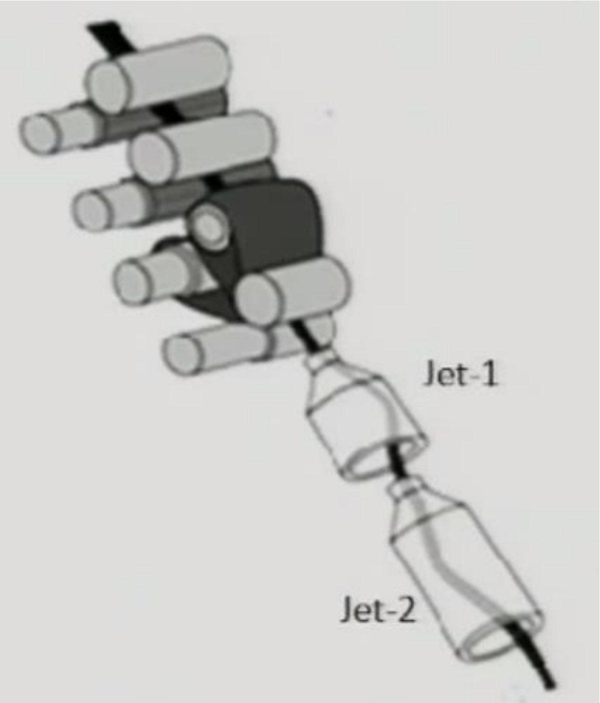
Some edge fibres escape the twist

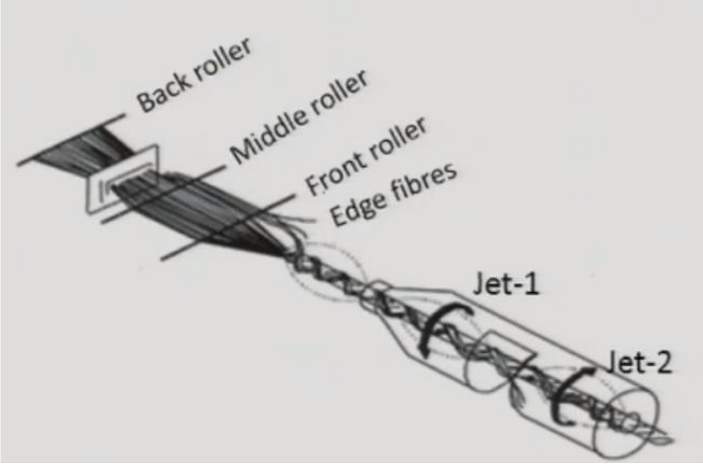
↓

Edge fibres get wrapped on core fibres by weaker Jet 1 (opposite direction of Jet 2)

↓

Core fibres will be reverse twisted and become parallel after Jet 2 and the edge fibres will be further reverse twisted and wrapped



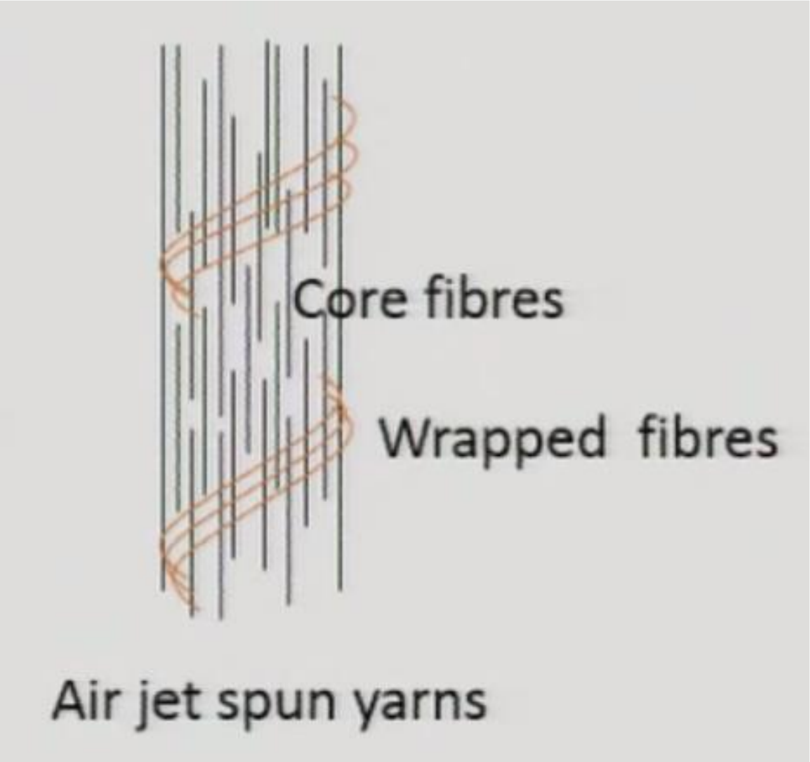


The delivery speed: 120–180 m/min in the case of Murata's MJS spinning system

Air-jet Spinning: Yarn structure

Air-jet yarns have fasciated structure:

- ✓ A core made of parallel fibres
- ✓ Bound by wrapper fibres



Wrapper Fibres

- Source of strength
- Need optimum number of wrapper fibres

Air-jet Spinning: Yarn properties

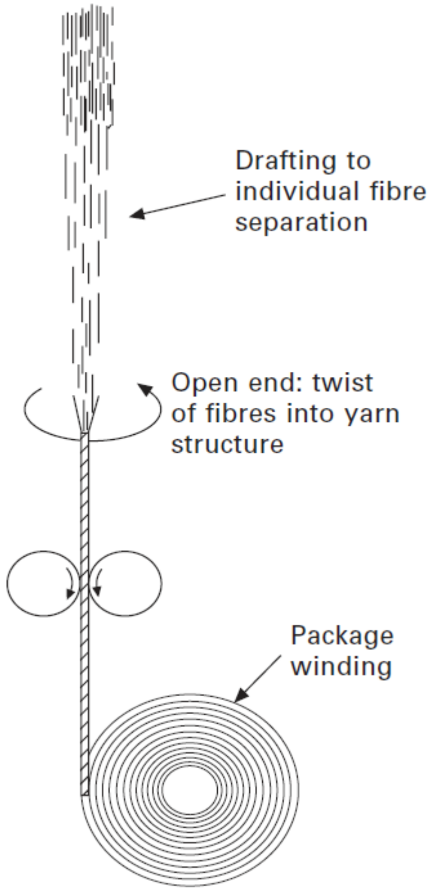
Yarn Properties

- Variable texture along the length
- Weaker (10-15%) as compared to ring yarn
- Bending rigidity is higher
- Hard feel
- Less hairiness
- Low pilling tendency
- Less covering power

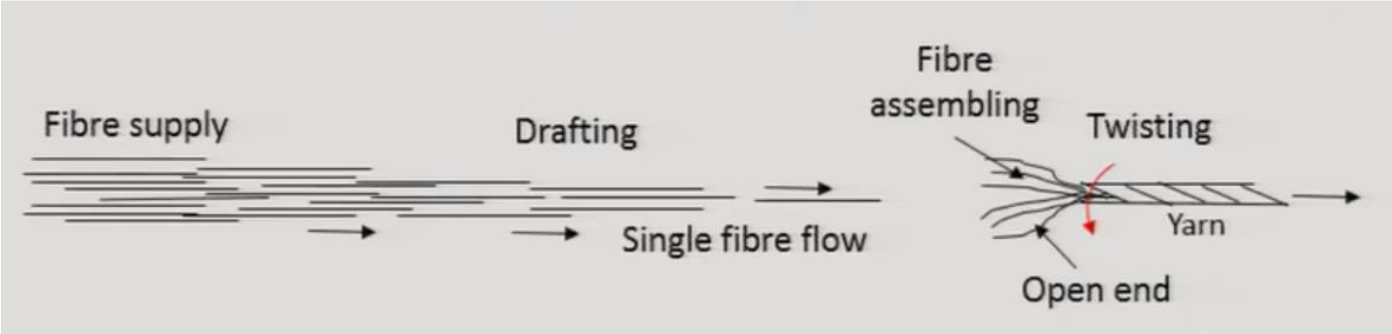
Limitations of Air-jet Spinning

- Difficult to produce coarser yarns
- Difficult to process 100% cotton yarns
  - ✓High bending rigidity
  - ✓Presence of dust

Open-end Spinning



Open-end or break spinning



Disruption in Fibre Overlapping

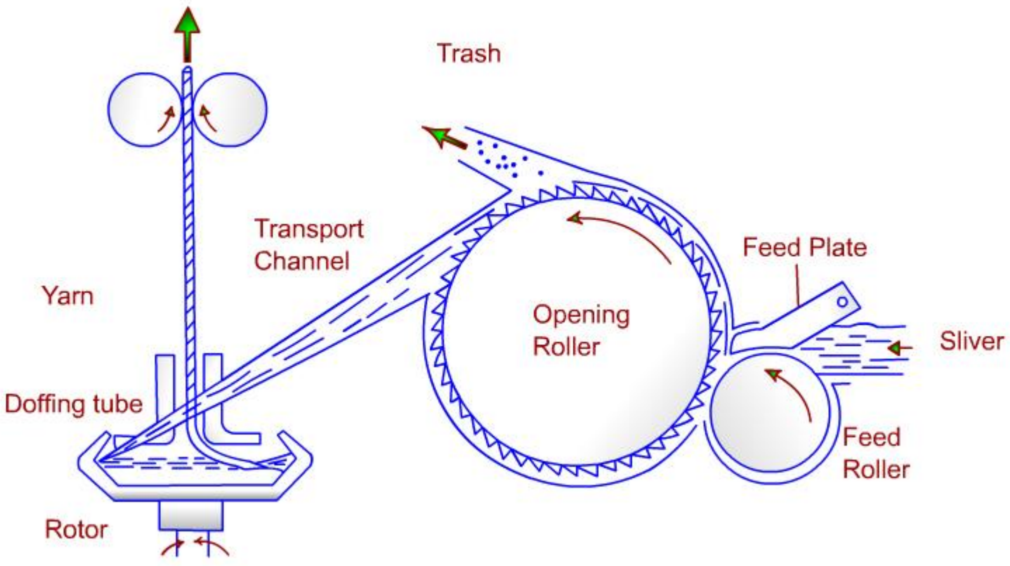
Requirements:

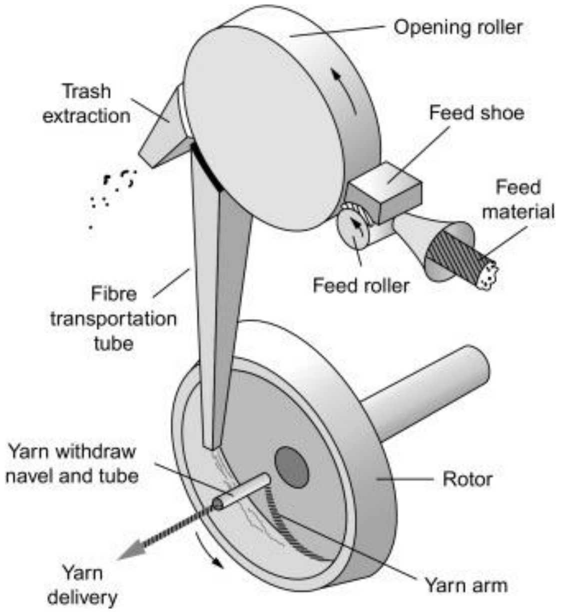
- ✓ Very high draft.
- ✓ Drafting rollers are not used.
- ✓ Opening rollers are used.

Advantages

- ✓ High twist insertion rate
- ✓ Low power consumption
- ✓ Large package size
- ✓ Elimination of some processes
- ✓ No drafting wave generation

Rotor Spinning





Sliver feed → Fibre separation and transport → Fibre accumulation and twisting → Yarn withdrawal → Package formation

Rotor Spinning

Rotor Spinning: Yarn Formation

Fibres are accumulated in the form of layers within the rotor groove

↓

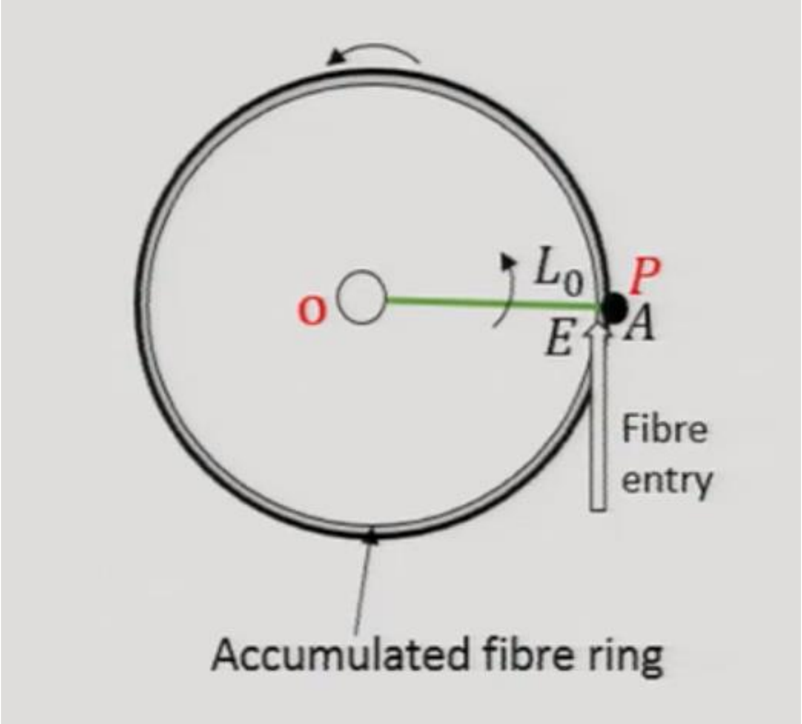
A seed yarn is inserted within the rotor through exit tube end O

↓

The seed yarn end reaches the deposited layer and attached to the fibre ring at P

↓

The yarn is pulled out radially



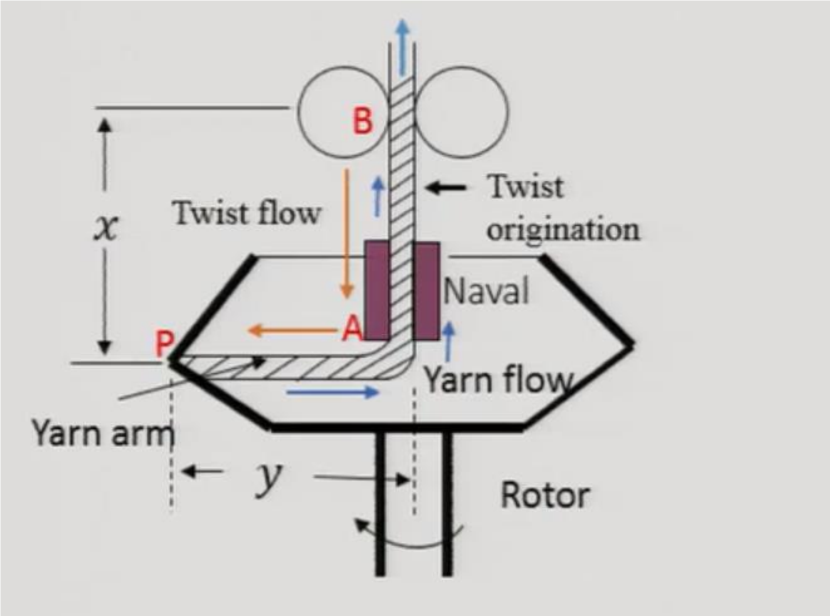
The fibres which land on the already twisted yarn form the wrapper fibres

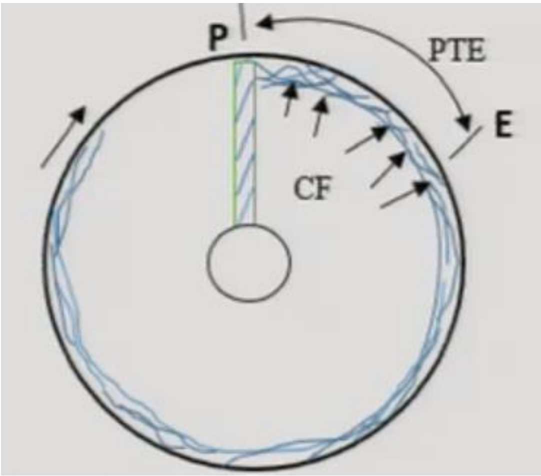
Rotor Spinning: Twisting Process

Twist generates in AB region due to rotation of arm AP

Twist flows to the AP region and then to PTE region

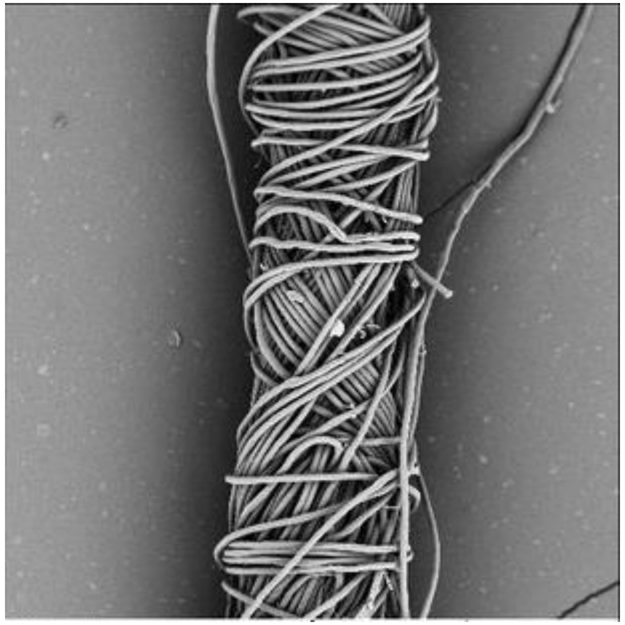
False twist generated in the naval increases the twist in AP region by 30-60%





Rotor Yarn Structure

- Three-part structure
  - ✓Core fibres
  - ✓Sheath fibres: loosely wrapped around core fibres
  - ✓Belts or wrapper fibres: wrapped tightly at 90°
- The yarn is core twisted, i.e. the twist is more in the core and less on the surface
- Fibre migration is more local in rotor spun yarn
  - ✓Lower and more distributed spinning tension
- Lower packing co-efficient as compared to ring yarn



Rotor Yarn Structure & Properties

- Lower strength as compared to ring yarn
- Better yarn evenness: Back doubling
- Better breaking elongation
- Higher stiffness
- Higher yarn volume
- Superior abrasion resistance
- Less lustrous
- Higher air permeability
- Lower shrinkage

Rotor spinning is suitable for finer or coarser count ?

Friction Spinning (Dref 2)

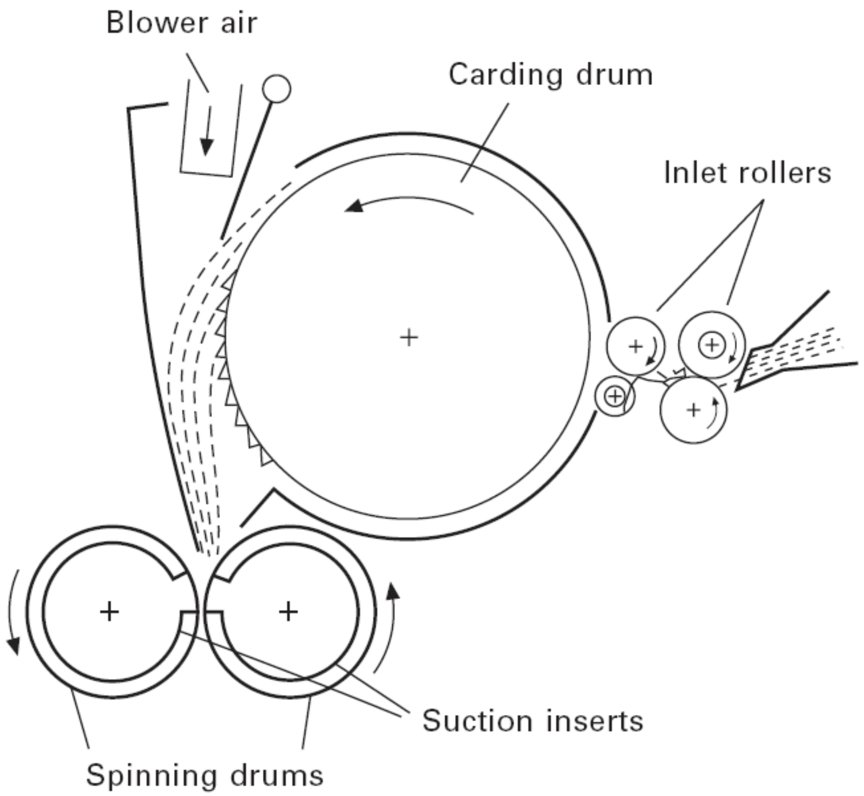
Slivers are slightly drafted and fed to a high-speed opening roller

Opening roller separates the fibres and releases into air

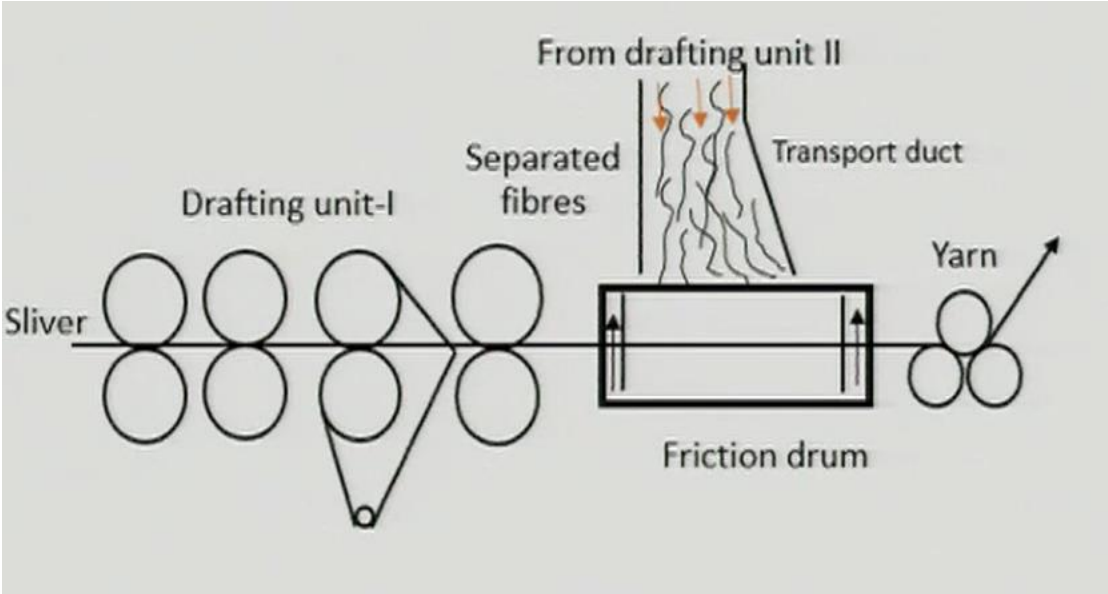
Air removes the separated fibres ad transport them to the surface of two friction drums rotating in the same direction

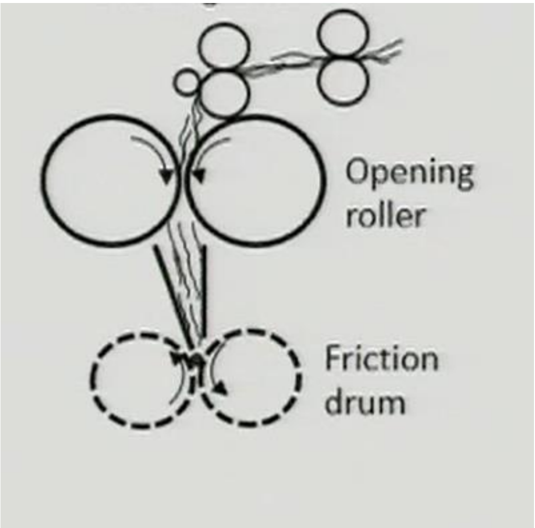
Fibres get twisted at the nip line by two oppositely rotating surfaces, one with a faster speed than the other

Yarn is withdrawn at 100-300 m/min and wound onto a winding drum



Friction Spinning (Dref 3)



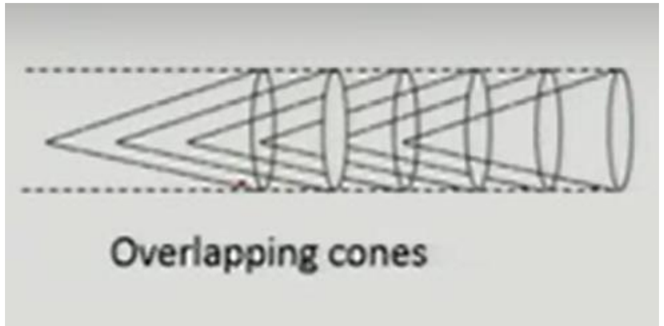


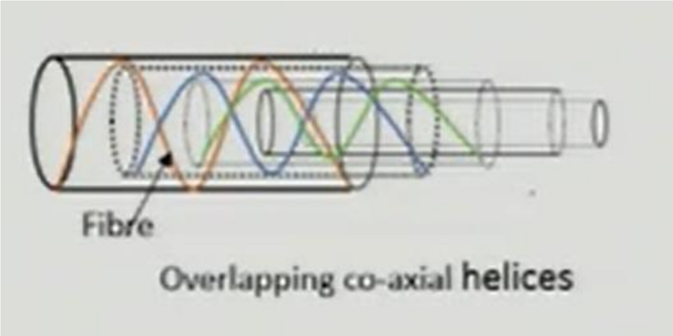
Drafting Unit II

- ✓ Fibres coming from Drafting unit I form the core of the yarn
- ✓ Fibres coming from Drafting unit II get twisted around the core fibres by friction drums
- ✓ The yarn will have core-sheath structure

Friction Yarns: Structure & Properties

- ✓ Less fibre migration
- ✓ Poor strength



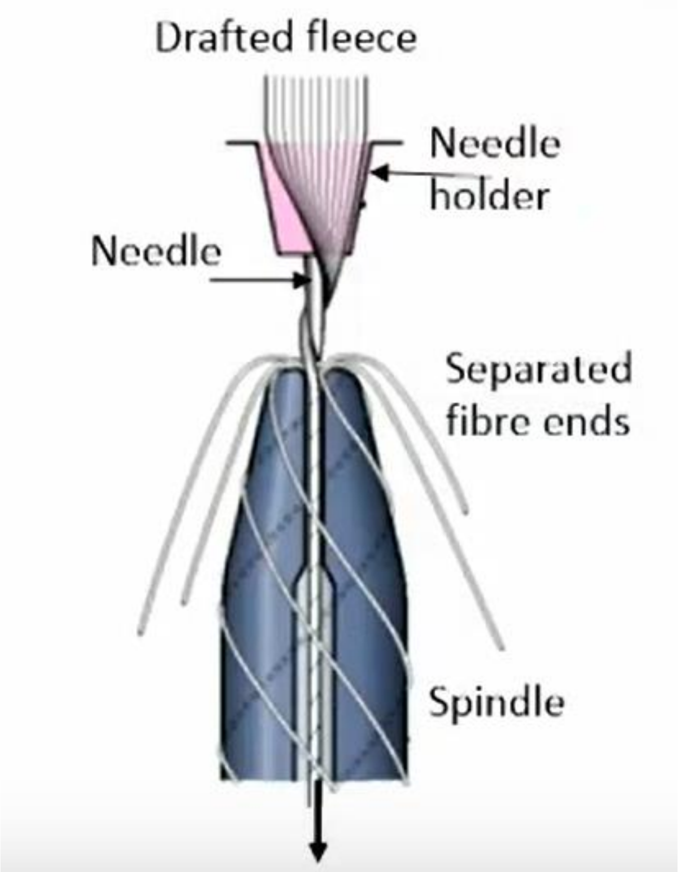


Dref 2 yarn structure

Yarn Properties	
Hairiness	High
Imperfections	High
Stiffness	Similar to rotor spun yarn
Evenness	Satisfactory
Tenacity	Lower than ring and rotor yarns

Friction spinning is suitable for coarser count

Vortex Spinning



Vortex Spinning: Yarn Structure & Properties

- ✓ Vortex yarn consists of parallel core fibres & wrapper fibres
- ✓ No. of wrapper fibres are higher than air-jet yarns

Yarn Properties	
Hairiness	Low
Bulk	High
Stiffness	High
Evenness	Low
Tenacity	85% of ring spun yarns, higher than air-jet yarns

End of Course

Thank you for your attention and participation …It was a pleasure teaching you!