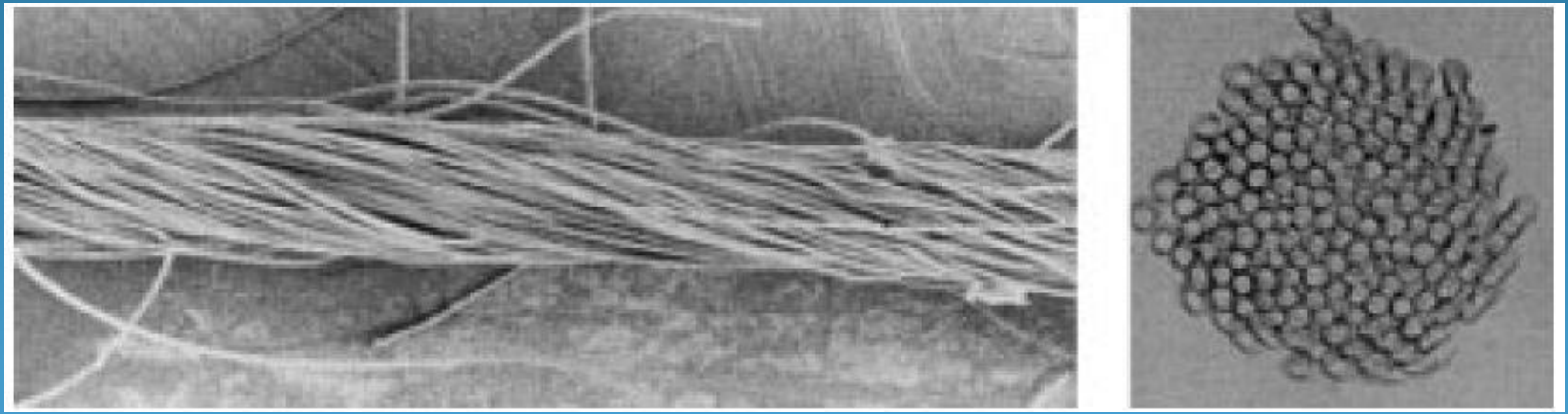
New Developments in Ring Spinning



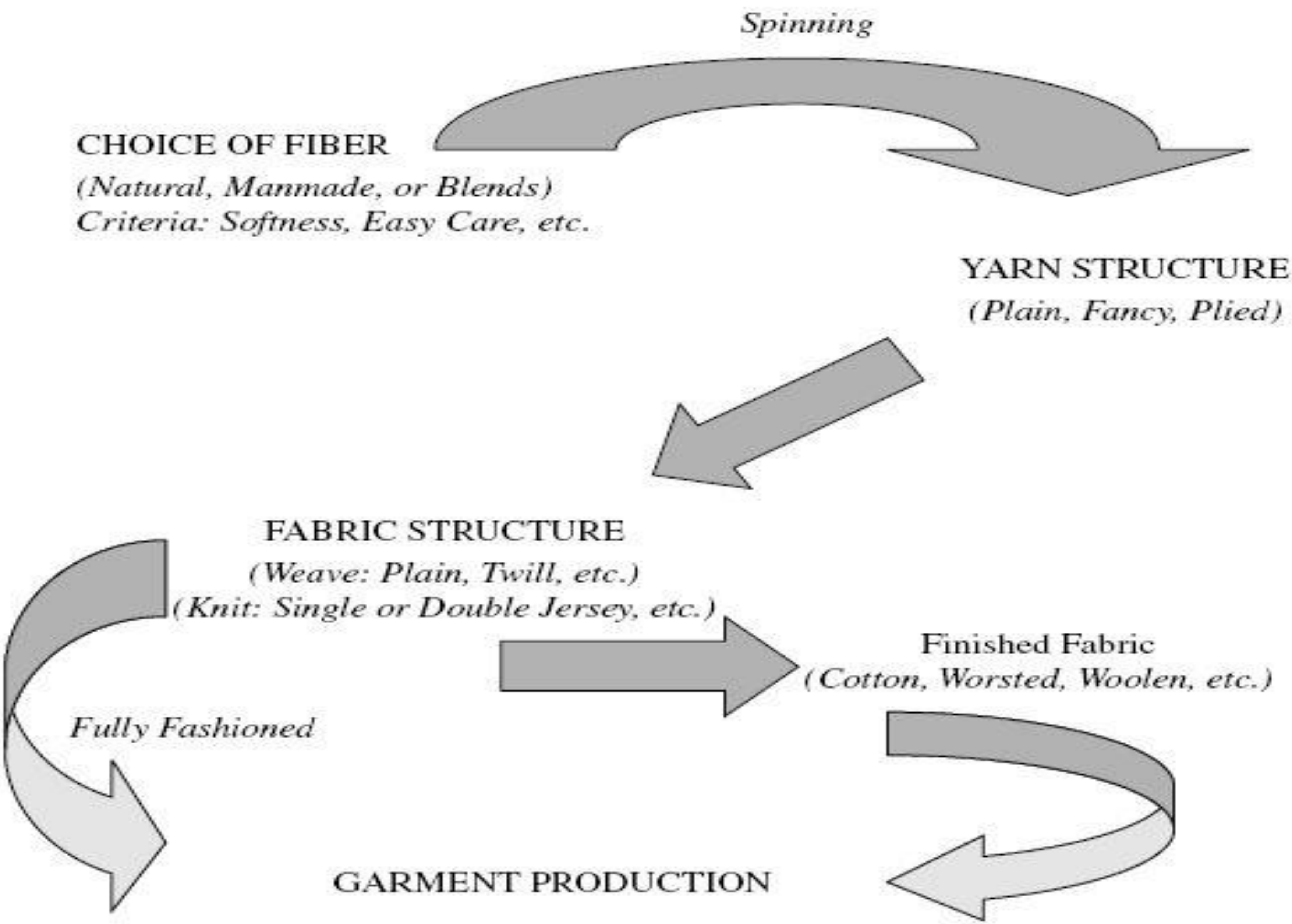
A yarn is a constructed assemblage of textile fibers which acts as a unit in fabric formation.

Classification of spun yarn

Group	Sub group	Examples
Continuous filament yarns	Untextured (flat)	Twisted Interlaced Tape
	Textured	False twisted Stuffer box crimped Bi-component Air-jet
Staple spun yarns	Noneffect/plain (unconventional)	Rotor spun Compact-ring spun Air-jet spun Friction spun Hollow-spindle wrap spun Repco
	Fiber blend	Blend of two or more fiber types comprising noneffect yarns
	Effect/fancy	Fancy twisted Hollow-spindle fancy yarn Spun effects

Composite yarns	Filament core Staple core	Core spun (filament or staple fibers forming the core) and staple fibers as the sheath of a noneffect staple yarn
Folded/plied/doubled	Filament staple	Two or more yarns twisted together

BASIC SEQUENCE TO GARMENTS



Spun yarn properties

- Yarn Count
- Twist
- Fibre parallelism

How these properties affect the fabric

Yarn Twist

Twist parameters

- Direction of twist- S twist or Z twist
- Twist angle – Angle of the twist
- Twist level – Turns per unit length
- Twist multiplier

Relationship

$$\text{Tan}\,\alpha = \pi \times d \times t$$

α- twist angle

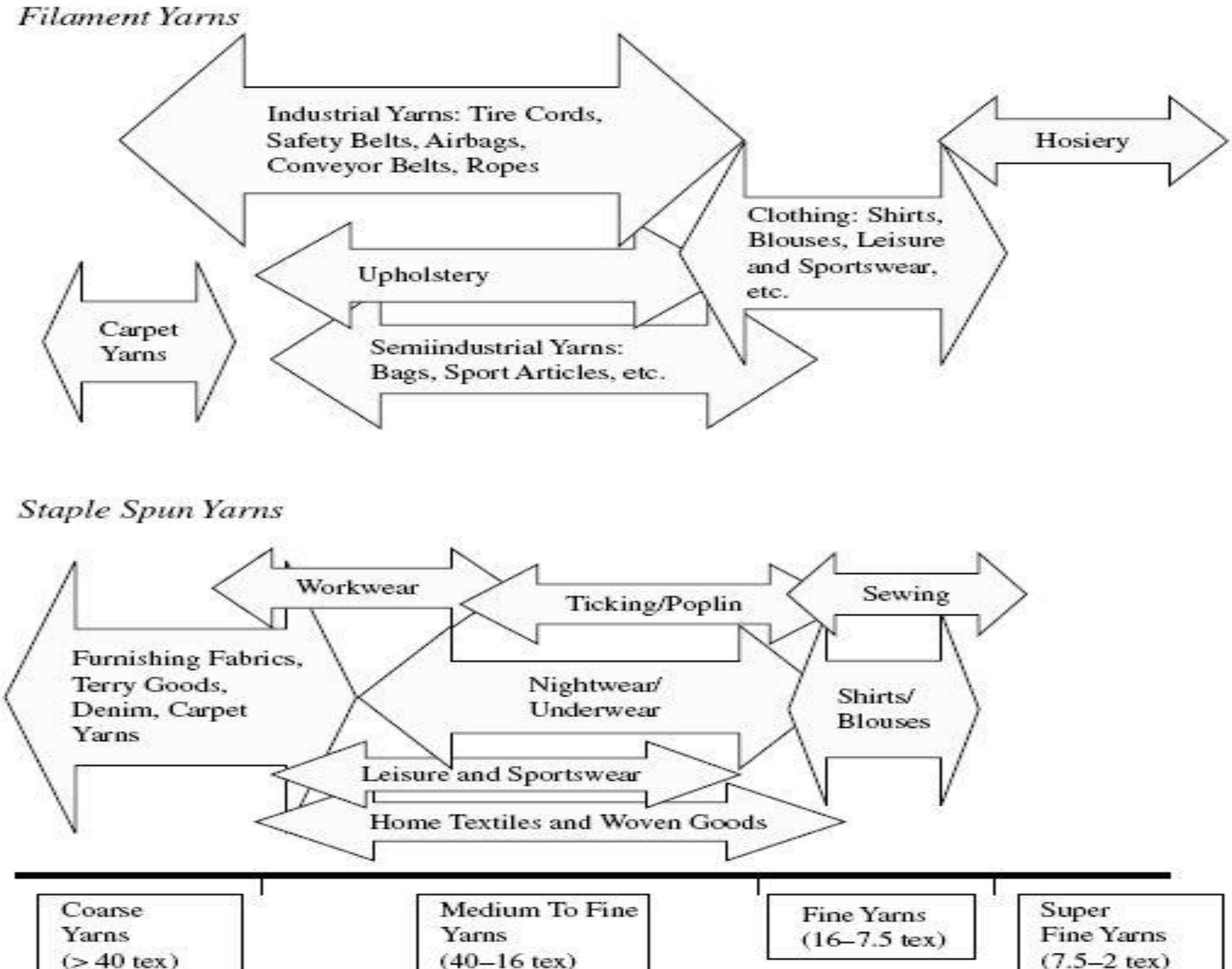
d- yarn diameter

t – twist level

By replacing "d"s value with the density of the yarn we can get the twist multiplier – assuming the helix model of the yarn.

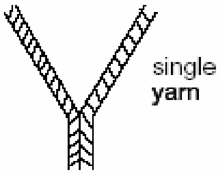
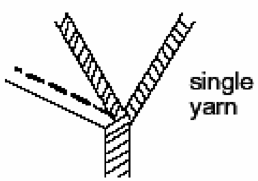
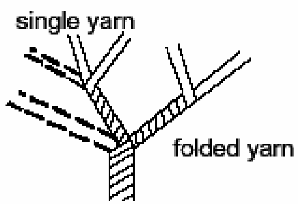
Yarn Count

- Direct count
- Indirect count


Filament Yarns
Industrial Yarns: Tire Cords, Safety Belts, Airbags, Conveyor Belts, Ropes
Hosiery
Clothing: Shirts, Blouses, Leisure and Sportswear, etc.
Upholstery
Carpet Yarns
Semiindustrial Yarns: Bags, Sport Articles, etc.
Staple Spun Yarns
Workwear
Ticking/Poplin
Sewing
Furnishing Fabrics, Terry Goods, Denim, Carpet Yarns
Nightwear/ Underwear
Shirts/ Blouses
Leisure and Sportswear
Home Textiles and Woven Goods
Coarse Yarns (> 40 tex)
Medium To Fine Yarns (40–16 tex)
Fine Yarns (16–7.5 tex)
Super Fine Yarns (7.5–2 tex)

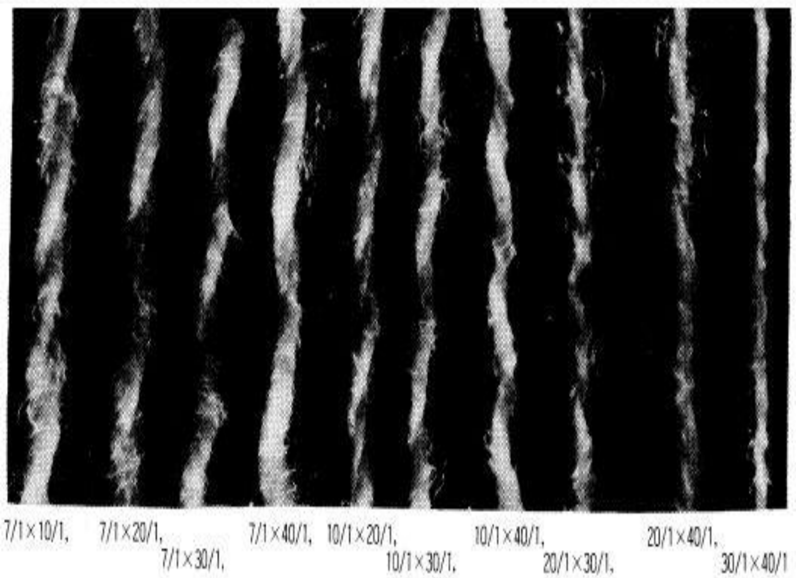
Fibre parallelism

- When twist is present in the yarn, the fiber parallelism is along the twist direction
- Will affect the yarn properties
- Dependant on the mechanical processes the fibres have to undergo prior to twist insertion

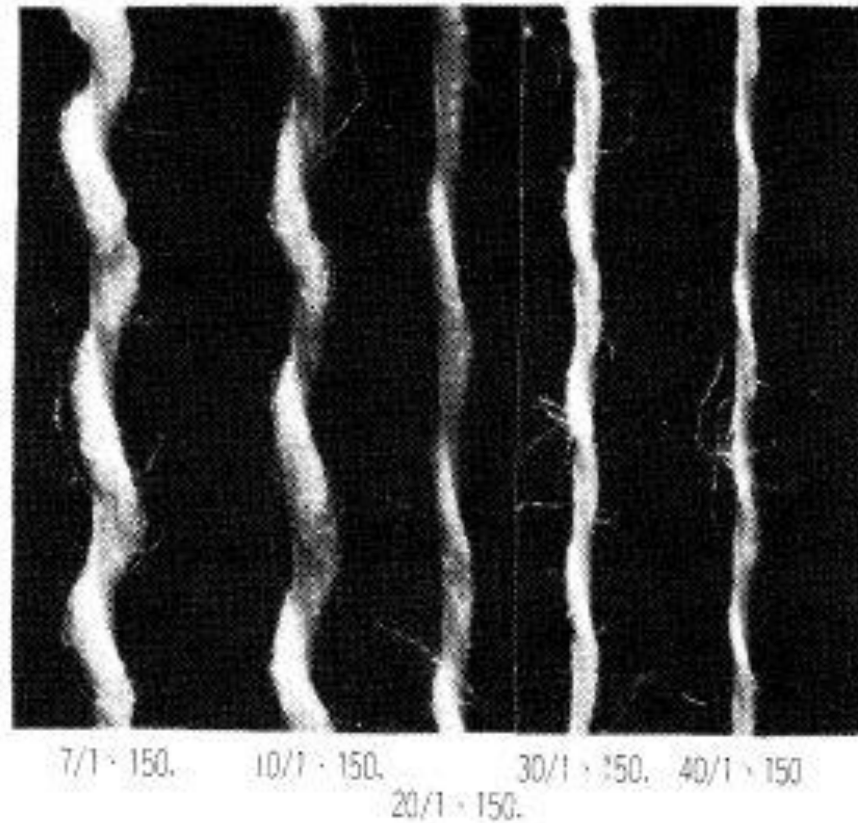
Definition	Explanation
 Single yarn	Spun yarn or Filament yarn
 Multiple wound yarn	Two or more components no twisting operation similar or dissimilar components
 Folded (plied yarn)	Two or more components one twisting operation similar or dissimilar components
 Cabled yarn	Two or more components more than one twisting operation similar or dissimilar components

Plied yarns and their effects on the fabric

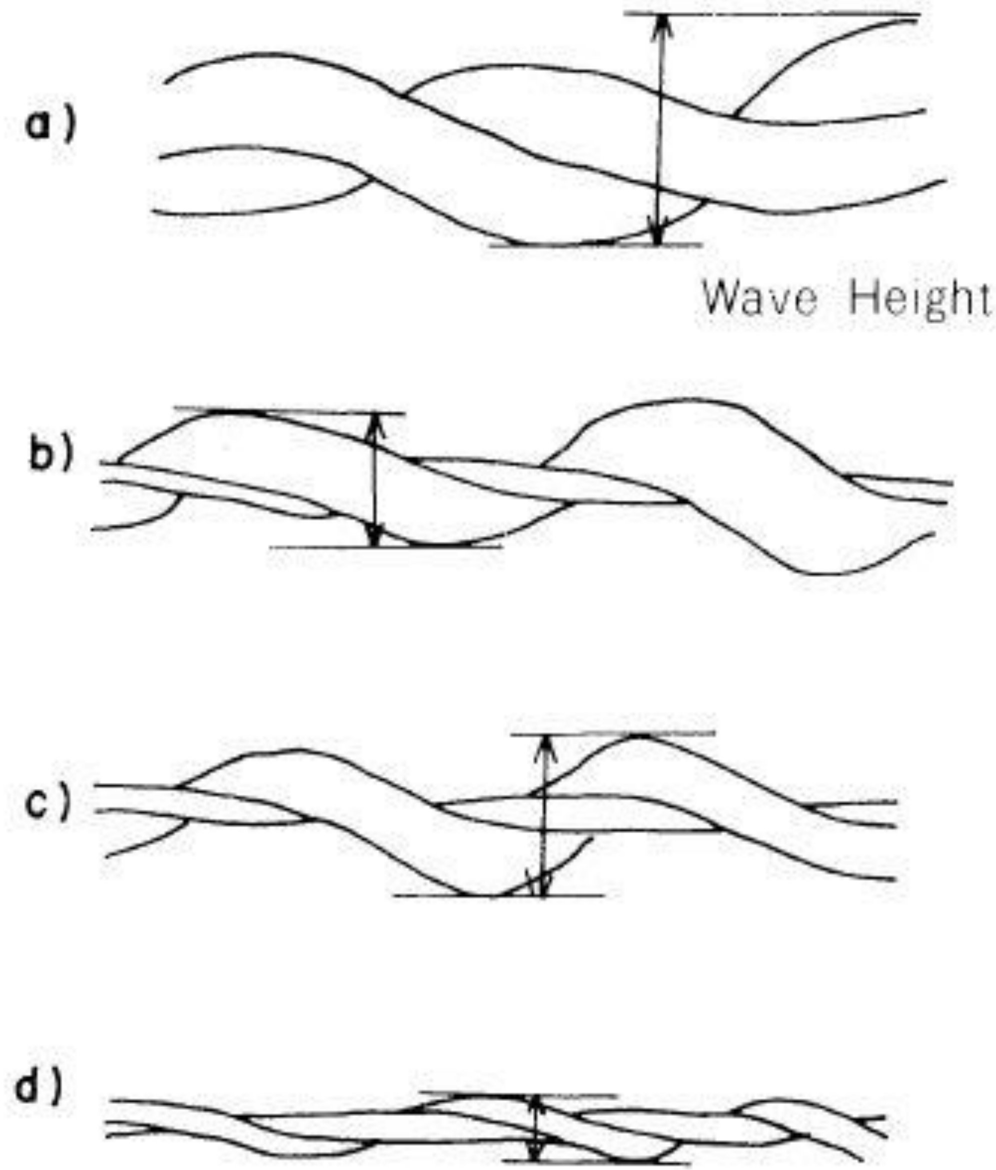
Plying two unbalanced yarns will provide a surface variation and a creates an effect on the surface of the fabric

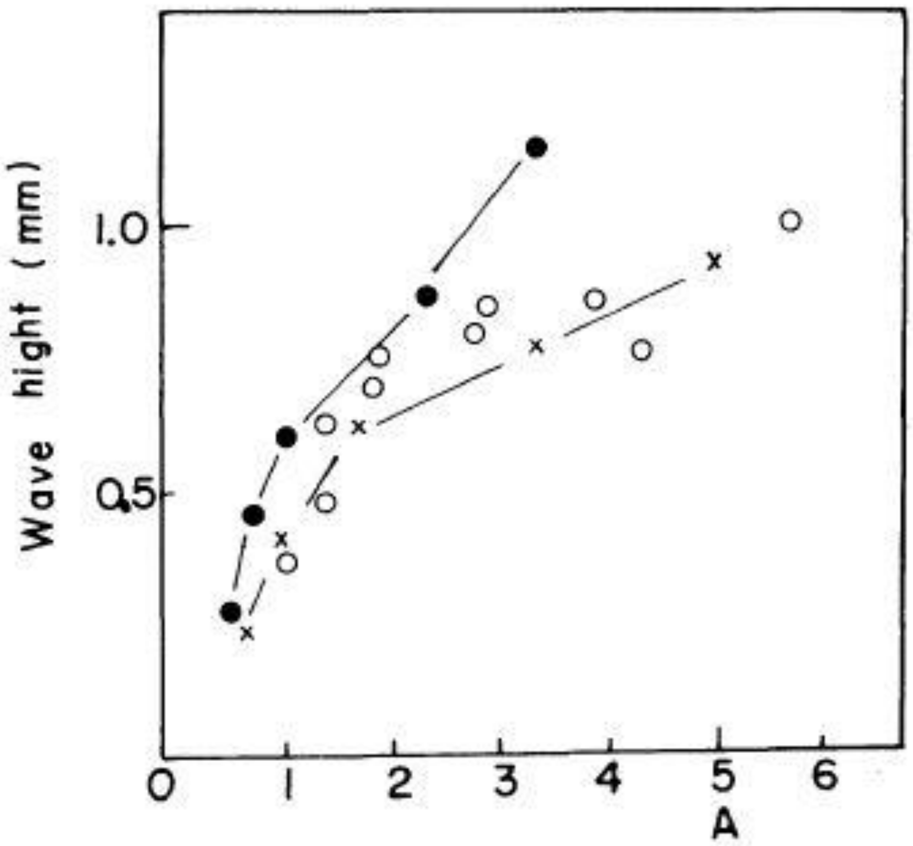


cotton/cotton plied yarn



cotton/polyester multi-filament yarn


a)
Wave Height
b)
c)
d)



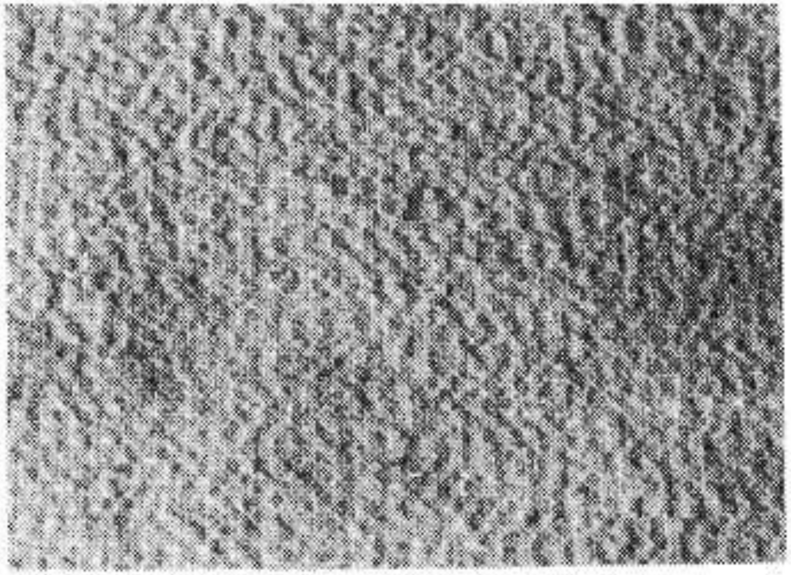
(b) Relation wave hight and A of plied yarns

Fig. 2 Morphology of plied yarns.

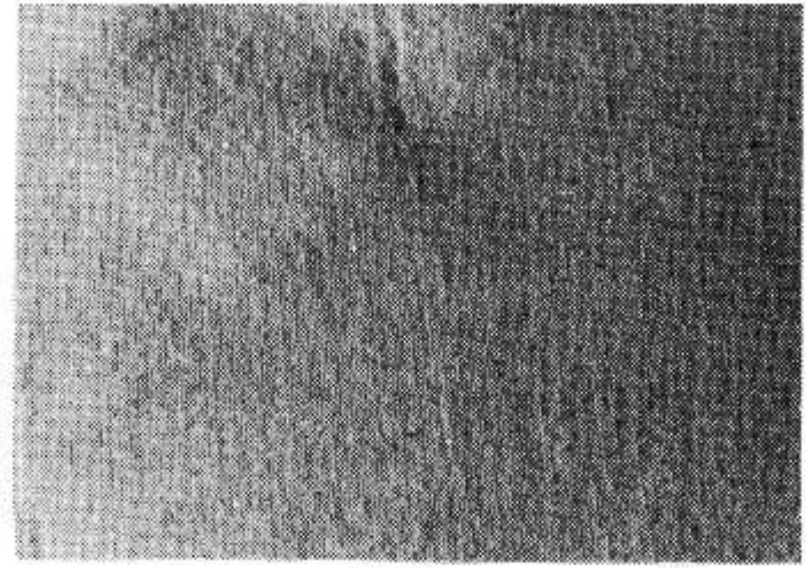
(●: C/EF250; ×: C/EF150; ○: C/C)

Y axis – Wave height

X axis – Count of thinner yarn / Count of thicker yarn

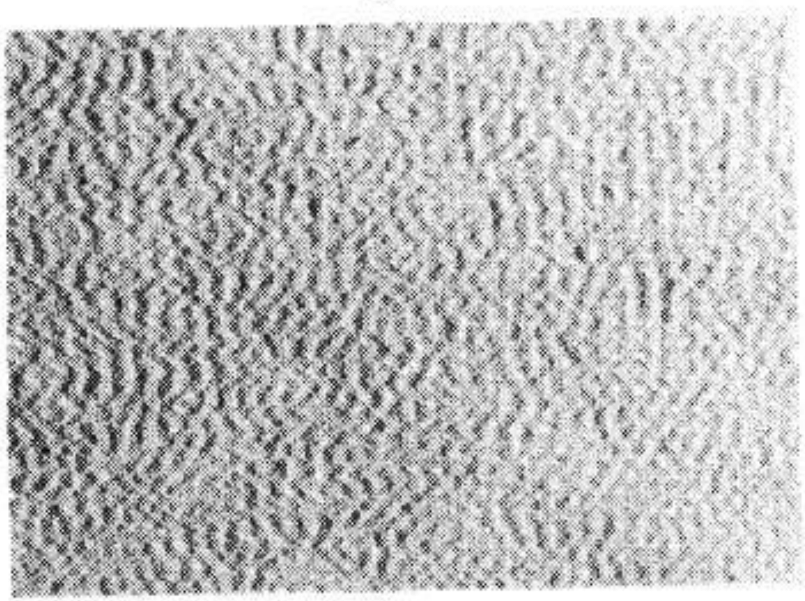


\# 4

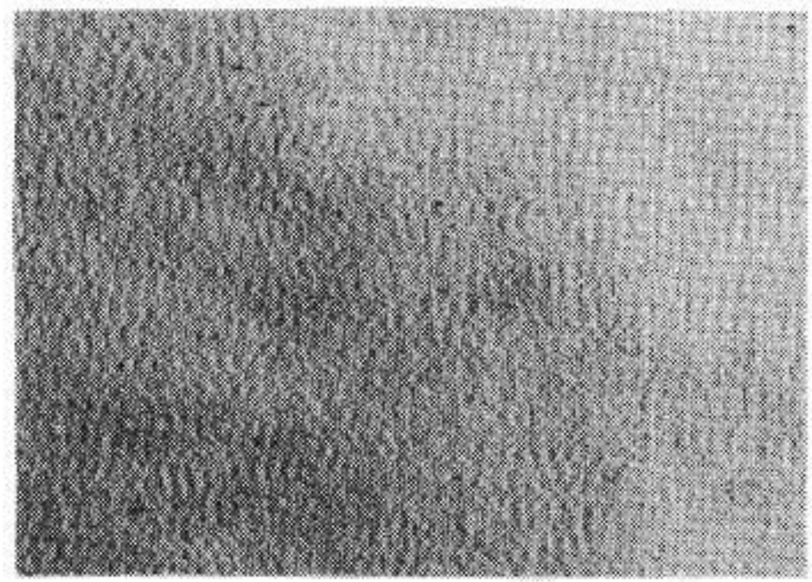


\# 10

cotton/cotton plied yarn fabric



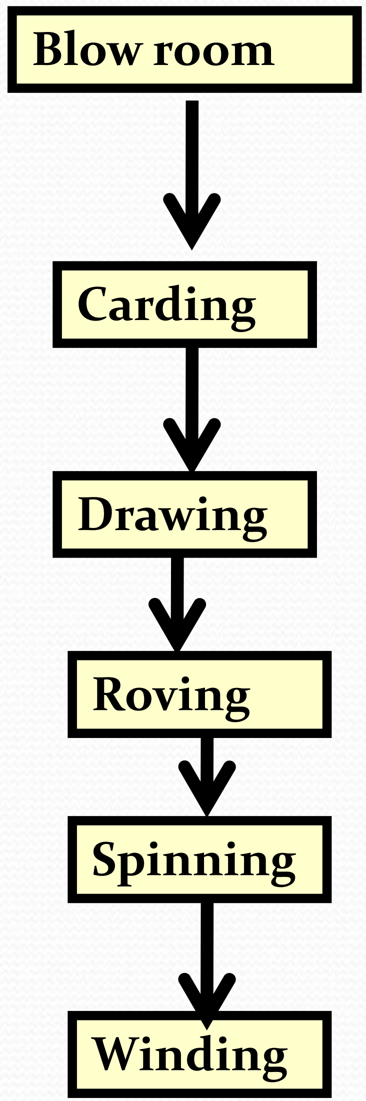
\# 12



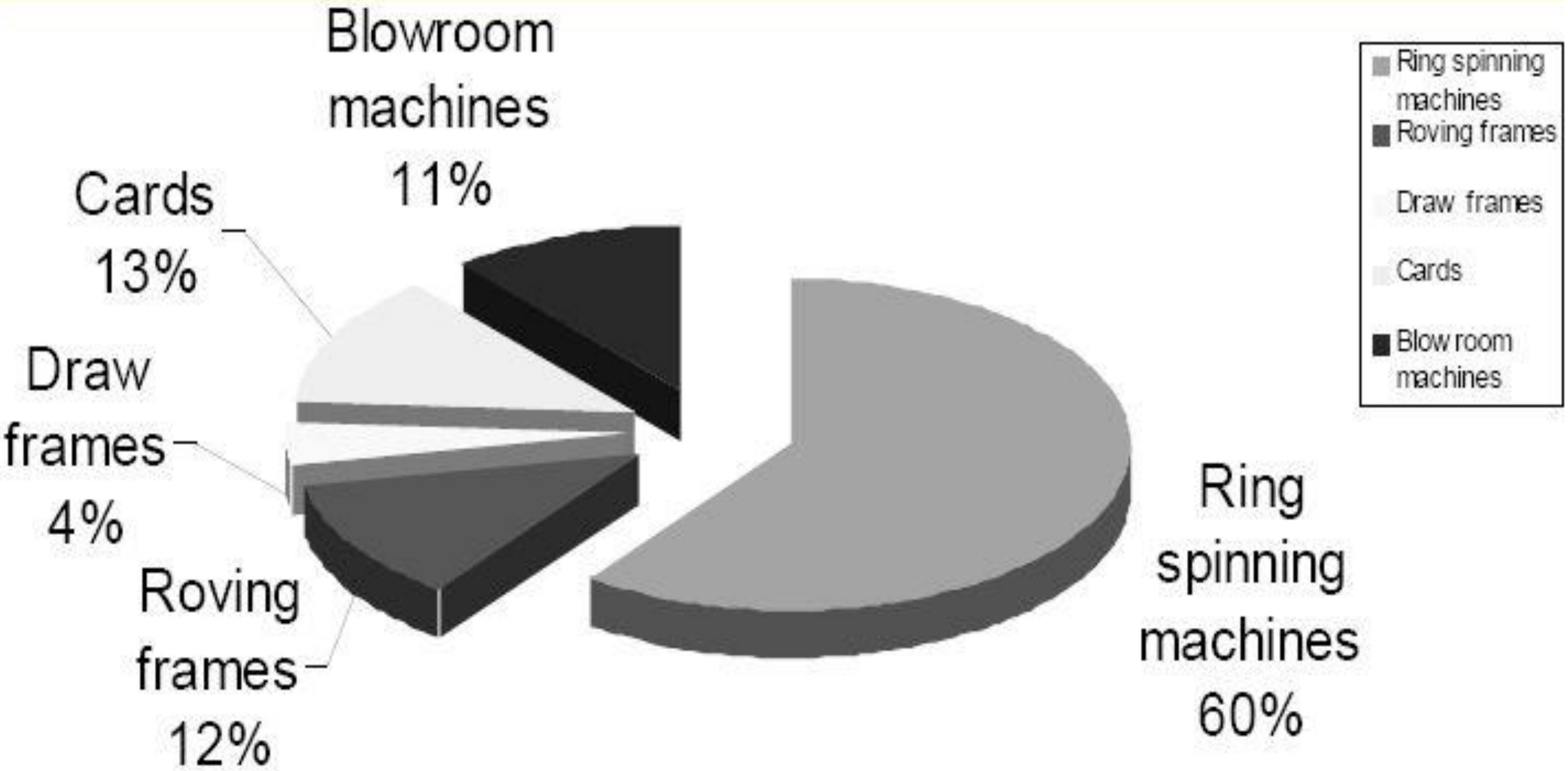
\# 16

cotton/polyester multi-filament yarn fabric

Carded ring spun yarns



The cost structure in ring spinning mill is shown in the graph.



How do the machines contribute to these yarn properties ?

Developments in drafting

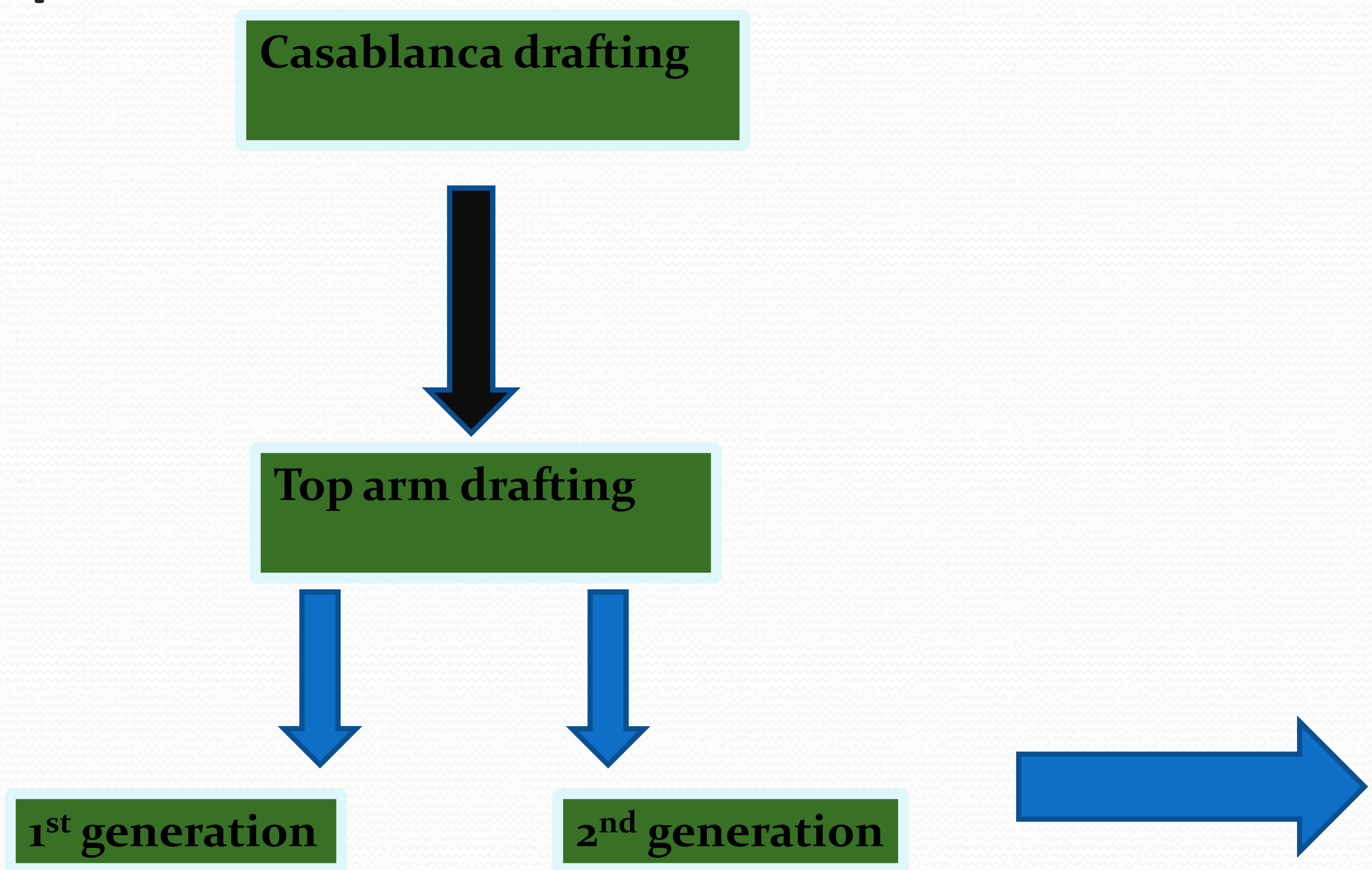
Why Drafting is of importance

- drafting at Ring Frame is a major influence on yarn qualities & ultimately tells on even fabric appearance
- Drafting has the maximum influence on yarn quality &ring performance.
- Drafting in Ring Frame considerably influences not only evenness and appearance of yarn, but also performance of yarn, appearance of fabric, and rejections due to yarn faults.

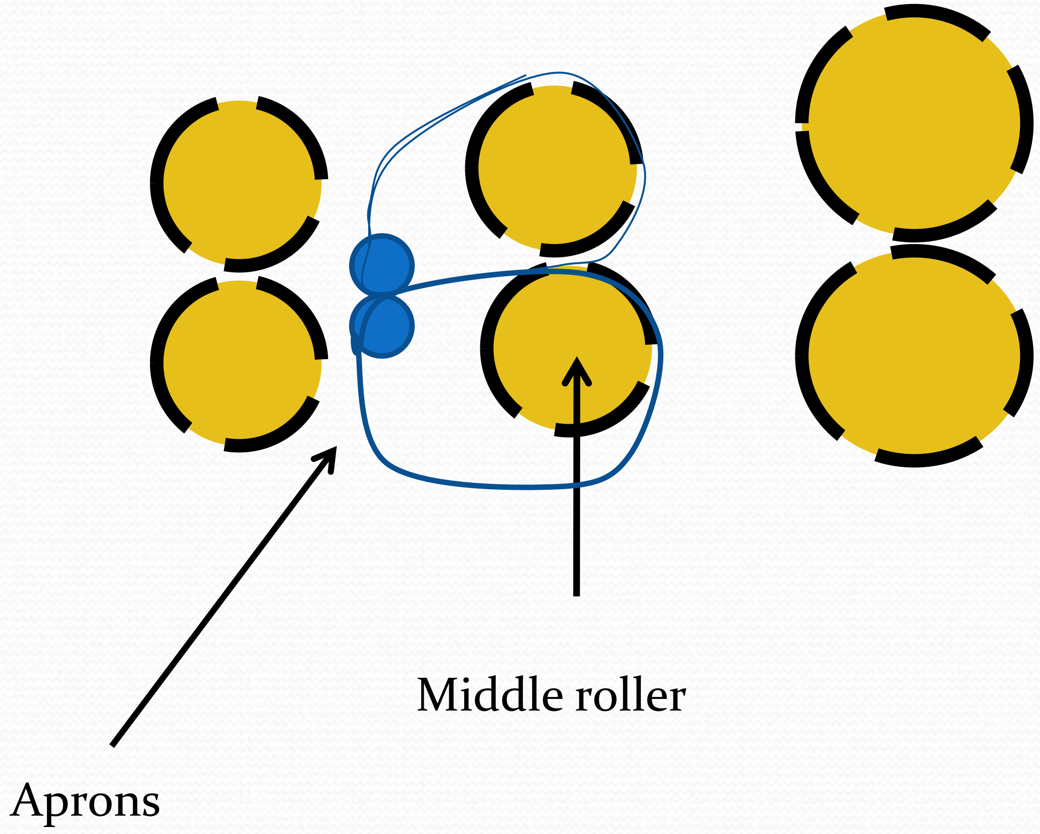
Irregularity in Drafting

- Inadequate control over the movement of short and floating fibres.
- Slippage of strand and fibres under the drafting roller.
- Variations in speed of drafting rollers.
- Mechanical faults.

How the current drafting system developed



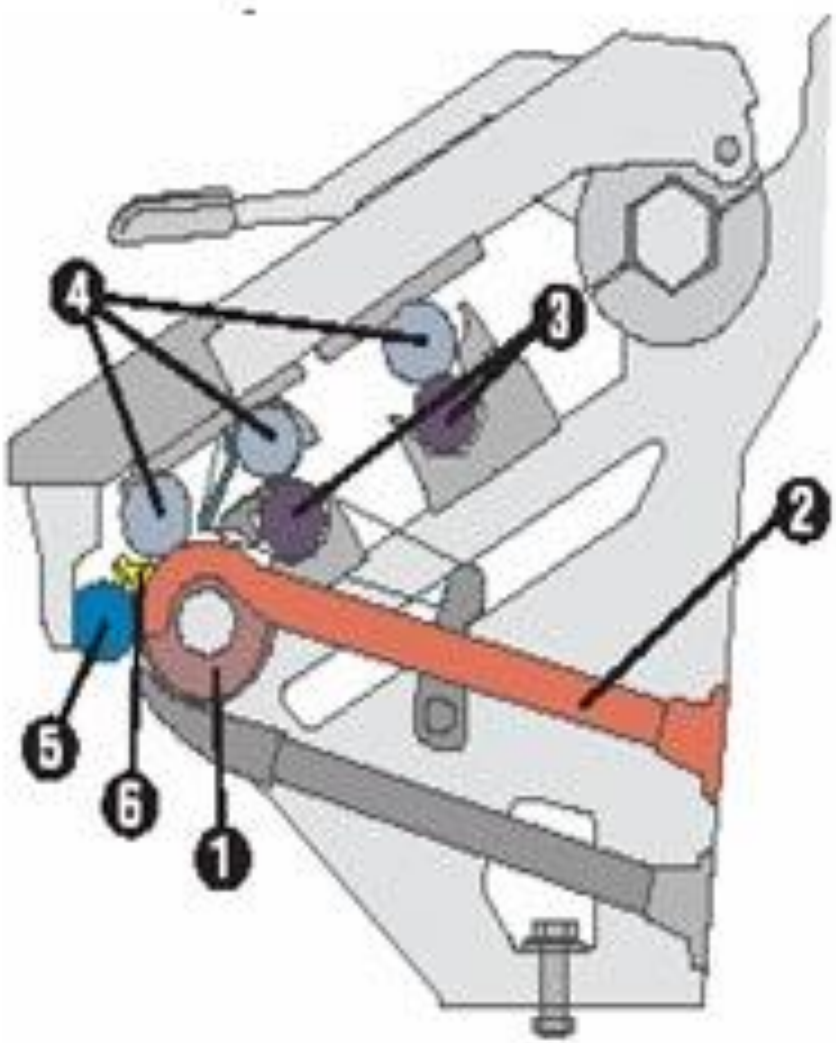
Casablanca A500 drafting represents the first development to improve the control over floating fibers.



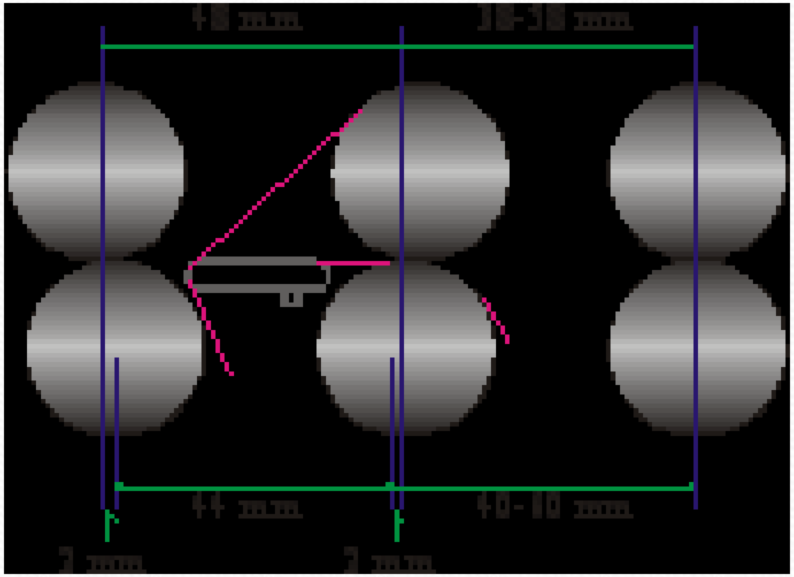
Drawbacks of such system

- Back roller will have more slippages due to its weight
- Back roller has a bigger diameter, hence the back zone setting will be too long to accommodate short fibres
- Middle and front roller pressure is given by springs, which will deteriorate over time
- Plain bearings are used for top rollers, which need frequent lubrication. Which will attract fluff

Top arm drafting represents a major break through in improving the quality and performance of drafting. Most of the problems that encountered with Casablanca drafting are overcome by Top arm drafting by adopting pendulum system of central arbour guidance. The top rollers are held at the middle of arbour by means of a saddle, which are weighted by heavy-duty springs.



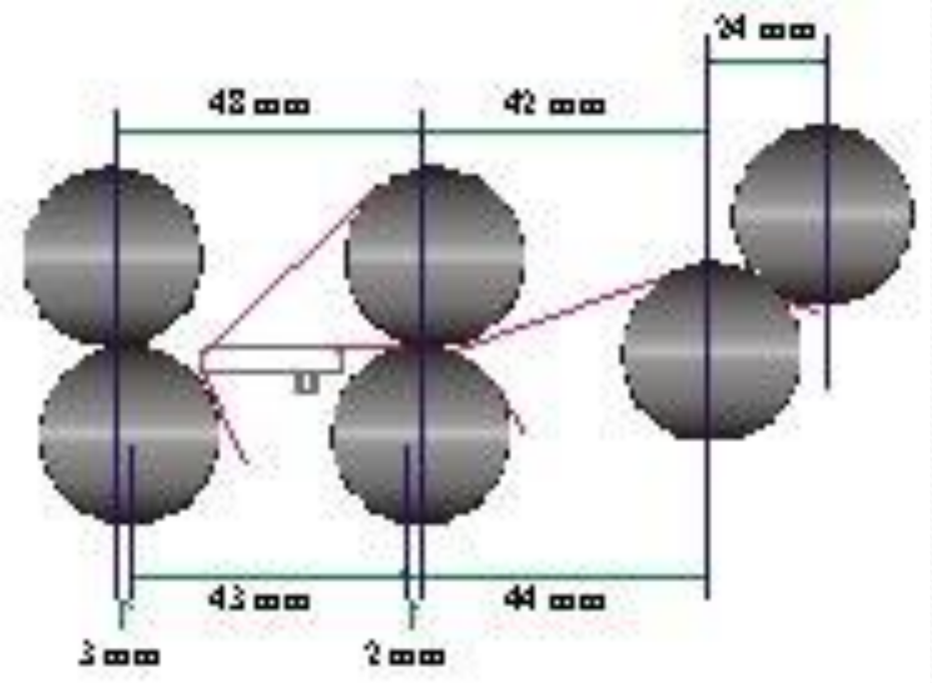
1 perforated drum
2 suction system
3 bottom roller
4 top roller
5 nip roller
6 air guide element



Advantages of the Top arm system

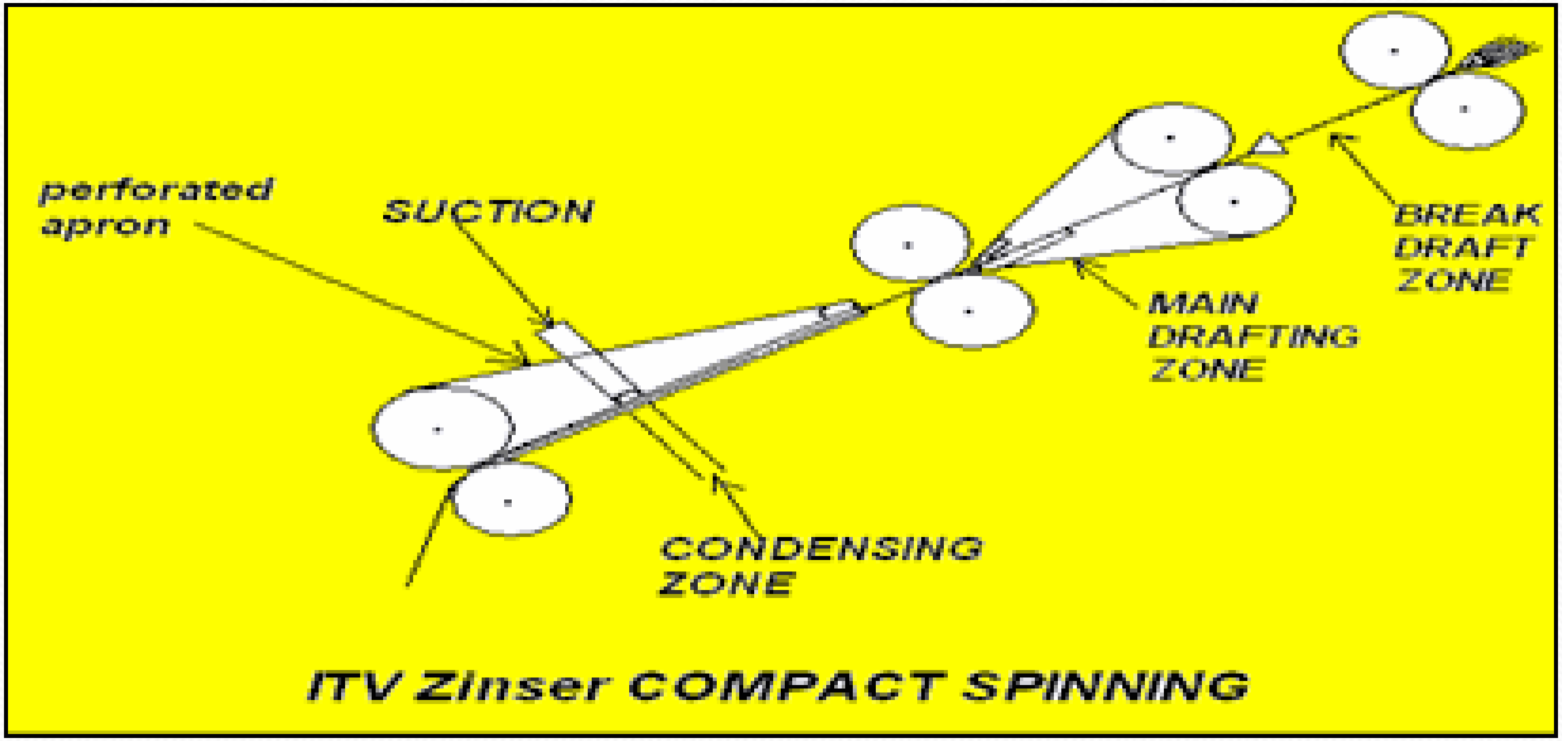
- Self-alignment of top roller in relation to bottom roller results on better grip over fibres.
- Higher drafts are achievable because of better control over fibres.
- About 1-1.5% units better U% and 15-20% reduction in imperfections are obtained by conversion to top arm drafting.
- Heavier weighting by the use of better grade springs reduces slippage.

Offset drafting

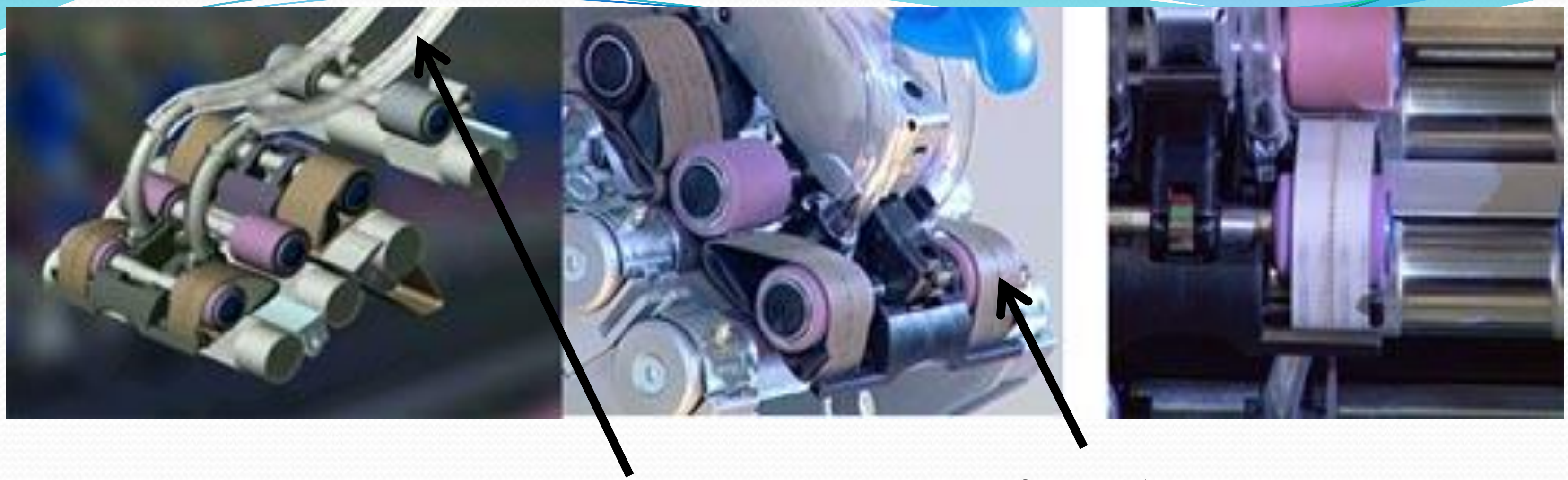


Improvements on Thick and Thin places

Zinser system

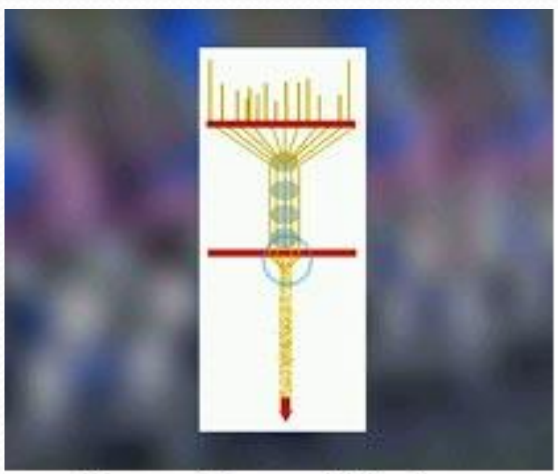


In ITV-Zinser system, illustrated in figure, condensing zone consists of a revolving perforated apron. The size of perforations in the apron is varied as per the count of the yarn to get the desired condensation



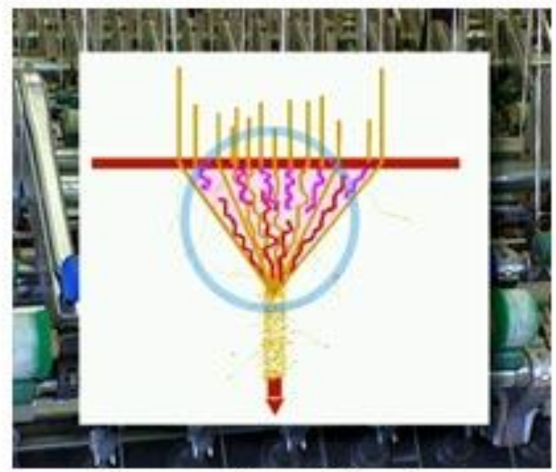
Suction

Perforated apron



Zinser Compact System

This shows very small spinning Triangle.



Conventional System

This shows very large spinning Triangle.

Lakshmi's development

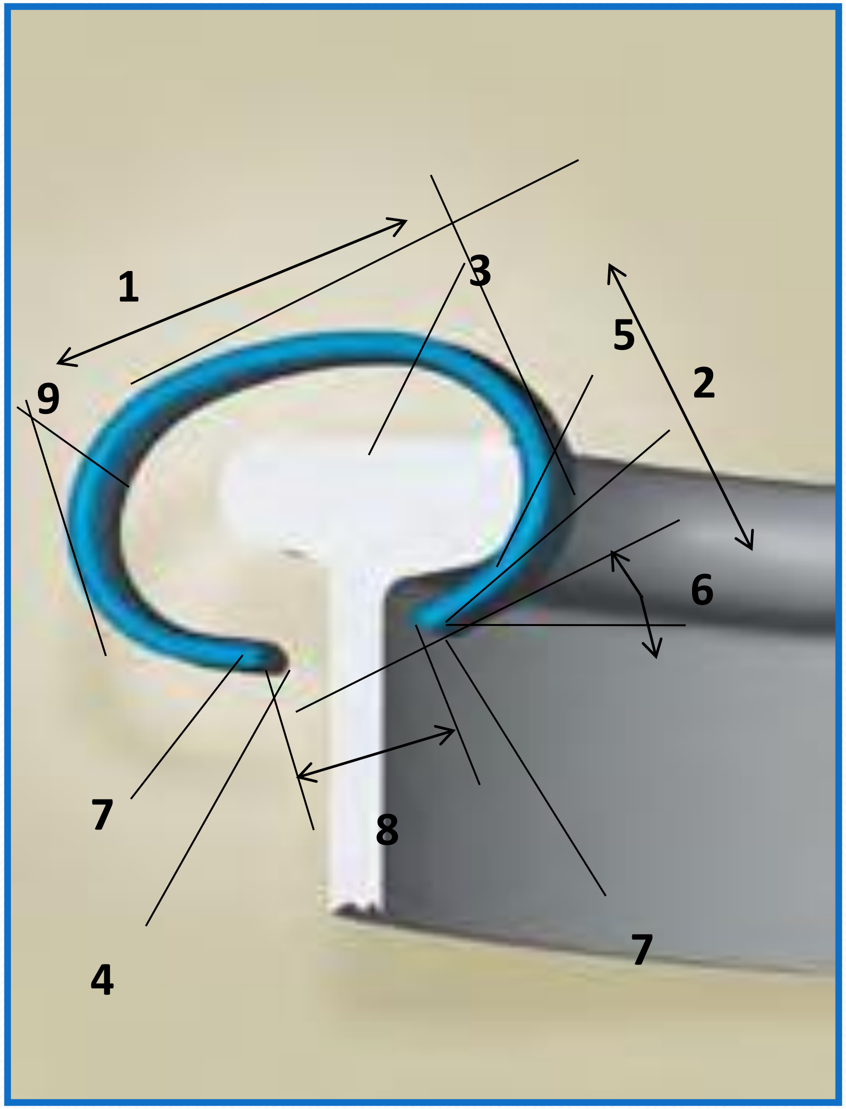
The Lakshmi RoCos Compact System, works without air suction & uses magnetic mechanical compacting principle.

Compacting yarn is produced by compacting the strand of fibres in the condensing zone to such an extent thereby avoiding spinning triangle and makes control over the strand of fibres.
The contour & the path of the fibres enables all the fibres to align itself along with the axis of yarn more uniformly.

SALIENT FEATURES:
Magnetic compacting is more user friendly & avoids
Air suction
Air pipes
Perforated drums or apron
Additional air conditioning requirements

Parts of a Traveller

1	-	Inner traveller width
2	-	Height of bow
3	-	Yarn passage
4	-	Wire section
5	-	Traveller – ring contact surface
6	-	Angle of toe
7	-	Toe
8	-	Opening
9	-	Upper part of traveller bow



Traveller classification

Travellers are required to wind up yarns of different types of variations. This includes *coarse/fine, smooth/hairy, strong/weak, natural/man made etc.*

Variances in traveler type to suit above changes of yarn type

- Form
- Mass
- Finishing process
- Wire profile
- Size of yarn clearance

Form of Traveller

- The traveller must be shaped to correspond exactly with the ring in the contact surface.
- The bow should be as flat as possible in order to keep centre of gravity low and improve smooth running.

•low-bowed traveller reduced yarn clearance
• low centre of gravity for fine cotton yarns for compact yarns
• Optimum fibre lubrication

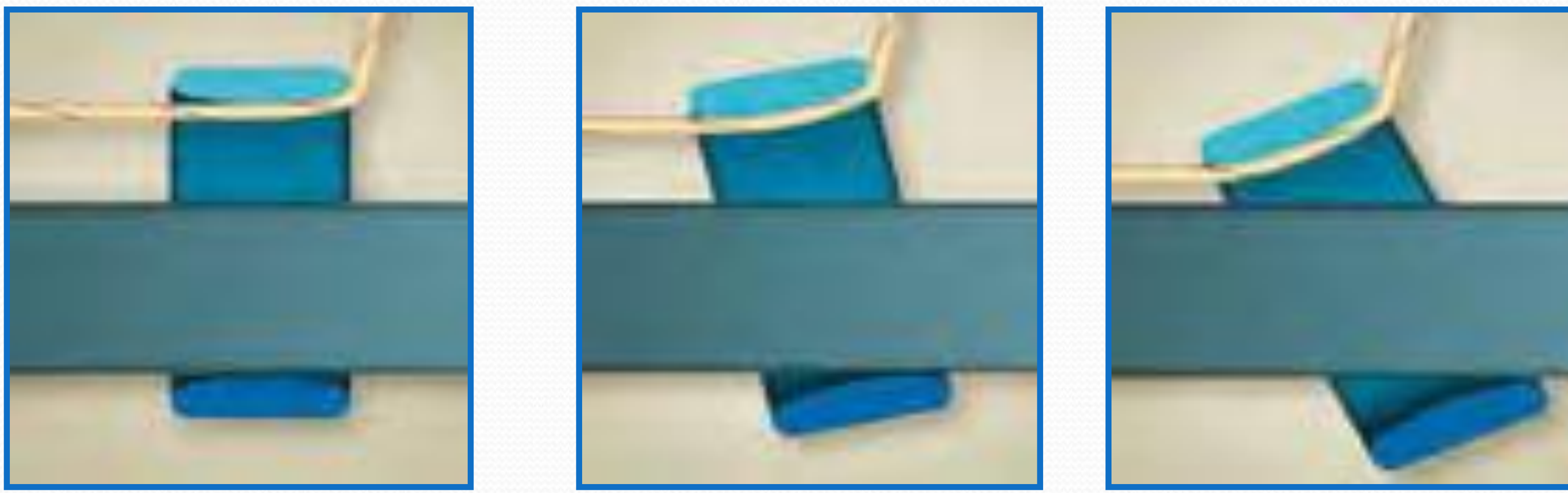
• low to medium bowed traveller
• small to medium yarn clearance for fine to medium fine cotton yarns
•Normal fibre lubrication

• high-bowed traveller
• large yarn clearance
• for medium to coarse cotton yarns, also suitable for blends and synthetics
• Reduced fibre lubrication

Low-bowed traveller

Vertical position

High-bowed traveller

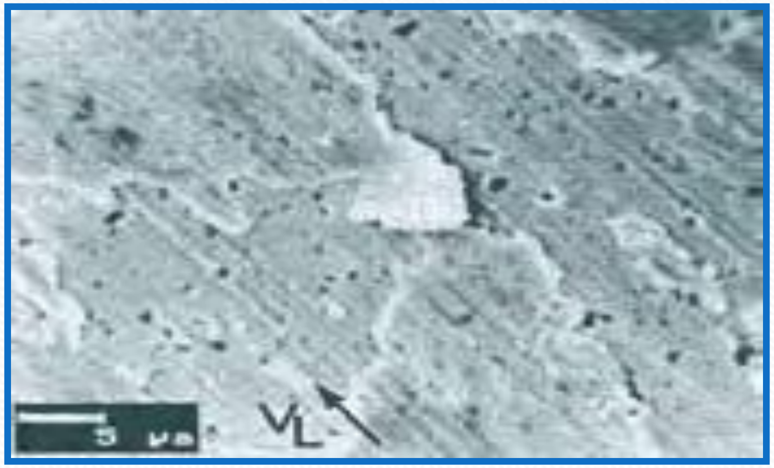


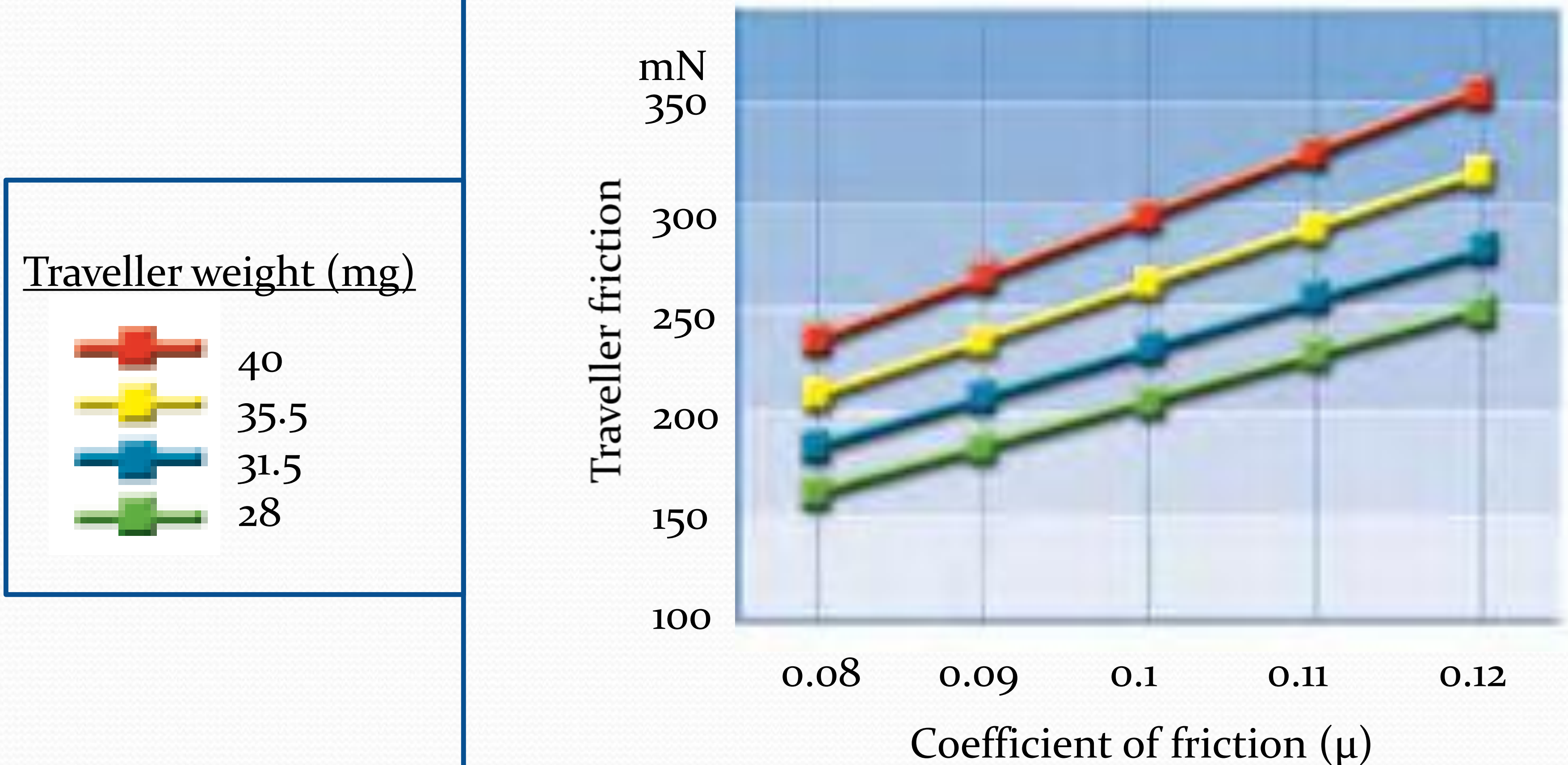
Vertical position

Traveller Friction

Traveller has to regulate the spinning tension, this has to be high enough to keep the thread balloon stable but not too high.

The fibres protruding from the yarn body between ring and traveller are crushed and form a steady regenerating lubrication film.




Traveller weight (mg)
40
35.5
31.5
28
mN
350
300
250
200
150
100
Traveller friction
0.08
0.09
0.1
0.11
0.12
Coefficient of friction (μ)

Wire sections

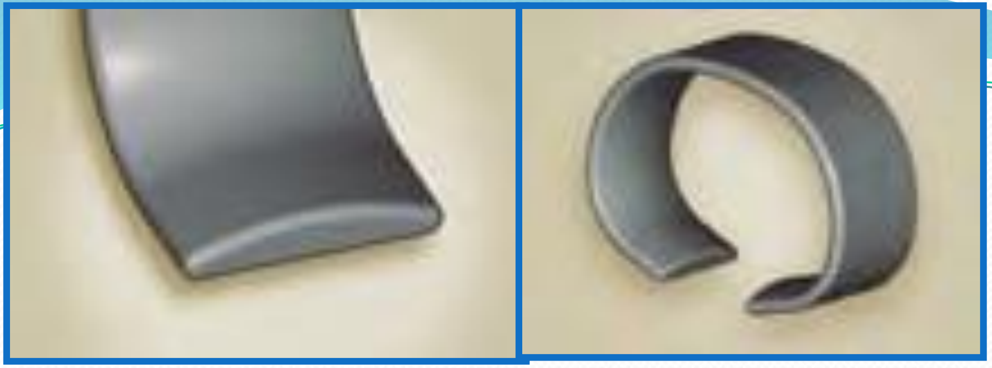
This influence *yarn quality, the running behavior and the life time of the traveller*.


Flat

- Used only for cotton
- Improves the traveller lubrication


Half round

- For synthetics and blends.
- Prevents fibre damage.



udr - Ultra half round

•For cotton and blends.

•Through an enlarged contact surface on the ring raceway, highest performances are possible.

•The mostly used wire section.

fr - Flat/round

•For Core yarns with PES core, acrylics and delicate fibres.

•f-profile at the toe increases the ring contact.

•r-profile for fibre protection in the yarn passage.

drh - Half round high

•Special profile for SU travellers.

•Application for Viscose and Polyester.

Finishing Treatments

Advantages of the additional finishes on travelers

•Higher traveller speeds

•Longer traveller life

•Improved running behavior and as a result a more consistent yarn quality

•Rust/oxidation protection (specially Starlet)

High performance travellers are only available with a finishing treatment

Finishing Treatments….

STARLET-Electrolytic surface treatment (special nickel plating)

A nickel coating is applied with a special process.

Low friction values in the yarn passage prevent fibre damages.

Optimum resistance to corrosion.

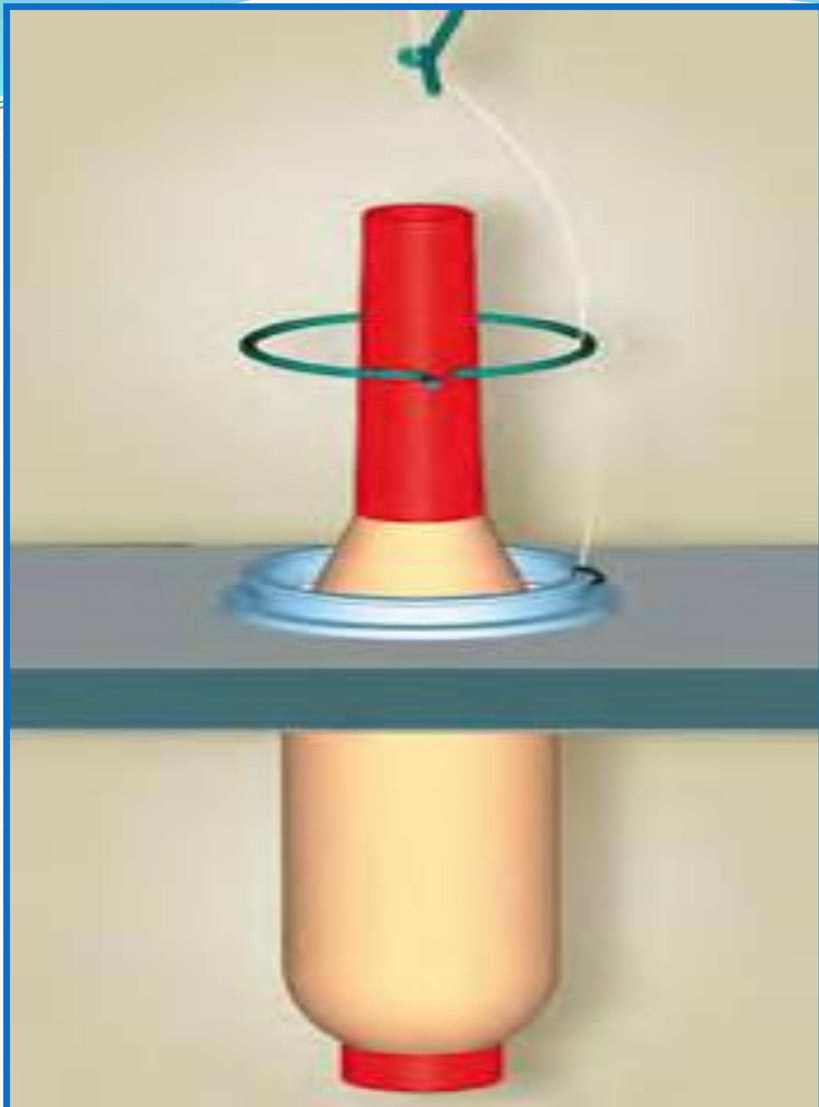
Finishing Treatments….

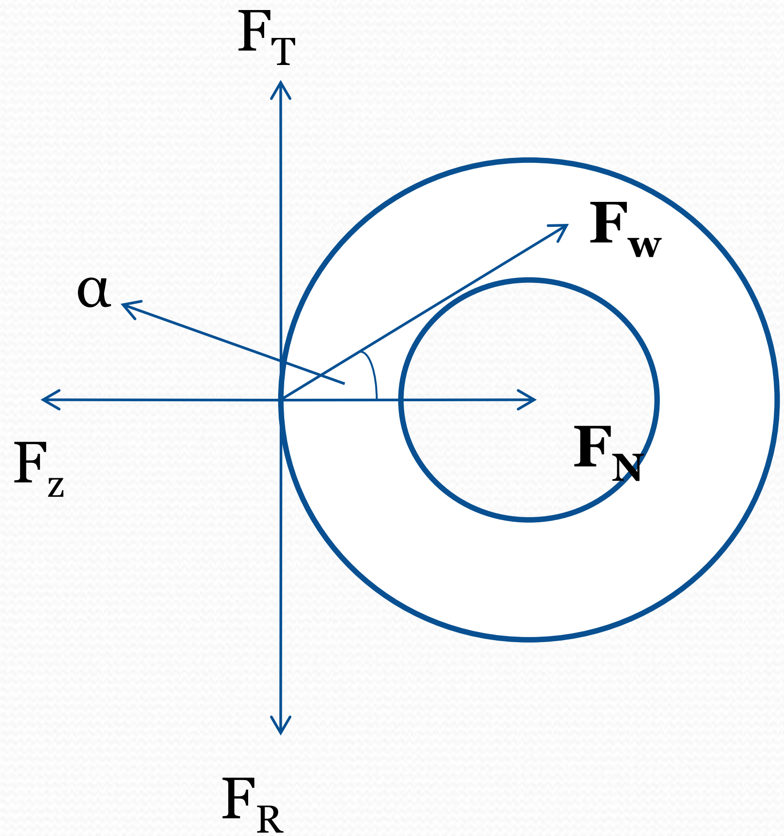
PYRIT

PYRIT treated travellers have a enriched steel structure through additional components.

The wear resistance is considerably increased. (Improves the running behaviour and guarantees a more consistent yarn quality.)

At high speeds the traveller service life can be increased by more than 100% compared to travellers with conventional finish





F_T
F_w
α
F_z
F_N
F_R

Ring/Traveller Systems

Orbit Ring/Traveller System

The Orbit ring/ traveller system (patented world-wide) is designed for spinning at top speeds whilst producing best yarn quality.

<u>The special features of the *Orbit System* are</u>

• Large contact area between traveller and the ring. This reduces the specific pressure.

•Optimum heat dissipation traveller to the ring.

Advantages of the "*Orbit System*"

- Increase in speed and production
- High dynamic stability in traveller running
- Reduction of yarn breakage
- Improved and more consistent yarn quality
- No thermal damage when processing synthetics

Applications

– Cotton combed
– Polyester/cotton blends
– Polyester 100%

Yarn counts : Ne 30 to 60 recommended
(finer and coarser both are possible)

SU Ring/Traveller System

The SU ring/ traveller system is suitable for the processing of synthetics (PAC, VC, PES) and their blends in the medium to coarse yarn count range.

Design features of the SU system

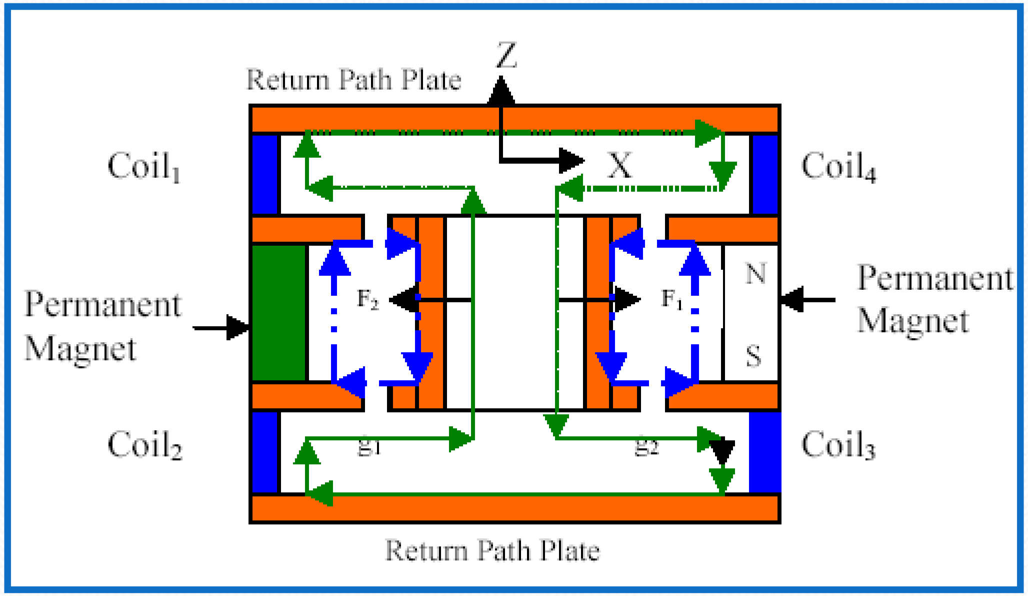
• Large contact area between ring and traveller reduces the specific pressure.

• Optimum heat dissipation traveller to ring

Advantages SU system

- Better and more even yarn quality
- Consistent yarn tension
- No thermal fibre damages
- Increased life cycle of travellers and rings
- Higher spindle speeds
- Lower yarn breakage rate
- No yarn stain

Magnetic Ring Spinning



Magnetic Ring Spinning

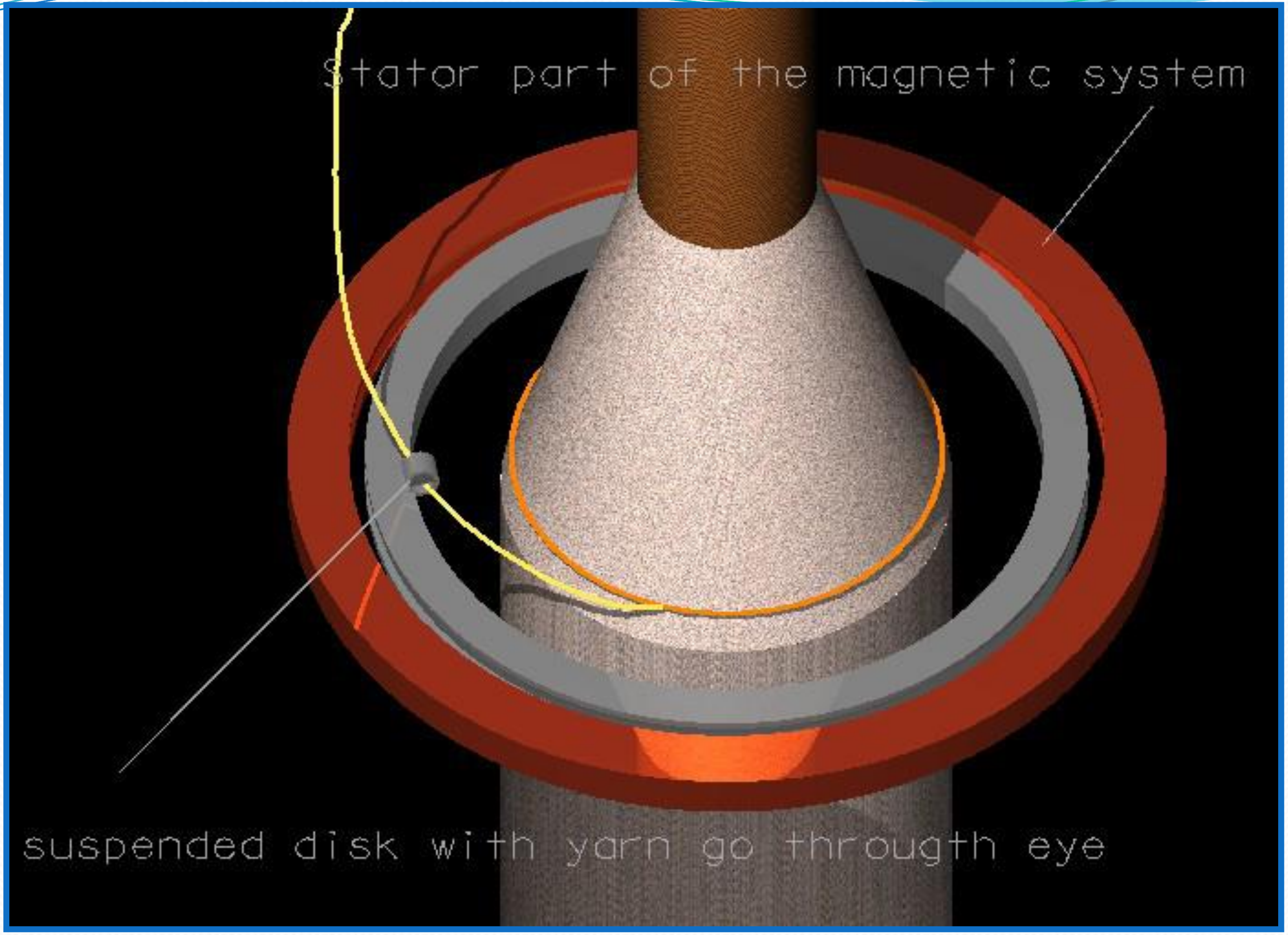
The factor which limits the production in ring spinning???

Friction between the traveller and the ring

Solution to overcome the limitation???

A ring spinning system with a suspended ring which has a the ability of stabilizing the suspended ring with a high degree of precession.

- Though there were systems of stabilizing the ring using air pressure and magnetic repulsion ,existence of two systems make it difficult to complicated



Stator part of the magnetic system
suspended disk with yarn go throught eye

The invention provides……

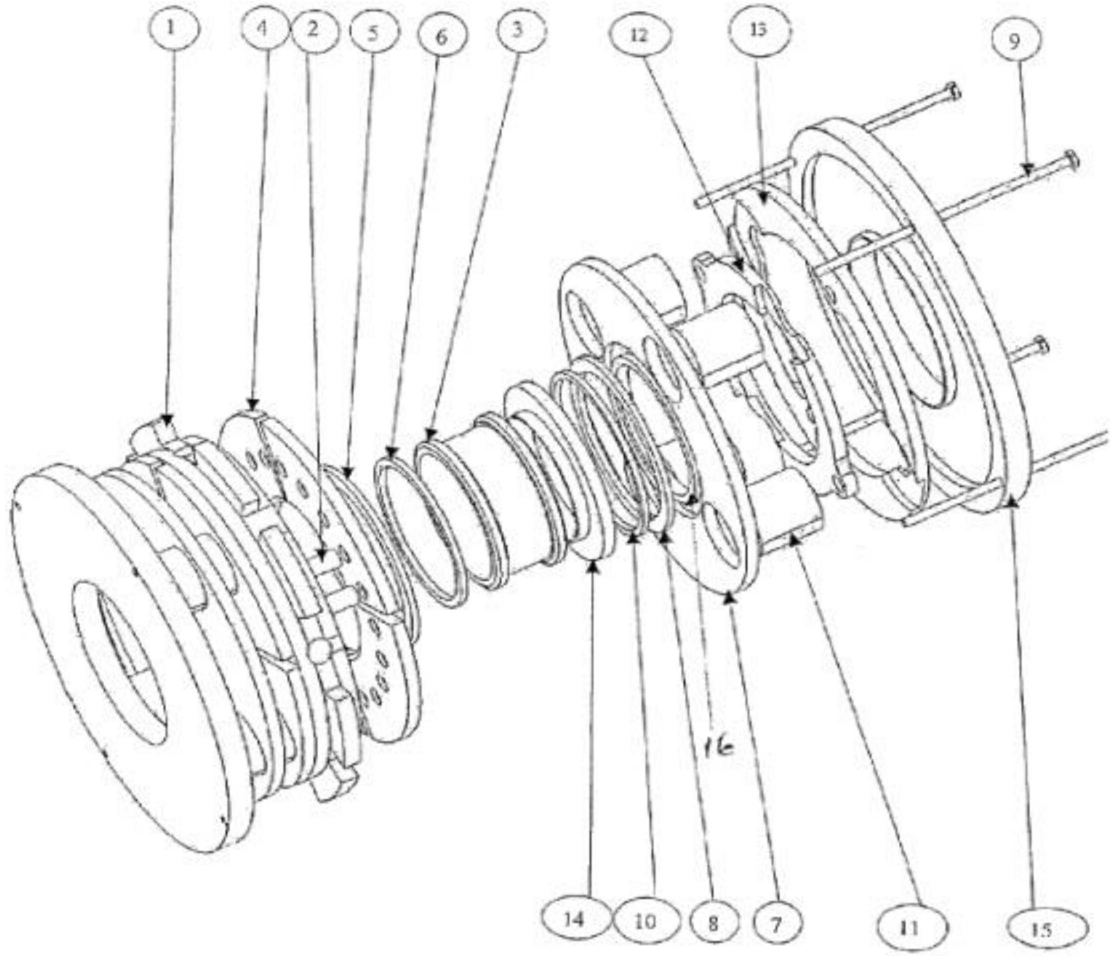
•Replacement of ring traveller configuration with only rotating, floating ring that has an eye on its inner middle surface.

•The ring is kept suspended in space by magnetic levitation system which were in earlier developments.

•The floating ring is rotated around its centre by the effect of winding of formed yarns over rotating spindle at the centre of the ring.

•Sensors and feedback systems are used to control the magnetic fields and control the central position of the ring

•The floating ring may be made out of any material but here they have used but preferably is made out of silicone steel material.


1
4
2
5
6
3
12
13
9
16
14
10
8
7
11
15

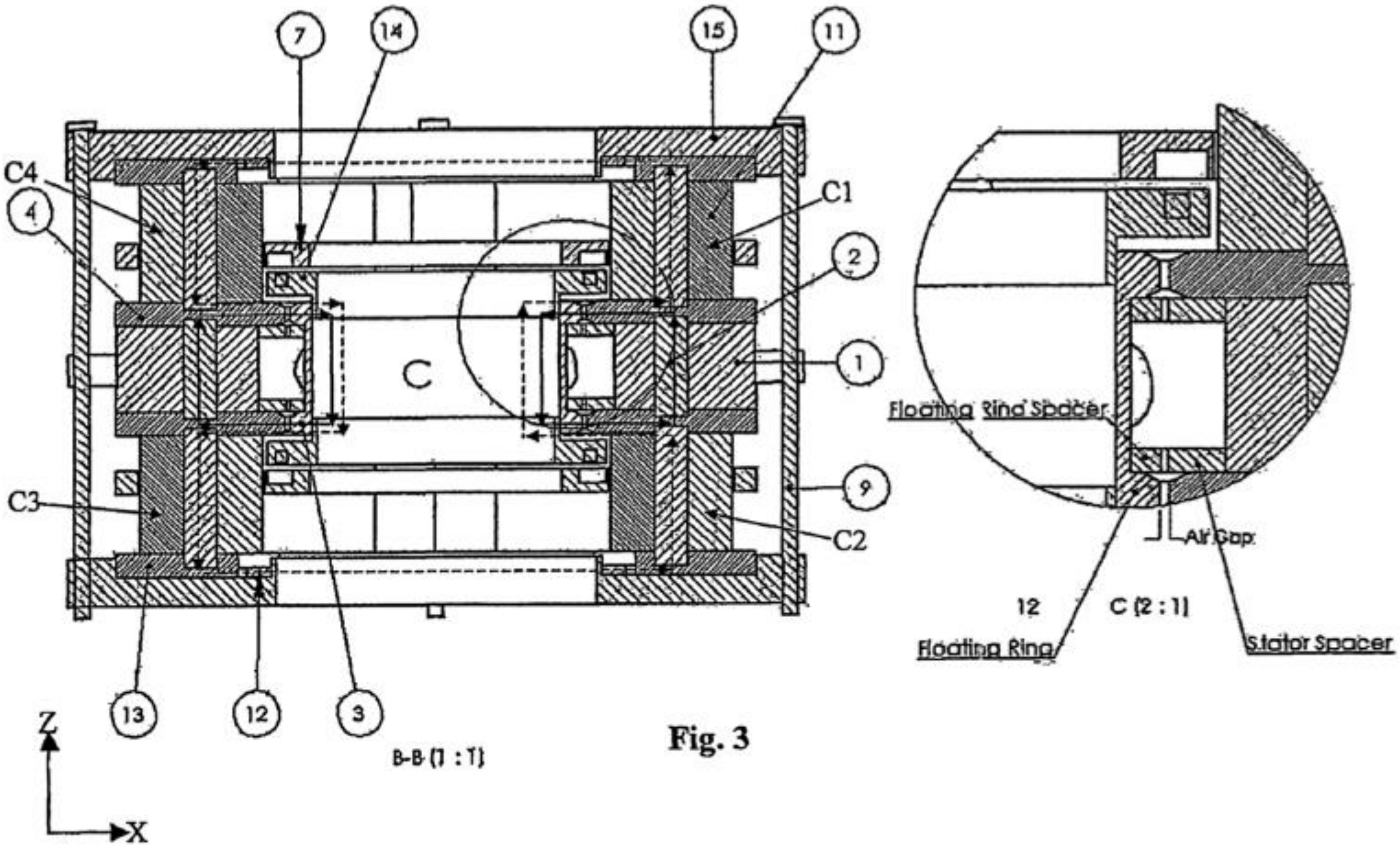

7
14
15
11
C4
4
C1
2
1
C
9
C3
C2
13
12
3
B-B (1 : 1)
Z
X
Floating Ring Spacer
Air Gap
12
C (2 : 1)
Floating Ring
Stator Spacer

Fig. 3

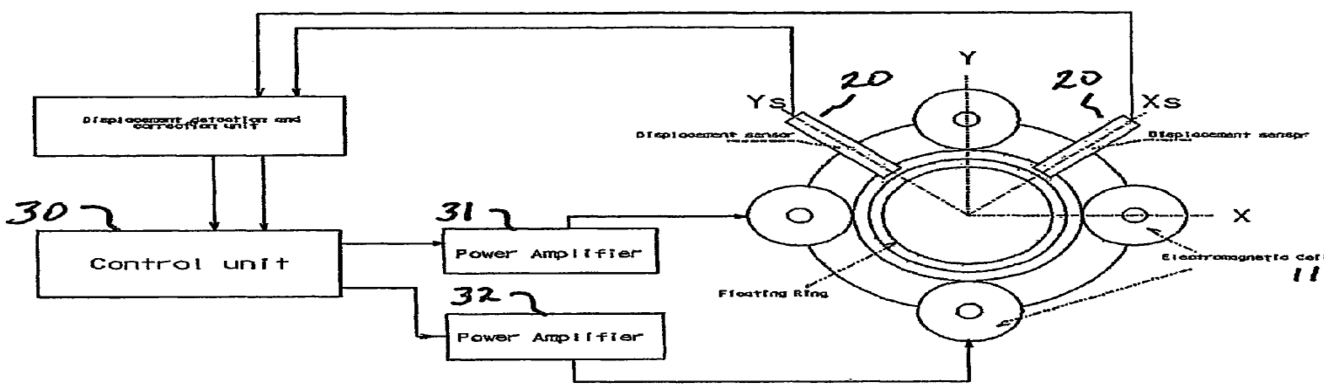
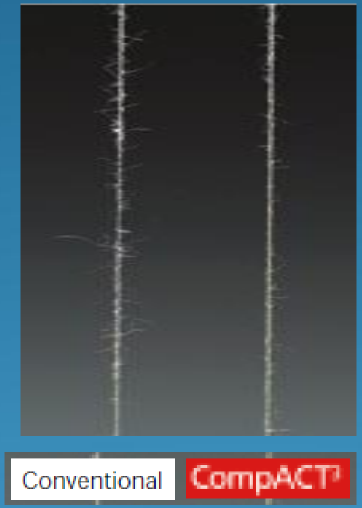

Displacement detection and correction unit
30
Control unit
31
Power Amplifier
32
Power Amplifier
Ys
20
20
Xs
Y
X
Displacement sensor
Displacement sensor
Floating Ring
Electromagnetic coil
11

FIG.14

Compact spinning



Compact Spinning is simply the modification of conventional ring spinning system

Compact Spinning systems are offered by:

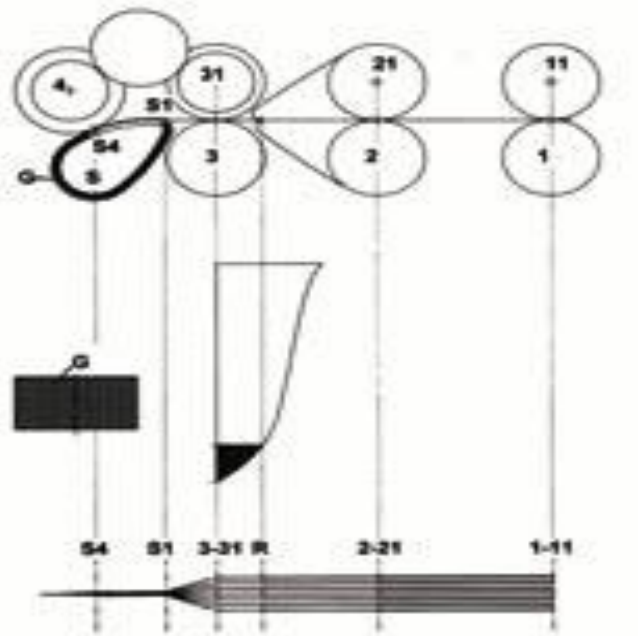
- REITER [COMFOURSPIN]
- SUESSEN [ELITE SPINNING SYSTEM]
- LAKSHMI [RoCos COMPACT SPINNING SYSTEM]
- ITV-ZINSER [CompACT3]

Future of compact spinning

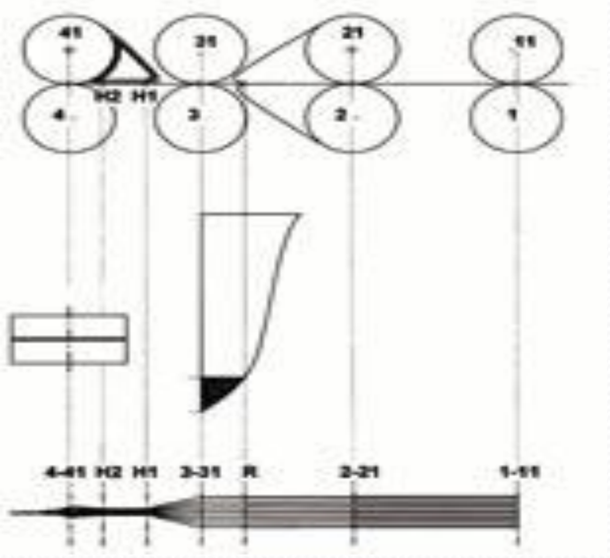
Ring yarns which are spun on ring spinning frame without a spinning triangle, are unsurpassed in respect of their high strength and minimum hairiness

Mechanism behind the compact spinning

Drafting equipment of the Suessen Fiomax E1 spinning machine



Drafting system of the Zinser AIR-COM-TEX 700 condenser ring spinning machine

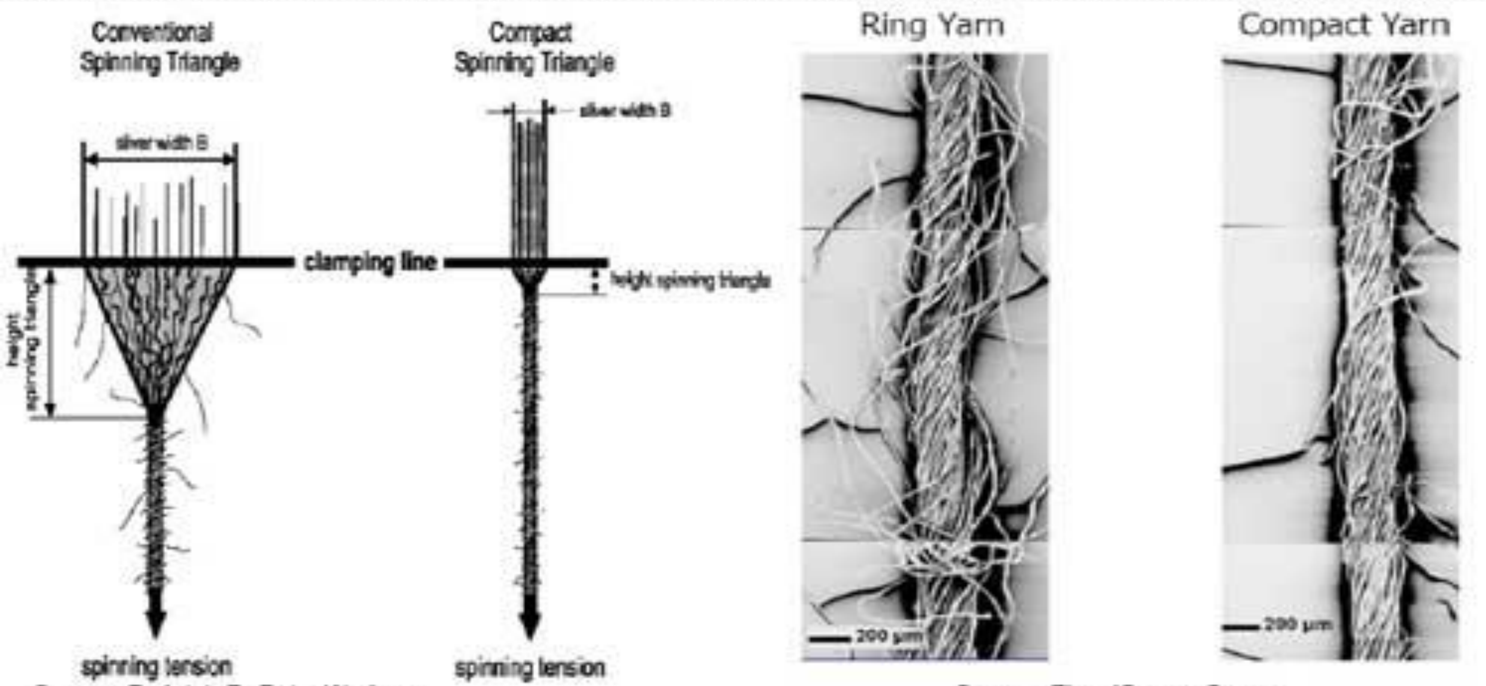


Pair of delivery rollers , a double aprons area, a pair of front rollers and a condensing zone

Standard three-cylinder drafting unit with two aprons and condensing unit

Yarn Structure

Comparison of Conventional Ring Spun Yarn & Compact Yarn



Source: P. Artzt, D. Bets, W. Joas, Int. of Textile Technology and Process Engineering Denkendorf, Germany

Source: Zinser|Saurer Group

Spinning triangle

- A long spinning triangle implies a long weak point -more end breaks
- A short triangle represent a small weak point -fewer end breaks

  -if it is too short then the fibers on the edge must be strongly deflected to bind them in.

Yarn characteristics

- Low hairiness
- Better strength & elongation

  -Higher production speeds
- Uniformity/less Irregularities (thick & thin places and neps)

Technological advantages of compact yarns

- Higher resistance to sloughing in winding process
- Bobbin reduction
- Cost savings at the weaving preparation stage due to decrease in sizing liquor
- Uniform dyeing
- Higher quality of the final product (good fibre utilization, increased lustre or a clearly enhanced colour contrast)

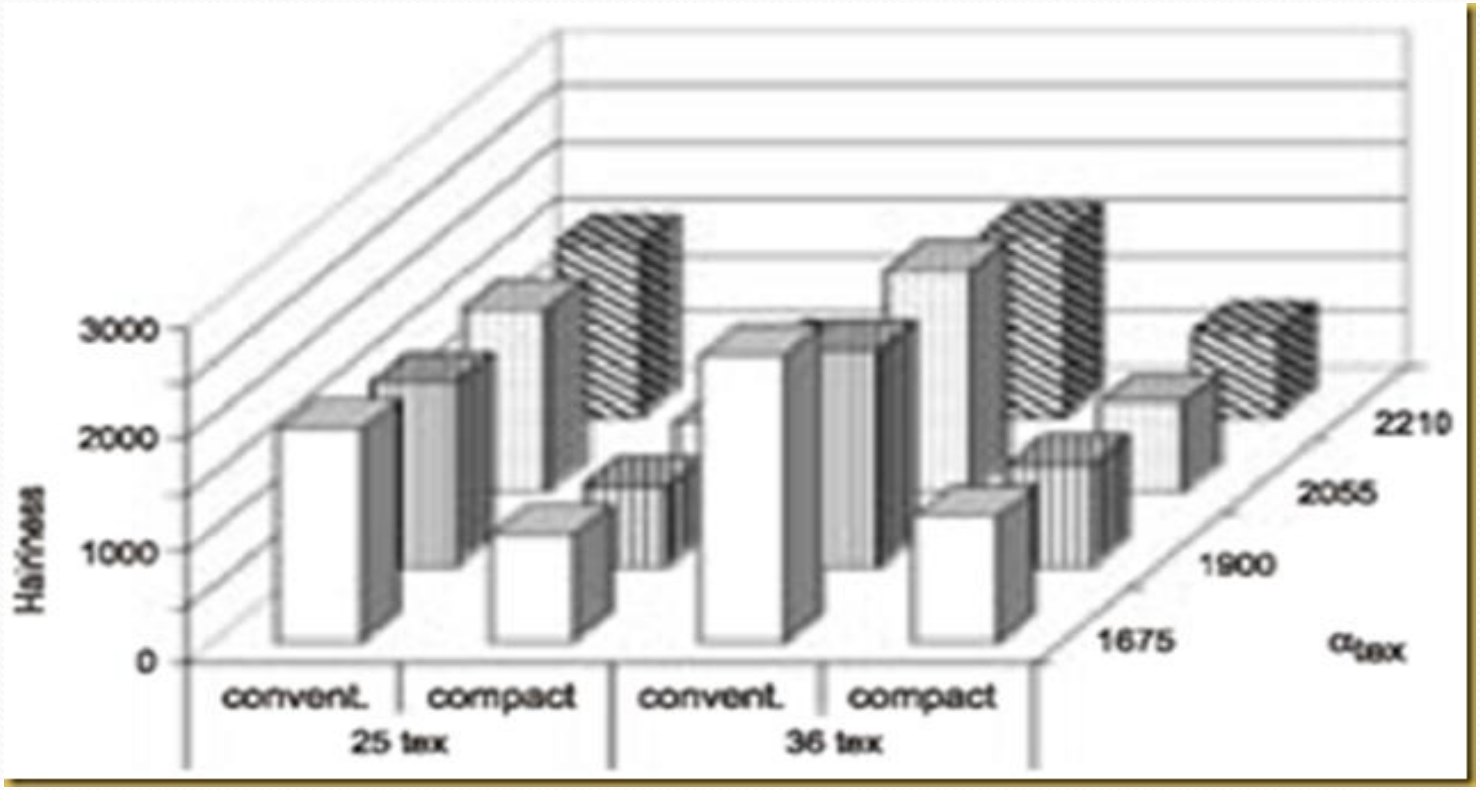
Compact Spinning for Long Staple Yarns

- High tenacity and elongation

  - higher than the conventional ones but at the high twist level, the elongation values of compact and conventional ring yarns are very similar

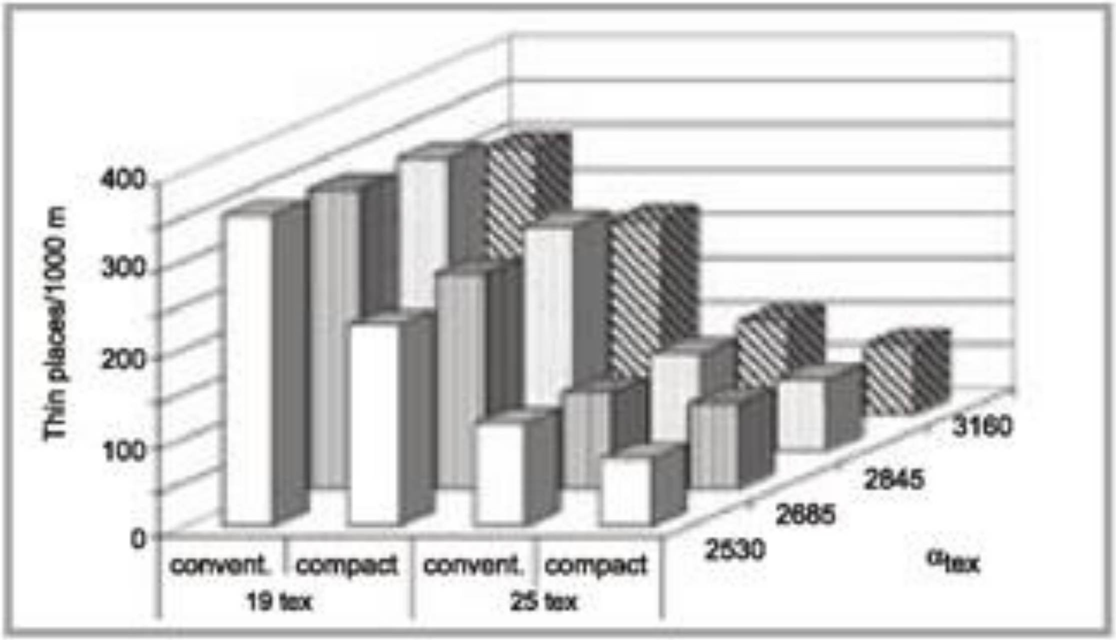
Hairiness

Very low, even for yarns with low twist levels for all material types



Thin places

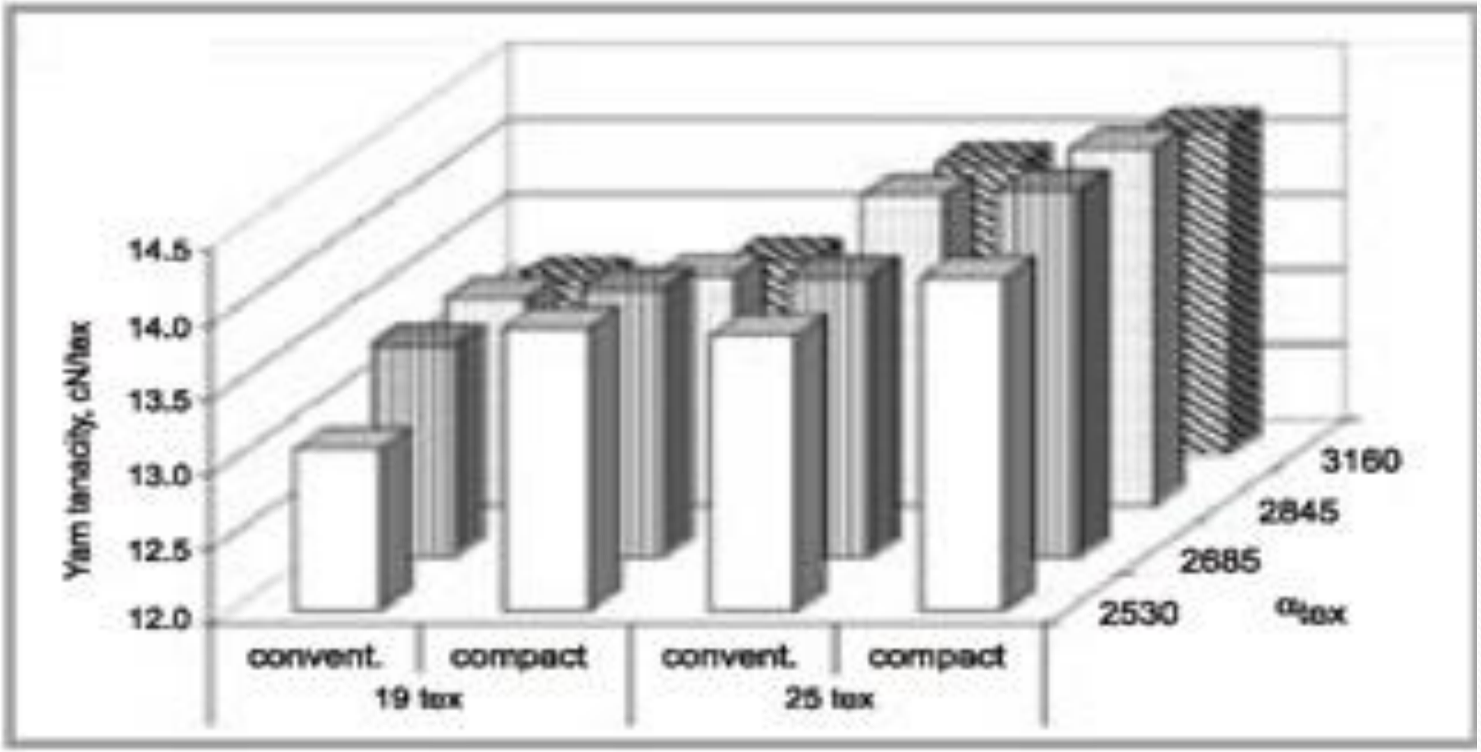
Statistically significant for only the fine yarn count



Thin places values of 100% wool yarns.

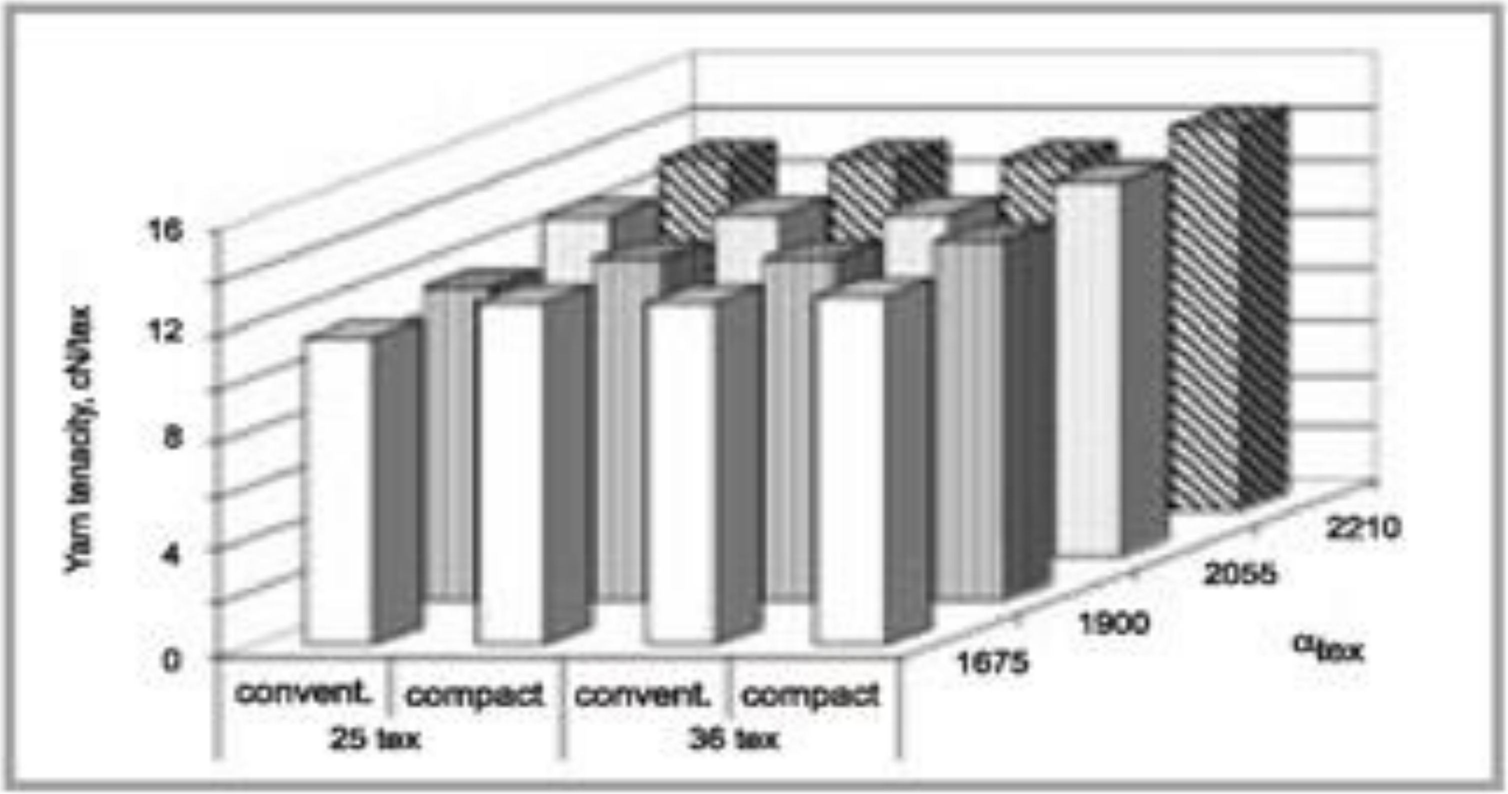
Yarn tenacity

Higher than the conventional but the difference of two systems changed according to the types of material



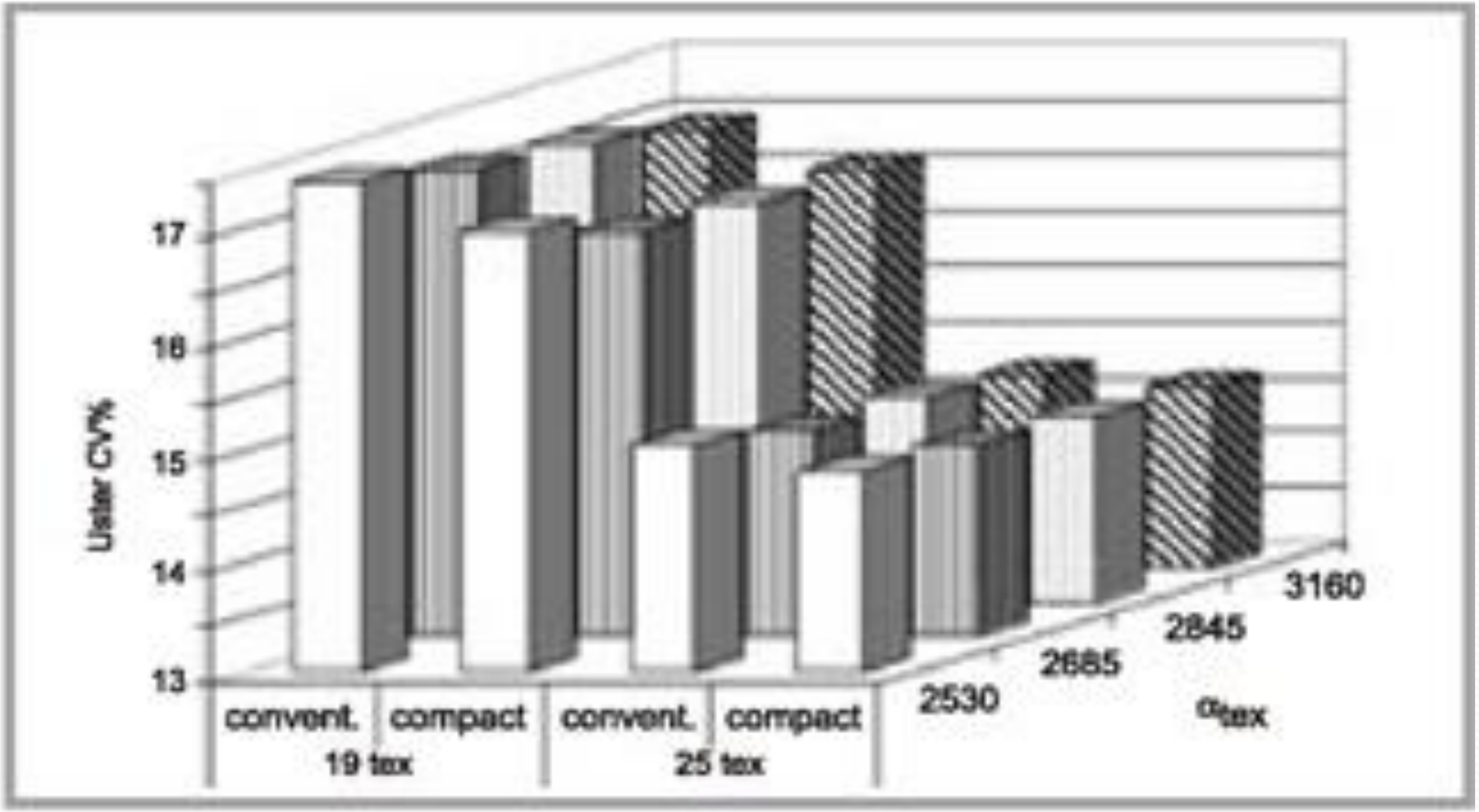
Yarn tenacity values of 45% wool/55% PET yarns.

Ctd..



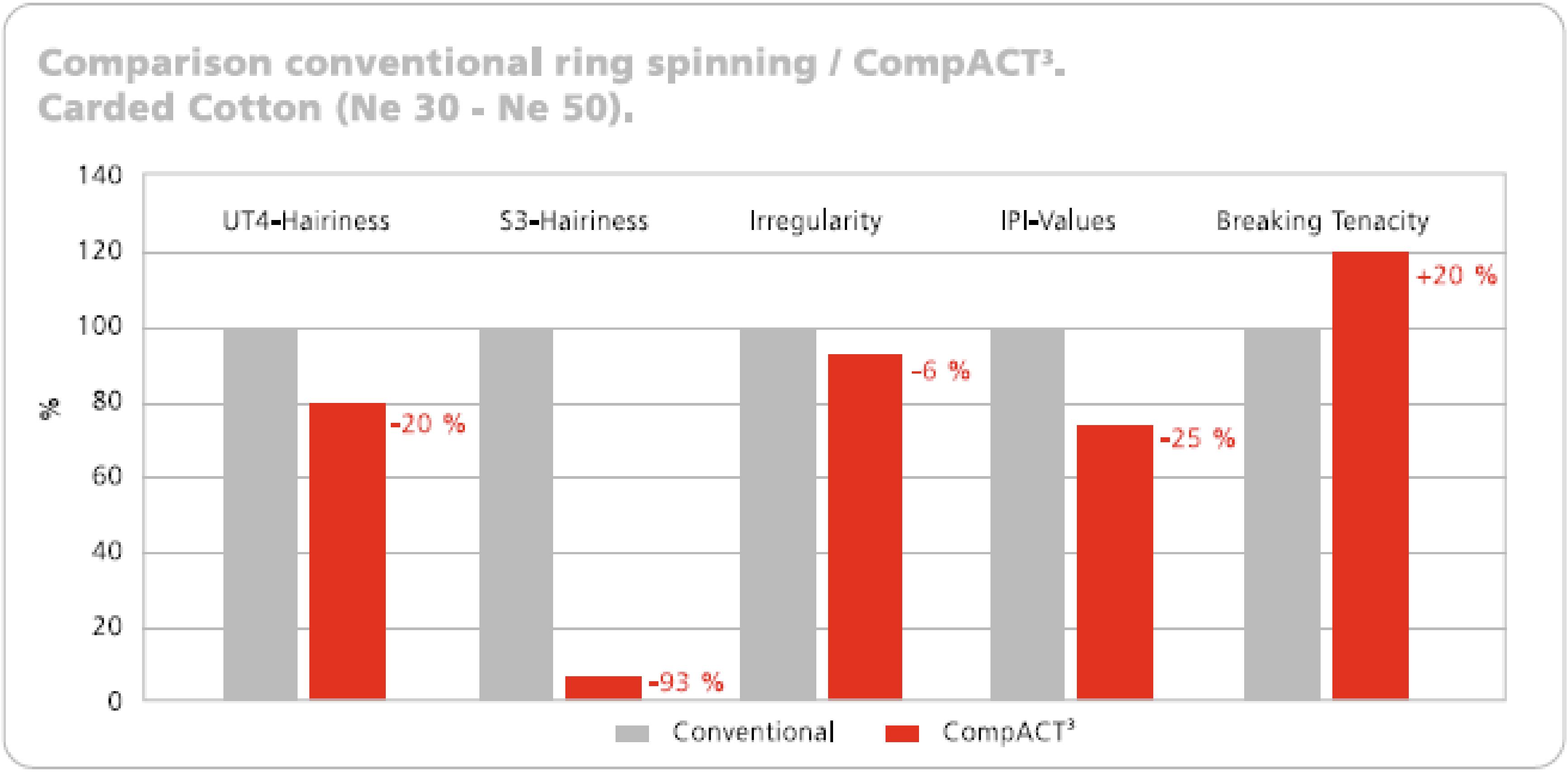
Yarn tenacity values of 100% PAN yarns.

Uster CV% values

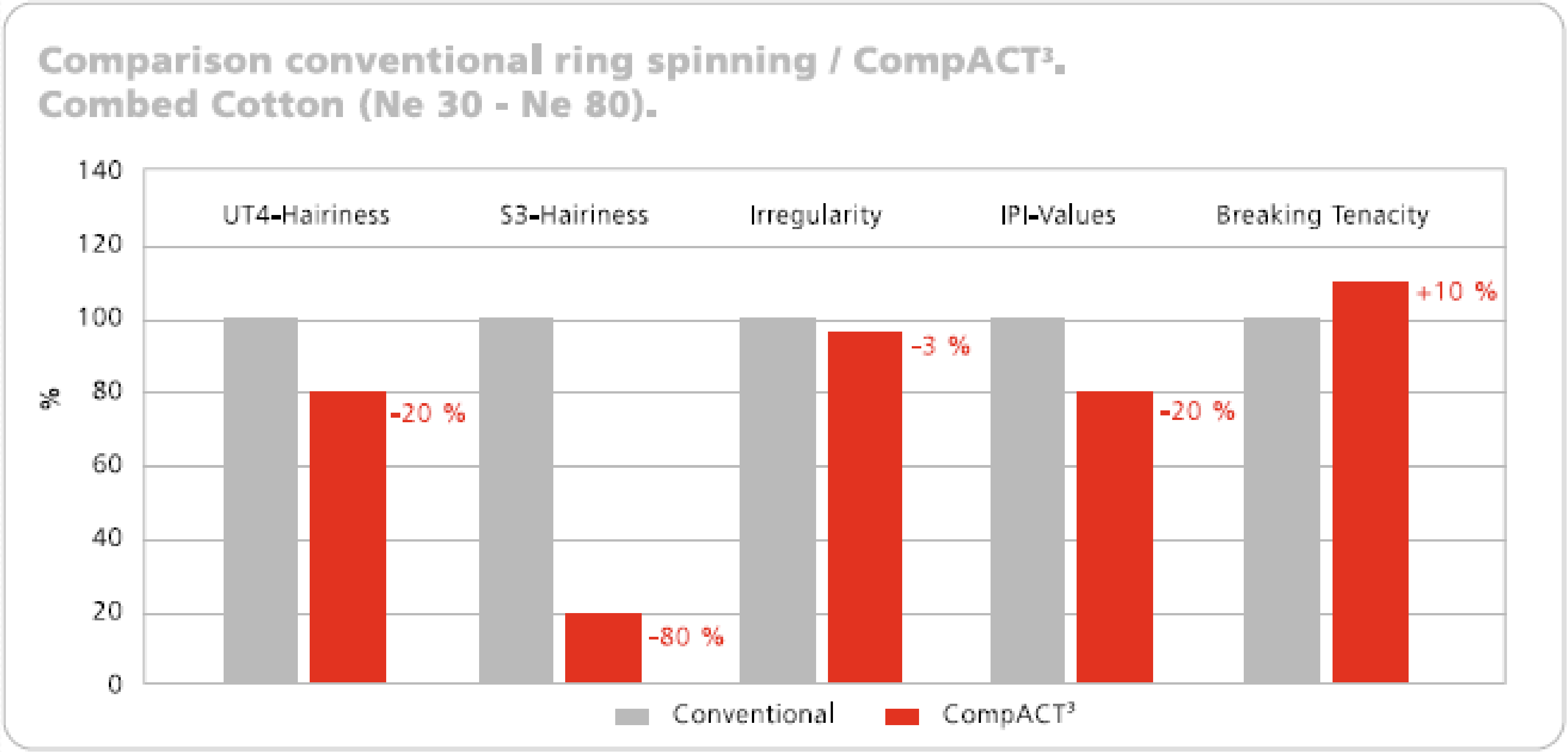


Uster CV% values of 45% wool/55% PET yarns.

Carded cotton



Combed Cotton



Future of compact spinning

Ring yarns which are spun on ring spinning frame without a spinning triangle, are unsurpassed in respect of their high strength and minimum hairiness

Development of Twin Air-jet Nozzle
System for Ring Spinning, to reduce hairiness

- Large scope of applications in air-jet
- Utility of the air- jet & ring combination, to reduce yarn hariness
- Still offer enough scope for further work
- Retaining of plus qualities of conventional rings spinning
- Combine the advantages of air-jet spinning system

Importance of reducing hairiness

- Yarn hairiness can be a problem in down stream processes
- Unevenness of the yarn
- Cause problems in fabric production stage. High yarn breakages etc..
- Appearance of yarns & ultimately in fabric appearance

Design & Development of Twin Air-jet Nozzle

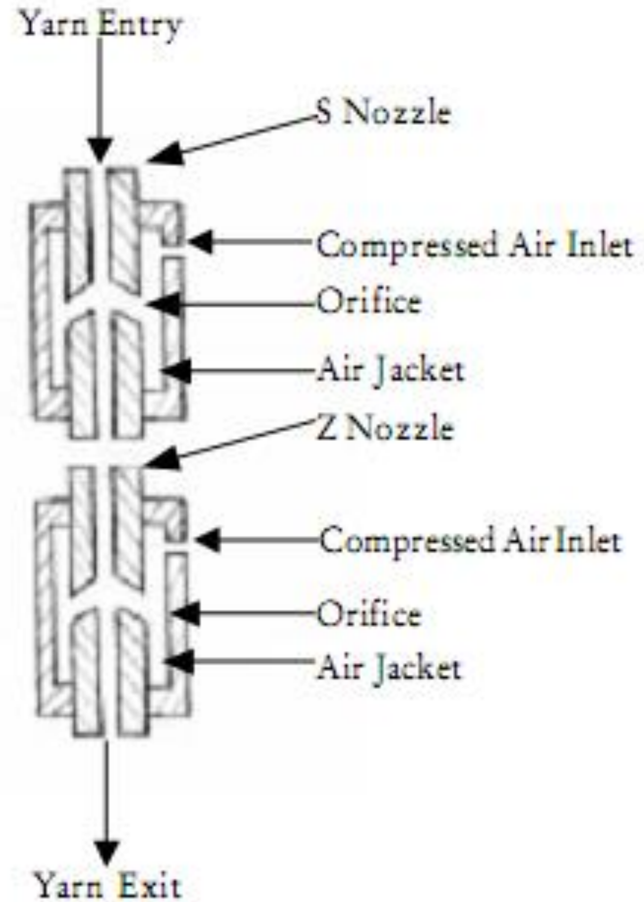
- Two Nozzles
  - <u>‘**S**’ nozzle</u>

    air vortex with rotational direction opposite to that of mechanical twist (given by ring & traveller)

  - <u>‘**Z**’ nozzle</u>

    air vortex with rotational direction same as that of mechanical twist (given by ring & traveller)

- Two nozzles with same dimensions but different directions of jet orifices
- Two nozzles are housed in air jacket in tandem



Twin air-jet nozzle arrangement

• Twin nozzle assembly is mounted in between the front roller nip & lappet hook in ring frame.

(Without altering spg angle)

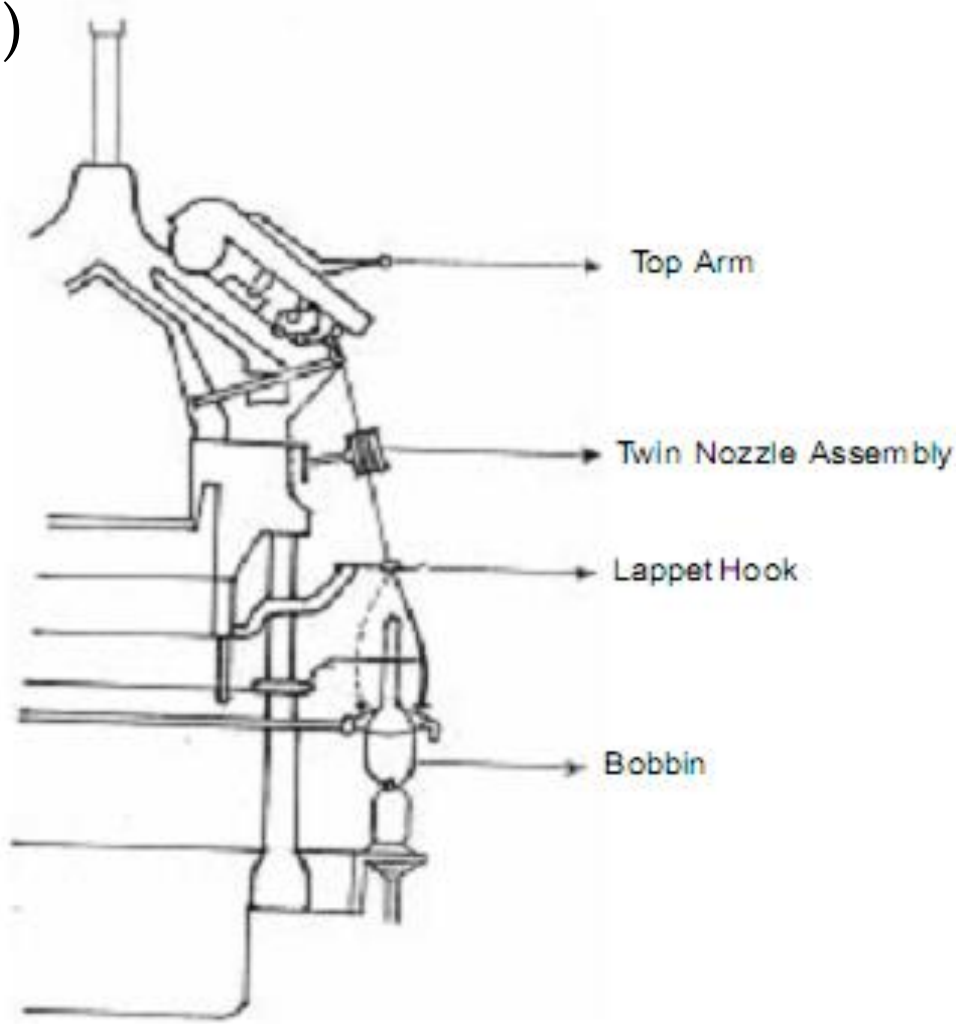


Figure 1 Twin air-jet nozzle arrangement for ring frame

- Compressed air was administered inside both the nozzles through air jackets
- Yarn emerge from drafting zone, passes though the twin nozzle
- Subjected to the action of opposing swirling air current created by vortex inside the nozzle

Trial conditions

- Spindle rpm – 14000
- Roving hank – 0.91
- Yarn count – 19.7 Tex(30 s')
  - carded cotton
- Twist direction of yarn – Z

Table 1 Air pressure combinations

Air Pressure in 'S' nozzle, bar	Air Pressure in 'Z' nozzle, bar
0.25	0.25
0.25	0.50
0.50	0.50
0.50	1.00

Results of the trials

- Number of results was obtained on various properties of ring spun yarn with & without air jet nozzle system

- Tenacity
- Elongation
- Evenness
- Hairiness
- Yarn quality index   etc....

Table 2 Properties of ring spun yarn and yarns spun with and without twin air-jet nozzle system

Properties	Parent Yarn	Air Pressure Combination			
		'S' Type Nozzle			
		0.25 bar	0.25 bar	0.50 bar	0.50 bar
		'Z' Type Nozzle			
		0.25 bar	0.50 bar	0.50 bar	1.0 bar
Yarn Count, Ne	30.2100	29.9200	29.9000	30.0300	30.5200
Yarn Twist, TPI	21.3300	21.1600	21.2520	21.3200	21.4800
Yarn Diameter, mm	0.2347	0.2013	0.1993	0.2205	0.2148
Tenacity, g/tex	19.9600	21.7600	23.4600	22.4500	20.5400
Elongation, %	6.8100	7.1800	7.0600	6.5200	6.6100
U, %	14.7700	15.5000	15.1600	14.9400	15.7200
Imperfections	—	—	—	—	—
Thin – 50%	91.0000	95.0000	91.0000	133.0000	183.0000
Thick + 50%	782.0000	767.0000	794.0000	749.0000	748.0000
Neps + 200%	794.0000	767.0000	828.0000	826.0000	855.0000
Hairiness Index	6.6300	6.4100	6.4700	6.8900	5.5800
Yarn Quality Index	9.2000	10.0800	10.9300	9.7900	8.6400
Packing Factor	0.3000	0.4091	0.4177	0.3397	0.3522

Effect of twin Air-jet system on Tensile properties

- 0.25 bar/0.5 bar combination have resulted the highest increase in Tenacity
- Except 0.5 bar/1.0bar combination, all others have a increase compared to yarn which was spun without jet arrangement.

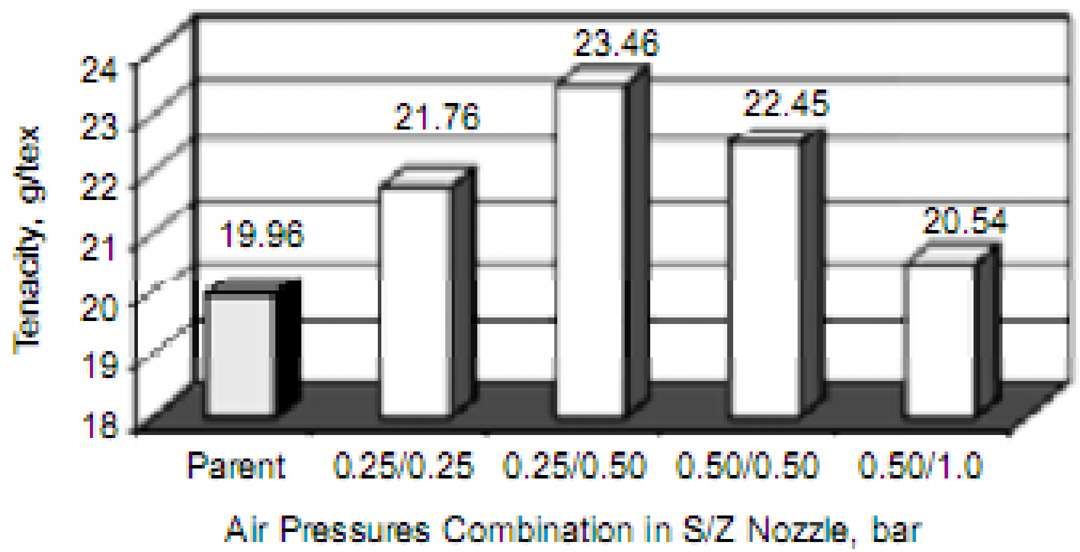


Figure 4 Effect of air pressure on tenacity

- Fibre strand leaves from roller nips, subjected to air vortex inside **'s'** nozzle. This vortex rotates the yarn opposite to yarn twist & moving opposite to the yarn flow direction.
- De-twist and loosen the structure.
- Then enters to the '**Z**' nozzle.
- This rotates same direction to yarn twist & moving opposite to the yarn flow direction.
- Loosened structure undergoes in Re-twist & get tightened.

Loosening & tightening up of the yarn structure results compaction of yarn.

This contribute to increase in yarn strength.

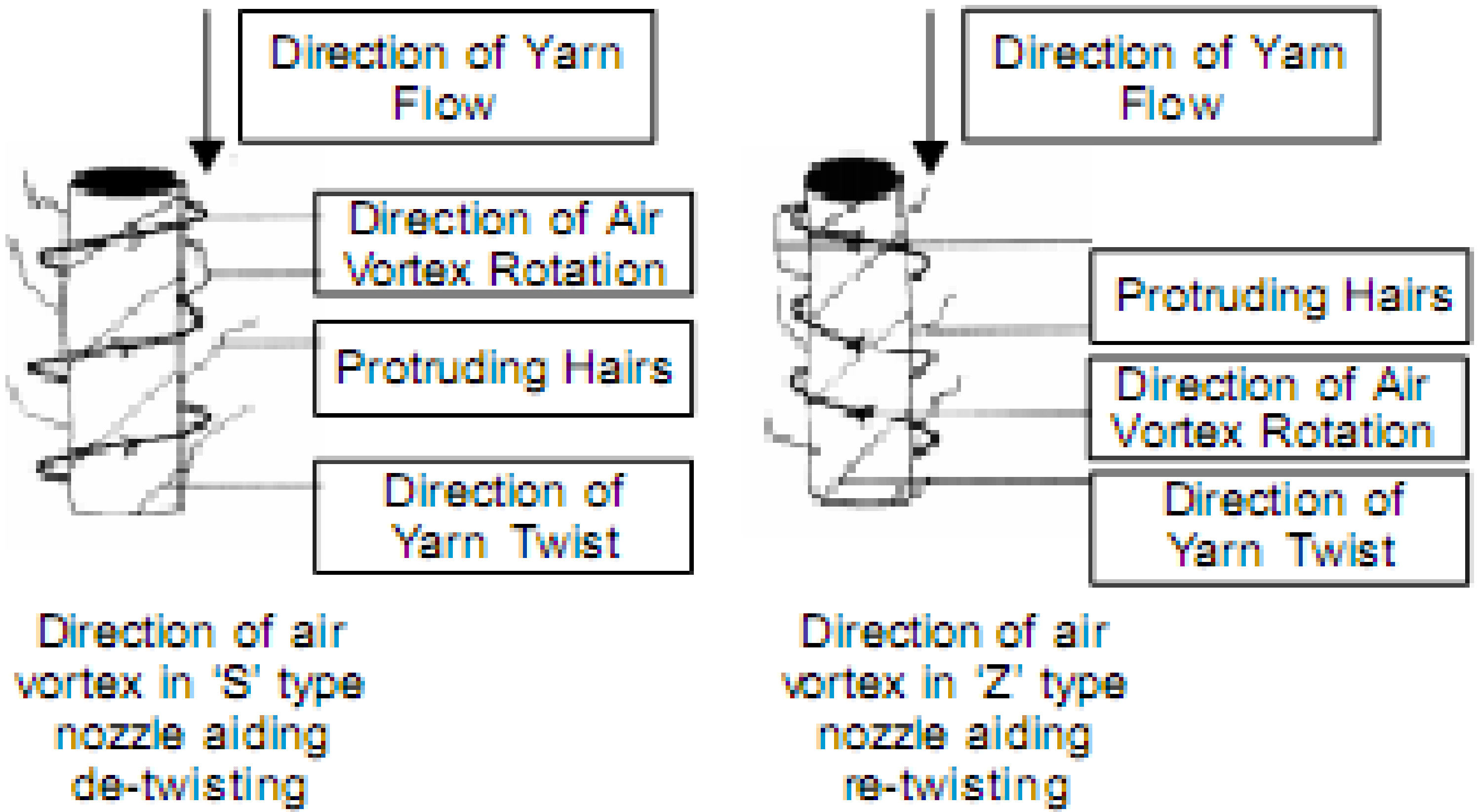


Figure 3 Direction of air vortex

Effect of twin Air-jet system on Hairiness of yarn

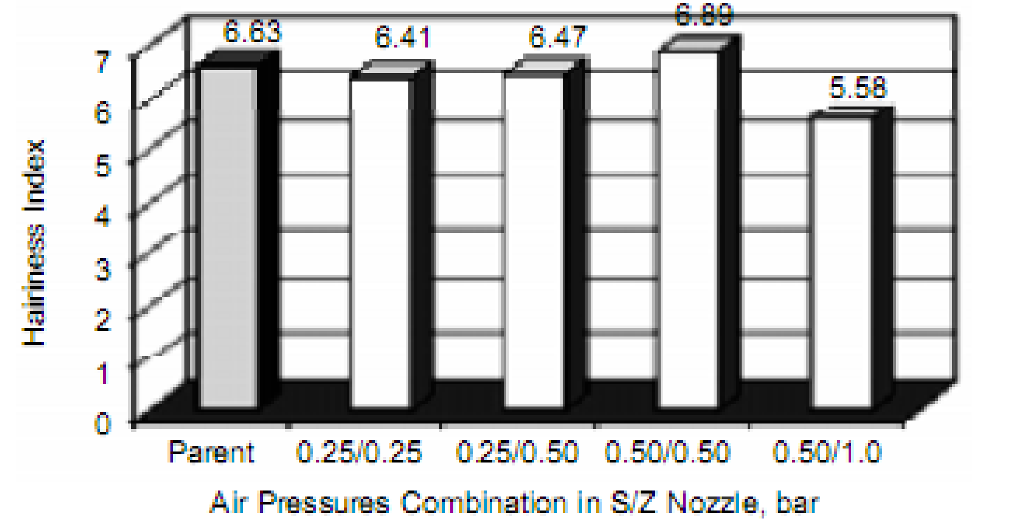


Figure 6 Effect of air pressure on hairiness index

- 0.5bar/1bar combination gives the lowest hairiness
- Due to the sweeping & binding action of the air vortex at 1 bar in Z nozzle.

Effect on other parameters

- Evenness – no significant variation.

  because evenness is mainly depend on drafting.
- Compaction – reduction of diameter, helps to increase the packing factor.
- Compaction of the yarn produced with jet system has contribute to the increase in tenacity.

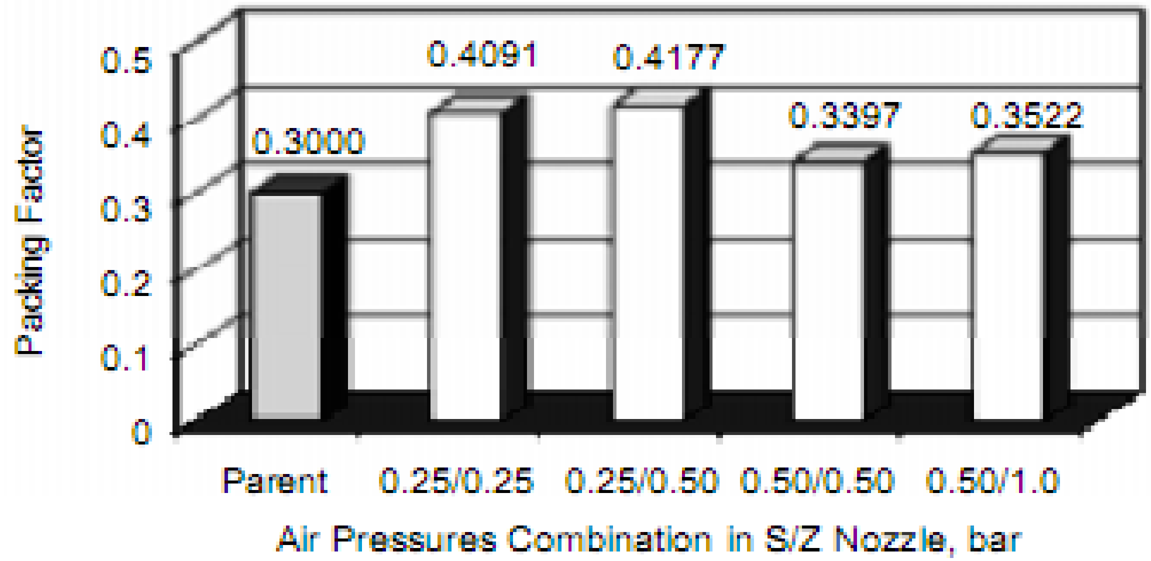


Figure 7 Effect of air pressure on packing factor

- Reduction of hairiness & increase of tenacity, compactness is explained by Tucking of fibres in to the core of the yarn due to swirling air current which resulted in loosening & tightening of yarn structure.

Automation in Ring Spinning

In these slides…

Following automation means used in Ring frame machine will be covered

-Ring Rail movement

-Motion to Drafting System

-Automatic Doffing

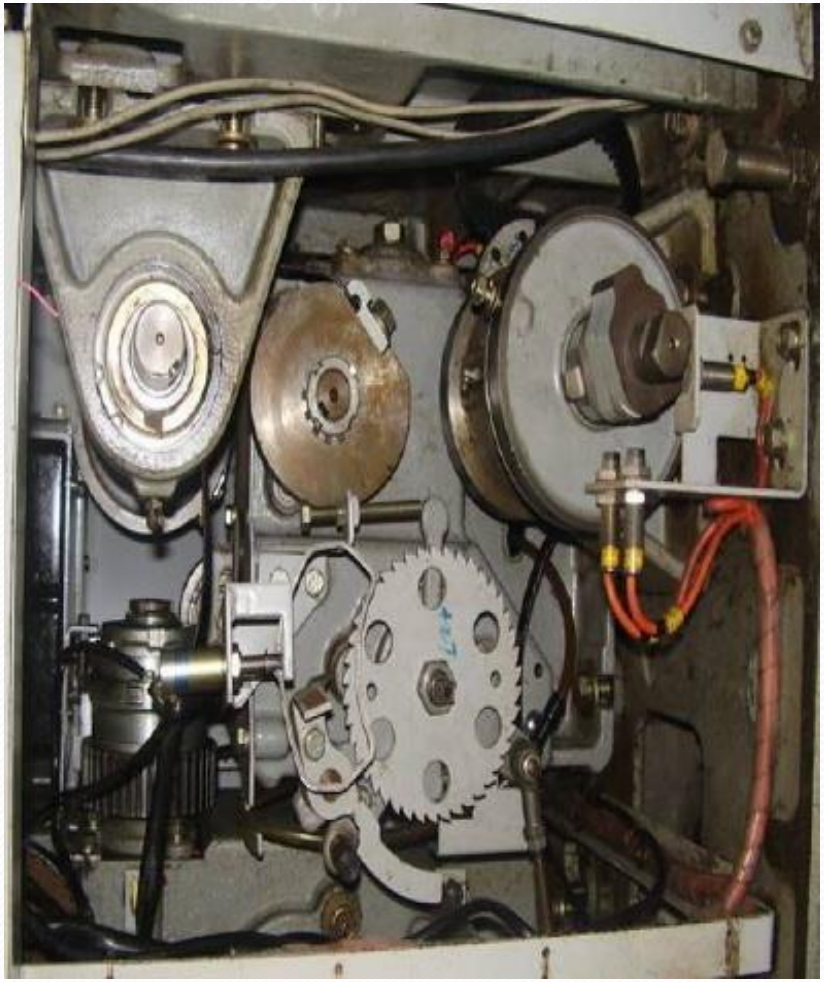
-Automatic Roving Transfer

-Online Quality Control

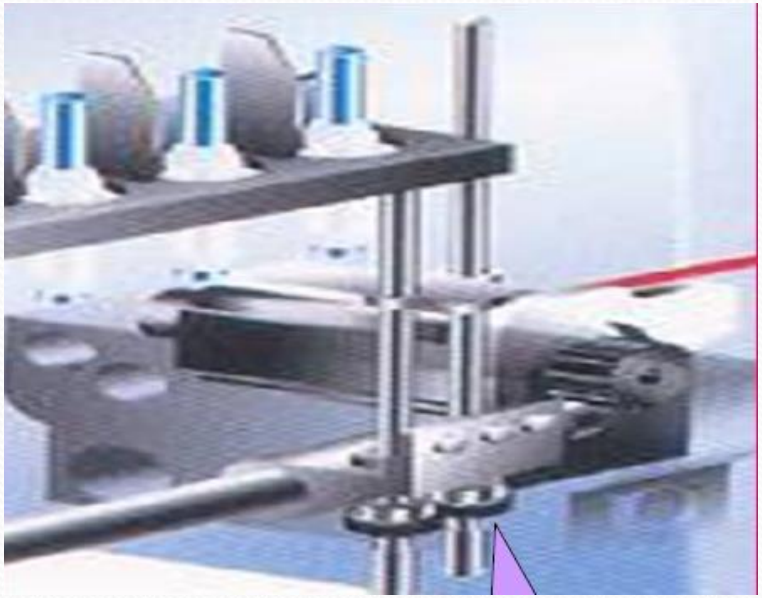
-Automatic Data Acquisition

Ring Rail movement

- In conventional system achieved by a complex CAM lift system



Ring Rail movement



New system

- Lifted by a servo drive with screw lifting system
- Setting alteration by key pad data entry.
- Assembly time reduces enhancing manufacturing capacities.

Motion to Drafting System

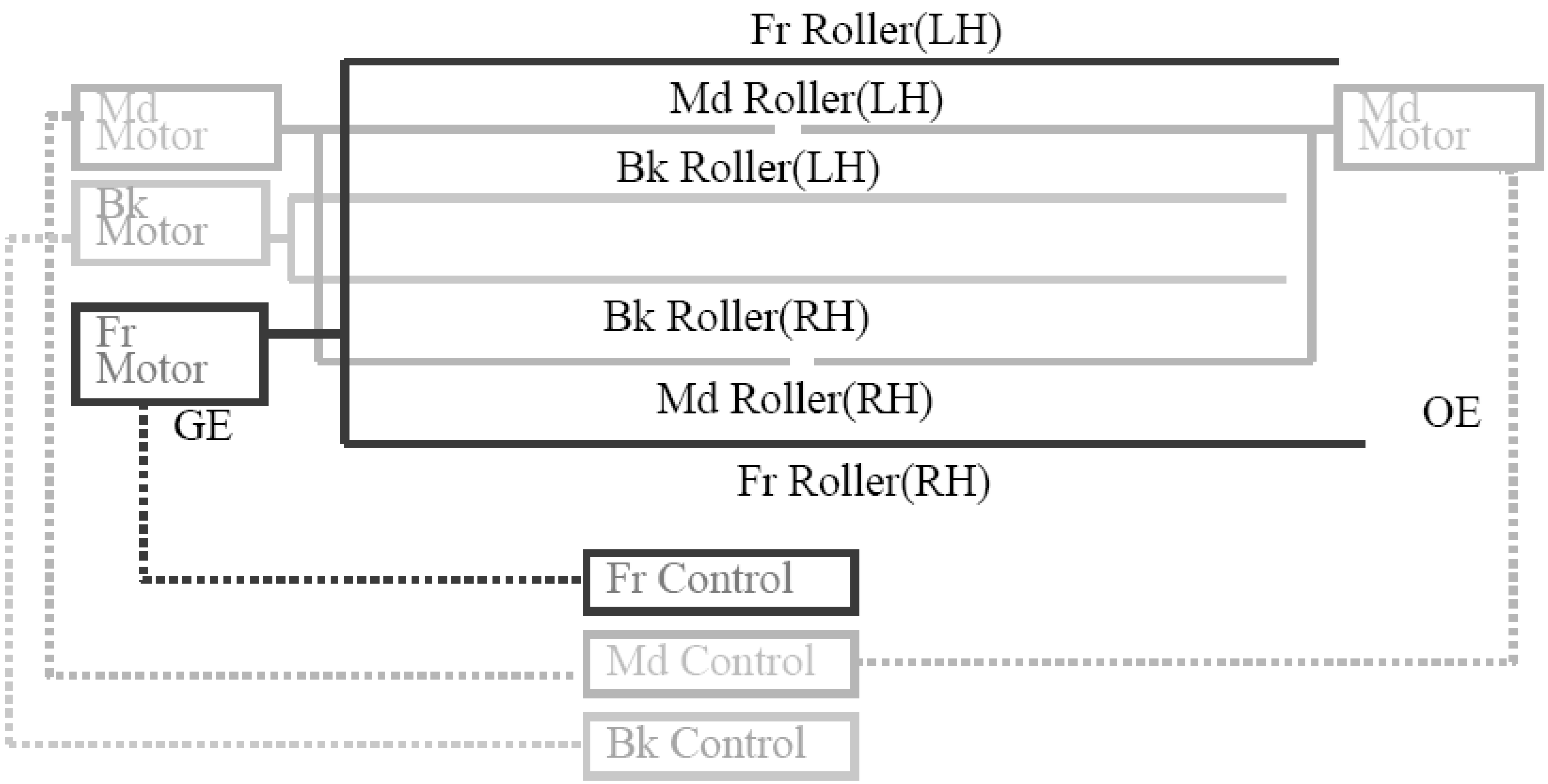
In conventional system

- All gear driven
- Difficulty with setting alteration
- Needs to change gears when some parameters to be changed

  e:g: Draft, Twist

New Automated Drafting System

Electro draft System



New Automated Drafting System

Features of New system

- All rollers driven by individual motors, controlled by individual drives.
- Possible to alter draft and twist from the key pad. Fine tuning of twist & draft adjustments possible.
- Interfacing & drive communication through Profibusand other types of protocols makes controls simple and very accurate.

Automatic Doffing

- Used to make the doffing function automated
- Has the main components

  -Doffing Beam Unit

  -Servo Disc Belt

  -ROBO DOFF unit

Automatic Doffing

How it
Happens?

-Full cops are gripped by the doffing unit and come down

Automatic Doffing

Full cops are placed on Servo disc belts & empty tubes are placed on spindles

Servo disc Belt to transport cops

Automatic Doffing

- The doffer transfers the full cops to the SERVO disc transport system, which conveys them either to the transfer station of the winder or to the fully automated ROBOload tube loader.
- The SERVO disc prevents tilting and thus ensure smooth transport, while the machine already resumes yarn production.

Automatic Doffing- "Robo Doff"

-Full packages are removed into a waiting container and empty tubes are fitted

-Has a transfer capacity of up to 32 cops per minute.

Automatic Roving Transfer

- Automatic Transfer of Roving Bobbins from Roving Frame to Ring Frame.

•No deterioration in Roving quality due to storage and handling.

•Better yarn quality.

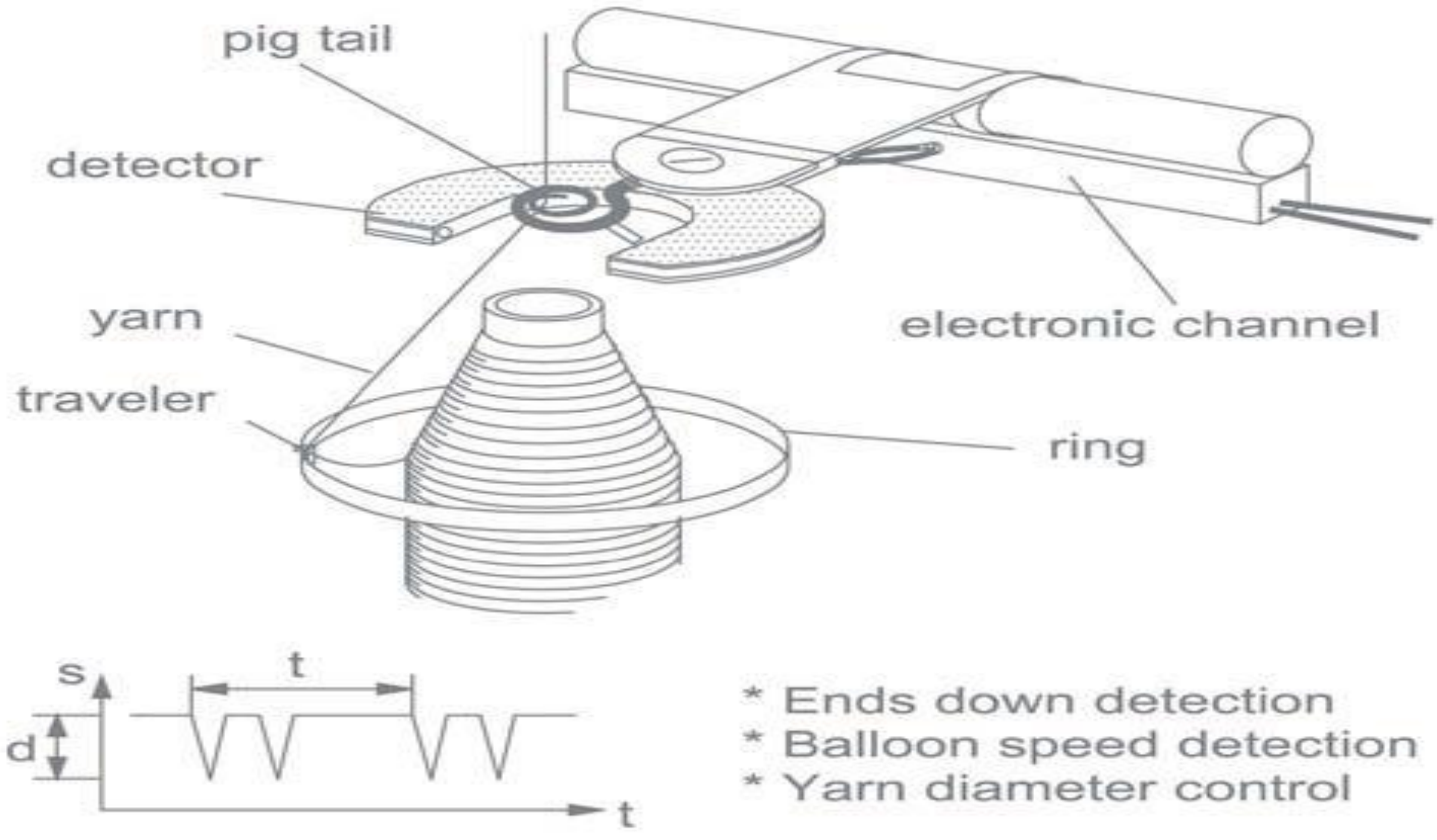
Online Quality Control

- Accurate recording of the spindle speed and real-time detection of yarn breakages.
- The stops are always assigned to the correct spindle automatically
- All sensors are connected to a PC-based central unit.
- All information concerning production, efficiency, ends down and slipping spindles is available on the display

Online Quality Control

- Individual Spindle Monitoring (ISM)
- Each & every spindle is monitored and controlled
- Sensor per each spindle and detects whether runs, slipper spindle or ends down spindle

Online Quality Control



* Ends down detection
* Balloon speed detection
* Yarn diameter control

Online Quality Control

- This sensor has a photo receiver facing a light emitting diode. During each revolution, the yarn balloon interrupts the light beam twice.
- The time between two successive interruptions serves as the basis for the calculation of the balloon speed, while the amount of light obstructed during the interruption is used as a rough diameter measure

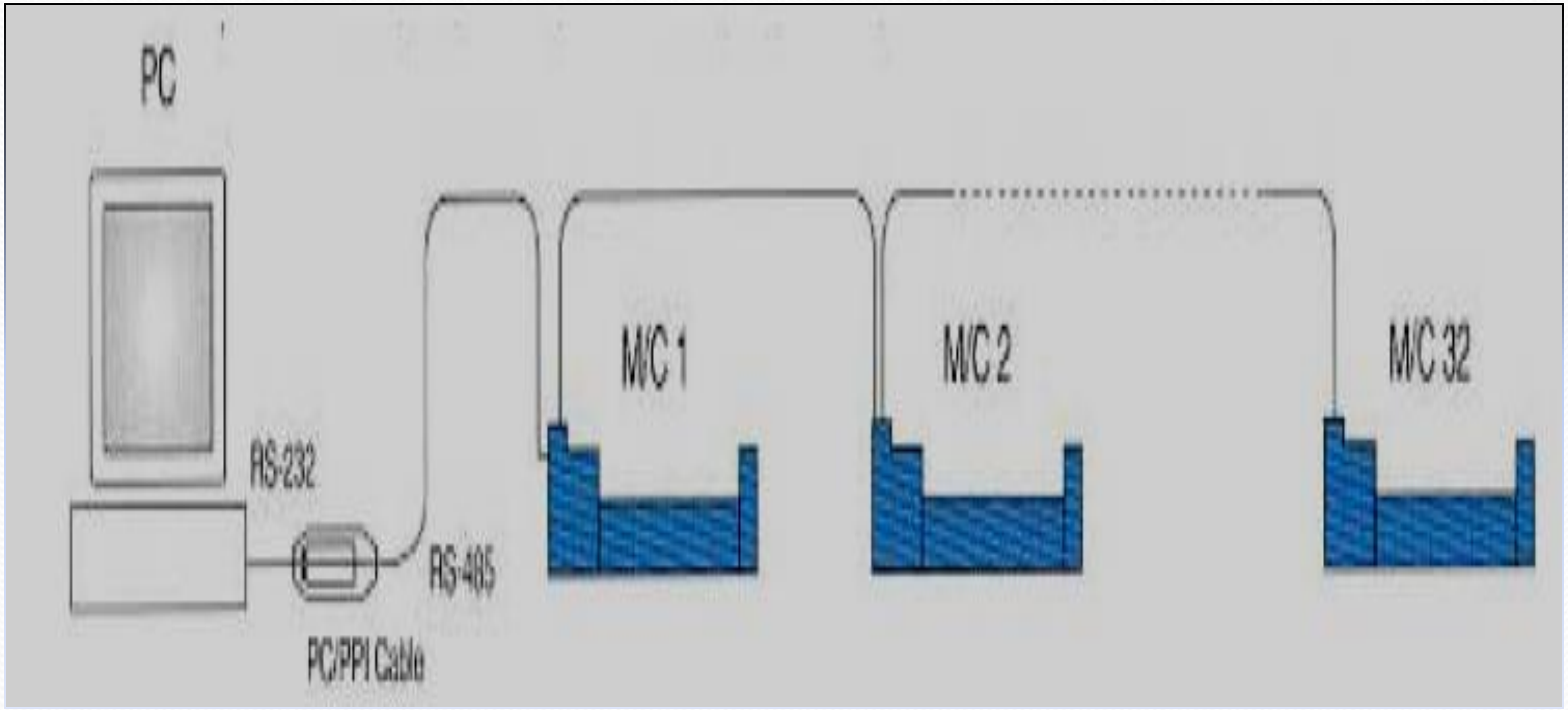
Online Quality Control

- All sensors on one machine are connected to the SCU(Sensor Control Unit).
- This unit offers a touch screen Windows-based user interface, USB interface and Ethernet connection which are used to monitor the progress of spinning

Online Quality Control

- Display of Monitoring…

Automatic Data Acquisition

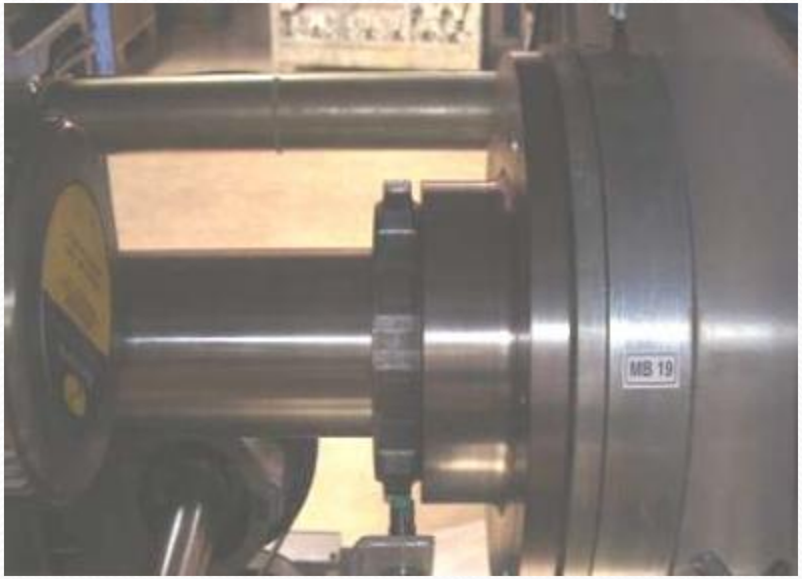


Automatic Data Acquisition

All machines are connected to a Central computer.

- Two way communication between the Computer and Machine can be established.
- Possible to change the speed parameters from the Computer.
- On line monitoring of the machine status.
- Data acquired can be converted to production report.

Machine Brake



In conventional type,
Brake is required on Ring Frame to prevent snarl formation while stopping the machine.

•Conventional system uses electro magnetic or mechanical brakes.

In new systems…
•DC Injection brake from main inverter.
•Optimum braking time by varying the parameters.
•Elimination of all mechanical parts which require frequent resetting.