New Developments in Ring Spinning
Group

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A yarn is a constructed assemblage of textile fibers which acts as a unit in fabric formation.
Classification of spun yarn
<table>
<thead>
<tr>
<th>Group</th>
<th>Sub group</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous filament yams</td>
<td>Untextured (flat)</td>
<td>Twisted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interlaced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tape</td>
</tr>
<tr>
<td></td>
<td>Textured</td>
<td>False twisted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stuffer box crimped</td>
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<tr>
<td></td>
<td></td>
<td>Bi-component</td>
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<tr>
<td></td>
<td></td>
<td>Air-jet</td>
</tr>
<tr>
<td>Staple spun yams</td>
<td>Noneffect/plain (unconventional)</td>
<td>Rotor spun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compact-ring spun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air-jet spun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Friction spun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hollow-spindle wrap spun</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repco</td>
</tr>
<tr>
<td></td>
<td>Fiber blend</td>
<td>Blend of two or more fiber types comprising noneffect yams</td>
</tr>
<tr>
<td></td>
<td>Effect/fancy</td>
<td>Fancy twisted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hollow-spindle fancy yam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spun effects</td>
</tr>
<tr>
<td>Composite yams</td>
<td>Filament core</td>
<td>Core spun (filament or staple fibers forming the core) and staple fibers as the sheath of a noneffect staple yam</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Staple core</td>
<td>Filament staple</td>
<td>Two or more yams twisted together</td>
</tr>
</tbody>
</table>
BASIC SEQUENCE TO GARMENTS

Spinning

CHOICE OF FIBER  
(Natural, Manufactured, or Blends)  
Criteria: Softness, Easy Care, etc.

YARN STRUCTURE  
(Plain, Fancy, Plied)

FABRIC STRUCTURE  
(Weave: Plain, Twill, etc.)  
(Knit: Single or Double Jersey, etc.)

Fully Fashioned

Finished Fabric  
(Cotton, Worsted, Woolen, etc.)

GARMENT PRODUCTION
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

\[
\tan \alpha = \pi \times d \times t
\]

\(\alpha\) - 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
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
<table>
<thead>
<tr>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single yarn</td>
<td>Spun yarn or Filament yarn</td>
</tr>
<tr>
<td>Multiple wound yarn</td>
<td>Two or more components no twisting operation similar or dissimilar components</td>
</tr>
<tr>
<td>Folded (plied yarn)</td>
<td>Two or more components one twisting operation similar or dissimilar components</td>
</tr>
<tr>
<td>Cabled yarn</td>
<td>Two or more components more than one twisting operation similar or dissimilar components</td>
</tr>
</tbody>
</table>
Plied yarns and their effects on the fabric

Plying two unbalanced yarns will provide a surface variation and creates an effect on the surface of the fabric.
Y axis – Wave height

X axis – Count of thinner yarn
Count of thicker yarn

(b) Relation wave height and A of plied yarns

Fig. 2 Morphology of plied yarns.

(●: C/EF250; ×: C/EF150; ○: C/C)
Carded ring spun yarns

- Blow room
- Carding
- Drawing
- Roving
- Spinning
- Winding
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.

Therefore conversion of drafting is given a high priority in the efforts to upgrade a Ring Frame and the payback from such investments is attractive.
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 drafting

Top arm drafting

1\textsuperscript{st} generation

2\textsuperscript{nd} generation
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 breakthrough 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.
Advantages of the Top arm system

• Self-alignment of top roller in relation to bottom roller results in 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
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
Perforated apron

Suction

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.
Coefficient of friction ($\mu$)

<table>
<thead>
<tr>
<th>Traveller weight (mg)</th>
<th>40</th>
<th>35.5</th>
<th>31.5</th>
<th>28</th>
</tr>
</thead>
</table>

Traveller friction

<table>
<thead>
<tr>
<th>Traveller friction</th>
<th>350</th>
<th>300</th>
<th>250</th>
<th>200</th>
<th>150</th>
<th>100</th>
</tr>
</thead>
</table>

Coefficient of friction ($\mu$)

<table>
<thead>
<tr>
<th>Coefficient of friction ($\mu$)</th>
<th>0.08</th>
<th>0.09</th>
<th>0.10</th>
<th>0.11</th>
<th>0.12</th>
</tr>
</thead>
</table>

mN
Wire sections

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

- Used only for cotton
- Improves the traveller lubrication

- For synthetics and blends.
- Prevents fibre damage.

Flat

Half round
- **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.
PYRIT

PYRIT treated travellers have an 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.
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.

The special features of the *Orbit System* are

- 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 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 through 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.
FIG. 14
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: Zinse|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
Yarn tenacity

Higher than the conventional but the difference of two systems changed according to the types of material.
Yarn tenacity values of 100% PAN yarns.
Uster CV% values

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

Comparison conventional ring spinning / CompACT³. Carded Cotton (Ne 30 - Ne 50).
Combed Cotton

Comparison conventional ring spinning / CompACT³. Combed Cotton (Ne 30 - Ne 80).

- UT4-Hairiness: -20%
- S3-Hairiness: -80%
- Irregularity: -3%
- IPI-Values: -20%
- Breaking Tenacity: +10%
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 harshness
- 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 downstream 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
  - ‘S’ nozzle
    - air vortex with rotational direction opposite to that of mechanical twist (given by ring & traveller)
  - ‘Z’ nozzle
    - 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 nozzle assembly is mounted in between the front roller nip & lappet hook in ring frame. (Without altering spg angle)
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

<table>
<thead>
<tr>
<th>Air Pressure in ‘S’ nozzle, bar</th>
<th>Air Pressure in ‘Z’ nozzle, bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Properties</th>
<th>Parent Yarn</th>
<th>Air Pressure Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>'S' Type Nozzle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.25 bar</td>
</tr>
<tr>
<td>Yarn Count, Ne</td>
<td>30.2100</td>
<td>29.9200</td>
</tr>
<tr>
<td>Yarn Diameter, mm</td>
<td>0.2347</td>
<td>0.2013</td>
</tr>
<tr>
<td>Tenacity, g/tex</td>
<td>19.9600</td>
<td>21.7600</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>6.8100</td>
<td>7.1800</td>
</tr>
<tr>
<td>U, %</td>
<td>14.7700</td>
<td>15.5000</td>
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<tr>
<td>Imperfections</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Thin - 50%</td>
<td>91.0000</td>
<td>95.0000</td>
</tr>
<tr>
<td>Thick + 50%</td>
<td>782.0000</td>
<td>767.0000</td>
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<tr>
<td>Neps + 200%</td>
<td>794.0000</td>
<td>767.0000</td>
</tr>
<tr>
<td>Hairiness Index</td>
<td>6.6300</td>
<td>6.4100</td>
</tr>
<tr>
<td>Packing Factor</td>
<td>0.3000</td>
<td>0.4091</td>
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</table>
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/1.0 bar combination, all others have an increase compared to yarn which was spun without jet arrangement.

![Bar chart showing the effect of air pressure on tenacity.](image)
• 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

- 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.
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 Profibus and 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

- Pig tail
- Detector
- Yarn
- Traveler
- Electronic channel
- Ring

* 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.
Questions ???
Thank you