Ring Spinning

The ring spinning machine was invented by an American named Thorp in 1828, and Jenk – another American – added the traveler rotating around the ring in 1830. In the intervening period of more than 180 years the ring spinning machine has undergone considerable modification in detail, but the basic concept has remained the same. For many years any noteworthy further development hardly seemed possible, yet a significant process of evolution took place during this time. The productivity of the ring spinning machine has increased by 40% since the late nineteen-seventies. This has been achieved by:

- using smaller rings and cop formats
- introducing piecing in the winding department
- substantial improvements in rings and travelers.
The ring spinning machine will continue to be the most widely used spinning process in short staple spinning, since it has considerable advantages over the new spinning processes:

- it can be used universally, i.e. any material and any yarn count can be spun on it
- it produces yarn with optimum properties (especially as regards structure and tenacity)
- it is uncomplicated and easy to control
- know-how for handling the machine is old, well established and accessible to everyone
- it is flexible with regard to volume (blend and batch sizes).

Cost structure in a typical ring spinning mill

- 60% Ring spinning
- 12% Roving
- 4% Drawing
- 13% Carding
- 11% Blowroom
Improvements can be achieved primarily by:

- further development of rings and travelers
- using automated take-off devices (doffers)
- reducing the ring diameter, which enables the rotation speed of the spindle to be increased while traveler speed remains unchanged.

For example, cost savings of some 7 US cents/kg of yarn are achieved by using a 42 mm ring instead of a 48 mm ring, despite a slight decline in efficiency. However, reductions in ring diameter presuppose the use of doffers on the ring spinning machine (except when wage costs are very low) and piecers on the winder. The slub-free length is then of little importance.

- increasing machine length, which reduces the machine price
- reducing ends down frequency, in which the new data collection systems and new drive systems can be of great assistance
- improving roving quality, since the causes of at least 50% of all ends down on the ring spinning machine are to be found in the preparatory machines
- combining the ring spinning machine and the automatic winder into a production unit
- roving stop motions, primarily for reducing waste and preventing laps; they could perhaps enable operations to be maintained with fewer personnel during certain working periods
- automation in the fields of roving bobbin transport and roving bobbin change.
The ring spinning machine has to:

- draw the roving to its final count in the drafting system
- impart tenacity to the bundle of fibers by twisting it, and
- wind up the resulting yarn in a suitable form for storage, transport and downstream processing.

Operating principle
Key:
1 = Roving bobbin creel
2 = Drafting system
3 = Ring rails and spindles
4 = ROBOdisc
5 = SERVODisc
6 = SERVODisc drive
7 = Ring rail drive
8 = Drafting system drive right-hand side
9 = Drafting system drive left-hand side
10 = Beacon
11 = Rod for travelling cleaner
The drafting system

If an assessment is based on quality alone, the drafting system is the most important part of the machine. It primarily influences the uniformity and tenacity of the yarns. The following aspects are therefore very important:

- the type of drafting system;
- its design;
- precise settings;
- choice of the correct components;
- choice of the correct drafts;
- maintenance and servicing, etc.
Influence on quality and economy

The upper limits for drafting:

- carded cotton yarn up to 40
- carded yarn blends up to 50
- combed cotton and blended yarns
  - medium counts up to 60
  - fine counts up to 70
  - man-made fibers up to 45 (- 50).

The drafting system
Cover hardness

soft: 60°-70° Shore
medium hard: 70°-90° Shore
hard: over 90° Shore

Covers with approx. 80°-85° Shore are usually used on the back rollers and 63°-67° Shore on the front rollers. Harder covers are also chosen at the front, i.e. at the delivery end, for coarser yarns and manmade fiber yarns due to wear (also due to the higher tendency to lap formation in the case of man-made fibers). Since the covers wear, they have to be ground on special grinding machines from time to time (after some 3 000 - 4 500 operating hours). The reduction in diameter should be some 0.2 mm, and the covers should never be ground to a total thickness of less than 3.5 mm.
Drafting system settings: *HI* Instruction G0002
Drafting system load: pneumatic
Cage lengths «A» in mm: 36.43 or 59

Diameter of rollers:

<table>
<thead>
<tr>
<th>Bottom roller</th>
<th>Top roller</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐ novo</td>
</tr>
<tr>
<td>B 27 mm</td>
<td>30 mm</td>
</tr>
<tr>
<td>C 27 mm</td>
<td>27 mm</td>
</tr>
<tr>
<td>D 27 mm</td>
<td>30 mm</td>
</tr>
</tbody>
</table>
Pressure arm with pneumatic loading
(Rieter FS 160 P 3.1)
Spindle drive

A basic distinction is made between three groups of spindle drive:

- tape drive
- tangential belt drive
- direct drive

Tape drive is in turn sub-divided into:

- individual spindle drive
- group drive

and direct drive into:

- mechanical
- motorized direct drive.
Marzoli RST-1 spindle drive

Zinser 351 spindle drive

Thread guide
Balloon checking ring

The separators
Requirements for optimum results

**Thread guide**
- Distance top of the tube/thread guide = 1.5 to 2x tube Ø (ring rail position at starting position)

**Anti-ballooning ring**
- Anti-ballooning ring Ø = ring Ø + 2mm
- Distance ring rail/Anti-ballooning ring (ring rail position in starting position) = 2/3 of the distance ring rail/thread guide

**Spinning ring**
- Spinning ring Ø: max 1/5 of the tube length (exception Core Yarns) see chart below
- Horizontal, firm fixation of the rings in the ring rail.
- Correct setting of the traveller cleaner (see

The importance of ring and traveler

The ring traveler is in most cases responsible for the limitation of the ring spinning machine's productivity, depending on the interaction of ring, traveler and yarn. It is therefore important for the specialist to be aware of the influencing factors and to act in accordance with this knowledge. Optimum running conditions depend on:

- ring and traveler material
- surface finish of the components
- the shape of both components
- coordination of the shapes
- wear resistance
- smooth running
- running in procedure
- fiber lubrication
The requirements for a good ring:

- the best possible raw material as starting material
- good, but not excessive surface smoothness
- flat surface
- precise ring roundness
- good, uniform surface hardness, higher than that of the traveler
- perfectly run-in rings (optimum running-in conditions)
- long service life
- correct ratio of ring diameter to tube diameter (2:1 to 2.2:1)
- exact horizontal position
- exactly centered relative to the spindle.

The ring material

High hardness of the boundary layer of about 800-850 HV* is required for the ring. A lower hardness (650-700 HV) should be chosen for the traveler, so that the traveler, which is less expensive and easier to replace, wears rather than the ring.

Surface smoothness is also important. It should be high, but not too high, otherwise a lubricating film cannot form.

The following materials are used:

- case hardening steel in some cases
- nitride steel
- ball bearing steel; this is currently the customary ring material.

* Vickers hardness test
Modern rings usually feature a surface coating. The object of such coatings is:
- to reduce friction,
- to reduce wear,
- to prevent corrosion and
- to simplify running-in the ring.

Coatings used include:
- oxides
- nitriding
- carbonitriding
- hard chrome
- nickel
- ceramics

Ring profiles

![Ring profiles](image-url)
Ring shapes
According to ring spinning machine (fixing methods)

Height 8 mm
12 mm
18 (19) mm

Fixing methods

Assembly Group
Zinser 351, Chinese ring spinning machines.

Assembly with metal foot (black)
Chinese ring spinning machines.

Assembly with Alu-holder
Circul Position
Zinser, Toyota, KTM
Designation of the ring parts

A  Inner diameter
B  Fitting diameter
C  Shoulder diameter
    (largest outer diameter)
D  Ring height
D1 Height above ring rail
D2 Height below ring rail
E  Flange (see page 55)
F  Flange width
G  Flange crown
H  Outer flange radius
I  Raceway of ring
K  Web
L  Shoulder
M  Slot for circlip
Fiber lubrication on the ring

Metal/metal friction would probably limit traveler speed to about 28-30 m/s. However, the traveler moves on a lubricant film it has created itself, consisting primarily of fiber abrasion waste. If fiber particles are caught between the ring and the traveler at high speeds and correspondingly high centrifugal forces, they are partially crushed by the traveler. It compresses them as small, colorlessly translucent lamina several \( \mu \text{m} \) thick into a solid running surface. These lamina adhere very differently to the ring and within the lubricant film, and are therefore repeatedly stripped off, but also renewed again.

The position, form and structure of the lubricant film depends on many factors, such as yarn count, yarn structure, yarn raw material, traveler mass, traveler speed, arc height, etc. For example, only little fiber lubrication can be expected with yarns finer than 7.5 tex (Ne 80) due to the low traveler mass and thus low centrifugal force. In this case maximum traveler speed is therefore lower than for medium-count yarns. Travelers reach speeds of up to 40 m/s and more with modern ring/traveler combinations when fiber lubrication is functioning effectively.

Depending on the fibre (dry or strong wax-containing cotton or softening agents on synthetics) the resulting coefficient of friction varies. The coefficient of friction \( \mu \) of the fibre lubrication can vary in extreme cases from 0.08 to 0.12. This is the reason, why in some cases for identical spinning conditions different traveller weights must be applied.
Start-up proceeding for new rings (Ring running-in)

If worn rings are replaced by new ones, these lack a lubricant film. Purely metal/metal friction therefore prevails for a certain length of time. This is a very critical phase, since the rings can very quickly be damaged by scoring and pick-up. Ring manufacturers have therefore specified precise rules for running-in, adapted to the given type of ring, for the running-in phase during which the surface of the ring has to be smoothed and passivated (oxidized) and coated with a lubricant film.

These can include, for instance:

• Do not degrease new rings, simply wipe them with a dry cloth.
• Select the correct ring traveler, but reduce spindle speeds by 15-20% (or normal spindle speeds and ring travelers 1-2 numbers lighter).
• First traveler change after 15 min.
• Second traveler change after 30 min.
• Third traveler change after 1-1 1/2 h.
• Fourth traveler change after 1st doffing.
• Traveler change after 2nd + 3rd doffing.
• Traveler change after 5th + 8th doffing.

Spindle speed can be increased in stages in the meantime. With yarns finer than 7.5 tex (Ne 80) running-in is an even more delicate and protracted procedure. In this case speeds should be reduced by 20-30% and the rings smeared from time to time with oil-soaked felt.
The Traveler

• imparts twist to the yarn and
• is responsible for winding the yarn onto the cop.

The take-up length always corresponds to the difference between the peripheral speeds of the ring and the traveler. This must be equal to the delivery length in the long run. The difference is due to the fact that the traveler speed lags behind the spindle speed, since the traveler does not have its own drive, but is only carried along by the spindle. The yarn tension (yarn tensile force) necessary for a stable balloon is generated by the friction of the traveler on the ring (and partly by the drag of the thread balloon). The traveler is pressed against the ring mainly by the centrifugal force acting on it. This results in the above-mentioned friction between the ring and the traveler. However, this friction caused by the high contact pressure (up to 35 N/mm) also generates considerable heat. This is the root of the ring/traveler problem, since the small mass of the traveler means that it is not possible to dissipate the heat generated in the time available. The result of this is the limitation in traveler speed.
The traveler should:

- generate as little heat as possible
- quickly distribute the heat that is nevertheless generated from the site where it occurs (contact surface) to the traveler as a whole
- dissipate the heat quickly to the ring and the air
- be elastic, so that the traveler can be pressed onto the ring without breaking
- display high wear resistance
- have a slightly lower hardness than the ring, since the traveler must wear rather than the ring.

The travelers used in short staple spinning are therefore made almost exclusively of steel. However, pure steel does not ideally fulfill the first three requirements. Traveler manufacturers have therefore been attempting for decades to improve running conditions through surface finishing.

The following methods are suitable for this:

- Electroplating, in which the traveler is coated with one or more layers of metal, such as nickel and silver, or
- Chemical treatment to change surface properties in order to reduce friction and scoring.
- The Bräcker company has developed a new process for introducing certain treatment components into the traveler surface by diffusion and fixing them there (sapphire traveler). This layer reduces heating and increases wear resistance.
Travelers have to wind up very different yarns:
- coarse/fine
- smooth/rough
- compact/bulky
- strong/weak
- natural fibers/manmade fibers.

It is impossible to spin this diversity of yarns using only one type of traveler; quite a wide range of travelers is required for this purpose. Differences arise from:
- shape
- mass
- raw material
- additional treatment of the material
- wire profile
- thread passage size (arc height).

It is up to the spinning mill operator to make a choice appropriate to his conditions and requirements.

Traveler shape

The shape of the traveler must coincide exactly with that of the ring flange, so that only one contact surface – which should be as large as possible – exists between the two units. The top of the traveler arc should also be as flat as possible in order to keep its center of gravity low and enhance smooth running. Both of these factors have a significant influence on the traveler speed that can be achieved. However, the flat arc shape must still leave sufficient space for thread passage. If this space is too small the thread rubs on the ring, which results in napping of the thread, high production of fiber fly, reduced quality and the formation of melt points in manmade fibers.
The following traveler shapes (basic shapes) are in use in short staple spinning (Fig. 36):

a) C travelers
b) flat or oval travelers
c) elliptical travelers
d) N travelers
e) and the ORBIT travelers

The wire profile also influences running behavior, i.e. through:

- the contact surface on the ring
- smooth running
- heat dissipation
- thread passage space
- and certain yarn properties:
  - sloughing resistance
  - hairiness.
Wire sections

The wire section does influence the yarn quality, the running behaviour, the performance and the life time of the travellers. The right choice of the wire section is an important factor for optimum results.

Only for cotton: improves the traveller lubrication.

Synthetics and blends: prevents fibre damage.
Fine cotton yarns: reduces production (push-back) neps.

f  flat

For cotton and blends: Through an enlarged contact surface on the ring raceway, highest performances are possible.

Most used wire section.

udr  ultra (wide) half round

fr  flat/round

drh  half round high

For Core yarns with PES core, acrylics and delicate fibres.
- profile at the toe increases the ring contact.
- profile for fibre protection in the yarn passage.

Special profile for SU travellers.
Application for Viscose and Polyester.

SFB travellers: udr, drh profile.
The mass of the traveler determines the degree of friction of the traveler on the ring and thus the yarn tension. If the mass is too low, the balloon becomes too large, the cop too soft and the amount of material taken up on the cop too small. On the other hand, too high a mass results in high thread tension and frequent ends down. The mass of the traveler must therefore be adjusted exactly to the yarn (count, tenacity) and the spindle speed. If there is a choice between two traveler weights, the heavier one is usually preferred, since this results in higher cop weight, smoother running of the traveler and better heat dissipation. The table (Bräcker) can be of assistance in approximately defining the traveler number: (ISO is the new standard here and specifies the mass of 1 000 travelers in grams).
## Traveller weights for T flange, ORBIT, SU

<table>
<thead>
<tr>
<th>Tex</th>
<th>Nm</th>
<th>No</th>
<th>T flange</th>
<th>ORBIT</th>
<th>SU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PES</td>
<td>PAC and CV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traveller No</td>
<td>ISO</td>
<td>ISO</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>6</td>
<td>14−18</td>
<td>250−235</td>
<td>250−235</td>
</tr>
<tr>
<td>72</td>
<td>14</td>
<td>8</td>
<td>11−14</td>
<td>190−250</td>
<td>200−250</td>
</tr>
<tr>
<td>59</td>
<td>17</td>
<td>10</td>
<td>9−11</td>
<td>140−180</td>
<td>140−180</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
<td>12</td>
<td>6−9</td>
<td>100−140</td>
<td>100−140</td>
</tr>
<tr>
<td>42</td>
<td>24</td>
<td>14</td>
<td>3−7</td>
<td>80−112</td>
<td>90−140</td>
</tr>
<tr>
<td>36</td>
<td>27</td>
<td>16</td>
<td>1−4</td>
<td>63−90</td>
<td>71−100</td>
</tr>
<tr>
<td>30</td>
<td>34</td>
<td>20</td>
<td>2−2</td>
<td>50−71</td>
<td>63−90</td>
</tr>
<tr>
<td>25</td>
<td>40</td>
<td>24</td>
<td>4−1</td>
<td>40−63</td>
<td>45−71</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>30</td>
<td>5−3</td>
<td>35−50</td>
<td>31.5−50</td>
</tr>
<tr>
<td>17</td>
<td>60</td>
<td>38</td>
<td>6−5</td>
<td>31.5−45</td>
<td>28−40</td>
</tr>
<tr>
<td>15</td>
<td>68</td>
<td>40</td>
<td>7−4</td>
<td>28−40</td>
<td>25−40</td>
</tr>
<tr>
<td>12</td>
<td>85</td>
<td>50</td>
<td>8−6</td>
<td>25−31.5</td>
<td>20−31.5</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>60</td>
<td>10−7</td>
<td>22.4−28</td>
<td>18−25</td>
</tr>
<tr>
<td>8.5</td>
<td>120</td>
<td>70</td>
<td>11−10</td>
<td>20−22.4</td>
<td>16−22.4</td>
</tr>
<tr>
<td>7.4</td>
<td>135</td>
<td>80</td>
<td>14−11</td>
<td>16−20</td>
<td>14−20</td>
</tr>
<tr>
<td>6.6</td>
<td>150</td>
<td>90</td>
<td>16−12</td>
<td>14−18</td>
<td>14−18</td>
</tr>
<tr>
<td>5.6</td>
<td>180</td>
<td>105</td>
<td>18−14</td>
<td>12.5−16</td>
<td>14−18</td>
</tr>
<tr>
<td>5.3</td>
<td>190</td>
<td>112</td>
<td>19−16</td>
<td>11.2−14</td>
<td>14−18</td>
</tr>
<tr>
<td>4.5</td>
<td>220</td>
<td>132</td>
<td>22−19</td>
<td>9−11.2</td>
<td>14−18</td>
</tr>
</tbody>
</table>

The traveller weights are determined beside the yarn number by the following parameters:

- **Yarn twist** &gt; Knitting &gt; Lighter travellers
- **Fibre type** &gt; Blends, synthetics &gt; 1−2 number heavier travellers
- **Spindle speed** &gt; Higher RPM &gt; Rather lighter travellers
- **Spinning geometry**
  - Small ring diameter &gt; Small balloon &gt; Lighter travellers
  - Large ring diameter &gt; Large balloon &gt; Heavier travellers
Relation between yarn count and traveler number

Evaluation of traveller weight

The traveller has to balance the yarn balloon. Because the balloon varies from bottom to top on large scale, is the traveller on the bottom rather too light, on the top too heavy. Choosing the correct traveller weight is always a compromise.

Measuring the yarn tension on ring spinning frame is not practicable. The best method is to judge the balloon shape. This can be done by a stroboscope but also with a flash light.

Insert travellers of two to three consecutive Nos. (weights) after doffing on a few spindles and observe the balloon.

1. Select the traveller weight at base of cop when the bobbin reaches full diameter (Fig 1)
2. Balloon should not touch:
   - Separators
   - Tip of tube
   - When using anti-balloon rings, lower part of balloon should be slightly bigger in diameter than upper part
3. Balloon should not collapse (double ballooning)
4. When shape of balloon is stable, traveller weight is correct
5. Check balloon at full cop (Fig 2): 
   - Balloon should not be too straight
6. Check yarn quality with selected traveller weight
Traveler clearer

When the yarn, which comprises a large number of more or less firmly integrated, yet relatively short fibers, is fed through the ring traveler, it is inevitable that fibers are detached. Most of them fly away from the traveler, but some also often remain attached to the traveler. These can accumulate and even form clumps. The resulting, excessively high mass of the traveler creates high thread tension and ultimately leads to thread breaks. Fiber strippers, so-called traveler clearers, are mounted near the rings in order to prevent these accumulations of fibers. These should be positioned as close to the traveler as possible, but far enough away not to interfere with the movement of the traveler. Accurate adjustment is very important.
Traveller friction

The spinning tension is the result of the following values:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Depending on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traveller weight</td>
<td>Yarn count, spinning geometry</td>
</tr>
<tr>
<td>Ring diameter</td>
<td>Spinning geometry, machine</td>
</tr>
<tr>
<td>Traveller speed</td>
<td>Spindle speed, ring diameter</td>
</tr>
<tr>
<td>Coefficient of friction</td>
<td>Fibre, yarn hairiness, use of existing resources.</td>
</tr>
</tbody>
</table>

Example:
- A traveller with 40 mg weight
- and a coefficient of friction of 0.08
- develops about the same friction as a traveller with 28 mg weight
- and a coefficient of friction of 0.12
Yarn clearance

- 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

Formula

\[ R = \mu \cdot N \]

- \( R \) = Traveller friction in mN
- \( \mu \) = Coefficient of friction
- \( N \) = Normal force \( \approx \frac{F_T}{10} \frac{m_i \cdot v^2}{r} \)
- \( F_T \) = Centrifugal force
- \( m_i \) = Mass of the traveller in mg
- \( v \) = Traveller speed in m/s
- \( r \) = Radius of the ring (inside) in mm
<table>
<thead>
<tr>
<th>Yarn clearance</th>
<th>Small, low</th>
<th>Large, high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn count</td>
<td>Fine</td>
<td>Coarse</td>
</tr>
<tr>
<td>Fibre</td>
<td>Cotton</td>
<td>Synthetics, blends</td>
</tr>
<tr>
<td>Influence on lubrication film</td>
<td>Good traveller lubrication</td>
<td>Reduced traveller lubrication</td>
</tr>
<tr>
<td>Influence on yarn quality</td>
<td>Danger of «push-back» neps and melting points (on synthetics).</td>
<td>Excellent yarn quality guaranteed</td>
</tr>
</tbody>
</table>

vertical (theoretical position)  medium inclination  strong inclination

in practice (after running for 1–2 hours)

Yarn passage
## Hairiness

<table>
<thead>
<tr>
<th>Kind of hairiness</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn</td>
<td>Ring condition:&lt;br&gt;• Rough gliding surfaces reduce the braking effect of the ring traveller or disturb smooth running.</td>
<td>Replace ring (traveler ring travellers only rarely or temporarily bring improvement; yarn breaks increase)</td>
</tr>
<tr>
<td>Cup</td>
<td>Traveller weight too light:&lt;br&gt;• Poor twist contraction of the fibres on the spinning triangle&lt;br&gt;• Heavy friction of the balloon on the anti-balloonringing resp. impact on the balloon separator&lt;br&gt;• Poor twist propagation to the spinning triangle.</td>
<td>Increase traveller weight or choose another traveller type</td>
</tr>
<tr>
<td></td>
<td>Too heavy traveller or too much wear on the traveller:&lt;br&gt;• Friction of the yarn leading to roughening and hairiness&lt;br&gt;• Traveller wear in yarn passage area, causing roughening</td>
<td>Reduce traveller weight or choose another traveller type&lt;br&gt;Reduce traveller running time</td>
</tr>
</tbody>
</table>

### Kind of hairiness

<table>
<thead>
<tr>
<th>Yarn</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Uneven yarn tension&lt;br&gt;• Poor ring centring&lt;br&gt;• Poorly centred thread guides&lt;br&gt;• Thread guides with rough surfaces&lt;br&gt;• Open anti-balloonring&lt;br&gt;• Crooked tubes</td>
<td>Re-centre rings, spindles resp. thread guides&lt;br&gt;Replace damaged parts&lt;br&gt;Close anti-balloon rings&lt;br&gt;New tubes</td>
</tr>
<tr>
<td></td>
<td>Yarn passage:&lt;br&gt;• Yarn is roughened in narrow yarn clearance&lt;br&gt;• Scratched up yarn passages catch the yarn and roughen it</td>
<td>Use a traveller with a larger yarn clearance&lt;br&gt;Reduce traveller running time</td>
</tr>
<tr>
<td></td>
<td>Wire profile:&lt;br&gt;• The wire profile can influence the yarn tension&lt;br&gt;• If necessary, adjust the traveller weight</td>
<td>Adjust traveller weight</td>
</tr>
<tr>
<td>Kind of hairiness</td>
<td>Cause</td>
<td>Remedy</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Yarn</td>
<td>Fibres protruding from the cop are caught by the traveller and cut. This function does not work if distance between traveller and cop is too large.</td>
<td>Set the cop diameter to the largest possible size Use &quot;beard breakers&quot;</td>
</tr>
<tr>
<td>Cop</td>
<td>Electrostatic: The fibres get electrostatically loaded (direction of charge +/- without significance)</td>
<td>Increase air humidity Assure conductive discharge with isolated ring rails</td>
</tr>
</tbody>
</table>

**Neps**

When neps are mentioned in connection with rings and travellers, it means production neps. They do occur merely (and they are measurable) on yarns Ne 40 and finer.

**Formation of neps**

Production neps do mainly occur in the upper half of the cop and on the top of the cone. It is the matter of pushed-back, retained fibres and they do arise on tight gliding points and edges as well as at too high spinning tensions.
<table>
<thead>
<tr>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn clearance too tight</td>
<td>Select a traveller with a higher bow</td>
</tr>
<tr>
<td>Yarn passage intersects with the wear and tear spot</td>
<td>Reduce life time, select a lighter traveller</td>
</tr>
<tr>
<td>Unsuitable wire profile</td>
<td>Change from t to udr, resp. from udr to dr.</td>
</tr>
<tr>
<td>Spinning tension too high</td>
<td>Select a lighter traveller</td>
</tr>
<tr>
<td>Notched thread guide</td>
<td>Replace</td>
</tr>
</tbody>
</table>

When yarn passage and wear and tear area separated:  
No risk for neps.

When yarn passage intersects with wear and tear area:  
Formation of neps possible.

**Processing of blended and synthetic yarns**

**Important points**

- **Thread guide**
  - Notched or slightly torn thread guides damage the fibres and roughen the yarn.

- **Anti-ballooning ring**
  - A large bulging balloon increases the friction on the anti-balloon ring, leading to mechanical and thermal fibre damages.

**Remedy**

- Replace guides

**Remedy**

- Apply heavier travellers to reduce friction on the anti-balloon ring. In extreme cases, remove anti-balloon ring (avoid balloon hitting on separators).
Inserting tools

removing tools

Yarn tension variation

Winding on full cop
Variation in yarn tension for winding on empty tube

Variation in yarn tension for winding on changing cop diameter

Distribution of yarn breaks while building up of the cop
Yarn breaks
Example of annual loss in production due to yarn breaks

Basic data

<table>
<thead>
<tr>
<th>No</th>
<th>Nm</th>
<th>Production/spindle/hour in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>40</td>
<td>35.8</td>
</tr>
<tr>
<td>30</td>
<td>50</td>
<td>22.7</td>
</tr>
<tr>
<td>40</td>
<td>70</td>
<td>15.7</td>
</tr>
</tbody>
</table>

Average duration of breakage: 10 min.
Hours of operation in 1 year: 8'000

Annual loss in production (in tons)

<table>
<thead>
<tr>
<th>No of yarn breaks</th>
<th>Ne 20</th>
<th>Ne 30</th>
<th>Ne 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>20'000 Spindles</td>
<td>19.1</td>
<td>28.7</td>
<td>38.3</td>
</tr>
<tr>
<td>30'000 Spindles</td>
<td>28.7</td>
<td>43.1</td>
<td>57.5</td>
</tr>
<tr>
<td>50'000 Spindles</td>
<td>47.8</td>
<td>71.8</td>
<td>95.8</td>
</tr>
</tbody>
</table>

Annual loss in production by 1'000 spindles in tons

Breakage rate per 1'000 spindles/hour
## Breaks during spinning process

<table>
<thead>
<tr>
<th>Cause of yarn breaks</th>
<th>Remedy (corrections / solutions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Caused by ring and traveller</strong></td>
<td></td>
</tr>
<tr>
<td>Unsuitable traveller type</td>
<td>Try another traveller shape, wire profile</td>
</tr>
<tr>
<td>Spinning tension too high resp. too low</td>
<td>Adjust traveller weight, strive for a well-balanced balloon</td>
</tr>
<tr>
<td>Uneven spinning tension, yarn tension peaks</td>
<td>Re-centre rings, anti-ballooning rings and thread guides</td>
</tr>
<tr>
<td>Poor condition of the ring</td>
<td>Replace rings</td>
</tr>
<tr>
<td>Running time of the travellers</td>
<td>Test wear and tear, shorten the replacing cycles</td>
</tr>
<tr>
<td><strong>Caused by drafting components</strong></td>
<td></td>
</tr>
<tr>
<td>Top roller covers worn out</td>
<td>Rerinding of the top roller covers, ev. replacement</td>
</tr>
<tr>
<td>Top roller cover too hard</td>
<td>Select softer top roller type</td>
</tr>
<tr>
<td>Wrapping tendency of the top roller cover</td>
<td>Surface treatment through berkoloizing</td>
</tr>
<tr>
<td>Top roller cover surface to glazed, berkoloizing process too long</td>
<td>Rerinding the top roller covers, reduce berkoloizing time</td>
</tr>
<tr>
<td>Film forming, smoothing of surface</td>
<td>Rerinding of the top roller covers, ev. replacement</td>
</tr>
<tr>
<td>Run-out fault of top or bottom roller</td>
<td>Rerinding of the top roller covers, aligning of the bottom rollers</td>
</tr>
<tr>
<td>Rough-running, damaged top roller bearing</td>
<td>Replace complete axes</td>
</tr>
<tr>
<td>Poor gliding aprons</td>
<td>Wash or replace aprons</td>
</tr>
<tr>
<td>Pluff accumulation in the cradle</td>
<td>Choose other apron</td>
</tr>
</tbody>
</table>

## Caused by other factors

<table>
<thead>
<tr>
<th>Cause of breakages</th>
<th>Remedy (corrections / solutions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient yarn strength related to the selected speed</td>
<td>Adjust the spindle speed to the yarn strength (rot yarns show a reduced strength).</td>
</tr>
<tr>
<td>Yarn evenness</td>
<td>Check spinning preparation, drafting system</td>
</tr>
<tr>
<td>Raw material</td>
<td>Analyse modification of the fibre quality resp. softening agents of chemical fibres</td>
</tr>
<tr>
<td>Climatic conditions not optimal, fly</td>
<td>Optimise climate, adjust blower and exhaust installation</td>
</tr>
</tbody>
</table>

## Breakage during doffing

<table>
<thead>
<tr>
<th>Cause of breakages</th>
<th>Remedy (corrections / solutions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn unthreading from travellers</td>
<td>Change traveller type (shape, profile), pay attention to toe gap</td>
</tr>
<tr>
<td>Setting of the machines</td>
<td>Adjust the lowering speed of the ring roll, check start-up program (compare with other machines).</td>
</tr>
<tr>
<td>Balloon stability too slowly built-up</td>
<td>Run up faster, increase traveller weight</td>
</tr>
<tr>
<td>Traveller jammed</td>
<td>Check condition of the ring, change type of traveller</td>
</tr>
<tr>
<td>High curling tendency of the yarn</td>
<td>Delay start-up of drafting system</td>
</tr>
</tbody>
</table>
Traveller speeds/performance calculations
in m/s (rounded figures), ring diameter 36–70 mm

Formula: ring diameter x n x n = m/s
                      1000 x 60                    Feet/min: ~ m/s x 200

<table>
<thead>
<tr>
<th>Ring-Ø</th>
<th>mm</th>
<th>Inches</th>
<th>Spindle speed n/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>2</td>
<td>33.34</td>
<td>38.41 42.44 45</td>
</tr>
<tr>
<td>69</td>
<td>2</td>
<td>33.34</td>
<td>38.41 42.44 45</td>
</tr>
<tr>
<td>62</td>
<td>2</td>
<td>31.33</td>
<td>36.38 43.46 45</td>
</tr>
<tr>
<td>63</td>
<td>2</td>
<td>31.33</td>
<td>36.38 43.46 45</td>
</tr>
<tr>
<td>60</td>
<td>2</td>
<td>33.33</td>
<td>36.38 43.46 45</td>
</tr>
<tr>
<td>57</td>
<td>2</td>
<td>29.27</td>
<td>32.34 37.40 41</td>
</tr>
<tr>
<td>54</td>
<td>2</td>
<td>29.27</td>
<td>32.34 37.40 41</td>
</tr>
<tr>
<td>51</td>
<td>2</td>
<td>25.62</td>
<td>30.34 36.38 40.42</td>
</tr>
<tr>
<td>48</td>
<td>2</td>
<td>22.24</td>
<td>27.29 30.31 33.37</td>
</tr>
<tr>
<td>45</td>
<td>2</td>
<td>21.22</td>
<td>26.26 29.29 32.34</td>
</tr>
<tr>
<td>42</td>
<td>2</td>
<td>20.21</td>
<td>25.26 28.29 31.33</td>
</tr>
<tr>
<td>40</td>
<td>2</td>
<td>19.20</td>
<td>24.25 27.29 30.32</td>
</tr>
<tr>
<td>38</td>
<td>2</td>
<td>18.18</td>
<td>23.23 26.27 29.29</td>
</tr>
<tr>
<td>36</td>
<td>2</td>
<td>17.17</td>
<td>22.22 25.26 28.29</td>
</tr>
</tbody>
</table>

Recommended ring diameter
- 51.48 mm
- 40.38 mm
- ≥ 54 mm
- 45.42 mm
- 36 mm

Recommended flange type
- Flange 1
- Flange 2
- ORBIT SF8 2.8
**Bobbin shape**

The cop, the typical package shape on the ring spinning machine, consists of three clearly distinguishable buildup sections (Fig. 44): the lower, rounded base (A) the middle, cylindrical section (Z) and the conical nose (S).

For layer winding the ring rail is usually moved slowly but at increasing pace upward, and rapidly but at decreasing pace downward. This results in a yarn length ratio of about 2:1 between the main winding (upward) and the cross winding (downward), whereby the total length of each double layer should be no more than 5 m (better 4 m) for unwinding purposes. The layering traverse of the ring rail is ideal if it is some 15-18% larger than the ring diameter.
Motor-powered cop formation
Automation

The operations on the ring spinning machine that can be considered for automation are:

- transport of roving bobbins to the ring spinning machine: this automation feature is available, with different automation levels;
- roving bobbin change: would also be useful, but is difficult to solve; initial units are available;
- roving infeed, eliminating roving ends down: difficult to achieve, doesn't often happen, initial approaches exist;
- waste collection and disposal: fully implemented in yarn extraction;
- repairing ends down: calls for complicated approaches which also fail to produce totally successful piecings; currently unfavorable cost/benefit ratio, but would be desirable;

- roving stop motion for ends down: this would be desirable, but the available solutions are complicated and expensive;
- cop change (doffing): already resolved, in full use;
- cleaning: largely resolved, albeit unsatisfactorily in terms of quality, by using traversing cleaners;
- servicing and maintenance: the effort involved is much less than it used to be, but a certain amount still has to be performed manually;
- transport of cops to the winders: automation of this process is available and has become well established in mill operations;
- machine monitoring: good solutions (e.g. Zellweger Ringdata, Rieter ISM (Individual Spindle Monitoring)) are available on the market;
- production and quality monitoring: good solutions are also available here (e.g. SPIDERweb);
- yarn uniformity monitoring: this cannot be performed economically for each spinning position.
Work performed by a ring spinning operative; A: percent, B: yarn count in Nm, I: roving supply, II: monitoring, III: yarn piecing, IV: allowance

Doffing

Preparation for doffing
The automatic doffing system consists of:

- A conveyor belt (T) equipped with discs to hold tubes (or cops), or a conveying mechanism with support discs arranged one behind the other on narrow rails for pushing the discs along the machine. In both cases the discs serve to convey the tubes prior to doffing and the cops after doffing;
- A doffing rail (B), also extending along the entire length of the machine, equipped with pegs (Z) which engage with the tubes (Zinser) or collars to grip the outside of the tubes and cops;
- A system of lifting levers (G), usually in the form of tongs, to raise and lower the rail and swivel it in and out;
- A tube preparation and creeling device at the end of the machine, and
- A cop storage device, also at the end of the machine, or a cop transfer unit to a directly connected winder.

The automatic doffing process

(1) (2)
SERVOgrip by RIETER
Doffing without underwinding

1. after cop build-up, the ring rail automatically moves downwards and opens the SERVOgrip.
2. The spindle, still revolving slowly, winds a very short length of yarn on the SERVOgrip.
3. The SERVOgrip is closed.
4. – 6. When the cop is subsequently replaced, the length of yarn remains firmly clamped, enabling piecing to be performed. The very short length of yarn remains clamped in the SERVOgrip throughout package build-up. When the SERVOgrip opens at the next package change, the length of yarn is released and taken off with the package, so that no yarn ends remain on the spindle.
**yarn detectors**

The individual yarn detector monitors the rotation of the steel ring traveller of each individual spindle and immediately detects any yarn breakage.

**The roving stop mechanism**

The roving stop receives the electronic signal of Individual yarn detector in case of a yarn breakage and interrupts the feeding of the roving in the drafting system area. This response occurs within a few milliseconds. Material losses are minimized and lapping is prevented. Optical signals show the yarn breakage, the operator’s workload is effectively reduced.
Vacuum and energy consumption

A relatively high vacuum is necessary to ensure reliable extraction. It should be approx. 600 to 800 Pa for cotton and approx. 1 000 to 1 200 Pa for man-made fibers. It should be borne in mind here that there can be a considerable drop in pressure between the fan and the last spindle. The longer the machines and the larger the air flow rate, the greater the drop in pressure. The air flow rate is usually between 5 and 10 m³/h. The energy consumption required for fiber extraction is substantial. It can account for up to 1/3 of the machine’s drive power and also depends on the length of the machine and the air flow rate. For example, energy consumption at 10 m³/h is 4.5 times higher than at 6 m³/h, due to the considerably higher vacuum.

Pressure drop in the fiber extraction system, starting from the first spindle on the fan side; N - spindle No.; I: short machine; II: long machine
The problem of dust and fly

Many short fibers are lost as fly during the processing of staple fibers on spinning machines, and a considerable quantity of fiber debris and dust is released. Fly and dust are deposited on machine components or are continuously being whipped up and around by rotating and circulating devices such as spindles, drums, drive wheels, etc. They have therefore always been a significant disturbing factor as regards service and maintenance as well as diminishing quality. This problem has intensified further with high production speeds and high drafts. The most fly and dust on ring spinning machines is released in the main drafting zone and the spinning triangle (up to 85%), while the balloon and travelers account for most of the remainder. Since it is impossible to prevent fly from being released, provision should at least be made for removing it. Whereas this always used to entail manual cleaning of the machine components, blower devices are mostly used for this nowadays. However, it has to be said that blower devices do not function ideally, since they blow fly and dust off the machine components rather than removing them at the place where they occur, and therefore also whirl them over the machines. The accumulations of dust and fly therefore do not always end up where one would like them to. They can thus again result in disturbances. However, no better solutions are known at present.

The types of device are differentiated as follows:
- agitators
- blower devices
- suction devices
- combined blower/suction devices

by the way they are utilized on the machines:
- individual units, i.e. devices for cleaning only one machine, and
- collective units, where one device traverses 2-8 machines

and by their mode of circulation:
- rotating and
- reciprocating.

Combined blower/suction devices operating as reciprocating collective units are currently very widely used.
Agitators

These are simple fans with short blower nozzles driven by a small electric motor, circulating on conductor rails over the machines. They are now only used, if at all, on winders, as they cannot clean selectively.

Blower/suction systems

The devices most widely used nowadays operate like agitators, but with significantly higher performance (- 3 kW, - 5 000 m³/h of air, up to 50 m/sec air speed at the nozzles) and feature several hoses, some of them reaching to the floor. One or two of these hoses on each side blow (a+b) and one (c) sucks the material which has been blown off up from the floor. The blowing hoses feature blowing nozzles at different heights, aimed precisely at the exposed zones in such a way that as far as possible they blow the fly downward. A filter with a filter cleaning device is a logical necessity when working with suction systems. On the Sohler system, for example, the traveling cleaner passes over a collecting box (e) at the end of the running rail (machine end), into which the filtered material is discharged. All the collecting boxes can be connected to a central suction system, which most practically leads to a pneumatic baling press.
In the case of individual units the traveling cleaner runs continuously back and forth over only one machine; in the case of collective units they can operate in either reciprocating (a) or rotary mode (b). The advantage of rotary mode is that the cleaner always passes the same position at the same interval, which is not possible in reciprocating mode. In reciprocating mode the blower cleans machine components that have just been cleaned when it reverses direction, whereas it takes a very long time for the blower to reach the machine at the other end of the track. Nevertheless, reciprocating mode is most frequently used because blowing occurs from different directions, in one pass from the right and in the next from the left, whereas in rotary mode the air jet always comes from the same side. There are many blind spots.
Multi-motor drive system

FLEXIdraft, the modern drafting system drive
Synchronous motors controlled by frequency converters drive the drafting system cylinders individually. The cylinders are split in the center of the machine to ensure very smooth running and drafting operation. The multi-motor drafting system drive (2 motors on each side at the head and foot of the machine, i.e. a total of 6” motors) offers maximum user-friendliness when adjusting the spinning parameters to new conditions.

Advantages
- yarn count and twist change at the push of a button
- high-precision settings
- start-up and spin-out in quarters
- maintenance-free
- S/Z twist can be set at the control panel
Possibility of producing fancy yarns

With the electronic drafting system drive both draft and twist can be varied in a controlled manner. Slubs of different thickness, length and twist are incorporated into the yarn. Thus fancy yarns in most different characteristics can be easily produced.

Zinser 351 FancyDraft system

Technical data
Zinser 351

<table>
<thead>
<tr>
<th>Application range</th>
<th>Draft range</th>
<th>Number of spindles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staple fibres up to 60 mm</td>
<td>6 – 80-fold</td>
<td>Gauge</td>
</tr>
<tr>
<td>Raw material qualities</td>
<td></td>
<td>70/75</td>
</tr>
<tr>
<td>Cotton, viscose, man-made fibres and their blends</td>
<td>70/75</td>
<td>up to 260 mm</td>
</tr>
<tr>
<td>Count range</td>
<td>167 – 4 tex</td>
<td>82.5</td>
</tr>
<tr>
<td>(Nm 6 – 270)</td>
<td></td>
<td>Tube length: 200 – 260 mm</td>
</tr>
<tr>
<td>(Ne 4 – 160)</td>
<td></td>
<td>Ring diameter: 38 – 57 mm</td>
</tr>
<tr>
<td>Twist range</td>
<td>100 – 3500 T/m</td>
<td>Spindle speed: 25,000 rpm (mechanical)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restrictions: for number of spindles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 1200 to 1488 spindles; applicable for cotton yarns and cotton blends</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 1200 spindles: middle suction</td>
</tr>
</tbody>
</table>

Options
- FancyDraft
- Zinser FlaxGuard
- Zinser RovingGuard
- Zinser DataGuard
- Zinser RingPilot
- Zinser SiroSpun (without yarn break detector)
- CoreSpun