The Rieter Manual of Spinning
Volume 2

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Volume 2 – Blowroom & Carding

Werner Klein

Publisher
Rieter Machine Works Ltd.

Cover page
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Available Volumes/Edition:

Volume 1 – Technology of Short-staple Spinning
ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0

Volume 2 – Blowroom & Carding
ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7

Volume 3 – Spinning Preparation
ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4

Volume 4 – Ring Spinning
ISBN 10 3-9523173-4-9 / ISBN 13 978-3-9523173-4-1

Volume 5 – Rotor Spinning
ISBN 10 3-9523173-5-7 / ISBN 13 978-3-9523173-5-8

Volume 6 – Alternative Spinning Systems
ISBN 10 3-9523173-6-5 / ISBN 13 978-3-9523173-6-5

Volume 7 – Processing of Man-Made Fibres
ISBN 10 3-9523173-7-3 / ISBN 13 978-3-9523173-7-2

Collectors Edition – all Volumes (Vol. 1-7)
ISBN 10 3-9523173-0-6 / ISBN 13 978-3-9523173-0-3

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Volume 2 – Blowroom & Carding

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THE RIETER MANUAL OF SPINNING

Volume 1 – Technology of Short-staple Spinning

This deals with basic, generally valid, technological relationships in short-staple spinning. Subsequent volumes are organised according to machines or machine groups. This separates generally valid basic principles from ongoing developments in machine design and construction.

Volume 2 – Blowroom & Carding

In-depth information is provided on opening, cleaning, blending and carding and additional aspects are covered such as acclimatisation of raw materials, anticipated waste from various grades of fibre, selection and setting of cleaning and blending machinery, waste recycling, transport and the functions of the various card components as well as selection and maintenance of card clothing and autolevelling systems.

Volume 3 – Spinning Preparation

Here the technical and technological aspects of the yarn production process between carding and ring spinning are covered, that means draw frame, combing section (including combing preparation) and roving frame. This is an important process stage, because the yarn quality largely depends on the quality of the intermediate products from which it is made.

Volume 4 – Ring Spinning

Technical and technological aspects of ring spinning are covered. This is the final process in yarn production. The ring spinning machine greatly influences the yarn and its quality. Ring-spun yarns still represent the standard for comparison when evaluating yarns produced by other spinning processes.

Volume 5 – Rotor Spinning

This process resulted from research into alternative spinning systems. This volume contains in-depth information on the rotor spinning process and its properties. Continual improvements in spinning elements and conditions make it now possible to spin a rotor yarn optically similar to a ring-spun yarn.

Volume 6 – Alternative Spinning Systems

To take full advantage of alternative spinning systems, a thorough understanding of them is therefore essential. This volume contributes towards reaching this goal by describing the most important alternative spinning systems in detail. One of them is the well known Air-jet spinning technology.

Volume 7 – Processing of Man-Made Fibres

Ever since the introduction of man-made fibres on a commercial scale, the market share of synthetic fibres has shown an impressive growth rate. In this important field, the variety of man-made fibres with different properties is continuously increasing. For numerous applications today, fibres that are practically “tailor-made” are available. Spinners must therefore have detailed understanding of the fibre properties and the specific characteristics that affect their processing.

EDITORIAL

„Blowroom & Carding" is the second volume in the series The Rieter Manual of Spinning, which updates the essential principles in modern short-staple spinning. It endeavors to describe the contemporary state of the art in spinning technology, with the objective of providing a reliable overview of currently available processes and techniques.

This volume and the subsequent ones are designed to contribute to the achievement of that goal. Taken together, the seven books of the Rieter Manual of Spinning will thoroughly cover the topic of short-staple spinning.

The second volume outlines detailed information on the preparatory processes of opening, cleaning, blending and carding. It covers practical aspects such as use and preparation of raw materials, waste removal and anticipated waste quantity from various grades of fiber, selection and setting of cleaning and blending machinery, recycling of waste, transport and feeding of material. It also deals with the functions of different components of the card, selection and maintenance of card clothing, and auto leveling systems. Background data explaining the tremendous progress and increase in card productivity is provided together with an outline of options and potential in process integration.

The main author of these books, Werner Klein, is a former senior lecturer of the Swiss Textile College and author of the original edition of the „Manual of Textile Technology" published by The Textile Institute Manchester. All further authors are textile industry experts, who among others in various positions within the Rieter Company, have many years of experience to their credit. The Manual also addresses aspects that extend beyond Rieter's current product range, taking processes and solutions developed by other manufacturers into account.

The structure of this manual and the organization of its subject matter were taken over from the original Technology of Short-staple Spinning published by the Textile Institute, Manchester, whom we thank for their kind permission to continue this standard work.

We wish all users of this compendium pleasant reading.

Rieter Machine Works Ltd.

CONTENTS

1. THE BLOWROOM

1.1. Introduction

The first volumes of the Rieter Manual of Spinning are mainly focused on the treatment of cotton. Handling man-made fibers is dealt with in a separate volume.

The task of the blowroom line is to:
- open the material into very fine tufts;
- eliminate most of the impurities;
- eliminate dust;
- provide a good blend.

And this has to be done:
- with very careful treatment of the raw material;
- with maximum utilization of the raw material;
- while assuring the optimum level of quality.

The relationships between the scope of tasks and the influencing factors are shown in Fig. 1.

The requirements mentioned here are standard for all blowroom lines; for modern high-performance lines the following are added:
- high operational efficiency;
- high economy;
- high flexibility;
- machines of ergonomic design, i.e. safe and easy to handle, maintenance friendly, reproducible and stable settings.

Considering the overall costs of a ring spinning plant, the share of the blowroom line with about 5 to 10 % is not very relevant. It is, however, very significant in respect of raw material treatment, e.g. the best possible utilization, the avoidance of deterioration, and optimum preparation for further processing. Looking additionally at the cost structure of a yarn in which the raw material accounts for about 50 - 70 %, it is clear that there is no better way to reduce costs than via the raw material. And this can be done, e.g., with a modern high-performance blowroom line, as it enables a somewhat cheaper material to be used than with an older blowroom line. The main saving potential, however, is achievable with the introduction of professional and competent raw material management. It enables the raw material to be selected to conform exactly to requirements, and also guarantees the optimum preparation and utilization of the raw material. The latter is not so easy to achieve with regard to one of the tasks of the blowroom, i.e. cleaning the raw material. Foreign matter cannot be eliminated without simultaneous extraction of good fibers. This is unavoidable, only the amount of good fiber loss can and must be influenced.

Another big problem with conventional blowroom lines is the deterioration of the raw material:
- about 50 % of all shortcomings in the yarn;
- about 50 % of all quality reducing factors; and
- around 50 % of all yarn break causes can be traced back to the operation of the blowroom and cards.

All the above-mentioned facts are what makes the blowroom line so very important.

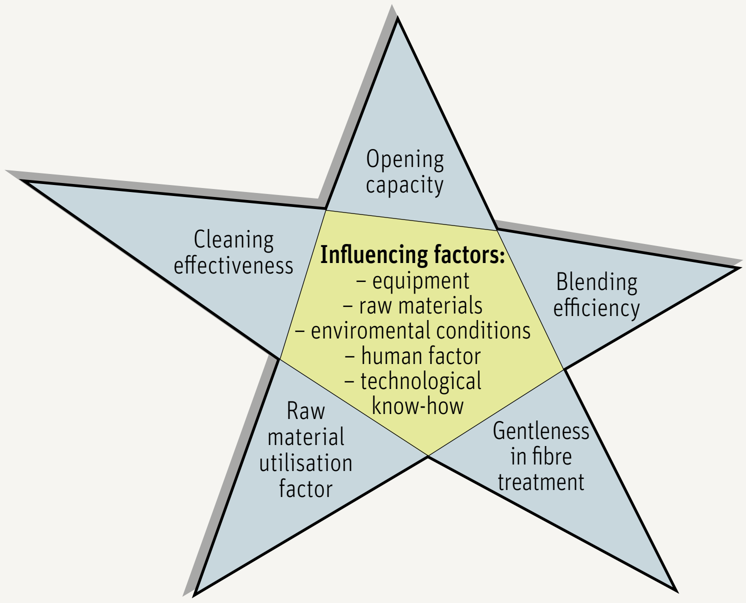


Fig. 1 – Technological performance of a blowroom line and influencing factors

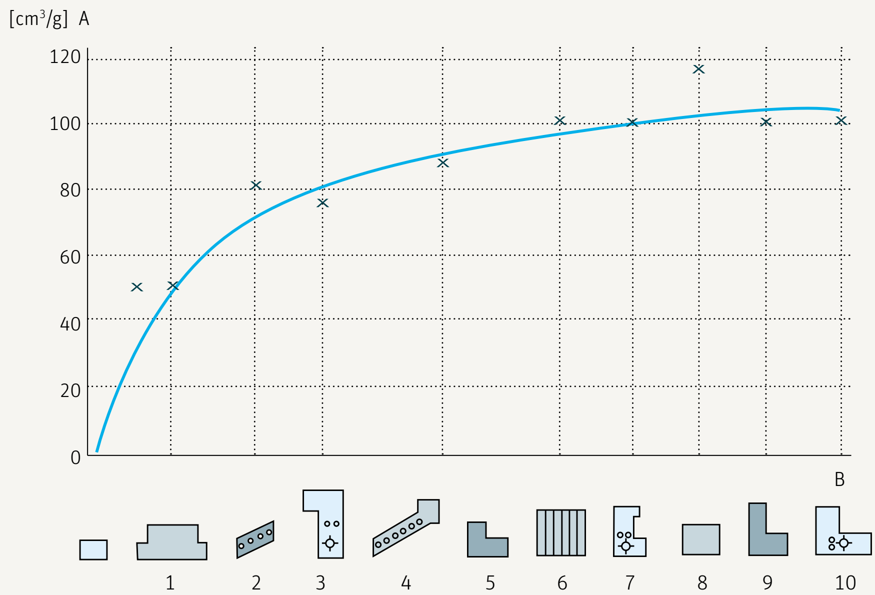


Fig. 2 – Openness of the fiber material after the various blowroom machine stages
axis A: Degree of opening (specific volume); axis B: Blowroom stages

Errors or negligence in selection, composition or treatment of raw material in this section can never and by no means be corrected in the subsequent process stages.

1.2. Summary of the process
1.2.1. Basic operations in the blowroom
1.2.1.1. Opening

The first operation required in the blowroom line is opening, carried out to the stage of tufts – in contrast to the cards, where it is performed to the stage of individual fibers. Tuft weight can be reduced to about 0,1 mg in the blowroom. Artzt, Schenek and Al Ali [2] indicate that the degree of opening changes along a blowroom line as shown in Fig. 2. This line is a theoretical layout for study purposes only. The flattening of the curve toward the end shows that the line is far too long. It should end somewhere at machine No. 3 or (at least) No. 4. The small improvements by each of the subsequent machines are obtained only by considerable additional effort, stressing of the material, unnecessary fiber loss and a striking increase in neppiness. If necessary the card is able to assume rather more of the overall task.

1.2.1.2. Cleaning

It has to be kept in mind that impurities can only be eliminated from surfaces of tufts. Within a progressive line of machines it is therefore necessary to create new surfaces continuously by opening the material. And even then the best blowroom line is not able to eliminate all, or even almost all, of the foreign matter in the raw material. A blowroom installation removes approximately 40 - 70 % of the impurities. The result is dependent on the raw material, the machines and the environmental conditions. The diagram by Trützschler in Fig. 3 illustrates the dependence of cleaning on raw material type, in this case on the level of impurities.

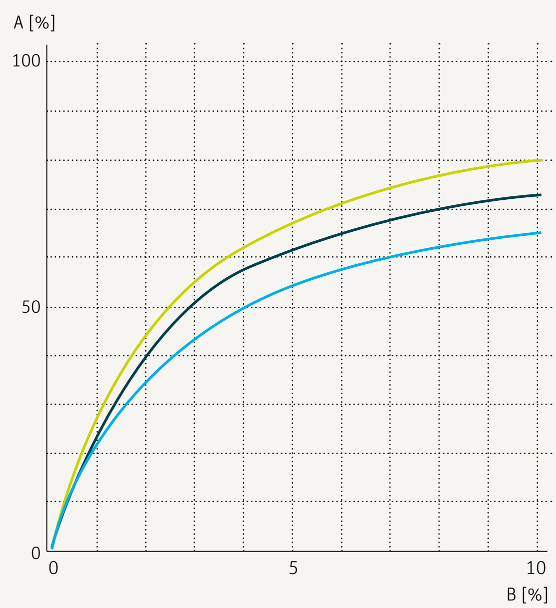


Fig. 3 – Degree of cleaning (A) as a function of the trash content (B) of the raw material in %

It is clear from this diagram that the cleaning effect cannot and should not be the same for all impurity levels, since it is easier to remove a high percentage of dirt from a highly contaminated material than from a less contaminated one. Looking at the machine, the cleaning effect is a matter of adjustment. However, as Fig. 4 shows, increasing the degree of cleaning also increases the negative effect on cotton when trying to improve cleaning by intensifying the operation, and this occurs mostly exponentially. Therefore each machine in the line has an optimum range of treatment. It is essential to know this range and to operate within it.

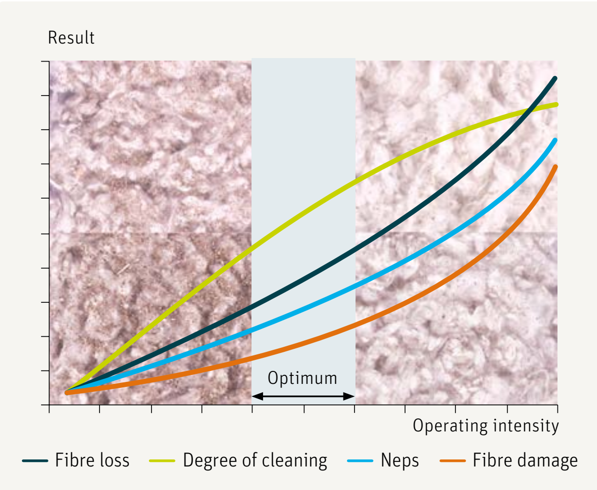


Fig. 4 – Operational efficiency and side effects

In an investigation by Siersch [3], the quantity of waste eliminated on a cleaning machine by modifying settings and speeds was raised from 0.6 % to 1.2 %: while the quantity of foreign matter eliminated increased by only 41 %, the quantity of fibers eliminated increased by 240 %. Normally, fibers represent about 40 - 60 % of blowroom waste. Thus, in order to clean, it is necessary to eliminate about as much fibers as foreign material. Since the proportion of fibers in waste differs from one machine to another, and can be strongly influenced, the fiber loss at each machine should be known. It can be expressed as a percentage of good fiber loss in relation to total material eliminated, i.e. in cleaning efficiency (C_E):

$$C_E = \frac{A_T - A_F}{A_T} \times 100$$

A_T = total waste (%); A_F = good fibers eliminated (%).

For example, if $A_T = 2.1$ % and $A_F = 0.65$ %:

$$C_E = \frac{2.1 - 0.65}{2.1} \times 100 = 69\ \%$$

1.2.1.3. Dust removal

Almost all manufacturers of blowroom machinery now offer dust-removing machines or equipment in addition to opening and cleaning machines. However, dust removal is not an easy operation, since the dust particles are completely enclosed within the flocks and hence are held back during suction (because the surrounding fibers act as a filter). Since, as shown by Mandl [4], it is mainly the suction units that remove dust (in this example 64 %), dust removal will be more intensive the smaller the tufts.
It follows that dust elimination takes place at all stages of the spinning process. Fig. 5 shows Mandl's figures for the various machines.

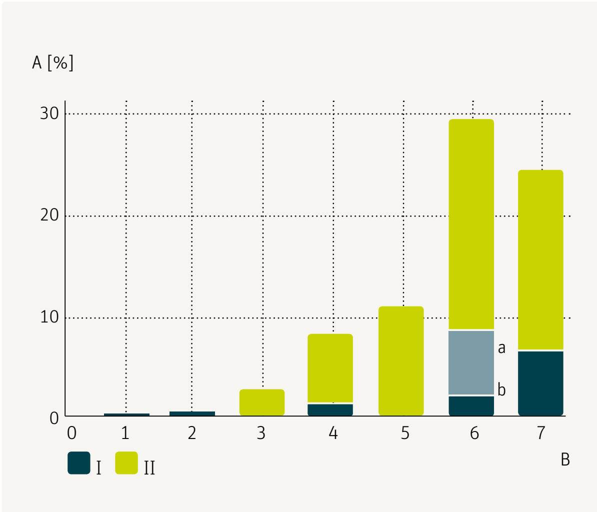


Fig. 5 – Dust removal as a percentage of the dust content of the raw cotton (A) at the various processing stages (B):
1 - 5, blowroom machines; 6, card; 7, draw frames; (a) filter deposit; (b) licker-in deposit; I, dust in the waste; II, dust in the exhaust air.

1.2.1.4. Blending

Blending of fiber material is an essential preliminary in the production of a yarn. Fibers can be blended at various stages of the process. These possibilities should always be fully exploited, for example by transverse doubling. However, the start of the process is one of the most important stages for blending, since the individual components are still separately available and therefore can be metered exactly and without dependence upon random effects.
A well-assembled bale layout and even (and as far as possible simultaneous) extraction of fibers from all bales is therefore of the utmost importance. Simultaneous extraction from all bales, which used to be normal in conventional blending batteries, is now no longer possible (automatic bale openers). Accordingly, intensive blending in

a suitable blending machine must be carried out after separate tuft extraction from individual bales of the layout. This blending operation must collect the bunches of fibers arriving sequentially from individual bales and mix them thoroughly (see Fig. 6, and description "1.4.4.3. The Rieter B 70 UNImix").

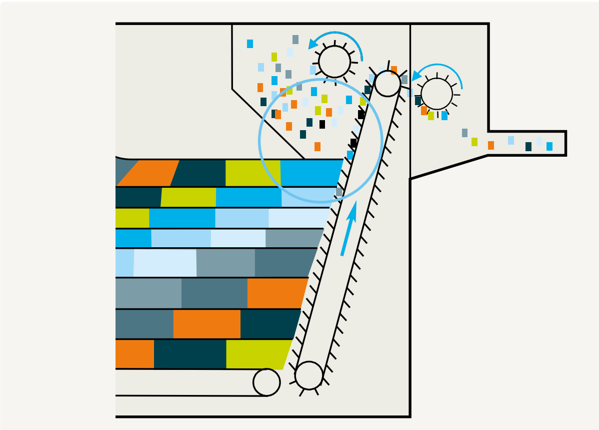


Fig. 6 – Sandwich blending of raw material components

1.2.1.5. Even feed of material to the card

Finally, the blowroom must ensure that raw material is evenly delivered to the cards. Previously, this was carried out by means of precisely weighed laps from the scutcher, but automatic tuft feeding installations are used nowadays. While in the introductory phase such installations were subject to problems regarding evenness of tuft delivery, today they generally operate well.

1.2.2. Feed material
1.2.2.1. Raw material

Fiber materials used in short-staple spinning can be divided into three groups:
- cotton, of various origins;
- man-made fibers, mainly polyester and polyacrylonitrile;
- regenerated fibers (viscose fibers).

An additional classification can be based on the degree of previous processing:
- raw fiber, direct from the ginning mill or the man-made fiber manufacturer;
- clean waste such as broken ends of sliver, lap and web;
- filter strippings from the draw frame, roving frame, ring spinning machine and rotor spinner;
- comber waste for the rotor spinning mill;
- recycled fibers from dirty waste in the blowroom and carding room;
- fibers torn out of hard waste such as roving, yarn and twisted threads.

Mostly, raw cotton and man-made fibers are used together with a small proportion of clean waste and possibly some recycled fibers blended with the raw material.

1.2.2.2. Re-usable waste

Rieter indicates average quantities of waste (in %) arising in the spinning mills of industrialized countries as shown in Table 1.
Binder [5] gives the following figures for the quantity of good fibers obtainable from waste material:

Machines	Cotton (length)				Synthetics
	1″	1 1/16″	1 1/8″	1 1/2″	
Ring spinning frame	1.5	2.2	2.7	3.0	2.2
Roving frame	1	1	1	1	1
Draw frame per passage	0.6	0.6	0.6	0.6	0.6
Comber	12	15	17	19	–
Ribbon lap	1	1	1	1	–
Sliver lap	0.5	0.5	0.5	0.5	–
Card	5	3.8	3.1	2.8	0.6
Blowroom	6	5	4	3	0.5

Table 1 – Amount of waste (%) from the different machines in industrialized countries

Clean waste	Good fiber (%)
– broken ends of sliver and lap	100
– filter waste	95 - 98
Comber waste	95 - 97
Dirty waste	
– from blowroom machines	35 - 55
– from cards (licker-in)	35 - 55
– flat and filter strippings	65 - 80
Hard waste – roving	95 - 97

1.2.2.3. Adding waste to the raw material

It will be apparent that raw fibers are usually better than waste fibers because waste contains processed and therefore stressed fibers. Furthermore, since waste fibers have experienced differing numbers of machine passages, they differ from each other in their characteristics. For example, lap web is very compressed, but waste from thread break suction systems is barely compressed at all.
Random and uncontrolled feeding of such fiber material back into the normal spinning process is to be avoided at all costs, since considerable count variation will result along with quality variations. It is preferable that:

- a constant, fixed percentage of waste fibers should be added to the fiber blend; and
- within this fixed proportion of waste, there should be a constant, fixed percentage of waste fibers of different sorts.

All of the clean waste arising in the mill can be returned to the same blend from which it arose; comber waste is used mostly in the rotor spinning mill; recycled fibers can be returned in limited quantities to the blend from which they arose. Rieter gives the following average amounts of recycled fibers that can be added to the normal blend:

Ring-spun yarns:
- carded up to 5 %
- combed up to 2.5 %

Rotor-spun yarns
- coarse up to 20 %
- medium up to 10 %
- fine up to 5 %

As regards fibers from hard waste, only roving is used. When such fibers are used at all, they are often not returned to the blend from which they came but to a lower quality blend, and even then only in the smallest possible quantities.

1.2.2.4. Material from bales

Production of a reasonably homogeneous product from inhomogeneous fiber material requires thorough blending of fibers from many bales. In practice, fiber is taken from 20 - 48 bales of cotton simultaneously; with man-made fibers 6 - 12 bales are sufficient. Simultaneous extraction of tufts from more than 48 bales is seldom useful, because usually there is no space for additional blend components in the blending chambers of the bale opener or blender without disturbing the evenness of distribution. On the other hand, the constancy of the blend can often be improved if care is taken with regard to homogeneity at the bale layout stage. The bales can be chosen in such a way that, for the layout as a whole, constant average values are obtained, for example for length, fineness and/or strength, within predetermined upper and lower limits, which is a bale management task. In order to achieve this, the quality of each bale must be known. Today computer software is available for optimizing bale grouping.

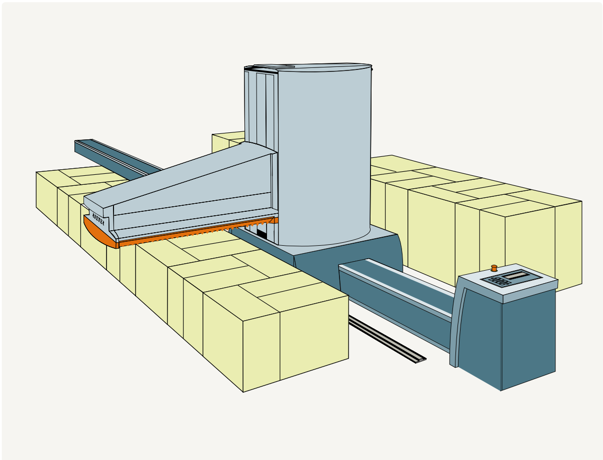


Fig. 7 – Bale layout in front of an automatic bale opener

1.2.2.5. Acclimatization of the raw material

Air temperature in the blowroom should be above 23°C and relative humidity should be in the 45 - 50 % range. Damp air makes for poor cleaning and over-dry air leads to fiber damage. It should be borne in mind, however, that it is not the condition of the air that matters, but that of the fibers. It is assumed, however, that the fibers adapt to the air conditions.

To enable this to happen, the fibers must be exposed to the air for an appropriate period. This is not achieved if cotton or, what is even worse, man-made fibers, are taken from the cold raw material store and processed as soon as they have been laid on the extraction floor. Cotton bales should be left to stand in the blowroom in an opened condition for at least 24 hours before extraction starts, better still for 48 hours. Synthetic fiber bales should be left to stand for 24 hours longer than cotton bales, but in an unopened condition. This allows the bales to warm up. Otherwise, condensation will form on the surfaces of the cold fibers. Further adjustment to the air conditioning occurs within the pneumatic transport devices. In such devices, the relatively small tufts are continually subjected to the air current in the transport ducts.

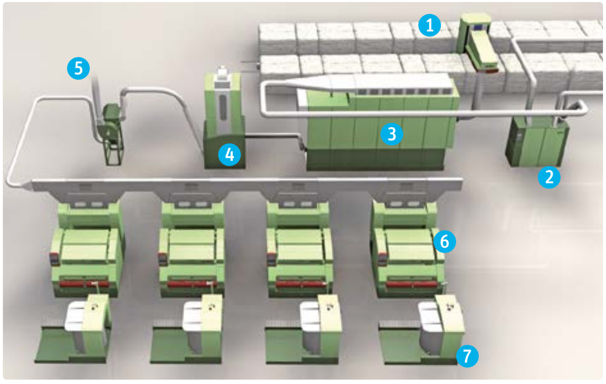


Fig. 8 – Rieter blowroom line
1. Bale opener A 11 UNIfloc
2. Pre-cleaner B 12 UNIclean
3. Homogenous mixer B 75 UNImix
4. Storage and feeding machine A 78 UNIstore
5. A 21 Condenser
6. C 60 card
7. CBA 4 Sliver Coiler

1.2.3. The blowroom installation as a sequence of machines

In processing the material, different types of machines are necessary, namely those suitable for opening, those for cleaning and those for blending. Different intensities of processing are also required, because the tufts continually become smaller as they pass from stage to stage. Accordingly, while a coarsely clothed cleaning assembly is ideal after the bale opener, for example, it is inappropriate at the end of the line. Therefore, there are no universal machines, and a blowroom line is a sequence of different machines arranged in series and connected by transport ducts. In its own position in the line, each machine gives optimum performance – at any other position it gives less than its optimum. Also there may be advantages in different modes of transport, feeding, processing, cleaning and so on from one machine to another along the line. Finally, the assembly of a blowroom line depends among other things on:

- the type of raw material;
- the characteristics of the raw material;
- waste content;
- dirt content;
- material throughput;
- the number of different origins of the material in a given blend.

In most cases a modern blowroom line consists of the following machines, as shown in Fig. 8 (Rieter) and Fig. 9 (Trützschler), illustrating two typical blowroom lines.

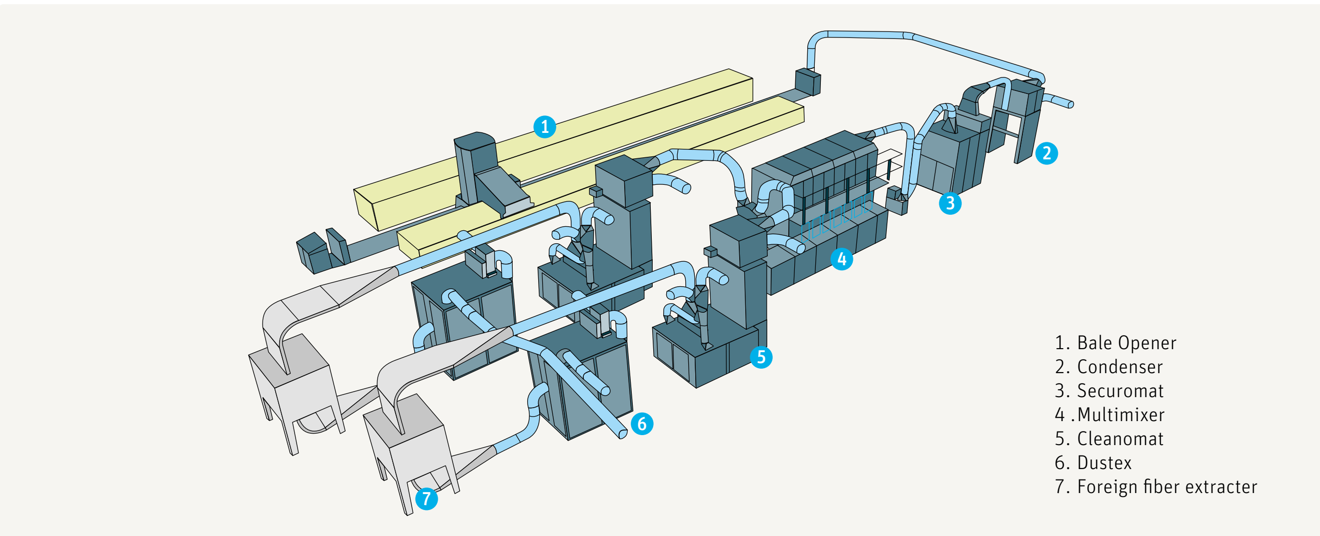


Fig. 9 – Trützschler blowroom line
(Conventional, for combed cotton. One line with a number of variations.)

1.3. The components of blowroom machines

1.3.1. Feeding apparatus

Feeding material to the opening rollers of an opening and/or cleaning machine occurs in free flight (gentle, but less intensive treatment of the fibers), or in a clamped condition (intensive but less gentle treatment). Free flight requires only a drop chute, suction pipe or vortex transport from rollers; a clamped feed condition calls for special machine components. In this case feed devices can be distinguished according to whether they comprise:

- two interacting clamping cylinders;
- a feed roller and a feed table;
- a feed roller and pedals.

Operating with two clamping cylinders (Fig. 10) gives the best forward motion, but unfortunately also the greatest clamping distance (a) between the cylinders and the beating elements.

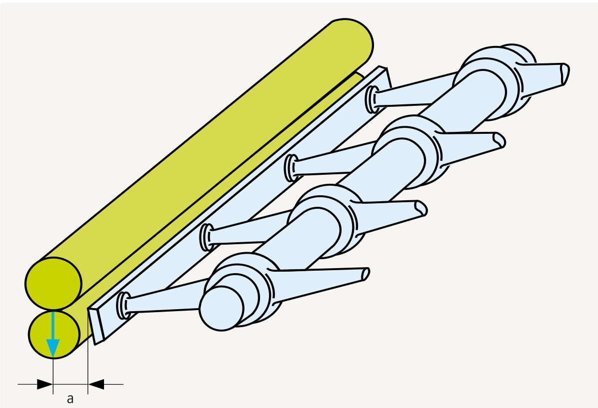


Fig. 10 – Feed to a beater with two clamping rollers

In a device with a feed roller and table (Fig. 11) the clamping distance (a) can be very small. This results in intensive opening. However, clamping over the whole width is poor, since the roller presses only on the highest points of the web. Thin places in the web can be dragged out of the web as clumps by the beaters.

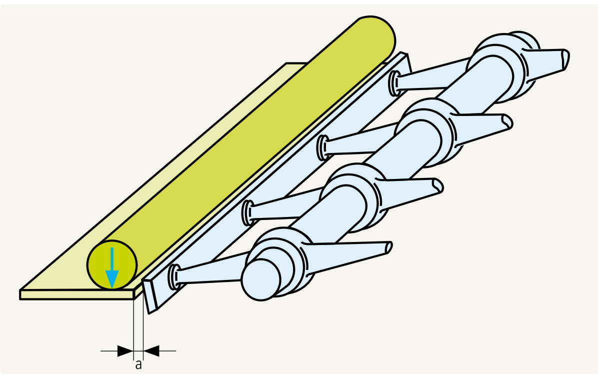


Fig. 11 – Feed with an upper roller and a bottom table

Where pedals are used (Fig. 12), the table is divided into many sections, each of which individually presses the web against the roller, e.g. via spring pressure. This provides secure clamping with a small clamping distance (a).
As far as the feed system is concerned, influence can be exerted on opening and cleaning only via the type of clamping, mainly via the clamping distance (a) to the opening element.

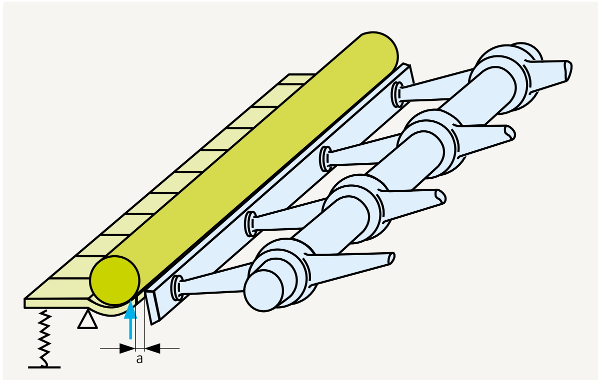


Fig. 12 – Feed with a roller and pedals

1.3.2. Opening devices

1.3.2.1. Classification

Some of the operating devices in blowroom machines function only for opening.
Most of them work, however, in cooperation with cleaning apparatus such as grids, etc., and thereby function also as cleaning units. Consequently, they are designed to operate both in opening and cleaning machines.
Opening units can be classified as:

- endless path;
- gripping devices;
- rotating assemblies.

Depending on their design, construction, adjustment, etc., these assemblies exert enormous influence on the whole process.

1.3.2.2. Endless path devices (spiked lattices)

1.3.2.2.1. Mode of operation

Spiked lattices (Fig. 13) serve as forwarding and opening devices in bale openers and hopper feeders. They consist of circulating, endless lattices or belts with transverse bars at short intervals.
The bars are of wood or aluminum; steel spikes are set into the bars at an angle and at greater or lesser spacings.

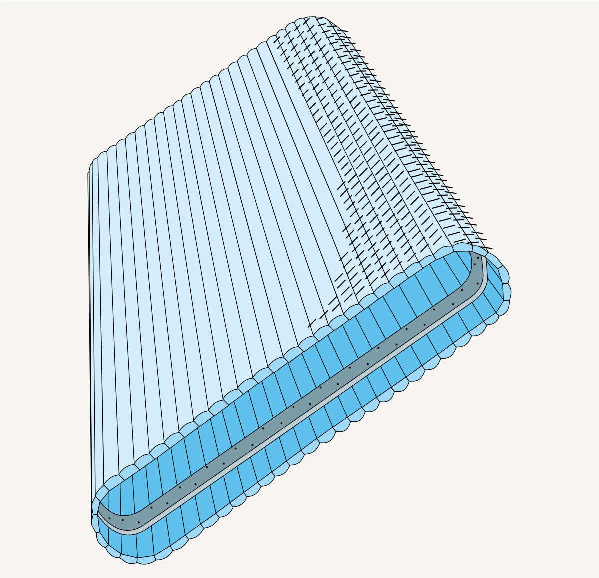


Fig. 13 – Spiked lattice

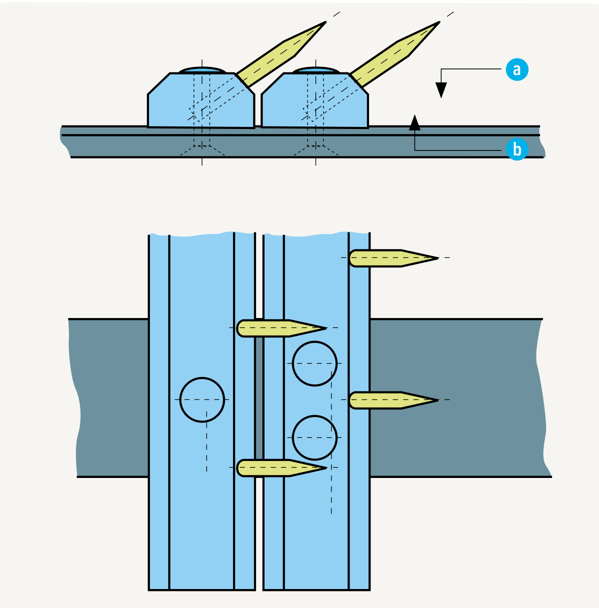


Fig. 14 – Securing band (a / b), bars and spikes of the inclined lattice

Owing to their configuration, inclined lattices usually feed the material upward at an angle. The spikes penetrating into the raw material carry the material along. Opening occurs because the spikes drag small tufts out of the large infeed material when passing the latter, and because in the upper region of the lattice there is a counter-rotating roller (Fig. 44), also clothed with spikes and located fairly close to the lattice. This roller strips the large material lumps from the lattice. The counter-operation of the two systems of spikes causes the tufts to be plucked apart. The intensity of the opening action is dependent upon:

- the distance between the devices;
- the speed ratios;
- the total working surface;
- the number of points.

Offsetting the spikes relative to each other can increase the opening effect. In this case they do not stand in rows and do not extract material along straight lines. Opening with spiked lattices is always gentle, even when fairly intensive.

1.3.2.2.2. Mixing and rolling effects

Spiked lattices are usually located in hoppers. Since only a small part of the material – the smaller tufts – can pass between the very closely spaced spike systems, the greater part is continually thrown back into the hopper and returned again from there by the inclined lattice. A continuously rotating roll of material forms in the hopper and this has both positive and negative effects. On the one hand, the rotation leads to thorough mixing; on the other, neps are formed. Both effects become more marked as the quantity of material in the hopper increases.

1.3.2.3. Gripping elements (plucking springs)

Some manufacturers, for example former Schubert & Salzer and Trützschler, have used plucking springs for opening. Two spring systems, facing each other like the jaws of a pair of tongs, are parted and dropped into the feed material and are then closed before being lifted clear. They grasp the material like fingers. This type of gripping is the most gentle of all methods of opening, but it produces mostly large to very large clumps of uneven size. This type of opening device is therefore no longer used.

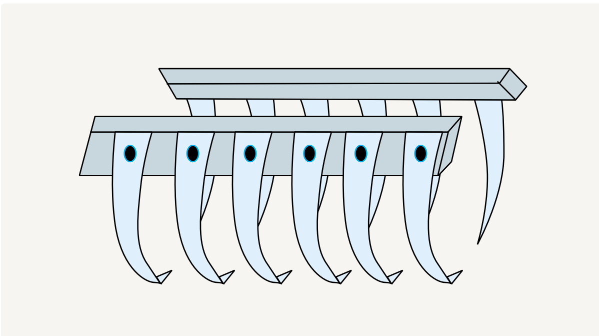


Fig. 15 – Plucking springs

1.3.2.4. Rotating devices

1.3.2.4.1. Rollers with teeth (blades) or spikes

Flat, oval or round bars are welded, riveted or screwed to closed cylinders. In another system flat bars are secured with the narrow side facing in the direction of rotation.

The rollers are therefore called spiked rollers (Fig. 16). Various spacings of the striker elements are used. These devices are incorporated mainly in modern horizontal cleaners, chute feeds, mixing bale openers, step cleaners, etc., which are located from the start to the middle of the blowroom line.
At the start of the line, the spacing of the striker elements on the roller is greater; finer spacings are used in the middle (to the end) of the line. The rollers rotate at speeds in the range of 600 - 1 000 rpm.

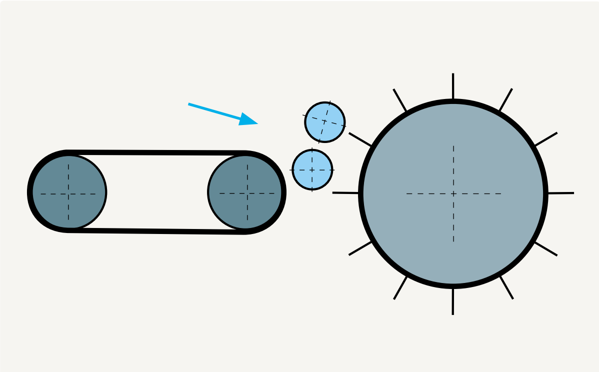


Fig. 16 – Spiked roller

1.3.2.4.2. Drums with teeth or spikes

The cylindrical parts are similar to those of the spiked rollers, but they have larger diameters of 600 mm and more. The striking elements are mostly of the same type, though they may differ.
In several designs, shafts carrying discs are used in place of cylindrical bodies. On their outer peripheries, the discs carry striker noses in the form of welded or riveted flat bars. The discs are maintained at the desired spacing by intervening collars.
In all opening assemblies, it is important to avoid removal of material from the feed batt in strips. For this purpose, the teeth or spikes are usually staggered to varying degrees.
The spacing of the striker elements on the drums is coarse when the drum is designed for use at the start of the process (the Rieter B 12 UNIclean, for example), and fine when the drum is designed for use in the middle or toward the end of the line (for example as the former porcupine cleaner).
Rotation speeds vary between 400 and 800 rpm and the device can be arranged parallel or at right angles to the material flow.

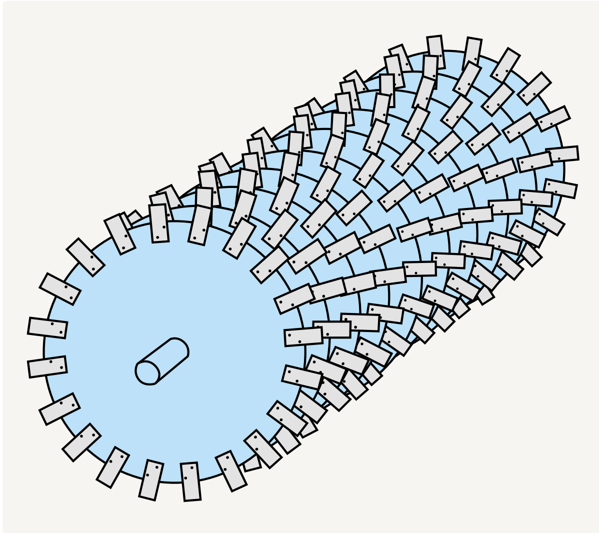


Fig. 17 – Bladed drum

Rieter uses a new arrangement for the UNIclean pre-cleaner: the double pins fixed by screws to the drum.

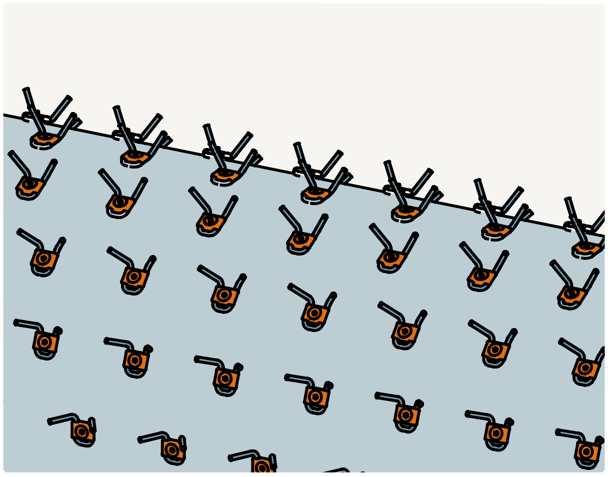


Fig. 18 – Drum with double pins

1.3.2.4.3. Blowroom rollers with toothed discs

In contrast to spiked rollers or drums, which have quadrilateral or round elements, toothed disc units have noses – triangular plucking elements (coarse saw teeth). The complete opening device is made up of many such toothed discs secured to a shaft with an appropriate number of spacers (Fig. 19). In this case also, removal of material in strips is to be avoided.
In toothed discs, the teeth are almost always asymmetrical, since they have to operate in only one direction, and therefore rotate in only one way.

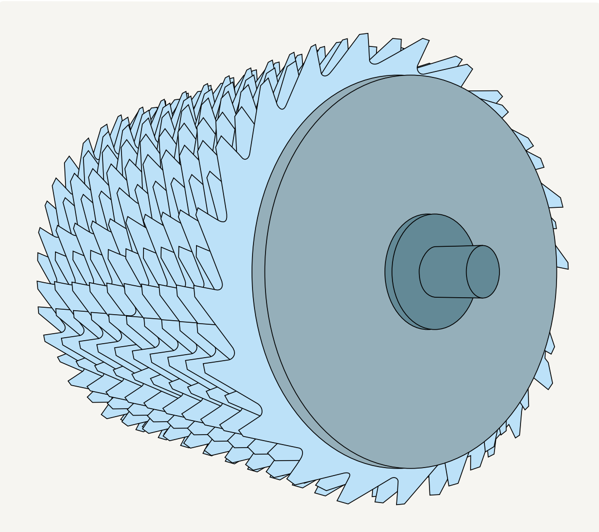


Fig. 19 – Rollers with toothed discs

Automatic bale opening machines often require alternative arrangements, since in many cases they move forward and backward, i.e. the directions of movement and removal of material vary. The material-extracting roller should therefore rotate sometimes in one direction and sometimes in the other. In this case the direction of rotation has to be changed according to requirements or two such rollers are to be used in the bale opener, rotating in different directions. If only one roller always rotating in the same direction is to be used, then it must have symmetrical teeth that are effective in both directions. This requirement can be satisfied if the elements are formed as double teeth (Fig. 20, Rieter UNIfloc).

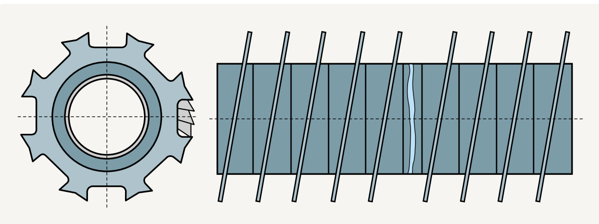


Fig. 20 – Take-off roller with two-sided teeth

1.3.2.4.4. Carding rollers

Not only has the quantity of dirt in cotton greatly increased in the past few decades, the impurities have become steadily smaller owing to hard ginning. They have consequently become more difficult to remove. If the machine is to eliminate even the smallest particles, then more tuft surface must be created, i.e. the material must be opened to substantially smaller tufts then before. That is not possible with the opening devices described already; significantly finer spacing of the elements is necessary for that purpose – saw-tooth wire, for example. As a result it became necessary several years ago to integrate the licker-in, i.e. a carding roller, into the blowroom. This roller produces the finest opening and best cleaning, but also stresses the fibers most severely. Setting the speed of rotation, and other adjustments, therefore demands a ‘feel’ for the operation. The type of clothing corresponds approximately to that of the licker-in, with tooth spacing of 6 - 8.5 mm, tooth height of 4.5 - 5.5 mm and about 6 - 8 turns per inch. The wire is secured in the same way as the wire of the licker-in. Rotation speeds are between 600 and 1 000 rpm. Carding rollers are the main part of modern fine cleaners, and used at the end of the line. Sometimes 2, 3 or even 4 such rollers are arranged in line in the machine.

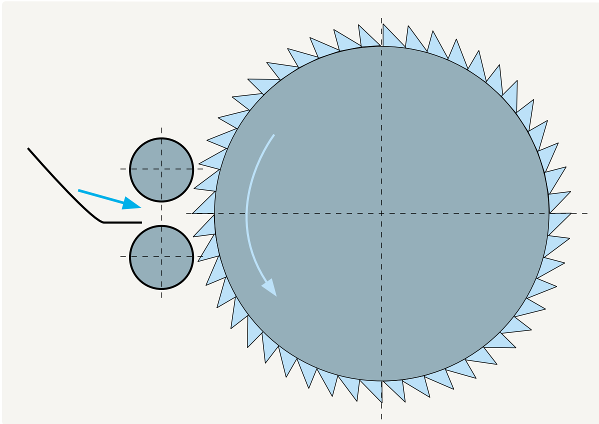


Fig. 21 – Carding rollers

1.3.2.4.5. Beater arms (multiple bladed beaters)

Multiple bladed beaters consist mainly of two or three beater bars arranged parallel to the supporting shaft and held by four or five cast-iron arms (Fig. 22). In the course of one rotation of the shaft, the web projecting from the feed rollers is subjected to two or three blows over its whole width. The opening effect, and hence the cleaning effect, is small. This machine is hardly used today; when it is found at all, it is only in the form of the old double beater scutcher.

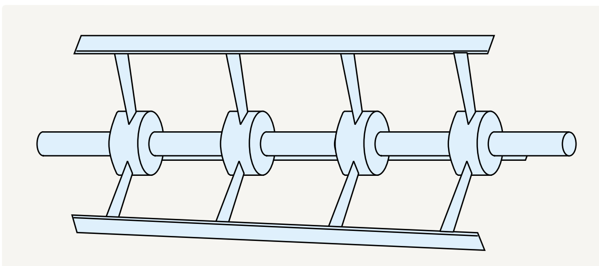


Fig. 22 – Bladed beater

1.3.2.4.6. Beaters and rollers with pinned bars

These machines are similar to the multiple bladed beaters, but instead of beater bars, pinned bars (pinned lags) are secured to the ends of the cast-iron arms. They were called Kirschner beaters and comb through the web at speeds of 800 - 900 rpm. The relatively high degree of penetration results in good opening. Kirschner beaters were therefore often used at the last opening position in the blowroom line, since good pre-opening of the fiber material permits gentle opening at the licker-in of the card. The cleaning efficiency of the Kirschner beater is high, but unfortunately, so too is fiber elimination. Some machinery manufacturers therefore replaced the grid under the Kirschner beater with a guide plate; the resulting machine was an opener, but no longer a cleaner.

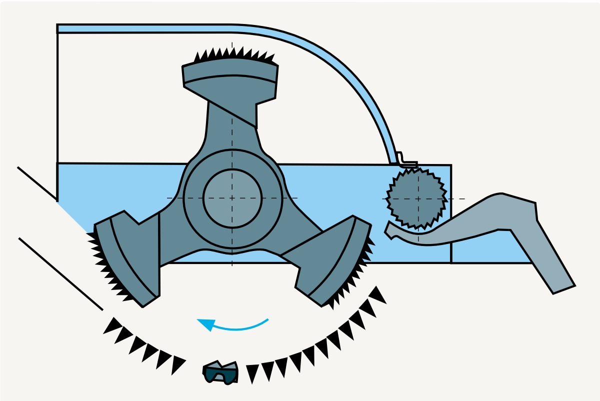


Fig. 23 – Beaters with pinned bars (Kirschner beaters)

Modern Kirschner openers are often designed as closed rollers rather than three-armed beater units. The design is simpler and the flow conditions are more favorable. In other respects, they operate like Kirschner beaters, but usually have four to six pinned bars instead of only three. If at all, Kirschner beaters or rollers are found only in old scutchers.

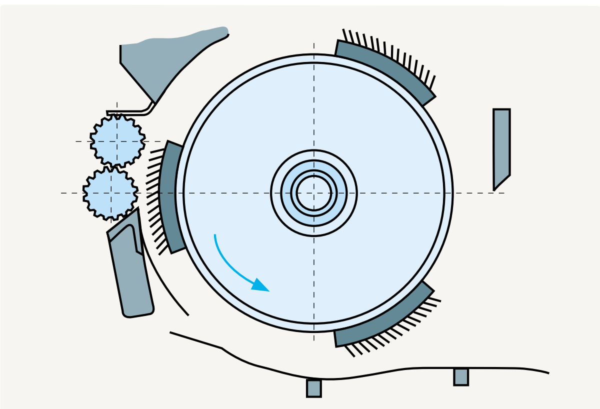


Fig. 24 – Rollers with pinned bars (Kirschner rollers)

1.3.3. The grid
1.3.3.1. The grid as an operating device

In the final analysis, it is the grid or a grid-like structure under the opening assembly that determines the level of waste and its composition in terms of impurities and good fibers. Grids are segment-shaped devices under the opening assemblies and consist of several (or many) individual polygonal bars or blades (i.e. elements with edges) and together these form a trough. The grid encircles at least 1/4, at most 3/4 and usually 1/3 to 1/2 of the opening assembly. The grid has a major influence on the cleaning effect via:
- the section of the bars;
- the grasping effect of the edges of the polygonal bars;
- the setting angle of the bars relative to the opening elements;
- the width of the gaps between the bars;
- the overall surface area of the grid.

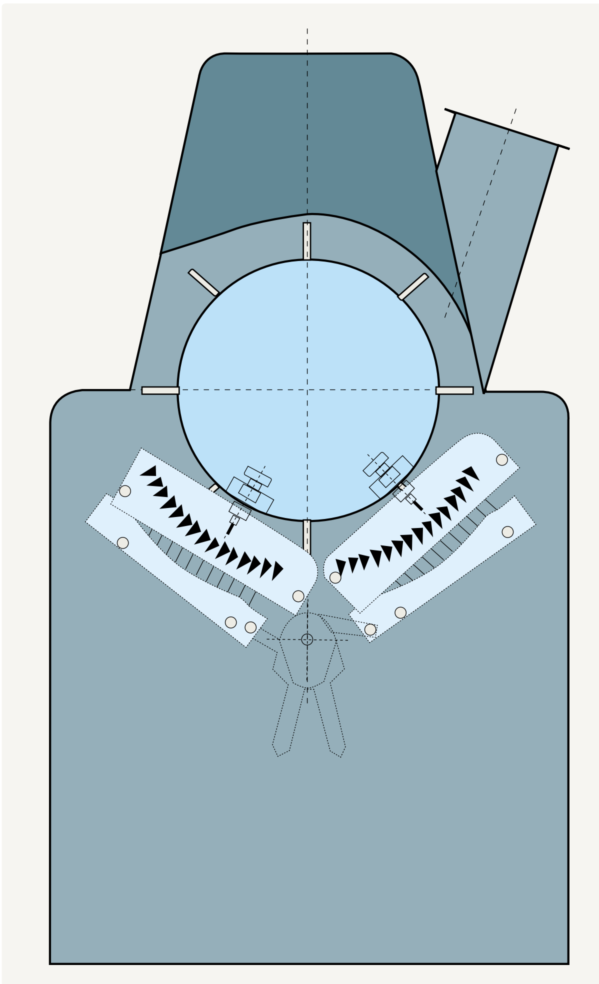


Fig. 25 – Two-part grid

1.3.3.2. The elements of the grid

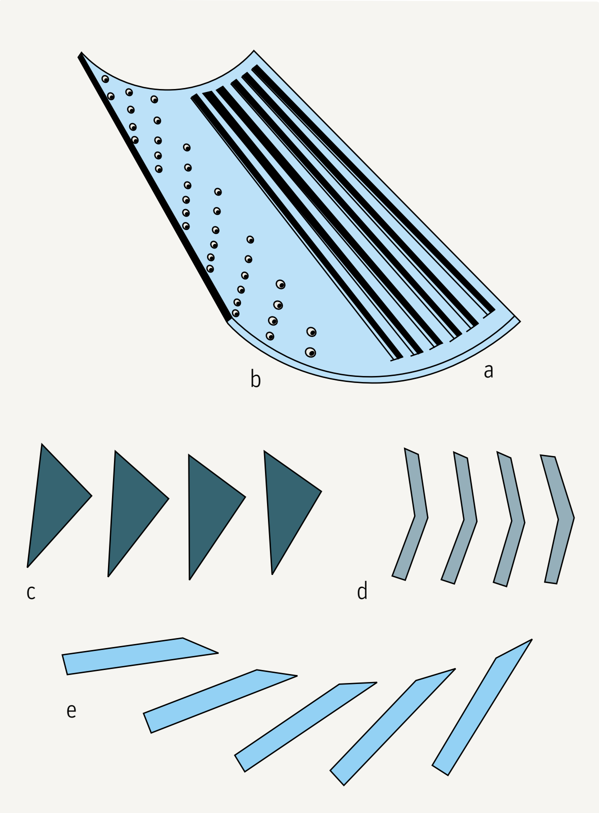


Fig. 26 – The elements of a grid

The following elements can be used in the grid:
- slotted sheets (a): poor cleaning;
- perforated sheets (b): poor cleaning;
- triangular section bars (c): the most widely used grid bars;
- angle bars (d): somewhat weak;
- blades (e): strong and effective.

They can be used individually or in combination, but slotted and perforated sheets, which were formerly placed under the licker-in, are to be found in old, obsolete cards only. Modern grids are mostly made up of triangular bars. They are robust, easy to manipulate and produce a good cleaning effect. The same is true of blade-grids.
Blades have been used as grid elements for a long time (the mote knife), almost always in combination with triangular section bars.
Today, grids are made up of knife blades alone, without other element types. Angle bars are somewhat less robust and can tend to create blockages.

1.3.3.3. Waste collecting chambers under the grid

Impurities and fibers fall through the grid gaps and accumulate in large quantities in the chamber under the grid. Waste used to be periodically removed manually, but pneumatic removal systems are used today. As far as the cleaning effect is concerned, modern waste chambers are passive elements, without influence on the operation. In older designs they sometimes participated actively, and afforded the possibility of exerting a significant influence on events by permitting some of the transport air for forwarding the tufts (the so-called secondary air) to enter through the waste chamber and the grid. Such systems enabled the interaction of airflow and beating power to be exploited. Heavy particles could drop out, against the airflow through the grid gaps, because of their high ratio of mass to volume. However, fibers were taken up again with the airflow because of their low ratio of mass to volume. Today, this principle cannot be exploited because of the small size of the foreign matter, which would now be carried back along with the fibers. Accordingly, a so-called dead chamber is now used; none of the transport air now passes through the grid gaps.

1.3.3.4. Grid adjustment

The grid can be in one, two or three parts. Correspondingly, it can be adjusted only as a unit or in individual sections. Three basic adjustments are possible:
- distance of the complete grid from the beater;
- width of the gaps between the bars (Fig. 28, a=closed, b=open);
- setting angle relative to the beater envelope (Fig. 27 and Fig. 28c).

It is not common to make all these three adjustments. In most the cases the machines are so designed that only two adjustment types are possible.

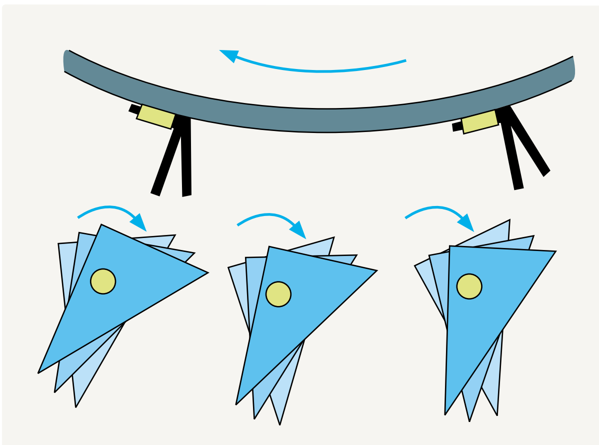


Fig. 27 – Changing the grid bar angle to the beater

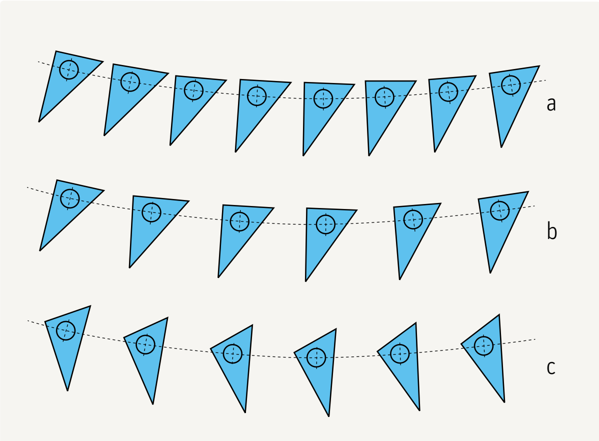


Fig. 28 – Adjustment of the grid bars

1.3.4. Interaction of feed assembly, opening element and grid

Fig. 29 to Fig. 32 demonstrate the influence of adjustments to these elements:

- Fig. 29, distance between feeding device and beater;
- Fig. 30, grid gap width;
- Fig. 31, beater speed 740 rpm (and setting angle of the grid bars);
- Fig. 32, beater speed 550 rpm.

The figures do not show fiber deterioration, or even damage, that can be caused. Nevertheless, very fine settings and high rotation speeds can produce very negative effects. On the other hand, the number of neps is scarcely affected. The design of the machine and its components exerts the strongest influence on neppiness.

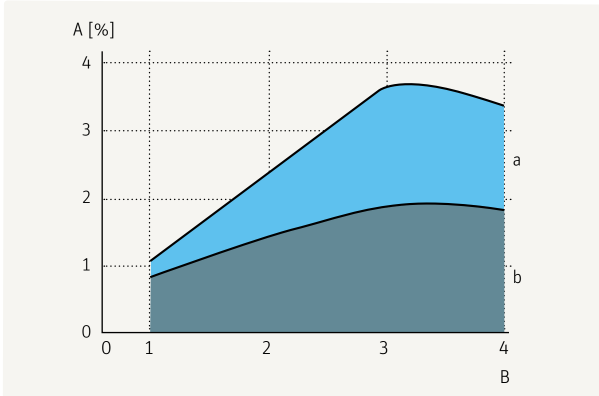


Fig. 30 – Dependence of waste elimination: (A, %) on the width of the grid gaps (B) (1 closed, 4 open). a = proportion of good fibers; b = trash content.

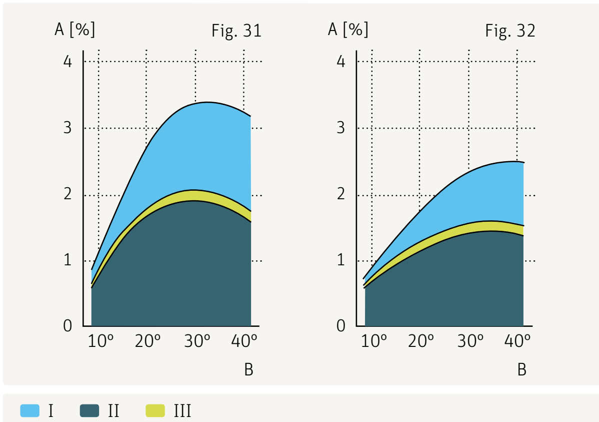


Fig. 31 – Dependence of waste elimination: (A, %) on the setting angle of the grid bars relative to the beater (B in degrees). I, fiber content; II, trash content; III, filter drum loss (Beater rotation speed: 740 rpm).
Fig. 32 – The same function as Fig. 31 but with a beater rotation rate of 550 rpm.

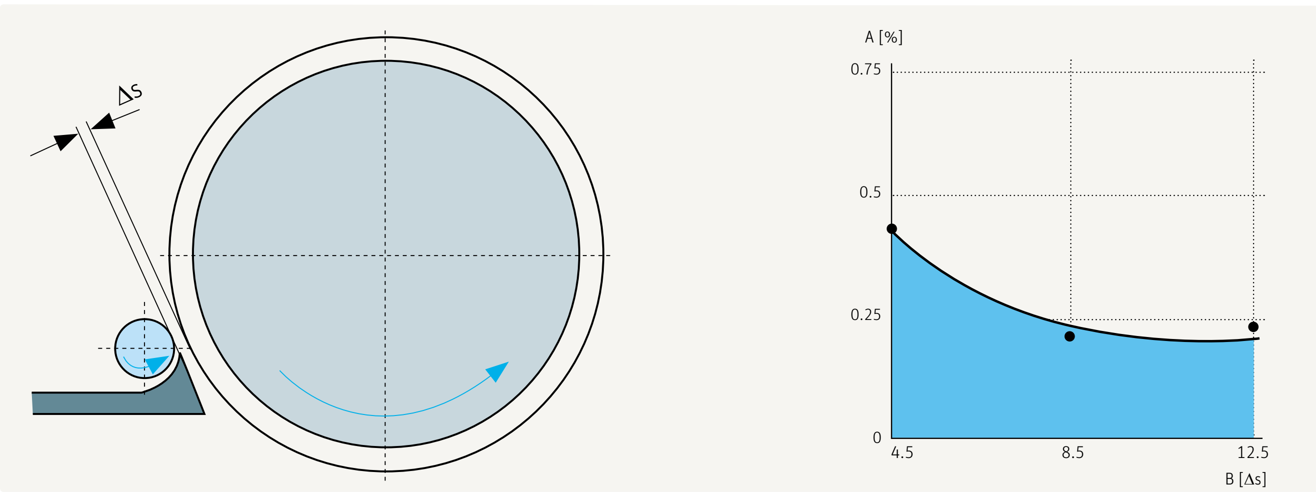


Fig. 29 – Influence of feed pedal distance (Δs; B, mm) on waste elimination (A, %)

1.3.5. Alternative cleaning possibilities

An alternative to the commonly used mechanical cleaning was the airflow cleaner from the former Platt Company.
The 'Air-stream-cleaner' comprises two parts, a Kirschner roller as opening assembly (and pre-cleaner) and the airstream cleaner itself, as shown diagrammatically in Fig. 33.
The cotton passes from the Kirschner roller (in front of A) into duct A. The transporting air is subjected first to acceleration due to convergence of the duct bore, and to an additional airstream created by fan (V).

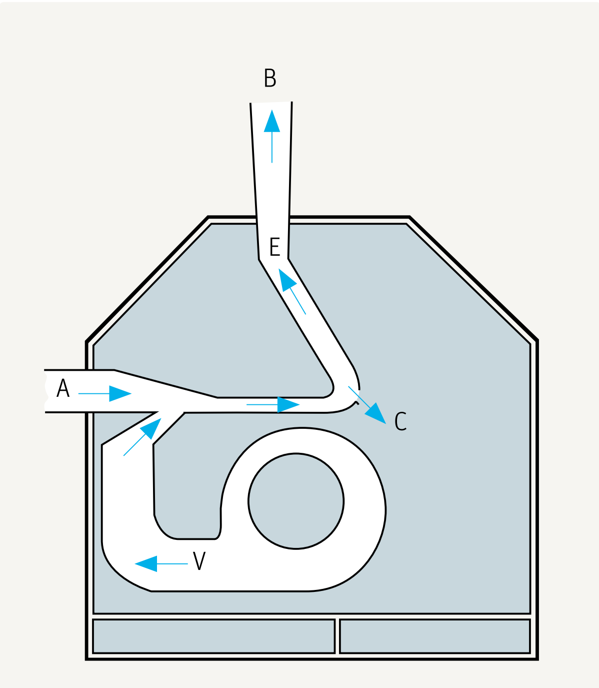


Fig. 33 – Airflow cleaner

In region C, the whole airstream undergoes a sharp diversion (of more than 90°) towards E.
While the relatively light cotton tufts can follow the change of direction, the heavier foreign particles fly through an opening in the duct, beyond region C, into the waste chamber.
This is an extremely gentle cleaning technique, but it requires foreign matter significantly less able to float than the fibers, i.e. it must be substantially heavier than the fibers.
Unfortunately, this is no longer true for all cotton varieties, and therefore this good cleaning idea is not applicable today.

1.3.6. General factors influencing opening and cleaning

Degree of opening, degree of cleaning and fiber loss are primarily dependent upon, and can therefore be influenced by:
- the type of opening device;
- speed of the opening device;
- degree of penetration into the material;
- type of feed;
- spacing of the feed from the opening device;
- type of grid;
- area of the grid surface;
- grid settings (airflow through the grid);
- condition of pre-opening;
- thickness of the feed web;
- material throughput;
- position of the machine in the machine sequence.

1.4. The machines comprising a blowroom installation
1.4.1. Summary
1.4.1.1. A modern blowroom line

As the operational means available are dealt with in the previous chapters, and as the conditions and influencing factors are also known, it is not very difficult to pinpoint (theoretically) a modern and effective blowroom line:
At the beginning a bale opener (automatic) is required, which opens the pressed cotton carefully into tufts that are as small as possible, allowing the presentation of a large, but not too large bale layout. It should be flexible to operate with a (at least small) variation of blends.
This first machine in the line, the automatic bale opener, produces a large quantity of surfaces that have not yet been cleaned. So after this opener a cleaning machine is required. As extensive surfaces are exposed for cleaning, and as the impurities can easily be eliminated from these surfaces, no additional opening operation is needed in this second machine, and also no feeding device. The cotton can be treated very carefully in free flight.
The machine required at this point is a pre-cleaner.
In contrast to the former bale opener batteries, in modern automatic bale openers cotton tufts are not plucked out of all bales of the layout simultaneously, i.e. the individual components are not yet fully blended together. That is why a separate blending machine is needed after the pre-cleaner. So we have the third machine in the line.
Although the automatic bale opener delivers quite a large quantity of surfaces cleaned by the pre-cleaner, there are still a lot of impurities within the tufts. A second cleaner is required to eliminate them. However, as this machine has to create more surfaces, and thereby

very small tufts, a cleaner with a high opening effect is required. Saw-toothed rollers with feeding in the clamped condition are required for treating the material here. Within this so-called fine cleaner the treatment of the material is, of course, quite aggressive but unavoidable. At this point the question arises whether there is any reason why the fine cleaner is behind and not in front of the blender. This reason is obvious. The fine opening machine has to be placed directly in front of the licker-in of the card, thereby enabling the material to be treated more carefully at the infeed of the card. As we learned in the early chapters, another task of the blowroom line is dedusting, and no machine has yet been mentioned for this purpose. However, the reason for this omission is very clear. High-performance machines in a modern blowroom line are constructed in such a way that dedusting arises as a very systematic side effect in every opening machine in the line. In normal cases no special dedusting machines are required. However, several manufacturers now offer special dust-removing machines or equipment. In the machine sequence, they appear mostly at the end of the line. Even when machines (from different manufacturers) within an individual zone differ in design, they are based on a common basic concept, so that all the machines of a given zone can in general be explained by taking one of them as an example, as in the following chapters.

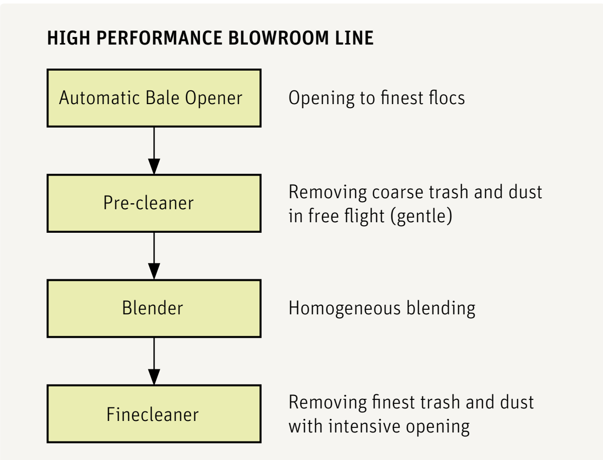


Fig. 34 – High performance blowroom line

These four machines (as shown Fig. 34) are the basic requirements of a modern high-performance blowroom line. More machines in the line result in raw material deterioration. However, extremely well designed machines are the prerequisite for these lines. This applies to the great majority of cotton lines; other arrangements and/or machines are only required for special treatments.

The line can be extended for special purposes by adding foreign matter extractors (i.e. plastic sheets, parts of bale wrapping, etc.), dedusting machines, recycling plants, etc. Blowroom lines of this high-performance type achieve a high opening rate and excellent cleaning efficiency, as shown in Fig. 35a.

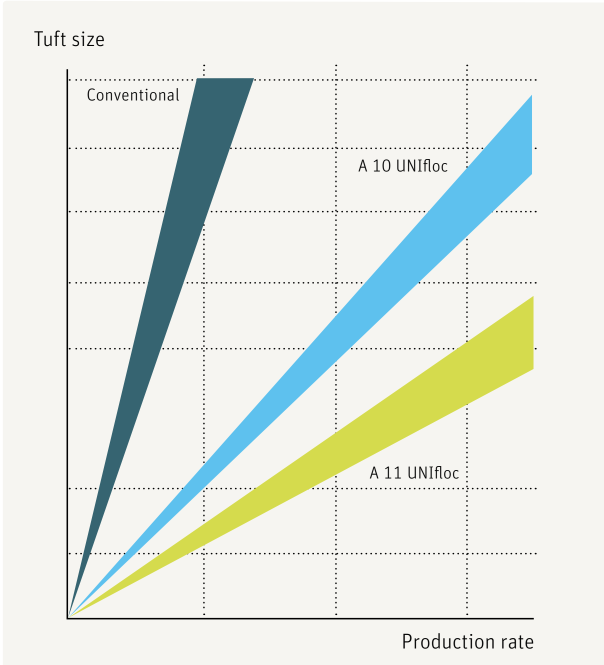


Fig. 35a – Opening performance of the automatic bale openers
Left: conventional machine; center: good, but the last but one generation of machines; right: high-performance bale opener of the latest generation

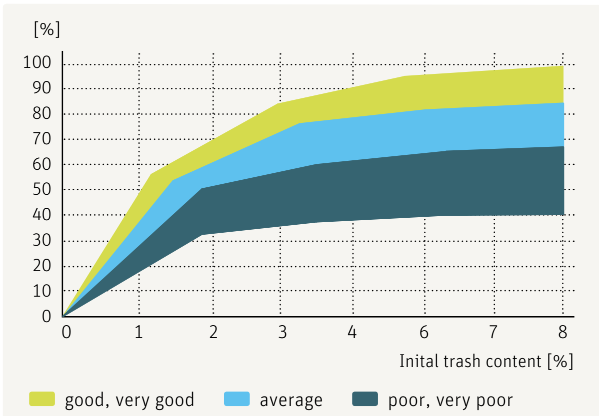


Fig. 35b – Cleaning efficiency of a high-performance blowroom line for cotton with different cleaning compliances

1.4.1.2. The last generation blowroom line

To illustrate this new concept we have to start with the card. Figs. 88 and 92 show the initial feed chutes of cards as a simple square structure. In the course of time substantial improvements were developed, e.g. integrated opening roller, controlled material compressing, transport air elimination, de-dusting, etc. (Fig. 93). At this stage of development some engineers in the research department discovered that an ideal fine cleaner could be obtained with some minor changes in the design of the card chute and with only little effort, since the infrastructure already existed. All that was required was to replace the coarse opening roll by a pinned roll with a new kind of feed roller in front and a scraping knife underneath the roll (Fig. 94).

This design made a separate fine cleaner in the blowroom line superfluous. The most modern blowroom lines therefore no longer feature a separate fine cleaner in front of the card. This function has now been transferred to the card feed chute as an integrated part of this unit. This solution results in a remarkable improvement in quality, since the material is treated more gently. As an integrated machine (only one) of a blowroom line the fine cleaner has to treat the total amount of material to be processed in this line, and does this with a saw-toothed roll operating in a somewhat aggressive manner. In the new line the same amount of material (up to 1 200 kg/h) is divided, for example, among 2 x 6 chutes equipped with pinned opening rolls (2 lines of cards with 6 cards each).

Another improvement, in this case in terms of rationalization, was introduced at the same time as this development, i.e. joining the card to the first passage draw frame (Fig. 36). The latter is placed directly following sliver delivery from the doffer. Incorporating these innovations, the most modern material treatment system at the beginning of the spinning process is a combined, integrated, homogenous unit comprising:

- bale opener;
- pre-cleaner;
- blender;
- card (combined with the first passage draw frame).

It can be described as the „material Preparatory section", and a modem spinning plant for coarse to medium counts then consists of three divisions:

- Material preparatory section (with only a few possible variations);
- Spinning preparatory section (with or without the combing section); and the
- Final spinning section.

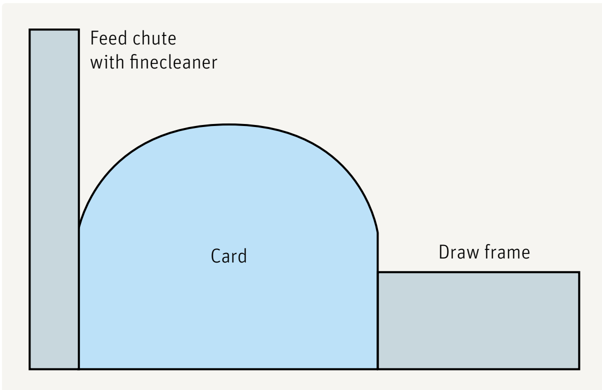


Fig. 36 – The compound card

1.4.2. Machines for "opening"

1.4.2.1. Automatic bale opening machines

The first generation automatic bale opening machines were mostly stationary. Only the bales were moved, either backward and forward or in a circle. The second generation machines are of the traveling type, i.e. they move past the stationary bales of the layout and extract material from top to bottom. Traveling machines have the advantage that more bales can be processed as an overall unit (charge), and thus a better long-term blend is achieved.

It should be noted, however, that these machines extract material only in batches, i.e. they can process only one, two or at most three bales simultaneously. If a long-term blend is to be achieved, then mixing machines must be included downstream from the bale opener.

A bale layout can comprise up to 130 bales from 4 to 6 different sources, i.e. 4 to 6 different types of bale per fiber blend. Intervening spaces sometimes have to be left between the individual bale groups so that the extraction roller can be adapted to varying bale heights. The machines are completely electronically controlled and extract material from all bales evenly, independently of varying bale densities and heights. The machines of this first zone should be able to:

- extract material evenly from all the bales of a lay-out;
- open the material gently;
- open up to the smallest tufts;
- form tufts of equal size;
- process as many bales as possible in a single charge;
- be universally applicable, i.e. easy to program;
- blend material right at the start of the process;
- permit the composition of a fiber blend from several components (fiber origins).

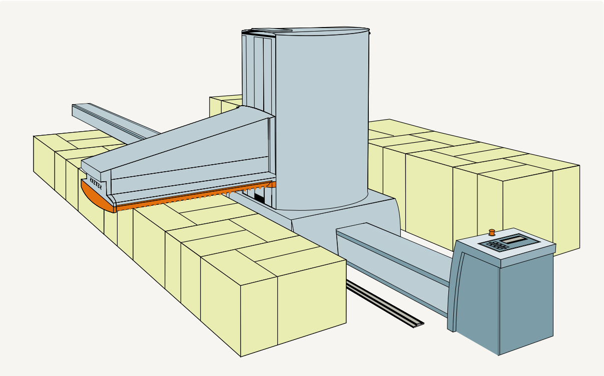
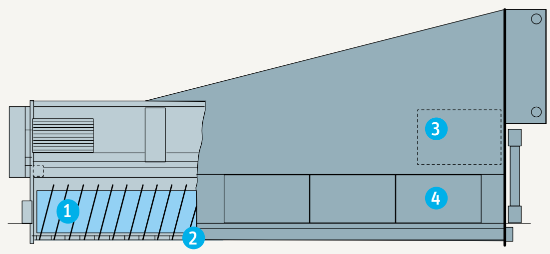


Fig. 37 – Rieter UNIfloc automatic bale opener

1.4.2.2. The Rieter A 11 UNIfloc

In concept, this is the most widely used type of machine today. Machines similar to the UNIfloc are built by other manufacturers too, e.g. Marzoli and Trützschler (Blendomat).



1. Opening roller
2. Grid
3. Motor
4. Safety rail

Fig. 38 – Tuft extracting device of the UNIfloc

The Rieter UNIfloc enables up to 130 bales arranged for up to four components (different bale types) per blend over a maximum bale layout length of 47.2 m to be processed. The machine can process one blend or up to 4 blends simultaneously. The production rate is normally up to 1 400 kg/h .

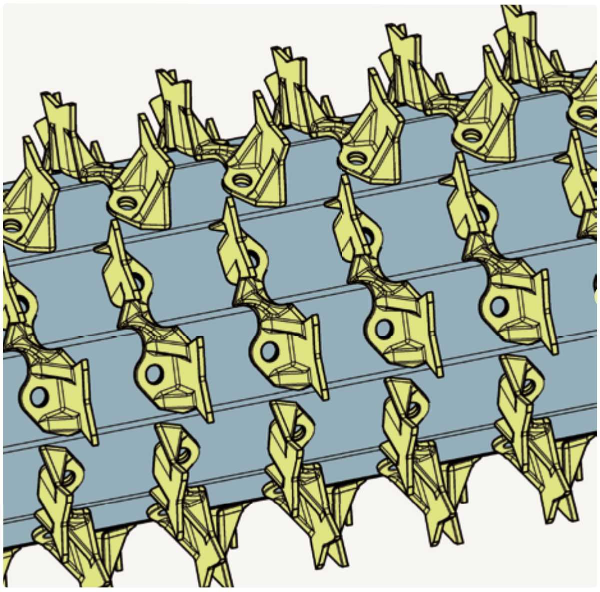


Fig. 39 – The opening device

The feed duct (Fig. 40, 1) and the two bottom rails are secured to the floor. A chassis, which moves back and forth on the guide rails, carries a turret (2), which swivels through 180° and supports an extracting assembly (3) which can be raised and lowered. The latter has individually replaceable double-teeth and changes its direction of rotation on reversal of the direction of movement of the chassis, so that material can be extracted in both directions of travel.

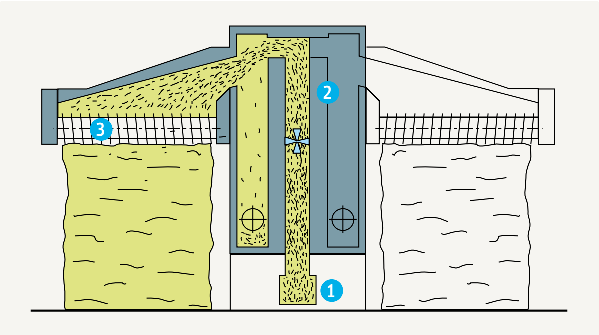


Fig. 40 – UNIfloc, suction system for the tufts

A microprocessor is provided for fully automatic extraction of material from the bales. The production rate and the total weight of feed material can be entered manually on the numerical keyboard. On the basis of the automatically detected bale heights, the machine then calculates all data required for fully automatic operation, including the penetration depth for extraction.
The bales laid out to left and right of the machine and

- bales can be processed from both sides simultaneously into one blend;
- from both sides simultaneously into several blends; or
- from one side only.

In the latter case, new bales can be prepared on one side and left to acclimatize, while other bales are processed on the other side.

1.4.2.3. Trützschler Blendomat BDT 020 automatic bale opener

This bale opener's extraction method differs from that of other openers. Whereas with normal openers a certain number of bales (the bale layout) are processed, and after that another bale layout is worked off, and then another, and so on, i.e. charge by charge, extraction of material on the BDT 020 takes place continuously.
For that purpose material has to be extracted from the bales in an inclined position. This means that the moment a bale is exhausted completely it will be replaced by new one, and the next exhausted bale by another new one.

Feeding of the new bales is automatic. Bales ranging from the maximum height to the minimum height are therefore always to be found on the bale transport conveyer, as already mentioned, in an inclined line (Fig. 41). A reserve belt, on which a certain number of bales can be placed for acclimatization, is usually installed in front of the transport conveyer belt. The extraction of the material occurs in the same way as on other bale openers. The only difference is that the opening device has to have the same angle of inclination as the bales fed to it (Fig. 42).
The advantage of this opening method is very good long-term blending (continuous, not charge by charge), the disadvantage a limited number of bales in the feed.

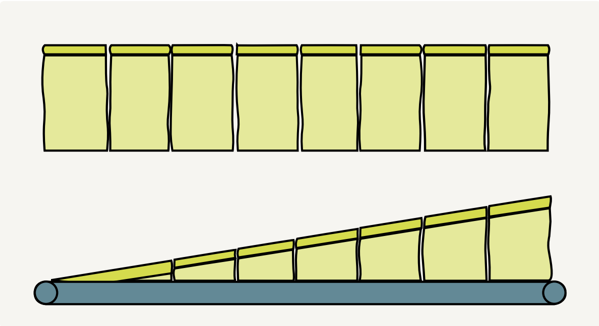


Fig. 41 – Inclined line of the exhausted bales in the feed

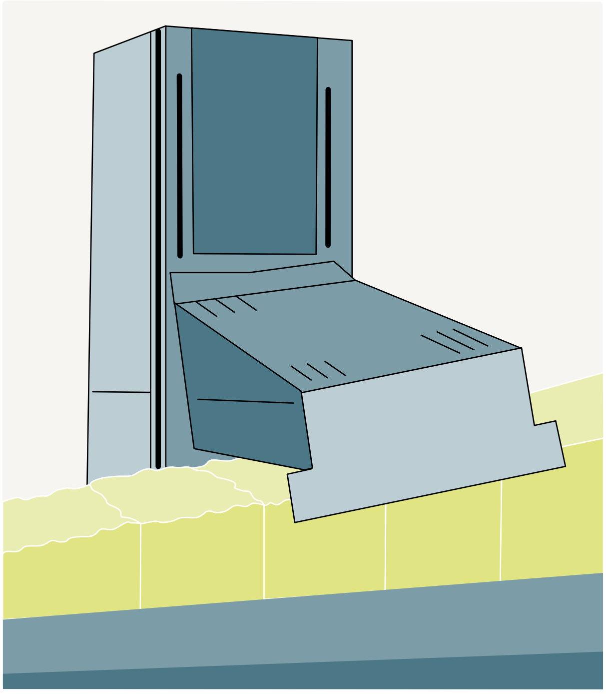


Fig. 42 – Inclined opening device of the bale opener

1.4.2.4. Conventional bale openers

Bale openers, blending openers, blending bale openers, mixing openers, waste openers (or machines under other such names) are manufactured by many companies. Previously, these were the standard bale openers; in newer installations, however, they are found mainly as waste feeders or for opening and blending of man-made fibers. Laying of material on the feed apron (Fig. 43) is performed manually or via condenser from a bale opening machine. The feed apron (2) pushes the fiber mass toward the inclined lattice (4). In its rapid rotation, the latter carries clumps of material upward. If these clumps are sufficiently opened, they pass between the inclined lattice and the evener rollers (at the top). However, most clumps are too large to pass through the space between the two units. They are thrown back into the blending hopper by the evener rollers, and from the hopper they pass once more into the operating region of the two assemblies (lattice and rollers).

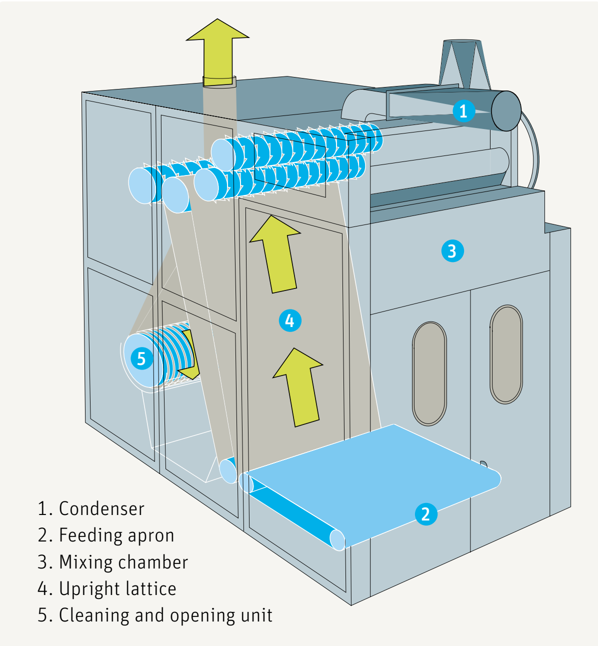


Fig. 43 – Bale opener

Each time they become smaller until finally they can pass through to the next unit. Production rate and degree of opening are determined by the speed of operation of the inclined lattice and its spacing from the evener roller. When processing wastes, which tend to form laps around the evener roller, this evener roller can be replaced by an evener lattice.

Some auxiliary units, depending on the material to be processed and in coordination with the other blowroom machines, can augment the basic units of the blending opener. These auxiliary units can, for example, involve deposit:

- onto a conveyor;
- into a suction duct;
- into a weighing unit;
- into an opening and cleaning unit (Fig. 44).

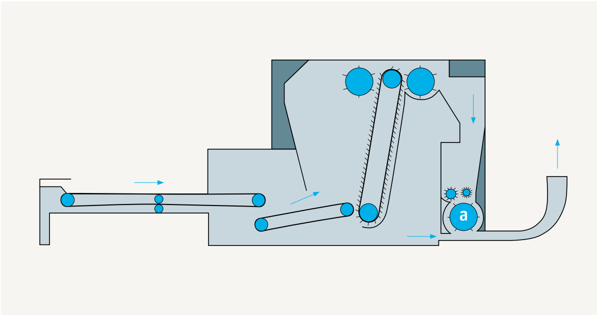


Fig. 44 – A cleaning unit behind the opener (a)

1.4.3. Machines for "coarse cleaning" (pre-cleaners)
1.4.3.1. Basics

These machines are preceded by the opening machines (bale openers), which create a large quantity of tufts, i.e. large surface areas (at least, the high-performance bale openers). The opening machines themselves cannot clean these surfaces because they are not fitted with cleaning devices, or, where such devices are present, they can eliminate only a fraction of the impurities owing to the high material throughput. But high-performance bale openers also require high-performance pre-cleaners in front of them with a high capacity for removing impurities from the surfaces presented. Old pre-cleaners are inefficient for this job.

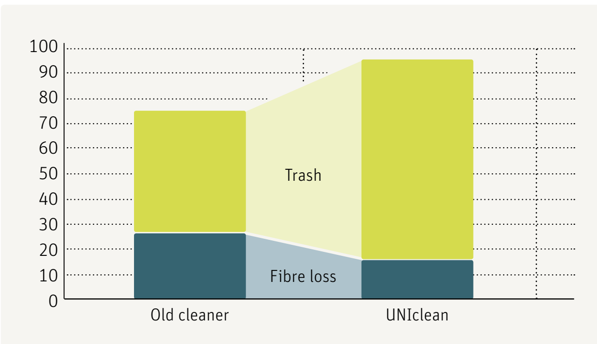


Fig. 45 – Cleaning capacity of a high-performance pre-cleaner compared with that of an old pre-cleaner

Two things are conspicuous in coarse cleaning machines: they generally process the material

- while it is in free flight; and
- the striker elements are widely spaced on the operating rollers or drums.

The opening effect is correspondingly very small. This is acceptable in zone after bale opening because adequate surface area has already been created before that stage. Therefore, in their basic design, coarse cleaning machines are optimal at their given position in the line, but not at other places.

1.4.3.2. The step cleaner

The material falls into the feed hopper and passes to the first beater. From there it is transported upward by the six (sometimes three or four) beater rollers, each carrying profiled bars; the beaters are arranged on a line inclined upward at 45°. Elimination of impurities takes place during the continual passage of the material over the grids arranged under the rollers (Fig. 46).
Some step cleaners have a high flow chamber with special baffle plates (a) to improve cleaning intensity. The grids are always adjustable and usually also the beater speed.

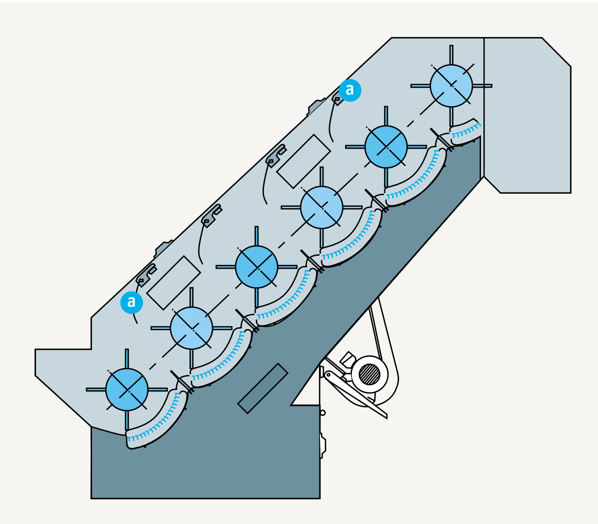


Fig. 46 – The step cleaner

1.4.3.3. The dual roller cleaner

(Example: Model B31/1 by Marzoli (Fig. 47)).
(Here again, similar models are offered by other manufacturers, e.g. AXI-FLO by Trützschler.)

The machine comprises a large cleaning chamber containing two drums of 610 mm diameter rotating in the same direction.

A fan downstream from the dual roller draws material through the machine by suction.
The first opening roller carries the material over the grid three times before it passes to the second roller. Trash falls onto the bucket wheel locks. Guide sheets in the hood direct the tufts.

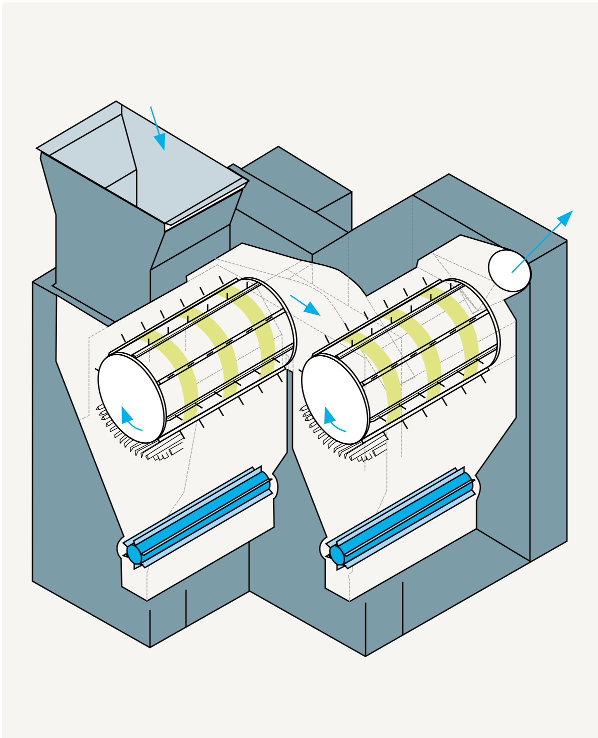


Fig. 47 – Marzoli dual roller cleaner

1.4.3.4. Rieter's former monocylinder cleaner

This machine operates in a similar manner to the dual roller cleaner but has only one drum. The material enters the machine at one side and flows through (parallel to the beater) to the other side. In order to prevent tufts from being drawn straight through the machine, the large hood above the drum is divided into three chambers by guide plates.
This causes the tufts to fall back into the region of the beater drum after being hurled out by the roller. In this way, the tufts are forced to circulate three times with the drum, i.e. pass three times over the grid; this produces an intensive cleaning effect. The grid is in two parts, and these are separately adjustable.

1.4.3.5. Rieter B 12 UNIclean

The basic design corresponds to that of the monocylinder cleaner, i.e. there is an inlet duct (4), a large cleaning drum (1) with special hooks, a waste suction device and an outlet duct (5).
But instead of the material rotating three times inside the machine, it is forced to pass over the grid five times, always presenting new surface areas to it. The tufts not only pass over the grid five times, they also pass over a specially arranged perforated sheet five times. The chamber behind this sheet is a low-pressure chamber. The air suction through this sheet provides very efficient dedusting.
The waste is collected inside the machine and fed to the waste transport via an airlock cylinder. Intermittent suction and connection to continuous suction is possible.
The airlock prevents good fibers from being sucked through the grid during waste removal.

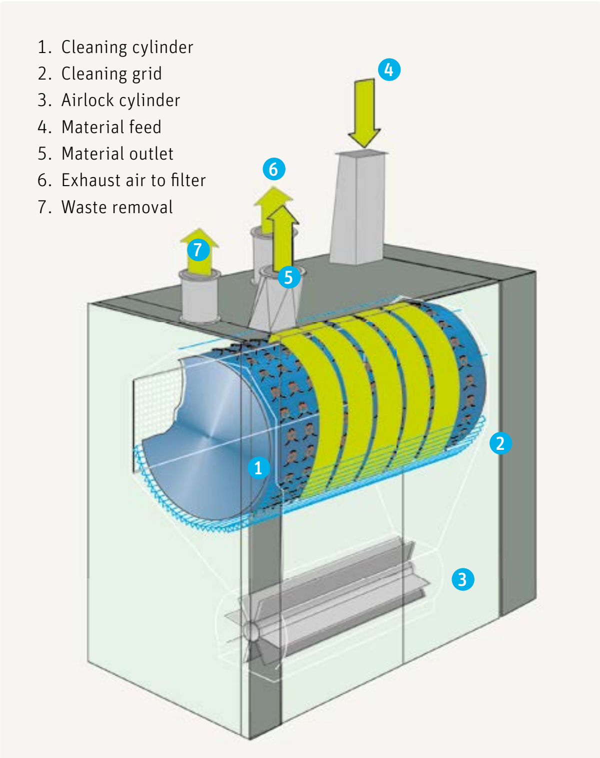


Fig. 48 – Rieter B 12 UNIclean

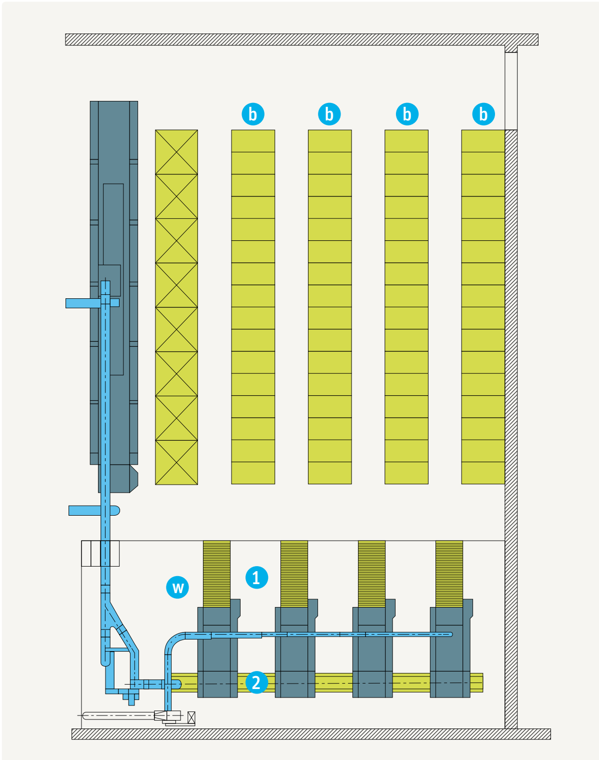


Fig. 49 – The mixing battery with a bale layout in front

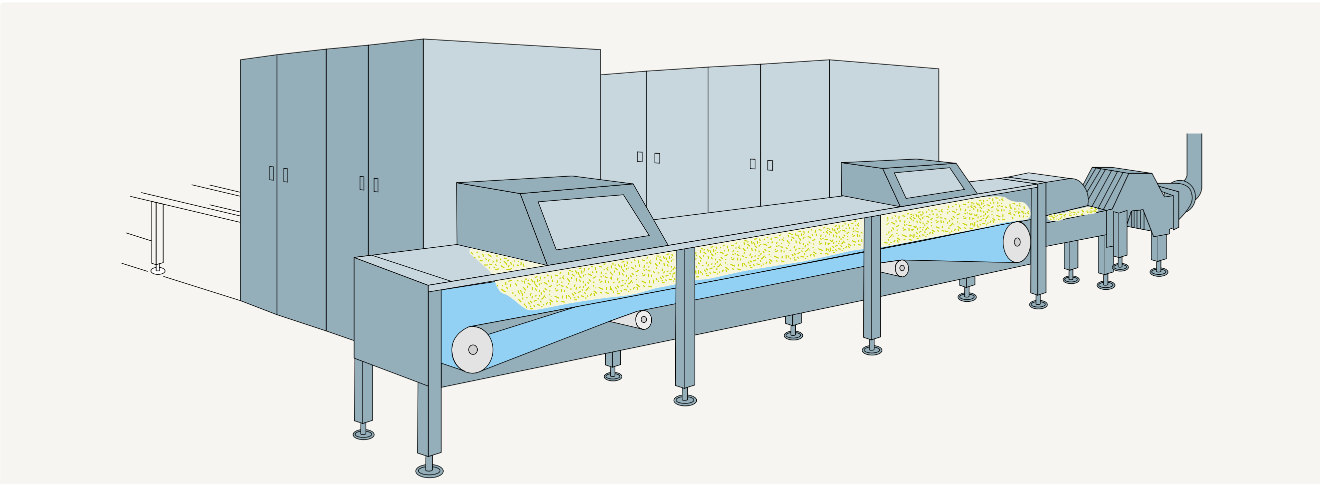


Fig. 50 – Feeding material from the bale openers onto a common conveyor

1.4.4. Machines for "blending"
1.4.4.1. The mixing battery (Fig. 49, 50)

This was once the most common type of mixer and it is still used. The mixing battery represents the conventional method of mixing at the start of the process:
2 - 5 mixing bale openers (Fig. 49, 1) operate together; usually one of these openers is a waste feeder (w). A good blend is obtained because each opener can be supplied with a plurality of bales (b), and the opened material from all bale openers flows together onto a common conveyor belt (2). If the bale openers are provided with weighing equipment (weighing hopper feeders), then blends of different components, e.g. cotton and man-made fibers, can be formed in a predetermined and metered manner.
Modern blowroom lines operate with automatic bale openers instead of mixing batteries, but special blending machines are required in the lines, two of which are presented below.

1.4.4.2. The Trützschler MCM/MPM Multiple Mixer

The machine (Fig. 51) comprises several (6 - 8) adjacent chute chambers into which the material is blown from above. The chutes are filled successively and material is removed from all chutes simultaneously. This gives a good long-term blend.
Ejection of tufts onto a collecting conveyor is performed by take-off and beating rollers under the chutes. The filling height in the chutes is held fairly constant by sensors. At the end of the machine a simple suction system or a cleaner can be incorporated.

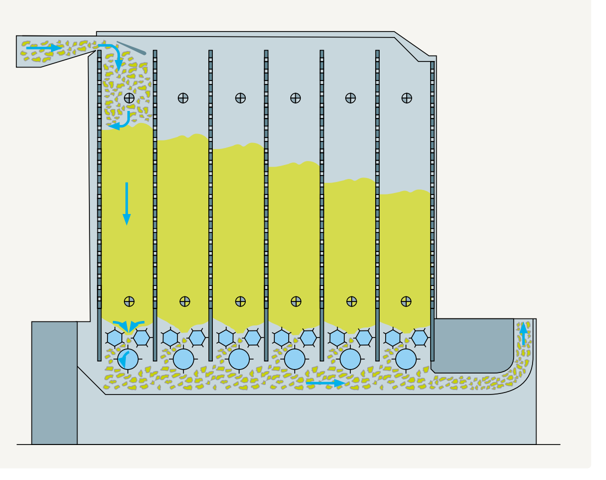


Fig. 51 – The Trützschler MPM Multiple Mixer

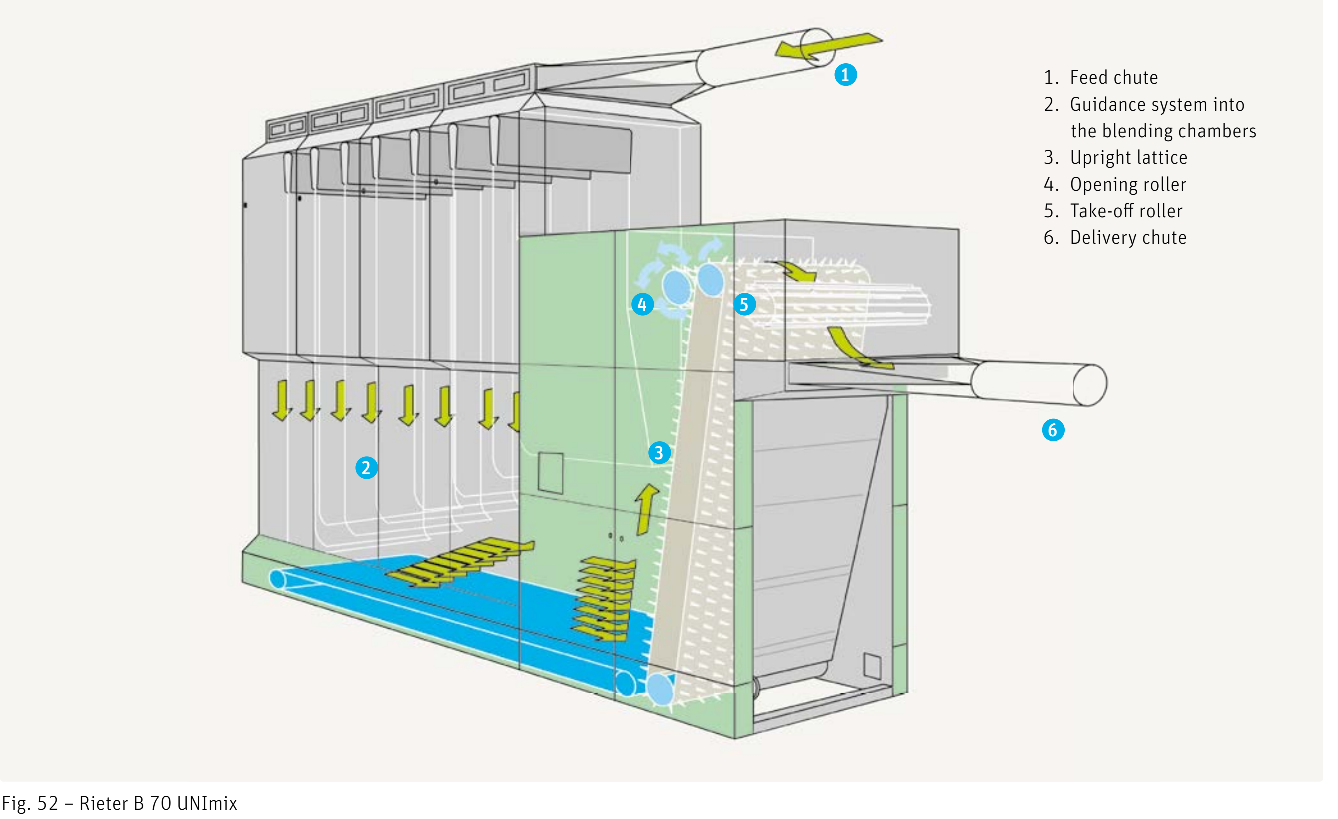


Fig. 52 – Rieter B 70 UNImix

1.4.4.3. The Rieter B 70 UNImix

The machine (Fig. 52, Fig. 53) is made up of three parts: a storage section, an intermediate chamber and a delivery section. Tufts are fed pneumatically and simultaneously into eight chutes (Fig. 52, 2) arranged one behind the other in the storage section. A conveyor belt feeds the stock through the intermediate chamber to the spiked lattice (3). The material columns are thus diverted from the vertical into the horizontal. In addition to a condensing effect, this 90° deflection in the material flow also produces a shift in the timing and spatial distribution of the fiber packages from the first to the last chute. This special construction with a deflection of 90°, and thereby different distances from the individual chutes to the lattice (at chute 1: short distance; at chute 8: long distance) in turn results in good long-term blending. Thereafter, as in a blending opener, material is extracted from the intermediate chamber and subjected to a further opening step between an inclined spiked lattice (3) and an evener roller (4) (short-term blending). An optical sensor ensures that only a small quantity of fiber stock is held in the mixing chamber in front of the lattice (3). Behind the spiked lattice there is a take-off roller and a simple pneumatic suction feed to the next machine.

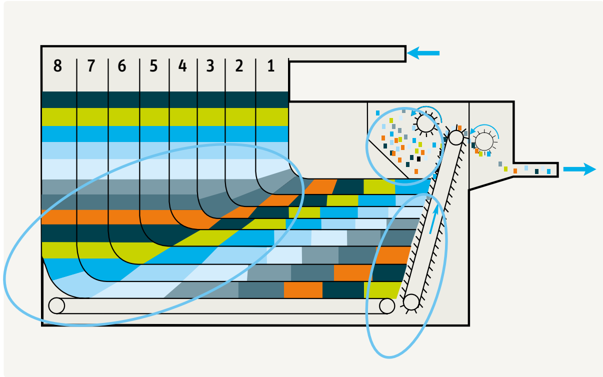


Fig. 53 – Rieter B 70 UNImix

1.4.4.4. Metering and blending on one machine

The blending machines mentioned above create random blends. They are excellent machines for blending one type of material (although with some varieties), e.g. cotton, or only one color shade. However, they are insufficient when blends of different materials (e.g. cotton/polyester) or different colors are required. These blends are produced mainly on draw frames, but can also be produced on the blowroom line. For these special cases Rieter offers its A 81 UNIblend (Fig. 54).

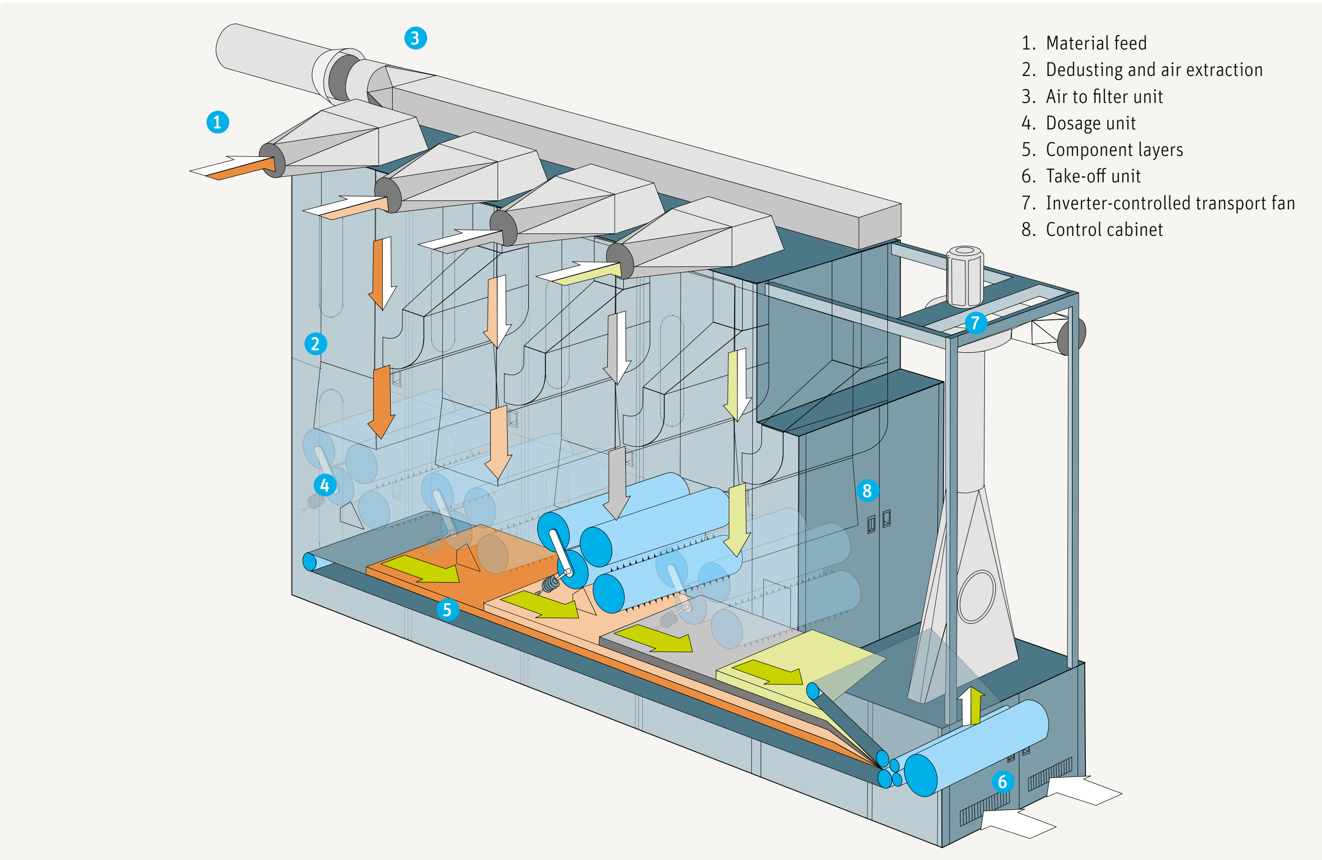


Fig. 54 – Rieter A 81 UNIblend

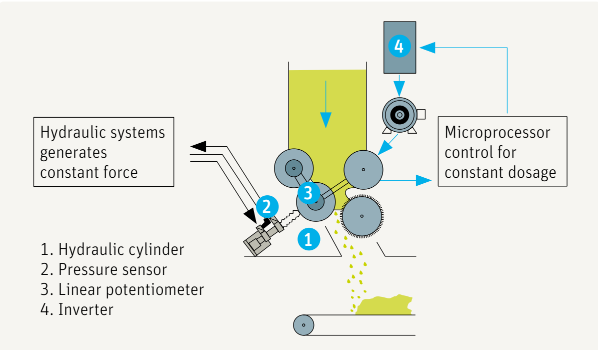


Fig. 55 – The metering device

As with the UNImix, several chutes are arranged side by side, but every chute has its own, separate feed (for the different types of material). Every chute ends at the bottom with an independent metering device (Fig. 55). Each chute therefore drops a precisely measured quantity of material onto the collecting conveyer belt, which again forwards the accurately metered material stock to the take-off unit.

1.4.5. Machines for "Intermediate cleaning"

(No longer required for high-performance blowroom lines)

1.4.5.1. Basics

In contrast to the pre-cleaners, these machines must again produce new surfaces; i.e. opening must precede the cleaning operation. They operate with clamp feeds or with feed in free flight. The spacing of the striker elements on the rollers must be finer than at the pre-cleaner. Bladed or spiked rollers were previously used, e.g. the well-known horizontal cleaner or the step cleaners. Although these machines are outdated, the Trützschler step cleaner is mentioned here as representative of all other such cleaners.

1.4.5.2. The Trützschler RN cleaner

This is the same step cleaner as described in chapter 1.4.3.2., but extended by a spiked beater.

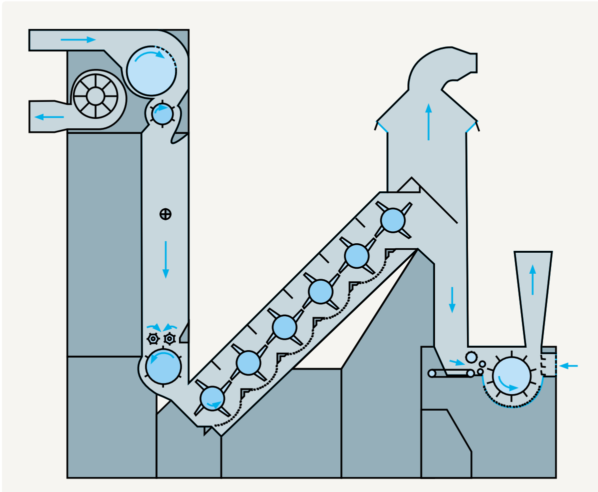


Fig. 56 – Trützschler RN cleaner

1.4.6. Machines for "fine cleaning"

1.4.6.1. Basics

In older installations this zone was provided by the scutcher in the form of a Kirschner beater. The Kirschner beater may still be integrated in a line of the last but one generation without a scutcher. But nowadays mainly saw-toothed rollers are in use for fine cleaning. This form of intensive cleaning with a carding roller has been forced on spinners in the last few decades, since cotton stock has become steadily more contaminated and the impurities have become steadily smaller, requiring far more intensive opening for creating very small tufts. In this zone, machines from the individual manufacturers exhibit many similarities. Often, they are universal machines, which can be fitted with different numbers and/or different types of opening rollers. As a representative example, the Rieter cleaner will be described.

1.4.6.2. Rieter B 60 UNIflex fine cleaner

A fan (Fig. 57, 6) draws the tufts by suction from the preceding machine and a distribution element ejects them into a filling chute (1). The rear wall of the chute consists of individual aluminum lamellae with slot-openings through which the air can escape (first dedusting step).

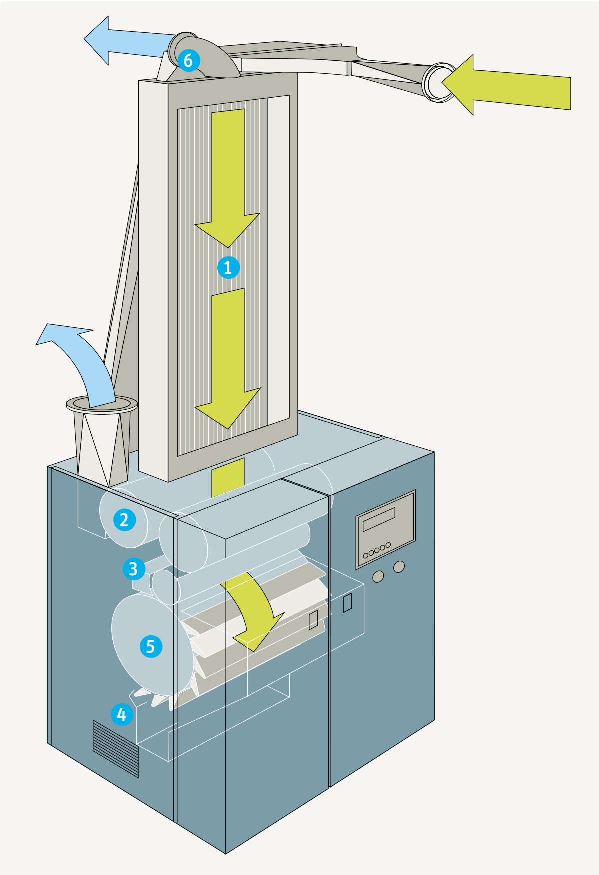


Fig. 57 – Rieter B 60 UNIflex fine cleaner

Thus a very homogeneous batting laydown is formed both lengthwise and crosswise. The adjustable chute depth determines the lap weight required depending on production and type of fiber. The material is carried further by a perforated drum (2) (second dedusting step) and a plain drum. The machine is equipped with automatic lap intake, thus no manual intervention is needed when starting up the fine cleaner. The distance between feed trough (3) and opening cylinder (5) is adapted by the programming to the material being processed. The feed roll supplies the material to the opening cylinder. The opening cylinder, which is available in different versions depending on the requirements of the material, takes over the material. Using VarioSet, the spinner can set the rotation speed of the opening cylinder according to his objectives and raw material. A grid (4) made of carding segments and knives forms the cleaning surface and extracts impurities.
The carding segments on the knives increase the degree of opening and consequently the cleaning. The operator can, once again, use the VarioSet to adjust the setting of the knives on the grid according to his objectives and raw material.

He thus has the opportunity to optimize waste extraction to suit his requirements without any mechanical intervention.

1.4.6.3. The Trützschler "CLEANOMAT TFV" fine cleaner

The special feature of this machine is that, depending on the type of material to be treated, it is available with different numbers of rollers – from one to four (Fig. 58 to Fig. 60).
But for all the different types the working principle is the same: a conveyer belt feeds the material to the feed roller pair. It again forwards the batt to the first roller, rotating downward, resulting in a good opening action. This roller transfers the material to the next, now upward rotating roller and so on to the end where the cleaned material is removed by suction. The waste elimination device is also specially designed. There is no grid, but in each case a single mote knife per roller (two for the first one) below that roller or above when the roller is rotating upward.
The mote knife is part of a suction tube, which immediately eliminates the scraped-off particles. From the first to the last roller not only the speed increases but also the wire on the roller becomes finer and finer.

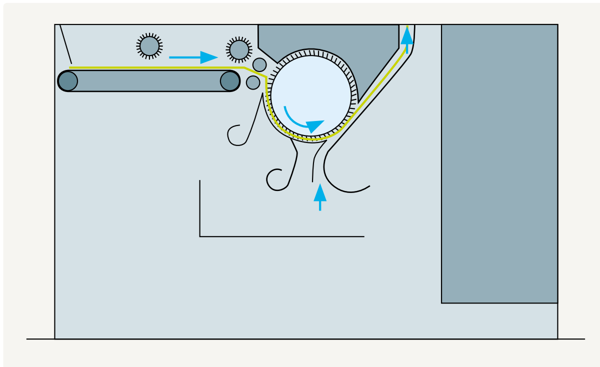


Fig. 58 – CLEANOMAT CL-C 1

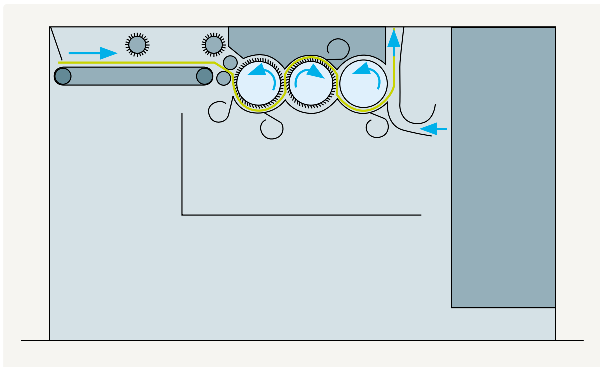


Fig. 59 – CLEANOMAT CL-C 3

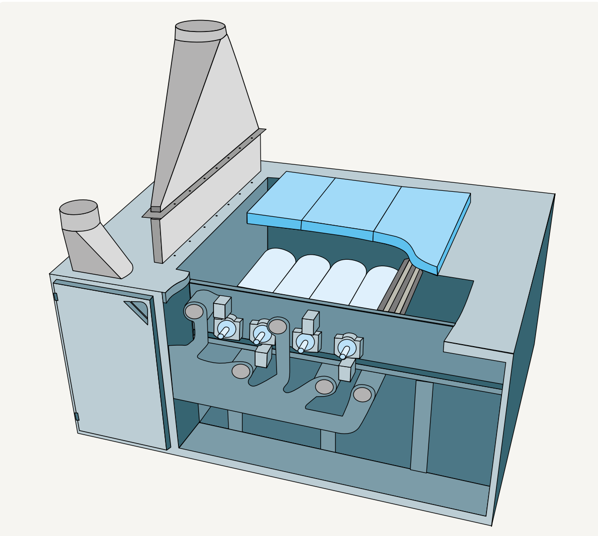
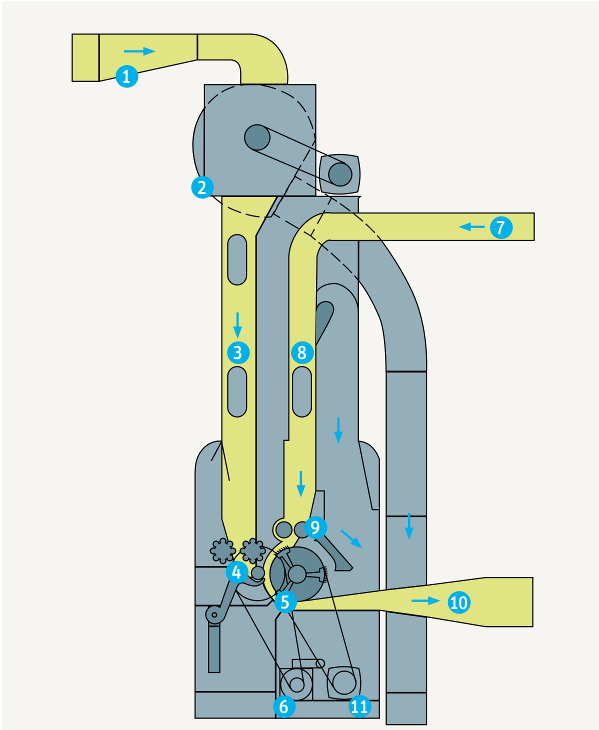


Fig. 60 – CLEANOMAT CL-C 4

1.4.7. Machines for “card feeding”
1.4.7.1. Basics

It is enormously important that the cards receive feed material that is itself homogeneous, uniform from card to card and remains constant over a long period. Fulfilling this requirement is not exactly easy for many modern installations with pneumatic tuft feed systems. Usually, a certain degree of design effort is necessary to deal with the problem. Lap feed was less problematical in this connection, since each scutcher lap was checked for constant lap weight and thus indirectly for even laps. Two further advantages of the scutcher should also be mentioned: it can be applied universally, and it permits operation with several blends. In comparison with tuft feed systems, however, it is considerably less economical. It is therefore discussed briefly here, while tuft feed systems will be discussed in the section dealing with the card.

1.4.7.2. Card feeding with the former Rieter AEROfeed



1 Material supply from blowroom
2 Condenser
3 Filling trunk with regulating flap
4 Ridged rollers and feed roller with pedal lever
5 Kirschner beater
6 Hydraulic gear with servomotor
7 Feed back from closed loop duct
8 Excess material
9 Return feed rollers
10 Material delivery to fan into circular duct
11 Beater motor

Fig. 61 – Rieter AEROfeed (1967)

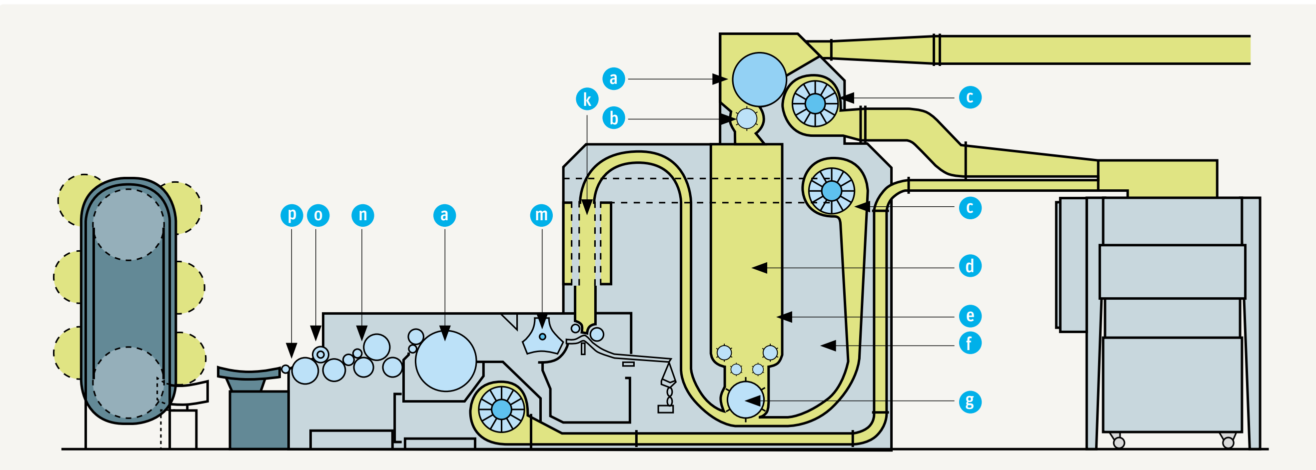


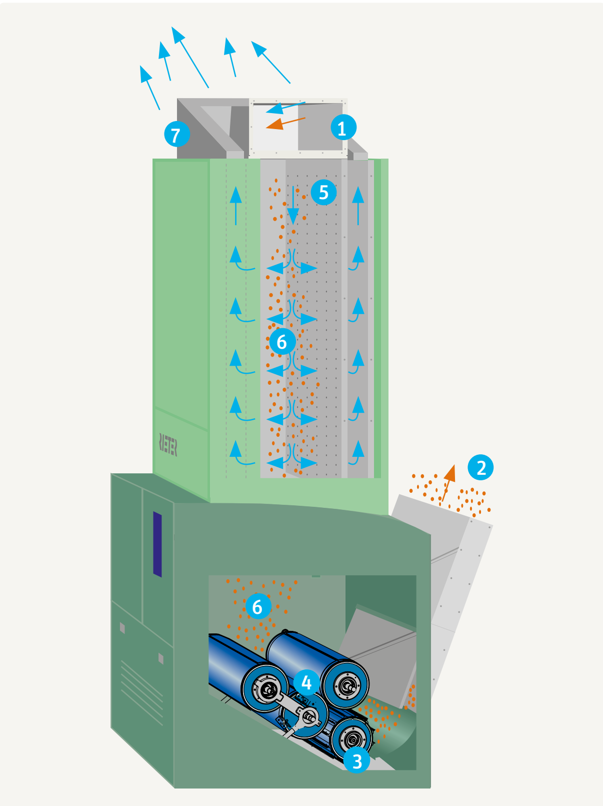
Fig. 62 – Trützschler scutcher line
a - k feeding; m - p lap forming; „a“ are two dust cages

1.4.7.3. Scutcher

In addition to the other functions of blowroom machines, the scutcher has to form a lap for supplying material to the cards. Previously, most of these machines were double scutchers; they had two beater positions and two pairs of perforated drums. Machines delivered in recent years have been almost exclusively single scutchers: they have only one beater position (Kirschner beater) and only one pair of perforated drums or even a single drum.

LAP WEIGHING
A lap-weighing device connected with the lap apparatus detects any deviation of lap weight from a set value. The result is registered on the output strip from a printer. Simultaneously, the deviation is indicated as a signal. When the deviation exceeds a preset value, the weighing device sends a pulse to a servomotor of a variable speed transmission, which regulates the weight per unit length of the lap.

1.4.7.4. Rieter A 78 UNIstore feeding machine



1 Material input
2 Material discharge
3 Opening rollers
4 Feed rollers
5 Perforated metal plate for air discharge
6 Light barrier for monitoring material height
7 Open exhaust air transfer

The A 78 UNIstore is used as a storage, dedusting and feeder machine in the blowroom. Its main purpose is to provide intermediate storage for material in order to ensure trouble-free blowroom operation. Long piping distances are frequently found to interfere with the smooth running of the processes and intermediate storage is necessary in many cases. The A 78 UNIstore is used where a mixing opener proves unsuitable for financial, technical or technological reasons. The integration of a mesh screen filter inside the A 78 UNIstore eliminates the transport air, and creates an efficient dedusting. The structure of the feeding and opening unit guarantees gentle fiber opening.

1.4.8. Dust removal
1.4.8.1. Basics

Removal of the finest particles of trash, contaminants and fiber fragments (dust) can be carried out by:
- releasing the dust into the air, e.g. by turning the material over and over, and then removing the dust-contaminated air;
- separating the particles directly from the fibers through suction or scraping.

In the latter case, care must be taken to ensure that fibers are not carried along; a fiber-retaining device is required. Release of dust into the air occurs wherever the raw material is rolled, beaten or thrown about.

Today, the air at such positions is therefore extracted by suction. However, in these arrangements, it is not only the removal of dust from the material which is important. Maintenance of a dust-free atmosphere in the workroom is of still greater significance, since in many countries laws have already been passed to prescribe the maximum permissible quantities of dust in the air.

With the second method, however, environmental conditions in the workroom are not of interest, only the elimination of the disturbing particles. Nevertheless, dust removal always arises as a side effect if material is transported by air. This happens at the end of the duct where, for example, the fibers are separated from the transport air. The following are used as direct and indirect means of dust removal:
- perforated drums (a rapidly rotating perforated drum following a carding roller can extract 50 % of the dust in the stock);
- non-rotating perforated surfaces (Rieter and Trützschler);
- circulating perforated belts;
- stationary combs.

Also, pneumatic transport in itself has an effect that should not be underestimated, since dust is always released during such transport. In the following section, a simple assembly and one machine (for dedusting) are described as representative of all others.

1.4.8.2. Rieter dust extractor

This equipment (Fig. 63) forms part of the pneumatic transport system. A chamber is included in the ducting and contains a pipe which converges and has perforations. As the material passes from 1 to 2 a special fan draws air from 3 and thus also draws dust from the transport duct. Since the fiber tufts are vigorously "washed" by air currents in this ducting, good separation of the smallest dust particles, and finally their removal, is achieved.

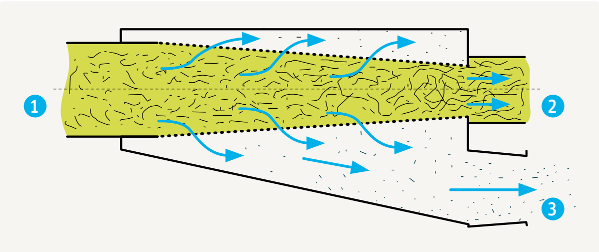
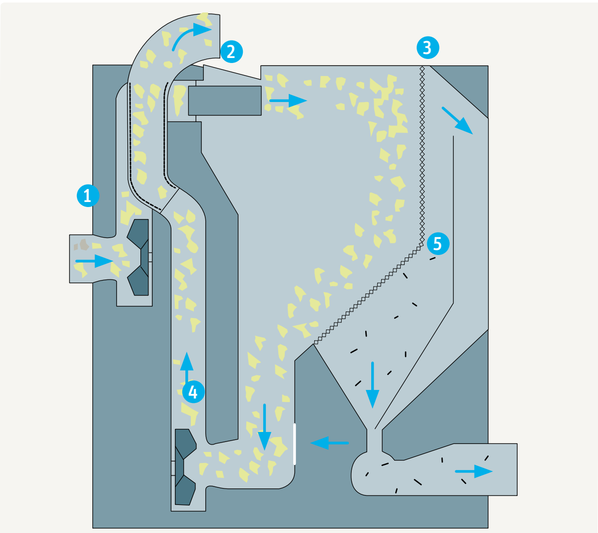


Fig. 63 – Dedusting within the transport duct

1.4.8.3. Trützschler "DUSTEX" dedusting machine



1 This fan sucks the material off the CLEANOMAT cleaner
2 The distribution flaps distribute the tufts over the working width of 1.6 m
3 Considerable dedusting is effected by the tufts hitting the perforated surface
4 The material drops into the suction system and is transported to the cards by the variable speed fan
5 The separated dust is permanently discharged

Fig. 64 – Trützschler DUSTEX

This machine consists mainly of a large chamber with a perforated sheet (3), the infeed of the material (1/2) and the withdrawal of the material at (4). In the chamber itself the material tufts are blown against the perforated sheet (3). Here they slide on the sheet down to the tip of the funnel (4) and pass to the suction after dust is extracted.

1.5. High-performance machines ought to be easy to handle

1.5.1. Demands

The subjects dealt with in the previous chapters are the main technological demands on a modern high-performance blowroom line, but another aspect is becoming more and more important: easy handling of machines everywhere. In detail this means:

- simple, time-saving adjustment;
- flexible adjustments, i.e. adaptable to all requirements;
- reproducible adjustments;
- durable adjustments, i.e. no uncontrolled changing of settings by the machines.

Above all, reliability and operational safety are vital in this respect. A system of this kind will be explained by means of the Rieter VarioSet, a component of the B 12 UNIclean and B 60 UNIflex.

1.5.2. Rieter VarioSet

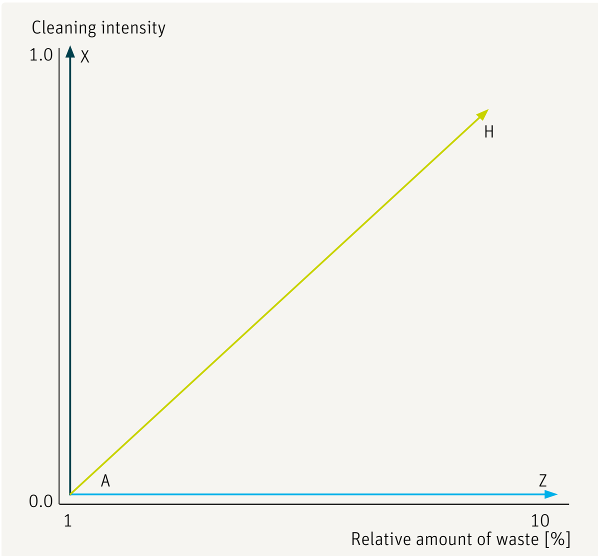


Fig. 65 – VarioSet cleaning field

All performance and treatment alterations on both machines mentioned can be made very easily and electronically during the normal operation of the machine from outside the machine without any stoppages.

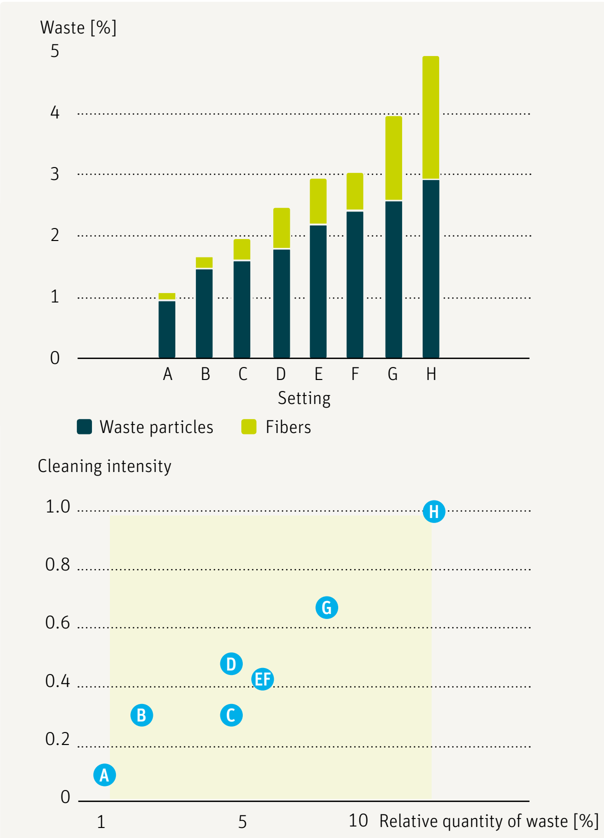


Fig. 66 – Practical examples and their effect on waste composition

An easily understandable and clearly arranged display is available at one side of the machine for this purpose. This display includes a special setting arrangement called VarioSet (Fig. 65). It enables operating personnel to adjust the degree of cleaning and the cleaning efficiency (to a certain extent the unavoidable loss of fibers) exactly to the raw material and the requirements of the mill. All that is needed is to push a few buttons on the operating panel at the side of the machine. Various setting positions can be fixed on the screen, e.g. for the degree of cleaning from 1 to 10 (marked here in the example from A to Z), and for cleaning efficiency from 0.0 to 1.0 (marked here from A to X).

VarioSet:
Changes in the extraction of trash and good fibers when changing the settings from A to X, Z till H.

Example:
Indian cotton: 1 1/8 inch, 2.2 % trash

From/to	Setting A	A → X	A → Z	A → H
Waste amount	0.62	0.80	0.65	1.08
Trash [%]	90	78.5	67	66
Good fibers [amount]	0.07	0.22	0.32	0.55
Good fibers [%]	10	21.5	33	34
Ratio of trash/fibers	9:1	3.6:1	2:1	2:1

The example from the B 12 UNIclean clearly shows that a change in the horizontal direction (A to Z, opening of the grid) results in a far higher loss of fibers than the change in the vertical direction (A to X, increasing roller revolutions). At the display it is possible to choose any point of operation adjustment within the complete cleaning field (the square A/X/Z/H): see Fig. 65.

1.6. Transport of material
1.6.1. The need for transport

Blowroom installations consist of a combination of a number of individual machines arranged in sequence. In processing, the material must be forwarded from one machine to the next. Previously, this was performed manually, but now it is done mechanically or pneumatically, i.e. using air as a transport medium. Mechanical transport is limited exclusively to forwarding within the machine; outside the machine, material is now transported only pneumatically.

1.6.2. Mechanical transport equipment

This comprises conveyor belts, lattices and spiked lattices. Conveyor belts permit high speeds.

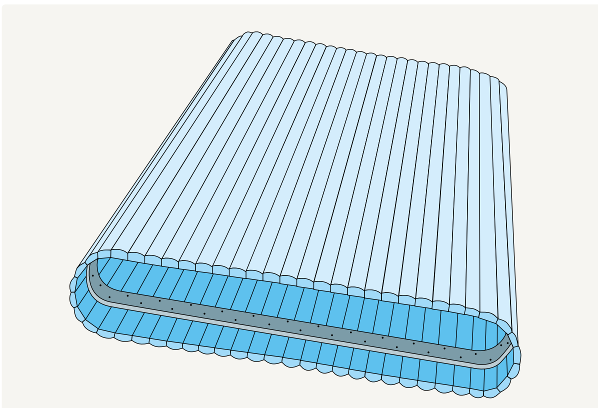


Fig. 67 – Georg Koinzer lattice

They are used as collector belts in mixing batteries or as infeed or horizontal conveyors in openers and hopper feeders. They have the disadvantage that sometimes the material slips on them.

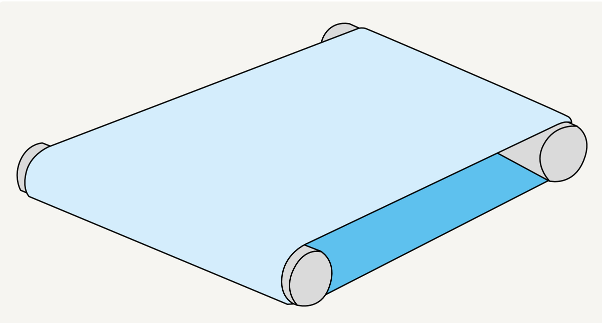


Fig. 68 – Habasit conveyor belt

The forwarding effect is often better on lattices (Fig. 67). They are used as horizontal feed lattices and as short transport belts within a machine. They are endless and consist of circulating belts to which closely spaced, individual hardwood crossbars are screwed or riveted. Today's conveyor belts (Fig. 68) no longer use crossbars. The belts consist of different layers with a fiber-free surface. The belts are driven by shafts that simultaneously serve for belt tensioning. The forwarding speed is usually very low.
Inclined lattices or spiked lattices (Fig. 13) are the same in terms of structure and drive. However, steel spikes are set at an angle in the crossbars, so that the raw material can be transported upward. Inclined lattices are operated at speeds up to 100 m/min. They usually interact with evener rollers, and thus function mainly as opening devices.

1.6.3. Pneumatic transport

1.6.3.1. Basic principle

Air is not inherently a very efficient transport medium. Very large quantities must be moved at high speeds in order to keep the tufts that are being transported floating. The current of air itself is a further disadvantage, since the air flows in a turbulent fashion through the ducting, i.e. vortexes are created. Since the tufts are subjected to these vortexes, entangling of tufts can arise in long ducts and finally neps can be formed. A closed duct (generally a pipe) and a source of partial vacuum (a fan) at one end of the duct are needed to move the air. The air speed should be at least 10 m/sec, and 12 - 15 m/sec is better; it should never exceed 20 - 24 m/sec. At a given air speed, the required quantity of air can be calculated as:

$L\ (m^3/s) = A \times v$

where L is the quantity of air; A is the cross section of the duct in m^2; v is the air speed in m/s. The duct must terminate in a device that separates the air from the material.

1.6.3.2. Separation of air and material

By far the most widely used assembly for this purpose is the perforated drum (Fig. 69). It is used in various machines and parts, often in so-called suction boxes (condensers).
A partial vacuum is created in the drum, and thus in the duct, by a fan at one end of the drum. Air and material flow toward the drum. However, while the air can pass through the perforations in the drum, and is then passed to filters for cleaning, the fiber tufts remain on the surface of the rotating drum and are carried along with it. In the lower region, the drum surface is screened off from the partial vacuum in its interior. The tufts are no longer retained by suction and fall into a chute.
Another assembly for separating air and material is the slotted chute of the Rieter UNIflex (Fig. 57), where the transport air is extracted through the slot, while the material slides down on the aluminum ribs of the rear wall of the chute.

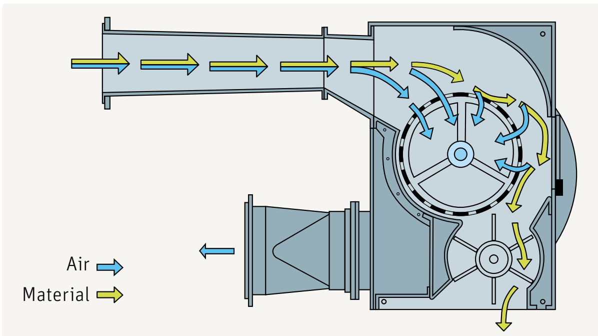


Fig. 69 – Separation of air and material

1.7. Control of material flow

1.7.1. Classification

Since, as already discussed, the blowroom line is a sequence of individual machines, each machine must always receive an exact quantity of material per unit of time from the preceding machine, and must pass on the same quantity per unit of time to the next. To ensure an adequate flow of material, the machines are adapted to each other so that each machine can produce a little more than the succeeding machine requires. Since each machine has excess capacity, a control system must be provided to ensure the correct delivery quantities. Two basic principles are used: batch operation and continuous operation.

In a hopper feeder, for example, the conveyor (1, Fig. 70) places material into the hopper until sensing lever (a) is pushed so far to the right that a contact is made to switch off the drive

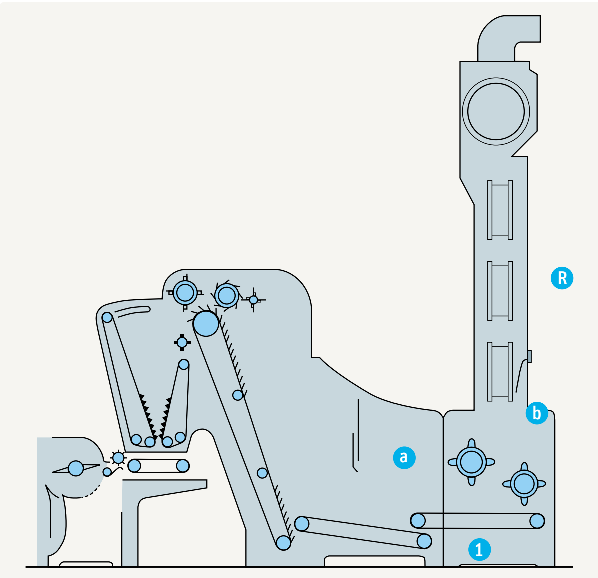
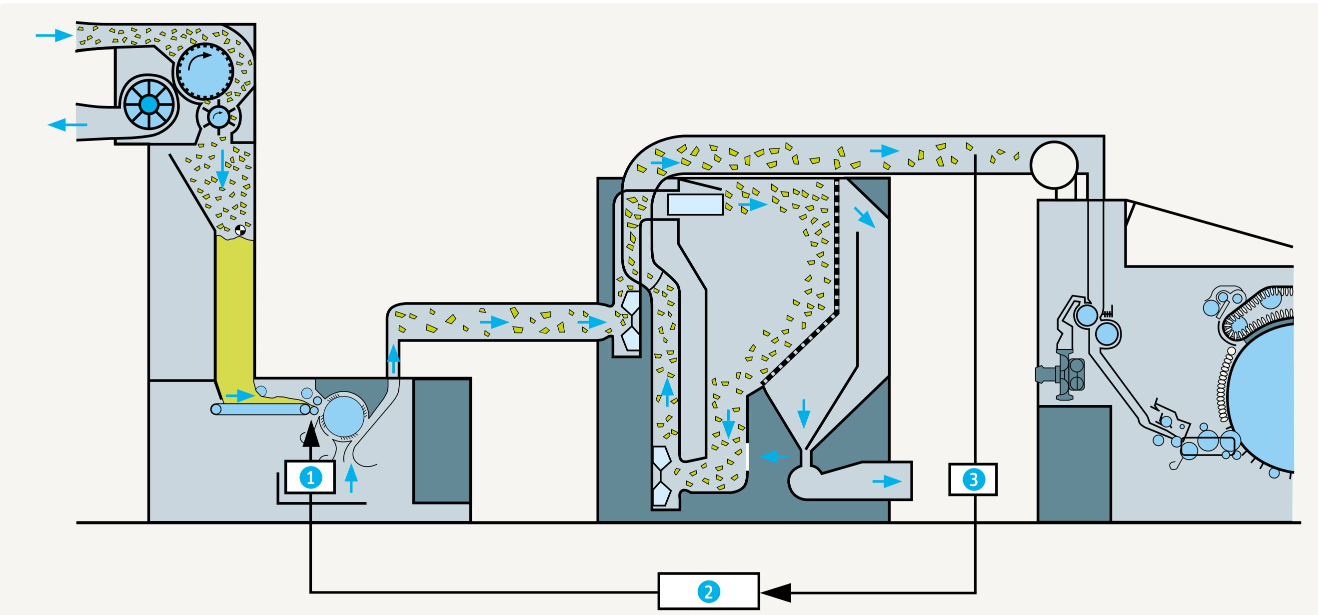


Fig. 70 – Regulated feed of material in the hopper feeder

of conveyor belt (1). In exactly the same way, during filling of the reserve hopper (R), the pressure exerted by the column of material eventually becomes so great that sensing lever (b) is depressed; this causes the preceding machine to be switched off. When the column of material has again been largely removed by conveyor (1), the sensing lever rises, the preceding machine is switched on and the reserve chute is refilled. Unfortunately, in practice the individual machines actually produce during a period that is often only 50 % of operating time and are unproductive during the remainder of the operating time. On the other hand, in continuous operation created by changing the speeds of the machines, the machines' production rates are much more closely adapted to each other. They operate almost continuously and without stops. A fine control device serves to maintain material throughput by adjusting the production speeds of the individual machines. Batch operation has the advantage that the machines always run at the same speed and with the same production rate when they are in operation. The treatment of the material remains uniform all the time. That means that the raw material is always processed under the same conditions, since there are only two treatment levels – full on or off. In continuous operation, however, there are continual slowdowns and accelerations, with possibly varying intensities of treatment of the raw material. Data provided by Trützschler indicate that there are no negative effects, provided variations in production rates do not exceed ± 20 %. The disadvantage of batch operation lies in the incorrect handling of the material throughput. As machines often do not operate during 50 % of the time, in their productive periods they are not working at, e.g., 300 kg/h as calculated by the spinner; instead they are actually processing material at a rate of 600 kg/h. The loading of the machine is high, and that might lead to a correspondingly poor cleaning effect. In the mill, therefore – and this is very important – an attempt should be made to regulate the installation so that the productive time of the individual machines is very high, and only few non-productive periods occur.

1.7.2. Optical regulating systems in batch operation

(Example: Marzoli horizontal cleaner)



1 Maintenance-free variable-speed motor
2 Controller including adjustment for basic rotation speed and target value
3 Pressure transducer

Fig. 71 – Trützschler CONTIFEED

Four optical monitoring devices (Fig. 72) are mounted in the filling chute, conveyor belt and mixing chamber of the machine.

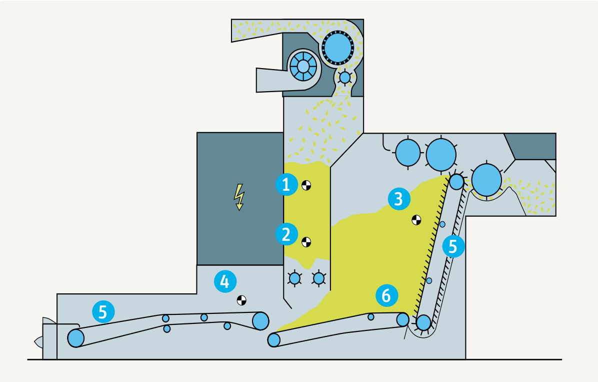


Fig. 72 – Optical regulation

If the column of material falls below light barrier (2), the preceding machine is switched on and delivers material. When the chute has been filled to such an extent that the material interrupts the light beam in light barrier (1), the machine is switched off again. Light barrier (1) is also an over-fill safety monitor. Light barrier (3) monitors the amount of material in the mixing chamber and controls the drive to conveyor belt (6) and the feed roller of the chute. Light barrier (4) will trigger an alarm if there is no material left on feed conveyor (5).

1.7.3. Continuous operation

As a concept, this is not new in the blowroom; it has been used for a long time in the scutcher as pedal regulation of the feed to the beater. What is new is that now the whole blowroom line operates continuously and regulation is performed electronically. This installation, developed by Trützschler, will be presented briefly (see Fig. 71).
The central regulating unit, to which all the individual machines are connected, is the "CONTIFEED". This receives an analog signal from the tacho-generators of the cards; the instantaneous demand for material is continuously calculated from this signal. Using this demand, the micro-computer can establish the basic speeds of all drives that determine the throughput and the drives can be correspondingly controlled. A second signal is superimposed on this basic speed signal, derived from the contents of the storage unit of the succeeding machine. In this way, the successive machines are linked via individual control loops. The programs for speeds, production quantities and allocation are first established manually, which represents a fairly substantial initial outlay. When balanced operation is achieved, they can be transferred to the "CONTIFEED" and stored there.

1.7.4. Rieter UNIcommand

As already mentioned, the blowroom line is a sequence of several machines. In their operation these machines have to be very well coordinated, requiring a good, reliable system for monitoring and controlling the individual machines, groups of

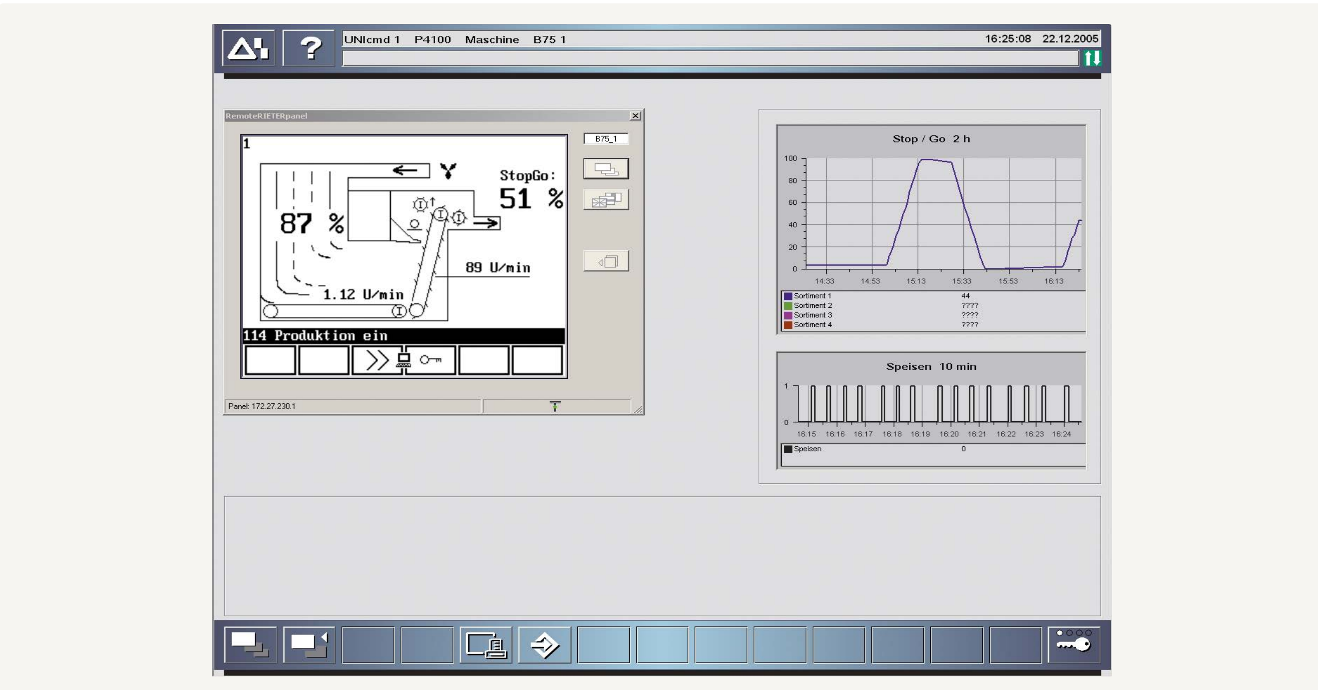


Fig. 73 – UNIcommand control system

machines and the total blowroom line. UNIcommand works on an electronic basis, and is a combination of PLCs (programmable logic) and PCs with a central control unit somewhere near the blowroom line, plus an additional PC in the supervisor's office as an option. No computer or software knowledge is required to handle the system. As everywhere, Rieter standardized panels are used. A language-independent color graphic representation and touch-sensitive monitors are chosen for the display. The main functional and operational requirements are:
- switching on/off;
- display of operational status of all system components;
- simple switch-over of the process sequence, e.g. from one- to two- or three-blend operation;
- automatic shift switch referring to the shift schedule;
- alarm indication of malfunction;
- machine remote control for adjusting and changing the operating mode.

The user interface is exactly the same as on the machine itself.

1.8. Damage prevention and fire protection
1.8.1. Metal detection
1.8.1.1. Magnetic metal extractors

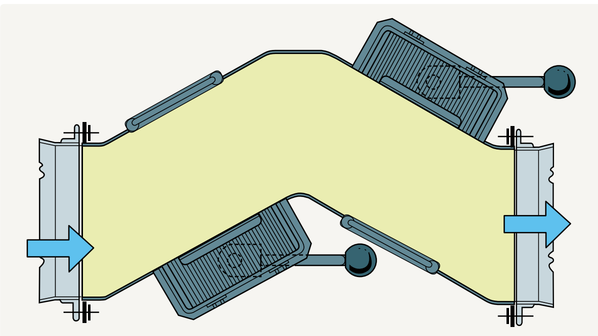


Fig. 74 – Magnetic extractor (Marzoli)

Magnets have been used for decades in ducting or in special parts of machines in order to eliminate pieces of ferrous material. The most effective form of device is a knee-bend within the feed duct having permanent magnets at the two impact surfaces. When tufts are driven against the magnets, ferrous particles are retained and can be removed from time to time. Magnetic extractors provide only a partial solution to the problem because they can eliminate only magnetizable metal particles, and let all others pass. Electronic extractors are needed to remove the other particles, too.

1.8.1.2. Electronic metal extractors

The material is fed from an opening machine such as Blendomat (Fig. 75, 1). The next device, normally a fan in front of the mixing machine, extracts the material by suction (5). Spark sensor (2) detects smoldering material and metal detector (3) any kind of metal. In either case, active operating flap (4) is opened by a signal from the detector and feeds the material into the receiving waste container, which is equipped with a fire extinguisher device (7) and a temperature sensor (8) to monitor the container (Fig. 75).

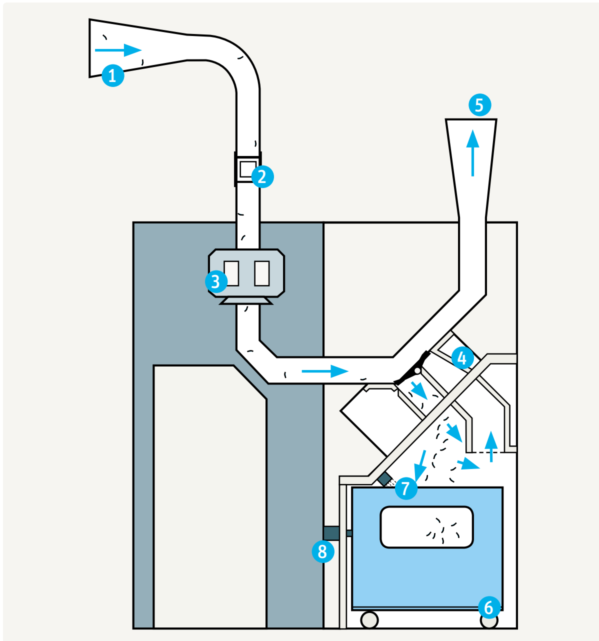


Fig. 75 – Electronic metal extractor (Trützschler)

1.8.1.3. ComboShield (Rieter)

This comprises a spark detector, a metal extractor and an eliminating device, and is built into the transport duct (Fig. 76). The spark detector pivots the rapidly operating flap as soon as the latter detects sparks or burning material. The material passes into a receiving container, which preferably stands outside the room. Simultaneously, an alarm is given and the blowroom line as well as the filter installation is switched off.
The pivoting flap remains in the eliminating condition until the line is switched on again. This device has a second function, the detection of metallic material. If such a piece of material is detected, the same rapidly operating flap is pivoted and the foreign material is ejected into a container. After an adjustable time the flap moves back into its normal position. In contrast to detected sparks, the blowroom line remains switched on.

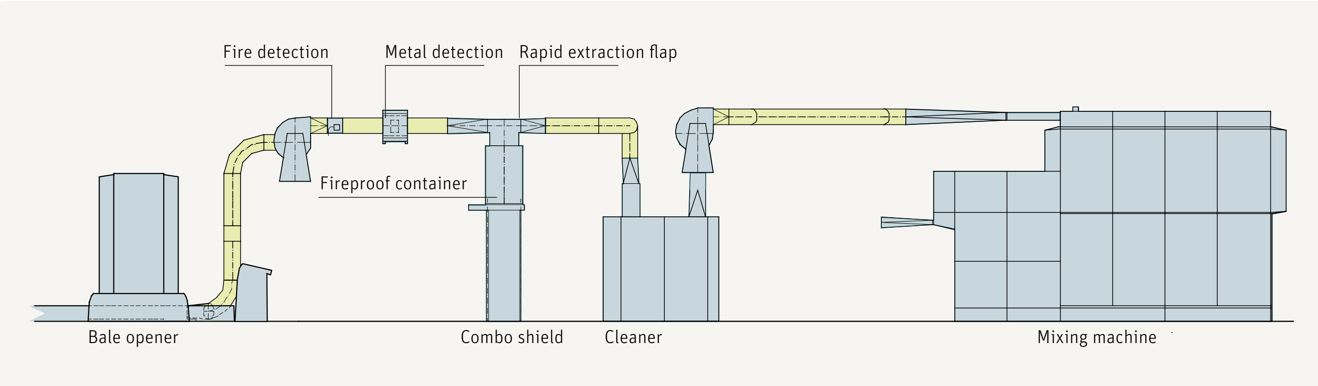


Fig. 76 – ComboShield (Rieter)

1.9. Waste management

1.9.1. Economy of raw material utilization

Raw material costs make up more than half the yarn costs. It is unlikely that much can be done about this, since rising raw material prices are to be expected in future. Increasingly, therefore, spinners will be forced to improve exploitation of the raw material. Without doubt, one possibility lies in recovery of fibers from waste: after all, on average about 50 % of blowroom and carding droppings consist of good fibers. Their recovery is not especially difficult and the saving in raw material costs is significant, as illustrated by the following very approximate, and not very exact calculation for a small spinning mill:

Quantity of raw material processed per year	10 000 t
Total waste from blowroom and carding room	800 t
Recoverable waste	360 t
Price of the raw material (net) per kg (US$)	1.32
Saving on raw material per year (US$)	475 000

An additional advantage of such recycling installations is that a somewhat higher degree of cleaning can be used in the blowroom machines, since with recovery of waste fibers the level of their elimination in blowroom and cards becomes relatively insignificant.

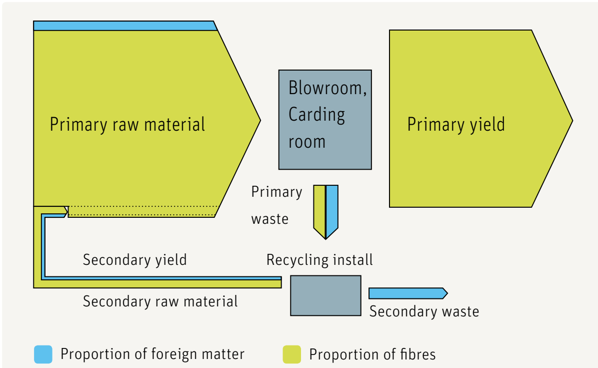


Fig. 77 – Material flow diagram for raw material and waste

1.9.2. Quantity of waste material

In spite of the emphasis on the proportion of waste in the diagram, it is clear that the quantities to be expected here are relatively small. On average, about 6 - 8 % primary waste, consisting of 50 % good fibers and 50 % contaminants, can be expected. About 90 % of the good fiber elimination can be recovered as secondary raw material, and this still contains about 6 % trash. Such secondary raw material can be mixed into the same blend up to a proportion of 2.5 % without any effect on quality. Up to 5 % can be blended with hardly noticeable changes in quality.

As far as possible, no more than 5 % should be returned to the blend (for ring spinning).

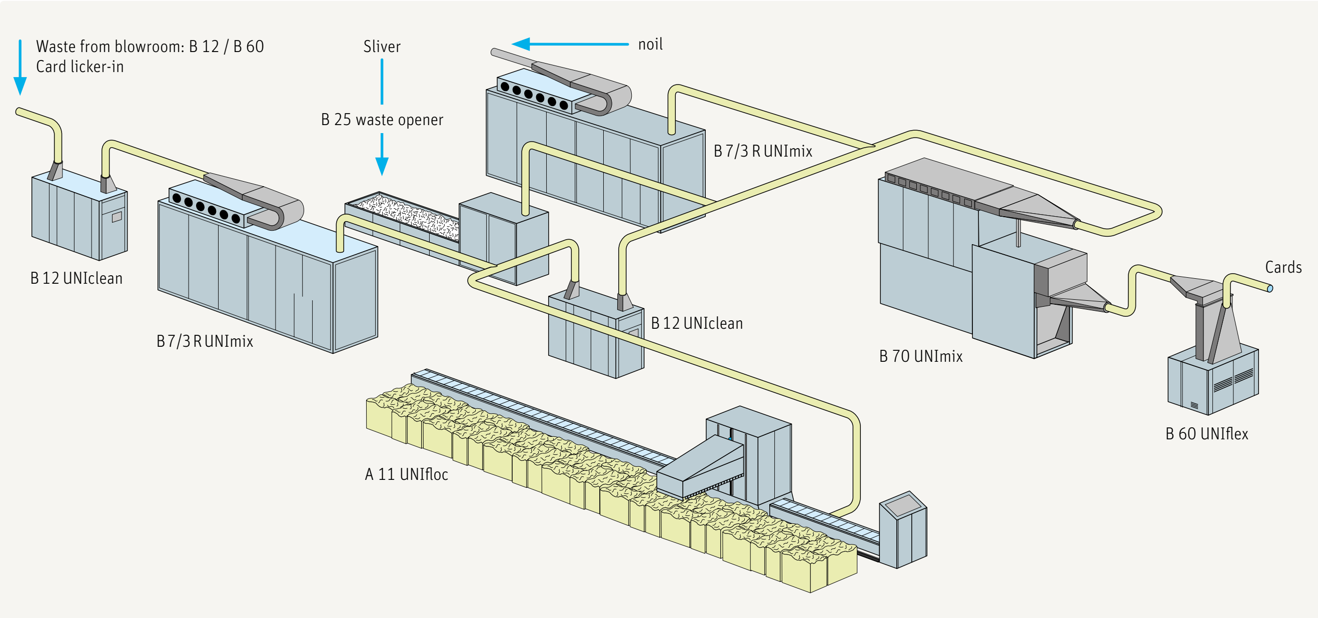


Fig. 78 – Integrated recycling plant by Rieter

1.9.3. Classification of spinning mill waste

A spinning mill produces the following waste, some in significant quantities:

- directly reusable waste;
- dirty waste; and
- dust and fly.

Waste materials falling into the first group can be collected without difficulty and can be fed back into the blowroom line in always the same admixing quantities. The other two groups cannot be dealt with so easily, since handling of these waste materials is unpleasant for mill personnel. Accordingly, in modern mills, waste material is now removed pneumatically. Air is used exclusively as the collecting and transport medium.

1.9.4. Recycling of waste

1.9.4.1. Recycling installation for reusable waste

As mentioned above, a considerable amount of waste can be reused in the same mill by feeding it through a bale opener (waste opener) into the normal blowroom line. Beyond that, in rotor spinning it is common to spin useful yarns from waste or by adding waste to the normal raw material. Since in this case the amount of waste is larger, the admixing cannot be performed by a single waste opener; a complete feeding installation as shown in the illustration (Fig. 79) is required. Dirty waste first has to pass through a special waste recycling plant before a portion of it (about 30 - 40 % good fibers) can be reused.

1.9.4.2. Recycling of dirty waste

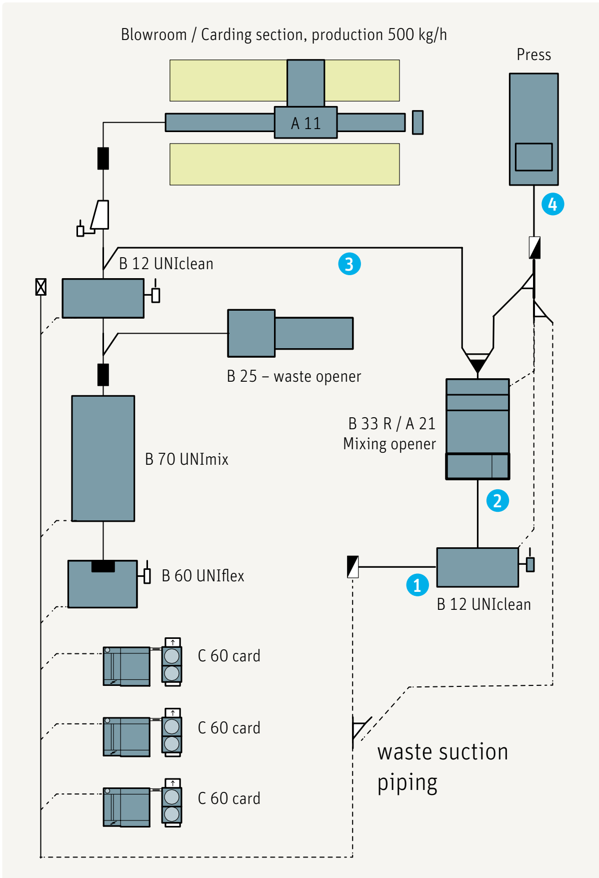


Fig. 79 – Rieter recycling installation

The various processes in the blowroom create various waste materials which cannot be reused for textile purposes, such as:

- coarse dirt remaining after recycling;
- fly from the preliminary filters;
- dust from the fine filters.

Dirty waste consists of a large amount of impurities and a smaller amount of fibers. The latter can be recycled in different recycling plants.
In Rieter installations, for example (see Fig. 79), waste from all blowroom machines and cards is sucked directly through the B 12 UNIclean cleaner of the recycling equipment (1) to a mixing bale opener (2). The mixing bale opener continuously feeds the cleaned material back into the blowroom line (3). If dirty waste is involved, an additional B 60 UNIflex cleaner should be inserted between the mixing bale opener (2) and the point of feed into the blowroom line. This installation can also be operated in off-line mode if the secondary raw material is not re-blended immediately but pressed into bales in a bale press (4).

1.9.4.3. Recycling plant for all types of waste

Almost all manufacturers of blowroom machines, and several others, now offer recycling installations. That of Rieter in conjunction with LUWA (Fig. 80) will be described here as representative of all the others. Primary waste is pneumatically fed via condensers into the B 34 mixing opener, pre-cleaned in the B 12 UNIclean, dedusted in the A 21 condenser and cleaned further in the B 51R fine cleaner. The transport air is always separated from material and fed to the pre-filter. The yield of good fibers is fed into the bale press. Secondary waste from the recycling machines and pre-filter is fed into the bale press for black waste. Since the same types of machines are used in this recycling installation as in the blowroom, handling is easy for the operators.

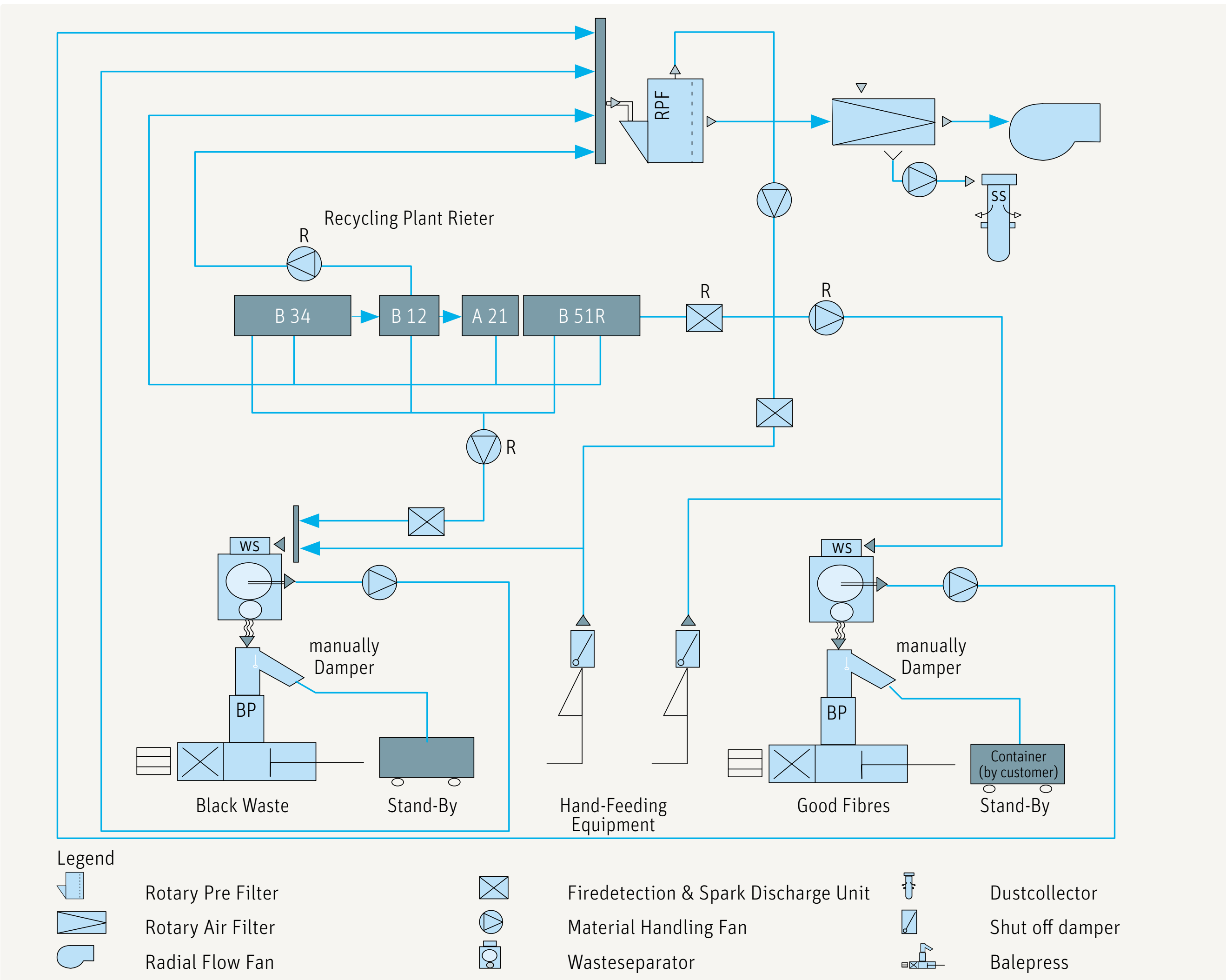


Fig. 80 – Recycling system

1.9.4.4. On-line recycling plant for the entire spinning mill

Installed equipment can be designed for continuous (on-line) or batch (off-line) operation. Continuous operation implies that secondary raw material is blended with the primary raw material again in the same quantity, and that this takes place permanently and immediately after recovery. For this purpose, the reclaiming installation can deliver to a bale opener (e.g. waste opener), or the material can be blown directly into the ducting of the blowroom line. Here, the reclaiming installation is an integral part of the blowroom. On the other hand, batch operation implies that the secondary raw material is first pressed into bales following recovery, and is then fed to the blowroom in the same way as other bales. In this system, all waste chambers of the blowroom machines, cards and combing machines are connected by suction ducts to central suction equipment that leads to pneumatic bale presses (or silos). In order to keep the various types of waste (comber waste, licker-in droppings, etc.) separate from each other, a bale press is required for each specific type. Such presses are available from Autefa, Bisinger, etc. If only one bale press is available, an individual silo must be provided for each type of waste. About three bale presses (or silos) should be sufficient for a normal cotton spinning mill. Waste chambers (one or more at a time) are selected intermittently and cyclically for suction, and the contents are blown into the presses, e.g. first from all blowroom machines. After automatic changeover to the second press, suction draw-off, for example of the flat strippings, is carried out. If the installation does not operate intermittently, then an extra duct is needed for each waste group. Both systems are used in practice.

1.9.5. Handling dust and fly

1.9.5.1. The problem of dust and fly

The Rieter plant is described here briefly by way of an example.

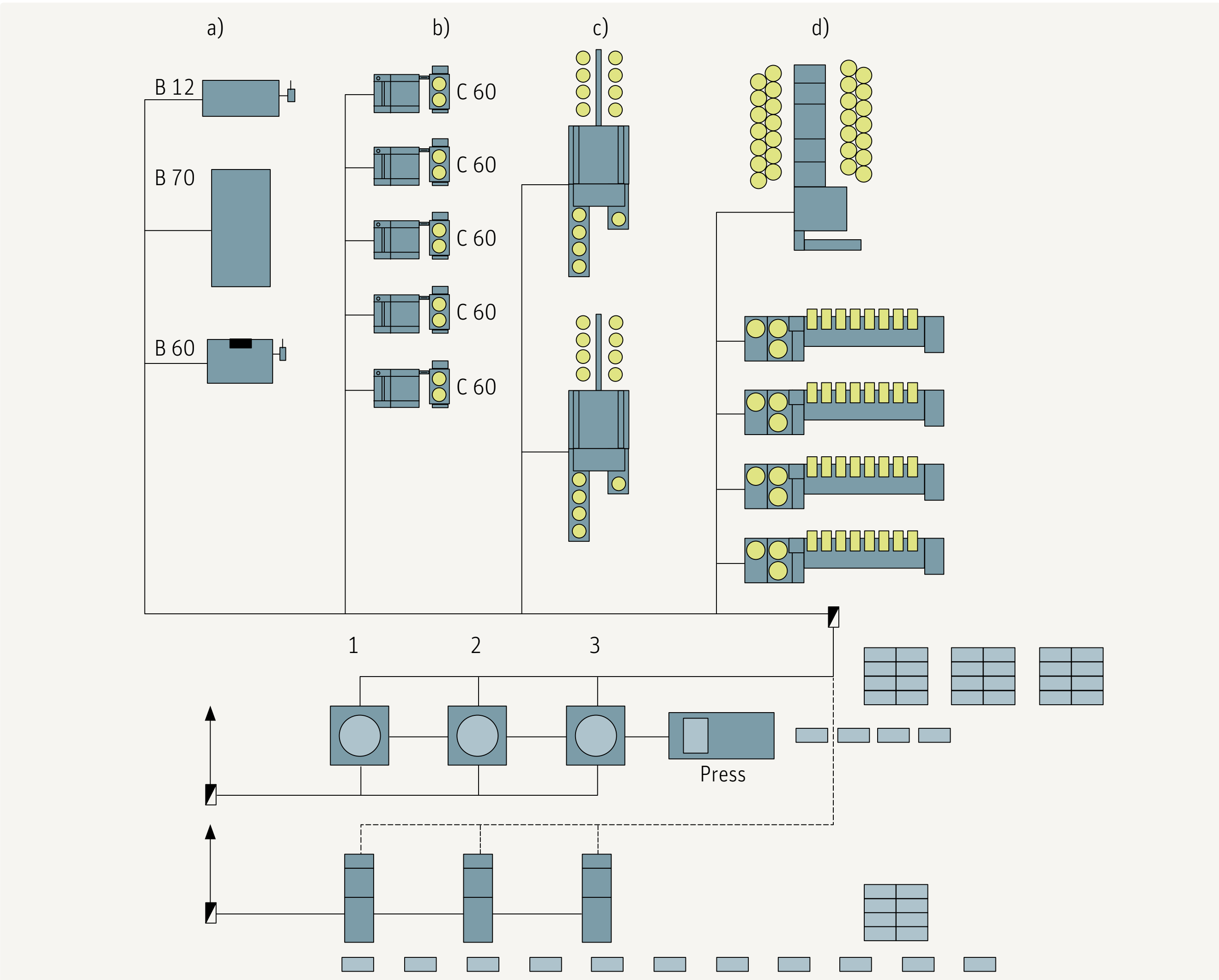


Fig. 81 – A feasible arrangement for the disposal of dirty waste
Blowroom (a); cards (b); draw frames (c); combing room (d); disposal installation with silos (1 - 3) and bale presses, or disposal installation with horizontal bale presses.

Dust is released at each machine, often in great quantities, owing to turning-over, plucking apart, etc., of the material. In processing it is important to ensure that this dust cannot bind with the fibers again and also that it cannot settle in the atmosphere. Today, almost all machines up to the draw frame are enclosed as far as possible and connected to dust extraction lines. Released dust passes immediately into this suction system, in which it must be separated from the air and carried away.

1.9.5.2. Dust filtering

Usually two filter stages are used because a great deal of fly is carried along in the removal of dust by suction. The stages are preliminary filtering and fine filtering. These operations can be performed with individual filters or a central filter.

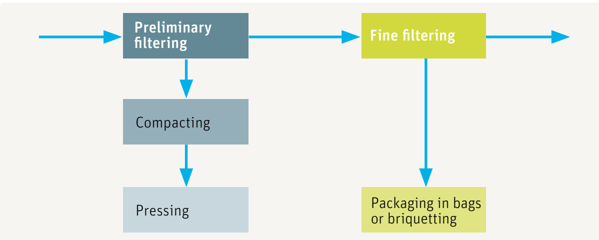


Fig. 82 – Principle diagram of filtration

In new installations in new buildings a central filter (part of the air-conditioning plant) will probably be chosen; individual filters may have to be used in older premises for reasons of space availability and room height. The dust-laden air flows against a slowly rotating filter drum (Fig. 83, 1). A layer of dust and fly forms, is removed by rollers and falls into a carriage located beneath the drum. Before the air returns into the room, it is passed through the fine filter in the form of a filter drum (Fig. 83, 2).

1.9.5.3. Central filter installations

Complete disposal of fly, dust and waste requires high air circulation with corresponding energy consumption. Simultaneously, a second system with high circulation is required, namely the air-conditioning installation. Of course, it is possible to install a self-contained, independently operating waste disposal system with its own air circulating arrangements, and additionally a second system - the air-conditioning installation – with similarly high air circulation. But it is more rational and economical in energy terms to combine these two systems into an integrated unit and to use the air circulation required for the waste disposal system as part of the air circulation in the air-conditioning installation. The waste disposal installation should then be incorporated into the air-conditioning system.

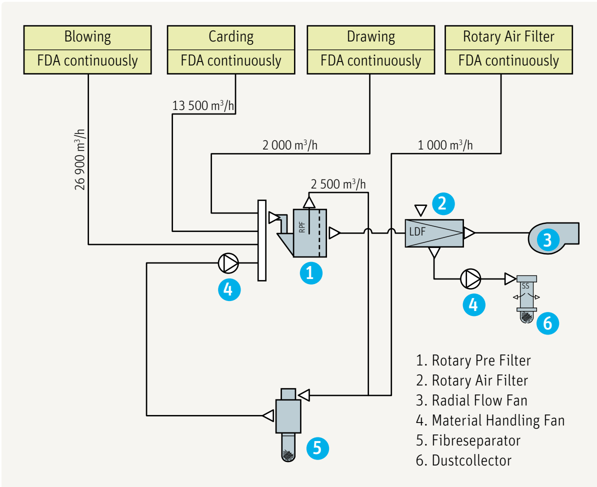


Fig. 83 – Flow diagram of waste removal plant

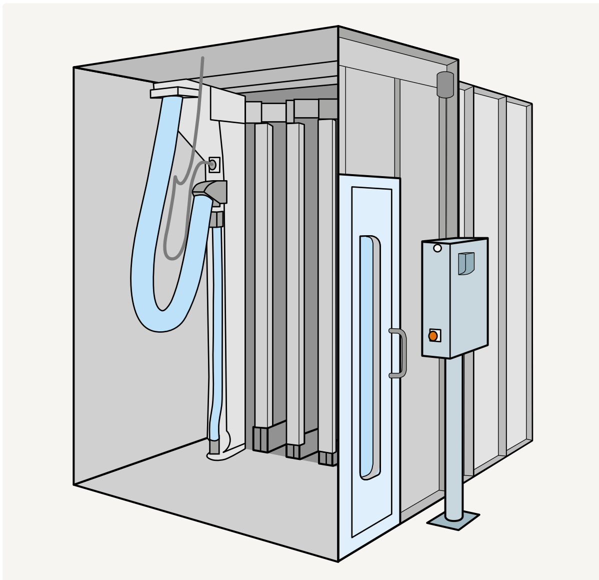


Fig. 84 – Panel pre-filter (LUWA)

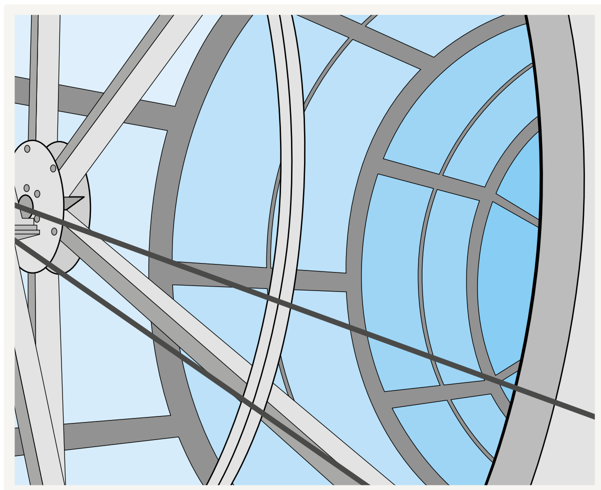


Fig. 85 – Rotary fine filter (LUWA)

1.9.6. Final disposal of waste

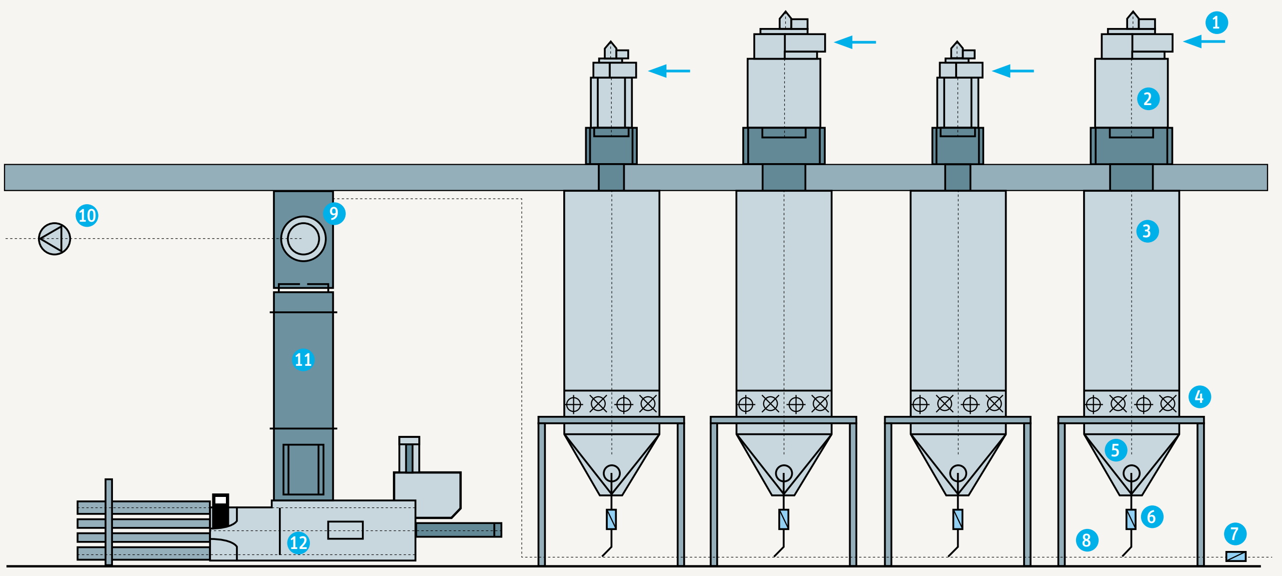
Dirty waste materials are preferably collected, baled, packed and removed so that manual handling is excluded as far as possible. There are several possibilities for baling and packing:

	Baling density [kg/m³]
After passage through a condenser, eject or press into container	100
Fill into sacks via fiber separators (compactor)	60 - 80
Re-used – lighter bale presses – heavy-duty bale presses	 80 - 120 200 - 250
Press into cakes or briquettes by briquetting presses	600 - 1 200

When waste is pressed into containers, or formed into bales or briquettes, handling and transport are simple.
In this form, mainly as briquettes, waste can be composted or burned. The heating value is approximately 4 kWh/ kg (for comparison, the value for heating oil is just over 12 kWh/kg).

Functional description of the Bale Press System (BPS, Fig. 86):

- The textile waste (material) is usually pneumatically conveyed (1) (and separated according to quality) directly from the production plant to the fiber separators.
  The fiber or waste separators are used as standard separators. It is essential that the dusty conveying air in the fiber separator is discharged into a filtering installation.
- The waste is discharged from the fiber separator (2) into the material silo (3).
- The discharge unit (4) moves the waste from the material silo to the internal material conveying system (8).
- The material can then be fed to the bale press (11) by means of waste separator WS (9).
- Subsequent pressing of the material is performed in the bale press (12).



1. Material conveying from production
2. Fiber separator FS
3. Material silo
4. Discharge unit
5. Discharge cone
6. Shut-off damper
7. Scavenging air shut-off damper
8. Conveying line
9. Waste separator WS
10. Transport fan
11. Bale press feeding hopper
12. Bale press

Fig. 86 – Example: Bale Press System with pneumatic material conveying

2. THE CARD

2.1. Summary

2.1.1. Introduction

Two maxims of the experts – 'The card is the heart of the spinning mill' and 'Well carded is half spun' – demonstrate the immense significance of carding for the final result of the spinning operation. According to Dr. Artzt of the Research Institute in Denkendorf, Germany, the operation of the card shows:

- the highest correlation to quality;
- and also to productivity.

The importance of carding is even greater where new spinning systems are concerned. The considerable influence of the card on yarn quality arises from the very complex series of events in the process itself, and also from the pressure to adopt an extremely high production rate on economic grounds. This high production rate causes problems, since there is a close relationship between increases in production and reductions in quality:

- the higher the performance, the more sensitive the carding operation becomes
- and the greater the danger of a negative influence on quality.

One of several causes is that we are still operating according to a concept dating from 1770 and with a type of machine dating from 1850. On the other hand, since 1965 production rates have increased from about 5 kg/h to about 220 kg/h – a rate of increase not matched by any other textile machine except the draw frame.
When dealing with cards it has to be kept in mind that nowadays cards and blowroom form an integral, homogeneous, inseparable unit, coordinated to complement one another.
While in the case of an easy-to-clean cotton, for example, the blowroom line might assume most of the working load required, for hard-to-clean cotton this might be done by the card.

2.1.2. The tasks of the card

2.1.2.1. Opening into individual fibers

Whereas the blowroom only opens the raw material into tufts, the card must open to the stage of individual fibers. This is essential to enable impurities to be eliminated and the other operations to be performed.

2.1.2.2. Elimination of impurities

Elimination of foreign matter occurs mainly but not exclusively in the region of the licker-in. Only a small part of the contaminants is carried along with the flat strippings, or falls out at other positions. The degree of cleaning achieved by the modern card is very high, in the range of 80 - 95 %. Thus, the overall degree of cleaning achieved by the blowroom and the carding room together is as high as 95 - 99 %. But carded sliver still contains 0.05 - 0.3 % of foreign matter.

2.1.2.3. Elimination of dust

In addition to free dust, which can be directly extracted by suction as in the blowroom, the card also removes a large proportion of the microparticles that are bound to the fibers. Significant fiber/metal or fiber/fiber friction is needed in order to loosen such particles. Both are available on the card to a considerable degree, i.e. the card is a good dust removing machine.

2.1.2.4. Disentangling neps

While the number of neps increases from machine to machine in the blowroom, the card reduces the remaining number to a small fraction. It is often falsely assumed that neps are eliminated at the card; in fact, they are mostly opened out. Only a fraction of the neps leaves the machine unopened via the flat strippings. Fig. 87 shows the approximate change in the number of neps in the process.
An improvement in the disentangling of neps is obtained by:

- reducing fiber density on the cylinder by using larger cylinder widths;
- closer spacing between the clothing surfaces;
- sharper clothing;
- optimal (not too low) licker-in speeds;
- low doffer speeds;
- lower throughput.

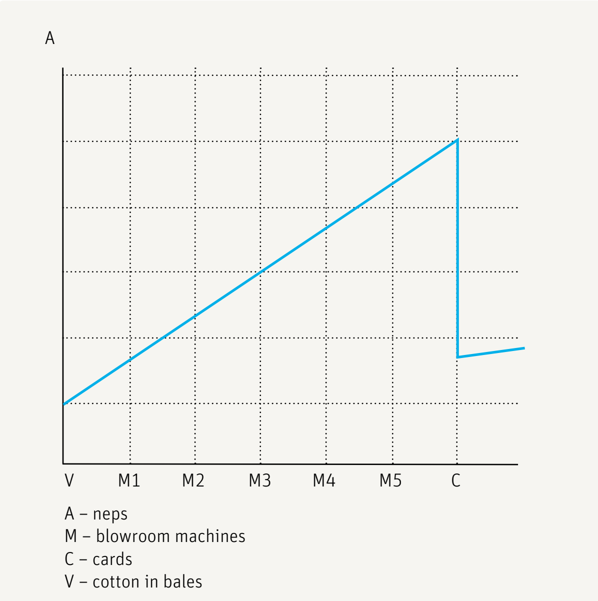


Fig. 87 – Change in the number of neps in the cotton when passing blowroom and cards

2.1.2.5. Elimination of short fibers

Short fibers can only be eliminated if they are pressed into and retained in the clothing. Since that is not possible with metallic clothing, only the flats can be considered in this context. The ability to select short as opposed to long fibers is based on the fact that long fibers have more contact with the clothing of the main cylinder than the short fibers. Thus longer fibers are continually caught and carried along by the main cylinder. Short fibers, on the other hand, offer less surface to the clothing of the main cylinder; they therefore remain caught in the flats clothing, are pressed into it and leave the machine in the flat strippings. Elimination of short fibers in the card must, however, be viewed in proportion. It is actually very small, as can be readily demonstrated. The card eliminates 1 - 2 % flat strippings. Approximately half of the strippings are made up of short fibers. The card therefore eliminates fewer than 1 % short fibers. In the staple diagram this is scarcely noticeable – the inaccuracy of the staple measurement procedure is greater than the change in value.

2.1.2.6. Fiber blending

The card scarcely improves long-term blending, since the time spent by the material in the machine is too short. However, it improves transverse blending and fiber-to-fiber blending because, apart from the OE spinner, the card is the only machine to process individual fibers. Intimate fiber-to-fiber mixing is achieved in the formation of the web.

2.1.2.7. Fiber orientation

Parallelizing action is often attributed to the card. This is not completely justified, since the fibers in the web are not parallel, although they do have, for the first time, a certain degree of longitudinal order. It is true that a parallel condition is achieved on the main cylinder, but it disappears during formation of the web between the cylinder and the doffer. Thus, the card can be given the task of creating partial longitudinal orientation of the fibers, but not that of creating parallelization.

2.1.2.8. Sliver formation

In order to be able to deposit the fiber material, transport it and process it further, an appropriate intermediate product must be formed. This is the sliver. In extreme cases, card sliver has a count of 3 ktex (new spinning processes) to 9 ktex. Generally the count lies between 4 and 7 ktex (for direct feeding of draw frames up to 20 ktex) in the short-staple spinning mill.

It also has to be kept in mind that all these operations must be performed:

- at very high output;
- with very careful treatment of the fibers; and
- very high utilization of the raw material.

2.1.3. Operating principle

In modern installations, raw material is supplied via pipe ducting (Fig. 88, 1) into the feed chute (of different designs) (2) of the card. An evenly compressed batt of about 500 - 900 ktex is formed in the chute. A transport roller (3) forwards this batt to the feed arrangement (4). This consists of a feed roller and a feeder plate designed to push the sheet of fiber slowly into the operating range of the licker-in (5) while maintaining optimal clamping.
The portion of the sheet projecting from the feed roller must be combed through and opened into tufts by the licker-in. These tufts are passed over grid equipment (6) and transferred to the main cylinder (8). In moving past mote knives, grids, carding segments (6), etc., the material loses the majority of its impurities. Suction ducts (7) carry away the waste. The tufts themselves are carried along with the main cylinder and opened up into individual fibers between the cylinder and the flats in the actual carding process.
The flats (10) comprise 80 - 116 individual carding bars combined into a belt moving on an endless path. Nowadays some 30 - 46 (modern cards about 27) of the flats are located in the carding position relative to the main cylinder;

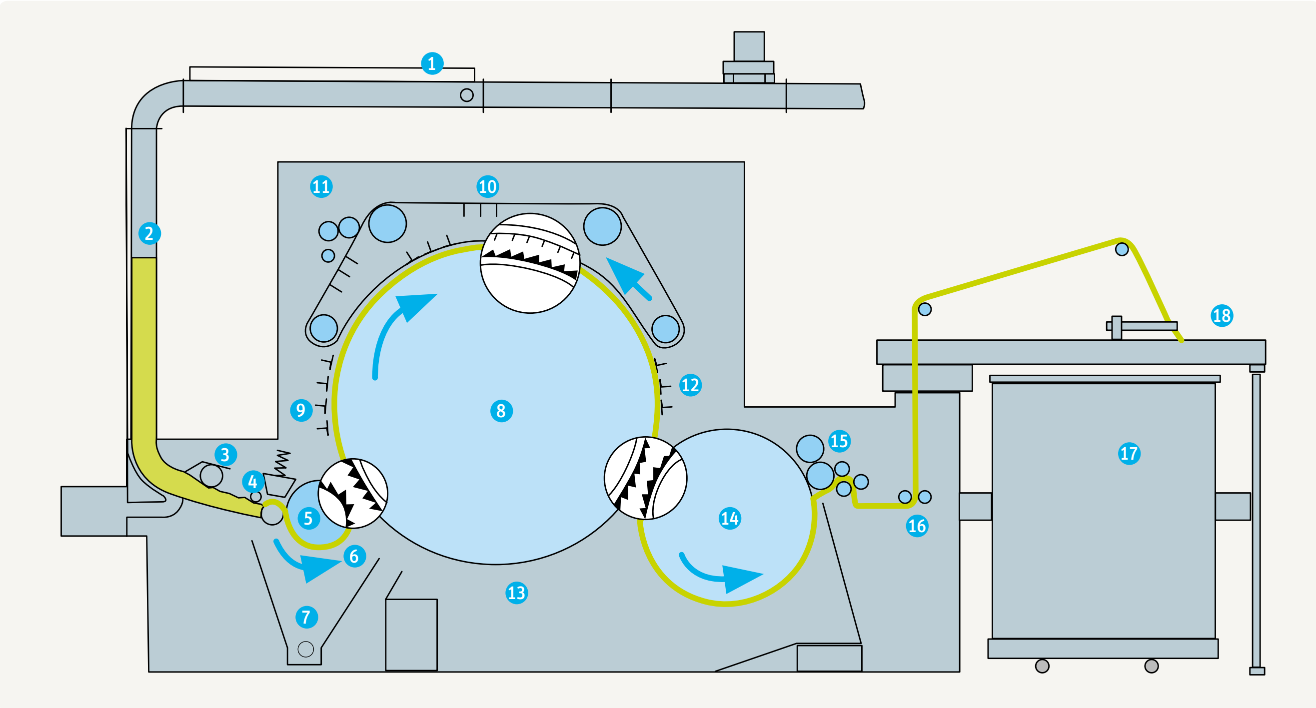


Fig. 88 – Modern high-performance card

the rest are on the return run. During this return, a cleaning unit (11) strips fibers, neps and foreign matter from the bars. Fixed carding bars (9) and (12) are designed to assist the operation of the card. Grids or cover plates (13) enclose the underside of the main cylinder. After the carding operation has been completed, the main cylinder carries along the fibers that are loose and lie parallel without hooks. However, in this condition the fibers do not form a transportable intermediate product. An additional cylinder, the doffer (14), is required for this purpose. The doffer combines the fibers into a web because of its substantially lower peripheral speed relative to the main cylinder.

A stripping device (15) draws the web from the doffer. After calender rolls (16) have compressed the sliver to some extent, the coiler (18) deposits it in cans (17). The working rollers, cylinder and flats are provided with clothing, which becomes worn during fiber processing, and these parts must be reground at regular intervals.

2.1.4. Varying types of design
2.1.4.1. Basic considerations

Carding engines are basically designed for processing either relatively long fibers (wool cards with carding rollers) or relatively short fibers such as those found in the usual short-staple spinning mill. Since machines of the latter type have flats circulating on an endless path, they are referred to as revolving flat cards.

The name card is derived from the Latin ‘carduus’, meaning thistle, the spiked fruit of which was used in earlier times for plucking fibers apart. The working width was usually 1 000 mm or 40 inches; Rieter recently increased it to 1 500 mm on its new C 60 card.

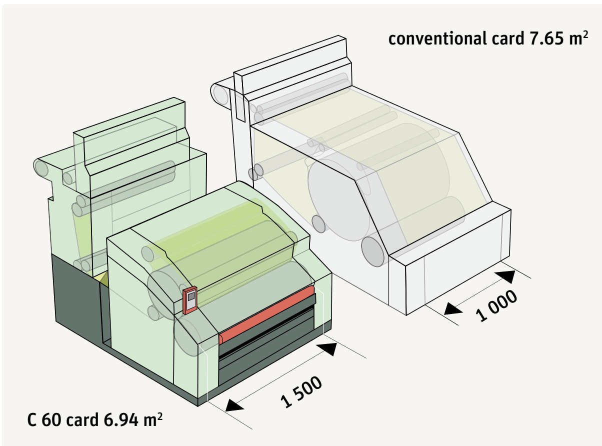


Fig. 89 – The Rieter C 60 card with a width of 1 500 mm compared with a standard card

This is one of the reasons (out of a dozent others) for the extremely large increase in production from usually 5 kg/h to max. 120 kg/h (the last but one generation) and to about 220 kg/h for the latest generation.

Although the card used today is still the same type as that designed in 1850, its performance has been improved tre-

mendously, mainly by some design details. The target was first of all to provide:
- better opening of the material in front of the main cylinder;
- far better and more even spread of fibers on the surface of the cylinder.

This was achieved by installing more opening and carding devices in front of and around the main cylinder, e.g.:
- an opening device in the feed chute;
- new feeding arrangement (directional feed) at the licker-in;
- a second and a third licker-in;
- carding bars in front of the flats and behind the flats at the cylinder.

Another means for achieving these improvements was the former Crosrol tandem card (no longer available), which will be described in the following chapter.

2.1.4.2. Duo or tandem cards

As the name implies, tandem cards consist of two individual cards joined together to make up a unit, in which the doffer of the first card feeds fiber material to the licker-in of the second card. Double carding of the raw material has a positive effect on quality and on blending. However, these advantages are purchased at the cost of expense in hardware and maintenance, and additional space is required. Modern cards of the latest generation give the same and better quality as tandem cards. Therefore tandem cards are not necessary and are no longer available (Fig. 90).

2.2. The operating zones of the card
2.2.1. Material feed
2.2.1.1. Requirements

In modern spinning installations the card is the first machine to deliver a cohesive intermediate product. Among other requirements, the product is expected to be very even and as far as possible free of faults. Irregularities in the sliver can be traced through into the yarn, at least in the spinning of carded yarns; that is, they diminish yarn quality.
A fault-free sliver cannot be obtained unless the feedstock is in an adequate condition, since every irregularity in the feedstock is transmitted completely into the sliver – in an elongated form owing to the draft. The time spent by the material in the machine is too short for total compensation. In spinning, as in any other type of manufacturing process, the rule must be that faults should not be corrected and hidden but their occurrence should be prevented from the start. It follows that the feed to the card must be very even. Where lap feed was used, this

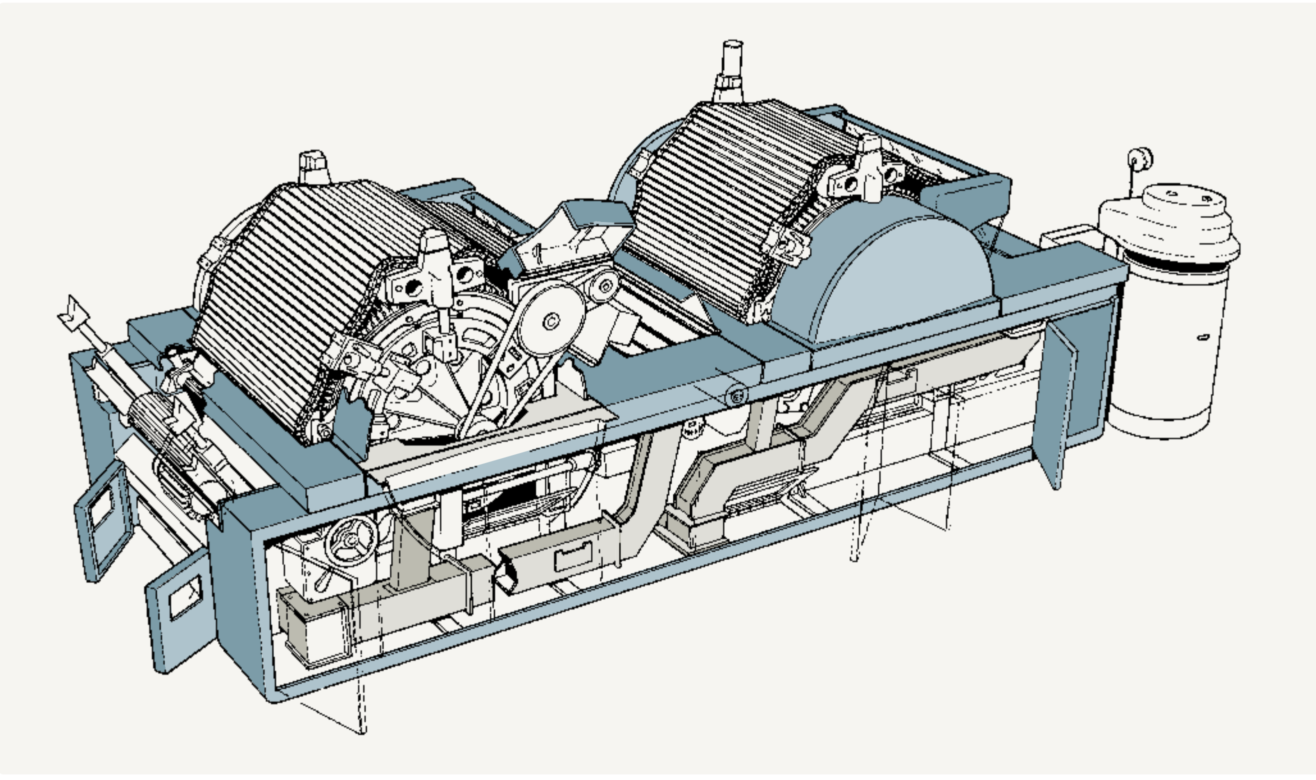


Fig. 90 – Crosrol tandem card

represented only a minor problem, since the scutcher formed even laps, each of which was checked for accuracy of count. Tuft feed systems react much more sensitively.
The tufts must be transported pneumatically from a distributor unit into the chutes of several cards. One of the cards is always located very close to the fan of the distributing system, whereas the others are located at steadily increasing distances from the fan. To obtain even feeding, the batts in the individual feed chutes of all cards must be equally thick, evenly distributed over the whole width of the chute and of equal density. This requirement cannot be fulfilled continuously without the expenditure of some effort. An additional requirement for the feedstock of high-performance cards is a high degree of openness. This very good openness in turn is the reason for the large increase in performance of this card in comparison with conventional machines. Higher loading of the clothing (600 to 900 ktex) permits greater throughput of material. Correspondingly finely opened material is therefore essential.

2.2.1.2. Basic concept of tuft feed

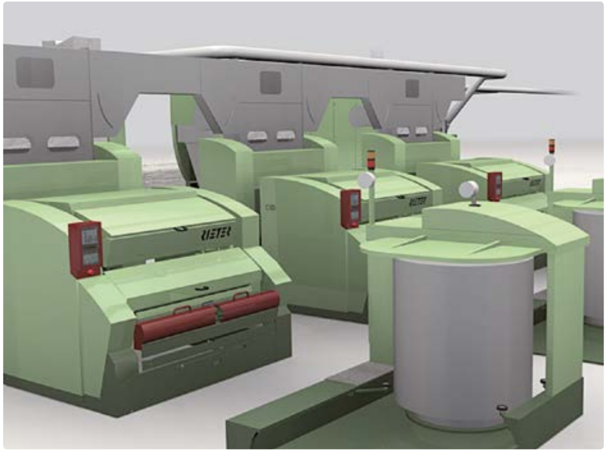


Fig. 91 – Material feed at the card

A distinction must be made between two basic tuft feed concepts:
- one-piece chute without an opening system (Fig. 92);
- two-piece chute with an opening system (Fig. 93).

In the one-piece chute, a column of material of a height that is somewhat variable over time is pushed forward toward the feed rollers. This form of chute is simple, uncomplicated, economical and needs little maintenance, but does not comply with the requirements of a high-performance card. In contrast to this chute, the two-piece chute is more complex and expensive, but delivers a more even batt with better opened material.

The upper half of the chute is a reserve chamber that serves to receive the material from the blowroom and to separate the material from the air. In the lower portion, after an opening stage at the opening roller the quantity of material is held constant. This material is lightly compressed by compressed air or by vibrating plates in a continuous and even manner to form an even batt - an ideal feedstock. A distinction is also drawn between feed installations with open and closed distribution systems. In open transport systems, the ducting terminates after the last card. In closed systems, there is a circulation path through which excess tufts, which have not been taken up by any card, are returned to the distributor unit. If too much material is present on the circulation path, neps can be formed. This type of installation is also inflexible, since an established association of the cards with the blowroom installation cannot be changed. In all forms of pneumatic chute feed it is important that when operation of a card ceases, all compression of material in the chute is terminated, whether such compression is effected by compressed air or by the shaking of a vibrating plate. Otherwise, material remaining in the chute will be over-compressed and when operation restarts the resulting sliver will be too heavy over a significant period. Cards with pneumatic feed mostly require regulating equipment to maintain constant sliver weight.

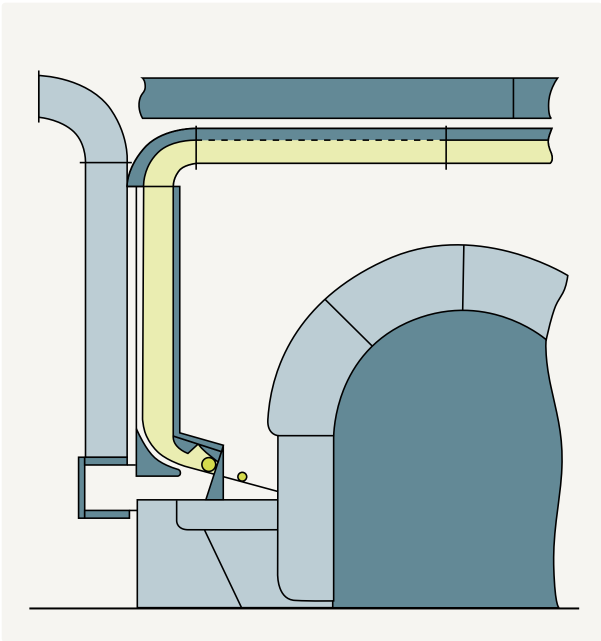


Fig. 92 – Tuft feed with a one-piece chute

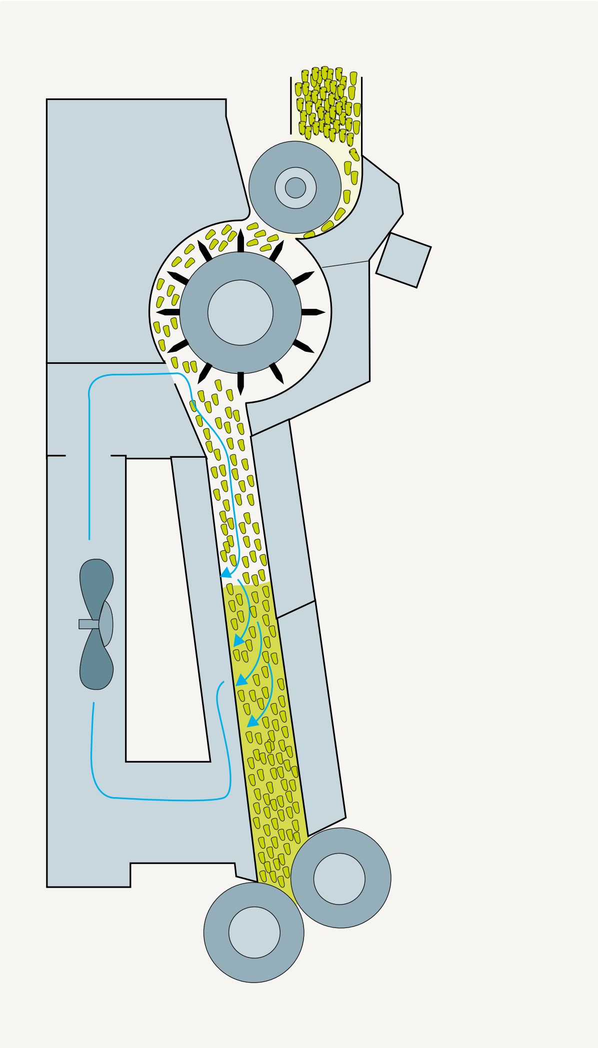


Fig. 93 – Tuft feed with a two-piece chute

2.2.1.3. The two-piece chute system

Raw material, delivered by a fan between the B 60 UNIflex and the chutes or by the A 78 UNIstore, travels via the transport duct, which extends over all integrated machines within a unit, into the reserve chutes (upper half of the chute) of the individual cards. The transport air escapes via a perforated sheet and is carried away by a suction duct. In this part of the chute (upper half) an electronic pressure regulator ensures an approximately constant height of material.
The feed roller, which seals the upper half of the chute, pushes the stock into the region of the opening roller, and this roller in turn plucks out fine tufts and discharges them into the actual feed chute (lower part). Here, controlled condensing is carried out by a metered supply of compressed air from a fan. A perforated sheet that is part of the rear wall permits the air to escape. It then flows back to the fan.
An electronic pressure switch ensures constant filling and density of material in the chute; this is obtained by adjusting the speed of the feed roll (above the opening roller).
The airflow in the chute continually carries the tufts to the zone in which the perforated sheet is currently least covered by fibers. Even distribution of tufts over the whole chute width is thus obtained.

2.2.1.4. Fine cleaning integrated in the card chute

With this solution, fine cleaning has been transferred to the card chute. The existing opening position is supplemented with a mote knife.
The result is:
- a card chute with integrated fine cleaning;
- the high production load of the blowroom is now distributed over several cards;
- fine cleaning is performed very gently at considerably lower production rates compared to the blowroom;
- yarn quality is improved; for example, imperfections (thick places, thin places and neps) are usually reduced and short fiber content improves.

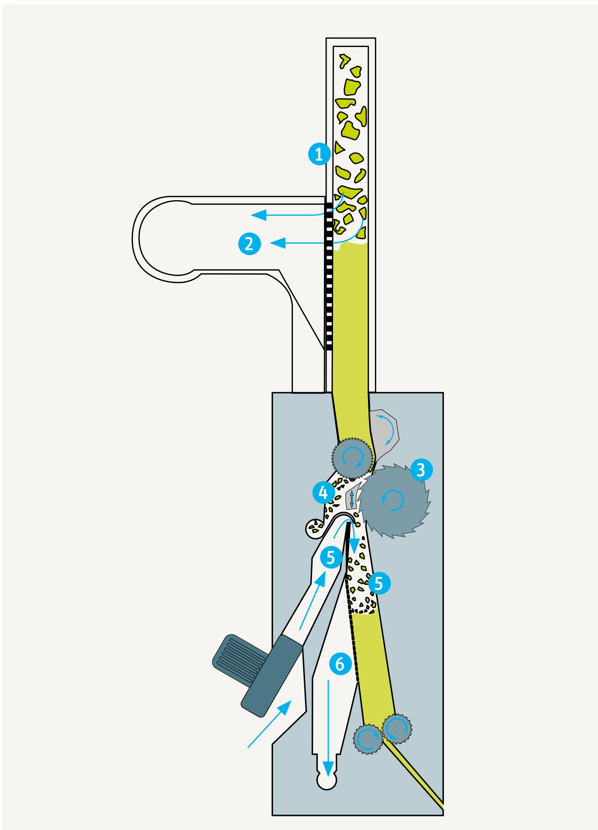


Fig. 94 – Fine cleaning in the card chute

Mode of operation (Fig. 94):
1. Fiber tufts are fed uniformly to the card chute with integrated fine cleaning.
2. The fiber tufts are separated from the transport air in the upper section of the card chute (1, 2) and form an initial homogeneous batt.
3. A feed roller with a feed trough (4) and a needled cylinder (3) produces small tufts and thus a large tuft surface.
4. The integrated mote knife immediately eliminates the exposed trash particles.
5. The released tufts are blown into the lower section (5) of the shaft by means of an additional controlled air current and condensed there into a homogeneous batt.
6. The perforated rear wall at this point permits additional dedusting of the tufts.

2.2.2. Feed device to the licker-in
2.2.2.1. Conventional system

A well designed feed device is expected to perform the following tasks:
- clamp the batt securely over its full width;
- be able to hold the material back against the action of the licker-in;
- present the batt to the licker-in in such a manner that opening can be carried out gently.

The conventional feed assembly (Fig. 95) comprises a stationary feed table with a feed plate (1) and a feed roller (2) pressed against the plate. The feed plate is formed as a special extension of the feed table and is adapted to the curvature of the cylinder.

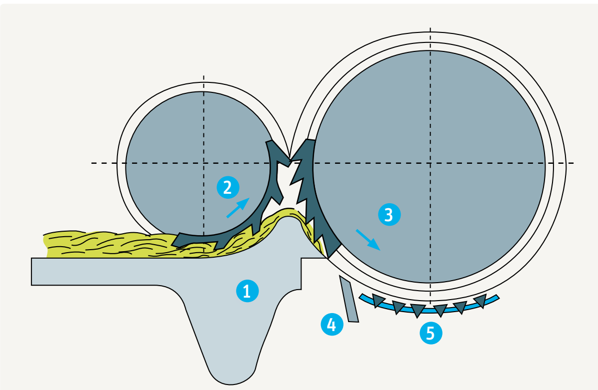


Fig. 95 – Conventional feed device

The plate is formed at its upper edge with a nose-like deflector (b, Fig. 96) to hold the batt. Facing the licker-in, the plate has a fairly long guide surface (a). The deflector nose and guide surface have a significant influence on quality and on the quantity of waste eliminated. A sharp deflector nose gives good retention of the fibers and hence an intensive, but unfortunately not very gentle, opening effect. On the other hand, an over-rounded curve results in poor retention and poor opening. In this case, the licker-in often tears out whole clumps of fibers. The length of the guide surface (Fig. 96 a) also influences waste elimination. If it is too short, the fibers can escape the action of the licker-in.

They are scraped off by the mote knives and are lost in the waste receiver. If this surface is too long, it presses the fibers into the clothing. This gives better take-up of the fibers, but at the same time better take-up of impurities. The result is a reduction in the cleaning effect. The length of the guide surface is dependent on the staple length, at least within a wide range. The feed roller has a diameter of 80 - 100 mm and is usually clothed with saw-tooth wire, the teeth being directed against the flow of material. This gives good retention of the batt, which ensures that the licker-in does not tear whole lumps out of the batt. The opening effect of the licker-in is thus more in the nature of combing.

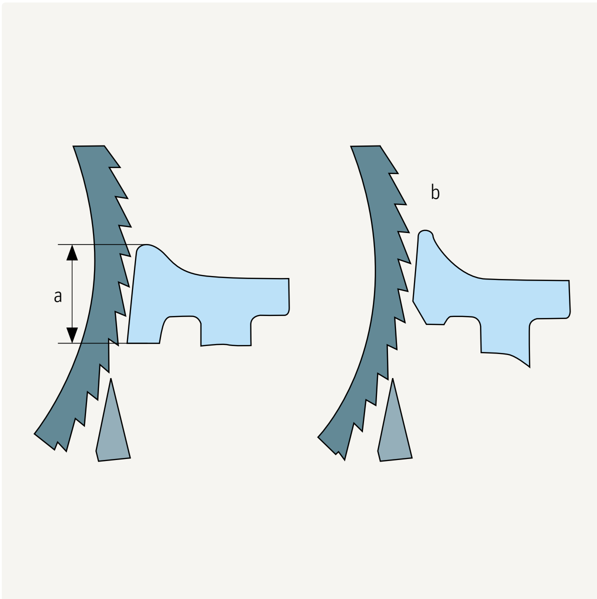


Fig. 96 – The shape of the feed plate

2.2.2.2. Feed in the same direction as licker-in rotation (unidirectional feed)

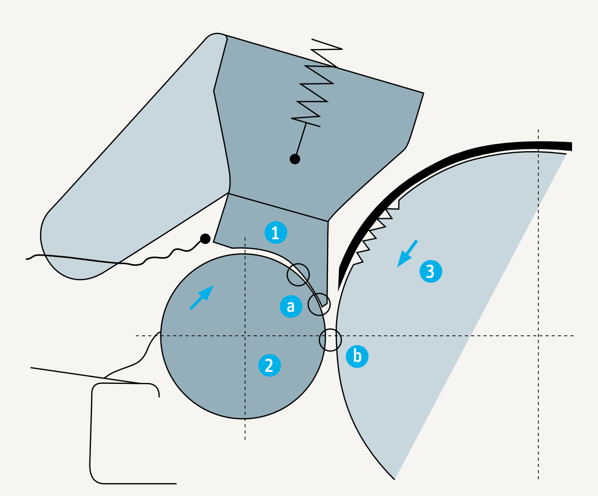


Fig. 97 – Feed in the same direction as drum rotation (Rieter)

When the conventional system is examined, it is observed that the material is pushed forward, illogically, against the direction of rotation of the licker-in. The batt must undergo a sharp bend so that the licker-in can sweep through it. This diversion certainly does not contribute to gentle fiber treatment. Rieter has therefore converted the feed system to enable material to be fed in the direction of rotation of the licker-in (Fig. 97). The arrangement of the two feed devices is opposite to that of the conventional system, i.e. feed roller (2) is located below and plate (1) is pressed against the roller by spring pressure. Owing to the rotation of the feed roller in the same direction as the licker-in, the batt runs downward without diversion directly into the teeth of the licker-in. In order to give perfect operating conditions in the conventional feed system, the spacing between the feed plate and the licker-in must be adapted precisely to the material. Where the direction of rotation of the feed roller and the drum is the same, the distance from the clamping zone (the exit from the plate) to the feed roller/licker-in clamping point (distance b/a) is adjustable.

2.2.3. The licker-in zone

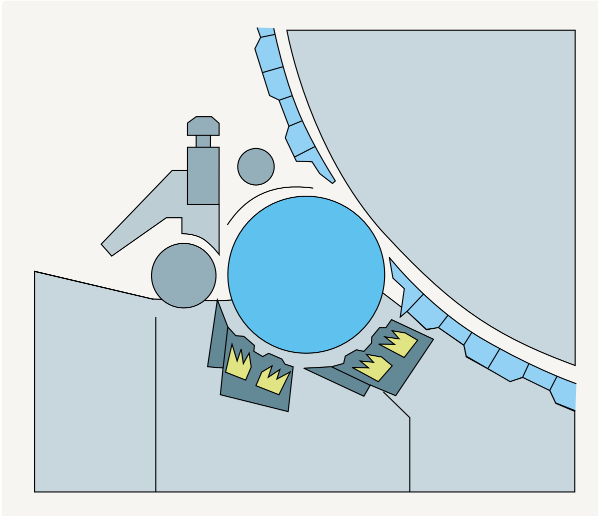


Fig. 98 – The licker-in

2.2.3.1. The licker-in

This is a cast roller with a diameter usually of around 250 mm. Saw-tooth clothing is applied to it. Beneath the licker-in there is an enclosure of grid elements or carding segments; above it is a protective casing of sheet metal. The purpose of the licker-in is to pluck finely opened tufts out of the feed batt, lead them over the dirt-eliminating parts under the roller and then deliver them to the main cylinder. In high-performance cards, rotation speeds are in the range of 800 - 2 000 rpm for cotton and about 600 rpm for synthetics.

2.2.3.2. The operation of the licker-in

By far the greatest part of opening and cleaning is performed by the licker-in. In machines with only one licker-in, opening is performed to an extent where more than 50 % of all fibers pass onto the surface of the main cylinder in the form of tufts, and slightly less than 50 % in the form of individual fibers. Treatment imparted by the licker-in is therefore very intensive, but unfortunately not very gentle. The licker-in combs through a fairly thick fiber fringe at a rotation speed of 1 600 rpm (approximately 600 000 wire points per second), a circumferential speed of around 21 m/sec (approximately 76 km/h) and a draft of more than 1 600. Even without sophisticated mathematical computation, it will be clear that fiber deterioration is very likely to occur at the opening point. Only the degree of deterioration can and must be precisely controlled by adjustment of:

- the thickness of the batt;
- the degree of openness of the raw material in the feedstock;
- the spacing between the operating devices;
- the degree of orientation of the fibers in the feedstock;
- the aggressiveness of the clothing;
- the rotation speed of the licker-in;
- the material throughput.

Opening itself involves the tearing away of the feed batt on a wedge shape by means of the licker-in; 'wedge shape' refers to the fact that the projecting fiber fringe becomes steadily thinner where it faces away from the clamping point owing to the plucking-out of fibers. The type and intensity of the opening process influences the final yarn, primarily as regards neppiness, imperfections, evenness and strength.

2.2.3.3. Elimination of waste

Waste elimination is very intensive and takes place under the licker-in by means of special devices. The classic cleaning assembly consisted of 1 - 2 mote knives and a grid, one half of which was made of slotted sheet and another half of perforated sheet. In this arrangement, elimination of foreign matter took place exclusively by scraping off on the mote knives. The grid sheets tend to serve as devices for guiding and holding-back fibers, i.e. they prevent additional fiber losses that could arise from ejection.
High-performance cards require alternative assemblies in order to be able to deal with the high material throughput. Accordingly, the lickers-in of such cards no longer operate with grids but with carding segments (4, Fig. 99).
In the last but one generation of the Rieter card, for example, the tufts are first guided over a mote knife (2), then over a carding plate (3), then again over a mote knife and again over a carding plate, before they finally pass to the main cylinder. The carding plates are fitted with special clothing (3a).

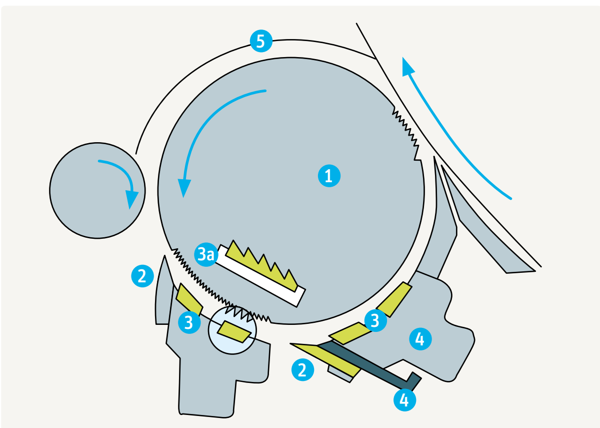


Fig. 99 – Carding segments under the licker-in of the Rieter C 51 card

A trash mote knife with suction unit is assigned to the licker-in. With the effective opening in the chute the C 60 card with single licker-in provides much better opening than the C 51. The single licker-in opens the material tufts even more with absolutely minimal loss of sound fibers, and extracts coarse trash and dust gently.

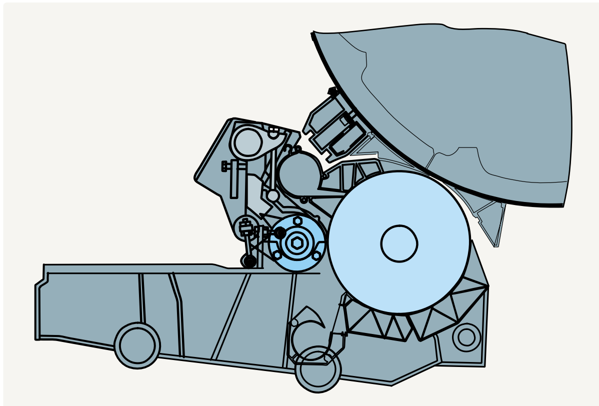


Fig. 100 – Single licker-in, Rieter C 60 card

2.2.3.4. Transfer of fibers to the main cylinder

Between licker-in and main cylinder the clothing is configured for doffing. It follows that the opening effect at this position cannot be very strong. Nevertheless, it exerts an influence on sliver quality and also on the improvement in the longitudinal orientation of the fibers that occurs here. The effect depends on the ratio of the speeds of the two devices. According to various investigations, this ratio should be about 1:2; i.e., the draft between the licker-in and the main cylinder should be slightly more than 2 (this refers to a card with one licker-in, not to a machine with several). The optimum ratio depends upon the raw material; in any event, when speeds are to be altered, this interdependence should be borne in mind.

2.2.4. Auxiliary carding devices (carding aids)

2.2.4.1. Need for such assemblies

The so-called combing rate was used previously in order to indicate the opening effect of the card. This was the ratio of the main cylinder's rotation speed (rpm) to the infeed speed (inches/min.). This number can no longer be used under modern production conditions. The opening effect can now be represented only by the number of points per fiber, i.e. average of total fibers fed in per unit of time over the number of points available in the same time. At the licker-in there may be, for example, 0.3 points per fiber (three fibers per point) and at the main cylinder perhaps 10 - 15 points per fiber.

If a given quality of yarn is required, a corresponding degree of opening at the card is needed. However, an increase in production at the card such as we have experienced in recent years means quite simply that more fibers must be passed through the machine.
In order to obtain the same carding effect (i.e. the same number of points per fiber), the number of points per unit of time must also be increased. This can be achieved by:

- more points per unit area (finer clothing);
- higher roller and cylinder speeds;
- more carding surface or carding positions;
- finer opening of the fibers before feeding to the cylinder.

Little can now be done to increase the number of points, since the mass of fiber also has to be accommodated between the clothing: coarse fibers and a high throughput demand coarser clothing; fine fibers and a lower throughput permit the use of finer clothing.
Much has already been achieved by increasing speeds, but further increases will prove steadily more difficult, as an example will demonstrate. If, for example, the production of a card is increased from 25 kg/h to 60 kg/h with the same number of points per fiber, the main cylinder speed must be raised from 300 rpm to 750 rpm (according to P. Artzt). This cannot be achieved from either the design or the technological standpoint. One effect, among many, would be severe deterioration of the fibers.
There remain only the third and fourth approach – insertion of additional carding surface or additional carding positions and/or installing more lickers-in. Here also, there are two possibilities:

- increase in the number of lickers-in;
- fitting of additional carding plates.

Both have been put into practice.

2.2.4.2. Increase in the number of lickers-in

The standard card has only one licker-in; for a long time attempts have been made to increase this number and thereby to increase the opening effect. With the introduction of modern high-production cards, several manufacturers again saw this approach as one way to improve performance. Various card designs therefore now incorporate multiple lickers-in, e.g. Rieter (Fig. 101), Trützschler or Marzoli.
They are optionally available. The clothing surfaces are in the doffing configuration relative to each other, and speeds must be increased in the throughflow direction, for example from 600 rpm (first licker-in) via 1 200 rpm to 1 800 rpm (third licker-in) (or the velocity by increasing the diameter). Instead of grids, the lickers-in are encapsulated in casings.
Within these casings there are a few small openings including sharp-edged grid blades to scrap off the impurities. The latter fall into a pipe and are sucked away to the waste collecting devices. For fine, long fibers mostly only one licker-in is used.

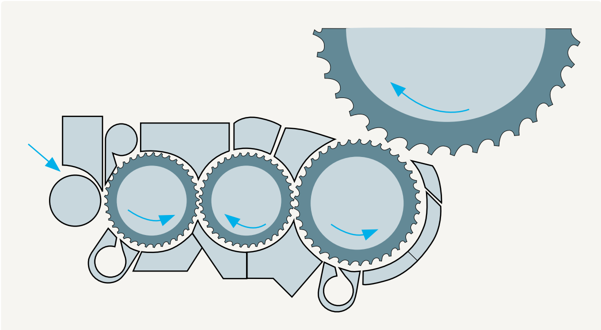


Fig. 101 – Three lickers-in on the Rieter C 60 card

2.2.4.3. Carding plates or carding bars

The other or additional method of intensifying the carding effect is the insertion of carding elements at special positions. Today, carding aids can be applied at three positions:

- under the licker-in;
- between the licker-in and the flats;
- between the flats and the doffer.

These aids are in the form of carding plates or carding bars.

Carding plates have already been illustrated in Fig. 99 at the licker-in, while carding bars are shown in Fig. 102 and Fig. 103.
Plates are usually used in the licker-in zone, while bars are being located increasingly in the region of the main cylinder (Fig. 102 and Fig. 103).
An aluminium carding profile (1) consists of 2 carding bars (2). One of the advantages of bars is that they can be provided in different finenesses, e.g. they can become finer in the through-flow direction. Different manufacturers use differing numbers of elements (between one and four) per position. Special clothing is required that must not be allowed to choke. Most modern high-performance cards are already fitted with these carding aids as integral equipment; all other machines can be retrofitted by, for example, Graf of Switzerland or Wolters of Germany.
In use are also other carding devices of different design and with different components, e.g. mote knives (4) with guiding element (5) and suction tubes (3), etc.

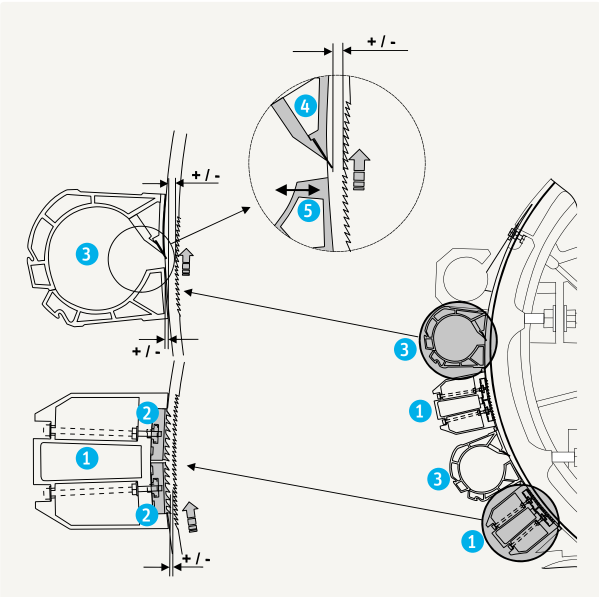


Fig. 102 – Carding bars at the infeed

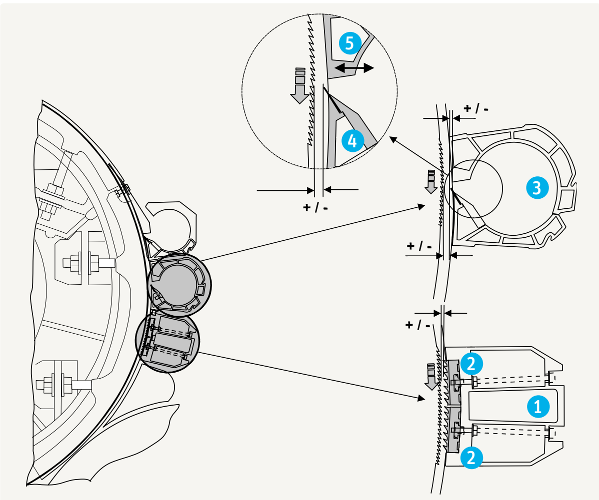


Fig. 103 – Different carding segments at the delivery

2.2.4.4. Purpose and effect of carding elements

If carding elements or additional lickers-in are not used, the licker-in delivers mostly tufts, if not whole lumps, to the main cylinder.
These are compact and relatively poorly distributed across the licker-in. If they pass into the space between the cylinder and the flats in this form, fiber-to-fiber separation becomes very difficult and imposes considerable loading on the clothing. The whole carding operation suffers.

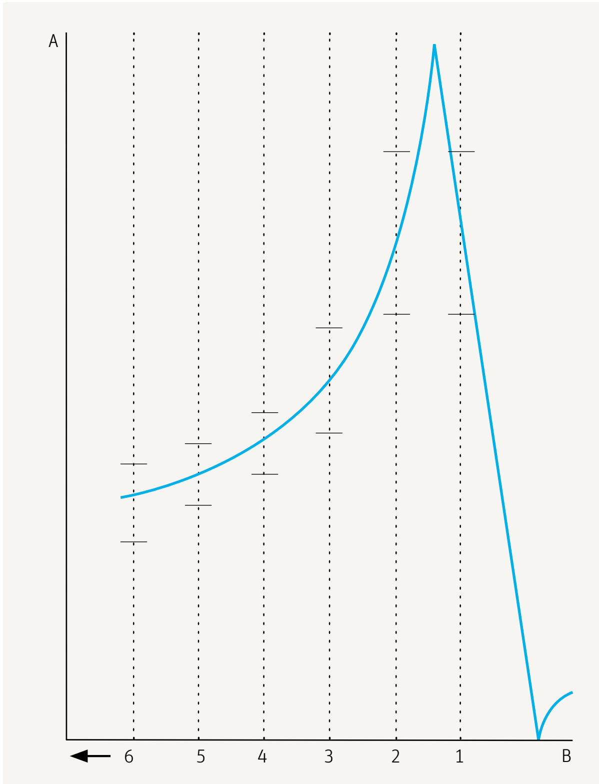


Fig. 104 – Carding effect in the flats in cards without additional carding segments:
A, carding effect (carding force);
B, number of the flat starting from the entry point.

That is why high-performance cards presuppose unconditionally individual fibers to be spread evenly over the whole surface of the cylinder, and this again can be obtained only by increasing the number of lickers-in and the inclusion of carding elements, since they ensure further opening, thinning out and primarily spreading out and improved distribution of the fibers over the total surface area.

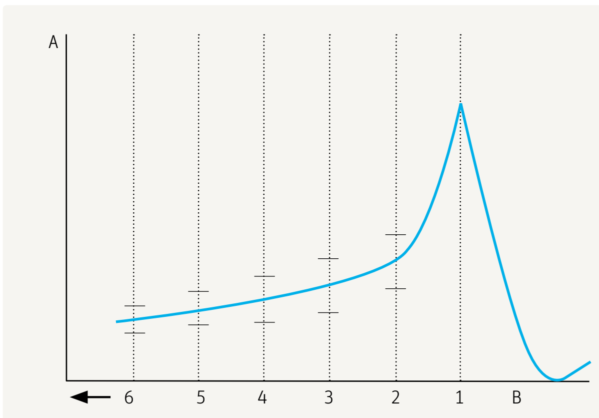


Fig. 105 – Carding effect in the flats in cards with additional carding segments over the licker-in
A, carding effect; B, number of the flat starting from the entry point.

In the final analysis, these additional devices reduce the loading on the carding zone cylinder/flats, among other things. Two diagrams (Fig. 104 and Fig. 105) by Schmolke and Schneider [10] illustrate loading of the flats with and without carding segments; in addition, it is clear from these diagrams that the main opening work is done at the first flats after entry of the material. Carding segments bring the following advantages:

- improved dirt and dust elimination;
- improved untangling of neps;
- the possibility of a speed increase and hence a production increase;
- preservation of the clothing;

and hence

- longer life of the clothing, especially on the flats;
- the possibility of using finer clothing;
- better yarn quality;
- less damage to the clothing;
- cleaner clothing.

Even carding elements following the flats exert a considerable influence on yarn quality – although the main carding work has been completed at that stage. This is shown in a diagram by Artzt, Abt and Maidel in Fig. 106 [11]. The segments create an additional fine carding zone as the fibers rotate 5 to 10 times with the cylinder before they pass to the doffer. This additional treatment of 5 to 10 times at the segments also improves both fiber orientation and transfer of fibers to the doffer.

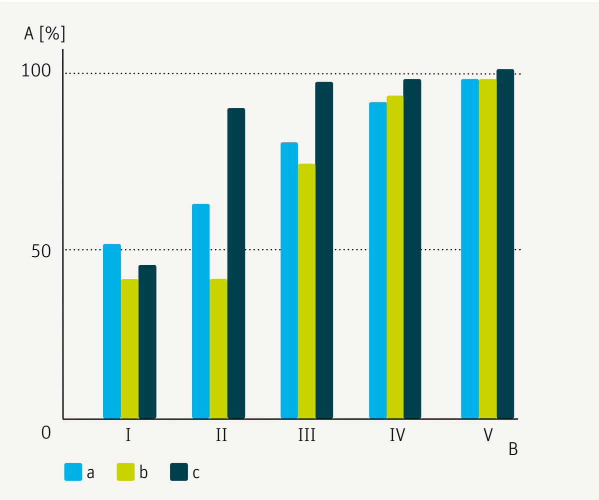


Fig. 106 – Improvement in yarn properties through the use of carding segments following the flats
A, comparison values related to cards without carding segments (100 %);
I, neps; II, thick places; III, thin places; IV, yarn evenness; V, tenacity;
a, main cylinder clothing: 430 points per square inch;
b, main cylinder clothing: 660 points per square inch;
c, main cylinder clothing: 760 points per square inch.

2.2.5. Main cylinder
2.2.5.1. The cylinder

The cylinder is usually manufactured from cast iron, but is now sometimes made of steel. Most cylinders have a diameter of 1 280 - 1 300 mm (Rieter C 60 card 814 mm, speed up to 900 rpm) and rotate at speeds between 250 and 500 (to 600) rpm. The roundness tolerance must be maintained within extremely tight limits – the narrowest setting distance (between the cylinder and the doffer) is only about 0.1 mm. The cylinder is generally supported in roller bearings.

2.2.5.2. The casing of the cylinder

Beneath the cylinder, and fully enclosing it, is a grid made of sheet metal provided with transverse slots. This is designed to remove impurities and maintain constant airflow conditions. However, since the cleaning effect is extremely small, some manufacturers, such as Rieter, have replaced the grid with a closed sheet metal casing. This enables the multitude of small air vortexes that tend to arise at the slots to be prevented. A closed sheet gives better fiber orientation on the cylinder surface and often reduces the number of neps at high cylinder speeds. Covering of the cylinder between the licker-in and the flats, and between these and the doffer, takes the form of protective casing. One of these protective sheets, near the flats at the front of the machine, is specially formed as a knife blade. The level and quality of the flat waste can be influenced by adjusting the distance between this blade and the cylinder. Narrow spacing produces little waste and wide spacing produces more strippings. This setting option is, however, not suitable for use as a means of adjusting the waste extraction effect of the flats. If, for example, an attempt is made to eliminate more short fibers by raising the flat waste level, it will not succeed. More long fibers rather than short fibers will be eliminated in the flat strippings. Fiber loss will be increased. Once an optimum has been established (mostly by the manufacturer), the setting should not be altered without excellent reasons.

2.2.6. Flats
2.2.6.1. Function

Together with the cylinder (Fig. 107, 1), the flats form the main carding zone. Here, the following effects should be achieved:

- opening of tufts into individual fibers;
- elimination of remaining impurities;
- elimination of some of the short fibers;
- untangling neps (possibly their elimination);
- dust removal (3);
- high degree of longitudinal orientation of the fibers.

In order to fulfill all these requirements, a large continuous carding surface is needed. The surface is created by a large number of individual clothing strips secured to the bars of the flats (2) and arranged in succession. 40 to 46 such strips are commonly used (30 in Trützschler machines) to make up the carding surface in the operating position. Since elimination of waste can be carried out only by filling the clothing, the flats must be cleaned continuously. They must therefore be moved past a cleaning device (4) (hence the name 'revolving flat cards'). The bars of the flats must be joined together to form an endless, circulating belt, for which purpose they are fixed to chains or toothed belts. In addition to the 40 - 46 flats (2) (Rieter C 60 card: 27 flats) that interact with the cylinder (1), further flats are needed for the return movement on the endless path, so that altogether 100 - 120 flats (Rieter 79) are fitted to the rotating chains.

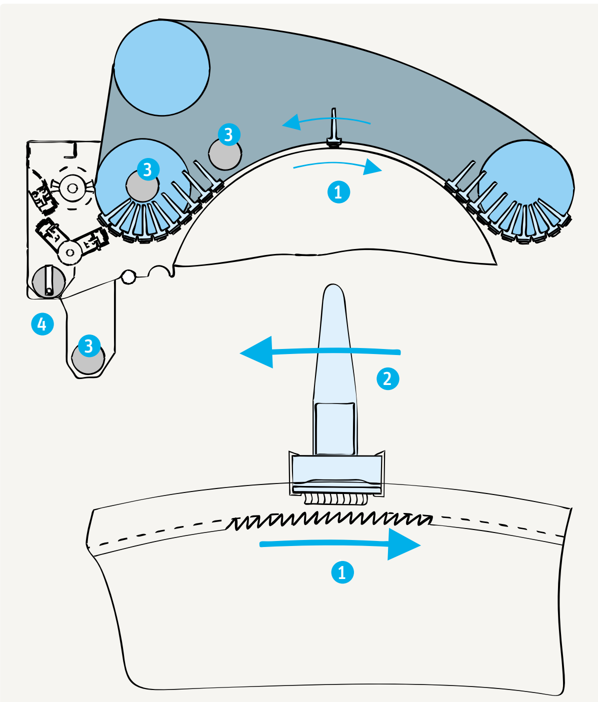


Fig. 107 – Carding zone between cylinder and flats

2.2.6.2. Construction of the flats

The bars of the flats are made of cast iron (nowadays aluminum profiles, Fig. 109) and are somewhat longer than the operating width of the card, since they rest on adjustable (so-called flexible) bends to the left and right of the main cylinder and must slide on these guide surfaces. Each bar is approximately 32 - 35 mm wide (might change to smaller widths). The bars are given a ribbed form (T-shape) in order to prevent longitudinal bending. A clothing strip (108 b) of the same width is stretched over each bar and secured by clamping, using clips (c) pushed onto the left- and right-hand sides of the assembly. Since some space is taken up by the upper edge of each clip, only a strip about 22 mm wide remains for the clothing (hooks or teeth). For this reason, the flats do not enable an absolutely continuous carding surface to be formed above the cylinder; there are gaps between the clothing strips.

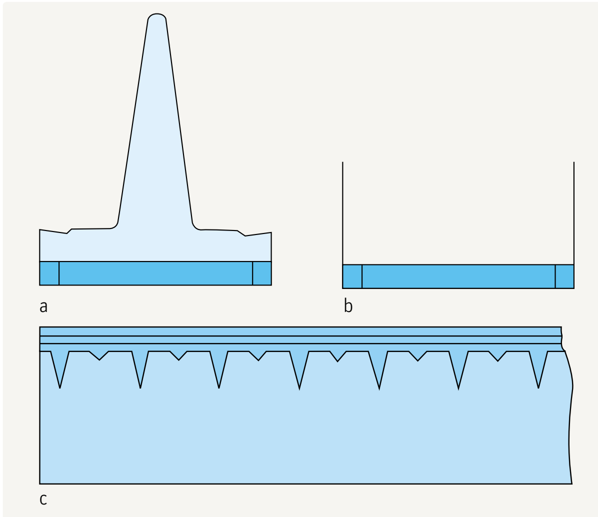


Fig. 108 – Mounting of the clothing strips (b) on the flat bars (a) using clips (c)

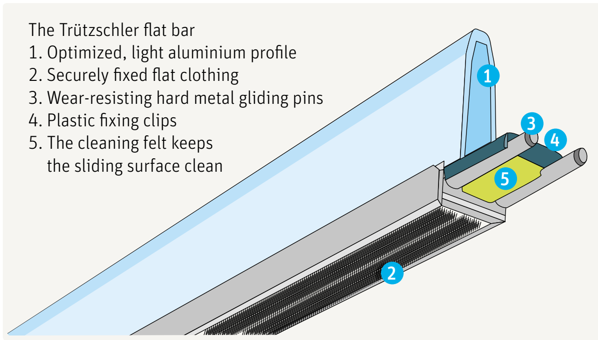


Fig. 109 – A modern flat construction

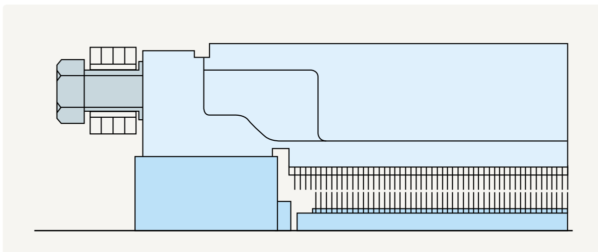


Fig. 110 – Securing the flat bars to the endless chain by means of screws

The bars are thickened at their left- and right-hand ends in order to take fixing screws corresponding with screw holes in the chains; the individual bars can thus be secured to respective links of the circulating chains (Fig. 110).
The slide surfaces on the bars are not ground level but are slightly inclined (Fig. 111). Therefore, as the flats move

over the cylinder, they have a slight tilt, i.e. viewed in the direction of material flow the leading edge of each bar is spaced further from the cylinder clothing than the trailing edge (1). The result is that the fibers are not pushed along in front of the flats, but can pass underneath them.

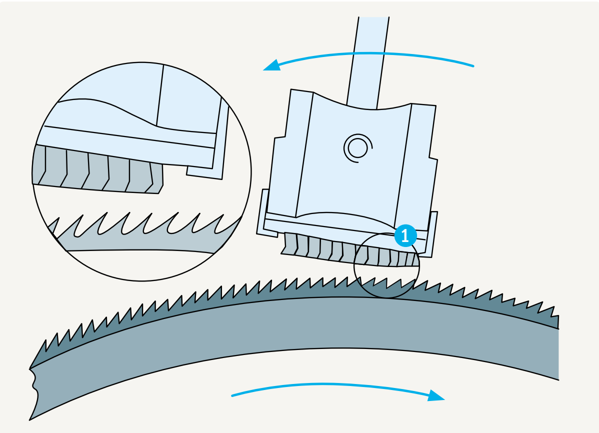


Fig. 111 – Inclined gap between flat clothing and main cylinder clothing

2.2.6.3. Movement of the flats

The bars of the flats mesh individually, like an internally toothed wheel, with the recesses in a sprocket gear, and are carried along by rotation of the sprocket. The ends of the bars of the operative flats slide over a continuous bend – with metal-to-metal friction.
As the flats move at a very low speed compared with that of the cylinder in principle, the flats can be moved forward or backward, i.e. in the same direction as or in opposition to the cylinder. If the flats move with the cylinder (forward), the cylinder assists in driving the flats and the removal of strippings is easier. Forward movement therefore gives design advantages. On the other hand, reverse movement (against the cylinder) brings technological advantages. In this system, the flats come into operative relationship with the cylinder clothing on the doffer side. At this stage, the flats are in a clean condition.
They then move toward the licker-in and fill up during this movement. Part of their receiving capacity is thus lost, but sufficient remains for elimination of dirt, since this step takes place where the material first enters the flats.
At that position, above the licker-in, the cylinder carries the material to be cleaned into the flats. The latter take up the dirt but do not transport it through the whole machine as in the forward movement system; instead, the dirt is immediately removed from the machine (directly at the point where the flats leave the machine).

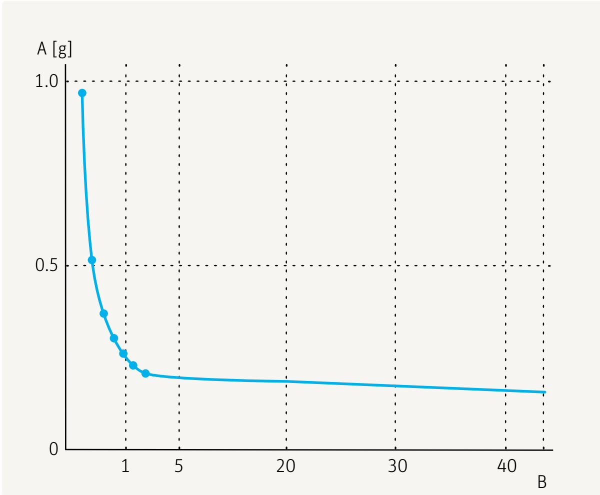


Fig. 112 – Dirt take-up of the flats from the entry point
A, dirt; B, flat number 1...40

A diagram by Rieter (Fig. 112) shows that this is not simply an abstract principle, demonstrating clearly that the greater part of the dirt is flung into the first flats directly above the licker-in. Rieter and Trützschler offer cards with backward movement of the flats.

2.2.6.4. Carding plates instead of flats

Stationary carding plates were used for a short time as carding elements in place of traveling flats (Fig. 113). For example, the former Hollingsworth company fitted four such plates above the main cylinder where the flats would otherwise be located. The plates were in the form of curved plates of aluminum, provided with special steel wire clothing on their internal surfaces. The plates were adjustable and replaceable. This latter feature is advantageous because the first plate, which wears faster than the others, can be exchanged with one of the others after a certain period and thus continues in service. This system has some striking advantages but also very serious disadvantages. It is therefore no longer available.

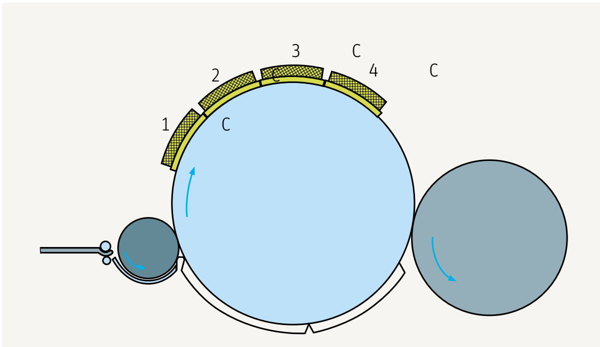


Fig. 113 – Carding plates instead of flats. C1; C2; C3; C4

2.2.6.5. Cleaning positions in front of the flats

Illustrated by the Rieter TREX system

The remaining impurities in the material on the cylinder, and a large proportion of the dust, can be removed only by way of total opening of the raw material, i.e. absolute separation of the fibers.
This degree of opening is achieved practically only once in the spinning process, namely on the card cylinder (similarly also in rotor spinning within the spinning unit). This position is therefore ideal for the finest cleaning.
The slotted grid beneath the cylinder that has been used formerly is not suited to this purpose. Mote knives are better. They have been in use for a long time at the cylinder (above the doffer) in the form of stripping blades for the flats, but they have never been properly exploited for cleaning.
For several years now, the manufacturers of cards have used assemblies better suited to this purpose, e.g. the Rieter company's TREX system (Fig. 114). Beneath the flats cover is a mote knife, set close to the cylinder; this knife is associated with a suction tube. Foreign matter stripped from the cylinder surface passes into the tube and is carried away.
Nowadays it is nearly standard to have assemblies comprising carding plates and mote knives (behind each other) above the doffer.

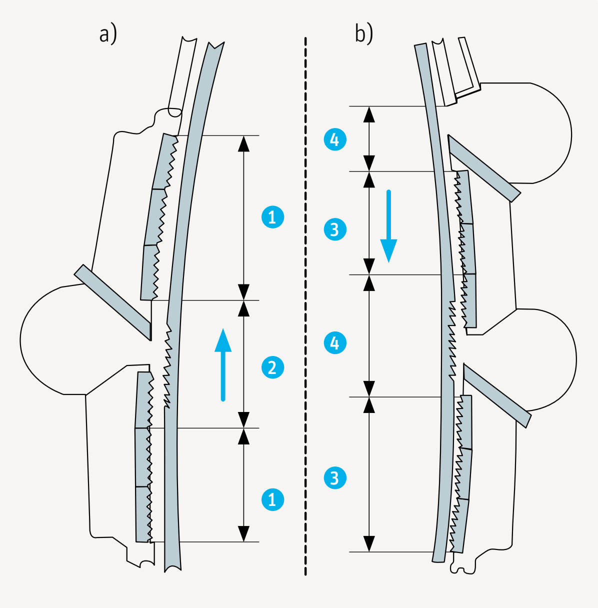


Fig. 114 – Rieter TREX system
a) above the licker-in; b) above the doffer

2.2.7. Doffing
2.2.7.1. The doffer

The cylinder is followed by the doffer, which is designed to take the individual fibers from the cylinder and condense them to a web. The doffer is mostly formed as a cast iron (or steel) drum with a diameter of about 600 - 707 mm. (680 mm on Rieter machines). It is fitted with metallic clothing and runs at speeds up to about 300 m/min.

2.2.7.2. The doffing operation

It would appear logical to arrange the clothing of the cylinder and doffer in the doffing configuration relative to each other. In practice, however, they are actually arranged in the carding configuration (Fig. 115). This clothing arrangement is essential because the web that is finally delivered must be cohesive and therefore the fibers must be interlaced with each other and condensed. Compared with the doffing configuration, the carding configuration at this point is disadvantageous in some respects. One disadvantage is that the desired fiber parallelization achieved on the main cylinder largely disappears again, since a degree of random orientation is necessary to form a web and to doff it.
Another is the undesirable bending of the fiber ends which occurs here, because the cylinder has to give up the fibers to the doffer clothing, during which a certain degree of sweeping through the fiber fleece takes place. In the course of this step, the fibers are caught as hooks on the points of the clothing. Accordingly

- over 50 % of the fibers in the web exhibit trailing hooks (at the rear end as viewed in the direction of material flow);
- about 15 % have leading hooks;
- another 15 % have double hooks; and
- only a small proportion are delivered without hook deformation of any kind.

A third disadvantage, namely the poor efficiency of fiber transfer from the cylinder to the doffer, is in practice more an advantage than a disadvantage. Of course, it is a fact that the fibers rotate with the main cylinder about 5 to 10 (15) times (!) before passing to the doffer, but it is also a fact that this results in some important improvements:

- it is an additional carding point;
- the fiber-to-fiber blending effect increases, i.e.
- a high degree of intermingling results there, which is important, e.g. for man-made fiber/cotton blending);
- it produces good diagonal and short-term regularity.

The carding configuration implies that it is more or less a matter of chance which of the two clothing surfaces will finally carry along any individual fiber. However, this operation favors the cylinder clothing, as the flats push the fibers vigorously into the cylinder clothing, and as the cylinder clothing has more points, both facts increase the retaining effect.

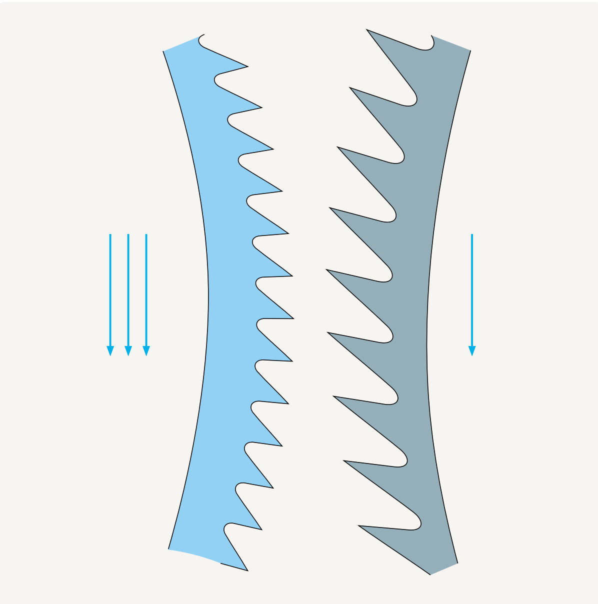


Fig. 115 – Clothing configuration between main cylinder and doffer

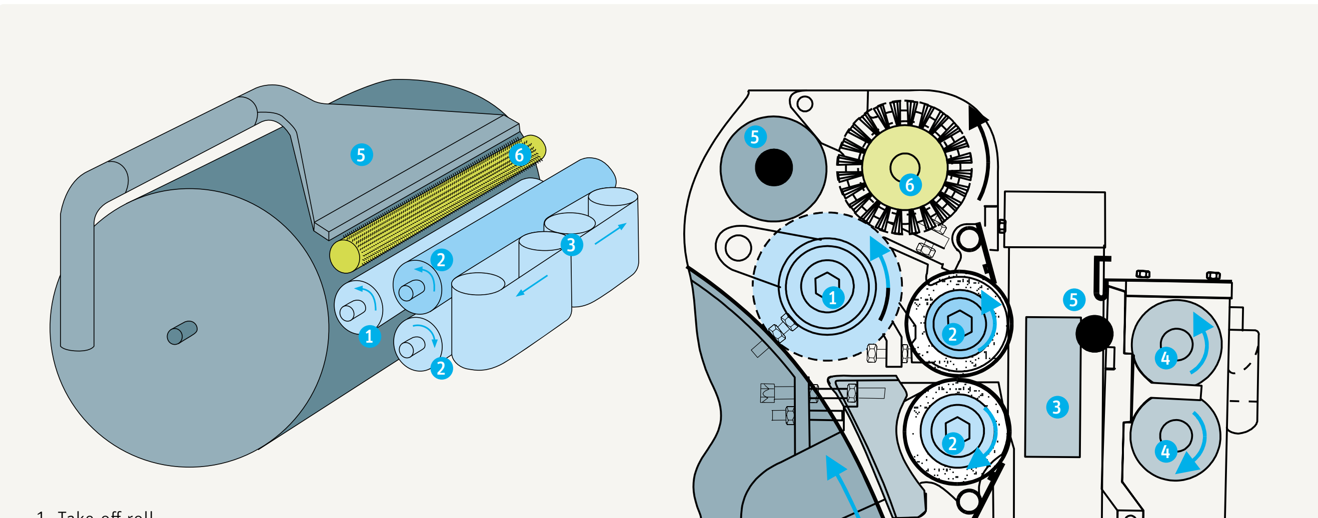
As mentioned above, the result is a poor transfer factor. However, certain provisions can influence the latter positively, mainly by:

- coordinating the clothing of both assemblies accordingly;
- the choice of a proper relationship of the peripheral speeds;
- providing for small distances between cylinder and doffer.

A reduction of the spacing between the two assemblies, e.g. from 0.18 mm to 0.08 mm results, for example, in a 100 % improvement in the transfer factor.

2.2.8. Detaching
2.2.8.1. The detaching apparatus

On old cards, a fly-comb (a rapidly oscillating comb) oscillating at up to 2 500 strokes per minute takes the web from the doffer. In modern high-performance cards, a fly-comb would be unable to perform this task because the stroke rate would have to be significantly higher (above the mechanical limit). A roller (Fig. 116, 1) now has the task of separating the web from the doffer. In old cards, the web is guided into a funnel, while being freely suspended over a distance of 30 - 50 cm and running together in a wedge shape.



1. Take-off roll
2. Delivery rolls
3. Web collection to center
4. Disc rollers
5. Suction system
6. Clearing brush

Fig. 116 – Web detaching using detaching rollers and transverse belts

This arrangement is also no longer possible at the high speeds of modern high-performance cards, since the web would fall apart.
Now, the web must be condensed into a sliver while still located within the detaching device.
This can be achieved in a number of ways; for example, with web guide plates upstream from the detaching device, with several transversely arranged guide rollers (Marzoli), or with a transverse sliver condenser (3). In the latter, either two counter-rotating belts carry the web into the center or one circulating belt carries the web to one side of the card.

2.2.8.2. Crushing rollers (web crushing)

Between take-off roller (1) and transverse sliver condenser (3), some manufacturers include two smooth steel rollers, arranged one above the other (Fig. 117). They can run without loading, in which case they serve simply as guide rollers, or they can be loaded with a pressure of about 15 N/cm and are thus converted into crushing rollers. Where cotton with medium to high dirt content is being processed, additional cleaning can be carried out here by squashing the foreign particles (the fragments fall away immediately after the rollers or in the subsequent machines).
In some models, the rollers are ground with a barrel shape. With this arrangement their central sections cannot escape the pressure – the pressing effect is the same over the full width. Clean fiber material should not be crushed. Owing to the absence of dirt particles, the full roller pressure would be exerted on the fibers, resulting in fiber damage.

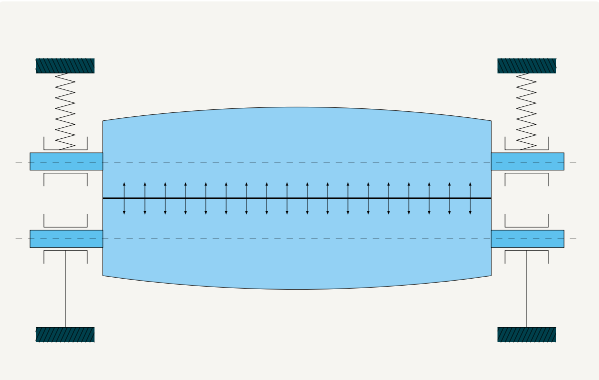


Fig. 117 – Web crushing

This would show up directly in the breaking strength of the yarn. Sticky cotton (honeydew) should also be carded without crushing, as should cotton with a high proportion of seed particles, because of the danger of lap formation at the rollers (again sticky effect).
With the high cleaning efficiency in high performance cards this arrangement is out-dated.

2.2.8.3. Coiling in cans

The sliver must be coiled in cans for storage and transport. As described in Volume 1, this is performed cycloidally, with large windings when working with smaller cans and small windings when working with larger cans. Can diameters now lie in the 600 to 1 200 mm range and can heights are between 1 000 and 1 220 mm. If the cans are supplied directly to the rotor spinning machine, they must be smaller because less space is available (better suited as round cans are rectangular cans).
The can diameter in this case is only about 350 to 400 mm. Fig. 118 gives Trützschler data on the capacity of cans with a height of 1 200 mm.
Most manufacturers offer cards with can changers as either standard equipment or an option. These permit efficient operation since they enable the need for attendance by mill personnel to be reduced substantially.

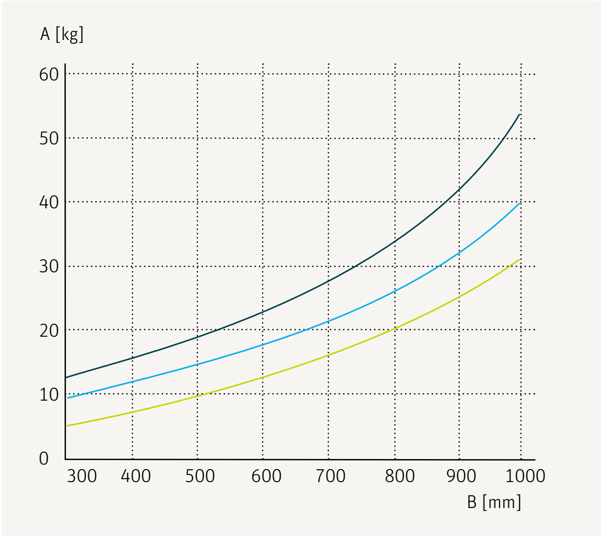


Fig. 118 – Capacity of cans (A) in kg; can diameter (B) in mm

2.3. The machine drive

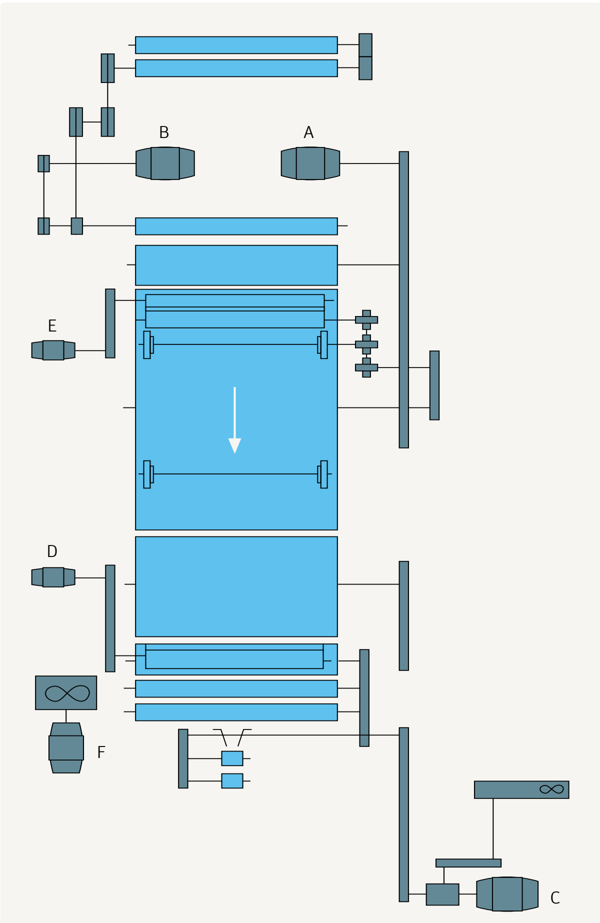


Fig. 119 – Drive of a modern card (Trützschler)

Old cards had only one drive motor. This drove the licker-in and main cylinder directly via belts and the other moving parts indirectly via belts and gear transmissions. Modern high-performance cards differ in that they include several drive motors so that the individual zones of the card are driven independently of each other as shown in Fig. 119 by Trützschler:

- A, main drive for the cylinder, licker-in and flats;
- B, drive for the infeed;
- C, drive for the delivery, i.e. doffer, detaching rollers and coiler;
- D, drive for the cleaning roller of the detaching roller;
- E, drive for the cleaning roller of the flats via the stripping roller;
- F, fan.

Several manufacturers, e.g. Rieter, also provide a separate drive for the flats. Individual drives have the advantage that transmission of the forces is better, and adjustments can be performed more quickly and conveniently. They are also better suited to operation with control equipment.

2.4. Card clothing

2.4.1. Choice of clothing

Of all the individual components of the card, the clothing has the greatest influence on quality and productivity. The development of new clothing enabled, for example, the production rate of the card to be increased from 5 kg/h to the current level of up to 220 kg/h. New clothing was not, of course, the only factor involved in this increase, but it made a major contribution to it. Unfortunately, a price has to be paid for this development in the form of a steadily increasing departure from any possibility of universal clothing, which was formerly aimed at. Mills now have to make a difficult choice between hundreds of available clothing types, a choice of the utmost importance. Selection criteria are:

- type and design of card;
- rotation speed of the cylinder;
- production rate;
- material throughput;
- raw material type (natural or man-made fibers);
- fiber characteristics (mainly fineness, length, bulk, dirt content);
- overall quality requirements;
- price of the clothing;
- service offered by the clothing supplier.

Operating conditions not only differ between mills – they can alter within a single mill. Compromises are therefore unavoidable.

2.4.2. Classification

If we consider not only the short-staple spinning mill, but all fields in which card clothing is used, thousands of variations are currently on offer. They can be divided into three groups.

Flexible clothing

This features hooks of round or oval wire set into elastic, multi-ply cloth backing. Each hook is bent into a U-shape and is formed with a knee that flexes under bending load and returns to its original position when the load is removed. In short-staple spinning mills this clothing is now found, if at all, only on the card flats (Fig. 120).

Semi-rigid clothing

In this, wires with square or round cross-sections and sharp points are set in backing which is less elastic than that of flexible clothing. This backing is a multi-ply structure with more plies than the backing of flexible clothing, comprising layers of both cloth and plastics. Flat wires are not formed with a knee, but round wires may have one. The wires cannot bend and are set so deeply in layers of cloth, and possibly foamed material, that they are practically immovable. When subjected to bending loads, they are therefore much less capable of yielding than flexible clothing types. They are also found only on the flats (Fig. 121).

Metallic clothing
These are continuous, self-supporting, square wire structures in which teeth are cut at the smallest possible spacings by a process resembling a punching operation. If the teeth are relatively large, for example as in the licker-in, the clothing is referred to as saw-tooth clothing. (The terms saw-tooth clothing and metallic clothing refer to the same thing.) Nowadays, the licker-in, main cylinder and doffer use metallic clothing without exception (Fig. 123).

2.4.3. Flexible clothing in detail

The substrate is formed as a continuous narrow band (51 mm for the main cylinder) or as a broad band (equal to the length of the flats) comprising five (flexible clothing), seven (semi-rigid clothing) or even more plies of cloth joined together by vulcanizing. Double hooks of round or oval wire are embedded in the substrate; each has a knee in the leg and a cross-bar at the foot. The knee is required so that the hook does not project too far outward when the leg is bent back; it is thus possible to operate with small spacings between the clothing surfaces. In order to make the clothing more aggressive, the points are mostly ground on both sides (lateral sharpening), and they are also hardened. In the flats, the point density is in the range of 240 - 500 points per square inch.

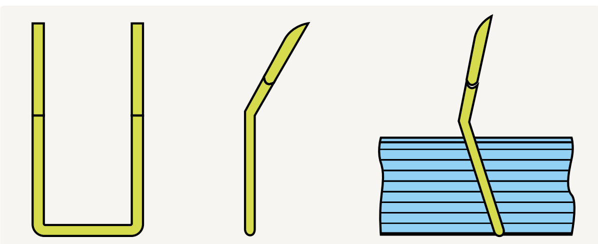


Fig. 120 – Flexible clothing

2.4.4. Semi-rigid clothing

This clothing is similar in structure to the flexible types. However, it has more cloth layers (possibly also foamed material) and has hooks of wire with squared cross-sections without a knee, or of reinforced round wire with or without a knee. Compared with flexible clothing, it has the advantage that it does not choke with fiber and thus eliminate less flat strippings. In addition, it does not need sharpening as often as flexible clothing types. At least in respect to flat wires, it should be mentioned that each sharpening removes material from the tip so that the working surface becomes steadily broader and the aggressiveness of the clothing declines over time. This wire clothing without lateral sharpening can be re-sharpened only once or twice; with lateral sharpening up to four times.

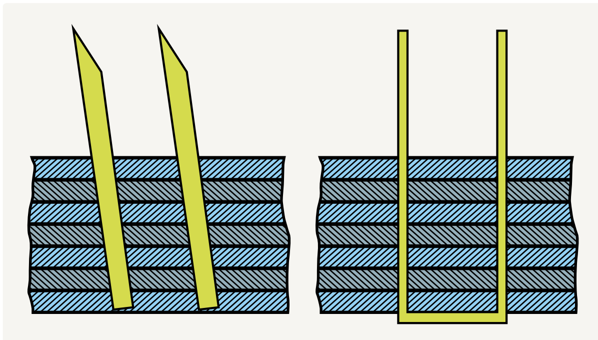


Fig. 121 – Semi-rigid clothing

2.4.5. Metallic clothing
2.4.5.1. Manufacture of metallic clothing

The starting material is round wire, which is rolled in several stages to give the desired profile (Fig. 122). This profiled stock is passed through a cutting machine. Here, a high-precision cutting tool, corresponding exactly to the shape of the gap between two teeth, punches (cuts) the wire away piece by piece between the teeth, which remain after the cutting operation. It is of the utmost importance that the dimensions are held within the finest tolerance limits. Hardening immediately follows cutting, i.e. the wire is passed through a flame and a quenching bath. Here also a high degree of uniformity is required, this time in the hardness achieved. The required 'feel' for this operation can only be appreciated when it is realized that in fine clothing the tip of the tooth has a thickness of only 0.05 - 0.06 mm.

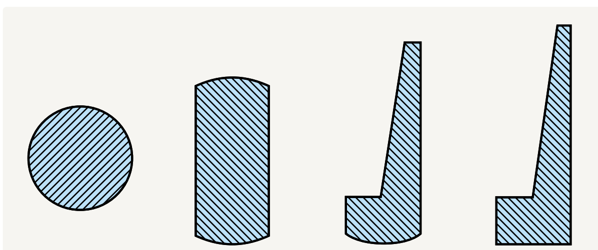


Fig. 122 – Forming the wire profile for metallic clothing

2.4.5.2. The geometry of the clothing [12]

No.	Name	Symbol or formula	Comment
1	Base width	*a1*	in mm
2	Tooth thickness at the root	*a2*	in mm
3	Tooth thickness at the tip	*a3*	in mm
4	Overall height	*h1*	in mm
5	Height of the base	*h2*	in mm
6	Depth of the tooth	*h3*	in mm
7	Tooth pitch	*T*	spacing between successive tooth tips measured with the wire stretched out
8	Carding angle	α	angle between a line at right angles to the base of the tooth and the leading edge of the tooth, measured with the wire stretched out
9	Tooth apex angle	β	angle between the leading and trailing edges of the tooth

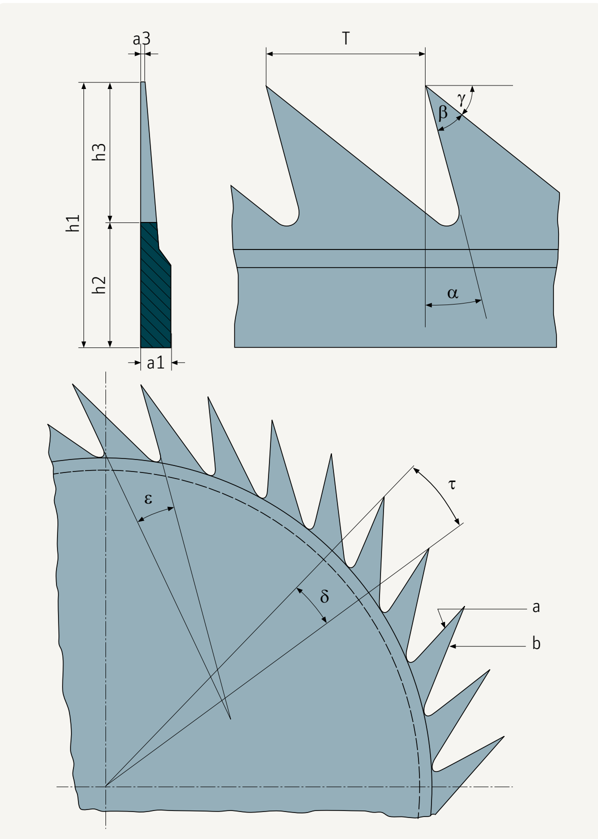


Fig. 123 – Angle and other dimensions of metallic clothing

2.4.5.3. The most important operating parameters of the clothing

POINT DENSITY (NUMBER OF POINTS PER UNIT SURFACE AREA)

The point (or tip) density has a significant influence on the carding operation. However, the number of points and the speed of rotation of the cylinder must be considered together. It is not simply the total number that is significant, but also the number available per unit of time, i.e. the product of the point density and the speed of movement of the surface. Thus, low point populations can be partially compensated by higher cylinder speeds. (This is not always possible, since the overall result may be deterioration in some quality parameters.)

It must also be kept in mind that the populations of the main cylinder and doffer clothing have to be adapted to each other. In general, the higher the point population, the better the carding effect – up to a certain optimum. Above that optimum, the positive influence becomes a negative one. This optimum is very dependent upon the material. Coarse fibers need fewer points, as they need more space in the card clothing; finer fibers must be processed with more points, since more fibers are present if the material throughput is the same. Point density is specified in terms of points per square inch or per square centimeter, and can be calculated as follows:

$$Points/inch^2 = \frac{645}{Basewidth(mm) \times Pitch\ (mm)}$$

$$Points/cm^2 = \frac{100}{Basewidth(mm) \times Pitch\ (mm)}$$

$$Points/cm^2 = \frac{Points/inch^2}{6.45}$$

BASE WIDTH (*a1*)
This influences the point density. The narrower the base, the greater the number of turns that can be wound on the cylinder and, correspondingly, the higher the point population.

HEIGHT OF THE CLOTHING (*h1*)
The height of metallic clothing on the cylinder today varies between 2 mm and 3.8 mm. The height must be very uniform. It can also exert an influence on the population, since shorter teeth – for a given tooth carding angle – leave space for more teeth. Where shorter teeth are used, the fibers are less able to escape into the clothing during carding and better carding over the total surface is obtained. Clothing with smaller teeth is also less inclined to choke with dirt particles.

TOOTH PITCH (*T*)
The population is also determined by the tip-to-tip spacing.

CARDING ANGLE (α)
This is the most important angle of the tooth:
- the aggressiveness of the clothing; and
- the hold on the fibers

are determined by this parameter. The angle specifies the inclination of the leading face of the tooth to the vertical. It is described as positive (a, Fig. 124), negative (b) or neutral. The angle is neutral if the leading edge of the tooth lies in the vertical (0°). Clothing with negative angles is used only in the licker-in, when processing some man-made fibers. Since the fibers are held less firmly by this form of tooth, they are transferred more easily to the cylinder and the clothing is less inclined to choke. Carding angles normally fall into the following ranges:

licker-in	+5° to -10°
Cylinder	+12° to +27°
Doffer	+20° to +40°

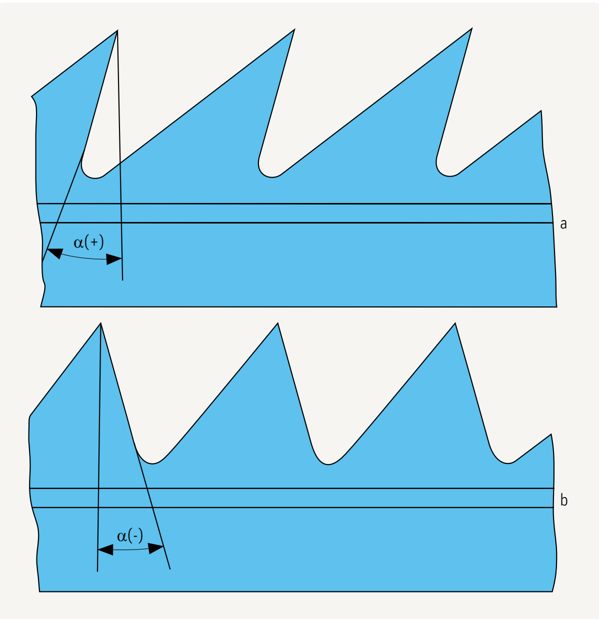


Fig. 124 – Positive (a) and negative (b) carding angle

THE TOOTH POINT
Carding is performed at the tips of the teeth and the formation of the point is therefore important (Fig. 125). For optimum operating conditions the point should have a surface or land (b) at its upper end rather than a needle form. This land should be as small as possible. To provide retaining power, the land should terminate in a sharp edge (a) at the front. Unfortunately, during processing of material this edge becomes steadily more rounded; the tooth point must therefore be re-sharpened from time to time. Formation of a burr at the edge (a) must be avoided during re-sharpening. The tooth must only be ground down to a given depth, otherwise land (b) becomes too large and satisfactory carding is impossible – the clothing has to be replaced.

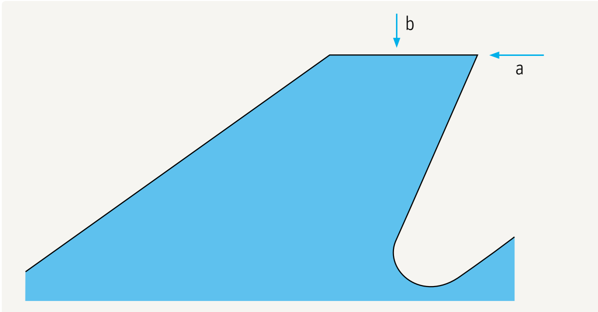


Fig. 125 – The tooth point

THE BASE OF THE TOOTH
The base is broader than the point in order to give the tooth adequate strength, and also to hold the individual windings apart. Various forms can be distinguished (Fig. 126). In order to mount the wire, the normal profile ((a) for the licker-in, (b) for the cylinder) is either pressed into a groove milled into the surface of the licker-in (a) or is simply wound under high tension onto the plain cylindrical surface of the main cylinder (b). (d) represents a locked wire and (c) a chained wire. Both can be applied to a smooth surface on the licker-in; in this case a milled groove is no longer necessary.

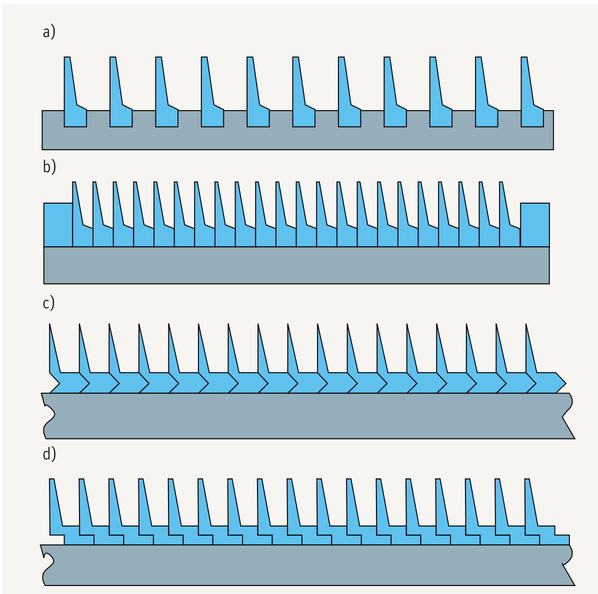


Fig. 126 – Formation of the tooth base and mounting on the drum

Tooth hardness

In order to be able to process as much material as possible with one clothing, the tooth point must not wear away rapidly. Accordingly, a very hard point is needed, although it cannot be too hard because otherwise it tends to break off. On the other hand, to enable winding of the wire on a round body, the base must remain flexible. Each tooth therefore has to be hard at the tip and soft at the base. A modern tooth has hardness structures as shown in Fig. 127 (Graf).

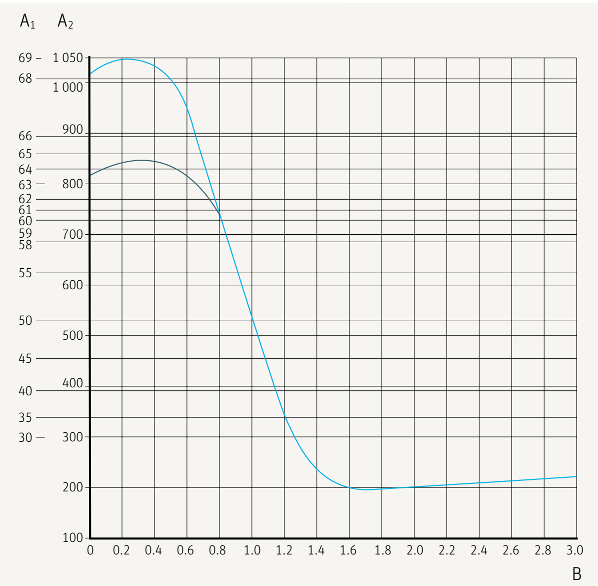


Fig. 127 – Metal hardness at various heights in the wire: A, hardness (A_1 = Rockwell, A_2 = Vickers); B, tooth height from the tip to the base

2.4.5.4. Clothing suggestions

Clothing – Technical data		
Fibers		Points / inch^2
Fine cotton	Cylinder wire	800 to 1 000
Man-made	Cylinder wire	450 to 650
Coarse cotton	Cylinder wire	600 to 800
Fine cotton	Flat clothing	500
Man-made	Flat clothing	270
Coarse cotton	Flat clothing	350 to 400
Universal wire	Doffer	340
Special wire for fine fibers	Doffer	400
Licker-in clothing wire wounds or pins		
Cotton, general	10° positive	36
Synthetics and rayon	0° - 5° positive	27

2.5. Autoleveling equipment

2.5.1. Basics

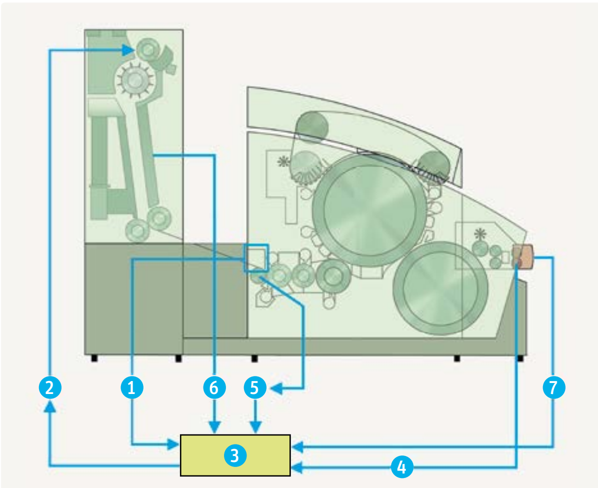
As already mentioned, the general aim of manufacturing everywhere is to create durable, faultless products, i.e. primarily: not to correct errors but rather to prevent them, especially and as far as possible at the start of the process. In the spinning mill, the card is the effective start of the process, since the first intermediate product, the sliver, is produced here. A relatively high degree of evenness is required in this product. For various reasons, the card cannot always operate absolutely evenly, for example, owing to uneven material feed. Spinning mills are therefore forced to use autoleveling equipment under highly varying circumstances. Different principles for autoleveling can be selected depending upon the quality requirements and the operating conditions in the individual mill.

2.5.2. Classification

Irregularities can actually be compensated:

- in the material supply system;
- at the feed;
- at the delivery

as shown in Fig. 128 of the Rieter card leveling system.



1. Input signal: infeed count
2. Output signal: feed speed in the chute
3. Control unit for signal processing
4. Input signal: delivery speed
5. Output signal: feed roller speed
6. Control signal: light barrier
7. Input signal: sliver count

Fig. 128 – Rieter card leveling system

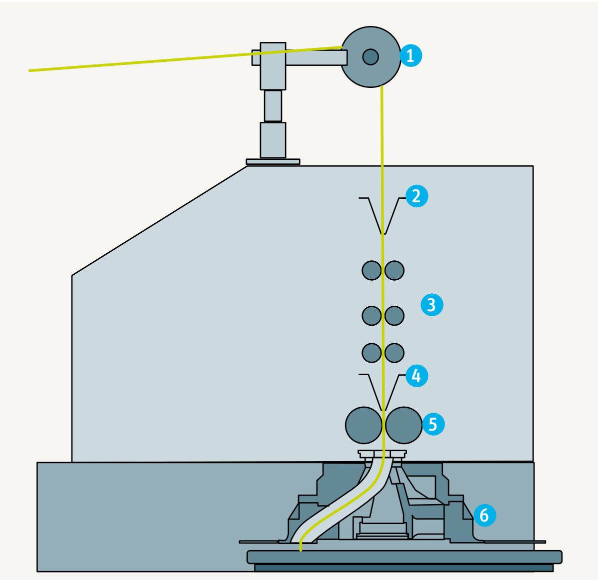
The material supply should operate with the greatest possible degree of accuracy in any case, since this has a direct effect on sliver evenness. It is therefore not surprising that more and more card manufacturers offer the double-chute system with a degree of coarse regulation in the lower chute section. However, the main regulating position is the feed; adjusting the feed roller speed (5) usually performs autoleveling. Virtually all autoleveling devices exploit this possibility; adjustment of the delivery speed is hardly ever used. A distinction should also be drawn between:

- short-term leveling systems, regulating lengths of product from 10 - 12 cm (rarely used in carding);
- medium-term leveling systems, for lengths above about 3 m;
- long-term leveling, for lengths above about 20 m (maintaining count).

In addition, regulating can be performed by open-loop or closed-loop control systems (see The Rieter Manual of Spinning, Volume 1 – Technology of Short-staple Spinning).

2.5.3. The principle of short-term autoleveling
2.5.3.1. Regulation at the delivery

If this is used, it calls for a drafting arrangement before coiling.



1. The deflection roller ensures vertical feed of the sliver into the measuring funnel
2. The input measuring funnel measures the sliver weight of the incoming sliver
3. The 3 over 3 drafting system corresponds to that of the TD 03 autoleveler draw frame
4. The output measuring funnel is the quality sensor of the system
5. The delivery rolls feed the sliver to the sliver coiling plate
6. The sliver coiling plate with the three-dimensionally curved tube coils the sliver smoothly in the can

Fig. 129 – Short-term leveling by Trützschler

In the open-loop control system illustrated in Fig. 129, a measuring point (2) is provided upstream from this drafting arrangement to sense the volume of the incoming sliver and transmit corresponding pulse signals to an electronic control unit. The control signal generated by this unit is passed to a regulating device that can be of various design, and which adapts the speed of the delivery drafting rollers to the measured sliver volume. If the measuring point is located downstream from the drafting arrangement, or if the delivery roller pair itself provides the measuring point, then the system is operating on the closed-loop control principle. If the open-loop principle is used in a short-term autoleveler, short lengths can certainly be made even, but it is not always possible to hold the average sliver count constant. On the other hand, closed-loop control is not suited for regulating short-wave variation because of the dead time inherent in the system. Finally, the drive to the delivery can present problems, since in this system the delivery speed must be continually varied, and in very small ranges. There are two possible applications for assemblies of this type, namely in processing comber noil and where card sliver is fed directly to the rotor spinning machine.

2.5.3.2. Autoleveling in the infeed

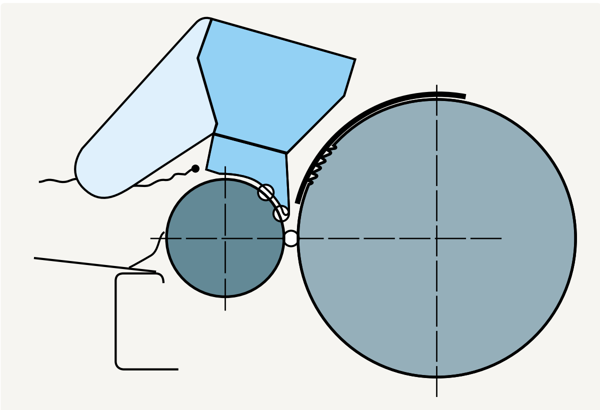


Fig. 130 – Autoleveling with sensing at the feed roller

Rieter card leveling operates as medium-term to long-term leveling (closed-loop, produced by a proportional-integral regulator) and is performed by a microprocessor. In the feed of the card the feed measuring device records the fluctuations in the cross-section of the batt feed. The speed of the feed roller of the card is changed electronically so that these fluctuations in the cross-section are leveled out. The chute is also included in the control loop. However, the filling level is not used for regulating the feed rollers in the chute but is considered as an additional control parameter.

In the delivery of the card a pair of disc rollers scan the cross-section of the carded sliver as it emerges. These readings are compared electronically with the preselected set value. Deviations in the set value are corrected electronically by altering the speed of the feed roller in the card (Fig. 130).

2.5.4. The principle of medium-term autoleveling

In former Zellweger equipment a medium-term autoleveler was provided as an addition to the long-term autoleveler. An optical measuring device (see Fig. 131) detects relative variations in the cross-section of the fiber layer on the main cylinder over the whole width of the cylinder. The measuring device is built into the protective cover above the doffer. The device measures reflection of infrared light from the fibers.
After comparison with the set value, a difference signal is generated and passed to an electronic regulating unit. This operates via a regulating drive to adjust the infeed speed of the card so that the depth of the fiber layer on the main cylinder is held constant.

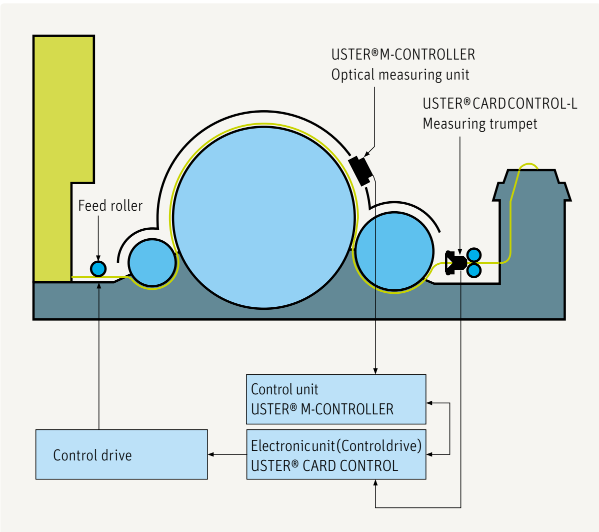


Fig. 131 – Medium-term leveling (Zellweger, Uster)

2.5.5. The principle of long-term leveling

This is the most commonly used principle of card autoleveling and serves to keep the sliver count constant. Measuring is performed by a sensor in the delivery (at the delivery roller). The pulses derived in this way are processed electronically so that the speed of the infeed roller can be adapted to the delivered sliver weight via mechanical or electronic regulating devices (see Fig. 132).

Long-term autoleveling is an integral part of modern cards, and in any case used in production of carded yarns and in the rotor spinning mill.

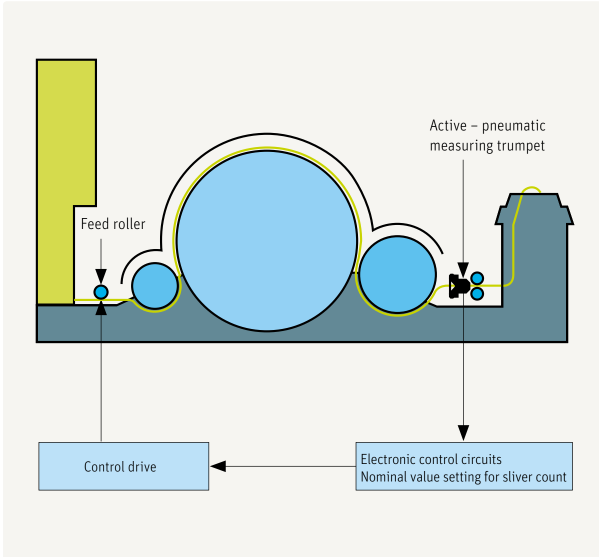


Fig. 132 – Long-term leveling (Zellweger, Uster)

2.5.6. Measuring devices
2.5.6.1. The active pneumatic system

In a normal card, a funnel is provided before the calender rollers (2, Fig. 133) in order to collect the web into a sliver. In Zellweger equipment, this funnel is developed to form a measuring device based on a simple physical principle. When fiber material enters the funnel (3), it carries along quite an amount of air held between the fibers. Owing to the continuous convergence of the funnel, air is squeezed out as the material passes through.
This generates air pressure in excess of atmospheric pressure, which is a function of the sliver cross-section if the sliver speed is kept constant. If all fiber characteristics also remain constant, this pressure is proportional to the volume. A lateral bore (5) in the funnel, and corresponding leads, transmit the pressure into the chamber of a pneumatic-electrical pressure transducer, using electrical induction to convert the pressure into an electrical signal.
Comparison of the signal with a set value enables pulses to be generated to control the electronic units in the regulator equipment. The advantage of active pneumatic measurement lies in the simplicity of the system, which does not require additional and/or sensitive moving parts. The disadvantage is that measurement is affected by the fiber count and hence count variation can lead to errors.

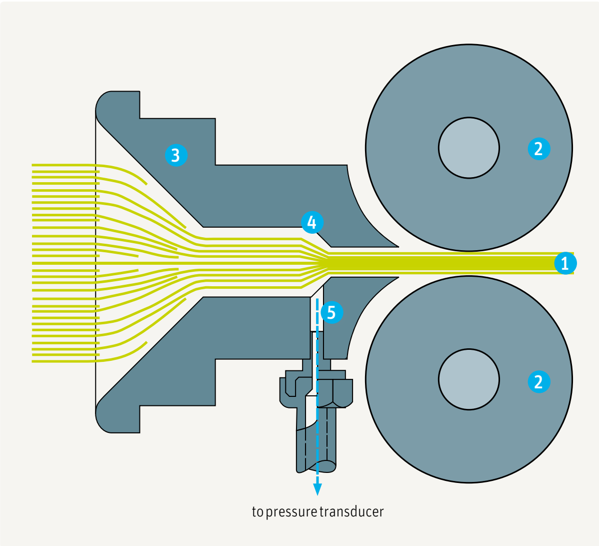


Fig. 133 – Active pneumatic measuring system (Zellweger, Uster)

2.5.6.2. The mechanical principle

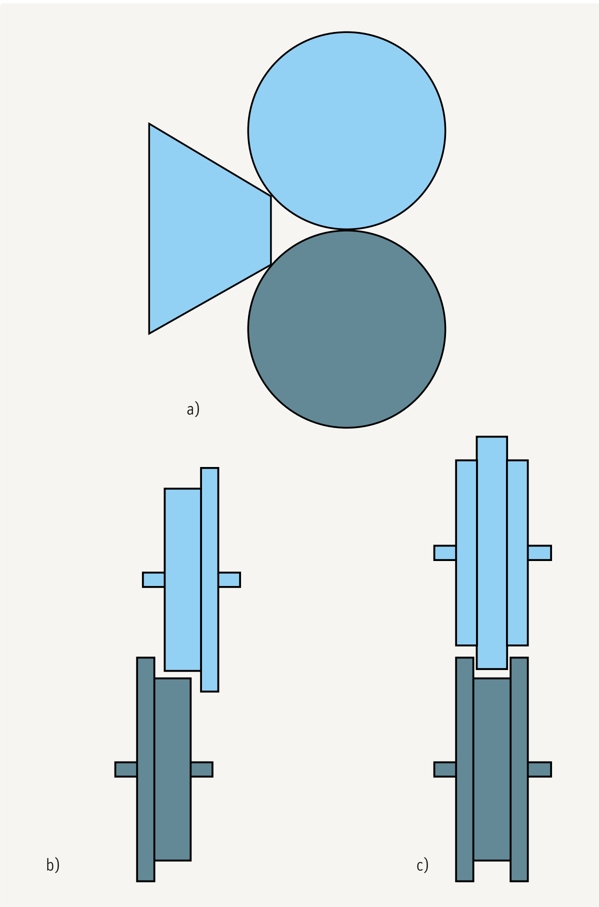


Fig. 134 – Mechanical measuring system

This is the most common system for deriving a measured value. Usually, two material-forwarding rollers are used. One of these rollers must be movable (up and down) relative to the other. The relative movement, corresponding to the volume of the material passing through (a, Fig. 134) gives the instantaneous value required for the regulation operation.
The rollers can be smooth or grooved, b and c. The latter arrangement prevents lateral escape of the fibers and thus gives more precise measurement. However, it must be so designed and must operate in such a manner that the fibers are not crushed at the roller edges.
The advantage of the mechanical principle lies in its insensitivity to variations in the characteristics of the raw material, with the possible exception of bulk.

2.6. Maintenance
2.6.1. Stripping the clothing

If at all, metallic clothing should not be cleaned out with a revolving brush, but rather with a hand scraper while the cylinder is rotated manually (not by the motor drive). Rapidly rotating brushes create considerable metal-to-metal friction (brush on saw-tooth wire) and cause more wear on the clothing points than do the fibers. The life of the clothing is markedly reduced.

2.6.2. Burnishing the clothing

Burnishing should be avoided for reasons already explained under cleaning out. A single burnish wears down the teeth more than processing tens of thousands of kilograms of material. Nevertheless, burnishing sometimes becomes unavoidable, for example if the teeth were ground too intensively in re-sharpening and the raw material is released relatively poorly from the clothing.
Occasionally, this proves necessary on the doffer. In that case, however, burnishing must be carried out in the direction of the teeth and not against them. Rotation of the brush with a stationary cylinder is to be avoided. Cleaning out with a hand scraper is often enough, without burnishing.

2.6.3. Grinding the clothing
2.6.3.1. Intervals between grinding

The operating life of clothing is quoted in terms of the total throughput of material. For the cylinder it normally lies between 300 000 and 600 000 kg, but it can be higher in some circumstances.

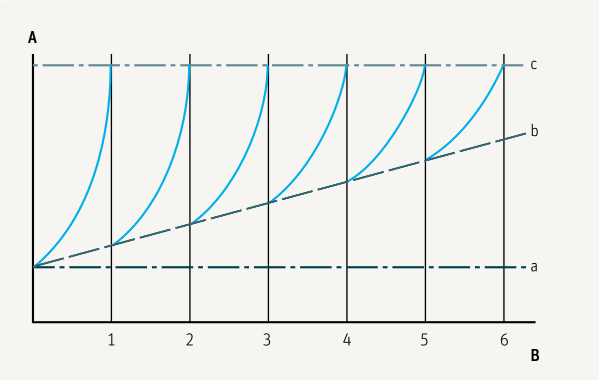


Fig. 135 – Increase in neps between grinding periods:
A, number of neps in the web; B, grinding interval; b, general rise of the lower nep level; c, mills limit for neps

Such quantities of material represent a huge number of fibers, which have to be processed by the individual tooth points. Processing therefore considerably wears down the teeth – they become rounded at the top and lose their aggressiveness. The direct result is a continuous increase in the nep content of the sliver (b).
The points must therefore be sharpened from time to time, in order to give a better shape to the edges by grinding them. Each new grinding operation reduces the number of neps, but the level never returns to that prior to the previous grinding. As Fig. 135 illustrates, the lower nep limit increases noticeably from “a” to “b”.
The deterioration in quality from one grinding interval to the next arises from the fact that the teeth are ground down to successively lower heights, the lands at the teeth points become steadily larger, and softer metal layers are gradually exposed. The following grinding intervals are currently in use:

	Cylinder	Flats
First grinding after [kg]	80 000 - 150 000	80 000 - 150 000
Each additional grinding after [kg]	80 000 - 120 000	80 000 - 120 000

The interval is best selected depending on the mills nep limit (c). Since the doffer clothing works much less than that of the cylinder, it should be ground only half as often, or even less frequently, except when man-made fibers are being processed: grinding should then be carried out more often but more lightly.
The clothing on the licker-in should not be ground; it should be renewed after a throughput of 100 000 - 200 000 kg.

2.6.3.2. Grinding depth

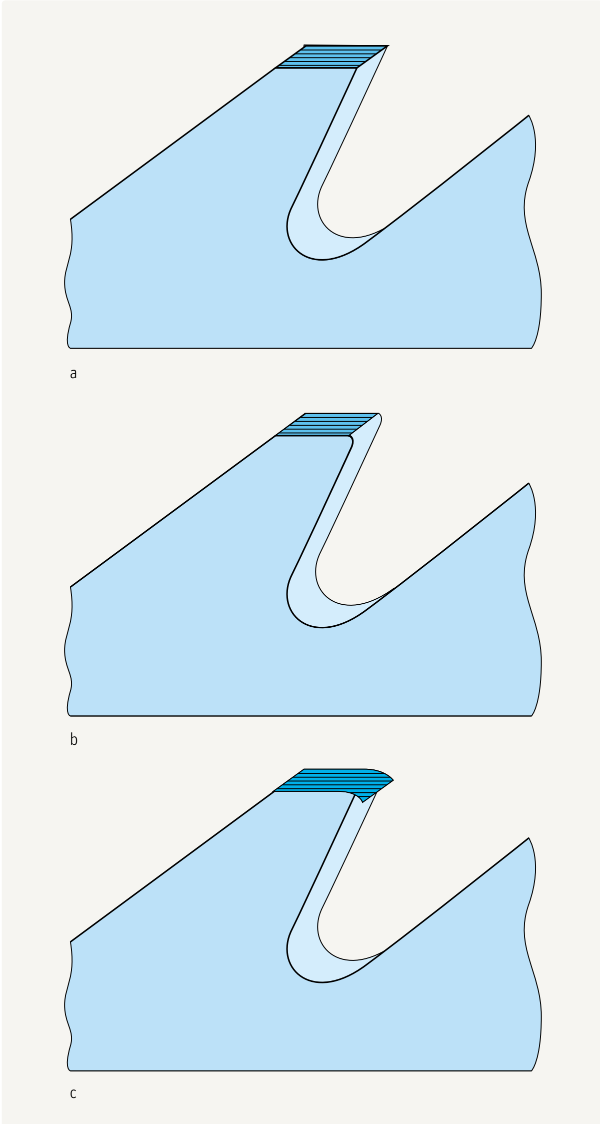


Fig. 136 – Correct grinding of the tooth point (a) and incorrect (b, c)

Grinding is carried out with the cylinder rotating in its normal direction at normal speed, so that the grinding roller moves with (not against) the teeth of the clothing. The grinding depth is such that a plane surface with a sharp edge is produced at the point of the tooth (a, Fig. 136). Satisfactory carding will not be achieved if too little material is ground away so that the front edge stays rounded (b), or if the grinding operation is too harsh (too much pressure on the grinding roller) so that a burr is formed at the tooth edge (c).

2.6.3.3. Grinding the flats

There are two possibilities, namely grinding in the card by installing the grinding roller on the machine for a short time under normal production conditions, or grinding the flats in a special grinding machine after removing them from the card. This machine comprises mainly a full-width grinding roller with moveable carriages mounted over it to receive 1 - 4 flats. During grinding, the carriages move the flats repeatedly back and forth over the grinding roller until they have been ground down to the precisely set height. Each of these two methods has its advantages and disadvantages. Grinding on the card is more efficient and demands significantly less effort; grinding in a flat grinding machine is somewhat more exact. It may prove advantageous to grind as often as possible on the card, but occasionally to put the flats on a flat grinding machine to level up.

2.6.3.4. The grinding tools

THE FULL-WIDTH GRINDING ROLLER

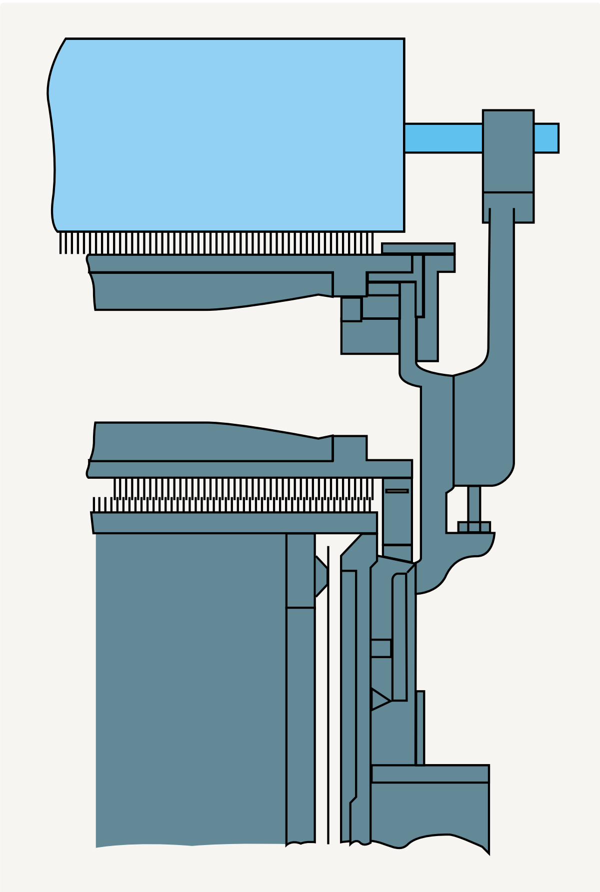


Fig. 137 – The full-width grinding roller

This has a drum with an abrasive sheet or, more generally nowadays, a coating of carborundum abrasive (Al_2O_3). The drum can be driven externally by a disc or internally by a motor within the drum. In the latter case, the tubular body of the roll forms the rotor. The grinding roller, in the form of the abrasive-coated drum, extends over the full width of the machine. Thus, the full width of the clothing on the operating elements of the card is treated simultaneously, which is very economical. On the other hand, if maintenance is poor, the drum can bend in the middle while revolving on the card. If this happens, the central portions of the main cylinder and doffer may be ground more than the edge zones. With modern grinding rollers the danger of this is minimal.

THE TRAVERSING GRINDING DISC

The grinding head (S), in the form of an abrasive disc 90 mm wide, can slide and is seated on a guide tube. It is driven back and forth over the clothing by a worm spindle in the interior of the tube. At any time it treats only a small portion of the total surface of the cylinder. Grinding takes far longer than with a full-width roller, but there is practically no danger of bending in the middle. In some equipment, the back-and-forth movement is not effected by a worm spindle but by specially driven belts. Drive is by individual motors.

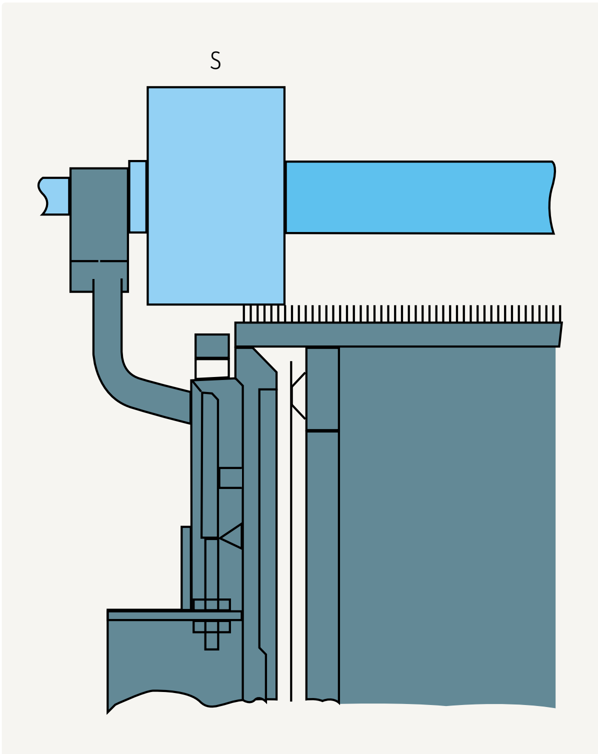


Fig. 138 – The traversing grinding disc

2.6.4. High-performance maintenance systems

2.6.4.1. Requirements

Card maintenance is a very demanding, uneconomical operation. Considerable effort is required to keep conventional cards running, and it is even greater for high-performance cards. It was therefore inevitable for manufacturers to equip their new types of cards with maintenance systems of different designs (depending on the manufacturer) that:

- are modern;
- ergonomic;
- save time and effort; and
- relieve personnel.

Rieter's solution (on the modular design principle) will be explained briefly by way of an example:

2.6.4.2. Easy exchange of modules

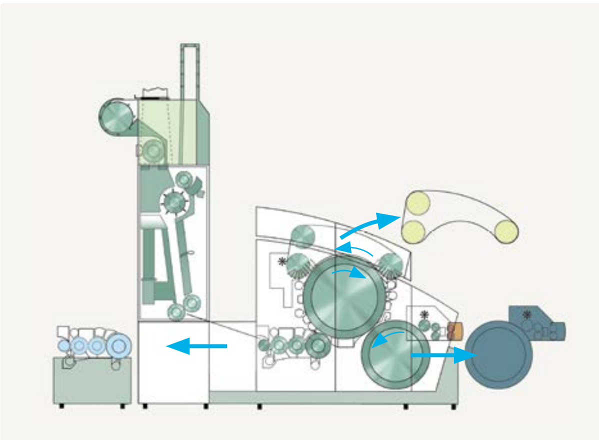


Fig. 139 – The modules of the C 60 card

To improve the accessibility and exchangeability of all parts of the card, Rieter designed its card on modular principles. The only fixed parts are the feed chute and the main cylinder; all other modules can be removed. As a result,

- cleaning;
- setting;
- wire mounting;
- exchanging (licker-in, flats);

can be performed easily by taking the modules out of the machine, e.g.:

- the licker-in module (Fig. 140);
- the flat assembly (Fig. 141);
- the doffer module (Fig. 142).

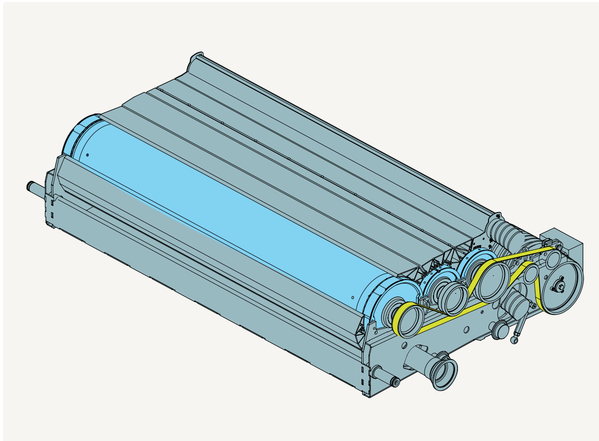


Fig. 140 – Licker-in module

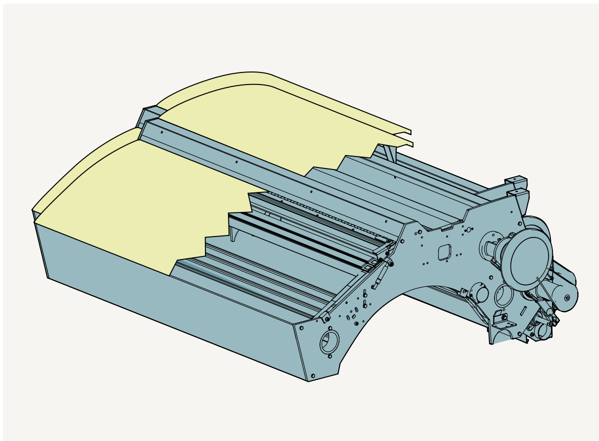


Fig. 141 – Flat assembly

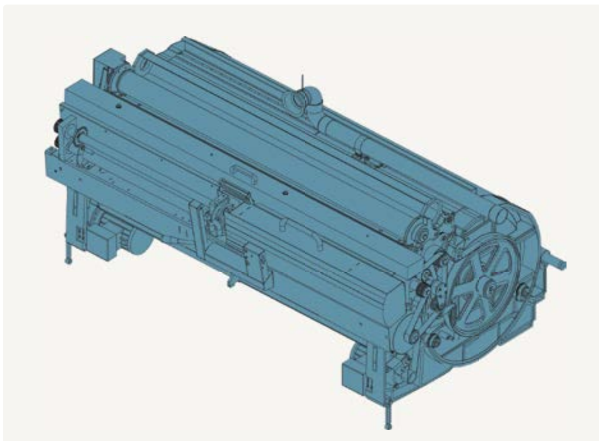


Fig. 142 – Doffer module

These systems not only facilitate maintenance, they also improve quality, as shown by Rieter's IGS device:

2.6.4.3. Rieter's automatic grinding system (IGS)

IGS stands for Integrated Grinding System
With IGS-classic a grindstone is moved over the cylinder clothing by the automatic control during production. This procedure takes place 400 times during the expected service life of the clothing, not every 80 - 100 tons, as is the case with labor-intensive manual grinding. There is absolutely no risk of damage to the clothing due to improper handling of the grinding system when using IGS-classic. The service life of the cylinder clothing has been prolonged by over 30 % thanks to IGS-classic. In addition, the savings made on maintenance are obvious. Also there are no downtimes where the machine is idle while manual grinding takes place.

The IGS-classic cylinder grinding system (Fig. 143)
consists of an aluminum profile as carrier and a linear-directed grindstone stabilized by spring pressure. In the parked position (right-hand side of the machine) the flat belt is pushed upwards by clamp profiles so that no dust or particles of fibers can get inside the profile. The parameters necessary for the grinding operation can be entered on the card. The program calculates the grinding schedule, distributing the fixed grinding cycles optimally over the lifetime of the cylinder clothing (270 and/or 400, to and fro = 1 cycle). The time between cycles is longer at the beginning of the schedule than at the end. On the way to the left-hand side of the machine the grindstone is lowered. Grinding occurs when the grindstone moves from the left to the right-hand side of the machine. This means a sharp wire all the time and thus constant quality (Fig. 144).

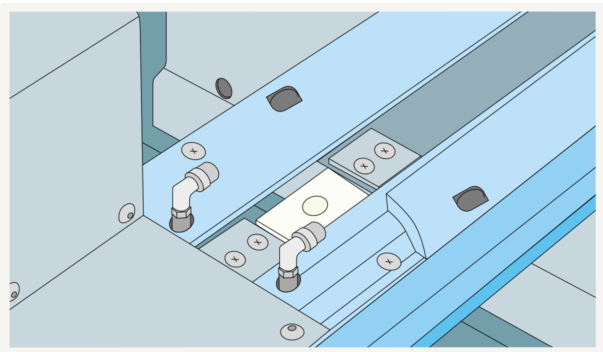


Fig. 143 – IGS-classic

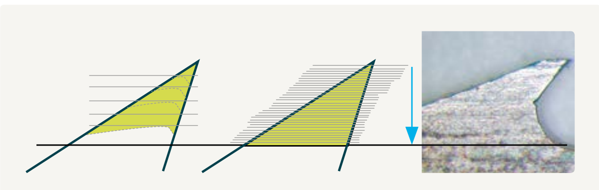


Fig. 144 – Grinding without (left) and with IGS (right)

2.6.4.4. IGS-top integrated grinding system

A grinding brush is permanently installed behind the flat cleaning device (Fig. 145). Under the grinding brush and the one flat in contact with this brush a spring is provided that presses the flat bar against the brush. The flats are thus raised one by one and ground at this point. With the IGS grinding device grinding takes place for more than 100 cycles during the lifetime of the clothing.

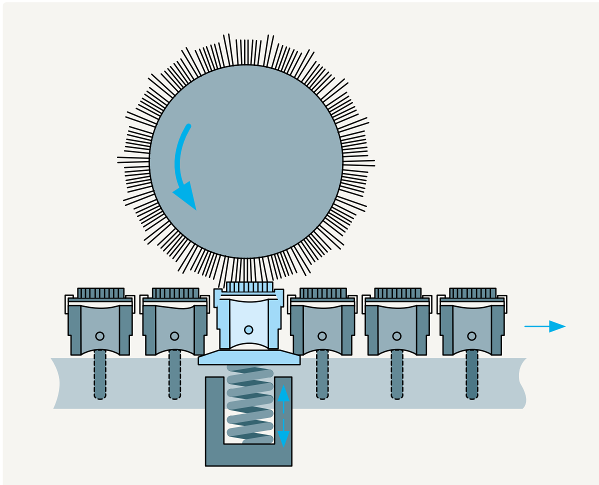


Fig. 145 – IGS-top grinding system

2.6.4.5. The sharp edge makes all the difference

IGS-classic and IGS-top feature considerably more frequent but less aggressive grinding than takes place in manual clothing maintenance. This prolongs the service life of the clothing, and at the same time the tips always stay sharp. The success of this approach is reflected in the card sliver through high consistency in purity and low nep content.

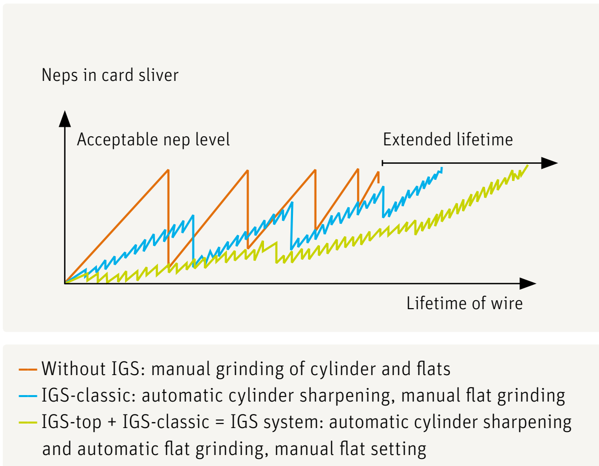


Fig. 146 – Graph of quality improvement using the IGS system

2.7. Settings
2.7.1. Basics

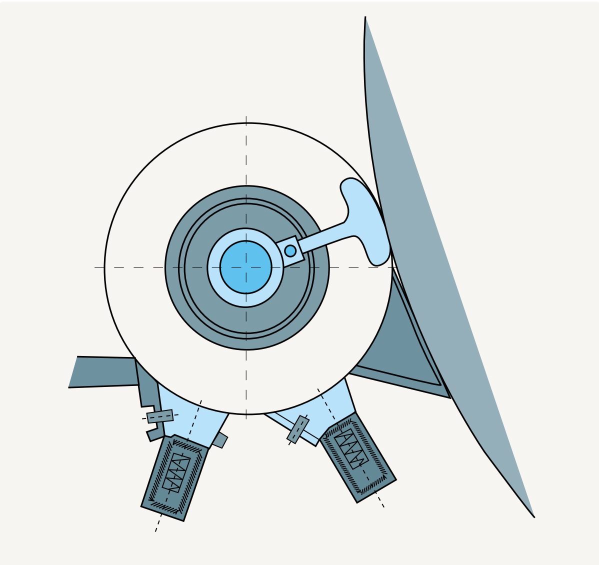


Fig. 147 – Template for setting the licker-in grid

The card comprises a large number of individual parts that guide the material, open it and clean it. Optimal, gentle treatment is only possible if these parts have the correct form and the right relative positions and spacings. The so-called settings of the card are of the greatest importance. For example, too narrow spacing of the operating elements leads to fiber damage (loss of breaking strength); too wide a setting produces more neps.
Table 2.7.2. shows the most common settings for conventional cards. The licker-in on these conventional cards calls for special treatment: the licker-in has to be removed and replaced by a gauge in the form of a pendulum (Fig. 147). The radius of the gauge has to correspond exactly to that of the licker-in. It should be realized that the settings vary from one make of machine to another – the setting instructions of the individual manufacturer must be followed. This applies especially to modern, high-performance cards. That is why no instructions for these cards can be given here.

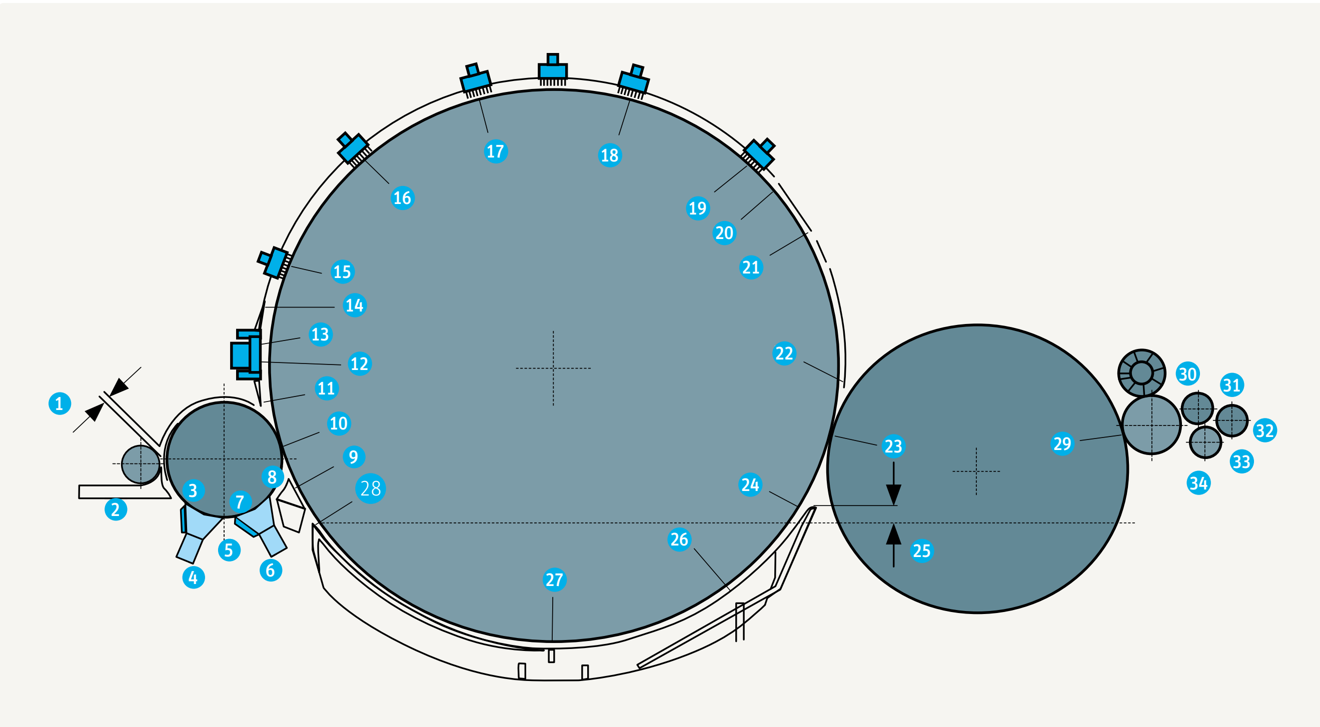


Fig. 148 – Setting positions on the card

2.7.2. Table of settings

For conventional cards (see Fig. 148)

Position	Remarks	Distance	
		mm	1/1 000″
1		0.2 - 0.5	8 - 20
2	Tuft feed	0.4 - 0.55	16 - 22
	Lap feed	0.25 - 0.4	10 - 16
3		0.3 - 0.45	12 - 18
4		0.45 - 0.55	18 - 22
5		0.6 - 0.8	24 - 32
6		0.45 - 0.55	18 - 22
7		0.45	18
8		0.55	22
9		0.55	22
10	Licker-in to main cylinder	0.2 - 0.25	8 - 10
11		0.4	16
12		0.35	14
13		0.3	12
14		0.35	14
15	Flat 1	0.35	14
16	Flat 2	0.3	12
17	Flat 3	0.25	10
18	Flat 4	0.25	10
19	Flat 5	0.25 - 0.3	10 - 12
20	Narrow setting = few flat strippings	0.85 (0.5)	33 (20)
21	Wider setting = more strippings	0.75 (0.375)	30 (15)
22		0.425 (0.3)	17 (12)
23	Main cylinder to doffer	0.1 - 0.125	4 - 5
24	Short staple	13 - 14	
	Long staple	10 - 12	
25		20 - 30	
26		3.5 (2.5)	
27		1.5 (2.5)	
28		0.55	22
29		0.15	6
30		0.25	10
31		0.125	5
32		0.25	10
33		0.1 - 0.15	4 - 5
34		0.25	10

2.8. Auxiliary equipment

2.8.1. Dust extraction on high-performance cards

More and more countries are enacting rigorous regulations governing permissible dust concentrations in the atmospheres of workrooms. The card releases enormous quantities of dust and it is essential to ensure comprehensive and immediate removal of this waste. For this purpose, modern cards are fully enclosed and subjected to permanent partial vacuum, so that dust and fly can no longer escape from the machine. Within the casing, suction removal systems are provided at some or all of the following positions:

- in the infeed region;
- at the entrance to the flats;
- within the flats;
- at the exit from the flats;
- between the main cylinder and the doffer;
- at the web detaching point;
- beneath the main cylinder;
- in the coiler.

The suction removal systems operate continuously to maintain constant conditions on the card. In modern plants the fly- and dust-laden air passes to the air-conditioning equipment. The quantity of suction air per card lies in the range from about 4 000 to 5 000 m^3/h.

2.8.2. Waste disposal

The card eliminates on an average 4 % of waste. In a carding room processing 500 kg/h of material, about 500 kg of waste is produced per day in three-shift operation.
The waste falls mainly into two categories:

- droppings from below the licker-in;
- flats and filter strippings.

Filter waste can be removed manually, but nowadays the attendants cannot be asked to perform manual removal of licker-in droppings. Modern cards are therefore fitted with suction waste-removal systems. These can operate either continuously or intermittently. An intermittent system, for example, empties the waste chambers under the lickers-in – individually in succession or simultaneously for two cards; in a second cycle, the waste chambers for flat stripping and filters are emptied. It continues with the next two cards a.s.o. The waste material is passed via piping to central bale presses (described in chapter ”Blowroom”). Handling of dirty material is therefore confined to removal of the pressed bales.

2.9. Technical data of three high performance cards

Manufacturer	**Rieter**	**Trützschler**	**Marzoli**
Model	C 60	TC 03	C 601N
Working width [mm]	1 500	1 055	1 026
Licker-in [∅]	180/180/253	3 x 172,5	1 x 350
Licker-in rpm	935 - 2 306	930 - 2 700	640 - 1 640
Main cylinder [∅]	814 mm	1 287 mm	1 290 mm
Main cylinder rpm	600 - 900	300 - 560	up to 650
Integrated grinding	IGS-classic	No, by hand only	No, by hand only
Doffer [∅]	680 mm	700 mm	706 mm
Delivery [m/min]	300, 400 mechanically	400, 500 with IDF	up to 400
Flat bars	79	84	75
In working position	27	30	25
Flat direction	backward	backward	backward
Power required for 75 kg/h	15 KW/h	18 KW/h	-
Pressure [bar]	6	7	6
Leveling	Medium and long term	Medium and long term	Medium and long term
Drafting module	SB (unleveled) max. draft of 5 max. 800 m/min delivery RSB (leveled) max. draft of 5 max. 700 m/min delivery	IDF (leveled) max. draft of 3 max. 500 m/min delivery IDF-R (rectangular can) max. draft of 3 max. 500 m/min delivery	

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ILLUSTRATIONS

The Rieter Manual of Spinning

Volume 2 – Blowroom & Carding

Volume 2 of The Rieter Manual of Spinning provides in-depth information on opening, cleaning, blending and carding, and covers aspects such as acclimatization of raw materials, anticipated waste from various grades of fibre, selection and setting of cleaning and blending machinery, waste recycling, transport and feed materials, the functions of the various card components, as well as selection and maintenance of card clothing and autolevelling systems.

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1922-v3 en 1611

www.rieter.com

ISBN 10 3-9523173-2-2
ISBN 13 978-3-9523173-2-7

9 783952 317327