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Autor: Furrer, Alfred J.

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Manmade fibre machinery and systems

Spiders and silkworms demonstrate a process whereby fine filaments are spun from liquids. However, chemical research only developed the ability to produce rayon filaments around 1890, thanks to the work of Count Hilaire de Chardonnet. However, the actual process of draw-spinning manmade fibres was only described in patent publications around 1900. Research work on artificial fibres was later boosted in particular by World War II; for example, considerable effort was put into the manufacture of parachute silks. In the history of this area of fibre research the large-scale projects of the global chemical groups play an especially prominent role. Names such as Du Pont, Hoechst, ICI, Ems, Toray and Viscosuisse stand for developments in the USA, Germany, Britain, France, Japan and Switzerland. Polyamides were initially of special importance in these projects. The triumphal progress of the nylon stocking, which officially appeared on the market for the first time in the USA on May 15, 1940, is referred to here as an example of the detours and black market influences involved.

It is a well-known fact that direct and indirect conflicts make resources available for research efforts which normal world trade could never afford. High-strength polyamides, Perlon, polyester and various other fibres therefore emerged in the course of World War II. At a later stage it was space technology which, for example, speeded up the development of aramids such as Kevlar.

While these synthetic filaments were initially used only in the textile sector, their applications were later also extended, for example, to the optical field, where outstanding results have recently been achieved, especially in medical technology.

Meanwhile, glass fibres are among those in use in telecommunications,

Technical terms used in connection with filament yarns

Description of yarn		Unwind speed (m/min.)	Further processing		
LOY	Low oriented yarns	<1000	➧	DTY	Draw texturised yarns
MOY	Middle oriented yarns	<2500	➧	ATY	Air jet texturised yarns
POY	Partially oriented yarns	<5500	➧	FDY	Fully drawn yarns
HOY	Highly oriented yarns	<5500			
FOY	Fully oriented yarns	<8000			
FDY	Fully drawn yarns	–			

repeatedly breaking records when used as fibre optic waveguides. Last but not least, manmade fibres opened up independent fields of application for the technology of geotextiles and the manufacture of artificial leathers. In the field of observed and reproduced nature, fibre reinforced plastics are now used in lightweight structures which only a short time ago were the stuff of technical dreams. The Airbus rudder unit made by Dornier, a German aircraft manufacturer, is an impressive example of this.

Links between fibre research by the chemical groups and textile machinery manufacture by Rieter

In large-scale, government-subsidized projects the chemical groups developed fibres vital for use in wartime or satisfied the needs of aerospace engineering. However, in the postwar years the costs involved increasingly outstripped government resources. The subsequent need to raise private capital therefore taught chemical research personnel to seek partnerships with noted engineering companies. They made their secret and patented technical processes available to them and called for first-rate machinery and equipment. Rieter's reputation as a machinery manufacturer thus brought the company into direct contact with manmade fibre research.

In the course of time, Rieter was gradually able to move on from this kind of contract design arrangement. The exclusive technologies and process know-how of the chemical groups was replaced by Rieter technology, which was also based on the know-how of consultant engineering firms such as that put on the market by Ems Inventa, Zimmer, Karl Fischer and others. Rieter's specialists increased their know-how through in-house trials and became increasingly conversant with the processes involved.

Manmade fibre lines and systems

The manufacture of manmade fibres starts with the process from which the spinning dopes emerge. After solidifying, these are processed into chips and can then be stored or transported. They are liquefied again in the spinning process by the action of pressure and heat, and pressed into filaments via spin-die manifolds and extruders with spinnerets. They solidify as fibres in cooling shafts, are lubricated with spinning dope, drawn over drawing rollers and fed to winding elements. Depending upon the system, the smooth filaments spun in this way are textured and processed further as continuous filament or cut into staple.

The figures for processing these fibres as filament or staple were as follows in 1992:

Fibre	Filament	Staple
- Polyamide (Nylon)	82 percent	18 percent
- Polyester	46 percent	54 percent
- Polyacrylic		100 percent

Incidentally, less than two percent of the crude oil produced worldwide is processed into fibres. Of the various stages of the manmade fibre process, texturing for home textiles, carpets and outerwear is especially important. Smooth fibres are used mainly for technical applications, such as those required in tyre cord.

Rieter's customers in the manmade fibre sector

In the development phase described to date, Rieter's customers in the manmade fibre sector were originally a research and quality elite who installed lines with a high degree of security. The top quality required of the machines and the attention paid to the companies' special requirements were also rewarded accordingly.

In the nineteen-sixties this special situation was superseded by the current concern for price/performance ratios. Contract machine manufacture using the customer's confidential technology was transformed into high-quality machine manufacturing with advice from Rieter on systems and technology. Rieter developed from a contract manufacturer into a systems supplier. The strategy of supplying complete systems was clearly underlined by the acquisition of Automatik AG.

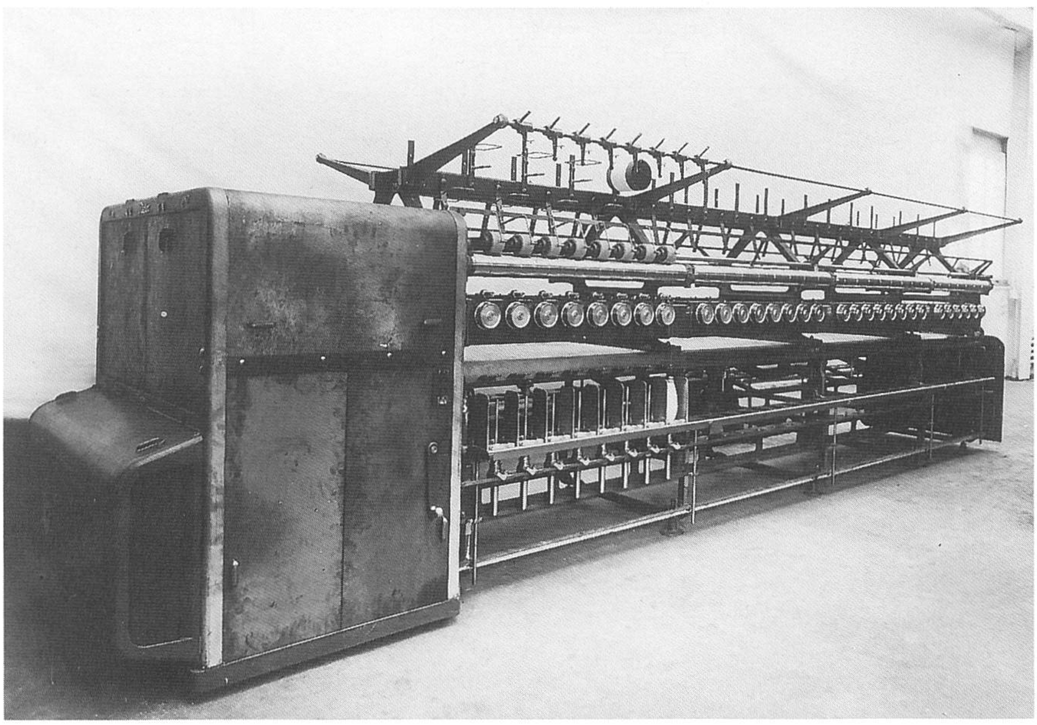
These ideas were already behind the construction of Rieter's research centre in Niedertîss at the beginning of the nineteen-sixties, since the buildings made provision for modifications which would have enabled a complete filament spinning mill to be operated at a later date. However, going it alone in the fields of chemistry, spinning and filament manufacture would clearly have been too costly, and would not have been conducive to further contacts with the industry.

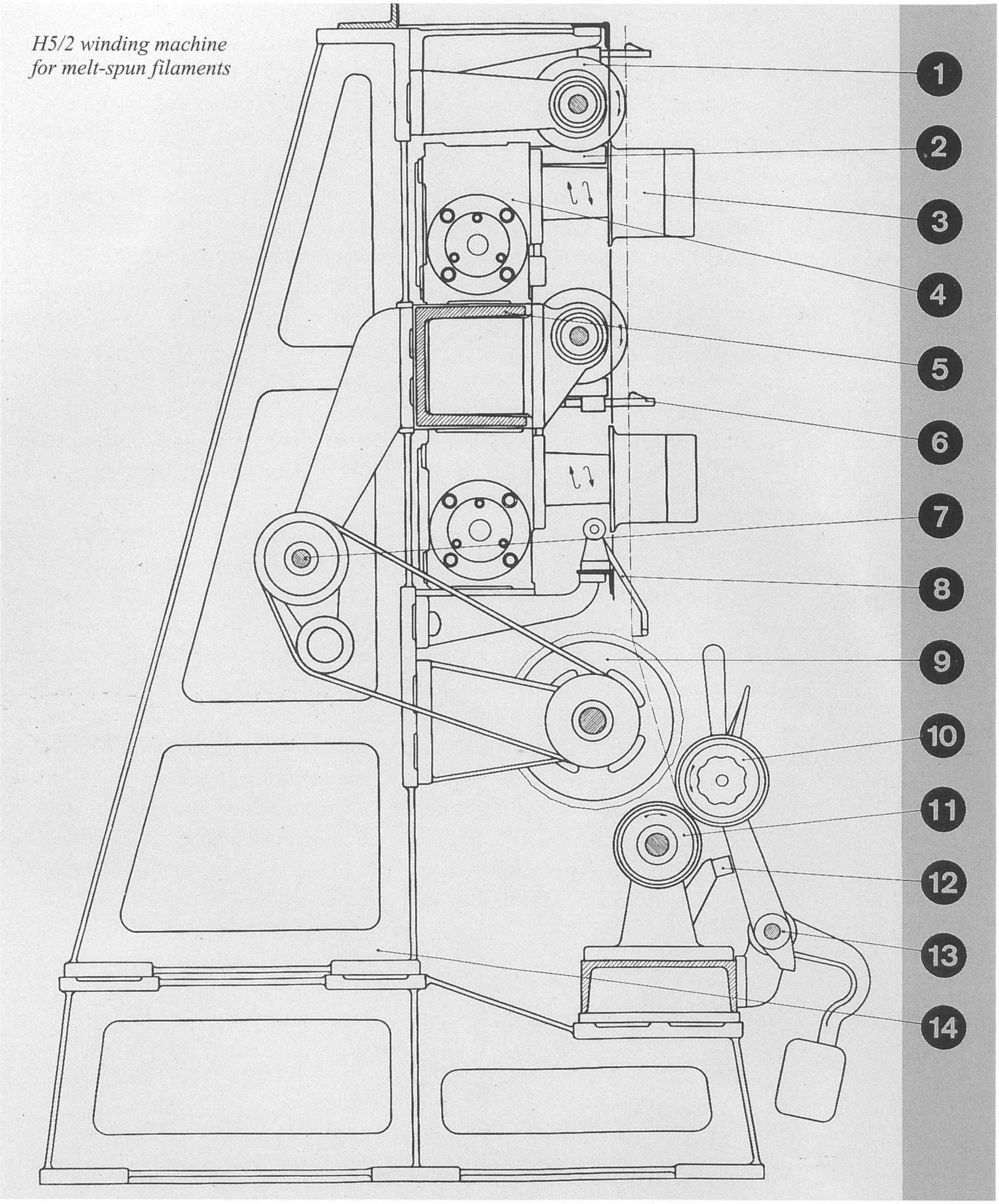
Special features of machine manufacture for manmade fibre technology

At the beginning of the manmade fibre era field trials with major European customers were still realistic and could be performed at short notice, but these opportunities have become much rarer due to changes in the markets. The focus on the Far East also affects the locations for trials, and monitoring over such long distances does not make development work any easier.

In mechanical engineering as such, filament lines saw the decline of the gearwheel and its replacement by variable-speed drives. This considerably increased the importance of electrical engineering in manmade fibre machinery, and it is not exceptional for this to account for 70 percent of the value. Rieter's own electrical engineering operations, Schaltag in Switzerland and Abbey in the UK, thus assume particular importance.

J5/1 draw-twister based on RB37 ring spinning frame, ca. 1950





1 Two-row, sintered corundum preparation discs
2 Adjustable mesh troughs with overflow nozzles
3 Two-row steel galettes with hard chrome plated surfaces and tapered ends
4 Oiltight enclosed cast housing with helical gearing for the galettes
5 Longitudinal supports for the gear boxes
6 Sintered ceramic thread guides, before and after each preparation disc
7 Intermediate transmission shaft for driving the grooved drums
8 Swivelling thread guides over the grooved drums
9 Grooved drums for thread traverse with V-belt controlled drive
10 Tensioning drum with internal and external tensioning discs for cylindrical, straight-sided spinning bobbins
11 Friction rollers with elastic, easy-to-release coupling
12 Permanent magnets for improved pressing of the packages on to the friction rollers (when starting spinning)
13 Swivelling package holders with handbrake and counterweights to regulate contact pressure
14 Heavy frame with two-part intermediate plates

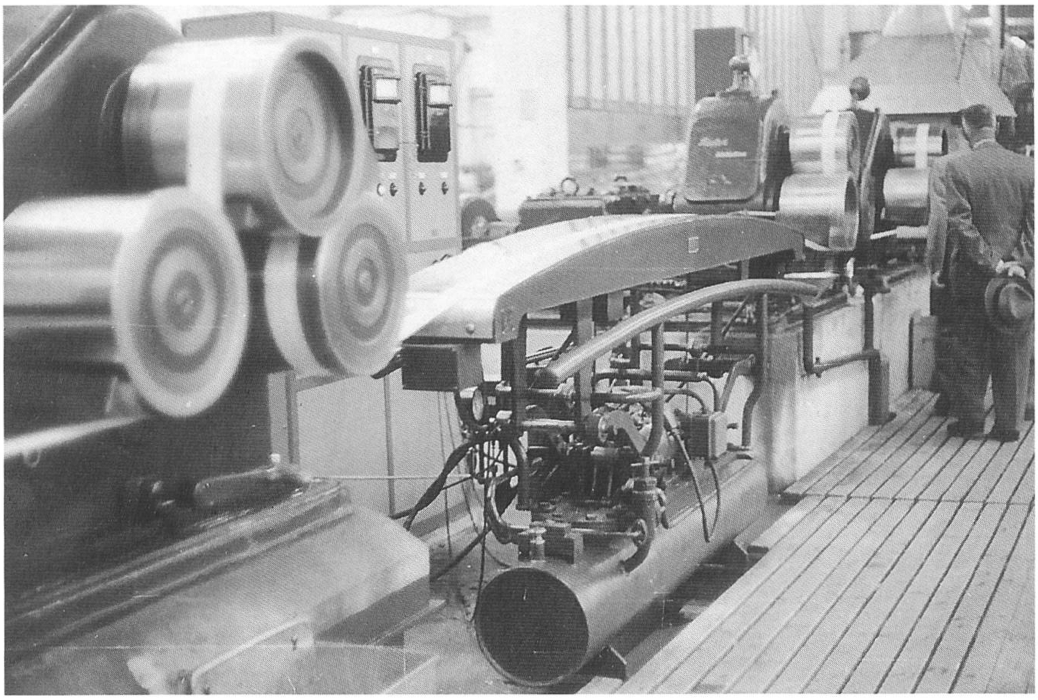
Manmade fibre machinery and systems

As we have already mentioned, Rieter was invited by the Ems company in 1948 to build the first draw-twisters for fibre manufacture. Rieter also started in 1949 with the design of the H5 winder, which was developed in various stages from the H5/0 prototype to the advanced H5/4 production machine. The first draw-twister, the J5/1, was produced at the same time on the basis of the RB 37 worsted ring spinning frame. This basic machine was equipped with gear troughs in its upper section, in which the draw rollers were mounted on bearings. The J5/1 to J5/12a Series was developed in several stages. History was made here by the J5/5 for fine yarn counts (with 846 machines) and the J5/10 (with 1596 machines). The recommended working speed of the J5/10 was set at 1200 to 1500 m/min., while that of the J5/12 was a remarkable 1500 to 1800 m/min. For heavy yarn counts, which were processed with two rows of draw rollers, outstanding sales figures were achieved with the J5/6 Series (81 machines) and the J5/7 Series (201 machines).

For the manufacture of cut staple fibres the continuous strands from the winding machines were assembled into cables, known as tows, which were conveyed together to drawing lines for drawing. Staple cutters produced by other companies then cut the continuous filaments to the required staple length. These fibres were then supplied to spinning mills in the form of pressed bales.

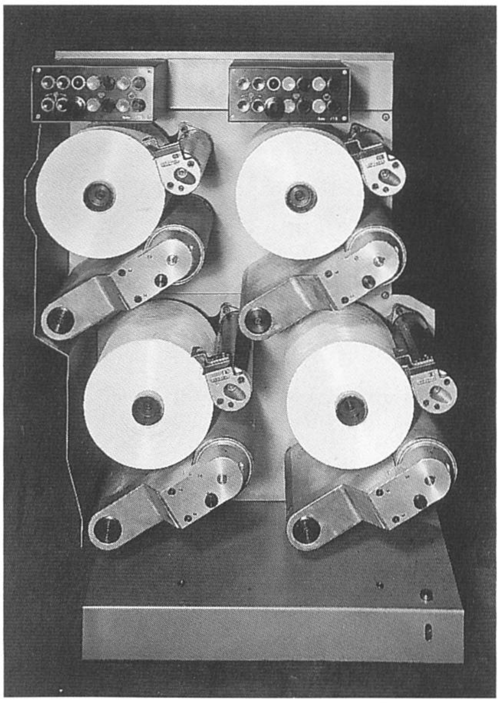
Drawing lines were produced under the model designation H4 between 1951 and 1965. However, as large-scale, very high precision gears they did not correspond to Rieter's manufacturing capabilities. The company therefore contracted out initial, smaller lines to Schweizerische Lokomotiv- und Maschinenfabrik (SLM) in Winterthur. Large machines were later built by Wülfel in Hanover. The drawing lines operated with cold drawing rollers, so that their drawing force made them suitable only for polyamide. The drawing of polyester would have required oil-heated rollers. Instead of devoting resources to this major design effort, Rieter concentrated on the extremely successful draw-twister and left drawing lines to its

H4/1 tow drawing line, mid-nineteen-fifties

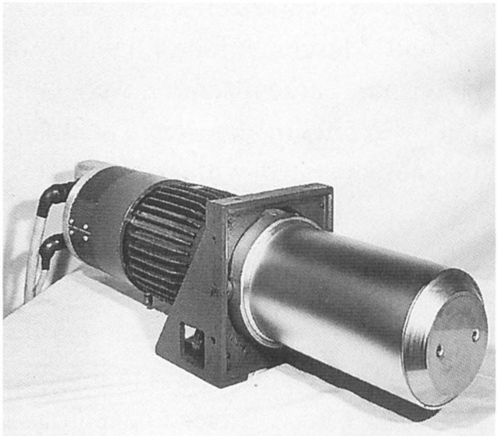


competitors. Successes in draw-twisting were accompanied by the J6 draw-winding machines, with the first J6/1a model appearing in 1966. However, only 52 machines of the succeeding models, the J6/1, J6/2 and J6/2a, were built up to 1975. Here, too, the version with one row of drawing rollers was used for polyamide, that with two rows of draw rollers for polyester. The two-row machine included «a» in its type designation.

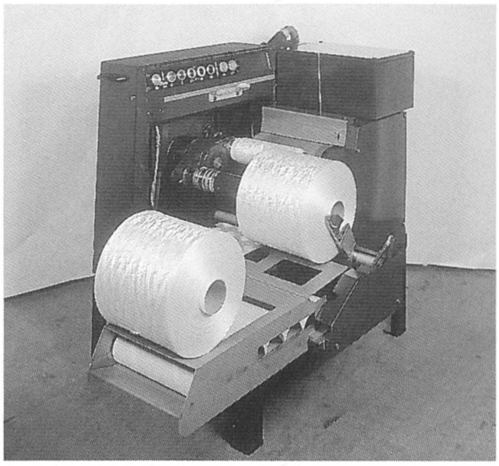
The mid-nineteen-sixties saw a move to new and much faster man-made fibre technology. The classical draw-twisters and draw-winders, Rieter's proven and highly successful models, were superseded by highly advanced drawing devices with heated rollers and superfast winders, with which working speeds were increased initially to some 2500 m/min. and later to 3000 m/min. and more, thus doubling output at the very beginning of the process. Hand winders for manual operation with working speeds of up to 4000 m/min. were produced as models J7/E, J7/G and J7/H. Parallel with these, Rieter developed automatic winders, starting with the J7/A1 Series for single-yarn operation in a very simple design, but with relatively large dimensions. The J7/A2, again single-yarn but with a compact design, was the next stage of development and could also be operated at up to 4000 m/min. Its successor, the J7/A3 Series, then operated with two yarns at 4000 m/min. The subsequent J7/A4 Series was designed for four yarns at 6000 m/min., but could not be operated with the required reliability at these high



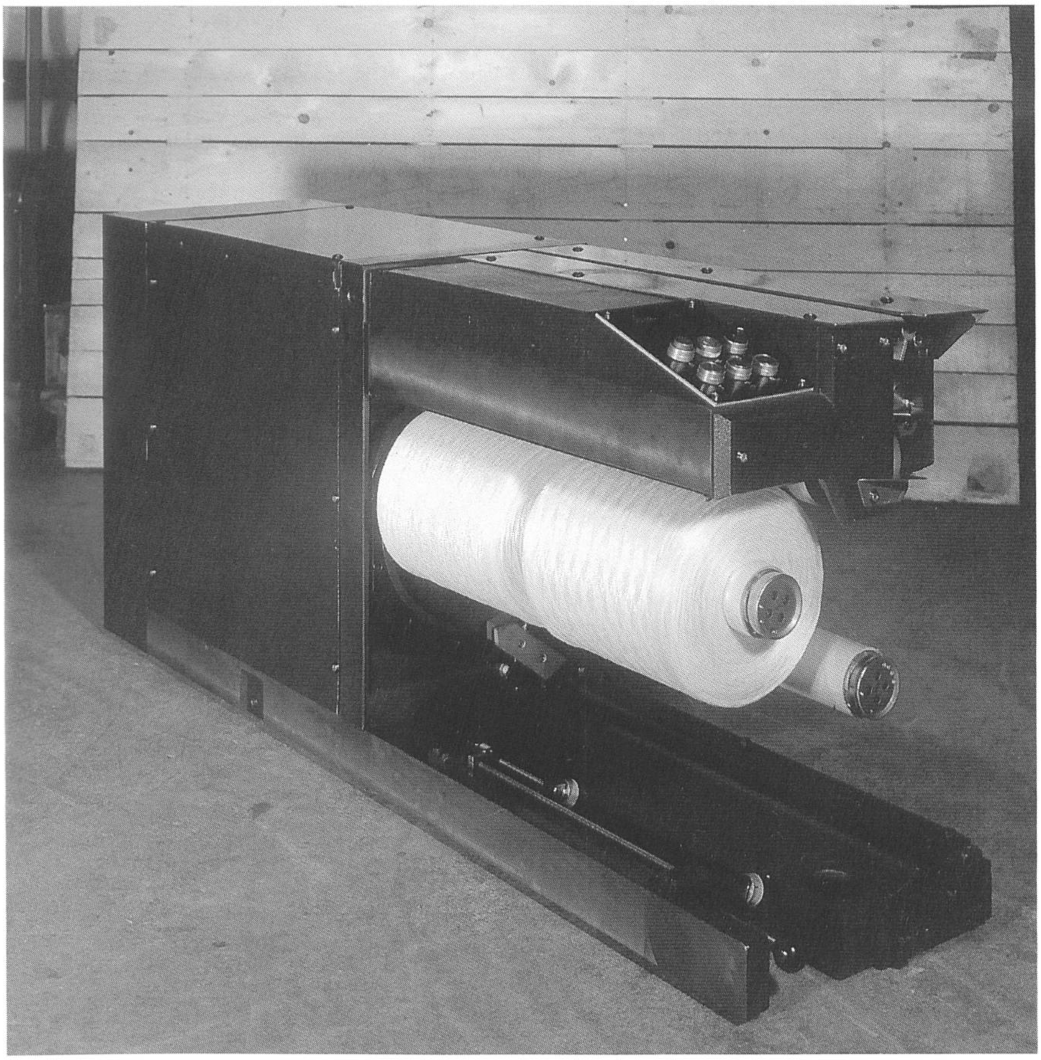
J7/G hand winder



J7/32 dual-shell draw roll unit



J7/A2 automatic winder



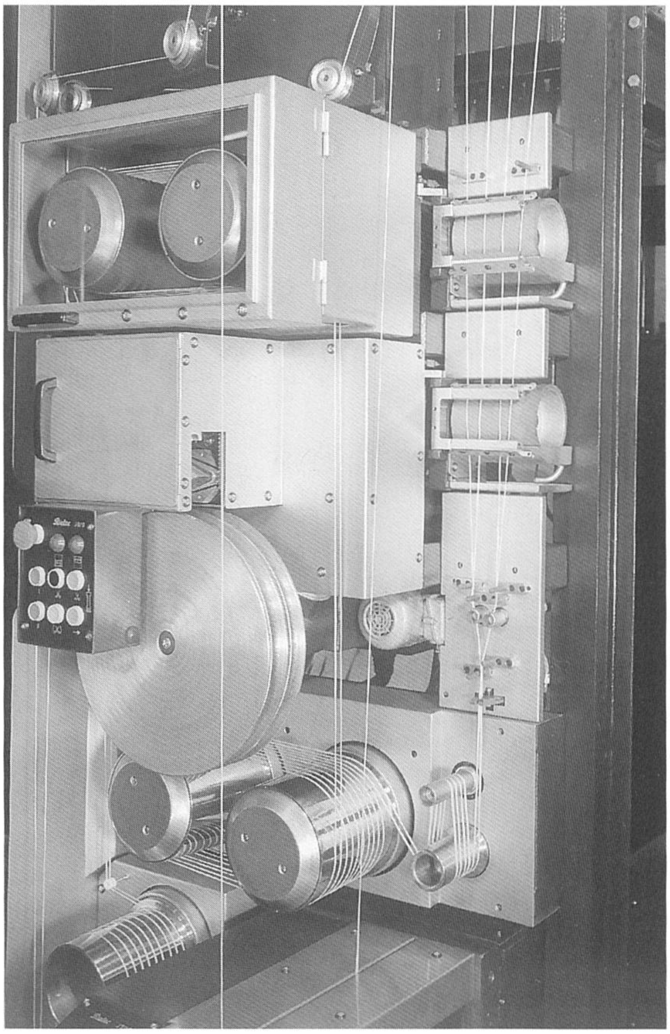
J7/A4-33 automatic winder, for max. 4000 m/min.

speeds in mill conditions. The J7/A4-21 Series was limited to 4000 m/min. for BCF and cord applications. With the latest J7/A6 Series winders, a modular design is currently in development which is intended to create a new generation of 6000 m/min. automatic winders for up to eight yarns.

The use of fast, automatic winders enables working speeds to be increased further, and has been exploited most successfully to date by Japanese competitors. As mill operations and operating risks show, there are wide differences between theoretical peak speeds and the operating figures actually achieved. This leaves the machine manufacturer with plenty to do.

The standard processes in use today include high-speed, heated drawing rollers. Rieter entered this field at the end of the nineteen-sixties with Dienes products, and later took up the challenge with its own J7 rollers. The units with working speeds of 6000 m/min. showed Rieter the practical risks of make-or-buy policies in the case of such advanced requirements. In the course of development to the 8000-metre roll, Rieter recalls its experience with FAG aircraft bearings, whose high quality then helped to extend bearing service lives significantly.

These combinations of J7 drawing roller units and J7/A automatic winders led Rieter to the development of spin/draw texturing machines for coarse yarn counts, starting with J0/1 carpet yarn lines. At present the J0/10 machine is available for two-yarn operation and the J0/12 for four-yarn operation. This sector also includes



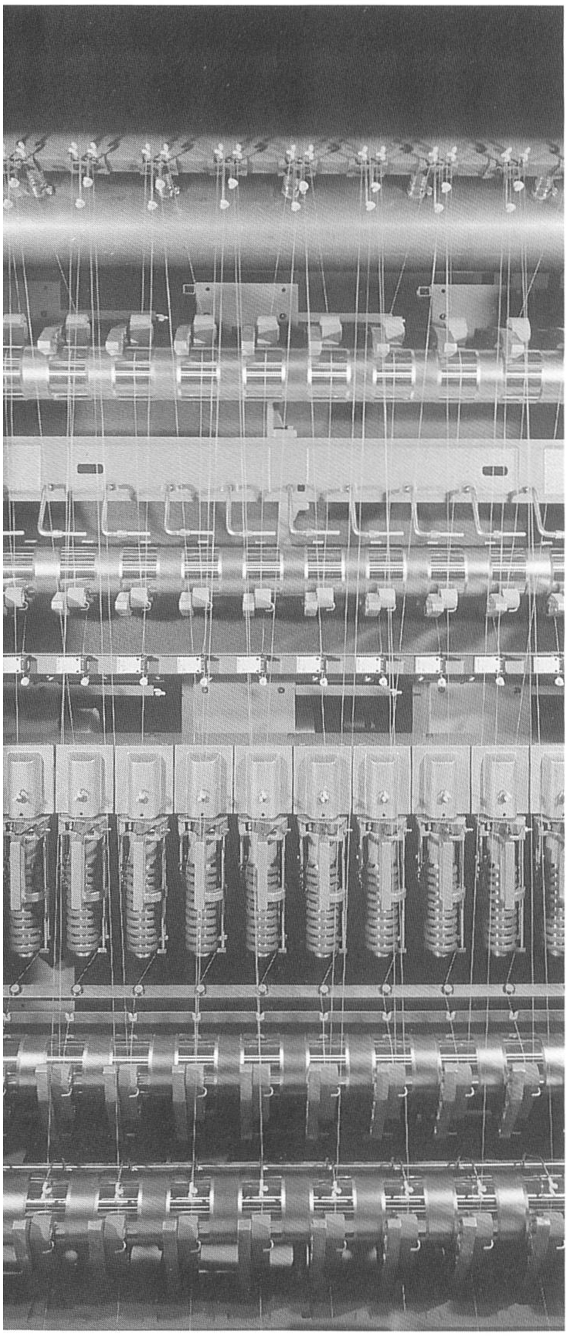
J0/10 spin/draw/texturing machine

the spin/draw winding machines, which with the J7/3A drawing device and the J7/A4 or J7/A6 automatic winder form the J3/1 and J3/10 modules, respectively. Unfortunately, modular theories often differ from the actual assembly potential, since the fixed structural pillars in existing spinning mill premises tend to create obstructions.

For the high content of electrical equipment in manmade fibre systems, Rieter produces its own control units, which monitor and control speeds and temperatures in the process with Rieter Texinvert.

Fine-count texturing – a complex process

The range of machinery and equipment produced would be incomplete without the sector of fine-count texturing. Initially going it alone, Rieter sought to solve the problem of fine-count texturing with its J 8/20 and J8/21 experimental machines in 1972 and 1981. The three one-sided prototypes which were built provided ideal material flow for yarn texturing and



J8/21 draw texturing machine; single-sided model with 120 positions

Rieter-Scragg DCS-1200 single-heater false-twist draw texturing machine

heater operation. However, penetrating the market in competition with Rieter's main rival would have been a very costly business, and an ideal solution was found in the acquisition of Ernest Scragg & Sons in Macclesfield (England) in 1982. Scragg's two proven machines, the SDS 700/900/1200 with twin heaters and the DCS 1200, covered Rieter's market needs ideally. With the new Rieter-Scragg company, which celebrated its centenary in 1989, Rieter has made a very valuable and cost-effective addition to its range of manmade fibre machinery.

Finally, the product range in the field of spinning, pelletizing, plastics technology and spinning preparation was significantly expanded with the acquisition of Automatik AG in Grossostheim (Germany) in 1992. Rieter thus became a full-range supplier and can now compete with the best in the field without any technological handicap.

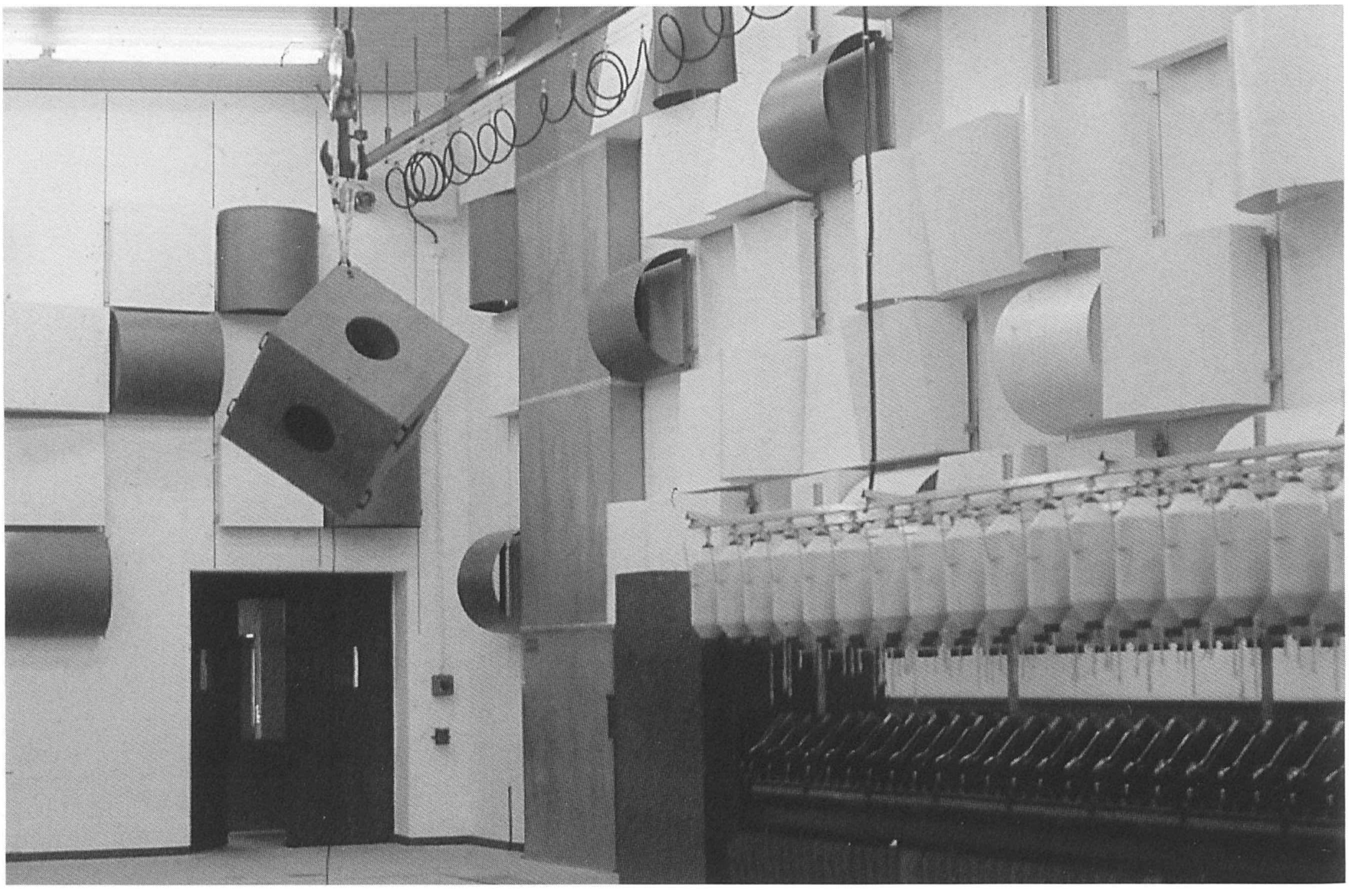
Outlook

Rieter became a full-range supplier in manmade fibre technology with the acquisitions of Scragg in 1982 and Automatik in 1992. As in the field of staple fibre technology, the company can thus offer filament technology and know-how advisory services.

In process development, an increase in working speeds from the current 5000 m/min. to 8000 m/min. and more is imminent.

In special filaments the requirements of aramids such as Kevlar and suchlike will have to be met in future. In classical manmade fibres, demands for very fine yarn counts for silky fabric effects will have to be satisfied.

In new, unconventional processes the strengths and weaknesses of bundle drawing processes, for example, must be studied and translated into what is industrially feasible. Last but not least, the shift in the market's focus to the Asian region must also be included in such calculations.



The acoustic laboratory at Niedertöss