27 September 1988
Dr. Fehrer's typically autocratic comments to the Textile Institute deriding the publication of the previous article THE YARN FORMATION IN FRICTION SPINNING

attributed to H.W. Krause, H.A. Soliman and H. Stalder

"....... I regret to have to note that Dr. Krause's statements concerning my DREF friction spinning machines are mostly untrue or incomplete."

".......Prof. Krause writes that the DREF friction spinning machines are principally used for the production of fancy yarns .... c) Only about 5% of the total DREF production is in the novelty yarn sector.

"Generally, Prof. Krause describes here, like in all other articles, the spinning process of the Platt-Masterspinner .... The fact that Prof. Krause wants to publish an article on the Masterspinner friction spinning process today, in September 1988, appears to me in light of the facts almost grotesque".

"Furthermore, Prof. Krause does not seem to know that Messrs. Schöller, Germany, who was the first spinning mill to have a Platt production machine installed, has stopped the production with this machine."

Obviously, Prof-Krause has not yet found it worth reading my article "An analysis of friction spinning" .... where I give the reasons, understandable also for the non-expert, why the Masterspinner friction spinning process can never work properly in practice".

Belroy's Judgement

The Austrian Dr. Fehrer couldn't get
his two perforated friction spinning technology
to produce commercially acceptable short staple yarns.

Nor could his German licensees Schlafhorst and Suessen.

They conveniently ignored that with the British MasterSpinner's
single perforated friction spinning technology Schoeller Textil
did produce commercially acceptable short staple yarns.

No publicity as to why Schoeller stopped production,
nor did the Austrian or German machine-builders ask the question!

Better to make the *'ostrich-like-assumption'*
that there is an insurmountable technological weakness
in relation to the friction spinning of mass-market short staple yarns.

Our technology cannot do it
But OK
Neither can that of anyone else!

Rest in Peace - Friction Spinning
September 1988

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EINGELANGT
26. SEP. 1988
Erledigt: ......

Ref 49/88

15 September 1988

Dr E Fehrer
Textilmaschinenfabrik
Wegscheiderstrasse 15
A-4021 Linz
AUSTRIA

Dear Dr Fehrer

Dr Krause and two colleagues have offered a paper on Friction Spinning for publication in the Journal.

Knowing of your expertise in this area, your large number of patents and your connection with the Textile Institute, I wonder if I may invite you to act as referee.

If you are able to accept I should be grateful.

I enclose a copy of the paper and also of a referee form.

I look forward to hearing from you and in the meantime send my best wishes.

Yours sincerely

Robert Beech

S.R. Beech
Deputy Editor
Journal of the Textile Institute

cc: Miss H Cohen

DR. PHIL. DR. H.C. ERNST FEHRER
VORSTAND DER FEHRER AG

Dr.F/KT
27/09/1988

The Textile Institute

10 Blackfriars Street
Manchester, M3 5DR

U. K.

Att. Mr. S. R. Beech

Dear Mr. Beech:

Thank you very much for your letter of September 15. According to your wishes let me give you my personal comment in a frank and open manner on the article by Prof. Dr. Krause, a copy of which you sent me:

I know Prof. Krause for some time now as a writer of articles on friction spinning, but I regret to have to note that Dr. Krause's statements concerning my DREF friction spinning machines are mostly untrue or incomplete. My Dr. Fuchs has tried already several times in discussions as well as in writing to convince Dr. Krause that his statements are not correct, but obviously without success.

Let me now give you in concrete terms my comments on Prof. Krause's statements:

1) On page 1 Prof. Krause writes that the DREF friction spinning machines - apparently DREF 2 and DREF 3 - are principally used for the production of fancy yarns in the coarse count range.
This is obviously an intentionally misleading and wrong remark:
   a) True is that about 70 % of the DREF 2 machines sold up to now, worth approx. 100 million dollars, are used for the production of yarns in a count range of 0.5 - 5.0 for blankets, upholstery fabrics, curtains, cleaning rags from waste fibers that cannot be processed with any other spinning system.

./.

b) About 25 % of the DREF 2 spinning machines sold up to now produce yarns, mostly with a multicomponent structure, from aramid fibers, i.e. Kevlar or Nomex, with carbon fiber blends and glas filaments.

These yarns are used as fire blockers in the aviation and aerospace industries as well as for the production of clutch and brake linings. In the meantime it has been shown that the best abrasion values can be achieved with DREF yarns, compared to all other production methods.

c) Only about 5 % of the total DREF production is in the novelty yarns sector.

2) The friction spinning machine DREF 3 is a highly specialized machine only for the production of technical yarns with a multicomonent structure.

3) I won't go into greater detail with regard to Prof. Krause's lengthy mathematical representations. But I do miss fundamental considerations on "probability", which must be of special importance in the emission of fibers into the spinning nip, if expressive and realistic results shall be obtained.

4) Generally, Prof. Krause describes here, like in all other articles, the spinning process of the Platt-Masterspinner, see fig. 6.

Obviously, Prof. Krause has not yet found it worth reading my article "An analysis of friction spinning" published in TEXTILPRAXIS INTERNATIONAL 1986/10, where I give the reasons, understandable also for the non-expert, w h y the Masterspinner friction spinning process can never work properly in practice.

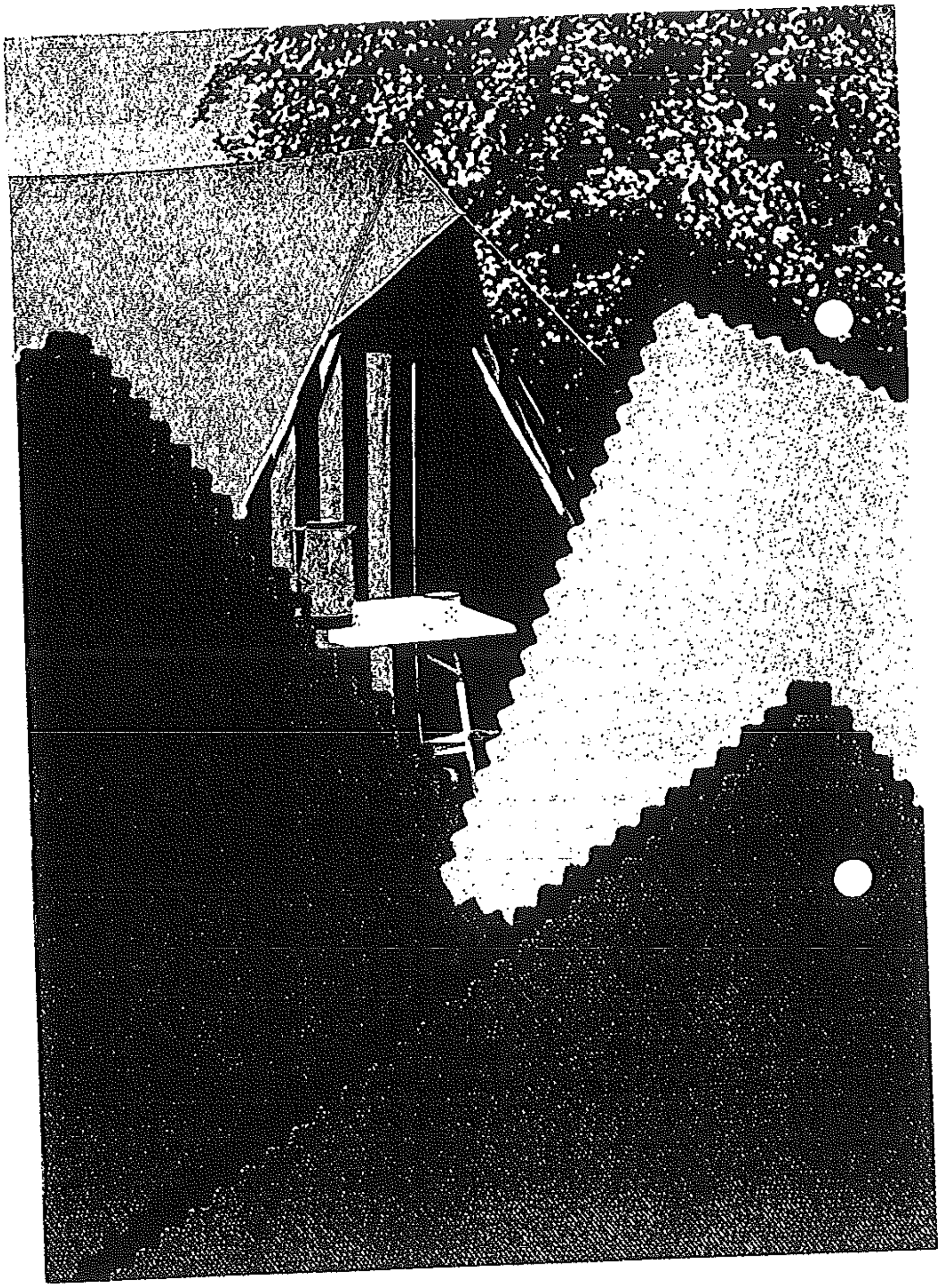
./.

The fact that Prof. Krause wants to publish an article on the Masterspinner friction spinning process today, in September 1988, appears to me in the light of the facts almost grotesque:
Obviously, Prof. Krause does not know that the only company who has worked with Masterspinner machines on a large scale, Messrs. Henderson, USA, has given up the production with these machines due to considerable problems and as far as I know there are legal proceedings between Messrs. Henderson and Messrs. Platt.
Furthermore, Prof. Krause does not seem to know that Messrs. Schöller, Germany, who was the first spinning mill to have a Platt production machine installed, has stopped the production with this machine.

To conclude with let me ask you to take my above statements as purely personal and confidential. Officially, I refuse to give any comment on the article of Prof. Krause due to the confidential aspects described above.

Sincerely,

Dr. E. Fehrer



DREF 3 - HIGH - TENACITY CORE YARNS FOR CANVAS FABRICS FOR MILITARY TENTS, TARPAULINS ETC.

1X WEFT
2X WARP.
(12/88).

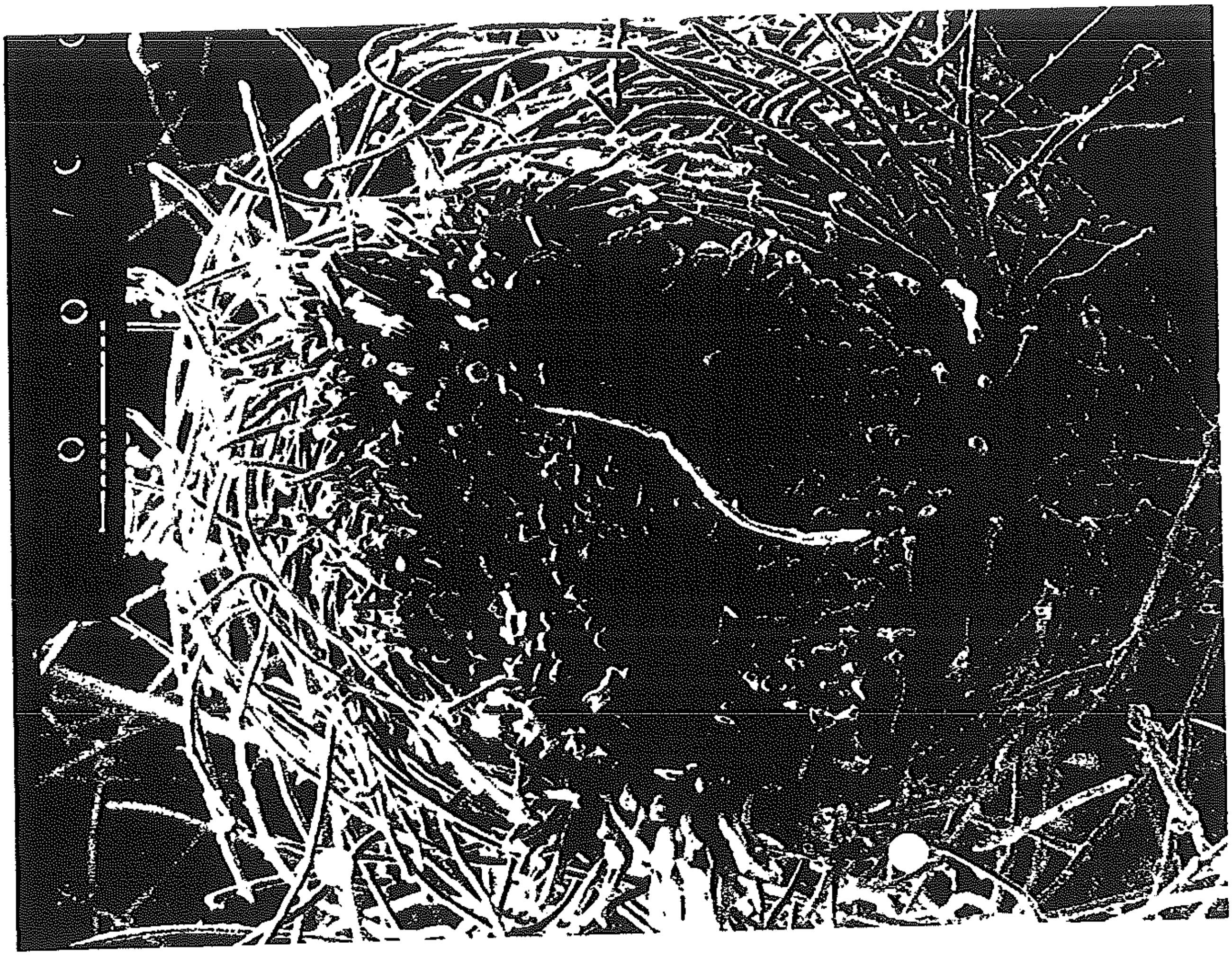
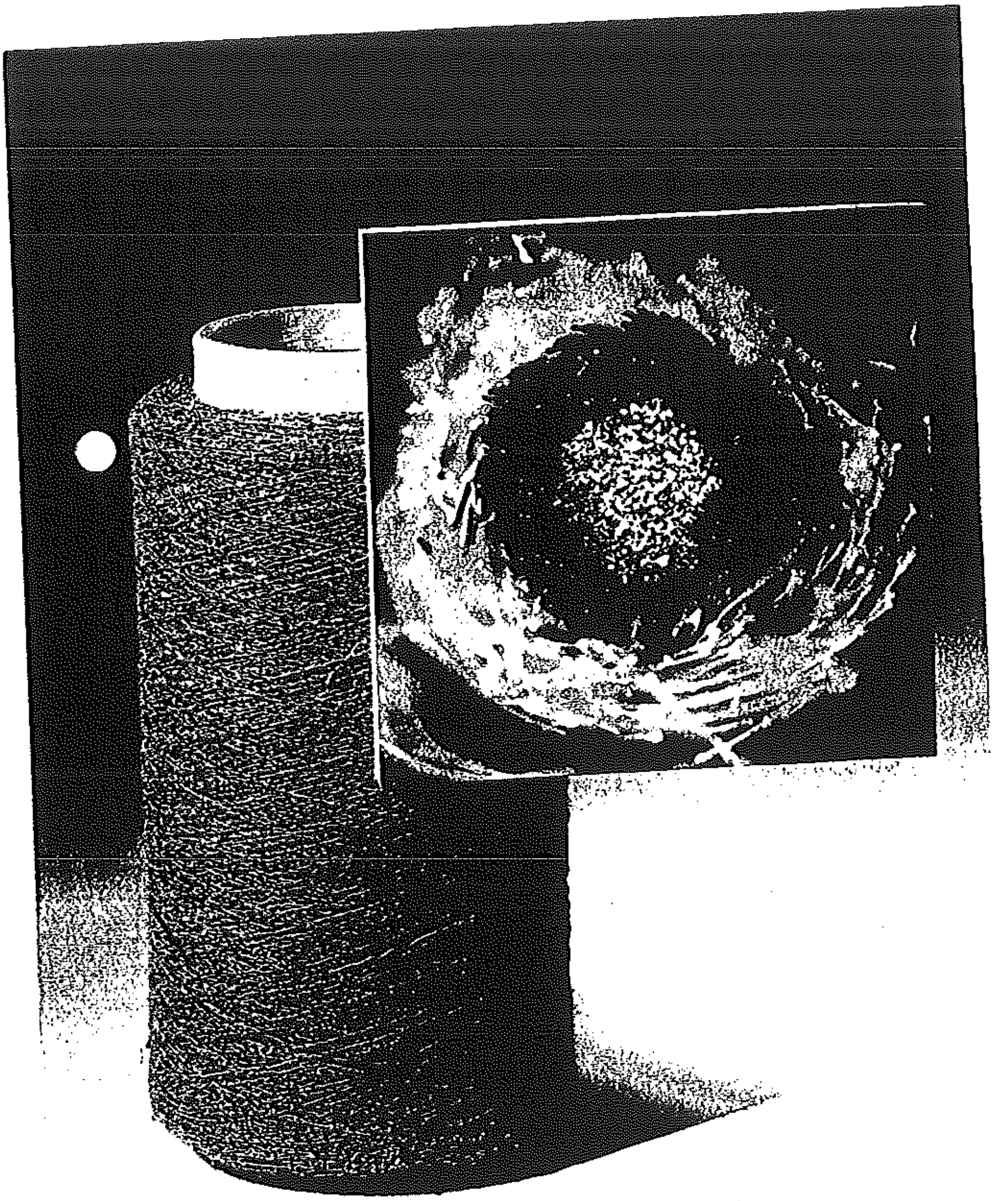


PHOTO OF A DREF 3
TWO COMPONENT YARN

2:



DREF 3 - MULTICOMPONENT YARN FOR FIRE BLOCKERS FOR THE AIRCRAFT INDUSTRY (8/88).

Eine Analyse des Friktionsspinnens

An analysis of friction spinning

Dr. phil. Dr. techn. h.c. Ernst Fehrer

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An analysis of friction spinning

Dr. phil. Dr. techn. h.c. Ernst Fehrer

In the July 86 edition of the German "tpi" magazine an article about "Experiences with Friction Spinning" was published. This article was of particular interest to me, as its author – Mr. Leopold Schoeller – recognized me as the originator of this new spinning technology, writing, "After Dr. Fehrer having pushed open the door to this new technology . . . ".
In his introduction, Mr. Schoeller writes that "the coarse yarn range is covered by DREF technology", but as his company is working in the fine yarn range, he exclusively reports on his experiences with the Platt friction spinning machine, which, however, "can still be improved" and furthermore belongs to the first generation.
In order to put matters straight, I would like to emphasize that 7 years *before* the Platt machine was presented at the ITMA in Milan, the FEHRER "DREF 2" had been introduced as the world's *first friction* spinning machine in *practical operation*. Today, as a fully-developed machine in its third generation, it widely covers the coarse yarn range and at present over 1000 machines (with 6 spinning heads each) are producing more than 200,000 tons of coarse yarn annually in some 50 countries.
Another FEHRER product – the DREF 3 friction spinning machine – for the manufacture of technical yarns has been in continuous production since 1983, although the huge fields of application for technical multi-component yarns have only recently been recognized by the potential market (see also tpi report, July 86 edition, about the "Techtextil" in Frankfurt/Main, June 86).
Mr. Schoeller writes that "physics still offers enormous increases in friction spinning". This statement is only partly true, as the **"Friction Spinning Unit"** is hardly able to "permit enormous increases as far as physics is concerned". In any case, from the days of my principal patent applications from 1973 – 76 up to the present, no new solutions for "a functioning friction spinning unit" have appeared and there are no signs of anything new on the horizon.
In the coming years, the **"Fibre Feeding Unit"** may be improved – for the fine yarn range – and more versatile and flexible solutions than those currently offered by the Platt friction spinner may be found. For DREF 2 and DREF 3 however, the problems of the fibre feed were already completely solved years ago (see also chapter "Fibre Feeding Unit").
In order to explain the above-mentioned in greater detail, allow me to consider the topics "Friction Spinning Unit" and "Fibre Feeding Unit" more closely:

The "Friction Spinning Unit"

works according to the known principle of twisting a fibre assembly, which is fed into the nip of two spinning drums, whereby these rotating bodies are rotating in the same sense, to form a yarn. The resulting "twist potential", however, does *not* correspond to the ratio of yarn diameter to drum diameter, as about 60 % of it is lost through slippage (where the torque is not effective), a loss which is system-immanent. For the manufacture of a reproducible friction yarn a constant "twist potential" is essential. To achieve this, it is necessary that the frictional forces acting on the *two* contact areas (yarn/spinning drum) are equal.
These frictional forces are calculated – according to Coulomb's law of friction – by multiplying the normal forces which, due to *evacuation* act on the contact areas of the yarn, and the friction coefficients of the two spinning drum surfaces (see Fig. 1: Friction forces).
In order to obtain the same normal forces on the two contact areas yarn/spinning drum, the spinning nip must be *evacuated from both sides*.
In this connection it must be taken into consideration that only 3 alternatives exist for evacuation in the nip zone of the two spinning drums:

a) Evacuation of *both* spinning drums in the nip zone.
b) Evacuation of *one* spinning drum in the nip zone, the evacuated drum being the one rotating *out* of the spinning nip.
c) Evacuation of *one* spinning drum in the nip zone, the evacuated drum being the one rotating *into* the spinning nip.

The alternatives a) and b) are covered by Dr. Ernst Fehrer patents till the mid-90's and may only be utilized by Fehrer and its licensees Schlafhorst and Suessen.
The third alternative (c) refers to the Platt spinning system described by Mr. Schoeller.
The above survey is especially interesting because it is well known that all important manufacturers of rotor spinning machines are making intensive efforts to develop friction spinning machines.
In his report, Mr. Schoeller points out that when spinning carded cotton Nm 30 on his Platt machine, breaking lengths of 8.7 cN/tex can be achieved. Mainly because of the considerably better twist potential of the DREF 5 (a joint Schlafhorst, Suessen and Fehrer development), breaking lengths of 10 – 11 cN/tex can already be achieved, when running exactly the same yarn constructions in Nm 30. The DREF 5 also reaches tenacities ranging in the upper half of the above-mentioned value for Nm 60 yarns.

The evacuation from both sides is also essential for another reason. Namely, the diameter of a yarn of medium count is about 200 microns and the fibre duct used in open-end friction spinning for the feeding of the individual fibres must have an opening width of at least 3 mm to guarantee trouble-free fibre transport. When evacuating the spinning zone from both sides, the resultant of the two air flow components is exactly vertical to the nip, so that the fibres guided into the spinning nip are immediately integrated into the yarn forming process. When only one drum is evacuated – especially if this is **not** the one rotating *out* of the nip – it cannot be avoided that some fibres, which could not be integrated, are transported out of the nip zone again. This is exactly the cause of the problems described in the Schoeller article, "Especially when spinning cotton, fly lint and dust particles, which are not integrated into the yarn, accumulate just where you need them least".

Furthermore, the friction coefficients of the two spinning drums must show equal values. If not, due to the slippage between the yarn and the spinning drums – immanent in the system – the drum surfaces would be subject to considerable wear – especially when processing aggressive fibres. As a result, the friction coefficients and consequently the yarn parameters would change in the course of time.
Therefore, it is absolutely essential that the drum surfaces are resistant to wear, e.g. by using plasma coatings.
In addition, the peak-to-valley heights of the spinning drum surfaces must be kept constant and the perforations have to be exactly geometrical and without any burrs. Naturally, these conditions set high standards for the manufacture of the spinning drums – the "heart of the friction spinning technology" – if we take into account that the peak-to-valley height should be less than 1/4 of the diameter of the individual fibres, i.e. max. 5 microns (this peak-to-valley height is of course only valid for fine yarn spinning machines).
This value is calculated as the optimum relation between the smallest possible form closure component and the largest possible adhesion component.

In order to guarantee a maximally tension-free yarn delivery – in axial direction – it is also necessary to set the speed of the drum rotating out of the nip by a few percent higher than the speed of the drum rotating into the nip. This avoids squeezing of the yarn in the nip, e.g. due to the increased axial wedge forces caused by thick places. This finding was already applied in the design of the first

DREF 2 machines, i.e. in 1976, so that patent applications from third parties after this date are of no avail.
At this point, I think it necessary to say a few words about the form of the spinning drums.
It is of minor importance whether the spinning drums are cylindrical or conical, or a combination of cylinder/disc. Among others, all these alternatives had already been invented and tested by the FEHRER company, and protected by patents in 1975. Therefore, later patent applications by other parties are also useless in this case.

The "Fibre Feeding Unit"

The present state-of-the-art offers 3 alternatives for transporting the fibres into the spinning nip:

a) Patents from the 1960's from Messrs. TMM Research Ltd. and the Cotton Silk and Man-Made Fibres Research Association show a friction system where a coherent fibre web is transported to an evacuated, perforated surface, twisted between this surface and a solid, i.e. not evacuated retaining roller, and delivered as a yarn at right angles to said direction.
This method offers neither a satisfactory stability of the yarn forming process, nor is it possible to produce an applicable yarn by "rolling up" a coherent fibre web. I mention this process only for the sake of completeness. – Therefore, the various patent applications made only recently, in which the fibres are fed in the form of a coherent fibre web, can already be regarded as obsolete (Fig. 2: Friction spinning principle).
b) The best-known fibre feeding method at present is the feeding of individual fibres via a closed or partly open fibre duct into the nip zone of the two spinning drums according to the open-end principle. As it is known, the DREF 2, DREF 5 and the Platt spinner use this system. It is obvious that in its functional principle, this feeding method was taken from the OE rotor spinning machine (Fig. 3: Fibre feed).
Now allow me to explain the problems I have encountered with this fibre feeding method.
In a rotor spinning machine, the individual fibres coming from an opening unit and fed via a fibre duct are *accelerated* by about five times their approach speed when joining the fibre assembly in the groove of the rotor.
However, in friction spinning the approaching fibres are *slowed down* when joining the fibre assembly in the nip zone by about the same amount. This means that in "rotor spinning" the fibres are drafted when joining the fibre assembly and in "friction spinning" the fibres are compressed.
It is, however, false to conclude that this compressing of the fibres is the only reason for the lower tenacities of friction-spun yarns compared to rotor-spun yarns. Above all, these lower values result from the formation of *"weak zones"* in the yarn, due to the following reasons.
As mentioned above, the OE-feeding method is practically the same for rotor and friction spinning (only the fibre ducts are dissimilar – because of the completely different design of the spinning units). An opening unit consisting of a feed pedal and a high-speed beater causes the fibres to be delivered from this unit in periods of about 10^{-2} sec in *irregular* quantities.
This irregular fibre delivery in the above-mentioned periods does not matter in rotor spinning, as due to the higher circumferential speed of the rotor – compared to the speed of the approaching fibres – a considerable doubling effect is achieved. As the speed relations are inverse in friction spinning, i.e. the approaching speed of the individual fibres is higher than the outlet speed of the yarn, the irregular fibre feed in periods of 10^{-2} sec. becomes noticeable. In this context it has to be taken into account that the average remaining time of the fed fibres within the yarn formation zone is also about 10^{-2} sec.
In addition, another problem arises, viz. it is not determinable in which spot within the provided yarn formation zone the individual fibre – coming from the opening unit – is really situated, i.e. definitely integrated into the yarn. These two factors are responsible for weak zones in the friction-spun yarn of approx. 3 – 10 mm – in regular intervals of 1/2 to 1 m – in which the number of fibres in the cross-section of the yarn is lower than it should be according to the yarn count.
The diagram in fig. 4 shows the Gaussian curve of a ring-spun yarn and of a rotor-spun yarn. Next to them is the Gaussian curve of a friction-spun yarn. The reduced mean value of the measured tenacities compared to ring-spun and rotor-spun yarns is due to the "compressing effect" (dotted). The left-hand curve (hatched) to the weak zones described above.
In this context, I would also like to comment on Schoeller's statements concerning yarn breakages:
It would be a confusion of cause and effect, if one assumed that the friction-spun yarn showed less yarn breakages compared to the ring-spun or rotor-spun yarn, because it is "stronger". The fact that friction-spun yarns run through the friction spinning machine without difficulty, i.e. with less yarn breakages, is entirely due to the friction spinning system itself working without tension, i.e. without tensile stress or torsional strain. In particular, a shearing off of the yarn, caused by torsional strains, which can occur in ring spinning and rotor spinning, is hardly possible in friction spinning, because there is only a limited torque for twisting the fibre assembly to form a yarn.
c) A third alternative for feeding the fibres into the friction spinning unit has been put into practice in the DREF 3 machine.
A drawn sliver coming from a drafting unit and fed in an axial direction is twisted in the nip zone of the two spinning drums. This twist is then fixed by individual fibres coming from a second drafting unit (Fig. 5: Axionometric view of DREF 3).
Contrary to current opinion, when the core of the yarn is evenly and completely covered by the "sheath fibres" coming from the second drafting unit, a minor degree of twist *actually* remains in the core sliver. This phenomenon is explained by the fact that the frictional forces of the core and sheath fibres joining in the yarn assembly can be stronger than the frictional forces between the yarn and the spinning drum surfaces. Thus, according to the principle of least resistance, a certain twist remains in the yarn. However, a precondition is that the sheath fibres are fed regularly and at a steeper angle to the yarn axis than the core fibres.
An even and perfect covering of the core sliver with sheath fibres is only possible by means of an entirely new feeding unit, which – incidentally – is fully covered by world-wide Dr. Fehrer patents. By the simultaneous feeding of *five* slivers, a regular emission of fibres is obtained – also when taking into consideration the periods of approx. 10^{-2} sec. In addition, by feeding these five slivers *at right angles* to the yarn axis, a good doubling effect is achieved.

Furthermore, it should be noted that the DREF 2 machine achieves the same good doubling effect by the vertical feeding of the slivers.
As on average the sheath fibres account for 30 % of the total fibre percentage in the yarn and 5 slivers are fed simultaneously, these 5 slivers are transported at a very low speed into the opening unit.
A conventional opening unit consisting of a feed pedal and a high-speed beater, however, would cause insoluble problems at this low inlet speed with regard to fibre shortenings, electrostatic charge, splitting of the individual fibres and the resulting accumulation of dust. This problem was solved by the above-mentioned, newly developed feeding system in the drafting unit II. It comprises the use of *two*, instead of one, high-speed carding drums. The distance between the clamping line/last pair of inlet rollers and the line of the narrowest distance between the two carding drums being approx. one fibre length. Thus, the individual fibres are released from the clamping line of the last pair of inlet rollers in that moment when they are grabbed by the teeth of the carding drums, so that practically no carding or combing effect with the described problems can occur.
In order to be able to process not only conventional synthetic fibres of about 40 mm but also fibres with 50 or 60 mm, the inlet rollers have been so designed, that the clamping distance can be changed from 40 to 50 and up to 60 mm by simply moving apart one of the inlet rollers, so that their distance to both carding drums is changed.
The completely straight and parallel position of the fibres in the core, the surface friction between which can still be increased by binding with sheath fibres, is the precondition for the fact that DREF 3 yarns can show *higher* tenacities than ring-spun yarns (Fig. 6: Fibre feed DREF 3).

In closing the "Fibre Feeding Unit" chapter, it must be said that at present it is entirely open, whether in the foreseeable future other, applicable solutions will be found for the feeding of fibres.

Summary

The aim of the above report is to give a generally understood description of all technological and physical parameters related to friction spinning. I would ask the reader to understand that for reasons of potential competition I was unable to go into greater detail concerning the various problems and the knowledge I have obtained during their solution.

A further reason for my writing this article was to make the patent situation clearer, as it is a constant source of frustration both to me and my engineers to see how inventions and technological developments produced here in Linz are "revived" by others years later as "new patent applications". Incidentally, the first attempts to bring down the principal patents for the DREF spinning system were dismissed in two trials before the German Patent Court (last instance) in the years 1981 and 1984.

The fact, that today *all* manufacturers of rotor machines – with a considerable engineering potential – are intensively involved in the development of their own friction spinning machines, clearly shows the direction of spinning technology for the future.

TEXTILMASCHINENFABRIK DR. ERNST FEHRER AG

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