Metallic Wire for High-Speed and High-Production Cotton Card

Part 7: High-Speed Carding at Light Sliver Weight

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— Abstract —

High-speed carding at light sliver weight is investigated by changing the sliver weights and the delivery speeds with maintaining the sliver production rate at a constant value.

Results

(1) The transfer ratio of fibres from the cylinder to the doffer increased as the cylinder speed was increased and the sliver weight was decreased. In this case, the fibre density on the cylinder surface decreased.

(2) The number of neps in the slivers decreased as the sliver weight was decreased. This is due to the reduction in the fibre density on the cylinder surface.

(3) No significant differences were found in the fibre lengths of the slivers and also in the short fibre contents in the slivers even when the sliver weight was changed. The fibre length and the short fibre contents were preferably much influenced by the cylinder speed.

(4) The fibre orientation of the slivers in the leading direction did not change when the sliver weight was decreased. However, the fibre orientation in the trailing direction was improved by decreasing the sliver weight and increasing the cylinder speed.

(5) The sliver irregularity did not change by decreasing the sliver weight and increasing the delivery speed of sliver while maintaining the sliver production rate at a constant value.

(This will be contributed to the use of a web gathering apparatus).

1. Introduction

For high-speed and high-production carding by using a flat card, the following two methods are suggested from the viewpoint of a production rate of slivers which is related to the sliver weight and the delivery speed respectively.

According to one method, slivers are produced at heavy sliver weight, not at increased delivery speed. On the contrary, by the other method, slivers are produced at light sliver weight and at high delivery speed.

Generally, the latter method where slivers are produced at light sliver weight and at high delivery speed has been more preferred for high-production carding by the flat card.

In this study, carding test was conducted, where the sliver weight and the delivery speed were varied so as to keep the sliver production rate at a constant value, and the qualities of slivers were examined.

2. Test Conditions

2-1 Carding Conditions

Table 1 tabulates the production rate, the sliver weight and the delivery speed. In this experiment, the sliver weights were set on 375 grains /6yd, 450 grains /6yd, and 590 grains /6yd, and the maximum delivery speed on 223 m/min.

Note-1 The tension draft ratio was 1.68.

Note-2 A web gathering apparatus was used.

2-2 Metallic Wire and Top Card Clothing used for the Test

The specifications of the Metallic Wire used are listed in Table 2.

Specification name of Metallic Wire

for cylinder	MC461
for doffer	DU39-0
for taker-in	TC45KH

The top card clothing used was a F-450N type.

Table 1 Carding condition

Surface speed (rpm) Speed (m/s)			Top Speed	Delivery speed	Sliver weight (grains/6yd)		
Cylinder	Doffer	Taker-in	(m/min)	(m/min)	375	450	590
300 (20.3)	18 (0.66)	792 (10.2)	104	65	—	—	60
	23 (0.84)			82	—	60	—
	29 (1.06)			103	60	—	—
450 (30.4)	27 (0.98)	1,187 (15.2)	156	97	—	—	90
	35 (1.28)			125	—	90	—
	43 (1.58)			154	90	—	—
650 (43.9)	39 (1.42)	1,715 (22.0)	226	140	—	—	130
	51 (1.87)			183	—	130	—
	62 (2.27)			223	130	—	—

※ Values in the table show the production rate (lbs/hr)

2-3 Settings of Card

Fig. 2 illustrates main settings of the card on each portion.

2-4 Raw Cotton

In this experiment, 20's raw cotton was used.

Properties of Raw Cotton

Mean fibre length : 23.7mm

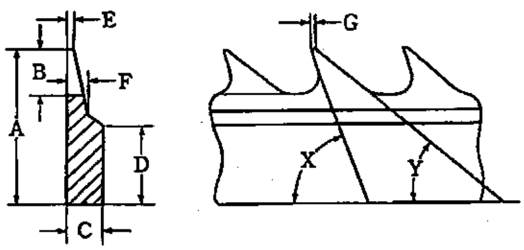

Fig. 1 Profiles of metallic wire

Short fibre contents : 29.5%
Micronaire : 4.18μg/in
Pressley strength : 87.6×10^3 lbs/in^2
Lap weight : 16.6 oz/yd
CV value
(lap weight variation) : 4.4%
Shirley Analysis
Lint contents : 97.3%
Trush contents : 1.6%

3. Testing Items

3-1 Transfer Ratio and Fibre Density
3-2 Number of Neps
3-3 Fibre Length
3-4 Fibre Orientaion
3-5 Sliver Irregularity
3-6 Relationship of Sliver Weight to Transfer Ratio and so forth

4. Test Results

4-1 Relationships between Transfer Ratio and Fibre Density

Fig. 3 shows the plots of the transfer ratio of fibres from the cylinder to the doffer and the fibre density on the cylinder surface against the cylinder speed.

In this experiment, the ratio of the cylinder to the doffer speeds was kept substantially constant for the respective sliver weight. The transfer ratio of fibres increased proportionally to the increases in the cylinder speed. The transfer ratio of fibres was improved as the sliver weight was decreased. The fibre densities, the weights of fibres positioned on a unit surface area of the cylinder, were calculated from the data of the transfer ratios of the fibres measured experimentally. As seen from Fig. 3, the fibre density decreased as the cylinder speed was increased, or as the sliver weight was decreased.

Table 2 Specifications of metallic wire

Dimensions / Roller and drums	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	X (degree)	Y (degree)	M (teeth /in)	P (points /in^2)
Cylinder	2.8	0.5	0.63	2.15	0.08	0.3	0.05	68	40	16	645
Doffer	4.0	2.2	0.85	1.3	0.2	0.5	0.15	60	40	13	388
Taker-in	5.6	3.5	1.1	1.5	0.25	0.65	0.1	80	38	4.5	—

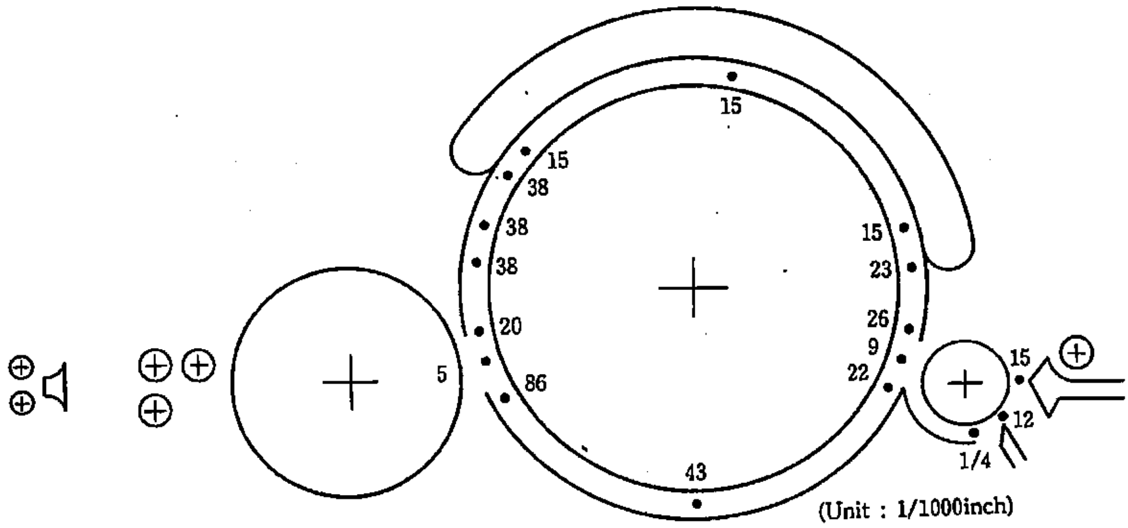

Fig. 2 Main settings

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
-·-■-·-	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

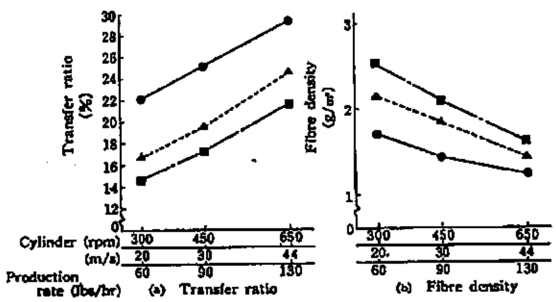

Fig. 3 Changes in the transfer ratio and the fibre density

4-2 Changes in Number of Neps

Fig. 4 shows the number of neps counted in the slivers for the different cylinder speeds. The number of neps decreased as the cylinder speed was increased for every sliver weight.

Fig. 4 (b) shows the relationship between the number of neps in the slivers and the sliver weight. The number of neps decreased as the sliver weight was decreased. The reason may lie in that the fibre density on the cylinder surface decreases with the decreases in the sliver weight, as seen from Fig. 3.

Conclusively, for high speed and high production, effectiveness of high-speed carding at light sliver weight has been recognized.

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
-·-■-·-	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

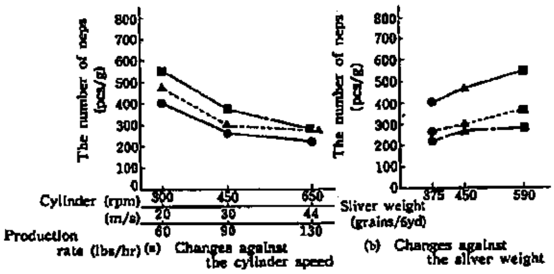

Fig. 4 Changes in the number of neps

4-3 Fibre Length in Sliver

Fig. 5 show the plots of the mean fibre length in the slivers and the short fibre contents in the slivers against the cylinder speed, respectively. As seen from Fig. 5, no apparent difference is found between the mean fibre lengths of the slivers measured at the respective sliver weights, but fibre breakage occurs increasingly as the cylinder speed is increased. As for the fibre length distribution shown in Fig. 6, The abovementioned tendency is observed.

Conclusively, the mean fibre length of the slivers and the short fibre contents, not considerably depending on the sliver weight, are relatively more influenced by the cylinder speed.

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
--■--	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

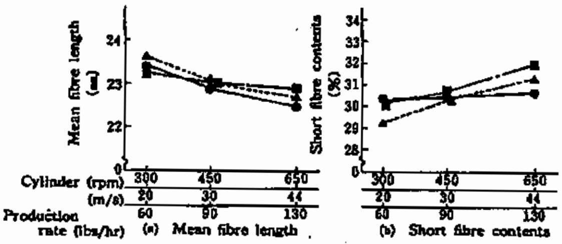

Fig. 5 Changes in the mean fibre length and the short fibre contents

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
--■--	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

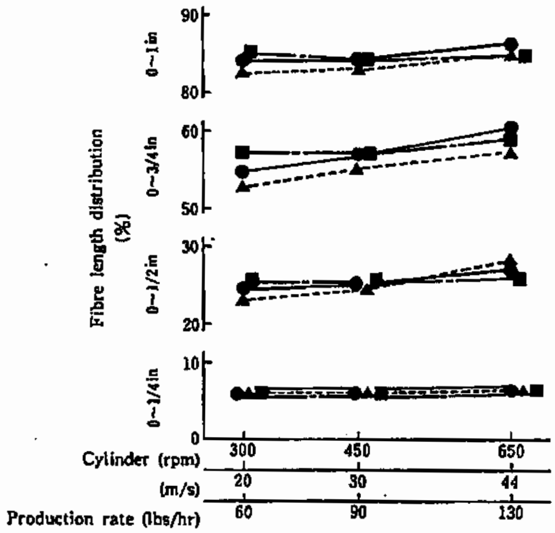

Fig. 6 Changes in the fibre length distribution

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
--■--	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

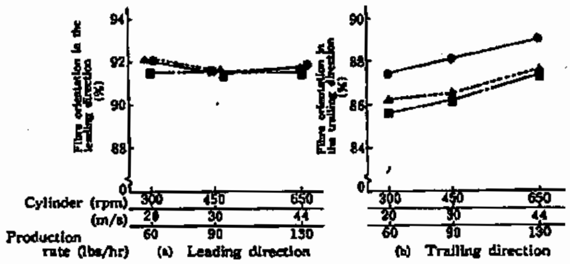

Fig. 7 Changes in the fibre orientation

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm)		
		300	450	650
—●—	375	29	43	62
---▲---	450	23	35	51
--■--	590	18	27	39

※ Numerical values in the table show the doffer speed (rpm).

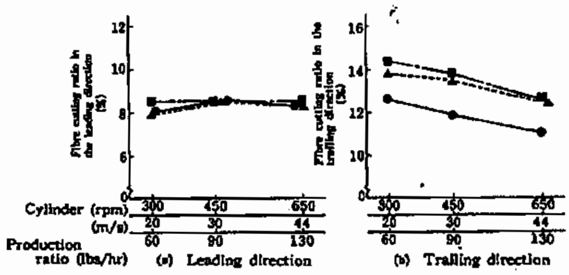

Fig. 8 Changes in the fibre cutting ratio

4-4 Changes in Fibre Orientations

Fig. 7 shows the plots of the fibre orientation of the slivers against the cylinder speed. The fibre orientation of the slivers in the leading direction was not considerably changed by the cylinder speed. On the contrary, the fibre orientation of the slivers in the trailing direction was improved, as the sliver weight was decreased, or as the the cylinder speed was increased.

Fig. 8 shows the plots of the fibre cutting ratio against the cylinder speed. The results suggests that the number of fibres hook-shaped in the slivers in trailing direction decreased with a lighter sliver weight and a higher cylinder speed.

Fig. 9 shows the relationship between the fibre density and the fibre orientation of the slivers. The fibre orientation of the slivers in the trailing direction, having a high correlation to the fibre density, was improved, as the fibre density on the cylinder surface was decreased. The fibre orientaion of the slivers in the leading direction had no significant correlation to the fibre density.

Figs. 10 and 11 show the relationships between the fibre orientation and the short fibre contents in the card slivers. The short fibre contents was taken as a means for quantifying the carding action on the card. The fibre orientation of the slivers in the trailing direction had a high correlation to the efficiency of the carding action.

In brief, by carding at the light sliver weight, the fibre density was relatively decreased, and the carding action was improved, resulting in an improvement in fibre orientation of the slivers.

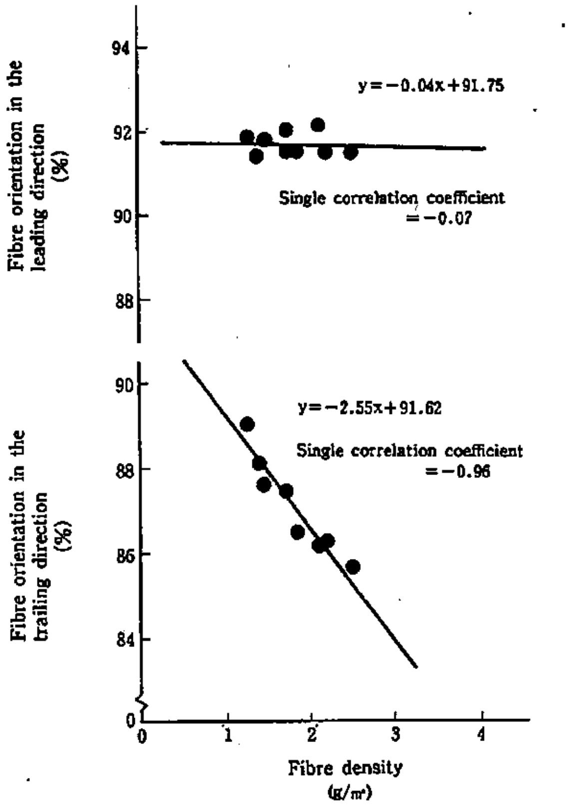

Fig. 9 Relationship between the fibre density and the fibre orientation

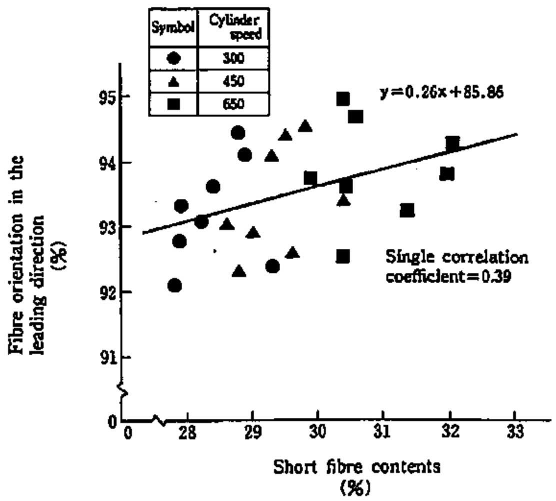

Fig. 10 Relationship between the fibre orientation and the fibre contents (Leading direction)

4-5 Changes in Sliver Irregularity

Fig. 12 shows the changes in the sliver irregulaity, which is substantially constant at the different sliver weights and delivery speeds.

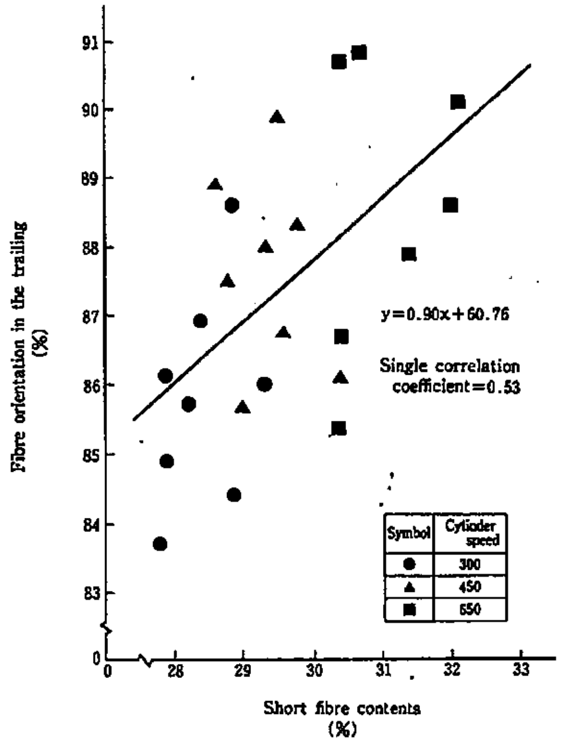

Fig. 11 Relationship between the fibre orientation and the short fibre contents

Symbol	Sliver weight (grains/6yd)	Cylinder speed (rpm) 300	450	650
—●—	375	29	43	62
—▲---	450	23	35	51
--■--	590	18	27	39

* Numerical values in the table show the doffer speed (rpm).

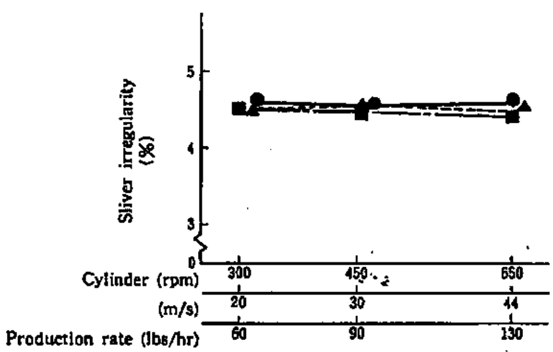

Fig. 12 Changes in the sliver irregularity

It should be noted that these results were obtained when a web gathering apparatus was used for the test. Without use of a web gathering apparatus, the sliver irregularity will be increased as the delivery speed is increased.

4-6 Relationship of Sliver Weight to Transfer Ratio and so forth

When the sliver weight is changed, the transfer ratio of fibres from the cylinder to the doffer and the irregularity percentage of the slivers will be varied. Further, they are influenced by specifications of metallic wire.
In this experiment, the relationships of the sliver weight to the transfer ratio of the fibres, the irregularity percentage of the slivers and so forth were examined under the constant conditions except for the sliver weight varied from 375 grains/6yd to 1000 grains/6yd.

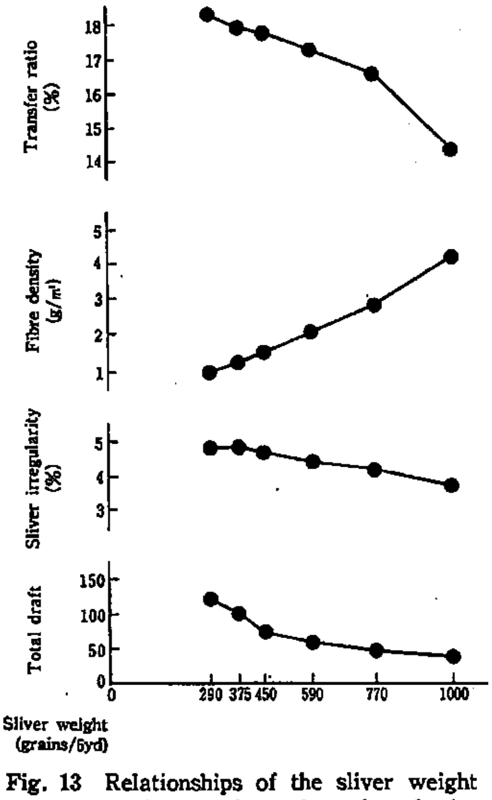

Fig. 13 Relationships of the sliver weight to the transfer ratio and so forth

Fig. 13 shows the test results. The transfer ratio of fibres from the cylinder to the doffer was decreased, as the sliver weight was increased. Particularly, when the sliver weight was 770 grains/6yd or higher, the transfer ratio was considerably decreased. with decreasing of the transfer ratio of the fibres, the density of the fibres accumlated on the cylinder surface was increased.

The sliver irregularity and the transfer ratio of fibres are influenced by specifications of metallic wire. For example, they can be controlled by selecting an appropriate depth of the teeth of metallic wire for a doffer.

5. Discussion

In our previous experiments, the carding were carried out at heavy sliver weight for the test. In this experiment, the carding test was conducted at different sliver weights and at various delivery speeds with the sliver production rate maintained at a constant value.

As understood from these results, by carding at the light sliver weight, the fibre density of the slivers was decreased, which led to the decrease of the number of neps in the slivers and the improvement in the fibre orientation.

On the other hand, no significant differences were found in the mean fibre lengths and also in the short fibre contents.

These results suggest that carding at the light sliver weight and at high delivery speed is effective for high speed and high production. However, when the carding are carried out at excessively high speed, the transfer ratio of the fibres from the cylinder to the doffer may become extremely high, which increases the sliver irregularity. Accordingly, considerations are required for specifications of metallic wire.