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

Part 3: Studies on Carding between the Cylinder and the Tops of Flat Card

This paper reproduces the 37th
lecture meeting of Textile Machinery Society of Japan held in 1984.

Kanai Juyo Kogyo Co., Ltd.

by Y. Ogita
K. Yagyu
T. Mituyoshi
S. Kanazawa

by J. Hosokawa
(Kyoto Institute of Technology)

— Abstract —

The carding action between the cylinder and the tops of the flat card is studied with the help of strain gauges while carding.

The carding action between the cylinder and the tops is examined by using the toothed mote knife and the conventional mote knife (without teeth) respectively and by changing the setting between the cylinder and the tops.

We investigated various relations between the carding action and the sliver quality from these test results.

Results

(1) The strain generating on the surface of foundation of the top card clothing i.e. the force working on the needle of the top card clothing is decreased in spite of the increase in the production rate when the cylinder speed is increased. This is probably because the fibre density on the cylinder is decreased according to the increase in transfer ratio of fibre from the cylinder to the doffer due to the high-speed of cylinder. The force working on the needle of the top card clothing is decreased according to the increase in the cylinder speed.

(2) The above tendency is intensified when a preliminary opening device such as the toothed mote knife is used.

(3) It can be expected to increase the production rate while maintaining the sliver quality under the normal conditions in high-speed carding in the mill, if preliminary opening devices, for example, more number of stationary flats on the taker-in side and the toothed mote knife are used pratically and efficiently.

1. Introduction

Effects and problems in high-speed and high-production carding were reported in previous papers [1] and [2].

We have recognized the great advantages through previous studies that the number of neps is reduced according to the increase in cylinder speed due to the decrease in fibre density on the cylinder in spite of high-production.

In a flat card, the carding action is made primarily between the cylinder and the tops, therefore, a study on carding action in high-speed and high-production carding is an important subject particularly for improving the sliver quality.

According to the studies done so far, a number of reports [3] have been published concerning the carding actions between the cylinder and the tops, but in most cases, the carding actions were not examined continuously while carding, practically they were judged by measuring the volume of flat strips deposited on each top card clothing.

In this study, the strain generating on the surface of foundation is measured with the help of strain gauges and the changes in the strain are examined along the path of the tops while cotton fibres are carded on the flat card.

We investigated relations between the carding action and the sliver quality from these test results.

In addition, carding tests were practiced with the toothed mote knife and the conventional one (without teeth) respectively, and with the changes

Table 1 Specifications of metallic wire

dimensions / drums and roller	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	X (degree)	Y (degree)	M(teeth /in)	P(points /in²)
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	—

in settings between the cylinder and the tops.

We compared the results of using the toothed mote knife with those of using the conventional one regarding the carding action and the sliver quality.

We studied the effect of the setting between the cylinder and the tops on the changes in sliver quality and carding action.

2. Test Conditions

2-1 Metallic wire and Top card clothing used for this test

Table 1 shows the specifications of the metallic wires for cylinder, doffer and taker-in used for testing.

Alphabets used in Table 1 indicate dimensions of each parts described in profile figures of the metallic wire in Fig. 1.

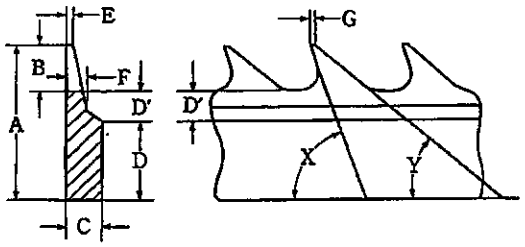

Fig. 1 Profiles of metallic wire

The cylinder wire used in this test has the depth of teeth (B) (=0.5mm) and the part of no teeth (D') (=A−B−D=0.15mm).

Other dimensions and angles are considered to be suitable for high-speed and high-production carding at present.

For doffer and taker-in wires, the standard specifications for cotton carding were used.

Specifications of the top card clothing are shown in Fig. 2.

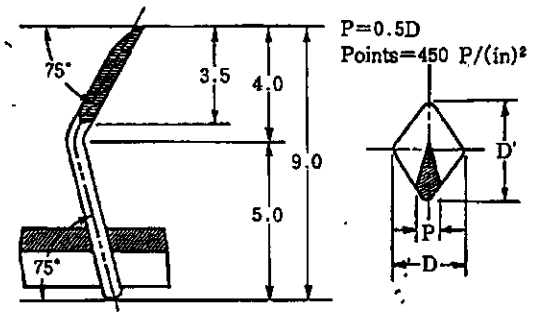

Fig. 2 Specifications of Top card clothing

As shown in Fig. 2, the total height is 9mm, working angle is 75°, point density is 450 points / (inch)² and the cross sectional view of wire is diamond shaped (F type).

2-2 Card used for this test

The specifications of the card used for this test are as follows.

The diameter of cylinder is 50 inch, that of doffer is 27 inch and the number of tops is 106 pieces. The width of the card is 40 inch. The type of card is a flat card for cotton.

2-3 Carding conditions

Table 2 shows the carding conditions for this

Table 2 Carding conditions

Speed (rpm) Surface speed (m/s)			Top speed	Sliver weight (grains /6yd)	Production rate (lbs/hr)
Cylinder	Doffer	taker-in	(m/min)		
300 (20.3)	18 (0.66)	792 (10.2)	104	590	60
450 (30.4)	27 (0.98)	1,187 (15.2)	156	〃	90
650 (43.9)	39 (1.42)	1,715 (22.0)	226	〃	130

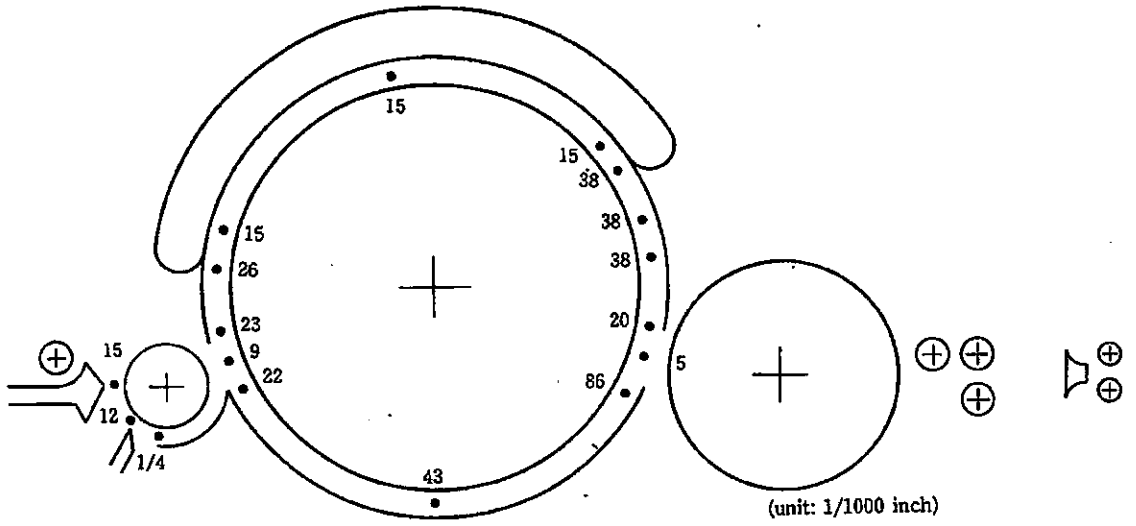

Fig. 3 Main Settings

test.

In this table, speeds for each drums and rollers are shown in the above column and the surface speeds in the parenthetical lower column.

The cylinder speed is increased while keeping the same surface speed ratio of each part of the card.

The cylinder speed is changed in the range from 300 rpm to 650 rpm and the maximum of surface speed is 44 m/s.

The speed of taker-in roller is 1,715 rpm at the cylinder speed of 650 rpm. The sliver weight is kept the same at 590 grains/6yd.

The maximum production rate is 130 lbs/hr (about 60 kg/hr).

2-4 Main Settings

Fig. 3 shows the settings of each part of the card.

In the primary test, the setting between the cylinder and the top is adopted at 15/1,000 inch as a standard. In additional test, the setting between those is adopted at 7/1,000 inch when the cylinder speed is 300 rpm, and at 13/1,000 inch and 10/1,000 inch respectively when the cylinder speed is 650 rpm in order to investigate the changes in the carding action.

The setting between the cylinder and the top under the normal carding conditions of high-speed card in the mill (for example, the cylinder speed is about 300 rpm) is normally set at 7/1,000 inch.

Therefore, we also carried out the experiment under the normal conditions in the mill and compared those results mentioned above.

When a toothed mote knife is equipped in the taker-in part in replace of the conventional mote knife (without teeth), the settings between the taker-in and the toothed mote knife are set at 12/1,000 inch at the inlet of the toothed mote knife and 32/1,000 inch at the outlet.

Details of test results concerning with the mote knife are to be reported.

3. The method to examine the carding action between the cylinder and tops

3-1 Measurement in the flat card

The strain on the surface of foundation measured is continiously with the help of strain gauges along the path of tops while carding.

Strain gauges are attached to the surface foundation with a pressure sensitive adhesive as shown in Fig. 4.

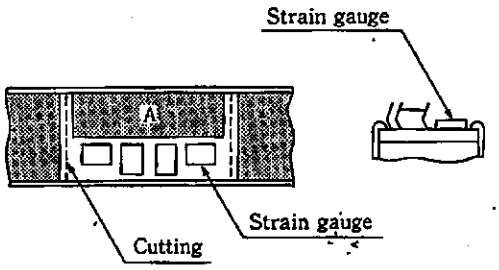

Fig. 4 How to attach strain gauges

At first, all needles of the top card clothing

where strain gauges are to be set are pulled out. The rectangular parts without smudging in Fig. 4 show the surface of top card clothing without needle. Locations of these parts are near the center of top card clothing.

Secondarily, the strain gauges are set carefully with the pressure sensitive adhesive.

3-2 The method to convert the strain on the surface of the foundation into force working on the needle

The strain on the surface of foundation is measured with the help of strain gauges while carding, but the force working on the needle while carding is not obtained directly in this test.

Therefore, we investigated the relationship between the strain on the surface of foundation and the force working on the needle by the following examination.

The method to examine the relationship between the strain and the force is shown in Fig. 5.

Regarding the strain measurement, we used strain gauges, the gauges box, the strain meter and the recorder in actual measurement.

We used a tensile tester to measure the strain on the surface of the foundation and the force working on the needle simultaneously in actual measurement as shown in Fig. 5.

It is assumed that all the fibre works evenly on each needle in the part A shown in Fig.4 while carding.

Based on this assumption, the force applied to each needle in the part A comes even by using the non-woven fabric as shown in Fig. 5.

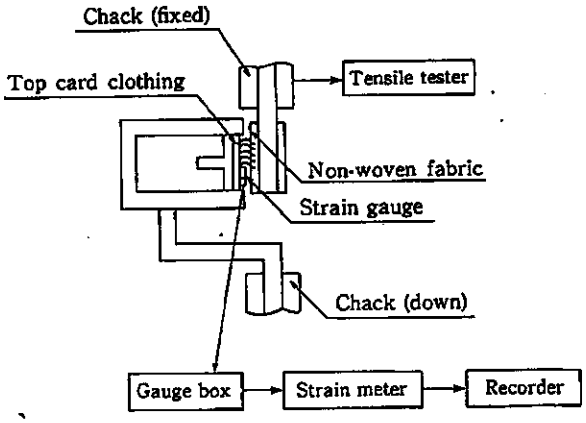

Fig. 5 The method to convert the strain on the surface of the foundation into the force

We compared these testing results with the results of actual strain measurement on the surface of foundation while carding. A trial to convert the strain on the surface of foundation to the force working on the needle is made by such a manner as mentioned above.

4. Test results

The results of strain measurement are as follows.

4-1 Carding action between the cylinder and the top

Fig. 6 shows the strains on the surface of foundation while carding at the cylinder speed of 650 rpm.

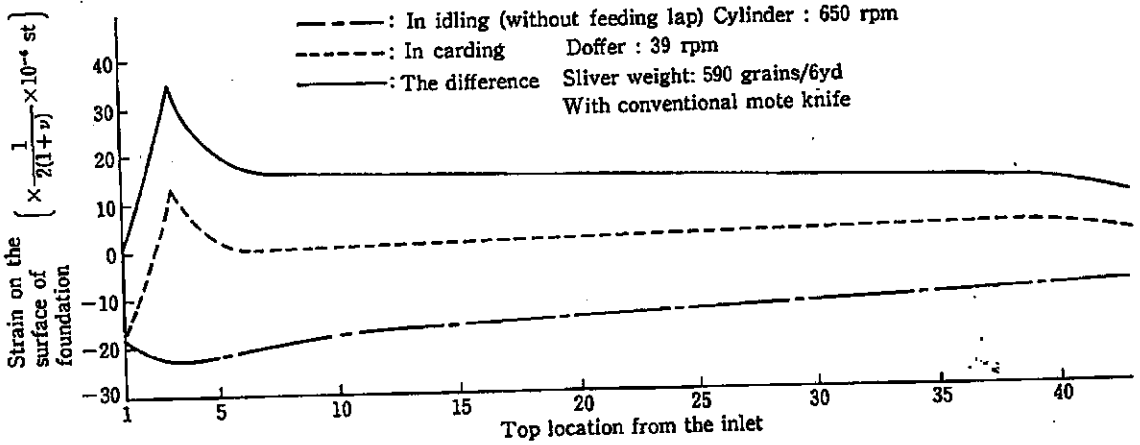

Fig. 6 Strain on the surface of foundation

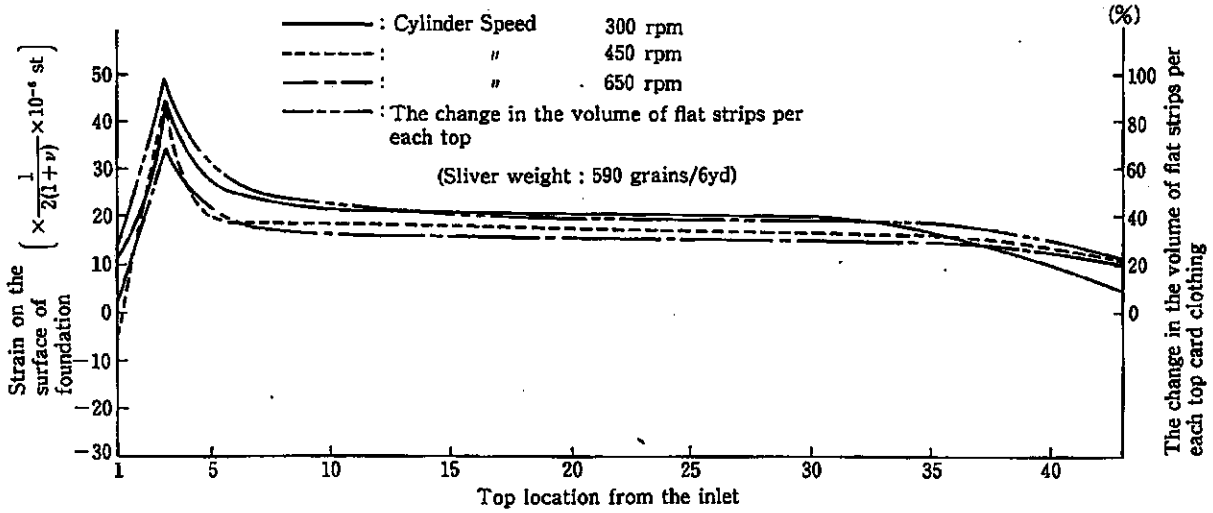

Fig. 7 Strain on the surface of foundation

In this test measurement, the strain on the surface of foundation is detected even when the cotton is not fed.

Therefore, this strain is deducted from the strain on the surface of foundation when the cotton is fed, and the difference between these strains is taken as a true strain on the surface of foundation.

The axis of abscissa in Fig. 6 shows top location. The number on the axis of abscissa indicates the number of top counted from the inlet along the path of top. The total number of tops contacted closely with the cylinder bend is 43 pieces.

And, ν in $1/\{2(1+\nu)\}\times10^{-6}$ indicated on the axis of ordinate in Fig. 6 shows Poissons's ratio of the rubber used on the surface of foundation.

Fig. 7 shows the results of measurement of the strain on the surface of foundation according to the changes in cylinder speeds when the conventional mote knife (without teeth) is equipped.

In this case, the strain generating on the surface of foundation is measured in the same way as shown in Fig. 6.

As shown in Fig. 7 the strain on the surface of foundation decreases as the cylinder speed increases.

The strain on the surface of foundation becomes maximum at the 3rd position from the top inlet along the flexible bend (where the slideway of top contacts completely with the flexible bend) and decreases or remain constant from the 7th or 8th position from the top inlet.

From those results, it is supposed that the top card clothing at the 7th or 8th position from the top inlet is fulfilled with the flat strips and the volume of flat strip per one top does not change thereafter.

Fig. 7 also shows the changes in the volume of flat strip per one top while carding. In this case, the maximum volume of flat strip is taken as a reference and other values are indicated in

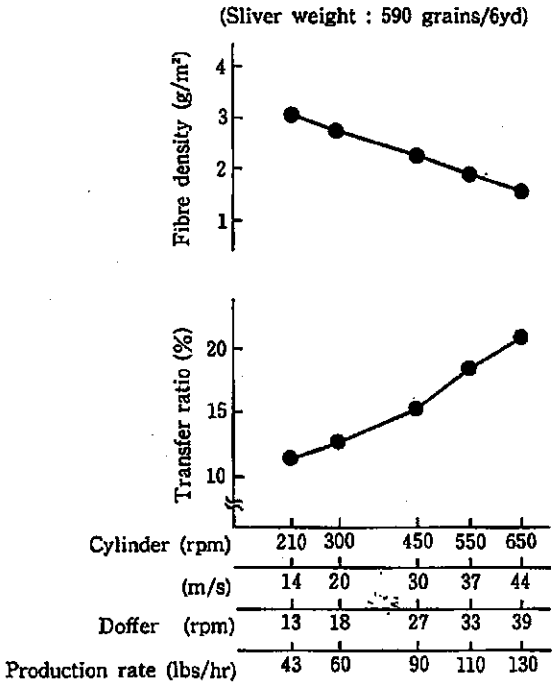

Fig. 8 Transfer ratio and fibre density

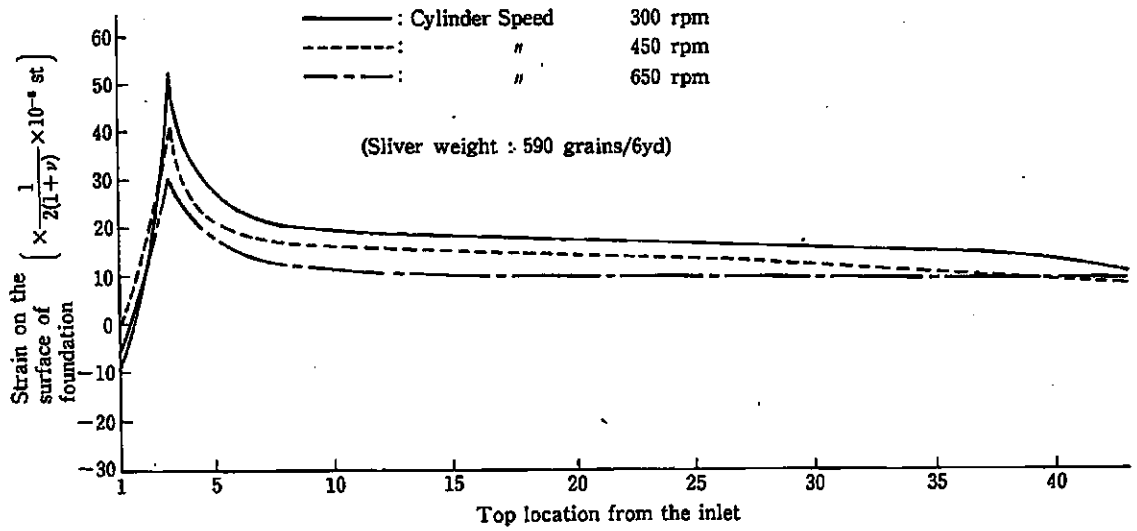

Fig. 9 The strain on the surface of foundation (with toothed mote knife)

ratio.

The changes in the volume of flat strips coincide well with the results of strain measurement on the surface of foundation as shown in Fig. 7.

The strain on the surface of foundation is decreased with the increase in cylinder speed.

It is considered that such phenomena have some relations with the fibre density on the cylinder.

Fig. 8 shows the changes in the transfer ratio from the cylinder to the doffer, and in the fibre density on the cylinder with the changes in the cylinder speed.

The fibre density on the cylinder is decreased with the increase in cylinder speed as shown in Fig. 8.

Furthermore, the strain on the surface of foundation is decreased with the increase in cylinder speed as shown in Fig. 7.

It is supposed from these results that the force working on the needle is decreased with the increase in cylinder speed. Therefore, the force working on the needle can be reduced by the decrease in fibre density on the cylinder.

Fig. 9 shows the changes in the strain on the surface of foundation when the toothed mote knife is equipped in place of the conventional mote knife (without teeth) in the taker-in part.

The changes in strain on the foundation with the toothed mote knife as shown in Fig. 9 coincide well the tendency with the conventional mote knife as shown in Fig. 7.

However, when two cases are compared at each cylinder speed, the strain on the foundation is reduced more with the toothed mote knife.

This is probably because the tufts fed from the taker-in to the cylinder are made finer by using the toothed mote knife.

We converted above results of the strain into the force working on the needle of the top with the help of strain gauges as shown in Fig. 5. The results are; at the 3rd position from the top inlet where the strain on the surface of foundation reaches the maximum while carding, the force of 450 to 500 grams works on 45mm×13mm area i. e. the force of 1.1 to 1.2 grams works on one needle.

After the 7th or 8th position of tops from the inlet, the force applied to each wire is 0.3 to 0.7 grams.

4-2 Influences of setting between the cylinder and the top on the carding action

High-speed carding is required to set slightly wider to prevent the contact of the needle of top with the metallic wire of the cylinder due to the expansion of cylinder drum at the high-speed.

As is commonly known, however, it is more effective to adopt the closer setting for the carding action.

Consequently, we investigated the extent of changes in the strain on the surface of foundation and in the sliver quality according to the changes in setting between the cylinder and the top.

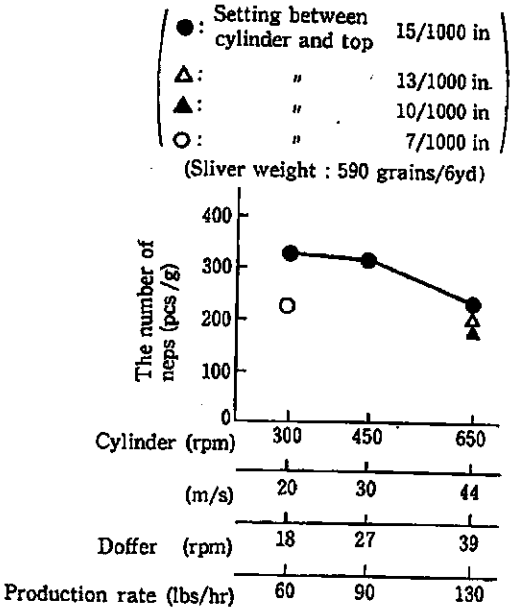

Fig. 10 Neps in the sliver

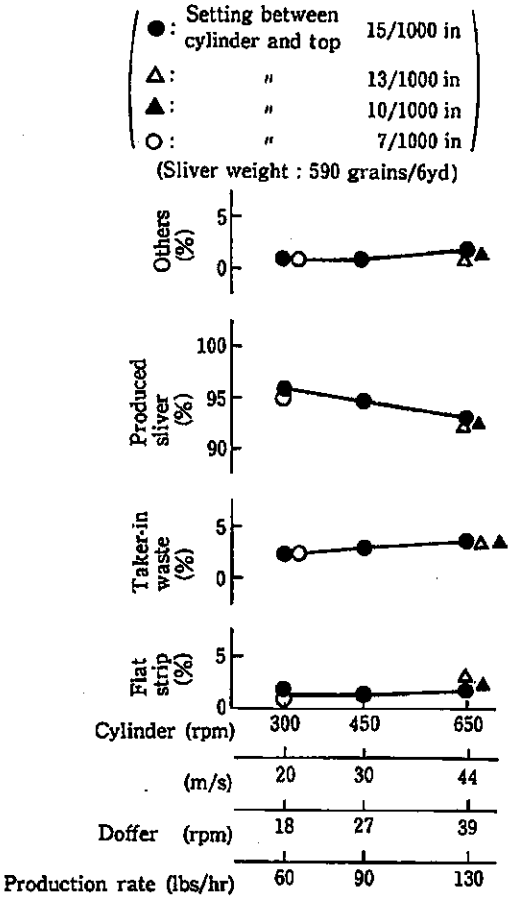

Fig. 11 Yield rate of carding procucts

The method for measuring the strain on the surface of foundation is the same as the method shown in Fig. 4.

i) Number of neps in the sliver

Fig. 10 shows the changes in the number of neps in the sliver according to the changes in setting between the cylinder and the top.

The number of neps in the sliver is decreased remarkably at the cylinder speed of 650 rpm as a result of the closer setting between the cylinder and the top.

Compared with the results under the normal carding conditions of the high-speed card in the mill (the cylinder speed is 300 rpm, the setting between the cylinder and the doffer is 7/1,000

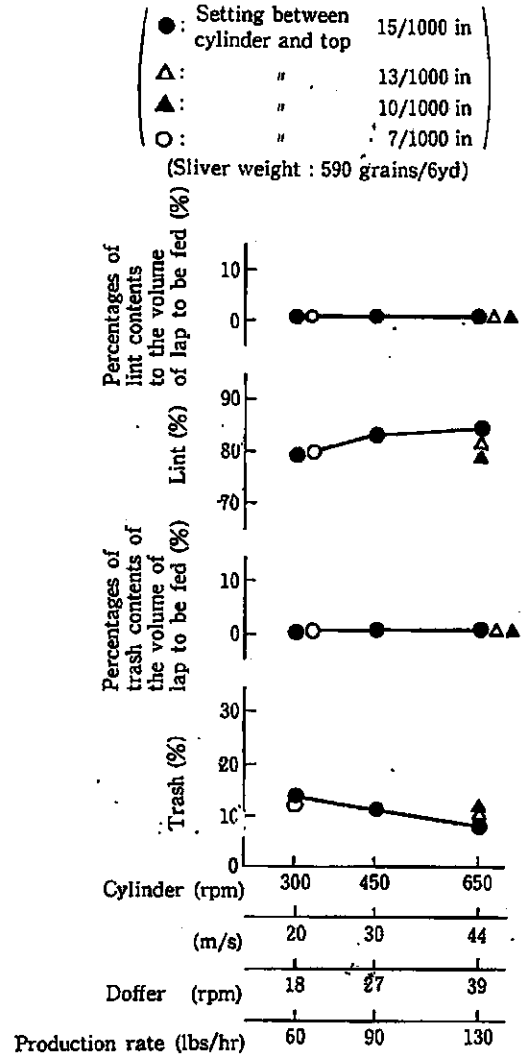

Fig. 12 Shirley Analysis of flat strip

inch), the number of neps is decreased, nevertheless the production rate is increased over two times.

It is, therefore, possible to increase the production rate while the sliver quality is kept constant or improved by increasing the cylinder speed.

ii) Yield rate of carding products

The yield rate of carding products is shown in Fig. 11.

As shown in Fig. 11, the flat strips tend to be increased slightly at the cylinder speeds of 300 rpm and 650 rpm as a result of the closer setting between the cylinder and the top.

iii) Shirley Analysis of flat strips

Fig. 12 shows the results of Shirley Analysis of flat strips.

As shown in Fig. 12, the trash contents in the flat strips tend to be increased at the cylinder speed of 650 rpm as a result of the closer setting between the cylinder and the top.

On the other hand, the lint contents tend to be decreased.

iv) Mean fibre length of the sliver

Fig. 13 shows the changes in mean fibre length of the sliver.

As shown in Fig. 10, the number of neps is decreased as a result of the closer setting between the cylinder and the top.

On the other hand, the mean fibre length of the sliver becomes shorter slightly and fibre breakage is increased.

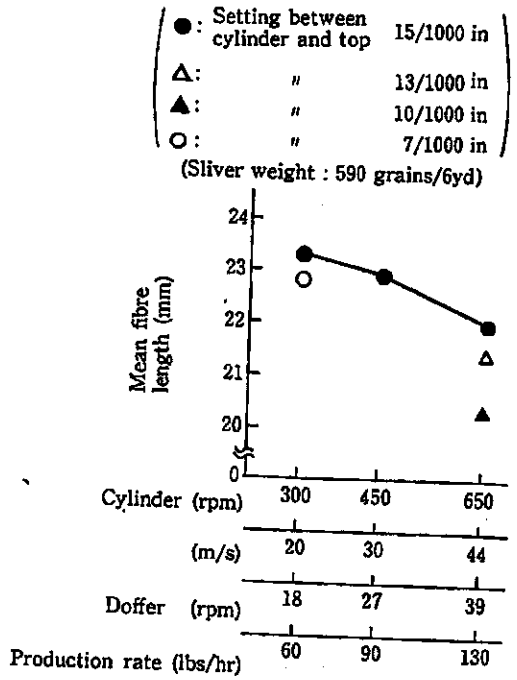

Fig. 13 Mean fibre length of the sliver (with Fibrograph)

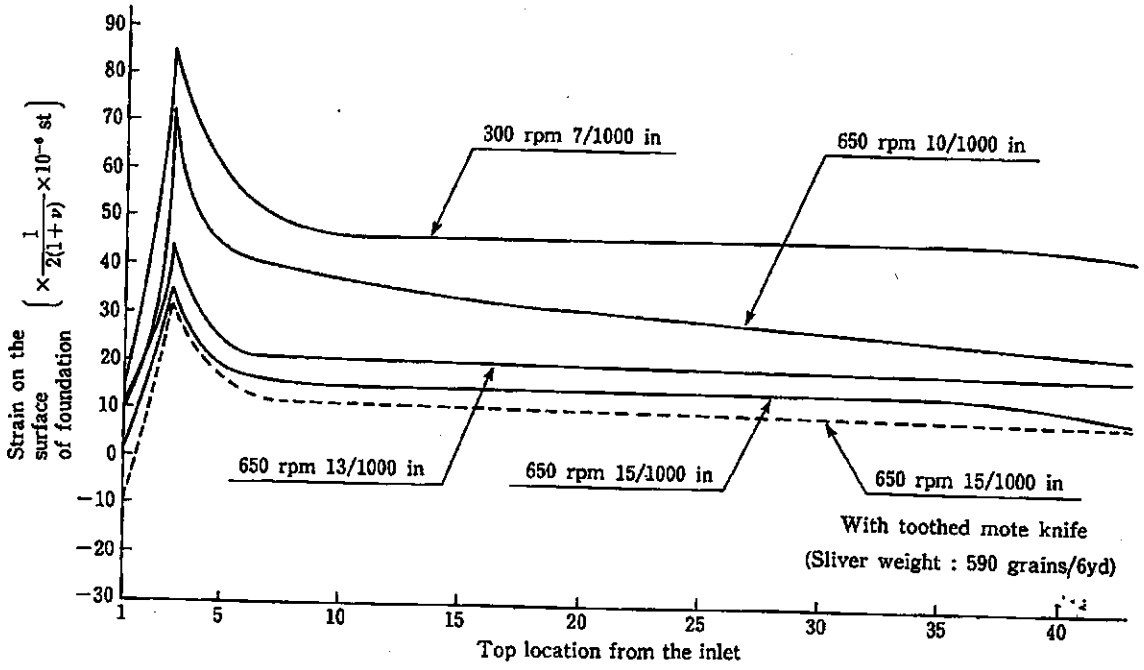

Fig. 14 Strain on the surface of foundation

v) **Carding action between the cylinder and the top**

The changes in carding action are shown in Fig. 14 when the settings between the cylinder and the top are changed.

It is found from the results that the strain on the surface of foundation is increased as a result of the closer setting between the cylinder and the tops.

In case of the cylinder speed of 650 rpm, the results shown in Fig. 14 coincide well with the results of the number of neps in the sliver (Fig. 10) and the mean fibre length of the sliver (Fig. 13)

Consequently, the carding action is improved owing to the increase in the force working on the needle.

As compared with the result under the normal carding conditions in the mill, the force working on the needle under the testing conditions (the cylinder speed is 650 rpm, the setting between the cylinder and the top is 10/1,000 inch) is lower than that under the normal carding conditions.

Additionally, the number of neps under the testing conditions is less than that under the normal carding conditions.

It can be considered that the decrease in force working on the needle and the number of neps are related to the decrease in fibre density on the cylinder as mentioned previously.

By using the toothed mote knife, the force working on the needle of the top card clothing can be reduced without deteriorating the sliver qualities such as the number of neps in the sliver and the mean fibre length.

5. Summary

The results of investigation for carding action between the cylinder and the top while carding lead to the following conclusions.

(1) The increase in cylinder speed decreases the force working on the needle of the top card clothing, although the production rate is increased. It can be considered that the decrease in the force working on the needle is related to the decrease in the fibre density on the cylinder.

(2) The above tendency is intensified further by the preliminary opening device such as the toothed mote knife.

(3) It can be expected to increase the production rate while the sliver quality is improved under the normal carding condition of the high-speed card by using the preliminary opening devices such as the stationary flats and the toothed mote knife.

Reference

(1) Hosokawa etc; Text of the 36th lecture meeting of Text. Mach. Soc., (401-1), 1983

(2) Hosokawa etc; Text of the 36th lecture meeting of Text. Mach. Soc., (401-2), 1983

(3) For example; Kimura, Hasegawa; Report of Nagoya Industrial Testing Laboratory, Vol. 28, No. 12, 1979