# MEASUREMENTS OF WINDING SPEED OF ROVING

T. ISSHI, M. NAKAZAWA and S. MATSUHASHI

*Department of Textile Machinery, Faculty of Textile Science and Technology, Shinshu University*

## INTRODUCTION

It is well known fact that one of the main functions of a winding part of a fly frame is to wind up roving so as to have a certain constant weight per unit length. To make the roving weight constant, what value should be operate constant ? There are two ideas to realize it. One of them is to operate winding tension constant and the other is to operate winding speed of roving to package constant. ISSHI et al. investigated the relations between the winding tension and the roving weight per unit length and concluded that the correlation between the both factors is not so high.[1)2)] The authors infer that the roving weight has rather good correlation with the winding speed. However to detect the winding speed directly and continuously when the machine is working is very difficult and has been almost impossible. The winding speeds obtained in the past were derived indirectly by multiplying package radius measured after the winding with relative revolving speed of bobbin shaft to flyer shaft. The revolving speed of the both shaft was measured by a revolution counter independently.

The first half of this paper reports the principle of the invention of a measurement apparatus of the winding speed of roving. In ordinary fly frame roving is drafted a little between front roller and flyer top. This draft has been considered improper and called as "improper draft" or "unstable draft". A great deal of endeavors has been concentrated to avoid this undesirable draft. But the authors consider that this draft is rather useful to control the roving weight in a certain range, only if we can catch winding speed on real time and manage it at our will. For this reason authors call this draft "winding draft" and intend to operate it positively.

The latter half of the report is spent to describe the influences of the factors of winding such as draft ratio of roller part, teeth number of shaper wheel and twisting number of roving to presser and flyer top, against such values as winding speed or winding draft ratio, roving weight per unit length and package diameter.

## PRINCIPLE OF MEASURING EQUIPMENTS OF WINDING SPEED

As already mentioned, one of the most important functions of a winding process of roving is to make such a roving as to have a certain constant weight per unit length throughout the whole layers of a package. The reasons why the roving weight per unit length does not become constant are considered as follows;

1) Roving fed to fly frame has own fluctuations before the drafting.
2) Draft parts of the frame cannot always give a constant draft to roving.
3) Winding part of the frame gives roving unexpected draft viz. winding draft.

The report this time only concerns with the irregularity of roving weight caused by the above reason 3). The mechanism of this irregularity can be described as follows;

Roving delivered from a front roller with constant speed U is fed in a flyer and is wound to a bobbin. Now let $\omega_b$ and $\omega_f$ be angular speed of bobbin and flyer respectively, then we obtain the following relation easily.

$$v=r(\omega_b-\omega_f) \quad (1)$$

where $v$ is winding speed of roving to bobbin and $r$ is radius of the layered bobbin. In this paper authors define the winding draft ratio,

$$D=v/U$$

As $r$ increases gradually with increase of layers, $\omega_b$ must be reduced gradually so that the right hand side of the equation (1) gives constant value. In the fly frame of present time the gradual changes of $\omega_b$ with increase of layers are settled beforehand by selection of shaper wheel. For this mechanism $v$ often cannot be constant. Impropriety of winding speed $v$ means impropriety of winding draft ratio and causes impropriety of roving weight per unit length. But authors suppose that none has ever measured the winding draft ratios and examined the correlations between these draft ratios and the roving weights per unit length. To study the above correlations the authors developed an apparatus which can detect the winding speed accordingly the winding draft ratio directly and continuously during the winding.

Fig. 1 shows the down view of a flyer and a bobbin. As was already mentioned, the roving is wound up to the bobbin with a relative angular velocity of the bobbin shaft against that of the flyer shaft. Owing to this mecha-

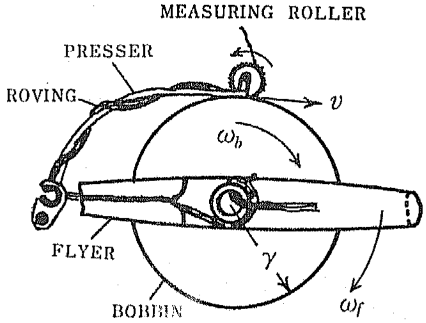


Fig. 1 Winding part and measuring roller

nism if we set a measuring apparatus on the flyer and measure the surface speed of the bobbin, we can get relative velocity of the bobbin against flyer (winding speed) easily. The authors use such a small roller, here named "measuring roller", as shown in Fig. 1. The roller rolls on a bobbin without any slip. Therefore the surface speed of the measuring roller is almost same with the winding speed of roving. This relation can be written as

$$v = \omega_R \, r_R \tag{2}$$

where $\omega_R$ and $r_R$ denotes angular velocity of the measuring roller and the radius of the roller respectively. If we measure the angular velocity of the roller continuously during the winding, we can detect the winding velocity on real time. An electric contact switch was employed to measure the angular velocity of the roller as shown in Fig. 2. The measuring roller produces electric pulses in proportion to its revolution numbers per unit time, as a cam mounted on the roller put off the contact switch of the electric circuit. To open and shut the contact switch perfectly a plate spring of phospher bronze is employed. Very small needle bearing is used as the bearing of the roller to

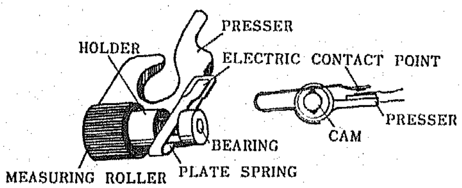


Fig. 2 Measuring roller

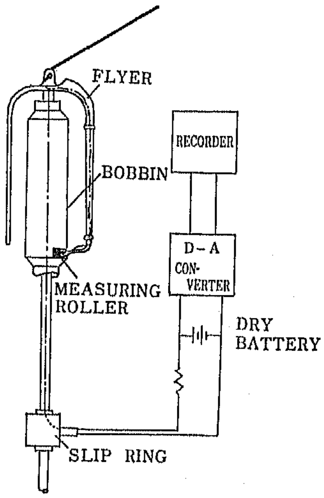

Fig. 3 Measurment system of winding speed

reduce frictional force to it. The digital electric pulses are led to the top of the flyer along flyer leg and taken out from the frame through an electric slip ring specially manufactured, or moreover led to the bottom of the flyer spindle and are taken out through a ready-made electric slip ring. The pulses transfered are led to a digital-analogue converter with dry batteries connected in parallel. Obtained analogic values are recorded by a pen recorder. Fig. 3 shows electric circuit of the measuring system.

## EXPERIMENTAL RESULTS AND DISCUSSIONS

### I. Examples of measuring of winding velocity

Fig. 4 shows examples of the records of winding speed which are detected by the measuring roller developed here. Fig. 4(a) shows the records for the case of ordinary conditions. Horizontal and vertical axes show time (viz. numbers of layer) and revolution number of the measuring roller per unit time (viz. winding speed of roving), respectively. The figure shows that winding speed is almost flat except the upper and lower end of the layered bobbin. At the end point of the layered bobbin the winding speed drop slightly because at this end roving tumbles down a little and the measuring roller also may slip down the slope of the end of bobbin. With growth of the layers of the package, these drops of the winding speed become more notable and fluctuations of the speed also become larger, because the package becames softer with increase of the layer number. Fig. 4(b) shows the case where roving is twisted at the top of flyer with 5/4 turns and twisted to the presser with 3 turns and so the resistance forces of flyer to roving are very large. The winding speed of this case also indicates flat in all. The remarkable tendency of this case is that the instantaneous fluctuations of the winding speed are smallest of all treated here, because the package is built up tightly as the tensions of roving from flyer is very large and so the measuring roller of this case does not bound up so easily as another cases. Fig. 4(c) shows on the contrary to the above the case where the roving resistance of flyer is very small, as the roving is twisted at the top of flyer with 1/4 turns and twisted to the presser with 1 turn. The figure shows pretty large fluctuations of the winding speed in comparison with any other one. This large fluctuations are brought by jumping of the measuring roller on the surface

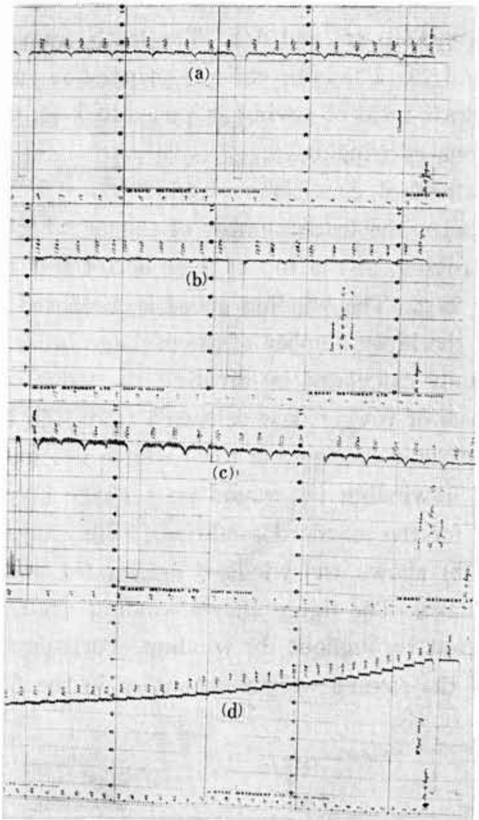

Fig. 4 Examples of measurig result of winding speed

of the soft and elastic package. The drops of the speed at the corner are also very large because the roller falls down from the corner and the roving also tumbles down a little at the corner. Fig. 4(d) shows the case where any roving is not delivered to the flyer. The bobbin used here is covered by a woolen cloth to keep off both slip and bound of the measuring roller. The measured results show that the winding speed falls down gradually with progress of the layers number, as the radius of the bobbin is that of naked bobbin throughout the winding

**II. Influences of some factors on winding of roving**

In the present report the effects of the factors concerning the winding, such as twisting number of roving to presser and that at flyer top, teeth number of shaper wheel, amount of false twists and quantity of roller draft, are examined, measuring diameter of layered bobbin, winding speed consequently winding draft ratio and roving weight per unit length. The twisting number of roving to presser are selected as 1, 2 and 3, and the twisting number at the flyer top used are 1/4, 3/4 and 5/4. The teeth number of shaper wheel selected are 21, 23 and 25. The false twist is changed by rubber cap put on the top of flyer. Roller draft ratio of roving is varied to 5. 34, 6. 77, 9. 33 and 10. 61.

(1) Standard conditions of winding

First of all the standard conditions of winding are settled as follows; The roller draft ratio is 8. 13, the teeth number of shaper wheel is equal to 23, the twisting number of roving at the top of flyer is 3/4 and the twisting number of roving to presser is 2. The winding speed is measured continuously by the measuring roller till the layer number of the package becomes 50. The winding draft ratio can be easily calculated by dividing the value of the winding speed by the value of speed of roving just delivered from the front roller. Roving weight per unit length and diameter of the package are measured by a balance and a ruler directly, unwinding the wound up package inversely. Fig. 5 shows experimental results for the standard conditions. Fig. 5(a) shows the diameters of the package and (b) shows the winding draft ratio and the roving weight against layer of package. The figure shows winding draft ratio becomes about 1. 10 and nearly constant throughout the winding. Perhaps this fact causes flatness of the curve of the roving weight as shown in the figure. The diameter

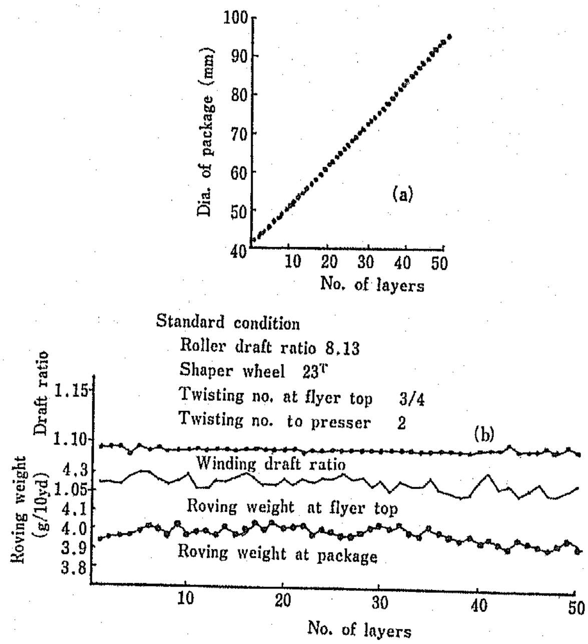


Fig. 5 Standard winding

of the package also hardly fluctuates. A few fluctuation of the weight may be brought by the initial fluctuations of the roving delivered from the front roller. The value of the roving at the top of flyer is also shown in Fig. 5.

(2) Effects of resistance force to roving

In the next part the effects of resistance force of flyer to roving are determined quantitatively. To change the resistance force of flyer to roving can be realized by chnging twisting number of roving both at top of flyer and that to presser.

Fig. 6 shows the results measured for the case where the twisting number

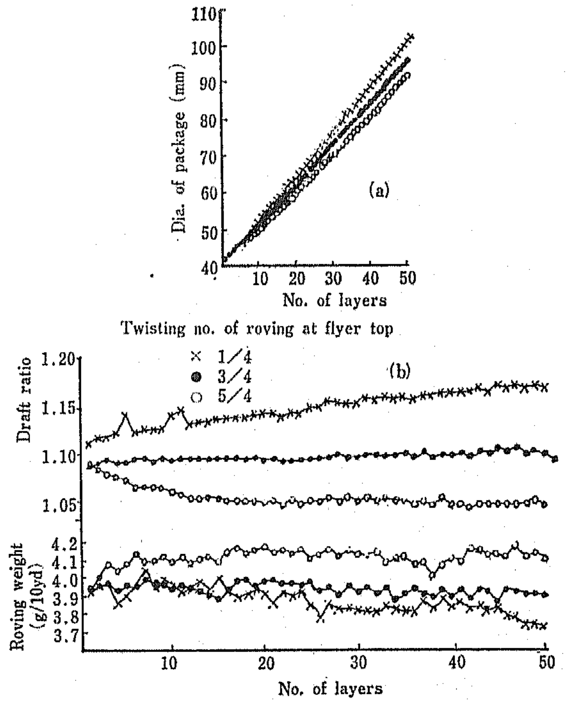


Fig. 6 Fffects of twisting no. at flyer top

of roving at the top of flyer is set to 1/4, 3/4 and 5/4, and another factors values are settled equal to those of the standard conditions. The figure points out that the diameter of the bobbin tends to smaller one with increase of the twisting number at flyer top. The reason of these facts, the authors consider, is that the package is wound harder as the roving tension becomes larger with change of the twisting number from standard value 3/4 to large one 5/4. The shorter diameter of package causes smaller winding draft ratio and larger roving weight per unit length. On the contrary by the same reason, when twist-

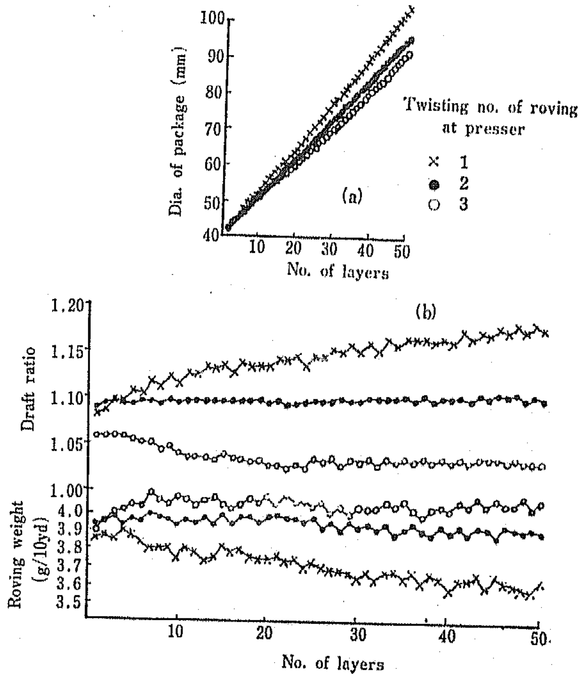


Fig. 7 Effects of twisting no. to presser

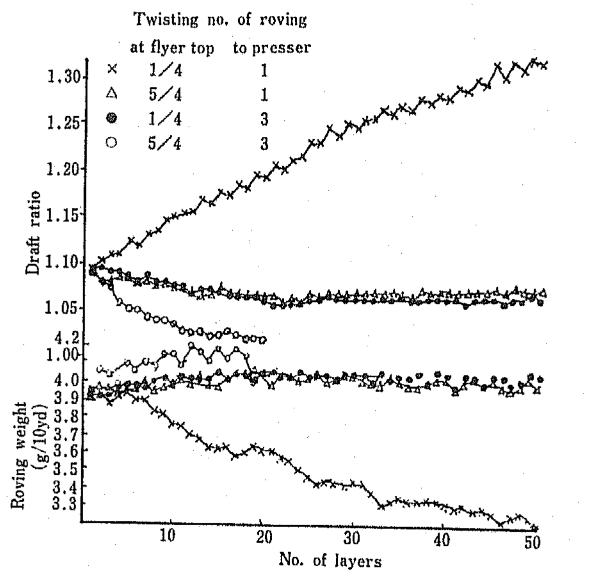


Fig. 8 Effects of twisting no. at fly top and to presser

ing number is decreased from 3/4 to 1/4, the roving weight becomes smaller.

Fig. 7 shows the influences of twisting number of roving to presser. The twisting number is changed to 1, 2 and 3. Experimental results show that the tendencies of the changes of the package diameter the winding draft ratio and the roving weight with increase of the twisting number to presser are just same as the case where the turning number at the top of flyer is varied. The results shown in Fig. 6 and 7 indicate that to increase twisting number of roving both to presser and at flyer top are same in its physical meaning. Increasing the twisting number means to raise resistance forces of flyer to roving, whichever part of flyer it may be. Fig. 8 shows the results where the twisting numbers both to presser and at flyer top are changed at once. When twisting number at flyer top is 1/4 and that to presser is 1, the resistance force of flyer to roving, consequently the roving tension is the smallest of all. Remarkable tendencies of Fig. 8 are that when the roving tension is small for example twisting number at flyer top is 1/4 and that to presser is 1, the roving weight goes down gradually with a certain constant rate. When the roving tension is large for example twisting number at flyer top is 5/4 and that to presser is 3, the roving weight becomes large by the same reason just disscussed above. But in the case of descent draft the roving weight cannot become large infinitely as the winding draft ratio has under limit equal to 1.0. When the value [winding speed of roving to package] / [delivery speed of roving from front roller] exceed under 1.00, then the roving becomes loose between the front roller and the flyer top and gradually droop more and more. At last the roving is cut down getting coiled around the flyer top. In the present experiment the roving is cut down at the 20th layer and cannot be wound again whenever twisting number to presser is adhered to 3 and that at flyer top to 5/4.

(3) Effects of teeth number of shaper wheel

In ordinary fly frame to change the rate of decrease of angular speed of bobbin shaft corresponding to the growth of layers is realized by the change of shaper wheel. Less the teeth number of shaper wheel, greater the progress of the belt of a speed converter of cone drum and therefore greater the rate of decrease of the angular speed of the bobbin shaft. The selection of the shaper wheel which gives well fitted winding condition is very important. Impropriety of selection of shaper wheel causes the discrepancy of winding draft ratio directly. However the aspect of this discrepancy has never investigated. For this view point the influences of selection of shaper wheel was examined varying teeth number of it to 21, 23 and 25. Another conditions of winding are just same as those of the standard conditions. Experimental results are shown

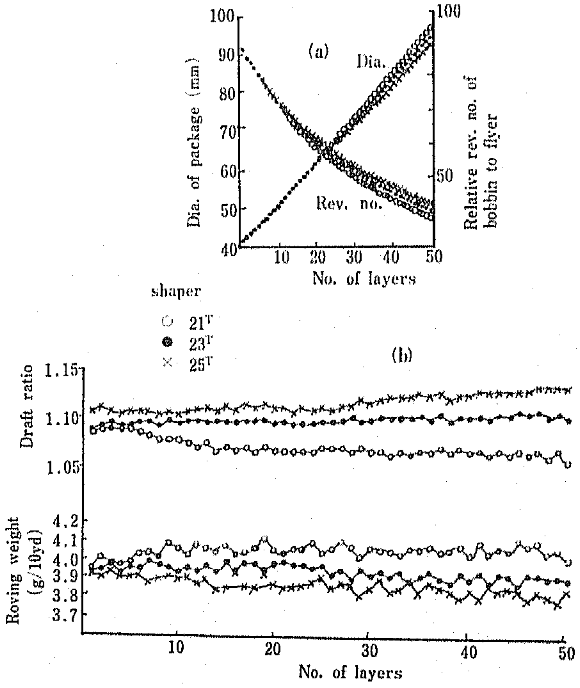


Fig. 9 Effects of selection of shaper wheel.

in Fig. 9. The curves of the figure indicate that when teeth number becomes smaller, winding draft ratio also becomes smaller. This tendency is caused by decrease of the relative angular speed. In this condition the roving weight becomes larger as the draft ratio is smaller. The package diameter becomes larger as the teeth number is smaller. The reason of the above fact is considered as follows;

As the draft ratio is small when teeth number of shaper wheel is small, roving is not wound firmly to flyer and so winding tension of roving is not so great and this causes soft and large diameter of package.

(4) Effects of false twists

False twists are given to the roving between the front roller and the flyer top so as to save cutting off and undesirable drafting of roving. In ordinary flyer false twists are produced by a circular hole at flyer top. But in recent years a square hole at flyer top or rubber cap covered on flyer top are adopted frequently to ensure false twists certainly. In this report the influences of ordinary flyer and rubber cap flyer are compared mutually. Fig. 10 shows the results observed. Any certain tendency cannot be found of the winding draft between ordinary flyer and rubber cap flyer. But the diameter of package

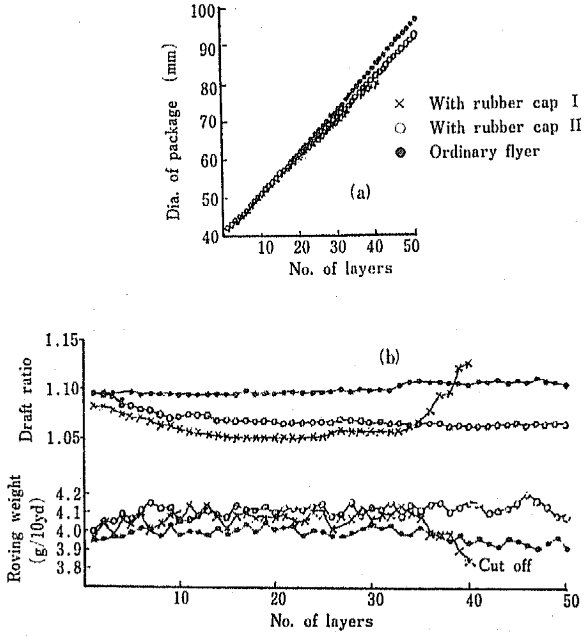


Fig. 10 Effects of false twists

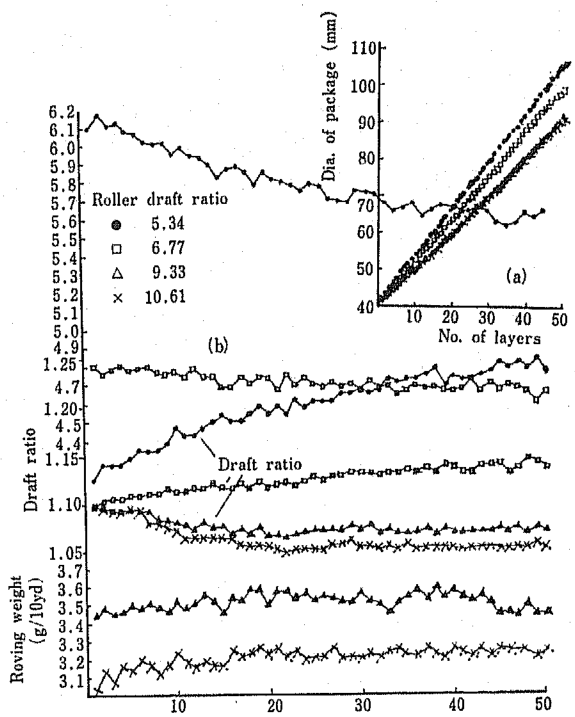


Fig. 11 Effects of roller draft ratio

wound by rubber cap flyer is smaller than that by ordinary flyer and the roving weight by rubber cap flyer is a little larger than that by ordinary flyer. The above inclination in supposed that as the roving of rubber cap flyer has more false twists than those of ordinary flyer, it becomes harder to draft and so tension of it becomes larger and package is wound in smaller diameter.

(5) Effects of roller draft ratio

The shaper wheel should be changed in order to wind a package properly when the ratio of roller draft is changed. Here the draft at the roller draft part of the frame is called as "roller draft" to distinguish it from "winding draft". The influences of roller draft ratio to the winding draft ratio and the roving weight are studied changing roller draft ratio and not changing any other factors as shown in Fig. 6. The graphs in Fig. 11 show the tendencies that the package diameter becomes larger and so the winding draft ratio becomes larger and the roving weight has declining character against layers with decrease of roller draft ratio.

(6) Correlations between winding draft and roving weight

Figs. from 5 to 11 show that there are considerably high correlations between the winding draft ratios and the roving weights. As the roving weight decreases if the winding draft ratio increases, reciprocals of the roving weights against the winding draft ratios are protted for some typical cases in Fig. 12. For each case the relations of reciprocals of the roving weight against the winding draft ratios seem to have some inclination, although the position of each group is not same. Fig. 13 shows the reciprocals of the ratio

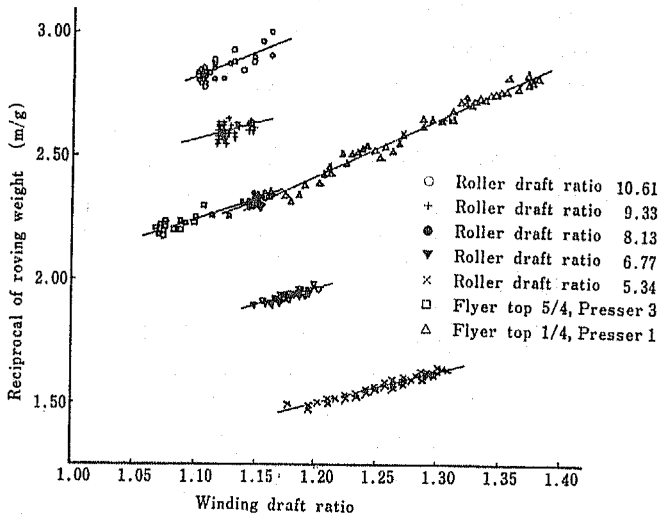


Fig. 12 Relations between winding draft and roving weight

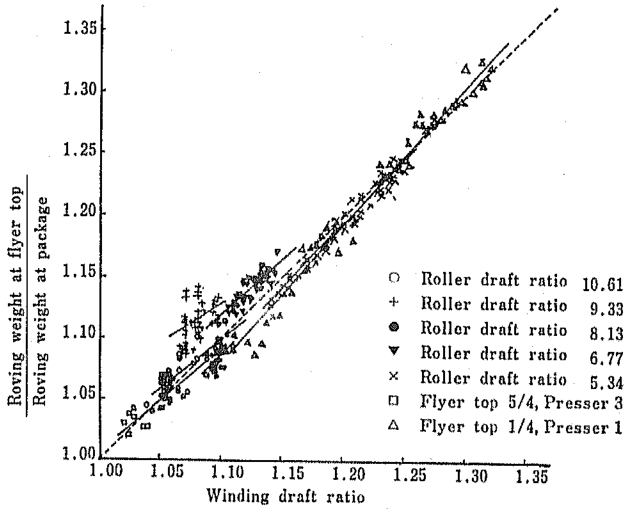


Fig. 13 Correlation between winding draft and roving weight

of roving weight at the package to the unit length weight of the roving delivered from front roller against the winding draft ratio. As the roving weights are normalized by the roving weights at the front roller, the relations are displayed nearly in one line for all cases. The dotted line indicates theoretical value. This strong correlation suggests that the roving weight must be controled positively within a certain range by managing of winding draft ratio namely winding speed.

## CONCLUSIONS

1) An apparatus for measurement of winding speed of roving to package continuously is devised. The principle of the apparatus is to detect winding speed by measurement or revolving speed of the roller which is attached at the end of presser and revolves keeping contact with package surface without any slip. The revolution speed of the roller is taken out from flyer spindle in form of digital pulse, which is afterwards converted in form of analogue value through a D–A converter.

2) Using this apparatus devised and other measuring instruments winding draft, roving weight per unit length and package diameter are measured and examined for various conditions of winding. The measured results and conclusions are as follows;

a) Roving weight increases with increase of resistance force of flyer to roving. For larger resistance force causes larger tension of roving and larger tention of roving makes the package firm and slender.

b) Winding draft becomes smaller and roving weight becomes larger when rate of decrease of revolution speed of bobbin shaft is set larger, changing teeth number of shaper wheel larger.

c) Roving weight increases with increase of false twist. Because hard twist makes package diameter smaller and causes smaller winding draft.

d) Winding draft ratio becomes larger and increasing of roving weight of couse larger and so growing rate of package diameter becomes larger when roller draft ratio is changed smaller.

e) There is pretty good correlation between roving weight ratio and winding draft ratio. This good correlation suggests that winding draft ratio should be chosen as operation value if control of roving weight ratio is intended.

## REFERENCES

1) T. Isshi: J. Text. Mach. Soc. Japan, 8, 15 (1962)
2) T. Isshi, M. Nakazawa and S. Matsuhashi: J. Text. Mach. Soc. Japan, 14, 64 (1968)