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# The Cleanliness of Rectilinear Combed Tops

## Part 2: The Influence of the Top Comb and Comb Cylinder

by

De V. Aldrich and P. J. Kruger

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P. O. BOX 1124
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# THE CLEANLINESS OF RECTILINEAR COMBED TOPS*

## PART II: THE INFLUENCE OF THE TOP COMB AND COMB CYLINDER

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### ABSTRACT

*The influence of the gap between pins, percentage void, pin density and pin thickness on the combing performance of top combs was investigated. Values for the gap and percentage void of the top comb, giving a minimum impurity content in the top, were established. No significant influence of top comb characteristics on the mean fibre length and C. of V. of fibre length of the top could be found. Variation of the characteristics of the comb cylinder within relatively wide limits, had an insignificant effect on the combing performance of the cylinder. The characteristics of the top comb appeared to be relatively more critical than those of the cylinder in respect of the removal of impurities.*

### KEY WORDS

Rectilinear comb — wool — top comb — comb cylinder — gap — percentage void — pin density — combing performance — neps — vegetable particles — percentage noil.

### INTRODUCTION

The importance of the comb cylinder and top comb in producing high quality rectilinear combed tops is generally appreciated. Only limited results have, however, been reported on the influence of the characteristics of the top comb and comb cylinder on the efficiency with which the comb removes impurities during combing. Ideas on the pinning of the top comb and comb cylinder differ widely and many combers use the recommendations of the manufacturer as a guide only in setting up specifications which to them seem to be suitable for their particular conditions.

Wegener[1] investigated the combing performance of 15 top combs, increasing in pin density from 4 to 32 pins per cm, when processing silk on a rectilinear type comb. In the range, 16 to 32 pins per cm, the percentage noil showed almost no change while a decrease of 50% in the number of neps was observed for the same range. In general there was an increase in the mean fibre length of the combed sliver with increasing pin density although the change in fibre length in the range 18 to 28 pins per cm was very small.

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*Part of a Ph.D.-thesis by De V. Aldrich submitted at the University of Port Elizabeth.

**TABLE 1**

**CHARACTERISTICS OF THE WOOLS USED**
**(Precombed slivers)**

| WOOL | A | B | C | D | E |
|---|---|---|---|---|---|
| Mean fibre length (mm) | 56,0 | 65,1 | 58,8 | 62,0 | 61,8 |
| Coefficient of Variation (%) | 65,1 | 51,3 | 58,1 | 58,0 | 58,7 |
| % Fibres shorter than 25 mm | 35,1 | 16,3 | 20,9 | 16,7 | 19,7 |
| Mean fibre diameter (microns) | 22,1 | 24,5 | 22,9 | 21,8 | 19,5 |
| Dichloromethane extractable matter (%) | 0,98 | 0,82 | 0,77 | 0,83 | 0,84 |
| **Impurities per 20 grams** | | | | | |
| Neps | 456 | 240 | 301 | 380 | 1115 |
| Vegetable particles: | | | | | |
| > 10 mm | 100 | – | – | – | – |
| > 3 mm, < 10 mm | 506 | 108 | 140 | 46 | 32 |
| < 3 mm | 1053 | 104 | 260 | 124 | 105 |
| Total vegetable particles | 1659 | 212 | 400 | 170 | 137 |
| % Vegetable matter (by mass) | 1,3 | – | – | – | – |

Similarly, Wegener[2] also investigated the combing performance of ten comb cylinders when processing silk. The pin density of the coarsest cylinder increased from 4 to 21 pins per cm and that of the finest comb cylinder from 13 to 30 pins per cm. No trend could be observed in the fibre length of the combed slivers, but the number of neps showed a decrease of 40% for the above increase in pin densities. Had the two comb cylinders with the highest and lowest pin densities not been taken into account, then the decrease would have been only 15%.

Belin[3] reported that an examination of the fringe of the rectilinear comb, just before withdrawal occurs, showed that there are no neps or vegetable particles in the withdrawal zone. Hence the unwanted impurities which appear in the top originate from beyond the withdrawal zone. Belin also reported that the top cleanliness was slightly improved by a decrease in the gap between the pins of the top comb from 140$\mu$ to 70$\mu$ and that cleanliness was related to the number of vegetable particles in the input material.

These results indicate that more emphasis should perhaps be placed on the efficiency of the top comb than on that of the comb cylinder. This paper, therefore, deals with the results of an investigation of how the combing performance of the top comb and comb cylinder is affected by their characteristics.

## EXPERIMENTAL

**Materials:**

The five wools used for these investigations are designated alphabetically A to E, and the details of each, prior to combing, are given in Table 1. Wool A contained 1,3% vegetable matter, but wools B, C, D and E were free or nearly free from vegetable matter.

**Scouring, carding and gilling:**

Scouring was done, in a four-bowl Petrie and McNaught pilot scale scouring plant, using a nonionic detergent and 0,1% soda ash in the first bowl. Each lot was well mixed before it was scoured to a residual grease content varying from 0,40% to 0,60%. After scouring 1% Eutectal (0,33% dichloromethane extractable) was added followed by sandwich blending before carding.

**TABLE 2**

**DETAILS OF THE TOP COMBS USED**

| Top comb | Pins per cm | Pitch (microns) | Pin dimensions | | Gap (microns) | Percentage void |
|---|---|---|---|---|---|---|
| | | | Thickness (microns) | Width (microns) | | |
| A | 30 | 333 | 288 | 785 | 45 | 13,5 |
| B | 28 | 358 | 298 | 850 | 60 | 16,8 |
| C | 26 | 385 | 325 | 875 | 60 | 15,6 |
| D | 26 | 385 | 315 | 875 | 70 | 18,2 |
| E | 25 | 400 | 325 | 840 | 75 | 18,8 |
| F | 24 | 415 | 335 | 875 | 80 | 19,3 |
| G | 23 | 435 | 365 | 850 | 70 | 16,1 |
| H | 22,5 | 445 | 395 | 875 | 50 | 11,2 |
| I | 21 | 475 | 405 | 850 | 70 | 14,7 |
| J | 20 | 500 | 370 | 1000 | 130 | 26,0 |
| K | 20 | 500 | 400 | 1050 | 100 | 20,0 |
| L | 30 | 333 | 305 | 746 | 28 | 8,4 |
| M | 28 | 358 | 307 | 738 | 51 | 13,4 |
| N | 25 | 400 | 326 | 735 | 76 | 19,0 |
| O | 21 | 475 | 269 | 755 | 206 | – |

All five lots were carded on a F.O.R. Biella Worsted Card with a continental forepart at a swift speed of 78 r.p.m. and a production rate of 16 to 18 Kg per hour. The card slivers were conditioned for at least 48 hours in an atmosphere of 20°C. and 68% relative humidity. All subsequent experiments were carried out under these conditions.

Each lot was subjected to three preparatory gillings on an NSC Intersecting gillbox with fallers having a pin density of 6,5 pins per cm.

**Combing:**

Combing was carried out on a Schlumberger (Model PB 26L) rectilinear comb. Care was taken to set the comb properly before the commencement of each series of

**TABLE 3**
**PIN DENSITIES (PINS PER CM) OF THE PIN STRIPS USED IN THE COMB CYLINDERS A TO I**

| Row No. | Comb Cylinders | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I |
| 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 2 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 3 | 6 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 4 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 5 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 6 | 10 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 7 | 12 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 8 | 15 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| 9 | 17 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 10 | 17 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 11 | 19 | 22 | 22 | 22 | 22 | 22 | 22 | 20 | 20 |
| 12 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 20 | 20 |
| 13 | 22 | 24 | 24 | 22 | 22 | 22 | 22 | 22 | 22 |
| 14 | 25 | 24 | 24 | 22 | 22 | 24 | 22 | 22 | 22 |
| 15 | 25 | 26 | 26 | 24 | 24 | 26 | 24 | 22 | 22 |
| 16 | 26 | 26 | 26 | 24 | 24 | 26 | 24 | 22 | 22 |
| 17 | 28 | 28 | 28 | 24 | 26 | 28 | 24 | 24 | — |
| 18 | 28 | 30 | 28 | 26 | 26 | — | — | — | — |
| 19 | 29 | 30 | 28 | 28 | — | — | — | — | — |
| 20 | 29 | 30 | 28 | 28 | — | — | — | — | — |

experiments. In all cases combing was carried out with the slivers entering the comb in the same direction as that in which they had left the card. The comb was allowed to run for at least 10 minutes before commencing with a series of experiments. For each experiment three 3-minute tests were carried out, and the average value taken to be the result of the experiment.

The details of the top combs used are given in Table 2 and those of the comb cylinders in Tables 3 and 4.

Top combs A to K were supplied by one manufacturer and L and O by another, all being of the pinned-strip type[4]. The gap, pin thickness and width as

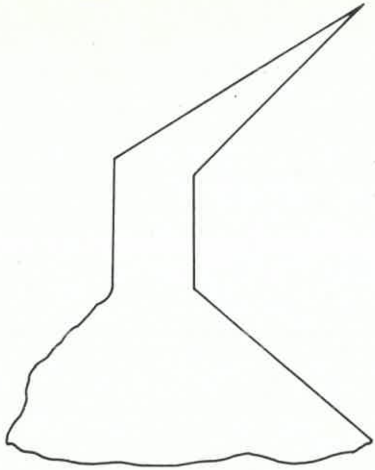
**TABLE 4**

**DETAILS OF THE PIN STRIPS USED TO ASSEMBLE THE COMB CYLINDERS B TO I**

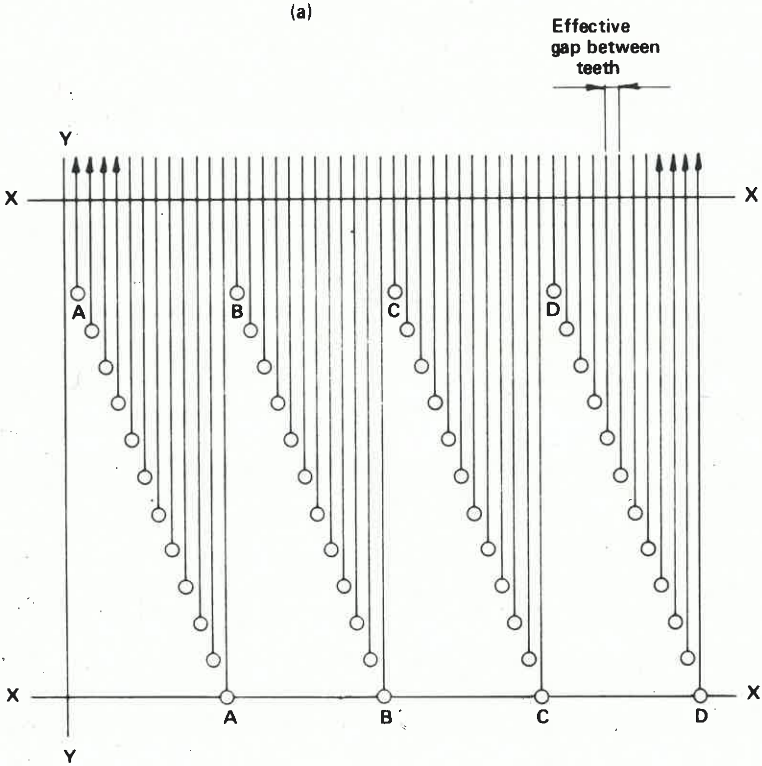
| Pin density of strip (Pins/cm) | Pitch (microns) | Dimensions of pins at root of projection (microns) | Wool space at root of projection (microns) | Projection (mm) |
|---|---|---|---|---|
| 30 | 333 | 308 X 680 | 25 | 4 |
| 28 | 355 | 325 X 690 | 30 | 4 |
| 26 | 385 | 335 X 700 | 50 | 4 |
| 24 | 415 | 340 X 720 | 75 | 4 |
| 22 | 455 | 350 X 780 | 105 | 4 |
| 20 | 500 | 360 X 910 | 140 | 4 |
| 18 | 555 | 370 X 1030 | 185 | 4 |
| 16 | 625 | 385 X 1150 | 240 | 4 |
| 14 | 715 | 420 X 1200 | 295 | 4 |
| 12 | 835 | 480 X 1380 | 355 | 5 |
| 10 | 1000 | 630 X 1400 | 370 | 5 |
| 8 | 1250 | 825 X 1440 | 425 | 5 |
| 6 | 1665 | 955 X 1625 | 710 | 6 |
| 5 | 2000 | 1065 X 1625 | 935 | 6 |

specified in Table 2 refer to the dimensions at the root of the projection. All the top combs (A to O) were used in conjunction with comb cylinder A.

Comb cylinders A to I were of the conventional type, with cylinder A containing round pins and B to I flat pins. Comb cylinders B to I were made up of pinned strips[5] which slide into grooves cut into the semi-cylindrical base of the cylinder. With this construction it was possible to replace individual pinned strips without interfering with any of the others. The number of pin rows for each comb



(a)




(b)

**FIGURE 1**

**The profile and Arrangement of the Saw-teeth on Comb Cylinders K and L**

segment and the pin densities (pins per cm) of each row are given in Table 3, while the manufacturer's details of the pins used on comb cylinders B to I are given in Table 4. All these dimensions refer to the root of the projection.

The construction of comb cylinders J and K was completely different to that of the conventional types B to I. It consisted basically of saw-teeth (like metallic card clothing) fixed in a staggered arrangement to a semi-cylindrical epoxy resin base. The profile and arrangement of these saw-teeth are shown in Fig. 1, with the axis of rotation of the comb cylinder, parallel to XX′ and the lines AA′, BB′, etc. representing the saw-toothed metallic wire strips, containing a saw-tooth at regular intervals. A detailed description of this type of comb cylinder was given in a previous report[6]. The coarse segment used in this experiment was the same for both J and K and had 46 teeth per $cm^2$, while the fine segment had 66 and 80 teeth per $cm^2$ for J and K, respectively.

## TABLE 5

### THE CHARACTERISTICS OF THE TOPS PRODUCED FROMWOOL A USING TOP COMBS A TO N

| Top comb | Pins per cm | Noil (%) | Impurities per 20 grams | | | | | Mean fibre length Top (Hauteur-mm) | Coeff. of Variation (Hauteur-%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Neps | Vegetable particles | | | | | |
| | | | | $>3$ mm $<10$ mm | $>10$ mm | $<3$ mm | Total | | |
| A | 30 | 10,30 | 55,7 | 3,5 | 0,7 | 13,7 | 17,9 | 59,6 | 53,7 |
| B | 28 | 9,43 | 69,2 | 3,8 | 1,5 | 13,6 | 18,9 | 59,2 | 54,2 |
| C | 26 | 9,69 | 60,7 | 4,4 | 0,9 | 13,5 | 18,8 | 58,5 | 54,8 |
| D | 26 | 9,60 | 76,6 | 4,5 | 1,2 | 13,6 | 19,3 | 59,3 | 54,2 |
| E | 25 | 9,25 | 97,2 | 5,6 | 0,8 | 18,2 | 24,6 | 59,3 | 54,3 |
| F | 24 | 9,43 | 98,2 | 4,8 | 2,0 | 16,2 | 23,0 | 59,2 | 54,1 |
| G | 23 | 9,54 | 56,0 | 4,9 | 0,5 | 13,1 | 18,5 | 58,6 | 55,1 |
| H | 22,5 | 9,91 | 55,7 | 3,5 | 0,6 | 13,0 | 17,1 | 59,1 | 53,9 |
| I | 21 | 9,32 | 67,4 | 3,7 | 1,2 | 13,2 | 18,1 | 58,7 | 54,8 |
| J | 20 | 8,78 | 150,7 | 7,0 | 2,3 | 12,9 | 22,1 | 59,0 | 54,7 |
| K | 20 | 9,20 | 136,4 | 6,6 | 1,1 | 14,6 | 23,3 | 58,4 | 55,6 |
| L | 30 | 9,17 | 138,9 | 7,1 | 1,1 | 15,1 | 23,3 | 59,6 | 54,5 |
| M | 28 | 9,42 | 56,8 | 4,4 | 0,7 | 11,7 | 16,8 | 58,7 | 54,2 |
| N | 25 | 8,86 | 80,0 | 4,9 | 1,5 | 16,1 | 22,5 | 58,3 | 55,2 |

In changing from one comb cylinder to another, care was taken to reproduce the setting of the nipper jaws relative to the cylinder, as accurately as possible. When interchanging the top combs care was taken to reproduce the setting of the top comb relative to the withdrawal rollers and shovel plate.

Combing was carried out at a gauge setting of 30 mm and 4,2 mm gill-feed (actual), using top comb M (28 pins per cm) when the different comb cylinders were investigated, and comb cylinder A when the different top combs were investigated.

In this investigation a study was made of the effect of the following four characteristics of the top comb on its combing performance:

(a) Pin density
(b) Pin thickness
(c) Gap between pins
(d) Percentage void.

The first two characteristics are independent parameters while the gap and the percentage void are functions of (a) and (b) and are given by:

$$g = \frac{1}{n} - d \text{ and} \quad \text{......} (1)$$

$$\text{Percentage void} = \frac{g}{p} \times 100 \quad \text{......} (2)$$

$$= g \times n \times 100 \quad \text{......} (3)$$

$$= (1 - nd)100 \quad \text{......} (4)$$

where g = gap (mm)

n = pins per mm

d = pin thickness at root of projection (mm)

$p = \frac{1}{n}$ = pitch (mm)

**Measurements:**

The nep and vegetable particle contents of the precombed and top slivers were determined using a Toenniessen Top Tester.

In the case of the precombed slivers six determinations were done (three each by two operators) on six samples drawn from six alternative cans after leaving the third gill-box. A mass of 30 grams was tested per sample, or 500 impurities (neps + vegetable particles) counted whichever limit was reached first. The results of the six determinations were then averaged.

In the case of the top samples a mass of 50 grams was tested, or 250 impurities counted, whichever limit was reached first, for every test. The results of the six determinations by two operators (one each per test), which involved a minimum of 300 grams material or 1 500 impurity counts, were then averaged and taken as the impurity content of the particular experiment.

In all cases, the nep and vegetable particle contents are expressed as the number of each per 20 grams material. All sizes of neps present were counted which resulted in the quoted values for nep content being relatively high. Where relevant, the vegetable particles were divided into three groups: shorter than 3 mm, longer than 3 mm, but shorter than 10 mm, and longer than 10 mm.

Fibre length measurements of the precombed slivers were carried out on the WIRA Single Fibre Length Tester, while those of the top samples were carried out on the Almeter.

**TABLE 6**

**THE CHARACTERISTICS OF THE TOPS PRODUCED FROM WOOL B USING TOP COMBS A TO N**

| Top comb | Pins per cm | Noil (%) | Impurities per 20 grams | | | | Mean fibre length Top (Jauteur-mm) | Coeff. of Variation (Hauteur-%) | Percentage fibres <25 mm (Almeter) |
|---|---|---|---|---|---|---|---|---|---|
| | | | Neps | Vegetable particles | | | | | |
| | | | | >3 mm | <3 mm | Total | | | |
| A | 30 | 3,56 | 17,0 | 0,6 | 3,5 | 4,1 | 71,3 | 47,0 | 7,2 |
| B | 28 | 3,22 | 21,0 | 0,7 | 3,5 | 4,2 | 70,1 | 47,4 | 7,2 |
| C | 26 | 3,33 | 17,3 | 0,4 | 3,6 | 4,0 | 71,8 | 46,4 | 6,7 |
| D | 26 | 3,39 | 19,5 | 1,0 | 4,6 | 5,6 | 70,3 | 47,4 | 7,1 |
| E | 25 | 3,14 | 27,8 | 1,8 | 5,8 | 7,6 | 70,3 | 47,8 | 8,1 |
| F | 24 | 3,27 | 24,0 | 1,9 | 4,3 | 6,2 | 70,4 | 47,3 | 7,2 |
| G | 23 | 3,31 | 15,3 | 1,2 | 3,4 | 4,6 | 70,2 | 48,0 | 7,8 |
| H | 22,5 | 3,38 | 12,5 | 0,9 | 3,4 | 4,3 | 70,5 | 47,8 | 7,4 |
| I | 21 | 3,22 | 21,0 | 1,2 | 3,6 | 4,8 | 69,8 | 47,9 | 7,9 |
| J | 20 | 2,90 | 30,2 | 1,7 | 4,8 | 6,5 | 70,9 | 45,7 | 7,6 |
| K | 20 | 3,00 | 28,3 | 1,9 | 4,8 | 6,7 | 70,0 | 48,4 | 7,9 |
| L | 30 | 3,17 | 22,3 | 1,8 | 3,5 | 5,3 | 69,8 | 48,8 | 8,4 |
| M | 28 | 3,40 | 16,3 | 1,0 | 3,5 | 4,5 | 70,9 | 46,4 | 6,7 |
| N | 25 | 3,03 | 25,4 | 1,1 | 4,1 | 5,2 | 69,9 | 48,7 | 7,4 |

## TABLE 7

### COMPARISON OF THE COMBING PERFORMANCE OF TOP COMBS WITH SIMILAR GAPS BUT DIFFERENT PIN DENSITIES AND THICKNESS

| Top comb | Gap (microns) | Void (%) | Pins/cm | Pin Thickness (microns) | Noil* (%) | Neps per 20 g | Vegetable particles per 20 g* |
|---|---|---|---|---|---|---|---|
| L | 28 | 8,4 | 30,0 | 305 | 5,26 | 53,3 | 10,3 |
| A | 45 | 13,5 | 30,0 | 288 | 6,05 | 24,5 | 7,4 |
| H | 50 | 11,2 | 22,5 | 395 | 5,77 | 24,2 | 7,2 |
| M | 51 | 13,4 | 28,0 | 307 | 5,57 | 26,0 | 7,4 |
| B | 60 | 16,8 | 28,0 | 298 | 5,42 | 35,5 | 8,4 |
| C | 60 | 15,6 | 26,0 | 325 | 5,62 | 28,1 | 7,5 |
| D | 70 | 18,2 | 26,0 | 315 | 5,62 | 33,9 | 8,4 |
| G | 70 | 16,1 | 23,0 | 365 | 5,57 | 25,2 | 8,0 |
| I | 70 | 14,7 | 21,0 | 405 | 5,46 | 30,1 | 8,3 |
| E | 75 | 18,8 | 25,0 | 325 | 5,32 | 44,1 | 10,3 |
| N | 76 | 19,0 | 25,0 | 336 | 5,03 | 43,3 | 9,5 |
| F | 80 | 19,3 | 24,0 | 335 | 5,47 | 46,3 | 9,9 |
| K | 100 | 20,0 | 20,0 | 400 | 5,10 | 65,7 | 10,2 |
| J | 130 | 26,0 | 20,0 | 370 | 4,95 | 70,8 | 9,9 |

*Average values for wools A, B, C, D and E

## RESULTS AND CONCLUSIONS

Five identical sets of experiments were carried out on wools A, B, C, D and E, using the top combs A to N as variable in each case. Combing was carried out at 30 mm gauge setting and the results for wools A and B are given in Tables 5 and 6, respectively, The results of wools C, D and E showed the same tendencies as did wools A and B, and are therefore not given here, but were included in the calculation of the average percentage noil, neps and vegetable particles per 20 grams for the five wools as given in Table 7. Each value of the above three quantities given in Table 7 is, therefore, effectively based on 15 determinations. In Table 7 the top combs are arranged in order of increasing gaps with those of similar or near similar gaps being grouped together.

The average numbers of neps are plotted versus the gap and the percentage void in Figs. 2 and 3, respectively. These graphs show that a minimum number of neps was obtained with a gap of approximately 50 microns and with a percentage void of about 12–15%. Table 7 also shows similar values of the gap and percentage

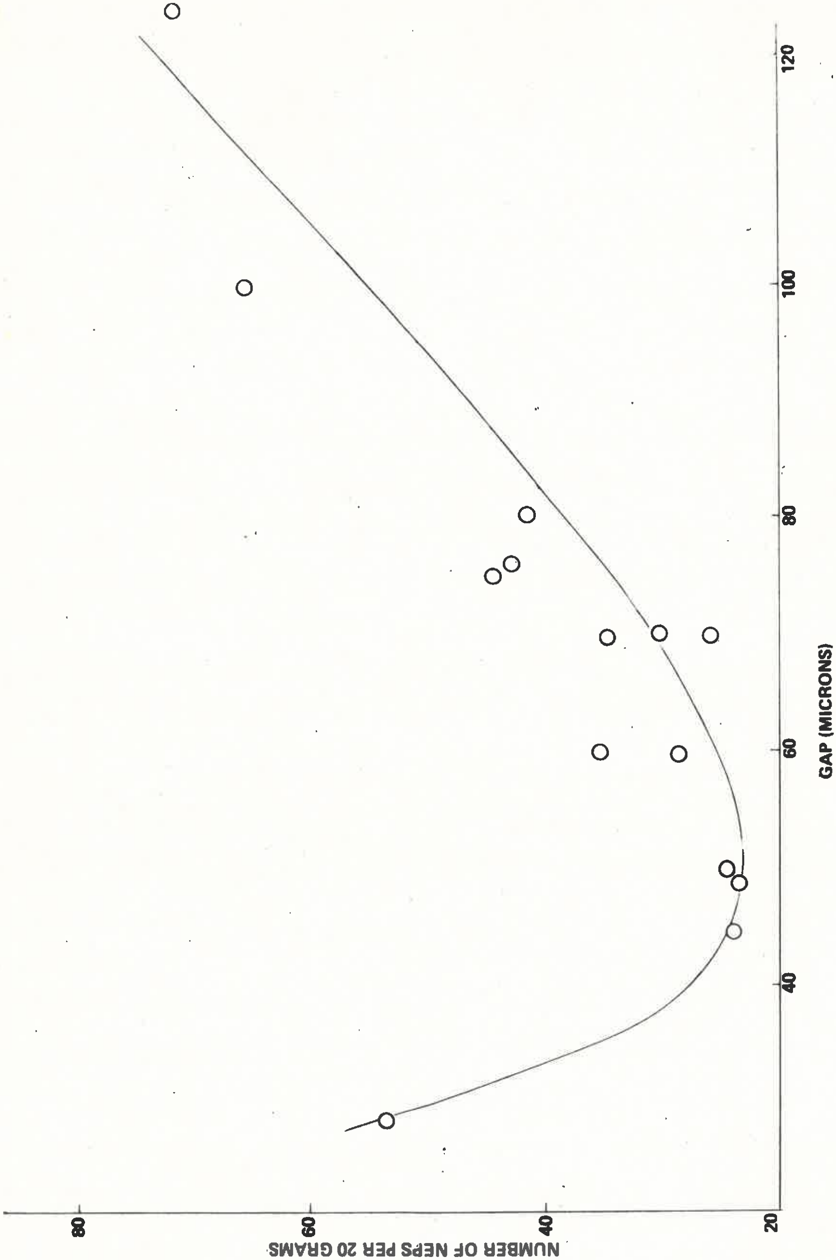



FIGURE 2

Number of Neps per 20 grams versus the Gap between the Pins of the Top Comb
(Average values for wools A, E, F, G, and H)

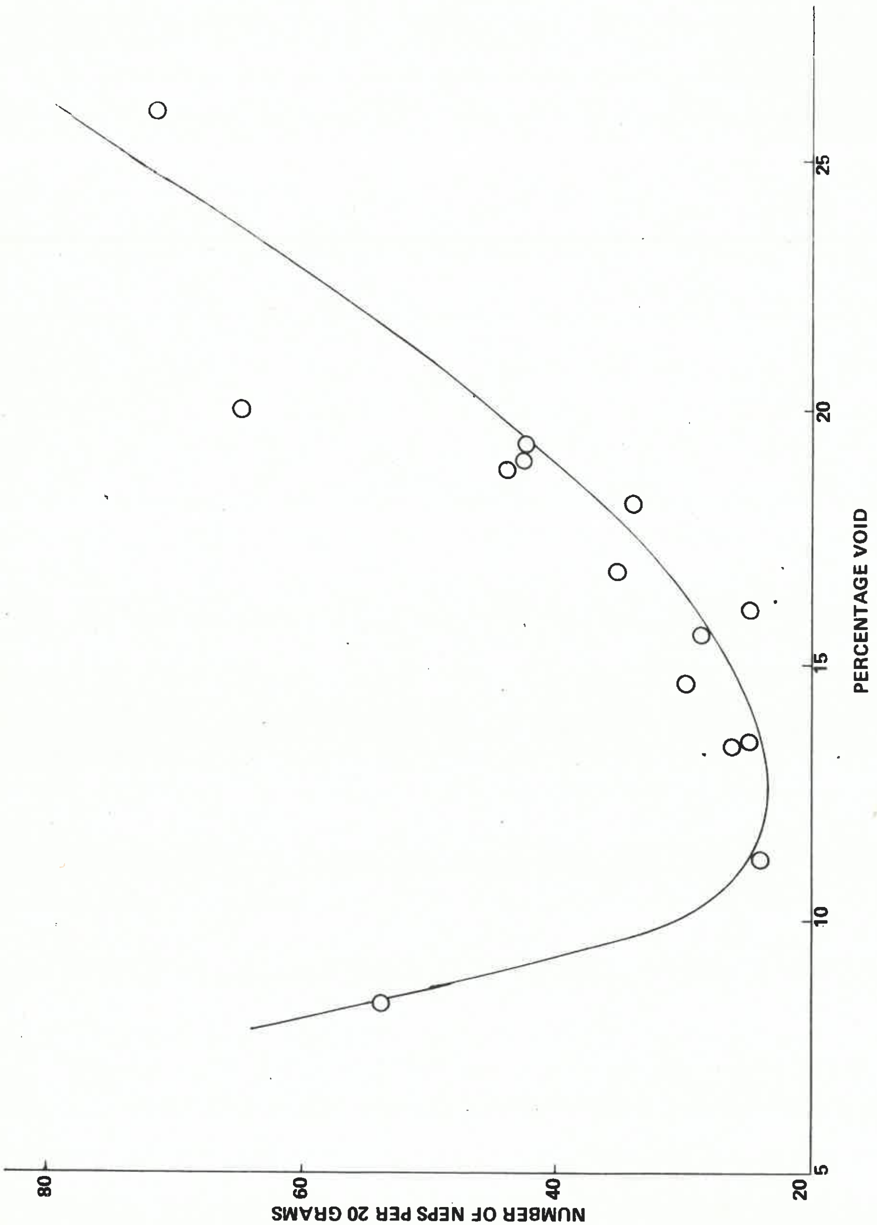



FIGURE 3

Number of Neps per 20 grams versus Percentage Void
(Average values for Wools A, E, F, G and H)

void giving a minimum number of vegetable particles. These values of gap and percentage void giving minimum impurities in the top also resulted in a slight increase in percentage noil. Top comb L with a gap of 28 microns gave, contrary to common belief, a poorer performance as far as impurities are concerned than did top combs with a gap of 50 microns. Top comb L, however, produced less noil than did top combs A, H and M.

For the purposes of the multiple covariance analysis of the influence of gap, pin thickness and pin density on the combing performance of a top comb, the top combs A to K were, therefore, treated as a group. The results of this analysis are given in Table 8. These results show that the gap was the most important factor in controlling the number of neps, vegetable particles and percentage noil. In all three cases pin density and pin thickness showed no significant influence. In the case of mean fibre length, all three variables produced no significant t-values and their influence on mean fibre length cannot be regarded as statistically significant. The results given in Table 8 are contrary to the general belief, that pin density is more important than or is as important as the gap in determining the combing performance of a top comb.

In the range of gaps from 45 to 130 microns, i.e. top combs A to N excluding top comb L, the number of impurities in the top increased with increasing gap, with a small concommitant decrease in the percentage noil. The action of the top comb with this range of gaps is clear; the ability of the top comb to prevent neps and vegetable particles from advancing through the top comb into the combed sliver decreased with increasing gap. The result is an increase in the impurity content of the top and a small but significant decrease in the percentage noil. The influence of gap on the removal of neps was more pronounced than it was on the removal of vegetable particles, due to their differences in character and behaviour in the sliver.

For different top combs to have an equal chance of removing neps and vegetable particles during withdrawal, they must penetrate the fringe completely before the withdrawal cycle starts. If this does not happen, impurities will move forward under the top comb and thus appear in the combed sliver. With decreasing gap, therefore, the ability of the top comb to remove impurities improves until a gap is reached beyond which efficient penetration of the fringe by the top comb is not possible, resulting in a sharp increase in the number of impurities in the combed sliver.

In the case of top comb L the dimensions of the gap were comparable to the transverse dimensions of single fibres, i.e. 28 microns against approximately 22 microns of the fibres. It was thus possible for the top comb to accommodate only a limited number of fibres in the gaps between the pins during withdrawal, and any fibres in excess of this could not be accommodated between the pins. Such fibres will, therefore, by-pass the pins of the top comb and impurities (neps and vegetable particles) present amongst these fibres will, therefore, be free to move forward during withdrawal without interference of the pins of the top comb.

**TABLE 8**
**RESULTS OF A MULTIPLE COVARIANCE ANALYSIS FOR WOOLS A, B, C, D AND E AND TOP COMBS A TO K**

| Combing performance | Top comb characteristic | Regression coefficient | t-value |
|---|---|---|---|
| Neps per 20 grams | Pins per cm | 0,808 | 1,007 |
| | Gap (mm) (pin thickness constant) | 699,236 | 6,426* |
| | Pin thickness (mm) | -38,482 | -0,787 |
| | Gap (mm) (pin density constant) | 649,355 | 7,619* |
| Total Vegetable Particles per 20 grams | Pins per cm | 0,068 | 0,930 |
| | Gap (mm) (pin thickness constant) | 44,457 | 4,456* |
| | Pin thickness (mm) | -4,813 | -1,082 |
| | Gap (mm) (pin density constant) | 41,314 | 5,325* |
| Percentage Noil | Pins per cm | 0,011 | 1,144 |
| | Gap (mm) (pin thickness constant) | -10,347 | -7,623* |
| | Pin thickness (mm) | -0,568 | -0,932 |
| | Gap (mm) (pin density constant) | -11,038 | -10,378* |
| Mean fibre length (mm) | Pins per cm | -0,044 | 1,455 |
| | Gap (mm) (pin thickness constant) | -3,630 | -0,882 |
| | Pin thickness (mm) | -2,557 | -1,387 |
| | Gap (mm) (pin density constant) | -6,036 | -1,878 |

*Significant at 0,1% level

The particular value of the gap giving optimum performance will, therefore, depend on the ease with which the pins will penetrate the beard. This, in turn, will depend, amongst other factors, on:

(a) the diameter and packing density of the fibres across the working width of the comb, and

(b) on the total number of gaps available in the top comb to accommodate these fibres during withdrawal.

The first factor is controlled by the total mass per unit length of the slivers being fed to the comb, i.e. by the production of the comb as far as it is determined by sliver mass per unit length. The importance of this factor will increase as the sliver mass per unit length is increased. The second factor is controlled by the pin density and the pin thickness if the gap remains constant, and is generally expressed as the percentage void, defined by the ratio of the gap to the pitch expressed as a percenrage.

The practical implication of these values of gap and percentage void giving minimum impurities is that the choice of pin density and thickness must comply with both the requirements of optimum gap and percentage void. To obtain the optimum gap (50 microns) and optimum percentage void (13%), as established for the conditions prevailing in this investigation, a pin density of 26 pins per cm and a pin thickness of 335 microns are required. Gap and percentage void cannot be separated and must be considered simultaneously. For a particular gap the percentage void will depend on the pin thickness, i.e. the thicker the pin, the smaller the percentage void. Similarly, for a particular percentage void, the value of the gap will depend on the pin density and the pin thickness.

Considering the influence of the characteristics of the comb cylinders on the percentage noil, it is shown in Tables 9 and 10 that within wide limits of pin density number of rows and construction, the comb cylinder has a relatively small influence on the percentage noil. Taking wool C as an example, the percentage difference between the maximum and minimum values was only 8% (5,05 to 5,49%). With due observance of the influence of other factors, these results indicate that the percentage noil is basically controlled by the gauge setting to which it is very sensitive.

For the fairly wide range of characteristics of the comb cylinders B to G and K and L no significant changes in the cleanliness of the top could be detected. These comb cylinders, therefore, performed with equal efficiency. Only in the cases where comb cylinders H, I and J were used were increases in the impurity content of the top observed.

The influence of the characteristics of the comb cylinders on the length characteristics of the top was even less and no changes in mean fibre length, coefficient of variation and short fibre content could be detected over the complete range of comb cylinders used.

Comparing the action of the comb cylinder and that of the top comb it is clear that the action of the comb cylinder is much more thorough, being executed by 15 to 20 rows of pins having progressively increasing pin densities. The efficien-

TABLE 9

THE CHARACTERISTICS OF TOPS PRODUCED FROM WOOLS B AND C USING DIFFERENT COMB CYLINDERS

| Comb cylinder | Noil (%) | Impurities per 20 grams | | | | Mean fibre length Top (Hauteur - mm) | Coeff. of Variation (Hauteur - %) | Percentage fibres <25 mm (Almeter) |
|---|---|---|---|---|---|---|---|---|
| | | Neps | Vegetable particles | | | | | |
| | | | >3 mm | <3 mm | Total | | | |
| WOOL B: | | | | | | | | |
| B | 3,65 | 14,4 | 1,0 | 2,8 | 3,8 | 71,0 | 46,6 | 6,6 |
| C | 3,48 | 13,5 | 1,4 | 3,8 | 5,2 | 70,9 | 46,9 | 7,2 |
| D | 3,50 | 14,4 | 0,7 | 3,5 | 4,2 | 71,1 | 46,3 | 6,9 |
| G | 3,48 | 14,8 | 1,7 | 4,0 | 5,7 | 70,5 | 47,8 | 7,3 |
| I | 3,31 | 16,6 | 2,9 | 4,8 | 7,7 | 70,1 | 46,8 | 7,9 |
| K | 3,31 | 14,5 | 1,2 | 3,3 | 4,5 | 71,3 | 46,6 | 6,8 |
| L | 3,42 | 14,6 | 1,0 | 3,9 | 4,9 | 70,0 | 48,2 | 7,9 |
| WOOL C: | | | | | | | | |
| B | 5,49 | 13,8 | 1,7 | 4,6 | 6,3 | 62,2 | 53,2 | 10,0 |
| C | 5,38 | 10,9 | 2,5 | 5,6 | 8,1 | 60,9 | 55,3 | 10,7 |
| D | 5,43 | 11,0 | 2,7 | 6,6 | 9,3 | 61,6 | 54,3 | 10,2 |
| E | 5,41 | 14,9 | 2,5 | 7,4 | 9,9 | 61,7 | 54,1 | 10,2 |
| F | 5,21 | 14,0 | 2,2 | 9,4 | 11,6 | 61,0 | 54,2 | 10,8 |
| G | 5,18 | 15,2 | 2,8 | 10,1 | 12,9 | 61,2 | 54,7 | 10,7 |
| H | 5,23 | 17,4 | 2,6 | 11,2 | 13,8 | 61,3 | 54,6 | 10,2 |
| I | 5,15 | 22,3 | 2,3 | 12,2 | 14,5 | 60,3 | 56,1 | 11,1 |
| J | 5,05 | 21,8 | 4,1 | 12,0 | 16,1 | 61,0 | 54,9 | 10,6 |
| K | 5,24 | 14,8 | 4,6 | 6,4 | 11,0 | 60,5 | 54,6 | 10,8 |
| L | 5,41 | 11,9 | 2,7 | 9,7 | 12,4 | 61,9 | 54,0 | 10,4 |

cy of the top comb is, however, solely determined by the action of a single row of pins.

Under normal conditions the efficiency with which the comb cylinder clears the fringe of neps and vegetable particles is, therefore, for all practical purposes, perfect. Neps and vegetable particles owe their presence in the combed sliver to their movement in the fringe during the withdrawal action. Some of these impurities move forward underneath the top comb before the latter penetrates the fringe properly and others simply move forward between the pins of the top comb. In view

**TABLE 10**

**THE CHARACTERISTICS OF TOPS PRODUCED FROM WOOLS D AND E USING DIFFERENT COMB CYLINDERS**

| Comb cylinder | Noil (%) | Impurities per 20 grams | | | | Mean fibre length Top (Hauteur - mm) | Coeff. of Variation (Hauteur - %) | Percentage fibres < 25 mm (Almeter) |
|---|---|---|---|---|---|---|---|---|
| | | Neps | Vegetable particles | | | | | |
| | | | > 3 mm | < 3 mm | Total | | | |
| **WOOL D:** | | | | | | | | |
| B | 3,80 | 15,9 | 0,2 | 2,3 | 2,5 | 65,0 | 50,2 | 3,9 |
| C | 3,77 | 16,3 | 0,5 | 1,7 | 2,2 | 65,2 | 50,1 | 3,7 |
| D | 3,72 | 16,7 | 0,4 | 2,1 | 2,5 | 65,2 | 49,7 | 3,3 |
| G | 3,62 | 16,6 | 0,6 | 2,8 | 3,4 | 65,6 | 50,6 | 3,8 |
| I | 3,58 | 18,2 | 0,6 | 3,6 | 4,2 | 65,0 | 50,7 | 3,9 |
| K | 3,72 | 16,9 | 0,4 | 2,7 | 3,1 | 66,5 | 49,2 | 3,1 |
| L | 3,70 | 16,8 | 0,4 | 2,3 | 2,7 | 65,9 | 49,5 | 3,6 |
| **WOOL E** | | | | | | | | |
| B | 6,54 | 23,9 | 1,0 | 3,3 | 4,3 | 70,0 | 47,4 | 5,9 |
| C | 6,21 | 21,4 | 1,1 | 2,5 | 3,6 | 68,9 | 48,5 | 6,0 |
| D | 6,17 | 21,7 | 0,4 | 3,1 | 3,5 | 68,7 | 48,4 | 6,7 |
| G | 6,06 | 27,6 | 0,8 | 2,8 | 3,6 | 69,3 | 47,9 | 6,3 |
| I | 5,91 | 38,2 | 1,5 | 4,4 | 5,9 | 68,2 | 49,6 | 7,3 |
| K | 6,13 | 22,3 | 0,7 | 3,6 | 4,3 | 69,1 | 47,9 | 6,1 |
| L | 6,02 | 22,0 | 0,5 | 3,2 | 3,7 | 67,9 | 49,7 | 7,1 |

of these results, more emphasis should, therefore, be placed on the efficiency of the top comb in the removal of impurities. Further investigations, using other top comb arrangements, will be reported on in a future paper.

## CONCLUSIONS

The results reported here indicate that of the different characteristics of a top comb only two, namely the gap between the pins and the percentage void (equation

(2)), are of paramount importance in determining the combing performance of the top comb. Values for both the gap and the percentage void were found to give a minimum number of neps and vegetable particles in the top, but a maximum percentage noil. The maximum percentage noil was, however, poorly defined and the differences in percentage noil from the different top combs were small. The effect of the characteristics of the top comb was also more pronounced in the removal of neps than in the removal of vegetable particles, although both showed the same tendencies.

The increase in the number of impurities with increasing gap and percentage void above the respective optimum values is due to the decreasing efficiency with which the top comb prevent the forward movement of impurities through the gaps. The increase in the number of impurities with decreasing gap and percentage void below the respective optimum values is, however, due to the inefficient penetration of the top comb through the fringe before withdrawal commences. In the latter case impurities move forward underneath the pins of the top comb into the combed sliver.

The influence of the characteristics of the top comb on the length characteristics of the top was insignificant.

The results on the combing performance of the different comb cylinders indicate that the combing performance of a comb cylinder is independent of its specifications if these are above a certain minimum value. Under these conditions the comb cylinder seems to operate with maximum efficiency which can hardly be improved upon. The efficiency with which the comb removes impurities is, therefore, basically dependent on the characteristics of the top comb, with due observance of the other factors which influence that efficiency.

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## THE USE OF PROPRIETARY NAMES

The fact that chemicals and machines with proprietary names have been mentioned in this report, does not in any way imply that SAWTRI recommends them or that there are not substitutes which may be of equal value or even better.

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