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Repco Wrapped Core-spun Wool Yarns

Part I: Performance of Repco Wrapped Core-spun Wool Yarns in Fine Gauge Double Jersey

by

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REPCO WRAPPED CORE-SPUN WOOL YARNS
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ABSTRACT

Very fine "singles" Repco wrapped core-spun (RWCS) wool *yarns were spun and knitted successfully into lightweight double jersey knitwear. The physical properties of the yarns and the fabrics produced are discussed and compared with similar yarns and fabrics knitted from spun polyester. The polyester yarn had greater breaking strength and was more regular but the RWCS wool yarns were more extensible. The fabrics knitted from RWCS wool yarns were slightly heavier and thicker and were superior to the polyester fabrics in respect of drape and pilling. The polyester fabrics in most cases had higher abrasion resistance than the wool fabrics.*

INTRODUCTION

It is well known that, normally, continuous filament yarns have great advantages over conventional fine staple yarns spun from natural fibres in respect of their tensile properties. Considerable development work has been carried out over the years towards improving the properties of spun yarns in order to produce fabrics more efficiently while still retaining the aesthetic properties of the natural fibres. Core-spun yarns[1] are spun by combining staple fibres and filament yarns during spinning and are known as core-spun and Woolfil yarns. In addition SELFIL[2] yarns have been developed for knitting on a modified Repco machine. The spinning of core-spun yarns on the Repco self-twist spinner has been carried out at SAWTRI[3] for some time and from this work a new technique for the spinning of *Repco wrapped core-spun yarns*[3,4] was developed in which very fine mohair yarns were spun and woven into ultra-lightweight mohair suitings[5].

This report deals with the knitting of *Repco wrapped core-spun wool yarns* on fine gauge double jersey machines and compares these yarns and fabrics with similar controls from spun polyester.

PRELIMINARY WORK AND DISCUSSION

Spinning

Yarn with linear densities of 10 and 12 tex were spun on the Repco spinner using the *Repco wrapped core-spun technique* [3]. For the spinning of such a fine yarn it was considered essential to use an 80's quality S.A. merino wool (mfd 17,7 μm and mfℓ 61,4 mm) and a 22 dtex f7 nylon flat filament was used for the core and the binder. The rovings used were of the double meshé type without twist and, although not considered ideal, performed satisfactorily during spinning. The recommended type of roving for the Repco machine is that produced with low twist on a speed-frame. The ST yarns were spun using normal roller loading, a front roller delivery speed of 220 m/min and the resultant yarns wound onto normal Repco packages. The details of roving tex and drafts used are shown in Table I. Yarns from the same wool lot as the above were spun on the ring frame for purposes of comparison.

Twisting

The yarns were then twisted into STT yarns on a Volkmann VTSO 6, 2-for-1 twister. The details of the twisting of the Repco wrapped core-spun wool yarns are given in Table I. After twisting the yarns were steam set and then cleared, waxed and wound onto cones on a Schlafhorst IKN winder fitted with electronic clearers and a classimat recorder.

TABLE I

YARN DETAILS OF THE WRAPPED CORE-SPUN WOOL YARNS

Yarn	Composition (%)		Roving linear density (tex)	Draft	STT turns/m	Tex Twist factor
	Wool	Nylon*				
10 tex RWCS	56	44	180	27	S 815	25,8
12 tex RWCS	64	36	180	21	S 897	31,0

* 22 dtex f7 Z 300

Yarn Physical Tests

The yarns as well as a 12 tex staple polyester (Trevira type 340) yarn were tested for friction, yarn linear density, breaking strength, extension, irregularity, thick and thin places and neps, and the results are shown in Table II.

From the results in Table II it appears that although the wrapped core-spun yarns were weaker than the 12 tex polyester yarns, they were much more extensible. The control ring yarn spun from all-wool had a very poor breaking strength and a low extension at break, and was completely unsatisfactory. In comparison with the polyester and the singles wool ring-spun yarn the irregularity of the RWCS yarns was high.

TABLE II

YARN PHYSICAL PROPERTIES

Yarn	Yarn linear density (tex)		Breaking Strength (cN)	Tenacity cN/tex	Extension (%)	Irregularity CV (%)	Thin places per 1 000 m	Thick places per 1 000 m	Neps per 1 000 m	Friction (cN)
	Nominal	Actual								
Commercial Control 100% spun polyester (Trevira type 340)	12	11,3	255,2	22,5	10,5	15,8	54	36	44	41
Repco wrapped core-spun wool (22dtex nylon)	10 (S 815)	9,5	212,3	22,4	41,8	28,8	1276	1170	1114	22
	12 (S 897)	12,0	217,6	18,1	27,8	27,1	1107	809	606	13—19
Control 100% wool ring-spun	12	12,0	68,4	5,7	11,0	21,8	410	290	20	14

The Repco wrapped core-spun yarns in this instance were spun with a 22 dtex f7 nylon core and binder and although the nylon filaments increased the breaking strength of the yarns the amount of nylon reduced the number of wool fibres per cross-section resulting in a high yarn irregularity. The polyester control yarn (a commercial yarn) had a very high yarn to metal friction implying that this yarn had perhaps not been waxed prior to knitting.

Knitting

The knitting trials were carried out on a Terrot, 30″ (72,6 cm) diameter, 28 gauge Jacquard double jersey knitting machine. In the first trial the procedure was simply to remove the polyester yarn packages (which were being knitted into interlock on a normal production run) and re-creel with the RWCS wool yarns and then to continue knitting without altering tensions or input speeds. It was found that these fine wool yarns knitted at the same tightness as the polyester yarn without any trouble.

When this initial trial proved to be successful, further knitting trials were carried out with a crossmiss interlock structure. The run-in ratio used was 1,8 : 1.

The commercial knitting speed utilised was 15 rev/min and it was found that the *Repco wrapped core-spun wool yarn* knitted without any difficulty at speeds up to 21 rev/min.

Schematic diagrams of the knitted structures are shown in Appendix 1.

Finishing

The wool fabrics were drycleaned and crabbed at 100° C for 15 min. both ways. They were then scoured at 50° C for 20 min. followed by two cold rinses. After piece dyeing on a winch using wool reactive dyes, the fabrics were finally tumble dried and decatised. The polyester control fabric was drycleaned, heatset at 180° C for 30's before being scoured at 70° C for 30 min., rinsed twice, piece dyed at the boil using a carrier, and finally dried on the stenter and decatised.

Fabric Physical Properties

The fabrics were tested for various physical properties using standard test methods[6]. The results are shown in Table III. It can be seen from Table III that when knitted the Repco wrapped core-spun wool yarns produced fabrics which were heavier than the polyester control which can be attributed to fabric relaxation and felting shrinkage which occurred during wet finishing.

As expected, the wool fabrics were also thicker. In the case of the polyester fabrics heatsetting stabilised the fabrics and there was virtually no change in dimensions. The polyester controls had slightly higher bursting

TABLE III

PHYSICAL PROPERTIES OF DOUBLE JERSEY FABRICS

FABRIC	Fabric mass (g/m^2)	Fabric thickness (mm)	Bursting Strength (kN/cm^2)	Bagging IR (%)	Drape Coefficient (24 cm disc) (%)	Martindale Abrasion	
						Mass loss at 10 000 cycles (%)	Pilling * IWS after rating 2000 cycles
Control 12 tex Polyester interlock	143	0,66	834	56,1	41,2	0	1,0
10 tex RWCS Interlock	167	0,93	808	57,9	59,1	4,8	3,7
12 tex RWCS Interlock	188	0,89	807	54,0	55,7	3,4	5,0
Control 12 tex Polyester crossmiss interlock	169	0,85	884	65,1	48,5	4,3	1,3
10 tex RWCS Crossmiss interlock	172	0,90	850	56,9	63,0	4,3	4,7
12 tex RWCS Crossmiss interlock	209	0,94	872	60,6	64,0	2,6	5,0

* 1 = poor
5 = good

strengths and a slightly higher resistance to bagging. The wool fabrics had high drape coefficients whereas the polyester fabric was considered to be very limp. There was very little difference in abrasion resistance but, as expected, the wool fabrics were far less susceptible to pilling than the polyester controls. There was also a noticeable improvement in the pilling performance of the wool fabrics as the yarn linear density increased. In general it can be concluded that this very lightweight wool knitwear compared most favourably with the commercial polyester controls. The elimination of pilling, improved drape as well as the aesthetic appeal of wool fabrics encouraged further trials.

EXPERIMENTAL

(a) Effect of STT twist level on knittability of Repco wrapped core-spun wool yarns

It was decided to select various levels of STT twist. RWCS yarns were spun with yarn linear densities of 14 and 16 tex and twisted to give STT yarn at three levels of twist, in order to determine an acceptable level of twist for RWCS yarns. The tex twist factors used were 21,1 (1,8 worsted) 23,5 (2,0) and 25,8 (2,2). The yarn physical properties were measured after waxing (see Table IV) and then the yarns were knitted into interlock and crossmiss interlock structures as previously.

(b) Knitting different structures from Repco WCS wool yarns

Several structures were knitted from RWCS and polyester yarns on the same 28 gg double jersey machine and the details of yarns used in each structure were as follows:

Interlock	SCSL	:	1,18 cm
	MTF	:	11,7
	Fabric 1. Yarn	:	12 tex S897 RWCS wool (22 dtex f7 nylon)
	Fabric 2. Yarn	:	12 tex polyester (control)
Crossmiss interlock	SCSL	:	3,01 cm
	Run-in ratio	:	1,7 : 1
	MTF	:	11,5
	Fabric 3. Yarn	:	12 tex S897 RWCS wool (22 dtex f7 nylon)
	Fabric 4. Yarn	:	12 tex polyester (control)
Single Pique	SCSL	:	1,61 cm
	Run-in ratio	:	1,2 : 1 Tuck : Interlock
	MTF	:	13,3
	Fabric 5. Yarn	:	12 tex S610 RWCS wool (17 dtex f7 nylon)
	Fabric 6. Yarn	:	12 tex polyester (control)

Double blister (2/2 Twill effect)

SCSL	:	9,48 cm
Run-in-ratio	:	1,2 : 1 ground : blister
MTF	:	11,7
Fabric 7. Yarn	:	12 tex S610 RWCS wool (17 dtex f5 nylon)
Fabric 8. Yarn	:	12 tex polyester (control)

Double blister (Hopsack effect)

SCSL	:	10,33 cm
Run-in ratio	:	1,5 : 1 ground : blister
MTF	:	11,6
Fabric 9. Yarn	:	14 tex S610 RWCS wool (17 dtex f5 nylon)
No fabric 10	:	The 12 tex polyester control yarn did not perform satisfactorily when knitted into this structure.

Piquette

SCSL	:	2,48 cm
Run-in ratio	:	1,5 : 1 Interlock : dial or cylinder only
MTF	:	12,1
Fabric 11. Yarn	:	14 tex S610 RWCS wool (17 dtex f5 nylon)
Fabric 12. Yarn	:	12 tex polyester (control)

Schematic diagrams of the above structures are shown in the Appendix 1 and fabric samples in Appendix 2.

Finishing was carried out in the same manner as described earlier in this report.

Fabric Testing

The fabrics were tested for physical properties as mentioned earlier in this report and the results are shown in Table V.

RESULTS AND DISCUSSION

(a) Effect of STT Twist Level

The results of the physical tests carried out on Repco wrapped core-spun wool yarns showing the effect of levels of STT-twist are given in Table IV. It can be seen from Table IV that very fine RWCS wool yarns (the yarn can be described as a wool yarn because of its aesthetic appearance and the fact that the yarns' surface is predominantly wool[5]) with very low twist factors were spun into fairly strong yarns with a high extension at break. The results show, however, that different twist factors had relatively very little influence on the yarn

TABLE IV

YARN PHYSICAL PROPERTIES OF WOOL REPCO WCS YARN

Yarn linear density (tex)	STT twist (turns/m)	Yarn linear density* (tex) (actual)	Breaking Strength (cN)	Tenacity (cN/tex)	Extension (%)	Irregularity (CV %)	Thin places per 1 000 m	Thick places per 1 000 m	Neps per 1 000 m	Friction (cN)
14	S563	13,8	222	16,1	30,4	23,9	725	448	422	12—16
	S626	13,8	226	16,4	27,3	24,3	745	508	396	13—18
(RWCS wool)	S690	13,8	222	16,1	28,3	24,4	804	519	447	14—20
16	S527	15,3	228	14,9	23,5	22,5	518	285	289	12—16
	S585	15,1	228	15,1	26,3	23,2	611	352	274	12—18
(RWCS wool)	S645	15,3	221	14,5	27,2	22,6	546	232	258	12—25

*including 2 ends of 22 dtex f7 nylon

TABLE V

PHYSICAL PROPERTIES OF VARIOUS STRUCTURES KNITTED FROM REPCO WRAPPED CORE-SPUN WOOL YARNS AS COMPARED WITH SIMILAR FABRICS KNITTED FROM TEXTURED POLYESTER YARN

Fabric structure		Fabric No.	Composition (%)	Fabric mass (g/m²)	Fabric thickness (mm)	Martindale abrasion		Bursting strength (kN/m²)	Bagging (IR %)	Drape coefficient	
						Mass loss after 10 000 cycles (%)	Pilling* (IWS rating after 2 000 cycles)			24 cm	30 cm
Interlock	RWCS	1	70/30 wool/ nylon	188	0,89	3,4	5,0	807	54,0	55,7	21,0
	Control	2	100 per cent polyester	154	0,76	5,5	1,0	761	—	42,1	14,9
Crossmiss	RWCS	3	70/30 wool/ nylon	209	0,94	2,6	5,0	872	60,6	64,0	24,5
	Control	4	100 per cent polyester	169	0,85	4,3	1,3	884	65,1	48,5	17,1
Single pique	RWCS	5	70/30 wool/ nylon	193	0,95	10,5	5,0	738	52,3	71,9	31,3
	Control	6	100 per cent polyester	181	0,94	4,5	2,3	781	55,8	56,6	20,6
2/2 Twill double blister	RWCS	7	70/30 wool/ nylon	263	1,19	8,1	5,0	821	56,3	78,2	37,1
	Control	8	100 per cent polyester	154	1,11	3,1	1,3	881	58,0	61,4	23,4
Blister	RWCS	9	75/25 wool/ nylon	285	1,21	9,0	5,0	814	58,0	77,0	35,8
Piquette	RWCS	11	75/25 wool/ nylon	248	0,92	9,9	4,8	1007	53,0	77,4	36,4
	Control	12	100 per cent polyester	198	0,92	3,9	1,2	991	59,6	56,9	20,8

*1 is poor
5 is good

properties. The yarn irregularity CV (%) results, together with those given in Table II, indicate that the irregularity CV (%) of the RWCS yarns was high, and was partially due to the fact that a relatively short wool (m.f.l. 61 mm) was used. In fact, it has been shown elsewhere[7] that the irregularity of RWCS yarns is relatively higher when compared with ringspun singles all-wool yarns even when longer wool (m.f.l. 77 mm) was used. It was decided that an STT tex twist factor of 24,0 would be used in future trials.

(b) Knitting of Different Structures

All the structures were knitted without difficulty from RWCS wool and polyester yarns, except in the case of the blister fabric where it was not possible to knit using the 12 tex polyester yarn because of excessive yarn breakages probably due to the high friction of this yarn.

It must be borne in mind that up to now knitting all-wool yarns on 28 gg gauge double jersey machines has been completely impractical, yet these extremely fine RWCS yarns knitted without *any breakages*, although a certain amount of fly was evident. As the knittability of the yarns was also found to be very sensitive to the takedown tension of the machine, strict control was necessary and a medium tension gave the best results. On occasion problems were encountered when the yarn passed over a rough surface causing the wool fibres to run up the filament, especially in the case of the yarn with a low twist factor (21,1). Care had, therefore, to be taken to ensure that the path of the yarn on the machine was snag free. (This would appear to be a problem peculiar to knitting as this problem did not arise in the case of RWCS mohair yarns woven as a weft yarn[4]).

The RWCS wool fabrics had a composition of either approximately 70/30 or 75/25 per cent wool/nylon depending on whether the yarn used was 12 or 14 tex yarn respectively, and the controls were 100% polyester. The handle of the fabrics knitted from RWCS wool yarns resembled that of wool even though they contained about 30% synthetic fibre, the reason for this being that the wrapper and core yarns tend to lie in the centre of the yarn after 2-for-1 twisting[5]. From Table V which gives the properties of the various structures, the following conclusions can be drawn.

The fabric mass of the Repco fabrics in all cases were again higher than those of the polyester controls due to relaxation shrinkage. They were also thicker, the reason being, as was mentioned earlier, relaxation and felting shrinkage of the wool fabrics during wet treatment in finishing. The general appearance of the double jersey fabrics was quite acceptable. In the case of the interlock and crossmiss structures, the Repco fabrics had better abrasion resistance than the polyester control fabric, but for the pique, piquette and blister structures the polyester fabrics showed a lower mass loss after 10 000 cycles than the RWCS wool fabrics. In all cases the wool fabrics were far superior to the polyester fabrics in respect of pilling and had much higher drape coefficients which in this case is desirable. The polyester fabrics, however, had better resistance to bagging while the bursting strength of the wool fabrics did not differ much from those of the polyester fabrics.

SUMMARY AND CONCLUSIONS

Repco wrapped core-spun wool yarns as fine as 12 tex have been produced on the Repco spinner and knitted into fine gauge (28) double jersey fabrics with a probable end use in lightweight ladies outerwear. All the yarns could be knitted under commercial conditions without difficulty.

A comparison of the yarn properties of the RWCS yarns and of staple polyester yarn of equivalent linear densities revealed that, although the polyester yarns had greater breaking strength and were more regular, the wool yarns had higher extension at break. As far as the fabric properties were concerned, the wool knitwear was superior especially in respect of pilling and drape. In some cases the polyester fabrics had better abrasion resistance and bursting strength. The wool fabrics were inclined to be heavier than the polyester fabrics after wet treatment due to shrinkage of the fabrics during finishing.

ACKNOWLEDGEMENTS

The authors wish to record their thanks to Mr S. Marsland for spinning the RWCS wool yarns and to Messrs Fabrina (Pty) Limited, Pinetown, for the use of their 28gg double jersey knitting machine.

Permission of the S.A. Wool Board to publish these results is also acknowledged.

REFERENCES

1. Allen, L.A. and Benson, M.R. Filament Blend Yarns and Their Application. *Wool Science Review,* No. 52, 2, (May, 1976).
2. CSIRO. SELFIL: A New Spinning System. CSIRO Division of Textile Industry. (July, 1975).
3. Turpie, D.W.F., Marsland, S.G. and Robinson, G.A., Production of Mohair Yarns on the Repco Spinner. Part I: Some Preliminary Spinning Trials. *SAWTRI Techn. Rep.* No. 296 (April, 1976).
4. Robinson, G.A., Marsland, S.G. and Ellis, R., Production of Mohair Yarns on the Repco Spinner. Part II: The Spinning of Wrapped Core-Spun Mohair Yarns and their Use in Lightweight Mohair Suiting Fabrics. *SAWTRI Techn. Rep.* No. 335 (Jan. 1977).
5. Robinson, G.A., Turpie, D.W.F., Fabrics from Repco Wrapped Core-Spun Yarns. Paper given at Symposium on New Developments in Fabric

Manufacture. College of Advanced Technical Education, Port Elizabeth. (17th Aug. 1977).
6. Smuts, S. and Hunter, L., Studies of Some Wool/Acrylic Woven Fabrics, Part I: Untreated Plain and 2/2 Twill Weave Fabrics from Wool Blended with Regular Acrylic. *SAWTRI Techn. Rep.* No. 305 (June, 1976).
7. Turpie, D.W.F. and Marsland, S.G., A Note on the Evenness Characteristics of Repco Wrapped Core-Spun Wool Yarns. *SAWTRI Bulletin,* **11** (3) 24. (September, 1977).

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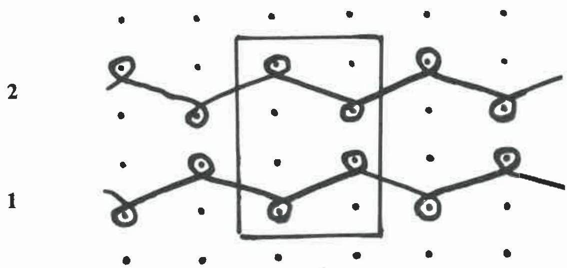
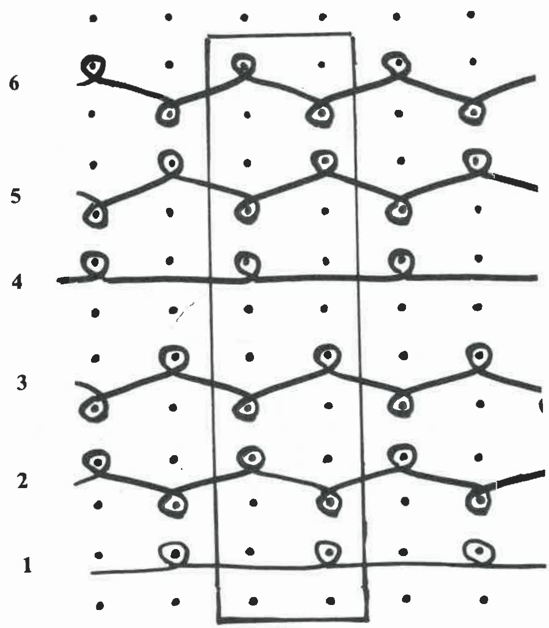
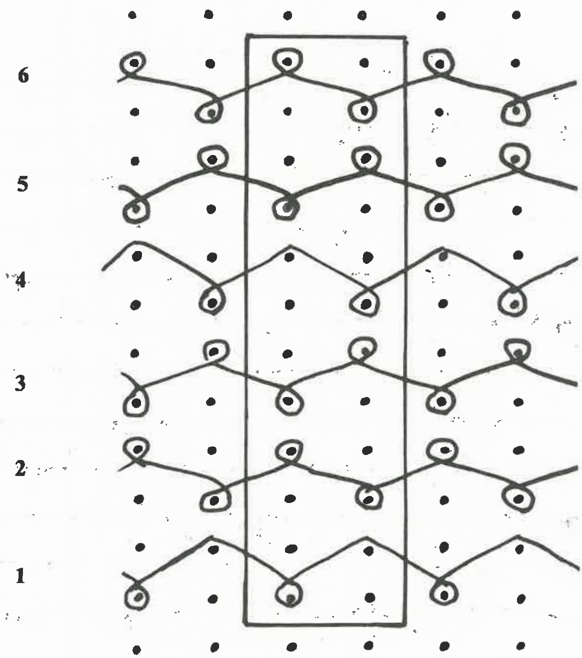
APPENDIX I



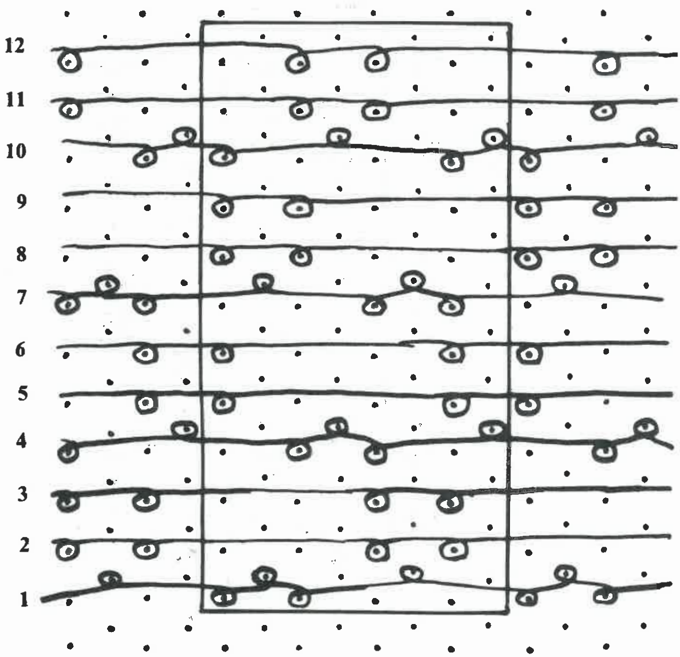
Interlock



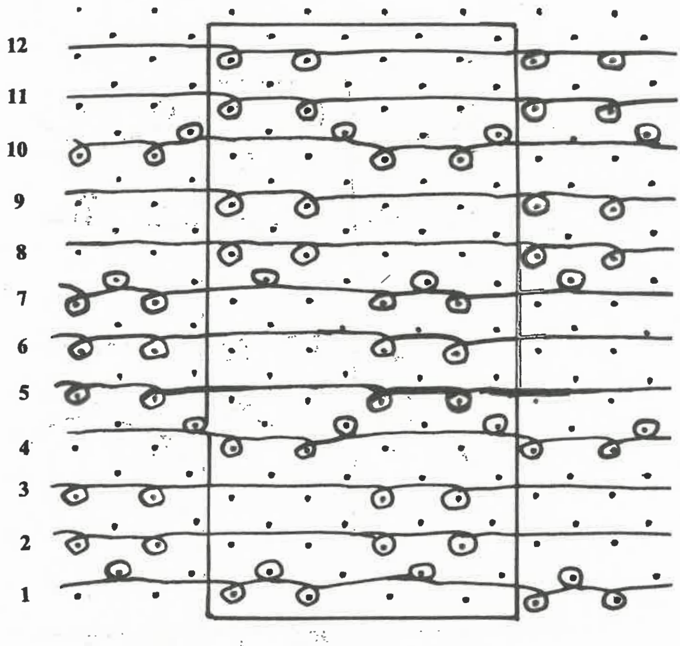
Crossmiss Interlock



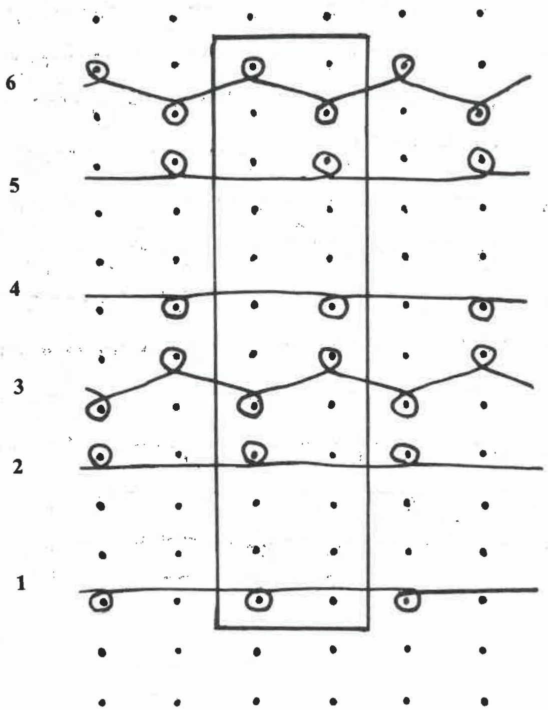
Single pique



Double Blister
(2/2 twill effect)



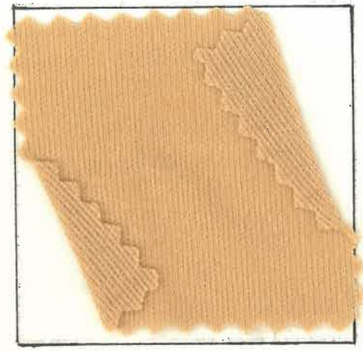
Double Blister
(Hopsack effect)



Piquette

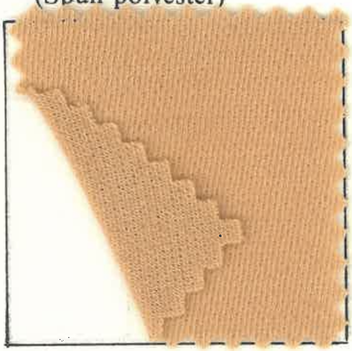
APPENDIX II
28gg DJ FABRIC SAMPLES

1. Interlock
(RWCS wool yarn)

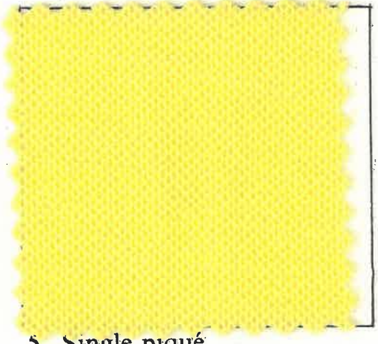


2. Interlock
(Spun polyester)

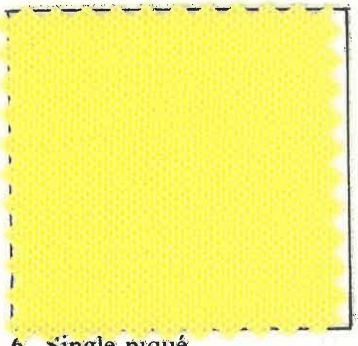
3. Crossmiss interlock
(RWCS wool yarn)



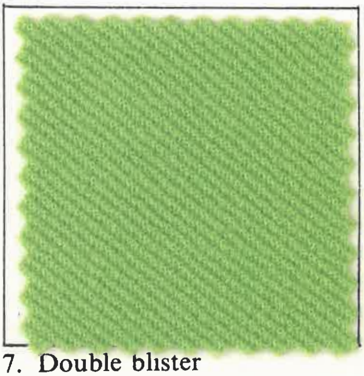
4. Crossmiss interlock
(spun polyester)



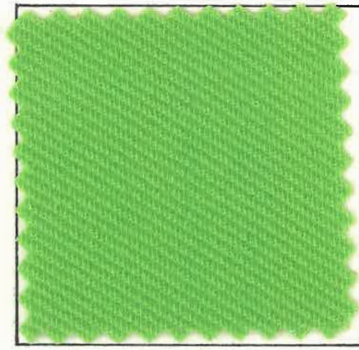
5. Single piqué
(RWCS wool yarn)



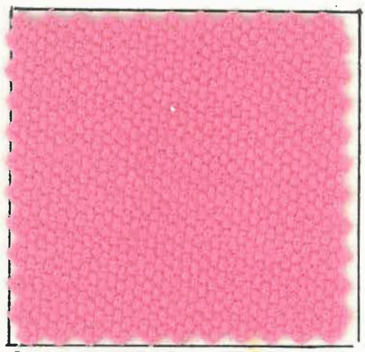
6. Single piqué
(spun polyester)



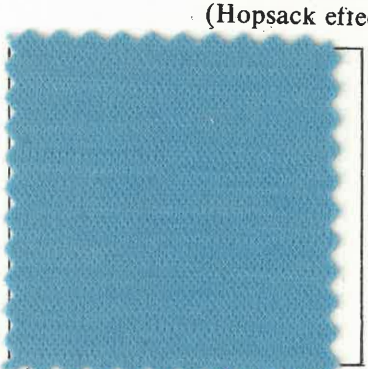
7. Double blister
(2/2 twill effect)
(RWCS wool yarn)



8. Double blister
(2/2 twill effect)
(spun polyester)



9. Double blister
(Hopsack effect) (RWCS wool yarn)



11. Piquette
(RWCS wool yarn)

12. Piquette
(spun polyester)