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INCORPORATION OF SMALL PERCENTAGE OF LENO USING CONTINUOUS FILAMENT YARNS IN LIGHTWEIGHT WOOL WORSTED FABRICS

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ABSTRACT

The effect of incorporating leno and up to 5 per cent of either multifilament or monofilament nylon into lightweight worsted suitings is described. Some of the fabrics were shrink-resist treated. All the fabrics were tested for physical and easy-care properties and it was shown that a combination of leno and filament yarns gave improved performance. Monofilament yarns caused no problems in weaving and of the two types of filament yarns used, these proved to be the most advantageous. Different shrink-resist treatments were tried and whilst felting shrinkage was eliminated, stiffness of the fabrics increased. It is recommended when reinforcing woven fabrics with synthetic yarns for improved properties that fine monofilament yarns be used.

KEY WORDS

Lightweight – wool-worsted fabrics – leno design – filament – yarns – physical properties – easy-care – wrinkling – stiffness – shrinkresistance.

INTRODUCTION

In a previous report[1] leno weave units were incorporated into plain all-wool ladies dress materials of an approximate mass of 160–180 g/m^2. The amount of leno, i.e. the number of half twists, was expressed as a percentage of the number of intersections per unit area in the fabric – namely the repeat of the design. It was shown that there were slight advantages accruing from this practice in respect of fabric wrinkling propensity and stiffness without detracting too much from the original fabric appearance. No attempt was made to use the leno twists for design purposes.

The present report deals with an extension of this work to include an investigation of the effect of incorporating fine filament yarns, as reinforcement in leno formation, into lightweight worsted men's suitings. The amount of filament yarn introduced was restricted to less than five *per cent* so that the fabrics could still comply with the Woolmark[2] specifications. Inevitably the filament yarns have a contrasting surface effect on the fabric and therefore introduce some design effect in the form of pin stripes into the fabrics. In the present investigation, however, the face side of the fabric was taken as the plain weave and the stripe effect can be clearly seen on the back of the fabric. (See Appendix II).

EXPERIMENTAL

A 50 kg lot of 64's quality South African Merino wool was spun into 24,5 tex Z640 yarn. The singles yarn was steamed at 110°C for 10 minutes after vacuuming at 660 mm of mercury for 2 minutes and then repeated.

The yarn was then cleared on an Uster Classimat after which it was plied to give R49 tex S500/2Z 640 yarns. After plying, the yarns were steam set again as described above.

It was decided to use nylon filament yarn rather than polyester. Factors affecting the choice were price, availability and ease of dyeing and finishing in respect of piece dyeing of the fabrics.

Preliminary work carried out with a 78 dtex f20 multifilament nylon yarn showed that there were excessive breakages and filamentation. It was decided to use 110 dtex f34 Z200 nylon yarn instead. However, the weavability of this filament warp was still considered unsatisfactory and an additional 100 t.p.m. of twist was inserted and further trials carried out. Although increasing the twist of the 110 dtex f34 yarn improved the weaving performance it was decided to carry out sizing of this uptwisted yarn.

Sizing of multifilament warps:

The filament warp yarn was sized with Bevaloid 2A according to Bevaloid Technical Bulletin[3] using the recommendations for nylon 66 producer twist yarn of low linear densities. The 110 dtex f34 Z300 filament nylon yarn was warped on a Hergeth Sample Warping machine and the following solution applied by immersion:

Bevaloid 2A (Bevaloid)	:	5 kg
Bevaloid 7186 lubricant	:	200 g
Add water to make 20 ℓ		

The size was applied at 50°C with a quetsch pressure of 200 kgf . The warp was dried by infra-red heaters, leased and beamed.

Weaving:

(a) **Incorporating Multifilament Nylon Leno Ends:**

Five fabrics were woven on a Saurer 100 WT 4 box, 190 cm wide weaving machine, equipped with dobby and leno attachments. The machine was set up with one set of leno doup healds and double beams. Flat steel leno healds were used. Of the five fabrics produced – all from the same looming plan – one was an all-wool plain weave control, and three were plain weaves of various mass with synthetic leno reinforcing threads in the weave, and the fifth fabric was woven as a check design with some filament yarn woven as a weft. (See Appendix I for draft and Weave Diagram. Fig. 1).

The warping and fabric details are given in Tables I and II.

Fabric 2 was an all-wool plain weave construction plus leno reinforcement in nylon (composition 97 *per cent* wool, 3 *per cent* nylon). The density used was 2.2.2.4/22 dents per inch in the reed because of the additional two ends of filament to every eight ends of wool yarn. Fabric 1 was made exactly as fabric 2 but with the filament leno ends removed, (i.e. 100 *per cent* wool in plain weave) and was used as a control. The third fabric was made to a fabric density approximately 10 *per cent* less than that of fabric 2 (composition also 97 *per cent*

TABLE I

WARP AND FABRIC DETAILS (MULTIFILAMENT YARNS)

Fabric No.	Warp Details		Reed Denting (dents/inch)	Weave	Finished Ends X Picks (per cm)
	Ground Beam	Leno Beam			
1	2 904 ends R49 tex/2 All-wool	–	2/22	plain	21,2 x 20,4
2	2 904 ends R49 tex/2 All-wool	726 ends 110 dtex f34 Z300 nylon (SIZED)	2.2.2.4/22	plain + 10% leno	25,2 x 20,4
3	2 508 ends R49 tex/2 All-wool	627 ends 110 dtex f34 Z300 nylon (SIZED)	2.2.2.4/19	plain + 10% leno	22,0 x 18,8
4	2 244 ends R49 tex/2 All-wool	561 ends 110 dtex f34 Z300 nylon (SIZED)	2.2.2.4/17	plain + 10% leno	21,2 x 18,8
5.	As No. 4	As No. 4	As No. 4	As No. 4 plus weft checking	20,0 x 18,4

TABLE II

WARP AND FABRIC DETAILS (MONOFILAMENT YARNS)

Fabric No.	Warp Details		Reed Denting	Weave	Finished Ends X Picks (per cm)
	Ground Beam	Leno Beam			
6	2 904 ends R40 tex/2 All-wool	726 ends 165 dtex nylon (mono-filament)	2.2.2.4/22	Plain weave + 10% leno	26,4 x 18,0
7	As No. 6	726 ends 110 dtex nylon (mono-filament)	As No. 6	As No. 6	25,2 x 18,8
8	As No. 6	726 ends 88 dtex nylon (mono-filament)	As No. 6	As No. 6	26,4 x 18,0
9	As No. 6	As No. 8	As No. 6	plain weave + 20% leno	25,6 x 18,0

wool, 3 *per cent* nylon). Fabric 4 was made approximately 10 *per cent* lighter again (composition also 97 *per cent* wool, 3 *per cent* nylon) and fabric 5 was produced exactly as fabric 4 with the exception that a filament weft was also used to produce a check pattern – two picks of filament to ten picks of wool. The composition of this fabric was 95 *per cent* wool, 5 *per cent* nylon.

(b) **Incorporating Monofilament Nylon Leno Ends:**

In the light of difficulties encountered in weaving the multifilament synthetic yarns, and the added disadvantage of possibly having to size filament warps under commercial manufacturing conditions, (a factor which could present a problem to most worsted manufacturers) it was decided to carry out further trials utilising monofilament instead of multifilament nylon yarns.

In this part of the investigation the wool yarn used was R40 tex S550/2Z 705 and four fabrics were woven from the same looming plan.

Table II gives the warping and fabric details.

As can be seen from Table II fabrics 6 to 8 had the same amount of leno as fabrics 2 to 4 (Table I). Fabric 9 was modified so that the leno ends crossed after every pick and this represented 20 *per cent* leno (see Appendix I, Fig. 2). The reed denting was kept constant 2.2.2.4/22 for all the fabrics, so that the only variables were the linear density of the monofilament leno ends and the amount of leno and all the fabrics were produced at about the same mass per unit area.

All the fabrics were inspected, burled and mended before being dyed and finished.

Dyeing and Finishing:

All nine lengths of fabric were sewn together and treated as a single piece. The total length of fabric was then crabbed and Dolly scoured, hydro extracted and tenter dried.

The fabrics were then dyed to a Navy Blue shade using

5%	Anhydrous Na_2SO_4		
2%	Acetic Acid (80% conc.)		
1%	Albegal A	:	(Ciba-Geigy)
2,5%	Cibalan Blue BL	:	(Ciba-Geigy)
2,5%	Cibalan Navy Blue RL	:	(Ciba-Geigy)

The fabrics were finally hydro extracted, steamed and brushed, cropped twice on the face side (plain side) only and decatised.

Shrink-resistant treatments:

It was decided that it would be unnecessary to carry out shrinkresist treatments on all the fabrics. Only fabrics 2 to 4 were treated, because these were of a standard construction similar to fabrics 6 to 8. It was assumed that similar results would be obtained for both these groups of fabrics and therefore it was unnecessary to duplicate this work.

The three lengths of leno reinforced fabrics, No's 2, 3 and 4 were chlorinated with Basolan DC (DCCA) (BASF) at room temperature for 1,5 secs, in a Peter Konrad Padder. The DCCA contained 1 *per cent* (v/v) of a 50 *per cent* (v/v) sulphuric acid and 10 *per cent* Glacial Acetic Acid. Two levels of chlorination were carried out, namely 1,0 *per cent* and 1,5 *per cent*[4].

After drying, the six lengths of fabric were halved. One half (2a, 2b, 3a, 3b, 4a and 4b) is referred to as the DCCA treated fabrics, and the other half (2c, 2d, 3c, 3d, 4c and 4d) was resin treated [0,75 *per cent* aminoplast Aerotex M3 (Cyanamid)]. The resin and Polyethylene softener were applied[5] at the Artos Padder. The fabrics were dried and cured on the stenter.

Physical Properties:

Various physical properties of the fabrics were measured. The FRL wrinkling performance was assessed by measuring the standard deviation (in mm) of the FRL wrinkling curve, with the fabrics being wrinkled and allowed to recover at 65 *per cent* RH and 20°C. The crease recovery was measured under standard conditions (i.e. 65 *per cent* RH, 20°C) on a Monsanto Wrinkle Recovery Tester(6).

Deformability was measured according to a method proposed by Slinger and Godawa(7) and later slightly modified by Shiloh(8).

Relaxation shrinkage was measured according to the Dynamic Relaxation Shrinkage test, I.W.S. Test Method 9, and the felting shrinkage according to I.W.S. Test Method 185.

Appearance after home laundering was assessed according to a method similar to the AATCC Method(9). The fabrics were washed in a Barlow's Washerette drum type washing machine, on *normal wash* for 12 minutes at 60°C, after which they were tumble dried. After 5 such wash cycles the fabrics were allowed to condition before being rated for durable press.

RESULTS AND DISCUSSION

The results of the physical tests carried out on the untreated fabrics are shown in Tables III and IV. Table III lists various physical properties while Table IV lists properties related to easy-care.

Fabrics 1 and 2 could be compared because they were made to similar specifications with the exception that fabric 2 had leno reinforcement incorporated in the form of filament yarn which accounted for the difference in mass. It can be seen from Table III that the thickness of the fabric was unaffected by the leno crossing of the filament threads, probably because of the fineness of the filament yarns used. The extra ends of filament (extra mass), however, reduced the air-permeability of the fabric slightly. Neither of these fabrics showed any sign of pilling after 2 000 cycles, and the filament leno reinforced fabric had the higher abrasion resistance, higher breaking strength, lower extension at break and a higher bursting strength.

It has therefore, been shown that as far as the physical properties are concerned, the fabric containing filament leno reinforcement gave significantly better results.

Fabrics 2 to 5 all contained filament leno reinforcement, and were produced at a progressively lower mass per unit area to determine how much the density of the fabric could be reduced, while maintaining fabric stability and good physical properties. It can be seen from Table III that the thickness tended to increase when the warp and weft setts were reduced. The air-permeability increased progressively. While none of the fabrics showed signs of pilling after 2 000 cycles on the Martindale Tester, their abrasion resistance dropped significantly.

TABLE III

PHYSICAL PROPERTIES OF THE UNTREATED CONTROL FABRICS – PLAIN AND LENO REINFORCED USING MULTIFILAMENT YARNS

FABRIC NUMBER	Mass/Unit Area (g/m²)	Thickness at 5 g/cm² pressure (mm)	Air-Permeability (cm³/sec/cm² of Fabric/cm Water Pressure)	MARTINDALE ABRASION		BREAKING STRENGTH (kgf)			EXTENSION AT BREAK (%)			Bursting Strength (kgf/cm²)
				Mass Loss % at 2500 Cycles	Number of Cycles to End Point	Warp	Weft	Mean	Warp	Weft	Mean	
1. Plain (100% wool)	222	0,52	10,6	3,6	>10 000	33,1	30,3	31,7	32,7	30,8	31,8	8,4
2. Plain + leno (97% wool/3% nylon)	228	0,52	8,3	2,2	>10 000	40,8	33,4	37,1	28,5	28,5	28,5	9,5
3. Plain + leno (97% wool/3% nylon)	201	0,57	19,1	5,3	5 400	34,9	27,2	31,1	25,2	22,8	24,0	8,5
4. Plain + leno (97% wool/3% nylon)	196	0,63	28,2	8,6	4 800	29,9	25,4	27,7	23,0	26,5	24,8	7,7
5. Plain + leno (check) (95% wool/5% nylon)	183	0,59	37,2	11,1	4 000	27,0	27,3	27,2	21,7	26,7	24,2	7,8

TABLE IV

DRAPE, STIFFNESS AND EASY-CARE PROPERTIES OF UNTREATED CONTROL FABRICS – PLAIN AND LENO REINFORCED USING MULTIFILAMENT YARNS

FABRIC NO.	DRAPE COEFFICIENT (%)	BENDING LENGTH (cm)			FLEXURAL RIGIDITY (mgf-cm/cm)			FRL WRINKLING (SD in mm of FRL wrinkling curve)			MONSANTO CREASE RECOVERY ANGLES (°)			RELAXATION SHRINKAGE (% Area)	FELTING SHRINKAGE (% Area)	DURABLE PRESS RATING
		Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Warp/Weft			
1. Plain (100% wool)	54	1,70	1,63	1,67	111	97	104	0,13	0,10	0,11	157	157	314	6,2	27,8	1,0
2. Plain + leno (97% wool/3% nylon)	52	1,68	1,67	1,68	108	106	107	0,12	0,10	0,11	157	160	317	2,9	36,4	1,0
3. Plain + leno (97% wool/3% nylon)	49	1,70	1,63	1,67	102	88	95	0,12	0,12	0,12	158	159	317	8,2	43,7	1,0
4. Plain + leno (97% wool/3% nylon)	49	1,68	1,58	1,63	92	78	85	0,10	0,11	0,10	156	158	314	9,5	53,1	1,3
5. Plain + leno check (95% wool/5% nylon)	49	1,41	1,61	1,51	53	77	65	0,15	0,11	0,13	155	156	311	8,5	52,3	1,3

TABLE V

PHYSICAL PROPERTIES OF TREATED FABRICS (MULTIFILAMENT YARNS)

FABRIC NO.	TREATMENT	Mass/Unit Area (g/m²)	Thickness at 5 gf/cm² pressure (mm)	Air-Permeability (cm³/sec/cm² of fabric/cm Water Pressure)	MARTINDALE ABRASION		BREAKING STRENGTH (kgf)			EXTENSION AT BREAK (%)			Bursting Strength (kgf/cm²)
					% Mass loss at 2 500 Cycles	Number of Cycles to End Point	Warp	Weft	Mean	Warp	Weft	Mean	
2 (97% wool/ 3% nylon)	Untreated control	228	0,52	8,3	2,2	> 10 000	40,8	33,4	37,1	28,5	28,5	28,5	9,5
2 (a)	1% Chlorine (DCCA)	229	0,58	10,3	2,9	> 10 000	39,4	38,3	38,9	35,5	37,0	36,3	9,7
2 (b)	1% Chlorine + 0,75% resin	237	0,56	9,8	2,4	> 10 000	40,8	36,3	38,6	32,0	32,5	32,3	9,5
2 (c)	1,5% Chlorine (DCCA)	228	0,57	12,3	2,7	> 10 000	40,5	37,0	38,8	36,8	32,7	34,8	9,6
2 (d)	1,5% Chlorine + 0,75% resin	229	0,55	12,6	2,7	> 10 000	39,9	36,1	38,0	30,5	35,0	32,8	9,4
3 (97% wool/ 3% nylon)	Untreated control	201	0,57	19,1	5,3	5 400	34,9	27,2	31,1	25,2	22,8	24,0	8,5
3(a)	1% Chlorine (DCCA)	204	0,60	21,1	4,0	> 10 000	38,1	31,9	35,0	30,0	29,5	29,8	8,7
3(b)	1% Chlorine + 0,75% resin	211	0,60	18,3	4,5	> 10 000	35,0	30,8	32,9	27,5	29,0	28,3	8,5
3(c)	1,5% Chlorine (DCCA)	198	0,60	26,6	5,2	9 800	38,5	32,9	35,7	30,7	36,0	33,4	8,5
3(d)	1,5% Chlorine + 0,75% resin	204	0,60	24,0	4,3	> 10 000	33,7	31,7	32,7	25,5	28,5	27,0	8,5
4 (97% wool/ 3% nylon)	Untreated control	196	0,63	28,2	8,6	4 800	29,9	25,4	27,7	23,0	26,5	24,8	7,7
4(a)	1% Chlorine (DCCA)	193	0,72	38,8	17,2	2 600	30,6	26,9	28,8	25,2	29,0	27,1	7,6
4(b)	1% Chlorine + 0,75% resin	196	0,66	45,1	13,4	3 200	31,2	26,8	29,0	27,2	23,7	25,5	7,7
4(c)	1,5% Chlorine (DCCA)	186	0,62	48,6	13,5	2 800	29,4	28,7	29,1	36,3	27,7	32,0	7,9
4(d)	1,5% Chlorine + 0,75% resin	195	0,64	48,3	10,5	4 600	29,3	29,5	29,4	26,2	30,5	28,4	7,7

TABLE VI

DRAPE, STIFFNESS AND EASY-CARE PROPERTIES OF TREATED FABRICS (MULTIFILAMENT YARNS)

Fabric No.	Treatment	Drape Coefficient (%)	Bending Length (cm)			Flexural Rigidity (mgf-cm²/cm)			FRL Wrinkling (SD in mm of FRL wrinkling curve)			Monsanto Crease Recovery Angles (°)			Relaxation Shrinkage (% area)	Felting Shrinkage (% area)	Durable Press Rating
			Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Mean			
2	Untreated control (97% wool/3% nylon)	52	1,68	1,67	1,68	108	106	107	0,12	0,10	0,11	157	160	317	2,9	36,4	1,0
2(a)	1% Chlorine (DCCA)	59	1,80	1,57	1,69	134	88	111	0,13	0,10	0,12	155	157	312	0,9	0,3	3,6
2(b)	1% Chlorine + 0,75% resin	56	1,67	1,76	1,72	112	129	121	0,14	0,15	0,15	153	153	306	0,9	0,8	3,8
2(c)	1,5% Chlorine (DCCA)	61	1,79	1,87	1,83	134	150	142	0,14	0,17	0,15	155	155	310	2,2	0,3	3,8
2(d)	1,5% Chlorine + 0,75% resin	57	1,71	1,77	1,74	115	126	121	0,13	0,14	0,13	156	157	313	2,1	0,8	3,5
3	Untreated control (97% wool/3% nylon)	49	1,70	1,63	1,67	102	88	95	0,12	0,12	0,12	158	159	317	8,2	43,7	1,0
3(a)	1% Chlorine (DCCA)	54	1,73	1,72	1,73	109	106	108	0,12	0,10	0,11	153	153	306	5,5	-1,0	3,6
3(b)	1% Chlorine + 0,75% resin	51	1,65	1,68	1,67	95	101	98	0,11	0,11	0,11	154	155	309	4,8	0,5	3,6
3(c)	1,5% Chlorine (DCCA)	61	1,86	1,77	1,82	127	111	119	0,14	0,17	0,15	156	154	310	5,4	-0,7	3,7
3(d)	1,5% Chlorine + 0,75% resin	56	1,73	1,75	1,74	106	109	108	0,10	0,14	0,12	156	157	313	5,5	-1,0	3,6
4	Untreated control (97% wool/3% nylon)	49	1,68	1,58	1,63	92	78	85	0,10	0,11	0,10	156	158	314	9,5	53,1	1,3
4(a)	1% Chlorine (DCCA)	58	1,68	1,69	1,69	91	95	93	0,11	0,19	0,15	155	153	308	5,6	0,2	3,7
4(b)	1% Chlorine + 0,75% resin	56	1,61	1,87	1,74	81	133	107	0,11	0,17	0,14	158	156	314	7,1	0,8	3,7
4(c)	1,5% Chlorine (DCCA)	72	1,79	2,33	2,06	107	234	171	0,16	0,26	0,21	154	154	308	7,5	-0,2	3,2
4(d)	1,5% Chlorine + 0,75% resin	60	1,62	2,01	1,82	83	157	120	0,23	0,21	0,22	154	156	310	5,3	0,5	3,5

TABLE VII

PHYSICAL PROPERTIES OF UNTREATED FABRICS – PLAIN AND LENO REINFORCED USING MONOFILAMENT YARNS

Fabric No.	Mass/Unit Area (g/m²)	Thickness at 5 g/cm² Pressure (mm)	Air-Permeability (cm³/sec/cm² of Fabric/cm Water Pressure)	Martindale Abrasion				Breaking Strength (kgf)			Extension at Break (%)			Bursting Strength (kgf/cm²)
				% Mass Loss			Number of cycles to end point							
				2500 Cycles	5000 Cycles	10000 Cycles		Warp	Weft	Mean	Warp	Weft	Mean	
6 (95% wool/5% nylon)	193	0,64	18,8	1,7	4,8	7,8	> 10 000	43,8	24,4	34,1	39,0	29,9	34,5	8,6
7 (96% wool/4% nylon)	187	0,60	20,2	3,0	4,8	7,8	> 10 000	41,2	25,6	33,4	39,8	29,3	34,6	8,3
8 (97% wool/3% nylon)	182	0,54	20,4	3,3	5,0	7,9	> 10 000	36,2	23,1	29,7	27,6	28,3	28,0	8,1
9 (96% wool/4% nylon)	186	0,52	19,8	2,6	3,9	5,5	> 10 000	30,2	23,7	27,0	32,3	27,0	29,7	7,5

TABLE VIII

DRAPE, STIFFNESS AND EASY-CARE PROPERTIES OF UNTREATED FABRICS – PLAIN AND LENO REINFORCED USING MONOFILAMENT YARNS

Fabric No.	Drape Coefficient %	Bending Length (cm)			Flexural Rigidity (mgf-cm²/cm)			FRL Wrinkling (SD in mm of FRL wrinkling curve)			Monsanto Crease Recovery Angles (°)			Relaxation Shrinkage (% Area)	Felting Shrinkage (% Area)	Durable Press Rating
		Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Mean	Warp	Weft	Mean			
6 (95% wool/5% nylon)	61	2,40	1,51	1,96	270	66	168	0,11	0,16	0,12	153	159	312	6,8	29,5	2,9
7 (96% wool/4% nylon)	60	2,11	1,58	1,85	176	74	125	0,12	0,15	0,13	153	154	307	6,4	26,2	3,2
8 (97% wool/3% nylon)	56	2,04	1,53	1,79	155	65	110	0,09	0,18	0,13	155	156	311	6,8	33,9	2,4
9 (96% wool/4% nylon)	54	1,81	1,57	1,69	110	72	91	0,10	0,16	0,13	160	159	319	4,8	21,5	2,0

Breaking strength, extension at break, and bursting strength followed a similar pattern, showing that although the fabrics 2 to 5 were reinforced with leno filament threads there was a practical limit to the fabric mass due to the adverse changes in physical properties.

TABLE IX

THE EFFECT OF INCORPORATING LENO USING SYNTHETIC FILAMENT YARNS ON THE DEFORMABILITY OF CERTAIN UNTREATED FABRICS

Fabric No.	Mass/ Unit Area (g/m²)	Deformability % (Immediate)		
		Warp	Weft	Total
1. Plain (100% wool) Control	222	1,24	1,70	2,94
2. Plain + 10 *per cent* leno (97% wool/3% Nylon) (Multifilament)	228	1,47	1,35	2,82
3. Plain + 10 *per cent* leno (97% wool/3% nylon) (Multifilament)	201	1,37	1,30	2,67
4. Plain + 10 *per cent* leno (97% wool/3% nylon) (Multifilament)	196	1,14	2,44	3,58
5. Plain + 10 *per cent* leno (Check) (95% Wool/5% nylon) (Multifilament)	183	0,94	1,90	2,84
9. Plain + 20 *per cent* leno (96% wool/4% nylon) (Monofilament)	186	0,98	2,41	3,39

The deformability of certain fabrics are shown in Table IX. If the values for fabrics 1 and 2 are compared it appears that incorporating filament leno did not significantly affect the deformability. It is interesting to note, however, that the deformability of the multifilament fabrics in the warp direction decreased as the fabric mass per unit area decreased.

It can be seen that fabrics 5 and 9 had the lowest deformability in the warp direction even though they had the lowest mass per unit area, possibly due to the increased percentage of filament yarn in the case of fabric 5 and the increased percentage of leno in the case of fabric 9. In the case of fabrics 2 and 3 there was only a marginal difference in the percentage deformability in the weft direction of the fabrics. Fabric 4 (lowest mass of the three multifilament fabrics) had a high weft deformability which was reduced when weft checking was introduced (fabric 5). Fabric 9 (low mass 186 g/m^2) also had a high weft deformability.

When comparing fabrics 1 and 2 (Table IV) it can be seen that the leno reinforced fabrics had a slightly lower drape coefficient. Bending length, flexural rigidity, FRL wrinkling, and crease recovery angles did not show any significant differences. However, relaxation shrinkage of the leno fabric 2 was less than the control fabric 1. When fabrics 2 to 5 are compared it can be seen that a reduction in fabric density was accompanied by a decrease in the drape coefficient, but all the fabrics draped well and were not considered too limp. Bending length and flexural rigidity also decreased. FRL wrinkling nor the crease recovery angles showed any appreciable deterioration. Relaxation shrinkage and felting shrinkage progressively increased as the fabrics became lighter. The durable press ratings of the untreated fabrics were poor.

Table V lists the physical properties of the shrink-resist treated fabrics as well as those of the untreated control fabric for each of the three fabric densities woven. All the fabrics in this table contained synthetic leno reinforcement. The fabrics had not been decatised after curing at the stenter, and therefore an increase in fabric thickness can be seen with a resulting increase in the openness of the fabric, causing the treated fabrics generally to have higher air-permeabilities.

Generally speaking for fabrics 2 to 4 chlorination at either the 1 *per cent* or 1,5 *per cent* level or the addition of resin, did not affect the abrasion resistance consistently, but did tend to increase the tensile properties of the fabrics. Table V shows that the chlorination with or without resin affects the drape of the fabric. All the treated fabrics showed increased drape coefficients, the 1,5 *per cent* chlorination affecting the drape to such an extent as to make the fabric quite stiff. The addition of resin at both the 1 *per cent* and 1,5 *per cent* level of chlorination reduced this stiffness quite considerably, which was rather surprising.

The bending length and flexural rigidity results confirmed the drape results in nearly every case, the treated fabrics were stiffer than the untreated controls, and in general the 1,5 *per cent* chlorinated fabrics were stiffer than the 1 *per cent* chlorinated fabrics. The treatment also had a small adverse effect on the FRL wrinkling and crease recovery angles.

All the treated fabrics showed improved relaxation shrinkage. Felting shrinkage was eliminated, and the durable press ratings for the fabrics were fairly good.

The results of the physical tests carried out on the untreated fabrics 6 to 9 (monofilament), are shown in Tables VII and VIII.

Table VII lists the physical properties and Table VIII lists the properties more associated with easy-care. A comparison of fabrics 6 to 8 shows the effect of the use of monofilaments of various linear densities, while a comparison of fabrics 8 and 9 shows the effect of added leno intersections for a similar constructional composition.

It can be seen from Table VII that all the fabrics were of about the same mass per unit area (190 g/m^2), although the mass of fabric 6 containing 165 dtex nylon monofilament was the highest and fabric 8 containing 88 dtex the lowest. Fabric 9 showed a slight increase in mass on fabric 8 because of the extra filament yarn involved in producing the higher leno content. Thickness, air-permeability, abrasion, breaking strength, extension and bursting strength all varied slightly in direct proportion to the linear density of the filament yarn used.

Comparing fabrics 4 and 5 (Table III) with fabrics 6 to 9 (Table VII) it can be seen that the monofilament fabrics were generally better in virtually all respects – especially in respect of air-permeability and abrasion resistance. This improvement in physical properties could have been influenced slightly by the fact that in the case of fabrics 6 to 9 the ends per centimetre were a little higher to ensure the same fabric mass per unit area with slightly finer yarns, and in all probability cannot be accredited to the leno monofilament yarns used.

From Tables IV and VIII it can be seen that the fabrics 6 to 8 had higher drape coefficients and were stiffer than fabrics 2 to 4, and it can generally be said that the fabrics containing multifilament yarns therefore had better properties as far as handle was concerned. In the case of easy-care properties, the relaxation shrinkage and felting shrinkage of fabrics 6 to 9 were less than in fabrics 2 to 5, and the durable press ratings were also much improved. It can be assumed that the treatment which resulted in the improvement of these properties, would in fact give similar improved properties in fabrics 6 to 9, making them superior.

Fabric 9 had a lower drape coefficient, stiffness and shrinkage than fabric 8, and could be regarded as a very acceptable fabric. All the fabrics were tested by the South African Wool Board's Technical Service Division and approved for the Woolmark.

During weaving of fabrics 6 to 9 (monofilament) it was noted that the monofilament yarns wove very well and that there was also a noticeable improvement in the general weaving of the worsted yarn.

It was decided to compare fabrics 1, 4 and 9 for the effect of wrinkling under high humidity conditions, and the results are shown in Table X.

TABLE X

THE EFFECT OF INCORPORATING LENO USING SYNTHETIC FILAMENT YARNS ON WRINKLING UNDER HIGH HUMIDITY AND TEMPERATURE CONDITIONS

Fabric No.	Mass/ Unit Area g/m^2	FRL Wrinkling (SD in mm of FRL wrinkling curve)*		
		Warp Creased	Weft Creased	Mean
1. Plain weave Control (100% wool)	222	1,29	1,48	1,38
4 Plain + 10 *per cent* leno (97% Wool/3% Nylon *multi*filament)	196	1,13	0,98	1,05
9 Plain + 20 *per cent* leno (96% Wool/4% Nylon *mono*filament)	186	1,08	1,04	1,06

*Wrinkled at 75% RH, 27°C, and allowed to recover at 65% RH, 20°C

From the results in Table X it can be seen that the 100 *per cent* all-wool plain fabric 1 of mass 222 g/m^2 wrinkled more than fabrics 4 and 9 which, even though they were lighter, contained leno filament reinforcing. There was no significant difference in the wrinkling performance of fabrics 4 and 9.

SUMMARY AND CONCLUSIONS

Leno reinforcement of fabrics using synthetic yarns had been investigated. Multifilament yarns with added twist, were sized and woven into a range of fabrics. Filamentation was encountered and therefore further experiments were carried out using monofilament yarns and it can be recommended that when reinforcing woven fabrics with synthetic yarns either for improved properties or design purposes (e.g. stripes) that monofilament yarns be used.

Shrinkresist treatments were carried out on the multifilament fabrics and the tests showed that although felting shrinkage was eliminated and durable press ratings improved, many other physical properties such as abrasion resistance, drape, wrinkling, etc., deteriorated. Fabrics containing multifilament leno threads had better handle properties than those containing monofilament yarns.

The inclusion of leno reinforcing can give added design characteristics such as pin stripes, and it was shown that the physical properties were improved, and especially so when fine monofilament yarns were utilised.

Increasing the percentage of leno to 20 *per cent* showed that in general improved physical properties were obtained than with a similar fabric containing only 10 *per cent* leno.

ACKNOWLEDGEMENTS

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THE USE OF PROPRIETARY NAMES

The fact that chemicals with proprietary names have been used in this investigation does not imply that SAWTRI recommends them or that there are not others equally as good or better.

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APPENDIX I
WEAVE DIAGRAMS AND DRAFT

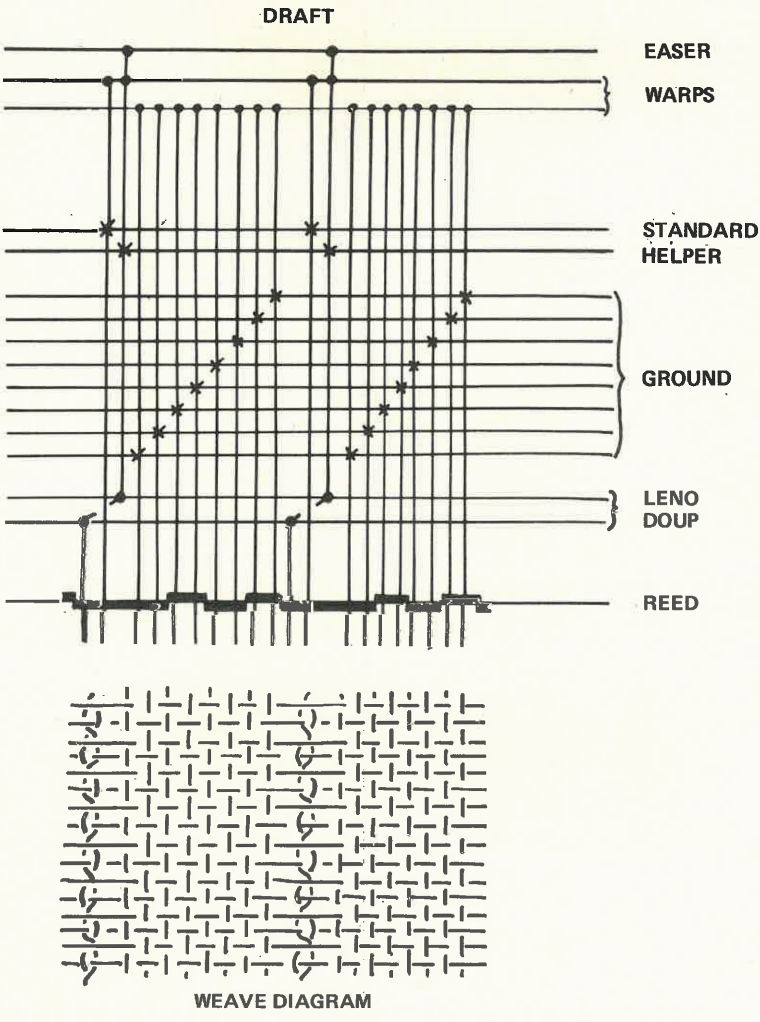


FIGURE 1

Draft and Weave Diagram for fabrics 2–4; 6–8

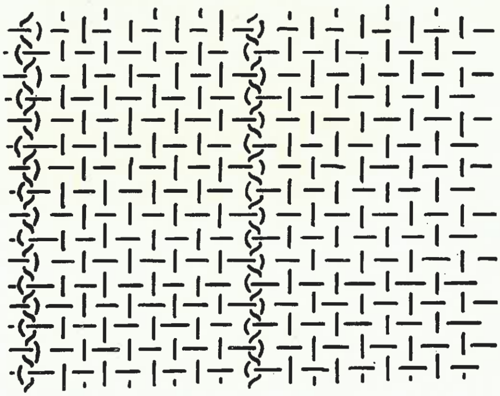
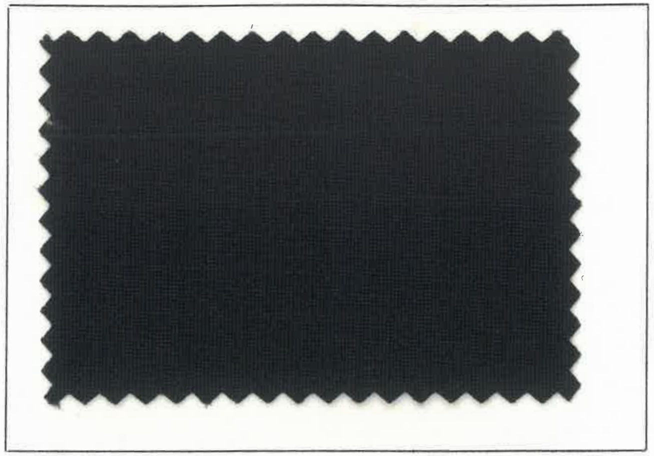


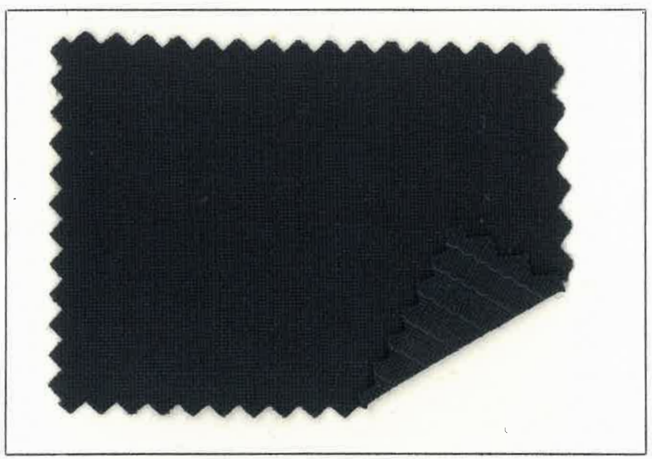
FIGURE 2
Weave diagram for fabric 9

APPENDIX II



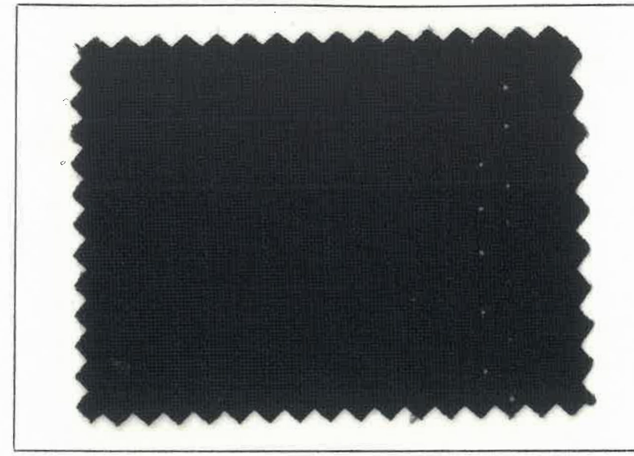
FABRIC NO. 1

Plain weave control fabric
100% Wool 222 g/m²
Untreated



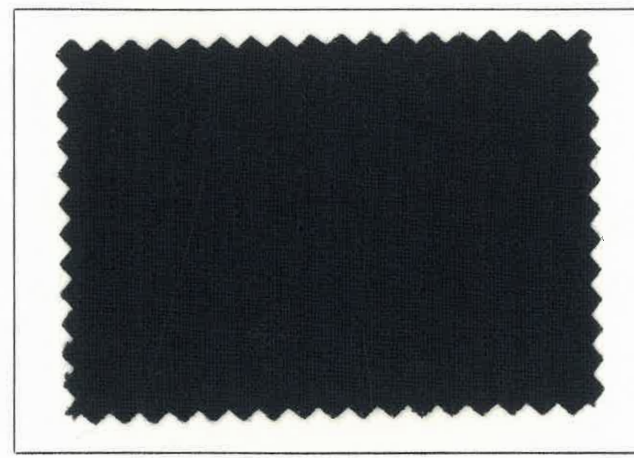
FABRIC NO. 2

Plain weave fabric reinforced with: 10% leno in multifilament nylon 97% Wool 3% Nylon 228 g/m²
Untreated



FABRIC NO. 2d

Plain weave fabric reinforced with: 10% leno in multifilament nylon 97% Wool 3% Nylon 229 g/m²
Treated



FABRIC NO. 9

Plain weave fabric reinforced with: 20% leno in monofilament nylon 97% Wool 3% Nylon 186 g/m²
Untreated

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