COMPARISON OF THE SERVICE QUALITIES OF CERTAIN ALL WOOL, ALL RAYON, AND WOOL AND RAYON MIXED FABRICS BEFORE AND AFTER DRY CLEANING

by

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INTRODUCTION

Three decades ago rayon was practically unknown. Silk, wool, flax and cotton were the principal fibers used. Between 1919 and 1924 rayon filament fibers rose to importance. With the introduction of rayon staple fibers and the diversification of their uses, more fabrics of a wider variety and beauty have been made.

The first domestic rayon staple fibers were produced by the viscose process about 1929, by the acetate process in 1935 and the cupra-ammonium process in 1937. The past decade reveals the interesting fact that the short fibers are gradually catching up to the filament fibers in consumption. This progress is attributed generally to the change in method adopted by the manufacturer from the techniques used for cotton spinning to wool. This change makes rayon staple fiber yarns look like wool yarns.

Wool manufacturers considered rayon staple fibers as an adulterant, as something to mix with the raw materials commonly employed to effect a lower cost. Today, the woolen and worsted industry consume about 10 percent of the rayon staple fibers manufactured in the United States.

The change from all wool to wool and rayon mixtures was not due to a shortage of wool, as it was in some foreign countries, nor to a desire to reduce the cost, but rather to the varied textures and effects made possible by mixing staple rayon fibers with wool and the ready acceptance of the public of this new style fabric.

Rayon staple fibers have not only stimulated the woolen and worsted industry by the introduction of mixed goods, but have enabled the fabric stylist and manufacturer to introduce a wider range of new and unique fabrics in all rayons.

With the increasing variety of textiles on the market, the average consumer finds it difficult to recognize the different kinds of materials, to be a good judge of their quality and suitability to various purposes, and to know how to care for them.

Consumers have had little definite knowledge on the service qualities of mixed wool and rayon fabrics. It is important that they be informed concerning wearing qualities and the care to be given these fabrics.

It is hoped that the results of this study may give the consumer some definite information on the comparative performance of wool and rayon mixed fabrics after dry cleaning.

PRESENT STATUS OF KNOWLEDGE

No study was found which deals with the service qualities, including crease resistance, of all wool, all rayon and wool and rayon mixed fabrics after dry cleaning.

Manufacturers have found that the shrinkage of mixed wool fabrics in washing is affected by the percentage of rayon staple fibers in the mixture. In general, prevention of shrinkage is obtained by mixing wool and the rayon staple fiber before spinning. However, the presence of viscose staple fibers has no special influence on shrinkage. The finer the denier of rayon fibers, the less is its effect on preventing felting. Felting is retarded by the formation of synthetic resin in wool, but no commercial success has been obtained on this problem (4).

METHODS OF PROCEDURE

Two and one-half yards each of 10 fabrics were purchased. Of these, eight were wool and rayon mixed fabrics, one all wool, and one all rayon.

The retail price of the materials was distributed as follows: seven pieces of mixed wool and rayon were $1.98 a yard; two, the all wool and one mixed wool and rayon were $1.69 a yard; and one all spun rayon fabric was $0.69 a yard.

The dry cleaning was done by the Manhattan Dry Cleaners, who are members of the National Dyers and Dry Cleaning Association. The Sanitone method which uses Stoddards solvent, a mixture of non-inflammable petroleum, sanitone and water was used. Sanitone renders water and petroleum miscible and thus facilitates the cleaning process.

Each of the 10 fabrics was divided equally into four pieces. The first piece was kept for the control, the second piece dry cleaned once, the third piece dry cleaned five times, and the fourth dry cleaned ten times.

Total desizing was accomplished with carbon tetrachloride and Takalab, a starch and protein solubilizing enzyme, according to the method outlined by Committee D-13 (2).

The percentage composition of the fabrics was determined by the $AlCl_3$ method of separation of wool from cotton and regenerated cellulose as outlined by Committee D-13 (2).

The breaking strength and elongation determinations were obtained by the ravel-strip method on a Scott strength tester according to the method outlined by Committee D-13 (2). Ten strips on the warp and filling were prepared for the dry breaking strength, and five strips each way were prepared for the wet breaking strength.

The twist of the yarn, which is the number of turns per inch, was determined on Suter twist counter. A 10 inch length was fastened in the jaws of the twist counter and twisted under tension until it broke. A second yarn was fastened in the jaws of the twist counter under the same tension with the left jaw of the counter locked. The yarn was then untwisted and partly retwisted in the opposite direction. The left jaw was unlocked and the twisting continued until it ruptured. The twist was then determined by the following formula:

$$\frac{N_1 - N_2}{21} = t \quad \text{in which}$$

N_2 = the number of turns of twist to rupture.

N_1 = the number of turns to untwist and retwist to rupture.

t = total number of turns in one inch.

l = length of the yarn.

Thickness was measured by a standard thickness gauge according to the method outlined by Committee D-13 (2).

Crimp was determined by the Schwarz micro method. The fabric was cut adjacent to and parallel with the yarns whose crimp was to be studied. The cut edge was mounted so that the edge could be viewed at any desired power through a regular compound microscope equipped with a camera lucida. A traced outline of the curves was made, and with a pair of dividers set close, the curved lines were stepped off. A straight line was drawn tangent to the points of the curve. The number of equal lengths on this line was counted. The difference between the number of two intervals divided by the number of intervals on the straight line multiplied by 100 was the percentage of crimp (8).

Eight inch squares were cut from each of the 10 fabrics for yarn count determination. After drying and weighing the warp and filling yarns were raveled and counted. The warp and filling yarns were then weighed separately. The combined weights of the warp and filling were compared with the original sample. The small discrepancy which was in favor of the fabric was divided equally between warp and filling. The amount of crimp was computed and added to the length. The yarn counts were calculated by the following formula:

$$\text{Yarn count} = K \times \frac{\text{Length of sample in yards}}{\text{Weight of the sample in grams}}$$

$$K = \frac{453.6 \text{ (grams in 1 lg.)}}{560 \text{ (yards per lb. in number } 1^{s} \text{ worsted system)}}$$

Shrinkage was determined by comparison of measurements made before and after dry cleaning. For this purpose 10 inch squares were marked off on the fabric with white cotton thread. These squares were measured after one, five, and ten dry cleanings and the percentage of shrinkage in length and width was calculated by the method outlined by Committee D-13 (2).

The relative wearing qualities of the fabrics were obtained by comparing the breaking strength of the original fabric with pieces that had been abraded by a M. I. T. model abrasion tester. Strips $6\frac{1}{2}$ x 26 inches were abraded 500 times using a one-half inch roller and crocus cloth for the abradent (14).

In determining the thread count, the actual number of warp and filling yarns in one inch was counted on 10 different places on the fabric and the average number of warp and filling yarns per inch was calculated. No two pieces counted included the same yarns. The breaking strength was corrected by multiplying the thread count of the control by the breaking strength of the fabric to be corrected and dividing by the thread count of the fabric to be corrected. The percentage of breaking strength was determined by the following formula:

$$\frac{\text{Corrected breaking strength of the fabric} \times 100}{\text{Corrected breaking strength of the control}}$$

Ten specimens 2 x $\frac{1}{2}$ inches were prepared both warpwise and fillingwise. With a pair of tweezers, a specimen was picked up and suspended on a horizontal wire of small diameter. At the end of three minutes the horizontal distance between the two ends was measured on an angular scale graduated in degrees. The specimen was folded with two ends together and placed under a pound weight for three minutes. The load was removed and at the end of three minutes the angle was again read. The ratio of the angle of the specimen after the load was applied to the angle of the specimen before the application of the load is designated as the resilience ratio, or

$\frac{A_2}{A_1}$ = resilience ratio where

A_2 = angle after load is applied

A_1 = angle before load is applied

FINDINGS AND DISCUSSION

Results of the tests made on the physical properties of all fabrics are found in Table 1. Mounted samples of all fabrics are found in Plates I, II, and III.

The fiber content of the mixed fabrics ranged from 13.6 percent wool to 94.6 percent wool. Increased percentage of wool in the mixed fabrics had no relation to price. The price of the all wool was less than that of the mixed fabrics. The price of the all rayon was the least.

The amount of sizing was slight ranging from 0.01 percent to 0.24 percent. In the all rayon fabric the percentage of sizing was least.

In most of the fabrics the twist per inch was greater in the warp than in the filling. The number of turns varied from 4.9 to 33.2 per inch in the warp and 4.8 to 33.1 per inch in the filling. Greater twist was found in the finer and lighter weight fabrics.

The amount of crimp was greater in the warp than in the filling. Deviation in crimp was from 2.5 to 13.9 percent in the warp and from 1.2 to 11.4 percent in the filling. There was no relation between crimp and elonga-

EXPLANATION OF PLATE I

Samples of Fabrics

Fig. 1	100.0	percent wool
Fig. 2	94.6	percent wool
Fig. 3	92.0	percent wool
Fig. 4	71.3	percent wool

PLATE I

Fig. 1

Fig. 2

Fig. 3

Fig. 4

EXPLANATION OF PLATE II

Samples of Fabrics

Fig. 5	63.0 percent wool
Fig. 6	51.6 percent wool
Fig. 7	51.3 percent wool
Fig. 8	34.6 percent wool

PLATE II

Fig. 5

Fig. 6

Fig. 7

Fig. 8

EXPLANATION OF PLATE III

Samples of Fabrics

Fig. 9	13.6 percent wool
Fig. 10	100.0 percent wool

PLATE III

Fig. 9

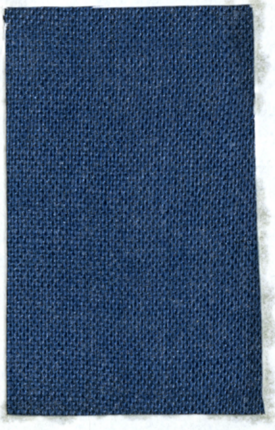
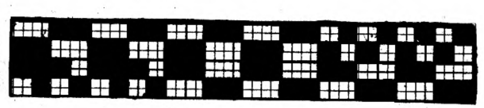
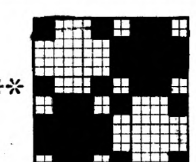


Fig. 10

Table 1. Physical characteristics of all fabrics used in the study and data relating to their purchase.

Fabric	Fiber Content	Place of purchasing	Price Per yd.	Width in in.	Weave	Twist direction warp	Twist direction filling	Twist per inch warp	Twist per inch filling	Yarn counts dry weight warp	Yarn counts dry weight filling	Sizing in %	% of fiber content wool	% of fiber content rayon	Percent of crimp warp	Percent of crimp filling
A	wool	Montgomery Ward Kansas City, Mo.	$1.69	40	1/1	S Z	S Z	14.5-1.4	12.6-0.3	25.8	28.9	o.04	100.0		5.3	5.3
B	wool viscose	Coles Manhattan, Kans.	1.98	54	1/1	Z	S	12.3±1.7	8.8±0.2	18.8	20.4	0.23	94.6	5.1	3.9	5.0
C	wool viscose	Weleck's St. Louis, Mo.	1.98	52	2/2	S	S	33.2±5.2	33.1±4.8	25.7	19.5	0.24	92.0	8.0	13.9	10.8
D	wool viscose	Coles Manhattan, Kans	1.98	54	1/1	Z	Z	17.7±0.8	15.9±1.1	20.9	22.3	0.1	71.3	28.7	4.5	5.6
E	wool viscose	Emery, Bird, Thayer, Kansas City, Mo.	1.98	54	1/1	S	S	12.5±0.8	12.2±0.1	11.19	19.2	0.3	63.0	37.0	6.0	6.9
F	wool viscose	Pelletiers Topeka, Kansas	1.98	54	1/1	S	S	4.9±0.3	4.8±0.4	13.28	13.1	0.4	51.9	48.1	7.2	5.1
G	wool viscose	Pelletiers Topeka, Kansas	1.69	52	*	S	Z	11.8±1.0	8.4±1.7	30.9	28.3	0.13	51.3	48.7	5.1	5.1
H	wool viscose	Coles Manhattan, Kans.	1.98	54	1/1	S	S	23.5±0.6	21.3±1.4	32.9	30.0	0.10	34.9	65.1	12.3	11.4
I	wool viscose	Weleck's St. Louis, Mo.	1.98	52	**	S	S	6.7±0.24	6.8±0.4	18.3	15.0	0.21	13.6	86.4	3.2	5.2
J	viscose spun rayon	Emery, Bird, Thayer Kansas City, Mo.	0.69	39	1/1	S	S	15.3±2.3	13.7±1.4	11.19	19.2	0.01		100.0	2.5	1.2

*  ** 

tion.

All data relating to thread count, breaking strength, corrected breaking strength, and percentage of breaking strength of all fabrics are found in Table 2.

The thread count of all fabrics was slightly greater in the warp than in the filling. Variation in thread count on the controls was from 33 to 58 yarns per inch in the warp, and from 29.3 to 51.0 yarns per inch in the filling. After each dry cleaning the thread count increased both warpwise and fillingwise. There was a corresponding increase in thread count both warpwise and fillingwise as the fabric shrank after each dry cleaning.

The percentage of corrected breaking strength of dry, wet, and abraded fabrics on the control and after one, five, and ten dry cleanings are shown in Figs. 1 to 10.

The breaking strength in the warp was greater than that of the filling. The dry breaking strength of the mixed fabrics increased with each dry cleaning, and the wet breaking strength decreased with each dry cleaning. The dry breaking strength of the all rayon decreased after each dry cleaning, but the dry breaking strength of the all wool increased after each dry cleaning. The variation

Table 2. Thread count and breaking strength, corrected breaking strength and percentage of breaking strength of dry, wet, and abraded samples of control fabrics and after one, five, and ten dry cleanings.

Fabric	Number of dry cleanings	Warp thread count: before abrasion	Warp thread count: after abrasion	Warp breaking strength, pounds: dry	pounds: wet	pounds: after abrasion	pounds corrected: dry	pounds corrected: wet	pounds corrected: after abrasion	percent of control: dry	percent of control: wet	percent of control: after abrasion
A	0	50.0	50.0	18.8±0.4	13.0±0.9	9.9±0.2	18.8	13.0	9.9	100.0	69.3	52.5
	1	50.0	51.6	19.5±0.4	4.1±0.6	15.4±0.7	19.5	4.1	14.9	103.8	21.8	79.4
	5	50.2	48.0	20.5±0.5	9.0±0.5	7.8±0.8	20.2	9.0	8.2	107.2	47.8	43.5
	10	51.0	49.0	21.2±0.7	5.4±0.5	7.5±0.6	21.8	5.3	7.7	115.6	28.2	40.8
B	0	36.7	36.0	18.0±0.6	10.5±0.3	12.6±0.7	18.0	10.5	12.8	100.0	58.5	71.0
	1	37.9	36.0	21.0±0.3	5.0±0.5	15.0±0.3	20.2	4.8	15.3	112.1	26.7	85.1
	5	38.0	37.0	20.0±0.4	4.0±0.1	20.0±0.3	19.3	3.8	19.8	107.2	21.1	109.9
	10	38.0	38.0	21.3±0.1	3.9±0.6	19.0±0.7	20.6	3.7	18.4	114.2	20.6	102.3
C	0	58.0	57.0	19.0±0.5	15.0±1.6	7.6±0.4	19.0	15.0	7.7	100.0	79.1	40.4
	1	58.0	56.5	20.0±0.3	6.8±0.3	7.2±0.7	20.0	6.8	7.4	105.1	35.7	38.9
	5	57.2	56.8	19.3±0.4	6.3±0.3	10.7±0.7	19.6	6.4	10.9	103.2	33.7	57.5
	10	56.2	55.7	17.7±0.8	3.7±0.3	10.9±0.2	~~15.9~~ 18.2	3.8	11.3	90.2	20.0	59.5
D	0	38.9	38.2	10.5±0.5	8.4±0.0	10.0±0.5	10.0	8.4	9.8	100.0	84.0	98.0
	1	41.0	39.8	14.0±0.1	4.6±0.1	14.7±0.2	13.3	4.4	14.4	133.0	44.0	144.0
	5	42.0	41.3	15.9±0.2	3.4±0.0	13.5±1.3	14.7	3.2	12.7	147.0	32.0	127.9
	10	44.4	41.3	16.1±0.4	3.1±0.0	13.5±0.5	14.1	2.7	12.7	141.0	27.0	127.0
E	0	35.0	34.7	26.0±0.5	16.0±0.3	23.0±0.3	26.0	16.0	23.2	100.0	61.5	89.2
	1	35.0	35.0	26.0±0.4	6.9±0.5	22.0±0.4	26.0	6.9	22.0	100.0	26.4	84.7
	5	35.1	35.0	27.0±0.4	6.7±0.3	26.0±0.3	26.9	6.6	26.0	103.3	25.4	100.0
	10	35.2	35.0	28.1±0.3	6.6±0.2	25.0±0.6	27.8	6.5	25.0	106.8	25.0	96.3

Table 2. (cont.)

Fabric	Number of dry cleanings	Warp thread count: before abrasion	Warp thread count: after abrasion	Warp breaking strength, pounds: dry	Warp breaking strength, pounds: wet	Warp breaking strength, pounds: after abrasion	Pounds corrected: dry	Pounds corrected: wet	Pounds corrected: after abrasion	Percent of control: dry	Percent of control: wet	Percent of control: after abrasion
F	0	33.0	32.3	22.0±0.6	11.5±0.1	21.3±0.2	22.0	11.5	21.8	100.0	52.3	99.1
	1	33.0	33.0	23.2±0.4	9.0±0.1	22.4±0.5	23.2	9.0	22.4	105.0	40.8	102.0
	5	34.1	33.1	24.8±0.3	4.8±0.3	24.8±0.3	24.1	4.7	24.7	109.5	21.4	112.1
	10	34.2	34.0	24.3±0.4	3.9±0.1	23.7±0.3	23.4	3.8	23.1	106.1	17.2	104.9
G	0	49.0	49.0	25.0±0.6	11.0±0.2	16.8±0.3	25.0	11.0	16.8	100.0	44.1	67.3
	1	50.0	49.2	24.0±0.4	8.2±0.3	14.0±0.3	23.5	8.1	13.9	93.8	32.4	55.6
	5	50.0	50.0	27.4±0.5	4.7±0.7	16.4±0.7	26.8	4.6	16.1	107.0	18.4	64.5
	10	53.4	51.5	23.0±0.2	4.0±0.7	15.2±1.1	21.1	3.7	14.5	84.5	14.8	58.0
H	0	55.8	53.7	21.0±0.2	12.5±0.3	16.5±0.2	21.0	12.5	17.1	100.0	59.5	81.5
	1	55.8	55.0	22.0±0.2	9.4±0.4	16.4±0.3	22.0	9.4	16.6	104.5	44.6	79.0
	5	56.0	56.0	24.1±0.4	5.4±0.3	16.7±0.3	24.0	5.4	16.7	114.0	25.7	79.5
	10	56.0	55.5	24.4±0.3	5.4±0.1	16.8±0.2	24.3	5.4	16.9	115.8	25.7	80.5
I	0	42.0	41.7	21.0±0.0	19.8±0.3	20.1±0.4	21.0	19.8	20.2	100.0	94.4	96.2
	1	42.0	41.8	33.0±0.1	15.6±0.5	20.6±0.4	33.0	15.6	20.6	157.0	74.4	97.9
	5	42.0	42.3	39.3±0.5	8.9±1.9	21.1±0.4	39.3	8.9	21.0	187.3	42.4	100.0
	10	42.0	42.8	37.0±0.5	8.4±0.5	20.8±0.5	37.0	8.4	20.9	176.5	40.0	99.5
J	0	43.0	42.8	27.0±0.7	9.0±0.5	11.1±0.9	27.0	9.0	11.1	100.0	33.3	41.1
	1	56.0	55.0	29.0±0.3	10.7±0.7	17.4±0.2	22.3	8.2	13.6	82.7	30.3	50.5
	5	56.0	55.0	30.0±0.4	11.6±0.5	13.4±0.8	23.0	8.9	10.5	85.2	32.9	38.9
	10	56.0	55.4	30.0±0.3	8.9±0.2	18.0±0.3	23.0	6.8	14.0	85.2	25.2	51.8

Table 2. (cont.)

Fab-ric	Number of dry cleanings	Filling thread count: before abrasion	Filling thread count: after abrasion	Filling breaking strength: pounds: dry	pounds: wet	pounds: after abrasion	pounds corrected: dry	pounds corrected: wet	pounds corrected: after abrasion	percent of control: dry	percent of control: wet	percent of control: after abrasion
A	0	40.0	41.6	8.4±0.0	6.0±0.1	5.0±0.3	8.4	6.0	4.8	100.0	71.5	57.2
	1	40.0	41.9	8.8±0.5	3.5±0.4	6.4±0.0	8.8	3.5	6.1	104.5	41.6	72.5
	5	40.0	43.0	9.4±0.2	4.9±0.2	6.1±0.3	9.4	4.9	5.7	111.6	58.4	67.9
	10	40.8	42.4	9.2±0.6	8.6±0.2	4.9±0.2	9.1	8.4	4.6	108.2	100.0	54.9
B	0	35.9	35.9	16.0±0.3	8.0±0.1	13.5±0.4	16.0	8.0	13.5	100.0	50.0	84.5
	1	36.0	36.0	20.0±0.0	5.2±0.0	17.9±0.4	19.9	5.1	17.8	124.2	31.8	111.2
	5	38.0	36.7	20.0±0.4	4.0±0.1	18.0±0.5	18.9	3.8	17.6	118.0	23.7	110.0
	10	38.0	37.0	18.2±0.3	4.2±0.1	17.1±0.6	17.2	3.9	16.6	107.5	24.3	100.0
C	0	42.0	42.0	12.0±0.3	11.5±0.0	2.5±0.2	12.0	11.5	2.5	100.0	95.8	20.8
	1	44.0	43.0	12.2±0.0	8.0±0.6	1.0±0.0	11.7	7.8	1.0	97.5	65.0	8.1
	5	44.0	43.7	11.7±0.4	3.9±0.0	1.0±0.3	11.2	3.7	1.0	93.5	30.9	8.0
	10	44.0	42.2	11.0±0.3	3.7±0.1	1.1±0.2	10.5	3.5	1.1	87.6	29.1	9.0
D	0	36.0	35.9	10.0±0.2	7.0±0.1	10.1±0.2	10.0	7.0	10.1	100.0	70.0	101.0
	1	37.0	37.6	12.0±0.1	3.9±0.0	14.4±0.2	11.6	3.8	13.8	116.0	38.0	108.0
	5	37.8	37.8	14.9±0.5	2.6±0.0	13.7±0.2	14.2	2.5	13.1	142.0	25.0	131.0
	10	38.0	39.5	12.2±0.2	2.5±0.0	11.6±0.2	11.5	2.4	11.0	115.0	24.0	110.0
E	0	30.0	29.3	20.0±0.0	9.4±0.1	15.7±0.4	20.0	9.4	16.1	100.0	47.0	80.5
	1	30.0	30.0	21.0±0.0	6.0±0.1	16.2±0.2	21.0	6.0	16.2	105.0	30.0	80.1
	5	30.4	30.0	21.6±0.9	5.0±0.1	19.7±0.3	21.3	4.9	19.7	106.5	24.5	98.5
	10	31.5	31.0	21.0±0.2	3.5±0.1	21.0±0.2	20.1	3.3	20.2	100.5	16.5	101.0

Table 2. (cont.)

Fabric	Number of dry cleanings	Filling thread count: before abrasion	Filling thread count: after abrasion	Filling breaking strength: pounds: dry	pounds: wet	pounds: after abrasion	pounds corrected: dry	pounds corrected: wet	pounds corrected: after abrasion	percent of control: dry	percent of control: wet	percent of control: after abrasion
F	0	29.3	28.1	22.0±0.1	11.0±0.1	18.7±0.6	22.0	11.0	19.5	100.0	50.0	88.8
	1	30.0	29.2	20.0±0.1	7.4±0.2	19.9±0.3	19.5	7.2	19.9	88.6	32.8	90.5
	5	30.0	29.2	23.2±0.4	5.0±0.0	20.0±0.2	22.6	4.9	20.0	102.5	22.3	91.0
	10	31.0	30.6	21.0±0.1	3.9±0.0	20.5±0.2	19.8	3.8	19.7	90.1	17.3	89.6
G	0	49.0	48.3	20.0±0.2	9.5±0.0	12.9±0.3	20.0	9.5	13.1	100.0	47.5	65.5
	1	49.0	48.9	20.0±0.1	7.2±0.0	10.6±0.4	20.0	7.2	10.6	100.0	36.0	53.0
	5	49.0	49.0	23.0±0.3	3.9±0.0	12.0±0.5	23.0	3.9	12.0	115.0	19.5	60.0
	10	49.6	49.3	19.6±0.5	3.7±0.1	13.9±0.4	19.4	3.6	13.8	97.0	18.0	69.0
H	0	51.0	50.7	19.4±0.3	12.7±0.3	16.3±0.4	19.4	12.7	16.4	100.0	65.4	84.5
	1	53.0	52.0	21.0±0.1	10.0±0.2	17.3±0.1	20.2	9.6	17.0	104.3	49.5	87.7
	5	53.5	52.7	24.9±0.4	4.6±0.0	14.6±0.9	23.8	4.4	14.1	122.4	22.6	72.7
	10	54.0	52.4	21.4±0.4	4.7±0.2	16.7±0.4	20.2	4.4	16.3	104.3	22.6	84.0
I	0	38.0	38.6	20.0±0.0	18.6±0.3	20.0±0.5	20.0	18.6	20.2	100.0	93.0	101.0
	1	39.0	38.6	33.0±0.5	12.0±0.0	21.6±0.5	32.2	11.7	21.2	161.0	58.5	106.0
	5	38.6	36.5	37.5±0.9	7.9±0.1	21.9±0.3	36.9	7.7	22.8	184.5	38.5	114.0
	10	39.0	34.7	35.6±0.1	7.7±0.0	21.4±0.2	34.7	7.5	23.4	173.5	37.5	117.0
J	0	43.0	42.6	21.4±0.7	8.0±0.8	10.7±0.7	21.4	8.0	10.8	100.0	37.4	50.5
	1	44.8	43.0	22.0±0.4	7.9±0.2	9.6±0.4	21.1	7.6	9.6	98.8	35.4	44.8
	5	46.0	43.9	22.0±0.4	8.6±0.4	10.1±0.4	20.6	8.1	9.9	96.5	37.8	46.2
	10	46.0	43.9	22.0±0.2	7.0±0.3	10.0±0.3	20.5	6.5	9.8	96.5	30.4	45.8

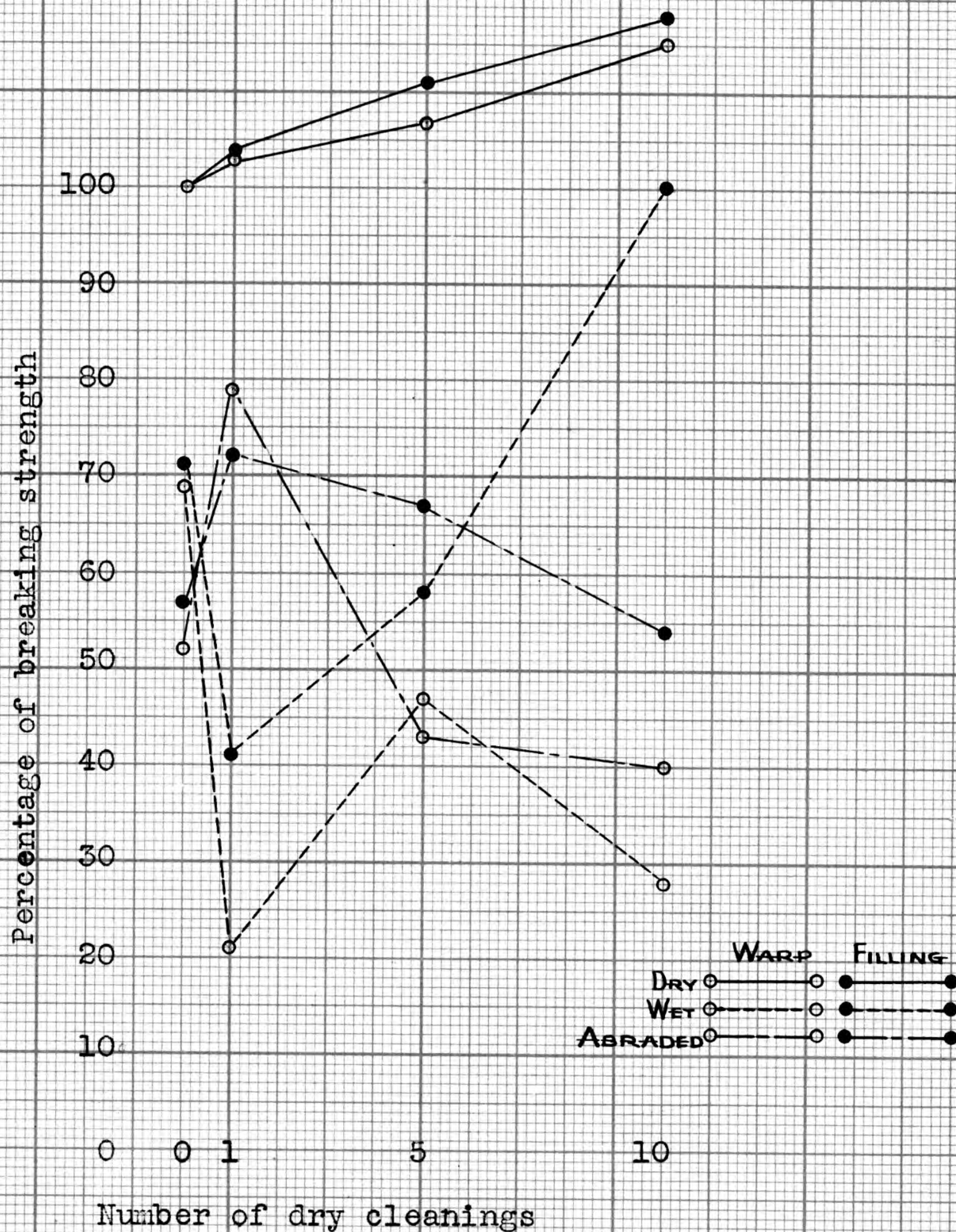


Fig. 1. Breaking strength in percent of control of dry, wet, and abraded for fabric A.

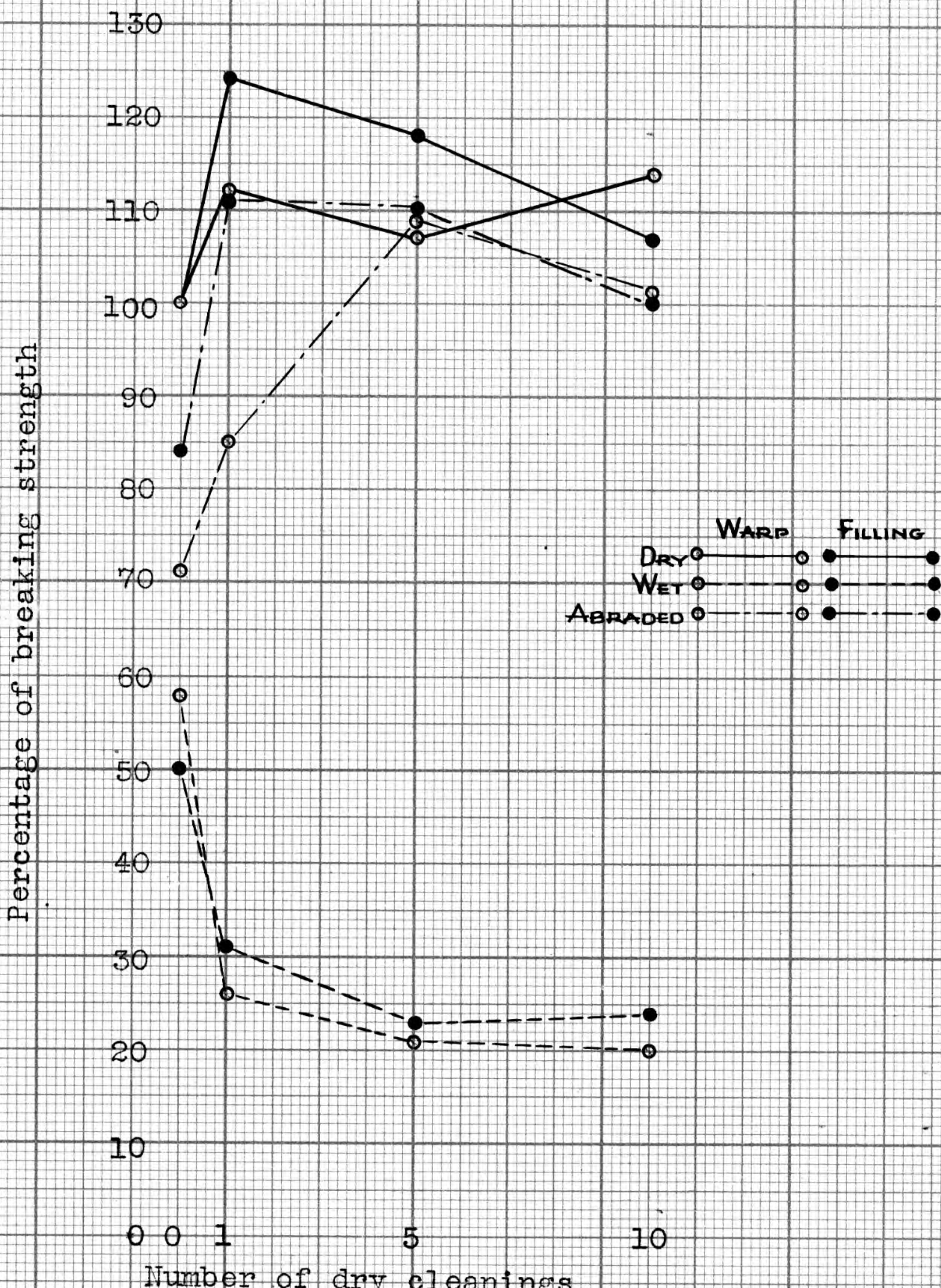


Fig. 2. Breaking strength in percent of control of dry, wet, and abraded for fabric B.

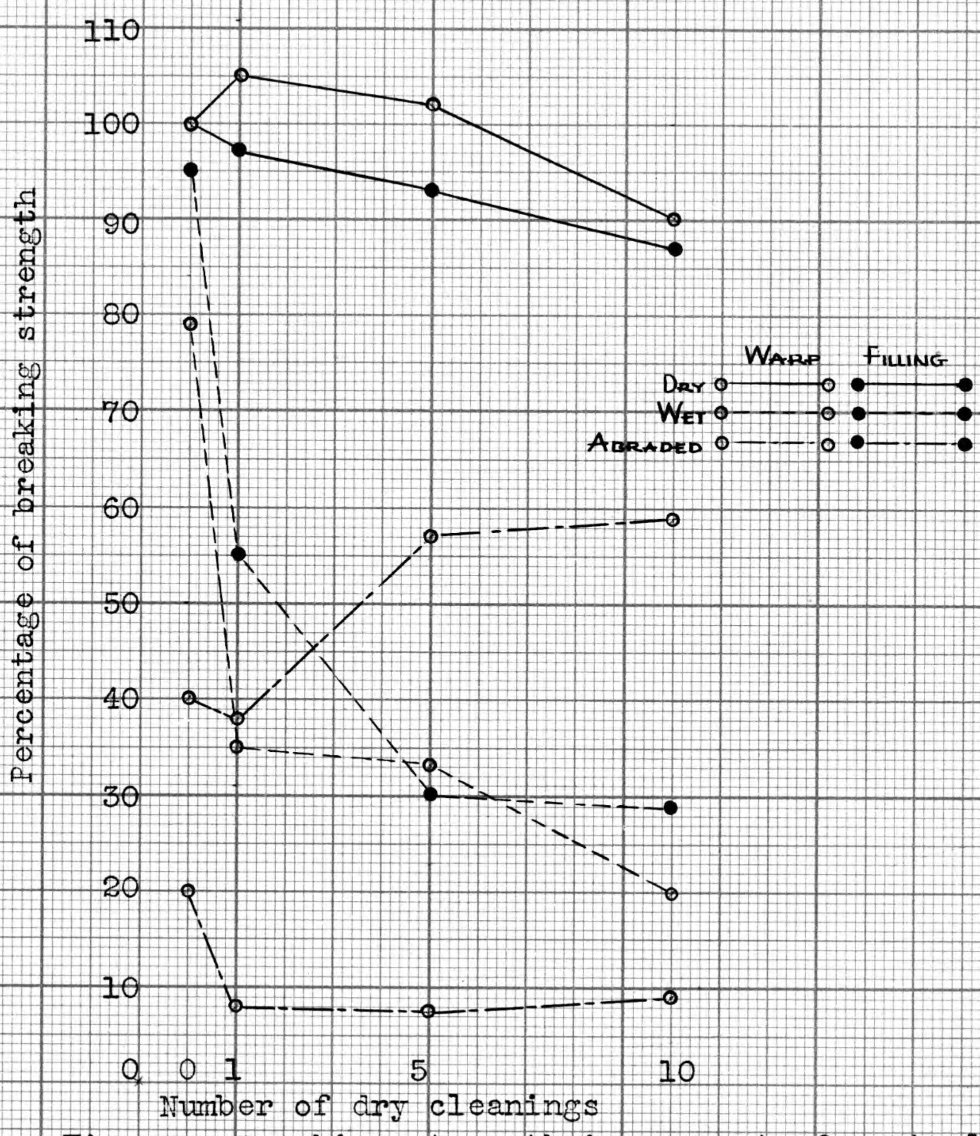


Fig. 3. Breaking strength in percent of control of dry, wet, and abraded for fabric C.

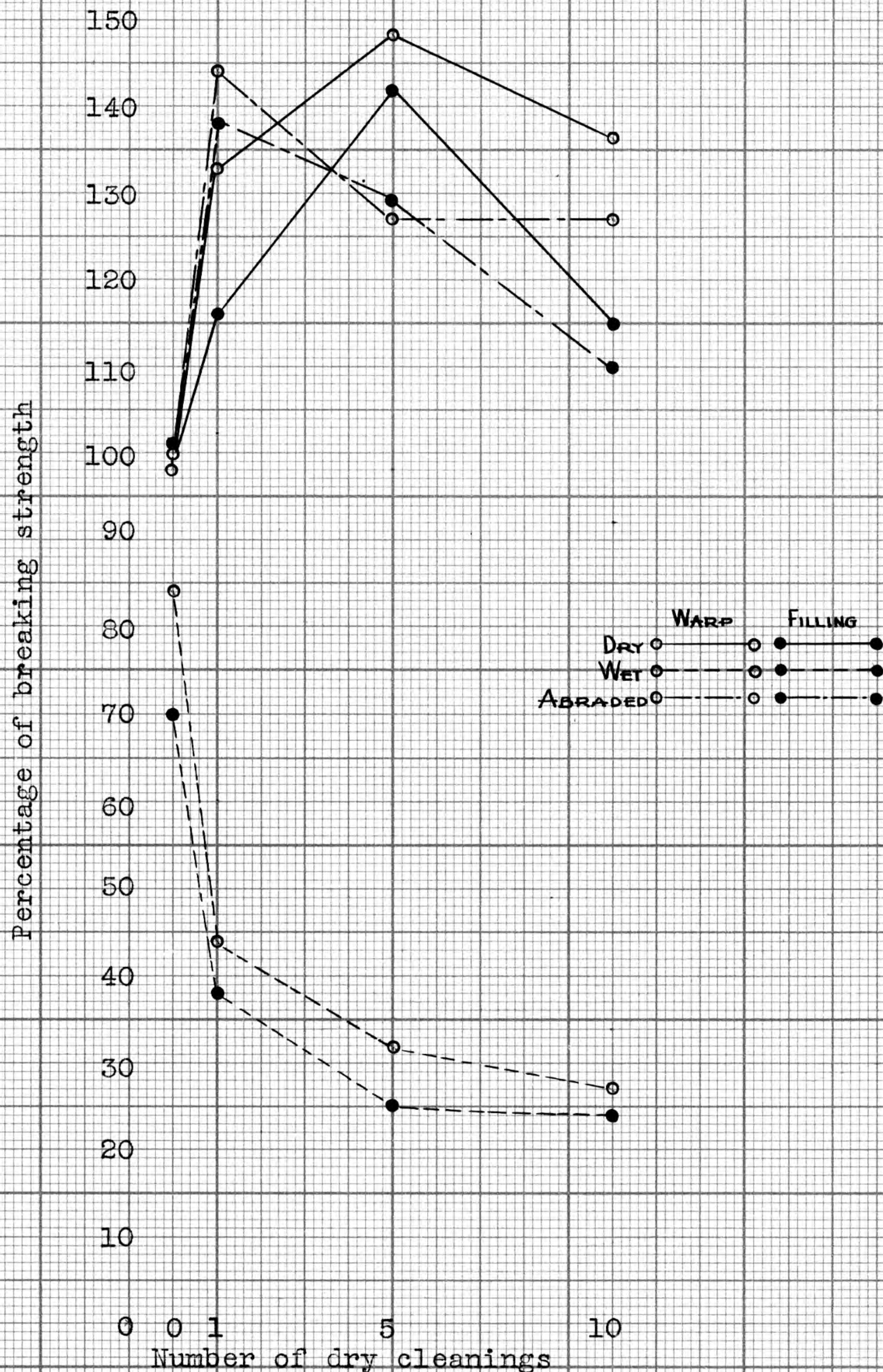


Fig. 4. Breaking strength in percent of control of dry, wet, and abraded for fabric D.

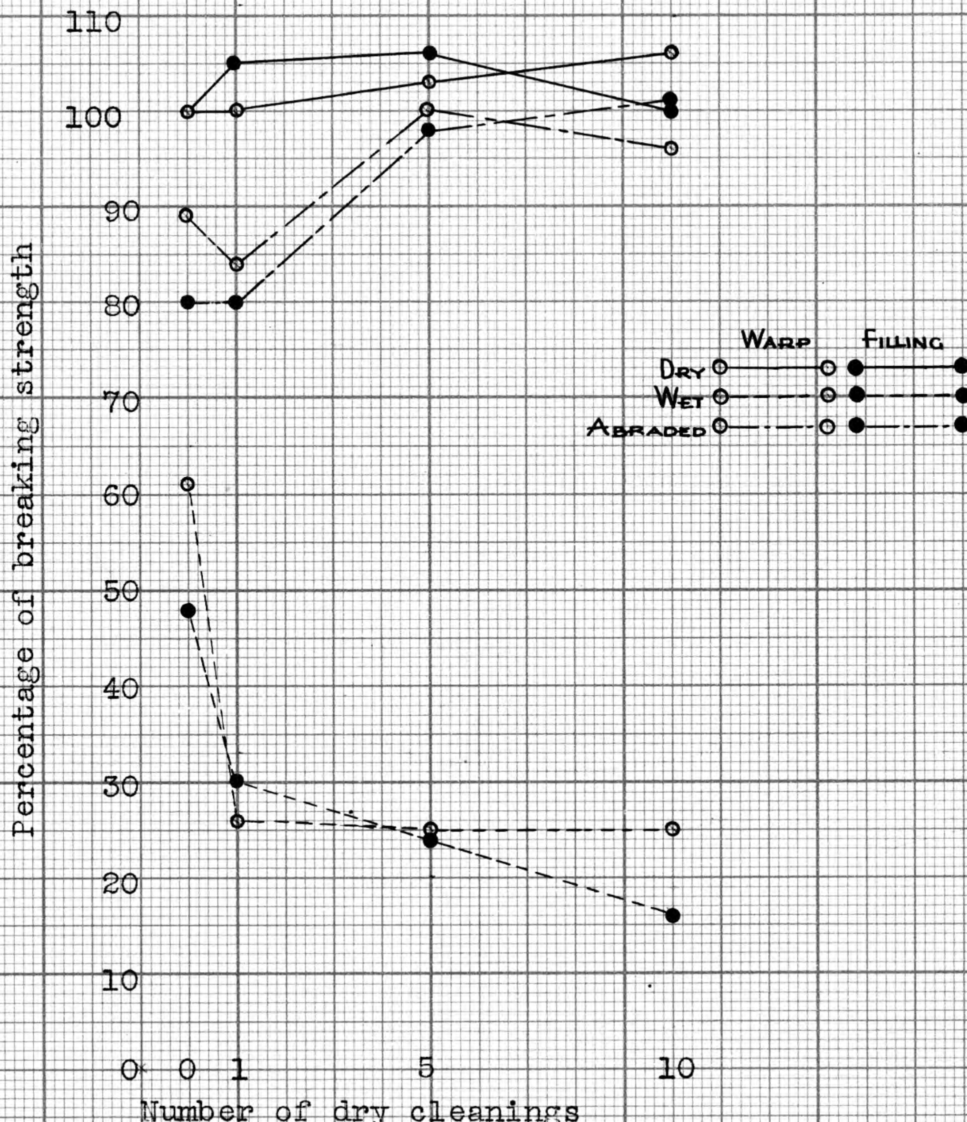


Fig. 5. Breaking strength in percent of control of dry, wet, and abraded for fabric E.

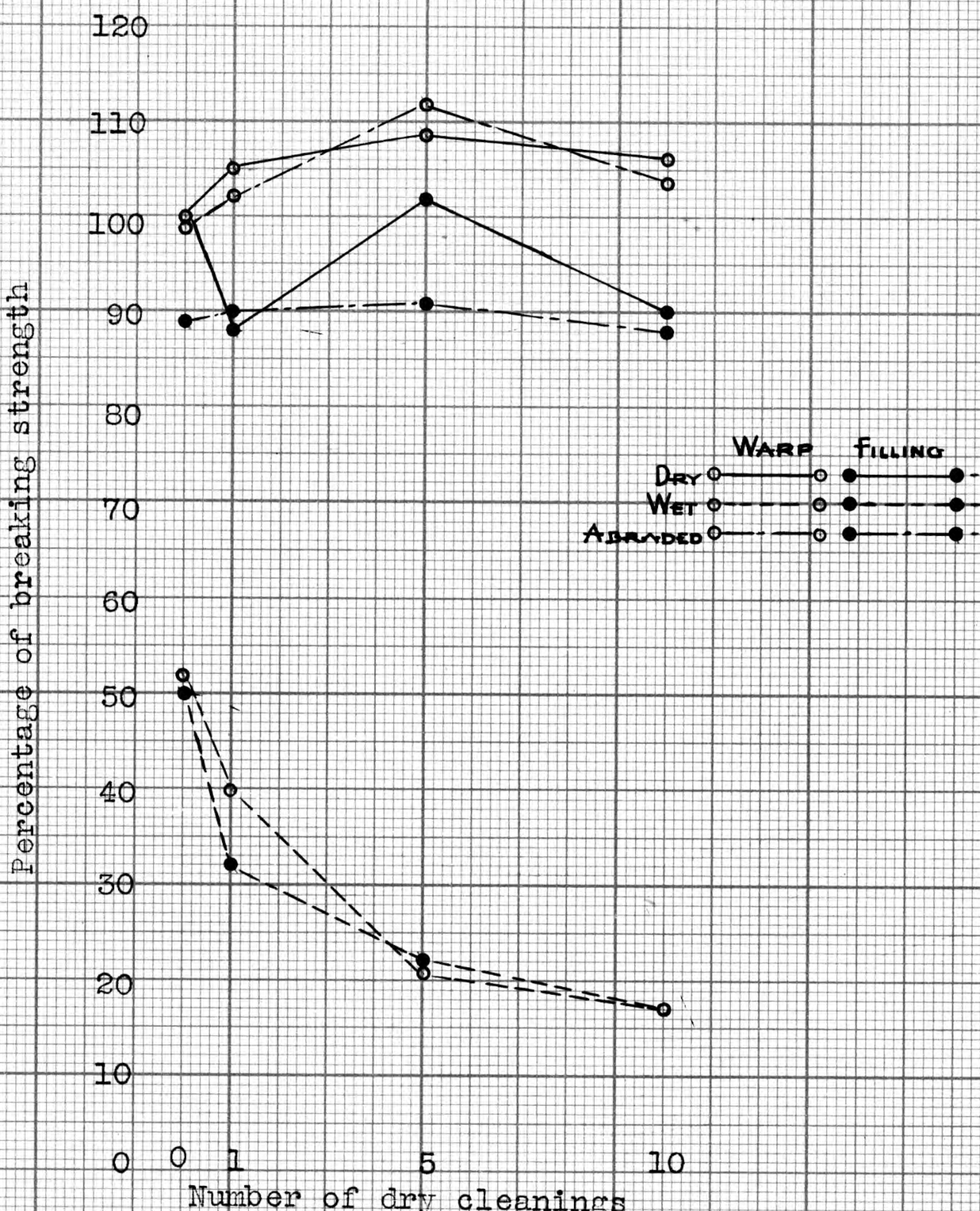


Fig. 6. Breaking strength in percent of control of wet, dry, and abraded for fabric F.

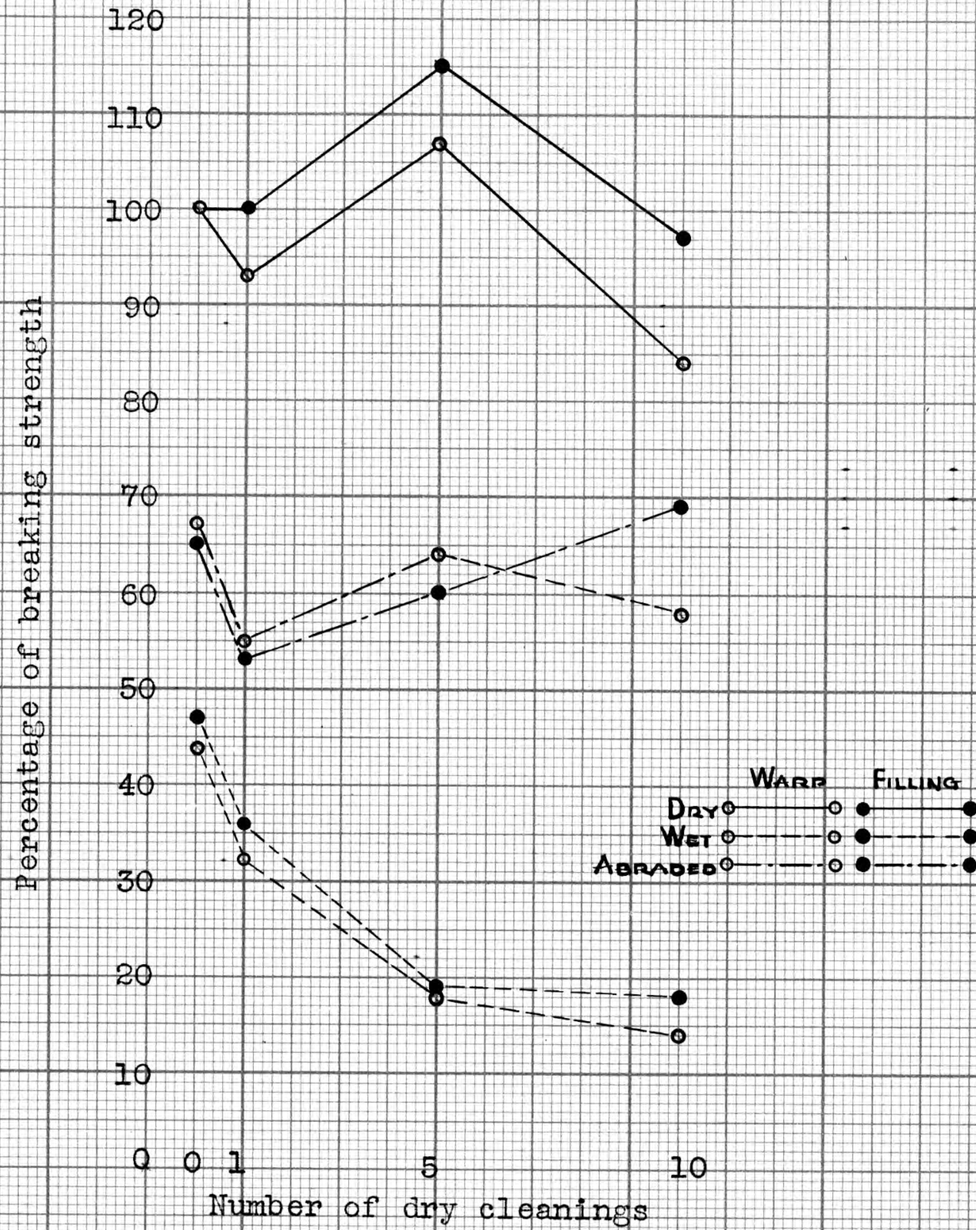


Fig. 7. Breaking strength in percent of control of dry, wet, and abraded for fabric G.

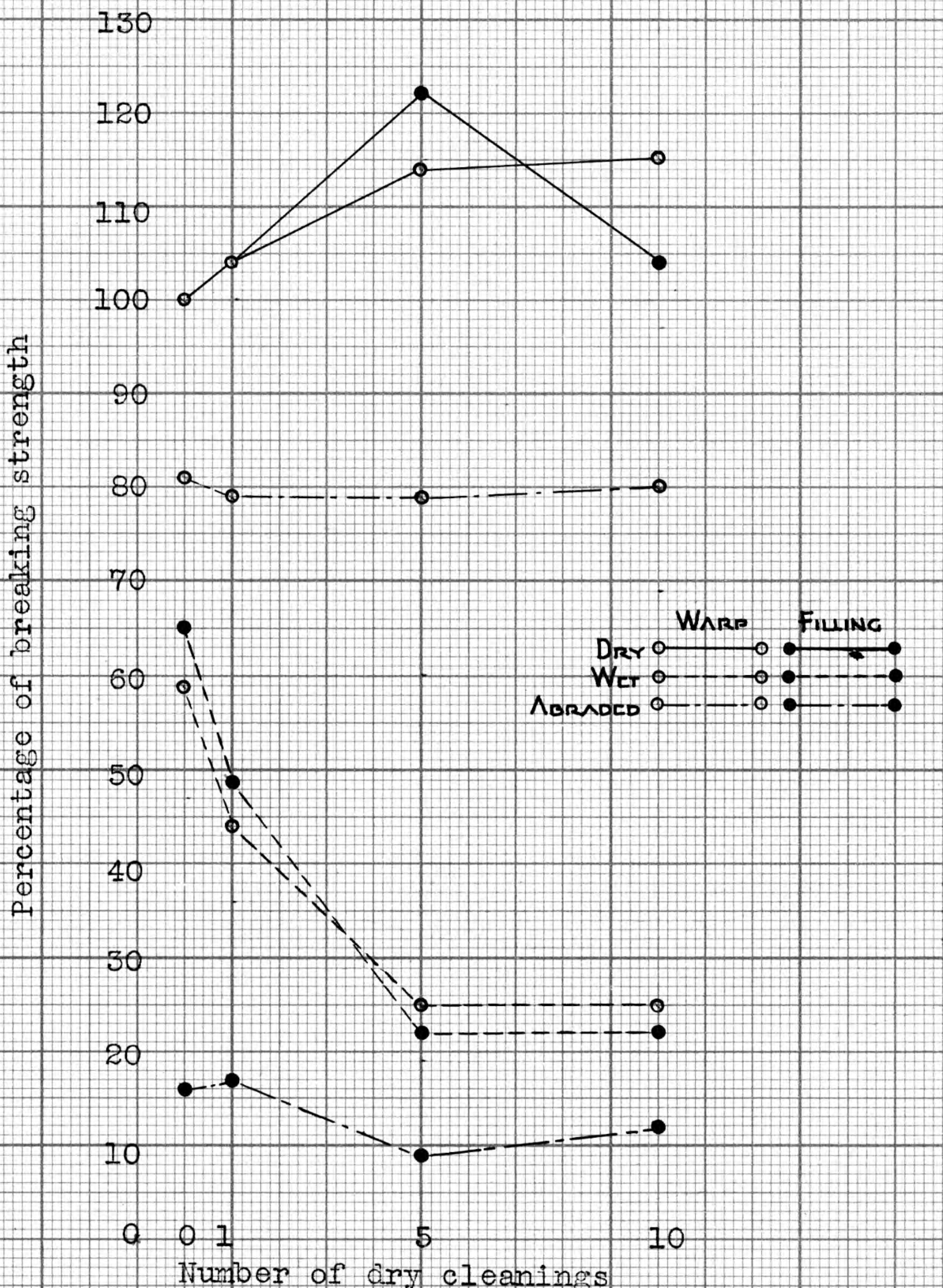


Fig. 8. Breaking strength in percent of control of dry, wet, and abraded for fabric H.

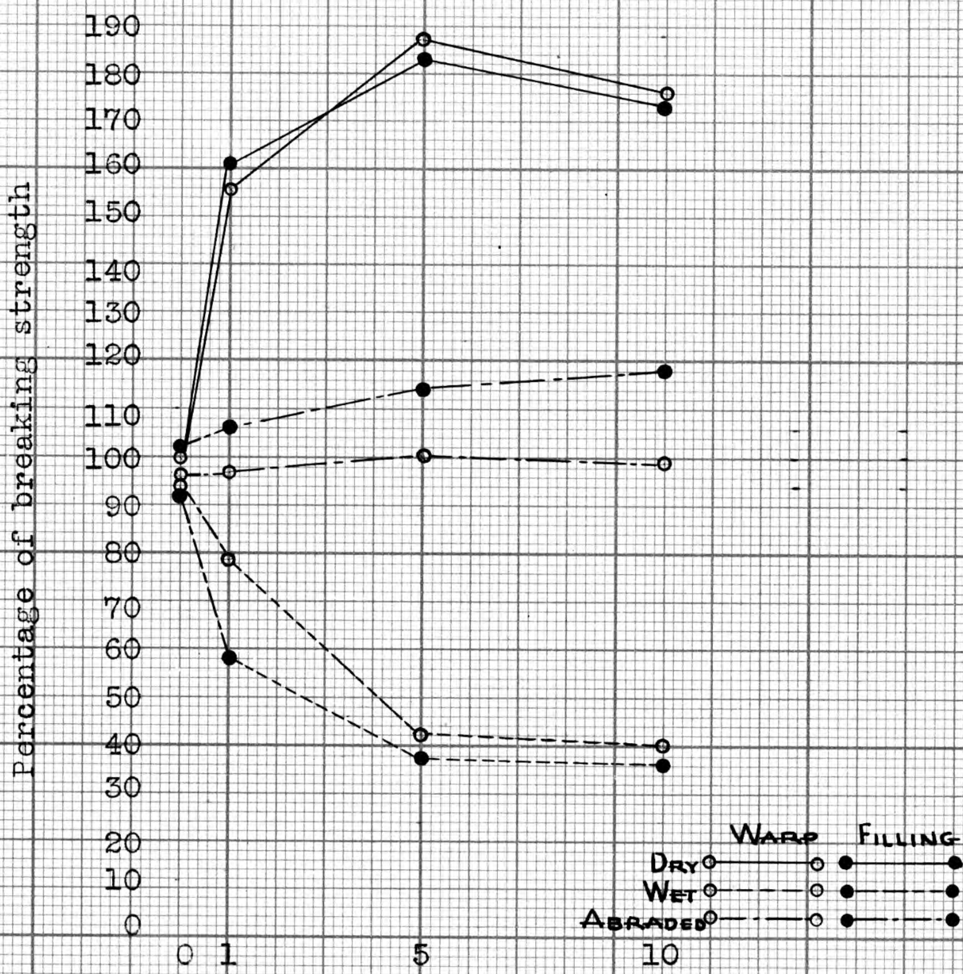


Fig. 9. Breakins strength in percent of control of dry, wet, and abraded for fabric I.

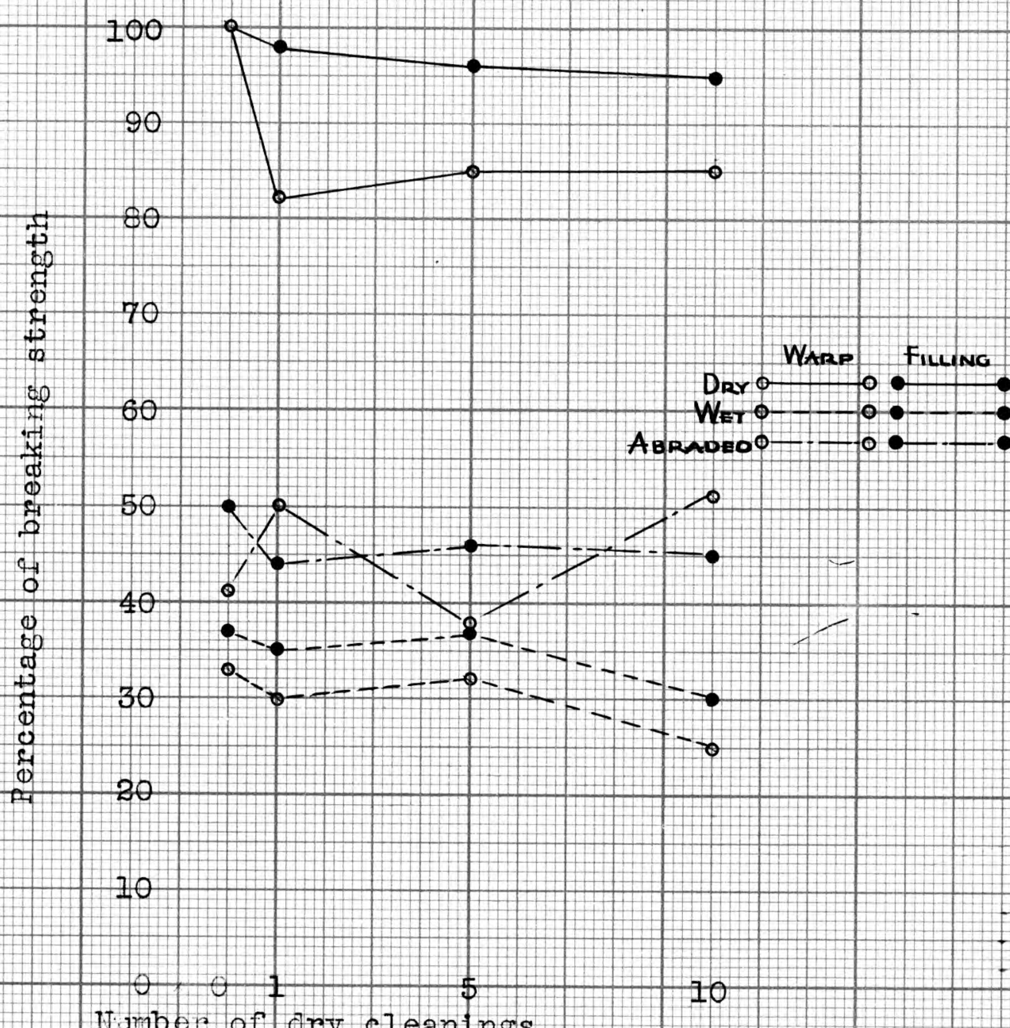


Fig. 10. Breaking strength in percent of control of dry, wet, and abraded for fabric J.

in the wet breaking strength of the mixed fabrics of the control varied from 44.1 to 94.4 percent in the warp and from 37.4 to 95.8 percent in the filling. There was a decided drop in breaking strength after the first dry cleaning as is shown in Figs. 1 to 10. There was a gradual decrease in the wet breaking strength after the fifth and tenth dry cleaning. The wet breaking strength of the all rayon varied little from the control after each dry cleaning. The dry breaking strength of the all rayon control was higher than that of the all wool. The controls of the mixed fabrics containing from 37 to 48.7 percent rayon had a higher breaking strength than did those of a higher percentage of either wool or rayon. In general, controls of the mixed fabrics with a greater percentage of rayon broke at a higher breaking strength than those of a greater percentage of wool.

No relation existed between thread count and breaking strength. Those of a higher thread count did not have a greater breaking strength than those of a lower thread count. As the shrinkage increased after each dry cleaning there was in most cases an increase in breaking strength after the correction for thread count had been made. The increased breaking strength after dry cleaning was probably due to felting of the wool fibers.

All data secured from dry, wet, and abraded fabrics for elongation are summarized in Table 3. The percentage of elongation of the dry, wet, and abraded fabrics after one, five, and ten dry cleanings are represented in Figs. 11 to 20.

The range of elongation of the dry control was from 8.0 to 28.0 percent in the warp and from 10.3 to 21.6 percent in the filling. The wet control range in elongation was from 13.0 to 63.3 percent in the warp and from 17.0 to 51.6 percent in the filling. The abraded control ranged from 6.6 to 25.0 percent on the warp and 8.3 to 19.6 percent on the filling. In general, the elongation of the wet was greater than that of the dry or abraded pieces. Dry cleaning had little effect on elongation of dry fabrics. In the wet there was an increase in elongation from the control to the tenth dry cleaning in most cases, and there was a slight increase in elongation after the first dry cleaning, as is shown in Figs. 11 to 20.

The percentage of elongation in the warp of the all wool dry control was almost twice as great as that of the all rayon. Fiber content, crimp, and number of twists had no effect on elongation.

Table 3. Elongation of dry, wet, and abraded fabrics on the control and after one, five, and ten dry cleanings.

Fabric	Number of dry cleanings	Warp elongation						Filling elongation					
		inches			percent			inches			percent		
		dry	wet	after abrasion	dry	wet	after abrasion	dry	wet	after abrasion	dry	wet	after abrasion
A	0	0.84±0.02	1.14±0.03	0.57±0.02	28.0	38.0	19.0	0.53±0.01	0.78±0.05	0.45±0.02	17.6	26.0	15.0
	1	1.03±0.02	1.04±0.03	0.67±0.01	34.3	34.6	22.3	0.99±0.04	0.61±0.03	0.54±0.02	33.0	20.3	18.0
	5	0.93±0.06	1.03±0.08	0.63±0.02	31.0	34.3	20.0	0.65±0.04	0.95±0.04	0.53±0.02	21.6	31.6	17.6
	10	0.98±0.00	0.89±0.08	0.64±0.03	32.6	29.6	21.3	0.62±0.07	1.25±0.02	0.52±0.02	20.6	41.6	17.3
B	0	0.37±0.02	0.73±0.01	0.20±0.30	12.3	24.3	6.6	0.54±0.02	1.55±0.30	0.37±0.00	18.0	51.6	12.3
	1	0.36±0.06	0.69±0.01	0.39±0.01	12.0	23.0	13.0	0.59±0.02	1.55±0.24	0.76±0.02	19.6	51.6	25.3
	5	0.38±0.00	0.51±0.03	0.45±0.01	12.2	17.0	15.0	0.65±0.01	0.70±0.03	0.77±0.02	21.6	23.3	25.6
	10	0.43±0.00	0.59±0.00	0.44±0.01	14.3	19.6	14.6	0.57±0.02	0.88±0.03	0.76±0.01	19.0	29.3	25.3
C	0	0.54±0.02	1.90±0.09	0.29±0.01	18.0	63.3	9.6	0.49±0.00	0.93±0.04	0.25±0.02	16.3	31.0	8.3
	1	0.46±0.01	1.50±0.08	0.40±0.04	15.3	50.0	13.3	0.44±0.01	0.44±0.02	0.07±0.01	14.6	14.6	0.2
	5	0.47±0.01	0.71±0.03	0.47±0.01	15.6	23.3	15.6	0.51±0.01	0.61±0.03	0.09±0.01	17.0	20.3	0.3
	10	0.31±0.03	0.65±0.04	0.18±0.04	10.3	21.6	6.0	0.46±0.01	0.70±0.01	0.18±0.04	15.3	23.3	6.0
D	0	0.24±0.02	0.95±0.03	0.47±0.02	8.0	31.6	15.6	0.31±0.00	1.07±0.28	0.49±0.02	10.3	35.6	16.3
	1	0.36±0.01	1.40±0.80	0.43±0.01	12.0	46.6	14.3	0.48±0.02	1.32±0.03	0.70±0.02	16.0	23.3	23.3
	5	0.47±0.01	0.85±0.01	0.34±0.03	15.6	28.3	11.3	0.54±0.02	0.80±0.02	0.74±0.01	18.0	24.6	24.6
	10	0.61±0.01	0.84±0.02	0.37±0.01	20.3	28.0	12.3	0.41±0.01	0.84±0.02	0.73±0.01	13.6	24.3	24.3
E	0	0.79±0.01	1.49±0.30	0.59±0.01	26.3	49.6	19.6	0.65±0.03	0.79±0.01	0.47±0.02	21.6	26.3	15.6
	1	0.51±0.03	1.28±0.02	0.76±0.01	17.0	42.6	25.3	0.58±0.01	0.45±0.02	0.37±0.01	17.3	15.0	12.3
	5	0.86±0.01	1.28±0.03	0.82±0.02	28.6	42.6	27.3	0.58±0.01	0.45±0.04	0.66±0.01	17.3	15.0	22.0
	10	0.69±0.01	1.42±0.05	0.74±0.02	23.0	47.3	24.3	0.58±0.01	0.68±0.02	0.58±0.01	17.3	22.6	9.3

Table 3. (cont.)

Fabric	Number of dry cleanings	Warp elongation: inches: dry	Warp elongation: inches: wet	Warp elongation: inches: after abrasion	Warp elongation: percent: dry	Warp elongation: percent: wet	Warp elongation: percent: after abrasion	Filling elongation: inches: dry	Filling elongation: inches: wet	Filling elongation: inches: after abrasion	Filling elongation: percent: dry	Filling elongation: percent: wet	Filling elongation: percent: after abrasion
F	0	0.40±0.02	0.76±0.02	0.36±0.00	13.3	25.3	12.0	0.40±0.02	0.80±0.04	0.31±0.16	13.3	26.6	10.3
	1	0.39±0.01	0.48±0.02	0.42±0.02	13.0	16.0	14.0	0.45±0.01	0.45±0.02	0.52±0.01	15.0	15.0	17.3
	5	0.46±0.01	0.53±0.01	0.50±0.01	15.3	17.6	16.6	0.45±0.01	0.75±0.04	0.51±0.01	15.0	25.0	17.0
	10	0.45±0.30	0.64±0.02	0.52±0.01	15.0	21.3	17.3	0.34±0.00	0.60±0.02	0.52±0.01	11.3	20.0	17.3
G	0	0.45±0.01	0.57±0.01	0.30±0.01	15.0	19.0	10.0	0.37±0.01	0.51±0.01	0.26±0.01	12.5	17.0	8.6
	1	0.49±0.01	0.34±0.03	0.12±0.00	16.3	11.3	4.0	0.34±0.01	0.36±0.01	0.13±0.01	11.3	12.0	4.3
	5	0.43±0.01	0.45±0.01	0.28±0.02	14.3	15.0	9.3	0.31±0.01	0.40±0.01	0.28±0.01	10.3	13.3	9.3
	10	0.42±0.01	0.52±0.01	0.39±0.01	14.0	17.3	13.0	0.34±0.01	0.43±0.01	0.29±0.02	11.3	14.6	9.6
H	0	0.65±0.01	1.20±0.11	0.41±0.01	21.6	40.0	13.6	0.63±0.01	1.17±0.03	0.49±0.01	21.0	39.0	16.3
	1	0.66±0.00	0.73±0.05	0.54±0.01	22.0	24.3	18.0	0.72±0.01	0.62±0.02	0.54±0.02	24.0	20.6	18.0
	5	0.64±0.10	0.83±0.01	0.60±0.02	21.3	27.6	20.0	0.70±0.01	0.90±0.03	0.48±0.03	23.3	30.0	16.0
	10	0.55±0.01	0.88±0.01	0.75±0.01	18.6	29.3	25.0	0.57±0.01	0.80±0.08	0.48±0.02	19.0	26.6	13.6
I	0	0.50±0.01	1.52±0.02	0.75±0.01	16.6	50.6	25.0	0.50±0.01	1.00±0.02	0.59±0.02	16.6	33.3	19.6
	1	0.77±0.03	1.00±0.14	0.64±0.02	25.6	30.3	21.3	0.76±0.02	0.60±0.01	0.60±0.01	25.3	21.0	20.0
	5	0.82±0.30	1.05±0.09	0.62±0.01	27.3	35.0	21.6	0.63±0.01	0.45±0.02	0.45±0.02	21.0	26.6	15.0
	10	0.76±0.01	0.77±0.02	0.66±0.02	25.3	25.6	22.0	0.62±0.01	0.61±0.02	0.61±0.02	20.6	26.6	20.3
J	0	0.43±0.01	0.39±0.01	0.34±0.01	14.3	13.0	11.3	0.44±0.01	0.53±0.01	0.32±0.01	14.6	17.6	10.6
	1	0.50±0.01	0.38±0.50	0.34±0.02	16.6	12.6	11.3	0.45±0.01	0.36±0.03	0.21±0.02	15.0	12.0	7.0
	5	0.47±0.01	0.41±0.01	0.77±0.60	15.6	13.6	25.6	0.44±0.01	0.46±0.03	0.43±0.01	14.6	15.3	14.3
	10	0.42±0.02	0.41±0.01	0.56±0.03	14.0	13.6	18.6	0.46±0.01	0.41±0.01	0.39±0.03	15.3	13.3	13.0

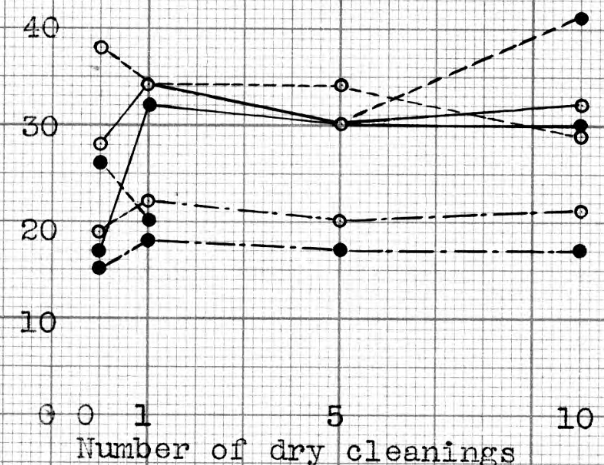


Fig. 11. Elongation in percent of control of dry, wet, and abraded for fabric A.

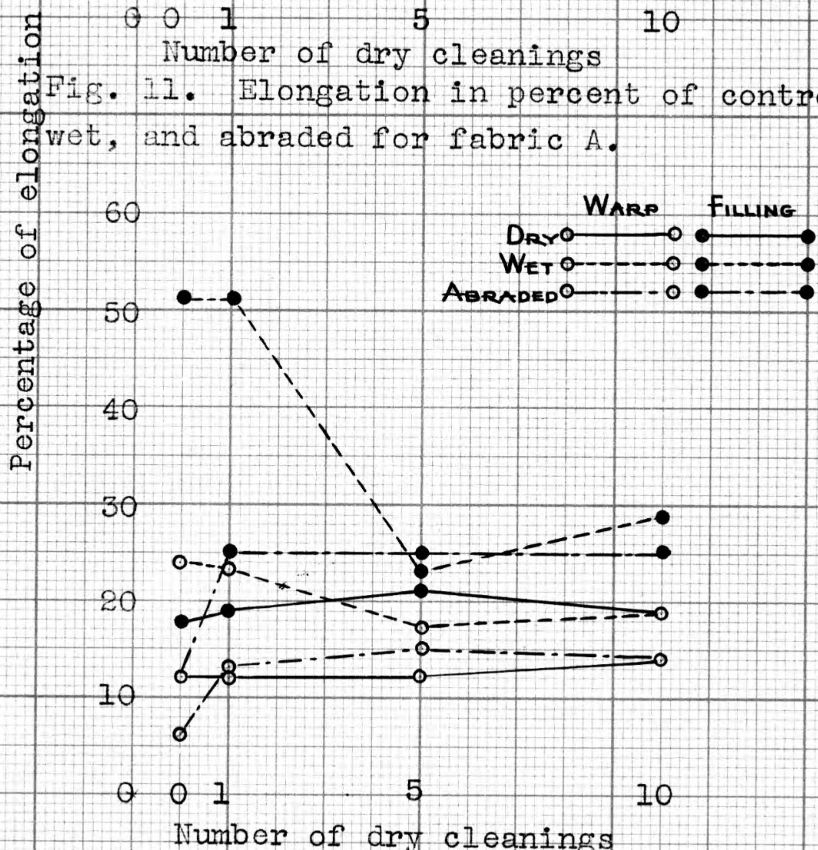


Fig. 12. Elongation in percent of control of dry, wet, and abraded for fabric B.

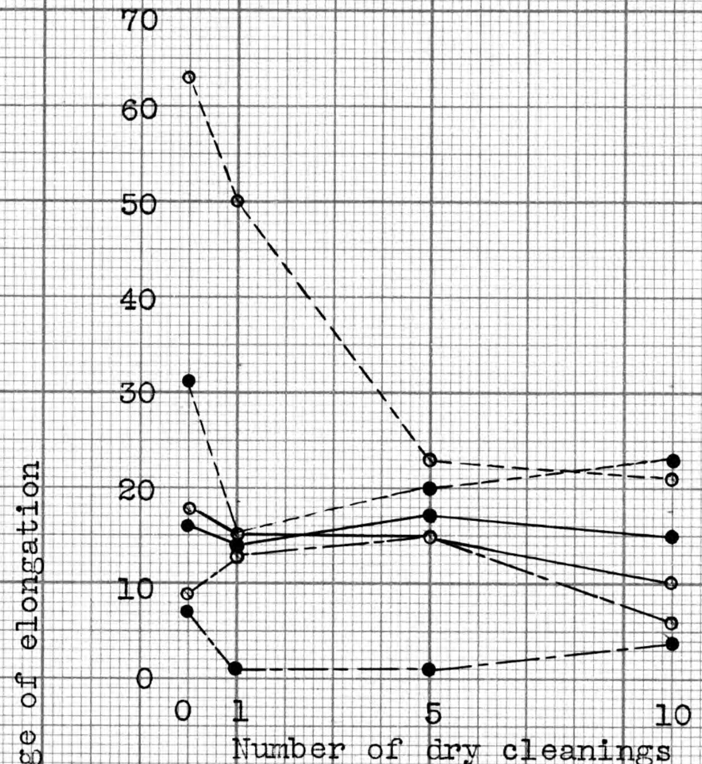


Fig. 13. Elongation in percent of control of dry, wet, and abraded for fabric C.

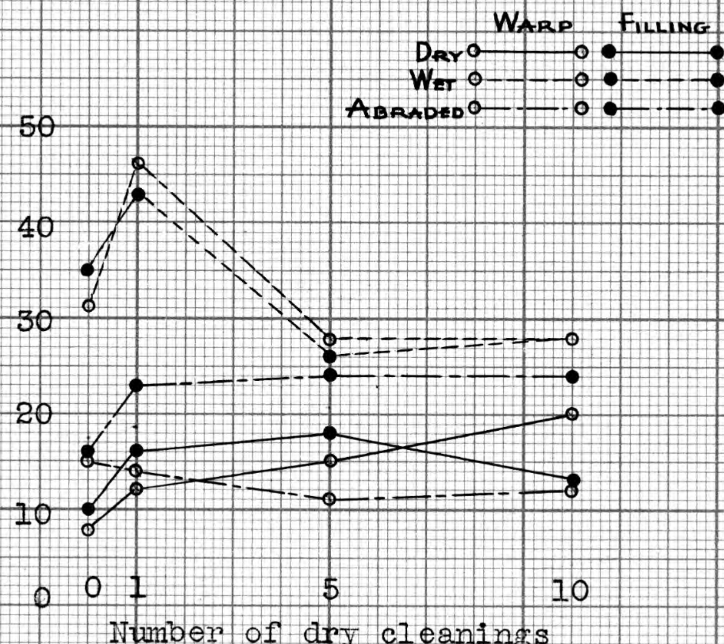


Fig. 14. Elongation in percent of control of dry, wet, and abraded for fabric D.

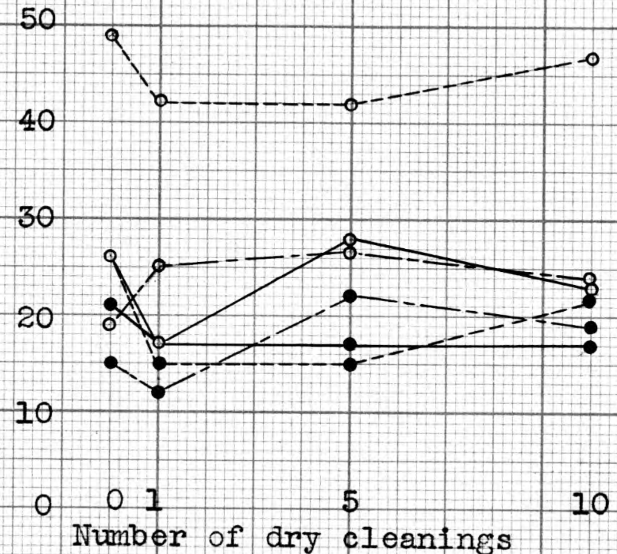
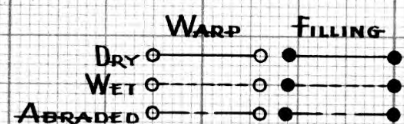


Fig. 15. Elongation in percent of control of dry, wet, and abraded for fabric E.



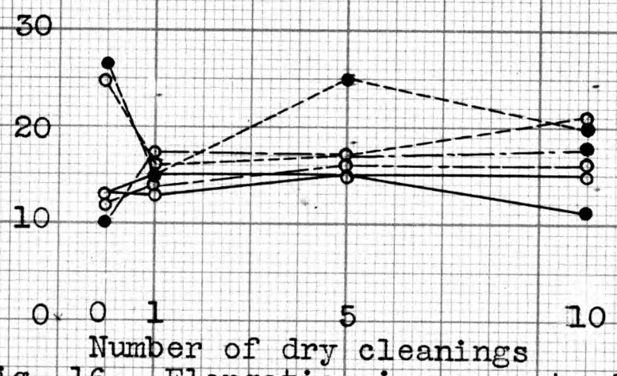


Fig. 16. Elongation in percent of control of dry, wet, and abraded for fabric F.

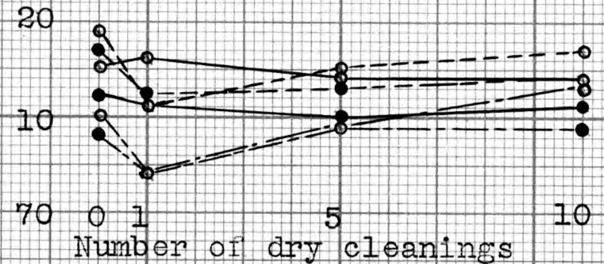


Fig. 17. Elongation in percent of control of dry, wet, and abraded for fabric G.

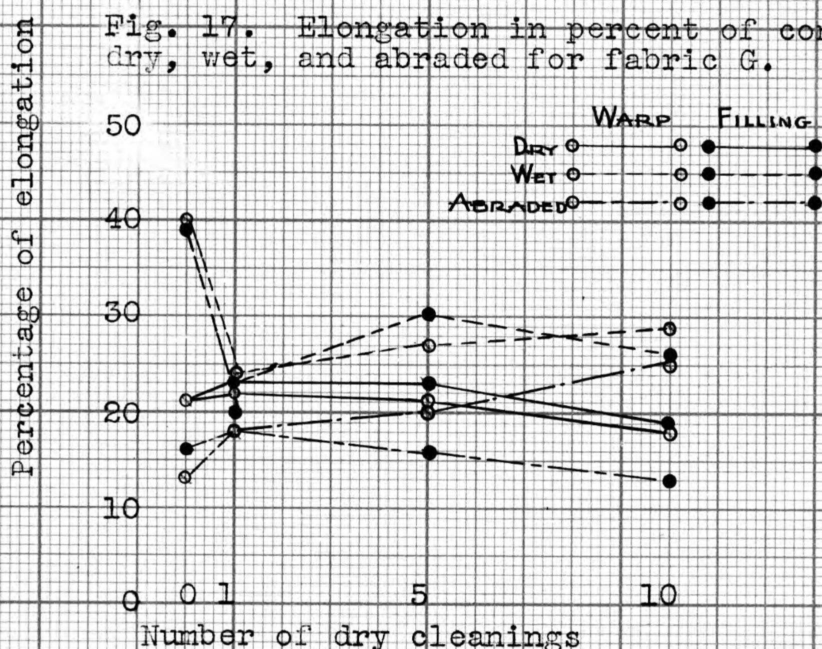


Fig. 18. Elongation in percent of control of dry, wet, and abraded for fabric H.

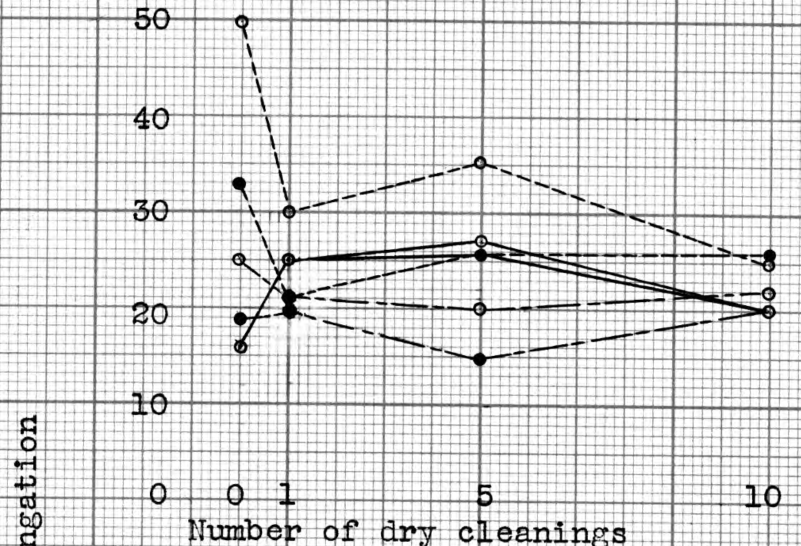


Fig. 19. Elongation in percent of control of dry, wet, and abraded for fabric I.

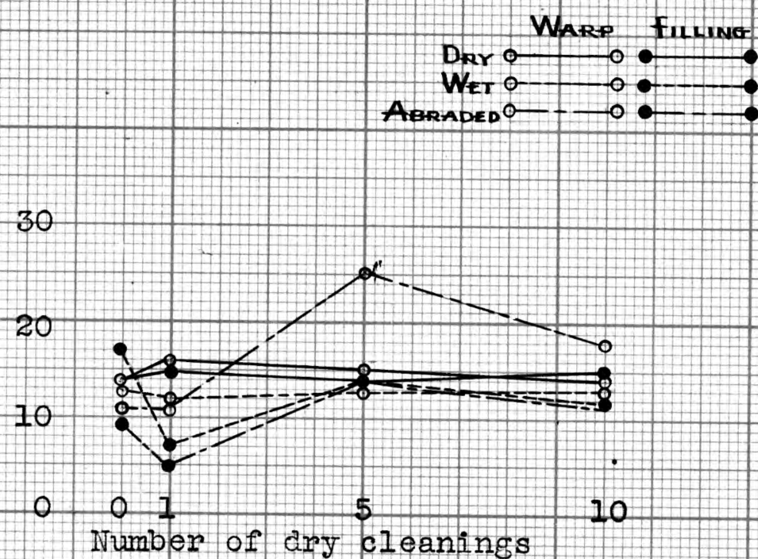


Fig. 20. Elongation in percent of control of dry, wet, and abraded for fabric J.

Data secured from shrinkage, thickness, weight per square yard, and crease resistance tests are summarized in Table 4.

The thickness of all of the control fabrics was similar. Thickness increased after each dry cleaning in direct proportion to the shrinkage in most cases. Abrasion had little effect on thickness.

Fabrics C and I were pre-shrunk. There was no shrinkage in the warp of fabric I. However, in the filling there was 3.8 percent and 4.4 percent respectively after the fifth and tenth dry cleaning. Fabric C stretched fillingwise 1.3 and 3.8 percent respectively after the first and fifth dry cleaning. The fabric shrank warpwise 3.1 percent and 5 percent, respectively, on the first and fifth dry cleaning. There was no shrinkage or stretching after the tenth dry cleaning. In the all wool and all rayon there was no shrinkage after the fifth and tenth dry cleaning. In the mixed fabrics there was an increase of shrinkage after each dry cleaning in most cases. However, the increase was not constant. The highest increase was from 2.5 percent after the first dry cleaning to 15 percent on the tenth dry cleaning. The least shrinkage was from 1.3

Table 4. Weight per square yard, thickness, resilience, and percent shrinkage.

Fabric	Number of dry cleanings	Weight per square yard in ounces	Thickness inches		Resilience						percent shrinkage	
			before abrasion	after abrasion	Warp			Filling				
					angle 1	angle 2	percent	angle 1	Angle 2	percent	warp	filling
A	0	3.87	0.028	0.028	127.0	101.0	63.0 93.6 97.6	128.0	109.0	~~57.0~~ 85.2	0.0	0.0
	1	3.89	0.030	0.030	130.0	110.0	61.0 84.8	126.0	105.0	~~60.0~~ 93.5	0.4	0.2
	5	3.99	0.030	0.030	130.0	111.0	61.0 85.3	128.0	107.0	54.0 83.5	0.4	0.2
	10	4.02	0.030	0.030	123.0	99.0	60.0 80.6	124.0	100.0	51.0 80.5	0.4	0.2
B	0	3.82	0.025	0.023	160.0	150.0	94.0	140.0	120.0	86.0	0.0	0.0
	1	4.25	0.024	0.024	160.0	140.0	87.0	150.0	125.0	83.5	1.3	1.0
	5	4.26	0.025	0.025	160.0	137.5	86.0	149.5	120.0	80.5	3.1	3.1
	10	4.55	0.025	0.024	159.5	137.0	86.0	149.5	120.0	80.5	5.0	5.0
C	0	5.20	0.028	0.028	140.0	120.0	86.0	110.0	94.0	85.0	0.0	0.0
	1	5.17	0.029	0.028	136.5	115.0	84.0	108.0	90.0	83.5	3.1	1.3*
	5	5.10	0.030	0.028	140.5	117.0	83.5	106.0	90.0	85.0	5.0	3.8
	10	5.02	0.029	0.026	137.5	115.5	84.0	108.0	92.0	85.0	5.0	3.8
D	0	3.95	0.026	0.026	130.0	121.0	92.0 8	130.0	120.0	92.0	0.0	0.0
	1	4.10	0.024	0.026	140.0	130.0	92.0	140.0	125.0	91.0	2.5	3.1
	5	4.88	0.030	0.029	140.0	120.0	~~91.0~~ 85.6	140.0	118.0	~~90.5~~ 84.3	9.3	10.0
	10	5.24	0.035	0.029	140.0	119.0	92.0 85.0	140.0	118.0	90.5 84.3	15.0	15.0
E	0	5.22	0.025	0.025	130.0	120.0	92.5	130.0	120.0	92.5	0.0	0.0
	1	5.42	0.027	0.027	131.0	120.0	91.7	130.0	116.0	89.0	1.9	2.5
	5	5.54	0.028	0.028	130.0	120.0	92.5	130.0	118.0	90.5	3.8	2.5
	10	5.54	0.028	0.029	130.0	120.0	92.5	130.0	116.0	89.0	5.0	2.5

* stretch

Table . (cont.)

Fabric	Number of dry cleanings	Weight per square yard in ounces	Thickness inches: before abrasion	Thickness inches: after abrasion	Resilience: Warp: angle 1	Resilience: Warp: angle 2	Resilience: Warp: percent	Resilience: Filling: angle 1	Resilience: Filling: angle 2	Resilience: Filling: percent	Percent shrinkage: warp	Percent shrinkage: filling
F	0	5.09	0.023	0.023	128.5	109.0	85.0	128.5	108.5	84.5	0.0	0.0
	1	5.58	0.024	0.024	139.5	121.0	86.7	130.0	114.0	87.5	2.6	0.0
	5	5.88	0.028	0.027	140.0	125.0	86.4 89.2	130.0	111.0	84.7 95.4	2.6	0.0
	10	5.99	0.029	0.027	140.0	120.0	86.0	130.0	110.0	84.7	2.6	0.0
G	0	3.88	0.019	0.019	145.0	135.0	96.5 93.0	140.0	130.0	93.5 92.6	0.0	0.0
	1	3.98	0.021	0.021	145.0	135.0	96.5	135.0	126.0	93.3	1.3	1.0
	5	3.98	0.021	0.021	140.0	130.0	93.5	135.0	125.0	92.5	1.9	3.8
	10	3.99	0.023	0.022	140.0	130.0	93.5 92.8	137.5	123.5	90.1 89.8	1.9	3.8
H	0	3.82	0.016	0.016	130.0	118.0	90.0 6	120.0	100.0	83.0 4	0.0	0.0
	1	4.07	0.017	0.017	120.0	100.0	83.0	124.0	99.0	80.0	2.5	0.0
	5	4.12	0.017	0.017	120.0	99.0	87.0 82.5	110.0	88.0	82.5 80.1	5.0	2.5
	10	4.21	0.018	0.017	101.0	86.0	80.0 85	110.0	89.0	82.0 81.0	5.0	2.5
I	0	5.48	0.030	0.030	138.0	111.0	80.0 4	131.0	100.0	77.0 76.3	0.0	0.0
	1	5.87	0.030	0.030	130.0	101.0	78.0 77.6	125.0	97.0	77.6	0.0	0.0
	5	5.93	0.030	0.030	130.0	100.0	77.0	120.0	90.0	75.5	0.0	3.8
	10	6.07	0.030	0.030	129.5	99.0	76.3	120.0	90.0	75.0	0.0	4.4
J	0	3.57	0.023	0.023	125.0	79.0	63.0	118.0	67.5	57.0 3	0.0	0.0
	1	3.65	0.024	0.024	120.0	73.0	61.0	111.0	67.0	60.0	0.4	0.2
	5	3.97	0.024	0.024	117.0	80.0	61.0 62.4	119.0	65.0	54.0 6	0.4	0.2
	10	3.97	0.025	0.025	102.0	62.0	60.0 8	102.0	50.0	~~51.0~~ 49.0	0.4	0.2

percent on the first dry cleaning to 1.9 percent on the tenth. In most cases the shrinkage was greater warpwise than fillingwise.

No relation existed between weight per square yard and thread count, breaking strength, or percentage composition. The weight varied on the control fabrics from 3.57 to 5.48 ounces per square yard. The all wool and all rayon weighed approximately the same.

Crease resistance of the all wool and the all rayon was the same. The crease resistance of the mixed fabrics was greater than that of the all wool or all rayon. The crease resistance of the mixed fabrics was from 80 to 96.5 percent on the warp while that of the all wool and all rayon was 63 percent. Mixed fabrics with a larger percentage of wool did not have a higher crease resistance than did those made of a larger percentage of rayon. Crease resistance decreased slightly after each dry cleaning.

There was little change in the appearance of the all wool fabric, (Fig. 1) after the first and fifth dry cleaning, but the fabric showed considerable felting after the tenth dry cleaning. Figure 9 turned slightly yellow after the fifth and tenth dry cleaning. Figure 4 faded and showed definite felting after the fifth and tenth dry cleaning. There was no noticeable change in appearance and texture of the other fabrics.

CONCLUSIONS

Dry cleaning had little effect on crease resistance of wool and rayon mixed fabrics.

Crease resistance was higher in wool and rayon mixed fabrics than in either all wool or all rayon.

Wool and rayon mixed fabrics shrank more than all wool or all rayon after each dry cleaning.

Dry cleaning increased the felting of those mixtures with a high percentage of wool.

Dry cleaning decreased the wet breaking strength, and increased the dry breaking strength of all mixed fabrics.

Abrasion had little effect on breaking strength of the fabrics after each dry cleaning.

The elongation of the wet fabrics was greater than that of the dry or abraded.

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