Shrink

R51-28

Construction Effect

Laundering Shrinkage Of Woolens

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IN THE fabrication of knitted garments, it is well known that the tightness of the structure affects the laundering behavior in use. Furthermore, it is generally understood in the industry and by most consumers that a loose, fluffy lady's sweater, for example, must be handled more carefully than a pair of machine-knit socks. While the pioneering work of Dutton has provided the first quantitative approach to the role of knitting stiffness in shrinkage, the factors constituting "tightness of structure" are not yet precisely understood.

Further work in this field was promoted by the recognition by the Army Quartermaster Corps that replacement of wool service clothing was largely due to shrinkage in washing under field and other conditions. While anti-felting treatments have contributed greatly to the amelioration of this problem, it is becoming clear that specification of the use of shrink-resistant wool, in the absence of construction limits, provides only a partial solution to the problem. It was, therefore, with the practical goal of providing a basis for the modification of procurement specifications with respect to construction that this investigation was undertaken, in the hope that improvement in laundering stability might be achieved and that some insight into the quantitative factors contributing to it might be gained.

Materials

Six-hundred pounds of 64s grade Australian wool top were obtained and divided into four parts. One part was set aside, and the others were treated in the mill by a commercial, continuous top-treating process employing alkaline wet chlorination. The treatment used was at three different levels, as judged by the top-shrinkage test; the latter measures the length change of top specimens subjected to wet mechanical action, and over a long period of use has been shown to correlate well with the shrinkage behavior of garments made from the top. The top-shrinkage values for the four groups of top were; untreated —35 per cent to 40 per cent; "mild" treatment—15 per ccent ; "optimum" treatment—seven per cent; "severe" treatment—two per cent. The adjectives describing the level of chlorination are based on the experience of processors in relating top-shrinkage values to the performance of Army fabrics; a seven per cent to 12 per cent top shrinkage is considered "optimum" for most Army constructions; a 12 per cent to 20 per cent top shrinkage, while adequate for many civilian consumer applications, may be too mild for vigorous Army laundering methods, while a two to seven per cent top shrinkage generally indicates a more severe treatment than is required for most uses.

The wool was top-dyed with chrome colors and then spun into the following yarns:

1—15/1 Bradford, normal knitting twist
2—15/1 Bradford, higher than normal twist
3—15/2 Bradford, normal knitting twist
4—15/2 Bradford, higher than normal twist in singles
5—26/1 Bradford, normal knitting twist
6—26/1 French, normal knitting twist
7—26/2 Bradford, normal knitting twist
8—26/2 French, normal knitting twist
9—36/1 French, normal knitting twist
10—36/2 French, normal knitting twist

The spinner's judgment as to "normal" or "higher than normal" twists was followed; actual values of the twists in the yarns are presented below.

The yarns, now representing ten types at four levels of treatment, were fabricated into socks or tubing on commercial-scale knitting machines, using either flat or 1 x 1 rib stitches. For each knitting machine, that number of loops was used which would produce a commercially acceptable fabric with a given type of yarn. The knitting stiffness was varied above and below this value in order to give a tight and a loose or sleazy construction in addition to the normal texture.

Methods

The knit fabrics were relaxed by submerging them in water at 80° F. for two hours, followed by hydroextraction and tumble drying. The laundering procedure used for most of the data reported here was similar to that known as the Army-wool mobile laundering, except that the load used was increased from 20 lbs. to 23½ pounds in order to accommodate all of the specimens in a single run. The wash cycle comprised two five-minute suds, using Igepon T as detergent, followed by three three-minute rinses, extraction and tumble drying; water temperature was maintained at 100° F. Five wash cycles resulted in severe felting of most of the untreated fabrics.

In order to resolve differences in felting behavior of some of the treated samples, a milder laundering procedure was also used in some cases. This comprised a four-minute suds followed by two two-minute rinses at high water level. This latter test is referred to below as the mild laundering. Measurements were made after five, ten and 20 mild launderings of this type.

In view of the large number of data obtained, the effect of each factor of construction is isolated, where possible, and the results are presented in separate tables. While the results for a given sample may thus be given in several places, it is believed that this method of presentation is justified because it greatly facilitates comparison.

Effect of Knitting Stiffness

For any given yarn, the tightness of knit or density of the fabric appears to be the most important variable of construction from the point of view of effect on felting shrinkage. Data illustrating the effect of this factor on untreated wool are presented in Table I. As shown by

TABLE I. Laundering Shrinkage of Untreated Knitted Fabrics as a Function of Knitting Stiffness

Fabric	Yarn No.	Fabric texture (wales/in.)	Fabric texture (courses/in.)	Shrinkage in five Army mobile launderings: Wales* (%)	Shrinkage in five Army mobile launderings: Courses† (%)
Flat-knit tubing	15/1	19	22	24	15
	15/1	20	25	22	11
Flat-knit tubing	15/2	13	16	24	14
	15/2	14	18	20	11
Rib-knit tubing	15/2	8	13	32	12
	15/2	12	18	14	0
Flat-knit tubing	26/1	25	28	24	13
	26/1	27	33	16	8
Flat-knit socks	26/2	17	20	28	19
	26/2	18	22	24	14
Flat-knit tubing	26/2	11	13	46	38
	26/2	14	20	35	26
Rib-knit tubing	26/2	11	17	35	25
	26/2	15	23	21	11
Flat-knit tubing	36/1	25	30	33	24
	36/1	30	46	12	6
Rib-knit tubing	36/1	22	27	21	21
	36/1	22	36	11	11
Flat-knit tubing	36/2	18	23	29	19
	36/2	20	26	22	13

*By wales shrinkage is meant shrinkage in the length dimension
†By courses shrinkage is meant shrinkage in the width dimension

these results, the tighter construction resists felting to a greater extent than does the slack knit made with the identical yarn. By increasing the knitting stiffness to a fairly high level, a substantial improvement in fabric stability is attained.

That the effect of knitting stiffness is not limited to untreated wool can be seen from the data in Table II, in which are summarized results of laundering shrinkage measurements on treated wool fabrics. The decrease in feltability with increasing knitting stiffness is again noted, this result showing good general agreement with the conclusions of Dutton on the role of knitted fabric texture in shrinkage. The results in Table II indicate that the manufacture of a satisfactory shrink-resistant garment depends upon a judicious combination of a proper level of treatment with a sufficiently firm construction. Thus, while a shrink-resistant garment can be made from untreated yarns knitted extremely tightly, such a garment would suffer a loss of the desirable softness and extensibility which are among wool's chief virtues. Conversely, a sleazy construction can be made quite shrink-resistant by overtreatment, but only with a resulting loss of soft hand and good wearing qualities.

Effect of Yarn Twist

The shrinkage in laundering of untreated fabrics in which the yarns differed in twist is shown in Table III. Since the previous section has confirmed the importance of knitting stiffness, comparisons are made only between fabrics which are similar in this respect.

The results indicate a small but consistent trend towards lower shrinkage values for the fabrics made with the higher-twist yarns. It is to be noted that the singles yarns differed in twist to a rather minor degree, and the differences in the felting of fabrics knitted from the 15s yarns, for example, are quite small.

Similar data are presented in Table IV for the fabrics knitted from shrink-resistant wool, in which similar small improvements in felt-resistance accompany the use of higher-twist yarns. It is observed that the improvement tends to be greater for the slacker-knit fabrics, an effect which can also be seen from some of Dutton's results.

Effect of Plying of Yarns

The role of plying in felting behavior was studied by laundering knitted fabrics made from 15s single ply yarns and comparing the results with those for fabrics made from 26s and 36s, two-ply. Such fabrics of similar texture were considered to be substantially the same with respect to

TABLE II. Laundering Shrinkage of Knitted Fabrics Made from Chlorinated Wool as a Function of Knitting Stiffness

Fabric	Yarn No.	Level of treatment	Fabric texture (wales/in.)	Fabric texture (courses/in.)	Shrinkage in five Army mobile launderings: Wales (%)	Shrinkage in five Army mobile launderings: Courses (%)
Rib-knit tubing	15/1	Optimum	13	18	13	8
	15/1	Optimum	16	20	10	8
Flat-knit tubing	15/1	Optimum	20	20	11	6
	15/1	Optimum	21	24	7	2
Flat-knit tubing	15/2	Optimum	7	8	34	8
	15/2	Optimum	8	10	21	12
			11	14	14	9
Flat-knit tubing	15/2	Severe	6	8	10	3
	15/2	Severe	8	10	1	2
Rib-knit tubing	15/2	Optimum	7	13	16	4
	15/2	Optimum	13	18	7	4
Rib-knit tubing	26/2	Optimum	11	18	17	5
	26/2	Optimum	14	23	9	3
Rib-knit tubing	26/2	Severe	11	17	6	-4
	26/2	Severe	13	19	1	-5
Flat-knit tubing	26/2	Optimum	10	12	19	6
	26/2	Optimum	14	17	10	1
Flat-knit tubing	26/2	Severe	10	13	10	-1
	26/2	Severe	14	18	4	2

TABLE III. Laundering Shrinkage of Knitted Fabrics Made from Untreated Wool as a Function of Yarn Twist

Fabric	Yarn No.	Fabric texture (wales/in.)	Fabric texture (courses/in.)	Yarn twist Singles (t.p.i.)	Yarn twist Ply (t.p.i.)	Shrinkage in five Army mobile launderings Wales (%)	Shrinkage in five Army mobile launderings Courses (%)
Flat-knit tubing	15/1	19	24	6.7	-	23	13
	15/1	19	24	8.1	-	20	11
Rib-knit tubing	15/1	14	18	6.7		28	18
	15/1	14	18	8.1		27	18
Flat-knit tubing	15/2	14	17	3.9	7.0	26	17
	15/2	14	17	7.7	5.1	23	13
	15/2	7	10	3.9	7.0	52	39
	15/2	7	9	7.7	5.1	47	33
	15/2	11	16	3.9	7.0	33	25
	15/2	11	15	7.7	5.1	34	25
Rib-knit tubing	15/2	8	13	3.9	7.0	39	15
	15/2	8	13	7.7	5.1	32	12
	15/2	10	13	3.9	7.0	33	10
	15/2	9	15	7.7	5.1	30	7

TABLE IV. Laundering Shrinkage of Knitted Fabrics Made from Shrink-Resistant Wool as a Function of Yarn Twist

Fabric	Yarn No.	Level of treatment	Fabric texture (wales/in.)	Fabric texture (courses/in.)	Yarn twist Singles (t.p.i.)	Yarn twist Ply (t.p.i.)	Shrinkage in five Army mobile launderings Wales (%)	Shrinkage in five Army mobile launderings Courses (%)
Flat-knit socks	15/1	Optimum	20	24	6.7	—	10	5
	15/1	Optimum	20	24	8.1	—	8	4
Flat-knit socks	15/2	Optimum	13	16	3.9	7.0	12	4
	15/2	Optimum	13	16	7.7	5.1	9	4
	15/2	Optimum	13	17	3.9	7.0	10	4
	15/2	Optimum	13	17	7.7	5.1	9	2
	15/2	Optimum	14	8	3.9	7.0	34	—8
	15/2	Optimum	14	8	7.7	5.1	22	3
Flat-knit socks	15/2	Severe	7	8	3.9	7.0	10	—3
	15/2	Severe	6	7	7.7	5.1	7	—2

weight. The results of wash tests are given in Table V for both untreated wool and for top subjected to the "optimum" chlorination treatment.

Plying is seen to produce no effect on the laundering shrinkage of untreated fabrics. On the other hand, the data in Table V suggest that with shrink-resistant wool,

TABLE V. Shrinkage of Knitted Fabrics as a Function of Plying of Yarns

Fabric	Yarn No.	Fabric texture (wales/in.)	Fabric texture (courses/in.)	Shrinkage in five Army mobile launderings Wales (%)	Shrinkage in five Army mobile launderings Courses (%)
Flat knit Untreated	15/1	20	25	22	12
Flat knit Untreated	36/2	20	26	22	13
Flat knit Untreated	15/1	19	22	28	14
Flat knit Untreated	26/2	18	22	25	14
Flat knit Untreated	36/2	18	23	20	10
Flat knit Optimum treatment	15/1	20	24	8	4
Flat knit Optimum treatment	36/2	20	21	3	3
Flat knit Optimum treatment	15/1	20	20	11	6
Flat knit Optimum treatment	26/2	18	21	9	8
Flat knit Optimum treatment	36/2	19	22	3	3

plying may result in superior resistance to felting. This is, however, believed to result from the differences in yarn twist in the samples that were available for comparison. The singles twist of the 15s, 26s and 36s yarns used in the treated fabrics were, respectively, 8.2, 8.8 and 11.6 turns per inch. The felting of the samples made from the 26/2 yarn is similar to that knit from the 15s yarn, whereas the felting of the 36/2 yarn with the higher twist is lower. The decrease in felting observed with the 36/2 higher-twist yarn is similar to that given in Table IV, and may therefore be attributed to the twist rather than to the plying. It is concluded that plying has little effect on felting in the absence of other interactions.

Type of Spinning

Comparisons for feltability of untreated fabrics made from yarns which were spun on the French or on the Bradford system are shown in Table VI. The results indicate negligible difference in felting behavior.

Effect of Yarn Numer

It was considered of interest to compare the fabrics of as nearly identical texture as possible but made from different untreated yarns. This, in effect, constitutes a different way of changing the weight of the cloth than through varying the knitting stiffness. The comparisons are shown in Table VII.

The results indicate that the heavier fabrics made with yarns of the lower yarn number are less feltable. Thus, increasing the density of the fabric by using a heavier yarn or by knitting with more loops per inch tends to produce a more shrink-resistant fabric. This result suggested that these two factors could be considered together. With woven

TABLE VI. Effect of Bradford vs. French Spinning on Shrinkage in Laundering of Untreated Wool

Fabric	Yarn No.	Fabric texture (wales in.)	Fabric texture (courses in.)	Type of spinning	Shrinkage in five Army mobile launderings Wales (%)	Shrinkage in five Army mobile launderings Courses (%)
Flat-knit tubing	26/1	27	35	Bradford	18	13
	26/1	27	33	French	18	8
Flat-knit socks	26/2	17	20	Bradford	27	10
	26/2	16	20	French	28	16
Flat-knit tubing	26/2	11	13	Bradford	46	38
	26/2	11	13	French	50	36
Rib-knit tubing	26/2	12	20	Bradford	29	16
	26/2	13	19	French	30	17

TABLE VII. Shrinkage of Untreated Knitted Fabrics of Approximately Equal Texture as a Function of Yarn Number

Fabric	Yarn No.	Fabric texture (wales in.)	Fabric texture (courses in.)	Shrinkage in five Army mobile launderings Wales (%)	Shrinkage in five Army mobile launderings Courses (%)
Flat-knit tubing	15/2	13	17	25	11
	26/2	16	19	30	18
Rib-knit tubing	15/2	12	18	14	0
	26/2	12	20	29	16
	15/1	15	17	30	19
Flat-knit tubing	26/2	18	22	25	14
	15/1	19	22	24	15
	36/2	18	23	29	19
Flat-knit tubing	15/2	8	10	30	25
	26/2	11	13	46	38
Flat-knit tubing	36/2	20	26	22	13
	26/1	25	33	23	16
	26/1	25	28	24	13
	36/1	25	30	33	24

fabrics, the parameter known as the "cover factor," F, is frequently used to define the fabric density; it is given by the relationship

$$F = \frac{T}{\sqrt{Y}},$$

where T is the number of picks or ends per inch and Y is the effective yarn number (the yarn number for singles; one-half the singles yarn number for two-ply yarns, etc.). Peirce analyzed the geometry of knitted fabrics and defined the density, pk, in terms of the unit weight of the yarn, g, and the course and wale spacings, p and w, respectively. Combining several of his equations, the density is given to a first approximation by:

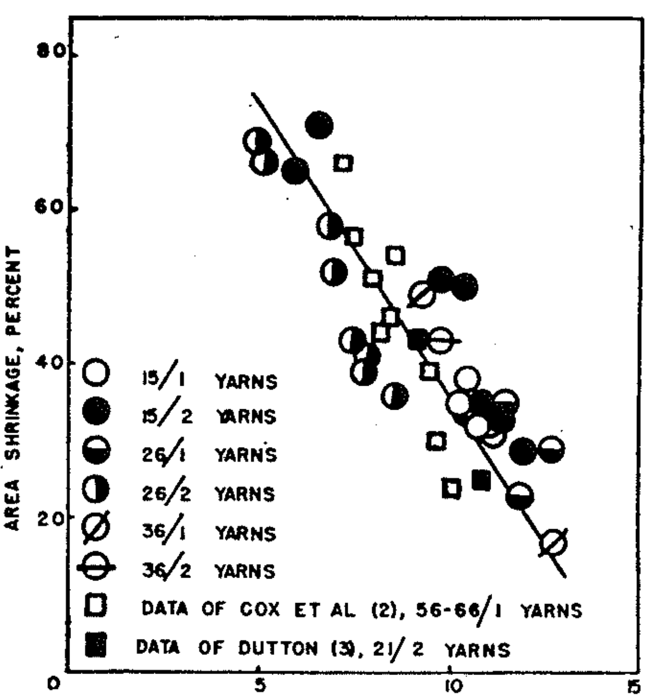
$$pk = \text{constant} \frac{g}{(p+w)^2}.$$

Since Peirce's weight per unit length, g, is inversely proportional to the yarn number, Y, and the course and wale spacings vary as the reciprocal of the number of courses and wales per inch, the cover factor can be seen to be related to the density of knitted fabrics, as given by Peirce. The somewhat arbitrary procedure was therefore followed of calculating a "cover factor" for the present knitted fabrics, using the relationship

$$F = \frac{T}{\sqrt{Y}},$$

and taking as T the sum of the number of courses and wales per inch. The factor so calculated is clearly related to the density of packing of wool in a given area of knitted goods, and it has the virtue of extreme simplicity.

The "cover factors" so calculated were plotted against the felting shrinkages, the curves being shown by the circles in Figs. 1 and 2 for the untreated flat and 1 x 1 rib knit



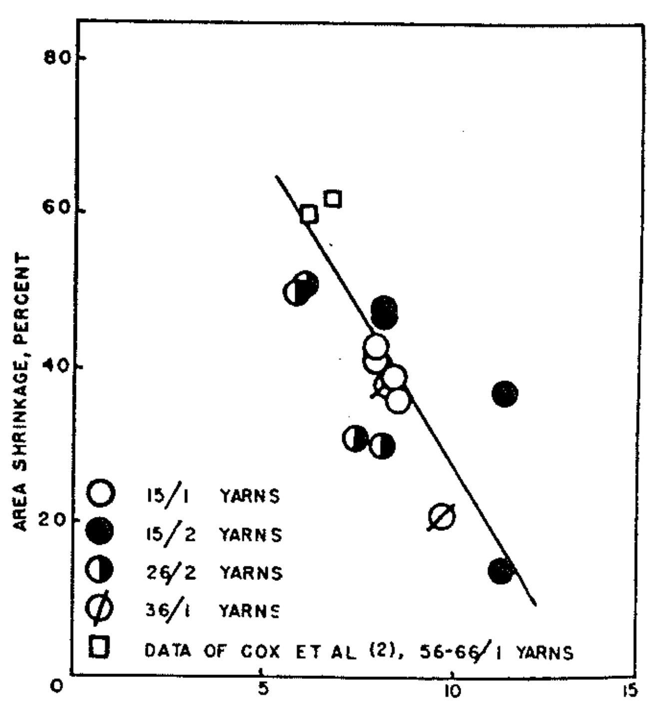


Fig. 1 *(left)*—Shrinkage of untreated flat knit fabrics in laundering as a function of cover factor. Fig. 2 *(right)*—Shrinkage of untreated rib knit fabrics in laundering as a function of cover factor.

fabrics, respectively. The correlation is quite good. One can estimate the felting for a wide variety of constructions and yarn types from the "cover-factor" values.

As a matter of general interest, an attempt was made to determine whether this relationship would also hold for other data. Accordingly, the data of Dutton and of Cox *et al.* were calculated in this way and plotted on the same curves. The plots (solid squares and open squares, respectively) are observed to fit very well to the present data, despite the considerable difference in the felting test methods used. This suggests that the observed relationship is of general usefulness, although the very good agreement between the present data and those of Dutton and Cox must be regarded as partly fortuitous, which is probably due to the fact that all the shrinkage tests involved were quite severe.

Effect of Level of Treatment

Comparison of the general shrinkage values in Tables I and II and in Tables III and IV reveal, as one would expect, that treatment for shrink-resistance is the largest factor in lowering feltability. An over-all view of this is given in Tables VIII and IX, which, in addition, give a picture of the magnitudes of the felting changes with continued laundering; these results are for the mild washing procedure, using low-titer soap as detergent.

The data demonstrate the importance of wool treatment in achieving acceptable shrink-resistance. There are socks (especially of the slack constructions) which are unsatisfactory as shrink-resistant garments because of inadequate construction, despite the over-all reduction in felting when chlorinated wool is employed. This point is of great importance and hence merits repetition: specification of shrink-resistance is of itself insufficient, and further description with respect to the construction in which the wool is to be used is required. One may thus "tailor" a treatment (within limits) to a given construction, or, alternatively, one must provide a sufficient tight construction for a given treatment in order to meet end-use requirements.

Summary and Conclusions

(1) Knitting stiffness, and, to a much smaller extent, yarn twist, contribute to the felting behavior of knitted fabrics. Increase in the number of wales and courses per inch and in the twist can be used to effect appreciable improvement in laundering stability.

(2) As the weight of the yarn used in a knitted structure is increased, the feltability decreases.

(3) The "cover factor," which is a measure of the amount of wool packed into a unit area of fabric, and which is proportional to the wales and courses and inversely proportional to the square root of the yarn number, correlates well with the relative shrink-resistance of a construction.

(4) Plying of yarns and type of spinning (Bradford *vs.* French) do not appear to affect feltability, other things being equal.

(5) Application of a shrink-resistant treatment to the wool produces a greater effect in reducing laundering shrinkage than any modification of construction here employed. Construction variables must necessarily be considered in relation to the level of treatment nonetheless, since un-

TABLE VIII. Shrinkage in Mild Laundering of Flat-Knit Socks

	Length shrinkage in laundering†						
	Untreated			Mild treatment		Optimum treatment	Severe treatment
Yarn Code No.*	5 cycles (%)	10 cycles (%)	20 cycles (%)	10 cycles (%)	20 cycles (%)	20 cycles (%)	20 cycles (%)
1—Slack knit	8	18	25	10	14	3	—
1—Tight knit	7	15	22	10	8	3	—
2—Slack knit	11	16	26	5	8	—	2
2—Tight knit	8	17	24	1	4	5	—
3—Slack knit	12	16	24	10	14	4	1
3—Tight knit	10	13	22	7	10	2	1
4—Slack knit	7	15	23	8	13	4	1
4—Tight knit	6	12	18	6	6	2	1
5—Slack knit	9	19	26	6	9	—	—
5—Tight knit	6	14	19	6	5	—	—
6—Slack knit	7	13	22	—	—	2	2
6—Tight knit	6	7	16	—	—	2	2
7—Slack knit	11	23	28	12	14	6	5
7—Tight knit	10	19	25	10	12	6	2
8—Slack knit	13	18	30	—	—	3	5
8—Tight knit	9	13	25	—	—	1	2
10—Slack knit	9	19	28	—	—	2	1
10—Tight knit	5	13	22	—	—	2	2

*The numbers correspond to the listing presented in the Materials section.

†Measured with the Schiefer device (Supplement to Fed. Spec. CCC-T-191a).

TABLE IX. Shrinkage in Mild Laundering of 1 × 1 Rib-Knit Socks or Tubing

	Length shrinkage in laundering†						
	Untreated			Mild treatment		Optimum treatment	Severe treatment
Yarn Code No.*	5 cycles (%)	10 cycles (%)	20 cycles (%)	10 cycles (%)	20 cycles (%)	20 cycles (%)	20 cycles (%)
1—Slack knit	11	26	33	17	19	0	5
1—Tight knit	11	16	20	4	6	0	3
2—Slack knit	14	23	32	9	13	5	5
2—Tight knit	7	9	21	4	9	3	—
9‡—Slack knit	8	12	18	—	—	—	—
9‡ Tight knit	9	6	8	—		—	—

*The numbers correspond to the listing presented in the Materials section.

†Measured with the Schiefer device (Supplement to Fed. Spec. CCC-T-191a).

‡Tubing specimens.

satisfactory stability may be found with shrink-resistant wools if the fabric construction is sleazy.

It is to be noted that the range of constructions considered in this experiment did not deviate too far from those considered normal in terms of conventional commercial practice. It is quite possible that combinations of variables which would give considerably better felting control than was found here, and which are not now used in industry, exist.

The work of Messrs. Bogarty, Harris, Sookne and Weiner was described in a recent issue of *Textile Research Journal*, monthly publication of the Textile Research Institute, Inc. Their research endeavors constitute a part of the Army Quartermaster program on shrink-resistant wool, which is under the supervision of the National Research Council Advisory Committee on Textile Finishing Research. The foregoing report is to be published by the Office of the Quartermaster General.

Mr. Weiner is associated with the Research and Development Laboratories of the Philadelphia (Pa.) Quartermaster Depot, while his collaborators are with Harris Research Laboratories of Washington, D. C.

[redacted]

THE following description of recent patents issued in the hosiery and knitgoods field is supplied by Eaton & Bell. Copies of the patents listed below may be obtained by sending company check, money order or silver to the Commissioner of Patents, Washington 25, D. C., at the rate of 25 cents per copy.

Lisle Mills, Inc., of Allentown, Pa., is assignee of Patent No. 2,519,534 from William W. Artzt of New Rochelle, N. Y. This patent calls for an undergarment formed of a knitted fabric comprising an integral body portion having front and back sides and one of the sides having a longitudinal zone of a knit more yieldable laterally than adjacent portions. The remainder of the body portion and including a crotch portion of the same are of the same knit as the zone and are joined with the other side of the body portion.

Patent No. 2,519,875 has been assigned to Dexdale Hosiery Mills of Lansdale, Pa., from Emil J. Berger and Howard K. West of the same city and relates to a straight knitting machine. The patent claims in a straight knitting machine, a bar with a series of hook needles and a bar with needle-hook cover points to co-operate with the needles in the stitch formation. Supporting means are rockable about a horizontal axis for the point bar and means are provided for rocking the point bar including a rotary cam. A cam actuates a spring biased follower arm, the arm being formed in two sections connected by a knuckle joint. Means are also provided for breaking the knuckle joint of the arm to prevent its actuation by the cam at predetermined times during the knitting and thereby precludes actuation of the point bar.

Eugene M. Zesch of Shillington, Pa., is assignor to Karl Lieberknecht, Inc. of Reading, Pa., of Patent No. 2,519,991. This patent claims a welt closing mechanism for knitting machine having a straight series of needles comprising a welt rod. The starting course of welt fabric on the needles is engaged by a bar with hook instrumentalities and this bar has a shouldered ledge at the back thereof upon which the welt rod is placed. A spring finger normally holds the rod upon the ledge. The welt bar is supported incident to movement of the welt bar away from the needles to draw off the welt fabric as it is being formed. Releasing means are automatically operable, after a definite length of welt fabric is produced, to dislodge the welt rod from the shoulder of the welt bar and to incidentally flex the spring finger and so release the rod to drop toward the fabric behind the hook instrumentalities of the bar.

Patent No. 2,520,091 has been assigned to Sanson Hosiery Mills, Inc., of Philadelphia, Pa., from Willy de Mond of Hollywood, Calif. This patent calls for a stocking plain-knitted from nylon and accordion pleated. The pleat-defining creases are permanently set into the fabric at an angle to the fabric course and visible when the stocking is relaxed but disappearing as the stocking is drawn onto the leg of the wearer.

Patent No. 2,521,218 has been issued to Carlos A. Hepp of Palisade, N. J., assignor to Alfred Hofmann & Co. of West New York, N. J., for a warp knitting machine and method of operation. This patent relates to a warp knitting machine of a type having a rotatable reel from which the yarns are supplied in the form of an advancing sheet to feed the banks of knitting instruments operable through successive cycles, with a frictional brake means operable in each knitting cycle for methodically retarding the reel rotation and comprising a friction shoe bearing upon a surface rotatable with the reel. A movable shipper means is operably connected to the shoe to impose or relax variably the braking action on the reel. A combination is claimed of a plurality of shiftable yarn guide rods around which in sequence the yarn sheet from the reel flows advancing toward the knitting point. Each rod is advancingly displaceable and retractingly returnable for the supplying and taking up of the yarn. A first one of the rods has resilient control means rendering it displaceable and returnable in each cycle in response to variations of the pull and slack of the yarns flowing around it caused by variations in the knitting demand for yarn. A second one of the shiftable rods has control means for displacing and returning it independently of such pull and slack of the flowing yarns and comprises a positive or power actuated mechanism pretimed to supply yarn to and take up yarn from the knitting point in each cycle to a variable extent co-ordinated with but insufficient fully to satisfy such pull and slack of the yarns. The first rod has a mechanical connection to the shipper whereby, to the extent that the yarn pull in any part of the cycle exceeds the supply afforded by the predetermined deficient advance of the second rod. The resilient yield of the first rod operates through the shipper to relax the braking of the reel thereby to facilitates the rotation of the reel for the feeding of yarn toward the knitting point at that part of the cycle; whereas, to the extent that the slack in any part of the cycle exceeds the take-up afforded by the predetermined deficient retraction of the second rod. The resilient yield of the first rod operates through the shipper to impose the braking of the reel thereby to retard the rotation of the reel for the curtailing of feed of yarn toward the knitting point at that part of the cycle.

Karel Semotan of Zlin, Czechoslovakia, is assignor of Patent No. 2,521,258 to Bata, Narodni Podnik of Zlin,