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METHODS OF TESTING HOSIERY

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DANIEL C. ROPER, Secretary

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METHODS OF TESTING HOSIERY

By

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and

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PREFACE

The purpose of this circular is to describe the methods of test used by the research associates of the National Association of Hosiery Manufacturers at the National Bureau of Standards for those concerned with the testing of hosiery. The test methods given in this circular were selected in order to eliminate unnecessary or undesirable variations in the general testing procedure and to eliminate confusion resulting from a diversity of methods.

July 16, 1938. LYMAN J. BRIGGS, *Director.*

METHODS OF TESTING HOSIERY

By E. Max Schenke [1] and Howard E. Shearer [1]

ABSTRACT

The object of a laboratory analysis of hosiery may be to provide data for a calculation of the cost of production, or to make possible the exact reproduction of hosiery. Often it is to determine the differences between two stockings, to relate defects to variations in yarns or construction, or to compare the service qualities of one stocking with another.

The procedures used by the research associateship of the National Association of Hosiery Manufacturers at the National Bureau of Standards, and by others, are described in this publication for the information of manufacturers, commercial testing laboratories, home economics teachers, and distributors of hosiery.

CONTENTS

[1] Research associate and assistant research associate, respectively, at the National Bureau of Standards, representing the National Association of Hosiery Manufacturers.

I. INTRODUCTION

The object of a laboratory analysis or test of hosiery may be to provide data for a calculation of the cost of production, or to make possible the exact reproduction of hosiery. Often it is to determine the difference between two stockings, or to relate defects to variation in yarns or construction, or to compare the service qualities of stockings.

The procedures used by the research associateship of the National Association of Hosiery Manufacturers at the National Bureau of Standards, and by others, are described in this publication for the information of manufacturers, commercial testing laboratories, home economics teachers, and distributors of hosiery.

The manuscript of this paper has been examined by the committee on standards of the National Association of Hosiery Manufacturers and the knit fabrics committee of the American Association of Textile Technologists, and the procedures given in it have received their official endorsement.

The technical terms used here are all defined in "The Manufacture of Hosiery and Its Problems" [1],[2] which also describes the methods of hosiery manufacture with which the laboratory technician should be familiar.

II. PRELIMINARY VISUAL EXAMINATION FOR TYPE

1. FULL-FASHIONED

There are two types of hosiery in general use, namely, full-fashioned and circular-knit (seamless). Modifications of each of these are to be found.

The fact that full-fashioned hosiery is knit flat and requires a seam affords several means of identification. When the thread of the seam of such a stocking is cut or raveled and the fabric opened, a selvage is revealed. On the inside of the welt at the end of the seam will be found an oval-shaped opening. In women's knee-length stockings, anklets, and men's ribbed-top half hose this opening does not appear as stockings of these classes do not have welts.

Another means of identification of a full-fashioned stocking is the presence of fashion marks as raised dots at the back of the upper leg (flare), the calf, heel, sole, and toe. It will be seen that at each of such marks the wales are reduced in number, usually by removing two needles from the knitting operation thereby narrowing the fabric without reducing the size of the stitches, which are maintained much the same throughout the stocking. The bottom of the heel and the tip of the toe are joined by looping.

2. CIRCULAR-KNIT

Because of the method of formation, circular-knit hosiery does not require a seam. A mock seam is, nevertheless, generally present, but if the seaming thread is cut, the fabric usually will be found to be closed or continuous. If, however, the fabric is found to have been cut it will have ragged instead of selvage edges. An oval-shaped opening may sometimes be present in the inside of the welt but this is not necessary and generally is absent. At the back of the upper leg, calf, and sole, a series of mock fashion marks may be observed. Inspection will reveal that the number of wales does not change at these points and that all the wales continue the full length of the stocking. It is to be observed that the shaping is done by tightening the stitches during knitting. In the heel and toe a gore or diagonal-knitted line is generally present. The toe closure is usually made by looping.

Sometimes a part of the ankle of circular-knit hosiery is cut away and the edges sewed. Also it may be found that the leg of a stocking has been knit by the full-fashioned process and attached to a foot knit by the circular process, or vice versa. It is therefore advisable to examine the stocking at several places in ascertaining its type.

[2] Figures in brackets indicate the literature references at the end of this paper.

3. FASHIONED SEAMLESS

There is a fashioned seamless stocking which is knit on a flat bed machine in which two flat beds are inclined at an angle of 45 degrees to each other. This type may be recognized by the rows of stitches converging in the form of a "V", wherever fashioning takes place.

4. CUT OR TAILORED HOSIERY

Cut or tailored hosiery is made by cutting fabric, of plain or lace construction, to the desired shape with a special cutting machine and sewing the pieces together. It may be of a heavy texture often referred to as glove silk hosiery, or a lace material made on a lace, tricot, or milanese machine.

5. CLASSES OF HOSIERY

Several classes of each of these different types of hosiery are made. These are readily identified as:

Women's	Men's	Misses'	Children's	Infants'
Full length. Thigh length. Knee length. Anklets.	Half hose. Golf hose. Anklets.	Misses'. Misses' ribbed.	Seven-eighths. Five-eighths. Anklets.	Ribbed. Socks. Anklets.

III. WORKMANSHIP

1. UNIFORMITY OF STITCH

The stocking is laid out on a flat surface and examined for sleaziness, crowsfeet, wrinkles, etc., reporting the amount and location of each. The stocking is then stretched on a hosiery form colored to give a contrasting background and examined for pin stitches, tuck stitches, needle or sinker lines, and other defects.

Defect	Description of defects
Sleaziness	Irregular, unevenly-shaped loops. These unevenly-shaped loops are more generally in the course direction.
Crowsfeet or mesh marks.	Distorted places and groups of distorted stitches.
Wrinkles	Pressure marks in the form of creases.
Strawberry, diamond, or pin stitch.	A lacy appearance throughout small sections of the fabric. Found in the welt more often than in any other section of the stocking.
Tuck stitch	An accidental accumulation of stitches at one place.
Needle or sinker line	A series of loops in the lengthwise direction of the knit fabric which are tighter, looser, or fuzzier than the remainder of the fabric.

2. EVENNESS AND CLEANNESS

The stocking is placed on a hosiery form of contrasting color and visually examined for evenness and cleanness. The "Evenometer"

[2] (for evenness only) or the "Seem" [3] grading cabinet may be used for this test.

3. QUALITY AND GRADE

The "Standards of Inspection for Ladies' Full-fashioned Hosiery" [4] developed and published by the National Association of Hosiery Manufacturers is followed when inspecting and grading finished silk hosiery. The stocking is divided into 4 zones, as shown in the inspection chart (fig. 1). The silk irregularities permitted in each zone are shown in figure 2.

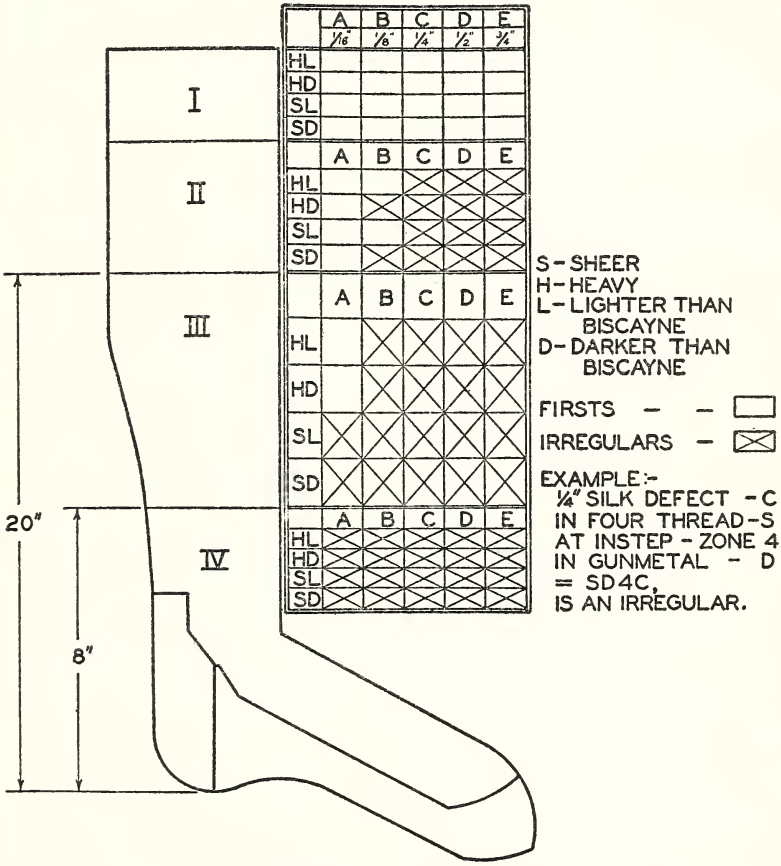

FIGURE 1.—*Inspection chart for women's hosiery showing zones, silk irregularities (or menders) which disqualify a stocking as first quality.*

4. VARIOUS TYPES OF DEFECTS IN SILK HOSIERY

The various types of defects or irregularities, commonly encountered in silk hosiery are illustrated in "Hosiery Fabric Defect Standards" [5].

The stocking is placed on a flat surface of contrasting color, and visually examined for defects. Each defect is compared with the photographs of the hosiery fabric defect standards and the defect classified accordingly.

The various defects are listed in accompanying the form, which shows the classification of causes of hosiery irregularities recommended by the raw silk committee of the National Association of Hosiery Manufacturers.

5. SEAMS AND LOOPING

The stocking is placed on a hosiery form and all seams and looping are examined for uniformity and lay, appearance, and cleanness of workmanship. Also for the matching of splicing, picots, fashionings, etc.

6. REINFORCEMENTS

The reinforcements are checked to see if they are distributed so as to serve the purpose intended. They should be of good appearance, properly plaited or spliced and not interfere with the fit of the stocking.

7. DYEING

The stocking is examined for dye streaks, work marks, chafing, penetration of dye, especially at the seam and splicing, and uniformity of shade.

8. FINISH

The stocking is examined when spread flat and when held at various angles for uniformity of finish, freedom from streaks and milky effects, whether dull or lustrous, and general handle and drape.

IV. DIMENSIONS

1. GENERAL DIRECTIONS

The length and size or foot length are measured in accordance with the methods of Commercial Standard CS46–36 [6]. The reader is referred to the Commercial Standard for the standard lengths and sizes as adopted by the industry.

The various parts of hosiery are shown in figures 3 and 4. The hosiery to be measured is laid out without tension on a smooth, flat surface, and freed from creases and wrinkles which may affect the measurements. Measurements are taken to the nearest one-eighth inch.

2. SIZE OR LENGTH OF FOOT

Full-fashioned hosiery.—The size is the distance from the tip of the toe to the back of the heel along a straight line from the tip of the toe through the uppermost fashion mark in the heel, which is approximately 1 inch above the bottom of the heel. The size is reported to the nearest one-half inch.

Circular-knit hosiery.—The size is the distance from the tip of the toe to the back of the heel along a straight line through the tip of the toe and the bottom of the heel gore. The size is reported to the nearest one-half inch.

3. LENGTH OF MEN'S AND WOMEN'S FULL-FASHIONED HOSIERY

A ruler is placed so that the edge touches the curve at the ankle and is parallel to the front line of the stocking. The length is the

CLASSIFICATION *of* CAUSES *of* HOSIERY IRREGULARS

Silk Lot No. Mill Date

	Photo No.	*Style* *Color* *Amount*						
I	1	TWO TONE						
		PER CENT						
II	2	Bad Casts and Loopy Threads						
	3	Small Slugs						
	4	Small Waste						
	5	Nibs						
	6	Large Bad Casts						
	7	Large Slugs						
	8	Double Ends						
		CLEANNESS DEFECT TOTAL						
		CLEANNESS DEFECT PER CENT						
III	9	Bad Matches—Size						
	10	Fine and Coarse Ends						
	11	3-Carrier Fine and Coarse Ends						
		EVENNESS DEFECT TOTAL						
		EVENNESS DEFECT PER CENT						
IV	12	Hard and Slack Twist						
	13	Bright Threads—Shiners						
	14	Split Threads						
	15	Large Waste						
	16	Fine Threads						
	17	Kinks						
	18	Bad Knots						
		YARN DEFECT TOTAL						
		YARN DEFECT PER CENT						
V	19	Tight and Loose Stitches						
	20	3-Carrier Lines						
	21	Drag on Thread						
	22	Holes						
	23	Load Up—Legger or Footer						
	24	Bad Plaiting						
	25	Bad Topping						
	26	Sinker or Needle Lines						
	27	Barré						
	28	Sleazy						
	29	Bad Selvage						
	30	Irregular Lengths						
	31	Bad Looping						
	32	Bad Seaming						
		MANUFACTURING DEFECT TOTAL						
		MANUFACTURING DEFECT PER CENT						
VI	33	Dyeing						
	34	Boarding						
	35	Pull Threads						
	36	All Other						
		FINISHING DEFECT TOTAL						
		FINISHING DEFECT PER CENT						
		TOTAL IRREGULARS						
		PER CENT IRREGULARS						

Recommended by RAW SILK COMMITTEE - National Association of Hosiery Manufacturers

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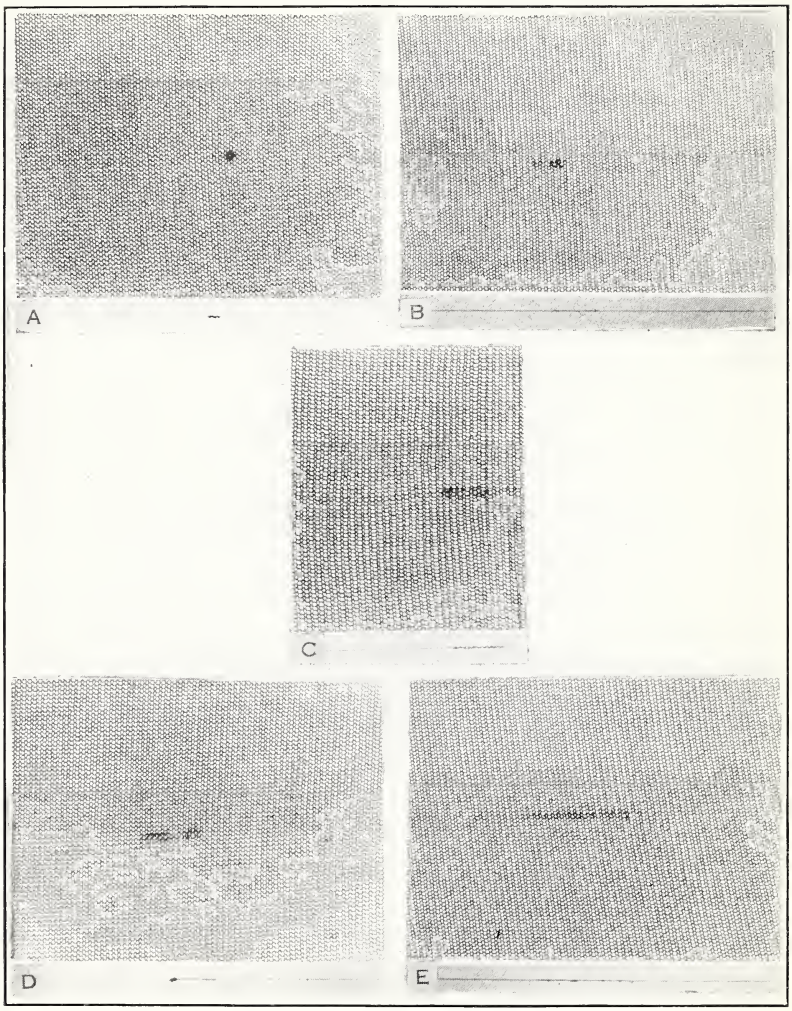

FIGURE 2.—*Silk irregularities.*

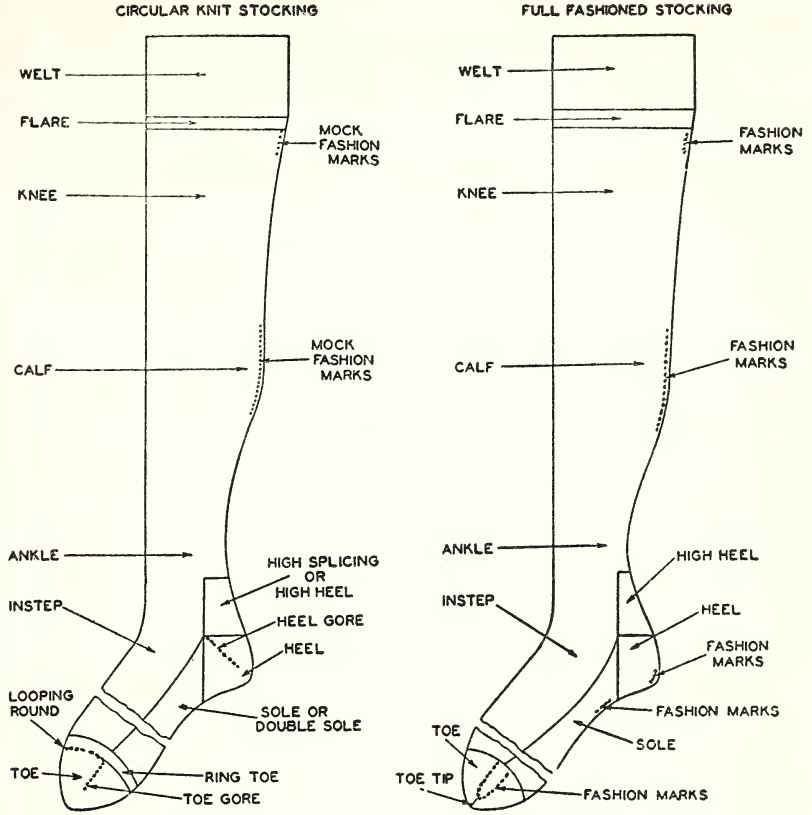

FIGURE 3.—*Various parts of women's hosiery.*

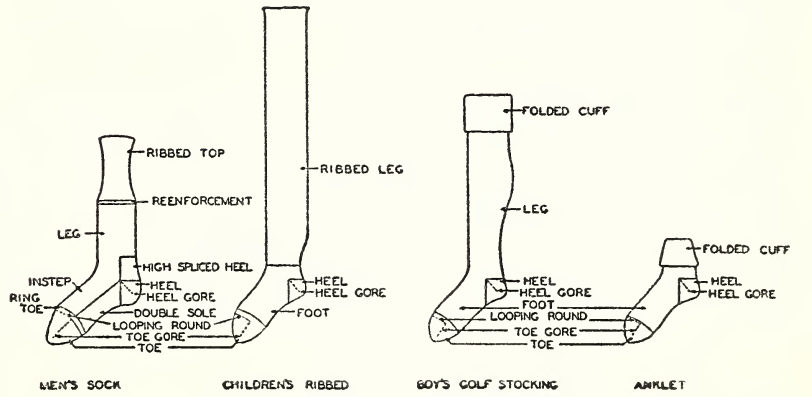

FIGURE 4.—*Various parts of hosiery.*

distance from the bottom of the heel to the uppermost edge or top of the stocking.

4. LENGTH OF MEN'S AND WOMEN'S CIRCULAR-KNIT HOSIERY

A ruler is placed so that the edge touches the lower end of the heel gore and the curve formed at the ankle. The length is the distance from the bottom of the heel to the uppermost edge or top of the stocking.

5. LENGTH OF BOYS', MISSES', CHILDREN'S, AND INFANTS' STOCKINGS OR SOCKS

A ruler is placed so that the edge touches the lower end of the heel gore and is parallel to the front line of the stocking. The length is the distance from the bottom of the heel to the uppermost edge or top of the stocking.

6. LENGTH OF THE VARIOUS PARTS OF HOSIERY

The lengths of the following parts are measured:

1. Welt or top.
2. Shadow welt or after welt.
3. Leg from shadow welt to high heel.
4. High heel.
5. Inner heel.
6. Heel.
7. Sole.
8. Ring toe.
9. Toe block.
10. Toe.
11. Foot or size.

7. WIDTH OF THE VARIOUS PARTS OF WOMEN'S FULL-FASHIONED AND CIRCULAR-KNIT HOSIERY

The width of the following parts are measured. (See fig. 3.)

1. Center of welt or top.
2. Leg at first flare narrowing.
3. Leg 4 inches below bottom of welt or top.
4. Leg 8 inches below bottom of welt or top.
5. Leg 14 inches below bottom of welt or top.
6. Leg 6 inches above the heel looping.
7. Top of high heel.
8. Heel (at center).
9. Across instep and heel.
10. Sole reinforcing (cradle adjoining heel).
11. Center part of foot.
12. Center part of sole.
13. Toe (cradle adjoining instep).
14. Reinforcing in top of toe (toe block).

8. WIDTH OF THE VARIOUS PARTS OF MEN'S SOCKS

The width of the following parts are measured.

1. Center of ribbed top.
2. Leg 1 inch below ribbed top.
3. Leg 6 inches below ribbed top.
4. Across instep and heel.
5. Center part of foot.
6. Center part of sole.
7. Toe at point where looping and toe gore join.

9. WIDTH OF THE VARIOUS PARTS OF ANKLETS

The width of the following parts are measured.

1. Center of folded cuff.
2. Leg adjacent to heel.
3. Heel (at center).
4. Foot (at center).
5. Across instep and heel.
6. Toe (adjoining instep).

V. CONSTRUCTION OF STOCKINGS

1. NUMBER OF NEEDLES

Each wale on the face of a stocking corresponds to a needle on the knitting machine. The total number of needles on which any particular section of the stocking was knit is ascertained by counting the number of wales.

There are a number of ways in which wales can be counted. One is to place the stocking over a cylinder of a diameter sufficient to slightly stretch the stocking and then count the wales with a magnifying glass and pick or needle. A short section of seam is opened to examine the hidden wales. This method is used for both full-fashioned and circular-knit hosiery. If a full-fashioned stocking is analyzed before seaming, the open fabric is stretched slightly and fastened on a flat surface. The wales are counted with a magnifying glass and a needle or with a "thread counter" consisting of a magnifying glass, scale, and pointer. If the welt has a picot edge the number of needles used to knit the stocking is determined by counting the picots, multiplying by the number of needles it takes to make each picot, and adding the number of wales outside of picot. Another method is to count the wales below calf narrowings, and add thereto the wales taken out in the narrowings above that point.

The number of needles used in knitting women's full-fashioned hosiery should conform to the proposed construction standards of the National Association of Hosiery Manufacturers [4]. The number of needles in a full 14-inch needle bar is:

Gage	Needles
39	364
42	392
45	420
48	448
51	476
54	504

2. GAGE

The gage of a full-fashioned stocking is the number of needles per 1½ inches on the knitting machine. The gage is determined by counting the number of wales in the widest part of a full-length stocking, assuming that the stocking was made on a full 14-inch needle bar. The number of wales is divided by the length of the needle bar (14 in.) and the quotient multiplied by 1½.

The gage of circular-knit hosiery is entirely different. It is the thickness of the needle shank in thousandths of an inch.

Circular-knit hosiery is referred to by the total number of needles used in knitting or wales in the stocking instead of by the gage.

3. WALES PER INCH

The wales are the rows of stitches running lengthwise in hosiery. The wales per inch are determined by mounting the stocking on the hosiery form shown in figure 5. Using a thread counter, the number

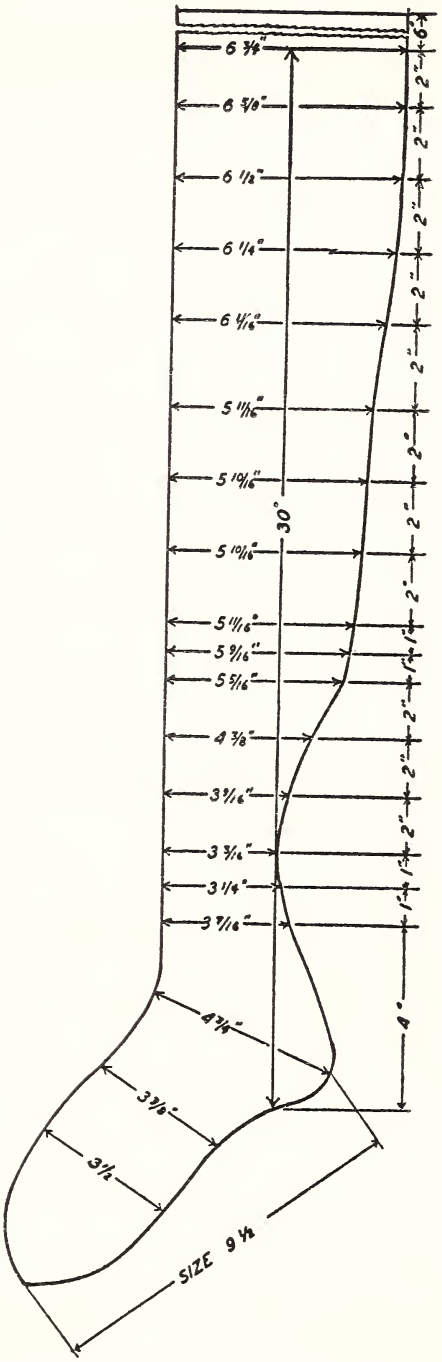

FIGURE 5.—*Inspection form for women's full-fashioned and circular-knit hosiery.*

of wales in 1 inch is counted on both sides of the stocking along a strip midway between the seam and the front edge at the locations enumerated below. The average of the two counts at any one section represents the wales per inch at that section.

Inside welt	Ankle (at high heel).
Outside welt	High heel.
Shadow welt	Heel.
4 inches below welt	Sole.
8 inches below welt	Instep.
14 inches below welt	Toe.

A count of the wales is an indication of the closeness of texture of the fabric at its finished width. It is not an indication of the texture of the fabric in the undyed state, or as it comes from the knitting machine, nor as worn by the user. A count of the wales per inch is of value when considered in connection with the finished width. While two stockings may appear of much the same texture when finished, when worn, the one with the more needles and greater width would have a closer texture.

4. COURSES PER INCH

Courses are rows of loops or stitches running across the stocking. The courses per inch are determined by mounting the hosiery on the hosiery form shown in figure 5. Using a thread counter, as for counting the wales, the courses in 1 inch along a wale are counted on both sides of the stocking at a point midway between the seam and the front edge at the same sections at which the wales per inch are counted. The average of the two counts at any one section represents the courses per inch in the finished stocking at that section.

The courses per inch are perhaps of more value than the wales per inch as an indication of the texture of the finished fabric and how it will appear when worn. The loops per square inch calculated from the wales and courses determine the texture of the fabric. Two finished stockings of different lengths may reveal a difference in courses per inch, the longer having fewer courses and a more open texture. Both may have been knit with the same courses per inch. The difference between these stockings would result from differences in stretching while boarding.

5. TOTAL COURSES

The total number of courses are counted by mounting the stocking on a hosiery form (fig. 5). The welt is turned back and using a thread counter (as for counting the wales and courses per inch) assisted by a needle or pick to mark the location while the counter is shifted, the number of courses in the inside welt are counted along any one wale from the first loose course to the upper edge of the welt or picot. The welt is then straightened out and the same operation followed by counting the courses in the welt, shadow welt, leg, high heel, and heel to the loose course (looping). It will be found convenient to select a wale to count along which runs continuously without interruption from the heel loose course to the upper edge of the welt. Such a wale may be readily selected by lightly running the point of the pick between two wales from the heel loose course to the welt. This will give the proper location at which to place the counter to start the test. It is also recommended that every hundredth course

be marked. A pick counter mounted on a screw 32 inches long is a convenient counter to use.

The number of courses in the various sections may then be added to secure the total courses in the stocking or in any sections desired.

6. FASHION MARKS (FULL-FASHIONED HOSIERY)

Fashion marks are raised dots appearing in groups on each side of the seam, at various sections of the stocking. The stocking is stretched over a hosiery form (fig. 5) and the number of fashion marks in each group on each side of the seam are counted.

The distance in inches or the number of courses between each group of fashion marks is also determined.

It is general practice to remove two needles at each fashion mark. The total number of needles taken out of operation in fashioning a stocking is determined by multiplying the total number of fashion marks by the number of needles removed at each of such marks.

7. TYPE OF KNITTING (SINGLE- OR THREE-CARRIER)

There are two general methods of knitting hosiery today, namely, single-carrier in which one carrier feeds in the same yarn every course, and three-carrier, or so-called ringless construction, in which three carriers alternate, each feeding in a different lead of yarn of the same size and type.

Whether the stocking is knit by the single- or three-carrier method is determined by cutting or pulling a thread in the leg across its width and raveling the yarn back to where it starts to make a continuous circuit. It will be necessary for the seam to be cut out or raveled to do this. If the yarn ravels out continuously from every course, the stocking is single-carrier. If the yarn ravels from but one complete course before catching at the selvage, and a different lead or yarn has to be handled for raveling out the following course, more than one carrier has been used. If the same lead or yarn may be raveled out only every third course, the stocking is three-carrier and is of the type now generally referred to as "ringless."

By grasping a stocking near each end, stretching it taut, and looking across the flat fabric at various angles, an experienced technician can usually determine whether a stocking is single- or three-carrier by the appearance in three-carrier hosiery of a faint series of lines or streaks traversing the fabric and equally spaced every third course. These are known as "washboard" effects. This is not a positive means of identification and is not always to be relied upon.

VI. PHYSICAL PROPERTIES OF STOCKINGS

The physical properties of stockings are tested at the standard atmospheric condition of 65- $\pm$2-percent relative humidity and 70° $\pm$2° F.

1. RESISTANCE TO SNAGGING

Snags are a source of great complaint by wearers of hosiery. It is the nature of hosiery fabric to be more or less susceptible to snagging and snags soon lead to failure of a stocking. In the absence of a more satisfactory method, the comparative snag resistance of stockings is

determined with the snag tester [7]. It consists essentially of a circular brass plate three-eighths inch thick and 3 inches in diameter, with an opening nineteen-thirty-seconds inch in diameter through the center. Mounted rigidly over the center of the opening is a screw micrometer by means of which the snagging point may be raised or lowered known distances. The snagging point is one-eighth inch long and tapers from a base three-thirty-seconds inch in diameter to a sharp point.

The stocking is placed on a rigid hosiery frame made of $\frac{3}{16}$-inch wire, chromium plated, and of the same dimensions as the form illustrated in figure 5. A smooth cardboard insert for the leg section is put in place, and the stocking secured by suitable means at the welt to prevent slipping. The stocking-covered frame is placed on a flat surface and the snag tester with the point retracted is carefully placed on the ankle section. The base plate of the tester is lightly grasped between the thumb and fingers so as to exert a minimum of downward pressure, and is passed back and forth the length of the leg. The snagging point is gradually lowered by means of the micrometer screw until contact is felt at some point along the path of operation. This contact setting is recorded. For each subsequent cycle the snagging point is lowered an additional 0.002 inch, the path of travel being shifted slightly so the effect of each micrometer setting can be studied. The number of snags and holes occurring between the lowermost calf fashion mark and the lower edge of the shadow welt are recorded. The setting at which the initial snagging takes place and the number and type of snags occurring at the various micrometer settings are considered in evaluating the comparative resistance of the stocking to snagging.

2. RESISTANCE TO ABRASION

Holes due to abrasion of the heel and toe sections of hosiery are common causes of complaint by the wearer. This is especially true of men's hosiery. Any machine designed to test the resistance of these sections to abrasion must necessarily be adapted to test small areas, and it should simulate the rubbing action of a shoe. The numerical results obtained on one machine probably would not duplicate those obtained on another even of the same type because of the difficulty of controlling all of the variables. The relative values obtained for different stockings should be much the same.

The general procedure in making such a test is to cut out the section to be tested and secure it to the test block. A small spherical or "half-ball" shape of polished wood over which the fabric is spread has been found to work well. This test block is usually given a reciprocating movement across the abrasive, under uniform pressure until a hole is formed in the fabric. A number of abrasive materials have been tried with varying degrees of success. Fine crocus cloth, such as 00 or closely woven balloon cloth, have been found to work well. They should be changed after every test for best results. A fine, uniform-mesh wire screen of monel metal has also been found successful and does not have to be changed so often. A rotary-type machine may also be used. Machines for this test are still in the development stage. One that is completely satisfactory has not yet been found, though the need for such a machine is great.

3. STRETCH—MANUAL

The ability of the stocking to be stretched is determined by grasping it at its two edges between the thumb and first finger, and stretching it along the edge of a ruler until it begins to slip from the grasp. The distance it has been stretched is noted, to the nearest one-eighth inch.

4. STRETCH AND RECOVERY

The stretch and recovery of hosiery is tested with a tensile testing machine of the pendulum type equipped with two chromium-plated steel bars, illustrated in figure 6, in place of the usual jaws. These bars are designed to be inserted for their full length in the stocking and to distend the stocking by separating at a rate of approximately 12 inches per minute. The testing machine is considered of the proper capacity for a test if the reading is within the working range of the instrument. The working range is defined as that portion of the total range within which the readings are correct within 1.5 percent. Wherever possible an autographic recorder should be used.

The stocking is first laid flat and its width measured. It is then placed on the bars which are close enough together so that the stocking fits snugly around them, but no load is shown on the dial of the machine. Garter clasps are attached to the stocking to prevent slippage from the bars. The machine is started. When the outside distance between the bars has increased to the lowest whole number of inches sufficient to show a load on the dial of the machine, the distance and load are observed and the machine immediately reversed. The stocking is removed, laid flat, and the width measured without loss of time. The stocking is then replaced on the bars, which are then separated to a distance of 1 inch greater than the first time when testing the welt and upper leg, the distance and load are observed, and the stocking removed and measured as before. These steps are repeated through successive 1-inch increments of separation of the bars to a maximum of 13 inches. The stocking is repeatedly stretched to this width nine additional times without removing before it is finally removed and the width measured. The stocking is then placed flat and left for 24 hours, at expiration of which time the width is again measured to ascertain the final contraction. When testing the ankle or foot, observations are made at ½-inch increments, to a maximum of 8 inches of bar separation.

Where the effect of finishing materials is to be ascertained the stockings are tested both before and after laundering. Laundering should be carried out according to the procedure set forth in the method of testing for fastness to laundering, section VII–1. The laundered stocking is dried at room temperature, without boarding.

While this test is of value in indicating the relative abilities of stockings to be stretched and to recover their shape after stretching and the influence of dyeing, finishing, and laundering on those properties, its greatest use is in the testing of hosiery in the greige as an aid to the manufacturer in securing the best machine adjustments for producing serviceable hosiery.

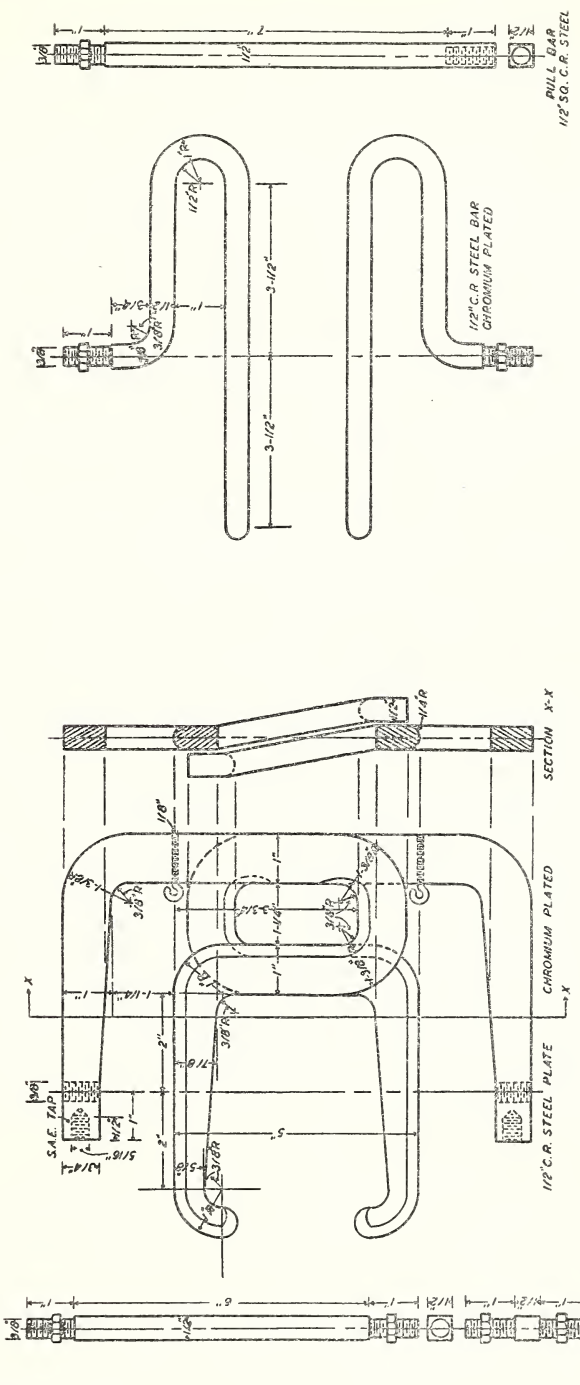

FIGURE 6.—*Chromium plated steel bars for testing the stretch and recovery of hosiery.*

5. "DISTENSIBILITY", "RECOVERABILITY", AND "STRETCH-ENDURABILITY"

Stockings which are well constructed from first-class materials may be inferior in elasticity because of the improper use or application of certain finishes. These are applied largely to appeal to the consumers' aesthetic sense. The lack of such elasticity is most often apparent in the welt and upper leg sections of women's hosiery, which must be capable of considerable distension. To compare the effects of these different finishing treatments on the elastic properties, the stockings should be tested before and after application of the finish and before after laundering.

A machine specially designed [8] in the textile section of the National Bureau of Standards is used. To make the test two smooth jaws are inserted in the upper part of the stocking, which is held in place by garter clasps attached to the welt and by a weight fastened to the ankle. The jaws are repeatedly separated and brought toward each other by a reciprocating mechanism in such a way that the circumference of the stocking is varied between predetermined limits for a certain number of cycles. Means are provided for recording on a chart the relationship between the load exerted on the stocking and the circumference for each cycle of loading and unloading. In this way numerical values for the properties called "distensibility," "recoverability," and "stretch-endurability" are obtained. These terms are defined in reference [8].

6. BURSTING STRENGTH (RESISTANCE TO POPPING)

Bursting-strength tests are made with the ball-burst attachment for the pendulum-type breaking-strength tester [9]. The same factors govern the operation of the machine as for making breaking-strength tests. Five determinations are made on each sample.

The metal test rings which hold the fabric have an outside diameter of 3¾ inches with a center opening 1¾ inches in diameter. To make the test the five bottom test rings are laid in a close row on a table. The hosiery fabric, which has been cut open along the seam, is spread smoothly over them without tension. The top rings are then placed in position, the fabric clipped around each pair of rings and the first pair locked in the machine for the test. When the machine is placed in operation a polished steel ball 1 inch in diameter is forced up through the center opening in the rings. In so doing, the fabric which has been clamped between the rings is completely enfolded around the upper section of the ball and extended upward until the fabric pops.

A bursting strength tester of the rubber-diaphragm type may also be used [10].

VII. COLOR FASTNESS

1. COLOR FASTNESS TO LAUNDERING

The stocking to be tested is immersed for 30 minutes in 200 ml of a solution containing 0.5 percent by weight of a "neutral" quality olive-oil soap. Three tests are made, one at 140° F, one at 110° F, and one at 80° F. A new sample is taken for each test. After treatment in the soap bath the fabric is rinsed three times, for 1 minute each time, in water at the same temperature. The fabric is hydro-

extracted, dried, and compared with the original fabric for change in color.

The color is considered "good" in fastness to laundering if it is not altered in the test at 140° F, "fair" if altered at 140° F, but not altered in the test at 110° F, "poor" if altered at 110° F. Stockings having "poor" fastness, but which are not altered in color when tested at 80° F, can be laundered if sufficient care is used. Those which are altered in color at 80° F will not withstand washing.

The laundering test is carried out in a Launder-Ometer [11], or similar machine. The essential features are that the jar containing the test sample is placed with its base toward a horizontal shaft 2 inches from the center of rotation, and the shaft rotated at a speed of 40 to 45 rpm.

2. COLOR FASTNESS TO PERSPIRATION [12]

Since perspiration may be either acid or alkaline, two solutions are required for this test.

Acid solution:

10 g of sodium chloride.
1 g of lactic acid, USP 85 percent.
1 g of disodium orthophosphate (anhydrous).
Make up to 1 liter with water.

Alkaline solution:

10 g of sodium chloride.
4 g of ammonium carbonate, USP.
1 g of disodium orthophosphate (anhydrous).
Make up to 1 liter with water.

Two pieces of hosiery fabric to be tested, measuring about 2 inches by 4 inches, and similar pieces of undyed cotton-worsted union cloth are required.

A piece of hosiery fabric and an undyed piece are thoroughly wet with the acid solution, rolled with the undyed piece on the outside and inserted in a glass tube, one end of which is closed, leaving one-third of the roll projecting. The tube is about 15 mm in diameter. The other piece of hosiery fabric and undyed piece are treated similarly, using the alkaline test solution.

The tubes are then placed in glass desiccators about 4 inches in diameter in the bottom of each of which is placed about 300 ml of a 70-percent aqueous solution of sulfuric acid. The treated samples should dry in about 48 hours. They are then ready for examination.

The extent to which the undyed or white material is stained and to which the dye has migrated from one part of the tested sample to another is taken into consideration in rating fastness to perspiration.

3. COLOR FASTNESS TO LIGHT

The sample to be tested is exposed for 8 hours to the radiation from a glass-enclosed carbon-arc lamp, the Fade-Ometer [13] or similar machine, with a current of approximately 13 amperes and 140 volts at the arc.

The sample to be tested is placed 10 inches from the arc and the lamp is so ventilated that the temperature at the test sample does not exceed 105° F (40° C). An area measuring approximately 1½ inches by 2 inches is exposed.

The fading is judged by comparison of the exposed area with the adjacent unexposed area. The sample should lie in a dark room at room temperature for 2 hours after exposure before the comparison is made. The exposed samples are graded as follows:

Good.—No perceptible change in shade.
Fair.—Slight change in shade.
Poor.—Appreciable change in shade.

4. COLOR FASTNESS TO RUBBING (CROCKING)

This is determined by rubbing the test sample against an unsized white cotton cloth. A similar test is made with the unsized white cotton cloth moistened with water. The white cloth is held over the flat end of a cylindrical "finger" five-eighths-inch in diameter and pressed against the dyed cloth with a load of 32 ounces. The finger is moved back and forth over the cloth 20 times at approximately 1 second per double stroke with a stroke 4 inches long. This test can be made conveniently with the machine known as the Crock Meter [14].

The staining of the white cloth by the test sample is compared with the staining when a standard sample is tested. When no standard sample has been established, the tested sample is rated on the following basis:

Good.—No appreciable staining of the wet white cloth.
Fair.—Appreciable staining of wet cloth, but no appreciable staining of the dry white cloth.
Poor.—Appreciable staining of the dry white cloth.

VIII. SHRINKAGE IN LAUNDERING

The stockings are laid flat and smoothed out to free them from wrinkles or creases. The lengths of the legs and of the feet are measured by the standard procedure. Each stocking to be tested is placed in a 1-pint jar containing 300 ml of soap solution at 120±2° F.

The soap solution contains approximately 0.5 percent of soap (olive oil) dissolved in soft water. The jar is agitated for 15 minutes at 120±2° F in a Launder-Ometer [11] or similar machine.

The stockings are removed from the jars and rinsed until the rinse water is clear. Excess water is removed by centrifuging or squeezing. The stockings are then boarded on drying forms of the size corresponding to the size of the original or unlaundered sample.

The stockings are dried on the form at room temperature, then removed and allowed to rest for 24 hours on a smooth horizontal surface with air maintained at 65 ±2 percent relative humidity and at 70° F.

The measurements described in paragraph 1 are repeated in order to determine the change in dimensions.

IX. COMPOSITION

1. TYPE OF DYE (DIRECT, SULFUR, ACID, BASIC, VAT, MORDANT, DIAZOTIZED AND DEVELOPED)

The dyes generally employed in dyeing hosiery are of the following types: Direct, basic, acid, sulfur, vat, mordant, diazotized and developed.

It frequently happens that the dye formula employed uses several of these types.

To identify the type of dye employed the reactions are carried out in test tubes with pieces of the dyed material one-half inch to three-fourths inch square, covered with 1 inch to 1½ inches of the reagent. When a fabric is composed of two or more differently-colored threads or types of fibers these should be separated if possible and tested separately.

The procedure to be followed in identifying the dye on various types of fibers varies somewhat, and often requires careful adherence to the methods laid down for accurate analysis. In such cases the procedure set forth in the "Analysis of Dyestuffs" [15] is recommended. For quick tentative identification the following examination may be made.

Direct and acid dyes.—Permanently decolorized with sodium hydrosulfite.

Acid dyes.—Color strips out in boiling dilute ammonia.

Basic dyes.—Color strips out in boiling 5-percent solution of acetic acid.

Sulfur dyes.—Immerse sample in acid stannous chloride solution, wrap the mouth of the test tube with filter paper, into the center of which place a drop of lead acetate solution. When heated the formation of a blackish-brown stain on filter paper indicates a sulfur dye.

Vat dyes.—Decolorized with sodium hydrosulfite. Color returns when exposed to air.

Mordant dyes.—Ash a small piece of the material. A residue of inorganic material suggests the presence of a mordant dye.

Diazotized and developed dyes.—Are direct dyes which have been treated to intensify the shade and improve their fastness to washing. They react to reducing agents such as sodium hydrosulfite, like other direct dyestuffs but are distinguished from the latter by their fastness to washing.

2. MOISTURE CONTENT OR REGAIN

A glass weighing bottle of approximately 100-ml capacity fitted with a ground-glass cover is dried at 221° to 230° F (105° to 110° C) to constant weight. The bottle and cover are placed separately in the oven. After drying for 1 hour, the bottle is closed and transferred to a desiccator and allowed to cool to room temperature. The closed bottle is then weighed on an analytical balance. The drying and weighing are repeated at ½-hour intervals until there is no progressive change in weight of the bottle. This is the "weight of the weighing bottle." This weighing bottle is kept in a desiccator when not in use.

A sample weighing approximately 2 g is first conditioned in the atmosphere under consideration. The sample is then placed in the cooled, dried weighing bottle from the desiccator and weighed. This is the "weight of weighing bottle plus sample." By subtracting the "weight of weighing bottle" from the bottle plus sample, the "weight of sample" is obtained. Let this weight of the conditioned sample eb designated "*A*."

The sample is removed from the weighing bottle and placed on a watch glass. The sample and the uncovered weighing bottle are placed in the oven (temperature 221° to 230° F) and dried for 1½ hours. The dried sample is then replaced in the weighing bottle,

which is placed covered in a dessicator. The sample and bottle are cooled to room temperature and weighed. The bottle and sample are then returned to the oven and the drying, cooling, and weighing are repeated until there is no progressive change in weight. This is the "weight of weighing bottle plus dry sample." By subtracting the "weight of weighing bottle" from "weight of weighing bottle plus dry sample" the "weight of the dry sample" is obtained. Let the weight of the oven-dried sample be designated "*B*."

The moisture content of the sample in percent equals:

$$\frac{\text{Weight of original sample}-\text{weight of dry sample}}{\text{Weight of original sample}}\times 100$$

or

$$\frac{A-B}{A}\times 100=\text{percentage of moisture.}$$

If it is desired to calculate the amount of moisture present on a regain basis, the following formula is used:

$$\frac{A-B}{B}\times 100=\text{percentage of regain.}$$

3. OIL CONTENT

The amount of oil on hosiery yarn or fabric is determined by extracting the oil from the sample in a soxhlet apparatus. The procedure is as follows: The accurately-weighed sample of approximately 2 g is dried, as described in section IX–2, to obtain the dry weight "*B*." It is then placed in a soxhlet extraction apparatus and extracted with carbon tetrachloride for 2 hours. The specimen is then removed, allowed to dry at room temperature, washed in warm distilled water, squeezed to remove excess water, returned to the oven, and dried to constant weight as before. This gives the weight of the dry, oil-free sample. Let the weight be designated as "*C*". The percentage of oil in the sample is

$$\frac{B-C}{B}\times 100.$$

It may sometimes be desirable to obtain the weight of the oil extracted from the sample. Where this is desired, the small flask of the soxhlet apparatus is first dried to constant weight and weighed as described in the first part of section IX–2 for obtaining the weight of the weighing bottle. The apparatus is then assembled and the sample is extracted with the solvent. The flask is removed, the solvent evaporated, and the flask again dried in the oven and weighed, as before. This weight, minus the weight of the clean dry flask, gives the weight of the oil in the sample.

4. TOTAL AMOUNT OF SIZING, FINISHING, AND OTHER NON-FIBROUS MATERIALS

After removal of moisture and oil, as described in sections IX–2 and IX–3, the sample is immersed in an approximately 0.5-percent suspension of a starch and protein hydrolyzing enzyme at 50° C (122° F) and squeezed while immersed. The squeezing is repeated at least six times to saturate the sample with the enzyme suspension.

The suspension is heated to 70° C (158° F) or to the temperature known to be optimum for the enzyme used, and kept at this temperature for 15 minutes or more with the specimen immersed in it. The specimen is rinsed at least 12 times in fresh portions of hot distilled water, agitated well in each rinse water, to aid in removing insoluble materials, and squeezed after each rinse. The specimen is dried to constant weight as before. This gives the weight of clean, dry fiber *"D"*. The sample is then ashed and the weight of the ash is subtracted from the weight of the clean dry fiber *"D"* to obtain the "corrected weight of the clean dry fiber." Total oil, sizing, finishing, and other nonfibrous materials in percent (dry basis) equals:

$$\frac{\text{Weight of oven-dry sample} - \text{corrected weight of clean dry fiber}}{\text{Weight of over-dry sample}} \times 100.$$

The purpose of this procedure is to remove all nonfibrous constituents. These include the oils, waxes, dirt, and similar materials associated with the fiber before it is processed, and sizing and finishing materials added by the manufacturer. The method described is effective for the removal of the usual natural constituents and starch, clay, some waxes, and nondrying oils. When it is necessary for the analyst to modify the procedure to remove certain nonfibrous materials, the effect of the modified treatment on the weight of clean fibers of the same kind as those in the specimen should be determined. This procedure is necessary only in certain instances, such as for lumbermen's socks and those which are made from reclaimed fibers.

5. FIBER IDENTIFICATION

The fibers oridinarily met with in hosiery are silk, wool, cotton, rayon, rabbit hair, and flax. Methods for identifying them are given here.

Small samples of the various yarns in the stocking are removed and examined under the microscope. If each contains but one kind of fiber the tests may be applied to the yarn. If the yarn contains a mixture of fibers it may be necessary to separate a few of each kind for test.

Successful identification of the fibers used in hosiery depends upon experience and familiarity with the fibers. The ultimate assurance of the correctness of the findings is based on comparison with a known standard sample. It is not only desirable but necessary for the analyst to have authentic samples of the fibers likely to occur in hosiery.

As a preliminary test burn a few individual fibers by applying a flame to their ends. *Silk, wool, and rabbit hair*, burn with the odor of burning feathers or hair and a black knob forms at the end of the fiber. *Cotton, viscose, cuprammonium rayon, and flax*, burn with the odor of burning paper and the ash drops off. *Acetate rayon* burns with a pungent odor.

The technique of mounting fibers for microscopic examination is relatively simple. If the fibers to be examined are dyed or coated with an oil or sizing, it is necessary to remove the dye, oil, or sizing, before applying the stain because these interfere with its action, as an indicator.

The "keying out" of an unknown is simply a matter of elimination. In every division and subdivision of the key there are two (in one case three) choices numbered alike. It is necessary to accept one as descriptive of the fiber in question and reject the others. It is quite possible that no phrase exactly describes the fiber, but it is necessary to choose one and to follow through the entire key, step by step.

I. Stain with "Herzberg." Examine under microscope, ×100.
Red: Cotton, linen, rayon.
1. Fibers short, flat, ribbon-like, twisted at intervals—cotton.
1. Fibers cylindrical, pointed at ends, with cross marks on surface; swollen nodes, and narrow lumen—linen.
1. Fibers continuous, fairly uniform diameter throughout—rayon—2.
2. Immerse in acetone or glacial acetic acid; fiber dissolves—acetate rayon.
2. Fibers fail to dissolve in acetone or glacial acetic acid—3.
3. Apply diphenylamine solution to dry fiber—fiber dissolves, producing blue coloration—nitrocellulose rayon.
3. No blue coloration—4.
4. Examine under microscope, ×100.
4. Fibers markedly striated longitudinally—viscose rayon.
4. Fibers not striated, often with light center channel—cuprammonium rayon—confirm by dyeing with Erie Fast Orange C. G. (Colour Index 621). Cuprammonium rayon is dyed a deep orange in a 0.2-percent solution; other rayons are white or weak orange.

I. Stain with "Herzberg." Examine under microscope, ×100.
Fibers colorless or yellow—silk, wool, rabbit.
1. Fibers continuous, transparent, with occasional flattened protrusions—silk 2.
2. Fibers ribbon-like, irregular, striated, diameter broad—tussah silk.
2. Not striated, diameter fine—cultivated silk.
1. Fibers shorter, not transparent (opaque), frequently pigmented—3.
3. Fibers with distinct medulla pigment packed in blocks—rabbit—4.
4. Pigment blocks in one or two rows—common rabbit.
4. Pigment blocks more than two rows—angora rabbit.
3. Medulla not always visible, fibers definitely scaled—wool.

HERZBERG'S SOLUTION

Solution A:

Zinc chloride	50 g.
Distilled water	25 ml.

Specific gravity at 28° C should be 1.8.

Solution B:

Potassium iodide	2.25 g.
Iodine	0.25 g.
Distilled water	12.5 ml.

Add *B* to *A;* let stand overnight; decant from sediment; add a leaf of iodine. Keep in dark bottle.

DIPHENYLAMINE SOLUTION

Concentrated sulfuric acid	20 ml.
Glacial acetic acid	10 ml.
Diphenylamine	0.30 g.

6. QUANTITATIVE FIBER ANALYSIS [16.]

If the different kinds of fibers are present in different yarns, remove the yarns from the fabric, weigh the different kinds separately and calculate the percentage composition from the weights.

When the fibers are mixed in the same yarn, a chemical analysis is made. The oil and sizing and finishing materials are removed according to the methods given in section IX–3 and IX–4. The residue of clean fiber is dried in the oven as in section IX–2 and an accurately weighed sample of about 2 g taken for test.

(a) WOOL IN MIXTURE WITH SILK, COTTON, RAYON, OR FLAX

Wool in mixture with silk, cotton, rayon, or flax is determined by the sulphuric acid method. If the material is at all tightly knit it is cut into strips one-eight to one-fourth inch wide, of if the yarns are highly twisted, they are partly untwisted. The clean dry sample is immersed in 200 ml of a boiling 1-percent solution of sulfuric acid (1.0 percent by weight of H_2SO_4) for 7 to 10 minutes. If the material is in the form of fabric or yarn, it is transferred to a gooch crucible (no asbestos). If it is loose fiber, it is transferred to a crucible having a medium fritted-glass bottom. The excess acid solution is removed by suction. The sample is then placed in 200 ml of a 70-percent solution of sulfuric acid (70.0 percent by weight of H_2SO_4) at 100° F and worked in this solution for 15 minutes, preferably with a mechanical stirring device (fig. 7). The undissolved fibers are then collected in a crucible with a fritted-glass bottom and well-washed with cold water, immersed in a 2-percent solution of sodium bicarbonate at room temperature for 5 minutes to neutralize any acid, collected again in the crucible, washed, and dried at 221° to 230° F (105° to 110° C) to constant weight. This gives the "weight of dry wool from sample," which is designated "*E*."

The percentage of wool in the sample is $E/D \times 100$, where E is the weight of dry wool from the sample, and D is the weight of the clean dry sample.

(b) COTTON IN MIXTURE WITH WOOL

Place the dry sample in a boiling 5-percent aqueous solution of potassium hydroxide (previously boiled to remove dissolved air) for 10 minutes; sufficient solution is taken to cover the sample continually. Decant or filter the solution and rinse the cotton residue with hot distilled water, then with a 5-percent aqueous solution of acetic acid, and finally with water until the rinse is neutral to blue litmus paper. The residue is dried and weighed as in section IX–2. This is the weight of dry cotton cellulose in the sample. Let this be designated "*F*." The percentage of cotton in the sample is $F/D \times 100$, where F = the weight of dry cotton cellulose, and D is the weight of the clean dry sample.

(c) CELLULOSE ACETATE RAYON (ACETONE SOLUBLE TYPES) IN MIXTURES

The weighed sample after drying and removal of oil, sizing, finishing, and other nonfibrous material in accordance with sections IX–2, IX–3, and IX–4 is agitated vigorously for 15 minutes in about 50 times its weight of acetone at room temperature. This dissolves the acetate rayon leaving the other fibers. The residue is rinsed by

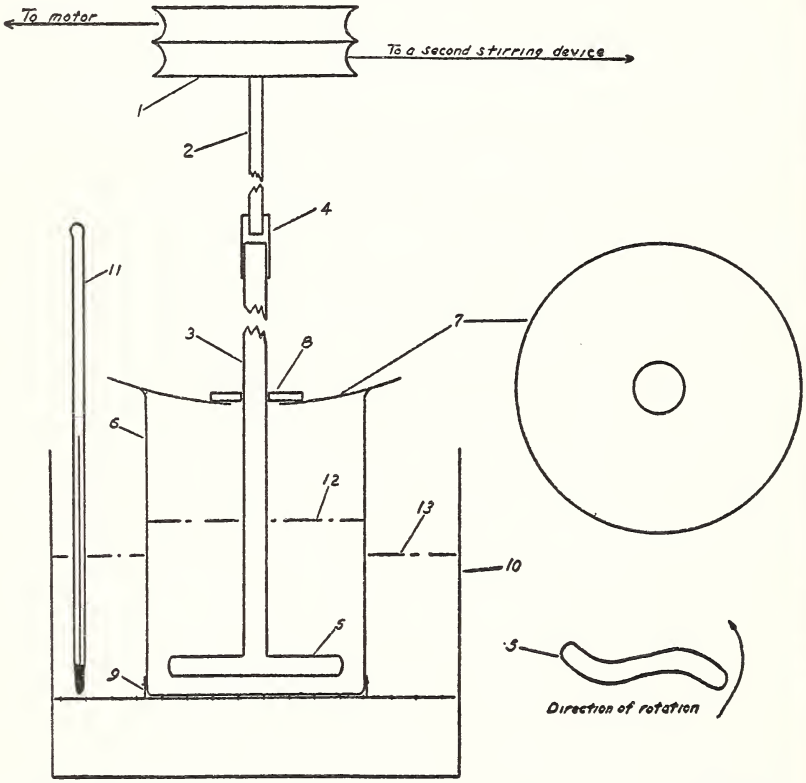

FIGURE 7.—*Mechanical stirrer to furnish mechanical action at a controlled temperature.*

1. Double-grooved pulley.
2. Metal shaft.
3. Glass stirring rod.
4. Rubber joint.
5. Glass stirring fins.
6. 600-ml beaker.
7. Watch glass with hole.
8. Rubber washer.
9. Wire-screen support.
10. Container for hot water.
11. Thermometer.
12. Level of solution.
13. Water level.

alternate squeezing and immersion in acetone, two fresh portions of acetone being used. The residue is allowed to dry at room temperature and then immersed in water at a temperature of about 158° F (70° C). The excess water is removed by squeezing and the residue dried to constant weight as described in section IX–2. This weight is designated as "G."

The percentage of cellulose acetate rayon in the oven dry sample is $D-G/D\times 100$, where D is the weight of the clean dry sample,

and G is the weight of the dry sample after removal of cellulose acetate rayon.

(d) SILK IN MIXTURE WITH WOOL, COTTON, RAYON, OR FLAX

If acetate rayon is present, it is removed according to the procedure outlined above. The residue is cut to lengths of about one-eighth to one-fourth inch. It is agitated vigorously for 1 hour, preferably with a mechanical stirring device (fig. 7) in 200 ml of a clear aqueous solution of calcium thiocyanate of specific gravity 1.20 to 1.21 at a temperature of 158° F (70° C) made just acid to litmus with acetic acid, and maintained at a temperature of 158°±4° F (70°±2.2° C). Precautions are taken to prevent evaporation from the solution with consequent concentration of thiocyanate. The fibers which are not dissolved are collected in a small büchner funnel, gooch crucible, or bitumen filter, preferably with the aid of suction. When a good pad of fibers has formed on the filter, the hot mother liquor is poured through a second time to recover all fibers on the pad. The fibers are then agitated for 5 minutes in a fresh 200-ml portion of the thiocyanate solution. The filtration is repeated and the fibers washed with hot distilled water until free from thiocyanate. They are dried to constant weight "*H*," as in section IX–2.

The percentage of silk in the oven-dried sample is $G-H/D\times 100$, where D is the weight of the clean dry sample; G is the weight of the dry sample after removal of acetate rayon; and H is the weight of the dry sample after removal of silk.

(e) REGENERATED CELLULOSE RAYON, IN MIXTURES WITH ACETATE RAYON, SILK, COTTON, AND WOOL

Silk and acetate rayon are removed by the procedures described above. The treatment described above for removing silk is applied again, substituting calcium thiocyanate of specific gravity 1.35 to 1.36 at a temperature of 158° F (70° C). The loss of weight in this solution is taken to be the weight of regenerated cellulose rayon. The weight of the dried residue from this treatment is designated "*I*."

The percentage of regenerated cellulose rayon in the oven-dried sample is $H-I/D\times 100$, where D is the weight of the clean dry sample; H is the weight of the dry sample after removal of silk and cellulose acetate rayon; and I is the weight of dry sample after removal of regenerated cellulose.

A simple and convenient apparatus for dissolving fibers in the sulfuric acid or the thiocyanate solution is shown in figure 7. This embodies certain principles which have been found essential for the conduct of these tests. It consists of a water bath for controlling the temperature of the solution within 2° C, a 600-ml beaker with cover, and an inverted T-shaped glass stirrer, which is operated at 320 to 350 rpm. The fins of the stirrer are bent in the direction opposite the direction of rotation to decrease the tendency of the fibers to become wrapped about them. The beaker is held in place by a form made of wire screen and is covered with a watch glass having a hole in the center through which the stem of the stirrer extends. The watch glass should fit the beaker sufficiently well so that not more than 5 ml of water is lost by evaporation from the solution in the beaker during the course of agitation. It is convenient to have a

battery of several such stirring devices which may be operated by one motor, so that a number of analyses can be made at one time.

X. YARN ANALYSIS AND TESTS

1. WEIGHT OF YARNS PER DOZEN PAIRS

The weight per dozen pairs of hosiery and the weight of each type and size of yarn going into the makeup of such lot is important to the manufacturer in estimating his costs of production. In the laboratory the weight per dozen pairs of any given type of stocking is generally based on the weight of but one stocking which has been conditioned at 65 ± 2 percent relative humidity and 70° ± 2 F for at least 24 hours. Weights are reported as so many ounces per dozen pairs.

In determining the weight of yarns per dozen pairs of greige (undyed) stockings, the usual sample or lot for test is at least 5 dozen pairs. Each individual dozen pair bundle is weighed to the nearest grain, and the average weight per dozen pair determined. Each stocking in a 1 dozen pair bundle is weighed and the average weight of the individual stocking determined. This method in weighing is followed to determine the variation between dozen pair bundles and between each stocking in a dozen pair bundle for purposes of production control. Two stockings are selected for test each of whose weight is the average obtained from weighing the 5 dozen pairs.

To make the test the conditioned stocking is weighed to the nearest 0.5 grain. It is then separated into its various sections which are either of different construction or made up of different yarns. These sections are generally: the seam, welt, and shadow welt, leg and instep, high heel, heel, sole, toe, toe block, etc. When more than one yarn is used in some sections the weights of the respective types of yarn and fiber in those sections are to be given. The separation of the various sections therein is accomplished by carefully cutting out these sections along their borders with as little waste as possible. The sum of the weights of the sections after cutting should correspond to the initial weight of the entire stocking within 0.5 grain. Adjustments may be made for this small difference which is much less than that existing between individual stockings of the same type. When two or more yarns of different size or fibers are contained in a section, they are carefully raveled out and their weights ascertained.

It may sometimes be found convenient instead of cutting to ravel out the individual sections, starting with the toe loose course.

The weight of each size of yarn and type of fiber in the various sections comprising the stocking is then individually calculated on a weight per dozen pair basis. The total of these calculated values should check with the weight before dissecting.

If the weight of the silk fiber (fibroin) minus gum and oils is desired, see section X–9 for method of removal of gum and oil.

2. SIZE OR COUNT OF YARN

The size or count of yarn is determined by weighing a known length. Because of variations in stocking constructions, and sections from which the yarns are raveled, no standard length of yarn can be used. Where obtainable it is recommended that a 50-yard length be taken. The length is measured on a 1-yard reel under just sufficient tension to hold the yarn straight. The weighing should be

carried out under standard atmospheric conditions (65 ±2 percent relative humidity and 70° ±2° F).

The count of yarns of different kinds of fibers is expressed in different systems.

For a continuous filament yarn, such as silk and rayon, the "Legal Denier Count" is the weight of a 450-meter skein in deniers (5 centigrams).

For cotton and spun silk yarn, the count is the number of 840-yard hanks in a pound. The count of folded or plied cotton yarns is expressed as the count of single yarn forming the ply. The count of folded or plied spun silk yarns is expressed as found instead of being based on the singles.

For worsted, the count is the number of 560-yard hanks in 1 pound. The count of folded or plied yarns is expressed as the count of the single yarn forming the ply.

For woolen, the cut count (Philadelphia) is used. This is the number of 300-yard "cuts" or hanks in a pound. The run count (New England) is the number of 1,600-yard hanks in a pound.

For linen, the count is the number of 300-yard hanks or leas in a pound. The count of the folded or plied yarns is expressed as the count of the single yarn forming the ply.

The many systems work a distinct hardship upon the hosiery industry which uses yarns of all of the common fibers.

The "TYPP" count system proposed by Fowle for all yarns, is recommended for calculating yarn size. According to this system, the count of any yarn regardless of the kind of fiber or number of plies is the number of "thousand yards per pound" of yarn.

Table 1 shows the relation between TYPP count and other counts in common use in the textile industry.

TABLE 1.—*Yarn number conversion*

TYPP count	Cotton and spun silk count	Silk and rayon count	Wool count (New England)	Worsted count	Linen count
	1	2	3	4	5
1	1.2	4,465	0.6	1.8	3.3
2	2.4	2,232	1.2	3.6	6.7
3	3.6	1,488	1.9	5.4	10.0
4	4.8	1,116	2.5	7.1	13.3
5	5.9	893	3.1	8.9	16.7
10	11.9	446	6.2	17.9	33.3
15	17.9	298	9.4	26.8	50.0
20	23.8	223	12.5	35.7	66.7
25	29.8	179	15.6	44.6	83.3
30	35.7	149	18.7	53.6	100.0
35	41.7	128	21.9	62.5	116.7
40	47.6	112	25.0	71.4	133.3
45	53.6	99	28.1	80.4	150.0
50	59.5	89	31.2	89.3	166.7
60	71.4	84	37.5	107.1	200.0
70	83.3	64	43.8	127.0	233.3
80	95.2	56	50.0	142.9	266.6
90	107.1	50	56.3	160.7	300.0
100	119.0	45	62.5	178.6	333.3

1. Cotton count-number of 840-yard lengths in a pound.
2. Rayon and silk count-weight in deniers of 450 meters.
3. Wool count New England-number of 1,600-yard lengths in a pound.
4. Worsted count-number of 560-yard lengths in a pound.
5. Linen count-number of 300-yard lengths in a pound.

3. NUMBER OF THREADS OF SILK

To count the number of threads of silk, the yarn is placed on a piece of felt or plush cloth, having a dark color for light yarns or a light color for dark yarns so as to secure the proper contrast. One end of the yarn is securely fastened down with a suitable weight or catch, which holds it in direct contact with the cloth. The other end of the yarn is grasped between thumb and forefinger and given a slight roll to remove the twist and loosen the threads. As the yarn is held close to the cloth each thread is separated by careful manipulation with a needle or pick, the plush background serving to hold each thread in place. A twist tester is used in removing the twist in composite high-twist yarns or yarns of the crepe type.

The twist is first removed from a suitable length (10 to 15 inches) of the composite yarn and the various threads or groups of threads separated by careful manipulation of the pick. Each of the thread groups, except one in which twist remains, is carefully cut loose at the jaws of the twist tester and placed out straight on the plush fabric. The twist is then removed from the group remaining on the tester, the threads carefully separated, and placed on the plush adjacent to the others. If one or more of the thread groups first cut out contains twist and is suspected of containing more than one thread, it is carefully replaced in the tester, with the distance between the jaws shortened several inches, and the above procedure repeated. The threads are placed upon the plush for better examination and check with the microscope, as described in section X–4.

4. NUMBER OF FILAMENTS IN SILK OR RAYON YARN

To count the number of filaments the first part of the procedure is identical to that given in section X–3.

After the threads have been separated and laid closely parallel on the plush, a glass microscope slide is slipped under them and another is used as a cover glass. The slides are then fastened with paper tabs and transferred to the stage of the microscope, where the filaments in each thread are counted. As the filaments in each thread of silk are generally closely associated in groups, the microscopic examination acts as a check upon the thread count, as determined in section X–3.

5. CONDITION OF COTTON YARNS: COMBED OR CARDED

It is impossible to say definitely from an examination of a finished yarn whether it is carded or combed. There are, however, certain characteristics which might give an indication of the method used in preparing the cotton before spinning.

A carded yarn usually contains impurities such as fragments of leaves and seeds adhering to the fiber and the fibers are of irregular length, short fibers predominating. The fibers do not lie parallel in the yarn and the yarn is quite uneven.

A good grade of combed yarn is usually free from impurities and nibs. The fibers are more nearly uniform in length as the shorter fibers have been removed. The fibers lie fairly parallel in the yarn and the yarn is quite even.

6. CONDITION OF COTTON YARNS: NOT MERCERIZED, MERCERIZED, GASSED

The fibers which make up the yarn are examined under a microscope.

The fibers of an unmercerized yarn, when viewed under the microscope, appear as twisted flat bands with thickened edges and in cross section like collapsed tubes.

The fibers of a mercerized yarn appear as rather smooth cylinders. The fibers have also lost a great deal of twist. In making this examination it may be found convenient to use various stains. None of these, however, gives a positive means of identification.

Gassed yarn does not exhibit the fuzziness found in ungassed yarn. The ends of the fibers that have been gassed have a characteristic appearance under the microscope and occasional fibers retain their charred ends.

7. TWIST IN YARNS

To determine the amount of twist in a yarn a twist tester is used. For plied yarns and for yarns of continuous fibers a distance of 10 inches between jaws is used. For singles cotton yarn and other short staple yarns 1 inch between jaws is used. To determine the amount of twist in a yarn, as it is in the stocking, the stocking is first cut and prepared so the yarn will ravel out freely and continuously under a minimum pull. Starting at one selvage the yarn is grasped close to where it emerges from the stitch and with the fabric held up close this end is fastened in the right jaw of the twist tester. The fabric is then passed to the left so as to ravel out just sufficient yarn to pass through the left jaw. The amount of tension placed on the yarn is only that sufficient to remove the slack from the yarn between the jaws. The left jaw is then fastened and the stocking laid on the table behind the left jaw without cutting loose the end; approximately 1 yard of yarn extending from this left jaw to the fabric. The twist is then removed by rotating the right jaw in the direction opposite to the twist. After some of the twist is removed a needle or pick is inserted between the plies at the left jaw, and as the twist is further removed, the pick is carefully drawn through the yarn until all the plies or filaments are parallel and the pick has reached the right jaw.

After testing the first length the right jaw is opened, the untwisted yarn grasped close to where it emerges from the fabric, and cut loose from the machine. The left jaw is then cleared, and the procedure is repeated 10 times and the average of these determinations reported.

8. YARN BREAKING STRENGTH AND ELONGATION

The single end breaking strength test is recommended for hosiery yarns. This test is made on a machine of the power-driven pendulum type operated in such a manner that the pulling jaw has a speed of $12 \pm \frac{1}{2}$ inches per minute. The jaw should be of the flat grip type with a distance of 10 inches between them at the start. The testing machine is considered of the proper capacity for a test if, when the sample breaks, the reading is within the working range of the instrument. The working range is defined as the portion of the total range within

which the readings are correct within 1.5 percent. In making the test it is important to clamp the yarn with a small and uniform tension. This is accomplished by first fastening the yarn in the upper jaw, leading it through the lower jaw, and applying just sufficient tension on the yarn to cause the freely swinging pendulum to move slightly from its vertical position. The lower jaw is clamped to the yarn when under this tension. The breaking strength and elongation are read either from the scales on the machine or from the record made by the autographic recording device. Determinations are made at 10 places approximately 3 yards apart and the averages recorded as the strength and elongation of the yarn. If a sample slips in the jaws, breaks in the jaws, or for any reason attributable to faulty operation the result is markedly above or below the average of the group, the result is disregarded, another sample taken, and the result of this break included in the average.

9. "BOIL-OFF" OF SILK

To remove the gum and oils from the raw silk single end or plied yarn up to 20 turns per inch, it is boiled-off in 25-percent olive oil soap solution, based on weight of sample, using two baths, and leaving the material in each for one-half hour.

If the twist of the yarn is above 20 turns per inch boil off in 40-percent olive oil soap solution, using two baths and leaving the material in each for three-fourths hour.

XI. FIBER TESTS

1. STAPLE LENGTH OF COTTON

The yarn is untwisted, four or five layers of fiber are slowly drawn from the yarn, placing each successive layer directly over the fibers previously drawn, using care to see that the right hand ends of all the layers are even with each other, between the thumb and forefinger of the right hand. The bundle of fibers so obtained is then laid out smooth on a plush-like fabric. The ends of the fibers are blocked off so as to indicate the length of the bulk or body of the fibers. The distance between the blocked-off ends is measured.

The United States Department of Agricultural Service and Regulatory Announcement 117, issued November 1929, states:

> The term "long-staple cotton," as used herein, shall, until further notice, be construed to mean cotton which is 1⅛ inches and above in length of staple.

2. GRADE OF WOOL

The grade of wool is determined by comparison with the official wool standards of the United States Department of Agriculture. The following are the official standard grades: 80, 70, 64, 60, 58, 56, 50, and 48.

Representative staple is drawn from the sample to form a sizeable tuft of straightened fibers, which are compared in diameter with the official standards and classified to grade accordingly.

This method was designed for the raw wool and not the finished yarn.

XII. OUTLINE OF HOSIERY ANALYSIS

The suggested method of tabulating the tests described in this publication recommended for manufacturing control is as follows:

Type.—{Full-fashioned / Circular-knit, etc}Gage ____ Total needles ____
Class.—Women's, men's, etc____ Cylinder diameter ____
Description.—All silk, cotton, etc____

Length measurements	*Inches*
Total length	
Welt or top	
Shadow welt	
Body or boot	
High heel	
Heel	
Foot	
Ring toe	
Toe	

Number of courses	
From start to picot edge	
To turning of the welt	
To beginning of body carrier	
To first flare narrowing	
To end of flare narrowing	
To beginning of leg narrowing	
To end of leg narrowing	
To beginning of high splicing	
To beginning of heel	
To beginning of heel looping line	
Total courses from picot edge to heel looping line	

Width measurements	*Inches*
Welt or top	
Four inches below welt	
Eight inches below welt	
Fourteen inches below welt	
Six inches above bottom of heel	
Heel (center)	
Across instep and heel	
Sole adjoining heel	
Sole (center)	
Sole adjoining toe	
Foot (center)	
Toe adjoining instep	
Reinforcing in top of toe	

Number of wales	*Needles*
Full-fashioned:	
Welt or top	
Below flare narrowing	
Ankle	
Heel	
Across sole and instep at start of foot	
Circular knit:	
Leg	
Foot	

Stitches per inch	*Courses*	*Wales*
Welt or top (inside)		
Welt or top (outside)		
Shadow welt		
Leg 4 inches below welt		
Leg 8 inches below welt		
Leg 14 inches below welt		
High heel		
Ankle		
Heel		
Instep		
Sole		

Number of narrowings	*One side*	Wales dropped *One side*
Flare		
Calf		
Heel		
Sole		
Toe		

Stretch-Manual (hand)	*Inches*
Welt or top	
Shadow welt	
Four inches below welt	
Six inches above bottom of heel	
Across instep and heel	
Across foot (center)	

Bursting strength	*Points*
Welt or top	
Leg 4 inches below welt	
Leg 8 inches below welt	
Leg 14 inches below welt	
Leg above high heel	
High heel	
Heel	
Sole	
Toe	

STRETCH—MECHANICAL EXPANSION AND CONTRACTION

Before laundering				After laundering			
	Width	Load	Contracted width		Width	Load	Contracted width
	Inches	*Pounds*	*Inches*		*Inches*	*Pounds*	*Inches*
Initial width				Initial width			
Expanded width	7			Expanded width	7		
	8				8		
	9				9		
	10				10		
	11				11		
	12				12		
	13				13		

Abrasion test		Snagging test		
	Number of rubs	Snagger setting	Number of snags	Type of snag
Welt or top				
Leg				
High heel				
Heel				
Sole				
Toe				
Seam				

Type of dye		Percent boil off	
Type of finish		Percent oil	
Fastness to laundering		Percent moisture	
Fastness to light		Percent weighting	
Fastness to perspiration			

YARN DATA

Section of stocking	Type	Number of threads or ends	Denier or count	Twist per inch	Number of filaments	Yardage	Weight in one stocking	Weight in one doz. pr.	Breaking strength	Stretch
							Grains	*Ounces*	*Grams*	*Percent*
Welt or top (back)										
Welt or top (face)										
Shadow welt										
Body or boot										
High heel										
Heel										
Sole										
Instep										
Ring toe										
Toe block or tip										
Seam										

XIII. TESTS FOR FASTNESS OF STAMPS (TRANSFERS)

A stamp which is not removable by any of the following treatments is considered of good fastness.

The stamp is rubbed moderately with a woolen cloth or brush saturated with hydrocarbon or chlorinated hydrocarbon solvents. Acetone, amyl acetate, other available solvents, and combinations of these, which will not injure the fabric, should be tried.

The hosiery fabric containing the stamp is boiled for 15 minutes in a 0.5 percent neutral soap solution, preferably olive-oil or castile soap, to which 0.2 percent of soda ash, based on weight, of solution has been added. The solution containing the fabric is stirred or agitated during the 15-minute boiling period and rinsed in warm water (120° F).

The hosiery fabric containing the stamp is run for 15 minutes at 160° F in the Launder-Ometer. The jars in the Launder-Ometer contain a 0.5 percent soap solution to which 0.2 percent of soda ash, based on the weight, of solution has been added. Ten rubber balls 1 cm in diameter, weighing approximately 17 g, are placed in the jars with the fabric to be tested. The fabric is rinsed at 120° F.

The hosiery fabric is submerged in bleaching solution for 5 minutes at 120° F and then rinsed well in water at room temperature (use for cotton hosiery only).

Bleaching solution:

1,000 ml of water.
40 g of bleaching powder.
(25 percent available chlorine).

The hosiery fabric is submerged in sodium bisulfite solution for 15 minutes at 160° F and then rinsed well in warm water (160° F).

Sodium bisulfite solution:

1,000 ml of water.
52 ml of hydrochloric acid (sp gr 1.19).
5 g of sodium bisulfite.

The hosiery fabric is submerged in oxalic acid solution for 5 minutes at 120° F. The solution is drained off and the fabric rinsed well in water at room temperature.

Oxalic acid solution:

717 ml of water.
283 ml of glacial acetic acid.
6 g of oxalic acid.

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WASHINGTON, MARCH 29, 1938.

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