CHANGE NOTICES ARE NOT CUMULATIVE AND SHALL BE RETAINED UNTIL SUCH TIME AS THE ENTIRE STANDARD IS REVISED

Fed. Test Method Std. No. 191
December 31, 1968
Change Notice 1
July 10, 1970

FEDERAL STANDARD

TEXTILE TEST METHODS

The following changes to Fed. Test Method Std. No. 191 dated December 31, 1968 have been approved by the Commissioner, Federal Supply Service, General Services Administration for the use of all Federal agencies.

1. CHANGES

1.1 Section 6 - Numerical Index updated.

1.2 Section 7 - Alphabetical Index updated.

1.3 Section 10 - Supersession Data, Source Information, and Interested Agencies updated.

1.4 TM 2011.1 - Added a spectrophotometer, a blank which is required for the initial adjustment of the spectrophotometer. The use of a buffer solution to preclude the influence of interfering ions. A standard curve limited to 20 to 60 microgram range. That the analysis be based on the dry weight of the specimen.

1.5 TM 3810.1 Deleted the requirement for the use of a rotary blade food cutter. Format revised.

1.6 TM 4010.1 Format revised.

1.7 TM 4021.1 Added conversion factors for expressing linear density.

1.8 TM 4050.1 Format revised.

1.9 TM 4052.1 Format revised.

1.10 TM 4054.1 Format revised.

1.11 TM 4100.1 Deleted the constant-rate-of load apparatus. Added new paragraph for determining tenacity. Added specific description of clamps used for holding specimen. Format revised.

1.12 TM 4104.1 Format revised.

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FSC 8300

1.13 TM 4108.1 Added specific description of apparatus and drawing of split-drum type clamp. Format revised.

1.14 TM 4110.1 Format revised.

1.15 TM 4112.1 Format revised.

1.16 TM 4308.1 Source of supply updated. Format revised.

1.17 TM 5030.1 Sources of supply updated.

1.18 TM 5206.1 Source of supply updated.

1.19 TM 5308.1 Source of supply updated. Format revised.

1.20 TM 5450.1 Source of supply updated.

1.21 TM 5556.1 Table II revised.

1.22 TM 5903.1 Sources of supply updated.

1.23 TM 5920.1 Format revised.

1.24 TM 7308.1 Source of supply updated. Format revised.

2. ADDITIONS

2.1 The following methods have been added to this Standard:

2.1.1 TM 2013. Fluorine Content of Textile Materials.

2.1.2 TM 2015. Sodium Salt of 5-Chloro-2- [4 Chloro-2- [3-(3, 4 Dichlorophenyl) -Uredio] -Phenoxy] Benzenesulfonate Content.

2.1.3 TM 5309. Abrasion Resistance of Textile Webbing.

2.1.4 TM 5764. Insect Resistance of Textile Materials.

3. DELETIONS

3.1 The following methods have been deleted from this Standard:

3.1.1 TM 1533. Identification by Softening Point of Thermoplastic Fibers. The test requirements are contained in TM 1534, Melting Point of Synthetic Fibers.

3.1.2 TM 4020. Yarn Number; Cotton-Yarn Method. The test requirements are contained in TM 4021, Yarn Number (Linear Density) of Yarn from Package.

3.1.3 TM 5910. Burning Rate of Cloth; 30° Angle.

SECTION 6

NUMERICAL INDEX OF TEST METHODS

METHOD NO.	TITLE
	Identification - Qualitative Analysis
1100	Identification of Wool
1110	Identification of Silk
1200	Identification of Cotton
1210	Identification of Flax
1220	Identification of Hemp
1230	Identification of Ramie
1240	Identification of Manila (Abaca'); Microscopic Method
1241	Identification of Manila (Abaca'); Ash Method
1250	Identification of Sisal; Microscopic Method
1251	Identification of Sisal; Ash Method
1260	Identification of Jute
1270	Identification of Coir; Microscopic Method
1271	Identification of Coir; Ash Method
1400	Identification of Asbestos
1410	Identification of Glass
1500	Identification of Rayon, Viscose
1510	Identification of Rayon, Acetate

Numerical Index (Cont'd)

Numerical Index (Cont'd)

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SECTION 7

ALPHABETICAL INDEX OF TEXT METHODS

METHOD NO.	TITLE
5300	Abrasion Resistance of Cloth; Flexing, Folding Bar (Stoll) Method
5302	Abrasion Resistance of Cloth; Inflated Diaphragm (Stoll) Method
5304	Abrasion Resistance of Cloth; Oscillatory Cylinder (Wyzenbeek) Method
5306	Abrasion Resistance of Cloth; Rotary Platform, Double-Head (Taber) Method
5308.1	Abrasion Resistance of Cloth; Uniform Abrasion (Schiefer) Method
5309	Abrasion Resistance of Textile Webbing.
4308.1	Abrasion Resistance of Yarn, Thread, and Light Cordage; Uniform Abrasion (Schiefer) Method
7308.1	Abrasion Resistance; Socks, Hosiery, and Knitted Cloth; Uniform Abrasion (Schiefer) Method
5851	Accelerated Ageing of Cloth; Closed Container Method
5850	Accelerated Ageing of Cloth; Oven Method
5852	Accelerated Ageing of Cloth; Oxygen Method
5506	Accelerated Dry Cleaning Test for Labels
5519	Accelerated Laundering Test for Labels
2810	Acidity (pH) of Textiles, Colorimetric Method
5960	Adhesion of Cemented Seams
5970	Adhesion of Coating; Adhesive Method
5972	Adhesion of Coating; Water Resistance Method

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

Alphabetical Index (Cont'd)

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Alphabetical Index (Cont'd)

DIHYDROXYDICHLORODIPHENYL METHANE CONTENT,

COLORIMETRIC METHOD

1. SCOPE

1.1 This method is intended for determining the dihydroxydichlorodiphenyl methane (2, 2' methylene bis - 4 - chlorophenol) content of textile materials that have been heated with this compound to prevent the formation of mildew.

2. TEST SPECIMEN

2.1 The specimen shall be one gram composite of the material prepared as described in 5.1.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, two specimens shall be tested from each sample unit.

4. APPARATUS AND REAGENTS

4.1 Apparatus

4.1.1 Spectrophotometer and accessories.

4.1.2 Volumetric flasks.

4.1.3 Microburette.

4.1.4 Beakers.

4.1.5 Pipettes.

4.1.6 Air oven.

4.1.7 Weighing bottle.

4.2 Reagents.

4.2.1 Crystallized 4-aminoantipyrine solution, freshly prepared. The solution shall be prepared by dissolving 2 ± 0.001 grams of 4-aminoantipyrine, m.p. 108°- 109° C. in 100 cc of distilled water.

4.2.2 Potassium ferricyanide solution, freshly prepared. The solution shall be prepared by dissolving 8 ± 0.001 grams of reagent grade potassium ferricyanide in 100 cc of distilled water.

4.2.3 Sodium carbonate solution, approximately 0.03 percent, pH between 10.4 and 10.6. Distilled water shall be used. The pH should be rechecked just prior to using.

4.2.4 Dihydroxydichlorodiphenyl methane(2, 2' methylene bis-4-chlorophenol) "G-4 Technical" or equal (see 7.1).

4.2.5 Buffer solution (distilled water),2.47 percent boric acid, 0.4 percent sodium hydroxide, pH of 9.1 to 9.2 (adjust with additional sodium hydroxide, if necessary.)

5. PROCEDURE

5.1 Preparation of specimen. Three specimens not less than two grams each shall be cut from the sample unit. One specimen shall be cut from each edge of the sample unit but will not include the selvage except for narrow fabrics such as braid, tape or webbing when it is not practical or possible. The third specimen shall be taken from the middle of the sample unit. No two specimens shall contain the same warp or filling yarns except narrow fabrics such as braid, tape or webbing when it is not practical or possible.

5.1.1 The three specimens taken from the sample unit shall be cut in small pieces approximately 1/8 inch (3.mm) square and thoroughly mixed to form a composite sample.

5.1.2 A specimen approximately one gram taken from the composite sample shall be placed in a tared weighing bottle and dried in a circulating air oven at 105° to 110°C. The specimen shall be dried to a weight which is constant to ± 0.001 gram.

5.2 Testing of specimen. The dried specimen shall be placed in a 200 cc beaker. Fifty cc of the 0.03 percent sodium carbonate solution shall be added to the beaker and contents heated to boiling. The solution shall be boiled gently for 5 minutes. The hot solution shall be decanted into a 200 cc volumetric flask. The extraction and boiling with sodium carbonate described above shall be repeated two more times and the extracts combined with the first extract in the 200 cc flask. The solution in the flask shall be diluted almost to the mark with the 0.03 percent sodium carbonate solution, using the diluent to wash the specimen two times. The flask and contents shall be permitted to cool to room temperature. The contents shall be diluted to the mark with the 0.03 percent sodium carbonate solution.

5.2.1 About 20 cc of the solution from 5.2 shall be filtered through a dry filter. A proper aliquot of this solution to provide a concentration that will fall within the points on the standard curve. The aliquot shall be placed in a 25 cc volumetric flask. A 0.5 cc of a 4-aminoantipyrine solution shall be added from a microburette or pipette and the solution diluted to the mark with the 0.03 percent sodium carbonate solution. (A buffered solution (see 4.2.5) may be used for the dilution. In this case the standard curve would be prepared using the same buffered solution.) Twenty-five hundredths of a cc of the potassium ferricyanide solution shall be added from the microburette or pipette. The solution shall be shaken vigorously, allowed to stand 5 minutes, poured into a cuvette and the percent transmission measured within 30 minutes at 505 nanometers with the spectrophotometer which has been adjusted to zero and 100 percent transmission with a blank. The blank shall be prepared in a 25 cc volumetric flask. 0.5 cc of the 4-aminoantipyrine solution shall be added from a microburette or pipette, and the solution diluted to the mark with the 0.03 percent sodium carbonate solution or the buffered solution (whichever was used for the sample). Twenty-five hundredths of a cc of the potassium ferricyanide solution shall be added from a microburette or pipette. The solution shall be shaken vigorously, allowed to stand 5 minutes, poured into a cuvette and the percent transmission adjusted to zero and 100 percent. The blank gives about the same transmission (98-100 percent) as that of distilled water.

5.3 Preparation of standard curve. 0.2 of a gram of dihydroxydichlorodiphenyl methane shall be weighed to the nearest milligram, dissolved in a few cc of acetone, transferred to a 200 cc volumetric flask, and filled to the mark with acetone. One cc of this solution shall be pipetted into a 100 cc volumetric flask and diluted to the mark with the 0.03 percent sodium carbonate solution. This solution which contains 10 micrograms of dihydroxydichlorodiphenyl methane per cc shall be used for suitable aliquots covering the range of 20 to 60 micrograms. (2 cc equals 20 micrograms, etc.). Each aliquot shall be placed in a 25 cc volumetric flask. The color shall be developed and the percent transmission determined as in 5.2.1. The standard curve shall be plotted on linear graph paper, plotting percent transmission versus micrograms of dihydroxydichlorodiphenyl methane in 25 cc of solution. The standard curve shall be drawn by connecting consecutive points between 20 and 60 micrograms by straight lines.

5.4 Calculations.

5.4.1 Unless otherwise specified, the dihydroxydichlorodiphenyl methane content of the specimen shall be calculated as follows:

$$\text{dihydroxydichlorodiphenyl methane, percent} = \frac{0.02A}{B \times S}$$

Where: A = Dihydroxydichlorodiphenyl methane concentration from the standard curve in micrograms.

B = Aliquot of 200 cc test solution taken, cubic centimeters.

S = Weight of oven dried specimen, grams.

6. REPORT

6.1 The dihydroxydichlorodiphenyl methane content of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.1 percent.

6.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

7. NOTES

7.1 Samples of "G-4 Technical" can be obtained from Sindar Corp., a Division of Givaudan Corporation, 125 Delawanna Avenue, Clifton, New Jersey 07014.

FLUORINE CONTENT OF TEXTILE MATERIALS

1. SCOPE

1.1 It is intended that this method be used to determine the fluorine content of materials which have fluorine compounds for moth repellency.

2. TEST SPECIMEN

2.1 The test specimen shall be 0.5 gram composite of the material prepared as described in 5.1.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, two specimens shall be tested from each sample unit.

4. APPARATUS AND REAGENTS

4.1 Apparatus.

4.1.1 Fluorine determination apparatus having a 300 cc flask with a no. 40/50 joint (see 7.1).

4.1.2 Burette

4.1.3 Beakers.

4.1.4 200 cc volumetric flask.

4.1.5 Bunsen burner or electric heater.

4.2 Reagents.

4.2.1 50 percent sulfuric acid (H_2SO_4) by volume in distilled water.

4.2.2 0.01N thorium nitrate $Th(NO_3)_4$ standardized against a standard sodium fluoride (NaF) solution.

4.2.3 0.1N hydrochloric acid (HCl) solution.

4.2.4 10 percent sodium hydroxide (NaOH) solution.

4.2.5 Indicator: 0.05 percent aqueous solution sodium alizarin sulfonate.

5. PROCEDURE

5.1 Preparation of specimen. Three specimens not less than two grams each shall be cut from the sample unit. One specimen shall be cut from each edge of the sample unit but will not include the selvage. The third specimen shall be taken from the center of the sample unit. No two specimens shall contain the same warp or filling yarns.

5.1.1 The three specimens taken from the sample unit shall be cut in small pieces approximately 1/8 inch(3mm) square and thoroughly mixed to form a composite sample.

5.2 Transfer specimen to the 300 cc flask of the fluorine apparatus (see figure 2013) and add 40 cc of 50 percent sulfuric acid. Connect the flask to the fluorine apparatus. Immerse the lower end of condenser in 20 cc of distilled water in the receiving beaker to insure the solution of gases.

5.3 Heat gradually to dissolve specimen and then start distillations with a high heat (Bunsen burner or electric heater). Avoid localized overheating when using Bunsen burner by protecting the flask with asbestos sheeting having a relatively small hole in the asbestos sheet placed directly under the bottom of the flask.

5.4 Maintain liquor temperature between 136° and 140°C by dropping distilled water from a separatory funnel inserted in the neck of the flask. Collect 200 cc but not less than 176 cc of distillate. Transfer distillate to 200 cc volumetric flask; if less than 200 cc is distilled make up to volume with distilled water. Shake well, then allow any fats or waxes that may have been distilled over to rise in the neck of the flask. Remove any of the fats or waxes that are present and again make up volume with distilled water.

5.5 Titrate two 20 cc aliquots of the distillate. To each aliquot add two drops sodium alizarin sulfonate indicator and one drop of

TWIST IN SINGLE YARNS; TURNS PER INCH

1. SCOPE

1.1 This method is intended for determining the turns per inch of single yarns by use of the untwist/twist method on a twist tester. This method is suitable for use on spun staple yarns where it is found difficult to determine zero twist by use of a needle as can be done in the case of wool or filament fibers.

2. TEST SPECIMEN

2.1 The specimen shall be at least a 12-inch (30.5 cm) length of the yarn taken as follows:

2.1.1 From package. Yarn from a tube, bobbin, spool, skein, cone, or ball shall be drawn from the side of the package and in such a manner that the twist will not be altered.

2.1.2 From cloth. Yarn shall be raveled from woven or knitted cloth, care being taken to avoid alteration in twist of the yarn. Where it is possible, at least three bobbin areas shall be included in the specimens prepared from the filling direction of the woven cloth.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, twenty specimens shall be tested from each sample unit.

4. APPARATUS

4.1 Twist counter consisting essentially of two clamps along the same horizontal axis. One clamp non-rotating but movable that can be held in position by a tightening thumb screw, the other clamp fixed in position but capable of being rotated in either direction and provided with a dial or counter for recording the number of turns. The twist counter shall also be provided with the following:

4.1.1 Means for adjusting the distance between the clamps within a range of 0 to 10 inches (0 to 25.4 cm).

4.1.2 Means for mounting the specimen in the clamps under a known tension applicable through the non-rotating clamp.

4.1.3 When applicable, means for determining the extension produced by removal of twist to an accuracy of at least 0.1 inch (2.54 mm).

4.1.4 Means of applying a load of 1 gram at the center of the specimen and means of measuring the deflection of the yarn at that point.

5. PROCEDURE

5.1 Unless otherwise specified in the material specification, the specimens shall be conditioned and tested under standard conditions in accordance with section 4 of this standard.

5.1.1 Standard procedure.

5.1.2 The counter of the tester shall be set at the zero mark. One end of the specimen shall be secured in the free non-rotating clamp, having a tension device and the other end placed at a distance of approximately 10 inches (25.4 cm), in the open rotatable fixed clamp. Tension shall be applied to the specimen by pulling it under the applicable load specified below until the distance between the clamps is adjusted to 10 inches (25.4 cm). The rotatable clamp shall then be tightened securely and the position of the movable clamp fixed by tightening the thumb screw.

5.1.3 Tension for mounting specimen. Unless otherwise specified in the material specifications, the specimen shall be mounted under the following tension in grams:

Cotton and spun yarn tension, grams = $\frac{156}{\text{Yarn No., cotton system}}$

Wool and worsted yarn tension, grams = weight of 100 yards (91.44 m) of yarn being tested.

Filament yarn tension:

grams = 10 grams (75 denier or finer);
grams = 20 grams (75 denier to 150 denier);
grams = 30 grams (coarser than 150 denier).

5.1.4 A one gram load shall then be applied at the center of the specimen and its height at this point measured or otherwise indicated. The one gram load shall be removed. Then the rotatable clamp shall be revolved in the direction which untwists the specimen, continuing the rotation in the same direction beyond the neutral point, thereby imparting a twist to the specimen which is opposite to the original direction.

5.1.5 When sufficient turns have been inserted to prevent slippage of the fiber, the one gram load shall be reapplied at the center of the specimen and the twisting continued until the initial height or position of the one gram load is obtained. When this point is reached, it is assumed that the same amount of twist has been reinserted as was initially in the specimen. The number of turns shown on the dial shall be recorded.

5.2 Alternate procedure.

5.2.1 The distance between the clamps shall be set at 10 inches (25.4 cm) and the counter of the tester set at the zero mark. The specimen shall be secured in the rotatable clamp and placed in the open fixed clamp while a tensioning load of one gram is applied at the center of the specimen. The free end shall then be pulled through the open clamp in such manner that a deflection of 0.125 inch (3.18 mm) is obtained at the point of application. The fixed clamp shall be tightened securely and the tensioning load removed.

5.2.2 The rotatable clamp shall be revolved in the direction which untwists the specimen, continuing the rotation in the same direction beyond the neutral point, thereby imparting a twist to the specimen opposite to the original direction.

5.2.3 When sufficient turns have been inserted to prevent slippage of the fibers, the tensioning load shall be reapplied and twisting continued until the deflection of 0.125 inch (3.18 mm) is obtained again. When this point is reached, it is assumed that the same amount of twist is reinserted as was initially in the specimen. The number of twists on the dial shall be recorded.

6. REPORT

6.1 Twist of specimen. The total number of revolutions divided by 20 shall be the twist in turns per inch of the specimen.

6.2 Twist of sample unit. The twist per inch of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported in turns per inch to the nearest whole number.

6.3 The individual values used to arrive at the average shall also be reported.

TWIST AND TWIST CONTRACTION; PLY YARNS

1. SCOPE

1.1 This method is intended for determining the number of turns of twist per inch of ply yarns and the twist contraction by untwisting on a twist tester.

2. TEST SPECIMENS

2.1 The specimen shall be at least a 12 inch (30.5 cm) length of yarn taken as follows:

2.1.1 From package. Yarn from a cop, bobbin, cone, tube, or similar put-up shall be drawn from the side of the package and in such a manner that the twist will not be altered.

2.1.2 From cloth. Yarn shall be ravelled from woven or knitted cloth, care being taken to avoid alteration in twist of the yarn. Where it is possible, at least three bobbin areas shall be included in the specimens prepared from the filling direction of the woven cloth.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens shall be tested from each sample unit.

4. APPARATUS

4.1 Twist counter consisting essentially of two clamps along the same horizontal axis. One clamp non-rotating but movable that can be held in position by tightening thumb screw, the other clamp fixed in position but capable of being rotated in either direction and provided with a dial or counter for recording the number of turns. The twist counter shall also be provided with the following:

4.1.1 Means for adjusting the distance between the clamps within a range of 0 to 10 inches (0 to 25.4 cm).

4.1.2 Means for mounting the specimen in the clamps under a known tension applicable through the non-rotating clamp.

4.1.3 When applicable, means for determining the extension produced by removal of twist to an accuracy of at least 0.1 inch (2.54 mm).

4.1.4 Needle

5. PROCEDURE

5.1 Unless otherwise specified in the material specification, the specimens tested shall be conditioned and tested under standard conditions in accordance with Section 4 of this Standard.

5.2 Twist. The counter of the tester shall be set at the zero mark. One end of the specimen shall be secured in the free non-rotating clamp having the tension device. The other end shall be drawn through the open rotatable fixed clamp to a distance of 10 inches (25.4 cm) between the clamps and secured while the specimen is under the applicable required load (5.2.1). The movable clamp shall be allowed to remain free. The ply twist shall then be removed by revolving the clamp until the component strands are parallel and can be separated along the entire length by means of a needle. The total number of revolutions shall be recorded. It is the number of turns of ply twist in the 10-inch (25.4 cm) long specimen.

5.2.1 Tension for mounting specimen. Unless otherwise specified in the material specification, the specimen shall be mounted under the following tension in grams:

$$\text{Cotton and spun yarn tension, grams} = \frac{156}{\text{Yarn No., Cotton system}}$$

Wool and worsted yarn tension, grams = weight of 100 yards (91.44 m) of yarn being tested

Filament yarn tension, grams = 10 grams (75 denier or finer)
= 20 grams (75 denier to 150 denier)
= 30 grams (coarser than 150 denier)

5.3 Twist contraction. The untwisted plies, 5.2, shall be maintained under the tension in the twist tester and their extended length shall be measured. The increase in length of the specimen due to the removal of twist is the twist contraction of the yarn. It may be read in inches or percent on a calibrated extension of the sliding jaw of the twist tester.

5.4 Calculations

5.4.1 The twist per inch of the specimen shall be the number of turns divided by 10.

5.4.2 Twist contraction, percent = $\frac{\text{entended length of untwisted specimen-10}}{\text{extended lenght of untwisted specimen}} \times 10$

6. REPORT

6.1 The twist of the yarn from the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.5 turn per inch.

6.2 The contraction of the yarn from a sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 0.1 percent.

6.3 The individual values used to arrive at the average shall also be reported.

10 percent sodium hydroxide. The addition of the sodium hydroxide will produce a light violet color (see 7.2, 7.3). Titrate the distillate with 0.1N hydrochloric acid to a yellow coloration then add five drops in excess (see 7.4). Titrate the resultant solution to a faint but definite pink coloration with 0.01N thorium nitrate solution.

5.6 The percent fluorine shall be calculated as follows:

Percent fluorine = cubic centimeters x 0.38

Where: cubic centimeters = cc of 0.01N $Th(NO_3)_4$ required for 20 cc aliquot titration. For 0.5g. specimen

5.6.1 In cases where an alternate calculation formula is necessary because the weight is less or more than 0.5 g, the percent fluorine (F) shall be calculated as follows:

$$\text{Percent fluorine} = \frac{\text{cc of } Th(NO_3)_4 \times \text{N of } Th(NO_3)_4 \times 0.19 \times 100}{\text{Sample weight (g)}}$$

6. REPORT

6.1 The percent fluorine shall be the average of specimens tested from a sample unit and shall be reported to the nearest 0.1 percent.

6.2 Individual results used to calculate the average shall also be reported.

7. NOTES

7.1 The apparatus for fluorine determination used in this method may be purchased from Ace Glass Inc., Vineland, N. J. 08360 as No. 6430.

7.2 Twenty cc aliquot of distillate should never require more than one drop of 10 percent sodium hydroxide solution. When more is required, contamination of the distillate by decomposition products is indicated. The distillate shall be discarded and a new specimen tested.

7.3 Sodium ion concentration in the distillate should be kept to a minimum since these ions cause erroneous (high) results.

7.4 The pH of the solution taken for titration is important. The pH provided by the addition of five drops excess 0.1N HCl is ideal (i.e. 3.2). The use of buffers is not recommended because the end point is not well defined even in the absence of a buffer.

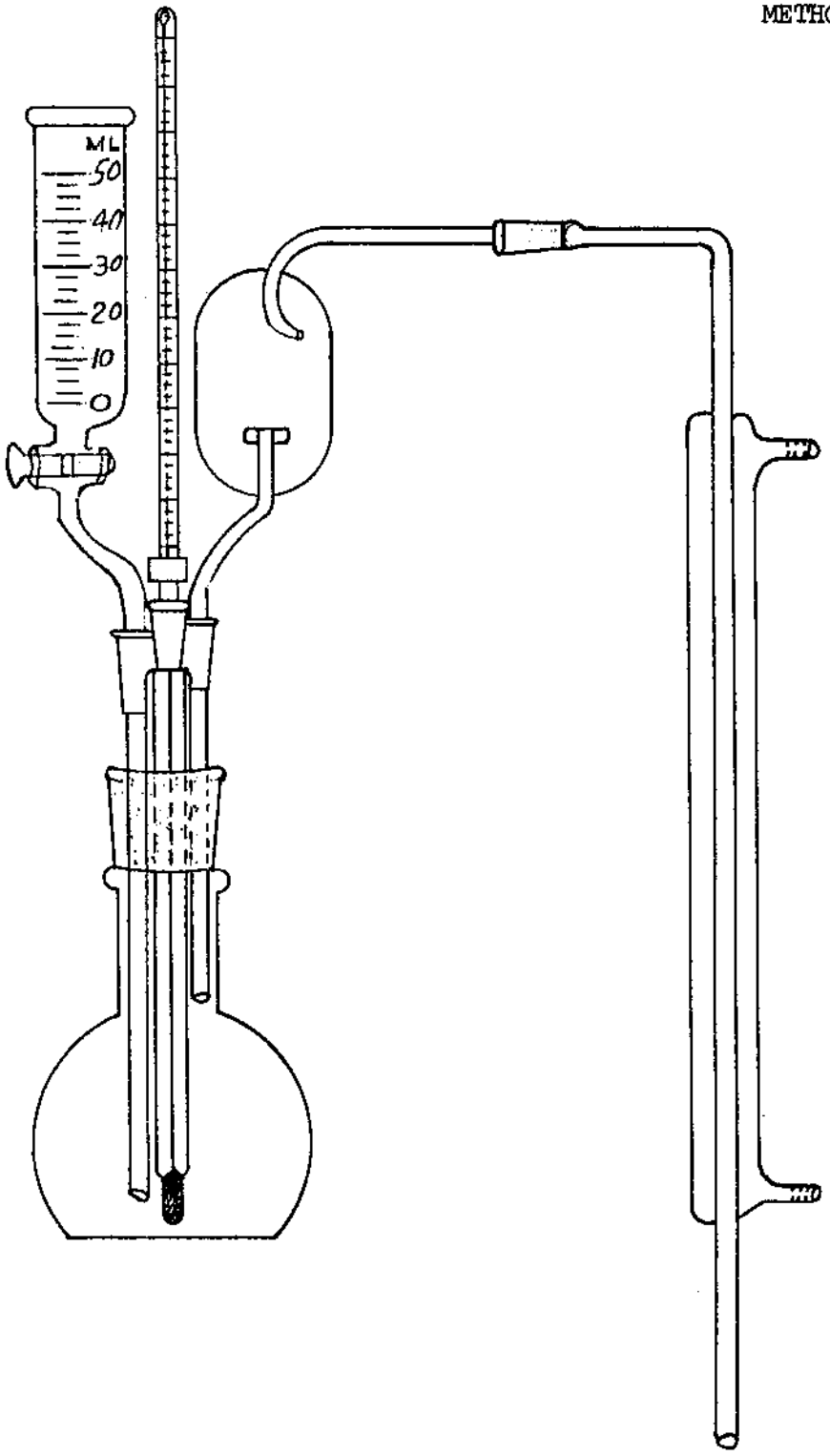

FIGURE 2013 - Test apparatus for fluorine content of textile materials.

SODIUM SALT OF 5-CHLORO-2-[4CHLORO-2-[3-(3, 4 DICHLOROPHENYL)-UREIDO]-PHENOXY] BENZENESULFONATE CONTENT

1. SCOPE

1.1 This method is intended to determine the sodium-5-chloro-2-[4 chloro-2-[3-(3,4 dichlorophenyl)-ureido]-phenoxy] benzenesulfonate content of woolen textile materials that have been treated with this compound as a mothproofing agent (see 7.2).

2. TEST SPECIMEN

2.1 When the material to be tested is 100 percent wool, the specimen shall be 500 ± 50 milligrams.

2.2 When the material to be tested is a blend of polyester and wool, the specimen shall be 1000 ± 100 milligrams.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified, two specimens shall be tested from each sample unit.

4. APPARATUS AND REAGENTS

4.1 Apparatus.

4.1.1 Electric heater with variable control.

4.1.2 250 cc, round bottom, single neck, alkali resistant, Pyrex glass flask.

4.1.3 250 cc trap bulb and connecting arm (see 7.1).

4.1.4 Graham condenser (jacket 300 mm, long).

4.1.5 Funnel.

4.1.6 500 cc volumetric flasks.

4.1.7 1000 cc volumetric flasks.

4.1.8 Pipettes.

4.1.9 Glass beads.

4.1.10 Spectrophotometer or filter photometer with a green filter having a maximum transmission at approximately 500 nanometers.

4.1.11 Silicone stopcock lubricant.

4.1.12 Potassium Iodide-Starch test paper.

4.1.13 Congo Red test paper.

4.1.14 Red and blue litmus paper.

4.1.15 Analytical balance.

4.1.16 Air oven.

4.2 Reagents.

4.2.1 2.0 N potassium hydroxide (KOH), 112 grams of potassium hydroxide pellets ACS, per 1000 cc of solution.

4.2.2 1.0 N hydrochloric acid (HCl), 85 cc of hydrochloric acid, 37.5 percent concentrated, ACS per 1000 cc of solution.

4.2.3 37.5 percent concentrated hydrochloric acid, ACS.

4.2.4 0.1 N sodium nitrite ($NaNO_2$), 6.9 grams sodium nitrite ACS, per 1000cc of solution. Sodium nitrite is subject to decomposition and should be made up fresh.

4.2.5 0.01 molar benzoyl-H-acid (1 napthol 3, 6 disulfonic acid, 8 benzamido), 8.9 grams 50 percent benzoyl-H-acid per 1000 cc of solution. Store protected from light, (see 7.1).

4.2.6 1.0 N sodium bicarbonate ($NaHCO_3$), 42 grams sodium bicarbonate ACS, per 1000 cc of solution.

4.2.7 3, 4 dichloroaniline (distilled and pure, melting point 71°-72°C), (see 7.1).

4.2.8 Antifoam agent (polysiloxane derivative).

4.2.9 Perchloroethylene (tetrachloroethylene).

4.2.10 Distilled water.

5. PROCEDURE

5.1 Preparation of standard reference solution.

5.1.1 Dichloroaniline-hydrochloride stock solution. On an analytical balance, weigh 162.0 ± 0.1 milligrams (mg) of 3, 4 dichloroaniline. Place in a 1000 cc volumetric flask. Add 10 cc of 37.5 percent concentrated hydrochloric acid. Heat the flask in a water bath with boiling water and keep shaking the flask until the dichloroaniline is completely dissolved. Dilute to volume with distilled water 18° to 27°C.

5.1.2 Standard reference solution. Pipette 20 cc of dichloroaniline-hydrochloride stock solution (5.1.1) into a 1000 cc volumetric flask. Add 30 cc of distilled water (7° to 10°C.). Cool the solution to 7° to 10°C., add 8 cc 1.0 N hydrochloric acid and 2 to 3 cc of 0.1 N sodium nitrite. Test with Congo Red test paper and the paper should turn dark blue instantly. Also test with Potassium Iodide-Starch test paper and the paper should turn black instantly. Agitate the solution thoroughly and keep at 7° to 10°C. for exactly 20 minutes out of direct light. Add 30 cc of 1.0 N sodium bicarbonate solution to effect neutrality while maintaining the cold temperature. Check for neutrality with both red and blue litmus paper. Immediately add 3 cc of 0.01 M benzoyl-H-acid and agitate for two minutes to effect good coupling. Dilute to volume with distilled water. Determine absorbence of this standard reference solution using a filter photometer or spectrophotometer. Maximum absorbence occurs at approximately 505 nanometers. When using a filter photometer, a green filter having a maximum transmission at approximately 500 nanometers should be used.

5.2 Weight of dry specimen. The specimen shall be placed in a weighing bottle, dried in a circulating air oven at a temperature of 105° to 110°C cooled in a desiccator, and weighed. Repeat this cycle until a weight is obtained that is constant to ± 0.001 gram. This is the "weight of the dry specimen" and in the calculation of results is indicated as "O".

5.3 Testing of specimens containing 100 percent wool.

5.3.1 Cut specimen into small pieces and place in a 250 cc round bottom distillation flask with a few glass beads. Add 130 cc of 2.0 N potassium hydroxide and two drops of antifoam agent. Grease all ground glass connecting joints of distilling apparatus with silicone grease. Assemble the complete distilling apparatus as shown in Figure 2015 so that the distillate is collected through a funnel into a 500 cc volumetric flask. Heat the distilling flask gently, using an electric heater with variable control, until the liquid boils, and boil gently for 10 minutes. Increase the heating until vapor passes through 250 cc trap bulb and connecting arm and into the condenser. Continue distillation until approximately 100 cc of distillate has been collected. The distillate must not be contaminated by any carry-over of the liquid being distilled. Cool distillate to 7° to 10°C. Add 8 cc of 1.0 N hydrochloric acid and 2-3 cc of 0.1 N sodium nitrite. Agitate and test with Congo Red test paper; paper turns dark blue instantly. Test with Potassium Iodide-Starch test paper; paper turns black instantly. Agitate solution thoroughly and keep at 7° to 10°C for 20 minutes while protecting from direct light. Add 30 cc of 1.0 N sodium bicarbonate solution and check solution for neutrality with red and blue litmus paper. Add 3 cc of 0.01 M benzoyl-H-acid and agitate 2 minutes to effect good coupling. Dilute to volume with distilled water and measure the absorbence using a filter photometer or spectrophotometer. Maximum absorbence occurs at approximately 505 nanometers. When using a filter photometer, a green filter having a maximum transmission at approximately 500 nanometers should be used.

5.4 Testing specimens of polyester/wool blend.

5.4.1 Place the specimen in a 250 cc round bottom distillation flask and a few glass beads. Add 150 cc of perchloroethylene, boiling point 119° to 121°C and connect flask to a reflux condenser. Reflux at the boil for two hours. Remove the specimen and rinse for one minute in 100 cc

of clean perchloroethylene at approximately 100°C. Air dry the specimen. Cut specimen into small pieces and place in distilling flask and continue with the procedure described in 5.3.1.

5.5 Calculations.

5.5.1 Specimens containing 100 percent wool. The percent mothproofing agent on the wool fiber shall be calculated from the absorbence measurements as follows:

$$\text{percent mothproofing agent} = \frac{544 \times A_t}{A_s \times O \times P}$$

Where: A_s = absorbence of standard reference solution. (see 5.5.3)
A_t = absorbence of test solution.
O = original dry weight of specimen in mg (5.2).
P = Proportion of wool in the sample, expressed as a decimal to the nearest 0.01

5.5.2 Specimens containing polyester/wool blend. The percent mothproofing agent on the wool fiber shall be calculated from absorbence measurements as follows:

$$\text{percent mothproofing agent} = \frac{544 \times A_t \times 1.06}{A_s \times O \times P}$$

Where: A_s = absorbence of standard reference solution. (see 5.5.3)
A_t = absorbence of test solution.
O = original dry weight of specimen in mg (5.2).
P = proportion of wool in the sample, expressed as a decimal to the nearest 0.01.

5.5.3 Where spectrometric measurements are taken from a transmission scale the absorbence shall be calculated as:

$$A = \text{Log}_{10}\ 1/T.$$

Where: T = transmission measurement.

A = Absorbence.

6. REPORT

6.1 The percent mothproofing agent content of a sample unit shall be reported as the average of values for the specimens tested from the sample unit.

6.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

7. NOTES

7.1 Materials required for testing. The 3, 4 dichloroaniline, the benzoyl-H-acid, and the 250 cc trap bulb and connecting arm may be obtained from Geigy Dyestuffs, Ardsley, New York 10502.

7.2 This method determines the content of a 100 percent active (pure) material.

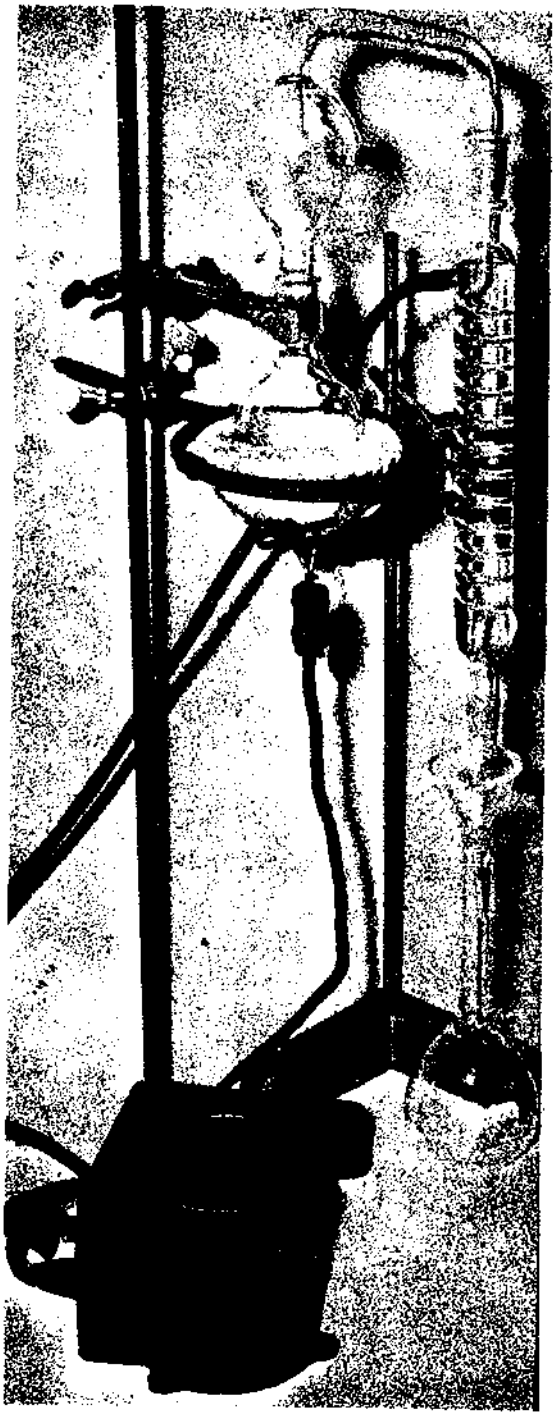

FIGURE 2015 - Distilling apparatus.

BECKER VALUE OF CORDAGE FIBER

1. SCOPE

1.1 This method is intended for evaluating the reflectance of abaca (Manila "Hemp") fiber. It is applicable to raw fiber and to fiber from cordage.

2. TEST SPECIMEN

2.1 The test specimen shall be 24 grams of a composite sample. When cordage is to be tested, the composite sample is prepared from 3 pieces, 12 inches (30.5 cm) long taken from a sample unit not less than 2 feet (61 cm) from each other. If rope, yarn or fiber is to be tested, take enough 12 inch (30.5 cm) lengths of the yarn or fiber, well distributed over the sample unit, to give a bundle 1 inch (25.4 mm) in diameter.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in this material specification, four specimens shall be tested from each sample unit.

4. APPARATUS AND REAGENTS

4.1 Reflectometer. A reflectometer shall be used whose geometrical and spectral characteristics conform to requirements for the measurement of Becker Value (see 7.4).

4.2 Standards. Reflectance standards of porcelain enamel which have been calibrated relative to magnesium oxide on a reflectometer known to conform to the geometric and spectral requirements of the definition for Becker Value (see 7.1) shall be used, (see 7.2). For accurate results, a reference standard must have the same spectral character and approximately the same Becker Value as that of the fiber being tested (see 7.3).

4.3 Cuvette. A specimen holder at least 5/8 inch (15.9 mm) deep with clear glass or optical grade plastic window in the bottom large enough to receive the entire beam of the reflectometer. See Appendix II.

4.4 Glass or plastic sheet shall have the same thickness and spectral transmission as the bottom of the cuvette (see 4.3) and having the length and width of the reflectance standard (see 4.2) preferably cut from the same piece as the bottom window of the cuvette for calibrating equipment. The glass or plastic sheet is inserted between the standard and receptor in reflectometers sensitive to geometric and optical changes caused by its emission.

4.5 Soxhlet extraction apparatus.

4.6 Reagent.

4.6.1 Petroleum ether, technical.

5. PROCEDURE

5.1 Preparation of specimen.

5.1.1 Cut 3 pieces from a sample unit of rope to be tested, 12 inches (30.5 cm) long. Open up a piece of rope and remove the paper marker if present. Untwist the strands and the yarns and make a cylindrical bundle including all the fibers in the cross-section of the rope. Compress the bundle as much as possible. It may be helpful to wrap the bundle in heavy Kraft paper. The fibers must be cut to a length of 2 mm $\pm$ 0.5 mm by slicing the bundle perpendicular to its long axis. Take care to avoid overheating and discoloration by too rapid cutting or a dull knife. Remove particles of paper, if used, from the cut fiber. Repeat this procedure for the 3 pieces cut from the sample unit.

5.1.2 Combine 8 gram portions of the cut fibers from each of the 3 pieces of rope and mix thoroughly.

5.1.3 Place approximately 10 grams of this composite sample in the thimble of the Soxhlet apparatus and extract by refluxing with petroleum ether for 2 hours. The solvent should be recycled approximately 15 times per hour.

5.1.4 Spread the extracted fibers out on a clean sheet of quantitative filter paper and allow them to dry completely at room temperature, preferably overnight.

5.2 Forming specimen in cuvette.

5.2.1 Carefully sprinkle the prepared specimen evenly into the cuvette from a spatula or folded sheet of paper. Do not handle the fibers with the fingers. When the window in the cuvette is evenly covered to a depth of about 1/16 inch (1.6 mm) add additional fibers more rapidly to a depth of 1/2 inch (12.7 mm). Do not tamp or pack the fibers. The fiber surface against the window of the cuvette constitutes the specimen measurement.

5.3 Becker Value.

5.3.1 Turn on the reflectometer and allow the equipment to warm up for about 1/2 hour to bring the response to a steady rate.

5.3.2 Calibrate the reflectometer as follows: Cover the reflectance standard, (see 4.2), with the glass or plastic sheet where necessary, (see 4.4), and place the combination over the specimen aperture of the reflectometer. Read the instrument. If the indicated reflectance differs from that of the reflectance standard, adjust the apparatus to give the correct reading.

5.3.3 If a Gardner Photometric Unit is being used, place the back (fig. 3810B) on the filled cuvette and place the cuvette with the window on the center of the specimen aperture of the reflectometer; completely covering it. Read the reflectance. Rotate the cuvette through 90 degrees and read the reflectance again. A large difference noted in rotating the cuvette indicates that the fibers are not arranged at random and the cuvette should be emptied and refilled. If the two readings agree within 0.3 Becker Value, check the calibration as in 5.3.2. If the calibration has not changed more than 0.3 Becker Value during the measurements, the two readings are acceptable. Average them to obtain a single value for the specimen. If the calibration has changed more than 0.3 Becker Value, the reflectance measurements must be repeated.

5.3.4 If a Photovolt Reflection Meter is being used, place the filled cuvette carefully on the center of the specimen aperture completely covering it, and take a reading. Raise the cuvette 1/4 inch (6.35 mm) above the surface of the reflectometer and allow it to drop back into place to settle the fiber. Take a second reading. Repeat this procedure until successive readings agree. Check the calibration with the reflectance standard as before and if it has not changed more than 0.3 Becker Value during the measurements, take the last reflectance reading to be the value for the specimen. Repeat the measurements if the calibration has changed more than 0.3 Becker Value.

6. REPORT

6.1 The Becker Value for the sample unit is the average of the values for the specimens measured.

6.2 The individual values used to arrive at the average value must be reported.

6.3 Report the Becker Value to the nearest whole number.

7. NOTES

7.1 Becker Value. The reflectance of a specimen relative to magnesium oxide when illuminated at 45° by CIE Source A passing through a Wratten 75 filter and viewed perpendicularly by a receptor whose spectral response is equivalent to that of the CIE Standard observer.

7.2 Reference standards may be obtained from the National Bureau of Standards, Washington, D. C. 20234 and Photovolt Corporation, 1115 Broadway, New York, N. Y. 10010.

7.3 A likely source of error in Becker Value measurements may be the departure of the spectral response of the reflectometer from the requirements of this method. A practical test for the conformance to spectral requirements may be made by adjusting the instrument to read correctly the Becker Value of a white reference standard then reading the value of a tan-colored standard that has nearly the same value as the fiber to be measured. The reading for the latter standard should be within a few tenths of the assigned values.

7.4 Gardner Photometric Unit when equipped with 45 degree exposure head and with Corning-403 and Wratten-75 filters between photocell and specimen is suitable. It may be obtained from Gardner Laboratories, Inc. Bethesda, Maryland 20014. The Photovolt Reflection Meter, when equipped with Corning 4010 and Corning 4308 filters, is suitable. It may be obtained from the Photovolt Corporation, 1115 Broadway, New York, N. Y. 10010. The Martens (visual) photometer with Wratten 75 filter over the eyepiece and Standard Light Source A of the CIE may be used as in the past, but measurement with this equipment is less precise and more time consuming than with the photoelectric equipment. Any photometer conforming to the general requirements may be used provided it is shown to yield Becker Values in close agreement with the values obtained with the equipment referred to above. (Appendix I).

APPENDIX 1

PHOTOMETRIC EQUIPMENT

To qualify photometric equipment for the Becker Value test, test at least 25 fiber specimens representing a range of Becker Values from 35 to 55 with it and with one of the photometers referred to in Section 7.4, of the test method without disturbing the surface measured. Plot the results as shown in Figure 3810A and fit a straight line to the data using the method of least squares. In the Becker Value range from 35 to 55, the discrepancy between this least squares line and a unit slope line through the zero intercept should not exceed 0.5 Becker Value.

Suggestions for the operation of photoelectric reflectometers follow. Locate the instrument on a bench or table free from vibration. Turn on the current at least ½ hour before measurement to allow the instrument to warm up, with the resulting steadier readings and less frequent calibration. If the current is not steady the reflectometer should be operated with a special voltage regulator or from a storage battery. Check the zero setting before each use and reset if necessary. Cover the sample aperture completely so that no outside light can reach the photocell. Calibrate with the reflectance standard before and after measurements. Frequent rechecking of calibration is essential. Clean the optical system from time to time to remove dust and dirt and clean the filter before each use. If the component parts of the filter separate they should be recemented. Follow the instructions of the manufacturer of the reflectometer.

APPENDIX II

CUVETTE OR SPECIMEN HOLDER

A suitable cuvette for use with the Gardner Photometric Unit is shown in Figure 3810B. The surface measured is that of the fiber against the window in the bottom of the cell shown in cross-section in the upper part of "a". The fiber is held against the window by the back of the cell shown in "b". A cell for use with the Photovolt Reflection Meter may be made from a one-inch length of 35 millimeter (outside diameter) Pyrex glass tubing, 2 millimeters wall thickness. The window is made from ophthalmic crown glass, Code #8361 (Corning) or equivalent, 1.6 millimeters plus or minus 0.1 millimeter thick cemented to one end of the Pyrex tube. Clean cuvettes periodically with a detergent and water followed by rinsing with alcohol and ether and drying in a stream of air. After each use, blow out with air to remove all fibers and dust. Do not wipe with cloth or soft paper as this will generate static electrical charges, and result in non-random distribution of cut fibers, and cause incorrect reflectance values.

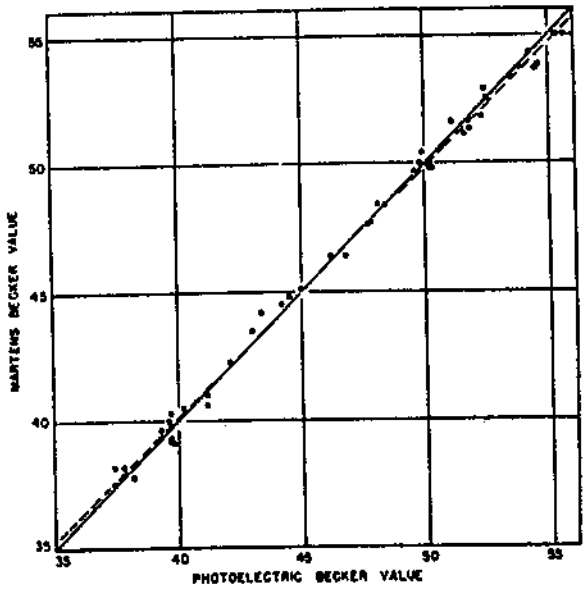

FIGURE 3810A - Photoelectric Becker values plotted against visual values.

Broken line represents the least-square line.

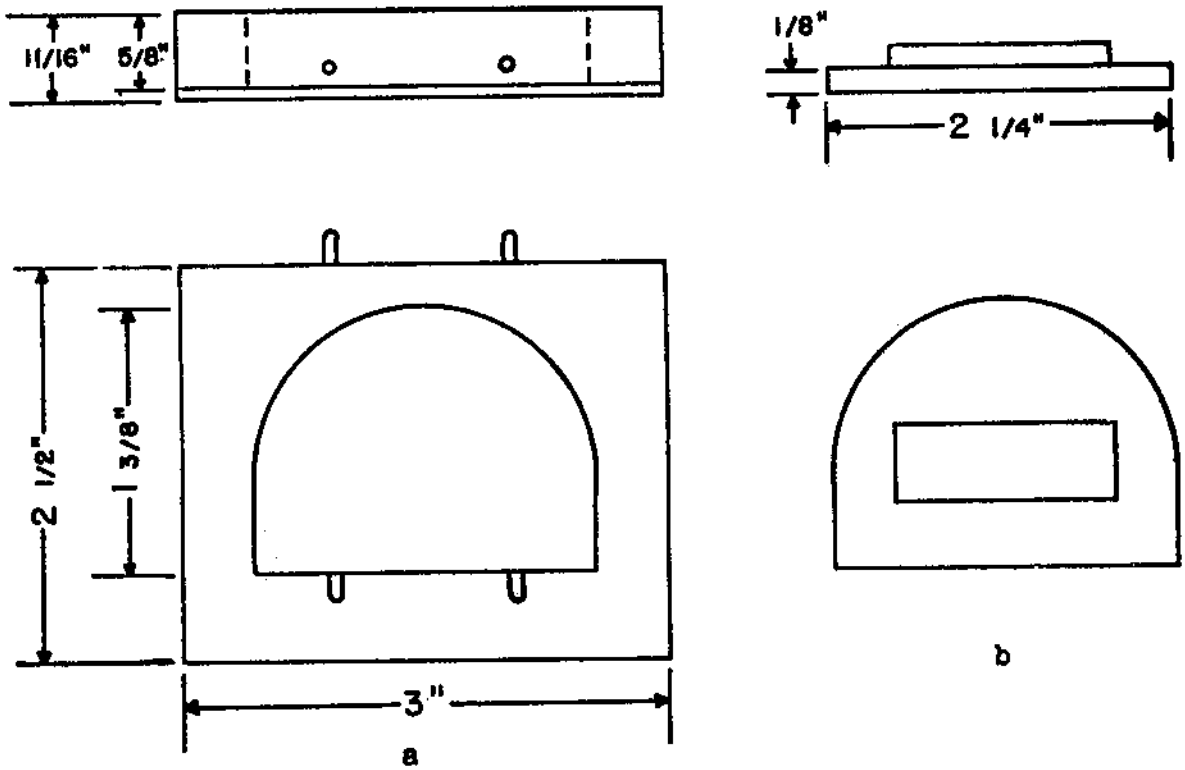

FIGURE 3810B - Cuvette used with Gardner photometric unit.

a. Body of cell.
b. Back of cell.

The back is held in place by the tension of rubber bands which are looped over the protruding studs in "a" and contact back on the rectangular raised portion.

LENGTH-WEIGHT RELATION; THREAD; YARDS PER POUND

1. SCOPE

1.1 This method is intended for determining the length per pound (length per kilogram) of sewing thread taken from such packages as spools or cones.

2. TEST SPECIMEN

2.1 The specimen shall be a skein of thread. Unless otherwise specified in the material specification, each skein of heavy thread shall contain not less than 30 yards (27.4 m); each skein of machine or basting thread shall contain not less than 120 yards (109.7 m).

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specifications, five specimens shall be tested from each sample unit.

4. APPARATUS

4.1 Reel, accurate to 0.1 percent, equipped with means for recording length, applying tension, and spreading the thread evenly on the reel.

4.2 Analytical balance or a grain-yarn scale, accurate to $\pm$0.25 percent.

5. PROCEDURE

5.1 Unless otherwise specified, the specimens tested shall be conditioned and tested under Standard Conditions in accordance with Section 4 of this Standard.

5.2 For threads wound on spools, cones, or similar put-up, the thread shall be drawn from the top of the package at a speed of 100 to 300 revolutions per minute of the reel. The thread shall be passed through the guides in such a way that the tension in the running yarn is sufficient to straighten it, but not high enough to cause serious stretching. If the reel has only one pig-tail guide per skein, tension shall be applied by taking one full wrap around the guide. If the reel has two or more guides, the thread shall pass straight through the guides onto the reel, the angle of the guides supplying necessary tension.

5.3 For threads on parallel tubes and large flanged spools, large tubes, certain warp wound bobbins or similar put up, the thread shall be drawn from the side at a speed of 20 to 30 revolutions per minute of the reel. Judgement must be used in applying tension on threads having a small or large amount of twist.

5.4 The finishing end of the skein shall be tied to the starting end of the skein in such a manner that the knot will not add additional length to the reel skein.

5.5 The prepared skein shall be weighed, using an analytical balance or a grain-yarn scale, to an accuracy of $\pm$ 0.25 percent of the total weight.

5.6 Calculations. The yards per pound (meters per kilogram) shall be calculated as follows:

$$\text{Yards per pound} = \frac{7000 \times \text{number of yards in specimen}}{\text{Weight of specimen in grains}}$$

OR

$$\text{Yards per pound} = \frac{453.6 \times \text{number of yards in specimen}}{\text{Weight of specimen in grams}}$$

OR

$$\text{Meters per kilogram} = \frac{\text{Number of meters in specimen}}{\text{Weight of specimen in kilograms}}$$

6. REPORT

6.1 The yards per pound (meters per kilogram) of a sample unit shall be the average of the specimens tested from the sample unit and shall be reported to the nearest yard (meter).

6.2 The individual values used to arrive at the average shall also be reported.

YARN NUMBER (LINEAR DENSITY) OF YARN FROM PACKAGE

1. SCOPE

1.1 This method is intended for determining the yarn number (linear density) of yarn taken from such packages as cones, cops, bobbins, tubes, and similar put-up. It is applicable to single and plied yarns.

2. TEST SPECIMEN

2.1 The test specimen shall be a skein of yarn. The specimen size shall be as follows:

2.1.1 Indirect system of units (length-weight ratio).

2.1.1.1 Skein length of all singles yarns shall be 120 yards, (109.7 meters).

2.1.1.2 Skein length of plied yarns shall be as follows:

Plied Yarn Equivalent Singles Numbers

Cotton and Spun Rayon	Linen and Wool Cut	Worsted	Wool Run	Length to Reel for Test	
				Yards	Meters
20 and above	56 and above	30 and above	11 and above	60	55
3 to 20	8.4 to 56	4.5 to 30	1.6 to 11	24	22
Below 3	Below 8.4	Below 4.5	Below 1.6	12	11

Direct System of Units (Weight per Unit Length)
Filament Yarns

Below 130 denier	300	275
130 to 650 denier	120	110
650 denier and above	15	14

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, four specimens shall be tested from each sample unit.

4. APPARATUS AND METHOD CITED

4.1 Apparatus.

4.1.1 Yarn reel accurate to ± 0.1 percent, equipped with means to record length, applying tension, and spreading the yarn evenly on the reel.

4.1.2 Analytical balance or grain-yarn scale, accurate to ± 0.25 percent.

4.2 Method cited.

4.2.1 Method 4054, Twist and Twist Contration; Ply Yarns.

5. PROCEDURE

5.1 Unless otherwise specified, the specimens tested shall be conditioned and tested under Standard Conditions in accordance with Section 4 of this Standard.

5.2 For yarn wound on cones, filling wound bobbins and cops, and small flange spools or tubes, the yarn shall be drawn from the top of the package at a speed of 100 to 300 revolutions per minute of the reel. The yarn shall be passed through the guides in such a way that the tension in the running yarn is sufficient to straighten it, but not high enough to cause serious stretching. If the reel has only one pigtail guide per skein, tension shall be applied by taking one full wrap around the guide. If the reel has two or more guides, the yarn shall pass straight through the guides onto the reel, the angle of the guides supplying the necessary tension.

5.3 For packages such as large flanged spools, large tubes, certain warp wound bobbins or similar put-up, the yarn shall be drawn from the side at a speed of 20 to 30 revolutions per minute of the reel. If the reel has two or more guides, the yarn shall pass straight through the guides onto the reel. Judgement must be used in applying tension on yarns having a small or large amount of twist.

5.4 The finishing end of the skein shall be tied to the starting end of the skein in such a manner that the knot will not add additional length to the reeled skein.

5.5 The prepared skein shall be weighed using an analytical balance or grain-yarn scale to an accuracy of ±0.25 percent of the total weight.

5.6 Calculations. The yarn number, using the weight and length of the skein, shall be calculated using the following formulas:

Indirect system:

$$\text{Yarn Number } N = \frac{L}{W} \times \frac{453.6}{Y} \quad \text{(or)} \quad N = \frac{L}{W_1} \times \frac{7000}{Y}$$

$$\text{Yarn Number } N_1 = \frac{L \times P}{(1-C/100)} \times \frac{453.6}{W \times Y} \quad \text{(or)} \quad N_1 = \frac{L \times P}{(1-C/100)} \times \frac{7000}{W_1 \times Y}$$

Direct system - Denier:

$$\text{Denier } N = \frac{W \times 9840}{L} \text{ (or) } \frac{W \times 9000}{L_1}$$

$$\text{Denier } N_1 = \frac{W \times 9840}{(1-C/100)\ L} \quad \text{(or)} \quad \frac{W \times 9000}{(1-C/100)\ L_1}$$

$$\text{Tex Units} = \frac{310.034}{\text{woolen run number}}$$

$$= \frac{590.541}{\text{cotton hank number}}$$

$$= \frac{885.812}{\text{worsted hank number}}$$

$$= \frac{1653.5}{\text{linen lea number}}$$

$$= \frac{1653.5}{\text{wool cut number}}$$

$$= \frac{\text{denier}}{9} \quad \text{(synthetics)}$$

Where:

N - equivalent single yarn number of plied yarn or number of single yarn.
N_1 - true single yarn number, i.e., single yarn number prior to plying.
L - length of single or ply yarn in yards.
L_1 - length of single or ply yarn in meters.
W - weight of skein in grams.
W_1 - weight of skein in grains.

453.6 grams in one pound.
7000 grains in one pound.

P - number of plies in yarn.
C - twist contraction in plying, percent (see Method 4054).
Y - yards of No. 1 yarn in one pound. The value of Y for indirect system is:

840 for cotton system (cotton, spun rayon)
300 for linen and wool, "cut" system
560 for worsted
1600 for wool, "run" system

Constant for direct system:

9000 for denier, grams per 9000 meters
9840 for denier, grams per 9840 yards

5.6.1 The yarn number of a specimen shall be based on its equivalent single yarn number. If the finished yarn is made up of plied components, the yarn number is expressed as a multiple of the single yarn number for the component yarns.

Examples:

Cotton, spun rayon and blends - A single yarn with an equivalent yarn number of 60 would be expressed as 60/1. A plied yarn composed of 3 single yarns of No. 60 and whose equivalent single yarn number may be for example, 19 or 20 shall be expressed as 60/3.

Wool cut or run, worsted and linen - A single yarn with an equivalent yarn number of 60 would be expressed as 1/60. A plied yarn composed

of 3 single yarns of No. 60 and whose equivalent single yarn number may be, for example, 19 or 20 shall be expressed as 3/60.

Filament yarn - A plied yarn of 4 single yarns of 210 denier, 34 filament shall be expressed as 210/34/4 ply.

6. REPORT

6.1 The yarn number of sample unit shall be the average of the specimens tested.

6.1.1 The yarn number in the indirect system shall be reported to the nearest 0.1 number for yarn numbers 0 to 12 inclusive, and to the nearest whole number for yarn numbers above 12.

6.1.2 Yarn number in the direct system shall be reported to the nearest whole number.

6.2 The individual values used to arrive at the results shall also be reported.

7. NOTES

7.1 Caution should be used when making plied yarn determinations because the amount of contraction due to twist will have an effect on the yarn number.

DIRECTION OF TWIST: YARN, THREAD, CORDAGE

1. SCOPE

1.1 This method is intended for determining the direction of twist of yarn, thread, and cordage.

2. TEST SPECIMEN

2.1 Unless otherwise specified in the material specification, the specimen shall be any convenient length.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, three specimens shall be tested from each sample unit.

4. APPARATUS

4.1 No special apparatus is required for this method, but a magnifying glass and pick needle may be necessary for testing extremely fine yarns.

5. PROCEDURE

5.1 The specimen shall be held in a vertical position and the direction of the slope of the twist spirals observed.

6. REPORT

6.1 Direction of twist of specimen. The direction of the twist of each specimen shall be expressed as "S" twist if the spirals conform in direction of slope to the central portion of the letter "S", and "Z" twist if the spirals conform in direction of slope to the central portion of the letter "Z" (see Figure 4050).

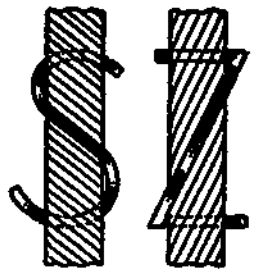

FIGURE 4050

6. REPORT

6.1 The resistance to abrasion shall be reported as the change in characteristics as specified in the applicable test method or material specification.

7. NOTES

7.1 The hexagonal rods used in this test method may be purchased from Narrow Fabrics Institute Inc., 271 North Avenue, New Rochelle, N. Y. 10801.

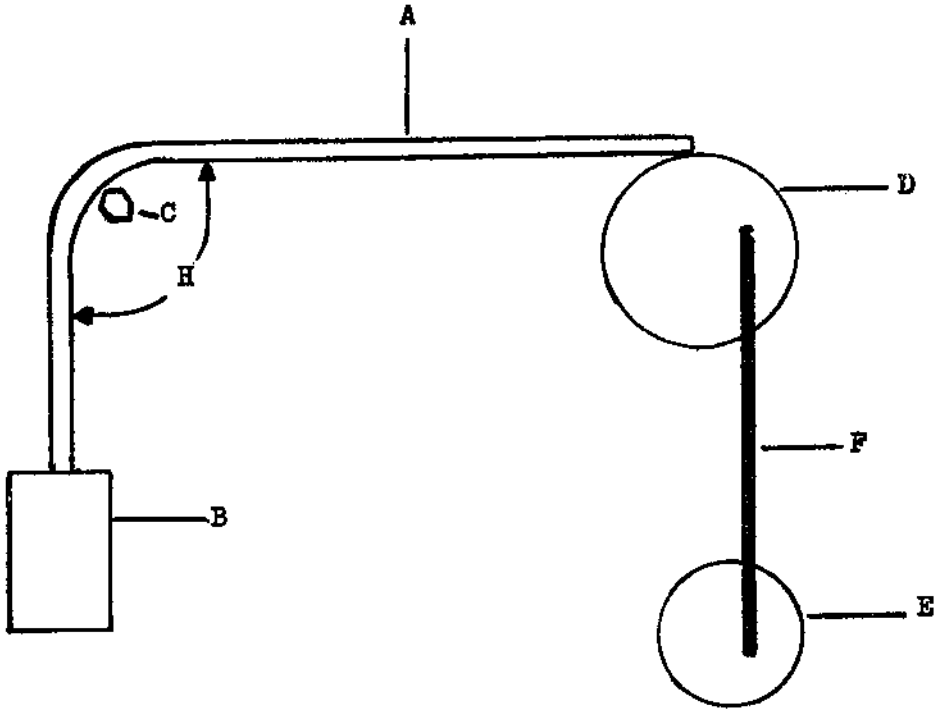

FIGURE 5309

PERMEABILITY TO AIR; CLOTH, CALIBRATED ORIFICE METHOD

1. SCOPE

1.1 This method is intended for determining the air permeability of cloth. It is recommended for cloths as thin and light as parachute cloth to those as thick and heavy as blanket material. It may be used for cloth having an air permeability from 0.1 to 5502.0 cubic feet of air per minute per square foot of cloth. The pressure drop across the cloth may also be varied within wide limits.

2. TEST SPECIMEN

2.1 The specimen shall be a square of cloth a minimum of 7 inches by 7 inches (17.8 cm by 17.8 cm) (see 7.2).

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, five specimens shall be tested from each sample unit.

4. APPARATUS (Fig. 5450A and 5450B)

4.1 Any air permeability instrument which has two oil or oil water manometers, one partly inclined, for measuring the pressure drop across the cloth under test; the other for measuring the pressure drop across the orifice. The partly inclined manometer shall be graduated to read pressure in inches of water.

4.1.1 The partly inclined manometer shall have one end left open to the atmosphere and the other end attached to the cylinder between the air orifice and the specimen. The vertical manometer shall have one end attached to the cylinder between the orifice and the fan, and the other end to the cylinder between the orifice and the cloth.

4.2 Leveling screws and a micrometer plunger for setting the meniscus of the inclined manometer to "zero" when no air is being drawn through the cloth.

4.3 An oil reservoir for each manometer. The reservoir for the vertical manometer shall have a large area in comparison to the cross sectional area of the manometer.

4.4 Nine air orifices having the following nominal diameters in millimeters: 1.0, 1.4, 2.0, 3.0, 4.0, 6.0, 8.0, 11.0 and 16.0.

4.5 Cylindrical chamber approximately 16+1/2 inches (42.9 cm) long and 6 inches (15 cm) in diameter containing a partition near the middle equipped to hold the air orifice. A cloth orifice over which the specimen is placed shall be at one end of the cylinder, and a motor-driven suction fan shall be at the other end of the cylinder.

4.6 A 3 pound (1.36 kg) beveled ring and clamp, attached if desired, so as to hold the specimen under tension and in a smooth condition against the cloth orifice.

4.7 Rheostat(s) used for varying the speed of the motor which drives the suction fan.

4.8 A removable attachment to vary the cloth orifice to allow readings from 0.1 to 5502.0 cubic feet of air per minute per square foot of cloth.

5. PROCEDURE

5.1 Unless otherwise specified in the material specification, the pressure drop across the cloth shall be 0.5 inch (12.7 mm) of water.

5.2 The specimen, which shall not have been previously folded, creased, or in any manner reformed, shall be placed across the cloth orifice and the beveled 3 pound (1.36 kg) ring and clamp shall be placed over the cloth to hold the specimen under a slight tension and in a smooth condition. Air shall be drawn through the cloth and through the calibrated orifice by means of the suction fan.

5.2.1 The appropriate size of orifice to use for a cloth, whose approximate air permeability is not known, is determined by a trial run.

5.3 The pressure drop across the cloth, measured on the inclined manometer, shall be adjusted to the required pressure drop by adjusting the speed of the suction fan motor. The pressure drop across the orifice shall then be noted on the vertical manometer. The volume of air passing through

the cloth shall be calculated from this value and the calibration of orifice. Due to variations in machines available, calculation of air volumes shall be performed in accordance with manufacturer's instructions.

5.3.1 The pressure drop indicated by the vertical manometer shall not be less than 3 inches (7.6 cm) nor more than 26 inches (66 cm).

6. REPORT

6.1 Unless otherwise specified in the material specification, the air permeability of the specimen shall be expressed in cubic feet of air per minute per square foot of cloth at a pressure drop of 0.5 inch (12.7 mm) of water across the specimen.

6.2 The air permeability of the sample unit shall be the average of the results obtained from the five specimens tested and shall be reported to the nearest 0.1 cubic foot.

6.3 Each individual value utilized in expressing the final result shall be reported.

7. NOTES

7.1 The oil used is "Meriam red oil" and can be obtained from the Meriam Instrument Co., 10978 Madison Avenue, Cleveland, Ohio 44102. An air permeability apparatus of the type described may be purchaed from the Frazier precision Instrument Company, 210 Oakmont Avenue, Gaithersburg, Maryland 20760.

7.2 A 0.0412 square foot area of cloth through which the air passes for approximately 900 cubic feet when using a 2 3/4 inch diameter opening and a 0.0077 square foot area for 5502 cubic feet when using a 1 3/16 inch diameter opening have been found satisfactory for the described uses.

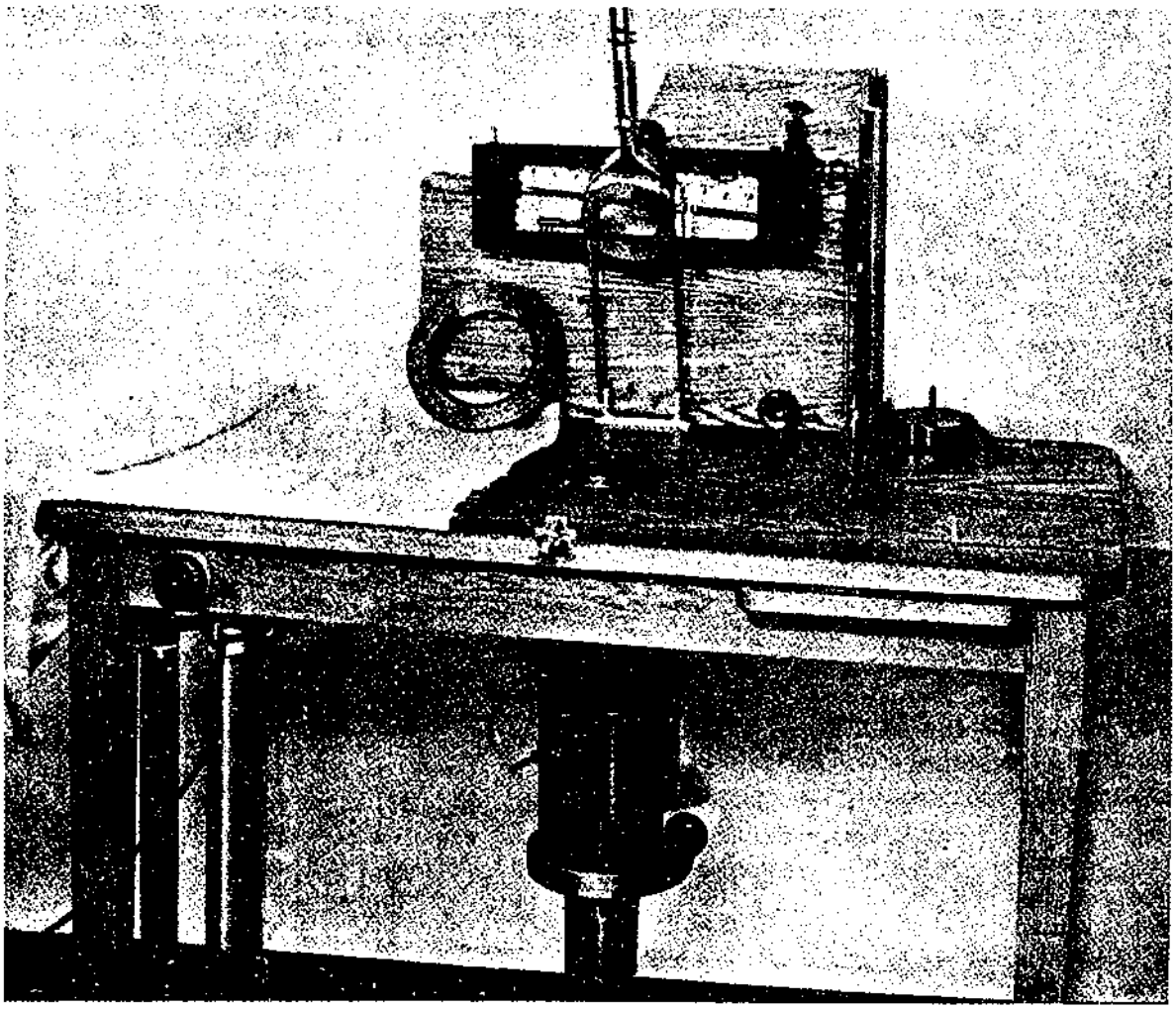

FIGURE 5450B

MOBILE LAUNDRY EVALUATION FOR TEXTILE MATERIALS

1. SCOPE

1.1 This method is intended for use where it is desired to reproduce, by means of a laboratory procedure, changes in dimensions of woven or knitted cloth (wool, cotton, synthetics, and blends) and measure the durability or efficiency of functional finishes by two different laundering procedures which simulate field conditions. The title of the procedures, i.e., "wool" and "cotton" are so designated to allow for easy reference in procurement documents. This test method allows for two general temperature ranges of laundering and the end use application and detail specification will determine the laundering procedure to be followed in evaluating the wide range of textile materials to which it is applicable. It also allows for determining the launderability of battings and feathers.

2. TEST SPECIMEN

2.1 Specimens for determining dimensional stability. Unless otherwise specified, the following shall apply:

2.1.1 Woven or warp knitted (single layer) cloth. The specimen shall be a square of cloth 22 inches by 22 inches (56 cm by 56 cm) except for wool cloth, then the specimen shall be 24 inches by 24 inches (61 cm by 61 cm).

2.1.2 Circular and tubular knit cloths. The specimen shall be 22 inches (56 cm) in length and the width of the cloth as received.

2.1.3 Cloths 22 inches (56 cm) and less in width. The specimen shall be at least 22 inches (56 cm) in length and the width of the cloth as received.

2.2 Specimens for evaluating durability and stability of functional finishes. Unless otherwise specified, the following shall apply:

2.2.1 Specimens for evaluating flame resistant finishes. The specimen shall be an 18-inch (46 cm) square of cloth.

2.2.2 Specimens for evaluating water resistant and other functional finishes as specified. The specimen shall be 1 linear yard (91 cm) full width of the cloth.

2.3 Specimens for determining the launderability of battings. The specimen shall be a 26-inch (66 cm) square of batting prepared as specified in 5.1.

2.4 Specimens for determining the launderability of feathers. The specimen shall be approximately 1 ounce (28.4 grams) of feathers prepared as specified in 5.1.

3. NUMBER OF DETERMINATIONS

3.1 Dimensional stability. Unless otherwise specified in the material specification, three specimens from each sample unit shall be tested in each of the warp or wale and filling or course directions.

3.2 Evaluating functional finishes and determining launderability of battings and feathers. The number of cycles of laundering (see 5.2.4) and the specific evaluation criteria shall be as specified in the material specification. The material encompassed in the sample unit for testing and the number of determinations for each criteria shall be as specified.

4. APPARATUS AND REAGENTS

4.1 Apparatus.

4.1.1 Wash wheel. A cylindrical wash wheel of the reversing type shall be used. The wheel (cage) shall be 20 to 24 inches (50 to 61 cm) inside diameter and 20 to 24 inches (50 to 61 cm) inside length. There shall be three fins each approximately 3 inches (7.6 cm) wide extending the full length of the inside of the wheel. One fin shall be located every 120 degrees around the inside diameter of the wheel. The wash wheel shall rotate at a speed of 30 ± 4 revolutions per minute and shall reverse a minimum of 3 times per minute. The water inlets shall be large enough to permit filling the wheel to an 8-inch (20 cm) level in less than 2 minutes, and the outlet shall be large enough to permit discharge of the same amount of water in less than 2 minutes. The wash wheel shall be equipped with a pipe for injecting live steam that shall be capable of raising the temperature of water at an 8-inch (20 cm) level from 100° to 140°F (37.8° to 60°C) in less than 2 minutes. The water shall be thermostatically controlled to maintain the required temperature in the cotton and wool procedures of 5.2.2 and 5.2.3.

4.1.1.1 The wash wheel shall be equipped with a thermometer or other equivalent equipment for determining the temperature of the water during the washing and rinsing procedures, and with an outside water gage.

4.1.2 Preheating tank or other device. A preheating device to supply water in quantity within ± 4°F (± 2.2°C).

4.1.3 Extractor. A centrifugal extractor with a perforated basket, approximately 11 inches (28 cm) deep by 17 inches (43 cm) in diameter with an operating speed of approximately 1500 revolutions per minute.

4.1.4 Drier. A drier of the rotary, tumble type having a cylindrical basket approximately 36 inches (91 cm) in diameter and 24 inches (61 cm) in length and rotating at 35 ± 2 revolutions per minute. The drier shall be capable of maintaining a minimum stack temperature of 120°F (48.9°C) during the entire drying cycle of the standard load. The stack temperature shall be measured 20 ± 2 inches (50.8 ± 5 cm) from the exhaust opening of the drier.

4.1.5 Pressing equipment. Any flat-bed press capable of pressing a specimen 24 inches (61 cm) square or a hand iron weighing approximately 6 pounds (2.7 kg) may be used as an alternative. The flat-bed press or iron shall be capable of being controlled to maintain the temperature between 248° to 305°F (120° to 151.7°C).

4.1.6 Measuring scale. A scale graduated to 1/8 inch (1 mm).

4.1.7 Scale or balance capable of measuring accurately to ±0.5 gram.

4.2 Reagents.

4.2.1 Synthetic detergent. Meeting the requirements of MIL-D-43362, Detergent, Laundry (Anionic-A Standard for Testing).

4.2.2 Sour. Meeting the requirements of P-S-683, Sour, Laundry, (Flouridated) Type I, (mixture of sodium silicofluoride and sodium acid fluoride).

4.2.3 Water of not over 50 parts per million hardness.

5. PROCEDURE

5.1 Preparation of specimen. Prior to initial markings for determining dimensional stability and prior to determining the change after laundering, the cloth shall be brought to equilibrium under standard atmospheric conditions as defined in Section 4. When evaluating woolen cloth, the edge shall be slit by diagonal cuts at intervals of about 6 inches (15 cm).

5.1.1 Preparation of specimen for dimensional stability.

5.1.1.1 Woven or warp knitted (single layer) cloth. The three (3) specimens required in 3.1 shall be selected from the cloth (sample unit) as follows: One specimen from each side of the cloth to within 3 inches (7.6 cm) of the selvage and one specimen from the center of the cloth. No two specimens shall contain the same filling yarns or courses. The specimens shall be laid without tension on a flat surface, care being taken that the cloth is free from wrinkles or creases. Three distances, each a minimum of 18 inches (45 cm) shall be measured and marked off parallel to each of the warp or wale and filling or course directions of the specimen. The distance shall be a minimum of 6 inches (15 cm) apart and 1 inch (2.5 cm) from any edge of the specimen. The distance may be marked with indelible ink and a fine pointed pen, or by sewing fine threads into the cloth, or by stamping machines. The measured distance shall be parallel to the respective yarns.

5.1.1.2 Circular and tubular knit cloths. Three distances, each a minimum of 18 (45 cm) shall be measured and marked off parallel to the wale direction of the specimen. The distance shall be a minimum of 6 inches (15 cm) apart.

5.1.1.3 Cloths 22 inches (56 cm) and less in width. Three distances, each a minimum of 18 inches (45 cm), shall be measured and marked off parallel to the warp or wale direction. Three width measurements shall be made and marked off along the full width of the cloth parallel to the filling or course direction. The distance shall be a minimum of 6 inches (15 cm) apart.

5.1.2 Preparation of specimen for laundering of batting. The 26 inch (66 cm) square of batting shall be sewn between two pieces of cotton balloon cloth conforming to MIL-C-332, type I, class 2. The bonded batting shall be between the two pieces of balloon cloth with the warp direction of the cloth coinciding with the length direction of the batting. The assembly shall be completely stitched on all four sides approximately 1 inch (2.5 cm) in from the outer edges. In addition, the assembly shall be stitched at 6-inch (15 cm) intervals in the warp direction yielding 4 channels in the test specimen.

5.1.3 Preparation of specimen for laundering of feathers. The one ounce specimen of feathers shall be sewn in a 17- by 6-inch (43 by 15 cm) cotton balloon cloth bag conforming to MIL-C-332, type I, class 2. Care shall be taken in constructing the bag to insure that seams are tight and strong to prevent against loss of feather material.

5.2 The procedure to be followed, i.e., cotton or wool, shall be specified in the end item specification or procurement document.

5.2.1 Standard loads. Unless otherwise specified in the material specification, the following standard loads comprising the specimen under test and clean ballast of comparable size, weight and type of cloth shall be utilized.

5.2.1.1 Cotton Laundering procedure. A total weight of 20 pounds (9.1 kg) consisting of specimen and ballast.

5.2.1.1.1 Cotton laundering procedure when evaluating flame resistant finishes. Twenty-four 18-inch (46 cm) squares of cloth consisting of specimen and ballast.

5.2.1.2 Wool laundering procedure. A total weight of 20 pounds (9.1 kg) consisting of specimen and ballast.

5.2.2 Cotton laundering procedure. Water of not over 50 parts per million hardness at the required temperature ± 4°F (± 2.2°C) shall be introduced into the wash wheel to the designated level. The schedule of table I shall be followed. At the end of each time interval, the machine shall be stopped, drained without removing the load and refilled to the proper level before starting again. The wheel shall be in motion a total of 22 minutes during the period of testing. After laundering, the standard load shall be extracted in two equivalent portions, a minimum of 3 minutes each. The specimens shall be separated, opened to full width and dried together with the ballast at 180° to 210°F (82.2° to 98.9°C) for 45 to 60 minutes in a rotating tumble drier.

TABLE I. Cotton laundering schedule (see 7.4)

Operation	Composition	Water Level (Inches)	Temp (°F.)	Time (Minutes)
1. Suds	Synthetic detergent (25 grams)	6 (15 cm)	100 (37.8°C)	5
2. Suds	Synthetic detergent (15 grams)	4 (10 cm)	140 (60.0°C)	5
3. Rinse		8 (20 cm)	140 (60.0°C)	3
4. Rinse		8 (20 cm)	120 (48.9°C)	3
5. Rinse	Sour (24 grams)	8 (20 cm)	100 (37.8°C)	3
6. Rinse		8 (20 cm)	100 (37.8°C)	3
				22

5.2.3 Wool laundering procedure. Water of not over 50 parts per million hardness at the required temperature ± 4°F (± 2.2°C) shall be introduced into the wash wheel to the designated level. The schedule of Table II shall be followed. At the end of each operation, the machine shall be stopped, drained without removing the load, and refilled to the required level before starting again. At the beginning of the fifth operation, water shall be admitted into the wash wheel to a level of 8 inches (20 cm), the laundry sour added in the quantity required, and the machine run 4 minutes before stopping and draining. After laundering, the standard load shall be extracted in two equivalent portions for five minutes each. The specimens shall be separated, opened to full width and dried together with the ballast at a stack temperature of 130° to 180°F (54.4°to 82.2°C) for 30 to 45 minutes.

TABLE II. Wool Laundering Schedule (see 7.4)

Operation	Composition	Water Level (Inches)	Temp (°F.)	Time (Minutes)
1. Suds	Synthetic detergent (25 grams)	7 (17.8 cm)	100 (37.8°C)	5
2. Suds	Synthetic detergent (15 grams)	7 (17.8 cm)	100 (37.8°C)	5
3. Rinse		8 (20 cm)	100 (37.8°C)	3
4. Rinse		8 (20 cm)	100 (37.8°C)	3
5. Rinse	Sour (24 grams)	8 (20 cm)	100 (37.8°C)	4
				20

5.2.4 Laundering cycles. When the requirement in the end item specification requires more than one laundering, the complete cycle of washing, extraction, and drying shall be performed the number of times specified. Pressing need only be performed once.

5.3 Pressing.

5.3.1 Pressing of cloths for dimensional stability. The dry specimen shall be allowed to cool a minimum of 5 minutes and shall then be sufficiently moistened with water to allow good pressing. This wetting of the specimen shall be accomplished by a spray nozzle set for fine mist or by applying wet cotton cloths weighing 6 to 8 ounces per square yard and having wet pickup of 90 to 100 percentapplied to the face and back of the cloth and allowed to stand in contact approximately 2 hours. If necessary, a platen weighing not more than two times the weight of the cloth area covered, may be used to apply a

moderate pressure against the cloth to permit transfer of the moisture from the applied cloths to the specimen. The specimen shall be permitted to remain in this condition for 5 minutes, smoothed to remove wrinkles but not distorted, and then pressed either with a flat-bed press or hand-iron. The head of the press or the hand-iron shall be at a temperature of 248° to 302° F (120° to 150° C).

5.3.2 When a hand-iron is used, the iron shall not be slid back and forth on the specimen, but simply pressed down upon it in a manner simulating the action of a flat-bed press.

5.3.3 Unless otherwise specified in the material specification, knitted cloths and functionally finished cloths other than those for shrink-resistant testing, battings, and feathers, shall not be moistened or pressed.

5.4 Evaluation.

5.4.1 Evaluation of cloth for dimensional stability. The specimen shall be laid out without tension on a flat surface in the standard atmosphere until moisture equilibrium is reached. Care shall be taken that the specimen is smooth and free from wrinkles or creases. The previously measured distance marked on the specimen shall again be measured in both the warp or wale and filling or course direction.

5.4.2 Evaluation of functional finishes, battings, and feathers. The criteria employed in evaluating functional finishes shall be as specified in the applicable end item specification.

5.5 Calculation of results.

5.5.1 The dimensional stability of the specimen shall be calculated as follows:

$$\text{Shrinkage, percent} = \frac{A - B}{A} \times 100$$

Where: A = average of initial measurements (3 specimens).
B = average of measurements after laundering (3 specimens).

6. REPORT

6.1 Dimensional stability.

6.1.1 The shrinkage of the sample unit in the warp or wale direction and in the filling or course direction shall be the average of the specimens tested from each direction, respectively, and shall be reported separately to the nearest 0.1 percent.

6.1.1.1 When a test result registers elongation rather than shrinkage, each elongation result shall be prefixed with a minus sign with both the minus sign and the value inclosed in parenthesis.

6.2 Durability or stability of functional finishes.

6.2.1 Reporting the results in the evaluation of functional finishes shall be as specified in the applicable end item specification.

6.3 Launderability of battingsand feathers. The reporting of results in the evaluation of launderability of battings and feathers shall be as specified in the applicable end item specification.

6.4 Each individual value utilized in expressing the final result shall be reported.

7. NOTES

7.1 The wash wheel and drier as described may be obtained from Robert Ewing & Sons, P. O. Box 454, Troy, New York, 12181.

7.2 The pressing equipment and extractor may be obtained from Robert Ewing & Sons, P. O. Box 454, Troy, New York, 12181; American Laundry Machinery Industries, 5050 Section Avenue, Cincinnati, Ohio, 45212 and Troy Laundry Machinery, East Moline, Illinois, 61244.

7.3 Synthetic Laundering Detergent (under the name of Igepon T-73) may be obtained from GAF Corporation, Dyestuff & Chemical Division, 140 West 51st Street, New York, N. Y., 10020.

7.4 The water levels shown in the tables are based on a wash wheel with 24 inch (61 cm) inside diameter and 24 inch (61 cm) inside length. The following table shows the volumes of liquids corresponding to these water levels:

TABLE III

Water Level in the Wash Wheel		Volume	
Inches	cm	Gallons	Liters
4	10.0	9.3	35.0
6	15.0	14.3	54.0
7	17.8	17.5	66.2
8	20.0	20.5	77.5
10	25.4	26.2	99.2

INSECT RESISTANCE OF TEXTILE MATERIALS

1. SCOPE

1.1 This method is intended to be used to evaluate the effectiveness of chemical insect deterrents applied to textile materials. This is accomplished by measuring quantitatively the amount of feeding (extent of damage) by a specified number and type of insects for a prescribed time under controlled temperature and humidity.

2. TEST SPECIMEN

2.1 The specimen shall be free of any solvents or carriers used in the application of chemical treatments and of any solvents or auxiliary agents used in subsequent durability tests.

2.2 The required specimens shall be as follows:

2.2.1 Treated specimens

2.2.1.1 Cloth. Each specimen shall have an area of two square inches and cut from the sample unit so that no two specimens contain the same warp and/or filling yarns.

2.2.1.2 Yarn. Each specimen shall be prepared by uniformly winding one layer of yarn on a square or rectangular piece of glazed cardboard, glass, or metal with an area of two square inches. The surface of the cardboard, glass, or metal shall be covered substantially by the yarn.

2.2.1.3 Carpet. Each specimen shall have an area of two square inches and cut from the sample unit so that no two specimens contain the same warp and/or filling yarns. The edges of the specimens are secured by coating the backing yarns with cellulose nitrate dissolved in acetone. For the cloth weight loss method, specimens are prepared by stapling pieces of yarn removed from the sample unit to pieces of glazed paper, each having an area of two square inches so that the surface is covered substantially by the yarn.

2.2.2 Untreated Specimens. The specimens shall be as specified in 2.2.1 except that they shall be cut from the same material as in 2.2.1 before it has been treated with insect deterrent.

2.2.3 Standard Control specimens. The specimens shall be as specified in 2.2.1 except that they shall be cut from a standard control cloth.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, four specimens shall be tested from each sample unit.

4. APPARATUS, MATERIALS, INSECTS

4.1 Apparatus.

4.1.1 Test Cages. Each cage may be any glass or metal flat-bottomed container large enough to permit the test insects to be either in contact with or off the horizontally placed test specimen. It must be well ventilated and provided with a 60-mesh metal screen cover.

4.1.2 No. 3 Gooch crucibles.

4.1.3 Analytical balance accurate to $\pm$ 0.2 milligrams.

4.1.4 Incubator - capable of maintaining a temperature of 27° $\pm$ 1°C and a relative humidity of 55 $\pm$ 5 percent and light excluded.

4.1.5 U.S. Standard Sieve Series Screens Nos. 8, 14, 16, 20, and 40.

4.1.6 Forceps.

4.1.7 Soft Hair Brush.

4.1.8 Air vacuum apparatus.

4.2 Material.

4.2.1 Standard control cloth - pure, undyed, scoured wool fabric (see 7.1).

4.3 Insects.

4.3.1 Black Carpet Beetle (Attagenus piceus (Oliv.),(See 7.6). Larvae are used from cultures maintained as described in Appendix. Larvae must be in the weight range of 6 to 7 milligrams each, and of such a size that they pass through a U.S. Standard Sieve Series No. 14 sieve, and are retained on a No. 16 sieve as described in Appendix.

4.3.2 Furniture Carpet Beetle (Anthrenus flavipes (LeConte), see 7.6.) Larvae from cultures maintained as described in Appendix may be used as alternative test insects with the black carpet beetle.

4.3.3 Webbing Clothes Moth (Tineala bisselliella (Hum) see 7.6). Larvae are used from cultures maintained as described in Appendix Larvae must be 25 to 27 days old as measured from the date of egg deposition to the time they are put on test since older larvae may pupate during the test period.

5. PROCEDURE

5.1 Control specimens for insect activity.

5.1.1 Control specimens of the standard control cloth shall be exposed to the same conditions as the test specimens.

5.1.2 Each lot of cloth used for control specimens and lots of cloth used as rearing medium shall be thoroughly checked to determine suitability prior to use.

5.2 Excrement weight method for carpet beetles.

5.2.1 Three sets of specimens of four specimens each, one set from the material to be tested, one set from the untreated material and one set from the standard control cloth prepared as specified in paragraph 2 shall be freed of any loosely adhering dirt or dust,(see 7.7), and placed face down in separate test cages. The four specimens of untreated material tested are for comparison purposes only.

5.2.2 Ten larvae as specified in 4.3.1 or 4.3.2 are placed on top of each specimen and the cages covered with 60-mesh screening.

5.2.3 The cages containing the test specimens and larvae are kept for 14 days at 27° ± 1°C , and 55 ± 5 percent relative humidity. Light shall be excluded.

5.2.4 Immediately after the 14 day period, remove and record the number of living and dead insects. Survival counts shall be made in all cases. Since they are important in demonstrating the vitality of the test larvae.

5.2.5 Damage to a test specimen is determined by the quantity of excrement deposited on the test specimen during the time period.

5.2.5.1 Remove the test specimen from the cage and by alternately tapping and brushing, transfer all loose material, excrement, exuvial, etc., back into the test cage.

5.2.5.2 Transfer contents of test cage into a No. 3 Gooch crucible and, by repeated tapping of the crucible, the excrement is sifted through the perforations into one of a pair of matched watch glasses. For the purpose of this test all the material that sifts through the perforations of the Gooch crucible shall be construed as excrement.

5.2.5.3 Weigh the excrement on an analytical balance accurately to the nearest 0.2 milligram and record.

5.2.6 Evaluation.

5.2.6.1 The test specimen is considered satisfactorily resistant to carpet beetles if an average quantity of excrement of not over 5 milligrams per specimen is deposited, provided that no single specimen shows more than 6 milligrams of excrement and that under the same conditions, the controls show an average quantity of excrement of not less than 15 milligrams per specimen.

5.2.6.2 The test is invalid if the quantity of excrement deposited on the control specimens averages less than 15 milligrams per specimen, or if less than 90 percent of the control larvae survive.

5.3 Cloth weight loss method for carpet beetle and clothes moths.

5.3.1 Three sets of specimen of eight specimens each, one set from the material to be tested, one set from the untreated material and one set from the standard control cloth are used for this method. Four specimens from each set shall be used for feeding tests and the other four shall be used as humidity checks. The specimens from the untreated material are tested for comparison only.

5.3.1.2 The four specimens from each set that are used for humidity checks are exposed to the same conditions as the feeding test specimens except that larvae are not used. A change in the weight of the humidity check specimens will be due to change in moisture content only and shall be used to adjust the weights of the feeding test specimens.

5.3.2 The feeding test specimens and the humidity check specimens from each set are freed of any loosely adhering dirt or dust and placed in separate test cages at 27° ± 1°C and 55 ± 5 percent relative humidity for 48 hours before weighing.

5.3.3 Weigh the specimens on an analytical balance to the nearest 0.2 milligram alternating the weighings between the test specimens and the humidity check specimens and record in the order of the weighings.

5.3.4 Ten larvae of the required insect (4.3) are placed on each feeding test specimen and the test cages covered with 60-mesh screen.

5.3.5 The test specimens and humidity check specimens are kept for 14 days at 27° ± 1°C and 55 ± 5 percent relative humidity. Light shall be excluded.

5.3.6 Immediately after the 14 day period, remove and record the number of living and dead insects. Survival counts shall be made in all cases, since they are important in demonstrating the vitality of the test larvae.

5.3.7 Damage to the test specimens is determined by weight loss of the specimen due to the feeding of the larvae as follows:

5.3.7.1 Brush the specimens to free them of all loose material such as excrement, webbing cast skins, loose fibers etc. Forceps are usually necessary to remove masses of webbing and excrement from clothes moths, test specimens and containers.

5.3.7.2 The cleaned test specimens and the humidity check specimens shall be reconditioned at 27° ± 1°C and 55 ± 5 percent relative humidity for not less than 24 hours.

5.3.7.3 The test specimens, and the humidity check specimens shall be weighed on an analytical balance to the nearest 0.2 milligrams and recorded in the same manner as specified in 5.3.3 and under conditions specified in 5.3.7.2.

5.3.7.4 Humidity check shall show not more than 5 percent variation in weight before and after the test.

5.3.7.5 The loss of weight, in milligrams, due to the feeding of the test larvae, as adjusted for humidity changes, shall be calculated as follows:

$$L = \frac{AC}{B} - D$$

where: L = adjusted loss of weight in milligrams due to insect feeding;
A = average weight of the four test specimens before testing;
B = average weight of the four humidity control specimens before testing;
C = average weight of the four humidity control specimens after testing;
D = average weight of the four test specimens after testing.

This formula is applicable regardless of whether the humidity control specimens gain or lose weight.

5.3.8 Evaluation

5.3.8.1 The test textile is considered satisfactorily resistant to the insect pests used, if the average loss of weight due to feeding is not more than 8 milligrams, provided that under the same conditions the average loss in weight of the control specimens is not less than 30 milligrams. No individual test specimen shall show more than 10 milligrams loss in weight.

5.3.8.2 The test is invalid if the amount of feeding results in less than 30 milligrams average weight loss per control specimen or less than 75 percent of the control larvae survive.

6. REPORT

6.1 Excrement weight method, 5.2. The specimen tested shall be reported as "pass" or "fail" and the report shall also contain the following information.

6.1.1 Weight of excrement in milligrams of each test specimen and standard control specimens. The number of larvae alive at the conclusion of the test.

6.2 The cloth loss method, 5.3. The specimens tested shall be reported as "pass" or "fail" and the report shall also contain the following information.

6.2.1 Individual weights of the test specimens and humidity check specimens before and after the testing.

6.2.2 Loss in weight of each test specimen and standard control specimen.

6.2.3 Number of larvae alive at the conclusion of the test.

6.2.4 Number of larvae pupated.

7. NOTES

7.1 AATCC moth test cloth is a standard pure, undyed, scoured wool fabric and is available from Test Fabrics, Inc., 55 Van Dam Street, New York, N.Y. 10013.

7.2 May be ordered from Ralston Purina Company, P.O. Box 240, Davenport, Iowa.

7.3 Available locally or from General Foods Corporation, P.O. Box 60, Youngstown, Ohio.

7.4 Yeasts which have proven satisfactory are (a) Brewer's Yeast Powder, Mead Johnson Company, available at most drug stores; (b) Dry Brewer's Yeast, U.S.P. from Yeast Products, Inc., 455 Fifth Avenue Patterson, N.J. with a minimum potency, per gram, of 150 micrograms thiamine, 45 micrograms riboflavin and 400 micrograms niacin.

7.5 Available from National Sea Products LTD., 39 Upper Water Street, Halifax, Nova Scotia, Canada.

7.6 Available from Crop Protection Institute, Durham, New Hampshire 03824 and Wisconsin Alumni Research Foundation, P.O. Box 2037, Madison, Wisconsin 53701.

7.7 No. 3 Special Filter Cloth from Mechanical Felt and Textiles Company, 50 W 18th St., Weehawken, N. J. and No. 70105 all-Wool Felt Color 10 White, from the American Felt Company, 315 Fourth Avenue, New York, N.Y.. Specific fabrics used for rearing moths must be free from insecticides.

7.8 It is extremely important that contamination, dirt, and dust be removed from the test specimens since it could be included later in the excrement weight. The test specimens, if their construction permits, can be vacuumed with the open end of a vacuum cleaner hose nozzle to remove dirt and other particles which might interfere with the subsequent determination of the excrement weight. It is suggested that each specimen be cleaned further by alternately tapping and brushing the specimens to rid them of any loose material such as dust, immediately before the specimens are subjected to testing.

APPENDIX

PROCEDURE FOR REARING AND HANDLING TEST INSECTS

1. SCOPE

1.1 The standardized procedure for rearing test insects is an essential part of the standard test procedure for determining resistance of fabrics to insect pests. The following procedures are to be used for rearing the black carpet beetle (Attagenus piceus (Oliv.)), webbing clothes moth (Tineala bisselliella (Hum)), and furniture carpet beetle (Anthrenus flavipes (LeConte)).

2. APPARATUS; MATERIAL

2.1 Rearing containers, wide mouth glass jars of 1 or 2 quart capacity or any other suitable type container such as mason jars, battery jars, or tin cans with lids replaced by coarse filter paper, screen, or cloth covers.

2.2 Oviposition Cage. A tin can $6\frac{1}{2}$ inches high and 6 inches in diameter. The bottom is removed and replaced with 16-mesh screen wire. Wool flannel is placed beneath the screen and supported in place by a cardobard circle fastened with masking tape to the rim of the can. A closure for the culture jars is soldered in place in an inverted position in the center of the lid of the can and an opening 2 inches in diameter is cut in the can lid within the area inclosed by the closure.

2.3 Rearing medium.

2.3.1 Clean, scoured, undyed wool cloth supplemented with about one teaspoonful of autoclaved (15 p.s.i. for 15 min.) dry Brewer's yeast or fish meal to each 30 grams of cloth. (See 7.4, 7.5).

2.3.2 Purina Laboratory Chow Meal (see 7.2) which passes through U.S. Standard Sieve Series Screen No. 16, with the coarse fraction discarded, or

2.3.3 95 percent by weight Gaines Dog Meal ground to pass through No. 20 screen plus 5 percent dry Brewer's yeast. (See 7.3, 7.4).

2.4 Fumigant Carbon disulfide.

2.5 Mold inhibitor Propionic acid.

2.6 Soft hair brush.

2.7 Kraft paper.

2.8 Entomological forcepts.

2.9 1/2 inch (13 mm) glue brush.

3. PROCEDURE

3.1 Black Carpet Beetle.

3.1.1 Sterilized the rearing medium to kill mites or insects that may be present. This may be done by an efficient fumigant (1 cc carbon disulfide per gallon) preferably in sealed glass containers for one week, dry heat (80°C for four hours or 100°C for one hour) or autoclaved at 15 p.s.i. for 15 minutes. Fumigated medium must be spread in shallow trays and cured in a ventillated hood for one or more days. Overheating may destroy the food value of the medium.

3.1.2 Store the sterile medium in sealed containers. Before using, dry the medium and adjust to 13 percent moisture by adding distilled water.

3.1.2.1 To dry the medium spread a quantity of medium to a depth of one-half to three-fourths of an inch in trays and dry to a constant weight (30 to 44 hours). in a forced draft oven at 66°C. Cool the medium and temper to 13 percent moisture immediately.

3.1.2.1.1 Tempering to 13 percent moisture. Determine the total weight of the medium and for each 100 grams, prepare 15 milliliters distilled water plus 0.38 milliliters propionic acid. Sieve the medium through a No. 20 screen. Add the combined water and propionic acid to the coarse fraction retained on the screen. Finally pour from tray to tray severl times, pass through a No. 16 screen and place in sealed containers until needed for cultures. The final mixture should contain 13 percent moisture and 0.38 percent propionic acid.

3.1.3 The rearing room or incubator shall have a constant temperature of 27° ± 1°C and a relative humidity of 55 ± 5 percent.

3.1.4 Maintenance of cultures. It is possible to maintain cultures of the black carpet beetle so that larvae of testing size and age are available at all times. This can be accomplished only when overcrowding is prevented and cultures are kept well supplied with food.

3.1.5 The black carpet beetle completes its life cycle in 8 to 10 months when reared and handled under optimum conditions as follows:

3.1.5.1 Once each week, pass maturing stock larvae cultures through a U. S. Standard Sieve Series Screen No. 16 and collect adults and prepare separately. The majority of the pupae and the mature larvae can be separated by spreading them out on Kraft paper. The larvae tend to cling to the paper when it is rolled and tilted to an upright position over a pan. The pupae fall into the pan and then the clinging larvae can be shaken into another pan. A No. 8 screen is useful for separating the small number of larvae still remaining with the pupae. The pupae are kept in a screen covered jar for one week for emergency. Count out 50 adults at random and measure their volume in a 15 cc centrifuge tube. The volume of 50 adults should be 1.2 to 1.5 cc if they are developed normally. Transfer the adults to a pint jar three-fourths full of rearing medium (containing 13 percent water). Cover the jar with a filter paper lid and set aside to age at 27° ± 1°C, and 55 ± 5 percent relative humidity.

3.1.5.2 The majority of eggs are laid during the next ten days, and these hatch 6 to 12 days after laying. The eggs are too fragile to be handled without injury and the jar must not be disturbed for at least 11 weeks. At This time, pass its contents through a No. 20 screen. A gentle stream of air, such as is produced by a hair dryer, is useful in removing cast skins. The larvae and coarse material (dead adults, coarse food particles, etc.) retained on the No. 20 screen are then separated by placing the material on the high end of a sloping platform or tray. By putting a light over this end, the larvae, since they are negatively phototrophic, will crawl away from the coarse material and collect at the other end of the tray. The collected larvae are then allowed to crawl through a nest No. 14, No. 16, and No. 20 screens under a light. After 5 minutes, the contents of the screens can be emptied into separate trays. Larvae caught in the mesh are gently stimulated with a soft brush to crawl through the screen or they can usually be removed without injury with Ward's feather-weight entomological forceps. Mites may be removed from the larvae, pupae, or adults by placing the infested insects in a jar that is half-filled with sterilized rearing medium and rotating the jar, screening to separate larvae from the medium and destroying or sterilizing this food which contains mites. It may be necessary to repeat this procedure several times.

3.1.5.3 Measure the volume of larvae collected in a centrifuge tube and estimate the percentage represented by each fraction, based on total numbers. For this purpose, 1 cc contains approximately 45 larvae held on a No. 14 screen, 70 larvae on a No. 16 screen, and 90 larvae held on a No. 20 screen. The number of larvae passed through the No. 20 screen should be estimated roughly and made a part of the total. If 10 to 20 percent of the larvae are not of a size to be held on the No. 14 screen, return all fractions of the larvae and medium to the same jar and age one or two weeks longer. The above step is quite important if satisfactory test larvae are to be obtained. When the jar first produces 10 to 20 percent of larvae held on the No. 14 screen, collect 6 cc of the larvae held on the No. 16 screen (approximately 400), pass them through sterile medium to remove mites, and transfer to quart jar 3/4 filled with medium. Save the remaining larvae held on the No. 16 screen for tests and discar the larvae held on the No. 14 and the No. 20 screens. Add 6 cc of larvae held on a No. 16 screen from new cultures on each of the following three weeks before starting a new jar. These are stock larvae cultures, which will produce pupae 6 to 8 months later. Three months and five months after starting the stock cultures, remove larvae from medium by a No. 16 screen as described in 3.1.5.2 and transfer to fresh medium.

3.1.5.4 At the time the stock larvae are collected, test larvae may be collected by means of the No. 14 and No. 16 screen. Larvae held on the No. 16 screen are test size, and they average 6 to 7 milligrams in weight. The unused larvae held on the No. 16 screen can be saved for possible use as test larvae that same week. All remaining larvae should be discarded at the end of the week.

3.1.5.5 A few weeks experience will determine the age of cultures meeting the requirements for sizing and use of larvae. A deviation of more than one week from this age indicates an abnormal rearing condition which may be caused by food, mites, or various other conditions. Abnormal cultures should be discarded.

3.2 Webbing Clothes Moth, (Tineala bisselliela (Hum)).

3.2.1 Adult moths are transferred to the oviposition cage and allowed to deposit their eggs for 2 to 4 days.

3.2.1.1 The adult moths may be transferred to the pint jar either by use of a suitable suction or by introducing into the container with the adults, a small amount of carbon dioxide (CO_2) gas which will facilitate the transfer of the moths.

3.2.1.2 When the $6\frac{1}{2}$ inch (165 mm) high by 6 inch (152 mm) diameter can is used, the culture jar with the adult moths is fastened in place in the closure and a bright light shined on the glass culture jar to drive the adults into the oviposition cage.

3.2.2 The pieces of cloth on which the eggs have been deposited are removed from the cage, placed in an enamel pan and vigorously brushed with a $\frac{1}{2}$ inch glue brush to remove the eggs. The adult moths are removed from the cage and destroyed. Since the eggs hatch in 4 days, this is the maximum interval that may be allowed between egg collecti ons.

3.2.3 The eggs are screened through a 40-mesh sieve and retained on a 60-mesh sieve. The eggs are measured in a graduated centrifuge tube, 0.2 cc representing approximately 4000 eggs.

3.2.4 The eggs are sprinkled on 4 by 10 inch (100 by 255 mm) strips of clean scoured wool fabric (total 25 to 30 grams) treated with about a teaspoonful of dry yeast. The wool strips are rolled up and placed in a one or two quart wide-mouthed jar, covered with filter paper lids and kept at 27° ± 1°C and a relative humidity of 55 ± 5 percent for 25 to 27 days as measured from the date of egg deposition to the time used for test. (See 7.7).

3.2.5 All moths that are older than required for testing shall be destroyed or kept for the purpose of maintaining a quantity of insects of testing age.

3.3 Furniture carpet beetle, (Anthrenus flavipes (LeConte)).

3.3.1 Place approximately 60 pupae in a rearing container with several 3 inch by 3 inch (75 mm by 75 mm) squares of wool cloth supplemented with dry Brewer's yeast or fish meal.

3.3.2 Examine rearing jars at weekly intervals and provide sufficient supplemental wool cloth to maintain an adequate food supply.

3.3.3 About eleven weeks after the pupae were placed in the rearing jars, the larvae are removed from the wool cloth, excrement, pupae cases, etc. After removing the excrement and excess Brewer's yeast with a 40-mesh sieve, larvae clinging to the cloth can be removed with a soft brush. If handled carefully, the larvae may also be transferred with light forceps.

3.3.4 The collected larvae are then allowed to crawl through nested No. 14, 16 and 20 screens under a light. The larvae held on the No. 20 screen are test size and average 1.0 to 1.5 milligrams in weight. If more than half of the larvae pass through the No. 20 screen, return all fractions of the larvae and medium to the same jar and age one week longer. A few weeks experience will determine the age of larvae meeting the requirements for sizing and use.

3.3.5 A portion of the larvae not used for tests can be placed in a large stock jar which serves as a source supply for pupae for the rearing jars.

HEATING (SPONTANEOUS) OF CLOTH; MACKEY

1. SCOPE

1.1 This method is applicable to all cloths and it may be used to determine the tendency of a cloth to undergo self-heating at moderate temperatures (below 100°C).

2. TEST SPECIMEN

2.1 The specimen shall be a strip of cloth approximately two inches (51 mm) wide and long enough to make a roll approximately 1½ inches (38 mm) in diameter.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification two specimens shall be tested from each sample unit.

4. APPARATUS (Figure 5920)

4.1 Double boiler made of corrosion-resistant metal such as copper or brass. The inside chamber shall be four inches (10.2 cm) in diameter by 7 inches (17.8 cm) deep, equipped with a cylindrical wire screen 1½ inches (38.1 mm) in diameter and 6 inches (15.2 cm) long to hold the specimen and shall be surrounded by a water jacket containing water maintained at the boiling temperature.

4.1.1 The water jacket shall be provided with an opening to permit the addition of water and a reflux condenser (air-cooled) in order to maintain a constant water level.

4.1.2 Insulated cover consisting of a double-walled section, 3 15/16 inches (10 cm) in diameter and 3/4 inch (19 mm) thick filled with rock wool, supported on the cell by a flange fitted with a felt gasket. The cover shall have three openings, each ½ inch (12.7 mm) diameter. The center

opening provides a place to insert the thermometer. The other two openings shall be fitted with $\frac{1}{2}$ inch (12.7 mm) diameter tubes, one of which extends 5 inches (12.7 cm) above the lid and the other 5 inches (12.7 cm) down into the cell to provide for air circulation through the cell.

4.2 A multiple unit of the same cell design may be used.

5. PROCEDURE

5.1 Conditioning. The specimen shall be suspended and heated in a circulating air oven at a temperature of 60° to 63°C for 4 ± $\frac{1}{4}$ hours before testing. Only one specimen shall be removed from the oven at a time and immediately introduced into the specimen holder.

5.2 Before the specimen is introduced into the chamber, the apparatus is assembled with lid and thermometer in place, and the water in the outer jacket boiled until equilibrium is established and the thermometer gives a constant reading. This initial temperature of the empty specimen chamber is the reference point above which self-heating is evidenced, and is the initial temperature of the specimen.

5.3 The specimen shall be wound into a roll approximately $1\frac{1}{2}$ inches (38.1 mm) in diameter so that a space is left in the center for the thermometer. The roll shall be slid into the wire screen provided to hold the specimen, and the assembly put into the air chamber. The lid shall be put on and the thermometer adjusted so that the bulb is at the center of the roll. The water in the jacket shall be boiled for four hours, and the temperature in the cloth roll shall be noted at intervals of sufficient frequency to permit the determination of the highest temperature reached. The last temperature reading shall be made at the end of the four hour boiling period.

6. REPORT

6.1 The self-heating of the sample unit shall be the average of the results obtained from the specimens tested and shall be reported to the nearest 1.0°C. Individual results used to calculate the average shall also be reported.

6.2 The initial temperatures of the specimen and the highest temperature reached for each specimen tested shall also be reported in degrees centigrade.

SPONTANEOUS HEATING APPARATUS

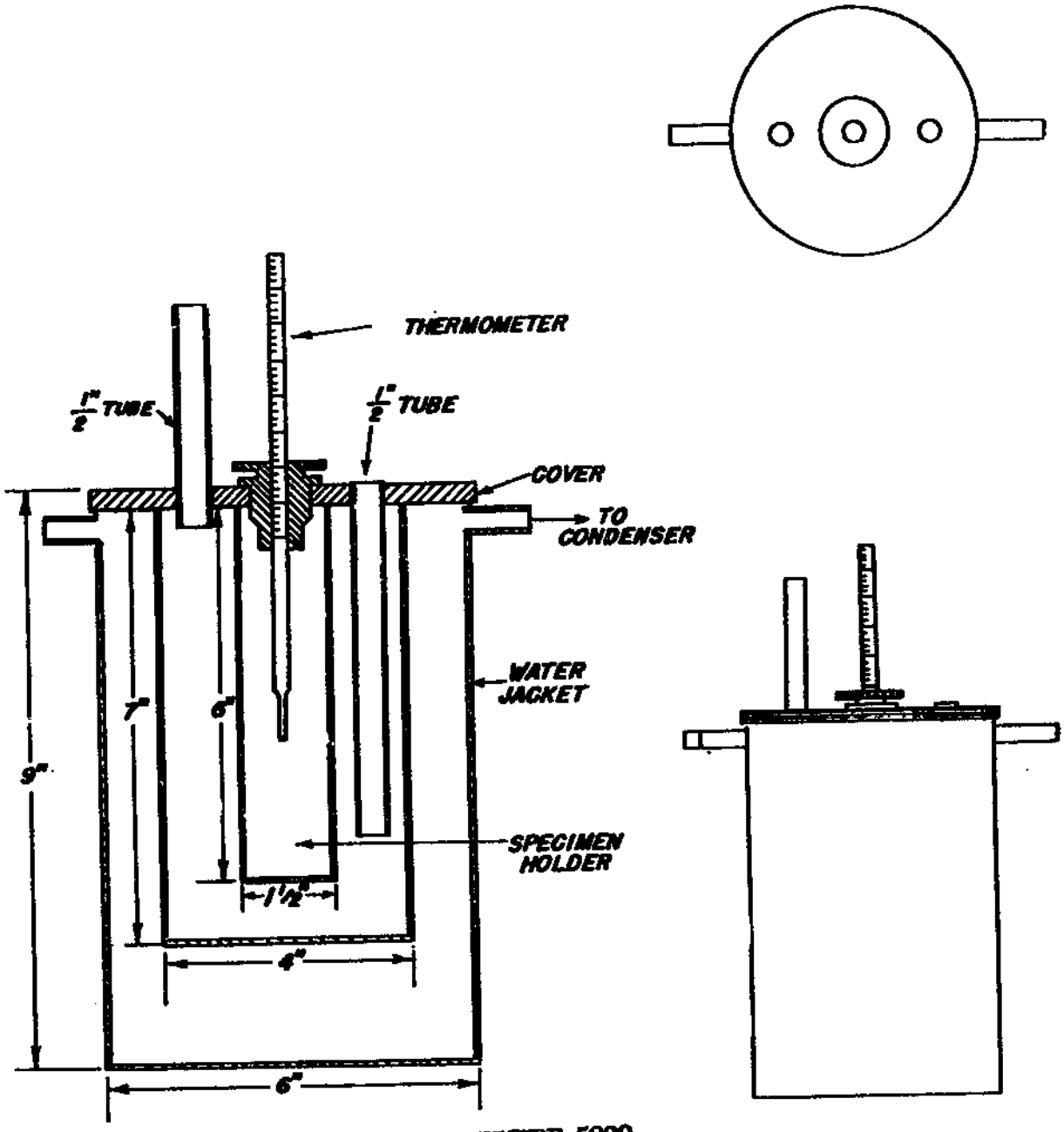

FIGURE 5920

ABRASION RESISTANCE; SOCKS, HOSIERY, AND KNITTED CLOTH; UNIFORM-ABRASION (SCHIEFER) METHOD

1. SCOPE

1.1 This method is intended for determining the resistance to abrasion of dry and wet specimens of the heel, toe, and sole of socks and hosiery and of knitted cloth It is applicable to products which vary in fiber content, construction, finishing treatment, and kind and amount of auxiliary substances.

2. TEST SPECIMEN

2.1 The toe or heel portion of the sock or hosiery, or a circle of knitted cloth cut with a metal die 2.4126 inches in diameter, or as specified in the material specification.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens shall be tested from each sample unit.

4. APPARATUS AND METHOD CITED

4.1 Apparatus.

4.1.1 Abrasion machine and accessories described in Method 5308 except for the clamp assembly which shall be as follows:

4.1.1.1 Clamp assembly for holding knitted specimen, figure 7308.

4.1.1.1.1 Tensioning base, A, figure 7308.

4.1.1.1.2 Clamp base, B, figure 7308, attachable to tensioning base.

4.1.1.1.3 Pressure ring, C, figure 7308, mounted on top of specimen resting on clamp base.

4.1.1.1.4 Outer ring, D, figure 7308, screwed on clamp base over the pressure ring to hold the specimen securely.

4.1.1.1.5 Two 2 1/2 pounds (1.134 kg) or other tension weights, as specified, to fit on tensioning base.

4.2 Method cited.

Method 5308, Abrasion Resistance of Cloth; Uniform Abrasion (Schiefer) Method.

5. PROCEDURE

5.1 Unless otherwise specified in the material specification, the procedure shall be as described in Method 5308.

6. REPORT

6.1 Unless otherwise specified in the material specification, the report shall be as described in Method 5308.

7. NOTES

7.1 An abrasion machine of the type described in this method is manufactured by Frazier Precision Instrument Company, Inc., 210 Oakmont Avenue, Gaithersburg, Maryland 20760.

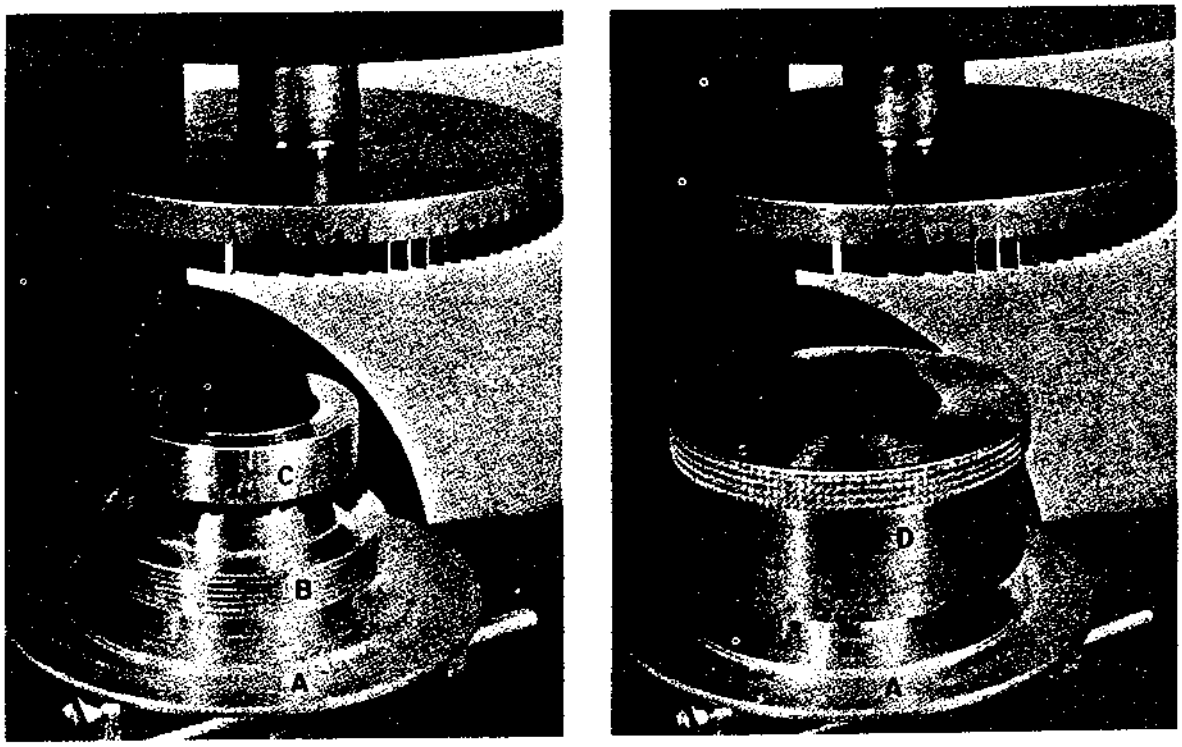

FIGURE 7308

SECTION 10

SUPERSESSION DATA, SOURCE INFORMATION, AND INTERESTED AGENCIES

10.1 This Standard incorporates and supersedes all the provisions of Federal Specification CCC-T-191, Textile Test Methods in addition to instituting revisions in testing procedures as required to provide a more technically adequate and updated laboratory tool.

10.2 This Standard contains the following changes with regard to Federal Specification CCC-T-191. The changes are effective on date of issue of this Standard.

Methods Combined	Consolidated Method
3660 Colorfastness to Light of Textile Fibers, Accelerated Method (Fade-Ometer) 5660 Colorfastness to Light of Cloth, Accelerated Method 4660 Colorfastness to Light; Yarn, Thread, Cordage; Accelerated Method (Fade-Ometer).	5660 Colorfastness to Light of Textile Materials; Accelerated Method.
3662 Colorfastness to Light of Textile Fibers, Natural Light Method 5662 Colorfastness to Light of Cloth, Natural Light Method 4662 Colorfastness to Light, Yarn, Thread, Cordage; Natural Light Method	5662 Colorfastness to Light of Textile Materials; Natural Light Method
3672 Colorfastness to Weather of Textile Fibers, Natural Weather Method 5672 Colorfastness to Weather of Cloth, Natural Weather Method 4672 Colorfastness to Weather; Yarn, Thread, Cordage; Natural Weathering Method	5672 Colorfastness to Weather of Textile Materials; Natural Weathering Method.
4600 Colorfastness to Chlorine Bleaching, Cotton Yarn, Thread and Cordage 5600 Colorfastness to Chlorine Bleaching; Cloth	5600 Colorfastness of Textile Materials to Chlorine Bleaching

Methods Combined	Consolidated Method
4610 Colorfastness to Laundering; Cotton and Linen Yarn, Thread Cordage; Launder-Ometer Method 5610 Colorfastness to Laundering of Cotton and/or Linen Cloth; Launder-Ometer Method	5610 Colorfastness to Laundering of Cotton and/or Linen Textile Materials; Launder-Ometer Method
4614 Colorfastness to Laundering; Wool, Silk and Rayon Yarn, Thread and Cordage; Launder-Ometer Method 5614 Colorfastness to Laundering of Wool, Silk, Rayon Cloth; Launder-Ometer Method	5614 Colorfastness to Laundering of Wool, Silk, Rayon and Other Textile Materials; Launder-Ometer Method
4620 Colorfastness to Dry Cleaning; Yarn, Thread and Cordage (Petroleum Solvent) 5620 Colorfastness to Dry Cleaning of Cloth (Petroleum Solvent)	5620 Colorfastness to Dry Cleaning of Textile Materials, (Petroleum Solvent)
4621 Colorfastness to Dry Cleaning; Yarn, Thread and Cordage (Perchloroethylene Solvent) 5621 Colorfastness to Dry Cleaning of Cloth (Perchloroethylene Solvent)	5621 Colorfastness to Dry Cleaning of Textile Materials (Perchloroethylene Solvent)
4622 Colorfastness to Wet Cleaning (Associated with Dry Cleaning); Yarn, Thread Cordage 5622 Colorfastness to Wet Cleaning (Associated with Dry Cleaning) of Cloth	5622 Colorfastness to Wet Cleaning of Textile Materials; (Associated with Dry Cleaning)
4630 Colorfastness to Water; Yarn, Thread, Cordage 5630 Colorfastness to Water of Cloth	5630 Colorfastness of Textile Materials to Water
4632 Colorfastness to Salt Water and Soap; Yarn, Thread, and Cordage 5632 Colorfastness to Salt Water and Soap of Cloth	5632 Colorfastness of Textile Materials to Salt Water and Soap
4640 Colorfastness to Dry and Wet Heat (Hot Pressing) of Yarn 5640 Colorfastness to Dry and Wet Heat (Hot Pressing of Cloth	5640 Colorfastness of Textile Materials to Dry and Wet Heat (Hot Pressing)

Methods Combined	Consolidated Method
4671 Colorfastness to Weather of Yarn; Accelerated Method (National Weathering Unit) 5671 Colorfastness to Weather of Cloth; Accelerated Method (National Weathering Unit)	5671 Colorfastness of Textile Materials to Weather; Accelerated Weathering Method
4680 Colorfastness to Perspiration; Yarn, Thread, Cordage; Perspirometer Method 5680 Colorfastness to Perspiration of Cloth; Perspirometer Method	5680 Colorfastness of Textile Materials to Perspiration; Perspirometer Method
4750 Mildew Resistance; Yarn, Thread, Cordage; Direct Inoculation, Pure Culture, Sterile Specimen Method 4751 Mildew Resistance; Yarn, Thread, Cordage; Direct Inoculation, Pure Culture, Non-Sterile Method 5751 Mildew Resistance of Cloth; Direct Inoculation Pure Culture Non-Sterile Method 5750 Mildew Resistance of Cloth; Direct Inoculation, Pure Culture, Sterile Specimen Method	5750 Mildew Resistance of Textile Materials; Single Culture Method
4760 Mildew Resistance; Thread, Cordage, Webbing, Soil Burial Method 5760 Mildew Resistance of Textile Mixed Culture Method	5760 Mildew Resistance of Textile Materials; Mixed Culture Method
4762 Mildew Resistance; Thread, Cordage, Webbing, Soil Burial Method 5762 Mildew Resistance of Cloth; Soil Burial Method	5762 Mildew Resistance of Textile Materials; Soil Burial Method
5902 Flame Resistance of Cloth; Vertical 5903 Flame Resistance of Cloth; Modified Vertical	5903 Flame Resistance of Cloth; Vertical

10.3 The following methods have been deleted as a result of combination with other procedures as outlined or as being obsolete:

1533 Identification by Softening Point of Thermoplastic Fibers
2052 Copper Content of Textiles; Colorimetric Method
3660 Colorfastness to Light of Textile Fibers, Accelerated Method (Fade-Ometer)

3662 Colorfastness to Light of Textile Fibers, Natural Light Method
3672 Colorfastness to Weather of Textile Fibers, Natural Weather Method
3710 Filling Power of Bulk Fibers
4020 Yarn Number; Cotton - Yarn Method
4600 Colorfastness to Chlorine Bleaching; Cotton, Yarn, Thread, And Cordage
4610 Colorfastness to Laundering; Cotton and Linen; Yarn, Thread and Cordage Launder-Ometer Method
4614 Colorfastness to Laundering; Wool, Silk and Rayon, Yarn, Thread and Cordage; Launder-Ometer Method
4620 Colorfastness to Dry Cleaning; Yarn, Thread, and Cordage (Petroleum Solvent)
4621 Colorfastness to Dry Cleaning; Yarn, Thread, and Cordage (Perchloroethylene Solvent)
4622 Colorfastness to Wet Cleaning (Associated with Dry Cleaning) Yarn, Thread, Cordage
4630 Colorfastness to Water; Yarn, Thread, Cordage
4632 Colorfastness to Salt Water and Soap; Yarn, Thread, Cordage
4640 Colorfastness to Dry and Wet Heat (Hot Pressing) of Yarn
4650 Crocking Resistance; Yarn, Thread, Cordage
4660 Colorfastness to Light; Yarn, Thread, Cordage; Accelerated Method (Fade-Ometer)
4662 Colorfastness to Light; Yarn, Thread, Cordage; Natural Light Method
4670 Colorfastness to Weather; Yarn, Thread, Cordage; Accelerated Method (Twin Arc Weather-Ometer)
4671 Colorfastness to Weather of Yarn; Accelerated Method (National Weathering Unit)
4672 Colorfastness to Weather; Yarn, Thread, Cordage; Natural Weathering Method
4680 Colorfastness to Perspiration; Yarn, Thread, Cordage; Perspirometer Method
5682 Colorfastness to Perspiration; Yarn, Thread, Cordage; Tube Method
4750 Mildew Resistance; Yarn, Thread, Cordage; Direct Inoculation, Pure Culture, Sterile Specimen Method
4751 Mildew Resistance; Yarn, Thread, Cordage; Direct Inoculation, Pure Culture, Non-Sterile Specimen Method
4752 Mildew Resistance; Yarn, Thread, Cordage, Webbing; Enriched Soil Suspension Method
4756 Mildew Resistance; Yarn, Thread, Light Cordage; Mycelial Mat, Degradation Method
4758 Mildew Resistance; Yarn, Thread, Cordage; Mycelial Mat, Disfiguration Method
4760 Mildew Resistance; Thread, Cordage, Mixed Culture Method
4762 Mildew Resistance; Thread, Cordage, Webbing, Soil Burial Method
5650 Crocking of Cloth; Direct Comparison AATCC Colorist Rating Chart Method
5670 Colorfastness to Weather of Cloth; Accelerated Method (Twin Arc Weather-Ometer)
5682 Colorfastness to Perspiration of Cloth; Tube Method
5751 Mildew Resistance of Cloth; Direct Inoculation, Pure Culture, Non-Sterile Specimen Method

5752 Mildew Resistance of Cloth, Enriched Soil Suspension Method
5756 Mildew Resistance of Cloth, Mycelial Mat, Degradation Method (bottle)
5757 Mildew Resistance of Cloth, Mycelial Mat, Degradation Method (Petri-Dish)
5758 Mildew Resistance of Cloth; Mycelial Mat, Disfiguration Method
5902 Flame Resistance of Cloth; Vertical
5910 Burning Rate of Cloth; 30° Angle

10.4 The following new methods have been included:

2013 Fluorine Content of Textile Materials
2015 Sodium Salt of 5-Chloro-2-[4 Chloro-2-[3-(3, 4 Dichlorophenyl)-Uredio]-Phenoxy] Benzensulfonate Content
2053 Small Amount of Copper and Manganese in Textiles
5309 Abrasion Resistance of Textile Webbing
5320 Pilling Resistance of Textile Fabrics; Brush and Sponge Method
5764 Insect Resistance of Textile Materials
6000 Length of Ten Turns; Cordage
6001 Picks Per Inch; Braided Cordage
6002 Diameter of Cordage
6003 Circumference of Cordage
6004 Length Per Pound; Cordage
6010 Determination of Shrinkage; Cordage; Boiling Water Method
6011 Water Absorption; Cordage
6015 Breaking Strength and Elongation of Cordage; Spliced Specimen Method
6016 Breaking Strength and Elongation of Cordage; Non-Spliced Specimen Method
6020 Hardness; Cordage

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BREAKING STRENGTH, ELONGATION, TENACITY; THREAD, YARN; SINGLE STRAND

1. SCOPE

1.1 This method is intended for determining the breaking strength, elongation, and tenacity of sewing thread and yarns. Single or ply threads and yarns may be tested by this method.

2. TEST SPECIMEN

2.1 The test specimen shall be of sufficient length to mount in the jaws of the apparatus. This distance between the pair of jaws of the apparatus (gage length) shall be 10 inches (25.4 cm) at the beginning of the test.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens shall be tested from each sample unit.

4. APPARATUS

4.1 The machine shall consist of three main parts:

(a) straining mechanism;
(b) clamps for holding specimen;
(c) load and elongation recording mechanism.

4.1.1 Straining mechanism. A machine wherein the specimen is held between two clamps and strained by a uniform movement of the pulling clamp shall be used. Unless otherwise specified in the material specification, the machine shall be adjusted so that the pulling clamp shall have a uniform speed of 12 ± 0.5 inches (30.48 ± 1.27 cm) per minute.

4.1.2 Clamps for holding specimen.

4.1.2.1 Natural fibers. Unless otherwise specified in the material specification, the machine shall have two clamps with two flat-grip type jaws on each clamp. The design of the two clamps shall be such that one gripping sur-

face or jaw may be an integral part of the rigid frame of the clamp or be fastened to allow a slight vertical movement, while the other gripping surface or jaw shall be completely movable. Unless otherwise specified, the dimension of the immovable rear jaw of each clamp shall measure one inch parallel to the application of the load, and the dimension of the jaw perpendicular to this direction shall measure one inch or more. The face of the movable front jaw of each clamp shall measure one inch by one inch (25.4 by 25.4 mm). Each jaw face shall have a flat smooth gripping surface. All edges which might cause cutting action shall be rounded to a radius of not over 1/64 inch (.397 mm). In cases where the specimen tends to slip when being tested, the jaws may be faced with rubber or other material to prevent slippage. Unless otherwise specified, the distance between the jaws (gage length) shall be 10 inches (25.4 cm) at the start of the test.

4.1.2.2 Synthetic fibers. Thread clamps embodying the flat anvil and drum principle with side closing cam, known as Callaway or U. S. Rubber Clamps, shall be used. The gage length shall be 10 inches, (25.4 cm) measured from the bite between the drum and flat jaw of the upper clamp around the periphery of each drum, and to the bite between the drum and flat jaw in the bottom clamp.

4.1.3 Load and elongation mechanism(s). Calibrated dial, scale or chart to indicate applied load and elongation. Unless otherwise specified for load determination, the machine shall be adjusted or set so that the maximum load required to break the specimen will remain indicated on the calibrated dial, scale or chart of autographic recording mechanism.

5. PROCEDURE

5.1 Unless otherwise specified, testing shall be performed on conditioned specimens and under standard conditions in accordance with Section 4 of this Standard. When wet breaking strength is required, it shall be specified in the applicable material specification and the method of wetting the specimen shall also be specified.

5.2 Specimen preparation.

5.2.1 Specimens taken from cop, bobbin, cone, tube, or similar put-up shall be drawn from the side of the package and in such a manner that the twist will not be altered.

5.2.2 If the sample has been previously wound in skein form, the skein shall be mounted on an umbrella reel from which a single end may be drawn.

5.2.3 When the yarn is taken from a woven or knitted cloth, the yarns shall be raveled from cut strips in such a manner that the yarn is not stretched and the twist is not altered.

5.3 Preliminary adjustments.

5.3.1 Prior to testing the operator shall verify that the apparatus has been calibrated in accordance with the procedure required for the make and model being used.

5.3.2 If an autographic mechanism is to be used, it shall be determined by a trial run of the apparatus that it is operating properly. Be sure that the recording pen has an ample supply of ink to avoid depletion of the supply during test.

5.3.3 Check distance between jaws (gage length) and speed of machine to insure they are as required.

5.3.4 Check alignment of jaws in each clamp and also the alignment of clamp with respect to each other.

5.4 Testing.

5.4.1 Initial load. When it is required to determine the elongation of a specimen, an initial load shall be applied to the specimen prior to tightening the second clamp. Unless otherwise specified, in the material specification, the initial load in grams shall be 0.25 grams per tex unit (see 7.1).

5.4.2 Breaking strength. The specimen shall be placed in the jaws of the clamps exercising care to insure that the twist of the specimen is not altered. Force is applied to break the specimen and this force read from the chart, dial or scale is recorded.

5.4.3 Elongation. The elongation of the specimen at any given load shall be determined when the breaking strength is measured for the same specimen. The initial length and, therefore, the measured elongation depend upon the load applied when placing the specimen in the clamps. Place one end of the specimen in a clamp and tighten sufficiently to prevent slipping. Apply the required initial load (see 5.4.1) to the other end of the specimen in such a manner that it does not interfere with tightening of the second clamp

sufficiently to prevent slipping. The elongation will be determined from the chart of the autographic recording mechanism.

5.5 Tenacity. The tenacity of the specimen shall be calculated using the breaking strength and equivalent denier size.

5.6 If a specimen slips between the jaws, breaks in a clamp, or if for any reason attributable to faulty technique, an individual measurement falls markedly below the average test result for the sample unit, such individual measurement shall be disregarded and another specimen shall be tested.

5.7 Calculation. The tenacity of a specimen tested shall be calculated as follows:

$$T = \frac{S}{D}$$

Where: T = Tenacity - $\frac{\text{grams}}{\text{denier}}$

S = Strength - grams

D = Yarn size - denier

or:

$$T = \frac{S_1 \times 453.6 \text{ grams}}{N \times 9.0}$$

Where: T = Tenacity - $\frac{\text{grams}}{\text{denier}}$

S_1 = Strength - pounds

N = Yarn size - tex units

6. REPORT

6.1 Unless otherwise specified in the material specification, the breaking strength of a sample unit shall be the average of the specimens tested. Individual values used to calculate the average shall also be reported. All values shall be reported to the nearest 0.1 pound.

6.2 Unless otherwise specified in the material specification, the elongation shall be determined and reported at the point of rupture of the specimen. It shall be reported as the percent elongation of the specimen tested and shall be calculated from the curve drawn on the autographic recording mechanism. The elongation of a sample unit shall be the average of specimens tested and shall be reported to the nearest 1.0 percent. Individual values used to calculate the average shall also be reported.

6.3 Tenacity. The tenacity of a sample unit shall be the average of the specimens tested. Individual values used to calculate the average shall also be reported.

7. NOTES

7.1 The Tex system for measuring the linear density of yarns is a direct system based on mass per unit length and employs metric units of length and weight. The Tex unit, grams per kilometer (1000 meters) may be calculated from other numbering systems as follows:

$$\text{Yarn Number in Tex Units} = \frac{310.034}{\text{wool run number}}$$

$$= \frac{590.541}{\text{cotton hank number}}$$

$$= \frac{885.812}{\text{worsted hank number}}$$

$$= \frac{1653.52}{\text{linen lea number}}$$

$$= \frac{1653.52}{\text{wool cut number}}$$

$$= \frac{\text{denier}}{9.0}$$

Example: Cotton hank number = 60 s

$$\text{Tex unit size} = \frac{590.541}{60} = 9.842$$

BREAKING STRENGTH; THREAD AND YARN; SKEIN METHOD

1. SCOPE

1.1 This method is intended for determining the breaking strength of single or plied thread and yarns in skein form.

2. TEST SPECIMEN

2.1 Unless otherwise specified in the material specification, the specimen shall be a skein containing 120 yards (109.7 m).

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, four specimens shall be tested from each sample unit.

4. APPARATUS

4.1 The machine shall consist of three main parts:

(a) straining mechanism;
(b) spools for holding specimen (skein);
(c) load and elongation recording mechanism(s).

4.1.1 Straining mechanism. A machine wherein the specimen is held by two spools and strained by a uniform movement of the pulling clamp shall be used. Unless otherwise specified in the material specification, the machine shall be adjusted so that pulling clamp shall have a uniform speed of 12 ± 0.5 inches (30.48 ± 1.27 cm) per minute.

4.1.2 Spools for holding the specimen. The spools for holding the specimen shall be cylindrical, with a diameter not less than one inch, a length of not less than one inch and shall be so supported that at least one spool can turn freely on its axis. The distance between the spools at the start of the test shall be just sufficient to allow the skein to be placed on the spools in a wide flat band.

4.1.3 Load recording mechanism. Calibrated dial, scale or chart to indicate applied load and elongation. Unless otherwise specified for load determination, the machine shall be adjusted or set so that the maximum load required to break the specimen will remain indicated on the calibrated dial, scale or chart of autographic recording mechanism.

4.2 Yarn reel. A reel having a perimeter of 1.5 yards (137.16 cm), accurate to ± 0.1 percent equipped with means to record length, apply tension and spread yarn evenly on the reel.

5. PROCEDURE

5.1 Unless otherwise specified, this test shall be performed on thread and yarn conditioned in accordance with Section 4 of this Standard. Conditioning can be performed either before or after reeling, but it will be accomplished quicker if the specimens are conditioned in skein form.

5.2 Specimen preparation.

5.2.1 For thread and yarn wound on cones, bobbins, cops, small flanged spools or tubes, the specimen shall be drawn from the top of the package at a speed of 100 to 300 revolutions per minute of the reel. The thread or yarn shall be passed through the guides in such a way that the tension in the running thread or yarn is sufficient to straighten it, but not high enough to cause serious stretching. If the reel has only one pigtail guide per skein, tension shall be applied by taking one full wrap around the guide. If the reel has two or more guides, the thread or yarn shall pass straight through the guides onto the reel, the angle of the guides supplying the necessary tension.

5.2.2 For packages such as large flanged spools, large tubes, certain warp-wound bobbins or similar put-up, the yarn shall be drawn from the side at a speed of 20 to 30 revolutions per minute of the reel. If the reel has two or more guides, the yarn shall pass straight through to the reel. Judgement must be used in applying tension on yarns having a small or large amount of twist.

5.2.3 If the sample has been previously wound in skein form, the skein shall be mounted on an umbrella reel from which a single end may be drawn, and passed through the guides onto the reel used to prepare the specimen for test, the angle of the guides supplying the necessary tension.

5.2.4 The finishing end of the skein shall be tied to the starting end of the skein using a square knot and in such a manner that will not add length to the skein.

5.3 Preliminary adjustments.

5.3.1 Prior to testing the operator shall verify that the apparatus has been calibrated in accordance with the procedure required for the make and model being used.

5.3.2 If an autographic mechanism is used, it shall be determined by a trial run of the apparatus that it is operating properly. Be sure that the pen has an ample supply of ink to avoid depletion of the supply during test.

5.3.3 Check the speed of the machine to insure that it is as required and check alignment of spools with respect to each other.

5.4 Testing.

5.4.1 Transfer the skein from the reel to the test apparatus (spools of machine) handling carefully. Keep the thread or yarn of the specimen parallel and the skein flat with no bunching or twisting. Do not stretch or jerk the thread or yarn and do not allow to kink.

5.4.2 When mounting a specimen that has a tendency to curl, the specimen may be held taut and in place by hand until the machine is started and the pulling spool removes the slack from the skein.

5.4.3 Force is applied to break the specimen and this force read from the chart, dial or scale is recorded.

6. REPORT

6.1 The breaking strength of the sample unit shall be the average of the specimens tested and shall be reported to the nearest 0.5 pound.

6.2 Individual values used to calculate the average shall also be reported.

BREAKING STRENGTH AND ELONGATION; TEXTILE WEBBING, TAPE AND BRAIDED ITEMS

1. SCOPE

1.1 This method is intended for determining the breaking strength and elongation of textile webbing, tape and braided items.

2. TEST SPECIMEN

2.1 The specimen shall be a single length of 54 inches (137.2 cm) and the full width of the material as received.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified, in the material specification five specimens shall be tested from each sample unit.

4. APPARATUS

4.1 The machine shall consist of three main parts:

(a) Straining mechanism
(b) Clamps
(c) Load and elongation recording mechanism(s)

4.1.1 Straining mechanism. A machine wherein the specimen is held by two clamps and subjected to strain by a uniform movement of the pulling clamp.

4.1.1.1 Unless otherwise specified the machine shall be adjusted so that the pulling clamp shall have a uniform speed of 3.0 ± 1.0 inches (7.62 ± 2.54 cm) per minute.

4.1.2 Clamps

4.1.2.1 Split drum. Unless otherwise specified the machine shall have

two clamps, split drum type as Figure 4108 and the distance between the clamps (gage length) shall be 10 ± 1/2 inches (25.4 ± 1.27 cm) center to center.

4.1.2.2 Flat surface clamps. When clamps are specified other than split drum type the machine shall have two clamps with two jaws on each clamp. Each jaw face shall have a flat, smooth gripping surface. The design shall be such that one gripping surface or jaw may be an integral part of the rigid frame of the clamp or be fastened to allow a slight vertical movement while the other gripping surface or jaw shall be completely movable. Unless otherwise specified the dimension of the jaws parallel to the application of the load shall measure one inch and the dimension of the jaws perpendicular to this direction shall be greater than width of the specimen being tested. All edges which might cause a cutting action shall be rounded to a radius not greater than 1/64 inch (.397 mm). In cases where the specimen tends to slip when being tested the jaws may be faced with rubber or other material. Unless otherwise specified the distance between the jaws (gage length) shall be 10 ± 1/2 inches (25.4 ± 1.27 cm).

4.1.3 Load recording mechanism(s). Calibrated chart, dial or scale to indicate applied load. Unless otherwise specified for load determination, the machine shall be adjusted or set so that the maximum load required to break the specimen shall remain indicated on the calibrated chart, dial or scale after the specimen has ruptured.

4.1.4 Capacity. The machine shall be of such capacity that the maximum load required to break the specimen shall be not greater than 85 percent or less than 15 percent of the rated capacity.

4.1.5 Machine efficiency. The error of the machine shall not exceed 2 percent for loads up to and including 50 pounds (22.67 kg) and shall not exceed 1 percent for loads greater than 50 pounds (22.67 kg).

5. PROCEDURE

5.1 Preparation of specimen

5.1.1 Unless otherwise specified, the specimens tested shall be conditioned and tested under standard conditions in accordance with Section 4 of this Standard.

5.1.2 When it is required that the elongation of the specimen shall be deter-

mined, two fine ink marks shall be placed on the specimens spaced five inches (12.7 cm) apart. The marks shall be placed in such a manner that neither mark is closer than 1 1/2 inches (3.81 cm) to each clamp when the specimen is mounted in the clamps.

5.2 The specimen shall be placed in the clamps of the machine with the long dimension parallel to the application of the load. When measurement of elongation is required a slight tension or a specific load required by the applicable specification shall be applied to the specimen as it is placed in the clamps and the two, fine ink marks shall not be closer than 1 1/2 inches (3.81 cm) to either clamp.

5.3 Breaking strength. Force shall be applied to the specimen at such a rate that the clamp through which the force is applied will move at a rate of 3.0 ± 1.0 inches (7.62 ± 2.54 cm) per minute until the specimen is ruptured. After rupture of the specimen, the breaking load shall be read from the dial, scale or chart and the value recorded.

5.4 Elongation. Elongation shall be determined on the same specimen being tested for breaking strength. The equipment will be stopped and the distance between the two fine ink marks measured with calipers at the load level specified in the applicable specification and recorded.

5.5 If a specimen slips between the clamps, breaks in or at the edges of the clamps, or if for any reason attributable to faulty technique, an individual measurement falls markedly below the average test result for the sample unit, such result shall be discarded and another specimen shall be tested.

6. REPORT

6.1 The breaking strength of the sample unit shall be the average of the results obtained from the five specimens tested and shall be reported to the nearest 1 pound for 500 pounds or less and to the nearest 5 pounds for values over 500 pounds.

6.2 The elongation of the sample unit shall be the average of the specimens tested and shall be reported to the nearest 1.0 percent. The report shall state that the elongation was measured at break or at the load specified.

6.3 The individual values used to arrive at the averages shall also be reported.

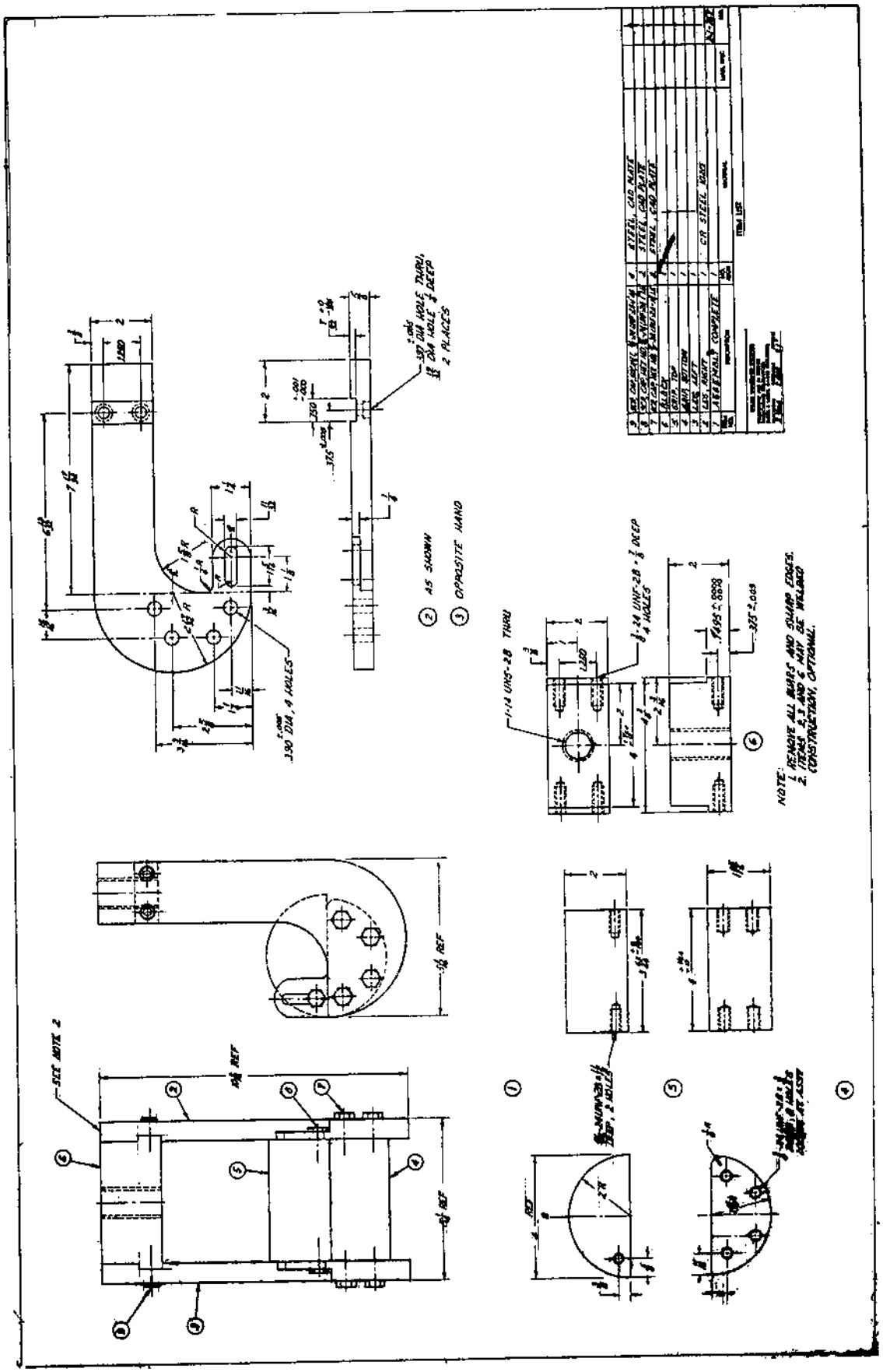

FIGURE 4108 - Test jaws for high strength textiles, assembly complete.

CRIMP IN YARNS FROM CLOTH; DEAD-LOAD METHOD

1. SCOPE

1.1 This method is intended for determining the crimp in yarns after they have been removed from cloth. This method is considered adequate for normal inspection work, requiring less time to perform than method 4112.

2. TEST SPECIMEN

2.1 The specimen shall be a yarn removed from a 14-inch (35.56 cm) length of cloth.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens in each of the warp and filling directions shall be tested from each sample unit.

4. APPARATUS

4.1 Twist tester equipped with a yarn-loading or similar device, which can apply a load within an approximate range of 0 to 300 grams.

4.2 Fifteen inch (38.1 cm) (minimum) rule graduated in 1/16 inch (1 mm) divisions.

4.3 Pen or other suitable device for marking the cloth.

5. PROCEDURE

5.1 Unless otherwise specified, the specimens tested shall be conditioned and tested under standard conditions in accordance with Section 4 of this Standard.

5.2 Specimen Preparation. A length of 14 inches (35.56 cm) shall be cut from the cloth parallel to the yarn to be tested. Tearing of the cloth to obtain a straight edge shall not be permitted. Several yarns shall be

raveled from the cloth along the cut edge to remove any severed or damaged yarns. Two parallel lines 10 inches (25.4 cm) apart (original length) shall be marked on the cloth. A yarn passing through these marks shall be raveled for a distance of about 2 inches (5.08 cm) beyond each mark, care being taken to avoid untwisting or stretching the yarn. At least three bobbin areas shall be included in the specimens prepared from the filling direction of the cloth. Generally specimens taken from the ends and center of a yard of cloth will include three bobbin areas.

5.3 The specimen shall be mounted in the twist tester with the jaws set 10 inches (25.4 cm) apart. The marked points shall be placed at the edges of the two jaws. A load shall be applied to the yarn just sufficient to remove the crimp when the yarn is examined visually or with the aid of a lens. The tension shall be applied slowly to avoid an impact loading. The total distance between the marks (jaws) shall be measured.

5.4 An indication of the necessary load in grams may be obtained by dividing a constant (K) by the single equivalent yarn number. In the cotton system 840 yards/pound K = 156. In the Tex system, 0.25 grams/Tex unit load shall be applied to the specimen being tested.

5.5 Calculation of results.

5.5.1 $$\text{Crimp, Percent} = \frac{\text{Distance between the marks on the straightened yarn} - 10}{10} \times 100$$

OR

$$\text{Crimp, Percent} = \frac{\text{Distance between the marks on the straightened yarn} - 25.4 \text{ cm}}{25.4 \text{ cm}} \times 100$$

6. REPORT

6.1 The crimp of the sample unit shall be the average of the results obtained from the specimens tested in each of the warp and filling directions respectively and shall be reported separately to the nearest 0.1 percent.

6.2 The individual values used to arrive at the average shall also be reported.

CRIMP IN YARNS FROM CLOTH; LOAD-ELONGATION METHOD

1. SCOPE

1.1 This method is intended for determining the crimp in yarns that have been removed from cloth. It is considered preferable for use where a higher degree of accuracy is desired thar that obtained by using Method 4110, but is more time consuming.

2. TEST SPECIMEN

2.1 The specimen shall be a yarn removed from a 14-inch (35.56 cm) length of cloth.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens in each of the warp and filling directions shall be tested from each sample unit.

4. APPARATUS

4.1 Single-thread strength tester equipped with flat-type jaws, suitable for determining the breaking strength of the yarns. Drum clamps or similar type clamps shall not be used.

4.1.2 Suitable autographic recording device and charts.

5. PROCEDURE

5.1 Unless otherwise specified, the specimens tested shall be conditioned and tested under standard conditions in accordance with Section 4 of this Standard.

5.2 Specimen Preparation. A length of 14 inches (35.56 cm) shall be cut from the cloth parallel to the yarn to be tested. Tearing of the cloth to obtain a straight edge shall not be permitted. Several yarns shall be raveled from the cloth along the cut edge to remove any severed or damaged yarns. Two parallel lines 10 inches (25.4 cm) apart (original length) shall be marked

on the cloth. A yarn passing through these marks shall be raveled for a distance of about 2 inches (5.08 cm) beyond each mark, care being taken to avoid untwisting or stretching the yarn. At least three bobbin areas shall be included in the specimens prepared from the filling direction of the cloth. Generally, specimens taken from the ends and center of a yard of cloth will include three bobbin areas.

5.3 The specimen shall be placed in the clamps of the machine which are 10 inches (25.4 cm) apart at the start of the test. The marked spots on the specimen shallcoincide with nips at the clamps, care being taken to avoid untwisting of the yarn. Sufficient tension shall be applied to the specimen to stretch or, if desired, break the specimen.

5.3.1 When an inclined plane type machine is used, impact loading caused by sudden movement of the carriage shall be minimized by removing the slack from the specimen prior to application of the load. This may be accomplished by manually controlling the descent of the carriage as the angle of the inclined plane increases until the instant the slack is removed from the specimen.

5.4 A load-elongation diagram shall be obtained on the autographic recording device for the specimen, and the extension due to crimp measured from the diagram as follows:

5.4.1 In the load-elongation diagram of a cotton yarn, Figure 4112, the region of the curve (AD) represents the removal of the crimp and the initial stretch of the yarn; and the straight region (DE) represents the elastic (stretch) region of the specimen. A line (DC) shall be drawn through the lower portion representing the elastic portion of the curve intersecting the line AX at C. The distance AC is the crimp in the specimen.

5.4.2 If required, the tension necessary to straighten the yarn to its length before weaving shall be determined as follows:

A line perpendicular to AX shall be passed through point C to intersect AD at B. The distance CB (AL) shall represent the required tension. (Figure 4112).

5.5 Calculation of results.

5.5.1 The crimp shall be calculated as follows:

$$\text{Crimp Percent} = \frac{\text{distance AC, inches}}{10} \times 100$$

OR

$$\text{Crimp Percent} = \frac{\text{distance AC, centimeters}}{25.4 \text{ cm}} \times 100$$

6. REPORT

6.1 The crimp of the sample unit shall be the average of the results obtained from the specimens tested in each of the warp and filling directions respectively and shall be reported separately to the nearest 0.1 percent.

6.2 The individual values used to arrive at the average shall also be reported.

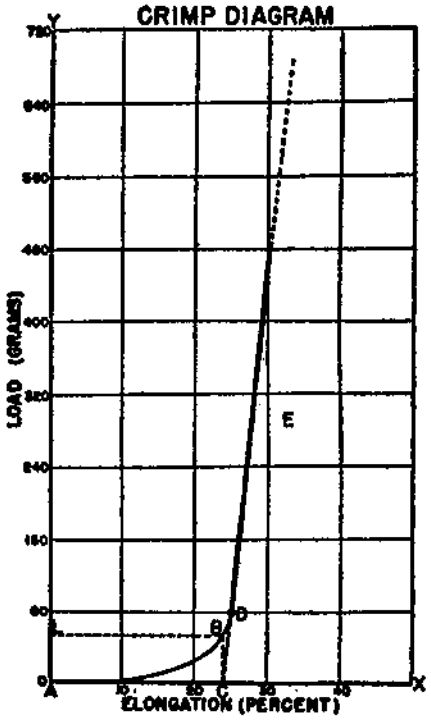

FIGURE 4112

ABRASION RESISTANCE OF YARN, THREAD, AND LIGHT CORDAGE; UNIFORM-ABRASION (SCHIEFER) METHOD

1. SCOPE

1.1 This method is intended for determining the resistance to abrasion of dry and wet yarns, threads, and light cordage. It is applicable to products which vary in fiber content, construction, finishing or coating treatment, and kind or amount of auxiliary substances.

2. TEST SPECIMEN

2.1 The specimen shall be a continuous length of the product threaded in the clamp described in 4.1.4 to form a series of short loops on the circumference of the four concentric circles.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, six specimens shall be tested from each sample unit.

4. APPARATUS

4.1 Abrasion machine, figure 4308A, consisting of abrading mechanism, specimen supporting mechanism, and driving mechanism. Essentially, the surface of the abradent lies in a plane parallel to the plane surface supporting the specimen and presses upon the specimen. The abradant and specimen rotate in the same direction at very nearly but not quite the same angular velocity, 250 r.p.m., on noncoaxial axes which are parallel to 0.001 inch (.254 mm). The small difference in speed is to permit each part of the specimen to come in contact with a different part of the abradant at each rotation.

4.1.1 The abrading mechanism included the abradant (letter A, figure 4308A) mounted at the lower end of a shaft; weights placed upon the upper end of the shaft to produce constant pressure between abradant and specimen throughout the test; lever and cam for raising and lowering the abradant; shaft; and weights (letter B, figure 4308A). A counter-weight for balancing the abradant shaft is used when tests are to be carried out at low pressure.

4.1.2 The driving mechanism consists of a motor-driven auxiliary drive shaft connected to the abradant-shaft and specimen-shaft by spur gears.

4.1.3 The machine is equipped with a resettable counter, G in figure 4308A, to indicate the number of rotations in a test.

4.1.4 The clamp shall consist of a circular plastic plate 2 10/16 inches (66.67 mm) in diameter and 9/16 inch (14.28 mm) high with holes arranged in four concentric circles for supporting the yarn, thread or cordage during abrasion, as shown in figure 4308B. It shall permit simultaneous exposure to abrasion of 54 portions of the specimen. Pins on the periphery of the plate shall be provided for fastening the ends of the specimen after threading. An aluminum disk shall be screwed to the bottom of the plate to hold the individual lengths of the specimen in position. For wet abrasion tests a soft rubber gasket shall be inserted between this aluminum disk and the bottom of the plate to prevent leakage of water from the holes at the bottom of the plate.

5. PROCEDURE

5.1 Unless otherwise specified in the material specification, the load of the abradant of the specimen shall be one pound (453.6 grams).

5.2 Unless otherwise specified in the material specification, the spring steel blade abradant shall be used.

5.2.1 The abradant shall be wiped off with carbon tetrachloride or other suitable solvent after each test to prevent the accumulation of finishing material on the blades.

5.3 Preparation of the specimen. The yarn, thread, or cord shall be threaded through the holes of the plastic plate, going around the plate in a counter-clockwise direction, starting at all times at the same hole of the outer circle. Moderate tension during threading shall be applied by hand.

5.3.1 The loops shall be oriented with respect to each other at angles differing by equal increments in the range from 0° to 360°.

5.3.2 In wet abrasion tests the specimen mounted in the plate is thoroughly wet by immersion in water prior to inserting the plate in the machine. The plate is then mounted in the machine and the surface is flooded with an excess of water. After each 1000 rotations of abrasion, or as specified, the machine is stopped and the surface of the plate flooded with an excess of water.

5.4 A test shall be carried out as follows: mount the specimen in the clamp taking care that it is clamped evenly and securely without distortion; place the specimen assembly in position in the machine, and lower the abradant on the specimen by rotating the upper cam; set the counter at zero and start the machine.

5.5 The test shall be continued for the required number of rotations of abrasion or until the specimen is to be inspected. The machine shall be stopped, the abradant raised by the upper cam, and the clamp and specimen removed from the machine.

5.6 The specimen shall be inspected or measured as required in the material specification without removing it from the clamp. Replace the assembly in the machine and continue the test, repeating the inspection at intervals as required.

5.7 Evaluation.

5.7.1 Unless otherwise specified in the material specification, the end point of abrasion shall be the number of rotations of the abradant relative to the specimen necessary to wear through 27 of the 54 exposed portions of the specimen.

5.7.1.1 The machine shall be stopped periodically for inspection of the abraded portions of the specimen. The number of loops completely worn through shall be noted at each stop. The cumulative frequency of worn loops shall be plotted against the number of rotations and the number of rotations corresponding to 27 worn loops shall be obtained from the plotted graph.

6. REPORT

6.1 Unless otherwise specified in the material specification, the abrasion resistance of the sample unit shall be the average of the number of rotations obtained from the specimens tested and shall be averaged to the nearest 10 rotations.

6.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

7. NOTES

7.1 An abrasion machine and clamp of the type described in this method are manufactured by Frazier Precision Instrument Company, Inc., 210 Oakmont Avenue, Gaithersburg, Maryland 20760.

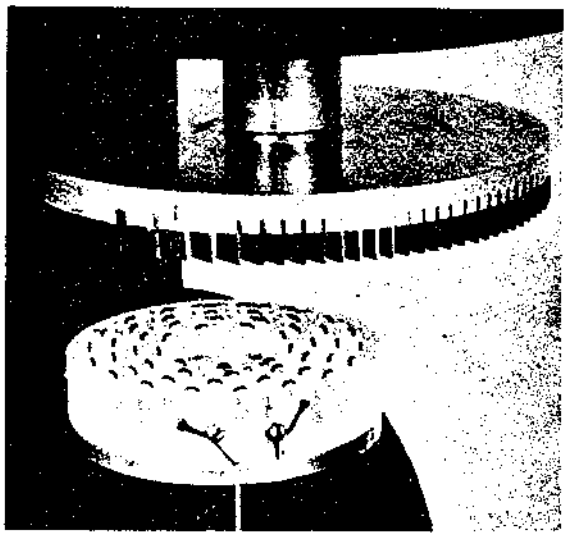

FIGURE 4308B

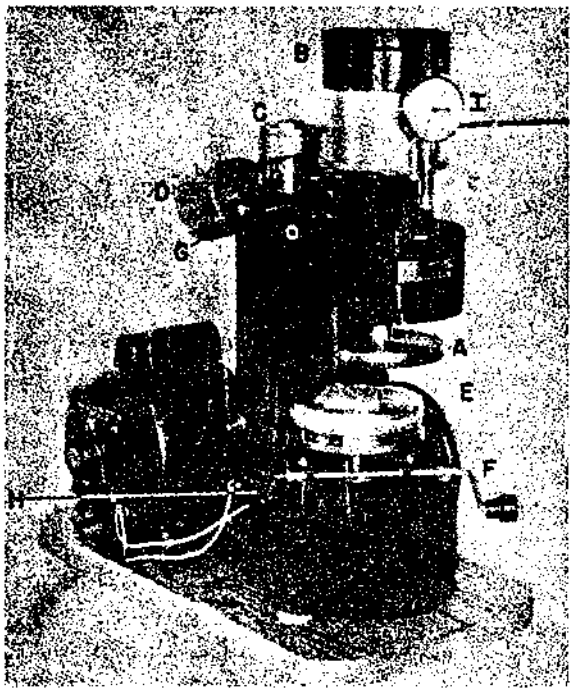

FIGURE 4308A - Schiefer abrasion testing machine.

A Abradant
B Weights on abradant shaft
C Cam and lever system for raising the abradant shaft, abradant, and weights
D Counterweight for balancing abradant and abradant shaft when tests are to be made at low pressures
E Specimen in place ready for test
F Cam for raising and lowering the speciman clamp seat
G Counter
H Microswitch
I Thickness gage

4. APPARATUS

4.1 Unless otherwise specified in the material specification, the apparatus shall be as applicable.

4.1.1 Woven and knitted materials, felts, nonwovens. Gage of the dead-weight type equipped with a dial graduated to read directly to 0.001 inch (.0254 mm). The presser foot shall be circular, with a diameter of 1.129 inches ± 0.001 inch (28.6 mm ± .0254 mm) and with the moving parts connected therewith weighted to apply a total load of 0.60 ± 0.03 pound per square inch to the specimen. The anvil shall be not less than 1.129 inches (28.6 mm) in diameter. The presser foot and anvil surface shall be plane to within 0.0001 inch (.00254 mm) and shall be parallel to each other to within 0.0001 inch (.00254 mm).

4.1.2 Coated cloths, narrow cloths, webbings, ribbons and braids. Gage of the dead-weight type equipped with a dial graduated to read directly to 0.001 inch (.0254 mm). The presser foot shall be circular with a diameter of 0.375 inch ± 0.001 inch (9.525 mm ± .0254 mm) and with the moving parts connected therewith weighted to apply a total load of 3.4 ± 0.1 pounds per square inch to the specimen. The anvil shall be not less than 1.129 inches (28.6 mm) in diameter. The presser foot and anvil surface shall be plane to within 0.0001 inch (.00254 mm) and shall be parallel to each other to within 0.0001 inch (.00254 mm).

4.1.3 Films, glass cloths, and tapes. Gage of the dead-weight type equipped with a dial graduated to read directly to 0.001 inch (.0254 mm). The presser foot shall be circular with a diameter of 0.250 inch ± 0.001 inch (6.350 mm ± .0254 mm), and with the moving parts weighted to apply a total load of 25 ± 2 pounds per square inch to the specimen. The anvil shall be not less than 0.250 inch (6.350 mm) in diameter. The presser foot and anvil surface shall be plane to within 0.0001 inch (.00254 mm) and shall be parallel to each other to within 0.0001 inch (.00254 mm). The micrometer shall be capable of repeating its readings to 0.00005 inch (.00127 mm) at zero setting or on a steel gage block.

4.1.4 Blankets, pile, or napped cloths. Gage of dead-weight type equipped with a dial graduated to read directly to 0.001 inch (.0254 mm). The presser foot shall be circular with a diameter of 1.129 ± 0.001 inches (28.6 ± .0254 mm), and with the moving parts connected therewith weighted to apply separate total loads of 0.1 ± 0.01 pounds per square inch

DETERMINATION OF THICKNESS OF TEXTILE MATERIALS

1. SCOPE

1.1 This method is intended for determining the thickness of woven and knitted cloths, nonwovens, felt, blankets, pile and napped cloths, narrow cloths, webbings, ribbons, braids, coated cloths, films, glass cloths and tapes.

2. TEST SPECIMEN

2.1 The specimen shall be a piece of material at least as large as the presser foot of the thickness gage, and shall be free of folds, creases, knots, or other distortions which are not representative of the material surface. When possible, no selvage shall be included in the sample tested. If the specimen is much larger than the anvil, the specimen shall be supported around the anvil and at the same height as the anvil to avoid distortion of the specimen, thereby raising the presser foot above its proper plane.

2.1.1 For narrow cloths and webbings, the specimen shall be the full width of the material. For ribbons and tapes, when one width of the material does not present a specimen as large as the presser foot, several lengths of the material shall be placed adjacent and parallel.

2.1.2 For films, glass cloths, and tapes, the specimen shall be of sufficient size to insure that all points on the periphery of the presser foot shall be at least 1/4 inch (6.35 mm) from the edge of the specimen.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, five specimens shall be tested from each sample unit.

and 1.1 ± 0.03 pounds per square inch to the specimen. The anvil shall be not less than 1.129 inches (28.6 mm) in diameter. The presser foot and anvil surface shall be plane to within 0.0001 inch (.00254 mm) and shall be parallel to each other to within 0.0001 inch (.00254 mm).

5. PROCEDURE

5.1 Unless otherwise specified, all tests shall be performed on conditioned material as specified in Section 4.

5.2 All materials except films. The specimen shall be placed face up on the anvil of the gage, smoothly, but without tension. The presser foot shall be lowered onto the specimen gradually and without impact, and allowed to rest there for 10 seconds. The dial reading shall then be taken to the nearest 0.001 inch (.0254 mm).

5.2.1 For narrow cloths and webbings, readings shall be taken along the centerline of the specimen.

5.3 Films, glass cloths and tapes. The specimen shall be placed between the micrometer surfaces, and the presser foot lowered onto the specimen at a location outside the area to be measured. The presser foot shall be raised a distance of 0.0003 to 0.0004 inches (.0076 to .0102 mm), the specimen moved to the measurement position, and the presser foot then dropped onto the specimen. The presser shall be allowed to rest there for a minimum of 5 seconds. The dial reading shall then be taken to the nearest 0.001 inch (.0254 mm).

6. REPORT

6.1 All materials except film, glass cloth and tapes. The thickness of the sample unit shall be the average of the results obtained from the specimens tested, and shall be reported to the nearest 0.001 inch (.0254 mm).

6.2 Films, glass cloth, tapes. The thickness of the sample unit shall be the average of the results obtained from the specimens tested, and shall be reported to the nearest 0.0001 inch (.00254 mm).

6.3 Each individual value for each individual specimen used to calculate the average shall also be reported.

7. NOTES

7.1 Apparatus of the type described in this method may be obtained from:

B. C. Ames Co., Lexington Street, Waltham, Mass. 02154.

Custom Scientific Instruments, Inc., 13 Wing Drive, Whippany, N. J. 07981.

Federal Products Corp., 1144 Eddy Street, Providence, R. I. 02901.

Frank E. Randall Co., 248 Ash Street, Waltham, Mass. 02154.

Testing Machines, Inc., 400 Bayview Avenue, Amityville, Long Island, New York 11701.

Frazier Precision Instrument Co., Inc., 210 Oakmont Avenue, Gaithersburg, Maryland 20760.

American Instrument Co., Inc., 8030 Georgia Avenue, Silver Spring, Maryland 20910.

STIFFNESS OF CLOTH, DRAPE AND FLEX; CANTILEVER BENDING METHOD

1. SCOPE

1.1 This method is intended for determining the drape stiffness (bending length) and flex (flexural rigidity) of cloth by employing the principle of cantilever bending of the cloth under its own weight. It is especially applicable where cloths are to be tested at extreme temperatures as well as at standard conditions. This method is not considered suitable for testing knitted cloths or very soft lightweight woven cloths. The method is not recommended for cloths when the specimen twists more than 45 degrees. Method 5200 is preferred for cloths in which the specimen twists for more than 45 degrees.

2. TEST SPECIMEN

2.1 The test specimen shall be a rectangular strip of cloth 6.00 ± 0.05 inches (152.4 ± 1.27 mm) long and 1 inch (25.4 mm) wide, prepared as described in 5.2.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, five specimens from each of the warp and filling directions shall be tested from each sample unit.

4. APPARATUS

4.1 The apparatus shall consist essentially of a horizontal platform, an indicator, a weight or specimen clamp, scale, and pointer, as shown in figure 5206.

4.1.1 The horizontal platform shall be not less than 1 1/2 by 6 inches (38.1 by 152.4 mm) in area and has a smooth, low-friction, flat surface such as polished metal or plastic. A leveling bulb or other means for determining that the platform is horizontal before conducting a test shall be incorporated in the platform.

4.1.2 The indicator is inclined at an angle of 41 1/2 degrees below the plane of the surface of the platform. This should consist of 2 guidelines not less than 1 1/4 inches (31.75 mm) apart, so that the tip of the specimen can pass between them. It may be formed by the end of a hollow stand on which the horizontal platform is mounted. A rectangular opening in the sloped end of the hollow stand makes it possible to measure cloths which twist when cut into strips. The length depends on the range of stiffness to be measured. The apparatus may be designed with a longer indicator than is necessary for a 6-inch (152.4 mm) specimen, or an extension may be used.

4.1.3 The weight consists of a metal bar not less than 1 by 6 inches (25.4 by 152.4 mm) in area and about 1/8 inch (3.175mm) thick. In conducting the test, the weight is placed on the specimen so that the leading edges of the specimen and bar coincide and slide out with the specimen.

4.1.4 A specimen clamp consists of a flat metal base plate 1 inch (25.4 mm) wide and approximately 8 inches (203.2 mm) long with a reference line or pointer located 6 inches (152.4 mm) from the leading edge and at right angles to the long dimension, and a flat metal spring for holding the specimen against the base plate. A hand grip for moving the specimen and clamp along the top surface of the horizontal platform may be used (see figure 5206).

4.1.5 The scale and pointer are provided for measuring the overhang of the specimen. The scale may be attached to the platform and the pointer to the weight or specimen holder. The scale should be a 6 inch (152.4 mm) scale with 0.1 inch (1 mm) graduation coincident with the leading edge or edge of the indicator when attached to the platform.

4.2 Analytical or calibrated balance.

5. PROCEDURE

5.1 Unless otherwise specified, all tests shall be performed under standard conditions in accordance with Section 4 of this Standard.

5.1.1 Unless otherwise specified in the material specification, the face side of the cloth shall be on the outside of the curvature when tested.

5.2 Preparation of specimen. The long dimension of the cloth shall be parallel to the warp direction for warp tests and parallel to the filling direction for filling tests. For some material, a longer specimen may be required to obtain a satisfactory reading on the apparatus (see 5.6). The specimen shall be accurately cut from a smooth area of the cloth which has not previously been folded or deformed in any manner. The specimen should be handled as little as possible both before and during the test.

5.3 The apparatus shall be on a table in such a manner that the platform and inclined reference lines are level and at eye height.

5.4 When a specimen clamp is used, the specimen shall be placed lengthwise in the clamp with the side up that is to be tested, so that the clamped end of the specimen is exactly even with the reference line on the base of the clamp. With the normal 6 inch specimen, the alignment may alternately be made by adjusting the specimen so that the free end of the specimen and the front end of the clamp coincide. The specimen clamp and specimen shall be placed on the platform so that the reference line on the clamp coincides with the zero point on the scale.

5.5 When the weight is used, the specimen shall be placed on the platform with the weight on top of it so that the leading edges coincide.

5.6 The clamp or weight together with the specimen shall be moved slowly and steadily against the ruler or pointer until the bottom of the free edge of the specimen drops to the 41-1/2 degree indicator when viewed parallel to the surface of the slope or guide lines. A reading shall be taken from the scale to the nearest 0.05 inch.. For a 6-inch specimen this is the overhang of the specimen. For a longer specimen, the length in excess of 6 inches is added to the scale reading to obtain the length of overhang.

5.6.1 If the specimen has a slight tendency to twist, the reading shall be taken when the midpoint of the leading edge is at the 41-1/2 degree angle.

5.7 When the 6-inch specimen does not bend sufficiently to permit a reading, a longer specimen (see 5.2) shall be used. When the longer specimen is used, it is necessary to increase the length of the indicator sufficiently

to accommodate the longer specimen.

5.8 Determination of weight of cloth (ounces per square yard). The specimen shall be weighed to the nearest 0.01 gram on an analytical balance or directly on a calibrated balance.

5.9 Calculation of results.

5.9.1 Weight per square yard, ounces = $\frac{\text{weight of specimen in gm x 36in/yd x 36in/yd}}{\text{area of specimen in sq. in. x 28.35 gms/oz}}$

5.9.2 The drape stiffness (bending length), c, inches shall be one-half of the length of the overhang of the specimen when it reaches the 41-1/2 degree slope.

Drape stiffness, c, centimeters = Drape stiffness, inches x 2.54

5.9.3 Flex stiffness (flexural rigidity), G, in inch-pounds shall be calculated as follows:

$$G = c^3 \times w \times 0.482 \times 10^{-4}$$

Where: c = Drape stiffness, inches, (see 5.9.2)
w = Weight of cloth in ounces per sq. yd., (see 5.8 and 5.9)

Flex stiffness, G, milligram-centimeters = G, inch-pounds x 1.152×10^6

6. REPORT

6.1 Unless otherwise specified in the material specification, the drape or flex stiffness of the sample unit shall be the arithmetic average of the results obtained from the specimens tested in each of the warp and filling directions, and shall be reported separately.

6.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

6.1.2 When a single drape or flex stiffness value for combined warp and filling directions is specified in the material specification, it shall be reported as the geometric mean of the two arithmetic averages for the warp and filling directions as follows:

$$G_o = G_w \times G_f$$

G_o = Overall drape or flex stiffness.

G_w = Average warp drape or flex stiffness.

G_f = Average filling drape or flex stiffness.

6.2 Drape stiffness of the sample unit shall be reported to the nearest 0.01 inch.

6.3 Flex stiffness of the sample unit shall be reported to the nearest 0.1×10^{-4} inch-pound.

7. NOTES

7.1 A Drape-Flex Stiffness Tester of the type shown in Figure 5206 may be purchased from J. J. Press, 5788 Eldergardens Street, San Diego, California. 92120.

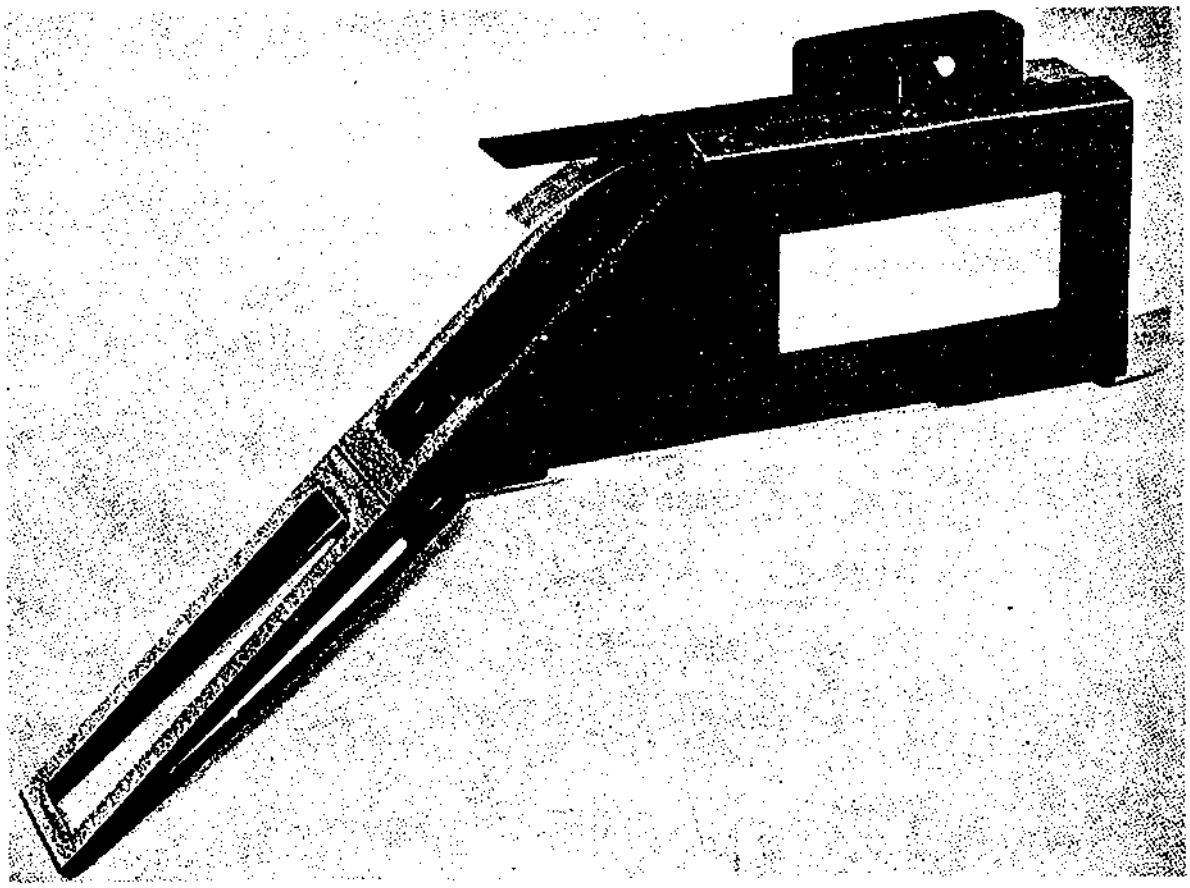

FIGURE 5206 - Stiffness tester.

ABRASION RESISTANCE OF CLOTH; UNIFORM ABRASION (SCHIEFER) METHOD

1. SCOPE

1.1 This method is intended for determining the resistance to abrasion of cloths of all kinds. The abrasive action is applied uniformly in all directions in the plane of the surface of the cloth about every point in it. The settings of the machine; method of mounting specimens; conditions of test as dry or wet; and criteria to be used in evaluating abrasive wear in the test depend upon the nature of the cloth to be tested and use to be made of the results. These details as well as requirements for abrasion resistance should be specified in all specifications calling for the use of the method. Only a general description of the equipment and procedures is given here (see 7.1).

2. TEST SPECIMEN

2.1 A circle of cloth 2.41 inches (61.2 mm), 3.41 inches (86.6 mm), or 3.81 inches (96.8 mm) in diameter or a cross cut from the cloth with arms 2 inches (50.8 mm) wide and 4.5 inches (114.3 mm) long, as specified in the material specification.

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, ten specimens shall be tested from each sample unit.

4. APPARATUS AND METHOD CITED

4.1 Apparatus.

4.1.1 Abrasion machine, figures 5308A and 5308B, consisting of abrading mechanism, specimen supporting mechanism, and driving mechanism. (see 7.2). Essentially, the surface of the abradant lies in a plane parallel to the plane surface supporting the specimen and presses upon the specimen. The abradant and specimen rotate in the same direction at very nearly but not quite the same angular velocity, 250 r.p.m., on noncoaxial axes which

are parallel to 0.001 inch (.0254 mm). The small difference in speed is to permit each part of the specimen to come in contact with a different part of the abradant at each rotation.

4.1.1.1 The abrading mechanism includes the abradant mounted at the lower end of a shaft; weights placed upon the upper end of the shaft to produce constant pressure between abradant and specimen throughout the test; lever and cam for raising and lowering the abradant; shaft; and weights. A counterweight for balancing the abradant and abradant shaft is used when tests are to be carried out at low pressures.

4.1.1.2 The specimen supporting mechanism provides for tension mounting of thinner, more flexible cloths and rigid mounting of thick, stiff cloths. For the first, a plastic presser foot 1/2, 1, 1 1/4, 1 1/2, or 2 inches in diameter, as called for, is mounted at the upper end of the specimen shaft to fix the area of the specimen to be abraded; a conical clamp seat fitted to the shaft rotates with it, but is free to move vertically on the shaft; a cam is provided for raising and lowering the clamp seat. The specimen clamp shown unassembled in figure 5308C fits on the seat, C in figure 5308C, and can be fastened to it by merely rotating it slightly to engage the two pins in the slots. The clamp and specimen assembly can be removed quickly for examination of the specimen and measurement of wear and returned to the machine without unclamping the specimen. When the clamp seat is lowered by turning the cam, the combined weight of the clamp seat and specimen clamp is suspended by the specimen over the presser foot. This places the specimen under constant tension throughout the test with take-up of any stretch in the specimen. Different tensions are applied to the specimen by changing the weight of the clamp seat, for example, by adding auxiliary weights. For rigid mounting of thick, stiff cloths such as carpeting and felts the specimen clamp and mounting aids shown in figure 5308D are used and the assembly screws onto the specimen shaft in place of the presser foot and specimen clamp seat.

4.1.1.3 The driving mechanism consists of a motor-driven auxiliary drive shaft connected to the abradant shaft and specimen shaft by spur gears.

4.1.1.4 The machine is equipped with a resettable counter, G in figure 5308B, to indicate the number of rotations in a test; sensitive microswitch, H in figure 5308B, to stop the machine automatically when a tension-suspended specimen is worn through; thickness gauge, I in figure 5308B, when specified, for indicating changes in thickness of the specimen during a test.

4.1.2 Abradant. The working surface of the abradant disk is sufficiently greater in diameter than the specimen supporting surface that the latter lies entirely inside the periphery of the abradant during a test. A spring steel blade abradant, B in figure 5308C, which is essentially constant in its action for a long period of use, is used for woven, felted, pile, and knitted fabrics and a cross-cut tungsten tool steel bla abradant, A in figure 5308C, is for coated cloths, unless otherwise specified in the material specification. Emery cloth, sand paper, duck, canvas, or other cloth in a suitable holder may be specified.

4.1.3 Specimen clamp and mounting aids illustrated in figure 5308C and 5308D.

4.1.4 Capacitor and capacitance test set when specified for evaluating the wear quantitatively.

4.1.4.1 The capacitor, figure 5308E, is of the guard-ring type. The guard electrode B is 1.2 inches (30.48 mm) outside diameter. The island electrode C is 0.4 inch (10.16 mm) in diameter. The electrodes are so arranged that the specimen clamp D can be readily inserted with the worn area of the specimen in it over the island and guard electrodes and the clamp suspended by the specimen, as it was in the abrasion testing machine. A third electrode E mounted in a heavy hinged lid F can be swung down to a fixed stop after the specimen and clamp are in place. The distance between the third electrode and the island electrode can be adjusted to precise known values with the micrometer head, I, of which the third electrode is a part. The capacitance test set is the commercial instrument which operates at a frequency of 465,000 cycles per second and is usually used to measure the capacitance between the electrodes of vacuum tubes.

4.2 Method Cited.

Method 5104, Strength and Elongation, Breaking, of Woven Cloth; Ravel Strip Method.

5. PROCEDURE

5.1 The cross-cut tungsten tool steel blade abradant shall be used for coated cloths, the spring steel blade abradant for all others, unless otherwise specified in the material specification.

5.2 The load on the abradant, the tensioning load on tension-suspended specimens, and the size of the presser foot shall be as specified in the material specification. If not specified, these elements shall be chosen to be such that the duration of the test to the end point for the least resistant material in a series to be compared is not less than 1000 rotations and/or the duration of the test for the most resistant is of the order of 20,000 rotations.

5.3 The end point of the test shall be as specified in the material specification. It may be a stated change in some characteristic as electrical capacitance, thickness, breaking strength, color, luster, cloth structure, napping or pilling after a stated number of rotations of abrasion, or the number of rotations required to produce the stated change, or the number required to completely wear through the cloth. When this last criterion is specified, the number of revolutions at which the cloth no longer supports the clamp assembly and the clamp drops, actuates the microswitch and stops the machine is the end point.

5.4 The face of the cloth (weave face, finished face, coated side, etc.) shall be the surface subjected to abrasion, unless otherwise specified in the material specification.

5.5 When wet abrasion resistance is to be tested, the specimen shall be immersed in water prior to mounting in the clamp. The area to be abraded is then flooded with water and the machine is started. After each 1000 rotations of the abradant, the machine is stopped and the area being abraded again flooded with water. Alternatively, water shall be supplied continuously during the test to the center of the abraded area through a small hole in the presser foot and specimen shaft.

5.6 A test shall be carried out as follows: Mount the specimen in the appropriate clamp as illustrated in figure 5308C, taking care that it is clamped evenly and securely without distortion. Place the specimen assembly in position in the machine, and if it is to be tension-suspended rotate the lower cam to stretch the specimen uniformly over the presser foot. Lower the abradant on the specimen by rotating the upper cam. Set the counter at zero and start the machine.

5.7 If changes in thickness are required, the thickness shall be read on the gage immediately after starting the machine and at regular intervals during the test.

5.8 The test shall be continued for the required number of rotations of abrasion or until the specimen is to be inspected. The machine shall be stopped, the abradant raised by the upper cam, the clamp assembly raised by the lower cam to release the tension on the specimen, and the clamp and specimen removed from the machine.

5.9 The specimen shall be inspected or measured as required in the material specification without removing it from the clamp. Replace the assembly in the machine and continue the test, repeating the inspection at intervals as required. If the test is to be carried to complete destruction of the test area, continue until the specimen no longer supports the clamp assembly and the latter drops, actuates the microswitch, and stops the machine.

5.10 Evaluation.

5.10.1 The resistance to abrasion shall be evaluated as specified in the material specification.

5.10.2 When the test is to run to complete destruction of the cloth, the resistance to abrasion of the specimen shall be the number of rotations of abradant required to terminate the test automatically, that is, the number of rotations at which the cloth no longer supports the clamp assembly and the clamp drops, throws the microswitch, and stops the test.

5.10.3 When change in electrical capacitance is taken as the measure of abrasion resistance, the following measurements shall be made: (1) Capacitance of the air in the capacitor without the specimen, C_a, (2) Capacitance of the unabraded specimen prior to insertion in the abrasion machine, C_o, and (3) Capacitance of the abraded specimen after a specified number of rotations or at a predetermined end point, C_R. The value of degree of destruction, Q, in percent, shall be calculated as follows:

$$Q = \frac{C_o - C_R}{C_o - C_a} \times 100$$

5.10.4 When change in thickness is required, the thickness of the specimen at the beginning of and at regular intervals during abrasion shall be read from the thickness gage.

5.10.5 When the change in breaking strength or residual breaking strength is specified, the breaking strength in each of the warp and filling directions of the original and abraded material shall be determined as described in Method 5104 except that (1) the distance between the jaws of the machine at the start of the test shall be 1 inch (25.4 mm) and (2) the abraded portion of the specimen shall be placed midway between the jaws of the machine.

5.10.6 When the effect of visual change in luster, color, cloth structure, napping, pilling, or other characteristic is required, the specimen shall be evaluated as described in the required method.

5.10.7 Unless otherwise specified in the material specification, change in thickness, breaking strength, or other characteristic shall be calculated as follows:

$$\text{Change in characteristic, percent} = \frac{O - E}{O} \times 100$$

Where: O = value before abrasion

E = value after abrasion.

6. REPORT

6.1 When a state of destruction is specified as the end point, unless otherwise specified in the material specification, the abrasion resistance of the sample unit shall be the average of the number of rotations obtained from the specimens tested, and shall be reported to the nearest 10 rotations.

6.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

6.2 When the number of rotations is specified as the end point, the resistance to abrasion of the sample unit shall be reported as the change in electrical capacitance, thickness, or breaking strength, the residual breaking strength, or the effect of visual change in luster, color, fabric structure, napping, pilling, or other characteristic, as specified in the material specification.

6.2.1 Unless otherwise specified in the material specification, change in electrical capacitance, thickness, breaking strength, or other characteristic shall be the average of the results obtained from the specimens tested, and shall be reported to the nearest 1.0 percent. When applicable, the values obtained for the warp and filling directions shall be reported separately.

6.2.1.1 The individual values for each individual specimen used to calculate the average shall also be reported.

6.2.2 Unless otherwise specified in the material specification, residual breaking strength shall be the average of the results obtained from the specimens tested, and shall be reported to the nearest 1.0 pound, (453.6 grams). When applicable, the value obtained for the warp and filling directions shall be reported separately.

6.2.2.1 The individual values for each individual specimen used to calculate the average shall also be reported.

6.2.3 Unless otherwise specified in the material specification, the effect of visual change in luster, color, cloth structure, napping, pilling, or other characteristic, as specified in the material specification, shall be reported for each specimen tested.

7. NOTES

7.1 The mathematical basis for this method is given in the Journal of Research of the National Bureau of Standards 39, 1 (1947), Research Paper RP 1807. The machine and its uses are described in the Journal of Research of the National Bureau of Standards 42, 481 (1949), Research Paper RP 1988.

7.2 An abrasion machine of the type described in this method is manufactured by Frazier Precision Instrument Company, Inc., 210 Oakmont Avenue, Gaithersburg, Maryland 20760.

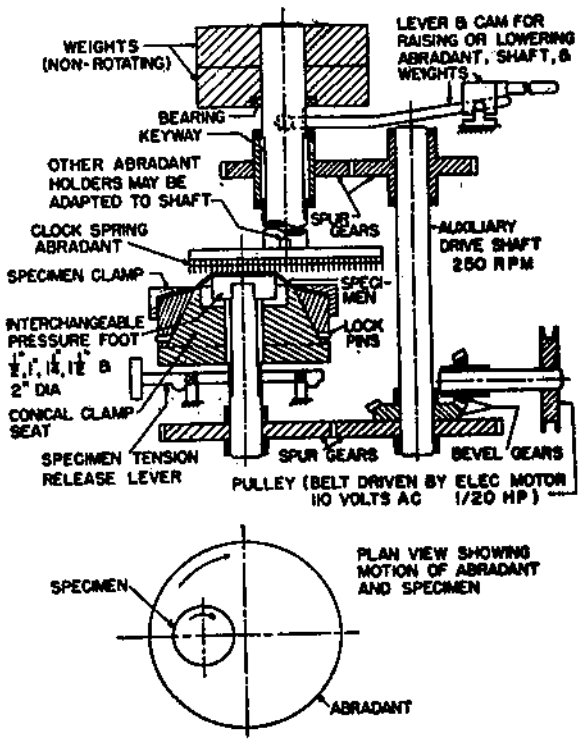

FIGURE 5308A – Schematic drawing of Schiefer abrasion testing machine.

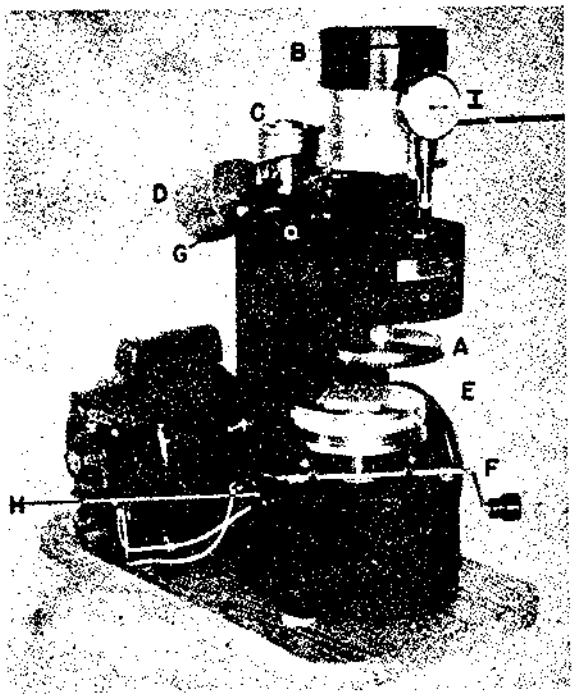

FIGURE 5308B - Schiefer abrasion testing machine.

A Abradant
B Weights on abradant shaft
C Cam and lever system for raising the abradant shaft, abradant, and weights
D Counterweight for balancing abradant and abradant shaft when tests are to be made at low pressures
E Specimen in place ready for test
F Cam for raising and lowering the speciman clamp seat
G Counter
H Microswitch
I Thickness gage

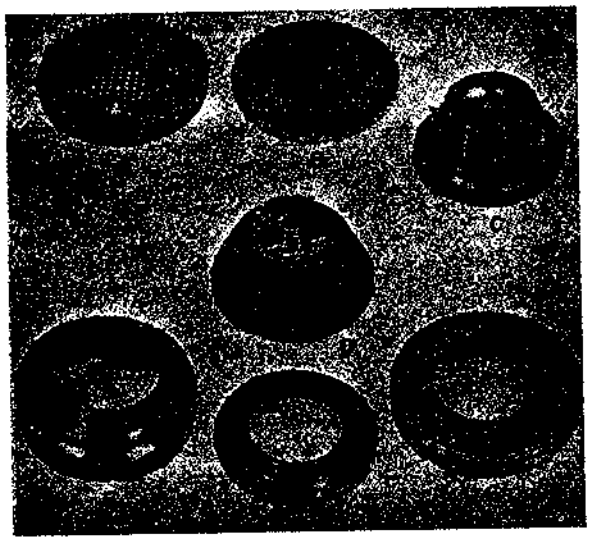

FIGURE 5308C - Abradants; specimen clamp seat; template and clamp for thinner flexible cloths which are to be held in the machine under tension.

A Cross-cut tungsten tool steel blade abradant
B Spring steel blade abradant
C Specimen clamp seat
D Template, which is placed under E to bulge the specimen when mounting it
E Base of specimen clamp, over which specimen is placed
F Pressure ring, which is placed on specimen
G Outer ring which is screwed down over F to hold the assembly together

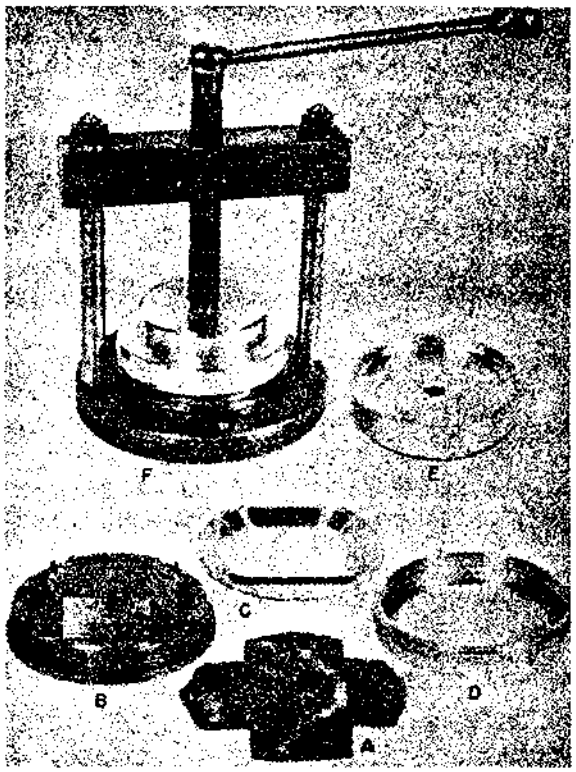

FIGURE 5308D - Specimen clamp and mounting aids for thick, stiff cloth such as carpeting and felts, which are to be mounted rigidly.

A Specimen
B Base of clamp
C Clamping plate
D Outer ring
E Pressure disk
F Assembly in screw press for forcing C down over specimen in order to tighten D and hold specimen firmly on the base

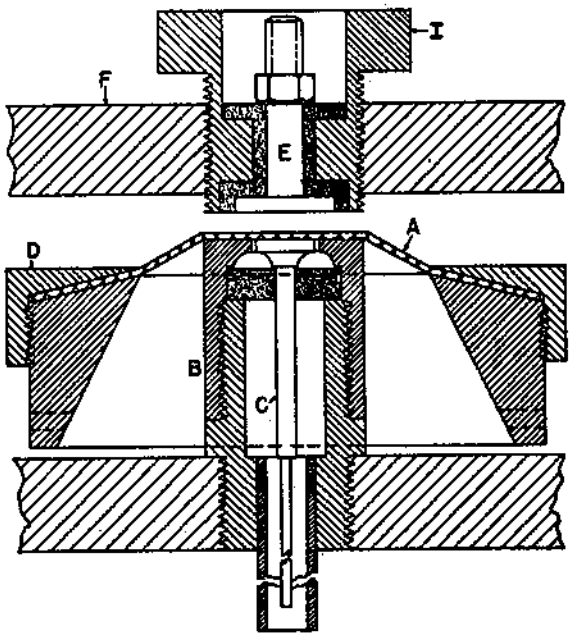

FIGURE 5308E - Schematic drawing of capacitor.

A Specimen	E Third electrode
B Guard electrode	F Heavy hinged lid
C Island electrode	I Micrometer head
D Specimen clamp	

ABRASION RESISTANCE OF TEXTILE WEBBING

1. SCOPE

1.1 This method is intended for determining the resistance to abrasion of textile webbing.

2. TEST SPECIMEN

2.1 The specimen shall be the full width of the material being tested and shall have a minimum length of 54 inches (137.2 cm).

3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the material specification, five specimens shall be tested from each sample unit.

4. APPARATUS

4.1 The apparatus (figure 5309) shall be as follows:

4.1.1 Weight (B), unless otherwise specified in the material specification, shall be 2 pounds ± 2 ounces for specified breaking strengths up to 1000 pounds, 4 pounds ± 2 ounces for 1000 to 3000 pounds, and 5.2 pounds ± 2 ounces over 3000 pounds.

4.1.2 Steel hexagonal rods (C) shall be 0.250 ± 0.001 inch (6.35 ± 0.03 millimeters) when measured across opposite flat sides and the radius of the edges shall be 0.020 ± 0.004 inch (0.5 ± 0.1 millimeter.) The steel shall have a cold drawn finish and a Rockwell Hardness of B-97 to B-101 (see 7.1). The edges of the hexagonal rods shall not have any burrs, nicks or scale and shall be smoothly polished.

4.1.3 Drum (D) shall have an outside diameter of 16 inches (40 centimeters) with a suitable means for attaching the specimen to be tested without damage to the specimen.

4.1.4 The crank (E) and crank-arm (F) shall be attached to the drum in such a manner that when the specimen is attached to the drum, the specimen

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