DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 41

TESTING AND PROPERTIES OF TEXTILE MATERIALS

[2d Edition]
Issued August 27, 1915

WASHINGTON
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1915

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I. INTRODUCTION

The textile industry is one of the greatest of the manufacturing activities of the United States. Large quantities of raw wool, cotton, silk, jute, and many other kinds of fiber are continually being converted into various forms of finished product. These products are the basis of commercial transactions both in domestic and foreign markets, involving large sums of money and indirectly affecting every individual consumer. While supply and demand affect their money value, the quality and kind of the raw material and the process and care used in manufacturing determine to a considerable extent their economic value. It is therefore desirable, both for the raw materials and for the finished goods produced from them, to have methods of testing which may be easily applied and which will furnish a reliable means for reaching harmonious agreements between producer, distributor, and consumer. Experience in the use of any material will show the characteristics which affect the suitability of that material for a certain purpose and the service which it may be expected to render. Having determined these characteristics, methods should be developed to measure them which will serve as a guide to both manufacturer and purchaser to assist them in determining in what degree they have been secured in individual cases.

The accurate description of the material and quality required, supplemented by an indication of the conditions and methods of test by which they are to be determined, forms a specification regarding which it should be possible for the buyer and seller to reach an agreement. For some materials, like products of iron and steel, cement, and other structural materials, there have, in recent years, been developed through the cooperation of producers, consumers, and engineering societies standard specifications and standard methods of testing. For textile materials no such standardization has been undertaken, and the industry is dependent very largely upon the units and methods of measurement as carried out by various manufacturers and individuals.

The study of the physical and chemical properties of textile material by means of laboratory tests has been carried on in this country in a more or less desultory fashion for a great many years.

The recent development of more systematic and greatly improved methods of testing has, however, given the results obtained much more significance than formerly.

The present general interest in the establishment of standardized and better methods of testing has resulted in the introduction of testing apparatus in textile institutions, public testing laboratories, stores, and mills.

In England, France, Germany, Austria, Italy, and Japan advanced methods of testing have been utilized with excellent results.

Large numbers of samples for investigation are being submitted to this Bureau not only by the Government departments but also by manufacturers, dealers, and other concerns and individuals. The fact that this work is rapidly increasing is good evidence of the value of the information received.

The Bureau will gladly cooperate with institutions, investigators, manufacturers, and consumers not only in the development of methods of testing and standardization, but also in furnishing information in its possession concerning methods of testing and the interpretation of results. It will be pleased to help in the design and construction of special testing apparatus. It is the object of this circular to outline the scope of work which is being undertaken by the Bureau and the range of fees for tests performed. It is not the policy of the Bureau, at present, to do commercial testing except for the Government departments, and for the public, in cases of dispute and where local facilities are not provided, in order that the Bureau's efforts may be devoted to investigational work leading to the establishment of better specifications of textiles and methods of testing.

II. GENERAL INFORMATION

All weighings and physical determinations will be made upon instruments which have been carefully adjusted and calibrated, and will be performed in an atmosphere of 65 per cent relative humidity at 21° C (70° F) temperature,[1] if not otherwise specified.

[1] These conditions are adopted temporarily, as they represent approximately the average of the standards of various European testing houses.

Such tests as weight, yarn number, and tensile strength will be made at bone-dry condition, i. e., subjecting the test specimens to 105° C. (221° F.) for two hours.

Tests will be made upon all kinds of textile materials. In general, these materials may be classified as (*a*) raw and unspun fibers; (*b*) yarn, thread, twine, and rope; (*c*) fabric.

III. RAW AND UNSPUN FIBERS

Whether the sample is composed of one or more than one variety of fiber, tests will be made to determine (1) identity of fiber or fibers present; (2) approximate average length of fiber; (3) percentage moisture and "regain" under any specified atmospheric condition within the Bureau's range of temperature and humidity; (4) the percentage of oil, grease, or other foreign matter present; (5) "shrinkage" determination upon raw wool (by scouring and conditioning).

1. IDENTITY OF FIBER OR FIBERS

This is ordinarily accomplished by careful inspection and by the use of the microscope and staining mediums, but other methods may be adopted from time to time after their accuracy and reliability has been definitely established. The Bureau has on hand a very complete collection of rare and commercial fibers and, if found necessary, recourse is had to these for comparison. To determine the percentage fiber composition of a mixture, the segregation and chemical methods outlined on page 16 are followed.

2. APPROXIMATE AVERAGE LENGTH OF FIBER

The fibers under consideration are spread upon a velvet background and carefully measured by a fine steel scale and magnifying glass.

3. PERCENTAGE OF MOISTURE AND REGAIN

Moisture.—All textile fibers normally contain moisture, the amount varying according to the surrounding atmosphere. Since the physical properties of the material are affected by this moisture, it is extremely necessary for uniformity in testing that some conditions of humidity and temperature should be recognized as standard in this country.

The material being tested is conditioned—that is, exposed for a certain length of time to the standard atmosphere—(p. 5) and weighed. It is then dried in an oven and reweighed. The time and temperature required for proper drying depends upon the variety of material under consideration. From the difference between the air-dry and bone-dry weights, the percentage of moisture present is ascertained, employing the air-dry weight as a basis of calculation.

REGAIN.—As there is some confusion regarding the meaning of the term "regain," an explanation will be made. A sample of bone-dry textile material—that is, material which has been so dried that all moisture has been expelled except that of chemical composition—will, if placed in the above-mentioned standard atmosphere, absorb a certain quantity of moisture. This increase is known as the "regain weight." From this is figured the "percentage regain," the bone-dry weight being used as a basis of calculation.

Under similar atmospheric conditions wool, cotton, silk, linen, jute, hemp, etc., will absorb percentages of moisture which vary somewhat with the sample, to a considerable extent with the grade and source of the fiber, and widely with the kind of fiber.

4. DETERMINATION OF OIL OR GREASE

The method of procedure is to weigh the sample after exposure to standard atmospheric conditions, extract with ether, benzene, or other solvents, expose the fibers and the extract to the standard atmosphere, and weigh both.

The percentage of oil or grease is ascertained either from the weight of the extract or from the difference between the weights of the material before and after extraction. In some cases fibers will absorb more moisture with large quantities of oil present than with small amounts. This has been noted in some instances when experimenting with scoured wool. Therefore, perhaps, a more reliable procedure is to make all weighings on a bone-dry basis if there appears to be much oil in the sample.

5. DETERMINING "SHRINKAGE" [2] OF RAW WOOL

As applied to raw wool, the term "shrinkage" means the percentage of dirt, wool grease, and foreign matter that may be washed out of the wool during the scouring process which necessarily precedes the carding of the fiber.

In determining the shrinkage the following operations are performed:

1. Weigh the sample after exposing it to standard atmospheric conditions.
2. Scour at 48° to 55° C (120° to 130° F) temperature in water containing a sufficient quantity of neutral olive-oil soap.
3. Wash thoroughly with cold water.
4. Throw out the excess water in the scoured wool by the use of a centrifugal machine or "hydroextractor."
5. Dry in an oven at 105° C (221° F) to constant weight.
6. Ascertain the quantity of grease remaining in the scoured wool and make the proper correction for it according to the methods outlined on page 7. From the dry weight, corrected for the remnant grease, the bone-dry shrinkage is obtained. If it is desired to know the air-dry shrinkage of the scoured wool, it is given a rough drying, then placed in the standard atmosphere, corrected for the grease content, and the shrinkage calculated from the weight thus obtained.

IV. DETERMINATIONS ON YARN, THREAD, AND TWINE

The important tests include the determination of (1) length; (2) tensile strength and elongation [3] or "elasticity"; (3) yarn number or "count"; (4) drying oven; (5) twist; (6) percentage of loading, sizing, or coloring material; (7) percentage fiber composition.

1. LENGTH OF YARN, THREAD, AND TWINE

Measuring.—The length test is made from the skein, cop, bobbin, spool, ball, or other form.

In order to obtain the correct length of material for testing, recourse is had to the instrument known as the "yarn reel." The

[2] In the raw-wool trade "shrinkage" does not have reference to change of length, but simply to loss in weight by scouring.

[3] The term "elongation" may be considered as meaning either (*a*) The maximum stretch under breaking stress or (*b*) percentage stretch under any other given stress.

arms of this apparatus are carefully constructed and so connected that the amount of bending or other alteration is so small as to be negligible.

The reeling is performed by passing the material through a smooth eyelet in a self-acting guide which lays the strands side by side so that the circumferential length is maintained unaltered throughout the winding. The reel is provided with an arrangement whereby certain tensions can be applied to the yarn being reeled and with a reliable counter and bell indicator to insure the correct number of turns being given.

2. TENSILE STRENGTH AND ELONGATION OF YARN, THREAD, AND TWINE

Tensile strength and elongation can be determined from tests upon single strands or, if desired, upon skeins which have been wound upon either a 36-inch or a 54-inch reel.

The instruments employed in these tests are of the dead-weight type. The pendulums are suspended upon knife edges, and stress is uniformly applied either by motor or by water pressure. These machines will register the strength and the elongation of the sample, separately or simultaneously. They are carefully calibrated, and any necessary correction is made after the tests have been performed. The lower drum or clamp holding the yarn descends at a uniform rate of 12 inches per minute.

All tests will be performed under standard atmospheric conditions and the yarn or twine being tested will be wound at least three times around a three-quarter-inch drum and securely held at either end, as shown in Fig. 1. The testing length between center of drums will be 6 inches and the pulling jaw will travel at a rate of 12 inches per minute. Special tests can be made upon any length up to 20 inches and under any ordinary atmospheric condition.

Unless otherwise requested, results will be reported as the average of 10 tests for the single-strand determination, or the average of 5 tests for the skein determination.

3. YARN NUMBER OR "COUNT" OF YARN, THREAD, AND TWINE

The yarn number—that is, the relation between weight and length as expressed by the use of arbitrary commercial standards—is a fundamental basis for textile calculation. (See p. 17.)

In testing for counts, four different results may be obtained by employing the following methods now in use:

1. Determination of the weight of the sample as received.

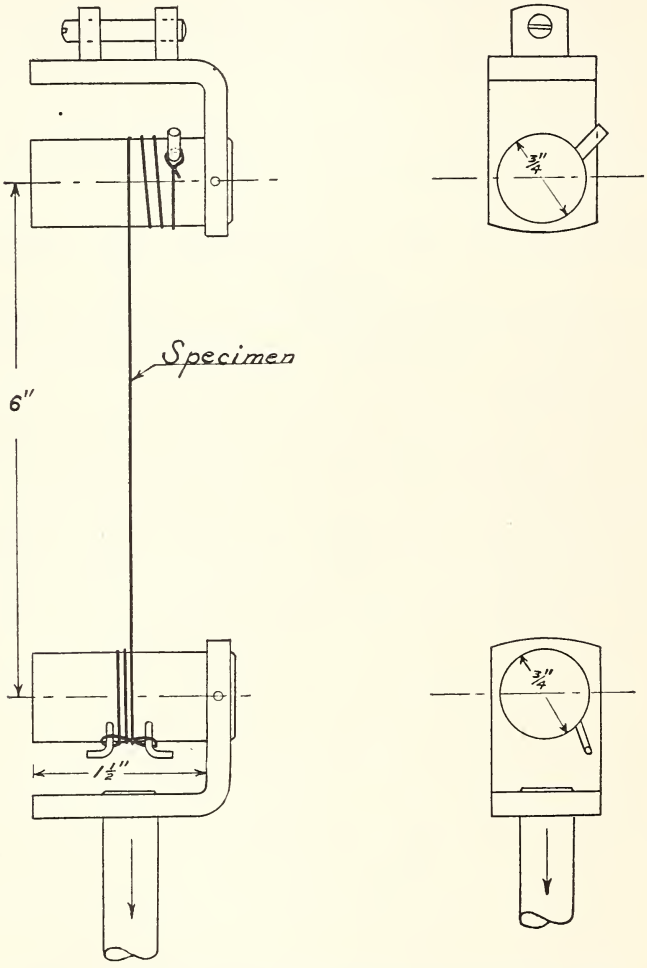

FIG. 1.—*Drums used in determining the tensile strength of twine*

2. Determination of the weight of the sample after it has been exposed to a specified standard atmosphere.

3. Determination of the weight of the sample after all moisture has been driven out (i. e., the "bone-dry" weight).

4. Determination of the "regain" weight.

In the first instance it will be readily understood that tests made for number upon yarn as received will give results which vary in accordance with the condition of the sample submitted. If the sample is in a very dry state, the resultant yarn number will be greater (the yarn will be lighter), or if submitted in a very damp state the resultant yarn number will be less (the yarn will be heavier) than if it were in accordance with normal conditions. The sample will not represent the bulk from which it was drawn unless it has been packed in an air-tight receptacle, as otherwise variation in weight will occur during transit according to the changing atmospheric conditions.

The confusion now existing with reference to calculating the results might be minimized if a standard atmosphere as outlined in No. 2 should be agreed upon, as all lengths and weights would then be determined in this atmosphere.

The basis of calculation in No. 3 is the "bone-dry" weight of the sample. In this instance the sample should first be exposed to the standard air conditions and the proper length taken.

In the case of No. 4 the same procedure must be followed as for No. 3, and in addition the percentage "regain" must be added to the dry weight. This method is employed by the Bureau of Standards, and the desired "regain" is added according to the specifications submitted.

The "regain" of the various forms of textile material under atmospheric conditions, as mentioned on page 7, is now being determined. It is hoped that in the near future standard "regains" will be definitely adopted in this country as they are in Europe.

The length of skeins and temperatures commonly used in commercial work for making yarn-number determinations are as follows:

Fiber	Length	Temperature
	Yards	
Silk	120	140° C (284° F)
Cotton	120	105° C (221° F)
Wool	20 or 50	105° C (221° F)
Worsted	20 or 80	105° C (221° F)
Linen	50	105° C (221° F)
Jute	50	105° C (221° F)

If specially requested, these lengths will be used by the Bureau; otherwise such lengths will be used as seem to be best adapted to the individual case.

4. DRYING OVEN

Bone-dry weighings are made in the oven shown in Fig. 2. The temperature of this oven is automatically maintained at the desired unit by a differential thermostat. A motor-driven fan circulates the atmosphere in the oven to insure uniformity of heat distribution. The sample to be weighed is placed in one of 10 small baskets carried by a chain. This chain may be turned by a wheel outside the oven, bringing each basket successively into such a position that it may be transferred to a hook suspended from one end of the balance beam by means of another hook operated from the outside of the oven. In this way 10 samples may be dried simultaneously and weighed without any opening of the oven doors after the samples have been introduced.

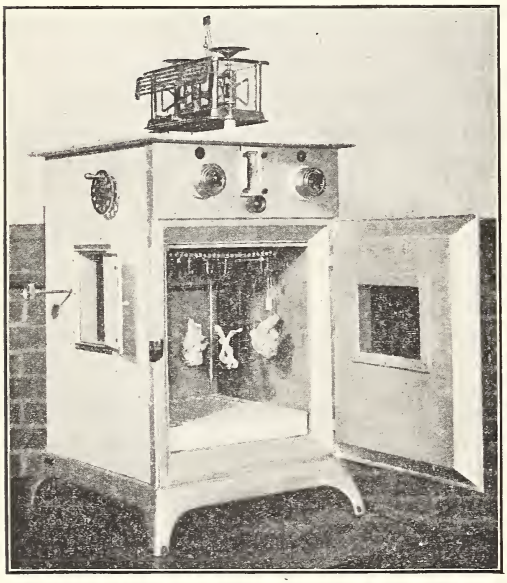

FIG. 2.—*Drying oven for textiles*

5. TWIST OF YARN, THREAD, AND TWINE

Yarn, thread, and twine necessarily contain more or less twist, the amount influencing the strength of the material and its adaptability for various uses.

In all determinations of the number of turns per inch 20 tests will be made, and the average of these will be reported, unless otherwise requested. The length of the specimen examined will be 1 inch or more, according to the length of staple and such other

considerations as the individual case may present. In the case of ply or folded material each test will be made on a 10-inch specimen, thus giving a result representing the average of 200 inches of yarn.

An instrument, specially designed for the purpose, is used in making these determinations. The specimen is held by two clamps. One of these is connected to a dial which may be turned to remove the twist from the specimen. The change in position of the dial shows the number of turns that have been given to the clamp, and therefore after all twist has been removed will show the number of turns originally present in the specimen. The other clamp is adjustable along a graduated bar, thus enabling the length of the specimen to be quickly and accurately regulated. A small spring attached to this clamp provides a uniform tension in the specimen, and an indicator carried by the spring shows the amount of elongation caused by the removal of the twist. The latter is only valuable in special cases and will not be reported unless requested.

If requested, the Bureau will report the individual results of twist tests as well as the average. The regularity of the twist will often give additional information regarding the quality of the material.

6. DETERMINATION OF LOADING, SIZING, AND COLORING MATERIAL OF YARN, THREAD, AND TWINE

The practice of adding to the weight of silk and to a less extent of cotton and other fibers during dyeing and finishing has become very common, and it is frequently necessary to ascertain the amount of true fiber present and the amount and kind of the weighting.

Black-dyed silks have been weighted to the extent of more than 400 per cent and cotton to more than 50 per cent. Consequently, the knowledge of the extent and kind of this adulteration is very important in many cases.

After weighing the sample to be tested in the standard atmosphere the necessary treatment for the elimination of the adulterant is performed. It is then weighed again under standard atmospheric conditions and the percentage of loss is computed

from the difference between these two weights. In some instances, depending upon the character of the loading, all weighings are made with the sample in bone-dry instead of air-dry condition.

7. PERCENTAGE FIBER COMPOSITION

SEGREGATION METHOD.—The specimen under test is exposed to the standard atmosphere and weighed. Each yarn is then carefully untwisted; the fibers of each different kind are placed in a separate pile in the standard atmosphere and weighed after proper exposure. The results of this test are checked or verified by the use of the microscope.

CHEMICAL METHOD.—The sample is weighed in the standard atmosphere and then the proper chemical procedure is followed, according to the constituent fibers present.

V. FABRICS

The following are some of the determinations made upon fabrics: (1) Weight, (2) tensile strength and elongation, (3) percentage fiber composition, (4) thread count, (5) yarn number or size, (6) folding endurance, (7) action of light on colors.

1. WEIGHT

Unless otherwise specified, weighings will be made in the standard atmosphere, and the results will be reported as ounces per square yard. They will also be reported, if desired, according to one of the following:

1. Grams per square meter.
2. Ounces per linear yard.
3. Yards per pound.

2. TENSILE STRENGTH AND ELONGATION

Test pieces are prepared by cutting samples 8 inches long by 1¼ inches wide and then pulling out threads from both sides until the standard width of 1 inch is reached.

The Bureau is prepared to make tensile-strength tests by either of two common methods: (*a*) Test specimens are exposed at least four hours to an atmosphere containing 65 per cent relative humidity at 21° C (70° F) temperature and then tested in this atmosphere; (*b*) test specimens are subjected to a temperature of

105° C (221° F) for two hours, and then the breaking stress is determined while the moisture is completely eliminated. In the latter case the test specimens should be broken while hot and within

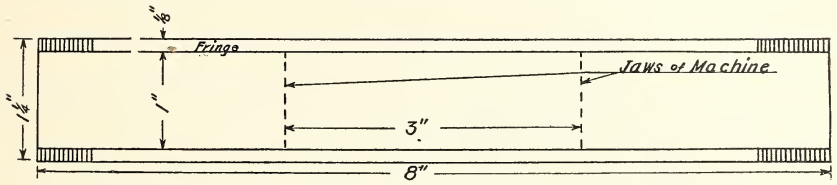

FIG. 3.—*Form of test specimen for cotton fabric*

30 seconds after being removed from oven. If requested, any other available condition will be used.

Five samples each from warp and filling directions are taken from various parts of the sample. The usual length of the test speci-

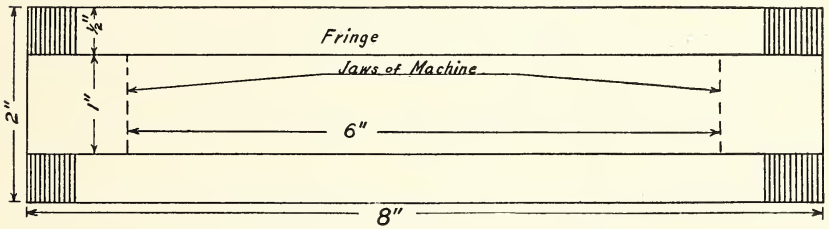

FIG. 4.—*Form of test specimen for wool fabric*

men between the jaws or clamps of the testing machine is 3 inches for cotton fabric and 6 inches for wool, silk, linen, or jute fabric. The pulling jaw or clamp travels at a uniform rate of 12 inches per minute. The Bureau is equipped to make tests upon all fabrics breaking at less than 2200 pounds stress. The average results of tests are reported separately for warp and filling.

SAMPLING FABRIC FOR STRENGTH SPECIMENS.—For the determination of the tensile strength, five test pieces each are cut from the warp and the filling. Fig. 5 illustrates the method of sampling or cutting the test pieces.

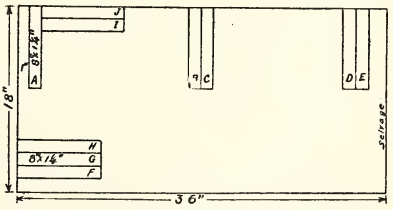

FIG. 5.—*Method of sampling fabric for tensile strength test specimens*

In order to enable the above tests to be made, the sample of fabric for test should be 18 inches long, if the cloth is 25 inches or more in width; but if less than 24 inches wide, then a 36-inch length should be furnished.

3. PERCENTAGE FIBER COMPOSITION

If only one fiber is present, it is ascertained as outlined under "Identity of fiber or fibers," page 6.

When composed of more than one kind of fiber, i. e., cotton, wool, silk, linen, etc., the following is an explanation of the usual methods of procedure:

1. The weight of the fabric under standard air condition is found.

2. A sample of convenient size is cut out and weighed as a whole. Then the warp and filling yarns are weighed separately and the percentages of warp and filling are calculated from these results.

Segregation Method.—Each warp yarn is carefully untwisted, the different varieties of fiber (cotton, wool, silk, linen, jute, etc.) found are placed in separate piles in the standard atmosphere and weighed. If any difficulty is experienced in identifying the composition of any pile, a chemical test combined with a microscopical examination is made. The same procedure is followed for the filling yarns.

Chemical Method.—For the ordinary determination a test specimen of about 4 square inches, or one or two repeats of a pattern, is weighed in standard atmosphere, then treated with the proper chemical or chemicals. The latter is neutralized and washed with distilled water and then dried, weighed, etc., in accordance with the procedure considered correct. In this way one constituent is eliminated at a time and the percentages are obtained by simple calculation.

For complicated fabrics a long series of tests is necessary, and this could only be outlined in a general way, because each fabric must be analyzed according to its fiber composition.

4. METHOD OF COUNTING THREADS

An instrument called a "thread counter" is generally employed to ascertain the threads per centimeter or per inch. The "counter" carries a pointer which may be moved along a horizontal bar by means of a turnscrew. Directly above the pointer and moving with it is a low-power magnifying eyepiece through which each

thread can be distinctly seen and readily counted. Under the pointer and resting upon the fabric under observation is a stationary piece of flat steel which is graduated to read to one-fourth inch divisions and to 0.5-cm divisions. It is therefore a comparatively simple matter to count the threads of most fabrics. If the number can not be determined by this instrument, a higher power microscope is employed, or the threads in a measured distance are pulled out by hand and counted. This test is also often made with light transmitted through the fabric.

The results of analysis, unless otherwise specified, will be reported as the number of threads per inch. If so desired, the number of warp ends across the full width of fabric will be determined.

5. DETERMINATION OF THE YARN NUMBER OR SIZE OF YARN IN FABRIC

The terms "yarn number" and "size" are commonly used to indicate the length of yarn per unit weight.

There are many systems of yarn numbering now in use. These are, for the most part, based upon arbitrary quantities, which differ according to the kind of material, the locality, or often the preference of the individual. Samples submitted to the Bureau for this determination should therefore be accompanied by a statement of the particular system it is desired to use. Otherwise the report will be made in terms of the system which is thought will be desired and most valuable.

The knowledge of the size of the yarn is necessary to spinners, cloth manufacturers, and to large consumers of yarn and fabric. It is obvious that spinners and cloth manufacturers must know the size of the yarn they are to manufacture, and the large consumer should give this information to the spinner in the form of a specification.

To illustrate the method of procedure in the case of a cotton fabric, the following example is given:

If the yarn number is desired in the warp direction only, 60 yarns each 24 inches long (equals 40 yards) from three different parts of the cloth are taken, aggregating 120 yards. If both the warp and filling are tested, shorter lengths are employed. Three tests are made for warp threads and six tests for filling threads, the latter generally being more irregular than the former.

The method of determining the yarn number in this case is the same as given in the procedure for yarn, thread, and twine (p. 9).

6. FOLDING ENDURANCE

Materials such as silk, book cloths, and window-shade cloth, when in actual use are subjected to folding to a considerable extent. In such cases folding endurance tests will show to what extent they may be expected to resist deterioration from this cause. In silk and book cloths that have been heavily weighted this test is an especially important one, as the material is then liable to be seriously damaged after short usage by cracking or splitting.

The folding test is made upon a specially constructed machine which registers the number of alternate folds the specimen endures before breaking under a given constant tension. The determination is made in the standard atmosphere upon a test strip 15 mm (19/32 inch) wide and 95 mm (3¾ inches) long. The number of double folds [4] made before rupture occurs is reported. A constant tension of 1000 g (35 ounces avoirdupois) is applied during the folding operation and the double folds are made at a rate of 200 per minute.

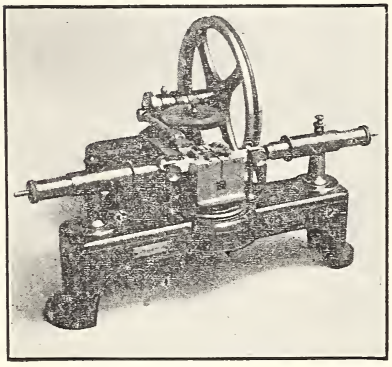

FIG. 6.—*Folding machine*

The machine used is called the "Schopper" folding machine and is the only instrument now available for such determinations. Other concerns, however, are constructing machines for this purpose and some of them will probably be completed during this year.

7. ACTION OF LIGHT ON COLORS

The permanency of the coloring material of certain fabrics when exposed to the action of sunlight is a matter of considerable importance.

Test strips of cloth are fastened to a board, one-half of each strip being covered and the other half exposed to direct sunlight. After various intervals the sample is examined to observe what change has occurred in the exposed portion.

[4] By a double fold is meant that the sample is folded flat upon itself, then opened and folded at the same point flat upon itself in the reverse direction.

Degree of Light Effect.—The result of tests of light action after any specified exposure will be reported as follows: (1) None; (2) slight (lighter or darker); (3) medium (lighter or darker); (4) decided (lighter or darker).

VI. GENERAL INSTRUCTIONS REGARDING APPLICATIONS FOR TESTS

1. APPLICATIONS FOR TEST

All articles submitted for test should be accompanied by a written request. This request should enumerate the material or materials, giving an identification mark, and should state explicitly the nature of the testing desired. When the test is one regularly provided for in the appended schedule, the fee may be computed in advance and should be sent with the request for the test at the time the material is shipped. When an article or material is sent simply for test without definite instructions the Bureau will, when practicable, decide upon the nature of the test without correspondence.

2. SPECIAL TESTS

The Bureau will gladly cooperate with scientific investigators, manufacturers of apparatus, and others who need higher precision than is provided in the regular tests, as far as the regular work of the Bureau will permit. Kinds of tests not at present provided for may be undertaken if the work is important and the facilities and time are available. Approved tests not provided for in the regular schedules will be considered special, and a special fee will be charged for them. The test should be arranged for by correspondence before shipment of the material. The application should state fully the need for the test, and the precision required. The special fee charged will depend chiefly upon the time consumed and the amount of alteration required in the regular testing apparatus. An estimate of the fee will be given when possible.

3. IDENTIFICATION MARKS

All packages should be plainly marked with the shipper's name and address and a list of the contents. Each separate piece or sample of material should be provided with an identification mark or number. The identification mark should also be given in the application for the test.

4. SHIPPING DIRECTIONS.

Apparatus or test specimens should be securely packed in cases or packages which will not be broken in transportation and which may be used in returning them to the owner. The shipment in both directions is at the applicant's expense and risk. The tops of boxes should be put on with screws, as the jar due to nailing and the subsequent opening is liable to cause damage. The tops of the shipping boxes should have the return or forwarding address on the underside. Transportation charges are payable by the party requesting the test. The charges for shipment to the Bureau must be prepaid, and, unless otherwise arranged, articles will be returned "charges collect."

5. ADDRESS

Material submitted for test, as well as all correspondence, should be addressed simply "Bureau of Standards, Washington, D. C."

6. REMITTANCES

Fees in accordance with the appended schedules should be sent when the material or apparatus is shipped, or promptly upon receipt of bill. Certificates are not given, nor is material returned, until the fees due thereon have been received. Remittances may be made by money order or by check drawn to the order of the "Bureau of Standards."

VII. FEES

The following schedule of fees for testing textile material will be followed in general from the date of issuance of this revised circular. The Bureau reserves the right, however, to make extra charges for any tests presenting unusual difficulties or to make changes in the schedule without notice.

1. Schedule 200.—RAW AND UNSPUN FIBERS

(*a*)	Identification of fiber (if composed of one fiber only)	$1.00
(*b*)	Identification of a mixture of fibers	2.00
(*c*)	Quantitative determination of a mixture	3.00
(*d*)	Determination of the approximate length (if composed of one fiber only)	1.00
(*e*)	Determination of the approximate length (if composed of two or more fibers)	2.00–3.00

(*f*) Quantitative determination of moisture $1. 50
(*g*) Determination of the percentage of oil or grease 3. 00
(*h*) "Shrinkage" determination of raw wool (scouring and conditioning).. 2. 50–5. 00

2. Schedule 201.—YARN, THREAD, AND TWINE

(*a*) Measuring of skeins, cops, bobbins, spools, or balls (average of two tests), one sample:
  (1) Lengths up to 1000 yards 1. 00
  (2) Lengths over 1000 yards 1. 50
(*b*) Tensile strength determination (average of 10 tests), one sample:
  (1) Breaking stresses from 0 to 1 kg (2.2 pounds) 50
  (2) Breaking stresses from 1 kg (2.2 pounds) to 50 kg (110 pounds). 1. 00
  (3) Breaking stresses from 50 kg (110 pounds) to 1000 kg (2200 pounds) 1. 50
(*c*) Elongation determination (average of 10 tests), one sample:
  (1) Determined at breaking stress of specimen 1. 50
  (2) Determined under a specified stress 1. 50
(*d*) Twist determination (average of 20 tests), one sample:
  (1) Single or one-ply strand 1. 50
  (2) Folded or ply yarn 1. 00
(*e*) Determination of yarn number (average of five tests), one sample 2. 00
(*f*) Identification of fiber (if composed of one fiber only) 1. 00
(*g*) Identification of a mixture of fibers 2. 00
(*h*) Percentage fiber composition, one sample:
  (1) If composed of two fibers only 3. 00
  (2) If composed of more than two fibers 3. 50
(*i*) Diameter of cord or rope 25

3. Schedule 202.—FABRIC

(*a*) Weight, one sample 50
(*b*) Tensile strength determination (average of five tests upon warp and filling, respectively), one sample 1. 50
(*c*) Elongation determination (average of five tests upon warp and filling, respectively), one sample:
  (1) Determined at breaking stress of specimen 2. 00
  (2) Determined under a specified stress 2. 00
(*d*) Fiber composition (percentage composition of warp, filling, and of whole fabric), one sample:
  (1) If composed of two fibers only 3. 00
  (2) If composed of more than two fibers 3. 50
  (3) Quantitative determination of warp or filling yarns, one sample (same as for Schedule 201*h*).
(*e*) Threads per inch (average of 10 tests both in warp and filling directions), one sample 50
(*f*) Determination of yarn number, one sample:
  (1) Yarn number of warp 2. 00
  (2) Yarn number of filling 2. 00
  (3) Average yarn number of whole fabric 2. 00

(*g*)	Folding determination, one sample:	
	(1) Testing less than 1000 double folds	$1. 00
	(2) Testing between 1000 and 10 000 double folds	1. 50
	(3) Testing between 10 000 and 100 000 double folds	2. 00
	(4) Testing more than 100 000 double folds	2. 50
(*h*)	Quantitative determination of starch, one sample	1. 50
(*i*)	Quantitative determination of moisture, one sample	1. 50
(*j*)	Action of light on colors, one sample	1. 00
(*k*)	Action of weather on colors, comparison of two samples	1. 00
(*l*)	Action of weather upon the tensile strength, one sample	3. 00
(*m*)	Fastness to washing, one sample	1. 00
(*n*)	Determination of thickness, one sample	. 50

S. W. STRATTON,
Director.

Approved:
E. E. PRATT,
Acting Secretary.

APPENDIX

1. SOME RESULTS OF TEXTILE TESTS

The tensile strength depends upon the quality and kind of material employed and the method of manufacture. The particular application that is to be made of the finished product determines the weight, threads or yarns per inch, yardage, composition, etc., used in manufacturing. Results of tests upon some of the more common textile materials are given in the following tables:

TABLE 1

Results of Tests on Fabric Used in the Manufacture of Cotton Bags

Used as container for—	Weight per square yard	Tensile strength		Threads per inch	
		Warp	Filling	Warp	Filling
	Ounces	Pounds	Pounds		
5 pounds of sugar	2. 75	25	15	64	60
10 pounds of sugar	3. 5	35	20	76	66
5 pounds of salt	3. 25	25	15	48	44
One-half bushel of seeds	5. 75	70	25	70	40
100 pounds of cement	8. 0	125	44	85	32
Do	8. 5	75	85	40	30

TABLE 2

Results of Tests of Common Tying Twines

Cotton		Jute	
Tensile strength in pounds	Yards per pound	Tensile strength in pounds	Yards per pound
10	1675	20	650
15	1050	25	625
20	850	50	350
25	675	75	125
50	300	150	70
75	150	225	40

TABLE 3

Results of Tests Upon Various Fabrics

Use or name of fabric	Weight per square yard	Tensile strength		Threads per inch	
		Warp	Filling	Warp	Filling
	Ounces	Pounds	Pounds		
Bleached cheesecloth	2.0	16	10	38	34
Cotton handkerchiefs	2.25	25	30	76	64
Linen handkerchiefs	2.25	30	45	90	84
Linen bed sheets	3.0	60	35	86	84
Chambray	4.0	40	35	76	64
Cotton bed sheets	4.5	65	50	72	60
Gingham	4.75	65	30	82	38
Bed ticking	7.75	105	60	76	58
Denim	8.0	110	60	70	40
Huck towel, linen and cotton	8.5	95	75	54	30
Roller toweling	9.0	100	85	64	30
Awning cloth	10.0	180	72	48	34
Burlap (jute)	10.5	55	75	12	12
Light-weight cotton canvas	10.5	130	100	54	36
Tire fabric (Egyptian)	17.25	280	290	23	23
Tire fabric (Sea Island)	17.25	300	320	23	23
Heavy cotton canvas	27.75	200	315	30	22

2. ADULTERATION OF TEXTILE PRODUCTS

The results of tests shown in the table below give some of the adulterations and the misrepresentation of some goods which are found in material commonly sold to the consumer:

TABLE 4

Name of material	Advertised composition	Found upon analysis to contain—
Wool yarn waste	100% wool	15% wool and 85% jute
Wool blanket	do	10% wool and 90% cotton
Do	do	35% wool and 65% cotton
Wool dress goods	do	50% wool and 50% cotton
Wool yarn	do	75% wool and 25% cotton
Wool blanket	do	75% wool and 25% jute
Linen thread	100% linen	100% cotton
Linen tape	do	Do.
Linen fabric	do	Do.
Linen towel	do	50% linen and 50% cotton
Flax twine	100% flax	100% jute
Flax packing	do	Do.
Flax twine	do	50% flax and 50% jute
Italian hemp twine	100% Italian hemp	100% Kentucky hemp
Silk tape	100% silk	30% silk and 70% mercerized cotton
Silk hosiery	do	50% silk and 50% artificial silk
Silk fabric	do	75% silk and 25% artificial silk

3. INFLUENCE OF HUMIDITY UPON THE STRENGTH OF YARNS

The necessity for exposing all test pieces to the same atmospheric conditions is well illustrated by a series of tensile-strength tests that have been made upon cotton and worsted yarns. Successive determinations were made on the same yarns, after they had been exposed to various degrees of humidity, the temperature remaining constant at 70° F. The results obtained were plotted in the accompanying diagrams. It will be observed that, in the case of the cotton yarns, the strength shows a regular increase according to the humidity, while the strength of the worsted yarns decreases. The degrees of humidity were not at all extreme and any of the results might have been obtained from yarns tested under prevailing conditions.

Fig. 7 shows an increase of 16 per cent in tensile strength and Fig. 8 shows a decrease of 18 per cent in tensile strength for 40 per cent increase of humidity.

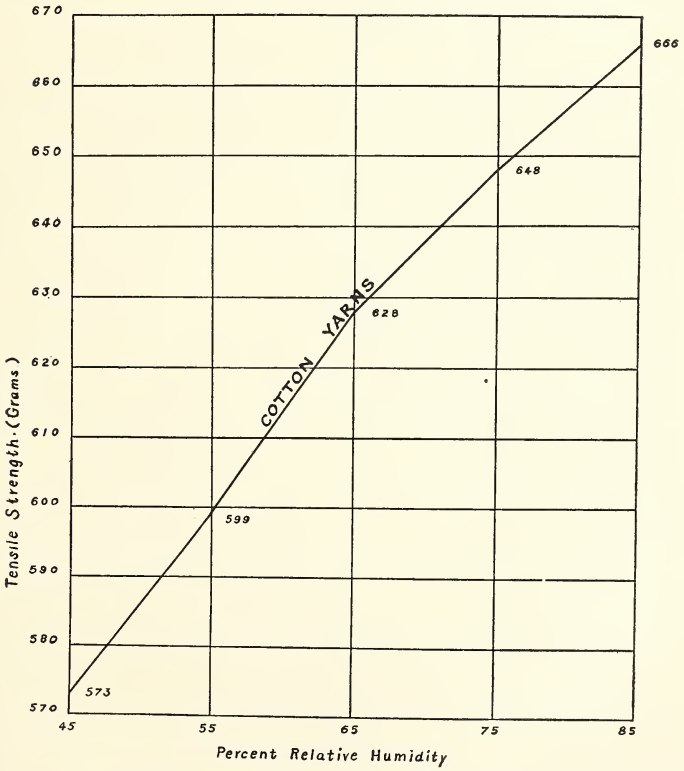

FIG. 7.—*The tensile strength of cotton yarns under different atmospheric conditions*

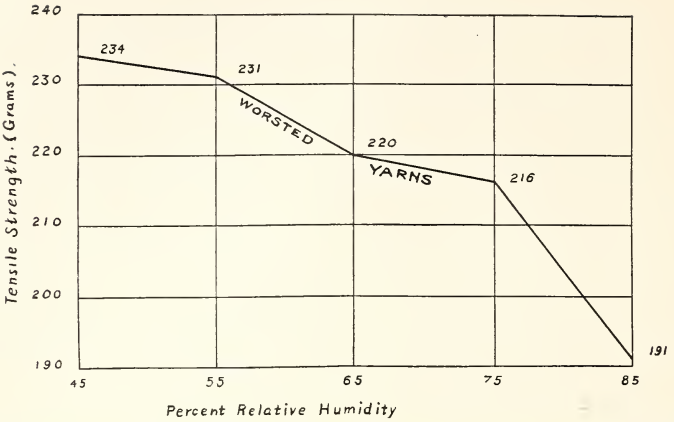

FIG. 8.—*The tensile strength of worsted yarns under different atmospheric conditions*

(Continued from second page of cover.)

46. Testing of Barometers.
47. Units of Weight and Measure; Definitions and Tables of Equivalents.
48. Standard Methods of Gas Testing.
49. Safety Rules to be Observed in the Operation of Electrical Equipment and Lines.
50. National Standard Hose Couplings and Fittings for Public Fire Service.
51. Measurement of Time and Tests of Timepieces.
52. Regulation of Electrotyping Solutions.
53. Composition, Properties, and Testing of Printing Inks.
54. Proposed National Electrical Safety Code.
55. Measurements for the Household.

[A complete list of Scientific Papers, Circulars, and miscellaneous publications may be obtained free of charge on application to the Bureau of Standards, Washington, D. C.]