The Project Method of Teaching

SILK TESTING

PART 2

PREPARED UNDER SUPERVISION OF

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ADVICE TO THE STUDENT

You learn only by thinking. Therefore, read your lesson slowly enough to think about what you read and try not to think of anything else. You cannot learn about a subject while thinking about other things. Think of the meaning of every word and every group of words. Sometimes you may need to read the text slowly several times in order to understand it and to remember the thought in it. This is what is meant by study.

Begin with the first line on page 1 and study every part of the lesson in its regular order. Do not skip anything. If you come to a part that you cannot understand after careful study, mark it in some way and come back to it after you have studied parts beyond it. If it still seems puzzling, write to us about it on one of our Information Blanks and tell us just what you do not understand.

Pay attention to words or groups of words printed in **black-face type.** They are important. Be sure that you know what they mean and that you understand what is said about them well enough to explain them to others.

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Remember that we are interested in your progress and that we will give you by correspondence all the special instruction on your Course that you may need to complete it. Remember, too, that you will get more good from your Course if you learn all that you can without asking for help.

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SILK TESTING
(PART 2)

WINDING, SIZING, AND COHESION TESTS

WINDING TEST

INTRODUCTION

1. Object of Winding Test.—Winding is one of the fundamental operations in silk throwing, and is necessary whenever silk must be transferred from a skein to a bobbin, so that it may be employed in the formation of warps for weaving, threads for knitting, or for other purposes. The machine on which winding is done is known as a winding frame, or simply as a winder. In the throwing mill it is the first machine on which the form of the silk is changed in any way, the purpose being to prepare the silk for succeeding operations.

Since winding is strictly a mill operation, it is desirable to obtain previous knowledge of the manner in which the silk will wind, or run, while being processed in the mill; consequently, a winding test is generally made in the laboratory, the results of which determine the running qualities of the silk and form a basis for judging its behavior during the actual winding in the mill. Thus the ease or difficulty with which the silk passes through the different operations will be known in advance; for silks that wind well usually spin well, and as a rule they pass through the remaining operations with a minimum amount of trouble. The importance of good winding may be realized when it is known that the finished product is influenced by the winding qualities of the silk.

2. Some silks wind with greater ease and less trouble than others, and so silks may be classified as to their winding qualities. Silks that wind poorly contain many broken ends, crossed ends, slugs, waste, nibs, and so on, which are detrimental to rapid winding. Silks that contain few defects and wind with very little trouble are usually referred to as *good winders,* and may be classed as good; conversely, silks that wind with a considerable amount of trouble are referred to as *poor winders,* and may be classed as poor. Silks tested in the laboratory and found to be good winders, may be expected to wind better in the throwing mill, pass through subsequent operations with less trouble, and produce a higher grade of product than silks classed as poor winders. Hence, they are generally selected for use in high-grade fabrics.

3. Reproduction of Mill Conditions.—A winding test, whether made in a private laboratory or in a public testing house, should reproduce as closely as possible, the actual conditions to which the silk will be exposed in the mill. Although satisfactory results are obtained from tests, it is extremely difficult at times to reproduce in the laboratory the exact conditions to be found in the mill. With only a few exceptions, the practice in American throwing mills is to soak all silks, before they are thrown, in a warm solution of water, soap, and oil; and as each mill prepares the soaking solution of such ingredients and of such proportions as are found to give the best results according to past experience, there are differences in the soaking solution. Moreover, the winding frames in the different mills are operated at various speeds, and this, also, has a direct influence on the results of the test. As a rule, winder speeds in the majority of mills are as high as possible.

4. European mill conditions are much more easily reproduced in the laboratory, because in those mills, the silk generally is not soaked, but is wound and worked in the raw state; that is, the silk is thrown *bright.* Besides, the speed of the throwing machinery is retarded to such a degree that the silk moves comparatively slowly, which is necessary when the silk is not soaked.

In order that the results of the winding test shall be uniform, the test is usually made without soaking the silk or preparing it in any way. The silk as received is sampled and immediately tested; also, the machines used for winding the silks during the test are operated at a uniform speed, governed by the denier size of the silk, and so the results obtained may be compared.

PREPARATORY OPERATIONS

5. Selection of Samples.—Samples for the winding test are drawn from the bale in the same manner as for the conditioning test. In general, silks that are to be tested for their winding qualities are also subjected to the moisture test, so that samples for both tests may be taken at the same time. If only a winding test is to be made, it is not necessary to obtain the bale weight, shirt weight, and so forth. The outer and inner coverings are removed, and after the cotton shirt has been opened, ten original skeins are drawn from ten different books of the bale, selected at random. Especial care is taken to see that no two skeins are drawn from the same book. After the skeins are marked for later identification, they are sent to the department in which the winding test is made.

6. When skeins are drawn from more than one bale, those from each bale should always be kept together during the test. Mixing them with skeins from another bale will frequently cause erratic test results. When a lot consisting of five bales is sampled, two bales are selected out of the five in the same manner as with the previous tests; when a larger lot is received, a proportionate number of bales is selected from the lot.

The original skeins selected are of sufficient length to supply test skeins for several tests; hence, two or more tests may be made from each of the original skeins. When a combination of tests is made, it sometimes happens that one test prepares the silk for a second test; for instance, silk wound on bobbins in a winding test may be used immediately in the sizing test, as the silk for the latter test must be prepared on bobbins.

But, if tests of physical qualities are to be made, it is not permissible to use original skeins that have undergone tests in which their physical properties may be affected. For example, silks that have been conditioned should not be employed as samples in tests for elasticity, strength, and so on, since the strands of silk may be affected by heat.

7. Opening and Examining Skeins.—Before the test skeins are subjected to the winding test they are very carefully opened and beaten out, so as to bring the threads into the positions they had when the skein was removed from the original reel in the reeling machine, and also to straighten the tangled threads and open the snarls, so that they will not hinder the winding operation. The operative draws out the end of the skein that is tucked in the body, untwists the skein and allows it to open so as to present an endless loop. He then thrusts one arm through one end of the loop and the other arm through the opposite end, so that the silk rests on his forearms. By moving his arms away from each other by a quick movement, he draws the skein taut with a snap. By repeating this operation several times in rapid succession, and shifting the position of the skein on the forearms after each tautening, a uniform tension is given to the threads in the skein. The shifting of the skein is necessary so that different portions of it will come in contact with the operative's forearms. The beating-out operation should not be too vigorous, especially when handling silks of the finer deniers, as these are frequently injured by too harsh treatment.

8. When a skein has been properly beaten out and while it still rests upon the operative's forearms, it will have a flat shape, measuring about 3½ inches across the face; and if it has been Grant reeled, it will also show the diamond-shaped openings. While in this position the skein should be very carefully examined to see whether any loose ends hang from the skein, indicating broken threads; whether the lacing strings are properly distributed throughout the skein and each is properly inserted in the skein; and whether the skein has any hard bands, known as gums, extending across it. Should the skein contain hard gums, the operative should note whether they are soft, medium, or hard, and whether they exhibit peculiar characteristics. The condition of the gums should be recorded on a working sheet, or memorandum sheet, and later transferred to the laboratory report, or certificate.

9. While the skein rests on his forearms, the operative should determine which is the outside of the skein, so that the skein may be placed on the swift in the proper manner. Sometimes this determination is difficult, especially if the skein has been opened carelessly. Since all skeins are not prepared in the same manner, the operative must be careful, when untwisting the skein prior to beating out, not to give it any unnecessary twists; otherwise, it will not assume its original shape. The portion of the skein that is on the outside will usually be found to be the outside of the skein, but this may be further assured by examining the method of fastening the end of the skein. Usually the outside end of the skein is tied to a small bunch of threads near a lacing string; but sometimes the end may be found affixed to a lacing string, or looped around the skein and tied.

10. After the outside has been found, the skein is placed on a swift and spread out, so that it is about 4 inches wide. Five of the ten selected skeins are placed on five swifts in the position they had when opened, so that they will wind from the outside. The remaining five skeins are turned inside out; that is, each is turned so that the face that was outside is on the inside. These five reversed skeins are then placed on swifts. When the ends of these skeins, which originally were inside ends, have been found, the winding operation may be started. Thus, five skeins will unwind from the outside, while the remaining five skeins will in reality unwind from the inside. Half of the skeins are reversed in this manner so that the winding quality of the outside and of the inside may be judged. The portion of the skeins that is not unwound is removed from the swifts and replaced in the bale from which they were drawn.

11. Finding End.—With the skein on the swift and in position on the winding frame, the lacing strings are carefully removed so as not to injure the silk. Usually they are pulled to one side, then cut with scissors, and gently withdrawn from the skein. Under no circumstances should the string be broken, as this is likely to break some of the threads. In the removal of the strings from the skein, care should be taken to observe whether the end of the skein is tied to a lacing string, or to a bunch of threads, or whether it is looped around the skein. If the end is attached to a lacing string, the end should be loosened and drawn from the skein, causing the latter to revolve and thus bring the remaining lacing strings to the top of the swift. When all the lacing strings have been removed, the skein should be further spread out on the swift, so that it will wind easily.

12. Many times the thread is broken and the end cannot be found attached to a lacing string, in which case it becomes necessary to find the end. This is best accomplished in the following manner: A top thread on the skein is grasped with one hand and gently lifted. In doing this, several other threads will also be lifted, and the operative then places several fingers of one hand under the top thread and follows it until it crosses other threads. There again the top thread of the group is selected and is followed until another snarl is discovered, whereupon the top thread is again taken. This is repeated until the end is finally found, whereupon a sufficient amount of silk should be pulled from the skein to assure the operative that the true end has been found. While pulling the silk from the skein he should observe the rotating swift, and if it revolves with a jerky or wobbly motion, adjustments should be made to cause it to run smoothly.

13. Variation in Preparatory Operations.—The winding test, when performed in the testing house, is made on the raw unsoaked silk, whereas, in mill laboratories, a slight soaking is oftentimes given the silk before it is tested. The purpose of soaking is to soften the gum and furnish a lubricant so that the silk will work better in succeeding operations. The soaking is accomplished by immersing the silk in a warm solution of water, olive oil, and olive-oil soap and allowing it to remain there until the gum is softened. This process produces a single that is a great deal more pliable than the wiry raw-silk single. However, if the skeins possess any hard gums, it is probable that additional soaking liquid must be applied to soften those parts. Should this procedure be necessary, it is customary to rub and separate the gummy portions so that the clinging threads will unwind without undue breakage. In the treatment of the gums, however, care must be taken to prevent unnecessary tangling or breakage of threads, since the silk, when in a moistened condition, stretches easily.

TESTING OPERATION

14. First Period of the Test.—The actual time required to complete the winding test is divided into two periods, known as the first period and the second period. In the first period, the end of one skein is wrapped around the barrel of a spare bobbin that is then placed in the running position on the winder. As the bobbin rotates, it winds, or takes up, the silk. The ends from the remaining skeins on the swifts are treated in the same manner. The winding operation of the first period is continued for 15 minutes, during which time the manner in which the silk winds is carefully observed. If a thread breaks, it should be tied immediately and the winding operation should be continued. If numerous breaks occur on the same skein, the troublesome skein should be carefully examined to determine the cause of the defect, and a notation should be made of it on a working sheet. Although the winding test furnishes a complete report of the running qualities of the silk, the breaks occurring in the first period are noted mostly for reference and are not reported in detail on the certificate, because the first period is considered as preparatory to the second period. In the first period, the outside threads that become snarled or tangled because of handling are carefully straightened and unwound. Obviously, the breaks that result from the clinging together and tangling of the threads when the skeins are placed on the swifts, are unavoidable and therefore should not be given in detail on the report.

15. At the end of the first period, the bobbins are stopped and removed from the winding frame, and each skein is carefully examined to determine its condition. If skeins are found that are snarled, tangled, ringy, and so on, they are further examined to ascertain whether the defective condition was caused by improper handling during reeling or by mishandling while being placed on the swifts. Should the examination disclose that the condition of the skeins resulted from improper handling and not from poor reeling, such skeins should be removed and not run in the second period of the test. In this case the test should be continued with the remaining skeins. Sometimes it becomes necessary to remove only one or two skeins. Should a greater number of skeins be removed, substitutions will be necessary, for the minimum number that should be run during the second period is eight skeins. The additional original skeins needed to replace the damaged skeins that are removed must be drawn from the bale. During both periods of the test, the atmosphere of the room wherein the winding frame is located should be kept at the correct humidity.

16. Second Period of the Test.—The second period is the actual testing period, for during this time the actual number of breaks of the threads of each skein are recorded, and the number of these breaks determines the winding quality of the raw silk in the bale. In the second period, the bobbins used in the first period are removed and a standard bobbin used in winding tests is placed on each spindle, and the end of the silk is wrapped around the barrel of the bobbin. As the thread winds on the bobbin it is directed between the heads of the bobbin by a thread guide to which a horizontal reciprocating motion is given so as to produce a smooth, firm bobbin. Proper attention should be given to the skeins during this period and small tangles or snarls that merely retard the bobbin, but fail to break the thread, should be untangled immediately. When threads break, they should be tied at once and the winding operation continued. If the thread from one skein or the threads from several skeins break with greater frequency than the threads from the remaining skeins, those skeins showing the breaks should receive additional attention and the winding should be assisted as much as possible. The winding operation should be continued until the silk is wound even with the heads of the bobbins.

17. The time required for the completion of the second period of the test is much greater than for the first period in order to wind an adequate length of thread on the bobbins. The yardage, of course, is dependent on the size of the thread; for, when silks of fine denier are wound, more time is required to fill the bobbin than when the silks are of a coarser size, and consequently the yardage will vary. Silks of about 13/15 deniers, that is, of 14-denier average size, require about an hour to fill the standard bobbin, during which time about 10,000 yards are wound. This yardage for the size of silk given, may be used as a basis for calculating the approximate yardage of silks of other deniers and to determine the time required to wind a certain yardage.

18. Weighing.—After the bobbins are filled they are removed from the winding frame and transferred to a reel. Here the silk is drawn from the bobbins and wound on a reel fly, thus producing skeins. This operation is performed with great care in order to avoid waste. The skeins are removed from the reel and are placed in a room wherein a standard atmosphere is maintained, and after they return to their normal moisture content, which return requires about 2 hours, they are weighed. Balances employed for this purpose are graduated in grams; after weighing, the weight of each skein is recorded on the working sheet and the total weight is found.

THREAD SPEED

19. Silk, during winding, is subjected to a strain that increases as the speed of the bobbin becomes higher. The silk will withstand this strain until a certain point is reached; but beyond that point the thread breaks with great frequency.

Therefore, in the winding test and also during the winding of silks in the mill, the speed of thread take-up must not be too high for the size of silk being wound. When the speed is too high in the winding test, the increased number of breaks reported on the certificate indicate that the silk is of poorer quality than is actually the case. For this reason, the speed of the winder must be adjusted according to the size of the silk.

20. In winding silk, either in the winding test or in the mill, the thread speed designates the rate at which the thread is being taken up on the rotating bobbin, and is usually expressed in yards per minute. Since the bobbin is driven at a constant speed, its number of revolutions per minute remains unchanged throughout the test. At the start, the thread is taken up at the surface speed of the bobbin barrel, which may therefore be considered as the minimum thread speed. As the bobbin becomes filled with silk, however, the working diameter gradually becomes larger and causes a corresponding increase in the speed of thread take-up. Hence, when the bobbin becomes filled, as at the completion of the test, the working diameter will be at its greatest and the thread will be taken up at the maximum speed. From this it can be seen that the thread speed constantly increases as the diameter of the bobbin becomes larger.

21. There are several methods of finding the thread speed on a winding frame. The following, which gives the approximate speed, is probably the simplest:

Rule.—*To find the thread speed, in yards per minute, divide the product of the circumference of the skein, in inches, and the number of revolutions per minute of the swift, by the number of inches in a yard.*

Example.—Find the thread speed in yards per minute if the circumference of the skein is 54 inches and the swift makes 100 revolutions per minute.

Solution.—Apply the rule, and the thread speed is,

$$\frac{54 \times 100}{36} = 150 \text{ yd. per min. Ans.}$$

22. The thread speed may also be calculated from the spindle by taking into consideration the speed of the spindle and the average circumference of the take-up bobbin. In that case the rule is as follows:

Rule.—*To find the average thread speed, in yards per minute, divide the product of the number of revolutions per minute of the spindle and the average circumference of the bobbin in inches, by the number of inches in a yard.*

EXAMPLE.—What is the average thread speed on a winding frame, if the diameter of the bobbin is $1\frac{3}{4}$ inches when empty and 2 inches when full, and the spindle speed is 800 revolutions per minute?

SOLUTION.—The average diameter of the bobbin is $\frac{1\frac{3}{4}+2}{2}=1\frac{7}{8}$ in., and the circumference is $3.1416 \times 1\frac{7}{8}$. Then, apply the rule, and the average thread speed is found to be

$$\frac{800 \times 3.1416 \times 1\frac{7}{8}}{36}=130.9 \text{ yd. per min. Ans.}$$

23. Instead of finding the average diameter of the bobbin, the thread speed may be calculated for the empty bobbin and also for the full bobbin, and the average of these two results will be the average thread speed. The advantage of this method is that it determines the maximum thread speed, which is that for the full bobbin; and the desirability of knowing the maximum rate of take-up of thread has already been pointed out. If the data given in the example of the preceding article are used, the minimum thread speed, or the surface speed of the bobbin barrel, is

$$\frac{800 \times 3.1416 \times 1\frac{3}{4}}{36}=122.1733 \text{ yards per minute.}$$

and the maximum thread speed is

$$\frac{800 \times 3.1416 \times 2}{36}=139.6266 \text{ yards per minute,}$$

the average of these two values being practically 130.9 yards per minute, as found in the solution of the example in the preceding article.

As the heavier sizes of silk withstand the strain of winding better than the finer sizes, it is customary to run them at a higher thread speed. The different rates of speed, therefore, are classed according to the denier size of the thread, as shown in Table I, which gives the average thread speeds in meters and in yards per minute.

24. It is desirable to maintain the average thread speed during winding; but the average speed is reached only when

TABLE I

AVERAGE THREAD SPEEDS FOR DIFFERENT SIZES OF SILK

Size of Silk Deniers	Average Thread Speed	
	Meters per Minute	Yards per Minute
Under 13	110	120
13 to 17...........	137½	150
Over 17	165	180

the bobbin is half full. At the start it is below the average, and at the end it is at a maximum, or above the average. If the bobbin used has larger heads than the standard bobbin, or is designed to hold a greater amount of silk, the average thread

TABLE II

CORRECT MAXIMUM THREAD SPEEDS FOR DIFFERENT SIZES OF SILK

Size of Silk Deniers	Maximum Thread Speed	
	Meters per Minute	Yards per Minute
Under 13	130	140
13 to 17...........	155	170
Over 17	180	200

speed may be correct for the thread being wound but the minimum speed will be low and the maximum speed will be too high. Therefore, in the calculating of thread speeds, it is advisable to find the maximum thread speed in addition to the average thread speed, so that the winding frame may be adjusted to take up the thread correctly at the completion of the test and at no time exceed the maximum thread speed. Excessive thread speeds are likely to reduce the value of the winding test by giving incorrect results. The correct maximum speeds are given in Table II.

CALCULATION OF WINDING-TEST RESULTS

25. The winding quality of the silk in the entire bale is determined from the results of the winding test, by calculation. All the information relating to the test, as well as the subsequent calculations that give the final result, is placed on the laboratory record sheet, one form of which is shown in Fig. 1. As shown in this record, some of the calculations are expressed as formulas, in which

B = number of breaks during period;
C = breaks per 100 grams;
S = average size of silk, in deniers;
W = weight wound, in grams.

If the number of breaks in each skein during the second period of the winding test is observed, and the gram weight of each skein is determined, the number of breaks in 100 grams of silk may be found by proportion. For example, suppose that a 13/15-denier silk shows twelve breaks in the second period, and that the reeling into skeins from the bobbins is done without waste, the reeled silk being found to weigh 152 grams. Then, the number of breaks per 100 grams, by simple proportion, is $x:12=100:152$, from which $x=(12\times 100)\div 152=7.894$. The number of breaks per pound may be found by multiplying the number of breaks in 100 grams by 4.5; thus, in the foregoing case, the number of breaks per pound is $7.894\times 4.5=35.523$.

26. It is often desirable to determine the approximate number of breaks in 100,000 yards. This is accomplished by multiplying the number of breaks per 100 grams by one-tenth of the average size of the silk being tested. In the example in the preceding article, a 13/15-denier silk, or a silk of

LABORATORY RECORD

Winding Test

Test No.______ Order No.______ Date ______ Kind ______

Marks ______ Bale No. ______ Chop ______

Average Size (S) 14 Denier

TEST

Speed of Winding 150 Yards per Minute

Condition of Gum Spots Very light

First Period: ______ Breaks 4

Remarks Skein 5, gum spots hard

Second Period: ______ Time 63 Minutes.

Skein Numbers		1	2	3	4	5	6	7	8	9	10	Breaks per ten
Breaks	1st ten	2	1	1		3		2		2	1	12
	2nd ten											
	3rd ten											

No. of Skeins Wound 10 Weight Wound (W) 152.0 Grams

12 (B) Breaks

Breaks per 100 Grams $= B \times \frac{100}{W} =$ 7.894 (C) Breaks

Breaks per Pound $C \times 4.5 =$ 35.523 Breaks

Breaks per 100,000 Yards $C \times \frac{S}{10} =$ 11.051 Breaks

Winding Quality (By Table III) Fair

Wound by ______ Weighed by ______

Computed by ______ Checked by ______

FIG. 1

14-denier average size, had 7.894 breaks per 100 grams; hence, the number of breaks per 100,000 yards is $7.894 \times \frac{14}{10} = 11.051$.

After the number of breaks has been found, it is desirable to compare the calculated results with a standard, and thus judge the winding quality of the thread. For this reason Table III is given, which shows the winding quality of threads, based on the calculated number of breaks per 100,000 yards.

TABLE III

WINDING QUALITY OF SILK, BASED ON BREAKS PER 100,000 YARDS

Number of Breaks per 100,000 Yards Not over	Winding Quality
5	Excellent
10	Good
20	Fair
30	Poor
Over 30	Very poor

For example, if the calculated number of breaks is less than 5 per 100,000 yards the silk would be regarded as of excellent winding quality. If the total number of breaks ranged between 20 and 30, the silk would be classed as poor in winding quality.

WINDING FRAME

27. General Construction.—The machine employed for winding silk in the winding test is identical in construction and operation with the winder regularly used in silk-throwing mills; hence, winding tests in mills are often made while the silk is being wound in the winding department. When this is done, however, the machine speeds must first be carefully checked, so that the thread speed will not be too high. The winding frame has two cast-iron end stands to which horizontal rails are attached, these rails being supported at intermediate points by cast-iron middle stands similar to the end stands. Securely fastened to the horizontal rails are the swift hangers that support the swifts. The object of the swift is to support the skein of silk during the winding operation. Directly in line with the swift hangers are the bobbin hangers, which support the bobbins that have previously been placed on spindles.

28. That part of a winding frame including one swift and its related parts is shown in Fig. 2. The raw-silk skein *a* is placed on the swift *b*, which supports the skein during the entire operation, and the end is passed upwards over the guide *c* and wound on the revolving bobbin *d*. The bobbin is supported on a spindle d_1 that rotates in the bobbin hanger, or spindle hanger, d_2, which forms part of the same casting that supports the swift. The bobbin hanger is attached to the horizontal rail *e*. The revolving bobbin draws the thread upwards and winds it on the barrel. At the same time a back-and-forth motion is given to the traverse bar c_1 and consequently to the guide *c* that it supports. The object of this traverse motion is to distribute the silk evenly between the heads of the bobbin.

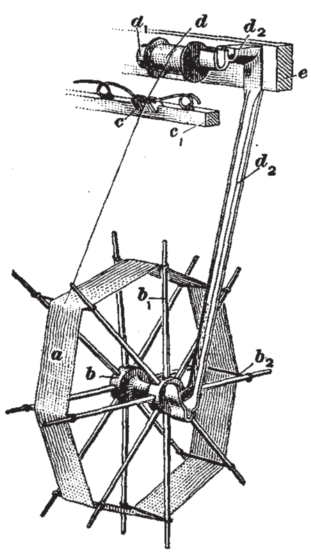

Fig. 2

29. Swifts.—The swift *b*, Fig. 2, is a holder that supports the skein while it is being unwound. A type of swift in common use is known as the *pin-hub swift*, which consists of a solid, wooden hub *b* having a set of six equally spaced holes at each end to receive the tapered wooden sticks b_1. Loops of string b_2 connect corresponding pairs of sticks and on these loops the skein of silk rests.

30. Bobbins.—To insure uniformity of test results, a standard bobbin should be used in all winding tests. What may be termed a standard bobbin for the winding test has two heads, each 2 inches, or 50 millimeters, in diameter, attached to a wooden barrel $1\frac{3}{4}$ inches, or 44 millimeters, in diameter. The length of the barrel, or the distance between the heads, is 3 inches, or 75 millimeters. Generally, the bobbins are carefully constructed of good materials, so that they may be made as light as is consistent with the use to which they are subjected. They should run without wobbling and be absolutely smooth, so as not to catch the silk and break the thread.

REGULAR SIZING TEST

TESTING OPERATIONS

31. Sampling.—The object of the regular, or 450-meter sizing test is to determine the average denier size of the raw-silk thread, and it is made by drawing a representative number of skeins from the lot and determining the denier size of the thread in these samples by weighing, in deniers, 450-meter lengths of thread. The method of sampling is the same as that described in Arts. **5** and **6**; but if a winding test and a sizing test are to be made on the same bale, the silk wound on the bobbins in the winding test may be used in the sizing test, thus obviating the necessity of drawing additional samples for the sizing test.

32. Winding Silk.—If a sizing test only is to be made on the silk, the original skeins selected for the test are placed on swifts and the silk is wound on bobbins. Before placing the skeins on the swifts, however, they should be carefully beaten out and arranged so that five skeins will unwind from the outside and the other five from the inside, exactly as in the winding test. Other precautions that were observed during that test should not be overlooked when winding the silk for the sizing test. Sometimes, especially in mill laboratories, the winding quality of the silk is noted and reported on the silk wound in the sizing test.

The time required to wind the silk for the sizing test is considerably less than in the winding test. This is to be expected, as, in the sizing test, it is not desired to find the running qualities of the thread but to wind a sufficient amount of silk on the bobbins so that the sizing-test skeins can be made.

33. Reeling Test Skeins.—After a sufficient amount of silk has been wound on them, the bobbins should be removed from the winding frame and placed on the sizing reel. The ten bobbins should be arranged on the bobbin shelf of the sizing reel in a staggered manner, so that there will be ample space between them. The thread is pulled upwards over the head of each bobbin and thence is led to the reel. After the threads have been passed through the guides and drop wires of the stop-motion, and tied to the reel arms, or to small screw eyes provided for this purpose on the inside of the reel arms, the reel should be set in motion. After running long enough to wind the required 450-meter test skeins, the reel is stopped automatically. The test skeins thus prepared are referred to as sizing skeins. After the first set of skeins has been reeled, the threads leading from the bobbins are broken; also, the end of each skein that was fastened to the reel arm is broken. Then the two ends are twisted once around each other, looped through the skein, and tied with a small knot. This operation is known as *banding off*. Skeins are not always banded off in this manner; sometimes the ends are tied together without being looped through the skein.

34. After the first set of ten test skeins has been reeled and banded, the guides that direct the thread to the reel are moved slightly to one side. This may be easily done, as the guides are fastened to a bar, and by moving the bar all the guides will be shifted the same distance. This distance is small, as it is necessary to shift the guides only far enough so that the strands of silk forming the second set of skeins will not be wound in contact with those of the preceding set. The reel is then started and permitted to run until it stops, and after the second set of skeins has been reeled and banded off, the guides are again shifted to one side, the reel is started, and a third set of skeins is prepared in the same way as before. The reel will then hold thirty banded skeins, each 450 meters in length, and since this is the number required for the sizing test, the skeins are removed from the reel. One reel arm is so constructed that it may be collapsed, thus relieving the tension on the skeins and allowing them to be easily stripped from the reel.

35. The sizing reel should always be located in a room that is equipped with automatic temperature and humidity control, in order that the atmosphere will be maintained in standard condition and the silk be worked with the normal moisture content. However, even though the test is performed in a standard atmosphere, a certain amount of moisture is given up by the skeins, due to the fanning action produced by the rapid rotation of the reel. Therefore, after the reeling operation is completed, and before weigh ing, the skeins should be exposed to a standard atmosphere until they have assumed a normal moisture content, which should require from 1 to 2 hours.

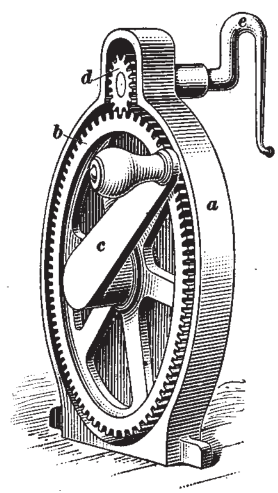

Fig. 3

36. Before they are weighed, the individual test skeins are frequently twisted into compact form by means of a sizing-skein twister such as that shown in Fig. 3. The brass housing *a* encloses the bronze spur gear *b* and carries the stud on which the gear is rotated by turning the chank *c*. The pinion *d* meshes with the gear and is fixed to one end of a short shaft that. is formed into a hook *e* at the other end. The device is firmly attached to a solid support, so that it may be used readily. The loop at one end of the skein is slipped over the hook, the other end is held in the hand, and the crank is turned until the skein is twisted tightly. Then the skein is removed and doubled and the free end is passed through the loop that was on the hook. The skein will untwist slightly when it is released, but will still be more or less compact. Sometimes the twists are not uniform, and, for the sake of appearance only, the looser portions are drawn tight.

37. Weighing Test Skeins.—When the skeins have been in the standard atmosphere long enough to absorb a normal amount of moisture they are carefully weighed twice. The first weighing is done on a special skein balance for silk, the total number of skeins being weighed at one time. The weight of the thirty skeins is taken in grams or deniers, but the result is reported in deniers. In the second weighing, the skeins are weighed individually on a direct yarn-numbering quadrant, or quadrant balance, which gives the weight of the skein in deniers, and consequently the denier size of the silk. The skeins should be weighed carefully and the reading of the scale should be taken to the nearest half-denier. After the thirty skeins have been separately weighed in this manner, their weights are added and the total is compared with the first weight, or collective weight of the skeins. The two weighings should not differ by more than one-half denier.

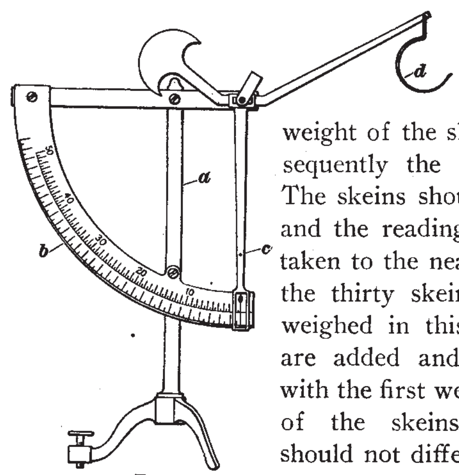

Fig. 4

An illustration of a direct yarn-numbering quadrant is given in Fig. 4. The column *a* is attached to a three-legged cast-iron base and supports the scale *b*, which is graduated in deniers. The pointer *c* is firmly attached to an arm that carries the hook *d* and that is formed into a counterweight at the opposite end. The pointer and the arm are pivoted on a pin held by the upper bar of the quadrant and are free to swing. The skein to be weighed is hung on the hook *d*, pulling it downwards and thus causing the pointer to swing toward the left. When the pointer comes to rest, the denier weight of the silk in the skein suspended from the hook is read from the scale.

One precaution that must be taken, when weighing silk on this type of scale, is to see that the column *a* is perpendicular, adjustment being made by turning the thumbscrew in the base of the balance. If the column is not perpendicular, the pointer will not register zero when the hook is unweighted.

RANGE

38. Since the weight of each test skein is recorded when the silk is weighed on the direct yarn-numbering quadrant, the difference in the weights, or the variation in size, may be readily seen. Such variation, of course, is caused during the silk reeling operation. At times, heavier cocoon ends are reeled than the weight required, thus producing a silk single that is heavier than the desired size. Again, cocoons are allowed to run out, so that at times an undersized end is reeled. Later, when the silk is tested, the test skeins made of portions that are heavy will show a coarser denier size than those made of parts that have an insufficient number of cocoon ends. Variations of this kind are found in all silks, but they are quite marked in some silks, especially those of a low grade. The difference between the finest size and the coarsest size shown by a sizing test, or the amount of variation in size, is usually referred to as the *range*, or *spring*. Suppose, for example, that a silk is tested for size, and it is found that the finest size is just 11 deniers, while the size of the coarsest silk is $17\frac{1}{2}$ deniers. Then the range is $17\frac{1}{2}-11=6\frac{1}{2}$ deniers.

CERTIFICATE FOR SIZE

39. The certificate regularly employed in connection with the sizing test, one form of which is shown in Fig. 5, is so designed that it will accommodate all the data placed on the working sheet during the test. The data shown on the card illustrated indicate that the test was made on ten skeins of yellow Japan raw silk that were drawn from the bale. The procedure for obtaining these data is as follows: After the ten original skeins are wound and reeled into thirty smaller skeins,

United States Testing Co., Inc.
OFFICIAL TESTING HOUSE FOR
The Silk Association of America

Certificate for Size, Twist, Elasticity & Tenacity

No. D Duplicate

New York, ______________ 19

Certificate for Messrs. ______________

for Test made on sample of Yellow, Japan Raw. 10 skeins.

SIZING			Tests made on 20 inch length: First Twist	Tests made on 20 inch length: Second Twist	Elasticity	Tenacity
10½	14½	16				
12	14½	16				
12½	14½	16½				
12½	15	17				
13½	15	17				
13½	15½	17½				
13½	15½	17½				
14	15½	17½				
14½	15½	18½				
14½	15½	19				

Total Addition 454.5	*Average:*
Total Weight 454.0	*First Twist,* *Turns per inch*
Average Size on Actual Weight 15.13	*Second Twist,* *Turns per inch*
Average Size on Condition Weight	*Elasticity*
Average Number of Thousand Yards per Pound 295	*Tenacity*
	Signed for the Company

Charges, $

N. B.: The samples are 450 meters long, weighed in half Decigrams. The average size is calculated on the total weight taken before the partial weights.

Elasticity in Millimeters Tenacity in Grams

Laboratory: 340 Hudson Street, New York.

Telephones 8751 / 8752 *Spring*

FIG. 5

the total weight of the thirty test skeins is found to be 454 deniers. The skeins are also weighed individually and the weights are recorded as they are found, but in arranging these denier sizes on the certificate, the finest size is placed first and the coarsest size is placed last, with the others in order between. By subtracting the finest from the coarsest size, the range in this case is found to be $19-10\frac{1}{2}=8\frac{1}{2}$ deniers. By adding all the denier weights, the total weight is found to be 454.5 deniers, which differs by only $\frac{1}{2}$ denier from the total weight or 454 deniers; hence, the difference is within the allowable limit.

After the total weight has been found, the *average size on actual weight* is determined by dividing the total weight of the skeins by the number of skeins taken. Thus, in the case illustrated, the average size on actual weight is $454 \div 30 = 15.13$ deniers. The number of thousand yards per pound is also reported on the certificate. It is found by dividing the number of yards in 1 pound of a 1-denier silk by the average denier size, or $4{,}464{,}528 \div 15.13 = 295{,}077.86$ yards, which may be stated as 295,000 yards, in round numbers.

SIZING REEL

40. Construction.—The sizing reel, illustrated in Fig. 6, has a reel fly, or swift, *a* with six equally spaced arms held in position by the spiders a_1, forming a reel having a circumference of $112\frac{1}{2}$ centimeters and capable of winding 450 meters in exactly 400 turns. The spiders that support the reel arms are mounted on a shaft a_2 that extends the entire width of the reel and carries at one end the leather-covered pulley *b*. This pulley is located above a large driving pulley, not shown in the illustration, that in turn is mounted on the shaft that carries the pulley *c*, which is driven by belt from a small electric motor *d* mounted on a cross-brace of the frame. The motor develops about $\frac{1}{6}$ horsepower and drives the reel at approximately 300 revolutions per minute.

41. At the front of the machine, Fig. 6, is the bobbin shelf *e* that supports the bobbins prepared for the test. The thread from the bobbins is led upwards over the heads of the bobbins and passes over a bar *f* securely attached to the machine. This bar changes the direction of the thread with a minimum of friction. From the rod, the ends pass through the porcelain guides *g*, are threaded through the drop wires g_1, then through the second set of porcelain guides g_2, and are tied to the reel arm. The guides *g* and g_2 are not in a direct

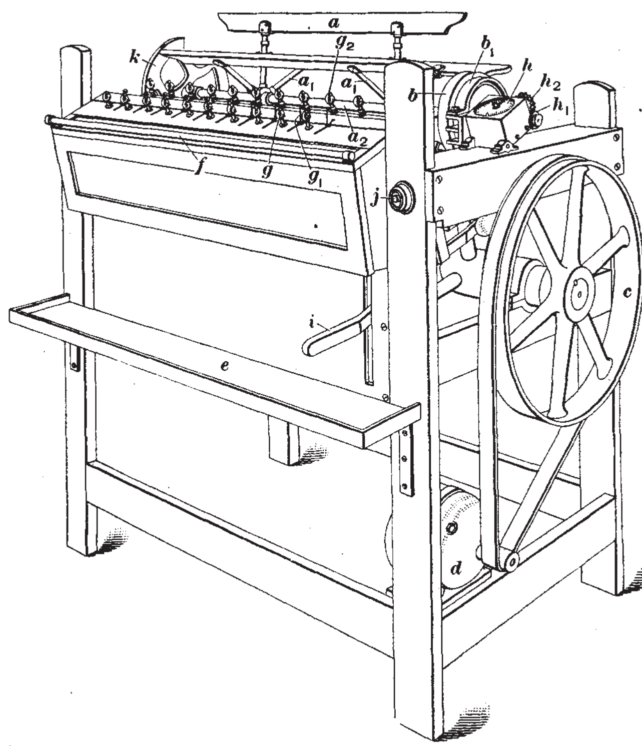

FIG. 6

line; therefore, while the ends are intact and running, the drop wires g_1 will be held in an upright position, but when an end breaks, the drop wire will fall backwards and, by means of an electrical device, cause the stop-motion to operate.

The stop-motion is also brought into operation by the measuring mechanism when the correct length of thread has been reeled. The clock h, located on a cross-bar of the frame, records the number of turns made by the reel and is driven from the reel shaft a_2 by a worm h_1 and a worm-gear h_2. It is hinged to the cross-bar, so that it may swing upwards when the reel fly rises during stopping. Although the clock swings, its worm-gear remains in mesh with the worm on the reel shaft, thus assuring that the correct number of turns will always be recorded. The clock is usually adjusted to stop the reel after 200 revolutions have been made, resulting in a 225-meter test skein. To reel a regular test skein of 450 meters, the reel is started again and allowed to run until another 200 revolutions have been made.

42. The stop-motion of the reel, Fig. 6, acts when a thread breaks or when a test skein of the required length has been reeled. When the starting handle i at the front of the machine is lifted, it allows the leather-covered pulley b to come in contact with its driving pulley, thus causing the rotation of the reel. When the reel is stopped by the stop-motion, the handle drops, causing the leather-covered pulley b to be raised out of contact with its driving pulley. Simultaneously, the contracting brake band b_1 applies pressure to a step of smaller diameter that forms part of the leather-covered pulley. By raising the pulley b from its driving pulley and applying the brake at the same time, the reel may be brought to a stop within $\frac{1}{4}$ revolution after the stop-motion acts. If it is desired to stop the reel at any instant, the operative presses the button j, which is connected to the electrical circuit by which the stop-motion acts. The effect of pressing the button is the same as the breaking of a thread or the automatic action of the measuring clock; that is, the reel is brought to a stop.

43. One of the arms of the reel, Fig. 6, is so constructed that it may be moved toward the reel shaft. The skeins are thus relieved of tension and may easily be moved to one end of the reel. To enable them to be removed from the reel without lifting it from its bearings, the end of the shaft opposite the drive-pulley end is fitted with a broken wheel k, frequently referred to as a skein taking-off device, shown to a larger scale in Fig. 7. The wheel is made with a deep notch in the edge and is grooved along its circumference so as to fit snugly over a corresponding tongue on the casting k_1 fixed to the frame of the machine. The shaft a_2 of the reel is carried by a bearing at the center of the wheel. After the skeins have been stripped from the reel arms and drawn to the end next the broken wheel, one side of the loop of the skeins is dropped into the notch in the wheel. The skeins are then held tightly and one full turn is given the wheel by means of the handle near its outer edge, which will free the skeins from the shaft and allow them to be removed.

44. Operation.—After the motor d, Fig. 6, has been started, the bobbins containing the silk to be reeled are placed on the bobbin shelf. The end from the first bobbin is brought upwards and passed through the guides and drop wire provided for the first end, and is then tied to an arm of the reel or attached to some form of device that is employed to hold the thread. The remaining threads are passed through their respective guides and drop wires and are attached to the reel arm in like manner.

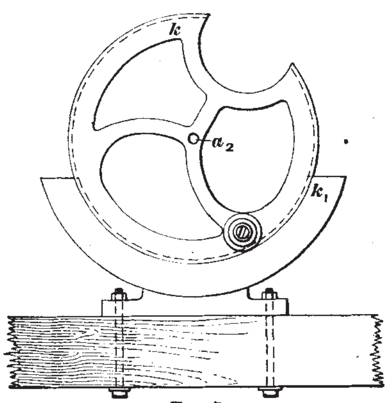

FIG. 7

Then the bar that holds the guides g_2 nearest the reel is adjusted so that it will cause the ends to wind in the first position. The clock is inspected, and the pointer is set to register zero on the dial, if it does not already do so. Next, the starting handle is lifted to start the fly and this movement usually lifts the drop wires to their running position, thus removing the strain from the ends of silk. When the reel is in motion, however, the handle should be released, so that it is free to fall whenever the stop-motion acts. Care should be taken to see that the automatic stop-motion is in working order during the entire test. If an end or several ends break, the reel should stop immediately; otherwise, short skeins are likely to be formed. Also, the reel should stop positively at the completion of the test, so that long skeins will not be produced.

VARIATIONS IN SIZING TESTS

AMERICAN SIZING TEST

45. Another sizing test that is very frequently made is the American sizing test, which differs from that just described only in using skeins 225 meters in length instead of 450 meters. The objects of the American sizing test are threefold. First, to ascertain the variation in the weight of the test skeins, the weights of the individual skeins being expressed in deniers. Second, to obtain the average weight of the test skeins, in deniers. This is found by adding and averaging the weights of all the test skeins. Third, to find the average denier size of the silk, the average being based on the regular 450-meter test skein.

The samples for the American sizing test are drawn from the bale in the same manner as for the regular sizing test, and the silk is then wound on bobbins. If it is tested for its winding qualities, then the bobbins prepared in that test may be employed immediately. The reel on which the test skeins are produced should be adjusted so that it will stop at the end of 200 turns, or when 225 meters has been wound. After thirty test skeins of 225-meter length are reeled, they should be removed and a second set of thirty skeins should be wound, making a total of sixty test skeins, which are weighed collectively on a skein balance, and the total denier weight is obtained. The skeins are then weighed on a direct yarn-numbering quadrant and the individual weights are found, and the total of these weights is checked against the collective weight. Then, the total weight of the skeins when weighed collectively, divided by the number of test skeins, will give the average weight of the test skeins.

46. Since the range of the silk is more accurately determined when a greater number of test skeins is taken, the result of the test on 225-meter skeins will be more exact than that on the 450-meter skeins. Though the regular test skeins are twice as long as those in the 225-meter test, the range found in the latter test cannot be converted into range of the 450-meter test by multiplying by two. If the results of the American sizing test are multiplied by two to obtain the range in the regular sizing test it must be assumed that the 225 meters of thread in the skein contains exactly as many fine and coarse portions as in the longer skein. This, however, is not the case; for, from actual tests, it is known that the range in the 450-meter test is always less than twice the range found in the 225-meter test.

As the average weight, in deniers, of 225-meter skeins gives only one-half the actual denier size, it must be multiplied by two to obtain the actual denier size; however, the average denier size may also be found by dividing the collective weight of the sixty skeins by 30.

CONDITIONED SIZING TEST

47. The sizing tests that have been described give the size of the thread as found. It is assumed that the silk contains a normal amount of moisture when it is weighed, as it is exposed to a standard atmosphere for at least an hour before the skeins are weighed. Occasionally, however, it is desired to obtain a more accurate result in the sizing test; so, to insure that the moisture content is absolutely correct, a conditioned sizing test is performed. In a conditioned sizing test, the test skeins are prepared in accordance with the kind of test. Thus, if a conditioned sizing test is to be made in conjunction with a regular sizing test, the thirty skeins, each 450 meters long, are prepared in the manner described for that test. After they are reeled, the skeins are placed in a conditioning oven and dried to absolute dryness, and their weight in deniers is found. Then the legal regain of 11 per cent. is added to the bone-dry weight and the result is divided by 30, the number of skeins taken. The result is the average conditioned size of the silk. The average size on conditioned weight is reported on the regular certificate for size, illustrated in Fig. 5, being placed directly under the average size on actual weight.

48. Conditioned sizings are also applied to the American, or 225-meter, sizing test. The procedure in this case is exactly as described for the regular sizing test. After the absolute dry weight of the sixty test skeins of silk has been found, 11 per cent. is added, to give the conditioned weight of the test skeins. The average conditioned size in the American sizing test is then found either by dividing the conditioned weight of the sixty sizing skeins by 30, or by dividing the total weight of the sizing skeins by 60 and then multiplying this average weight by two.

COMPOUND SIZING TEST

49. Infrequently, a compound sizing test is made on silks for the purpose of obtaining a more exact determination of the average size than is found in the foregoing tests. In the compound sizing test, greater accuracy is insured since longer test skeins are used. Thus, twenty original skeins are drawn from one bale and a test skein, 4,500 meters long, is reeled from each, so that 90,000 meters of silk is available for weighing. The weight of this length of silk is taken in deniers and from the result the average denier size is calculated.

DETERMINING SIZE OF THROWN SILKS

50. The method of finding the size, or count, of thread after it is thrown is similar to that used in the sizing of raw silks, but a different system of yarn numbering is used. Thrown silks, with only rare exceptions, are sized by what is known as the *dram system,* the size of the silk being designated by the weight, in drams, of 1,000 yards of yarn. The method of procedure is to reel 1,000 yards of yarn and to weigh this in drams, the result being the size of the yarn in drams. For instance, if 1,000 yards of thrown silk weighs 4 drams, the yarn will be known as a 4-dram silk. Should the 1,000-yard skein produce too much waste in the reeling, a 500- or 250-yard skein may be prepared, and the resultant dram weight may be multiplied by two or four, as the case may be, to obtain the size of the silk.

COHESION TEST

COHESIVE QUALITIES OF SILK

51. Definition of Cohesion.—Cohesion, as used with reference to the silk fiber, may be defined as the resistance of the cocoon filament to separation of the brins. It is known that silk as it leaves the spinneret of the silkworm is composed of two brins that are held together by the sericin. If portions of the fiber are devoid of gum, or if the percentage of gum is very low, the resistance to separation of the brins will not be great. If, on the contrary, the brins are evenly coated with a sufficient amount of sericin, their resistance to separation will be considerably greater.

Since a single cocoon filament is entirely too frail to be employed for commercial purposes, several filaments are grouped to produce a usable thread. When preparing this thread, the cocoons are immersed in hot water to soften the sericin, and the ends from a certain number are gathered and formed into a thread. The thread is wound on a reel, and during this operation a peculiar twist, known as a *crossing,* is given to the silk. This causes the individual filaments to be united into one thread, or raw-silk single, that is well covered by the softened sericin. When dry, the thread is firm and solid, but it remains pliable at all times. Thus, the term cohesion, as applied to commercial raw-silk thread, refers to the resistance of the raw-silk single to separation of the cocoon filaments.

The cohesion of raw-silk singles varies according to the species of worm producing the silk, but it is also affected by several other factors that are more or less under the control of the reeler. The most important of these is the length of the twist or crossing. If the silk is reeled with a short crossing, it is usually inferior in cohesive qualities to silk reeled with a crossing of correct length. The longer crossing produces a better grade of silk, but the output of the reel will be decreased, since its speed must be reduced.

52. Measurement of Cohesion.—When grading raw silk, inspectors formerly used either one of two methods of determining the degree of cohesion possessed by the silk. One method was to grasp a single thread of silk with both hands and gradually stretch it until it broke. The broken ends were then carefully examined, and if they appeared as though they were cut with a sharp knife, and the brins of the cocoon filaments were still tightly bound together by the sericin, the thread was considered as having good cohesion. If, on the other hand, the brins were broken and separated, and not of approximately the same length, the thread was considered to have poor cohesion.

The second method employed by the silk inspectors was a friction test. A raw-silk single was tightly wound several times around the forefinger of the left hand and prevented from unwinding by the pressure of the thumb. The tightly wound turns were then scratched, or rubbed, with the finger nail until they parted or split, into the several cocoon filaments from which they were produced. The cohesive quality of the silk was then judged according to the number of times the singles were scratched before they opened. Thus, silks that were firmly agglutinated required a greater number of scratches to open the singles than poorly agglutinated silks required. With this method of testing the cohesion, the results obtained even by the same inspector were not uniform since the pressure exerted on the thread was not constant. The results of these tests assisted in grading silks, but other factors were considered before the grade was fixed.

53. Object of Cohesion Test.—In practically all silk-manufacturing processes, the thread is subjected to a certain amount of friction while it is being made into the desired product. When threads are knitted into fabrics, the silk is subjected to friction and chafing while passing through the knitting needles of the machine. In the production of woven goods, the ends are subjected to friction in passing over guides, around tension wires, and through drop-wire eyes. When being warped, they pass through the reeds on the warper; and in weaving they are guided through heddles and also the reed in the loom. While in the loom, the threads are under constant tension, and this, together with the rubbing and chafing produced when the loom is in operation, frequently causes the silk to fray and split. A report of the workable qualities of the silk is very desirable, especially if it is obtained before the silk is to be used. To obtain this information in advance, silk is frequently subjected to the cohesion test. The object of the cohesion test is to determine the amount of agglutination of the several cocoon filaments that compose the raw-silk single, and from this result to ascertain the relative degree of compactness of the single. The test is made by arranging a number of strands closely side by side on a flat, smooth card, known as a cohesion card, or mirror, and then subjecting these strands to the friction and pressure of a roller that moves back and forth over them until they are opened into their individual brins. The number of strokes, or movements, of the roller required to open, or split, the threads, is the measure of the cohesive quality of the silk.

PREPARATORY OPERATIONS

54. Sampling.—Samples for the cohesion test may be obtained in either of two ways. Thus, five original, or intact, skeins are selected from the bale of silk, and from these skeins is taken the silk that is employed in the test. The skeins are drawn directly from the bale when only a cohesion test is to be made. But if on the other hand, the winding test, or any other test requiring the silk to be wound on bobbins, has been made, then five bobbins are selected for the cohesion test. This is permissible, as the silk prepared on bobbins was wound from original skeins and passed through operations similar to those that are necessary in preparing silk for the cohesion test. However, silk previously subjected to a moisture test, a conditioned sizing test, or any other test that may affect its physical qualities, should not be employed; for the purpose of the cohesion test is to determine the degree of cohesion of the

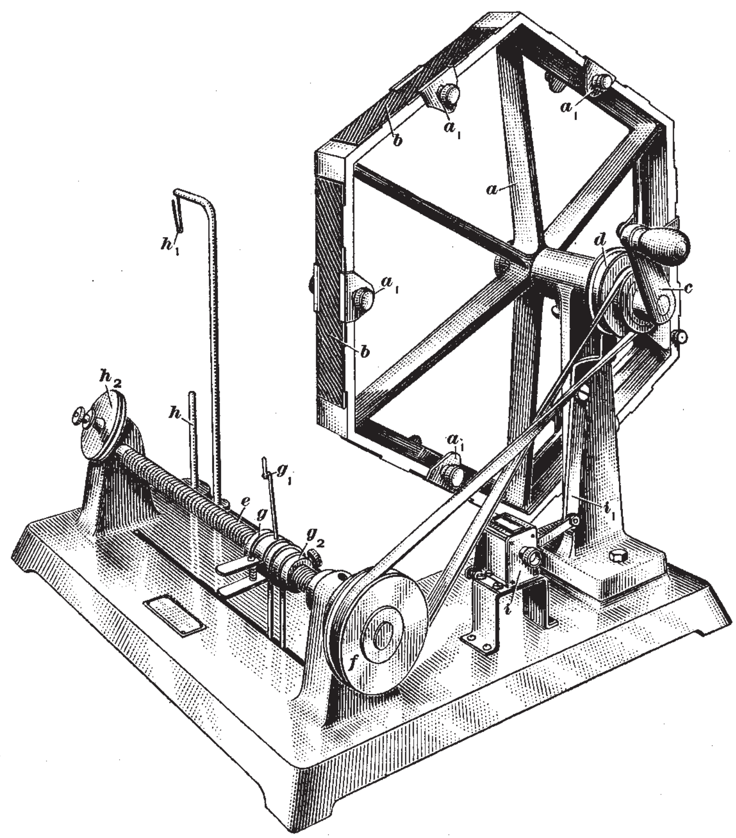

Fig. 8

cocoon filaments in the raw-silk single, and if these are damaged before the test, misleading results will follow.

55. Cohesion-Card Winder.—The machine used in preparing cards for the cohesion test is of the form shown in Fig. 8. The six-sided reel a carries clamps a_1 by which the six cohesion cards b are held in position during the winding operation. The reel is fixed to a shaft supported in a bearing on an upright bolted to the base plate of the winder. The reel is turned by means of the handle c and with it turns the two-step pulley d. A threaded spindle e in front of the reel carries a two-step pulley f that is connected with the pulley d by a crossed belt; thus, when the reel turns, the spindle e rotates. On the spindle is a split nut g, to the upper half of which is fixed the thread guide g_1, and the rotation of the spindle e thus causes the nut and the thread guide to move slowly from one end of the spindle toward the other. At the start, the carrier g is snug against the adjustable stop-collar g_2 on the spindle.

56. The bobbin from which the silk is to be unwound is placed on the spindle h, Fig. 8, and the thread from the bobbin is carried up over the hook h_1 and then down to the tension device h_2, the purpose of which is to keep a uniform tension on the thread during winding. The tension device consists of two flat disks that are pressed together by a spring on the central stud. The thread passes between the disks, and the tension is increased by screwing down the nurled nut, which puts the spring under greater compression and increases the pressure of the outer disk against the inner one. From the tension device the thread is led through the guide g_1 and fastened to the reel. The reel is then given fifty turns by means of the handle c, the number being noted on the counter i, operated from the reel shaft through the arm i_1. The turning of the reel rotates the spindle e and moves the thread guide g_1, so that, at the end of 50 revolutions, there are fifty strands laid closely side by side over the cards on the face of the reel. Usually these fifty strands occupy a width of 1 inch.

57. Before the winder is started, when preparing a set of cards, the revolution counter i, Fig. 8, is set to zero, by turning the nurled head that projects from one side. Also, the carrier g should be set over against the collar g_2. The carrier has a short arm attached to each half, and when these arms are pressed together, the two parts of the split nut are forced apart, thus disengaging them from the thread on the spindle e, after which the carrier may easily be moved over against the stop-collar. The speed of the carrier, and hence the distance between strands on the cards, may be increased by shifting the belt to the larger step on the pulley *d* and the smaller step on the pulley *f*.

58. Removal of Cards.—After the fifty turns of thread have been wound on the reel, the winder is stopped and the thread is broken and tied to the reel so the wound threads will remain taut. Narrow strips of gummed paper are pasted across the wound silk at the ends of each card, to hold the strands in their correct relative positions on the card, and the threads extending from one card to the next are cut. The clamps are then removed, the six cards are taken from the reel, and each is carefully inspected. The one that contains silk most closely representing the average condition of the silk on the six cards is selected for the cohesion test. Ordinarily, one out of the six will be found suitable for the test; but if all the cards have defects as to evenness and cleanness, or if 50 per cent. or more of the threads are uneven, the whole set of six should be rejected and a new set prepared from the same bobbin. The card for the test is selected with such care, because the cohesion of the average threads of the lot is desired, and not that of the fine or coarse ends.

Sometimes, instead of the winder illustrated, an ordinary wrap reel is used to prepare the samples. The strips of cardboard, or *mirrors,* as they are also called, are attached to the reel arms by means of paper clips and the silk is wound on them in the usual way, after which gummed strips are pasted across the threads and the cards are removed from the reel.

59. Requirements for Cohesion Cards.—The cohesion cards, or mirrors, employed in the cohesion test are made of cardboard of high quality and hard surface, usually black in color to furnish a contrasting background for the white or yellow silk threads. The cardboard should be of a uniform quality throughout, as hard places will cause the thread to open, or split, more quickly during the cohesion test, whereas soft spots will retard the opening of the threads as much as 2 or 3 per cent. The thickness of the cardboard must be uniform, so that the threads will be acted on by the roller during the full length of its stroke. The cohesion card that is supplied with a new machine should be used as a sample for quality when purchasing new stock and as a pattern for size when new cards are to be cut.

60. Conditioning Samples.—As five original skeins are selected from the bale, and one card is chosen from the six that are prepared from each skein, there will be five cards in the lot prepared for the cohesion test. Before they are subjected to the testing operation, they should be placed in a room in which a standard atmosphere is maintained, and be allowed to remain at least an hour, at the end of which time they may be assumed to have reached a standard condition. The machine used in making the cohesion test should also be located in a room having a standard atmosphere, to insure that the silk shall contain the correct content of moisture at all times.

COHESION MACHINE

61. Construction and Operation.—The machine on which the cohesion test is made is illustrated in Fig. 9. The mechanism by which the moving parts are driven is contained inside the metal case *a*, the power being derived from a small electric motor connected by belt to a pulley on a shaft that projects through the side of the case. When the machine is in operation, a to-and-fro movement is given to the two carriages *b*, which move in opposite directions. At each end of each carriage is a clamp b_1 by which the cohesion card, or mirror, is firmly fixed to the carriage. Care must be taken to have the card flat against the carriage throughout its length. The arms *d* that carry the rollers *c* in the brackets c_1 are then swung down so as to bring the rollers against the silk on the cards. The arms *d* are pivoted on pins *e* so that they may be swung out of the way when cards are to be inserted or removed.

62. Each carriage *b*, Fig. 9, has a starting lever *g* by which it may be set in motion independently of the other. When the cards are in place, the starting levers are shifted and the carriages move back and forth in the guides b_2 at a speed of 120 strokes per minute, the length of stroke being about 2 inches. Their movement should be smooth and regular. The rollers are about $\frac{1}{4}$ inch in diameter and slightly wider than the carriage, and are made of highly polished tool steel. To increase the friction of the roller against the threads, it is set at an angle of $87\frac{1}{2}$ degrees to the line of motion of the carriage.

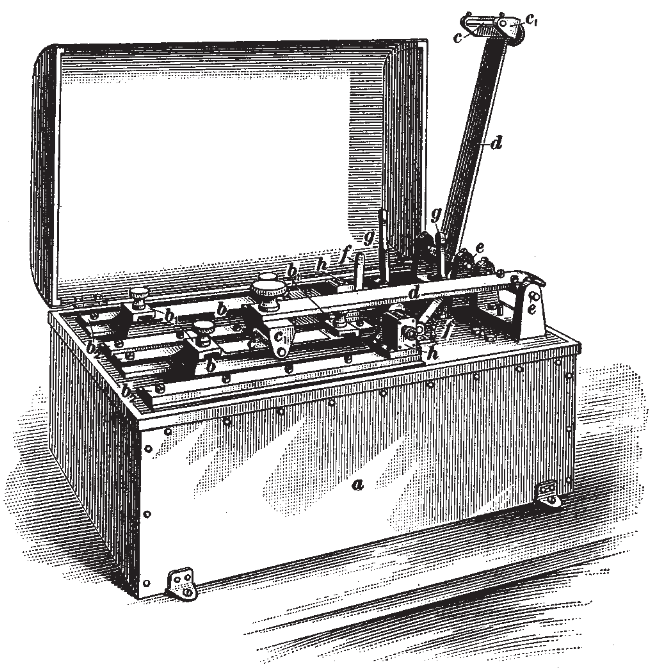

FIG. 9

The friction thus developed is assumed to be equivalent to that which the thread would receive in the loom. A counter *h* is connected to each carriage to register the number of strokes made. One forward and one backward movement of the carriage together comprise one stroke as registered by the counter.

63. When the carriage has been in operation for a time deemed sufficient to cause the threads on the card to open, it is stopped by shifting the lever *g*, Fig. 9, the arm *d* is raised, the clamps are loosened, and the card is removed, so that the threads may be examined. The card is bent slightly, to cause the threads to become slack, and a strip of thin metal is inserted between them and the card and turned on its edge, thus raising the threads. They should then be very carefully examined, to see whether they are open completely. If they are not, the card is reclamped in the carriage and the test is continued, but the sample is removed for examination at the end of each additional 50 strokes. When all the threads are open, the test is ended, and the number of strokes registered by the counter is recorded as the result of the test. Usually, the threads open at about the same time, so that all are parted at the close of the test; but, if some of the threads do not open, the test is brought to an end when 90 per cent. of the threads are open. Each of the five sample cards is tested in this manner, and the results are recorded on a blank of suitable form.

64. Sometimes it is desired to raise the roller *c*, Fig. 9, slightly from the carriage so as to relieve the pressure on the bearings. In this instance, the arm *d* is raised, allowing the rest *f* to swing into a vertical position. This rest is a lever of **L** shape, pivoted at the angle of the bend, and its short horizontal arm is weighted, so as to cause the longer arm to swing to a vertical position as soon as the arm *d* is raised. The arm *d* is then supported by the rest *f* and the roller is about $\frac{1}{2}$ inch above the carriage. When the roller arm is to be lowered so as to bring the roller into the operative position, the unweighted end of the rest is pressed downwards and the roller arm may then be lowered.

65. Cohesion Test Report.—A form for recording the results of a cohesion test is shown in Fig. 10. From the data shown, it is apparent that five sample cards prepared from five skeins were tested, each card containing fifty strands. The number of strokes required to open at least 90 per cent. of the threads on each sample is recorded in the table at the center of the report, the total being 6,050, or an average of 1,210 per sample. The lowest number of strokes required was 1,150

LABORATORY RECORD

Cohesion Test

Test Number ______ Order Number ______ Date ______ Kind ______

Marks ______ Bale Number ______ Chop ______

TEST

Number of Sample Skeins 5 Number of strands on card 50

Sample Skein	Number Strokes
1	1300
2	1250
3	1150
4	1150
5	1200
Total	6050
Average	1210

Extremes 1150 to 1300

Tested by ______

FIG. 10

and the greatest was 1,300, and these extremes are separately recorded, to indicate the maximum variation in the results. The cohesive quality of the silk is judged from the test results by making use of Table IV. For example, the silk whose test results are shown in Fig. 10 would be graded as having fair cohesive quality, because the average of five cards is not less than 1,100 strokes and no individual card required less than 800 strokes. If, as may sometimes happen, the number of strokes for an individual card is less than the minimum specified in the table, another card prepared from the same skein should be tested.

66. Starting New Machines.—When a new cohesion machine is received at a testing laboratory, it should be very

TABLE IV

GRADES OF COHESION OF SILK

Grade of Cohesion	Average of Five Cards	Individual Cards
	Number of Strokes Not Less Than	
Excellent	1,500	1,200
Good	1,300	1,000
Fair	1,100	800
Poor	1,000	600

thoroughly cleaned before it is used. Usually the polished parts, such as the rollers and their bearings, are covered with a heavy coating of grease, and the arms, carriages, clamps, and other bright parts are smeared with a film of oil or grease. This is applied soon after the machine is built, to protect it from moisture and prevent rusting. The grease generally collects dust and grit; hence, in cleaning the machine, the bulk of the grease should be removed first, and a more careful cleaning should follow. Otherwise, the adhering grit may scratch the smooth surfaces when they are rubbed with a cloth. The grease may be removed easily by wiping the parts with a cloth that has previously been dampened with gasoline or alcohol. After the grease is removed, the roller should be polished by rubbing it with a cloth sprinkled with a small amount of powdered chalk. The chalk must be of very high grade; for, if it contains dirt or grit, it is likely to scratch the roller. A roller damaged in this way may injure the silk during a test and cause inaccurate results to be recorded.

67. Adjustment and Care of Rollers.—After the rollers are polished, an empty cohesion card should be placed on each carriage and clamped in position. The rollers should then be lowered on the cards and the carriages set in motion, exactly as in an actual test. After about 4 hours of running, the machine should be stopped and the cards carefully examined to determine whether the roller comes in contact with the entire surface of the card. If the roller touches all parts of the surface and exerts uniform pressure throughout the stroke, the card will appear shiny, or glazed. However, if the roller presses against one edge only, the part in contact with the roller will be shiny and the remaining parts of the surface will not be affected. When one side of the card is thus found to be higher than the other, a paper liner should be placed under the low side of the carriage guide, to bring it level and in contact with the roller across its entire width and at all parts of the stroke.

68. It is very important that the roller be held loosely in its bearings, so that it will turn freely during the test. To test this, it is a good plan to draw the fingers rapidly over the roller before each test, and cause it to spin. By noting how long the roller continues to spin and whether it has a uniform speed, the operative can readily ascertain if the roller binds in any way; for binding will be evidenced by a jerky motion, and by the fact that the roller will stop very quickly.

The roller is likely to become gummy in passing back and forth over gummy silks; or, moisture may collect on the roller and cause corrosion. Also, in testing the freedom of the roller by spinning, perspiration from the hand may be deposited on the polished surface; therefore, the roller should be thoroughly cleaned immediately after each spinning test, by using powdered chalk and a soft cloth. The roller should be lifted from the carriage when the machine is to remain idle for any length of time. This is done by raising the roller arm and allowing the arm rest to swing into the vertical position. Then the lid of the case should be closed to protect the various parts from dust and moisture.

69. Oiling.—All moving parts of the cohesion machine should be well oiled, and if the machine is in constant use, this point should receive periodic attention. The guides in which the carriages slide should be oiled frequently with a light machine oil. The worm and worm-gears inside the case should be lubricated with a half-and-half mixture of cylinder oil and machine oil. This mixture is poured into the gear housing, which should be kept three-quarters full. The bearings of the rollers which are subjected to constant friction during a test, should be lubricated with a very light oil. These bearings are **V**-shaped and when they are properly oiled, the rollers will rotate with very little friction. During the oiling of the machine, oil should not be allowed to run on the rollers, as it would then come in contact with the silk. All excess oil should be wiped from the bearings and rollers with a cloth dampened in gasoline.

SILK TESTING
(PART 2)

Serial 5001B — Edition 1

EXAMINATION QUESTIONS

Notice to Students.—*Study the Instruction Paper thoroughly before you attempt to answer these questions.* **Read each question carefully and be sure you understand it;** *then write the best answer you can. When your answers are completed, examine them closely and correct all the errors you can find; then mail your work to us.*

(1) What is the object of the regular, or 450-meter, sizing test and how is the test made?

(2) What is meant by *range,* or *spring,* as used in connection with sizing tests?

(3) Explain how, after the outside of the ten selected skeins has been determined, the skeins are placed on the swifts, and why is this procedure followed.

(4) State the purpose of the winding test.

(5) Explain how, in the regular sizing test, the thirty test skeins are weighed, on both the special skein balance and the direct yarn-numbering quadrant.

(6) Explain fully the qualities that should be possessed by cohesion cards used in the cohesion test.

(7) What is the object of the cohesion test and how is the test made?

(8) When finding the correct speed at which silk of a certain size should run in the winding test, why is it advisable to calculate the maximum thread speed, in addition to the average thread speed?

(9) How are sizing skeins removed from a sizing reel equipped with a broken wheel, or skein taking-off device?

(10) (*a*) When starting a new cohesion machine, how can it be ascertained whether the roller is in contact with the entire width of the card? (*b*) What should be done if one side of the card is not touched by the roller?

(11) Describe the operations necessary when removing cohesion cards from the cohesion-card winder.

(12) Why does the reel shown in Fig. 6 stop when the button *j* is pressed?

(13) What are the objects of the American sizing test?

(14) In making the cohesion test, how may the threads on the cards be easily examined?

(15) How much time is allowed for the first period of the winding test, and what observations are made during this time?

(16) Why are conditioned sizing tests made on raw silks, and how is the conditioned size found?

(17) Exactly 125 grams of a 14/16-denier silk is wound in the second period of the winding test, with only ten breaks. (*a*) Find the number of breaks that would occur in winding 1 pound of silk. (*b*) Find the number of breaks per 100,000 yards.

Ans. (*a*) 36; (*b*) 12

(18) If the bone-dry weight of sixty sizing skeins, each 225 meters long, is 400 deniers, what is the average conditioned size of the silk? Ans. 14.8 deniers

(19) A bobbin $1\frac{1}{2}$ inches in diameter when empty, is used in a winding test. If it makes 900 revolutions per minute, and is 2 inches in diameter when full, what is the average thread speed? Ans. 137.445 yd. per min.

(20) If the total weight of thirty test skeins, each 450 meters long, is 645 deniers, what is the average size of the silk, in deniers? Ans. 21.5 deniers

Mail your work on this lesson as soon as you have finished it and looked it over carefully. DO NOT HOLD IT until another lesson is ready.


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