The Project Method of Teaching

SILK THROWING

PART 2

By
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INSTRUCTION PAPER
WITH EXAMINATION QUESTIONS
PREPARED ESPECIALLY FOR
INTERNATIONAL CORRESPONDENCE SCHOOLS

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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.

Rules are printed in *italics;* they, too, are important; you should learn to repeat them without looking at the book. With rules are usually given *Examples for Practice.* Work all of these examples according to the rules, but do not send us your work if you are able to get the right answers. If you cannot get the correct answer to an example, send us all of your work on it so that we can find your mistakes. Use one of our Information Blanks.

After you have finished studying part of a lesson, review that part; that is, study it again. Then go on with the next part. When you have finished studying an Instruction Paper, review all of it. Then answer the Examination Questions at the end of the Paper. It is not well to look at these questions until you have finished studying and reviewing the whole Paper.

Answer the Examination Questions in the same order as they are given and number your answers to agree with the question numbers. Do not write the questions. If you cannot answer a question, write us about it on an Information Blank before you send in any of your answers.

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.

INTERNATIONAL CORRESPONDENCE SCHOOLS

SILK THROWING
(PART 2)

OPENING, SOAKING, AND DRYING
(Continued)

SOAKING RAW SILK

SOAPS FOR SOAKING SILK

1. Although various kinds of soap are used in the preparation of soaking solutions for raw silk, it may be said, without serious contradiction, that only the very best and most suitable soap obtainable should be employed for this purpose. This is true not only because silk is so valuable, but also on account of the fact that the material is very easily damaged if a soap that is unsuitable for the purpose is used. A soap that is not suitable for soaking raw silk, or that is of poor quality, may not only act harmfully on the silk and cause difficulty and an increased amount of waste in throwing and weaving, but also may seriously depreciate the value and quality both of the thrown silk and of the waste made during the manufacturing operations.

2. Certain requirements must be fully met by any soap that can be used with entire satisfaction for soaking silk. One of the first considerations is that such a soap must not injure the physical properties of the silk, including its strength, luster, *feel*, or *handle*, flexibility, and thread structure. In fact, no change in physical condition should be made that will alter the inherent nature of the silk or the facility with

which the material can be worked in succeeding processes. Another very important requirement is that a soap for soaking silk must contain no ingredients that will remain on the fiber and not be removed during the ordinary processes of boiling off and dyeing, either of thrown silks or the fabrics made from them. The soap, moreover, must not impart a yellow color to white silks, nor should it stain the silk in any way that will prevent perfect shades being obtained when the subsequent dyeing of light colors is undertaken. Soaps made with cotton seed oil are apt to be highly colored and are likely to stain the silk.

3. To the throwster, also, it is extremely important that a silk-soaking soap shall not dissolve, or discharge, the natural silk gum of raw silk. The primary object of soaking raw silk is not to remove this gum, but to soften it so that the silk can be unwound from the skeins without undue breakage and so that it can be worked to advantage in other processes. Should the gummy material that envelops and protects the raw-silk thread be dissolved to any marked degree by the soaking solution, not only will the silk be softened too much to work well in throwing and other processes, but the loss in weight of the silk will cause an appreciable amount of invisible waste in throwing that cannot be accounted for in the ordinary mill-waste calculations. This is a matter of great moment to the public, or custom, throwster who must account for all of the silk shipped to him by his customers.

4. An alkaline soap has a tendency to dissolve the silk gum and, hence, it is desirable to employ a soap for soaking that is neutral, or that contains as small an amount of free caustic alkali as is possible. In addition, free alkali has a tendency to injure and diminish the luster of the fiber, thus destroying, to a greater or lesser extent, one of the most desirable characteristics of silk. Most soaps contain traces of free alkali, but for soaking silk, a soap should contain no appreciable amount of uncombined alkali.

5. Soaps for soaking silk should not contain any considerable percentage of uncombined fatty matter, since such soaps

tend to become rancid if left on the silk for some time. Soaps made from palm oil and coconut oil, while free from objectionable color and of an easily soluble nature, also have a tendency to become rancid. A silk-soaking soap should not leave a strong or objectionable odor upon the material. Castor-oil soap, for instance, is easily soluble and softens the silk gum in an efficient manner, but imparts to the silk a very strong odor that clings to the fiber with great tenacity. It is desirable to the throwster that the soap used for soaking shall dissolve quickly when boiled to prepare the soaking solution, and also that it shall have a positive and comparatively quick, but mild, action in softening the silk gum.

6. Soap is a material that is easily adulterated and, moreover, may contain an excessive amount of moisture. In purchasing soap that is not pure and that has not been made by a reputable manufacturer, the throwster, therefore, may pay for excessive weight if the soap contains a large percentage of water and, at the same time, he may pay for ingredients that have no value as softening agents for soaking silk, and that may be positively injurious to the silk. For instance, cheap soaps are often *filled* with sodium chloride (common salt), silicate of soda, starch, fullers' earth, clay, and similar materials. Such substances have no desirable softening action on the silk and, in addition, are apt to injure it by diminishing the luster, strength, and feel of the fiber. Moreover, certain fillers that are sometimes employed enable a soap to absorb and retain an abnormal amount of water.

7. In addition to mineral loading, soaps that are sold for soaking silk sometimes are adulterated with tallow, resin, wax, unsaponifiable oil or grease, and other materials that should not be used in the treatment of silk. In general, there is no excuse for using cheap and adulterated soaps for silk soaking. Such soaps, while sold at a price that is a few cents cheaper than the cost of pure soaps, are expensive to use and actually expensive to the throwster if consideration is given to the increased amount of such soaps that must be employed in the soaking solutions. A good hard soap in the customary cake,

or bar, form should not contain more than 28 to 30 per cent. of moisture and practically no insoluble matter, certainly not more than $\frac{1}{2}$ per cent. Soaps that are supplied in chipped or granulated form generally contain small percentages of water since the moisture is driven off during the process of manufacture.

8. Soaps that may be purchased for soaking raw silk may be made from olive oil, red oil, tallow, lard oil, rape-seed oil, peanut oil, corn oil, palm oil, coconut oil, cotton seed oil, and other oils or fats of similar nature. Without doubt, a white or green, hard, olive-oil soap that is neutral is best adapted to silk soaking. Such a soap is made with a caustic-soda base, but some throwsters contend that an olive-oil soft soap, made with a potash base, is superior. Others claim that the potash in a soft soap has a tendency to discolor white silks. In the majority of cases, a hard soap is employed. Soaps made from red oil are frequently employed for silk soaking and such soaps often serve the purpose in an excellent manner. Red-oil soaps, like olive-oil soaps, if pure, are very soluble, free from odor, and easily removed from the fiber. Sometimes, silk-soaking soaps are made from a mixture of olive oil and red oil. Such soaps often give excellent results and are not too expensive for practical operations on a large scale.

9. Either olive-oil soaps or red-oil soaps may be adulterated by the use of other oils or greases. In general, tallow and lard oil are unsuitable for silk-soaking soaps. Palm-oil soaps and coconut-oil soaps are apt to become rancid if left upon the silk for some time. Some throwsters, however, defend the use of coconut oil. Cotton seed oil is very highly colored in some cases and is likely to stain the silk. Castor oil leaves an unpleasant odor on the material. Many soaps for silk soaking are sold under trade names and brands, but the throwster should learn the nature of such soaps before using them. Some brands are of excellent quality while others are of doubtful worth. Reputable soap manufacturers are generally willing, and even desire, to furnish analyses of their products.

10. Olive-Oil Soaps.—A pure, well-made, neutral soap manufactured from a good grade of olive oil is undoubtedly

the safest and best soap to employ for soaking silk. Olive oil is obtained by pressing olives, obtained principally from California and the southern parts of Europe. Olive oils imported from Italy are said to be adulterated less frequently and to make the best silk soaps. The olives are gathered when ripe and ground into a pasty mass which is pressed to extract the oil. The oil obtained by the first pressing of the olives is known as *virgin oil* and is chiefly used for table purposes. This oil is colorless and of superlative quality, but it is too expensive for making soap. The oil, however, is not entirely removed by the first pressing of the olives. The material is now subjected to further treatments and pressings and oils varying from pale yellow and light green to very dark green are obtained. These oils are generally spoken of as *olive-oil foots* and vary greatly in quality and in freedom from adulterants. However, when a good grade of foots, free from impurities, is employed, an excellent grade of soap for soaking silk may be produced. Formerly, throwsters used large quantities of Marseilles soap for soaking silk. Originally, this was a pure olive-oil soap but the name is used so indiscriminately today and adulteration is so prevalent that no dependence can be placed on soap sold by this name.

11. Olive-oil soap is often received by the throwster in bars that weigh about 4 pounds each. A careful analysis of such a bar of olive-oil soap for silk soaking gave the following result which indicates an excellent quality of soap:

Constituent	Percentage
Water	27.00
Total fat	65.45
Free, or uncombined, fat	0
Total alkali	7.16
Free alkali	.02
Glycerine	0
Silicates and fillers	0
Carbonates	.33
Sodium chloride (salt)	.04
Total	100.00

12. Red-Oil Soaps.—In the treatment of tallow and fat to obtain glycerine and other products, a splendid oil for textile purposes is obtained. In this process, the tallow and fats are treated with steam under high pressure in suitable digesters. The high temperature involved in this process imparts to the oil, which is obtained by pressing the treated material in hydraulic presses, a color that varies from a light reddish yellow to a dark brownish red. While not generally considered to be the equal of olive-oil soap for soaking silk, red oil produces an excellent and easily soluble soap that is free from objectionable odor. Red oil is sometimes used to adulterate olive-oil soap and both olive-oil and red-oil soaps are often adulterated with light-bodied tallow or light-colored grease. These substances aid in the saponification of the olive oil or red oil and, in addition, cheapen the cost of manufacture. Olive-oil and red-oil soaps that are adulterated with tallow often appear brighter and feel harder and drier than a pure soap. Such soaps, however, are not so well adapted to soaking silk, although they may appear attractive and be sold for a few cents less per pound.

OILS FOR SILK

13. In England and on the continent of Europe, it is customary to soak raw silk in a solution composed only of a good silk soap dissolved in water. In America, however, most throwsters add a certain amount of oil to the soap solution and thus form an emulsion in which the silk is soaked. There can be no doubt that the addition of a good pure oil to the soaking liquor aids in softening the silk gum and lubricates the raw-silk thread so that it can be easily worked in machines that operate at high speed in accordance with American practice. The principal disadvantages in the use of oil in silk-soaking solutions are the difficulty of securing a suitable pure oil and of making a perfect emulsion in which the oil is suspended in the form of finely divided particles, with no tendency to separate out and rise to the surface of the soaking liquor. Some throwsters add a small amount of glycerine to the silk-soaking bath, but this practice is unnecessary.

14. The best oil to use in a silk-soaking solution is a pure olive oil. Such an oil is desirable since olive oil makes an excellent emulsion, does not become rancid easily, has a mild and pleasant odor, does not stain white silk, and is easily removed from the silk by subsequent processes. Olive oils, however, are often adulterated with cotton seed oil and other vegetable oils of a similar nature. Many throwsters use neat's-foot oil for soaking silk, but this oil, also, varies in quality, many of the cheap brands being adulterated, sometimes with mineral oils, although neat's-foot oil is an animal product. Pure neat's-foot oil is a fine light-colored oil that is obtained from the feet of neat animals, and that has qualities that make it well suited to the throwster's use. The oil is free from objectionable odor, if of high grade, emulsifies well, is easily removed from the silk, does not quickly become rancid, and lubricates the silk thread in an efficient manner.

15. A chemically treated neat's-foot oil is often employed for soaking silk; this oil is called *prepared oil*, or *soluble oil*, and is sometimes known as *silk oil*. Soluble oils are also prepared by chemically treating other oils; all such oils are so prepared that they will form an emulsion with water alone, no addition of soap or other materials to *cut* the oil being required. When made by a reputable manufacturer, such oils often are well suited for soaking silk and give excellent results. They are often sold under branded names and are guaranteed to prove satisfactory for the purpose intended. In general, such oils if carefully prepared, tend to form a uniform emulsion that will not separate even if allowed to stand for a considerable period of time. The danger in their use lies in the fact that unless carefully prepared by responsible manufacturers, prepared oils may contain acids, alkalies, or other substances that are injurious to the silk. Oils that are prepared to be soluble in water, also, may contain only a nominal percentage of oil, and the oil, of course, is the lubricant of the silk thread that is valuable to the throwster.

16. Mineral oils are occasionally used for soaking silk, but not to a great extent. Their use should be discouraged as,

in many ways, such oils are unsuitable for this purpose. Sometimes, however, the use of mineral oil is inadvertent, the throwster purchasing a supposedly suitable oil that has been adulterated with mineral oil. While mineral oil does not easily mix with water and form an emulsion, it can be successfully emulsified by the use of suitable chemicals and methods. Such an emulsion can be made that does not separate easily and that, as an emulsion, is all that could be desired. The great difficulty lies in the fact that any unsaponifiable oil, like mineral oil, if once separated out of the emulsion and deposited upon the silk is extremely hard to remove.

A very small amount of unsaponifiable oil will coat a considerable quantity of silk with a thin film of oil and, moreover, in a very uneven manner. This will result in very uneven dyeing and in the discoloration and deterioration of the finished fabric. Mineral oils mixed with lard oil, or some similar oil, are sometimes sold for soaking silk, but such oils should be avoided, even if they emulsify readily. Mineral oil is especially objectionable if the silk is subsequently to be dyed a light color.

TESTING SOAPS AND OILS

17. The accurate, quantitative analysis of soaps and oils is a matter that requires expert technical knowledge and an extensive laboratory equipment. Silk throwsters, therefore, should submit samples of suspected materials to a competent analytical chemist for analysis, preferably to an analyst who has a special knowledge of soaps and oils. Large throwing establishments, if they do not employ a competent chemist, often arrange with such an analyst to test every shipment of soap or oil received by them. In sending samples of soap or oil to a chemist for analysis, he should be supplied with about $\frac{1}{2}$ pound of soap or 8 ounces of oil. Complete tests cannot well be made with lesser amounts of the materials. Although a complete analysis of soaps and oils is beyond the province of most throwing mills, and should not be attempted, except with proper equipment, there are certain qualitative and rough, or mill, tests that may be made in connection with either soap

or oil the quality of which is suspected. Some tests of this character are described in the following paragraphs.

18. Moisture in Soap.—When soap contains an excessive amount of moisture, it is expensive if bought by weight, as is usually the case when silk-soaking soaps are purchased. A good, hard, soaking soap should not contain more than 28 or 30 per cent. of water. To determine the amount of water in soap, a small sample should be taken from the center of the bar, the outside crust of the bar, which is usually drier, being rejected. This sample should be placed in a clean, dry, light-weight saucer or dish and the dish and soap weighed very carefully. The weight of the dish, which has been previously ascertained, should be subtracted from the total weight to obtain the actual weight of the soap. Next, the dish with its contained soap, should be placed in a drying oven and the soap dried at a temperature of about 220° to 230° Fahrenheit, until the sample ceases to lose weight. This condition is reached when all of the moisture has been driven from the soap and may be determined by making several test weighings. After cooling, the dish and soap are again weighed, and the weight thus obtained is subtracted from the original weight of the dish and soap. The remainder represents the weight of the water in the original sample or soap. The percentage of moisture may now be ascertained by dividing the weight of the water by the original weight of the sample of soap.

EXAMPLE.—Weight of dish, $4\frac{1}{4}$ oz.; weight of dish and sample of soap, $9\frac{3}{4}$ oz.; weight of dish and dried sample, 8 oz. Find the percentage of moisture in the soap.

SOLUTION.—$9\frac{3}{4}$ oz. $-4\frac{1}{4}$ oz. $=5\frac{1}{2}$ oz. Weight of sample.
$9\frac{3}{4}$ oz. -8 oz. $=1\frac{3}{4}$ oz. Weight of moisture.
$1\frac{3}{4}$ oz. $\div 5\frac{1}{2}$ oz. $=.318$, or 31.8 per cent. of moisture. Ans.

19. Free Alkali.—The presence of free alkali in soaps, even in small quantities, may be readily determined by testing with a solution of phenolphthalein, which may be obtained from a druggist. Phenolphthalein is a yellowish-white, crystalline substance the alkaline solutions of which are red while its acid solutions are decolorized. For testing soap, a solution of

about 1 part of phenolphthalein to 500 parts of alcohol should be prepared, and only a few ounces of this solution are required for hundreds of tests. The method of making the test consists of placing a drop of the phenolphthalein solution upon a freshly cut surface of the bar of soap. If a red color is immediately developed, it is a certain indication of the presence of free alkali in the soap; but if the surface of the soap is unaltered in color, free alkali is absent. Soap solutions, also, may be tested for the presence of free alkali by adding a few drops of the indicator to a small quantity of the solution, the presence of alkali being indicated by the characteristic reddish suffusion. The phenolphthalein solution is very sensitive to alkali and all containers used for tests should be carefully washed and dried to avoid accidental contamination. The indicating solution is best kept in a small glass-stoppered bottle.

20. Filling and Loading Ingredients.—The presence in silk soaps of such substances as clay, starch, silicate of soda, and other filling and loading materials may be determined by making use of the fact that such substances are generally insoluble in alcohol. In making a test for these substances, a solution of the soap is made by dissolving it in pure grain alcohol. A pure soap will be entirely dissolved, but if a soap contains fillers and loading ingredients, these will settle out of the solution to the bottom of the container. The presence of silicate of soda as an adulterant in silk soaps can be ascertained by the use of sulphuric acid. In making a test for the presence of this substance alone, a solution of the soap to be tested is made with water, preferably distilled or rain water. Sulphuric acid is now added and the solution allowed to stand for some time. The presence of the silicate is indicated by a jelly-like cloud or precipitate at the bottom of the container, the fats contained in the soap, which is broken up by the acid, rising to the surface of the solution.

21. Free Acid.—A small amount of free acid in the oil used for soaking silk is not injurious to the fiber, since animal fibers, with which silk may be classed, tend to resist the action of mild acids. Olive oil often contains traces of acid that

may have been present originally or that may have developed during storage. Other oils of a fatty nature often contain a considerable amount of free fatty acid, due to the decomposition and breaking up of the oil into its constituent parts. These acids violently attack certain metals, especially brass and copper. Mineral oils rarely contain acid, unless sulphuric acid is present, due to careless manufacture. A comparatively simple test to detect the presence of acid in oil may be made with a phenolphthalein solution. In this case, a few drops of caustic alkali should be added to the phenolphthalein solution, to cause it to assume a pink color. A small quantity of this pinkish solution should now be added to a sample of the oil to be tested and the mixture well shaken. If acid is present in the oil, the phenolphthalein solution will become decolorized, as will be seen when it separates from the oil.

22. Detection of Mineral Oil.—Throwsters often desire to ascertain whether or not the oil employed for soaking silk has been adulterated with mineral oil. This may be accomplished in the following manner: First, a small piece of caustic potash—a piece about twice the size of a pea—is dissolved in approximately $\frac{1}{3}$ ounce of alcohol. Several drops of the oil that is to be tested are now added to this solution, and the mixture boiled for a period of 2 or 3 minutes. Next, add about $\frac{1}{4}$ ounce of distilled water, or rain water, and carefully observe the solution. If the solution remains clear, it may be considered that only fatty oils, presumably suitable for soaking silk, are present. Should the oil have been adulterated with mineral oil, even with as little as 2 or 3 per cent., the solution will appear roily, or turbid.

SOAKING SOLUTIONS

23. Quantities of Ingredients.—The relative percentages and amounts of soap, oil, water, and other ingredients, employed in preparing soaking solutions for raw silk, and the quantities of such materials used for soaking a given amount of silk, vary greatly. This variation is due to the

nature and kind of silk to be thrown, the character of the yarn to be produced, the kind and quality of soap and oil employed, and the ideas of the individual throwster as to the character of the soaking solution that is best adapted to the requirements of his work. Because of these variations in the practice of different mills, and on account of different conditions, no definite formula or recipe for preparing a soaking solution that will best serve for soaking raw silk can be given. Instead, each case should be considered individually and good judgment exercised in preparing a soaking bath that is best adapted to that particular lot of silk.

24. In preparing a soaking solution, one of the first considerations is the nature of the silk and the amount and hardness of the gum that it contains. The percentage of sericin, or gum, varies greatly in different kinds of silk and, also, in raw silks of the same kind in different seasons. Moreover, in a single season, there is often a considerable variation in different lots or shipments of one kind of silk, so that it often is desirable to alter the soaking solution when soaking different lots, even of the same kind of silk. In general, the yellow silks are harder and contain larger percentages of gum than the white silks. The actual amount of gum present may vary from nearly 25 per cent. in some yellow Italian and French silks to as low as 8 per cent. in some wild, or uncultivated, silks. Many of the silks from Japan and China contain in the vicinity of 18 per cent. of gum, but certain varieties of the Chinese product often contain slightly more gum than the Japanese silk.

25. When estimating the proper amount of soap and oil to use for soaking a certain silk, not only must the amount of gum in the silk be considered, but the hardness of the gum should also be given due consideration. The gums in some silks are softened much more easily than those in other kinds of silk. Such silks are of a naturally soft nature, while other silks may be characterized as hard. If soft silks are subjected to the action of strong soaking solutions, or treated for too great a period of time, they may be injured so that they will

fray and chafe badly during subsequent processes. In some silks, on the other hand, the gum spots where the skeins rested upon the bars of the reel, are so hard that stronger soaking solutions are required to soften them properly. It may be said, therefore, that consideration should be given to the amount of gum and the hardness of the gum in the silk, and also to the nature of the silk, when estimating the amount of soap and oil to employ in soaking it.

26. The character of the thrown silk yarn that it is desired to produce is also an important factor that must be taken into account in connection with the mixing of soaking solutions. Usually, the greater the amount of twist that is inserted in a thrown yarn, the greater should be the amount of soap and oil employed in the soaking solution. The reason for this is that the insertion of a large amount of twist, as in crêpe and other hard-twist threads, requires flexibility on the part of the silk in order that the twist may be inserted evenly and so that it will *set* well. If the twist in such yarns is even and sets well, the yarns will be more pliable and less likely to kink. On the other hand, organzine and tram—the latter especially—do not require a large number of turns of twist per inch and, hence, the silk from which they are made will not need to be softened and lubricated to so great an extent.

27. It also should be noted that when pure, high-grade soaps and oils are used for silk-soaking solutions, it is usually true that lesser amounts of these materials will suffice to give satisfactory, and even superior, results. For this reason alone, it is generally better to use the best soaps and oils that can be obtained for the purpose. In addition, capable throwsters carefully observe the results that they obtain and formulate soaking mixtures that give the best results in their own mills, and for the grades of silk that they use, and the kinds of thrown yarns that they produce. When throwing machinery is not operated at high speed, also, less softening of the gum and less lubrication of the silk is required to make the thread *machine* well in throwing.

It would seem that every lot of silk would require a different amount of soap and oil for the soaking solution, but it would be a very difficult matter to make such frequent alterations of the soaking bath. It is usual, therefore, for a mill to adopt one or more standard soaking solutions for the silks that are customarily thrown in that mill, and to change the proportions of soap and oil only when some exceptional lot of silk is to be thrown, and on special orders, or in view of other conditions.

28. If the highest grade soaps and oils are employed, raw silk that has fairly free gum can be thrown to advantage if the soaking solution contains as little as 1 per cent. of soap and 1 per cent. of oil. That is, for every 100 pounds of silk, 1 pound of soap and about 1 pint (1 pound) of oil would be employed. On account of the difficulty of obtaining soaps and oils of really high quality and because of the quality of the ordinary run of raw silks, many throwsters employ at least 2 per cent. of soap and 2 per cent. of oil in the soaking bath. This would mean 2 pounds of soap and about 1 quart of oil per 100 pounds of silk, but, for other reasons, most throwsters—public, or custom, throwsters, especially—use much larger quantities of soap and oil in soaking silk.

29. For Japans to be thrown into organzine and tram, from 1 to 5 pounds of olive-oil soap and from 2 to 4 pints of olive or neat's-foot oil are employed per 100 pounds of silk. For Chinas and tsatlees, similar variations in the quantities of soap and oil are made, depending on the nature of the particular lot of silk and the hardness of the gums. Cantons are often soaked in a solution containing about 4 pounds of soap and 3 pints of oil for each 100 pounds of silk. Italians are sometimes thrown without soap, only a soluble oil or an oil emulsion being employed. Usually, however, from 1 to 4 pounds of soap and up to 4 pints of oil are used for each 100 pounds of silk. In soaking silk for the production of crêpe yarns with seventy or eighty turns of twist per inch, or of other hard-twist threads, some throwing mills use as much as 8 pounds of soap and 12 pints of oil per 100 pounds of silk, although this is a very heavy soaking.

30. A solution that has been employed with success for soaking Japan silk, prior to the throwing of crêpe yarns, consists of 4 pounds of olive-oil soap and 12 pints of olive oil. For soaking silk for such hard-twisted yarns, the proportion of oil relative to the amount of soap is often increased to some extent and, often, to hold this oil in suspension and form an emulsion that will not separate, a small amount of borax is added to the solution. If an emulsion tends to separate so that the oil rises to the surface of the solution, after standing for some time, a small quantity of borax will usually remedy the condition.

31. Typical Soaking Solutions.—Although silk-soaking solutions are so variable in composition that actual mixtures which may be used in all cases cannot be given, the study of the compositions of a few typical solutions will serve to impart a knowledge of what constitutes good practice in this matter. By the careful observation of individual conditions and of the results obtained, mixtures can then be altered to suit individual cases and to obtain the best results. Some typical soaking solutions that have been used in actual work of a practical nature will, therefore, be given. These are as follows:

Good Quality Italians (*Medium Gums*)	
Water	80–85 gal.
Olive-oil soap	3 lb.
Olive oil	3 pt.
Temperature	80°–85° F.

Good Quality Chinas (*Hard Gums*)	
Water	80–85 gal.
Olive-oil soap	5 lb.
Neat's-foot oil	4 pt.
Temperature	90° F.

Cantons	
Water	80–85 gal.
Olive-oil soap	$4\frac{1}{2}$ lb.
Neat's-foot oil	3 pt.
Temperature	80°–85° F.

Good Quality Japan	
Water	80–85 gal.
Olive-oil soap	$3\frac{1}{2}$–$4\frac{1}{2}$ lb.
Neat's-foot oil	2–3 pt.
Temperature	80°–85° F.

Crêpe Yarns

Water	80–85 gal.
Olive-oil soap	6 lb.
Olive or neat's-foot oil	8 pt.
Borax	6 oz.
Temperature	85° F.

32. The period of time during which the silk was soaked in all of the foregoing cases was over night, or from 12 to 14 hours, and the quantities given are for 100 pounds of silk. If smaller or larger amounts of silk are placed in the soaking tubs, the quantities of the various materials should be altered in accordance. The silk was entered at the temperatures indicated, but no additional heat was applied to maintain the temperature. Instead, the soaking solution was allowed to cool in a natural manner.

ABSORPTION OF SOAP AND OIL

33. The amount of soap and oil absorbed by silk during the soaking process varies in accordance with the character of the silk, the amounts of soap and oil used in the solution for a given quantity of silk, the kind and quality of soap and oil, and the length of time that the silk is allowed to remain in the solution. In most cases, the silk will absorb from 50 to 70 per cent. of the total weight of soap and oil employed in the soaking mixture, and probably about 60 per cent. represents the average degree of absorption. The silk, of course, will absorb more soap and oil from a heavy, or strong, soaking solution than from a solution that contains smaller quantities of these materials, but the percentage of the total amount of soap and oil used in the solution that is absorbed, will be greater in the case of the weaker solution. That is, when heavy soaking solutions are employed, a greater percentage of soap and oil will fail to be absorbed by the silk and, hence, will be wasted.

34. In general, the strength of the soaking solution should be such that the silk will absorb just enough soap and oil to work well during the throwing and subsequent processes. When throwing operations are conducted in an efficient manner and only a reasonable quantity of waste is made, the absorption of soap and oil by the silk during soaking will just about counterbalance the loss of weight due to the waste produced in the throwing process. Manufacturers, importers, and others who have silk thrown on commission, therefore,

expect to receive from the throwster a weight of thrown silk yarn that is about equal to the weight of the raw silk that they shipped to him and, in many cases, the weight of the thrown yarn returned is even greater than the weight of the raw silk received by the throwster.

THROWSTER'S TINTS

35. When different kinds and qualities of raw silk are thrown at one time in a single establishment, or when different varieties and sizes of thrown yarns are produced, or work for various customers is simultaneously being done, some adequate method must be adopted in a throwing mill to prevent the mixing of different lots of silk. If this is not done, different lots of silk are almost sure to become mixed, and endless trouble will result. It is extremely difficult to separate mixed lots of silk and place each kind in its proper lot, because the material is so fine and differs so slightly from other lots that a most careful examination must be made. Often, each bobbin or skein will require examination to determine the direction of twist in the yarn, number of threads, size of yarn, and so on.

36. The manufacture of crêpe fabrics furnishes an instance that well illustrates the necessity for keeping silk yarns carefully separated. A crêpe fabric is distinguished from a fabric of ordinary construction by the possession of a crinkly appearance. This effect is obtained by the use of right-hand twisted and left-hand twisted yarns, and one of the principal factors in the successful production of the fabric lies in the care with which the correct arrangement of these oppositely twisted yarns is maintained. In a georgette crêpe, the warp, or series of threads that run lengthwise of the fabric, is arranged with two ends of right-hand twisted yarn alternating with two ends of left-hand twisted yarn. The filling, or series of threads that are disposed crosswise of the fabric, is arranged in a similar manner, two picks of right-hand twist alternating with two picks of left-hand twist. During, and after throwing, right-hand twisted and left-hand twisted yarns are similar

in appearance and can not be distinguished except by making a critical examination and untwisting the thread to ascertain the direction in which the twist has been inserted. It will be seen, therefore, how important it is to adopt some method of readily and quickly distinguishing different silk yarns, both during and after throwing.

37. For reasons similar to those that occur when different twists must be distinguished, it is always important to have some method of quickly distinguishing organzine, tram, or other yarns that are composed of different numbers of ends twisted together, or that are made of different kinds of raw silk, or of different sizes, or with other variations in structure. This is usually accomplished by tinting the silk during the soaking operation, certain tints representing certain kinds of yarn. As many colors, or tints, are used, as are needed for the kinds of yarn produced in the mill but it is usually best to select colors possessing as great a difference in appearance as possible, because it is difficult to distinguish some colors from others, especially by artificial light. The colors usually employed are pink, blue, yellow, purple, green, and so on.

38. In tinting silk during soaking, it is extremely important to use only a pure, throwster's, or water, tint that is made especially for the purpose. A coloring matter must be employed that will not dye, or chemically unite, with the silk fiber. Instead, the coloring matter must be of such a nature that it will merely stain the silk, and in such a manner that the color may be easily and completely removed during the finishing of the fabric. Throwster's tints may be obtained that are guaranteed not to discolor the silk fiber permanently and to be easily removed when required. These tints are usually supplied in powdered form and, since they are used only in small quantities, they are comparatively inexpensive.

39. The method of applying the tint to the silk is extremely simple. Usually, from 1 ounce to $2\frac{1}{2}$ ounces of the powdered tint, depending on the depth of the color that it is desired to impart to the silk and the recommendation of the

manufacturer of the tint, are dissolved in boiling water in a suitable receptacle. Then, a pailful of the soap and oil soaking solution is dipped from the tub in which the silk is to be soaked, and the dissolved coloring matter poured into it. The mixture is then well stirred and the pailful of solution poured back into the soaking tub, the whole being again stirred. The silk may now be soaked and, after soaking, will be found to be tinted in the desired manner. It is usually best when mixing a tint for silk, to use a small quantity of the coloring matter and make a light tint. This will enable the silk to be distinguished satisfactorily, the light tint will be more easily removed from the silk and, moreover, it will be less likely to discolor seriously the solutions employed in dyeing and finishing operations.

WATER FOR SILK-SOAKING SOLUTIONS

40. Effects of Impure Water.—In preparing soaking solutions for the treatment of raw silk prior to throwing, it is important that only a pure, soft water be employed. If the water available for the purpose contains either organic or inorganic, insoluble, solid matters in suspension, that is, if it is roily, or turbid, these matters are likely to be deposited upon the silk fiber during soaking. While some impurities of this nature may not cause much injury to the silk, others may coat and stain the fiber, diminish its luster, injure the feel of the silk, or render it difficult to obtain *level* shades in dyeing. Such water, therefore, should be clarified by filtration or settling before being used in a solution for soaking silk.

41. For soaking silk, however, the hardness of many natural waters is the most important defect to be noted. The hard nature of such water is due to the presence of soluble mineral compounds that have been dissolved by the water, the most common matters contained in solution being various compounds of calcium and magnesium. Hard water does not lather freely with soap, and before a soap emulsion can be formed with hard water, a considerable quantity of the soap will be utilized in softening the water. The use of hard water

in silk-soaking solutions, therefore, is expensive on account of the very considerable waste of high-priced, olive-oil soap. Moreover, if hard water is employed, the soap and oil used in the soaking solution are decomposed and the fatty matters contained in them unite with the calcium and magnesium compounds, which are also broken up, and form insoluble substances. These insoluble compounds are of a sticky, pasty nature and, being formed in the soaking solution, are deposited upon the silk while it is being soaked. They envelop the fiber more or less completely and are extremely difficult to remove on account of their insoluble and sticky nature. If not removed, moreover, subsequent dyeing and finishing operations are greatly hampered and the production of even, level colors is almost impossible.

42. Depending on the nature of the calcium, magnesium, or other compounds contained in hard water, the hardness may be considered to be either *temporary* or *permanent*. The latter designation, however, is a misnomer in a way, since any hard water may be softened by the adoption of correct methods.

43. Temporary Hardness.—Water that contains bicarbonates of calcium or magnesium in solution is said to possess temporary hardness, since such water may be softened by simply boiling it. The effect of boiling is to convert the soluble bicarbonates into monocarbonates that, in a practical sense, are insoluble in water and that, therefore, are precipitated so that the softened water may be drawn off. This method of softening water is not applicable to water that possesses permanent hardness and, in addition, is expensive for practical purposes since the softening takes place only gradually. Usually, temporarily hard water must be boiled for at least $\frac{1}{2}$ hour in order to soften it completely.

44. Permanent Hardness.—Water that contains in solution the chlorides or sulphates of calcium or magnesium, as is often the case, is said to be permanently hard. Boiling simply concentrates the hardness of permanently hard water,

and therefore serves no useful purpose. Moreover, water that is permanently hard may contain compounds other than those mentioned, and, in general, all such permanently hard waters must be softened by chemical means.

45. Water Softening.—There are several substances that will serve to soften both temporarily and permanently hard water. For instance, caustic soda will soften water that contains most of the compounds that ordinarily make water hard. While this substance would be too expensive, perhaps, for softening large quantities of water, it is entirely suitable for use in connection with the comparatively small amounts of water used by throwsters in soaking silk. From 3 to 5 pounds of caustic soda will soften 1,000 gallons of water, depending, of course, on the degree of hardness possessed by the water.

46. It is important, however, to have an analysis of the water used for soaking silk made by a competent analytical chemist. Moreover, such an analysis should be made from time to time, since the character of water frequently changes in some cases. An analysis of the water will disclose the compounds that make the water hard and the exact amounts of these compounds present. The chemist can then indicate what substance should be employed to soften the water and the exact amount of that substance required to neutralize completely the compounds contained in the water. This latter point is very important, since if too great a quantity of the chemical used for softening the water is introduced, the silk may be injured to a greater extent than would be the case if the hard water was used for soaking, without previously being softened. For instance, if an excessive amount of caustic soda was employed, free alkali would be introduced into the soaking solution and this, of course, would have a very deleterious effect on the silk.

47. Large establishments, that use large quantities of water, should always be equipped with some form of water-softening apparatus if they do not have an ample supply of water that is naturally suitable for manufacturing purposes.

Since such apparatus may also be obtained in small units, it often is desirable for even small throwing mills to install a water-softening device. The manufacturers of such apparatus will make an analysis of the water to be softened and supply a suitable arrangement, guaranteed to supply a specified quantity of thoroughly soft, pure water.

TREATMENT OF TUSSAH SILK

48. The wild silks, commonly called *tussah silk*, require a method of treatment previous to throwing that differs somewhat from the treatment accorded to domesticated, or cultivated, silks. Tussah silk is harsh, rough, coarse, and hairy, as compared with cultivated silk, and is difficult to throw. In fact, the throwing of wild silk always results in the production of a much greater percentage of waste than is made in throwing cultivated silks of average quality. The principal difficulty in the throwing of tussah, however, and the fact that makes differences in the preliminary treatment necessary, is the lack of cohesion in the raw thread. The silk, as imported in reeled skeins, usually consists of a single end composed of eight or sixteen cocoon filaments, although in some cases tussah raw silk will be found to have been reeled from four, twelve, or some other number of cocoons. These cocoon filaments, however, do not adhere to each other as closely and firmly in wild silk as in cultivated silk and, therefore, the filaments of the thread are easily separated so that the thread becomes loose and open. This condition is due to the nature of wild silks and to the somewhat different methods that must be employed in reeling them to produce the raw-silk single. The opening and roughening of the thread and the consequent breakage of many filaments is the principal difficulty in the throwing of tussah, causing much waste and tending to make the thrown yarn, rough, uneven, and hairy.

49. Because of its lack of cohesion and on account of its tendency to become roughened easily, tussah silk cannot usually be softened for throwing by soaking in a solution of

soap and oil in warm water, as in the case of cultivated silk. Instead, to soften the silk so that it may be successfully unwound from the skein and to enhance the cohesion of the thread so that it will work well during throwing, it is customary to treat tussah only with oil. Moreover, the silk is not entered into an oil bath, nor into an oil-and-water emulsion, but the oil is sprinkled or sprayed directly upon the opened skeins of silk. This is usually done by spreading the skeins of silk on a table and applying the oil with a whisk broom or with some simple form of sprayer or atomizer. The skeins should be turned over after one side has been oiled and the other side of the skeins treated in a similar manner.

50. After the oil is applied, the skeins of silk are allowed, in some mills, to hang on poles over night, or for a considerable period of time, before the silk is thrown. The object of this is to allow sufficient time for the oil to spread over all of the silk and to penetrate the thread. In some cases, this distribution and penetration of oil is effected by hanging the skeins for a period of 1 or 2 minutes in a box, or compartment, to which steam is admitted. This not only distributes the oil effectively but also allows the silk to be thrown immediately. Sometimes, the oil is applied to the silk while it is hung on poles, instead of being spread on a table or bench and, sometimes, each pole with its supported skeins is laid upon a table, the silk oiled, and the pole then returned to its proper place.

51. Olive oil, neat's-foot oil, coconut oil, and doubtless many other oils and special preparations are employed in treating tussah silk to improve its throwing qualities. In some cases, paraffin, beeswax, or other materials are added to the oil to improve the cohesion of the silk, and the oils and mixtures are sometimes applied warm and sometimes cold. One mixture that has been used with success consists of paraffin dissolved in warm neat's-foot oil in the proportion of 1 pound of paraffin to 2 quarts of oil. It requires a considerable amount of oil to treat the silk properly, but exact quantities cannot well be specified, since much depends on the method of treatment and the judgment of the throwster.

52. When tussah silks are thrown for sale on the open market, they are often loaded with a quantity of oil greatly in excess of the actual requirements for proper throwing. This is done to increase the weight of the thrown yarn and, of course, the profits of the venture. Thrown wild silks are often so oily that the oil is readily apparent, staining the paper or other material in which the silk is wrapped. Since this condition would be clearly evident to a prospective purchaser of the yarn, starch, chalk, or other substances are sometimes employed to dry the oil on the silk and render the oily condition of the silk less easily observed. Such practices, of course, should not be employed as they constitute abuses that are sure to react, sooner or later, on the throwster.

EXTRACTION OF WATER

53. Although some throwsters commence throwing operations with the process of winding while the silk is in a damp condition, it is clearly evident that the material cannot be worked upon the throwing machinery when it is in the saturated condition that results from the soaking of the raw silk. After the silk has been soaked for the required length of time, therefore, it must be taken from the soaking tubs and the excessive amount of water removed from the material. This is best accomplished by a machine known as a *hydroextractor*, but commonly called a *whiz*, or *whizzer*, in the silk trade. Hydroextractors are not designed to dry stock completely, but simply to remove the bulk of the water contained in various wet materials, and in a minimum of time.

SELF-BALANCING EXTRACTOR

54. In Fig. 1 a type of hydroextractor known as a self-balancing extractor is shown. The machine consists essentially of a wrought-iron casing *a* that is supported by the standards *b*. The standards are cupped out to receive the ball-shaped heads of the supporting rods *c*, which lead down to the lower flange of the casing and are there attached by

similar ball-and-socket joints. The necessary adjustments for leveling the outer casing and parts carried by it are secured by means of turnbuckles on the supporting rods. These may be securely fastened by means of check-nuts.

55. The basket *d*, Fig. 1, of the extractor is made of perforated metal and is built on a central shaft *e* supported at the

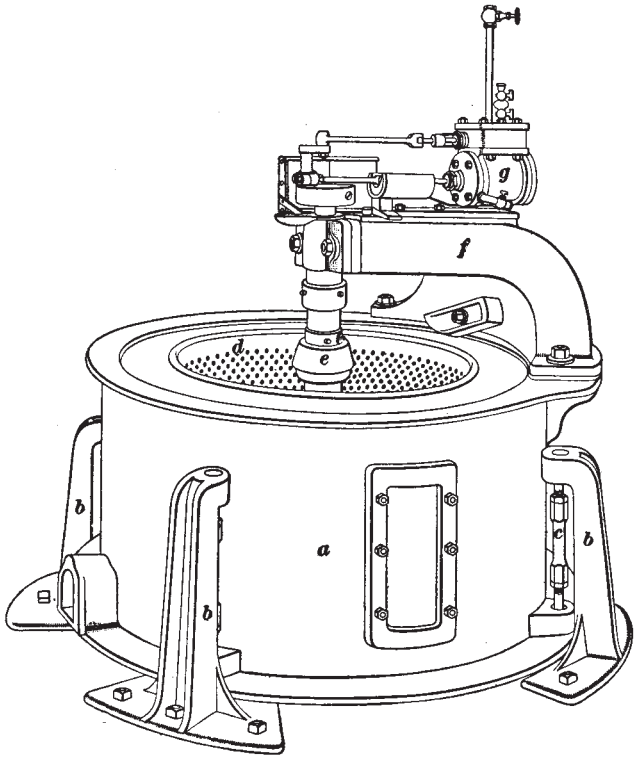

FIG. 1

top by a housing *f* that rises from one side of the outer casing and extends to the center of the machine. The basket is driven by a small steam engine *g* carried on the housing. The machine, therefore, requires no belting or shafting of any kind. The engine is attached directly to a crank on the shaft of the basket, and the loaded basket serves as a flywheel when the

extractor is in operation. This allows the basket to be started very quickly, as no time is lost by belt slipping, and the machine is at full speed in a few seconds.

56. Operation.—If the silk has been placed in soaking bags prior to the soaking process, the bags of silk are now removed from the soaking tubs and placed in the basket of the hydroextractor. The silk should not be taken out of the bags until extraction is completed. Also, if the silk is in bags while being extracted, great care in placing it in the basket of the extractor is not required, although the load should be evenly distributed to avoid excessive vibration when the basket is rotated at high speed. If, however, the silk has been soaked in opened and loosely tied skeins, great care should be exercised in packing the basket of the extractor in order to avoid tangling and matting the skeins. In this case, the skeins should be packed in the basket in such a manner that they will be kept straightened out as the basket rotates. Sometimes, this is accomplished by packing the bundles of skeins carefully in a single layer against the wall of the basket, although sometimes the basket is more heavily loaded. In other cases, the skeins are doubled once in the middle and laid in the basket so that the doubled part of the skeins faces the direction in which the basket rotates. In any event, the basket of the extractor should be packed carefully and evenly and the silk not just tumbled in.

57. The machine is now started by giving the basket a twirl in the direction that it rotates and admitting steam to the engine. In a few seconds, the basket attains a high rate of speed and the water is driven through the perforated sides of the basket by the centrifugal force generated by rapid rotation. The water forced from the silk is retained by the outer casing, from which it passes off as waste water through a suitable outlet in the casing. In a few moments, the bulk of the water contained in the stock is removed and the machine may then be stopped, emptied, and another lot placed in the basket. The extractor should not be allowed to run too long, however, in an attempt to remove too much

moisture. Usually, in from 5 to 10 minutes, depending largely on the speed of the extractor, no more water will be observed to run out of the outlet, and the machine may be stopped. Sometimes, extractors are operated for as long as 20 minutes before the silk is removed.

58. The vibration of the basket is a feature of all hydroextractors that it is impossible to remedy and is due to the unequal loading of the heavy, wet material. In the self-balancing type of extractor, the difficulties that would ordinarily arise because of this unavoidable vibration are overcome by carrying the entire machine on movable supports. The machine is thus entirely suspended and is free to vibrate in any direction, if unevenly loaded, thus preserving the parts in their original relation to one another. The machine also operates without imparting excessive shaking to the floor or the building in which it is located.

MOTOR-DRIVEN EXTRACTOR

59. The electrically driven hydroextractor, shown in Fig. 2, is of the self-balancing type and consists of the usual outer casing *a*, supported by standards *b* and ball-end rods *c*. The perforated basket *d* is mounted on a vertical spindle and is driven by a motor *e*, located beneath the basket and in a pit under the machine. The rotor of the motor is mounted directly upon the shaft that supports the basket and this shaft rotates on two sets of ball bearings. As a protection against moisture, the windings of the motor are impregnated with a special waterproof composition. The machine is started by means of the switch push button *f* and is stopped by means of the handle *g*. When this handle is operated, the arm *h* opens the switch and a brake located just above the motor is applied by means of the rod *i*.

60. In the machine shown in Fig. 2, there is no central shaft in the basket, nor is the machine constructed with a housing extending over the basket, as in the case of the extractor illustrated in Fig. 1. This is a great advantage in

loading and unloading the machine, since the entire top of the machine is open and these operations can be easily and quickly performed. Moreover, there are no bearings or other parts

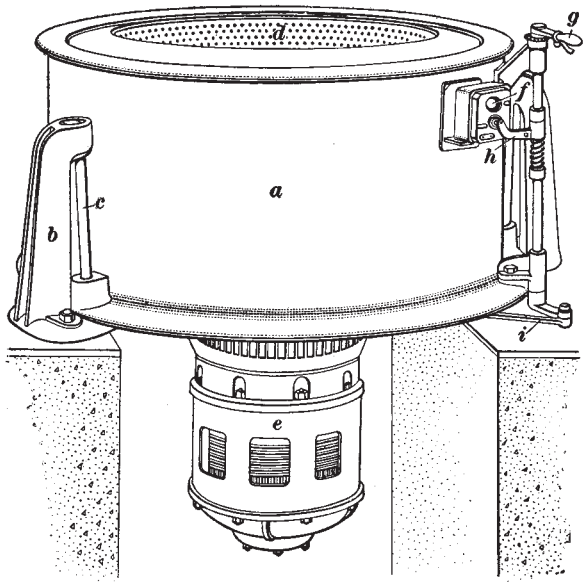

FIG. 2

supported above the basket of the machine and, therefore, there is no danger of oil or dirt falling upon the silk and injuring it.

GYRATING-BASKET EXTRACTOR

61. The hydroextractor shown in Fig. 3, is not built on the self-balancing principle. Instead, vibration is taken care of in this machine, by allowing the basket to gyrate, or wobble, within the outer casing. While this, perhaps, requires an outer casing that is somewhat larger and does not at all times preserve the basket and casing in their original relation to each other, this type of machine gives excellent service and is satisfactory in operation. The entire basket of the machine is open for loading and unloading and, in this particular case the machine is driven by a belt.

62. The machine consists of an outer casing *a*, Fig. 3, enclosing a perforated basket *b*, which is fastened to a spindle *c* that rotates on the pivot *d*. A pulley *e* is attached to the lower end of the spindle, motion being imparted to the basket by means of a belt passing around this pulley, to which it is guided from a driving shaft by means of two guide pulleys, the one shown being marked *f*. In order to reduce the vibration and at the same time furnish a certain freedom of motion, the pivot

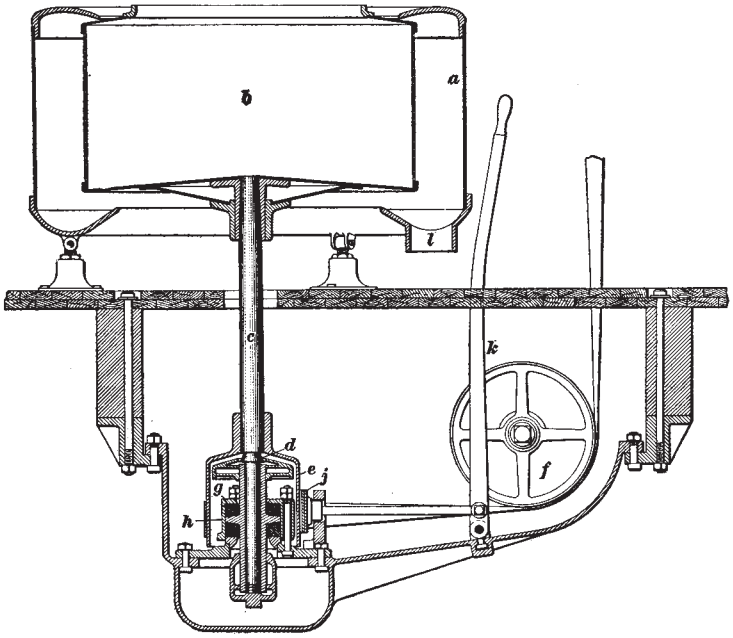

FIG. 3

box is supported by rubber cushions *g* carried in a gland *h*. In order that the machine may be stopped quickly, a brake shoe *j* is arranged to be pressed against the pulley *e* by means of a brake lever *k*. The working parts of the machine are all enclosed in a water-tight, cast-iron trough, or casing, which is bolted to the floor under the extractor; but where this machine is to be erected in basements, it is usually carried on a bed-plate erected over a concrete or masonry pit.

63. In operation, the stock to be extracted is placed in the basket *b*, Fig. 3, which if unevenly loaded gyrates within the casing *a* until a speed is attained that makes it assume an upright position, that is, until it spins like a top. The water thrown from the stock is retained by the casing and finds an exit through the outlet at *l*.

OTHER TYPES OF HYDROEXTRACTOR

64. Centrifugal hydroextractors are made in many types other than those described, but almost any type will prove satisfactory for extracting the moisture from raw silks subsequent to soaking. Steam engines and electric motors are carried in various positions and the basket of the machine is driven from them in different ways. In addition to the direct connections illustrated, friction drives and geared connections are frequently encountered. Some machines are driven by steam turbines which are said to produce a very smooth-running machine. Provisions for the absorption of vibration and other details of construction also vary greatly. Baskets are built of galvanized steel, brass, copper, tinned copper, and so on. Sometimes the bottom of the basket and its top ring are made of manganese bronze and the basket is often strengthened by steel bands. The curb of the outer casing and the basket are sometimes rubber-covered or lead-lined as a protection to the metal when the extractor is used for acid work. Such protection, however, is not required when the machine is used only to extract the moisture from raw silk after the soaking process.

65. Safety appliances are often attached and in many cases the use of certain approved safeguards is required. To generate the centrifugal force required to drive the water from the stock, the basket of a hydroextractor must revolve at high speed and the machine, therefore, is of a somewhat dangerous character. Attendants should exercise care in the operation of extractors and, especially, no attempt should be made to touch or handle the basket or the silk contained in it, while the machine is in motion. Accidents have occurred in which

attendants have been pulled into the baskets of large machines and seriously or fatally injured.

66. The size of extractors is designated by the diameter of the basket in inches. This dimension may vary from 24 inches, or less, up to 60 inches and in some cases, even more. The capacity of the basket varies from 5 to 25 cubic feet. The speed of the basket is from 600 revolutions per minute to 1,200 revolutions per minute, depending on the size of the machine. Small machines are operated at high speeds. The circumferential velocity of the periphery of the basket varies from about 9,000 feet per minute to somewhat less than 8,000 feet per minute. A higher velocity can be maintained in small machines and, hence, the smaller extractors, while requiring the expenditure of more time in loading and unloading operations, are actually slightly more efficient in extracting water than are the larger machines. It is important that the speed of an extractor never be allowed to exceed the speed recommended by the manufacturer of the machine, or a dangerous accident is likely to result. Bearings must always be kept well oiled and the machine should be periodically inspected and adjusted. The power required to drive an extractor varies from about 3 H. P. in the smaller machines to as much as 10 H. P. in large extractors.

67. Sometimes, rubber-covered wringer rolls are employed, instead of a hydroextractor, for removing the excessive amount of water contained in silk after removal from the soaking tubs. These rolls may be operated either by hand or by power, although, of course, the latter is usually the case. This method of extracting water involves an additional amount of labor and is much more likely to injure the silk than is the customary treatment in a centrifugal extractor. The likelihood of injury to the silk and the increased labor involved are due principally to the increased amount of handling required when the silk is passed through wringer rolls. Moreover, the pressure of the rolls required to remove the excessive moisture effectively may injure the silk, especially since the fibre is in a softened condition on account of the prolonged soaking.

RUBBING GUMS

SILK GUMS

68. The amount of silk gum, or sericin, and the nature of the gum vary so much in different raw silks that the treatment of the material must sometimes be varied in accordance. For instance, when silks possess what are known as *hard gums*, a special treatment, known as *rubbing the gums*, is necessary.

69. During the process of reeling raw silk, the cocoons are soaked in hot water to soften the gum and to enable the silk filament to be unwound. If the raw-silk thread is not dried before it is wound upon the reel, or if the drying is not thoroughly performed, there is a tendency for the threads of the skein to adhere to each other when the skein becomes dry. This, of course, is due to the sticky nature of the softened gum and the tension with which the thread is wound in forming the skein. The tendency for the threads of the raw-silk skein to become fastened together is especially noted at those places in the skein where they pass over the bars, or arms, of the reel while the skein is being wound. This is due to the pressure with which the threads bear upon the arms of the reel in being wrapped around it to form the skein. In a skein of raw silk, therefore, there will often be found places in which the gummy deposit is abnormally hard and in which the threads are apt to adhere to each other with a considerable degree of firmness.

70. These hard, gummy places are known technically as *the gums*. They form hard bands extending across the skein and will be found to be spaced equally around the skein. If the silk has been reeled on a reel, or swift, that has four bars, or arms, there will be four places of this nature in the skein, but if the skein has been formed on a reel containing six arms, there will be six gummy places in it. Generally, the gums are harder in a skein that has been made on a four-arm reel than in one that has been formed on a reel with six arms. This is

due to the greater angle and pressure of the thread in passing over a bar of a four-arm reel.

71. In some silks, the gums are very hard and the threads cemented firmly together; in others, the gums are quite free and do not require rubbing. In general, the yellow silks are apt to have harder gums than the white varieties. Some of the Italian silks and the higher grades of silk from Japan are very free from gum spots, and can be unwound from the skein without rubbing. Tsatlees, China Steam Filatures, Cantons, and Kakedas are apt to have hard gums and, hence, require thorough rubbing. The presence or absence of hard gums is due principally to the methods employed in reeling the raw silk and is not an inherent quality of the particular kind of silk.

METHOD OF RUBBING GUMS

72. The silk is now removed from the basket of the hydroextractor and, if it has been bagged for soaking and extracting, is next removed from the bags and usually is placed upon a table or bench. If the silk has been tied in bundles, the cords are removed and each skein opened out. The operative takes the skeins and opens them out to the full length, one at a time, holding the skein between the hands and at the same time spreading it in the direction of the lacing strings, provided the skein has been traverse reeled. When the skein has been opened and straightened correctly, it will appear flat, will be about $3\frac{1}{2}$ inches wide, and have the same form and shape as when reeled.

73. The silk will be found to be in a moist or damp condition as it is removed from the hydroextractor and will feel soapy to the touch. The gum will also be found to have been softened, but if the silk contained hard gums, no amount of soap and oil in the soaking will have completely removed the gum spots. These gummy places, however, will be found to be softened, although they would regain much of their characteristic hardness if the silk were allowed to dry without treatment. It is necessary, therefore, to manipulate the skeins and rub the gums at this time, in order to free the threads and

prevent them, as much as possible, from adhering to each other as the silk becomes dry. This is done by taking the skeins, one at a time, carefully examining and straightening them, and rubbing each gum spot between the thumbs and fingers, or in the palm of the hand, with a scrubbing movement. At the same time, the skein is spread until the threads are free and separated from each other. Sometimes, small quantities of warm neat's-foot oil, or of the standard soaking solution, are applied to the gum spots, to assist in loosening the threads. The rubbing must be gently and carefully done and the operative's hands must not be so rough as to catch the silk. Harsh rubbing is liable to cause the raw-silk thread to separate, or split, thus causing a defect, known as *split ends*, that may cause trouble in succeeding operations. The rubbing of the gums is often performed after the silk has been hung on drying racks and become partly dried. In this case, each skein is removed from the rack and the gums rubbed, after which the skein is again hung upon the rack.

74. Some throwsters do not rub the gums while the silk is in the damp condition in which it is removed from the extractor. Instead, the silk is first dried in such mills, and is then sent to the winding room where the gums are rubbed as the silk is made ready for the winders. The advantage claimed for this practice, is that if the gums are rubbed and the threads separated before drying the silk, the threads will again become amalgamated and stuck together as the skein becomes dry. This is due to the fact that the gum is soft while the skein is damp and, hence, the threads will again adhere to each other before the skein and gum are dried. Furthermore, it is sometimes the custom in such establishments to do as little rubbing as possible, the process being resorted to only when trouble is encountered in the winding of certain lots of silk.

GUM-RUBBING MACHINE

75. While in most throwing mills the hard gums are rubbed by hand, in some cases, a gum-rubbing machine is employed. This machine performs the work in an efficient manner and

its use tends to avoid the production of split ends. A saving in labor is usually effected by machine rubbing, especially in large mills, since one operative with a gum-rubbing machine can treat more silk than two or three operatives who rub the gums by hand. However, for certain kinds of work, some throwsters prefer hand rubbing, considering the action of the gum-rubbing machine to be rather severe on the skein.

76. Construction.—The gum-rubbing machine illustrated in Fig. 4, consists of a frame *a* that is firmly secured to the floor and that supports the driving and working parts of the machine. A casting bolted to the top of the frame carries bearings for the driving shaft *b* and has a projecting arm *c* upon which two steel bedplates *d* are mounted. Upon these bedplates, four steel bars, each about $\frac{1}{4}$ inch square, are supported in a horizontal position and parallel to each other. Each of these bars is closely set with a single row of steel pins *e* that are tapered from the bar to the ends, and are finished with smooth, round points. The pins, therefore, resemble coarse needles, with rather blunt points that will not separate the filaments of the raw-silk thread.

77. The two outside bars *f*, Fig. 4, are secured to the plate *d* in a fixed position and, therefore, are stationary at all times. The two inside bars *g*, however, are free to slide back and forth on the plate for a short distance and are connected by rods *h* to two eccentrics *i* secured to the driving shaft *b*. The eccentrics are set opposite to each other, that is, with the throws of the eccentrics 180 degrees apart. When, therefore, motion is imparted by the belt to the driving pulley *j* and shaft *b*, the inside bars *g*, together with their needles, will be oscillated in opposite directions, that is, one bar will be moving away from the driving shaft while the other bar is moving toward it, and vice versa.

Since the shaft *b* is usually driven at a speed of about 1,400 revolutions per minute, the speed of oscillation of the bars and needles is very rapid.

78. Operation.—In operating the gum-rubbing machine, the attendant stands or sits in a position facing the projecting

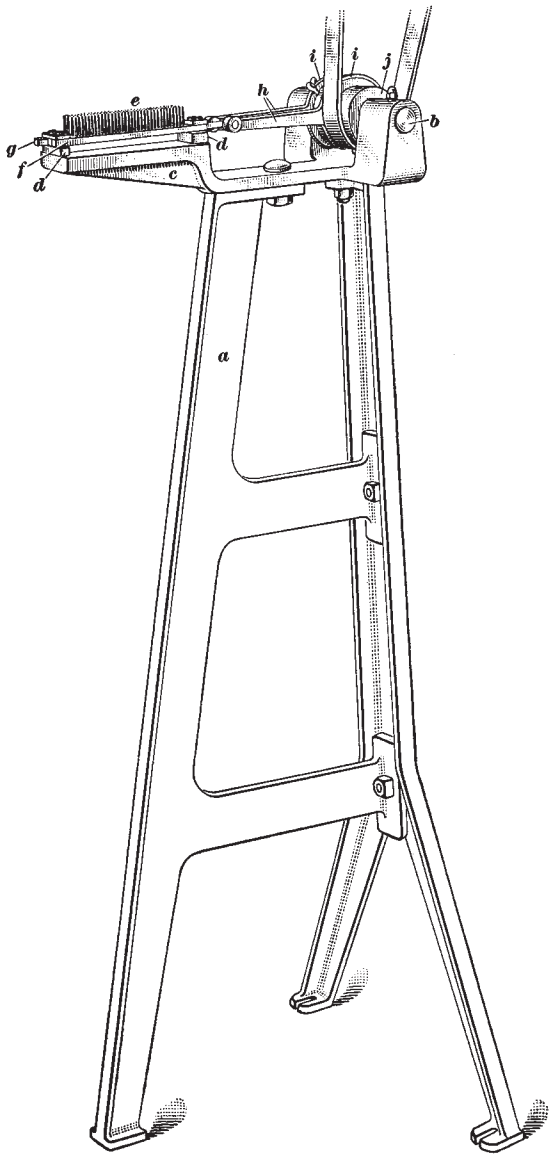

FIG. 4

arm *c*, Fig. 4, and the needle bars. Each skein of silk is treated individually and each gum spot is rubbed separately, and usually two times. The operator grasps the skein upon each side of the gum spot to be treated, with the hands close to the gummy place, and forces the skein down quickly upon the bank of needles. The skein is forced down with considerable pressure, until the points of the needles have penetrated it, and is held in that position for about 1 second. Next, the skein is raised from the needles, given a quarter turn, and the same spot again pressed down upon the needles and held there for about the same length of time. In these two movements, the machine has operated on the gum spot from the side and also from the edge of the skein.

79. This treatment will usually be found sufficient to break up the hard gummy deposit and free the threads so that they may be readily separated. If, however, the nature of the gum spot is such that it is not entirely loosened, the skein may be pressed down upon the needles again, but care should be taken not to overdo the rubbing as excessive treatment might injure the silk. The operator proceeds in like manner with each skein, treating all of the gum spots that are not free and examining the skeins carefully to see that no spots are missed to cause trouble in winding.

DRYING

80. The practice of different throwsters in regard to the drying of the silk subsequent to soaking and extracting varies to some extent. In a considerable number of throwing mills, the trouble and expense of rubbing the gums and drying the silk is avoided by sending the silk directly to the winders in the damp condition in which it is taken from the hydro-extractor.

81. There is, however, considerable objection to winding silk when it is damp. In the first place, the skein is heavy when placed upon the swift of the winder in this state, and the drag, or tension, of the thread is considerably greater than

normal. Moreover, silk stretches during winding when it is damp and this stretch is aggravated by the increased weight of the damp skein. As the winding proceeds, the revolving of the skein on the swift produces a fanning effect that will dry the silk. The silk wound from the latter part of the skein, therefore, will not be stretched, or, at least, will not be stretched so much as the silk first unwound from the skein. Also, some parts of a skein may be drier than others and, in addition, the first skeins placed on the winder are very apt to contain more moisture than those that are treated later, after the silk has laid for a considerable length of time and dried out. In these ways, an irregularity of size is introduced into the silk that previously did not exist in the raw thread. This may result in effects that are injurious and far reaching, as, for instance, in the production of corkscrewed yarns.

82. Sometimes, when silk is wound so damp that it does not become dry until after it is wound upon the bobbin, a large amount of waste is made because of the practice. This is due to the fact that when the silk does dry, the threads will become very firmly attached to each other because of the tension with which the thread is wound upon the bobbin and because the gum is soft when the winding takes place. It is almost impossible to unwind the thread from some bobbins in such cases, and the entire bobbin of silk must be considered to be waste. In other cases, much delay and trouble is occasioned by the frequent breakage of the thread during unwinding in subsequent processes. Moreover, silk that lies around in a damp condition may become mildewed and is apt to collect dirt or be otherwise injured.

83. To avoid difficulties of this nature, some throwsters who send the silk directly to the winders after extraction, arrange to whiz the silk for a longer period of time in the extractor and thus have it in a drier condition when it is removed from the machine. This, of course, takes more time and involves a larger expenditure of power for driving the extractor as well as additional wear and tear on the machine. In other throwing mills, the silk is taken to the winders and

arrangements made to place the skeins upon the swifts in rotation so that the skeins most nearly dry will always be taken first. Sometimes, just before the attendant places a skein on the swift of the winder, it is carefully inspected for hard gummy places and these are rubbed and the threads freed at

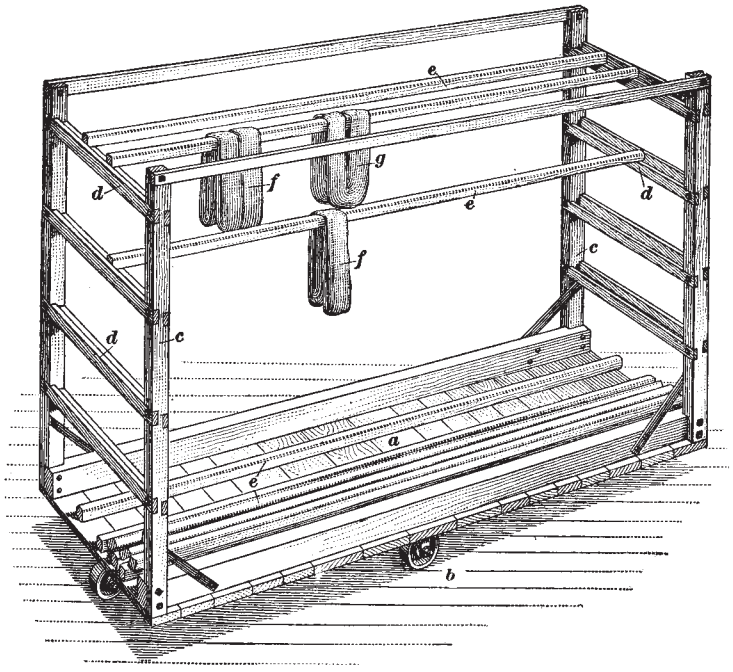

FIG. 5

this time. The best practice, however, dictates that the silk should be dried after being extracted, and the gums rubbed if necessary.

84. Drying Racks.—The drying of the silk is usually accomplished by hanging the skeins on wooden poles, or bars, that are supported by some suitable form of drying rack. Such racks are sometimes made about 6 feet in height and approximately 8 feet long. A simple form of rack, illustrated in Fig. 5, consists of a wooden platform *a* mounted upon four heavy casters *b*. Upon this platform, a rack is erected that

consists, essentially, of four upright posts *c* to which four sets of cross-bars *d* are bolted. These cross-bars support the poles, or bars, *e* upon which the skeins of silk are placed. The skeins are hung upon the poles either *double* or *single*. When hung double, as at *f*, the skein is simply laid over the bar with the two ends hanging down. When laid single on the pole, as shown at *g*, the same method is followed, but the parts of the skein that rest upon the bar are spread out and arranged side by side so that the skein will not be of double thickness at the point of support. When the skeins are hung double, each skein will occupy about 3 inches of space upon the bar, but if hung single, approximately 6 inches of space on the bar will be required. Thus, if hung double, about thirty skeins of silk, or one book, can be placed upon a drying bar that is approximately 8 feet in length. If hung single, two bars, of course, will be required for each book. In the rack illustrated in Fig. 5, seven or eight poles may be placed in each tier. The rack, therefore, will accommodate about thirty poles and, hence, a bale of silk, which usually contains approximately thirty books, may be placed upon it if hung double, but two racks will be required for each bale if the skeins are hung single.

85. Sometimes, drying racks are constructed with single supports at each end to which several cross-arms are bolted. These cross-arms support poles upon each side of the rack, on which to hang the silk. Other forms of drying racks are frequently employed and are often so constructed as to be entirely satisfactory. A rack for drying silk should be equipped with heavy, easy-rolling casters so that it may be easily moved, even when heavily loaded with silk. It should be of substantial construction in order to stand the abuse of constant service and support the weight of the damp and heavy silk. The bars of the racks should be smooth, so as not to catch the silk, and may be varnished or painted. They should be protected from injury and should not be bruised, cut, or otherwise damaged.

86. Drying Rooms.—After the skeins of silk have been opened and carefully hung upon the drying racks, they are

allowed to become dry in this opened condition. Sometimes, this drying is allowed to take place at a normal temperature, the racks of silk being allowed to stand in some convenient place. Since this is apt to require too great a length of time, however, especially in damp weather, most throwing mills employ a special drying room in which the racks of silk are placed. Such a drying room is usually made large enough to accommodate a number of drying racks and is equipped with steam pipes for supplying the necessary heat. A fan, or blower, is often arranged so as to draw a current of air around and through the banks of steam pipes, which are sometimes located in a separate compartment, and through the drying room. This not only greatly shortens the length of time required to dry the silk, but also tends to dry the silk uniformly in all parts of the room.

Drying rooms are usually very simply constructed of wooden partitions, but sometimes they are lined with metal to prevent all possibility of fire or are suitably insulated to retain the heat. Fire is not likely to occur in a silk-drying room, however, since only very moderate temperatures are employed. Special drying machines may be used for the drying process, but these are hardly necessary in throwing mills and are rarely employed.

87. Usually a temperature of from 100° to 110° Fahrenheit, is maintained in a silk-drying room, but the length of time required to dry the silk in the required manner varies considerably. Much depends on the length of time that the material was whizzed in the extractor and on other conditions. In some cases, when the silk is hung double on the drying racks, a period of 6 hours is required to dry it to the degree of dryness desired. On the other hand, silk that is hung single can sometimes be dried in 2 hours.

88. Some throwsters dry the silk very thoroughly and then allow it to stand for at least 24 hours before being used, in order that the material may regain its natural moisture content. While it is important that the silk shall not be subjected to subsequent operations in a very dry condition, since it is then harsh and brittle, this method is quite wasteful of time. Most

throwsters, therefore, frequently examine the silk while drying or gauge the length of time that the material remains in the drying room, so that it may be removed and sent to the winders when in just the right condition, that is, when just enough moisture remains in the silk to enable it to be worked properly. When in just the right condition, the skeins of silk will not feel too moist, nor will they feel absolutely dry. Instead, they will feel cool and slightly damp, a condition that may readily be recognized by experience.

SILK THROWING

(PART 2)

Serial 5002B 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) Mention briefly the qualities that should be possessed by a soap that is suitable for soaking silk.

(2) What kind of soap is best suited for a silk-soaking solution?

(3) What is the danger, in soaking silk, of a soap that contains an excessive amount of free alkali?

(4) How may soap be tested for the presence of free alkali?

(5) (*a*) Describe a method of determining the percentage of moisture in soap. (*b*) What percentage of water in a hard soap, in bar form, should not be exceeded?

(6) Is neat's-foot oil suitable for use in silk-soaking solutions?

(7) Why is mineral oil undesirable in soaking solutions?

(8) Why is the amount of soap and oil increased when soaking silk for the production of crêpe and other hard-twisted yarns?

(9) What is the average percentage of absorption of soap and oil by the silk during soaking?

(10) Explain why hard water is unsuitable for use in silk soaking.

(11) Why is silk tinted and how is it done?

(12) Describe the treatment of tussah silk, prior to throwing.

(13) Discuss the loading of silk into the basket of a hydroextractor.

(14) Describe the operation of a hydroextractor, explaining how and why the machine removes the water from the silk.

(15) Explain the nature and cause of hard gums in raw silk.

(16) Describe the operation of rubbing the gums: (*a*) By hand. (*b*) By machine.

(17) What is the advantage of rubbing the gums after drying?

(18) Explain the advantages and disadvantages of drying silk and of winding it while damp.

(19) What can be said in regard to the proper temperature to employ in drying?

(20) Assume that 1 lb. of soap is placed in a suitable container, weighing $4\frac{1}{2}$ oz., and dried. What is the percentage of water in the soap if the dried soap and the container weigh $15\frac{1}{2}$ oz.? Ans. $31\frac{1}{4}$ per cent.

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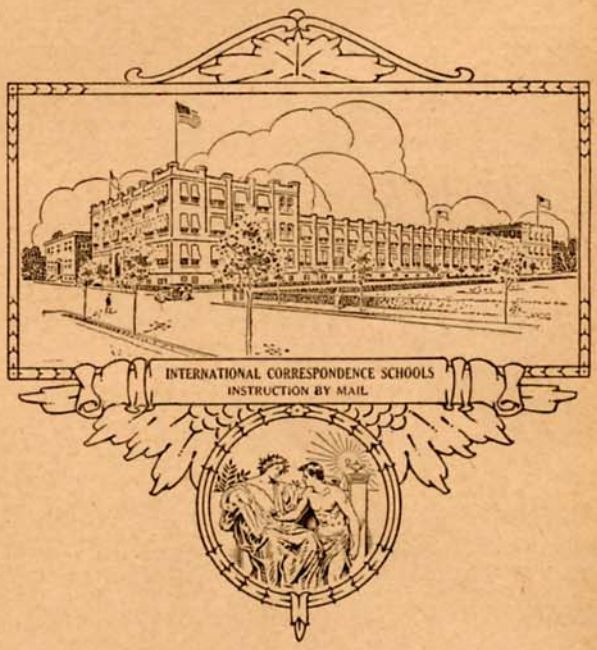
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