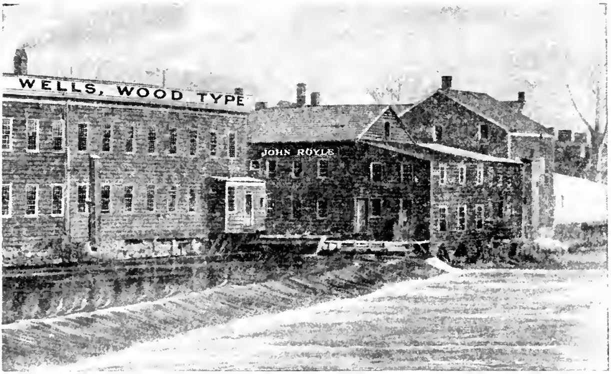
HAND BOOKS OF THE TEXTILE INDUSTRY, VOL. 3

SILK THROWING

E. A. POSSELT, PHILADELPHIA



Original shop of John Royle & Sons at Paterson, N. J.

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Absolute accuracy is the first essential in machinery for cutting and lacing Jacquard cards, and this fact was thoroughly appreciated by John Royle and his two sons, when they started, forty years ago, to build piano machines in the little shop shown at the right in the illustration above. Already they had acquired an enviable reputation as makers of high-class machinery for wood-engravers and wood-type manufacturers; so that they had the advantage of experience and suitable equipment, for work of an exacting character.

At first, only foot-power piano machines were made, but five years later in 1883, they brought out the positive-action power-operated repeater; and about 1890 developed the first successful automatic lock-stitch lacer. Within more recent years they have introduced a power-operated piano machine, and a hand-operated type of repeater.

From the beginning of their business John Royle & Sons have adhered rigidly to the highest possible standards of material and workmanship, and have brought to bear on their work a family talent for mechanical design, which has found its highest expression, so far, in the many inventions of Vernon Royle, the present head of the firm. The result has been a continual series of improvements so that Royle machines of to-day represent all that is best in twentieth-century machine building as well as in fitness for the special duties they must perform.

It is worthy of mention also, that the little shop shown above has been succeeded by a series of four and five story brick buildings which contain many thousand feet of floor space and are equipped with a complete assortment of modern machine tools and other manufacturing facilities. In addition to Jacquard card machinery, this firm manufactures a wide line of machinery for photo-engravers; and a third line for rubber-working establishments.

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HAND BOOKS OF THE TEXTILE INDUSTRY Vol. 3

Silk Throwing

Giving the Most Complete Data ever Published on the Various Processes Raw Silk is Subjected to When Converting it into Yarn

E. A. POSSELT,

Editor of "Posselt's Textile Journal"

AUTHOR and PUBLISHER of numerous books on the Textile Industry

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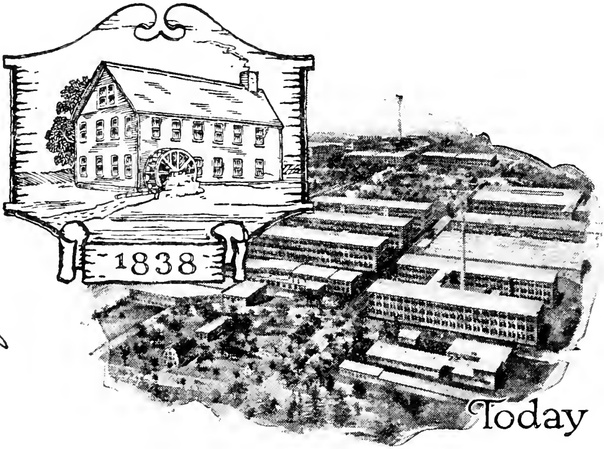

1838
Today

Synopsis.

Raw silk denotes silk in skeins, as reeled from the cocoon or rereeled.

Raw silk is the finest, most elastic, and most durable of all textile fibres, being especially prized for its lustre. It is the most costly fibre used by the textile industry, because of the great amount of time and care involved in raising the worm and reeling the silk.

The main silk-producing countries are Japan, China, and Italy, followed by Turkey, Russia, France, Austria-Hungary, Persia, India, Greece, Spain, Indo-China, and the Balkan States.

Silk originated in China and for over 3,000 years the Chinese monopolized not only its production but its manufacture. In the export of raw silk China maintained its supremacy until within the last decade, and when Japan assumed first place.

Silk is the product of the silk worm or caterpillar, of which there are many varieties. The one that produces the bulk of the world's silk, as well as the best, is the *Bombyx mori* which has been domesticated for centuries. TUSSAH SILKS, used in the production of goods of rough appearance, are produced by "wild" (*i. e.,* undomesticated) silk worms.

Domesticated silkworms are hatched out by subjecting the stored eggs to artificial heat.

In Japan about 60 per cent of the crop is usually produced in the spring, about 10 per cent in the summer, and about 30 per cent in the autumn.

The voracious worm is fed on leaves stripped from mulberry trees and grows so rapidly that four times within a feeding period of a little over a month it sheds its skin and grows a new one. After reaching full development, the worm starts to spin its cocoon or silken envelope; the silk fluid is exuded from the worm's underlip in two strands called *brins,* which immediately unite to form the *bave* or silk filament. The worm completes its cocoon in about three days, then changes into a chrysalis, and this within a fortnight, if not killed, develops into a moth, which breaks its way out of one end of the cocoon. The female moth lays her eggs and dies shortly thereafter. The cycle from birth to death, including all transformations, is less than 60 days. As there is a lapse of about 10 months between the laying time and the next hatching, some silk firms have extensive cold-storage rooms for keeping the eggs.

Pierced cocoons, from which moths have emerged, can not be reeled, so only about 2 per cent of the chrysalides are allowed to develop into moths and emerge to lay eggs for the next crop; the remainder are killed in the cocoon, usually by stifling in hot, dry air.

About 10 per cent of the cocoon crop consists of *doupions,* or double cocoons, where adjacent worms have spun their cocoons side by side and have so interwoven that the two filaments must be reeled together. Such silk is coarse and uneven and is usually kept for local manufacture, though some is exported for use in making goods of rough appearance.

Reeling of Raw Silk.

Reeling is a most simple process, requiring the product of from 2,500 to 3,000 silkworms to produce a pound of raw silk. The reelable silk in a cocoon varies between 300 and 700 yards; only about half, and that the middle length of the silk, as spun by the worm, is strong and even enough for reeling. In most cases six cocoons are reeled into one to form the raw silk, but the number varies from 3 to 12 or more, according to the quality of silk and the size of thread desired. The cocoons that are to be reeled together are placed in a basin of warm water, and after the natural gum with which the fibre is combined has softened, and the outer coating of loose and uneven fibres is brushed off, the reeler finds the ends of the true or reelable filaments and runs them on the reel together; the filaments stick together and form one thread by reason of their softened gum. The silk is cleaned and twisted in reeling, either by bringing the thread back and passing it around itself about 200 times in a seven-inch spiral, or by twisting the threads of two different basins around each other before they are passed on to separate reels.

The best raw silks are produced in steam filatures. The water in the basins is heated by steam and kept at a uniform temperature; the reels are power driven, and care is taken to produce even and reliable sizes. Many filatures still use hand power; country silks are always reeled in this manner. Silks such as Chinese "Tsatlees," for example, are usually very inferior, as the home reelers use primitive appliances and are careless in their methods, owing to lack of supervision. A contributing cause of their irregularity is the haste with which the cocoons have to be reeled. The chrysalides in these wild silks, which constitute the bulk of the Chinese crop, are not stifled, so the silk has to be unwound within two weeks after the cocoons are gathered from the trees, before the moths have time to emerge. For brilliancy, whiteness and "nerve," however, such silks are unsurpassed. Most of the country silks, as well as some filature silks, must be rereeled before they are acceptable to throwsters abroad. In rereeling the hanks are sorted for size, and, after foul threads and bad piecings have been taken out and the threads subjected to a cleaning process, are run off into the smaller standard skeins.

Numbering of Raw Silk.

The size of single cocoon filaments varies considerably. Cantons average under 2 deniers, Chinas (Shanghai) about $2\frac{1}{4}$ deniers, while Japanese are mainly between $2\frac{1}{4}$ and 3 deniers. It is interesting to note that some worms produce a silk filament or bave (itself composed of two brins) slightly finer than $1\frac{1}{2}$ deniers, measuring as much as 3,000,000 yards, or over 1,700 miles, to the pound.

Because single cocoon filaments are too attenuated to stand much strain, several are always united to form the raw-silk thread of commerce. The 13/15 denier silk, generally reeled from five or six cocoons, is usually taken as the standard count, and is the raw silk in largest demand for skein-dyed fabrics. Owing to the variation in size of different cocoon filaments, and of the same filament at different portions of its length, it is impossible to make the combined raw-silk thread of an exact size; in specifying the number, therefore, the limits are given 2 deniers apart. Usual sizes of raw silk are 8/10 to 28/30 deniers (say, within the extreme limits of 558,066 to 148,818 yards to the pound.

Sericulture in the United States.

The United States is the largest consumer of raw silk, but imports every pound that it manufactures, and there is apparently no prospect of a supply being produced locally. For nearly 300 years efforts have been made to raise silk in this country. Appropriations for the encouragement of sericulture were made by the early colonies, by various states, and by the Nation. The most remarkable event in this record was the sericultural craze of the thirties, starting about 1829 and finally ending about 1844; much money was lost in the collapse of that boom.

Consumption of Raw Silk.

In normal times raw silk is manufactured mainly in the United States, China, France, Japan, Germany, Switzerland, Russia, Italy, and Austria-Hungary. Estimates as to the production and consumption of raw silk in China are very vague, but such facts as are obtainable tend to show that the United States is now by far the largest consumer of raw silk in the world, and that China probably ranks second, France third, and Japan fourth.

The bulk of the raw silk used in American mills comes from Japan, smaller amounts being supplied by China and Italy. The United States is normally the largest buyer on the raw-silk markets of both Japan and Italy. Of Japanese exports of raw silk, averaging 10,061,588 kin (of 1.32277 pounds each) during the 10 years 1901-1910, the United States took 68.01 per cent, while of similar Japanese exports of 21,741,976 kin in the calendar year 1916 the United States took 83.63 per cent. The United States, on the whole, buys the best grades, while the inferior silks are left to be manufactured by countries where labor is cheap enough to permit the time and care necessary to make them into presentable articles.

SILK COCOONS.

The silk cocoons imported into the United States are for use in the spun-silk industry and consist of unreelable cocoons, such as "pierced cocoons," of which the filament layers have been torn through by the moths that were allowed to emerge to lay eggs for the next crop, cocoons of irregular formation, and cocoons damaged in handling. Owing to the amount of good filament that they contain, unreelable cocoons are listed among the best classes of silk waste.

SILK WASTE.

SILK WASTE includes all silk that can not be reeled from the cocoon, as well as waste made in manufacturing. Such silk was formerly almost valueless, hence called "silk waste," but with the adaptation of machinery processes to the preparation and spinning of short lengths of unreelable silk, there has been built up the spun-silk industry which now forms a very important branch of silk manufacture.

Only about half of the silk in a good cocoon is reelable, as the outer layers are usually coarse, uneven, and broken, while the extreme inner layers, spun as the worm is nearing exhaustion of its supply, are too attenuated to stand the strain of reeling. In addition there are many cocoons entirely unreelable. One authority estimates that for every pound of raw silk produced there are about $1\frac{1}{6}$ pounds of unreelable silk remaining.

Silk waste is a comprehensive term covering many varieties which may be classified, according to the stages at which produced, under a few general heads as follows:

(*a*) Pierced and other unreelable cocoons, including cocoons of various wild silks which are either unreelable or more profitably worked by carding.

(*b*) Cocoon wastes, including not only the loose outer layers of silk stripped off the cocoon before reeling and known as frisons or floss, but also the inner layers of the cocoon next to the chrysalis, which remain after the reelable silk has been removed.

(*c*) Reel wastes, made in reeling from the cocoon or in rereeling.

(*d*) Mill wastes, including particularly throwsters' wastes and exhausted noils.

The cocoon wastes and the real wastes are frequently lumped together as "filature waste" or "steam filature waste," according to the character of the reeling establishment where obtained. They make up the bulk of the silk waste imported into the United States; noils and cocoons are the wastes imported in next largest amounts. Silk noil exceeding 2 inches in length is dutiable as partially manufactured silk, so the noil that enters free as silk waste is 2 inches or less in length and is mainly "exhausted noil" from the last dressing or combing process; it is called exhausted noil because it is too short to yield another draft of combed fibre. This short noil has been imported mainly for the purpose of carding with wool and has been used by the woolen manufacturers rather than by the spun-silk manufacturer. To-day however it is confined mainly to the manufacture of powder bags for big guns. These powder bags must be of silk (silk noil being used because of its comparative cheapness), as it is essential to use a textile that will burn up quickly and completely without any smoldering remnant.

Thrown Silk.

THROWN SILK may be defined as yarn made from raw silk, that is, from silk reeled from the cocoon.

RAW SILK consists of several parallel cocoon filaments held together by the natural gum, emitted by the worm. It can not be boiled off, dyed and weighted, and remain in workable condition.

If the silk is to be skein dyed it must therefore first be *thrown* into yarn.

Silk *"throwing"* (from the Saxon *"thrawan,"* i. e., to twist) is the technical term used for the processes involved in making yarn from raw silk. As raw silk is already in the form of a continuous strand, there is no occasion for the preparatory machinery that is needed for the manufacture of yarns for all other textiles, and where a mass of short tangled fibres of varied lengths has to be transformed into a continuous length of roving.

In silk throwing the main object is the insertion of twist into the raw silk, with such doubling as may be desired.

Thrown silks are known as *organzine, tram,* or *singles,* according to the method of manufacture.

ORGANZINE (mainly used as warp) is made by doubling two or more threads which have first been well twisted in the single, and then giving them a firm twisting in the opposite direction.

TRAM (mainly used as filling) is made by combining two or more raw-silk threads, and then twisting them together with a slack twist. Strength is not as essential as it is in the warp, the slack twisted filling permitting a more brilliant finish.

SINGLES are single raw-silk threads, twisted or not. Such yarns, when very hard twisted, are used for the warp and filling of chiffon and kindred fabrics. Some singles are woven in the gum, without twist, and produce cloths which after being boiled out and bleached have a softness and brilliancy unattainable in cloths made of twisted yarns. The famous *"habutae"* of Japan is a striking illustration of such work.

More than two-thirds of the thrown silk used in the American industry is thrown on contract by commission throwsters, either for weaving mills or for silk merchants. Most of the throwing mills are located in Pennsylvania, gravitating toward the coal mining region, where fuel is cheap and female labor available, since the mines employ only males.

The processes in a throwing mill are as follows:

For Organzine:
- Soaking.
- Winding.
- Spinning, first time.
- Doubling.
- Spinning, second time.
- Reeling.

For Tram:
- Soaking.
- Winding.
- Doubling.
- Tram spinning.
- Reeling.

When the raw silk in skeins is received at the throwing mill the skeins are first weighed, assorted according to quality, and tagged to indicate the manufacturer for whom the silk is to be thrown, and whether it is for organzine or tram. The skeins are put into light cotton bags and soaked overnight in warm, oily soapsuds (to soften the natural gum), dried, placed on reel swifts, and wound off onto small double-headed bobbins.

Some very dirty and irregular silks may require cleaning. In such cases the silk is transferred from one bobbin to another, passing during the transfer through a cleaner, which consists of parallel plates set just far enough apart to catch any irregularity in the thread.

After winding, the *tram* goes to the *doubling frame,* but the *organzine* goes to the *first-time spinning frame.* The principle of spinning or twisting consists of winding a thread onto a horizontal bobbin from a vertical one that revolves at a faster speed. The yarn runs through the eye of a little metal flyer on the top of the vertical bobbin, and the difference in speed between the two bobbins regulates the amount of twist. In other textile industries "spinning" is a process by which roving is drafted or attenuated and then twisted into yarn, but in the manufacture of yarn from raw silk no drafting is possible and the spinning process is one of twisting only.

Doubling is a process whereby threads from two or more bobbins are wound together, without twisting onto another bobbin.

In the *second-time spinning* the machine is similar to that used for first-time spinning, but, instead of inserting twist into single threads, it twists into one the threads which the doubling machine has brought together. The direction of the twisting is opposite to that in the single thread.

During the spinning process the thread is wound upon bobbins. Before being dyed the thread must be reeled again into skeins. The skeins are laced by running short strings in and out through each skein, dividing each into four parts, so as to prevent tangling during the dyeing process. These are then made up into compact bundles.

The work of the throwster usually ends with reeling and bundling, and the skeins are then sent to separate establishments, where they are dyed and then sent to the weaving or knitting mill.

In tram spinning, the original thread is not twisted, but, after winding, two or more of the raw-silk threads are doubled and then twisted together with a slack twist of from 2 to 6 turns to the inch. They are then reeled and bundled and sent to the dyehouse as in the case of organzine.

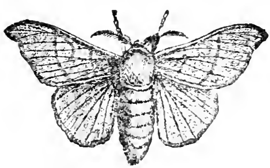
It is obvious, from the above, that yarn is produced from raw silk with fewer and simpler processes than from any other textile fibre, and the better the silk the less is the trouble and expense. In the United States the higher average of wages paid makes it essential to get the maximum production from each operative, and manufacturers do not find it economical to employ many grades of silk used in other countries. As a rule only the better grades are imported.

In this country as well as England, thrown silk is usually numbered according to the weight in drams of a hank 1,000 yards in length; in Continental Europe thrown silk is numbered the same as raw silk, which is usually according to the weight in deniers of a hank 450 meters long. To reduce denier counts to dram counts, divide the deniers by 17.44. Thus four-thread tram of 16/18 denier size would be $17 \times 4 = 68 \div 17.44 = 3.90$ drams. There are 256 drams to the pound avoirdupois.

The trade in thrown silk differs from the trade in spun silk in that imports are very small, in fact negligible, as compared with the domestic production of thrown silk. The throwing industry in the United States is very highly developed, and as manufacturers prefer to buy the special quality of raw silk desired and then to have it thrown according to their particular needs at the time, either by commission throwsters or in their own plant, thrown silk is not, in this country, largely purchased in its finished state, and there is little inducement to import.

The next volume of this series of Technical Books will deal with **"The Manufacture of Spun Silk"** covering: Cocoon Waste; Cleansing Silk Waste under Steam Pressure; Disintegrating Poorer Grades of Waste by Fermenting, *i. e.*, Rotting; Scouring and Beetling; Sprinkling; Beating; Cocoon Opener; Mixing; Opening; Dressing; Spreading; Spreader, Ribbon Former. Doubling and Drawing—Slubbing and Roving—Fine Spinning; Finishing Spun Silk, Cleaning—Gassing—Sizing—Packing; Grading Spun Silk; International Counts of Yarn; Comparative Silk Yarn Tables, etc., etc.

Contents.



Illustrations.

SILK THROWING.

Differing from every other textile raw material, silk is a yarn from the start, the original spinner having been the silkworm which emits a (double) most delicate filament, hundreds of yards in length, while forming its cocoon. Four, five or more of these (double) filaments are united into one thread, at the places where the silk is raised, producing in turn the silk-thread of commerce, and which is wound on a reel, formed in a skein and securely tied, in order to permit ready unwinding at the public throwsters, or the throwing department of the mill. The silk manufacturer thus dealing with a thread for his raw material, it explains why the machinery and processes used in silk throwing (*i. e.*, silk spinning) are less cumbersome than such as are used for preparing other textile fibres, like cotton, wool, etc., and converting them by various processes (depending on the material) into yarn. But we hardly think that the name of spinner (or throwster) can be denied to the silk worker, because the original reeling by the sericulturist and that of the throwing processes amounts to the spinning of a thread by means of winding, doubling and twisting.

Throwing is carried on either as a branch plant in connection with large weaving or knitting mills, or what is possibly more often the case, operated independently as a public throwing mill, obtaining work from weaving as well as knitting mills; some of our prominent silk yarn importers and dealers run their own throwing mills, selling their thrown products.

The advantages of a public throwing plant over that of a mill doing its own work are many, chiefly that when one or the other class of fabric is dull in the market, another mill will furnish work for the throwster to keep his help going, whereas if a mill would do its own throwing, for instance if dealing with a ribbon mill, and work would run slack or cease, the throwing help then would have to find other occupations, in turn disturbing the smooth running of that department, noticed more particularly when work again begins to come in. At the same time we must take into consideration that the throwster himself, as a rule, is a practical man or employs a competent manager which the average silk weaving or knitting mill could not procure, and when then throwing in a mill department would be done in a haphazard manner, resulting in excess of waste which is a most important item and may spell loss to many a silk manufacturer.

Waste in throwing varies from 1¾ to 6 per cent with the exception of press-packed tussahs which run from 7½ to 10 per cent. Among others, regular organzine runs from 1¾ to 2½, regular tram 1¾ to 3, Canton tram 4¼ to 6; crack tussah chops 3½; lower grade tussah 5; crêpe twists 2 to 3 and tsatlees 3 to 5 per cent.

Previously to going more in detail with throwing, it may be well to consider where to erect a new mill if such an affair comes under consideration; when locating a new throwing plant be sure of a constant plentiful supply of female labor. A village or a small town may provide this feature for some time after you educate your help, but when other industries enter your ideal place everybody gets short handed and the cost of labor in proportion rises. This will point in favor of using large towns, or a fair size city where female labor is plenty, and although at the start labor may be more expensive, in a short time the village help will make similar demands.

In considering the equipment to install for a public throwing plant problems arise that need most careful consideration. What kind of raw silk do you expect to handle, will it be all one grade or vary considerably? What class of machinery will be best adapted, also their speed, etc.? Is the supply of your help such that you can run some of the machinery day and night?

Who are to be your customers, the market, or do you expect to work only for one or two mills? The latter proposition will greatly simplify matters to you. Do you expect to handle organzine or tram, or both, also if tram, what average ends; if organzine, the amount of twist? Are you to handle Italian, Japan, Canton, or Tsatlees? Will there be any crêpe twist, *i. e.*, extra hard twist? Are you to handle tussah, etc.?

With reference to machinery, will you install individual machinery for every process, like hard silk winders, doubling machines, spinning machines, reeling frames, etc., or follow the progressive trend and install, wherever possible, combination frames?

Doubling and spinning tram may be done on two machines, again a combination machine will accomplish the same, using less floor space and requiring less help. First-spinning, doubling, as well as second-spinning of organzine is frequently done on three individual machines, again the progressive combination frame will accomplish all three processes on one machine, saving again in floor space, equipment and help.

As will be readily understood, planning a throwing department for an established weaving or knitting mill is considerably easier than if establishing a public throwing plant, since in the first instance you know what you are after, and in most instances have more or less uniform work all the year around. The case differs in a public throwing plant, and when you are then confronted with all sorts of conditions, materials, and customers you have to do work for and live up to their whims, and in many instances may be asked to do the impossible. Certainly you may decline to throw, for instance yarns for which you have not the proper machinery, or do not want to take the responsibility; you may for instance object to handling tussah, long reeled cantons or other low grades of poorly reeled silks. By refusing you may lose a good customer, and for which reason you may have to throw silk in many instances which costs you more to handle than you can charge for it.

The class of machinery to purchase is another question, and which will be influenced by the floor space at your command, the power question, as well as your financial resources. In many instances you may find double-deck machines having advantages over single-deck frames, again combination machines will certainly outclass single process machines, and pay you to install, provided the financial end permits it.

The ages and sex of the help available may also have an influence upon the type of machinery you are to install, since children may be worked with success on single-deck or single process machinery, whereas grown and experienced help will be necessary for double-deck and more particularly for the new combination machinery.

Being an advantage to the plant, to run your machinery every minute day and night, and thus at the highest speed possible, you will have to consider if you have sufficient help at your disposal to do it. Running machinery day and night will lessen the cost of the plant per unit of output. Winders, doublers, reelers and tram spinners as a rule are only run during daytime, whereas organzine spindles should be run with two shifts of help, *i. e.,* day and night. During noon and midnight hours the spindles run without attention, as they also do when changing shifts on day and night work, resulting in quite as good and possibly better work than if the machinery was stopped.

The hard silk winding department is the one which feels the effect first, provided inferior silk reaches the plant, a poorly reeled grège will cut down the output of that department quickly and seriously, and which in turn will influence the spindles throughout the rest of the throwing plant. For this reason, when installing hard silk winders do not stint yourself, add sufficient spindles so that if by accident you strike silk that runs poorly in winding, you can start up frames that otherwise would be idle.

If a throwster works on commission, he has to follow orders given him, whereas if he buys raw silk on his own account, he then either makes it up into the standard yarns used by his customers, or he has to wait for orders to ascertain what yarns are wanted.

All throwsters do not handle silks as if they know what they are handling, due in some instances to an insufficient knowledge of the fibre, inefficient organization in their mills, poor management of the silk in the throwing process, poor equipment, or the class of help employed. However, there are some concerns that represent all that standardized business organizations stand for, and which should serve as examples of what can be accomplished.

When buying thrown silk, in order to be sure of what you are getting, it is necessary to know all about the raw stock, its origin, grade, etc., points rather hard to ascertain, since it is not to the sellers interest to tell all that he knows.

Raw silk of commerce comes from the silk producing countries packed in bales, varying in weight not more than five per cent. In this way European silks come packed in bales weighing 220, Japan's 135, Shanghai's 135, Tussah's 135 and Canton's 106$\frac{2}{3}$ pounds net. Although the five per cent of variation previously referred to indicates a fair average, it is the custom of the market to accept such a difference or any similar one at the prevailing market rates when goods are delivered.

European silks are sold conditioned weight on the strength of the report of their respective conditioning house through which they passed and of which there are eleven each in Italy and in France, two each in Switzerland and Germany, and one in Austria. Yokohama, Japan also has a conditioning house, so has the United States in New York and in Paterson, N. J. There are other conditioning houses in Europe, but they however handle all kinds of textile fibres. This certificate as furnished by the European conditioning houses is binding to the importer in this country, although the buyer may, if he cares (at his expense) have the silk re-conditioned in New York or Paterson, and when, provided the result should be one-third of one per cent less than the European certificate, the seller then must accept the ruling of the United States Conditioning and Testing Company, and besides pay the expense of re-conditioning every bale individually in the lot.

Japan's, China Steam and Canton Filatures are sold in New York, conditioned weight plus two per cent, or actual weight.

China and Canton Rereels are sold conditioned weight plus two and one-half per cent, or actual weight, or invoice weight.

Tussah silks are sold solely on invoice weight, *i. e.*, not subjected to condition house tests.

Counts of Silk Yarn.

The fineness or counts of silk yarn is determined the same as other yarns by a given (standard) length and weight.

Two systems of calculating silk are in use, *viz.*, the *denier* and the *dram* system. Raw silk is generally indicated by the *denier* system, whereas thrown silk is mostly indicated by what is known as the *dram* system.

The *Legal Denier* is a skein of silk four hundred and fifty meters long, wound in four hundred turns on a reel of one hundred and twelve and one-half centimeters in circumference and weighed by a unit of five centigrams, known as denier.

One meter = 39.37 inches, therefore
One legal denier = 450 meters = 492.12 yards.
One pound = 453.6 grams.
One ounce = 566.99 legal deniers.
One gram = 20 legal deniers, hence
One pound = 9072 legal deniers.

Since one legal denier equals 492.12 yards, consequently 9072 legal deniers are equal to 4,464,513 yards.

The *Dram System* of calculating silk is based upon the measure of 1,000 yards for a weight of one dram, and which equals 256,000 yards per pound; (16 drams = 1 oz., 16 ozs. = 1 lb., 256 drams = 1 lb.). A 2 dram silk is one-half of this, or 128,000 yards per pound, and so on. Half and quarter drams are also used, hence $3\frac{3}{4}$ drams equals 68,266 yards, etc.

The length of the skein is 1,000 yards, except in connection with the heavier counts, and where 1,000 yards skeins would be bulky, and cause excessive waste, then such test hanks or skeins are made up in shorter lengths, for example, 500, or only 250 yards in length, and their weight taken in proportion to the 1,000 yards. Thus, if a skein be made up to contain 500 yards weighs 4 drams, the silk then is $(4 \times 2 =)$ 8 dram silk; if a skein made up into 250 yards weighs $1\frac{3}{4}$ drams, the silk will be $(1\frac{3}{4} \times 4 =)$ 7 dram silk.

To find the dramage of any given length per pound, divide 256,000 by the yards.

To find the yardage of any given dramage, divide 256,000 by the drams.

Dividing 4,464,513 yards by 256,000 gives us as the result 17.44 as the legal denier, (*i. e.*, constant number) for one dram.

To reduce any given dramage to deniers, multiply the dramage by 17.44.

To reduce any given deniers to drams, divide the deniers by 17.44.

The size of yarn, whether graded by the dram or the denier system of numbering, is always given for their "gum" weight; that is, their condition "before boiling-off."

The grading of raw silk by the denier system is always done by covering three numbers. In this way we express raw silk measuring between 14, 15 and 16 deniers, technically written as 14/16 denier silk, to weigh in an average from $14\frac{1}{2}$ to $15\frac{1}{2}$ deniers; in the same way 15/17 as from $15\frac{1}{2}$ to $16\frac{1}{2}$ deniers, etc., the character of the cocoon as well as the number of individual silk threads as wound by the sericulturist, and which occasionally vary, being the cause of the variation. In this way the average number of yards of raw silk in some of the most often met with silks are thus:

Raw Silk Expressed in Deniers.		Yards per Pound.
24/26 or $24\frac{1}{2}$ to $25\frac{1}{2}$	=	175,100 to 182,200
20/22 " $20\frac{1}{2}$ " $21\frac{1}{2}$	=	207,600 " 217,900
18/20 " $18\frac{1}{2}$ " $19\frac{1}{2}$	=	229,200 " 241,300
16/18 " $16\frac{1}{2}$ " $17\frac{1}{2}$	=	255,100 " 270,600
15/17 " $15\frac{1}{2}$ " $16\frac{1}{2}$	=	270,000 " 288,000
14/16 " $14\frac{1}{2}$ " $15\frac{1}{2}$	=	288,000 " 307,900
13/15 " $13\frac{1}{2}$ " $14\frac{1}{2}$	=	307,900 " 330,700
12/14 " $12\frac{1}{2}$ " $13\frac{1}{2}$	=	330,700 " 357,100
11/13 " $11\frac{1}{2}$ " $12\frac{1}{2}$	=	357,100 " 388,200
10/12 " $10\frac{1}{2}$ " $11\frac{1}{2}$	=	388,200 " 425,200
9/11 " $9\frac{1}{2}$ " $10\frac{1}{2}$	=	425,200 " 469,900

To establish the size of a lot of raw silk, the accustomed rule of the conditioning house is to take ten skeins from every bale and this from different parts of the bale; from each skein three test skeins (called *Flottilons*) are reeled off, and thus measured. Next reduce these test skeins to absolute weight, adding 11 per cent of allowed moisture.

In some instances it may be found necessary for the silk manufacturer or the throwster to ascertain the twist in a lot of raw silk. For this purpose take a sample of three or four yards from each skein to be tested, wind it on a metallic holder and boil-off the sample or samples, in order to free the yarn from its sericin.

The tests are then made on a fixed length, say using half a meter, or on 20 inches (which is nearly its equal, 19.69 inches).

If ascertaining the elasticity of a thread, whether dealing with raw or thrown silk, the same is expressed in millimeters on one meter; its tenacity is expressed in grams on one meter.

When calculating thrown silk don't miss to take proper allowance for soap, oil, take-up of twist, etc., into consideration.

The allowance in take-up (shortening) for twist in silk, unsoaked (thrown bright) is taken by the United States Conditioning and Testing Company at about three per cent, depending upon varying twists; to this you have to add oil or soap or both, as used in the throwing, and which means from one or more per cent up in the thrown silk, and which is removed in connection with the sericin, etc. the natural silk contains, in the boil-off.

The average limits within which silk fluctuates in the market is: Raw silk, 9 to 30 deniers, Organzine, 18 to 34 deniers, Tram, 24 to 60 deniers; however, these limits are not fixed, and vary in either direction, depending upon the origin of the silk. Italian silk spins to the finest count, is the most carefully reeled raw silk brought in our market, hence commands the highest price of any silk. Japan comes next in value, the better grades of it being a close competitor to Italian silks. Canton and Chinas are of less value.

Other Systems of Deniers.

Besides the legal denier thus far referred to, and which is the one adopted in the United States, *viz.:* 450 meters weighed by a unit of 0.05 grams, there may be met with in Europe the following denier measurements:

International	=	500 meters	—	0.05	grams.
Turin	=	476 meters	—	0.05336	grams.
Milan	=	476 meters	—	0.0511	grams.
Old Lyonese	=	476 meters	—	0.05311	grams.
New Lyonese	=	500 meters	—	0.05311	grams.

Therefore, 100 legal deniers equals 103.501 Milan deniers, or 99.117 Turin deniers, or 99.583 Old Lyonese deniers, or 111.111 International deniers.

To find the equivalent of a 14 legal denier silk in a 14 Turin denier silk, multiply 14 by 0.99117 = 13.87638.

ASCERTAINING COUNTS FROM COCOON FILAMENTS.

It is claimed that the individual cocoon filaments in raw silk reel about $2\frac{1}{4}$ deniers, consequently the number of deniers in the single thread is somewhat more than double the number of cocoon filaments used in the formation of the thread; thus, if six cocoons are reeled together, a single of ($2\frac{1}{4} \times 6 = 13\frac{1}{2}$) practically 13 deniers will be the resulting silk thread.

Throwing.

The operations of throwing comprise: opening, weighing and examining of the silk; opening of the skeins and soaking them, followed by wringing out of the water; unfolding the damp skeins and rubbing off some of the sericin where such is necessary to be done on account of threads adhering excessively to each other; drying and permitting the silk to regain its natural moisture; spinning for *organzine* or *tram,* using in connection with organzine: winding, first-spinning, doubling, second-spinning, reeling, stitching of the skeins, examining, bundling, packing and shipping. One spinning process only is used in connection with tram.

Besides organzine and tram we also find the following three kinds of silk, viz: *Dumb-singles, Singles* and *No-throw.*

These three kinds of silk are also known respectively by the names of *Singles, Singles-twisted* and *Floss.*

Dumb-singles and which means the raw silk thread of commerce, as formed by the reeling of the sericulturist, and which are the finest yarns known to textile workers, being woven by the natives in Asia, in silk gauzes, corahs, bandannas or other light fabrics.

Singles, or what is more to the point, *thrown-singles* are dumb-singles, which have been thrown or twisted, *i. e.,* the several fine filaments as united in one thread by the sericulturist are in turn, by the throwster, subjected to twist, and which materially changes the character of these yarns.

Both, dumb and thrown singles are most often woven in the gum on account of the greater strength the silk possesses in this state and the gum boiled-off afterwards from the woven fabric. In some instances such single silk is also dyed without boiling-off, which, however, is done at the sacrifice of some of its lustre, but the additional strength left to the yarn will not only result in better weaving, *i. e.*, in more production to the mill, but at the same time the woven cloth will gain in strength and weight, and which may be the cause of some of the lustre being occasionally sacrificed.

No-throw, sometimes called *doubling*, as the name indicates consists in winding two, three or more single ends (from a corresponding number of spools) side by side onto one spool, but without any twist as we might say, the throwster only imparting sufficient twist to bind the two, three or more threads together to permit re-reeling later on. The greatest of care must be exercised, in this process, in order that the threads (as doubled) do not separate and form kinks which not only are objectionable to the face of the fabric, but at the same time weaken the thread. However, it is essential that in order to impart a well covered face to the fabrics these yarns are used for, that no more twist than absolutely necessary be imparted to them in the throwing.

Tram being destined for filling purposes is spun (twisted) as lightly as possible. In this instance, two, three or sometimes four single ends of dumb singles are wound on the doubling frame on one spool, the same as done with no-throw; then the ply thread is spun.

As a rule from 2½ to 3 turns of twist per inch and never more than 5 or 6 (the latter in connection only with the elastic webbing trade) are put in tram. When two single threads are thus united into one thread, the latter is known as 2-thread tram, if three single threads are united, as 3-thread tram, etc.

Organzine is made up of two or more singles, doubled and twisted together, the number of threads and degree of twist being determined by the purpose of the fabric the yarn is to be used for. It refers as a rule to warp yarn, giving backbone to the fabric for which it is used; it has to stand the strain of warping as well as the chafing action of the harnesses and the reed.

With reference to the amount of twist put into organzine, the opinions of throwsters differ, some claiming that a very good twist for organzine of good quality is 16 and 14 turns per inch, whereas others go above or below, depending upon the fabric for which the organzine is intended.

With reference to a variation in twist, in both, organzine and tram, an average variation of 10 per cent in organzine (20 test skeins) either way from the twist, as ordered, is permissible. On tram, containing from 2½ to 3 turns, a variation of ½ turn, either way, is permissible. In tying up the ends, a large increase of twist necessarily occurs, which afterwards spreads each way along the thread. For this reason, tests should never be made near knots in the thrown silk, and numerous and careful tests are necessary to show exact conditions as to twist, although a single set of tests will generally serve to give a fair idea of the work done in the throwing.

In judging silk to be made into tram or organzine, a mistake in judgment by the manufacturer or his inspector, may mean considerable loss. The greatest of care is required in order to have satisfaction in its after manufacture, and for a fact some manufacturers can get a better fabric, as to appearance and wear, from a low quality of silk than others can from a better grade.

Raw or *hard* silk varies as to hanks in size and quality. To classify them is the work of the sorter, or as also called inspector. Quality and weight to length are the two standards; upon the skill of the sorter the quality of a lot of yarn depends, and in a similar way upon his accuracy in weight and measurement the spinner relies for quantity.

The qualifications in a lot of silk for which a sorter looks, are fineness, regularity, clearness and freedom from knibs or knots. The sorter selects the various qualities by touch and sight and sorts them accordingly. Thus classified, the hanks are weighed and measured. Without great labor accuracy of measurement is impossible and when the sorter has to depend upon samples taken. It is also part of the duty of the sorter to detach loose ends and straighten them. Sorting, results in waste known as "sorters' waste," and which, the same as parters' and splitters' waste (later on referred to) is *bright.*

In the production of a perfect thread, *i. e.,* to obtain quantity and quality of production on the loom, the throwster or overseer of the department must take every precaution to minimize original defects in the raw silk by carefully cleaning the latter in connection with the proper machinery and devices, exercising at the same time proper care in the throwing processes, thus avoiding imperfections. He must adapt, *i. e.,* vary the treatment to suit the character and quality of silk under operation.

Silks as a rule are fairly even in size, and the skeins reeled in hanks are suited for winding without splitting, with the exception of the silk raised by the Chinese on their silk farms and from where they are collected by traveling dealers. They are reeled in a rather primitive way, and reach the market in bundles known as *books,* which in turn are divided into skeins known as *mosses,* weighing nearly 1 lb. For this reason they require very careful splitting into smaller skeins since the mosses would be too heavy to put upon the swifts of the winding frame, *i. e.,* the strain on the single end in the winding process would be so great that it would continually break and thus cause endless trouble to the winder, with its consequent amount of waste to the mill. The throwster splits up the moss into three or more sections, known as *slips,* and thus has a chance to handle them properly. The size of these slips or sections, as made from the mosses varies, although it is the throwster's object to have them as much alike as possible. It will be readily understood that this separating of the moss into slips is a most tedious work when handling silk that has been reeled carelessly by the sericulturist.

The apparatus used for splitting the mosses or large skeins into slips consists of a frame or table, upon which are placed, in an upright position and some distance apart from each other, two barrels or swifts, one of which is movable at its bottom in a slot in the table, so as to permit the distance between the two barrels to be varied to accommodate the handling of mosses of different diameters. The moss is opened out by the operator (sitting in front of the table) and placed over the two barrels or swifts, previously alluded to. Then the operator places her hands in between the two sides of the moss, and revolves it quickly round and round the swifts, which operation causes the moss to open out on the face of the swifts, tending to get the threads straight, and as nearly as possible in the same position as when the moss was on the reel of the sericulturist.

In this way the moss is made ready for being divided into the required number of slips of similar size at most suitable places, and split or parted with a minimum of broken threads between each division.

In this parting of the book into mosses, and the splitting of the mosses into slips, there is a certain amount of waste made, known in the trade as *parters'* and *splitters' waste,* which is always bright—that is to say, free from soap or other matter.

China, however, is always more and more improving the reeling of its silk, with the result that the condition of the reeling of their skeins has been greatly improved, thus simplifying the work of the throwster, doing away more or less with the unnecessary labor of splitting these heavy skeins.

Sorting.

The skeins, hanks or slips as we may variously call them are now ready for sorting, in order to balance the uneven thickness (diameter, *i. e.,* count) found in these yarns, since otherwise the union of a thick and thin thread will produce a yarn presenting a loopy, crinkled, corkscrew appearance, which is a serious fault and drawback to the after-processes in the manufacture of yarns and fabrics.

The requirements of a competent raw silk inspector or sorter in a silk mill, and where he is responsible for every pound of yarn received, are a general knowledge of silk manufacturing, besides thoroughly understanding the practical end of throwing, including machinery and processes, the silk fibre as well as the various kinds and grades (good and poor qualities) of silk he may have to come in contact. To meet the competition of the market, besides procuring the raw silk for his plant at the lowest possible cost, he must bear in mind quality and production. He must produce a perfect yarn, using in the construction of the latter the proper class of raw silk to suit the kind of fabric desired, as well as keeping in mind the color to be used in connection with the dyeing of the yarn, since some silks take colors more level than others. Better, *i. e.,* finer counts of silk are more satisfactorily used for light shades, like pink, light blue, cream, lilac, etc., whereas for black a somewhat inferior silk will answer the purpose, the main feature in connection with the latter color being to have a strong silk thread so as to stand the weighting. Be careful that you use an even silk in fabrics for such colors that are apt to show unevenness more closely than others.

The amount of twist to impart to organzine and tram in connection with various fabrics is a most important item for the throwster. As a rule, with reference to regular organzine twist, 16 turns are inserted in the first spinning and 14 turns in the second spinning. Other combinations of twist, for instance some satin and umbrella organzines are often thrown as low as 10 and 8 turns, whereas taffetas are run up to 14 and 12, heavy linings 16 and 14, and exceptional strong and hard organzines for special fabrics up to 18 and 16 turns per inch for their respective first and second spinning process.

With reference to tram, less twist is imparted to it than to organzine, from 1 to 3 turns per inch (in connection with one process of spinning) is all that is desired in order to present cover to the fabric, *i. e.,* make it fill better.

Although there are a great many silk manufacturers met with who do not trouble with a careful inspection of the silk they buy, leaving the matter to their importer, there are others who inspect their raw silks most carefully, and this for a fact several times during its run through the mill, from the time the sample is offered, to the finished fabric for the market.

The raw silk is first examined when received in the shape of skeins, or books; when they conform to sample, the entire lot is then examined so as to obtain a fair average of the latter. The next examination is made during the different processes comprising throwing, boiling-off, dyeing, etc., a careful consideration being finally bestowed upon the woven and finished goods ready for the market.

Carelessness by a silk manufacturer not knowing what he is doing is frequently the cause of trouble for the silk importer. Preliminary tests made by the manufacturer might have prevented trouble, they might have told him that either he was using the wrong kind of silk or the wrong process as to twist, count of yarn, texture, etc. In this way he could have exchanged his lot of silk before using it, a feature the silk importer would have gladly done to hold the friendship of his customer, and when the changing of importers as now frequently done by mills, would be a thing of the past.

There are, however, any number of silk manufacturers who will not trouble with tests, life is too short for them, their chief aim being production. After selecting the lowest grade of silk consistent with possible results, they will rely on the dyer for the proper shade and lustre, may have him run his yarn through a lustering machine, instructing in turn the finisher to add sufficient glue and paste to the fabric to give it the touch to the hand the market requires.

At the same time it may be found by manufacturers that for certain fabrics inferior silks are sometimes of equal if not more value as compared to more expensive kinds of silks.

The fact that a # 1 silk often spins better than a # 1 Extra may be due to the "Extra" having a large number of defects which off-sets its supposed higher value. When the manufacturer buys such a better grade he pays a higher price, the throwing is more expensive, but in the end he may find that the yarn is not as good as if he had used the lower grade of raw silk referred to, which contained a less percentage of defects both in regard to quality and size.

The defects to be considered are: The size of the raw silk knots (which if over $\frac{1}{8}$ inch in length must be taken out), nibs, slugs, fine, coarse, loops, splits, corkscrews, bad throw, adhering waste, etc.

Knowing the kind of goods he has to produce, the manufacturer should procure the silk best suited to his needs, considering the size or denier, the winding qualities (as affected by the defects) strength (especially of advantage in silks to be heavily weighted) evenness (where a lack of it would give an unevenly dyed appearance to the cloth, as in the case of some bright colors) and the following where they are essential to the production of characteristic qualities in certain fabrics: lustre, elasticity and handle or feel.

As will be readily understood the price of any kind of raw silk is not standard—it fluctuates with the market conditions, *i.e.*, with the supply and demand, hence it remains for the manufacturer to know anytime the value of a lot of silk to him.

What Silk to Use.

When planning the construction of a new fabric, we must know the characteristics of the kind of silk we are to use, since upon the proper selection of the same the success of the mill largely depends. Not only must the yarn wind, warp and weave well in order to obtain production, but at the same time the kind of silk selected must be of such a quality which will cause the goods to present the most desirable appearance, feeling, etc., when finished. To accomplish this, we must have a perfect raw silk thread to begin with, *i. e.,* a commercially perfect skein of raw silk must be furnished to the throwster, one of continuous length, even in size, and knotted together by short knots ($\frac{1}{8}$ inch or shorter) and free from such defects as are larger than these short raw knots referred to.

There are however many manufacturers who buy silk for their mills who do not possess a sufficient knowledge of the subject they are dealing with, neither making a perceptible effort to acquire such a knowledge, buying the costly silk yarn in the dark as we might say, knowing hardly any more of silk than the difference of organzine and tram, and from which limited knowledge they expect to make any kind of fabric that the market may demand.

The most prized qualities silk possesses are: (1) Its great brilliancy and lustre, it being the most lustrous of all textile fibres. (2) Its great strength. (3) Its superior elasticity. (4) Its durability, which is very considerable when the fibre is pure silk.

In this country there is not the large market for spot thrown silks that exists in Europe, and where the most exact information is available about each lot. In this country, throwing silks and selling them afterwards to manufacturers is done only more or less in a limited way, few houses being engaged in this trade. Mills who buy thrown silks from stock are, as a rule, such whose uses of silk are either small or of a varying character, or concerns operating with a limited capital, although sometimes large silk mills may need a special lot of silk in a hurry and cannot take the time to buy raw silk and have it thrown.

Among raw silks there are varieties a manufacturer may be called upon to buy, *viz:* true or cultivated silk, wild or tussah silk, spun silk or chappe.

Considering true silk, the same is raised in various countries of the world. Not only does silk raised in different countries differ from each other, but we must at the same time remember that there is also a wide difference in the characteristics of silk as is coming from one country. This may seem an impossibility for a fibre as fine as the $\frac{1}{1000}$th of an inch, as is the brin of the Bombyx mori, to undergo subdivision, when one considers its apparently structureless nature, both to the unassisted eye as well as under the highest power of the microscope.

The most widely used silks in this country are those of Japan and China, followed in turn by smaller quantities from Italy, the Levant, etc.

America consumes the largest amount of silks raised in Asia, each year increasing the quantity purchased owing to the various uses in the construction of fabrics they can be put to.

Provided some of the defects, characteristic to some of these Asiatic silks, *viz.,* lack of uniformity of grade; unevenness in size; frequency of fine, coarse, double and split ends; lack of cleanliness; irregularity of twisting and streakiness, could be avoided, Asiatic silks within a short time would supplant European silks entirely in the American market.

The imperfections characteristic to some of these Asiatic silks, more particularly to those coming from China could be easily remedied, a feature shown by Japanese silks, which, with reference to their state of condition are far superior to those coming from China, and for a fact nearly equal to those from Europe. Japan has made in recent years remarkable progress in improving the quality of their raw silks by introducing European methods.

Buying China silks is somewhat of a lottery to American silk manufacturers; many of the latter, who could substitute the best qualities of these silks for those they procure from Europe hesitate to make a change, on account of the uncertainty regarding the quality of the former.

Some of our prominent silk manufacturers, of high financial standing in the Yokohama, Shanghai and Canton markets, and who buy either through their own representatives there, or through New York silk houses controlling filatures there, have less complaints to make, getting a silk of good quality, clean, uniform and well reeled.

American silk mills however have at times to depend upon the Asiatic market for their raw silk and thus have frequently to accept inferior silk from China in order to keep their mills running, a feature which causes them to hesitate wherever possible in the purchase of silk from China, giving Japan and European silks the preference.

Japan Silks.

A great quantity of silk comes from Japan, all being well reeled and easy to handle by the throwster. The color as a rule is a creamy white, produced by annuals, and qualities range from the very finest downwards. A few exceptions are bivoltins and yellow. Japan has about ten kinds of cocoons. They take more care in the selection and hatching of eggs compared to the Chinese so that they practically control the crop during two-thirds of the season. The raw silks shipped to America, as a rule are selected from among the nervy and hard natured silks, characteristic of the Japanese Bombyx mori.

Provided any defects are found in Japan silk, they no doubt are due to the heavy demand for silk at the present time and when reelers are forced more or less to devote their energies to obtaining production in place of quality of reeling, claiming that manufacturers do not like to pay the additional expenses of more careful reeling.

China's Silks.

China has a great variety of cocoons, there being at least five polyvoltine kinds, yellow, green or white. The Cantons are all polyvoltins, whereas in the northern provinces several are annual. The Chinese yellow cocoons as a rule are poor and many of them very bad, except those of the Tsie-Kiang Province.

North China silks considered in their bulk are brilliant, white, clean and nervy; those reeled in the steam filatures by European methods, known as *China Steam Filatures* are second to none, and are growing in favor with American manufacturers. They are usually sold under three gradings to a chop, *Nos. 1, 2* and *3,* but chops are grouped according to merit under half a dozen divisions, from *Extra Best* chops to *Secondary* chops. The native reelings, called *Tsatlees,* while of excellent nature, are irregular in size, and must be handled most carefully in the mill. They are offered in three selections to a chop, either *Nos. 1, 2* and *3,* or *Extra, No. 1* and *No. 2.* These chops are divided into some five groups, ranging from *Extra Best* to *Market No. 2.* There are also other Chinese selections such as *Haineen Filatures, Cross-reeled Tsatlees,* etc.

Some of these silks produced in the north of China are about equal to Italian silk, and if they were treated with the same degree of care would yield raw silk of the very best quality.

From South China come the *Canton silks,* not so white as those from the North; while lustrous, on account of the hot damp climate they are softer, more spongy, hairy, gummy, with little tenacity and medium elasticity, permitting their use only for special fabrics. Here again, better reeling is the important demand. They embrace nine selections, from *Extra Extra A,* (crack chops) down to *No. 3 B.*

The improvement in China silks (the country considered as a whole) must be accomplished in the first reeling, as well as the elimination of hand reeling and the extensions of the filature system all over the country.

To improve the condition of China's silk *i. e.* to show them their carelessness in raising and reeling silk, the U. S. Conditioning and Testing Company and the Silk Association of America combined in preparing in December 1915 a raw silk exhibit of Italian, Japanese and Chinese skeins, showing the better methods of reeling practiced by Italy and Japan in comparison to the defective reeling of Cantons and other Chinese silks.

This exhibit, together with a statement setting forth the difficulties experienced by American silk manufacturers in handling a great many of the silks from Canton and Shanghai, was carried to China by Minister Kai Fu Shah and who is now using his influence to help to secure the desired improvements, and from which statement we quote most important items in the interest of our readers showing them the disadvantages of China silk compared to Japan and European silk.

The statement referred to covered the following points that must be complied with by China's silk interests to increase the value of their product in the American market.

(1) Silk must be clean, free from defects like slugs, waste, loops, long knots, loose ends, double ends, etc., all of which cause excessive waste in the winding and spinning, as well as breakage of the warp-threads at the warping and in the harness of the loom.

(2) Silk must be of uniform size, *i. e.,* no excessively fine or coarse portions should be present in the thread.

(3) Silk must be made in China into skeins which will unwind readily, without excessive breaking of the thread, considering the high speed of American

throwing machinery necessary to obtain quantity of production with a minimum amount of manual labor and waste. He can not do as Europe does, take low grades of silks and rereel and clean them. He will find the use of better grades of silk to his advantage.

The purpose of the exhibit was to show:

(1) Difference in rate of winding raw silk from the skeins on to the spools.

(2) The causes of these differences.

(3) Differences in the formation of Italian, Japanese, China and Canton skeins.

(4) Effect of the different kinds of lacing yarns upon the waste produced in throwing.

(5) The effect of gum spots or reel marks on the winding.

In the winding demonstration a wide range of silks was shown, grading from poor winding silk with an average production per operative of from 6 to 8 lbs. per day in connection with Chinese silk, up to the splendid winding silks from Japan and Italy at an average production per operative per day of from 35 to 40 lbs.

Canton Steam Filatures, marked "Miu Lun Silk Shed" with two peacocks. Silk was 14/16 denier, of good elasticity and tenacity, showing that it came from good cocoons, but it was so poorly reeled and so uneven that it broke frequently, with a result showing that the average production per operative would be only from 6 to 8 lbs. per day, and this with an amount of waste of from 8 to 12 per cent.

Canton Steam Filature, marked "Miu King & Cie," showed good elasticity and tenacity: coming from good cocoons they reeled better than the first, resulting in an average production per operative of from 15 to 18 lbs. per day. The amount of waste made in winding this silk in the mill would be from 3 to 8 per cent.

Tsatlee, marked "Hong Foo Muen Silk Hong," showed to be silk of from 16/18 denier, of good elasticity and tenacity and quite well reeled, indicating an average production per operative of from 16 to 20 lbs. per day, and this with an amount of waste made of from 2 to 5 per cent.

Tsatlee, marked "San Yuen Silk Hong, Chieng Zu," presented a 16/18 denier silk of good elasticity and tenacity, also reeling good, with an average production per operative of from 16 to 18 lbs. per day, causing a waste of from 2 to 3.5 per cent.

China Filature, marked "E-Wo Filature," presented a silk of from 13/15 denier, of excellent elasticity and tenacity; reeling good with an average production per operative of from 18 to 22 lbs. per day, and this with a waste made of from 1 to 3 per cent.

Japan Extra, 13/15 denier, reeled excellently, showing an average production per operative of from 35 to 40 lbs. per day, with a waste amounting to from 1 to 2 per cent.

Italian Classical, 14/16 denier, reeled excellently with an average production per operative per day of from 35 to 40 lbs., indicating a waste of from 1 to 2 per cent.

Silks quoted were all reeled from first quality cocoons, but the manner of reeling and the form and condition of the skeins were the causes of the difference in amount of production and percentage of waste. The latter was indicated for one process only, and approximately the same relation would hold for these silks through all the later processes they are subjected to, for it is a fact that the action of the raw silk in the winding operation is a reliable indication of its action throughout all other operations, and that a silk which makes large winding wastes will make large wastes in each throwing, etc., operation.

As a further step in its efforts to expand the sources of supply of raw silk by improving the reeling of Chinese silk skeins, so that much more of China's raw silk supply may become available for the American market, the Silk Association of America has lately suggested to the raw silk producers and merchants of the Chinese Empire, the possibility of establishing a direct means of conducting silk transactions between China and America.

The Association cites that this might be accomplished by forming a China-American Corporation for the purpose of preparing silk for reeling in Canton and marketing it in America. In addition, it suggests establishing a raw silk house under Chinese management in New York, as well as establishing an American house with Chinese associates in Canton.

The possibility of founding a Sericultural Institute under the Chinese Empire for the development of Chinese sericulture along European lines, and the extension of the Chinese raw silk industry, is also proposed, as well as the possibility of the government establishing in Canton and the Shanghai districts conditioning houses where the silk can be accurately tested and certified.

A further possibility suggested is that of securing a government subsidy for the opening of modern equipped filatures, and the payment of a bonus upon properly reeled silks, until the modern methods become thoroughly established. The income to the government on the increased foreign trade, it is believed, would justify an endeavor of this kind.

Among other propositions under consideration is the possibility of introducing into the various silk districts of China, the European methods of cocoon reeling by sending a number of Chinese reelers to Italy to learn the methods, and by inducing a number of Italian or French reelers to go to China and work as teachers or superintendents.

Also, the establishment in the Canton district of at least one filature, equipped with European basins and reels, for trial and example. This filature could be established and maintained, the Silk Association claims, by means of Chinese capital, or through a joint organization of Chinese reelers, with government support.

The great advantages of a properly formed, laced and packed skein for the American trade, the Association points out, have been thoroughly demonstrated since the adoption by Japan, and parts of China, of the American Standard Skein.

The defects which cause Chinese raw silks to wind poorly are thus:

A raw silk thread containing many fine and coarse parts will break in the fine places, consequently reducing production.

Insufficient and irregular crossing of the thread in the reeling from the cocoon or in the rereeling, will cause the thread to become tangled and break, adding to the waste produced in throwing as well as reduction in output.

The lacing should be laced back and forward through the skein several times and tied with short knots to avoid being tangled in the silk, by handling.

When the silk has been reeled so as to form masses of gum where the skein rests on the reel arms, it will be found difficult to soften these spots and keep them soft until the skein can be unwound. These gum spots are the cause of frequent breaks; besides the silk is apt to be damaged by excessive rubbing necessary to free the thread so that it will unwind.

Some Chinese silks after being prepared by soaking in an emulsion of soap, oil and water, are very sticky or gummy, as though they contained an excess of gum or some foreign paste matter such as starch, dextrine, or vegetable glue, and when the threads mat together and wind poorly. The suggestion has been made that the water in the basins where the cocoons are soaked is not changed with sufficient frequency.

Many slugs, large knots, waste, etc., in the silk, catch the thread and when running fast break it, especially when the skeins are large and heavy, like Cantons.

Double ends characteristic to Chinese silk and which are often several hundred yards long, cause a great amount of waste, since they all must be removed.

The old forms of skeins, especially those from Canton, show the following defects:

They vary in size and many are too large and too heavy, requiring larger swifts, more floor space and slower winding speed. The traverse and therefore the crossing is not large enough.

The lacings are often placed as bands around the skein, instead of being laced through it, and the lacing material used is too large and too hard twisted. The size makes it slow and difficult to remove from the skeins and the hard twist causes it to curl and become tangled in the silk after it is soaked with the silk in the emulsion of soap and oil.

The fly bars in the sericultural reel should be shaped so as to form broader and softer gum spots.

Sales Conditions of Silks.

Japan Silks, China Steam Filatures and Canton Filatures are sold in New York conditioned weight plus 2 per cent, or actual weight, or invoice weight.

China Rereels and Canton Rereels are sold conditioned weight plus 2½ per cent, or actual weight, or invoice weight.

Shanghai Rereels and Native Filatures are guaranteed by Seller not to lose more than 22 per cent by a boil-off at the U. S. Conditioning and Testing Co. Buyer and Seller may have as many tests made as they see fit, the average of all such tests to govern the basis of the amount of boil-off.

Growing Demand for Asiatic Silks.

To show the growing demand of Asiatic silks by American manufacturers, we quote from the last report of the Silk Association available, by percentage, the amount of importations from the various countries, based upon the grand importation of 31 million pounds of silk imported in 1915, compared to that of the year 1906:

FRANCE in 1906 contributed 2.8 per cent of our total silk imports, and which in 1915 *dropped* to 0.3 per cent.

ITALY in 1906 contributed 22.1 per cent of our total silk imports, and which in 1915 *dropped* to 10.3 per cent.

CHINA in 1906 contributed 16.4 per cent of our total silk imports, and which it *raised* in 1915 to 24.7 per cent.

JAPAN in 1906 contributed 58.1 per cent of our total silk imports, and which it *raised* in 1915 to 64.5 per cent.

OTHER COUNTRIES in 1906 contributed 0.6 per cent of our total silk imports, and which in 1915 *dropped* to 0.2 per cent.

IMPORTS OF RAW SILKS

for Years 1906, 1913 and 1915 respectively, showing *Decrease* of Imports in European Silk and *Increase* of Imports in Asiatic Silk.

	1906 Pounds	*% of Total Imports*	*1913 Pounds*	*% of Total Imports*	*1915 Pounds*	*% of Total Imports*
France:	474,286	2.8	76,489	0.3	72,920	0.3
Italy:	3,728,822	22.1	2,409,434	8.6	3,190,705	10.3
China:	2,769,228	16.4	6,100,485	21.8	7,627,476	24.7
Japan:	9,764,246	58.1	19,056,919	68.1	20,039,640	64.5
Others:	107,453	0.6	335,478	1.2	47,904	0.2
	16,844,035	100.0	27,978,805	100.0	30,978,645	100.0

European and Levant Silks.

Italy produces a large quantity of silk, not only from cocoons raised in that country, but also from such cocoons as are sent there from the Levant, Syria, Broussia, Roumelia, Persia, etc., when there is a shortage of their crop in Italian and French filatures. Italian silks, known as Piedmonts and Friouls are second to none in the world. Sicily also is the home of many excellent qualities of silk.

From France come the well known Cevennes silks, supposed to be the best silk in the world, but being rather softer and hairier than desirable for some purposes; some of this silk is slightly dusty.

There is also a limited quantity of good silk sent out of Hungary and which as a rule is well reeled.

Spanish silks, and of which some occasionally find their way to this country, are very good silks.

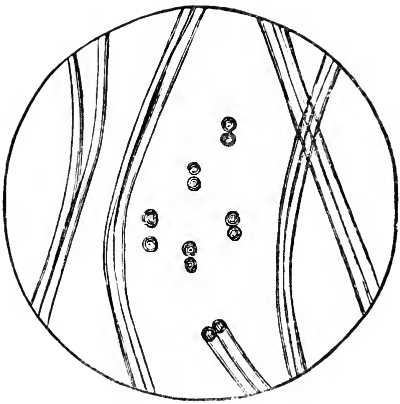


Fig. 1

The cocoon of the Bombyx mori, hatched annually is the only one that gives satisfaction with reference to raising silk in Europe, although it is said that some trivoltin kinds are found in Tuscany and Milan Italy, but if so, these are exceptions. Fig. 1 is a view, magnified 500 diameters, of the silk of the Bombyx mori, showing the longitudinal fibres as issued in pairs from the seripositor of the silkworm. The single fibre is termed *brin,* and the double fibre *bave.* The rounded spots in the illustration are transverse sections of the bave.

European Silks are sold conditioned weight, and European Conditioning House tests must be accepted, unless Buyer chooses, at his own expense, to have the silk reconditioned in New York. Should the result be $\frac{1}{3}$rd per cent less than European conditioned weights, Seller must accept the New York conditioned weights and pay costs of the re-conditioning; each bale to be treated individually.

India's Silk.

The Bombyx fortunatus is about the only domestic cocoon in India. Bengal cocoons are polyvoltines and of a yellow color. The first crop out of six is by far the best. These silks are always dusty but somewhat superior to Cantons.

Indo-China also raises a fair silk. Two-thirds are yellow and one-third white polyvoltines. The climate of Tong-King is most suitable for raising silkworms, but the natives are a lazy class of people and their reeling process is of a primitive nature.

Wild Silk.

There is also a large amount of wild silk (generally known as *Tussah*) used, most of which comes to us from Manchuria and other parts of North China, some coming from India and some from Japan. *Tussah,* also called *Tussur* or *Tussore* is derived from the Hindu word *Tusuru* (a shuttle).

Wild silks are the product of silkworms which cannot be domesticated and live freely on the mulberry and other trees.

Wild silkworms make two kinds of cocoons, *i. e.,* such as partly opened or closed. Those that are entirely opened can only be used in connection with the waste silk business. All wild silkworms must be closely watched on the tree where they choose to build their cocoons and picked before the butterfly has time to get out of his prison.

There are several well-known industrial species of wild silk, of which the Indian, *Antheræa Mylitta,* which feeds on the leaves of sub-tropical plants, and the Chinese species, *Antheræa Pernyi,* the larva of which feeds on the leaves of the various species of the oak, are of the Tussur species. Their cocoons, which are larger than the Bombyx mori's, seem to be closed, but are really made up of several tubular coatings closed at each end by the gums so that the reeling of these silks in China, India etc., is done differently than with the ordinary cocoon. The basins used in the filatures must be flat because if cocoons are completely immersed in water, the gums at each end dissolve and this allows water to get inside, which should

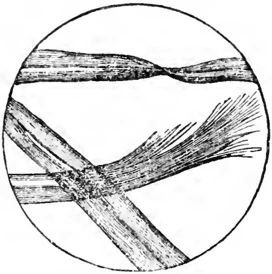


Fig. 2

be prevented for proper reeling. The cocoons once wet, are deposited on wooden tablets and unwound from them. This is called dry reeling. In the wet reeling (water-reels) cocoons are unwound in hot water and soda. It is to be noted that the latter system shows a much larger percentage of waste.

The Chinese add some dark greasy matter to the soda, which gives a brownish color to Tussahs thus treated. This color is removed easily in a hot-water bath.

Before 1875, Tussahs were not used much in the silk industry, owing to the color of the raw silk being uneven. Since then it has been bleached white through a chemical composition of oxygen, water and bioxyd of barium.

Very large quantities of native woven Tussah fabrics, called Shantungs and Honans, are regularly arriving in this country and Europe from native looms in China and India, being used for motor dress purposes and other garments and where during late years they have become deservedly popular.

Tussah silk is hard to dye by ordinary processes and it took the German dyestuff concerns a long time to master the subject.

The fibre of the Indian Tussah silk is $\frac{1}{620}$th of an inch in diameter, that of the Chinese Tussah being $\frac{1}{760}$th of an inch, that of the Italian silk of the Bombyx mori $\frac{1}{1900}$th of an inch, of Bombyx fortunatus of Bengal $\frac{1}{2000}$th of an inch.

It is interesting to notice the ribbed appearance of wild silk fibres. The darker striations appear to be of solid silk, while the lighter parts consist of somewhat less soluble silky matter, which it is not easy to detach from the more fibrous part.

Filature tussahs made from Manchurian cocoons, especially those from Cheefoo, reel off silks quite per-

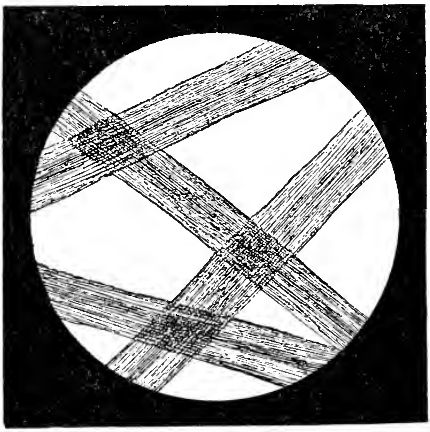


Fig. 3

fect, both in uniformity and cleanliness and are well spoken of in the market, mixed with other silks, doupions, spun silks, cottons, etc. They come in the market in five classes, graded from *Extra Best* down to *Market No. 1,* each chop as a rule being offered in two grades. Most of the Tussahs coming in the New York market from China are eight cocoon threads.

Contrary to these filature tussahs, those reeled by the natives in China, as well as in India, etc., show considerable irregularities, anywhere from 50 to 150

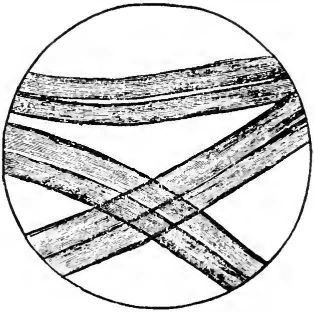


Fig. 4

deniers variation, and consequently present no well recognized gradings, hence are of little consequence to the silk market, the greater part of it being used by the natives to mix with the better grades of tussah, etc.

Fig. 2 shows the Indian Tussah silk of the *Antheræa Mylitta,* magnified, showing divided fibrillæ, or divisions produced by permanganate of potassium.

Fig. 3 shows the microscopic appearance of the double fibre, or bave, from the *Antheræa Pernyi,* or Chinese Tussah silk, and which differs from the Indian Tussah in both form and texture; from it the silk cloths called Shantungs and Honans are made.

Fig. 4 shows fibre from the *Antheræa Yama-mai,* also spelled *Yamamy.* It belongs to the family *Saturniidæ* and its fibre is ribbed like that of tussah silk. It is a most useful specie of wild silk, although of a coarser fibre than that of the Bombyx mori and has a very glossy appearance, being flat and striated. The diameter of the fibre is one-thousandth of an inch.

This wild silkworm feeds on the leaves of the oak tree of Japan and where (according to Sira-kawa & de Rosny) he has been known since 1487, then discovered upon the island of Fatsitsyo and transplanted to Nippon. His original home, however, seems to have been China and where he has been met with in the mountain regions in a fully wild state. This is the reason why in Japan he is called *Yamamayu* (silk worm of the mountains).

This silkworm, in its method of living and breeding, closely resembles the Bombyx mori, and the silk obtained from it is of considerable value. In former times the product of this silkworm was entirely reserved for the reigning house of Japan, the penalty of being found guilty of exporting eggs being death.

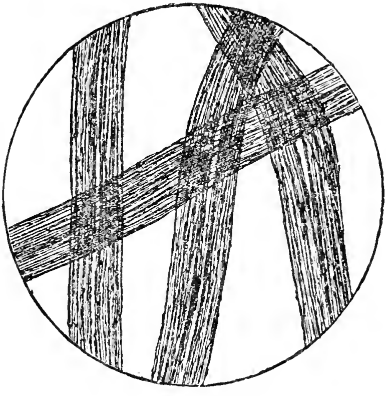


Fig. 5

Japan raises the Yama-mai worm in several districts, *viz:* Goshiu, Tango, Etshigo, Koshiu and Owari and very extensively in Sinschin, where several villages, known collectively as Matsukawagumi with Furumaya as its centre, depend entirely upon its raising.

The silk of the *Antheræa Assama* or as also called *Muga silk,* is the wild silk next in structural importance to Tussah, and has great promise of utilization if the natives could be induced to grow it in quantity for export. Fig. 5 shows the microscopic appearance of the pairs of silk fibres as seriposited by the worm.

Wild silks, collectively known as Tussah, are sold invoice weights, or actual weights carrying no guarantee of loss in weight by conditioning.

Weight of Silk Bales.

The weight of silk bales vary according to the country from where they come; the number should not vary more than 5 per cent from the following (net) average weights: Europeans 220 pounds, Japans 135 pounds, Shanghais 135 pounds, Tussahs 135 pounds, Cantons 106⅔ pounds. Variation in weight beyond the allowed 5 per cent is not a cause for cancellation of contract, and is to be adjusted with the seller at market rates at the time of delivery.

Testing Raw Silk.

Tests as to variation in count and winding of silk are made in the filatures, but if it is necessary to have a definite proof, have the U. S. Conditioning & Testing Company make their test for comparison. The latter concern, besides having desiccators for ascertaining moisture in silk, has all the necessary apparatuses for testing size, twist, elasticity and tenacity. cleanliness of the silk, as well as for its boil-off. All their tests are kept absolutely secret, being carried on as follows:

Conditioning.

For ascertaining the amount of moisture in silk, *i. e.,* the conditioning of silk, all operations of weighing at the U. S. Conditioning and Testing Co. are made by two persons, one checking the other.

Sample skeins are taken from all parts of the bale, and these divided into three equal lots.

The three sample lots are then weighed on two different scales and by two different persons. If these weighings do not differ from each other by more than $1\frac{1}{2}$ decigram, the first weight is definite, and forms the basis for the calculation.

Two of the three sample lots are then submitted to desiccation or drying out in the conditioning ovens at a temperature not exceeding 140 degrees C., and weighed within one decigram. The weight obtained is the dry weight or absolute weight.

If the difference in the percentage of loss of the two lots does not exceed $\frac{1}{2}$ per cent, the average of the two losses constitutes the basis for calculating the absolute weight of the whole bale, from which the conditioned or commercial weight is obtained by adding 11 per cent for allowed normal moisture.

If the difference in the percentage of loss of the two lots exceeds $\frac{1}{2}$ per cent, the third lot, kept in reserve, is also submitted to the desiccation. If the difference in the percentage of loss of the three lots does not exceed 1 per cent, the average of the three losses forms the basis for calculating the conditioned weight of the whole bale.

In case the maximum difference in the percentage of loss of all three lots should exceed 1 per cent, the conditioning operation is inconclusive. The silk has then to be spread openly during 48 hours in order to obtain uniformity in the state of moisture, and when a new test is made.

Sizing Tests.

The fineness, or count, of silk is determined by the size. The latter is the number of deniers which a skein of a certain length weighs. The legal denier is a skein of silk 450 m. long, wound in 400 turns on a reel of $112\frac{1}{2}$ *cm* in circumference and weighed by a unit of five centigrams, which is called a denier.

To establish the size of a lot of silk, ten skeins are taken from every bale and from different parts of the bale, and from each skein three test skeins (called *flottilons*) are reeled off.

The conditioned size is obtained by reducing the test skeins to the absolute weight and adding 11 per cent of allowed moisture.

The average size under contract, according to the rules of the Silk Association of America, shall not vary more than given herewith for different classes and grades of silk.

EUROPEAN SILKS. European conditioning house sizing tickets shall be final, unless demonstrated to be wrong by the U. S. Conditioning and Testing Co. *Extra Classical* to *No. 1* inclusive 11/12 and finer shall not vary more than $\frac{3}{8}$ denier either way from the average given on each and every bale.

From 11/13 to 15/17...	$\frac{1}{2}$	denier	either	way	is	allowed
From 16/18 to 19/21...	$\frac{3}{4}$	"	"	"	"	"
From 20/22 to 24/26...	$\frac{7}{8}$	"	"	"	"	"
From 25/27 to 28/30...	1	"	"	"	"	"

JAPANS. Seller's sizing tests, or Yokohama conditioning house sizing tickets shall be final, unless demonstrated to be wrong by the U. S. Conditioning and Testing Co. *Fancy* and *Double Extra* are governed by the same rule as Europeans. *Filatures* and *Rereels, Extra* to *No. 1 to 1½* inclusive, and *Best Extra Kakedas* 14/16 and Finer, shall not vary more than $\frac{1}{2}$ denier either way for the lot, and 1 denier for each bale, from the average given. *Filatures* and *Rereels No. 1½* to *No. 2* inclusive and *Kakedas Extra* to *No. 1* inclusive 14/18 and Finer, shall not vary more than 1 denier either way for the lot, and 1½ denier for each bale, from the average given. *Lower grades* carry no guarantee of size.

Size 16/18 and Coarser in *Filatures No. 1* and Higher Grades shall not vary more than the European allowances for the lot, and $\frac{1}{2}$ denier additional for each bale, from the average given. *Coarse Sizes* below No. 1 carry no guarantee of size.

CHINA STEAM FILATURES. Seller's sizing tests shall be final, unless demonstrated to be wrong by the U. S. Conditioning and Testing Co. *Filatures First*

Category are governed by the rule for Europeans. *Filatures Second Category* 14/16 and Finer shall not vary more than ½ denier either way for the lot, and 1 denier for each bale, from the average given. *Filatures Third Category* 14/16 and Finer shall not vary more than ¾ denier either way for the lot, and 1 denier for each bale, from the average given.

SHANGHAI REREELS, NATIVE FILATURES and TUSSAHS carry no guarantee of size.

CANTON FILATURES. Seller's sizing tests shall be final, unless demonstrated to be wrong by the U. S. Conditioning and Testing Co. *Double Extra* and *Extra* 14/16 and finer shall not vary more than ¾ denier either way for the lot, and 1¼ denier for each bale, from the average given. 16/20 to 28/32 shall not vary more than 1½ denier either way for the lot, and 2 deniers for each bale, from the average given. *Filatures No. 1*, 14/16 and finer shall not vary more than 1 denier either way for the lot, and 1½ denier for each bale, from the average given.

CANTON FILATURES NO. 2 and LOWER CANTON REREELS carry no guarantee of size.

Twist Tests.

Samples of about 3 to 4 yards are taken from each skein and reeled on a metallic holder. A short boiling operation serves to free the silk from the gum. The tests are made on a fixed length (half meter or about 20 inches) and the number of turns reported on one meter, and also per inch by dividing turns per meter by 40 (the exact equivalent being 39.37 inches).

Elasticity and Tenacity.

The elasticity is expressed in millimeters on one meter and tenacity in grams on one meter.

Boil-Off Tests.

The boil-off test shows the loss of gum which silk, (raw or thrown) sustains by boiling twice for one-half hour in a separate solution of soap. The quantity of soap in each solution to be 25 per cent of the absolute weight of the silk. The sample to be tested is reduced to the absolute weight before and after the boiling-off. The difference betwen the two weights gives the percentage of loss.

Raw Silk Inspection.

Some of the large silk manufacturers have their own raw silk expert, *i. e.,* inspector, who makes his test based on a life long experience, on the whole lot of silk under consideration, whereas only a few bales, taken at random of a lot, are handled by the Conditioning Company.

A raw silk expert is the man who can, simply by looking at and handling a few skeins representing a lot of silk, determine the grading as well as its uses in the fabric. He must be above all an experienced manufacturer, to be able to apply his knowledge of the raw materials together with the one of manufacturing to the greatest profit for the mill.

In order to meet competition, with a uniform cost of raw material and labor, and taking into consideration that the cost of raw silk is in a greater proportion to that of wages, the only way open for him is a careful selection and use of the cheapest suitable raw silk qualities for each and every different use he has in the mill, giving the greatest attention to the selections of the low price and suitability of the grèges he can procure, in place of considering its running-quality.

Raw silk inspection in this country is still in its early stage and is done differently from that abroad, to suit the difference in manufacturing conditions between here and in Europe. Here the markets are unsteady, subject to political depressions, tariff tinkering, crop conditions, prosperity of the iron and steel trade, financial panics and so on, all items more or less unknown in Europe (not considering the present war). Here manufacturers rush their orders, hence they must be supplied with a silk that runs well in the winding, warping and on the loom. The high cost of labor here compared to that abroad is another reason why we only can use good running silks.

To claim lack of time, or being too busy, is no excuse for a manufacturer to eliminate raw silk inspection. He must remember that if the same is found profitable in Europe and where the manufacturing cost is lower, the same care should be applied by every mill here.

In Europe, one must first look for suitability and low price and second for production, whereas here in America we must look for production as well as suitability and low price.

Raw Silk Importers seem to have no objection to manufacturers testing their silks before they buy, since it relieves them of part of their responsibility, but manufacturers as a rule seem to object to it, relying solely on the word of the importers' inspection instead of on their own, yet the same manufacturers would not buy any of the minor supplies for their mills upon the word of others.

He may claim that the dyer gives him the proper shades, that passing the thread through a lustring machine will give him the required lustre for his goods; that singeing the goods will impart the touch required, and that glue will substitute all the stiffness and handle the silk is short of. His chief aim in buying his silk may rest in production, quality to be produced by artificial means.

Some of the more careful silk manufacturers inspect their raw silks. The first inspection is made when sample skeins are submitted, the next is made from some of the bales bought to see if they conform with the samples, in turn obtaining a more thorough test. Additional tests are also made by some mills during or after throwing or dyeing or in the finished goods. Keeping a careful record of these tests will enable a manufacturer to gain a superior knowledge of raw silk, *i. e.*, the kind of silk wanted by him for a certain fabric he intends to make, as well as full data as to condition and value of a lot of raw silk offered to him, a knowledge of which will account for his success as a silk manufacturer. The expenses for fitting up a small laboratory for his mill will cost little and repay itself within a short time.

In testing raw silk, the same should be carefully handled when drawing a skein for testing from a book (bundle of skeins); the skein should be carefully opened and after examining very carefully re-twisted (without breaking the ends or disarranging the skein) and with care replaced into the book, from where it was taken, in order that the skein will be in proper shape when handled on the raw silk winder in the mill. As a rule, this care in removing skeins from a book is not exercised, inspectors rip and tear the skeins and tangle them badly and then put them back into the book in a haphazard manner, not only ruining the skein handled, but also those adjoining.

The adopted standard for ascertaining the quality of a lot of silk is thus:

Winding:

A proper winding test is represented by the number of breaks in the whole skein, *i. e.,* considering its top, middle and bottom. Breaks depend on the speed of the reel, the size or count of the thread, kind of reels used and whether weighted or not; the amount of sericin present in the silk, as well as the atmospheric conditions in the winding room.

Based on 50 r. p. m. of swift, for a 2 hour test.

100	bobbins,	1 break or none					=	extra good.
100	"	from	2	to	4	breaks	=	very good.
90	"	"	4	"	6	"	=	good.
80	"	"	6	"	8	"	=	good to fair.
70	"	"	8	"	10	"	=	fair.
60	"	"	10	"	15	"	=	fair to poor.
50	"	"	15	"	25	"	=	poor.
40	"	"	25	"	40	"	=	very poor.

Cleanliness:

The same is pronounced as

Extra Good, provided thread is absolutely pure.

Very Good, provided the thread contains only a few nibs or corkscrews.

Good, provided the thread shows nests besides a few nibs, also appears slightly hairy.

Fair, means imperfections to the thread previously referred to, plus particles of cocoons.

Provided defects previously referred to appear in quantities such a lot of silk is known as *poor* and in very bad cases, as *very poor* or as also called *unfit.*

Variation in Counts of Grège,

depends on the kind of silk we deal with, classification based on a 10,000 m. test, being known thus:

Extra Good Regularity: Variation 2 to 3 deniers; characteristics of Piedmond Extra, Extra, Yellow.

Very Good: Variation 3 to 4 deniers; characteristics of Italian Extra Classical.

Good: Variation 4 to 5 deniers; characteristics of China steam best.

Good to Fair: Variation 5 to 6; characteristics of Japan Best No. 1.

Fair: Variation 6 to 7; characteristics of Japan rereel No. 1½.

Poor: Variation 7 to 8; characteristics of Canton XXA.

Very Poor: Variation 8 to 10 and more; characteristics of Low Grade Tsatlee.

Elasticity.

The same can be ascertained by the feel of the hand or by an apparatus called a serimeter.

Raw Silk Tests.

Raw Silk Inspection formed a most interesting subject read by Geo. A. Post of Post & Sheldon Corporation, Paterson, N. J., at the Second Silk Convention, and from which we quote:

The silk is (by his concern) first examined visually for *uniformity,* and a percentage given for it, according to a regular form that his mill uses by experience as a standard. The skeins are then *examined,* and given a percentage of perfection. *Thickness* is looked into next, also *reeling, lacing,* and the amount and character of the *sericin* the silk contains. These various features are all given an arbitrary value, and the average taken. Although these points are not taken into deep consideration, they must be noted.

The first test of importance made is the *winding* test. We run for this test sixty ends for two hours, and count the breaks each half hour at a speed of 180 yards per minute. A good silk (for example) may give as an average on it, for the first half hour 3, for the second 7, for the third 6, for the fourth 3, or a total average of 10 breaks per hour. This, according to a table of classification used by the mill gives 100 per cent for the winding. A poor silk (for example) may show breaks on an average of 95 per hour. This shows a great difference and, according to the table used by my mill, 48 per cent.

The *spinning* is averaged next and reported.

The *color* in turn is noted. The conditioning house in New York uses a lot of adjective names for the colors, *viz:* yellow, white, ivory, cream, etc., and they have adopted a rotation of these names, thus giving them a relative value. The importance of color is found when dyeing into the lighter shades.

Then there is the *uniformity* of the threads to be tested, which is graded by the conditioning house in: very even, even, fairly even, slightly uneven, uneven and very uneven.

Lustre, touch to the hand, nature, cohesion, etc., are then treated in the same way.

Lustre (as a rule) indicates the bloom of a nervy, healthy fibre, but it is not always true to this condition, since it may be produced in the sericultural reeling of cocoons. As this quality also can be artificially produced in dyeing it is of minor importance. The twist and soaking also change the lustre so that very little can be said of this quality when once thrown into organzine or tram.

Touch to the Hand may be classed as silky, nervy, spongy and strawy. This quality has much to do with the feel and cover of the finished cloth, but as almost any feel to the hand can be supplied in finishing the cloth, it need not be considered as an essential qualification.

Nature of Silk. The same may be classed as hard, medium and soft. There seems to be no definite knowledge of this quality; also there is a great variance in opinion as to its importance. We find in Japan silks a hard, soft and medium nature. The hard natures have a hard, dense thread and are very strong, offering great resistance in boiling-off. It is well known among practical throwsters that hard natured silks are far more buoyant in the soak tub than soft natured, from which it would appear that hard natured silks are made such by the nature of the sericin causing the fibres to unite more firmly and resisting the action of the soapy liquor to a greater extent than a soft natured silk. From this it may be concluded that by using a standard soap solution and temperature, the time in which a skein of silk becomes saturated would indicate a unit showing the various natures of silk. It is generally admitted that not only notable differences in the composition of the fibroin exist in the silk from different districts, but that a varying action is exhibited toward acid and alkaline solutions.

Cohesion is the quality of the thread that causes cocoon fibres to stick together as one compact thread and resist friction in warping and weaving without splitting; it is dependent on the nature of the sericin and a long twist in reeling from cocoons.

Keep track of the defects thus quoted in the winding of the silk for two hours, and make a memorandum of it, tabulate it, and you will have a good record for future reference.

Cleanliness: This is one of the principle qualities of silk, for which the latter may be tested in four ways:

Take ten skeins and examine each one very carefully, and put down what you consider is a proper percentage for each skein. Look over the ten skeins and then get an average for the ten.

Then take twenty blackboards, called "mirrors", and wind the silk on them, which will show up every single thread and then you can see defects most distinctly. Standards are kept by the mill for each board or mirror and then the average for the twenty is taken.

Twenty bobbins are then examined in the same way and put through the same course and an average for them obtained.

Then we take an average for the dirt we discover in winding.

Add these four averages and divide the sum by four, and you will obtain the average cleanliness of a lot of silk thus tested.

Evenness: The next test made is that for evenness. There is a difference of opinion about this test. Some mills think it is more important than any other, whereas others think cleanliness is more important. At any rate, make an exhaustive test for evenness. For instance, make 300 sizings of 225 meters each. Classify and group them in all sorts of ways, and any sizing that is not a true sizing penalize a certain number of points, and after going over each sizing add up these penalties. By a table prepared by experience in the mill, these penalties are then changed into percentages.

Then examine the silk again for evenness on twenty blackboards, as previously referred to, and look each one over carefully on both sides, mark any defects and compare them by standards for percentages. Mark the percentage of each blackboard; then get the average on the twenty.

Keep also a tab on the uneven threads in winding for two hours and record the defects and causes for breakages.

We now have four percentages; adding these and dividing them by four we get a good average for evenness of the lot of silk thus tested.

Elasticity: Test twenty skeins and get an average elasticity, and then get the average of the weak skeins.

Tenacity: These tests are made in the same way.

Tests thus quoted are the principal points to test for, all having the same value, although there are some tests that have more value than others.

Mr. Post mentioned that the management of his mill takes evenness as being the most important in any of these tests, and has given it a value of 40 per cent of the whole. Multiply the evenness percentage by forty, and get a product.

The next important point of perfect silk Mr. Post considers is cleanliness—about one-half as important as evenness. Multiply the percentage of cleanliness perfection by twenty and get another product.

The next important thing to consider is the winding, and we think there is about 12 per cent importance attached to winding.

For elasticity we allow 8 per cent.

For tenacity we allow 5 per cent; for hand and touch we allow 7 per cent; for lustre 4 per cent; uniformity 2 per cent; and spinning 2 per cent. This takes care of the 100 per cent.

By multiplying these percentages for each test and taking the average, you get a general average. We have in our mill an arbitrary table which works well, and which shows that 88 and 90 per cent silk is a superior, double extra. Silk that runs between 83 and 87 we classify as double extra; silks that run between 80 and 82 we classify as extra; between 77 and 79 we classify as fair extra; between 73 and 76 we classify as Best No. 1 extra; 60 to 72 we classify as Best No. 1; 63 to 68 we classify as Good No. 1; 60 to 64 we classify as No. 1. Anything below that is 1½ or worse. These are all arbitrary classifications, but they are proving themselves to be very good, and compare with the reliable grades and chops with surprising accuracy.

Grading Silk.

The gradings under which the different silks are sold vary; those adopted by the Silk Association of America are:

EUROPEAN SILKS are classed in seven grades, *viz:* Grand Extra, Extra Classical, Best Classical, Classical, Best No. 1, No. 1, and Realina.

JAPAN SILKS are classed either in Filatures, Rereels or Kakeda.

Japan Filatures are again classed into eleven grades beginning with Double Extra, Extra, Sinshiu Extra down to No. 2.

Japan Rereels are again classed into nine grades, starting with Extra, going down by numbers and fractions of numbers to No. 3.

Kakeda's are again classed in five grades, *viz:* Best Extra, Extra, Nos. 1, 2 and 3.

New York classification differs from those of Yokohama, for instance, Best No. 1 Japan silks of the New York market correspond only with the No. 1 of the Yokohama market, and other grades accordingly.

Grades from Best No. 1 to Extra comprise the bulk of Japan silk used by our mills for organzine; No. 1½ to No. 1 and Rereels from No. 1½ to No. 1 are used for tram.

Cocoons vary from year to year in quality, for which reason Best Classicals of one year may be no better than the Classicals of another year, the same being the case with other grades. Where there are more than one yearly crop, like for instance in Japan and where there are a summer and a spring reeling, the first produces the better silk. In the same way, in connection with Cantons and of which there are six (and sometimes seven) crops the three crops reeled during damp weather are inferior to the next three.

In the same way as the condition of the climate influences the quality of the silk produced from one family of silkworms in one section of the country, in the same way differences in altitude, water and other conditions, will frequently result in a wide difference in the merit of the silk produced, even from the same lot of silkworm eggs. Different provinces in the silk producing countries have their own peculiar varieties of worms, and each reeling establishment will have its own style of management and conditions of work with a consequent reputation for good or bad work.

While distinct grades are recognized, the products of the many filatures are so varied that the qualities blend into one another without any distinct dividing line, for which reason prefixes, as for instance *Strict No.* 1, *Good No.* 1, or *Fair No.* 1 will be used; again a silk that some may call No. 1, others may rate as No. 1½, etc., for which reason the reputation of different marks is more or less shifting. Improved machinery and better help and management used will improve the quality of the output of a filature; in the same way bad management of a filature may cause the rating of its output to drop in the market.

A manufacturer having used a certain chop for a considerable length of time in his mill and receiving satisfaction from it, both as to quality and quantity of production, naturally is in favor of reordering this brand with his raw silk dealer. In doing this he may find that he received an inferior silk, and consequently is in a quandary to know the reason why. To this we may have to suggest two causes, either the reeler or the filature in Asia has substituted a lower grade to meet the demand for the certain chop, and thus reap the benefit, or again, somebody may have substituted a popular chop ticket for a lower grade of silk in the market, in order to dispose of a lot of silk on hand, or from a financial benefit.

The manufacturer having made his contract, based on a certain brand of silk, and being unsupported by any definite characteristics regarding the silk he bought, naturally has no resources in the matter to law, and the only chance open for him is that provided he is a desirable customer to the seller and can allow the latter sufficient time to correct the mistake, he will be the loser and have to put up with it, being more careful the next time when ordering silk and include definite measureable characteristics in his contract, and thus know where he stands.

In this statement we are upheld by the fact that in a single lot of silk of one kind you will find some bales which will wind well, others poorly, showing that they either must come from a different filature or comprise two grades from one filature.

Rational Raw Silk Classification.

Facts thus quoted clearly show that there is no actual standard system of silk classification, and in which statement we are upheld by Mr. D. E. Douty, General Manager of the U. S. Conditioning and Testing Co., whose paper on the "Possibilities of a Rational Raw Silk Classification" appeared for the first time in the February 1915 issue of *"Posselt's Textile Journal"* and from which we quote:

"The requisites of any system of grading or classification, in order that it may be standard, are as follows: (1) It must be uniform, unchanging and definite. (2) It must be as simple and as natural as possible. (3) It must be capable of use and interpretation by any individual of average intelligence and experience in the business of which it is a part.

"Any system of classification which depends upon visual inspection and individual judgment only, cannot become a universal standard because it possesses no values capable of accurate definition and is dependent entirely upon the experience, judgment and personal bias of the individual inspector.

"Such a system not only fails to furnish a standard by which trading can be conducted and controlled with complete understanding but becomes an untrustworthy and fluctuating measure capable of widely varying interpretation.

"At the present time there is no real standard system of silk classification. In the large silk centres of the world there have grown up separately so called systems of grading, which serve to divide the raw silk supply into rather indefinitely defined rough groups. These systems are not related or tied to one another by any fundamental principle and are therefore subject to a wide difference in interpretation.

"Such a classification as Grand Extra, Extra Classical, Best Classical, Classical, etc.; or as Double Extra, Best Extra, Extra, Best No. 1, No. 2, etc., as adopted by the Silk Association of America, without any further description, is exceedingly indefinite and the subject of continuous controversy.

"In the entire American market there are only a very few men capable of grading raw silk. If the American manufacturers and their employees were given 100 books of Japan raw, ranging from Double Extra to No. 2, probably 99 per cent of them would be unable to sort them into their respective grades. Of those who could sort them, it is a question if any two would entirely agree.

"Inasmuch as America is not a producer of raw silk, it is certainly desirable that a standard classification of raw silk should be international; at least with Japan and China, the countries most interested.

"A classification which shall be useful must be based upon the largest possible number of properties which can be accurately measured and the smallest possible number of properties which must be estimated or guessed.

"The properties of raw silk may be grouped into two general classes; those which influence the quality of the manufactured product and those which influence its cost of production.

"The properties which affect the quality of goods produced from raw silk are tenacity, elasticity, size, uniformity, cleanliness, flossiness, number of single, double and split ends, evenness of twisting, nature and color.

"Those which affect directly the cost of production are moisture, condition, amount of gum or sericin and the reeling by the sericulturist or the filature. These may easily be considered as secondary qualifications unnecessary to a proper classification because they can be accurately specified in each contract for sale, and are subject to accurate determination for each lot of silk.

"Of those which influence quality the first four (tenacity, elasticity, size and uniformity) can be accurately determined; they are by far the most important.

"The single silk fibre, the bave, as it comes from the cocoon is the most uniform of all the textile fibres. It is believed that the tensile strength per unit of cross section is fairly uniform and that the elasticity is usually proportional to the tensile strength. Probably by far the greatest part of the variation in tensile strength in silk reeled from the same quality of cocoons is due to imperfections in the reeling. Silk which shows uniformity in size will show uniformity in tenacity and elasticity.

"That there are seasonal fluctuations in the physical properties of silk is well known. But in even the poorest seasons there never fails to be on the market, according to the present classification, a quantity of the highest grades.

"With the current methods of grading it is the manufacturer who must stand the burden of the poor quality crop.

"The only possible basis for an International Classification of raw silk are those properties which can be measured. It is vital that the measurements be made by the same methods under the same atmospheric conditions. To attempt to develop a system which would include all kinds of raw silk would be unwise, expensive, and very difficult. Inasmuch as European silks are not used extensively in America, and Asiatic silks form the chief supply, the first attempt might properly be limited to interesting Japan and China in an endeavor to develop an International Classification and International Standards for use in our trade with those countries."

What Kind of Raw Silk to Buy.

Large consumers of silk will carefully study the merit of the season's crop, and of the particular grades they use, holding some marks in esteem whereas others they would not have at any price. They must also buy that kind of silk most suitable to the class of goods they intend to make. Provided you are not versed in the silk market, but know the goods you want to produce, you may get excellent guidance from some of our high class raw silk houses as to what you should buy, and with their advice you will not get far astray. Buying by their advice and having the silk thrown and dyed to your own order, you then know exactly what is going into the goods you are to make and will have no trouble in duplicating them later on. This advantage you do not have when buying thrown silk.

The characteristics required by the fabric you are to make, *i. e.,* to buy the silk for, will vary; it may refer to the amount of lustre wanted; the closeness of its face, *i. e.,* cover of the fabric; its suppleness, firmness, softness, crispness, rustle. Its draping qualities; cleanness of face, *i. e.,* neither hairy, lousy or specky are also items that must be most carefully considered when buying your silk for a new kind of fabric you intend to make. Color, twist, texture and weave are in this instance other items well worth to be taken under consideration when selecting the kind of silk to use in the construction of a new fabric structure.

To acquire a knowledge of buying silk requires experience as well as a close study of the market. Silk will vary in regularity of count, strength, elasticity, lustre, the loss in its boil-off as well as the color it will take after boiling-off. Other items to be considered are freedom from streakiness, firmness, adhesion of the filaments of the grège thread without a tendency to split up in the dyeing, presence or absence of nibs, slugs, or other imperfections, *i. e.,* cleanness of thread. Hardness of the sericin, condition of the skeins and how reeled at the filatures, *i. e.,* whether there are any double ends, length or weight and diameter of the skeins, as well as the character of the crossings, the number and condition of the tie-bands or lacings, etc., are all characteristics of silk that must be carefully investigated when examining a lot of raw silk.

Defects met with in Raw Silk.

For the purpose of examining a lot of raw silk, draw a double skein called a roll from a book, or bale, or, if more than one book or bale is available, you may then take a roll from each of two or three books or bales, resulting in turn in a more accurate test.

These rolls are then carefully examined on their exterior for the presence of any imperfections, hairiness, color, etc. To ascertain nerve, hardness or mushiness of the silk, grip the roll or rolls firmly in your hands and when feel will guide you as to the life the silk possesses.

The roll is then carefully separated into its two skeins of which a roll is usually made, and when one of the skeins, in order to be examined, is thrown over the cross-arms of a stretching post, drawn down taut and spread out a little on the arm, and by the movements of the hands is slowly drawn round and round, and spread open more or less by the fingers, being observed critically all the time. A black background placed behind the post will greatly assist you in your work.

Next examine your skein for any imperfections in the thread, since the spinning qualities of raw silk are mainly dependent upon the number and kind of defects in the silk, for which reason an Extra is frequently no better than a No. 1, whereas there are cases where a No. 1 shows better than an Extra.

The main defects met with in raw silk are: Double ends, Fine threads, Coarse threads, Loose ends, Waste, Bad raw knots, Nibs, Slugs, Corkscrews, Loops, Split ends, Bad throws, Bouchons, Fouls or Slubs, Vrilles, Duvets, Lousiness, etc.

Double Ends is a bad defect to silk and must be carefully looked out for. They are the result of reeling several raw silk skeins from different sets of cocoons at the filature, and when two or these sets of cocoons run together without being noticed by the reeler, the raw silk thread then for some distance being twice its thickness.

Fine Threads are such where cocoons run out without the sericultural reeler noticing it in time; moderate differences in the size of the threads (one or two cocoons short) are not readily noticed. Fine ends are liable to break in winding the silk, hence are a defect, and must be searched for. Fine ends are frequently found accompanied by bad throws, coarse threads, knots, etc., caused by the sericultural reeler when noticing the thread running fine (*i. e.*, short of one or two cocoons), he then adds several cocoon filaments at once which with the superfluous end or ends thus added causes a sudden increase in the diameter of the silk thread to such an extent that they are caught in the cleaner of the hard silk winder in the throwing plant, and in turn break the thread during winding.

Coarse Threads are caused by double cocoons or when several more cocoon filaments than required have been added by the sericultural reeler to his raw silk thread.

Loose Ends, if present in quantities in the skein may increase the cost of the silk to the mill up to 10 or 15 cents per pound. The cause of them may be the result of breaking out of defects during inspection of the skein.

Waste are all loose formations more or less spread out on the raw silk thread and which imperfections are not loops or bad throws, being a class of defects to the raw silk thread that are very annoying, about one-third breaking out during the process of throwing. The larger defects are chiefly met with in the lower grades of raw silk.

Bad Knots are known in raw silk either by their ends being glued together in the sericultural reeling, or are made in the rereeling of the skeins dry at the filature, either one causing trouble in throwing, warping and weaving. About 40 per cent of them break out in the throwing.

A commercially perfect skein of raw silk may be expressed as a thread of continuous length, knotted together by short knots, $\frac{1}{8}$th. inch or if possible (and better) shorter. These *Small knots* are therefore no defect, but are a necessity for a perfect thread. On Italian silks they run from 10 to 100, on Japanese silks they run from 100 to 700.

Nibs are small slugs, about the size of a raw knot or slightly larger, and which will not show in the thrown thread, whereas if there are two nibs close together, forming a larger, oblong imperfection, they are then known as *Slugs*, and are a defect to the thread. They show up about twice as large in the dyed state, and since they as a rule are glued firmly together, only a small amount of them is removed in the throwing process.

Corkscrews are caused by an uneven tension to the cocoon filaments at the sericultural reeling, the loose filament imparting to the raw silk thread an over-twist effect resembling the twist effect of a corkscrew, hence the name. It not only affects the loopy appearance of the raw silk thread and in turn the face of the fabric, but it at the same time reduces the elasticity and strength of the silk thread, for the fact that the loose cocoon filament is not subjected to an equivalent strain as compared to that of the tight filaments in the silk thread during throwing, warping and weaving.

Loops are a defect somewhat related in their origin to that of corkscrews. On a closer examination of the defect you will notice in the imperfections that one of the cocoon filaments is longer than the rest. Loops are produced by intermittent slack running of one of the cocoon filaments, hence they show up off and on (in spots) on the raw silk thread, whereas with corkscrews the cocoon filament which is the cause of the trouble, runs slack in periods. Loops of a fair size will double up in the cleaners of the hard silk winder and break down the thread.

Split Ends affect the strength of the silk thread; they are only caught when a loose cocoon filament splits off the silk thread and in turn causes a break on the hard silk winder. They are a defect to the silk, reducing its strength, and silk lots in which this defect is noticed are better left alone, since where you notice a few, any amount will be present in the lot.

Bad Throws are the result of carelessness in the sericultural reeling, and means that the raw silk thread shows quite uneven throughout its length, indicating a shiftless reeler.

Bouchons are an imperfection caused by imperfect reeling of the cocoons by the sericulturist, a more aggravated form of imperfection to silk reeling compared to that of *Duvets,* the layers of the thread on the cocoon in this instance coming off more than one at a time. Also known as *Fouls* or *Slubs.*

Vrilles are an imperfection to the silk thread of commerce caused by imperfect reeling and produced by the breakage of one of the baves when it is necessary to reduce the number of the cocoons.

Duvets are an imperfection caused by bad reeling of cocoons, giving the thread the appearance of short fibres thrown off from the base of the thread. This was attributed formerly to the silkworm spinning an imperfect bave on the cocoon; but while there may be variation in thickness between the first and last end of the spun thread, there is no mechanical imperfection caused naturally. The microscope reveals to us the real cause, either frequent and imperfect joinings as the cocoons become attached to the main thread, or still more by an uneven temperature in the reeling basin (which should be kept at 140 to 160 deg. F.) thus causing the silk to unwind itself unevenly and cause small loops.

Lousiness of Raw Silk.

Lousiness is a defect to raw silk, *i. e.,* to the silk filament as it comes from the cocoon. It does not refer to any mechanical defects in the sericultural reeling of the cocoons, such as duvets, vrilles, knots, etc., but is the tendency of the original bave, as it comes from the cocoon, to split into its elemental fibrillæ and thus become flossy upon being degummed in a neutral solution of olive oil soap and water.

The flossy condition caused by it may be aggravated by rough and improper handling in the throwing and dyeing processes, or kept at a minimum by careful handling. The Italian name for it is *fiocchetti,* whereas German dyers call it *farbstaub* or *seidenlaus* (dyedust or silk louse). French silk manufacturers call it *perlage.*

Judging from their appearance, the roughnesses were at first thought to be little grains of atmospheric dust which is sometimes scattered over the threads, but their extraordinary resistance to brushing or washing very quickly persuaded the manufacturers of a different origin.

The strangest hypotheses were afterwards put forward as to the source and the nature of these slubs or excrescences. Some believed them to be due to a defect in the reeling, throwing, or manufacture; others attributed them to some insect or parasite, known as the silk louse, which found on the thread or brin a substance suitable to its development; and some even ascribed it to an abnormal appetite and digestion in the silkworm, which caused it to emit, contemporaneously with the fibres or brins, incompletely digested vegetable particles.

The upholders of these absurd hypotheses tried to find confirmation in the fact that these whitish excrescences did not take the dye in the same manner as the rest of the thread, and for this reason they asserted them to be formed of cellulose, or some such substance. Not less serious was the assertion that the defect was characteristic of silks coming from certain sources, and that it might be imputed more especially to the species of worm and to the methods of rearing, or to the manner of disinfection.

Lousiness is a most serious defect to raw silk and consists of little roughnesses or inequalities caused by microscopic specks, slubs, or excrescences of very fine fibrillæ unevenly distributed, and of a lighter color than the brin or material of which these imperfections are formed.

For the fact that lousiness is formed of fibroin, the defects receive the tinctorial substances in the dyeing process (as has been demonstrated by microscopic examination) but they appear of a lighter hue on the color of the thread on account of their extreme thinness, for the same cause that makes the dust of colored glass appear colorless, or grey the detritus of black marble, analogous also to what occurs with the foam of a colored liquid which always results in a color less intense than the liquid itself.

In weaving, these slubs or fiocchetti hinder the free running of the thread and cause it to break frequently as it passes the heddle eye and reed. It dulls the brightness of the material, and none of the means hitherto tried have succeeded in overcoming the depreciation of the tissue caused by them.

Lousiness cannot be discovered in the raw silk inspections as usually practiced. The defect in question is only noticed after the silk is boiled-off and dyed, and this more pronounced in a raw silk of a soft nature as compared to a silk of a hard nature. Lousy silk is excessively flossy and in most cases there appear on it numerous white or light colored specks resembling dust or lint.

It would be in the interest of silk manufacturers that some means were discovered for detecting quickly lousiness in raw silk, *i. e.*, before the latter has reached the advance state of manufacture, and when the same might have been put to use in connection with other fabrics of less exacting use.

During late years this trouble of lousiness has become again prevalent, numerous inquiries regarding it being made by silk men to the U. S. Conditioning and Testing Co. to ascertain the cause of this trouble which was not noticed by these people until the silk was boiled-off and dyed, many of them thinking that the trouble rested with imperfect handling at the dyeing. The matter was closely investigated by D. E. Douty the manager and K. B. Lamb his assistant, who at the same time took any number of photographs of silk thus affected in the various stages they were handling them for inspection and of which the most interesting ones are given.

Both men proved that lousiness in the silk filament exists as it comes from the cocoon and is not caused by faulty filature reeling, imperfect soaking, or rough handling in throwing, neither is it done in boiling-off or dyeing, although a rough handling will aggravate the imperfection.

The cause of lousiness according to both experts is thus:

"The single *bave* or *end* as it comes from the spinneret of the worm is composed of two filaments, secreted by the two glands of the worm and cemented

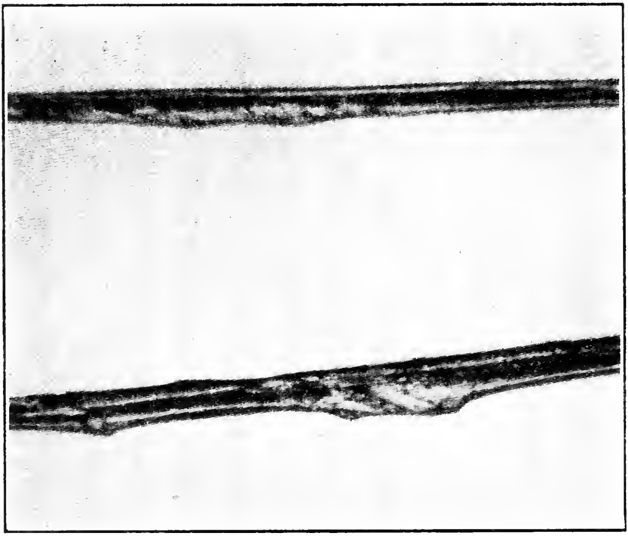


Fig. 6

together by sericin or gum. Each filament or fibroin is itself composed of bundles of exceedingly fine fibrillæ also cemented into a compact mass by the sericin.

"When a normal silk is prepared for dyeing a portion of the gum is boiled-off. A sufficient amount remains to cement the two filaments and the fibrillæ, of

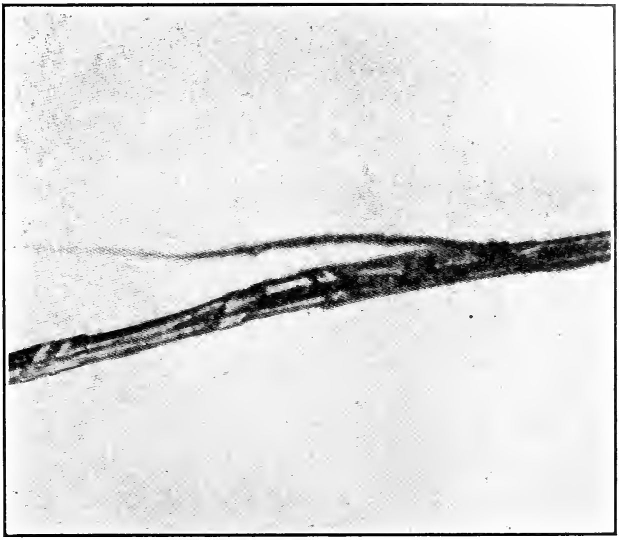


Fig. 7

which they are composed, compactly together and the thread remains smooth and lustrous. If insufficient gum remains to hold the filaments together they separate and form a loose soft thread, the ends split, the silk becomes flossy, and, in extreme cases, the filaments themselves separate into the fibrillæ and the silk becomes very flossy. Even normal silks differ quite widely in the ease with which the gum dissolves.

"Lousiness is the tendency which the original bave, as it comes from the cocoon, has to split into its elemental fibrillæ and when it becomes unusually flossy upon being degummed in a neutral solution of olive oil soap and water.

"An examination of the specks on lousy silk by means of the microscope shows that they are masses of the exceedingly fine silk fibrillæ all matted and tangled together. They may occur regularly or irregularly and may be plentiful or few. They give the skein a dirty, dusty appearance and the term lousiness when used in the slang sense really describes this appearance very well and is probably one reason why the term is in such popular use. The fact that they do not seem to take the dye has led many to believe they are

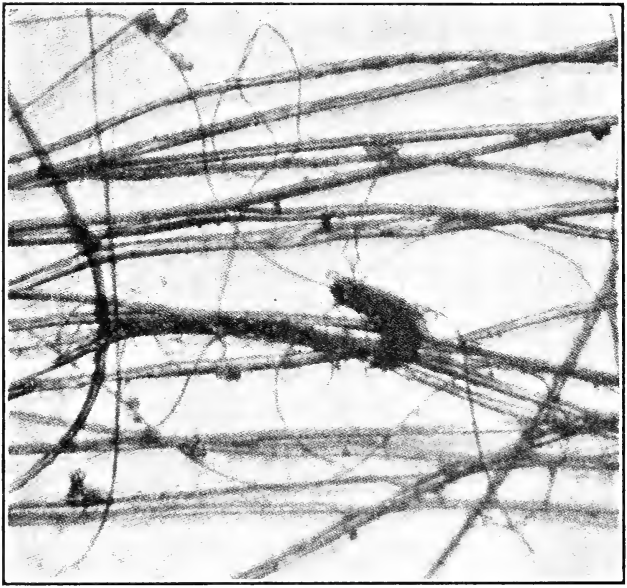


Fig. 8

composed of some foreign material. Since they are composed entirely of silk and resemble dust or lint we suggest that they would be called *silk lint.*"

With reference to photomicrographic views of lousy silk taken by Messrs. Douty and Lamb, "Fig. 6 shows raw silk, magnified 150 diameters, showing two baves or cocoon ends to have abnormal swellings and cross striations which are so frequent in lousy silk. On boiling-off the silk, these lumps

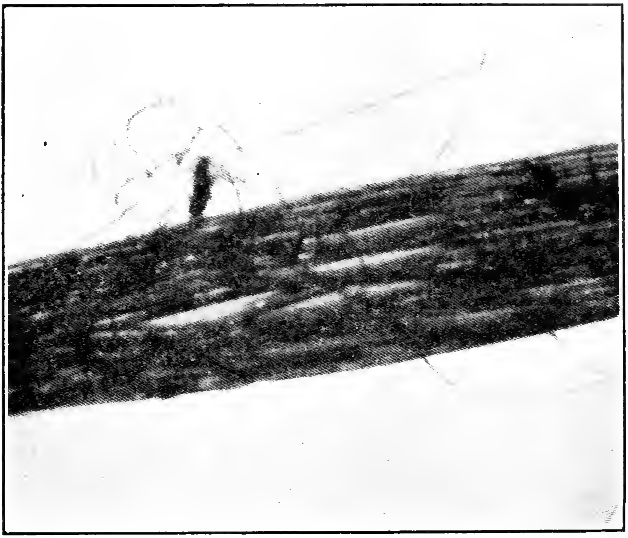


Fig. 9

partially split up into the very fine fibrillæ, and are evidently due to faulty secretion of the fibroin by the worm. This photomicrograph also clearly shows the formation of the bave, *i. e.,* how it consists of two filaments cemented together by the sericin or silk gum.

"Fig. 7 shows raw silk magnified 150 diameters, showing more of the cross markings found in lousy silk. In addition it shows how part of the filament has split off from the main filament. If this silk was boiled-off the detached part would further split up into the small fibrillæ.

"Fig. 8 shows silk boiled-off 10 minutes, magnified 150 diameters. It shows how lousy silk splits up into the elemental fibrillæ even after a very short boil-off. The fine hair-like lines shown in the photograph are the fibrillæ which have split off from the main filaments and the dark mass in the center of the photograph is a bunch of these matted together.

"Fig. 9 shows boiled-off dyed tram, magnified 150 diameters. This photomicrograph shows a small speck of the silk lint on the surface of the thread. The fibrillæ are again in evidence as they always are in cases of lousy silk.

"Fig. 10 shows boiled-off dyed organzine, magnified 150 diameters, showing a large matted mass of the silk lint in connection with a tangled knot of a filament. Silk lint is usually found at some portion of the thread that has a knot, snarl, or other obstruction upon it, the same affording a good collecting place for the fibrillæ which partly mass together during the boil-off, dyeing, winding and spooling of the silk."

Other Points to be Looked After.

Look also for the general condition of the skein, *i. e.*, is it poorly done up, are poorly tied or loose crossing strings used, or are there broken threads which will make excessive waste in winding? Is the traverse of the wound skein sharp and true so that broken ends may easily be found on the hard silk winder? Is the skein free from rings, caused by the cocoon thread winding for some time, on one place on the reel until noticed by the reeler, the thread having skipped from the guide on the traverse bar and wound itself round and round in the same place without traversing, a feature which will give great trouble and cause much waste on the hard silk winder.

The question of whether a skein of silk is of standard size or not, is of importance to the throwing department of the mill or the public throwster. In the same way a skein too bulky will not handle well in the winding. Lustre, touch, color as well as amount and condition of sericin present will also greatly influence the value of a silk.

Elasticity and tenacity of a thread may be approximately ascertained by stretching the latter on a flat sur-

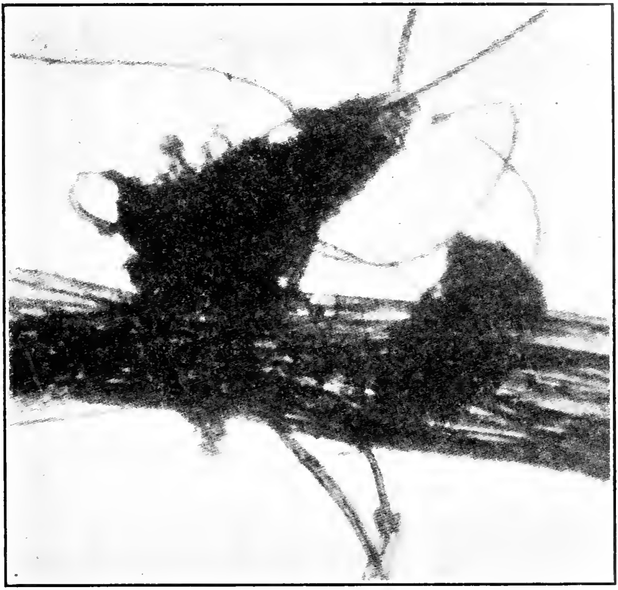


Fig. 10

face between the thumb and fore-finger of both hands until the thread breaks, in this way judging its breaking strength. In place of using your hands, a testing machine (later on referred to) may be employed, which accurately records the breaking strength of fibres or yarns.

Imperfections in threads are readily shown by reeling the same around a sheet of black cardboard, spacing the reelings of the thread a slight distance apart from each other in turn showing up every imperfection in the thread clearly against the black background. A suitable apparatus of this kind is handled by Alfred Suter, Fifth Ave. Bldg., New York, City.

Lustre is also a most important factor to look after in the buying of raw silk; not for its real value, but for the fact that smoothness of silk is indicated by its lustre. All bright silks are smooth, but not all smooth silks are bright, since the color imparted to the silk is frequently too dark for the lustre to be noticed as distinctly as if it were clear and white.

The boil-off of silk is obtained by a boiling-off test, best done by the U. S. Conditioning & Testing Co.; or if preferred it may be done at the mill by installing a Conditioning Oven, handled by Alfred Suter, New York, City.

Suggestions given should enable any silk buyer with some practical experience, to form a fair judgment as to the value of a lot of silk.

With reference to the kind of silk to buy, better grades of silk will permit a higher speed of machinery, and consequently larger production in the mill, as well as producing a more satisfactory fabric, showing more lustre as well as regularity of face. Using silk deficient in strength and elasticity as well as irregular in size, will reduce the production of the loom, and in most cases not warrant using such silks.

The kind of silk to use in a mill also depends upon the class of help you have, since the finer in denier the silk, the more difficult it is to be thrown. This also refers to production on the loom, which if run at high speed, will only permit the use of a better grade of silk.

Provided you use two ends for one in the heddle eye of the harness, a lower grade of silk can be used, since then the two minor threads working in unison help to support each other during the weaving.

The amount of twist put in organzine will also greatly affect the face of the fabric, the less turns imparted to the second twist compared to the first twist, the more lofty the thread, giving in many instances a superior face to the fabric, and this without retarding the weaving qualities of the silk.

Twist is also necessary in silk on account of dyeing. Each raw silk thread is composed of several of the double filaments as emitted by the silkworm, lying parallel side by side and being held together solely by sericin which the silkworm had emitted when spinning the double filament as forming the cocoon. If any attempt was made to dye silk in its raw state, the hot water would dissolve the sericin, *i. e.,* gum, and the water would loosen and separate the silk filaments as form the threads which in turn would become entangled.

Throwing the Raw Silk.

Rules Governing the Work.

The various processes comprising throwing, all require care and if satisfactorily done uphold the reputation of the throwing plant. To prove this latter assertion ask any weaving or knitting mill superintendent if there is not a noticeable difference in the handling of the skeins of one throwster over those of another and undoubtedly he will tell you that it has been his experience that reelings from some of the throwing mills run better than others, and yet at the same time if you would visit a throwing plant and suggest improvements, you would undoubtedly be smiled at.

This is proven by the words of a superintendent of a most prominent throwing plant, a well known expert on silk throwing in this country, who in talking about this subject informed us that when in his younger days he was employed by a prominent throwster, he then took the liberty to suggest to the owner an idea of his own and of which he was confident that if properly tried out, it would improve the resulting skeins considerably, being sure that they would wind at least 5 per cent better on the soft silk frames. He claimed that the boss looked at him for a few moments and then confidently informed him that he had theories in his head which would not work out, more particularly since with such an important trade as throwing there could be no trifling done, that it required experience and that these theories of young mechanics are of no practical value.

The same man a few years later got in positions where he was able to put his theories in use, and they proved of such practical value that the affairs were talked of among the trade. He mentioned that he had theoretical ideas, the results of experience in the throwing mills for some time, and that he found that managers as a rule are not well disposed towards their foremen and do not encourage employees to try out any new ideas, except the manager himself was the originator. He suggests that mill owners and general superintendents as a whole should look carefully into the methods of these non-progressive managers who prefer to work in the old route style they have been accustomed to for years and thus form a lead weight to the management of the mill. He claims that he is proud of the fact that many of his ideas which he gained in his young years in the various throwing mills where he worked, and which others declared as foolish theories, are now seen in practical operation, producing superior results and desired economics which result in quality and production that count so much at the present time when competition holds throwing prices down to the lowest possible margin of profit.

In the early days of our silk industry and when throwing was at its infancy, prices received for this work gave the throwster large profits no matter what machinery he used, neither was carefulness and economy in his plant at a premium. As the silk industry grew up, consumers of organzine and tram erected their own throwing plants causing more and more competition, so that today only public throwing plants practicing most rigid economics in their work and having most improved machinery installed can show a substantial profit at the close of the year. Labor conditions have changed for higher wages, bringing in turn more intelligent operatives, able to handle improved machinery which years ago nobody would have been rash enough to install and try and operate.

Commission throwsters do not vary their prices according to the quality of the silk, although they should properly do so, but they vary it according to the size or denier. The lower in number the count, and consequently the finer in size the thread, the higher the charges of the throwster.

Work done by different throwsters varies, and if silk is to weave well throwing must be done well. Poor, irregular grège will make bad silk for the winding, warping and weaving, though a good, careful throwster may convert a bad lot of raw silk into a fair thrown silk, but this can be accomplished only at considerable extra expense to the throwster; again a careless throwster may make a bad job out of a lot of good grège.

A most important problem the silk manufacturer has to contend with is the question of the waste made in throwing. According to the old method of throwsters calculating their bills no testing of the silk was done. The throwster received the actual or invoice weight of the silk, and the manufacturer figured as a rule 2½ per cent loss on this weight for throwing. This was a most unreliable procedure, although it is still in use by some of the less progressive firms.

In 1907 the Silk Throwsters' Association of America adopted the following rules and regulations to govern transactions in throwing silk and which was approved by the Board of Managers of the Silk Association of America.

I. Winding: Raw silk is single thread as reeled from the cocoons and known as (raw silk with knotted ends). It is understood to be a continuous thread from beginning to end of the skein and as a rule this class of silk must be such that one winder can attend to one hundred swifts with a thread speed of sixty yards per minute.

II. Soaking: Only such ingredients shall be added in soaking the silk as will boil out easily in the ordinary process of dyeing, and only such amounts as shall be necessary for the proper throwing of the silk, but not to exceed 5 per cent gain in weight.

III. Twist: An average variation of 10 per cent on organzine (20 test skeins) either way from the twist as ordered is permissible. On tram two and one-half to three turns per inch, a variation of one-half turn either way may be allowed.

IV. Size: The fineness of silk is determined by its count. The size is the number of deniers which a skein of a certain length weighs. The legal denier is a skein of silk four hundred and fifty metres long, wound in four hundred turns on a reel of one hundred and twelve and one-half centimeters in circumference and weighed by a unit of five centigrams (called denier).

To establish the size of a lot of silk, ten skeins are taken from every bale and from different parts of the bale, and from each skein two test skeins are reeled off, on Japan silks, one inside and one outside skein. The weight of these test skeins is to be reduced to conditioned weight in case either of the parties to the transaction desires. On raw silk up to twenty deniers a margin of one-half denier average, above or below, is permissible; coarser sizes are treated as special articles.

The regularity (evenness) of the thread of different grades shall be such that the difference between the finest and coarsest test skeins shall not be more than is decided by the Rules of the Silk Association of America.

V. Reeling into Skeins: An average variation of 5 per cent shall be allowed from the number of yards per skein, as ordered for thrown silk. The minimum number of test skeins is twenty. The procedure is similar to that for sizing silk; Condition House rules to apply.

VI. Price, Terms, etc.: The price for throwing is net cash, final settlement to be made on the average date of the return delivery of the product. The throwster is entitled to payment on account in proportion to his deliveries, and on completion of work when held for orders.

Weights for throwing silk shall be estimated upon invoice weights, in no case less than condition weight plus two per cent, or upon condition weight, when given, plus two per cent.

Condition weight, as here used, is found by adding eleven per cent to absolute dry weight, determined from samples by customary methods.

VII. Payment of Transportation, etc.: The consignee pays the transportation charges on receipt of the raw silk; the consignor pays the transportation charges on the return of the thrown silk.

VIII. Liability for Silk: A commission throwster who accepts a lot of raw silk for the manufacture of tram or organzine or any other operation, is responsible to the owner for the full value of the silk as long as it remains in his possession. The throwster must cover by insurance the loss of silk against fire while in his immediate possession.

IX. Determination of Loss: In order to establish a claim against a throwster for excess of loss in working, the whole parcel of raw silk to be thrown should be sent to the Condition Works to be tested for the conditioned weight, where skeins of the raw silk should be retained. The entire quantity of the thrown silk should be returned to the Condition Works to be reweighed for conditioned weight. The boil-off tests of the raw skeins so retained and the skeins of thrown silk should be tested simultaneously in the same process, and the boil-off established in this manner by the identical process; as the matter of boiling-off is so involved in uncertainty if done at different times.

Five skeins of the raw silk should be retained from each bale, and three skeins of the thrown silk from each one hundred pounds for the boiling-off test.

This is the generally accepted practice in Europe, and the matter of the amount of loss to be allowed in the actual working of a given silk (to be arrived at as above stated) is universally a matter of agreement between the manufacturer and the throwster. The throwster is responsible at the price agreed upon on receipt of the silk for an excess of loss above the amount agreed, and the owner is to pay the throwster at this price when any less loss is made than the amount as agreed.

The manufacturer is to furnish a description of the raw silk, giving the origin, classification and grading, and is responsible to the throwster for a proper delivery of the raw silk as agreed upon. Duplicate tickets of all tests to be supplied to the throwster.

Some ten years ago the need for ascertaining a definite basis for silk throwing led to what is now known as the "One Hundred Per Cent Throwing Method."

Closely corresponding to the method practiced in Europe, "La Grande Façon," the "One Hundred Per Cent Throwing Method" adjusts the price to be paid for throwing on a basis which determines the exact amount of waste made by the throwster, and for which waste he has to pay full price.

To determine this exact amount of waste made in connection with the "One Hundred Per Cent Throwing Method," four facts are necessary to be known:

(*a*) the conditioned weight of the raw silk;

(*b*) the per cent of boil-off of the raw silk, including sericin and other impurities found in raw silk, collectively known as gum;

(*c*) the conditioned weight of the thrown silk;

(*d*) the per cent of boil-off of the thrown silk, including gum as well as soap, oil, etc., as may be used in throwing; if throwing silk bright, only gum comes in this instance into consideration.

Subject will be best explained in connection with a practical example:

102.22 lbs. raw silk invoice weight which, reduced to conditioned weight (and which is 2 per cent difference) equals	100.22 lbs.	
Deduct raw boil-off sample, which is not sent to throwster	.22 lbs.	
Raw silk sent to throwster, conditioned weight	100. lbs.	
Raw boil-off, 19 per cent.....	19. lbs.	
Conditioned weight of clean fibre in raw silk..........		81. lbs.
Silk returned by throwster, conditioned weight, including gum, soap, oil, etc.....	102.5 lbs.	
Thrown boil-off, 23 per cent.	23.57 lbs.	
Conditioned weight of clean fibre in thrown silk.......		78.93 lbs.
Clean fibre (conditioned) in raw silk	81. lbs.	
Clean fibre (conditioned) in thrown silk	78.93 lbs.	
Waste of clean fibre..........	2.07 lbs., and	

2.07 : X : : 81 : 100 = 2.56 lbs. raw silk waste made.

This waste is the waste made in throwing and is charged by the manufacturer against the throwster at full thrown silk price. The throwster for this reason must make his throwing cost sufficiently high to cover this charge.

THROWSTER'S BILL made out for previous example will explain subject:

100 lbs. conditioned weight of raw silk received to be thrown @ 75 cents...		$75.
Less waste made in raw silk (conditioned weight) 2.56 lbs. @ $3.80...	$9.73	
Less throwing 2.56 lbs. as above @ 75 cents	1.92	
Less 2.56 lbs. at $4.55 for thrown silk		11.65
Total charges of throwster		$63.35

Advantages gained by the "One Hundred Per Cent Method" are:

1st. The cost per pound of the thrown silk is known definitely in advance (after deducting raw boil-off samples) since the throwster pays for all the waste, allowance for which is included in the increased price for throwing, compared to the old method.

2nd. The weights of the raw and thrown silk and the loss by boiling-off are definitely known, instead of being estimated or assumed, as in the old method, giving the clearance a mathematical accuracy obtainable in no other way.

3rd. The use of this method *tends to produce a minimum of waste,* as a direct loss to the throwster is the result of any waste made in excess of the amount expected.

4th. Both, the silk manufacturer and throwster proceed on a known basis regarding the weight of the silk at all stages where the weight is affected, and both parties are on a mutually understood basis where their respective rights can be accurately determined by mathematical processes.

5th. The conditioned weight and boil-off of the thrown silk being known, the manufacturer is able to order his weightings with greater precision.

Soaking.

It now depends on the throwster whether he will work the silk bright or with soap. By the first is understood that he will work the skeins or slips as they are, whereas by the latter method it is understood that the skeins or slips are to be washed or soaked with soap, which is done to make the silk wind more easily. Filatures and rereels are generally worked bright, whereas Chinese native reeled silk (tsatlees) are soaked. Silk to be thrown bright is at once taken to the winding, etc., department.

Silks thrown in the bright should be handled in a mill equipped with an efficient humidifying and moistening apparatus, to prevent the electricity in the fibre and in the exceedingly dry atmosphere of the mill from making trouble in the winding, doubling, spinning and reeling processes.

The soaking as is practiced by the throwsters with silk which requires softening to permit winding more readily, is not a very complicated operation, the slips being soaked in a solution of hot water and soap. The hot water, in connection with the alkali contained in the soap, will soften the natural gum, *i.e.*, sericin of the silk, which makes the threads in the skein in some places more or less adhere to each other, in turn freeing, *i.e.*, separating the individual rounds of the sericultural skein from each other, and which, until soaked, adhere more or less to each other. The fatty matter the soap contains is simultaneously deposited on the thread, which prevents the matting together of the ends during the drying of the skeins.

Proper Silk Soap to Use.

The soap being the prime factor for this loosening of the silk threads from each other, and since it must be used, in order to facilitate winding, should be a settled soap of the best quality, since a cheap soap of poor color, will dry yellow on the silk, and consequently lower its quality and in turn its value.

The ideal soap for the treatment of silk is a settled soap, made by preference from caustic soda and olive oil, or a very high-grade of olive oil foots. The latter will produce a cheaper soap than the former, hence is more often used by throwsters, but when the thrown silk later on has to be dyed a delicate bright color, the pure white olive oil soap is the one to be used in soaking as well as later on in the degumming (boiling-off) of the thrown silk by the dyer. Either kind of soap used must be perfectly neutral, *i. e.,* contain no free alkali or fat. The higher the grade of oil or foots employed, the better the silk soap produced will be. It is claimed by the soap trade that oils from Italy produce the best grade of silk soaps.

Some few throwsters are using what they call Marseilles soap. This, in years gone by, was a pure olive oil soap, but at present may mean most anything, whether made here or abroad.

Domestic silk soap manufacturers can produce a superior article, and it remains for the throwster to buy his soap of a concern that has a reputation for producing only a pure article of uniform quality, a soap that is firm, readily soluble, and which has a somewhat quick dissolving action on the sericin the raw silk contains. Be sure that no free alkali is present in your silk soap, since the same will diminish the natural lustre the silk possesses.

A standard olive oil soap should contain from 60 to 65 per cent of fatty acids, from 6 to 7 per cent of combined alkalies, while insoluble matter should be as near *nil* as possible and positively not over a half of one per cent. Permissible moisture for the soap to contain should be as near as possible to 30 per cent. Another advantage of a pure olive oil silk soap, besides its superior solvent action on the sericin of the fibre, is its easy removal by rinsing with lukewarm water and this without leaving any odor behind.

Among the cheap and inferior soaps used by some of the throwsters are those made of cotton seed, rape seed, peanut, corn, etc. oils, all of which however, produce poor results. Some throwsters we found to have a good word for the use of cocoanut oil.

Although the entire literature in print covering English and French, as well as German authorities, are against the use of any additions to a good silk soap, we find that some of our most prominent throwing plants use a good pure neatsfoot oil obtained from a reliable house.

The only objection to using in connection with the soaking of silk a small amount of neatsfoot oil, is the fact that cheap brands are on the market, badly adulterated with mineral oil, which of course is unsuitable and injurious. Some throwsters claim that they add a few drops of glycerine to their soap liquor in place of using neatsfoot oil, others use pure olive oil.

Being requested to collect data regarding recipes for soaking—this refers to the practical end of the throwing industry and where recipes are superseded by experience, the kind of silk we deal with, the atmospheric condition—summer, fall, winter or spring—dry or wet weather, the amount of twist to put in the yarn, for example, crêpe twist or next to no twist, etc. are all items that would make table work more of a disadvantage than a help to the throwster, dyer, warper, weaver, etc.

Having shown the advantages of using a standard silk soap, it will be of interest to throwsters to refer to a few simple soap tests, which anybody can readily make, selecting for this purpose samples (say about 2 to 4 ounces) taken at random from the core of a few bars of the lot of soap under consideration.

As mentioned before, a good silk soap should contain about 30 per cent moisture. This means water—and if the soap should contain more than 30 per cent moisture it means to the throwster water bought at the price of soap.

Moisture in soap is readily ascertained by means of using a clean, empty, light-weight dish, a pair of balances, and a small heating oven in which the soap sample after weighing the same, and recording the weight, is heated to 105 deg. *C.*, for some time until all moisture has been driven (evaporated) from the sample, after which the latter remains in the oven until perfectly cool, and when then the sample with the dish is weighed again; the difference in the two weighings indicate the amount of moisture the soap thus tested contained.

Silicate of soda, clay, starch, common salt or similar adulterants used to cheapen soap are detected by such substances being insoluble in pure grain alcohol (do not use any other) settling out of the solution, whereas such alcohol will dissolve a pure silk soap. Provided silicate of soda only has been used as an adulterant, this will show by adding sulphuric acid to a solution of soap in water and when upon standing, the silicia will collect on the bottom in a jelly-like cloud, while fatty acids will rise to the surface.

Free caustic alkali present in silk soap is readily detected by applying a drop of a solution of phenolphthalein to the fresh cut surface of a bar of the soap, and which will show a red spot.

A poor soap will not only act harmfully to the silk to be thrown, but also to the waste made during the process, in turn cheapening both. The fatty matters of the soap thus deposited on the silk will naturally act as a weighting compound, some throwsters using more soap than others for this purpose. The most satisfactory plan is to use enough soap to cause a moderate weighting. Silk thus soaked or washed with a good soap will lose about 26 to 28 per cent during the boiling-off process, whereas silk thrown minus washing, *i. e.*, thrown bright, will lose only from 18 to 22 per cent, showing a weighting of silk by the soap of from 6 to 8 per cent. In some instances as low as from . to 2 per cent of soap are only added.

The condition of the water used in connection with the soap for soaking the silk previously to the throwing, is also of the greatest importance, since water and soap go hand in hand. Calcareous water is of no use; a soft water from granitic regions is a good water to use, but the same is not found plentiful, for which reason the installation of a water softening apparatus will be a most valuable adjunct to any silk throwing plant.

Frequently throwsters pay little attention to the scientific side of soaking, leaving the process in the hands of incompetent help, whether full grown, or boys, a class of help which only work to fill in time, without taking into consideration what harm they are doing, performing the process of soaking in a most unsatisfactory manner, considered not only from the actual process of soaking, but also handling the silk roughly, breaking the ends in untwisting, using poor tie strings which catch onto the silk and when liberated break it, all to the detriment of the silk handled. They throw and jam the silk into the tub holding the soaking liquor, weighting the same down, never taking into consideration the delicate, valuable material they handle, neither do they pay attention to the temperature of the soaking liquor and frequently hurt the silk by using too high a temperature, resulting in imparting a rough surface to the silk, more so when leaving the silk in this hot soaking solution over night.

Apparatus for Soaking Silk.

It will pay the throwster to pay careful attention to this soaking, and wherever possible use an apparatus designed for it, and of which a diagram of a specimen is given in Fig. 11, illustrating construction as well as operation of the same. *a* indicates a wooden vat into which the silk is placed for soaking, loose enough to allow it to float in the liquor, and not packed down tight by weighting, as some throwsters do when using common tubs for this work. The vat is formed with a perforated wooden top and bottom *b,* the top one of which is removed temporarily for the immersion of the silk, after which it is again securely fastened in proper place. *c* is the reservoir for holding the soaking liquor, and in which the same is saponified, the steam for boiling the liquor being supplied through perforated pipes *d* placed at the bottom of the tank. *e* is a centrifugal

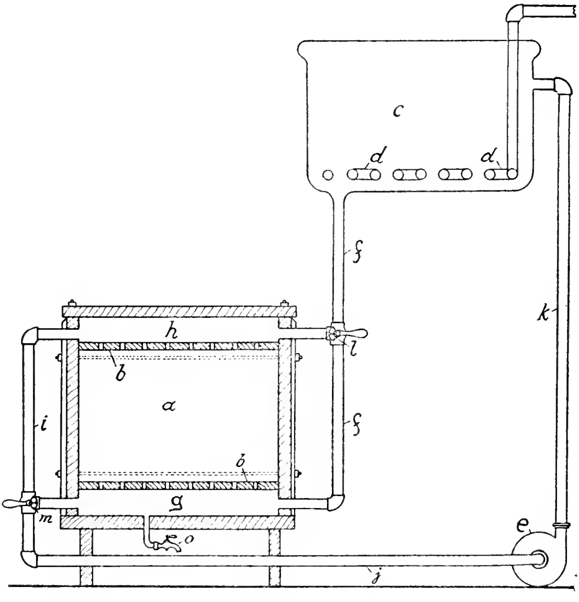


Fig. 11

pump, operated in the usual way, used for circulating the soaking solution, drawing it from tank *c* through pipe *f*, into reservoir *g*, and from there through the perforated wooden bottom into the vat *a*, through the silk in the vat, and from where it is passed through the upper perforated wooden top *b* into receptacle *h*, and from where, by pipes *i* and *j*, it is returned by centrifugal pump *e* through pipe *k* to the reservoir *c*, circulating the soaking solution in the manner thus described through the silk.

By reversing valves *l* and *m*, the solution is made to enter the vat *a* in the opposite direction from that previously described, and thus passes through the silk in the opposite direction from that previously explained. *o* is an outlet for the purpose of draining vat *a*, when so required.

Circulating the soaking solution through the silk continually, once in one direction and then in the other direction, will insure a uniform penetration of the soaking liquor through the silk, obviating the settlement of the soap and oil at the bottom of the tub, as is the case with the practice of using a common soaking tub. The solution being introduced through the silk by a force pump, it will penetrate the innermost portion of the skeins, again the pump can be regulated as to speed, and thus the flow of the liquor through the silk can be correspondingly regulated to suit the condition of the silk.

Another item of value by the use of this apparatus is that the skeins are deposited in the vat *a*, in the same condition as they are taken from the bundles (technically called books) without untwisting, thereby saving labor and cost of tying as is necessary with the old-fashioned tub process as well as doing away with abuses to the silk by unskilled help, reducing injury of silk by the process of soaking to a minimum. Some throwsters use special compounds in place of the soap, which they put on the silk skeins by means of a brush, the silk being left to lie in this state for a day *i. e.*, until the gum gets softened.

Silk Spinning.

Description of the Process.

After washing, the skeins are wrung out, by hand, thoroughly hydro-extracted, after which the damp skeins are unfolded and some of the sericin rubbed off where such is necessary to be done, on account of the threads adhering excessively to each other. The skeins are then dried, hanging them for this purpose either for a few days in a room of ordinary temperature, or when a quicker drying is desired, hanging them in a steam heated chamber.

In the latter instance the thus bone dry silk is then permitted to regain its natural (11 per cent) moisture and is then ready for the actual throwing, *i.e.,* winding, spinning, doubling, etc., until ready for bundling, packing and shipping.

Grège Silk, *i. e.,* the Raw, Hard Silk thread of commerce, also called Dumb Singles, is used in that state only in a rather limited way (for Passementerie work, Trimmings, Braids, etc.). For most of the fabrics, covering Weaving, Knitting, Embroidery, etc., grège silk must be submitted to a treatment which will transfer the thin, raw silk thread as reeled by the sericulturist, into a heavier, stronger as well as cleaner compound thread, suitable for use in the textile art.

The process by which this is accomplished is known collectively as Throwing *(Mulinieren, Moulinage)* which has for its object the uniting of two or more of these grège threads into one compound thread, and this with more or less twist.

In some instances these grège threads, for the use of special fabrics are twisted themselves (then technically known as Singles) and by which procedure these threads gain in roundness, compactness as well as strength. Otherwise, without this twist, the grège thread, and which is the union of four, five or six silk filaments, each composed of two fibrils adhering to each other by the saliva (sericin) the silkworm emits during spinning of the cocoon, would have these fibrils separate from each other in the boil-off process the silk is subjected to later on, producing in turn a loose, rough thread, of little or no value for future commercial use.

The manner in which the throwing process is practiced, *i. e.,* the care bestowed upon it, as well as the kind and make of machinery used, etc., has a most important influence upon the resulting yarn, and in turn the finished fabric. The latter with reference to its salability depends not only upon the proper texture, weave, etc., used, but also to a considerable extent upon the proper amount of twist imparted to the silk thread, a feature which is of more importance in connection with silk compared to that of the other fibres.

Its Invention in France, Italy and England.

Silk throwing *i. e.,* winding, cleaning, doubling and twisting silk dates back to the thirteenth century, when history tells us that throwing was first practiced in Paris *(Fileresses).* Twisting of dumb singles, as well as that of using two or more grège threads doubled and twisted into one thread was originally done by hand, and is yet done in some remote parts of Asia, the modus operandi practiced imitating that of rope making.

Spinning silk by machinery first found its use in Italy in connection with what was known as the *Round Mulinier-loom,* whereas another twisting machine known as the *Oval Silk Frame* is of French origin. The invention of the first Mulinier-loom *(Seidenmühle Filatorio, Moulin à soie)* is credited to *Borghesano* of Bologna, Italy, who also is credited with the improvement of the silk-reel. The date of its invention is not definitely known; one historian claims the year 1272, another one 1282 (see *Mém. de l'Acad. des Sciences* 1751) while still another *(Masini, Bologna illustrata)* claims the year 1372 for it. Years quoted have three of the numerals of the year corresponding, changing the 7 to an 8 in one instance, and the 2 to a 3 in the other instance, may explain the difference in years previously quoted. No matter which year is correct (according to *Livi, I mercenti di seta Lucchesi a Bologna nei sec.* XIII *e* XIV. 1881) the Mulinier-loom remained the secret property of Bologna for two and a half centuries, to be introduced into France in 1470 by *Girandi* and *Orsenico.* In 1719 an Englishman by the name *Lombe* obtained drawings of this Borghesano loom which he brought to England. Later on the machine was improved by *Avesani, Landriani* and more particularly by *Vaucanson.*

History of Silk Throwing in America.

The development of the silk throwing industry during the past centuries is of great interest and importance.

During a period of about sixty years (1780 to 1840) the actual foundation of silk throwing was laid in America, and so substantially that to-day the manufacture of silk yarns represents the investment of millions of dollars, the industry giving employment to hundreds of thousands of operatives.

In the infancy of the silk throwing industry the production was limited and the machinery crude, although producing results which in those days fully answered the purpose.

Connecticut was the state where the industry was first developed; Massachusetts, New York, New Jersey, Pennsylvania, Delaware and Maryland following. That a solid foundation was laid in those days is attested by the fact that the descendants of a number of these pioneers are still identified with the silk throwing industry.

With reference to the type of silk throwing machinery used and improvements made in the early days of the industry, it is recorded that about 1800 Horace Hanks invented a double wheel for spinning silk yarn, and that about the year 1810, he and his brother Rodney erected a mill at Mansfield, Conn., 10 by 20 feet, which it is claimed was the first silk throwing plant in the United States, operated by power.

Later, in 1814, they, in conjunction with Harrison Holland and John Gilbert, erected a larger throwing mill at Gurleyville, Conn., and of which a photograph is given in Fig. 12. In 1821, Rodney Hanks erected another mill for the manufacture of sewing silks at Mansfield, Conn., and associated with him, his son, Geo. R.; this mill continued in operation until about 1828, when the project was abandoned on account of the crude machinery used.

A new company was then formed to operate the mill and the name changed to the Mansfield (Conn.) Silk Co., and who were able to operate the mill more or less successfully for some time. This vigorous undertaking aroused, far and near, an interest in the industry, both as to culture and manufacture of silk.

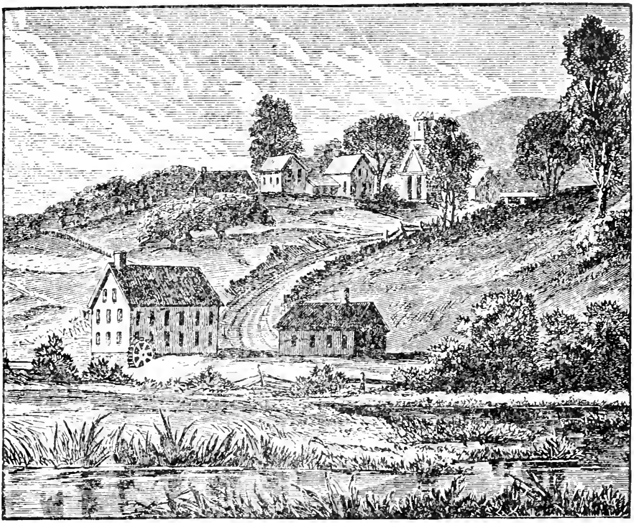


Fig. 12

It stimulated the efforts of other pioneers in the business, and made a permanent impression as to the solid reality of the silk manufacture in this country. The partners were Alfred Lilly, Joseph Conant, William A. Fisk, William Atwood, Storrs Hovey and Jesse Bingham. The company was incorporated by the Connecticut Legislature in 1829.

While it was a part of the company's purpose to encourage the production of silk, its efforts were especially directed to the improvement of the methods and machinery for reeling and throwing, and to the manufacture of a better article of sewing-silk. Its first successful machinery was made by Mr. Lilly, in accordance with the descriptions and rude drawings of Edmund Golding, a young English "throwster," who came to this country at the age of seventeen, expecting to find employment in his particular branch of the business. The great difficulty was in reeling.

It was not until a year or more after the concern had started in business that, by the advice and instruction of a Mr. Brown, an English silk manufacturer who had just commenced business in Boston, they were able to construct a reel which did its work satisfactorily. It was worked by water-power, and not by hand, like the reels of Cobb, Gideon Smith, Morris, Duponceau, and others. The reeling was successful, and the company advertised their willingness to purchase all the cocoons that might be offered.

Encouraged by their success, and the demand which now sprung up for American sewing-silk (though colors and evenness of it were not yet perfect) the company committed a very natural, but, as the event proved, a very grave error. They sought to become silk culturists on a large scale as well as silk manufacturers. They leased land at numerous points in Connecticut and adjacent States, planted large mulberry orchards and entrusted to their agents the rearing of silkworms. They also applied to the Legislature, in 1832, asking State aid for encouraging the culture and manufacture of silk. A bounty of $1,500 was granted to the company, and premiums were offered for raising mulberry trees and for reeling silk. They soon attempted silk weaving, but their machinery was not well adapted to the work. An ingenious mechanic in Mansfield, Nathan Rixford, had already made improvements in the machinery for winding, doubling, and spinning, which were eagerly purchased by competing companies, and which distanced theirs. Their capital was too small, and the experiments they made in the culture of silk were unwise and expensive.

Mr. Lilly, the originator of the company, withdrew from it in 1835, and three of the other five partners in 1839; the company dissolved the same year, though they let their establishment to others, who carried on the silk manufacture. Notwithstanding the misfortunes which closed their career, the Mansfield Silk

Fig. 13

Company is fairly entitled to the credit of having built the first mill in this country in which the manufacture of silk was practically successful.

The mill at Mansfield (Centre) as well as the one at Gurleyville, is still operated by descendants of the originator O. G. Hanks, under the name of O. G. Hanks and Co.

At least a hundred-fifty years ago, near Northampton, Mass. (then an agricultural village of historic fame in struggles with the Indians) a building was erected which was known as "The Old Oil Mill," a photograph of which is shown in Fig. 13. The village of Florence, now containing 3,000 inhabitants, which has since grown up around this mill was then not in existence. Its site is on the Mill River, a stream made memorable in 1874 by the bursting of the Williamburgh reservoir. The stones of the mill still remaining by the roadside are a record of the early uses of the building, which, after doing good service in its original capacity, was for some years occupied as a gristmill. About 1832, under the direction of Samuel Whitmarsh, this building was put in order for housing silk machinery made by Nathan Rixford, to whom we referred to before as an inventor of textile machinery. Mr. Whitmarsh at this period outran all his competitors in enthusiasm concerning silk culture and its manufacture. He had previously accumulated some $25,000 in New York City, while in partnership with a Mr. St. John in the tailoring business, on Broadway, opposite the old City Hotel.

He went to Northampton in 1830, bought land there and built a mansion, also two hothouses, each 100 feet long, for raising mulberry trees in winter. Such was Mr. Whitmarsh's faith in the scheme that he spent all the money he had upon it.

He in turn succeeded in impressing his own enthusiasm upon others, and induced several gentlemen of Middletown, Conn., to take stock in his new enterprise to be known as "The New York and Northampton Silk Company," and take over his "old oil mill" he had equipped with silk machinery. Among these investors were Augustus and Samuel Russell, who had established in China the firm of Russell & Co., the leading American house in that empire. "The New York and Northampton Silk Company" was formed and incorporated in 1834. They erected a brick building, to supersede "the old oil mill." Broad plantations were stocked with mulberry trees, and extensive preparations made for a large supply of raw silk. The supply was, however, always (very) deficient. Some specimens of watch ribbons, satin vests, etc., were made by this concern. Henry Clay, Daniel Webster and A. A. Lawrence were each presented with a heavy black satin vest pattern, and they evinced a lively interest in the success of the enterprise. Samuel Whitmarsh was the leader in this undertaking; he became President of the Company in 1835. He went to Europe in the following year, to obtain information respecting silk

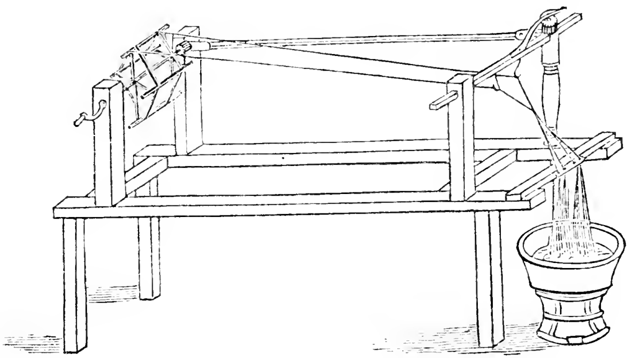


Fig. 14

culture, and early in 1839 published, through the press of J. H. Butler, of Northampton, a work entitled, "Eight Years' Experience and Observation in the Culture of the Mulberry Tree and in the Care of the Silkworm; with Remarks adapted to the American System of Producing Raw Silk for Exportation. By Samuel Whitmarsh."

The "New York & Northampton Silk Co.," continued under the management of Samuel Whitmarsh (its founder) for several years, until he withdrew and the plant came under the management of Joseph Conant, who had then been identified with a number of pioneer silk throwing plants. After several experiments, the plant eventually came into the hands of the Nonotuck Silk Co., who have enlarged and improved the same and operate it, on a large scale, to-day under the name of "Corticelli Silk Mills," engaged in the throwing of silk yarns of every variety of fabric.

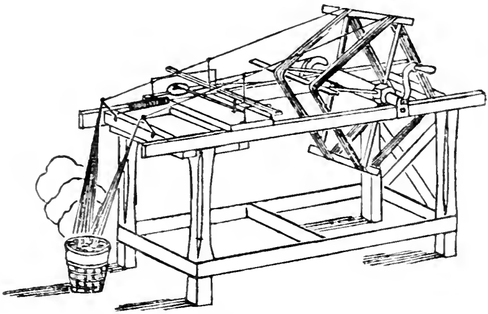


Fig. 15

Simultaneously with the growth of the silk industry in this country improvements in silk reeling and throwing machinery kept on. In 1825 Dr. James Mease of Philadelphia imported a Piedmontese silk reel from Genoa, Italy, and of which an illustration is given in Fig. 14, in order to take care of the prospects of the silk to be raised in this country.

In 1828 Jonathan H. Cobb of Dedham, Mass., who was raising silk on a small scale, invented a new reel, shown in Fig. 15, to take care of his cocoons, which reel he claimed was a great improvement on the Piedmontese reel shown in Fig. 14. In 1835 he built a mill at Dedham which was operated by "The New England Silk Co."

Nathan Rixford in 1838 also made great improvements in machinery for spinning silk in his "Friction Roller Mill," built for Ralph Cheney, of Cheney Brothers, and for Aaron Mitchell, of Nantucket. Two silk banners, each twelve feet long and six feet wide, woven from Pennsylvania silk, by J. D'Homergue, and some other silk goods of the same silk, were exhibited in 1830 at the Fair of the Franklin Institute.

Christopher Colt, Jr., whose father was the president of the "Connecticut Silk Mfg. Co.," of Hartford, Conn., in the years 1835-39, in 1838 became agent of

John Ryle

ONE OF THE FOUNDERS OF AMERICA'S SILK INDUSTRY.

the mill over which his father presided, and which mill had to close in 1839. In the meantime Samuel Colt, the brother of Christopher Colt, Sr., had built a large factory in Paterson, N. J., for making revolvers he had invented, and he then offered the use of the fourth story of the factory to Christopher Colt, Jr. to be used as a silk throwing plant. The mill is still standing and houses several silk manufacturing concerns, it being popularly known in Paterson as the "Old Gun Mill", a picture of which is given in Fig. 16.

In 1839 John Ryle, of Macclesfield, England, who had learned the art of silk throwing in his home city, heard about the strides that the silk industry was making in America, *the multicaulis fever* then being at its height, and he promptly packed his traps and sailed for America.

John Ryle in hearing of Samuel Whitmarsh, when coming to this country, then visited the few New England silk throwing plants in Hartford, Northampton, Florence, etc., which convinced him that these mills at that period were run at a loss of money, *i. e.,* the mills were kept running those days in order to increase the sale of mulberry trees. During his stay in Northampton, and working as a weaver for Samuel Whitmarsh, the latter mentioned to Ryle that "he expects to make two hundred and fifty thousand dollars before winter by his raising *multicaulis trees.*" Before winter came, Whitmarsh had neither cash nor credit enough to buy a barrel of flour.

During his stay in Northampton Ryle made the acquaintance of G. W. Murray whom he later on again met in New York, with the result that Murray bought Colt's then idle silk throwing plant in Paterson's revolver factory for $3200 and put Ryle in charge of it under a contract for three years' employment, thus laying the foundation of the first successful silk throwing plant in Paterson, then a village of 7,000 inhabitants.

After the three years' contract, Ryle became a partner in Murray's business and in 1846 (assisted by his brothers in England) bought out Murray's interest and continued in the throwing business, spool silks, etc. In 1850 he visited France and Italy so as to complete his knowledge with reference to silk throwing.

Mr. Ryle had no rival in his business in Paterson for twelve years. His first competitor was John C.

Benson who then built a small silk mill on Bridge Street. The first great rivals Ryle had to compete with later on were Hamil & Booth, who started in a small scale as throwsters in 1854 in Paterson, and continued exclusively in that line for about fourteen years.

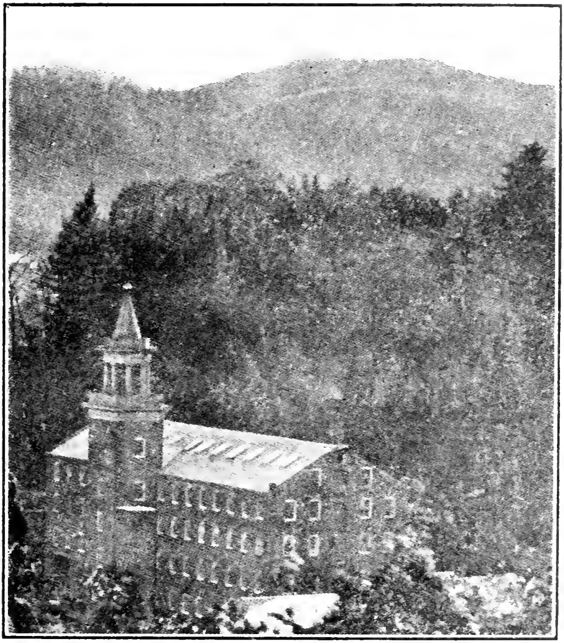


Fig. 16

In January 1838, Ward, Rush, Frank and Ralph Cheney started at South Manchester, Connecticut, the Mount Nebo Silk Mills. They had for four or five years previous to this been raising silkworms and producing some silk, like their neighbors. The mills were closed for a time, when Ward, Rush, and Frank removed temporarily to Burlington, N. J. They established there mulberry orchards, cocooneries, etc., and conducted and published from July, 1838, to July, 1840, the magazine known as the "Silk Growers' Manual." Other members of the family established mulberry plantations near Augusta, Ga., in Florida, and at Mt. Healthy, Ohio. In 1841 they returned to South Manchester, heavy losers by the failure of the *morus multicaulis* scheme. They reopened the Mount Nebo Silk Mill, and with new machinery commenced the manufacture of sewing-silk and twist, using mostly imported grège, since the supply of domestic grown silk was too scanty to supply their needs. They added, after a time, ribbons, handkerchiefs, and eventually broad silk goods to their output. They also made the first experiments in this country in the production of Spun Silk, from pierced cocoons, floss, silk waste, *i. e.*, silk that could not be reeled.

The Morus Multicaulis Mania.

The same took hold of the American silk industry, in the early 30's and was at its height in 1839, its aim being to raise silk if they could, but at all events to raise multicaulis trees. Grave doctors of medicine and doctors of divinity, men learned in the law, agriculturists, mechanics and merchants, women as well as men, seemed to be infected with a strange frenzy in regard to this mulberry tree. They met in solemn conclaves over bundles of morus multicaulis twigs, discussing seriously the glorious time, when, in the not distant future, every farm should be a nursery for the young trees, every house should have its cocooneries attached, its silkworms of the bivoltine, trivoltine, or polyvoltine breeds, yielding two, three or four crops of cocoons per year. The farmers' wives and daughters, when not engaged in feeding the worms, were to reel the silk, and to spin and twist it, till silk should become as cheap as cotton, and every matron and maid rejoice in the possession of at least a dozen silk dresses. It does not clearly appear where and on what occasions they were to wear these dresses, for their whole time was to be occupied with the care of the silkworms and reeling cocoons.

Gideon B. Smith, of Baltimore, is said to have owned the first multicaulis tree in the United States, which was planted in 1826; but Dr. Felix Pascalis, of New York, was the first to make known to the public the remarkably rapid growth, and supposed excellent qualities of the tree, and so may be said to have opened this Pandora's box, from which so many evils escaped. The excitement in regard to the morus multicaulis grew steadily; slowly, indeed, at first, but increasing with a geometrical progression until 1839, when it culminated in utter ruin to the cultivators. The shrewdest and wariest operators, men who did not believe in its loudly heralded virtues, were fairly carried off their feet by the surging tide of speculation. The young trees or cuttings, which were sold in 1834 or 1835 for $3 or $5 a hundred, came soon to be worth $25, $50, $100, $200, and even $500 a hundred.

In the Spring of 1839 Mr. Whitmarsh and Dr. Stebbins of Northampton, Mass., were rejoicing over the purchase of a dozen multicaulis cuttings, not more than two feet long and of the thickness of a pipe-stem, for $25. "They are worth $60", exclaimed the Doctor, in his enthusiasm. It is said that Mr. Carroll, a florist and nursery-man on Long Island, who was one of the first to introduce the tree into New England, though he had no particular faith in it, devised a plan for enhancing its price. He had sold small quantities to nursery-men in Providence and Newport, and several of the Massachusetts cities and large towns. One day, in 1835, while at work in his nursery in Long Island, he determined to make a bold push for a speculation. Hastily returning to his house and putting on a change of apparel, he mounted his sulky, drove into New York and boarded the Providence boat.

Arriving at Newport, he landed, drove to the first nursery there and asked, in an excited way, "Have you any multicaulis trees?" "A few," was the reply. "I will give you fifty cents apiece for all you have," said the Long Islander. The nursery-man thought a moment. "If," he said to himself, "Carroll is willing to give that price for them, it is because he knows they are worth more." He raised his head, "I don't think I want to sell what few I have, Mr. Carroll." "Very well," was the reply. "I presume I can get them for that," and he drove off. Every nursery-man who was known to have any trees in Newport, Providence, Worcester, Boston, or the towns adjacent, Springfield, Northampton, etc., was visited, the same offer made, and a similar answer returned. "I came back," said Mr. Carroll, "without any trees, but you could not have bought multicaulis trees, in any of the towns I had visited, for a dollar apiece, although a week before they would have been fully satisfied to have obtained twenty-five cents apiece for them." Yet this very man, shrewd as he was, was carried off his feet by the greatness of the demand which followed. He imported large quantities from France, multiplied his cuttings by all the devices known to his profession; and at last, so enormous were his sales, that, in the winter of 1838-9, he sent an agent to France with $80,000 in hand, with orders to purchase one million or more trees, to be delivered in the Summer and Fall. Before the whole of his purchase had arrived, the crisis had come. The nursery-man had failed for so large a sum that he could never reckon up his indebtedness, and the next spring his multicaulis trees were offered in vain to the neighboring farmers at a dollar a hundred, for pea-brush. Numbers of these plunged into the multicaulis speculation, and made it more disastrous in its results than it otherwise would have been; but there is this ground of consolation in regard to them, that not one of them escaped the ruin they helped to bring upon others, and which ended silk raising in America.

Modern Throwing Machinery and Processes.

ORGANZINE, TRAM, THROWN SINGLES AND FLOSS.

Having the grège, hard or raw silk, by means of sorting, splitting, soaking, drying, etc., (now known as *Singles* or *Dumb Singles*) prepared for the actual winding and twisting processes, the manufacture of one of the two kinds of silk yarns most frequently met with in the market, now confronts us, *viz:* is it to be *Organzine* or *Tram,* using in connection with Organzine: (1) Winding and Cleaning, the latter only when necessary by the condition of the silk — European and Japan silks as a rule do not need it. (2) First Twisting or Spinning (*filage, 1er apprêt*). (3) Doubling. (4) Second Twisting or Spinning (*organsinage, 2e apprêt*). (5) Reeling; to be followed by Stitching the skeins, Examining, Bundling, etc., *i. e.,* making the thrown silk ready for shipping to the mill, or the dyehouse. In connection with tram, similar processes are practiced, but only one spinning process is made use of in place of the two used in the spinning of organzine.

In some throwing plants, special machines are used for each of the four or five processes referred to, whereas lately our more progressive throwsters, as well as silk weaving or knitting mills who throw their own silk, use a *Combination Machine* for the doubling and twisting operations, cutting in this way the spinning of organzine as well as that of tram down to three machines, *i. e.,* three processes.

When these combination machines were first introduced, considerable doubt as to their success was expressed by silk men, but they proved of value and run now more than successful competition to the single machines, saving in floor space and machinery equipment, besides resulting in an increase of production.

Besides spinning Singles into Organzine and Tram, the same is also thrown in what is called *Thrown Singles* and *Floss;* both yarns will be later on referred to.

Spinning Properties of Silk.

The real cause of the spinning property of silk fibres may be ascribed as follows:

(1) Its gummy nature;
(2) Its fineness;
(3) Its strength and elasticity;
(4) Its uneven surface, produced by the twisting;
(5) Its length.

If grège is thrown or spun into yarn while in a heated and dry condition (when its gummy nature is partially or completely destroyed) the yarn produced is inferior; a superior yarn can be spun in a room the atmosphere of which is heated, but moist. The surfaces of the fibres in the latter instance are thus softened and rendered gummy and the fibres cannot be drawn apart so easily, hence the yarn is stronger than that produced from a similar material, but under different conditions. The moist condition of the atmosphere is also of advantage in removing the electricity the silk fibre holds, on account of its non-conductive nature; it was found by throwsters by experience, before these properties were studied, that the best atmosphere for the production of good silk yarns is one which is heated and moist.

We will now describe a most up-to-date silk spinning equipment, dealing with single as well as combination machines.

Considered from a mechanical point of view, silk spinning machinery is most simple in its construction, and its method of operation readily explained, none of the complicated machinery, devices and calculations found in cotton, worsted, woolen or spun silk spinning being required.

Winding.

The next process to which grège, *i. e.,* raw or hard silk is subjected to, whether it has been soaked and dried or is to be thrown *bright* (minus soaking) is winding, *i. e.,* transferring the silk, then in the shape of skeins or hanks, onto bobbins.

Grège silk, previous to winding is best kept in a damp place for some time, this being of advantage to the strength of the thread.

The individual skeins previous to winding are examined, to locate any places where the threads stick together, in turn liberating, *i. e.,* loosening the bunch

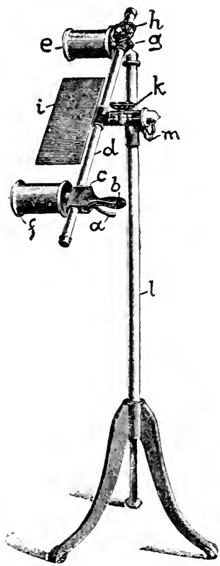


Fig. 17

of threads in such places (known as *gommures*) from each other by subjecting them to a mild ($\frac{1}{2}$ per cent) lukewarm soap solution.

An apparatus known as an "Examining Stand" is a convenient adjunct for examining silk skeins previous to winding. Fig. 17 shows such a stand, built by Chas. H. Knapp, Paterson, N. J. This apparatus is adjustable for handling different size skeins by pressing lever *a* towards handle *b,* of slide *c,* loosening in turn the grip of the latter on guide rod *d,* thus permitting the positioning of slide *c* either up or down on rod *d,* to suit the diameter of the skein (not shown) to be examined, and which is placed over rollers *e* and *f.* Slide *g,* operating on rod *d,* can be also adjusted (if needed) by means of tightening knob *h.* To make examination more quickly and at the same time more thorough, backboard (mirror) *i* is provided, being secured in its centre to rod *d.* The latter, and with it the apparatus, can be tipped in any position as required by the examiner and secured in that position by tightening knob *k;* the raising and lowering of the apparatus on the standard *l* is done by loosening and then tightening knob *m.*

Winding is done on machines known as *Winders* (also called "Hard Silk Winders") which contain any number of swifts or reels, upon which the respective skeins are stretched, one skein on each swift.

The Process of Winding.

Winding must be well and carefully done to insure good work through the after processes. These frames should contain about seventy spindles, or swifts, the spindles made with a double head and considerably hang over the take-up pulley. This gives an easy start to the bobbin, which can be run at high speed without jumping, giving a uniform tension with a resulting bobbin wound smooth and not too hard. Such a bobbin will usually spin off without a break. The use of a swift that is automatically expanded, being always balanced, with a rigid support for the skein, keeping the latter well spread, will greatly increase the output, besides improving the bobbin wound.

After the skeins are placed by the girl on the swifts, she then finds the end of the silk on the outer portion of the hank and passes said end through the porcelain guide of a vibrating traverse bar, which thus guides the thread (to and fro) across the width of the bobbin until the latter is filled. This take-up bobbin (as we technically call it) is driven by a friction wheel, hence each skein and bobbin is operated independently. When the bobbin is filled a new one is substituted, a new skein being put on whenever the one wound runs out. The construction of the winder is such that the silk thread is wound on the spool without any friction, *i. e.,* is not flattened in this way.

Finding the outside end of the skein for starting to unwind the latter is not all the work that there is in store for the girl; the hank will not always run smooth and in some cases run quite the reverse, making the girl lots of trouble and worry. The end may break for some reason or other, and when it will have to be found, and pieced up; at the same time removing by hand any imperfect portions of the thread, provided this was the cause of the break and not the entanglement of ends in the hank or a wrong handling of the outside end. Waste thus made is known as "Winder's Waste" and is kept separate from other waste made before or after this process.

Winding clearly shows the condition of a lot of silk under consideration, and for which reason a proper winding test should be made by the mill when grading silk, as well as to ascertain if the silk is up to the guarantee given by the seller, *i. e.,* the number of spindles one girl can handle consistent with quality and production. The cost of a lot of silk may be increased from 10 to 15 cents a pound by an excessive number of loose ends in the skeins, caused by the breaking out of imperfections during inspection and by preparing the skeins for winding, which are defects to the silk to be taken into consideration (as previously mentioned) when grading silk.

The following details with reference to winding are given by an expert of one of our large throwing plants. Thread speed, 165 yards p.m., using ordinary swifts, pin hub unweighted. Silk soaked properly with the sericin rubbed out when moist, and air dried to about 17 per cent moisture. Silk wound at an atmospheric humidity of about 70 per cent, with a similar temperature in the room.

Some defects met with in the winding process are hard spools, long knots and looped ends.

The first are caused by poor washing, *i. e.,* an inferior quality of soap being used in the soaking, or insufficient drying; the surplus gum covering the threads instead of being removed or loosened, being by carelessness only softened into a paste. If such trouble occurs, comb out the silk hanks and if necessary dampen them and allow them to dry perfectly previous to winding. Be careful when *soaking* (or as it is also called *washing*) the next lot of silk, and pour several pails of warm, soft water in the hydro-extractor containing the washed silk, so as to give the latter a good rinsing, and be sure that all the water is extracted before removing the silk from the machine.

With reference to the second defect referred to, *i. e.,* long knots made by the winder, they will catch during the next processes of throwing and will be the cause of split ends, more particularly so with tram, or with no-throw (the latter being also called floss).

Be careful when tying-up an end on the winder that a previously wound-on length of the thread is not looped over the end to which you tie on, since then the yarn during the next processes will unwind with friction, *i. e.,* come off the spool tight and in turn cause loopy yarn. More particularly will this cause trouble in connection with no-throw or tram.

The winding is the most expensive operation in throwing, and the value of silk may be reduced a grade by excessive labor cost and waste.

Description of the Process, with Data to Machinery Used.

A perspective view of a Hard Silk Winding Frame, built by the Atwood Machine Co., Stonington, Conn., used for the operation previously described, is shown in Fig. 18. The illustration shows what we can call a sample machine, showing only a double banked nine-spindle outfit, *i. e.,* eighteen spindles, whereas a standard frame contains from 60 to 70 spindles. A winder equipped with 60 swifts measures 18 feet 4 inches in length, and 4 feet 2 inches in width; driving cone 3, 4, 5 and 6 inch diameter for 1¼ inch belt. Machines are built in any desired length to suit the

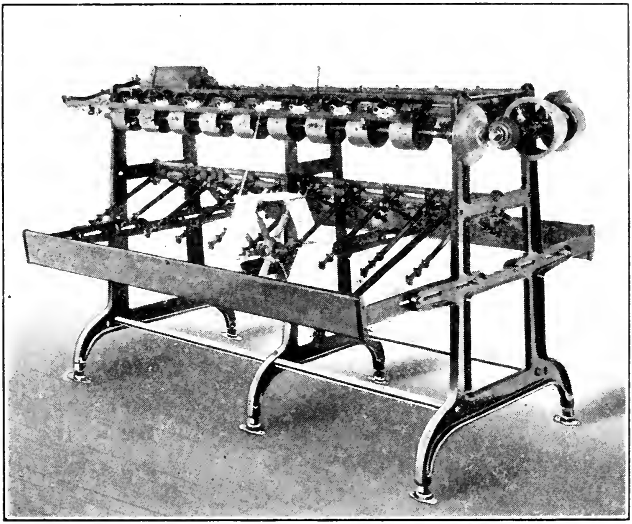


Fig. 18

demands of a mill. By double bank is meant that there are two rows of spools wound, one on each side of the machine. The average speed of a winder is: Run cross-head and take-up shaft from 225 to 250 r.p.m.

The frame of the winder is of steel, very strong and rigid and equipped with a deep shelf on top. The to and fro motion for the travere bar is produced by an adjustable cam, but if so desired an automatic screw traverse motion can be substituted, giving a perfectly smooth wound spool. Either the regular spindle take-up with single or double head drive is provided, or the drum take-up with open fingers or swinging bobbin-hangers is furnished, the latter giving uniform speed of wind, greatly increasing the product over the spindle take-up.

The swift-hangers are adjustable for height and have triple bearings for various size swifts to be used; the knee-rails are adjustable to suit different sizes of swifts used. The drive of the frame is by cone pulley and cross-head, either geared or variable speed cones; provision is also made for permitting the attaching of electric drive.

Fig. 19 is a working diagram of this Hard Silk Winder, clearly showing its operation. *a* shows by means of dotted lines the outlines of one of the end frames of the machine. *b* is one of the swift hangers adjustable as to height, being secured at *c* to two rods *d* extending the full length of the machine. *e* is one of the swifts for carrying skein *f*, the end *g* of which passes through the eye of porcelain guide *h* (secured to the traverse bar *i*) and from there onto the take-up bobbin *j*, driven by friction wheel *k*. As seen from Fig. 18 there is one friction wheel for each bobbin in the frame. *l* in Fig. 19 is the knee board, adjustable to suit the size of swifts used. Arrow *o* shows the direction of travel of the silk thread from the skein *f* to the take-up bobbin *j*.

h^1 i^1 and k^1 indicate respectively the guide, the traverse bar and the friction wheel of the other bank or section (rear in this instance) of this winder.

During winding, any cleaning of the silk thread that is necessary is done; knots, nibs, slugs, fine and coarse ends, waste and other imperfections in the thread, if present, are removed by hand.

It is customary in the sale of grège to indicate the number of bobbins a winder can handle, thus indicating its quality. Since the introduction of the knotted ends known as *bouts noués* in the original reeling of the grège at the filatures, the winding at the throwing plants has been considerably simplified.

European silk permits the winder to attend to about 100 bobbins, whereas with some of the China grèges, like Tsatlees, only about 15 to 20 bobbins can be handled. The latter are, as a rule, more or less full

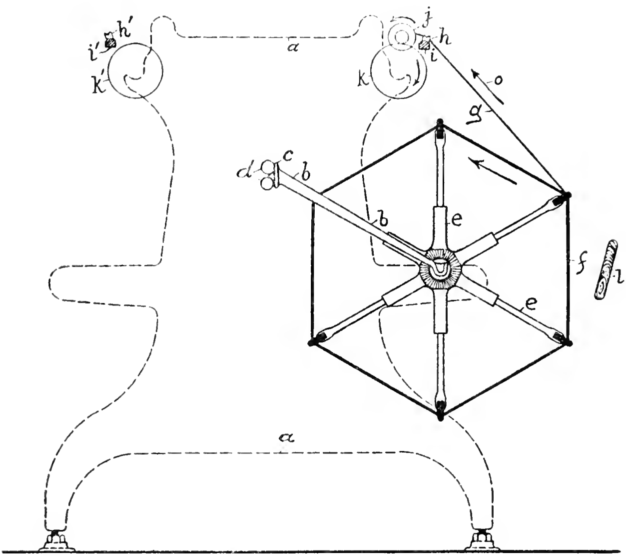


Fig. 19

of the imperfections previously referred to, hence breaking of the thread is a frequent occurrence. The winding of such grèges consequently requires the greatest of care on the part of the operator, since visible imperfections to the thread must be removed by her during the winding process or the thread run through a "Cleaner" referred to later on. This at the same time indicates that the amount of waste made in winding these China silks is rather excessive, varying from 3 to 5 per cent, whereas the waste made with European silks does not, as a rule, amount to more than $\frac{1}{4}$ to $\frac{1}{2}$ per cent. The condition of China silks is however for years steadily improving. Similar in their cleanliness to European silks are those of Japan, the same unwinding practically uninterrupted from their skeins.

The impurities thus removed by the operator from the grège silk however comprise only a portion of that which the silk contains. The main work of the operator consists in breaking out those threads that in longer or shorter distances carry more or less knots; excessively thin or thick places found in the yarn, must also be removed by her.

When the grège thread has to be cleaned during the winding, the thread when leaving the swift passes through an eyelet, and from there to a cleaner (formed by means of two adjustable steel blades) between which the silk thread is made to pass, the two blades being set sufficiently close to scrape off any impurities or have knots and bunches in the yarn catch on the blades, which by means of operating a stop motion arrest the motion of the bobbin and in turn give the operator a chance to take out any imperfections in the yarn. Another way (but not as good) of cleaning a cheap, imperfect grège is to run the same through guide eyes covered with a soft (plush) cloth, and in this way brush off some of the impurities this silk contains.

If dealing with such imperfect silk, the best plan to follow is to wind it first on the "Hard Silk Winder" and then rewind said bobbins on other bobbins on a special constructed "Cleaning Frame," running your thread through "Cleaners" (as before explained) in their travel from one bobbin to another; repeating the procedure if found necessary to do so.

The wound silk in some instances is placed for about 10 minutes in a steam box and there treated in lukewarm water, a treatment which it is claimed increases the lustre and pliability of the thread.

Having obtained clean "Singles" (also called "Dumb-singles") the next process the latter is subjected to depends upon the purpose the silk is to be used for later on.

It may be used either as Thrown-singles, Floss, Tram or Organzine; also for some special yarns, which will be treated later on.

(1) THROWN-SINGLES. For this purpose Singles are twisted by themselves (on a Spinning Frame) in order to impart roundness and strength to the thread which then is used in this condition in the construction of certain fabrics, the yarn then being known as "Thrown-singles." Such of the yarn destined for warp receives more twist than that for filling. On account of the greater strength of silk in its gum state, Thrown-singles are sometimes woven in this state into plain and figured pongees, some kind of satins, etc., the gum being boiled-off afterwards in the woven fabric. In some instances such Thrown-singles are also dyed without boiling-off the gum (sericin); this is done at a sacrifice of lustre, however the additional strength retained by the yarn will result in better weaving. At the same time, by the woven cloth gaining in strength and weight it may repay for some of the lustre sacrificed by not boiling-off.

(2) FLOSS. The same is also known as *No-throw* and refers to the doubling of 2, 3 or more Singles into one thread, either without twist on the Doubling Frame, or imparting only a very slight twist to the compound thread on the Spinning Frame; just sufficient twist ($\frac{1}{2}$ turn or more) to keep the minor threads somewhat united so as to insure proper running off of the compound thread from the bobbin or the skein, as the case may be.

(3) TRAM. For this purpose from 2 to 10 Singles are either doubled on a Doubling Frame and then twisted on a Spinning Frame, inserting from 1 to 2 turns of twist per inch (never more than 3 turns, and this only in extreme cases and for special fabrics)

or the two processes are accomplished by one operation on what is known as a "Combined Doubling and Spinning Frame for Tram." The small amount of twist inserted into Tram is done to make it fill better in the woven cloth.

(4) ORGANZINE. For this purpose Dumb-singles are subjected to a *first-spinning* on a Spinning Frame, *i. e.,* are transformed into Thrown-singles, which are then *doubled* on a Doubling Frame and in turn have a *second-spinning,* (a second twist) imparted to the compound thread on a Spinning Frame. In either process the twisting in the second-spinning is done in the reverse direction from that of the first-spinning.

The amount of twist imparted in these two spinnings varies, some throwsters considering 12 turns for the first-spinning and 10 turns in the second-spinning, technically expressed as "12 and 10 turns per inch" (12/10) as a very good (regular or standard) twist for organzine, whereas others go above or below this, depending upon the kind of fabric for which the organzine is intended. Satin and umbrella organzines are often thrown 10/8 turns, taffetas 14/12, heavy linings 16/14; for some exceptionally strong and hard organzine 18/16 is used.

These three processes as practiced in connection with the spinning of organzine, *i. e.,* first-spinning, doubling and second-spinning, are now combined in one operation by using the "Combination Spinning, Doubling and Twisting Frame."

Since either separate machines, or combination machines are used for the throwing of the silk yarns, we will explain both systems, *viz:* the "Doubling Frame," the "Spinning Frame," the "Combined Doubling and Spinning Frame for Tram," and the "Combination Spinning, Doubling and Twisting Frame for Organzine," thus giving a complete description of any kind of machinery you may come in contact with in any modern throwing plant.

Doubling.

Doubling comprises the winding of from 2 to 10 Dumb-singles, previously cleaned and wound on bobbins, or in addition twisted, *i. e.*, Thrown-singles, side by side upon one bobbin. The chief object

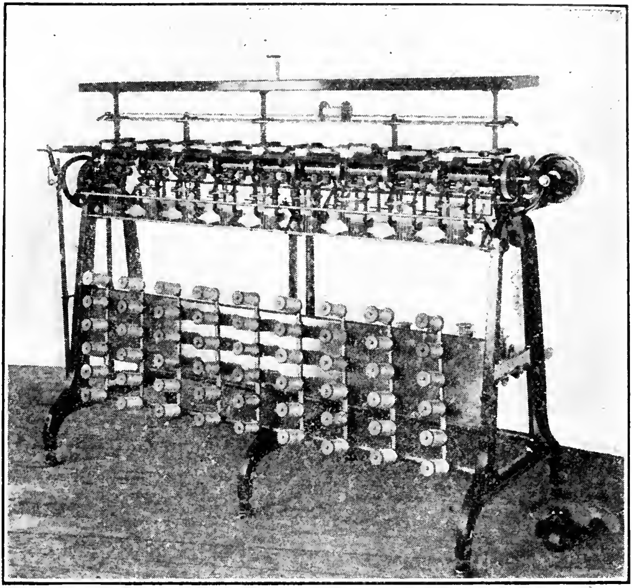


Fig. 20

aimed at in the process of doubling is to wind these minor threads under a most equal tension, accomplished by suitably provided weighting rollers and counter-weights. To preserve the roundness of the threads do not use an excessive tension, which might have a tendency to flatten the threads.

Silk is doubled without twist — to the cotton or worsted spinner this may seem queer, but it is so. The minor silk threads are in this instance first run together and wound on one bobbin, before being twisted on another machine.

Doubling is done on what is known as a DOUBLING FRAME. Fig. 20 is a perspective view of such a machine, built by the Atwood Machine Company. The same refers to a double bank machine and is built in any length desired, to suit the demands of the mills. It is driven direct or by cross-head; cones 4, 5 and 6 inches diameter for $1\frac{1}{4}$ inch belt are furnished. Spindles are either wood or iron head; the drop wires are of the vertical type; the stop motion is very quick acting and lifts the spindle from its mate friction wheel. The machine is equipped with hinged reversible jack-boards shown in illustration, fitted for six end-pin doublings (up to ten end-pin doublings are furnished if so desired). The angle of the jack-boards is adjustable, in turn exerting more or less friction on the spools. During the winding on of the ply thread a slight twist imparts itself to it, sufficient to hold the minor threads together, so that the bobbin runs well off at the spinning frame without breaking. The twist thus referred to is again automatically taken out when the compound thread is running off the bobbin. Every spindle is driven by friction, any one of which can be arrested independent of the others. An individual stop motion is provided for each spindle to automatically arrest the motion of the take-up bobbin anytime a minor thread breaks.

Fig. 21 is a diagrammatical section of this Doubling Frame, being given to more clearly show the process by means of quoting letters of reference in the illustration, and of which *a* shows by means of dotted lines one of the heads of the machine. *b, b′* are two jack-boards, one for each bank, having secured to them pin rail *c,* carrying in this instance six pins for each vertical section; up to ten pins to one section are used, in which instance up to ten minor threads may be used for doubling into one compound thread. The six minor threads used in our specimen of a machine, as clearly shown, are then passed (see arrow *o*) alternately over and under parting rod *d*

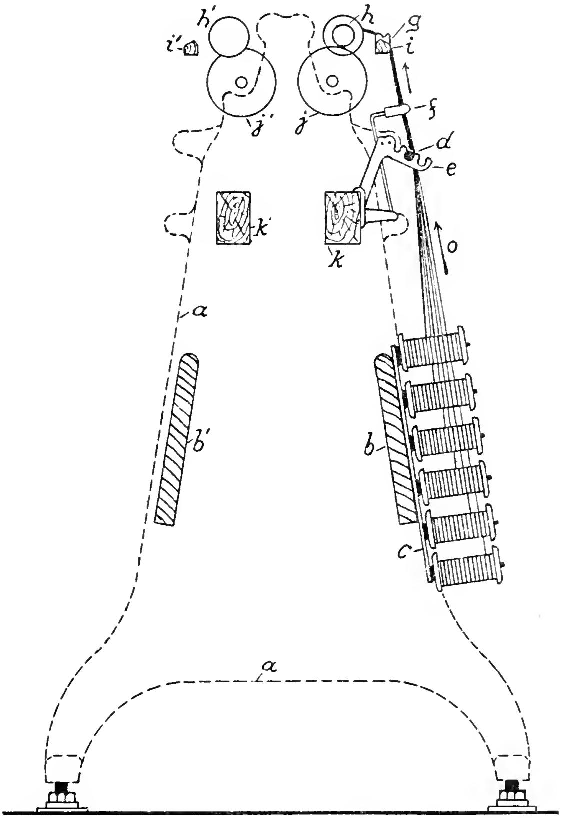


Fig. 21

(carried in rod stand *e*) passing in turn through faller wires *f,* through guide *g* onto the take-up bobbin *h.* The guide *g* is secured to traverse bar *i,* which receives a to and fro motion, to guide and regulate the winding of the compound thread onto its take-up bobbin. *j* is the friction wheel for imparting motion to the take-up bobbin. *k* and *k'* are two wooden girts extending the full length of the machine. *i'*, *h'* and *z'* refer to the rear bank of the machine. The speed of the take-up shaft of this Doubler is from 225 to 250 r.p.m.

The Spinning Frame.

The same is used for:

(1) Imparting twist to Dumb-singles after the same have been wound on bobbins on the Hard Silk Winding Frame, *i. e.*, changing Dumb-singles to Thrown-singles.

(2) Imparting the necessary twist to tram as received from the doubling frame, if handled by the older method of throwing machinery, which is yet extensively used. The doubled silk then goes to the reeling frame. The usual amount of twist inserted for tram is about 2½ to 3 turns per inch, which is merely enough to hold together the several ends composing the thread.

The more up-to-date method of making tram is on a machine known as the "Combined Doubler and Spinner", which takes the spools from the Hard Silk Winder and spins them direct, thus eliminating the separate operation of doubling. This machine will be fully explained later on.

Tram skeins are usually reeled 5, 10 or 15 thousand yards, depending upon coarseness of thread.

(3) Imparting "first-spinning" or "first-time twist" followed by "doubling" and later on "second-spinning" or "second-time twist" to organzine, if handled by the older method of throwing machinery, still extensively used.

For the "first-spinning", the filled bobbins are received from the Hard Silk Winder. The twist imparted in this "first-spinning" as a rule is a left-hand twist of 16 turns per inch. The number of spindles on a single machine of this type is about 200, and a fair average per operator is about 1,200 spindles.

After receiving the "first-time" twist, the silk, which has been run on iron head shafts, is placed on a steam box and steamed for several minutes. This tends to prevent the silk from snarling. The silk is now taken to the Doubling Frame, where two, three, four or more ends are run together, after which the "second-time" or right-hand twist is given to the thread with 14 turns per inch. The thread thus resulting is known as a 16/14 twist, and will be varied in accordance with its intended use.

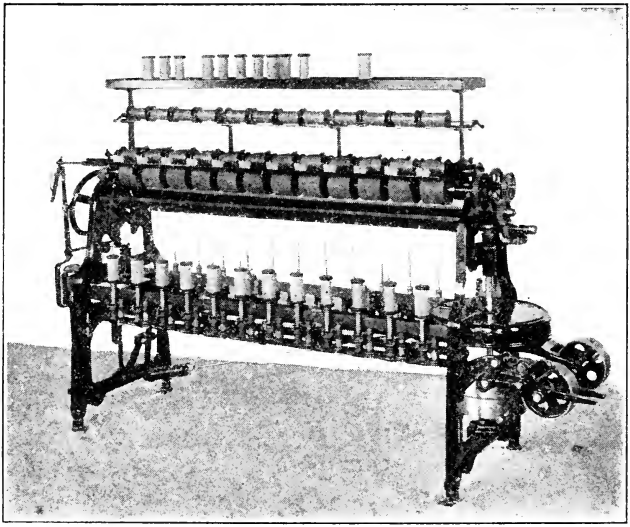


Fig. 22

The improved method of making organzine is by the use of a "Combination Spinner, Doubler and Twister", which does the work of "first-time" twist, "doubling" and "second-time" twist in one operation. It also makes it unnecessary to steam as frequently and thus tends to preserve the life of the silk. This machine will be fully explained later on.

Fig. 22 shows a perspective view of a Spinning Frame, built by the Atwood Machine Company. Fig. 23 shows a diagrammatical end view and Fig. 24 a

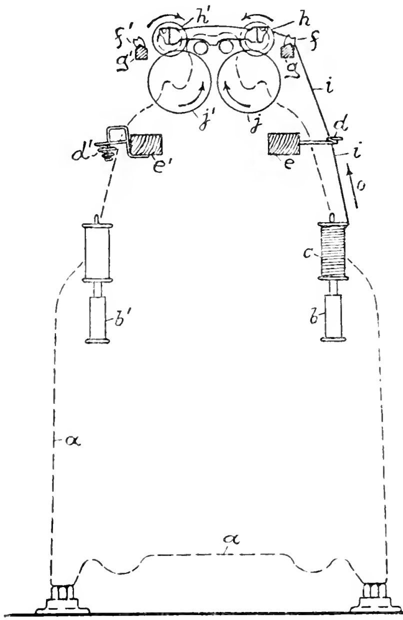


Fig. 23

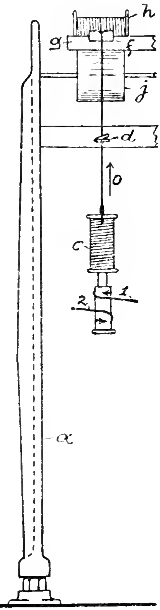


Fig. 24

diagrammatical front view of a portion of this machine, both views being given to show the course of the thread through the machine.

This machine can be built any length desired; standard lengths built are 112 spindles for first time spinning and 92 spindles for second time spinning. Fig. 22 clearly shows the endless belt for driving the spindles by friction, and which belt can be made to run one way or the other, as required.

Letters and numerals of reference in Figs. 23 and 24, are selected to correspond, *i. e.*, indicate the same parts, *viz: a* one of the end frames or heads of the machine. *b* one of the spindles, arrow 1 indicating direction of rotating spindles for "first-time" twist, arrow 2 indicating direction of rotating spindles for "second-time" twist. *b′* one of the spindles of the rear bank. *c* delivery bobbin, *d* centring eye secured to wooden girt *e,* extending the entire length of the machine. *d′* shows a cone tension wire attached to girt *e′*, used if so desired in place of the centring eye *d*. *f* is a porcelain guide, secured to traverse bar *g,* and *h* the take-up bobbin.

The twisted thread *i,* upon leaving the delivery bobbin *c,* passes (see arrow *o*) through the centring eye *d* (or the cone tension wire *d′*) and is then wound most uniformly onto the take-up bobbin *h* by means of the porcelain guide *f* being moved to and fro (by means of the traverse rod *g* to which it is fastened) the entire width of the bobbin; *j* is the drum for turning the take-up bobbin. *f′* is the porcelain guide, *g′* the traverse bar and *j′*, the drum for the rear bank of the machine, being identical with those of the front bank explained. The r.p.m. of the spindles with a "First Spinner" is from 9,600 to 11,000 and that of a "Second Spinner" according to flyer system or without flyer, from 8,000 to 10.000.

Combined Doubling and Spinning Frame for Tram.

A perspective view of this machine is given in Fig. 25, the same combining the two operations of doubling and spinning in one. This machine, like any other spinning or winding machine, is built any length desired, a standard length often met with being 100 spindles, measuring 20 feet over all, 1 foot, 3 inches wide. The machine is driven by tight and loose pulleys, 10 inches diameter, 2 inches face. One revolution of the driving pulley gives 15 revolutions to the spindles; the latter being run at from 5,000 to 6,000 r.p.m.

This frame is designed for tram spinning and will double and spin up to six, eight, and ten ends. The spindles are belt driven and self-oiling. The threads

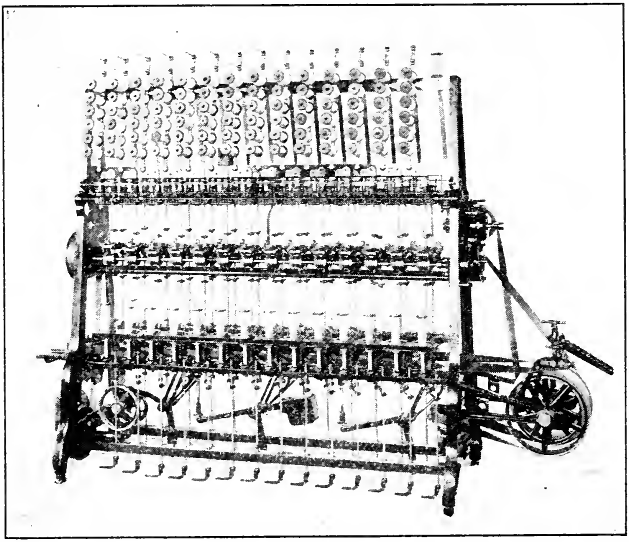


Fig. 25

are delivered from the bobbin above, passing down through drop-wires to gear driven feed-rollers, which ensures accurate doubling of the threads delivered to the spindle below; the flat ring and bar traveler are used. The spindles run four to five thousand revolutions per minute on about three turns per inch; ample provision is made for all adjustments of spindles, traverse and changes of twist; change gears are furnished with each machine.

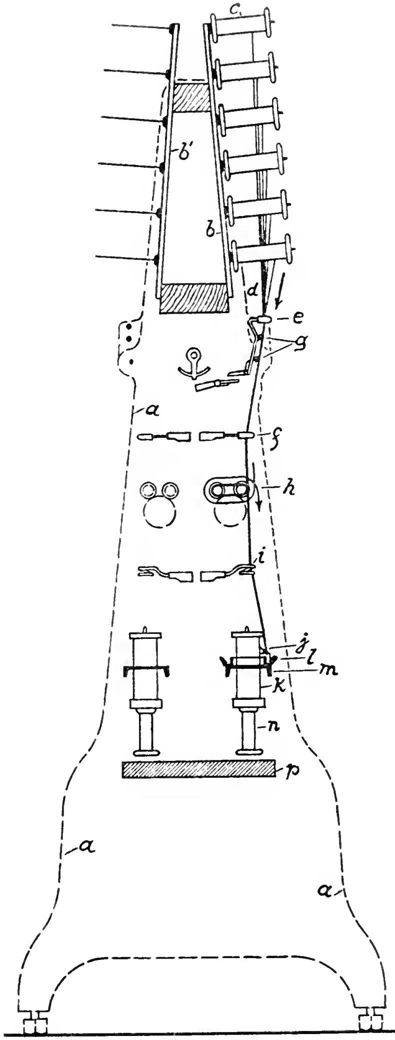


Fig. 26

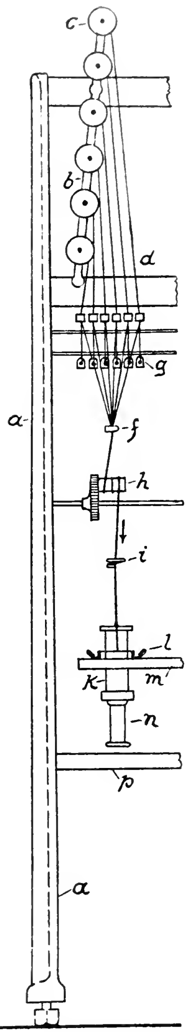


Fig. 27

Fig. 26 is a diagrammatic end elevation and Fig. 27 a similar front elevation of this machine. Letters of reference in both illustrations are selected to correspond and indicate thus:

a one of the end frames of the machine, *b* and *b'* one of the front and rear bank creel frames for holding delivery bobbins *c*, as received from the Hard Silk Winder previously explained; six bobbins to one tire are shown; less or more (up to ten) may be used. The six minor ends *d* coming from the delivery bobbins are shown at *e* to enter the faller wires of the stop motion, in their travel to the centring eye *f*.

g are strained wires operating with the stop motion, and *h* are gear driven feed rollers around which the ply thread travels (twice around) ensuring accurate doubling of the threads, which in turn, passing through centring eye *i* are twisted into one, being delivered through the ring traveler *j* onto take-up bobbin *k*. The ring traveler *j* runs on the flange of ring *l* as is secured to the ring rail *m*.

n is the spindle which turns in one direction only, since one twist only is inserted into tram; *p* indicates the spindle rail.

Combination Spinning, Doubling and Twisting Frame.

This is the combination machine for spinning organzine by one operation in place of three machines as used in some mills, *i. e.*, combining first-spinning, doubling and second-spinning in one operation.

Fig. 28 shows this machine as built by the Atwood Machine Company, in its perspective view. This Combination Organzine Frame can be built in any length, a standard size being 160 first-time and 80 second-time spindles, dealing with a machine 19 feet, 5 inches long, 1 foot, 11 inches wide and 3 feet, 8 inches high to feed rollers.

The spindles are belt-driven, and of the self-oiling type, the first-time spindles being mounted in an automatic, swinging holder and the second-time spindles in an adjustable holder, thus ensuring uniform drive with minimum of power; the arrangement of spindle belts is very simple and effective, and are provided with suitable take-up devices.

The first-time spindles take a standard winder bobbin in general use; the twist is regulated by the change of a single gear and the relative amount of

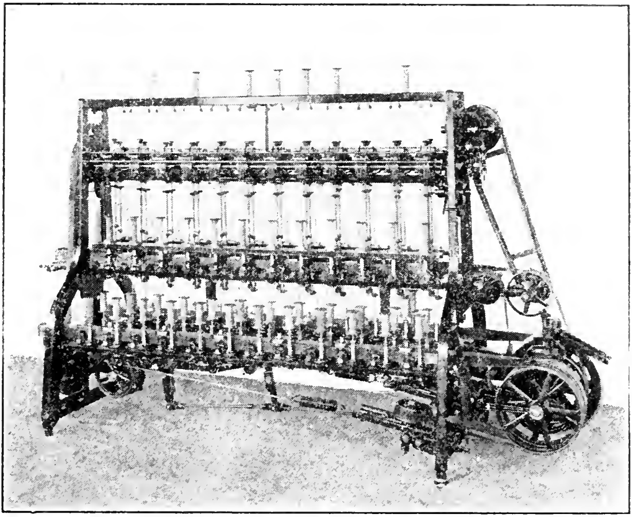


Fig. 28

first and second-time twist is obtained by change of a single pulley. Feed rollers are removable singly and all parts of the frame are easily accessible; stop motion is very simple and instant in operation; rings are of the double adjustable type.

In operation, the first-time ends are brought up through the drop wires, around the feed-rollers and down to the receiving bobbin; any break of either end releases the faller, lifts the feed-rollers and stops the receiving of twisting spindles.

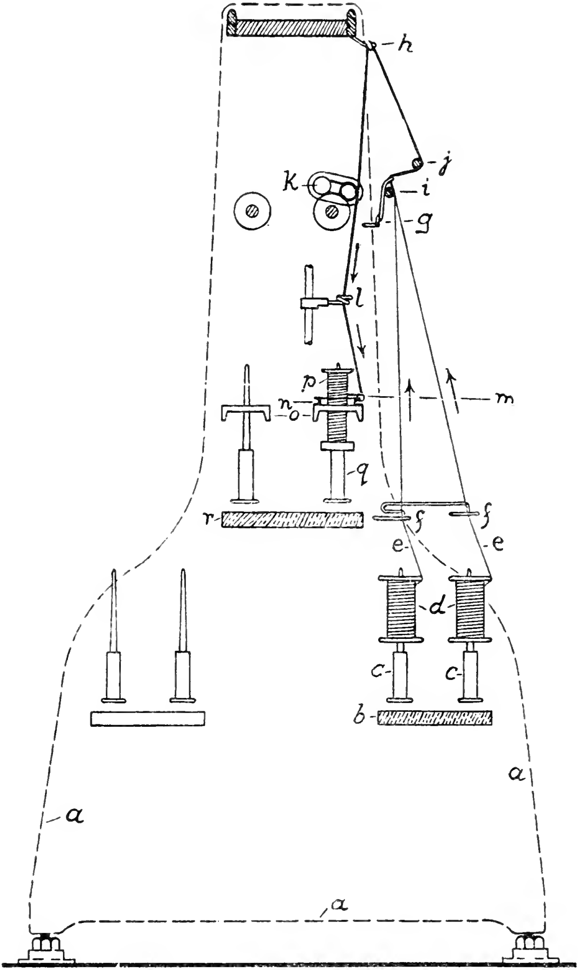


Fig. 29

Fig. 29 is a diagrammatical end view of the machine, clearly showing the run of threads through it.

a is one of the two end frames, shown by dotted lines. *b* is the spindle rail and *c* the spindles for carrying the "first-time" bobbins *d*, the ends *e* of which are brought up through tension wires *f* and in turn through faller wires *g*, then through guide eye *h*. The two threads are guided in their travel by two parallel rods *i* and *j*.

From guide eye *h* the threads pass several times around feed rollers *k* in order to produce a uniform doubling of the two minor threads, after which the now twisted thread passes through the automatic centring eye *l*, through the loop of the ring traveller *m* (as sprung onto the flange of ring *n* carried on ring rail *o*) and onto the "second-time" bobbin *p* carried and operated by spindle *q* working in conjunction with spindle rail *r*. The r.p.m. of spindle *q* is from 9,600 to 10,000.

Water Stretching.

After twisting, in some instances the silk is stretched on a machine known as a "Water Stretcher," of which a perspective view is given in Fig. 30. This treatment smoothens and consolidates the constituent fibres, imparting a superior evenness to the silk. A sufficient number of filled bobbins are for this purpose placed in water and the silk wound on to the lower of the two copper rollers of the machine. From the lower roller it passes upward to the upper roller, which turns faster than the lower one, thereby stretching the silk. From the upper roller it passes again on to a bobbin, to be in turn reeled off in hanks or skeins (in the next process) and when then it is ready for the dyehouse.

Reeling.

Thrown silk is yarn, but is hardly ready for all purposes. The natural gum (sericin) still clings to it, and its color is very dull. In this condition the silk is in some instances woven, the boiling-off and dyeing being done to the cloth. This does not always serve; in most instances, the thrown silk must be boiled-off, dyed, bleached, weighted, lustred, etc., previous to weaving, and when the yarns then must

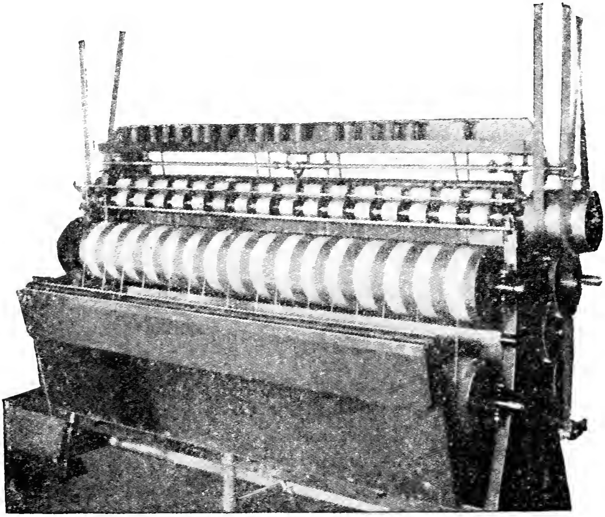


Fig. 30

be unwound from the bobbins and changed into skeins so they can be handled by the dyer. Another reason for reeling the filled bobbins into skeins is the fact that silk in commerce is handled to a great extent in skeins.

This reeling process is simply the reverse from that of the winding process previously explained, *i. e.*, the silk on the spools being, in this instance, rewound on skeins.

Fig. 31 shows such a Reeling Frame (used for organzine or tram) in its perspective view, the same being built by the Atwood Machine Company. The illustration shows one section, with only one reel in, the rear bank reel being omitted in order to show the construction of the machine more clearly. For practical use the machine is built in sections of two reel-flys each, each fly being driven independently, by friction. The width of the machine is 2 feet, 9 inches;

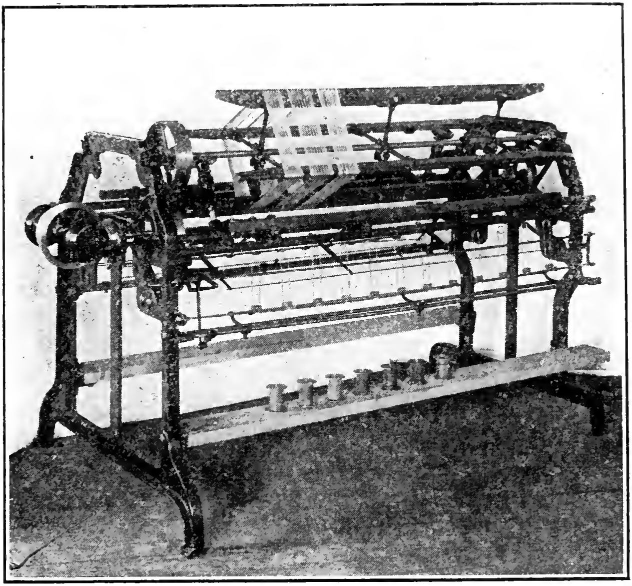


Fig. 31

the length of 2 sections is 11 feet, 3 sections 16 feet, 4 sections 21 feet. The machine is driven by cross head, 6 and 7 inch cone for 1½ inch belt, or direct idler drive, pulley 9 inch diameter, for 2 inch belt. The machine is built with the reel bearings detachable; stop motion for each end operating instantly; the action of starting the reel lifts the drop wires of the stop motion into position. It is provided with a quick or slow traverse motion, to produce any style of skein crossing desired. As will be seen from the illustration, the bottom shelf, holding the delivery bobbins, is adjustable in the head framings up or down. The reel-flys are strongly built and well balanced, thus allowing a speed of from 350 to 400 r.p.m. As a rule, the dimensions of the reel-fly and the machine are such that the skeins wound are spaced four inches apart from centre to centre, with 12 skeins per fly. The counting or registering device is of two styles, quickly adjusted; one style can be set each 50 yards, up to 25,000 yards by an indexed register; the other style is locked for the required length of skein and the reel cannot be removed, or the counter changed in any way until the skein is completed, thus preventing any tampering with length of skein by the operative.

The standard skein for thrown silk in the United States is 54 inches; however larger sizes of reeling frames are also built, taking reel-flys up to 60 inch circumference. Coming back to our standard reel of 54 inches circumference, organzine is usually made up into 20,000 yard skeins, but tram is made in 5,000; 7,500; 10,000; 15,000 and 20,000 yard skeins depending upon the demands of the manufacturer. There would, therefore be on a 54 inch reel 3,333; 5,000; 6,666; 10,000; 13,333 turns respectively for the sizes of skeins quoted.

Different countries use different measurements for their skeins. For example, England uses a skein 48 inches in circumference (= 1.219 m) with 2,496 threads, or a skein of 44 inches circumference (= 1.118 m) with 818 threads. In France the circumference of the skein in 1 m, 1 skein = 4 sections at 3,000 threads, thus 12,000 m.

An average variation of 5 per cent is allowed from the number of yards per skein, as ordered for thrown silk. The minimum number of test skeins is twenty.

Fig. 32 is a diagrammatical section of the Reeling Frame, shown in Fig. 31 in its perspective view,

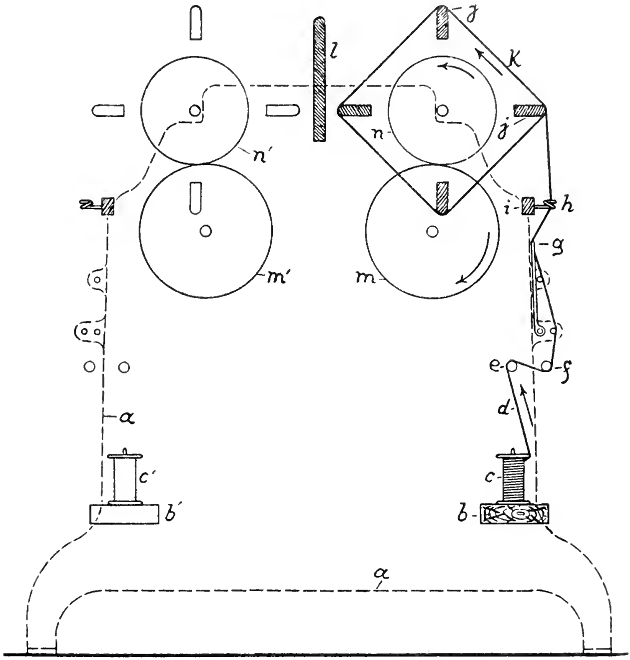


Fig. 32

clearly showing the operation of the Reel by quoting letters of reference used in the illustration.

a is one of the heads of the machine, into which the bottom shelf *b*, carrying the delivery bobbins *c*, is adjustably secured. The silk thread *d*, whether organzine or tram, is guided from its delivery bobbins *c* over and under guide rods *e* and *f*, through drop wire *g* of the stop motion, through guide eye *h* as secured to wooden bar *i* and onto reel-flys *j* forming the skein *k*. A suitable *to* and *fro* motion (by cams) is given to bar *i* and thus in turn to porcelain guide eye *h;* imparting to the skein the characteristic "diamond" winding so essential for good winding.

l is a wooden shield to keep the wind, or draft of the reel-fly off the rear bank reel-fly and vice versa. *m* and *m'* are the two driving pulleys for the reel-fly pulleys *n* and *n'*. Arrows accompanying illustration indicate travel of the organzine or tram thread from bobbin to skein, also rotation of reel, driving pulleys as well as reel-fly pulleys.

After reeling, the skeins are again steamed, either while still on the reel, or while suspended loosely as skeins, the action of the steam on the reels which are collapsible, is harmful, so that in many mills the other method of steaming is followed.

After reeling, laces are placed in the skeins as an aid in the proper placing of the skeins on the swifts, for rewinding on bobbins for the warper, the quiller, or on bobbins used by the knit goods industry, etc. The final step in the throwing department is to make the skeins up into bundles, in what is known as a *Bundling Press* and in which shape they may be sent to the warehouse, the dye-house or the mill who furnished the grége for having it thrown.

Points of Interest.

One of the most frequently met with troubles for which the throwster is generally blamed, is that of poorly wound skeins. The trouble may rest with the foreman, he may consider that all he has to do is to occasionally inspect guides and faller wires, changing them when he notices that they are worn out and cut. This is all very well, but these examinations should be made regularly and this at stated times; besides this, he should remember that there is more to be done by him to insure the making of a perfectly wound skein, producing a skein well filled, one that after subjecting it to boiling-off and dyeing, etc., will reach the soft-silk winder in the weaving or knitting mill in a condition that is a credit to the throwster.

One of the most important items for the overseer of the reeling department is to see to it that there is as little drag as possible on the threads pulling over the guide rods and through the faller wires of the stop motion, onto the reel-fly. Provided this tension is not proper it will be noticed that the skein bags when stripped from the fly, whereas if the skein has been formed with too light a tension, the result then will be a mussy skein when stripped from the fly, and for which reason the foreman must see to it that a good medium between the two extremes are used.

When stripping the skeins from the fly, care must be exercised to draw them uniformly and evenly from the latter, since if bunched the skein will become snarled and the lacings displaced.

When hanging the strippings, be careful that the skeins when hung up do not twist, each stripping to be hung on a long pin provided for this purpose and long enough to keep the skeins intact. Do not twist each stripping, since this is an unnecessary process and a waste of time. Provided each stripping as taken from the fly is put upon a long peg, it will simplify the work for the maker-up of bundles, thus enabling him to pick his skein singly, clean and free for inspection without having to lose any time.

The skein may be perfectly reeled on the machine, but may have been injured by the bundler in his work, thus reaching the dyer in a poor condition. It will not do for the bundler to twist the rolls too tight, since it will have a tendency to cause the sides of the skein to bag. The skeins, whether two, three or four are included in a roll, should be twisted together as lightly as possible, the bundler keeping in mind that the strong point for him to observe is to keep the skeins free from bagging and sagging, regardless of the looks of the packages. Broken ends in skeins will result from tight twisting by the bundler.

The foreman should be in constant touch with reelers, lacers, strippers and bundlers, closely watching their work, since poor bundling may spoil good work previously done in the mill.

It will be of interest here to refer to an improvement in reeling introduced by C. H. Knepka, a silk reeling expert, who stated that some time ago, feeling that he had his reeling department in the best possible condition, it occurred to him that he could produce a still better skein. By carefully studying how to produce such a skein, he noticed that where the flys were run at a speed of about 500 revolutions per minute, that the play of the traverse bar caused the thread on every reverse motion of the traverse to strike the faller wires of the stop motion, on account of the restriction in the play of from three-quarters to one inch, thus jumping the thread so that it built up thicker on the edges of the skein, leaving hollow centres. When stripped, the skeins bagged, and readily snarled, resulting in troublesome winding.

The accompanying illustration Fig. 33 shows a front view, and Fig. 34 a side elevation of what Knepka did to overcome the trouble. As the circular part of the regular faller wire through which the thread passes from the delivery bobbin *a* to the reel-fly *b* is only about three-quarters of an inch in diameter, he concluded that owing to the high speed of the flys, this limited range of play for the thread caused it to bind on the edges of the skein, raising them higher at these points than in the centre.

Noticing this, he stripped a few of the regular faller wires on the machine, inserting in place of them some faller wires of his own construction, see *c* in illustrations. These wires were made with a round eye on the bottom for fastening on the faller rod and terminating in a flat oval loop at the top, through which the thread passes. This oval loop is to be about a quarter of an inch wider than the width of the skein to be wound. The material of the wire is the same as that used for the faller wires in the regular stop motion. The flat oval eye *c*, through which the thread passes, permits the same to play the full width of the traverse, resulting in a skein of uniform thickness

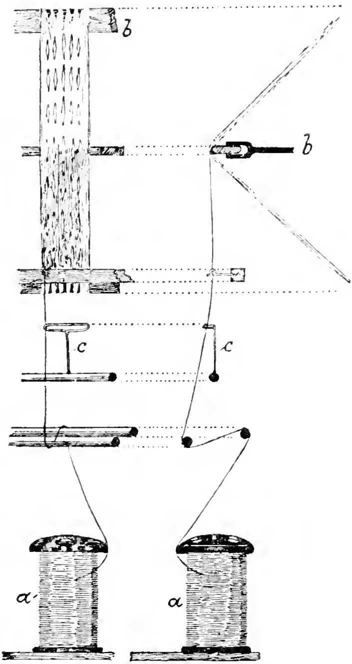


Fig. 33 *Fig. 34*

throughout its width, with the crosses preserved in perfect diamond shapes throughout the skein.

Another advantage possessed by this style of a faller wire in connection with a stop motion is, that, since the thread is not restricted in the small eye of the present faller wire it does not cut, and consequently lasts as we might say, indefinitely.

It is also of the greatest of importance in a throwing plant that the bobbins used are the best that can be procured. All spinner bobbins should have the upper head at least of fibre, and all be kept in racks or on pins; the old method of throwing them all promiscuously into boxes or baskets and bruising the heads of the bobbins, should not be tolerated in a modern, well managed mill.

There is a great need for technically educated foremen and superintendents of throwing plants. The hardest thing in these days is for the manager to find a foreman who really knows silk and how to handle it. Mills are willing to pay high salaries to men who can handle their machines and silk understandingly and properly, but are unable to find them. It is no uncommon thing for the owner of a plant to send to the builder of the machines for a man to come and put them in order after a few months operation under the care of a so-called competent foreman.

Although competition has reduced the throwing prices, there is still a good return for a well equipped, up-to-date mill that is intelligently and economically managed.

To prevent drawing or curling up of twisted skeins of silk (organzine—heavily twisted) place them after reeling in a lukewarm water bath. In Italy a treatment known as *brova* is in use, it referring to a steaming of the yarn while on the reel for from 15 to 20 minutes, after which the silk is placed in a drying chamber and for a short time subjected to a heat of from 80 to 90 deg. C. It is claimed that this procedure greatly enhances the lustre and pliability of the silk, but the drying is not made use of everywhere.

Organzines, trams and floss, for convenient handling in transit, are made up into hanks, each hank containing a number of skeins. These hanks are then made up into bundles; those of organzine are generally short and weigh from 6 to 8 lbs., whereas those of tram are long, the length of the reel, weighing from 12 to 17 lbs. The bundles are then tied up in the ordinary way with string, but as there is always an allowance made to the buyer on account of using this string, throwsters are not very sparing in this respect.

Defects met with in Thrown Silk.

In connection with thrown silk, *i. e.*, floss, tram or organzine, defects we may come across are:

(1) Minor ends running out or breaking, caused by the stop motion being out of order and this trouble not noticed at once by the attendant;

(2) Uneven tension given to some of the minor threads as fed to the doubler or the spinning frame, which will give to the twisted thread a spiral effect, technically known as corkscrew;

(3) Uneven counts or sizes of minor threads put up for twisting into one thread, may also be at the bottom of corkscrew, and so also

(4) the union of minor threads containing a different percentage of moisture, which in turn will cause an uneven contraction of the thread when dry.

Corkscrew of the thread, in connection with organzine, will cause trouble at the weaving; the short minor thread of the organzine, not being able to stand the strain of weaving, will break, and when the loose end will form itself into a bunch, which will catch either in the mail of the harness or in the dents of the reed, and thus be the cause of the end breaking during weaving.

With reference to the first twist, *i. e.*, the twist imparted to the minor threads, in connection with organzine, defects met with are: soft twisted ends, and kinks or snarls. The first may be the result of slack spindle bands, sticky spindle bolsters or spindles out of true.

Such a soft twisted thread can be readily detected by the attendant, since the spools containing such silk will handle soft. Such yarn should not be used in this state in connection with perfectly spun yarn, since if used, it will clearly reveal the defect after passing through the boiling-off process, and finally may be the cause of spoiling the face of the fabric.

Kinks or snarls in the first twisting process can be generally traced back to improper working of the stop motion, *i. e.*, the latter failing to operate when the spindle stops. Kinks should either be stretched, rubbed or pieced out, previously to again starting up the machine.

Other Kinds of Silk.

Besides dumb and thrown singles, floss, tram and organzine, we may come in contact with:

SEWING SILK: Refers to silk composed of 3 to 24 threads, 2, 4, or 6 of which are united by twisting.

EMBROIDERY SILK: Refers to silk composed of untwisted threads, a number of which are united by a slight twisting.

CORDONNET SILK: Is a silk used for braiding, knitting, etc.; it consists of 4 to 8 threads loosely twisted with a left-hand twist to form the primary threads, 3 of which are then twisted together with a right-hand twist.

MARABOUT SILK: Is a silk used for crapè; it consists of 2 or 3 threads united without preliminary twisting, then dyed without scouring and strongly twisted together, so as to yield a stiff thread.

SOIÈ ONDEE: Refers to a silk prepared by doubling a coarse and a fine thread. It is used in making gauze, to which it gives a watered appearance.

Buying Silk on Guarantee.

When thrown silk is bought, stipulate the price per pound on the basis of:

(1) A certain amount of moisture.

(2) A certain amount of fibre (not boil-off).

(3) A certain size (length). Subject to official tests.

When:

Amount of moisture is less than stipulated, pay for the difference.

Amount of fibre is more than stipulated, pay for the difference.

Size is finer than stipulated, pay for the difference, and vice-versa.

The application of this method automatically removes all unpleasantness and disputes, as all those will testify who have resorted to this practice. This method is known as the "100 per cent proportion basis of thrown silk."

It may become necessary or desirable to incorporate in the contract a certain minimum size and possibly a certain maximum size.

Supposing a transaction had been closed thus:

Price per lb. $4.00.

Moisture rate 11 per cent (conditioned weight).

Fibre rate 77 per cent (boil-off 23 per cent).

Size 8.53 drams per 1000 yards. (30,000 yards per lb.) and supposing a shipment of lbs. 100.00 net weight had been made and tests showing:

(*a*) Conditioned weight lbs. 98.00.

(*b*) Fibre rate 78.57 per cent (boil-off 21.43 per cent).

(*c*) Size 8.70 drams (29.425 yards per lb.)

the bill would read:

100 lbs. net at $4.00 = $400.

$400.00 ÷ 100 × 98 = $392. (moisture).

$392.00 ÷ 77 × 78.57 = $400. (fibre).

$400.00 ÷ 8.70 × 8.53 = final $392.30 (length).

This shows:

(1) A loss on account of excessive moisture.

(2) An increase on account of increased fibre.

(3) A loss on account of reduced length.

Vice-versa, supposing the tests had shown:

(*a*) Conditioned weight lbs. 102.

(*b*) Fibre 75 per cent (boil-off 25 per cent).

(*c*) Size 8.36 drams (30622 yards).

Bill would read:

100 lbs. net at $4.00 = $400.
$400. ÷ 100 × 102 = $408.00 (weight).
$408. ÷ 77 × 75 = $397.40 (fibre).
$397.40 ÷ 8.36 × 8.53 = final $405.47 (length).

The difference between the bills on the net basis and after adjustments may naturally become very much greater than in these examples, the differences in the final bills become larger in the same proportion as the difference in the condition of the silk between the actual delivery and the condition stipulated become larger, for which reason this method can be called the self balancing or self adjusting purchasing method, otherwise known as the 100 per cent basis.

The One Hundred Per Cent throwing method, closely corresponding to what is known in Europe as La Grande Façon (equivalent to "the complete working out" or demonstration) is a method of adjusting the price to be paid for throwing, on a basis which determines the amount of waste made by the throwster for which he is required to pay at the thrown silk price.

Advantages of the Method.

The cost per pound of the thrown silk is known definitely in advance—after deducting raw boil-off samples—since the throwster pays for all the waste, allowance for which is included in the increased price for throwing.

The weights of the raw and thrown silk and the loss by boiling off are definitely known, instead of being estimated or assumed, giving the clearance a mathematical accuracy obtainable in no other way.

The use of this method tends to produce a minimum of waste, as a direct loss to the throwster is the result of any waste made in excess of the amount expected.

Both the owner and throwster proceed on a known basis regarding the weight of the silk at all stages where the weight is affected, and both parties are on a mutually understood basis where their respective rights can be accurately determined by mathematical processes.

The conditioned weight and boil-off of the thrown silk being known, the manufacturer is able to order his weightings with greater precision.

Throwing Silk for the Knit Goods Industry.

The continually growing demand for silk hosiery has brought into the silk market a large and growing consumer of raw and thrown silks, and for a fact, with some of our public throwsters, the knit goods field has become an important and special feature. The kinds and grades of silks used for hosiery and knit neckwear varies according to the class of goods made, ranging from Tussah to fine Italians including Shinshiu, Kansai Filatures, some of the intermediates like Tsatlee Filatures, etc., also Canton Filatures and Rereels.

The greater part of the raw silk used by the knitting industry is 13/15 denier silk. Provided the silk was of such an even construction that the thread was at no place finer, nor coarser than 14 deniers, the amount of waste made in throwing would probably then amount to only about one-tenth part of what it actually amounts to. Such waste would then consist chiefly of those short clippings made after tying a knot (for one reason or another) since there would be no breaks of the threads anywhere. But silk is not of such even construction; silk of 14 deniers may in certain places run as heavy as 20 deniers, and in other places may be as fine as 10 deniers, or even less. Those fine ends become so fine at places that the thin thread cannot hold the weight of the skeins and swifts or the spools, and consequently will break. Wherever such a break occurs it will be necessary to remove all those fine portions which at times may amount to hundreds of yards. The more uneven the silk, the more often do these breaks occur. Waste originating from this source may amount to one, two, three and even more per cent, whereas the unavoidable waste or legitimate waste might only have amounted to a small fraction of one per cent. Taking into consideration that the waste caused by the unevenness of the thread naturally consists of but the finest part of the silk in question, we will at once understand that if the waste in weight should have proved to be, say 3 per cent, the waste in length would naturally be more than that.

If, for an example, the average of the size (as before) was 14 deniers, and the 3 per cent of waste in weight was composed of an average of 10 deniers, then we must consider that while the waste in weight was 3 per cent, the waste in length is considerably more.

One hundred pounds of 14 denier silk equal 32,000,000 yards.

Three pounds of waste of 10 deniers equals 1,369,500 yards, being 4.28 per cent waste in length.

There are two systems of grading of silk yarns used, *viz:* the Denier and the Dram system.

THE DENIER SYSTEM. The length of the skein adopted for its basis in the U. S., is 450 meters, and the unit of weight $\frac{1}{2}$ decigram; thus the count is expressed by the number of $\frac{1}{2}$ decigrams that 450 meters of silk weigh.

450 meters = 492.12 yards.
1 lb. = 453.6 grams.
1 gram = 20 deniers.
1 lb. = 9072 deniers.
1 denier = 492.12 yards.
9072 deniers = 4,464,513 yards.

DRAM SYSTEM. This system of grading has for its basis the number of drams (avoirdupois) a 1000 yard hank weighs. Fractions of drams are used, *viz:* $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of one dram.

The knit goods manufacturer should have a particular interest in the possible improvement of the silk with regard to its evenness, and it is an easy matter for him to contribute toward bringing this about. He should discriminate. He should look for the best silk in this particular direction. He should make it a part of his contract to stipulate what he considers an acceptable silk for his purpose. He should be guided by a standard.

By this he is doing away with all speculation or gambling with regard to the quality. He will not deceive himself. He will know he is economizing by doing away with that unnecessary or invisible waste. When paying the price for a high-grade silk and refusing to accept any substitution at a lower figure, he will naturally create an interest on the part of the producer to produce the best possible silk at an equitable remuneration, contrary to the present interest in producing a low grade silk at a falsely attractive figure.

Establishing of standards will reduce the number of qualities or grades. Every reduction in the number of grades will mean an increase in the efficiency of output and returns. We may not so much be harmed directly by following the course of least resistance as producers, but we should absolutely refuse to adhere to this doctrine as consumers.

Mills running on the better grades of Accordion Knit and Flat Goods, in two-toned mixtures, require the silk to be delivered in skeins.

For converting skeins (either in its *Thrown* or *Dyed* state) the "ALTEMUS **2B** WINDER" should be used, the same being equipped with an ingenious attachment that winds the new type of Yarn-package automatically traversed in its progress of building the Pyramid Cone. This wind will produce a most perfect fabric, uniform in its structure, flexible in its texture, and what is more: eliminates press-offs and seconds and equalizes and increases the production, pairing to the uniformity of requirements.

Mills running on popular-priced grades of goods, which are dyed in the piece, require their silks to be

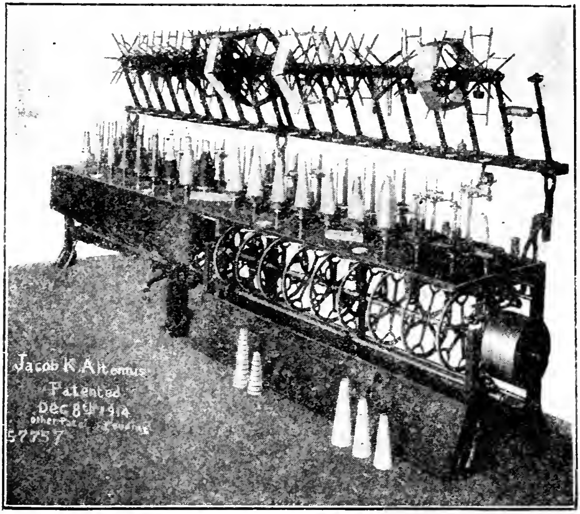


Fig. 35

furnished on cones, this being the reason why some of our throwsters had to install "Altemus **2B** Cone Winders," of which a photographic view is given in Fig. 35.

This Winder will *increase* your *production* and *decrease Press-offs* and *Seconds,* and above all produce a more uniform fabric; save time in pairing up, making your fabric flexible and soft.

Besides all-silk hosiery, a good portion of hosiery is made with cotton foot and top. Where mercerized cotton is used in place of regular cotton, the mercerizing gives the cotton a greater affinity for most dyes, and they, dyed together with the boiled-off silk will produce most satisfactory results.

For piece dyeing the most economical plan is to use the silk in the gum and boil-off the goods previous to bleaching or dyeing.

To produce a popular priced silk hose for the market, tussah is used. This silk, on account of its irregularity, however, lumps up in the latch of the knitting needles, breaks the latches, and makes expensive press-offs and seconds. The working of this silk in knitting machines can be materially improved by imparting to the yarn a little extra twist so as to increase its elasticity. Cleaner yarns will also result through finishing them on special yarn finishing machines which lay any protruding fibres to the body of the thread, resulting in added lustre to the silk, also increasing its elasticity, and of which tussah possesses very little.

Silks thrown for knitting purposes require a most uniform twist, a long drag insuring uniformity in twist.

Care must be also taken in connection with throwing silk for the knit goods trade, that operators piece ends with the bobbin off the spindle, so as to avoid hard twists.

Throwing Silk for the Cotton Industry.

Another broad field for silk throwsters is found in the increased output of cotton and silk mixtures by the fine count cotton goods mills, using silk for stripes and figuring, in the construction of fancy shirtings, dress goods, etc. These mills are continually increasing their consumption of silk, some of which they buy direct from raw silk importers and have them thrown by public throwsters, whereas others are still buying thrown silks, as they need it. While silk mixtures have long been made by these mills, the number of mills engaged in the manufacture of silk and cotton mixtures of a novelty character is constantly growing.

These mills have become such large users of silks that it would not be surprising to see more of them following the lead of some of the large mills which have already installed their own plant of silk throwing.

The Testing of Raw Silks.

Clearances Figured on Yardage.

Some of the inquiries and comments which have been lately received by the U. S. Conditioning and Testing Co., in reference to methods of computing clearance, have revealed to them the fact that many silk manufacturers use the yardage of their thrown silk, determined either by sizing or measuring tests, as a basis for calculating clearances and costs.

The method is subject to so many causes of inaccuracy that it seemed desirable for the Testing Co. to call attention of the silk industry to them and at the same time point out a more reliable method:

The use of yardage as a basis for computing the clearance of a lot of thrown silk may be inaccurate through the following causes:

1st: Variation in the size of skeins.

2nd: Variation in the size of the silk, both raw and thrown.

3rd: Stretching of the silk in winding.

First: According to the Rules and Regulations of the Silk Association of America, governing transactions in the throwing of silk; an average variation of five per cent shall be allowed from the number of yards per skein as ordered for thrown silk. This rule indicates that in the opinion of the Association the reeling of thrown silk is a mill operation, subject to such variation that if the average length of the skeins produced does not differ more than five per cent from the length specified, the delivery shall be satisfactory.

Since the rule applies to the *average* length as determined by test, the delivery may be good and still have in it skeins which differ from the length ordered by an amount considerably larger than five per cent.

Take a ten-bundle lot, as illustration, ordered to be thrown into organzine 20,000-yard skeins. The lot returned by the throwster is sent to the Conditioning House for a measuring test. Ten skeins are drawn at random, one from each bundle, wound onto spools and re-reeled into skeins on a precision reel having an accurately divided dial for reading the number of revolutions of the fly.

Suppose the average is 19,500 yards per skein, equal to 2.5 per cent less than the ordered yardage. Some of the skeins in the test must have been shorter than 19,500 yards and others between 19,500 and 20,000 yards. The probability that an appreciable number in the lot should exceed 20,000 yards is, with the modern reel, very remote. The lot would contain approximately 1,600 skeins, which, in a moderate size throwing plant, would probably have been reeled upon at least ten different flies. Of the 1,600 skeins, ten skeins, or approximately 0.6 per cent, were selected for the test and the manufacturer who uses the measuring test to calculate the total number of yards of organzine or tram in a lot by multiplying the average yardage by the total number of skeins is assuming that these ten skeins can be so selected that their average will be the same as the average of the whole 1,600 skeins found by measuring them all.

When the Silk Association in its Rules and Regulations declares that a variation of five per cent in the lengths of skeins is a permissible allowance, and from this it may be inferred that individual skeins might vary as much as ten per cent from the ordered skein, it should require but slight consideration to see that the probability of the average yardage, by the measuring test, equaling the true average yardage of the whole lot, is very remote.

The manufacturer who attempts to calculate his clearance and the commission throwster who accepts a clearance based upon a chance, where the odds are liable to be so great, introduces a very dangerous element of chance into the control of his business. The measuring test was never intended by its originators as a means of calculating quantity of material. It cannot be made with sufficient accuracy and is subject to too many uncertainties to be used for such a purpose. For determining the number of warps, the length of warps or roughly the production which can be gotten to advantage from a given lot or even determining for limited orders the quantity to be dyed, it may be quite accurate enough. But in the accurate control of the quantity of as valuable material as silk it should certainly have no place.

The thing which seems to recommend it is its cheapness and simplicity, but he who uses it to measure pounds of material at from $4.00 to $5.00 per pound is practicing a penny wise and pound foolish policy and deceiving himself into thinking that he is watching his "wastes and leaks by testing."

SECOND: A clearance calculated on a sizing test which gives the number of drams per 1,000 yards, and yards per pound of a thrown silk is slightly better than one based on the measuring test, but is also subject to some of the same inaccuracies. For the sizing test, ten skeins are drawn, from which twenty small skeins are re-reeled and weighed. The average of these twenty skeins is the average size and may be expressed in yards per pound. From the weight of the lot, the number of yards returned may be calculated. The selection of ten skeins from a ten-bundle, 1,600-skein lot, depends upon the same principle as the measuring test, but the size of thrown silk does not vary as much as the size of the skeins, and hence the sizing sample will be very much more representative than the measuring sample and the average size upon a single test will agree more closely with the average or true size of the lot. Variation in length of the skeins or the number of skeins does not affect the size.

But to apply the sizing to determine the yardage of the lot, the weight must be known, and at this point the amount of moisture, soap and oil in the thrown silk enters. Unless the conditioned weight and boil-off is determined no accurate clearance can be calculated.

But these are the only tests required to make an accurate clearance based upon clean fibre as described below.

If the throwster's invoice weight is accepted and the size applied to it to determine yardage, the uncertainties regarding it enter into the value.

The sizing test is influenced by the natural variation in the raw silk. This is recognized in the silk trade as shown by expressing the size between limits instead of the average size.

THIRD: Probably the greatest weakness of the yardage as a basis of computing clearance is the possibility of stretching the silk by reeling it into skeins at increased tension. The elasticity or stretch of the silk thread ranges from fifteen per cent to twenty-five per cent before it breaks. The first half of this stretch is accomplished by a small increase in tension. The stretch increases with increase of moisture and therefore, by the adjustment of tension and moisture, it is possible to manipulate the yardage. The yardage determined either by measuring or sizing test becomes therefore almost useless as a basis for computing clearance of thrown silk.

CORRECT METHOD.

Clearances of thrown silk should always be computed upon the basis of conditioned weight of clean fibre. The conditioned weight and boil-off of the raw should be determined by the Conditioning House before the silk is shipped from New York and the thrown silk should be returned to the Conditioning House either in New York, Philadelphia or Paterson, and the conditioned weight and boil-off again determined.

Every five-bale lot should have two bales conditioned, three bales shirt weighed and one boil-off made on the raw; then two conditionings of five bundles each and two boil-off on the thrown.

The selection of bales and bundles to be tested should always be made by the Conditioning House.

With the information which these tests will furnish, it is possible to compute an accurate, reliable clearance not subject to manipulation. The slight increase in expense will be more than justified by the saving involved.

Points on the Proper Raising (*Cross-breeding*) of Silkworm Eggs.

This subject has been excellently dealt with by *Dr. Umberto Zanoni,* one of Italy's experts on this subject, and from which we quote items that will be of the greatest of interest.

Italy, the most important silk producing country of Europe, is, likewise, at the head of silk raising countries in the production of silkworm eggs by modern improved methods.

While the Far East, China and Japan, are the leading countries in so far as amount of cocoons produced, they have not, however, yet approached the technique and science attained of late by Italy in the production of the eggs.

Japan is now beginning to take up seriously the improvement along this line, having, during the last years, sent to Italy several students, in order to learn these methods, for adoption in their country. Numerous, already, are the establishments in Japan engaged exclusively in the production of silkworm eggs, which have adopted the system of cellular selection. In China less progress has as yet been made in the microscopical selection of silkworm eggs.

The production of the eggs, as practised in Italy, includes various processes, *viz.:*

(*a*) *Preparation of the cocoons for reproductive purposes.*

(*b*) *Treatment of the cocoons in the reproduction.*

(*c*) *Microscopical selection of reproductive moths in cells.*

It aims at:

1st. Producing eggs of yellow Italian varieties, in accordance with the requirements of the silk exporting trade and adapted to the localities, in Italy, where they are raised.

2nd. Obtaining on a large scale crossbreeds, especially with Chinese varieties.

In the other important silk raising countries, namely, in France, China and Japan, this industry aims almost exclusively at producing eggs of pure local varieties. In France are usually reproduced the local yellow species, in China the Chinese white and yellow, and in Japan more especially the Japanese white.

In the above stated countries, no less than in Italy, the necessity is beginning to be felt of resorting to *crossing*, chiefly *for the purpose of further strengthening the larva,* destined to silk raising on a commercial scale.

In Italy conditions arising from competition in the silk market have of late years caused the producers of silkworm eggs to turn their attention to the production of pure species, and of such crossbreeds as will secure the highest production, together with the best quality, of silk, and the largest yield at the basin.

The producer of silkworm eggs in Italy, after first having secured, with the adoption of the *cellular system,* safe immunity from the pebrine disease, has, of late years, aimed continually at the improvement of his seed productions. This was done in order to enable the raiser of silkworms to obtain the highest yield in silk from his cocoons, as well as to strengthen the position of the reeler on the market, and enable him to overcome the competition, which has become gradually keener from the Far East and from those other countries, which, of late years, have, by various means of encouragement, promoted and gradually developed their silk industry.

In Italy, the substitution with crossbreeds of the Italian yellow varieties has been due to the fact that in almost the entire North the various yellow species were subject to serious attacks of *flacherie,* one of the most dreaded diseases of the silkworm. By crossing different species, breeds have been obtained more resistant to this disease.

The Chinese cross, as is commonly designated the issue from an Italian yellow crossed with a Chinese, is the variety that has now prevailed over all others, having demonstrated its aptness to answer the requirements of both good quality and good yield of the silk, reeled from its cocoons, besides being sufficiently hardy, a quality that the producers of silkworm eggs had formerly exploited to their advantage and obtained (not without prejudice, however, to the quality and yield of the silk) by crossing the Italian yellow with the vigorous Japanese green and Japanese white.

The raising of silkworms for reproductive purposes usually takes place in the healthiest localities of Italy, it having been ascertained that species yielding small cocoons succeed satisfactorily in Northern Italy; while experience has shown that the Italian yellow gives better results in the climate of Central and Southern Italy.

Cultivations for this purpose are usually of a fractional character, seldom reaching in individual cases one ounce (of grams, 30.35) of seed, and are entrusted to the best of the small raisers of silkworms in the localities chosen for reproductive purposes.

The best, among these, are for Northern Italy the hilly districts of Venetia and Lombardy, and for Central Italy the hilly regions of the Marches and Abbruzzi.

A district, to be suitable to the raising of silkworms for reproductive purposes, should be characterized by healthy climate and good quality of the mulberry foliage, and should present conditions most favorable to the rearing, especially in regard to freedom from hereditary contagious diseases, and particularly from pebrine, the most feared. Preventive disinfections, thoroughly accomplished, of the rearing house, material and utensils used, are indispensable every season.

The systems of rearing silkworms which have proved to fulfil the best requirement of the case, and to promote the healthy condition of the larva, such as the economical method of the primitive Frioulan cloth, suspended on horses, are especially recommendable in the rearing of silkworms for reproductive purposes and the production of seed.

Treatment of the Cocoons.

Cocoons for reproductive purposes are picked when perfectly developed, and carried in small baskets, or in light layers on trays, so as to avoid damage while in transit to the seed rearing establishment.

Upon arrival at the establishent, the cocoons undergo several operations. They are, first of all, freed from their coating of floss, and are next submitted to a process of selection, in order to separate the good from the faulty cocoons.

The freeing of the cocoons from the coating of floss in which they are enveloped, yields cocoons with a decidedly clean surface, which helps the moths, at the time of disclosure, to detach themselves from the cocoons. The deflossing of the cocoons is accomplished by means of very simple machines, in going through which the cocoons are brought in contact with grooved steel cylinders, revolving on their longitudinal axis, and freeing them thoroughly of the floss.

The selection of the cocoons is usually accomplished by hand, and consists in eliminating all cocoons which are imperfect as to quality of the silk, or as to form, color, strength of the silk tissue, etc.

In this manner are obtained the cocoons destined to maintain, by reproduction, the racial characters, either for crossbreeding or for the continuation of the species.

The separation of the male from the female cocoons is the next operation, accomplished by means of specially devised scales, known under the designation of *ginecrini,* of which the most popular are the multiple types, capable of sorting several cocoons at a time.

Sex separation, although accomplished, in the case of the cocoons, only in an approximate manner, is, however, especially important for the purpose of cross-breeding, enabling the rearer of seed to govern his breeding and to obtain crossbreeds with different strains, suitable to the requirements and demand of the raisers of silkworms.

In order to separate the sexes, and avoid copulation between males and females of one same race, cocoons are usually placed in so-called insulators, which, by confining each moth within its own cell, keep them separate upon coming out of the cocoons.

The hatching of the cocoons and caring of the moths is the most important stage in the production of silkworm eggs, as it comprehends all the phases from the hatching to the pairing and separation of the couples, to the bagging of the moths in the cells (*cellular system of production*), to the tying and hanging of the cells on the so-called harps, in order to preserve the eggs deposited.

Microscopical Selection.

The microscopical selection of the reproductive moths, in order to obtain cellular seed, immune from pebrine, was readily adopted after the important investigations of Cantoni and Pasteur, by all rational producers of silkworm eggs. The truth of the following conclusion, arrived at at the First International Congress of Sericulture, held at Gorizia in 1870 has thus received practical recognition: "The microscopical selection of the productive moths, paired in cells, is, in the present condition of the silkworm industry, the only means to secure seed immune from corpuscular infection and of reproducing the valuable old yellow species, freeing ourselves from the heavy tribute which is now paid to Japan."

Microscopical selection includes two phases, *viz.:*

(*a*) Crushing and mashing of the moths.

(*b*) Microscopical examination of the mashed specimens of each individual moth.

The moths are usually crushed in small mortars, either of porcelain, ebonite, brass, or other suitable material, operated by hand.

In crushing the moths, sufficient care must be taken to avoid the possibility of spreading, by contagion through contact either with the hands or with utensils, the pebrine disease, thus augmenting, instead of eliminating the actual percentage of infection.

Crushing may be accomplished by means of special mechanical crushers, reproducing to some extent the action of ordinary hand mortars.

Following right upon the mashing of the moths is the microscopical examination, which consists in examining under the microscope a drop of each individual moth specimen, so as to identify the diseased moths and eliminate the eggs deposited by them.

The microscopical examiners are handed the slides, already prepared, of the specimens for examination, so that they can readily proceed with their work, collecting in a special small receptacle of glass, for the final checking, the specimens found free from infection.

The cells containing the eggs deposited which have been found upon examination sound and immune from pebrine are grouped and hung again in the rooms where the seed is kept.

The microscopical examination of the eggs takes place usually in August, September and October.

Collecting the Seed.

The gathering of the eggs from the cells begins in November.

This operation is preceded, however, by a careful selection and re-examination of the eggs, made by opening each individual cell and by eliminating by means of a suitable brush faulty eggs, such as yellow (empty), shriveled, black, or badly shaped eggs.

The eggs are collected by placing the cells in water baths, as from the moistened paper, to which the eggs adhere, they are easily detached.

The detached seed is carefully washed by means of suitable sieves and next bathed in special disinfecting liquids in order to secure, together with a thorough cleansing, a superficial disinfection of the eggs.

The grain is next air dried by means of powerful ventilators, which eliminate also all impurities and residues, and separate thoroughly the light and imperfect eggs from the good eggs.

After the previously stated treatment the seed is weighed and packed in small gauze bags or cardboard boxes and is in a condition for hibernation, which takes place usually in January, February and March.

At the beginning of April distribution of the seed to silkworm raisers commences, and this closes the work of the grain producer and marks the commencement of the labors of the rearer.

It is rightly said that the production of silkworm eggs is an industry of special importance, and of thorough confidence in the establishment from which the seed is obtained.

Importance of Soap and Water in Treatment of Silk.

From the cocoon to the finished fabric, soap plays a very important part in the treatment of silk, and the commercial value of a number of fabrics depends upon the quality and nature of the soap used.

It is not the purpose of the present article to treat on any special make of soap, but to direct the attention of the throwster and dyer to the difference existing in various soaps and the influences they are likely to have upon the silk.

The ideal soap for the treatment of silk is a hard curd of settled soap, made from caustic soda and olive oil, or a very high-grade olive oil foots, the latter being the most widely used, because it is cheaper than the white olive oil soap. Some dyers prefer the use of a white soap provided the silk later on is to be dyed delicate colors. Either soap should be perfectly neutral, that is, should contain neither free alkali nor free fat.

At one time large quantities of soap of French manufacture known as Marseilles soap were imported, and a few still find their way to our market, but to-day Marseilles does not signify anything. Centuries ago, soap made in Marseilles was a pure olive soap, but to-day it may be anything. It is even made here, and stamped Marseilles, thus the name Marseilles alone, now stands for nothing, without being upheld by the name of a reputable maker, to be sure you are getting the proper article.

Formulas in soap books give Marseilles soap as containing olive oil, bleached palm, tallow, cocoanut oil, and even cotton-seed oil, so that you can readily see that Marseilles means nothing.

Our domestic manufacturer can produce the best that is possible to-day. It is only necessary to *know from whom to buy it;* that is, to know the house with the reputation for making the pure article.

There are, however, on the market many brands of silk soaps recommended on account of one or more properties, but what the silk man is particularly anxious about, is a soap that is firm, readily soluble, and which has a reasonably quick solvent action on the silk gum, *i. e.,* sericin.

No free alkali should be present in olive silk soap on account of the consequent impairment to the natural lustre of the silk.

The choice of olive oil for the manufacture of silk soap is a matter of some concern, and the higher grade of oil or foots employed, *the better* will be the soap. What is termed "fair average quality foots" or "soap stocks," which are the second or third pressing, and of a dirty brown reddish color, coming from countries where the olive originally is of an inferior grade, find their way in cheap grades of soap, but better grades of oil are to be desired when a soap for silk manufacturing is intended.

It is curious that the oil from certain regions has properties of producing soaps of different consistencies, it being conceded that the Italian oils produce the highest grade soaps.

Owing to competition, the soap maker is tempted to use cheaper oils than olive, and this has opened the door for cotton-seed, rape-seed, peanut, corn, poppy and sesame oils, none of which, however, add to the value of the soap, but on the contrary, produce very poor and unsatisfactory results.

It is also a fact that powdered soapstone and even barytes have been found as fillers. Olive oil soaps for silk purposes should contain from 60 to 65 per cent of fatty acids (upon which the real value of the soap depends) and from 6½ to 7½ per cent of sodium oxide, while the insoluble matter should be not over 0.5 per cent. The moisture in the soap should be between 27 and 33 per cent.

Consumers of fairly large quantities of soap should always purchase upon specification and contract, and have deliveries frequently analyzed by a competent chemist, naming specifically the soap constituents to be determined, for the reason that the average soap consumer, not being a chemist, is frequently unable to read and understand a chemist's report worded in technical language.

It should be remembered that what the manufacturer wants is soap, consisting of a compound of soda and olive oil and containing a certain amount of water held mechanically, and there is no occasion for excessive quantities of water to form part of any delivery. If a soap consumer orders "olive oil soap"—which is what he should use for silk—the soap manufacturer should deliver it; and it is quite within the province of the chemist to report whether or not the fatty oil used in making the soap was olive oil, or the same mixed with other and cheaper oils. It is not a case of one soap doing what another will do, but of the silk worker getting what he pays for.

Some soaps rinse out more readily than others. Some soaps, while apparently completely removed by rinsing, leave a distinct soapy odor which baffles removal. One of the most prominent advantages of pure olive oil soaps for silks, is not only its effective solvent action on silk gum, but its easy removal by rinsing with luke-warm soft water without leaving any odor behind.

Silk thoroughly degummed, if to be weighted and dyed, should be rinsed with the utmost care and attention, for lack of care at this stage may cause the silk to be responsible for defective pieces later.

By care is meant the use of soft water, for not only the boiling-off but for the rinsing as well, the reason being that any hardness of water due to the presence of magnesia or calcium, immediately forms insoluble alkaline earth soaps with the fatty acid of the remaining traces of soap adhering to the skeins. These magnesia and calcium soaps stick tenaciously to the skeins and are difficult of removal, and when these skeins at a later time are either weighted in a tin bath, or not weighted but dyed in an acidulated dye-bath, the fatty acids are liberated, and it is well known that free fatty acids are positively detrimental to silk and cause its ultimate disintegration.

Many silk fabrics, perfect otherwise, perhaps moderately weighted, show occasionally one or more threads adjacent to each other, which seems to suddenly lose their strength and fall to pieces in the fabric, and the consensus of opinion of those who have investigated the silk fiber, after it has been made up into fabrics, is that such breaking is in all probability due to the presence of fatty acids.

Of course there are other substances besides the above mentioned that act destructively upon silk, sodium chloride (common salt) being also an enemy that must be seriously considered.

In dyeing blacks with logwood, silk soap is very frequently added to the second dye-bath, and if after dyeing, the rinsing has not been thorough, appreciable traces of soap may remain in the goods, and in such cases the use of muriatic-acid-olive-oil brightening mixture is certain to liberate free fatty acids that would in time positively injure the goods.

Water a Most Important Item.

The water problem in silk mills comes prominently in mind when soap is considered, as both go hand in hand. No silk mill can turn out a uniform article, if the quality of the water changes, which is a matter of frequent occurrence in mills depending upon a natural source of supply.

Calcareous water is not to be considered, and no silk mill should be located where such water only is to be had. Naturally soft water from granitic regions is eminently suitable, but such localities are not numerous.

The chemical treatment of water containing excessive quantities of lime or magnesia is not an easy matter in the dye house, and any attempt to correct water by the tubfull is usually without result.

The safest course to pursue by a mill using reasonably large quantities of water daily, is to install one of the softening plants and processes that are available, the result being that the dyer will always have at command a sufficient volume of water for his requirements of uniform quality, thereby relieving his mind of any consequences that would arise under other circumstances.

A soft (zero) water always leads to level shades in dyeing, especially for colors, while a hard water causes a certain loss of dyestuff, which not only tends to unevenness, but materially influences the crocking.

The process for water softening now most commonly used is that requiring very simple chemicals, known as the Permutit Process, resulting in an unfailing supply of Zero Water. Cases are known where so-called soft water had been used, the adoption of "Permutit" resulted in a saving of more than half the soap formerly used—to say nothing of important added savings in dyes, labor, fuel and power costs. The result is practically complete removal of the soluble impurities in the water, the same being thrown out as an insoluble precipitate, leaving the water clear and soft.

The operation of these various plants can be adjusted to such a degree of nicety, that very little attention is required, while water of uniform purity is constantly delivered.

There is no question but that the two items, **soap** and **water**, are not given the full attention in silk mills that their importance demands, and this should not be, as all the good qualities possessed by a finished fabric have a direct bearing upon the quality of both soap and water.

Chemical Analysis of Textile Soaps

Long custom dictated that soaps intended for use in the silk industry should be so-called hard soaps and made from an olive oil base. Owing to the delicacy of the silk fiber, throwsters and dyers have insisted, and quite properly, that silk soaps should be practically free from any free or uncombined fat—*i. e.*, oil or fat not wholly changed into soap, and also from any free alkali, *i. e.*, alkali not completely removed from the soap, after cooking of the soap batch is finished.

The present article is written principally to indicate a line of practical chemical analysis easily adapted to the needs of throwsters, dyers and silk mills, which will enable them to keep in close touch with their soap problems.

There are many methods published for soap analysis, but it is a matter of some difficulty for the young mill chemist to make a proper selection of the one that has been found best suited to his general practice. As a rule, most methods that have been published are overburdened with a number of unnecessary details that cause the mill chemist to go very slowly before deciding upon a choice.

Except in very few instances, the buyer of soaps for a mill or the throwster who does his own buying is only interested in knowing that what he has had delivered to him is the soap found best suited for his purpose. It is not a brand or trade-mark that he is buying, but soap; consequently he wants to know how much real soap, moisture, free alkali if present, free fat filler if present, and information as to whether the base is olive oil or some other oil or fatty mixture.

In order to analyze a sample of soap properly, cut a bar through the middle, taking the outside as well as the core of the bar. About four ounces are sufficient to cover all the tests, the first of which is for moisture.

MOISTURE IN SOAP is determined by taking a carefully weighed portion of the sample in thin shavings and drying in an oven, heated to 105 deg. C. cooling and weighing from time to time until the weight remains constant. The difference is recorded as *moisture*. To carry out this apparently simple operation, there is required a flat, wide mouth, thin and light weighing bottle and a dessicator, in which to place each article while warm from the oven and in which it is allowed to become cold before weighing.

Example of moisture determination records from practice:

Weighing bottle with soap sample.....	27.19	grams.
Weight of empty bottle..............	21.62	"
Weight of soap taken for drying......	5.57	"
AFTER DRYING:		
Weight of bottle and dried soap......	25.83	grams.
Weight of empty bottle..............	21.62	"
Weight of dried soap................	4.21	"

Subtracting the weight of the dried soap from the weight of the same sample before drying, the loss of moisture is ascertained, *viz:* 1.36 grams, which is equal to 24.41 per cent.

The difference between 24.41 and 100 is 75.59, which represents the *actual percentage* of *real soap* in the sample.

The next determination is to find the amount of fatty acid contained in the sample. Have ready an absolutely clean straight sided, tall round glass beaker of 300 cubic centimetres capacity and also a glass rod. Place in the clean and dry weighing bottle a quantity of soap shavings and weigh. Then transfer from the bottle to the beaker about 10 grams of the soap without weighing, but ascertain the exact amount transferred by reweighing the bottle and noting the loss in weight.

Dissolve this transferred quantity of soap in about 200 cubic centimetres of water with the aid of heat, but it is not necessary to boil the solution. To this soap solution add a few drops of a solution of methyl orange, and add from a graduated burette, 40 cubic centimetres of normal solution of hydrochloric acid. This acid decomposes the soap, setting free the fatty acids which must be taken up and weighed, and which is done by weighing accurately about 15 grams of pure stearic acid, and carefully placing in the beaker containing the decomposed soap solution. Heat gradually on a ring stand until the solid stearic acid has melted, when it completely takes up the free fatty acids from the soap solution. Allow to become cold after standing a few hours and carefully remove the round cake of solid fatty acids, wiping off any drops of solution that may adhere, place in the dessicator for an hour and weigh. The increase in weight over the recorded weight of the stearic acid taken is that of the fatty acids, and which multiplied by the factor .968 gives the weight of the fatty-acid anhydride in the soap taken.

Thus:	Soap taken	10	grams.
	Stearic acid	15.00	"
	Stearic acid plus fatty acids	22.165	"
	Fatty acids	7.165	"

7.165 multiplied by .968 (anhydride factor) gives 6.936, which corresponds exactly to 6.936 per cent of fatty acid anhydride, as we took exactly 10 grams of soap for the test.

We have remaining in the beaker the solution containing an excess of normal hydrochloric acid. Add from a burette a solution of normal sodic hydrate (1 cc neutralizes exactly 1 cc of the normal acid that was previously used in the same beaker) until the pink coloration changes to yellow, showing that the excess of normal hydrochloric acid added to effect the complete separation of the fats, is completely neutralized. The number of cubic centimeters of normal soda added, subtracted from the total number of cubic centimeters of hydrochloric acid added, gives the number of cubic centimeters of the acid actually required to combine with the total soda of the soap sample. Thus:

Normal acid added....................	40 ccs
Normal soda added to bring back to neutralizing point	19.9 ccs
Difference, amount of acid required to combine with the total alkali of the soap..	20.1 ccs

As 1 cc of this normal acid corresponds to .031 grams of Na_2O (Oxide of sodium) 20.1 ccs equal .623 grams, therefore we have .623 grams of total alkali, or 6.23 per cent.

Our analysis now reads:

Moisture	24.41	per cent.
Fatty acid anhydride..............	69.36	"
Total alkali	6.23	"
Total	100.00	per cent.

To this it is always best to add the following *qualitative tests*. Pure soap always dissolves in pure grain alcohol, giving a clear solution. (Do not use denatured alcohol.) The presence of silicate of soda, clay, starch, etc., including common salt is always shown by such substances being insoluble, and clouding the solution. If only silicate of soda is present as an adulterant, it will be shown after acidulating a water solution of the soap with sulphuric acid; fatty acids will rise to the surface upon standing while the silicate will collect on the bottom in a jelly-like cloud.

A drop of a solution of phenolphthalein applied to the fresh cut surface of a bar of the soap will instantly indicate the presence of *free caustic alkali* by showing a red spot.

Soaking Oils.

The oils most often met with for soaking silk previously to the process of throwing are Neatsfoot Oil, Olive Oil, Nilsap, etc.

To understand the difference in grade, and why different oils can be sold at such widely varying prices, it is necessary to understand the general methods of their manufacture.

Briefly, the first oils obtained from the raw product are the best and highest priced, and the last, the poorest and lowest priced.

In olive oils, the best grades are those obtained from the first light pressing of the fruit. The next grades are obtained by more severe pressure in which the olives are crushed to a pulp. These are the two grades of olive oil used as edible oils.

Hot water is then added and the mass pressed again. This gives a third grade of oil, which is used for soap-making, soaking, etc. The fourth grade of oil is obtained by beating the remaining pulp, which still contains from ten to twenty per cent of oil, in special mills with hot water. After standing for a period, the oil is skimmed off the surface of the water. Finally the pulp is extracted with a volatile solvent to remove the last traces. These lowest grades are called "foots."

In the manufacture of Neatsfoot Oil the feet of cattle are boiled in water and the oil skimmed from the surface as it rises. The best grades are the first skimmings, and the poorer grades the later skimming. Further treatment consists of continued boiling with steam, and of concentration, which gives the lower grades of oil.

Testing Soaking Oils Used.

Previously to purchasing a soaking oil, the first point to determine is its purity, *i. e.,* freedom from adulteration with some cheaper oil, which is sometimes difficult to do, since small amounts of another oil are frequently difficult to find. Physical and chemical analysis can be made which give certain factors, which are constant within a small variation for any one type of oil, and adulteration is shown by higher or lower values.

After the purity is determined, the actual quality of the oil should be obtained.

The first thing to be done is to determine the percentage of free acid. A large amount of it being present shows the oil is rancid, due either to a poor grade of raw material, to the age of the oil, or both, or to adulteration. Fermentation of the olive oil pulp or putrefaction of the neatsfoot oil stock will give a high free acid content to the oil. As a rule the lower the grade of oil, the higher the percentage of free acid and vice versa.

The best edible olive oils and highest grades of neatsfoot oil contain very litttle free acid, perhaps one to three per cent or even less, while the lower grades may contain from ten per cent to twenty-five per cent, or even more. Besides showing a very low quality of oil, a large amount of free acid gives an unsatisfactory soaking bath, forming both a scum and a poor emulsion.

An examination for mineral oil and cotton seed oil should always be made. This last oil is quite commonly used to adulterate olive oils.

Unsaponifiable matter is that matter which can not be "saponified" or made into soap. It is therefore apt to stick in the silk after washing in the soap and often causes trouble in the dyeing later on. Tests for the amount of unsaponifiable matter should therefore be made.

An emulsification test should be made as nearly as possible following the actual working conditions as to strength of the soap solution, amount of oil, temperatures, etc.

Additional tests of value are the flash and fire points, specific gravity, iodine number, saponification number, temperature test, viscosity, etc.

The tests that are necessary for a complete examination will vary somewhat with the sample under consideration, but the final result should give the purity, freshness, grade and suitability of the oil.

Briefly, then, those qualities which are found in a good high grade oil are purity (that is freedom from adulteration) low free acid content, freshness, cleanliness, a small amount of unsaponifiable matter, a good light color, and standard physical and chemical constants.

Things to be guarded against are, a large amount of free acid or unsaponifiable matter, suspended dirt, staleness, adulteration of any kind, particularly with mineral oil, dark color, and variable and unnatural chemical and physical constants.

NILSAP.

Nilsap is a whitish color and of a soft soap consistency; it possesses a distinct odor of neatsfoot oil; it retains its semi-solid or pasty consistency at ordinary temperatures; it is neutral in reaction, and forms with warm water or hot water an emulsion, which, when viewed under the microscope, shows the globules of free oil to be in a most finely divided state. The emulsion appears to retain this condition for a long period of time without "breaking."

Carefully made tests to ascertain the usefulness of this composition in the treatment of raw silk, demonstrate that it possesses the property of softening the natural gum or "sericin" on the silk fibres, thereby loosening the fibres, but without any appreciable solvent action on the sericin itself.

When the silk is immersed in an emulsion made with this "composition" in a suitable proportion, the action is not at once noticeable, but after a period of two or more hours, a softening is apparent, and upon a further immersion of six to ten hours, the action is practically complete. The "sericin" has been effectively softened, and the fibres are free. The oil contained in the "composition," instead of being deposited *on* the fibres, is completely absorbed, and this property adds a certain amount of weight to the silk, which will probably offset the usual small amount of waste that always is present in the operation of throwing.

The proportion of this "composition" that may be necessary for satisfactory work on average qualities of raw silk, according to experiments, is about two per cent (2%) of the weight of the silk to be treated. That is, two pounds of the "composition" for each one hundred pounds of skein silk. This proportion may be varied, depending upon the nature and quality of the silk to be treated, from as low as 1½ pounds to 2½ pounds. This detail can only be determined by working up large scale lots in a throwing mill. However, tests show conclusively, that by immersing the skeins of raw silk in a bath of the emulsion as before outlined, a silk is obtained that possesses all the qualities of skeins ready for throwing.

The practical details, as worked out for treating raw silk with *"Nilsap"* is as follows:

For 100 Pounds of Raw Silk

weigh off two pounds of the composition, and make a thin cream of it with about five gallons of water heated to about 125° *F.*, then stir until no particles remain as lumps—all must break up, forming an emulsion. This emulsion is then added with constant stirring, to the vats or kettles in which the silk is to be immersed. These vats should be filled with proper amount of hot water, at about 100° *F.*, stir well, and then enter the skeins of silk. As silk has a tendency to float, a lattice may be placed in the vat to keep the silk below the surface of the liquor in the bath. Keep the temperature between 90 and 100° *F.*, and allow the silk to remain immersed over night. In the morning, remove the skeins from the bath, allow them to drain, and then hydro-extract them to remove the excess of soaking solution, and dry.

After drying, the skeins (containing the soapy and oily proportions of the emulsion) are then exposed to the action of free air so that the silk fibres may take up from the atmosphere the normal amount of moisture. They are then ready for winding.

Some throwing establishments permit the practice of winding the skeins while in a damp condition, and while we do not attempt to question the practice of any mill, this course is likely to be detrimental, since some portions of skeins may thus be drier than others, and cause thereby uneven winding, which has at times reflected upon the "kind of soap" and oils used by the throwster.

With this "Nilsap Composition" we believe that constant uniformity of output is assured, provided the throwster exercises care to wind under constantly uniform conditions.

No additions are found necessary to use in connection with this "composition," since it contains within itself, all the essential components to prepare the skeins for proper throwing, and is a distinct advantage over the usual compounds made in throwing establishments, where soaps and oils are weighed or measured, and combined together in the vat. It also appears to possess the advantage of not being liable to become rancid.

Diseases of Silkworms.

This subject has been dealt with in a most interesting article by Iwajiro Honda, Director of the Tokyo Imperial Sericultural Institute, and of which we quote.

"He states that if the silkworm is stricken with *Muscardine,* this disease does not show any remarkable symptoms at the beginning, and the silkworm has every appearance of good health, but begins to cease taking leaves, to be in agony, and to show an intense impulse of its dorsal vessel a few hours before its death; moreover irregular brownish black spots often appear in the skin of the ventral or the lateral part of the body. In short, it is always impossible to be aware of the presence of the disease until the first few worms have been suddenly stricken and die. The disease is specially characterized by the fact that the dead body becomes hardened after several days, and sometimes presents a reddish violet color which afterward changes into white. Muscardine attacks not only the larvae, but also both pupa and moths.

Besides muscardine, we find several kinds of silkworm diseases, caused by *parasitic fungi.* Those which have been known up to the present time are as follows: Nomuræa parcina Delacroix, Oospora destructor, Isaria densa Link (A. Giard.), Isaria farinsoa Fr., Isaria funosorosæ Cashimir Wze., and a variety of Aspergillus species, etc. These injurious fungi cause sometimes great damage, but they are not so serious as in the case of the muscardine.

In order to prevent the disease caused by *Botrytis bassiana* and other fungi, the following data should be noticed:

(1) The disinfection of breeding chamber and instruments.

(2) Precaution during breeding.

(3) Worms attacked accidentally with the fungi are distinguished from healthy ones, and are so far as possible taken out previous to their forming spores, and the litter is often removed to clean the silkworm tray. Since a damp atmosphere greatly assists the growing of the fungus, we should avoid too much wetness in the breeding chambers so far as possible.

(4) Flacherie is a disease caused by parasitic microbes. Although the silkworms in every stage are attacked by this disease, it especially happens at the end of the fifth age, and the following days up to the time of moulting, causing serious damage to the sericulturists.

(5) Various bacteria are injurious to the silkworms among which *Bacillus sotto Ishiwata,* and *Streptococcus bombycis Chon.* are important. The former is a bacillus with a rod like shape. The body is covered with a fruitful crop of fine cilia with which the bacillus moves violently. It forms an oval endospore in the middle or one side of the body. The bacillus produces a kind of toxin in this endospore, and its pathogenic action is due to the production of the toxin. The bacillus which has been swallowed by a silkworm causes its sudden death after from thirty minutes to an hour. The form and color of the body of an effected worm are not distinguished from those of a healthy worm, but in looking at the body carefully, we will find the following symptoms: The two or three segments near the head are somewhat transparent at the beginning of the disease and the silkworm raises its head, shaking it right and left. The posterior part has always a wrinkled skin; the legs losing the power to hold the body, the worm easily falls down if only touched, it becomes soft and flabby to the touch. The bacillus attacks not only worms, but larva and moths, lurking for a while in the body after contagion.

The second microbe is a round *streptococcus.* These bacteria do not cause as severe a malady as the ones just mentioned. The diseased worm presents the first disorder after a great multiplicity of the microbes in the mucous membrane of the alimentary canal. It injures vigorous worms but little, but on account of its causing a formidable malady to the weak ones, often a great many of them are suddenly condemned to death.

The symptoms of the disease vary according to the period attacked, worms stricken with this disease after their moulting remain small and lose their vital aspect; those attacked with it during the active period of feeding also remain small and finally die or the fore part of the body is swollen up and becomes transparent and the end part shrinks into a remarkably small compass. The streptococcus attacks worms at any stage but it is especially injurious to them before moulting.

By the following directions the rearer can prevent the disease:

(*a*) By the disinfection of the silkworm chambers and instruments.

By disinfection of the silkworm chambers and instruments any bacteria left are destroyed.

(*b*) By the selection of healthy seed.

On account of the fact that vigorous silkworms are little attacked by the disease, healthy seed is selected and protected completely.

(*c*) Precautions during breeding.

A proper temperature and moisture are kept, good ventilation is indispensable in the nurseries; that a proper quantity of food be given to the worms; of course the affected or attacked silkworms are taken out and the removal of the litter is often practiced.

(*d*) The *"Uji"* disease, caused by the parasitic growth of an insect called *Ugimiya* (Crossoscosmia) *sericaria Rondani.* This parasitic maggot caused great damage to our sericulturists. The cause of the disease is due to the worm's swallowing the eggs of the fly which are laid on mulberry leaves. The fly lays eggs between the middle and the latter part of May on mulberry leaves which are given to the worms after the third age. The female and the male imago of the maggot are different in size; the male is fifteen *mm.* in length and its wings are thirty *mm.* in length and female fourteen *mm.* in length and its wings twenty-eight *mm.* The body is blackish brown and covered with coarse hairs. We always find some seven or eight thousand eggs in the female body among which several thousand eggs are actually laid. The female flies do not lay their eggs in any one place but in so many places that the number of eggs laid on one mulberry leaf being only one or two, at most seven or eight, thousands of the leaves receive the eggs of only a single female fly. The egg is black and shiny and has the marks of a regular hexagonal shape, like the meshes of a net. The form of the egg is an elongated oval, its length is 0.33 *mm.* and its width is 0.2 *mm.* As soon as the egg is laid, its nucleus begins to develop and finally hatches into a tiny larva soon after it is swallowed by the poor worm. The larva or maggot escapes into the body space through the wall of the alimentary canal and finally invades a ganglion. The time from the hatching until it reaches this stage, is only one hour. Thus the maggot lives on the ganglion, and after one or two weeks it comes out again into the body space and remains in the inside of a stigma, turning its hind end to the stigma and stretching its mouth into the interior of the body. In this position the maggot grows, absorbing the nutriment from the diseased worm. After the maggot continues one to three weeks in this state, it matures and leaves the patient, that is ten to fourteen days after the worm has spun a cocoon. Either when the worm is attacked with the disease while it is young or when it is injured by several maggots, the worm is killed before it spins a cocoon. The mature maggot is of a cylindrical form whose one end is round and the other pointed, it is yellowish white, twenty *mm.* in length, six *mm.* in width and consists of twelve segments. It moves very actively and lies low in the ground escaping out of the nurseries through a narrow space. The maggot has thus buried itself in the ground, changes into a chrysalis whose puparium is a blackish brown and elongated oval. Passing the Winter in earth, the maggot reappears as an imago or fly in the middle of April, of the next Spring. Many swarm about mulberries and lay eggs on the leaves.

The worm attacked with the disease presents different symptoms. In the case of an attack by a single maggot, the silkworm has every appearance of good health and accomplishes all the stages but after pupation the stigma of the pupa is always black and it can never change into a moth. On account of this fact, the parasite causes a serious damage to our egg producing. Either when the worm is stricken with this disease while it is young, or when the worm is attacked by several maggots, it presents such symptoms as *Tareko* (the hanging worm) that means the worm which hangs down on the edge of the tray and dies, *Kubimagari* (the worm bending its anterior parts) or sometimes *Hadaka-sanagi* (the naked pupa) that is the pupa which does not imprison itself in a cocoon.

In order to prevent this disease the rearer should take the following measures:

(*a*) The maggots which come from the cocoons should be killed.

(*b*) The rearer should sweep and dust under the floors of the mulberries after the breeding is finished and destroy the puparium of the maggot which lies low in the ground to pass the Winter.

(*c*) Mulberry leaves which are suspected of carrying the eggs of the fly should not be given to silkworms and especially the leaves should be carefully selected to feed the worms of the fifth age.

Japanese Raw Silks.

By Mitsui & Co. (Ltd.) New York.

The bulk of the higher grades of Japanese raw silks is sold to the U. S.; the Japanese retain chiefly the lower grades for home consumption. Over three-fourths of the exports are taken by the U. S., at present.

In the raw-silk trade there are very few spot sales from stock in New York; the usual custom is for the American manufacturers to place contracts for future delivery with raw-silk importers, who in turn cover by placing orders with Japanese filatures.

American manufacturers place orders with raw-silk dealers at least a month in advance, more often three to six months ahead, and often for deliveries extending over a period of months.

On arrival of a silk cargo the importers make up solid *"silk specials"* and send these across from San Francisco, or other Pacific port, to New York in about six days, the silk mostly being delivered and paid for in New York.

When railroad facilities are normal it does not take, at longest, over 24 days actual time for shipments to reach New York from Yokohama, the great silk port. Yokohama to San Francisco requires about 17 days; Yokohama to Seattle or Tacoma about 12 to 15 days, according to the steamer; Yokohama to Vancouver only 12 days. In fact, two Canadian Pacific Railway Steamship Co.'s steamers ran between Vancouver and Yokohama in 9 days. The difference is due not only to the distance, but also to the speed of the steamers which are in service.

The freight rate on raw silk across the American continent is $4 per 100 pounds. There has been no change in this rate for years, but we hear that this rate may be raised shortly. Steamship rates, however, have increased considerably. From Yokohama to American ports on the Pacific the rate was $2 per 100 pounds in 1914, just before the war, and is now (January, 1918) $7. Formerly the rates from Canton, Shanghai and Yokohama were the same, but now steamship rates to American ports on the Pacific are $10 from Canton and $8 from Shanghai, though this latter rate will probably soon be raised to $9 or $10.

Before the war, therefore, the through freight rate to New York on raw silk was $6 per 100 pounds from Yokohama, Canton, or Shanghai, whereas it is now $11 from Yokohama, $12 from Shanghai, and $14 from Canton, which makes the freight item one worth considering.

Raw silk requires very little cargo space. In these days when cargo space is valuable for war needs this fact should be emphasized. The largest import of raw silk from Japan, some 200,000 bales in 1916, did not require over 30,000 tons cargo space. Japanese raw silk is mainly shipped in bales weighing about 140 pounds gross each, and about 7 bales make up a ton of 40 cubic feet. The steamship companies have the option of charging by weight or measurement, and, as they can make more on the weight, the charge for raw silk is per hundred pounds.

The price variations on raw silk during the war are best shown by taking the prices per pound of No. 1 Japanese raw silk as quoted in New York City. This was quoted at $4 per pound on August 1, 1914; it reached high-water mark at $7.15 on August 1, 1917, and declined to $5.45 on November 5, 1917.

When *taffetas* are in fashion the 13/15 deniers is the leading raw-silk count imported. In the last two years, however, with the vogue of *Georgette crêpe* and *crêpe de chine,* there have been larger imports of coarser counts, especially the 16/18, 18/20, and 20/22 deniers, the latter predominating.

Japanese raw silk is numbered according to the standard denier system, which is now almost universal, the count indicating the weight in 5-centigram deniers of a 450-meter hank.

The fineness of cocoon filaments varies considerably with different silks, during different seasons, and at different portions of each cocoon.

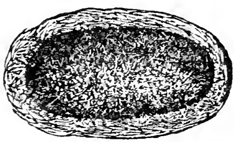
In general, CANTONS will average under 2 deniers, CHINAS (*Shanghai*) about $2\frac{1}{4}$ deniers, while JAPANS usually vary between $2\frac{1}{4}$ and 3 deniers. Some Japanese cocoon filaments, however, are found as fine as $1\frac{3}{4}$ deniers, while some run coarser than $3\frac{1}{2}$ deniers. In all cases the middle portion of the cocoon filament is the thickest and heaviest portion. DOUPIONS (*double cocoons*) form some 5 to 10 per cent of the Japanese cocoons. They are kept mainly for home use. There has been a slightly larger use here of doupions in the last two years for making goods of rough appearance. The main crop of cocoons is produced in the spring with an increasing proportion in the autumn as well as a small amount in the summer.

There are no accurate figures as to the total raw-silk production of the world. The available supply in sight is compiled each year by the Union of Raw Silk Merchants of Lyon. In these figures, however, they show statistics for the raw-silk production of countries like Turkey and Persia, where it is very difficult to obtain accurate statistics, and yet for a country like Japan where the production of cocoons is published by the Government, they list only the exports. There are no accurate figures obtainable as to the total amount of raw silk produced and consumed in China, but the production in Japan has increased so rapidly in the last few decades that it is now usually estimated that Japan is the largest producer of raw silk.

As the largest producer of raw silk Japan is thereby also the largest producer of waste silk. A large proportion of this waste silk is still exported, but an increasing amount is being turned into spun silk in local factories. The largest spun-silk factories are those of the *Fuji Gasu Boseki Kaisha* at *Hodogaya,* a suburb of Yokohama, and those of the *Kanegafuchi Boseki Kaisha* at Kyoto. The larger portion of Japanese spun silk is used in Japan. Of the spun silk exported the bulk is taken by British India.

The Japanese make several special cloths. The most famous of these is *habutae.* This is made in various sections of Japan but particularly in the districts west of Tokyo, especially in *Fukui, Ishikawa,* and *Fukushima.* Neither the Fuji nor the Kanegafuchi mills make habutae. It is, however, now made most usually on power looms and its manufacture is no longer confined to hand-loom weavers. Habutae is always woven in the gray. The gum is boiled out after weaving and before selling.

Another specialty is *kaiki.* This is a changeable taffeta made with dyed yarns. It comes mainly from *Koshu* and might well be classed with other taffetas instead of being shown separately in the export statistics.



The Silk Industry of the U. S.*

Scope of the Industry.

The silk-manufacturing industry includes the manufacture of finished silk products, such as woven fabrics; braids; trimmings; sewing, embroidery, and floss silks; machine twist, etc., whether the preliminary throwing is done or not; and also the manufacture of *thrown* silk (known technically as *organzine* and *tram*) and *spun* silk.

The concerns engaged only in the manufacture of organzine and tram are known as *throwsters;* with these are included winders and manufacturers of spun-silk yarns, the former performing the work of winding or rewinding from skeins to spools, bobbins, quills, etc., or from skeins, spools, etc., of one size to those of another.

Many establishments do not include the entire process of silk manufacture in their operations, a frequent practice being for a weaving mill to buy the raw silk and have it thrown on a commission basis by an independent throwing plant. Although the establishments engaged solely in throwing, winding, etc., in 1914 formed more than one-fifth of the total number of establishments included in the industry and employed more than one-sixth of the total number of wage earners, they reported only 8.8 per cent of the total cost of materials and 8.4 per cent of the total value of products. This is due to the fact that many of the throwsters operated on a commission basis and reported no cost of materials and only the amount received for work done as value of products; the es-

*An Abstract of the 1914 Census of Manufacturers in the U. S., just published by the Dept. of Commerce, under the supervision of W. M. Stewart, Chief Statistician for Manufactures.

tablishments for which the throwing was done reported the cost of the thrown silk in their cost of materials and the amount paid for throwing as contract work, one of the items of expense.

Comparison of Censuses for Ten Years.

	1914	1909	1904
Establishments	902	852	624
Proprietors	591	664	525
Salaried employees	6,810	5,537	4,027
Wage earners	108,170	99,037	79,601
Horsepower	116,924	97,947	71,760
Capital	$210,071,679	$152,158,002	$109,556,621
Salaries	10,506,905	7,527,279	4,742,270
Wages	47,108,469	38,570,085	26,767,943
Contract work	14,550,762	12,008,744	6,859,586
Rent and taxes	2,031,897	1,570,381	1,040,334
Cost of materials	144,442,321	107,766,916	75,861,188
Value of products	254,011,257	196,911,667	133,288,072

"Rent and Taxes" for 1914 and 1909 include internal revenue, those for 1904 exclude internal revenue.

Growth of the Industry.

Statistics for the silk-manufacturing industry were first obtained at the census of 1849 when 67 establishments, employing an average of 1,723 operatives, and manufacturing products valued at $1,809,476, were reported.

At the census of 1859 there were 139 establishments, giving employment to an average of 5,435 operatives, and manufacturing products valued at $6,607,771.

The figures for 1869 include those for establishments that reported silk hose and silk knit goods as their products of chief value, while such establishments are now classified under the hosiery and knit goods industry. As the volume of business of such establishments was comparatively small at that time, this inclusion does not materially affect the comparability of the figures for the different censuses.

During the 10 years, 1904 to 1914, the number of silk mills nearly doubled; wage earners increased 65.4 per cent, value of products advanced 136.8 per cent, and value added by manufacture 144.3 per cent.

While the last censuses each mark a period of development in the industry, the greatest relative growth was from 1904 to 1909, when wage earners increased 24.4, value of products 47.7 per cent, and value added 55.2 per cent.

Location of the Industry.

With reference to "Comparison Table" previously quoted, the following details according to states will be of interest:

States	Number of Establishments	Average Number of Help	Percentage of Distribution of the Latter
Penna.	284	44,755	41.4
N. J.	368	28,263	26.1
Conn.	44	10,668	9.9
N. Y.	143	11,659	10.8
Mass.	19	4,495	4.2
R. I.	12	2,325	2.1
Va.	9	691	0.6
Md.	5	874	0.8
"Others"	18	4,440	4.1
Total:	902	108,170	100.0

States	Value of Products	Percentage of the Latter	Value added by Manufacture	Percentage of the Latter
Penna.	$86,938,554	34.2	$38,143,073	34.8
N. J.	75,706,449	29.8	34,823,584	31.8
Conn.	30,591,825	12.0	12,185,573	11.1
N. Y.	29,260,763	11.5	12,524,542	11.4
Mass.	10,676,681	4.2	4,715,544	4.3
R. I.	7,664,472	3.0	2,337,878	2.1
Va.	1,772,931	0.7	679,079	0.6
Md.	910,882	0.4	487,367	0.4
"Others"	10,488,700	4.1	3,672,296	3.4
Total:	$254,011,257	100.0	$109,568,936	100.0

"Others" cover: California, Delaware, Georgia, Maine, Ohio, West Virginia and Wisconsin, each state 1. Michigan and New Hampshire each 2. Illinois 3 and North Carolina 4.

From this table thus quoted it will be seen that the silk-manufacturing industry is confined to 19 states, all of which, except California, where there was only one establishment, are located east of the Mississippi River.

The industry in the southern states is represented by 21 establishments located in Maryland, Delaware, West Virginia, Virginia, North Carolina, and Georgia.

Pennsylvania is the leading state in the industry, the value of its product being more than one-third of the total silk manufactures in the United States in 1914, and the number of wage earners employed in the silk mills of the state representing more than two-fifths of the entire number employed in the 19 states reporting. More wage earners have been employed in silk manufacture in Pennsylvania at each of the last three censuses than in any other state, and in 1914 the number employed formed a relatively larger proportion of the total for the industry than did its value of products or value added by manufacture. This is due to the fact that many establishments in Pennsylvania are engaged in throwing raw silk into organzine and tram for further processes of manufacture outside the state, and since such establishments confine their operations largely to contract work, their value of products does not include the value of the organzine and tram produced, but consists mainly of the amount received for work done. Prior to 1914, New Jersey was for many years the ranking state in the value of silk products, but employed fewer wage earners than Pennsylvania both in 1909 and 1904.

The industry is concentrated in a much smaller area in New Jersey than in any other state; 79.1 per cent of the establishments in this state were located within the city limits of Paterson, these establishments reporting 59 per cent of the total value of products of the state. Most of the remaining establishments in New Jersey were located in Passaic County, in which the city of Paterson is situated, or in the counties immediately adjoining.

In Pennsylvania the industry is chiefly concentrated in the eastern half of the state, in the mill towns on the Susquehanna, Schuylkill, and Lehigh Rivers.

New Jersey and Pennsylvania together reported about two-thirds of the total number of wage earners and total value of products for the industry in 1914.

New York ranked third in number of wage earners and fourth in value of products in 1914, and third in each respect in 1909, 1904, and 1899.

Rhode Island, while not an important state in the industry, as measured by value of products, shows the largest percentages of increase from 1904 to 1914 of any of the states.

The counties in New York, New Jersey and Pennsylvania, having more than 10 establishments, together with number of establishments in each county are:

New York:	
Greater New York	94
New Jersey:	
Hudson County	31
Passaic County	306
Pennsylvania:	
Philadelphia	32
Northampton County	23
Lehigh County	39
Berks County	11
Carbon County	11
Lackawanna County	41
Luzerne County	30

The industry was largely centralized in a few cities.

Persons Engaged in the Industry.

The aggregate number of persons engaged in the silk-manufacturing industry in 1914 was 115,571, an increase of 10,333, or 9.8 per cent over 1909. Of the different classes of employees, wage earners represented 93.6 per cent, clerks and other salaried employees 4.4 per cent, and proprietors and officials 2 per cent. Each of these classes shows an increase over 1909 and their proportion of the total persons employed differs only slightly from that of the previous census.

More than half of the silk mills of the country are located in Paterson, N. J.; New York, N. Y.; Philadelphia, Pa.; Allentown, Pa. and Scranton, Pa. The combined production of these cities in 1914 was valued at $83,882,625, or one-third of the total amount reported for the industry. This figure represents an increase of 58.6 per cent during the decade, but a decrease of 6.6 per cent in the proportion of the total output contributed by the five cities in 1914, as compared with 1904. The value of Paterson's production at the last two censuses was greater than that of the other cities combined.

The number of females engaged in the industry in 1914 was considerably in excess of the number of males, the proportion which the two sexes formed of the total being 56.8 per cent and 43.2 per cent, respectively. Relatively fewer women were employed in 1914 than in 1909, however, when they represented 59.9 per cent of the total. Of the total wage earners employed in 1914, 59.2 per cent were females, as compared with 62.6 per cent in 1909.

Wage Earners.

Female wage earners were reported from all the states in which the industry was carried on, and in every state except Connecticut exceeded the males in number. The largest number, 29,288, or 46.4 per cent of the total for the industry in the United States, was reported for Pennsylvania, and the next largest number, 14,623, for New Jersey. The four leading states, as measured by value of products, New Jersey, Pennsylvania, New York, and Connecticut, together employed 54,834 female wage earners, or almost seven-eighths (86.9 per cent) of the total number for the United States. Wage earners under 16 years of age were reported by 16 states; the largest number, 5,519, were in Pennsylvania, in which state they represented 12.5 per cent of the total number of wage earners in the industry. The proportion of children employed was highest in Maryland, where they represented 22.1 per cent of the total number of wage earners in the industry, and lowest in New Jersey, where they constituted only 2.1 per cent.

Among spinners, females greatly outnumbered the males, the ratio being about two and one-half to one in 1914 and the proportion only slightly less than in 1909. Among the weavers the males were in excess in 1914 by 2,300. A majority of the weavers making broad silks, however, were females.

The relative number of spinners and weavers varied considerably in the different states. In only one of the five states (New Jersey) did the number of weavers exceed the number of spinners. In Pennsylvania, 56.5 per cent of the wage earners were spinners, while in Connecticut such operators constituted only 28.9 per cent of the total. Of the total male wage earners 16 years of age or over in 1914, almost one-half (49.2 per cent) were weavers and about one-third (31.9 per cent) spinners, the proportion of weavers having decreased somewhat during the five-year period 1909-1914, while the proportion of spinners increased slightly.

In the case of women wage earners, the proportions are practically reversed, about one-third (30.8 per cent) of the total number being weavers and more than one-half (57.9 per cent) spinners; the proportion of weavers decreased and that of spinners increased during the five-year period. More than three-fourths (79.6 per cent) of the children employed as wage earners were spinners.

The silk industry is not, to any appreciable extent, subject to seasonal variations; the spring and early summer months of 1914 show the heaviest enrollment of labor for that year, as a result of market conditions.

The smallest number (100,045) of wage earners employed during any month was reported for December, and the largest number (112,761) for May, the minimum number being equal to 88.7 per cent of the maximum. In 1909 the maximum number of wage earners, 100,753, was reported for March, and the minimum number 96,534, for July, the latter number being equal to 95.8 per cent of the former, while in 1904 the minimum number, 76,587, reported for January, was 92.6 per cent of the maximum, 82,724, in December.

Size of Establishments.

The tendency of the industry to become concentrated in large establishments is shown by the statistics given in the accompanying table, covering census 1909 and 1914, the last two taken:

Value of Product.	Census year.	No. of establishments.	Average number of wage earners.	Value of products.	Value added by manufacture.
Less than $5,000...	1914	46	167	133,454	103,894
	1909	45	242	113,378	69,038
$5,000 to $20,000..	1914	122	2,073	1,627,286	1,131,234
	1909	130	1,930	1,511,784	1,018,282
$20,000 to $100,000.	1914	305	13,527	15,739,554	8,146,471
	1909	298	14,713	15,328,061	8,838,024
$100,000 to $1,000,000	1914	368	51,131	118,210,811	52,077,901
	1909	342	53,582	111,378,638	51,651,501
$1,000,000 and over.	1914	61	41,272	118,300,152	48,109,436
	1909	37	28,570	68,579,806	27,567,906
All classes.....	1914	902	108,170	$254,011,257	$109,568,936
	1909	852	99,037	196,911,667	89,144,751

Although establishments with products valued at $100,000 to $1,000,000 formed the most important class numerically in 1914, and employed the greatest number of wage earners, in value of production, such establishments were surpassed by those with products valued at $1,000,000 and over.

The average value of products per establishment increased from $231,117 in 1909 to $281,609 in 1914 and the average value added by manufacture from $104,630 in 1909 to $121,473 in 1914. The average number of wage earners per establishment, on the other hand, shows but a slight increase—from 116 in 1909 to 120 in 1914.

The large mills (those employing over 500 wage earners) increased from 28 in 1909 to 34 in 1914, and the wage earners employed in these establishments increased by 6,697 or 25.7 per cent. Nearly one-third of the total wage earners employed in the silk mills in 1914 were in establishments of this size, compared with about one-fourth in 1909. The number employed in establishments having between 101 and 500 wage earners in 1914 was 52,059, or nearly one-half of the total, though such establishments represented but 26.7 per cent of the entire number. This class, however, shows a very slight decrease since 1909 both in number of establishments and in wage earners. The class employing 100 wage earners or less reported the largest number of establishments (625) but employed only 21.6 per cent of all the wage earners. This group showed an increase of 15.9 per cent in wage earners and of 8.1 per cent in number of establishments. There were two establishments in 1914 that employed no wage earners. These were both small plants in which all the work was done by the proprietors.

The large silk mills were distributed throughout a number of states, but the greatest number were located in New Jersey and Pennsylvania.

Summary of the Two Branches of the Industry.

The silk industry is divided into two branches, *viz:* (*a*) mills engaged in the manufacture of finished silk products, and (*b*) those engaged in making partially finished products. The latter branch is composed mostly of throwsters, but includes some winders and manufacturers of spun silk.

Concerns making partially finished products use (to a considerable extent) only two materials *viz:* raw silk, and silk waste, such as frisons, floss, noils, etc. The use of the former was confined to throwsters which produced organzine and tram for sale. The five concerns which manufactured spun silk for sale used all the frisons, floss, noils, etc., reported for this branch of the industry.

One-eighth of the total amount of raw silk used in the industry in 1914, and considerably more than one-half of the frisons, floss, noils, etc., were reported by concerns engaged in throwing, winding, etc. Larger amounts of each of these materials were reported by this branch of the industry in 1914 than in 1909. Of the additional materials shown separately in the accompanying table on "Materials Used in the Industry," almost all were used by concerns making finished products, the cost of all these other materials reported by concerns engaged in throwing, winding, etc., being only $338,383.

Considerably more than half (57 per cent) of the spun silk made for sale in the industry was reported by the five concerns engaged exclusively in the manufacture of this product. The remainder of the spun silk reported for the industry (690,821 pounds) was made by concerns which were engaged primarily in the production of broad silks, ribbons, etc. A few throwsters engaged in the manufacture for sale of organzine and tram, produced as secondary products, machine twist, sewing and embroidery silks, and fringe and floss, to the value of $160,816.

Materials Used in the Industry.

	1914	1909	1904
SILK:			
Raw—			
Pounds	22,374,700	17,472,204	11,572,783
Cost	$86,416,857	$67,787,037	$45,318,416
Spun—			
Pounds	3,209,309	2,112,972	1,951,201
Cost	$8,094,427	$4,848,789	$4,310,061
Artificial—			
Pounds	1,902,974	914,494	466,151
Cost	$3,440,154	$1,926,894	$1,623,473
Organzine and tram purchased—			
Pounds	3,855,899	3,377,972	3,236,744
Cost	$16,703,096	$14,679,719	$14,552,425
Frison, floss, noils and other waste purchased—			
Pounds	4,328,536	2,402,960	*49,811
Cost	$3,066,297	$1,637,187	*$187,159
YARNS, OTHER THAN SILK:			
Cotton—			
Pounds	16,869,511	12,617,292	8,387,048
Cost	$6,163,240	$4,687,173	$2,586,954
Mercerized cotton—			
Pounds	1,464,299	1,494,586	631,247
Cost	$1,078,337	$1,124,409	$471,035
Woolen or worsted—			
Pounds	1,987,918	610,588	443,155
Cost	$2,087,804	$765,989	$409,867
Mohair—			
Pounds	2,645,055	710,108	138,389
Cost	$1,604,362	$640,529	$137,097
All other—			
Pounds	291,672	353,780	130,930
Cost	$438,944	$456,597	$108,841
ALL OTHER MATERIALS	$15,348,803	$9,212,593	$6,155,860
Total cost	$144,442,321	$107,766,916	$75,861,188

* Does not include waste, noils, etc., which were included with "all other materials" in 1904.

Attention is called to the fact that the statistics for raw silk shown in this table do not represent the total amount of this material used in the industry. More than two-thirds of the raw silk used was thrown on contract, either for silk merchants, or for weaving mills, but as this silk was not owned by the mills doing the throwing, its amount and value were not included by them in their report as to materials used. The silk thrown for the weaving mills, however, formed part of the materials reported by such mills and accordingly is included in the table, but that thrown for merchants and dealers, not being owned by the silk-manufacturing concerns, was not reported and so is not included in the statistics for the industry; consequently it is impossible to give the amount of silk so thrown, but the quantity must have been considerable. Silk thrown for merchants and later sold by them as organzine and tram to establishments within the silk industry does not figure in the statistics of materials as a raw silk, but as organzine or tram only.

The tendency toward the manufacture of silk-mixed goods is shown by the relatively large increase in the amount of yarns, other than silk, used during the decade as compared with the increase in the amount of silk used. The amount of cotton yarn used in 1914 was more than twice as great as in 1904, and even greater relative increases are shown for mohair and for woolen or worsted yarns.

The amount of purchased spun-silk yarn used shows a relatively smaller increase during the decade than any other material shown separately in the last table given, except organzine and tram. The quantity used exceeded the quantity reported as made for sale by 1,601,893 pounds in 1914, 1,333,510 pounds in 1909 and 1,380,672 pounds in 1904. A large part of this material is imported, the total quantity brought into the country during the year ending December 31, 1914, being 2,490,655 pounds.

Spun-silk yarn is used principally in the manufacture of velvets, plushes, and other pile fabrics, and also in silk-mixed goods; large quantities are also used in cotton and wool manufactures and in the manufacture of hosiery and knit goods. The spun-silk yarn manufactured in the United States is made chiefly from reelers' waste, that is, from pierced cocoons, filature waste, and frisons—while a comparatively small amount comes from the waste of throwing and winding. Reelers' waste is not a worked-over material, like wool shoddy, but is a sound new fibre, superior to the throwsters' waste.

Owing to the high price of silk and to its limited supply, great efforts have been made to secure satisfactory substitutes. As a result, a number of processes have been invented for making fibres closely resembling animal silk, resulting in the production of artificial silk, the manufacture of which is largely confined to Germany and France, although other countries have mills devoted to its manufacture. The production of artificial silk in the United States was reported in 1914 by only one establishment, but American silk mills used twice as much artificial silk in 1914 as in 1909 and four times as much as in 1904.

Consumption of Silk in all Textile Industries.

In addition to the silk used in the silk-manufacturing industry, considerable amounts are used in other textile industries in the manufacture of mixed goods and silk hosiery and other knit goods. Silk is also used to some extent in the electrical industry for covering wire, but data in regard to its consumption are not available.

The quantity of silk yarn used in other textile industries in 1909 was more than three times as large as in 1899, but increased very little from 1909 to 1914.

The amounts used in the manufacture of hosiery and knit goods show a very large increase during the fifteen year period; the quantity used in wool manufactures more than doubled.

In cotton manufactures, silk is used largely in the manufacture of fancy woven fabrics with silk stripes or figures, and also in cotton-backed satins, and in plain and printed fabrics with cotton warps and silk filling.

The increase shown for the hosiery and knit-goods industry is accounted for by the marked increase in the production of silk hosiery, *viz:* 12,572 dozen pairs in 1899, 42,065 dozen pairs in 1904, 434,414 dozen pairs in 1909, and 2,354,648 dozen pairs in 1914.

Raw Silk Thrown Under Contract.

Formerly the throwing of raw silk in the United States was carried on chiefly in establishments which used the organzine and tram in further processes of manufacture, but there is a growing practice among weaving mills of having the silk thrown under contract in establishments whose activities are limited to this work.

The total amount of raw silk thrown under contract in 1914 was equal to 62 per cent of the total amount used in the industry, the corresponding ratio for 1909 being 73 per cent and that for 1904, 61.4 per cent.

While these percentages do not show the proportion of the total amount of raw silk used within the industry which was thrown under contract in the respective years, owing to the fact that the silk reported as thrown under contract includes that thrown for merchants and others not in the silk manufacturing industry, they are sufficiently close to give a general idea of the relative extent of commission throwing and of increase in the relative importance of such throwing during the 15 years.

The quantity of silk thrown under contract more than trebled during the period 1899-1914. Pennsylvania has reported more silk thrown on commission at each of the last four censuses, than all of the rest of the United States combined, and is moreover, doing an increasingly greater proportion of this kind of work; mills in this state reported 70.3 per cent of the total silk thrown on commission in 1914, 60.6 per cent in 1909, 58 per cent in 1904, and 52.6 per cent in 1899.

Imports.

Silk mills depend upon imports for their raw silk material. The accompanying table shows the quantity and value of imports of raw silk, spun silk, raw silk waste, and artificial silk for each fiscal year from 1904 to 1914, inclusive.

Imported Silk Materials.[1]

Year Ending June 30.	Raw Silk.	Spun Silk.	Raw-silk Waste.	Artificial Silk.
Quantity. (Pounds).				
1914	28,594,672	3,093,336	5,951,157	2,759,306
1913	26,049,472	3,582,268	6,052,083	1,942,177
1912	21,609,520	3,243,657	4,975,442	1,457,544
1911	22,379,998	3,245,582	4,286,093	[2]1,947,423
1910	20,363,327	3,235,369	3,093,896	(3)
1909	23,333,750	2,343,576	1,854,207	(3)
1908	15,424,041	2,140,848	1,238,091	(3)
1907	16,722,207	2,479,364	2,021,697	(3)
1906	14,505,324	2,257,260	2,846,697	(3)
1905	17,812,133	2,352,406	4,545,174	(3)
1904	12,630,883	2,053,274	4,091,826	(3)
Value Expressed in Dollars.				
1914	$97,828,243	$5,752,463	$3,101,782	$3,461,039
1913	82,147,523	6,383,872	2,767,194	2,385,350
1912	67,173,382	5,663,691	2,368,290	1,757,989
1911	72,713,984	5,708,804	2,284,281	[2]3,279,559
1910	65,424,784	5,064,111	1,704,819	(3)
1909	78,830,568	3,583,857	1,073,018	(3)
1908	63,665,534	3,702,232	881,369	(3)
1907	70,229,518	3,775,744	1,182,381	(3)
1906	52,855,611	3,227,920	1,224,893	(3)
1905	59,542,892	3,287,642	1,497,161	(3)
1904	44,461,564	3,047,817	1,638,936	(3)

[1] Bureau of Foreign and Domestic Commerce.
[2] Includes also manufactures of artificial silk.
[3] Prior to 1911 included with silk.

Summary of Products.

The total production of silk goods of broad weave (broad silks, velvets, plushes, tapestries, and upholstery) in 1914 was 241,944,522 running yards valued at $157,265,554, as compared with 198,787,027 running yards valued at $115,136,724 in 1909. Broad silks formed nine-tenths of all broad weaves in 1914 and 1909. All-silk goods constituted almost two-thirds of the broad-silk product in 1914, but the production of such goods did not increase as rapidly during the decade as did the production of silk-mixed broad silks.

The production of velvets more than doubled during the decade, but there was even a more marked increase in that of plushes. The production of tapestries and upholstery decreased, all of the decrease taking place during the earlier part of the decade.

Narrow woven fabrics, such as ribbons, are of such varied widths that statistics of output in yards would have little significance.

Figures for organzine and tram made for sale fall short of representing the total production of organzine and tram other than for the use of the establishment doing throwing, owing to the fact that they do not include the large amount of organzine and tram thrown under contract for establishments furnishing the raw silk. A total of 12,869,239 pounds of raw silk was thrown under contract in 1914.

"All other products" for which the value was separately reported in 1914, includes a variety of commodities, some of which may have been included at previous censuses among those for which separate quantities and values were shown. Silk hosiery and knit goods were not separately called for in the schedule used in 1899, 1904, 1909, and 1914. Hence the figures given for silk hosiery under "all other products" may not cover the entire production in silk mills. The various items comprising this total for 1914, in so far as they can be segregated, were as follows:

Articles Included in "All Other Products."	Value.
Trimmings, cords, tassels, ornaments, etc., other than military and tailors' trimmings	$1,674,399
Mufflers and handkerchiefs	76,477
Cravats and tubular neckties	747,508
Fabrics (in the gray)	3,453,744
Labels	971,789
Hatbands	607,204
Fishlines	177,150
Miscellaneous products, other than silk (cotton and woolen yarn, cotton fabrics, etc.)	2,405,604
Silk hosiery and knitted fabrics	1,013,565
Raw silk, skein-dyed	229,415
Miscellaneous, unclassified silk products and waste	2,400,917
Total	$13,757,772

Silk goods to the value of $47,460,109 were manufactured as subsidiary products by establishments assigned to industries other than the silk-manufacturing industry proper.

The accompanying table shows for 1914, the value of the total production of silk goods manufactured in the industry designated "silk manufactures" and by establishments engaged primarily in the manufacture of other products.

Product.	Production in Silk Mills.	Production in Other Industries.
Broad silks:		
Finished	137,719,564	218,156
In the gray	3,141,765	488,040
Plushes	10,135,842	3,750
Ribbons	38,201,293	8,264
Braids and bindings	3,073,648	52,745
Trimmings	642,163	7,293
Fringes and gimps	1,025,188	76,463
Spun silk	4,577,058	666,953
Sewing silk	5,046,452	84,774
Machine twist	4,036,807	126,619
Shirts and drawers	....	1,528,048
Combination suits	....	6,592,350
Hosiery	179,014	29,792,681
Gloves and mittens	....	4,683,479
Jersey cloth and stockinettes	....	2,738,932
Other knit goods	834,551	357,959
All other	45,397,912	43,603
Total value	$254,011,257	$47,460,109

The total value of products reported for the silk-manufacturing industry proper in 1914 includes $20,600,986, representing the value of organzine, tram, and spun silk, a large part of which was sold to other silk-manufacturing establishments for use as material in the manufacture of silk goods, $8,400,607, constituting the amount received for contract work by silk mills, which involves a very large amount of duplication, and $2,405,604, representing the value of products other than silk manufactures, so far as these were separately returned. The subtraction of these figures from the total value of products for the industry leaves a remainder of $222,604,060, which represents approximately the value of the finished silk goods made in the industry, although it may include the value of some products other than silk goods which were not specifically reported. On the other hand, silk and silk-mixed hosiery and underwear to the value of $37,913,079 were reported by establishments in the hosiery and knit-goods industry, $1,079,249 of this amount being reported by mills using silk materials exclusively. In addition, knitting mills using silk exclusively as a material reported other silk products such as gloves, jersey cloth and stockinette, etc., to the value of $7,770,370, while other silk manufactures to the value of $1,776,660, were reported by establishments engaged primarily in the manufacture of other products. It is probable that these latter two figures do not represent the total production of silk manufactures outside the silk-manufacturing industry, as some establishments making these products may not have reported them separately. Combining the three figures just given with that previously given as representing the approximate value of finished silk goods made by establishments in the silk-manufacturing industry proper, a total of $270,064,169 is obtained, which represents approximately the total value of finished silk goods manufactured in 1914.

The leading product reported by establishments not in the silk industry, is silk hosiery, the value of which in 1914 constituted about two-thirds of the total production of silk manufactures of such establishments. As shown by table given last the total value of silk hosiery manufactured in 1914 was $29,971,695, of which amount less than 1 per cent represented the value of hosiery made in silk mills.

Products, by States.

Pennsylvania is the leading state in the production of each kind of broad silks, except yarn-dyed silk-mixed goods, in the production of which the state ranked second to New Jersey. Pennsylvania produces the largest amount of organzine and tram made for sale, much of which was sold to establishments in other states. More than four-fifths of the total value of ribbons made in the United States come from New Jersey and Pennsylvania. The production of laces, nets, veils, etc., is practically confined to New York and New Jersey. New York also produces nearly two-thirds of the total value of fringes and gimps and more than three-fifths of the value of braids and bindings. Connecticut furnishes almost the entire output of velvet, and more than one-half of the plushes, and also leads in the production of machine twist and of sewing and embroidery silks, as well as in that of spun-silk yarn.

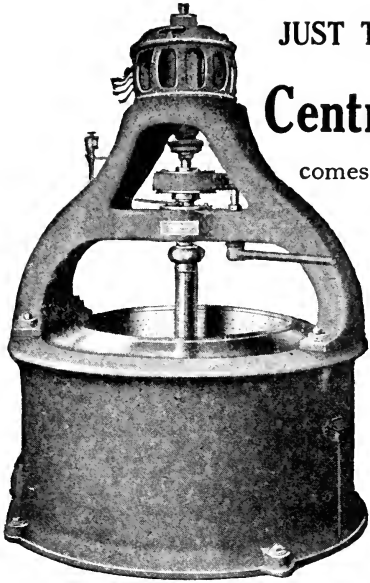
Silk Looms

in operation in 1914.

Broad, inc. Velvets	73,504
Ribbons	11,554
Total	85,058

These looms were operated in the following states:

	Broad		Ribbon		Total
Connecticut:	5,213	+	323	=	5,536
Massachusetts.	3,267	+	12	=	3,279
New Jersey:	23,049	+	4,732	=	27,781
New York:	5,981	+	1,881	=	7,862
Pennsylvania:	29,302	+	4,392	=	33,694
Rhode Island:	3,045	+	.....	=	3,045
Other States:	3,647	+	214	=	3,861
	73,504	+	11,554	=	85,058



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Specimen Page of "Technology of Textile Design"
(Reduced in Size

BRACKET WEAVES.

Under this name we classify weaves in which the body of the fabric is enclosed, on face and back, by a special system of threads.

We may arrange this special system of threads to enclose the body of the fabric either warp or filling ways or in both directions; that means that said body structure may be covered on both sides of the fabric either by a special warp, or by a special filling, or by means of a special warp and filling.

Bracket Weaves Constructed with Two Systems Warp and One System Filling.

A. Arrangement 1 @ 1.

For explaining the subject the accompanying illustration, Fig. 1472, has been given, and which shows the section of the fabric enclosed by means of a special warp. Letters of reference in our illustration indicate thus: *C*, the interior-warp; *i*, the filling; *S* indicates the exterior warp for enclosing (bracketing-in) the body structure.

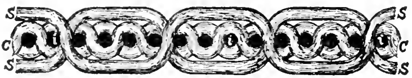


FIG. 1472.

FIG. 1473.

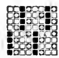


FIG. 1474.

This diagram will indicate at once to the student that for such weaves he must use frequently interlacing weaves (tight interlacing) for the body structure, whereas for the exterior warp (the bracket warp) large floating effects are required. For body structure we generally use the plain weave.

Fig. 1473 shows us the common $\frac{4}{4}$ rib weave warp effect. In weave Fig. 1474 we see said rib weave placed on every alternate warp thread only, on every uneven warp thread in the weave (see ■ type), whereas the even-numbered warp threads, 2–4–6–8, are arranged (see □) to interlace in the plain weave. The floating warp threads of the $\frac{4}{4}$ rib weave will, in weaving, arrange themselves so as to cover face and back of the fabric and hide the plain weaving structure.

FIG. 1475.

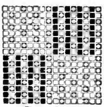


FIG. 1476.

FIG. 1477.

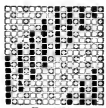


FIG. 1478.

FIG. 1479.

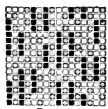


FIG. 1480.

A further example of this system of weaving is shown by means of weaves Figs. 1475 and 1476. Weave Fig. 1475 shows us the common 4 by 4 basket; whereas 1476 shows us said basket arranged for a bracket weave, *i. e.*, every uneven-number warp thread in the new weave interlaces for floating on face and back of the body structure, which in this instance is formed by means of having every even-numbered warp thread in the new weave interlace on common plain.

On account of the plain weaving part of the fabric, the floating threads which have to produce the basket effects on the face and back of the fabric will push apart. If for this reason we would not use an extra high warp texture, the result would be that the basket effect would not appear symmetrical on both sides of cloth, *i. e.*, the squares, as clearly seen by Fig. 1475, would get elongated in the direction of the filling, for this reason the basket weave (in the bracket weave) has been arranged for double its length in the complete weave, and if producing a fabric according to weave 1476, the face and back of the fabric will clearly resemble the common single cloth, weave Fig. 1475. Further examples are shown by means of weaves Figs. 1477 to 1480. The

Specimen Page of "Textile Calculations."

(Reduced in Size)

TO FIND THE TEXTURE OF A CLOTH USE—

Rule.—Multiply the number of threads of a given count of yarn that will lie side by side in one inch by the threads in one repeat of the pattern, and divide the product by the number of threads in repeat, plus the corresponding number of interlacings of both systems of threads found in one repeat of the weave.

By the number of interlacings of a weave we understand the number of changes from riser to sinkers, and *vice versa*, for each individual thread in each system.

Examples.—Fig. 10 represents one pick of the common twill known as $\frac{2}{2}\frac{1}{2}\frac{1}{2}$ and shown in one full repeat in Fig. 11. Diagram Fig. 12 illustrates the corresponding section to pick 1 shown in Fig. 10. The full black spots represent one repeat, whereas the commencement of the second repeat is shown in dotted lines. A careful examination of both diagrams, Figs. 10 and 12, will readily illustrate to the student the number of interlacings in one repeat (6), as indicated by corresponding numbers below diagram Fig. 12. Thus, in order to find the number of warp threads of a given count per inch for a cloth made with this weave, we must multiply the number of diameters of threads that will lie side by side with 10 (being one complete repeat of the weave) and divide the product thus derived by 16 (10 plus 6, or repeat plus number of interlacings). The result will be the required number of warp threads per inch. If given illustrations would refer to a 32-cut woolen yarn, we find answer as follows:

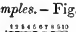


Fig. 10.

Fig. 12.

Fig. 11.

32-cut yarn = 9,600 yards per lb.

32-cut yarn = 82.2 threads will lie side by side.

Thus: 82.2×10 = 822 ÷ 16 = 51½, or

51 warp threads per inch (or actually 51½ per inch, or 103 threads for every two inches of 32-cut woolen yarn will be the proper number to use. In diagram Fig. 13 we illustrate a pick of another 10-harness twill weave. Fig. 14 represents the corresponding section, and Fig. 15 one complete repeat of the weave.

Fig. 13

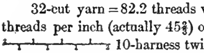


Fig. 14.

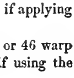


Fig. 15.

All three diagrams show 8 points of interlacings for each thread in one repeat; hence, if applying counts of yarn from previously given example for this case we find:

32-cut yarn = 82.2 threads will lie side by side. Thus: 82.2×10 = 822 ÷ 18 = 45⅔, or 46 warp threads per inch (actually 45⅔) of 32-cut woolen yarn are the proper number of threads if using the $\frac{2}{1}\frac{1}{1}\frac{1}{1}\frac{1}{2}$ 10-harness twill.

Answers.—For both given examples are as follows:

Warp yarn used 32-cut woolen yarn.

$\frac{2}{2}\frac{1}{2}\frac{1}{2}$ 10-harness twill = 6 interlacings = 51½ warp threads per inch.

$\frac{2}{1}\frac{1}{1}\frac{1}{1}\frac{1}{2}$ 10- " " = 8 " = 45⅔ " " "

A careful examination and recalculation of these two examples will readily illustrate to any student the entire modus operandi.

Example.—Find number of threads for warp for a fancy worsted suiting, to be interlaced with the 6-harness $\frac{5}{1}$ twill (see Fig. 16) and made of 2/32's worsted yarn. (Fig. 17 illustrates number 1 pick separated and Fig. 18 its corresponding section.)

Fig. 16.

Fig. 17.

2/32 = 1/16 = 16×560 = 8,960 yards per lb.

$\sqrt{8{,}960}$ less 10 per cent. = 85 threads of 2/32's worsted yarn will lie side by side in one inch. And

$$\left\{\begin{matrix}\text{Diameters}\\ \text{per inch.}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Repeat of}\\ \text{weave.}\end{matrix}\right\} \qquad \left\{\begin{matrix}\text{Repeat of}\\ \text{weave.}\end{matrix}\right\} + \left\{\begin{matrix}\text{Interlacings}\\ \text{in repeat.}\end{matrix}\right\}$$

$$85 \times 6 = 510 \div 8 \quad (6 + 2) = 64$$

Fig 18.

Specimen Page of "Wool, Cotton, Silk from Fibre to Finished Fabric."
(Reduced in Size)

caustic potash, then wash it well and re-dry it. During boiling add from time to time a few drops of water so as to prevent the alkali from becoming too concentrated. After drying at 212° F. the residue is weighed, the result giving the weight of cotton, and the loss, that of wool. Instead of potash, 7° B. caustic soda may be used, boiling being in this case restricted to a quarter of an hour

To Separate Wool from Cotton, remove any size or dye by boiling the sample in dilute hydrochloric acid, dilute lye, or by extraction with alcohol, ether, etc., and dried at 212° F., and placed in four parts of sulphuric acid and one part of water for twelve hours, then mixed with three volumes of absolute alcohol and water and filtered. The residue is washed in absolute alcohol until the washings are colorless, and afterwards with water, being finally dried and weighed to ascertain the weight of wool present.

Another method is thus: After freeing the sample from dye and sizing as before, and washing, the same is dried and weighed, and then immersed in ammoniacal copper oxide for twenty minutes, after which water is added. The residue left after filtration is thoroughly washed, dried and weighed, the result giving the amount of wool in the mixture.

To Separate Silk, Cotton and Wool in a sample containing these three fibres, remove the size and dye, as previously explained, and in turn treat the sample with ammoniacal nickel oxide, which dissolves the silk at once. The cotton in turn is then dissolved from the remaining portion of the sample by means of ammoniacal copper oxide, leaving the wool behind.

To ascertain the percentage of each in a sample composed of Silk, Cotton and Wool, two samples of yarn, each weighing 2 grams, are dried, weighed and boiled for a quarter to half an hour, in 200 c.c. of 3° B. hydrochloric acid, to remove the size and dye, and are then thoroughly washed and pressed. One sample is then immersed for a short time in a boiling solution of basic zinc chloride, then washed thoroughly, first in acidified, afterwards in clean water, then dried and weighed, the difference in weight giving the amount of silk. The second sample is then boiled for fifteen minutes in 60 to 80 c.c. of caustic soda (sp. gr. 1.02), and then washed, dried, and weighed, the difference in weight representing the proportion of wool. The residue is cotton, the dry weight of which must be augmented by about 5 per cent to compensate for the corrosion of the fibre during the operation.

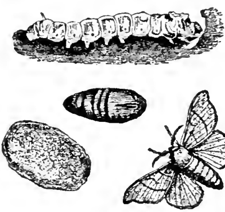
To Separate Silk, Tussah Silk, Wool and Cotton in a sample, have the sample first acted on by boiling half a minute with concentrated hydrochloric acid, which immediately dissolves the silk, the tussah silk being dissolved at the end of two minutes' further boiling. On treating the remainder of the sample with hot caustic potash, the wool will then be dissolved, and the cotton left.

To Determine the Presence of Cotton and Flax in a sample, the same is dyed by immersion in alcoholic fuchsine solution (1 gram fuchsine in 100 c.c. alcohol), then washed with clean water until the color ceases to run, and steeped in ammonia for about three minutes. The flax fibres or threads will then have been dyed rose color, whereas the cotton fibres or threads will be decolorized.

For the purpose of quantitative separation, the sample after having been freed from any size or dye, by a suitable boiling in dilute hydrochloric acid or distilled water, followed by a thorough rinsing, is then dipped for one and a half or two minutes in concentrated 66° B. sulphuric acid, then rinsed out well, rubbed between the fingers and neutralized by steeping in dilute ammonia or sodium carbonate solution. After washing over again in water the sample is pressed between blotting paper and dried and when flax fibres or threads will, as a rule, be found to have retained their structure whilst the cotton fibres or threads have dissolved after passing through a gelatinous stage in which they will tear like tinder.

SILK.

Silk is the simplest, and in its properties the highest and most perfect of all spinning materials. It differs from other textile fibres, both as to its nature as well as the machinery used in preparing it for the loom, the machinery used being much simpler and less cumbersome than the processes employed in preparing other fibres.



THE SILK WORM.
Larva,—Cocoon,—Chrysalis,—Moth.

The countries that produce silk are in the temperate zone. Starting from Japan to China and the belt of Central Asia, including a part of India, the silk-producing belt runs westward through Persia, the Caucasus, Syria, Asia Minor, Turkey, and the countries of South and Western Europe. Silk is divided into three main groups: (1) Cultivated silk, (2) Wild silk, (3) Artificial silk; the most important by far to the textile industry being

CULTIVATED SILK.

The same is imported in the form of "raw silk" *i. e.* in skeins, which are carefully packed in linen, with an outer covering of rush matting. The bales are square shaped, and as a rule contain 9 or 10 compound bundles of 9 or 10 skeins each. These bales, thus received by the manufacturer, on account of the high price of silk (it takes from 2250 to 3000 cocoons to make one pound of reeled silk), are carefully weighed and their contents subjected to a critical examination.

New York City, the only raw silk market in America, now holds the first place among all the raw silk markets of the world, Shanghai alone excepted; more raw silk being annually sold here than is consumed in France, which is still the largest raw silk consuming country in Europe.

The standard sizes of swifts in American mills are twenty-two and twenty-four inches, that is, the skein to measure fifty-six to fifty-eight inches in circumference. The reelers of Japan silks conform more nearly to this standard than do the reelers of Canton and Italian silks. The reelers of China steam filatures are quite uniform in the diameter of their skeins, but are apt to put too little silk in their skeins, which

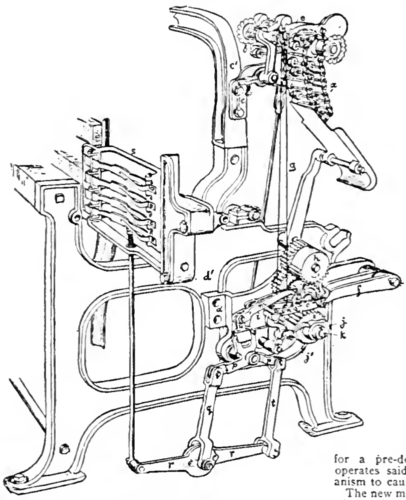
Specimen Page of "Textile Machinery Relating to Weaving."
(Reduced in Size)

BOX MOTIONS AND SHUTTLE BOXES.

THE KNOWLES GINGHAM BOX MOTION.*

(For 4 x 1 or 6 x 1 Box Looms.)

This motion, as shown in the accompanying illustration, is controlled by the box pattern chain *a*, which is operated in connection with a multiplier chain *b*, by a cam on the bottom shaft (not shown). The stand *c*, for the box pattern and multiplier mechanism is bolted to the arch *c'*, and the stand *d*, for the box motion itself is fastened to the loom side *d'*. The box motion is also run from the bottom shaft. This causes



a complete movement of all the parts once in two picks and prevents the boxes from changing when the shuttle is in the dead box.

When a roll of the pattern chain *a*, comes under one of the levers *e*, which is connected with the vibrator lever *f*, by rod *g*, it raises the vibrator lever *f*, into connection with the top cylinder gear *h*. In order to prevent any skips, a lock-knife *i*, closes in under or over the vibrator lever *f*, as soon as it has been raised or lowered to its correct position, the lock-knife *i*, being operated by a cam *j*, (and lock-knife finger *j'*) on the shaft *k*, of the bottom cylinder gear *k'*.

Whenever the vibrator gear *l*, is raised into contact with the top cylinder gear *h*, the vibrator gear *l*, is turned through half a revolution, carrying the vibrator connector *m*, from the left to the right and locking it as it comes into the line of centres; in addition to this there is a lock-lever *n*, and spring *o*, which holds the connector *m* in place.

The motion of the vibrator connector *m*, in connection with the angle lever *p*, raises the boxes. The front lever *t*, using the end of the compound lever *r* as a fulcrum raises two shuttle boxes *s*. The back lever *q*, using the centre of the compound lever *r*, as a fulcrum raises one shuttle box *s*.

In the case of the 6 x 1 box loom there are two levers which raise two boxes each, and one that raises one box.

The adjustment of the box is effected by means of an adjustable tip *u*, which connects the vibrator connector *m*, to the angle lever *p*. (*Crompton and Knowles Loom Works.*)

MULTIPLIER MECHANISM FOR KNOWLES LOOMS.

This invention relates to that class of looms which are provided with an auxiliary or multiplier pattern-chain in addition to the main pattern-chain. By means of the auxiliary or multiplier pattern-chain, certain bars of the main pattern-chain of the drop-box-indicating mechanism may be repeated without constructing successive similar bars in said main pattern-chain.

The object of the present invention is to provide a supplemental mechanism, to be combined with the main-pattern-chain and auxiliary or multiplier pattern-chain mechanism, which will operate automatically to stop, for a pre-determined time, the mechanism which operates said pattern-chains and to start said mechanism to cause the pattern-chains to operate.

The new mechanism may be combined with any loom of the class referred to, and is designed particularly for looms for weaving handkerchiefs, cotton blankets, etc., in which a solid color is put into the body of the goods for a certain number of picks.

In using the improvements on looms of the class referred to, the inventor of the new device, Mr. Wm. Wattie, combines the same with the cloth-take-up friction-roll, so that after a certain amount of cloth is taken up, the mechanism will operate automatically to start the mechanism which drives the pattern-

*See also article on "Mechanism for Operating Shedding and Drop-box Pattern Indicators for Knowles Looms" in previous chapter.

HAND BOOKS OF THE TEXTILE INDUSTRY, VOL. I

Dictionary of Weaves

PART I.

A COLLECTION OF ALL WEAVES FROM FOUR TO NINE HARNESS

By E. A. POSSELT
Editor of Posselt's Textile Journal

Two Thousand Weaves Conveniently Arranged for Handy Use

Bound in Cloth and Gold, Price Two Dollars

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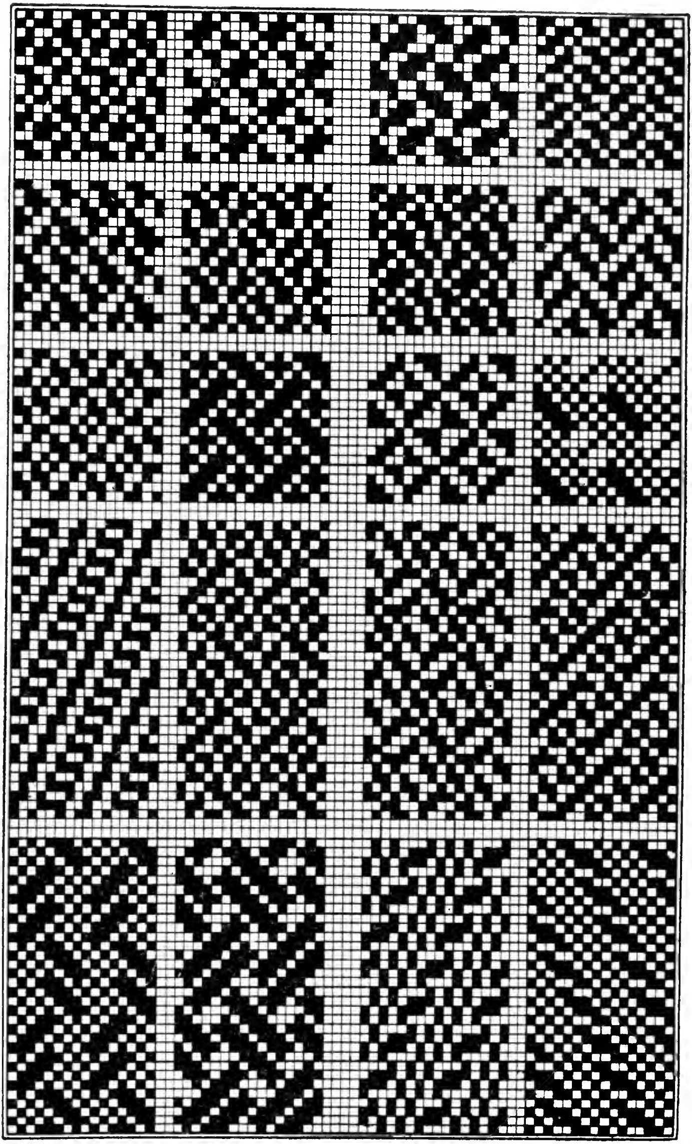
EIGHT HARNESS



8 × 8 8 × 16

Specimen Page of "Cotton Manufacturing, Part 2."
(Reduced in Size)

serves the purpose to keep the slivers better down on the spoons *G*, thus obtaining a prompt action of the stop motion. From the spoons *G*, the slivers pass down a specially shaped guide plate *H*, each sliver being kept separated from the others by means of grooves or channels *I*, through which they pass. The slivers are in this manner brought

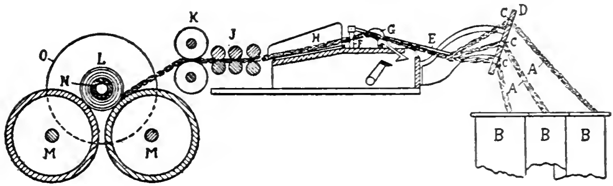


Fig. 106.

together and made into a comparatively level sheet without overlapping each other as they enter the series of drawing rolls *J*, side by side. The object of the machine is not to draw the slivers out, but to lay them side by side in the form of an even lap, for which reason the draft in the rollers *J* is just enough to prevent bulkiness of the lap and should not exceed about $1\frac{3}{4}$ to 2. Emerging from the drawing rolls *J*, the cotton

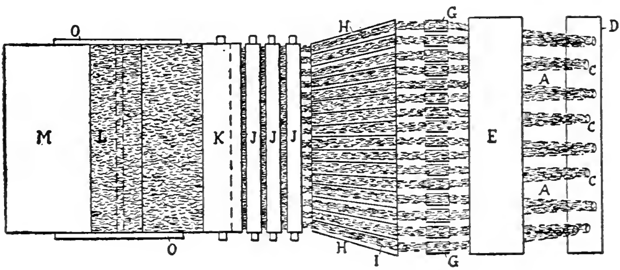


Fig 107

is conducted between a pair of heavy calender rolls *K*, which compress it into a sheet or lap which enables it to be rolled up. The top calender roller *K* is weighted either by a spring or lever arrangement at each end, with from 80 to 140 lbs. pressure. After the cotton leaves the calender rollers *K*, it is wound in the form of a lap *L*, upon the wooden spool *N*

filling, entering from the left, interlaces in taffeta until coming to the point where the entering threads have to be drawn into the fabric, passing after this below the right hand situated entering thread, sur-

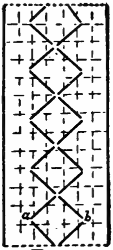


Fig. 120

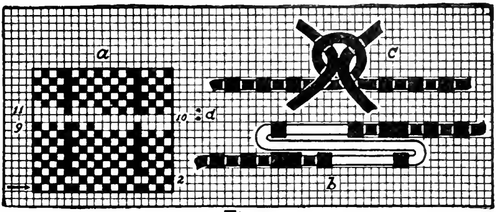


Fig. 121

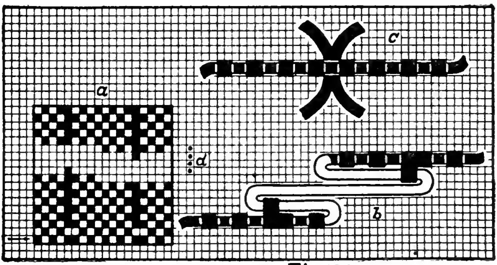


Fig. 122

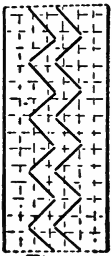


Fig. 123

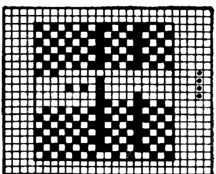


Fig. 124

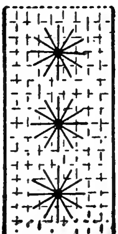


Fig. 125

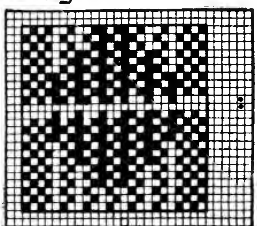


Fig. 126

rounding then, in union with pick 10, this entering thread as situated on the right hand side of the design.

Pick 10, in unison with pick 11, loops around the left hand situated entering thread; pick 11 forming in the body of the fabric the continuation to pick 9.

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S ... cing
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