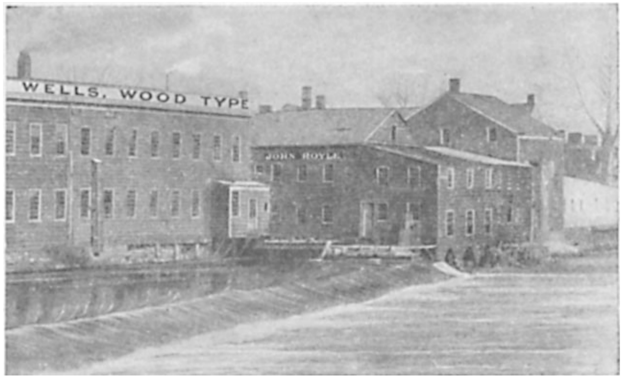
HAND BOOKS OF THE TEXTILE INDUSTRY, VOL. 3

SILK THROWING

E. A. POSSELT, PHILADELPHIA



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

Forty Years of Progress

in the Manufacture of Jacquard Card-Cutting and Lacing Machinery

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.

Silk Throwing

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

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RICHLY ILLUSTRATED

TEXTILE PUBLISHING COMPANY

2154 N. 21st St., PHILADELPHIA

LONDON, ENG: Sampson Low, Marston & Co., Ltd.

TOKYO, JAPAN: Maruzen Co., Ltd.

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 2¼ deniers, while Japanese are mainly between 2¼ 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 1½ 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:	**For Tram:**
Soaking.	Soaking.
Winding.	Winding.
Spinning, first time.	Doubling.
Doubling.	Tram spinning.
Spinning, second time.	Reeling.
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.

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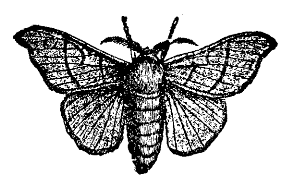

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SILK THROWING.

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 $1\frac{3}{4}$ to 6 per cent with the exception of press-packed tussahs which run from $7\frac{1}{2}$ to 10 per cent. Among others, regular organzine runs from $1\frac{3}{4}$ to $2\frac{1}{2}$, regular tram $1\frac{3}{4}$ to 3, Canton tram $4\frac{1}{4}$ to 6; crack tussah chops $3\frac{1}{2}$; 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 106⅔ 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 24½ to 25½	=	175,100 to 182,200
20/22 " 20½ " 21½	=	207,600 " 217,900
18/20 " 18½ " 19½	=	229,200 " 241,300
16/18 " 16½ " 17½	=	255,100 " 270,600
15/17 " 15½ " 16½	=	270,000 " 288,000
14/16 " 14½ " 15½	=	288,000 " 307,900
13/15 " 13½ " 14½	=	307,900 " 330,700
12/14 " 12½ " 13½	=	330,700 " 357,100
11/13 " 11½ " 12½	=	357,100 " 388,200
10/12 " 10½ " 11½	=	388,200 " 425,200
9/11 " 9½ " 10½	=	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 $2\frac{1}{2}$ 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 $2\frac{1}{2}$ to 3 turns, a variation of $\frac{1}{2}$ 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 ⅛ 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.

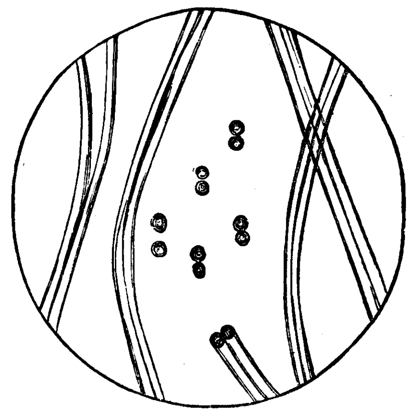


Fig. 1

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

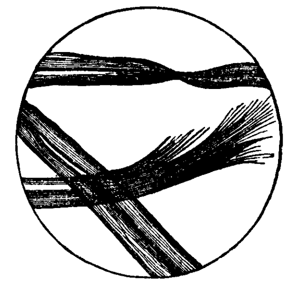


Fig. 2

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 purpòses 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-

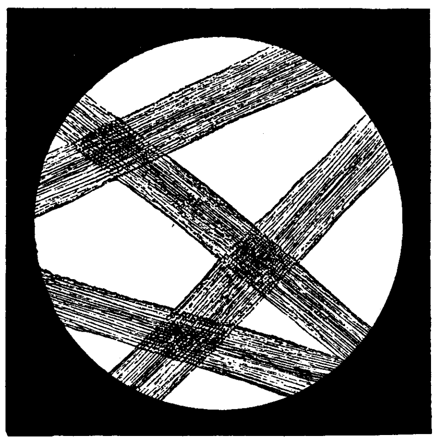


Fig. 3

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

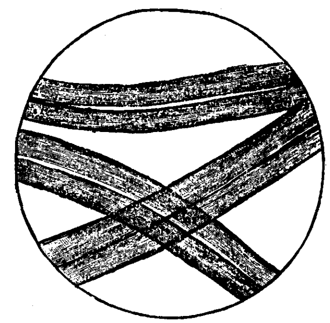


Fig. 4

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.

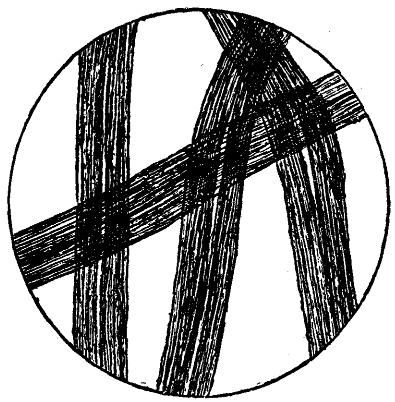


Fig. 5

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 im-

portance 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 1½ 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 ½ 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 ½ 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 112½ *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 ⅜ denier either way from the average given on each and every bale.

From 11/13 to 15/17...	½	denier either way is allowed
From 16/18 to 19/21...	¾	" " " " "
From 20/22 to 24/26...	⅞	" " " " "
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 ½ 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 ½ 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 retwisted (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

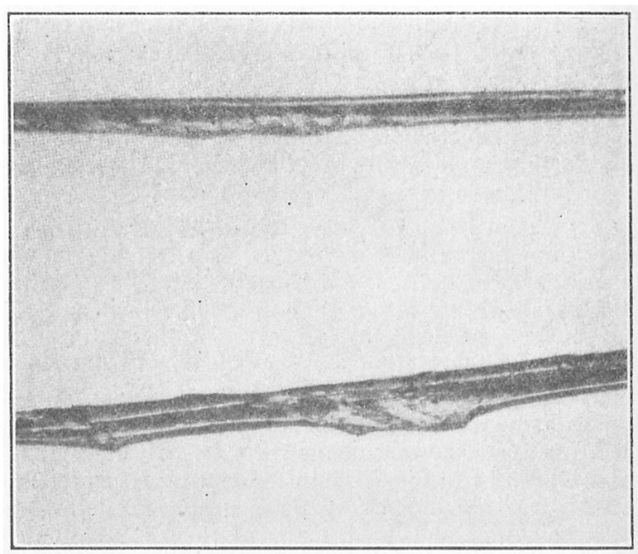


Fig. 6

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

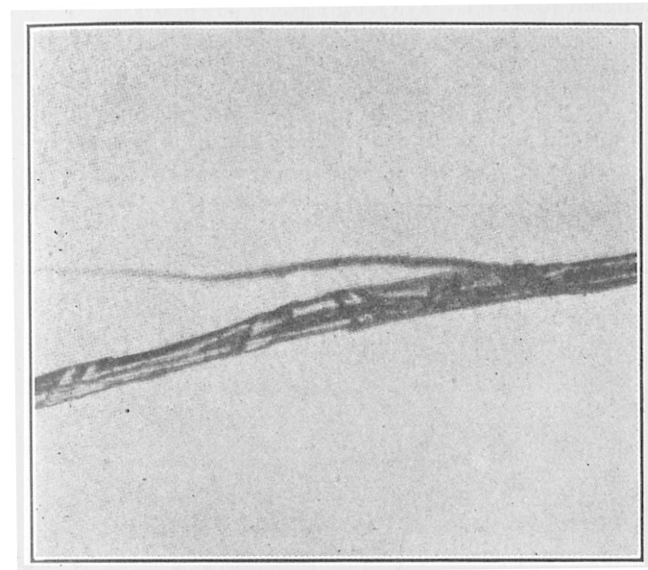


Fig. 7

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

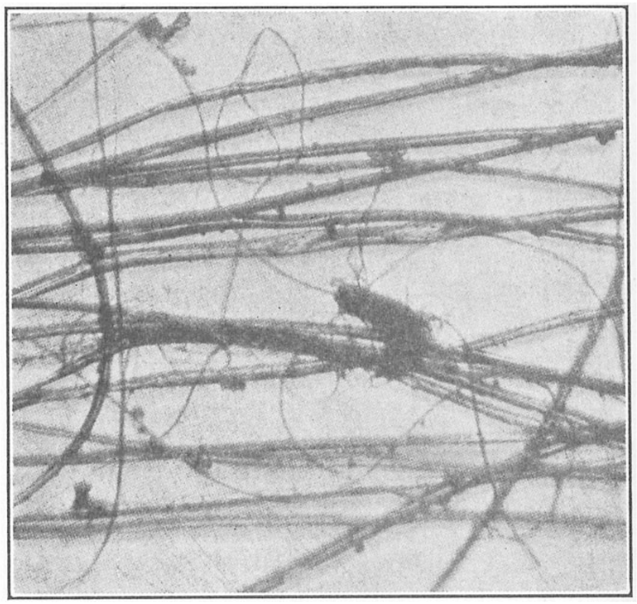


Fig. 8

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

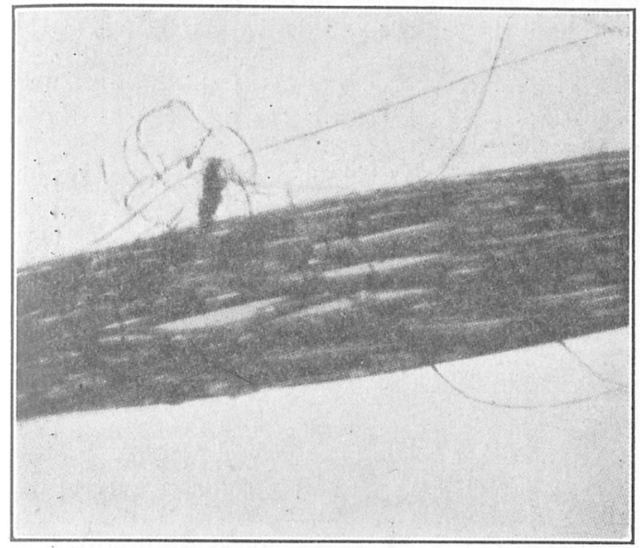


Fig. 9

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-

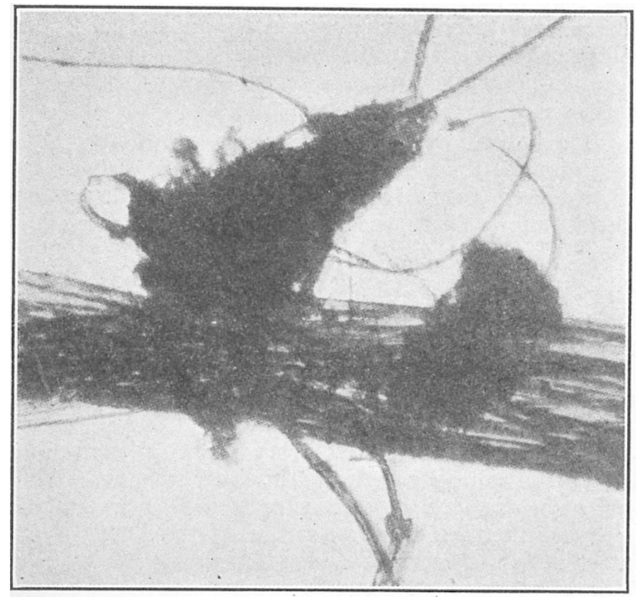


Fig. 10

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 : $\times$: : 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 1 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

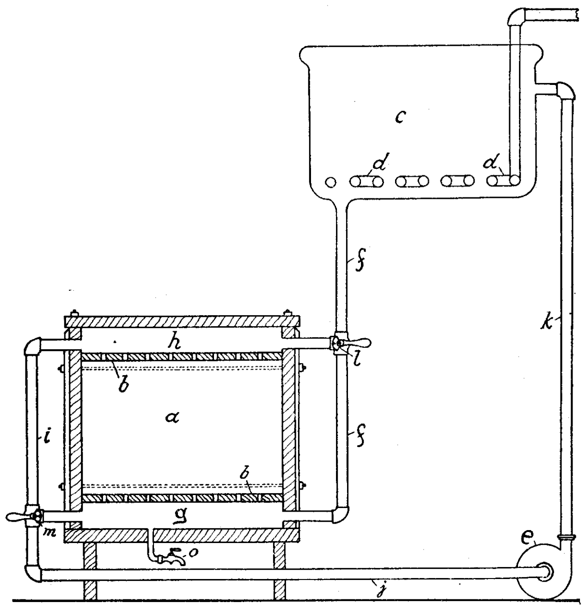


Fig. 11

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

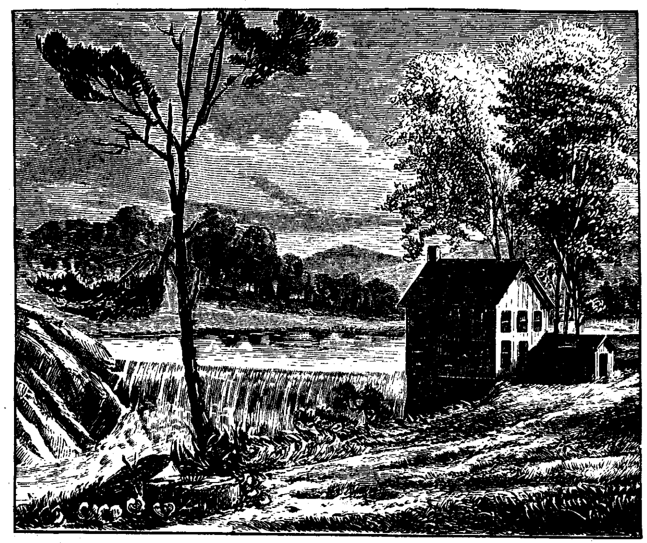


Fig. 13

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

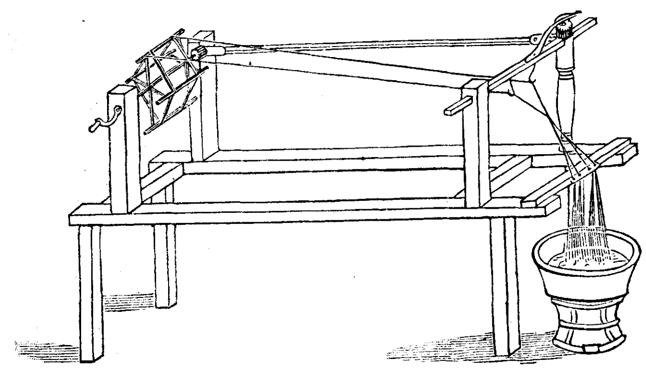


Fig. 14

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.

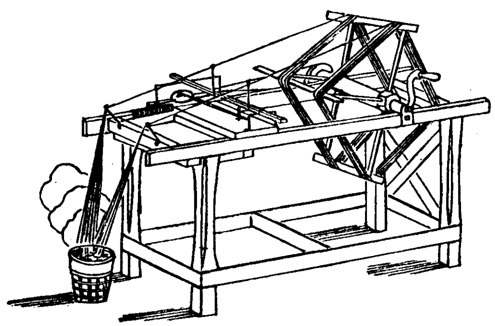


Fig. 15

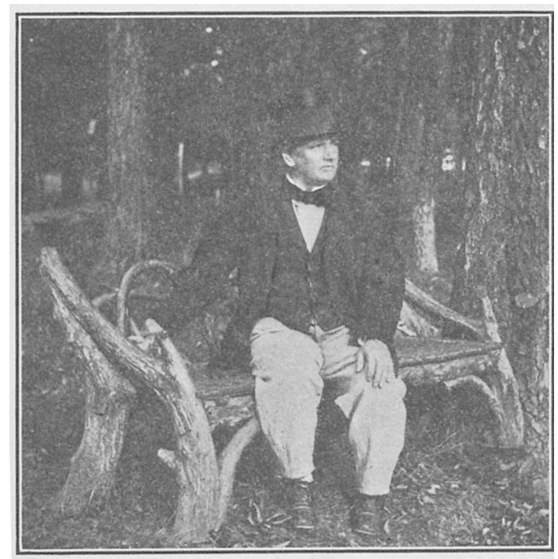
Simultaneously with the growth of the silk industry in this country improvements in silk reeling and throwing machinery kept on. In 1825 Dr. James Mease of Philadelphia imported a Piedmontese silk reel from Genoa, Italy, and of which an illustration is given in Fig. 14, in order to take care of the prospects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

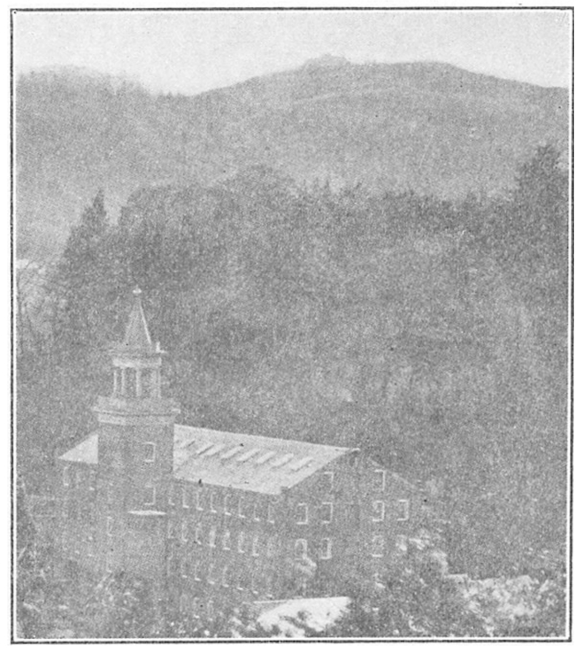


Fig. 16

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.

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

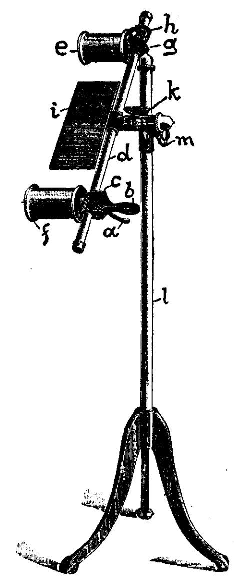


Fig. 17

of threads in such places (known as *gommures*) from each other by subjecting them to a mild (½ 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 $1\frac{1}{4}$ inch belt. Machines are built in any desired length to suit the

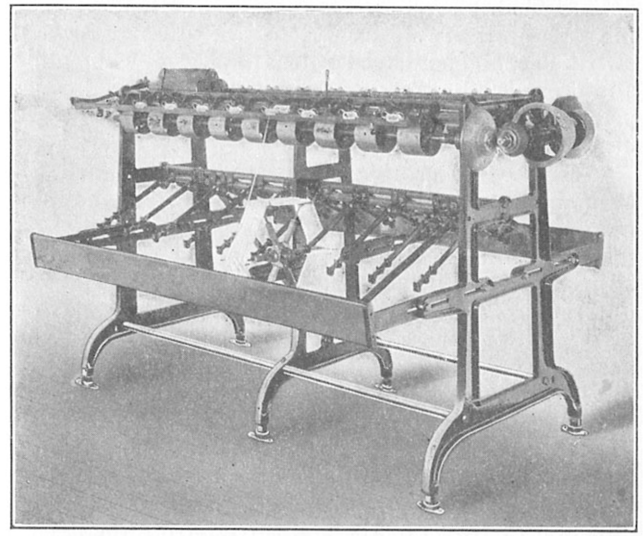


Fig. 18

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