# AMERICAN SILK INDUSTRY.

## *WHY SILK WORM CULTURE HAS FAILED AND SILK MANUFACTURE SUCCEEDED.*

**The Growth and Present Condition of Silk Working in this Country—Model Mills—How Raw Silk is Made into the Beautiful Fabrics—The Multifarious Processes by which Spun Silk is Produced—American Goods Honest—Advantages of American Manufacturers—The "Lyons of America."**

Ever since the days of King James I. of England, misguided persons have been endeavoring to force silk culture in this country. That eccentric monarch made strenuous efforts to compel the planters of Virginia to grow mulberry trees and raise silkworms instead of tobacco, and nobody knows what he might have done in the course of time toward effecting that substitution but for events that gave him a livelier interest in home affairs. When the stern Puritan Cromwell came into power he did not think it worth while to bother himself about silk culture, if, indeed, he ever thought of it, and thenceforth that industry had to make its way in the new world by virtue of its own attractiveness and promises of profit. It would not be possible to cite any other interest to which so much earnest effort has been devoted in this country, with so uniform a record of failure, yet with so many devoted and hopeful victims, spread over so vast an expanse of territory and through such a long course of years. From the beginning there has been just sufficient success attained to demonstrate that the conditions were favorable, in almost every part of the country, for the actual growing of the silkworms and their food, but at the same time the existence of an insurmountable obstacle to the profitable prosecution of the business was no less clearly shown. As early as 1656 silk culture in Virginia was reported as "moderately thriving." Handkerchiefs, dresses, waistcoats, and even a royal robe for Charles I. or Charles II. were, it is said, made in the colonies of native-grown silk. In 1732 the industry was started in Georgia, and twenty-seven years later 10,000 pounds of raw silk were shipped from Savannah to England, where it commanded a better price than any other. South Carolina commenced it about the same time, and in 1755 it was begun in Connecticut—the first mulberry plantation having been started on Long Island. In 1767 the delusion that silk growing was a good thing to do penetrated Pennsylvania, and a few years later to New Jersey, New York, and even to the New England States as far north as Maine. Everywhere the result was the same; the interesting experiment proved to be a financial failure. Yet people kept on struggling with it. Families here and there produced from five to fifty pounds of silk per annum, sometimes even more, but their product was of poor quality, clumsily reeled, and badly spun, fit only for domestic use. In 1810 the three counties of Connecticut in which the industry was then most flourishing—New London, Windham, and Tolland—produced sewing and raw silk of the value of $28,503, and fabrics from the refuse silk worth possibly half as much more, and still it was a failure. Of course it was not in American human nature to recognize that a thing could be done, yet admit that a way could not be found for doing it profitably; so Legislatures strove to encourage the silk culture; Congress patted it on the back; the Secretary of the Treasury published a big book about it; rich men, theorists, and experimenters mounted and rode it as a hobby, and finally the ill-advised endeavors of speculative energy and misplaced ingenuity culminated in the memorable morus multicaulis mania of 1838-'39. The frenzy that possessed all sorts of persons for the cultivation of white mulberry trees amounted to almost as great a madness as the once famous tulip mania in Holland. Slips of the young trees, worth $3 per 100 in 1835, were sold at $5 each four years later, and there were not enough in the country to supply the demand. Everybody was going to get rich in sericulture. Suddenly, when the bubble was blown to its utmost capacity of expansion, it burst. Thousands of persons were ruined, and silk growing got such a set-back in popular estimation as it has never yet recovered from. But still there are obstinate beings scattered here and there over the land who try to carry on the business, in defiance of the lesson of others' hard experience. A devoted Frenchman in Kansas has sunk a fortune in it; many thousands of dollars were annually spent for several years past in trying to force it in California, and all over the country there are small experiments in it going on constantly. Only a few days ago a large New England silk manufacturer received a letter from a man out West, saying that he had 3,000 cocoons for sale, and wanted to know how many cents each they were worth. They were worth, to that manufacturer, only a few cents per pound, and their quantity was not sufficient to be worth writing a letter for. There is insurmountable obstacle in the way of profitable sericulture in this country, to which reference has been made, and one which it is scarcely to be hoped can ever cease to exist here, is the impossibility of procuring intelligent, skilled labor at prices such as are paid in China, Japan, Turkey, Italy, and France. The production of the cocoon is a very simple matter; the utilization of it a difficult and expensive one. In 1,000 ounces of cocoons there are only 70 ounces of pure silk, and of that only 80 to 100 are fit for reeling. It is that process of reeling that the value of the silk is established, for it is an exceedingly delicate, slow, and painstaking art, on which depends the evenness of the thread, which is the great desideratum. The cocoons are thrown into warm water to soften the gum which makes the filaments adhere. If the water is too hot it partly dissolves the silk; if hard, it makes the silk liable to break. Six, eight, or ten filaments, each as thin as a thread of a spider's web, are deftly unwound by the reeler from as many cocoons. The gum they bear causes them to adhere. The same number must be kept together all the time. When one breaks, or the available part of a cocoon is exausted, another must be joined on so evenly that not even under a microscope is a roughness perceptible. The floss adhering on the outside of the cocoon is not available and a certain quantity near the chrysalis must be rejected because it is not an even thickness with the rest and its color is not good. The cocoons are never of the same size, their filaments varying from 1,200 to 3,500 yards in length, and the reeler must know just where to start and where to stop on each individual cocoon, to turn out perfect raw silk. And when he or she knows how to do all that, and is careful in doing it, and works faithfully, heor she may turn out one and a half or two pounds of raw silk by a week's hard labor, and in doing so will earn 15 or 20 cents per diem if working in France or Italy, half as much in Turkey, or one-third as much, or even less, in Japan or China. Is it any wonder, then, that silk culture—the technical name for a filament-winding establishment—cannot flourish in this country, where laborers capable at such work count not be got for less than $1 per diem? Several attempts have been made to start filatures in different parts of this country, and they have always failed, just for that reason—the inability to secure sufficiently cheap labor. And the cocoons, viewed as a crude crop, to be shipped abroad for reeling, do not pay. Twelve pounds of them, on the average, will yield only one pound of reeled silk, and that, in the "raw" gum state, is worth only about $5 25, or, if of the very highest quality, $6.50. When the cost of shipment, reeling, reshipment, duties, and various profits come to be subtracted from that, how much will be thought is left for the cocoon grower? That these results attained have not been satisfactory is sufficiently evidenced by the fact that in 1876 it was computed that of 56,000,000 pounds of silk the world's product, only 15,000 were furnished by the United States, Brazil and Mexico together. Not a very encouraging showing for the enormous expenditure hundred and fifty years of incessant endeavor to establish sericulture in this country.

### THE FIRST SILK MILLS.

But if silk culture has been a great failure silk manufacture, on the other hand, has been an enormous success, and though for many years it had a hard struggle to make its footing good, the position it now occupies is one of which the country may well be proud. It was in 1810 that Rodney and Horatio Hanks started the first silk mill in America, in the town of Mansfield, Conn., for the making of sewing silk and twist. It was not a precentious affair, being only twelve feet square, and its machinery primitive in the extreme. The brothers made it themselves, exercising for their tasks of the adaptability of means to ends. With varying fortunes the Hanks family stuck to the enterprise for several years, but finally gave it up. Then Wm. H. Horstmann of Cassel, Germany, in 1815, established in Philadelphia a manufactory of trimmings, wholly or partly silk, to which were subsequently added ribbons, plaited and braided goods, fringes, sashes, &c. As early as 1824 he introduced in his works the Jacquard loom, and fourteen years later power looms invented by his son, Wm. J. Horstmann. That old concern is still in existence, has the largest mills in the country engaged in its special line of work, and stands at the head of the long list of manufacturers now engaged in the production of its class of goods. In 1827-8 the Mansfield (Conn.) Silk Company started a mill, but, through an erroneous idea that they could profitably raise their own cocoons instead of importing the raw silk, failed in 1839, after the expenditure of a large capital, but with the satisfactory compensation of having practically demonstrated that silk manufacture here could be successfully prosecuted, if unhampered by unwise attempts at silk culture. It does not seem necessary or even desirable to recount, in this connection, the very long list of silk manufacturing enterprises that then sprang up here and there over the country, and with varying fortunes—generally rather adverse, however—kept the industry alive and gradually growing. Some of those enterprises are still flourishing and have, in these later years of prosperity, grown strong and great. Many more failed early, but the failures did not deter, but, on the contrary, rather seemed to excite to emulation other sanguine experimenters. As almost the entire amount of raw silk used by these factories was imported, owing to the impossibility of getting American silk properly reeled, the importations of that crude material might well be taken as at least an approximate indication of the vicissitudes of silk manufacture in its earlier years in this country, due allowance being made for other influences affecting importation. Reviewing these, we find that the dutiable imports in different years varied thus:

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| 1824 | $1,254 | 1830 | $119,074 |
| 1825 | 8,068 | 1831 | 174,376 |
| 1826 | 192,486 | 1832 | 48,936 |
| 1827 | 135,239 | 1833 | 155,348 |
| 1828 | 698,738 | 1834 | 130,236 |
| 1829 | 101,766 | 1835 | 10,715 |

Not until 1853 did the importation of raw silk reach the extraordinary amount of 1924, but in that year it amounted to $712,092, and in the succeeding year (1854) to $1,085,261, and in only one year since (1862) did it fall below, amounting to only $489,516. In 1858 the duty was taken off raw silk—with the exception of 10 per cent, levied on that imported via the Cape of Good Hope, which was maintained until 1863. From that time the imports of raw silk have been in value as follows:

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| 1866 | $3,437,000 | 1873 | $6,463,621 |
| 1867 | 2,469,000 | 1874 | 3,954,188 |
| 1868 | 3,204,000 | 1875 | 4,203,849 |
| 1869 | 3,318,000 | 1876 | 5,000,677 |
| 1870 | 3,017,000 | 1877 | 5,591,284 |
| 1871 | 5,730,000 | 1878 | 6,867,724 |
| 1872 | 5,425,620 | 1879 | 9,021,032 |

At the close of 1873 there were only 156 firms engaged in the silk manufacture, in all its branches, in the country, of which 30 were in New Jersey, 61 in New York, 25 in Pennsylvania, 22 in Connecticut, and the others scattering. The total capital invested in the industry was only $15,988,677; the total products were valued at $19,894,874, and the operatives numbered only 10,651. In 1876 the number of firms had grown to 213, the hands employed to 20,000, the capital to $27,000,000. By 1879 the figures given for the whole country six years before little more than covered the silk interests of Paterson alone, which then had 102 firms and corporations engaged in it, employing 12,599 hands, with $9,955,500 invested, and produced $12,172,995 worth of goods that year.

### WHERE RAW SILK IS PRODUCED.

The raw silk as it comes to this country is of very variable quality. That from Italy and France is finest, Japan's product and that of Broussa (or Brutia) is nearly or quite as good, and that from China is poorest. The difference amounts to as much as $2 per pound, and that simply because of the greater care employed in reeling the Italian and French products from the cocoons. The Japanese produce some exceedingly fine raw silk, quite worthy of ranking among the best, and the Chinese are fully capable of doing so, but are either too lazy or too dishonest. That the latter is the real reason is the firm conviction of some of the oldest manufacturers. They have found that where the Chinese can do so they will ingeniously load their raw silk with foreign substances—rice, sugar, &c.—to make it weigh heavier, and that even when they know the deception must inevitably be detected, and will lose them good and steady customers. The only way to put a check on them is by a concerted action among American manufacturers to shut out of this market all their raw silk, which does not come up to a certain standard. This is now taken care of in the American Silk Association. An experienced manufacturer here says that "all considerations are inoperative to make the Chinaman honest in his dealings with the foreigner." The raw silk comes in bales of 100 pounds, or piculi bales of 133⅓ pounds, and in either case is primarily in skeins, secondarily in bundles of from eight to twenty-five pounds each, and, lastly, in the big bales. That from some parts of China and Japan is of a lustrous light golden color, but much more from China and the general supply from Broussa and Europe is of a snowy white. In this condition it feels hard, owing to the glaze of the natural gum that is still on it, and one of the earliest processes through which it must pass is the removal of this material, by which it loses about 25 per cent. of its weight. If the Chinaman has been at it with his cunning devices, the necessary loss will be still greater, and the "thrower"—as he is termed who prepares these filaments for weaving or working—will have to suffer a loss beyond the recognized allowance for that diminution. Formerly, it was the custom here, as it still is in some parts of Europe, for the thrower's establishment to be as independent of all the other processes of silk manufacture as the diversilti is to a great degree even in this country. All the processes of cleaning, winding, doubling, twisting, sorting, rewinding, and reeling, according to the various uses for which the completed thread was intended, belonged to him and were contracted for by the weaver or dealer in finished silk threads. Now, however, the largest silk manufacturing establishments in this country do all their own "throwing." That word, by the way, is said to be derived from the old Saxon thrawan, to twist.

### SILK MANUFACTURE.

In order to arrive at as clear an understanding of the multifarious processes of silk manufacture as may be conveyed in the narrow limits of a newspaper article, the works of two representative factories, one dealing with the raw silk and the other utilizing a very different material, will best illustrate how the main products of popular use in silk goods are attained. The first is the extensive mill of the Cheney Brothers Manufacturing Company (formerly B. B. Tilt & Son) in Paterson, N. J., where in the busy season 1,000 hands are employed, and where, even in the present dull time, between seasons, 900 are at work. This mill, like nearly all the old silk works in the country, has grown by accretion, by additions of building to building in meet the requirements of business, so that to say it rambles is stating the fact mildly, especially after one has endeavored to pursue the raw silk through its various scattered divisions. But throughout it all are evidences that belong exclusively to a silk mill—cleanliness and pure atmosphere. Cotton and woollen mills are foul and noisome places by comparison with it. The raw silk, when first received, is carried to the sorting room, where the different degrees of fineness regulate the assortment by deft-fingered girls into separate piles. Then a parcel of skeins of uniform grade of thread—if the lightly twisted filaments from the cocoons can so be called—is enclosed in a light cotton bag, and soaked in water at about the temperature of 110° Fahr. for a few hours for the purpose of softening the gum, and facilitating the process of winding. When taken out of the water these bags are put in an open cylinder, porous on the sides, and set in a machine which is operated by steam power and causes the cylinder to revolve with great velocity. In five or ten minutes the water is pressed out, and the gum sufficiently softened to permit of easy winding. It is then wound first on a speed about 3½ inches in length. If it is Chinese silk, it is carried by hand to a place beyond the cleaning machine, each thread usually, but not always, passing between two sharp-edged metal plates, which remove any unevenness, leaving the filament smooth, clean, and even. The Italian silk does not usually require this cleaning. The silk on this second speed is next passed to a doubling machine, where two or more threads are joined together and drawn upon a third spool. The silk in this state is put in the spinning machine and spun a certain number of turns per inch, more loosely if intended for the "organzine" warp, making the "warp" or "filling"—than if meant for "organzine," which is the warp. In common parlance the words warp and organzine are used indiscriminately, but this is incorrect. When two of these threads are doubled together and spun upon a fourth spool, twist being reversed to make the thread stronger, the resultant thread is organzine, whether it ever becomes warp or not. The number of threads joined for tram depends upon the fineness of the raw silk, and also upon the character of the goods to be woven. For instance, ribbons requiring a coarser shot thread than bonnet ribbons, and some sashes and silk dress goods requiring heavier filling than others. Where it is intended to make sewing silk, or twist, four, five, six, or even ten threads are joined together in the spinning machine. Twist is not thought of in this mill, so can only be incidentally mentioned here. When the silk is thus brought into the condition of thrown silk, tram, or organzine, it is usually transferred to a reel, and made up into skeins preparatory to being dyed of the desired color. The dyeing of the thread of this mill is done by outside parties, as is the case with a number of the best Paterson mills, the manufacturers deeming it best to confine that very delicate and highly responsible process to parties who make a specialty of it, and have at their disposal the best facilities for it they could readily be obtained in an overcrowded establishment. It is practicable for the diver to load the thread with two, three, or even six times its weight of chemicals, filling the interstices between the fibres and the filaments themselves with dyestuffs which make the thread seem more solid, thick, and strong than it would naturally be, and this is a common practice in Europe; but such silks rapidly grow thin in wearing, crack, fray, and gets a dirty white color. Nothing of the sort is done with the goods of this mill, or, indeed, of any reputable American silk manufacturer, and it is to this fact above everything else, this high credit of absolute honesty, that American silk goods owe their present reputation for durability. Even the wadding, further mention of this matter will necessarily be made in another connection, and here it need only be reverted to. Leaving out of the question dyeing, which may or may not be required, before it becomes organzine raw silk must pass through the successive processes of assorting, winding, cleaning, spinning, doubling, twisting, drachming, winding, cleaning, doubling, warping, and picking. For tram it must go through assorting, winding, cleaning, doubling, spinning, drachming, winding, cleaning, doubling, and quilling. The dyeing comes after the seventh process mentioned for organzine and the sixth for tram. The drachming is a delicate process of weighing the silk, skein by skein, and according to its grade, or rather the thickness of its thread, which is thus determined, dividing it off into from many to nine separate lots. To the inexperienced eye and touch they all seem alike, but this nice discrimination is absolutely necessary to secure that perfect evenness on which the success of manufacture depends.

### THE JACQUARD LOOM.

The tram silk is wound on quills for the shuttles; the organzine, run from the spools on a warping mill, a great upright revolving cylinder five or six feet in diameter, and finally, after every thread has been carefully picked over, is rolled on the weaver's beam. Tedious and long have been the processes by which the slender filaments have been brought into this present stage of preparation, and there is still one job to be gone through with that looks as if it would make a nervous man wild, and that is the leading of the threads of the warp, one by one, each through its individual slot in the reeds of the swinging lay and loop in the harness. There are thousands of those threads, and an error in the placing of one would play the mischief with the whole business. Anybody who can find real enjoyment in straightening out a fish line tangled by an active owl might like this sort of work, but few surely possess such Job-like patience. After this, however, the reward of realization of the perfect artistic work, toward which all preceding has been but gradual advancement, is to be enjoyed. Beneath the practically elastic and bouncing 300 power looms, in constant operation, forms rich in beauty of design and brilliant in the glory of color are momentarily growing into being as the swiftly flying shuttles carry their wealth of glowing tints through the ever-changing intricacies of the shedding of the stiffing warps. Machine that the prophet might have added—had he known anything about it—to "the way of the wind," "the way of a serpent on a rock," and other things noteworthily hard to find out, it would doubtless be the Jacquard loom. Why irregularly punched holes in a seemingly endless succession of card boards should result in developing the most wondrously intricate patterns on the fabric growing into being below is a puzzle that few persons outside the fraternity of weavers can honestly say that they comprehend. And yet, as Mr. Thorp, the superintendent here, explains it, it seems simple enough for the moment. Each card represents one thread of the filling. A thousand ends of wires, more or less, press against each card, as the machinery brings it in turn into its place where the holes are, the wires go through, by pressure of a spring at their other ends, and so a hook, connected with each wire, is allowed to come forward far enough to be caught by a rising blade of steel, and that pulls on certain strings which, through a complicated tie of the wires, which in turn lift up selected threads of the warp, and make at each moment new paths for the shuttles to travel through. The wires that have no holes to get through of course cannot bring their hooks forward far enough to catch the lifting bars, and the threads of the warp which they affect remain down until next time, or some other. To complete a pattern sometimes requires as many as ten thousand cards, all strung together by their edges, like a "Jack's shirt," going flippety-flop after each other up to the head of the loom and down again. Ordinary portraits woven in ribbon silk require from 1,500 to 4,500 cards, and fine pieces of badge work, such as the Cardinal Mahoney book mark or the splendid one gotten up at the latest Paris Exposition by the firm, about 6,000. The weavers of Lyons used to hold preeminence over the rest of the world for their Jacquard loom productions, but their best work has been outdone by this establishment, and by comparison with some of the designs woven here, the most pretentious English works look like bad caricatures. The pictures or other designs which are to be woven are first drawn by Messrs. Alcock and Hood, in the size they really appear, on ruled paper, representing the warp divided to minute squares, and finally the holes are punched in the cards in correspondence with the marked squares on the enlarged design. A great deal of secrecy is observed in this department to prevent rival manufacturers finding out what is going on, and to keep the world of new designs. The intricacy of the Jacquard loom—and really it does look like a terrible thing as one views its enormous sheaf of twitching strings, and thousand rattling wires, and five thousand wriggling cards—will further increase if an attempt be made down below, in imagination, to trace the ways, by which they throw, as required, four different shuttles bearing threads of various colors; but that cannot be explained without diagrams. Other looms there are, appropriately called gang looms, which will weave from two to twenty-four ribbons at once, that will have woven, beautiful flowers, gay-plumaged birds, curious Oriental designs, and other blossomings of the designers' fertile fancy. A great many of the men employed in this mill are from Macclesfield, England, and they have contrived to call the latest arrivals among them "sparrows." There are fewer "sparrows" than there used to be, by the way, for some of the latest arrivals, horrified by that very hot spell of weather in early May, wheeled around and flew back to England. But before they left the idea occurred to one of the artists to get up a "sparrow" design for some figured dress goods, and it has proved so popular with dealers that a large number of looms are working on the reproduction in various colors of that bird, and they call it the sparrow pattern. The success of this design illustrates an advantage which our manufacturers enjoy, and it is not an unimportant one, in the readiness with which they can meet a demand for any novel thing they may get out which strikes the popular fancy. Instead of long waiting, possibly until the whim of fashion had changed, while the European silk weaver would have to dread in entering to the market of this country. From the looms the woven goods go to the finishers, undergoing processes of scouring, scarching for imperfections, measuring, and folding, after which they are ready for the market, with the exceptions of the ribbons, which are first wound on blocks, and the handkerchiefs, which are cut apart, hemmed, and put up in packages. The Paterson handkerchiefs are much more beautiful and more durable than any imported, but are not large.

The manufacturers say that the market demands a small silk handkerchief, and does not want a large one. The products of this mill include ribbons of every grade, gros grains, satins, and other dress goods, scarfs, handkerchiefs, figured ribbons of every description, book marks, badges, &c., in endless variety. Seventy hand looms are still kept in operation by the Phoenix Manufacturing Company on the Passaic, here, and it must be said that experience has demonstrated that while the power loom may closely simulate in its rapid automatic action, all the processes of the old hand loom, it cannot supply the place of the careful hand weaver, who watches for imperfections, and instant remedying them. In the weaving department of the mill about two-thirds of the employees are men and one-third women. In the throwing department the proportions are reversed. Wherever men and women do the same work, they receive the same pay. The average wages of a thrower or weaver is $1.50 per diem. The weaver earns more while his work is actually in operation, but his loss of time in waiting for beams, arranging the loom, &c., brings his earnings down to about that amount. Formerly there was a great deal of private weaving in and near Paterson. Almost every skilled weaver who came over from England brought with him his loom, and it was customary to give out beams ready set with warp, at quite a number of hitting, and the pieces woven returned to the employer, who made up the goods. But in time manufacturers found that this system practically put them at the mercy of the independent private workmen. A man might finish his work 150 yards in twenty-three weeks, and might delay over it as much longer as he chose, for the weaver had the warp, might get intoxicated and spoil it altogether, and he might, if dishonestly disposed, steal a duplicate of the cards of a particularly beautiful and valuable pattern and a competitor of the same other manufacturer. So gradually the greater part of the weaving was done or called in the mills, where it can be done under the best and most economical conditions, and there are now hardly more than 200 private looms, it is estimated, in Paterson. In some other parts of the country, however, the old practice still is kept up by small manufacturers to a considerable extent.

### SPUN SILK.

The second representative mill to which reference has been made, that of Cheney Bros., is in South Manchester, Conn., with a branch for ribbon weaving in Hartford. The processes employed in the manufacture of spun silk are different from those which have been reviewed, so much so as almost to deserve to be classed as a separate industry, for here the starting point is not the raw silk reeled from the cocoons, but the cocoons themselves. This is known as the manufacture of spun silk, and the Cheney Bros. not only practically monopolize it in this country, but have brought it to such perfection that their goods excel any others of like class made in Europe. There is a larger silk factory in England devoted entirely to the making of thread and twist from spun silk, but the establishment of the Cheney Bros. is the largest in the world for the production of woven fabrics from spun silk entirely or its admixtures with "thrown" silk. There are certain cocoons from which the filament cannot be unwound, such as doubles, in such form as to be reeled by themselves together, crossing and entangling their threads beyond hope of straightening out by the most patient tempers, and these sometimes amount to as much as ten per cent. of the product of a cocoon crop. Then there are others which have been pierced by the moth, expanding a fluid which softens one end of its encasement and enables it to push its way out, and these, too, are unfit for reeling. Then there is a great deal of "frisons" or "feature waste," the refuse of the floss on the outside of the cocoon, and the waste made in stripping them. Last of all, there is a limited quantity of raw silk more or less broken and tangled in the earlier operations of the silk mill, and known as "mill waste." All these are excellent material, gives silk of a quality which, if the power of reeling were equally as durable as those from the raw silk, and in their finer grades almost as beautiful, lacking only a little of the lustre belonging to the reeled silk products. But to utilize this material requires costly machinery, specially adapted for the purpose, and an infinite deal of care and labor. To begin at the beginning: The cocoons come in vast bales from China, Japan, Asia, India, Turkey, France, Italy, and Spain, and are worth, according to quality and other conditions of value, from 10 cents up to $1.50 per pound. The best are in the form known as Sawata, prepared in Japan, which presents the material no longer in the crude cocoon shape, but as a wad or tuft, like silken "batting," each wad weighing about a quarter of an ounce and containing the silk of probably a dozen cocoons, which have been soaked in hot water, freed from the dead chrysalis enclosed, and spread out so as to part their filaments. The first process with all the cocoons is to bring them to the mawata condition. To do this, they are soaked in hot water, to which a certain proportion of alkali has been added. This softens the gum and loosens the filaments. Then the dead chrysalis—if double cocoons are under treatment—is extracted, and the fibres are pulled apart sufficiently to admit of thorough and comparatively easy disentanglement by the machinery. After being well washed and dried, the material is next carded by huge machines bearing a distant resemblance to cotton or wool carding apparatus, but much larger, and with stronger parts throughout to grapple with the fibre to be treated. The carded mass of straightened filaments, as it passes around the great drum of the machine, is cut off in lengths of about eight inches, and these are successively, by skillful hands, taken off between boards to keep them in their straight, and in that condition are known as "books."

In another machine, these "books" are placed one by one, and the glossy fibres are combed by machinery, after which the now thoroughly disentangled and orderly arranged ribbons of filaments from each book is carefully rolled together in a bunch weighing only a fractional part of an ounce, and carried to the department in which its first approximation to the thread form is made. These bunches are spread out evenly on a belt which forms an endless table, and are carried forward to another belt running at right angles with it in such manner that successive portions of the filaments are laid partly on those placed before, as shingles are laid upon the roof of a house, and in this condition are passed through machinery which forms them into a loosely pressed, soft, lustrous band. This band is, by other machinery, drawn out, doubled, twisted, drawn out again, again doubled, and so on, until it finally takes the form of any desired thickness, according as it is intended for tram, organzine, sewing silk, or twist. From the time it assumes the soft band form the processes through which it passes are so closely akin, generally, to those of cotton spinning that detailed description of them is needless. There is, however, much greater delicacy in the machinery and much more care exercised in its manipulation in the spinning of silk, the attainment of a thread devoid of projecting fibres and of absolute smoothness being the end constantly in view. To this end, in one stage of its progress the silk thread is made to pass at great speed over a succession of whirling spindles, which polish off many of its roughnesses, and then it runs through the flame of a gas jet, which burns off any loose ends of fibres, but cannot harm the swiftly moving body of the thread itself.

The lowest grade of spun silk thread produced by all this labor is worth $4 per pound, and the highest $8, which is far below what thrown silk commands, and consequently enables the manufacturer to make an excellent quality of pure silk goods at very low prices. As an indication of what a vast deal of machinery is required for this spun silk factory, it is worthy of mention that it has an exhausted capacity of 400 horse power engine, and that another of equal force is about to be added, while the mill itself occupies four buildings, each 50 feet by 250 feet, and three stories in height. From this mill the thread is transferred to another—the old factory—stationed a little distance away, where all the processes of dyeing, weaving, printing, and finishing are carried on. In regard to the weaving, there is little to say about it other than has already been said of the similar department in the Phoenix mill, except that here there are only about a hundred Jacquard looms and four hundred plain wide and gang looms, the products of this mill being, to a large extent, serges, gauzes, handkerchiefs, brocades, mummy cloth, ribbons, and stuff suitable for printing. Exquisite novelties in figured goods for milliners' uses are, however, turned out from these looms, among others of the present season, embossed silks, satin, corduroy, and printed satins in almost endless variety. The printing is done by a huge press, akin to a cotton printing machine, which gives off its color from engraved copper cylinders, and is capable of printing five colors at once with great rapidity and accuracy of register. The colors thus put on are set by exposure to steam in a close chamber, and are as durable as the goods impartial by nature. One peculiarity in this printing work is the impression on a colored web of a chemical which takes on the ground color wherever it touches, a process which is called "discharging color." In the finishing the goods are smoothed by passing over heated cylinders, under a hot pressure, and the heavy fabrics of the finer grass, such as brocades, are made to run over gas jet flames, which burn off any fibres that may break the evenness of the surface without in the least injuring the web. There are some goods that have to go through the rolls at an exceedingly light pressure, others that require a squeeze of 50,000 pounds; some that must be pressed hot and others cold. Different surfaces on the rolls may convert plain silks into striped ones or changes an to more or less figure. Brocades and fancy silks as well as plain goods must go through the process, and the effect in bringing out the beauty of figured goods is sometimes very remarkable. Satin requires an enormous pressure to bring out the full lustre which constitutes its beauty.

The processes of dyeing, formerly a great mystery, are now, since the introduction of aniline colors, exceedingly simple. As a rule the color is imparted to the thread in skeins, but some classes of fabrics are dyed in the web. Purity of color and a lasting quality are the leading requisites which too generally disgrace European goods, are amongst prominent characteristics which, with the added qualities of strength and durability, have given an enviable reputation to the goods produced by this mill. Notwithstanding the great variety of fabrics made, from the wiredly of spun silk or lined satin that nestles on a rocket silk warp, the excellence of their manufacture is such that it is not easy even for experts to detect them from others woven wholly of reeled silk, yet their price is only a trifle more than that of the latter, and they are, in the aggregate, only about half as great. The works employ 1,500 hands, even in between seasons, and last year turned out goods to the value of $2,250,000.

### THE EXTENT OF THE INDUSTRY.

Among the more than two hundred silk manufactories in this country there are many branches of the industry which are necessarily passed over without such detailed description as the three herein given to be deemed most likely to invite most popular interest. One of these is the making of sewing silk and machine twist, which was among the first started on this continent. At present our silk mills are supplied with a very large part of the required yarn, and in Europe it is of superior quality, strong and free from fine weight of added chemicals in the dyeing. Still another and exceedingly interesting branch of the industry is the weaving of silk ties. For this all the processes of silk manufacture enter, from "singling"—which are merely doubled threads—up to substantial silk yarns, and the most elaborate kinds of hand-made ties are so perfectly counterfeited that it is almost impossible to detect the work of the loom. Lace makers, too, are a large class of the trade, and to infer our list description. They resemble no other mechanism, and to understand them, even superficially, requires a degree of patient research. Bullion fringes are outstanding. In a case in point just years ago a Paterson fellow-citizen, who had been in business in Paterson, Newark, and New York, and who had made a fortune in the business, was induced to go to Springfield, Ill., to start a silk factory there, in the belief that Americans, with their skill, would be preferred to the Swiss girls who had been employed in the business. He succeeded, and the factory is now in full blast, and the girls are all Americans. Sewing silk is the staple product, and the business is said to be very profitable. Another branch of the business is the manufacture of fringes, tassels, and other articles for the trade, and in this Paterson has a large establishment, which has been in operation for years, and which has been a great success. The proprietor, who is a German, and who started in the business in Germany, is now in Europe, where he has been for some time, and he is expected home in the spring. The Messrs. Hamil, Newark, N. J., have a large factory for the manufacture of silk fringes, tassels, and other articles for the trade, and they have been in business for years, and have been very successful. Their goods are of the highest quality, and they have a large trade. Mr. Hamil, the senior partner, is now in Europe, and is expected home in the spring.

Mr. Thomas Hamil, who died in Jersey City recently, at the age of 72 years, started in the business in Paterson, N. J., in 1848, and was the son of the late Thomas Hamil, who was a prominent silk manufacturer in Paterson, and who died in 1869. The business was carried on by the son, who was a great grandson of the Rev. Robert Cathcart, who was a prominent Presbyterian clergyman in Paterson, and who died in 1857, at the age of 97 years