used in certain affections as a local agent to great advantage, and that the results obtained are certainly due to its specific action.

SILK MANUFACTURE.

Although silk is a substance that is produced by several varieties of insects, it has come to be almost exclusively associated in the public mind with the product of a particular variety of caterpillar, which is popularly known as the silkworm, and by the entomologists as the larva of *Bombyx mori*, or the mulberry-feeding moth. The eggs of the silkworm are hatched by artificial means, and are exceedingly small, weighing about a hundred to the grain. It is customary to place pieces of finely punctured paper above the trays in which the eggs are being hatched. As soon as the worms break through the shell they creep through the holes in the paper in their endeavor to get to the light, and in doing so scrape off the pieces of shell which may adhere to their bodies. They are reared in rooms where particular care is taken that an abundance of fresh air and light are present, and where the temperature may be kept at an even point. The worms are voracious feeders and begin to increase rapidly in size from the day they are hatched. As a rule the silkworm moults four times during its life; usually about the sixth, tenth, fifteenth, and twenty-third days after being hatched. As soon as the caterpillars have reached their full growth they climb the twigs and small branches which have been prepared for them, and begin the spinning of their cocoons. The silk glands of the worm consist of two sacks running along the sides of the body, with a common opening on the under lip of the worm. In the process of spinning its cocoon the silkworm ejects from both glands a line of extremely fine thread. The two filaments from each gland are laid side by side and are held together by an adhesive secretion from the worm. The cocoons are either deep yellow, white, or light green in color, and oviform in shape. Their average length is from an inch to an inch and a half, and they are from half an inch to an inch in diameter. The cocoon consists of an exterior made up of broken and straggling filaments, while the interior layers are densely glued together into a mass which is not unlike parchment, and which is impossible to unwind except by moistening.

The manufacture of silk may be broadley divided under the heads of reel silk manufacture and the manufacture of spun or waste silk. The first method has to do with continuous fibers thousands of yards in length. In the spun silk industry the raw materials are worked up by methods similar to those used in the case of cotton and other fibrous materials.

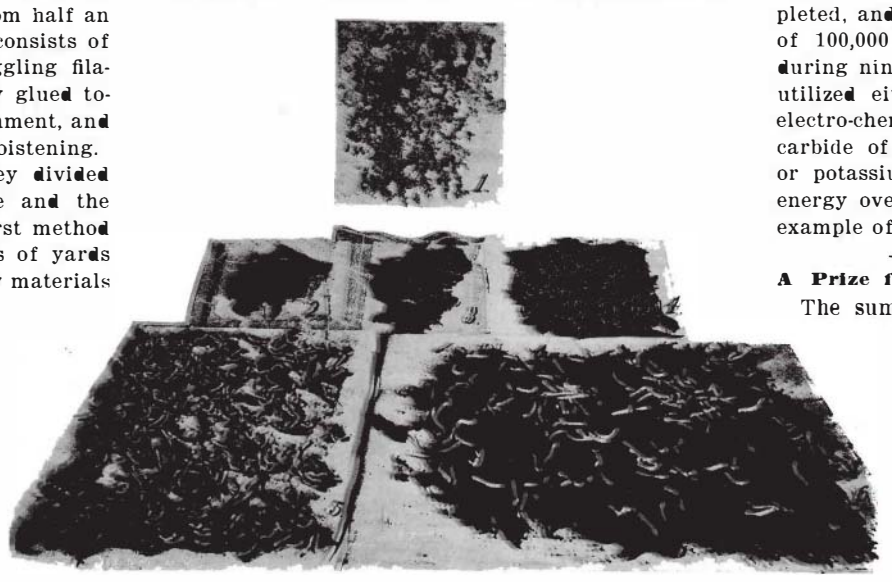
The first operation is to produce the "raw silk" of commerce. The cocoons are placed in warm water for the purpose of softening the natural gum with which the filaments of the cocoon were fastened at the time it was spun. From six to ten of the cocoons are put in a bath, and as soon as they are properly softened the threads of each are caught up by an attendant on a fine brush, and passed through an eyelet to a reel, upon which they are wound. The reel consists of a light, wooden, revolving frame, which winds the silk into what are known as skeins, and it is in this form that the silk is usually received at the silk mills.

The first thing to be done with the skeins after they are taken from the bales is to soak them thoroughly in cold water. The raw silk is too fine and delicate for textile manipulation, and has to be doubled and twisted to give it the necessary body and strength. To this end the skeins of raw silk are placed on light wheels, known as "shifts," from which the silk is wound onto spools; then two spools of silk are run together and doubled and afterward twisted, some of the twisting machines, however, performing the doubling and twisting in one operation. The twisted silk is then wound onto rectangular frames, known as creels or reels, and at the same time is measured off into lengths of from 10,000 to 15,000 yards, the silk now being once more in the form of skeins. It is then taken from the creels and rolled up into hanks, ready for dyeing.

After the silk has been dyed it is returned in skeins, which are slipped on over a set of what are known as "soft silk" winders, from which it is wound onto spools once more. It is then taken to the warping department, where the spools are placed upon tables which may carry from 110 up to as many as 600 pegs. In the hand-warping machines there will be from 100 to 120 spools on a table, while the power-warping machines will carry from 300 to 600 spools. The operator gathers up the ends of silk on each spool and runs the threads onto the frames in the mill, the threads in this case being wound parallel. From 100 to 4,000 threads are run off on warping spools, which are technically known as "beams"—round cylinders of wood or iron which are 6 or 7 inches in diameter, and of a width which varies from 4 inches to 36 inches, according to the character of the fabric of which the thread is to form the warp.

The beams are then carried to the looms, where the threads are first led through a "harness," and then passed through a steel "reed" or comb, there being from two to fourteen threads in one "dent," according to the quality of the goods. The harness consists of a series of top and bottom slats known as "shafts," each pair of which is connected by a number of parallel vertical threads at the center of each of which is a small brass eyelet through which the silk threads are passed. Several of these sets are arranged vertically behind each other in the loom, and each harness with its set of threads is raised in turn between each passage of the shuttle through the warp. Each harness thus serves to lift a different set of threads for the passage of the shuttle; and it is by the proper adjustment of the vertical motions of the harness to the strokes of the shuttle that the nature of the weave of the goods is determined. The woven fabric is then taken to the packing room, where all knots, dirt, and stains are removed.

The goods are now taken to the finishing department, where it is put through a variety of operations which would necessitate another article to adequately describe them. Among other operations is that of singeing, to take off any rough nap that may be left on the goods, and sprinkling or sponging with a preparation of wax and gelatine, a process which is not unlike that of starching in laundry work. The final gloss or finish is secured by calendering, in which the fabric is run between a series of superimposed steel rolls, where it is ironed out and the fine glossy finish is secured. The goods are then either folded or wrapped on blocks ready for the market.



THE SILKWORM, FROM EGG TO FULL-GROWN LARVA.

1. Eggs on paper. 2. Newly-hatched worms feeding on mulberry leaves. 3. Silkworms at first moult. 4. Second moult. 5. Third moult. 6. Full-grown, ready to spin.

Projects for Utilizing the Hydraulic Power of the Rhone.

A number of projects are under consideration for utilizing the hydraulic power of the Rhone, and there is no doubt that before long a number of plants will be established at different points, and it is expected that more than 200,000 horse power at a maximum, or 100,000 at a minimum, will be obtained. Three important projects have been planned, each by a syndicate of manufacturers; these plants will all be installed upon that portion of the Rhone which lies between Pyrimont and Fort de l'Ecluse, near the Swiss frontier. In this region the river has many rapids and falls; for instance, over a distance of only 12 miles the difference of level is about 200 feet. On the other hand, since the city of Geneva, using Lake Leman as a reservoir, has regularized the supply at periods of low water, as much as 160 cubic yards per second may be counted upon, below the junction of the Rhone and the Arve; from this it follows that over this stretch of 12 miles about 100,000 horse power may be obtained at low water. During 9 or 10 months, the maximum period, as much as 200,000 horse power is obtained. A hydraulic plant has already been installed in this region by an Anglo-Swiss company, who use about 10,000 horse power. The three projects in consideration have been made by syndicates of French manufacturers, who are only waiting until the formalities have been completed before commencing work. The plans have all been drawn up for some time past, and the land has been purchased. The first of these projects is that of Malpertuis. At 2½ miles below Bellegarde the river falls at a height of 30 to 35 feet at the "Passe de Malpertuis." The river here flows between two perpendicular banks only 160 feet apart. According to this project, a dam will be constructed at a point above the fall, and a part of the water, 160 cubic yards per second, will be taken off by a tunnel of 60 square yards section and 1.2 miles long; a total fall of 51 to 55 feet will thus be utilized, from which a force of 25,000 horse power will be obtained at low water. The second project is that of the "Boucle de Rhone." A dam will be placed at Les Andelieres, near Bellegarde; here the banks are somewhat wider, and the dam will cover 100 feet and have 20 to 22 feet height. A tunnel just above the dam will take off 160 cubic yards per second (80 to 90 at low water). The tunnel will be somewhat shorter than the preceding, and will end at Essertoux. A total fall of 80 to 85 feet will thus be obtained, giving 24,000 to 25,000 horse power, besides 5,000 to 6,000 horse power taken directly by a small hydraulic plant installed beside the dam on the right bank; this gives a total of 30,000 horse power. The third project is that of the Pont de Gresin. At this point, about 8 miles from the Swiss frontier, the river flows in a narrow gorge only 80 feet wide, and is here 25 feet deep, on an average. This point is near the railroad from Lyons to Geneva, and is thus a good locality for establishing industries; a branch line of 2 miles would connect it to the railroad. The fall of water obtained by a dam at this point will be 65 feet, with an output of 150 cubic yards per second during low water, and double this amount for the rest of the year. A minimum of 30,000 horse power may thus be counted on. The plant will include a dam with movable gates, a hydraulic plant with turbines and dynamos, and a system of canals for the discharge of water. The dam will form a vast lake, or water reservoir, and the water will be taken directly into the station by conduits passing through the walls; after passing the turbines it will be discharged into the river below the dam. The generating plant will contain fifteen turbine-dynamo groups of 2,000 horse power each; the turbines with horizontal shaft will be coupled directly to polyphase alternators; a set of smaller turbines will drive the exciting dynamos, and the station will have the necessary switchboards and appliances. It is probable that within three years these projects will have been completed, and the Bellegarde region will possess a total of 100,000 horse power at low water, and 200,000 during nine or ten months of the year. This will be utilized either on the spot for the manufacture of electro-chemical or metallurgical products—such as carbide of calcium, vanadium, carbonates of sodium or potassium, aluminium, etc.—or for the supply of energy over a radius of 80 to 90 miles, following the example of the Niagara plant.

A Prize for Communication With Other Planets.

The sum of 100,000 francs was bequeathed to the French Academy of Sciences in 1891 to be awarded to the first person who would be successful in communicating with another world. The Academy at first did not care to accept such a curious bequest, but finally it did so in the following words: "Madame Veuve Guzmann, a friend of astronomy and a believer in the plurality of inhabited worlds, has left to the Academy the sum of 100,000 francs to be given as a prize to the person who shall first enter into communication of an astre other than the planet Mars." The will wisely further stipulates that each time the prize has not been awarded for a period of five years, the accumulated interest shall be devoted to a work which will help the progress of astronomy. The intentions of the founder will be scrupulously followed. Astronomers naturally wonder why Mars was debarred.

A Funeral Trolley Car.

Baltimore has a number of fine suburban cemeteries, all of which are reached by some division of the street railway lines, and the company found by putting in a few crossovers they could take a car from any part of the city to any one of the burying grounds. It was, therefore, decided to offer cars for the transportation of funeral parties, says The Street Railway Review. The company built a special car well adapted for the purpose. The car is divided into two compartments, the smaller of which has running its full length another compartment or vault in which the casket is carried. A heavy plate glass door hinged to swing downward gives access to the vault from the outside. When a casket is to be placed in the car, the shelf is drawn out, the casket lifted upon it, and the shelf is then pushed back in place. The larger compartment has twelve cross seats in the center aisle, giving a seating capacity of twenty-four; the smaller compartment has four seats. Heavy black curtains divide this section into two private compartments for the immediate family of the deceased. Floral contributions are piled upon the top of the vault, and can be seen from the street. The car is finished inside and out with black enamel with nickel plated fixtures. The car has been named "Dolores," meaning sorrow, and it is rented at from $20 to $25 for each interment.

Automobile News.

The New York Zoological Society will soon operate automobiles of its own for the convenience of the public.

Consul Gibbs reports from Tamatave, December 3, 1900, that Mr. E. Cayeux, a sawmill owner of that city, invites correspondence in regard to liquid-air motors. Correspondence may be conducted in the English language.

A beginning has been made in Chicago to supplant the clanging gongs of public vehicles by more mellow chimes, says The Electrical World. A downtown firm which operates several automobiles was the first to make the change. The Municipal Art Association and the Anti-Noise League are interested in the matter, and it has been suggested that a crusade against gongs be inaugurated.

One of the disadvantages of motor-driven ambulances has been that they do not get the right of way as easily as horse driven vehicles. The familiar clanging of the ambulance gong and the sound of the clattering hoofs of the horses was always sure to clear the way promptly for an ambulance. Now the ambulances have been provided with electric bells which do not differ materially from those which other electric vehicles carry, and the result is that trucks or wagons do not get out of the way as quickly. It has been suggested that compressed air whistles or larger gongs might be used. A return to the old foot gong would probably obviate the difficulty to a certain extent.

An automobile exposition is to be held in Vienna this year, under the auspices of the Automobile Club of Austria and the patronage of the Archduke Francis-Salvator, who is himself a great lover of the sport. The exposition will be held from the 25th of May to the 6th of June, in the Prater, where a large space has been set apart for it. All kinds of automobile vehicles will be represented, including private carriages, towing machines, delivery wagons, motocycles, etc., besides the accessories and detached pieces, representing the advanced stage of development which the industry has reached in Austria. Foreign exhibitors will also be well represented, and the Automobile Club has extended a cordial invitation to all manufacturers. The club is taking measures to have the foreign products passed through the custom house free of duty on condition that they will be brought back directly after the exposition. It is expected that the German industry will show the advances it has recently made by a large number of exhibits.

Lieut. Edouard Engles, of Frankfort-on-the-Main, has lately made a tour of the Alps with a Benz machine of five horse power, accompanied by his wife and an assistant. The machine weighed 1,500 pounds and carried 175 pounds of baggage. Starting from Frankfort, they passed through Stuttgart and Munich, then Inssbruck by way of Kochelsee and Walchersee, and crossed the Karwendel at an altitude of 3,500 feet, and afterward the Brenner at 4,080 feet. They then continued their voyage by Sterzing, Cortino, Trevisi, to Kenmestri (Venice). The return trip was made by way of Trieste, the passes of Tonal (5,640 feet), Epaica (3,540 feet), then by Tirano and Stilfser Joch (8,260 feet), reaching Bregenz, Friedrichshofen, and Ulm. According to the declaration of the custom house officers at Stilfser Joch, theirs was the first German machine to make the passage at that point. About 1,200 miles in all were made on this trip, and the time was about 99 hours, giving an average speed of about 12 miles an hour, in spite of the high altitudes reached.

Among the novelties is the acetylene automobile which has been recently brought out in France. According to reports, the machine is quite successful in its operation. In one of these machines the truck, which weighs about 1,100 pounds, carries a double motor of four cylinders and two explosion chambers; the motor is of the same general type as the petroleum motor, but has received some modifications to adapt it for use with acetylene. The normal speed of the motor is 2,000 revolutions per minute, and it works without a flywheel; the vehicle is given a mean speed of 12 miles an hour on level road. The motor is not reversible, but there is a mechanism for speed changing which is worked by a foot-pedal; the same device also makes the reversal of the machine at the rate of 2 miles an hour. The usual gasoline reservoir is replaced by an acetylene generator, and the supply of carbide carried on the machine will enable it to cover a distance of about 70 miles at a mean speed of 8 to 10 miles an hour. The motor is designed to develop from 8 to 10 horse power at normal working; it is mounted at the front of the truck, and the explosive mixture acts upon two pistons working in contrary directions, and thus the vibrations are almost neutralized. The apparatus is regulated so that the working of the motor is proportional to the power necessary to develop, and the supply of gas is furnished accordingly. If necessary, the motor may be made to work with gasoline. It is expected that further details will be given as to this interesting system.

Archæological News.

Excavations are being carried on at Pompeii around the Basilica.

Many Etruscan tombs have been found in central Italy during the last two years.

The theater at Ephesus has been laid bare by the Austrian excavations. The great harbor appears to be of Greek, not Roman, origin.

L. Lindet considers that the windmill was imported into France and England from the East in the eleventh century, though it may have been in use earlier.

Remains of the ancient theater of Augusta Taurivorum (Turin) have been found in the area of the Palazzo Vecchio on the northern side of the ancient town.

Remains of a house of Republican times have been found under the crypt of S. Cecilia in Trastevere, Rome. It was restored in the first part of the second century A. D.

In carrying out the repairs to the Temple of Karnak M. Legrain discovered a city gate. It is the first found in Egypt and is of great height. The chief causes of the fall of part of the temple are the character of the soil and the artificial flooding of the temple.

Drs. Grenfell and Hunt have a great mass of Ptolemaic papyri, some used for inside padding of crocodile coffins, others made up into human coffins, like the Petrie papyri. These latter have not been explored; the former contain at all events the official papers of a komogramateus, or village mayor, of the second century B. C.

The Palazzo Piombino has housed the notable collection of antique marbles transferred to it from the Villa Ludovici. This collection has been acquired by the Italian government and will be placed temporarily in the museum at the Baths of Diocletian. They will be transferred to the Villa Borghese after it is acquired by the government.

Below the pavement of the Æmilian Basilica in the Roman Forum a great antique sewer has been opened. Just where it passes under the steps which led up from the street to the outer arcade of the Basilica the base of a small circular shrine projects into the roadway. It has been suggested that this is the temple of Venus Cloacina, the cleaning goddess.

Cupellation is one of the most ancient of metallurgical processes, and was well known at least as early as the year 600 B. C., says Nature. It was used by the Romans to extract silver from its ores in Spain and at Laurian, but it has been hitherto supposed that the hearths of their furnaces were made of comparatively non-absorbent materials, such as clay and marl, the litharge and other oxides being skimmed off or allowed to flow away in side channels. It is now shown, however, by Mr. Gowland, in a paper read before the Society of Antiquaries in May last, that a silver refinery was worked at Silchester in which argentiferous copper was cupeled on hearths made of bone-ash. Bone-ash has the property of absorbing molten litharge and some other oxides as readily as blotting-paper absorbs water, and apparently only its high cost prevented its use by the Romans in all their later cupellation furnaces. Careful examination of the remains found at Silchester convinced Mr. Gowland that the work there resembled some of the operations formerly practised in Japan, and that it is probable that it consisted in the recovery of the silver from Roman copper coins issued in the third century A. D. The metal contained four per cent of silver, and was cupeled in three furnaces in succession with the aid of repeated additions of small quantities of lead.

American universities have received 118 papyri from the Egyptian Exploration Fund. Among the sixteen papyri for Yale are portions of a lost comedy of the second century and of Plato's Republic of the century before and after Christ. Harvard's share includes a fragment of Paul's Epistle to the Romans, of Aloman, the chief lyric poet of Sparta, 651 B. C., and seventeen other papyri. Columbia receives Xenophon's Hellenica, first century, a letter to the King of Macedon, and fourteen other pieces. Johns Hopkins gets extracts from Thucydides of the second century, two of Demosthenes on the Crown, and thirteen other fragments. A piece of Herodotus of the second century, a complete contract for a loan in the reign of Nero, and eleven other pieces are assigned to Princeton. Of five papyri for Hamilton College, one is a letter to the Clerk of the Court in the time of Trajan, acknowledging the receipt of a will; and of four papyri to Vassar College, one is about a loan of 3,000 drachmæ of silver, which shows that 8 per cent interest was then paid (third century). Of the total 118 papyri, 29 are presented to the University of Pennsylvania. The larger part of the papyri are from Oxyrhyncus and the rest from various sites. The former is where the "New Sayings of Jesus" were found by the society, and also portions of St. Matthew, Mark, and John, far antedating any other known texts.

Electrical Notes.

The moving sidewalk of the Paris Exposition was a great success; 6,694,308 persons paid for the privilege of using the platforms, while only 2,635,867 used the railway that carried passengers in the other direction.

Recent experiments in wireless telegraphy, in connection with the French fleet, have been so satisfactory that it has been decided to provide the whole Mediterranean squadron with wireless apparatus, which will be subjected to decisive tests during the coming cruise of the squadron.

A new hotel which is to be built on Fifth Avenue will have many interesting electrical features, among which will be a system of electric service elevators, or movable pantries, fitted with electric heating tables. They will be run through every apartment, thereby insuring rapid service and hot food to guests taking their meals in their rooms.

Visitors to Boston have often wondered at the obsolete Back Bay horse car line, which consisted of only two cars operated by four men. All the other street car lines in the city are, of course, operated electrically. The trolley is hardly adapted to that section of the Back Bay district served by the horse car line. The tracks are to be taken up and electric omnibuses are taking the place of the cars.

A test of the Murphy third-rail sectional system took place recently in the Baltimore & Ohio tunnel and in the yards at Baltimore. One of the heavy locomotives ran up and down the yard track at a high rate of speed by the sectional third-rail system. Everything worked perfectly, each switch operated as intended. It took six months to install the system through the yard and tunnel.

Prof. W. Nipher, of Washington University, has discovered that sensitized plates which have been exposed to sunlight and are therefore useless for ordinary photography can be employed in making X-ray photographs. The development of such plates which have been acted upon by the X-rays gives a positive image. Moreover, the plates can be developed by the feeble light of an ordinary lamp, so that the fine details which may be lost by over-development can be carefully observed.

The installation of Marconi's wireless telegraphy upon the vessels plying between Dover and Ostend has proved a great success. In the first test the operators after they had left the latter port, and while still some distance from land, succeeded in communicating with the Marconi station at Dovercourt in Essex, considerably over 100 miles away. The distance from Dover to Ostend is 73 miles, and the operators were successful in transmitting a message from the vessel as she entered the harbor at Dover to the station on the Belgian side. The utility of the system was, however, more adequately exemplified a few days after its installation during a gale. The vessel encountered heavy seas, and her passage was consequently delayed. The operators, however, continued in communication with the shore, and were able to announce their bearings from time to time. Messages were also transmitted for the passengers, while one was received from Brussels. The system has been of great advantage in connection with the navigation of the vessel, since on more than one occasion the captain has received notification by ether communication of the presence of fogs off the Belgian shore, and has, therefore, been able to reduce the speed of his vessel accordingly.

The Central London Electric Railway has met with such popularity that the officials are experiencing considerable difficulty in preventing overcrowding of the carriages. The daily conveyance of passengers now amounts to over 200,000, and on wet days the complement is greatly increased. One solution of the problem is the lengthening of the trains by the addition of one or two extra carriages, but if this is resorted to the platforms will have to be extended. Another suggestion is a more frequent service, but the success of this scheme depends entirely upon the public itself. At the present time the trains are only scheduled to make a 15 seconds stoppage at the stations, but, of course, at some places such a short stoppage is impossible. The duration of a stop must depend upon the number of passengers who desire to detrain at that particular point. The company suggests that the passengers should prepare to leave the train before it reaches their destination. If this were followed no doubt the difficulty would be to a certain extent solved. The trains are at present running at intervals of 3 minutes, but this service is to be increased to 2½ minutes headway. Probably this latter will be the limit at which the trains can run with perfect safety. The earning capacity of the railway is enormous, as may be recognized from the number of passengers carried, but up to the present nothing has been published regarding the expenses, so that it is impossible to estimate what dividend the railway will pay.

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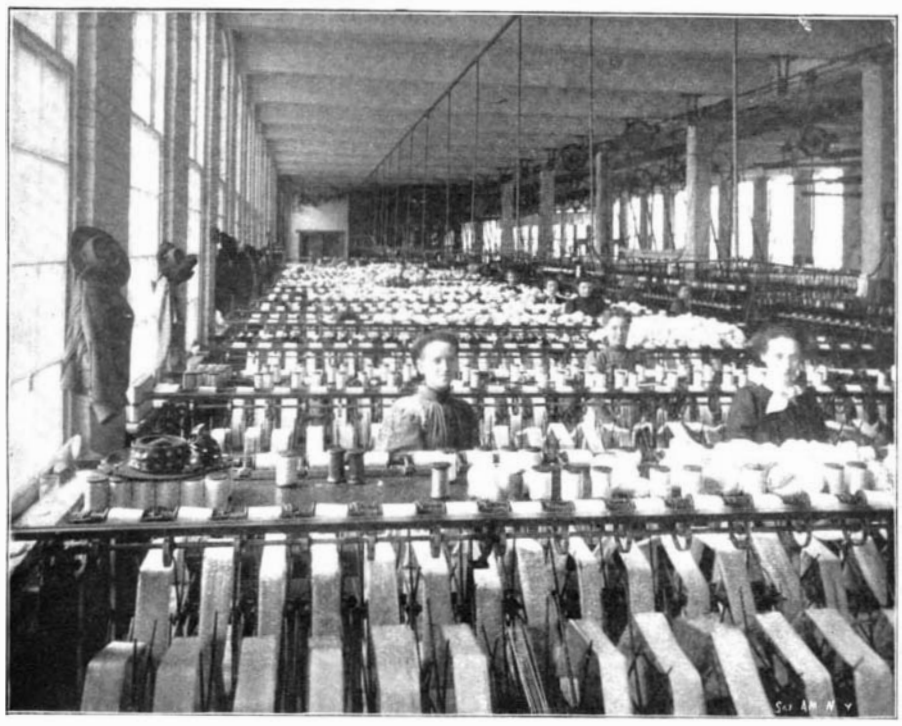
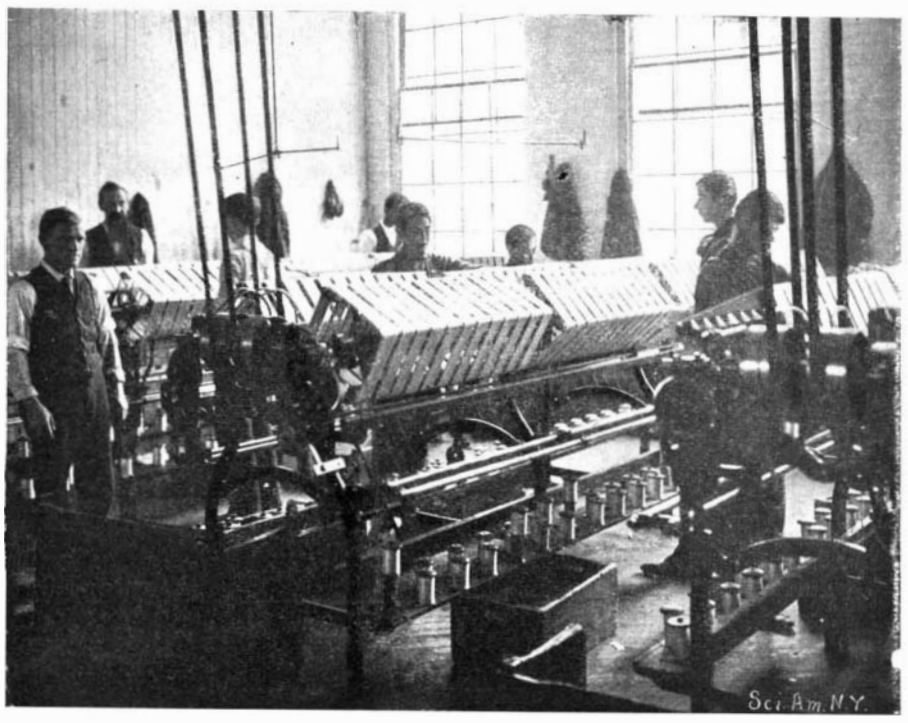


Throwing Silk—Spinning and Doubling Machines.



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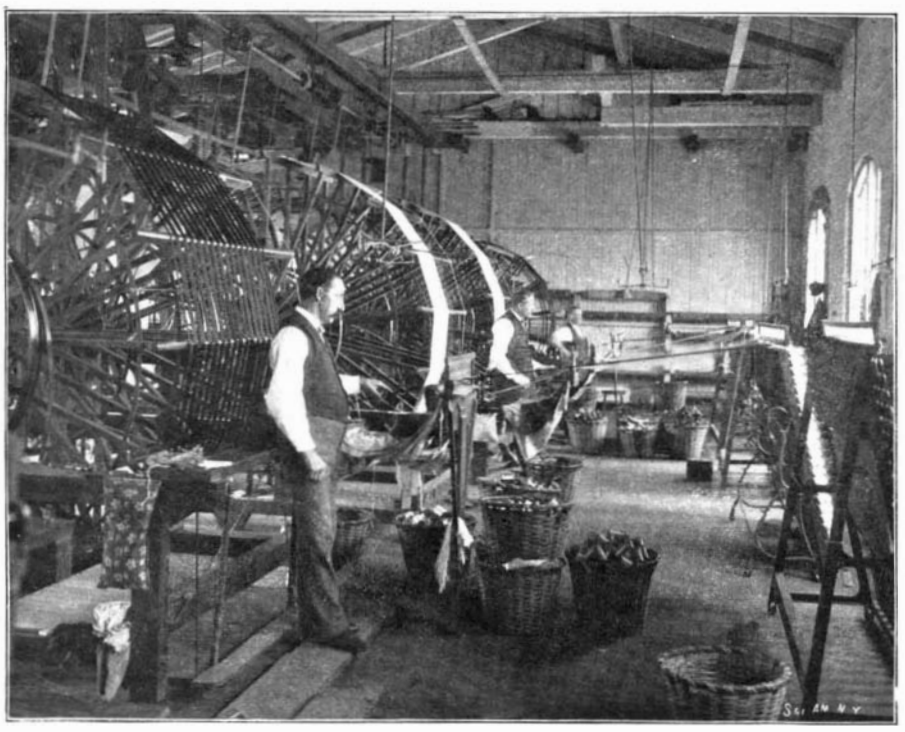

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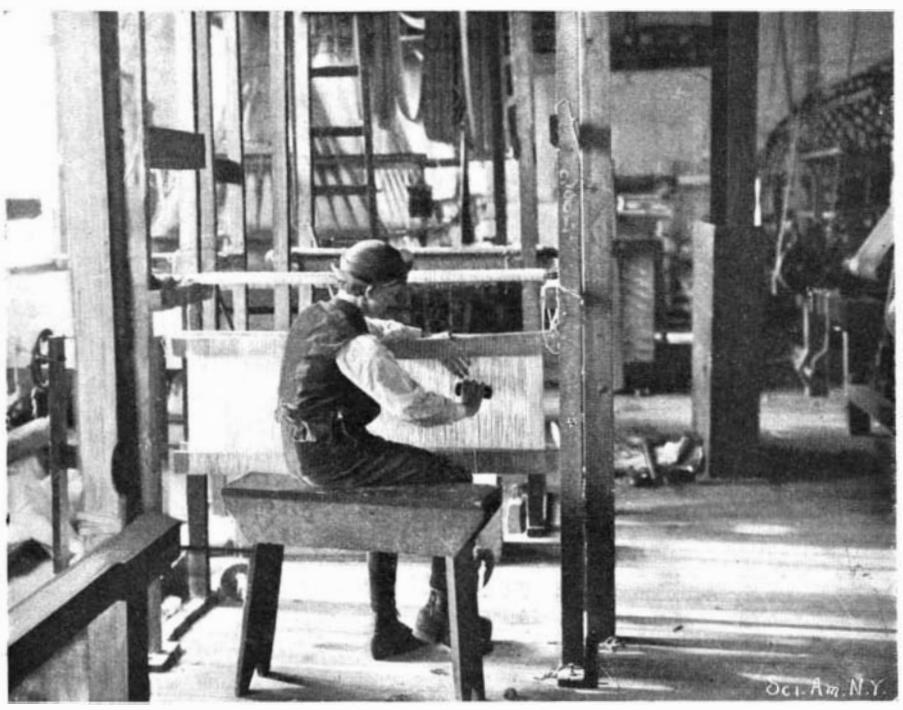
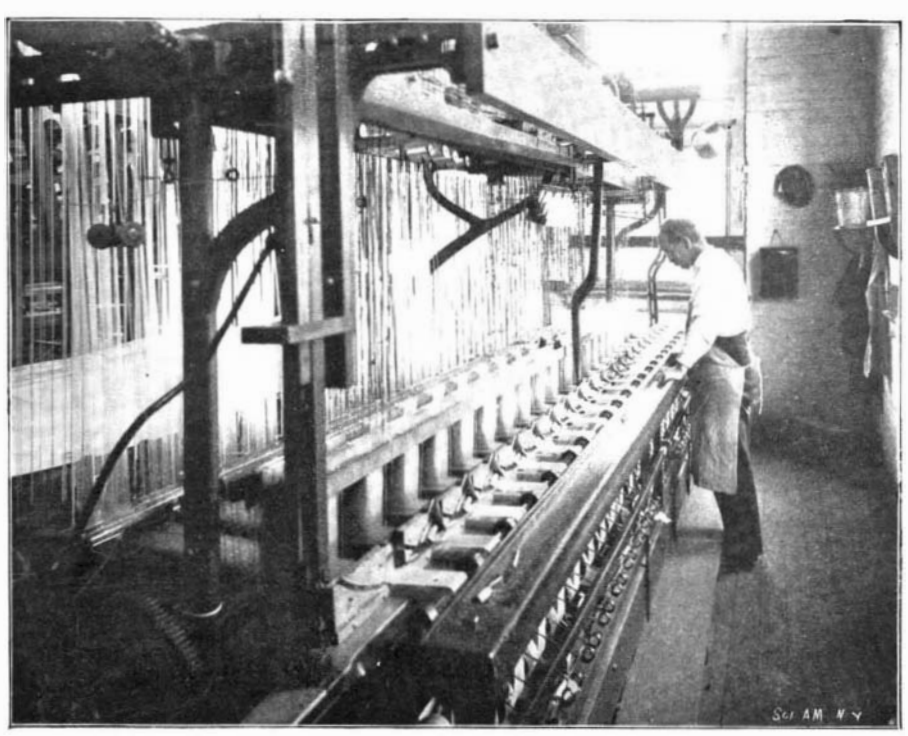
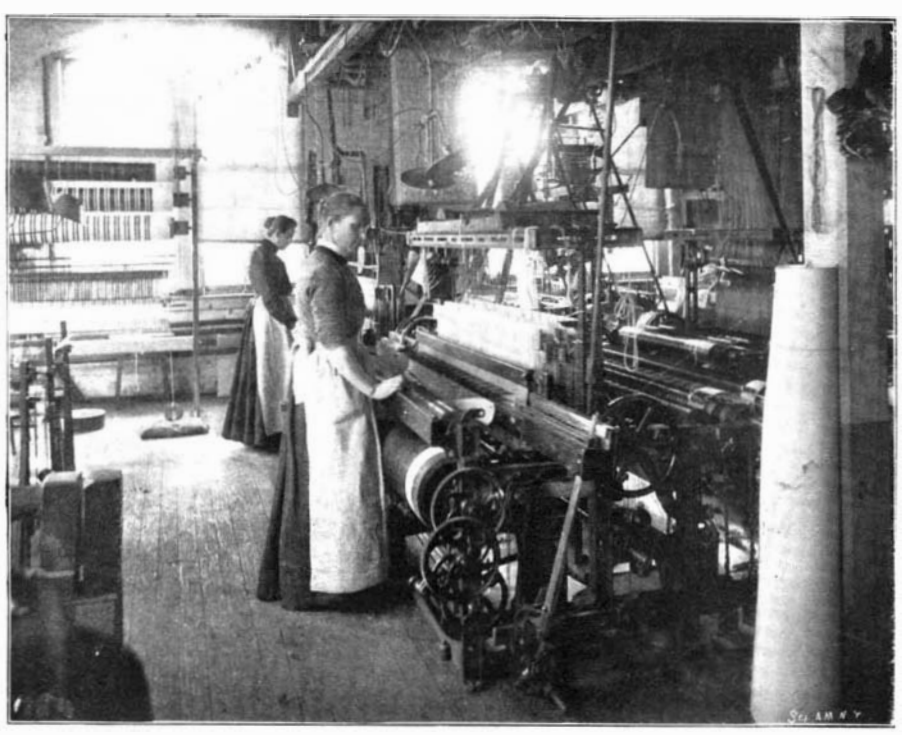


Cleaning a Harness.



A Ribbon Loom.



A Broad Silk Loom.

THE SILK INDUSTRY.—[See page 118.]