basket. The essence is so valuable, that the operatives are closely watched. Six men can work up 8,000 lemons a day: two cut off the peel, while four extract the essence, and obtain 136 gallons of lemon-juice and 7 pounds of essence. In the extraction of essence, defective fruit — thorn-picked fruit, blown down by the wind or attacked by rust — is used. This fruit is sold by the "thousand," equivalent to 119 kilograms, and thus classified: (1) mixed lemons as they come from the groves during December and January, of good quality but not always marketable, often from top branches; (2) lemons from March blooms; (3) lemons refused at the packing-houses; (4) dropped fruit; and (5) shrivelled or deformed fruit.

Lemons grown on clay soil yield more essence and juice than those grown on sandy or rocky soil. Dealers sometimes adulterate their essences with fixed oils, alcohol, or turpentine. Adulteration by fixed oils is detected by pouring a few drops of essence on a sheet of paper, and heating it: upon the evaporation of the essence, a greasy spot will remain. Alcohol is detected by pouring a few drops of the essence into a glass tube in which a small quantity of chloride of lime has been dissolved. The tube is then heated and well shaken, and, its contents being allowed to settle, the essence will float on the denser liquid. For the production of raw and concentrated lemon-juice, the following is the system employed. When the lemons have been peeled and cut in two, as described above, they are carried to the press and thrown into large wicker bags, circular in form, and then well pressed. If the juice is to be exported raw, only perfectly sound lemons can be used; but if the juice is to be boiled down, one-fifth of the lemons may be of an inferior quality. The juice from sound lemons is yellowish in color, and has a pleasant aroma: its density decreases with age.

With all classes of lemons the yield of juice and its acidity vary considerably from month to month. The amount of juice increases from October to April, its acidity and density decrease; and the same is the case with the density of the essence, owing to winter rains. An addition of five per cent of alcohol will prevent raw lemon-juice from spoiling. Lemon-juice is adulterated with salt or tartaric acid. Raw and concentrated lemon-juice is exported in casks of 130 gallons capacity. It requires about 1,500 lemons to yield 26 gallons of juice, while it takes 2,500 to yield the same quantity of concentrated juice, and 2,000,000, more or less, according to their acidity, to give a cask. Experience has shown that the lemons of the province of Messina, especially from the eastern shore, contain more acidity than the lemons grown elsewhere in Sicily. The value of lemon-juice is governed by its acidity. The rule is that concentrated lemon-juice shall show 60 degrees of acidity (the juice extracted from the bergamot or the sour orange must show 48 degrees, or one-fifth less than that derived from the lemon; it also sells for one-fifth less than lemon-juice). Formerly a citrometer, known as Rouchetti's gauge, was used to ascertain the percentage of acidity; now, however, resort is had to chemical analysis, which is said to be more satisfactory to both buyer and seller. Of late years a new article, known as vacuum pan concentrated natural juice of the lemon, has been manufactured at Messina. The juice concentrated by this method contains 600 grains of crystallizable citric acid for every quart. It is exported in casks containing 112 gallons, and in half and quarter casks. It is also shipped in bottles of 500, 300, and 150 grains each. Consul Jones says, in conclusion, that there is an establishment at Messina, probably the only one of its kind in Italy, in which crystallized citric acid is prepared. It takes from 340 to 380 lemons to make a pound of citric acid, which sells at about forty-four cents. The quantity of essence of lemon exported from Messina during the year 1887 amounted to 440,000 pounds avoirdupois, valued at $625,000; while of lemon-juice, 4,438 pipes were exported during the twelve months ended Nov. 30, 1887.

ARTIFICIAL SILK.

SCIENCE and industry are ever combining to copy Nature, and even dare to attempt improvements on her processes. The Champ de Mars contains many illustrations of this; but perhaps the boldest and most curious attempt of this kind is to be seen in the manufacture of artificial silk, described in a recent number of *Engineering*. Near the end of the Machinery Hall, that end by the Avenue du Suffren, and quite close to the elevator which raises passengers to the travelling bridges, there is an exhibit showing the manufacture of silk without any aid from silkworms, and on a system which appears to be entirely novel, and is certainly of wonderful simplicity. The silk industry has seen great vicissitudes, and has had to suffer many cruel troubles from disease both of the worms and of the trees they feed upon; but up to the present we believe that it has been spared the struggles of competition. If this new process should prove to be what it promises, a new and dangerous rival to the silk-trade will have to be reckoned with.

The composition of silk may be briefly described as follows: it is a relatively strong, brilliant material, the produce of the digestive juices of the worm acting on the leaves of the mulberry that constitute its food. The cellulose of the leaf is triturated by the worm, and transformed by its special organism into a peculiar substance, transparent, and somewhat resembling horn. This is called kerotine, and it fills two glands, from which it exudes in the form of two threads, which unite as soon as they leave the body of the worm. But this material no longer possesses the chemical composition of cellulose: it is largely combined with a new element characteristic of animal tissues, — nitrogen. The silk-fibre thus discharged forms a continuous thread, which often reaches the great length of 350 metres, the diameter of the fibre being only eighteen thousandths of a millimetre.

It was reserved for the present generation of inventors to devise a means of imitating by science the mechanical and chemical functions of the silkworm.

An old student of the Ecole Polytechnique, M. le Comte de Chardonnet, set himself some time ago to try and solve the problem. He took as his material pure cellulose, — a material, as we have seen, entirely different to that of which natural silk is composed. Cellulose is, as is well known, the basis of vegetable tissues, and particularly of wood. Thus all soft woods appeared to be well adapted for the purpose: in fact, any material suitable for the production of a good quality of paper — white wood, cotton waste, etc. — appeared fitted for the production of artificial silk. Paper pulp is, in fact, the starting-point of the industry. The first operation to which the pulp is subjected is that of nitration, which transforms it into pyroxile. This is done by steeping the pulp in a perfectly defined mixture of sulphuric acid and nitric acid. After thorough washing and drying, the nitrated cellulose is formed into collodion by dissolving it in a mixture of 38 parts of ether and 42 parts of alcohol. The collodion thus made is drawn into fibre by the mechanical means which will be described presently, but the thread requires further and very important preparation. The fibre, as it issues from the apparatus that imitates the glands of the silkworm, is one of the most inflammable of substances, and in that state would be absolutely useless: an absolute process of denitration is therefore a necessity. Of this operation nothing can be said, because it is kept a secret by the inventor. Its object is of course to extract from the filament the greater part of the nitric acid that it contains, and it would be curious to know if the nitrogen that does remain after the process is in the same proportion as that contained in natural silk.

However this may be, the thread after treatment ceases to be inflammable to any marked extent; but it may, if desired, be rendered still less liable to burn. After the denitration process, the filament becomes gelatinous, and other substances can be incorporated with it. Thus, when in this state, it can be impregnated with incombustible material, such as ammonia phosphate; and it is at this stage that the filament can be dyed to any desired color. This latter operation cannot precede the denitration process, as all the color would be taken out during that operation.

The mode of manufacture is very simple, and in the exhibition three apparatus are shown in operation to the public. The first of these is only a model to illustrate the principle. The chief feature consists of a glass tube reduced at the upper end to a capillary passage. It is through this passage that the filament of collodion is forced out under pressure. As it issues, the fibre is in a pasty state, and would have no consistency if it did not consolidate immediately. This solidification is secured by means of a second glass tube, which surrounds the first one, and extends beyond it.

Connected to it is a small pipe which supplies a current of water that bathes the collodion filament, and sets it so that it can be secured by pincers and drawn out without breaking. It is afterwards led to a spool, on which it is wound.

The second apparatus, which is more complete, contains a number of such glass tubes, and illustrates the method by which two or more filaments can be drawn out and twisted so as to form one thread. The third machine is arranged for practical work. The dissolved collodion is contained in a copper receiver having a capacity of about 15 litres. In this receiver it is subjected to a pressure of from 8 to 10 atmospheres that forces the liquid through a horizontal tube, to which are connected 72 capillary tubes, each with their surrounding water-casings. In this manner 72 filaments of artificial silk are produced simultaneously, and these can be spun into threads of various thickness; three such filaments being twisted as a minimum, and ten as a maximum. To effect this, there is placed parallel to the horizontal tube a rack carrying a series of bronze blades that serve to guide the filaments. The twisted threads are wound upon bobbins running on spindles mounted parallel to the horizontal tube. A frame carrying as many pincers as there are capillary tubes can be put in movement by means of a cord, and, if any of the threads are broken, these pincers take hold of the filament and join up the broken parts. This apparatus is enclosed in an hermetically sealed glass case, through which a current of air is continually forced by means of a fan. This air is warmed to assist in drying the filaments; but it becomes cool at the exit, and deposits the vapors of ether and alcohol. The circulating water, which is employed to harden the filaments, is discharged into a receiver. It contains a large percentage of the volatile products, which can be recovered by distillation, and in this way only about 20 per cent of the ether and 10 per cent of the alcohol are lost. One tube can produce from 3 to 5 pennyweight of filaments per hour, or a length of nearly 1¾ miles. The apparatus works continuously, and with but little attention; and, if by any chance one of the capillary openings becomes sealed, it can be cleared by applying heat.

Under the conditions in which the machine is exhibited at work, the artificial silk can be sold at from 15 francs to 20 francs the kilogram, while real silk costs from 45 francs to 120 francs the kilogram. The manufactured product resembles very closely the natural one. It is smooth and brilliant, and the filament has a strength about two-thirds that of silk. Woven into a tissue, it appears stronger and less liable to cut, this property being due to the fact that it is not charged with destructive materials, which appear to be always used in dying silk, such as zinc or lead. These foreign matters are probably introduced solely for the purpose of weighting the silk; but there is no object for similar adulteration of the artificial product, because the metallic preparations employed cost as much as the collodion thread. According to M. de Chardonnet, the density of his product lies between that of raw and finished silk. Its resistance to a tensile strain varies from 15 tons to 22 tons per square inch (copper breaks under a load of about 18 tons, and iron under 23 tons). The elasticity is about the same as that of natural silk, and the inventor claims that it has a superior brilliancy. M. de Chardonnet exhibits a number of stuffs woven wholly with the artificial silk, as well as others mixed with natural silk and other textile materials. The results are really very remarkable. Among other objects, he shows a chasuble of artificial silk which will bear very close examination.

Artificial silk is not yet manufactured on an industrial scale, but it appears that this will very shortly be done; and, while it is impossible to foretell with certainty what will be the commercial results of this curious invention, it is impossible to resist the conclusion that it is highly practicable, and that it even contains the elements of great future success.

TENTH CONVENTION OF THE NATIONAL ECECTRIC-LIGHT ASSOCIATION.

THE tenth convention of the National Electric-Light Association was held at Niagara Falls, N.Y., on Tuesday, Wednesday, and Thursday, Aug. 6, 7, and 8, the sessions being held in the Casino. The convention was called to order on Tuesday morning by Mr. E. R. Weeks of Kansas City, president of the association, who, in his opening address, briefly outlined the objects of the meeting, and gave a synopsis of the progress made in the electric-light industry since the preceding convention. The address concluded with the statement that statistics of the association show that the number of arc lamps in service in the United States alone during the last six months has increased from 219,924 to 237,017; that of incandescent lamps, from 2,504,490 to 2,704,768; and that the number of street-railroads operated by electricity is now 109, comprising 575 miles of track and 936 motor-cars. The capital invested in these industries at present amounts to $275,000,000.

At the conclusion of his address the president introduced the Hon. W. C. Ely of Niagara Falls, who delivered the address of welcome. In his address Mr. Ely touched upon the much-talked-of project of utilizing Niagara Falls as a motive power for the generation of electricity on a grand scale, quoting Sir William Thomson's statement that Niagara Falls possesses more power than all the coal-mines in the world, and Edison's remark that Niagara is the greatest storage-battery in the world. "This latter," Mr. Ely added, "is absolutely truthful, and, with the power of the waterfall developed by means of an hydraulic tunnel, a system of powerful dynamos to transform the water-power into electricity, and this transmitted to Buffalo, that city might be supplied with light and power far more cheaply than at present, and a demonstration of the capabilities of electrical power and transmission afforded that would give us something more sure than the world has as yet had."

After Mr. Ely's address, the secretary read a letter from the mayor of this city to the president of the association, Mr. Weeks, requesting his presence at a "conference of representative citizens to consider the advisability of holding an international exposition at New York in 1892, and to arrange for the preliminary work if it is deemed advisable." This letter was responded to by the appointment of a committee of five, whose chairman is to represent the association in any manner desired by the mayor. The members of the committee are, Dr. Otto A. Moses of New York, chairman; E. T. Lynch, jun., of New York; C. J. Field of Brooklyn; Fred A. Gilbert of Boston; and J. P. Morrison of Baltimore.

The report of the committee on the revision of the constitution and by-laws was then received, printed copies of the proposed constitution ordered distributed among the members, and its discussion made a special business for the Thursday morning session. The committee on underground conduits and conductors, being called upon for its report, asked for an extension of time until the next annual convention, which was granted. Mr. E. A. Foote then read a paper on "The Value of Economic Data to the Electric Industry," which was discussed by Messrs. Morrison, Morris, De Camp, Coggeshall, and Whipple; and a resolution based upon the paper was adopted, to the effect that a committee of five be appointed by the president to report at the next convention of the association forms and a system of records and accounts to be kept by central station companies, a system for reporting the same to the association, and for comparing and publishing the data so secured, for the use and benefit of the members of the association.

Mr. M. D. Law then read a paper entitled "The Perfect Arc Central Station," treating of boiler-rooms and boilers, engines, shafting, dynamos, switch-board, lines, store-room, and shop. This paper was discussed by Messrs. Morrison, Law, Smith, Leonard, and De Camp. At the close of the session the president announced the following committee on electrical statistics: A. R. Foote, chairman; A. J. De Camp, S. A. Duncan, E. F. Peck, and S. S. Leonard, assistants.

At the Wednesday forenoon session the secretary and treasurer presented their report, showing a present membership of 251, an increase of 55 per cent over last year. The annual income of the association is at present $5,050, and the expenses for the past six months were $2,241.80. The report of the committee on harmonizing electrical and insurance interests was then received and adopted, and the committee continued, with instructions to take under advisement the feasibility of establishing a mutual insurance company. A committee was also appointed to prepare a petition for the abolition of import duties on copper. At the afternoon session a paper was read by Mr. F. A. Wyman, on "The Constitu-