Cot'ton and Cot'ton Manufact'ures. Cotton, (Fr. *coton*, Ger. *baumwolle*, Ital. *bambagia*, Port. *algodao*, Span. *algodon*,) a vegetable hair or filament constituting the wing

The Cotton-plant, (*Gossypium.*)

of the seed of the different species of *Gossypium*, a plant belonging to the order of *Malvaceæ*, growing both in the temperate and tropical climates, indigenous in Asia, Africa, and S. Am. Both fiber and seed are produced in pods not unlike the outer shell of the walnut. When the seed approaches maturity the fiber in which it is enveloped, which had previously been in a cylindrical form filled with watery sap, becomes dry. The sap is then deposited upon the walls of the outer cell, which then collapses longitudinally and takes on a spiral form slightly blunt at the point where it is attached to the seed, and pointed at the end. In the green-seed variety, the one chiefly cultivated, it is of a white or yellowish hue, soft, flexible, and a non-conductor of heat.

The fiber consists chiefly of carbonaceous material drawn from the atmosphere, and is one of the purest forms of cellulose. One may obtain an idea of the tenuity of the C. fiber by consideration of the fact that it takes from 14,000 to 20,000 filaments of Amer. C. to make the weight of one grain, while the separate fibers, placed end to end in a straight line, would extend 2,200 m. within the weight of a single pound of 16 ounces avoirdupois. It is to this spiral form that the possibility of spinning C. is due. The fibers interlock one with another nearly to the end. They are somewhat like a twisted ribbon, a little thicker at the edges than in the middle. After rags have been made into pulp and converted into paper C. can be detected in the latter, if the separate fibers are put under the microscope, so persistent is the spiral twist in each fiber. Although C.-seed, which is produced at the ratio in weight of two and a half to three parts of seed to each one of fiber, has long been the source of valuable oils and food for cattle in Egypt and in India, the C.-seed of the U. S. was, in former days, mostly wasted. It has now become a secondary product of very great value. Tree C. (*G. arboreum*) is found in India, China, Egypt, the western coast of Africa, and in some parts of Am., especially in the West Indies. It only attains the h. of from 12 to 20 ft.; but another C.-bearing tree, (*bombax ceiba*,) seen in the West Indies and elsewhere, familiarly called the umbrella tree, attains the h. of 100 ft. The produce of the latter, however, is of a short and brittle fiber, and is also without the convolution or spiral twist which gives other varieties their spinning quality. Being unfit for spinning, it is only useful for stuffing pillows and beds. Shrub C. (*G. religiosum*) occurs in one or other of its varieties throughout the tropical parts of Asia, Africa, and Am. In appearance it resembles a currant-bush. Its duration varies according to the climate; in the hottest countries it is perennial, while in cooler places it becomes an annual. In the former two crops a yr. are gathered, one from Oct. to Dec., the other from Feb. to April. The Guiana, Brazil, and most of the West India C. is of this kind, the whole being long-stapled. Herbaceous C., (*G. herbaceum*,) commonly called the green-seed variety, is by far the most useful and important of the three kinds we have noticed; it is an annual plant cultivated in the U. S., India, China, and many other countries. It attains the h. of 18 or 24 in. The seed is usually planted in rows in March, April, and May; the C. is gathered by hand within a few days of the opening of the pods, in Aug., Sept., and Oct.; in the U. S. often through Nov. and Dec., or even until it becomes necessary to prepare the land for a new crop. It is to this kind that planters mainly confine their attention in the U. S. In places where C. is most extensively cultivated the following varieties are commonly distinguished: (1) Nankeen C., abundant in produce, the seed covered with down, the wool of a dirty yellow color, and usually low-priced. (2) Green-seeded C., which, as well as the former, is grown in upland and middle districts, whence the latter is called upland, also short-staple, and, from the mode in which it was formerly cleaned, "bowed Georgia C." This kind was at first chiefly raised in Ga. and S. C., but in later yrs. its cultivation has been very greatly extended throughout the Southern States. (3) Sea-island, or long-stapled C., the finest of all, is distinguished by the black color of its seed, and the fine yellowish-white, strong and silky long staple by which it is surrounded; it is grown in the lower parts of Ga. and S. C., near the sea, between Charleston and Savannah, and on small islands adjoining the shore and in Florida. Owing to the peculiar combination of circumstances requisite for the production of this kind, it forms only a trifling proportion of the C. grown in the U. S.; nor is the quantity on the increase. All the varieties of the plant require a dry and sandy soil. Marshy ground is wholly unfit for it, and a wet season is destructive to the crops, which are besides precarious from the disease to which the plant is subject, particularly blight produced by wetness at the roots. In general it flourishes most luxuriantly and yields produce of the best quality on the coast, as is proved by the growth of the sea-island C., which is mostly exposed to the action of the ocean's spray; and a manure of salt mud is known to impart a healthful action to the plant, and to produce a staple at once strong and silky. To this rule, however, the fine Pernambuco C. is an exception; also the Egyptian, the growth of the upper provinces being greatly superior to that of the Nile Delta. In the U. S. the average yield of C. is about one bale for three acres, and a large proportion of the crop is grown W. of the Mississippi; although under good cultivation a bale to the acre is very common, and by special cultivation two, three, and even four bales of 500 lbs. each can be made on a single acre. **History.**—The manufacture of C. has been carried on in Hindustan from the remotest antiquity, but the employment of C. for textile fabrics obtained no footing worth mentioning in Europe till the last c. From the first introduction of C. manufactures in England (probably in the early part of the 17th c.) down to 1773 the weft or transverse threads of the web only were of C.; the warp, or longitudinal threads, consisting wholly of linen yarn, was principally imported from Germany and Ireland. In the first stage of the manufacture the weavers, dispersed in cottages throughout the country, furnished themselves as well as they could with the warp and weft for their webs, and carried them to market when they were finished; but about 1760 a new system was introduced. The Manchester merchants began about that time to send agents into the country, who employed weavers, whom they supplied with foreign or Irish linen yarn for warp, and with raw C., which, being carded and spun, by means of a common spindle or distaff, in the weaver's own family, was then used for weft. In 1767, however, James Hargreaves invented the spinning-jenny. At first this admirable machine enabled 16 to 30 threads to be spun with the same facility as one; and it was subsequently brought to such perfection that a little girl was enabled to work no fewer than from 80 to 120 spindles. A little later Arkwright perfected the method of extending the strands of C. by carrying it through successive pairs of rollers—one plain and one fluted in each pair—arranged in sets of two, three, or even four pairs, those in front revolving at a little higher speed than those behind. In this way, and by constantly bringing two or more strands together into one, great evenness is imparted to the sliver or strand before the final twist is imparted to it by which it is converted into yarn. The jenny was applicable only to the spinning of C. for weft, being unable to give to the yarn that degree of firmness and hardness which is required for the longitudinal threads, or warp; but this deficiency was soon after supplied by the introduction of the spinning-frame, that wonderful piece of machinery which spins a vast number of threads of any degree of fineness and hardness, leaving to man merely to feed the machine with C., and to join the threads when they happen to break. Arkwright gave his machine the name of the water-frame; but it has since become known as the spinning-frame. Nearly at the same time that the spinning department was thus wonderfully improved, Cartwright, in 1787, invented the power-loom, a machine which has almost entirely superseded weaving by the hand. While these extraordinary inventions were being made, Watt was perfecting the steam-engine, and was thus not only supplying the manufacturers with a new power applicable to every purpose and easy of control, but with one that might be placed in the most convenient situations, and in the midst of a population trained to industrious habits. Still, something remained to complete this astonishing sequence of discovery. Without a vastly increased supply of the raw material at a lower price than it had previously brought the inventions of Hargreaves, Arkwright, and Watt would have been of comparatively little value. Luckily, what they did for the manufacturers Eli Whitney did for the Amer. C.-growers. His invention of the C.-gin, which came into operation in 1793, forms an important era in the history of the C. trade. This invention, by which one man can separate 300 lbs. of C. in a day, has powerfully contributed to the extension of its cultivation. In consequence of these and other innumerable inventions and improvements, the prices of C. cloth and yarn have gone on progressively diminishing. But as the demand for C. has been, owing to its extraordinary cheapness, extended in a still greater degree, the value of the goods produced and the number of persons employed in the manufacture have been steadily increasing. The first machines set up in the U. S. were at East Bridgewater, Mass., in 1786, by two Scotchmen, employed by a Mr. Orr of that place. The manufactures, however, languished for want of competent machinery until 1790, when the late Samuel Slater, who had been employed in the English C.-mills in Derbyshire, and had there acquired a knowledge of the Arkwright processes, established himself, in conjunction with partners, at Providence, R. I., bringing the design of the machinery in his memory. In 1806 Slater's brother came over from England, and joined him, when they at once started business at the village of Slatersville, in the same State, and gave an extraordinary impetus to the manufacture in the U. S., which, by 1816, had increased to the consumption of about 100,000 bales of the raw material, turning

out 81,000,000 yds. of cloth, employing 100,000 operatives and engaging a working capital of about $40,000,000. The C.-mill on the power-loom principle, first established in Waltham, Mass., was fully adopted at Lowell, Mass., in 1822 —the nucleus of a system of manufacturing operations which in 1852 had increased to 51 mills, giving employment to 12,633 hands. The manufacture is no longer confined to the New England States, though in these it has been greatly extended. In other Northern States, such as N. Y., N. J., Pa., Del., Md., O., and Ind., new mills have been erected; while in the Southern States, especially in Ala., Ga., S. C., N. C., Miss., Va., etc., the manufacture as well as the growth of C. has become an important industry. The number of spindles, which was 5,235,727 in 1860, and 7,432,415 in 1870, was 15,841,000 in 1894. The capital invested was $98,000,000 in 1860, $141,000,000 in 1870, $201,000,000 in 1878, $224,000,000 in 1888, and $354,020,843 by census of 1890.

Manufacture.—When the pods have been collected from the plants they comprise seeds as well as fibers; and the latter cannot be spun into thread until the former have been removed. This removal of seeds is practically the first stage in the manufacture. It is always done, more or less completely, in the country where the C. is grown, and is called *ginning*. In India the natives have for ages used a single machine, called a *Churka*, consisting of two small wooden rollers so placed as to revolve in contact. The dirty C. is put in at one side between the rollers, the seeds fall down in front, because they cannot pass through; and then the comparatively clean fibers are pushed out at the other side. Want of care in weeding the crop while growing, in picking it when ripe, and in ginning it when picked are the reasons why Indian C. never commands so good a price in the market as the Amer. In this country long-stapled C. used to be *bowed*, or struck with a kind of bow-string plucked with the fingers, to open the tufts. It is now more usually subjected to the action of a wooden roller and a kind of comb. But short-styled C. requires to be ginned, or torn open with some degree of force, to extricate the seeds. Whitney's saw-gin is a vast improvement on the Hindu *Churka*. It comprises a series of circular saws, mounted on a frame, and turned with a fly-wheel; nearly in contact with it rotates another cylinder, mounted with brushes; and the C., drawn between the two, is deprived of its seed by the action of the saw-teeth against the brushes. After traveling along an endless apron, the C. is seized by a spiked roller, partially opened and transferred by a vibrating comb to other rollers studded with blades. The following will give a fair notion of the order of subsequent processes now generally followed, varied in detail in different establishments. An experienced sorter, as soon as the bags are opened, examines and separates, classifies and mixes, according as the C. is wanted for coarse or for fine yarns. Much of the success of the manufacture depends upon this sorting. The C., after sorting, is spread out upon an endless apron of narrow wooden laths, which carries it forward horizontally to the opener, where fluted rollers and cylinders armed with rows of teeth, revolving 1,000 times or more per minute, tear open the tufts of C., and convey them onward in a cleansed condition. A scutcher, called in this country a picker, comprising feed-rollers and toothed cylinders, receives the opened C. at one end, and drags or combs it out into a flat layer, which becomes thinner and thinner, and more even and regular at each movement. This thinning of the layer or fleece results from the last pair of cylinders revolving more rapidly than the first. Processes of *willowing* and *batting* are sometimes employed instead of opening and scutching. In the opener, but more fully in the picker, the C. is converted from the form of fleece to that of a roller, or lap; the fleece, subjected to three or four compressions by rollers, then passes to the cards, where it is narrowed and coiled up on a sort of flat roll. The *carding-engine* has cylinders clothed with fine wire teeth, so arranged that when the laps of C. are drawn between them the teeth drag opposite ways, comb and straighten the fibers, and rub off some of the impurities which attach to them. The best engines of this kind have an apparatus for cleaning the teeth and carrying off the dirt and fragments. The fleece becomes a ribbon or sliver of fine downy substance. Several slivers are passed through four pairs of rollers in the drawing-frame; they all become combined into one, and are at the same time drawn out or attenuated. The C. is now a loose porous cord of parallel fibers. The slubbing-frame contains numerous upright steel spindles, on which rotate steel arms or flyers and wooden bobbins; and it has also a set of rollers. The apparatus is so contrived that the porous cord, as received from the drawing-frame, is still further elongated and attenuated, partially spun or twisted, and wound upon the wooden bobbins. The roving-frame so far resembles the slubbing-frame as to have rollers, spindles, and bobbins; and the object of the roving process is to combine two or more slubbings together by further rolling, twisting, and winding upon smaller bobbins. The C. assumes more and more the condition of a thread, though still having very little hardness or compactness. **Spinning.**—The bobbins full of prepared roving are placed on the top of the frame or in the creel of the mule. Rollers and bobbins and flyers draw out the fibers, elongating and attenuating them, and at the same time twisting them tightly into a compact yarn, well adapted for the warp or long threads of woven goods. In the technical language of a C.-mill, the throstle is used for the hard, coarse yarns up to about No. 40. For fine work the mule is used. In this mule action the bobbins containing the rovings are on a fixed frame; the spindles by which the rovings are to be twisted into yarn are on a movable frame; the movable frame, by traveling 4 or 5 ft. outward, then an equal distance backward, and so on alternately, stretches and attenuates the threads. The two sets of operations, elongating and spinning, succeed each other with exquisite regularity, 1,000 to 1,300 threads, all arranged parallel, being managed by self-regulating mechanism. "*Mule*-yarn," as it is technically called, is twisted more softly and carefully than *throstle* yarn, and is, therefore, more suitable for the weft or cross-threads of coarse goods, and for both warp and weft of fine goods. The C. having been spun, we have next to follow the yarns through the various processes incident to weaving into calico, muslin, etc. The first of these is *reeling*. The reel is a sort of six-sided frame, several feet long, revolving on a horizontal axis. The bobbins and cops are so placed in rows that the yarn unwinds from them, and winds itself upon the reel. One hundred and twenty yds. thus wound are called a *rap*, and seven raps, or 840 yds., make an *hank*. Each hank is removed as wound, and tied so as to keep in place. In order that the hanks may be conveniently packed for sending to market, they are squeezed in a bundling-press. All hanks are the same l., 340 yds.; all are weighed by the same unit of weight, 1 lb.; and the number attached to each kind denotes the number of hanks of that kind which go to a pound. Usually about 10 lbs., of whatever number or fineness, are pressed together to form a *bundle;* and from 30 to 40 of these bundles are pressed together into a *bale*, which then weighs from 300 to 500 lbs. But the yarn may be woven into cloth in the same mill where it has been spun. In this case the reeling and bundling are dispensed with, and the yarn goes at once to the *winding-machine*. This is an assemblage of rollers and other mechanism by which the yarn is unwound from the spindles and cops, passed through minute slips or openings that will scrape off roughnesses and inequalities of surface, then passed under the action of brushes which clear it of dirt, and finally wound on bobbins. The yarn is now for the first time to be brought into parallel threads, the first germs of the warp of the cloth. The warping-machine employed is so constructed as to wind the yarn from the bobbins, and wind it round a large roller, with as much parallelism as possible, and an equable degree of tension. C. is never woven in its natural state. It receives a dressing or coating of some kind of liquid size, in a machine known as a slasher, which is allowed to dry before the weaving begins. The object is to diminish the roughness on the fibrous surface of the yarns, and thereby facilitate the weaving. The yarns from several rollers are unwound and made to pass through a vessel of hot liquid size on the slasher, and then between rollers which squeeze the glutinous composition into the very heart of the thread. Thence the yarns pass over drying cylinders, made of sheet-iron or copper, heated within steam-pipes. This quickly dries the size, and prepares the yarn to be wound upon the *weaver's beam*, a roller which receives uniform layers from end to end. The *beaming* is for the warp thread; the *winding* for the weft. The yarn for the weft, usually softer and finer than for the warp, is placed in the shuttle. Then comes the actual weaving process, for which we refer to Loom and Weaving. When the C. cloth has been woven, it winds itself upon a roller called the *cloth-beam*, which is then taken to the *folding-machine*, by which the cloth is unwound, measured, and folded with great precision. Whether the cloth is to be sold in the gray or unbleached state, or whether it is to be bleached, (with or without subsequent dyeing or printing,) it is removed from the folding-machine to the hydraulic press, where it is

compressed into compact bales of definite size, the weights of which are made to suit various markets. (See BLEACHING, CALICO-PRINTING, DYEING, etc.) The progress in C. production, like that of many other industries in this country, is westward. In 1849 Ala. stood in the front rank, with 22.8 per cent. of the crop, and Ga. ranked next, with Miss. following closely. Scarcely an eighth of the crop was produced W. of the Mississippi. In 1869 about three tenths of the product came from beyond the Mississippi. N. C. had declined from 2.9 to 2.7 per cent., S. C. had fallen from 12 to 6.4, and Ga. from 19.8 to 13. La. had advanced from 7.2 to 14.4, and Ark. from 2.2 to 6.8. At the present time more than three eighths of the crop is grown W. of the Mississippi, Tex. making rapid strides.

COTTON MANUFACTURES OF THE UNITED STATES.

From the Report of the Tenth Census upon the Specific Cotton Manufacture of the United States.

STATES.	Number of Looms.	Number of Spindles.	Number of Bales of Cotton used.	Persons Employed.
Alabama	1,060	55,072	14,887	1,600
Arkansas	28	2,015	720	64
Connecticut	18,036	931,538	107,877	15,497
Delaware	823	48,858	7,512	695
Florida	.....	816	350	33
Georgia	4,713	200,974	67,874	6,678
Illinois	24	4,860	2,261	281
Indiana	776	33,396	11,558	720
Kentucky	73	9,022	4,215	359
Louisiana	120	6,096	1,354	108
Maine	15,978	696,685	112,361	11,318
Maryland	2,325	125,014	46,947	4,159
Massachusetts	94,788	4,465,290	578,590	62,794
Michigan	131	12,120	600	208
Mississippi	704	26,172	6,411	748
Missouri	341	19,312	6,399	515
New Hampshire	25,487	1,008,521	172,746	16,657
New Jersey	3,344	232,305	20,569	4,658
New York	12,822	578,512	70,014	10,710
North Carolina	1,960	102,767	27,508	3,428
Ohio	42	14,328	10,597	563
Pennsylvania	10,541	446,379	86,355	11,871
Rhode Island	30,274	1,649,295	161,694	22,228
South Carolina	1,776	92,788	33,099	2,195
Tennessee	1,068	46,268	11,699	1,312
Texas	71	2,648	246	71
Utah	14	432	.....	29
Vermont	1,180	55,088	7,404	735
Virginia	1,324	44,336	11,461	1,112
Wisconsin	400	10,240	3,173	282
Total	230,223	10,921,147	1,586,481	181,628

NOTE.—The above does not include the Hosiery Mills, or any of the mills known as Woolen Mills, where cotton may be a component material used in the manufacture. These classes will be found treated in the article WOOL.

COTTON CROP OF THE UNITED STATES.

Year.	Bales.	Year.	Bales.
1829	870,415	1862-65	No record.
1830	976,845	1866	2,193,987
1831	1,038,848	1867	2,019,774
1832	987,487	1868	2,593,993
1833	1,070,438	1869	2,439,089
1834	1,205,324	1870	3,154,946
1835	1,254,328	1871	4,352,317
1836	1,360,752	1872	2,974,351
1837	1,422,930	1873	3,930,508
1838	1,801,497	1874	4,170,388
1839	1,360,532	1875	3,832,991
1840	2,177,835	1876	4,669,288
1841	1,634,945	1877	4,485,423
1842	1,683,574	1878	4,811,265
1843	2,378,875	1879	5,073,531
1844	2,030,409	1880	5,757,397
1845	2,394,503	1881	6,589,329
1846	2,100,537	1882	5,435,845
1847	1,778,651	1883	6,992,234
1848	2,347,634	1884	5,714,052
1849	2,728,596	1885	5,669,021
1850	2,096,706	1886	6,550,215
1851	2,355,257	1887	6,513,623
1852	3,015,029	1888	7,017,707
1853	3,262,882	1889	6,935,082
1854	2,930,027	1890	7,313,726
1855	2,847,339	1891	8,655,518
1856	3,527,845	1892	9,038,707
1857	2,939,519	1893	6,717,142
1858	3,113,962	1894	7,527,211
1859	3,851,481		
1860	4,669,770		
1861	3,656,006		

NOTE.—The average net weight per bale is 440 lbs.