CHINA.

THE MARITIME CUSTOMS.

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THE PRINCIPAL ARTICLES OF CHINESE COMMERCE

(IMPORT AND EXPORT).

With a description of the origin, appearance, characteristics, and general properties of each commodity; an account of the methods of preparation or manufacture; together with various tests, etc., by means of which the different products may be readily identified.

BY

ERNEST WATSON,

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PREFATORY NOTE.

In issuing this book as a Service publication, the primary object is to provide a textbook on articles of Chinese commerce, the need for which has long been felt, to the Examining branch of the Customs Service; and it is hoped that the book, which has been compiled under the Inspector General's instructions by Mr. E. Watson, Chief Appraiser, will be found useful in Examining work and will be carefully studied.

C. A. V. BOWRA,
Officiating Inspector General, ad interim.

Inspectorate General of Customs,
Peking, 13*th August* 1920.

INTRODUCTION.

THIS volume, written at the special request of the Inspector General for the use of the Examination staff of the Customs Service, is a collection of information on the various commodities met with during many years spent in the Chinese Customs. Although based on notes made originally for personal use, numerous works of reference have also been consulted and freely quoted from. To the authors of these works, a list of which follows, acknowledgments and thanks are tendered, also to Lady Aglen, for the use of her library; to Mr. E. Bull, for information on Chinese methods of dyeing with indigo; to Messrs. Edward Evans and Sons, Shanghai, for the illustration of the microscope; to Messrs. Macmillan & Co., for permission to use the illustration on Fibres, from "The Structure of the Cotton Fibre" and "The Structure of the Wool Fibre," by Dr. Bowman; to Mr. W. J. Lye, for packings of tea; to Mr. W. S. Bungey, for packings of tobacco and cigarettes; to Mr. Henning, for packings of metals; to Mr. J. Pearson, for packings and weights of silk; to Messrs. Brunner, Mond & Co., for packings of soda; and to the technical staff of the Inspectorate General of Customs, Statistical Department, for preparing the illustrations, etc., particularly to Mr. E. Poskitt for the care he has used in passing the proofs and for the helpful queries he has raised. The undersigned is also indebted to the late Rev. F. W. Baller for many useful suggestions and to the late Dr. G. E. Morrison for valuable advice and for the use of his library.

ERNEST WATSON.

SHANGHAI, *March* 1923.

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THE PRINCIPAL ARTICLES OF CHINESE COMMERCE

(IMPORT AND EXPORT).

SECTION I.

FIBRES.

絲　絨　蔴　棉　各　線　類

(Ssŭ, Jung, Ma, Mien, Kê Hsien Lei.)

COTTON (棉 花, *Mien-hua*).—Cotton is the seed hair of various species of *Gossypium*, plants which belong to the natural order *Malvaceæ*.

According to practically all authorities, the cotton plant originated in the East; it is also considered to be indigenous to the West Indies and to South America. There is no doubt that cotton was known in very ancient times, and old records state that as long ago as 400 B.C. it was used for textile purposes in or near China. It was not until the twelfth century A.D., however, that the cotton plant was actually cultivated to any great extent in China for the sake of its fibre, although the "cotton tree" *(Bombax malabaricum)*, and possibly *Gossypium* also, appears to have been grown for ornamental purposes long before that date. History states that in order to encourage and properly establish the cultivation of *Gossypium*, a large proportion of the tribute exacted in China during the thirteenth century was levied in cotton, with the result that by the fourteenth century the cotton plant was cultivated throughout a great part of the country.

World's Crop of Cotton.—The cotton plant is now very widely distributed and is grown in most tropical and sub-tropical countries between latitude 34° S. and 45° N. Of the world's cotton crop (which weighs about 12,000 million pounds, and which is worth about three and a half times as much as the whole of the gold extracted from the earth in one year), about six-tenths is produced in the United States, in which country there are about 35,994,000 acres of land under cotton cultivation, most of the crop being produced in the South Atlantic and Gulf States; India, Egypt, Brazil, Russia, and China are also important producers. A competent authority states that of all countries in the world, China ranks third as a cotton producer, the amount of her crop being exceeded only by that of the United States and of India. It is estimated that at least from 700 to 800 million pounds weight of cotton are produced annually in China, the chief cotton-producing districts being Kiangsu, Chekiang, Hunan, Hupeh, and North China. Due mainly to the efforts of Mr. Chang Chien, the cultivation of cotton has made rapid strides in Kiangsu province during recent years, particularly in the Tungchow district.

Tientsin, Hankow, Shanghai, and Ningpo are the principal centres of the Chinese cotton trade. Most of the cotton exported from China goes to Japan, but considerable quantities are also shipped to Europe.

Consumption of Cotton Goods in China.—Although China grows such a large amount of cotton, she imports more cotton yarn than any other country in the world; in addition, Chinese cotton mills produce from 200 to 250 million pounds of cotton yarn annually. In cotton piece goods, China is second only to India in the amount imported, while the cotton cloth woven in China is considered to be more than that imported from abroad. This huge consumption of cotton in China is due to the fact that the bulk of the population dress in cotton clothes the whole year round (summer and winter), thick clothing, bed covers, etc., for winter use being made of cotton cloth wadded with raw cotton.

Varieties of Cotton.—As cotton is grown over such a wide area, the fibre naturally varies considerably in quality and in appearance. Almost all cotton is white, or almost white, but coloured varieties are also produced to a certain extent in various places. Reddish, brown, yellow, and grey cottons are grown; a green cotton has been evolved in South Carolina, and even a jet-black cotton is said to have been developed in Mexico; it is also considered feasible to produce a blue cotton. The numerous varieties of cotton produced throughout the world are usually named after the country of origin, the best known being: "American cotton," also known by the name of the state in which it is grown and by various other names, such as "Uplands" ("long" staple and "short" staple), "Peelers," "Benders," "Allenseeds," etc.; "Indian cotton," also called "Surat," from the name of the port whence it was formerly shipped; "Egyptian cotton," grown from American seed in the Nile Valley and Delta; "Brazilian" and "Peruvian" cotton, from South America; "Chinese cotton," from China, etc.

According to length of staple, the various cottons are roughly classified as follows: (1) Sea Island cotton; (2) Egyptian cotton; (3) South American cotton; (4) American cotton; (5) Eastern cotton, including Indian, Chinese, Japanese, etc.

Sea Island Cotton.—Sea Island cotton is said to have been originally a native of the West Indies, but it is now grown chiefly along the Atlantic coast of South Carolina, Florida, and Georgia, the finest quality being produced in the Sea Islands off the coast (Edisto, St. John, Wadmalow, etc.), where it is largely cultivated and whence it derives its name. The seeds are black in colour and bear long fibres only. The plant grows from 3 to 8 feet in height and yields the most perfect and most valuable cotton fibre grown. The average length of the staple is almost 2 inches. Much of the cotton grown in the Sea Islands themselves is about $2\frac{1}{2}$ inches in length; the same variety when grown on the mainland (in the districts within 100 miles from the coast) has an average staple of from $1\frac{5}{8}$ to $1\frac{3}{4}$ inches. Sea Island cotton has a small diameter, is very silky, and is uniform in length and strength. So extremely fine is this cotton that it is said to have been spun into counts as fine as 2,150 hanks to the pound. Sea Island cotton is used for making the finest yarns, threads, and laces; it is of paramount importance in the thread industry and, on account of its fineness and strength, is preferred to all other cottons for making the linings of pneumatic tires.

Egyptian Cotton.—Egyptian cotton, grown from American seed in the Nile Valley and Delta, is very silky, strong, fine, and supple. It is of a golden or brownish yellow colour and is used in the production of yarns up to about 200's, which are afterwards manufactured chiefly into hosiery and underwear.

South American Cotton.—As regards staple and quality, South American cotton stands midway between Egyptian and American cottons. It has a staple of from 1.15 to 1.35 inches and is used in manufacturing yarns up to about 60's.

American Cotton.—American cotton, grown chiefly in the Southern States, is the cotton which forms the greater part of the world's crop. This class of cotton, of which there are said to be over 500 different varieties, is very carefully and skilfully grown, gathered, and cleaned. It is made into counts of up to about 50's and is the most useful of all cottons, as its peculiar properties cause it to be suitable for spinning into the particular class of yarns from which the greater part of cotton piece goods are woven. The bulk of the crop has a staple of about 1 inch; a longer stapled cotton ($1\frac{1}{8}$ to $1\frac{5}{8}$ inches) is also grown, but not nearly to the same extent as the shorter stapled variety.

Eastern Cotton.—Eastern cotton is usually coarse, uneven, and of short staple, the staple varying from 0.30 to 1.20 inches. Chinese cotton is whiter than Indian cotton, but is shorter in staple. Some Indian cotton can be used for yarns up to 32's, but the cotton produced in China is, as a rule, unsuitable for spinning yarns finer than 16's or 20's, these yarns being used chiefly for wefts. The best quality of Chinese cotton on the Shanghai market comes from Tungchow, Kiangsu. It is of good white colour, soft, and fairly strong, and has a staple of from $\frac{3}{4}$ to 1 inch. Tungchow cotton is suitable for spinning yarns of 12, 14, or 16 count, some being used for 20's or even over. It is usually quoted at about Tls 1 per picul higher than any other cotton on the Shanghai market. Taichong cotton comes next as regards quality, the cotton grown near Shanghai and Ningpo being slightly inferior. Poor qualities which are not suitable for spinning into yarn are shipped to Japan, where they are used in making wadding, stuffing, explosives, etc.

From time to time efforts have been made in China to cultivate cotton from American seed, but the results obtained have been varying and, on the whole, not very satisfactory. One of the reasons for the lack of success is said to be that, though the American cotton grows to a good height, it takes longer to mature than the Chinese cotton does and so interferes with other crops which are usually grown after Chinese cotton has been gathered. The bolls on American cotton are also said by Chinese farmers to open upwards (instead of downwards, as Chinese cotton does), so that an excess of rain causes the cotton to rot or be otherwise damaged and frequently to fall off before reaching maturity. Other objections are that American cotton is usually more liable to the attacks of insects than Chinese cotton is, and that, though longer in staple, it is not as strong as the native cotton. Many experts, however, are of the opinion that American cotton can be successfully grown in China and suggest that extensive experiments be carried out. The soil and climate of China are considered to be very favourable to the growth of cotton, and probably, when the efforts that are now being made to improve the cultivation are conducted on a larger scale, there will be a tremendous improvement in the quality of the cotton produced in China.

In addition to the numerous varieties and species of *Gossypium* already mentioned, there are many so-called "cottons" known by various names, such as "silk cotton," "vegetable cotton," etc. Probably the best known of these is "kapok," the seed hair of a large tree *(Eriodendron*

anfractuosum, or *Ceiba pentandra)* found growing in many tropical countries, particularly in Java and the Philippine Islands. Kapok is exceedingly light and silky; it is also said to be both waterproof and insect-proof, on which account it is now being extensively used in making waterproof garments. The "tree cotton" of South China (木棉花, *mu-mien-hua*) is the seed hair of *Bombax malabaricum*, a large tree 30 to 40 feet high, with a red flower. It is used chiefly for stuffing cushions, etc., but is also used by the Chinese in medicine, in the treatment of menorrhagia, and to staunch a flow of blood; the Chinese also use the bark of the tree as an emetic and astringent, and both the leaves and roots for other medicinal purposes. Kapok, tree cotton, and other similar so-called cottons differ from ordinary cotton in that their fibres are straight and smooth and have no twist; because of this absence of twist, such fibres cannot be successfully spun into yarn. They are, however, frequently mixed with wool and used for high lustre fabrics, but, on account of their elastic, springy nature, are chiefly used for stuffing mattresses, pillows, cushions, etc.

Animalised Cotton.—"Animalised cotton" consists of ordinary cotton which has been mordanted and then coated with solutions of wool, silk, or gelatine in order to increase the lustre of the fibre and to enable the cotton to be dyed with the same dyes as those used to dye wool and other animal fibres.

Silicate Cotton.—*See* separate heading.

Absorbent Cotton (脫汁棉 or 脫脂棉, *T'o-chih-mien*; 食水絮, *Shih-shui-hsü*; or 吸液棉, *Hsi-i-mien*).—Absorbent cotton, or *Gossypium purificatum*, sometimes called "cotton wool," consists of purified raw cotton freed from fat, wax, etc., and thereby rendered absorbent by being boiled in a weak alkaline solution, then bleached in a weak solution of chloride of lime, and immersed in a dilute solution of hydrochloric acid, and finally rinsed in pure water. Absorbent cotton is often medicated with boracic acid, salicylic acid, etc., and is used by doctors and surgeons to staunch the flow of blood from wounds, etc. It is imported into China usually in ½-pound or 1-pound paper packages.

The Cotton Plant.—The various species of *Gossypium* vary in height from 2 to over 20 feet and, owing to differences of soil, climate, cultivation, etc., are so numerous that botanists are not agreed as to how many species there really are. In some cases the plant is a perennial; in others, an annual or biennial; while, according to some authorities, all species of *Gossypium* are perennial, under suitable environment, if left alone.

Growth of Cotton.—Cotton flourishes best in a light, sandy soil near the coast, and requires an even temperature, with plenty of rain during the late spring and early summer months; it is easily damaged by frost. By raising new plants from seed every year better results are obtained than by allowing the plants to grow for several years. In the Yangtze region the seed, which is either white or yellow, is sown in the spring, the crop being gathered in autumn, while in Chihli and other northern provinces the seed is sown in November and the crop gathered about the following September. As a rule, about one week after the seed has been sown the plant shows above the ground. Almost five weeks later the first buds appear, and after another period of 20 to 30 days expand into flowers, which vary in colour from white to red. The

boll, or capsule, which is left after the fall of the flower, is divided into from three to five cells, which contain the seeds—frequently over 30 in number,—to the surface of which the cotton fibres are attached. The boll increases in size for about 60 days after the fall of the flower and then opens, thus liberating the seeds and fibres, which rapidly expand into a large fluffy mass, which, when ripened by the action of the sun and air, is ready for gathering. The crop, which consists of the seeds and the fibres attached to them, is picked by hand and is known as "seed cotton" (子 棉, *tzŭ-mien*).

Yield per Acre.—On experimental stations in China a yield of about 1,120 pounds of seed cotton (from American seed) has been obtained from 1 acre, the largest yield from native seed grown under similar conditions being about 800 pounds per acre. The ordinary yield of Chinese raw cotton (*i.e.*, "lint," or fibre) per acre is from 150 to 200 pounds, but a yield of from 200 to 300 pounds per acre is quite frequently obtained from good land. In America 350 pounds of raw cotton per acre is considered to be a remarkably good crop, although higher yields are sometimes obtained; the average yield of the whole cotton-growing area in the United States, however, is rather less than 200 pounds of raw cotton per acre.

Chinese seed cotton yields from 25 to 30 per cent. of raw cotton; in that respect it compares fairly well with American seed cotton, which yields from 25 up to 45 per cent., the latter proportion very rarely, the average yield being rather less than 33⅓ per cent. Of cotton seed itself, about 40 per cent. is hull.

Ginning.—Formerly the fibres were separated from the seed by hand, but this is now done by a process called "ginning," the machine used being called a "gin" (軋 棉 機, *ya-mien-chi*).

There are many varieties of gins, some of which, however, are liable to tear or otherwise damage the fibre. In the Macarthy gin, now extensively employed for long-stapled cottons, a specially constructed leather roller brings the seed cotton in contact with a metal plate (called the "doctor") fixed tangentially to the roller; at the same time a carefully adjusted blade (called the "beater") strikes the cotton repeatedly and thus causes the seed to fall out. Another variety, known as the "saw" gin, more rapidly separates the lint from the seed, but frequently damages the fibre to a more or less extent during the process. In using the saw gin the cotton is placed in a box with a grating on one side, through which project a number of steel discs, notched on the edge and called "saws"; when these saws are made to rotate, the teeth catch hold of the fibre and pull it away from the seed; the fibre is then carried away from the saws by means of a strong current of air.

As a result of ginning, which is the first mechanical process to which cotton is subjected, two products are obtained—cotton seeds and cotton fibre (also called "lint"), the latter constituting the "raw cotton" of commerce. The process of ginning is a very important one; it should not only separate the fibre from the seed, but should also remove any coarse impurities, such as leaves, twigs, etc., that may be present in the crop. All pieces of broken seed should also be removed, because if any particles of seed, no matter how small, get mixed with the yarn they give trouble in dyeing, on account of the oil which they contain. (Particulars of cotton seed, and of the oil and other products obtained from the seed, are given under the heading of "Cotton Seed Oil.")

Packing of Raw Cotton.—Chinese raw cotton, for use in China, is usually packed in long bags made of coarse white or greyish cotton cloth, each bag, as a rule, being bound with a strong hemp rope. The packages vary considerably in size. The largest (about 82 by 46 inches) weigh from 225 to 250 pounds net; the medium (about 70 by 44 inches) weigh from 160 to 170 pounds net; while the smallest (about 48 by 36 inches) weigh from 75 to 95 pounds net. Chinese raw cotton for export abroad is packed by hydraulic pressure into bales, which are covered with burlap or gunny cloth, and which are securely bound with narrow hoop iron wrapped round the bale from 12 to 18 times. The size of these bales varies from 48 by 19 by 19 inches to 48 by 24 by 18 inches, there being about 44 pounds per cubic foot in large bales and 46.6 pounds per cubic foot in small bales; the net weight is usually from 350 to 400 catties (467 to 533 pounds). Raw cotton imported from abroad is in similar shaped bales hydraulically packed and then bound with hoop iron. That imported from India is in bales containing 392 pounds net ($3\frac{1}{2}$ hundredweight), 400 pounds net, or sometimes 500 pounds net and, like Chinese-packed cotton, is covered with jute or gunny cloth and lashed with iron or mild steel hoops.

Chemical Composition of the Cotton Fibre.—Cotton as it comes on the market contains roughly about 88 to 91 per cent. of cellulose, 8 per cent. of water, and from 1 to 4 per cent. of other substances, consisting of cotton wax, cotton oil, pectic acid, colouring matters, and albuminous matters. The exact composition varies with the nature and condition of the cotton; the water contents vary with the humidity of the atmosphere and with the amount of adulteration practised. Almost all the substances other than cellulose are removed during the bleaching process; thus bleached cotton consists of almost pure cellulose.

Cellulose.—Cellulose ($C_6H_{10}O_5$) (called in Chinese, 木材質, *mu-ts'ai-chih*), of which the cotton fibre mainly consists, enters largely into the composition of all vegetable fibres and occurs in the wood of all trees and in the stems and leaves of almost all plants. It is white or almost colourless, tasteless, and odourless. When smouldering, it emits a characteristic, though not unpleasant, smell, but when burning freely gives off very little odour. Cellulose is insoluble in water, alcohol, ether, or other ordinary solvents, but dissolves in concentrated solutions of zinc chloride, copper hydroxide in ammonia, concentrated sulphuric acid, etc. (*see* "Tests for Fibres"); the solution in zinc chloride is used for making cellulose filaments, which are carbonised for use in incandescent lamps. Cellulose is characterised by being coloured from violet to blue by sulphuric acid and iodine; chloriodide of zinc; chloriodide of calcium; iodine and aluminium chloride; or iodine and phosphoric acid. By being dissolved in concentrated sulphuric acid and the solution being afterwards diluted and boiled, cellulose may be converted into a kind of sugar, known as "glucose" or "dextrose."

Water Contents of Cotton.—Although cotton is very hygroscopic, any excess over 8 per cent. of water is usually regarded as adulteration, except in very damp climates. As the quantity of water in baled cotton is not subject to great variation (unlike wool or silk), it has been suggested that the adulteration of cotton by dishonest merchants might be controlled to a great extent by packing cotton into bales (by hydraulic pressure) as soon as it has been ginned.

Conditioning Houses, etc.—In order to check the adulteration of cotton, "testing stations," or "conditioning houses," have been established in the principal commercial centres

throughout the world, the method of determining the percentage of water being conducted as follows. A sample of from 2 to 3 pounds is weighed in the condition in which the cotton is received. After being dried in a specially constructed oven (heated to about 212° F.) until all moisture has been evaporated, the sample is again weighed; the allowance representing the legal percentage of water is then added to the dry weight and calculations made in order to arrive at the percentage of water originally contained in the cotton being tested. A certificate is afterwards issued to the merchant showing the result of the testing operation. It is stated that if 100 parts of absolutely dry cotton be exposed to air of ordinary humidity, about 8½ per cent. of moisture will be absorbed; hence this is the percentage of water adopted as the standard allowance for moisture in cotton throughout all official testing houses in Great Britain, Europe, and the United States.

In the Shanghai Cotton Testing House,* established in 1911, 12 per cent. is adopted as the standard allowance for moisture, although cotton containing up to 15 per cent. is also accepted. When a merchant applies to have cotton tested, an employé of the Cotton Testing House is detailed to draw the necessary samples—from 10 to 20 per cent., according to the condition of the cotton. These samples are sent in closed tins to the testing house, and from them a portion, say, 50 grammes, is carefully weighed and afterwards placed in an oven in which it is exposed to a temperature of 220° F. for one and a quarter hours until every vestige of moisture has been evaporated; the sample is then again carefully weighed. The moisture present in the original sample is represented by the difference in weight between the cotton in its original state and in its dry state. The calculation for ascertaining the percentage of moisture is made as follows:—

Example:

Weight of sample in its original moist state, say, 50 grammes.

Weight of sample when absolutely dry, say, 45 grammes.

$\frac{45 \times 100}{50} = 90$; $100 - 90 = 10$, that is, 10 per cent. loss in weight, and, therefore, 10 per cent. moisture.

A shorter and more convenient method of making the calculations is as follows:—

$50 - 45 = 5$; $5 \times 2 = 10$; that is, 10 per cent. moisture.

Strictly speaking, this method is not quite correct, as the amount allowed for regain should, according to the practice in Europe, be added to the dry weight of the cotton, as is shown in the following example taken from the "Cotton Year Book":—

"Suppose 2 pounds of cotton, taken from a 480-pound bale, to lose 4 ounces in drying. The dry weight is thus 1 pound 12 ounces, or 28 ounces. Adding 8½ per cent. of the latter (namely, 2.38), we obtain 30.38 ounces as the correct weight. Then, by proportion, if the correct weight of 2 pounds, or 32 ounces, be 30.38 ounces, what is the correct weight of 480 pounds?

$$\frac{30.38 \times 480}{32} = 455.7 \text{ pounds.}$$

Excess moisture = $480 - 455.7 = 24.3$ pounds."

* From particulars kindly supplied by Mr. R. Macgregor, late manager of the Shanghai Cotton Testing House.

With each lot of cotton tested in Shanghai a certificate is issued, on which is recorded the maximum, the minimum, and the mean percentage of moisture in the samples tested; when the mean water contents do not exceed 12 per cent., the certificate is stamped "Standard"; if over 12 per cent. and not more than 15 per cent. of moisture is found, the certificate is stamped "Below Standard."

A *pro forma* of the certificate issued by the Shanghai Cotton Testing House is here given; on the face of the document the particulars are written in English; on the back, in Chinese.

(Recto.)

FORM F.

Application No. C ..... *Certificate No. C* .....

SHANGHAI COTTON TESTING HOUSE.

COTTON TEST CERTIFICATE.

THIS CERTIFIES that the undermentioned cotton as per application No. C ..... stored at ..... presented by Messrs. ..... has been duly sampled and tested by this office and found to contain ..... (Mean) per cent. of moisture.

MARKS OR CHOP.	BALES.	APPROXIMATE PICULS.	REMARKS.
此 印 記 不 可 更 改 These marks must not be altered.	Press Packed Large Medium Small Mat Bags (Small)		Percentage of Moisture. Max. Min.

THIS ALSO CERTIFIES that Mexican Dollars ..... have been paid as fees.

SHANGHAI, ... *192*....

.....

Manager.

If the cotton herein mentioned is repacked for exportation, on application to the Cotton Testing House, this certificate can be exchanged for a new one giving the shipping marks, after the Testing House examiner has fully satisfied himself that the cotton repacked is truly represented by this certificate.

(Verso.)

檢查棉花憑單

上海棉花檢查處爲檢查棉花給發憑單事

茲據商人　　呈到第　　號

報單稟請將左列棉花檢查並給發憑單

等因當經本處詳細查驗得該棉花每百

分中含水　　分合行給發憑單須至

憑單者

計開

貨物印記		包數	重量
	大		
	中		
	小		
	散包		

再此項棉花已付檢查費銀　　元

角　　分合併聲明

民國　　年　　月　　日給

憑單第　　號

報單第　　號

注意　如欲將上列之棉花改包者應持

該憑單呈請本處換給改包憑單

可也

The Structure of the Cotton Fibre.—The structure of the cotton fibre is such that cotton of good quality can be obtained only when the fibre has been perfectly and fully developed and ripened. Each individual cotton fibre consists of a single, circular, elongated cell, filled, when the fibre is young, with a natural liquid secretion. As the cotton ripens and develops, the cell walls become thinner and the liquid contents gradually dry up and solidify, thus forming a partial vacuum within the cell. Atmospheric pressure on this now partly empty, hollow tube causes the cell walls to collapse, with the result that the fibre becomes of a flattened, instead of a circular, form. At the same time, owing to the unequal distribution of the solidified contents on the inner wall of the cell and to the way in which the fibres are tangled together in the boll, the fibre becomes irregularly twisted—the finer, riper, more perfect, and more fully developed the fibre, the more the number of twists. (*See* Figs. 1 to 6.) These twists, which are characteristic of the cotton fibre, are not all in the same direction—they reverse,—and it is this peculiar, natural, reversed twist that renders cotton so valuable for spinning purposes, as it increases the locking action or holding power of the fibres when they are spun into yarn. It should be particularly noticed that the twists are formed only as the fibre ripens, and that the riper the fibre becomes the more numerous and the more pronounced become the number of twists, and hence the more valuable the cotton. Unripe fibres having no twist, immature pods gathered from plants which have been killed by frost, etc., should not be added to a

crop of fully matured and ripened cotton, as such fibres reduce the value of the whole crop. It is entirely due to the absence of twist in thistle-down, kapok, and several other vegetable fibres allied to cotton that these fibres cannot be successfully used alone for spinning yarn.

Appearance under the Microscope (Figs. 1 to 6).—Fully ripe cotton fibres, when examined under the microscope, have the appearance of flattened, irregularly twisted tubes, thickest at the base, but of more or less equal thickness for about three-quarters of the length, and then tapering to a blunt point at the apex. They have been compared to a hollow, twisted ribbon, with considerably thickened or corded edges. The fibres are perfectly transparent, and the unicellular structure is distinctly visible. They are not quite smooth, but, particularly when not fully ripe, often exhibit on the surface oblique striation, wrinkles, folds, or other markings, the cuticle sometimes presenting a delicately granular appearance. In the large central cavity or canal can be clearly seen a varying amount of cloudy or pithy matter. Unripe fibres are thin, weak, and brittle, deficient in twist, and do not exhibit so distinctly the corded edge and the hollow cylindrical formation seen in fully ripe fibres. (*See* Figs. 1 to 3.) Examined in section (Fig. 4), ripe fibres show the collapsed cylindrical structure, appearing somewhat dumb-bell shaped, with an irregular outline; the cell walls appear thick in comparison with the bore, which is usually narrow and elongated, rarely round, and probably never polygonal.

Mercerised cotton fibres differ somewhat from unmercerised fibres, in that they are fuller, thicker, and rounder, while the characteristic twist, though still discernible, is not so pronounced as in unmercerised cotton, in some cases being scarcely noticeable. (Figs. 5 and 6.)

Grading of Cotton.—With reference to the grading of cotton, the following, taken from "Cotton," by R. J. Peake, will be found useful:—

> "The grade and price of cotton are regulated by the following characteristics: length of staple, fineness, strength, colour, cohesiveness, and regularity in all its features; by the amount of leaf, sand, seed, neps, shell, and immatured fibres contained in the sample. . . . The following are some of the principal defects: variation in length of staple; variation in diameter of fibre; weak fibres; rough, harsh, intractable staple; bad colour; insufficient lustre or bloom; large percentage of sand, dirt, shell, seeds, small pieces of broken seeds with fibre attached to them, called "bearded motes," neps (which consist of a small number of fibres rolled together, forming a ball about the size of a pin-head), dead and unripe fibres, also fibres with few helical twistings owing to the cotton being grown under bad conditions. All the above defects have a deteriorating effect upon the value of cotton. . . . The longer the staple, providing the fibres are regular in length, the finer the fibre with the least percentage of the above defects, and the higher the price of the cotton. . . . Boll-stained or tinged cotton, sun-dried cotton, also samples which have been damaged by frost, insects, etc., have a lower value."

The chief adulterations in cotton consist of seed cotton and water.

The strength of cotton fibre is often estimated by pulling the staple with the fingers, but, in order to get more accurate results, a special apparatus is used, which shows the breaking strain in grains; the breaking strain varies from 46 to 212 grains per fibre.

Manufacture of Cotton Yarn.—Cotton spins best in a moist atmosphere, and therefore many modern mills, except in damp climates, are fitted with humidifying appliances. Practically the whole of the work in cotton mills, even down to opening the bales, is done by machinery. After the bales have been opened the raw cotton is submitted to the action of a machine, called an "opener," which shakes and opens out the mass of cotton, pulls the fibres apart, and thoroughly mixes them together; during the process many of the heavy impurities, such as sand, shell, or leaf, fall out by their own weight. The cotton is then passed through other machines, in which it is more thoroughly cleaned and then formed into a sheet and delivered to the "scutcher," a machine which further cleans the cotton and forms it into a more even sheet or "lap" ready for the carding machine.* The carding machine consists of several sets of revolving cylinders covered with steel wire teeth, which cause the fibres to lie approximately parallel to each other, and which remove practically all impurities which remain in the cotton after the previous processes, at the same time extracting all immature, short, or broken fibres and drawing out the lap into a very thin sheet, finally delivering it in a soft, ribbon-like form, called a "sliver," ready for the drawing frames. In the drawing frames several slivers are doubled together and are then attenuated by being drawn down to a thin sliver, the object being to minimise any irregularities and to arrange the fibres more perfectly in parallel order. The sliver thus formed is placed in the "bobbin and fly frames" (slubbing, roving, intermediate, and jack), where it is drawn finer, slightly twisted for the first time, and made ready for the final process of spinning. The bobbins are then placed in a spinning machine (either a mule, a ring frame, or a flyer throstle), which draws out the material finer and gives the necessary twist to it, thus converting it into yarn. In addition, the best qualities of yarn go through the process of "combing," which extracts all fibres below a certain required length.

The refuse obtained during the process of manufacturing yarn is classified as "cotton waste" (棉花頭, *mien-hua-t'ou*), and consists chiefly of small, knotty, irregular, severed ends of yarn, etc., mostly obtained from the reeling and winding machines as waste, sometimes mixed with strippings from carding and other machines, sweepings, etc. It is classified according to quality as "hard" and "soft," the hard being the better quality. Cotton waste is used chiefly in the manufacture of lampwick, wadding, twine, explosives, carpets, etc.; also in engine rooms for cleaning purposes. The soft, short-stapled waste cotton thrown off during the process of carding, combing, etc., is commonly called "fly cotton" (飛棉花, *fei-mien-hua*), a product which is used for making twine, carpets, explosives, lampwick, etc., or for mixing with ordinary raw cotton and then spinning into yarn. Cotton waste and fly cotton are exported from China, chiefly from Shanghai and Ningpo, to Europe and Japan, usually in hydraulically packed, iron-bound, gunny-covered bales.

Each of the three machines most commonly used in actually spinning cotton yarn (the mule, the ring frame, and the flyer throstle) produces a more or less characteristic yarn. The mule, invented by Samuel Crompton in 1779, is an intermittent, very complicated spinning machine (often up to 120 feet in length) in which the spindles are placed upon a carriage which draws out from the roller beam when the yarn is being spun and returns to them when the yarn

* "The term 'card' is derived from the Latin word for thistle, with which this carding process was once performed."—"Encyclopædia Britannica."

is being wound on to the cop; it spins a soft yarn, which is much used for wefts or fillings. The ring frame, unlike the mule, is a continuous spinner and spins the yarn by means of a ring and traveller in place of a fly and cap; most ring-spun yarn is used for warps. The flyer throstle spins the yarn on to a bobbin by means of a "flyer" and forms a strong, hard-twisted yarn which is used exclusively for warps. The method by which a yarn has been spun is frequently indicated by the words "mule spun," "ring spun," etc., being printed in large letters on the outer covering of a bale of yarn.

Packing of Cotton Yarn.—Cotton yarn, grey, is packed by hydraulic pressure into bales of standard type. The regulation manner of packing cotton yarn is as follows. The bales are always covered with 10 to 12 ounce burlap or gunny cloth, with paper underneath. Indian and European yarns have tarred burlap between the outer covering of burlap and the wrapping paper: this is not done, however, with Japanese or Chinese yarns, as these are close to the market and therefore do not require so much protection against damage. Each bale is bound with from four to six iron hoops. With Indian cotton yarn this hoop iron is usually coloured red; with Japanese it is either black or plain; while with Chinese it may be either red, black, or plain, according to the practice of the mill where the yarn has been manufactured. At each corner of the bale, and under the iron hoops, is a strip of wood which runs the length of the bale; the object of this is to prevent the iron hoops from cutting into the yarn. With Indian cotton yarn this strip of wood is always dark coloured, usually being made of teak or some other hard wood; with Japanese yarn it is always made of soft, white wood; while with Chinese cotton yarn, soft wood, sometimes bamboo, is used.

Each standard bale of cotton yarn usually contains 40 separate packages, each of which, in low and medium counts—of which the greater part of the yarn on the Chinese market consists,—weighs 10 pounds net (finer counts are made into 5-pound packages). The number of knots in a package varies, corresponding with the number or count of the yarn; *e.g.*, 12 knots of 12's, 20 of 20's, 16 of 16's, etc. Each package is wrapped in paper and tied with a string. Indian and European yarns always weigh 300 catties net (400 pounds), but Japanese and Chinese yarns usually run about $7\frac{1}{2}$ catties—sometimes up to about 20 catties—in excess of the standard weight of 3 piculs. This extra weight is added by enclosing with each of the 40 packages a small skein weighing 4 ounces and upwards. It is said that the Japanese introduced this innovation as a means of assisting them to obtain a hold on the market; Chinese mills now frequently follow the same practice.

As a load for a camel weighs about 3 piculs (150 catties each side of the animal), cotton yarn is sometimes imported into China (particularly in the North) packed in bales of 150 catties net, thus meeting the requirements of the overland market by avoiding the delay and expense of having the larger bales repacked. These small packages, or "half-bales," are of a standard type of packing similar to that used for the large 3-picul bales.

Length of Yarn in a Hank.—Cotton yarn is wound on to a 54-inch reel. Every hank is divided into seven sections or lengths of 120 yards, each section (called a "lea") being formed of 80 threads of 54 inches ($1\frac{1}{2}$ yards) in length. Thus a hank of cotton yarn consists of seven leas tied together and contains 840 yards of yarn ($1\frac{1}{2} \times 80 \times 7$).

Count of Cotton Yarn.—On the cover of each bale of yarn there is usually a number—16, 20, 40, 10, etc.; this number denotes the "count" of the yarn. The count of cotton yarn is the number given to a yarn according to the number of hanks to a pound and, therefore, indicates the fineness of the yarn: the larger the count the finer the yarn. Thus "60's" cotton yarn is a yarn that requires 60 hanks to weigh 1 pound, and "10's," one that requires 10 hanks to weigh 1 pound. Each pound of 60's yarn contains 50,400 yards (840 × 60), and each pound of 10's yarn, 8,400 yards (840 × 10).

The count of cotton yarn may be found as follows:—

(*a.*) Weigh 1 pound of the yarn and then count the number of hanks;
(*b.*) Divide 7,000 (the number of grains in 1 pound) by the weight of one hank in grains;
(*c.*) Divide 1,000 (the number of grains in one-seventh of a pound) by the weight of one lea (one-seventh of a hank) in grains;
(*d.*) Measure 184 yards and divide 100 by the weight in grains; or
(*e.*) Multiply the length of yarn in yards by $8\frac{1}{3}$ and divide by the weight in grains.

In coarse yarns below 3's, known as "bump yarns," the count is denoted by the number of yards it takes to weigh 1 ounce.

Two-fold yarns or three-fold yarns in cotton are called by the counts out of which the compound yarn is made. Thus a hank of 2/40's weighs the same as a hank of 20's single, and 3/30's the same as 10's single.

Standard counts below 10 usually rise one at a time (3, 4, 5, etc.); then two at a time up to 24 (10, 12, 14, etc.); 4 at a time up to 40 (24, 28, 32, etc.); above this, sometimes 5 (40, 45, 50, etc.), but generally 10 at a step (40, 50, 60, etc.). Any count between these numbers can be spun to order. Number 300 is the usual limit of fineness in mercantile cotton yarn.

In the metric system of counts the number of metres the yarn measures is divided by twice the number of grammes it weighs. The metric count No. 1 is equal to 1.18 British hanks. Therefore, dividing the British count by 1.18 will give the corresponding metric count, and multiplying the metric count by 1.18 will give the corresponding British count.

METRIC SYSTEM OF COUNTS (LENGTH, 1,000 METRES).

	WEIGHT.		WEIGHT.
	Grammes.		*Grammes.*
Count 1's	500.00	Count 6's	83.33
„ 2's	250.00	„ 7's	71.43
„ 3's	166.66	„ 8's	62.50
„ 4's	125.00	„ 9's	55.55
„ 5's	100.00	„ 10's	50.00

Counts used in China.—The yarn trade of China is confined mainly to coarse counts, usually not over 20's. Most Indian yarn imported consists of 10's, 12's, 14's, and 20's. The greater part of the Japanese yarn imported is usually 16's or 20's, the two numbers which have