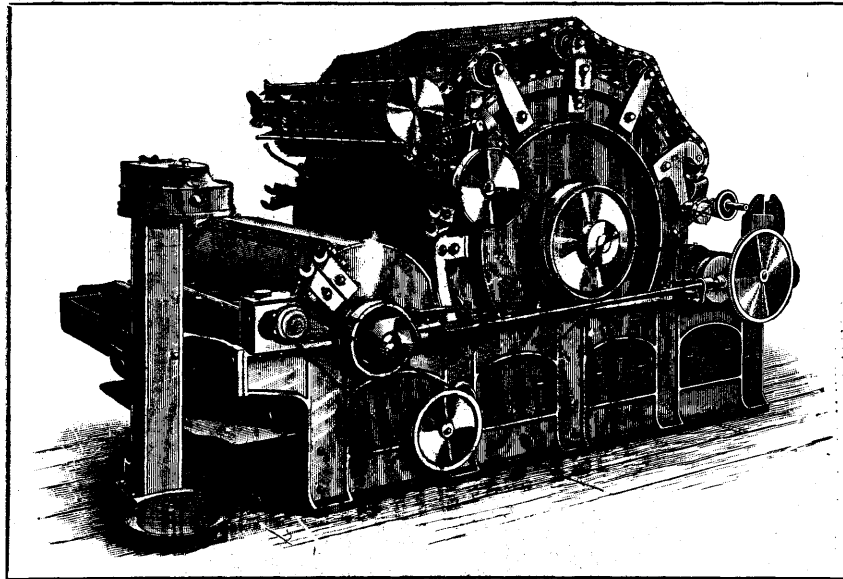
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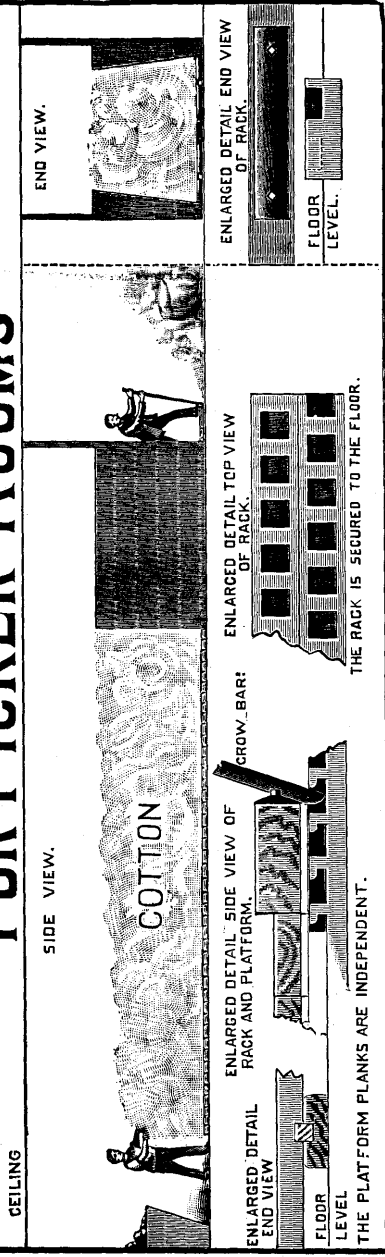
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COTTON MANUFACTURING

PART I.

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Giving a Complete Description of the Manufacture of Cotton Yarns from Planting
the Seed to the Sliver Ready for Drawing or Combing, Explaining
also the Construction of the Most Approved Modern
Machinery Used in Connection with it.

BY

E. A. POSSELT,

Consulting Expert on Textile Designing and Manufacturing. Author and Publisher of "Technology
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PREFACE.

THE purpose of the present volume is to give the reader a thorough understanding of the cotton fibre and its manufacture into yarn up to and including carding. Practice without theory is blind and has to grope its way forward in the dark, but theory without practice is equally blind and also has to grope its way forward in the dark. It is the object of the present volume, as well as this entire series of books on the general subject of cotton manufacturing, to reflect back upon first principles and unite theory and practice on a solid foundation, as regards the nature, construction and uses of the cotton thread.

The greatest of care has been exercised in the preparation of the present volume to bring every subject before the reader as plain as possible. Illustrations selected with reference to machinery cover both that of American and English build, a feature no book on cotton spinning thus far published contains; since, as a fact, no book of consequence with reference to American-built cotton-spinning machinery has thus far been published. Subsequent volumes, to be issued regularly hereafter—one each year—will in turn take up:

Combing, Drawing and Fly Frames;

Mule, Ring Frame, Winding, Doubling and Yarn Preparing Machinery;

Designing, Weaving and Calculations;

Dyeing and Finishing, respectively.

INTRODUCTION.

Of the four great staples which provide us with clothing (cotton, silk, wool and flax) cotton, now the cheapest and most indispensable, was last to come into general use, although thousands of years before it was the national cloth of India the same as linen was of Egypt. The Chinese, who had known the cotton plant from the earliest times, began its manufacture into cloth during the thirteenth century. The earliest explorers of this continent found beautiful fabrics of cotton among the natives of Mexico and South America. In the fourteenth century (long after linens, woolens and silks had become articles of commerce) cottons were introduced into Europe but necessarily they were very expensive on account of the distance they were brought, and the clumsy methods of their manufacture; thus giving almost a monopoly to woolens, silks and linens. However the great inventions of Hargreaves, Arkwright, Crompton, Cartwright and Whitney, late in the 18th century changed the subject and made cotton the chief clothing for us, and thus marked an era in the industrial development of the world. It is an industry which affects every class of people, furnishing employment for men, women and children, who in turn absorb its product. No other industry can have a greater interest for the mass of the people and the development of no other can therefore affect them to the same extent.

The production of cloth of any kind requires the production of yarn in advance, spinning being the art of producing this yarn by twisting short fibres into a continuous strand, consequently cotton spinning machinery has continued to engross a large share of the attention of inventors, and their utmost efforts have been expended in developing and perfecting its appliances. This devotion has been fully rewarded, as the result of their labors has proved of inestimable value, forming the base of the modern system of cotton manufacturing, and the important results that have sprung therefrom. The influence exerted upon all the textile industries by the successful application of machinery to the performance of the delicate processes of cotton spinning, and the adaptation of cotton machinery to the manufacture of wool, silk and flax, is a fact which must not be overlooked. By it, industry has put on a new face, and social conditions have been revolutionized.

History credits John Wyatt and Lewis Paul as the first inventors of spinning machinery and this between the years 1733 and 1758. In 1743 John Kaye invented the fly shuttle and in 1769 Robert Kaye (son of John Kaye) invented the rise and drop box, besides improving the shuttle, thus enabling one weaver to operate a loom where two were formerly required, the one operative at the same time doubling production. The general adoption of Kaye's improvements actually was the beginning of the modern epoch of invention with reference to textile machinery, since through it a greater demand for yarn was created, in turn necessitating improvements in

INTRODUCTION.

spinning machinery. In 1767 James Hargreaves invented the spinning jenny said to have been suggested to him by the accidental overturning of a spinning wheel. Two years later Richard Arkwright invented the water frame, by putting Wyatt's machine into better mechanical form, in turn producing a yarn of a closer texture (warp) as compared to that spun on the jenny (filling yarn). Wyatt had failed in being unable to get his fitting done correctly. Arkwright did not alter the principle of the machine, the same being found incapable of improvement up to the present day, the mechanical detail only having been improved. About the year 1779 Samuel Crompton, combined the best part of Hargreaves' jenny, the spindle frame, and made it movable with the best part of Arkwright's water frame, the drawing rollers, and thus brought out the spinning mule or mule jenny, which ultimately, in 1832, was made self-acting by Richard Roberts, whose quadrant winding motion is one of the most ingenious mechanical movements the world has ever seen; hence the term "Self-actor mule." Crompton, after five months attendance in the lobbies of the House of Commons got a Parliamentary grant of £5000, which about recouped him the expense he had been put to in constructing his mule, Roberts dying in the deepest of poverty.

With reference to carding, the same had its origin in connection with woolen yarn, since as previously mentioned, it needed the inventions of Hargreaves, Arkwright, Crompton, Cartwright and Whitney to make cotton the chief textile fibre. Up to 1720 no other process of carding was known but the hand cards, where the fibre was put between and then drawn alternately until it became a long "carding" ready for the distaff and spindle. The tumming stock, or stock frame was an improvement upon the hand cards. This apparatus consisted of an inclined board, on which were fixed iron teeth; the carder sat in front of this stock and drew his hand cards over the wool, ready for the carding process. This process was further improved by suspending a board covered with teeth from the ceiling. This board was swung against the tumming stock, thereby easing the hand carder and doing more work. In 1733 John Kaye obtained a patent (No. 542) to further improve carding by means of a scray covered with wire pins. By the use of wheels the rollers over the scrays acted briskly and more evenly, and thereby the wool was cleaned and better opened than before. Daniel Bourn in May 1748, took out the first patent for carding cotton by the use of cylinders; Lewis Paul in 1758 invented what was called the ribbon cylinder process, because instead of the cards being put upon the cylinder in parallel rows, they were fixed round the cylinder and made a longer carding when pulled off. In the South Kensington Museum there can be found one of the first carding machines by cylinder, without either server or stripping motion. It has three cylinders and is patented by R. Arkwright, No. 931, date 1769, he having had the inventions of Bourn and Paul to go by. This was turned by hand power, and has no resemblance to the carding engine of the present day. At that time it was considered to be the height of perfection. Robert Peel is credited with the invention of the stripping motion, which although a wonderful improvement

INTRODUCTION.

from the start, took twenty years to bring it into popular use. John Lees, is the inventor of the apron feed, or server. Other improvements followed, until the modern revolving flat card has been the result.

In 1784 Dr. Cartwright invented the power loom and it remained for Eli Whitney to complete this series of remarkable discoveries by inventing in 1793 the saw gin. The great industry of modern times was then begun, and since then inventions have rapidly followed each other. Of importance to note are the invention of the scutcher in 1797 by Snodgrass; the invention of the lap machine by Crighton early in the 19th century; the invention of the differential motion in 1822 by Asa Arnold of Rhode Island, although this motion is frequently credited to Holdsworth, but the fact is that Arnold's mechanism in 1825 had been taken to Manchester, England, where Holdsworth saw it and one year later in 1826 brought out his motion. Ring spinning was invented in 1828 by John Thorpe of Providence, R. I. In 1862 Lord invented the piano feed motion for feeding to pickers and scutchers.

The rise of cotton manufacturing in this country was effected after a long series of experiments, for which reason no one place can claim the distinction of its birthplace, although Beverly, Mass., may more or less lay claim to having been the seat of the first cotton factory here, since there cotton spinning was carried on first, further than by the hand card and one thread wheel. Massachusetts was the first state to give aid and thus encouragement to the cotton industry, although Philadelphia was the original centre of the manufacturing movement in this country. Tench Coxe, a prominent resident of that city, was the pioneer of this movement there, and so untiring was he in his labors that he earned for himself the title of "Father of American Manufactures." He also was prominent in urging the cultivation of cotton in the South, and this at a time when the plant was scarcely seen outside of a flower garden. Through him, also, it was that in 1775 the first spinning jenny, constructed by one Christopher Tully, after the plans of Hargreaves, was exhibited at Philadelphia. This machine was secured by the "United Company of Philadelphia for promoting American Manufactures," a company formed through the instrumentality of Mr. Coxe, for the purpose of encouraging home industries. However Tully's machine was a rude and more or less unsatisfactory affair, especially since Arkwright's water frame was then giving a decided impetus to the cotton industry in England, and which country guarded Arkwright's invention jealously, forbidding every exportation of models, some of them as made in 1786 for Mr. Coxe being seized by the English customs officials. Relief to this state of affairs to the cotton industry then in this country came through Hugh Orr, Esq., of Bridgewater, Mass., who had in his employ two Scotchmen, Robert and Alexander Barr, they being familiar with the English spinning system, besides Orr himself was something of an inventor. Orr had the Barrs build three machines, respectively for carding, roving and spinning, which when completed were probably the first stock-card in the country. A year later, Thomas Somers, an English midshipman, drifted to Bridgewater and at Orr's direction constructed an imperfect form of Arkwright's water frame. These machines were then exhibited by Mr. Orr as state's models, with the result of experiments in spinning at Beverly and Worcester, Mass., and Providence, R. I. However it was at Beverly that the first real advance was

INTRODUCTION.

made, the Beverly Company being formed there in 1787, building a small brick factory on Bass River. The machinery used consisted of one or more spinning jennies and a carding machine. The enterprise however was not a financial success. The expenditures were large as compared with the receipts, the machinery rude, and as a result, the fabrics were of a coarse quality. After appealing to and receiving an appropriation from the state legislature, both in 1787 and 1790, for the purpose of promoting the manufacturing of cotton in Massachusetts, the promoter of said Beverly Company failed to improve even after it, the machinery being too imperfect to compete with that across the water.

Daniel Anthony was the one who secured the plans from Bridgewater for Providence. He, with Andrew Dexter and Lewis Peck, had started a company in that city for the making of home spun cloth, a stuff of linen warp and cotton filling. But the new venture proved also unsuccessful and the machines passed into the hands of Almy & Brown, to be pronounced utterly worthless at the close of 1789 by Samuel Slater, who then was fresh from the centre of the cotton industry in England. Born in Belper, Derbyshire, in 1768, he was at fourteen years of age apprenticed to Jedediah Strutt of Milford, a partner with Richard Arkwright in the spinning business. This gave young Slater every opportunity to master the details of the construction of the best cotton machinery then in use in England. During the last years of his apprenticeship he was a general overseer, not only in making machinery but also in the manufacturing department of Strutt's factory. Slater being of an energetic nature learned from an American paper that fell into his hands of the general interest that was being taken by our country in cotton manufacturing and the generous bounties promised those who should build satisfactory machinery. This determined him to emigrate hither, but knowing that he could not carry with him either models nor drawings, he laid up in a retentive memory every detail of the business in which he had been trained. These, fortified by his long experience, gave him an equipment that no custom officials could seize. He landed in New York in November 1789, and after some delay in that city, pushed on to Providence, where Almy & Brown, as mentioned before, were trying to operate the card and jennies which they had bought from the old home spun cloth company. Slater looked them over, and as mentioned before, pronounced the whole lot utterly worthless. Moses Brown, the head of the firm, a worthy Friend, was rather astounded at this wholesale condemnation of his plant, however he recovered sufficiently to reply, "But thee hast said thee canst make the Arkwright machines; why not do it?" The result was that Slater then contracted with him to produce a perpetual card and spinning system. On January 18, 1790, Moses Brown drove Slater out to Pawtucket and there let him begin his work, securing for him a shop by the Blackstone River, on what was then known as Quaker Lane, now East Ave. Slater had to make all the plans from memory, having a Sylvanus Brown to do the wood-work, a David Wilkinson the metallic, and an old colored man supplying the needed power by turning a wheel. Behind closed doors and barred windows, to keep out rivals, this quartette worked until December 20, 1790, when three cards, drawing and roving, together with seventy-two spindles, were complete for trial. The commendatory words of Moses Brown, "Samuel, thee hast done well," tell the story of the experiment and greeted the birth of a great industry in the western hemisphere.

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THE COTTON FIBRE.

The word cotton is plainly formed from the Arabic *Gatn*, *Kotan*, or *Kutn*, signifying soft. Its name in different countries are:—*Algodon* (Span.); *Coton* (Fr.); *Cotone* (It.); *Baumwolle* (Ger.); *Hopi* (Moqui Indian); *Pucü* (Indian name); *Ychcaxihitvül* (Yuc. or ancient Mex.); *Vavai* (Tahiti); *Pembeh* or *Poombeh* (Pers.); *Cay Haung* (Cochin China); *Hoa mein* (China); *Watta ik* or *Watta noki* (Jap.); *Tonfai* (Siam); *Nurma* (Hind.); *Deo Kurpas* and *Deo Kapas*, God's Cotton (Mysore and Bomb.); *Nu-wa* (Burm.); *Kohung* (Mong.), etc.

BOTANY.—The vegetable kingdom is primarily divided into three classes—viz: (1) Dicotyledons; (2) Monocotyledons; and (3) Acotyledons.

The cotton plant is known scientifically by the generic name "*Gossypium*", belonging in turn to the natural order "*Malvaceae*", which is one of a very large number forming an important division of the "*Dicotyledons*" where the stamens are found to be inserted below the pistil, and where the corolla is composed of free separate petals, and where the plant has a flower, bearing both calyx and corolla. The name *Gossypium* was given to the cotton plant by Pliny, although there is no reason on record for his doing so.

The substance, cotton itself, may be defined as the woolly denticulated fibrous material enveloping the seeds of various species and varieties of the genus *Gossypium*, and which is indigenous principally to the islands and maritime regions of the tropics; however under cultivation its range has been extended to 40° or more on either side of the Equator, or to the isothermal line of 60° F. In our country latitude 37° north about represents the limit of its economic growth.

ADVANTAGES.—Compared to the product of the flax plant, cotton is of greater advantage for clothing, since it is a bad conductor of heat, and thus preserves the human body at a more equal temperature. The functions of the skin by means of perspiration serve to keep the human body amidst the changes of the atmosphere at an equal temperature. Flax, as used for the manufacture of linen clothing being a good conductor of heat, thus freely condenses the vapor of perspiration, accumulating moisture upon the skin; the wetted linen getting cold; chills the body, besides checking the perspiration. In opposition, cotton, as already previously stated, being a bad conductor of heat, will thus condense only little of the perspiration, permitting it to pass off in the shape of vapor. If perspiration is so pronounced as to accumulate moisture, cotton will again absorb more of the latter than flax; thus the advantages for cotton are of a two fold character, first cotton ac-

accumulates less moisture, and secondly, if moisture is on hand, cotton absorbs quicker and more.

ORIGIN AND ITS INTRODUCTION INTO THE U. S.—The origin of the cotton plant is a question not easily settled, as cotton has been grown in many countries from an exceedingly remote period. It is probable that a plant numbering so many species is indigenous in different localities, though "Rhind" states that it may possibly have come from Persia originally, then crossed into Egypt, thence to Asia Minor and the Indian Archipelago. "Bernardin" the curator of the Industrial Museum of Ghent, in his "Nomenclature Usuelle de Fibres Textiles", gives the origin of the several species named, crediting at least two to North America, *G. barbadense* from the West Indies, and *G. hirsutum* from Mexico. *G. herbaceum* he regards as originally an East Indian specie. So much has been written upon this subject and authorities differ so widely that great confusion has resulted. To add to the complication, cotton has been cultivated in portions of the earth from remote ages, and in many countries for centuries—for a period of over 3,000 years in India—for we read that when Egypt was in the zenith of her glory the delicate cotton tissues of India were famous, and Egypt at that time had a cotton industry of her own. On our continent the Aztecs of Mexico and the Incas of Peru, ages and ages ago, spun and wove cotton, and the Hopi Indians of Arizona, preserving a tradition and the requirements of a custom that has come down from remote times, will only use in their religious ceremonies strings or cords made from native grown cotton, twisted by the officiating priests.

The actual beginning of the culture of cotton in our country occurred about one hundred and seventy-five years before the industry became at all important. According to Bancroft, the first experiment in cotton culture in the colonies was made in 1621 in Virginia during Wyatt's administration of the Government. In 1789 James Habersham, a merchant prince of early times, exported the first bale of lint cotton to England. So great was the surprise of the merchants at Liverpool that, on seeing these bags of cotton, they declared them to be of Eastern origin and prevailed on the customs officers to make a seizure. But it was not until after the invention of Eli Whitney's saw gin in 1793 that the United States became the principal source of cotton supply for the world, and this at a period when spinning machinery was a recent invention and the modern factory system in its infancy. Since then American cotton, such as is grown in the fertile regions forming the south portion of our country has remained the typical cotton fibre, "King cotton". Its general uniformity, the skill with which it is cultivated, gathered, and ginned, and the excellence of its spinning qualities, within the range of counts where by far the largest quantity of yarn is required, render it pre-eminently "the cotton fibre".

Cotton growing here is confined to the Southern States, being the most valuable "money crop" of the country, furnishing the raw material

for one of our most important manufacturing industries as well as from one-fourth to one-third of our total exports. It is claimed that the cotton raised here alone provides the raw material for more than half the calico used by the entire human race. The same as Great Britain was the last of the European countries to take up cotton manufacture, and carry it to its fullest development, so the United States was the last to enter the list of cotton growing countries, and has been for over a hundred years the foremost of them all. To give an idea how indispensable American cotton is to the mills of the world, we only have to remember the cotton famine resulting from the civil war. In the absence of the accustomed staples, certain cottons of India, Italy and other southern parts of Europe, etc., had to be substituted, which proved a sore trial to the patience of spinners and weavers, who, in one notable instance (in England), when the first wagon load of our cotton arrived after the war, gave expression to their joy by singing "Praise God, from whom all blessings flow". The experimenting with cotton raising in southern parts of Europe stopped at once after the war.

As previously mentioned our cotton is considered the typical cotton fibre of the world, since its usual soundness of staple, and freedom from impurities, render it eminently fitted for the production of all kinds of yarns and fabrics where color, regularity, and wearing qualities are required. It passes through the various processes necessary in its conversion from the fibre to the finished fabric, whether handled in its pure state or colored, with less trouble and difficulty than any other cotton; it is the standard by which other cottons are compared, and thus rules the cotton market of the world. Our cotton is of two types. One, the Sea Island or black seed cotton is confined to islands and shores of South Carolina and Georgia, to Florida, and to an extremely limited distribution along the Gulf coast. It has the longest and finest staple and commands the highest price of any commercial cotton, being spun in the finest yarns and used very largely for thread, laces, and fine cambrics. More than 99 per cent of our crop, however, is known as American Upland, varying from the fine Mississippi cottons, Peelers, Benders, to the short clean Uplands cotton, having a green seed to which the filaments closely adhere, being only surpassed in length of staple by one kind of Egyptian cotton, which, in these respects, comes between the American Mainland and Sea Island. The greatest advantage to raising a superior cotton in this country is due to the advantage of climate in the production of the distinctive type of cotton of the United States, the varieties of green seed Upland. Our cotton belt has the sunshine of Italy and a rainfall largely in excess of the national average; and cotton is a sun plant, fond of water, with a taproot to get it by piercing the friable and finely comminuted soil so characteristic of its areas of densest distribution. Hence any cotton suited to prevalent climatic conditions naturally im-

proves under cultivation. This climatic adaptation and soil suitably give a practical monopoly which cheap labor elsewhere may never hope to overcome.

FOREIGN VARIETIES.—Amongst them we find the “Brown Egyptian”, which in fineness of quality and length of staple comes nearest to the lower grades of our Sea Island and is used extensively in the manufacture of fine yarns and fabrics both here and abroad. The other kinds of cottons raised in Egypt are of no great commercial importance. Other cottons are Brazilian which chiefly goes to Europe, Peruvian of which the “Rough Peruvian” variety (only) is imported by our manufacturers, the other varieties as well as other South American cottons including Mexican cotton being of no importance. China produces cotton for home use only. India raises considerable cotton, but a very low grade, both for use in their own mills as well as for export to Europe.

STRUCTURE OF THE FIBRE.—As mentioned before the cotton fibre is the hair which grows around the seeds of the various species of the cotton plant, which varies in height according to the climate and soil. The leaves of the cotton plant grow upon stalks placed alternately upon the branches, most frequently being formed in the shape of a heart, and generally either three or five lobed, with the lobes sharp or rounded. The flowers are usually large and showy, and grow singly upon stalks in the axils of the leaves.

The fruits of the cotton plant known as “bolls” (of about 1 inch diameter) are divided by membranous walls into three or five cells containing three or four seeds each, covered with the thin transparent cylindrical filaments known as Cotton and which by one end are attached to the seed. Towards maturity of the fruit these filaments exchange their cylindrical form to a compressed or ribbon shape, by means of the collapse of their walls; simultaneously each fibre twisting on its axis, causing in turn a sufficient pressure on the inside of the boll to burst the latter at the junctions of the compartments in the outer casing, which by this time has become dried up. After being left on the plant for a few days, so as to properly ripen the fibres, the cotton is picked. During the time the cotton thus remains on the plant, exposed to the direct influence of the air, (if the weather is unfavorable) great damage to the fibre may be done either by rain which stains the cotton; excessive heat which renders the fibres harsh and brittle; or by means of storms which fill the boll with leaves, dust and sand.

The length of the cotton fibre varies from about $\frac{1}{2}$ inch to 2 inches, and upon this length, commercially known as “staple”, the value of a respective lot of cotton depends. Naturally, “short staples” are less valuable than “long staples”, Upland being an example of the former and Sea Island one of the latter.

The color of the cotton fibre is not always white, but sometimes

creamy, as in Sea Island, or a light and varying golden tint, as in some kinds of Egyptian and American.

The cotton fibre is not, as it appears to the eye, a solid, cylindrical hair, but when fully developed and examined microscopically, the same appears as a long and relatively narrow, flattened tube, spirally twisted about its axis. It is, indeed, an enormously elongated compound plant cell, one end of which is pointed and closed, and the other—by means of which the fibre was attached to the seed—being irregularly torn. There is, however, much individuality amongst cotton and no two are precisely alike. These variations are still more marked when cross sections of various fibres are examined, some exhibiting thick cell walls with a very small central cavity, while in others the hollow tubular space is greatly enlarged. Certain fibres also retain much of their original cylindrical form, while others are completely flattened and exhibit a mere line instead of a central cavity, such changes in structure being respectively known as unripe or dead fibres.

Under certain conditions, but not invariably, the cotton fibre is surrounded by an extremely thin membrane, termed the "*Cuticula*", which envelops or is wound round it in a spiral manner. During the bleaching process, however, this is removed, or, at any rate, modified in such a manner that it cannot afterwards be distinguished from the rest of the fibre.

PHYSICAL PROPERTIES.—Under this heading we may distinguish strength, spinning property and capillarity.

With reference to its strength, the breaking strain of the fibre varies pretty regularly with the diameter, the coarser varieties being stronger than the finer sorts. The breaking strain of a single fibre varies from eighty to about one hundred and sixty grains (= 5 to 10 grams).

The diameter of the cotton fibre, which varies from 0.0004 inch in the best of Sea Island to 0.001 inch in the lowest of Indian, is, in the average, somewhat less than that of wool, the latter ranging from 0.0005 to 0.002 inch; but a comparison of the thickness is of absolutely no value in distinguishing between the fibres. In this respect silk also is similar, having a diameter of about 0.0007 inch. Comparing silk, wool and cotton fibres of equal diameter, silk is much the strongest fibre, wool the weakest, while cotton holds an intermediate place. In respect to elasticity, however—apart from that due to the spiral character of the fibre—both wool and silk are much superior to cotton.

The spinning property of the cotton fibre largely depends upon its spiral character, which feature greatly facilitates the interlocking of the fibres and largely increases their grip upon one another. This spiral character of the fibre—its natural twist—is due to unequal or irregular drying of the cell walls. The direction and the amount of twist varies, increasing as the plant is cultivated. No turning of the axis takes place in the formation of this twist, the same being the re-

sult of the action of natural laws acting externally, and is not an inherent feature or essential part of the life of the plant. Experiments in this line have shown about 200 turns per inch in Egyptian and as high as 300 turns (and more) in the best of Sea Island cotton. Owing to this presence of natural twist, cotton is easily distinguishable from every other variety of vegetable and animal fibre, and its appearance can readily be detected by means of the microscope in any cloth or fabric, whether in a rough, dressed, dyed or undyed condition; however it must be added that wild silks have frequently a very similar flattened and twisted fibre, and may frequently be mistaken for cotton if the microscopic appearance alone is relied upon. The two fibres are, however, readily distinguished by other tests. "Dead" cotton and "Mercerized" cotton have also an entirely different appearance to ordinary cotton.

Capillary attraction as exerted by the fibre is due to its tubular structure, and to the fact that the cell walls, where at all thick, separate during the drying of the fibre substance into several layers, between each two of which there is a minute cavity. The absorption and retention of liquids by capillarity is one of the chief factors which govern the behavior of the fibre during dyeing processes.

RIPE AND UNRIPE FIBRES.—Throughout all cotton supplies we find besides the ripe fibre a certain amount of half ripe and unripe or dead fibres which, according to amount present, depreciate the value of a lot of cotton. Such fibres are the result of the cotton being removed from the pod before fully matured, a feature readily explained by the fact that the stages of maturity vary considerably even on different parts of the same seed, since the germination of cells does not begin simultaneously at every point on the surface of the seed, and the absorption of the parts of the cell walls in contact throughout each linear deposit is not effected at the same moment, and that the secretive and suctional powers of each individual tube are not all of the same force and energy.

Ripe cotton fibres are hollow nearly throughout their entire length, with the exception of the end which had not been attached to the seed. This hollowness of the ripe fibre allows the dye stuffs to penetrate. Half ripe fibres form a medium between ripe and unripe or dead fibres, in the latter the cell taking the form of a ribbon or band, the tubular form having never been developed. Cross sections of such fibres, appear as thin, irregularly bent flat rods. Some of the fibres never attain maturity from some cause or other, either their position on the matrix preventing their getting a sufficiency of light or nourishment, or some other reason interfering with the perfect development of the hair, and the proportion of this fibre being more or less dependent on the character of the season and the health of the plant. Fibres produced on the crown of the seed are always more advanced compared to those on the base; and it is by the removal of this undergrowth, in the process

of ginning, that so much immature fibre exists in the general supplies. Such unripe or dead cotton is very difficult to dye, and frequently appears as white specks on dyed pieces, particularly in such as are dyed indigo blue or turkey red; again such fibres are also devoid of spinning qualities and consequently produce poor yarn according to amount present in a lot of cotton. A fair representation (highly magnified)

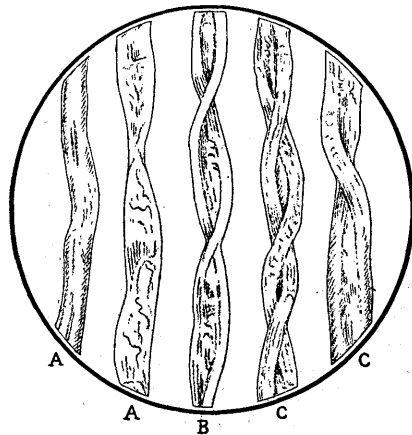


Fig. 1.

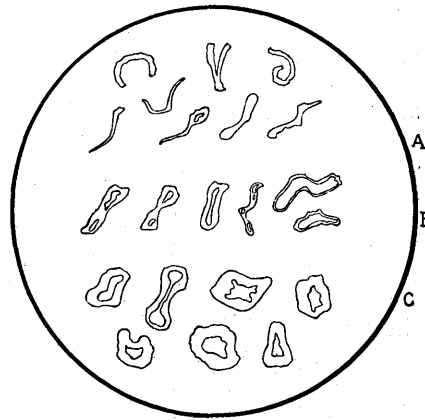


Fig. 2.

of these three classes of cotton fibres is given in Fig. 1, of which A shows unripe or dead fibres, B half ripe and C fully matured or ripe fibres. Fig. 2 shows cross sections of these three classes of fibres.

CHEMICAL COMPOSITION.—The most reliable analysis of American cotton is as follows:—

Water	6.74 per cent.
Ash	1.65 " "
Protein	1.50 " "
Fibre	83.71 " "
Nitrogen—free extract	5.79 " "
Fat	0.61 " "
	100.00

SCIENTIFIC CLASSIFICATION.—The same has always been a perplexing and rather difficult question, although it has received careful attention from the leading botanists and has been made the subject of frequent discussions among them, it has by no means been authoritatively settled. Cultivated for the great value of its fibre for unknown ages, its wild species and their habits are little known, besides

the real points of difference are so slight, that the systematic botanist has scarcely any ground to go upon in the determination of the various species. One writer has gone so far as to discover 42 species (?) but it would be waste of time to trouble with them, which even if so, are of no value to the manufacturer.

Dr. Royle the well known English botanist brought down the genus to the four species, G. Herbaceum, G. Arboreum, G. Hirsutum, G. Barbadense.

Bowman considers the best division to be that of herbaceous, shrub, and tree cotton, and that in one or other of these forms the cotton plant is indigenous of many of the warm climates, especially to India, Egypt, and America. He considers the herbaceous cotton the most valuable and being that from which our crop is obtained. The shrub he considers about the size of an ordinary currant bush, and which in the hottest climates becomes perennial. Tree cotton, known as G. Arboreum grows to a height varying from 12 to 20 feet. Its flowers are red, the seeds are covered with a greenish colored fur enveloped in a fine silky wool, the plant being found in Egypt, Arabia, India and China.

Hamilton sought to avoid confusion by dividing the genus into the white seeded, black seeded, and yellow linted, to which he gave respectively the names *album*, *nigrum*, and *croceum*.

No cultivated plant responds so quickly to ameliorated conditions of soil, climate, and cultivation as the cotton plant, and to this fact is due much of the confusion as to species and varieties. Other factors entering into the confusion are the imperfectly known types that in some instances have been described as species and the fact that cotton seed was brought in from all quarters of the globe, and thus the American plant, the result of innumerable crossings, remains, as to its origin, a puzzle to botanists. Authorities differ widely regarding the specific origin of the short staple or Upland cotton, while more nearly agreeing that the Sea Island cotton originated from G. Barbadense which is indigenous to a group of the West Indian Islands named the Lesser Antilles and received its name from Barbadoes, one of the West Indies. This Sea Island variety was introduced into Egypt in 1821 by Mehemet Ali, and the long stapled cottons of that country are regarded as proceeding from this importation.

STAPLE.—By this we refer to the length and diameter of the individual fibre. A good demonstration of the tenuity of the cotton fibre is given by the fact that from 14,000 to 20,000 individual filaments only weigh one grain, so that there are about 140,000,000 in every pound, and each hair only weighs on the average about the $\frac{1}{17000}$ part of a grain, and if the separate fibres were placed end to end in a straight line one pound weight would reach 2,200 miles. As a rule the quality of the staple improves with the proximity to the sea, but there are exceptions to this. The cottons which are grown in different parts of the world differ from each other with reference to length and fine-

ness of staple, our Sea Island cotton attaining a length of about two inches with a diameter of about 0.0005 inch, while the short native cottons of India average not quite three quarters of an inch in length with a diameter of about 0.0008 inch. Upon this character of the staple to a very large extent, depends the quantity of waste which will be made in the various stages of manufacture, and the degree of perfection to which the various processes can be carried. All our carding, drawing, and spinning processes depend on an average uniformity in this respect, since the setting of the cards and rollers is necessarily constant for the same cotton. With reference to staple of cottons our spinners come in contact with, the following data will be of value:— Sea Island $1\frac{3}{8}$ to $2\frac{1}{4}$ " in length and 0.0004 to 0.0006" diameter; Florida Sea Island $1\frac{1}{4}$ to $1\frac{3}{4}$ " in length and 0.0005 to 0.0006" diameter; Brown Egyptian $1\frac{1}{8}$ to $1\frac{1}{2}$ " in length and 0.0005 to 0.0007" diameter; Rough Peruvian $1\frac{1}{8}$ to $1\frac{3}{8}$ " in length and 0.0006 to 0.0008" diameter; Gulf Cotton, Benders, Mobile, Peelers, Allan Seed 1 to $1\frac{1}{4}$ " in length and 0.0004 to 0.0007" diameter; Uplands $\frac{3}{4}$ to 1" in length and 0.0005 to 0.0007" diameter.

CULTIVATION.—Cotton stands pre-eminent among farm crops in the ease and cheapness of its production, as compared with the variety and value of its products. No crop makes so slight a drain upon the fertility of the soil, and for none has modern enterprise found so many uses for its several parts. The cotton plant yields, in fact, a double crop—a most beautiful fibre and a seed yielding both oil and feed, which, although neglected for a long time, is now esteemed worth one-sixth as much as the fibre. In addition to this, the roots yield a drug.

Cotton in its several species and many varieties is a product which belongs to all intertropical countries, for the plant has been so widely distributed and has been in cultivation so long a time that in many of these countries it is considered indigenous. Spon gives the geographical parallels between which cotton is usually cultivated as stretching in varying girdles between 36° north latitude and 36° south latitude, though Dr. Evans places the parallels at 40° or more on either side of the Equator, or to the isothermal line of 60° F. In our country, latitude 37° north about represents the limit of economic growth.

The fleecy fields first greet your eye as you travel southward from Richmond, Virginia, or go into Tennessee, the Carolinas, Arkansas, Indian Territory or Texas, the latter state raising the bulk of the crop. Georgia comes next, with an annual crop of a million bales or more. Along the Atlantic seaboard and sea islands and reaching about a hundred miles into the interior, the cotton raised is "long staple", or Sea Island, being the finest quality grown, bringing 21 cents a pound when ordinary cotton sells at 8 cents. The center of cotton production, the point where the weight of all the cotton produced in the various regions of the cotton belt would stand in equilibrium, was located in 1850 a few miles north of Montgomery, Ala. In 1860 this center had moved 200

miles west to a point some 20 miles northeast from Jackson, Miss. Its movement in 1870 was northeast to a point near Carthage, Leake County, Miss. It again moved northeastward into Noxubee County, Miss., in 1880. Its movement was about 60 miles northwest in 1890 to Kosciusko, in Attala County, in the same State. It is probable that since that date the increasing crops of Arkansas, northern Texas, and Indian Territory have drawn the center of cotton production still farther to the northwest. The cotton states proper are North and South Carolina, Georgia, Alabama, Mississippi, Florida, Tennessee, Louisiana, Arkansas, a great part of Texas and the adjoining Indian Territory. Over all this belt the cultivation of the cotton plant differs considerably, with the variations in soil and climate.

The quantity and quality of a good fibre depends:— 1st on the atmosphere and climate, 2nd the soil, 3rd the seed, and 4th the method of cultivation.

Atmosphere and Climate.—The cotton plant loves heat and wants moisture in due quantities, being a very sensitive plant which easily suffers from cold, drought, or undue moisture. Climatic conditions generally favorable to the production of cotton are found south of a line which crosses our country a little below latitude 37°. North of this line the short season and relatively low mean temperature are unfavorable; also the mountain region, altitudes above 1,000 feet, south of this line. The essential features of a climate adapted to this culture are that the season must be sufficiently long for the crop to mature. One of the most important factors therefore, is the probable date of the last killing frost in the spring and of the earliest frost in the autumn, for cotton has a very long growing period, its picking often extending into the winter and when the first killing frost of autumn checks the active growth of the plant, and blossoms or young bolls starting at this time consequently will not develop into mature fruit. The crop requires six or seven months of favorable growing weather for its development. The next most important consideration is the amount and distribution of the heat and rainfall. Cotton is a plant which thrives in a very warm or even hot atmosphere, provided the atmosphere is moist and the transpiration is not so excessive as to overtax the powers of the plant. The temperature should be high and the daily range uniform during the early growing period of the plant. The mean daily temperature should normally increase from the time the seed is put in until about the first of August, after which it should rapidly fall, thus providing two distinct periods for the life of the plant. During the first period of high and increasing temperature the plant should be in full vegetative growth. Any great and sudden range in temperature, or any prolonged cold spell, is liable to check the vegetative growth of the plant and tend to ripen it, which is very undesirable during this stage of development. By the first or middle of August the plant should have attained its full vegetative growth—that is, it should have

stored up all of the food material it needs. From this time on a decreasing temperature and a greater range of temperature between day and night are favorable to the production of a maximum crop, for this checks the vegetative growth and induces the plant to convert the food material it has accumulated into fruit. The soil also should be drier during this second period.

As a rule the rainfall normally increases in the South from the spring to the middle of summer, when it decreases, and the climate during the autumn is usually remarkably dry and bracing. These conditions are favorable to cotton production. During the earlier period the rain should fall in frequent showers rather than in heavy storms, and the very best seasons are when these showers occur at night, giving with a large and well distributed rainfall a large amount of sunshine.

Soil.—Cotton is at present cultivated with more or less success on nearly all kinds of soils within the region in which the climatic conditions are favorable to its growth and development. It is grown alike on light sandy soils, on loams, on heavy clay soils, and on bottom lands, but not with equal success on all of these different types of soil. On the sandy Uplands the yield of cotton is usually very small; on clay lands, especially in wet seasons, the plants attain large size, but yield a small amount of lint in proportion to the size of the plants, a feature which is also likely to be the case on bottom lands. On these bottom lands in very favorable seasons the crop often produces a very large yield, but it is not so certain, and in unfavorable seasons the plants are liable to disease and to insect ravages. The safest soil for the cotton crop is a medium or a deep loam, naturally well drained, but sufficiently retentive of moisture to maintain a uniform supply throughout the entire growing season. The alluvial river bottoms like those of the Mississippi valley, where stones are as rare as diamonds, furnish an excellent soil, producing the choice cottons, known as "Benders", and which derive their name from the fact that they are grown on the fine, black alluvial soil of the bends of the Mississippi river. However, superior to any soil is ground containing saline matter i. e. land situated in the vicinity of the seashore, since the roots of the plant absorb a certain amount of the salt, which in turn passes into and circulates with the vital fluids of the plant, greatly assisting in a perfect development and formation of all its parts.

Formerly little attention was paid to the matter of fertilizers, the great bulk of the cotton crop previous to 1860 having been grown without artificial fertilization. However, the cotton planter now sees the necessity of using the best fertilizers. Among the fertilizers employed, in various combinations, are Peruvian guano, dissolved bones, land plaster, kainit, acid phosphate, the phosphate rocks, barnyard manures, the many forms of cotton seed fertilizer, as rotted seed, meal hulls, ash, etc., and others.

Seed.—If the seed, as used for sowing, is too old or not entirely

developed previously to its removal from the boll or capsule, or spoiled in some other way, then the amount and quality of the crop will be unsatisfactory, consequently the selection of the proper seed is a main factor for the successful planter and must be entrusted by him to a competent person. Saving seed from the earliest maturing bolls, the "first pickings", is practiced largely on account of the higher fertilization and cultivation which seed saved in this manner usually receive, and which tends to lengthen the fibre and make the plants more productive. Regarding the seed itself, it may be said that though the cotton plant is said to be indigenous to some of the places where it is grown in America, yet it is supposed that the cultivated kinds known as Green Seed, to which the Upland cottons belong, was probably years ago imported from Mexico at the beginning of the nineteenth century. Regarding this, there is a story to the effect that an American consul at the city of Mexico having recognized the superior quality of the cotton grown in that country, requested permission of the Government to be supplied with some of the seed. This was declined, but over the dinner table one of the ministers told him that he could not take seed out of the country, but that the authorities had no objection to the exportation of dolls. It is said that the consul acted upon this suggestion, and straightway stuffed some hundreds of dolls, with the desired seed, and in this way, we are told, the famous Mexican seed found its way into the United States. Our Sea Island or black seed cotton originated from *G. Barbadosense* as is indigenous to a group of the West Indian Islands.

Planting and Cultivating.—The time of preparing the land commences in November and continues to March and April, though the land should be broken as near the time for planting as practicable. Deep plowing and subsoiling have generally been considered essential in this culture. To stand a two weeks drought, a cotton plant should have four inches depth of soil, six inches depth of subsoil, well broken, and for every additional week an inch more of soil with the same subsoiling.

Sowing takes place according to the climate of the country and the danger from frosts, the time of planting ranging from March 1 in southern Texas, to May 20 in northeast Georgia, and the first blooms appear May 15 in southern Texas to July 25 in northwest Tennessee. The first bolls open June 15 in southern Texas, and September 15 in north Arkansas. Picking commences in the two sections, respectively, July 10 and October 1, and may continue until the middle of December.

The distance apart which the seeds (about five or six in one hole) should be set, is still a moot question, but it is generally admitted to be unsafe to plant at greater distances than 12 inches. When sown, a light covering is put over, and in a few days—about twelve generally—the tiny plant makes its appearance, showing itself above ground in a hooked form, soon after lifting its stem, displaying two delicate leaves

folded together. Then it straightens itself, its color becomes a light, oily green, the lobed leaves separating themselves, and expanding. Subsequently a third leaf presents itself. What has next to be done is very particular work, viz:— cutting down and thinning the plants, which, if allowed to grow, would simply choke one another. Here and there at suitable distances, groups of plants in the same row are selected as “stands” or groups of plants from which will be selected the best plant, which is allowed to go forward in its growth, all the rest being weeded out. Banking up or bedding up is the next process, and this is done by running the plow in the spaces between the ridges or practically over the old cotton bed of the preceding season. This will improve the ventilating power of the bed considerably and prevent somewhat the logging of the soil, which is extremely undesirable. The plow is immediately followed by the field laborers, whose work is now to draw the loose soil around the cotton plants. This last process of “hauling” completes the laborers’ work for a time, and is done for the purpose of keeping the plant erect and preventing it from falling down. This hauling process is repeated until only one plant is left out of the five or six which were planted originally. After four haulings, the productive processes may be said to be completed. As the plant grows it throws out flower stalks, and at the end of each of these there is developed a pod with fringed leaf shields or calyces. This pod opens itself and discloses a bloom differing in color according to specie. In some, like that of the Sea Islands, it is always a pale yellow, but in others it changes considerably. In some cases the bloom is said to exist in its complete beauty for about twenty four hours, when, by a curious movement, it gradually but imperceptibly twists itself off. After the bloom has gone, a capsular pod or boll appears, supported by triangular leaves. Within this boll are cells, sometimes three and in others four or five. This pod or boll, green at first, increases until it is the size of a large filbert, the outer case gradually getting brown and hard, until at last it bursts itself into sections, and is seen to contain in each cell a quantity of tufted cotton, each cell containing as many separate fleeces as seeds, and each seed having its own tufted outgrowth. Nature provides no lovelier sight than the newly opened capsules containing the pure white and creamy flocculent masses of the cotton fibre as they hang from almost every branch of the plant at the end of a favorable season.

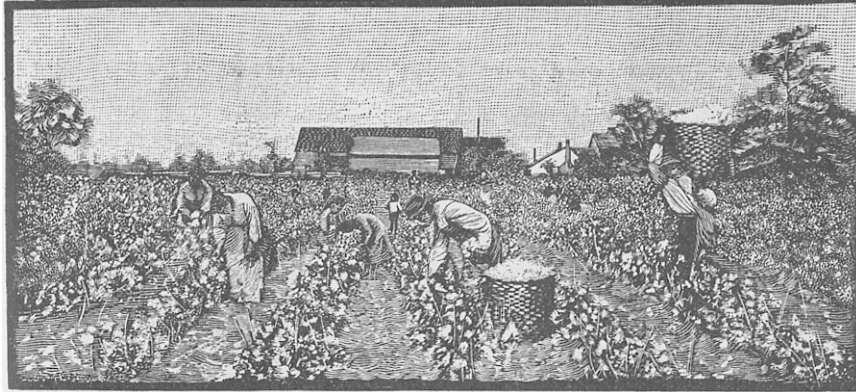
With reference to the cultivation of Sea Island cotton, the same is identical with that of Upland cottons before described, only that more care is taken on account of its higher value. Nature in this instance, on account of the nearness to the ocean, provides an efficient system of irrigation and drainage which can be kept up with comparative ease, and besides this, such ground contains saline matter which the plants readily absorb.

The first successful crop of Sea Island cotton was grown by

William Elliott on Hilton Head near Beaufort, S. C. in 1790. The highest prices Sea Island cotton brought was when in 1825 a Mr. Kinsey Burden, of South Carolina sold 60 bales at \$1.10 per pound and also sold his crop of another year for \$1.25 per pound when the average price of uplands was 9½ cents. In 1828 the same gentleman sold two bales at \$2.— per pound, which price will remain the highest Sea Island cotton ever was sold for. About 1889 the cultivation of Sea Island cotton was taken up among the small farmers of the pine levels at a considerable distance inland from the sea. So successful has this adventure proved that in 1894 the Sea Island crop of Georgia rose, while that of Florida fell and South Carolina, where this culture had originated and flourished longest, fell way back entirely. It had seemed for many years that islands on the South Carolina coast possessed a natural monopoly for the production of the finest staple. At that time the culture was conducted under the superintendence of men of high intelligence, and the selection of the seed and the cultivation and preparation of crop for market was attended to with great skill and the most scrupulous care. But at present it is chiefly in the hands of small farmers of the colored race, whose intelligence, skill and care are wholly occupied in securing a bare subsistence for themselves. It is doubtful if there is any local monopoly of the production of long staple cotton. It has been grown successfully in the up country; more than 100 miles from the coast, and all the seed from which the finest strains of Sea Island cotton have been derived came from seed planted in the interior of South Carolina, for several years, during the civil war.

The culture of Sea Island cotton as raised in the interior of Georgia is not so elaborate as the method pursued on the coast. In this case seed is brought every year from the coast in quantities to plant patches sufficient to furnish seed for the whole crop the ensuing year. The seed of the second season is thought to do better, but after that the staple deteriorates and seed is used which has been planted away from the coast only one year. The general culture there resembles that of Upland cotton.

Picking.—Cotton is picked by hand, notwithstanding that considerable skill and capital have been expended in the efforts to produce a machine cotton picker. It cannot be said that any of these machines have been successful, as they gather limbs, leaves, and hulls, necessitating the passing of the whole through a separator. As high as 333 pounds of cotton have been picked per day by one man, though it is probable that 100 pounds is nearer the days work of the average plantation laborer. As a rule, the cotton plants have their bottom, or first crop gathered during the time that the leaves of the plant are green; but the second crop, from the upper part of the plant, is liable to attacks of frost, which interferes with the picking harvest. Cotton picking is the most tedious and expensive operation in cotton growing, the most of the picking being paid for at the rate of from 40 to 50 cents



COTTON PICKING.

per hundredweight, expert pickers in this way earning from \$1.— to \$1.50 per day. It is very light work, at the most pleasant season of the year and it is effectively performed by women and even by small children, as well as by men.

Having thus described the method of cultivation and picking of cotton, the following abstract from a paper read by Mr. R. Derdeyn before the New England Cotton Manufacturers Association may be of interest. He says: "How is it that the cotton planter does not share in the prosperity of the United States in general? What is it that makes him poorer and poorer every year and reduces him slowly, but surely, from a planter to a pauper? Ask him, himself, the cotton planter; ask the thousands of them, and to a man they will say—The low price of cotton. This is a signal error. This answer is only true in so far as low priced cotton makes him feel more keenly the old time perquisites still levied by the thousands of vampires and barnacles surrounding him; and mainly in that the low price of cotton is the effect of the following cause, to wit: The unbusiness-like, wasteful and careless manner in which cotton is being handled by himself as well as by the aforementioned gentry. When cotton opens, all the thoughts of the planter are centered on picking it; so, whether the snowy flakes are dry or wet with dew or recent rains, the pickers are sent forth to gather them. As pickers work mostly by the 100 lb., they are not over particular, and thus leaves, hulls, limbs, and quite frequently lumps of dirt and mud find their way into the sacks to make up the weight of the day's picking. The cotton is emptied out of the picking sacks in baskets, hauled to the cotton house, or is piled on the turn row, to lie there exposed to the elements until it is hauled to the cotton house or the gin."

DISEASES OF AND ENEMIES TO THE COTTON PLANT.—The cotton plant which has escaped the risks of drought or rain however is not free from danger. It has diseases as well as living enemies of a more or less deadly kind to contend with.

Diseases.—Some of these are physiological in their nature, being due to disturbances of nutrition and assimilation, whereas others are due to the action of fungus organisms, which live as parasites in various parts of the plant, consuming the nutriment and causing destructive changes, which bring about the death of the part attacked if not of the entire plant. These diseases may be classed in three general divisions, according to their etiology viz:— Diseases due to physiological causes—Mosaic disease or yellow leaf blight, red leaf blight, shedding of bolls, and angular leaf spot; Fungus diseases—Frenching, sore shin, damping off or seedling rot, anthracnose, root rot, cotton leaf blight, areolate mildew, cotton boll rot, and ripe decay of bolls; Nematode diseases—Root galls.

Enemies of the cotton plant.—Aside from the cotton worm, the bollworm, and the Mexican cotton boll weevil, the cotton plant does not suffer to any consequence from insects. • Cutworms now and then damage young plants; plant lice may cause the withering of the terminal leaves; again there are bugs which sting the young bolls, although never to any serious extent; grasshoppers sometimes devour the leaves, and again there are several leaf feeding caterpillars which appear later in the season, but which only remove superabundant foliage thus exposing the bolls to the sun, causing earlier ripening, and thus actually are more beneficial than injurious.

The cotton worm, familiar to all cotton growers, is to be found in cotton fields in the Gulf States all through the summer. It is generally not noticed in the early part of the season on account of its insignificant numbers, but later on through the ragging of the leaves becomes noticeable, and in seasons of abundance defoliates the plant entirely. Farther north the insect makes its appearance at a later date in the season, and there the caterpillars are not the offspring of hibernating moths, but of the moths of the first or second generation, which have developed in more southern cotton fields and have flown north with the prevailing southern winds. The best plan to get rid of this insect is to distribute dry paris green over the plants.

The cotton boll worm, unlike the cotton worm, is not confined to America, nor to cotton as a food plant. It is by no means so easy to destroy this enemy of the cotton plant (as is the case with the cotton worm) since the same feeds in the interior of the cotton boll and is not readily found. The most efficacious preventative is the raising of suitable "trap crops" of sweet corn within the cotton field being planted so as to mature at different times and thus in turn protect the cotton plant.

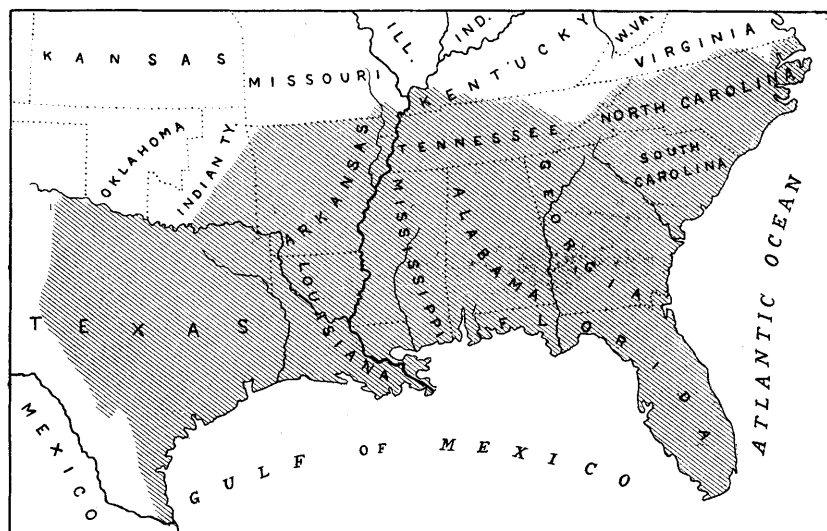
The Mexican cotton boll weevil, is another enemy to the cotton

plant, and is found in the cotton fields throughout the season, puncturing and laying its eggs in the squares and bolls. The remedies for destroying this insect are: Trapping overwintered beetles by means of a few early planted cotton plants. Destruction of volunteer plants in cornfields or abandoned fields. Picking fallen squares as fast as practicable, from the time the squares are formed on the plant. Cutting and burning the cotton stalks as early in the fall as practicable, and, if possible, plowing the cotton fields at the same time. Trapping the last weevils in the field by means of a few plants left standing. There can be no doubt that this insect may become the most serious enemy to the cotton plant with which cotton growers in this country will have to contend.

SEA ISLAND COTTON,—is the best grade of cotton in the world; such as raised on its respective islands off the coast of South Carolina and Georgia or directly on the coast having a staple of from $1\frac{3}{4}$ to $2\frac{1}{2}$ inches. The fibre closely resembles silk, being extremely fine, strong and clean, permitting it to be spun readily into 150's and, if the case should require, up to 400's for ply yarn. Such of this cotton as grown further away from the coast in Georgia and South Carolina averages from $1\frac{1}{2}$ to 2 inches in length of staple and closely resembles the actual Sea Island cotton, from which it is grown, permitting, if required, its spinning into 150's and up to 200's for ply yarn. The fineness of Sea Island cotton may be illustrated by the fact that English authorities on this subject claim that in one instance it has been spun into counts as high as 2,150 hanks to the pound, which means that 1 lb. of such yarn would extend upwards of 1,000 miles.

Florida Sea Island Cotton—is grown on the mainland of Florida from Sea Island seed. It has a white, glossy, strong fibre, a little coarser than strict Sea Island, from $1\frac{1}{4}$ to $1\frac{3}{4}$ inches in length, and is not as carefully handled during cultivation. It is suited for lower grades of Sea Island yarns spun up to 150's and 200's for ply. Sea Island cottons are always combed and extensively used for thread and lace making purposes; again, if dealing with special fabrics, such as lining of bicycle tires, sail cloth, etc., and where a very strong fibre is required in connection with heavy counts of yarns, Sea Island cotton is sometimes used.

AMERICAN OR MAINLAND COTTON.—Although the Sea Island is American cotton, yet this name is never used in connection with it; the name American meaning the typical cotton of the world grown in what is considered the "mainland cotton belt" which extends from southeast Virginia to Texas, its distribution being mainly between the tide water district and the foothills of the Appalachian Mountain system. The deep alluvial soils of the Mississippi Valley favor extension of cotton growing much farther northward, from the sugar district of southern Louisiana to the southern border of Missouri, including most of Arkansas and western Tennessee, while the higher elevation



COTTON BELT OF THE UNITED STATES.

of central and eastern Tennessee limits culture and diverts sharply the line of limitation around the foothills of northwestern Georgia. Fifty years ago Mississippi, near the western border of cultivation, had surpassed other States and produced nearly a fourth of the product; now Texas, on the extreme west, yields one-third of a crop doubled in volume. Except a very limited area in Virginia, Kentucky, Missouri, and Indian Territory, cultivation is mainly confined to suitable and comparatively limited districts in North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana and Texas. This cotton is suited for all numbers of yarn up to 50's warp and 80's filling, being clean, regular in length of staple and well graded. On account of these features, as well as the fact that the quantity raised is greater than that in all other parts of the world together, the price of American cotton regulates the price of cotton throughout the world.

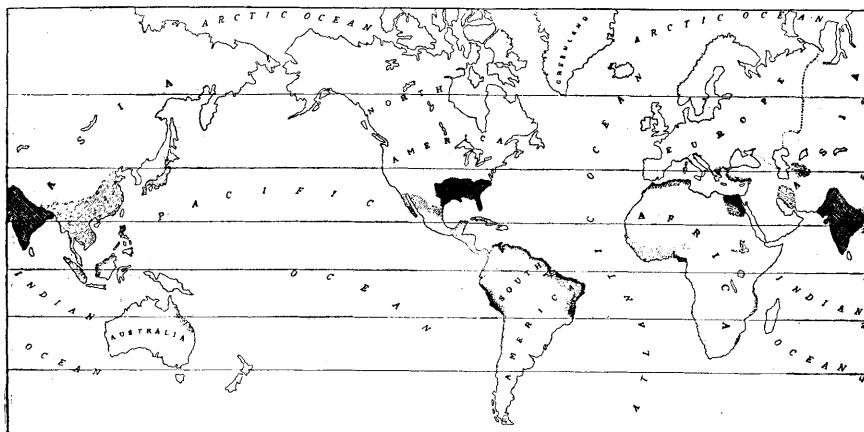
Of this American cotton the Gulf (or New Orleans), Benders or Bottom Land varieties are the most important, varying as to length of staple from 1 to $1\frac{3}{8}$ inches ($1\frac{5}{8}$ inches in special instances), permitting spinning up to 50's warp and 80's filling. Cottons brought in the market as Mobile, Peelers and Allan Seed, belong to the same variety and are next in importance, while Mississippi, Louisiana, Selma, Arkansas and Memphis cottons also belonging to this variety, are slightly inferior. Texas cotton varies from $\frac{7}{8}$ to 1 inch in length of staple, and is well suited for warp yarns up to 32's. Next in importance are the Uplands cotton, having a length of staple of from $\frac{3}{4}$ to 1 inch, permitting

ready spinning into 30's to 40's filling. Cottons as brought in the market under the name of Georgia, Boweds, Norfolk, or Savannah cotton also belong to the variety of Uplands.

FOREIGN COTTONS.—Amongst these we find of the greatest of value to our manufacturers (on account of their radical difference in staple as compared to our own cottons) the “Brown Egyptian” and the “Rough Peruvian”, others being of no interest to us.

Egyptian Cotton.—Generally speaking this cotton stands high in the estimation of the commercial world, the success of growing being largely due to the equability of the climate in the delta of the Nile. Of the different varieties grown there the one known as Brown Egyptian is the best, permitting ready combing on account of its regularities of staple. The color itself varies from dark cream to a brown tint, according to soil in which it is grown. The length of its fibre varies from $1\frac{1}{8}$ to $1\frac{1}{2}$ inches and is spun in 50's to 80's warp, up to 100's for filling and up to 120's for ply yarn. It is not as fine as Sea Island cotton, and of course does not bring so high a price, but is better than our mainland cotton especially for goods requiring smooth finish and high lustre, at the same time giving to fabrics a soft silk like finish, a feature which makes this cotton very desirable for use in cotton mixed silk goods. Egypt has many advantages over our planters, in that in the first place, she can get almost twice as much cotton from the acre, so productive is the soil, and besides labor is cheaper, and the plant itself when young is not subject to the devastating frosts so often met with here. The imports of this cotton into this country are constantly increasing. Although cotton is raised in other parts of Africa, yet the same is of little importance to the world's product.

Peru,—produces a considerable amount of cotton, three varieties being brought into the market, called respectively, Sea Island, Rough and Smooth. The “Rough Peruvian” is the most important variety, having a strong, rough, woolly, crinkly staple, about $1\frac{1}{4}$ to $1\frac{1}{2}$ inch long and is usually very clean and well handled. Its chief use is for mixing with wool in the manufacture of Merino yarns, for which reason it is called “vegetable wool”, and when carded its resemblance is so close and its characteristics so strikingly similar to wool that it could readily be sold as wool, even to a dealer. When woven into goods along with wool the cotton fibres cannot be determined with any certainty except by using chemical tests. This cotton is extensively imported by us and chiefly sold to manufacturers of woollen goods, for the purpose of mixing with wool, although some is used by itself in the manufacture of cotton yarns. When mixed with wool it reduces the tendency of the goods in which it is used to shrink, makes them more durable, lessens their cost of production, besides giving them a better lustre and finish; hence it is frequently used in the manufacture of underwear and hosiery. For dyed goods it is equally suitable, as it takes the dye very well, i. e. it makes fast colors. This peculiarity of the Peruvian cotton



MAP OF THE COTTON GROWING COUNTRIES OF THE WORLD
(SHADED ACCORDING TO IMPORTANCE).

is probably the result of soil and climate, and its cultivation is therefore likely to be restricted to that country. It would be very difficult to find a section in the United States that would furnish a uniform and high heat during the ten months necessary for the development of the plant, or the other conditions which contribute to the successful cultivation of this cotton. Some of this cotton is "high colored" and some actually "Red", a feature explained by means of the copper soil on which raised. The "Smooth Peruvian" variety is somewhat shorter and resembles our Gulf cotton; whereas the "Peruvian Sea Island" resembles our Florida Sea Island, although by no means being as clean as the latter. The cotton crop of Mexico, West Indies and the remaining Central and South American states is of little importance.

Brazil,—also produces a great amount of cotton, however the same is badly cultivated and brought into the market poorly ginned. Its staple is somewhat longer than the average of our Mainland cotton, and is more or less characterized by a harsh, wiry feel, giving in turn an oozy character to the yarn. Most all of the crop goes to Europe.

Indian Cotton,—is the lowest class cultivated, owing to the great carelessness in cultivation as well as poor ginning. It possesses a short, coarse staple, although there are some classes of it which have a comparatively better staple. It is chiefly exported to the continent of Europe on account of the spinning of low counts there.

Of European grown cotton, but which is of no consequence, we find the same sparingly raised in Greece and Turkey.

Russia raises some cotton in its Asiatic territory, in Turkestan and Transcaucasia, and so does Turkey in Smyrna and Syria.

China,—produces a considerable amount of cotton which however is almost all consumed in that country. It is a white cotton, somewhat harsh to the touch, but of a comparatively short staple.

The amount of cotton raised in Japan is unimportant as that country imports more cotton than she grows.

The Philippine Islands, Borneo, Sumatra, etc., all raise some cotton but which is of little consequence to the market.

In Australia, cotton culture has been attempted, and while a little fibre is grown it can hardly be called a promising industry. Very small quantities are also produced in many of the islands of the Pacific, and in some of them the product shows a good staple. The Fiji and Tahiti cottons being exported.

DEFECTS TO THE FIBRE AND IMPURITIES FOUND IN COTTON,—are the cause of imperfections in yarn and consequently a loss to the spinner in the selling price of the yarn, and a loss to the manufacture due to defects showing in the fabric. The same are unripe fibres, broken fibres, broken leaves, seeds, sand and mineral matter, excessive moisture and stained cottons.

Unripe cotton,—can be divided into dead and half ripe fibres.

Dead cotton, appears under the microscope to be extremely thin and transparent, and generally with little or no twist in it and is of little use. When it exists to any great extent in any lot, it seriously reduces the value of the material, being in what is called a "green state"; it contracts and curls up when subjected to the warm atmosphere of the factory rooms, and by entwining itself around good fibres it becomes exceedingly difficult to remove. If all cotton capsules on the plant would ripen simultaneously, there would be scarcely any dead cotton. They are those fibres which do not undergo distention, or only in a smaller degree, during the maturing of the pod, and which in turn become wrinkled and matted after the ginning process, being respectively designated as dead, gin cut, unripe, or half ripe cotton. They are a source of trouble all along to the manufacturer since they will not spin, (having a great tendency to curl up or nep), dye (refuse to take color), or finish perfectly. The tufts of dead fibres are frequently accompanied by short fibres at the lower part of the capsule segments, and where a greater compression is exercised on the fibres of those seeds that are seated in the lower part of the capsules most dead cotton will be produced. When cotton is picked before ripe there is always a greater chance for dead cotton and short staple. In the preparatory processes of cotton spinning a great amount of dead cotton is taken out, however frequently tufts are passed on, and in turn may give rise to neppiness or a weakening against the pulling strains, and also a cloudiness due to parts where the short or immature fibres have lost their hold on the surface of the yarn. Cotton seeds have a woolly down attached to their surface, which is left on the seeds after the fibres have been ginned. If the gin works defectively this down may

pass on with the good fibres and when it is difficult to remove during opening, picking and carding on account of the lightness of the short down. If tufts of this short down in turn are passed on in the yarn after carding they give rise to white specks of fluff, classed as dead cotton. To determine the presence of dead cotton requires the greatest of attention.

In half ripe cotton, we observe the connecting link between those fibres just described and those which are perfectly developed. While the dead cotton is tissue like in formation, and presents little or no appearance in the thickness of the walls, the half ripe fibre is more clearly defined, and the deposit of matter on the inner surface is observable. It has also an approach to a convoluted structure, and seems to possess some tenacity and strength of which dead cotton is devoid.

Broken Fibres.—Owing to the rapidity with which cotton is fed to the saws of the saw gin, or (although not as hurtful) to the rollers of other types of gins, and the gins being sometimes out of order, it is an easy matter for the fibres to become gin-cut or broken. It must be remembered also that the cotton is fed to the gin in tangled masses, the fibres lying in every direction, and thus the longer the staple of the cotton the more liable the same is to damage, especially when dealing with the saw gin which is notoriously liable to give gin-cut cotton; the saw gin being unfit for any grade of the long stapled cottons.

Broken Leaves.—Owing to the proximity of the leaf to the cotton, and the rapidity at which cotton has to be picked, there will be always more or less leaf taken by the picker from the plants along with the cotton, which if not removed by the cotton cleaner will pass to the gin, and where the leaf gets broken up during ginning, making it more difficult afterwards at the preparatory processes of spinning to extract such particles of leaf. When leaf in a lot of cotton barely exceeds $\frac{1}{4}$ inch in size, it may in some instances indicate that the cotton in question has not been handled harsh at the gin and thus the staple to be pretty uniform in tension and flexibility; however it will require skillfulness on the part of the buyer to judge whether the size and quantity of the leaf is a fair standard. When said leaf is smaller than $\frac{1}{4}$ inch it is less controllable in the opening and picking processes in the mill and will readily pass on with the fibres causing the "lap" to have a more or less dull, pepper dust-like appearance. The greatest cleaning principle we have in cotton spinning is the repeated opening or drawing out of the cotton at stage after stage, so that the impurities will then fall out by the force of gravity. Leaf when broken up so fine becomes much more difficult to extract, on account of its becoming so light that it will not drop out. If leaf present in a lot of cotton is larger in size than $\frac{1}{4}$ inch it gives to the cotton a blotchy appearance, such cotton being designated as "black jack" staple. These large particles of leaf are a source of trouble to the spinner and manufacturer since if not ejected at once

in the preparatory processes, they will there get further broken up and are hard removed. Some of these pieces of leaf are physically strengthened by the addition of veins with rough surfaces or corners, some of which are known as "sticks" or "legs", which easily adhere to the fibres of cotton, (like some burs do in connection with wool), and which are often carried on with the material, appearing in the yarn and where they are frequently a source of trouble at winding, beaming, slashing, weaving, owing to the wiry particles or veins protruding from the body of the yarn, interrupting the course of the yarn and thus cause breakage. Cottons which contain such particles of veins in connection with leaf are difficult to sell to experienced manufacturers, since said impurities are hard to remove in cotton spinning.

Seeds.—The seeds of the cotton boll are separated from the fibre by gins, which as a rule are run at high speeds and are frequently over fed. Some of the seeds, therefore, either broken or whole, are conveyed along with the fibre, and, being brought to the mill, constitute a defect in the cotton. Seeds have generally a few fibres attached to them, which when broken give rise to "bearded motes", the beard adhering to the lap, sliver, roving and yarn, being difficult to remove. Seeds, both on account of loss in weight as well as the liability of being broken up into bearded motes are a loss to the manufacturer. Seed is a heavy impurity in cotton, as compared to leaf which is a light impurity. "Shell" is a term used when seed coverings are prominent in a lot of cotton, or when they have been struck out from seeds by the beater of the picker or scutcher. Pieces of the fleshy kernel of the seeds are also often termed shell and rank with seeds as heavy impurities.

Sand and mineral matter.—Owing to the winds loading the cotton plant with sand at times, as well as a possible adulteration, there is more or less present in cotton sand and mineral matter, which is not only a dead loss to the manufacturer, but frequently the cause of damage to machinery as well as of fire. In some cottons the presence of a little black soil is regarded as a good sign, indicating that the cotton has been grown in a rich soil.

Moisture in cotton.—A certain quantity of moisture is a necessary accompaniment to good commercial fibres, in order to keep them soft, pliable and elastic for the satisfactory manipulation of the fibre in spinning, and if for any reason a portion of this natural moisture is driven out, the spinning of the yarn is rendered more difficult until the moisture is replaced in the air. It is worth while remembering that new cotton may be expected to contain more moisture than cotton a season or few months old, owing to natural evaporation. This water always present in cotton cannot be driven out by a moderate heat, and, in fact, after it has been expelled by excessive heat, is replaced by a percentage of moisture from the atmosphere after the super-heated cotton is allowed to stand in the open air. The amount of water thus existing naturally in cotton is given by the Experimental Station in Tennessee,

as 6.74 per cent. This natural moisture is termed the water of hydration, in order to distinguish it from artificial moisture as may be added to "weight" cotton, or is absorbed by the cotton when in one shape or the other exposed to rain, such condition of the cotton in which the amount of moisture is heavier than the permissible limit, being termed "lossy" and bales of such cottons are termed "water-packed".

Stained Cotton.—These imperfections to the fibre are known respectively as boll stained, hoop stained, oil stained and fungoid stained.

Boll or brown stained cotton is caused by the seed cotton remaining in the unopened pod until it has become saturated by the rain entering at the partly opened sutures, thus causing the coloring matter from the inner membrane of the pod to permeate the fibres, giving them a red or brown shade. Some cotton pods have only one or two of the cavity locks of seed cotton stained, while the third, fourth, or fifth cavity is unstained or white; but in the ginning the two kinds get mixed up together. Bleaching gets rid of the staining, but if the fabric is not to be bleached, such stained cotton can be used for warp yarns, mixing it moderately with cottons of a better staple, and when the stain disappears in the size box.

Hoop stained fibres are caused by rusty hoops of the bale coming in contact with the fibre; this coloring being only temporary is got rid of in the mixing and opening processes.

Oil stained fibres are mainly due to the crushing of the seed at ginning, the oil of the kernel glands oozing out, in turn contaminating attached fibres, giving them a faint yellow color. Oil staining is also caused by seeds not expelled by the gin, such seeds in turn being crushed in the preparatory machinery, thus giving rise to oil stained bearded notes. Oil staining causes trouble in carding and spinning, causing the laps to lick, and the fibres of slivers to be repulsive and curl up in the frames and mule.

Fungoid stained are mildewed fibres, weakening the staple and giving it a musty odor.

In some cottons the impurities are of such a character that a double process of carding must be resorted to, however it is always best to rely upon the preparatory processes to get out most of the impurities.

BYE PRODUCTS OF COTTON SEED.—A complete cotton plant consists of roots, stems, leaves, bolls, seed and lint. If these six parts of the plant are weighed (water free), the average result will be:—Roots 8.80 %, Stems 23.15 %, Leaves 20.25 %, Bolls 14.21 %, Seed 23.03 %, Lint 10.56 %. By this it will be seen that only a small proportion by weight of the plant is taken up by the lint i. e. cotton fibre. It is these bye products that put cotton raising on a paying basis. Amongst them we find:

Linters, which are the short fibres or fuzz that clings to the seed after the lint has been removed in ginning. These short fibres are in

turn removed by special constructed gins and are sold either as waste for spinning low counts of yarn in connection with better cotton, or made into batting (wadding).

The outer casings of the seed, the hulls, are split off preparatory to extracting the oil and in turn are largely used either in the manufacture of a good grade of paper or as cattle food.

Cotton Seed Oil, is the most valuable bye product and is extracted from the meats which form the center of the seeds. The crude oil, after being refined is known as "summer yellow", a prime quality of it being called butter oil, largely used in the manufacture of oleomargarine, butterine, etc. When a selected summer yellow is subjected to cold pressure, it becomes salad oil, used for dressing salads and in cooking. "Summer white" is obtained from summer yellow by treating it with fullers' earth, or some other bleaching powder, and is used in the manufacture of compound lard and for like purposes. "Winter white" is the same as summer white, except that it has been cold pressed. It is used for burning in miners' lamps and in the manufacture of various medicinal compounds. Ordinary summer yellow is largely used in manufacturing, such as tempering steel, making of bolts and nuts, etc. As an illuminating oil it ranks next to sperm, but its principal use is as a food oil, nearly all of the oil sold here as olive oil being really cotton seed oil. The Italian Government enacted a high tariff regulation against the importation of cotton seed oil into that country in competition with oils made there. Similar regulations have been made in Germany against refined cotton seed oil, which in the form of butterine was being substituted for the butter of the German dairies. The stearine left on the cloths in the filter press when the oil is refined is used for making butter and lard surrogates and candles. As a food, cotton seed oil was first used as an adulterant to soften and temper lard intended for use in cold climates. Later on, the fluidity of the oil itself was corrected by mixing it with beef fat. This mixture was put on the market under the name of compound or refined lard. It was so kindly received by the public that before long all disguise was dropped and it was sold on its merits in competition with lard. A fair foreign opinion of the value of cotton seed oil is given by the "Lancet" a prominent medical journal of England which states "Because cotton seed oil has been employed by unscrupulous persons as an adulterant of pure olive oil and butter a certain amount of prejudice has been entertained against it as an element in dietetics. The ease, however, with which cotton seed oil saponifies would indicate it to be a useful food and an excellent substitute for more familiar fats. Indeed, there is some evidence in favor of the view that properly refined cotton seed oil is as wholesome as butter. However wholesome and nutritious, though, cotton seed oil may be, it should be sold under its right name and should not be allowed to masquerade under titles to which it has not the slightest claim". The late Dr. Cambell Morfit devoted considerable

attention to the purity of cotton seed oil for edible and pharmaceutical purposes. He demonstrated the exceptional capacity for assimilation which cotton seed oil possesses when chemically pure by five years experience of its use in chronic dyspepsia. Where the diet was strictly limited and the stomach was intolerant of any other fat, even of butter, the daily consumption of a small quantity of cotton seed oil produced results unattainable from any other food. After the oil has been pressed out of the seed, the meats are left in the form of a cake, "Oil Cake", which in turn is broken into small pieces and ground into meal, being used either as cattle food, or it is mixed with other substances, and used as a valuable fertilizer.

Of the remainder of bye products the roots yield a drug; stems, leaves and bolls being burned and used as fertilizer.

GRADING OF COTTON.—The value of all cotton is determined by the length and fineness of the staple, as well as absence of impurities. Our cotton is the standard, and rules the price of any cotton all over the world. A study of the conditions in which cotton is placed by the demands and requirements of commerce cannot help but be of importance to any manufacturer since in buying at the proper price—in connection with the proper staple, etc., he lays the foundation for profit or loss in his mill. Besides he should have a thoroughly sound knowledge of every point connected with the material, its qualities, and the characteristics of each sample submitted to his notice, whilst a delicate touch and good eyesight are also much needed physical qualities. Occasional microscopic investigations will be required. A rise in the price of cotton, or a scarcity of a particular class that is in fair demand, may cause some uneasiness to the spinner when under contract, for if the cotton is not forthcoming he has to resort to the nearest best quality that is available, without regard to its selling price. There are several principal factors in a good cotton, length of staple, uniformity, strength, color, cleanliness, and flexibility. The first can be found by the gradual reduction of a tuft by the hand until individual fibres are drawn from the tuft, so as to enable their length to be ascertained. To do this well only requires a little practice, and no explanation can make anyone perfect. In examining the cotton, not only should its length be ascertained, but the uniformity of the length of the fibres in the sample. If these are uneven the cotton is of less value than if it were a little shorter, but of greater evenness. The color of any cotton affects the question, because of the necessity of keeping an even shade of yarn. The cleanliness affects the amount of waste made, which is a matter of great importance. It can be ascertained on inspection, and by shaking the sample over paper it will be seen if it contains much dirt or sand. The flexibility of the cotton can be ascertained by the feel, which will show if it is soft or harsh, this again being a matter only acquired fully by practice. Flexibility does not necessarily imply a lack of strength, which some might regard as a more essential factor, but rather includes

it. A weak fibre would not be a flexible but a brittle one, and without considerable strength flexibility in the true sense cannot exist. On the other hand, a fibre might be strong and harsh and yet not flexible, being, therefore, not so suitable for spinning. Warp yarns, as a rule are spun for higher counts compared to filling, and the higher the count spun the greater the necessity for a long uniformly even staple. Again the warp yarn has to stand considerable strain during weaving, a feature not required by the filling, hence the strongest cottons have to be used for warp yarns. Filling, although required to be made from fibres of proper length and strength, in order not to influence the strength of the fabric, yet requires a soft and flexible fibre. Any attempt to determine the average strength of single fibres in a lot of cotton necessitates the testing of an enormous number of fibres, since a pound of cotton contains at least one hundred million fibres, and the strength of the fibres varies widely. In order to ascertain the strength of fibres, the amount of their elasticity, the use of a little machine as shown in the accompanying illustration Fig. 3 will be found of advantage. Letters of reference in the illustration indicate as follows: A is a base board of hard wood (generally leaded) upon which is fixed a pillar B.

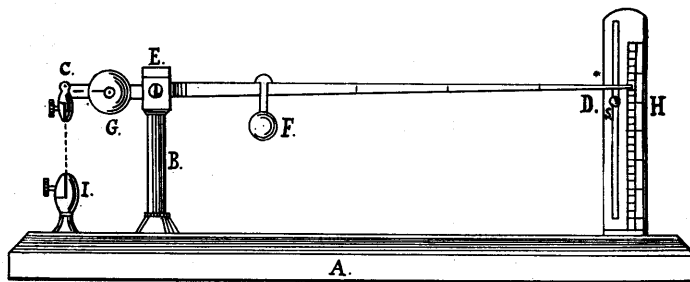


FIG. 3.

The top end is forked into a jaw, carrying on each side a screwed centre-piece, into which is fixed the fulcrum of the lever C D. These two centre pieces can be screwed closer together, or farther apart, as required, and the pivot which forms the fulcrum E of the lever is pointed at each end, and fits into a hollow in the two ends of the centre pieces and enables it to work perfectly free, and yet can have no lateral motion as would be the case if knife edges were used. The lever from E to D is divided into five equal parts, each of which is equal to the distance of the centre of the jaws C from the centre of the fulcrum at E. G is a balance weight to counterpoise the longer arm E D of the lever. Each of the five divisions of the lever E D are again divided into ten parts (not shown). The range of the instrument depends upon the weight of the sliding weight F, which can be varied when desirable. Three different weights, viz., 50 grains, 100 grains, and 1,000 grains are

used, and the range of the instrument with these different weights is as follows:

WEIGHT.	FIRST DIVISION.	SECOND DIVISION.	THIRD DIVISION.	FOURTH DIVISION.	FIFTH DIVISION.
Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
50	50	100	150	200	250
100	100	200	300	400	500
1,000	1,000	2,000	3,000	4,000	5,000

By using the intermediate decimal divisions of spaces on the levers we obtain in the case of the fifty grain weight an increase of 5 grains for each division, with the 100 grain weight 10 grains for each division, and with the 1,000 grain weight 100 grains for each division; so that the range is from 50 grains up to 5,000 grains, with difference of not less than 2.5 grains when the 50 grain weight is used, 5 grains when the 100 grain weight is used, and 50 grains when the 1,000 grain weight is used. At the end of the lever D, a graduated scale H, is placed, divided into spaces which enable the elasticity of the fibre to be measured in terms of the distance of the two jaws C and I from each other. The arrangement generally used is, that if the jaws C and I are separated one-tenth of an inch it will indicate half an inch on the scale H, thus enabling very small ranges of elasticity to be readily seen. A small stop S, adjusted by a thumb screw at the back of the plate, is inserted in a long slot in the divided plate so as to prevent the lever from falling when the point of fracture is reached. For moving the weight along the lever a fine silk thread (attached to the ring which slides along the lever) is generally used so as to avoid any pressure which otherwise would be exercised if using the fingers. Generally two or three experimental tests are made previous to the final ones as required for reference.

The handling of cotton in the field and thence to the gin was formerly, when dealing with large plantations, carried on neater than it is now and the ginning was also in several regards better done. The different pickings were ginned separately, each picking on the large plantations being sufficient to make a run for the gins, and the different grades of cotton were thus kept distinct. The sub-division of farms since the civil war however has changed this. In the old gin house the lint was blown from the gin into a spacious lint room, where another separation took place, the dust laden and consequently heavier lint falling nearest to the gin, while the cleaner and lighter flocks were thrown to the farther side. The distinction between these piles was carefully observed in baling the cotton.

The different varieties of the cotton plant are distinguished in commercial transactions by the names of the countries or districts in which they have been grown, or ports shipped from or by the peculiarities of

their appearance; but as each country produces several distinct varieties, owing to the difference which exists in the seed, soil, methods of cultivation and atmospheric influences in the various districts, there are, of course, many sub-divisions of each variety, which are ranged into grades, and classified in the markets under the headings recognized as applicable to their general qualities.

Raw cotton may be divided into three classes viz:— long, medium and short staples. The long staples comprise Sea Island and Florida Sea Island; the medium staples comprising Egyptian, Rough Peruvian, Benders, Peelers, Allans etc., while the short staples take in the Up-lands, Texas, etc., cottons.

The classification of our Mainland cotton is generally done by means of 7 full grades, which if required are divided in half or quarter grades, thus giving a chance to grade either by 7 full, 13 half, or 25 quarter grades as the case may warrant.

The full grades are Fair, Middling Fair, Good Middling, Middling, Low Middling, Good Ordinary and Ordinary. "Fair" is considered the best quality, the others varying downwards in proportion, so that "Ordinary" becomes the lowest, or perhaps has the shortest staple, and will chiefly lend itself for the spinning of inferior counts.

The half grades are designated by the prefix "Strict".

The quarter grades are designated by the prefixes of "Barely", meaning the mean point between the half grade and the next full grade above, and "Fully", meaning the mean point between the half grade and the next full grade below.

Sea Island cottons are graded as follows:— Extra Fine, Fine, Medium Fine, Good Medium, Medium, Common and Ordinary which is the lowest priced staple.

Egyptian cottons are as a rule quoted under four or five grades viz:— Good, Fully Good Fair, Good Fair and Fair which is the lowest quality. Between the grades Good and Fully Good Fair there is often an intermediate grade adopted, called Extra Fully Good Fair.

Notwithstanding the numerous grades in which cotton is classified, their determination is practically a rule of thumb matter, and samplers will be found to classify and price the same sample very differently. A few ounces out of a 500 pound bale is taken in the hand, opened and the fibres pulled out between the thumb and forefinger, and the classification decided. For many points it is sufficient; the length of the staple is observed in a general way, its color, its strength, and its freedom from dirt and, so far as the sample goes, from motes and seed and leaf. The sampler knows that there are severe laws against fraudulently packed cotton; that the contents of the bale will not differ widely from the sample he has examined, and if it should, that the marks on the bale will enable the purchaser to trace it back to the producer and make reclamation.

CLEANING, GINNING AND BALING.

When the picked cotton is gathered on the field it is of course heavily weighted with all kinds of impurities which either are to be removed by ginning, or, in some instances by means of cleaning and ginning.

CLEANING,—precedes with some classes of cotton the operation of ginning and is carried on in the Ginnery on a machine known as a Cleaner, the purpose of which is to break any unopened bolls, disintegrate clods or lumps formed by dirt, burs or other trash that becomes mingled with the cotton, and thoroughly separate all foreign substances of fine or coarse dimensions from the cotton and discharge the separated material into a bin or other receptacle, or direct to the gin.

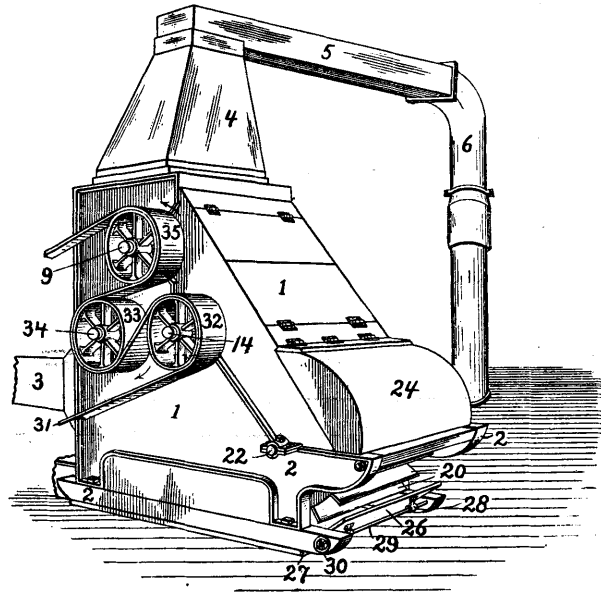


FIG. 4

Fig. 4 is a perspective view of such a cotton cleaner, showing the suction flue broken away, and a pneumatic elevating and feeding tube.

applied. Fig. 5 is a vertical longitudinal section through the machine.

Referring to Fig. 4 it will be seen that the machine comprises a casing 1 erected upon the side frames 2 and connected with a rear suction flue 3 leading to any suitable means for exhausting air and by which a suction is created through the machine. The casing is substantially air tight so that the machine may be fed pneumatically through the spreading cap 4 from the valved pipe 5 and telescope 6.

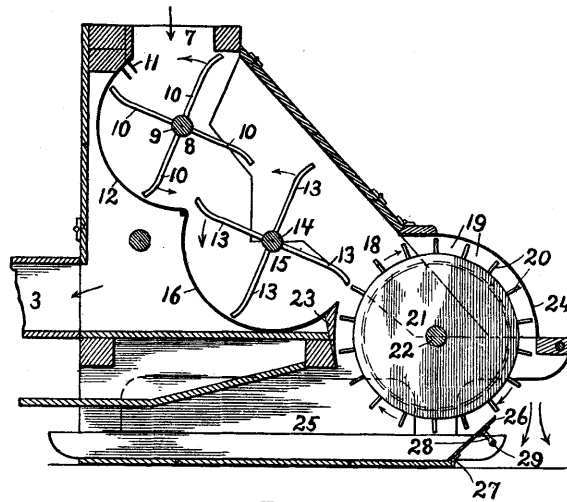


FIG. 5.

Referring to Fig. 5, 7 represents the feed opening, through which material to be treated is fed directly onto the rapidly rotating beater 8 composed of a through shaft 9 and radial arms 10 having backwardly curved outer ends. The material is driven by the outer portions of said arms past the comb 11, by which clods, lumps and hulls are broken and partly disintegrated, thence over the upper concave screen 12 where the particles of trash are driven by the air current and by centrifugal action outward against the screen and if of small dimensions through said screen to the exhaust flue and thence off the lower end of screen 12 and outward, where it is caught by the oppositely moving arm 13 rotating with the shaft 14 of the lower beater 15, by which the material is thrown back upon another screen 16 where still further particles escape with the air current. By the contrary action of the opposed sides of the beaters the material is picked, turned and lightened up, so that the foreign substances become thoroughly detached therefrom and allowed to find their way to the screen and all parts that can pass through the screens are thus permitted to escape. From the lower screen 16 the material is thrown by beater 15 outward over the tailing outlet 18, where it settles into the pockets 19 formed by flights 20 on the discharging and separating drum 21, to which rapid revolution is imparted through its shaft 22. The drum 21 makes substantially air tight connection at its inner side with the wall 23 and on its outer side with the shield 24, so that the suction from the feed opening through the casing and past the screens is not materially interfered with, the

material in the pockets making a complete closure on the outer side. There exists in some cotton and especially in the latter portion of a crop, a proportion of unmaturing bolls, commonly called "cracked bolls," which contain good cotton, but the hulls of which have a tough fibrous inner lining that prevents them from disintegrating sufficiently to pass through the screens. These parts of hulls, as well as larger pieces of leaf, trash, etc., remain with the staple and enter the discharging and separating drum. During their passage around this drum the cotton is heavier, as the seed is not removed, than the foreign substances and finds its way to the outside, so that the foreign substances named settle to the bottom of the pockets. This enables a thorough separation of these parts by the following means: 25 is a trash flue into which the discharging and separating drum dips and the bottom of which terminates at front in a cant board 26, hinged at 27 and rendered adjustable to and from the periphery of the drum through the medium of toggle links 28 (one on each side of the machine) and shaft 29, the latter being rotatable through a hand wheel 30. By the construction of the flighted drum an air current is set up over the cant board into the flue, which may be more or less intensified by the adjustment of the cant board to and from the drum. Such adjustment can also be made to define accurately the plane of division between the material deflected by the air current and that continuing in the line of discharge, and thus insure a complete separation of the trash from the cotton. The machine is driven by belt 31 passing over a pulley 32 on the shaft 14 of the lower beater, thence around tightening pulley 33, fixed on shaft 34, and thence over pulley 35 on upper beater shaft 9. The shaft 34 passes through the machine and upon its opposite end carries a pulley connected by a short belt with another pulley fast on the drum shaft 22; all of the shafts being driven at the same speed. The lengths of the beater arms in the lower beater are longer than those of the upper beater and the extreme diameter of the discharge drum is greater than that of the lower beater, measuring to the extremities of the arms, a feature which will result in that the material is driven constantly faster as it passes through the machine, and as the revolution of the upper beater practically controls the admission of material it will be observed that it is impossible to choke the machine or overcrowd it, as the material is accelerated after leaving the upper drum; about five hundred revolutions per minute giving the best results.

GINNING.—The cotton as received from the field or such as has been cleaned, is in turn submitted to the action of the cotton gin, which has for its object to separate the cotton fibres from the husk, berry or seeds to which the filaments most tenaciously adhere. It will be readily understood that on account of the delicate structure of the cotton fibre this process of ginning should be carried on with the greatest of care in order not to injure the staple. The fibre, after being separated from the seed by the ginning process, is then technically known as "lint".

The word gin is derived from *engine*. In many cases a plantation has its own gin, again some of the ginneries are located in villages or on a large scale in the interior towns, and may vary in construction and mechanical adaptation, from a rude wooden shed, in which the motive power is got from mules or horses, to a solid structure containing the most modern steam driven machinery. Cotton intended for use in the mills in the vicinity of the cotton raising districts is, in some instances, taken straight from the field to the mill and ginned there, consequently giving such mills advantages over others, since they will carry on ginning more carefully in their own interest, so as not to injure the staple. Cotton ginned in a defective machine is damaged either by the fibres being broken or by their being rubbed up into little knots or "neps," the presence of which, in large quantities, always indicates bad ginning; so do also sticks and broken leaf indicate poorly ginned cotton. The method employed in every gin is to pull the fibre through a narrow space which is too small to permit the seed to follow. Separation is then effected either by the passive resistance offered to the passage of the seed, or to the seed being mechanically pushed in an opposite direction to that in which the fibre is being drawn.

Cotton gins are of two types, the roller and the saw gin. Different makes of these machines are in the market, every machine builder having introduced some speciality in their construction by means of which, claiming either superiority as to quality or quantity of production or both combined, however the principles of operation remain identical. The roller gin is used for long stapled cottons, while the saw gin is used in connection with the other cottons.

THE ROLLER GIN.—The principle underlying roller ginning dates back to ancient times, it having been the method practiced by the Hindoos. The roller gin is used only in connection with long staple cottons and where it is of the greatest importance to preserve the length of the fibres. The amount of work done, in a given time, in connection with this gin is considerably less compared to the saw gin, but which feature is of minor importance as it is of course essential to deliver this finest of all cotton fibres to the markets without the slightest impairment of its quality. Much effort has been made to invent a gin that will combine the advantages of both machines but until recently no progress was made in this direction.

Sea Island cotton is ginned altogether by the roller gin. This cotton on account of its high price is handled more carefully all around, from the field to the ginning process proper as compared to other cottons. When the cotton has been picked, weighed and housed, it is next spread out in the sun on what is called an "arbor", which is a platform twenty-five feet or more square made usually of inch boards. Here the sun and air dry the cotton, preventing it from heating (which it is liable to do when stored in bulk) and, it is also thought, causes the lint to absorb some of the oil in the seed, which adds to the silky lustre of the

fibre. After being thus dried, the cotton is either stored or passed at once to a cleaning machine which knocks the dust and sand out and leaves the cotton whiter and more open. Formerly this cotton was all sorted previous to ginning, 150 pounds of seed cotton constituting a day's task for one person, he thus thoroughly overhauling this amount of cotton, picking out all specks, stained fibres, fragments of leaf, etc. At present, however, this work is done during the process of ginning by two persons who examine the cotton as it passes to the feed of the gin, two other persons at the delivery end of the machine picking out cracked seed, motes, etc., as the lint issues from the gin.

The construction and operation of different types of modern roller gins in use, is given by means of describing illustrations Figs. 6 to 12.

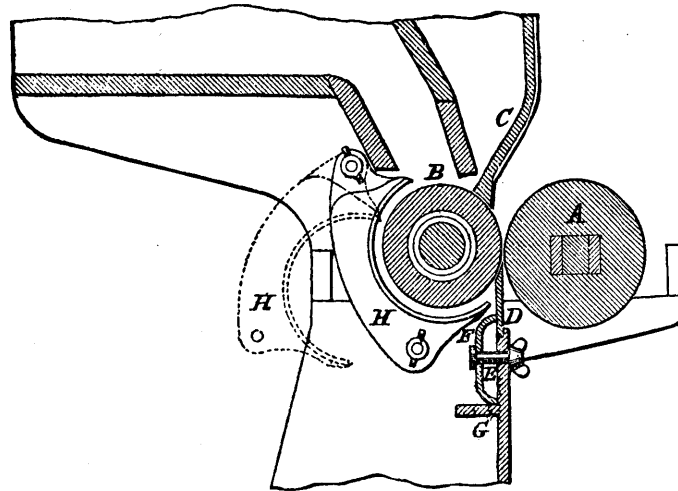


FIG. 6.

Figs. 6 and 7 show one type of these gins. Fig. 6 is a section through the centre of the machine, showing the knife roller, leather roller, grating, and pressing or doctor knife; Fig. 7 being a plan view of the knife and leather rollers. The seed cotton as fed to the hopper of the gin, travels down the incline of the feed board and in turn is seized by knife blades constituting the roller *B* (see Fig. 7) and carried forward by said roller. *C* is a guard which prevents too much cotton at one time passing into action. The seed cotton as taken along by the knife roller *B* has its fibres in turn taken up by the roughened surface of leather roller *A*. Interposed between rollers *A* and *B* is a stationary doctor knife *D*, which by means of a spring *F* resting on cross bar *G* is

kept pressed against the leather roller *A*, the amount of pressure being regulated by thumb screw *E*. The rotation of the roller *A*, to which the fibres adhere on account of its roughened surface, strips the cotton from its seeds over the edge of the doctor knife *D* since the seeds on account of their size cannot pass said knife, they being in turn engaged

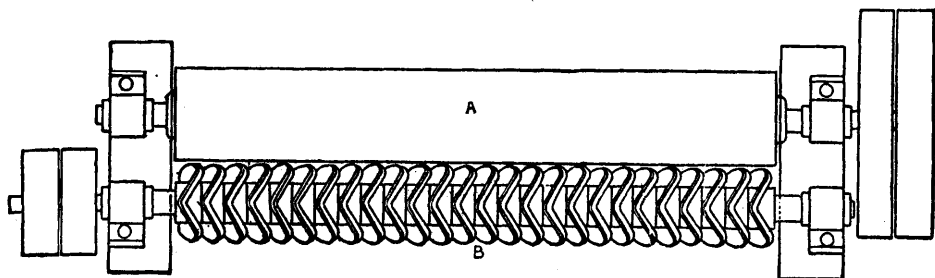


FIG. 7.

by the blades of the knife roller *B* which alternately rub and strike against the seeds and thus gradually loosen their hold on the fibres until they separate, when they are carried around in the grooves of the knife roller *B* and dropped out of the machine through grid *H* as situated beneath the knife roller *B*. The freed fibre (lint) in turn passes around with the roller *A* from which it is stripped, in a continuous film, by a stripping board acting on the roller on the opposite side to the doctor knife, and delivered outside the machine, being kept away from the seed by means of a dividing plate on the machine. A double action form of this machine is also built; in this instance a leather roller and doctor knife being placed on each side of the knife roller so that the seed cotton is taken up by two leather rollers and doctor knives (the knife roller acting on both sets) thus greatly increasing the production of the machine.

Another construction of a roller gin, which separates the seed by a different principle, is shown by Figs. 8, 9 and 10; Fig. 8 referring to a single action, Fig. 9 to a double action arrangement, while Fig. 10 shows the principle of liberating the seed from the fibres as observed in both machines. With reference to the single action machine as shown in Fig. 8, *A* is the feed table from which the cotton in turn falls in the hopper *A'* and from where it is pushed into action by means of a reciprocating feeder bar *A''*. *B* is the doctor knife, supported above the leather roller *C*, and *D* is a spring which presses the doctor knife *B* against the leather roller *C*. As this leather roller revolves in the direction shown by the arrow, its rough leather surface carries the cotton fibres past the doctor knife, but not the seeds which are arrested by the doctor knife. The quickness of this action i. e. the seeds fol-

lowing the fibre and being suddenly checked by the doctor knife will certainly cause some of the fibres to separate and follow the leather roller, however the bulk of the seeds will remain at the knife edge with the fibres still adhering to them. To liberate them from the fibre they are then struck upward by means of beater blade *E* which is connected by means of rod *F* with a crank *G* on the driving shaft and to a rod *H* which is centered at *I*; the seeds being acted upon by the rapid recipro-

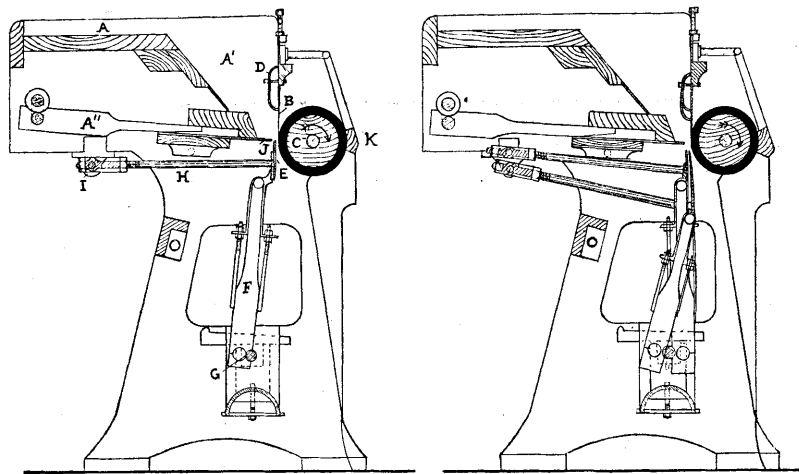


FIG. 8.

FIG. 9

cating motion given to the beater blade *E* by the crank *G*. The repeated blows the seeds receive, soon detach them from the fibres which are carried forward with the leather roller, the seeds meanwhile falling through grids *J* in the feed plate and thus out of the machine. The beater blade *E* is guided in its path, which is a portion of a circle having *I* as a centre, through its connection with the bar *H*, the latter being also the means for adjusting the distance of the blade *E* from the leather roller *C* according to the size of the seeds in the cotton under operation. To permit ready adjustment for this purpose the ends of rod *H* are screw threaded and fitted with adjusting nuts. The ginned cotton is stripped from the leather roller *C* by means of stripping boards *K* and when the lint falls to the floor in a continuous film, being kept from mixing with the seeds, as fall under the gin, by means of a sheet iron dividing plate. The double action machine, as shown in Fig. 9 has identically the same parts and the same action for separating the seed from the fibre as the single action machine thus described, the only difference being that the beater blades and its connections are dupli-

cated, the two beater blades acting alternately on the seeds, in turn increasing production of the machine. In Fig. 10 is shown the method as employed in both machines for liberating the seed. In said illustration *C* is the leather roller, *B* the doctor knife and *E* the beater blade. At *S* is shown a seed as removed by the beater blade *E* which is operated as indicated by dotted lines (rising up to about three-eighths of an inch above the edge of the doctor knife), the seed in turn falling out of the machine through apertures *J* in the feed plate.

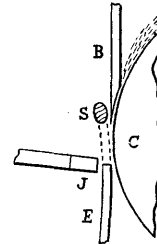


FIG. 10.

Another method of separating the seeds from the cotton is shown by Fig. 11, being a transverse section of the stripping mechanism of a roller gin. The seed cotton to be ginned is placed in the hopper *E*, in connection with which reciprocates a feed table *D*, which delivers the seed cotton to the rough leather roller *B*, to which the fibres readily adhere, passing in turn between said roller and a doctor blade *F*—but prevents the seeds from entering. The upper edge of this doctor blade is formed into a knife edge, the back being curved and extends into a spring shank *F'* as bolted to a plurality of arms *F²*. In order to positively draw down the cotton

fibres between the roller *B* and doctor blade *F*, two small drawing rollers *I* and *I'* are mounted below the doctor blade *F* in a bar *J* which is engaged at its centre by a rib *K*. Rods *L*, actuated by spring *L'* in bearing *N*, press the rib *K* with enough force to keep the rollers *I* *I'* in engagement with roller *B*, the amount of pressure required being regulated by screw rod *O*. Directly over the doctor blade *F* is a stripper blade *G*, secured to a rod *G'*. As mentioned before the seed cotton delivered to the roller *B* (rotating in the direction of arrow *a'*) has its fibres drawn between said roll and the doctor blade *F*, holding the seed sections which cannot enter, on the knife

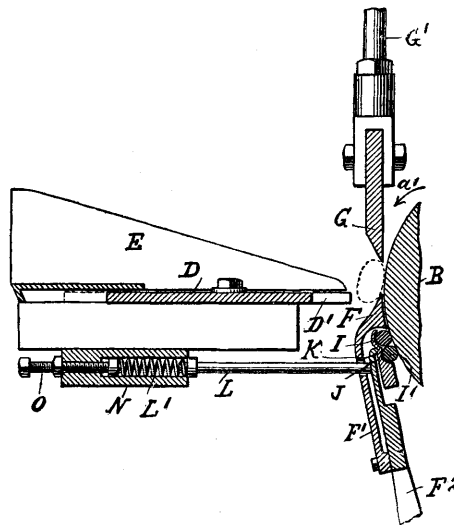


FIG. 11.

edge of the doctor blade, where in turn the same are engaged by the stripper blade *G*, which, acting in conjunction with the doctor blade *F*, breaks the seeds from the fibres, pushing the seeds out and over said

doctor blade *F* (as shown by means of one seed in dotted lines in the illustration) falling in turn between openings (grating) *D'* in the feed table *D*, while the lint is drawn down by the rollers *I I'* as acting in conjunction with the roller *B* and in turn stripped from the latter by means of a stripping board.

In Fig. 12 a sectional view of another construction of a roller gin is given. The mechanism is shown as mounted in a main frame *A*,

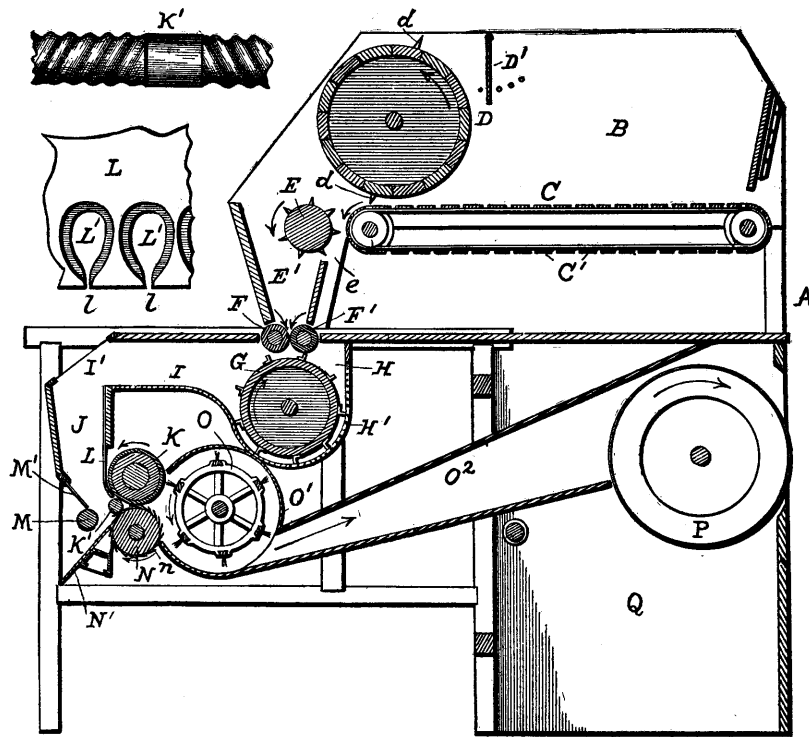


FIG. 12.

upon which is fastened the hopper *B* for receiving the seed cotton. *C* is an endless lattice apron consisting of belts connected by parallel cross bars *C'* with spaces between, through which impurities can fall, said apron forming the bottom of the hopper and which carries the cotton into contact with feed roller *D* which has its lower section moving in the opposite direction to the rotation of the endless lattice apron *C*. This cylinder *D* is armed with two transverse rows of teeth *d* and revolves rapidly enough to enable its teeth to pick up the required quantity of seed cotton, carry it over the cylinder, and drop it on a

smaller, similarly toothed, lifting roller *E*, rotating in the same direction with the cylinder near the rear end of the apron *C*, and at about the same level in a hopper *E'*. The quantity of cotton carried over by the feed cylinder *D* is regulated by an adjustable gate *D'*. The lifting roller *E* acts not only upon the seed cotton deposited upon it by the feed cylinder, but upon any that may pass between that cylinder and the lattice apron, the space between them being always sufficient to allow stones, immature cotton bolls, and other foreign matters to pass between them and drop out of the machine through an opening *e*. The seed cotton thus deposited in the second hopper *E'* is fed downward in regulated quantities between small rubber rolls *F F'*, revolving close together in its open bottom upon a transversely ribbed beater cylinder *G*, revolving rapidly in a chamber *H*, the lower portion of which conforms to the contour of the cylinder, which revolves from rear to front, so as to carry the seed cotton entirely around it before discharging it through its tunnel *I*. The front and lower portion of the beater chamber is composed of a perforated screen *H'*, through which dust, sand, leaves, etc., may be blown out of the machine. The beater *G* discharges the seed cotton through the tunnel *I* into a descending chute *J*, which conducts it to the ginning rolls; a screen *I'* constituting a portion of the tunnel wall where it intersects the chute, permitting the escape of dust, etc., and also prevents the formation of cross currents at that point. The ginning rolls are arranged with their rear surfaces in line with the front wall of the chute near its open bottom. The upper ginning roll *K* is of comparatively large diameter—about five inches—with a smooth surface composed of elastic material—such as rubber packing—wound spirally thereon while the lower ginning roll *K'* is of much smaller diameter—about nine-sixteenths of an inch—of metal, with its surface spirally grooved or fluted, so as to resemble a screw (see special—enlarged—illustration). This roll revolves in the same direction as the larger roll, so that their adjacent surfaces move in opposite directions, and the smaller or screw roll tends to lift the seed and wrench the lint therefrom with an endwise movement. Both gin rollers *K* and *K'* are made in sections, the grooves in the small roller *K'* being reversed from the center of the machine. The smaller ginning roller is provided with ball bearings which enables it to be easily run at a very high speed—3,500 revolutions per minute. The front wall of the chute *J* consists of a guard plate *L*, the lower portion of which conforms to the contour of the large ginning roll, close to and between which and the lower ginning roll its lower edge lies. This guard plate is adjustable and its lower edge is provided with a series of egg shaped openings *L'* (see special—enlarged—illustration) arranged point downward, with slots *l* extending through the edge of the guard plate. These openings flare outward to receive the seed cotton which rests in them against the face of the larger ginning roll which draws the lint therefrom, but prevent the seed from passing through as it revolves close to

the inner edge of the plate. The larger roll tends to draw the lint and seed down through the slots l upon the screw roll K' which, as previously mentioned, tends to lift the seed and wrench the lint therefrom and from the larger roller. A carrying roller M , turning in the bottom of the chute near the ginning rolls, assists in feeding the seed cotton to them, and an adjustable grating M' above this roll regulates the width of the discharge opening, through which grating a portion of the seed passes into a receptacle. The greater portion of the seed, however, passes down between the carrying roll M and clearer roll N over an inclined chute board N' . The lint and seed escaping from the ginning rolls are acted upon by a clearer roll N , the surface of which is covered with longitudinal rows of parallel ribs n , of elastic material—such as thin rubber packing—which revolve in contact with both ginning rolls and effectually remove any adhering lint therefrom. The front edges of the ribs are secured to the rolls, while their rear ends are free, and overlap each other. The inclined chute boards N' are provided with slots and clamp screws and lie tangentially to the surface of this clearer roll and are adjustable endwise so as to allow more or less of the ribs to act, the inner or upper edges of the plates covering more or less of the clearer roll N , according to the distance of said edges from the smaller ginning roll K' . A brush wheel O , revolving rapidly close to the larger ginning roll and clearer roll, not only clears them from the lint, but creates an air blast which drives the lint through the brush wheel casing O' and its hood O^2 and deposits it upon a perforated screen P , revolving therein, which in turn carries it out of the machine. The air passing through this screen and escaping on its lower side drives the lint therefrom, and thus prevents the clogging of the screen, while any dust left in the lint falls through the screen into a box Q and from where it is readily removed.

THE SAW GIN.—The same is the invention of Eli Whitney and in its principle of operation has withstood the criticisms of practical manufacturers and theorists for more than a century, and to-day it practically prepares the bulk of the cotton crop for market. It bids fair to be continued in use in this manner for times to come unless some inventive genius can bring out something to take its place which will perform the work as speedily and cheaply but would retain the staple unbroken; the latter item being the only disadvantage to this principle of ginning.

Eli Whitney was born in Westboro, Mass., December 8th, 1765, and from boyhood up was an inventive genius all around. When 19 years of age, he decided to prepare for college, earning his living besides carrying on his studies, being able in this way to enter Yale in 1789. When graduating in the autumn of 1792 he went to Georgia with the view of entering into the legal profession. By invitation he made his home with the widow of General Green, the Revolutionary hero, and there had his attention directed to the need of a machine for preparing Up-

land (i. e. short staple) seed cotton for the market. This cotton adhered so obstinately to the seed that the task of cleaning it had to be done by hand, consequently it was laborious work. Separating one pound of the clean staple in this manner from the seed was a day's work for a woman; but the time usually devoted to picking cotton was the evening, after the labor of the field was over and when the slaves, men, women and children were collected in circles, while an overseer stood by to rouse the dozing and urge the indolent. Consequently this kind of cotton—now the bulk of the cotton crop of the world—was of little value to the planter. Whitney, foreseeing that important results would follow a speedier process, at once started to construct a machine for doing this work, thus producing his famous gin, for which he received a patent in 1793.

Sometimes it is said that Whitney is not the real inventor of the saw gin, mostly no doubt on account of the numerous law suits he was engaged in, however the contemporaneous history of Whitney's times shows pretty clearly that he was really the inventor; for example, the Legislature of South Carolina purchasing from him (by act of December 19, 1801) the right to use his patent in that state for the sum of \$50,000. The Augusta (Ga.) "Herald" of December 30, 1801, mentions the passage of this act and says "In the course of the negotiations between the legislature of South Carolina and the patentee we understand that every satisfactory evidence of the originality of the invention was produced and its principles so fully explained by the ingenious inventor that little or no diversity of opinion existed as to the propriety of making a contract." In December, 1802, Mr. Whitney negotiated a sale of his patent-right with the state of North Carolina. The legislature laid a tax of two shillings and sixpence upon every saw (some of the gins had forty saws) employed in ginning cotton, to be continued for five years, which sum was to be collected by the sheriffs in the same manner as the public taxes; and after deducting the expenses of collection, the avails were faithfully paid over to the patentee. Whitney's right to the invention was further established by act of the legislature of Tennessee, at their session in 1803, when laying a tax of thirty-seven cents and a half per annum on every saw, for the period of four years; and further in 1806 by the passage of the following resolution, "Whereas it has been made to appear to the satisfaction of the general assembly that Eli Whitney, from whom this state purchased the patent right to a machine for cleaning cotton, commonly called the saw gin, is the true inventor of said machine, etc., etc."

That Whitney's cotton gin has conferred vast benefits in developing the power and progress of the United States is a matter of well authenticated history. The inventor made the prosperity of the Southern states agriculturally, financially and commercially; made England rich, and changed the commerce of the world. The debt which the nation and the world owe to Eli Whitney is proclaimed by the eloquence of

statistics, and which indicate that Lord Macaulay was not too extravagant in saying, "What Peter the Great did to make Russia dominant, Eli Whitney's invention of the cotton gin has more than equaled in its relation to the power and progress of the United States." Whitney died January 8, 1825. The accompanying illustration Fig. 13 is

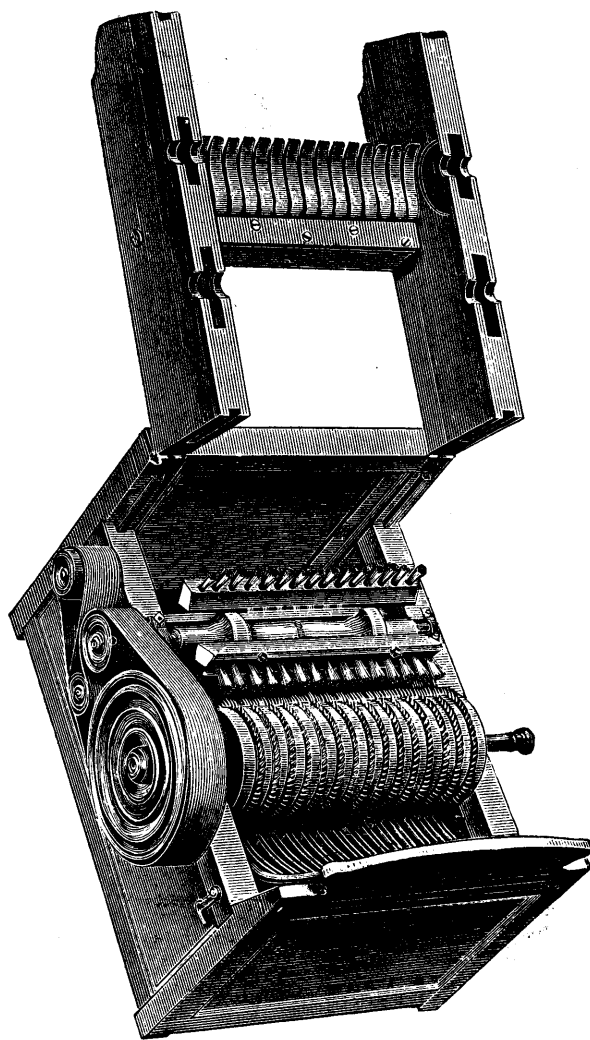


FIG. 13.

taken from a small model of a gin, made under Whitney's own direction in 1800 and now at the Smithsonian Institute.

Coming next to consider the action of the saw gin upon the cotton fibre, we certainly find a weak spot in that this gin considerably damages the staple by more or less breaking individual fibres; however a great advantage remains for it in the fact that it cleans the cotton from its seed thoroughly and rapidly. In times before the Civil War, cotton growing was carried on on large plantations which owned their own ginneries. They ginned slower and as a result the fibre was little cut or broken, nor crimped or knotted, a feature explained by the fact that a slow speed gives a loose

roll of cotton for the saws to operate upon whereas a high speed of the

machine results in a closer and more compact roll of cotton for the saws to operate upon. Certainly the high speed gives the largest amount of work and at the same time cleans the cotton more thoroughly; however strains and breaks more of the fibres, adding numbers of short fibres, often nipping off fragments of seed and passing immature seed with lint attached through the breast of the gin along with the good fibre.

As mentioned before, no radical change in the saw gin has taken place since the days of its inventor, the principle of its action has remained the same. The seed cotton is held in a box, one side of which is a grate of steel bars or ribs. Through the intervals of the grate a number of thin steel disks notched on the edge (saws) rotate rapidly. The teeth of these saws engage the fibre and pull it from the seed, which as they are cleaned fall out of the machine through a slit below the ribs. Behind the cylinder holding the saws is a larger cylinder (the brush) filled with bristles acting in contact with the saws. Both cylinders rotate in the same direction, the brush cylinder sweeping from the saws the fibres they have detached, which by the draft created by the rapid revolution of the two cylinders are blown out from the gin. The most notable improvements made to the gin consist in placing rotatable plates at the ends of the cotton roll, as forming in the gin breast, thus reducing friction and assisting the revolving of the roll of seed cotton. Again the mote board, invented in 1845, permits regulation of the air current produced by the wings on the brush so nicely that the current is just strong enough to carry off the cleaned cotton, but not enough to carry off the motes, or immature seeds which thus become separated. In 1878 a condenser was added, and made a part of the gin. This condenser is a revolving screen, and as the cotton is blown against it, the air passes through, leaving the lint on the screen in the form of a bat, the air passing out through the bottom and ends of the condenser, and carrying the dust and dirt with it, the screen, as it revolves, constantly presenting new surfaces to the oncoming cotton. A bat roll is placed over the top of the revolving screen, and lifts the cotton from it, delivering it into a chute. The addition of this air current, and the passing of the cotton through flues to a lint room, or a condenser, also materially assists in opening up neps occasionally caused by the films of cotton doubling around the teeth of the saws and becoming snarled. The original hand feeding of the seed cotton to the gin has also now days been greatly simplified and improved, in that a fan blower draws a current of air through a wood or metal flue, sucks the cotton up from the wagon or bin in which it has been stored, and delivers it to the gin. At first the cotton was allowed to pass through the fan on its way to the gin, however the friction in the fan ignited the cotton, and fires occurred. Now the fan is placed on the farther side of a receiver, where a screen stops the cotton, but allows the air with the dust it has collected from the cotton, to pass on and out. From the receiver the cotton is delivered by a revolving roller onto a belt, which deposits it in the hoppers

of the gins, or the belt may be dispensed with and the cotton delivered into receptacles of sufficient capacity over each gin, and from where it is in turn automatically deposited in the hoppers of the gins.

The operation of the saw gin will be readily understood by means

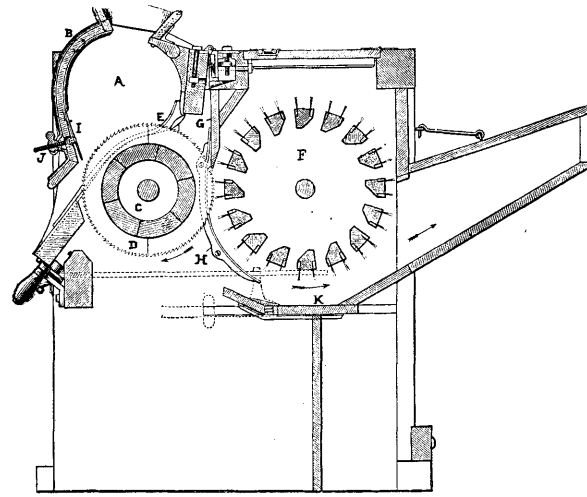


FIG. 14.

of illustration Fig. 14 being a sectional view through the machine. The seed cotton is fed to the hopper *A*, the front wall of which comprises a seed board *B* which is curved to allow free turning of the roll of cotton as formed by the rotation of the saws in the hopper. *C* is a cylinder carrying a series of saw blades *D*, each of which is working

in one of a corresponding series of apertures of grate *E* as forming the bottom of the hopper *A*, and which grate *E* can be lifted from the saws, when necessary to clean them, by means of a lever extending outside of the machine. The bars of the grate *E* are placed sufficiently apart to permit the saws to rotate and pull the fibres through in tufts, (and thus break them from the seeds) but not the seed, which in turn drop out of the machine. In engagement with the saws is placed a rotating brush *F* which doffs the cotton fibres from the teeth of the saws and by means of draft created by cylinder *C* and brush *F*, forces them out of the gin proper. A wind board *G* is placed between the saws and brush to prevent the fibres on the saws from being disturbed by the air current created by the revolution of the brush *F*, said wind board also supporting the iron brush guard *H*. The bottom of the seed board *B* has an iron plate *I* which can be adjusted to or from the saws by screw *J* in order to regulate the extent of the cleaning of the seed. Below the brush *F* is placed a sliding mote board *K* which can be so adjusted that the draft caused by brush *F* and cylinder *C* is just sufficient to carry the clean lint out of the gin proper, to a bin, a condenser or pneumatic conveyor, while heavy motes or other impurities will fall on said board *K*, from where they are readily removed.

In Fig. 15 a gin similar to the one thus described is shown, the dif-

ference being in the construction of the mote board *K* which in this instance is L shaped and interposed between the lower portion of the saws *D* and the brush *F*. The lower portion of this board *K* encircles a whip roll brush *L*, while the upper part is inclined and overlies said whip roll brush. By placing the mote board in this position a draft is prevented between the saws and mote board, and on account of the rapid revolution of the brush *F* the heavier motes and trash fall between the saws and mote board, while the good lint passes along with brush *F* to the whip roll brush *L*, whereby the fibres are straightened out. Below the mote board *K* is arranged a stationary board *M*, in the rear of which is a board *N* provided with a rack bar *O* which travels on a pinion *P*, thus permitting said board *N* to be set nearer or farther from the board *M*, as the case requires. The front end of the board *N* is beveled at *Q*, to present a sharp edge to the cotton, the lighter motes still remaining in the cotton passing through the opening between the boards *M* and *N*, while the lint adhering closely to the brush *F* is carried round and out of the gin through chute *R*.

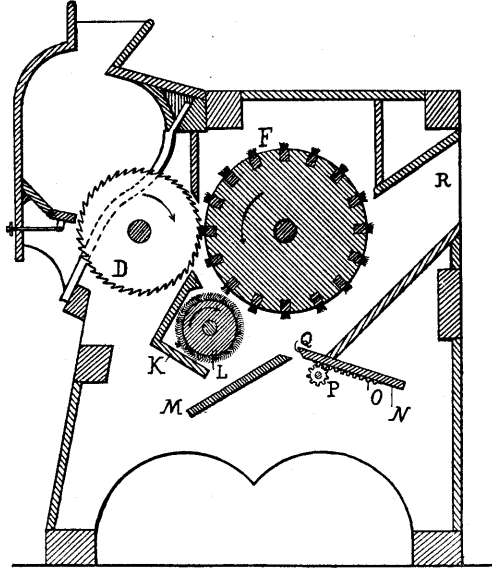


FIG. 15.

In place of using a single series of saws, a double series is sometimes used, this arrangement being shown by illustration Fig. 16. The two saws *B* (shown partly broken away to exhibit the adjustment of the grate) as mounted in the gin breast *A* interlap, a series of steel plates *C* being mounted in the ribs *a* of the grate, said plates being adjustable by clamp screws *c*² and serve to lessen the wear on the ribs *a*. These ribs *a* are offset at *a'* so that the saws *B* can not interfere with each other when in operation, since they do not work in the same plane. By thus using two series of saws the same may be run at a slower speed, in turn lessening damage to the cotton and yet increase production.

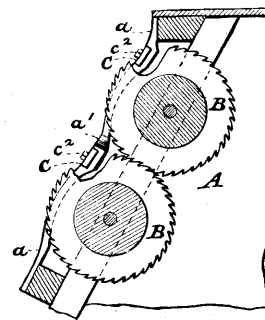


FIG. 16.

Gins are either used single or arranged in what is termed batteries, the number of gins in a battery depending upon the size of the ginnery. In most instances a battery comprises four gins, which are connected, either by a single flue for all the gins or a separate flue for each gin, with the condenser; the lint being forwarded through the flue—from the gin to the condenser—by the blast created by the rotation of the saw and brush cylinders of the gin. During its passage through the flue (made of wood or metal) the current of air straightens out the fibres crimped by the ginning, the heavier sand falls into a pocket arranged to receive it as the lint rises to the condenser, the lighter dust being blown off and escapes from the building through flues issuing from the condenser.

Fig. 17 illustrates the connection of a single saw gin with a condenser, showing also a simple arrangement of a Cleaner mounted above the gin. The seed cotton as conveyed to the hopper *A* is

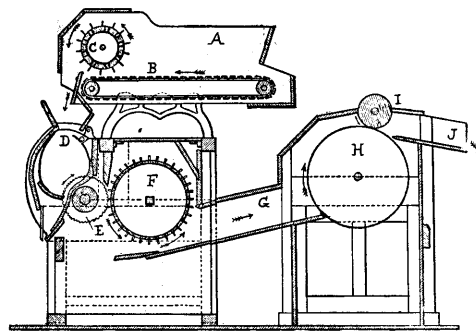


FIG. 17.

carried by the feed apron *B* into engagement with the picker roll *C*, from which it is dropped into the breast *D* to be in turn engaged by the saws *E*, brush *F*, and then travels in flue *G* to the condenser *H* by means of which and the bat roll *I* the lint is formed into a film, in which state it passes out of the machine through chute *J* from where it finds its way into the press.

Fig. 18 illustrates the connection of a battery of gins (4 gins in this instance, although more or less might be used) to one condenser, each gin *A* being connected by a separate flue *B* to the condenser *C*. The hood *D* as forming the connection between each gin and its flue has its ends *E* inclined at an angle, as shown, a feature which causes the lint as coming from the gin to be deflected against the curved back *F* of said hood and thus passes readily to the flue *B*. By thus making the hood *D* with the curved back *F* and this in connection with the elbows of the flue *B*, as shown in the illustration, being bent at a very slight angle, said flue is practically shortened to a minimum, and the lint passes in the most direct line possible from the gin to the condenser, distributing the friction of the cotton over the entire length of the flue. The end walls *E* of the hoods *D* are provided with a glass covered opening at *G*, to permit of a view of the interior of the hood, said opening, when the glass is removed, serving also as a hand hole to afford access to the interior of the hood for cleaning purposes.

Like most other establishments engaged in manufacture, the tendency is toward the consolidation and enlargement of ginneries, some of them now having a capacity of from 50 to 75 bales a day, while one

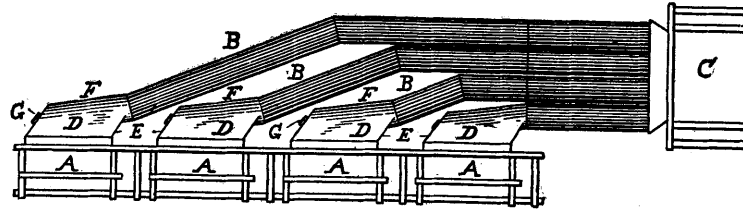


FIG. 18.

near Waco, Texas, claims that it can turn out 250 bales per day; however the necessity of being compelled to transport bulky seed cotton from the farms to the ginneries will always more or less restrict their growth. A modern equipped ginhouse is free from dust and lint, which, not only would be a great nuisance but also a chance for fire. Ginning being there carried on, under cover, the observer will fail to see cotton anywhere except he sees the lint sliding from the condenser into the press. Seed cotton—and there need never be as much of it as a bale in a ginnery, so quickly is the work of receiving and cleaning it dispatched—while easily ignited, merely flashes over, and the fire goes out. But it is different with lint cotton, which, when once on fire will burn and smolder indefinitely. A burning bale when thrown into the water will float and burn until all of it is destroyed. But at the ginnery the lint passes at once into the press, and should it catch fire there, the plunger that tramps in the cotton is let down on it and smothers the fire until steps are taken to remove and extinguish it. Risk from fire is for these reasons at a modern equipped ginnery at a minimum.

Cases are on record where the saw gin has been used in connection with Florida Sea Island in order to get production. The lint after ginning was passed through a whipper, tangling up the mass of fibres and consequently giving it the appearance of having been ginned on the roller gin, and the buyers took it as roller ginned and paid the higher price for it.

THE HULLER OR DOUBLE BREASTED GIN,—is a type of a saw gin specially built for handling the cotton grown in the lowlands of the Mississippi Delta, and to some extent in the Red River, Brazos, and other bottom lands, where, on account of the rank growth of the plant and the damp weather, the cotton is gathered with a large amount of the hulls clinging to it, which if fed into the top of the roll, as is done in the regular gin, would be so cut to pieces and ground up by the saws that the staple of cotton would be very much deteriorated. A section of

this gin is given by Fig. 19. The saws, the frame work, roll box, brush

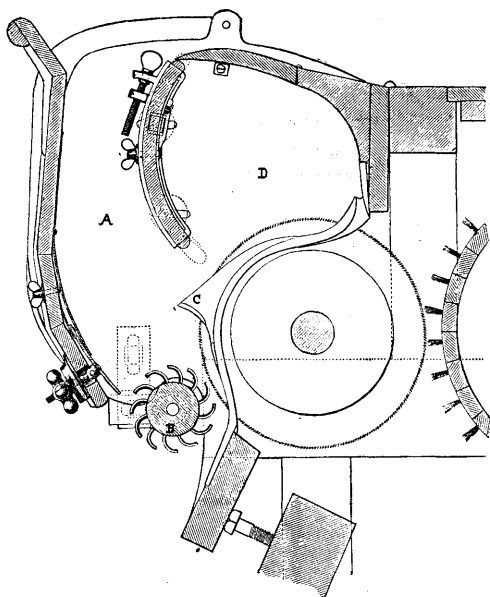


FIG. 19.

and in fact all parts of the gin are made larger in proportion compared to the regular gin. The breast is double, and the cotton is fed into the front division *A*, at the lower part of which is placed a spiked roller *B* that revolves quite rapidly in the direction of the saws, catching the locks of cotton and drawing them upward through the projection *C* on the rib; these projections being so close together (about three-eighths of an inch apart), that hulls and other similar substances are separated from the cotton and thrown back upon the roller *B* and allowed to be fed or dropped through or between the spikes, thus falling beneath the gin with

the seed. The cotton drawn through the hulling ribs *C* at the bottom of the roll box *D* starts the roll of cotton in motion which is ginned in the same manner as it is by the regular gin. The claims for this gin are that, in the first place, it cleans the cotton better, from the fact that the cotton drops upon a spiked roller and is thoroughly loosened up and cleaned, thereby improving the quality of the lint. It also separates the immature locks which would otherwise go into the gin and the short staple therefrom be mixed with the other, and in this respect the hulling attachment really improves the staple. The process of cleaning the dirt also separates heavy foreign substances which sometimes get into the cotton, such as nails, screws, etc., which in the regular gin would go into the cotton roll and injure the saws, consequently the saws will last longer. The saws and brush being larger in this gin, a less number of revolutions per minute are required to do the same amount of work as compared to the smaller saws and brush used in the regular gin. For these reasons the huller or double breasted gin will unquestionably last longer than the regular gin. This machine is equipped with all the improvements incident to the regular gin. Although being a superior machine all around, the reason for it not being more extensively used all over the South, and practically not at all for hilly sections, is the

fact that the machine is heavier built, thus harder to manage and possibly the main reason—more expensive.

LINTING MACHINE.—With Sea Island or black seed cotton, the seeds are entirely freed from lint by the gin; however in connection with the ginning of Mainland (Upland) or green seed cotton this is not the case, there remaining (more or less short) fibres still adhering to the seed after the latter has been delivered from the gin, amounting to about 10 per cent. of the total weight of the seed. After sifting and cleaning, the seed passes to what is known as the linter room, which contains a number of linting machines which are specimens of cotton gins specially adapted for removing the fibres still adhering to the seed. These linting machines have, compared to the gin, their saws set closer, the teeth being also finer set, and in order to keep the mass of seed revolving in the hopper a toothed roller is provided at the bottom of the hopper, its teeth constantly stirring up the mass of seed so that all are subjected to the action of the saws. The linting is generally completed in two operations, the result from the first being superior to that from the second, since it contains some perfect fibres not removed in the ginning of seed cotton. The fibres, short or long, thus obtained are technically known as “Linters” and are delivered by the condenser of the linting machine as a sheet or film which in turn is either pressed in bales and sold as waste to mills, for use in connection with better staples of cotton in the spinning of cheap and low counts of yarns, or by means of rough carding transferred into a sheet or film which in turn, on an automatic machine, is put up in one pound rolls, in which shape it comes into the market as batting, largely used as a lining for quilts, etc. The seeds meanwhile fall from the gin into a screw conveyor (preferably with a perforated bottom, to allow the escape of sand), and are either delivered directly to a wagon or into the seed house or dropped into a flue from the blower, which transports them wherever it is desired; being in turn delivered to the oil mill and there subjected to a hulling machine, which takes off the outside shell which it passes to one side, while the green kernels of the seeds go down a chute, filling certain receptacles placed in the oil press, and when in turn they are submitted to hydraulic pressure, thus producing the cotton seed oil referred to under “Bye Products of Cotton” in the former chapter. The remains of the green kernel are then pressed into what are termed cattle cakes, or oil cakes, for feeding cattle.

BALING.—Sea Island cotton as is cleaned on the roller gin is always put up in loose round bales to avoid any injury to the delicate, high priced, staple. However this process is carried on differently with the bulk of our cotton, the common, or mainland cotton, and where the lint as coming either from the condenser, or the linter room, enters the box of a cotton baling press. In connection with small ginneries using one or at the most two gins only, this may be a single press, but which would not answer (on account of necessary time required in packing

the bale and thus not able to keep up to pack the lint from a battery of gins) for the average size ginnery and when a Revolving Double Box Press must be used, being a press which has two boxes placed on a revolving platform so as to bring them alternately under the action of the press, one box being filled and tramped while the other is pressed and tied. After the bagging (covering) has been properly arranged in the box as not under the operation of the press, the lint cotton is entered, and the box when filled subjected to the action of a "tramper" which presses down the cotton in order to reduce space occupied. Said tramper is automatically raised and lowered by steam power, new lint cotton being let into the box between said operations and which are continued several times until the box is packed tightly with lint, and when the platform is revolved thus bringing the other box (previously spread with bagging) under the action of the lint supply and placing the filled box over the press proper, the platform of which is moved upwards either by screw, hydraulic or direct steam power; the first mentioned power being the one most frequently used because it is the most simple and inexpensive, running up in about four minutes and down in two, in this manner easily taking care of a battery of four gins. Steam power is very quick acting but more expensive, this being the power used, provided dealing with single box presses; hydraulic power is the most powerful of all, is as quick or quicker acting than the others, but not as simple as the screw and more expensive, although when once installed it takes less steam and fuel than either of the other two powers quoted. After sufficient pressure has been put on the bale, the ties are passed around and buckled, the pressure released and the finished bale removed by throwing open the sides or doors of the box and delivered, as the case may be, either to the planter to be taken by him in turn to the market and sold, or forwarded direct to the mill or consigner. The size of the press boxes is either 27×54 or 24×54 inches, the latter being the new standard, and the bales are pressed down to 28 to 30 inches, being intended to contain nearly 500 pounds (inclusive of bagging and ties, or about 475 to 480 pounds of lint) on the average. Bales however vary considerably in size and dimension and to a still greater degree as regards the density of their contents according to what make of press has been used, the ones quoted being the acknowledged standard dimensions. Most of these box bales as not consumed by the mills in the vicinity, find their way to one or the other cotton compress establishments to have their bulk reduced in size by means of extra powerful hydraulic pressure and in this shape new ties put on, in order to permit handier storing of the bale in the hold of ships or cars as the case may be. By microscopical examinations it has been found that the great pressure, although amounting to several thousand tons over the surface of the bale, does not injure the fibre since the aggregate number of individual fibres sharing this pressure is infinite. Since a few years a heavier built revolving double box press has also been brought into the market, permitting more or less "compress" packing at once at the ginnery thus

saving in many cases the additional expense of a recompressing. The boxes of this "revolving double box compress" are 20×54 inches and the size of the bale after being turned out of the press and expanding about one half inch on each side is 21 inches by 55 inches in length, and in height from about 20 inches to 26 inches, varying between these two points, according to the amount of lint that is put in—from 400 to 600 pounds. Egyptian bales are compressed into a size somewhat similar to the American bale, but the average weight is usually about 700 pounds, showing that they are heavier compressed, a feature which renders this bale more fire proof; again the packing of this cotton is done much neater all around as compared to ours. They are packed to a density of about 45 pounds to the cubic foot, against about 22 pounds for our ordinary bale. The Indian cotton is also more closely compressed than ours, said bales weighing about 400 pounds. Peruvian and Brazilian bales only average about 200 pounds, the reason for this being that they have to be carried mostly on mule back to the seacoast.

Since the last few years a system of cylindrical baling has come into the market to supplant the square bale, which is known to be anything but satisfactorily packed; but the affair has thus far not met with the success expected, since there are a great many disadvantages connected with these cylindrical bales, which first will have to be overcome. Most of these bales went to Europe, probably on account of those spinners having constantly received the square bale in a worse condition than we ever saw any, by reason of the numerous handlings necessary, and thus took to any chance to get a better condition; however the result there has been the same as with such of our mills who experimented in this line. The principal object of these cylindrical bales is to increase the density to which cotton is packed, and consequently reduce the space required in transportation, thus effecting a saving in freight charges. It is also claimed for the new bale that its contents are better protected than in the square bale. Amongst cylindrical bales of some note, we find the Lowry and the Bessonette bale, either one weighing about 250 pounds.

The Lowry bale is built up in a somewhat similar manner to which the sliver is coiled in the can at the carding engine, by the coiling of the web of cotton as it comes from the condenser of the gin into an iron cylinder of the size of the bale required, from which, when completed, the bale is ejected at the opposite end, bound with four wire bands which pass down the centre of the bale and up the outside again, and then inserted in a bag of cotton duck. To sample this bale it is simply necessary to untie the mouth of the bag and take out the sample, but if there should be any difficulty in getting the sample, the breaking of one of the wires makes it perfectly easy. An advantage claimed for this bale is that several of these bales can be placed side by side, and the slivers uncoiled and drawn off simultaneously, thus obtaining a uniform blending.

The Bessonette bale is practically a condensed breaker lap 36 in

in length and 22 in. in diameter, the weight of the lap being about 32 oz. to the running yard. When these bales were first put on the market they were not at all satisfactory, owing to the fact that the cotton was unduly compressed at the core, and that difficulty was found in unwinding the last part of the bale. This is now claimed to have been overcome, for which reason we give a description of

Bessonette's latest Cotton Press,—the object being to provide means for winding the bale under even pressure from the start and at

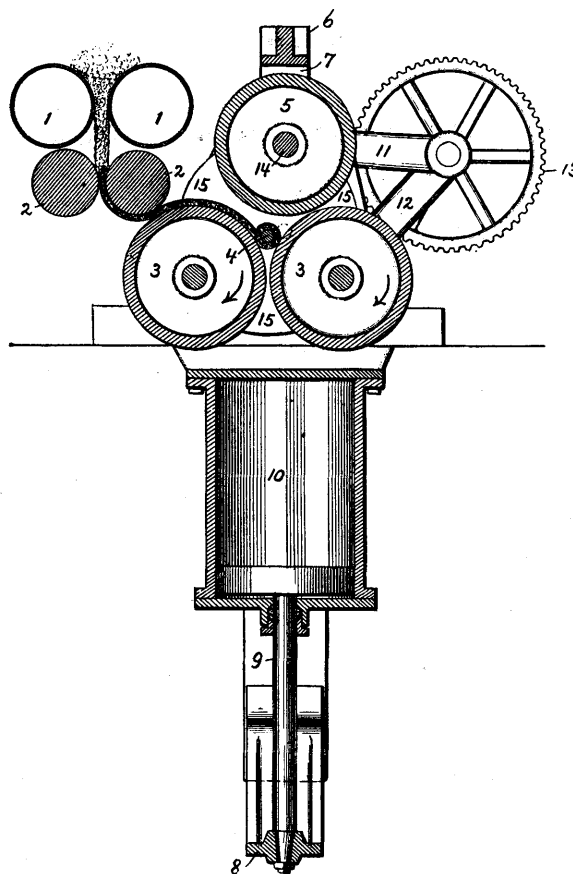


FIG. 20.

the same time keep the ends of the bale even. The illustration Fig. 20 is a sectional view of this cotton press, showing the manner of starting the bale as well as the mechanism employed for applying the pressure in order to get an even wound bale. The cotton, in its travel from the condenser of the gin or gins passes between two series of condensing rollers 1 and 2, and over one of a pair of compressing rollers 3 which revolve in the same direction. The layer of cotton is started winding on a light wooden roll 4, and as two or three layers are wound on, the roll of cotton engages a third compressing roll 5, situated above the pair of rollers 3. This roll 5 is mounted in a frame 6, which is vertically movable in standards (not shown) on the machine, the side bars 7 of the frame 6 being connected at their lower ends to a cross head 8 of a piston rod 9, which moves in a steam

the same time keep the ends of the bale even. The illustration Fig. 20 is a sectional view of this cotton press, showing the manner of starting the bale as well as the mechanism employed for applying the pressure in order to get an even wound bale. The cotton, in its travel from the condenser of the gin or gins passes between two series of condensing rollers 1 and 2, and over one of a pair of compressing rollers 3 which revolve in the same direction. The layer of cotton is started winding on a light wooden roll 4, and as two or three layers are wound on, the roll of cotton engages a third compressing

chamber 10, bolted to the under side of the machine. When the bale is started, steam is admitted to the upper portion of the chamber 10, thus putting a sufficient amount of pressure on the roll 5 and in turn the bale. As the size of the bale increases the roll 5 will be raised, the rotation of said roll continuing, since the arms 11 and 12 simply expand to keep the gear wheel 13 always in engagement with the gear on the shaft 14 of the roll 5. In order to keep the ends of the bale even, head plates 15 are provided (one on each side of the machine), the layers of cotton being compressed at their edges against said head plates and thus evened. At the completion of the bale, after the same has been bagged with a light weight burlap or cotton duck, pressure is relieved from the upper portion of the cylinder 10 and applied to the lower side of the piston, thereby raising the compressing roll 5 from the bale, and also raising the head plates 15 clear of the lower rolls. The said plates are then swung outward, permitting a ready removal of the bale. It will be seen that the feeder and press is nothing but a larger and heavier form of the automatic feeder and breaker lapper of the mills. A round bale is about ten times as dense as the round lap of the mill, and it usually has to be made in one-twentieth of the time of making a round lap. From a mechanical standpoint, the affair is a success, but from a commercial standpoint it is not fully established, although it is claimed that the prospects in that direction are good.

COTTON SPINNING COMPRISES —

I.—Preparatory processes.

- a, Opening compressed cotton by means of the bale breaker. (This process is frequently omitted).
- b, Mixing.
- c, Picking.
- d, Scutching.

The purpose of these preparatory processes is to uniformly mix the contents of several bales of cotton as delivered to the mill and in turn transfer the same into a continuous fleece, wound into a roll or lap for use at the carding engine, at the same time freeing the cotton as much as possible from impurities adhering to it from the field, gin, compress or transit.

II.—Carding,—has for its purpose to continue and finish the cleaning of the cotton from impurities not removed by any of the preparatory processes, at the same time laying the fibres more and more parallel to each other and changing the lap into a sliver.

III.—Combing.

- a, Combining a number of slivers and forming them into a narrow lap.

b, Doubling and attenuating these laps.

c, Combing proper, and at the same time transforming the narrow laps into strands.

These processes are used in connection with spinning fine yarns only, long stapled cottons, and have for their object to take out any short fibres and lay such as are of proper length parallel to each other.

IV.—Drawing,—has for its object the parallelization and attenuation of fibres as composing the sliver or strand.

V.—Roving.

a, Slubbing frame.

b, Intermediate frame.

c, Roving frame.

These operations have for their object further attenuation, at the same time slightly twisting the strand. On common work two processes only are used in place of the three, whereas in connection with fine spinning a fourth process termed “second roving or jacking” is frequently employed.

VI.—Spinning,—using for this purpose either

a, Mule,

b, Fly frame, or

c, Ring frame.

The object of either of these processes is to further attenuate the roving strand, put twist into it and wind the yarn thus produced on bobbins, cops, etc., as the case may be.

VII.—Doubling,—using for this purpose either

a, Twiner, or

b, Ring twister.

Either operation has for its object to twist two or more threads together.

VIII.—Bobbin Winding,—is used in connection with yarns for warp purposes to facilitate matters.

IX.—Preparing Machinery.

a, Reeling,—is used for bringing yarn in shape for dyeing, bleaching, etc.

b, Gassing,—has for its purpose to smoothen the thread.

c, Bundling,—compressing a number of hanks of yarn in a smaller compass for handier shipment.

PREPARATORY PROCESSES.

If cotton could be delivered to the mill in the condition in which it is picked on the field, minus seeds, leaf, sand or other impurities, spinning would be easy work, and all the preparation before carding might be dispensed with; but a large quantity of broken seeds, leaf, sand or other impurities, are left after ginning in the lint, again the difficulties attending baling or compressing, necessary on account of handy transport, cause the cotton to become caked and matted, in consequence of which it is necessary that costly and tedious work is to be done before carding in order to loosen the fibres, to render them soft and to separate them from foreign or deleterious substances. To accomplish this is the object of the various processes classified in cotton spinning as "preparatory processes" which have for their object to prepare the cotton as received at the mill in bales, for the carding engine; the purpose being to open out the lint and form the same into a continuous fleece (lap) for use at the carding engine, liberating during these processes as much impurities from the cotton as possible.

BALE BREAKERS.—The contents of heavy compressed square cotton bales as received in the mill should be first subjected to the action of a bale breaker. Certainly in smaller mills this procedure may yet be done by hand; again in southern mills which often stand surrounded by cotton fields and where the cotton can be taken direct from the gin in its natural fleecy state to the mill, or in mills which get their supply in what we termed box bales (those bulky bales as made at the ginners), the bale breaker is not required, the cotton being in this case either at once subjected to mixing, or where this is not done fed direct to the hopper feed of the picker, or in some mills direct to the picker. It is the necessity of transport which involves the opening of cotton and thus in connection with mills handling compressed cotton the advantage of a bale breaker cannot well be overestimated, since by the same the cotton is opened up better and more evenly than by hand, and with much less labor on the part of the operatives. In addition to this, the wear and tear on the machinery following this operation is considerably reduced, as the cotton loses during this operation some of the heavy dirt and is presented to the picker in a much more open state than it is possible to get from hand work. This process certainly does not refer to Sea Island cotton, neither to one or the other shape of the round bale. The object of the bale breaker is to undo the work of the Compress by pulling the large lumps of matted cotton into small pieces, thus opening out the cotton; at the same time extracting a great part of the impurities the cotton always contains. Undoubtedly the chief value of a bale breaker is found in the ease with which it lends itself to the

economical distribution of the material, this being very valuable, especially for mixing purposes. As generally arranged it is combined with lattice aprons in such a way that all labor is practically abolished. Two principles of operation are observed in the construction of these machines viz:—the roller and the comber bale breaker.

The roller bale breaker.—There are again different lines of construction observed in these bale breakers, viz:—using either toothed disk rollers or solid fluted rollers. With reference to the first mentioned style of construction, the same consists of four pairs of toothed disk rollers, so arranged that the toothed disks forming the top rollers fall between those of the bottom rollers and also between those of each other, the teeth of the top rollers having a more acute angle than those

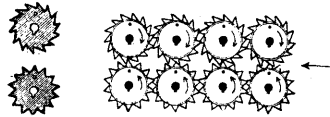


FIG. 21.

FIG. 22.

of the bottom rollers as is readily seen from Fig. 21. Fig. 22 shows a section through the four pairs of toothed disk rollers, the arrows indicating the direction of their rotation. Fig. 23 is a top plan view of the machine, with its pressure springs removed for sake of clearness, showing feed apron, gearing and position of the disks of the four top series of rollers towards each other, and which arrangement is duplicated with reference to top and bottom disks of each pair of rollers. The top rollers are made to run at a slower speed than the bottom ones of its respective pair, while each successive pair of rollers travels at a greater speed than the preceding ones; the result being that the cotton while held by the slower moving top roller is more or less opened and always thrown off in smaller pieces to the next pair of rollers by means of the quicker running bottom roller. The top rollers are weighted by spiral springs (not shown) so that when an extra large lump of cotton passes between the rollers they will yield and thus avoid any possible damage to the rollers, the cotton being fed direct to the rollers by an endless traveling apron.

With reference to the use of solid fluted rollers in these bale breakers the most often used arrangement is that of a series of three pairs of rollers, the last pair being considerably larger in diameter than the others. In front of the first pair of rollers is placed a feeding roller working over a series of weighted levers, the cotton delivered by the traveling apron passing between the feed end of these weighted levers and the feed roller. By

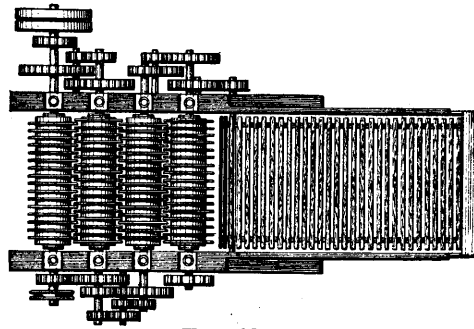


FIG. 23.

this arrangement the grip of the cotton is brought nearer to the first pair of rollers thus effectively breaking up large as well as smaller lumps of cotton as passing to the rollers. Again there are machines constructed using only two series of rollers, a quickly revolving small porcupine cylinder being in this case added in rear, the cotton as emerging from the last pair of rollers being struck by said porcupine cylinder, thus breaking up the hard lumps of cotton thoroughly, at the same time knocking a greater part of the impurities the cotton contained through a grid as situated below the porcupine cylinder, being a valuable feature when dealing with extra dirty cotton.

The comber bale breaker,—as the name implies, treats the cotton more to a combing action in place of tearing and pulling as is the case with the roller bale breaker. In a specimen of this machine, a section of which is shown by means of Fig. 24 the cotton as fed to the receiver *A* of the machine, either by hand in large quantities or by a slow mov-

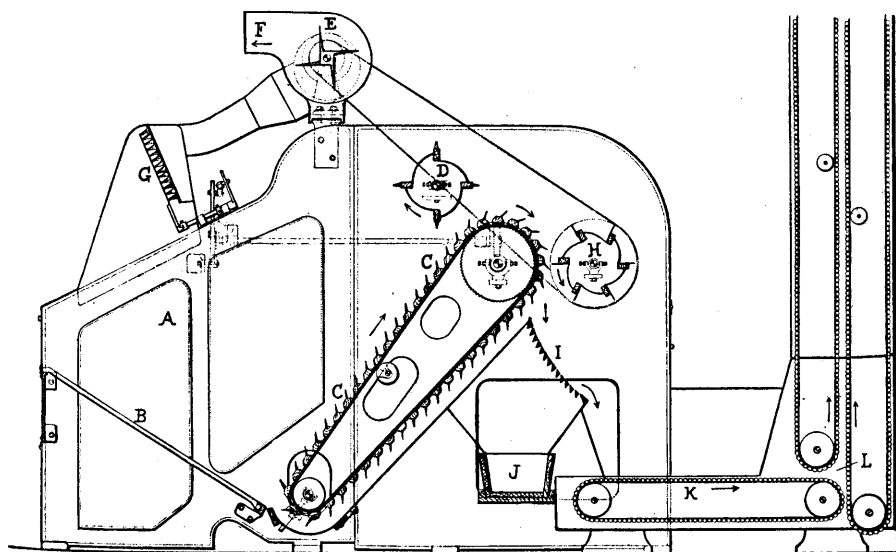


FIG. 24.

ing feed apron, slides down over an inclined grid *B* (forming the bottom of the receiver and through which any loose dirt falls, which in turn can be readily removed without stopping the machine), to the foot of a spiked lattice apron *C*. The cotton is then taken up by said spiked lattice apron and brought in contact with an evener roll *D* which is made adjustable so that it can be easily set at any required distance from the lattice, in order to accommodate different kinds of cotton worked and regulating the amount of cotton carried by the lattice out

of the receiver *A*. The treatment thus far has opened the cotton to a considerable degree, and loosened a large amount of dirt, sand, etc. To prevent such impurities from being carried along with the cotton in the machine, an exhaust fan *E* is positioned over the hopper, with the mouth placed over the centre of the receiver or bin of the machine; this mouth or entrance to the fan being covered with a perforated sheet, through which the dust, etc., is drawn and carried away by a pipe *F* in the usual manner to the dust chamber or any convenient place. To keep this perforated sheet clear of fluff or any accumulation whatever, which would greatly reduce the efficiency of the process, a mechanical stripper or cleaner is employed, consisting of a light brush *G* which is slowly passed to and fro over the surface of the perforated sheet at the mouth of the exhaust fan. This motion is derived from the lattice shaft, on which is placed a worm, working into a worm wheel on a side shaft, with connections and levers as shown, which oscillates the brush on the stud or pivot at its lower extremity, thus keeping the entrance to the exhaust pipe always clear without any attention from the attendant. In place of this arrangement a perforated revolving cage, connected with the exhaust fan placed above or below the machine can be used, being provided inside with a damper and arrangement for automatically cleaning the same with a brush or scraper. Such of the cotton as elevated by the spiked lattice *C* and as not removed by the evener roll *D*, is in turn by the lattice brought under the action of a flap roller *H* working over a set of grid bars *I*. The object of this flap roller *H*

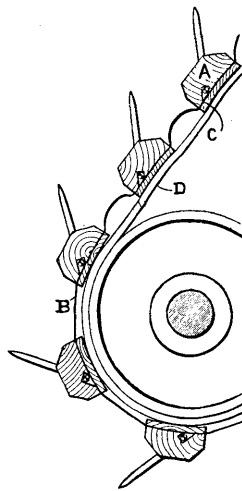


FIG. 25.

is to beat off (comb off) the cotton from the lattice, delivering the same in turn onto the grid bars *I* which are so arranged that it is impossible for the cotton to miss them before leaving the machine and which permit all the heavy dirt, etc., which has been loosened from the cotton after leaving the front portion of the machine to drop through. Underneath the grid *I* is placed a box *J* to receive these droppings, which thus can easily be removed and emptied at any time. The cotton then falls from grid *I* onto an endless apron *K* to be delivered by it to a lattice arrangement *L* for conveying the cotton to the mixing room; or the machine can be made to feed direct into a picker when mixings are not made. In the latter instance the picker is supplied with a self regulating feed which, temporary, automatically moves the driving belt of the bale opener onto the loose pulley when too much cotton is being fed or sent forward. In Fig. 25 a section (enlarged compared to Fig. 24) of the spiked lattice apron *C* is given, in the construction of which the laths *A*, carrying the spikes or teeth, are secured to an endless can-

vas *B*, by fixing them to a strip of wood *C*, on the other side of the canvas sheet *B*. The whole combination is then fastened to endless leather bands *D* in such a manner that the canvas sheet *B* hangs slack between each lath, when on a straight line, at the same time preventing any pulling on the canvas when going around the pulleys, thus preventing bits of cotton, dirt, etc., from working in between the laths and the canvas, a feature which would finally result in the breakage of the lath or the splitting of the canvas.

Another construction of a comber bale breaker is shown in its section by Fig. 26. The matted cotton as taken from the heavily com-

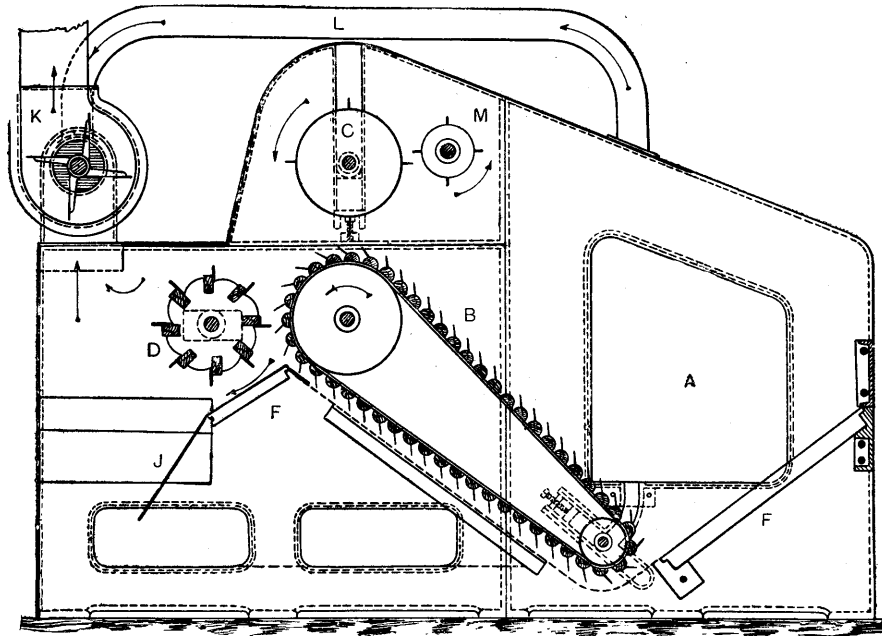


FIG. 26.

pressed bale is placed in the receiver *A* where it is taken up by the spiked apron *B*, any surplus supply being in turn engaged by the evener roller *C*. All the cotton passing this roller and held by the spikes of the lattice apron *B* is beaten off the same by the flap roller *D*. Grids *F* as situated respectively one in the receiver *A* and one beneath the flap roller *D*, allow a great deal of the heavy dirt which the cotton contains to drop out, while exhaust fan *K* takes out the dust as released from the cotton at the delivery end of the machine as well as such as coming from the receiver *A* through flue pipe *L* and discharges it into the dust flue of the picking or scutching room or any convenient place. The pins of the evener roller *C* are kept stripped of cotton by the

stripper roller *M*, thus preventing any cotton from going over the evener roller *C*. The cotton after leaving the flap roller *D* and cleaned of a great many of its impurities, in turn leaves the machine, passing over guide plate *J* on to a horizontal lattice which carries it either to the elevator lattice and on to the mixings, or delivers it through the floor on to the mixing lattices in the room below.

As will be seen later on when dealing with the subject of "Feeding the pickers" the comber bale breaker is nothing more than a heavily built hopper feed. Either construction of bale breaker however is at best limited in its opening effect, and does no more than prepare the cotton for further treatment, although it is very useful in breaking up the cotton into small pieces which after exposure to the atmosphere are found to be much softened.

MIXING.—The mixing of cottons together is essential for good yarn, since thus the fibres of the different bales composing the mixing are incorporated together with some regard to the affinity of such fibres one to another. This operation is one that can scarcely be over-estimated in its importance on the ultimate result of the quality of the yarn spun, especially when dealing with medium grades of yarns. Mistakes made in this department, whether arising from carelessness or incapacity, are irremediable when once the cotton has got into the machines, and in consequence reflect in the finished yarn. The saying that "there is a deal of spinning done in the mixing room" is sufficient proof of the importance of careful mixing, the object of which is to obtain as near as possible uniformity in length, quality and color of staple. To attain even partial success in arriving at these results, it is absolutely necessary to have experience and judgment.

Mixing does not mean simply the mixing up of various classifications or varieties of cotton, for mixing is just as necessary if only one growth of cotton is used, since irregularities of growth and staple exist in every bale. Cotton from the same district, or even from adjoining fields, will vary in quality through a difference in the character of the soil in which the plants grow. The length of time the open boll has been exposed to the sun will also vary the quality of cotton, again the grading or classification, for one reason or the other, may be imperfect, thus a buyer has no guarantee that every bale is to sample. Considering two or more different grades of cotton we will find that they possess characteristics which are the compliments of those possessed by others. It is therefore possible, instead of using one class of cotton only for spinning, to use two or three, by combining them in a judicious manner. The purpose of this practice is to enable a material to be finally obtained which will be more economical than if any single variety be used, in this instance the object of mixing being a purely commercial one. Considerable experience is absolutely necessary to obtain comparative perfection as a mixer, for a failure in this first stage cannot be remedied afterwards, and a very heavy loss may be incurred by the

mill. In mixing different classes of cotton a great many points have to be considered in making a perfect mixing all around, and of which the following are the most important:—Choose cottons of equal staple; mix strong harsh fibres with others a little weaker and softer for warp, however not for filling and where only soft pliable fibres should be used; again try and select cottons of colors which when amalgamated produce the required shade in the yarn; also consider the cleanliness of the cottons; and lastly take into account the price of the cottons mixed.

Staple.—This is the most important point since if mixing cottons which do not approximately equal each other in length of staple, a great evil is created, both from a standpoint of quality and economy. The tendency in carding and combing being to separate the short and long fibres and to eliminate the former, will readily explain that long and short staples will not mix for good and economical work. The draft rollers in the process of drawing cannot be set to accommodate and work long and short stapled cottons at the same time, for if set to accommodate the shorter fibres, loss is entailed by the rupture of the long fibres, and on the other hand, if set for the longer fibres, the yarn is weakened by the loss of a great many short fibres which, not able to be held by the rollers, are thrown off and accumulate on the clearers. Consequently, in such a case, no matter how the rollers are set, the result will be disastrous to the yarn since the same will be of a weak and irregular character. In the process of twisting, the short fibres, not having the same grip as those of greater length, are not properly twisted in the thread and an oozy yarn will be the result. The average length of staple of a lot of cotton is readily ascertained by taking a few loose fibres and holding them firmly down at one end upon a rule divided into sixty-fourths of an inch, and then by evening the fibres upon the rule, find out their length. After a little practice this procedure will be soon mastered.

Character.—It is to be remembered that in mixing, the character of the fibre is of equal importance as its length, and that the facility with which fibres will twist has an important bearing upon the subject. For warp yarn a harsher or stronger variety of cotton may have to be mixed with one more flexible, so long as their other characteristics are the same, with the result that a stronger yarn will be produced; but a harsh wiry fibre like Rough Peruvian and a soft pliable one like Bender, however well their length might agree, would make an unsuitable mixture, as the treatment which is absolutely essential in one case is different in the other. For filling purposes only cottons of a pliable nature must be mixed. This is the reason why some cottons are filling cottons and others warp cottons.

Color.—Though this may be considered of little importance from a colorist's point of view, yet it is different from a cotton spinner's standpoint, the color of cotton mixed being an important factor which should be carefully considered. Cottons often differ very widely in this respect

and a few bales of a different color may soon affect the general character of the mixing, and of course depreciate the value of the yarn, consequently cottons of different colors are usually not mixed. If a white thread is wanted, colored cottons must be avoided. In selecting cottons so far as color is concerned, it is advisable to take into consideration whether they are wanted for warp or filling purposes, as, owing to the incidence of light on the fibres after twisting, the former is always many shades darker than the latter.

Cleanliness.—Cottons to be mixed should not vary too much in regard to cleanliness, as the amount of scutching required in a great measure depends upon the cleanliness of the cotton; a clean cotton requiring not as much scutching as a cotton containing much foreign matter. Thus when a clean and a dirty cotton are mixed, the scutching which is required to adequately clean the dirtier portion will be more than sufficient for the clean, and as a result the action of the beater, in the picker and scutcher, on the cotton will more or less damage and weaken said fibre, and in turn the yarn spun from it. When a number of cotton bales have dirty ends or sides, which is frequently the case, these ought to be taken off and kept away, in order not to soil the clean cotton with the dirt arising from such portions of the bale, which cotton later on may either be used up by degrees, or made up into a separate mixing, to be made into separate laps, and mixed in the scutcher when convenient.

Price.—Provided length and character of staple as well as color are satisfactory for mixing two or more kinds of cotton, yet we have to consider the price of each kind in order to arrive at an average value of the mixing. For example:—Find average price per pound for a mixing of 40 bales of cotton of which the lint in 20 bales = 9600 lbs. costing 9 cents per lb., in 10 bales = 4785 lbs. costing $8\frac{1}{2}$ cents per lb., and in 10 bales with 4,722 lbs. costing 8 cents per lb. Answer:— $9,600 \times 9$ cents = \$864.00; $4,785 \times 8\frac{1}{2}$ cents = \$406.72; $4,722 \times 8$ cents = \$377.76.

\$864.00	9,600 lbs.
406.72	4,785 lbs.
377.76	4,722 lbs.

\$1,648.48 cost of mix. 19,107 lbs. of lint in mix,
and $\$1,648.48 \div 19,107 = \0.08627 or practically the price of the mix
per pound = 8.63 cents.

Waste.—The waste usually returned to a mixing room is that which is technically known as “soft” waste, that is, such waste as contains little if any twist. It includes waste from the carding, combing, drawing, roving and spinning departments; but excludes yarn waste (“hard waste”) or carding engine flat waste or fly (“short waste”) which waste has to be kept separate, and if re-used by a mill can only be done in connection with cheap and low counts of yarns, waste yarns. Where

this system of using soft waste is in use, great care should be exercised to carefully spread the waste over the mixing, using it at the same time very sparingly, or else considerable trouble and irregularity will be introduced by the laps licking, as well as by the yarn getting weak, since the fibres of this waste have been shortened by the various operations they have passed through, and many being short fibres from the start. If using too much of this waste a very great loss can soon be sustained by means of irregular work, bringing with it a whole train of attendant evils. We will find greater accumulations of fly and waste in all the different processes, especially in the spinning department where it displays itself very conspicuously by the increased amount of waste made. This loss, however, is intensified by the fact that in a great majority of instances the operatives experience great difficulty in coping with the increased work, and in consequence cannot exercise the same vigilance over their work. How much of this soft waste to use in connection with a mixing varies considerably according to the counts of yarn that are required to be spun from cotton under operation. Some mills prefer to use up much of their waste in filling lots, upon the basis that the filling does not require to be a strong yarn. This may be all right with some fabrics, but it does not apply in all cases. For example with "print cloths", where warp and filling are of equal importance all around, and where the amount of size used is only just sufficient to sustain the warp while the cloth is being woven, it raises an interesting point as to where the waste ought to be mixed. If it is used in connection with the filling it means a weaker filling, and if it is used in connection with the warp it may mean the same fault; but the warp yarn, and with it the waste, receives a coating of size, and although it is lightly used yet it imparts a certain amount of strength, which could not be imparted to the filling and therefore it may sometimes be found that waste is used in connection with warp mixing.

Warp or filling.—Long and strong stapled cottons are generally better suited for warp, and short, soft stapled fibres for filling; indicating that a lot of cotton may be either better suited for warp or for filling. To mills who besides spinning do their own weaving it will make no difference to purchase large consignments of cotton that partake of either warp or filling qualities, so long as the length of staple and price is satisfactory, since they can sort out those bales that take more for either warp or filling, and make their mixings accordingly, the yarns from either mixing being woven into cloth in their mill and thus not liable to the same amount of criticism as yarns spun for the trade. In mixing cottons for warp yarns, besides the length and strength of staple sometimes color is also a factor; but for filling, color is very important, whilst strength of staple may or may not be essential. With reference to color, a mixing which is to be spun into warp will be several shades darker than if it is spun into filling, a feature explained by the fact that as a rule warp yarn is spun with more turns per inch than filling, i. e. "harder twisted", and it is owing to this increase in twist

that the color of warp yarn is deeper. The reason for this is found in the varying reflection of the light from the surface of the yarn, owing to the different disposition of the fibres, since the difference in color depends on the number of rays reflected.

Testing the loss in a fresh supply of cotton.—Every new lot of cotton should be tried to discover the percentage of loss both as to moisture and dirt. For this purpose a certain quantity of cotton is taken from the middle of several bales until say about 100 lbs. is got together; it is then exposed to a warm atmosphere for a considerable number of hours, so as to allow of the evaporation of any water which may have been absorbed, or, as is not infrequently the case, has been fraudulently put there for the purpose of increasing the weight of the bale; after this process it is reweighed, thus readily giving us the loss by moisture. Then this sample of cotton is passed through a picker and scutcher, the insides of which have been thoroughly well swept out, after which the laps made are weighed, and the machines once more swept out, and all the droppings, dust, sand, seeds, etc., that have come out of it are collected and weighed, keeping each kind of impurity as much as possible by themselves. All these different weights thus obtained are entered in the book kept for this purpose, opposite the mark of the cotton, in this manner clearly showing the first loss in any lot of cotton as handled by the mill. To test the working qualities of a mixture a small sample lot of a few pounds should be made first, and in turn passed through the machinery and spun into yarn, in this way ascertaining whether any change is required before proceeding with the large lot or lots.

Yet, in spite of all these dangers connected with careless mixings, it is a fact that its gravity is not sufficiently appreciated by many superintendents of mills, being left to the care of subordinates, many of whom are not fully alive to the importance of their work.

Proper Mixing.—Since there is always more or less difference in the contents of bales, it is very desirable that a mixing should be made large enough to last for some time (as large as possible), as in this way more regular spinning and a nicer, uniform yarn is obtained. In addition to this the cotton is all the better for standing in the stack a short time, as by this means the air can circulate through it and render it far softer and more supple than it would otherwise be. The mixings must be made according to the counts and quality of the yarn required, the price at which it is to be sold, or used in the mill, and according to the machinery with which it has to be made. The first thing to be done with the cotton is to sort and examine every bale previous to mixing, and put aside any bales that are not up to standard, for further examination and consideration as to what should be done with them. Falsely packed bales, or water packed bales, or such as full of sand, etc., should be rejected or proper claims made.

If the cotton is mixed by hand, the method usually adopted is to have the bales ranged conveniently. The contents of the first bale are

pulled into small pieces and spread out in a thin layer, aided by a rake, over the whole surface of the mixing bin or section of the room allotted for it. Then in turn the second bale is spread on top of the first, the third in like manner, and so on, until a great pile is formed, these layers being trampled down exactly in the same manner as building a hay stack. When the cotton is required for use, it should be pulled from one end of the mixing, in a regular cut as it were, from top to bottom, taking care to handle the layers cautiously and disturb them as little as possible in order to present the mass to the action of the first machine with the greatest amount of uniformity. In some mills only the half of the hoops of a number of bales are opened at first, in order to see what difference there is in the staples; but another advantage for this procedure is, that it allows a comparison to be made as to the amount of expansion each half bale will show when released, from which feature alone a judgment may sometimes be drawn as to the normal or excessive amount of moisture which individual bales contain. If the half of the released portion of the bale rises up considerably above that of another, it may be taken as a sign that the cotton was packed under fairly good conditions; but if another half bale shows a much less amount of elasticity, when unpacked, in comparison to others, it may be due to an absorption of moisture by the fibres that has probably occurred during packing, and its evaporation will cause a certain amount of invisible loss during its usage. It is obvious that by the use of machinery a much more intimate mixture can be made of the various grades than is possible by hand mixing, and it must be remembered, that if any advantage is to be gained from mixing, the earlier the fibres are thoroughly diffused among the mass the better, and much of the work of the earlier machines (picking, scutching, carding) is removed if this object is attained at this stage.

In mixing by the aid of a bale breaker or a hopper feed used in connection with a picker, or single, the bales, say ten or about, containing the various qualities of cotton to be mixed are opened and placed near the machine. A layer from each bale is taken in succession and placed upon the lattice feed apron or in the hopper, as the case may be, of the machine, and is thus opened out. The machine in turn delivers the opened cotton onto a lattice, from which it is carried automatically to the mixing bin or bins, which can be located on the same floor or below the opening room as the case may be. If the bale breaker or hopper feed is over the mixing room the cotton is dropped through the floor upon a lattice placed underneath and by means of the latter delivered to its bin. If the mixing bin is situated at a considerable distance from the bale room in which the breaker or hopper is working, the cotton is drawn from the machine to the bin, through a long tube by means of an exhauster. If the bale breaker or hopper feed is on the same level as the mixing room, the cotton is deposited by the machine upon a horizontal apron which delivers it to elevating ladders, from whence it is deposited upon any desired mixing. To give a clear understanding

of the subject, Fig. 27 is given, showing in section and plan view an approved method for conveying opened cotton to mixings and delivery of the latter to the picker room. The cotton as it comes from the machine (as previously referred to) is in one way or the other delivered onto a traveling lattice *A*, as situated near to the ceiling of the mixing room. This lattice is one of a series *A*, *B*, *C*, *D*, which are so arranged that the cotton can be taken as required to any one of the four mixing stacks or bins shown in the illustration. The method of delivery of cotton is thus:—The cotton is taken along by the lattices *A* and *B*, both running in the same direction. From *B* the cotton falls on a cross lattice *C*, which can be run in either direction, as the case requires, to in turn deliver the cotton either to mixing bin *I* or *II*, and where it is spread out over the whole surface. For delivering the cotton either to mixing bin *III* or *IV* the

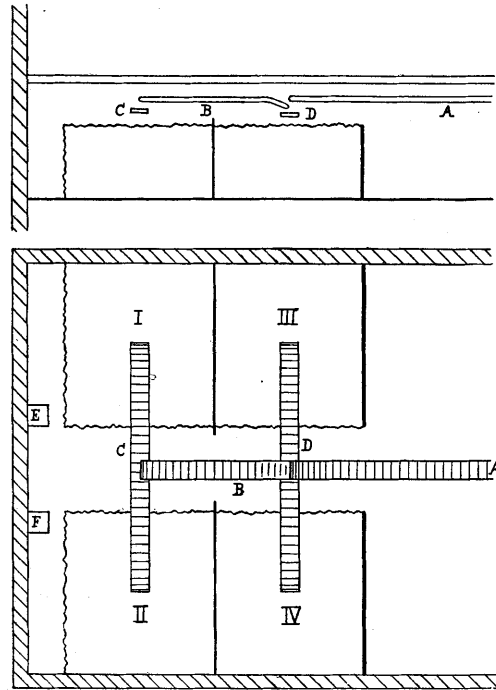


FIG. 27.

run of the lattice *B* is reversed and when lattice *A* will thus deliver the cotton at the junction of lattices *A* and *B* onto lattice *D* which works similar to lattice *C* and thus delivers the cotton either to the third or fourth mixing as the case may be. In the same manner as feeding to bin *III* or *IV*, two or more additional mixing bins may be provided, in which instance the arrangement of lattices *B* and *C* is simply duplicated for each additional series of bins. For fine work it is a good plan to let the cotton stand in the mixing at least a week—longer, if possible, in order to give the fibre an opportunity to absorb air and expand. Should the cotton be of a leafy nature, the room should be heated artificially, so that each fibre becomes of the same temperature. Another reason is, that when cotton containing leaf is subjected to a little heat the leaf rolls up and becomes crisp, and can be got out by the beater without being broken up. If the cotton contains seeds, heat causes trouble, as the cotton clings to the seeds. By allowing the cotton to lie in an open state in the mixing a few days, the dirt being more exposed and the

fibres of an even temperature, we can treat the cotton less harshly in the picking and scutching by running the beaters slower, and thus do not knock the nature out of the staple, in turn making stronger yarn. When feeding one or the other mixing to the picker, break in the mixing in as regular a cut down in the stack as possible, thus giving a greater chance of regularity of the mixing, since it enables a little of every layer in the stack to be passed through the picker in a short time. *E* and *F* show the mouth of trunks, to which the mixings are readily fed, carrying the material direct to the hopper feeder of the picker or placing it within easy reach of the person feeding the picker or pickers, provided no hopper feed is used.

In many mills no special mixing is done, the cotton being simply taken from several bales as placed near the hopper feed, or in some mills (where no hopper feed is used) placed near the picker; the taking of layers now and then from one or the other bale being in this case the only mixing done. This "ageing" of cotton i. e. giving the fibre an opportunity to absorb air and expand, is by some cotton manufacturers, who although doing no special mixing, considered of such importance that they use it in connection with direct bale mixing to the hopper feeds or pickers where the former are not used. In the picker rooms it is always difficult to keep the cotton in unbaled condition for the proper length of time, as it is often more convenient to the help to supply a recently unbaled lot of cotton to the hopper feeds or pickers than to attain access to that which has been standing unbaled for a considerable length of time. To overcome this trouble i. e. to insure that the oldest cotton, or that which has been unbaled for the longest time, shall always be supplied first, the appliance shown in Fig. 28 will be

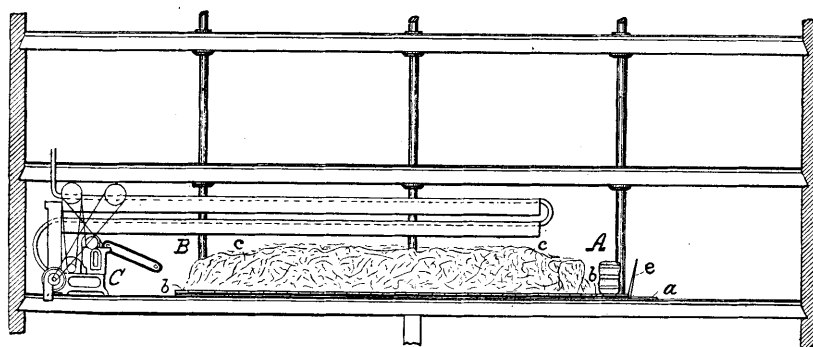


FIG. 28.

found of the greatest of advantage, the illustration being a longitudinal section of a portion of a picker house showing the method of opening bales and feeding the cotton to the hopper feeds or pickers in order to obtain ageing of the cotton. To accomplish this result, the portion of the picker house that is to be provided with the appliances has its floor

provided with guideways or rails *a*, extending from a point *A* near where the baled cotton is stored, to a point *B* near the hopper feeds or pickers *C*. Upon said rails *a*, are supported a number of planks *b* and which together constitute a platform upon which the pile *c* of loose cotton is supported, the bales of cotton being opened at or near the rear end *A* of said platform, as shown, and the loose cotton from the bales piled up on the platform against that in advance of it. The platform should be of sufficient length to support a pile of loose cotton that will supply the corresponding machines or pickers *C* for a number of days, or for the length of time which is found in practice to be sufficient to thoroughly "age" the cotton in its loose condition; and as the cotton is always removed from the forward end of the pile at *B* to be supplied to the machines it will be seen that the cotton which is added to the pile at *A* will not be supplied to the machines until the entire pile in advance of it has been used up. As the cotton is being constantly withdrawn from one end of the pile and added at the other end, it is necessary that the entire platform *b*, with the pile of cotton upon it, is moved forward from time to time, in proportion as the cotton is taken away at the end *B*, by levers *e*—one near each side—suitable fulcrum supports being provided in the rails *a* for the lower ends of levers *e*. With the appliance thus described, two men operating two of the levers *e* can easily advance the platform and the pile of cotton upon it. When the cotton has been removed from the forward end at *B* sufficiently to uncover one or more of the platform sections *b*, the latter are taken up from the rails and carried around and applied to the rails at the rear end *A*, so that the platform, although constantly advancing, remains as a whole in about the same position at all times and remains of about the same length.

PICKING.—When taken from the mixings, the cotton is operated upon by a series of machines, which open out, clean the fibre, and finally form it into a sheet or web of uniform width and thickness, which is rolled into a "lap" ready to be fed, in combination with others, into the succeeding machines. The machines which accomplish these processes are called hopper feeders, pickers and scutchers. In some mills as already previously stated, this is the first process the cotton, as arrived at the mill, is subjected to; bale breaking, mixing, one or the other or both, being omitted, the first possibly on account of the opened condition of the lint, the other in some instances, considered not necessary. The transferring of the mixing to the picker, or otherwise the feeding of the picker direct from bale or bales, can be done either by means of open feeding, or by a hopper feeder, the last method being the most satisfactory.

Open feeding.—Until several years ago, and in fact in some of the smaller mills yet, the practice of feeding of the mixing or of the cotton from the bale, had been or is, to feed the material direct to the picker, the procedure being technically known as "open feeding." The disad-

vantages of this feeding, by which is meant the delivery by hand to the machine, of cotton in masses, are so obvious that it may be looked upon as nearly obsolete. There is no guarantee under such circumstances that the machine shall be dealing with equal quantities at two different periods, and this is a matter of great importance if the picker is combined with a scutcher, since in this event, a lap is produced uneven in substance and body, containing defects which require removing at a later stage. The unevenness thus created is often very great, and practically irremovable by such means as are at hand. The only regulation possible is at a point prior to entering the scutchers, when the cotton is ejected from the picker into an exhaust flue, and the scutcher is provided with a feed regulating motion, which compensates, to a large extent, for the inequality in the rate of feeding.

Hopper feeding.—This machine has come during the past years into general use as an auxiliary machine to pickers. There is no doubt as to the usefulness of the hopper feeder, for, when properly applied, it certainly prepares the material in the best form possible (more or less already opened) for the picker, feeding it at the same time evenly and regularly to it, in order that the same may pass the cotton on in like manner to the scutchers, permitting an even lap to be formed. At the same time the action of the picker is more effective and greater cleaning power obtained. Both items, the even feed and greater cleanliness will be the reason for a stronger yarn and better production. Since heavy objects, nails, etc., cannot pass the feeder, the risk of fires in the picker room is lessened. Another item in favor of the hopper feed is economy in wages, as one operative can tend easily to three machines.

Fig. 29 shows in its section such a hopper feed. In the same *A* indicates the chamber, the bottom of which is formed by an endless lattice apron *B* on which the cotton as deposited by hand rests, and whereby the same is constantly urged against the spiked vertical lattice apron *C*, which is traveling upwards, driven by a roller *D* at the top, specially made to avoid slipping. The apron *C* is supported at intervals, on its elevating side, by carrier rolls, in order to render a straight, steady surface to the cotton, and consists of a heavy canvas belt, backed with leather strips, fastened to which are wooden slats, from which project pins by which the cotton is caught and carried upwards. To regulate the supply and prevent lumps being carried through, a spiked roller *E*, revolving in the opposite direction to the lattice, is placed at the top of the machine, its action being to comb the surplus cotton off the vertical lattice, and throw it back into the hopper. To prevent the cotton from being carried round this roller and thus clog its action, its spikes work through suitable slots in an endless leather apron, the full width of the machine, said apron passing round a second, plain, tightening roller *F*. The spiked lattice *C*, having passed the driving roller *D* at the top of the machine, the spikes are naturally pointing downwards, and the cotton is then easily removed from it by the stripper or doffer roller *G*, as is driven from a countershaft, and

consists of four wooden blades, faced with leather (flaps) extending across its whole face, and which flaps come slightly in contact with the pins of the elevating apron. As the doffer *G* runs at a considerable high speed as compared to the slow speed of the feeding apron *C*, a con-

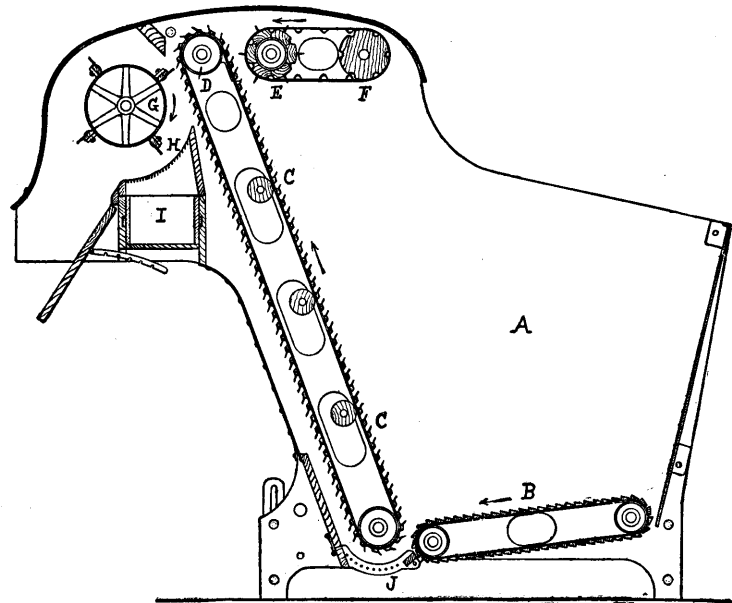


FIG. 29.

tinuous series of blows are given by the flaps to the cotton as on the feeding apron, by means of which the cotton is stripped or beaten from the pins and thrown against a screen or grid *H* directly beneath the doffer, through which any loose dirt will fall. Beneath this screen is a dirt drawer *I*, which receives dust and dirt that is beaten out of the cotton by the doffer. A screen *J* as placed beneath the spiked lattice *C* permits impurities falling from the latter to drop out of the machine, the screen being arranged so that it can be readily dropped and accumulated dirt removed when necessary. From the screen *H* the cotton then leaves the machine, assisted by the current of air produced by the doffer *G*, passing down the inclined delivery end of the hopper feed, which in turn delivers the cotton either in a loose state on the floor, on a traveling lattice apron, or direct onto the feed apron of the picker. To regulate the amount of feed of the machine in order to accommodate different cottons, the frame carrying the spiked and plain rollers *E* and *F* can be moved within certain limits so as to vary the distance between the spikes of the roller *E* and those of the lattice *C*. The greater the

distance between them the heavier will be the feed, and vice versa. This distance depends also, to some extent, on the kind of cotton being worked, indicators being provided on both sides of the framing, showing the distance between the points, and being graduated so that the relative positions of the spikes can be readily adjusted by means of a handle and eccentrics. In order to regulate the feed of the machine, to compensate for the necessary change in amount of material at one time in the hopper, and which would influence the amount of feed of the machine, a cone regulator can be applied, which controls the amount of cotton delivered by the hopper feed regardless whether the hopper is full, half full or nearly empty. The cotton in this instance, when leaving the hopper feed, is made to pass between two evener rollers, the bearing of the one being fixed, and that of the other being movable in a horizontal slot. The bearing of the latter rests against the short arm of a lever, of which the long arm is in connection with the strap fork in the cone box, and thus by suitable connections modifies the speed of the spiked lattice *C* according to the thickness of the cotton passing between the evener rollers mentioned before. When the hopper feed is connected direct to the picker, the feed to the latter is regulated in unison with the spiked lattice *C* of the hopper feed, so that when the quantity of cotton in the hopper diminishes, the lattice *C* of the hopper feed and also the feed rolls of the picker correspondingly increase in speed, the quantity of cotton delivered to the action of the beater thus remaining the same. In addition to the variation of the speed of the spiked lattice *C* obtainable from the cones, and to that of the feed obtainable by advancing or withdrawing the spiked roller *E*, the fundamental speed of the spiked lattice can be altered by change wheels; the object of varying the speed a great deal depending upon the class and condition of the cotton under operation, the more hard and matted the cotton as presented to the feeder, the slower the speed of the lattice required to obtain a given weight of feed.

Fig. 30 shows in its section, another construction of a hopper feed. The same is fed from the mixing room by a trunk *A* which delivers the cotton in the chamber *B*, the bottom of which is formed by the endless lattice *C* which carries the cotton forward to where it is engaged by the upright spiked lattice *D*. The surplus cotton as carried upward by this lattice is evened off from the same and returned to the chamber *B* by a toothed evener roller *E*, the teeth of which are kept clean (self-stripping) by an eccentric arrangement which causes said teeth to project through the casing of the roller as they approach the spiked lattice *D* and recede within after they have performed their evening action on said spiked lattice *D*. The cotton is now carried over the top of the spiked lattice *D*, and as the spikes on it are then inclined in a downward direction, it is an easy matter for the rapidly revolving stripper roller *F* to take the cotton from them by means of the flexible flaps around its surface. By this action the cotton is thrown against a grid *G*, and when, to some extent, loose sand, leaf, motes, etc., fall into

a dust box below, from where they are readily removed. From the grid *G* the cleaned cotton passes down an incline and is deposited on an endless delivery apron, passing in turn under a roller *H* and thence out of the machine. No pedal regulating motion is used in connection with this machine, since the roller *H* to a certain extent acts to even the cotton on the delivery apron. In machines of this description the apron *D* will always carry away more cotton and produce a heavier feed when the chamber *B* is full than if it is nearly empty, thus in order to keep the feeding of the machine uniform, the trunk *A* must be kept always full of cotton, for which purpose a series of feeler bars *J*, extending the

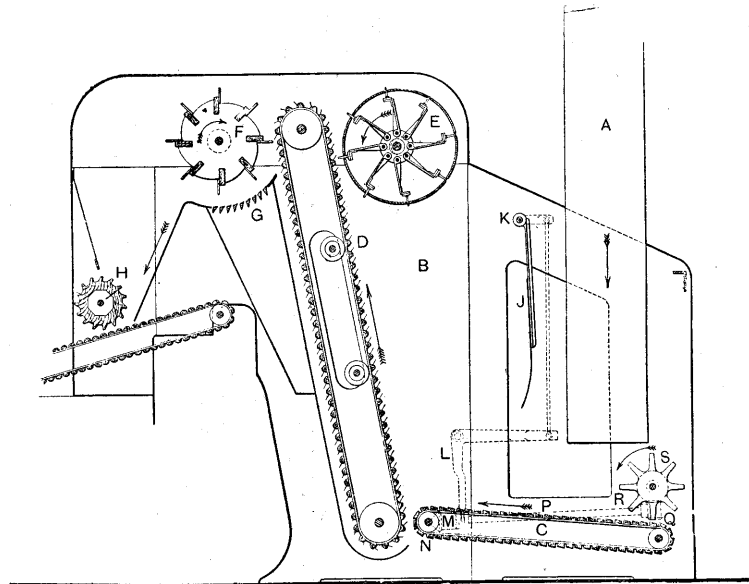


FIG. 30.

full width of the machine and pivoted at *K*, are placed in the chamber *B*, and when an accumulation of cotton in said chamber forces these feeler bars forward and through a lever *L*, as connected to it, puts a clutch *M* fast to one end of shaft *P* out of engagement with the drive for the roller *N* as driving the lattice *C*. The other end of the shaft *P* carries a worm *Q*, which through worm wheel *R* drives a spiked feed roller *S*. Thus as the clutch *M* is thrown out of engagement, the rotation of the feed roller *S* is also stopped in unison with lattice *C* until the surplus amount of cotton in chamber *B* is taken up and when the feeler bars *J* move backward and throw the clutch *M* again into engagement with the drive for the roller *N*.

The description of the hopper feed thus far given has shown that there are three principal parts in its construction, viz:—the spiked

lattice apron, the rotating top evener, and the back stripper. Since it is at these three points of engagement that the actual work of the hopper feed takes place it will be well to consider them more particular.

The spiked lattice apron must be so driven that any possible chance of slip is avoided, to ensure which, the largest sized pulleys which can be conveniently arranged for, should be used; for the reason that any variation in the speed of this apron will result in an uneven delivery. The angle which the face of the apron forms with the horizontal should not be too obtuse, as otherwise the tendency would be for the apron to carry too much cotton into action, and thus not produce that tearing effect to the mass of cotton so desirable. Neither should this angle approach too near to a horizontal line, since in this case the cotton is removed from the hopper box too quick, while provided a vertical line were followed, the cotton would be torn away more slowly and in less quantity than desirable. In order to give stability to the spiked apron, and thus avoid bagging, the same, if necessary, should be sustained. The shape and position of the spikes (pins) in the slats of the lattice apron also affect the carrying capacity of this apron and thus the quantity of cotton removed by it from the hopper box.

The purpose of the evener is to reduce the size of the lumps which are being carried up by the apron, and also to throw back such of them as are too large, to be in turn further operated on by the spikes of the apron. Where pieces of cotton are firmly held by the spikes of the apron, the teeth of the quicker running evener will tear them apart provided said pieces are of a comparatively large size, but the pitch of the teeth of the evener roller will not effect the reduction of small sized pieces which thus will pass on. At the point where the evener roller and the spiked lattice come nearest together, i. e. act upon the cotton, the latter must be well supported, in order not to yield, what would prevent large pieces of cotton from coming under the action of the evener roller and in turn pass on. Again care must be taken that the teeth of the evener roller are automatically kept clean to thus prevent their becoming clogged with cotton and unfit for good work.

The stripping of the cotton, as previously explained, is done by the rapid revolution of a stripper roller, which beats off the cotton from the comparatively slow running spiked lattice apron at a point where the latter is also supported, and delivers it in its proper channel to the picker or wherever required. The great speed at which the stripper roller is revolved causes the latter to act as a beater, this action tending to considerably disintegrate the pieces of cotton under action, as well as to liberate a considerable amount of impurities from the cotton, for which reason we find a grid, through which the impurities can fall, placed below the stripper roller.

From the foregoing it will be seen that the hopper feeder is a true opener of the matted pieces of cotton and that it can be depended on to restore the cotton to its original fleecy condition, quite equal to that

obtained by any type of picker beater. It also has been shown that its principle of action is not a beating, but rather a combing or tearing action, even the stripper roller, although it beats, being so constructed that its teeth comb out the pieces subjected to its action, and which principle is carried out throughout all points of operation of the machine. It is this combing action of the hopper feed which is so much in its favor compared to the brutal beater action of the picker; and as we have seen, the hopper feed assists in opening and picking the cotton, thus by its use less beating by the beater of the picker will be required, with the result of a better and stronger yarn.

The hopper feed can be used either by itself, in connection with the picker or in some instances in connection with the

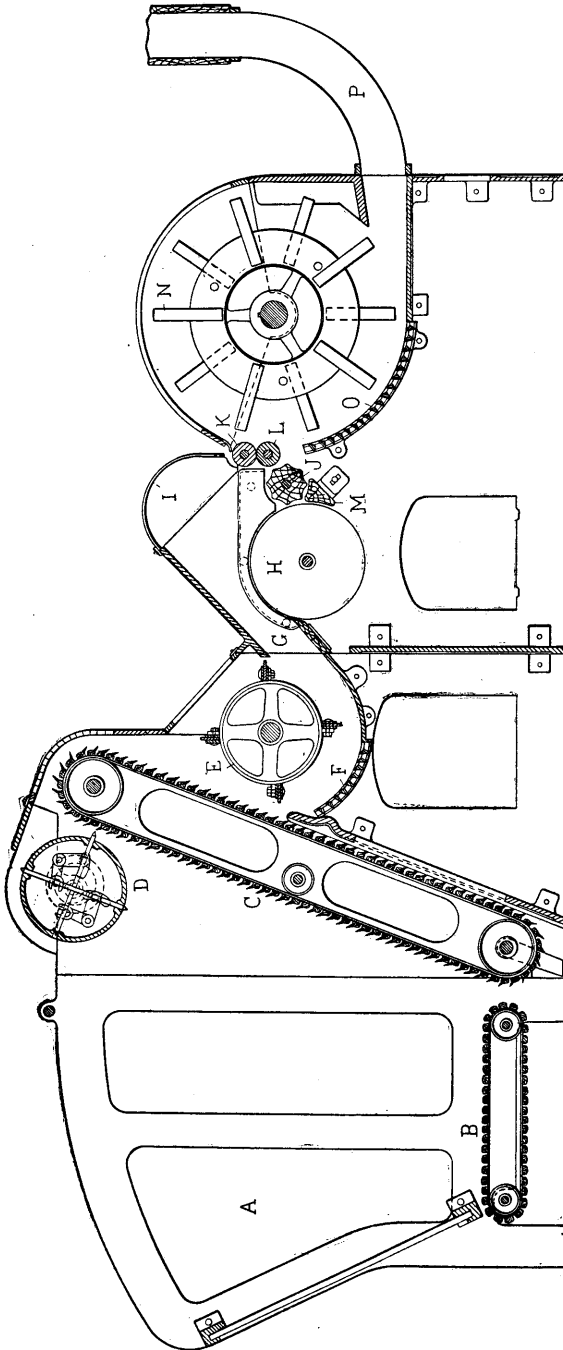


FIG. 31.

scutcher, in the latter instance the picker delivering the cotton in an open state while the scutchers are open fed, the hopper feed being placed before the scutcher feed table. Should in this instance the picker be supplying two scutchers, a reversible lattice is arranged to receive the cotton from the picker and carry it to the two hopper feeders, each end of the lattice being over a hopper, so that the cotton can be dropped into either, the operative being able to reverse the lattice at will and thus keep both hoppers filled.

Combined picker and hopper feed.—This machine is in most mills in this country the first preparatory machine used, its construction and operation being shown by means of Fig. 31. The cotton as taken from the bales or mixing stacks is deposited into the hopper *A*. The horizontal lattice apron *B* carries the cotton forward and into contact with the vertical spiked apron *C*, the ascending side of which carries a portion of the cotton with it as it rises. *D* is the evener roller, revolving at a high speed, which removes any surplus cotton from the spiked apron *C*, thus rendering the feed of the machine more even. In order to keep the teeth of this evener roller *D* always clean, an arrangement of eccentrics is provided (in place of the spiked roller and leather apron as described in the preceding explained construction of a hopper feed) which causes the teeth to project through the casing of the roller as they approach the lattice and recede within after having performed their evening action.

The mechanism for protruding and withdrawing the teeth of the evener roller in this manner is shown by special illustration Fig. 32 which is a section through the evener roller. In the same, two sets of pins *a b*, secured to bars *c d*, extend through the evener roller, said pins being fitted to slide in holes *e* in the surface of said roller. For effecting the back and forth movement of the pins *a b*, two shafts *f g* are employed, provided respectively with lever arms *h i* and *j k*, the ends *i k* of which are forked to straddle the bars *c d*, while the free ends *h j* are provided with rolls *l m*. These rolls travel in an eccentric groove *n* (shown in dotted lines) in a stationary plate at one end of the evener roller *D* and thus through their respective lever arms gradually withdraw the pins inside the evener roller to thus clean them of cotton; and as the evener roller travels further around, the pins are gradually projected through the outside of the

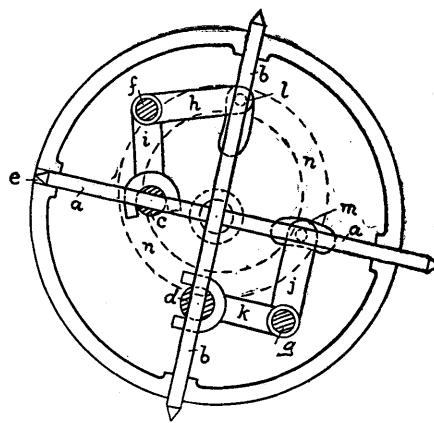


FIG. 32.

evener roller to thus engage and operate upon the cotton on the spiked lattice apron *C* of the hopper feed. In order to increase or lessen the amount of cotton passing between the evener roller *D* and the spiked lattice apron *C* without the necessity of moving the former nearer to or farther from said spiked apron, the plate carrying the groove *n* can be readily adjusted by means of a lever (not shown) so that the full extent of protrusion of the pins *a b* is caused either before or after reaching the spiked apron *C*, thus varying the distance between the ends of said pins and those of the spiked apron at the operative point. With reference to Fig. 31 the cotton is now carried over the top of the spiked lattice apron *C* and as the spikes on it are then inclined in a downward direction, it is an easy matter for the rapidly revolving stripper roller *E* to take the cotton from them by means of the flexible flaps around its surface. By this action, the cotton is driven against a series of grid bars *F* and when, to some extent, grosser impurities fall into a dust box

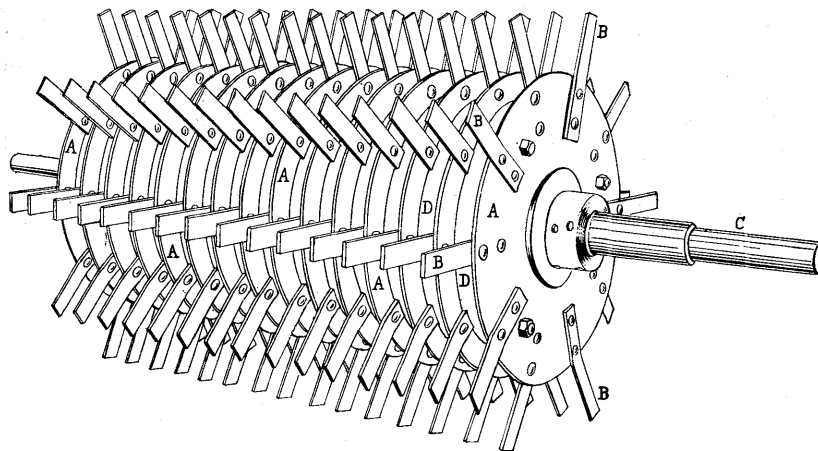


FIG. 33.

below, from where they are readily removed. From this point, the cotton passes forward through channel *G* into the cage section of the machine, passing over screen cage *H*, which acts as a carrier and at the same time takes from the cotton some of its impurities. *I* is the hood of the cage section which when required for cleaning purposes can be moved to permit easy access to the cage section. *J* is a starred stripper roller which strips the film or sheet of cotton from the cage *H* and guides it to and between the pair of picker feed rollers *K* and *L*. *M* is an adjustable clearer bar, extending across the machine, for preventing the cotton from following the cage. The film of cotton as delivered by the feed rollers *K* and *L* is in turn engaged by the rapidly revolving blades or fingers *N* of a porcupine picker cylinder, which throw the

cotton with more or less force against another grid *O* where another cleaning process of the cotton takes place, after which the cotton passes out of the machine through the trunk *P*.

This porcupine picker cylinder (see Fig. 33) is made up of a number of steel disks *A* (15 in our illustration) turned to a given diameter and having a series of hardened steel fingers *B* riveted to them. The disks *A* are placed on a shaft *C* over a key, and separating pulleys *D* of the required width placed in series between the disks, also over the key; the fingers *B* being so offset that one revolution of the cylinder covers the entire width of the feed rolls, the ends being ground so that their strike is parallel to the feed roll. The disks and separating pulleys are clamped together on the picker shaft by jamming nuts on either end of shaft and by tie bolts running endwise through the cylinder. The cylinder is accurately balanced and has no openings through which sand, etc., can enter to cause it to run out after being

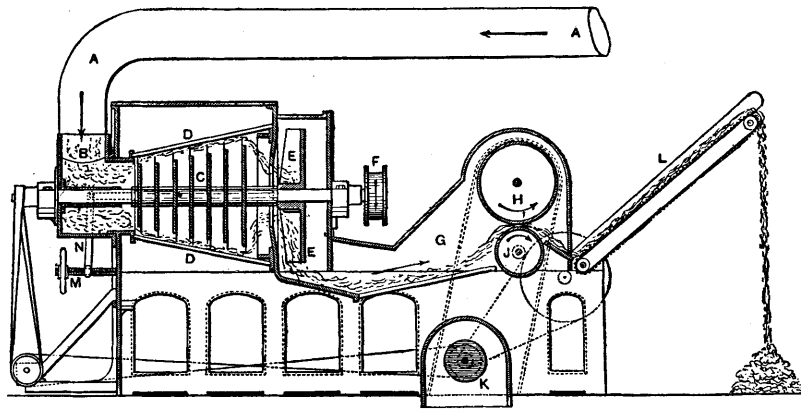


FIG. 34.

used a short time. In case of accident to fingers or plates through hard substances getting into the machine, the damaged portion can be easily removed and replaced. In place of this porcupine picker, a two or three winged rigid beater (as are explained later on in connection with scutchers) can be used.

A horizontal conical exhaust picker,—being a machine extensively used in England and the Continent is shown in its section in Fig. 34. The cotton as coming from the bale breaker, hopper feed or mixing (not shown) is fed into a trunk *A* and forced along to the entrance *B* of the beater casing, by means of a powerful fan *E* driven from pulley *F*, which exhausts the air in the trunk, the inrush of air into the trunk at its other end, forcing the cotton as fed to it along. The cotton as it leaves the entrance *B* comes under the action of the blades *C* of a horizontal conical beater, surrounded by the casing *D* and when any dirt removed

by this beater passes out of the machine through perforations in said casing. After the cotton passes the beater *C* and the fan *E*, it is drawn by the draft of fan *K* into the chamber *G* and deposited on the screen cages *H* and *J* which take out lighter impurities in the cotton not previously removed by the beater, the cotton in turn leaving the machine by the traveling lattice apron *L* and is deposited on the floor to be in turn fed by means of a hopper feed or open feeding to the breaker scutcher, or the latter can be connected direct to the delivery end of the picker. In order to change the distance of the blades *C* from the casing *D* to suit the amount of feed, the casing *D* is made movable and an arrangement is provided so that by turning the screw *M*, a lever *N* connected to the casing by links acts to move the casing either out or in and thus vary the distance of the same from the blades *C*. This machine is best adapted for long stapled cotton for the reason that on account of the cotton being drawn through the machine so quickly the same does not have time to get damaged, while the action of the beater is sufficient to open the cotton thoroughly. This machine gives a larger

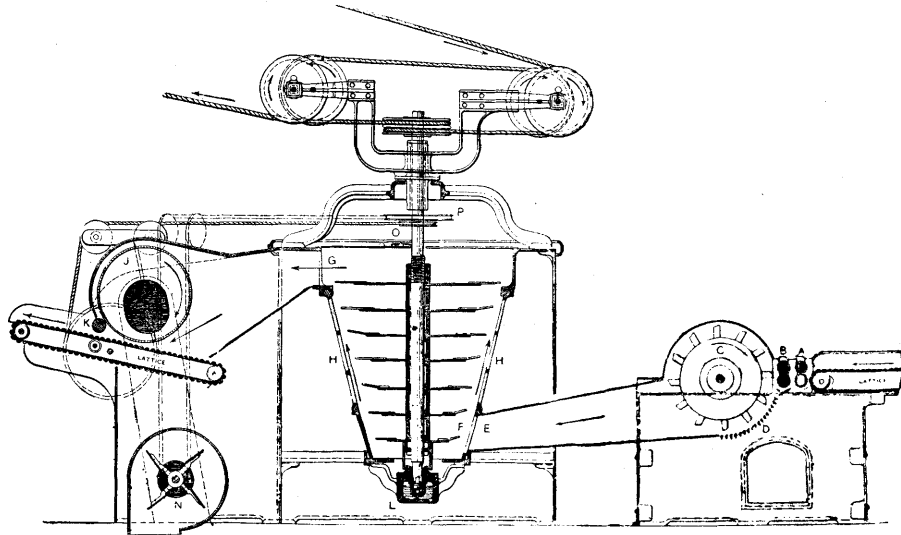


FIG. 35.

production than the porcupine cylinder picker; the English system of arrangement being to have it followed either by two single beater breaker and two single beater finisher scutchers for ordinary grades of American cotton, or by three single beater finishers for Sea Island and Egyptian cotton.

The vertical picker,—more familiarly known as the “Crighton Opener” is another picker extensively used in England and the Continent. A section of this picker is given by Fig. 35, showing the same

combined with a small porcupine picker. The cotton as taken either from the bale or mixing stack is fed to the porcupine picker, being placed for this purpose on an endless lattice apron which in turn feeds the cotton between two pairs of rollers *A B*, from where it is engaged by a porcupine beater *C* which breaks the matted cotton into small tufts, releasing at the same time a great amount of the dirt the cotton contains, which drops out through the grid *D*. A fan *N* at the delivery end of the vertical picker sets up a vacuum through the machine and thus draws the cotton from the porcupine picker along through the passage way *E* and when it is brought in contact with the blades *F* of the bottom disk of the series as forming the vertical conical beater proper. The high speed of this disk loosens up the cotton, allowing it at the same time to rise to the next disk where it is further loosened by the action of its blades and drawn up by the air current to the next disk; this operation being repeated until the cotton reaches the top disk where it escapes from the beater chamber through the passage *G*. While the cotton is beaten and consequently loosened by the blades of the beater, the dirt which is shaken out is driven through holes in the beater casing *H*. From the passage *G* the cotton is drawn along onto a revolving screen cage *J*, from which it is stripped by the roller *K* and taken up by the traveling lattice apron which deposits it either on the floor or direct to a breaker scutcher, as the case may be, while any dust and light impurities pass through the screen cage *J* and are drawn out of the machine by the action of the fan *N*. The shaft as carrying the beater disks has its lower end mounted in a foot step *L* surrounded with a reservoir filled with oil to provide easy running. The drive for the screen cages and exhaust fan consists of two pulleys *O* and *P* mounted on the beater shaft and over which ropes extend for driving the pulleys of the fan and cage. From description given it will be readily seen that the beating action of this vertical picker does not damage the cotton since the latter is struck by the blades *F* when it is entirely free (non-supported), the picker at the same time exerting a powerful cleaning action on the cotton, a feature found especially useful when dealing with dirty cotton.

Feeding round bales.—The cotton is now in many instances received at the mill in the shape of cylindrical bales, two styles of it being chiefly used, viz:—the Besonette and the Lowry bale (see pages 51-53). With reference to the first, the same are fed to the picker by a similar feeding device as is used in (and will be explained later on more in detail) connection with the feeding of intermediate or finisher scutchers. Fig. 36 is given to illustrate the arrangement. Four (or more or less) round bales after having their covering removed

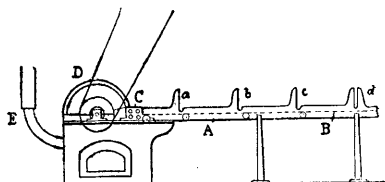


FIG. 36.

and rods inserted in their core, are in turn placed on the rack feed of the picker, composed of two side frames *A*, having four extensions *a b c d*, for keeping the respective number of bales, as placed with their protruding rods against the respective extensions, in position. The bales rest and unroll on the endless feed apron *B* and thus are fed to the feed rollers *C* of the picker *D* in as many layers as there are bales put up on the feed. A great advantage to this round bale feeding is the fact that no special mixing of loose cotton is necessary, since it is easy to select bales from different lots for feeding at one time. The disadvantage to round bale feeding is that with some bales the layers may more or less lick during unwinding, requiring tearing up, with hooks, of such bales or part of bales and feeding them in this state either to the hopper feed or by open feeding to the picker direct, the latter having either a porcupine cylinder or a two or three winged beater. The opened and cleaned cotton is delivered from the picker either on the floor, on a conveying apron or by means of trunk connections *E*, as shown, delivered to the breaker scutcher through a common exhaust trunk, or an incline or horizontal cleaning trunk.

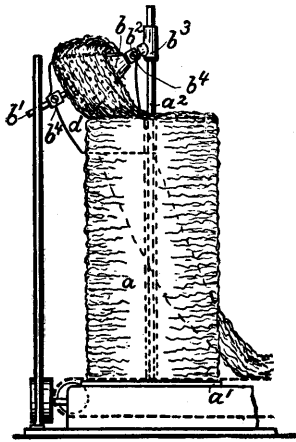


FIG. 37.

The Lowry cylindrical bale is fed to the hopper feed or direct to the picker by mechanisms as illustrated by means of Figs. 37 to 40; of which Fig. 37 is an elevation of one form of apparatus with a conical roller, Fig. 38 a plan thereof and Fig. 39 a detached view of the stripping plate. After uncovering the bale *a*, the same is placed on a revolving plate *a'*, being supported by a vertical spindle *a²* passed through its core and secured to the plate *a'*. *b* is a conical roller free to rotate on a rod *b¹*, which is connected at *b²* to a sleeve *b³*, free to slide up and down on the spindle *a²*. This roller *b* is provided with pins and rests with its base on the top of the bale, so that as the latter is rotated, the roller *b* also rotates through its contact with the cotton, and the pins nearest the base pick up and take with them as they rise out of the cotton some of the latter. The coherence of the fibres will cause the contiguous parts of the cotton to leave the bale, and the whole of the top layer is thus removed and carried upward and over the roller *b* in the direction of the arrow *y* in Fig. 38 to the traveling apron *e*, which in turn delivers the cotton either to a hopper feed or to the picker direct. To strip the lifted cotton clear of the pins, a curved stripping plate *d* (see Fig. 39) is mounted partly over and behind the conical roller *b*, the fore edge of said stripping plate being notched so as to form fingers *d'*, which are set sufficiently far apart to pass between

the pins of the roller at their front ends. The length of the notches is such as to prevent contact between the plate and the pins of the roller as the latter descend toward the bale. The fingers d' thus lift the cotton off the conical roller, while the extension d^5 of the stripping plate serves as a support and a guide for the cotton on its way to the traveling apron e . The stripping plate is secured by set screws b^4 to the rod b' , so as to descend therewith, and thus always occupy the same relative position to the roller, and as the height of the bale decreases the sleeve b^3 descends along the spindle a^2 by gravity, thus keeping the roller b in continual contact with the upper end of the bale, and interruption of the process whether from shortness of staple or breaks of continuity in the coil of cotton is prevented. Fig. 40

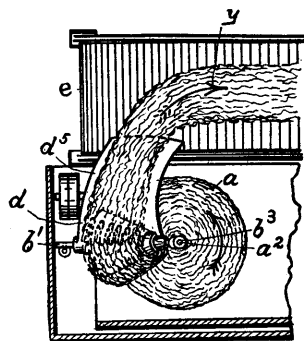


FIG. 38.

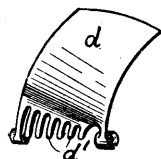


FIG. 39.

shows a modification of the device and in which a cylindrical shaped roller b^5 is employed in place of the conical roller previously used. In this case the rotation of the roller b^5 is not effected by the direct contact of the pins of the roller on the cotton, the roller being secured to a shaft d^4 , which rotates in bearings d^2 , d^3 , carried by sleeves sliding on a central spindle a^2 and a side spindle c' . Secured on the same shaft d^4 , but on the other side of the centre of the bale is a disk f armed with spikes. The disk f and the cylindrical roller b^5 are of such relative diameters that the pins of the roller b^5 just clear the surface of the cotton, while the whole weight of the shaft bears with the disk f on the end face of the bale. The rolling contact between the end of the bale and the disk f will cause the latter to rotate with a similar surface direction to that of the bale itself at that point. This rotary motion is transmitted by the shaft d^4 to the roller b^5 , so that its pins will meet the cotton as it approaches. In starting to unwind the bale the cotton is first lifted by hand over the roller b^5 , which will then continue to draw it off the end of the bale and carry it forward in the same direction, as indicated by the arrow y' . In the manner as thus described, a series of four or five of such bales (or

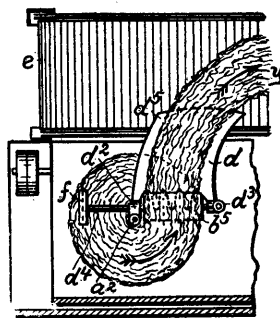


FIG. 40.

even more) can be arranged to deliver cotton in their turn onto the same traveling apron *e*, the cotton thus taken from said bales, being in unison fed to the hopper feed or picker, as the case may be.

CLEANING TRUNKS.—The same form the connection between the Picker and the Breaker scutcher and have for their object, by passing the cotton over a fine grid surface at a slow velocity, to remove light dirt and leaf yet adhering to the cotton which cannot be removed by the scutchers as the fan draft essential to the formation of a good film on the screens of the scutcher would carry a great amount of these lighter impurities along with the cotton and thus into the lap and when in turn they would make hard work in carding. By thus passing the

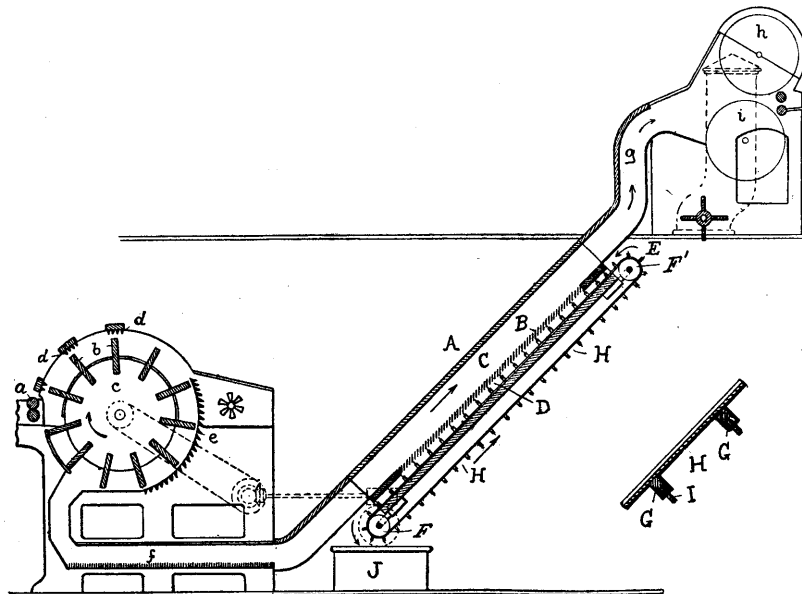


FIG. 41.

cotton over a fine grid surface, at a slow velocity, all foreign matter that is heavier than the cotton will gradually settle through the grid into the channel of the trunk thus provided, and from where they are readily removed. These cleaning trunks are arranged either inclined or horizontal according to construction of mill or placing of machinery.

Inclined trunks.—The principle of operation of these trunks is explained by means of Fig. 41 which shows such a trunk in connection with a picker and breaker scutcher, at the same time also showing a different construction and method of operation of a picker than heretofore explained. The cotton coming from the feed rollers *a* is engaged

by the fingers *b* of the porcupine picker cylinder *c* rotating in the direction of arrow. The cotton as it is carried around by the picker cylinder is dashed against conical projections *d* on the under side of the cover plate, which act to free the cotton of impurities to such an extent that when the cotton is thrown against the grid *e* they fall out more readily. The cotton then leaves the picker, passing over grid *f* into the inclined cleaning trunk *A*, divided by a grating of grid bars *B* into a cotton passage *C* above and a dust chamber *D* below. Below this dust chamber *D* is placed an endless apron *E*, mounted on rollers *F F'*, the apron being so arranged that one-half of it only is always situated in the dust chamber. Mounted on this apron is a series of upright partitions *G* (see special enlarged diagram of this apron) which act to divide the dust chamber *D* into a number of separate receptacles or pockets *H*. To the upper edge of each of these partitions *G* is fastened a strip of leather *I* which rubs against the grid bars *B* of the trunk, so as to keep them clean. The impurities as dropping through the grid bars *B* are collected in the pockets *H* of the apron, and as the latter revolves around lower roller *F* the pockets empty impurities collected into a receptacle *J*. The cotton after leaving the passage *C* of the cleaning trunk *A*, is conducted through trunk connection *g* to the two screen cages *h* and *i* of the breaker scutcher.

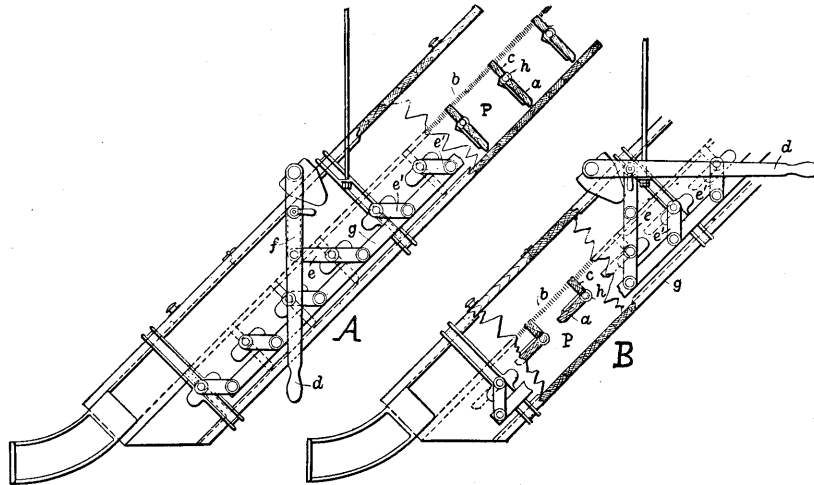


FIG. 42.

Another construction of an inclined trunk is shown by means of Fig. 42, of which *A* shows the normal position of the movable partitions, while *B* shows said partitions in the position occupied when it is desired to clean the trunk. The cotton in its travel through the trunk passes over its grid surface *b* through which the impurities fall and are col-

lected in pockets *P* formed by movable partitions *a*. The bottom of said pockets form an uninterrupted path throughout the whole length of the trunk and over which path the impurities released from the cotton slide by gravity into a receptacle placed at the lower end, any time the movable partitions are raised, as is shown in *B*. This raising of partitions *a* is accomplished by moving the lever *d* from the position shown in *A* to the position shown in *B*, thus through levers *e*, *f*, connecting rod *g* and levers *c* transmitting motion to the partitions *a*, so that they move about the hinge shafts *h* on bar *c* and open. After the trunk has been cleaned, the lever *d* is moved back in position *A*, in turn closing the partitions *a* and thus forming pockets again.

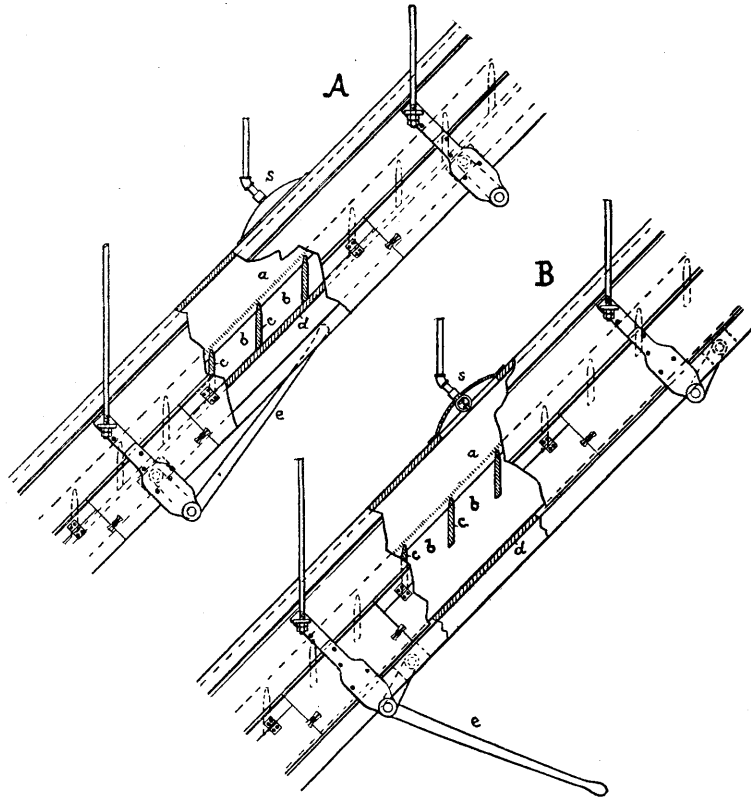


FIG. 43.

Fig. 43 shows still another principle of construction of an inclined cleaning trunk showing the latter in *A* in its normal and in *B* in its position for cleaning; part of the trunk casing being shown broken away for sake of clearness. The cotton as passing over the grid *a*, deposits

impurities into pockets *b* formed by stationary partitions *c* and bottom *d*. This bottom is formed in one piece for all the pockets in the trunk, and can, for the purpose of cleaning the trunk, by means of suitable connections to lever *e*, be lowered by the latter (see *B*), thus forming a path for the impurities to slide by gravity out of the trunk. After thus cleaning the pockets, lever *e* is moved in position shown in *A* and thus the bottom *d* raised against the stationary partitions *c*, in turn forming pockets again. The top of the passage way for the cotton in this trunk is shown provided with an automatic sprinkler *s* which operates in case of the cotton catching fire. Similar sprinklers can be arranged in connection with any trunk.

Horizontal trunks.—These trunks present a greater cleaning surface to the cotton than the inclined trunks, the picker and breaker scutcher being in this instance situated farther away from each other. To remove in these trunks the impurities from the dust chamber, an exhaust fan connecting with said chamber is employed. Fig. 44 shows in section, one form of such a horizontal trunk and its connection with the exhaust fan. As the cotton passes over the grid *a*, the impurities settle in the pockets *b*, the bottoms *c* of which are hinged at *d*. To each hinge is fastened a handle *e*, on the outside of the trunk, held in place by a spring *f*, which when pressed releases the handle and in turn permits the bottom *c* of the respective pocket to swing on its hinge in a vertical position as is shown in two instances in the illustration. The impurities in said pocket thus fall into the passage way *g*, which is connected at one end by a pipe *l* to an exhaust fan, and has at each end a door *i-j* respectively. When it is necessary to clean the trunk, both these doors are thrown open in order to produce a current of air through the passage way *g*, and when each pocket in turn is emptied and again closed; the impurities thus taken from the cotton pass

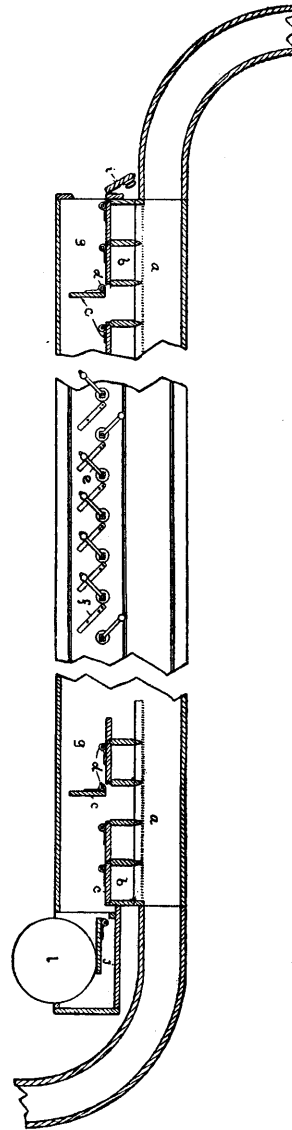


FIG. 44.

through pipe *l* to the exhaust fan, from where they are discharged into the dust room.

Another style of horizontal trunks is shown by Fig. 45 which is a transverse sectional view through the trunk. In this construction the bottom *a* of the pocket is hinged at one end to a bracket *b*, while its other end has an auxiliary plate *c*, which normally rests on the bar *d*. When it is necessary to clean the pockets, the plate *c* is displaced from the bar *d*, in turn permitting the bottom *a* of the pocket to drop into the position shown by dotted lines, with its end resting on the bar *d*, thus putting the pocket in connection with the flue *e* which by means of an exhaust fan carries away the impurities in said pocket.

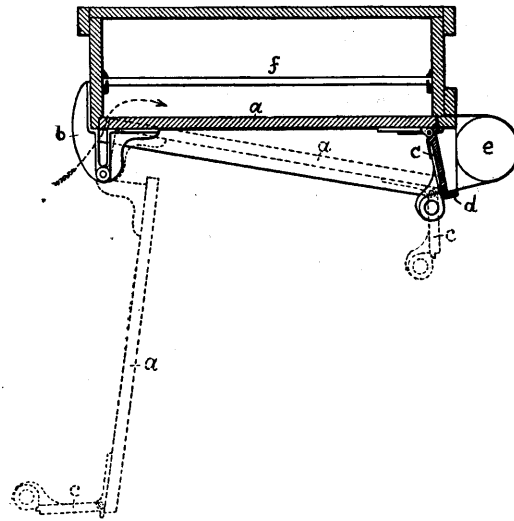


FIG. 45.

In order to prevent the suction of said flue drawing the cotton through the grid *f*, an opening is provided into the pocket which allows air to enter, as shown by the arrow, thus providing for the necessary draft. When now and then it becomes necessary to clean the grid *f* the bottom *a* of the pocket is for this purpose dropped entirely out of the way of the grid *f*, i. e. into the lowermost position as shown by dotted lines, thus permitting free access to the grid.

In the horizontal trunk shown by Fig. 46 an automatic arrangement is provided whereby the trunk is continually cleaned. Below the grid *a*, as forms the bottom of the cotton passage way *b*, are provided the usual pockets, the bottom of which is formed of a six bladed revolving doffer *c*. The side partitions *d* of the pockets are so shaped that at least one blade of each doffer is in contact with the same on either side and thus a tight joint is maintained since the edges of the doffer are of leather. As the doffer rotates slowly, it continually conveys the im-

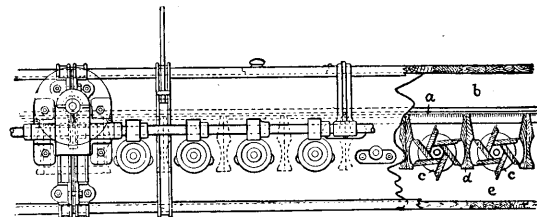


FIG. 46.

As the doffer rotates slowly, it continually conveys the im-

purities from the pockets to the dust passage way e which is in direct communication with an exhaust fan for removing the impurities from the passage way e , a damper at one end of said passage way regulating the draft. The doffers will through their revolving clean themselves thoroughly and besides will assist the exhaust fan in carrying the impurities forward. By the use of this doffer, dropping of doors by hand, as required by the previously explained trunks, is obviated and thus also stoppage of machines to clean out the trunk.

BREAKER SCUTCHER AND LAPPER.—The cotton is fed to this machine either by a hopper feeder or direct from the picker, the object being to further clean the cotton and form it into a lap for use at the intermediate or the finisher scutcher. Single as well as double section breaker scutchers (also frequently called breaker lappers) are built according to the demands of the mill. Fig. 47 shows the principle of

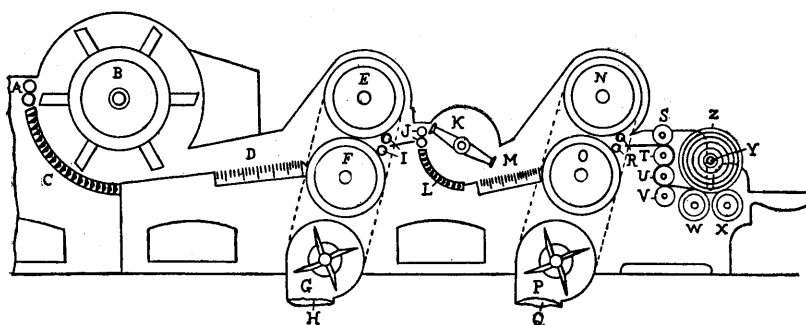


FIG. 47.

operation of one of the latter in connection with a porcupine picker cylinder. The cotton as is fed to the feed rollers A of the picker (either by means of a hopper feed or by open feeding on an endless traveling apron) upon leaving them is struck by the blades or fingers of the porcupine picker cylinder B , which in this instance are tooth shaped; some manufacturers claiming that this shape is of advantage in opening and freeing the cotton from impurities, which are discharged through the bars of grid C . The cylinder B by the force of its draft in turn throws the cotton forward over a longitudinal grid D (and where an additional cleaning of the cotton takes place) to a pair of (screen) dust cages E and F , made of perforated sheet zinc, upon which the cotton is deposited in a regular manner in consequence of the air being drawn away from the interior of said cages (which are connected at the ends to upright dust chambers, called chimneys) by the fan G , taking along from the cotton as on the cages a great amount of finer impurities the latter yet contains, and which by the fan are forced through a flue H into the dust room (below ground) and from there conducted to the open air by means of a dust chimney. The direction of motion of the fan depends

on whether the flue runs along under the lap section or in the direction of the feed. The speed at which to run the fan is a very important item for any kind of scutcher, since if too excessive, the cotton will not be spread on the dust cages properly, will stick in the holes, and wind so roughly on the lap as to cause it to lick when placed behind the next scutcher, or the carding engine provided if dealing with a finisher scutcher; again it will draw the cotton so rapidly from the beater to the cages as not to clean it properly, i. e. the dirt not having a chance to fall out. The air beneath the grids at this point aids the fall of the dirt materially, for which reason it is customary to leave an inlet for air at the ends of the beater case and which air is formed into a current by the rotation of the beater. If running the fan too slow, the result will be loss in cleaning power and too loose a film. Experience is, if not the only, anyway the best teacher, remembering at the same time to set up just sufficient suction to attach the cotton to the cages, since the propulsion given by the beater is sufficient to throw the cotton forward to the cages, and all that the fan is required to do is to attach it to the surface of the cages. Large fans running at a slow velocity will be found to do better work than small fans running at a greater velocity. Dampers are placed at the ends of the cages for the purpose of regulating the fan drafts, which thus can be regulated so that the suction is principally through the top cage, thus preventing an equal distribution of the draft on the surfaces of both cages, a feature which would cause the attachment of the cotton to be equal on either cage and in turn result in a more or less two fold lap, only compressed in one by means of the calender rollers i. e. a lap which on being fed to the intermediate or finisher scutcher, or to the carding engine if dealing with a finisher scutcher, would be liable to divide and split and consequently make poor work there. Another method towards preventing the splitting of laps is to make the perforations or meshes in the top cage larger than those in the bottom cage, in turn allowing more air to pass through the top cage, resulting in a heavier sheet of cotton formed on said cage compared to that on the lower cage. For the same reason we find that some scutchers have two sizes of cages, the top cage being considerably larger than the bottom one, and by which construction a larger and thicker sheet of cotton is formed on the top cage. The outlet to the fan i. e. the shape of the flue *H*, must be of a form to allow perfect freedom for the moving air from the machine to the dust room, i. e. sharp corners, abrupt turnings, narrow passages, etc., must be avoided, since they would cause back pressure, chopping of air, and in turn greatly neutralize the action of the fan. At the same time care must be taken that there is a division between the various fans as leading to the dust chamber so as to prevent one air current from fighting against and neutralizing the other. The ends of the dust cages *E* and *F* must fit so as to avoid the possibility of air being drawn out between the cages and the framing, for which reason the latter is sometimes recessed to admit the cage ends. These two dust cages form what is called the

screen section of the breaker and are for the purpose of cleaning the cotton and forming it into a condensed sheet to be fed to the beater. As the dust cages *E* and *F* revolve, their coating of cotton is removed by the two drawing off rollers *I* and passed on to the two feed rollers *J*, where it meets the rapidly revolving two winged beater *K*, armed with hardened steel blades. (A three winged beater or a carding beater, however, according to requirements or difference of opinion, can be used in place of the two winged beater as shown in the illustration). This beater which on account of its high speed must be carefully balanced before leaving the machine shop, knocks out a further quantity of extraneous matter through the bars of grid *L*, and when again the cotton is passed on over a second longitudinal grid *M* to a second pair of dust cages *N* and *O*, acting similar as the first pair in connection with fan *P* and flue *Q*, and from which the coating of cotton is delivered by means of the two drawing off rollers *R* to the consolidating calender rollers *S*, *T*, *U* and *V*, respectively (as shown by heavy line in the illustration), the last pair passing it onto the pair of fluted rollers *W* and *X*, between which it is lapped or rolled upon a lap roller *Y*, the latter being bored for the insertion of a steel lap rod when the lap *Z* is ready to doff, the rod remaining in the centre of the lap when the roller *Y* is removed.

In order to prevent the laps from licking when unwound at the next process, one of the calender rollers is run a little quicker than the other, or they are made to vary in diameter, either change having the effect of smoothening down the fibres and so prevent their interlocking with those already on the lap they come in contact with. Sometimes a lap may have a ragged, uneven or thin edge which in many instances is caused by the cotton being drawn unequally across the whole face of the dust cages by the fan not working properly or the dampers of the cages not being properly set, either case drawing the cotton more towards one side of the cages. Again the fault may rest with back pressure set up when the wind is blowing in a certain direction and the outlet of the flue is not perfectly free to discharge or is subjected to down drafts. It is claimed that the system of diminishing the width of the laps during the different scutchings is of advantage for producing good edges to the final lap; for example a 45-inch lap from the breaker scutcher fed to a finisher scutcher having 42-inch wide cages and winding 40-inch wide on the lap machine, or similar reductions.

The laps as thus produced on the breaker scutcher will vary considerably in weight and uniformity. When taken from the machine each lap is weighed and correspondingly marked, since when selecting the laps for feeding the intermediate or the finisher scutcher, notice must be paid to these variations, and laps of under weight balanced with such of over weight, in order to get the next lap as near as possible perfect as to weight and uniformity of body. As in the next following scutcher four (or more or less) of these breaker laps are fed at the same time, it follows that to a great extent the irregularity existing in one

breaker lap is corrected by the converse irregularity of another, or any way distributed. The same affair also refers to feeding laps from the intermediate to the finisher scutcher, provided the former machine is used, and which thus besides more cleaning the cotton will greatly assist in producing a most perfect lap from the finisher scutcher. By this system of doubling as well as the feed regulating mechanisms used in connection with intermediate and finisher scutchers, the lap produced finally has rarely more variation than 5 per cent., and frequently (in connection with a good carder) the variation does not exceed $1\frac{1}{2}$ per cent. From the breaker scutcher the laps are taken either first to an intermediate and then to a finisher scutcher or direct to the finisher scutcher (as regulated by the kind of cotton and yarn under operation), the features of both machines being similar. In former times the double carding system was used almost wholly, the trade then being neither so particular as to even and proper counts of yarn as now, again lower counts being then more frequently spun and when scutchers with two or three beaters combined in one machine were frequently used in order to lessen labor and expenses in the preparatory department; intermediate scutchers having been little used then, double carding doing a great part towards even yarn. However with the increasing tendency towards spinning finer yarns, the single carding system in connection with the general introduction of the revolving flat card became popular, in turn making it necessary for the preparatory department to produce scutcher laps, for the card, more uniform in substance and what led to the adoption of more frequently using three scutchers (breaker, intermediate and finisher) each carrying one beater only in place of the two (breaker and finisher) two or three beater machines formerly used, since it is this additional doubling of laps at the intermediate scutcher which greatly assists towards even yarn.

Fig. 48 shows in section an approved construction of a breaker scutcher and lapper. In this instance, the cotton after leaving the picker, as situated on the floor below, enters the machine by means of an inclined cleaning trunk connected to the trunk *A* of the scutcher, and in turn is deposited upon the pair of slowly revolving dust cages *B* and *C*, each being provided at their ends with an opening *D*, leading into a dust passage *E*. By means of the draft created by fan *F* a great amount of fine particles of dust yet adhering to the cotton, as well as broken short fibres, pass through the screens and through openings *D* out of the cages and through pipe *G* in the dust room. In order to prevent the cotton from collecting between the top of cage *C* and its casing, a leather faced strip is provided. As the cages revolve in a direction away from each other (see arrows) the cotton as deposited upon a part of their surfaces is carried around to the pair of drawing off rolls *H* and *I* and stripped by them. The film of cotton then passes onto the feed rolls *J* and *K* which bring it under the action of the blades of the beater *L* (a three winged beater being shown—a two winged or a carding beater however can take its place) which opens the cotton and knocks

out further impurities from it which fall through the bars of grid *M*. The opened cotton then passes in the direction of arrow over the inclined grid *N*, being prevented from following the air current produced by the beater by a stripping plate *L'* set closely to the path of the beater. The grid *N* has dead air spaces formed by every fourth bar of it extending to the bottom of the dirt box *N'*, in turn preventing the dirt from

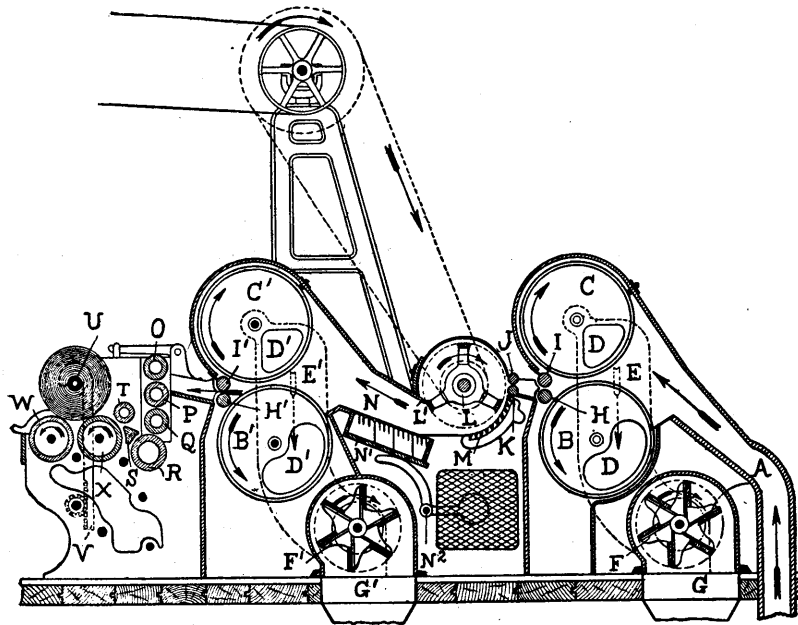


FIG. 48.

being drawn back into the cotton. The bottom of this box *N'* is movable and is normally held in closed position by two weighted angle levers *N*², as situated one on each side of the machine. When the box *N'* is filled with impurities, these weighted levers *N*² are tipped, permitting the bottom of the box to swing open and release the dirt, after which the bottom automatically adjusts itself to the box. After leaving grid *N* the cotton passes onto the second section of the breaker, which is a duplicate of the first section (*B' C' D' E' F' G' H' I'*) of the breaker. The film of cotton as coming from the drawing off rolls *H'* and *I'* in the direction of arrow, for the sake of compression to permit later on ready unwinding, passes then onto the lapping section of the machine i. e. in turn between heavily weighted calender rollers *O P—P Q—Q R*, next over guide plate *S*, under press roller *T* and is then

wound on lap roller *U* which is heavily weighted by a friction arrangement through rod *V*, and rests upon two large fluted rollers *W* and *X* whose revolution causes the lap roller to revolve, and in doing so winds on the sheet of cotton as it comes from the calender rollers. When the lap is of the required size (weight) the feed is automatically stopped, a steel lap rod inserted in the lap roller, the lap doffed and the procedure of forming a new lap repeated.

When the breaker scutcher is located a considerable distance from the picker, being connected to it by a horizontal cleaning trunk, there will always be a great amount of cotton in the trunks as forming the connection between the two machines when they are in operation. When doffing the lap on the breaker scutcher, as a rule the picker is also stopped temporary. This feature would result in drawing the cotton as in the trunk forward and depositing it to the feed of the breaker scutcher, leaving at the same time an empty space in the trunk and its connections, which would cause in the first instance a heavy place formed in the first part of the new lap wound, followed in turn by a thin place. In order to prevent such irregularities to the lap, the receiving end of the breaker scutcher is for this purpose provided with a condenser and gauge box as shown in the section of the breaker scutcher Fig. 49. *A* is the trunk as forming the connections between the cleaning trunk and the condenser and gauge box of the scutcher, and in which the cotton travels in the direction of arrow. In the top of the condenser is a revolving screen cage *B* on the inside of which is a stationary shield or cradle *C* which covers a little more than one-half of its surface; the air current passing through the perforations of that portion of the cage as is not covered by the cradle. The cotton, as entering the condenser at its top, is in turn deposited upon the open side of the screen cage *B*, the ends of which open into a dust passage *D* (shown in the illustration by dotted lines) as is situated on the outside of the gauge box. The air, by the action of fan *E*, passes out through the ends of the cage referred to, down dust passage *D*, and from which it is forced through the flue *F* to the dust room, taking along a great many impurities from the cotton. As the screen cage *B* slowly revolves, the cotton as deposited upon it is brought around between it and roll *G*. The cradle *C* at this point covers the screen cage, and thus prevents air from passing through, in turn permitting easy stripping of the cotton from the screen cage by the rolls *G H*, as rotating reversely to the rotation of the screen cage, and which rolls deliver the cotton upon the feed apron *I*. Roll *H* is stationary, while roll *G* is supported at either end of the scutcher by an angle lever *J*, fulcrumed at *K*, its short end carrying the roll *G* while its long end, on account of its weight, keeps the roll *G* pressed towards the screen cage *B*. The gauge box of the machine has a front and back chamber *L* and *M*, respectively formed by swinging partition *N*, and which regulates the amount of cotton to be delivered on the feed apron *I*. Chamber *L* receives the cotton as it falls from rolls *G H* and is normally kept about half full, but, with the

stopping of the scatcher and picker, the cotton is drawn out of the cleaning trunk and in turn fills this chamber *L* while any surplus in supply falls over partition *N* into the back chamber *M*, having a door *O* through which said surplus cotton, when required, is removed by hand for reworking. The cotton in the front chamber in turn serves as a temporary source of supply until the picker, cleaning trunk and its connections provide the regular supply of cotton to the machine. Partition *N* can be adjusted by means of a pin as fitting into a series of holes

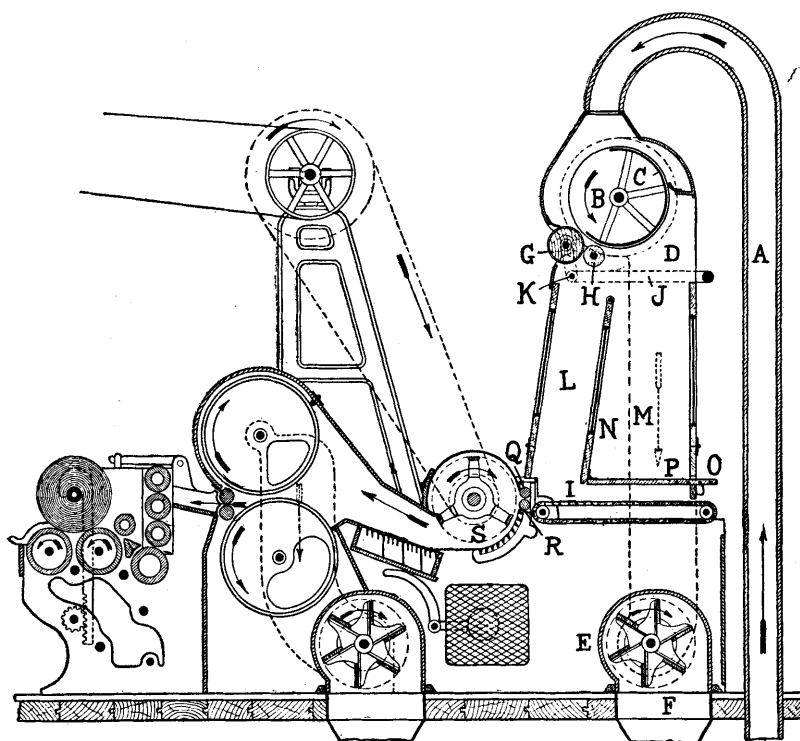


FIG. 49.

bored in the bottom of board *P* forming the bottom of the chamber *M*, to in turn cover more or less of the surface of the feed apron *I*, in turn making the feeding lighter or heavier as the case may require. From the feed apron, the cotton is drawn between the feed rolls *Q* and *R*, and brought into contact with the blades of the beater *S*, and when the machine is a duplicate of the one previously described.

A single breaker scatcher with a feed regulating device applied is

shown in its longitudinal section by Fig. 50. The cotton as coming from the picker through the trunk *A* is deposited on a revolving cage *B* having a stationary damper *C*, said cage being connected with an exhaust fan *D* by means of dust box *E*, to thus remove impurities from the cage *B*. The cotton next passes between the cage *B* and a roller *F* into a chamber *G*, any cotton adhering to the cage *B* being knocked off by a revolving clearer roll *H* which also carries over the partition *I* into the chamber *J* any surplus cotton accumulating in the chamber *G* and from where it can be readily removed through the door *K*. The bot-

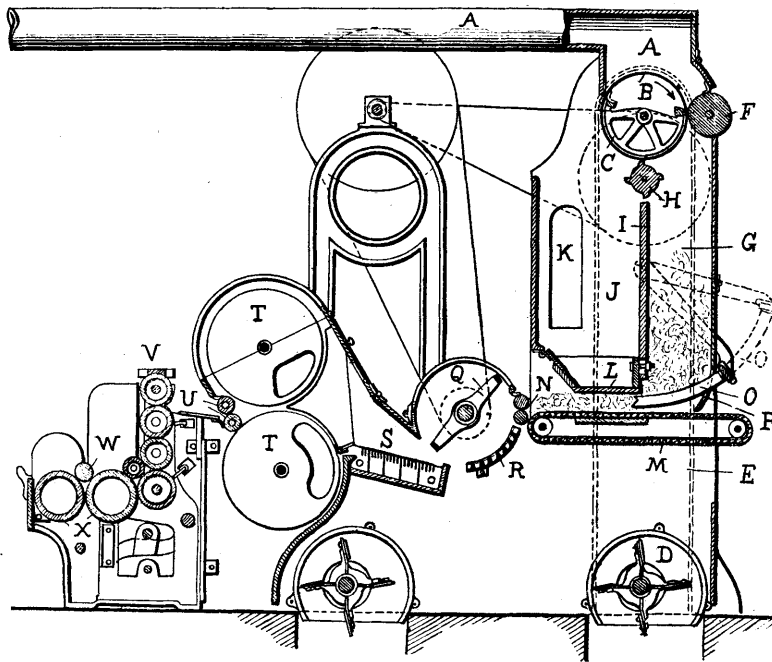


FIG. 50.

tom *L* of the chamber *J* is adjustable and forms the top of the feed throat, the bottom wall of which is formed by endless apron *M*. The feed of the cotton through the throat to the feed rollers *N* of the beater, is effected in conjunction with the apron *M*, by a series of curved fingers *O*, which swing on their pivot as shown by dotted lines, through a comb *P*, thus when the fingers *O* are retracted (see dotted lines), the cotton in the chamber *G* falls on the apron *M* and on the return movement of said fingers an even amount of cotton will be pushed forward into the feed throat of the machine. The cotton in turn passes through the feed rolls *N* to the beater *Q*, grids *R*, *S*, dust cages *T*, drawing off

rolls *U*, and calendering rollers *V*, being in turn wound in a lap on roll *W* by means of the pair of fluted rollers *X*.

INTERMEDIATE AND FINISHER SCUTCHER WITH LAP MACHINE.—Both these scutchers are identical in their construction and operation and form the connecting link between the breaker scutcher and the card. In some instances the intermediate scutcher is omitted, especially when previously dealing with a double breaker scutcher. The cotton as has now passed through the Hopper feed, Picker and Breaker scutcher has been delivered by the lapping device of the latter machine in the shape of a roll or lap, a great many of the impurities the cotton originally contained having been extracted during said processes, however the same is in no sense what we could call clean. To accomplish a great deal towards this latter end is the object of the intermediate or the finisher scutcher, a diagram of which is given in Fig. 51,

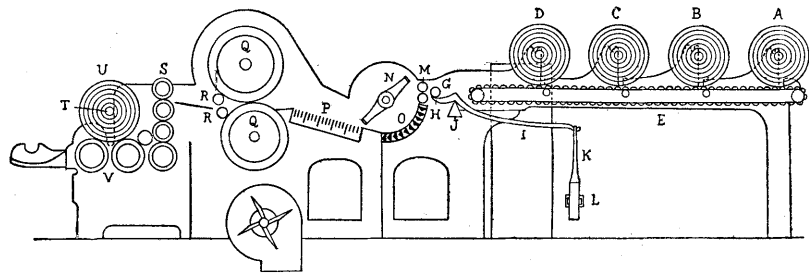


FIG. 51.

and which machine in its construction and action, with the exception of feeding, is identical with those of the breaker scutcher. Both the intermediate as well as the finisher scutcher tend towards producing a more even lap by combining four (or more or less) laps as produced by the breaker scutcher and redrawing them in one, since there must be with a machine fed from four laps and delivering in one, a considerable amount of draft exercised, for, as a rule, the resultant lap shall be no heavier than any one of those fed, and in most cases lighter. That is to say, the lap is elongated, a procedure which will result in that irregularities of thickness existing in any of the laps fed to the machine are diminished by the draft of the machine; and when this feature is considered in connection with four laps thus treated in unison, it will be readily seen that with care and good machinery even and uniform laps must result. It is desirable to get as many doublings as possible, and where extra good work is required the cotton is passed through three machines (breaker, intermediate and finisher scutcher) before the final laps are produced. The machine illustrated in Fig. 51 consists of feed lattice, beater, cage section and lap machine, and in this form is called a single scutcher, vice versa a double scutcher which has an additional

beater and cage section. Both the intermediate as well as the finisher scutcher, as mentioned before, are fed by means of laps as coming from the breaker scutcher; four of these laps *A B C D* (although more or less could be used), each having a lap rod passed through their center, are placed in the respective guide brackets of the frames of the feed table *E* and are unrolled by the endless lattice apron *F*, one layer of one lap resting always on top of the layer from the preceding lap. Thus the layer from lap *B* rests on that from lap *A*, the layer from lap *C* rests on those from laps *A B*, and finally the layer from lap *D* rests on those from laps *A B C*, in this way "doubling" or feeding four laps to the machine, the object of which is to balance any irregularities in the individual laps. Fig. 52 is given to more clearly explain this doubling of

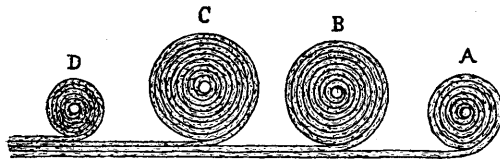


FIG. 52.

laps; at the same time serving to illustrate another point, viz.—that the running out of the laps must be varied in order to keep up the continuity of even feeding of the four fold thickness of lap to the scutcher. As shown by

the difference in size of laps *A B C* and *D* it will be readily understood that they will run out at different times, thus any time one of them runs out its replacement by a new lap is quickly effected and the piecing not noticed, whereas if two, three or all four laps would run out at the same time their replacement would take much longer, and the risk would be run of a thin place occurring in the combined lap through the piecing not being performed quickly. The end of this four fold lap is then passed between a weighted pedal roller *G* and the noses *H* of a series (20 to 30) of pedals or levers *I*, loosely supported on a Λ rail *J*, having pendants *K* hung on their tail ends, the latter passing through a frame *L*; *G H I J K* and *L* form part of a feed regulating device as will be dealt with later on. The four fold doubled lap as emerging between roller *G* and noses *H* of levers *I* then passes between a pair of feed rollers *M* which bring it (feed it) in the range of the blades of the beater *N* (a two winged beater being shown, however a three winged beater or a carding beater can be used in its place) and by which it is struck. This action opens the cotton again into tufts, throwing them upon a grid *O* through the bars of which, impurities in the cotton find an outlet, the cotton itself passing along over grid *P* (another cleaning process for the cotton) onto dust cages *Q* (still another cleaning process for the cotton), from which it is stripped by rolls *R*, and the new film condensed by means of calender rollers *S* and wound on a lap roller *T* into a lap *U* by means of fluted rollers *V*. The lap thus formed, if on an intermediate scutcher, is in turn taken to the finisher scutcher, where four (or more or less) of these laps are again fed to the machine and

the process just explained repeated. The lap as formed on the finisher scutcher leaves the preparatory department of the mill, known as the picker or scutcher room, and is next met with in the carding department, where, if the work in the preparatory process has been carried on properly, there should practically be nothing left for the carding engine to remove, but nep, short fibres and motes.

Draft regulating devices for scutchers.—Fig. 53 is a vertical section of a scutcher showing such a device, the purpose of which is the thorough removal of the smaller impurities from the cotton as fed in

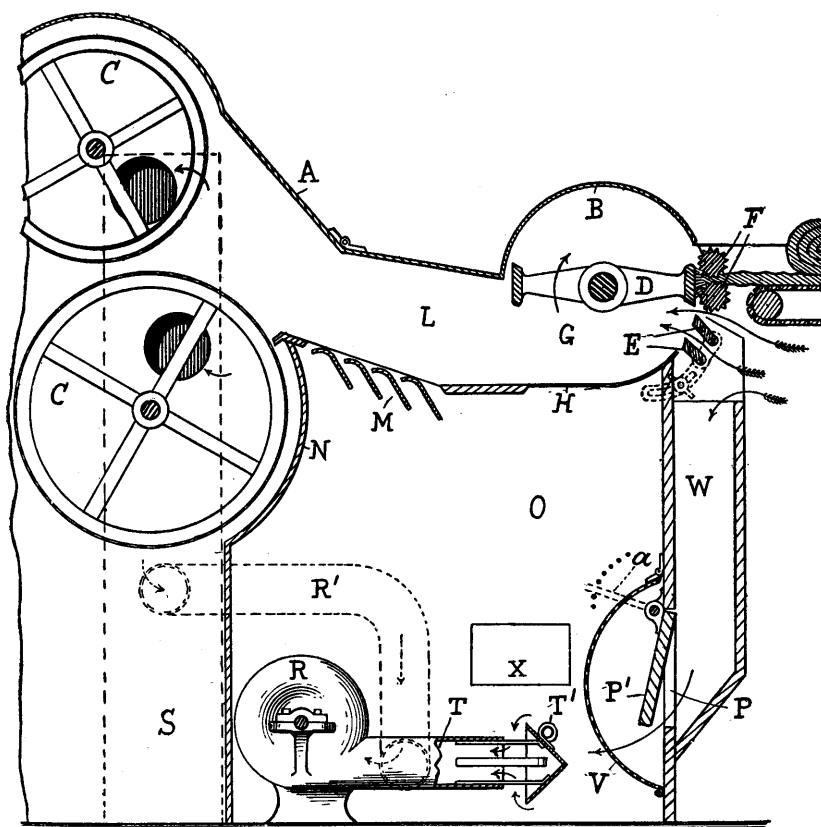


FIG. 53.

one shape or the other to the machine, and which finer impurities are always more or less difficult to remove. With reference to the illustration, *A* indicates the frame of the machine, *B* the beater casing, *C* the dust cages, *D* the beater arms, *E* adjustable grid bars as located under

the feed rolls *F*. Said bars *E* are so adjusted that their operative edges are turned up at a suitable angle to receive such fibres as torn from the mass of cotton fed to the machine. The impact of the beater arms against the cotton coming from the feed rolls *F* and the whipping out of said fibres against the edges of the bars *E*, beat out of it all the heavier impurities the cotton contains and drives them out between said bars. *H* is a screen forming the bottom for casing *B*, said screen *H* drawing the greater part of the finer impurities remaining in the cotton which has been carried by the beater arms across the edges of the bars *E*. A passage *L* is provided between the beater casing *B* and the two dust cages *C*, a part of the bottom of said passage way being formed of a series of grating *M*. The dust cages are inclosed in a part of the machine which has no connection with the part thereof lying under the beater cylinder and the passage *L*, a partition *N* being for this purpose located across the feed end of the machine and constitutes in that part under the beater cylinder an inclosed chamber *O*, into which the air has no access except through an opening *P* in the end thereof and through the screen *H* and grating *M*. By means of handle *a* the door *P'* as pivotally hung above the opening *P*, is adapted to close said opening more or less, as may be necessary. The air is exhausted from the dust cages *C* by a fan *R*, located in compartment *O*, from the suction pipe of which a pipe connection *R'* extends to a vertical conduit (chimney) *S*, from which connections are made to the circular stationary heads of one end of the dust cages *C*. The suction pipe of fan *R* is indicated by *T* and its open end is provided with sliding cap *T'*, by means of which the area of said open end may be reduced, as desired, by moving said cap *T'* more or less toward the end of said pipe. The screen *V* is for the purpose of catching any of the impurities beaten out of the cotton, and which as passing through the bars *E*, are drawn toward the compartment *O* through the conduit *W*. An opening *X*, closed by a door, is made in the casing forming the side of the compartment *O*, whereby the accumulations of impurities which are drawn into the said compartment may be from time to time removed. The proper operation of a scutcher, depends upon the proper regulation of the air currents entering the machine and upon means for regulating the relative degree of vacuum to be maintained in the dust cages *C* and the compartment *O* and the beater cylinder *G*, a feature which by means of the devices described can be regulated to a nicety, since when the machine is in motion the operator by examining the product and the waste of the machine can determine at a glance whether or not the action of the air upon the fibre is such as to insure the best results. If too much loose fibre is found with the waste behind the screen *V*, it indicates that not enough air is passing through the bars *E*. and by closing the door *P'* more or less the air will pass through said bars in proportion as it is excluded from the vertical conduit *W*. If again it is found that the finer impurities do not pass down through the screen *H* in proper quantities, the operator by manipulating the cap *T'* on the end of the exhaust pipe

T of the fan can increase the area of the opening of the latter and thus an additional part of the air current entering through the bars *E* will be diverted downward through the screen, carrying with it the light particles of impurities. Furthermore, it frequently happens, owing to atmospheric conditions or peculiar conditions of the fibre, that a lesser degree of exhaust is required on the dust cages *C* than at other times. When this occurs the defect is remedied by reducing the exhaust action of the fan on said cylinders by a further opening of the end of the pipe *T*, as before described, and if this operation causes too strong a current downward through the screen this can be offset by slightly increasing the opening *P*.

Fig. 54 is a longitudinal vertical sectional elevation of an intermediate or a finisher scutcher, showing another mechanism whereby a handy regulation and control of the drafts for the cages is provided, so

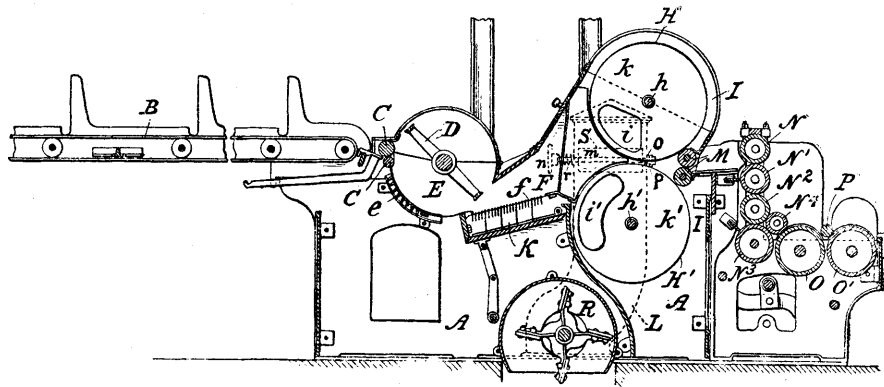


FIG. 54.

as to produce a uniform lap over its entire width, as well as prevent the lap from splitting when fed to the next machine. *A* is the frame of the machine, *B* the feed apron, *C* the feed rolls, and *D* the beater, mounted in chamber *E*, which is provided in its bottom with grid *e*. Leading from the beater chamber *E* is a passage way *F*, through which the cotton passes to the cages *H H'*, mounted one above the other in the closed chamber *I*, upon their respective shafts *h h'* and *f* is a horizontal grid emptying into receptacle *K*. *L* indicates the flue which communicates at its upper portion with the interior of the cages through the orifices *i i'*, formed in their stationary heads *k k'*. *M* indicates the stripper rolls, *N N' N² N³ N⁴* the calender rolls, *O O'* the fluted winding rolls and *P* the lap roller. *R* is the exhaust fan, and the device for regulating its force of draft to the cages consists of a damper *S*, journaled on a shaft *m* in the flue *L* opposite the space between the cages *H H'*. This damper *S* can be turned by a knob *n* in any position required, to in turn regulate the fan draft to either cage at will, said damper being held in

this position by a friction washer *o*, clamped by a collar *p* to the side of flue *L*, by the pressure of a coiled spring *r* surrounding the shaft *m*.

The evening mechanism.—The same has for its object to keep the delivery of cotton in the intermediate or the finisher scutcher, uniformly even. One form of this evening mechanism (used extensively in connection with English built machinery) known as the “piano feed” is shown by Figs. 55 and 56, being respectively its side and end elevation. (It will simplify the study of construction of this device to con-

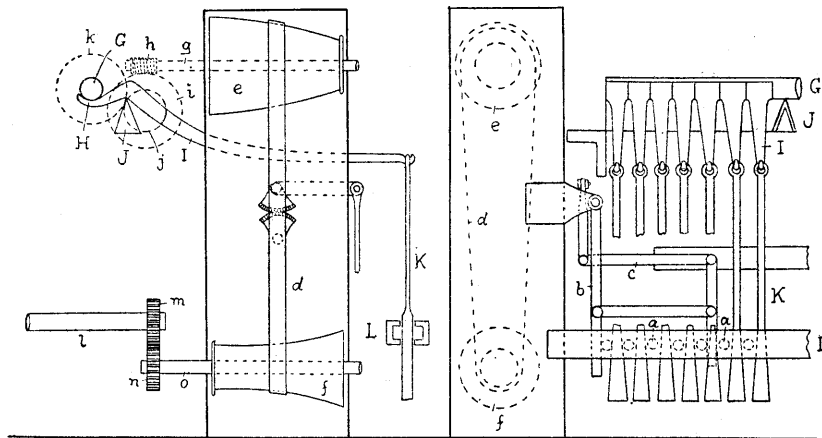


FIG. 55.

FIG. 56.

sult Fig. 51 showing its application to an intermediate or a finisher scutcher; see corresponding letters of references in illustrations). The cotton is fed to the beater feed rolls of the scutcher through the pedal roller *G*, working on the noses *H* of the levers *I* as fulcrumed on the rail *J*; the tail ends of the levers *I* carrying peculiar shaped pendants *K*. Seven of these pendants are only shown in the illustration, sixteen as a rule being used, the last one (not shown) working against the frame of the mechanism and to which bar *L* is secured; thus the pendants can communicate excess of motion in one direction only. The first five pendants are shown broken away for sake of clearness of other parts. These pendants extend through the bar *L*, the bottom of each pendant being fan shaped and separated in the bar *L* by a series of friction bowls *a*. The series of pedal levers *I* extend across the full width of the machine and normally rest with their noses *H* against the pedal roller *G*. When the sheet of cotton coming from the laps is passed between this roller *G* and noses *H*, if said sheet were regular, all the pedal levers would be depressed equally and thus no regulation device required, but this is not the case. If again thick and thin places in the sheet of cotton were always evenly distributed and thus one-half of the pedals raised

on account of the heavy places, the other half equally depressed on account of thin places, thus neutralizing each other, the result would be the same. However, either thick or thin places predominate continually in the sheet, thus the variation of depression of the different pedal levers is sometimes slight and at other times excessive, in turn indicating an insufficient or an excess of feed, to overcome which is the purpose of the evening mechanism. The pendants *K* are guided by the rail *L* and as the pendants move up or down as the thickness of the feed varies, said movement, even of one pendant, will affect the position of all the bowls *a*. The last of the pendants, as situated nearest to the cone pulley, is joined to a lever *b* connected with the shifter lever *c*, the excess movement of the friction bowls moving lever *b* and in turn lever *c* shifts through connections the position of the belt *d* on the cone pulleys *e* and *f*. When an average thickness of cotton (normal feeding) is passing below the pedal roll *G*, the belt *d* works in the middle of the two cone drums. If the belt, on account of thin feeding, moves to the large end of the driving (bottom) cone it will simultaneously move to the smaller end of the top cone and in turn revolve said cone quicker, again if belt, on account of heavy feeding, moves to the small end of the driving cone it will simultaneously move to the large end of the top cone and in turn drive said cone more slowly; the top cone being geared to the pedal roller *G*. Thus it will be seen that if a pendant was lifted, the bowls *a* would move outward to shift the belt to the smaller diameter of the bottom cone pulley and in turn decrease the feed, again if at the same time another pendant was dropped to the same extent as the one raised, no change in feed would result, since in the latter case bowls would move at the same time also inward and thus neutralize the previous action. By this it will be readily seen that it is only when the average action of the whole of the pedals is in excess, one way or the other, that the lever *b* is moved either in or out, to in turn through lever *c* shift the belt and accordingly vary the speed of the cone pulleys and in turn that of the pedal roller *G*, which regulates the feed by being geared to the driving shaft of the feed apron. The connections for accomplishing this variation in speed of the pedal roller consist in providing on the extended shaft *g* of the top cone pulley a worm *h* which meshes with worm gear *i*, the pinion *j* of which engages with a gear wheel *k* fast on the pedal roller *G*, thus any change in the speed of the top cone pulley will be immediately transmitted to the pedal roller *G* and the feed in turn kept even. The cones are driven at a constant speed from the lap end through shaft *l*, carrying gear wheel *m* meshing with wheel *n* fast on shaft *o* of the bottom cone drum *f*.

Fig. 57 shows in perspective view another construction of an evening mechanism, working in connection with a different beater feeding, the pedal roller in this case serving at the same time, in connection with a heavily weighted roller, to form the pair of feed rollers to the beater. *A* indicates one of the beater blades, *B* the fluted pedal roller, *C* the lower feed roller as weighted heavily by means of weight *C'*, and

D a series of evener plates (eight being shown, but more or less can be used) fulcrumed on the rail *E* and cooperating with the top feed roller *B*, on account of their arms *B'* extending below the feed apron *F*. (A section of this part of the mechanism is shown in connection with Fig. 61). The tail ends of the arms *B'* are provided with links *h*, slotted

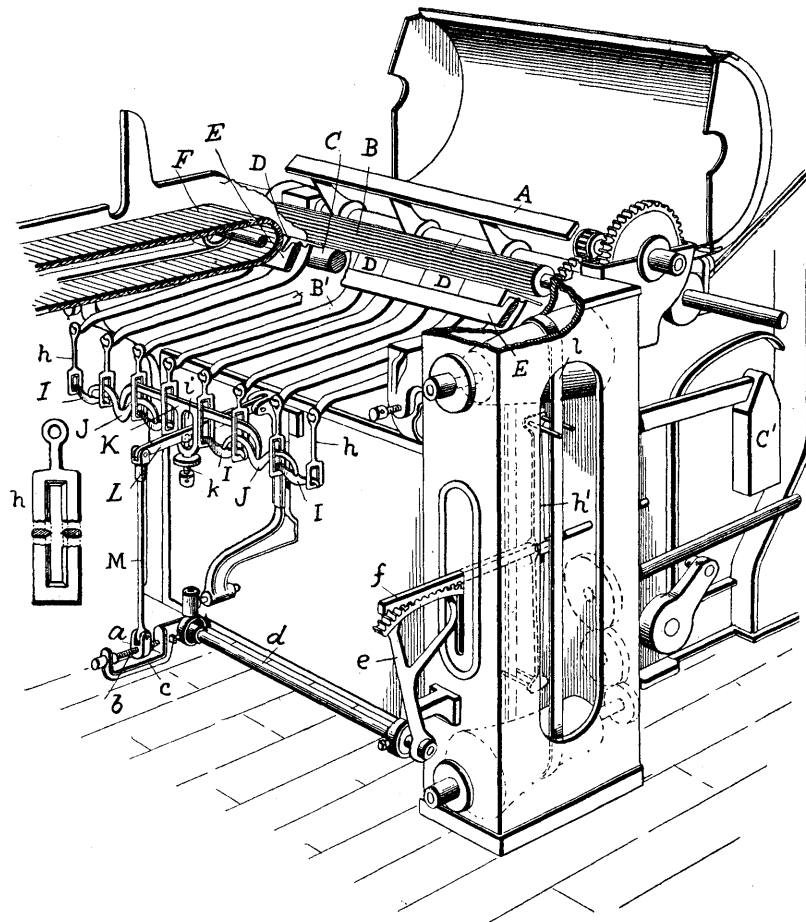


FIG. 57.

longitudinally for the reception of levers *I*, the edges of said slots being beveled, as best shown in detail illustration of one of these links *h*, to produce the least possible friction to the levers. In order to bring the excess of movement imparted by the sheet of cotton fed to the arms *B'*, gradually under the operation of one lever and to neutralize equality of

opposite movement of the arms B' from acting on said lever, four levers I are provided, each of which connects a pair of the links h . Each pair of the levers I are in turn connected by one of the two larger levers J , the latter in turn operating with the main lever K , provided with a slot i at its middle. By this arrangement of levers, any excess of movement to the arms B' , on either side of the centre of lever K , will act to correspondingly raise or lower said lever, but if raising and lowering of arms B' are equal, no movement will be given to lever K . In order to transmit the movement of the lever K to the cone pulleys and thus regulate the feed, we find extending through slot i in the lever K , a lever L , supported on an adjusting screw k , the outer end of the lever L being connected to a rod M which at its lower end is joined to a nut a on screw b as mounted in arm c , fast to rock shaft d . This rock shaft carries a toothed sector e , which, when the lever K is moved up or down according to the excess of movement of the arms B' , acts to slide a rack bar f in one or the other direction to move the shipper lever h' and in turn vary the position of the belt l on the cone pulleys so as to run the pedal roller B , as is geared to the driving shaft of the feed apron, either at a slower or faster speed and thus keep the feed always even.

Another arrangement for evening the feed is shown by Fig. 58 in its end elevation. In this arrangement the tail ends of the series of arms B' as carrying the evener plates D in front, are provided with pulleys a . Below the ends of the arms B' is placed a stationary bar b carrying another series of pulleys c , and mounted onto and below said bar is a cross arm d , the two ends of which are each provided with pulleys e . Over these pulleys a c and e , on each side from the centre of the cross arm d , extends a chain f fastened at its ends to bar b . By this arrangement it will be seen that a corresponding amount of raising and lowering of the arms B' will not influence lever L as resting upon cross arm d and in turn the feed will not be changed, but an excess of movement of the arms B' in one direc-

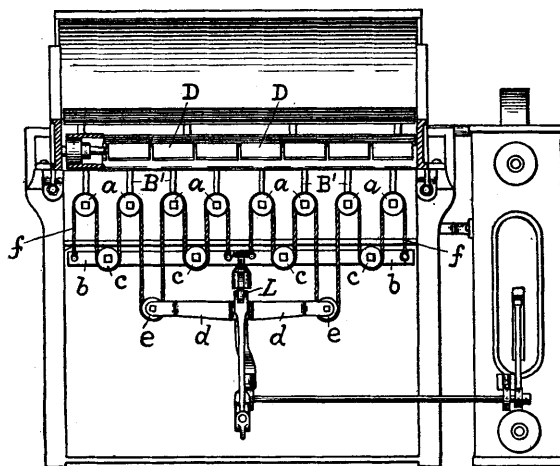


FIG. 58.

tion will not influence lever L as resting upon cross arm d and in turn the feed will not be changed, but an excess of movement of the arms B' in one direc-

tion or the other will act to either raise or lower the lever *L* and through similar connections with said lever as explained in the preceding device, the belt on the cone pulleys is shifted, to in turn regulate the speed of the pedal i. e. feed roller. Instead of fastening the chain *f* in the centre of the bar *b* as shown, a roller may be placed on the bar at this point and the chain passed around it, thus making a chain of one piece.

Feeding arrangements.—There are three principles of feeding scutchers in use, viz:—1st a single roller used in connection with the noses of the pedal levers, 2nd using besides the preceding arrangement a pair of beater feed rollers and 3rd using pedal levers working in direct connection with a pair of feed rollers. The first two styles of feeding refer more particularly to English built machinery, whereas the

third style shows the feeding adopted by American builders. With reference to the first style of feeding, see Fig. 59, the cotton is fed from the feed lattice *A* between pedal roller *B* as placed above the noses *C* of the series of pedal levers *D*, the latter working upon the knife rail *E*. In this case the cotton is fed to the scutcher by the pressure exerted on it as it is fed between

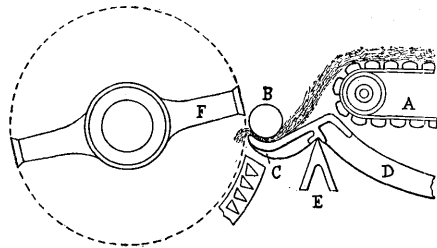


FIG. 59.

the pedal roller *B* and the noses *C*. This system is used more especially in connection with short stapled cotton. It is the practice of many makers to shape the nose of the pedals different, some providing peculiar shaped rounded surfaces for them, claiming in that manner to produce the necessary rounded surface for the deflection of the fibres as struck by beater blades *F*, and which must take place in any event, thus trying to do away with the extra pair of feed rollers *G* and *H*, as are shown in connection with Fig. 60, referring to the second style of feeding, which is more adapted for longer staples, the theory being that the cotton being struck round a less acute surface is less liable to damage; again the distance and difference in speed between the pedal roller and the feed rollers permits a slight draft to be given to the cotton before it is brought in contact with the beater, and where instead of being struck over a pedal nose, as in the first case, it is struck round the bottom feed roller, in this way minimizing the possible damage to the fibres, and at the same time allowing the blow to draw out the cotton without breaking it. Letters of references in this illustration

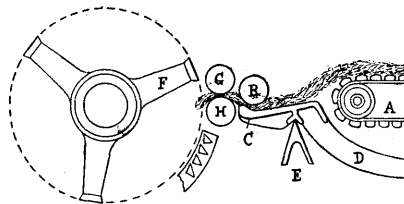


FIG. 60.

correspond to those of Fig. 59. The question of the distance from the point at which the cotton is held (the "bite") and that at which it is struck (the "blow") is of the greatest importance, since if the distance between these points is too great, the blow of the beater first bends down the lap end and then strikes off the fibres. It is obvious that unless the cotton is removed regularly in this way, there exists a danger in the second blow of some bruising of the cotton. Again, care must be exercised not to set the feed rollers too close, since otherwise they will crush the cotton and consequently reduce the strength of the staple.

Fig. 61 shows the third style, i. e. the feeding of an intermediate or finisher scutcher by means of a series of pedal levers working in connection with two feed rollers, only so much of the scutcher being shown as is necessary to explain the subject. The cotton as coming from the

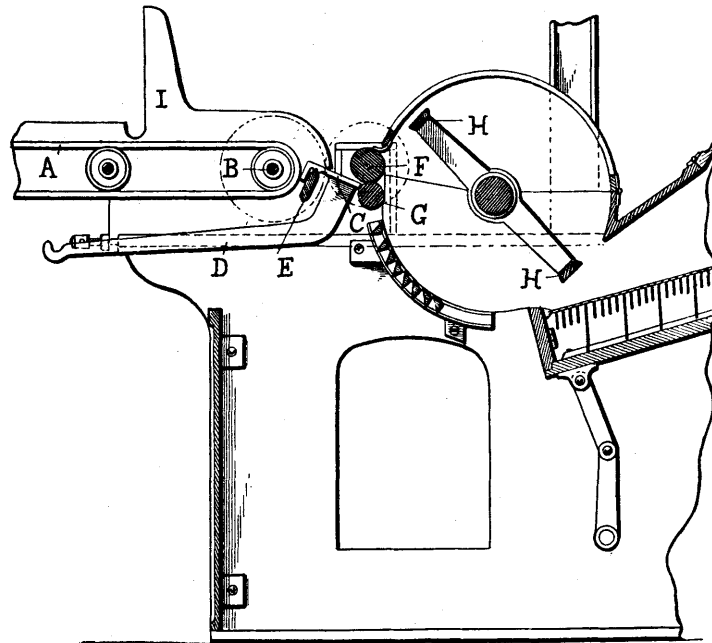


FIG. 61.

laps is fed to the feeding arrangement (and in turn to the beater) by means of lattice apron *A* as driven from the apron driving shaft *B*, from where it travels over the evener plates *C* as adjusted to pedal lever *D* and being fulcrumed to rail bar *E*. Said evener plate *C* works against pedal roller *F*, against which roller *G* is pressed by means of being heavily weighted. It will thus be seen that the pedal roller *F* answers a two fold purpose, viz:—operating the evening mechanism in connec-