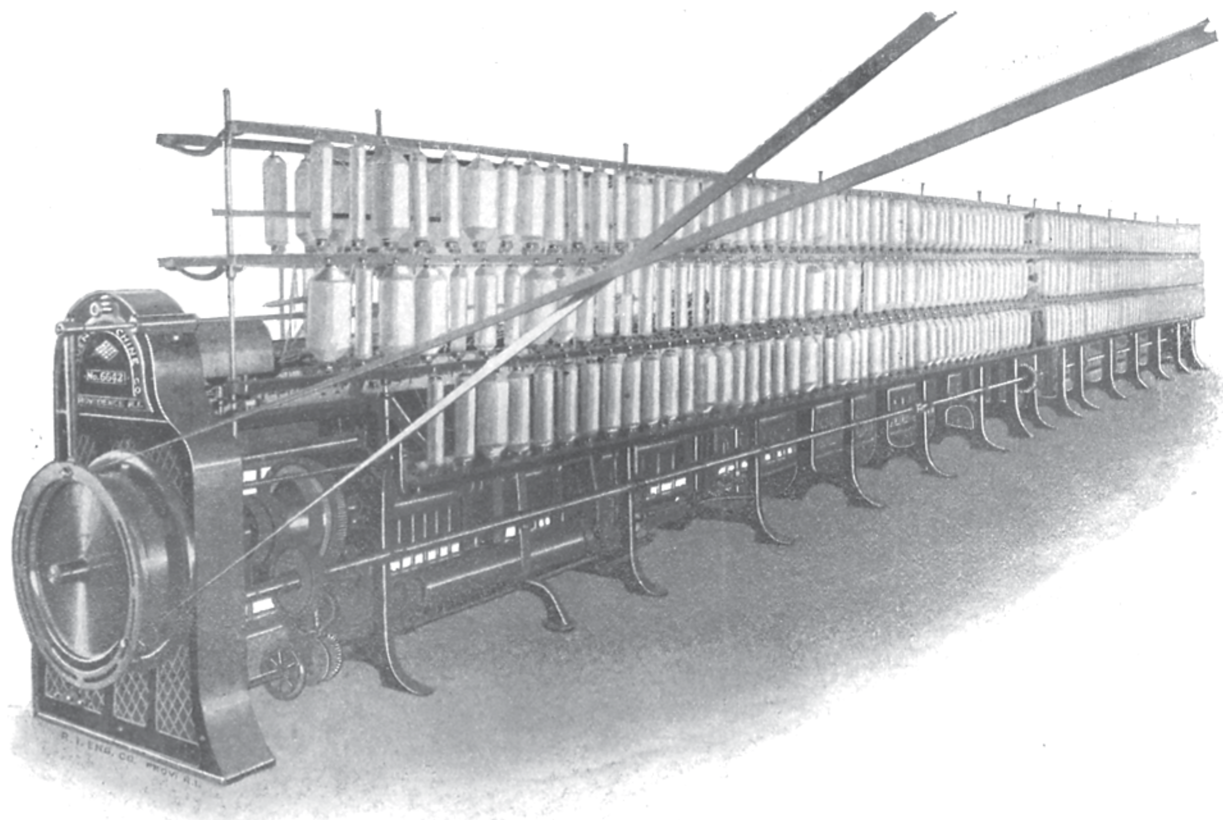

ADVANCED TYPE OF COTTON ROVING FRAME
Providence Machine Co.

Cyclopedia
of
Textile Work

A General Reference Library

ON COTTON, WOOLEN AND WORSTED YARN MANUFACTURE, WEAVING, DESIGNING, CHEMISTRY AND DYEING, FINISHING, KNITTING, AND ALLIED SUBJECTS.

Prepared by a Corps of

TEXTILE EXPERTS AND LEADING MANUFACTURERS

Illustrated with over Two Thousand Engravings

SEVEN VOLUMES

CHICAGO
AMERICAN TECHNICAL SOCIETY
1907

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THE editors have freely consulted the standard technical literature of Europe and America in the preparation of these volumes and desire to express their indebtedness, particularly to the following eminent authorities, whose well known treatises should be in the library of every one connected with textile manufacturing.

Grateful acknowledgment is here made also for the invaluable co-operation of the foremost manufacturers of textile machinery, in making these volumes thoroughly representative of the best and latest practice in the design and construction of textile appliances; also for the valuable drawings and data, suggestions, criticisms, and other courtesies.

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Introductory Note

THE Cyclopedia of Textile Work is compiled from the most practical and comprehensive instruction papers of the American School of Correspondence. It is intended to furnish instruction to those who cannot take a correspondence course, in the same manner as the American School of Correspondence affords instruction to those who cannot attend a resident textile school.

¶ The instruction papers forming the Cyclopedia have been prepared especially for home study by acknowledged authorities, and represent the most careful study of practical needs and conditions. Although primarily intended for correspondence study they are used as text-books by the Lowell Textile School, the Textile Department of the Clemson Agricultural College, the Textile Department of the North Carolina College of Agriculture and Mechanic Arts, the Mississippi Textile School, and for reference in the leading libraries and mills.

¶ Years of experience in the mill, laboratory and class room have been required in the preparation of the various sections of the Cyclopedia. Each section has been tested by actual use for its practical value to the man who desires to know the latest and best practice from the card room to the finishing department.

Numerous examples for practice are inserted at intervals. These, with the test questions, help the reader to fix in mind the essential points, thus combining the advantages of a textbook with a reference work.

Grateful acknowledgment is due to the corps of authors and collaborators, who have prepared the many sections of this work. The hearty co-operation of these men — manufacturers and educators of wide practical experience and acknowledged ability — has alone made these volumes possible.

The Cyclopedia has been compiled with the idea of making it a work thoroughly technical, yet easily comprehended by the man who has but little time in which to acquaint himself with the fundamental branches of textile manufacturing. If, therefore, it should benefit any of the large number of workers who need, yet lack, technical training, the editors will feel that its mission has been accomplished.

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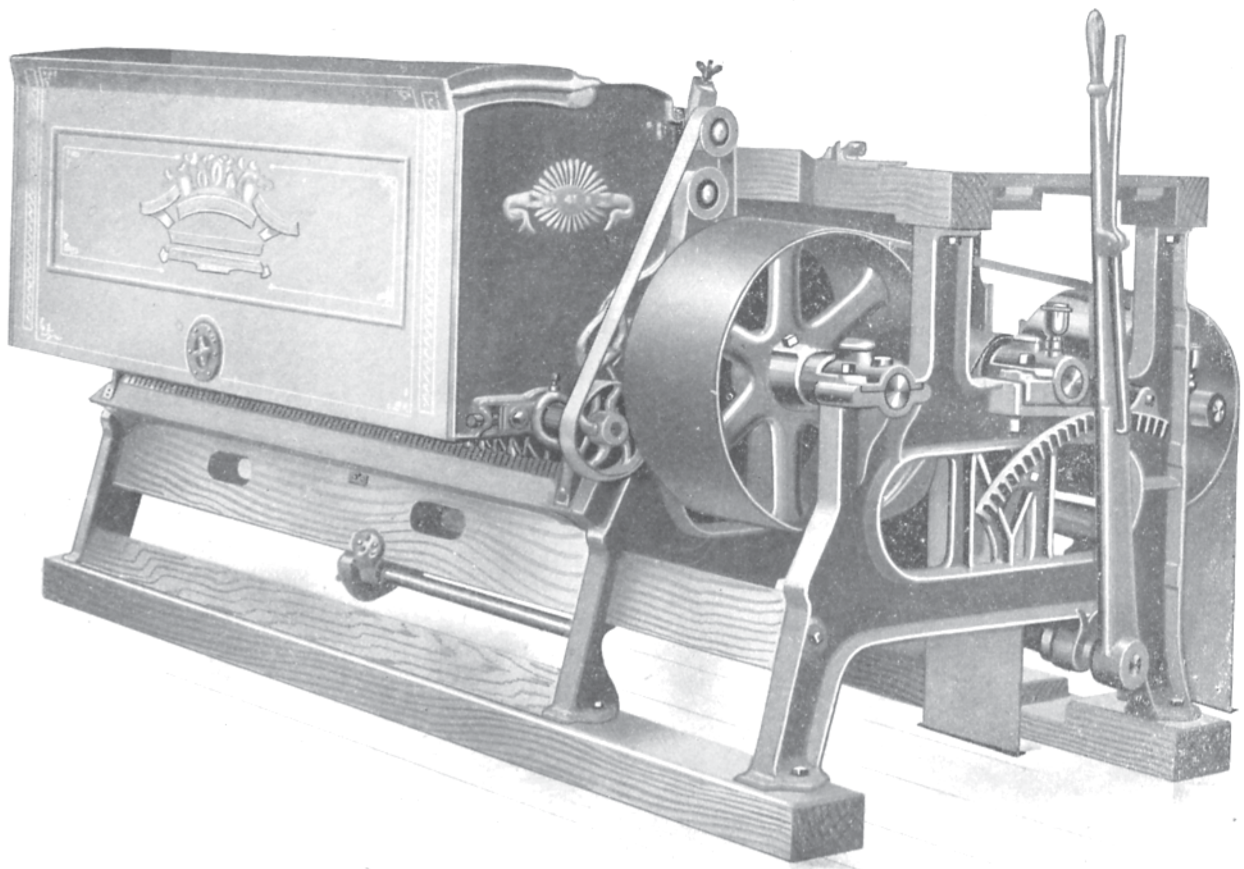


MUNGER MAIN BELT HULLER COTTON GIN
Continental Gin Co.

COTTON FIBER.

Before studying the manufacture of cotton, it will be interesting to know something of the history, botany and general characteristics of the plant, and of the early records of the application of its fiber to the manufacture of cloth.

It is probable that to the Hindoos should be credited the first practical use of the cotton fiber. Early records show that it was known as early as 800 B.C. both as a plant and as a textile.

Heroditus, 445 B.C., makes mention several times of the cotton plant, and of the fiber for the manufacture of cloth.

The cultivation of the plant or the manufacture of cloth from the fiber did not attract much attention at this time in any country but India; in fact, from about 1500 B.C. to 1500 A.D. India was the center of the manufacturing as well as the cotton-raising industry.

Although flax was the article most used by Egyptian weavers, it is probable that cotton was known to them at a very early date, as Pliny writes: "In upper Egypt, toward Arabia, there grows a shrub which some call Gossypium and others Xylon, from which the stuffs are made which we call Xylina," and his description of the plant which follows refers to cotton.

There is abundant evidence that cotton was grown in the New World prior to the advent of the earlier discoverers.

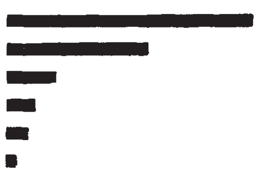
Columbus in 1492 found cotton growing in the West Indies. He and other explorers found it equally abundant on the mainland, and also found the natives showing considerable skill in the manipulation of its fiber in the manufacture of cloth, fish lines and nets.

Cortez found cotton in Mexico in 1519, and used it in stuffing the clothing of his soldiers as a protection against the natives. Pizzaro found cotton in Peru in 1522, and cotton cloth has been found in the ancient tombs of that country. De Vica in 1536 found the cotton plant growing in that region which is now Texas and Louisiana.

Summing the matter up, we are led to believe that on a belt of the earth's surface coinciding very nearly with the cotton belt of to-day, the plant was found either in a wild or cultivated state in the earliest ages of which we have records.

At the present day the cotton-raising territory includes practically the whole of India, parts of China and Japan, Central Asia, the valley of the Nile in Egypt, and Syria in the Old World. In the New World, the Southern States and their islands, Mexico, Brazil, Peru, and several islands in the Pacific.

The following diagram shows approximately the proportions of the world's crop raised in the various countries mentioned. The figures given represent bales of five hundred pounds each.



World's Crop	1892-93	11,950,000
United States	1892-93	6,700,000
India	1892-93	2,200,000
China	1892-93	1,200,000
Egypt	1892-93	1,000,000
South America	1892-93	225,000

COTTON IN THE UNITED STATES.

According to the most reliable records, the first cotton cultivated in the American colonies was in Virginia, in 1609.

A more extensive effort at cotton cultivation was undertaken in the same colony in 1621, at which time "cotton wool" was quoted at eight shillings per pound. English colonists in the Carolinas undertook the cultivation of cotton about 1660.

The first export of any considerable amount of cotton occurred in 1770, at which time twenty bales were shipped to Liverpool.

One hundred years later the exports amounted to about three million bales, and at the present time the export of American cotton is between six and seven million bales annually.

The following diagram allows a comparison between the world's crop and the crop of the United States for the years 1893 and 1900. It will be seen that in 1900 Texas alone produced thirty-four per cent of the crop of the United States, and about twenty-five per cent of the world's crop.

World's Crop 1893 and 1900
United States 1893 and 1900
Texas 1900

The following table gives approximately the amounts of cotton raised in the different states of the United States for the years 1870, 1895 and 1900. The figures given represent bales of five hundred pounds each.

	1870	1895	1900
Alabama	429,500	1,000,000	1,023,000
Arkansas	248,000	850,000	813,000
Georgia	474,000	1,300,000	1,203,000
Louisiana	351,000	600,000	705,000
Mississippi	565,090	1,200,000	1,046,000
North Carolina	145,000	465,000	477,000
South Carolina	224,500	800,000	748,000
Texas	350,000	3,276,000	3,438,000
All others	225,000	410.000	670,000
Total	3,012.000	9,901,000	10,123,000

BOTANICAL VARIETIES.

Cotton is the most widely cultivated and manufactured of all the textiles, and is the product of a plant belonging to the Malvaceæ or Mallow family, to which family also belong the Mallow Hollyhock and Okia. It is known scientifically by its generic name, Gossypium.

Among the early botanists much confusion existed in regard to the proper classification of the species growing in different parts of the world, their classifications ranging from three to eighty-eight species. It is generally agreed that Dr. Boyle's classification covers those cottons known to commerce, and can be accepted as satisfactory for all practical purposes. His classification gives G. Arboreum, G. Barbadense, G. Herbaceum, and G. Hirsutum.

Gossypium Arboreum, or Tree Cotton. This cotton is a perennial, varying in height from six to twenty feet, and sometimes attains a diameter of five inches; the flowers are brownish red, seed green, and adhering strongly to the fibers. The fibers are of a yellowish tinge, soft, silky, and an inch or less in length. This cotton cannot be considered as a cultivated variety, and comparatively little is used.

Gossypium Barbadense. This species is so called from the fact that it is a native of Barbadoes. It has a yellowish blossom, a black seed which is free from the hairy covering of other varieties, and is distinctly shrubby in growth. Height from six to ten feet. Commercially, this is a very valuable and important cotton, being fine and long stapled. The long, silky cotton known as Sea Island, and the more valuable of Egyptian cottons, belong to this species. By cultivation this species has been extended to the West Indies, the coast of the Southern States and their islands, Central America, Jamaica, Porto Rico, Egypt, Island of Bourbon and Australia.

The yield of lint from Sea Island cotton is in smaller proportion than from any other kind of cotton grown in this country, but on account of the length and quality of its fiber it is adapted to the finest classes of goods, and on that account can be considered a very valuable variety.

Gossypium Herbaceum. This is undoubtedly the hardiest variety of cotton, and on that account has the widest geographical range. Most of the cotton produced in the Old World is of this species, which is generally considered to be of Asiatic origin. It is an annual, and herbaceous in nature; average height, five feet. It has yellow seeds covered with a gray down, fibers adhering strongly to the seeds. Staple of medium length. This cotton is grown in Arabia, India, China, Turkey and Egypt, as well as in this country.

Gossypium Hirsutum. This variety is so named on account of the hairy character of the plant. Maximum height about six feet, but varying greatly in different locations and soils. Seeds are covered with a greenish down. Staple white, and regular in length. The greater proportion of Gulf and Upland cotton cultivated in the United States belongs to this species, though some varieties have more of the characteristics of the Herbaceum type.

Another species of cotton, G. Peruvanium, is often given, but many botanists include this with G. Barbadense. This cotton is a native of Peru, and is of some importance. Its chief characteristic seems to be a harsh, woolly condition of the fiber, though of good length.

CULTIVATION OF AMERICAN COTTON.

The methods of cultivation and the time of planting and picking vary in the different localities of the cotton-raising portion of the United States, and is due to differences in soil and temperature. Planting is done as early as possible; in fact as soon as danger from frosts has passed. There can be considered two distinct periods in the life of the cotton plant. The first is from the time of planting to midsummer, when every effort is made to secure a strong, vigorous growth. At this time plenty of moisture, sunshine and cultivation are necessary, and tropical conditions are desired to secure and store the strength which will later go to the seed. The second period is from midsummer to the time of picking. Cultivation is now stopped, the ground is allowed to become hard and compact, and dry, cooler weather is desirable. These conditions tend to retard the further growth of the plant, and allow the stored strength to go to the seed.

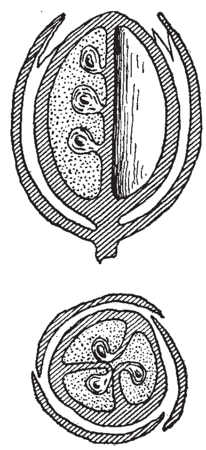


Fig. 1.

Cotton is planted in rows three or four feet apart, and appears above the ground in about ten days. As soon as the plants are large enough to give evidence of strength the rows are "chopped out," leaving hills from eight to fifteen inches apart, and from these hills the weaker plants are pulled. From this time until about the end of June the crop is constantly cultivated by means of shovel plows, scrapers and "scooties," to retain the moisture in the soil and to keep the field clear from weeds and crab grass.

In seventy-five or eighty days after planting the blossom appears, and the plant continues to blossom for some time. These blossoms are at first a creamy white; the second day they turn pink or red, and the third day a purplish blue, at which time they drop off. After the dropping of the blossom the seed-pod, or "boll," commences to form, and attains its full growth in from six to eight weeks.

When fully developed the boll bursts, commencing at the apex, and the separations extending down the sides disclose from

care is taken in picking, and, as a result, the cotton is more free from leaf and dirt than Upland cotton. The seed cotton is hauled from the field to the storehouse, or directly to the cotton gin, where the seed and lint are separated.

GINNING.

Ginning is the operation of removing the cotton fibers from the seed. Of cotton picked, two-thirds by weight consists of seed and only one-third is material that can be used in the manufacture of cloth. Some cottons are much easier to gin than others, as the seeds are smooth, free from down, and adhere less strongly to the fibers. Sea Island and Egyptian cottons belong to this class.

There are two styles of gins in use: the roller gin and the saw gin; there are also several forms of each, differing in mechanical construction but similar in principle and operation.

The origin of the roller gin dates from the time of the early cultivation of cotton in India. The original roller gin, known as the foot-roller, consisted simply of a flat stone and a round wooden roll. The cotton was spread over the stone and a rolling motion imparted to the roll by the foot of the worker, the effect being to detach the fibers from the seed and force the seed away from the fibers. This primitive form of gin was employed only for hard seeded cotton, and the product of one person was only about five pounds per day.

The next step in advance gave an improvement over the foot-roller, and was known as the "Churka." This "machine" is of very ancient origin, it was formerly used in most of the cotton-growing countries, and can be found in some districts of India to-day. It consisted of two rollers: an upper one of iron about half an inch in diameter, and a lower one of wood about two inches in diameter. These rolls were revolved toward each other, and were fixed in rigid bearings, very close together. The cotton was fed by hand to these rolls, which grasped the fibers and passed them between the rolls. The fibers were freed from the seed by this action, as the seed was too large to pass through the limited space between the rolls. The action of this gin was very easy on the cotton fiber, but the product was small, about eight or ten pounds a day being the capacity of the machine.

The modern roller gin, of which there are several forms used in this country for Sea Island cotton, may be briefly described as follows: The seed cotton is fed on a table, or by an endless apron, to a leather roller, generally of walrus hide. Along the face of this roller, where the seed is delivered, is a steel blade, the edge of which is set close to the surface of the roll, and prevents the passage of seed. The leather-covered roll revolves toward the steel blade, or "doctor," and being rough on its surface draws the fibers under the blade and away from the seed.

There is a rapidly oscillating comb which knocks the seed away from the "doctor" after its fibers have been engaged and drawn under by the rapidly revolving roll. The cleaned seeds fall through slots in the feeding table, and the fibers are cleaned from the roll and delivered by a revolving brush.

The cotton fiber receives little if any damage from the action of the roller gin, and in this particular the roller gin is considered far superior to the saw gin. The chief disadvantage of the roller gin is its limited production, being under average conditions about two bales per day.

A late form of roller gin, known as the Prior gin, differs from others in the construction of the cylinder. In this gin the revolving cylinder is covered with a lagging composed of horse-hair and rubber, giving a rough surface, which readily grasps the cotton fiber. The production of this gin is somewhat in advance of that of the ordinary roller gin, but is much less than that of the average saw gin.

Roller gins are built with both single and double rollers.

The saw gin (Fig. 3), which is generally used in this country for everything but Sea Island cotton, was invented by Eli Whitney in 1794. The modern saw gin consists of a box or chamber, M, into which the seed cotton is automatically fed by an endless spiked apron. One side of this receptacle consists of a grate of metal bars or ribs, C. Through the slots of this grate project notched steel discs or saws, B, from forty to eighty in number, arranged on an arbor with collars between. The teeth of these saws, which revolve at a speed of three hundred to five hundred revolutions per minute, engage the fiber and pull it from the seed and through the grate, allowing the cleaned seeds to fall through a slot, K, at the bottom of the box. The cotton fiber clinging to the teeth of the saws is removed by a rapidly revolving brush, H, which, aided by the current of air which it generates, throws the ginned cotton on the floor of the ginhouse, or against condensing cages, which deliver it.

Saw gins are also built with a double set of saws, but their construction is substantially the same. A saw gin of sixty saws, at a speed of four hundred revolutions per minute, will gin about ten bales per day, although a smaller production would give a better quality of product.

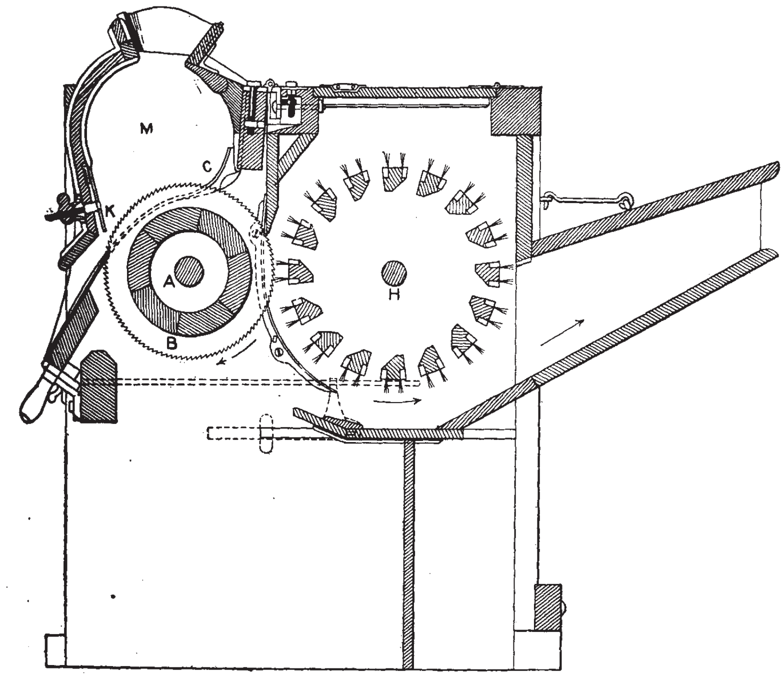


Fig. 3.

There are several conditions which will cause a decided damage to the cotton in the operation of ginning. An experienced judge of cotton can readily detect the result of improper ginning by an examination of cotton in the bale.

Cut staple is the result of too high saw speed, or of having the teeth of the saws too sharp on the edge. This damage is a serious one, as it greatly weakens the fibers that are not actually cut by the operation.

Neppy cotton is another serious condition which may arise from overcrowding the gin, or from the fact that the saws are set too close to the bars of the grate. Neps are little tangled fibers, or tangled bunches of fibers, which are hard to remove from the cotton in the after processes, and the presence of neps in any considerable quantity condemns cotton which otherwise might grade well.

Stringy or "*tailed*" *cotton* is the result of ginning when the cotton is too wet. Although not as serious a defect as the two preceding, it has an influence on the grading of the stock and on the action of the cotton in manufacturing operations.

The damage to the fiber in ginning is not present to any extent when roller gins are used, and for that reason roller-ginned cotton will bring a better price, other conditions equal, than saw-ginned cotton. There has for some time been an effort to secure the adoption of some form of roller gin in the South, some manufacturers claiming that roller-ginned cotton is worth to them one-half to one cent per pound more than saw-ginned cotton. Up to the present time no great advance has been made in this direction, but many predict that the roller gin will eventually displace the present form of saw gin.

BALING.

After being ginned the cotton is ready for baling. There are several forms of baling press, the most common of which is the screw press connected with the ginhouse. This press gives a bale which on reaching the market or shipping point is again compressed.

The square bale, or American bale (Fig. 4), though varying greatly in size, is supposed to be fifty-four inches long, twenty-seven inches wide, and to weigh five hundred pounds. The thickness depends upon the amount of compression, and averages about sixteen inches. This bale is covered with coarse burlap bagging and bound with iron hoops or "ties." The American bale has the reputation of being the poorest bale made. The ties, six or eight in number, are hardly sufficient to confine the bale, the covers are generally of poor quality, and the weight of bagging and ties a large per cent of the gross weight. The loss of room in shipping and the loss of cotton and damage is considerable; in short, the bale is clumsy, dirty, expensive and far from satisfactory.

Egyptian cotton is received in this country in much better shape. The cotton is completely covered by the bagging and bound by eleven or twelve ties. The Egyptian bale (Fig. 5) is compressed to a density of about forty-five pounds to the cubic foot, and weighs on an average seven hundred pounds.

Peruvian cotton is received in smaller bales, of about two hundred pounds weight, and generally in good condition.

There are two other systems of baling, of comparatively recent date, which are attracting considerable attention among manufac-

Fig. 4.

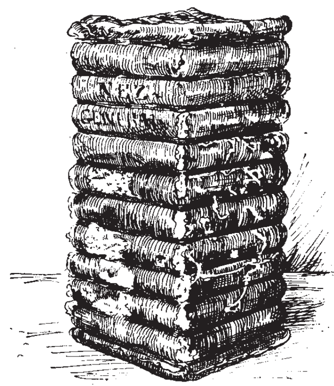


Fig. 5.

turers and cotton planters. One of these is called the Bessonette or "round-lap" system. By this system the lint as it comes from the gin is blown into a reservoir or bat former, where it is converted into an even, continuous sheet. This sheet is wound around an arbor or core under pressure, the pressure being light at first and increasing with the size of the roll. The pressure is applied by revolving iron rolls until the bale becomes of full size and density. By this method of rolling under pressure, bales are produced which are twenty-two inches in diameter, thirty-four and forty-eight inches in length, and averaging 275 and 425 pounds each. The density of this bale is about thirty-five pounds to the cubic foot as against about twenty-two pounds in the American bale. With the Bessonette bale no hoops are needed, as the bale is covered with a strip of cotton cloth before the baling pressure is released, and the ends of the bale are capped with cloth, also. Of the cotton crop of 1900, about five hundred thousand bales were of this type.

Another form of cylindrical bale is the "Lowry bale." This bale is formed by feeding the cotton loose from the gin into a receptacle, the bottom of which is a revolving plate containing several slots radiating from a center to the circumference. Under this revolving plate is a cylindrical chamber, into which the cotton is first packed by hand. The bottom of this chamber is held by hydraulic pressure. The cotton in the receptacle passes through the slots in the revolving plate, and by the circular motion of the plate is drawn through and placed very compactly in the chamber below. As the bale builds, the pressure of the cotton overcomes the hydraulic pressure, and the bottom of the cylinder is forced downward until the bale has attained the required length. This bale is secured by several wire ties placed longitudinally around the bale and afterward enclosed in cotton cloth. This bale is of uniform size, eighteen inches in diameter and thirty-six inches in length, and is compressed to a density of about forty-five pounds per cubic foot, weighing, with cover, about 250 pounds. There were 122 presses of this type operated throughout the country for the crop of 1900, producing about 375,000 bales.

There are several advantages possessed by both of these cylindrical bales over the old-style American bale. They are easier and cheaper to handle, less waste from sampling, cleaner, smaller percentage of bagging and ties, less risk from fire and greater salvage in case of fire. The insurance and freight are also lower. The Bessonette bale is sometimes called the Underwriters bale.

The tare, or bagging, and ties on the American bale amount to twenty-four to thirty pounds per bale, or about five or six per cent. On either form of cylindrical bale the cover weighs two and one-half or three pounds per bale, giving less than two per cent of tare.

The position of the cotton in the Bessonette bale can be compared to a roll of wide tape. In the Lowry bale its form is more that of a flat coiled spring.

COTTON FIBER.

Although a knowledge of the diseases to which a cotton plant is liable, the insects which affect its growth, and the cost of production in various localities is interesting and valuable, a consideration of the structure of the fiber and the commercial varieties and gradings is far more important.

In every lot of cotton three classes of fibers can be recognized: the ripe, half-ripe and unripe. A perfect cotton fiber consists of four parts: First, an outer membrane; second, the real cellulose, which constitutes about eighty-five per cent of the fiber; third, a central spiral deposit of harder nature; and fourth, a central secretion corresponding to the pith of a quill.

Covering the fiber is a varnish amounting to less than one per cent of the weight of the fiber, and known as "cotton wax." This is the substance which makes the fiber slow to absorb moisture, and which in absorbent cotton has been removed by chemical action.

The cotton fiber, which appears to be a smooth, round filament to the naked eye, has under the microscope a very different appearance. The ripe cotton fiber, when seen under the microscope, has the appearance of a collapsed, twisted tube with corded and slightly corrugated edges, and somewhat resembles an elongated corkscrew. These convolutions or twists of the fiber are peculiar to cotton, and are not present to any extent in any other fiber, either vegetable or animal. To these convolutions is due to a great extent the value of the cotton fiber. The twisting which the fibers receive in the process of spinning interlocks these convolutions of the fiber and gives great strength to the yarn. It also overcomes any tendency of the fibers to slip over each other when tension is applied. Fig. 6 shows the appearance of various fibers under the microscope. A and B represent the appearance of fibers of wool, showing the scales which in spinning are interlocked, which gives considerable strength to woolen yarn. C represents the appearance of a ripe cotton fiber, and shows the twists or convolutions and the corded edges. D represents a fiber of silk and E of camel's-hair. These twists of the cotton fiber are not as numerous in half-ripe fiber, and are almost lacking in the unripe or immature fiber. Owing to this fact the unripe fiber is of little value to manufacturers. It is also lacking in strength, and is slow to take dye, as its structure is less porous. Unripe fiber can be detected by the eye on account of its glossy, transparent appearance.

Fig. 7 shows the appearance of several cotton fibers at different stages of maturity. A and B are the unripe fibers, C the half-ripe, and D and E are the fully ripe or mature fibers.

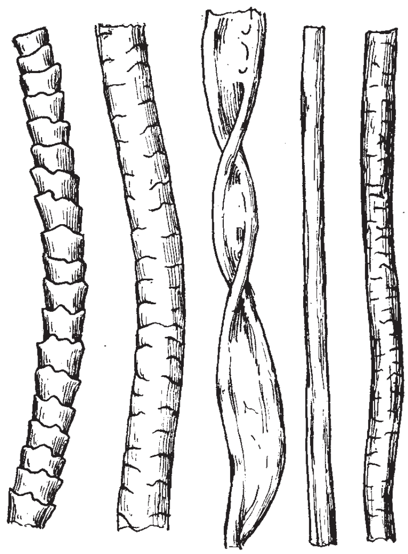


Fig: 6.

Fig. 8 represents cross-sections of the same. A represents the unripe fibers, B the half ripe and C the fully ripe.

The **microscope** can therefore be depended upon to identify the cotton fiber. Other tests, however, can be made. The burning of the fiber will distinguish between cotton and wool or silk. The cotton fiber burns with a flash, leaving a white ash, while wool or silk emit a disagreeable odor, leaving a small lump of carbonized matter on the end of the fiber. A strong solution of caustic soda will entirely destroy wool or silk; the effect of wetting a cotton fiber with caustic soda is to distend the fiber and almost eradicate the convolutions, leaving it stronger than before. It also gives it the appearance of a round glass rod which has been bent in every direction.

The value of cotton depends principally on the length, strength and fineness of the staple. The diameter of cotton fibers vary from $\frac{1}{2000}$ inch to $\frac{1}{1000}$ inch, and length from $\frac{1}{2}$ inch to $2\frac{1}{4}$ inches. De Bowman estimates that there are 140,000,000 fibers to the pound. The number of convolutions or twists in the cotton fiber is greater and more regular in some varieties than in others. In Sea Island cotton the convolutions are very regular, and have been estimated as between three and four hundred per inch of fiber length. Poorer varieties of cotton have less frequent convolutions, as low in some cases as one hundred per inch of length.

As the authorities on the lengths of cotton fiber do not entirely agree in all cases, it will be safe in treating this subject to give the average length, diameter and general characteristics of a few of the more important commercial varieties in the order of their length of staple. The numbers and kinds of yarn for which the different lengths and varieties of cotton are used will be found to vary widely in different locations and under different conditions. These numbers are for warp yarns, and, in many cases, the cotton can be spun into somewhat finer numbers for filling yarn, as the required strength for filling is not as great.

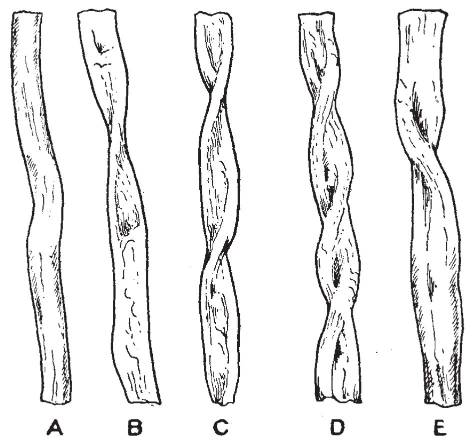


Fig. 7.

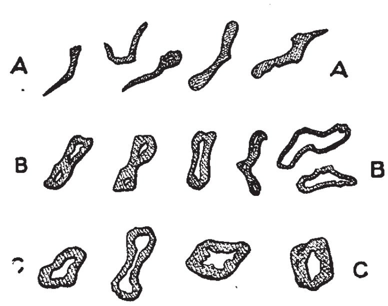


Fig. 8.

Sea Island is by far the finest cotton grown, and therefore careful attention is given to the picking, ginning and baling. The best of Sea Island cotton is grown on Edisto, Port Royal and St. Helena Islands off the coast of South Carolina, and the Cumberland Islands off the coast of Georgia. Some Sea Island cotton is grown on the low portion of the coasts of these States. It has a long, glossy, silky fiber, with regular convolutions, and contains much unripe fiber; it is usually combed. The black seed free from hairy covering makes the ginning comparatively easy. It is ginned on roller gins only. It is used largely for the manufacture of sewing thread and for the finest of lawns and muslins. It is regularly spun from 150 to 300, and commercially as fine as 600; has been spun experimentally as high as 2,000.

The territory adapted to the raising of this crop is very limited, which accounts for the comparatively small amount grown. The Sea Island crop of 1900 amounted to 88,294 bales, a decrease of 8,985 bales from the crop of the preceding year. The principal markets for Sea Island cotton are Charleston, S. C., and Savannah, Ga. The average price obtained for 1900 was for South Carolina, \$.256; Georgia, \$.20, and Florida, \$.19 per pound.

Egyptian Cotton. The brown Egyptian cotton is used to a considerable extent in this country. It is a long, silky, clean cotton, from a dark to light golden color. It contains a large per cent of short fibers and is generally combed. The color of this cotton is due to the presence of a natural substance known as "Endochrome." Length of fiber from $1\frac{1}{8}$ to $1\frac{1}{2}$ inches, a large proportion running about $1\frac{5}{16}$ inches. This cotton ranks next to Sea Island, and larger amounts are being imported each year. It is largely used for the better grades of underwear and hosiery, and to some extent for thread for lace work. The yarn made from this cotton is one of the best for mercerizing, as the fiber is naturally smooth. It is grown in the valley of the Nile in Egypt. The principal market is Alexandria. The imports of this cotton into the United States were about sixty thousand bales in 1895.

Gulf cotton, or New Orleans as it is known in England, is the best of strictly American cotton, for Sea Island cotton, although grown in this country, is not generally ranked as an American cotton, but occupies a class by itself. Gulf cotton properly includes many varieties, known as Peeler-Benders, Red River, Allan seed, etc. These last varieties of Gulf cotton somewhat resemble the poorer Sea Island grades. Peeler is one of the best of the Gulf cottons that are raised in sufficient amounts to be of commercial value. It is long, silky, and of bluish white color, generally combed, and a fine working cotton, somewhat similar in that respect to Egyptian. Gulf cotton, as a rule, ranges from $1\frac{1}{8}$ to $1\frac{3}{8}$ inches in length of staple, though some of the better varieties are longer. Gulf cotton is used for warps from 30 to 50, and for filling from 50 to 70.

Upland Cotton. This is the most common and useful cotton grown and constitutes the greater part of the world's crop. The fibers are very uniform in length; color generally good, and is a strong, reliable cotton. This cotton is grown in Georgia, North and South Carolina, Alabama and Virginia. There are many varieties of Upland cotton, taking their names from States or localities where they are grown. Upland cotton is used for warp yarns up to 38 and for filling to 48. Upland staple ranges from $\frac{7}{8}$ inch to $1\frac{1}{8}$ inches in length, a large portion reaching $1\frac{1}{8}$ inches. The average price for middling Upland $1\frac{1}{8}$ inches for the year 1900 was $.0896+ per pound.

Texas cotton is somewhat similar to Upland, but slightly shorter and more harsh, though of very good quality. The character of the crop varies largely from year to year. During a dry year it is likely to be unusually harsh, short and brittle, and is often "tinged" or off color. The production of Texas cotton is increasing, and more care is constantly being given to its cultivation and preparation. Texas cotton is especially suited for warp yarns from 24 to 36. Length of staple from $\frac{7}{8}$ inch to $1\frac{1}{8}$ inches. This is the best of American cottons for use in mixing with wool. Principal market, Galveston.

Peruvian cotton is comparatively little used in this country. It is very harsh and wiry. Red Peruvian is a deep reddish brown in color, the white Peruvian being of a cream tint. The small amount that is consumed is used largely for woolen adulteration, as the fiber more nearly resembles wool in feeling than that of any cotton grown.

GRADING.

The grading of cotton is entirely a matter of judgment and experience, and no definite rules can be given. The cotton grader is one who from long experience and numberless comparisons has educated his eye and hand to distinguish between the grades and recognize the differences in quality which would add to or detract from the market value of the cotton. Cotton is universally sold (except in some districts of the South) by samples and not by inspection of the bales. It is also graded in the same way.

In grading cotton the principal points to be taken into consideration are: First, the strength and evenness in length of the staple; second, its freedom from "neps," "leaf-motes," sand and other foreign substances, and third, the color or evenness of color.

The strength of the staple is important in determining the grade, as that is one of the principal points of value of the stock.

The *evenness* in length is also very important, for a cotton that is of good average length and that is clean may contain a large proportion of very short fibers, in which case the strength of the yarn is considerably diminished.

The freedom of the cotton from foreign impurities is one of the principal factors in determining the grade, for not only must the impurities be considered as waste, but their removal, if present in considerable amounts, adds greatly to the cost of the manufactured product. The presence of foreign matter is largely due to carelessness in picking and ginning. A certain amount of leaf, boll, husk, seed and sand is present in any cotton, and if this amount is considerable the grade of the cotton is lowered accordingly. The presence of "neps," "motes" and immature fibers also detracts from the value of the cotton and influences the grading.

"Neps" are tangled fibers or minute panglens of several fibers. Their appearance is that of a small white "fleck," hardly larger than a grain of sand, which, if examined under a microscope, will be found to consist of a ball of fibers so rolled and knotted together as to make their separation an impossibility. "Neps" are caused by improper ginning when found in cotton samples, though they are often produced in the manufacturing process in the picker and card.

"Motes" are minute pieces of seed, or immature seeds, and are hard to remove in the process of manufacture, especially if they are "bearded motes," or small pieces of seed to which adheres the downy seed covering.

Another condition to be taken into consideration in the grading is the color of the cotton. A pure white cotton is desirable, and it is important that the color or tint shall be uniform throughout a lot of cotton. This is especially true if the cotton is to be used for filling yarn, as in this case it will show largely on the face of the goods, for it is used without any dressing or sizing, which might effect or modify its color. Should a sample of cotton show portions that were stained, or off color, the grading would suffer accordingly, and in some cases the cotton would be classed as "tinged."

Cotton is usually graded according to a standard agreed upon in the leading cotton markets. The American system consists of seven *full* grades, the best of which is "fair." They are:

Fair
Middling Fair
Good Middling
Middling
Low Middling
Good Ordinary
Ordinary

These grades are subdivided into quarter, half and three-quarter grades, which express the minutest difference in condition and cleanliness. In the market the quarter and three-quarter grades are seldom recognized. The quarter, half and three-quarter grades are expressed by the prefixes, "barely," "strict" and "fully."

The following table presents the gradings of American cotton in as comprehensive a manner as possible:

QUARTER GRADE.	HALF GRADE.	THREE-QUARTER GRADE.
Barely Fair	Strict Middling Fair	Fully Middling Fair
Barely Middling Fair	Strict Good Middling	Fully Good Middling
Barely Good Middling	Strict Middling	Fully Middling
Barely Middling	Strict Low Middling	Fully Low Middling
Barely Low Middling	Strict Good Ordinary	Fully Good Ordinary
Barely Good Ordinary	Strict Ordinary	Fully Ordinary

FULL GRADE.

Middling Fair
Good Middling
Middling
Low Middling
Good Ordinary
Ordinary

Egyptian cotton is commonly divided into four grades. They are:

Good
Fully Good Fair
Good Fair
Fair

Brazilian and Peruvian cotton usually have these grades:

Good Fair
Fair
Middling Fair

It will be seen from the foregoing that grade really means the appearance of the cotton, particularly as to cleanliness.

In buying cotton for mill use there are several important points to be considered. First, the length of the staple. Second, the strength of the staple. Third, the uniformity in length.

These facts are determined by a process known as "pulling cotton." This process consists of grasping a small amount of cotton with both hands and pulling it apart. One-half is then thrown away, and the ends of the fibers projecting from the half which is retained are grasped between the thumb and forefinger of the right hand with the thumb held uppermost and drawn from the mass in the left hand, which is discarded. We now have a tuft of cotton held at one end between the thumb and forefinger of the right hand. With the left hand this tuft of fibers is straightened out, the short fibers removed and the ends grasped with the left hand. The right hand, or the forefinger and thumb of the right hand, now straighten out the projecting fibers and remove the shorter fibers, leaving a little tuft of cotton, the fibers of which are particularly uniform in length and parallel. This tuft of straightened fibers can be measured to determine the length of staple. They can be broken by firmly grasping the ends with the forefinger and thumb of both hands, and the power required to break gives the expert an idea of the strength of the staple. The amount of short fiber removed in the pulling process determines approximately the proportion of short fiber in the sample.

Something of harshness, strength and spinning qualities of cotton is sometimes determined by noting the sound produced by pulling apart a bunch of cotton held close to the ear.

After the length, strength and evenness have been determined, the next points are: The amount of sand and foreign matter contained; the proportion of unripe fibers; the color and evenness of color, and the amount of moisture.

In examining a cotton sample to determine the amount of impurity contained, it is fair to assume that a proportion of the sand and dirt has been shaken out in the handling which a cotton sample receives, and on that account the sample will be slightly cleaner than the original stock. The amount of dirt in the cotton must, however, be determined by the appearance of the sample and the amount of sand and dirt on the paper in which the sample is wrapped.

Unripe fibers can be detected by the eye on account of their semitransparent, glossy appearance. "Neps" and "motes" are also evident on close examination and inspection of the sample.

The color of a cotton sample can best be determined by comparison, and for such comparisons a north light is desirable. A sample of cotton may seem of good color when examined alone, and show a very decided tint when compared with other cotton or with an object which is a clean white. The presence of blue paper near a cotton sample has a tendency to neutralize the yellow tint and make cotton appear a pure white.

"Tinged" cotton is cotton which is stained in spots from the action of the juices from the crushed seed or plant, or from the presence of coloring matter from the soil. Tinged cotton should be avoided, especially for the manufacture of white goods.

The amount of moisture contained in the cotton cannot be determined from the sample unless the sample be freshly drawn, which is seldom the case. The odor of mildew, which is easily detected, is an indication of excess of moisture in the bale from which the sample is drawn.

In examining a bale of cotton at the mill, and in comparing it with the sample by which the cotton was sold, which is commonly done, the amount of moisture contained, if excessive, is easily determined by the feeling of the cotton, or by holding a handful against the face. A more correct method of determining the amount of moisture is by the "furnace test."

In this case a handful of cotton from the bale is very carefully weighed on delicate scales and the weight noted. The cotton is then subjected to the heat of a gas oven for several hours, at a temperature from 170° to 180°, and weighed again. This gives the entire amount of moisture in the cotton. The cotton is now allowed to remain for some time in the air, under normal conditions, until it has absorbed a reasonable amount of moisture from the air, after which it is again weighed. The difference between the first and last weighing gives the excess of moisture in the cotton, which is often from two to four per cent. A certain amount of moisture is desirable in working the stock, but manufacturers do not care to pay for large amounts of water. (From five to eight per cent of moisture is normal.)

One very important condition to be kept in mind, in selecting cotton for mill use, is to see that the samples are "even running" as to length of staple. In other words, to see that one or more bales of longer or shorter staple have not been mixed in with the cotton. Long-staple cotton is more valuable than short staple, all other conditions being equal, but the presence of long staple with the short causes an endless amount of trouble and annoyance in the mill, as will be explained later, and on that account great care is exercised to be sure that the cotton in the several bales of one lot is of about the same length of staple.

The purchase of cotton by the mills of New England is generally made from November to February inclusive, at which time it is not unusual for a year's supply to be secured.

Cotton is generally sold to Northern manufacturers on cash terms and delivered at New York, Fall River or Boston. The cotton is invoiced at gross weight, no allowance being made for bagging and ties. Cotton shipped to England, or "The Continent," is invoiced at net weight, as it is the custom to purchase it in that manner in those countries.

In invoicing cotton, or in purchasing cotton, the variety, grade and length of staple are mentioned as well as the number of bales and the weight of each. An order for cotton might read as follows: One hundred bales, Georgia Midland, Strict Middling, inch and one-eighth, or

500 Bales — Texas — Low Middling — One inch.

OPENING AND MIXING.

The opening of the American bale simply consists in cutting the ties, removing the bagging and ties, and breaking up and shaking out the condensed mass of cotton. When the bale is opened, the contents will be found in sheets, or layers, of condensed cotton, due to the pressure exerted in baling. This cotton is hard and compact, and before use must be allowed to expand. One advantage claimed for the round lap bale is that several bales can be unrolled and fed to the opener, or breaker picker, at the same time. In this case, however, the mixing is not as extensive as it is when the cotton is taken from a pile consisting of many bales.

There is a machine in general use in England, but comparatively little known in this country, called the Bale Breaker. This machine takes the condensed sheets of cotton as they come from the bale and tears them apart, delivering them in smaller pieces, and allowing the cotton to open or expand in the process. The bale breaker, a common type of which is shown in Fig. 9, consists of an endless apron, or lattice, on which the sheets of cotton

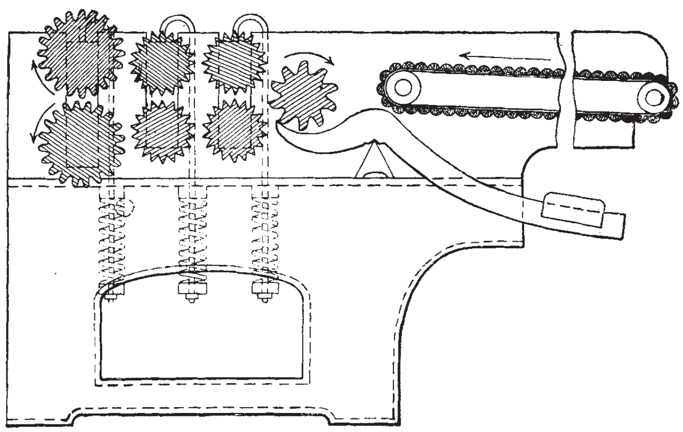


Fig. 9.

from the bale are placed. Directly in front of this traveling lattice is a revolving feed roll which grasps the cotton from the lattice and passes it over the pedals to the first pair of fluted and toothed rolls. There are usually three pairs of these rolls running at increased speeds. As the cotton passes from the back to the front of the machine the mass is pulled apart.

These rolls are driven by spur gearing and are positive in their action; the top roll in each case being weighted by stiff coil springs. The surface speed of the middle pair of rolls is about three times that of the back roll, and of the front roll about seven times that of the middle roll, which gives the surface speed of the front roll about twenty-one times that of the back roll, or a draft of twenty-one. The draft of the bale breaker, or the relation of the surface speeds of the front and back roll, varies according to conditions, but is commonly twenty to one to thirty to one, or a draft of from twenty to thirty.

Another form of bale breaker is shown in Fig. 10. In this case a swiftly revolving beater with projecting arms is employed to still further open the cotton and remove a portion of the heavier impurities.

The first process in the cotton mill after the bales have been opened is the mixing. This is, or should be, a part of the process of every mill, but in some cases its importance is underestimated. By mixing we do not necessarily mean only the mixing of differ-

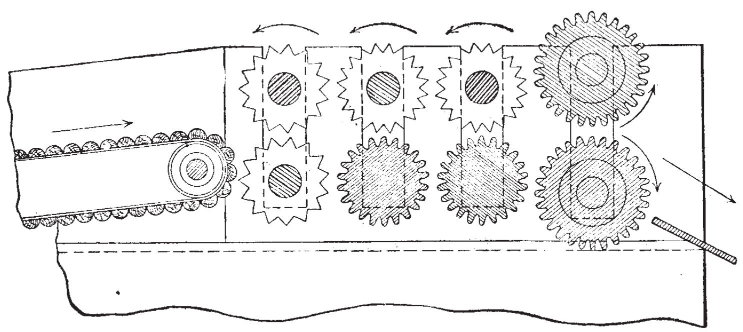


Fig. 10.

ent grades or varieties of cotton, but the mixing of different bales of the same grade and variety. This is absolutely necessary to produce the best results, for even when the different bales are of the same variety, the same grade, and grown in the same locality, and supposed to be of the same length of staple, there are likely to be found slight differences in length, color and condition.

There is also a great difference in the amount of moisture in different bales. Some are too dry to work well and some too moist, and by mixing, the dry absorbs some of the moisture from the damp bales, and a better average condition is secured. The mixing also allows the "opening up" or expanding of the condensed cotton, leaving it in better shape for the action of the beaters in the picking process. The common method of mixing in this country is to provide extensive floor space back of the feeders. The larger the better within reasonable limits. When the bales are opened, a sheet or armful of cotton is taken from one or more bales and scattered evenly over the floor. This is repeated with cotton from other bales until a pile or stack is formed containing enough cotton for several days' run. This pile of cotton is composed of many thin layers, each layer representing a bale, more or less. When this cotton is fed to the machines it is taken in as nearly vertical sections as possible, so that each armful will contain parts of several bales. In this way a very thorough mixing is secured, giving a uniform condition of cotton from start to finish. Large mixings are to be preferred to small ones; the size being limited in many instances only by the floor space available.

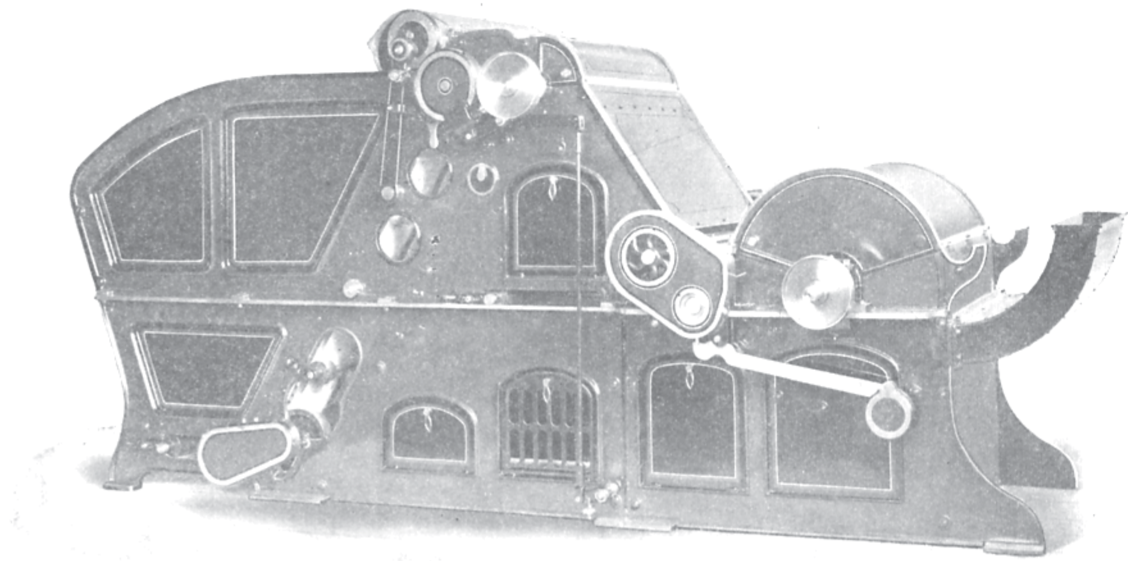
Many modifications of this process are to be found in different cotton mills. In some cases the bales are opened in the storehouse, and the cotton from several bales fed into the hopper of a distributor. From here the cotton is drawn by an air current through sheet metal pipes and delivered on the floor of the picker-room back of the feeders.

In some cases the mixing is done in large bins which have movable floors, so that, as the cotton is used, the stack can be moved forward to be at all times within convenient distance of the feeders, and mixing can be carried on at the back of the bin. In this case the cotton from several bales is thrown into the bin through a hole in the floor above. With this arrangement the mixing is a continuous operation and can be performed at the back of the bin while the cotton from the front is being used.

In English spinning mills there are in many instances elaborate preparations for very large mixings; in some cases sufficient amounts to last during a month's run. This is necessary on account of using so many different grades and varieties of cotton, in which case the mixing of several kinds at a different price, each to produce a certain result at a certain cost, becomes a fine art.

Variation in color or tint in the yarn produced is less liable to occur where large mixings are used.

When different cottons should be mixed in exact proportions, or when a combination of colored and white cotton is used to produce a certain tint, the mixing can be done more correctly at the intermediate or finisher picker. This will be explained more fully later. If mixed in the stack, the proportion of each would not run evenly from start to finish, therefore producing yarn which would vary slightly in color from time to time.



COMBINED SELF FEEDER AND OPENER WITH 30-INCH SPECIAL CYLINDER
Howard & Bullough Am. Machine Co. (Ltd.)

COTTON SPINNING.

PART I.

OPENING AND PICKING.

When upland cotton has been ginned, it is made ready for transportation into loosely packed bales, in which form it is often used in nearby cotton mills, but for shipment to any distance, by railroad or steamship, the bales are collected at some central point and compressed by heavy presses and made less bulky, saving much space.

The dimensions of the standard bale are 54 inches length by 27 inches width, the thickness depending upon the pressure to which it has been subjected, and is intended to weigh 500 pounds. But, as a fact, the bales vary from 52 to 72 inches in length, from 24 to 30 inches in width, 18 to 24 inches in thickness, and weigh from 400 to 600 pounds.

They are covered with bagging and bound with hoop-iron bands, or ties, fastened together by iron buckles. The bagging is of such coarsely woven stuff that it is very easily torn and offers but scant protection against dust, rain and fire, and, as the bales are often allowed to stay in a cotton yard some time before shipment, the cotton on the surface becomes very much damaged. It is certain that this method of baling and handling cannot add to the value of the cotton, and custom alone seems responsible for it.

Another form in which cotton is packed is the "round bale." These, as the name implies, are cylindrical, and are of two lengths, 35 and 48 inches; and 22 and 25 inches, respectively, in diameter. They are made by feeding the cotton to a revolving core, or arbor, which is held in position between two iron rolls by a heavy rubber belt. One of the rolls is stationary and the other, which is kept firmly held against the bale by hydraulic pressure, recedes as the bale increases in size. The friction of the belt and rolls causes the bat to be wound into a hard, firm roll, which weighs about 35 pounds to the cubic foot. When the bale has reached the full diameter, and before it is removed from the press, it is wound with one turn of cotton cloth, which is sewed on.

Cotton that is grown in different localities varies in quality, and as bales from widely separated districts are likely to be used in the same mill, careful selection is necessary. Wide experience and good judgment are required to get the best results.

To obtain as nearly as possible uniformity in quality, length of staple, and, for some varieties of work, color, and the cotton is mixed; that is, the bales to be used are placed on edge, the ties and bagging removed. They are then turned on their sides, and a sheet of cotton taken from each in turn, by hand, and thrown into the cotton bin, ready for the opener. By this means an average is obtained.

Cotton which is to be spun into fine yarn must be long staple, uniform in color, and clean, while that to be used for goods which are to be bleached may require long staple, while color and cleanliness are not so essential, but no rule for mixing the different varieties and grades can be followed. Some mills use lower grades of stock than others for the same class of work with apparently equally good results.

In many of the smaller mills it is the custom to mix enough cotton to last three or four days, or even longer, if space in the opening and mixing room will permit, and, by allowing it to air for several days, an equalization of the moisture in the whole mass takes place. In large mills, on the contrary, it is usually the practice, because of the amount consumed, to take the cotton from the bales and throw it directly into the feeder of the opener. It is not necessary to air the cotton, as it is bought in large quantities and stored in cotton houses, where it often remains for a long period and is therefore partially dried.

Opening and picking, which is the first mechanical process the cotton undergoes, is, briefly stated, the removal of as much foreign substance as possible with the least injury to the fibers. The foreign substances found are particles of sand, which have been blown about and have become lodged in the bolls; dirt, which, during a heavy rain has spattered upon the bolls, which grow low upon the stalks; particles of dried leaves and stalks, gathered in picking, and pieces of seed and husks, broken in ginning.

The various styles of machines used in picking differ but slightly in principle and design, each having some features peculiar to each particular make. They are arranged, generally, in sets of two, three or four, the number of sets depending upon the production required and the number of machines in each set; upon the quality and condition of the stock being worked, very dirty cotton requiring, of course, more picking and cleaning.

There are four systems into which the operation of picking may be divided:

1. That in which part of the machinery is on one floor and part on another.

2. That in which all of the machinery is on one floor and no cleaning trunk is used.

3. That in which all of the machinery is on one floor and a cleaning trunk is used.

4. That in which the bales are opened in an adjoining building or room and the cotton is "blown" into the picker room.

The arrangement of the several machines necessary in each system depends upon the location of the carding machinery; the aim being to have the laps delivered from the finisher picker upon the same floor, and as near the cards as possible, in order to save time and expense in carrying them about and to avoid any unnecessary handling of the cotton. This, of course, cannot be done always, especially in some of the old mills, but in planning a new one this should be borne in mind.

SYSTEM ONE.

Fig. 1 is a plan of the opening room of a modern cotton mill equipped with two sets of picking machinery, arranged on the three-process system, a style in use in many mills at the present time. Fig. 2 is a plan of the second floor of the same mill, and Fig. 3 is a sectional elevation.

The machines on the first floor are an automatic feeder, A, connected to an opener, B; and on the second floor are a single beater breaker picker, D, with a condenser and gauge-box, a single beater intermediate picker, E, and a single beater finisher picker,

F. A cleaning trunk, C, connects the opener on the first floor with the breaker on the second.

Beneath the opening-room is the dust-room, into which the

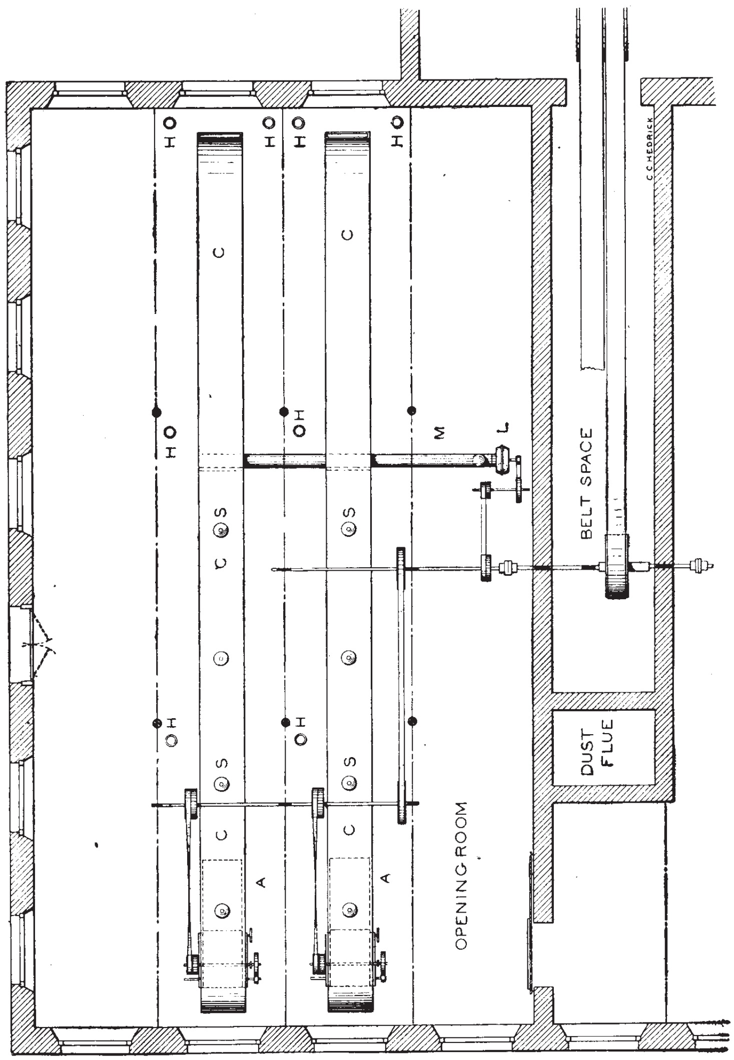
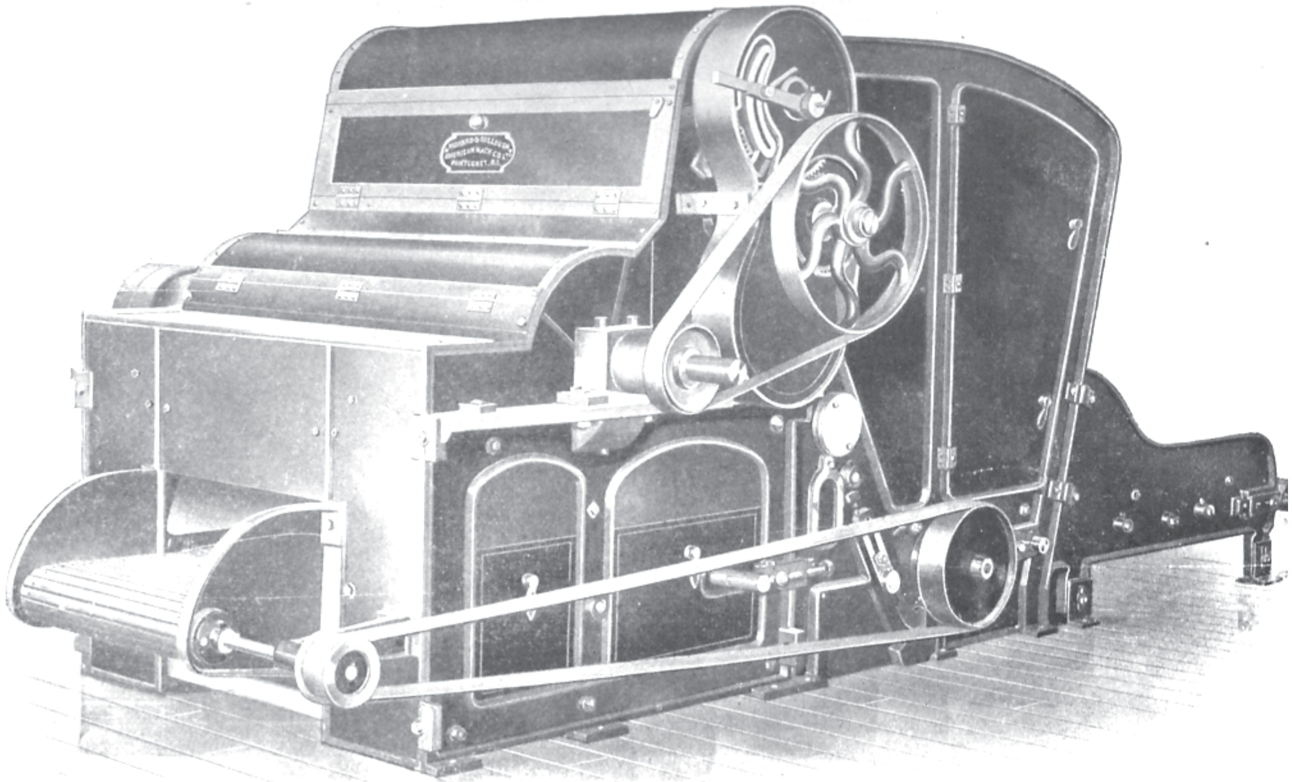


Fig. 1. Plan of Opening Room.

dust, dirt and fine particles of cotton are discharged from the picker by fans, through the galvanized iron pipes, H. These pipes are provided with an automatic closing damper, K, which is



HOPPER BALE OPENER, CAPACITY 175,000 LBS. PER WEEK
Howard & Bullough Am. Machine Co. (Ltd.)

kept open while the picker is running by the pressure of air in the pipe, but when the machine is stopped the pressure ceases, and the damper closes of its own weight, assisted by the pressure in the dust room, produced by the other fans. This automatic closing of the damper prevents the dust and dirt from blowing back into any machine not running.

The dust-room is provided with a flue, or chimney, which leads through the roof and which should have an area of about 3 square feet for each fan. It usually occupies all of the space beneath the opening-room the floor should be cemented, and the overhead woodwork covered with tin or any fireproof material. The heavy dust and leaf settle to the floor, while the light dirt passes out with the air.

In the systems shown in Figs. 1, 2 and 3, the cotton is thrown into the hopper of the automatic feeder, A, and is then delivered to the feed apron of the opener, B, by which it is carried forward between the feed rolls to the beater. Most openers have a three-bladed beater about 20 inches in diameter. Beneath the beater is a grid, over which the dirt is driven as the cotton is drawn through its surface and up through the cleaning trunk, C, to the breaker picker, D. The starting and stopping of the feed of both opener and feeder are controlled by the breaker picker.

The cleaning trunk is provided with a grid surface, over which the cotton passes to the breaker picker. The dirt, which is heavier than the cotton, settles between the grids into pockets directly beneath, which can be cleaned out when necessary.

The cotton enters the breaker picker through a condenser and gauge-box, which delivers it to the feed apron. It then passes forward through the feed rolls to the beater, which is usually three-bladed, where it receives a most thorough cleaning. Passing forward over inclined grid bars, through which some of the loose dirt falls, it is deposited upon two slowly revolving cages or screens. From these cages it is drawn forward between several calender rolls, formed into a sheet and wound upon a lap roll. This is the first formation of a lap in the process.

The laps from the breaker are now taken to the intermediate picker, E, to undergo another cleaning and picking. Four laps are placed upon the apron of this machine, this being the first doubling of the laps. The cotton next passes through the intermediate and is formed into a lap in the same manner as in the breaker picker. From the intermediate it passes to the third

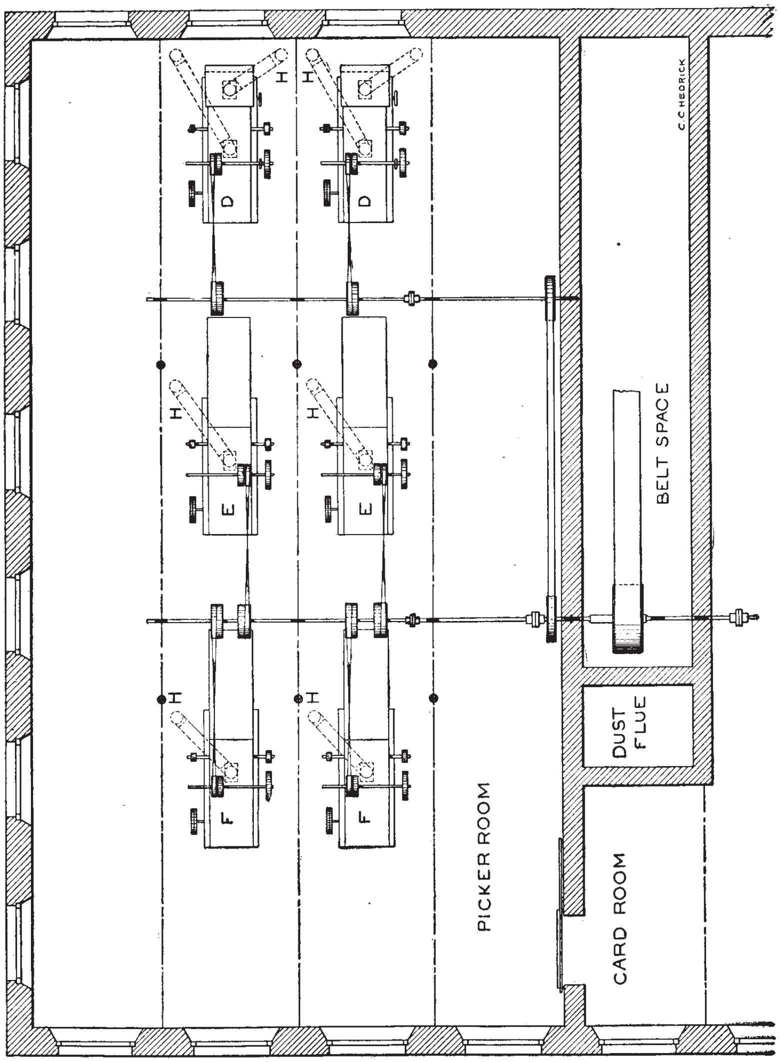


Fig. 2. Plan of Picker Room.

machine, the finisher picker, F, which is substantially the same as the two previously mentioned machines, the laps being doubled four into one on the apron. Here the cotton is formed into a finished lap, ready for the card. As before stated, both the intermediate and finisher pickers are generally provided with eveners, several styles of which will be shown.

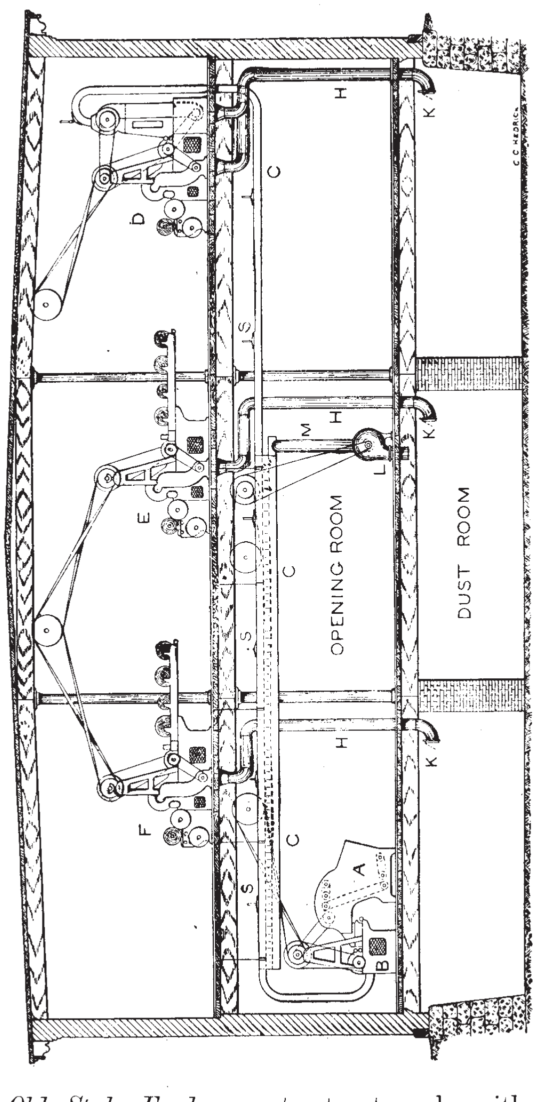


Fig. 3. Sectional Elevation.

The Old Style Feeder contrasts strongly with the present automatic or hopper feeder, and a description of it may be interesting to some. In the old way the feed apron was divided off every yard or two, usually by painting some of the apron slats a darker color than the rest, and the attendant would place an armful of cotton on a pair of scales set to some particular weight and then spread the amount between the divisions on the apron. The attendants were often careless, sometimes the weight of their arms was included, while at other times they simply went through the motions of weighing, not even looking to see if the scales balanced or not. Frequently, when pressed for time, they would take an armful from a bale and throw it on the apron, regardless of the amount. It will readily be seen that this method could not be satisfactory.

The Automatic Feeder and Opener. Fig. 4 shows an automatic feeder connected to an opener. The hopper A is kept about two-thirds full, in order that the cotton shall be fed as evenly as possible. The bottom of the hopper is formed by a horizontal apron, B, called the bottom apron, or lattice, by which the cotton is carried forward against the elevating apron C^1, which runs in an almost vertical position, and which is supported at intervals by carrier rolls, and consists of a heavy canvas belt backed with leather strips, to which are fastened wooden slats. Projecting from these slats are pins, by which the cotton is caught and carried upwards. At the top of the elevating apron is situated the spike roll D, which is about six inches in diameter and has steel pins or spikes projecting about three-fourths of an inch from its surface. The object of this roll is that it should strike off any surplus bunches of cotton which cling to the elevating apron, and to regulate the amount of cotton carried forward to the opener. Around the spike roll runs an endless leather apron, E, called the spike-roll apron, which has slots or openings in it corresponding in position to the pins of the roll, and through which the pins project as the apron passes around the roll. Any cotton that is disposed to collect on the pins is readily stripped off by this means.

The amount of cotton which is delivered to the opener is regulated by the position of the spike roll, which is adjustable horizontally; thus, the greater the space between it and the elevating apron, the more cotton is allowed to pass. In order that the spike roll shall stand parallel to the elevating apron, and that the roll shall be moved parallel with it when changing its position, indexes are placed on the outside of either side of the hopper, by which the exact position may be noted. Between the lower end of the elevating apron and the end of the bottom apron is a space of about $1\frac{1}{2}$ inches, which allows dirt and foreign substances to fall through into the hopper screen. This screen can be dropped and the dirt removed.

The cotton which is left upon the pins of the elevating apron, after it has passed the spike roll, is next acted upon by the doffer, F. This is driven from a countershaft by the belt, K, and is about 15 inches in diameter, and has, extending across its whole

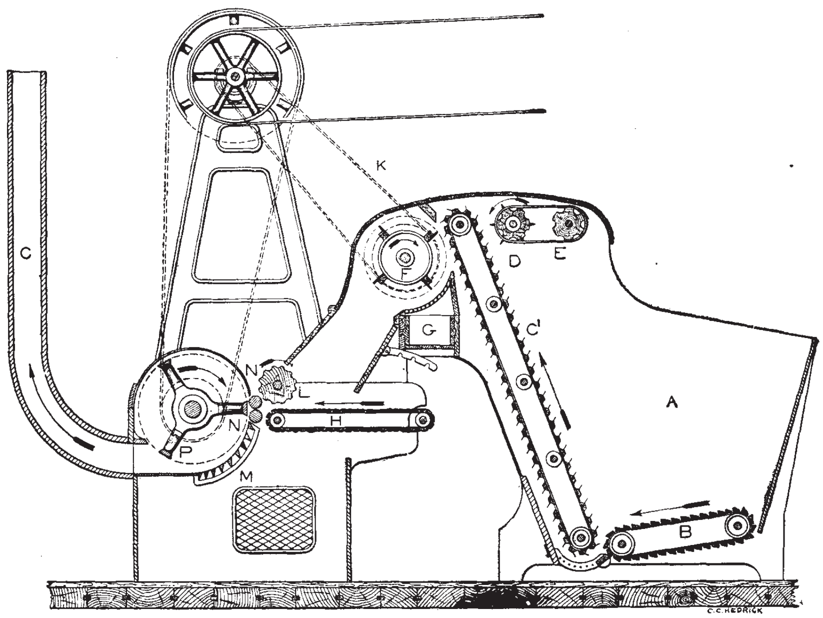


Fig. 4. **Section of Automatic Feeder and Opener.**

face, four wooden blades faced with leather, which are slightly in contact with the pins of the elevating apron, and, as the doffer runs about 160 revolutions per minute, a continuous series of blows is given, by which the cotton is stripped or beaten from the pins and thrown against a screen or grid directly beneath the doffer, called the doffer screen, through which any loose dirt will fall. Beneath the doffer screen is a dust drawer, G, which receives dust and dirt that is beaten out by the doffer. From the doffer screen the cotton passes down an incline on to the feed apron of the opener, H, being assisted by the current of air produced by the doffer.

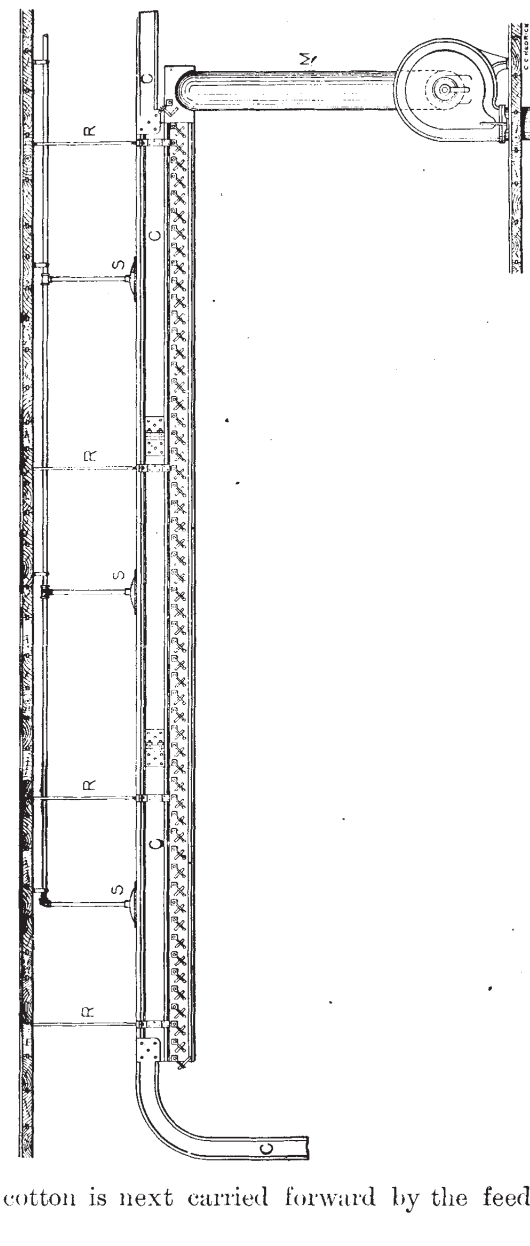


Fig. 5. Horizontal Cleaning Trunk.

The cotton is next carried forward by the feed apron, passing under the press roll, L, to the feed rolls, N. The press roll condenses the cotton, that it may be drawn readily between the feed rolls, which, being small in diameter, could not receive it in a loose form. After passing the feed rolls the cotton is acted upon by the blades of the rigid beater, P. This consists of three steel blades running across the width of the machine, which are securely riveted to four or five sets of arms or spiders, which are fastened to the beater shaft. These blades are beveled slightly

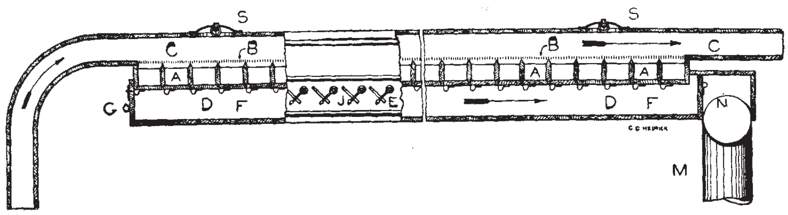


Fig. 6. Section of Horizontal Cleaning Trunk.

on each edge, but not enough to cut the cotton, and as they become dulled by constant use the beater can be reversed in its bearings and the other edges brought into use, both ends of the beater shaft being made alike for this purpose.

The beater generally runs 1,200 revolutions per minute, therefore each inch of cotton delivered by the feed rolls receives a great many blows, by which it is opened, cleaned and removed from the rolls in small tufts, which are thrown with considerable

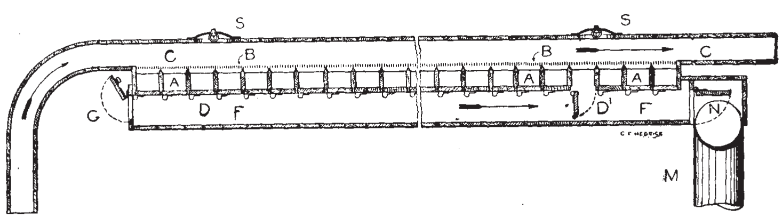


Fig. 7. Same as above, with pockets Dropped for Cleaning.

force against the beater grid, M. Thus the dirt, seed and heavy impurities, which are struck down with the cotton, fall between the bars into the space below, while the cotton, which is very light, is prevented from passing through with the dirt by the current of air which draws it through the trunk to the breaker and which is produced by the fan in the gauge-box section of the breaker.

Horizontal Cleaning Trunk. Figs. 5, 6 and 7 show details of the trunk connecting the opener and breaker picker. Fig. 5 shows the whole length of the grid, or cleaning surface, 40 feet being usually sufficient for all but very dirty stock. The trunk is hung from the under side of the floor above by rods, R, placed about 10 feet apart, lengthwise, and upon each side. As many of the fires which occur in the picker room are caused by the beater in the opener striking some hard substance, means must be provided to prevent injury to the trunk, which, being of wood, takes fire very easily; hence automatic sprinklers, S, are placed at intervals along the top of the trunk opening into the passage through which the cotton is drawn, a very slight fire causing the sprinklers to operate. At one end of the trunk is a galvanized iron pipe, M, connected to a fan, L. This is for cleaning the trunk, which must be done regularly. Usually the fan is connected to the end of the trunk nearest the opener, as the greater portion of dirt falls out of the cotton before it reaches the farthest end of the grid surface; but for convenience it is sometimes connected to the other end, and in order to show the arrangement without obstructing the view of the opener, it is placed in this position in Figs. 1, 3 and 5.

Enlarged sections of the trunk are shown in Figs. 6 and 7. The trunk is divided vertically into three sections. The top one, C, through which the cotton passes to the breaker, is separated from the middle one by a grid surface, B. The middle section consists of a series of pockets, or compartments, A, into which the dirt and leaf settle as the cotton passes slowly over the grid. The bottom of these pockets, D, is hinged at one side, the hinge being connected to a handle, E, on the outside of the trunk, which is held in a closed position by a spring, J. The lower section of the trunk F is a passage, connected to the exhaust fan L by the pipe M. The bottom of the pockets opens into this passage, which is closed at both ends by the doors G and N.

When it becomes necessary to clean the trunk, which is done from two to four times a day, the feed on the opener is usually stopped. The fan L, which is driven separately from the opener, from a countershaft, is started, and the doors G and N opened as shown in Fig. 7, this producing a strong current of air through the lower section or passage leading to the fan. The springs on the outside of the trunk, which hold the bottom of the pockets in position, are pressed and release the handles and allow the bottom of the pockets to fall into a vertical position, as shown at D^1 in Fig. 7. The refuse falls into the passage and is carried along by the air current and discharged into the dust room. Every other pocket is usually taken at one cleaning.

Breaker Picker with Condenser and Gauge-box. When the breaker picker is located at some distance from the opener and is connected by a trunk, as in Figs. 1, 2 and 3. There must be considerable cotton in transit between them when they are in operation. As the feed of the opener is stopped, usually, for a brief period while doffing the breaker, it is evident that the cotton in the trunk would be drawn forward and deposited upon the apron of the breaker. This would cause a thick place to be formed in the first part of the next lap wound, followed immediately by a thin place, while the cotton is being drawn along the trunk. This is, of course, for a short time only, but in order to insure the laps being free from any irregularities in weight from such cause, the receiving end of the breaker is provided with a condenser and gauge-box, which is shown in the section of the breaker picker in Fig. 8.

In the top of the condenser is a revolving screen, or cage, A, on the inside of which is a stationary shield, or cradle, B, which covers a little more than one-half of its surface, the air current passes through the perforations of the cage not closed by the cradle. The cotton, which enters from the trunk C through the top of the condenser box, is deposited upon the open side of the cage. Each end of this cage opens directly into a dust passage, D (shown by dotted lines), on the outside of the gauge-box. The air passes out through the ends of the cage and down this dust passage to the fan E, from which it is forced out through the pipe H to the dust room.

As the screen revolves slowly, the cotton which is deposited upon its surface is brought around between the screen and the roll F. At this point the cradle covers the screen, preventing the passage of air; the cotton is thus very readily stripped from its surface, being assisted by the roll G, whose surface runs in the opposite direction to the surface of the cage. The cotton passes between the rolls, F and G, and falls upon the feed apron, J.

It will be seen that the roll, G, is held rigidly in its bearings, but the roll, F, is supported at either end by a lever, G^1, which is centered at F^1. The short end of this lever carries the roll, while the long end, being heavier, keeps it pressed against the cage, subject to the varying thickness of the cotton passing through.

The gauge-box is divided into front and back compartments, M and K, by a swinging partition, L, which regulates the amount of cotton allowed to pass forward on the feed apron. The front compartment, which receives the cotton as it falls from the condenser roll, is usually about half full, but with the stopping of the breaker and feed of the opener, the cotton is drawn out of the trunk and fills this compartment. Any surplus will fall over into the back compartment, and can be removed by opening a door at K^1. With the starting of the breaker, the cotton that is contained in the front compartment serves as a source of supply until the cotton comes through the trunk. By narrowing the front compartment by the swinging partition, L, the feed may be made lighter, as a smaller portion of the surface of the feed apron will be covered. The position of the partition is regulated by a pin which fits into a series of holes drilled in the under side of the board, L^1, which forms the bottom of the compartment, K.

From the feed apron the cotton is drawn between the feed rolls, N^1 and N^2, and brought into contact with the blades of the rigid beater, P. This beater, which is constructed in the same manner as the one previously described in the opener, runs about 1,500 revolutions per minute. The object of this beater is to continue opening and cleaning, the dirt being driven down between the bars of the beater grid, G^2, by the force of the blows it receives from the blades of the beater.

It will now be seen that a double operation is going on, the cotton being drawn along by the air draft, while the heavy impurities are being driven through the grid against the air draft which enters from below and passes up between the bars.

The speed of the fan, F, which is about 1,000 revolutions per minute, plays an important part in separating the dirt from the cotton. If the draught is not strong enough the cotton will be driven down through the grid with the dirt, making too much waste, while if it is too strong, the dirt will be drawn along with the cotton into the lap.

The beater grid consists of stationary bars, which extend from side to side and around the beater for a quarter of its circumference. The first bar under the bottom feed roll is set about $\frac{3}{8}$ inch from the circle described by the beater blade. while

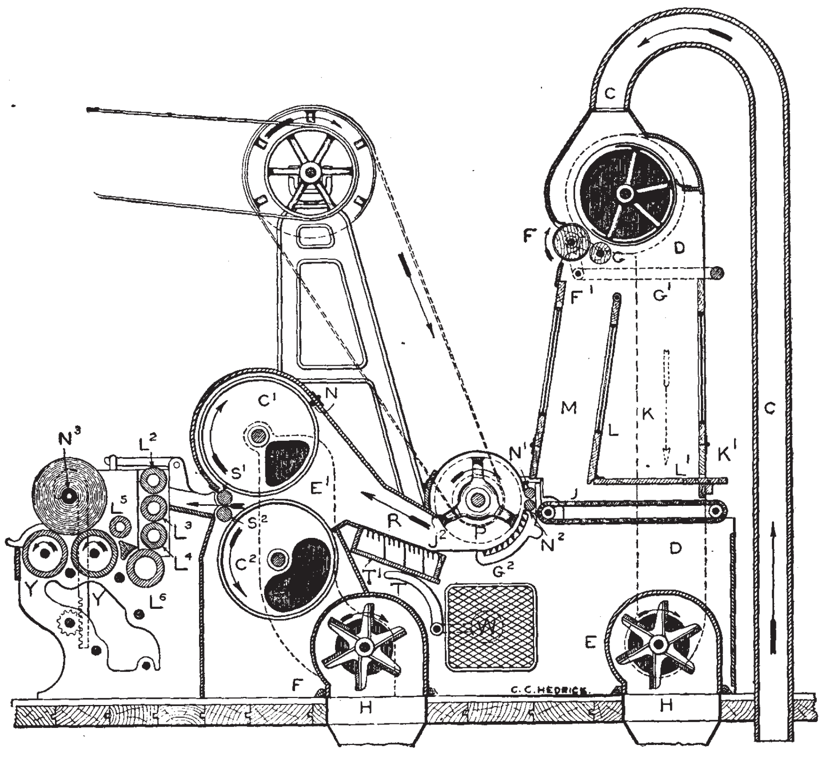


Fig. 8. Section of Breaker Picker, with Condenser and Gauge Box Section.

the last bar is set about $1\frac{1}{4}$ inches away. The grid bars are supported by brackets, which are adjustable, and are bolted to the frame. The space between the bars is graduated, those nearest the feed roll having the widest space between them, as the greater part of the dirt is removed before the cotton passes to the last of them.

The cotton is now under the influence of the fan draft, by which it is drawn forward over the inclined grate bars, R, and is collected upon the revolving cages, C^1 and C^2. The strip, N, which is faced with leather, prevents it from collecting above this point on the top cage. As the cotton passes over the inclined grate bars, the dust and dirt which are shaken out of it settle down between them into the box, T^1. A dead-air space is formed by every fourth bar extending to the bottom of the box, thus preventing the dirt from being drawn back into the cotton. The bottom of the box is kept up in position by the lever, T, and the weight, W, as shown by dotted lines on the outside of the picker. When it is necessary to clean out the box the weight is raised, allowing the bottom, which is hinged at one side, to swing down.

The stripping plate, J^2, by reason of being set close to the beater, prevents the cotton from following around with the air current caused by the beater. The air draft passes out at both ends of the cages, through the openings, D^1 and D^2, and down the dust passage, E^1, (represented by dotted lines), to the fan, F. From this point the air is forced out through the pipe, H, into the dust-room. The cages thus form a screen which assists in cleaning the cotton, the fine particles of dust and lint passing through the perforations with the air draft. The openings, D^1 and D^2, can be closed by dampers when it is desired to throw the draft all on one side of the cages, as the lap sometimes becomes thin on one edge. The perforations, or meshes, in the top cage are generally made larger than those in the bottom cage, thus allowing a greater passage of air through the top cage, and consequently a thicker sheet of cotton is formed. If the cotton is deposited equally on each cage, although formed into one sheet by passing between, there is a tendency to separate, or split, when unrolled behind the finisher picker or card, but as the sheet from the top cage forms the inside face of the lap, this trouble is in a measure overcome.

Another method for preventing the splitting of the laps, and which is in use by some builders of machinery, is to have the top cage considerably larger in diameter than the bottom one. By this means the exposed surface of the top cage is made larger and a thicker sheet of cotton is formed. When one cage is used in the formation of a sheet the laps are not as likely to split, since there is only one surface upon which the cotton is deposited.

From the cages the cotton is stripped off by the stripping rolls S^1 and S^2, and drawn between the calender rolls L^2, L^3, L^4 and L^6, which are heavily weighted, and being slightly different in diameter, the faces of the lap are smoothed or ironed, which also tends to prevent them from splitting. After leaving the calender rolls the cotton passes forward under the press roll L^5, and is wound on lap roll N^3. This lap roll is held down by friction and rests upon two fluted rolls, Y, called lap calender rolls, which revolve and cause the lap roll to wind on the sheet of cotton as it comes from the calender rolls. The lap is thus wound very compactly and firmly.

Leaving the breaker picker, the cotton passes through the intermediate and finisher pickers. The principle of these two machines, so far as the opening and cleaning is concerned, is the same as in the breaker picker, with the addition of an evener and a long feed apron. The design is also practically the same, differing only in mechanical construction.

When the double-carding system was used almost wholly, not so much attention was given to the weight of the picker laps, but with the increasing tendency towards spinning finer yarns, and the general introduction of the revolving flat card, it became necessary to produce picker laps of a more uniform size and weight. This led to the adoption of single beater pickers instead of using two or three beater machines as formerly.

The first operation of doubling is placing four laps upon the apron of the intermediate picker, so that the thin or light places will be distributed over its surface. If the laps from the breaker are unrolled and held to the light, there will be seen thick and thin places, and as they are not always in the same portion of the lap, by placing one lap over another we get a more even sheet, but one four times as thick.

Intermediate and Finisher Pickers. A section of an intermediate picker is shown in Fig. 9. The laps M, B, A and G, from the breaker, rest upon the feed apron D, by which they are unrolled. It is advisable that they be of different diameters, so that a continuous sheet four laps thick may pass through the feed rolls.

If the laps are all of the same diameter, or nearly so, there is a possibility of two or more running out at once, and, during the time required to replace them, a break is likely to occur in the continuity of the four thicknesses; but with the laps of different

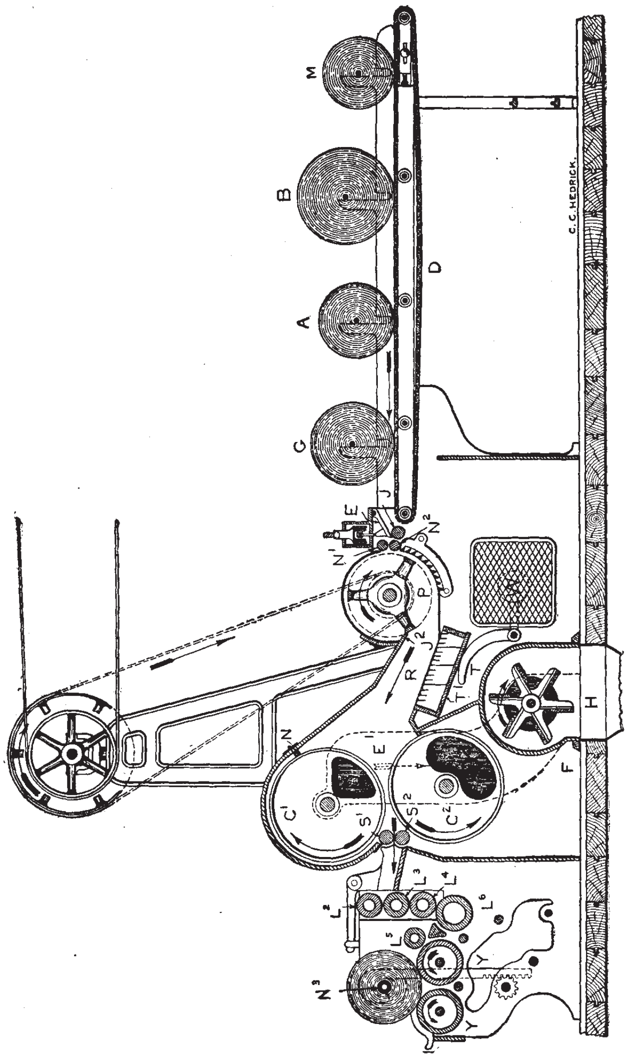


Fig. 9. Section of Intermediate or Finisher Picker.

diameters, the replacement of one, which can be done very quickly, makes a break in the doubled laps well-nigh impossible. The laps are carried forward on the feed apron, and are drawn between the evener roll, J, and the sectional plates, E, then between the feed rolls, N^1 and N^2. From this point the cotton is treated in exactly the same manner as in the breaker. The letters of reference are the same on the sections of both machines.

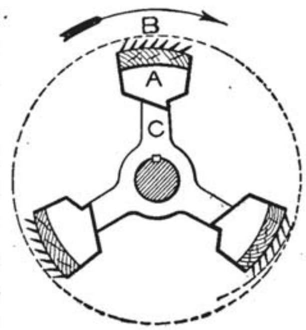


Fig. 10. Carding Beater.

The cotton when taken from the intermediate picker goes through the third process, that of the finisher picker. It is treated the same as in the previous machine, the only difference in the two machines being the carding beater, used generally in the finisher.

Beaters. Of the different styles of pin beaters which have been in use from time to time, the carding beater gives the best results. A section of this beater is shown in Fig. 10. It will be seen that it consists of three wooden lags, A, securely fastened to the arms, C, of the beater shaft. From these lags project steel pins, B, arranged spirally, each row being farther from the center than the row preceding it. The carding and beating action is combined in this beater, the pins penetrating the tufts of cotton, thoroughly separating and dividing them. In this way the cotton is deposited on the cages in a finer and more even sheet, and the work of the card is lessened slightly. Notwithstanding the claim made by many to the contrary, the carding beater is capable of removing more dirt and leaf than the rigid beater. Figs. 11 and 12 show sections of two-bladed and three-bladed rigid beaters. In comparing them, it will be seen that the two-bladed one must be run at a higher speed to get the same number of blows per minute, and while

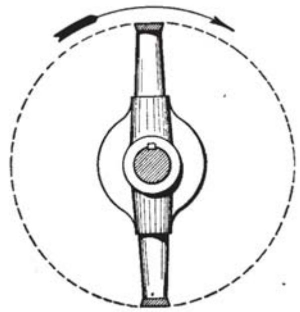


Fig. 11. Two-bladed Beater.

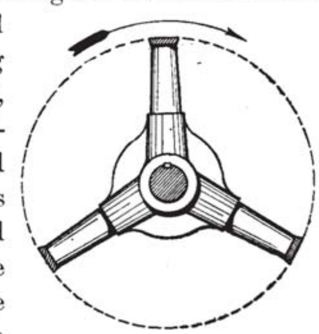


Fig. 12. Three-bladed Beater.

some object to this necessary high speed, it is certainly cheaper to construct this style. The three bladed beater is generally used on openers, and the two bladed on breakers, intermediates and finishers.

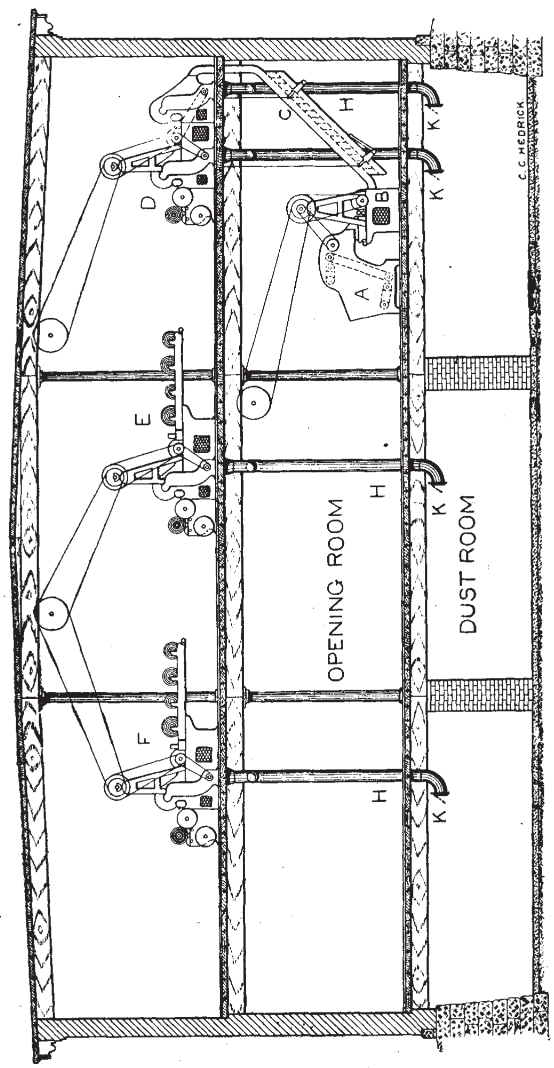
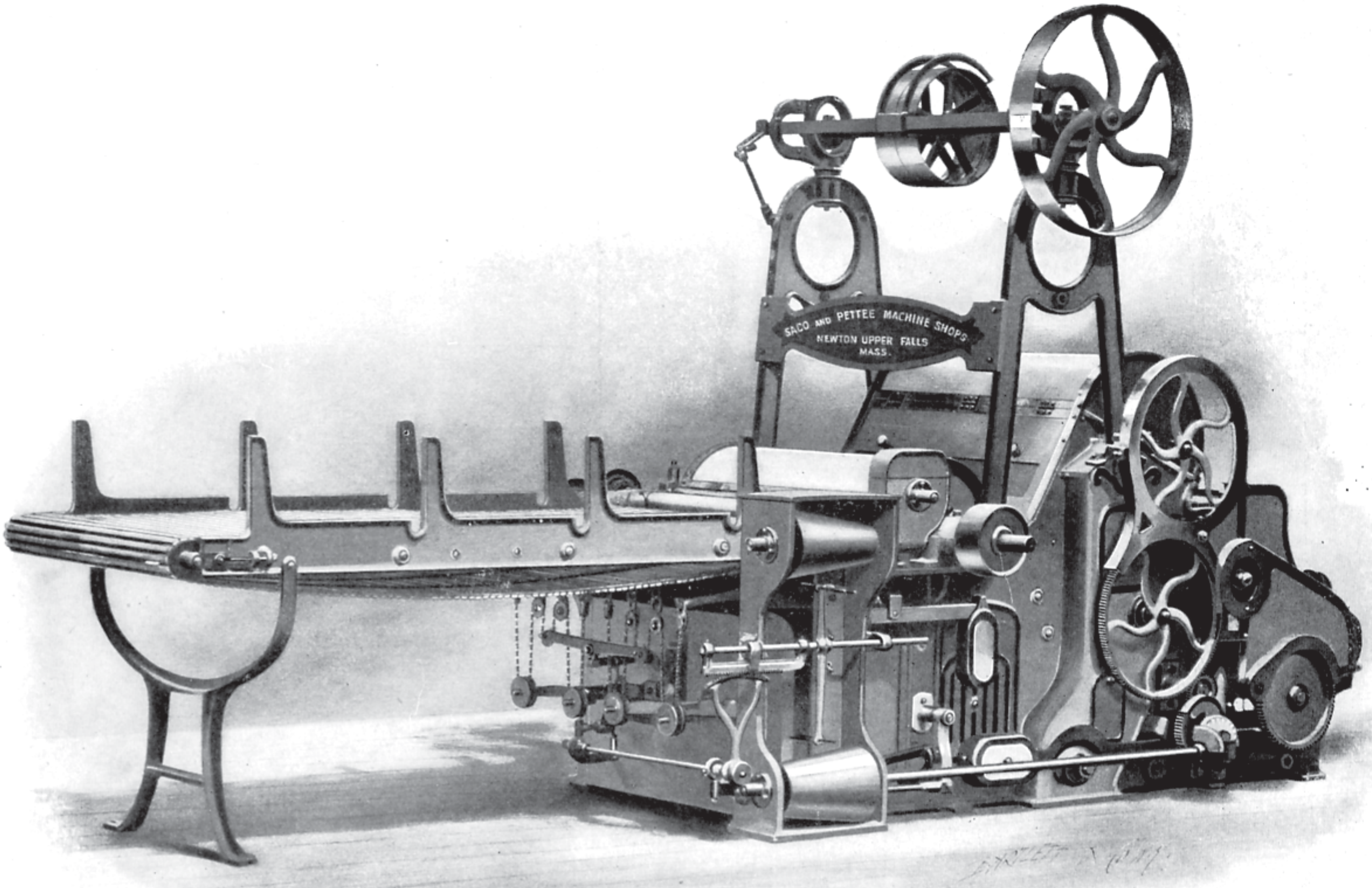


Fig. 13. Section of Elevation of Mill showing Inclined Cleaning Trunk.

Some of the rigid beaters are made with the edges of the blades of hardened steel, but these do not wear any better than



SINGLE BEATER INTERMEDIATE AND FINISHER LAPPER WITH SECTIONAL EVENER
AND CONSOLIDATED LAP HEAD

the ordinary ones, and become dulled about as soon, and cannot be sharpened without grinding, which is considerable trouble, while the others can be sharpened by simply planing off the dulled edges.

Picking Machinery on Different Floors. This is shown in the sectional elevation of a cotton mill in Fig. 13, which is very similar to the one shown previously in Fig. 3, also

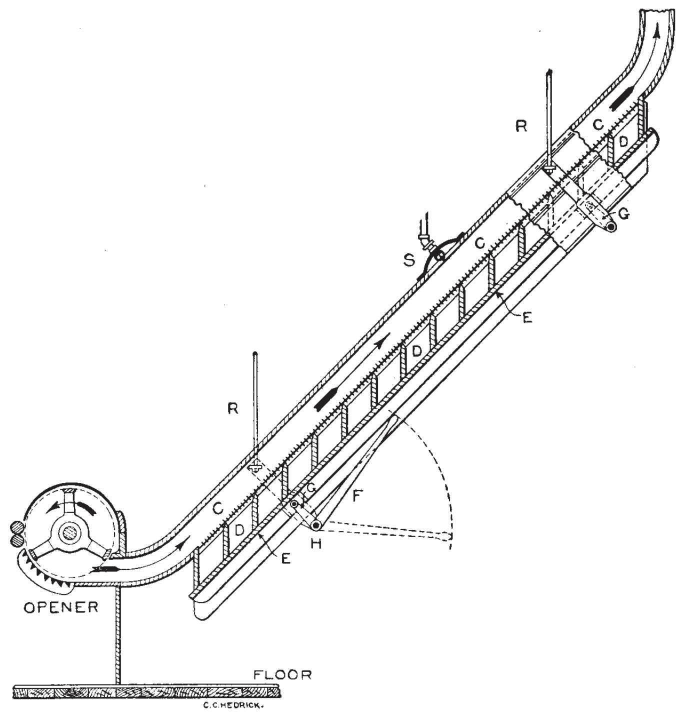


Fig. 14. Section of Inclined Cleaning Trunk, with Pockets closed.

a three-beater system. The horizontal cleaning trunk is dispensed with and an inclined trunk used in its place. One end of this trunk is connected to an opener on the first floor, the other to a one-beater breaker picker, with a screen section on the second floor. The distance between the opener and the breaker is short and does not require a condenser and gauge-box to receive the cotton, otherwise the machinery used is exactly the same as in Fig. 3. The inclined cleaning trunk is used quite extensively in

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preference to the horizontal one, as the length of grid, or cleaning, surface is considered by many to be sufficient for the removal of nearly all of the loose dirt, and the cleaning of this style of trunk can be very quickly accomplished.

Inclined Cleaning Trunk. Fig. 14 shows a section of an inclined trunk, with the pockets closed, as when the machine is running. It is suspended from the floor above by rods R, and consists of two parts: the top passage C, through which the

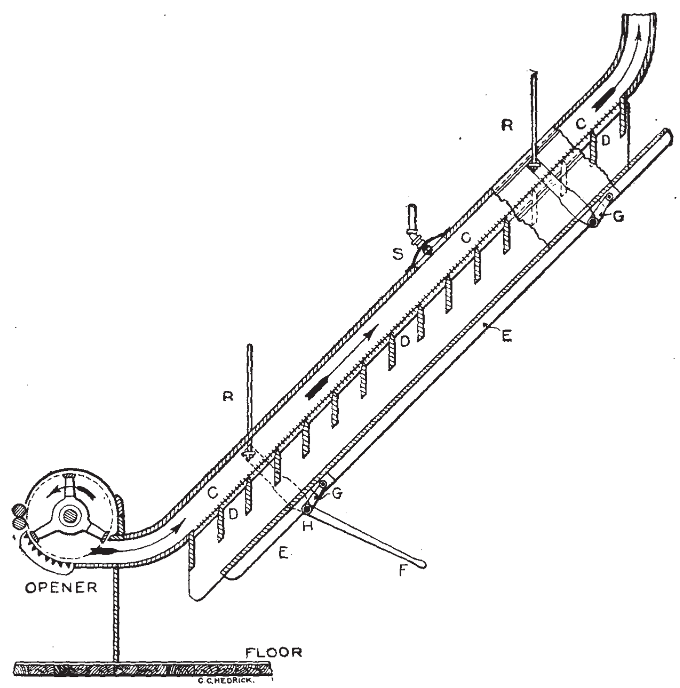

Fig. 15. Section of Inclined Cleaning Trunk, with Pockets open.

cotton passes from the opener to the breaker; and the pockets D, which receive the dirt which falls out of the cotton. The top passage is provided, in case of fire, with an automatic sprinkler, S. The pockets are separated from the passage by the grid surface, which consists of flat iron slats placed edgewise and running across the trunk at right angles to the direction of the cotton in transit. As the cotton is drawn along by the air draft, each slat presents a narrow surface, against which it strikes, causing the dirt to be shaken out and to fall between them into the pockets.

The bottom, E, of these pockets is made in one piece, extending the whole length of the trunk, and is held up against the under side of them by levers G, which are fastened at each end of the bottom to a strip which runs along the under side. These levers are controlled by a handle, F, the bottom forming a connection to the upper lever. Fig. 15 shows a trunk with the pockets

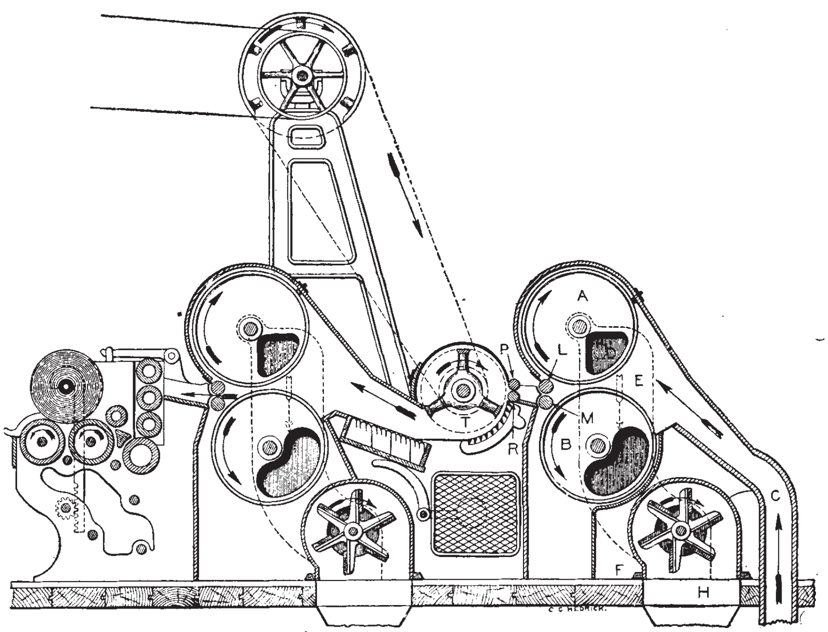

Fig. 16. Section of Breaker Picker, with Screen Section.

opened for cleaning. The handle is swung down into the position shown, which draws the bottom away from the under side of the pockets. The refuse slides down into a box, or basket, placed beneath the lower end of the trunk. Sometimes the trunk is provided with a connection, by which the dust is allowed to fall directly into the dust room.

Breaker Picker with Screen Section. Fig. 16 shows a section of a breaker picker. The cotton enters from the trunk C, and is deposited upon two revolving screens, A and B, which form the screen section and are simply for cleaning the cotton and forming it into a sheet, to be fed to the beater. As the distance traversed by the cotton between the opener and the breaker

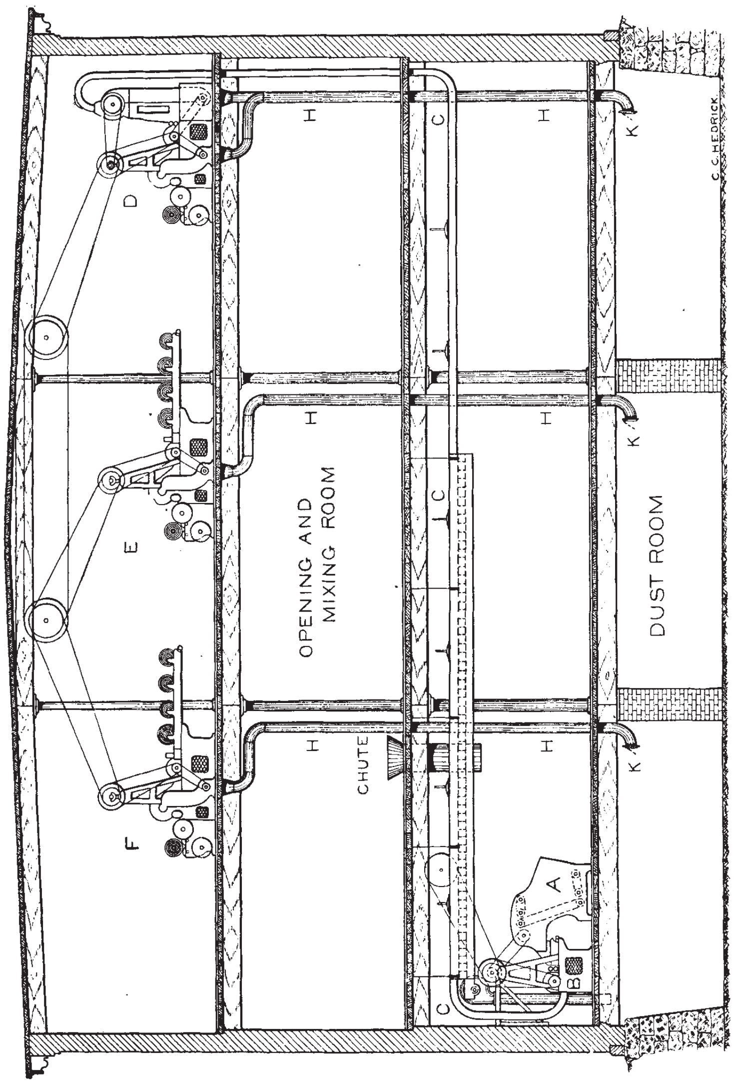

Fig. 17. Sectional Elevation of Three-story Mill, with Horizontal Cleaning Trunk.

is short, what little cotton there might be in the trunk would not materially affect the weight of the laps by the stopping of the feed of the opener while doffing the breaker, and this may be entirely overcome by doffing without stopping the feed. Each screen is provided with an opening, D, at each end, which leads into a dust passage to the fan F, by which the dust and dirt are forced through the pipe H into the dust room. As the screens revolve, the cotton is carried around to the stripping rolls L and M, and removed by them. Passing forward between the feed rolls P and R, it comes into contact with the blades of the rigid beater T. From this point the cotton undergoes the same treatment as in the machines previously described.

Three-storied Mill Arrangement. Fig. 17 shows a sectional elevation with a three-beater system. The openers and feeders are placed on the first floor and connected by a horizontal cleaning trunk. The breaker is fitted with a condenser and gauge-box, which provides for the long distance traversed by the cotton.

The second floor is used for opening and mixing the cotton, after which it is dropped through a chute to the feeders on the floor below. It will be seen that the fan for cleaning the trunk is upon brackets which are fastened to the wall on the end of the trunk nearest the opener, instead of the opposite end, as in the first arrangement shown (Fig. 3). Sometimes only a part of the second floor is used for opening and mixing, while often the first floor is used for this purpose, and the second floor devoted to some other process.

Another way of arranging this system is to divide the first floor into sections, leaving only a small space around the feeders for the cotton, the rest of the floor being used as a repair shop.

When the pipes leading to the dust room pass through the rooms below, it is customary usually to bring them down near the side walls or some of the columns, in order that they shall be out of the way as much as possible.

SYSTEM TWO.

Fig. 18 shows an arrangement with all of the machinery on one floor, as when space is limited, and the cotton is opened and made into a finished lap on the same floor as the card room. With this arrangement no cleaning trunk is used. The machinery consists of a two-beater breaker with an automatic feeder, the first section of the breaker corresponding to the opener, which is shown in the arrangement with the trunk system. The rest of the machinery is a single-beater intermediate picker, also with an evener and a carding beater. Any of these single-beater machines can be made with two or three beaters when the nature of the cotton requires a very thorough cleaning and the floor space is limited.

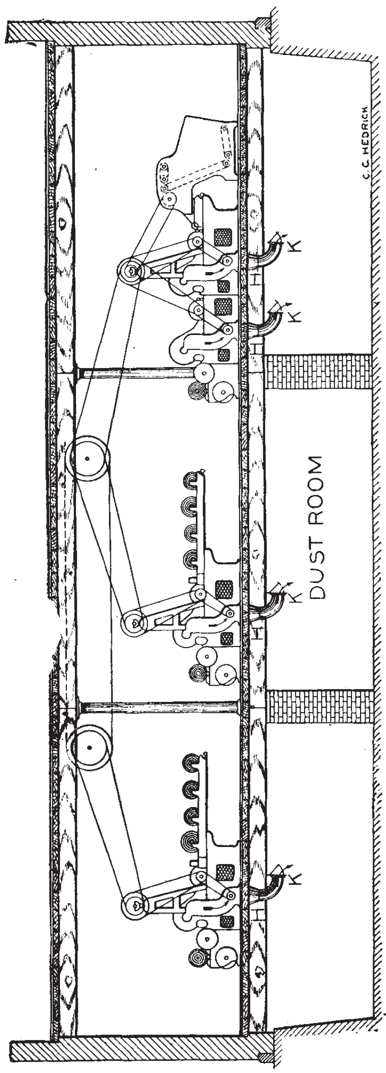

Fig. 18. Section of Mill with three processes, and no Cleaning Trunk.

For spinning fine numbers of yarn which require long staple cotton, the fibers must be treated as carefully as possible, and as the opening and cleaning process is an unavoidable evil, it is necessary to reduce the beaters in a system to the least number possible. Fig. 19 shows a system which consists of an automatic feeder, usually provided with an evener, connected to a single beater breaker picker, and a single-beater finisher with an evener and rigid beater.

In all the arrangements previously described, the carding beater has been recommended for the finisher picker, as giving the best results, but for the treatment of very long staple cotton, the rigid beater is used in preference, as the action of the carding beater is considered too harsh.

Combination Machine. When in small mills the production per day is not large enough for even one complete set of machines, a combination breaker and finisher picker with a feeder attached is used. This machine is shown in sectional elevation in Fig. 20 and is simply a finisher picker with a feeder connected to the end of a long feed apron.

If the cotton is to undergo three processes, the number of pounds required for the day's run is put through the picker and allowed to fall in a loose pile in front of the calender head, and then is carried to the rear end and thrown onto the feeder again for the second process, when it is formed into laps. For the third process the laps are doubled, three or four, on the apron and made into the finished lap ready for the card-room. While this is the

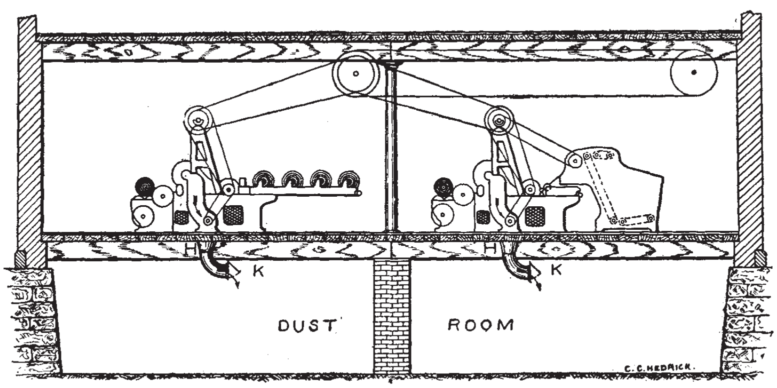

Fig. 19. Section of Mill with two processes, and no Cleaning Trunk.

usual method of handling the cotton, it can be made into laps after each process, if desired. When two processes only are required, the cotton should always be formed into laps the first time it is run through the machine.

The combination breaker and finisher is fitted with an evener specially adapted for running loose stock, and of which reference will be made later. It should have also a rigid beater, as the pin beater will not do when the cotton is put through three processes. Sometimes this style of machine is made with two beaters, when it is desired to give the cotton a very thorough cleaning and to put it through twice only. The front section may then be provided with a pin beater and the rear with a rigid beater.

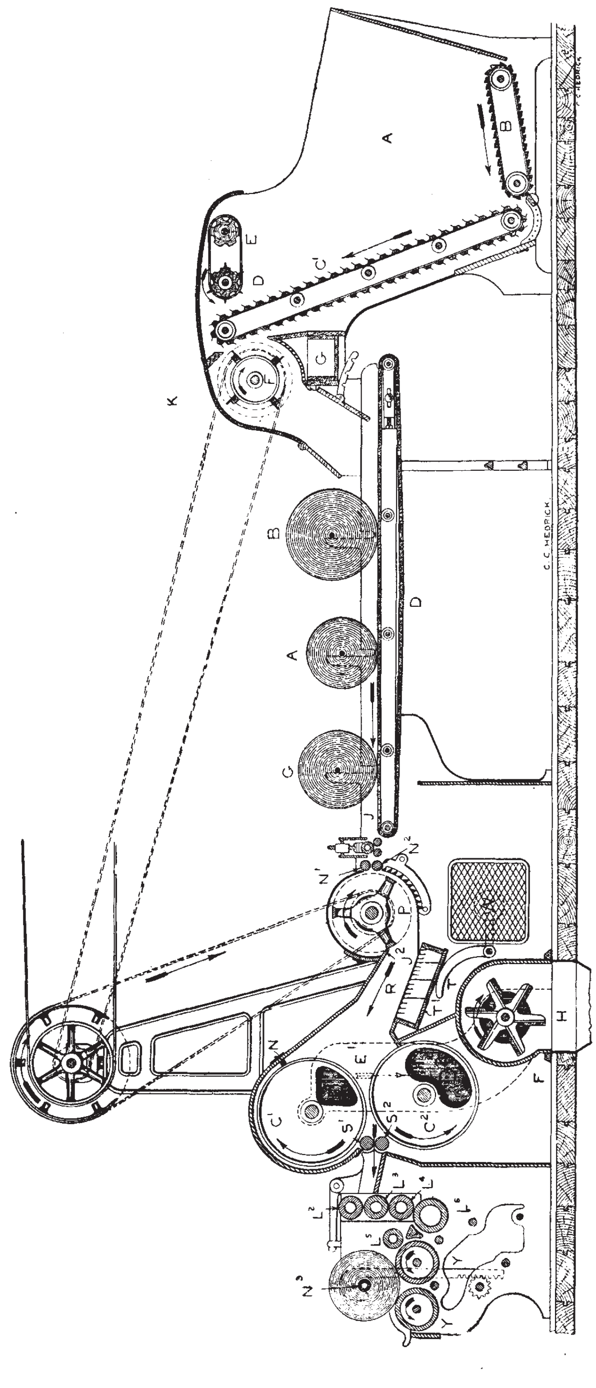

Fig. 20. Section of Combination Breaker and Finisher Picker with Automatic Feeder.

SYSTEM THREE.

When the picking machinery is all upon the same floor, and a trunk is used for connecting the opener and breaker, the machinery may be arranged as in Fig. 21. The inclined cleaning trunk which is used for this is connected to the condenser of the breaker by a galvanized iron conveying pipe about 12 inches in diameter, which extends horizontally above the finisher and intermediate to the back of the breaker. In this way the loose cotton is fed to the opener and returned in the form of a lap in about the same part of the opening room.

Another method of arranging the machines all on one floor, with a horizontal trunk, is shown in Fig. 22. The feeder and opener are close to the breaker by having the trunk in two sections of 20 feet each, one just above the other. This saves considerable space across the room. The trunk is cleaned in the manner described in Figs. 6 and 7, one end of each section being connected to the cleaning fan.

Both of these arrangements are frequently used in a one-story building, but in the drawings shown the second floor is used for a slasher room.

SYSTEM FOUR.

It often happens that the bales of cotton cannot be unloaded near the opening room, and when this is the case an additional handling is necessary, which is quite an expense, particularly in a large mill. A method adopted by some of the leading manufacturers is to connect the opening room with the cotton house (where the bales are unloaded) by a galvanized iron pipe 12 to 24 inches in diameter and of any reasonable length.

In the cotton house is an automatic feeder which is connected to one end of the pipe. The cotton is thrown into this feeder, which delivers it to the pipe, through which it is drawn by a strong current of air produced by an exhaust fan. This fan has a style of wheel known as a wool wheel, which is ordinarily used for blowing wool. The other end of the pipe is provided with a condenser, consisting of a revolving screen about 18 inches in diameter, upon which the cotton is deposited. The screen is connected to

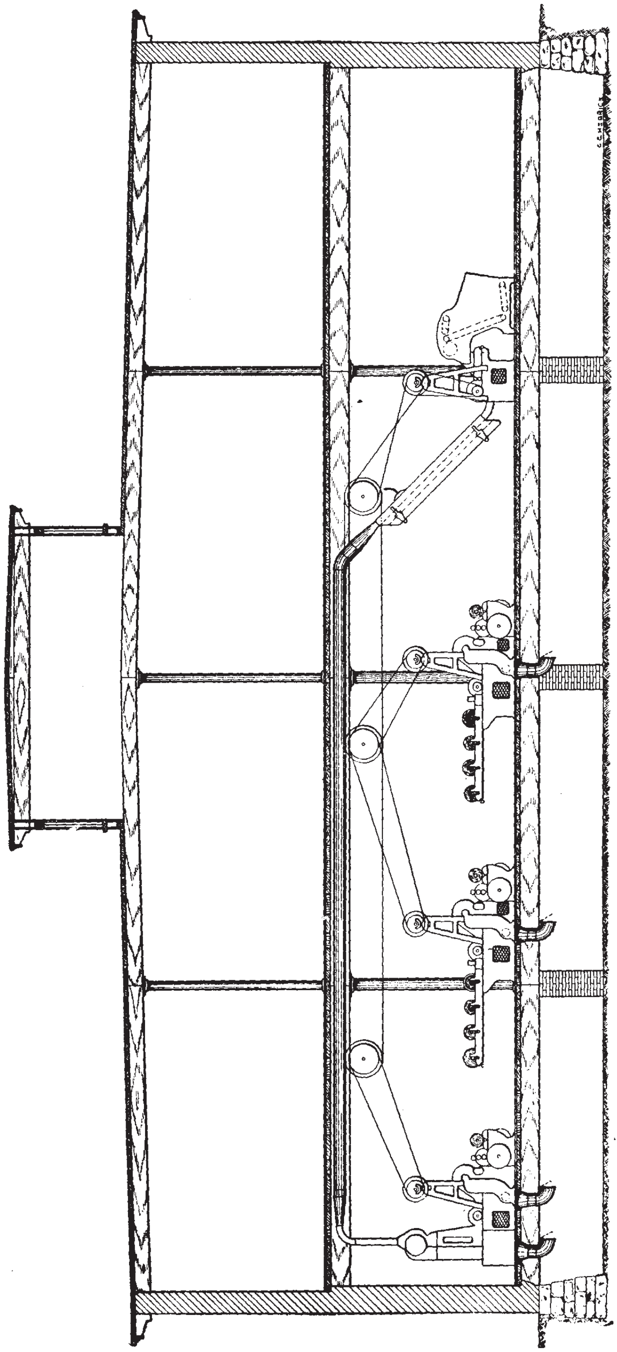

Fig. 21. Section of Mill, showing all machinery on same floor with Inclined Cleaning Trunk.

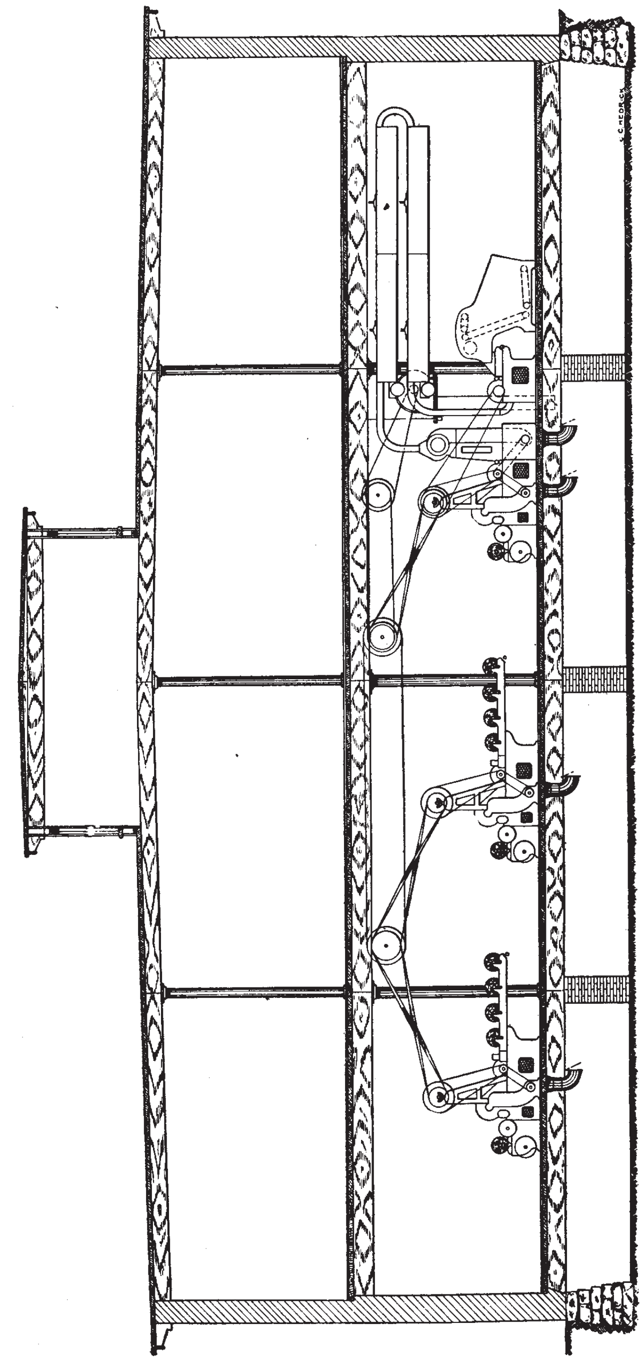

Fig. 22. Section of Mill, showing all machinery on same floor with Horizontal Cleaning Trunk.

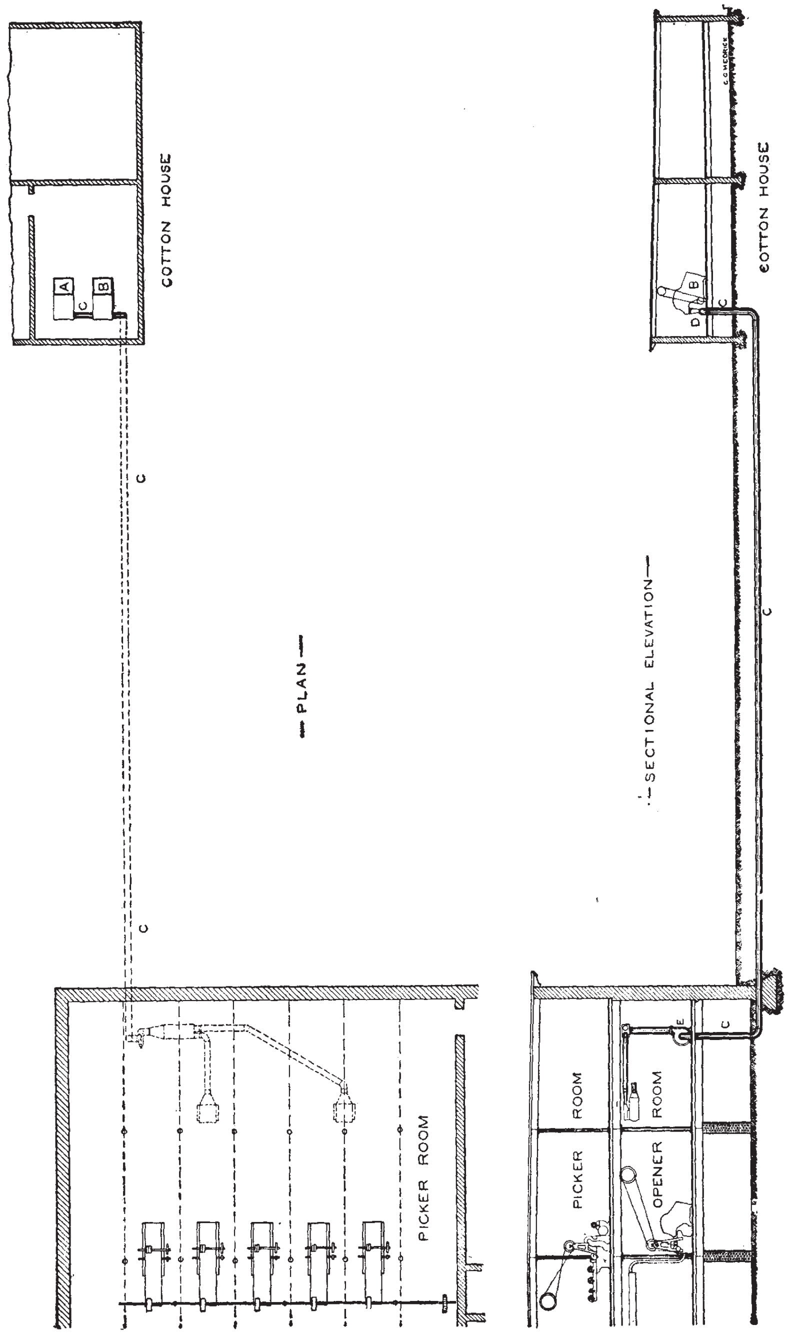

Fig. 23. Plan and Sectional Elevation of Mill and Storehouse, showing Blowing System.

a fan, and being open at both ends, the light lint and dust pass through, while the cotton is removed as the screen revolves and falls in a pile upon the floor.

A system of this kind is shown in Figs. 23 to 27, inclusive. Fig. 23 is a plan and sectional elevation of a mill and storehouse, with a galvanized iron pipe 14 inches in diameter connecting them for conveying the cotton, and Fig. 24 is a plan and elevation, on a larger scale, of the automatic feeders for this system.

One end of the cotton house is partitioned off from the remainder of the building by a brick division wall, which forms a room where the bales are opened. In this room are two automatic feeders,

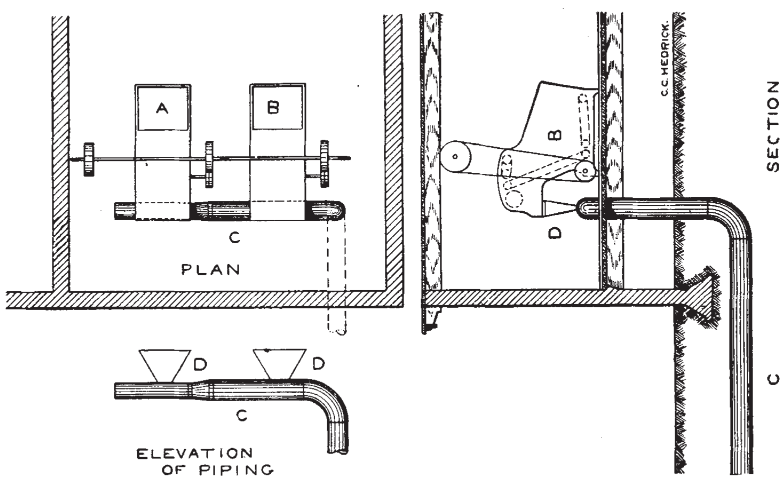

Fig. 24. Plan and Sectional Elevation of Feeders in Storehouse.

A and B, with especially large hoppers, which are driven by an electric motor and which deliver the cotton to the conveying pipe, C, through mouthpieces, D. The fan, E, for drawing the cotton through the pipe, is placed in the opener room at the top of the upright pipe.

Fig. 25 is a plan and elevation showing the piping in detail. Two condensers are used for supplying the five feeders. This affords an opportunity for distributing the cotton in two piles, so that it may be readily supplied to the feeders.

After the cotton passes through the fan, it enters an enlarged part of the pipe, rectangular in section and in which is a gate, K, shown by dotted lines, which may be operated from the outside of the pipe. From this point, the pipe divides, line, F, leading to condenser, G, and line, H, to condenser, J. If it is desired to send all of the cotton through condenser, J, the gate is moved to the position shown, which closes the opening in pipe, F, all of the cotton passing through pipe H. But if both condensers are to be run,

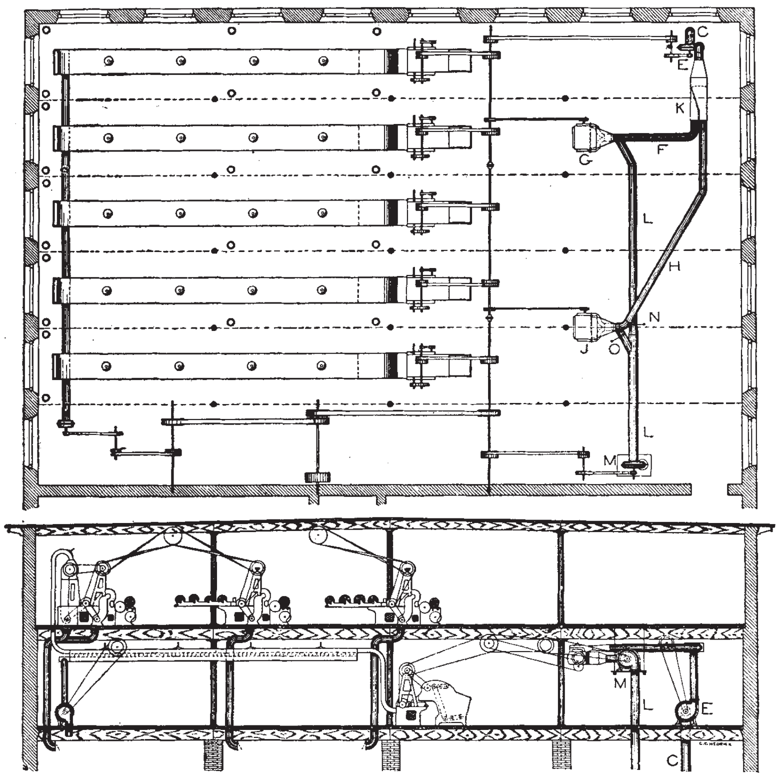

Fig. 25. Plans and Sectional Elevation, showing details of piping for Blowing System.

the gate is moved straightway of the pipe, leaving both branch pipes open to the condensers.

The dust and dirt from the condensers are discharged into the dust room through the pipe, L, by the fan, M. When only one condenser is running, it is necessary to close the pipe leading to the other so that the air will all be drawn from the one that is running. This necessitates the wind gates, N and O. If the condenser, J, is running, the gate, N, should be closed, while if G is running, O is closed. When both are in operation, the gates should both be left open, so that the air will draw equally from each, but as the draft from the condenser nearest the fan is generally the strongest, it is often necessary to slightly close one of the gates, so that the draft from each condenser shall be equal.

When a small quantity of cotton is to be run through a blowing system, instead of having an automatic feeder as in Fig. 24, the feed end of the pipe is

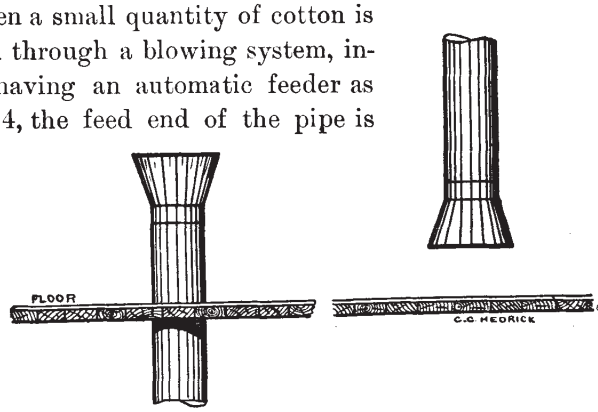

Fig. 26. Straight Pipe Mouth Pieces.

made as shown in Figs. 26 and 27. In Fig. 26 it is enlarged slightly, so that the cotton may be thrown in readily. The pipe may be inverted and the cotton drawn up instead of down which is much better, as it affords an opportunity for pieces of hoop iron, nails etc., to drop out, while with the pipe leading down, as in the drawing, the heavy substances simply fall to the bottom of the vertical part of the pipe and have to be removed. Hand holes are made in this part of the pipe and in all parts where it is necessary.

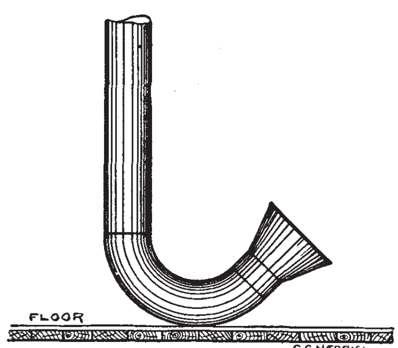

Fig. 27. Elbow Mouth Pieces.

Fig. 27 shows another form for the feed end of the pipe, which embodies the points of both pipes previously referred to in Fig. 26. The shape of the pipe permits the cotton to be dropped in and the vertical part allows the heavy dirt to fall to the bottom, where it can be removed.

It is considered advisable in all cases to use an automatic feeder with a blowing system in the cotton house, as the lumps of cotton are broken better by being tumbled about in the hopper, and the danger of fire is less from the fan striking a hard substance, particularly when putting a large quantity through the pipe. The production from one feeder may be called, safely, 8,000 pounds for a day of ten hours, without crowding the machine.

Eveners. One of the characteristics of good yarn is evenness. This is dependent upon the successful manipulation of the cotton in all of the processes which it undergoes. Reference has been made previously to the doubling of the laps upon the aprons of the intermediate and finisher pickers. This is of great importance in the process of evening, but the first stage in the formation of the lap, which is upon the breaker picker, may be considered as the starting-point for this operation. While it is true that a carefully made lap may be entirely spoiled by the careless handling of the machines before it is spun into yarn, as is often the case, the sooner we commence the operation of evening the mass of cotton, the better final result will be obtained.

It is a well-known fact that when the hopper of the automatic feeder is quite full, the lap is apt to be heavy, and if the cotton is allowed to run low in the hopper, the lap will be found to be correspondingly light. When an attendant is required to take care of quite a number of feeders, the laps from the breaker picker vary considerably in weight, owing to his inability to keep them filled to near enough a uniform height. In order that the automatic feeder shall deliver the same amount of cotton to the opener at all times, many feeders are provided with eveners of some description.

Evener for Automatic Feeder. Fig. 28 shows a section of an automatic feeder which, besides having an evening device, possesses some points quite distinct from all other feeders. It consists of a bottom apron, A, an elevating apron, B, supported by carrier rolls, and a doffer, C. Beneath the doffer is a screen, D, and a dust drawer, or box, E, while beneath the elevating apron is also a screen, all of which parts are common to most feeders. Instead, however, of having a spike-roll to remove the surplus bunches of cotton from the elevating apron, this feeder is provided with the heavy dirt to fall to the bottom, where it can be removed.

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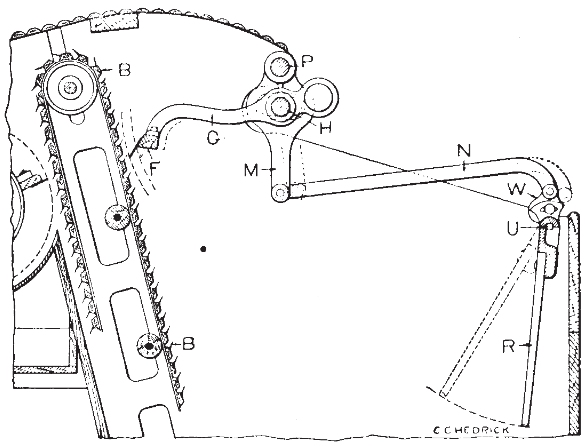


Fig. 29. Section Showing Evener Parts.

fastened to the outside ends of the studs, U, from which the rack swings. The pull of the springs is such as to draw the rack

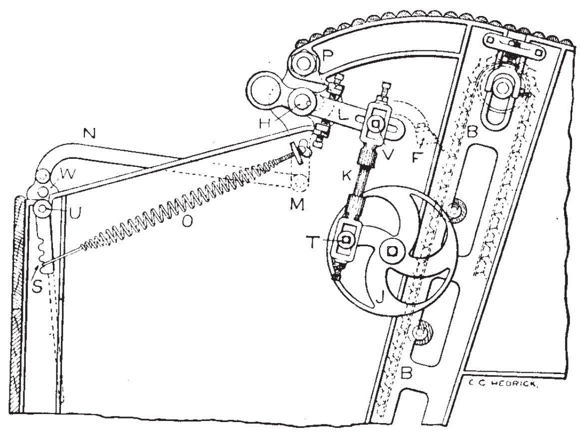


Fig. 30. Elevation Showing Evener Parts.

towards the elevating apron. When the hopper is full, or nearly so, the cotton keeps the rack in an almost vertical position, but as it

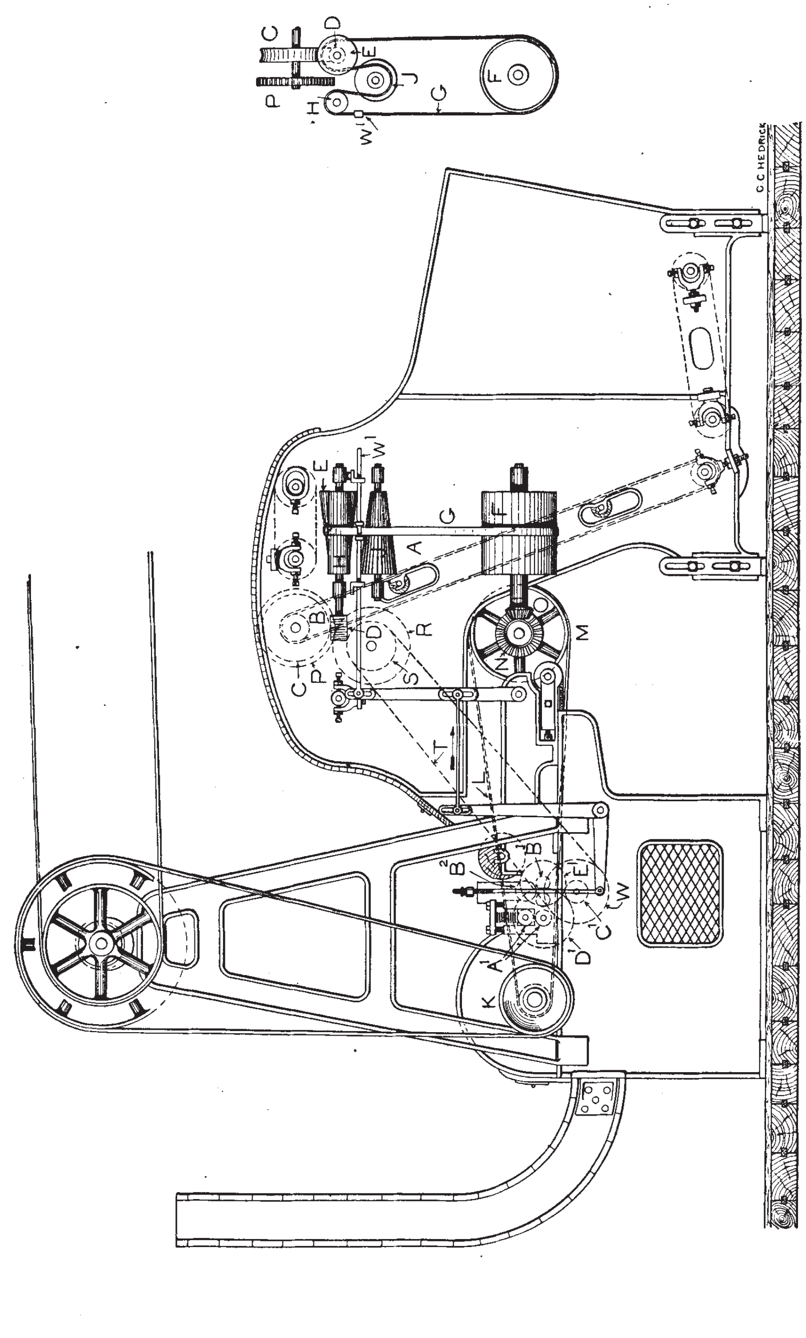


Fig. 31. Section of Automatic Feeder with Cone Evener Attached.

gets low in the hopper, the springs draw the rack forward towards the elevating apron while the comb is drawn slightly away from it. By thus increasing the distance between the comb and the apron (which is shown by the dotted lines in Fig. 29), more cotton is allowed to pass forward to the opener, tending to keep the delivery of the feed the same at all times.

Another style of automatic feeder, provided with an evener, is shown in connection with an opener in Fig. 31. With this feeder the supply of cotton delivered to the opener is regulated by the speed of the elevating apron, which in turn is governed by the thickness of the sheet of cotton passing between the evener rolls. As the quantity of cotton in the hopper grows less, the amount fed to the opener is lighter; thus the speed of the elevating apron and the feed rolls on the opener are correspondingly increased, so that the amount of cotton delivered shall be always the same. The elevating apron, A, is driven by frictional contact with the top apron roll, B, on the end of which is a worm gear, C, which is driven from the worm, D, upon the end of the cone, E. This cone is driven from the drum, F, by the belt, G, which passes around the carrier roll, H, and the binder cone, J.

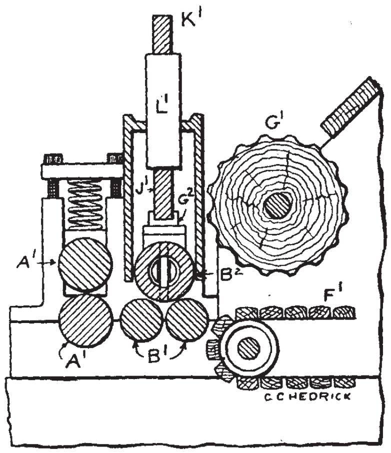


Fig. 32. Section Showing Evener Rolls and Feed Rolls.

An end elevation of the cone is shown at the right in Fig. 31. On the end of the beater shaft, and shown by dotted lines, is a pulley, K, which drives the drum, F, by means of the belt, L, pulley, M, and gears, N and O, the last being upon the end of the drum shaft. On the top apron roll is a gear, P, which drives a similar gear, R, and upon the hub of the latter is a sprocket wheel, S, which drives, by means of the sprocket chain, T, the wheel, W. The feed rolls, A^1, are driven from the hub of this sprocket by the gears, C^1

municated to the comb by the parts described. On the outside of the hopper are springs, O, connected to the arms, S, which are

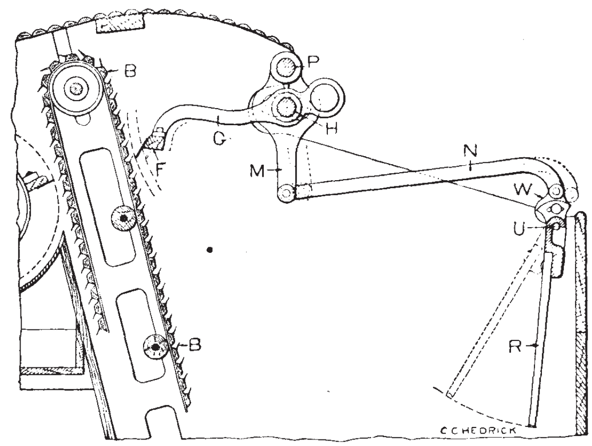


Fig. 29. Section Showing Evener Parts.

fastened to the outside ends of the studs, U, from which the rack swings. The pull of the springs is such as to draw the rack

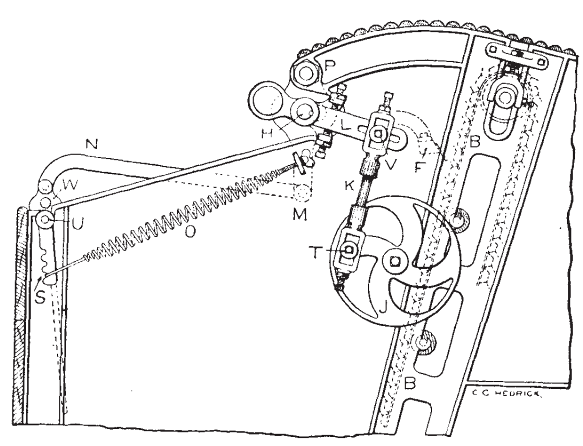


Fig. 30. Elevation Showing Evener Parts.

towards the elevating apron. When the hopper is full, or nearly so, the cotton keeps the rack in an almost vertical position, but as it

H^1, while a main saddle, J^1, forms a connection between all of them. On the top of the evener case is the evener lever, K^1, which is connected to the main saddle by the stem, L^1. The fulcrum of the lever is at M^1 and the long end is connected to a rod, N^1.

Fig. 35 is a side elevation showing the connections between the evener lever and the cone-belt guide. It will be seen that the lower end of the rod, N^1, is connected to a bell crank-lever, O^1, which turns on a stud, P^1. A horizontal rod, R^1, connects the vertical arm of this lever with the lever, S^1. At the lower end of the

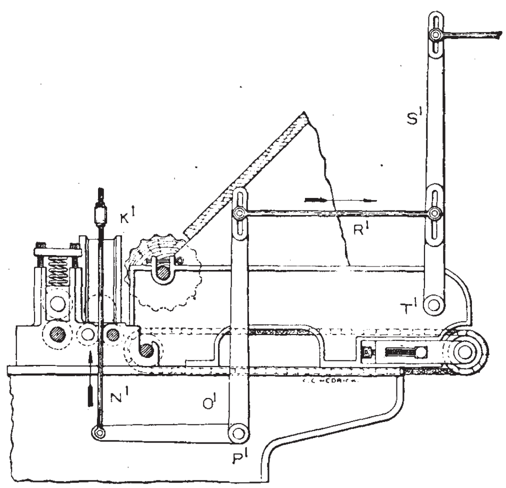


Fig. 35. Elevation Showing Connections from Evener to Cone Belt.

latter is a stud, T^1, which forms a fulcrum about which the lever turns and at the upper end is connected the cone-belt guide, W^1. When the evener roll is raised, by reason of an unusual thickness of cotton going through, the evener lever also raises and the connections, just described, move in the direction shown by arrows. This moves the cone belt towards the large end of the driven cone, E (Fig. 31), and a slower movement of the elevating apron takes place, delivering less cotton to the opener. A light feed will cause a reverse movement in the direction of the cone belt towards the small end of the driven cone, thus increasing the speed of the elevating apron. This style of evener, for regulating the feed of cotton when in loose form, "raw stock" as it is called, is one of the most perfect in use.

Eveners for Pickers. The operations of the evener on the intermediate and finisher pickers depend wholly upon the thick-

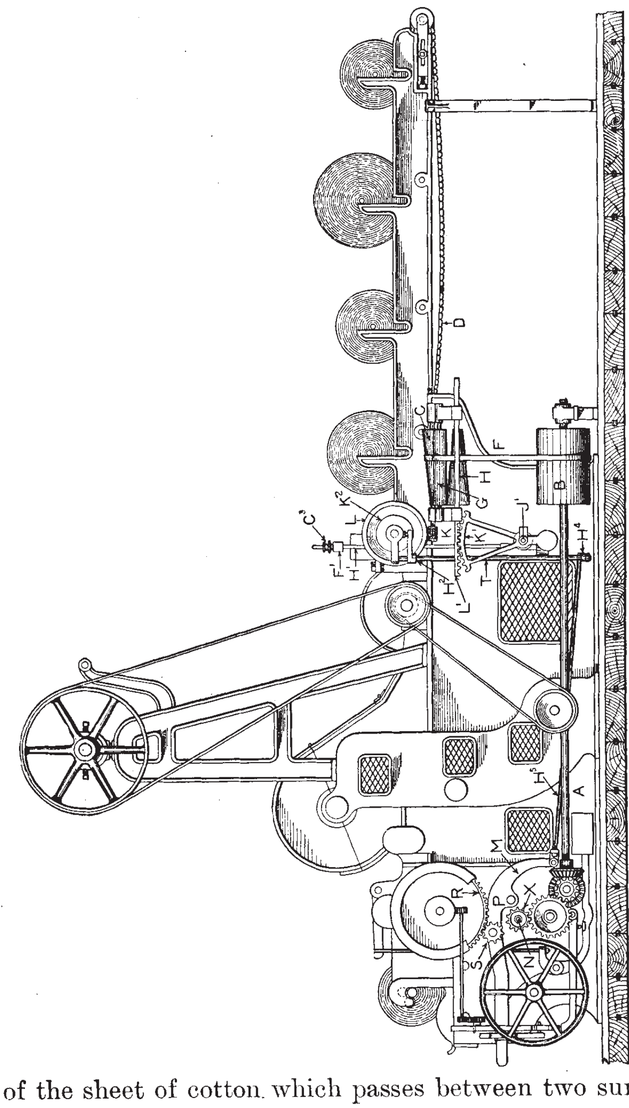


Fig. 36. Elevation of Picker with Evener Attached.

ness of the sheet of cotton which passes between two surfaces and not upon the weight, as is also the case when the evener is applied to the automatic feeder and, unless the cotton has been thoroughly opened, the same weight in a lap may be slightly different in thickness, consequently the evener is not always absolutely perfect in its work.

A side elevation of a finisher picker provided with an evener is shown in Fig. 36. The evener is driven from the draft gear, X, on the calender head, or delivery end of the machine, by the side shaft, A. On the back end of this shaft is a drum, B, which drives the evener cone, C, by means of the belt, F, which passes over the carrier roll, G, and under the binder cone, H, which can be lowered to take up the slack as the belt stretches. On the end of the evener cone is a worm, K, which drives the worm gear, L, which is connected directly to the evener and feed rolls.

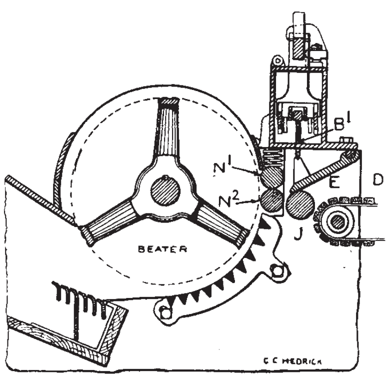


Fig. 37. Section Showing Evener Rolls and Feed Rolls.

Fig. 37 shows a section through the evener and Fig. 38 shows a side elevation and section of the same.

The laps are carried forward on the feed apron, D, and are drawn between the evener roll, J, and the sectional plates, E, then between the feed rolls, N^1 and N^2. The sectional plates, of which there are sixteen, extend across the whole width of the face of the evener roll. Resting in a socket on the top of each of these plates are short rods, B^1, which support saddles, C^1. These saddles are connected to the stem, D^1, by other and larger saddles all of which act as levers, the stem forming a connection between the top saddle, E^1, and the top lever, F^1. The top lever, which has its fulcrum at G^1, is connected at its long end by a rod, H^1, the lower end of which terminates in a rack, A^1, which is in gear with a pinion, C^4, this last being on the quadrant shaft, J^1. On the outer end of the quadrant shaft is a segment gear, K^1, called the quadrant, the teeth of which are in contact with the teeth of the cone-belt guide, L^1.

When the position of the sectional plates is changed, by reason of a difference in thickness of the sheet of cotton passing under them, the quadrant shaft is turned slightly, and by the connections just described, the cone belt is moved to a different position on the face of the cone, changing the speed of the evener and feed rolls. This will continue until the thick or thin place, as the case may be, has passed by the sectional plates, when they will resume their normal position. At the top end of the rod, H^1, is a thumbscrew, C^3, by which the position of the cone belt may be changed slightly when adjusting the evener.

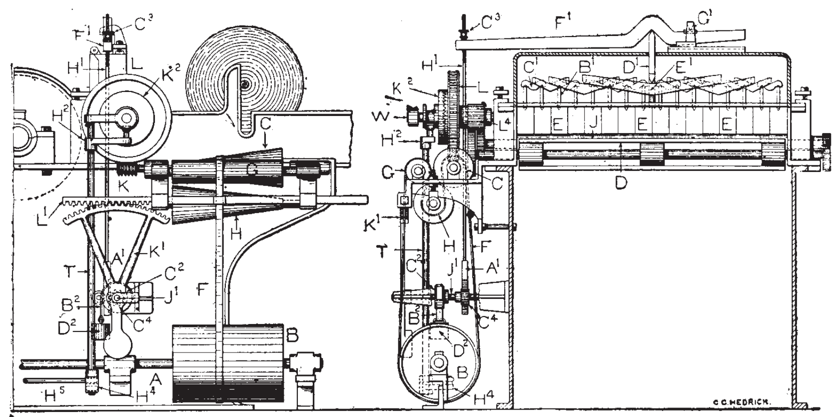


Fig. 38. Section and Side Elevation of Evener for Picker.

In order that the sectional plates shall not rise too easily, a drum, or weight pulley, C^2, is fastened to the quadrant shaft. Around this pulley, and fastened to it, passes a strap, B^2, the lower end of which is connected to a weight hook upon which hangs a weight, D^2. By this means, the sectional plates are pressed firmly down upon the lap.

The gearing of the picker is so arranged that the feed and delivery of the cotton can be started and stopped while the picker is running. It will be seen that in Fig. 36 the gear, R, which is upon the delivery calender roll, is driven from the pinion, S, which is carried by the drop lever, M, and that the feed rolls and evener rolls are driven from the draft gear, X, which is on the end of the shaft, N. Both the pinion and draft gears are driven from the calender pulleys on the opposite side of the calender head and revolve all the time that the picker is running. The drop lever turns on a stud at P. To the lower end of the lever is fastened a rod, H^5, which is connected to the lower end of the upright shaft, T, by the arm, H^4. When the feed rolls are started, the drop lever is raised and the pinion, S, is brought into contact with the gear, R, and at the same time, the evener and feed rolls are started by means of a clutch being thrown into contact with the worm gear.

An enlarged section, an elevation and a partial plan of this clutch and worm gear are shown in Fig. 39. On the stud, W, is a sleeve, L^4, with a gear on one end which drives the evener and feed rolls and a dog, or driver, L^2, keyed to the other end. The clutch, K^2, has two lugs, or bosses, N, which project between the arms of the dog. The worm gear, L, which runs loose on the sleeve, has teeth upon one side which engage with the teeth in the clutch. When the clutch is thrown out, the worm gear runs without imparting motion to the evener and feed rolls but when the calender head is started, the shipper rod, H^5, which is drawn forward by the raising of the drop lever causes the clutch to engage with the teeth of the worm gear, the sleeve being driven by the lugs projecting between the arms of the dog.

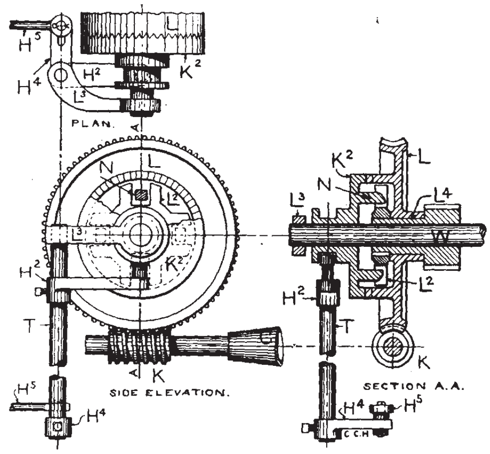
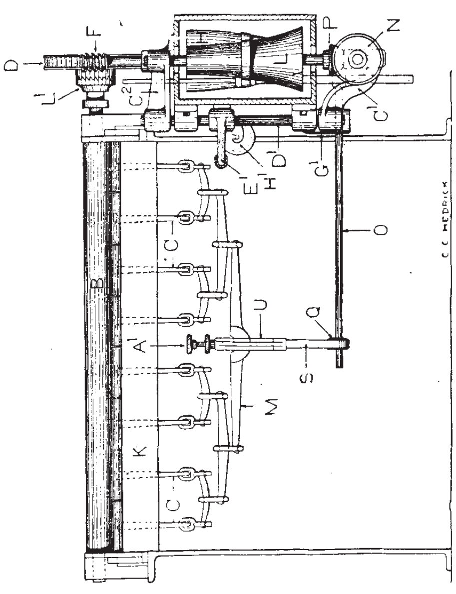


Fig. 39. Clutch and Worm Gear.

Another style of evener, which is applied to intermediate or finisher pickers, is shown in three views, a section, an end elevation and a partial plan in Fig. 40. On the end of the evener roll, B, is a worm gear, D, which is driven by a worm, F, on the upper end of the driven cone, H. This cone is driven by a belt, J, from the driving cone, L, which in turn is driven from the side shaft, R, by the gears, N and P. The cotton passes on the feed apron, A, and between the evener roll, and the pedals, C, then between the feed rolls, E and G. These pedals, eight in number, are made with one end a flat surface over which the cotton passes, and are balanced on a knife blade, K. To the long end of the pedals is connected a series of links and saddles, which are connected to a main saddle, M, the whole arrangement being similar to the evener shown last. Directly beneath the main saddle is a shaft, O, on one end of which is a roll, or drum, Q, which is connected to the main saddle by a thin steel band, S, and a yoke, U. One end of the band passes



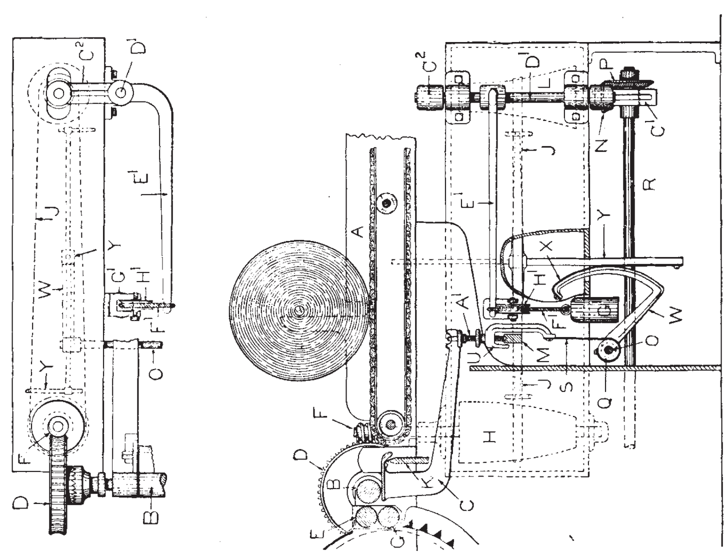


Fig. 40. Section and Elevation and Partial Plan of Evener.

partially around the drum and the other is fastened to the lower end of the yoke. On the other end of the shaft is a quadrant, W, which is connected to the cone-belt guide, Y, by a thin, steel band, X, similar to the one connecting the main saddle.

When the position of the pedals is changed by a difference in the thickness of the cotton passing between them and the evener roll, the shaft, O, is rotated and the cone belt moved to a different position on the face of the cones. An adjusting screw, A^1, connects the yoke and main saddle, by which the cone belt may be moved slightly when adjusting the evener for the correct weight of lap.

The driven cone, H, is held rigidly in its bearings but the driving cone, L, is held by arms, C^1 and C^2, which swing from the shaft, D^1. Fastened to the shaft is a lever, E^1, on the end of which is connected a chain, F^1, and weight, G^1, the chain running over a pulley, H^1. By this arrangement the cones are kept apart and the cone belt tight.

Evener Cones. The question often arises as to why the outlines of the evener cones are curved instead of being a straight taper. The reason for this is very simple but, in order that it shall be understood, a few words on the subject may not be amiss.

It is usually customary to double four laps on the apron of the picker so that four thicknesses shall pass under the evener roll, but, if one of the laps should run out, it is evident that the evener roll ought to run proportionately faster in order that the same weight of cotton shall be fed to the beater in a given time.

A diagram of a pair of cones and an evener roll is shown in Fig. 41. The roll, A, is 9 inches in circumference or $2\frac{7}{8}$ inches in diameter. On the end of it is a worm gear, B, of sixty teeth, which is driven by a single threaded worm, C, on the upper end of the driven cone, D. The driving cone, E, runs at a constant speed of 480 revolutions per minute and is driven from the side shaft, H, by gears, F and G. Let us suppose that four laps, each weighing 12 ounces per yard, are passing under the evener roll, the speed of which is 8 revolutions per minute; now, as the roll is 9 inches in circumference, there would be fed into the machine 72 inches, or 2 yards, of cotton weighing 48 ounces per yard, 96 ounces in all. With the evener roll at 8 revolutions, the cone will make 480 revolutions ($8 \times 60 \div 1 = 480$) the cone belt being midway of the ends of the cone. Now suppose one lap runs out, leaving only three thicknesses, or 36 ounces, passing into the machine, it is evident that the evener roll should increase enough in speed to feed in an equal amount, weighing 36 ounces per yard in the same time as when that weighing

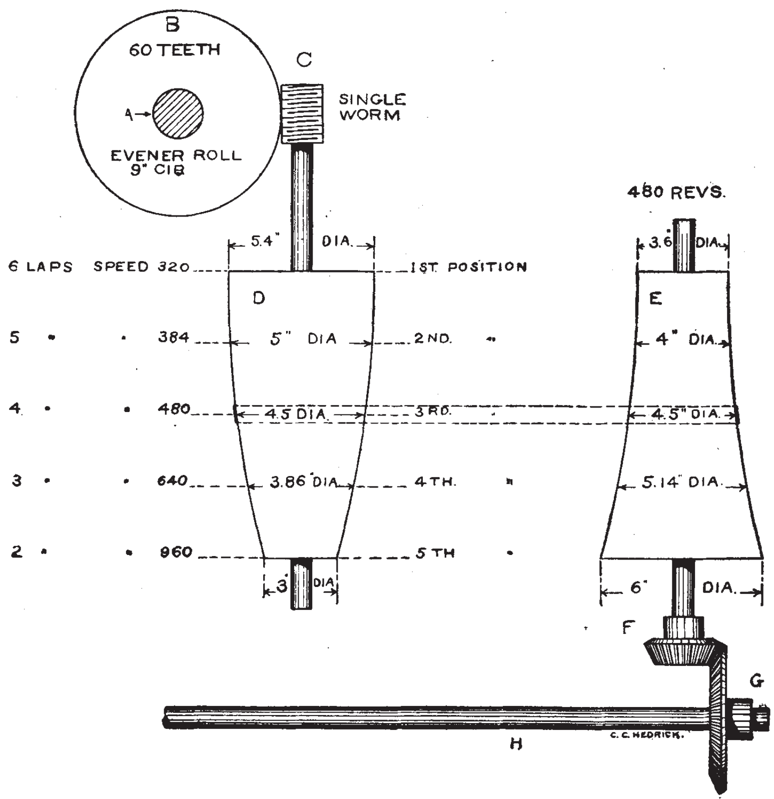


Fig. 41. Evener Cones with Correct Outline.

48 ounces per yard is going in. To accomplish this, the speed of the roll must be increased to 10.66 revolutions per minute, which will feed in 2.66 yards, which, weighing 36 ounces per yard, brings the total to 96 ounces. To give the evener roll 10.66 revolutions per minute, the driven cone would have to run 640 revolutions per minute and as the driving cone runs 480 revolutions, it is easily seen that the belt should move to a point on the face of the cones

where the diameter will be such as to give 640 revolutions to the driven cone.

The cones in the diagram are made with a difference in diameter between the large and small ends to provide for a range in speed adapted to pass in from two to six laps, and, as the cones are 16 inches long, the difference of one lap in the thickness of the sheet will move the cone belt up or down the face of the cones 4 inches. Therefore, with three thicknesses of lap going through, the cone belt will move down the cones to the fourth position and the speed of the driven cone will be 640 revolutions per minute. The diameters of the cones at this point should be 5.14 inches for the driving cone and 3.86 inches for the driven cone.

The following table shows the speeds of the evener roll and driven cones and the corresponding diameters of the cones necessary for the different speeds. From the table, it will be seen that the diameters of both cones, taken at the same points and added together, give the same total.

Weight in ounces delivered by evener roll.	Length in yards delivered by evener roll.	Revolutions of driven cone per minute.	Revolutions of evener roll per minute.	Combined weight in ounces per yard.	Number of laps going through.	Diameter in inches of driving cone.	Diameter in inches of driven cone.
96	1.33	320	5.33	72	6	3.6	5.4
96	1.60	384	6.40	60	5	4	5
96	2.00	480	8.00	48	4	4.5	4.5
96	2.66	640	10.66	36	3	5.14	3.86
96	4.00	960	16.00	24	2	6	3

Fig. 42 shows a diagram of a pair of straight taper cones which serve for comparison with those of correct outline shown in the previous diagram. The large end of each is 6 inches in diameter, the small end 3 inches in diameter and the middle $4\frac{1}{2}$ inches in diameter; the speed of the driving cone is 480 revolutions per minute. While the speeds of the driven cone, with two and four laps going in, are 960 and 480 revolutions per minute respectively and are correct, at all other points the diameters of the cones are such as to give incorrect speeds as will be seen by comparing the two diagrams.

Friction Let-off. The friction let-off, by which the laps on the picker are caused to be wound firmly, is constructed very similarly by all builders. Three views, a front elevation, a side elevation and a section of this device are shown in Fig. 43.

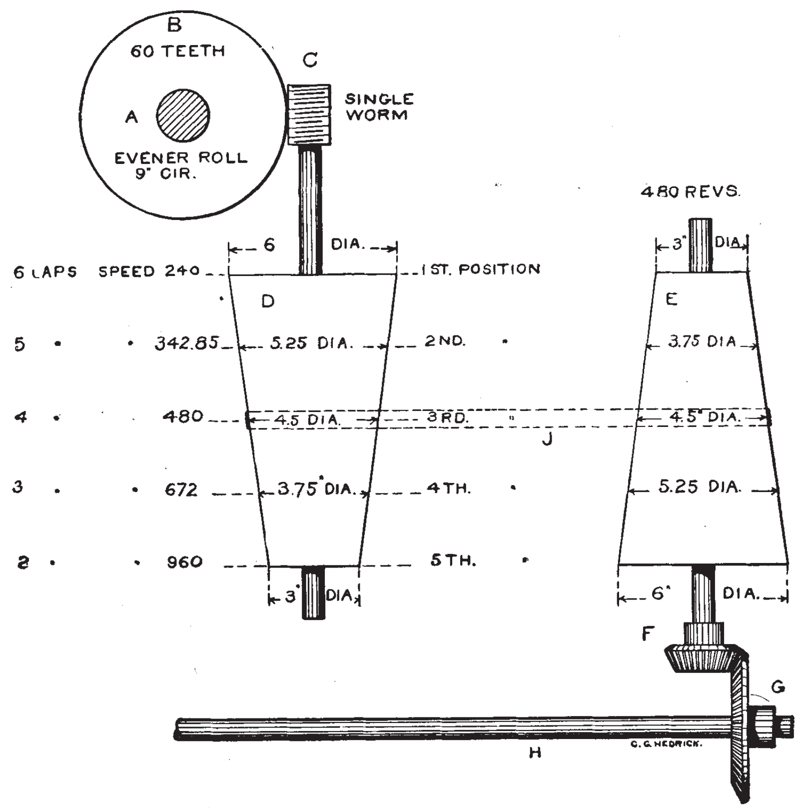


Fig. 42. Evener Cones with Incorrect Outlines.

The lap, which is wound upon the lap arbor, N^3, is held in contact with the lap roll, Y, by the racks, K and K^1, which bear upon either end of the lap roll. The top of the racks is recessed to receive two rolls, A and B, which form roller bearings and which greatly reduce the friction and wear upon the lap roll. The lower end of the rack, K is in gear with the pinion, W, while K^1

is in gear with the pinion, D; both pinions are secured to the rack shaft, G. The gear, R, also on the rack shaft, is connected with the pinion, O, which is on the hub of the break pulley, N, by the gears, S and P. These gears turn loose on the shaft, L, and are held in position by the collars, F and H. The break pulley, N, is free to turn on the rack shaft and is held in position by the collar, C. Loose upon the shaft, L, is the break lever, E, which bears against the under side of the break pulley and is kept in con-

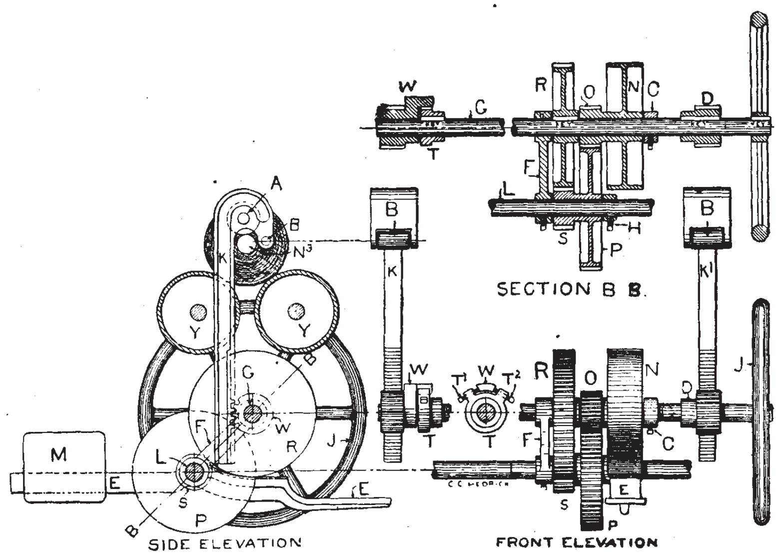
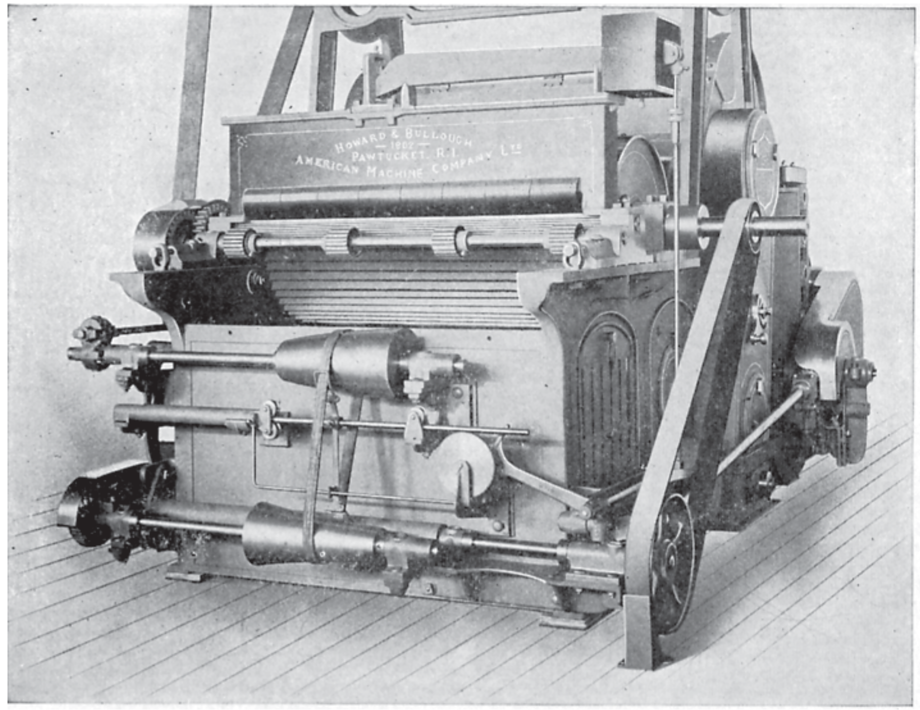


Fig. 43. Friction Let-off.

tact with it by the weight, M. The face of the break lever which bears against the pulley is lined with leather.

As the lap increases in diameter, it draws up on the racks which are kept from rising by the friction of the break lever against the break pulley. When it has been wound to its full diameter, the attendant presses down upon the break lever, releasing it from contact with the break pulley; then the rack can be raised by turning the handwheel, J, on the end of the rack shaft.

In order to bring both racks to the same height, so that the lap will be wound equally in diameter on each end, the pinion, D, which gears into the rack, K^1, is keyed directly to the rack shaft



IMPROVED EVENER WITH EVENER CONES LOCATED CONVENIENTLY UNDER FEEDING APRON

Howard & Bullough American Machine Co. (Ltd.)

while the pinion, W, which gears into the rack, K, is connected to the rack shaft by a lug projecting between the arms of a dog, or carrier, T, which is keyed to the rack shaft. In the arms of the dog are adjusting screws, T^1 and T^2, which bear against the projecting lug of the pinion and by turning these screws the pinion can be moved a slight distance around the rack shaft in either direction and the rack, K, brought exactly in line with the rack, K^1.

On warm, damp days, the leather facing of the break lever adheres closely to the break pulley and it is often necessary to move the weight, M, in from the end of the break lever, thus reducing the pressure of the lever against the break pulley. Sometimes it is necessary to remove the weight as too great pressure tends to break the lap rolls and to wind too hard laps, which may split when unrolled.

Care should be taken in oiling to avoid getting oil upon the break pulley as the friction is rendered well-nigh useless and the lap is consequently too soft.

Automatic Safety-stop. It is necessary that the laps, particularly those from the finisher picker, shall be as free as possible from foreign substances which, if by accident are wound into the lap, cause considerable injury to the card. Most pickers are provided with some form of device to prevent this. Two views of an automatic safety-stop are shown in Fig. 44, a side elevation and a partial front elevation.

The calender rolls, feed rolls and cages are all driven by the pinion, S, through the gear, R, which is upon one of the calender rolls, consequently, by disengaging these gears, the calender rolls and parts connected are stopped. This is accomplished in the following manner: The cotton, after leaving the cages, passes between the top and second calender rolls, L and N. Resting on the top of the bearings, at either end of the top calender roll, is a lever, F, called the top lever. The rolls, which are heavily weighted, are connected to the weight by the top lever, the rod, H, and the weight lever, G, upon which is the weight, J. The weight lever has its fulcrum at K. Directly above a part of the weight lever is the knock-off lever, A, which turns on the shaft, C, and has a screw, D, near its inner end by which it is adjusted and which bears against a lug, projecting from the weight lever. When it is in its normal position, its outer end is just clear of the under side of the knock-off latch, E. This latch turns on the stud, T, and has a notch, B^1, in its upper end by which the drop lever, M, that carries the pinion, S, is held in position. Should any foreign substance be drawn between the calender rolls, the unusual thickness of the lap caused by it will lift the top calender roll, and, through the connection just described, the knock-off lever will be raised and its outer end brought in contact with the knock-off latch

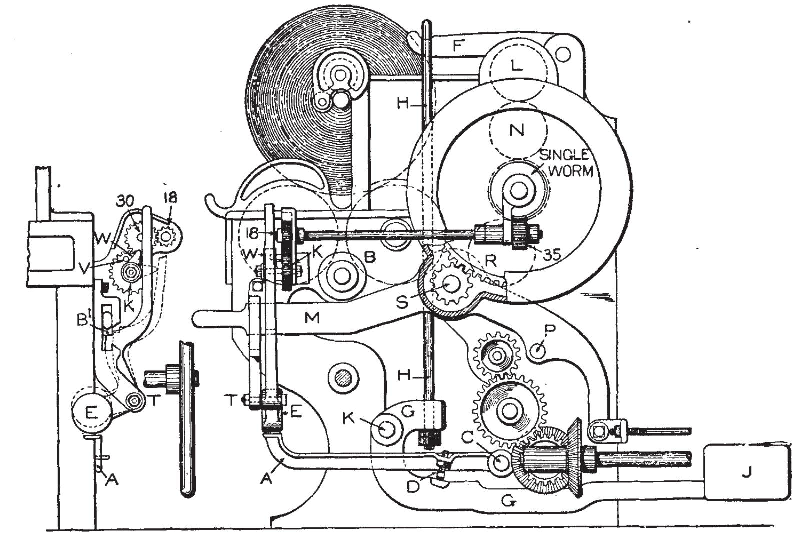


Fig. 44. Automatic Safety Stop.

which in turn will be moved to one side, allowing the drop lever to fall, disengaging the gears, R and S, and stopping the calender rolls. The adjusting screw enables the picker to be set so that a very slight increase of thickness in the lap will cause the picker to knock off, as it will also when the evener fails to take care of unusually heavy laps.

Knock-off Device. In order to get the best results, the laps should be as near the same weight as possible; not that each square yard of lap must weigh the same, but the total weight of each lap must be within one-half pound variation of a forty pound lap. In some cases, for very fine work, particularly with single carding and the revolving flat card, each lap from the finisher picker is weighed, and, if found to vary from the limit, which has been established as a standard, is not allowed to pass to the card-room. Sometimes every other lap is weighed and often they are weighed every hour though in some mills it is not considered necessary to weigh them more than once or twice a day.

Calculations. The weight of the lap is governed by the number of yards it contains and is measured by the revolutions of the lap roll, the picker being stopped automatically after the required number of yards has been wound. The device, by which this is regulated, is called the knock-off, a diagram of the gearing of which is shown in Fig. 45, which should be used in connection with Fig. 44.

The knock-off, or change gear, K, is driven from the calender roll by the side shaft, B. Loose upon the hub of this gear is a dog,

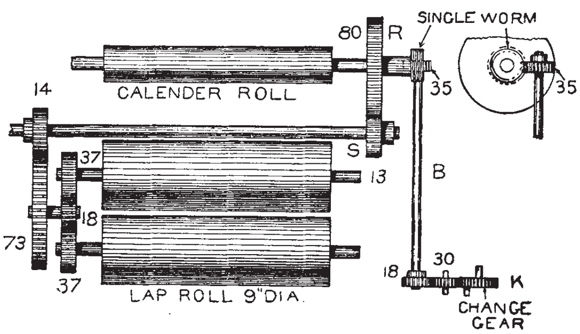


Fig. 45. Diagram of Knock-off Gearing.

W, driven by a pin, V, which forms part of the gear. As the latter turns, the dog is brought against the upper end of the knock-off latch, E, moving it out and allowing the drop lever, M, to fall, disengaging the pinion, S, and the gear, R, and, as the dog assumes a vertical position, by reason of being loose on the hub of the gear, the picker can be started immediately after it has knocked off and the lap has been removed. The knock-off gear makes one revolution for each lap wound, so a change in the number of teeth it contains gives a different number of yards in a lap.

When the weight per yard and the total weight of the lap have been established, the constant number or factor, by which the number of teeth in the knock-off gear is calculated, can be figured. The lap rolls are 9 inches in diameter, or 28.27 inches in circumference, therefore 1.27 revolutions will be required to wind one yard, thus: $36 \div 28.27 = 1.27$.

On the end of the lap roll is a gear of 37 teeth which is driven from a pinion of 18 teeth. Compounded with the pinion is a gear of 73 teeth, which is driven from the calender shaft by a pinion of 14 teeth. On the right end of the calender shaft is a pinion, S, of 13 teeth which drives the gear, R, of 80 teeth. On the hub of the latter is a single-threaded worm which drives a gear of 35 teeth which is upon the side shaft. On the opposite end of the side shaft is a pinion of 18 teeth, which drives the knock-off, K, through the intermediate gear of 30 teeth.

Following are the rules governing the calculations for the picker:

Rule 1. To find the factor for the knock-off gear, multiply the drivers together and divide the product by the product of the driven gears multiplied by the number of revolutions of the lap roll necessary to wind one yard, leaving out all intermediate gears and the knock-off gear.

$$\text{Example: } \frac{35 \times 80 \times 14 \times 18}{18 \times 1 \times 13 \times 73 \times 37 \times 1.27} = .879$$

Rule 2. To find the number of yards in a lap, multiply the factor by the number of teeth in the knock-off gear, 30.

Example: $.879 \times 30 = 26.37$

Rule 3. To find the number of yards in a lap, without using the factor, multiply the number of teeth in the knock-off gear by the product of the drivers, and divide that product by the product of the driven gears multiplied by the number of revolutions of the lap roll necessary to wind one yard, leaving out all intermediate gears.

$$\text{Example: } \frac{30 \times 35 \times 80 \times 14 \times 18}{18 \times 1 \times 13 \times 73 \times 37 \times 1.27} = 26.37$$

Rule 4. To find the number of teeth in the knock-off gear divide the number of yards in the lap by the factor.

Example: $26.37 \div .879 = 30$

The weight of the laps from the finisher picker depends upon the production required, the counts of yarn it is desired to make and the class of cotton used. It will run from 10 to 16 ounces per yard. The laps on the apron of the finisher picker will average about 15 ounces per yard, and as there are four laps on the apron at one time, the combined weight of the laps entering the finisher is 60 ounces per yard, and as the weight of the lap from the finisher is between 10 and 16 ounces per yard, it is evident that some means must be employed to reduce this weight to that required. This is accomplished by introducing a certain amount of draft between the feed rolls and the lap rolls. By the word draft, as applied to cotton machinery, is meant the ratio of the length of lap passing the lap rolls in a given time, to the length of lap which passes the feed rolls in the same time. If the circumferential velocity of the feed rolls is 25 feet per minute, while in the same time the velocity of the lap roll is one hundred feet or four times as much, there is a draft of four. It follows if the combined weight entering the feed rolls is 60 ounces per yard, the weight delivered will be one-fourth as much, or 15 ounces per yard.

To make this clear to those not familiar with the subject, we will call the weight of each of the laps on the apron of the finisher 16 ounces per yard and that of the lap delivered by the finisher 15 ounces per yard. The draft will be found in the following way:

Rule 5. To find the draft of the finisher, multiply the number of laps on the apron by the weight per yard and divide the product by the weight of the lap being delivered.

$$\text{Example: } \frac{4 \times 16}{15} = 4.2$$

Rule 6. To find the weight of lap being delivered, draft being known, multiply the number of laps on the apron by the weight per yard and divide the product by the draft.

$$\text{Example: } \frac{4 \times 16}{4.2} = 15.$$

After the draft has been calculated, which in this case we have found to be 4.2, the draft factor, or constant number, must be found by which the number of teeth in the draft gear may be determined. A diagram of the gearing of a finisher picker is shown in Fig. 46.

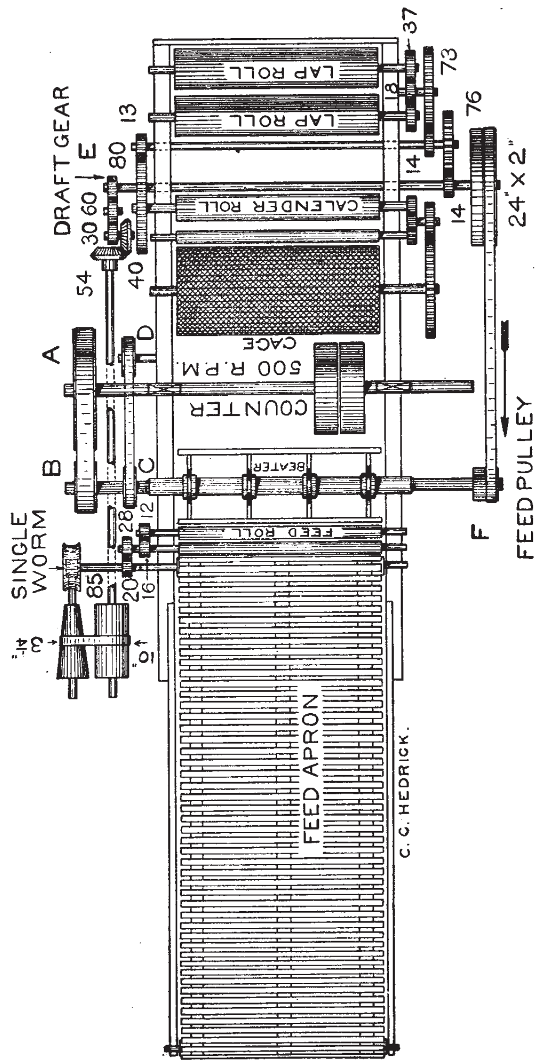


Fig. 46 Diagram of Gearing of Finishing Picker.

The feed roll is $2\frac{1}{8}$ inches in diameter and has upon the end a spur gear of 12 teeth, which is driven from the evener roll by a gear of 16 teeth. Compounded with this gear is one of 28 teeth, which is driven from the apron roll by a gear of 20 teeth. On the outer end of the apron roll is a worm gear of 85 teeth that is driven by a single-threaded worm which is upon one end of the evener cone. The diameter of the evener cone is taken at a point midway of the ends and is $3\frac{1}{4}$ inches. The cone is driven from a 10-inch diameter drum on the side shaft. On the front end of the side shaft is a bevel gear of 54 teeth, driven from a similar gear of 40 teeth compounded with a spur gear of 30 teeth, which is driven from the draft gear, E, (on the end of the driving shaft) through an intermediate gear of 60 teeth. On the other end of the driving shaft is a pinion of 14 teeth, which drives the lap rolls through gears of 76, 14, 73, 18 and 37 teeth. The last gear is upon the lap rolls which are nine inches in diameter.

Rule 7. To find the constant number, or factor, of the picker, multiply the diameter of the lap roll by the drivers and divide the product by the product of the diameter of the feed roll multiplied by the driven gears, leaving out all intermediate gears and the draft gear.

Example:

$$\frac{9 \times 18 \times 14 \times 14 \times 30 \times 54 \times 3\frac{1}{4} \times 85 \times 28 \times 12}{2\frac{1}{8} \times 37 \times 73 \times 76 \times 40 \times 10 \times 1 \times 20 \times 16} = 85.51$$

Rule 8. To find the number of teeth in the draft gear, divide the draft factor by the draft, 42.

Example: $85.51 \div 4.2 = 20$

Rule 9. To find the draft, when the number of teeth in the draft gear is known, divide the draft factor by the number of teeth in the draft gear, 20.

Example: $85.51 \div 20 = 4.2$

Rule 10. To find the draft, without first finding the factor, multiply the diameter of the lap roll by the drivers and divide the product by the product of the diameter of the feed roll multiplied by the driven gears and the draft gear, leaving out the intermediate gears.

Example:

$$\frac{9 \times 18 \times 14 \times 14 \times 30 \times 54 \times 3\frac{1}{4} \times 85 \times 28 \times 12}{2\frac{1}{8} \times 37 \times 73 \times 76 \times 20 \times 40 \times 10 \times 1 \times 20 \times 16} = 4.2$$

Rule 11. To find the speed of the beater, multiply the speed of the countershaft by the diameter of the pulley, A, (24 inches) and divide the product by the diameter of the beater pulley, B, (8 inches).

$$\text{Example: } \frac{500 \times 24}{8} = 1500.$$

Rule 12. To find the speed of the fan, multiply the speed of the beater by the diameter of the pulley, C, (5 inches) and divide the product by the diameter of the pulley, D, (8 inches).

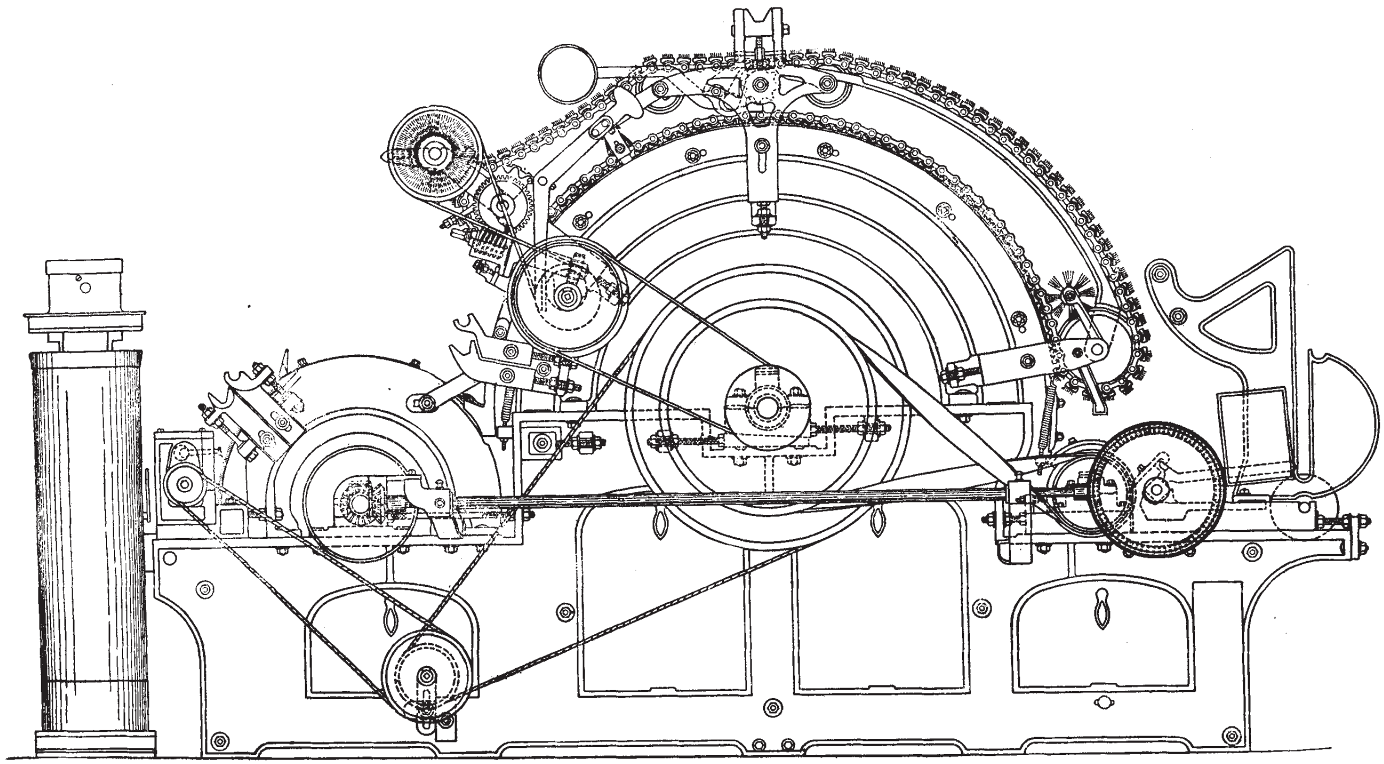
$$\text{Example: } \frac{1500 \times 5}{8} = 937.5$$

Rule 13. To find the factor for the production of the picker, multiply together the number of revolutions of the beater shaft, the circumference of the lap roll and the drivers and divide the product by the product of the diameter of the pulley on the calender head (24 inches) multiplied by the driven gears and 36 (number of inches in a yard).

$$\text{Example: } \frac{1500 \times 28.27 \times 14 \times 14 \times 18}{24 \times 76 \times 73 \times 37 \times 36} = .8435$$

Rule 14. To find the production of the picker, multiply the factor, the diameter of the feed pulley, F, ($4\frac{1}{2}$ inches) the minutes run per day (600) and the weight of the lap per yard (15 ounces) together and divide the product by ounces per pound.

$$\text{Example: } \frac{.8435 \times 4\frac{1}{2} \times 600 \times 15}{16} = 2135.10 \text{ lbs.}$$



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COTTON SPINNING.

PART II.

CARDING.

After the cotton has passed through the opening and cleaning process, there still remains a considerable amount of leaf, sand, particles of seed and small clusters of unripe fibers which must be removed before it can be spun properly into yarn. If we examine carefully a lap from the finisher picker, we shall see that in addition to these impurities, the fibers lie in different directions in small tangled tufts of unequal thickness and density, also that it is necessary to comb or card them to disentangle, straighten and clean them.

Arrangement of Card Room. The cotton card, like all other machines used in cotton spinning, has grown from a very primitive form. At the present time, the revolving flat card is used almost exclusively. Before entering upon a description of the card, some attention should be given to the placing of the machinery in the card room. An arrangement adopted in many mills is shown in plan in Fig. 47 and in sectional elevation in Fig. 48.

The cards are placed in rows, extending lengthwise of the mill, six to seven feet on centers except where a line comes between columns. The alleys should be about four feet wide if space will permit. This allows a lap truck to pass down the alley, clear of the machines, a point which should be considered, as laps are frequently torn by coming in contact with the machinery. The cards in two adjoining lines should be placed with the coilers towards each other, except when the width of the mill is such as to cause an odd number of rows, as shown in the drawings. In that case the odd row, is placed, usually, in the center of the room.

The shafting for driving the cards should be placed over the front or coiler alley, so that the driving belt will not interfere with the application of the flat grinder which is attached at the back on most cards. In no case should the shafting be placed over the cards, as oil is very apt to work out of the hanger boxes and drop on to the clothing of the flats and destroy it completely.

The cards should be so arranged that each is driven from a separate pulley. This is more necessary than it seems at first

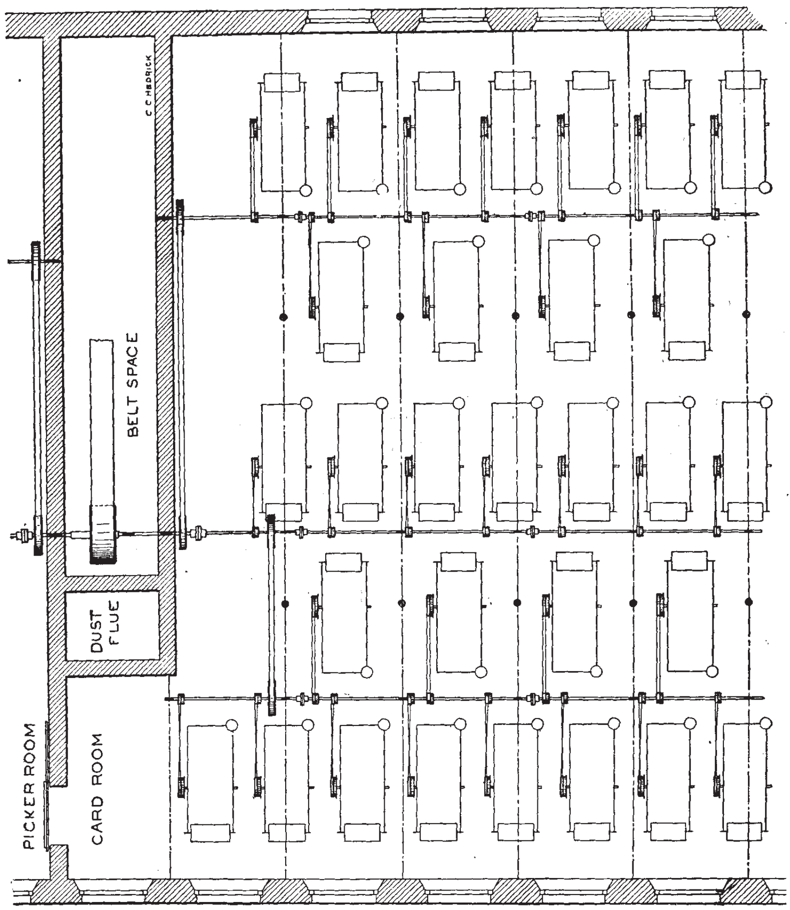

Fig. 47. Plan of Card Room.

thought. If the cards are not erected exactly parallelly with the shaft, the driving belt may run to one side of the face of the pulley and to overcome this the pulley is moved slightly along the shaft. If two cards were driven from the same pulley, this could not be done. With the old-fashioned top flat cards it was customary to drive two from the same pulley, the pulley having a flange in the center of the face, which formed a division between the two belts. If the cards were not set parallelly with the shaft,

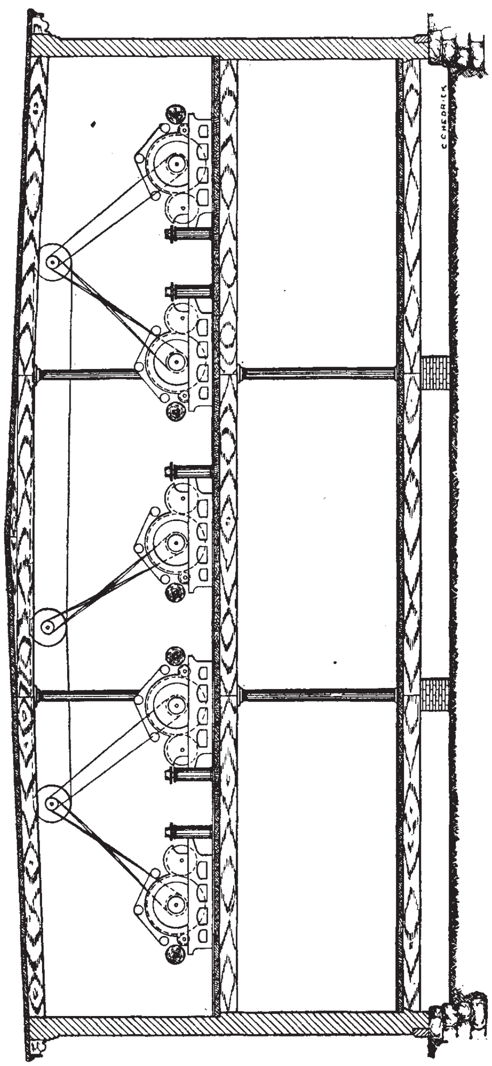

Fig. 48 Sectional elevation of Card Room.

the belt would run to one side. To remedy this, the cards, instead of the pulleys, were moved enough to cause the belt to run true, but

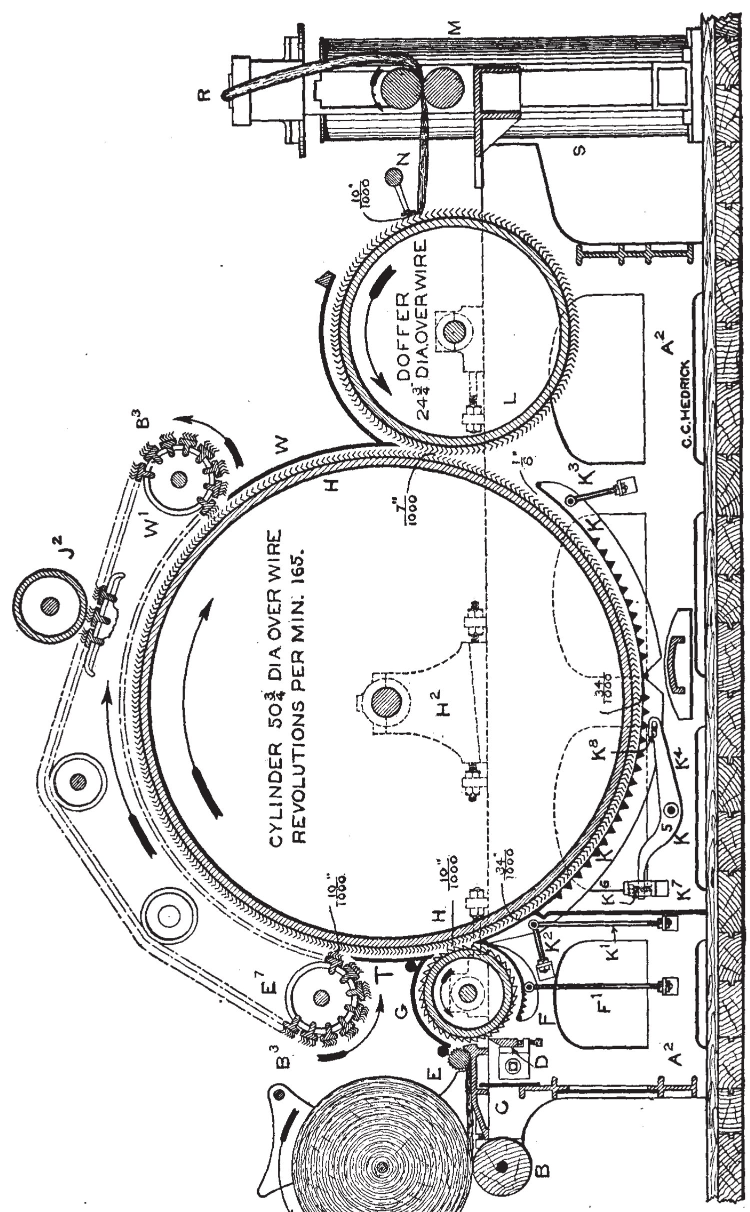

Fig. 49. Section of Revolving Flat Card.

with the revolving flat cards, it is not considered advisable to move them, as the settings are easily disturbed.

Theory of Carding. In the sectional elevation shown in Fig. 49, the lap, A, from the finisher picker, is placed in the lap stands and rests upon the lap roll, B, by which it is revolved slowly, the surface speed of the lap roll being just sufficient to unwind the lap at the same speed that it is received by the feed roll. It then passes forward on the feed plate, C, and under the feed roll, E. As the fibers pass up over the curved part or nose of the feed plate, they come in contact with the teeth of the leader or licker-in, G, which is about $9\frac{1}{2}$ inches in diameter and is covered with steel teeth, inserted in its surface, which resemble the teeth of a saw. The action of the leader is twofold; that of removing dirt and that of combing and straightening the fibers. When the teeth of the leader (the surface speed of which is about 1,050 revolutions per minute) strike the fibers, the force of the blow strikes down and partially removes the dirt. The fibers, which have now advanced far enough beyond the bite of the feed roll, are removed and carried by the leader, while those which are held by the feed roll are combed and straightened. The fibers thus receive a very effectual cleaning, more dirt being removed at this point than in any part of the card. As they are carried around by the leader, the fibers are drawn over the top edge of the mote knife, D, which also aids in cleaning. Directly under the leader is a screen or grid, F, called the leader screen. The part of the screen with which the fibers come in contact first consists of a series of bars, running across from side to side of the card; the rest of the screen, from the last bar to a point where it is hinged to the cylinder screen, is perforated with small holes. The object of this screen is to prevent the cotton from leaving the leader, and to allow foreign substances, which, being heavier, are thrown out by centrifugal force, to drop through these perforations.

The fibers, which have been brought around by the leader, are now taken up by the cylinder, H, the surface velocity of which is a little more than twice that of the leader. The wire teeth (card clothing) of the cylinder are much finer than those of the leader, and as both surfaces run in the same direction, the fibers are readily stripped from the teeth of the leader and are carried forward under the flats, B^3, to the doffer, L. The flats are faced with card clothing, similar to that of the cylinder, and embrace a little more than one-third of its circumference and travel slowly in the same direction as the cylinder. As the fibers are carried under each successive flat, they become more thoroughly cleaned and straightened. The speed of the cylinder plays an important part in this operation. If the fibers are short, they will be removed by the flats, but if sufficiently long, they will hold to the cylinder and be combed by them. The fibers are now transferred to the doffer. Just how this is done may be perplexing to many, but if we stop to consider a moment, it will be found very simple. Although the surfaces of the cylinder and doffer run in the same direction, the clothing of each stands at a different angle, the doffer clothing presenting a series of hooks upon which the fibers are caught and drawn from the cylinder. If we examine the cylinder closely, we will see that many of the fibers stand out from its surface, not in straight lines parallel with the circumference, but in a loosely tangled mass which is effected partly by centrifugal force but more by the naturally irregular disposition of the cotton, and, as most of the fibers are carried around by the cylinder a great many times before they are transferred to the doffer, their repeated passing beneath the flats changes their position and finally results in their withdrawal from the cylinder. Then, too, the fibers cross and recross each other, so the withdrawal of one or more easily affects the others.

Beneath the cylinder is the cylinder screen, K, which extends from the leader screen almost to the doffer and which is made in two parts, hinged in about the center. For the greater part of the length, each half consists of a series of bars, running from side to side. If no screen is used under the cylinder, its high surface velocity (about 2,150 feet per minute) will cause the fibers to stand out and finally become detached but with a screen, this cannot happen while the heavier impurities, thrown out by centrifugal force, fall between the bars.

The doffer, which is $24\frac{3}{4}$ inches in diameter outside of the wire clothing, runs at a very slow speed, not over twenty revolutions per minute at the most. Consequently the fibers are

The last plate, shown in Fig. 53, is for Sea Island cotton. In this style, the length of the face is greater than on the plates used for all other varieties of cotton. The exact size and outline of the nose and face of the plates are shown at the right hand of the drawing in all four views; the distance between the bite of the feed roll and the lower edge of the plate is indicated by dotted lines. In all cases, this distance should be slightly more (from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch) than the average length of staple being worked, otherwise, the fibers will be broken by the leader teeth trying to take them away before they are liberated from the bite of the feed roll. The angle of the face of the feed plate should be such as to cause the teeth of the leader to comb the fibers for about two-thirds their length before they become detached.

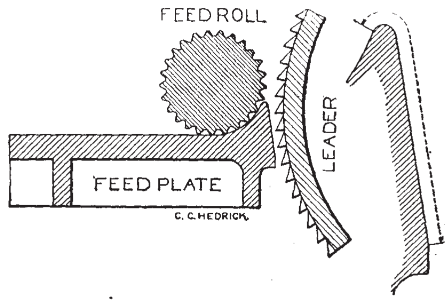

Fig. 52. Feed Plate for Egyptian Cotton.

In Fig. 54 is shown a section of an adjustable feed plate, intended to provide for different lengths of fibers. This plate consists of two parts; a top piece, A, which is movable and is adjusted by the screw, C, and a base piece, B, which is fastened to the side of the card. Strips of wood, D, of different thicknesses, are used to fill the space between the pieces. This plate possesses no merits, not giving good results when put into use.

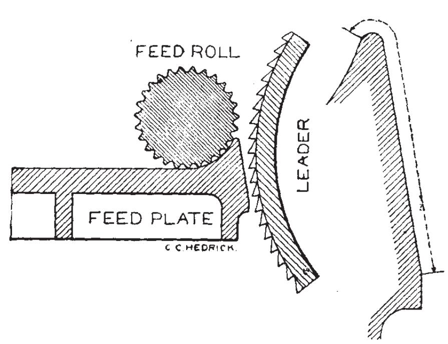

Fig. 53. Feed Plate for Sea Island Cotton.

Fig. 55 shows the method used for feeding the card before the feed plate became generally adopted. It may be found still on the old style of stationary top cards. Instead of a single feed roll, two rolls were used which were about $1\frac{3}{8}$ inches in diameter. The cotton was carried forward between them to the leader, or cylinder, many of the older cards having no leader. The distance from the bite of the feed rolls to the point of contact with the leader (indicated by radial lines A and B) was about $1\frac{1}{8}$ inches, and, unless the fibers were at least $1\frac{1}{4}$ inches long, they became detached from the bite of the rolls before they had received any combing and the cotton was delivered to the cylinder in small tufts. To remedy this, the rolls were made small in diameter but this introduced another evil; the rolls would spring apart in the center and cause the lap to be fed very unevenly.

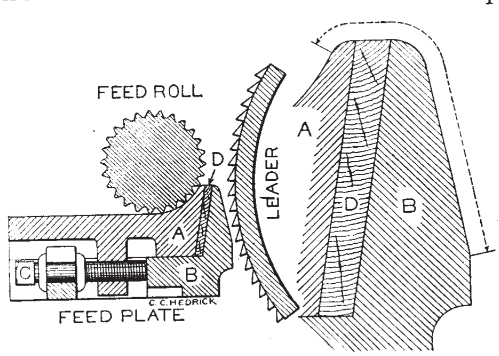

Fig. 54. Adjustable Feed Plate.

The half-tone in Fig. 56 shows two sections of laps taken from cards. The one marked A was from a card provided with a feed plate while B was taken from an old style card with two feed rolls. The point, where the fibers were liberated, is indicated by a horizontal line and it will be seen that in section A, they were combed and cleaned for a much greater portion of their length than were those in section B which received very little combing, before being taken away by the leader. The fibers are always more or less broken by this method.

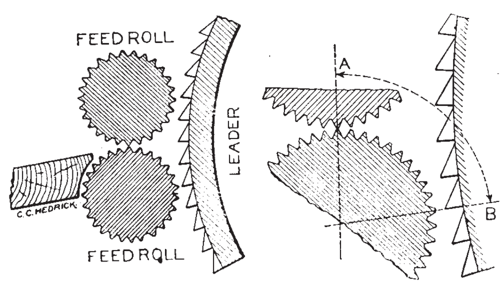

Fig. 55. Feed Rolls for old style cards.

Leader, Cylinder and Flats. A section of the leader, the cylinder and the parts connected and a section of a flat in relation to the cylinder are shown in Fig. 57.

HE editors have freely consulted the standard technical literature of Europe and America in the preparation of these volumes and desire to express their indebtedness, particularly to the following eminent authorities, whose well known treatises should be in the library of every one connected with textile manufacturing.

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The mote knife, **D**, is adjusted in either direction, horizontally by moving the bracket, D^1, by which it is attached to the leader shroud, and vertically by the screw, D^2. The correct distance from the teeth of the leader may be obtained in this way very easily, and as the leader shroud moves with the leader shaft when the position of the leader is changed, the mote knife moves with it, avoiding the necessity of resetting. Over the leader is a steel

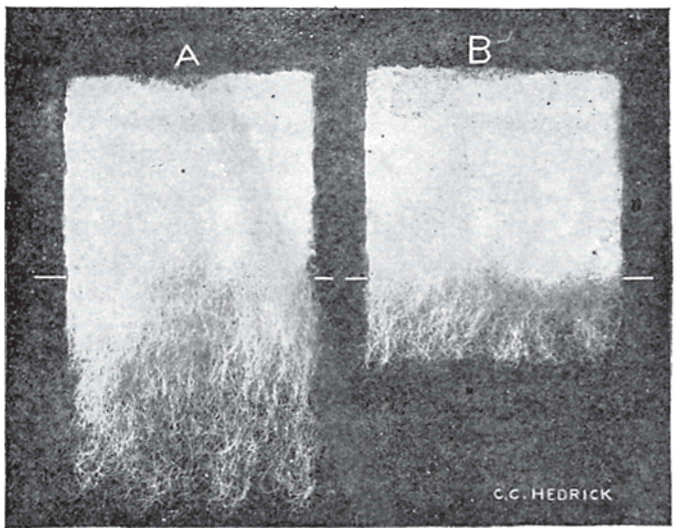

Fig. 56. Section of card sliver.

bonnet, J, called the leader bonnet. At the point where this cover and the back plate, T, come together is placed a round iron rod, P, covered with flannel, which serves as a fill-up piece, preventing the dust and short fibers from blowing out. Resting upon the feed roll and between it and the leader bonnet is another rod, P, similar to the one just described. At this point, the rod performs double duty, keeping the dust from blowing out and also acting as a clearer for the feed roll.

In the section of the flat and the cylinder, it will be seen that the space between the wires of each is greater at the toe, or point, where the cotton enters than at the heel where it leaves. By inclining the flat in this manner, the fibers receive combing from the greater portion of its wires, and, as they stand out slightly from the surface of the cylinder by being drawn into a small space, are more easily dealt with than they would be if the flat were brought close at the toe.

Cylinder Doffer and Flats. In Fig. 58 is shown a partial section through the cylinder, doffer and parts directly connected. The flats, B^3, pass around the front block, W^1, in the direction shown by the arrow and the short fibers, or strippings, which

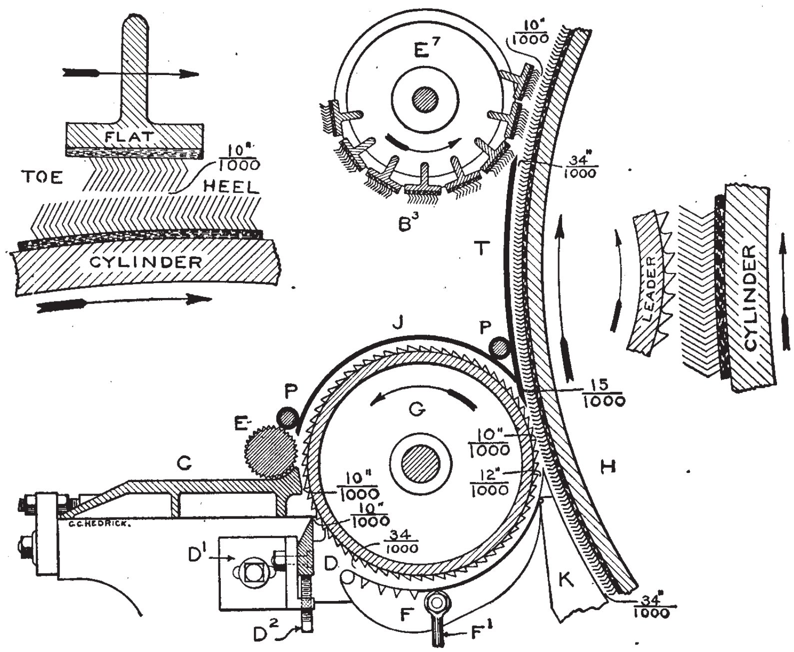

Fig. 57. Section of cylinder, leader and flat.

adhere to them, are removed by the stripping comb, W^2. Passing along toward the rear of the card, they are cleaned by a revolving brush, W^3, called the stripping brush which is itself cleaned by a stationary comb, W^4, called the stripping brush comb. Directly beneath the stripping comb is the strip roll, W^5. This is a wooden roll about $1\frac{1}{2}$ inches in diameter, covered with flannel and supported at either end by arms, W^6. As the flats pass around the front block, the strippings, which are removed by the comb, are wound upon the roll which revolves by being held lightly in contact with the flats.

It was the custom, formerly, to allow the strippings to drop upon the doffer cover in a loose mass and, when an amount had collected, it was removed. With the strip roll the strippings are wound in a neat and very compact form and can be removed very

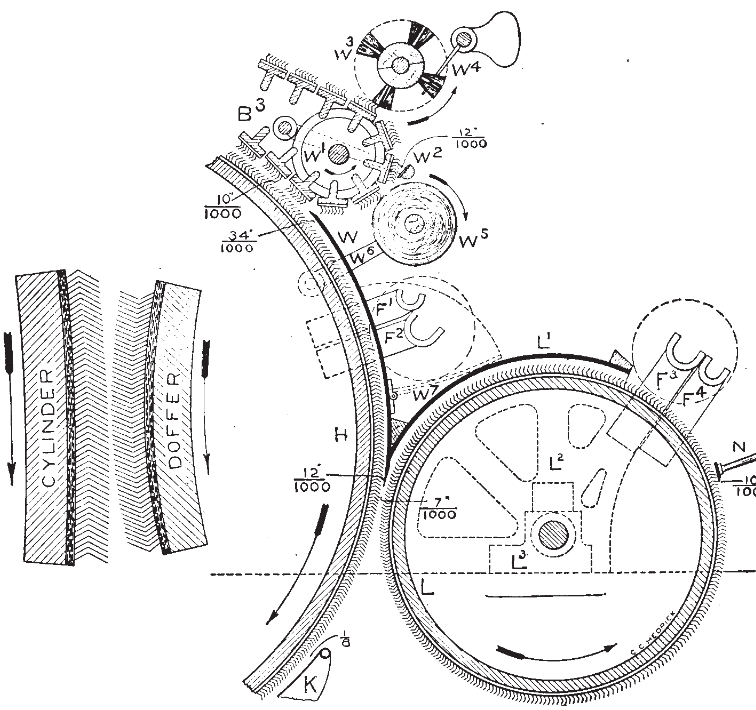

Fig. 58. Section of cylinder and doffer.

quickly, and by reason of the compactness, the removal does not have to be performed so often.

When it is necessary to grind, or strip, the cylinder, the door, W^7, which is hinged to the front plate, can be turned down as shown by dotted lines. Over the doffer is a cover, L^1, called the doffer bonnet, which is fastened to the doffer shroud, L^2, which, in turn, is fastened to the doffer bearing, L^3.

The main cylinder is made 50″ in diameter by 40″ or 45″ face.

The doffer is made 24″, 27″ or 28″ in diameter and 40″ or 45″ face. The clothing adds $\frac{3}{4}$″ to the diameter. The flats are $1\frac{3}{8}$″ wide and there are 104 or 110 in a chain. With 104, there are 39 at work and with 110, there are 44 at work.

Settings. A few words may be said now in regard to the settings of the various parts of the card, a detail which is very often slighted and the quality of the work suffers.

The construction of the revolving flat card is such as to require very fine adjustment and too much attention cannot be given to grinding, setting, stripping and cleaning, as the results of poor carding cannot be rectified in any of the subsequent processes. Very close setting, with the card freshly ground, will produce extra good work but the wires will become dull much quicker than with more open settings, which are productive of good average carding from one grinding to the next.

Gauges. For setting the doffer, leader, feed plate, screens and back and front plates, most machinery builders supply a four-leaf gauge of the following sizes: $\frac{5}{1000}$″, $\frac{7}{1000}$″, $\frac{10}{1000}$″ and $\frac{12}{1000}$″ thickness. For setting the tops, three gauges with detachable handles are used; these are $\frac{9}{1000}$″, $\frac{10}{1000}$″ and $\frac{11}{1000}$″ in thickness.

To understand fully the setting points, reference should be made to Figs. 49, 57 and 58. The settings given, although liable to slight changes under different conditions, are recommended.

Cylinder Screen. For setting the cylinder screen, openings are provided in the sides of the screen for inserting the gauge. The front part, or nose, of the screen is adjusted by the rod, K^3, while at the back, where it joins the leader screen, the vertical adjustment is obtained by the rod, K^1, and the lateral movement is governed by the rod, K^2. The center of the screen is adjusted by the lever, K^4, which turns upon a stud, K^5. One end of the lever is connected to the screen by a pin, K^8, the other end is tapped to receive an adjusting screw, K^6, which is held between the projecting lugs of a stand, K^7.

The usual setting of the screen, from the cylinder wire, at the back and center, is about $\frac{34}{1000}$″ (four gauges, 5, 7, 10 and 12). At the front, or doffer end, it is set from $\frac{1}{8}$″ to $\frac{1}{4}$″ from the cylinder wire. The setting of the front half of the screen controls the side waste and droppings under the doffer. By setting it away from the cylinder, it allows the fibers to be drawn gradually between the screen and cylinder. If set too close, a great amount of waste is made as the fibers are thrown off the cylinder.

Back Plate. The back plate, T, which extends from the leader to the flats, is set, at its lower edge, about $\frac{15}{1000}''$ (two gauges, 5 and 10) from the cylinder wire. At the upper edge, the best results are obtained by setting it about $\frac{34}{1000}''$ (four gauges) from the cylinder wire. This allows the fibers to free themselves and stand out a little from the cylinder before they meet the flats.

Leader and Leader Screen. The leader is set to the cylinder with a $\frac{10}{1000}''$ gauge. The leader screen is set to the leader, at the point where it is hinged to the cylinder screen, with a $\frac{12}{1000}''$ gauge. The nose of the screen, with which the fibers first come in contact, is set away from the leader wires from $\frac{12}{1000}''$ to $\frac{34}{1000}''$. This depends upon the condition of the cotton and the amount of fly it is desired to remove. By so setting the screen, the fibers are drawn gradually into a more compact space, as they pass around on the leader, and present a more even sheet to the teeth of the cylinder. When it is desired to use the cotton for a very fine grade of work, it is best to remove as much fly as possible, at this point, rather than let it fall out between the rolls of the drawing frame or during other processes. This may be accomplished by setting the nose of the screen close to the leader, but not too close, as it is possible to remove much good cotton. Correct setting depends upon the judgment of the carder. The screen may be adjusted by the rod, F^1, the lower end of which passes through a bracket fastened to the card side.

Mote Knife. The mote knife is set from the leader with a $\frac{10}{1000}''$ gauge, and care should be taken that it is set exactly parallel with the leader. The percentage of waste may be increased by changing the height of the knife which is adjusted by the screw, D^2.

Feed Plate. For setting the feed plate from the leader, the gauge used depends somewhat upon the weight of the lap being carded. For a lap weighing 12 ounces per yard or under, a $\frac{10}{1000}''$ gauge is generally used, while for laps above 12 ounces per yard, the setting is sometimes as great as $\frac{17}{1000}''$ (two gauges).

Stripping Plate. Extending from the doffer to the flats is a polished steel cover, W, called the front or stripping plate. Upon the correct setting of this plate, depends the removal of the strippings from the flats. Usually, it is set, at its lower edge, about $\frac{12}{1000}''$ from the cylinder and about $\frac{34}{1000}''$ at the top edge. If set too close at the top edge, the strippings will be removed from the flats by the cylinder when they reach the edge of the plate, and, on the other hand, if set away at the top, the fibers will cling to the flats and be combed off when they reach the stripping comb.

Doffer. The doffer is set $\frac{7}{1000}''$ from the cylinder, close enough for any class of work.

Doffer Comb. For setting the doffer comb, the $\frac{10}{1000}''$ gauge should be used, although with a very light sliver, a $\frac{7}{1000}''$ gauge may be used.

Stripping Comb. The stripping comb should be set to the flats with a $\frac{12}{1000}''$ gauge.

Flats. In setting the flats, it is necessary to remove five at certain intervals in the chain, so that the gauge may be admitted at points nearly under the sprocket stand, back block, center block, quarter block and grinder bracket. The spacing varies, depending upon the number of flats in the chain and the make of the card.

The flats should not be set closer than $\frac{10}{1000}''$ to the cylinder, and as the setting necessitates a thorough understanding of the principles and construction of the flexible bend, it should be considered in reference to it.

Gearing. The method of driving the various parts of the card will now be considered and illustrated by Fig. 59, an elevation of the right-hand side of a left-hand card, and Fig. 60, an elevation showing the left-hand side.

To determine the hand of a card, the custom, followed by all cotton machinery builders in this country, is to face the machine at the delivery, or doffer, end and whichever side the driving pulley is upon decides the question. Fig. 61 shows a right-hand card. Upon the leader is a pulley, B, driven from a large pulley, D^3, which is upon the cylinder shaft, by the crossed belt, E. The doffer comb is driven from the groove in this pulley by the band, D^1, which passes to a double grooved carrier pulley, C^1, from