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COTTON
PICKERS
COTTON CARDS
DRAWING ROLLS
RAILWAY HEADS AND DRAWING FRAMES
COMBERS
FLY FRAMES

SCRANTON
INTERNATIONAL TEXTBOOK COMPANY
87

87 PRINTED IN THE UNITED STATES. 15405

CONTENTS

COTTON

COTTON CULTIVATION

INTRODUCTION

1. Principal Species.—Cotton is a vegetable fiber—the fruit of a plant belonging to the order of the Malvaceæ, to which belong the mallow, the hollyhock, and the okra. The cotton plant belongs to the genus **Gossypium,** and the number of species from a botanical point of view is variously stated as from four to eighty-eight, according to different botanists. The principal species of the cotton plant cultivated for commercial purposes are: *Gossypium herbaceum*, *Gossypium arboreum*, *Gossypium hirsutum*, and *Gossypium Barbadense.*

The species known as **Gossypium herbaceum** grows from 2 to 6 feet high and is found native or exotic in Northern Africa and in Asia; it is also largely cultivated in the United States of America.

The **Gossypium arboreum** grows to the height of 15 or 20 feet, whence it derives the name of tree cotton. The seeds are covered with a short green fiber. While the plant is found in Asia, it is most largely cultivated in Central and South America.

The **Gossypium hirsutum** is a shrubby plant, its maximum height being about 6 feet. The young pods are hairy; the seeds numerous, free, and covered with firmly adhering green down under the long white wool.

The **Gossypium Barbadense** attains a height of from 5 to 10 feet. The seeds of this plant are black and smooth and the fiber the longest known to commerce. The name is derived from the fact that the plant is a native of the Barbados, or has been cultivated there for a long time. The sea-island cotton plant of the United States belongs to this species.

Cotton fiber is known to commerce under the simple name of *cotton* in English-speaking countries, although by some people it is spoken of as *cotton wool*. Its German name is *baum-wolle;* in French, its name is *coton;* in Spanish, it is called *algodon*.

2. Growth and Development.—In cultivating cotton in the United States, the time of planting the seed varies according to the latitude of the district in question, but occurs in April in the majority of districts. In some of the favored districts of Mississippi, Louisiana, and Texas, where the season is abnormally long, the seed is planted in the latter part of March. In the heart of the cotton belt, April 1 is accepted as a suitable date; in North and South Carolina and Tennessee it is considered unwise to plant before April 15; while in the extreme northern edge of the belt, as in Virginia, planting is deferred to the last days of April or early in May.

Germination occurs rapidly after the sowing of the seed, the first appearance of the plant above the ground being from 4 to 14 days after sowing. From the germination period until the middle of the summer the stalk and foliage of the plant are developed until the plant attains its maximum size; during this period hot, humid weather with frequent showers is favorable. From the middle of summer and onwards the bearing season of the plant occurs, when more heat and less moisture are desirable.

Usually about 40 days after the plant shows above the ground there appears the first **square**, or bud. From the formation of this bud 24 to 30 days elapse before the appearance of the flower. The flower on the first day of the opening of the bud is yellowish white and has five petals. One peculiarity of the cotton plant is in the change of color of the flower. This, which on the first day is of a shade varying from a dull white to a yellow, is found on the second day to be of a distinctly pink or reddish hue; the flower drops off on the succeeding, or third, day.

After the petals fall, there remains the small boll enveloped in the calyx; this develops until it becomes about the shape and size of an egg, and finally bursts from 50 to 60 days after the appearance of the flower.

When the boll bursts, it exposes from three to five cells divided by membranous walls; each cell contains seeds,

FIG. 1

which are attached by filaments to the membrane of the boll. The filaments ultimately disappear, leaving the seed loose in the cavity and covered with cotton. Each seed is entirely enveloped by the cotton fibers attached to it just as the human hair is attached to the head. The seeds vary in number from thirty-two to thirty-six in each pod, or boll. The view at *a*, Fig. 1, shows an empty pod, or capsule; *b* is the seed cotton out of one cavity of the pod just as it appears after it has been removed by the fingers of the cotton picker; *c* shows the individual seeds and fibers of which the mass *b* is composed. The next view, Fig. 2, is a reproduction of sections of these seeds with the fibers radiating in all directions, each attached at one end to the seed. Botanists differ as to the exact cause of the bursting of the boll, but it is probably due to the increased space occupied by the fiber as it ripens and dries and the contraction and splitting of the pod from the same cause.

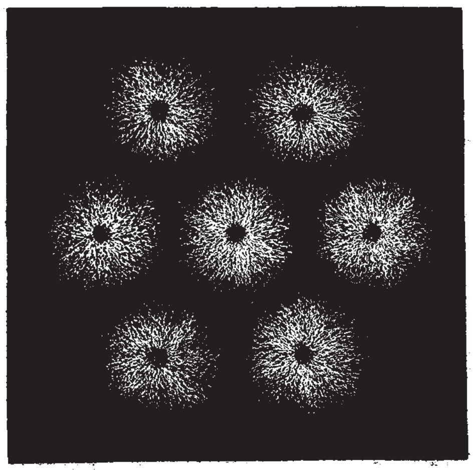


Fig. 2

3. The operations of cotton culture on land that has been previously cultivated, and on well-managed farms, may be summarized as follows, varying according to the latitude of the cotton field: Breaking up, burying vegetation, broadcast manuring, and harrowing, December and January; bedding up, February; fertilizing, March; sowing seeds, April; chopping out to a stand and throwing soil up to the root, May; (considerably more seeds are sown than plants required; the excess of plants are chopped out with hoes); cultivating by plow and hoe, or cultivator, latter part of May or in June; period of rest, part of July and part of August; picking, August, September, October, November, and if the season is an open one, December and even January.

STRUCTURE OF THE COTTON FIBER

4. The cotton fiber, which to the naked eye appears to be a fine, smooth, and solid filament, exhibits a somewhat complicated structure when examined under a microscope. A microscopic view of cotton fibers is shown in Fig. 3. Each fiber appears to be a collapsed tube with corded edges, twisted many times throughout its length and having the appearance of an elongated corkscrew. This semi-spiral construction assists in the formation of a strong thread from such a comparatively weak fiber as cotton. In the formation of a thread, the convolutions interlock with one another and help to resist any tension put on the yarn. These convolutions

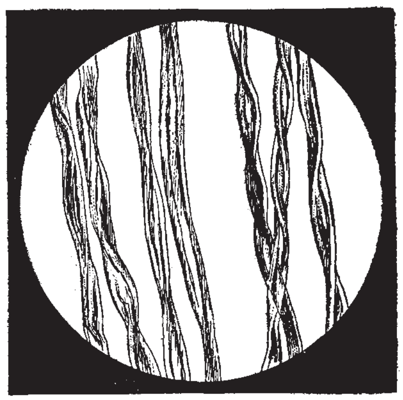


FIG. 3

are less and less frequent as the fiber is less matured, and are almost altogether absent in the immature fiber, which has merely the appearance of a flattened ribbon when examined under a microscope. The immature fiber is transparent and has a glossy appearance, so that when it exists in any quantity in a bale of cotton it can readily be detected with the naked eye. It has the feature of not taking dye so readily as ripened cotton.

If examined under a more powerful microscope, the cotton fiber is found to consist of four distinct membranes, or layers of matter. Ignoring the removable foreign matter contained in raw cotton, such as sand and other mineral substances, leaf, pieces of boll, or stalk, and considering the fiber as being entirely cleared from this, it is found to be composed of cellulose, permeated by a small amount of mineral matter, and that each fiber is surrounded by soluble substances present to the extent of from 1 to 2 per cent. The small amount of mineral matter may be liberated by burning the fiber, the inorganic matter remaining as an ash retaining more or less the formation of the fiber and being about 1 per cent. of the original weight.

Cellulose is the largest constituent of the cotton fiber; in fact, it is the chief constituent of almost everything of vegetable origin, but is found with its most characteristic features in such commercial fibers as cotton, ramie, flax, and so on. It is a carbohydrate, so called because it is composed of carbon, hydrogen, and oxygen, the hydrogen and oxygen being present in the same proportion as in water. It is this cellulose that absorbs and retains moisture, the cellulose in the cotton fiber, when in an air-dry condition, containing about $7\frac{1}{2}$ per cent.

The soluble substances present in the cotton fiber, principally located on the outside, are waxy or oily substances permeated with other material and amounting in the aggregate to from $1\frac{1}{2}$ to 2 per cent. of the weight of raw cotton. The nature of these materials is, as yet, more or less obscure; the portion that is removable by scouring with a weak solution of soda ash is commonly spoken of as *cotton wax*, while others removable by prolonged boiling in distilled water are given the name of *water extract*.

5. The amount of removable foreign matter in cotton varies greatly with the variety, and even in different growths of the same variety. It is present to the extent of from 1 per cent. in carefully cultivated sea-island to 6 per cent. or more in coarse, negligently cultivated East Indian cotton. Assuming 2 per cent. as a fair average, the following data represent the constituent parts of what is commercially known as raw cotton: Cellulose, 87 per cent.; waxy, or other easily soluble substances, 2 per cent.; ash, 1 per cent. (giving 90 per cent. of fiber if absolutely dry); removable foreign matter, 2 per cent.; moisture, 8 per cent. Of course no two analyses give the same result and these figures only represent what would be found in an average of American-grown cotton in an air-dry condition.

6. The property of containing and retaining moisture, even when in an air-dry condition, or *hygroscopicity*, is common to most of the commercial textile fibers, although cotton possesses this property to a smaller extent than most other fibrous materials. There is a quantity of water always present in cotton that cannot be driven out by a moderate heat, and which, even after it has been expelled by excessive heat, is replaced by moisture from the atmosphere when the superheated cotton is allowed to stand in the open air. When in an air-dry state, under ordinary atmospheric conditions, cotton contains about 8 per cent. of moisture.

The expression *air dry* is used to describe the condition of cotton after it has been exposed to the atmosphere for such a length of time and under such conditions as will cause it to lose all excessive moisture or regain deficient moisture, so as to be in a normal condition. The expression *absolutely dry cotton* means cotton that has been heated to such a high temperature and under such conditions that all the moisture has been expelled and the sample being tested will cease to lose weight.

Moisture is necessary to the satisfactory manipulation of the fiber in spinning, and if for any reason a portion of this natural moisture is driven out, the spinning of the yarn is rendered more difficult until it is replaced. Frequently, from 1 to $1\frac{1}{2}$ per cent. of excessive or artificial moisture is found in cotton beyond the amount named. The amount of moisture in raw cotton depends largely on the treatment of cotton after picking and before baling, on the age of the cotton, and where it has been stored. The largest amount of natural moisture in cotton is found immediately after it has been picked from the cotton plant, especially in the case of cotton picked early in the season. In some districts, especially in the sea islands, it is customary to spread the newly picked cotton in the sun, to ripen and dry it, before ginning; but in the main cotton belt no such care is taken, the result being that the cotton is ginned while moist, tending to *gin damage;* but the planter ignores this in his anxiety to have it baled with as little loss of weight as possible.

The determination of the amount of moisture present is commonly spoken of as *conditioning*. The accurate meaning of this expression is the testing of raw stock, yarn, or fabrics as to what should be their true weight if the normal regain of moisture were added to their absolutely dry weight. From this expression, the name *conditioning houses* has been derived to indicate those establishments, very common in Europe, where fibrous substances are tested as to their hygroscopic conditions. At all these, the standard of moisture in cotton is what is known as an $8\frac{1}{2}$-*per-cent. regain*. This does not mean that every 100 pounds, or other units of weight of cotton, when in an air-dry condition contains $8\frac{1}{2}$ units of water; the meaning of the term is that if a sample of cotton has been subjected to sufficient heat to render it absolutely dry, each 100 parts by weight when exposed to ordinary atmospheric conditions will regain $8\frac{1}{2}$ parts. Thus, in an absolutely dry condition, such a sample of cotton would contain 7.834 per cent. of water, which is the relation of $8\frac{1}{2}$ to $108\frac{1}{2}$.

7. Measurements of the Cotton Fiber.—Cotton fibers even from the same seed vary considerably in length and in diameter, and only approximate measurements can be given. The diameter of a cotton fiber varies from .0004 to .001 inch, and the length of the fiber from $\frac{1}{2}$ inch to $2\frac{1}{4}$ inches. Doctor Bowman is the authority for stating that there are 140,000,000 fibers in a pound. The general average measurements for cottons of the United States are given in the United States Government Tenth Census Reports as follows: Length, 1.10 inches (27.89 millimeters); diameter, .00091 inch (.023 millimeter); strength, 125.6 grains (8.14 grams).

The strength of individual cotton fibers varies from 75 to 300 grains, according to the kind of cotton, the distance between the points of suspension in making the test, and the portion of the fiber selected for the test. Usually the long-stapled, fine cottons break with the least strain, and the short coarse cottons stand the greatest strain. The ordinary American cottons have a breaking strain of from 120 to 140 grains.

8. Testing Yarns and Fabrics Containing Cotton. It is sometimes necessary to determine whether or not a fabric or a yarn is made of cotton, and while the experienced manufacturer is usually able to detect this by the appearance of the fabric, there are several tests that can be applied. In the first place, a microscope is useful, as the appearance of the cotton fiber when highly magnified is different from that of silk, linen, or wool, the wool fiber being covered with overlapping scales, silk being smooth like a glass rod, and linen showing the vascular fiber bundles that make up the complete fiber. In addition to the microscopical test, another may be made by burning a small portion of the yarn or fabric. Cotton will be found to burn with a flash, leaving a very light ash, while animal fibers, such as silk and wool, burn more slowly, emitting an offensive odor and leaving a curled bead, or globule, of carbonized matter. Chemical tests may also be made by which the nature of the fiber may be determined without any doubt.

COTTONS OF THE WORLD

9. Quantity and Quality Produced.—While the cotton crop of the United States is the most important and most useful in the world—being of such importance, in fact, that the price of American cotton practically controls the price of other cottons—there are numerous cotton fields in various parts of the world where extensive crops are raised and the product used for purposes for which American cotton cannot be utilized. The most important cotton-growing countries, other than the United States, are India, Egypt, China, and Brazil. Fig. 4 shows the proportion of cotton raised in several countries to the world's crop in 1900–1901.

Sea-island cotton of the United States represents the highest quality, and is spun into the finest yarn, being used very largely for thread, laces, and fine cambrics. Next in fineness of quality and length of staple is the brown Egyptian cotton, so called because of its brownish tinge, which is a distinctive feature of this fiber; this is very largely used for fine cotton yarns and goods of all varieties. Among other long-staple cottons that are not important commercially are the Tahiti sea-island, the Peruvian, the white Egyptian, and Egyptian Gallini cottons. The next grade of cotton of any importance is known as Brazilian; it has a staple rather longer than the average American cotton, but is somewhat rough in appearance and touch. The American cottons form the next class, as regards quality, varying from the fine Mississippi cottons, Peelers, and benders, to the short, clean uplands cotton.

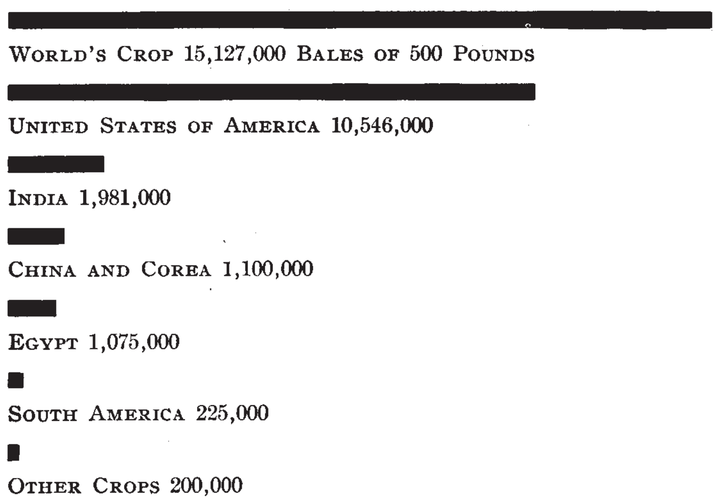


Fig. 4

Next to the United States, China produces one of the largest crops of cotton, which is almost all consumed in that country. It is a beautiful white cotton, somewhat harsh to the touch, but, unfortunately for its commercial importance, is comparatively short-staple, being about the length of the shortest American uplands cotton. The East India crop is also large, but is regarded as being both the dirtiest and the shortest-staple cotton produced.

10. Productive Regions.—Owing to the long seasons of considerable heat required in order to bring cotton to maturity, this fiber can only be profitably cultivated in certain regions bordering north and south of the equator. This is usually described as being the regions bounded by the lines of latitude 45° north and 35° south of the equator, but no such arbitrary divisions can be made, as the isothermal lines must be taken into account. For instance, a line

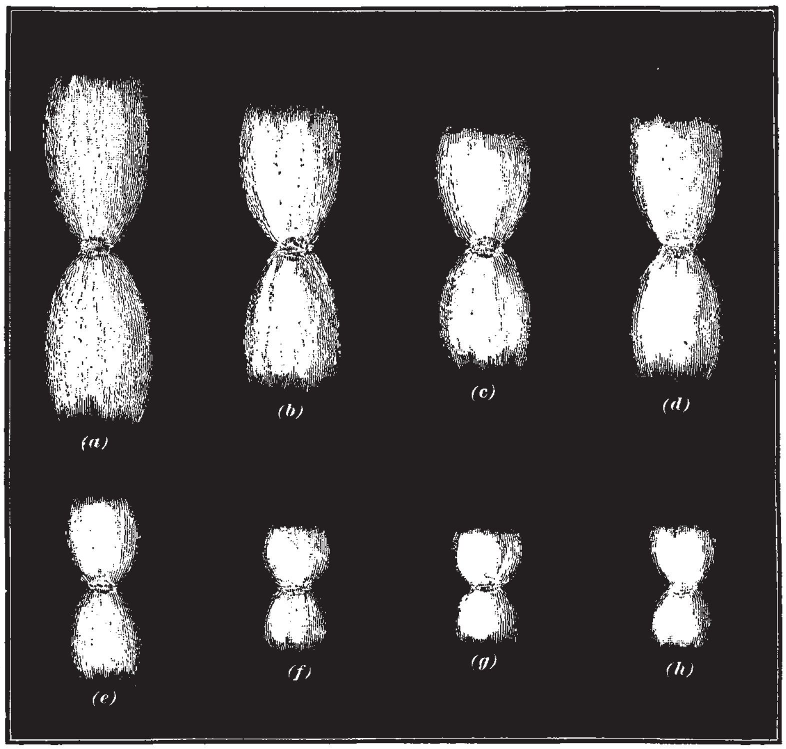


FIG. 5

drawn along 45° north latitude includes such districts as New England and portions of Canada, where it is impossible to grow cotton under natural conditions, while if the lines were drawn about 38° north latitude, which is the northern limit of cotton-growing districts in the United States, it would exclude portions of Turkestan, Southern Italy, Greece, and other districts where it is possible to cultivate the cotton plant with success. Thus, an isotherm must be followed along the lines of equal temperature in the northern hemisphere, and another isothermal line in the southern hemisphere. This practically embraces in North America all the southern portion of the United States, including all of Georgia, South Carolina, Alabama, Mississippi, Texas, Louisiana, and Arkansas, and parts of Virginia, North Carolina, Tennessee, Indian Territory, California, and Florida; Mexico and Central America; and in South America, Peru, the Argentine Republic, Brazil, Venezuela, and Guiana. In Europe, the islands of Malta, Sicily, southern portions of Spain and Italy, and parts of Greece and Turkey are included, while the Asiatic countries are Arabia, Persia, Turkestan, India, China, Japan, and some of the islands in the Malay Archipelago. In Africa, a very large region is suited to the cultivation of cotton, but at present it is cultivated only in Egypt, in some of the countries on the western coast, and to a small extent in South Africa. In Australasia, it can be cultivated in Queensland and the Fiji Islands.

Fig. 5 shows the relative length of staples of the following leading growths: (*a*) American sea-island, (*b*) Peruvian, (*c*) Brazilian, (*d*) brown Egyptian, (*e*) American, (*f*) Indian, (*g*) Chinese, (*h*) Japanese.

Tables I, II, III, and IV show the relative importance, according to the quality, of cottons raised in various countries.

COTTON USED IN AMERICA

SEA-ISLAND COTTON

11. Sea-island cotton is the name used commercially to indicate the United States sea-island cotton. This is grown on Edisto, St. Helena, Port Royal, James, and John islands off the coast of South Carolina, St. Simon and Cumberland islands off the coast of Georgia, and others. It is recognized as being the best cotton that is grown in any part of the world. Very careful attention is given to its cultivation and ginning, quality being considered before quantity, and thus sea-island cotton has a long, fine, strong and silky fiber with comparatively regular convolutions, of a diameter from .0004 to .0006 inch, ranging in length from $1\frac{3}{8}$ to $2\frac{1}{4}$ inches. The sea-island cotton crop is about 93,000 bales per annum; Charleston, South Carolina, is the leading market for it.

Sea-island cotton is largely used for thread and lace-making purposes, and is regularly spun into from 150s to 400s yarn, and occasionally, even for commercial purposes, as high as 600s. It is said that 2,150s yarn was spun from sea-island cotton at the exhibition of London in 1851. Where great strength is required for heavy goods, sea-island cotton is sometimes used, even for coarse yarns; as, for example, the linings of bicycle tires, sail cloth, and so on.

The variety of so-called Florida sea-island cotton is grown on the mainland of Florida from sea-island seed; this is somewhat inferior to the sea-island proper, but is a very useful cotton for making yarns of a little better quality than those made from Egyptian cotton. It has a white, glossy, strong fiber, a little coarser than the strictly sea-island, and is not quite so carefully cultivated. It is suitable for yarns from 150s to 200s.

AMERICAN COTTON

12. While the sea-island cottons just described are American, this name is seldom applied to them, but is used to indicate the typical cotton of the world, which is grown in the Southern States of the United States and used wherever cotton-spinning mills exist. The cotton described commercially as **American** is suited to medium numbers of yarn; is usually clean, fairly regular in length of staple, satisfactorily graded, and consequently is one of the most reliable and useful cottons for a manufacturer's use. The quantity is greater than that produced in all other parts of the world together, and consequently the price of American cotton in Liverpool, which is the greatest market for it, greatly influences the price of cotton throughout the world.

American cotton may be divided into three important classes; namely, *gulf cotton; uplands*, or *boweds;* and *Texas cotton*.

13. Gulf, or New Orleans, cotton usually consists of cotton raised in the basin of the Mississippi River, including the states of Louisiana, Mississippi, parts of Arkansas, and Alabama. The name gulf cotton is generally used in America and originates from the fact that most of this cotton is shipped from states bordering on the Gulf of Mexico. In Europe, the name New Orleans is usually applied, and is derived from the shipping port of that name. Gulf cotton is from 1 inch to $1\frac{1}{4}$ inches in length of staple, from .0004 to .0007 inch in diameter, and is generally used for yarn from 28s to 44s warp and from 50s to 70s filling or ply. This style of cotton may be subdivided into others, known as Memphis, benders, Allan-seed, Peelers, and so on. These names were originally intended to represent certain kinds of cotton, but have been very much misapplied of late years. The benders, or bottom-land, cotton is supposed to be grown at the bends of the Mississippi River, which are occasionally flooded and consequently well fertilized by the silt of the river. It is one of the better grades of gulf cotton, and is used for the higher numbers named above. The best qualities of gulf cotton are known as Allan-seed and Peelers. These are used for fine yarns, often for fine combed yarns, and by some spinners are preferred to Egyptian. The color is bluish-white rather than cream-colored, and somewhat resembles short Florida sea-island.

14. Uplands cotton is grown in the undulating country between the ocean and the mountains in the states of Georgia, North and South Carolina, Virginia, and Alabama. It is generally used for filling yarns below 40s, although it may be spun higher if required. The length of the staple is from $\frac{3}{4}$ to 1 inch and the fiber is from .0006 to .0007 inch in diameter. This cotton is usually very clean.

15. The cultivation of **Texas cotton** is largely on the increase, and for coarse warp yarn it is the most suitable cotton. In dry seasons, it is apt to be somewhat harsh and brittle and cannot be relied on as much as gulf or uplands cotton. The staple is usually from $\frac{7}{8}$ to 1 inch in length (sometimes exceeding this), and from .0005 to .0007 inch in diameter. Up to 26s and 32s warp yarns and 32s and 40s filling yarns are often made from Texas cotton, although it is eminently useful for warp. Indian Territory and Oklahoma cottons are of the Texas style.

Local circumstances often affect the use of cotton in the Southern States. A North Carolina mill may use an uplands cotton both for warp and filling, because of its being grown in the vicinity of the mill, although it is really a filling cotton; while a Mississippi mill may use local cotton for both warp and filling, although it is really too good for the latter, and so on.

BROWN EGYPTIAN COTTON

16. The cotton used in American mills is almost entirely grown in the United States, but in the fine-spinning districts a quantity of **brown Egyptian cotton** is used, and in the woolen mills some long, rough-stapled cotton, such as rough Peruvian, is in demand. The brown Egyptian cotton is generally used for warp yarns from 50s upwards, and filling yarns from 60s upwards intended for use in fine-woven cotton goods. Some of this cotton is also used for hosiery yarns and for the manufacture of Balbriggan underwear; in this case it is spun into lower numbers than those just mentioned.

Almost all the Egyptian cotton used in the United States is combed. The features of brown Egyptian cotton are the length of staple and fineness of the fiber, it being very silky and delicate in structure. The Egyptian cotton now grown is almost entirely of the so-called brown Egyptian type, being of a very light brown color.

TABLES OF COTTON CHARACTERISTICS

17. Four tables are printed herewith that have been gradually compiled during the last 20 years; they are the result of exhaustive observation and investigation. They give all the known cottons under their trade names and state where the cotton is grown, the length of the staple, the diameter in 10,000ths of an inch, the characteristics and appearance of the cotton, the numbers of yarn into which it is usually spun, and whether these yarns are for warp (twist), filling (weft), or ply yarns (doubling), with other information.

These tables are intended to indicate the numbers of yarns usually spun for commercial purposes. For special yarns that must be strong or of a high grade, the cotton may be used for lower numbers; or for special or local reasons, it may possibly be spun into higher numbers, or into warp, filling, or ply yarn, where not so specified, but these are unusual cases, and are not considered in formulating the tables.

The cottons are divided into four kinds: long-stapled, medium- to long-stapled, medium-stapled, and short-stapled.

GINNING AND BALING

18. Art. **3** gave a summary of the processes necessary for the cultivation of cotton, including cotton picking; but after it is picked, and before shipment to the mill, it must be ginned and baled. Seed cotton as it is picked contains about two-thirds of its weight in seeds; that is, out of 3 pounds of seed cotton, only about 1 pound is fiber.

THE SAW GIN

19. The gin commonly used in America for removing the fiber from the seed, except in the case of sea-island cotton, is the one known as the **saw gin.** Its construction may be briefly described as a series of revolving circular saws with

TABLE I

LONG-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for Ply Yarn	Remarks
Sea-island	Edisto, John, James, Port Royal, and St. Helena, S. C.; Cumberland and St. Simon, Ga.	$1\frac{3}{8}$ to $2\frac{1}{4}$	4 to 6	Silky, fine, strong, and clean	150s to 400s	Said to have been spun to 2,150s in London in 1851
Florida sea-island .	On mainland of Florida, near coast, from sea-island seed	$1\frac{1}{4}$ to $1\frac{3}{4}$	5 to 6	Silky and clean	150s to 200s	Good for lower grade sea-island yarn
Peruvian sea-island	On Peruvian mainland, from sea-island seed	$1\frac{1}{2}$	4 to 7	Silky and strong, but not clean	100s to 150s	
Fiji and Tahiti sea-island	Polynesian Islands, South Pacific Ocean	$1\frac{1}{2}$ to 2	4 to 6	Silky, strong, and clean	100s to 200s	Very rarely used and little grown
Bourbon	French Island, off coast of Africa	$\frac{3}{4}$ to $1\frac{1}{8}$		Weak		Very rarely used and little grown

TABLE II

MEDIUM- TO LONG-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for: Single Yarn, Warp	Single Yarn, Filling	Ply Yarn	Remarks
Brown Egyptian, or Mako	Lower, Middle, and Upper Egypt	$1\frac{1}{8}$ to $1\frac{3}{8}$	5 to 7	Golden brown to brown	50s to 100s	60s to 150s	70s to 150s	
Mitafifi	Lower and Middle Egypt	$1\frac{3}{16}$ to $1\frac{3}{8}$	5 to 7	Rich dark brown, long, strong, and fine				Principal variety
Ashmouni	Lower, Middle, and Upper Egypt	$1\frac{3}{16}$ to $1\frac{3}{8}$	5 to 7	Light brown, fine				
Bamia	Lower Egypt	$1\frac{1}{8}$ to $1\frac{1}{4}$	5 to 7	Brown and weak				
Abbasi	Lower Egypt	$1\frac{1}{8}$ to $1\frac{1}{4}$	5 to 7	Almost white, fine, and silky				Varies from season to season, not reliable
White Egyptian		$1\frac{3}{16}$	6 to 7	White				From American seed. Resembling gulf, or New Orleans, cotton. Very rarely seen
Gallini	Egypt	$1\frac{1}{4}$ to $1\frac{1}{2}$	5 to 6	White and silky			80s to 150s	From sea-island seed. Resembling Florida sea-island. Very rarely grown
Parahiba	Brazil	1 to $1\frac{3}{8}$	6 to 8	All Brazilian is harsh, wiry, clean, creamy colored, tree cotton	40s to 60s			The first two are about the best of Brazilian cottons
Maranhão					40s to 60s			
Ceara								
Aracaju					32s to 50s			All Brazilian cotton is good for warp yarns, especially yarns for heavy sizing. Gives strength when mixed with American
Rio Grande					32s to 50s			
Pernambuco					32s to 50s			
Bahia					32s to 50s			
Maceio					32s to 50s			
San Paulo					32s to 50s			

TABLE II—(Continued)

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for			Remarks
					Single Yarn		Ply Yarn	
					Warp	Filling		
Santos	Brazil				32s to 50s			American seed
Rough Peruvian	Peru	$1\frac{1}{4}$ to $1\frac{1}{2}$	6 to 8	Rougher than Brazilian	40s to 70s			Some very weak and high color
Surinam, Berbice, Cayenne, Demerara	British and French Guiana	$1\frac{1}{8}$ to $1\frac{3}{8}$		Smooth and fine	Said to spin 160s			Very little grown or used
Guatemala	Central America	1 to $1\frac{1}{8}$		White and clean				Resembles the cotton from Guiana
Santo Domingo, or Hayti, Puerto Rico, Anguilla	West India Islands	1 to $1\frac{1}{2}$	6 to 8	Smooth, glossy, and clean; variable	Said to spin 120s			Very little grown or used
Catamarca, Santa Fé, Salta	Argentine	$\frac{7}{8}$ to $1\frac{1}{4}$		Reddish				
San Luis	Argentine	$1\frac{1}{8}$ to $1\frac{5}{8}$		Reddish				
Rioja, Paraná	Argentine	1 to $1\frac{1}{2}$		White				
Hawaii	Hawaiian Islands	1 to $1\frac{1}{2}$						

TABLE III

MEDIUM-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for Single Yarn: Warp	Single Yarn: Filling	Remarks
AMERICAN COTTONS							
Gulf cotton, or New Orleans	Mississippi, Louisiana, and neighboring states	1 to $1\frac{1}{4}$	4 to 7		28s to 44s	50s to 70s	
Benders, or bottom-land	Mississippi River bottom, Louisiana, and Mississippi				28s to 44s	50s to 70s	A variety of gulf, or New Orleans, cotton
Peelers	Varieties originated in Mississippi and grown usually in Mississippi, Louisiana, Arkansas, and Alabama			Bluish-white usually	28s to 44s	50s to 70s	Somewhat resembles short Florida sea-island
Allan-seed				Long staple	28s to 44s	50s to 70s	Ranking among best of New Orleans cotton, usually bad to card
Uplands	Georgia, North Carolina, South Carolina, and Virginia	$\frac{3}{4}$ to 1	6 to 7			30s to 40s	A clean, easily manipulated, useful cotton, suitable for filling
Texas	Texas	$\frac{7}{8}$ to 1	5 to 7		Below 32s	Below 40s	Suited for warp
Georgia	Georgia					Below 40s	A variety of uplands
Mississippi, or Louisiana	Mississippi or Louisiana				Below 32s	Below 40s	Varieties of gulf cotton
Selma	Alabama			Generally very clean	Below 32s	Below 40s	Variety of gulf cotton
Arkansas	Arkansas				Below 32s	Below 40s	Variety of gulf cotton
Boweds					Below 32s	Below 40s	Another name for uplands
Memphis	Alabama			Generally good staple but leafy	Below 32s	Below 40s	Variety of gulf cotton
Norfolk	North Carolina and Virginia			Generally very clean	Below 32s	Below 40s	Variety of boweds, or uplands
Savannah	Georgia			Generally clean	Below 32s	Below 40s	Variety of boweds, or uplands

TABLE IV

SHORT-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inch	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Warp	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Filling	Remarks
INDIAN COTTONS							
Comptah	Central Provinces	$\frac{3}{4}$ to $\frac{7}{8}$	7 to 9		14s and below	18s and below	Dirty
Hinghunghat	Central Provinces	1 to $1\frac{1}{8}$	7 to 9				Very seldom used
Oomrawattee	Berars in Central India	$\frac{7}{8}$ to 1	7 to 9	Good color, cleaner than Dhollera	18s and below	24s and below	Dirty
Dharwar	Bombay Pres. Extreme South	$\frac{3}{4}$ to 1	7 to 9	Neppy	14s and below	20s and below	
Scinde	Extreme Western India, Province of Scinde	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9		6s to 12s	6s to 12s	
Broach	Bombay Pres. Western coast	$\frac{3}{4}$ to $\frac{7}{8}$	7 to 9	Soft fiber and high color	14s and below	22s and below	
Khandesh	Bombay Pres.	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9				
Bilatee	Bombay Pres.	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9				
Dhollera	Bombay Pres.	$\frac{7}{8}$ to $1\frac{1}{16}$	7 to 9	White, and has considerable dirt	16s and below	24s and below	
Surat	Port, Bombay Pres. Dist. of Broach						A name given to all Bombay Presidency cotton
Tinnevelli	Presidency of Madras	$\frac{3}{4}$ to 1	7 to 9	Creamy	18s and below	24s and below	
Western	Western Madras	$\frac{5}{8}$ to $\frac{7}{8}$		Dirty	Very low numbers	Very low numbers	
Bengal	Bengal Pres.	$\frac{1}{2}$ to $\frac{5}{8}$	7 to 9	Tinged, dirty, weak fiber	4s to 8s	4s to 10s	Dirtiest cotton grown
Dacca	Bengal Pres.	$\frac{1}{2}$ to $\frac{3}{4}$	7 to 9	Short, harsh, rough staple, not very clean, often tinged	6s to 8s	6s to 12s	Resembles wool
Coconada	India	$\frac{1}{2}$ to $\frac{5}{8}$	7 to 9	Red color, weak, irregular, and dirty	4s to 6s	4s to 10s	
Red Northern							A high-colored variety of Indian cotton
Assam	Northeastern India	$\frac{1}{2}$ to $\frac{3}{4}$		Dull appearance, harsh, stiff fiber, and fairly clean	6s to 10s	6s to 16s	Resembles wool

TABLE IV—(Continued)

Trade Name	Where Grown	Length of Staple Inch	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Warp	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Filling	Remarks
OTHER ASIAN COTTONS							
China and Corea		1/2 to 3/4		Rough, but very clean	6s to 10s	6s to 14s	
Camilla	China	1/2 to 3/4		Bright, very clean, harsh, and rough	6s to 14s	6s to 14s	A variety of China
Turkestan. Indigenous	Central Asia (Russian provinces)	About 1		Rough, good color, and clean			
Turkestan. Exotic	Central Asia (Russian provinces)	About 1		Smooth, good color, and clean			From American seed
Japan	Japan	5/8 to 3/4		Very clean			
Philippine	Philippine Islands	5/8 to 1		Clean and smooth			
Java	Island of Java	3/8 to 5/8		Weak and dirty	4s to 6s	4s to 6s	
Persian	Persia	3/4 to 1 1/16		Bright, creamy color, leafy, and strong			Resembles, but is superior to, the best Indian
Smyrna	Asia Minor	5/8 to 1		Creamy, dull, and leafy			
SUNDRY COTTONS							
Nankin	United States	3/4	4 to 7	Clean, high color, weak staple			Not now grown
African	Liberia and West Coast	About 1		High color and irregular			Somewhat resembles Brazilian
Greek	Greece	1/2 to 3/4		Short and brittle			
Caucasian	Caucasia	7/8 to 1		Brown and smooth			
Queensland	Australia	7/8 to 1					
Clarence River	Australia	7/8 to 1		Clean			Gray seed
Mexican, including Yucatan, Laguna, Campeche, and Oaxaca	Mexico	3/4 to 1		Clean, creamy, not very strong			
Cyprus	Island of Cyprus						Very little grown
Malta	Island of Malta						Very little grown
Turkish	Bulgaria	3/4 to 1		Dull color			
Italian	Neighborhood of Naples	3/4					Very little grown
Sicilian	Island of Sicily	3/4					Very little grown

fine teeth, so placed that an arc of their circumference projects through a grid into a receptacle containing the seed cotton. The lint is torn from the seed and carried through the grid by the saws, from which it is removed by a brush and carried to a condenser.

Fig. 6 is a section through a gin, one of the saws being marked *d*. The seed-cotton receptacle, or seed box, is marked *a*; *c* is the saw cylinder on which the saws are fixed; *e* shows the grate through which the saws project, known as

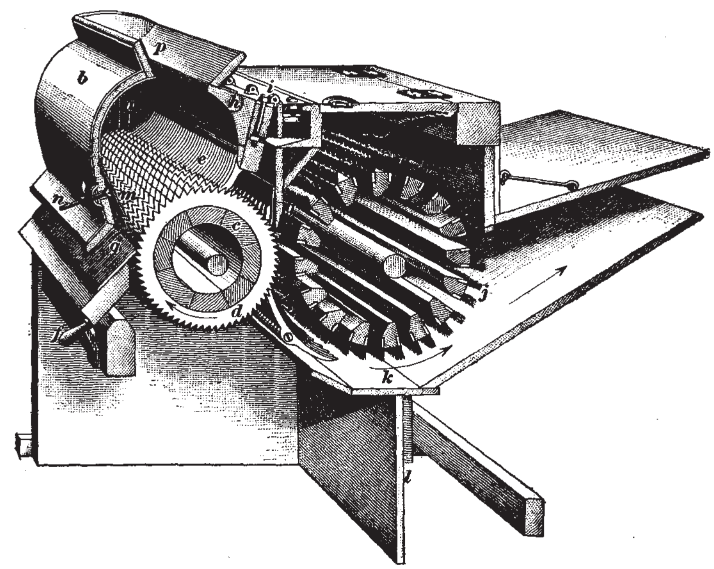


Fig. 6

the breast, or grate fall. The chamber *a* is full of seed and seed cotton. The seed cotton is on the outside of a core of seed and is thus brought within the operation of the saws.

The seed cotton, having been fed into the chamber *a*, passes around on the outside of the mass of seed. The teeth of the saws, projecting through the grid about $\frac{1}{2}$ or $\frac{3}{4}$ inch, tear the fibers from the seeds nearest to them. The quick speed of the saws (about 350 revolutions per minute) sets up a rolling motion of the mass of seed, for which reason the chamber *a* is sometimes called the *roll box.* New seed cotton is continually being brought under the action of the saws, being fed in at *p*, while the seed when freed from its fiber drops, at *q*, to the floor. The fibers are carried forwards by the revolution of the saws and are removed by a rotary brush.

The circular brush, shown at *j*, Fig. 6, is an important part of the machine; it should be filled with heavy bristles and the framework and ribs should be strongly constructed and well bound together. The brush makes four or five times as many revolutions per minute as the saws, in the direction indicated by the arrow below it, Fig. 6, and the cotton is either blown into a lint room, on the old system, or, where a condenser is used, the fibers are drawn forwards by the air-current to the surface of wire-covered drums or screens; by passing between these screens they are delivered in the form of a sheet, being deposited on the floor in the case of gins that are not connected to a conveyer.

The gins most frequently used have from sixty to eighty saws, which are either 10 or 12 inches in diameter. The highest speed that 12-inch saw cylinders should be driven for good work is 300 revolutions per minute, although they are frequently detrimentally run up to 400 revolutions per minute and above. A suitable production for a 60-saw gin is one bale of 500 pounds per hour.

THE ROLLER GIN

20. A type of gin used both for long- and short-stapled cotton in many parts of the world—as exemplified by its almost exclusive use in Egypt, where long-stapled cotton is grown, and in India, where the cotton is almost all short-stapled—is the **roller gin.** There is not much doubt that the roller gin separates the fiber from the seed with a very much easier action than the saw gin, but it has not been adopted in the United States to so large an extent as it should, being used principally in the sea-island districts, and even there only to a limited extent. The reason for this is that the production of the machine is not so great as that of the saw gin.

There are at least two distinct types of construction of roller gins in general use, but both of them depend on the same principle for the removal of the fiber from the seed, which is to draw the fiber between a rapidly revolving roll and a sharp knife edge resting against this roll, so that the fibers are cut off near the point of attachment to the seed. The usual method is to place the seed cotton on a table or hopper, from which it is gradually fed into a seed box and presented to a roll covered with heavy hide that has a roughened surface. A stout knife extends across the machine near the revolving roll, its edge being parallel with the shaft on which the roll is mounted. The fine fibers adhere to the leather covering of the roll, and are drawn between it and the knife until the seed is pulled against the edge, when the fibers are severed from it. The same seed is continually drawn against this knife edge by different fibers attached to its surface, until it is entirely stripped, when it falls down and another seed takes its place. The cotton is being constantly removed from the surface of the leather roll.

In order to agitate the seeds and aid in the removal of the fibers as they pass between the knife and the roll, two methods are adopted, and this difference of construction characterizes the leading types of roller gins.

21. In what is known as the **knife-roller gin,** a roll with **V**-shaped or angularly set knives is rotated in front of the leather roll, and on account of the angle at which the knives are set, pushes the seeds from side to side and agitates them sufficiently to aid in stripping the fibers from them by presenting new surfaces of each to the stripping knife, until it is absolutely stripped of fiber.

22. In another type of gin, known as the **Macarthy gin,** a vertical knife mounted on a connecting-rod attached to a crank is given a reciprocating motion, and thus effects the same object. In what is known as the double Macarthy gin there are two of these knives operated by a double crank below the machine.

23. All roller gins require considerable care in operation, especially with regard to maintaining a true surface on the leather rolls and an even pressure of the stripping knife on the roll at all points, as well as a proper adjustment of the blades of the knife roller in the knife-roller gin, or of the vertical knives in the Macarthy gin. The Macarthy gin has a production of about 350 pounds of ginned cotton in a day of 10 hours from the single gin, or 500 pounds in a day of 10 hours from the double gin, and absorbs from 1 to $1\frac{1}{2}$ horsepower. The knife-roller gin has a production of 800 to 1,000 pounds in a day of 10 hours, and requires $2\frac{1}{2}$ horsepower to drive it.

BALING

24. After ginning, the cotton is baled. This is done by enclosing it in a baling press with an outside wrapper of coarse burlap, in which it is pressed into comparatively small compass and held by iron ties.

The bales as they come from the farms or the cotton gins are too large for economical shipment either by railroad or steamship. Consequently, at every inland city and seaport in each cotton state there are compresses. These are powerful steam baling presses, in which the cotton bale can be reduced to smaller dimensions.

Previous to compressing, the exporters affix a tag to each bale by which to identify it, and take from each bale a sample, which is numbered the same as the tag. The samples are then graded and assorted into lots of low middling, middling, good middling, and so on, as will be explained, and then shipped (usually in lots of 100 bales) either to Northern mills or to Europe.

MARKETING COTTON

SELECTION AND CLASSIFICATION

25. The selection of cotton from samples, or the judging of cotton, is a matter of considerable importance. In order to become thoroughly proficient, a long period of practice is required to produce the trained eye and hand necessary to distinguish the gradations and differences in quality that add to, or detract from, the market value of the fiber. This is not of so much importance in the Southern markets, where the bales are usually on hand to be referred to in case of dispute, but in the Northern states, and in any country where cotton is largely purchased from samples, it is of the utmost importance.

26. Samples.—Cotton is seldom, if ever, purchased from the examination of the bale, but from parcels containing small pieces of cotton from each bale, technically known as **papers of samples.** It is customary in well-managed mills to take samples of each new lot of cotton that arrives at the mill, sometimes a sample from every bale, and at other mills only from a certain number of bales out of each hundred. The samples are then compared with the buying samples to see if the cotton is equal to the quality purchased.

27. Points to Be Considered in Judging Cotton. In judging cotton from a sample, or in selecting cotton from a sample with a view to purchasing it, the first thing to do is to investigate the authenticity of the sample. The points then determined are: (1) the grade of the sample, (2) the staple, (3) the color, (4) the amount of sand, (5) the amount of dampness, (6) whether the cotton is even running or not. These points are arranged in order of their usual importance.

This is not necessarily accurate enough for some purposes;

for instance, in cotton to be used for filling yarns, the color is more important than in cotton for warp yarns. As the warp yarn has to be sized, the appearance of a good-colored cotton is somewhat spoiled, while on the other hand defects of a dull-colored cotton are hidden. In either case, the length of staple may be the most important point to consider where it is desired to produce a strong yarn without regard to its appearance.

28. Grade.—American cotton is usually graded according to a standard agreed on in all the leading cotton markets of the world, the highest grade being *fair*, followed by six other grades, the lowest being *ordinary;* cotton of lower grade is called *inferior*. The seven full grades of American cotton are *fair*, *middling fair*, *good middling*, *middling*, *low middling*, *good ordinary*, and *ordinary*.

This gradation is not sufficiently fine for the cotton merchant, and consequently each grade is subdivided into what are known as half grades and quarter grades. By this means a list is made up giving twenty-six different grades of cotton. This list is as follows:

Fair, barely fair, strict middling fair, fully middling fair.

Middling fair, barely middling fair, strict good middling, fully good middling.

Good middling, barely good middling, strict middling, fully middling.

Middling, barely middling, strict low middling, fully low middling.

Low middling, barely low middling, strict good ordinary, fully good ordinary.

Good ordinary, barely good ordinary, strict ordinary.

Ordinary, low ordinary, inferior.

Those terms having the word *strict* are the half grades, while those having the words *barely* and *fully* are the quarter grades. The full grades are printed in bold-face type.

Grade really means the appearance of the cotton as regards cleanliness, and the above system of grading depends on the appearance of the cotton as to its freedom from leaf and other impurities. Some graders take into consideration what is known as *bloom*, or *brightness*, of the cotton, which adds to the grade; also, discoloration, known as *off color*, or *tinges*, which detracts from the grade.

29. Staple.—After determining the grade, the next thing to do is to find the staple. The word **staple** usually means the average length of the bulk of the fibers forming the bale assessed, and is found by taking a small portion of cotton in the way hereafter described, preparing a tuft of fibers from which the very short fibers have been removed, and then measuring the average length of fibers remaining. Cotton is spoken of by the length of staple; thus, 1-inch cotton, $1\frac{1}{4}$-inch cotton, and so on. There is something more that is usually implied by the word staple—strength of the fiber. This is determined by holding one end of the tuft between the first finger and thumb of each hand and breaking it. The word staple may therefore be taken to mean the average length of the fibers forming the bale, and may also be understood to include the strength of the fibers; thus, the expressions *length of staple* and *strength of staple* are obtained.

An expert cotton sampler or buyer will often judge cotton by simply taking a tuft and giving it one pull, judging it by the amount of drag or cling that must be overcome in pulling it apart. He thus tests both the length and strength of the staple at the same time. This skilfulness comes only with experience, but is the most rapid method of judging cotton.

30. Sand and Dirt.—After the staple has been determined, it is necessary to discover the amount of sand and dirt in the cotton. This is often done by raising the cotton from the paper that holds it and noticing the amount of sand remaining on the paper, this sand having fallen out by the repeated handling of the cotton. It is, perhaps, better to hold the handful of cotton as high as one's head and shake it so that the sand, if there is any, can be seen to fall from it.

31. Dampness.—Another test is that for dampness. This can only be detected in the sample paper if the samples are newly drawn, in which case it can be felt by the hand. If the samples have been in stock for some time, the water originally contained in them will have evaporated and cannot be ascertained unless it has previously been so great as to cause a slight formation of mildew on the cotton, in which case it is indicated by the smell.

32. The rich, bright, creamy appearance that cotton has, especially in the early part of the year, is called the **bloom.** This bloom is only found on certain growths of cotton and adds somewhat to its value, especially where it is to be used for making weft, or filling, yarn, or where the goods into which it is to be made are to be sold in their unbleached or undyed state, technically known in Europe as *in the gray*, and in some parts of America as *brown goods.*

Tinges, high color, or off color, should be looked for. These are caused where the cotton has become tinged while on the plant, through rain stains, or by having fallen on the ground and become mixed with some of the red clay of the cotton field. These bales should be avoided, and in case of purchasing from a sample containing indications of having come from tinged bales, an agreement for a reduction in price on the bales ought to be arranged, or a condition made that these bales be thrown out before shipment of the quantity purchased.

33. The last point, and one that is important, is to see that all bales are somewhat alike. Usually a sample paper is made up of a handful of cotton from each of the lot of bales; by testing first one sample and then another it is discovered whether the lot of cotton is even running. Occasionally, however, if not graded properly by the cotton factor, a lot of cotton is found to be mixed; some bales may be higher grade than others, some may be longer-stapled than others, and even in the same bale an abnormal variation in length and strength of staple may be found. Cotton of this kind should be avoided altogether, as it is almost impossible to make satisfactory yarn out of cotton mixed in this manner.

34. As has been stated, constant practice is necessary to become a good judge of cotton. Even experienced cotton graders and cotton buyers improve year by year in their judgment of the fiber, until some of them, by a quick glance or the slightest touch, can determine at once whether the cotton is suitable for their purposes or not. It is not an unusual thing for a cotton buyer in a market like Liverpool to become so expert as to be able to examine in a single day type samples representing tens of thousands of bales.

Usually the grade is mentally determined; then a small handful of cotton is grasped by both hands, having the thumbs uppermost, and pulled apart. One-half is thrown away, and the ends of the fibers that project from the other piece are grasped between the thumb and the first finger of the right hand, and the left hand is employed in removing short fibers, or *fud*, from the tuft. The tuft of cotton, now much lessened in size, is grasped by holding the other ends of the fibers in the left hand, while the right hand removes more short fibers, or fud. By these few quick movements an experienced cotton sampler has arrived at a small tuft of fibers laid parallel, which can first be measured, usually with the eye only, and afterwards grasped firmly between the first finger and the thumb of each hand, the thumbs being uppermost, and broken by a short, strong pull. By always taking the same amount of cotton in the hand at once, and reducing it to the same-sized tuft, the cotton sampler fixes a standard of length and strength for himself, by which he can assess the value of almost any kind of cotton.

An accurate judgment of the length of staple can only be acquired by experience and practice, and a uniform method should be cultivated. By removing all short fibers and retaining only the longest ones for measurement, too long a measurement is obtained. This is often done by those interested in the sale of the cotton. By throwing out the long fibers and measuring the shortest ones, the length obtained does not fairly represent the staple of the cotton. A cotton sampler who wishes to give an impartial judgment will throw out all the shortest fibers, or the fud and the waste, and also the longest fibers, which are evidently unrepresentative of the bulk of the cotton, leaving a bunch of fibers fairly even in length and typical of the majority of the fibers in the bale. These fibers are then measured.

35. After the grade and staple have been determined in the manner just named, a test is made for sand and for uneven running; the appearance as to bloom, color, and evidences of gin damage is then noticed, completing the test of the cotton, by which time a cotton expert should have made a mental estimate of its value.

In regard to gin damage, it should be stated that this often occurs when cotton is ginned on the saw gin while damp; it is also caused if the gin is operated at too high a speed. Cotton in this condition can be recognized by being curled and stringy, with the fiber broken or cut.

Another point to be noted in this connection is that local circumstances often affect the judgment on a lot of cotton; for instance, a good north light is the best in which to judge cotton, as this light is more regular than any other. Cotton should not be purchased from a sample wrapped in paper with a blue lining, unless it is removed for examination, as this causes the cotton to appear better than it really is.

COTTON MARKETS OF THE UNITED STATES

36. The largest crop in any of the states is raised in Texas, and this makes Houston one of the most important interior markets of the United States. In the season of 1899–1900, 550,000 bales of cotton were sold in this market, which amount was excelled only by the gulf port New Orleans, where 1,002,000 bales were sold in the same season. Memphis, on the Mississippi River, is a market of importance and is a great center for long-stapled cotton. In the season referred to, 477,000 bales were handled at Memphis and 267,000 at Augusta, Georgia.

Among other important cotton markets are Savannah, Georgia; Charleston, South Carolina; Mobile, Alabama; St. Louis, Missouri; Shreveport, Louisiana; Vicksburg and Columbus, Mississippi; Macon, Columbus, and Rome, Georgia; Selma, Montgomery, and Eufaula, Alabama; and Nashville, Tennessee.

MILL PURCHASES OF COTTON

37. The cities of Boston, Providence, New Bedford, and Fall River are important markets for cotton, as many of the Southern factors have agents or branch offices at these points. In the fall, the salesmen of these houses, together with special agents who are sent from the cotton belt, are very busy in offering cotton to the manufacturers, who buy large quantities from October until March. The treasurers of the mills are usually the cotton buyers, and they select cotton from the samples that have been sent from the cotton factor, showing the style of cotton that he is offering. Practically the whole of the cotton required for a year is purchased in the period named above, and very frequently it is shipped North immediately after the sale takes place. Arrangements are occasionally made for the shipment of so many bales per month.

Money can be borrowed at very much lower rates of interest in New England than in the South, and consequently it is much cheaper to carry or hold cotton in the North, as in most cases the parties hold it on behalf of the banks that have loaned money to enable them to carry it. For this reason most of the large cotton-manufacturing establishments of New England have very large storehouses connected with their mill buildings, and the winter is usually a very busy time in receiving this cotton, and weighing, sampling, and storing it for future use

The terms on which Northern manufacturers buy cotton are very simple. Usually the cotton is sold on cash terms, with no discount being allowed and no allowance being made for bags or ties, the gross weight being invoiced. The cotton is usually purchased delivered in Boston or an equivalent point, a freight rate allowance being made by the shipper equal to the amount that the manufacturer pays for the freight on arrival of the cotton. It will be seen that the above system requires that a very large stock of cotton be kept at the mills for a considerable portion of the year.

While the above system is a general one, there are special cases in which the cotton is purchased as needed; in these cases it is not unusual for manufacturers to send mail orders to reliable Southern houses that know what grade of cotton they are accustomed to use, specifying the length of staple, grade, and style of cotton, and leaving it to the Southern merchant to ship the quality of cotton desired. In cases of this kind, cotton is said to be bought on description; that is to say, the mill will purchase cotton, simply stating that it is to be of a certain grade and certain length of staple; for instance, 100 or 1,000 bales good middling $1\frac{1}{4}$ inches.

EXPORTATION OF COTTON

38. The exports of cotton and its products from the United States in the fiscal year ending 1901 exceeded the export value of any other class of exports, averaging $1,000,000 per day throughout the year. The actual figures are as follows:

Cotton, raw	$313,673,443
Cotton manufactures	20,272,418
Cottonseed oil	16,541,321
Cottonseed meal	13,119,968
Cotton waste	1,431,604
Cottonseed	366,953
Total	$365,405,707

PICKERS

(PART 1)

YARN-PREPARATION PROCESSES

INTRODUCTION

1. Condition of Stock.—The condition in which the raw cotton reaches the cotton mill is that of a compressed bale. In a few sections in the United States and in some foreign countries where cotton mills are located in close proximity to the cotton fields, the cotton is delivered to the mill in a loosely packed bale that has not been compressed, and in some cases even as loose cotton taken from the cotton gin to the mill without baling. Instances of this kind are very rare, however, compared with the general method of delivering cotton in the form of a compressed bale, which is the condition that will be accepted as a standard. A compressed bale of cotton is a matted mass of innumerable fibers lying in all directions, with which are intermixed sand, broken leaf, sticks, broken seed, and other foreign matter. The fibers themselves, although approximately of the same quality, are not, even in the same bale, exactly of the same length, nor are they all ripened to the same point of maturity, while some of them may have been cut by the action of the gin, or rolled into *neps;* that is, into small bunches of closely matted and tangled fibers that have the appearance of specks in the cotton and, while varying in size, are generally very minute, rarely being larger than an ordinary pin head.

2. Object of Cotton-Yarn Mills.—From this material, it is the object of the cotton-yarn mill to produce a clean, smooth, even thread from which all foreign matter has been removed, and which consists only of the perfect, or approximately perfect, fibers, the neps and excessively short fiber having been thrown out. In order to produce a comparatively strong thread, the fibers not only must be cleaned, but must be arranged approximately parallel to each other and assembled by a system in which a loose strand or ribbon of fibers is produced, which is gradually attenuated until it arrives at the correct fineness, when it is twisted to give it strength, and in that condition is spoken of in the cotton manufacturing business as **yarn.** This, then, in general, is the object of the cotton-yarn mill—to produce from the bale of raw cotton as large a percentage as possible of cotton yarn, which should be smooth, clean, even, and strong.

One pound of cotton must be spun into yarn of which there is seldom less than 1 mile to a pound, usually 10 miles or even a greater length than this; and in some cases, for special purposes, there may be 100 miles or more. The problem is not only a mechanical one, but one involving a constant study of economy and also aiming at an excellence of production as far as is consistent with the proper economical operation of the yarn mill.

PROCESSES EMPLOYED FOR PRODUCTION OF COTTON YARN

3. In order to produce cotton yarn, the fiber is passed through a number of processes, varying from ten in a mill manufacturing coarse yarns to fifteen in one making fine yarns. These processes may be divided into three classes, as follows: (1) mixing; (2) cleaning; (3) parallelizing and attenuating. In this classification, those processes that follow the spinning are of course ignored, although in a mill making yarn for sale, a fourth class might be made of processes for preparing the yarn for the market.

4. Yarn is spoken of as being *coarse*, *medium*, or *fine*, according to the thickness of the thread, and this in turn is determined by the number of hanks to the pound. A hank of cotton yarn contains 840 yards, and the size of the yarn is indicated by the number of these hanks required to weigh 1 pound; thus, 10s yarn would contain 10 hanks, or 10×840 yards, making 8,400 yards, in a pound; 40s yarn would contain 40 hanks, or 33,600 yards, in a pound. The higher the numbers, that is, the greater the number of hanks in a pound, the finer is the yarn.

No arbitrary rule can be given for determining which is coarse yarn, which is medium, or which is fine, as a manufacturer accustomed to making only coarse yarn might consider 30s fine, while another manufacturer engaged principally in the use of fine yarns would consider 30s coarse. A general classification would be to consider yarns below 30s as coarse; from 30s to 60s as medium numbers; and above 60s as fine yarns. The expression *low numbers* is sometimes applied to coarse yarns, and *high numbers*, to fine yarns. The number of a given yarn is commonly spoken of as its *counts;* thus, it is said that the counts of yarns are 10s, 12s, 36s, etc.

5. The processes adopted in different mills vary according to whether the mills are intended for coarse, medium, or fine yarns. A mill making medium yarns, for instance about 32s, would in most cases use the following machines: automatic feeder, opener, breaker picker, intermediate picker, finisher picker, card, first drawing, second drawing, third drawing, slubber, intermediate, roving frame, spinning frame. In cases where the railway head is used, it comes between the card and the first drawing; in this case the third drawing is omitted. Where the bale breaker, or cotton puller, is used, it takes a position before the automatic feeder. Where the mule is used, it takes the place of the spinning frame.

For coarser numbers, the above list is changed by omitting one or more of the parallelizing and attenuating processes, and sometimes adding a cleaning process. In changing the list to suit finer yarns, the reverse is the case; one cleaning process, or more, is omitted and attenuating processes are added, but for very fine yarns, a cleaning process, namely, combing, is added.

Below will be found combinations of machinery suitable for mills making various numbers.

6. The machinery for yarn mills making 10s and below is as follows: automatic feeder, opener, breaker picker, intermediate picker, finisher picker, card, first drawing, second drawing, slubber, roving frame, spinning frame. The railway head may be used instead of the first drawing process.

The machinery used in yarn mills making about 100s is as follows: automatic feeder, opener, breaker picker, finisher picker, card, sliver-lap machine, ribbon-lap machine, comber, first drawing, second drawing, third drawing, fourth drawing (optional), slubber, first intermediate, second intermediate, roving frame, mule. Sometimes a drawing process is used between the card and the sliver-lap machine. Where four processes of drawing are used, the roving frame is not necessary, and where four processes of fly frames (slubber, first intermediate, second intermediate, and roving frame) are used, it is not always necessary to have more than three processes of drawing.

The machinery used in yarn mills for making 200s is as follows: automatic feeder, opener, breaker picker, card, sliver-lap machine, ribbon-lap machine, comber, first drawing, second drawing, third drawing, fourth drawing, slubber, first intermediate, second intermediate, roving frame, mule.

The names given to the fly frames vary in different sections, and in some places they are known as slubber, intermediate, roving frame, and jack frame.

7. What are known as *double-carding processes* were formerly very often employed, but are now going out of use both for coarse and fine yarns. Any of the preceding combinations can be converted into double-carding combinations by adding after the card the names of derby doubler and finisher card.

8. It is advisable to carefully study the combinations just given, noticing the difference between one combination and another, and becoming thoroughly familiar with the order in which the machines are mentioned, so that a knowledge of the accurate sequence of processes may be obtained. While the foregoing combinations of machinery are reliable and may be considered as the standards for the class of work to which they refer, it occasionally happens that mills are found using different layouts. This may be because the mill is intended to make a lower or a higher grade of yarn than is customary for the numbers referred to, or because it is a mill that has been changed over from other numbers and the old machinery has been retained; or there may be many other reasons.

Different opinions are held among millmen and mill engineers as to the proper equipment for mills. In this connection, as well as in regard to all other statements concerning cotton-mill machinery—especially as to its construction and operation—it may be said that there is perhaps no industry in which so much variety of opinion will be found regarding the best methods of arriving at certain objects as in the cotton-mill business. Not only do differences of opinion arise among manufacturers, but a machine builder frequently looks at a problem from a point of view differing from that of a manufacturer. He looks on a machine or a process as a mechanical problem to be solved, while a manufacturer looks at it as a problem to obtain certain results effectively and economically. Again, American practice differs considerably in some respects from European methods. For these reasons it is almost impossible to give definite statements of the customary use and practice accepted by all millmen, and therefore the statements made are in every case, as far as possible, either what has been found from experience to be correct, or what the majority of manufacturers would accept as being accurate, according to American practice.

9. A thorough comprehension of the principles of cotton-yarn preparation can best be obtained by a careful study of each machine or process in its proper sequence, including the objects of the machine, the principle on which it is constructed, and the mechanism employed to arrive at its objects; and by considering the operation and management of the machine not only theoretically, but from actual observation. In doing this, the desired knowledge will be obtained sooner if the combined objects of all cotton-yarn-preparation machines are borne in mind: (1) the separation of the matted mass of fiber into loose flakes and the removal of the heavier and more bulky impurities, which objects are principally attained in the opening and picking processes; (2) the further cleansing of the stock from light and minute particles of foreign matter by such means as are adopted in the carding and combing processes; (3) the parallelizing, evening, and attenuation of the fibers, as performed in the carding and drawing processes, in the fly frames, and in the spinning process; (4) the strengthening of the product by twisting, as exemplified in ring or mule spinning.

COTTON MIXING

10. Receipt of Cotton at the Mill.—If cotton is received at the mill in large quantities, as is usually the case, it must necessarily be stored until it is required for use. Before storing, however, it should be carefully ascertained whether the quality of the cotton in each bale is equal to the quality of the sample from which it was bought. After this has been accomplished, all the bales of one kind, grade, and staple (approximately) should be placed together in the storehouse, irrespective of their original marks.

11. Objects.—When a new lot of cotton is to be used, as many bales as it is desired to mix at one time are taken from the storehouse to the **mixing room**, where the cotton is mixed. The objects of mixing the cotton from a number of bales are: (1) to allow the cotton to assume its normal condition; (2) to establish an average quality of grade in the lot. As regards the first object it should be understood that cotton when compressed is subjected to great pressure—

so much so that the space occupied by seventy uncompressed bales is often equal to that occupied by one hundred that are compressed. Cotton, when in this compressed state, cannot be worked so advantageously as when in its normal condition, and for this reason should be allowed to stand for some time after being opened before it is used.

As regards the second object of mixing, it may be stated that, theoretically, to make a perfect product, all the fibers should be of the same length, diameter, strength, cleanliness, and color; in other words, they should be equally matured and grown under the same conditions.

It is impossible, however, to obtain a large quantity of cotton that will not vary in quality, because the lot is made up of cotton collected from various plantations, which are probably some distance from each other and subject to different climatic conditions, different methods of cultivation, different seed and soil. The result is that the cotton from the plantation where the conditions were most favorable is in a higher state of maturity than that raised on the other plantations. Even in bales from the same plantation a variation is found. An experienced cotton sampler can find points of difference—slight in many cases, but still variations—in almost every bale of each lot of cotton. In order to neutralize this variation as much as possible and insure a continuance of a supply of even-running stock over as long a period as possible in the mill, mixing the bales is resorted to.

12. Size of the Mixing.—The quantity of cotton used in a mixing should be as large as possible; for the larger the mixing, the easier it is to keep the work regular for a considerable length of time. The reason for this is that no two mixings are alike, this being due not only to the variation found in different bales of the same kind, but also to atmospheric changes that affect the cotton, especially in regard to moisture. In addition to securing regularity, another reason for having large mixings is to give cotton from compressed bales an opportunity to expand. By making a large mixing and allowing it to stand for some days in a room, the temperature and humidity of which are about the same as those of the room in which the cotton is to be worked, it will be found that the stock will run much more evenly, make less waste, and produce a stronger yarn than when used directly from the bale.

13. Method of Mixing.—Mixings when made by hand should occupy a considerable amount of floor space. The first bale should be spread over all this space, the second bale spread to cover the first, the third to cover the second, and so on. By this means the mixing is built up of layers from each bale of cotton. When a mixing is used, the cotton should be pulled away in small sections from the top to the bottom of the mixing so as to obtain portions of each bale.

It is a good plan when using bales of different marks, to average the mixing so that no two bales of the same mark shall come in contact with each other. The following rule is used to find the number of sections that should be made in order to obtain the correct proportion of each mark in a section.

14. Rule.—*To find the number of sections of which a mixing should consist, find the largest number that will exactly divide the number of bales of each mark. Then, to find the number of bales of each mark that there should be in each section, divide the number of bales of each mark by the number of sections in the mixing.*

EXAMPLE.—Find a suitable order for mixing 100 bales, the mixing to consist of 40 bales marked A B C; 20, G H I; 10, J K L; and 30, D E F.

SOLUTION.— 10 is the largest number that will exactly divide 40, 20, 10, and 30; therefore, the mixing should be made up of 10 sections, and in order to prevent any two bales of the same mark coming in contact with each other, they could be arranged as follows:

$$\left.\begin{array}{c}\text{G H I}\\ \text{D E F}\\ \text{A B C}\\ \text{J K L}\\ \text{D E F}\\ \text{A B C}\\ \text{G H I}\\ \text{A B C}\\ \text{D E F}\\ \text{A B C}\end{array}\right\}\text{10 times. Ans.}$$

15. It is the practice in some mills to go over the covers of the bales after the cotton has been removed and pick off the loose pieces of cotton adhering to them. This is a practice that should only be encouraged to a small degree, as the amount of cotton obtained is hardly sufficient to pay for the time occupied in its removal, and there is also a liability of jute fibers from the burlap becoming mixed with the cotton and causing poor work in the subsequent processes.

16. Mixing Different Varieties of Cotton.—The subject as it has been treated refers only to mixings where the cotton of different marks is all approximately of the same grade. Where it is desired to blend cotton of different varieties for special purposes, it is not necessary that it should be done in the mixing. For example, where it is desired to mix exact proportions of different varieties, as American with Egyptian, or where dyed stock of one color, or more, is to be blended with white, the cotton may be blended to better advantage at some of the subsequent processes.

Different growths of cotton are sometimes mixed together for special purposes. Thus, American cotton is mixed with Egyptian in order to cheapen the mixture, Egyptian cotton usually being higher priced than American. By this means a yarn is produced that practically has the qualities of a pure Egyptian yarn, and yet the cost is less than that of pure Egyptian. Brazilian cotton is sometimes mixed with American in order to increase the strength of the yarn, as Brazilian has a strong, wiry staple; while rough Peruvian cotton is mixed with Egyptian in order to give the latter woolly qualities, the Peruvian being of a harsh, crisp nature.

Although cotton is often mixed in this way, it must be understood that there is a certain limit to the mixing of harsh and soft cottons, as they do not give the same results under the same treatment in the subsequent processes; nor is it practical to mix long- and short-stapled cotton, as the machines of the later processes are set according to the length of the staple, and if set for one length of staple will either damage cotton of a different length or cause an imperfect product.

BALE BREAKER

17. Description.—A machine known as a **bale breaker** is sometimes used in mixing cotton. Its object is to separate the matted masses of cotton as they come from the bale and to deliver the cotton in an open state to the mixing bins. This machine, consequently, does the work that is performed by hand in hand mixings. When using a bale breaker for mixing cotton, a good method is to have about six bales open around the feed-end of the machine and to take a layer of cotton in rotation from the top of each bale. The principle employed to attain the object of the bale breaker is to have three or four pair of rolls, each pair revolving at a higher rate of speed than the preceding pair. The cotton fed to the pair that is revolving at a slow speed, is pulled apart when it comes under the action of the pair revolving at a faster speed. Fig. 1 shows a view of a bale breaker with conveying aprons attached, while Fig. 2 gives an illustration of the different sets of rolls that act on the cotton and constitute the principal mechanism of this machine. Referring to these two figures, the cotton is taken from the bales and placed on the horizontal apron *a*, which is moving in the direction shown by the arrow. As the cotton reaches the first set of rolls, it is gripped and carried forwards to the next set, each pair of rolls having a greater circumferential velocity than the preceding pair, the circumferential velocity of the second pair being about twice that of the first pair, while the circumferential velocity of the third pair is about four times that of the second, and the last pair about five times that of the third. The first set of rolls usually makes between 5 and 6 revolutions per minute.

The space between the different sets of rolls will be found to vary with different makes, but usually from the center of one pair to the center of the next is about 9 inches. The upper roll of each set rotates in bearings having a vertical movement, but held down by means of strong springs *b* connected with the upper rolls by means of the rods *c*. By this means the upper rolls are allowed to give when an

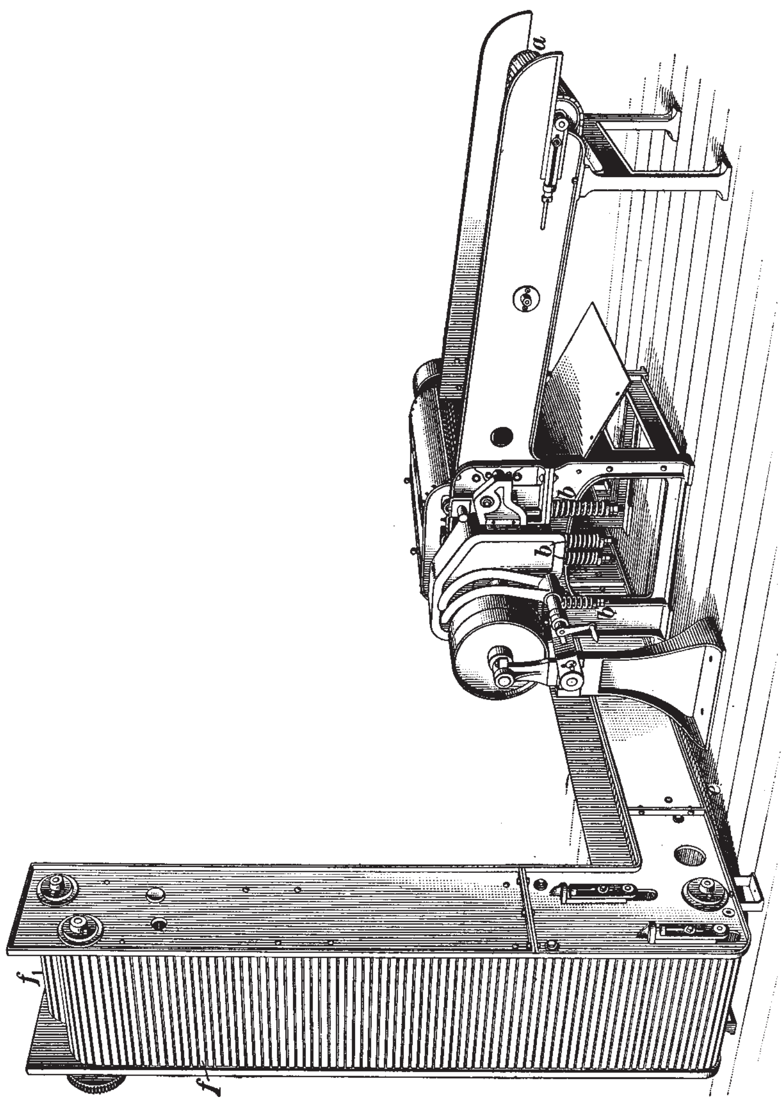


FIG. 1

excess of cotton passes between the rolls. In the bale breaker shown in these illustrations, the pair of rolls farthest from the feed-end of the machine is the largest, being nearly 9 inches in outside diameter, while all the other rolls are $7\frac{1}{4}$ inches in outside diameter. These rolls will be found to vary in construction, in some cases being solid with flutes their whole length, while in other cases they are made up of rings having projecting spikes and placed side by side on a core in such a manner that when a spike breaks it is simply necessary to replace the ring containing the broken spike.

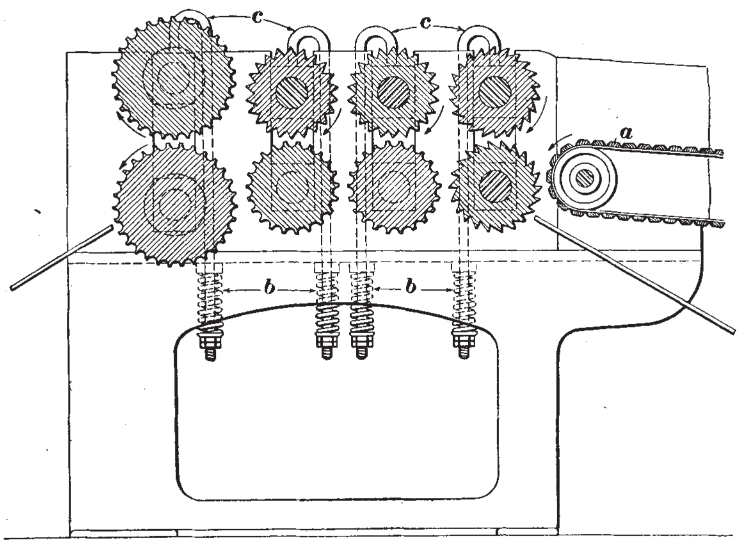


Fig. 2

A somewhat different arrangement of the rolls is shown in Fig. 3, in which a series of nosed levers *d* are made to take the place of the lower roll of the first set.

The cotton as it leaves the last set of rolls drops to the lower apron *e*, Fig. 1, which conveys it to the lifting aprons f, f_1. These lifting aprons have their inner surfaces moving in the same direction and sufficiently close together to prevent the cotton dropping down. The aprons are built of wooden laths, with rounded edges, fastened to endless leather belts. It is customary to construct the elevating aprons with laths at intervals that project higher than the rest, and thus convey the cotton more positively than if all are of the same thickness. From these elevating aprons the cotton is delivered to horizontal aprons, which carry the stock to the different mixing bins.

18. Care of Bale Breakers.—There are several points that should receive attention in the care of bale breakers. The cotton should not be fed in too thick layers, since this

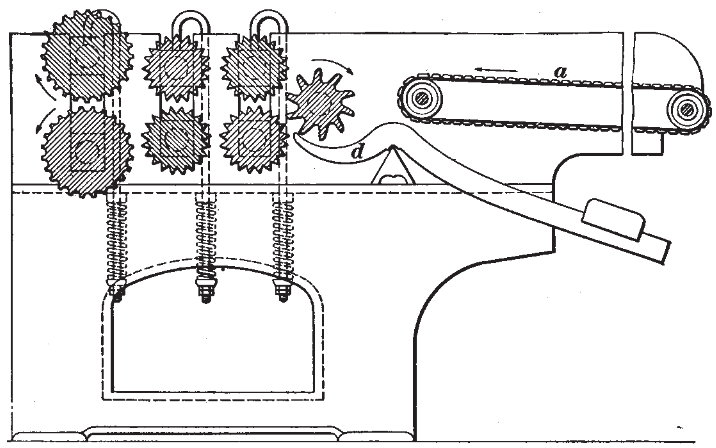


Fig. 3

is liable to strain the rolls; all the dirt from underneath the machine, which consists chiefly of sand and other foreign substances that drop from the cotton as it is pulled apart, should be removed periodically; and what is more important, the machine should be properly oiled. The aprons should also be adjusted so that they will not come in contact with each other at any point.

PICKER ROOMS

19. The room containing the machinery through which the cotton passes during its first stages of manufacture is known as the **picker room,** and its equipment for medium counts generally consists of an automatic feeder, opener, breaker picker, intermediate picker, and finisher picker.

Where the bale breaker is used, that, also, may be found in this room, although it is usually in the mixing room. Other machines, in some cases, may also be found in this room, such as waste openers and waste breakers. In mills using long-stapled cotton and producing fine yarns, either the intermediate or the intermediate and finisher pickers would be omitted from the above list in order to lessen the beating action.

20. Location of Picker Rooms.—The picker room is sometimes located in a building some distance from the main mill, but if it is a part of the main building, it should be separated by a fireproof partition or wall. The machinery located in this room being a heavy type of cotton-mill machinery and running at a very high rate of speed, also dealing with stock in a very unclean condition, necessitates these precautions, since, if the swiftly moving parts of the machinery come in contact with any foreign matter of a hard nature, a fire will in almost every case occur and spread throughout the cotton. Fires occur more frequently in the earlier processes of the manipulation of the raw stock than at any other time. Therefore, the planning of the rooms and the arrangement of the machinery in them must be given very careful attention.

ARRANGEMENT OF MACHINES

21. In large mills, usually two rooms at least are devoted to the mixing and picking, the mixing, feeding, and opening being generally carried on in one room, while the breaker, intermediate, and finisher pickers are located in another room. Fig. 4 shows such an arrangement. With the machines arranged as shown in this figure, the cotton will be opened on the first floor and then fed to the automatic feeder *a*, passing from this to the opener *b* and then by trunking *c* to the breaker picker *d*, which is located on the second floor. From the breaker picker, the cotton passes to the intermediate picker *e*, while the finisher picker *f* takes the cotton from the intermediate. In case a bale breaker were used with this arrangement, it would be situated in the

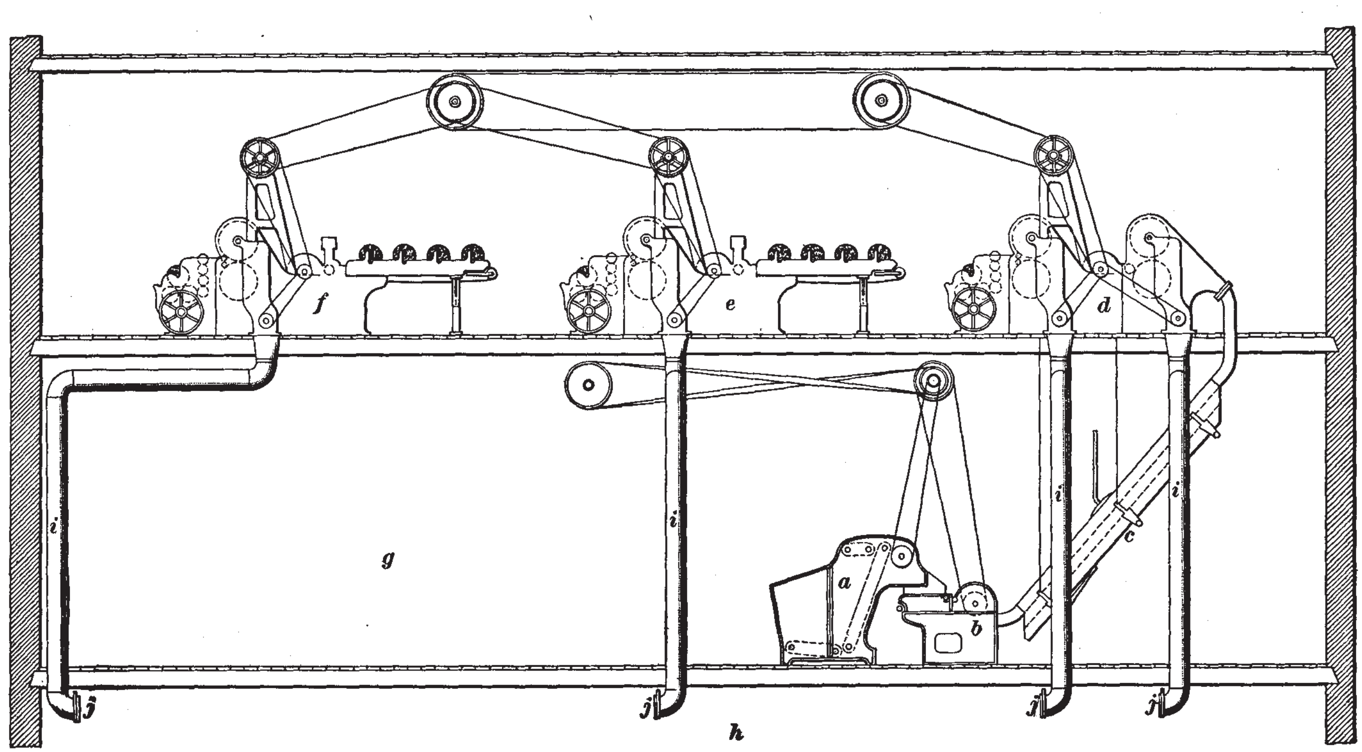


Fig. 4

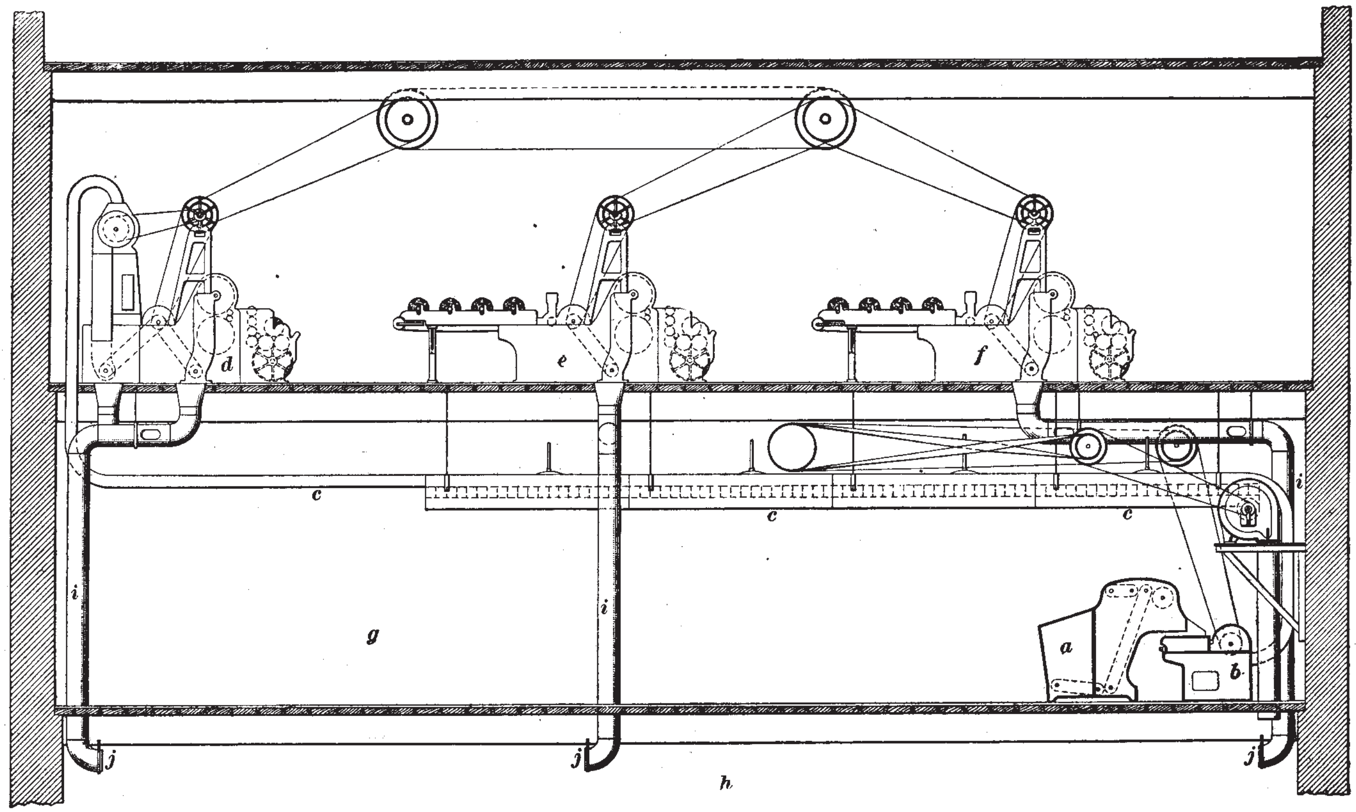


Fig. 5

opening room *g* and aprons would be so arranged that the cotton would be carried from the bale breaker to mixing bins situated in such a position behind the automatic feeders that the cotton could be conveniently handled.

22. Fig. 5 shows a very similar arrangement to that shown in Fig. 4. In this figure, however, a different method of connecting the breaker picker and opener is adopted. The feeder is shown at *a* and the opener at *b*. From the opener the cotton is conveyed to the breaker picker *d* by means of a horizontal trunk *c*. The intermediate picker *e* takes the cotton from the breaker, and the finisher picker *f* takes it from the intermediate.

Many different arrangements of these machines will be found in mills. In some cases, the bale breaker, together with the automatic feeder and opener, is located on the second floor and connected by trunking with the pickers, which are on the first floor. In other cases, all the machines are in one room. In Figs. 4 and 5, a dust room *h* is shown under the opening room *g*. This is usually constructed in the basement, and to it are conducted the dust trunks *i*. The ends of these trunks are usually provided with automatic closing dampers *j*, which remain closed when the machine from which the dirt comes is not in operation. By this means, a draft in the trunks is prevented in case of fire, and any back draft that would cause dust and particles of dirt to reenter the cotton is also avoided.

FEEDING AND OPENING

AUTOMATIC FEEDER

23. Principle.—The **automatic feeder** is the first machine that receives the cotton after it has been mixed, and, as its name indicates, is used for the purpose of automatically supplying or feeding another machine.

Formerly, the opener or breaker picker was fed by one of three methods: (1) by spreading the cotton on a feed-apron by hand, the amount depending on the judgment of the operator; (2) by weighing a certain amount of cotton and spreading it by hand on a measured space on a feed-apron; (3) by presenting a portion of cotton to an opening in a pneumatic tube and allowing it to be drawn in by the air-current. With these methods it was very difficult to obtain a uniform feed.

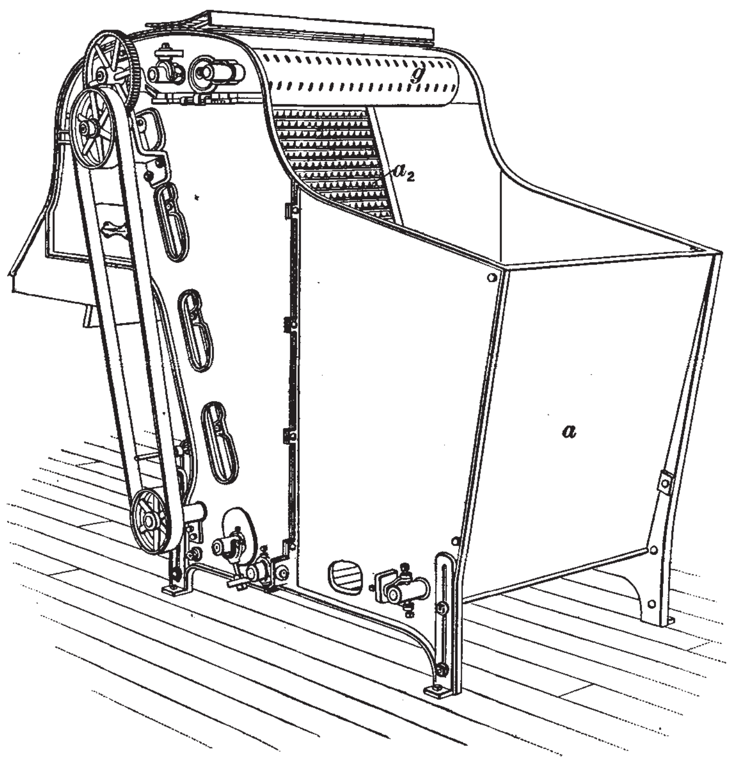


FIG. 6

The principle employed in the automatic feeder is that of having an apron with projecting spikes carry away from a mass of cotton a larger quantity than is required, the excessive amount being removed by suitable mechanism and only that portion which is required being allowed to pass forwards to supply the next machine. Fig. 6 is a perspective view of the automatic feeder, while Fig. 7 shows a section. The cotton is fed by the operator to the hopper *a*, which should be kept at least half full. The bottom apron a_1 tends to carry the whole mass toward the lifting apron a_2, the cotton being retarded slightly by friction with the sides of the hopper. The spikes in the lifting apron fill with fiber from the base to the point, and often retain comparatively large bunches of stock. After filling, they continue to move upwards, and the tendency for so large a number of points

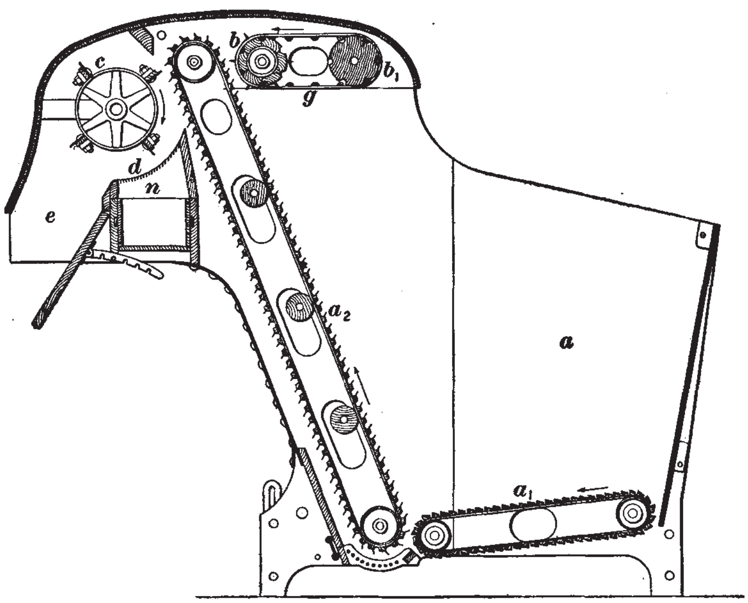


FIG. 7

acting on the mass of cotton is to impart a rolling motion to it. The stripping roll *b* acts continuously on the cotton carried by the lifting apron as it arrives at the point nearest to the stripping roll. The surface of this roll, moving in the opposite direction from the lifting apron and only about 1 inch from the point of the spikes, strikes off the excess cotton.

The cotton remaining on the lifting apron is the amount necessary to supply the machine to which the feeder is attached, and must be removed from the pins carrying it.

This is done by the doffer beater *c*, the surface of which moves in the same direction as the part of the apron nearest to it, but at a greater speed. The fibers removed from the lifting apron are in small tufts, and a certain quantity of sand, etc. is thrown out by the centrifugal force of the doffer beater or drops by its own weight. This passes through the bars of the grating *d* into the chamber *n*. The cotton passes forwards and through the passage *e*.

A feeder is sometimes used to take the place of the bale breaker previously described. This feeder is constructed on practically the same lines as the one illustrated here, although the parts are made much heavier in order to withstand the greater strain that is brought on them on account of dealing with stock directly from the bale. In some mills running fine counts, the bale breaker is dispensed with and two automatic feeders used, the cotton as it comes from one being fed into the other. In such cases the cotton, of course, must be opened and mixed to a certain extent by hand.

24. Lifting Apron.—The lifting apron of the automatic feeder as generally constructed consists of an endless canvas sheet mounted on leather belts, to which it is fastened by copper rivets. On this canvas sheet wooden laths are fastened $1\frac{1}{2}$ inches apart. Set in the laths about 1 inch apart are steel spikes that project from the laths about 1 inch. It is these spikes of the lifting apron that convey the cotton to the point desired as it is presented to them by the feed-apron.

25. Stripping Device.—Fig. 8 (*a*) and (*b*) shows detail views of the stripping device found on the feeder shown in Fig. 6. It consists of two rolls b, b_1 of wood mounted on an iron core. An endless leather apron *g* passes around the rolls; on the inside of the apron are secured strips of wood that engage with grooves in the rolls, so that the apron *g* and roll b_1 are positively driven by *b*. These rolls are not exactly alike in every respect, as the one nearer the lifting apron carries pins that project through elongated holes in the apron, as shown in this figure. At the point *h* the pins strike the excess cotton from the lifting apron back into the hopper, while that which adheres to the pins is removed as the roll revolves and the pins are drawn through the apron. In (*b*) are shown the adjustments provided for regulating the distance from the pins of the stripper comb to the lifting apron, and thus regulating the amount of excess cotton removed; the adjustment for regulating the tension of the apron is also shown. In order to regulate the distance between the roll *b* and the lifting apron, the casting that supports the bearings

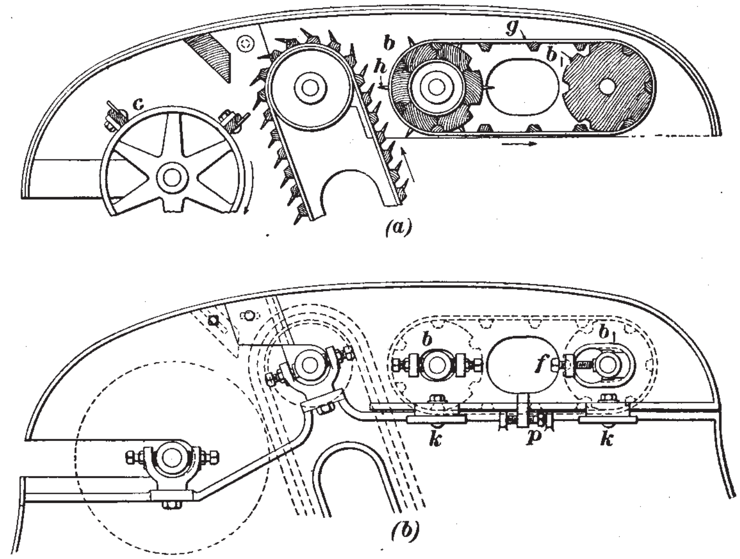


Fig. 8

of this roll is made so that it may be moved on the framework by loosening the bolts at *k* and turning the screw *p*. The tension of the stripping apron is regulated by the screw *f*, which holds the bearing of the roll b_1 in position.

A stripping device that differs in construction from that shown in Fig. 8 is shown in the two sectional views, Fig. 9 (*a*) and (*b*). It consists of a metal shell that contains two shafts a, a_1, which have bearings in the circular ends of the shell and are capable of being moved in these bearings. These shafts carry castings b, b_1, known as *trailing levers*. On the end of each trailing lever are studs c, c_1 that work

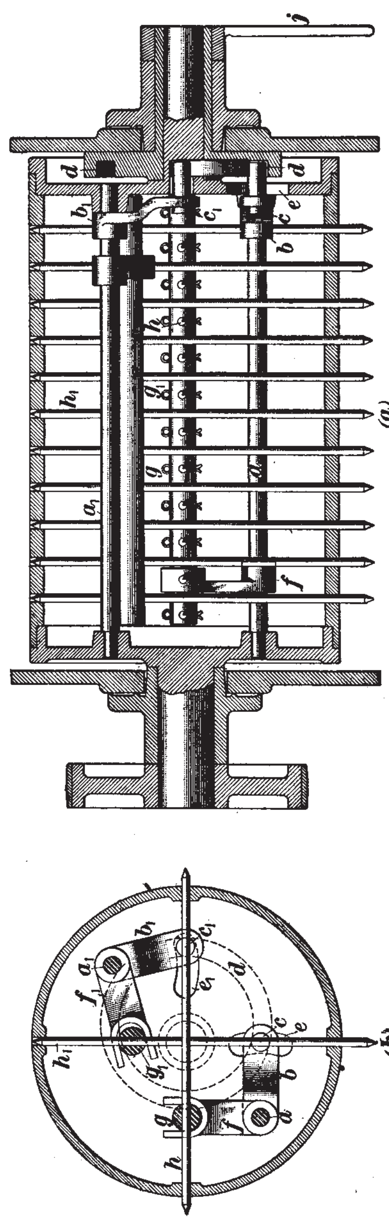


Fig. 9

in a cam-course d. The cam is on the outside of the shell, while the trailing levers are on the inside; slots e, e_1 are provided in the end of the shell for the studs to project through, and also in order that they may have a certain freedom of movement.

Supported from the shafts a, a_1 by means of the brackets f, f_1, of which there are several in the length of the shell, are the shafts g, g_1. Each of these shafts carries a series of pointed rods h, h_1 that project through the surface of the shell. As the shell revolves and the cam remains stationary, an oscillating motion is imparted to the shafts a, a_1; motion is also given to the shafts g, g_1, which results in one end of the pointed rods projecting from the shell during a part of its revolution, while at other times they are within the shell.

In Fig. 9 (a) is shown a handle j by means of which the position of the cam may be regulated. If it is desired to feed more cotton, the position of the cam is changed so that the points will not project so far at the point where they are nearest the lifting apron. If it is desired to feed less cotton, the position of the cam is so changed that the points will project farther from the shell when nearest the lifting apron and thus strike off more cotton. The cam, after being placed in the correct position, is secured by a setscrew.

In Fig. 9 (*b*) it will be seen that when one end of a pointed rod is projecting, the other end has been withdrawn into the shell. By this means, any cotton adhering to the rod is removed and falls back into the hopper.

26. Doffer Beater.—The doffer beater differs in construction in different makes of machines. In some cases it consists of a cylinder carrying four rows of teeth that project about $2\frac{3}{4}$ inches from the cylinder, each row containing as many teeth as there are teeth in one row on a slat of the lifting apron. Such a doffer is so placed that one of its teeth will project between two of the teeth of the lifting apron and be just half way between them. By this means, as the doffer revolves, it removes the cotton from the lifting apron and drives it downwards through the passage provided. In other cases the doffer, instead of having spikes to remove the cotton from the lifting apron, has strips of heavy leather projecting about 2 inches and secured to horizontal pieces of wood mounted on a central shaft, while in still other cases the doffer beater is constructed in such a manner that rows of spikes will alternate with strips of leather.

Fig. 10 shows a perspective view of an automatic feeder combined with an opener, while Fig. 11 shows a sectional view of a similar arrangement. The feeder shown in these illustrations differs from that previously described principally in regard to the manner in which it regulates the amount of cotton fed. By referring to these figures it will be noticed that the lifting apron is driven by a pair of cones, the ends of which are shown in Fig. 11. The belt guide that regulates the position of the belt on the cones is shown at *g*. By turning the hand wheel *l*, Fig. 10, the belt is moved on the cones and the speed of the lifting apron regulated as may be

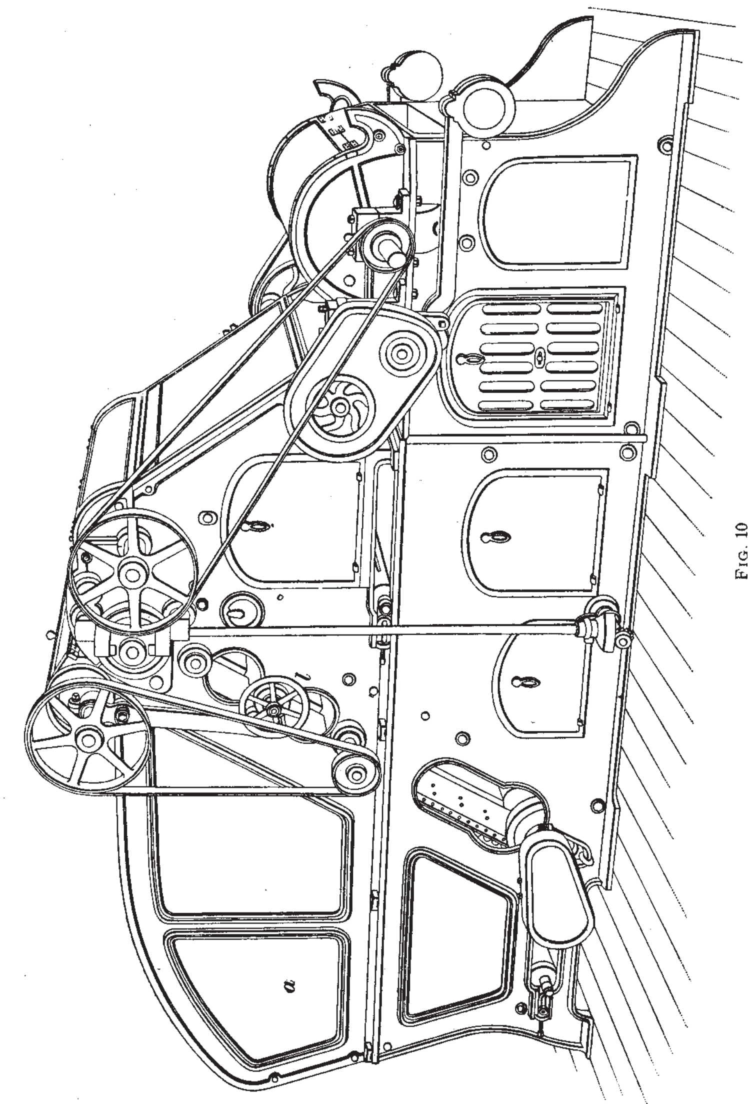


Fig. 10

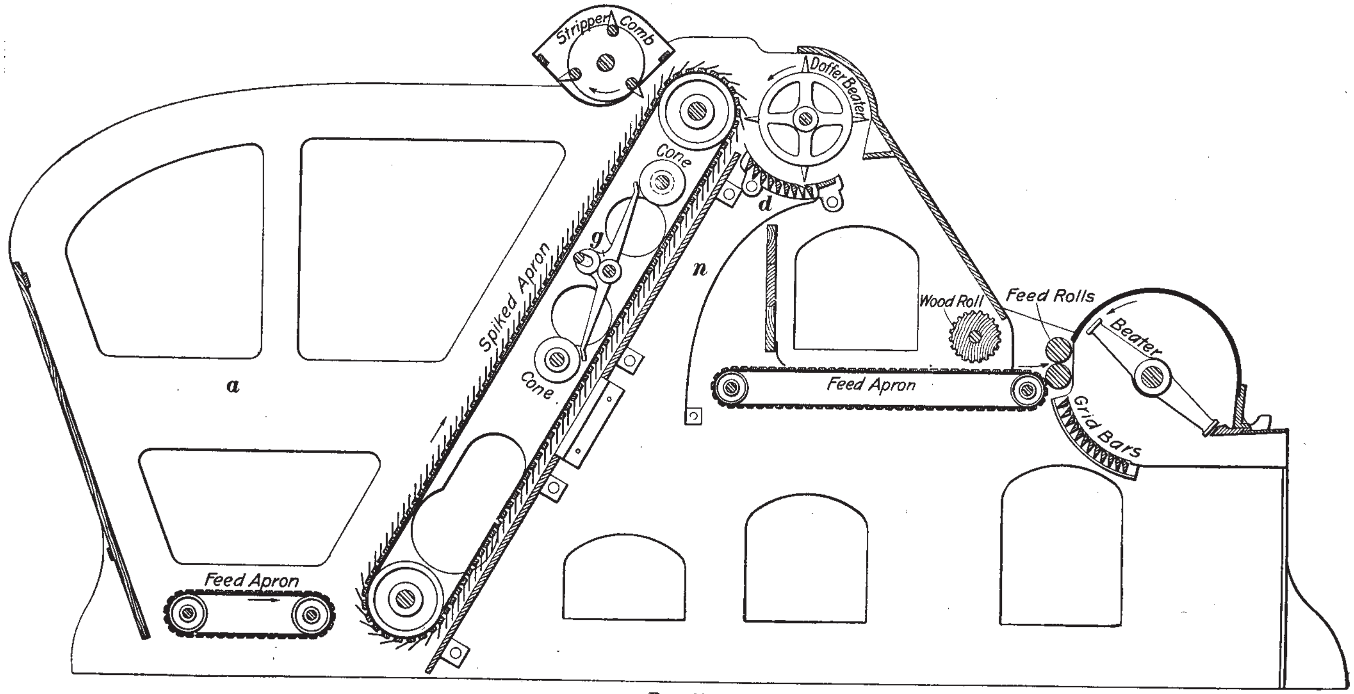

Stripper
Comb
Doffer Beater
Spiked Apron
Cone
Cone
g
d
n
a
Wood Roll
Feed Rolls
Beater
Grid Bars
Feed Apron
Feed Apron

FIG. 11

desired. The connection between the cones and the lifting apron is described later. This method of regulating the feed is frequently resorted to, as it affords a ready means of making the necessary change. It will be seen that, if the stripping roll should be moved too far from the lifting apron, the cotton would be liable to be fed in lumps and thus would not be sufficiently opened. On this account it has been found to be advisable, in ordinary cases, to increase the speed of the lifting apron when it is desired to feed more cotton, and for this reason most feeders, as now built, have some method by which the speed of the lifting apron may be regulated, either by the cone drive, as illustrated above, or by change pulleys, change gears, or step cones. The regulation of the speed of the lifting apron, as well as the position of the stripping roll to give a required weight of cotton fed, is a matter of experiment and observation and depends entirely on the stock used.

The passage provided in this machine for the dirt that is struck from the cotton by the doffer beater consists of a grid *d* made of metal bars set with a slight space between them.

27. Gearing.—The gearing of the automatic feeder shown in Figs. 10 and 11 is as follows: The doffer beater is driven from the countershaft or main shaft of the machine that the feeder supplies and runs at a speed of from 400 to 500 revolutions per minute. On the shaft of the doffer beater is a 6-inch pulley that drives a 16-inch pulley on the bottom cone. The two cones are 6 inches in diameter at their larger ends and 3 inches in diameter at their smaller ends. On the shaft of the top cone, a gear of 16 teeth drives a gear of 69 teeth on a shaft that extends across the feeder. A gear of 17 teeth on this shaft drives a clutch gear of 58 teeth on the top carrier roll of the lifting apron. This top carrier roll is 9 inches in diameter. The feed-apron is driven from the bottom bearing shaft of the lifting apron, on which there is a sprocket gear of 18 teeth, which drives, by means of a chain, a sprocket gear of 28 teeth on a roll supporting the feed-apron. This roll is 3 inches in diameter. The wooden roll, feed-apron, and feed-rolls of the opener shown in these illustrations are driven by means of a chain and sprocket gears from the shaft of the top carrier roll of the lifting apron.

28. Capacity.—The capacity of automatic feeders is very great, but since the amount of work they do is governed entirely by the requirements of the machine they feed, they are rarely run at their full capacity. Usually about 3,000 pounds in 10 hours is the maximum amount run through a feeder.

29. Care of Feeders.—In order that feeders may perform their best work, they should be kept well oiled. The dirt should be removed periodically; the aprons should be kept taut by the tension screws provided for this purpose; and the hopper should be kept at least half full, since the less cotton there is in the hopper, the greater is the liability of the lifting apron securing an insufficient amount, thus causing the weight to vary. It is customary for one man to attend to about ten feeders in large mills. In smaller mills the work of feeding is combined with other duties.

The feeder requires from $1\frac{1}{2}$ to 2 horsepower, and occupies a floor space of about 6 feet 4 inches by 6 feet 6 inches.

OPENER

30. The **opener** is not used in all mills, as the automatic feeder is sometimes connected directly to the breaker picker, but in mills where this machine is used it generally forms a combination machine with the automatic feeder, as shown in Fig. 10. Technically, the automatic feeder ends with the doffer beater, or, as it is sometimes called, the *pin beater*, Fig. 11.

The opener has for its objects the cleaning of the heavy impurities from the cotton and the separating of the cotton into small tufts that are light enough in weight to be influenced by an air-current generated by a fan in the succeeding machine. It attains these objects by presenting a fringe of cotton to a beater that makes from 1,200 to 1,800 revolutions per minute. This beater usually has two blades, and consequently for every revolution delivers two blows to the fringe of cotton. By this means any foreign substance will be struck from the fringe of cotton as it is held by the feed-rolls, and knocked through the grid bars shown in Fig. 11. The tufts of cotton will also be removed from the fringe as soon as they are released from the bite of the feed-rolls, and thus they will be sufficiently light to be acted on by the air-current that conveys the cotton to the next machine.

The cotton after being acted on by the doffer beater of the automatic feeder falls on a feed-apron, and being separated into small tufts, occupies so much space that the wooden roll and feed-rolls, shown in Fig. 11, are used to condense its bulk before being presented to the beater of the opener.

The opener alone occupies a floor space of about 5 feet by 6 feet 6 inches, and when connected with a feeder occupies a space of 11 feet 4 inches by 6 feet 6 inches. It requires about 3 horsepower to drive it. Openers are rarely run at their full capacity, the amount of cotton they are made to deliver depending on the amount required to supply the breaker picker.

TRUNKING

31. The cotton from the opener is carried along a **trunk** to the next machine by means of an air-current that is generated by a fan. This fan exhausts the air in the trunk, and thus the air in the room containing the feeder enters through the openings between the grate bars in the opener, and carries the cotton with it as it passes through the trunk to the fan.

The various forms of trunks are as follows: (1) *plain conducting trunks*, (2) *horizontal cleaning trunks*, (3) *inclined cleaning trunks*.

32. A **plain conducting trunk** consists of a circular tube of sheet metal from 10 to 13 inches in diameter. It should have easy curves wherever the tube bends, and should contain sufficient doors for cleaning purposes. The inner surface should be smooth, so as to cause as little friction as possible in the transit of the cotton. These trunks are used simply to conduct cotton from one point to another.

Horizontal cleaning trunks are constructed of wood and contain doors for the removal of the dirt, also grids

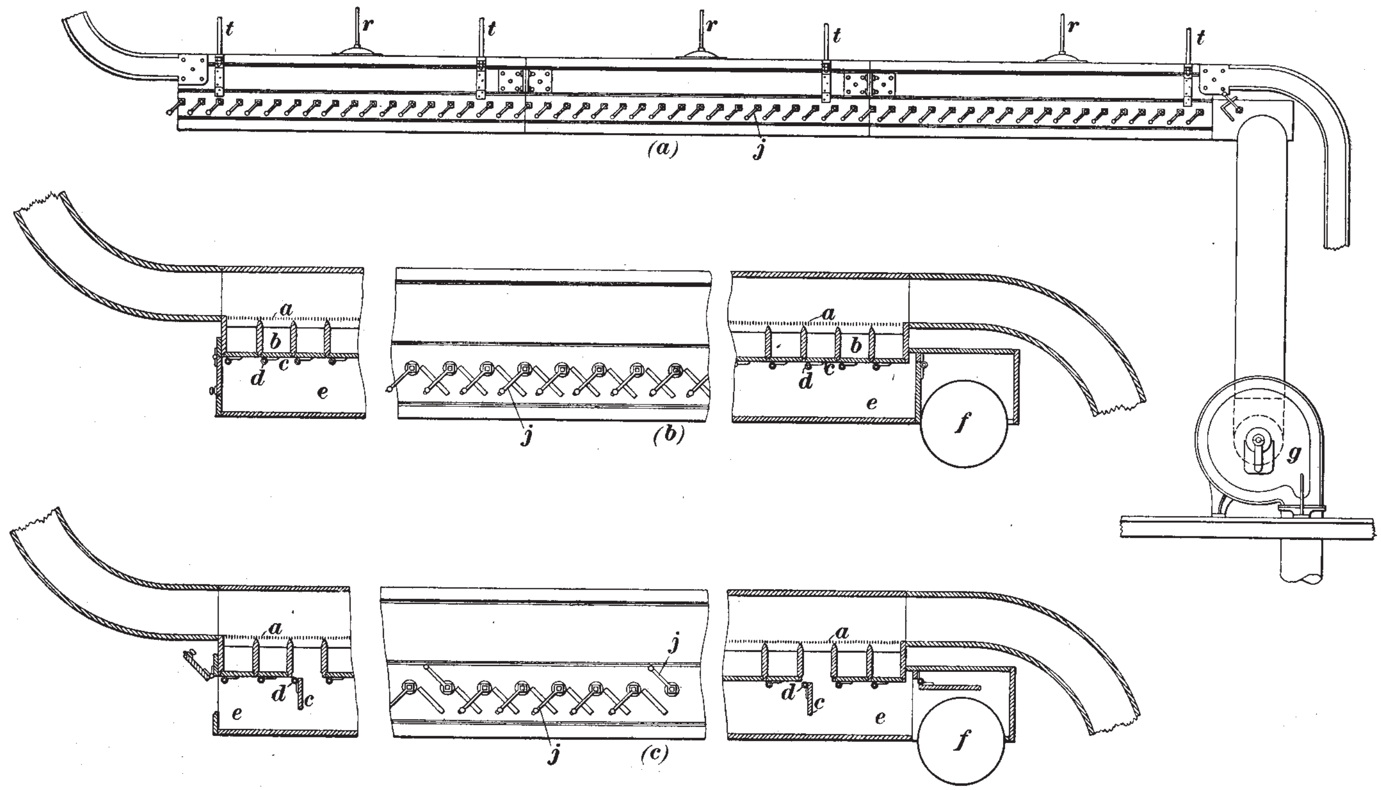


Fig. 12

through which the dirt falls. They may be built either shallow and wide, or narrow and deep.

Inclined cleaning trunks are of the same construction as horizontal cleaning trunks, but have an inclined position.

33. Fig. 12 (*a*), (*b*), and (*c*) shows a horizontal cleaning trunk supported by rods *t* placed about 10 feet apart on each side of the trunk. In the center of the trunk are connections for sprinklers *r*. A section of this trunk is shown in Fig. 12 (*b*). The upper part is a clear passage, along which the cotton is carried over a grating *a*. During this passage of the cotton, any foreign matter that is too heavy to be carried along with the cotton by the force of the air-current, will drop through the grating *a* into the pockets *b*.

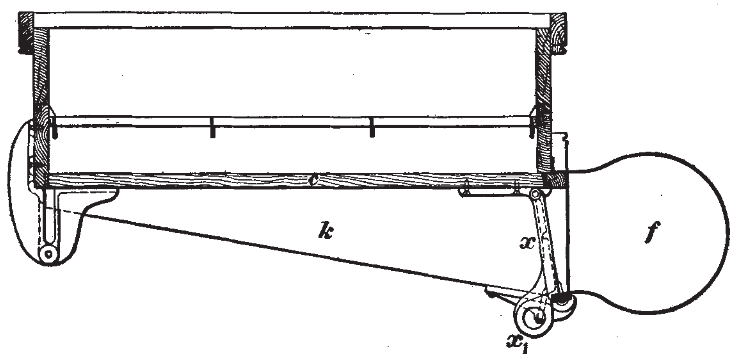


FIG. 13

The portion of the trunk containing the grating is called a cleaning trunk and does not extend the entire length of the trunk, the remainder being simply a conducting trunk. Forming the bottom of each pocket *b* are doors *c* hinged at *d*, below which is another passage *e*, which has a door at each end. Connecting with this passage *e* is a trunk *f*, which extends to the dust room and contains a fan *g*.

When it is desired to remove the dirt that has fallen through the grating, the breaker picker is first stopped; the springs that hold the doors are released; and the doors fall, delivering the dirt into the passage *e*. The doors *c* are then closed by means of the handles *j*, and the doors at each

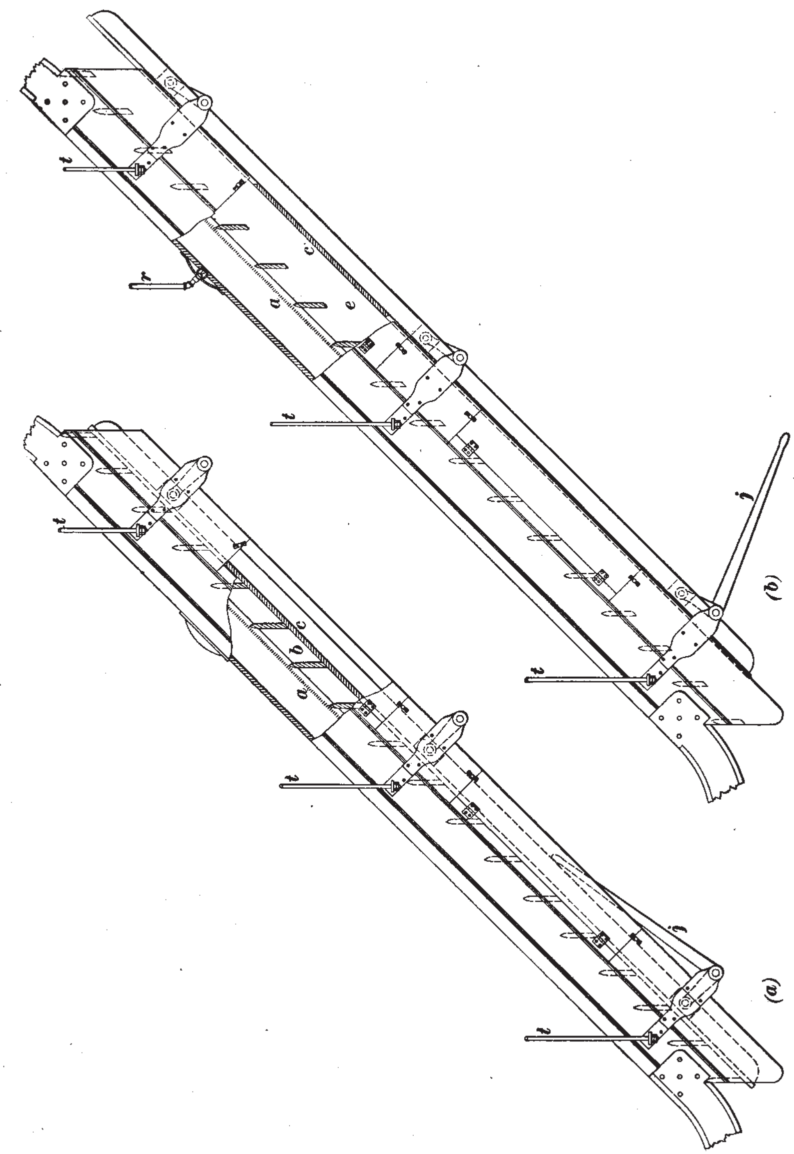


FIG. 14

end of the passage *e* opened. The fan *g* creates a current of air in the passage *e*, which carries the dirt to the dust room. The positions that the doors assume at various times during this process are shown in Fig. 12 (*c*).

If the breaker picker were not stopped during this process, the air-current of this machine would tend to draw the dirt back into the cotton when the doors *c* were opened. The air-current of the breaker picker would also act against the air-current of the fan *g* if both were running.

34. Another style of horizontal trunk is shown in Fig. 13. The passage for the cotton and the grating are constructed on the same principles as those just described; but the trunk *f* for removing the dirt, instead of being at the end, extends along the side of the main trunk. When it is desired to remove the dirt, the doors *c*, which are made of wood and supported by the latch *x*, are dropped by pulling the ring x_1, thus causing the latch to be pulled off its support. This forms an incline down which the dirt slides into the trunk *f*. In order to prevent the dirt from falling off the sides of the door *c* when it is lowered, there are boards *k* that form sides as the door *c* drops between them.

35. One style of an inclined cleaning trunk is shown in Fig. 14 (*a*) and (*b*). This trunk contains the usual grating *a*, over which the cotton passes, while the dirt and other foreign substances fall through this grating into the pockets *b*. The bottom of these pockets is formed by *c*, which is capable of being raised or lowered by the lever *j*. The position that the bottom ordinarily occupies is shown in Fig. 14 (*a*); when, however, it is desired to remove the dirt from the pockets *b*, the lever *j* is brought into the position shown in Fig. 14 (*b*). In this case the bottom *c* is lowered into the position shown, causing the dirt from the different pockets to fall out into the chamber *e* and slide, by its own weight, down the incline into the dust chamber.

PICKERS

(PART 2)

COTTON PICKERS

BREAKER PICKERS

METHODS OF FEEDING

1. The **breaker picker** is the first machine that deals with the cotton after it leaves the opener. This machine may receive the cotton either directly from an automatic feeder, or from an opener through a trunk; in the latter case, the cotton first comes in contact with either a *condenser* and *gauge box* or a *cage section*. When the breaker picker is fed directly from an automatic feeder, the cotton is generally dropped on an apron, from which it is taken by the feed-rolls of the picker.

2. The Condenser and Gauge Box.—The manner of feeding the picker by means of a **condenser** and **gauge box,** when the cotton is conveyed through a trunk from the opener, is shown in Fig. 1. The air-current that draws the cotton from the opener through the trunk *a* is generated by a fan *b*. After leaving the trunk, the cotton first comes in contact with a cylinder of wire netting known as a *cage*, shown at *c*. About two-thirds of the inner circumference of this cage is protected by a cradle *d* of sheet metal, which prevents the cotton from being drawn to this protected part of the cage, the air-current passing out through the ends of the cage and down the passage b_1. The cradle d remains stationary, but the cage c revolves in the direction shown by the arrow, and thus the cotton, which is drawn to that part of the cage that is not protected by the cradle, is brought around until it comes under the action of the stripping rolls f, g, which remove it from the cage. The roll f is held

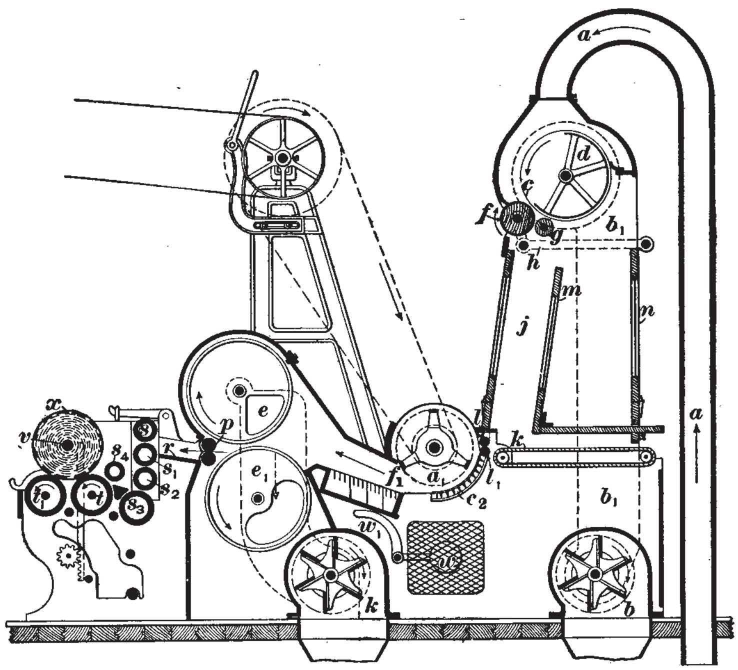


Fig. 1

in position in pivoted bearings by the lever h, so that it will be as close to the cage as the bulk of cotton passing will permit. The cotton then drops into the gauge box j and on to the apron k, from which it is removed by the feed-rolls l, l_1, of the breaker picker.

The condenser is usually understood to consist of the upper part of the arrangement shown in Fig. 1, including the parts marked c, d, f, g, and h.

3. The cotton that passes through the picker is wound in the form of a sheet on a lap roll *v*, shown at the front of the machine in Fig. 1, the lap that the cotton forms being marked *x*. When the lap is removed, the feeder that supplies this machine is usually stopped and also all parts of the breaker picker except the beaters, fans, and revolving parts of the condenser. Since the fans continue to run during this

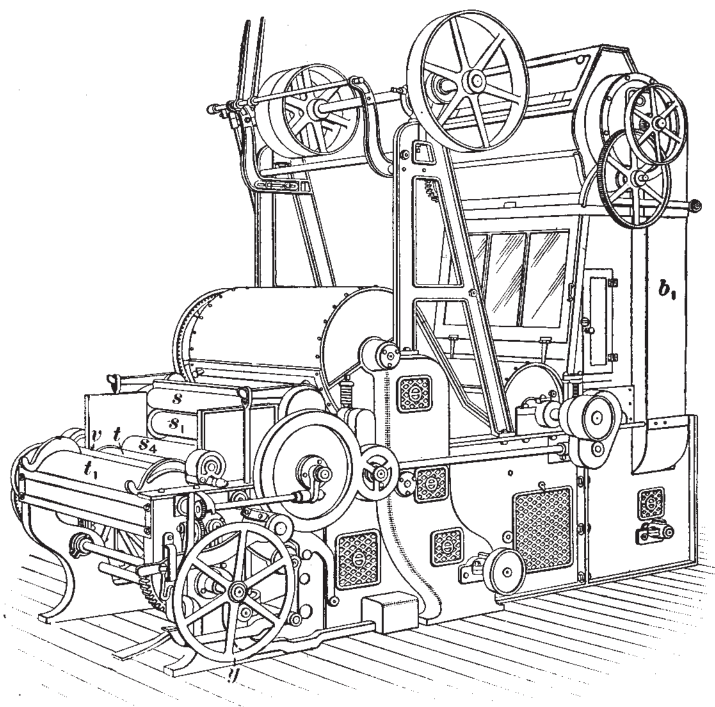


FIG. 2

period, the cotton that is in the trunk *a* will be delivered to the picker. It is the object of the condenser and gauge box to take care of this stock and thus prevent the passage from becoming blocked by the cotton coming from the trunk. With the arrangement shown in Fig. 1, the cotton collects, while the picker is stopped, in the gauge box *j* until it is completely filled, when any more cotton coming from the trunking will fall over the top of the partition *m*; it can then be removed by means of the door *n* and returned to the mixing. When the picker and feeder are restarted, the amount of cotton that is in the gauge box *j* will supply the feed-rolls l, l_1 of the picker until sufficient cotton is coming through the trunk *a*.

Fig. 2 is a perspective view of a picker with a condenser and gauge box.

4. Cage Section.—A sectional view of a breaker picker that receives the cotton by means of a cage, or screen, section

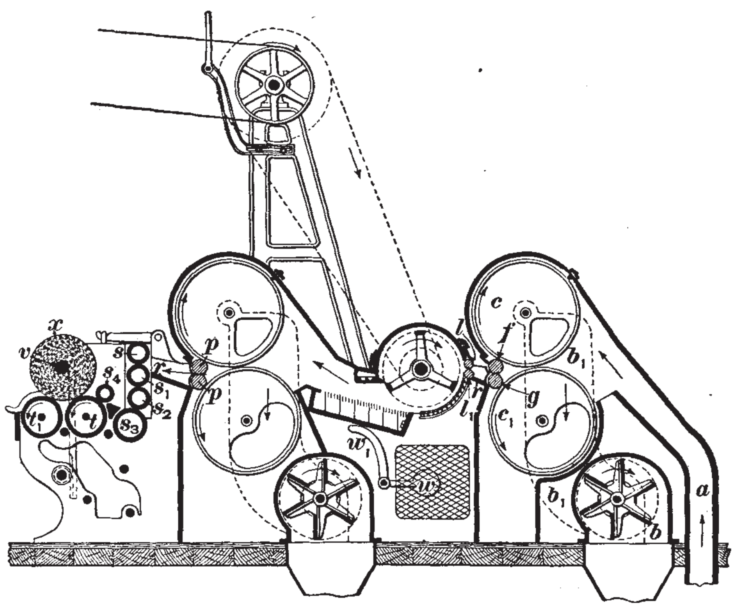


FIG. 3

is shown in Fig. 3, while Fig. 4 is a perspective view. An air-current generated by a fan *b* draws the cotton from an opener through a trunk *a* to two cages, or screens, c, c_1. These cages are protected so that as the air-current passes out through their ends, down the flue b_1 to the dust room, the cotton is drawn to the portions of their circumferences nearest the delivery end of the trunk *a* and, as the cages revolve in the direction shown by the arrows, is condensed in a sheet between them; it is removed by the stripping

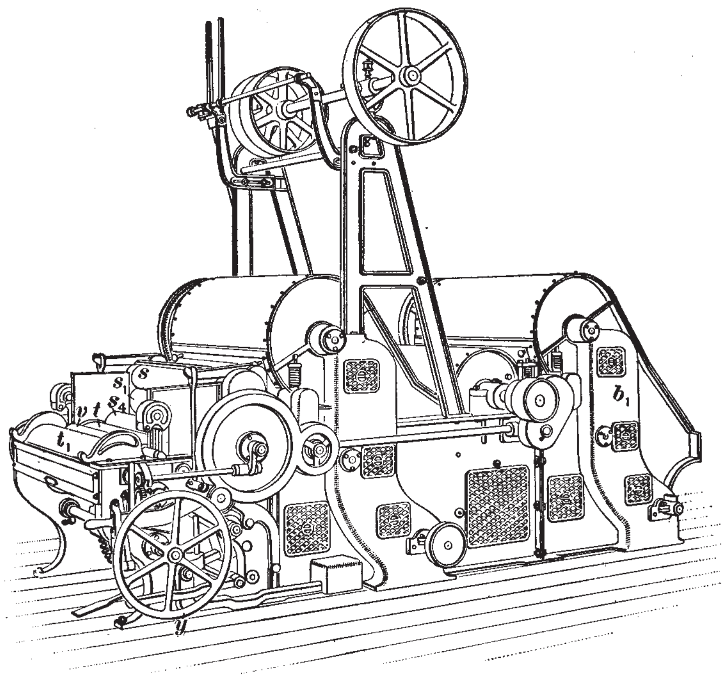


FIG. 4

rolls f, g on to a stripping plate r, from which it is removed by the feed-rolls l, l_1 of the picker.

CONSTRUCTION AND OPERATION OF THE BREAKER PICKER

5. Objects of the Breaker Picker.—The objects of the breaker picker are: (1) To remove foreign matter, especially the heavier and larger impurities, such as dirt, pieces of seed, leaf, etc.; (2) to separate the tufts of cotton so that they may be more easily manipulated at the next process; (3) to form the cotton into a layer and wind it on a roll in a cylindrical form known as a **lap**.

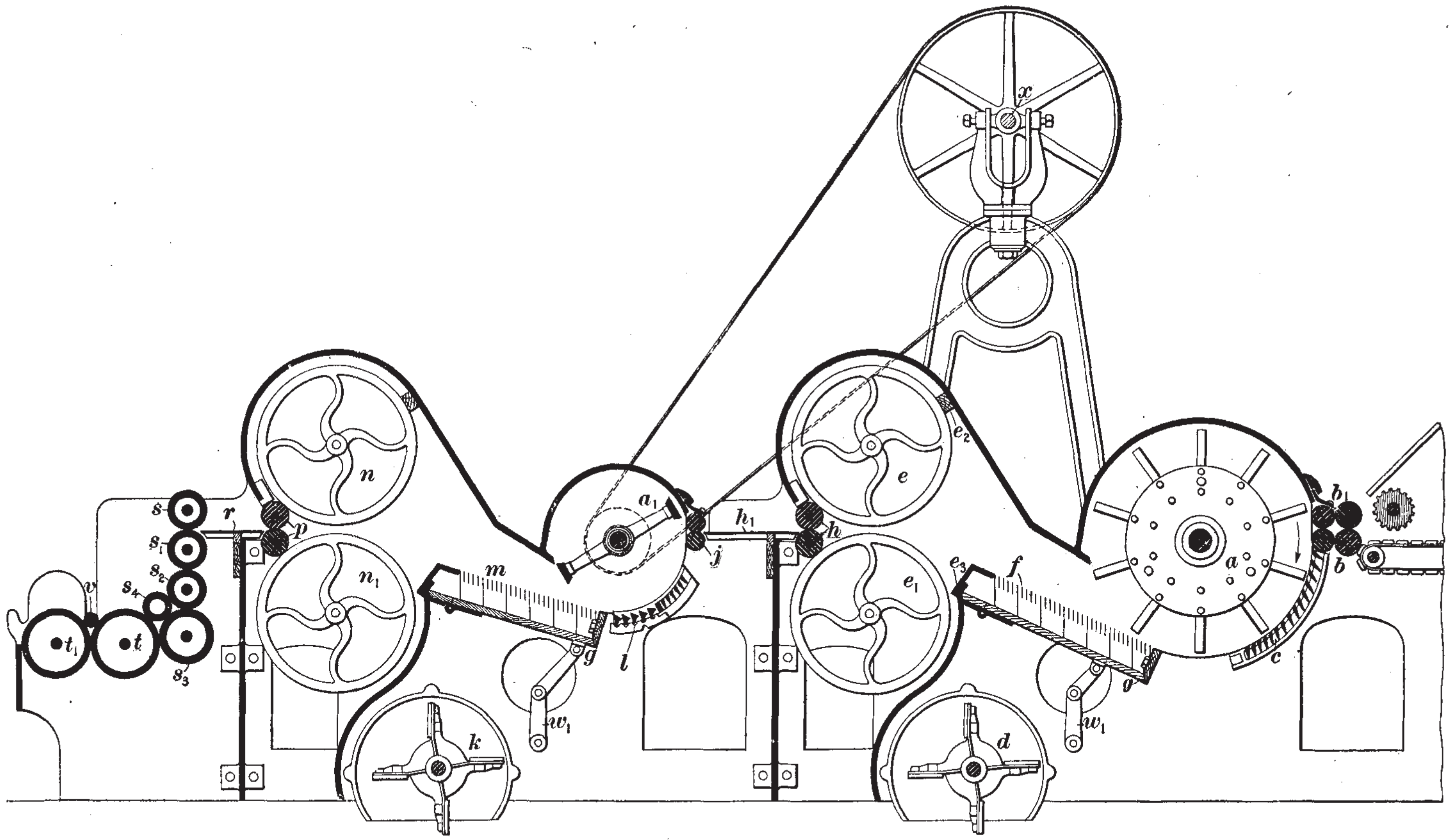


FIG. 5

The method used to attain these objects is to have a rapidly revolving *beater* strike a fringe of cotton, which is presented to it by a slowly revolving pair of feed-rolls, thus breaking up the sheet of cotton into small tufts and striking off any foreign matter in the cotton. The process of cleaning is also aided by an air-current, which draws dust from the cotton through screens, or cages, to which it is being drawn. These cages revolve and deliver the cotton in a sheet ready to be wound into a lap by means of a **lap head.**

6. Pickers are known as *pickers in single section* or *pickers in double section* according to whether they give a single or a double beating action to the stock passing through them. Breaker pickers in single section are shown in Figs. 1, 2, 3, and 4. The passage of cotton through breaker pickers in single section, whether they are fed by a condenser and gauge box, as in Fig. 1, or by a cage section, as in Fig. 3, is the same. Referring to Fig. 1, after the cotton delivered by the feed-rolls l, l_1 has been struck by the rapidly revolving beater a_1, it passes over grid bars c_2 in order that any dirt or other foreign matter may be separated and fall through the spaces between the bars. Then it is carried over inclined cleaning, or grate, bars f_1 so that other foreign matter, too heavy to be carried by the air-current, may have an opportunity of dropping through the spaces between the bars. This cleaning process is continued while the cotton collects in a layer on the surface of two revolving cages, or screens, e, e_1, through which a current of air is drawn by a revolving fan k. The cotton, now in the form of a sheet or layer, is removed by stripping rolls p, and allowed to pass over a stripping plate r, between smooth calender, or presser, rolls s, s_1, s_2, s_3, between rolls s_4 and t, and around the lap roll v that rests on the fluted calender rolls t, t_1, thus forming the lap x.

7. Fig. 5 shows a section through a breaker picker in double section with what is known as a *porcupine beater.* This picker is connected directly to an automatic feeder by means of an apron, a portion of which is shown. In case a picker in double section is fed by trunking from an opener and feeder combined, the cotton is delivered to a cage section similar to that shown in Fig. 3, while a beater of the type shown at a_1, Fig. 5, usually replaces the porcupine beater.

Referring to Fig. 5, as the cotton is delivered to the picker by the feed-apron, it is taken by feed-rolls b, b_1, from which it is struck by a beater a that is rapidly revolving in the direction shown by the arrow. It then passes over grid bars c, through which dirt and other foreign matter fall; then over inclined cleaning, or grate, bars f to cages e, e_1, from which it is delivered in a sheet to rolls h. These rolls deliver it to a stripping plate h_1, from which it is taken by

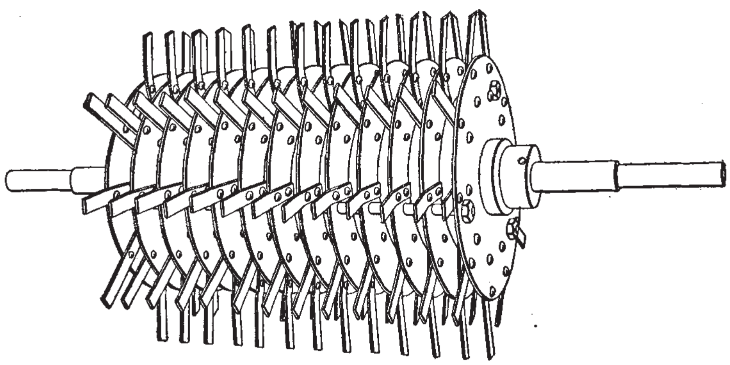


FIG. 6

rolls j and delivered to a beater a_1, which strikes it down over grid bars l. It then passes over cleaning bars m to cages n, n_1, which deliver it in a sheet to rolls p, from which it passes over a stripping plate r; then between rolls s, s_1; s_1, s_2; s_2, s_3; under roll s_4, over roll t, and is finally wound in the form of a lap on a lap roll v.

8. Types of Beaters.—There are several types of beaters, that known as a **porcupine beater** being shown in elevation at a, Fig. 5, and in perspective in Fig. 6; it consists of steel projections riveted to circular metal plates. This style is a special make and is most frequently found on openers. A **carding beater** is shown in section in Fig. 7, and in perspective in Fig. 8; this beater has been adopted in recent years. It consists of three wooden lags *a*, *a*, *a* that are securely fastened to the arms *b*, *b*, *b* of the beater, which is mounted on the shaft *c*. Steel pins *d*, *d*, *d*, arranged spirally, project from the lags, those pins that first come in contact with the cotton being shorter than the others, as shown in Figs. 7 and 8. With this arrangement, the pins penetrate and break up the cotton, and as they enter it gradually, the strain incident to the operation of picking is almost equally distributed among them, causing the beater to combine a carding and a beating action. The carding beater is used to the greatest extent in breaker pickers and sometimes, though not often, in intermediate pickers.

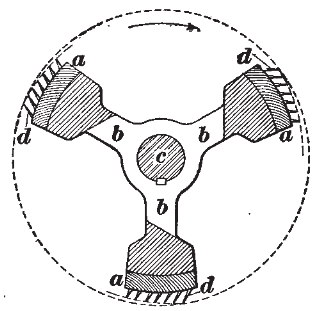


FIG. 7

Another type, and one that is more commonly met with, is known as the **ordinary knife, or rigid-blade, beater.** A two- and a three-blade beater of this type are shown in perspective in Figs. 9 and 10, respectively. The edges of the blades should not have a knife edge, neither should they

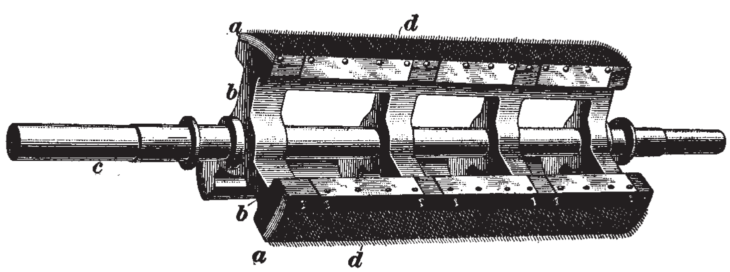


FIG. 8

be too blunt. As soon as the edges wear, the beater should be turned around so that the other edges of the blades will come in contact with the fringe of cotton. When both sides are dull, sufficient metal should be planed from the blades to give two new edges on each. Sometimes, beaters are constructed with hardened steel edges fastened to the blades; these edges may be replaced when necessary.

9. Action of the Beater.—The action of the beater is the most important part of picking; for it is desired not only to clean the cotton, but also to do this with as little injury

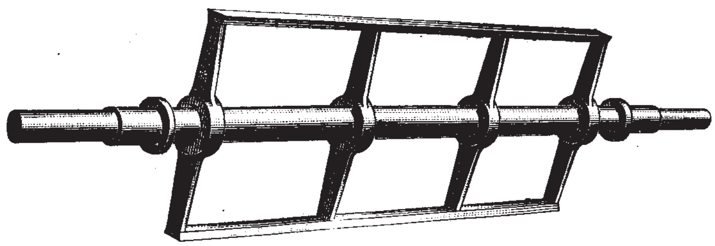


FIG. 9

to the fibers as possible. The speed of the beater must therefore be so regulated that the blades will not strike the cotton too often and thus injure the staple; neither should the speed be so low that they will not strike the cotton often enough and thus not clean it sufficiently. Beaters as a rule should not strike more than about 60 nor less than 20 blows per inch of cotton fed.

The speeds of beaters vary considerably, but the following

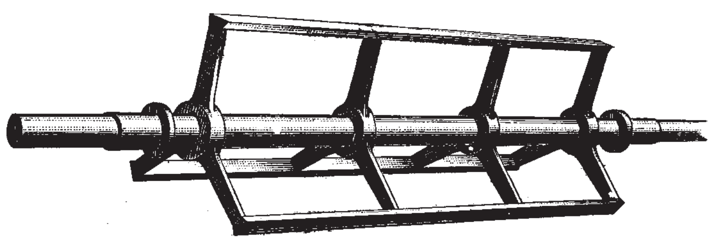


FIG. 10

are about the maximum and minimum for the different machines and types:

Porcupine beater, 30 inches in diameter, in opener, 500 to 600 revolutions per minute; 18-inch, two-blade, ordinary knife beater in breaker, 1,400 to 1,600 revolutions per minute; 20-inch, three-blade, ordinary knife beater in breaker, 850 to

1,050 revolutions per minute; 16-inch, two-blade, ordinary knife beater in intermediate or finisher, 1,250 to 1,500 revolutions per minute; 18-inch, two-blade, ordinary knife beater in intermediate or finisher, 1,200 to 1,450 revolutions per minute; 18-inch, three-blade, ordinary knife beater in intermediate or finisher, 800 to 950 revolutions per minute.

10. The **grid bars** through which the beater knocks the impurities are important agents in the cleaning of the cotton. They are triangular in section and extend from one side of

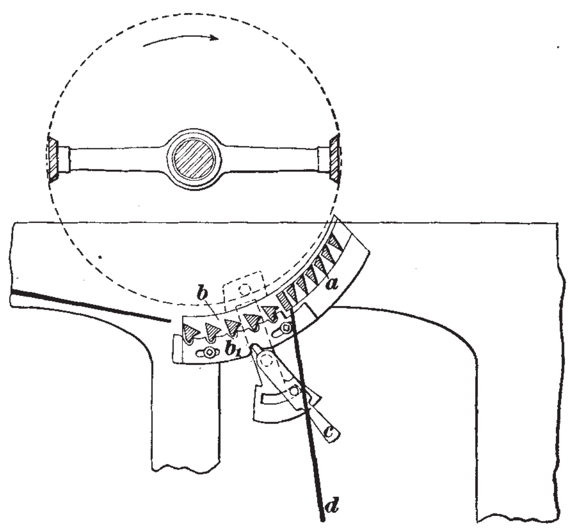


FIG. 11

the machine to the other. There are a sufficient number of them to occupy an arc of a circle extending for about a quarter of the path of the beater. When using 1-inch American cotton, the bar nearest the feed-roll is usually set in such a manner that the beater blade in revolving will be about $\frac{1}{2}$ inch from it when at its nearest point, while the last bar should be about $\frac{3}{4}$ inch from the beater blade when at its nearest point. Thus, the arc of the circle formed by the bars is not concentric with that formed by the path of the beater blade. The reason for setting the bars in this manner is that the cotton expands and tends to fly from the beater blade, as the beater revolves, and thus would come against the bars if they were too near. The angle at which the bars are set, as well as the distance between them, also form important points in the setting of this part of the picker. The bars close to the feed-roll should have more space between them than those more distant. For 1-inch American cotton, there is usually about $\frac{1}{2}$ inch from edge to edge of the first three bars, while the lower bars are about $\frac{3}{8}$ inch apart.

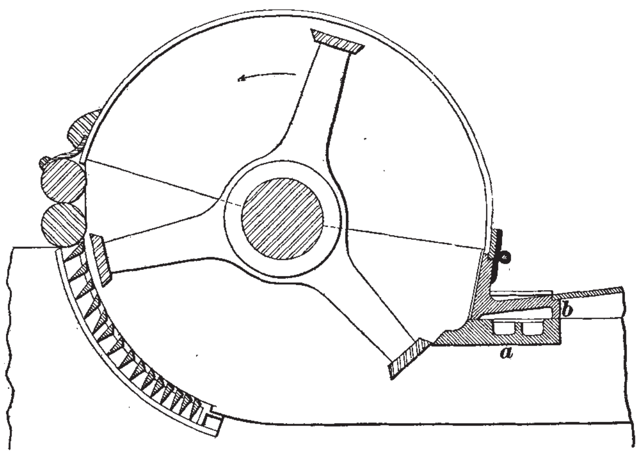


Fig. 12

11. An adjustment for **setting the grid bars** is shown in Fig. 11. The upper six bars *a* are of the ordinary pattern and through these the heavier forms of leaf and dirt are ejected by the action of the beater. The dirt that passes through these bars falls into a separate chamber, and, as the small capacity of this chamber will prevent any strong current issuing in the opposite direction through the bars, the impurities are prevented from returning. This advantage is further augmented by arranging the last five bars *b* so that they are adjustable. By this means an almost perfect regulation of the current of air passing upwards through the bars *a* can be obtained; for, the more air passing through the bars *b*, the less will pass through the bars *a*. The bars *b* are also arranged to prevent by their shape, as far as possible, any return of dirt that may be driven through them by the beater. The adjustment is made by means of sliding plates b_1, into which the lower parts of the bars loosely fit. These plates can be moved backwards or forwards by a handle c, which, when set correctly, can be firmly fixed in position. The division plate d is an important factor and must be set accurately to obtain the best results.

12. Stripping Rail.—As soon as the cotton is released from the feed-rolls b, b_1, Fig. 5, it is acted on by the beater and then by an air-current that is generated by the fan d.

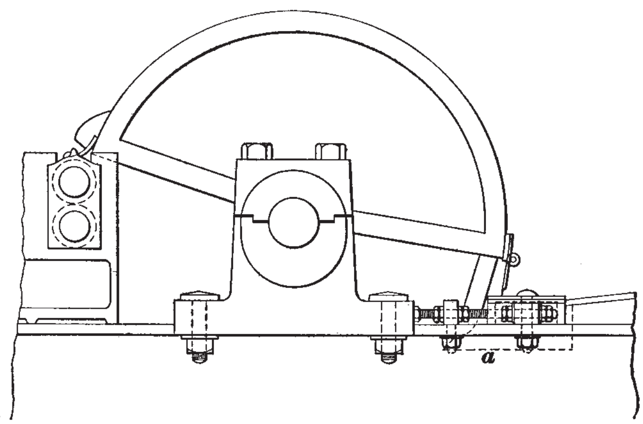


Fig. 13

This fan exhausts the air in the passage between the beater a and the cages e, e_1, and thus the air rushes in from the room through the opening shown in the side of the picker, passes through the grid bars c, through the passage to the cages, out at the ends of the cages, and down a flue to the dust room. By this means the cotton is carried through the passage over the cleaning bars f to the cages e, e_1. The top of the passage projects to some extent toward the beater and supports what is known as the **stripping rail,** one type of which is shown in Figs. 12 and 13 at a. It is the function of this rail to remove any cotton that has adhered to the beater instead of being carried to the cages. In some cases the stripping rail cannot be moved, while in other cases it is capable of being adjusted. The type of stripping rail shown in Fig. 12 is an adjustable one, as the rail *a* is entirely separate from its support *b*. The adjustment for the stripping rail is shown in Fig. 13. Although the stripping rail is described in connection with a porcupine beater, it is generally and more appropriately used in connection with two- or three-blade beaters.

13. Inclined Cleaning Bars.—The bottom of the passage between the beater and the cages is formed by the series of cleaning bars *f*, Fig. 5, known as the **inclined cleaning, or grate, bars.** These bars are so placed that any foreign matter that is too heavy to be carried along by the air-current will drop of its own weight through them and thus be prevented from reentering the cotton. Every fifth bar is a deep one, in order to prevent the dirt that drops between the bars at a point nearest the cages from sliding down the incline. If this were not provided for, considerable dirt would accumulate at the lowest point of the incline and make it possible for a portion, at least, to reenter the cotton, as underneath these bars is a door *g*, Fig. 5, that is held in place by a weight on a lever, a portion of which is shown at w_1. This door can be lowered, in order to remove the dirt that has accumulated, but the picker should be stopped when this is done so that the air-current will not enter the passage to the cages through the grate bars and thus take some of the dirt with it into the cotton that is being drawn to the cages.

The cages e, e_1, Fig. 5, on which the cotton is delivered from this passage, are similar in construction to those that have been described, and are usually about 22 inches in diameter; in some cases, the top one is larger than the bottom one, or vice versa.

14. At a point e_2, Fig. 5, is a block that prevents air or cotton from being drawn to the surface of the upper cage beyond this point; the framework e_3 accomplishes the same object for the bottom cage. These cages are also usually protected at the ends and other places so that the cotton cannot be drawn to any point but that nearest the passage. The cages aid in the cleaning of the cotton, since, as it is brought with some force against them, dust and foreign matter small enough to go through will be carried to the dust room. In addition to this, the cages, by revolving,

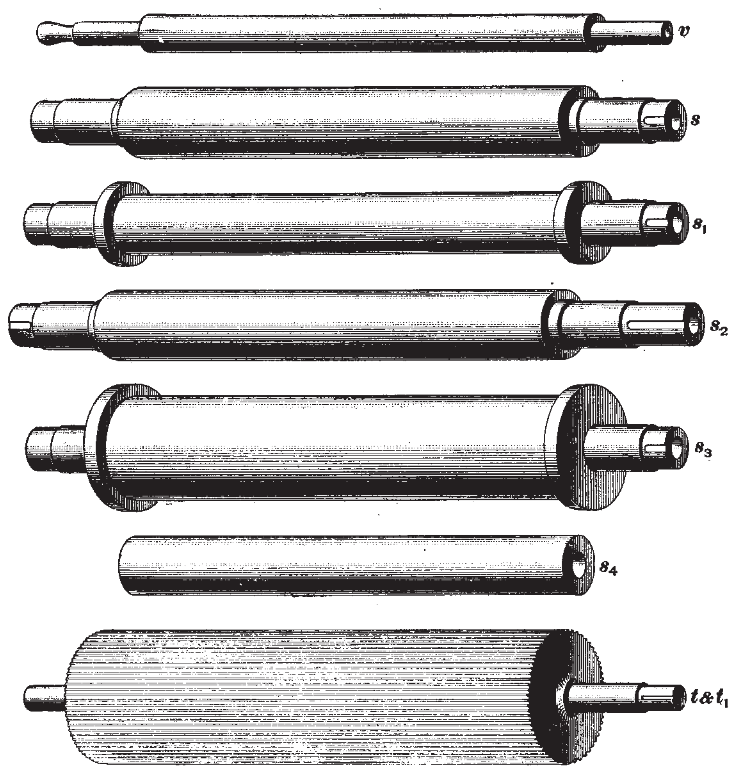


FIG. 14

form the cotton into a layer, which is taken by the stripping rolls h and delivered on the stripping plate h_1.

The cotton next passes over this stripping plate and is gripped by the feed-rolls j; in passing from these to the stripping rolls p, it is treated in the same manner as during its passage from the feed-rolls b, b_1 to the stripping rolls h.

In this section of the picker, however, there is a different type of beater, and the air-current is generated by the fan k, the air passing in through the grid bars l, and carrying the cotton over the cleaning bars m on to the cages n, n_1, from which it is stripped by rolls p and delivered on to the plate r. The cotton passes from the plate r, between the rolls s and s_1, then between s_1 and s_2, between s_2 and s_3, and under the compression roll s_4. The object of the last roll is to further condense the cotton. It has no bearings, being held in position by the rolls s_3, t and receiving motion by frictional contact with them; this roll is also shown at s_4, Fig. 14. The rolls s, s_1, s_2, s_3 are known as **smooth calender rolls,** and their purpose is to condense the layer of cotton. Their bearings are held in vertical slides, so that they are capable of being separated slightly when an excessive amount of cotton passes through. If they were held in fixed bearings, considerable strain would be brought on them at such a time. Two of these rolls that are not adjacent are constructed with collars, so that the four rolls fit into each other, as shown in s, s_1, s_2, s_3, Fig. 14. In addition to their own weight, downward pressure is exerted at each end by a weighted lever attached to two rods, one suspended from each side of a saddle resting on the bearings of the upper roll.

15. Lap Roll.—Between and resting on the fluted calender rolls t, t_1 is the lap roll v, which is held in position as shown in Fig. 5. This roll is revolved by frictional contact with t and t_1, and serves to roll the cotton into a cylindrical form known as a **lap.** When the lap has reached the desired size, the lap roll is withdrawn and the lap removed from the machine. The lap roll, which is also shown in Fig. 14 at v, is built in two styles; sometimes it is solid, and when the lap is used at a succeeding process a rod is pushed through the opening thus made, while in other cases it is hollow, so that a rod having a large, flat head may be inserted while the lap is still on the lap roll and thus be in position when the roll is withdrawn from the lap.

16. Lap Rack.—In order to build a solid lap, a device known as a **lap rack** is employed, the construction of which is shown in Fig. 15 (*a*) and (*b*), Fig. 15 (*a*) being a side

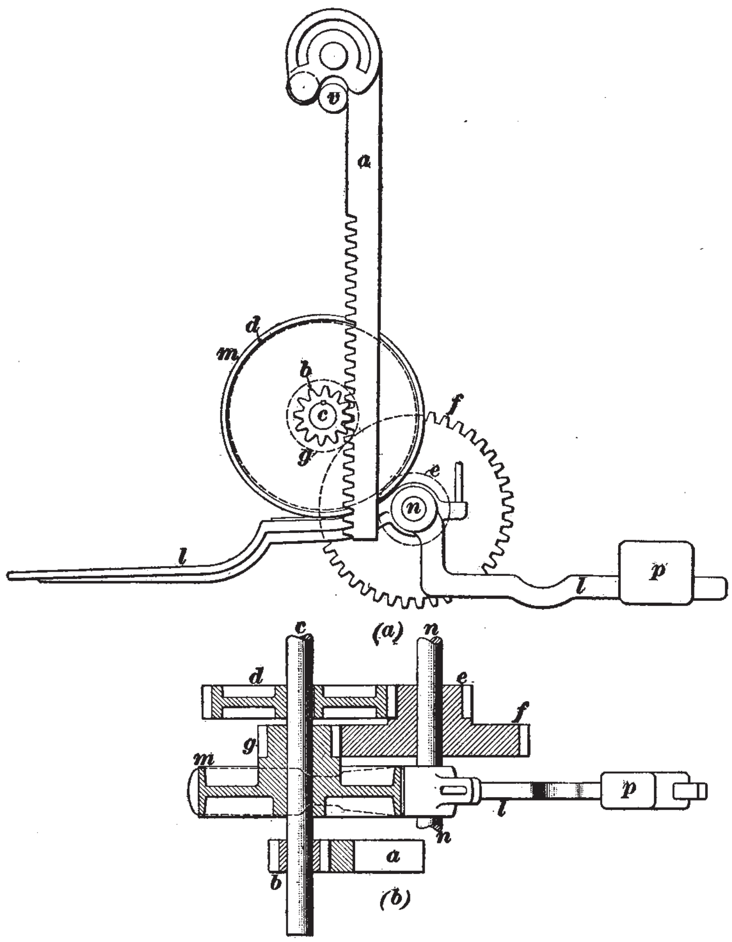
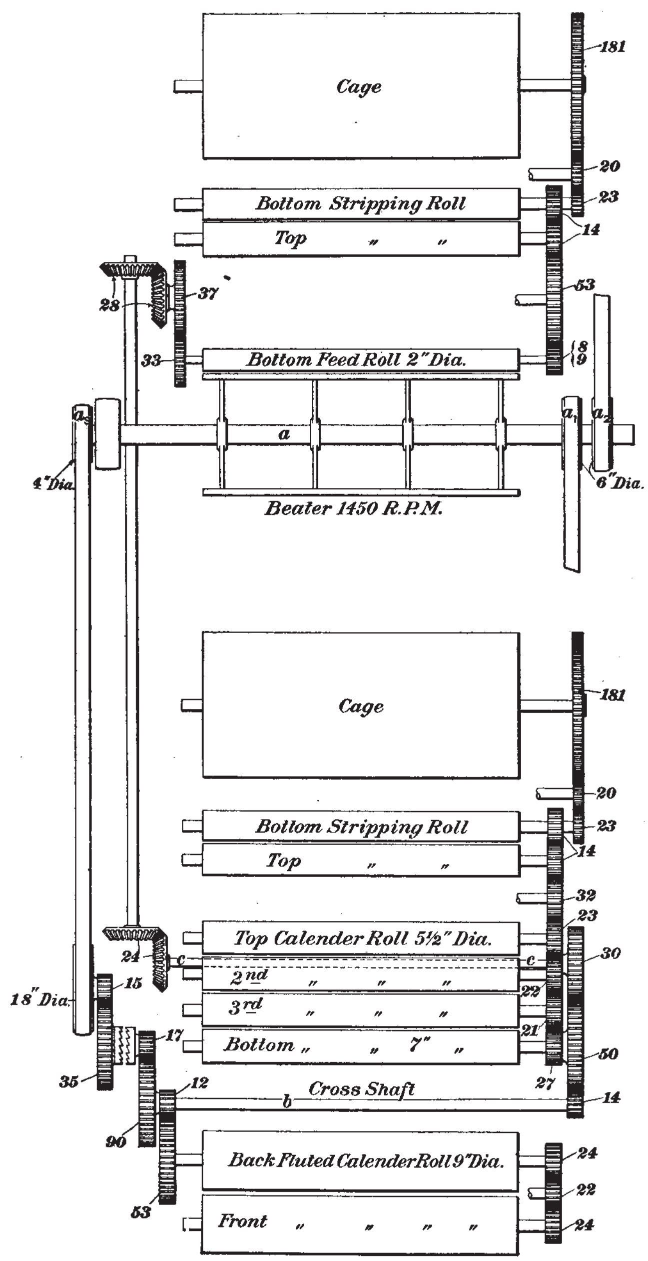


Fig. 15

elevation and Fig. 15 (*b*) a plan view, partly in section. At each end of the lap roll *v* is the lap rack *a*, the upper part of which has a bearing on the lap roll; the lower part has teeth that engage with a gear *b* on the shaft *c*. Fixed to the shaft *c*



Cage
181
20
Bottom Stripping Roll
23
Top " "
14
28
37
53
33
Bottom Feed Roll 2" Dia.
8
9
a
4" Dia.
6" Dia.
Beater 1450 R.P.M.
Cage
181
20
Bottom Stripping Roll
23
Top " "
14
32
23
Top Calender Roll 5½" Dia.
24
c
c
30
18" Dia.
15
2nd " " "
22
3rd " " "
21
17
Bottom " " 7" "
50
35
27
12
Cross Shaft
b
14
90
Back Fluted Calender Roll 9" Dia.
24
22
53
Front " " " "
24

FIG. 16

is a gear d that meshes with a gear e on a sleeve on the stud n. This sleeve also carries another gear f that meshes with the gear g loose on the shaft c and compounded with the friction pulley m. Pressing against this friction pulley is a strip of leather, which is held against it with considerable pressure by means of the weight p on the lever l fulcrumed on n.

As the lap increases in size on the roll v, it must overcome the total resistance of the friction pulley and the friction of the gearing; by this means it is made comparatively firm. When it is necessary to remove the lap, the friction is released by depressing the end of the lever l, opposite to the weight p, with the foot. The cotton then has a tendency to expand, which will lift the racks a, to some extent, but they are further raised by means of a hand wheel, shown at y, Figs. 2 and 4, and which is on the shaft c, Fig. 15 (a).

17. Gearing.—Above the machine in Fig. 5 is shown a framework carrying a countershaft x. The speed of the beater is so high that it cannot be driven directly from the main shaft of the room without using very large pulleys; for this reason, the countershaft is used and the beater driven from it as shown in Fig. 5. In some cases instead of being on the machine the countershaft is attached to the ceiling.

A plan of gearing for a picker in single section having a cage section is shown in Fig. 16. On one end of the beater shaft a are two pulleys a_1, a_2; a_1 drives the fan that produces the air-current for the cages nearest the lap head, while a_2 drives the fan that produces the air-current necessary to draw the cotton from the trunking to the cage section. These pulleys are 6 inches in diameter and drive pulleys on the fan shaft 8 inches in diameter; therefore, when the beater shaft a is making 1,450 revolutions per minute, the speed of each fan is $\frac{1{,}450 \times 6}{8} = 1{,}087.5$ revolutions per minute.

On the other end of the beater shaft is a 4-inch feed-pulley a_3 driving an 18-inch pulley compounded with a 15-tooth gear, which, through two gears connected, or compounded, by a clutch arrangement, drives a cross-shaft *b*, from which the fluted calender rolls receive motion. At the other end of the cross-shaft from the 12-tooth gear driving the fluted calender rolls is a gear of 14 teeth, driving a gear of 50 teeth, which is compounded with a gear of 27 teeth.

The method by which the calender rolls, stripping rolls, and top cage are driven from this gear of 27 teeth may be readily traced. The bottom cage is driven from the top cage. The 14-tooth gear on the cross-shaft *b* drives a 30-tooth gear on the end of another cross-shaft *c* through the 50-tooth gear. The shaft *c*, by means of bevel gears, drives a shaft extending along the side of the picker. The feed-rolls receive motion from this shaft, and the stripping rolls, together with the cages of the first cage section, are driven from the bottom feed-roll.

18. The cross-shaft *b* that carries the gear of 14 teeth is driven through the 18-inch pulley by a 35-tooth gear, a clutch gear, and a 17-tooth gear meshing with one of 90 teeth on the cross-shaft. When the clutch is disconnected, the lap head and the feed-rolls will stop, but the beater and fans will continue to run. When it is desired to remove a lap, this clutch is disconnected.

The reason for this construction is that the beater and fans, owing to their high speed, could not be stopped immediately when it was desired to remove a lap without putting an excessive strain on the beater; neither would it be advisable to start the beater and fans from a standstill each time the feed was started, since too much time would be required for these parts to acquire their maximum speed. By this construction, however, the cotton may be stopped or started through the picker almost instantly.

19. Draft of a Breaker Picker.—The draft of a breaker picker is usually a little less than 2, and is figured from the fluted calender rolls to the feed-rolls. The draft of the picker shown in Fig. 16 is

$$\frac{9 \times 24 \times 12 \times 30 \times 24 \times 28 \times 33}{24 \times 53 \times 14 \times 24 \times 28 \times 37 \times 2} = 1.947$$

20. Floor Space of a Breaker.—The floor space of a breaker varies according to the style and make of the machine. One type of a single-beater breaker with a cage section occupies a floor space of 13 feet 9 inches by 6 feet $8\frac{1}{2}$ inches, allowing for trunk connections. A double-beater machine, other particulars as above, occupies 19 feet 10 inches by

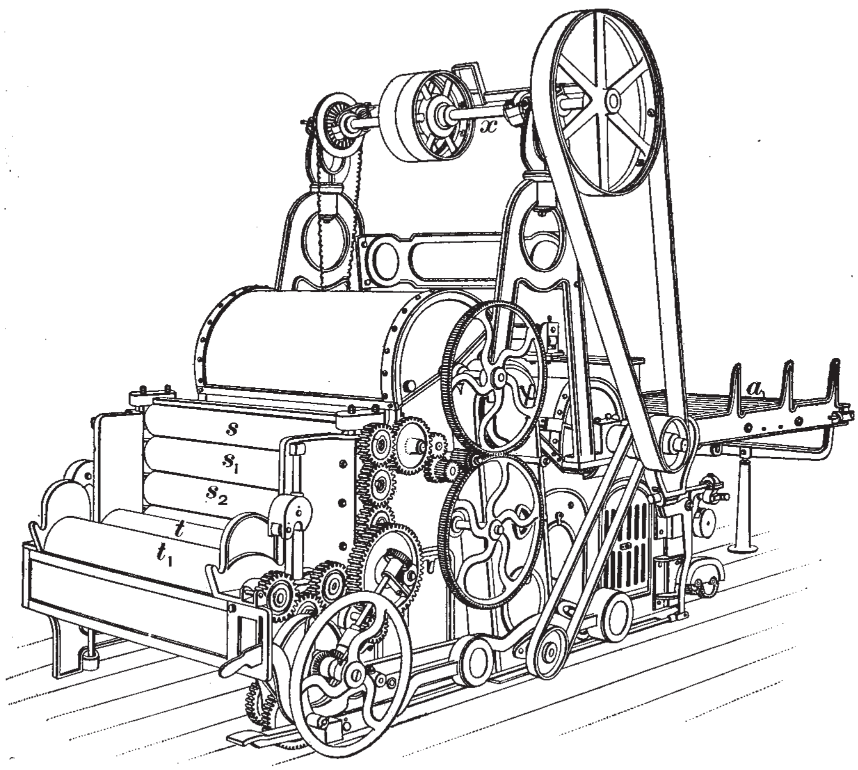


FIG. 17

6 feet $8\frac{1}{2}$ inches. Where a condenser and gauge box are used instead of a cage section, from 7 to 9 inches may be deducted from the length given above. These measurements are for pickers that make laps 40 inches wide.

When in single section, breaker pickers require about $4\frac{1}{2}$ horsepower; when in double section, about 7 horsepower.

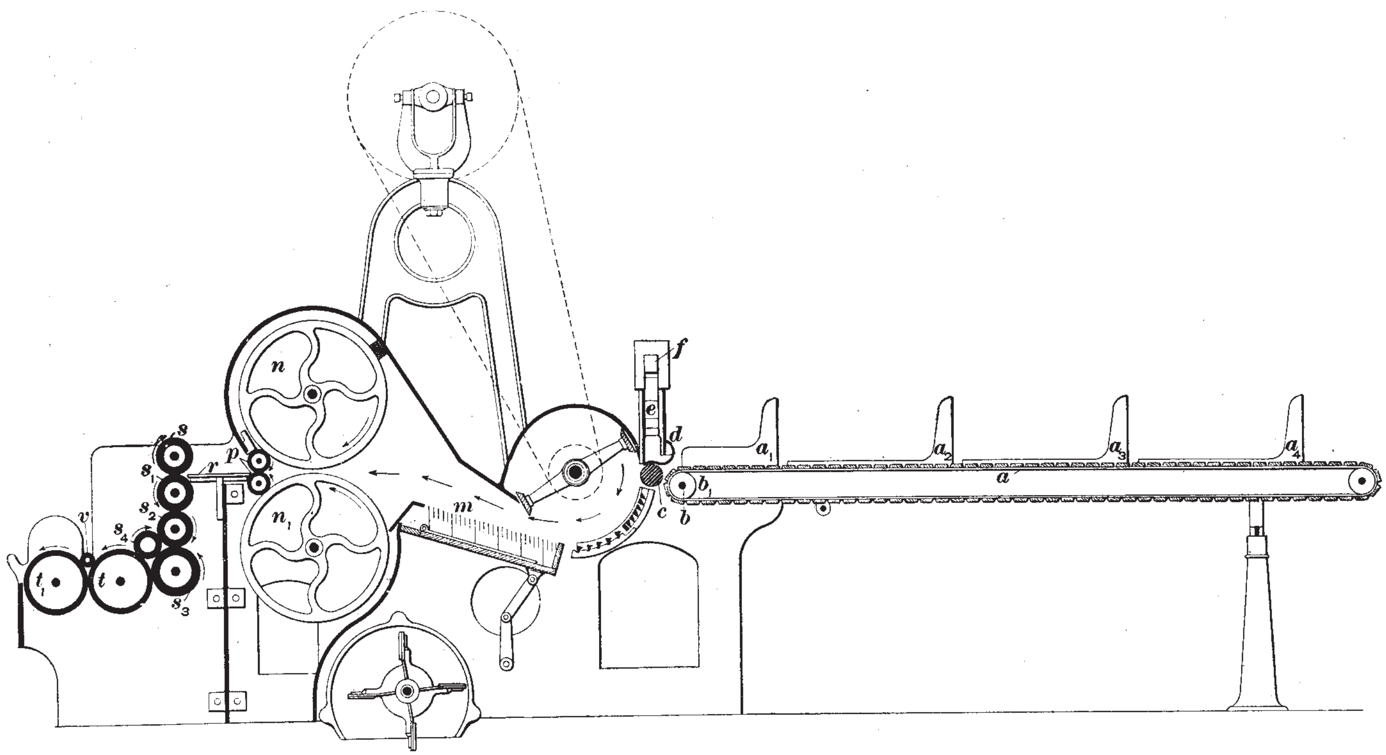


FIG. 18

The production depends on the speed, width of lap, and weight of lap per yard. A common production is about 500 pounds per hour, or 25,000 pounds for a week of 50 hours actual running time, as about 8 hours is allowed for stoppages.

INTERMEDIATE AND FINISHER PICKERS

21. Intermediate and finisher pickers are practically alike in construction and differ very little from a breaker picker in single section. Their objects are the same as those of the breaker picker; the lap that they produce, however, is of a more uniform weight per yard.

Fig. 17 shows a perspective view of a finisher picker, while Fig. 18 shows a section through the same machine. Four

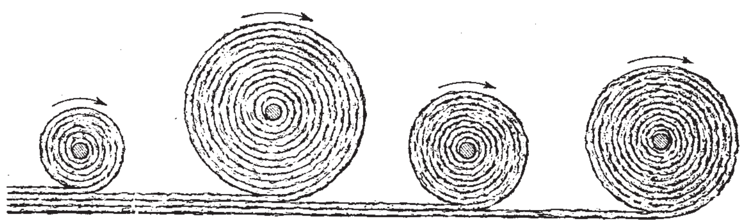


Fig. 19

laps taken from the previous picker are placed on the apron *a*, and thus the advantage gained by doubling is secured.

22. Fig. 19 shows how the laps pass under each other on the apron that conducts them to the feed-rolls. Rods passing through the centers of these laps and being in contact with the brackets a_1, a_2, a_3, a_4, Fig. 18, hold the laps in position.

The laps, shown in Fig. 19, vary in diameter. This is necessary in order to keep four layers of cotton supplied to the feed-rolls at all times. If all the laps were of the same diameter, they would run out at the same time, and thus there would be a liability of the cotton running through the machine before all the new laps were supplied, as well as a tendency to irregularity through four piecings coming near together.

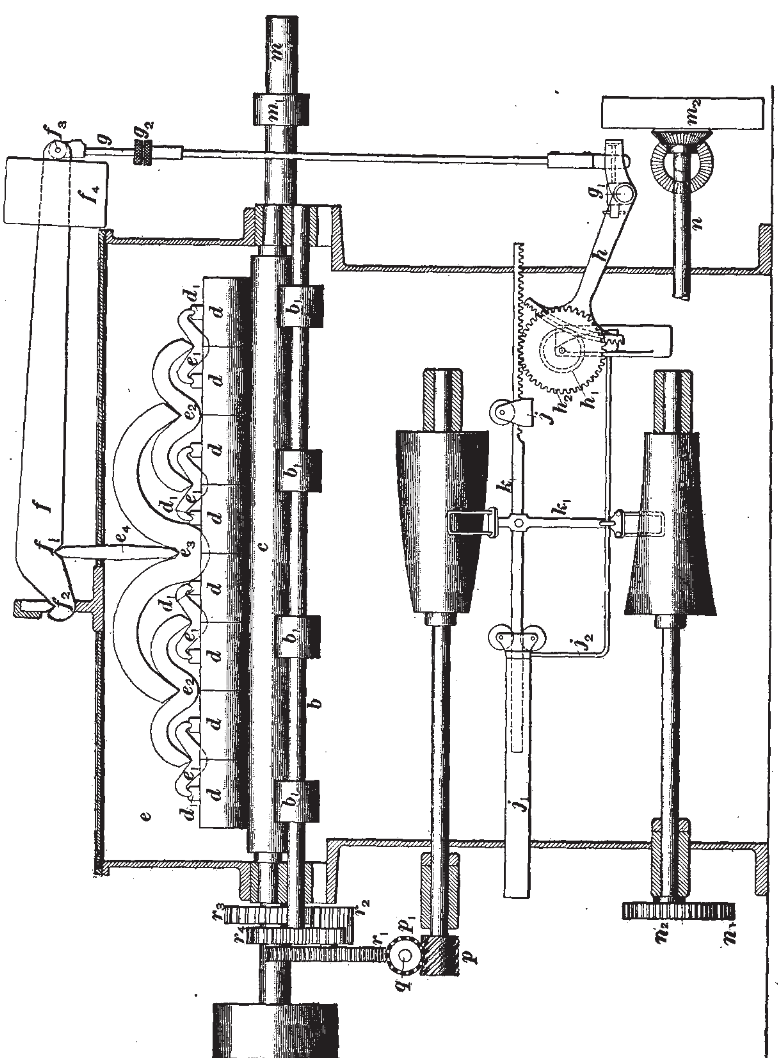

m
m₁
m₂
n
n₁
n₂
g
g₁
g₂
f
f₁
f₂
f₃
f₄
e
e₁
e₂
e₃
e₄
d
d₁
b
b₁
c
h
h₂
j
j₁
j₂
k
k₁
p
p₁
q
r₁
r₂
r₃

FIG. 20

EVENER MOTIONS

23. After it is delivered by the feed-rolls, the cotton is treated in the same manner as in the breaker picker, but the manner in which it is fed into the intermediate and the finisher pickers is somewhat different from that in a breaker picker, as indicated by the curved section plate *d* above the roll *c*, Fig. 18. This section plate is a portion of a motion known as the **evener motion,** the object of which is to regulate the speed of the feed-roll in accordance with the weight of cotton fed so that a uniform weight will be presented to the beater.

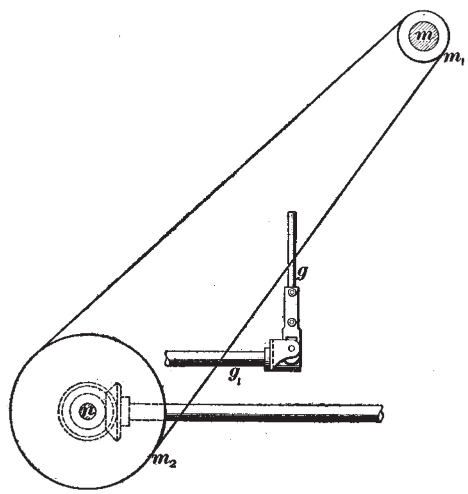


FIG. 21

Fig. 20 is a complete view of all the attachments of an evener, while Figs. 21 and 22 are portions of side elevations. A shaft *b*, Fig. 20, carries rolls b_1, which give motion to and support the feed-apron *a*, Fig. 18, while *c*, Fig. 20, is a feed-roll, or evener roll, extending across the machine.

24. Scale Box.—Fig. 20 shows eight sectional plates *d*, each of which is about 5 inches in width, and carries a projection d_1 that passes inside a box known as the **scale box** *e*. The plates are connected in pairs by four short saddles e_1. Each pair of these saddles e_1 is, in turn, connected by a larger saddle e_2, while the centers of e_2 are connected by a still larger saddle e_3.

Extending from the center of the saddle e_3 is a pin e_4, which projects out of the scale box and forms a bearing for a lever f at f_1. The fulcrum of the lever is at f_2 and is formed by a bracket fastened to the scale box. At the other end of the lever, fastened at f_3, is a vertical rod g that is connected to a short shaft g_1 at the side of the picker. At the opposite end of this shaft is fastened a segment h, the teeth of which engage with a gear h_1. This

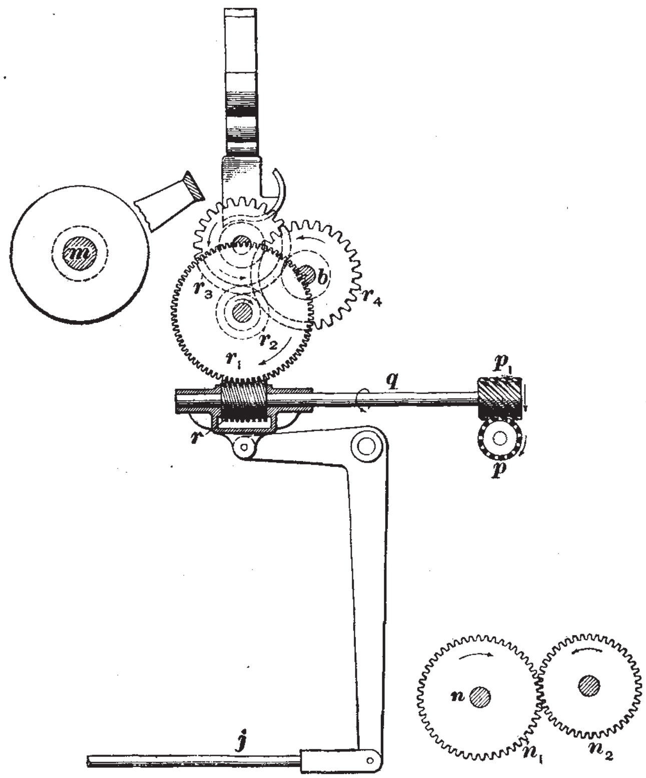


FIG. 22

gear is on a sleeve with a gear h_2, the sleeve being supported by a stud that projects from a bracket bolted to the framework under the apron. Supported from this same part of the machine are bearings j, j_1 that hold a rack k in position. The teeth of this rack engage with the teeth of the gear h_2.

25. Connected to the rack k is a belt guide k_1 that controls the position of the belt on the cones and thus regulates the speed of the driven cone. A rod j_2 that extends downwards from the bearing j_1 and then horizontally through a projection on the belt guide serves to steady the guide.

26. Feed-Roll.—The manner in which the feed-roll is driven through the cones may be seen by reference to Figs. 21 and 22 in connection with Fig. 20. On the beater shaft m is a pulley m_1 driving a pulley m_2 on a shaft n that extends across the picker. The lower-cone shaft is driven from the shaft n by the gears n_1, n_2, while motion is imparted to the top-cone shaft by a belt that passes around both cones.

On one end of the top-cone shaft is a spiral gear p, Figs. 20 and 22, that drives a spiral gear p_1 on a short shaft q. At the other end of this shaft is a double worm r that drives a worm-gear r_1 of 78 teeth. Compounded with the gear r_1 is a gear r_2, which is of extra width so that it drives a gear r_3 on the feed-roll and also a gear r_4 on the apron shaft b.

27. Operation.—The manner in which this evener regulates the speed of the feed-roll in accordance with the weight of cotton fed is as follows: The sectional plates d, Fig. 20, are pressed down on the roll c by the weight f_4, shown on the lever f, through the connection made by e_4 and the saddles. The distance that these plates are raised from the roll c is governed by the amount of cotton that passes between them and the roll; and, by following the connections, it will be seen that the distance these plates are raised will govern the position of the belt on the cones, and, consequently, the speed of the roll c that feeds the cotton.

When the proper weight of cotton is being fed uniformly throughout the length of the feed-roll c, the plates are raised the same distance from the roll c and the belt should be exactly in the center of the cones. If, however, a portion of cotton 1 inch thicker than the average thickness comes under the section plate at the extreme left, this section plate will be raised 1 inch from its normal position. The result of this will be that the end of the lever e_1 resting on this plate will be raised 1 inch, which in turn will raise the end of the lever e_2 connected to e_1 $\frac{1}{2}$ inch. The end of the lever e_3 that is connected to this lever e_2 will therefore be raised $\frac{1}{4}$ inch, which, by causing the pin e_4 to be raised $\frac{1}{8}$ inch, will result in the lever f being raised $\frac{1}{8}$ inch at the point f_1.

As the lever f cannot rise at f_2, its other end must rise and, through the rod g, turn the shaft g_1. The segment h

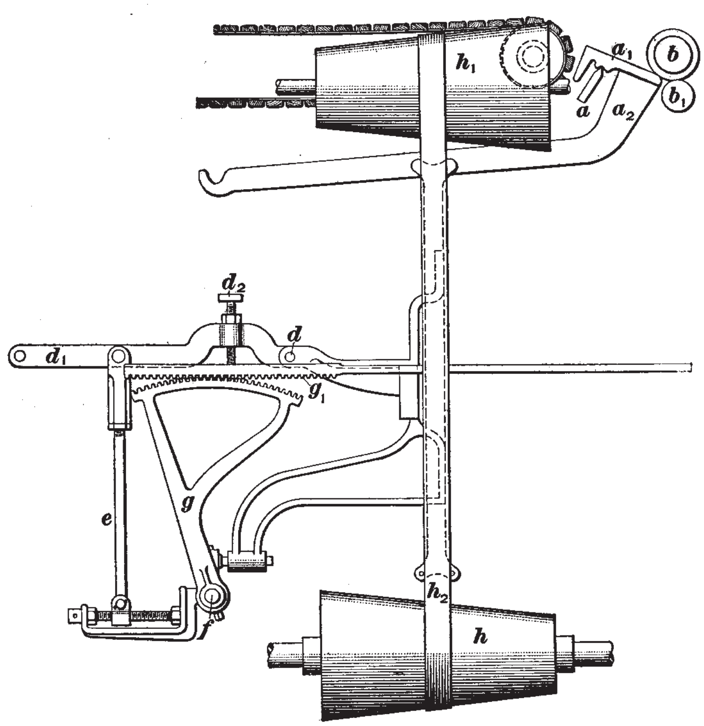


Fig. 23

will therefore be moved, and through the gears h_1, h_2 and the rack k, the belt will be guided on to the smaller part of the lower, or driving, cone, thus decreasing the speed of the feed-roll and reducing the weight of cotton fed. As soon as this heavier portion of cotton has passed and the correct weight is fed, the parts will be brought to their normal positions by means of the weight on the lever f.

In this illustration, an extreme case has been taken, as it is seldom that an extra portion of cotton 1 inch thicker than the average comes under one of the section plates; but the belt would be moved the same distance if a portion of cotton $\frac{1}{8}$ inch thicker than the average should come under all the section plates. If four of the plates are raised $\frac{1}{4}$ inch from

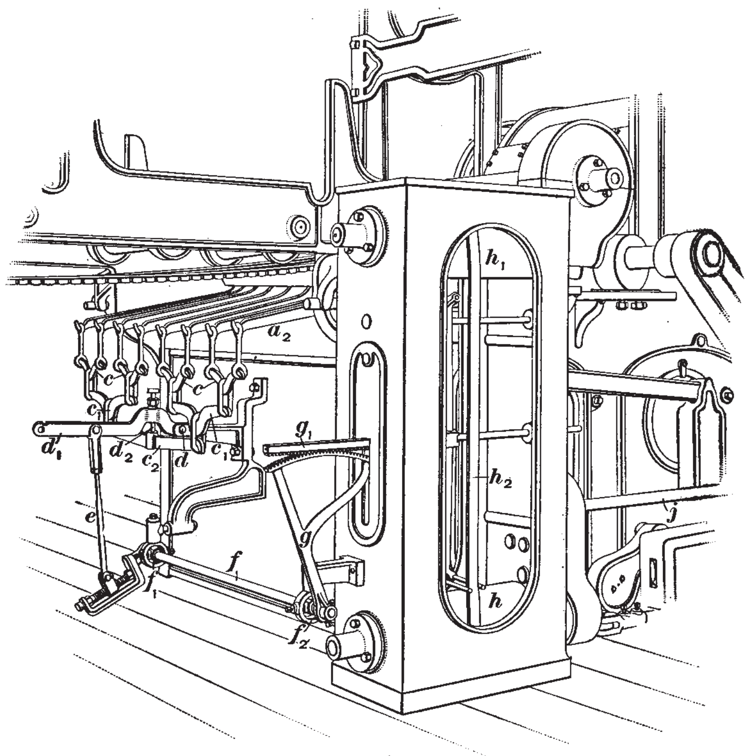


FIG. 24

their normal position, it will have the same effect as raising each plate $\frac{1}{8}$ inch. It is therefore obvious that the arrangement is designed to insure an average weight of cotton being fed regardless of the number of plates that are affected.

28. Another type of evener is shown in Figs. 23 and 24. Extending across the machine between the apron roll and

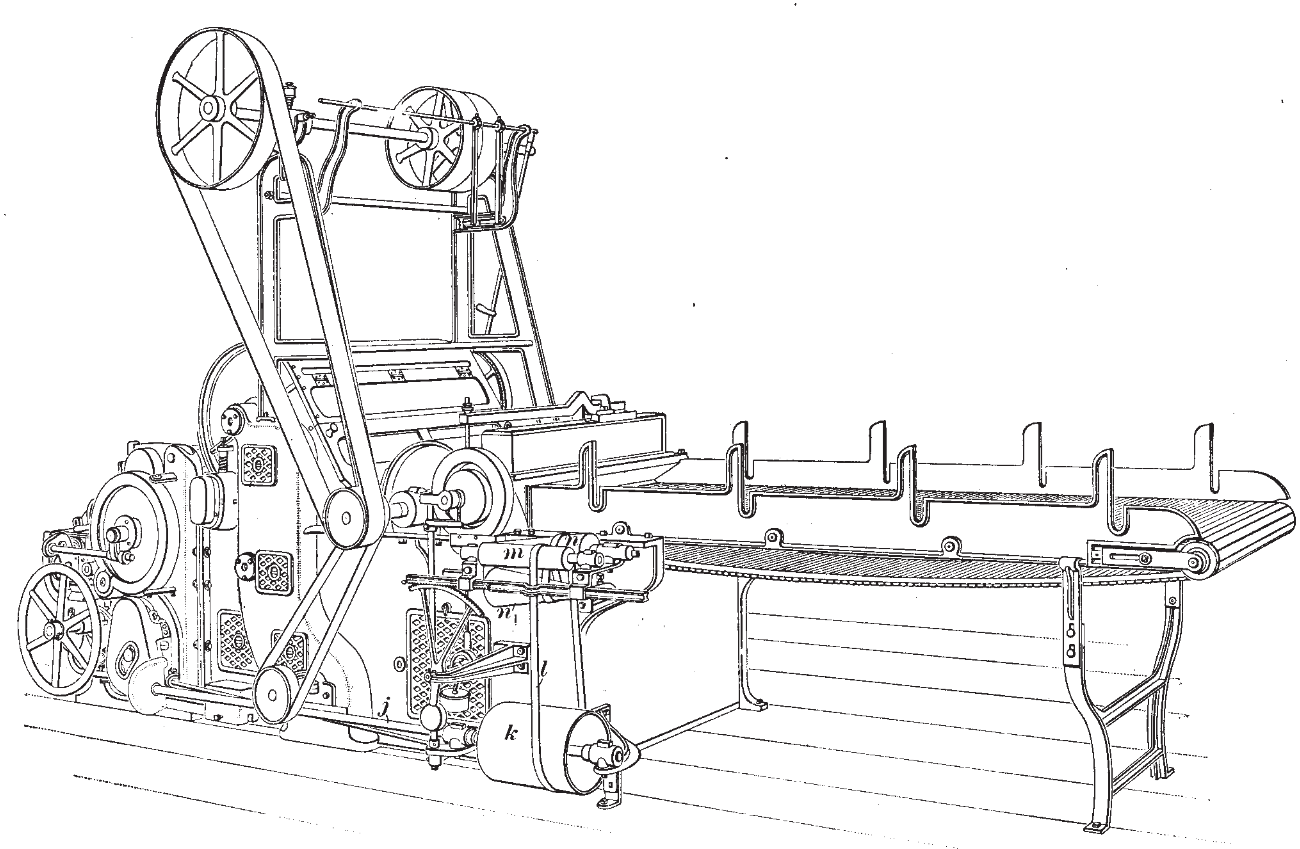


FIG. 25

the feed-rolls is a plate a, Fig. 23, that has a sharp edge on the top. Bearing on this are eight sectional plates a_1 that are in a position to be affected by the cotton just before it passes to the feed-rolls b, b_1. The lower feed-roll is smaller than the upper one, and thus the plates are allowed to lie under the upper one and so come very close to the bite of the rolls. Arms a_2 extend from these plates under the feed, or lap, apron, as shown in Figs. 23 and 24, and are connected in pairs by means of bridges c, c, which, in turn, are connected to a large bridge c_2, by means of two other bridges c_1, c_1. Fulcrumed at d is a lever d_1 that contains a screw d_2 having a bearing on the large bridge c_2. Extending from this lever d_1 is a rod e that connects with shaft f having bearings at f_1 and f_2. At the end of the shaft f nearest the bearing f_2 is attached a segment g, the teeth of which engage with a rack g_1 that governs the position of the belt h_2 on the cones h, h_1.

The bottom cone h is driven by gearing from the side shaft j, which receives motion from the lap head. The top cone h_1, driven by the bottom cone, drives the feed-rolls by means of a worm-drive; consequently, any movement of the belt on the cones will alter the speed of the feed-rolls and thus affect the weight of the cotton fed.

When the proper weight of cotton is being fed, the plates are all depressed the same distance; but, if a portion of cotton heavier than the average weight passes over a plate, this plate will be further depressed. As the plate is fulcrumed on a, this will cause the outer end of the arm a_2 to rise, which will result in the lever d_1 being raised through the connections made by the bridges c, c_1, c_2. The raising of the lever d_1 will impart motion to the shaft f by means of the connecting-rod e, which will cause the segment g to move the rack g_1 in such a manner that the belt h_2 will be moved to the small end of the driving cone. When the heavy portion of cotton has passed, the plate will be returned to its normal position by the weight of the arm a_2, together with the weight of the bridges, lever, and connecting-rod. If less than the average weight of cotton is presented to the plates, the arm a_2 and the lever d_1, together with the bridges, will fall, because of their weight, and the result will be that the belt will be moved to the larger end of the driving cone, thus increasing the speed of the feed-rolls.

29. A picker with another type of evener motion attached is shown in Fig. 25. The scale box and its connections with the segment resemble those in Fig. 20. The rolls of this evener, however, instead of being driven merely through cones, are driven by a combination of two cones, a drum, and a roll.

The manner in which this method of driving is arranged can be readily traced. A side shaft j, Fig. 25, that carries a drum k at one end receives motion from the lap head. A belt l from the drum k passes first over a roll m and then around the cones n_1, n. The feed-rolls receive their motion through a worm-drive from the top cone n.

It is possible to attach eveners to automatic feeders, although this is not commonly done, since the effect of the evener on the uniform weight of cotton is destroyed to some extent during its passage from the feeder to the breaker picker, especially if an opener is used and the cotton is conveyed from it to the breaker picker by trunking.

MEASURING MOTION

30. The **measuring motion** is used to a greater extent on intermediate and finisher pickers than on breaker pickers. Its object is, when a definite length has been wound on the lap roll, automatically to stop the feed-rolls, the smooth calender rolls, and in some cases the fluted calender rolls, while the beater shaft and fans continue to revolve.

A view of a measuring motion, the value of the gearing of which is given later in this Section, under Gearing, is shown in Fig. 26; a represents the end of the bottom calender roll, carrying a worm b, which through a worm-gear c drives a shaft c_1 carrying a bevel gear d, which drives a bevel gear e. The gear e, together with a dog f, is loose on a stud g and carries a projection e_1, the dog f also carrying a projection f_1.

The dog, if allowed to do so, would fall because of its own weight so that its point would be down, but as the gear *e* receives motion from the bottom calender roll, the projection e_1 on the gear *e* comes in contact with the projection f_1 on the dog *f* and thus continually forces the dog around ahead of it; consequently, when the projection e_1 is at its highest position, the parts mentioned occupy the position shown in Fig. 26.

As the gear *e* continues to revolve, the dog *f* will be brought in contact with a projection on a lever *h* that is

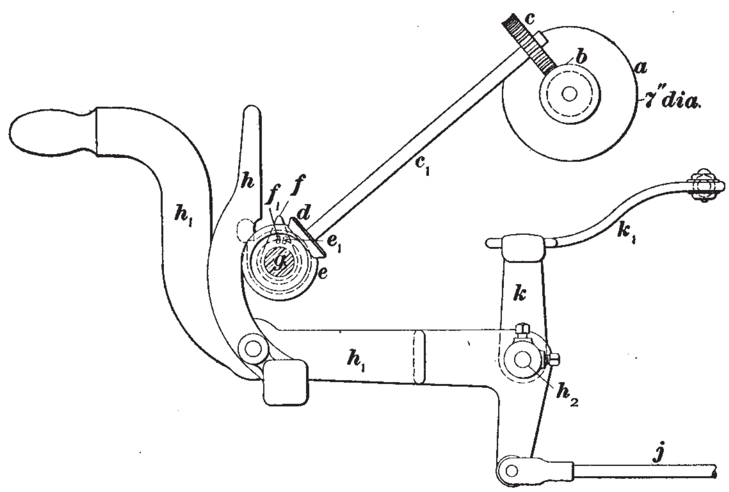


Fig. 26

connected to the starting lever h_1 fulcrumed at h_2. Connected to h_1 is a rod *j*, Figs. 22 and 26, that runs along the side of the picker and connects with a double worm *r*, Fig. 22. A bracket *k*, Fig. 26, is also attached to the rod h_2, while attached to this bracket is a rod k_1 that connects with the clutch *l*, Fig. 27, through which the lap head is driven.

31. When the picker is running, the cut-out, shown in dotted lines, in the lever *h*, Fig. 26, has a bearing on a casting, and thus the starting lever h_1 is held in such a position that the worm *r*, Fig. 22, is in contact with the worm-gear r_1, the clutch l, Fig. 27, being closed. When, however, the gear e, Fig. 26, has made one revolution and has brought the dog f into contact with the lever h, any further movement causes the dog f to force the cut-out on h from its bearing. This causes the starting lever h_1 to drop, disconnecting the clutch l; the worm r is also thrown out of gear, causing the calender rolls and the feed-rolls to stop.

In some cases, the gearing is so arranged that only the smooth calender rolls and the feed-rolls stop, while the fluted calender rolls continue to run, thereby resulting in the lap of cotton being broken away from the sheet of cotton held by the rolls that have been stopped. In other cases the fluted calender rolls stop and the lap is broken from the cotton in the machine by giving it a partial revolution with the hands.

After the lap has been thus separated, the racks described in connection with Fig. 15 are raised, the roll v withdrawn, and the lap is removed from the machine. The starting lever h_1, Fig. 26, is then raised until the cut-out rests on the casting, thereby throwing the clutch l, Fig. 27, and the worm r, Fig. 22, into gear, and starting the cotton through the machine. The lap roll is then placed in position and the layer of cotton started around it by hand, after which the foot is placed on the lever l, Fig. 15, allowing the racks to descend by their own weight and hold the lap roll in position. This operation is repeated each time the gear e makes one revolution and releases the lever h, Fig. 26.

ADJUSTMENTS

32. The distance between the blade of the beater and the feed-rolls when in closest proximity is an important point in a picker. If this distance is too great, the fringe of cotton will not receive the full benefit of the beating process, and thus the impurities will not be properly removed or the cotton separated into sufficiently fine pieces. On the other hand, if the beater blade is set too close, the fibers of the cotton will be injured.

An adjustment is therefore provided for moving the feed-rolls nearer to, or farther from, the beater. The reason for moving the feed-rolls instead of the beater is that, as the feed-rolls revolve much more slowly than the beater, they would not be injured as much if, after changing their position, their bearings were not exactly in line. The distance between the blade of the beater and the feed-rolls is dependent principally on the length of the staple being run, the diameter of the feed-rolls, and the thickness of the cotton being delivered to the beater.

The longer the staple, the smaller the diameter of the feed-rolls, and the thicker the cotton being delivered, the farther the feed-rolls should be set from the beater. With 3-inch feed-rolls, and using 1-inch American cotton, the distance between the blade of the beater and the feed-rolls should be from $\frac{3}{16}$ to $\frac{5}{16}$ inch.

33. Evener Adjusting Screw.—Near the top of the rod g, Fig. 20, is shown an **adjusting screw** g_2. Sometimes, owing to atmospheric changes and other conditions, the weight of the cotton will vary; that is, it may feed a little heavier or a little lighter one day than another. This causes the weight of the lap per yard to vary also. As the same weight of lap per yard is usually required each day, an adjustment must be provided by means of which the variation may be reduced to a minimum. If the lap is delivered too heavy or too light per yard, a change, of course, can be made in the draft change gear, but in case the variation is very slight, a change of 1 tooth in the draft gear will probably cause too great an alteration. For this reason, therefore, the adjustment is provided on the rod g and, by turning the screw g_2 up or down on this rod, the belt may be moved on the cones, thus making a very slight change in the speed of the feed-rolls. All evener motions are provided with somewhat similar adjustments.

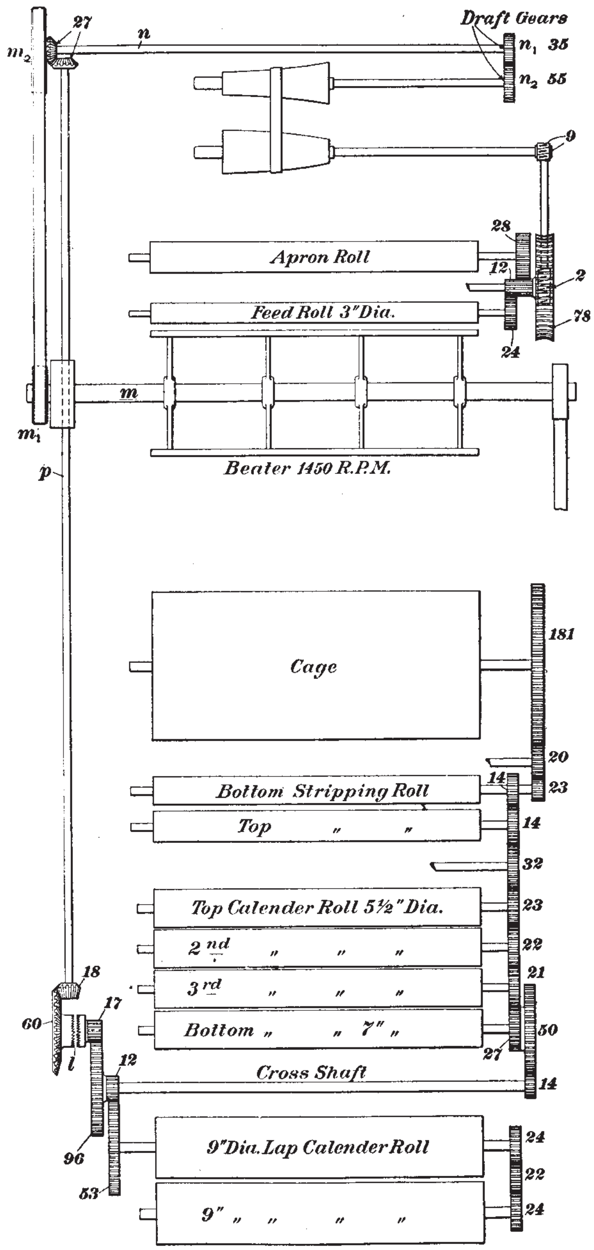

Draft Gears
27
n
m_2
n_1 35
n_2 55
9
28
Apron Roll
12
2
Feed Roll 3" Dia.
78
24
m
m_1
p
Beater 1450 R.P.M.
181
Cage
20
14
23
Bottom Stripping Roll
Top " "
14
32
Top Calender Roll 5½" Dia.
23
2nd " " "
22
3rd " " "
21
18
17
60
Bottom " " 7" "
50
27
l
12
Cross Shaft
14
96
53
9" Dia. Lap Calender Roll
24
22
9" " " " "
24

Fig. 27

GEARING

34. The gearing of a picker equipped with the evener motion illustrated in Fig. 20 is shown in Fig. 27. The beater shaft *m* is driven from a countershaft, as explained in connection with the breaker picker, and carries the usual pulleys for driving the fan and feed-rolls.

The feed-pulley m_1 drives a pulley m_2 on a shaft *n* extending across the picker. From this shaft, the cones and the feed-rolls, together with the feed-apron, are driven. As the feed-apron is driven through the cones, its speed will always be in accordance with that of the feed-rolls. The lap head, cages, and stripping rolls are driven through a side shaft *p*, which receives its motion from the shaft *n*. The driving plan of the picker shown in Fig. 25 is given in Fig. 28.

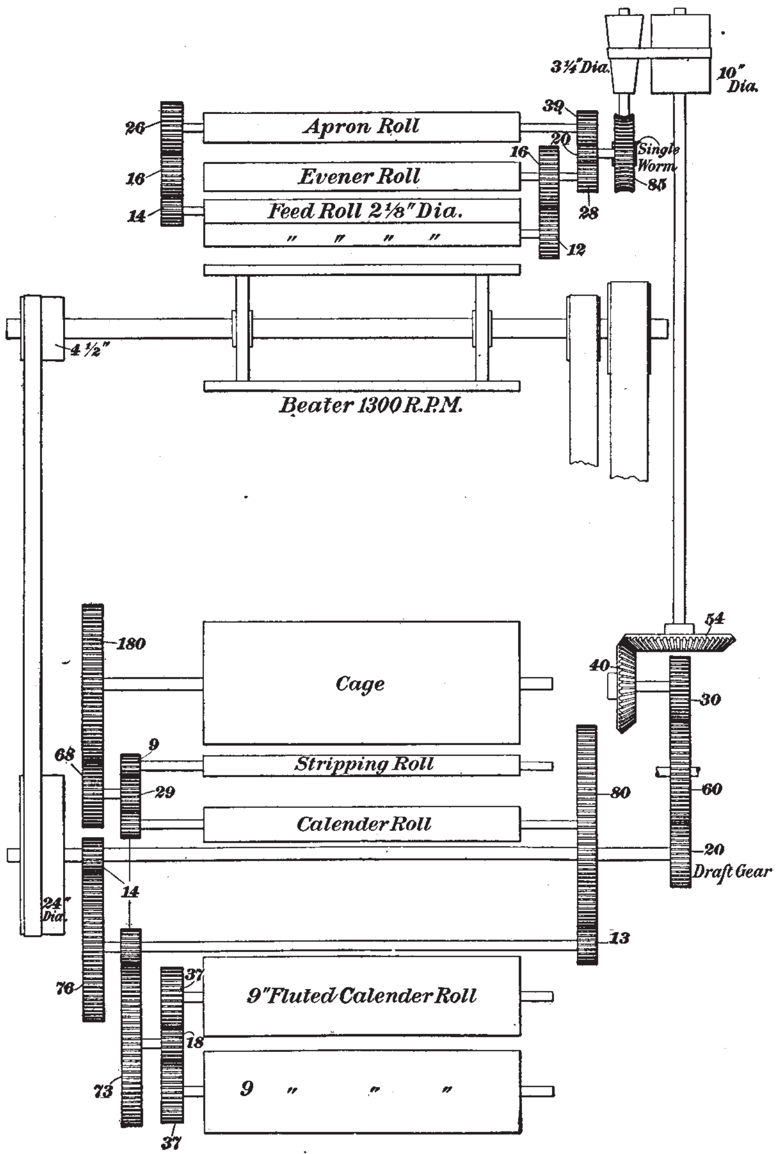
The measuring motion is provided with **change gears**, by means of which different lengths of laps can be procured. When finding the length of lap, the number of revolutions made by the bottom calender roll while the knock-off gear is revolving once should first be determined; this result multiplied by the circumference of the roll will give the length of lap. Referring to Fig. 26, the bottom calender roll *a* is 7 inches in diameter, *b* is a single worm, and the worm-gear *c* is the change gear; the gear *d* has 21 teeth, while the knock-off gear *e* contains 30 teeth.

The length of lap delivered when using a 45-tooth change gear is as follows: $\frac{30 \times 45}{21 \times 1} = 64.285$ revolutions of roll to one revolution of gear *e*. $64.285 \times 7 \times 3.1416 = 1{,}413.704$ inches. $1{,}413.704$ inches $\div 36 = 39.269$ yards, length of lap.

This example could also be expressed as follows:

$$\frac{30 \times 45 \times 7 \times 3.1416}{21 \times 1 \times 36} = 39.26 \text{ yards}$$

A constant for the measuring motion may be obtained by omitting the change gear or considering it a 1-tooth gear. This constant, multiplied by the number of teeth in any change gear, will give the length of lap delivered when using that gear, and consequently the gear for producing a certain



3¼" Dia.
10" Dia.
39
20
Single Worm
85
28
26
Apron Roll
16
Evener Roll
16
14
Feed Roll 2⅛" Dia.
" " " "
12
4½"
Beater 1300 R.P.M.
54
40
30
180
Cage
9
68
Stripping Roll
29
80
60
Calender Roll
20
Draft Gear
14
24" Dia.
13
76
37
9" Fluted Calender Roll
18
73
9 " " "
37

Fig. 28

length may be found by dividing the length of lap required by the constant. The constant is obtained as follows:

$$\frac{30 \times (1) \times 7 \times 3.1416}{21 \times 1 \times 36} = .8726, \text{ constant}$$

35. Draft of Intermediate and Finisher Pickers. The draft change gears are shown on both plans, Figs. 27 and 28. In the machine shown in Fig. 27, there are two change gears n_1, n_2 so that if the proper draft cannot be obtained by changing one gear, the other may be changed. The draft of an intermediate picker is usually about 4.25 and that of a finisher picker about 4.50, when there are 4 laps up at the back.

The total draft of the machine shown in Fig. 27, with a gear of 55 teeth on the lower-cone shaft meshing with a gear of 35 teeth, and with the belt in the center of the cones, is as follows:

$$\frac{9 \times 24 \times 12 \times 17 \times 18 \times 27 \times 55 \times 9 \times 78 \times 24}{24 \times 53 \times 96 \times 60 \times 27 \times 35 \times 9 \times 2 \times 12 \times 3} = 4.422, \text{ draft}$$

The total draft of the machine shown in Fig. 28, with a 20-draft gear and the belt in the center of the cones, is as follows:

$$\frac{9 \times 18 \times 14 \times 14 \times 30 \times 54 \times 3.25 \times 85 \times 28 \times 12}{37 \times 73 \times 76 \times 20 \times 40 \times 10 \times 1 \times 20 \times 16 \times 2\frac{1}{8}} = 4.275,$$
draft

CARE OF PICKERS

36. Regulation of Air-Current.—The air-current that draws the cotton to the cages should be regulated to draw the cotton to them in such proportions that the upper cage will receive an amount slightly in excess of that which the bottom one receives, since, if the stock is drawn to the cages in equal amounts, the sheet delivered at the front of the picker will be formed of two layers of practically the same thickness, and when run through the next machine, will be liable to split. Pickers are constructed with dampers in the flue so that the required adjustments may be made. The making of a good lap is an important point. It should be perfectly cylindrical when removed from the machine, and should feel as firm at one point as at another. It should be built so that the layers will unroll easily at the next process without sticking together. This defect, which is known as **splitting,** or **licking,** is due to various causes; such as excessive fan speed, improper division of the air-currents, oil dropping on the cotton, etc.

If the air-current is stronger on one side than on the other, the side having the weaker current is usually soft. The velocity of the air-current is also responsible for the amount of waste removed. If the air-current is too strong, it prevents good cotton from being struck through the bars, but at the same time prevents all the dirt from being removed, since the current is strong enough to carry it forwards. On the other hand, if the current is so weak that the dirt drops readily, good cotton may also drop with it, causing excessive waste. A medium air-current must therefore be found that will allow the removal of the greatest amount of dirt with the least amount of cotton. The setting of the grid bars also aids in this, and the matter of keeping all the parts clean cannot receive too much attention. In some cases it is found necessary, in order to avoid an excessive amount of air entering through the grid bars and preventing the removal of the dirt, to admit air through the ends of the beater cover or through the casing that extends over the passage between the beater and the cages.

The laps delivered should be as near a uniform weight as possible. Each lap from the finisher picker is usually weighed, and a variation of $\frac{1}{2}$ pound in either direction is allowed; that is, if laps weighing 35 pounds are delivered when they are the correct weight per yard, any laps weighing between $34\frac{1}{2}$ and $35\frac{1}{2}$ pounds are allowed to pass. Laps weighing outside this range should be put back and run over again, and if too many of these laps are uniformly heavy or light, the regulating screw on the evener should be adjusted.

37. Causes of Uneven Laps.—When laps are found to be weighing unevenly, the fault may be at several places. The feeder may be feeding unevenly; the evener, either on the intermediate or finisher lapper, may be out of order, possibly through not being cleaned and oiled properly or through using a stiff evener driving belt. This should be perfectly pliable and have good piecings. Cotton may also remain in the trunks or over the inclined cleaning bars because these are not kept clean.

Another cause for uneven laps is often found in the position of the cone belt on the cones of the evener motion. If, when the proper amount of cotton is passing through the picker, the cone belt is running at one end of the cones, it will not allow the belt to be shifted far enough toward the nearest end of the cones to correct any considerable variation requiring a movement of the belt in that direction. The different parts of the evener motion should be so adjusted that the belt will run at the center of the cones when the correct amount of cotton is passing through the machine. This will give the cone belt one-half of the cones to work on for regulating either light or heavy laps.

Below is given a table showing for what numbers of yarn certain weights of lap are generally used:

Numbers of Yarn	Weight of Lap per Yard From Finisher Picker Ounces
1s to 10s	14.0
10s to 20s	13.5
20s to 30s	13.0
30s to 40s	12.0
40s to 50s	11.5
50s to 60s	11.0
60s to 70s	11.0
70s to 80s	11.0
80s to 90s	10.0
90s to 100s	10.0
100s to 120s	9.5
120s to 150s	9.0

A good production for an intermediate or finisher picker is about 12,500 pounds per week, allowing from 6 to 10 hours for stoppages. A finisher picker for making 40-inch laps occupies a floor space of about 16 feet by 6 feet $8\frac{1}{2}$ inches and requires about 4 horsepower to drive it.

38. Cleaning and Oiling.—Pickers should be kept well cleaned and oiled. All oil holes, wherever possible, should be covered in order to keep grit and sand from the bearings. In oiling, care should be taken not to allow the oil to get on the inside of the casings where the cotton passes. The beater, grid bars, inclined cleaning bars, and cages should be picked clean of cotton daily and kept free from dirt and oil. All air passages and pipes from fans should be kept clean, but the covers of the doors of these air passages or pipes should not be removed while the machine is running.

COTTON CARDS

(PART 1)

INTRODUCTION

1. The lap of cotton as it leaves the picker consists of cotton fibers crossed in all directions, together with a small amount of foreign matter, consisting more especially of lighter impurities such as pieces of leaf, seed, or stalk, and thin membranes from the cotton boll. Such material is of too light a nature to be removed by the action of the beaters or to drop through between the grid or inclined cleaning bars of the pickers, so that it is carried forwards with the cotton and into the lap. In order to remove this foreign matter, machinery of an entirely different character from the cleaning machinery previously used must be adopted, and for this purpose the **cotton card** is employed, the process being known as **carding.** Carding is regarded by many manufacturers as one of the most important processes in cotton-yarn preparation. In addition to cleaning the cotton, it is also the first step in the series of attenuating processes, which gradually reduce the weight of cotton per unit of length sufficiently to form a thread. The lap from the picker is comparatively heavy, and must be reduced considerably in weight at various machines in order to give the weight per unit of length required in the yarn. The carding process is the one that follows the picking operations in all cotton mills, whether coarse or fine, and whether making carded or combed yarns.

2. Objects of Carding.—The objects of carding are: (1) The disentangling of the cotton fibers, or the separation of the bunches, or tufts, of fiber into *individual fibers, and the* commencement of their parallelization; (2) the removal of the smaller and lighter impurities; (3) changing the formation of cotton from a lap to a *sliver*, accompanied by the reduction of the weight per yard of the material. A **sliver** is a round, loose strand of cotton without, or almost without, twist, and usually from 40 to 80 grains per yard in weight. It is generally coiled in a can, and is made at the carding, drawing, and combing processes.

3. Principles of Carding.—In order to arrive at the previously mentioned objects, the principle of combing the fibers between sets of closely arranged wire teeth is adopted; one set may be fixed and the other moving, or each set may be moving in the opposite direction to the other, or both may be moving in the same direction but at different speeds. In any case, the sets of wire teeth are in close proximity to one another. The first and second objects—the disentangling of the cotton fibers and the removal of the impurities—are attained by this means, as the fibers forming the small tufts are drawn apart and the lighter impurities are caught between the wires, where they remain until removed by special means. Use is also made of the centrifugal force of a cylinder covered with wire teeth and revolving at a high speed in attaining the first and second objects of carding; the ends of the fibers are thrown against stationary or moving points of wire and the fibers thus combed out, while heavier impurities such as sand, dirt, and dust are thrown out, owing to the high speed of the cylinder. Another method of arriving at the second object is that of arranging knives or bars partly around the revolving portions of the card, to clean and throw off the dirt, sand, and dust from the fibers as they are drawn past such obstructions. The third object is attained by adopting the principle of drafting, the attenuation of the material being produced by revolving cylinders covered with wire teeth, instead of by the usual method of rolls, which are used in this machine only at the feed and delivery.

Carding is really a combing or brushing action, the fibers being operated on by a series of wire teeth, which has the same effect as loosely holding a few fibers at a time and striking them with a comb; the process, however, must not be confused with that technically known as *combing*, which is an entirely separate process and used only in the manufacture of fine yarns. The machine employed in carding is usually spoken of as a *card*, or sometimes as a *carding engine;* this latter name, however, is used more commonly in England than in the United States.

CARD CONSTRUCTION

THE REVOLVING-TOP FLAT CARD

PRINCIPAL PARTS

4. The **card** that is most commonly used and now almost universally adopted for new cotton mills is known as the **revolving-top flat card,** sometimes spoken of as the *revolving flat card*, or the *English card*. Views of it are shown in Figs. 1 and 2, Fig. 1 showing one side of the card, with the machine in condition for operation, while Fig. 2 shows the other side as it is seen when stopped and without any stock passing through. A section through the same card from back to front is shown in Fig. 3. The various parts of the card are lettered the same in all three figures, and reference letters should be referred to on Fig. 3 especially; but it is also advisable to refer to Figs. 1 and 2 for the same parts, in order to identify them and ascertain their relations to one another. The same letters are used in other figures throughout this Section in accordance with the following list. All parts of a single motion or section of the card are designated by the same letter, which in some instances is followed by a figure, known as the *subscript*, to distinguish the particular part for which it is used from related parts having the same reference letter.

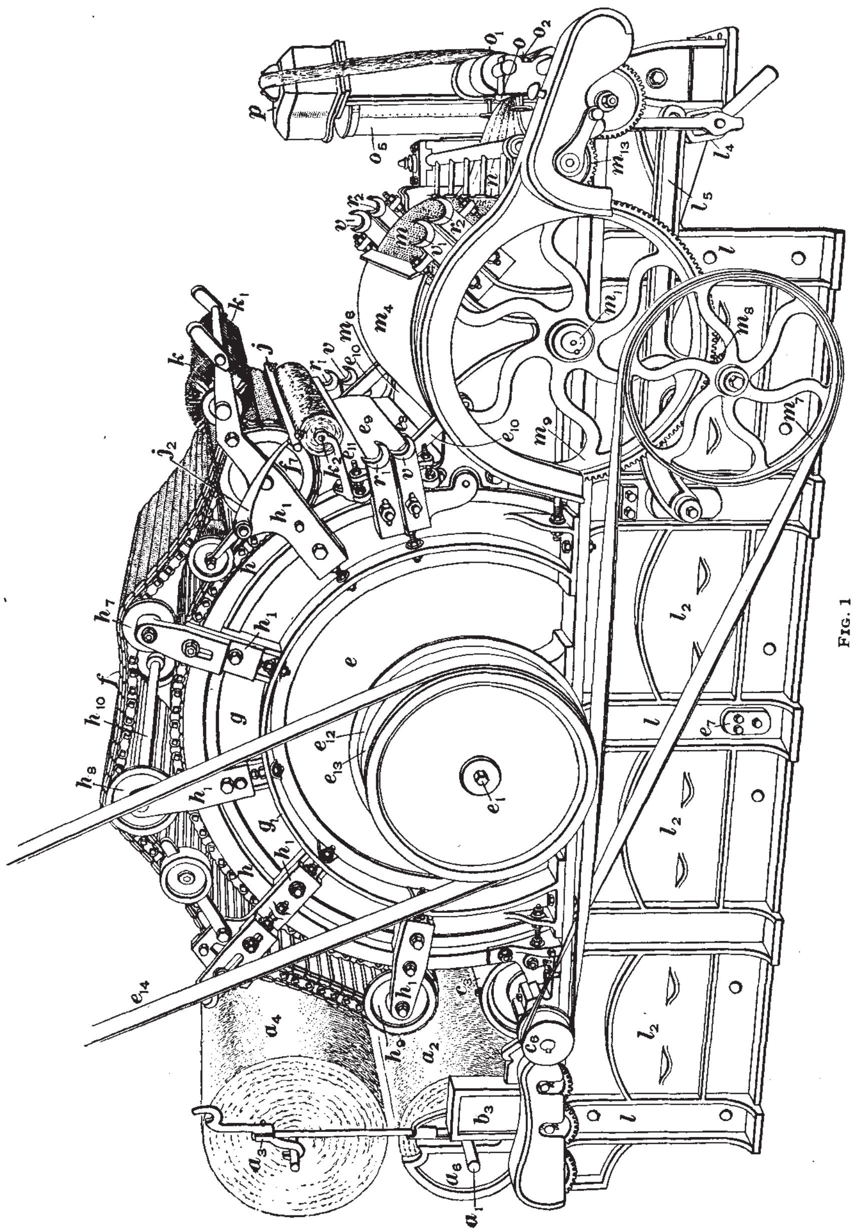


FIG. 1

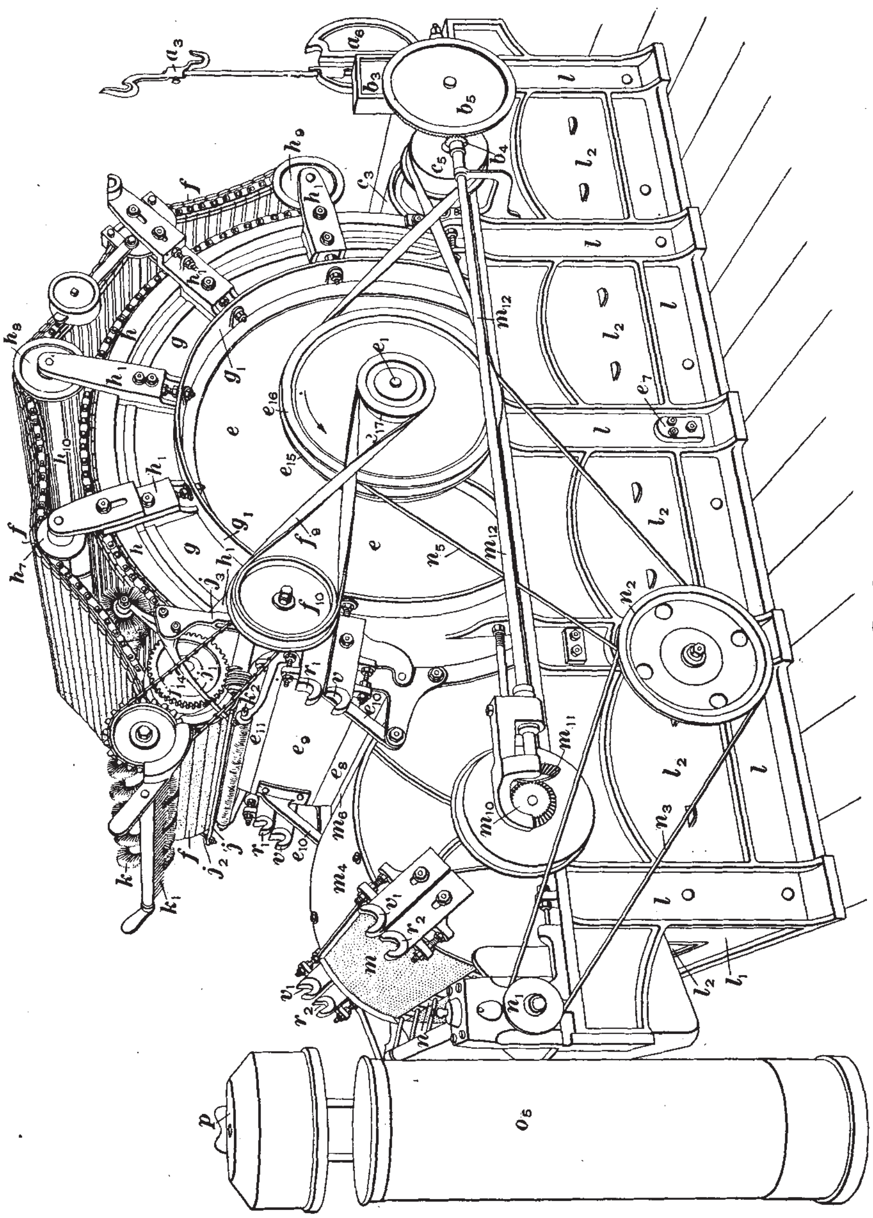
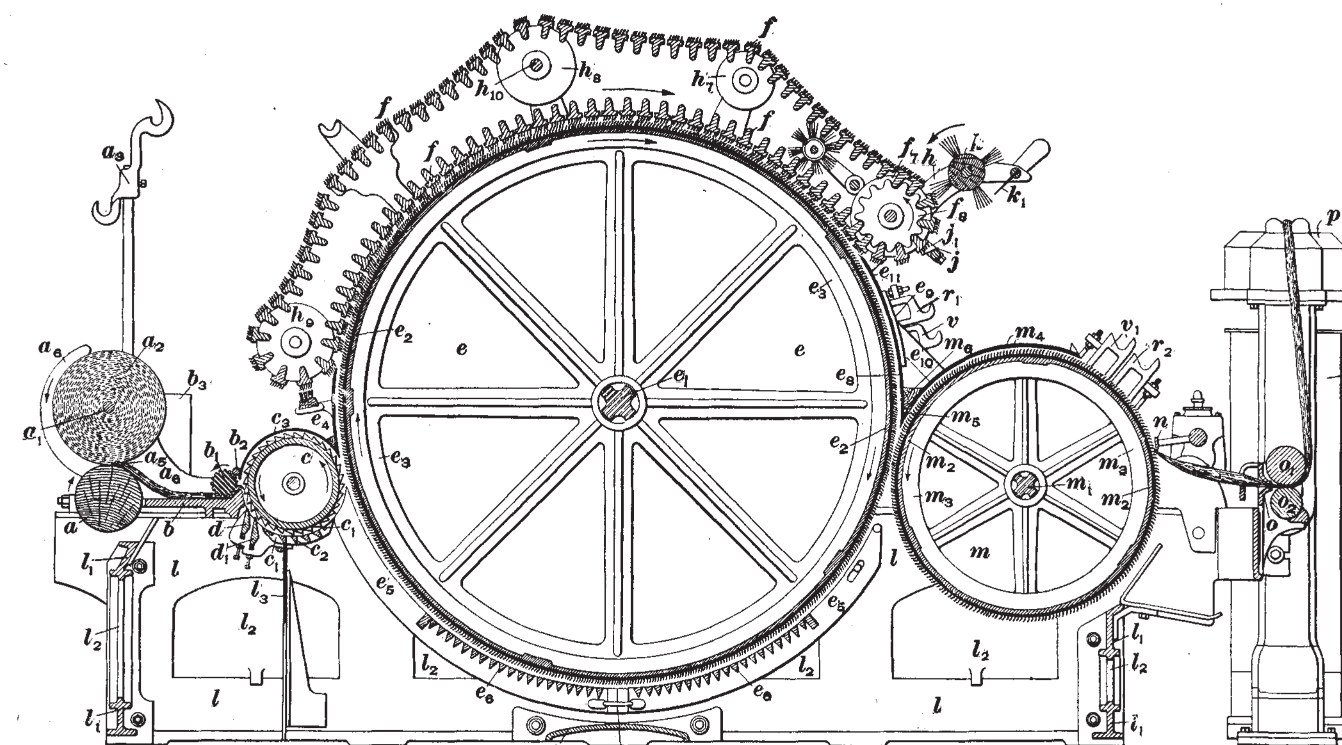


Fig. 2



a
a_1
a_2
a_3
a_5
a_6
b
b_1
b_2
b_3
c
c_1
c_2
c_3
d
d_1
e
e_1
e_2
e_3
e_4
e_5
e_6
e_7
e_8
e_9
e_{10}
e_{11}
f
f_7
f_8
h
h_7
h_8
h_9
h_{10}
j
j_1
k_1
l
l_1
l_2
l_3
m
m_1
m_2
m_3
m_4
m_5
m_6
n
o
o_1
o_2
o_5
p
r_1
r_2
v
v_1

FIG. 3

5. The principal parts of the machine are as follows:

a, Lap roll.
a_2, Lap that is being carded.
a_4, Spare lap.
a_6, Lap plates.
b, Feed-plate.
b_1, Feed-roll.
b_3, Weights for feed-roll.
c, Licker.
c_1, Licker screen.
d, d_1, Mote knives.
e, Cylinder.
e_4, Back knife plate.
e_5, Cylinder screen.
e_8, Lower front plate.
e_9, Door at front of cylinder.
e_{11}, Front knife plate.
e_{12}, Tight pulley on cylinder.
e_{13}, Loose pulley on cylinder.
f, Flats.
g, Arches of card.
h, Flexible bend on which a portion of the flats rests.
h_7, h_8, h_9, Pulleys for supporting flats.
j, Flat-stripping comb.
k, Flat-stripping brush.
k_1, Hackle comb for cleaning flat stripping brush.
l, Card sides.
l_1, Cross-girts.
l_2, Doors in frame of card.
m, Doffer.
m_4, Doffer bonnet.
m_8, Barrow gear.
m_{12}, Side shaft.
n, Doffer comb.
o, Trumpet.
o_1, Top calender roll.
o_2, Bottom calender roll.
o_5, Can in which sliver is coiled.
p, Cover of coiler.
p_1, Coiler calender rolls.

Figs. 4 and 5 show a revolving flat card of another style of construction, but all essential parts are the same and are lettered as in Figs. 1, 2, and 3.

6. Feed-Roll and Feed-Plate.—At the back of the card in Fig. 1 is shown the lap a_2, which has a rod a_1 passed through its center and rests on the lap roll a, shown in Fig. 3. The lap a_2 is the one being carded, a spare lap a_4 being shown above it in Fig. 1, resting in a stand a_3. The lap roll a is constructed of wood and is either fluted or has a rough surface, sometimes produced by covering it with a coat of paint mixed with sand, in order to cause the lap to unroll by friction with the lap roll and without any slippage.

The cotton is drawn over the feed-plate b, Fig. 3, by the feed-roll b_1, the single layer, or sheet, leaving the lap at the

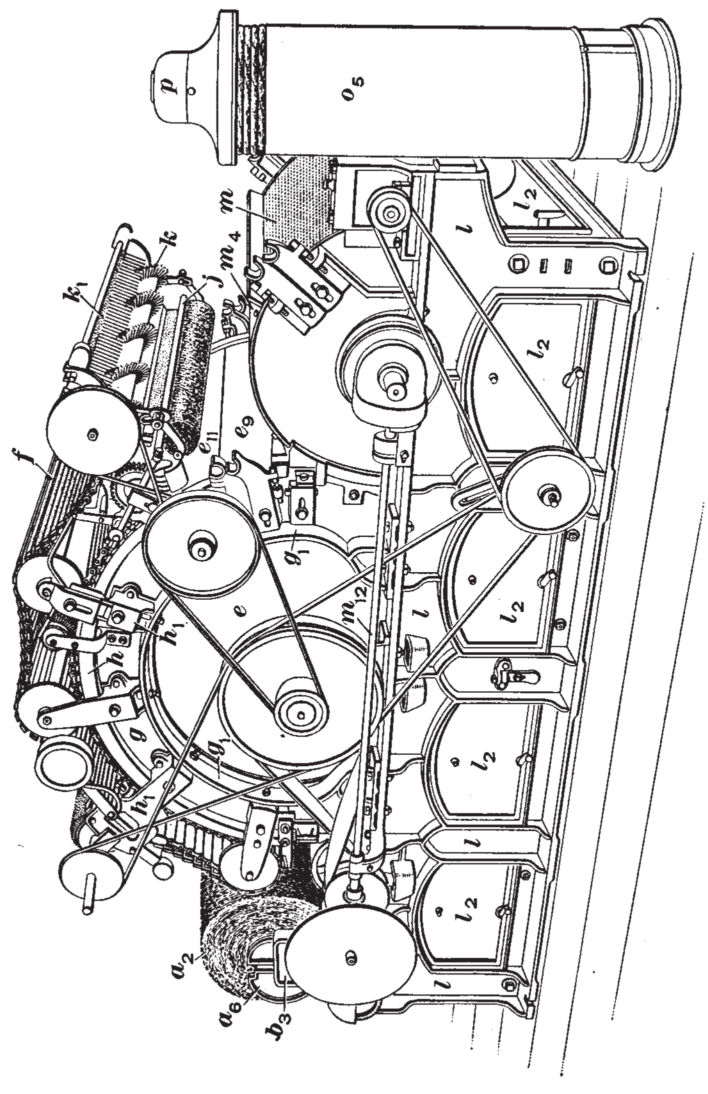


Fig. 4

point a_5. As it passes from the lap to the feed-roll, each outer edge of the sheet comes in contact with a lap guide—a wedge-shaped piece of metal bolted on the inside of the

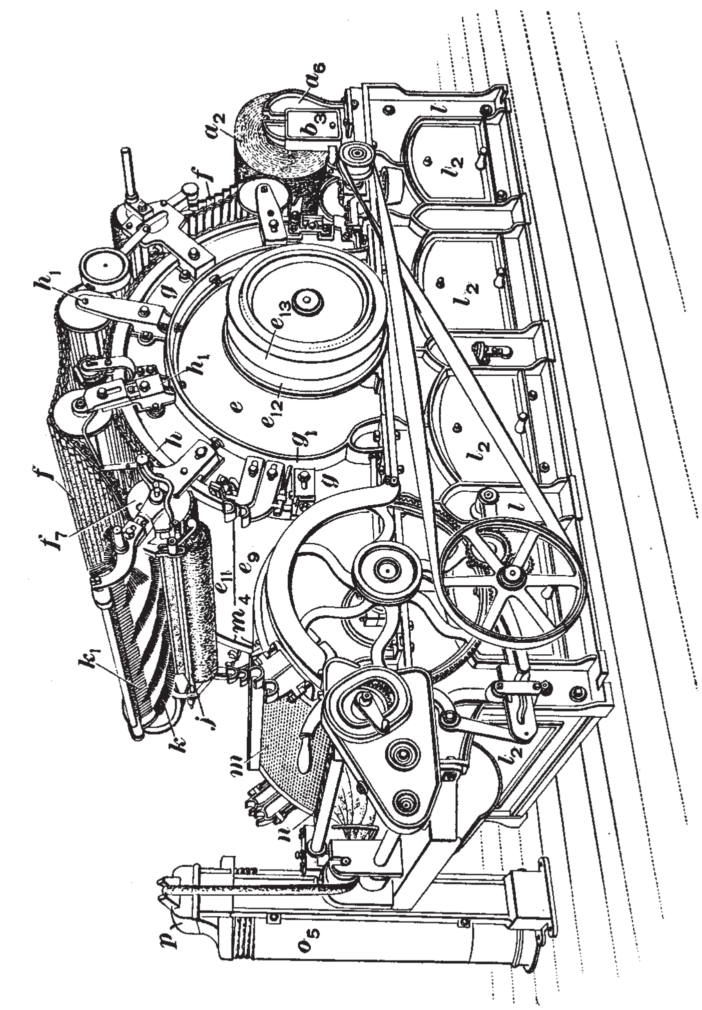


FIG. 5

plate a_6. This guide turns up the edges of the sheet to a small extent, making it slightly narrower as it approaches the feed-roll. This tends to prevent the outer edge of the cotton from spreading and producing a ragged edge. The feed-plate b extends under the feed-roll b_1, with its nose projecting upwards in front of the feed-roll almost to the teeth shown on the circumference of the licker c. The feed-roll b_1, which revolves in the direction indicated by the arrow, is fluted longitudinally and is sufficiently large in diameter to resist any tendency to spring or bend when a thick piece of cotton passes beneath it. Its ends rest in slides and it is weighted at each end by means of a weight b_3, Figs. 1 and 2, on a lever that has, as a fulcrum, a lug on the feed-plate. The lever has a bearing on a bushing on the feed-roll and thus produces the pressure of the feed-roll on the sheet of cotton on the feed-plate, the extent of which may be regulated by moving the weight b_3 along the lever. If the pressure is too light, the action of the licker will pull the cotton from the feed-roll before it should be delivered. This is known as *plucking*, and results in cotton being taken by the licker in large and tangled flakes that have not been opened, thus causing uneven work and requiring the finer parts of the card to perform the heavy work, which should be done by the licker.

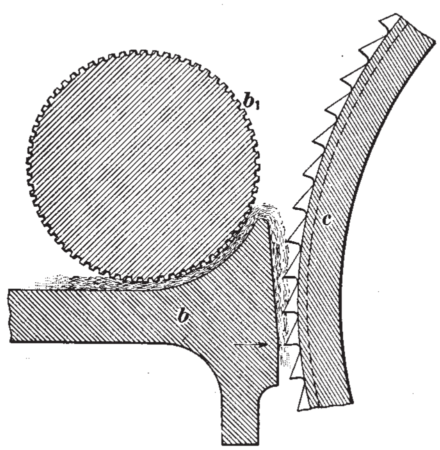


Fig. 6

Above the feed-roll rests a small iron rod b_2 that is revolved by frictional contact with this roll and, since it is covered with flannel, collects any fiber or dirt that may be carried upwards over the surface of the feed-roll and thus acts as a clearer. It also serves to prevent any air-current from passing between the feed-roll and the licker cover.

The lap roll a is positively geared with the feed-roll b_1 in such a manner that the feed-roll takes up exactly the amount of cotton delivered by the lap roll, without any strain or sagging, and as it revolves, carries this cotton over the nose of the feed-plate so that a fringe is brought under the action of the licker *c* in the manner shown in Fig. 3, and on a larger scale in Figs. 6, 7, 8, and 12. The upper end of the nose of the feed-plate is rounded so as not to damage the cotton resting on it and pressed against it by the action of the licker.

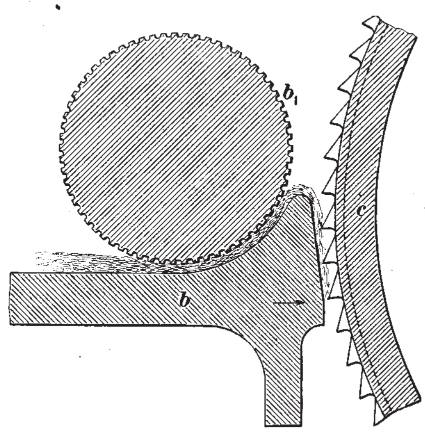


Fig. 7

7. The important difference in various feed-plates is in the distance from the bite of the feed-roll to the lower end of the face, indicated by the arrow in Figs. 6, 7, and 8. By regulating this distance in accordance with the length of staple being worked, the entire length of staple is so supported that it receives the full benefit of the cleaning and disentangling action of the licker, which reduces the work on the finer parts of the card. The distance between the bite of the feed-roll and the lower edge of the face of the feed-plate should be from $\frac{1}{16}$ to $\frac{1}{8}$ inch longer than the average length of the cotton being worked, as it is necessary that the fibers should be free from the bite of the feed-roll before the action of the teeth of the licker exerts its greatest pull, which

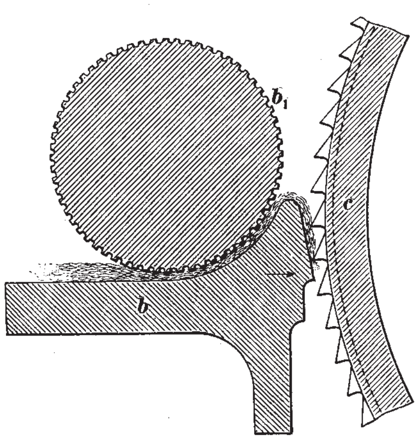


Fig. 8

is at the lower edge of the plate; otherwise, the fibers would be broken. The fringe of cotton is shown in Fig. 9. The feed-plate shown in Fig. 6 is suitable for sea-island cotton, as it has a face that makes it possible for the long fibers to hang down; the feed-plate shown in Fig. 7 is the style commonly used in America, being adapted for the various grades of American and Egyptian cottons. A feed-plate with a shorter face, as shown in Fig. 8, is sometimes made for very short-stapled cottons, such as those grown in India and China.

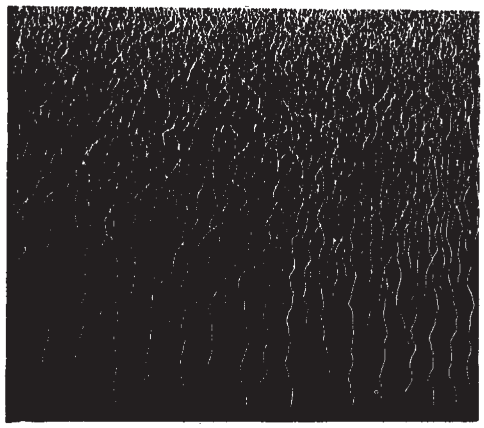


Fig. 9

8. Two-Roll Method of Feeding.—Some cards, instead of having the feed-roll and feed-plate, are constructed so as to feed the licker by means of two feed-rolls, as shown in Fig. 10. This is an older form of feeding and is not so desirable. The disadvantage of this method is that a fourth of the diameter of the lower feed-roll is covered with loose cotton before it reaches the point where it comes under the action of the teeth of the licker, thus tending to increase the possibility

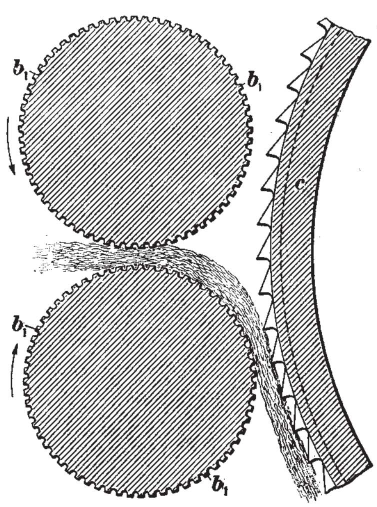


Fig. 10

of the licker plucking large tufts of cotton before the cotton ought to be delivered. This system is also inferior on account of the brief opportunity given for the licker to operate on the fringe of cotton, as compared with the roll and feed-plate system, where a long fringe of cotton is presented to the licker, thus giving a much better opportunity for combing and removing the dirt. In fact, the combed fringe of cotton in a card using the feed-plate can be arranged to be about three times the length of that in a card using the two-roll method of feeding.

9. Licker.—The object of either of these feeds is to feed a regular supply of cotton to the licker *c*, shown in

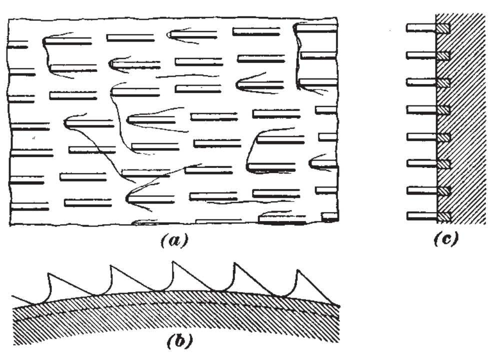


FIG. 11

Fig. 3, sometimes called the *leader*, *taker-in*, or *licker-in*. The **licker** consists of a hollow metal roll about 9 inches in diameter. On the outside of the shell, or curved part, of the roll, and extending from one end to the other, are spiral grooves into which rows of teeth are inserted. Fig. 11 (*a*) is a view of the teeth of the licker as they appear when looked at from above, and also shows the fibers being carried by them from the feed-roll, thus indicating the manner in which the lap of cotton is separated almost into individual fibers by the operation of the licker, which revolves so rapidly, compared with the amount of cotton delivered, that about 2,000,000 teeth pass the nose of the feed-plate while 1 inch of cotton is being delivered. It will be seen from Fig. 11 (*a*) that the teeth are scattered, or *staggered*, over the shell of the roll in consequence of the spiral arrangement, and thus one tooth does not strike the fringe of cotton exactly where the previous one struck.

Fig. 11 (*c*) is a section of a portion of a licker showing the construction of the wire from which the teeth are formed, and also the method of fastening it securely in the roll. The teeth are punched out of a narrow, flat, strip of steel, or wire, carrying a thickened rib along one edge. This rib is forced into the grooves prepared in the shell of the licker, and the teeth project, as shown in Fig. 11 (*b*), the dotted line indicating the depth to which the rib is sunk into the shell of the licker. Several separate spirals are laid side by side, the distance between two rounds of any one spiral being 1 inch, and there are either five, six, seven, eight, nine, or ten spirals side by side, according to the class of work for which the card is intended. This results in the distance between the centers of two consecutive spirals being either $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$, or $\frac{1}{10}$ inch apart, while the points of the teeth are usually $\frac{1}{4}$ inch apart lengthwise of the wire.

The shell of the licker *c* is shown in section in Figs. 3 and 12, which also show the relative position of the licker to the contiguous portions of the card. Below the feed-roll b_1, clearer b_2, and feed-plate *b* are seen the sections of two knives d, d_1, which are known as **mote knives.** These knives extend across the card in the position shown, with the blade of the knife near the teeth of the licker; their object is to remove such impurities as hulls, husks, bearded motes, etc., or in other words, all portions of matter other than cotton.

At the nose of the feed-plate, the licker is moving in a downward direction and the teeth are pointing in the direction of its revolution. Since the fringe of cotton is held by the roll, it will be disentangled as the teeth pass through it. When the cotton is released from the bite of the feed-roll, it will be taken by the teeth of the licker. Any short fibers, however, that are not sufficiently long to be secured by the licker, will fall through the space between the mote knives.

The cotton that drops in this manner is known as **fly,** and its loss is beneficial since it leaves the cotton that passes forwards in a more uniform condition as regards its length of staple. The licker has a surface speed of about 1,000 feet per minute, and thus, as it revolves with the cotton, the portions of the fibers that are not in contact with the teeth will be thrown out by centrifugal force, so that the impurities that project from the fibers on the surface of the licker will

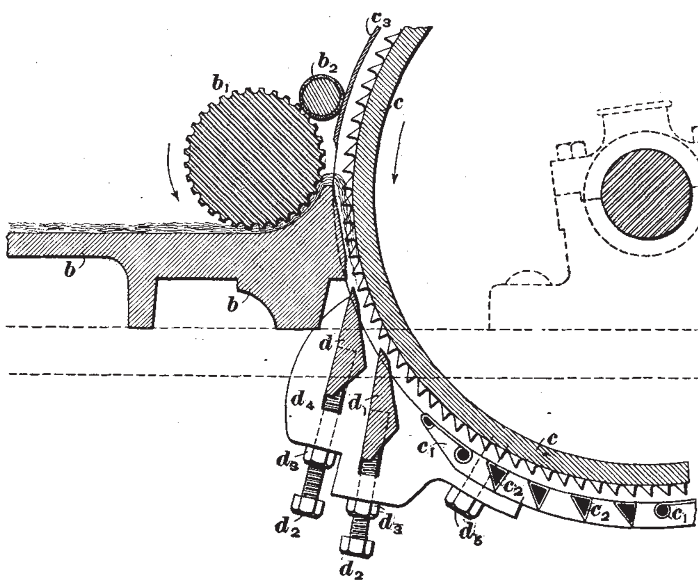


Fig. 12

come in contact with the blades of the mote knives and be removed, dropping into the cavity below the knives.

In the usual construction of cards there are two of these mote knives, although one may be used. The knives are rigidly held in suitable supports, and in the style under consideration their correct angle is decided by the machine builder, the arrangement being such that this angle cannot be changed. They are sometimes, however, made adjustable, either by being placed in a swinging frame or, as in Fig. 12, by being provided with setscrews d_2 and locknuts d_3, by means of which either knife may be moved closer to or farther from the licker and then locked in position; or the entire bracket d_4 that carries both knives, may be moved farther from or closer to the feed-plate by loosening the screw d_5, sliding the entire bracket d_4 on the frame of the licker screen, and then relocking it.

10. Licker Screen and Licker Cover.—Underneath the licker is a casing c_1 known as the **licker screen.** This casing, which is shown in Figs. 3 and 12, is made of tin and extends across the card. The portion of the screen directly under the licker is composed of tranverse bars c_2, triangular in shape with rounded corners and set with their bases inverted, the remainder of the screen being plain metal. As the licker revolves, whatever heavy impurities were not previously taken out will be thrown through the openings in the screen, due to the action of centrifugal force. The cotton will also come in contact with the screen as it did with the mote knives, and thus additional impurities will be removed.

The top of the licker is protected by a metal cover c_3 known as the **licker cover,** or **bonnet,** which is curved to correspond to the curved surface of the licker. This cover is held in position by two disks, one at each end, through which the shaft of the licker projects. These disks are held in position by flanges attached to them, which rest in the licker bearings attached to the framework of the card. The licker cover is screwed to these disks, and thus the licker is completely enclosed. The points where the shaft passes through the disks should be kept clean and well oiled; otherwise, the points of contact will become heated and tend to bind the shaft.

11. Card Cylinders.—Situated about midway between the back and front of the card, and a prominent feature in its construction, is the cylinder e, mounted on the shaft e_1. This cylinder is usually 50 inches in diameter, while its width depends on the width of the card, being usually 36, 40, or 45 inches. Formerly card cylinders were made of wood, but it is now the universal practice to construct them of cast iron, as metal resists the changes of temperature and humidity better than wood, which is liable to warp and twist and thus prevent accurate setting of the card. When metal cylinders were first used, the shell e_2, Fig. 3, was constructed in two pieces, which were bolted together, but the best and most modern method is to make the shell in one casting, with a sufficient number of longitudinal and sectional ribs on the interior of the shell to make it strong and rigid. This shell is mounted at each end on a spider e_3, which consists of a heavy rim cast in one piece with a series of strong supporting arms. The hubs of the spiders are accurately bored for the reception of the shaft of the cylinder, while the rims are turned to a true shape and size and accurately fitted to the ends of the shell.

The cylinder should be mounted on its shaft as rigidly as possible, to avoid the possibility of its becoming loose. The method adopted in the card under consideration is as follows: A shaft long enough to pass through the shell and project sufficiently beyond to rest in the bearings and also carry the necessary pulleys for driving the cylinder and various parts of the card is forced into its position through the hub of each of the spiders by means of a powerful screw press. It is then secured to the spiders by means of two large taper dowels, one at each end of the cylinder. These dowels are driven into holes drilled through the hubs of the spiders and through the shaft.

The complete cylinder should be turned and afterwards ground while resting on its own bearing, not on a mandrel, so as to produce an absolutely true surface when in operation. As these cylinders are intended to run at a high speed, they are also balanced so as to insure even running, and when their construction is complete the ends are cased in with sheet iron to prevent dust or fiber from entering the cylinder and to avoid accidents that would be liable to result if they were rotated at a high speed with uncovered arms. In Figs. 1 and 2, the letter e applies more directly to these end casings, although it is used to indicate the cylinder as a whole.

The surface of this cylinder is covered with card clothing, which is a fabric with teeth embedded in it and projecting through it at an angle. The addition of the clothing to the cylinder increases its diameter to about $50\frac{3}{4}$ inches. Reference to Fig. 3 shows the teeth on the surface of this cylinder pointing in the direction of its motion, as indicated by the arrow shown on the shell of the cylinder. A point on the surface of the cylinder travels about 2,150 feet per minute. The teeth of the wire are set very closely in the fabric, there being about 72,000 points to the square foot and more than 3,000,000 points on the entire cylinder. A fuller description of this clothing, together with the manner in which it is applied, is given later.

12. The description of the licker and its operation on the cotton has been carried far enough to explain how the heavier impurities are removed from the fringe of cotton projecting over the feed-plate and driven downwards into the space beneath the card, and also how the fibers are removed from this fringe when they project downwards sufficiently to be released and are carried along on the ends of the teeth of the licker at a speed of about 1,000 feet per minute. These fibers are now transferred to the surface of the cylinder, which is rendered possible by the respective directions of motion of the cylinder and licker and by the direction in which their teeth are pointing. At the point where the licker and the cylinder almost come in contact, both are moving in the same direction and have their teeth pointing upwards. The teeth on the licker are comparatively coarsely set, while those on the cylinder are finely set and have a much greater tendency to hold and to retain the minute fibers than the teeth of the licker. The cylinder is also revolving at more than double the surface speed of the licker, and consequently the fibers are swept off the surface of the licker where the surfaces of the licker and cylinder are in closest proximity and carried upwards on the surface of the cylinder.

Fig. 13 shows the relative positions and the respective styles of construction of the licker and the cylinder at the point where they approach each other, while Fig. 14 shows an enlarged view of the teeth.

In Figs. 3 and 13, a metal plate designated as a *cover* is shown in connection with the licker cover. This cover e_4, which is known as the **back knife plate,** protects the cylinder at this point and prevents an air-current from being formed by the motion of the cylinder. A wedge-shaped piece of wood c_4 covered with flannel is usually placed in the receptacle formed by the junction of the licker cover with the back knife plate, in order to prevent any possible chance of an air-current.

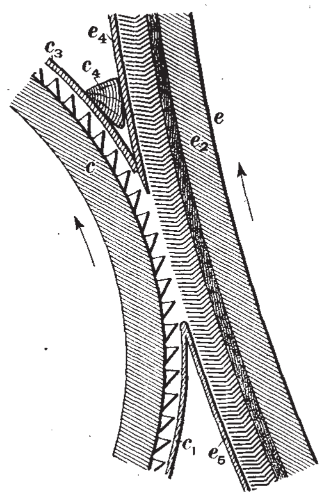


Fig. 13

13. Flats.—Above the cylinder and partly surrounding its upper portion is a chain of flats *f*, as shown in Figs. 1, 2, and 3. These are the parts that give the name *revolving-top flat card* to the card. They are made of cast iron, approximately **T**-shaped in section, and are partly covered with card clothing about $\frac{15}{16}$ inch wide. They are usually $1\frac{1}{8}$ inches wide and slightly longer than the width of the cylinder, but are covered with clothing only over the portion of their length that corresponds to the width of the cylinder. This clothing is of a finer wire, with the teeth more

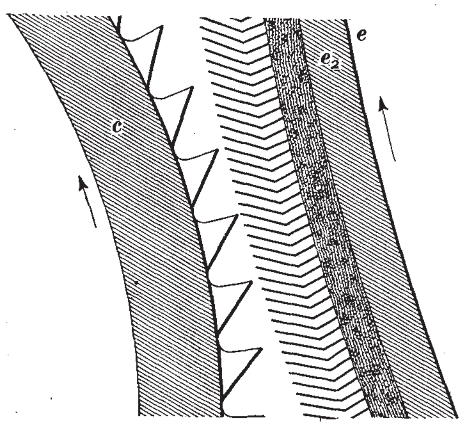


Fig. 14

closely set, than that on the cylinder, and is usually fastened to the flat by clips on each side of the flat. There are from 104 to 110 flats on a card, but as they are in proximity to the cylinder for only about one-third of its circumference, only from 39 to 43 flats are presented to the cylinder at one time. Fig. 15 (*a*) gives an end view of a flat, while (*b*) shows a section. Each end is drilled and tapped to receive a set-screw, which passes through a hollow stud carrying links, and as each link extends from one flat to the next and each end of each link encircles one of these hollow studs, the flats are connected in an endless chain. The screw that is inserted is of special construction, right-hand screws being used on one side of the card and left-hand screws on the other, so that the motion of the flats will tend to tighten rather than to loosen the screws and thus avoid the possibility of their becoming loose and allowing a flat to come in contact with the cylinder, which would cause considerable damage.

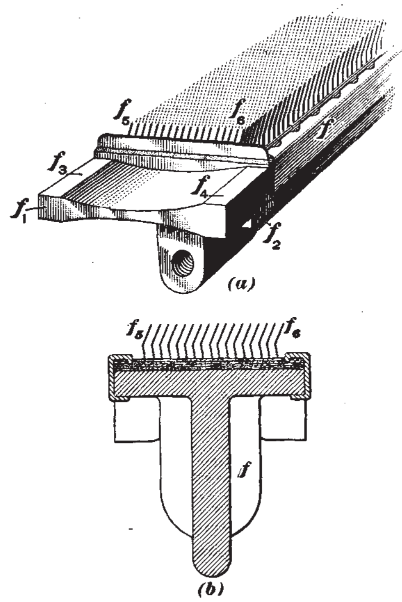


Fig. 15

The flats must be so arranged that they will be supported immediately above the cylinder without coming in contact with it or without their supports interfering with its rotation. This is done by means of two arches *g*, Figs. 1 and 2, which are strongly constructed castings resting on the framework of the card, one on each side, and securely bolted to it. Each arch carries five brackets h_1, which are composed of several pieces. One portion of each bracket projects upwards sufficiently to carry a pulley that serves as a support for those flats that are not performing any carding action and that are passing backwards over the cylinder, while another portion of each bracket serves as a support for the flexible bend *h* and provides a ready means of adjusting it in order to move the wire teeth of the flats that are at work nearer to or farther from the wire teeth on the surface of the cylinder. A fuller description of the arrangements for adjusting the flexible bends will be given in the description of setting cards; it is sufficient to state here that the flexible bends can be moved farther from, or nearer to, the cylinder shaft at any one of five setting points on either side of the card, and by this means the upper edges of the bends can be adjusted so as to be practically concentric with the circumference, or wire surface, of the cylinder.

About forty of the flats rest on the flexible bend at each side of the card; the portions that are in contact with the bends are the two surfaces f_3 and f_4, Figs. 15 and 16. The chains are placed as near the flexible bends as possible, since if they are too far away, the pull and weight of the chains will cause a deflection in the flat. It is absolutely necessary that the chains on each side shall be exactly alike and work with the same tension, as the smallest variation will pull the flats out of their proper positions over the cylinder, and their accuracy will thus be destroyed. Chains are now so made that the whole variation from the standard is not more than $\frac{1}{50}$ inch. The flats are, of course, linked together on each side of the card by an exactly similar arrangement, except that, as has been previously stated, left-hand screws are used on one side and right-hand screws on the other.

14. Another representation of flats at work is given in Fig. 16, which shows them resting on the flexible bend, and held so that the points of the wire on their surfaces are almost touching the points of the wire on the cylinder. The exact distance between the wire on the flats and that on the cylinder is adjustable, and is usually about $\frac{10}{1000}$ inch. The distance between the wires, however, is not the same at each point in the width of the flat, as will be seen by referring to Fig. 16. The wire of the flat at the point f_5 is closer to the cylinder than at the point f_6 in each case. The end view of the flat in Fig. 15 (a) shows that the metal composing the flat end is cut away more on the side f_1 than on the side f_2; consequently, when this flat is turned over and rests on the flexible bend, the side f_1 will drop closer to the cylinder than the side f_2, and the wires on the side f_5 will drop lower than the wires on the side f_6, thus making a slightly wedge-shaped space between the wires of the flat and the wires of the cylinder. The side f_5 of the flat, which is nearer to the cylinder, is known as the **heel**, while the side that is farther from the cylinder, namely, f_6, is known as the **toe**. Flats are always constructed with this heel-and-toe formation, and it should be preserved throughout the life of the card.

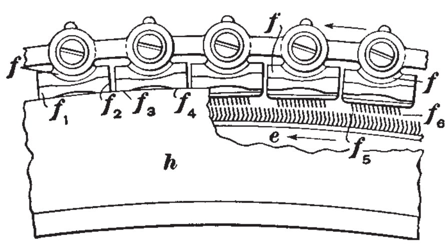


FIG. 16

The chain of flats is not stationary, but moves at a very slow speed, those flats nearest the cylinder moving toward the front of the card, while of course, the flats that are not working are carried backwards over the top of those that are at work. The means of imparting motion to the flats, which will be described in connection with the gearing of the card, results in a steady, smooth movement usually at the rate of about 3 inches per minute, although this may be changed to either a faster or slower speed, according to whether it is desired to remove more or less waste, respectively, from the cotton. The object of giving a movement to the flats is to carry toward the front of the card those flats that have become filled with impurities, so that they may be stripped and brushed out before they become too full of leaf and other foreign matter to perform the duty of carding the cotton.

15. The method of supporting the flats that are not at work is shown in Figs. 1, 2, and 3. They are supported at the front by two pulleys f_7, one at each end of a shaft that has its bearings in two brackets, one on each side of the card. On the same shaft with these two pulleys are two sprocket gears, the one shown being marked f_8, the teeth of which mesh with the ribs on the back of the flats, and as this shaft is driven by means of worms and worm-gears, the sprocket gears drive the flats. The portion of the chain of flats directly above the cylinder and resting on the flexible bends revolves in the same direction as the cylinder, namely, toward the front. The flats that are not at work move backwards, in the opposite direction to the cylinder, and rest on pulleys h_7, h_8, h_9 supported by brackets h_1 attached to the arch of the card and duplicated on each side. The ends of the flats rest on these pulleys and impart motion to them by frictional contact. Two of these pulleys h_8 at about the center of the card are connected by a shaft h_{10} that extends across the card. The pulleys h_9, which are directly over the licker, form the turning point of the flats. Those that have been cleaned and carried along over the top turn and pass over the cylinder to perform their work, while those that have just finished their work, being charged with impurities, pass around the pulleys at the front and are cleaned. The bracket h_1, which supports the pulley h_8, is so constructed that the pulley may be raised or lowered to take out the sag, or slack, in the chain of flats or to allow sufficient slack for the flats to revolve freely.

16. As previously explained, the cotton is transferred to the face of the cylinder from the licker at the point where the two surfaces nearly touch each other, and is carried upwards and forwards by it until brought to the point where the flats and cylinder are brought into close proximity. When the cylinder reaches the first flat, the cotton on its surface has a tendency to project from it on account of the centrifugal force of the cylinder, and comes in contact with the teeth at the toe of the first flat. The stock is gradually drawn through the teeth of the flat, receiving more and more of a combing or carding action, until the heel of the flat is reached, where the teeth of the flat and the cylinder are in the closest proximity, and where the cotton consequently receives the greatest carding action.

Some of the fibers that have not projected sufficiently may not have received any carding action, and the cylinder carries them forwards to the next flat. Those fibers that have been carded once may be carded again, with such additional fibers as are brought under the action of the succeeding flat, and so on throughout the entire series. The flats are set a little closer to the cylinder at the front, or delivery end, than at the back, or feed, end, of the card, and this method combined with the heel-and-toe arrangement of the flat insures a gradual and effective carding of all the fibers before they have passed under the last flat. The small impurities are left behind, since they are forced between the teeth of the wire on the flats or cylinder and remain there until the wire is cleaned, or stripped, as will be explained later. Thus the short fibers and impurities are retained, while the long, clean fibers are passed forwards.

17. Flat-Stripping Combs.—At the front of the card in Figs. 1, 2, and 3 is shown a comb j supported by two arms j_1, j_2. This comb consists of a thin sheet of steel attached to a shaft and having its lower edge made up of fine teeth. It is capable of adjustment so as to be moved closer to, or farther from, the wire on the flats. The comb is given an oscillating motion by means of a cam acting on the arm j_3, Fig. 2, and at each stroke strips from a flat a portion of the short fiber, leaf, and other impurities that adhere to its face. With the arrangement shown in Figs. 1 and 2, a close setting between the comb and flats is not possible owing to the difficulty in giving a backward movement to the comb without damaging the clothing of the flats.

Fig. 17 (a) represents a method of actuating the comb j that differs somewhat from that adopted on the card shown in Figs. 1 and 2. Fig. 17 (b) is a front view of the comb j with bearing j_5 and actuating lever j_8. This comb has two motions; namely, an oscillating motion, which it receives through the arm j_3 from the cam j_4, by letting the arm j_1 swing around the point j_7 as a fulcrum, and a turning motion in its bearings j_5, received through the lever j_8 from the cam j_6. The teeth of the flats f are stripped while they are pointing downwards by a downward stroke of the comb, governed by the cam j_4. As the comb lifts, it is traveling in a direction opposite to that in which the teeth are pointing, and to prevent injury to the wire the comb is turned away

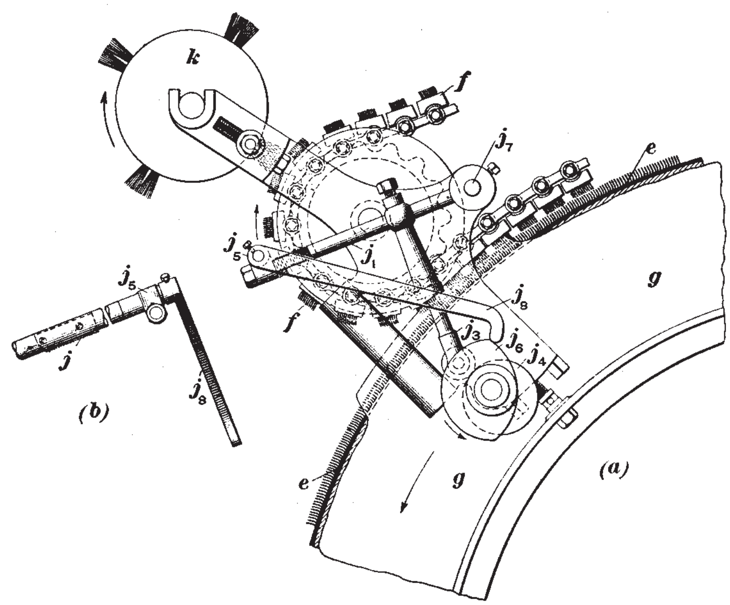


FIG. 17

from the flats by means of the cam j_6. By the use of this arrangement, a closer stripping action is obtained without damaging the wire.

18. Brush.—After the waste, known as *flat strippings*, has been removed by the comb j, the flats are brushed out by means of the brush k, shown in Fig. 17 (a) and also in Figs. 1, 2, and 3. This brush consists of a wooden barrel around the surface of which bristles are inserted in four spiral coils, the bristles being long, for a short distance at each end in order to brush the ends of the flats, and shorter in the middle so as to just reach into the wire of the flat clothing. It is possible to adjust the position of this revolving brush so as to remove from the flats any impurities that were not taken out by the comb. The brush after it has operated on the flats is cleaned by means of a hackle comb k_1, Figs. 1, 2, and 3, the teeth of which project into the bristles of the brush and remove impurities. The hackle comb is periodically cleaned by hand. The flat strippings are either allowed to fall from the stripping comb on the steel covers m_4, e_8 or are collected on a round rod k_2, Fig. 1, which is suspended directly below the comb and rotated by frictional contact with the flats, thus collecting the strippings as they fall from the flats. These strippings, whether allowed to drop on the steel cover or wound on the surface of the rod, are removed periodically by hand.

19. Cylinder Screen.—Beneath the cylinder is placed a screen e_5, Fig. 3, known as the **cylinder screen.** This consists of circular frames on each side of the card, practically corresponding to the curvature of the cylinder and connected by triangular cross-bars e_6. As shown, the cylinder screen is constructed in halves, which are held together at e_7. It is so supported that it may be set closer to, or farther from, the cylinder, while at the same time it retains practically the same curvature as the cylinder. As the cylinder revolves, the fibers that project come in contact with the screens, and thus the dirt and other foreign substances will be struck off or thrown through the openings in the screens, and cannot be drawn back. The screens also aid in preventing the good cotton from leaving the cylinder. A screen of a similar character was mentioned as being placed below the licker; the licker screens and cylinder screens are usually connected so as to form one complete adjustable undercasing beneath both licker and cylinder.

20. Card Frame.—The entire mechanism thus far described is supported on the framework of the card. This consists of two strong and solid card sides l, which are connected by cross-girts l_1 with the ends accurately milled and securely bolted to the card sides, thus forming a large rectangular frame. To this is attached a partition l_3, Fig. 3, that separates the dirt and fly produced by the mote knives from the licker and cylinder fly. In the card under description, this partition only projects downwards for half the distance between the licker screen and the floor. In some styles, however, the partition extends down to the floor and has a door in the center so that access can be obtained to the rear of the cylinder screen and space below. Around the framework of the card are doors l_2 that can be removed for the purpose of removing fly, setting undercasings, or examining the under parts of the card. There are four of these doors on each side of the card in addition to one at the front and one at the back.

21. Doffer.—Directly in front of the cylinder, in Figs. 1, 2, and 3, is seen the doffer m, which is supported by the doffer shaft m_1 and is constructed on the same principle as the cylinder. It consists of a perfectly rigid cylindrical shell m_2 carried at each end on a spider m_3 with six arms, to which it is firmly secured, the whole being rigidly attached to the doffer shaft. The doffer is covered with card clothing in a similar manner to the cylinder, except that the wire on the doffer is more closely set and somewhat finer. The doffer is the same width as the cylinder, but is of a much smaller diameter usually about 24 inches, but sometimes 27 inches. A large doffer is to be preferred, since it gives the same production with a lower speed or a larger surface speed with the same number of revolutions, and also gives the cylinder a better chance to deliver the fibers on account of its presenting a larger wire surface, although the advantage is not very great in either case. The doffer revolves in the opposite direction to that of the cylinder, the respective direction of motion at the place where they most nearly approach one another being shown by arrows in Fig. 3. At this place also the teeth of the cylinder and doffer point in opposite directions. As the teeth of the cylinder point in the direction in which it moves and were pointing upwards at the place where they took the cotton from the licker, they consequently point downwards at the front of the card, while the teeth of the doffer at this place point upwards. The surface speed of the doffer, which varies from 44 to 107 feet per minute, is much less than that of the cylinder. As the cylinder approaches the doffer its surface is covered with separated fibers of cotton. Since it is set within about .005 inch from the doffer and the doffer is revolving so much more slowly, the fibers of cotton are deposited by the cylinder on the face of the doffer. They are condensed considerably from their arrangement on the surface of the cylinder because while spread over from 20 to 40 inches on the surface of the cylinder, they are laid in the space of about 1 inch on the surface of the doffer. The amount of this condensation varies according to the relative speed of the cylinder and doffer.

It does not necessarily follow that all the fibers are taken from the cylinder by the doffer the first time the cotton passes the point where the transfer is made, as they may not be in the proper position to become attached to the doffer. In this case, they may be carried around by the cylinder a second time and be more effectively carded. The doffer may be considered as merely a convenient means of removing the fiber from the cylinder. It is not intended to have any cleaning action, as the cleaning on the card is practically completed when the cotton has passed the flats, but as a matter of fact, it does remove some short fiber and light impurities that adhere within the interstices of the wire.

There is no screen beneath the doffer, as it is unnecessary, but placed above it is a protection consisting of a metal cover m_4 known as the **doffer bonnet** and shown in Figs. 1, 2, and 3, while another view is given in Fig. 18. This metal cover extends over the upper surface of the doffer, protects it from injury, and forms a portion of a receptacle to hold flat strippings in case no other method of gathering them is provided. At the point m_5 it extends to, and is almost in contact with, a plate of steel e_8 placed over the front part of the cylinder that performs the same duty for the cylinder; namely, protecting it from damage and forming a part of the receptacle for the flat strippings. This plate e_8 extends upwards until a loose portion e_9 is reached, which forms a door, the position of which, when closed, is shown in Fig. 18 in dotted lines. This door swings on arms e_{10} so constructed that it can be thrown forwards and rest on the doffer bonnet; it is shown in this position in Fig. 18. Immediately above the space formed by the opening of this door is another plate e_{11}, which extends from the

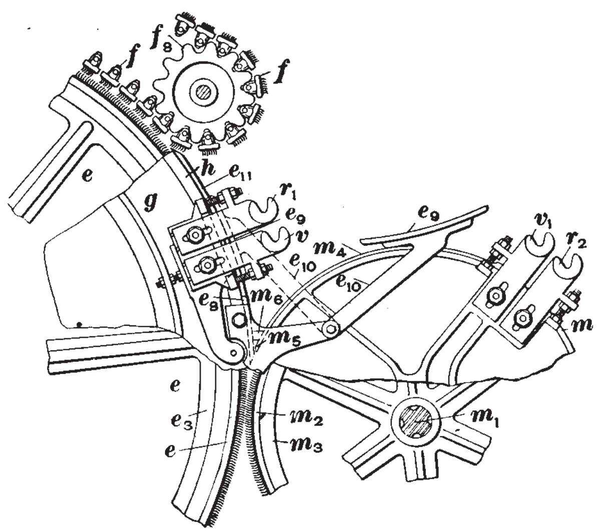


FIG. 18

door up into the space between the flats and the cylinder, almost in contact with both of them. This plate e_{11} is known as the **front knife plate.** It is also the object of these covers, or plates, mentioned in connection with the cylinder, doffer, and licker, to guard against accidents to the operatives, the licker being especially dangerous.

A draft strip, or making-up piece, m_6 is usually placed in the recess formed by the doffer bonnet and the plate e_8, so as to fit the angle between the doffer and the cylinder and thus prevent dirt from entering the space between these two parts. It also prevents draft and thus does away with fly, which would otherwise gather and come through in lumps.

22. Doffer Comb.—The cotton is carried around by the doffer on its under side until it reaches the doffer comb *n*, Fig. 3, which is directly in front of the doffer and has an oscillating motion of about 1,800 or 2,000 strokes per minute. One of the bearings of the comb is an ordinary bearing,

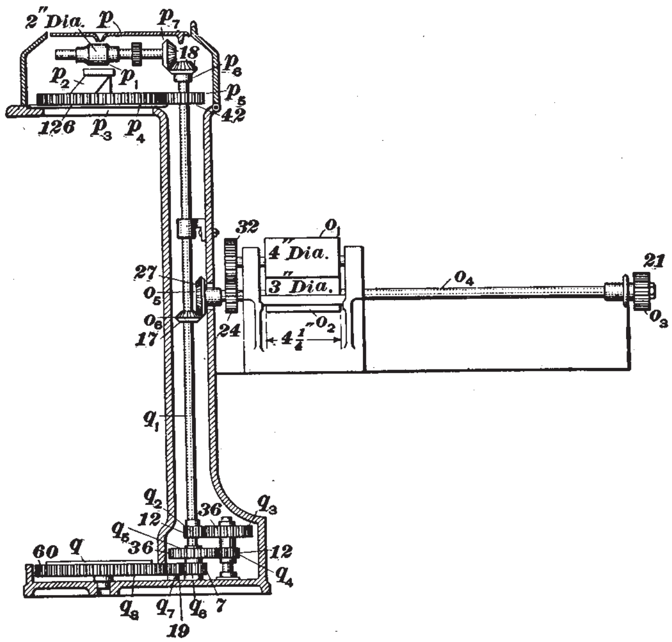


FIG. 19

while the other is in a box known as the **comb box**, which contains the eccentric that gives the motion to the comb. The position of these bearings can be altered by adjusting screws in order to obtain the proper distance between the comb and the surface of the doffer. The comb, as shown in Figs. 1, 2, and 3, consists of a thin sheet of steel attached to a shaft by a number of small arms; its lower edge is composed of fine teeth resembling somewhat the teeth of a fine saw. The teeth of the doffer, which were pointing upwards when in position to receive the cotton from the cylinder, are pointing downwards at the point nearest the comb. The downward strokes of the comb are in the same direction that the teeth of the doffer are pointing and in close proximity to them, thus making the operation of removing the cotton very easy.

The cotton, when it leaves the doffer, is in the form of a transparent web of the same width as the doffer. The next work required of the card is that of reducing the web to a sliver. This is attained by passing the cotton through a guide and then through a trumpet o, on the other side of which are two calendar rolls o_1, o_2, Figs. 1, 3, and 19. The bottom roll is $4\frac{1}{4}$ inches wide and 3 inches in diameter, and by means of a gear drives the top calender roll, which is self-weighted, being 4 inches in diameter. The object of these rolls is to compress the sliver so that it will occupy a comparatively small space.

23. Coiler.—From the calender rolls o_1, o_2 the cotton passes through a hole in the cover p of the upright framework, known as the **coiler head**, the connections of which are shown in Fig. 19. It is drawn through the hole in the cover by two coiler calender rolls, the one shown being marked p_1, which further condense it, and is then delivered into an inclined tube p_2 on a revolving plate p_3. The end of the tube that receives the cotton is in the center of the plate, directly under the calender rolls p_1, while the end of the tube from which the cotton is delivered is at the outer edge of the plate p_3. At the bottom of the coiler head is a plate q on which rests the can that receives the sliver. In consequence of the sliver being delivered down the rotating tube p_2, it will describe a circle and be laid in the can in the form of coils. The circle described by the bottom of the tube p_2 is little more than half the diameter of the can. If the top of the tube p_2 were directly over the center of the plate q on which the can rests and if the can did not turn, causing the laying of the sliver to depend entirely on the rotation of the coiler tube, the sliver would be placed in a series of ascending coils, which would have as a center the center of the can, while the outside edges of the coils would be placed some distance from the side of the can. The result of this would be that only a very short length of sliver could be laid in the can and the coils would become entangled, causing the sliver to be broken as it was drawn out. In order to overcome this difficulty the top of the tube p_2 is slightly beyond the center of the plate q, while q is revolving in the opposite direction to that of the tube p_2, but very slowly as compared with the speed of this tube, p_2 making about 26 revolutions to 1 of q. As a result of this arrangement each coil of sliver that is placed in the can is in contact with the side of the can and no one coil comes directly above the preceding coil. A top view of the sliver as it appears when placed in the can in this manner is shown in Fig. 20.

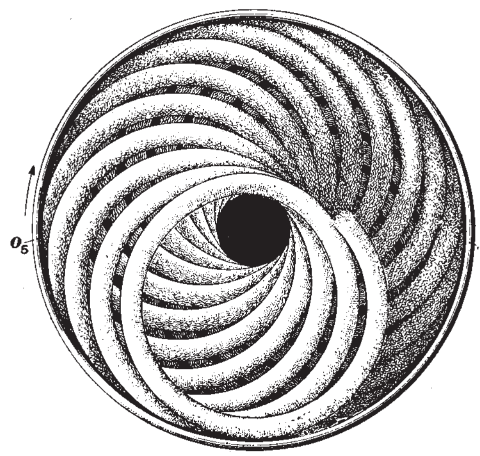


Fig. 20

The cover for the coiler head is now constructed so as to be held in position by a hinge, on which it can be raised and held open, without breaking the sliver. This gives an opportunity for inspection and oiling.

Formerly coiler heads were so constructed that it was necessary to remove the sliver from the coiler or break the end of sliver in order to oil the bearings, which necessarily caused additional waste and loss of production. Occasionally the sliver breaks and collects within the coiler, causing what is called a *bung-up*.

One feature of the coiler head for the card under description is the use of the swinging calender roll in place of the old-style calender roll, which revolved in fixed bearings and caused considerable trouble in case of a bung-up in the coiler head. The calender roll that receives motion from the upright shaft revolves in fixed bearings, while the other one is mounted on a swing, or hinge, bearing. The weight of the roll and bearing is sufficient to keep it in contact with the fixed roll. It receives motion from the other roll by means of two spur gears, one on the shaft of the roll revolving in fixed bearings and the other on the shaft of the swinging roll. When the coiler tube chokes, the sliver collects around the top of it and forces the swinging roll up, thus throwing it out of gear with the fixed roll and preventing any more cotton from entering the coiler. When a lap forms on either roll, the increasing diameter of the roll forces up the swinging roll and thus prevents the cotton from winding so firmly around the roll. This arrangement is also very convenient because of the fact that the swinging roll can be moved out of the way in removing the cotton that has lapped around one of the rolls, thus making it very easy to remove the lap, whether it has formed on the swinging roll or on the stationary roll. It also does away with the strain on the bearings and the necessity of using a knife to cut the lap from the roll, and thus prevents the surface of the roll from being damaged by the careless use of a knife.

GEARING

24. In describing the method of driving the different parts of the card reference will be made to Figs. 21 and 22, but in order to more fully identify the parts, the plan of the gearing, Fig. 23, and also those figures that show the parts of the card assembled, such as Figs. 1 and 2, should be consulted, especially for those parts that cannot well be indicated on Figs. 21 and 22. Referring first to Fig. 21, which shows the main driving side of the card, the tight pulley e_{12} on the end of the cylinder shaft receives motion from the driving belt e_{14}, which is driven from the pulley either on the main shaft or a countershaft of the room. On the other side of the cylinder, as shown in Fig. 22, is placed a pulley with four separate faces, the face e_{15} carrying the crossed belt that drives the pulley c_5 on the licker c. Referring again to Fig. 21, on the other end of the licker is a pulley c_6 that drives the barrow pulley m_7 by means of a crossed belt. Compounded

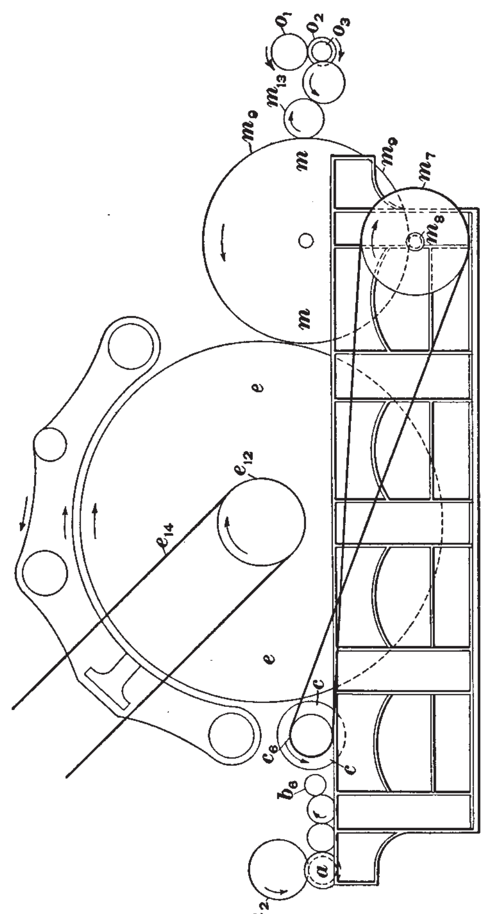


Fig. 21

with this pulley is the barrow gear m_8, which drives the doffer gear m_9 on the end of the doffer shaft.

Reference should now be made to Fig. 22, which shows the other side of the doffer. On this side is a bevel gear m_{10}

driving a bevel gear m_{11} on the side shaft m_{12}, which carries at its other end a bevel gear b_4 driving a gear b_5 on the end of the feed-roll. On the other end of the feed-roll, as shown in Fig. 21, is a gear b_6 that drives by means of two carrier gears the lap roll a. Referring again to Fig. 22, the pulley e_{16}, by means of the band n_5, drives the pulley n_4 that is compounded with another pulley n_2; this, by means of the band n_3, drives a pulley n_1 on a short shaft carrying the eccentric that gives motion to the doffer comb. A third pulley e_{17} on the end of the cylinder shaft, as shown in Fig. 22, drives by

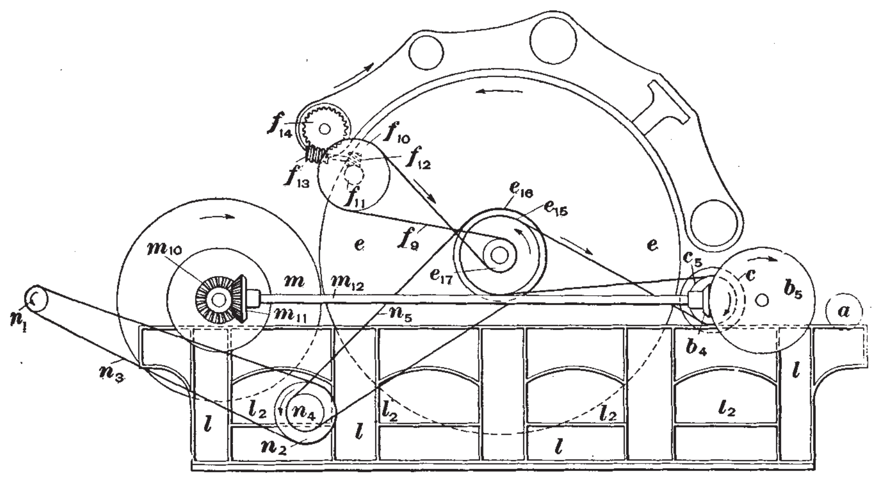


FIG. 22

means of the belt f_9 the pulley f_{10}, which is on the same shaft as the worm f_{11} gearing into the worm-gear f_{12}. On the short shaft with the worm-gear f_{12} is a worm f_{13} driving the worm-gear f_{14}, which is mounted on a shaft carrying two sprockets that gear directly into the ribs on the back of the flats.

The coiler connections are driven as follows, reference being made to Figs. 19 and 23: The large gear m_9, Fig. 23, that is on the end of the doffer and receives motion from the barrow gear, drives by means of two carrier gears a gear o_3 on one end of the calender-roll shaft o_4. On the other end of this shaft is a bevel gear o_5, Fig. 19, that drives

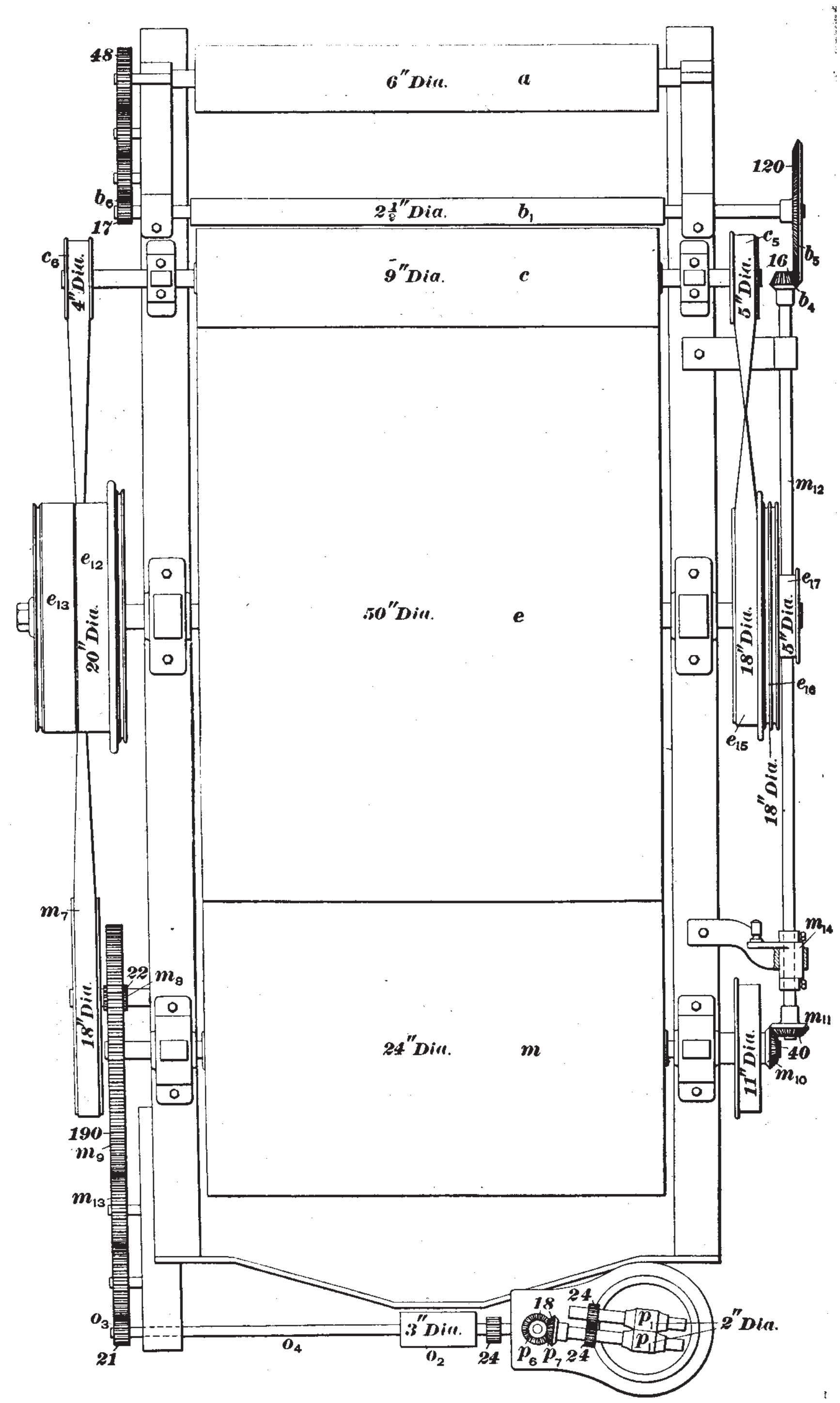

6" Dia.
a
48
120
b_6
17
2½" Dia.
b_1
c_6
4" Dia.
9" Dia.
c
c_5
5" Dia.
16
b_5
b_4
m_{12}
e_{12}
e_{13}
20" Dia.
50" Dia.
e
e_{17}
18" Dia.
5" Dia.
e_{16}
e_{15}
18" Dia.
m_7
m_{14}
22
m_8
18" Dia.
24" Dia.
m
m_{11}
11" Dia.
40
m_{10}
190
m_9
m_{13}
o_3
21
o_4
3" Dia.
o_2
24
18
24
p_6
p_7
24
p_1
p_1
2" Dia.

FIG. 23

the bevel gear o_6 on an upright shaft. At the upper end of this upright shaft are two gears, the gear p_5 driving the gear p_4 on the coiler plate, while the bevel gear p_6 drives the bevel gear p_7 on the coiler calender-roll shaft. The can table q is driven by means of a number of gears at the bottom of the upright shaft and in a rather circuitous manner, which is rendered necessary in order to obtain the slow motion at which the can table should travel. The gear q_2 is fast to the upright shaft q_1, while the gears q_5, q_6 are loose on the same shaft but compounded by means of a sleeve. The gear q_2 drives the gear q_3, which is compounded with the gear q_4, both gears working loosely on a short upright stud. The gear q_4 drives the gear q_5, and since q_5 and q_6 are compounded, the gear q_8 on the can table will receive motion through the carrier q_7.

25. When it is desired to stop the card from delivering the cotton and yet not break down the end at the coiler, the catch l_4, Fig. 24, is released. This figure shows one method of driving a doffer; it will be seen that as the feed-roll, calender roll, and all coiler connections are driven from the doffer, they will stop when the catch l_4 is released, throwing the gear m_8 out of contact with the doffer gear m_9. By this method it is a simple matter to stop the delivery of the cotton very suddenly if necessary and at the same time allow the swiftly revolving parts, such as the cylinder and licker, to remain in motion. Another advantage of this arrangement is that no waste results when the delivery is stopped. When the gear m_8 is again meshed with the gear m_9, the portion of the doffer that was presented to the cylinder when the doffer was stopped will contain an excessive amount of cotton. This excess will cause a thick or uneven place in the sliver, which should be removed. This arrangement is sometimes called the *barrow motion*, and the gear m_8 the *barrow gear*.

The gear m_8 is usually a change gear, so that the doffer may be driven at any required speed, as the production of the card depends on the speed of the doffer. In decreasing or increasing the speed of the doffer by changing the

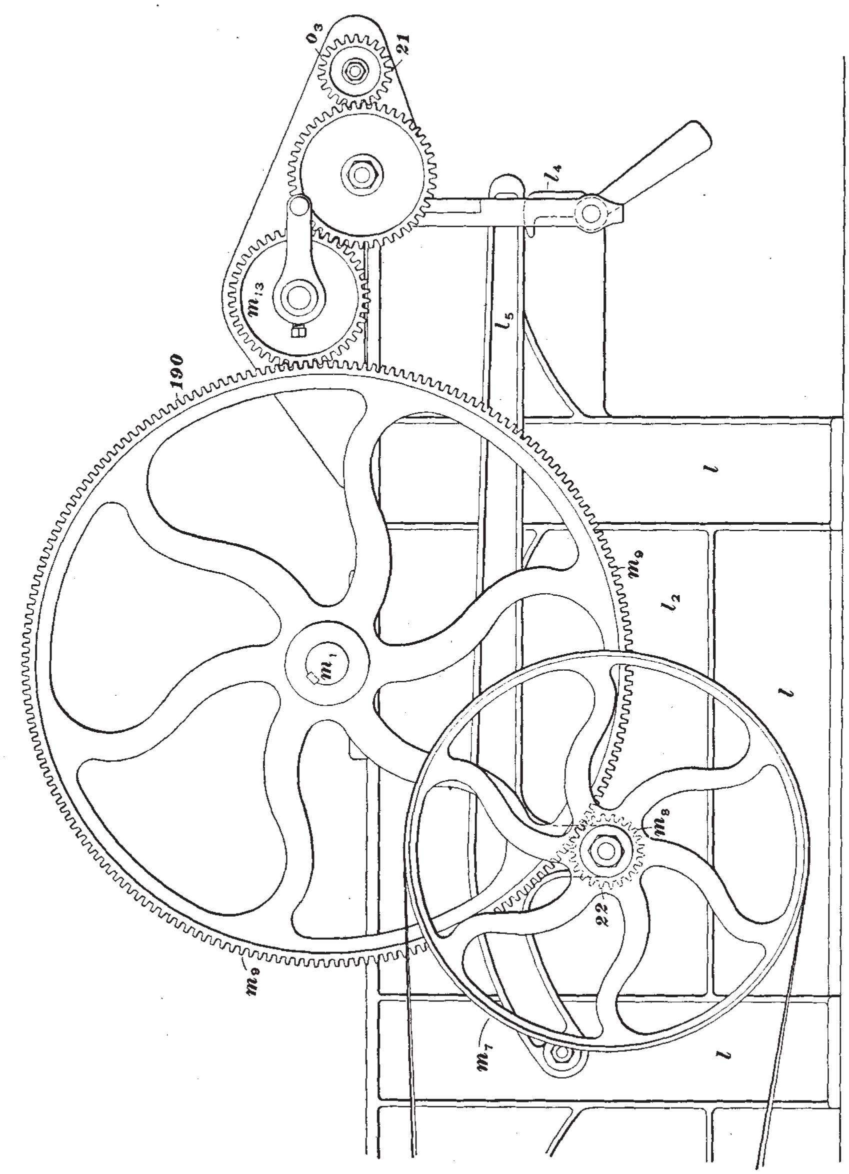


Fig. 21

gear m_8, the draft of the card and, consequently, the weight of the sliver delivered, are not affected, since the feed-rolls, lap roll, and all coiler connections receive motion from the doffer and therefore have the same relative speed, whether m_8 is a large or a small gear.

Another method of stopping the delivery of the cotton without breaking down the end at the coiler is to break the connection at the doffer by moving the side shaft m_{12}, Figs. 22 and 23, and also break the connection between the doffer and calender rolls by turning the handle on the carrier gear m_{13}, Fig. 24. The shaft m_{12} carries a gear at each end, the gear b_4 driving the gear b_5 that is on the end of the feed-roll, while the gear m_{11} receives motion from the gear m_{10} on the end of the doffer shaft. By means of the movable bearing m_{14}, it is possible to move the shaft m_{12} outwards at its front end and thereby disconnect the gears m_{10}, m_{11} and thus stop the feed, while by throwing out the gear m_{13} the calender rolls are stopped, thus allowing the cotton that is on the doffer to fall between the doffer and the calender rolls. This method of stopping the delivery of cotton by the card allows the doffer to run without making an uneven and cut sliver when restarting.

SPEED CALCULATIONS

26. If the driving shaft makes 340 revolutions per minute and carries a 10-inch pulley, the pulley e_{12}, Figs. 21 and 23, which is 20 inches in diameter, will be driven as follows:

$$\frac{340 \times 10}{20} = 170 \text{ revolutions per minute}$$

As the cylinder is $50\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will therefore be as follows:

$$\frac{170 \times 50\frac{3}{4} \times 3.1416}{12} = 2{,}258.679 \text{ feet per minute}$$

27. Licker.—On the end of the cylinder opposite that of the pulley e_{12} is the pulley e_{15}, Figs. 22 and 23, which is connected to the pulley c_5 by means of a cross-belt and thus drives the licker. The diameter of e_{15} is 18 inches and that of c_5 is 7 inches, so that when the cylinder makes 170 revolutions per minute, the revolutions per minute made by the licker will be as follows:

$$\frac{170 \times 18}{7} = 437.142 \text{ revolutions per minute}$$

As the licker is usually 9 inches in diameter, its surface speed will be as follows:

$$\frac{437.142 \times 9 \times 3.1416}{12} = 1{,}029.993 \text{ feet per minute}$$

28. Doffer.—The 4-inch pulley c_6, Figs. 21 and 23, on the end of the licker drives the 18-inch barrow pulley m_7, which is compounded with the doffer change gear m_8. This gear, for the purpose of calculation, will be assumed to have 22 teeth; the gear on the end of the doffer contains 190 teeth. With the licker making 437.142 revolutions per minute, the speed of the doffer will be as follows:

$$\frac{437.142 \times 4 \times 22}{18 \times 190} = 11.248 \text{ revolutions per minute}$$

As the doffer is $24\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will be as follows:

$$\frac{11.248 \times 24\frac{3}{4} \times 3.1416}{12} = 72.881 \text{ feet per minute}$$

On some cards there is an arrangement for driving the doffer at two different speeds, the slow speed being used when piecing up an end. One method of construction for driving at different speeds is to have two pulleys of different sizes on the licker shaft and to have two belts extending to m_7. At m_7 there are three pulleys, the center pulley being loose, while the other two are fastened to the shaft; consequently, when one belt is on the loose pulley, the other is on one of the fastened pulleys. The belts are shifted by means of a shipper handle.

29. Flats.—With the cylinder making 170 revolutions per minute; diameter of e_{17}, Figs. 22 and 23, 5 inches; diameter of f_{10}, 10 inches; f_{11}, single-threaded worm; f_{12}, 16 teeth; f_{13}, single-threaded worm; f_{14}, 42 teeth; and diameter of pulley driving flats, 8 inches; the speed of the flats will be as follows:

$$\frac{170 \times 5 \times 1 \times 1 \times 8 \times 3.1416}{10 \times 16 \times 42} = 3.179 \text{ inches per minute}$$

30. Draft.—The following examples illustrate the manner of finding the draft:

EXAMPLE 1.—Find the draft between the lap roll and feed-roll, referring to Fig. 23 for data.

SOLUTION.— $\frac{2.5 \times 48}{6 \times 17} = 1.176$, draft. Ans.

EXAMPLE 2.—Find the draft between the feed-roll and doffer, using a 16 change gear at b_4.

SOLUTION.— $\frac{24 \times 40 \times 120}{2.5 \times 40 \times 16} = 72$, draft. Ans.

EXAMPLE 3.—Find the draft between the doffer and bottom calender roll.

SOLUTION.— $\frac{3 \times 190}{24 \times 21} = 1.13$, draft. Ans.

EXAMPLE 4.—Find the draft between the bottom calender roll and coiler calender rolls, referring to Fig. 19 for data.

SOLUTION.— $\frac{2 \times 24 \times 18 \times 27}{3 \times 24 \times 18 \times 17} = 1.059$, draft. Ans.

EXAMPLE 5.—Find the total draft of the card shown in Fig. 23, figuring from the coiler calender rolls p_1, Figs. 19 and 23, to the lap roll a, Figs. 21 and 23, and using a 16 change gear at b_4.

SOLUTION.— $\frac{2 \times 24 \times 18 \times 27 \times 190 \times 40 \times 120 \times 48}{6 \times 24 \times 18 \times 17 \times 21 \times 40 \times 16 \times 17} = 101.433$, draft. Ans.

PROOF.—To prove that intermediate drafts equal total draft, $1.176 \times 72 \times 1.130 \times 1.059 = 101.325$.

31. Waste.—In the passage of the cotton through the card there are several places where waste is made. There is a certain amount under the licker and the cylinder, and also between the wires of the clothing on the flats, cylinder, and doffer. This amount of waste should not as a rule exceed 5 per cent., and the work of the card should be closely watched, especially with regard to the waste under the cylinder, which should be examined at frequent intervals to see if it contains too much good cotton.

32. Production.—The production of the card varies according to the class of work, a good production on low numbers being from 700 to 1,000 pounds per week, while for fine yarns it is much lower. The weights of delivered sliver suitable for certain classes of work are as follows:

Variety of Cotton	Numbers	Weight per Yard Grains
Average American	1s to 10s	70
	10s to 15s	65
	15s to 20s	60
	20s to 30s	55
	30s to 40s	50
Allan-seed and Peelers	40s to 60s	50
	60s to 70s	45
	70s to 100s	40
Egyptian	40s to 60s	55
	60s to 70s	50
	70s to 100s	45
Sea-Island	70s to 100s	35
	100s upwards	30

33. Weight and Horsepower.—The weight of a single revolving flat card is about 5,000 pounds. It requires from $\frac{3}{4}$ to 1 horsepower to drive it after the initial strain of starting, which requires much greater power.

34. Dimensions.—A 40-inch revolving flat card with a 24-inch doffer occupies a space about 9 feet $11\frac{1}{2}$ inches by 5 feet 4 inches. Extra allowance must be made for the diameter of the lap. When the doffer is 45 inches wide, 5 inches must be added to the width in the above dimensions, while 3 inches must be added to the length when the doffer is 27 inches in diameter.

COTTON CARDS

(PART 2)

FORMER METHODS OF CARD CONSTRUCTION

1. While the machine described in *Cotton Cards*, Part 1, is the one that is now almost universally adopted for cotton carding, it does not by any means adequately represent the different methods of carding that are, or have been, used. The method of carding cotton before the era of machinery was by means of hand cards, which consisted merely of pieces of wood about 12 inches long and 5 inches wide to which a handle was attached. A piece of leather through which a number of iron wires had been driven was attached to the surface of the board and two of these hand cards were used, the operator holding one in each hand. The cotton, after being picked and cleaned, was spread on one of these cards, and the other was used to brush, scrape, or comb it until the fibers of cotton lay comparatively parallel to one another. From this were obtained soft fleecy rolls about 12 inches long and $\frac{3}{4}$ inch in diameter, called *cardings*. These cardings were pieced together and spun on the hand spinning wheel. Later developments resulted in the introduction of the principle of carding by means of a cylinder carrying wire teeth operating against a stationary framework carrying wire teeth, this being the first style of mechanical card. From this was ultimately developed a card used very largely in America under the name of *stationary-top flat card*, and to a limited extent in Europe, under the name of the *Wellman card*. This stationary-top flat card was used in almost every

American cotton mill until within the last 10 years, and is still used occasionally.

The most popular style of card in Europe prior to the development of the revolving-top flat card was that known as the *roller-and-clearer card*, sometimes called the *worker-and-stripper card*. This roller-and-clearer card was constructed with either one or two cylinders, being known respectively as a single or a double card. Sometimes a combination card was built with rollers and clearers on the back cylinder and flats on the front; combination cards have also been built with single cylinders having flats at the front and rollers and clearers behind. For special purposes cards have been built with three cylinders. The system of carding cotton by rollers and clearers, or workers and strippers, somewhat resembles the methods now in use for carding purposes in the woolen industry.

Owing to the world-wide tendency now to adopt the revolving-top flat card in the cotton industry, considerable space has been devoted to thoroughly describing that style of construction, but as there are still in use a number of stationary-top flat cards and also a number of the roller-and-clearer cards, a brief description of each of these styles of construction will be given.

STATIONARY-TOP FLAT CARD

2. The **stationary-top flat card,** shown in Fig. 1, is a smaller and less substantial machine than the revolving-top flat card, but is very similar to it in the principle of carding the cotton, differing mainly in the method of stripping the flats. The machine consists of the usual framework supporting the cylinder and doffer together with the various parts common to all cards, while above the cylinder are placed a number of flats. In the older cards these are constructed of wood, as shown in Fig. 1, but in the newer cards they are made of iron. Iron flats are usually made $1\frac{3}{8}$ inches wide with a strip of clothing $\frac{13}{16}$ inch wide, and it is possible to have 40 of them extending over an arc equal to about two-fifths of the circumference of the cylinder. When wooden flats are used it is not possible to have so many. The functions of these flats are the same as of those in the revolving flat card previously described. The flats rest on the arch of the card and are so constructed as to preserve the proper angle with the card wire on the cylinder. Each flat is set independently of any other by means of threaded pins secured by nuts.

The peculiarity of this card consists in the method of stripping the flats. An arrangement is shown above the

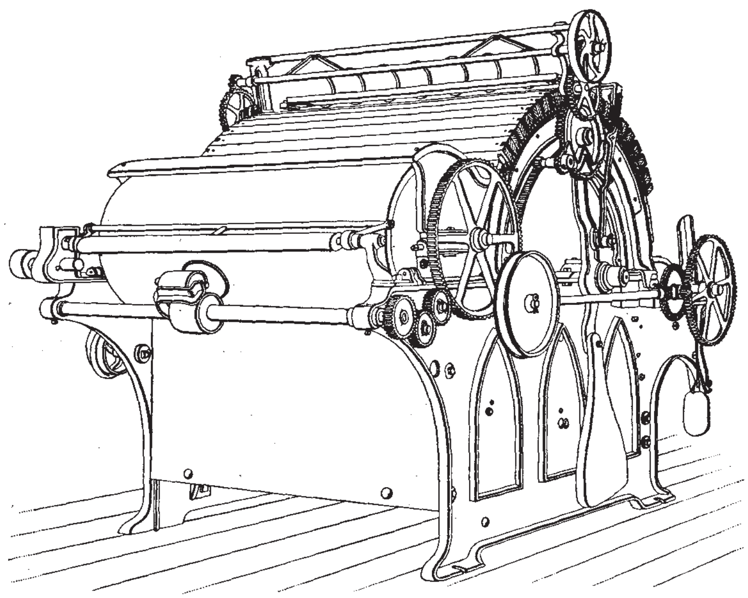


FIG. 1

machine in Fig. 1 by which any one flat may be raised from its seat sufficiently to allow a stripping card to be passed beneath it and drawn across its face, removing the impurities, which are retained in a wire framework; immediately after the stripping is completed the mechanism lowers the flat to its position. As this one piece of stripping mechanism has to clean each flat, it is necessary to have it so constructed that it may be moved from one flat to another; this is provided for, as shown in Fig. 1, by means of a small gear, which is a part of the stripping mechanism, meshing with a semicircular rack arranged on the arch of one side of the card; as this gear revolves the mechanism is moved from flat to flat. This can be arranged either to strip the flats consecutively, thus the first, second, third, fourth, and so on, or to strip them alternately, thus stripping the first, third, fifth, seventh and returning to strip the second, fourth, sixth, eighth, etc.; or in the improved quick stripper it may be made variable in its action, in order to strip the flats nearest to the feed-rolls oftener than those nearest to the doffer. This stripper lifts, strips, and replaces a flat in less than 4 seconds. The stationary-top flat cards are usually made with all parts smaller than either the revolving-top flat cards or the roller-and-clearer cards. The main cylinder is not usually more than 42 inches in diameter and the doffer not more than 18 inches, while the width of the card is not generally more than 37 inches. The construction of the stationary-top flat card made it especially suitable to be used in sections of a number of cards that delivered the slivers to a traveling lattice. The latter conveyed them to a *railway head*, a machine that combines all the slivers into one sliver which it deposits into a can in suitable form for the next process. This method was, and is still to some extent, used where double carding is resorted to; however, owing to the comparatively small amount of the production for the floor space occupied and the difficulty of arriving at accurate settings and adjustment, especially where wooden flats are used, it is now largely replaced by the revolving-top flat card.

A modern construction of a stationary-top flat card occupies 9 feet 6 inches by 5 feet 6 inches with a coiler, and 8 feet 2 inches by 5 feet 2 inches without a coiler. When making a 60-grain sliver with the doffer making 10 revolutions it cards about 60 pounds per day; it of course produces more than this on coarse work with a heavier sliver and the doffer running more quickly, and less for fine work with a slower doffer speed and lighter sliver.

ROLLER-AND-CLEARER CARD

3. The **roller-and-clearer card,** a section of which is shown in Fig. 2, although rarely used in America, is employed to some extent in certain parts of Europe. The machine consists primarily of a cylinder *d*, 45 inches in diameter, which is covered with fillet card clothing and rotates at a surface velocity of about 1,600 feet per minute. Placed over this cylinder are a number of **rollers** *e* about 6 inches in diameter, sometimes known as **workers,** and also a number of **clearers** *f* about $3\frac{1}{2}$ inches in diameter, sometimes called **strippers.** Both the workers and clearers are covered with fillet card clothing, the former rotating at a surface velocity of about 20 feet per minute and the latter at a circumferential speed of about 400 feet per minute. The clearers are set in close proximity to the cylinder, and the workers are adjusted both to the cylinder and to the clearers. These settings are obtained by means of screws and setting nuts with which the poppet heads *g* that support the shafts of the workers and clearers can be adjusted. The clearers are driven from a pulley d_1 on the cylinder shaft by means of a belt, or band, d_2 passing over pulleys on the clearer shafts and also around a binder pulley *h*. The workers are usually driven by a pulley on the doffer shaft that drives a belt, band, or in some cases a chain passing around pulleys or sprockets on the shafts of all the workers. The card is equipped with an 8-inch licker *c*, which is covered with fillet and rotates at a surface velocity of about 700 feet per minute; a doffer *j* of the ordinary construction is also employed.

In operation, a lap a_1 is placed in stands at the back of the card and, resting on a rotating wooden roll *a*, is fed to the card by means of a fluted feed-roll b_1 and a feed-plate *b*. As the licker *c* rotates downwards past the feed-plate, its teeth take the cotton that is fed to it and carry it to the cylinder *d*. The points of the teeth on the cylinder moving rapidly past the backs of the teeth on the licker results in the former taking the cotton from the latter and conveying it to the doffer. In its passage from the licker to the doffer,

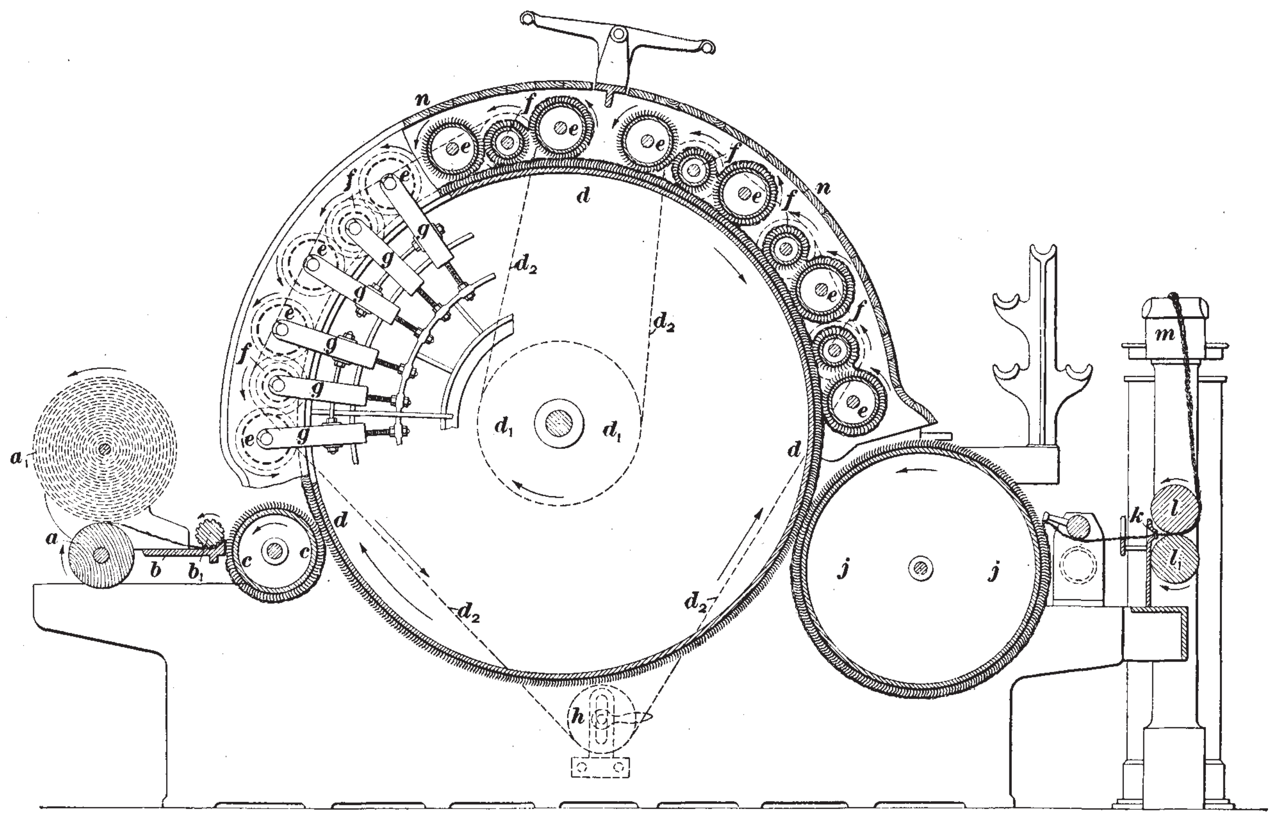


Fig. 2

however, the cotton is subjected to the action of each of the workers. The stock is held loosely and projects somewhat from the teeth of the cylinder, which rapidly pass the workers and operate point against point with the teeth of the latter. The result of this is that the cotton is carded and opened out and deposited on the workers, where it remains until the rotation of the worker brings it under the action of the clearer. Since the teeth of the clearer work with their points against the backs of the teeth on the worker, they take the cotton from the latter and convey it back to the main cylinder, which by virtue of its speed and the direction of inclination of its teeth, strips the cotton from the clearer. The expressions point against point and point against back, when referring to the card teeth of the various rolls, should not be construed to mean that the teeth of any two rolls are in actual contact, as these expressions refer only to the relative inclination of the card teeth. It will be noticed that the first eight workers are arranged in pairs, each pair being stripped by a single clearer, but that the last two workers are each stripped by a separate clearer. Sometimes the entire complement of workers and clearers are arranged as are the last two in the illustration. The cotton is taken from the cylinder by the doffer j in the ordinary manner and passed to the coiler m through the trumpet k and calender rolls l, l_1. This form of card is apt to make a considerable amount of flyings on account of the speed of the various parts, and in order to prevent these from flying from the card the latter is enclosed with a wooden cover n.

This method of carding results in the stock being thoroughly opened and cleaned, and it is claimed that it does less damage to the fibers and that a yarn 5 per cent. stronger can be produced than by the methods in more common use at the present time. As this card, however, requires more help to operate it and does not produce as much work as the more recent card, its use is not considered profitable.

DOUBLE CARDING

4. Formerly in order to obtain a high-grade yarn it was considered necessary to adopt the principle of **double carding**; viz., that of carding cotton first on a breaker card and then, after having taken a number of the slivers and by means of a lap head formed them into a lap, putting this lap through a finisher card. Since the revolving flat card has been improved so greatly that it does almost as good work as was done with the old system of double carding, and since the introduction of the comber, which produces work superior to either double carding or revolving flat card products, double carding is going out of practice.

5. Formation of the Lap.—The cards employed in double carding are similar to those already described and need no further mention. The formation of the lap for the second process of carding may be accomplished in several ways: (1) Where the breaker cards deposit slivers in cans, the lap is usually formed by means of a Derby doubler. (2) Where the first carding is arranged in sections of six, eight, ten, or twelve cards connected by a railway trough, the slivers may be passed through a railway head, in which they are deposited in a can, and afterwards passed through a lap head. (3) The slivers from the section of a railway trough may be guided directly into a lap head and the lap formed in this manner.

The first method, that of using a Derby doubler, is an arrangement by which a number of cans from the breaker cards, varying from twenty to sixty, are placed behind a long V-shaped table and the slivers from them passed through rolls, forming at the front one wide sheet, which may be any width from 10 to 40 inches. The lap is wound on a roll in somewhat the same manner as a lap is formed in the picker room. This lap is then placed on the lap roll at the finisher card and recarded.

When it is desired to form a lap for the finisher cards without the intervention of the railway head or can system for each card, the slivers from the railway trough are guided around rolls at such an angle as to arrange for slivers from two or more lines of breaker cards to be guided into a lap head and there wound into a lap usually half the width necessary to supply the finisher card.

CARD CLOTHING

CONSTRUCTION

FOUNDATION

6. Card clothing is the material with which the cylinder, doffer, and flats of the card are covered and by means of which the cotton is opened and the fibers straightened and laid parallel to each other. It consists of wire teeth bent in the form of a staple and inserted in a suitable foundation material. The teeth in addition to being bent in the form of a staple, also have a forward bend, or inclination, from a point known as the **knee** of the tooth. Fig. 3 is an enlarged view showing the shape of a single card tooth and the method of inserting it in the foundation y. The knee of the tooth is shown at y_1, while y_2 indicates the portion of the tooth, known as the **crown,** that is on the back of the foundation after the tooth has been inserted in it; y_3 are the **points** of the tooth, each tooth of course having two points.

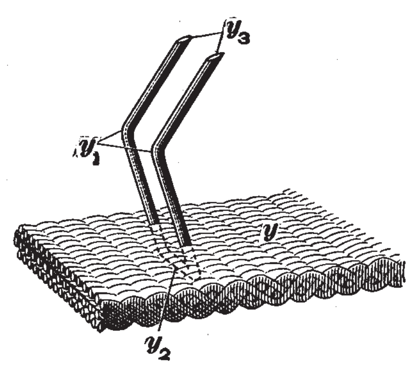


FIG. 3

7. Although the teeth of the clothing do the actual carding, much depends on the character of the foundation, since if the former are not held with considerable firmness and yet allowed a certain freedom of motion, the best results in carding cannot be obtained. The foundation material must also be such that it will not stretch after it is applied to the card, for if the clothing becomes loose it will rise in places, or as is commonly said, will *blister*. When this happens not only is the thoroughness of the carding deteriorated, but there is also great liability of the clothing itself being damaged by coming in contact with the clothing on other parts of the card. In addition, if the clothing is slack, the teeth will not be held up to their work properly but will be forced backwards by the strain in carding the cotton; this will result in neutralizing to a certain extent the effect of the forward bend of the tooth, making the clothing act more like a brush and allowing the cotton to pass without being properly carded.

The foundation material generally used is a fabric woven from cotton and woolen yarns, although sometimes cotton and linen are employed, the linen being used on account of its strength and freedom from stretching. The woolen yarn, however, is well adapted for this purpose, as it possesses a certain elasticity that, while holding the tooth in place with sufficient security, allows a certain freedom of movement; this is very desirable, since if the card teeth are held too rigidly, there is some liability of their becoming bent or broken. The foundation is generally woven three- or four-ply, in order to obtain the required strength and the thickness that is necessary to secure the teeth. A very good foundation consists of a two-ply woolen fabric inserted between two cotton fabrics, the latter imparting the requisite strength and the former giving a firm but elastic grip on the teeth. Sometimes the surface of the foundation is coated with a veneer of india-rubber, but in this there are disadvantages as well as advantages. The rubber has a yielding grip on the tooth that allows it enough freedom to move when the strain of carding is on it, and at the same time it is of a tough nature so that the movement of the tooth does not work a large hole in the foundation, which would render the teeth loosely secured so that the full benefit of the elasticity of the wire could not be obtained. The india-rubber-covered clothing is also much easier to strip, but on the other hand is not so durable as clothing made with the ordinary foundation. The rubber deteriorates with age, becoming hard and stiff and cracking between the points where the teeth pass through it. This deterioration is much more rapid if the clothing is in a hot room or subjected to the direct rays of the sun, and many times it has been found that the foundation of rubber clothing was totally spoiled before the wire was appreciably worn.

TEETH

8. The wire teeth actually do the carding, separating the cotton, fiber from fiber, and rearranging it in a homogeneous mass in which the fibers lie more or less parallel; they are therefore of even more importance than the foundation in which they are inserted. The material from which the wire is made, the number (diameter) of the wire, the angle at which the wire passes through the foundation, the angle at the knee of the tooth, the relative height of the knee and point, and the method of insertion in the foundation are all important considerations when card clothing is to be purchased for general or special uses.

Clothing is set with many different kinds of wire, such as iron, brass, mild steel, tempered steel, tinned steel, etc., but for cotton carding hardened and tempered steel, which makes a springy, elastic tooth that will not easily be bent out of place or broken, is the best material. Mild-steel wire wears too easily, losing its point and requiring frequent grinding to keep the card in good working condition. On the other hand it is easily ground, while tempered steel, although necessitating less frequent grinding, is harder to grind and requires a longer time to secure the required point, since if the grinding operation is forced the wire is liable to become heated and the temper drawn. The strength, elasticity, and durability of the tempered steel, however, make it much more desirable than any other material.

The wire generally employed is round in section, but various other shapes have been used at different times; one of these was the elliptical form obtained by slightly flattening the round wire by passing it through heavy rolls. While this form gave great strength to the tooth, it was objectionable because the teeth had a tendency to work holes in the foundation. After round wire has been set in the foundation it is ground to a point, and this alters the form of the section of the tooth at the point, or in some cases as far down as the knee, although the part of the tooth that passes through the foundation is always round in section. There are three methods of grinding the clothing, which give to it the following names: (1) *top-ground;* (2) *needle-*, or *side-*, *ground;* (3) *plow-ground.*

9. Top-ground wire is obtained by an emery grinding roll having a very slight traverse motion, so that the point of the tooth is ground down only on the top, producing what is known as a **flat,** or **chisel,** point.

In the **needle-,** or **side-, ground wire** the thickness of the tooth is reduced at the sides for a short distance from the point, and the wire is also ground down at the top. This form of point is known as the **needle point** and is produced by a comparatively narrow emery grinding wheel that, in addition to having a rotary motion, is rapidly traversed back and forth across the clothing.

Both top and needle grinding are practiced in the mill, the former being accomplished with the so-called dead-roll and the latter with the traverse grinding roll, but **plow grinding** is usually done by the manufacturers of the clothing. With this method of grinding, the thickness of the wire is reduced by grinding down each side from the point of the tooth to the knee. This is accomplished by means of emery disks that project into the clothing to the knee of the tooth. To aid in this method of grinding, the teeth are separated by means of plows, or guides, so that the emery disk will pass between the wires and not knock down the teeth, hence the name plow-ground. A plow-ground tooth is the best, since it is not only strong, elastic, and easily kept in good condition, but also gives a wedge-shaped space between the teeth, which can more readily engage with the cotton, and at the same time does not reduce the number of points per square foot. It should be understood that plow grinding alone does not give the necessary keen point to the tooth, as it simply reduces the section of the tooth from the knee up by grinding the sides flat; consequently, after the wire has been plow-ground it must be either top-ground or needle-ground, in order to bevel the tooth and bring it to a point.

10. Diameter of Wire.—The diameter of the wire varies according to the class of cotton to be carded, since fine cotton requires clothing with a large number of points per square foot, while coarse work requires fewer points; and in the former case fine wire must be used, while in the latter case wire of a large diameter is more suitable. As will be explained later, it is customary to set the clothing with a certain number of points per square foot for a certain diameter of wire. There are two gauges employed for numbering wire; namely, the Birmingham, or Stubbs, which is the English standard, and the Brown & Sharpe, which is the American standard. The following table shows the comparative diameters, expressed in decimal parts of an inch, of different numbers of wire of each system:

TABLE I

Birmingham Diameter in Inches	Number of Wire	American Diameter in Inches
.014	28	.012641
.013	29	.011257
.012	30	.010025
.010	31	.008928
.009	32	.007950
.008	33	.007080
.007	34	.006305
.005	35	.005615
.004	36	.005000

For an average grade of cotton, No. 33 wire (American gauge) for the doffer and flats and No. 32 for the cylinder will give good results; for coarse work the wire is proportionally increased in diameter, and for finer work proportionally decreased. The cylinder should always be covered with wire one number coarser than the doffer and flats, which should have wire of the same diameter.

11. In regard to the shape of the tooth and the angle at which it is inserted in the foundation, several important points should be noted. The knee of the tooth should be located about four-sevenths of the length of the tooth from the crown and three-sevenths from the point. If the knee is placed higher the tooth will be stronger and have a harsher action on the cotton, while if the knee is lower the clothing will be more flexible and have a more brush-like action. The tooth should penetrate the foundation at an angle of about 75°, to offset the bend at the knee, so that the point of the tooth will not be too far forwards. The angle of insertion in the foundation and the bend of the knee should be such that the point of the tooth will just touch or very slightly pass a perpendicular line drawn from the point where the tooth emerges from the foundation. Should the forward inclination be such that the tooth passes the perpendicular to any great extent, the point of the tooth will rise when it is moved back by the strain of carding. This is more clearly shown by reference to Fig. 4. Suppose that the shape of the tooth is such that its point is inclined forwards past the perpendicular y_4, y_5, as shown at y_3; then when the strain comes on the tooth, the point will be moved back to y_6, owing to the flexibility of the tooth and the freedom of motion allowed by the foundation. The point, therefore, in swinging through the arc $y_3 y_6$ will rise through the distance x, which in the case of

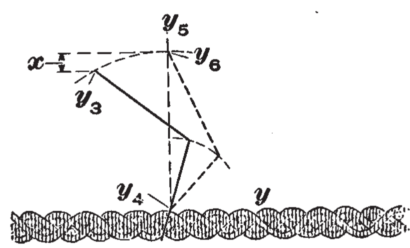


FIG. 4

a close setting might be sufficient to make the wire strike the clothing on other parts of the card. This action of the tooth is also aggravated by the tendency to straighten at the knee, so that even if no contact results, the setting will be made much closer and many fibers will be broken. On the other hand, if the inclination of the tooth does not carry its point past the perpendicular, the tendency of the tooth in moving backwards under the strain of carding will be to depress the point, making the setting more open and reducing the strain.

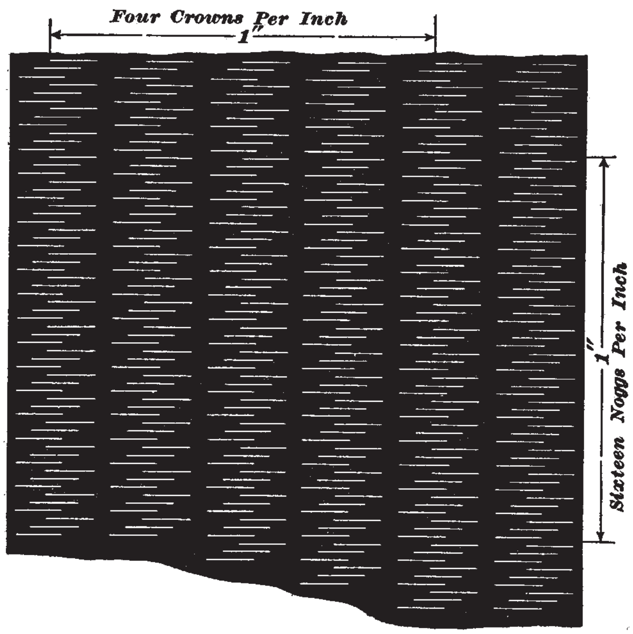


FIG. 5

CALCULATIONS

12. Card clothing for cotton cards is made in long continuous strips 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, and 2 inches in width known as **fillet,** or **filleting,** and in narrow sheets known as **tops;** the former is used for covering the cylinder and doffer, while the latter is used for the flats. Fillet clothing is made in what is known as **rib set;** that is, with the crowns of the teeth, which are on the back of the clothing, running in ribs, or rows, lengthwise of the fillet. Fig. 5 shows the appearance of the back of a piece of $1\frac{1}{2}$-inch rib-set fillet, the horizontal lines indicating the crowns of the teeth and showing the method in which they are inserted. The teeth are set into tops so that the crowns of the teeth on the back side of the foundation are **twilled;** that is, they are set in diagonal lines like a piece of twilled cloth. Fig. 6 shows the appearance of the back of a top, the horizontal lines showing the method of twilling the crowns.

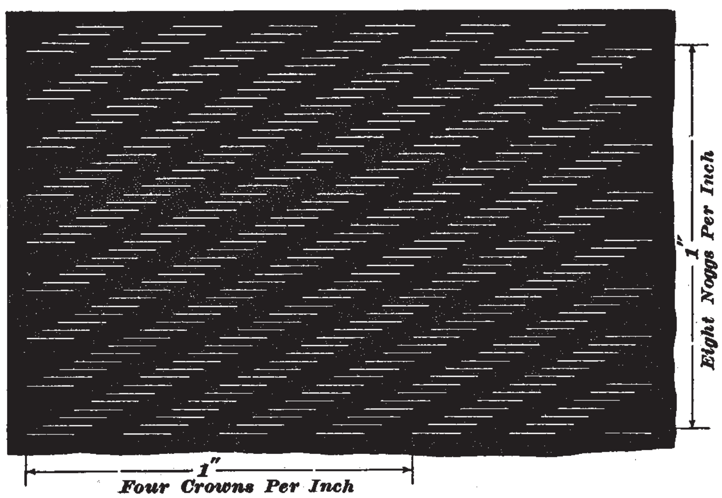


FIG. 6

All card clothing in America, unless especially ordered, is made with 4 crowns in 1 inch on the back of the clothing, or 8 points in 1 inch on the face, and is known as 8-crown clothing. From this it will be seen that a 2-inch fillet will have 8 ribs on the back and a $1\frac{1}{2}$-inch fillet, 6 ribs, etc. It should be noted that the actual width of the foundation of fillet clothing is about $\frac{1}{16}$ inch greater than the width of the wire-covered space; thus, a 2-inch fillet is actually $2\frac{1}{16}$ inches in width. Sometimes in special cases where a large number of points per square foot are desired, the clothing is made

10-crown; that is, with 10 points per inch in width on the face of the clothing, or 5 crowns per inch on the back of the clothing.

The term **nogg,** which is used in connection with card clothing, refers to the distance between the first tooth of one line of twill and the next line. It will be noticed in Fig. 6 that there are 6 teeth to a nogg and 8 noggs per inch, while in Fig. 5 there are half as many teeth per nogg and 16 noggs per inch. Owing to the manner in which the teeth are set in fillet clothing, there are always one-half the number of teeth per nogg and twice the number of noggs per inch as in clothing for tops with the same number of points per square foot. The number of noggs per inch always governs the number of points per square foot in the clothing. If more points per square foot are wanted, the noggs per inch are increased, while if fewer points are wanted, the noggs per inch are decreased, the crowns always remaining the same.

13. To find the points per square foot in card clothing:

Rule.—*Multiply the crowns per inch by the points per tooth (2), by the teeth per nogg, by the noggs per inch, and by the number of square inches in a square foot (144).*

EXAMPLE 1.—Find the points per square foot in the sample of card clothing shown in Fig. 5, the crowns per inch being 4, the teeth per nogg 3, and the noggs per inch 16.

SOLUTION.—

```
        4 crowns per in.
        2 points per tooth
        -
        8 points per in.
        3 teeth per nogg
       --
       24
       16 noggs per in.
      ---
      144
      24
      ---
      384 points per sq. in.
      144 in. per sq. ft.
     ----
     1536
    1536
    384
    -----
    55296 points per sq. ft.   Ans.
```

Dividing the points per square foot by the noggs per inch, thus, 55,296 ÷ 16 = 3,456, it will be noticed that with 8-crown fillet (4 crowns per inch) each nogg increases the points per square foot by 3,456. From this it will be seen that in order to find the points per square foot in 8-crown fillet clothing, it is only necessary to multiply the noggs per inch by 3,456.

EXAMPLE 2.—Find the points per square foot in the sample of card clothing shown in Fig. 6, the crowns per inch being 4, teeth per nogg 6, noggs per inch 8.

SOLUTION.—

4	crowns per in.
2	points per tooth
8	points per in.
6	teeth per nogg
48	
8	noggs per in.
384	points per sq. in.
144	
1536	
1536	
384	
55296	points per sq. ft. Ans.

Dividing the points per square foot by the noggs per inch, thus, 55,296 ÷ 8 = 6,912, it will be noticed that with 8-crown twill-set clothing each nogg increases the points per square foot by 6,912. From this it will be seen that in order to find the points per square foot in twill-set clothing it is only necessary to multiply the noggs per inch by 6,912.

In Table II is given the number of points per square foot of 8-crown, rib-set fillet (4 crowns per inch) with 3 teeth per nogg and with from 10 to 27 noggs per inch, and also shows the numbers of wire (American gauge) generally used in each case.

In Table III is given the number of points per square foot of 8-crown, twill-set clothing with 6 teeth per nogg and with from 5 to 13 noggs per inch and also shows the numbers of wire (American gauge) generally used in each case.

For an average grade of cotton the doffer should have 20 or 21 noggs per inch and the flats 10 or 10½ noggs per

TABLE II

Noggs per Inch	Points per Square Foot	American Number of Wire
10	34,560	28
11	38,016	28
12	41,472	29
13	44,928	29
14	48,384	30
15	51,840	30
16	55,296	31
17	58,752	31
18	62,208	32
19	65,664	32
20	69,120	33
21	72,576	33
22	76,032	34
23	79,488	34
24	82,944	35
25	86,400	35
26	89,856	36
27	93,312	36

TABLE III

Noggs per Inch	Points per Square Foot	American Number of Wire
5	34,560	28
6	41,472	29
7	48,384	30
8	55,296	31
9	62,208	32
10	69,120	33
11	76,032	34
12	82,944	35
13	89,856	36

inch, which in each case would give 69,120 or 72,576 points per square foot. For the main cylinder 18 or 19 noggs per inch are suitable, which would give 62,208 or 65,664 points per square foot. The number of points may of course be varied to suit the class of work, but it is generally desirable to have the same number of points in the doffer and flats,

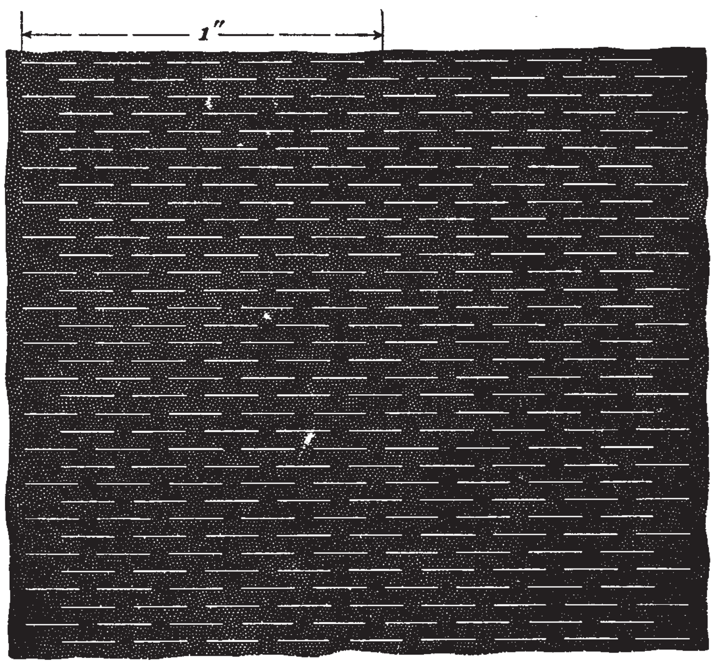


FIG. 7

while the main cylinder should have a slightly smaller number than either.

14. English Method of Numbering Card Clothing. English card clothing was formerly made with the teeth inserted according to a method known as the **plain-**, or **open-, set**, in which the crowns, or backs, of the teeth overlapped each other exactly as bricks in a wall, as shown in Fig. 7. The teeth were inserted in sheets 4 inches in width, and the clothing was made with 5 crowns on the back, or 10 points on the face, in 1 inch lengthwise of the sheet, or crosswise of the card after the sheet had been applied to the same; that is, it was 10-crown clothing. Plain-set clothing is not often used in America, and although rarely used in England today, it forms the basis of the whole English system of numbering clothing. The English system designates card clothing by the **counts,** a term that indicates the number of points per square foot on the face of the clothing absolutely, but which gives no clue to the method of inserting the teeth, whether plain-, rib-, or twill-set; that is, 100s-count card clothing indicates a definite number of points per square foot and nothing else.

As stated, the English system of numbering card clothing is based on the 10-crown, plain-set clothing, the term counts indicating the number of noggs in 4 inches, which was the original width of the sheets. Thus, if a sheet of plain-set, 10-crown clothing had 60 noggs in its width, it was 60s-count, or if it had 100 noggs in the width of the sheet, it was 100s-count clothing, etc. As plain-set clothing was invariably made on the 10-crown basis, the number of noggs in the width of the sheet, or the counts, always indicated a definite number of points per square foot. For example, in 100s-count clothing, as there are 100 noggs in 4 inches, then in 12 inches, or 1 foot, there are 300 noggs, and as in plain-set clothing there are 2 teeth per nogg, there are $300 \times 2 = 600$ points crosswise of the sheets. Since 10-crown clothing has 10 points per inch, there are $10 \times 12 = 120$ points in 1 foot lengthwise of the sheet, which multiplied by 600 points per foot crosswise of the sheet equals 72,000 points per square foot. From this it will be seen that as 100s-count clothing contains 72,000 points per square foot, each count increases the points per square foot $72{,}000 \div 100 = 720$ points. Therefore, to find the points per square foot in card clothing of any counts, it is only necessary to multiply the counts by 720; and inversely, to find the counts of any card clothing, divide the points per square foot by 720.

Although plain-set, 10-crown clothing has been largely superseded in both England and America by 8-crown, twilled-set clothing for the flats and 8-crown, rib-set clothing for the cylinder and doffer, the English system of numbering clothing is still based on the plain-set clothing, in which each count is equal to 720 points per square foot. Table IV shows the points per square foot in card clothing of various counts and also the number of wire (American gauge) that is usually used.

TABLE IV

English Counts	Points per Square Foot	American Number of Wire
60s	43,200	28
70s	50,400	30
80s	57,600	31
90s	64,800	32
100s	72,000	33
110s	79,200	34
120s	86,400	35
130s	93,600	36

METHOD OF CLOTHING CARDS

CLOTHING FLATS

15. The clothing for the flats is made in sheets with a 1-inch space between the sections of wire; these are afterwards cut up to form the **tops.** Formerly one of the most difficult problems for cotton-card builders and manufacturers of card clothing was to attach satisfactorily the top to the flat. The first method employed was to drill holes in each edge of the flat and secure the clothing by rivets. This method, while it held the clothing securely, had a tendency to weaken the flats, causing them to deflect; and in addition, the cotton occasionally caught on the rivets until a bunch was formed, which would pass into the card again and form a nep in the web. Another method was to sew the top to the flat, but this was not entirely satisfactory.

The present method is to employ a steel clamp of the same length as the clothing and bent in a **U**-shape. One edge of this clamp in some cases is serrated, so as to grip the foundation, while the other edge engages the edge of the flat, holding the clothing and flat securely together. The foundation of the card clothing is pulled toward the edges of the flat and clamps applied simultaneously to both edges, so that the clothing is fastened while under tension. Afterwards end pieces are usually fastened on in order to make the clothing absolutely secure. The flats should be ground after the clothing is applied, so as to make them perfectly true.

CLOTHING CYLINDER AND DOFFER

16. Both the cylinder and doffer, which are covered with filleting, have parallel rows of holes drilled across them, which are plugged with hardwood. The fillet is wound spirally and secured by means of tacks driven in the hardwood plugs. Cylinders are usually covered with 2-inch, and doffers with $1\frac{1}{2}$-inch, filleting. Formerly it was customary to give the surface of the cylinder a thin coat of paint or cover it with calico before applying the clothing, but the present practice is to wind the fillet on the bare cylinder. The plugs should be flush with the surface of the cylinder, which should be smooth, free from rust, and perfectly dry before the clothing is applied. Since the fillet is wound spirally, it must be tapered at each end of the cylinder or doffer, so that it will not overlap.

17. There are several methods of shaping the *tail-ends*, as they are called, but the best is that known as the **inside taper,** since it is stronger and neater than any other. Fig. 8 (a) shows the method of cutting the fillet for an inside taper. Three lengths x, x_1, x_2, each equal to one-half the circumference of the cylinder or doffer, as the case may be, are first marked out on the end of the fillet; in the case of a 50-inch cylinder these distances x, x_1, x_2 would be

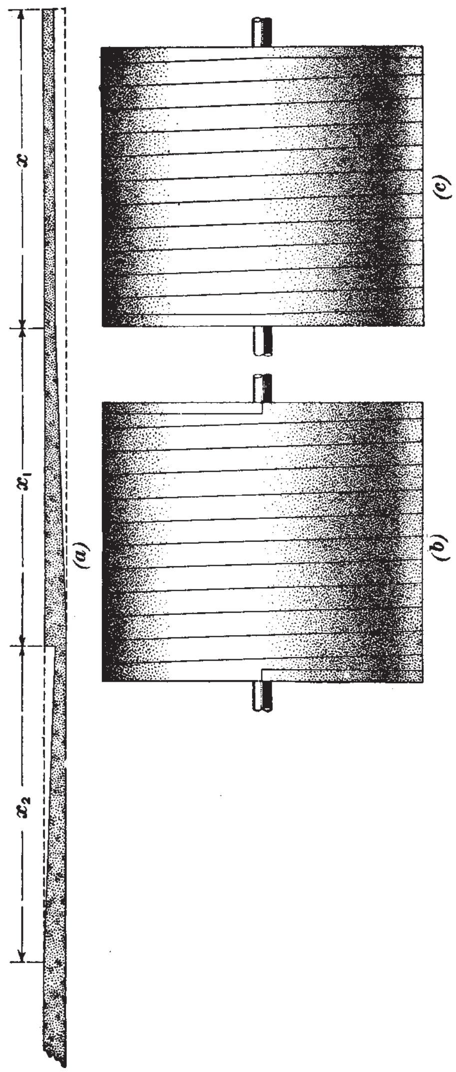


FIG. 8

6.545 feet each. For the first distance x, the fillet is cut exactly through the middle; for the second distance x_1, it is tapered from half the width of the fillet to the full width; for the distance x_2, a cut is made on the opposite side of the fillet exactly half way through it and the fillet tapered out to its full width again. The dotted lines in Fig. 8 (*a*) indicate the original width and shape of the fillet, while the full lines show the shape of the tail-end when cut. Fig. 8 (*b*) shows the method of winding the fillet on the cylinder and the way the tail-ends are fastened. After one tail-end is cut, the end of the fillet is tacked to the plugs in the cylinder and the fillet wound around the cylinder spirally, as shown in Fig. 8 (*b*) and (*c*); the other tail-end is then cut and fastened to the cylinder in the same manner as the first tail-end. Care should be taken in cutting each tail-end to have the straight, or uncut, edge of the fillet x, x_1 coincide with the edge of the cylinder. Fig. 8 (*c*) shows the opposite side of the cylinder shown in Fig. 8 (*b*).

18. To find the length of filleting to cover a cylinder, doffer, or other roll:

Rule.—*Multiply the diameter of the roll by its width (both expressed in inches) and by 3.1416 and divide the product thus obtained by the width of the fillet multiplied by 12. The result thus obtained will be the required number of feet of filleting.*

NOTE.—An allowance must be made for tapering the tail-ends, generally a length equal to the circumference of the roll being sufficient.

EXAMPLE.—What length of 2-inch filleting is required to clothe a cylinder 50 inches in diameter and 40 inches wide?

SOLUTION.— $\frac{50 \times 40 \times 3.1416}{2 \times 12} = 261.8$ ft.

Adding a length equal to the circumference of the cylinder, which is 13.09 ft., the length required will be 274.89 ft. Ans.

19. Fillet-Winding Machine.—Before applying the fillet, it should remain for several days in the room in which it is to be used; otherwise, it will have a tendency to expand after being fixed on the cylinder, which causes it to rise in places. The fillet is applied to cylinders or doffers by means of special winding machines; formerly it was wound by hand. Fig. 9 shows a good type of fillet-winding machine, which consists primarily of a carriage *a* that slides on a bed *b*. Sufficient motion is imparted to the carriage, by means of a rotating screw *c* that engages with a gear c_1 on a shaft, to guide the spirals of fillet close to each other. The gear c_1 is prevented from turning, after the position of the machine

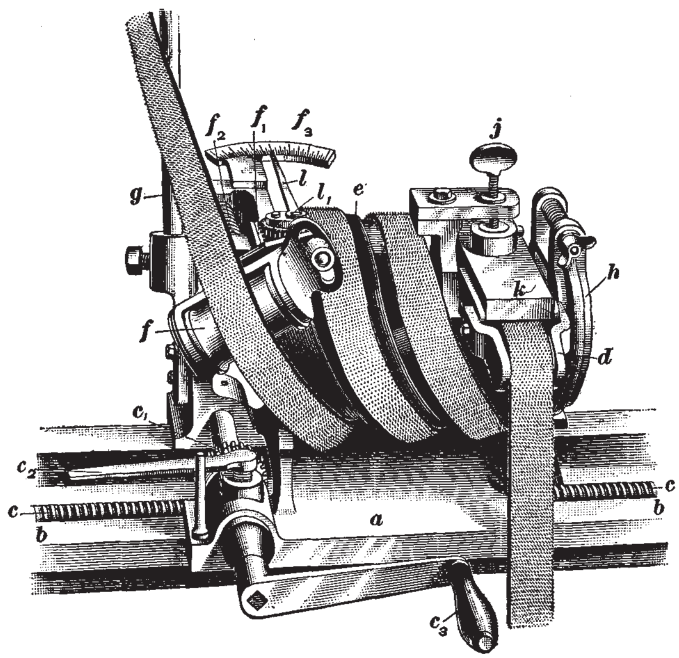


FIG. 9

is once adjusted with the crank c_3, by a lever c_2, which operates a screw that secures its shaft. The fillet when being wound is usually placed in a basket, or other receptacle, from which the end is taken and passed through the trough *d* to what is known as the cone drum *e*, around which it is wrapped three times. The fillet emerges over the roll *f* and is guided on the cylinder to be clothed by the rod *g*. The fillet must always be passed through the trough *d* so that the teeth will point in the opposite direction to its motion; otherwise, they will be injured.

The tension is obtained in the following manner: The drum *e*, which revolves as the fillet passes over it, is made in three sections—the first $6\frac{1}{2}$ inches, the second 7 inches, and the third $7\frac{1}{2}$ inches in diameter. The section with the largest diameter is covered with leather, so that this portion of the drum and the fillet revolve together; and as it requires a greater length of fillet to cover this surface than it does to cover either of the smaller sections, the fillet is drawn over these at a speed greater than that of their surfaces, which will have the same effect as if the smaller sections were working in a direction opposite to that of the larger section. The friction between the fillet and the drum produces the tension on the former, the amount of which may be regulated by the brake *h* on the drum shaft and also by a thumbscrew *j* that presses the die *k* down on the fillet, which is drawn over a spring cushion in the trough *d*. About 200 pounds tension may be obtained by means of the brake *h* alone, the rest being obtained by means of the thumbscrew *j*. For main cylinders wound with 2-inch fillet, a tension of 270 to 300 pounds is about right; narrower fillet requires less tension. Doffers may have fillet applied with about 175 pounds tension. The amount of tension with which the fillet is being wound in this machine is indicated by a finger *l* on the dial f_3. This is accomplished by arranging the roll *f* to press against a strong coil spring f_2, connection being made with a rack f_1 and pinion l_1, so that the motion of the roll when acted on by the tension of the fillet is communicated to the finger and indicated on the dial.

In using this machine, it is essential that for each revolution of the cylinder being covered the carriage shall move along the bed a distance corresponding to the width of the fillet. This is accomplished by gearing the screw that imparts the traverse motion to the carriage from the cylinder being covered, the train of gears being so arranged that one tooth of the change gear moves the carriage $\frac{1}{32}$ inch to each revolution of the cylinder being covered. From this it will be seen that $1\frac{1}{2}$-inch fillet will require a 48-tooth gear and 2-inch fillet a 64-tooth gear. In actual practice, however, a 49-tooth gear is used for $1\frac{1}{2}$-inch and a 66-tooth gear for 2-inch fillet, since the fillet is wider than the nominal width and measures $1\frac{17}{32}$ inches and $2\frac{1}{16}$ inches, respectively. A crank arrangement is usually applied to the cylinder and doffer so that they can be turned by hand while the clothing is being applied.

After cylinders are covered with fillet they should be allowed to stand for 3 or 4 hours in order that the fillet may become adjusted, when it should be tacked crosswise of the cylinder.

COTTON CARDS

(PART 3)

CARE OF CARDS

INTRODUCTION

1. The method of managing a card room very materially affects the quality of the product of a cotton mill, as in order to insure satisfactory results it is very essential that the carding process shall have careful attention. Care should especially be given to several important operations that must be performed at intervals.

Those parts of the card that are clothed—the flats, the cylinder, and the doffer—are constantly collecting waste from the cotton that is being operated on. This waste, consisting of short fiber and foreign matter that fills up the interstices of the card wire and prevents the card from doing its best work, must be removed at intervals from the clothing, the process being known as *stripping*. Fig. 1 is a view of a card showing arrangements applied for stripping the doffer and flats.

As the points of the card wire become dull, on account of the constant friction, and consequently do not card the cotton as satisfactorily as when sharp, they must be sharpened by means of emery rolls; this is accomplished by the process known as *grinding*. A view of a card, with arrangements applied for grinding the doffer and cylinder, is shown in Fig. 2.

When two wire surfaces are presented to each other, there

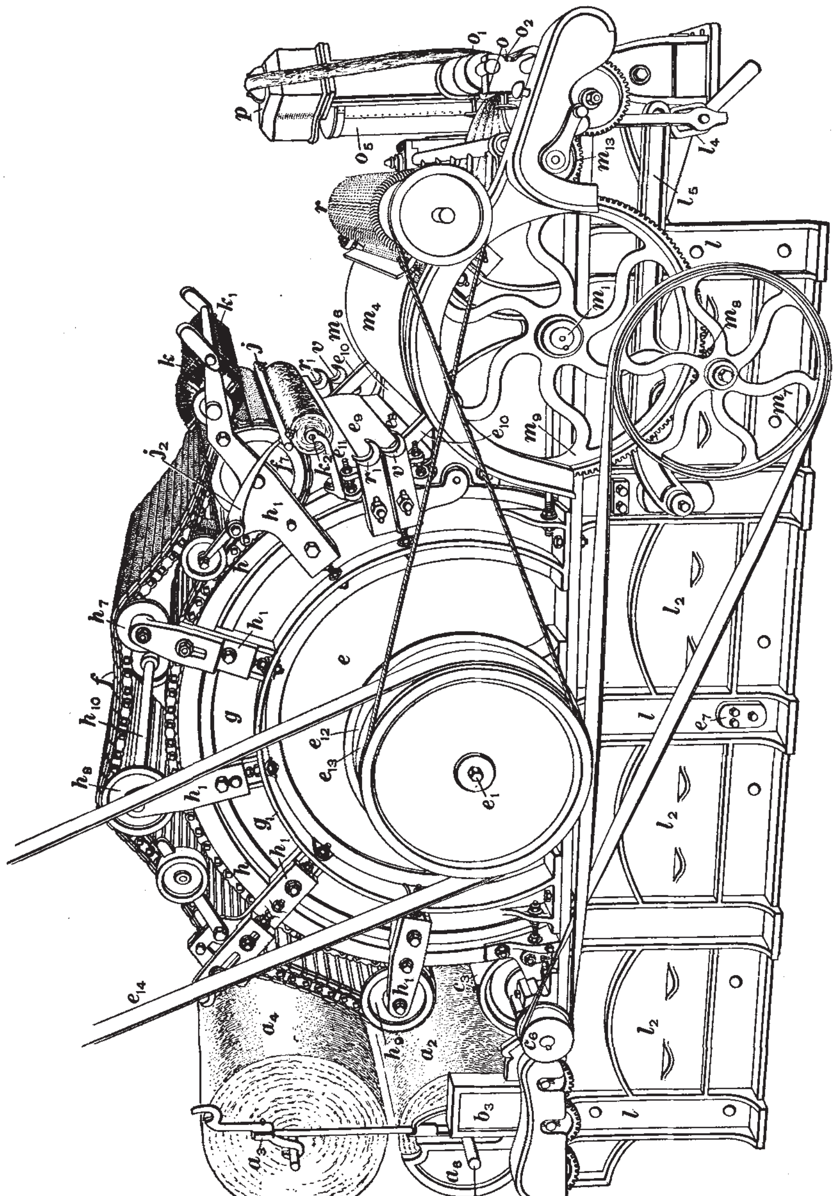


Fig. 1

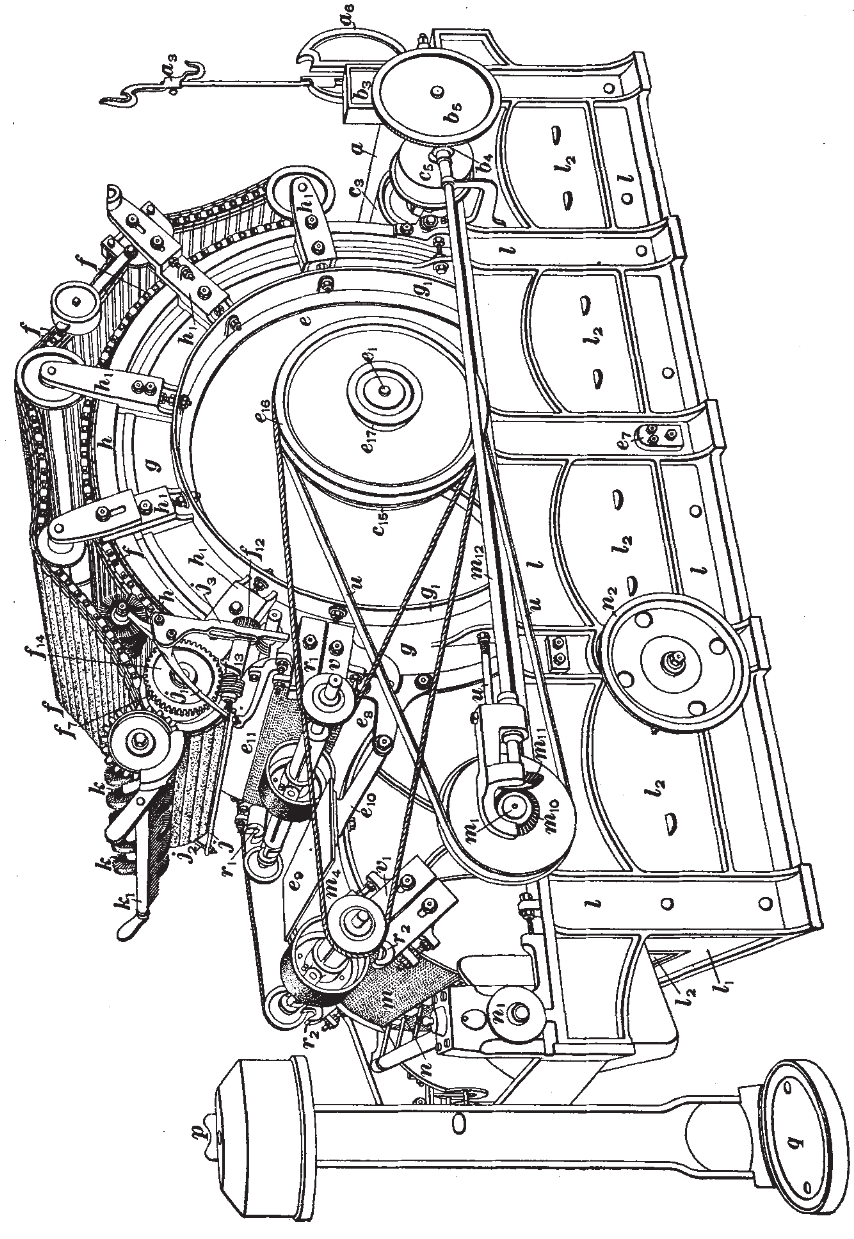


FIG. 2

is sometimes too much space between them, caused by parts of the card moving slightly out of position or by the shortening of the wire by the grinding process. The operation of regulating the distance between the two wire surfaces is known as *setting*.

In common with all machinery, the oiling of the parts must be periodically attended to, as well as the cleaning of the machine and the removal of fly from below the card. Very little more attention is necessary in connection with carding cotton with the revolving-top flat card other than keeping the machine supplied with laps and removing the cans when full.

STRIPPING

2. Methods of Stripping.—Various methods of **stripping** cards have been adopted. One of the earliest methods used in cotton carding, and one that is now in use in connection with woolen carding, was by means of a flat board from 4 to 6 inches wide and as long as half the width of the card, on the upper part of which a handle was attached, while a piece of card clothing was nailed on the lower part with the

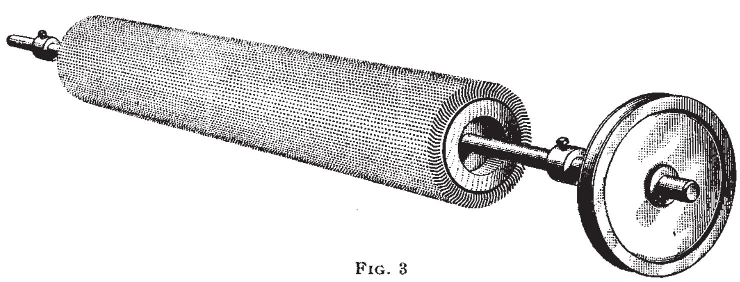


Fig. 3

points projecting toward the operator. The cylinder was slowly turned by hand, after it had been partly uncovered at the front, and the stripping card pressed into the wire of the cylinder and alternately pushed backwards and drawn forwards, the latter movement removing the waste from the cylinder. A similar operation cleaned the waste from the doffer.

A much better method of stripping the card and the one now commonly adopted is by means of a stripping roll, such as is shown in Fig. 3. This roll consists of a wooden cylinder mounted on an iron shaft and having wire clothing wound around it so as entirely to cover its surface, although on some rolls a narrow space without teeth is left from one end to the other. The clothing used for the stripping roll carries a very much longer tooth than that used to cover the cylinder or doffer, and the wire teeth are not set so closely together.

3. Frequency of Stripping.—The number of times that a card should be stripped within a stated period will be found to vary, but it may be said to depend on two factors. One is that the greater the weight of cotton that is put through the card per day, the more frequently it should be stripped; the other is that in fine work the clothing should be kept as free as possible from short fiber and particles of foreign matter, so that when running fine work the card should receive more frequent stripping, notwithstanding the fact that a lighter weight of cotton is being put through the card than in coarse work. It may be stated as a common practice that for fine work the card should be stripped three times a day unless a very large production is being obtained, when it is advisable to strip four or even five times per day, while with a medium production and where a very high grade of work is not called for, it is not necessary to strip the cylinder and doffer more than twice a day.

To stop a card for stripping purposes necessarily means a reduction in the amount of product, but by carefully planning so that the card will not be stopped any longer than necessary before it is stripped, and by getting it in operation again immediately after stripping, the loss can be reduced to a very small amount. In stripping cards two men are usually employed, since one cannot readily handle the long stripping roll; and time can also be saved by having one man preparing the next card for stripping while the other man is performing the operation of restarting the card previously stripped and removing the strippings from the stripping roll. Since it is the usual practice to strip the cylinder before stripping the doffer, time may also be saved by starting the feed while the doffer is being stripped. In this manner the cylinder will be filled and the sliver will be ready to be pieced up as soon as the stripping action is completed. In order to economize in the amount of strippings removed from the card, the feed-roll and calender rolls should be stopped a short time before the card is stopped, thus allowing the good cotton to run through the card and drop on the floor in front of the doffer; it is then removed and returned to the mixing room.

4. **Operation of Stripping.**—The operation of stripping is as follows: The card is first stopped by shipping the driving belt from the tight to the loose pulley. The feed-roll should have been previously stopped by disengaging the side shaft m_{12}, Fig. 2, at the doffer, and the gear m_{13}, Fig. 1, should also have previously been thrown out of gear by means of the handle, thus stopping the calender rolls and coiler and allowing the good cotton to run through the card until exhausted, as previously stated. As the cylinder is the first to be stripped, the cover, or door e_9, that protects the cylinder at the front and is hinged on the arms e_{10}, is lowered so as to leave the cylinder bare at that point. The stripping roll is now placed in the upper set of bearings r_1 and a band run from the outer groove of the loose pulley of the card to the grooved pulley on the end of the stripping roll. This band should be crossed in order to give the correct direction of motion to the stripping roll. With the stripping roll in this position its teeth should project a slight distance into the wire of the cylinder, usually about $\frac{1}{8}$ inch, and should point in the direction of revolution of the roll. At the point where the roll is in contact with the cylinder, the teeth of both are pointing in the same direction and the surface speed of the roll is greater than that of the cylinder, thus making the stripping possible. The driving belt of the card is now moved sufficiently on to the tight pulley to turn the cylinder slightly and at the same time leave

enough of the belt on the loose pulley to give the necessary power to drive the stripping roll.

It is advisable for the operator to be able to control the speed of the stripping roll at all times and to stop it suddenly if necessary. On this account the band that runs from the loose pulley to the stripping roll is not usually tight, the stripper creating sufficient tension to drive the stripping roll by pressing his hand on the band. By this means the wire teeth on the rapidly revolving stripping roll remove the waste from the spaces between the teeth of the card wire on the cylinder, this waste adhering to the surface of the stripping roll. In performing this operation, care should be taken that the cylinder does not attain a greater surface speed than the roll, since in this case the excess surface speed of the cylinder will cause the waste to be taken from the roll by the cylinder.

After the cylinder has made one complete revolution, the band that drives the stripping roll is removed and the stripping roll taken from the stands r_1 and cleaned and then placed in lower stands at the doffer, as shown in Fig. 1. A band somewhat longer than the one previously used is then run from the loose pulley of the card to the grooved pulley on the stripping roll r. This band is also crossed, and the operation of stripping the doffer is performed in the same way as that of stripping the cylinder. It is the practice in some mills, especially those making coarse counts, to run the card while stripping the doffer. This, however, is not good practice, since the stripping roll throws out considerable dirt, a good part of which is liable to drop into the web and be carried through into the finished sliver.

5. Cleaning the Stripping Roll.—After stripping the cylinder of each card, and also the doffer, the strippings retained by the stripping roll should be removed from the stripping roll. These strippings may be removed by a hand card or by placing a finger in the narrow space that is without wire teeth, when one is left in the stripping roll, breaking the circular web at this point, and unrolling it from the roll. Another method of removing the strippings from the stripping roll and one that is used in a large number of mills is to employ a box that is placed on wheels. This box is usually about 18 inches wide, 3 feet deep, and long enough to allow the clothed part of the stripping roll to rest between its ends, while the ends of the shaft rest in **V**-shaped grooves in the ends of the box. A strip of wood about 4 inches wide covered with card sheets is fixed between the ends of the box in such a position below the stripping roll that the wire teeth of the roll will just enter the wire of the sheets when the shaft of the roll is set in the grooves in the ends of the box. When cleaning the roll, it is turned by hand with a backward and forward movement, which causes the strippings to be removed and dropped into the box. This method is quicker and better than the hand card and provides a place for keeping the roll. The box also serves as a receptacle for the strippings.

It will be noticed that a card immediately after being stripped produces a sliver slightly lighter in weight, which is due to the spaces between the teeth of the clothing filling up again with fiber. In mills where it is desired to make exceptionally even yarns it is not advisable to strip at one time all the cards supplying one subsequent machine, but to take them in sections of either two or four supplying different machines.

GRINDING

GRINDING ROLLS

6. Grinding is the process of sharpening the teeth of the card wire on the cylinder, doffer, or flats by means of rolls called **grinding rolls,** and is of great importance in connection with carding. Formerly when mild-steel wire was used grinding had to be performed frequently. The clothing, however, that is almost universally used at the present time is made of hardened-and-tempered-steel wire that is ground on the sides after having been inserted through the foundation; consequently, the tooth is almost wedge-shaped, so that even when the extreme point is worn away there still remains a comparatively sharp tooth. Grinding is therefore required less frequently than formerly, not only because the hardened-and-tempered-wire retains its point longer, but also on account of the shape of the tooth.

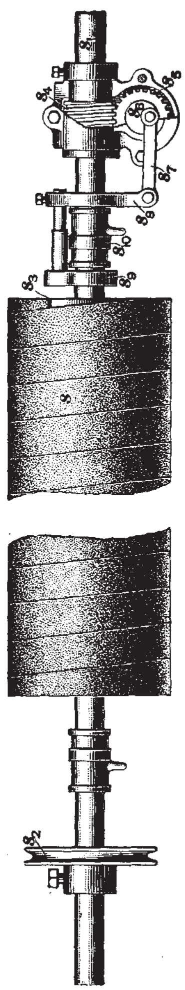


Fig. 4

7. Dead Rolls.—Grinding rolls are of two kinds—the *dead roll* and the *traverse grinder*. The **dead roll** is shown in Fig. 4. It consists principally of a hollow shell s mounted on a shaft s_1. This shell is covered with emery fillet wound spirally on its surface. At the ends of the shell, where the fillet tapers to a point it is passed through slots, one of which is shown at s_3, and is firmly fastened by means of a steel clip setscrewed to the inner side of the shell. A dead roll suitable for grinding purposes on a 40-inch card is about 42 inches long and $6\frac{3}{4}$ inches in diameter.

When grinding, the dead roll is given a slight traversing motion and grinds the back of the teeth with a slight tendency toward grinding the sides. The traversing motion is obtained in the following manner: The shaft that carries the shell s projects beyond both ends of the shell sufficiently to carry at one end the worm s_4 and at the other end the pulley s_2, through which the roll receives its rotary motion; this pulley is driven by a band that passes around the grooved pulley on the end of the cylinder shaft of the card. The worm s_4, which is fast to the shaft s_1, drives a worm-gear s_5 that carries a pin s_6 set away from the center of s_5 and loosely connected to the rod s_7, the other end of the rod being connected to the bracket s_8, which is loose on the shaft s_1. Connected to the bracket s_8 by means of a short rod is another bracket s_9, that is loose on the shaft s_1. The two brackets s_8, s_9 enclose a brass bushing s_{10} that rests in one of the bearings for the grinding roll when the roll is in position, while a similar bushing on the other end of the shaft rests in the other bearing. Pins on these bushings project into holes provided in the bearings and thus hold the bushings firmly in one position. These bushings are loose on the shaft s_1; consequently, the shaft is free to revolve and also to move laterally. With this construction, it will be seen that as the worm s_4 drives the worm-gear s_5, the latter, acting as an eccentric because of the position of the pin s_6, will tend to impart a reciprocating motion to the brackets s_8, s_9 through the connecting arm s_7, but will be prevented from doing so on account of these brackets being held in one position by means of the bushing s_{10}. Since the brackets are stationary, the rod s_7 and the pin s_6 that connects it with the gear s_5 can have no lateral movement; consequently s_5, by its eccentric movement around s_6, will, through its bearing in the gear-cover, a portion of which is shown broken away in Fig. 4, and through the collars on the shaft at each side of the cover, impart a traversing movement to the shaft s_1 and the roll s. Dead rolls are used for grinding the flats of the card, but seldom for grinding the cylinder or doffer, it being the custom to grind these two parts with the dead roll only when they have been newly clothed or when their surfaces become very uneven.

8. The Traverse Grinder.—The second type of roll, known as the **traverse grinder,** or sometimes as the **Horsfall grinder,** is shown in Fig. 5. It consists of a roll t about 4 inches wide covered with emery fillet and mounted so as to slide on a hollow barrel, or shell, of large diameter. Inside the barrel is a shaft containing right- and left-hand threads connected at the ends. A fork t_1 fits into these threads, and a pin that projects from it passes into

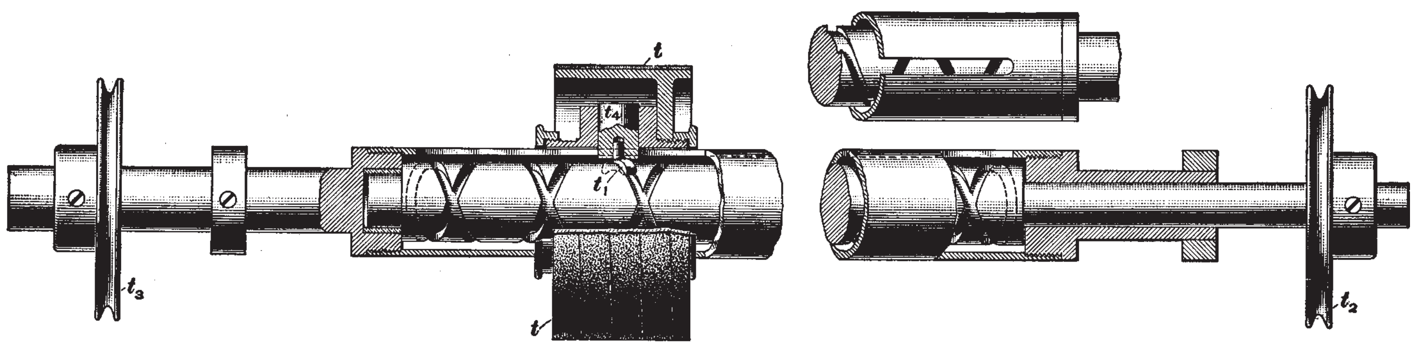


FIG. 5

another pin t_4 that projects into a straight slot in the outer barrel and enters the roll. There are two pulleys, one of which t_2 is on the inner shaft, while the other t_3 is on an extended portion of the barrel. With this construction the barrel is rotated when t_3 is driven; the pressure of the edge of the slot against the pin t_4 when the barrel is revolved causes the grinding roll also to revolve. A traverse motion is also imparted to the roll t by driving the pulley t_2, which causes the fork t_1 to be moved from side to side, changing from one thread to the other at each side of the card. Since the grinding roll presses against the clothing, the result of its traverse motion is to cause the teeth that are in contact with it to be bent, or inclined, toward the side of the card to which the roll is moving. The result of this is that the sides of the points of the teeth are ground down slightly, as well as the top of the points. In consequence of the roll being so narrow, it requires a longer time to grind the card with this mechanism than with the dead roll, other conditions being the same, but the results are so much better that it is very largely used. There is an unavoidable dwell on each side, which tends to grind down the sides rather more than the center; this is the only other important disadvantage in the use of this grinder.

Grinding rolls, whether traverse grinders or dead rolls, are usually covered with emery fillet; this is a tape 1 inch wide covered on one side with emery, and is supplied in lengths of about 300 feet. It can be obtained with emery of different degrees of coarseness or fineness, the kind generally used for card grinding being known as No. 40.

PREPARATION FOR GRINDING

9. All grinding is usually performed by a man known as a **grinder,** who in large mills has from twenty to sixty revolving-top flat cards under his charge. The cards are usually ground in turn, unless some accident or defect necessitates some card to be ground out of the regular order. Before the grinding takes place, however, the card must be prepared for this purpose, and the operation is somewhat as follows: The lap is either broken off at the back and the end allowed to run through, or more usually the side shaft m_{12}, Fig. 2, is disengaged and the feed-roll turned backwards by turning the plate bevel gear b_5 in the opposite direction from that in which it usually revolves. This rolls up the sheet and takes the fringe of cotton away from the licker. Any cotton in the card is allowed to run through and the cylinder and doffer are then stripped clean of short fibers, care being taken that no cotton remains on the part stripped. The card is then started and the flats allowed to run bare of all strippings; this takes from 25 to 40 minutes, according to the speed of the flats and nature of the cotton being carded. The card is then stopped and the fly taken out from under the card and from between the sides of the cylinder and framework and between the sides of the doffer and framework, where it collects. Card makers have in late years greatly lessened this space and in so doing partly reduced the amount of fly at these points. This waste is sometimes called **cylinder-end waste**, and is removed from these parts by means of a long, thin hook usually made from a bale tie. Fly also collects around the shaft that connects the sprocket gears that drive the flats. Care should be taken to remove all loose fly from around and under the card before grinding is commenced. If any remains there is great danger of fire, as sometimes the grinding roll strikes sparks.

After making certain that the gear m_{13}, Fig. 1, and the side shaft, m_{12}, Fig. 2, which where thrown out of gear before stripping, are well out of contact, disengage the doffer and barrow gears by throwing up the front end of the catch l_4, Fig. 1, which will drop the lever l_5 that supports the barrow gear. The licker belt, flat belt, and comb bands may then be removed. In some cases, when grinding, it is necessary to remove the pulley on the shaft with the worm that drives the flats, in order to accommodate the bands that are placed on the card for grinding, but where this is not necessary the flats should always be run with their driving belt reversed, so that when the direction of rotation of the cylinder is changed for grinding, as described later, the flats will move in the same direction and at the same speed as when carding. If the flats are stationary during the grinding process they will be filled with dirt by the cylinder, and the first cotton that is put through the card after grinding will have to be considered as waste on account of the unclean condition of the flats.

During grinding, the cylinder is driven at the usual speed but in the opposite direction to that in which it is driven for carding purposes. It is necessary to reverse its direction in order that the back of the tooth may be presented to the grinding roll when grinding. If the front of the tooth were presented to the grinding roll, the tooth would be beveled off at the front, which is directly the reverse of what is desired; in addition to this, the grinding roll acting on the front of the tooth would tend to raise it from its foundation and cause it to stand higher than it should. In order to reverse the direction of the cylinder it is necessary to cross the driving belt, if it was previously open; but if the belt for driving the cylinder when carding was crossed, it is simply necessary to have the belt open when grinding. If it is necessary to cross the belt when grinding it will be somewhat tight; to avoid this it is sometimes the custom to use an extra belt of the right length, which is carried from card to card by the grinder, although the same belt is more often used for both grinding and carding. In this case, if the belt was crossed when carding it must be taken up when used for grinding. This is accomplished by punching two holes in a line crosswise of the belt and two holes similarly placed but a short distance from the first holes and inserting a lacing of horsehide, thus forming a loop in the belt. The distance between these two pairs of holes depends on the amount of slack that it is necessary to take up in order to drive the cylinder with an open belt.

The doffer when being ground is driven in the same direction as for carding purposes, but at a higher speed, by a special belt *u*, Fig. 2, from a pulley on the cylinder shaft. By these arrangements both the cylinder and doffer revolve with the wire pointing in the opposite direction to the direction of motion.

10. After making sure that everything is clear of the cylinder and doffer and that the belts for driving them are properly adjusted, the card is started. The cylinder and doffer are then brushed by means of a brush about 2 feet long and 3 inches wide, which is held in contact with the cylinder and doffer wire by the operative and moved from side to side of the card, thus removing all dust from the interstices of the wire. The card is then allowed to run a few minutes to remove from the flats the dust that has lodged there when brushing the cylinder and doffer.

Next the card is stopped and the grinder removes such covers and bonnets as are necessary to be removed. The grinding roll for the cylinder is then placed in the stands v, Fig. 2, with the pulley that gives the traversing motion to the roll on the same side as the main driving belt of the card. A band for giving the rotary motion is put on the pulley t_3, Fig. 5, of the grinding roll and around one of the grooves of the pulley e_{16}, Fig. 2, on the cylinder shaft. The grinding roll for the doffer is now placed in position in the stands v_1 in the same manner as the cylinder grinding roll. A band is passed around the pulley t_3, Fig. 5, and around the other groove of the pulley e_{16} on the cylinder shaft.

The pulley t_2, Fig. 5, on the opposite end of the grinding roll imparts the traversing motion to the roll t. A band that passes around the grooved pulley compounded with the tight pulley on the cylinder shaft passes around the pulley t_2 on the doffer-grinding-roll shaft and also over the pulley t_2 on the cylinder-grinding-roll shaft, thus imparting motion to the latter by slight friction only. In some cases an extra pulley is placed on the shaft of the doffer grinding roll and a band passed from this pulley around one of similar size on the shaft of the cylinder grinding roll, thus giving a more positive traversing motion. The former method of imparting the traversing motion to both rolls is not very satisfactory, as the cylinder roll does not receive as positive a motion as it should, owing to the small portion of the pulley that comes in contact with the band.

It is possible to use one bracket for carrying both the stripping and the grinding rolls, but it is very inconvenient, as the wire of the stripping roll should project a short distance into the wire of the cylinder or doffer, while the surface of the grinding roll should only lightly touch the points of the wire on the cylinder or doffer; consequently, the distance from the center of the shaft to the surface of the roll will be different in each case. Even if the two rolls are arranged at first so that the necessary distances are obtained, the wire on the stripping roll will wear down more quickly than the emery on the grinding roll, and thus it will be necessary to adjust the brackets when changing from one roll to the other. Consequently, it should be ascertained which bracket must be used for each purpose, and in operating the card this fact should be remembered.

OPERATION OF GRINDING

11. Grinding the Cylinder and Doffer.—After having placed the grinding rolls in their stands, and usually before the proper bands are adjusted, the grinder proceeds to set the grinding roll to the wire on the cylinder and doffer. In performing this operation it is generally first necessary to use a card gauge, in order to make sure that neither grinding roll is pressing too heavily on any part of the cylinder or doffer. After this the proper bands are adjusted, the card is started and the grinder determines the actual setting of the grinding rolls to the wire by placing his ear as close as possible to the point at which the grinding roll comes in contact with the wire and judging by the amount of sound that is made whether either grinding roll is in its correct position. In light grinding, which is preferable, only a light buzzing sound should be distinguished, and care should be taken that this is the same at all points on the cylinder or doffer. When setting the grinding rolls, the brackets that support them are adjusted by means of nuts and setscrews provided for that purpose.

During the grinding operation, the grinding roll of both the cylinder and the doffer is rotated at a speed of from 800 to 900 feet per minute; the cylinder is making about 2,150 feet per minute, while a point on the surface of the doffer will move about 1,866 feet per minute in the card under consideration. The direction of the rotation of the cylinder and the doffer, and the inclination of the teeth are such that the grinding roll grinds the back of the teeth. At the same time, because of its traversing motion, it also grinds the sides as has been explained. The grinding roll does not merely touch the wire but produces a slight pressure on it, which tends to force the point of the wire forwards toward the foundation of the clothing; consequently, if the roll grinds on one portion longer than the other, the wire will be lower in this place. This is more liable to occur with the traverse rolls at the edges of the cylinder and doffer, where the rolls have a slight dwell during the reversing of the traverse. If possible this reversing should take place almost beyond the edges of the cylinder and doffer, and grinding stands are now set wide enough to allow a longer roll to be used, which permits the disk to traverse almost off the wire while reversing. After the card is ground, the grinder removes the grinding rolls and brushes out the cylinder and doffer clothing, for the purpose of removing all small pieces of steel or emery caused by the grinding. After stopping the card, the grinder removes the belt driving the doffer, makes the necessary settings, changes the driving belt, and replaces all belts, bands, and parts that were either removed or changed in position to prepare the card for grinding; he then puts on a lap and starts up the card.

The length of time required for grinding depends to a great extent on the condition of the wire, since if the points of the teeth are dulled considerably, a longer time will be required than if the clothing is in comparatively good condition. The degree of coarseness of the emery on the grinding roll also governs to some extent the time required for grinding, since coarse emery cuts much faster than fine emery. The time required for grinding is also governed by the amount of pressure exerted by the grinding roll on the clothing. If the grinding roll is set so that it presses heavily on the wire, the grinding will be accomplished in less time, although there is more danger of injuring the wire; such grinding is known as *heavy grinding*. If the grinding roll presses only lightly against the clothing, a greater time will be required to secure the proper point on the teeth, but there is less danger of injuring the wire; this method of grinding is spoken of as *light grinding*.

The temper of the wire with which the card clothing is set also affects the length of time required for proper grinding, since hardened and tempered wire grinds more slowly than soft wire.

As a general rule it may be stated that from one-half to one working day, or from 5 to 10 hours, is the usual time required for properly grinding the cylinder and doffer of a card.

The interval between the times of grinding depends somewhat on the product of the card, the condition of the wire, and the opinion of the person in charge. Generally speaking, it is advisable to grind frequently and lightly for a long time rather than at more remote intervals and heavily for a short time, as the former method is not so liable to heat the wire and to take out the temper. If the cards are turning off an average production for medium counts, grinding the cylinder and doffer once in every 20 or 30 days will be found sufficient. In many mills they are not ground so frequently.

12. Grinding a New Card.—A card that has been newly clothed requires grinding before being used for carding purposes, and this first grinding operation will be found to differ somewhat from the usual method of grinding, the object being to render the surface of the cylinder and doffer perfectly level at all points. If the fillet is not put on with a regular tension it is liable to rise, or blister, at places, and if the tacks that hold it have not been driven with care the wires around them will be high. Sometimes the edges of the fillet are allowed to overlap slightly or the fillet is crowded too closely, thereby causing the wire to be higher in some places than in others. If the card is carefully clothed these faults should not occur to any extent, but when they do those wires that are higher than the others must be ground level with the rest of the surface. A newly clothed card is first ground with dead rolls, which are left on until the surface of the wire on the cylinder and doffer is perfectly smooth; this takes from 3 to 10 days. After the wire has been ground level by means of the dead rolls, the traverse rolls are used for the purpose of putting a point on the wire and are left on about a similar period, the length of time depending on the temper of the wire and also on the length of time that the wire has been ground by the dead rolls.

13. Grinding the Flats.—The card wire on the flats requires grinding periodically, and while some portions of the preceding description and remarks apply to grinding in general and can be applied to the grinding of the flats, there are special features in connection with this process that make it differ somewhat from the grinding of the cylinder and doffer. The fact that the flats are arranged in an endless chain and slide for a portion of their movement on a smooth, circular arc, while at another portion of their circuit they are carried over rolls on which they are suspended, prevents their being driven past the grinding roll at the same speed as the card wire on the cylinder or doffer. On this account and also because there are, during the running of the card, a number of the flats that are performing no actual work for a considerable length of time, it is customary to grind the flats while the card is in operation and with the flats moving at their working speed, which saves a loss of time and production. This slow movement of the flats, since only one flat is ground at a time, causes considerable time to elapse before all the flats can be brought under the action of the grinding roll. The dead roll is almost always used for grinding the flats and is placed in brackets on each side of the card. These brackets are so adjusted that the roll, when resting in them, will lightly touch the wire of the flats as they pass from the front to the back of the card; that is, it grinds the flats while they are suspended by the bracket over which they move. An arrangement is adopted to firmly support the flat while it is being ground, and at the same time hold it in such a position with relation to the grinding roll that the heel of the flat will not be ground off. When the flats are at work the heel is closer to the card wire on the cylinder than is the toe, and if this relative position

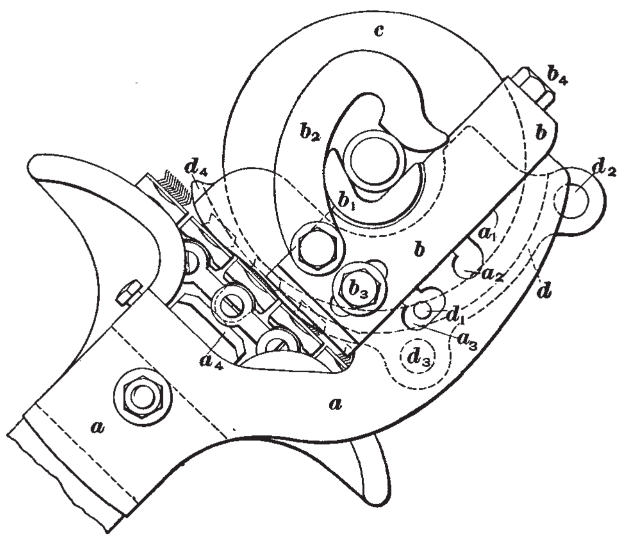


FIG. 6

were preserved with regard to the grinding roll, the wire at the heel would be ground off before the wire at the toe was touched by the grinding roll.

14. One type of grinding apparatus is illustrated in Figs. 6 and 7; Fig. 6 shows the grinding apparatus in position, while Fig. 7 is a perspective view of some of the essential parts. The bracket a that supports the different parts is firmly attached to the side of the card, there being a bracket on each side. Resting against the inclined surface a_1 of the bracket a is a casting b that carries the bearings b_1 for the grinding roll c. Attached to this casting is a finger b_2 that serves to lock the grinding roll firmly in position. The casting b is firmly secured to the piece d and can be adjusted by loosening the nut b_3 and turning the set nut b_4, thus moving the grinding roll nearer to or farther from the teeth of the flats, as may be desired. A pin d_1 that is carried by d may be set in either of the slots a_2, a_3 cast in the bracket a. At its lower part the piece d carries the **former** d_4, which is so shaped that if it is pressed firmly against the end of the flat, the wire surface of the flat will be presented in such a position to the grinding roll that the flat will be ground evenly across its width. These parts are, of course, duplicated on the other side of the card, and rods that serve to connect the two sides at the points d_2, d_3 extend across the card, the entire mechanism being known as the **cradle.**

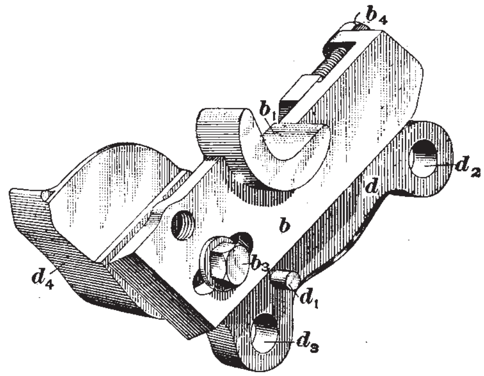


FIG. 7

The parts mentioned form the principal parts of this mechanism and its operation is as follows: When the cradle is in position for grinding, the pin d_1 on d projects through the slot a_2 of the bracket a, but it should be clearly understood that during grinding, d is not supported by the bracket, since the weight of all the parts is made to bear on the ends of the flats, which during this time are supported by the bracket a_4, attached to the bracket a. In this manner, each flat during its movement from the front to the back of the card is brought between the bracket a_4 and the former d_4, against which it will be rigidly held; the former d_4 is milled in such a manner as to cause the flat to assume its correct position in relation to the grinding roll and to be held in this position until it has passed entirely from under the action of the grinding roll. When this grinding arrangement is not in use it may be raised and the pin d_1 inserted in the slot a_2, thus bringing all the parts out of contact with the flats; or when it is desired, all the parts may be removed to another card for the purpose of grinding.

15. Another device for holding the flats in the correct position for grinding is shown in Figs. 8 and 9; Fig. 8 shows the mechanism as it appears when looking at the side of the card, while Fig. 9 shows certain of the parts as viewed from

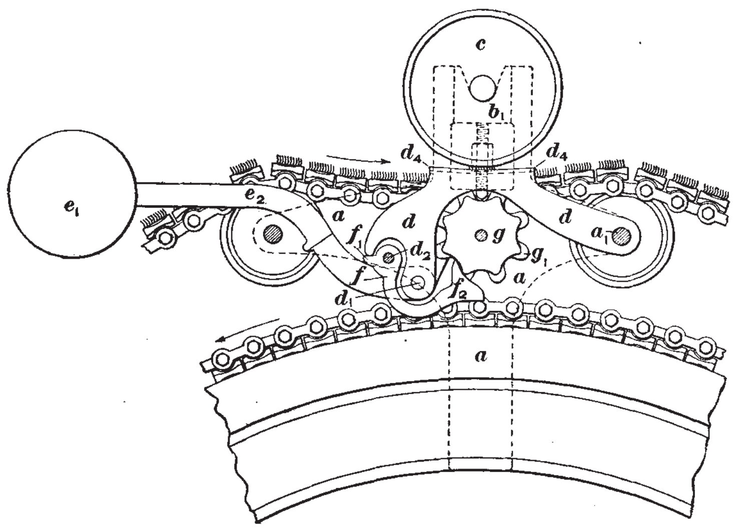


FIG. 8

the inside; consequently, one view is the exact reverse of the other. These parts are duplicated on each side of the card, but as they both work exactly alike only one will need a description. The grinding roll c is placed directly over the center of the cylinder and rests in the bearing b_1 supported by the stand a, which is firmly attached to the framework of the card. In the illustrations, the bearing b_1 and stand a are indicated by dotted lines in order to leave an unobstructed view of the interior parts. Pivoted to the stand a at the point a_1 is a casting d, the upper part of which projects sufficiently to come directly over the outer ends of the flat, and constitutes the former d_4. If the flat is forced against this projecting piece, or former, the teeth will assume the correct position for grinding. Pivoted to the casting d at the point d_1 is a lever e_2 that carries at its outer end a weight e_1, while the inner arm e of this lever bears against the under side of the flat. Pivoted to the bracket a at the point d_2 is a lever f that carries a shoulder f_1 that bears against a projection on the casting d. At its other end, the lever f has a projecting finger f_2 that bears against the cam g. Compounded with

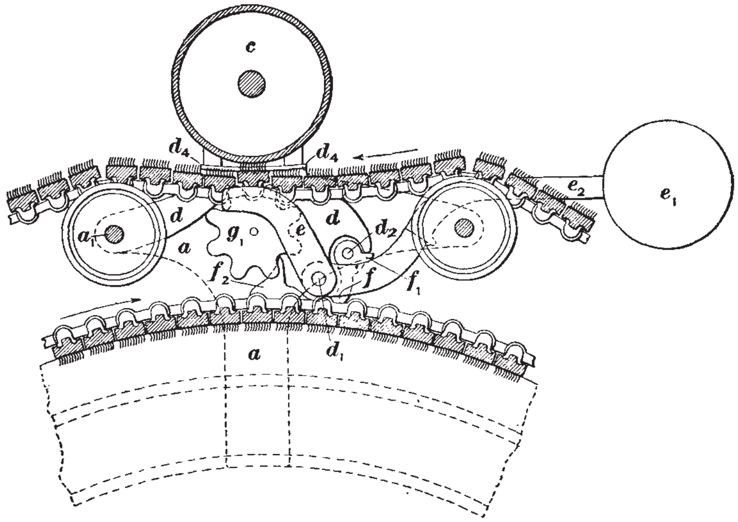


Fig. 9

the cam g is a sprocket gear g_1, the teeth of which engage with the ribs on the backs of the flats.

The operation of this mechanism is as follows: The flats move continuously, the upper line being face up and moving in the direction indicated by the arrow. The movement of the flats causes the sprocket gear g_1 to revolve on its stud, and since the cam g is compounded with the sprocket gear, it will revolve also. The projection f_2 of the lever f is held in contact with the face of the cam by the pressure of the casting d on the shoulder f_1; consequently, as the cam revolves and one of the high portions of its face comes in contact with the projection f_2, it will force the projection f_2 downwards, and allow it to rise again when one of the low portions of the face of the cam approaches. This movement of the lever f causes the casting d and former d_4 to be alternately raised and lowered to a slight extent.

As the flats move in the direction indicated by the arrow, a portion of the rib of each comes in contact with the upper surface of the arm e, which tends to raise each flat but is prevented from doing so by the former d_4; consequently, the flat is practically locked between these two parts, although its movement in the direction indicated by the arrow is not prevented. As the former d_4 is raised the flat that is thus locked is carried upwards until it assumes its proper position for grinding, which is controlled by the cam g and the former d_4. After the flat has moved sufficiently to be free from the action of the grinding roll c, the former d_4 and arm e are lowered to allow another flat to be brought into position to be raised and ground. This operation is continued throughout the grinding of each flat in the entire set. The lowering of the former and arm allows each flat to be brought into position before being raised in contact with the grinding roll, thus insuring that each flat will occupy its proper position before coming under the action of the grinding roll.

16. Owing to the fact that the flat when performing its carding action is supported at each end only, and also on account of its length being so much in excess of its width, there is a tendency for the flats to bend downwards, or deflect, in the center. The rib forming the back of the flat is so shaped as to reduce the amount of deflection to a minimum, but it cannot be altogether overcome. It will thus be seen that if the flats are ground perfectly level when the wire is upwards, the surface when reversed, that is with the wire downwards in position for carding, will be slightly convex and consequently the ends of the flats cannot be set so close to the cylinder as their centers. To overcome this difficulty and also to avoid dirt and pieces of emery dropping on the cylinder, which sometimes occurs when the grinding takes place above the cylinder, the flats are sometimes ground in their working position. Such a method is shown in Fig. 10. In this case, the grinding apparatus is placed at the back of the card and the flats are ground with their faces downwards

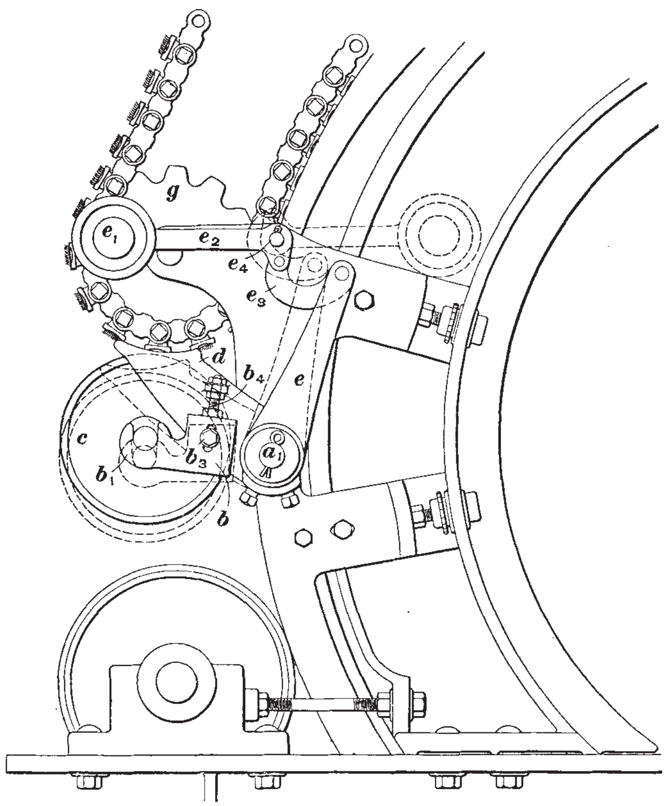


Fig. 10

while in the same relative positions as they occupy when carding. The face of the flat being underneath partly prevents broken wires, pieces of steel, and emery from lodging in the wire and thus being carried around into the carded cotton and incurring the risk of injuring the clothing. The grinding roll c is supported by bearings b_1 that form a part of the bracket *b*, which is fastened to the lower part of the former *d* by means of a setscrew b_3. The bracket that supports the bearings is adjustable and may be altered to bring the grinding roll into its correct position by loosening the setscrew b_3 and turning the adjusting nuts on the setscrew b_4. The upper part of the shoe, or former, *d*, is so shaped as to give the correct position to the flat, and at its lower end is pivoted on the stud a_1. Pivoted on this same stud and connected with the former, is a lever *e* that is connected to another lever e_2 by means of the link e_3; the lever e_2 is pivoted at e_4 and carries at its outer end the weight e_1. When the weight is thrown back in the position shown by the full lines in Fig. 10, it raises the former together with the bearings for the grinding roll, causing the former to bear against the end of the flats and thus give each flat the correct position for grinding as it is brought around by the sprocket *g*. When the grinding apparatus is not in operation, the weight is thrown forwards. By this means the former, together with the bearings for the grinding roll, is lowered, and no part is in contact with the flats. The positions assumed by the different parts when the weight is thrown forwards are shown by the dotted lines in Fig. 10.

The length of time given to grinding the flats varies for the same reasons as those given in connection with grinding the cylinder and doffer, but the intervals between grindings are longer. It is considered sufficient to grind the flats every 4 or 6 weeks. It is advisable, but seldom the practice, for a mill to own a machine for grinding the flats of the revolving-top flat cards. When a mill is in possession of such a machine, it is customary at least once a year to remove the flats from each card and to grind them all to exactly the same gauge, thus insuring that no flat differs from any other in the same card owing to the unequal wear either of the wire or of the ends that rest on the bends.

17. Grinding the Licker.—The licker seldom requires grinding, generally only after an accident has happened to it. When it is necessary to grind the licker, the **solid emery**

or **carborundum wheel** should be used. The licker and wheel are revolved in such a way as to cause the wheel to run against the points of the teeth of the licker. After grinding, the motion of the licker is reversed and the end of a board moistened with oil and sprinkled with powdered emery is pressed against the teeth. By this means the teeth are made smooth. Other methods are sometimes used, such as applying a soft brick or a piece of sandstone to the back of the teeth while the licker is revolving in an opposite direction to its working one.

18. Burnishing.—The card-wire manufacturers supply what is known as a **burnishing brush,** which is now used in some mills. The action of plow grinding or side grinding in the manufacture of wire tends to leave the wire rough at the side, and it is always burnished very carefully before leaving the factory. As it wears down, parts of the wire are reached that have either become rough or were not acted on by the burnishing brush in the manufacturing of the wire. The burnishing brush is therefore used in the mill to burnish the wire on the cylinder, doffer, and flats. It is somewhat the same as the stripping roll, but has absolutely straight wire about $\frac{3}{4}$ inch in length set loosely in the foundation. The brush rests in the stands usually occupied by the grinding roll. It is set into the card wire about $\frac{1}{8}$ inch and makes about 600 revolutions per minute; its outside diameter is 7 inches. It is usually left in operation for a whole day or even longer.

When burnishing the wire on both the cylinder and the doffer it is customary to run them at a very slow speed. This is accomplished in the card under description as follows: A band pulley $14\frac{1}{2}$ inches in diameter having three grooves on its face is compounded with a 20-tooth barrow gear by means of a sleeve. The regular barrow pulley and barrow gear are removed from the barrow stud and the band pulley and gear substituted. The main driving belt runs on the loose pulley, on the edge of which is a groove 20 inches in diameter. In this groove a band is placed that drives the band pulley on the barrow stud at about 220 revolutions per minute. The additional grooves in this pulley, by means of bands, drive the burnishing brushes. The speed of the doffer by this method is about 23 revolutions per minute, and as it carries a pulley 11 inches in diameter that drives an 18-inch pulley on the cylinder shaft, the cylinder will rotate at about 14 revolutions per minute. The circumferential speed of the burnishing brushes is about six times that of the cylinder.

SETTING

19. The setting of the different parts of the card requires careful attention and is one of the most important points in the management of the card room. Owing to the wear of the wire in grinding and the wearing of the journals of the shafts carrying the cylinder, doffer, and licker, there is a constant tendency for the wire teeth of the different parts of the card to separate and thus increase the distance between their surfaces. This calls for a readjustment of the various parts, which is known as **setting.**

The principal places where setting is required are as follows: between the cylinder and the flats, between the licker and the cylinder, and between the doffer and the cylinder. Other places for setting are between the mote knives and the licker, between the feed-plate and the licker, between the cylinder screen and cylinder, between the licker screen and the licker, between the back knife plate and the cylinder, between the front knife plate and the cylinder, between the flat-stripping comb and the flats, and between the doffer comb and the doffer. In order to determine when these parts require setting, it is sometimes necessary to remove certain covers or bonnets and insert gauges, while in other cases the proper time for setting is determined by examining the work delivered by the card, a method requiring an experienced eye. The intervals at which cards are set vary in different mills, but the parts that contain the clothing are usually set directly after grinding, while the time for setting the other parts is governed largely by the amount of work done by the card and the stock being used or to be used.

20. Gauges.—The exact setting, or distance between certain parts, of the card is determined by the use of **gauges;** two, and in some cases three, kinds are used. The first one is about 9 inches long and $1\frac{3}{4}$ inches wide and contains four leaves pivoted together. These leaves are made of thin sheet steel and are usually $\frac{5}{1000}$, $\frac{7}{1000}$, $\frac{10}{1000}$, and $\frac{12}{1000}$ inch thick, respectively. The second gauge, which is used exclusively for flat setting, consists of a strip of sheet steel about $2\frac{1}{2}$ inches long and $1\frac{1}{4}$ inches in width bent at right angles about $\frac{1}{2}$ inch from one end, with a handle attached to this end. The other end is the part used for setting and is usually $\frac{12}{1000}$, $\frac{10}{1000}$, or $\frac{8}{1000}$ inch thick. The third gauge consists of a quadrant or semicircle mounted on a shaft and is used for setting the top of the cylinder screen to the cylinder and licker, and also in some cases to set the licker screen to the licker. The curvature of this gauge corresponds to the curvature of the licker. Card gauges are spoken of in the mill as being of a certain number, thus a gauge $\frac{7}{1000}$ inch thick is termed a No. 7 gauge, while a gauge $\frac{10}{1000}$ inch thick is termed a No. 10 gauge.

Since the leaf and flat gauges are very thin, they are easily damaged, and in this condition are of little use, producing faulty settings; consequently, great care should be used to prevent the faces becoming dented, bent, or injured in any way. As the efficiency of the card depends on the proper settings, it will be seen that any defect in the gauge will injure the quality of the production of the card. In many cases poor work results from faulty settings or poor gauges.

21. Setting the Flats.—In order to make it possible to set the teeth of the flats the required distance from the teeth of the cylinder it is necessary that some means be adopted by which the flats may be raised or lowered as desired. The manner of accomplishing this will be found to differ on different makes of cards; one method is shown in

Fig. 11. In this figure a portion of the cylinder *e* of the card, the arch *g*, and the flats *f* supported by the flexible bend *h* are shown. It should be understood that there is a flexible bend similar to *h* on the other side of the card and that the ends of the flats rest on this bend in a similar manner to that shown in Fig. 11. The bend *h* is supported by brackets, which in some cases are composed of two parts h_1, h_2. In

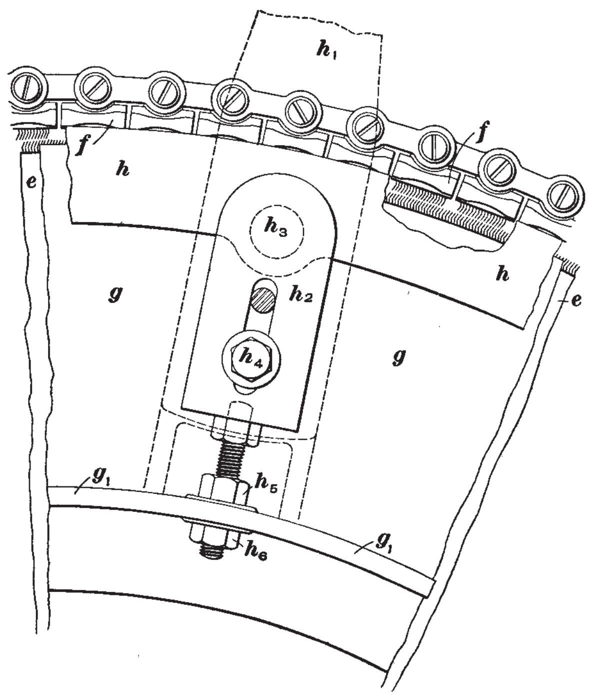
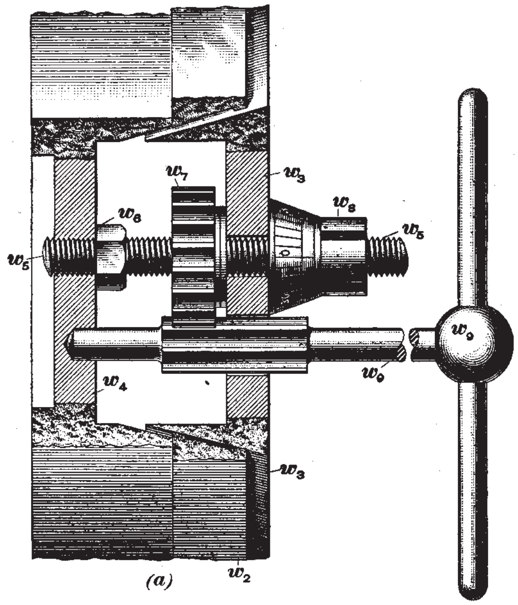


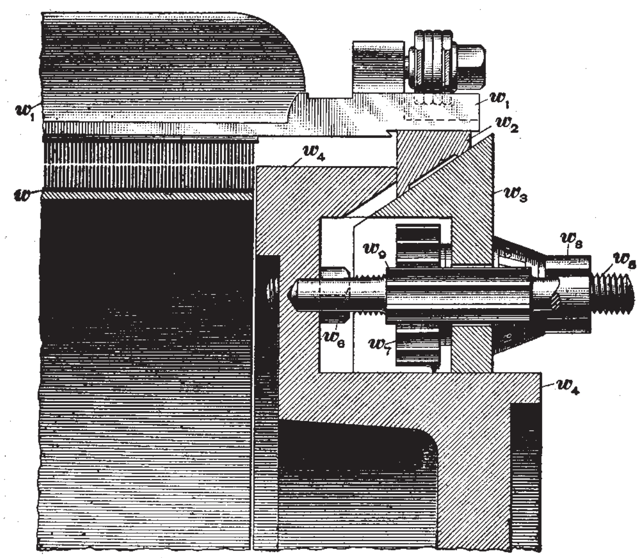
FIG. 11

Fig. 11, the outer portion h_1 is shown in dotted lines. The inner portion h_2 is so made that a projecting lug h_3 fits into a hole in the bend and securely holds it in position. The part h_2 is supported by a screw that passes through the rib g_1 of the arch and carries two set nuts h_5, h_6, one above and one below the rib. The bracket is also further held in position by means of the screw h_4, which passes through a slot in the bracket and enters the arch of the card. It is by raising or lowering the bend h by means of the bracket h_2 that the flats are raised or lowered as desired. There are five of these brackets on each side of the card, and when setting the flats care should be taken that all the brackets are properly adjusted. When setting the flats, the screw h_4 and nut h_6 are loosened and the flats raised or lowered by turning the nut h_5 either down or up, respectively. After the flat has been set in the desired position, the screw h_4 and the nuts h_5, h_6 are firmly secured, thus holding the bracket and bend securely in their proper positions.

22. Another arrangement for setting, or adjusting, the flats is shown in Fig. 12 (*a*) and (*b*), of which (*a*) is a plan view, partly in section, and (*b*) a sectional elevation. The flats are supported by the flexible bend in the usual manner, but the method of supporting the flexible bend is a radical departure from the one just described, the only resemblance being that both have five setting points on each side of the card. The shell of the cylinder covered with fillet is shown at w, while w_1 represents the flat, which is supported by the flexible conical bend w_2, and this in turn is supported by the rigid conical bend w_3 instead of brackets. The bend w_3 rests on the arch w_4 of the card. It can be seen by referring to the figures that the under surface of the flexible bend is beveled and rests on the beveled surface of the rigid bend; consequently, when the bend w_3 is forced in toward the cylinder the bend w_2 must rise, while on the other hand if w_3 is forced outwards the bend w_2 must fall, thus raising or lowering the flats as may be desired. The bend w_3 is operated by a screw w_5 that projects through this bend into the arch of the card and is held in place by the binding nut w_6. On the inner side of the bend w_3 is a toothed nut w_7 that serves as a binding nut and also as a device for forcing the rigid bend away from the cylinder. On the outer side of the bend is a nut w_8 that serves as an index nut, a binding nut, and also as a device for forcing the rigid bend in toward the cylinder. The toothed nut w_7 is operated by a key w_9 that has a fluted, or toothed, portion to fit the teeth of the nut w_7.



(a)



(b)

Fig. 12

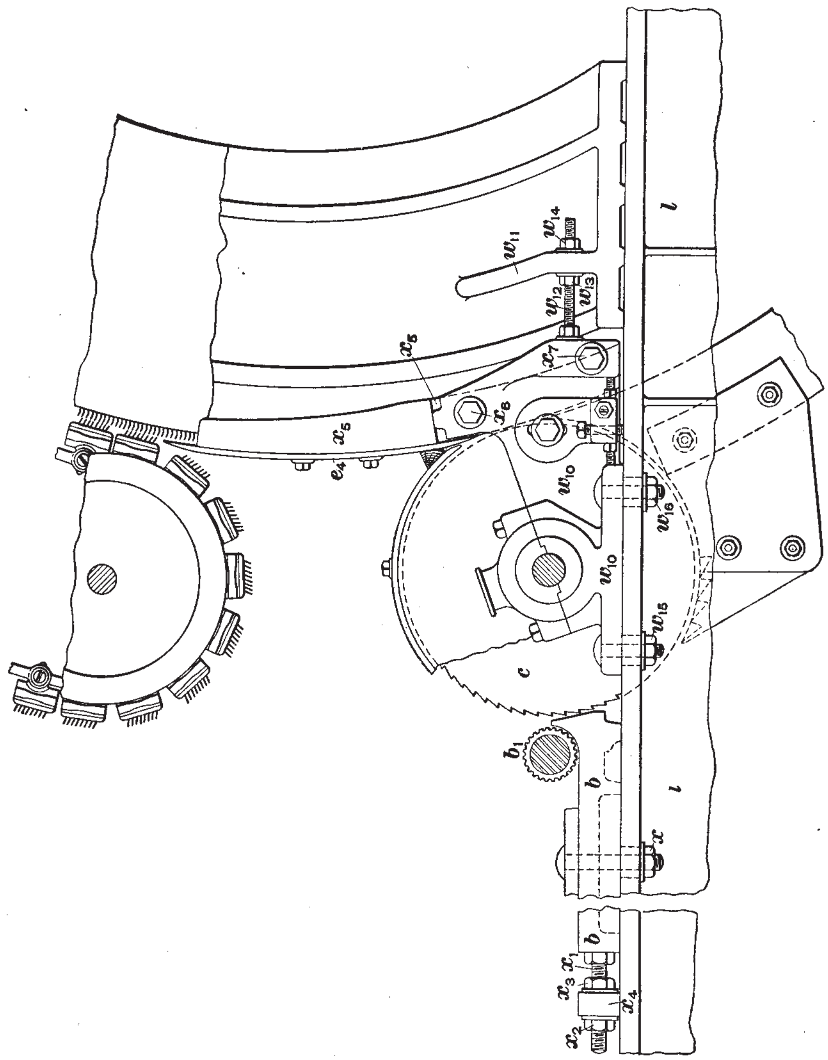
When it is desired to lower the flats, or set them closer to the cylinder, the key w_9 is inserted in a hole in the rigid bend and engages with the teeth of the nut w_7. The index nut is moved out on the screw and then the toothed nut is tightened by means of the key, thus forcing out the rigid bend and binding it firmly in position. When it is desired to raise the flats, the toothed nut is loosened and the index nut moved in, thus forcing the rigid bend in until the desired position is reached, after which the toothed nut is again tightened. The index nut is provided in order that the person making the adjustment may tell at a glance just how far the flats are moved.

23. The flats are set by means of the flat gauges described, while the card is stopped, and preferably when other machinery in the room is also stopped, so as to prevent any vibration of the floor. In order to provide a blank space in which to insert these gauges, it is necessary to remove certain flats from the chain of flats above the cylinder. Two methods of removing these flats are followed, depending on the method of setting that it is intended to adopt. In those cards constructed with five setting points on each side of the card, it is common to use five flats for setting purposes, a flat being selected that stands almost immediately above each setting point. The flats on each side of the setting flats, as they are called, are removed, making it possible to slip in a gauge on either side of the setting flat; thus, there are ten flats in all removed. A short shaft carries the worm-gear f_{12} and the worm f_{13}, Fig. 2, through which the flats are driven; on this shaft a crank is placed and used to turn the flats while setting. By means of this crank the flats are turned until each of the five setting flats comes directly above a setting point, and they remain in that position until the setting of the flats is completed.

Another method is to remove a flat on each side of one setting flat only, or sometimes two setting flats. This gives but one or two flats that are used for setting purposes, and as there are five setting points on the flexible bend, the chain of flats must be turned several times in order to bring these setting flats directly over the places where the gauges are inserted. Advantages are claimed for each system, but on the whole there is less work and quicker setting when using five setting flats.

The side of the flat used for setting purposes is the *heel*, which is the side nearest the wire on the cylinder, being about $\frac{3}{100}$ inch nearer than the *toe*. Having brought the setting flats into the correct position over the setting points, the gauge is inserted first between the flat and the cylinder above the central setting point, and the proper adjustment made, as has been described. In setting a flat it is only possible to set one end at a time. The end that is being set, however, should be held firmly in position on its bearings with one hand while the gauge is moved back and forth across the card between the flat and the cylinder with the other hand. Owing to the width of the card it is impossible to move the gauge the entire length of the flat; consequently, one side is set temporarily and then the other side is set in a similar manner, after which the first side set should be tested and also the second side set to make sure that the flat is in the proper position. When both ends of the central flat have been set, the flat at the extreme front of the card is usually set next, at both ends; then both ends of the flat nearest the rear of the card are set, and then the two intervening flats. In setting flats there should be a certain amount of friction, or resistance, felt when moving the gauge along between the flat and the cylinder.

The settings mentioned are only temporary settings, and after the adjustment of the flats the brackets should be secured and the settings again tested, in order to make sure that the proper spaces exist between the cylinder and the flats. The cylinder should now be slowly revolved, the flats at the same time being moved, and if any rustling sound is heard it is an indication that the wire surface of the flats is coming in contact with the wire surface of the cylinder at some point, in which case the flats should be set farther from the cylinder at that point.



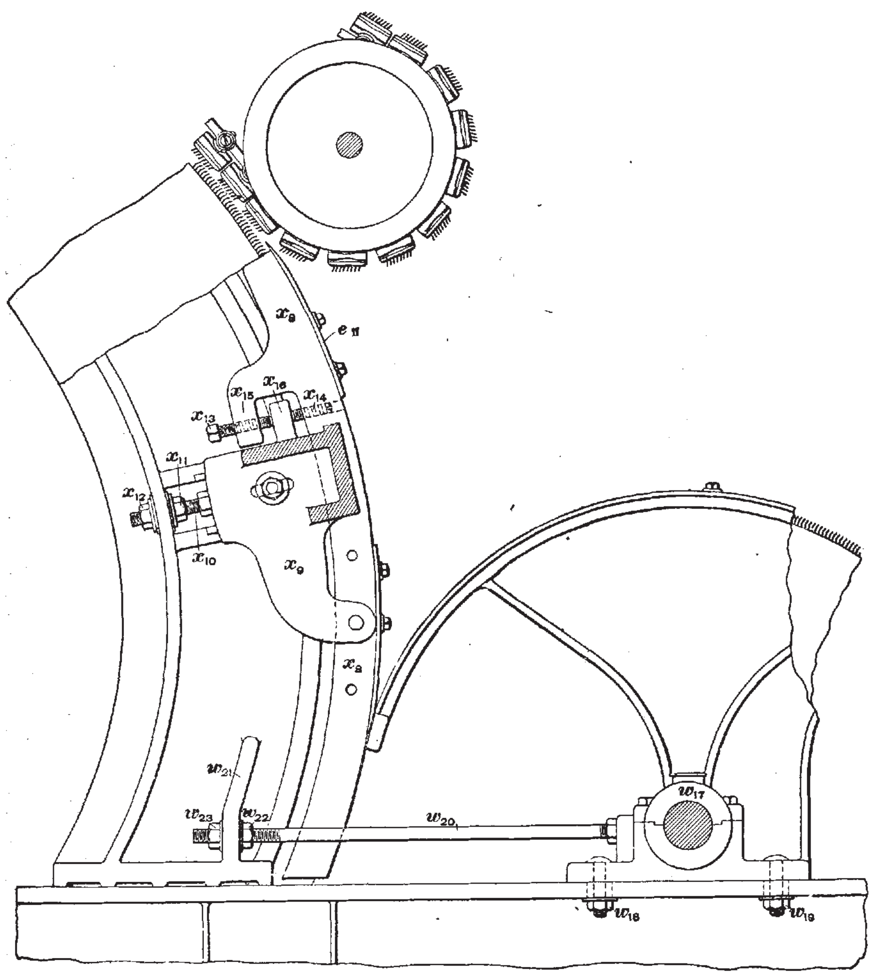
l
w_{14}
w_{11}
w_{12}
w_{13}
x_8
x_7
x_6
x_5
e_4
w_{10}
w_{16}
w_{10}
w_{15}
c
b_1
b
l
x
b
x_1
x_3
x_2
x_4

FIG. 13

The flats are usually set about $\frac{10}{1000}$ inch from the cylinder at the heel of the flat. The flats at the front of the card should be set the closest to the cylinder, while the space between the flats and the cylinder should gradually increase toward the back. If a No. 10 gauge is used, the flats at the back are set loosely to the gauge; those at the top and center, a little closer; while those at the front are set still closer.

24. Setting the Licker.—The licker is mounted on movable bearings w_{10} resting on and secured to the framework, or base, of the card as shown in Fig. 13. There is a lug w_{11} on the arch of the card, through which an adjusting screw w_{12} for adjusting the licker to the cylinder is passed. By loosening the nuts w_{15}, w_{16}, which securely hold the bearing to the framework, and by operating the adjusting nuts w_{13}, w_{14} on the adjusting screw w_{12}, the licker may be moved nearer to or farther from the cylinder, as desired. The leaf gauge is used for this setting and the licker is generally set to the cylinder with a No. 10 gauge.

25. Setting the Doffer.—The doffer is also mounted in movable bearings w_{17}, Fig. 14, which rest on the framework of the card and are securely fastened to it by the bolts and nuts w_{18}, w_{19}. An adjusting screw w_{20} connects the bearing of the doffer with a lug w_{21} on the arch of the card. When it is desired to set the doffer, the nuts w_{18}, w_{19} are loosened, and the doffer can then be set to the desired position by means of the adjusting screw w_{20} and the nuts w_{22}, w_{23}. The doffer is usually set to the cylinder with a No. 5 or No. 7 leaf gauge by inserting the gauge between the doffer and the cylinder where they are in closest proximity. When a No. 7 gauge is used, the doffer is usually set tight to the gauge. After attaining the proper distance between the doffer and the cylinder, the nuts w_{18}, w_{19} are tightened, as well as the adjusting nuts w_{22}, w_{23}. The position of the doffer with relation to the cylinder is an important matter and should receive careful attention. If the doffer is set too far away from the cylinder, a patchy or cloudy web will result, owing to the doffer not taking



x_8
e_{11}
x_{15}
x_{16}
x_{14}
x_{13}
x_{11}
x_{12}
x_{10}
x_9
x_8
w_{21}
w_{23}
w_{22}
w_{20}
w_{17}
w_{18}
w_{19}

FIG. 14

the fiber from the cylinder regularly and thus allowing the wire of the cylinder to fill up.

The mote knives are carried by two brackets, one at either end, and can be adjusted in regard to the relative distance between their blades and the surface of the licker as described in connection with the construction and operation of the various parts of the card. These knives are set to the licker by means of the leaf gauge and the number of the gauge varies from 12 to 17.

26. Setting the Feed-Plate.—The feed-plate b rests on the frame of the card, as shown in Fig. 13, and is fastened to it by means of the bolts and nut x. When it is desired to set the feed-plate b to the licker c, the nut x is loosened and the plate moved nearer to or farther from it by means of the adjusting screw x_1 and the nuts x_2, x_3. The screw x_1 passes through a lug x_4 on the framework of the card and into the feed-plate. The leaf gauge is also used to make this setting and is inserted between the licker and the face of the feed-plate. The number of the gauge varies from 12 to 20.

27. Setting the Cylinder Screen.—The cylinder screen is made in two sections in the card under description and these sections are fastened together by two staple-shaped bolts, one on each side of the card. These bolts pass through the framework of the card near the floor. Inside the framework of the card on each side is a thin metal arch adjusted so as to be in close proximity to the end of the cylinder. When the screen is in position, it is between, and attached to, these arches, thus forming a casing for the lower portion of the cylinder. The screen is held in position by a number of bolts passing through the side arches of the screen. There are a number of slots in the circular arches of the screen through which the gauge can be inserted in order to obtain the proper distance between the cylinder and the screen.

The nuts on the bolts that hold the screen in position are on the outside of the arches. When it is deemed necessary to set the screens, the doors on the sides of the card are removed to give access to the nuts on the bolts and to allow a gauge of the proper thickness to be inserted in any of the slots of the screen arch. The screen is raised or lowered to the proper position as determined by the gauge and the nuts are then tightened, thus holding the screen in position. The screen is set farther from the cylinder at the front than at any other point, the distance being about .25 inch, while the screen at the center and back is set about .032 inch from the cylinder. This arrangement prevents the ends of the fibers that have been thrown out by centrifugal force from coming in contact with the front edge of the screen and thus being removed from the cylinder as fly.

28. Setting the Licker Screen.—As the licker and cylinder screens are very close to each other at their nearest point, and as the front end of the licker screen must be set only a short distance below this point, it is nearly impossible to make an accurate setting with the licker in position. The best method is to remove the licker and use a quadrant gauge, the curvature of the outside surface of which should correspond exactly to the curvature of the surface of the licker. This gauge is mounted loosely on a shaft of exactly the same bore as the licker shaft. The ends of the shaft rest in the licker bearings and the screens are set to the proper distance from the quadrant gauge by sliding the quadrant along the shaft. The front edge of the licker screen at the point where it is hinged to the cylinder screen is usually set about .011 inch from the licker. The nose, or portion of the licker screen with which the fibers first come in contact, is set $\frac{1}{32}$ to $\frac{1}{8}$ inch from the teeth of the licker, according to the amount of cleaning action desired at this point and the staple of the cotton being used. Setting the screen farther from the licker at the nose than at the front allows the fibers to be drawn gradually into a more compact space and presents a more even layer of fibers to the action of the wire on the cylinder.

29. Setting the Back Knife Plate.—The back knife plate e_4, Fig. 13, extends from the licker cover, or bonnet, upwards to the flats and corresponds in curvature to the curvature of the cylinder. This plate is fastened to a circular bend x_5 by means of two screws at each end, and the bend is attached to the adjustable bracket of the licker by means of two setscrews x_6, x_7; consequently, when the licker is adjusted the back knife plate is adjusted, or it can be adjusted independently by means of the setscrews x_6, x_7. The plate is set to the cylinder to about a No. 17 leaf gauge at the lower edge and a No. 32 at the upper edge. This allows the fibers to free themselves and stand out a little from the cylinder before coming in contact with the flats.

30. Setting the Front Knife Plate.—The front knife plate e_{11}, Fig. 14, extends from the cylinder door above the doffer to the point where the flats first leave the cylinder. The amount of flat strippings depends to a great extent on the setting of this plate. The plate is fastened to a circular bend x_8 by means of two screws at each end, and can be adjusted by means of the bracket x_9, the adjusting screw x_{10}, and nuts x_{11}, x_{12}; or it can be adjusted to a certain extent by the setscrews x_{13}, x_{14}. The screw x_{13} passes through an arm x_{16} of the circular bend x_8, while both screws x_{13}, x_{14} come in contact with the arm x_{16} of the bracket x_9; thus by loosening one screw and tightening the other the plate can be adjusted. The front knife plate is also set with the leaf gauge, its distance from the cylinder at the lower edge being about .017 inch. The space between the upper edge of the plate and the cylinder depends on the amount of waste that it is desired to remove as flat strippings, but the usual setting is about .032 inch. If the plate is set farther from the cylinder, more and heavier strippings will be made, and if moved too far away, the strips will form one continuous web instead of being connected by merely a few fibers. If the plate is set too close, some of the short fibers and dirt removed from the cotton by the flats will in turn be taken from the flats by the knife and carried around by the cylinder, thus producing bad work.

31. Setting the Stripping Comb.—The flat stripping comb is mounted on two arms, as described in connection with the construction and operation of the various parts of the card. There is one nut on each side of the comb at each end. The comb is set by adjusting the nuts on the arms when it is at the lowest part of its swing, with its teeth opposite the toe of the flat. Sometimes it will be necessary to try two or three flats before the comb is set in its proper position. The distance between the toe of the flat and the comb is determined with the leaf gauge and is usually about .007 inch; although this setting should be close enough to allow the comb to remove the strippings from the flats, it should not be so close that the comb will strike the wire and damage it.

32. Setting the Brush and Hackle Comb.—The brush for stripping or brushing out the dust, etc., from between the interstices of the flats is set so that the ends of the bristles do not quite reach the foundation of the fillet on the flats. The brush has longer bristles near its ends, in order to brush the ends of the flats where they rest on the flexible bends, so as to keep them clean and preserve the accuracy of the settings.

The hackle comb is set so that the needles, or teeth, of the comb project for a short distance into the bristles of the brush, in order that all the waste may be removed from the brush.

33. Setting the Doffer Comb.—The doffer comb is set in a manner similar to that in which the doffer and licker are set. The comb is mounted on sliding bearings fastened to the framework, or base, of the card by means of bolts. A setting screw is fastened to the bearing of the comb at each side and passes through a lug that is fastened to the framework of the card. When it is desired to set the comb, the nuts on the bolts that attach the bearings to the framework are loosened and the comb drawn nearer to or farther from the doffer by means of the adjusting nuts on the setting screws, as described in connection with the setting of the doffer and feed-plate. When the proper distance is obtained, all the nuts are tightened. The comb is usually set to the doffer at the point where they are in closest proximity with a No. 7 leaf gauge.

The doffer comb, in addition to being adjustable as to its distance from the doffer, is adjustable as to the position of its stroke, which is changed by altering the relative positions of the comb and the eccentric from which it receives its motion. If the web should follow the doffer instead of being removed by the comb, the position of the stroke should be lowered; while if the web sags between the doffer and the trumpet, as it sometimes does, owing to atmospheric changes, etc., the position of the stroke should be raised.

The settings given are used only as a basis. The settings of the various parts of the card vary according to the stock being used, the quality and kind of finished work, and the opinion and judgment of the superintendent or overseer in charge.

It is sometimes desirable to make a setting for which there is no gauge of the proper thickness at hand. In such cases it is customary to use in combination two or more of the leaves of the leaf gauge; for instance, if it is desired to set the mote knives to the licker with a 17 gauge and no such gauge is available, the 10 and 7 leaves of the leaf gauge can be used together.

MANAGEMENT OF ROOM

34. In the management of cards many points should be watched, but more especially those that have for their objects: (1) the production of good work; (2) turning off as large a production as is consistent with the quality of the work required; (3) economy by avoiding unnecessary waste and keeping down the expenses of wages, power, supplies, etc.; (4) maintaining the machinery in good condition.

35. Quality of Production.—With reference to the first requirement, it may be said that good work is usually judged by examining the web from the front of the doffer. By withdrawing a portion of it as the card is running and holding it to the light, the foreign matter and also the neps remaining in the cotton can be observed. If it is the opinion of the overseer that from the grade of stock being used and from the speed of the card such work is not sufficiently good, the card should be examined to ascertain whether it requires grinding or setting. An allowance should be made if the card is examined just before the time for stripping, as at that time the card wire is usually so full of dirt that more or less necessarily passes through, although this is to some extent an indication that stripping should be performed more frequently. In order to test whether wire requires grinding, or in other words whether it is sufficiently sharp to do its work, it is customary to rest the fingers of one hand on the face of the wire when the card is stopped and by drawing the thumb against the points judge of their sharpness by the amount of resistance that is felt. Dull wire allows the thumb to pass with the least resistance. Should the wire show a glistening surface or appear bright on the end of each point, it may generally be considered dull, although this is not an infallible test, owing to the direction in which the light strikes the wire.

The cotton should leave the doffer in a level sheet, free from cloudiness and having good sides. The intermittent clouded effects and flock sides formerly so common are not met with so frequently in revolving flat cards. Sometimes these defects are caused by cotton lodging in some part of the card, more especially in connection with the screens or at the point where the cylinder and the doffer meet, until there is sufficient to be pulled through in one lump by the wire. Another test is to examine the fly underneath the card and if it is found to contain an appreciable amount of good fiber, it indicates that the screens need adjusting. In case of the feed-plate, and more especially where two feed-rolls are used instead of a feed-plate and a feed-roll, plucking sometimes occurs and causes a cloudy effect. Cotton lapping on the doffer instead of being stripped off by the comb is troublesome, more especially when the rooms are allowed to get cold during frosty weather.

36. Quantity of Production.—The second point of management is that of obtaining as large a production as possible. This can be obtained by reducing to a minimum the time when the card is stopped for stripping, grinding, or setting, also by the attendants putting on the new lap as soon as the old one has run off and by not allowing the card to remain stopped on account of the end having broken down in front. When these economies of time have had attention, the only other method of increasing the production is to speed up the card, which is usually done by increasing the size of the barrow gear. The increase in the speed of the doffer is in direct proportion to the increase in the size of the gear. There are many cards at work producing 1,000 pounds per week of 60 hours, and the production of a card varies from this down to 200 or 300 pounds per week. A good speed for American cotton when intended for 32s yarn, carding 800 pounds per week, is about $12\frac{1}{2}$ revolutions per minute of a 24-inch doffer for a 60-grain sliver. When carding Egyptian cotton intended for 60s to 90s yarn and carding about 500 pounds in a week of 60 hours, a good speed for a 50-grain sliver is about 10 revolutions per minute. With sea-island cotton intended for yarn finer than 100s, carding 250 to 300 pounds per week and producing a 35-grain sliver, a good speed for the doffer would be about $6\frac{1}{2}$ to 8 revolutions per minute. With a 27-inch doffer the number of revolutions would be proportionally smaller. The maximum average stoppages during a week for stripping, grinding, cleaning, and all sundry repairs around the card ought not to exceed 10 per cent., and with care this might be reduced to $7\frac{1}{2}$ per cent.

37. Economy.—The third point in the management of card rooms is that of economy; this is most important in respect to the amount of waste produced. The largest percentage of waste in any part of a card is in flat strippings and amounts to about $1\frac{1}{2}$ per cent. The next is the amount of fly from beneath the licker and cylinder, amounting to an average of 1 per cent. The cylinder and doffer strippings together amount to about $\frac{3}{4}$ per cent., making a total loss at the card of about $3\frac{1}{4}$ per cent., or somewhat over $3\frac{1}{2}$ per cent. if the card sweepings are taken into account. No allowance is here made for the unavoidable loss in the weight of the cotton due to its drying in the hot card room. For fine yarns or particular work these figures may be increased, and for coarse yarns and inferior product, decreased.

In order to secure economy in the flat strippings the front plate should be set in such a manner that the flats will not take out any good cotton. When it is set otherwise, the strippings from the flats seem to be connected by a thick film of good cotton that is generally sold together with the strippings as waste. As previously described, this film can be reduced until the strippings cling together by means of a few fibers only. Beyond this point the only method of reducing the amount of flat strips is to lessen the speed at which the flats move, although this is not advisable, as it deteriorates the quality of the work by not removing so much foreign matter from the cotton. The flats will also be connected by a thick strip of cotton if the heel and toe are not preserved in grinding. The principal method of reducing the percentage of the cylinder and doffer strippings is to reduce the number of strippings, which is undesirable unless it is desired to lower the quality of the work. The fly beneath the card can either be increased or decreased according to the style and setting of the screens under the card and the setting of the mote knives. Tests have been made with cards without screens and it is found that they make about ten times as much fly as cards with screens. Both the knives and the triangular bars that form the screens should be so arranged that they will give free passage for any dirt that tends to lodge there and also to allow the ends of the fibers to be combed or brushed over the edges of the knives, but the spaces between the bars of the screens should not be so large as to allow the fibers themselves to be driven through.

38. Proper Care of Machinery.—The fourth point in the management of cards, namely, keeping the machinery in good condition, necessitates first of all proper oiling. All parts of the card that are in contact with swiftly moving parts, such as the mechanism in the comb box, the cylinder-shaft bearings, and licker-shaft bearings, should be oiled twice daily; certain other parts that do not revolve so rapidly, for instance the doffer, calender-roll shaft, side shaft, coiler, and all idler pulleys and gears, should be oiled daily; while once a week, generally Monday morning, every moving part of the card should be oiled. Cylinder, licker, and doffer bearings should be filled with tallow, having a small hole in the center so that it will allow the oil to run directly on the shafts and provide a reserve of lubrication that will melt in case of a hot bearing. In oiling the bearings of the doffer and cylinder, care should be taken not to allow the oil to get on the heads of the cylinder or doffer, since in this case it is apt to come in contact with and spoil the clothing. Care should also be used in oiling the traverse grinder that the oil does not fly on to the clothing.

The cards should be kept free from fly and dust and it is usually the custom to clean them after the stripping process. An opportunity should be given at least once a week, usually on Saturday morning, for the cards to be stopped 2 hours for cleaning purposes, at which time a more thorough cleaning is given to all parts than can be given while the cards are running. About once a month the coiler should be taken apart and cleaned, the feed-roll taken out and cleaned, the licker picked free of all foreign substances, and all belts carefully looked over. The belts should be cleaned and dressed as often as it is necessary. Fly from under the card is generally removed twice a week, and any cotton or fly attached to the screens should be picked or brushed off at the same time. The roll on which the lap rests should not be allowed to wear too smooth, but should be painted with some rough composition, such as paint mixed with sand, that will give it a rough surface and prevent the slipping of the lap. The cylinder and licker screens should be taken out periodically and cleaned, a good practice being to polish them well with black lead, which makes them dry and smooth.

The inside faces of the front and back knife plates and the bonnets of the doffer and licker should also be polished with black lead.

After disturbing the settings of a card in any way, the cylinder and licker should be turned around by hand to make sure that there are no parts rubbing. After setting or grinding, and whenever there has been occasion to loosen screws, nuts, or other parts of the card, these parts should all be gone over to make sure that they are tight before starting the card.

39. The speeds of the different parts of the machine are taken by a **speed indicator.** The doffer, however, has so few revolutions per minute that its speed can be ascertained by watching a point on its circumference and counting the number of revolutions it makes.

There should be only sufficient draft between the lap roll and feed-roll, the doffer and the bottom calender roll, the bottom calender roll and the calender roll in the coiler to take up any slack that may occur between these parts. Any excessive draft causes the sliver to be unevenly drawn, thus making thick and thin places in the yarn.

DRAWING ROLLS

COMMON ROLLS

BOTTOM ROLLS

1. Introduction.—The principle of roll drafting is the most important feature of parallelizing and attenuating machinery and in the production of good yarn. Therefore, the construction of *drawing rolls* and various points pertaining to them justify a detailed description. **Drawing rolls,** of which there are two kinds—*common* and *metallic*—are placed in pairs one above the other, the lower ones being driven positively by means of gears; the upper ones, when common, are driven by frictional contact from the bottom rolls, while those that are metallic are driven positively, as will be described later.

2. Construction.—Fig. 1 shows a set of **common rolls** consisting of three pairs, *a* being a bottom roll and a_1 a top roll. The bearings of the bottom rolls rest on stands *b* that are bolted to the roll beam *c*. The construction of the bearings for the rolls and the method of adjusting them in order to obtain the desired distance between any two pairs is fully explained in later pages. Fig. 2 shows a cross-section of the bottom roll *a*, Fig. 1. These rolls are almost always constructed of steel, and are fluted; that is, grooves are cut lengthwise in the surface of the rolls at certain intervals. These flutes aid the bottom rolls in obtaining a better grip on the cotton as it passes between them and the top rolls. The grooves, as shown in Fig. 2, are not perfectly wedge-shaped, nor do they end in a knife edge, although the face of the roll carries almost a square corner on each side of a flute. A groove is a little less in width at the bottom

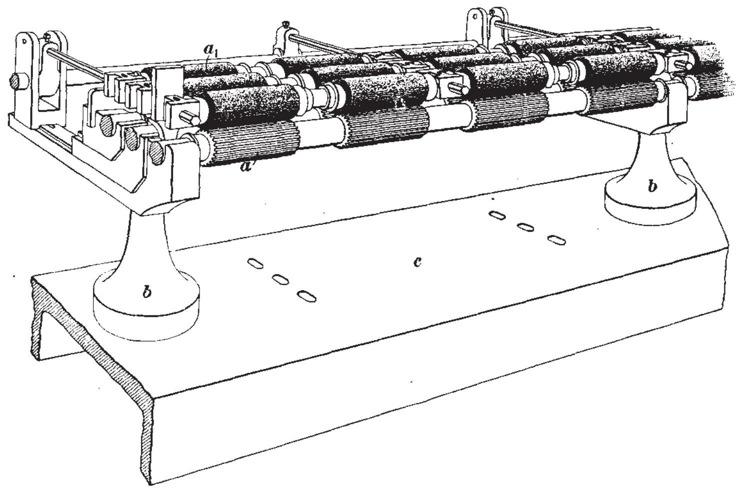


Fig. 1

than at the top, while the number of flutes for the various rolls increases with the diameter of the rolls and with the fineness of the work for which the machine is intended. For example, a roll $1\frac{1}{8}$ inches in diameter will contain more flutes than a roll 1 inch in diameter, while a roll intended to be run on a machine that deals with the stock in the later processes will contain more flutes than a roll of the same diameter that is intended to be run on a machine dealing with the stock in the earlier processes, since the cotton in the former case is not in as bulky a condition.

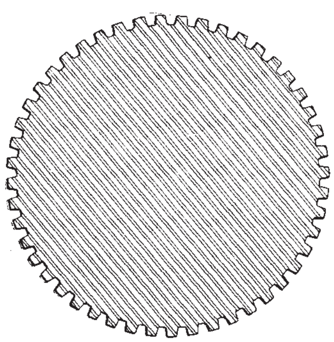


Fig. 2

Rolls are often made with the flutes unevenly spaced; that is, the distance between two flutes in one place is different from the distance between two flutes in another part of the same roll. This is done in order to prevent the cutting of flutes in the top leather roll that would correspond with those of the bottom roll, which would be detrimental to good work. It is also necessary to have these rolls refluted at times, since the constant action of the cotton on the flutes will wear them very smooth on the edges and thus prevent their gripping the fibers. It is important not to have the roll stands for the bottom rolls too far apart, since in this case the roll, due to the weight of the top rolls and other weight placed on it, will be deflected out of a straight line, causing the roll to run untrue and resulting in poor work.

The bottom rolls are almost always case-hardened in the *necks*, or bearings, and in some cases throughout. They are thus rendered stiffer and stronger, which makes them more capable of resisting torsion, the necks wear longer, and the flutes are not so liable to become damaged by an accident or by carelessness. The preservation of the necks is also assisted by inserting brass bearings into the roll stands.

3. Method of Connecting Sections.—The bottom rolls are built in sections varying from 13 to 24 inches in length, each section being joined to the next by means of a squared end of one roll fitting into a squared recess in another roll. It is of the utmost importance that these ends shall fit into their sockets accurately, and if they become worn, as is sometimes the case with the older makes of rolls composed of soft metal, they should be resquared. It will easily be seen that in a frame 20 or 30 feet long having a number of these joints in each roll, a minute fraction of play at each socket will become an important item in the whole length of the frame and tends to produce what is technically called *cut yarn*. When the rolls are removed in sections, care should be taken that each section is replaced in the position from which it was taken. In order to make this convenient, the end of each section is numbered, the numbers generally running consecutively from the driving end of the machine.

TOP ROLLS

4. Construction.—Top rolls are constructed of iron and are made in short lengths, a portion of their circumference being afterwards covered with cloth and leather. That part of the roll that is used for drawing the cotton, which in common top rolls is the leather-covered portion, is known as the *boss* and is always of a larger diameter than the remainder of the roll. Top rolls may be made with one or

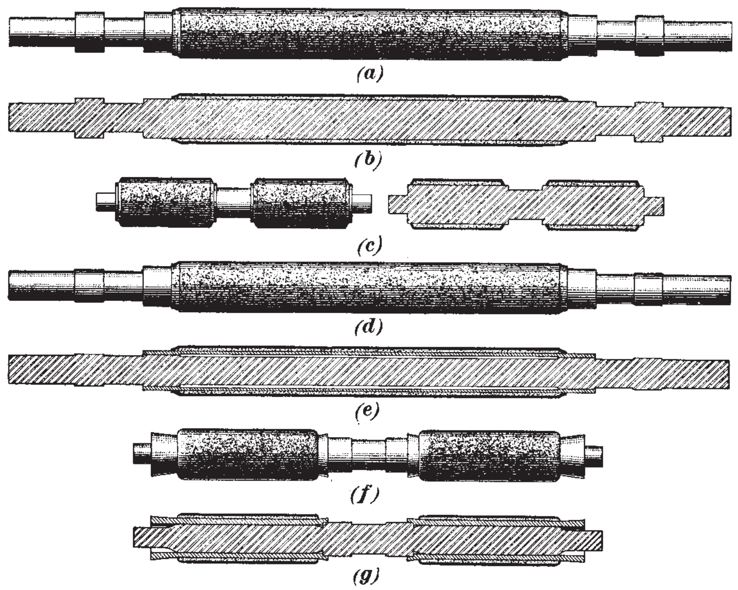


FIG. 3

two bosses, being known as *single-boss* and *double-boss*, respectively; the boss in both single- and double-boss rolls may be detachable. When the boss of a roll is detachable, the roll is known as a *loose-boss*, or *shell*, *roll;* when the boss is not detachable, the roll is known as a *solid roll*. In loose-boss rolls the part that is detachable is known as the *shell* of the roll, while the part on which the shell rests is known as the *arbor*.

Fig. 3 shows the different styles of top rolls. A solid roll having a single boss is shown at (*a*), a longitudinal section of this same roll being shown at (*b*); a solid roll with a double boss and a longitudinal section of the same roll are shown at (*c*). A loose-boss roll having only one boss and a longitudinal section of the same roll are shown at (*d*) and (*e*), while a loose-boss roll with a double boss and its longitudinal section are shown at (*f*) and (*g*).

5. Single- and Double-Boss Rolls.—In certain machines that utilize drawing rolls there is one roll to every delivery; that is, all the fibers passing one roll are gathered together into one sliver at the front; therefore, for these machines the single boss is preferred. In certain other machines there are always two or more ends coming from each roll, so that the **double-boss** construction is preferable. Sometimes one end comes from one boss; in other cases two ends come from one boss; while in still other cases three ends are found coming from each boss of a double-boss roll, making six from the roll.

The advantage of double-boss over single-boss rolls is due to the fact that there are less weights, hooks, and wires on a machine equipped with double-boss rolls and, therefore, the machine can be better and more easily cleaned. The cost of construction is also less with double-boss rolls, and the weighting is simpler. It also requires less oil, thus reducing the probability of staining the cotton. Another advantage that is claimed for double-boss rolls with the loose boss is that any slight variation in the diameter of either boss, as compared with the other, is offset to a certain extent, on account of the independent motion of each boss.

One great advantage that the **single-boss roll** has over the double-boss roll is that more even yarn is produced with the former, as each end or group of ends is treated independently of the others.

6. Solid- and Loose-Boss Rolls.—**Solid-boss rolls** are gradually passing into disuse except for the back rolls of frames, being replaced by rolls with loose bosses. With a **loose-boss roll** only the shell revolves, consequently the neck and ends do not need oiling. When it is desired to oil the roll, the shell is removed and a few drops of oil placed on the arbor. With such a construction, especially when such thorough lubrication can be obtained, it is very easy for the shell to revolve and there is also little danger of oil getting on the cotton.

The portion of the arbor enclosed by the boss is barrel-shaped, being large at the center and tapering off toward each end. This construction reduces the friction by reducing the bearing surface of the shell on the arbor, and the oil tends to run toward the thickest portion of the arbor, thus insuring proper lubrication and preventing the leakage of oil.

Rolls are also constructed on this principle with the shell having ball bearings on the arbor.

COVERING TOP ROLLS

7. As two metal rolls revolving in contact would tend to crush the delicate cotton fibers, a leather covering is provided for the top rolls of the common type. The iron surface of the roll is first covered with a specially woven woolen cloth, which is cemented to the roll, giving a good, elastic foundation. When a thin leather covering that fits very tightly is drawn over this foundation, the roll is capable of gripping the fibers and, owing to the yielding quality of the leather and cloth, does not damage them.

In order to secure the best results, the greatest care should be exercised in covering the roll, and the best stock should be used. The production of an even thread depends more on the quality of the cloth and the leather, the manner in which it is applied, and the care of the rolls in the machine than on any other factor in the process of manufacture, with the exception of the grade of cotton used. Various substitutes for woolen cloth and lambskin or sheepskin have been tried from time to time, but none have been adopted to any great extent. Woolen cloth and lambskin have been used for over 100 years for covering rolls. In fact, the first frame built for spinning had top rolls that were covered, the skin being used without any cloth. The uncovered roll known as the metallic roll is the only one that has displaced these materials to any great extent.

8. Roller Cloth.—The cloth that lies underneath the leather should be made of the finest and best wool. The wool should be carefully carded, so that every piece of foreign matter will be removed, and the weaving and the finishing of the cloth should also receive very close attention. It should not be possible to detect by the hand the slightest variation of thickness in any portion of the cloth. American and English roll cloths are used in covering rolls. They vary considerably in weight; the American cloth is figured on a width of 54 inches, while English cloths are figured 27 inches in width. It should be remembered, therefore, in ordering roll cloth that an American 32-ounce, for example, is the same as an English 16-ounce.

In mills covering their own rolls, the old leather should be removed and the cloth carefully examined. If it shows any evidence of disintegration, or wear, or an uneven surface, it should be condemned and removed. The old cloth may be removed by soaking it in water, after which the roll should be cleaned thoroughly. When rolls are sent out to be covered, it is considered advisable to cut the cloth with a knife in order to prevent the same cloth being used again, thus avoiding the danger of having old cloth covered with new leather.

9. Method of Putting on Cloth Covering.—In covering rolls, the cloth is cut into strips slightly narrower than the boss of the roll. A strip of this cloth is then laid flat on a table and a clean roll, the boss of which is covered with glue, is placed on the end of the strip and the cloth wound on the roll. The roll during this operation should be neither hot nor cold—simply warm. The cloth is cut with a sharp knife at the point where it begins to pass around the roll the second time, and the seam is then pressed into place.

Another method of covering rolls with cloth is to lay a number of strips of cloth of the required width in a miter box and cut them to a gauge of the required length, thus giving 15 or 20 pieces of the exact size required to cover one roll. In this way the cloth may be put on the rolls much faster than when cutting each piece on the roll. After the cloth is put on and the seam pressed together with the fingers, the roll should be put into evening, or smoothing, rolls for the purpose of smoothing out any lumps or foreign matter that may have been in the glue, thereby producing a perfectly true and even surface.

10. Leather Covering for Rolls.—In yarn-preparation machinery it is the duty of a pair of rolls to maintain a firm grip on the fibers of cotton as they are passing between them, and yet the fibers must not be damaged in any degree. The rolls at the time are revolving in some cases at a high rate of speed, and therefore the material with which they are covered should be of such a nature that it will resist a certain amount of wear. The substance that has been found most suitable to meet these requirements is the skin of the lamb or the sheep, or the skin of the goat, which, like the skins of most animals, consists of more than one layer. The outside layer is very thin and tough, and, while horny, is very elastic.

Fig. 4 is a section of sheepskin very much enlarged; *c* represents sweat ducts and *d* the epidermis. This is the part that withstands the wear when at work. It consists of a horny layer above the Malpighian nets, or inside layer, and is commonly called the *grain*. A fibrous tissue *e* binds the true skin *f* to the epidermis *d*. This fibrous tissue is formed of multitudinous fibers bound together by a soft, milky, gelatinous substance. Hollow, loose skins result if this substance is improperly treated during manufacture.

On the character of the fibrous tissue, which is directly beneath the grain, depends the strength of the skin; the larger the size of the skin, the coarser and weaker it will be. The explanation of this is that there are a certain number of fibers in the tissue at the birth of the lamb that increase in thickness but do not increase in numbers with the growth of the animal. The spaces between these fibers are filled in with a quantity of the gelatinous substance mentioned, much of which is dissolved in the process of manufacture. Therefore, as the strength of the skin depends on the number of fibers, and since in 1 square inch of lambskin there are more fibers than in 1 square inch of sheepskin, the younger skin will be the stronger.

Beneath the mass of muscular fibers is the layer *f* that is next to the flesh of the animal. This layer is composed of

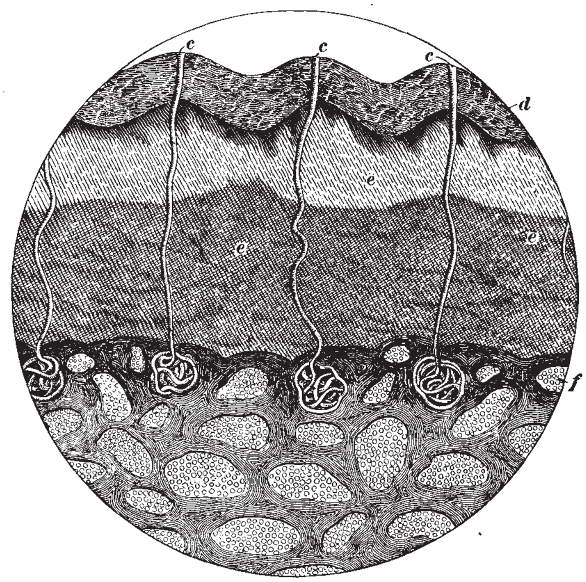


FIG. 4

cellular matter and varies in thickness in different parts of the skin. If a roll were therefore covered with a skin of natural thickness, some rolls or parts of the same roll would vary in thickness. In order to make the skin the same thickness throughout, a process known as **shaving** is employed.

As skins are usually thicker over the spine from the tail to the neck, a test can be made after the shaving process to determine whether they are the same thickness throughout by making a pile consisting of 50 or 60 skins. If the pile is higher in the center than at any other portion, the shaving process has not been performed properly.

11. The color should also be taken into consideration when selecting a skin. English skins usually have a color known as the natural oak-bark color, which is a light brown, while others are given a reddish color by means of dye. American skins are usually of a dark-cream color. The red color is preferred by some spinners, who claim that because of the color they can more readily see when the cotton is absent from the rolls, but as the rolls get to be somewhat of the same color after being used a few days, the red does not possess an advantage in this respect for any length of time. The darker the shades, however, the more the grain defects are hidden from view.

The size and color of skins depend on the size and age of the animal from which they are obtained. Lambskin is used for the more delicate work, as it is finer than sheepskin, while sheepskin (especially that which is old, being thick and coarse) is used for the coarser work. A top roll is really a cushion that will only yield enough to prevent crushing the fibers and yet maintain a pressure against the steel roll. As the covering for rolls on coarse work must yield to a greater extent than that of rolls on fine work, it is evident that the thicker skin and the heavier cloth should be used on rolls for coarse work.

12. **Selection of Skins.**—The skin from which the largest number of roll coverings can be obtained is the most economical to use, and the number of coverings that can be obtained from a skin should be estimated when purchasing. A *cot* is the piece of leather intended to cover one boss of a roll, cut to a rectangular shape with two of its edges afterwards joined together so that the leather will form a tube. The skin should be purchased by the minimum measurement; that is, it should be measured at its shortest parts. The diagram shown in Fig. 5 will serve to illustrate this point. A parallelogram *a a a a*, which indicates the area of the number of leather tubes, or cots, that may be cut, is placed on the skin and, if the skin is shorter than the distance *b b* or narrower than the distance *c c*, the skin is below the minimum measurement. The neck should not be measured, as it is not suitable for roll covering.

The shape of the skin shown in Fig. 5 is the best for roll skins. If there are any defects, such as knife cuts, or any evidence of overshaving on the flesh side, the skin is not of the first quality and can only be used on coarse work.

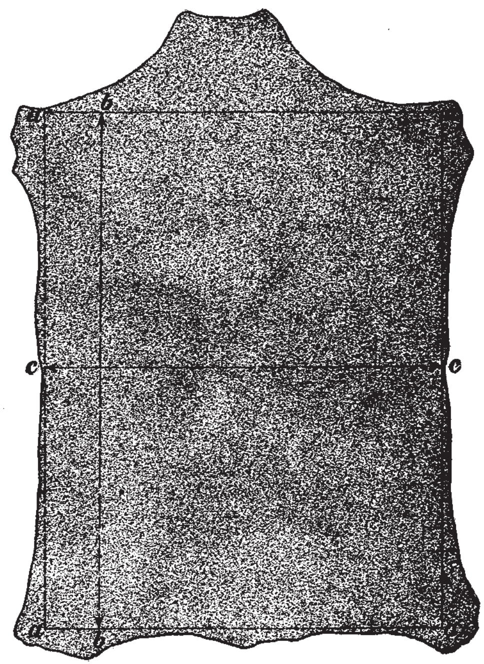


FIG. 5

Another serious defect is the presence of fine hairs, and if such are detected the skin should be condemned.

A hard-grained skin, in which the firmness is introduced by the method of finishing the skin, will not act successfully as a cushion. The grain side of the skin should feel smooth and firm, yet be pliable and capable of expansion and compression, while the flesh side should have a nap as fine as cloth. The effect of handling the whole skin should be the same as handling a kid glove, allowing for the difference in substance. The skin when placed under tension and examined by a magnifying glass should show an unbroken surface with no cracks on it.

13. Method of Putting on Leather Covering. When placing the leather covering on rolls, the skins are cut up into strips rather wider than the boss of the roll so as to allow for burning off the ends. The strips are next cut into small pieces just sufficient to fold around the boss of the roll, and their ends are beveled so as to make a joint that will not be perceptible to the touch. Beveling machines are used for cutting the bevel, the skin being placed in the machine so that the knife enters at the flesh side. The beveled ends are next joined together with cement, great care being taken in performing this operation. The leather tube, or cot, is placed in a press for a short time in order to insure a perfect joint. Hand or power presses are now constructed in which cots may be made and pressed.

The next operation is to draw the cot over the boss of the roll—an operation somewhat similar to drawing the finger of a glove on the finger. The roll is then revolved at a high rate of speed and any part of the leather that projects over the boss is burned off by friction with a hard piece of wood. The charred portion of the skin forms a collar at the ends of each boss.

With long rolls it is difficult to make a cot of exactly the same diameter throughout and draw it on the roll with the same tension in every part. This difficulty is overcome by some roll coverers by taking a long strip of leather and winding it around the roll spirally, attaching it with cement as they wind it on. The skins in this case are cut into strips from 1 inch to $1\frac{1}{2}$ inches wide.

The extra cost of covering and the extreme care that is necessary in order to keep the roll true are the disadvantages of this method. It is also claimed by some that the cushion effect of the leather is destroyed by this method of covering, as a hard piecing extends completely around the roll throughout its entire length; while on the roll covered with a cot, there is one hard piecing straight across.

Among the precautions that should be observed is the manner in which the roll is placed in the machine. It should be placed so that it will not run against the joint, and in some cases the way the lap runs is marked by a dot of ink on the grain side of the skin. In putting cots on double-boss rolls care should be taken that the bevels run the same way and that the cots are of the same thickness.

VARNISHING

14. It is the general practice in almost all mills to varnish the rolls that perform the heaviest work; namely, the rolls of the railway head, drawing frame, comber, sliver lap, ribbon lap, and in some cases the slubber. The reason for this is that the grain of the leather wears away and becomes broken, on account of the high speed at which the rolls revolve and the heavy work that they have to do compared with rolls in other frames. It is therefore necessary that something should be used as a substitute for the natural grain of the leather, which gives the roll its drawing properties, and a varnished surface has been adopted as the most practical.

Varnished rolls should present a smooth, hard surface that has dried without cracking and that does not cause fiber or dust to adhere to it. Too much glue in the varnish gives the rolls the appearance of a highly polished surface, which has a tendency to crack when dry, while too little allows the varnish to wear away very quickly. Almost every mill has its own system of preparing varnish, while roll coverers have for sale various compositions for this purpose.

15. Recipes for Roll Varnish.—Three recipes for preparing varnish are given:

1. 9 ounces of fish glue; 2 quarts of acetic acid; 2 teaspoonfuls of oil of Origanum. This mixture should stand for about 2 days in order that the glue may be thoroughly dissolved, after which it may be thickened with fine powdered paint of any color that may be desired.

2. $1\frac{1}{2}$ pounds of fish glue; $\frac{1}{2}$ pound of gum arabic; $\frac{1}{4}$ pound of powdered alum; 2 pounds of acetic acid; 4 pounds of water. This mixture should be thoroughly dissolved over a slow fire, after which it may be thickened with paint in the same manner as in the first recipe.

3. 1 ounce of ordinary glue; $\frac{1}{4}$ ounce of fish glue; $\frac{1}{4}$ ounce of gum arabic. This mixture should be dissolved in $2\frac{1}{2}$ gills of water and allowed to simmer for 1 hour over a slow fire, after which 6 ounces of thoroughly ground paint of any color may be added to thicken it.

In mixing any varnish it should be done in a regular melting pot in order that it may not be burned. After the varnish is made it may be kept in stock for any length of time, but should be put away in a covered receptacle; it is advisable to have this cover air-tight, although it is not absolutely necessary. If when it is desired to use the varnish it is found to be too thick to spread properly on the rolls, it may be thinned by adding a little vinegar, or acetic acid; while on the other hand if it is found to be too thin, a little paint may be added to thicken it.

16. Method of Applying the Varnish.—The methods of putting the varnish on the rolls differ. One method is to apply it with a brush the same as in painting a round stick, taking care to spread the varnish evenly over the surface of the leather so that when it is dry it will have a true, smooth surface. Another method is to have a board made a little longer than the roll and about as wide as the roll is long. The upper part of the board is covered with woolen cloth, the cloth being pulled tightly and tacked at the edges. The varnish is put on the cloth with a brush and the roll moved over the surface of the cloth by placing the palm of each hand on the bushing of the roll and moving it backwards and forwards until the varnish is spread over the whole surface.

In some cases before the roll is varnished it is ground, in order to insure its being the same diameter throughout its length. This is a practice that should not be encouraged, as it shortens the life of the leather.

The rolls are generally given one coat of varnish, although sometimes where fine numbers are required they are given two coats. New, or newly covered, rolls are given two or even three coats before they are put into the frame, one coat being allowed to dry before another coat is put on. Care should be taken that the rolls are perfectly dry before they are put back into the frame, since if this is not done the cotton will stick to them, making it almost impossible to run the frame. The rolls, if not dry, will also become fluted.

METALLIC ROLLS

17. For many years inventors have endeavored to substitute something for the common, leather-covered top rolls, principally because the covering of these rolls is an item of considerable expense in the production of yarn, and also because they are troublesome in certain conditions of the atmosphere or for certain kinds of stock, especially colored or bleached stock, on account of their licking and causing bad work. The most practical of the substitutes that have been tried is to have flutes in the top steel roll corresponding to those in the bottom roll. The flutes of the rolls mesh together, but in order to prevent the teeth of one roll from reaching to the bottom of the spaces between the teeth of the other roll, the rolls are held somewhat apart by collars.

There is a wider space between the flutes of metallic rolls than there is between the flutes of the common bottom steel rolls, the spacing being the same for both top and bottom rolls of the same pair. There are, however, different spacings in different pairs of rolls and, as now applied, wider spacings are used for back than for front rolls.

18. Construction.—A mounted section of a set of metallic rolls is given in Fig. 6, while Fig. 7 represents a portion of a pair of these rolls. Fig. 8 is a cross-section of the same pair. b, b_1 are the fluted portions of the rolls and a, a_1 the collars, which prevent the rolls from coming into too close contact. The flutes of the back rolls are always of a coarser pitch than those of the front rolls, owing to the greater bulk of cotton that comes under the action of the back

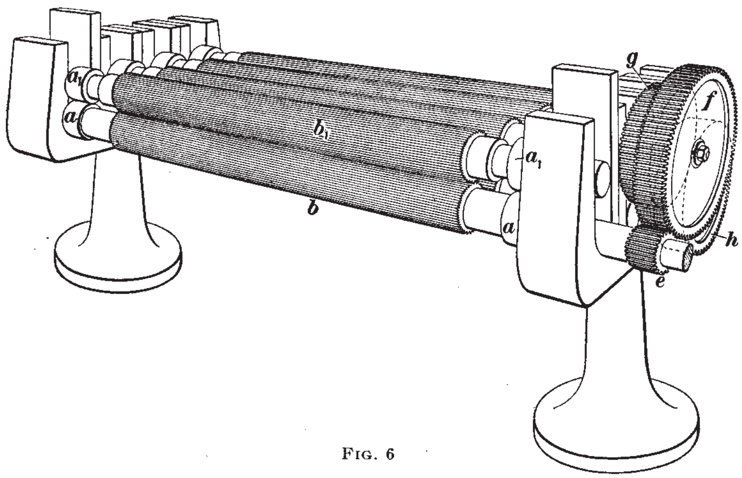


Fig. 6

rolls. The back rolls for drawing frames as now constructed have 16 flutes on their circumference for each inch of diameter. The third roll has 24 flutes, while the front and second

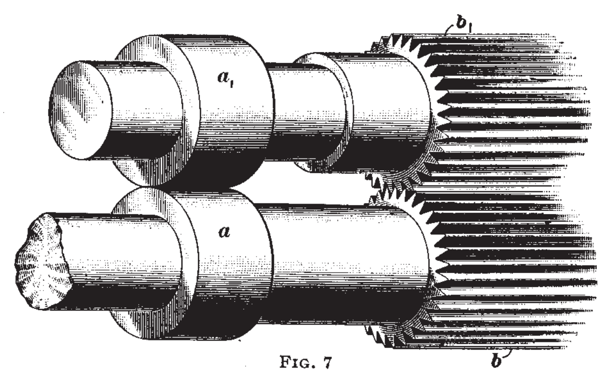


Fig. 7

have 32 flutes. They are therefore known as rolls with a 16 pitch, 24 pitch, and 32 pitch, respectively.

On a 16-pitch roll the diameter of the collars is .07 inch less than the diameter of the fluted section, and as both rolls are the same, the amount of overlap is .07 inch. With a 24-pitch roll the collars are .06 inch less in diameter than the fluted section, and on a 32-pitch roll they are .044 inch less. Thus, the amount of overlap with 24-pitch rolls is .06 inch and with 32-pitch rolls, .044 inch. This amount of overlap is sufficient to grip the sliver as shown in Fig. 8.

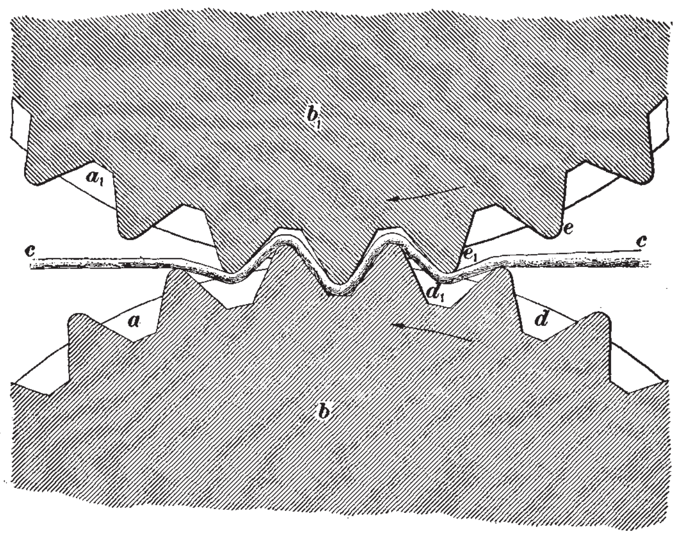


FIG. 8

It will be seen that the cotton does not follow a straight line, as it does with common rolls, but is crimped to some extent, and if the collar did not keep the rolls partly separated, the fibers would be damaged by the contact of the flutes. The amount of the overlap is so small that it merely grips the fibers enough to attain a draft and does not damage them to any appreciable extent.

19. Advantage of Metallic Rolls.—The top rolls of a metallic set are positively driven by the flutes of the lower roll meshing with the flutes of the upper roll, and consequently a more positive draft is obtained than with the common rolls. The cost of roll covering and subsequent varnishing is saved, and the bad work that arises from imperfectly varnished rolls is entirely obviated.

It is claimed that, as metallic rolls run on collars, friction is greatly reduced; that licking, from the presence of electricity and atmospheric changes, is prevented; that consequent waste is avoided; and that the product of each frame equipped with metallic rolls is greater than a machine equipped with common rolls running under the same conditions, because of the curved path taken by the cotton. It is further stated that metallic rolls produce work that is equal in quality to that produced by common rolls and that there is no necessity of keeping extra rolls in stock. However, metallic rolls at the present time are not used to any large extent except on railway heads, drawing frames, sliver-lap machines, and slubbers.

SETTING AND WEIGHTING ROLLS

RULES GOVERNING SETTING

20. One of the most important points in relation to cotton machinery is the relative position of one pair of rolls to another, which position is governed by the length of the staple and bulk of cotton being used. The bad work that will result from the improper setting of rolls can never be remedied. In setting rolls, there is one broad principle that must always be followed: the distance between the centers of each pair of rolls must always exceed the average length of the staple of the cotton being used. If this were not so, the fiber would come under the action of the forward pair of rolls before it was released by the preceding pair, and since the speed of the rolls increases with each pair that is nearer the front of the machine, this would result in the fiber being strained and broken.

In addition to the length of staple being run, there are several other principles that should be considered in setting rolls. Rapidly revolving rolls require wider settings than those having slow speed, since with a slow speed the rolls could be set closer together and still the fibers would be given a sufficient length of time to be drawn away from the mass of cotton without being strained. From this statement the conclusion should not be drawn that, since the front pair of rolls in any frame revolves faster than the back pair, the front rolls should be set farther from the middle rolls than the back rolls; for this is not so, as other circumstances, having to be considered, overbalance that of the speed of the rolls. Since the speed of the rolls increases with each pair that is nearer the front of the machine, the cotton as it passes through the roll is greatly diminished in weight per yard from back to front, and since it is much easier to draw the fibers past each other when there is only a comparatively small number of fibers than when there is a large number, two pair of rolls that are near the front would have a less space between them than two pair of rolls at the back. For this reason the space between each two pair of rolls in a set increases from delivery roll to feed-roll. For example, if the staple of the cotton being used on a drawing frame is 1 inch, the distance between the front and second pairs of rolls might be $1\frac{1}{4}$ inches; between the second and third, $1\frac{3}{8}$ inches; and between the third and back, $1\frac{1}{2}$ inches.

When the ends put up at the back are heavily twisted, the settings are wider on the same machine than when the ends fed are slightly twisted. This is due to the fact that it is more difficult to draw the fibers past each other in the former case than in the latter. Harsh, wiry cotton requires wider settings than smooth, silky cotton, because it does not draw so easily.

As the rolls are set according to the staple of the cotton used, it is therefore evident that the rolls intended to run on coarse counts, which is made from short-staple cotton, must be smaller in diameter than those intended to work long-staple cotton, in order that the centers of the rolls may be brought near enough together. Sometimes the middle roll is made smaller than the front and back, where three pair of rolls are used, so that a close setting may be made.

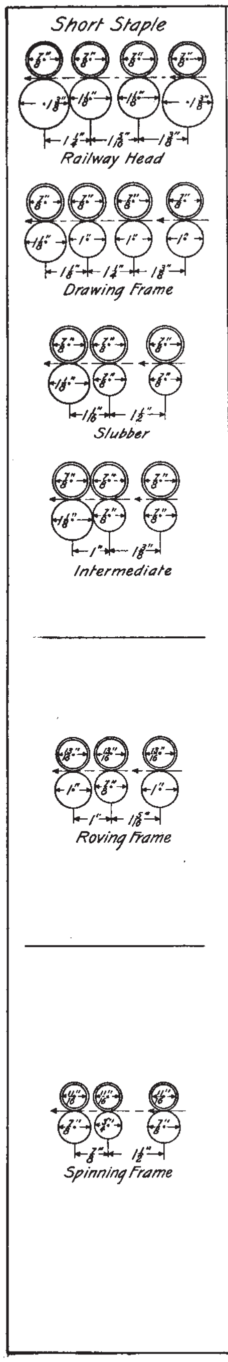


FIG. 9

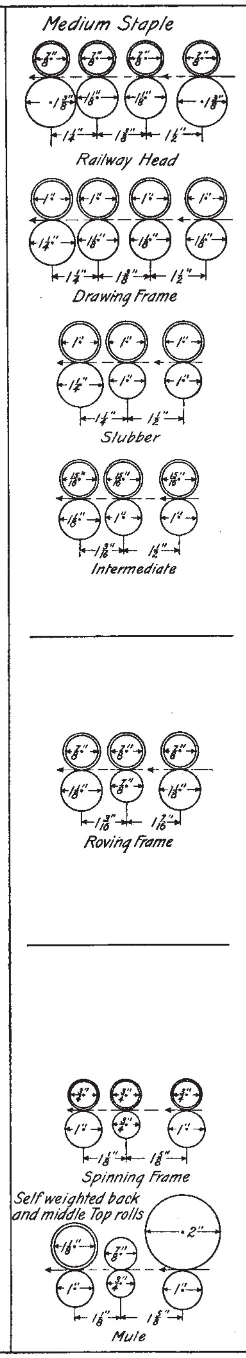


FIG. 10

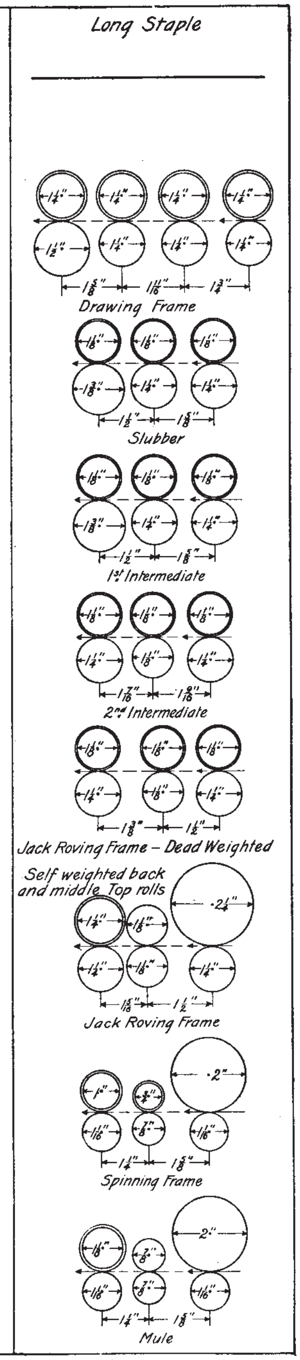


FIG. 11

The diagrams that are included in Figs. 9, 10, and 11 show the settings and diameters for different kinds of cotton, with the method of measuring distances from center to center of rolls; they will vary, however, according to conditions, as already stated.

The following settings for American cotton of about 1-inch staple are taken from actual measurements in a mill making an average of 32s:

TABLE I

	Speed of Front Roll	Weight of Sliver at Back	Distance Between Centers		
			Front and Second	Second and Third	Third and Back
First drawings	411	68 grains	$1\frac{7}{16}$ inches	$1\frac{5}{8}$ inches	$1\frac{3}{4}$ inches
Second drawings	411	68 grains	$1\frac{7}{16}$ inches	$1\frac{5}{8}$ inches	$1\frac{5}{8}$ inches
Third drawings	411	68 grains	$1\frac{3}{8}$ inches	$1\frac{5}{8}$ inches	$1\frac{5}{8}$ inches
Slubbing	162	68 grains	$1\frac{1}{4}$ inches	$1\frac{3}{4}$ inches	
Intermediate	143	.57-hank	$1\frac{3}{16}$ inches	$1\frac{5}{8}$ inches	
Roving	116	1.61-hank	$1\frac{1}{8}$ inches	$1\frac{9}{16}$ inches	
Spinning	125	5-hank	$1\frac{1}{16}$ inches	$1\frac{3}{8}$ inches	

Each case of roll setting must be judged by its requirements. Table I shows ordinary settings on the intermediates, roving, and spinning, and excessively wide settings on the drawing and slubber on account of the unusually heavy sliver and high speed; but in the mill in question, after numerous experiments were made, it was found that under the circumstances the best yarn was made with the above settings. A more ordinary setting for a 60-grain sliver, 350 revolutions per minute at the drawings, would be $1\frac{1}{4}$, $1\frac{3}{8}$, and $1\frac{1}{2}$ inches, with the same cotton.

21. Adjusting Points.—On all the attenuating machines of a cotton-yarn mill, adjustments are provided by which the distance between the rolls may be regulated. In Fig. 12, b is shown as one of the roll stands that support the rolls, this being a stand for three pair of rolls. The bearing b_1 of the front roll is cast solid with the main support b, and consequently the front-roll bearing cannot be moved. Separate bearings, which are adjustable, are provided for the other two lines of rolls; b_2 is the bearing for the center line of rolls and is capable of sliding on b_1, while b_3, which is the bearing for

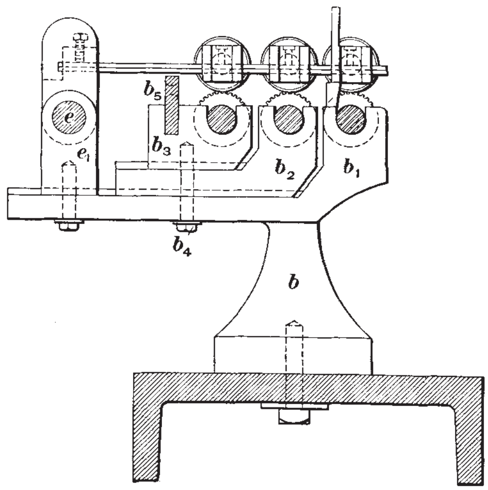


FIG. 12

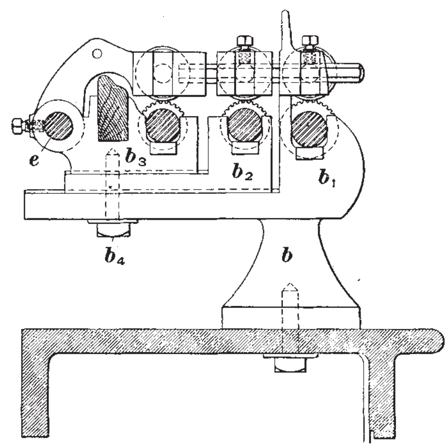


FIG. 13

the third line, can slide on b_2. Fig. 13 shows a roll stand that differs somewhat from that shown in Fig. 12, although the letters of reference will be found to apply to the same parts.

When it is desired to set the rolls, the set of top rolls that is at the end of the frame is removed, together with other sets of top rolls at frequent intervals, usually at every other stand. The screws b_4 that secure the bearings of the bottom rolls are then loosened throughout the length of the frame. The required distance between the bites of the rolls should next be determined, and from this, together with the diameter of the rolls, the distance between the bosses of each pair may be learned, after which gauges of the correct thickness are selected. For example, suppose that the distance between the centers of the front and second bottom rolls is to be 1 inch, and the front roll is 1 inch in diameter

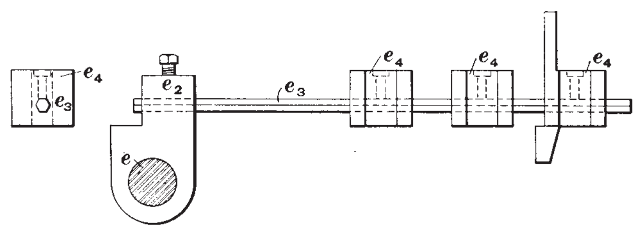


FIG. 14

and the second roll $\frac{7}{8}$ inch. Then the space occupied by the rolls themselves would be the sum of one-half of the diameter of each roll, which is $\frac{7}{16} + \frac{8}{16}$, or $\frac{15}{16}$. Since the distance from center to center is to be 1 inch, the space between the bosses of the rolls would be $1 - \frac{15}{16}$, or $\frac{1}{16}$ inch; therefore, a $\frac{1}{16}$-inch gauge would be selected in setting these rolls. These gauges are inserted between the bosses of the rolls, after which the rolls are drawn up until the gauge sets snugly, when the binding screws b_4 are tightened. This operation is repeated at every stand where top rolls have been removed. The gauges used are generally made of wood, brass, or iron and are about 2 inches long, $\frac{3}{4}$ inch wide, and of various thicknesses, in order to suit the work.

22. Cap Bars.—The top rolls have their bearing on the bottom rolls and are held in position by an arrangement of **cap bars,** one of which is shown in Fig. 14. The cap bars are constructed in such a manner that the top rolls may be removed easily, it also being possible to readily turn the cap bars away from the bottom rolls.

The manner of supporting the cap bars is shown in Figs. 12, 13, and 14. A shaft e runs lengthwise of the frame and is supported either by brackets e_1, Fig. 12, which are fixed to the roll stand, or by the bearing of the back roll, as shown in Fig. 13. On this shaft, at various intervals, are brackets e_2, Fig. 14, that carry a long finger e_3 shaped so as to fit the hole in the casting e_2; on this finger are the nebs e_4 that keep the top rolls in position. The nebs are secured to the finger, and as the holes are made to fit the peculiar shape of the finger, they are prevented from turning.

23. Setting Top Rolls.—When setting the top rolls, it is usual to have all the rolls in position and by using the correct gauges to set these rolls so that they will come directly over the bottom rolls. In order to move the top rolls so that they will occupy the correct position, it is simply necessary to loosen the screws that hold the nebs, after which the nebs may be moved to any desired position. In some cases it is the practice to insert the gauges between the nebs, although this practice is not to be recommended, since if the nebs are not of the same thickness, the rolls will not be properly in line.

In connection with Fig. 13 it should be noted that with the stands constructed in the manner shown in this figure, the bearings for the back top roll are moved together with the bearings for the bottom back roll; consequently, when the bottom back roll is set, the top back roll will always be in its correct position. This is the more modern, and is usually considered the better, arrangement.

TOP-ROLL WEIGHTING

24. In order to maintain a grip on the fibers, the top rolls must have a constant pressure on the bottom rolls. The pressure of the top roll on the bottom roll is maintained by means of weights, light weights being applied to slow-running frames and heavier ones to frames where the rolls run at high speeds, which cause considerable vibration and tend to jerk the top rolls. The system of weighting is classed as follows: (1) *Self-weighting;* (2) *dead-weighting*, which may be subdivided into (*a*) direct dead-weighting and (*b*) weighting with the intervention of springs; (3) *lever-weighting*, which may again be subdivided into (*a*) direct weighting and (*b*) weighting by saddles and bridles.

SELF-WEIGHTING

25. The method known as **self-weighting** consists of having the top roll heavy enough to maintain the necessary pressure on the fiber, and is used on the center and back rolls of fine roving frames, spinning frames, and mules intended for very fine spinning. The middle roll, which is usually $\frac{3}{4}$ inch in diameter, weighs from 2 to 4 ounces, while the back roll, which is from 2 to $2\frac{1}{4}$ inches in diameter, weighs from $1\frac{1}{4}$ to $2\frac{1}{4}$ pounds. This method is shown in Fig. 11, where the back and middle rolls of one of the jack-frames, the mule, and the spinning frame are self-weighted.

Since in spinning fine numbers the rolls generally have a slow speed, this amount of weighting is sufficient to give the necessary grip on the fibers. The method of self-weighting, however, cannot be applied to all classes of work, since, where the work is coarse and the top rolls require considerable weight, if they were made large enough to give this weight, they would be too bulky for use. On coarse work the rolls revolve rapidly and the vibration caused would prevent satisfactory use of self-weighting systems.

DEAD-WEIGHTING

26. The method known as **dead-weighting** is shown in Fig. 15. The rolls *a*, *b* illustrate direct dead-weighting, one weight serving for one roll; but by using a saddle d_2 and bridle d_3, as shown in Fig. 16, one weight can be used for two rolls, which reduces the number of weights on a machine.

The system of dead-weighting in which a spring intervenes between the weight hook and weight is shown on the rolls *c*, *d*, Fig. 15. The object of adopting this construction is to have the spring tend to neutralize the effect of any slight shock that the roll may receive.

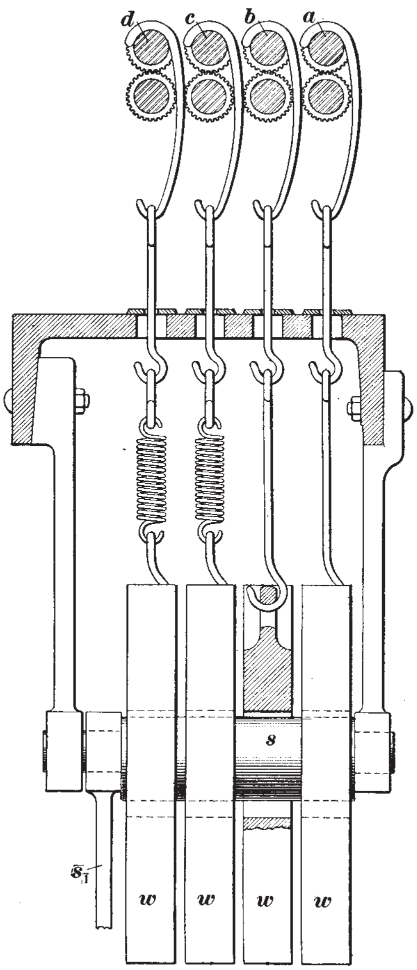


FIG. 15

If, in the case of Fig. 15, the rolls are single-boss rolls, then there will be a weight similar to *w* suspended from each end of each top roll; consequently, if the weight is, say, 14 pounds, each top roll will exert a pressure of 28 pounds on the bottom roll. If the top rolls are double-boss

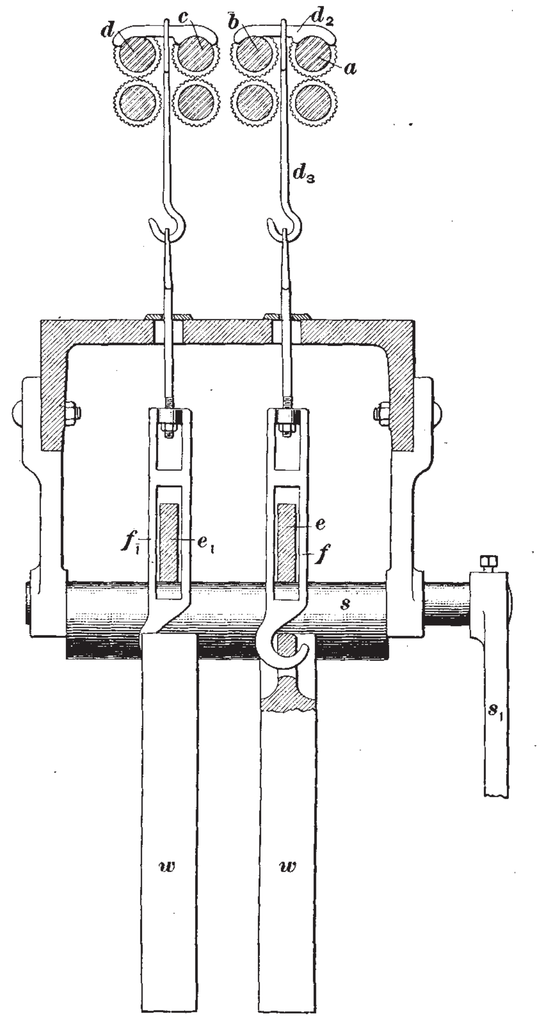


Fig. 16

rolls, there will be one weight suspended from the center of the roll, each boss having a bearing point on the bottom roll, and if the weight w weighs, say, 20 pounds, each boss will exert a pressure of 10 pounds on the bottom roll.

In the case of Fig. 16, the weight w will be distributed somewhat differently. If the top rolls are single-boss rolls, there will be weights similar to w at each end of the roll, and if these weights weigh, say, 20 pounds, there will be a pressure of 10 pounds on the end of each top roll, giving a total

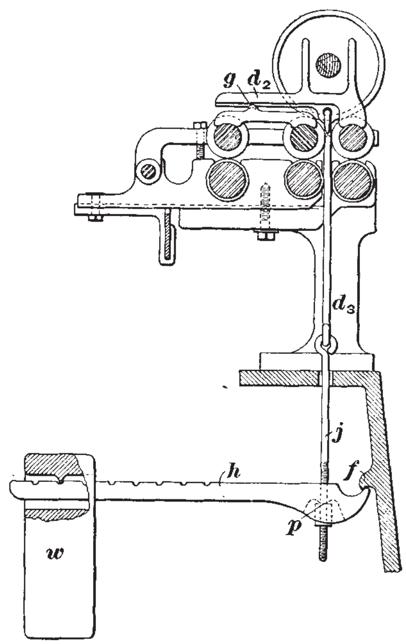


Fig. 17

pressure of 20 pounds on each roll. If the top rolls are double-boss rolls and the weight is, say, 30 pounds, then there will be a pressure at the center of each roll of 15 pounds, causing each boss of one top roll to exert a pressure of $7\frac{1}{2}$ pounds on the bottom roll.

LEVER-WEIGHTING

27. The principle of **lever-weighting** is that of exerting pressure by means of a weight acting through a lever. By this means a smaller weight may be used and