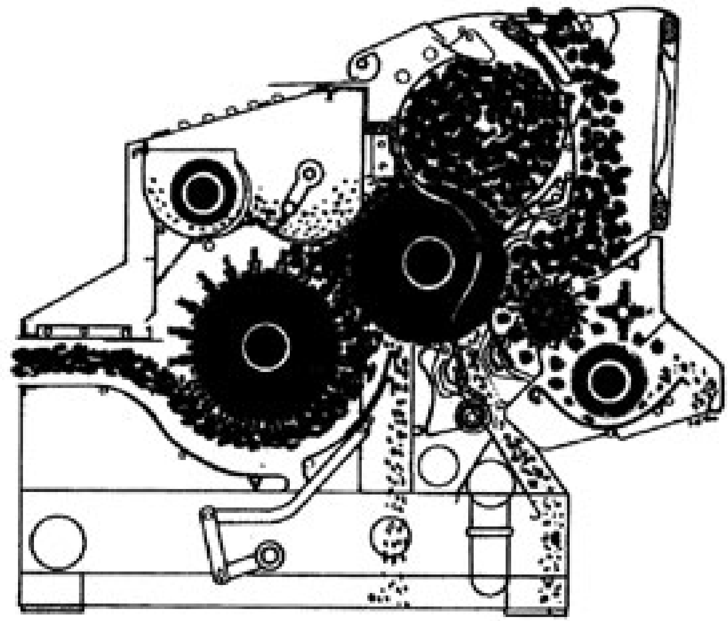
Cotton Gin Saw Developments



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COTTON SAW GIN STAND DEVELOPMENTS

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ABSTRACT

This paper reviews and compiles most of the significant developments and research conducted on saw gin stands for cotton gins since about 1958. It describes the design and operation of various types and models of saw gin stands, and gives an appraisal of gin stand designs and settings that may be most useful at current cotton gins. The compiled information and recommendations should prove useful to ginners, scientists planning future ginning studies, and engineer's selecting gin stand designs and types for commercial gins.

INTRODUCTION

Two primary types of cotton are typically grown in the United States-- *Gossypium Barbadense* (extra-long staple) and *Gossypium Hirsutum* (Upland, long or short staple). These cottons are comprised of fibers attached to seeds. Before cotton fibers can be used to manufacture textile goods, they must be separated from the seed (ginned). The first method of ginning cotton was undoubtedly by the human fingers. This perhaps might be termed "pinch ginning." A second method to follow was probably the archaic foot-roller on a stone. Several types of the primitive small, hand-operated churka gins were used, probably first in India (Bennett, circa 1959; Mayfield and Anthony, 1994).

The churka method of ginning was a roller-type gin with small diameter picking rollers that pulled fiber from the seed without crushing the seed (Figure 1). A hand churka gin would probably produce about five pounds of fiber in a long day, compared to about one pound for hand ginning. The move away from the ancient churka gin occurred in 1840 with the invention of the McCarthy roller gin (Figure 2).

The 1840 McCarthy roller gin revolutionized roller ginning by the use of a fixed blade (sometimes called a doctor knife) held tightly against a ginning roller, and having a moving knife, which co-operated with the roller and doctor knife in performing the separation of the fiber from the cottonseeds. A McCarthy-type roller gin usually produced from 60 to 90 pounds of fiber per hour for a standard 40-in. roller length.

Some Upland short-staple cotton was grown in the North American colonies before the American Revolution. However, Sea-Island cotton varieties (extra-long staple) dominated in quantity and quality. Both kinds of cotton were ginned by hand or primitive roller gins. With the invention of tooth-type cotton gins by Eli Whitney in 1794 and the improved version by Henry Ogden Holmes in 1796, the production of Upland cotton increased rapidly. Early saw-

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tooth ginning establishments were mainly confined to single gin stands on plantations (Bennett, circa 1961).

Whitney's gin used needle or metal spikes driven into a wooden cylinder (Figure 3). The spikes pulled lint through slots that were too narrow for the seeds to pass. A revolving brush then removed the lint from the spikes. The gin handled one batch of seed cotton at a time because the seed had to be removed by hand after the batch of cotton was ginned. Holmes gin used metal saws positioned on a shaft to replace Whitney's rows of spikes (Figure 4). In the Holmes gin, slots or ribs allowed the cleaned seeds to fall out the bottom, making ginning a continuous process. Modern saw gins use Holmes' basic principle with many improvements.

A detailed history of roller cotton ginning (1742-1958) and saw-tooth ginning (1789-1960) are described by Charles A. Bennett in two journals (Bennett, circa 1959, circa 1961).

OBJECTIVE

This paper reviews and compiles most of the significant developments and research conducted on saw gin stands for cotton gins since about 1958. It describes the design and operation of various types and models of saw gin stands, and gives an appraisal of gin stand designs and settings that may be most useful at current cotton gins. Materials from the review are arranged chronologically. The compiled information and recommendations should prove useful to ginners, scientists planning future ginning studies, and engineer's selecting gin stand designs and types for commercial gins.

DEVELOPMENTS

The following section describes various construction features and operating performances for many of the gin stand developments that were marketed during the period 1958 - 2000. Most of the information and capacity claims were taken from manufacturer's catalogs and have not been independently validated.

History of Developments

Many gin stand developments and the gins' approximate date of first use in commercial cotton gins are shown in this section. Also listed are some of the basic features of the gins and the manufacturers.

YEAR	DEVELOPMENT	FEATURES	MANUFACTURER
1958	100 saw	12-in. dia. saw	Hardwicke-Etter Co.
1958	90 saw	12-in. dia. Saw	Cen-Tennial Cotton Gin Co.
1958	120 saw	12-in. dia. Saw	Cen-Tennial Cotton Gin Co.
1958	120 saw	12-in. dia. saw	Hardwicke-Etter Co.
1958	88 saw, Super	12-in. dia. Saw	Lummus Cotton Gin Co.
1962	177 saw, 2cyl.	11¾- in., 12-in. saw	Hardwicke-Etter Co.
1962	178 saw, 2 cyl.	11¾- in., 12-in. saw	Hardwicke-Etter Co.
1962	224 saw, 2 cyl.	11¾- in., 12-in. saw	Hardwicke-Etter Co.
1962	120 saw	12-in. dia. saw	The Murray Co. of TX
1962	80 saw	18-in. dia. saw	The Murray Co. of TX

1962	120 saw	12-in. dia. saw	Continental Gin Co.
1962	79 saw	16-in. dia. saw	Continental Gin Co.
1962	119 saw	16-in. dia. saw	Continental Gin Co.
1962	88 saw, Imperial	12-in. dia. Saw	Lummus Cotton Gin Co.
1962	75 saw	16-in. dia. saw	Moss Gordin Co.
1962	140 saw	16-in. dia. saw	Moss Gordin Co.
1962	177 saw, 2cyl.	11¾- in., 12-in. saw	Hardwicke-Etter Co.
1962	120 saw	18-in. dia. saw	The Murray Co. of TX
1964	128 saw, Imperial	12-in. dia. Saw, 8 bales/h	Lummus Industries, Inc.
1968	94 saw	18-in. dia. saw	Maguinas-Piratininga
1968	120 saw	18-in. dia. saw	Maguinas-Piratininga
1973	142 saw	18-in. dia. saw	The Murray Co. of TX
1973	93 saw	16-in. dia. saw	Continental/Moss Gordin
1973	141 saw	16-in. dia. saw	Continental/Moss Gordin
1974	108 saw, Imperial	12-in. dia. saw, 7 bales/h	Lummus Industries, Inc.
1974	158 saw, Imperial	12-in. dia. saw, 10 bales/h	Lummus Industries Inc.
1974	200 saw, 2 cyl.	11¾ - in., 12-in. saw	Hardwicke-Etter Co.
1974	252 saw, 2 cyl.	11¾ - in., 12-in. saw	Hardwicke-Etter Co.
1979	141 saw	16-in. dia. saw, seed tube	Continental/Moss Gordin
1980	94 saw	18-in. dia. saw, seed tube	The Murray Co. of TX
1982	142 saw, Triple Crown	18-in. dia. saw, seed tube	The Murray Co. of TX
1986	164 saw	12-in. dia. saw, 10 bales/h	Consolidated HGM Corp.
1987	158 saw, Imperial II	12-in. dia. saw, 12 bales/h	Lummus Industries, Inc.
1988	108 saw, Imperial II	12-in. dia.saw, 8 1/2 bales/h	Lummus Industries, Inc.
1988	161 saw	16-in dia. saw, seed tube	Continental Eagle Corp.
1988	112 saw	12-in. dia. saw, 6-8 bales/h	Consolidated HGM Corp.
1989	158 saw	12-in. dia saw, 15 bales/h	Lummus Corporation
1989	112 saw	12-in. dia.saw, 8 1/2 bales/h	Consolidated HGM Corp.
1989	164 saw	12-in. dia. saw, 12 bales/h	Consolidated HGM Corp.
1994	170 saw, Imperial III	12-in. dia. Saw, 15 bales/h	Lummus Corporation
1996	116 saw, Imperial III	12-in. dia. Saw, 10 bales/h	Lummus Corporation
2000	198 saw	12-in. dia.saw, 14½ bales/h	Consolidated Cotton Gin Co.

Hardwicke-Etter Centurian 100- Saw Gin

The Centurian 100-saw gin was capable of producing 3 or more bales of cotton per ginning hour. It could be installed in place of any Hardwicke-Etter 80-saw or 90-saw gin, using the same anchor bolts. Its features included split huller ribs, positive vacuum moting, and a hot roll box. The Centurian air-blast nozzle took lint away from the saws at a point below that generally used in air-blast gins (Hardwicke-Etter Company, circa 1958a).

Centurian's split huller ribs permitted closer spacing of gin saws for more teeth in contact with the seed roll. Gin saws had 282 teeth of a modified roach-back design. The moting system used a rotating, self-cleaning mote cylinder, eliminating reciprocating mote boards.

In the reclaimer section, a saw located under the picker roll prevented cotton from being lost with the trash. A brush located above the reclaimer saw removed reclaimed cotton and put it back into the stream entering the roll box. The hot-roll box was a thermostatically controlled, electric heating device for the back of the roll box, reducing the turning friction of the seed roll.

Hardwicke-Etter CXX Gin

Hardwicke-Etter's C-double-X (CXX) 120 saw, air-blast gin was developed to satisfy the growing demand for higher capacity ginning (Figure 5). Its features included split huller ribs, vacuum moting, easy breast lift, heavier saws, adjustable air nozzle, case-hardened spot on ginning rib at ginning point, reclaimer section, and adjustable seed fingers (Hardwicke-Etter Company, circa 1958b). The CXX gin had many of the same features as the Centurian 100-saw gin.

Hardwicke-Etter 100/120 Saw Brush-Type Gin

Hardwicke-Etter's 100 and 120 saw, brush-type gin used many features found on its air-blast gins (Figure 6). Its doffing brush was adjustable to and from the saw while maintaining correct relationships in other sections of the gin (Hardwicke-Etter Company, circa 1958c).

Multiple-moting was used with centrifugal moting and gravity moting, both above and below the saw. The lower mote board is adjustable to suit the type of cotton being ginned. The front edge of the chamber, which is set close to the saw teeth, serves as a lint cleaner grid bar in removing motes and extraneous material. A revolving sweeper keeps the mote chamber clean by wiping trash into a conveyer.

The gin breast can be manually placed in and out of ginning position using a balancing linkage. The gins could be equipped with air cylinders operated from a central control panel to place the gin breasts in operating or non-operating positions.

Hardwicke-Etter Dual Saw Gins

The basic design of the Hardwicke-Etter dual saw gin was established in 1960. The principle involves utilizing two saw cylinders taking cotton from the same roll box. Thus, capacity is increased by utilizing more saws in the gin stand. The first dual saw gin operated with 177 saws, 88 saws on one saw cylinder and 89 saws on the second cylinder. It was referred to as the Dual 177 (Figure 7) (Hardwicke-Etter Company, circa 1962a).

A dual 177 was designed to occupy about the same floor space as 80- or 90- saw gin stands. Each saw cylinder assists the others in turning the seed roll. The two set of saws agitate the seed roll, causing teeth to strike at places in the roll where there is unginned cotton missed by the other saws. Thus, this avoids the necessity of a special agitator to force-feed the saws while occupying the center of the roll area.

The design of the dual saw gin was retained in the design of the Regal 178 and Regal 224 dual saw gin stands. Features of the Regal 178 and 224 included an automatic feed control system, seed labrequins to control seed discharge, split huller ribs in the huller front, and overhead moting system. Air cylinders were available to place the gin breasts in operating or non-operating positions from a central control panel (Hardwicke-Etter Company, circa 1962b, circa 1962c).

Super Regal 200 and Super Regal 252 dual saw gins were also built by the Hardwicke-Etter Company (Figure 8). There were more saws at work in the Super Regal 252 than there were in any other gin then on the market at the time (Hardwicke-Etter Company, circa 1974a, circa 1974b).
Important settings and adjustments for the Super Regal gins are also noted in **Figure 8**. These are: 1) saw projection through split rib, 3/16 in.; 2) saw projection through gin rib, 2-3/8 in.; 3) huller knife projection into saw, ½ - 5/8 in.; 4) brush to saw, throat of tooth; 5) lower cutoff plate to brush, 1/16 in. or closer; 6) upper cutoff plate to brush, 1/8 in.; 7) mote board to saw, 1/16 – 3/32 in.; 8) mote board to brush, 1-1/16 in.; 9) lower mote board to saw, ¾ in.; 10) air gaps, nonadjustable; 11) upper scroll to saw, 3/32 in.; 12) top brush scroll to brush, ¼ in. minimum: The upper saw speed was 695 rpm and the lower saw speed was 650 rpm.

Cen-Tennial Combination 90/120 Saw Gins
The Cen-Tennial Combination Gin was furnished in 90 or 120 saws. The term "Combination" indicated that they cleaned as they ginned. They were air blast-type gins (Figure 9) (Cen-Tennial Cotton Gin Co., circa 1951, circa 1960). These gins had stainless steel roll boxes with cadmium plated roll box heads to reduce friction and allow the large, loose roll to turn freely. Gin fronts were polished heavy gauge stainless steel and were collapsible types to control fires that might start in overhead machinery. Gin breasts were self-locking in the out-of-ginning position.

A huller front rib agitator kept cotton from building on top of huller ribs. The proper saw-rib ginning point was maintained with a 6-way breast adjustment. The gin breast could be operated electrically by a push button, or with a hand lever and clutch for optional manual control.

All moving parts were driven from a 700 rpm saw shaft with V-belt and gear reduction boxes. Saws were 12 in. in diameter. Die cast aluminum space blocks were used to reduce weight. The saw cylinder could be removed without lifting the gin breast. A bottom hinge point acted as a pivot for lowering the breast to the floor.

There was a large overhead cleaning and moting area on the gin stand plus a lower moting feature. A revolving stainless steel roller behind the saws and double wipers gave positive control of motes and trash.

A full length hinged door gave access to the cleaning and moting chamber. Doffing air nozzles could be adjusted to the saws and cleaned at any point by opening this door.

Murray 90/120 Saw Safety Gins
The Murray Company of Texas, Inc. was the first manufacturer to incorporate the Reciprocating (Government Type) Lint Cleaning Bar in a gin. It was featured in their 1957 Model 90-Saw Recipro Safety Air-blast Gin (Figure 10) (The Murray Company of Texas, Inc., circa 1960).

This device consisted of a Reciprocating (Government Type) Grid Bar located with leading edge closely spaced at rear of saws between the back of the ribs at ginning point and top of air blast nozzle. A positive action single-arm wiper that reciprocated with the grid bar assembly rotated slowly, preventing accumulation on the grid bar. Horizontal travel of the grid bar assembly was slightly greater than center-to-center distance between the saws. These lint-cleaning bars worked with both handpicked and machine-harvested cottons. No suction was used in the moting chamber.

The saws are 12-in. diameter, 0.037 gauge, with 264 teeth. A glass panel gave full vision across the entire front of the gin. The entire front assembly is hinged at the bottom so that the top swings forward and away from the saw cylinder.
Features of the 90-saw Safety Gin, including the Reciprocating Lint Cleaning Bar were incorporated into Murray's 120-Saw Brush Safety Gin (Figure 11). This gin contained a dynamically balanced brush cylinder for positive doffing of the lint cotton. Gin stands could be furnished with an electric, automatic front control, which could be operated from individual gins or from a master panel (The Murray Company of Texas, Inc., circa 1962a).

Murray 80/90/94/120/142 18-in. Gins
The development of the 80-18 gin stand by the Murray Company of Texas, Inc. about 1962 was an industry first. The saws were 18-in. diameter and 0.045-in. thick. The gin was manufactured with both airblast doffing (Figure 12) and brush doffing (Figure 13) (The Murray Company of Texas, Inc., circa 1962b, circa 1962c).

Features included an adjustable seed channel, a heavy fabricated and plated reciprocating mote bar, and a 9-in. mote conveyor for handling moting. Brush doffing utilized a dynamically balanced 18-in. diameter brush cylinder.

Important settings and adjustments for the 18-in. airblast gin are noted in Figure 12. These are: 1) saw projection through huller rib, 3/16 in.; 2) ginning point to point of rib, 2 in.; 3) airblast nozzle to saw, 3/32 in.; 4) foot of huller rib to ginning rib, 3 in.; and 5) saw speed, 456 rpm. The airblast pressure was 10-16 in. of water.

Important settings and adjustments for the 18-in. brush gin are noted in Figure 13. These are: 1) saw projection through huller rib, 3/16 in.; 2) ginning point to point of rib, 2 in.; 3) brush to saw, depth of sawteeth; 4) foot of huller rib to ginning rib, 3 in.; and 5) mote bar to saw, 3/32 in.. The saw speed was 545 rpm.

About 1968, the Murray Company manufactured the 18-in. diameter saw gin with 90, 94, and 120 saws; and in 1973 with 142 saws (The Murray Company of Texas, Inc., circa 1962d, circa 1968a, circa 1968b; Maguinas-Piratininga Machinery Corp., circa 1973). Ginning rates for the 80-18, 94-18, 120-18, and 142-18 gins were 4-5, 5-6, 6, and 8 bales per hours, respectively.

Murray also developed two conversion units, the 142-18 and 94-18. The 142-18 was designed to replace the ginning front in the 120-18 gin. This unit fit both the brush and airblast gins. The 94-18 replaced the ginning front in the Murray 80-18 brush and airblast gins (Murray Gin Division, circa 1980).

Murray Triple Crown Gin

Murray-Carver, Inc. introduced its Murray Triple Crown Brush Gin in 1980 (Figure 14). Triple Crown gins had the traditional Murray stainless steel roll box; 18-in. diameter, 0.045-in. thick gin saws; hardened, plated ginning ribs; and balanced 18-in. diameter brush cylinder (Murray-Carver, Inc., circa 1981).

A stainless steel tube in the roll box removes a percentage of the clean seed, and increases ginning capacity. These gins were available in both 94-18 in. saw (6-8 bales/hour) and 142-18 in. saw (8-10 bales/hour) models. The 94-18 inch saw model was converted in the field.

Continental Comet 79-saw/Comet Supreme 119-saw

Continental's Comet 79-saw gin was manufactured to replace any 80 or 90 saw gins (Figure 15). It used 16-in. diameter gin saws and was designed to operate at 4 bales per hour. Both brush and air-blast gins were available (Continental Gin Company, circa 1962a).

The Comet gin stand was designed with a stainless steel roll box and top mounted rib which contributed to its capacity. It operates with a loose seed roll without an agitator. There was an improved huller front and adjustable two-way seed fingers. The doffing brush was 15 in. in diameter.

Continental's Comet Supreme 119-saw gin had the same features as the Comet gin. It was designed to replace any 120-saw gin and operated at 6 bales per hour. Both gin models were generally used at cotton gins in 1962 (Continental Gin Company, circa 1962b).

Moss-Gordin Gins

The Moss-Gordin Company manufactured the Moss-Gordin 140 x 16", Moss-Gordin 100 x 16", Moss-Gordin 75 x 16", and Moss-Gordin 75 x 14" gin stands. They were the first to use a 16-in. saw. Each saw had 344 teeth (Moss Gordin Company, circa 1962b).

Both Moss-Gordin air-blast and brush gin stands were manufactured. An air-wash system in the overhead moting system helped to remove dust, green leaf, and fine trash. Features of Moss-Gordin gins included a roll box that provided a free running seed roll. There was a large huller front with huller ribs in 10-rib sections, and a reclaimer cylinder. Steel ginning ribs were non-tagging and built in 10-rib sections. Moss-Gordin gins were the first to provide a front that rolled straight out.

Moss-Gordin's Slip-in Gin

Moss-Gordin's Slip-in gin has 75 saws of 14-in. diameter. It was designed for added capacity with a minimum investment. The slip-in gin replaced any 80 or 90 saw gin and doubled capacity. It occupied the same space as 80 or 90 saw gins. Features of the gin included the straight roll-out front, a huller front, and tag-free designed ginning rib (Moss-Gordin Company, circa 1962a).

Moss-Gordin 16-in. Gin

Moss-Gordin's 16-in. diameter saw gins stands were manufactured with 75, 100, and 140 saws. The M/G 100 x 16" was introduced to fill the gap between the high capacity M/G 140 x 16" and a flexible 75 x 16". The same features of the M/G 140 are used in the 100 (Figure 16).

The Moss-Gordin 140 x 16" gin is rated at 6 to 8 bales per hour. It is used on everything from green machine-picked or stripped to hand-snapped cotton. The 140 x 16" was available as an air-blast or brush unit. Its saw cylinder is mounted on 8-in. steel tubing with shaft running through for strength and rigidity. Ginning ribs are made of steel with hard chrome plating at ginning points to reduce wear to a minimum. The M/G 140 x 16" gin was used about 1960. (Continental /Moss-Gordin, circa 1973a).

Continental Murray 120 Saw Gin

The Continental Murray 120 saw gin was introduced about 1987 (Figure 17). It was a slight refinement of a model produced in 1962. The ginning breast tilts forward for easy inspection of huller ribs, ginning ribs and roll box. Its huller front swings forward for accessibility to picker rollers and roll box. V-belt drives were used throughout (Continental Murray Ginning Systems, 1987).

There is overhead moting with positive wiper action. The gin saws are 12 in. diameter and of standard gauge. A stainless steel, engineered-shape roll box was used with automatic feed and roll density control. Doffing brushes remove lint from the gin saws.

Continental 93-saw/141-saw

Continental/Moss-Gordin (Continental Eagle) introduced their 93-saw and 141-saw gins about 1973 (Figure 18). The gins used 16-in. diameter saws and were rated at 5 and 7½ bales per hour, respectively. The 93-saw unit had the same engineering features as the larger 141-saw gin. Features of these gins included dual moting, stainless steel roll box, top-mounted ginning ribs, and doffing brushes. (Continental/Moss-Gordin, circa 1973b).

Important settings and adjustments are noted in Figure 18. These are: 1) saw projection through huller rib, ⅜ in.; 2) gravity mote board to brush, 1½ in.; 3) overhead mote board to saw, 1/16 in.; and 4) ginning point to point of rib, 2 in. The saw speed was 625 rpm and the brush speed was 1,850 rpm (Columbus, et al., 1994).

Continental 93/141 Saw Double Eagle/ 161 Saw Golden Eagle

Continental Murray Ginning System (a unit of Continental Eagle Corporation) marketed its Double Eagle and Golden Eagle series gins about 1989. The Double Eagle 93-saw gin handled 6 to 8 bales per hour. Doffing brushes clean lint from the 16-in. diameter gin saws. A high capacity is maintained by discharging seed from the roll box at a high rate. A seed roll conveyor tube conveys seed from inside of the seed roll. Speed of the louvered tube is coordinated to nearly match the natural rotation of the seed roll, thus not acting as an agitator to force lint and seed from the roll box. This procedure helps to remove seed without damage. The ginning ribs are top mounted (Continental Murray Ginning Systems, 1989).

The higher capacity Double Eagle Model 141-saw gin is rated at 12 bales per hour (Continental Murray Ginning Systems, circa 1979). It is similar in design to the 93-saw Double Eagle and uses the seed roll conveyor tube to rapidly remove seed from the gins (Figure 19). Features include overhead moting, doffing brushes, 16-in. diameter gin saws, stainless steel roll box, and top mounted ginning ribs.

Important settings and adjustments for this gin are noted in Figure 19. These are: 1) saw projection through huller rib, 3/8 in.; 2) gravity mote board to brush, 1½ in.; 3) overhead mote board to saw, 1/16 in.; and 4) ginning point to point of rib, 2 in. The saw speed is 615 rpm and the brush speed is 1,552 rpm.

A Golden Eagle Model 161-saw gin is manufactured, which is similar in design to the Double Eagle Model 141-saw gin (Figure 20). However, the 161-saw gin uses only one rotating brush in its huller front (Continental Eagle Corporation, 1993).

Continental's Eagle 10-Saw Gin

Continental's Eagle 10-saw gins are designed primarily for laboratory use and for seed breeders. The 10-saw gin requires a 1½ hp electric motor. The gin operates at 300-rpm saw speed and a ginning rate of 3.5 to 4.5 pounds of lint per saw per hour. Capacity will vary with each type of cotton as well as its moisture and trash content. Brushes doff the lint from the saw and deliver it to a condenser at the back of the gin. The condenser separates the lint from the air and forms the cotton into a batt (Continental Gin Co., circa 1960).

Lummus 88/108/116/128/158/170 Saw Gins

The Lummus Super 88 gin was the first basically new development in gin stand design in over 20 years. The Super 88 was an air-blast gin that had features which enabled it to gin at a capacity up to twice, that of the average 90 saw gin (Figure 21). The Super 88 could fit into the space required by the usual 80 or 90-saw gin. It was introduced in 1958 (Lummus Cotton Gin Co., 1959, circa 1964).

Six, light-weight ball bearing rollers provide a low friction surface for loose seed roll operation. The power driven agitator in the Super 88's roll box improved loading of the saw teeth giving increased capacity. Lummus' Imperial 88-saw gins were manufactured in either the air-blast (Figure 22) or brush type (Figure 23). Both feature many of the standards of the Super 88 gin (Lummus Cotton Gin Co., circa 1962).

The Lummus Imperial 88-saw gin uses a new huller front design that uses the sling-off action principle for trash extraction. This huller front is made in three sections rather than the usual one- or two-piece construction. A convenient lever is provided to open the lower section of the huller front for access to the huller ribs. The moting system is also new and simplified. It incorporates a Teflon covered, adjustable lip to provide optimum top moting.

Important settings and adjustments for the air-blast gin stand are noted in Figure 22. These are: 1) saw projections through huller rib, ½ - $^{9}/_{16}$ in.; 2) airblast nozzle to saw, 1/16 in.; 3) airblast mote board to saw, ¼ in.; 4) airblast throat opening, 1-13/16 in.; and 5) overhead mote lip to saw, 1/8 in. The saw speed is 830 rpm and the airblast pressure 16 to 19-in. of water column.

Important settings and adjustments for the brush gin are noted in Figure 23. These are: 1) saw projection through huller rib, ½ - $^{9}/_{16}$ in.; 2) brush to saw, depth of sawteeth; 3) mote board to saw, ¼ in.; 4) mote board to brush, 1-3/4 in.; and 5) overhead mote lip to saw, 1/8 in. The saw speed is 830 rpm and the brush speed 1,770 rpm.

An Imperial 128-saw gin is also available in either the air blast or brush type. Both the brush and air blast models are equipped with top and bottom moting systems, which are adjustable to provide the degree of moting desired. The majority of the components that make up the Imperial 128 are interchangeable with the Imperial 88 with the exception of those parts which are of necessity longer and heavier (Lummus Cotton Gin Co., circa 1964).

The Lummus Imperial 108-saw and 158-saw gins have all electric drives. The electric drive allows manual mode for feed roller speed control or automatic mode for seed roll density control. A 108-saw Imperial fits in the same floor space as an 88-saw gin but has increased capacity. Normal ginning rates for the Imperial 108 and 158 are 7 and 10 bales per hour, respectively, (Lummus Industries, 1974a, 1974b).

A panel on the Imperial 108- and 158-saw gins operates the solid-state controller and provides continuous readings of the seed roll density and feed rate. If the "auto" mode is selected and "density set" dial set, the controller automatically adjusts the feed rate for constant roll density. An electric drive for the serrated cylinder in the roll box continuously senses the seed roll density and signals the controller of any change.

A Lummus Electric Drive Conversion Kit for Lummus Imperial Gins is also available. It allows adding the automatic mode seed roll density control on Imperial 88 or 128 gins (Lummus Industries,
Inc., 1983).

In the mid-1980's, Lummus redesigned the Imperial 108 and 158 gins, removing the huller front and replacing it with a scroll assembly and reconfigured picker roller (Lummus Corporation, 1995a, 1995b). This "hullerless" front design was designated the Imperial II. The new design resulted in approximately a 20% increase in gin stand capacity. The 158-saw Imperial II gin was commercially introduced in 1987, and the 108-saw Imperial II followed in 1988 (Figure 24). Settings and adjustments for the Imperial II model gins are noted in the figures.

In 1994, the Imperial III series of Lummus gins was introduced with the 170-saw gin (Lummus Corporation, 1995c). The 116-saw Imperial III followed in 1996 (Lummus Corporation, 1997). The Imperial III series still features a hullerless front design and 12-in. diameter gin saw with brush doffing. However, the outer breast and roll box areas are substantially different from their predecessors (Figure 25). The outer breast and upper openings into the gin front have been enlarged to facilitate higher flow of seed cotton from the feeder apron into the gin. There are some additional changes involving cross-section of the seed roll, seed roll pressure, and seed reclaiming.

The 116-saw Imperial III is driven independently by a 100-hp motor and is rated at 10-12 bales per hour. The 170-saw Imperial III features a 150-hp independent drive and is rated at 15-18 bales per hour.

Consolidated 112/164/198 Saw Brush Gins
Consolidated HGM Corporation manufactured the Horn 164 saw gin stand about 1986 (Figure 26). It was described as a culmination of 49 years of A.L. Vandergriff research (Consolidated

HGM Corporation, circa 1986). A space-saving, compact, 112-saw version is also available with the same strength and construction as the 164 saw gin stand (Consolidated HGM Corporation, circa 1988).

The 112-saw gin operates with a 50-hp motor to produce a ginning rate of 6-8 bales per hour, or an optional 60/75-hp motor to obtain 8.5 bales per hour. A 164-saw gin uses 75-and 100-hp motors for capacities of 10 and 12 bales per hour, respectively. All motors rotate at 1,800 rpm.

A Consolidated 198-saw gin stand is also manufactured with the same features as the 164 saw brush gin. In 2000, this gin had more saws than any other gin stand in the world was rated at 15 – 18 bales per hour (Consolidated Cotton Gin Co., Inc., circa 2000).

Consolidated gin stands sometimes operate above these horsepower and capacities. For example, the horsepower of the 112-saw gins has been increased in some cases to 100 hp, with capacities around 9-10 bales per hour. For 164-saw gins, up to 150 hp has been applied with capacities up to 17-18 bales per hour. For 198-saw gin stands there are 200-hp motors operating at capacities of 21-22 bales per hour.

Gin saws of the 112/164 stands are 12 in. diameter and 0.045 in. thick. They are mounted on a solid steel, 4¾ in. diameter mandrel supported by 3-7/16 in. diameter roller bearings.
The stainless steel ginning ribs are manufactured with removable inserts of 72 Rockwell Hardness at the ginning point. This allows replacement of the gin points without removing gin ribs. Features include a stainless steel roll box that contains a powered oscillator cylinder, which facilitates rotation of the seed roll, and an adjustable upper moting system. End heads are heavy 1-in. steel plates. There is a load sensing electric gin control that allows adjustment of feed rate and seed roll density while providing overload protection.

Important settings and adjustments are noted in Figure 26. These are: 1) saw-to-seed finger assemble 1-27/32 in.; 2) saw to picker roller, 19/32 in.; 3) saw to bottom "cut off", running clearance; 4) brush to "cut off", running clearance; 5) saw to mote wiper plate tip, 9/32 in.; 6) saw to mote bar, 1/8 – 3/16 in. The saw speed is 841 rpm and the brush speed is 1,799 rpm.

Rib/Saw/Brush Relationships
The relationship of the saw to the ribs is critical. Four critical saw-rib dimensions (A, B, C, and D) are shown in Figure 27. The manufacturer's current literature should be consulted in checking the dimensions for a particular gin stand model (Columbus, et al., 1994).

To ensure good ginning, the saw teeth must pass through the ribs at the proper angle. The leading edge of the tooth should be parallel with the rib, or the point of the tooth should enter the ginning rib slightly ahead of the throat (Figure 28). If the saw-rib relationship is improperly adjusted so that the throat of the tooth enters the rib ahead of the point, the resulting cutting action will reduce capacity and break fibers. It can cause choking at the top of the ginning ribs.

For proper doffing, the brush should mesh to the depth of the sawtooth (Figure 29). Proper brush speed must be maintained to provide sufficient air velocity in the lint flue so that backlashing is prevented.

RESEARCH

Gin-Saw Teeth Design

Ginning experiments revealed that loose-seed-roll ginning provided better quality lint than tight-seed-roll ginning, but at a sacrifice of ginning capacity. In an effort to obtain desirable capacity and yet employ loose seed rolls in ginning, the U.S. Department of Agriculture started a series of studies in 1934 involving several designs of gin-saw teeth (Martin and Stredronsky, 1939).

The number of teeth per saw is referred to in the ginning industry as "fineness." Pitch refers to the slope of the leading edge of the tooth. "Roached" and "straight" refer to the shape of the trailing edge, or back of the tooth. The "face" or leading edge of the saw tooth is always straight, regardless of the shape of the back. The straight tooth appears to have been universally used until the advent of the double-rib huller gin in 1889. Since then, roached teeth have been brought into use.

Using a 12-in. diameter saw of 264 teeth shaped with a modified roach back as the control, saws representing departures from it in fineness, pitch, and shapes were studied by the USDA. The tests showed that with the existing designs of gins, capacity could be improved by making reasonable increases in the number of roached teeth on saws, by moderately increasing the pitch of these teeth, or by changing the roach-backed shape of the teeth to a straight-back design. Increasing the number of roached teeth from 264 to 300 teeth per saw resulted in about 8% savings in ginning time. A finer saw (318 teeth per saw) gave no advantage from this standpoint over the control saw. Increasing the pitch angle of the saw teeth up to 7 degrees improved ginning capacity 6 to 13%. Ginning capacity of straight teeth was about 7% better than that of roached teeth.

Reductions made in saw diameter of one-sixteenth of an inch by wear and sharpening caused appreciable loses in lint turnout. These losses occurred in spite of readjustment made in breast and saw position.

An evaluation of the performance of two gin saw tooth designs was conducted during 1968-1969 at Stoneville, Miss. A newly designed gin saw was compared with that of the standard 12- and 16- in. diameter saws used in the cotton ginning industry (Mayfield and McCaskill, 1970).

The standard and special saws both had 42° pitch angles. The standard saws had 264 straight-backed teeth on a 12-in. diameter saw, and 350 moderately roached teeth on the 16-in.-diameter saw. The teeth on the special saws were larger and had more throat than the standard saws. There were 235 and 300 moderately roached back teeth on the 12-in. and 16-in.-diameter special saws.

It was concluded that the 12-in. diameter, specially designed saw performed at least as well as the 12-in. diameter standard saw. There was a significant decrease in mechanical seed damage caused by the special saw.

Experiments showed that the standard 16- in. diameter gin saw required less energy to gin cotton than the special 16-in. diameter saw. Also, the fiber ginned on the 16-in. diameter special saw was slightly shorter on the average than identical fiber ginned on a 16-in. standard saw. No other differences were found in the performance of the two 16-in. saws.

Cottonseed Damage

Comprehensive tests conducted at the U.S. Cotton Ginning Research Laboratory, ARS, USDA, Stoneville, MS, in 1965 showed an average of 16.6% mechanical damaged cottonseed in the finished gin seed. A breakdown of this figure showed an average of 7.4% was added by the gin stand (Moore and Shaw, 1967).

Because of cottonseed merchants concerns about damage to cottonseed that occurs at the cotton gin, a two-year study (1992-93) was conducted to determine the effect of cottonseed moisture levels and seed cotton feedrates during ginning on cottonseed damage and the occurrence of seed coat fragments (SCF) in the lint. Nine cottonseed moisture levels (5-17%) and four feedrates (18-25 lb lint/saw/h) were tested. During the first-year experiment, the higher feedrate gave significantly higher seed damage while the SCF count only showed a higher trend. However, neither seed damage nor SCF numbers were significantly affected by the feedrates in the second-year experiment, although both parameters tended to be higher for the higher feedrate. Seed damage increased with moisture content with the largest increase occurring at seed moisture levels above 12%. Seed coat fragment numbers and weights in ginned lint tended to be larger for the higher moisture contents. The study indicated cottonseed was more susceptible to damage at higher moisture contents and that high feedrates seem to accelerate the damage process (Columbus and Mangialardi, 1996).

Differential Ginning

An experimental technique was tested at Stoneville, MS, in 1958 that required partially ginning the cotton in stages and gave rise to the name "differential ginning" or "stage ginning" (Griffin, et al., 1960). The roll box of a 70-saw gin was filled with raw cotton that was ginned for 15 seconds without additional cotton being allowed to enter the roll box. This achieved partial ginning of the seed cotton, which resulted in the longer fibers being removed while the shorter fibers remained on the seeds. This treatment was designated as "first-stage ginning". Second-stage ginning was accomplished by filling the roll box with partially ginning cotton from stage one, and again ginning for 15 seconds. This batch process continued until there were five 15-second stages. Upper quartile length for ginning stages 1, 2, 3, 4, and 5 averaged 1.26, 1.22, 1.20, 1.16, and 1.08 in., respectively.

In a later study, a Continental Model 93 brush-doff gin stand was modified by installing a motor-driven auger in the seed-roll box (Columbus and Backe, 1992). Seed cotton was fed continuously into the left one-third of the patented gin stand, partially ginned, and the auger moved the cotton along the roll box to the right side of the gin stand. The seed cotton was completely ginned as it reached the right side of the gin stand. The modified gin stand ginned about 55% of the fibers from the seeds in the left one-third and the remaining 45% was ginned in the right two-thirds. Fibers from the two sections were kept separate throughout the ginning process by sheet-metal partitions. Length distribution and yarn quality for the fibers removed first were of superior quality as compared to the remaining fibers and to those ginned in a conventional gin stand. For example, the upper half mean was 1.11, 1.09 and 1.02 in., respectively, for the left, middle and right sections of the gin stand. Short fiber content was 6.5, 9.5 and 23.5% from those sections. By comparison, the upper half mean and short fiber content were 1.10 in. and 9.4% for the control. Mill analyses indicated that the left-side fibers could be spun into higher yarn numbers and resulted in fewer ends down per 1000 spindle hours.

Fiber Breakage

Several experiments involving tests on single fibers and of fibers en masse were conducted by the U.S. Cotton Ginning Laboratory, ARS, USDA, Stoneville, MS, to better understand the nature and causes of fiber damage at cotton gins (Anthony and Griffin, 2001). An important finding was that the force required to break the fiber averaged 1.8 times greater than the force to extract it from the seedcoat, but this difference was non-linear and was less at low moisture and more at high moisture contents. It was also shown that during field exposure, fiber breakage strength declines more rapidly than fiber separation force.

It was concluded in other experiments that modern high-capacity gins used in the United States do not create an abnormal quantity of short fibers when ginning rates recommended by the manufacturers are not exceeded (Griffin, 1977). A fiber-moisture content of 7% adequately protected cotton fibers against excessive breakage during ginning. The use of higher than normal ginning rates on cotton at 5% moisture or lower plus two stages of saw-cylinder lint cleaning caused an excessive amount of broken fibers.

A lint moisture content at about 7% at the gin stand was recommended by the USDA in 1964. This was a change from the 5 to 7% previously recommended. Research had shown that cotton at the higher moisture content is more able to withstand tensile stresses without breaking than cotton at lower moisture contents (Griffin, 1964).

An evaluation of the effects of modern gin stands on neps and short fiber content was conducted about 1998. Total nep count per gram and short fiber content by weight were both significantly different among the five gin strands tested. Average nep counts ranged from 153 to 179 neps per gram and average short fiber content varied form 6.8 to 8.0 percent (Buser, 1999). The double saw gin stand appeared to produce higher quality fiber.

Saw Spacing

A 1956 experiment was designed to show that greater fiber length and fewer neps in ginned lint would result from increasing the distance between adjacent saws over the conventional 0.75 in. (Griffin and McCaskill, 1969). Saw mandrels were modified to also give double spacing (1.50 in.) and saws at 1.125 in. spacing.

Although fiber-properties data did not show significant differences, the data indicated that the cotton ginned at the widest saw spacing had the greatest upper half mean length and contained the smallest number of neps. The quantity of lint ginned per unit of time decreased as the number of saws decreased, but when the ginning rate was expressed on a per saw basis, the wider spaced saws were found to be ginning at higher rates than closely spaced saws.

Observations of seed fall during ginning showed that at 0.75 in. spacing, only cleanly ginned seeds fell from the roll box. At 1.125 in. spacing, some seeds with lint tags fell, and at 1.50 in.

spacing, many seeds fell with considerable lint still attached. These observations were reflected as differences in lint turnout.

Seed-Roll Box Cores/Liners

Experiments were conducted in 1957-58 to investigate the effects of roll-box core design and operation. A 20-saw gin with 10 in. diameter saws was used with several devices installed inside the roll box for accelerating the seed roll (Griffin and McCaskill, 1969).

A driven, metal-clad, 4¾ in. diameter wood core with 12 rows of 2-7/16 in. spikes that provided acceleration with a 9-5/8 in. sweep diameter gave the best ginning rate increase. This produced about 6% more ginned lint than a larger (7¼ in.) diameter core. Spike length on all cores was sufficient to cause the spikes to pass between the gin saws. When the smooth core was used, less cotton was ginned than when the no-core gin was used, and when the core with spikes was used, more cotton was ginned than when the no-core gin was used.

When the seed-roll velocity was compared by treatments, the smooth core was found to actually give lower velocity than the no-core gin, whereas the spiked core gave seed-roll velocities 20 to 30 rpm less than those of the core itself. The apparent slippage between seed roll and core was attributed to be one of the causes for the increased ginning rate. Experiments using undriven cores did not show significant ginning rate increases.

Stainless-steel liners that altered the contour of the seed-roll box cavity were tested in 1964 (Griffin and McCaskill, 1969). Generally, these liners reduced the roll-box circumference and increased the seed-roll velocity. Using a conventional gin stand, the mean ginning rate for the gin equipped with the liners was 12.89 pounds of lint per saw per hour, which was 16% higher than the 11.07 pounds per saw per hour produced on the gin without the liners. Fiber quality was adversely affected to a slight degree. Upper quartile length was reduced from 1.24 in. to 1.22 in. by ginning with the liners.

Seed-Roll Density/Saw Speed

Experiments were conducted by the USDA from 1930 to 1934 to determine the influence of gin saw speed and seed-roll density on ginning capacity, power requirements, and on the quality and monetary value of the lint (Bennett and Gerdes, 1936). By feeding cotton to the gin stand at different rates, loose and tight seed rolls were produced at each gin saw speed.

Only small effects on the lint quality and the ginning capacity resulted from varying the gin-saw speed 100 rpm above or below the manufacturer's recommended speeds for two gin stands. Lowering the speed 100 rpm improved the quality slightly, but raising the gin-saw speed 100 rpm did not change the quality appreciably.

Changes in seed-roll density, caused by changing the feed rate, were more important than the change in gin-saw speed in affecting the quality of the ginned lint and operation of the gin stand. Loose-roll ginning gave the better quality cotton. Staple-length differences between loose- and tight-roll samples showed slight tendencies for the loose-roll samples to be classed longer.

Ginning capacity for a gin with four 70-saw gin stands was increased 3 bales per 8-hour day by increasing gin-saw speed 200 rpm, and 11 bales by using a tight seed roll instead of a loose seed roll.

Six pounds of fiber per 12-in. gin saw per hour was considered loose-roll ginning, whereas 9 pounds of fiber per 12-in. gin saw per hour was considered tight seed-roll ginning (Bennett and Gerdes, 1951). The loose roll had a hollow center, while the tight roll was solid.

A study in 1957 showed that regardless of saw speed or ginning rate used, the seed-roll velocity was relatively constant. The mean seed-roll velocity for four experiments at saw speeds of 600, 800, and 1,000 rpm was about 180 feet per minute (Griffin and McCaskill, 1969).

Fibrous Waste

The material removed by saw-type gin stands was investigated in three studies during 1997-1998 (Anthony, 2000). Twenty-five varieties and two locations were involved in the studies. Overall, gin stand waste varied from 5 to 18 pounds per 500-pound bale. Dramatic differences occurred between the amount of material removed by the gin stand as a function of cotton and growth condition.

Roller versus Saw Ginning

Upland cotton (long and short-staple) is normally saw ginned and Pima cotton (extra-long staple) roller ginned. Because of interest in roller ginning some of the longer staple length Upland cottons, the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, NM, compared the fiber quality of cotton ginned by the two methods. Pima and several varieties of Upland cotton were included in the study (Hughs and Lalor, 1989).

Roller ginning the Upland cotton when compared to saw ginning, improved the raw fiber properties of length, length uniformity, and nep contents, but did not decrease short fiber content. However, the yarn quality of saw-ginned lint, as measured by strength and evenness on 40's yarn, was improved. Results showed that yarn made from saw-ginned Upland cotton is stronger and more uniform than yarn made from roller-ginned Upland cotton. Roller-ginned Pima fiber makes better yarn than saw-ginned Pima fiber.

Energy Required

Comprehensive tests at six gins in 1962 showed that the average operating load was 609.6 hp. Per bale energy consumption averaged 47.5 kw-hr (Watson and Holder, 1964). Ginning accounted for 109.4 hp and used 8.5 kw-hr per bale for energy. Gin plant capacities ranged from 9.6 to 12.2 bales/hr.

A study was conducted about 1988 to evaluate the energy required for fiber-seed separation from varieties ginned in modern gins (Anthony, 1989). Twenty varieties were evaluated. They were planted on two dates and grown in Mississippi and South Carolina. Lint moisture content during ginning averaged 5.7%. In a similar study involving 38 varieties of cotton, electrical energy required for fiber/seed separation ranged from 16.2 to 23.2 watt-hours per pound of lint (Boykin, 2004).

Coating Seed-Roll Boxes
Two experiments were conducted about 1968 to determine if coating the seed-roll box of a gin stand with Teflon would produce a measurable effect on gin-stand capacity and operation, and on lint quality (Parnell and Garner, 1969). In Experiment I, 40% of the seed-roll box's circumference was covered with a Teflon sheet. Results showed that the seed-cotton velocity increased from 196.7 feet per minute for the control to 206.3 feet per minute for the experimental, a 4.6% increase. At the same time, the seed-roll density decreased from 173.3 grams (strain gage measurement) for the control to 152.8 grams for the experimental, a reduction of 11.8%. No significant differences were found in lint quality.

In Experiment II, a Teflon-coated sheet-metal liner was placed in the seed-roll box. Data indicated that this Teflon-coated seed-roll box did not produce a significant increase in gin-stand capacity. This was attributed to a marked decrease in relative humidity that occurred during Experiment II, which caused a large increase in charge buildup on the Teflon coating. A nearly constant ambient relative humidity had been maintained during Experiment I. Thus, results of the investigations did not warrant recommending that seed-roll boxes be coated with Teflon on the premise that the Teflon coating would significantly increase the gin-stand capacity.

Huller Fronts
The use of huller fronts on gin stands started about 1858. These consisted of a single huller rib, an outer breast, and a lower picker roller. The assembly removed some hulls (carpel walls) and fed seed cotton into the gin roll box through the huller ribs. This basic principle is still used in many cotton gins.

From experiments conducted in 1963, it was concluded that gin stand huller fronts used in gin plants of the 1960s added little or nothing to improving the quality of machine-harvested cotton (Watson and Moore, 1964). In some cases, the huller front had an adverse effect by actually increasing the amount of foreign matter in the ginned lint. This was attributed to the huller front reducing the large trash particles to pin trash or smaller particles. Finer particles are more difficult to remove with the gin stand moting systems and lint cleaners.

Thus, it appeared that the main function of the huller front is to provide a means for feeding seed cotton into the gin stand roll box. It was suggested that the huller front be eliminated, and the seed cotton fed directly into the gin stand roll box. This would reduce the initial cost of the gin stand, and lower power requirements and energy costs. However, it would increase the risk of hulls being ground up in the seed roll and added to the lint.

Gin Stand Capacity
From 1920 to 1960, cotton gins ranged from 80 to 120 saws per gin stand. Each gin saw of 12-in. diameter produced 6 to 12 pounds of ginned lint per hour. Thus, a plant with three 90-saw gin stands would gin about 5 bales per hour. Three to five gin stands per gin appeared to be the general choice of ginners. In 1960, some gin stands used saws of 16 in. diameter (Bennett, circa 1961).

High capacity gin stands have been manufactured with saws having 12-, 14-, 16- and 18- in. diameters. Production rates may exceed 35 pounds of lint per saw per hour. Thus, a high-capacity, 90-saw unit might exceed a ginning rate of 6.6 bales per hour. Research has shown that cotton ginned at the higher ginning rates by increasing seed-roll density resulted in lower lint grade because of rough preparation (Griffin and McCaskill, 1969).

Ginning rates per saw are listed for several modern high-capacity gin stands at the manufacturer's rated capacity:

Number of saws	Saw diameter (in.)	Features	Horsepower	Rated capacity (bales/h)	Gin rate (lb lint/saw-h)
141	16		75	7.5	15.9
141	16		125	12	25.5
161	16	Seed tube	150	15	40.9
164	12		75	10	29.3
164	12		100	12	35.1
164	12		150	18	52.6
198	12		150	16.5	41.7
198	12		200	21.5	54.2
158	12	Oscillator	100	10	30.4
158	12	Oscillator	125	12	36.5
158	12	Oscillator	150	15	45.6
142	18		100	8	27.0
142	18	Seed tube	100	10	33.8

Power Paddle Roll Gin Stand
The USDA Agricultural Research Service in Lubbock, TX, developed an experimental paddle roll gin stand about 2000. It was developed on a saw gin stand (Figure 30). Objectives of the experimental gin were to produce more lint from seed cotton compared to a conventional high capacity saw gin stand, and to give better staple length and less short fiber (Laird, et al., 2002).

Essential design changes involved creating a large, round roll box shape, installing a properly sized and centered powered paddle roll in the roll box, and providing an induction slot for seed cotton in the upper front of the roll box. In the lower front of the roll box, increased area was provided, and a seed finger roll installed for more effective charging of cotton onto the saw and to remove ginned seeds quickly. In Figure 30, "A" is the new inlet slot arrangement and "B" is the expanded lower roll box section with rotating seed finger roll.

In a series of tests, the experimental paddle roll gin stand consistently gave higher lint turnout and better fiber properties than a modern conventional high capacity saw gin stand when it was properly set up. It was also shown that changes of the gin stand that make up the powered paddle roll design must be done together or the performance and fiber quality results may be lower than with a conventional saw gin stand.

In a later study, the powered roll technology was applied to a modern gin stand with 16- in. diameter saws (Laird and Holt, 2003). The gin stand with powered roll technology was capable of ginning at 17 bales or more per hour on wet late season cotton. The conventional gin stand roll became too tight and stopped on cotton at about 12 bales per hour. The powered roll technology gin stand also increased average lint turnout by closer ginning of the cottonseeds. Turnout was more than 2% higher (over 30 pounds per bale) compared to the conventional gin stand.

NOISE

Gin stands are one of the primary sources of noise in a cotton gin (Anthony, 1974). Much of the noise is attributed to the paddle-type doffing brush that is used to remove the ginned fiber from the saw teeth. The brush typically operates at 1,500 to 1,800 rpm and is equipped with 14 to 28 brush sticks (paddles). Replacement of the conventional doffing brush with a brush cylinder with a solid doffing surface eliminates most of the noise from the gin stand (Anthony, 1977; and Laird and Anderson, 1977). These low-noise brush cylinders (Figure 31) have been used in a few research gin stands since the 1980's; and are currently used in a few commercial gins (Anthony and Glover, 2003).

SUMMARY AND CONCLUSIONS

The toothed cotton gin was invented by Whitney and Holmes. Although many modifications and improvements have been made, their design is still the basis for the modern saw gin stand. An ideal saw gin stand removes fiber from the cottonseed without causing damage to the fiber or seed. Quality of the lint is generally obtained by separating fibers at the seed surface. Gin stands are the heart of the gin plant system. The capacity of the gin stands sets specifications for the other machinery in the gin. There are many models of saw gin stands manufactured today. Gin stands use 75 to 198 saws with saw diameters of 12 to 18 in. Their capacities range from 4 to 22 bales per hour per gin stand.

Quality of the lint and cottonseed are influenced by many factors. These include feed rate, seed-roll density, fiber and seed moisture contents, saw speed and condition, and settings and adjustments of gin stand components. Best average results are generally obtained on a gin stand model by following the recommendations of the manufacturer of the unit.

Seed-roll density is an important factor affecting the quality of the ginned lint and operation of the gin stand. Increasing the feed rate generally increases the seed-roll density. Loose-roll ginning gives better quality cotton than tight-roll ginning. Modern high-capacity gin stands rated at 8 to 12 bales per hour average ginning 27 to 41 pounds of lint per saw per hour.

A lint moisture content at about 7% at the gin stand is recommended. Cotton at this moisture content is more able to withstand tensile stresses without breaking than cotton at lower moisture contents. To prevent seed damage and large seed coat fragment numbers, ginning should not occur at seed moisture levels above 12%. Cottonseed is more susceptible to damage at higher moisture contents.

Experiments have shown only small effects on the lint quality and the ginning capacity from varying the gin-saw speed 100 rpm above or below the manufacturer's recommended speeds. One study showed that regardless of saw speed or ginning rate used, the seed-roll velocity was relatively constant. A mean seed-roll velocity of about 180 feet per minute was obtained.

Lateral adjustment of the gin breast should be correct. The saws should be positioned to operate in the center of the rib slots. The seed fingers (lambrequin) should be set as wide as possible but close enough that the seeds will be cleaned. Holding seeds in the roll box longer than necessary will reduce ginning rate, give tight seed rolls, and may cause seed damage.

Gin saws should be examined frequently. The teeth should be sharp and straight. Lint will not doff properly from bent teeth and can damage the saws. The doffing brush must maintain a proper speed, and the bristles should mesh to the depth of the saw tooth.

Overhead and gravity moting systems in gin stands should be kept in good conditions. Moting bars and seals should be cleared frequently when sticky motes are encountered.

High capacity gin stands now on the market are the result of years of research and experience. They will give good service if they are kept in good condition and are properly adjusted. They must operate at their design capacity.

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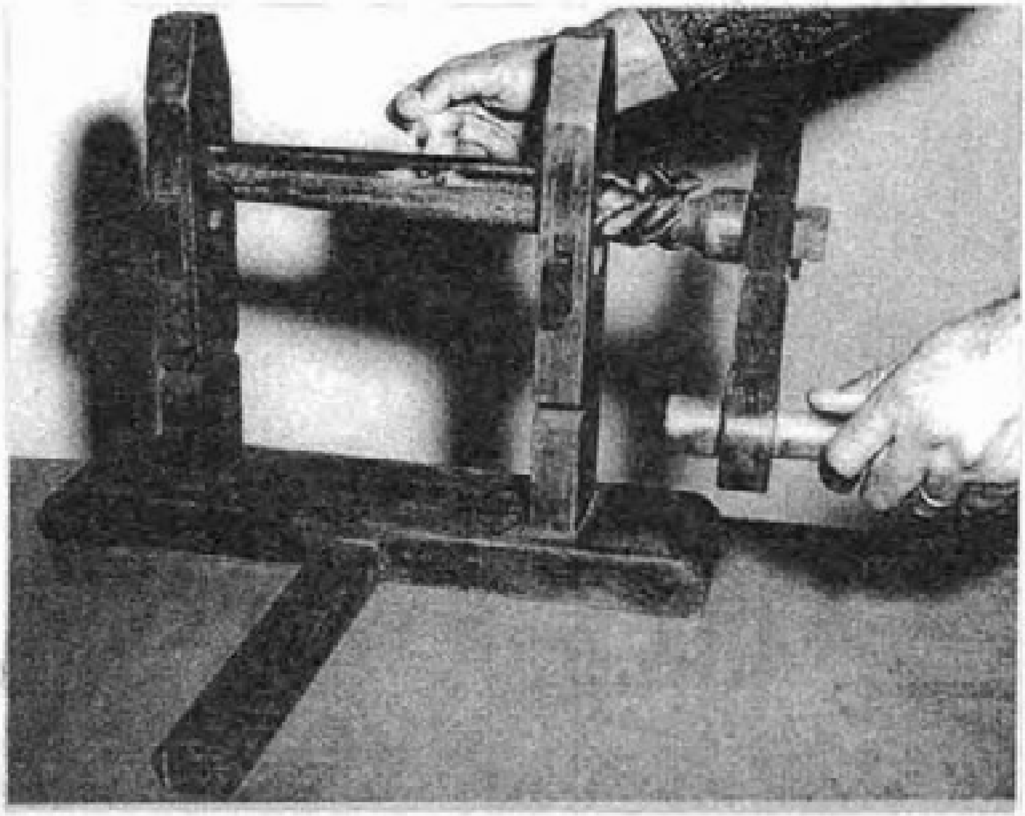

Figure 1. Hand-operated Churka Gin.

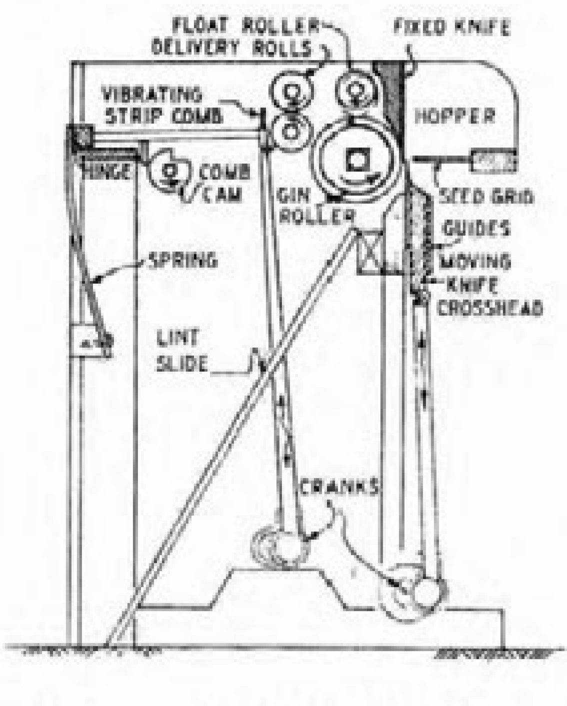

Figure 2. Cross-section of 1840 McCarthy Roller Gin.

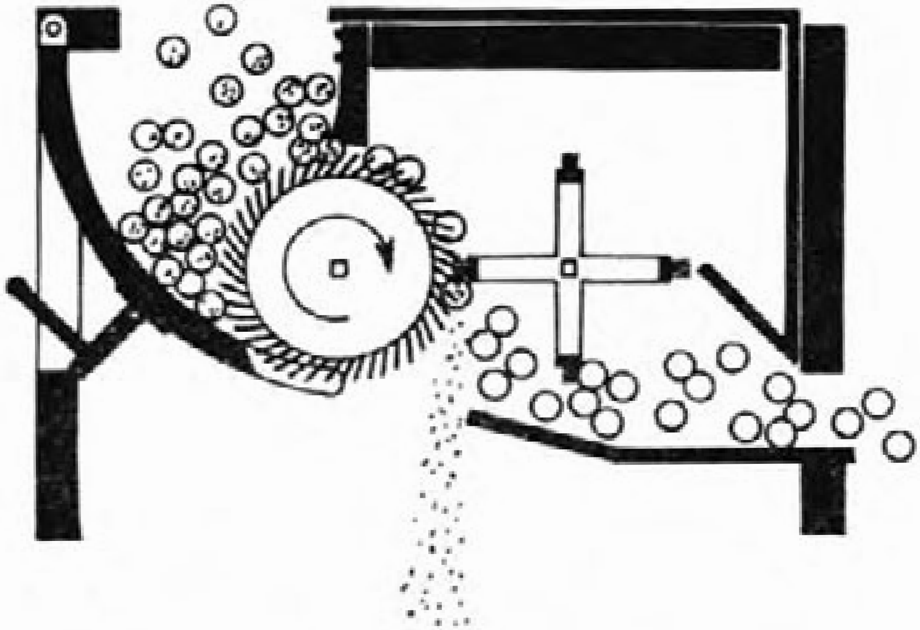

Figure 3. Cross-section of Whitney-type Gin.

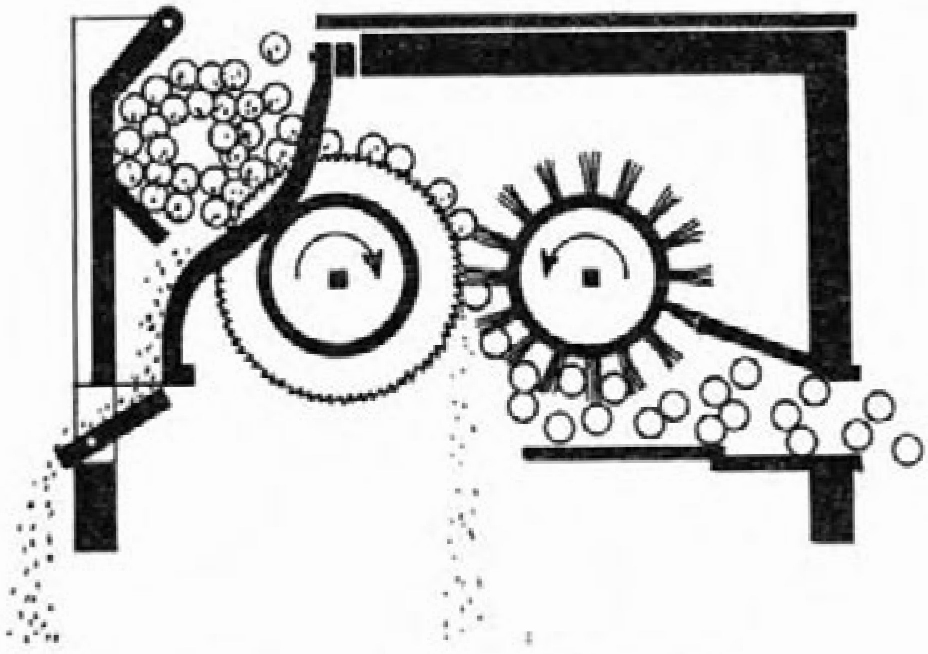

Figure 4. Cross-section of Holmes-type Gin.

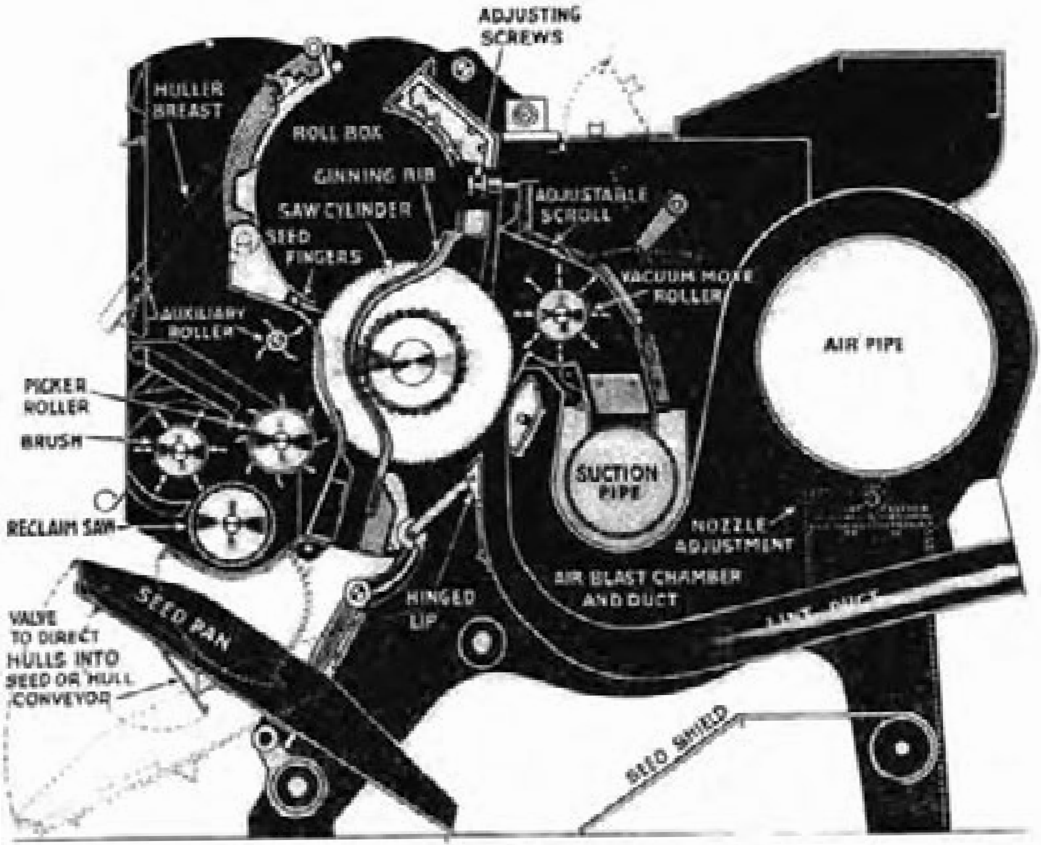

Figure 5. Hardwicke-Etter CXX 120 Saw Air-blast Gin.

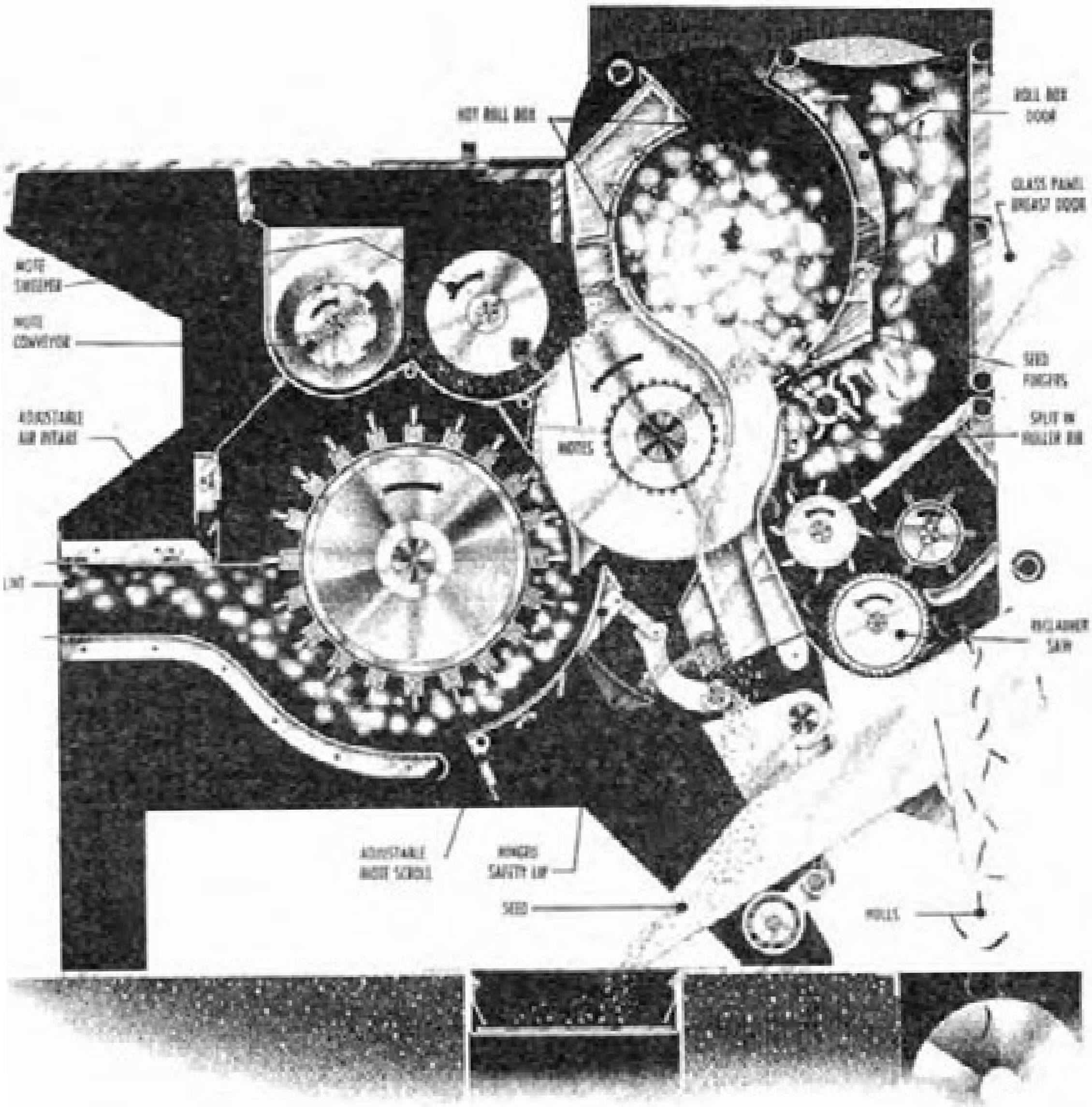

Figure 6. Hardwicke-Etter 100 and 120 Saw Brush-type Gin.

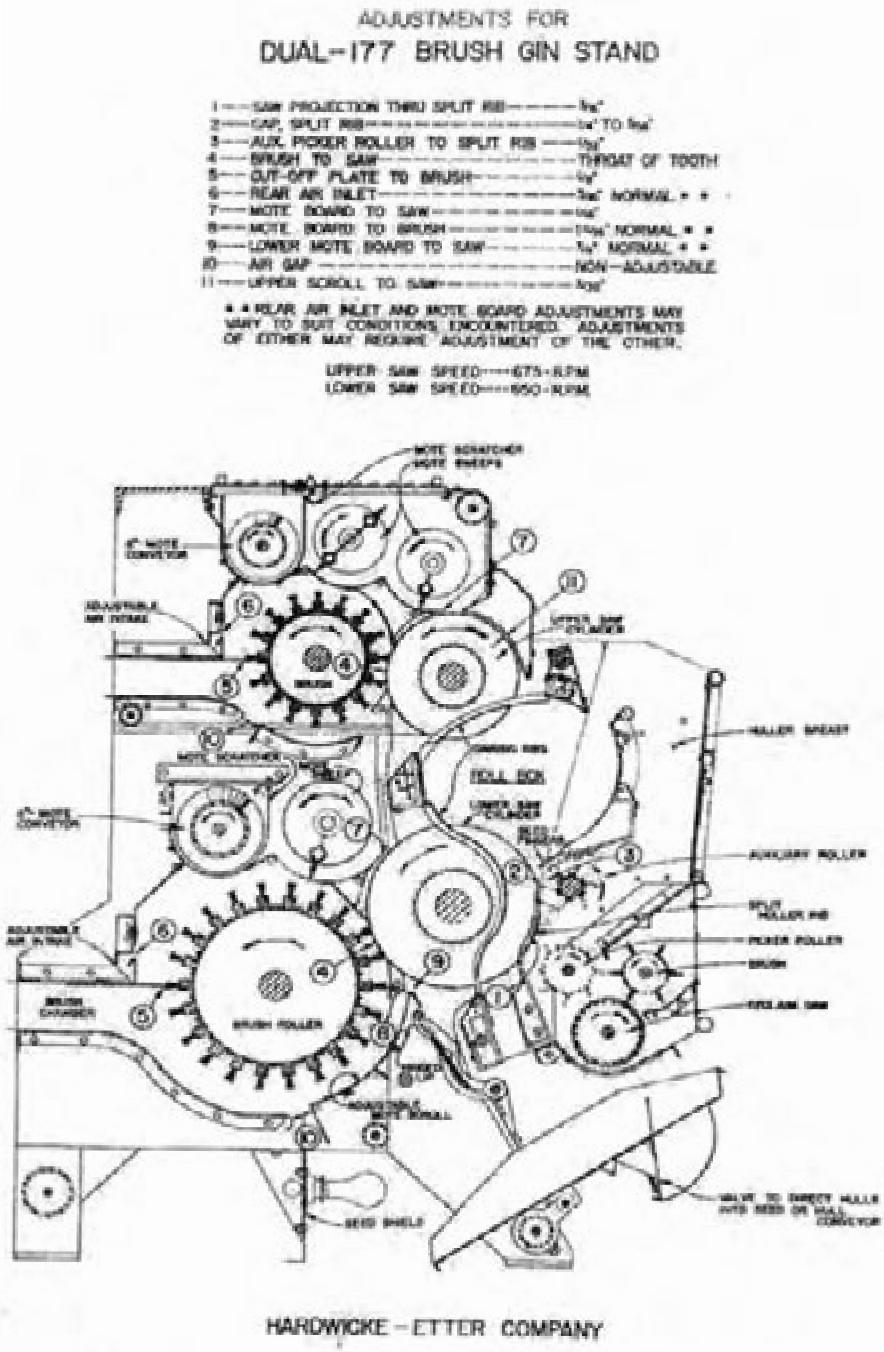

Figure 7. Hardwicke-Etter 177 Dual Saw Brush Gin.

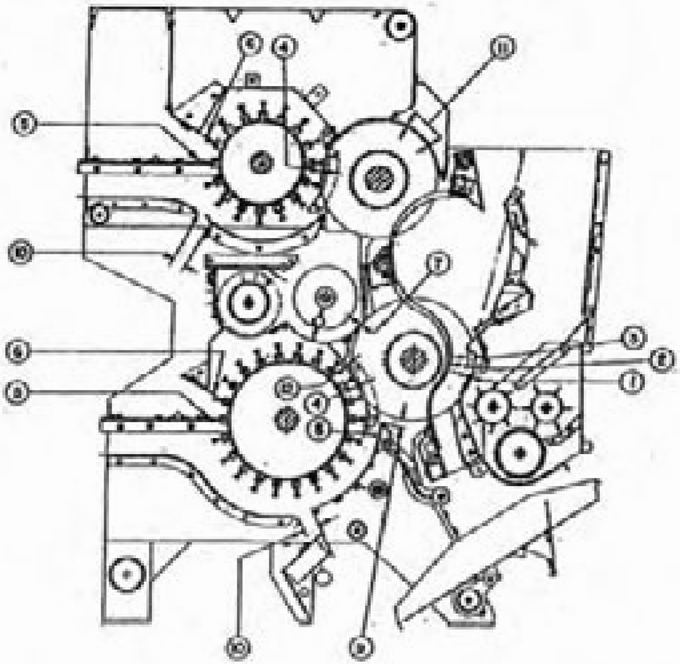

Figure 8. Hardwicke-Etter Super Regal 200 and 252 Dual Saw Gin. Important noted settings and adjustments are given in the text.

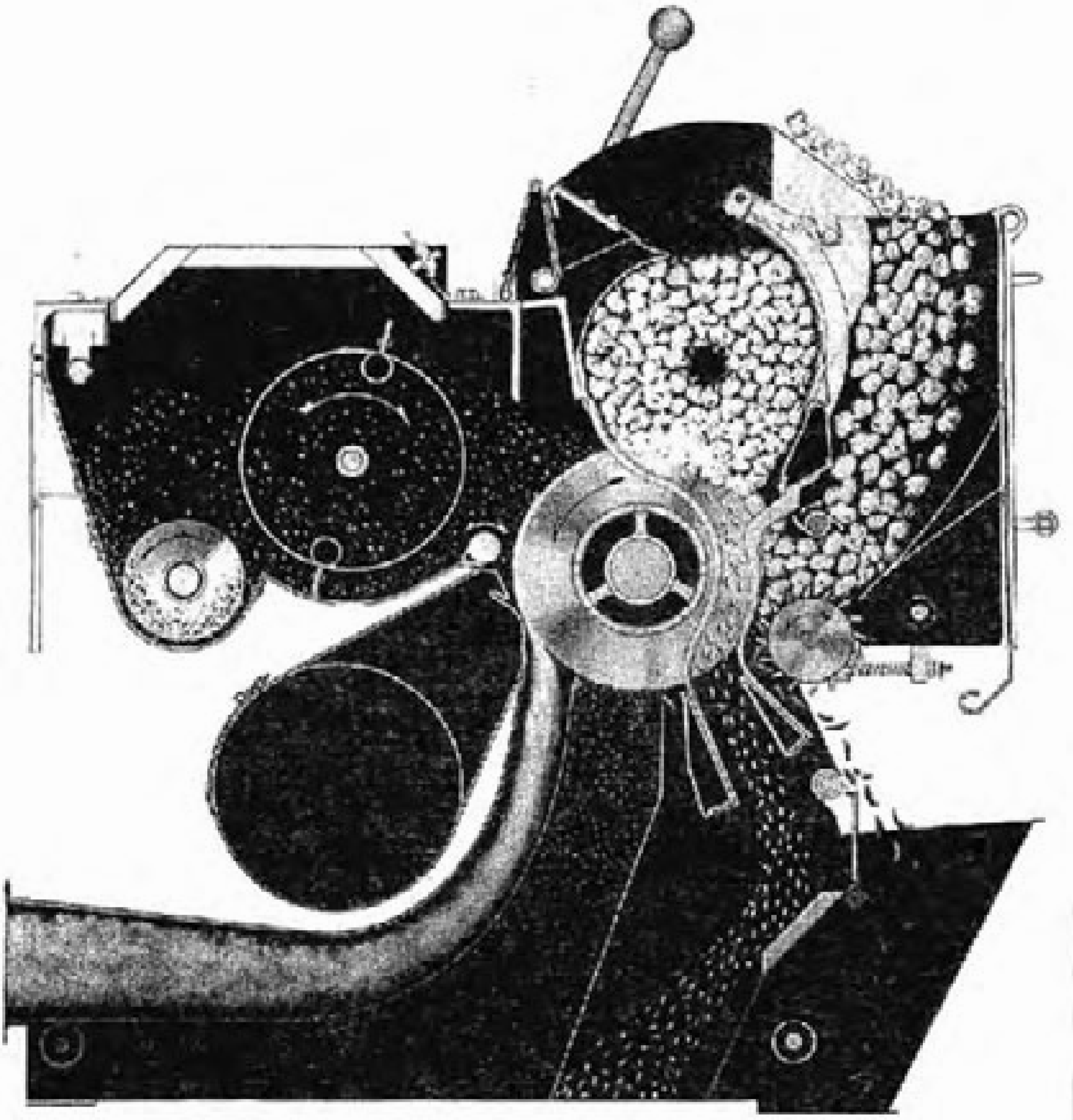

Figure 9. Cen-Tennial combination 90 and 120 Saw Air-blast Gins.

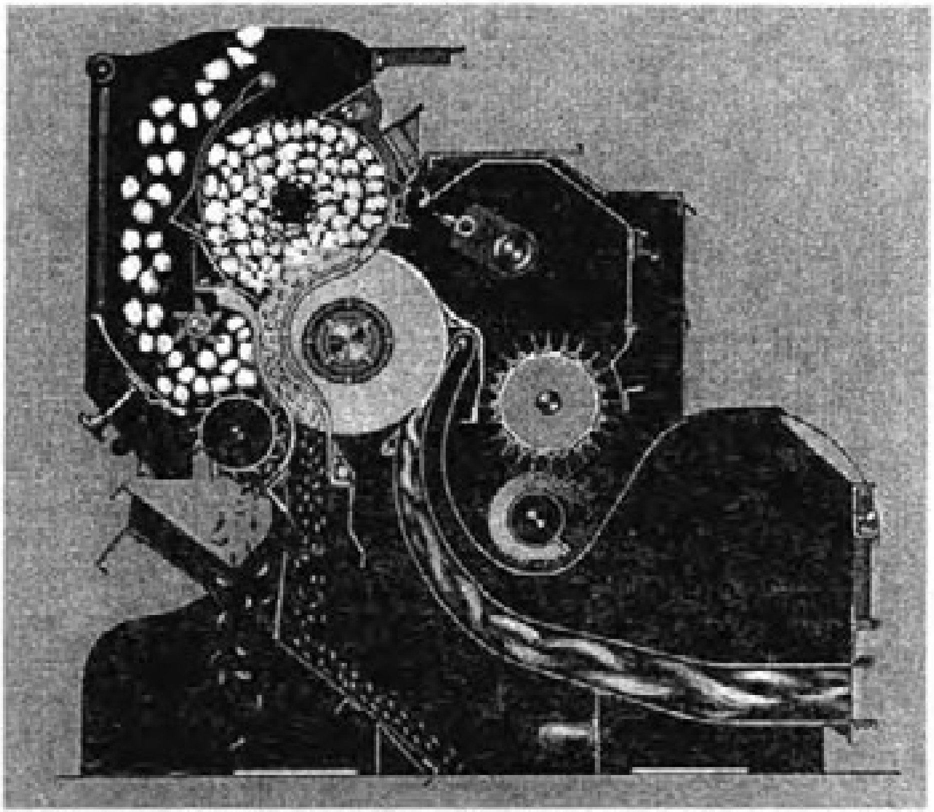

Figure 10. Murray 90 Saw Safety Air-blast Gin.

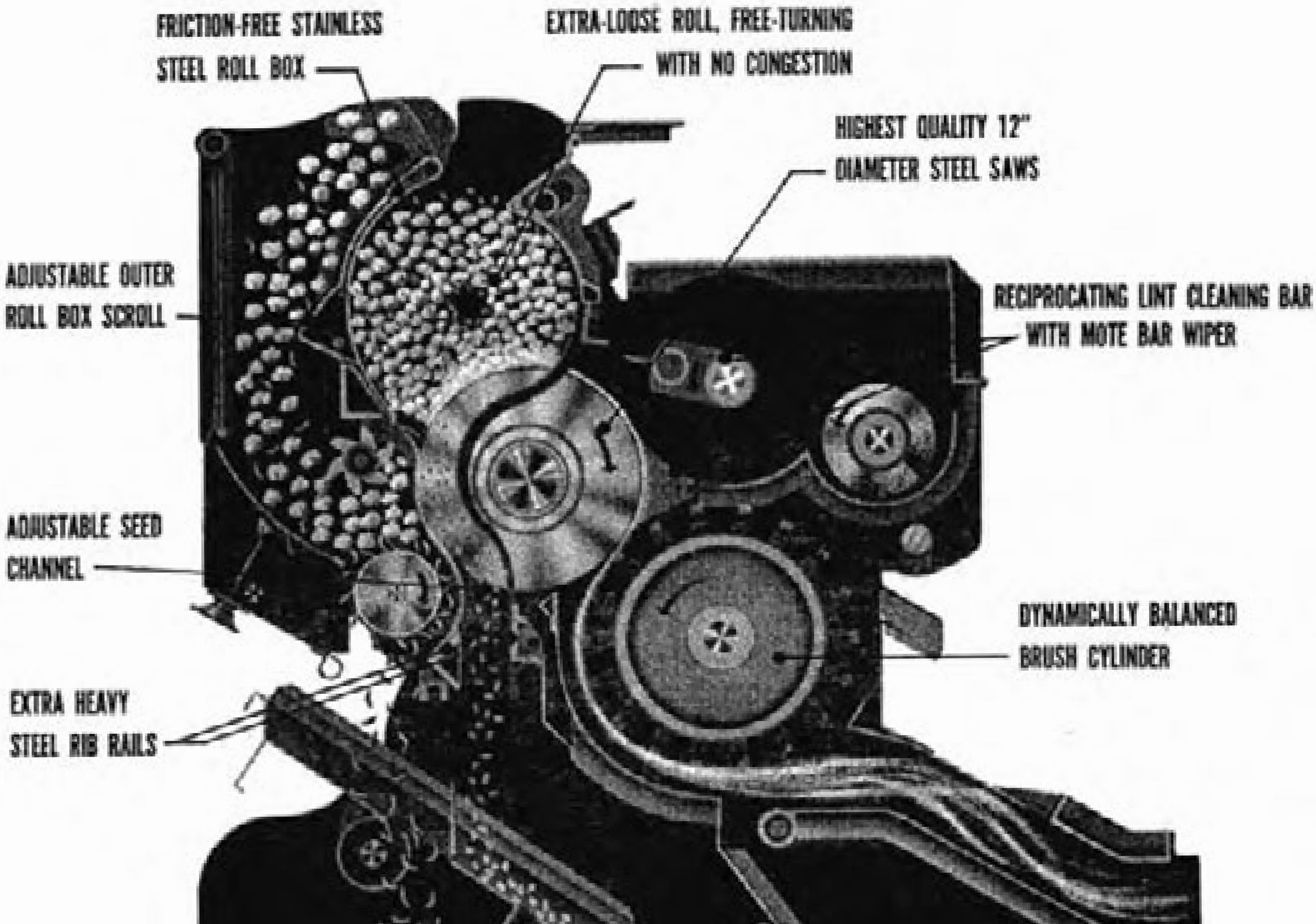

Figure.11. Murray 120 Saw Safety Brush-type Gin.

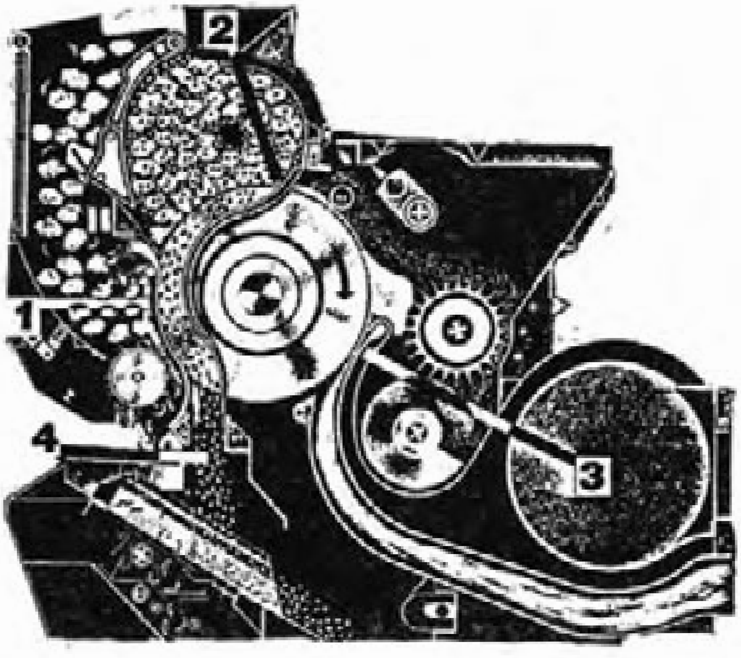

Figure 12. Murray 120-18 Air-blast Gin. Important noted settings and adjustments are given in the text.

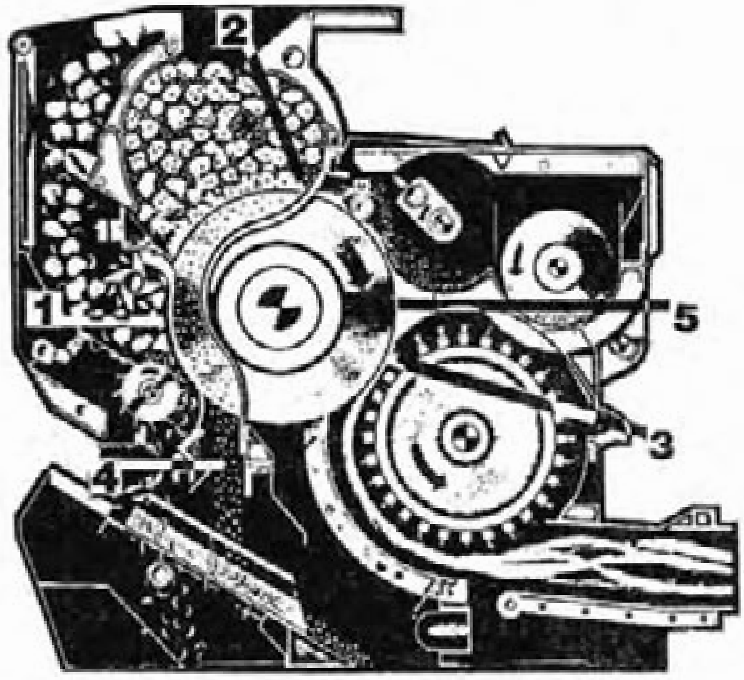

Figure 13. Murray 142-18 Brush Gin. Important noted settings and adjustments are given in the text.

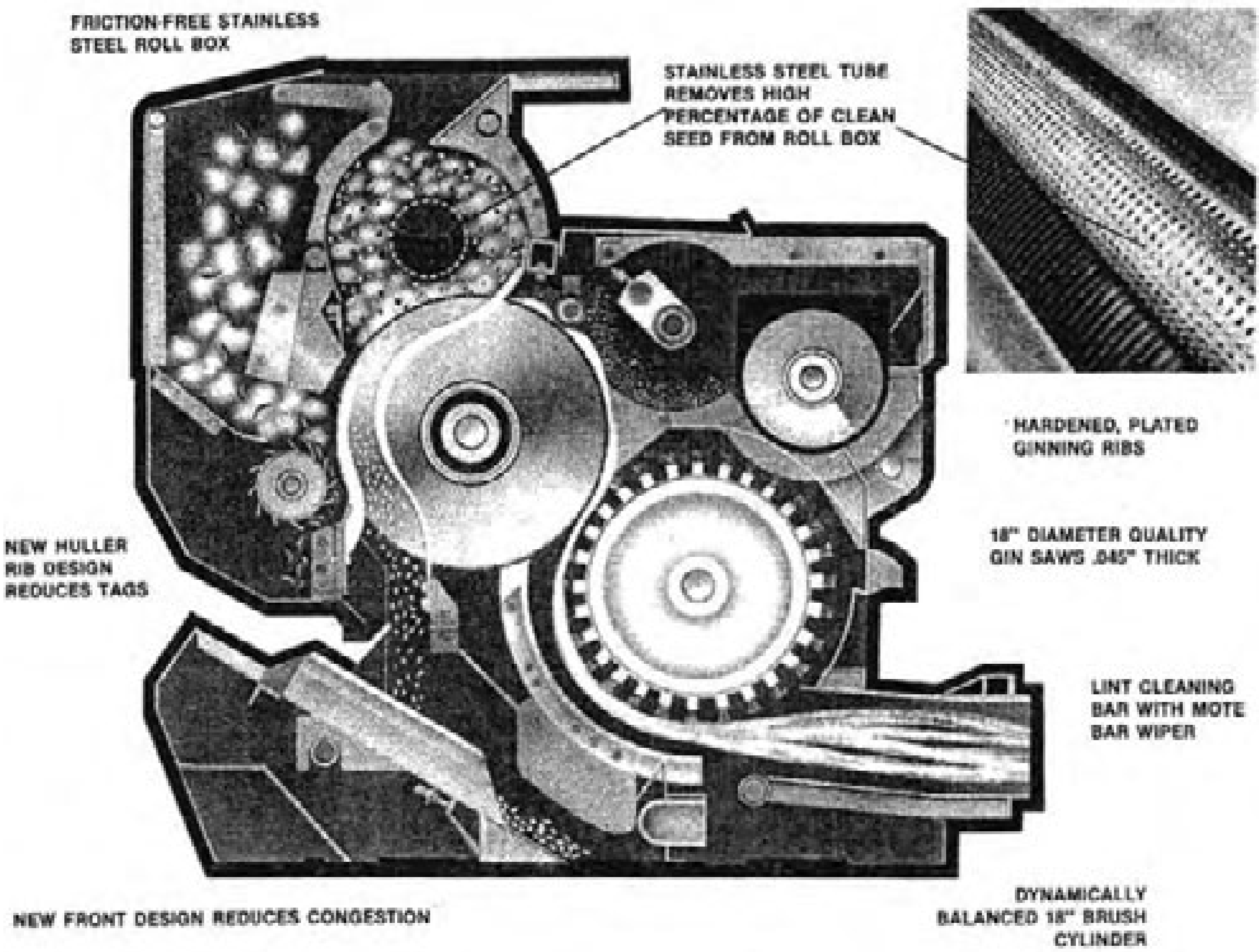

Figure 14. Murray Triple Crown 94/142 Saw Brush Gin.

1. SAW PROJECTION THROUGH HULLER RIB ----- 5/8"
2. HULL PAN EXTENSION ---------------- 1"
3. RECLAIM SAW TO HULL PAN ---------- 3/8"
4. GRAVITY MOTE BOARD TO SAW---------- 2"
5. GRAVITY MOTE BOARD TO BRUSH------- 1-1/2"
6. CUT OFF BOARD TO BRUSH ------------ 1/8"
7. AIR INLET ------------------------- 1/4"
8. OVERHEAD MOTE BOARD TO SAW------- 3/8"
9. GINNING POINT TO POINT OF RIB------- 2"

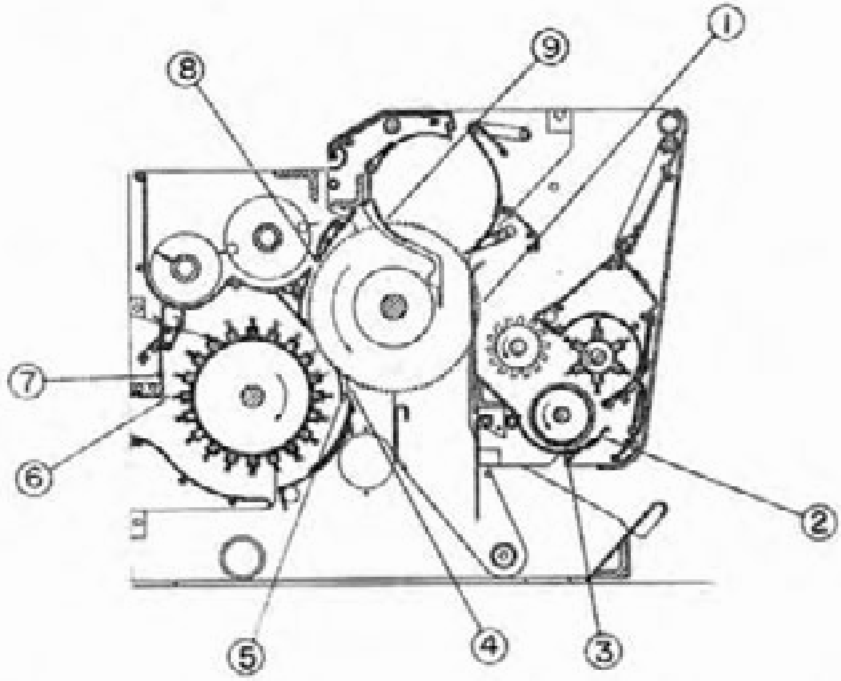

Figure 15. Continental 79-saw Comet and 119-saw Comet Supreme Brush–type Gins.

1. SAW PROJECTION THROUGH HULLER RIB
   (a) ABOVE KNUCKLE - - - - 5/16"
   (b) BELOW KNUCKLE - - - - 3/16"
2. KNUCKLE BOTTOM TO SAW ENTRY - - - - - - 2-3/4"
3. FRONT OF GIN RIB TO FRONT OF SAW 2-7/16"
4. AIR BLAST TO SAW - - - - - - - - - - - - 1/8" TO 5/32"
5. FRONT OF NOZZLE TO SAW - - - - - 1/16" TO 3/32"
6. GINNING POINT TO POINT OF RIB - - - - 2-5/16"
7. SAW SPEED - - - - - - - - - - - - - - - - - 700 RPM

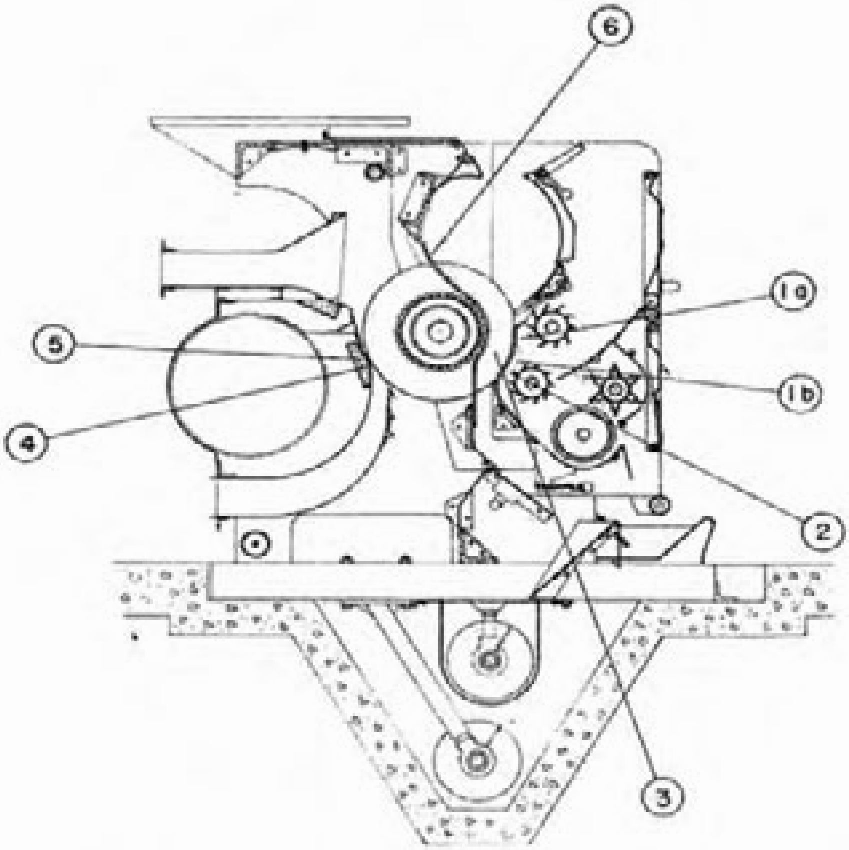

Figure 16. Moss-Gordin 16-in. Saw Air-blast Gin.

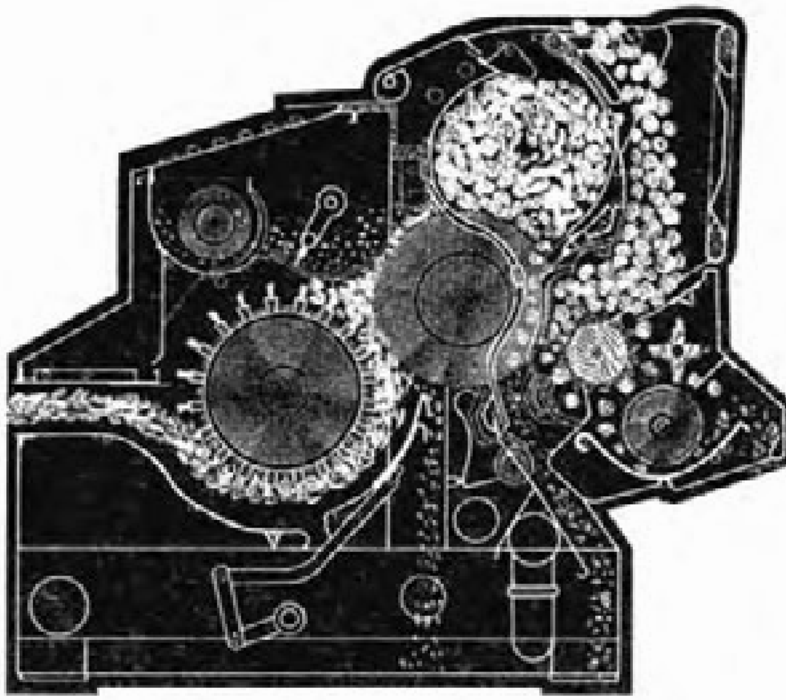

Figure 17. Continental Murray 120 Saw Brush Gin.

Figure 18. Continental Eagle 141 Saw-brush Gin. Important noted settings and adjustments are given in the text.

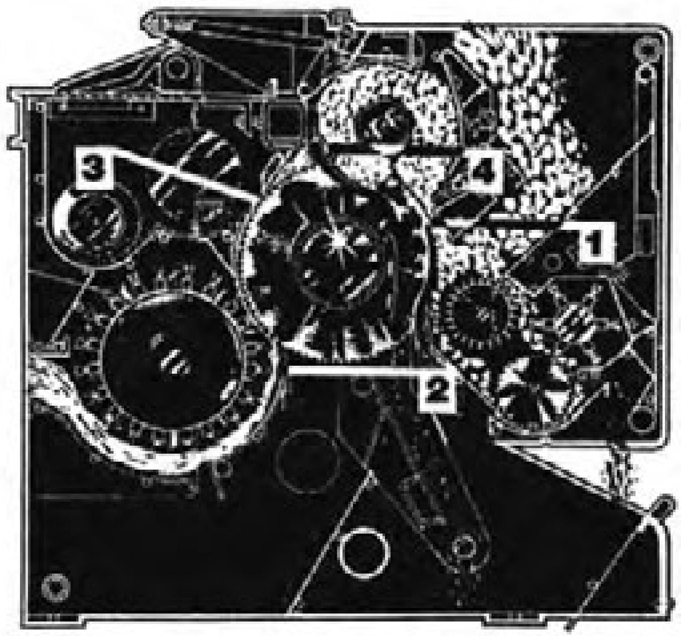

Figure 19. Continental Eagle 141 Double Eagle and 161 Golden Eagle Saw Brush-type Gin. Important noted settings and adjustments are given in the text.

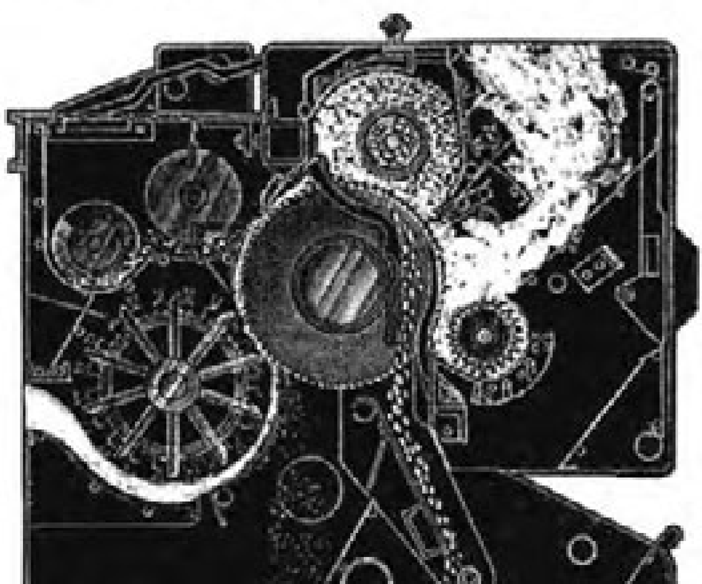

Figure 20. Continental Eagle 161 Golden Eagle Saw Brush-type Gin.

1. SAW PROJECTION THROUGH HULLER RIB - - 9/16"
2. AIR BLAST MOTE BOARD TO SAW - - - - - - - - 1/2"
3. AIR BLAST TO SAW - - - - - - - - - - - - - - - - - 1/16"

SAW SPEED - 900 r.p.m.
AIR BLAST PRESSURE - - - - - - - - - - - - - 16" WATER
MAXIMUM GIN HOOD PRESSURE - - 1-1/4" WATER

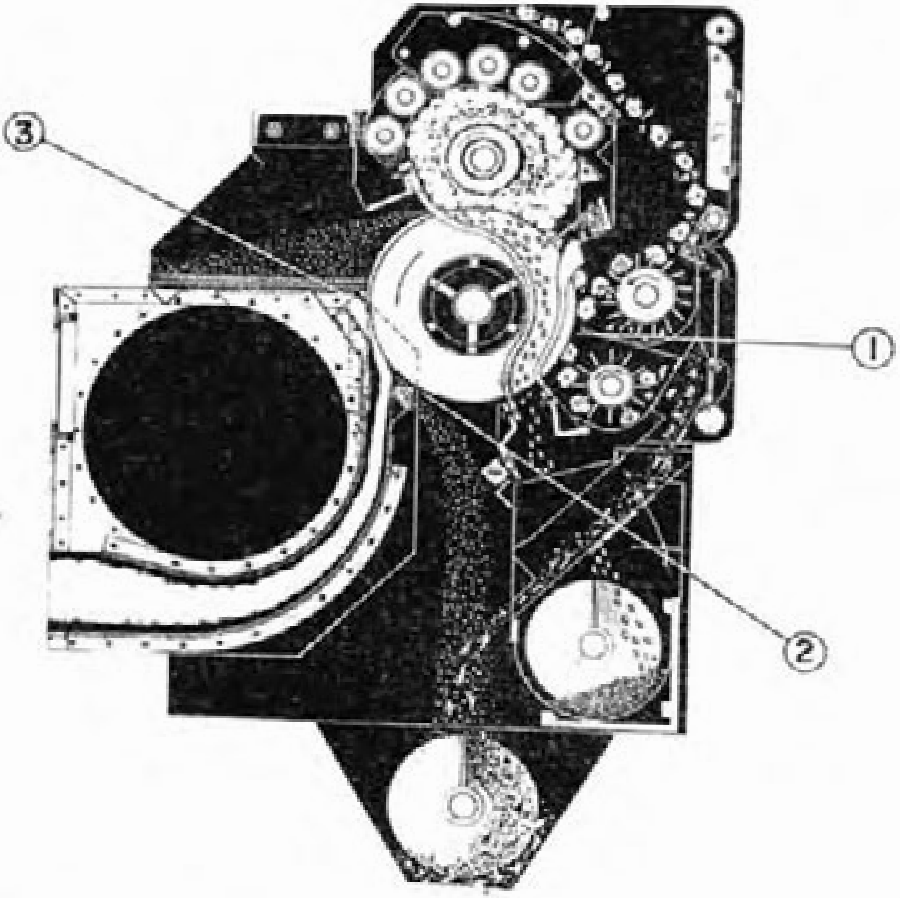

Figure 21. Important settings and adjustments for the Lummus Super 88 Gin.

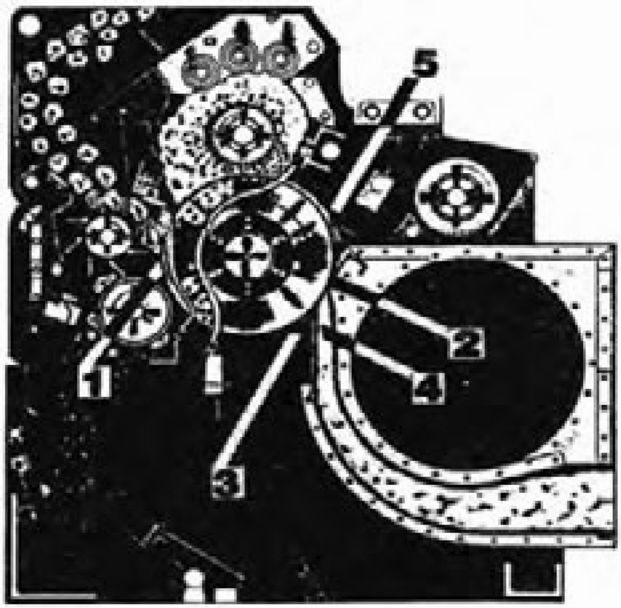

Figure 22. Lummus Imperial 88 and 128 Saw Air-blast Gins. Important noted settings and adjustments are given in the text.

Figure 23. Lummus Imperial 88, 108, 128, and 158 Saw-brush Gins. Important noted settings and adjustments are given in the text.

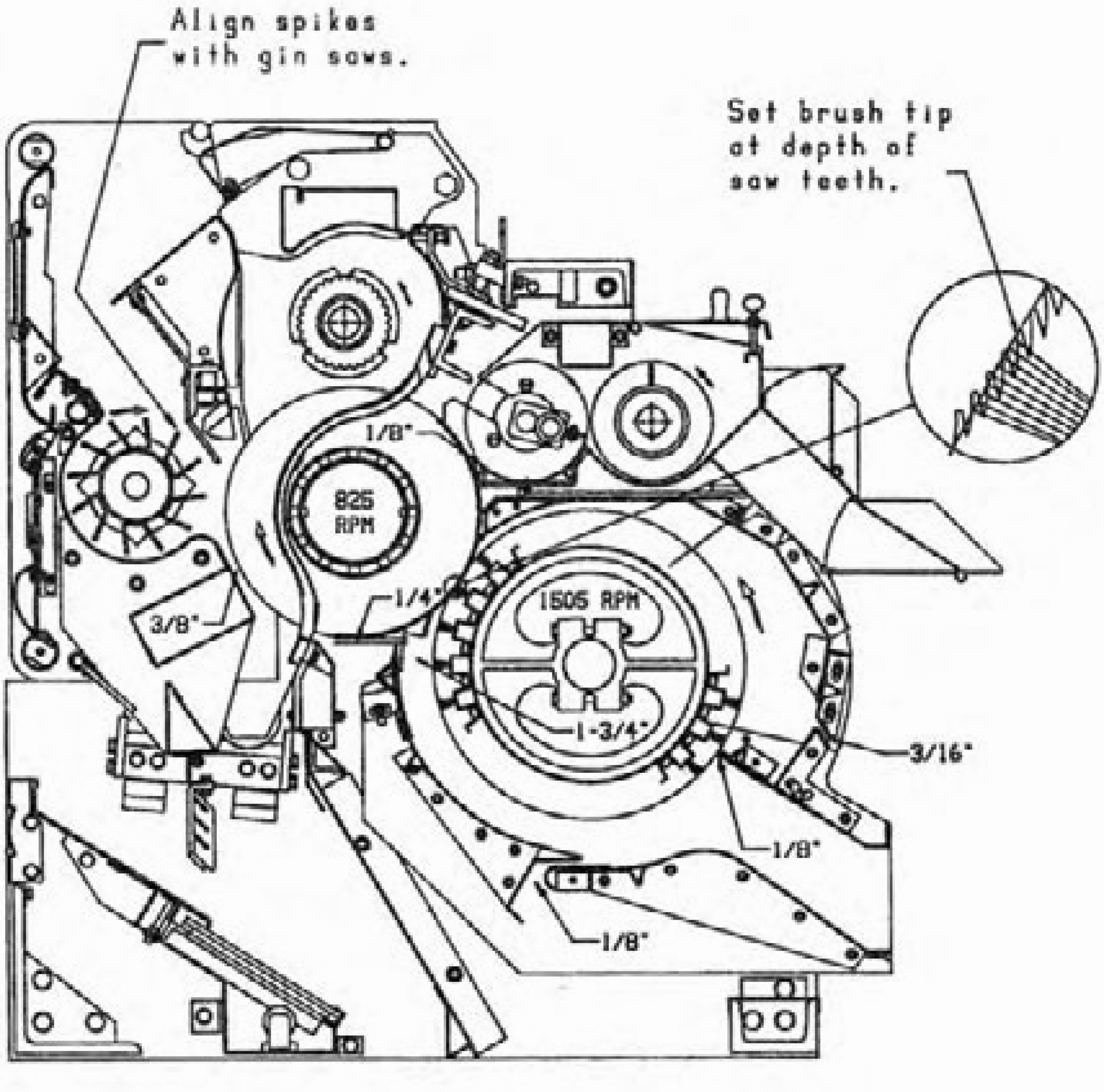

Figure 24. Settings and adjustments for Lummus Imperial II 108 and 158 Saw Gins.

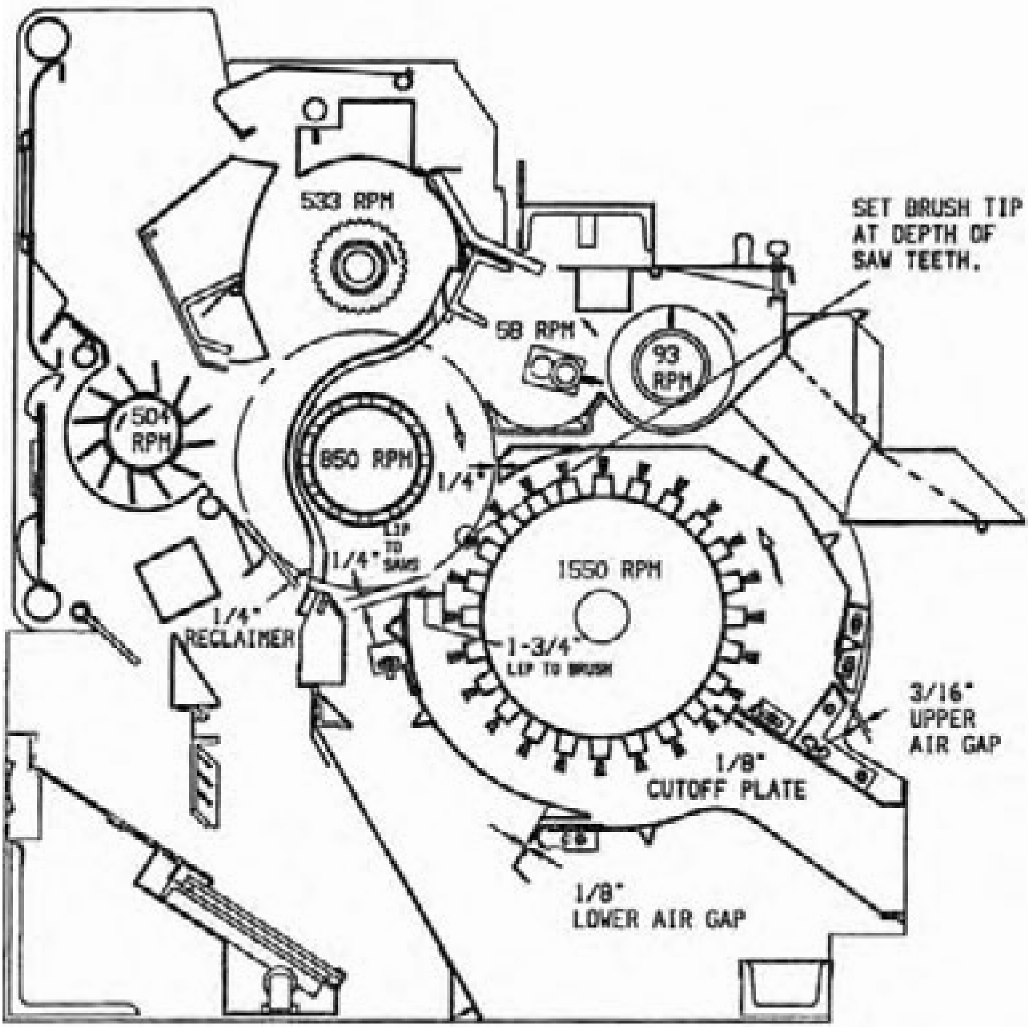

Figure 25. Settings and adjustments for Lummus Imperial III 116 and 170-saw gins.

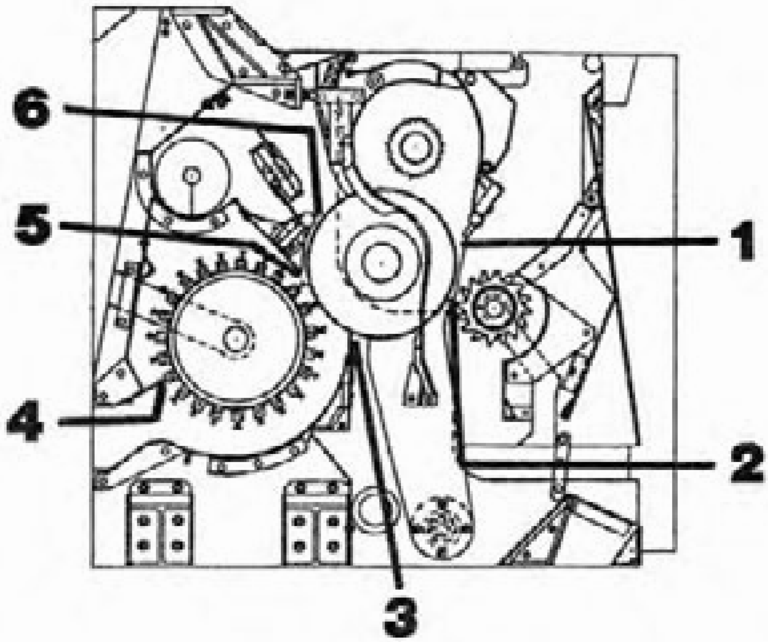

Figure 26. Consolidated Cotton Gin Company, Inc. 112- and 164-saw brush-type Gin. Important noted settings and adjustments are given in the text.

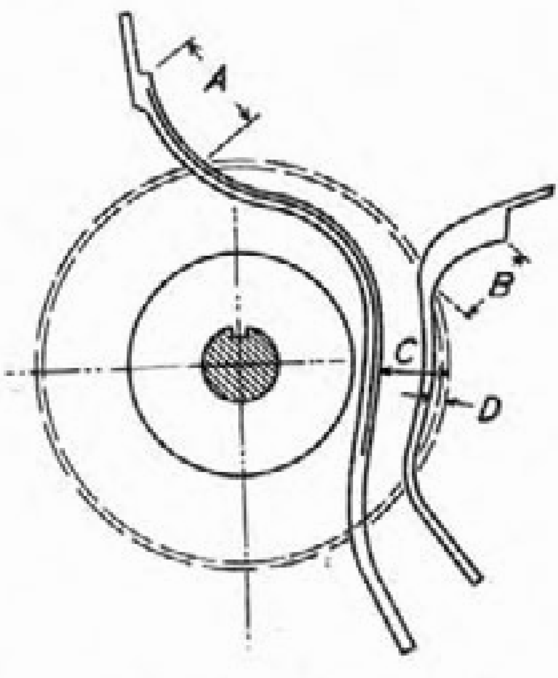

Figure 27. Critical saw-rib dimensions (A, B, C, and D) that vary with manufacturer's make and model.

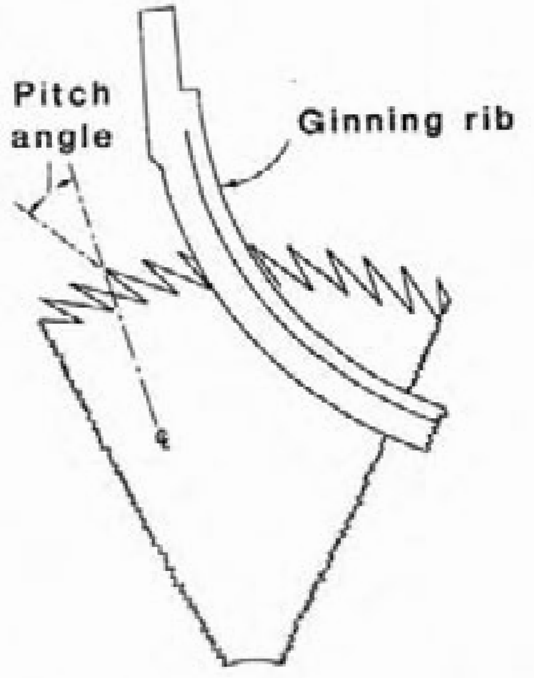

Figure 28. Leading edge of the tooth should enter the ginning rib surface, or the point of the tooth should lead the throat slightly.

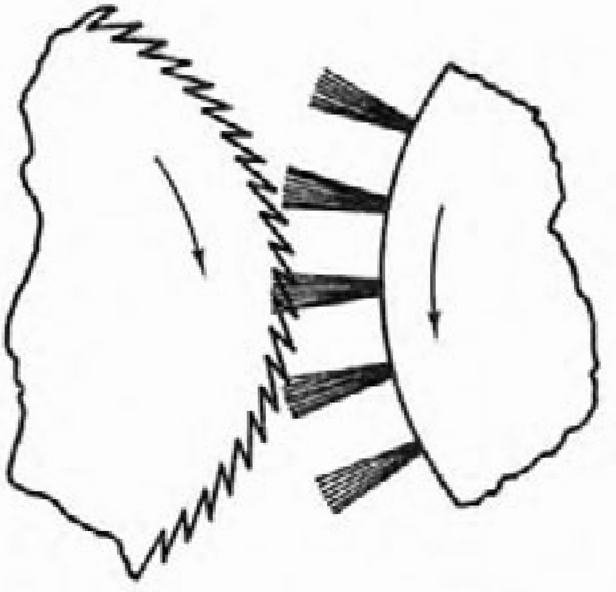

Figure 29. For proper doffing, the gin brush should be set to mesh with the depth of the sawteeth.

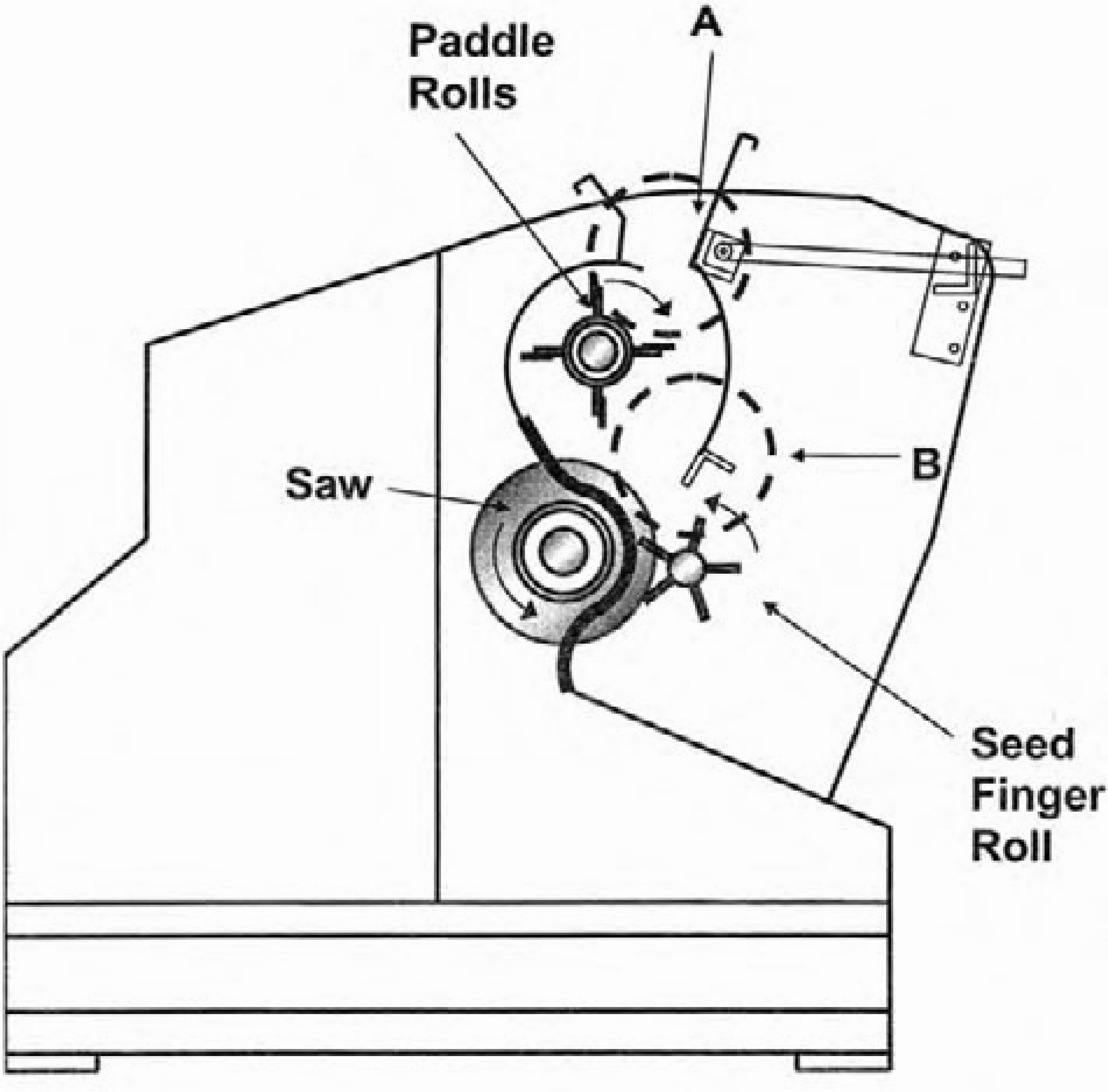

Figure 30. Schematic cross section of Powered Paddle Roll Gin Stand. Circled areas A and B required major changes from the conventional layout.

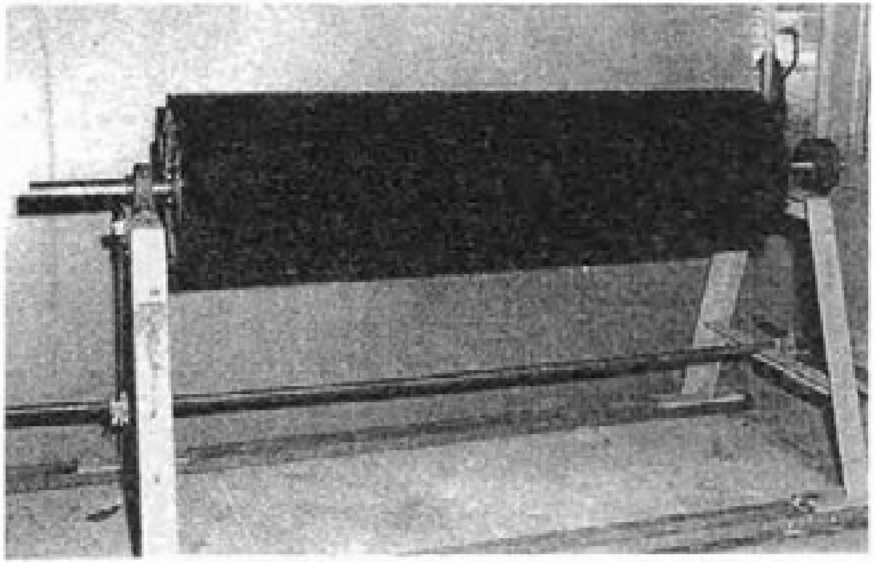

Figure 31. Brush cylinder with a solid doffing surface used to reduce noise.