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ENGINEERING AND GINNING

Roller Ginning

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ABSTRACT

Roller ginning provided the first mechanical means of separating cotton lint from seed. The first true roller gin was the Churka gin, which produced up to 2.3 kg (5.0 lb) of lint/day. In 1840, the McCarthy gin was invented to gin extra-long-staple (ELS) cotton. Although the ginning capacity of the McCarthy gin was a major improvement over the Churka gin, capacity was limited to about 18 kg (40 lb) of lint per hour. In the late 1950s and early 1960s, a rotary-knife roller gin was developed. The rotary-knife roller gin had a ginning rate 12 times higher than the McCarthy gin, though the rotary knife gin still processed cotton at only about one-fifth the rate of a saw gin with an equivalent width. Around 2005, commercial development of a high-speed rotary-knife roller gin was accomplished. The high-speed roller gin processes cotton at approximately the same rate per unit width as a saw gin. The high-speed roller gin not only allows ELS cotton (such as Pima) to be ginned more efficiently, but also permits high-quality Upland cotton to be roller ginned at a rate more comparable with the saw gin while achieving the benefits of better fiber quality resulting from roller ginning. Although variations of the McCarthy gin are used today in many countries to gin ELS cottons, the rotary-knife roller gin is the only type of roller gin used in the U.S.

Roller gins provided the first mechanical means of separating lint from seed (Bennett, 1960). The first true roller gin was the Churka gin, named from the ancient Indian Sanskrit language and originating from the term "jerky". Although the exact origin of the Churka gin is unknown, it is thought to have been developed and used during the 12th and 14th centuries in Indian and Chinese markets and became the dominant type of gin by the 16th century (Lakwete, 2003). The Churka gin, shown in Figs. 1 and 2, was hand operated and consisted of two hard rollers that ran together at the same surface speed, pinching fiber from the seed and producing up to 2.3 kg (5.0 lb) of lint/day (Porcher and Fick, 2005). During the 1700s, a series of developments using the roller principle followed, but ginning rates remained low. The next major development in the ginning industry occurred in 1794, when Eli Whitney invented a batch processing gin that removed fiber from the seed by means of spikes on a cylinder. In 1796, Henry Ogden Holmes invented a gin having saws and ribs. This gin replaced Whitney's gin and made ginning a continuous-flow process rather than a batch process. Although Whitney's and Ogden's gins processed cotton much faster than a roller gin, they were not used on extra-long-staple (ELS) cottons because the saws harmed the high-quality fiber. The slower but gentler Churka and other roller-type gin stands continued to be used on ELS cottons through the early 1800s.

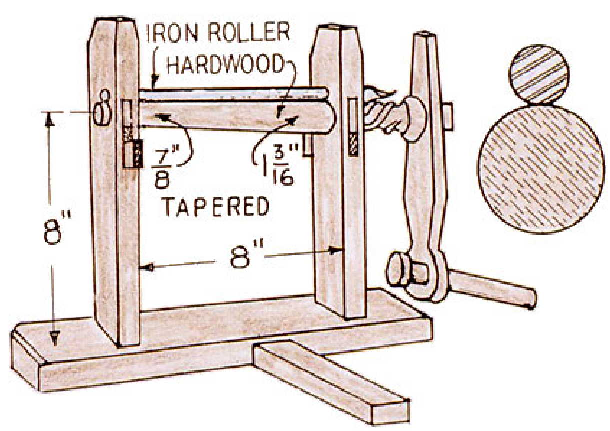

Figure 1. Drawing of a typical Churka gin.

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Figure 2. Photograph of a Churka Gin.

In 1840, Fones McCarthy invented a more efficient roller gin to process ELS cottons (Lakwete, 2003). The McCarthy gin was 1-m (40-in) wide and consisted of a leather ginning roller, a stationary knife held tightly against the roller, and a reciprocating knife that pulled the seed from the lint as the lint was held by the roller and stationary knife (Fig. 3). The McCarthy roller gin was a much gentler and less damaging process than the saw gin. It tended to pull the fiber off of the seed in a more uniform mass; this was in contrast to the saw gin, which picked at the fiber on the seed as many as 30 to 40 times before all of the lint was removed. Although the ginning capacity of the McCarthy gin was a major improvement over the Churka gin, capacity was limited to approximately 18 kg (40 lb) of lint per hour due to incoming seed cotton competing with exiting seed for space, mechanical vibration of the reciprocating knife, and associated gin stand maintenance problems. Variations of the McCarthy gin are still used today in many countries (other than the U.S.) to gin ELS and Upland cottons.

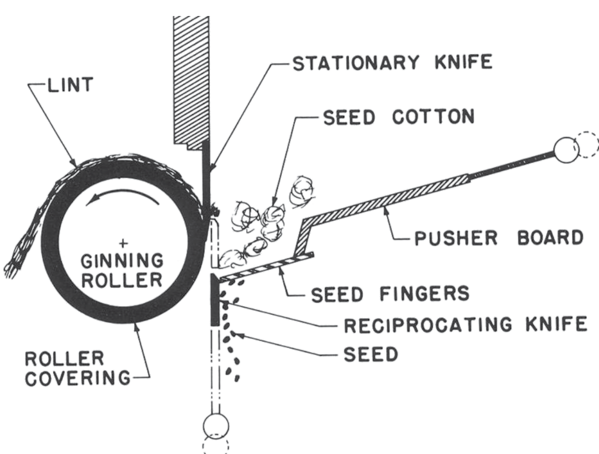

Figure 3. Principle of the McCarthy roller gin.

In the late 1950s and early 1960s, a rotary-knife roller gin was developed by the USDA-ARS Southwestern Cotton Ginning Research Laboratory (Mesilla Park, NM), gin manufacturers, and private gins (Gillum, 1985). The rotary-knife roller gin is the only type of roller gin used in the U.S. The roller and stationary knife of this gin are similar to those of the McCarthy gin, but a rotary knife is used instead of the reciprocating knife (Fig. 4). The rotary knife helps guide (with the roller) seed cotton directly to the ginning point, it sweeps away seed from the ginning point, and it removes any seed cotton not able to be ginned (carryover). The rotary knife vibrates less than the reciprocating knife. It also is more efficient than the reciprocating knife, because the rotary motion results in a much more continual ginning process in contrast to the reciprocating knife that does not gin any cotton (wasted time) during each backstroke. The rotary-knife roller gin has a considerably higher ginning rate than the McCarthy gin [218 kg (480 lb) versus 18 kg (40 lb) of lint per hour on a 1-m (40-in) wide stand], though the rotary knife gin still processes cotton at only about one-fifth the rate of a saw gin with an equivalent width.

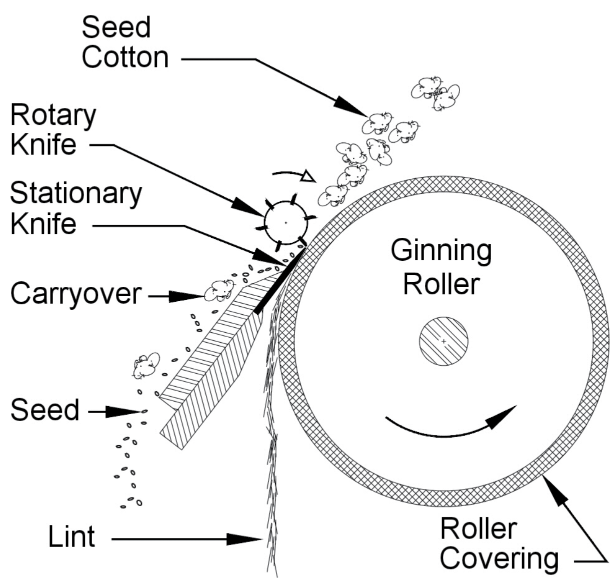

Figure 4. Principle of the rotary-knife roller gin.

The rotary-knife roller gin is used to gin American Pima cotton, the predominant U.S. ELS cotton. Pima cotton belongs to the species *Gossypium barbadense* L. (Niles and Feaster, 1984) and is a long, strong, and uniform fiber, averaging 48 staple length (48 thirty-seconds of an inch), 42 g/tex strength, and 86% length uniformity (USDA, 2017a). Grown in California, Arizona, New Mexico, and El Paso

County, Texas, Pima cotton comprises 3 to 5% of the U.S. crop (USDA, 2017b), and 25 to 30% of world ELS production (Supima, 2017). Specialty markets exist for Pima cotton, and textile mills pay a premium for it to use in finer apparels, bedclothes, and bath towels. American Pima cotton successfully competes with other ELS cottons worldwide.

More recently, many gins in the Far West have begun to roller gin higher-quality Upland cotton (Acala), which belongs to the species *Gossypium hirsutum* L. (Armijo and Gillum, 2007). As mentioned earlier, roller ginning does less harm to the fiber because it is a much gentler process than saw ginning. Roller ginning upland cotton results in fiber that can average two staple lengths longer, two percentage points higher in length uniformity, and two percentage points lower in short fiber compared to saw ginning the same cotton. Roller-ginned Upland cotton also contains fewer fiber entanglements (neps) than the saw-ginned cotton. Although roller-ginned Upland cotton is a niche market, textile mills value the higher quality obtained from roller ginning and are willing to pay an additional 13 to 26 ¢/kg (6-12 ¢/lb) for it (Armijo et al., 2013). If the market awards this premium to newly developed high-quality Upland cultivars (non Acala), it could make roller ginning an economically viable option in parts of the U.S. where roller ginning previously has not been used.

In a 2004-05 survey of 24 out of 26 U.S. roller gins, Whitelock et al. (2007) reported that the typical roller gin had 16 gin stands with each stand producing approximately 218 kg/m/hr (144 lb/ft/hr) of lint or approximately one bale per hour. Research began in the 1980s on increasing the process rate of the rotary-knife roller gin (Gillum, 1985), but it was not until 20 years later that commercial development of a high-speed roller gin was accomplished due mostly to advancements in control technologies (Armijo and Gillum, 2007, 2010; Armijo et al., 2013). The high-speed roller gin processes cotton at approximately 872 kg/m/hr (576 lb/ft/hr) or about four bales per hour (Armijo and Gillum, 2007), the same per-unit-width rate as a saw gin. This high-speed ginning rate not only allows Pima cotton to be ginned more efficiently, but it also permits high-quality Upland cotton to be roller ginned at a rate more comparable with the saw gin while achieving the benefits of better fiber quality resulting from roller ginning. Currently, much of the California Acala crop is roller ginned with both conventional and high-speed stands and sold directly to the spinning mill on a contract basis for special use. Some of this cotton is of sufficient quality that mills are able to blend it with Pima cotton.

Rotary-Knife Roller Gin Components. Cross sections of three rotary-knife roller gin stands and extractor-feeders from the three major manufactures are shown in Figs. 5 through 7. Extractor-feeders used in roller ginning are similar to those found in saw ginning, but contain fewer cleaning and extracting cylinders. Proper feeder operation contributes to the efficiency of the gin stand. Feeder output must be uniform and steady with as much single locking of the seed cotton as possible. Increasing the feed rate corresponds to a higher ginning rate as well as more carryover (unginned seed cotton). Optimum feed rate is difficult to maintain because the trash and moisture content of the seed cotton varies, and this affects the efficiency of the extractor-feeder and gin stand. Gillum and Armijo (1995) reported that using a microprocessor-based automatic feed control system to monitor and control feed rate not only increased ginning rate without affecting fiber properties, but also prevented gin stand choke-ups, helping to reduce facility downtime. The commercially available Lummus Series 2000 high-speed roller gin (Lummus Corp., Savanah, GA) uses a sophisticated control system to monitor and manage production rates of more than four bales per hour.

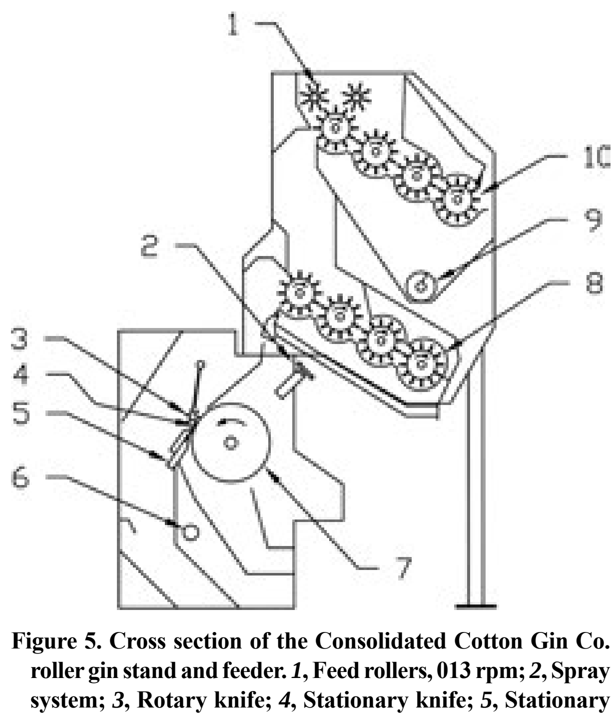

Figure 5. Cross section of the Consolidated Cotton Gin Co. roller gin stand and feeder. *1*, Feed rollers, 013 rpm; *2*, Spray system; *3*, Rotary knife; *4*, Stationary knife; *5*, Stationary knife holder; *6*, Countershaft, 361 rpm; *7*, Ginning roller; *8*, Preparation cylinders, 745 rpm; *9*, Trash conveyor; *10*, Spiked cleaning cylinders, 745 rpm. (Courtesy of Lummus Corporation.)

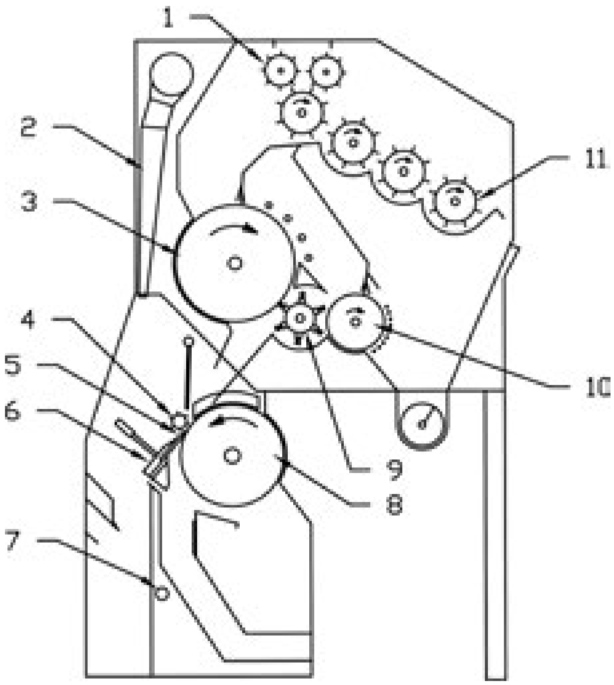

Figure 6. Cross section of the Continental Eagle roller gin stand and feeder. *1*, Feed rollers, 010 rpm; *2*, Dust hood; *3*, Main saw, 316 rpm; *4*, Rotary knife; *5*, Stationary knife; *6*, Knife bar; *7*, Jack shaft, 316 rpm; *8*, Ginning roller; *9*, Doffing brush, 1,308 rpm; *10*, Reclaimer saw, 351 rpm; *11*, Spiked cylinder, 530 rpm. (Courtesy of Bajaj ConEagle LLC.)

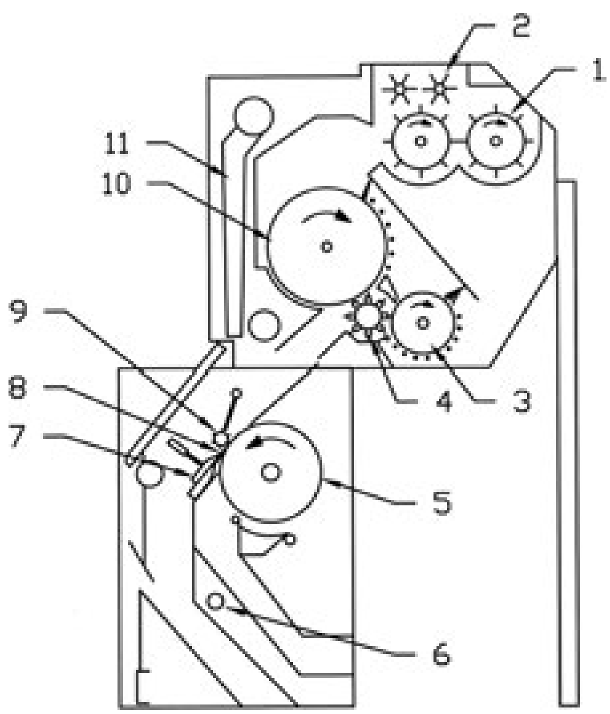

Figure 7. Cross section of the Lummus Corporation roller gin stand and feeder. *1*, Spiked cleaning cylinders, 542 rpm; *2*, Feed rollers, 012 rpm; *3*, Reclaimer saw cylinder, 306 rpm; *4*, Brush doffing cylinder, 1,354 rpm; *5*, Packing roll; *6*, Jack shaft, 435 rpm; *7*, Knife holder; *8*, Stationary knife; *9*, Rotary knife; *10*, Main saw cylinder, 345 rpm; *11*, Dust hood. (Courtesy of Lummus Corporation.)

The main components of a rotary-knife roller gin stand include the stationary knife, rotary knife, and ginning roller (packing roll). End or sectional views of these components are shown in Figs. 8 through 10, respectively; dimensions are given in Tables 1a and 1b. The stationary knife must be hard and abrasion resistant; however it might chip if it is too brittle. Also, the stationary knife must be ground to the proper size and shape; grinding to less than A_{min} (see Fig. 8 and Tables 1a and 1b) or to a wrong angle makes gin stand adjustment difficult. Roller gins use both the spiral- and straight-blade rotary knife (Figs. 11 and 12, respectively). The spiral rotary knife is used more commonly, because it operates with less vibration and allows easier clearing of spindle-twist tags. However, the spiral knife does not increase ginning rate. The blade points of the rotary knife should be beveled 1.6 mm (0.0625 in) at the edge.

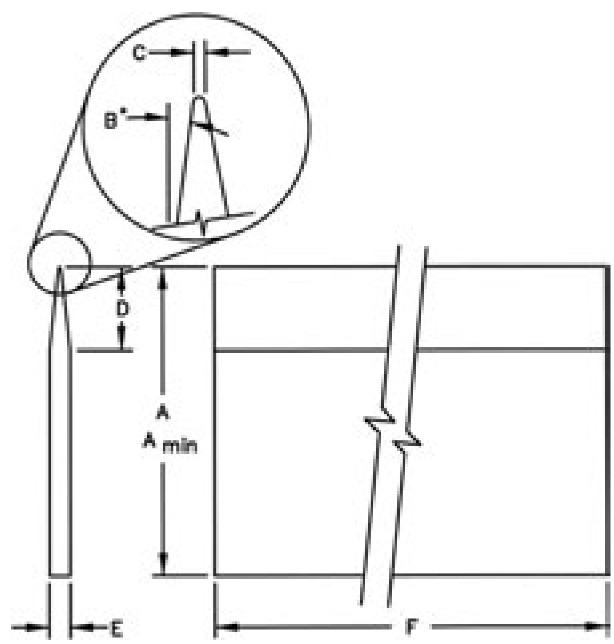

Figure 8. Side view of a stationary knife (see Tables 1a and 1b for dimensions).

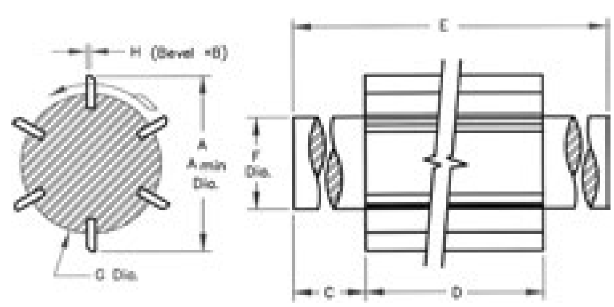

Figure 9. Side view of a rotary knife (see Tables 1a and 1b for dimensions).

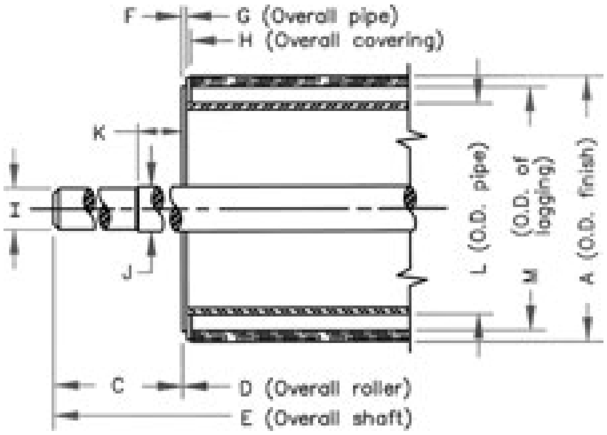

Figure 10. Sectional view of a ginning roller (see Tables 1a and 1b for dimensions).

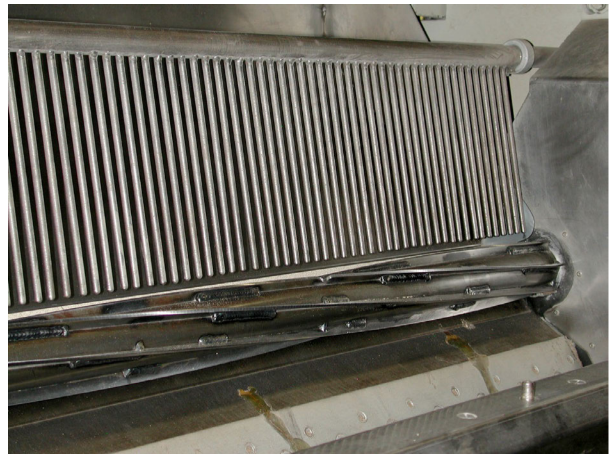

Figure 11. Photograph of a six-blade spiral rotary knife.

Table 1a. Component dimensions of the stationary knife (Fig. 8), rotary knife (Fig. 9), and ginning roller (Fig. 10) on a rotary-knife roller gin stand (SI units)

Manufacturer and model	A mm	A_{min} mm	B deg.	C mm	D mm	E mm	F mm	G mm	H mm	I mm	J mm	K mm	L mm	M mm
Consolidated Gin Co.														
Stationary knife	95.3	88.9	6.24	0.787	25.4	6.35	1022.4	-	-	-	-	-	-	-
Rotary knife	69.9	66.7	45.0	101.6	1025.7	1390.7	36.5	55.6	1.52	-	-	-	-	-
Ginning roller	381	-	-	41.4	1028.7	1676.4	6.35	1016.0	1003.3	55.6	61.9	3.18	273.1	342.9
Continental Rotobar														
Stationary knife	152.4	146.1	8.26	0.813	23.8	7.62	1244.6	-	-	-	-	-	-	-
Rotary knife	69.9	66.7	45.0	249.3	1231.9	1590.7	36.5	49.2	0.787	-	-	-	-	-
Ginning roller	381.0	-	-	276.2	1203.3	1806.6	9.53	1184.3	1158.9	55.6	61.9	-69.9	323.9	342.9
Continental/Murray														
Phoenix Rotobar														
Stationary knife	152.4	146.1	8.26	0.813	23.8	7.62	1244.6	-	-	-	-	-	-	-
Rotary knife	69.2	66.7	45.0	287.4	1231.9	659	36.5	49.2	0.787	-	-	-	-	-
Ginning roller	381.0	-	-	174.6	1203.3	1692.3	9.53	1184.3	1158.9	55.6	61.9	-15.9	266.7	342.9
Hardwicke-Etter HI-CAP														
Stationary knife	95.3	88.9	6.24	0.787	25.4	6.35	1025.7	-	-	-	-	-	-	-
Rotary knife	69.9	66.7	45.0	98.4	1022.4	1384.3	36.5	55.6	1.60	-	-	-	-	-
Ginning roller	381.0	-	-	336.6	1028.7	1701.8	6.35	1016.0	1003.3	55.6	61.9	101.6	273.1	342.9
Lummus Rota-Matic														
12400/13400/14400														
Stationary knife	95.3	88.9	6.24	0.787	25.4	6.35	1025.7	-	-	-	-	-	-	-
Rotary knife	69.9	66.7	45.0	98.4	1022.4	1384.3	36.5	55.6	1.60	-	-	-	-	-
Ginning roller	381.0	-	-	336.6	1016.0	1701.8	6.35	1003.3	990.6	55.6	61.9	101.6	273.1	342.9
Lummus Rota-Matic Series 2000														
High-Speed Roller Gin														
Stationary knife	95.3	88.9	6.24	0.787	25.4	6.35	1025.7	-	-	-	-	-	-	-
Rotary knife	69.9	66.7	45.0	98.4	1022.4	1384.3	36.5	55.6	1.60	-	-	-	-	-
Ginning roller	381.0	-	-	336.6	1016.0	1701.8	6.35	1003.3	990.6	55.6	61.9	101.6	273.1	342.9

Table 1b. Component dimensions of the stationary knife (Fig. 8), rotary knife (Fig. 9), and ginning roller (Fig. 10) on a rotary-knife roller gin stand (I-P units).

Manufacturer and model	A	A_{min}	B	C	D	E	F	G	H	I	J	K	L	M
	in	in	deg.	in	in	in	in	in	in	in	in	in	in	in
Consolidated Gin Co.														
Stationary knife	3.75	3.50	6.24	0.031	1.00	0.250	40.25	-	-	-	-	-	-	-
Rotary knife	2.75	2.625	45.0	4.00	40.38	54.75	1.438	2.188	0.060	-	-	-	-	-
Ginning roller	15.0	-	-	12.63	40.50	66.00	0.250	40.00	39.50	2.188	2.438	0.125	10.75	13.50
Continental Rotobar														
Stationary knife	6.00	5.75	8.26	0.032	0.9375	0.300	49.00	-	-	-	-	-	-	-
Rotary knife	2.75	2.625	45.0	9.813	48.50	62.625	1.437	1.938	0.031	-	-	-	-	-
Ginning roller	15.0	-	-	10.875	47.375	71.125	0.375	46.625	45.625	2.188	2.438	-2.75	12.75	13.50
Continental/Murray														
Phoenix Rotobar														
Stationary knife	6.00	5.75	8.26	0.032	0.9375	0.300	49.00	-	-	-	-	-	-	-
Rotary knife	2.726	2.625	45.0	11.313	48.50	65.313	1.437	1.938	0.031	-	-	-	-	-
Ginning roller	15.0	-	-	6.875	47.375	66.625	0.375	46.625	45.625	2.188	2.438	-0.625	10.5	13.50
Hardwicke-Etter HI-CAP														
Stationary knife	3.75	3.50	6.24	0.031	1.00	0.25	40.38	-	-	-	-	-	-	-
Rotary knife	2.75	2.625	45.0	3.875	40.25	54.5	1.438	2.188	0.063	-	-	-	-	-
Ginning roller	15.0	-	-	13.25	40.50	67.00	0.250	40.00	39.50	2.188	2.438	4.00	10.75	13.50
Lummus Rota-Matic														
12400/13400/14400														
Stationary knife	3.75	3.50	6.24	0.031	1.00	0.25	40.38	-	-	-	-	-	-	-
Rotary knife	2.75	2.625	45.0	3.875	40.25	54.50	1.438	2.188	0.063	-	-	-	-	-
Ginning roller	15.0	-	-	13.25	40.00	67.00	0.250	39.50	39.00	2.188	2.438	4.00	10.75	13.50
Lummus Rota-Matic Series 2000														
High-Speed Roller Gin														
Stationary knife	3.75	3.50	6.24	0.031	1.00	0.25	40.38	-	-	-	-	-	-	-
Rotary knife	2.75	2.625	45.0	3.875	40.25	54.50	1.438	2.188	0.063	-	-	-	-	-
Ginning roller	15.0	-	-	13.25	40.00	67.00	0.250	39.50	39.00	2.188	2.438	4.00	10.75	13.50

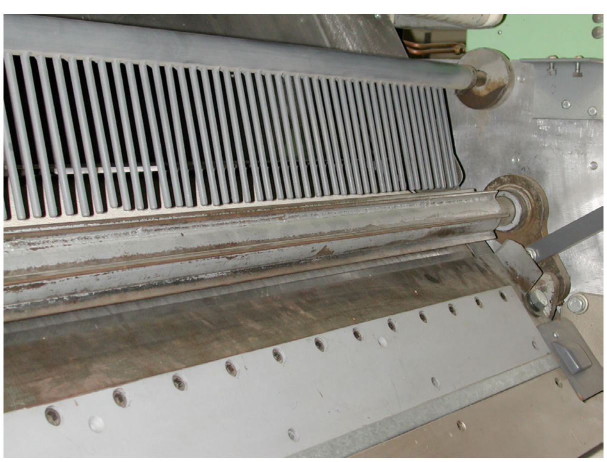

Figure 12. Photograph of a six-blade straight rotary knife.

The ginning roller is the most important and expensive component of the roller gin stand. Roller covering material is made from 13 layers of plain-woven cotton fabric cemented together with a white rubber compound to form a sheet that is approximately 19-mm (0.75-in) thick. This material is cut into long strips approximately 22-mm (0.875-in) wide (Fig. 13). The strips are wound around the lagging so that the fabric lays on the bias, so that neither the warp nor the fill yarn is parallel to the direction of cutting. This arrangement prevents the covering material from unraveling from the roller core. The roller covering material is mounted onto the roller core with the cut edges of the fabric layers serving as the ginning surface (Fig. 14). The covering material is available in either 9.1-m (30-ft) long coiled strips that require splicing, or reels that do not require splicing. About 61 m (200 ft) of roller material are needed to cover a 1-m (40-inch) long by 0.4-m (15-in) diameter roller. The roller material hardness should be approximately 55 to 60 DO on a durometer scale. Material of different hardness should not be used on the same roller, as unequal wear will occur. Material hardness changes with age and temperature.

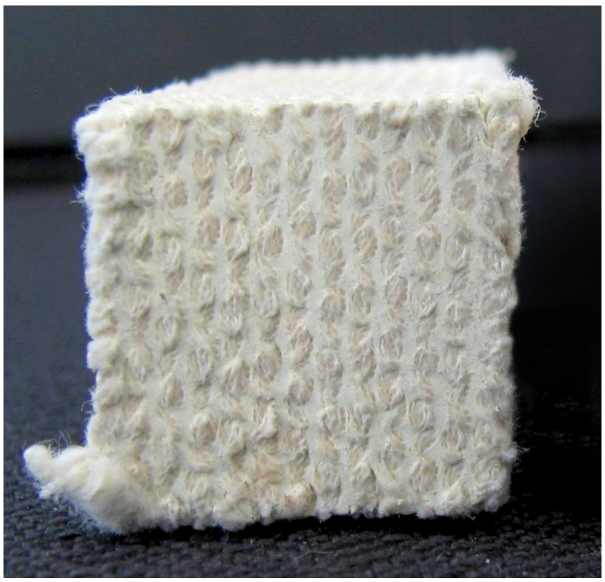

Figure 13. Photograph of a section of roller covering material.

Figure 14. Photograph of a ginning roller.

Rotary-Knife Roller Gin Stand Theory of Operation. Fiber is separated from seed on a roller gin stand due to frictional forces that occur between a moving (roller) and fixed (stationary knife) surface (Gillum, 1985). Three frictional forces exist when roller ginning cotton: (1) roller-to-stationary knife (RSK), (2) roller-to-fiber, and (3) stationary knife-to-fiber. During normal ginning, the roller-to-fiber force is greater than the stationary knife-to-fiber force, so the fiber sticks to the roller surface and slips on the stationary knife surface. The greater the force between the stationary knife and ginning roller, the greater the frictional pulling force between the fiber and ginning roller.

Cotton is ginned at the rate that cotton fibers adhere to the roller surface and slip under the stationary knife. Overfeeding or feeding in bunches causes fiber and seed to tangle and stop at the stationary knife edge. When stoppage occurs, roller surface is wasted, and the accumulated cotton is rejected as carryover by the rotary knife. Underfeeding results in areas of the roller surface being devoid of cotton. The roller then uselessly slides on the stationary knife, thereby heating and wearing the roller surface.

Rotary-Knife Roller Gin Stand Adjustment. Recommended values of roller speed, rotary knife speed, velocity ratio, air cylinder pressure, RSK force, and rotary-knife-to-stationary-knife clearance for some representative gin stands are shown in Table 2. The values are for both conventional and high-speed stands. A typical RSK force is approximately 10.5 kN/m (60 lb/in) of roller length, or approximately 420 kN/m (2,400 lb) across the entire roller. The RSK force results from the air cylinders pushing the ginning roller against the stationary knife and its holder. This force must be controlled to maintain the proper RSK clearance. The RSK clearance is critical. Maintaining this clearance within a small tolerance reduces spindle twists, lint tags, and broken seed at the stationary knife edge.

The RSK force causes friction and heat on the roller surface. Most of the power driving the roller is converted to heat because of this friction. Uniformity of the surface temperature across the ginning roller is an indicator of the uniformity of RSK force. Across the roller, the coefficient of friction can change and give misleading estimates of RSK force. During ginning, cotton reduces the friction between the roller and stationary knife and absorbs some of the heat from the friction. But even when the flow of cotton is uniform, the roller surface temperature increases when the power driving the roller is increased. A warm ginning roller has a lower coefficient of friction with the stationary knife and improves ginning efficiency. Roller surface temperature should be kept under 107 °C (225 °F) to ensure normal roller life. Roller temperature should not exceed 149 °C (300 °F) or the roller covering material will deteriorate rapidly.

Table 2. Recommended operating parameters of commercial rotary-knife roller gin stands.

Manufacturer and model	Roller speed		Rotary-knife speed			Velocity ratio	Cylinder air pressure		RSK force		Knife-to-knife clearance	
	m/s	rpm	m/s	rpm	strokes/s	roller/ knife	kPa	psi	kN/m	lb/inch	mm	in
Consolidated Gin Co.	2.39	120	1.48[z]	406[z]	40.6	1.61	310	45	11.28	64.42	0.25	0.010
Continental Rotobar	2.19	110	0.878	240	24	2.49	620	90	12.16	69.41	0.81	0.032
Continental/ Murray												
Phoenix Rotobar	2.33	117	1.38	380	38	1.69	620	90	12.16	69.41	0.81	0.032
Hardwicke-Etter HI-CAP	2.31	116	1.63	447	44.7	1.42	517-620	75−90	11.1	63.61	0.25	0.010
Lummus Rota-Matic												
12400/13400/ 14400	2.31	116	1.63	447	44.7	1.42	517-620	75−90	11.1	63.61	0.25	0.010
Lummus Rota-Matic												
Series 2000 High Speed	4.00-8.98	200-450	2.37-5.31	650-1450	65-145	1.69	550	80	10.17	58.1	0.25	0.010

[z] When roller gin stand is equipped with a 4-bladed rotary knife, the rotary-knife speed is 2.21 m/s (605 rpm).

Increasing the roller surface velocity and RSK force increases the ginning rate (Gillum, 1985). Unfortunately, higher ginning rates require more input power, which in turn produces higher roller temperatures that requires more attention from the ginner. The high-speed roller gin uses an auxiliary roller cooler to help manage roller temperatures at elevated ginning rates. Rotary knife speed does not directly affect ginning rate. It is recommended that the roller surface velocity be faster than the tip velocity of the rotary knife (velocity ratio greater than 1) to prevent trapping and crushing of seed (Table 2).

During ginning, seed cotton and ginned and partially ginned seed could accumulate on the stationary knife. But each stroke of the rotary knife clears the stationary knife edge of accumulated seed cotton and seed, thereby restoring the effectiveness of the gin. Partially ginned seed is either pulled back to the stationary knife and completely ginned or swept along with the seed and carryover and later reclaimed. At the ginning point, approximately 45% of seed cotton trash goes with the lint, and the remainder goes with the seed. Dust liberated by the rotary knife is picked up by the dust hood. The rotary knife barrier guards and safety interlocks must be used.

The carryover reclaimer (Figs. 15 and 16) removes unginned and partially ginned seed cotton and spindle twists from the seed belt and returns them to the gin stand for ginning. The reclaimer does not distinguish between seed cotton and spindle twists. Spindle twists do not gin properly, hang up on the stationary knife, and cause reduced ginning rates and possible damage to the ginning roller. Most of the spindle twists are returned by the reclaimer and can accumulate at the gin stand, resulting in reduced ginning efficiency and premature wear of the roller and rotary knife. Spindle twists eventually will follow the lint and, in turn, reduce the value of the producer's crop and cause problems at the textile mill.

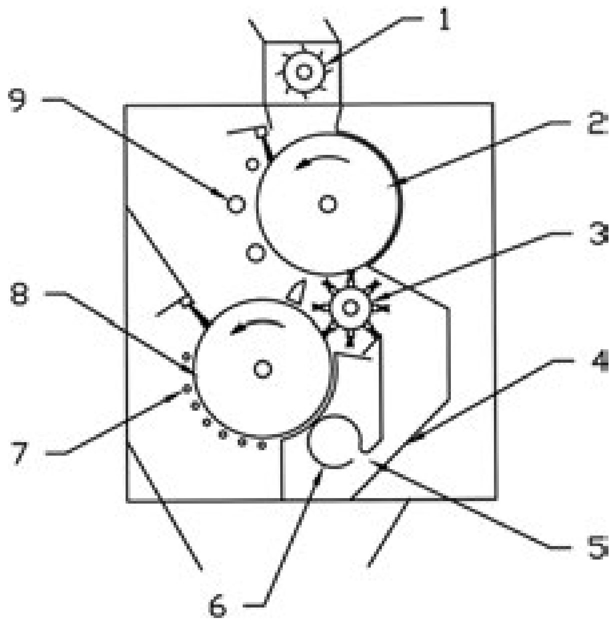

Figure 15. Cross section of a Continental Eagle reclaimer. *1*, Breaker cylinder, 1,005 rpm; *2*, Main saw cylinder, 449 rpm; *3*, Doffing brush, 1,005 rpm; *4*, Adjustable sheet; *5*, Reclaimed seed cotton inlet; *6*, Aspiration tube; *7*, Grid bars; *8*, Reclaimer saw cylinder, 340 rpm; *9*, Control bars. (Courtesy of Bajaj ConEagle Corporation.)

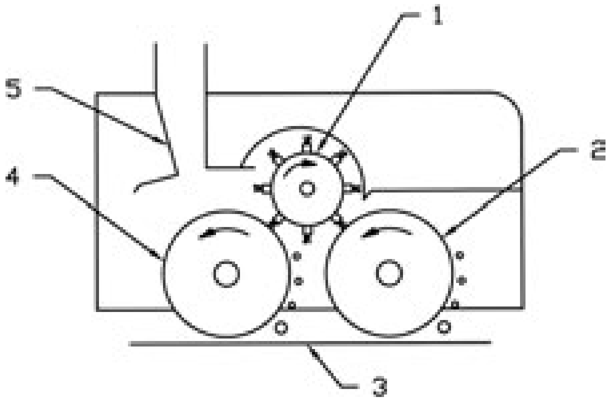

Figure 16. Cross section of Lummus Corporation reclaimer. *1*, Doffing cylinder, 700 rpm; *2*, Second saw cylinder, 175 rpm; *3*, Seed drag belt; *4*, First saw cylinder, 175 rpm; *5*, Suction pickup deflector. (Courtesy of Lummus Corporation.)

Carryover increases with feed rate but is typically less than 6% of the seed cotton fed for conventional roller ginning (Gillum, 1979), and slightly more for high-speed roller ginning. Conventional reclaimers were designed for conventional roller ginning production rates and, therefore, might not have the capacity to handle the increased carryover of high-speed roller ginning. Research is currently being conducted to develop a high-capacity reclaimer.

It is important to use and follow manufacturer's service manuals for detailed instructions on how to set up and adjust roller gin components. Specialized tools are available from the manufacturer. Proper adjustment and maintenance will ensure maximum performance of the roller gin stand.

Seed Cotton Harvesting and Storing for Roller Ginning. Because roller ginned Pima and Upland cotton command a premium price due to their superior fiber properties, these cottons must be harvested and stored with the utmost care. Fields having a lot of litter, weeds, green leaves, immature bolls, or high seed cotton moisture content should not be harvested until conditions are improved. Cotton that contains excess green leaves or high moisture (12% or more) should not be harvested unless the cotton can be ginned immediately with appropriate drying (National Cotton Council, 2016). Harvesting under unfavorable conditions contributes to spindle twist, and reduced fiber grade and seed quality. Picking machines must be in the best condition possible with the water system, spindles, and cabinet and picker bar alignment properly set to avoid spindle twists.

The benefits of roller ginning high quality cottons are only realized when the cotton quality is maintained from the field to the ginnery. Modules allow long term storage of cotton. Whether the module is a conventional type that is formed at the edge of a field, or an onboard type that is formed on the picker, they must be properly built and stored on well-drained areas. Modules must be protected with good module covers or wrap. Studies have shown that improperly covered modules result in lower lint values due to reduced color grades and lower turnout, and higher ginning costs due to reduced gin productivity and increased energy for drying due to high-moisture cotton (Searcy et al., 2010).

The moisture content of cotton during storage is critical. Excess moisture causes stored cotton to overheat, resulting in lint discoloration (yellowing), lower seed germination, and possible spontaneous combustion (Searcy et al., 2010). Seed cotton above 12% moisture content should not be stored. The internal temperature of newly built modules should be monitored for the first 5 to 7 d of cotton storage. Modules that experience a 7 °C (20 °F) rise in temperature or are above 43 °C (110 °F) should be ginned immediately to avoid the possibility of major loss (National Cotton Council, 2016). These recommendations, although important for all cotton ginned, are especially important for roller ginned cottons due to their higher quality and value.

Seed Cotton Conditioning for Roller Ginning. Seed cotton conditioning equipment in roller ginneries is the same type used in saw ginneries. Cleaning equipment includes cylinder cleaners, stick machines, and serrated disk (impact) cleaners. Research by Gillum and Armijo (1997) showed that up to nine seed cotton cleaners did not adversely affect cotton quality. Whitelock et al. (2007) reported that the total number of seed cotton cleaners (not including the extractor-feeder) used in roller ginneries ranged from three to 11, with five cleaners being most commonly used.

Tower dryers and hot air cylinder cleaners are commonly used for seed cotton drying. Optimum fiber moisture content for roller ginning is 5 to 6% (Leonard and Gillum, 1974). Drying fiber to lower than 4% could result in static electricity problems and fiber breakage. Whitelock et al. (2007) reported that all U.S. roller gins have at least two stages of drying and 69% of the gins have three drying stages. Also, many roller gin operators believe that warm cotton gins operate better, thus they apply heat to even relatively dry seed cotton or add heat to the gin stand feeder hopper. An increase in cotton temperature could decrease the viscosity of the waxy cuticle material on the fiber and this could reduce the force needed to gin the fibers by reducing hydrodynamic friction (Slade, 1998).

Roller Gin Lint Cleaning. In the past, the mill-type opener/air-jet lint cleaner combination was used to remove motes, broken seed, entanglements caused by mechanical pickers, and small trash not removed in seed cotton cleaning (Alberson, 1964). Because of their low capacity, many of the mill-type openers have been replaced by cylinder (incline) and serrated disk (impact) cleaners in combination with an air-jet cleaner. Figures 17 through 20 show lint cleaning systems recommended by different manufacturers. More recently, many roller gins have been using the Lummus Guardian lint cleaner (Fig. 20). The Guardian uses a pin cylinder to comb and clean the fiber; it also uses an air-jet cleaner to further remove trash particles from the lint. There is no standard machinery sequence for lint cleaning roller ginned cotton today. Whitelock et al. (2007) found a mixed use of lint cleaners in roller gins: 88% used one or two cylinder cleaners, 17% used an impact cleaner, 25% used a Guardian lint cleaner, and essentially all of the gins used an air-jet cleaner. They found the most common machinery setup was one or two cylinder cleaners and one air-jet cleaner, and that lint value was increased from \$1.66 to \$1.72 kg^{-1} (\$0.755 to \$0.781 lb^{-1}) due to lint cleaning.

Roller Gin Safety. Roller gin machinery is dangerous. The rotary knife on a conventional and high-speed gin stand turns at 400 and 1,200 rpm, respectively. Beater, pin cylinder, and spiked lint cleaning cylinders run between 450 and 1,000 rpm. The reclaimer contains saws that are running at 175 rpm and are in close proximity to the seed belt. A body part caught in any of these machines is severed instantly. Ensure that all guards are in place, including the rotary knife barrier guard. Occasionally, the operator might need to raise the barrier guard to clear a choke-up or tag at the rotary knife. The rotary knife barrier guard has a safety interlock to ensure that the gin stand cannot operate when the guard is raised. Do not work on any machinery until all moving parts have stopped, and the machinery has been properly locked out. Safety precautions must be followed at all times.

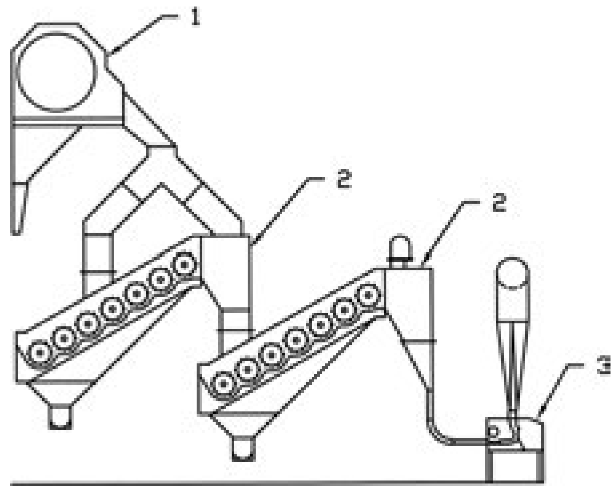

Figure 17. Cross section of the Consolidated lint cleaning system. *1*, Lint cleaner condenser, 86-inch; *2*, Gravity cleaner, 96-inch; *3*, Super mote cleaner, 84-inch. (Courtesy of Lummus Corporation.)

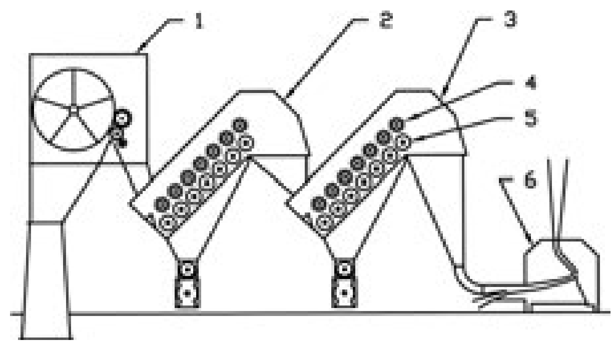

Figure 18. Cross section of the Continental lint cleaning system. *1*, Condenser; *2*, Impact lint cleaner or Gravity incline cleaner; *3*, Impact lint cleaner; *4*, Spiked cylinder, 676 rpm; *5*, Serrated disc cylinder, 460 rpm; *6*, Centrifugal lint cleaner. (Courtesy of Bajaj ConEagle LLC).

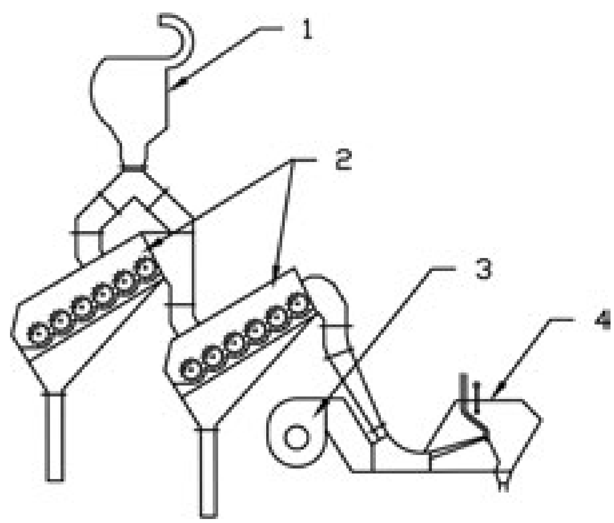

Figure 19. Cross section of the Lummus lint cleaning system. *1*, Lint cleaner condenser; *2*, Six-cylinder gravity cleaner, 96-inch; *3*, Booster fan; *4*, Super-jet™ cleaner, 94-inch. (Courtesy of Lummus Corporation.)

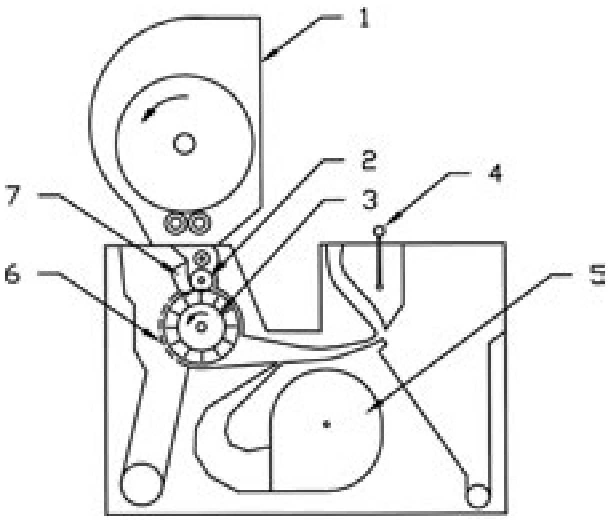

Figure 20. Cross section of the Lummus Guardian™ lint cleaning system. *1*, Drum condenser; *2*, Main feed roller; *3*, Pin cylinder; *4*, Adjustment lever; *5*, Booster fan; *6*, Grid rack; *7*, Feed plate. (Courtesy of Lummus Corporation.)

DISCLAIMER

Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

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