

## **New Developments in Cotton Ginning from Lummus**

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In an ever-changing marketplace, the cotton industry is continually striving to find better ways to improve competitiveness. Both Pima and Upland cotton producers are always in search of that improved variety to give them an edge. Additionally, cotton gins have continued to seek better methods to process the seed cotton into fiber that better meets the needs of the spinning mills.

For cotton ginning machinery, two product development areas in which Lummus has played a major role in recent years are high-speed roller ginning and non-conventional saw-type lint cleaning. This paper will discuss the background of these developments and their importance to the long-term future of cotton ginning in general.

### **High-Speed Roller Ginning**

#### Background

While the saw-type cotton gin is, by far, the most prevalent type of ginning found in the world, this process does contribute to fiber damage (increased short fiber content, reduced uniformity, and increased neps), which lower mill efficiency and yarn quality, especially in mills equipped with more modern technology. Roller-type ginning (using either a reciprocating knife or a rotary knife) is used to process long staple Pima cotton around the world. From a capacity standpoint, the rotary-knife roller gin stand is, by far, a higher-capacity option versus its reciprocating-knife counterpart, typically without compromising fiber-spinning quality. While roller-type ginning has long been shown to be a gentler way of separating the cotton lint from the seed, the low capacities typically obtained in traditional roller gins provide an economic barrier to their more widespread application. Most modern roller ginning facilities around the world are equipped with rotary-knife roller gins. The principle of the rotary-knife roller gin is shown in Figure 1.

The seed cotton is applied to the ginning roller, with the separation of fiber and seed taking place as the lint (adhering to the ginning roller) is pulled under the stationary knife (which is exerting high pressure against the ginning roller). The rotary knife directs seed cotton to the ginning point, sweeps cottonseed away from the ginning point, and releases the seed cotton that was not fully ginned to be drawn back to the tip of the stationary knife for further ginning.

#### Research Summary

Over the last five decades, the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) Southwestern Cotton Ginning Research Laboratory in Mesilla Park, New Mexico has been instrumental in the development of the modern rotary-knife roller gin and has performed extensive research on roller gins in an effort to optimize their performance and develop means by which this performance can be taken to higher levels. Since the mid 1980's,

Mesilla Park researchers, including Marvis Gillum, Carlos Armijo and others, under the supervision of research leader, Ed Hughs, have investigated a variety of components of roller ginning operation, not only to make it more effective for improved performance on Pima cotton, but also as a potential cost-effective alternative for ginning Upland cotton for a more quality-conscious marketplace. Much of this research has been published in the technical journals of the American Society of Agricultural and Biological Engineers and presented at numerous technical conferences, including the Beltwide Cotton Conferences.

Some of the research studies done more recently at Mesilla Park have focused on the optimization of rotary knife load, both for Pima and Upland cotton processing, along with the development of an independent drive for the rotary knife, which allows for automatic control of the roller ginning process, something previously not feasible. Also studied were the designs of the rotary knife itself (number of blades) and stationary knife in order to maximize performance of the gin stand on different types of cotton. Fiber quality properties (short fiber content, length, nep count) were not compromised in any of the tests as speeds/capacities were increased.

The most recent research, published in early 2007, applied many of the concepts learned in previous studies to modify a conventional rotary-knife roller gin stand into a “high-speed” version, through the increase of rotary knife and ginning roller speeds and the increase of pressure between the ginning roller and stationary knife. Other changes to the conventional machinery set-up included modifications to the extractor feeder above the gin stand, increased horsepower for the ginning roller drive, and a cooling system with blower for the ginning roller, to preserve ginning roll life.

In addition to the research performed at the USDA-ARS laboratory gin in Mesilla Park, two roller gins and feeders at a commercial gin in Arizona were converted into the high-capacity configuration. With Pima cotton’s weaker fiber attachment to the seed, substantial capacity increase would certainly not be unexpected. However, due to Upland cotton’s stronger attachment force to the seed, the true test would be in processing Upland cotton through the machinery. The studies from the gin lab showed that the high-speed roller gin stand could gin Upland cotton at nearly the same rate and at the equivalent power of a conventional saw gin stand. More encouraging was that the Upland fiber ginned on the roller gin was more than one staple length longer and had fewer short fibers and neps.

### From Research to Market

Since the most recent work performed at Mesilla Park was carried out on the three major brands of late-model roller gins (Continental, Consolidated, and Lummus), the overall concepts were universal in nature, and, thus, could be applied to any one of these designs. Lummus engineers took a keen interest in this body of research, as there are over 400 Lummus roller gins and feeders in operation around the world. In fact, Senior Vice President and Chief Technology Officer, Don Van Doorn, collaborated with the Mesilla Park staff and co-authored one of the research publications in 2004. Joe Thomas, Lummus Vice President of Technology, and the entire Lummus engineering department, worked closely with researchers Armijo and Gillum to design conversion kits for upgrading existing late-model roller gins and feeders (regardless of

manufacturer) to the high-speed configuration. Fourteen Lummus roller gins and feeders, all in California, were converted in 2006 and operated during the 2006 ginning season.

In early 2007, Lummus introduced the all-new Series 2000 roller gin and feeder, which incorporates all the upgrades and concepts into a production machine. To date, 25 new roller gins and feeders have been installed and commissioned in California, Arkansas, and Brazil. While the California and Arkansas installations process primarily Pima, the Brazil installation processes Upland, in order to produce a premium fiber for the market.

## **Non-Conventional Saw-Type Lint Cleaning**

### Background

Lint cleaners in cotton gins fall into two basic categories: flow-through, air type centrifugal lint cleaners and saw-type lint cleaners. Because they have no moving parts, air-type lint cleaners cause no fiber damage, and they should be designed into any modern gin plant as the first stage of lint cleaning. Based upon current marketing conditions, gins utilizing an air-type lint cleaner followed by a single stage of saw-type lint cleaning typically can maximize lint turnout and market value while keeping fiber damage at a tolerable level for the textile mill. If multiple stages of saw-type lint cleaning are available, the machinery arrangement should provide for bypass capability whenever possible.

Controlled-batt saw-type lint cleaners were introduced in cotton gins throughout the United States in the late 1940's, in order to reduce the unprecedented amounts of trash which resulted when mechanical harvesters began to replace hand harvesting. A typical controlled-batt, saw-type lint cleaner (the Lummus Model 108) is shown in Figure 3.

These lint cleaners operate under the principle that the lint is formed into a batt by a slow-moving condenser drum, fed through a series of rollers (the feed works), then applied to the high-speed saw cylinder teeth by a closely-spaced feed roller and feed plate. The difference in speed of the batt versus the saw speed at the transfer point is known as the combing ratio and is what results in the smooth appearance of the lint following one or more stages of saw-type lint cleaning. Over the years, numerous tests run on saw-type lint cleaners have quantified the level of fiber breakage that takes place in these machines. Further, these studies show that almost all of the fiber breakage takes place in saw-type lint cleaners where the sharp saw teeth plow through the firmly-held batt of fibers being fed to the saws.

### A New Design

In an effort to eliminate this significant source of the fiber damage in a conventional saw-type lint cleaner, Lummus introduced the Sentinel™ Lint Cleaner in 1999 (see Figure 3). The Sentinel™ is a non-conventional saw-type lint cleaner that applies individual tufts of fiber directly to the saw (through the use of a high-speed perforated air and dust separator cylinder), rather than agglomerating the fiber into a batt on a low-speed revolving condenser drum. By using this method, the conveying air and dust are more effectively removed than in conventional saw-type lint cleaners, where the batt tends to act as a filter, trapping dust before it can be

exhausted with the conveying air. Also, trash particles are never compressed into the fiber due to the absence of the traditional lint cleaner feed works.

Studies on the Sentinel™ in both single-stage and two-stage (tandem) installations, have documented substantially better fiber properties from the Sentinel™ (brighter color, better uniformity, and reduced dust, short fiber content, and neps) than conventional controlled-batt, saw-type line cleaners, with no reduction in visual quality grade.

The only real negative issue experienced with the original Sentinel™ design was operational – the traversing blow-down nozzle system required a substantial compressed air supply and was a source for an unacceptable level of maintenance. Therefore, in 2007, Lummus tested an alternative feeding system, utilizing a high-speed applicator brush cylinder and stationary perforated panels for air removal in lieu of the high-speed perforated separator cylinder and traversing blow-down assembly. This new feeding system, which currently has a U.S. Patent pending, was a great success.

Thus, in 2008, the first production model of the Sentinel™ II Lint Cleaner entered the marketplace (see Figure 4). In addition to the new feeding method, the Sentinel™ II has other refinements, the most notable being the reduction in the number of grid bars from eight to six. The bottom two grid bars in the 8-grid bar original Sentinel™ design had proven to be unnecessary from a cleaning aspect, so their removal produced a lower-cost and simpler machine configuration. Along with the new Sentinel™ II, a conversion package for existing Sentinel™ Lint Cleaners was introduced as well.

### **Summary**

With the continued demand from the world textile industry for longer, more uniform fiber with less neps, high-speed roller ginning and non-conventional saw-type lint cleaning certainly should play a substantial role in the production of high-quality fiber for the future. The continued progress of the ICAC Task Force on the Commercial Standardization of Instrument Testing of Cotton (CSITC) is setting the stage for a worldwide cotton classification system based on truly measurable/repeatable fiber quality properties. Therefore, as accurate and repeatable instrument classification becomes the norm, the improved fiber quality properties of cotton fiber produced with the machinery discussed in this paper will become even more significant in the marketplace. The success thus far and the future implementation of these technologies in additional regions will offer the potential for an even greater supply of high-quality raw material for mills worldwide. In this way, despite the ups and down of the industry, cotton will continue its leadership role as the natural fiber of choice around the world.

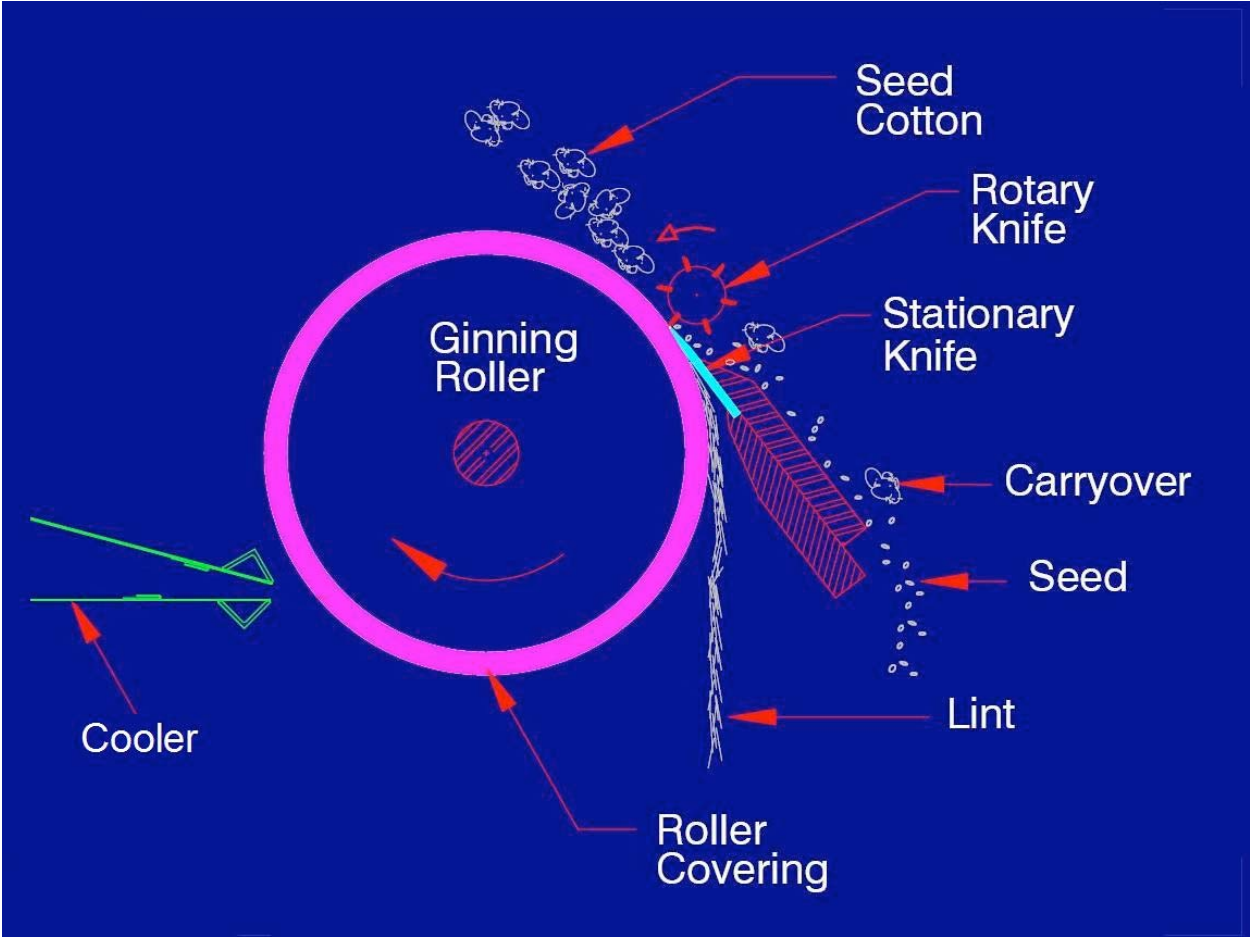


Figure 1. Principle of the rotary-knife roller gin stand. (courtesy of the USDA-ARS Southwestern Cotton Ginning Research Laboratory)

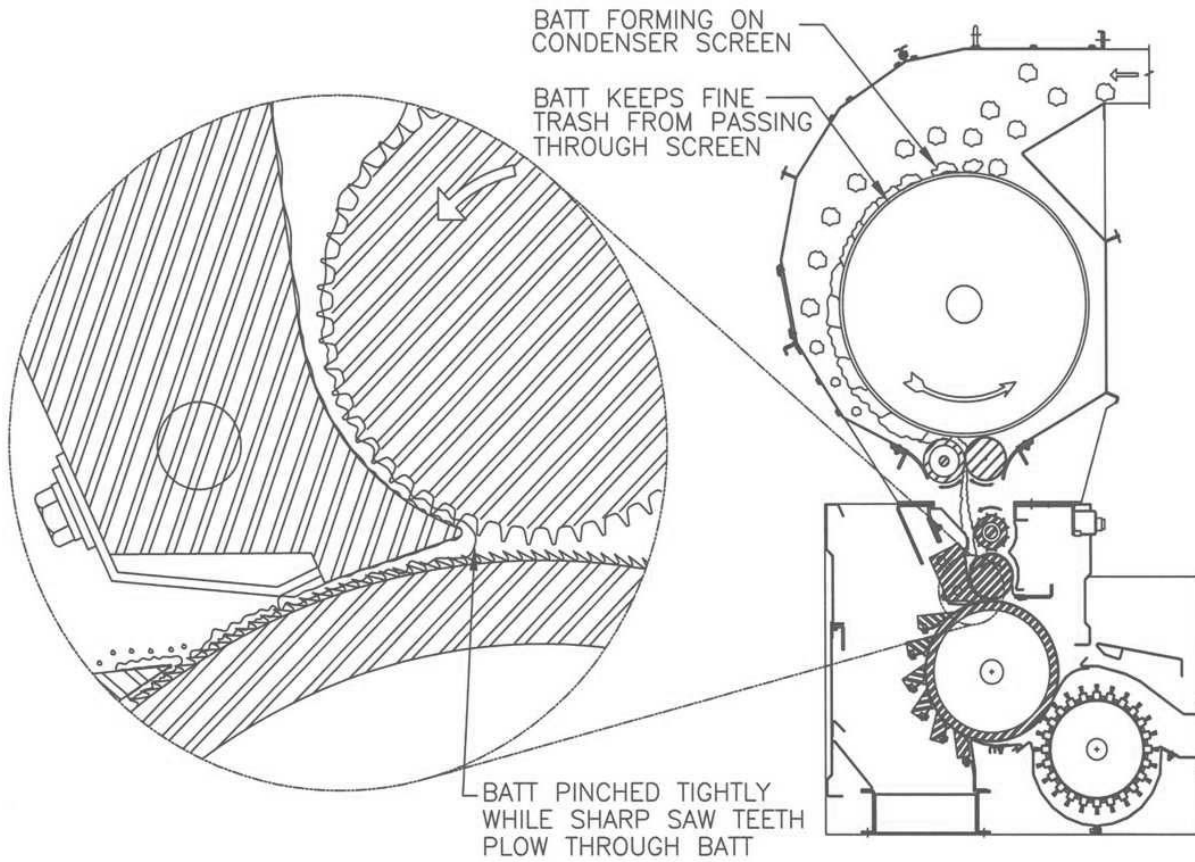


Figure 2. A typical conventional controlled-batt, saw-type lint cleaner (the Lummus Model 108 Lint Cleaner).

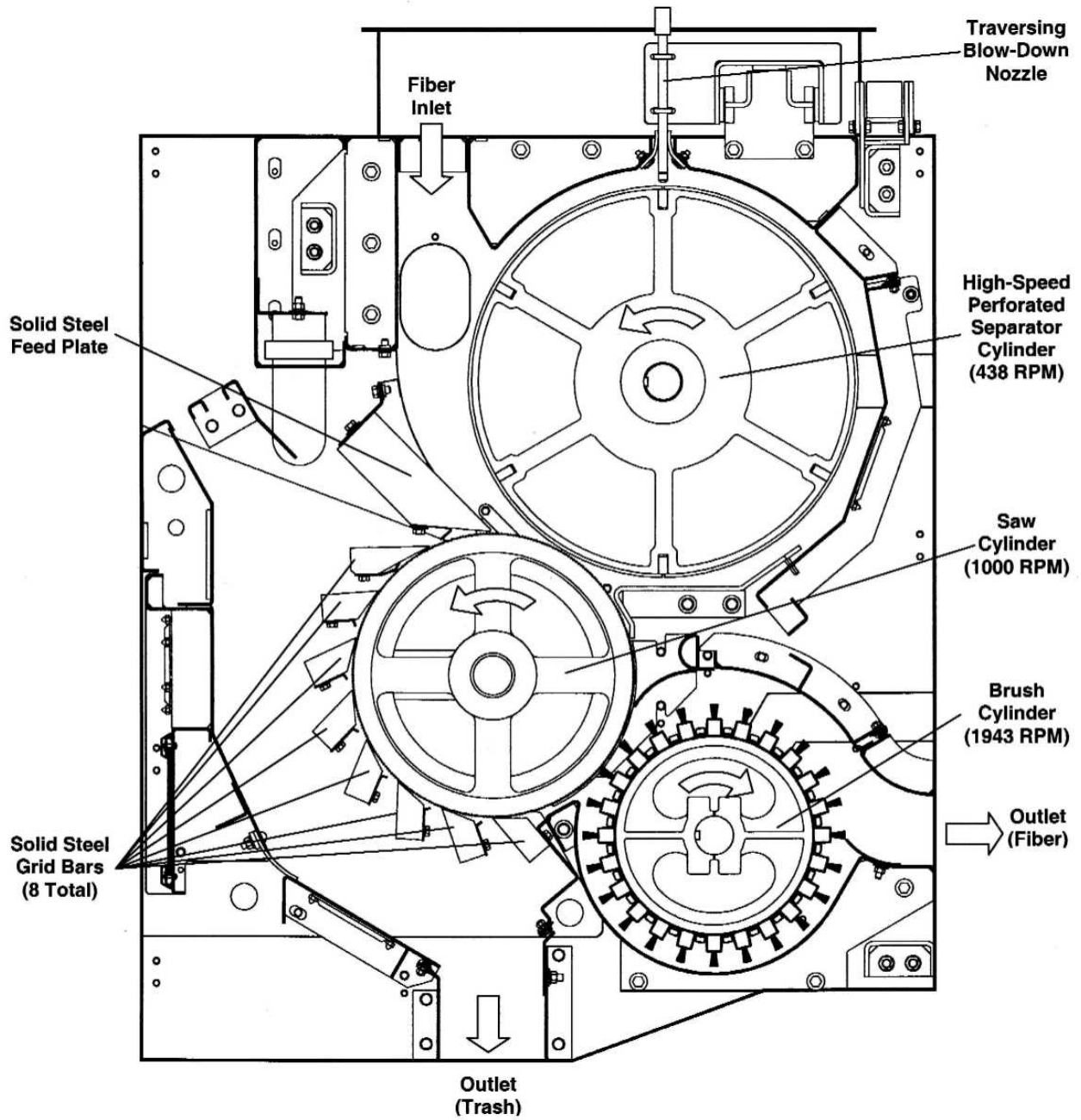


Figure 3. The Lummus Sentinel™ Lint Cleaner.

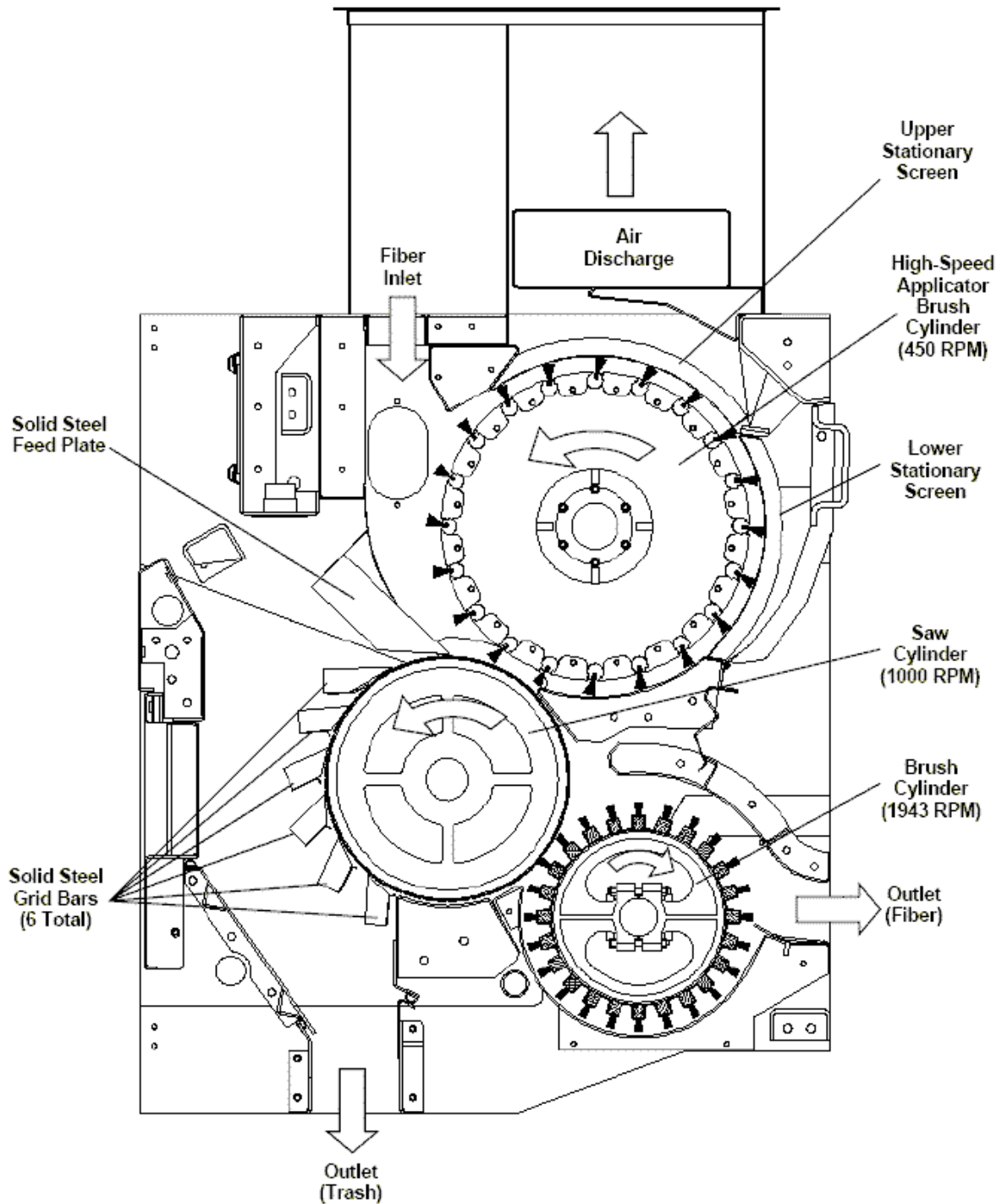


Figure 4. The Lummus Sentinel™ II Lint Cleaner