THE LUMMUS SENTINEL™ LINT CLEANER

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Abstract

The Lummus Sentinel™ Lint Cleaner is a 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 lint 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. The reduction in mechanical parts due to the elimination of the condenser and its drive assembly, along with the simplified feeding concept have yielded a more forgiving design for operation over a wider range of ginning speeds. The Sentinel™ design incorporates numerous maintenance-friendly features and improvements without compromising safety. Testing at two locations during the fall of 1998 yielded encouraging results in both fiber quality and throughput capacity. Sentinel™ Lint Cleaners will be installed at two additional locations in 1999, and further testing/evaluation performed. Commercial introduction is scheduled for the year 2000, with the unit to be offered in both 86" and 108" widths.

Background

Historical

For the past five decades, lint cleaners in cotton gins have fallen into two categories: 1) the flow-through air-type (Figure 1) which uses centrifugal force to separate trash from fiber, and 2) the controlled-batt saw-type (Figure 2) which condenses the fiber into a batt on a low-speed, revolving screen drum, feeds it through an array of doffing and feed rollers, and compresses it into a thin layer of fiber against the feed plate, metering the fiber onto a saw cylinder turning at from 1000 to 1200 revolutions/minute (rpm), which aggressively combs the fiber and carries it across grid bars that separate the trash from the fiber. While there are differences between manufacturers on the specifics of their machines (e.g., number of grid bars, feed plate size, saw cylinder diameter, etc.), the basic operational principles of saw-type lint cleaners remain the same.

In the late 1980's, a cooperative research project between Cotton Incorporated, the USDA Ginning Lab in Mesilla Park, NM and Lummus developed the Coupled Gin-Lint Cleaner (Figure 3). This machine directly coupled two saw-type lint cleaner assemblies to the back of a saw gin, and lint was applied to each lint cleaner saw directly from the preceding machine's doffing brush. To allow sufficient air flow to properly doff the gin saws and lint cleaner saws, the lint cleaner saws were modified to a design comprised of stacked 16" diameter gin saws, rather than the conventional solid, spiral-wrapped lint cleaner saw cylinder. Raw fiber qualities, spinning and weaving results were promising (Price and Gillum 1998). However, the Coupled Gin-Lint Cleaner suffered from operational problems, most notably in the lint cleaner section, due to the close proximity of the various components to each other, which prohibited easy access for maintenance. Also, this unit, by its very design, eliminated the possibility of incorporating an air-type lint cleaner into the system that would provide additional fiber cleaning without any fiber damage. Thus, from a commercial feasibility standpoint, its future is uncertain.

Marketplace Changes

With the advent of HVI and AFIS technology, much research has been done on the adverse effects of individual ginning machines on cotton fiber properties that affect spinning at the textile mill. Because they have no moving parts, flow-through air-type lint cleaners (like the Lummus Super-Jet®) cause no fiber damage. However, the same cannot be said for conventional saw-type lint cleaners. There is consensus within the ginning industry that no more than two stages of saw-type lint cleaning should ever be used during ginning, with one stage being preferred. 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. In fact, larger, progressive textile mills have instituted "gin-to-mill" direct contracts with some gins for a portion of the mill's raw cotton requirements. This allows the mills to specify the use of only single-stage saw-type lint cleaning in trade for waiving some of the normal discounts associated with higher trash contents in the lint and lint preparation.

Because a cotton gin is a seasonal business that must accomplish much during a short time to remain profitable, throughput capacity and high lint turnout are essential for success. However, lint quality cannot be compromised at the price of capacity; otherwise, the gin may not find an end user for the fiber. The ultimate customer of the ginned cotton, the textile mill, will source cotton that meets its needs for spinning, regardless of where it is ginned. Based upon much of the knowledge gained through the Coupled Gin-Lint Cleaner project, Lummus set out to design a saw-type lint cleaner that yields improved fiber properties (reduced neps, short fiber content, dust, visible foreign matter, etc.) for the mills, while providing high capacity and turnout and reduced maintenance and downtime for the ginners.

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Discussion

Design Objectives

During initial design work on the Sentinel™, some basic design objectives were developed. These included (in no particular order):

1. Capacities should meet or exceed current Lummus lint cleaner ratings - 18 bales per hour (bph) for the 108" wide model, 12 bph for the 86" wide model.
2. Design should accommodate use of an air-type lint cleaner immediately behind the gin stand.
3. Design should retrofit into existing gin installations with a minimum of machinery, foundation and electrical modification.
4. Design should not "condense" the fiber into a batt which would then have to be "combed" out by the saw.
5. The number of moving parts should be significantly reduced.
6. Design should facilitate ease of manufacture and assembly at the factory and ease of installation and maintenance in the field.
7. Design should reduce operational downtime and maintenance costs.
8. Design should improve lint value in the marketing system.
9. Design should improve lint spinning quality and minimize good fiber loss.

Phase I Prototype

As discussed above, a major drawback of the Coupled Gin-Lint Cleaner is that it prohibits the use of an air-type lint cleaner immediately following the gin stand. Because the concept of using stacked, closely-spaced gin saws as a lint cleaner saw cylinder had been proven, this design was selected for use in the first test unit. A 28" wide prototype using modified end heads from a Lummus Model 86 Lint Cleaner was constructed and tested behind a 40-saw gin and 28" wide Super-Jet® (Figure 4). The principle of directly feeding the lint cleaner from a Super-Jet® was successful; hence, a 108" wide prototype was built and installed for testing at Sowega Cotton Gin in south Georgia during early 1998 (Figure 5).

Results from the Phase I testing at Sowega in side-by-side comparison to a 1995 model Lummus Model 108 Lint Cleaner were encouraging. The lint produced on the Phase I unit had slightly higher staple length, uniformity index, and market value. However, with regard to color, in side-by-side visual comparisons, we felt that we could get better dust removal by modifying the design.

Phase II Prototype

In order to allow for air and dust separation while minimizing the possibility of condensing the fiber into a batt, the Phase II prototype (Figure 6) incorporated a high-speed (815 rpm) 16" diameter separator cylinder with a perforated metal covering (Figure 7) to directly feed the saw cylinder. In lieu of the stacked saw cylinder assembly, a conventional spiral-wrapped lint cleaner saw was used. The existing 28" wide Phase I prototype was modified to reflect these changes and tested with very encouraging results, especially in the brighter lint with less fine trash as compared to conventional saw-type lint cleaners.

At this point, three 108" wide Phase II prototypes were manufactured. The first was installed at Sowega Cotton Gin in the 2A position where the original full-size Phase I unit was tested (Figure 8). A second was installed in the No. 3 ginning line at Jones County Cotton Gin in North Carolina (Figure 9). The third was installed during the late fall at Sowega Cotton Gin in the 2B position to form a tandem arrangement (Figure 10). Miscellaneous samples were taken during the ginning season at both locations and analyzed using both HVI and AFIS. However, since all test results have not been received, only basic trends will be presented here.

Test Results - Jones County

One of the most direct tests run at Jones County had all three Lummus 170-saw Imperial III gins operating at the same ginning rate. The samples for each comparison were drawn simultaneously to assure the same quality seed cotton was being processed. A 20-sample test compared the single Sentinel™ (10 samples) to a competitor's 86" wide lint cleaner with a modified rolling feed bar conversion (10 samples). HVI Color (Rd) and Trash (Area %) and AFIS Dust (Cnt/g), Total Trash (Cnt/g), Trash (Cnt/g) and Visible Foreign Matter (%) were substantially better for the Sentinel™, reflecting the action of the high-speed separator cylinder in removing dust and fine trash from the cotton tufts prior to applying the lint to the saw. Other fiber property results were basically the same for the samples.

Test Results - Sowega

Similar test to those run at Jones County were also run at Sowega comparing a single Sentinel™ to a single conventional Lummus Model 108 lint cleaner running at the same ginning rate. Comparable results in most fiber properties were seen, with especially outstanding trash and dust removal results from the Sentinel™. Unfortunately, at the time of this publication, late-season tandem lint cleaner comparison test results from Sowega were not yet available.

Sentinel™ Design Features

Based upon the testing at Jones County and Sowega, some reconfiguration of the Sentinel™ Lint Cleaner is currently underway. However, many of the salient design features of the Sentinel™ will apply, regardless of any minor improvements. These include:

1. Eight (8) grid bars for better cleaning and less fiber loss.

2. Removable grid bar section with rigid frame, which allows for removal of the saw cylinder through the front of the machine without disturbing grid bar settings.
3. No feed works for simplified maintenance and operation (due to the elimination of the requirement to alter feed works speed based upon fluctuations in ginning rate).
4. High-speed Separator Cylinder for improved dust and fine trash removal.
5. Stop-Motion Sensors with indicator lights on door interlocks for personnel safety (Figure 11).
6. Saw and Brush Cylinders are the same as those used in Lummus' Model 86 and 108 Lint Cleaners.
7. Heavy-duty steel Feed Plate, Grid Bars and End Heads.
8. Only three (3) cylinders in the entire machine, and the same pillow block bearing is used on all three shafts (Figure 12).
9. Only one motor per lint cleaner (30 hp for 86" wide model, 40 hp for 108" wide model) - no variable-speed condenser drive motors.

Summary

The Sentinel™ Lint Cleaner promises to be a significant addition to Lummus' gin machinery line for upland cotton, and continued refinement is ongoing. The 108" wide unit is available currently on a limited basis. Full-scale commercial availability is slated for late 1999, with the Sentinel™ to be offered in both 86" and 108" widths.

References

Price, J. B. and M. N. Gillum. 1998. Weaving Performance from the Coupled Lint Cleaner: A Preliminary Report. Proceedings Beltwide Cotton Conference. 1705-1708.

Acknowledgements

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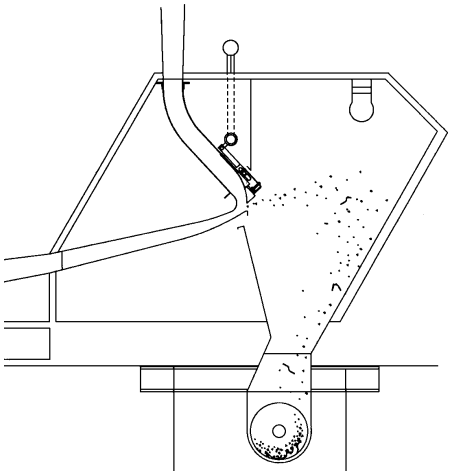

Figure 1. Air-type Lint Cleaner (Lummus Super-Jet® Lint Cleaner).

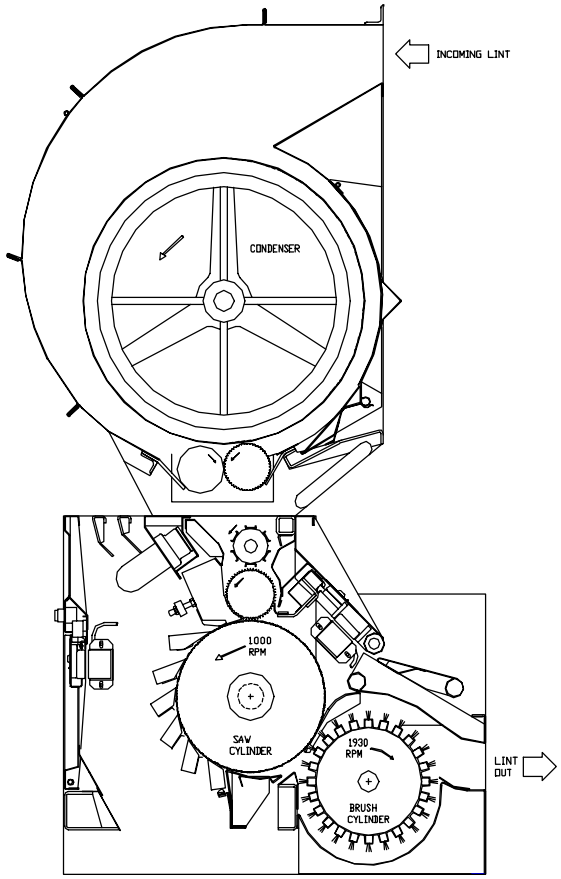

Figure 2. Controlled-Batt Saw-Type Lint Cleaner (Lummus Modsel 86 or 108 Lint Cleaner).

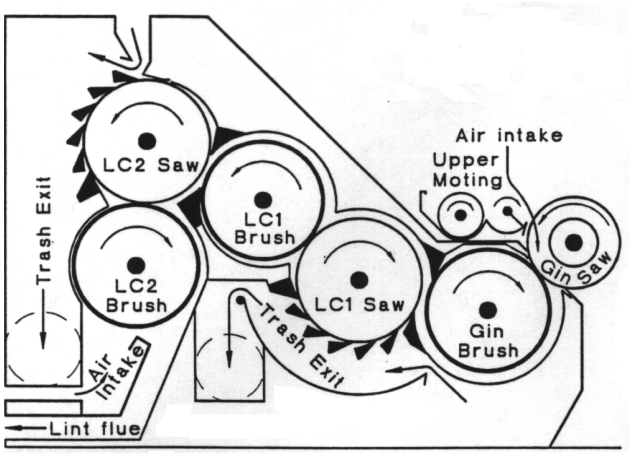

Figure 3. The Coupled Gin-Lint Cleaner.

Figure 4. 28" wide Phase I Sentinel™ Lint Cleaner.

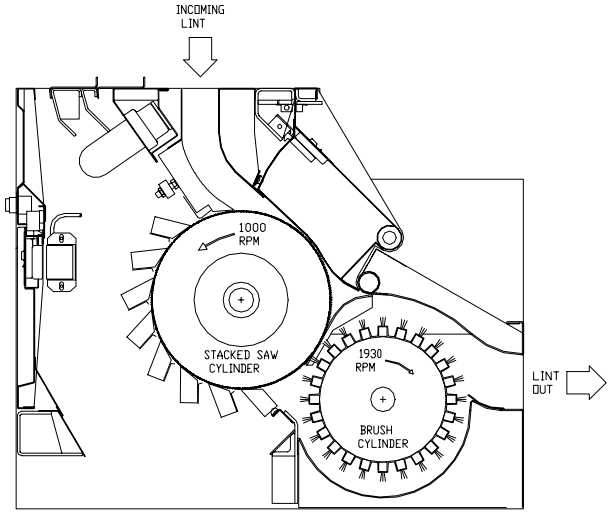

Figure 5. Cross-section of Phase I Sentinel™ Lint Cleaner.

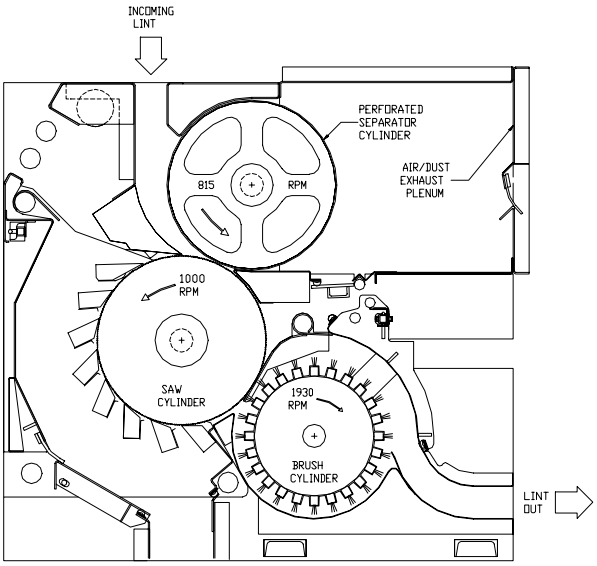

Figure 6. Cross-section of Phase II Sentinel™ Lint Cleaner.

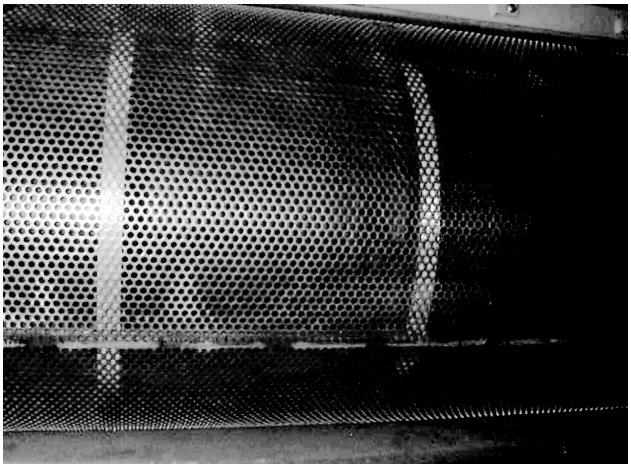

Figure 7. Separator Drum on Sentinel™ Lint Cleaner.

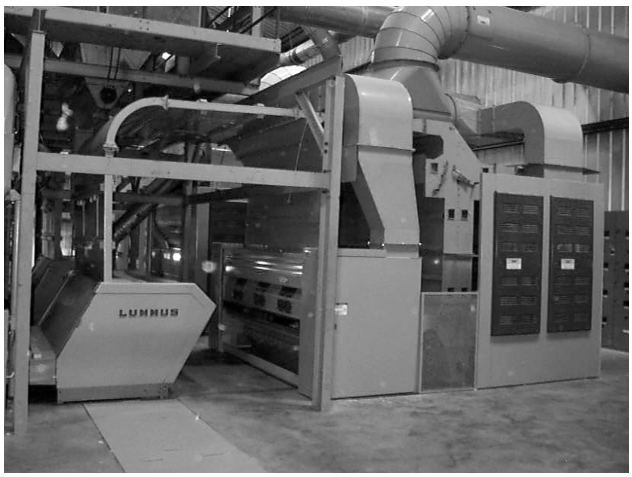

Figure 8. Installation of first Phase II Sentinel™ Lint Cleaner at Sowega Cotton Gin.

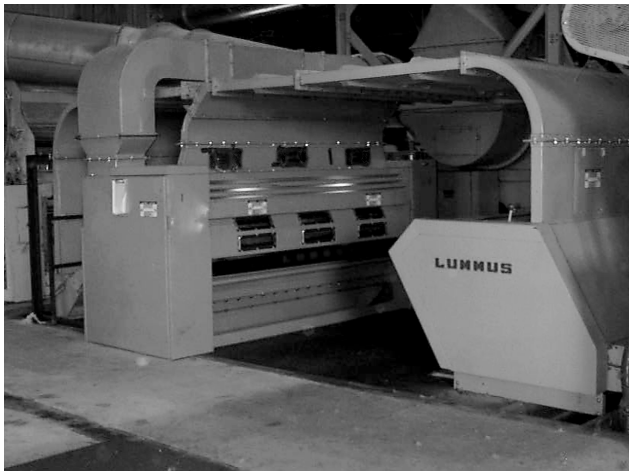

Figure 9. Installation of second Phase II Sentinel Lint Cleaner at Jones County Cotton Gin.

Figure 10. Installation of third Phase II Sentinel™ Lint Cleaner at Sowega Cotton Gin.

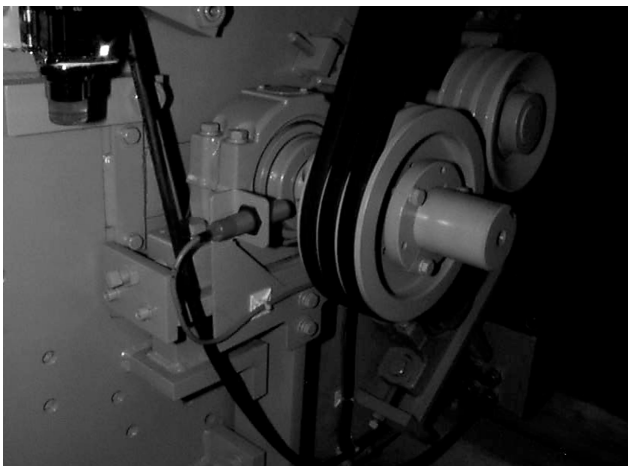

Figure 11. Stop-Motion Sensor on Sentinel™ Lint Cleaner saw shaft.

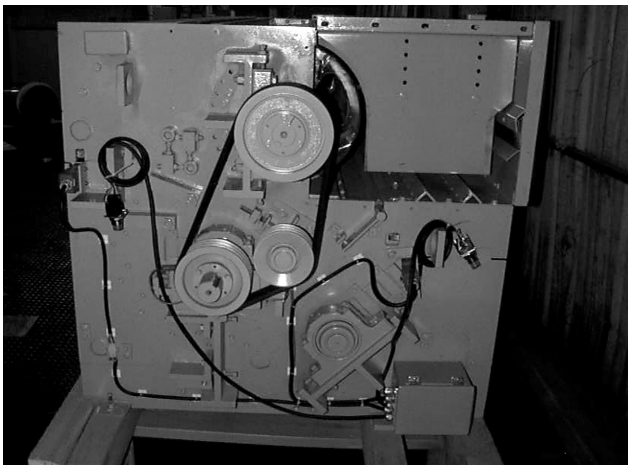

Figure 12. Side view of Sentinel™ Lint Cleaner.