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FIELD EVALUATION OF THE SENTINEL™ SAW-TYPE LINT CLEANER

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Abstract

Since its introduction in 1999, the Lummus Sentinel™ Lint Cleaner has undergone continuous evaluation and design refinement, leading to the current production model. Fiber sample comparisons between this non-traditional saw-type lint cleaner and a conventional controlled-batt saw-type lint cleaner from the 1999-2000 ginning season are presented. Additionally, in the primary focus of the study, fiber samples from the four U.S. locations operating these lint cleaners during the 2001 ginning season (two in Arizona, one in Mississippi, and one in North Carolina) were evaluated and compared to their respective regional averages from the USDA Classing offices. When possible, both HVI and AFIS quality measurements are presented.

Background

Historical

The Sentinel™ Lint Cleaner was originally introduced during the "New Developments From Industry" session at the 1999 Beltwide Cotton Conference in Orlando, Florida (Rutherford, et. al., 1999). Its fundamental design concept is one of a saw-type lint cleaner that feeds individual tufts of fiber directly to the saw, rather than agglomerating the fiber into a batt on a slow-moving condenser drum. Two prototype designs of the Sentinel™ were tested and evaluated with encouraging results.

Subsequent Development and Testing

However, some operational issues required additional design refinement, so a third-generation design was developed (see Figures 1 and 2). It features a 22" (56 cm) diameter separator cylinder in lieu of the previous 16" (41 cm) diameter version, which allows an increased air flow and dust removal surface and reduced operating speed (438 rpm). This, coupled with the addition of the traversing blow-down air nozzles (2), provides for positive removal of the short fiber/dust which had been accumulating on the interior of the separator cylinder, requiring frequent cleaning/maintenance. The effectiveness of the Sentinel™ separator cylinder in removing dust and short fiber was one of the most promising aspects of its operation. Until this upgraded design was introduced, the separator cylinder maintenance requirement had proven to be one of the unit's most troublesome obstacles to customer acceptance.

Four Sentinel™ Lint Cleaners were installed at Jones County Cotton Gin in Trenton, North Carolina, for the 1999 ginning season. Each unit was placed in the first (A) position behind the four 170-Saw Imperial III Gins and Super-Jet® Lint Cleaners. In order to obtain comparison data between the Sentinel™ and a conventional controlled-batt saw-type lint cleaner, two single Lummus Model 108 Lint Cleaners were installed in the second (B) position of ginning lines 1 and 4 (see Figure 3). The Sentinel™ Lint Cleaner in ginning line 1 was bypassed and samples were taken simultaneously from ginning line 1 (after the Model 108 Lint Cleaner) and ginning line 2 (after the Sentinel™ Lint Cleaner). Eight samples from each ginning line over two modules (four samples per line per module) were collected, and the AFIS test results are shown in Table 1.

2001 Testing

Plant Installations

Table 2 lists the Sentinel™ Lint Cleaner installations in the United States, including the dates on which samples were taken at the respective gins. The machinery arrangements for the four gins are shown in Figures 4 through 7. Although the machine placements are not identical, the machinery flow sequence for all locations is the same. Cotton flows from a Lummus 170-Saw Imperial III gin stand through a Lummus Super-Jet® air-type lint cleaner to the Sentinel™ in a single arrangement.

Testing Protocol

All the plants in the study had sampling done in two ginning/lint cleaning lines, with the exception of Safford Valley, which is equipped with only one ginning/lint cleaning group. Samples were taken before and after the Sentinel™ Lint Cleaners during the processing of four different bales. Three repetitions per sampling point were taken per bale. All the samples, identified only by a Lummus-assigned numbering system, were sent to Cotton Incorporated's office in Cary, North Carolina, for independent HVI and AFIS analyses.

Results

In order to maintain confidentiality for the gins participating in this study, each has been arbitrarily designated Gin A, B, C, or D. HVI results for each gin are presented in Tables 3 through 6, while AFIS results for all four gins can be found in Table 7. The results for each sampling point in each gin were averaged to obtain the data in the tables, with the exception of Color Grade (CGRD), where the HVI results (Tables 3 through 6) were divided into individual calls, with the total occurrences of each call shown in parentheses. For example, in Table 3, the Before Sentinel™ samples (12 total) are broken down as follows: 33% Good Middling [11-4 (4)], 50% Strict Middling [21-3 (4), 21-4 (2)], and 17% Middling [31-3 (2)].

HVI results showed that the Sentinel™ typically raised the Color Grade one full grade. Reflectance (Rd) contributed more to the color improvement than yellowness (+b). This is indicative of the dust removal characteristics of the Sentinel™, which result from the tufts of fiber never being matted together on a slow-moving condenser drum, as is the case with a conventional controlled-batt saw-type lint cleaner. Overall, the color of the samples was better than it had to be in many instances, indicating excellent growing and harvesting conditions.

HVI Upper Half Mean (UHM) was affected very little at any of the locations. This fiber length preservation is the result of the less aggressive saw-feeding action of the Sentinel™ on the fibers, where the saw does not harshly plow through a thick, tightly-held batt of cotton like conventional saw-type lint cleaners do.

AFIS results presented an even stronger case that the Sentinel™ preserves the fiber quality properties so desired by textile mills. The Sentinel™ reduced AFIS Dust in the samples an average of 33.7%. This is a direct reflection of the feeding concept of the Sentinel™, where the tufts of fiber have their dust more effectively removed, since they are never agglomerated. In addition to substantial dust removal, Visible Foreign Matter (VFM) was reduced 32.1%, and Total Trash was lowered by 34.1%.

AFIS Neps increased 14.3% through the Sentinel™, which is just over half the typical increase (24.5%) experienced in a single stage of conventional controlled-batt saw-type lint cleaning (Cotton Incorporated, 2000). In three of the four locations, the AFIS Short Fiber Content (SFC) through the Sentinel™ actually showed a slight decrease, while the fourth showed only a 5.1% increase. These compare very favorably to a typical increased short fiber content in a single stage of conventional saw-type lint cleaning (30.3%) (Cotton Incorporated, 2000). These results are tangible evidence that the action of the Sentinel™ high-speed air separator cylinder not only removes substantial dust from the fiber tufts, but also produces less short fibers (less than ½" or 13 mm) as well.

Summary

During these troubled times for the textile industry, mills continue to work toward improving their efficiencies through the use of new technologies. However, by doing so they will place increasing demands on their raw cotton suppliers to provide a product that has not been subjected to unnecessary fiber quality degradation. It is generally accepted within the ginning industry that an air-type lint cleaner followed by a single stage of saw-type lint cleaning typically maximizes lint turnout and market value, while holding fiber damage to an acceptable level for the textile mill.

As shown in this paper, the Lummus Sentinel™ Lint Cleaner is certainly a significant step in the right direction, answering both the needs of the textile industry and the ginning industry at the same time. Its simpler design (only three revolving parts, as opposed to as many as nine in comparable machines) provides for substantially easier maintenance for the gin. Its cleaning performance while minimizing fiber damage results in more money for the grower and a better raw product for the textile mill.

As improved cotton quality measurement instrumentation makes its way into the marketplace, there will soon come the time when arbitrary visual cotton classing gives way to real-time measurable fiber quality properties being used to determine cotton's market value. When this happens, machines like the Sentinel™ Lint Cleaner will be the rule, not the exception, in superior performing cotton ginning operations.

Acknowledgements

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ARS Southwestern Ginning Lab in Mesilla Park, New Mexico, for their pioneering research on the concepts that led to the development of the Sentinel™ Lint Cleaner.

Disclaimer

Use of the Cotton Incorporated research study data or the names of Cotton Incorporated and the USDA-ARS Southwestern Ginning Lab does not constitute any endorsement by either of these organizations of any machinery discussed in this paper.

References

Rutherford, R.D., D.W. Van Doorn, and M.D. Cory. 1999. The Lummus Sentinel™ Lint Cleaner. Proceedings of the Beltwide Cotton Conference. Vol. 1: 81-85.

Cotton Incorporated. 2000. Fiber Length Study Report Number 2000-1 (FPL-98-178). Cary, NC.

Table 1. AFIS data for fiber samples from 1999/2000 season comparison testing.

	Length (w) (inches)	SFC (w) (%)	UQL (w) (inches)	Length (n) (inches)	SFC (n) (%)	UQL (n) (inches)	Neps/g
After Model 108 Lint Cleaner	0.949	9.35	1.179	0.769	25.35	1.047	244
After Sentinel™ Lint Cleaner	0.968	8.43	1.201	0.790	23.59	1.071	223.5

Table 2. Sentinel™ Lint Cleaner installations.

Gin Plant	City	Year of Installation	Quantity	Sampling Date
Jones County Cotton Gin, Inc.	Trenton, NC	1999	4	11/21/01
Farmers Gin, Inc.	Buckeye, AZ	2000	2	11/16/01
Safford Valley Cotton Growers Coop	Safford, AZ	2001	1	11/15/01
Silver Creek Gin	Holly Bluff, MS	2001	4	11/10/01

Table 3. HVI data for fiber samples from Gin A (2001).

	UHM (inches)	UI (%)	Rd	+b	CGRD	Area (%)	SFC (%)
Before Sentinel™	1.075	81	77.7	9.4	33% GM [11-4 (4)] 50% SM [21-3 (4), 21-4 (2)] 17%M [31-3 (2)]	1.16	10.1
After Sentinel™	1.070	81	79.7	9.7	92% GM [11-3 (6), 11-4 (5)] 8% SM [21-3 (1)]	0.90	10.5
USDA Average			79.1	8.64	SM (21-1)		

Table 4. HVI data for fiber samples from Gin B (2001).

	UHM (inches)	UI (%)	Rd	+b	CGRD	Area (%)	SFC (%)
Before Sentinel™	1.055	83	70.3	9.5	8% SLM [41-4 (1)] 92% SLM (LS) [42-1 (9), 42-2 (2)]	1.32	8.7
After Sentinel™	1.055	83	72.0	9.6	8% SM [31-4 (1)] 25% M (LS) [32-3 (3)] 67% SLM (LS) [42-1 (3), 42-2 (5)]	1.00	9.4
USDA Average			73.8	8.67	SLM (41-3)		

Table 5. HVI data for fiber samples from Gin C (2001).

	UHM (inches)	UI (%)	Rd	+b	CGRD	Area (%)	SFC (%)
Before Sentinel™	1.115	82	78.2	8.1	100% M [31-1 (10), 31-2 (2)]	1.14	8.8
After Sentinel™	1.110	82	79.7	8.2	100% SM [21-1 (3), 21-2 (9)]	0.91	9.3
USDA Average			78.1	7.72	M (31-2)		

Table 6. HVI data for fiber samples from Gin D (2001).

	UHM (inches)	UI (%)	Rd	+b	CGRD	Area (%)	SFC (%)
Before Sentinel™	1.22	83	77.8	9.5	100% SM [21-3 (7), 21-4 (5)]	1.01	7.1
After Sentinel™	1.20	82	79.0	9.5	58% GM [11-4 (7)] 42% SM [21-3 (5)]	0.85	7.9
USDA Average			79.1	8.64	SM (21-1)		

Table 7. AFIS data for fiber samples from Gins A, B, C, and D (2001).

LOCATION	Neps/g	Length (w) (inches)	UQL (w) (inches)	SFC (w) (%)	Total Trash (Cnt/g)	Dust (Cnt/g)	VFM (%)
Gin A							
Before Sentinel™	195	0.955	1.157	8.65	531	434	3.16
After Sentinel™	218	0.955	1.157	8.36	308	276	1.83
Gin B							
Before Sentinel™	140	0.975	1.148	6.55	678	554	3.01
After Sentinel™	174	0.975	1.152	6.40	501	404	2.29
Gin C							
Before Sentinel™	211	0.990	1.197	8.00	701	586	3.03
After Sentinel™	238	0.985	1.195	7.90	484	398	2.05
Gin D							
Before Sentinel™	236	1.045	1.274	7.8	857	734	2.25
After Sentinel™	264	1.034	1.270	8.2	531	452	1.60

Figure 1. The Lummus Sentinel™ Lint Cleaner.

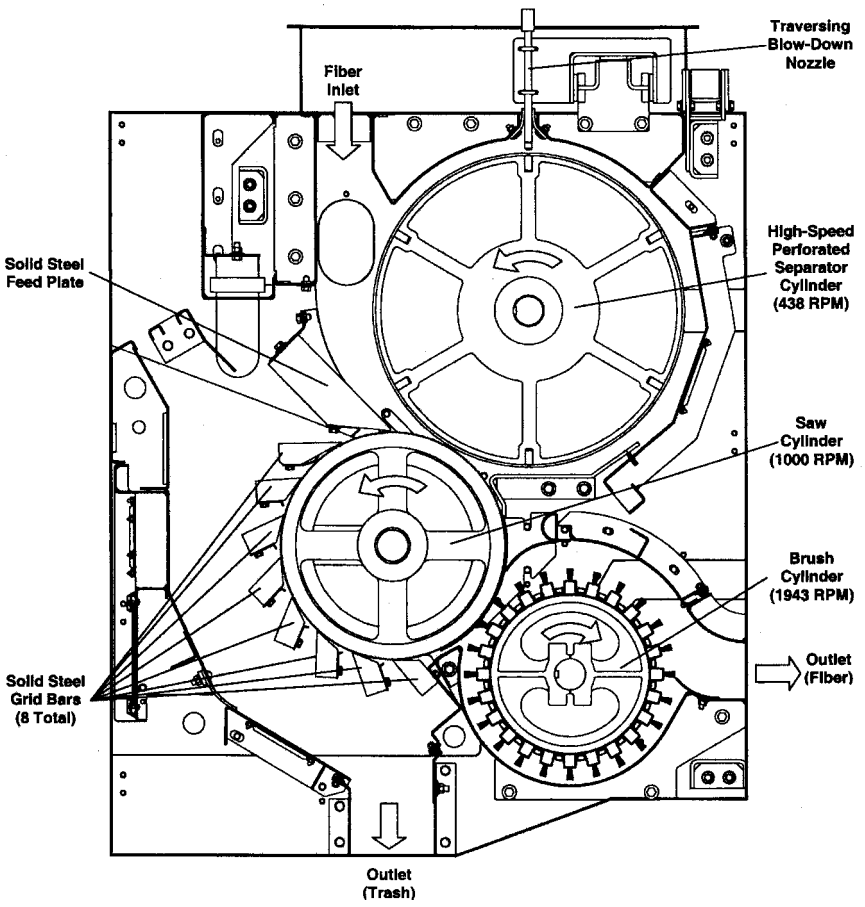

Figure 2. Cross-section of the Lummus Sentinel™ Lint Cleaner.

Figure 3. Sentinel™ Lint Cleaner (left) and Model 108 Lint Cleaner (right) installation at Jones County Cotton Gin.

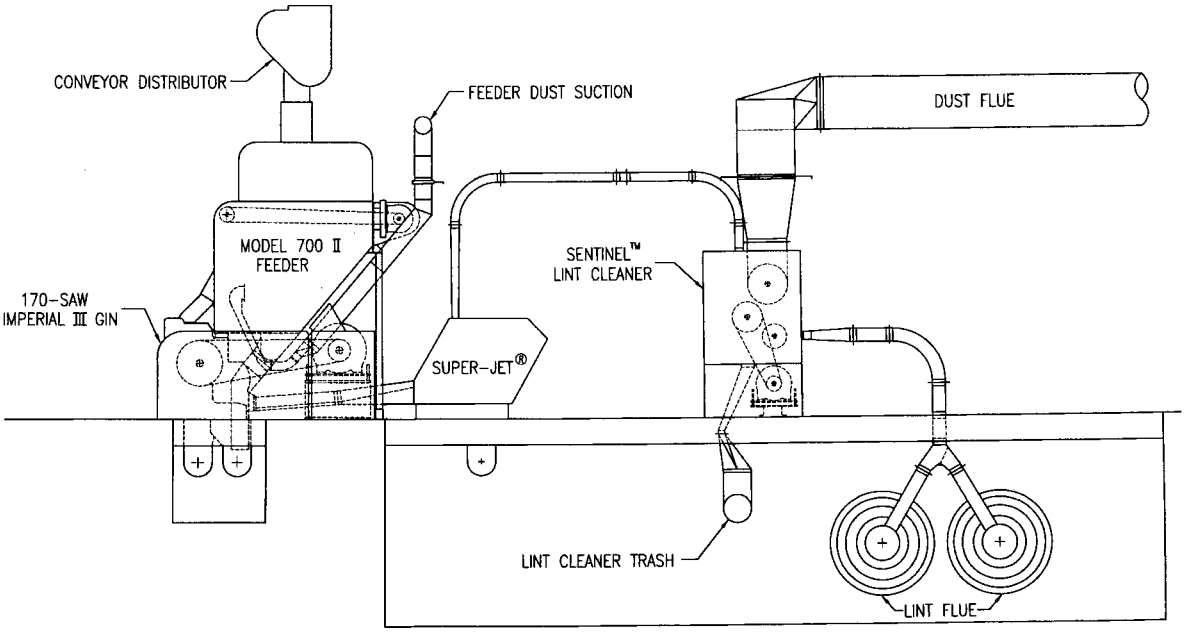

Figure 4. Sentinel™ Lint Cleaner installation at Jones County Cotton Gin, Inc. in Trenton, North Carolina.

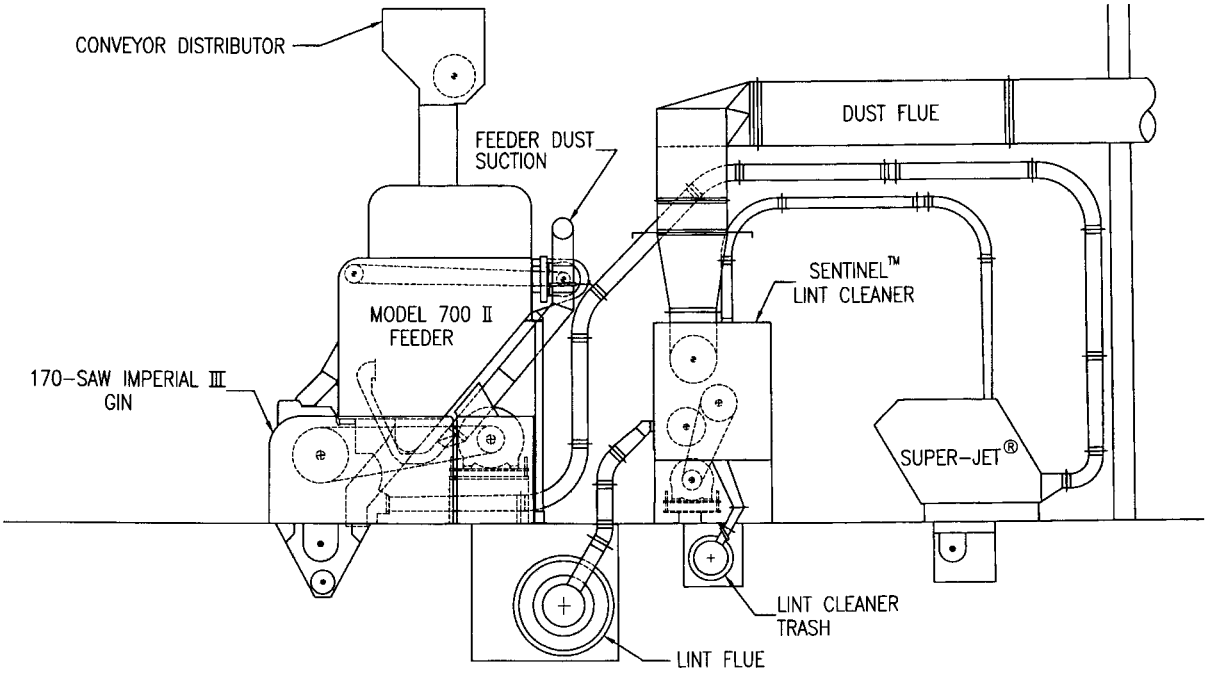

Figure 5. Sentinel™ Lint Cleaner installation at Farmers Gin, Inc. in Buckeye, Arizona.

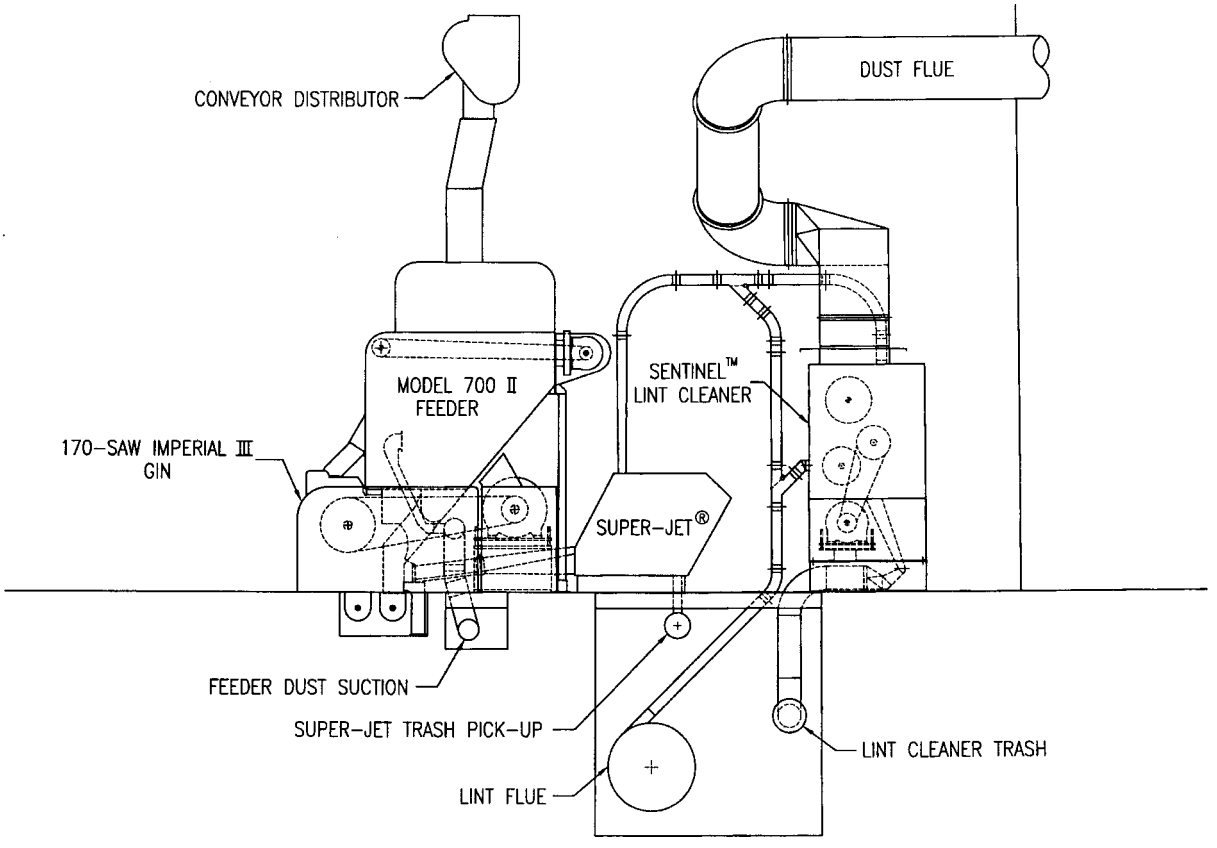

Figure 6. Sentinel™ Lint Cleaner installation at Safford Valley Cotton Growers in Safford, Arizona.

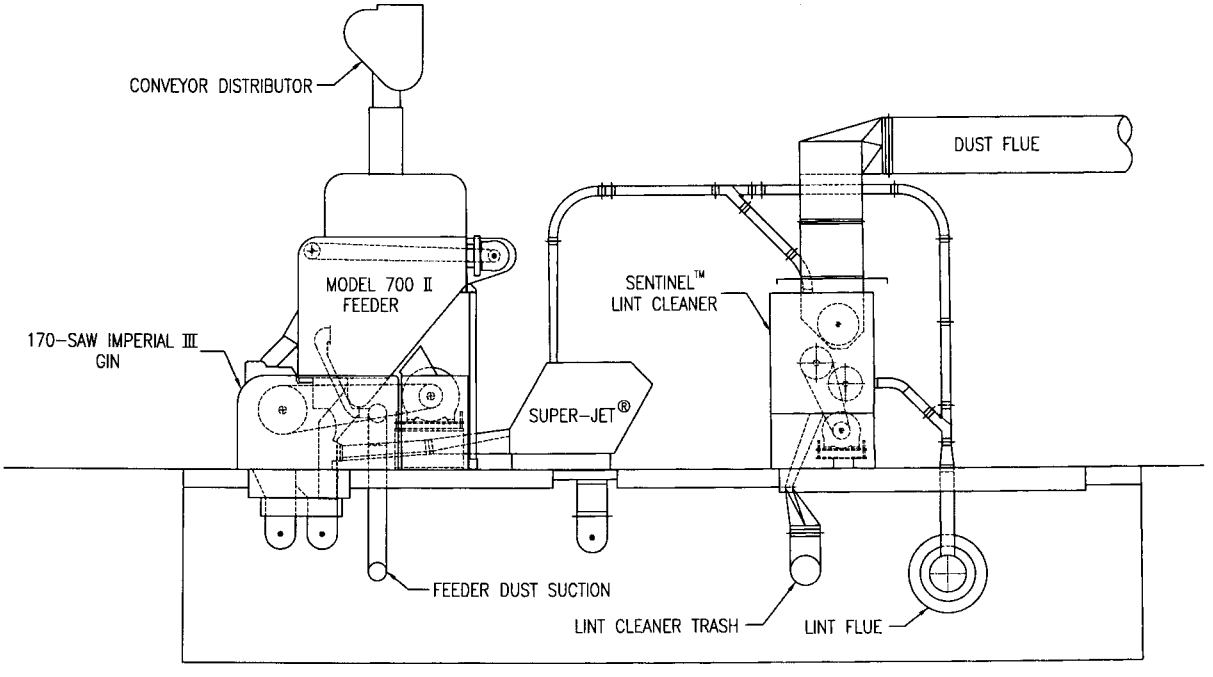

Figure 7. Sentinel™ Lint Cleaner installation at Silver Creek Gin in Holly Bluff, Mississippi.