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ANALYSIS OF THE STRUCTURE AND WORKING PARTS OF SAW GINNING MACHINES

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Abstract:
This paper reviews the structure and function of saw ginning machines and fiber cleaners, focusing on models like 4DP-130 and 8DP-90. It presents technical improvements that enhance fiber quality and ginning efficiency.

Keywords: Saw ginning machine**,** cotton fiber, seed cotton processing, lint, fiber cleaning, gin saw cylinder, grate (kolosnik), collet-type grid, air chamber, trash conveyor, fiber cleaner.

Introduction

Cotton fiber, used as a raw material in the textile and light industries, is essential for producing the highest quality and diverse natural products. Its market price is increasing several times daily on the global market. To fulfill such enormous tasks, the cotton cleaning industry is equipped with various machines and equipment developed based on the latest scientific and technological achievements.

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The productivity of a cotton processing plant is directly linked to the condition of the technological machines and equipment in use. These enterprises own a large number of auxiliary devices and transportation tools to mechanize and automate the extensive operations involved in processing seed cotton. These systems operate under three shifts, at high speeds, in dusty and corrosive environments, and under pressure. All these factors contribute to the wear and tear of machine components, reducing their service life, increasing idle time, and raising repair costs.

With the introduction of progressive technology into production, many high-efficiency machines, aggregates, complexes, and entire technological units are replacing outdated equipment in cotton processing enterprises. Currently, one of the main objectives in preliminary cotton processing technology is to increase lint output by automating saw ginning machines that separate fiber from the seed. In cotton cleaning plants, ginning and linting sections mainly use saw gins such as 3XDDM, DP-130, 8DP-90, 4DP-130, 5DP-130, and DPZ-180 models to separate fiber from seed in medium-staple and specific grades of long-staple cotton with 7–9% moisture content.

Design of Saw Ginning Machines

The construction of saw ginning machines consists of the following working parts:

- Working chamber (fartuk, seed comb, feed board);
- Grate with louvered bars;
- Saw cylinder;
- Lint removal device from saw teeth;
- Seed separator hood;
- Trash conveyor;
- Main base made of cast iron.

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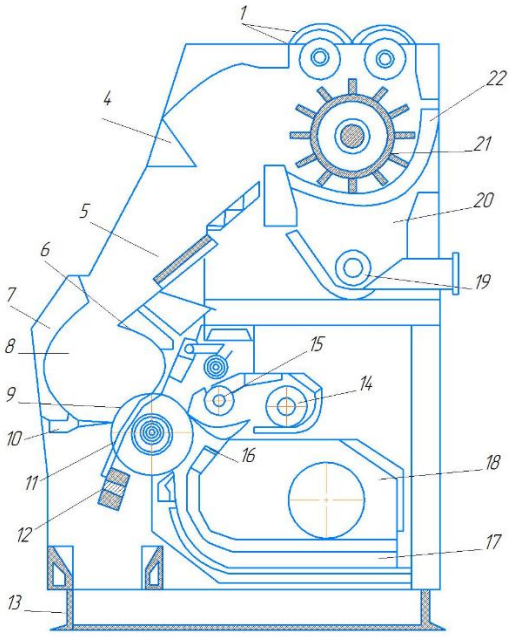

Fig 1: Structure of 4DP-130 Saw Gin

1- Components include feed rollers, 2- spiked drum, 3 - mesh surface, 4 - guide barrier, 5 - magnet, 6 - feed board, 7- front fartuk, 8 - working chamber, 9 - saw cylinder (disc), 10 - seed comb, 11- grate(kolosnik), 12 - lower board, 13 - trash bunker, 14 - screw conveyor for impurities, 15 - discharge system, 16 - Waste transfer screw conveyor, 17 - Nozzle (saplo), 18 - air chamber, 19 - Fiber transfer duct.

Working Principle of 4DP-130 Saw Gin.

The feed drum first opens up the cotton and removes fine impurities, feeding it in the required quantity into the gin. The cotton falls into the working chamber, forming a fiber layer that is captured by the saw teeth and passes through the grate. Since the space between the grates is smaller than the seed size, only the fiber can pass through. The fiber on the saw teeth is separated by air from the air chamber and carried to the next process via a fiber duct. As the fiber passes through the grate, it hits a knife behind the saw which removes trash and debris. These are transported out of the machine via a screw conveyor.

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Table 1 Technical Specifications of 4DP-130 and 5DP-130 Saw Gin Machines

Parameter	4DP-130	5DP-130
Productivity per saw (kg/s)	15.3	15.3
Number of saws on shaft	130	130
Productivity (kg/hour)	2000–2200	2000–2200
Saw diameter (mm)	320	320
Saw cylinder rotation (min^{-1})	730	730
Cross-section area (m^2)	0.13	0.13
Number of saw teeth	280	280
Spacer thickness (mm)	17.05	17.05
Cleaning efficiency (%)	15–30	15–30
Air consumption via nozzle (m^3/s)	up to 0.8	up to 0.8
Static air pressure in chamber (Pa)	up to 2200	up to 2200
Grate spacing (mm)	2.8–3.2	2.8–3.2
Cutting arc length (mm)	240	240
Installed power (kW)	78.3	78.3

Fiber Cleaners

Each fiber cleaner can be divided into one or two lines for each gin. At cotton processing plants, fiber cleaning is mainly carried out using single-stage fiber cleaners. Currently, at cotton processing plants, multi-stage fiber cleaners such as the 1VP and single-stage 1VPU models are being used (Figures 2 and 3) [4].

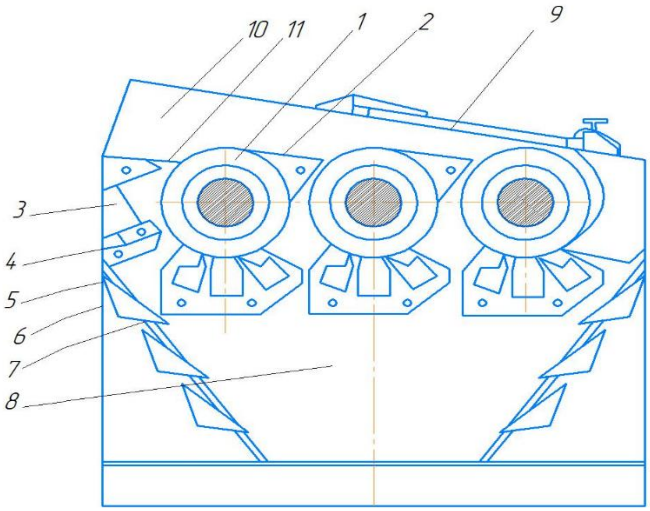

Figure 2. Diagram of the 1VP Fiber Cleaner:
1 – Saw cylinder, 2 – Separator, 3 – Intake duct, 4 - 6 – Straight guiding brush, 5 – Grid with collets, 7 – Louvered grid, 8 – Waste chamber, 9 – Upper cover, 10 – Discharge duct, 11 – Separator knife.

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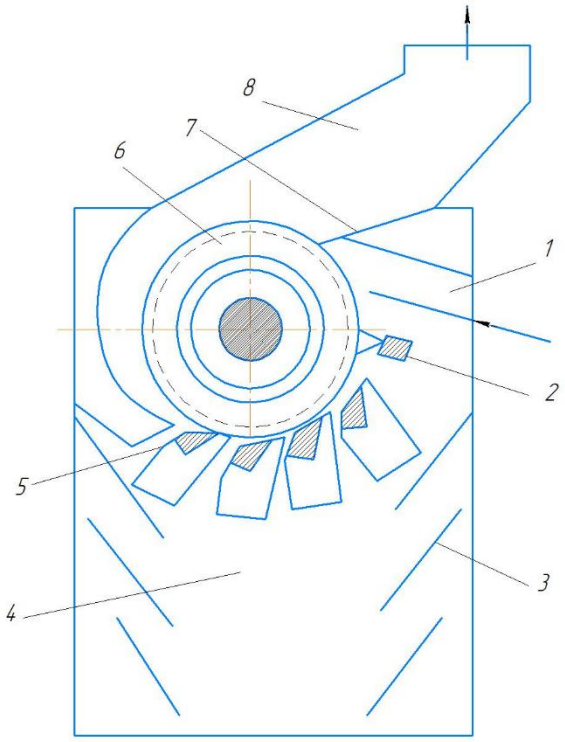

Figure 3. Diagram of the 1VPU Fiber Cleaner:
1 – Intake duct, 2 – Straight guiding brush, 3 – Louvered grid, 4 – Waste chamber, 5 – Grid with collets, 6 – Saw cylinder, 7 – Knife, 8 – Discharge duct

Table 2. Technical Specifications of Fiber Cleaners

Parameter	1VPU	1VP
Productivity (kg/h)	2000	2000
Cleaning efficiency (%)	25–30	30–40
Clean fiber in waste (%)	up to 25	up to 30
Rotor speed (min^{-1})	1450	1450
Saw diameter (mm)	320	320
Number of saws on shaft	231	231
Spacer width (mm)	280	280
Spacer thickness (mm)	6	6
Motor power (kW)	5.5	16.5

At cotton processing plants, lint is separated from the seed in linter machines through multiple passes and at various speeds. Depending on the type and quality of lint required, the following technologies may be applied:

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-Double-pass linting, with intensified linting during the first pass, or
-Double-pass linting, with intensified linting during the second pass [4].

In 2016, researchers at the "Scientific Center of Cotton Industry" JSC developed the 8DP-90 model saw gin with 90 saws (Figure 4). The gin was successfully tested and has since been widely introduced into production. Compared to the existing 130-saw gin, the introduction of the 8DP-90 model has increased productivity per saw by an average of 20–25% across different cotton grades.

For fiber cleaning, the gin is equipped with a grid with collets (kolosnik-type grid) installed at the part of the gin's working chamber, consisting of three collets [5].

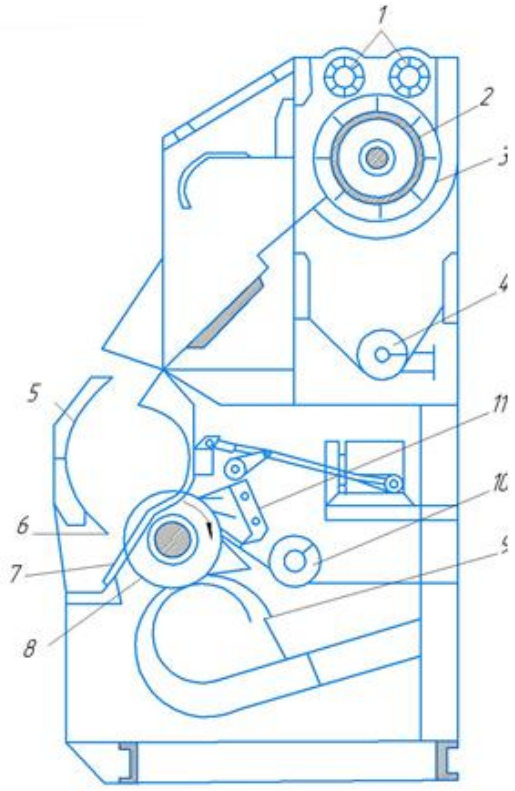

Figure 5. Cross-sectional diagram of the 8DP-90 saw gin:
1 – Feeding rollers, 2 – Spiked drum, 3 – Mesh surface, 4 – Trash auger, 5 – Working chamber, 6 – Seed comb, 7 – Saw cylinder, 8 – Collet, 9 – Air chamber, 10 – Lint auger, 11 – Separator grid with collets.

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In this design, the distance between the collets is 45 mm, and the inclination angle relative to the radius of the saw cylinder is 45°. When cotton is ginned using the 90-saw gin, and the produced fiber is cleaned using the collet grid consisting of three collets, the mass content of defects and impurities in the cleaned fiber averages 3.14%. This indicates an average improvement of 0.21% (absolute) in fiber quality compared to fiber produced using the existing two separate collet-type gins. The fiber cleaning efficiency of the gin is approximately 20.4%, which is on average 4.0% (absolute) higher than that of existing gins. However, despite the higher cleaning efficiency, the system was found to be insufficient in removing fine impurities and lint residue, which led to excessive retention of impurities in the cleaned fiber and consequently a decline in fiber quality.

To evaluate the performance of the cleaning system in the 8DP-90 saw gin, experimental research was conducted under real production conditions. The studies were carried out at a cotton processing plant in Uzbekistan using hand-picked, hard-to-clean S-6524 variety cotton of Grade I and III, Class 2.During the research, the fiber quality was analyzed by installing and removing the three-collet cleaning grid located at the rear of the gin, both for fiber cleaned in the gin and fiber not cleaned in the gin [5].

The above analysis shows that the improvement of disk gin saw technology plays an important role in enhancing the quality of cotton products, increasing productivity, reducing waste, and preventing mechanical damage. The introduction of gin machines based on modern designs contributes to the development of the cotton processing industry.

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