IMPROVEMENT OF FIBER CLEANERS TO REDUCE THE LOSS OF SPINNING FIBER TO WASTE

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Abstract

Based on analytical and experimental studies, a direct-flow single-cylinder fiber cleaner with a horizontal feed of the receiving neck to the saw cylinder was modernized. This allowed the fiber cleaner to maximize the release of foreign impurities, as well as to eliminate the transit of uncleaned fiber to the discharge neck.

Keywords: cotton, fiber, fiber cleaner, working chamber, cleaning effect,
clogging, humidity, defect, litter, fibrous waste.

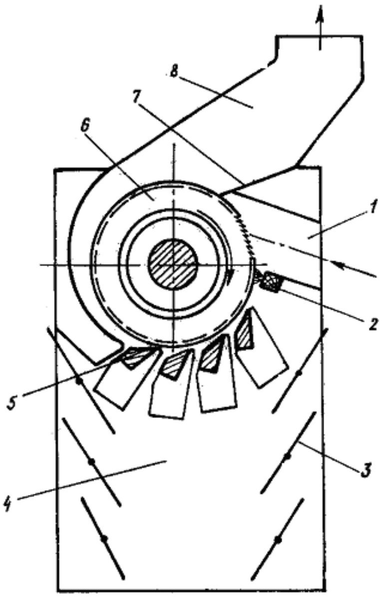
New economic conditions require a constant search for reserves to increase productivity, reduce operating costs, and obtain competitive products.

In this regard, the improvement of raw cotton processing equipment and technology is of current importance, ensuring the production of high-quality fiber, preserving its natural properties, and reducing the loss of spinning fiber as waste [1].

The problem of improving fiber quality remains one of the most important among the primary tasks facing the cotton ginning industry.

Based on this, developments aimed at reducing defects and foreign impurities in the fiber, reducing its losses with waste from process machines, deserve special attention.

The aeromechanical cleaning method, which combines both aerodynamic and mechanical cleaning principles in its design, is accepted in the domestic cotton ginning industry and has been tested over a long period of operation on serial straight-through machines of the 1ВПУ brand (Fig. 1), and has shown its viability [2].



1- receiving neck; 2- lapping brush; 3- louvered grate; 4- carbon monoxide chamber; 5- grate;

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6- saw cylinder; 7- cutting knife; 8- discharge neck.

Fig. 1. Scheme of the fiber cleaner 1ВПУ

It should be noted that the straight-through fiber cleaning principle allows for the creation of a simple-to-design and highly economical machine in terms of power consumption.

The straight-through saw fiber cleaner is an individual type machine designed to operate in combination with a saw gin of existing designs.

Experimental part. To set the tasks in this direction, we will consider scientific and applied developments that, in our opinion, are of interest in the most promising areas for research of a serial fiber cleaner: selection of the optimal direction of the trajectory of feeding the fiber-air mixture to the receiving cylinder, development of a device for fixing the fiber strands on its garniture, separation of the fiber-air mixture in the feed zone and distribution of air flows among the elements of the fiber cleaner, optimal arrangement of the saw cylinders of the fiber cleaner [3].

In this regard, at the first stage of the study it is necessary to study the feed zone of fiber cleaning machines, which determines the efficiency of the equipment.

Analysis of the work showed that one of the reserves for increasing the efficiency of the process is the organization of targeted transportation of fiber and feeding of the fibrous mass to the periphery of the receiving saw cylinder. Considerable attention was paid to the study of the physics of the fiber removal process and its distribution across the cross-section of the fiber removal pipe in the work, where it was established that the fiber strands in the area of the removal device are separated by weight composition, correlating with the content of foreign impurities, and are transported along separate trajectories (Fig. 2) [4].

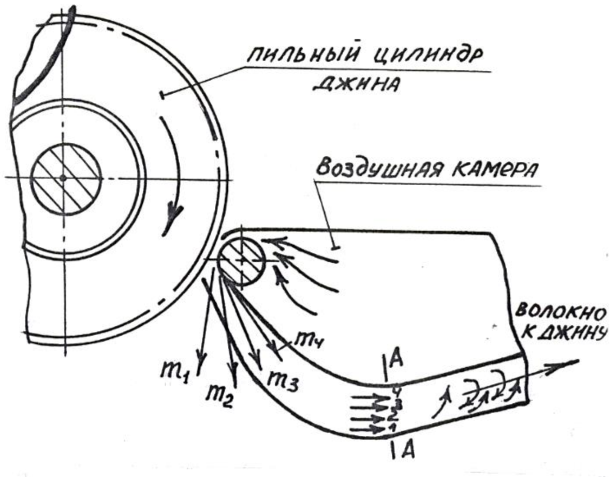


Рис.2. Analysis of the fiber removal process

Thus, the technological situation in the zone under consideration determined satisfactory conditions for the implementation of the fiber cleaning process, where the fiber strand is in a divided state according to the degree of contamination. However, the transport transition from the gin to the fiber cleaner, made in the form of a rectangular pipe, creates a situation of repeated mixing of the separated fractions due to the suction and ejection of air jets along the section of the pipe.

Maintaining the technological situation in the fiber removal zone can be achieved by giving the fiber removal pipe a curved shape with the convexity facing the waste chamber (Fig. 3).

Research conducted in showed that pre-separated fiber scraps in the removal zone, moving to the radius profile of the throat transport channel under the action of mass forces, maintain their trajectory [5].

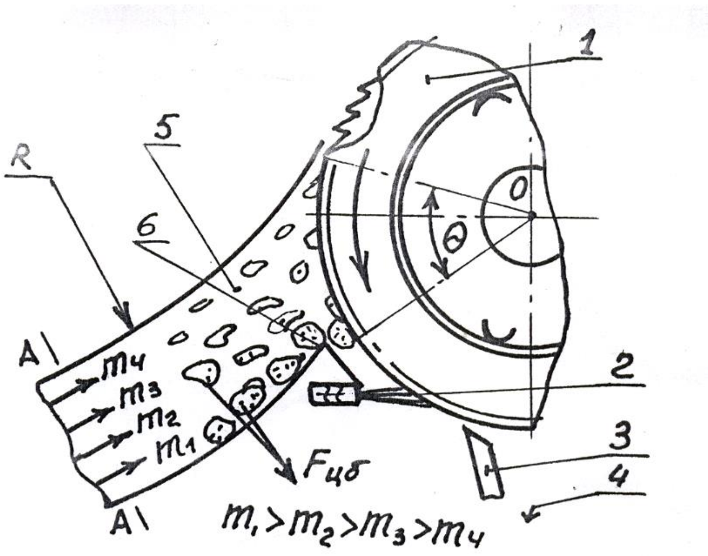


Рис.3. Scheme of the process of separation of fiber particles in a curved pipe during transportation to a fiber cleaner

In this case, additional separation of fiber scraps with varying degrees of contamination occurs, which will be selectively thrown onto the headset of the receiving sector of the saw cylinder, where the more contaminated fraction will be fixed in the lapping brush zone, without mixing with the cleaner fraction, and undergo more effective cleaning.

Preliminary production tests have shown an increase in cleaning efficiency, in comparison with a serial machine, due to a decrease in the content of skin with fiber and broken seeds, as well as an increase in the overall cleaning effect.

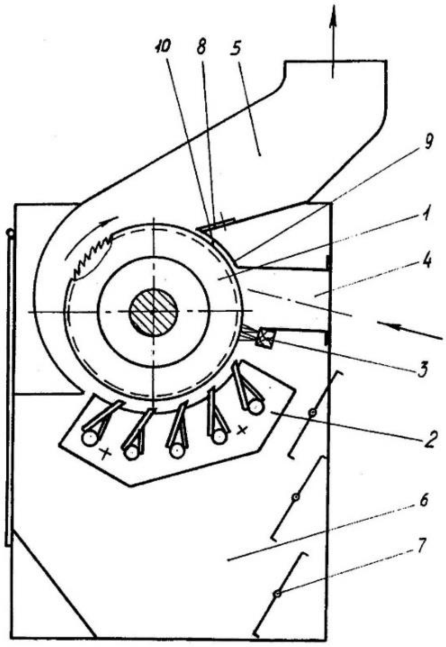
The efficiency of a multi-stage fiber cleaner, like a single-stage one, is significantly affected by a change in static pressure in the carbon monoxide chamber in the grate zone: with an increase in normal pressure by 0.5-0.6 mm water column, fiber blowing into waste increases, and with a decrease in pressure, the cleaning capacity of the machine is significantly reduced [6]. Previously conducted studies have established that the direction of the trajectory of the fiber-air mixture feed to the headband of the receiving saw cylinder correlates with the efficiency of fiber capture and distribution over the surface of the saw cylinder and largely determines the magnitude of the impact pulse during its interaction with the headband of the rotating surface of the cylinder [7].

The most preferable, from the standpoint of ensuring smooth capture of fiber by the headband of the saw cylinder and preserving the natural qualities of the fibrous material, is the tangential feed of the fiber-air mixture to the receiving saw cylinder, with the horizontal supply pipe located below the center of rotation of the cylinder to eliminate the conditions of counter-rotation of the headband and the fiber-air mixture.

This ensures favorable aerodynamic conditions for mixing the incoming air flow with the rotating air layer in the inter-saw space of the receiving cylinder. The unidirectionality of the flow movement eliminates the effect of swirling of the counter-flow and additional air pressure in the supply pipe. As the practice of operating serial fiber cleaners at cotton mills has shown, there is a transit of the original fiber, fed from the inlet pipe to the saw cylinder, and then to the outlet pipe, without cleaning [8].

This leads to a decrease in the efficiency of fiber cleaning and the transit passage of foreign matter and broken seeds together with the uncleaned fiber into the gap between the edge of the cutter knife of the outlet pipe and the periphery of the saw cylinder.

It is possible to eliminate this drawback by installing a guide visor between the cutter knife and the upper edge of the wall of the inlet pipe, forming a channel with the periphery of the saw cylinder, while the length of this channel, during the process, can be 60-120 mm. The proposed scheme of the fiber cleaner is shown in Figure 4 and includes a saw cylinder 1, a grate 2 with a lapping brush 3, inlet 4 and outlet 5 pipes, the axes of which intersect at an acute angle, a carbon monoxide chamber 6 with a louvered grate 7. On the continuation of the lower wall of the outlet pipe 5, with a gap to the saw cylinder 1, a cutting knife 8 is installed, between the cutting knife and the upper edge of the wall of the inlet pipe 4, a guide visor 9 is mounted, forming a channel 10 with the periphery of the saw cylinder.



1- saw cylinder; 2- grate; 3- lapping brush; 4- inlet pipe; 5- outlet pipe; 6- carbon monoxide chamber; 7- louvered grille; 8- cutting knife; 9- guide visor; 10- forming channel.

Рис.4. Scheme of experimental fiber cleaner

The cleaning process technology is implemented as follows. The contaminated fiber, mixed with air, is fed from the gin (not shown in Figure 4) through the branch pipe 4 to the periphery of the saw cylinder 1, is captured by its teeth and secured by the lapping brush 3, and is then cleaned of debris, interacting with the grate 2. Debris impurities fall through the gaps of the grate into the carbon monoxide chamber 6, the aerodynamic mode of operation of which is regulated by the position of the louvered grates 7. The air flow passes into the inter-

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saw space of the cylinder and then, facilitating the removal of the cleaned fiber from the saw teeth, transports it to the discharge branch pipe (the fiber-air mixture is sucked out of the fiber cleaner by a fan through a condenser, not shown in the diagram). The formation of an extended channel 10, guide visor 9, will allow the organization of a counter air flow in this channel by the fittings of the rotating saw cylinder 1, which will practically eliminate the transit passage of part of the air flow together with the clogged fiber from the branch pipe 4 to the branch pipe 5. Preliminary studies have established that the length of channel 10 less than 60 mm reduces the reliability in eliminating the transit passage of uncleaned fiber, and increasing it over 120 mm is not accompanied by an additional positive effect.

Conclusions.

Based on the analytical studies conducted, a single-cylinder fiber cleaner feed zone diagram with a horizontal feed of the feed throat to the saw cylinder was selected. This allows, firstly, to increase the length of the section between the upper edge of the feed throat and the lower edge of the discharge throat and to eliminate the transit passage of uncleaned fiber, and secondly, to maximize the release of foreign impurities.

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