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ANALYSIS OF THE DEVICE DESIGN FOR DISCHARGING HEAVY MIXTURES FROM THE SEDIMENTATION CHAMBER

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Abstract: This article explores the process of continuously discharging heavy mixtures from the working chamber of a sedimentation device. It examines the designs of the relevant mechanisms and highlights their shortcomings. The necessity of conducting future scientific research aimed at improving the efficiency of devices that discharge heavy mixtures from the sedimentation chamber is substantiated

Keywords: line, inlet pipe (diffuser), working chamber, pocket, valve, unloading chamber, plasticine valve, auto-valve, stone collector, outlet pipe.

Introduction. During the processes of cotton harvesting, drying in the field, loading, transportation, storage preparation, and the processing of cotton bolls, various-sized heavy objects often fall into the cotton. These foreign objects enter the working chamber of machines, disrupting the operational process, damaging working components, and reducing the efficiency of the machine. Moreover, heavy objects are a primary cause of fires in cotton ginning factories. Therefore, the issue of separating heavy objects from cotton is of significant importance. Even when the cotton harvesting and storage guidelines are fully followed, the risk of foreign objects contaminating the cotton remains. For this reason, the need for the development of new, efficient stone-catching devices to ensure the long-term operation of the working components of cotton processing machines has increased in recent years.

The operational experience of cotton factories shows that the existing stone-catching devices are insufficient for effectively separating heavy objects from cotton. As a result, various devices created by the workers and engineering staff of cotton ginning factories and preparation points can be seen in these plants. These devices have relatively low efficiency, primarily trapping larger heavy objects, while smaller ones pass through the technological process. Furthermore, the existing stone-catching devices have high aerodynamic resistance, which leads to a sharp decrease in air pressure within the pneumatic transport pipes, causing the stone-catching pockets to become filled with cotton and leading to contamination. Additionally, the stone-catching devices currently in use in factories are not fully automated, and the processes of compressing and cleaning the cotton during transportation have not been properly implemented. Therefore, the task of developing high-efficiency equipment for removing heavy objects from cotton and improving existing systems remains urgent and relevant.

There are many types of stone-catching devices, which not only serve to separate cotton from various contaminants and improve its quality, but also prevent damage to the saw blades during the ginning process caused by stones or metal fragments. As we know, cotton fiber is a highly flammable element. If sparks occur during the process, it can lead to a large fire, potentially destroying the entire factory. This can result in severe damage to the enterprise due to the fire.

To solve the above-mentioned problems, the stone-catching device must operate continuously during working hours and fully meet all the required standards.

II. Discussion. Despite the importance of improving the process of separating heavy contaminants from cotton, no equipment with sufficient efficiency has been developed to date. As a result, several low-efficiency devices that capture heavy contaminants have been incorporated into the cotton processing technological chain. This reduces the productivity of production, limits the range of the transportation process, and leads to a decrease in the quality of the cotton.

The stone-catching efficiency of the 2ChTL series line stone-catcher reaches 60-70%. The first experiments in this area were conducted by the scientist K.M. Qobuljanov [5], who developed the 2ChTL series line stone-catcher (Figure 1).

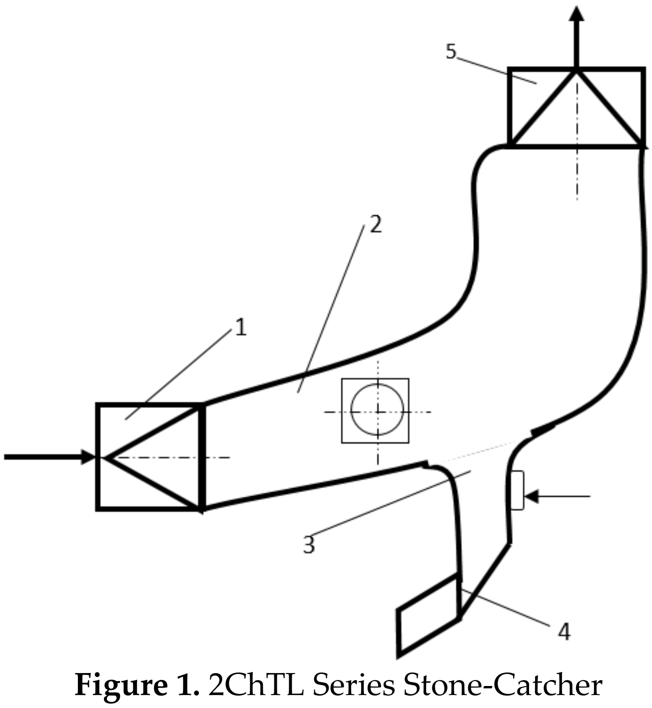

Figure 1. 2ChTL Series Stone-Catcher
1 - Inlet pipe, 2 - Working chamber, 3 - Pocket, 4- Valve, 5 - Outlet pipe.

The heavy contaminants mixed with cotton enter the separation chamber (2) through the pipe (1). Here, the contaminants are separated when they lose speed upon hitting the stationary wall of the stone-catcher, and their separation occurs due to the simultaneous expansion of the cross-sectional area of the air passage. The heavy contaminants fall into the unloading chamber (3), and when the plasticine valve (4) of the device opens, they are discharged. The cotton is then expelled from the stone-catcher through the outlet pipe (5) and directed to the subsequent transportation system.

The cotton, separated from heavy contaminants, continues its movement in the airflow. This design is the result of efforts aimed at creating line stone-catchers with various structures.

The stone-catcher device created by the scientist T.D. Mahametov (Figure 2).

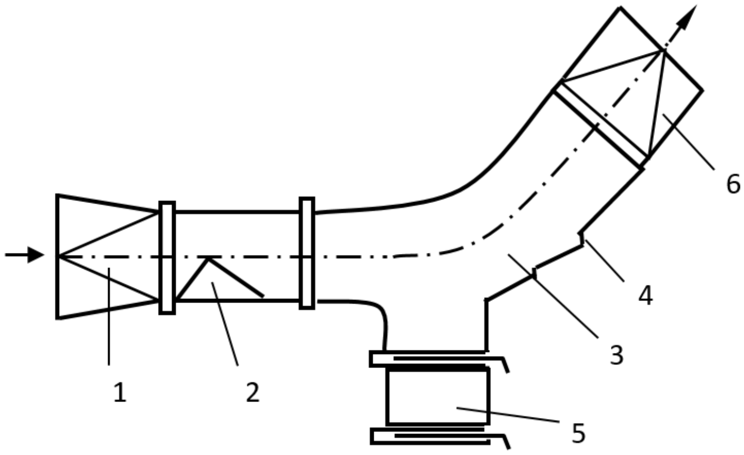

Figure 2. Stone-Catcher

1 - Inlet pipe (diffuser), 2 - Cone-shaped splitter, 3 - Separation chamber, 4 - Ladder-shaped deflector, 5 - Pocket, 6 - Outlet pipe

Heavy objects and foreign contaminants mixed with cotton move through the pneumatic pipe and enter the inlet pipe (diffuser) (1), where they pass through the cone-shaped splitter (2) located at the bottom. The cotton pieces are agitated, and then they enter the separation chamber (3). In the separation chamber, as the cross-sectional area expands, the speed of the cotton decreases, leading to the separation of heavy contaminants from the cotton. The ladder-shaped deflectors (4) are designed in such a way that heavy contaminants, when hitting them, change their direction toward the pocket. The separated heavy contaminants fall into the pocket (5) and are discharged, while the cotton pieces separated from the heavy contaminants continue their movement in the airflow through the outlet pipe (6) [1].

The next cleaning device, also proposed by Professors R.M. Murodov and O.Sh. Sarimsakov, is a cotton cleaning device for separating heavy contaminants (Figure 3), and it operates as follows.

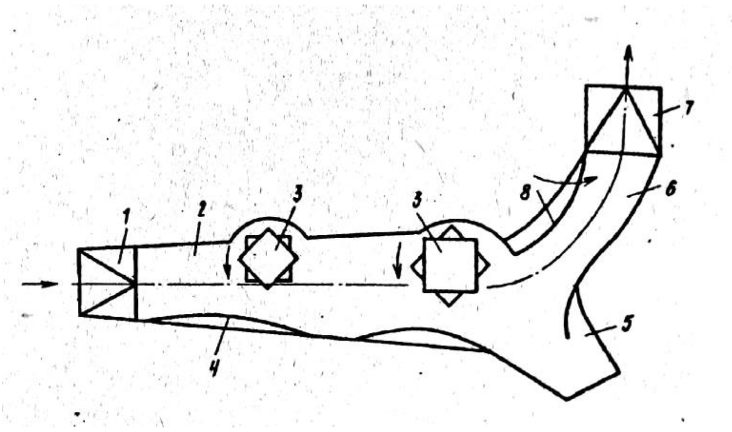

Figure 3. Cotton Separation Device for Heavy Contaminants
1 - Inlet pipe (diffuser), 2 - Separation chamber, 3 - Acceleration drums, 4 - V-shaped deflectors, 5 - Stone collector, 7 - Outlet pipe, 8 – Hinge

The cotton raw material moves through the air duct and enters the separation chamber (2) via the device's inlet pipe (diffuser). The separation chamber contains acceleration drums (3) made of square elastic plates that are mounted along the longitudinal axis, shifted 45° from the symmetry axis. Below each drum, i.e., on the lower wall of the separation chamber, there are V-shaped deflectors (4). As the cross-sectional area of the working chamber gradually increases, the speed of the moving cotton decreases, and the raw material moves toward the lower part of the separation chamber. The V-shaped deflectors direct the cotton towards the acceleration drums, causing the raw material to be agitated and leading to the separation of heavy contaminants. The separated heavy contaminants fall into the stone collector (5) and are discharged. The cleaned cotton then moves to the next process through the outlet pipe (7). A hinge (8) is installed on the upper part of the chamber to adjust and modify the passing section of the chamber [3,6,7].

According to Professor R. Murodov, one of the main drawbacks of the stone-catchers used in cotton cleaning plants is the accumulation of a certain amount of cotton in the pockets during operation. This issue can be observed when inspecting three types of stone-catchers installed in the conveying system using air in the technological process of cotton processing. The first stone-catcher is installed before the drying drum, the second in the cleaning section, and the third is installed between the cleaning and ginning linting sections.

It is recommended to manually remove the cotton mixed with heavy contaminants from the stone collector and return it to the conveying system pipe using air. However, in some cases, the cotton there gets mixed with various contaminants, increasing its impurity, and it becomes impossible to separate them by hand. For this reason, the above recommendation is often ignored in many factories, and the cotton is sent to waste.

The amount of cotton in the waste collected in the stone-catcher pocket is significantly lower, being two times less than in the first one. In addition to heavy objects, the stone-catcher bunker also contains other contaminants (such as underdeveloped bolls and others) besides cotton.

This stone-catcher has rubber components installed in its pockets, which occupy a large part of the pocket's cross-sectional area. (Figure 4).

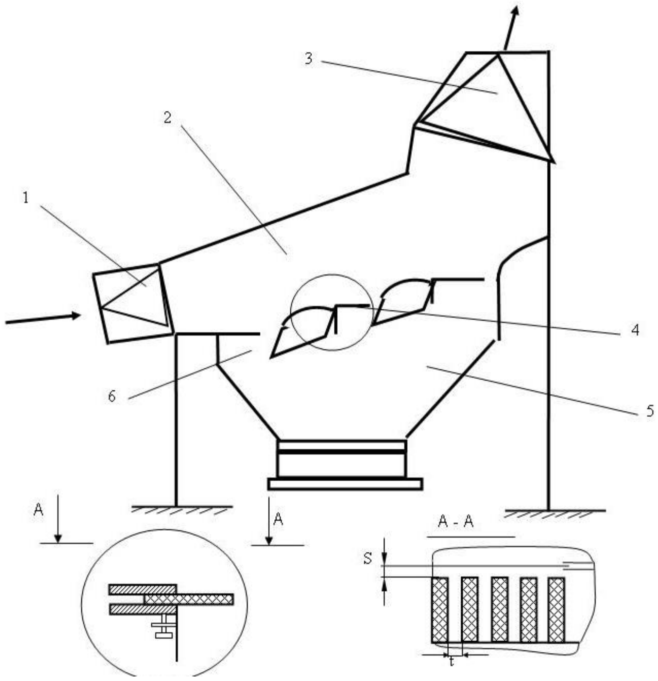

Figure 4. Installation of rubber deflectors in the pockets. M.G. No. 1747546

1 - Inlet pipe; 2 - Separation chamber; 3 - Outlet pipe; 4 - Rubber deflector; 5 - Stone collector; 6 – Pocket

When rubber deflectors are installed in the pockets, the stone-catcher operates as follows. The cotton enters the separation chamber (2) through the inlet pipe (1) with the help of the air flow. Heavy contaminants fall onto the surface of the rubber deflector (4) installed in the pocket (6) along with some cotton pieces. Due to the bending of the rubber deflector, the heavy contaminants fall down into the stone collector (5). The cotton, meanwhile, is directed to the next process through the outlet pipe (3), blending with the main mass in the separation chamber. [3,4]

This device serves to automatically discharge large, heavy contaminants from the cotton air ducts without the need for manual effort during transportation.

Currently, in the existing transport systems of cotton cleaning plants, two sluice devices are used to discharge the heavy contaminants mentioned earlier. The operator, in order to remove the heavy contaminants, opens the first sluice, lets them drop into the second sluice, then closes the first sluice again. Afterward, the second sluice is opened, and the heavy contaminants are discharged.

When the conveying system operates with air, the stone-catcher pockets become filled with heavy contaminants, causing a disruption in the timely opening of the sluices. As a result, heavy contaminants pass through the stone-catcher without being separated.

In the new device, the above-mentioned shortcomings are eliminated. There is no need for the operator to open the sluices sequentially. This is because, during the operation of the system, the heavy contaminants are automatically separated. Workers do not need to spend time separating the heavy contaminants. As a result, they can fully focus on controlling other processes in the system.

The device does not require electrical energy consumption. Its design is very simple, and complex manufacturing processes are not required for its production. To facilitate repairs, many parts are designed to be easily replaceable, and standard materials are used. Installing it in the current production system does not require excessive costs. The moving parts of the device are prepared to operate under varying load conditions over a long period.

Operating principle of the device: Once the heavy objects in the system accumulate in the stone collector and reach a certain weight, the corresponding discharge valve opens simultaneously under the effect of the load. As a result, the upper valve is directed downward.

When the load bunker is fully emptied, the upper valve returns to its position under the influence of the load. During the operation, the lower valve remains closed, ensuring that the system's hermetic condition is not disturbed.

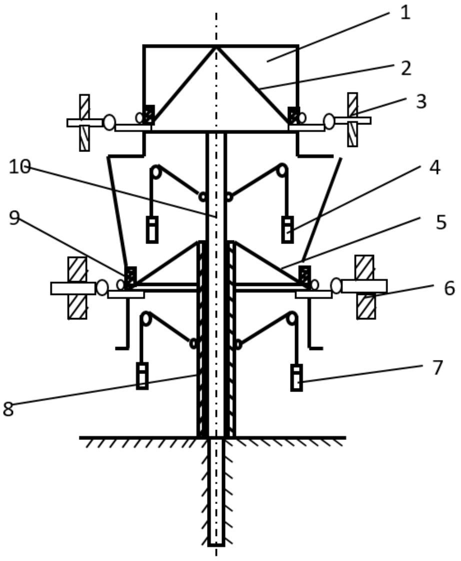

Figure 5. Auto-valve diagram

1 – Body; 2-5 – Valves; 3 - Upper valve discharge load; 4 - Upper valve return load; 6 -Lower valve discharge load; 7 - Lower valve return load; 8 - Lower valve deflector; 9 - Sealing rubber; 10 - Upper valve deflector

The discharge load of the lower valve corresponds to several cycles of the upper valve. Once the weight of the waste in the bunker exceeds the discharge load of the valve, the load overcomes the discharge weight of the valve, and the valve moves downward, allowing the waste to exit the system completely. During the operation of the lower valve, since the upper valve remains closed, the hermetic integrity of the system is maintained. After the waste has been fully discharged, the return load of the valve returns it to its original position, and the cycle is considered complete.

In previous devices, the failure to open the sluice in a timely manner by the operators caused heavy contaminants to pass through without being separated, leading them to enter the subsequent cleaning and ginning machines. In the proposed auto-valve, these issues have been addressed, and the possibility of heavy contaminants, accumulated in the pockets, being automatically separated and discharged without the involvement of operators has been created.

III. Conclusion. Upon reviewing the works of scholars and based on the research conducted above, it can be concluded that by considering all the characteristics of cotton raw materials, the process of harvesting, placing on the field, storing, and transferring to the production technological process ensures the preservation of its natural properties. Furthermore, the continuous operation of the technological process is directly related to the effective separation of heavy contaminants from the cotton's composition.

Currently, in cotton cleaning factories, the low efficiency of cotton cleaning machines designed to separate heavy contaminants from the raw cotton causes these contaminants to pass into the subsequent technological process, negatively affecting the continuous operation of the process. Additionally, despite the improvements in cotton cleaning machines, the incomplete automation of these devices, as well as the unresolved issues with trapping fine impurities during the cotton transportation process, are still significant challenges. To address these shortcomings, it is necessary to conduct scientific research on the improvement of devices that continuously discharge heavy contaminants from the cotton composition.

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