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EFFECT OF THE FORCES ON THE SEPARATION OF FIBER FLOW FROM THE SAW IN AN IMPROVED LOWER FIBER REMOVAL DEVICE

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Abstract: In the article is presented an analysis of a fiber bottom stripping device in the cotton gin industry that allows increased airflow rate, consumes less air and improves the efficiency of stripping fibers from saw teeth of the saw cylinder. The effects of forces in isolating the fiber stream from the saw have been studied.

Keywords: saw gin, fiber stripping device, air consumption, air velocity, force effect.

Introduction. Stripping the fiber from the saw teeth is done using a rotating brush drum or an air stream supplied from the slit to the saw cylinder. In air-assisted fiber separators, active airflow creates a vacuum in the fiber stripping zone, removing the fiber from the saw teeth and directing it to the receiving tube. The static pressure in the air chamber is almost equal to the dynamic pressure on the outer edge of the slit. The efficiency of the air stripping device will depend on the width of the slit, the flow rate of the active current, the time of contact of the saw teeth with the Working current, the length and curvature of the guide part, the discharge coefficient, the shape and location of the transmission pipes to the fiber intake and fiber cleaner [1-3].

The bottom fiber stripping device of the 5DP-130 saw cotton cleaner is known. This construction of the lower fiber stripping device has a housing, an air chamber mounted on it, a triangular visor, a guide pipe with a round cross section and a receiving pipe . In this case, the space between the guide pipe and the surface of the saw cylinder is at an angle of 52° with respect to the horizontal axis of the saw cylinder [4-7].

The disadvantage of this construction is the high air consumption and loss of speed due to the triangular shape of the visor, as well as the coverage of the space between the surfaces of the pipe and the saw cylinder by the forced air at a large angle. In addition, the airspeed decreases due to an increase in the space formed between the outer surface of the saw and the grate, which reduces the efficiency of removing fibers from the saw teeth.

The closest to the proposed saw gin's bottom fiber stripper, which includes a body, an air chamber mounted on it, a visor, a guide tube, and a receiving tube. The visor is in the shape of a circular part, while the guide pipe is made with rectangular protrusions with a height of h=2.0-4.0 mm, with rounded edges [8].

The disadvantages of this construction are instability to vibrations and structural unreliability due to the reduction of the live cross section of the guide pipe, as a result of which the gaps between the guide pipe, visor and saw are not constant. In addition, a decrease in air pressure in the fiber transmission pipe caused by a decrease in air consumption due to a 12-25% contraction of the gap was not taken into account, which leads to a sharp decrease in productivity and frequent clogging of the saw gin.

The aim of the study is to increase the productivity of the saw gin by increasing the efficiency of fiber removal from the teeth of the saw cylinder and reducing the energy consumption for the fiber removal process.

The fiber stripping device is illustrated with drawings, where Figure 1 gives the overall scheme of the device, Figure 2 gives the A-a cut in Figure 1, Figure 3 gives the B-B cut in Figure 1, and Figure 4 gives the 3D image of the air hammer construction.

The device consists of a body 1 (gin body) with a spiral-shaped air chamber 2 mounted inside, which contains a comb-shaped air hammer with air ducts 3, a guidance cylinder 4, a receiving pipe 5, and a fiber transmission pipe 6 , which connects jin to a fiber cleaner 9.

The device works as follows. Under a certain pressure from the fan (not shown in the picture), air flow is sent through the pipes to the air chamber 2 and smoothly narrows along the surface of the spiral shape of the chamber, through the holes of the soplo, through the middle of the surfaces of the guide cylinder 4 and the SAWS of the saw cylinder 7.he device works as follows. Under a certain pressure from the fan (not shown in the picture), air flow is sent through the pipes to the air chamber 2 and smoothly narrows along the surface of the spiral shape of the chamber, through the holes of the soplo, through the middle of the surfaces of the guide cylinder 4 and the SAWS of the saw cylinder 7. According to the design of the air nozzle, the cross-sectional area of each saw blade of the saw cylinder 8 is 50 mm 2, and individual channels are formed in the amount equal to the number of saw blades. In this case, the air acting on the fibers captured by the 8-saw 7 teeth of the saw cylinder at a certain speed directs them 5 to the receiving pipe.n this case, the air acting on the fibers captured by the 8-saw 7 teeth of the saw cylinder at a certain speed directs them 5 to the receiving pipe. It should be noted that an air nozzle with separate channels for each saw leads to a decrease in the volume of space by 40-45%, which significantly increases the air speed comb shape directs the effect of air flow directly to the saw teeth , which increases the efficiency of removing fibers from the teeth of the saw cylinder. The fiber is then transported through the fiber transfer pipe 6 and enters the fiber cleaner 9.

Improved fiber recovery device for saw gin. The improved construction allows to increase the velocity of airflow in the workplace and consumes less air and increases the efficiency of removing fibers from the saw teeth of the saw cylinder.

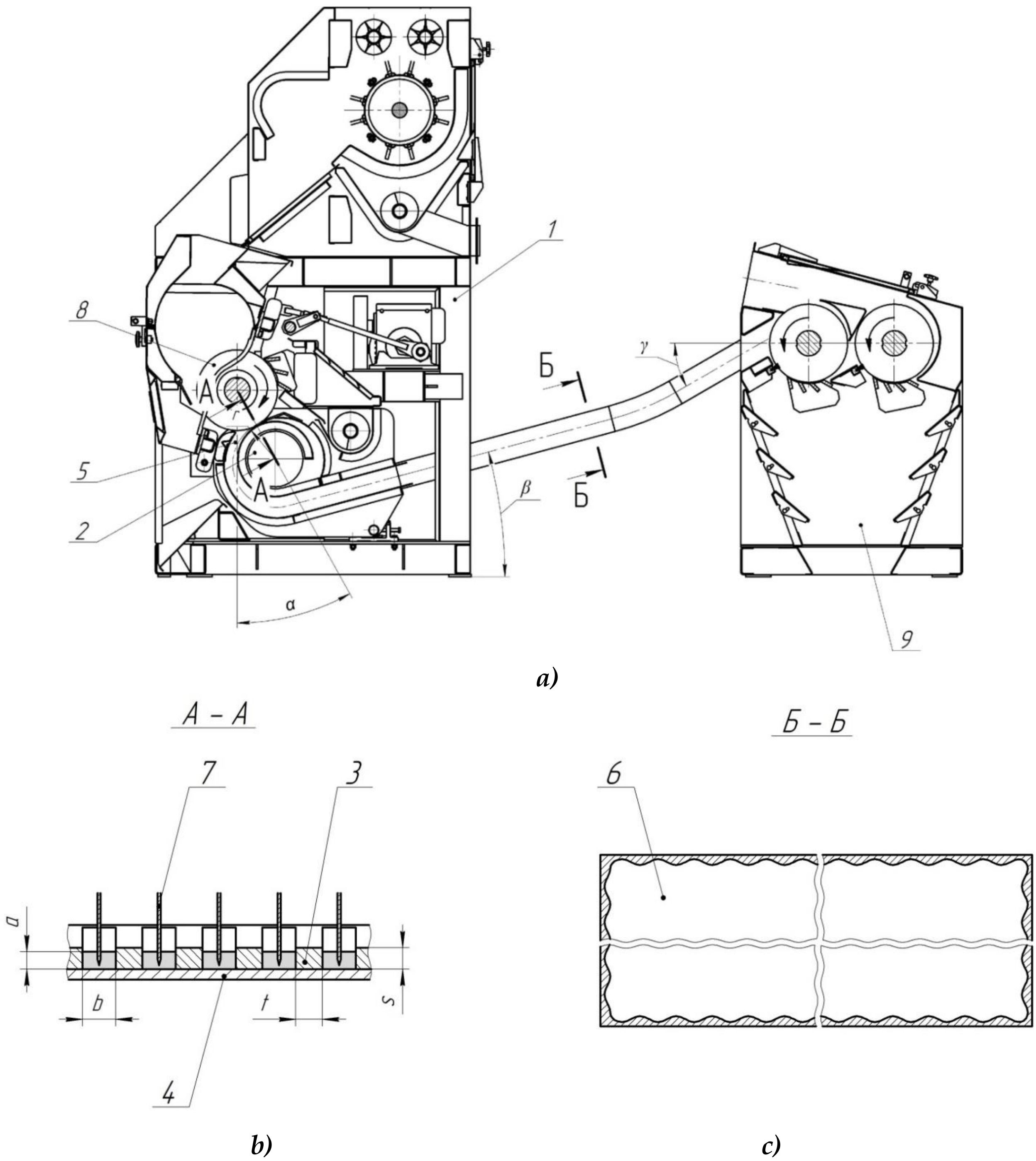

Fig.1. Improved fiber recovery device for saw gin
a) overview of aggregate; b) air nozzle;
c) transmission pipe to fiber cleaning machine

Analysis of effect of the forces on the separation of fiber flow. We is constructed the differential equation of motion along the OY axis under the influence of forces that separate the flow of fibers from the saw.

$$m\ddot{y} = F_{m.q} + mg\cdot\cos\alpha \tag{1}$$

We is defined the second-order non-homogeneous differential equation (1) as homogeneous and private solutions, the following external forces are formed when the fibers are exposed to the saw teeth. $F_{m.q}$ - centrifugal force, mg - weight force. $F_{m.q} = m\cdot\omega^2\cdot l;$ ω - angular velocity of saw blade; l - length of saw tooth; m- mass of fibers.

$$m\cdot\ddot{y} = -m\cdot\omega^2\cdot l + m\cdot g\cdot\cos\alpha \tag{2}$$

Dividing both sides of the expression (2) by the mass m.

$$\ddot{y} = -\omega^2\cdot l + g\cdot\cos\alpha \tag{3}$$

Substituted the expression (3) into the above expression $\vartheta = \omega\cdot l \Rightarrow \omega = \frac{\vartheta}{l} = \frac{\dot{y}}{l}$

$$\ddot{y} + \frac{1}{l}\cdot\dot{y}^2 = g\cdot\cos\alpha \tag{4}$$

Calculating the homogeneous part of $\ddot{y} = \frac{d(\dot{y})^2}{dt}\cdot\frac{2dy}{2dy} = \frac{d(\dot{y})}{2dt}$ using this definition from the homogeneous part of the expression (3).

$$\frac{d(\dot{y})^2}{dt} + \frac{1}{l}\cdot\dot{y}^2 = 0 \tag{5}$$

Calculating the homogeneous part of the solution of equation (5) by defining $\dot{y}^2 = z$.

$\frac{dz}{2dt} - \frac{1}{l}\cdot z = 0 \Rightarrow \frac{dz}{2dt} - \frac{1}{l}\cdot z = 0 \Rightarrow \frac{dz}{z} = \frac{2}{l}\cdot dt$ this expression differentiates.

$$\ln z = \frac{2}{l}\cdot t \Rightarrow \ z = e^{\frac{2}{l}\cdot t}\cdot C_1 \tag{6}$$

by placing $\dot{y}^2 = z$ on the expression we represent the movement of wool fibers affected by the vibrating roller on the *OY* axis.

Using $\dot{y}^2 = e^{\frac{2}{l}\cdot t}\cdot C_1 \Rightarrow \dot{y} = e^{\frac{t}{l}}\cdot C_1 \Rightarrow y = l\cdot e^{\frac{t}{l}}\cdot C_1$ initial condition, we determine the constant value of *S1*. $C_1 = \frac{l_0}{l}$ is equivalent to $(y)_{t=0} = l_0$

$$y_1 = l_0\cdot e^{\frac{t}{l}} \tag{7}$$

We look for a particular solution to the expression in the following form

$$y_2 = A\cdot t + B \tag{8}$$

Results of analysis. We find the constants by taking derivatives of this expression and substituting them into the equation (4).

$$\dot{y}_2 = A;\ \ddot{y}_2 = 0$$

$$\frac{1}{l} \cdot A^2 = g \cdot \cos\alpha \tag{9}$$

By equating the coefficients of this equation, we can determine the values of A and B.

$$A = \sqrt{g \cdot l \cdot \cos\alpha} \tag{10}$$

We substitute the values determined from the system of equations (10) into the equation (8) and determine the particular solution.

$$y_2 = \sqrt{g \cdot l \cdot \cos\alpha} \cdot t \tag{11}$$

We determine the general equation of the trajectory of the fibers moving along the axis OY of the saw blade.

$$y = y_1 + y_2 = l_0 \cdot e^{\frac{t}{l}} + \sqrt{g \cdot l \cdot \cos\alpha} \cdot t \tag{12}$$

Expression (12) describes the movement of the saw teeth along the OY axis under the influence of the fiber flow. The analysis of this expression is presented in graphs using the Maple program (Fig.2 and Fig.3). The following parameter values are given in the calculation: $y,(см)$

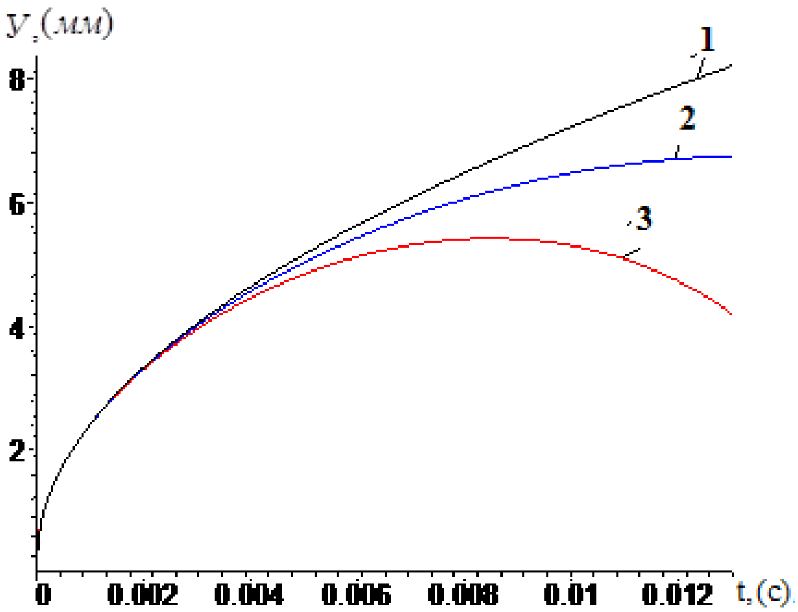

Fig. 2. A time-dependent graph of the angle of inclination of the air tube pointing on the lunar axis at different values $\alpha_1 = 27^0; \alpha_2 = 29^0; \alpha_3 = 31^0$ when extracting fibers from the saw teeth

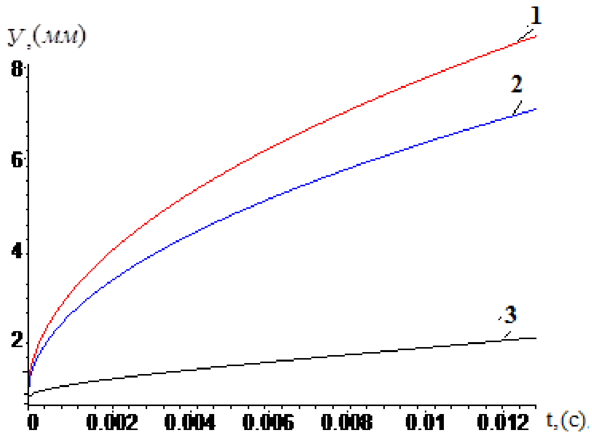

Fig. 3. Time-dependent graph of directional air velocities on the lunar axis at different values $\vartheta_1 = 75 м/с; \vartheta_2 = 80 м/с; \vartheta_3 = 85 м/с$ when extracting fibers from Saw teeth

Conclusion: The trajectory of movement of the fibers separated from the Saw teeth on the OU axis is given. When separating the fibers, it has been found that the directional velocity in the transmission to the pipe under the influence of the directional air flow changes the fibers in time at the value of $\alpha_1 = 27^0$; the angle of deviation of the directional air pipe at the value of $\vartheta_1 = 75 м/с$.

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