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Machine Unit with a Drive Mechanism for Paired Staking Cylinders of Cotton Cleaner 1XKM-12

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ABSTRACT: The article presents a constructional scheme and the principal operation of a fibrous material cleaner from fine litter through twelve consecutive cylinders with a stake. Based on the decision of problems of dynamics of machine aggregates purifier taking into account the mechanical characteristics of the motors, the elastic-dissipative properties of the elastic transmission delay and processing loads from cleaning fibrous material the regularities of change of angular velocity and their irregularities. A part from it, the loading level of gear system is formed graphical dependence of parameters, which was proved the best parameter values of the cleaner of fibrous material. The positive effect of cleaning the fibrous material based on the results of comparative production experiments of the recommended machine is presented.

KEY WORDS: Fibrous material, Fine Litter, Feeder, Staking Cylinder, Mesh, Dynamics, Moment, Elasticity, Dissipation, Effect, Test.

I.INTRODUCTION

In seriate cleaners 1XK, which raw cotton is fed to the last cylinder in the row rotating the raw cotton around itself from the top to the bottom on the perforated grids located below them and under the next cylinders in the row, after which the cylinders transport the raw cotton through these grids and the last cylinder in the course unloads it from the cleaner [1,2,3]. The main drawback of this method is that its usage does not ensure the achievement of a potentially high cleaning effect of the cleaner, which mainly depends on the number of impulsive impacts of cylinders on raw cotton-the more impulsive impacts, the more loosened raw cotton and the smaller impurities are released through the holes of perforated nets. As a result, while using this method, the cleaning effect of the cleaner is limited and the number of cylinders used in it, the increase of which is not advisable for constructive and project reasons. Therefore, in order to provide the required total cleaning effect, in the technological process of cleaning raw cotton, which leads to an increase in energy consumption and costs for their repair and maintenance. In addition, to cleaners from large litter, several cleaners of raw cotton from fine litter are consistently included [4,5]. Thus, the aim of the research is to improve the method of cleaning, to increase cleaning efficiency with cleaner of raw cotton from small litter, to promote productivity and reliable operation, reduce energy consumption of a cleaner and the integrated equipment.

New constructional scheme of the 1XKM-12 cleaner

The scheme of the cleaner using a sophisticated method of cleaning raw cotton is shown in fig. 1.

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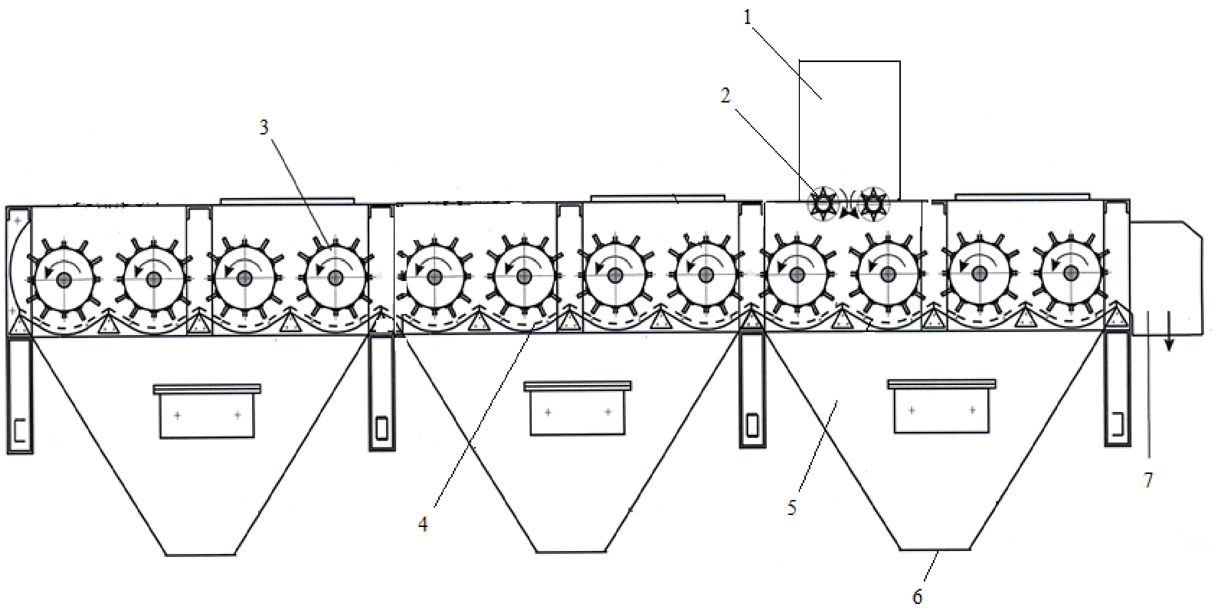

1-mine, 2-feed rollers, 3-stake cylinders, 4-perforated nets, 5-weed bins, 6-discharge hole for weed impurities, 7-discharge tray for raw cotton.

Fig.1. Scheme of improved design of the raw cotton cleaner from small weed impurities 1XKM-12

This scheme shows a cleaner containing twelve loosening cylinders 3, with perforated grids, 4 located below them, feeding rollers 2, three bunkers 5, and a shaft 1. This cleaner differs from the seriate cleaner only in the location of the feed rollers 2 above the ripping cylinders 3, installed three cylinders from the edge of the cylinder. The cleaner works as follow.

Raw cotton is fed by feeding rollers 2 to the ripping cylinders 3, which is carrying over it above them in the direction of the rightmost cylinder 3, which moves the raw cotton from the top to the bottom on the perforated grids 4. Then all the other cylinders 3 are carried over the raw cotton through the perforated grids 4 in the direction of the leftmost cylinder and then to the shaft 1, through which the raw cotton is discharged from the cleaner. When transporting raw cotton with loosening cylinders 3, weeds are separated from it, mainly small ones, which are released by air flows through holes in the perforated grids 4 in the hopper 5 and through holes 6 in their lower part are released from the cleaner [6].

II. RESEARCH METHODS

Formulating a dynamic and mathematical model of the movement of the working parts of the cleaner

The 1XKM-12 cotton cleaner contains a feeder and 12 stake cylinders with heat-removing grids under them. Rotational movement of the feed rollers and stake cylinders are obtained from six identical asynchronous motors of the 4A112M643 brand, with P=3.0 kW, n=945 rpm and belt drives. Gear ratio for staking cylinders U_d=2.25. Then, n_c=420 rpm, ω_c=43.96 s^{-1}.

Paired staking cylinders (from the third to twelve) receive rotational motion from an asynchronous motor. In this case, the system consists of a three-mass system with two branches (fig.1). The load of variator and feed rollers on the first two pegboard cylinders will be even greater than on the other two adjacent cylinders of the cleaner.

During the operation, the 1XKM-12 cleaner allows the necessary loosening and cleaning of raw cotton from fine litter. The task of the research included finding the law of variation of unevenness stake cylinders, feed rollers and rotor of

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the induction motor and changes in torque on the shafts taking into account the moments of inertia of the working parts, elastic-dissipative characteristics of belt drives and load from cleaned raw cotton in various performance of machine.

In the process of cleaning raw cotton from fine litter from the 5th to the 12th, the peg cylinders experience loads with a decreasing regularity, since the resistance to the peg cylinders also decreases with increasing looseness of the cotton. For fig.3 the loading diagram of the 1 KM-12 cleaner's peaking cylinders is presented.

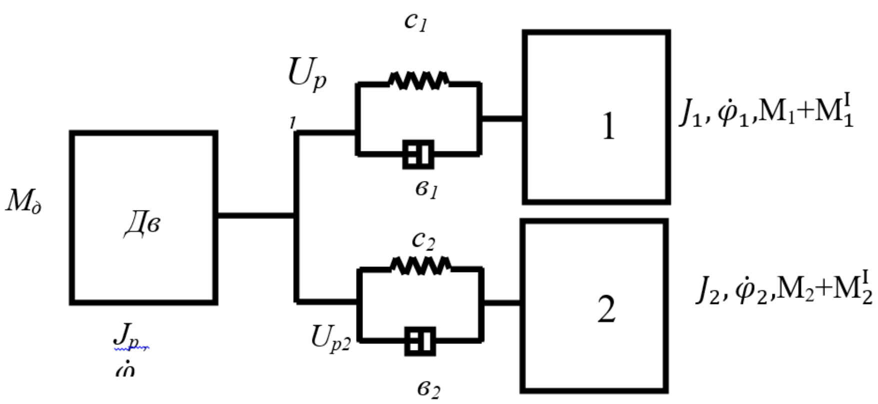
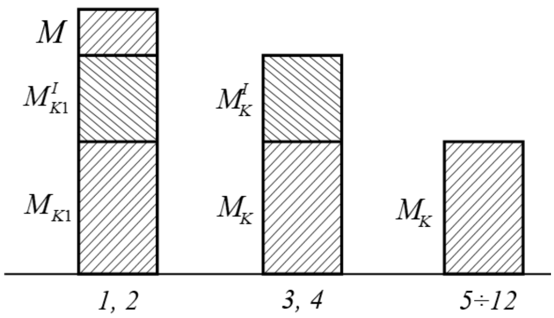


Fig.2. Constructional scheme of the machine unit with the drive of the staking cylinders of the 1XKM-12 cleaner.

Analysis of the histogram in fig.3 shows that in the first two staking cylinders operates the moments of resistance of cotton, M_{K1}^{I} - from transportable cotton from the top of the stake cylinders, M_{K1} - from drags, cotton stake reels on mesh surfaces, M_n - by reducing the angular velocity of the reels due to the resistance from the power consumption of the CVT and the supply rollers. At the same time, only loads are applied to the next 3, 4 stake cylinders, M_{K2} and M_{K2}^{I}, only moments of resistance from the cotton being dragged along the mesh surfaces are applied to the stake cylinders 5÷12.



Numbers of staking cylinders
Fig .3. Histogram of loading of the cotton cleaner's staking cylinders 1XKM-12

The equations of motion were made using Lagrange equations of the second kind, taking into account the mechanical dynamic characteristics of the engine, elastic – dissipative and inertial characteristics, as well as technological loads from cotton:

$$\dot{M}_{\partial} = 2M_K\omega_c - 2M_\kappa \cdot \rho \cdot \dot{\varphi}_p - \omega_c S_K M_\partial$$

$$J_p \cdot \ddot{\varphi}_p = M_\partial - c_1 \cdot \left(\varphi_p - u_{p1} \cdot \varphi_1\right) - \textit{в}_1 \cdot \left(\dot{\varphi}_p - u_{p1} \cdot \dot{\varphi}_1\right) - c_2 \cdot \left(\varphi_p - u_{p2} \cdot \varphi_2\right) - \textit{в}_2 \cdot \left(\dot{\varphi}_p - u_{p2} \cdot \dot{\varphi}_2\right);$$

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$$J_1 \cdot \ddot{\varphi}_1 = c_1 U_{p1} \cdot \left(\varphi_p - u_{p1} \cdot \varphi_1\right) + в_1 \cdot \left(\dot{\varphi}_p - u_{p1} \cdot \dot{\varphi}_1\right) - M_1 - M_1^I;$$
$$J_2 \cdot \ddot{\varphi}_2 = c_2 U_{p2} \cdot \left(\varphi_p - u_{p2} \cdot \varphi_2\right) + в_2 \cdot \left(\dot{\varphi}_p - u_{p2} \cdot \dot{\varphi}_2\right) - M_2 - M_2^{II}. \quad (1)$$

where, M_g, M_K – the moment on the shaft of an asynchronous motor and its critical value; $\dot{\varphi}_p, \dot{\varphi}_1, \dot{\varphi}_2$ – angular velocities of the motor rotor and the pegboard cylinders; J_p, J_1, J_2 – moments of inertia of the rotor and the pegboard cylinders; $C_1, C_2, в_1, в_2$ – coefficients of circular stiffness and belt transmission dissipation; U_{p1}, U_{p2} – belt transmission ratios; M_1, M_1^I, M_2, M_2^I – moments of technological resistances.

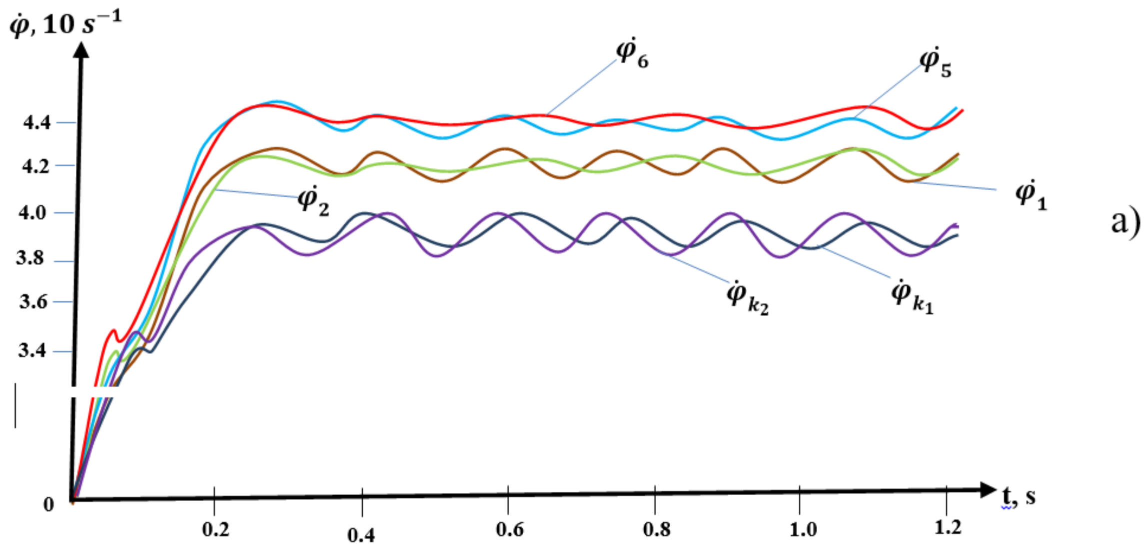
III. RESULTS AND DISCUSSION

The solution of the system of equations (1) produced by the following initial conditions: $t = 0;\ \dot{\varphi}_p = 0;\ \dot{\varphi}_{K1} = 0;\ \dot{\varphi}_{K2} = 0;\ \dot{\varphi}_1 = 0;\ \dot{\varphi}_2 = 0;\ M_x = 0;\ M_K = 0.$

The following parameters of the machine unit are taken into account: engine 4А112МА6У3, P=3.0 kW, n=945 rpm, f_c=50 Hz, cosφ=0.86; ω_0=157.1 s^{-1}; η=0.83;ω_K=98.91 s^{-1}; S_H=0.052; S_K=0.193; P=2; $U_{p1}=U_{p2}$=2.25; U_{23}=2.5; U_{34}=8.4; U_{45}=1.0; J_P=0.117 kgm^2; J_1=2.91 kgm^2; J_2=2.91 kgm^2; C_1=(200÷250) Nm/rad; C_2=(220÷260) Nm/rad; C_3=(160÷180) Nm/rad; B_1=(4.0÷6.0) Nm·s/rad; B_2=(4.5÷6.5) Nm·s/rad; B_3=(3.5÷4.0) Nm·s/rad.

On the bases of numerical solution of problems (1) and (2) regularities of change of angular velocity staking cylinders, rotor of the electric motor, loading motor, which is shown in fig.4.

Changes and obtained $\dot{\varphi}_1$ and $\dot{\varphi}_2$ by the solution of system (1) taking into account the fact that the equations of the system are excluded M_1^I, M_2^I, is, at the same time, the resistance forces from the cotton pulling on the mesh surfaces only act on the stake cylinders from the 5th to the 12th. Analysis of the obtained dependencies of the angular velocities of the pegboard cylinders according to Fig.5 shows that with increasing productivity, the values of angular velocity fluctuations increase, and their average values decrease accordingly. Based on the processing of the obtained laws of motion with variations in performance, stiffness coefficients of belt drives, graphical dependencies $M_\partial, \dot{\varphi}_p, \dot{\varphi}_{K1}, \dot{\varphi}_{K2}, \dot{\varphi}_1, \dot{\varphi}_2, \dot{\varphi}_5, \dot{\varphi}_6, \delta, \Delta\dot{\varphi}$ are constructed, which are presented in fig. 5, 6.



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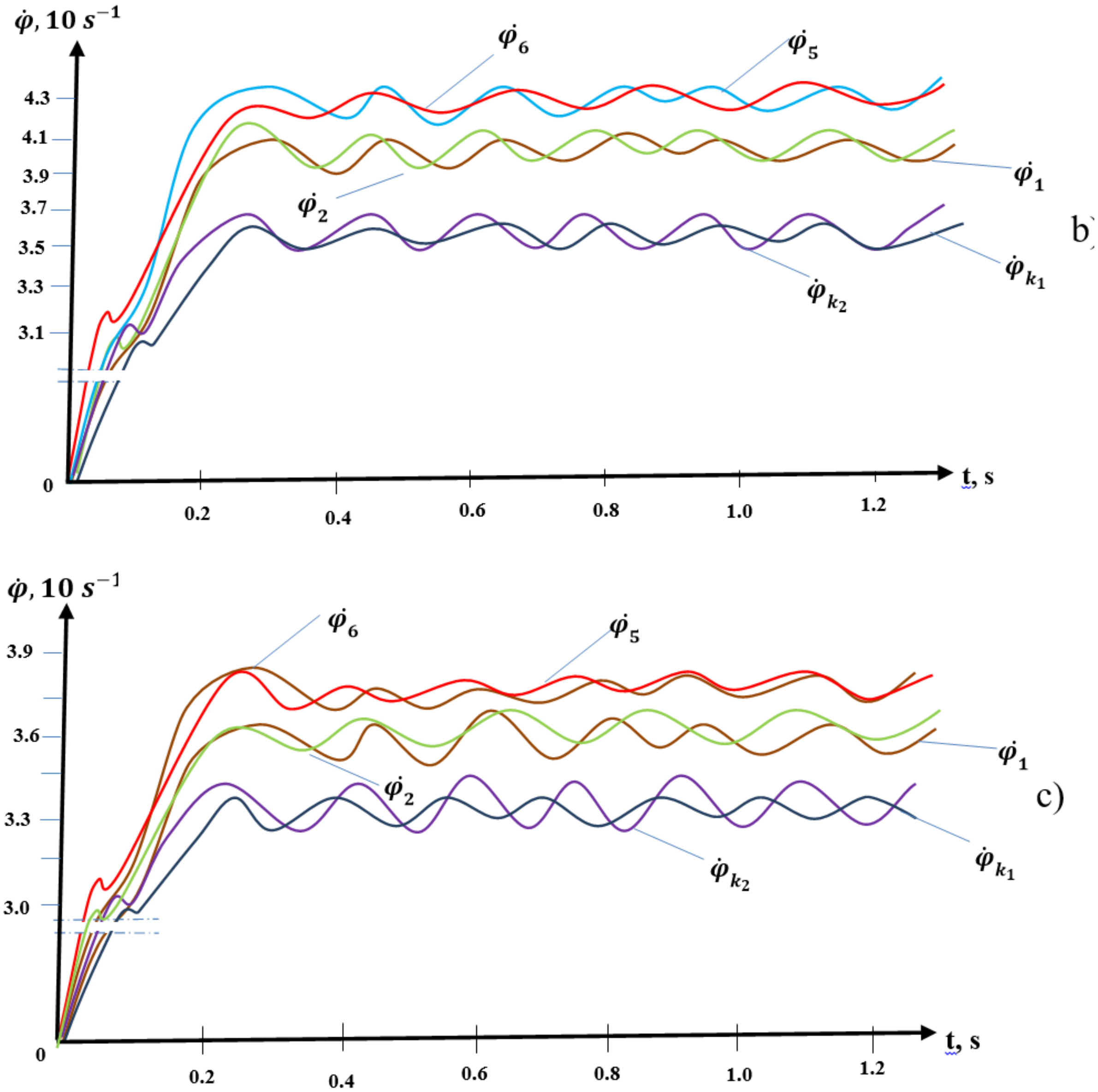

a-at n_p=5.5 t/h; b-at n_p=7.0 t/h; c-at n_p=8.5 t/h.
Fig.4. Regularities of changes in the angular velocities of the peeled cylinders of the raw cotton cleaner 1XKM-12

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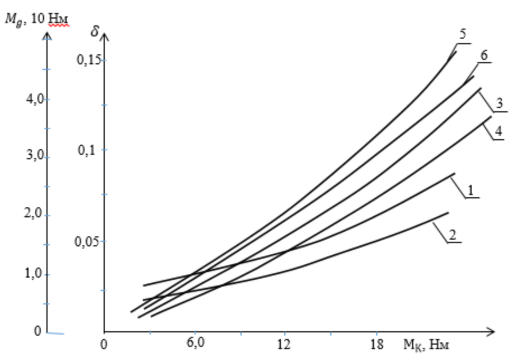
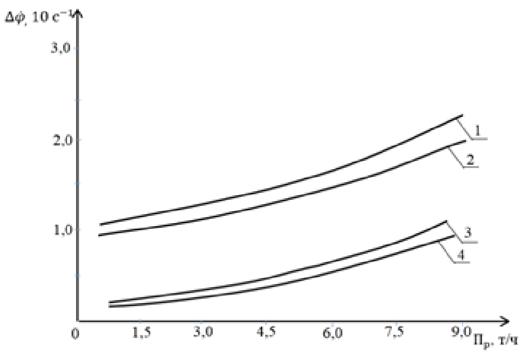


where, 1-$\dot{\varphi}_1 = f(\Pi_p)$; 2-$\dot{\varphi}_2 = f(\Pi_p)$; 3-$\dot{\varphi}_5 = f(\Pi_p)$; 4-$\dot{\varphi}_6 = f(\Pi_p)$;

Fig.5. Dependence of changes in the angular speeds of the staking cylinders on changes in the performance of the cleaner 1 XKM-12.



where, 1-$\dot{\varphi}_1 = f(\Pi_p)$; 2-$\dot{\varphi}_2 = f(\Pi_p)$; 3-$\dot{\varphi}_5 = f(\Pi_p)$; 4-$\dot{\varphi}_6 = f(\Pi_p)$;

Fig.6. The dependence of the change in the angular speeds of the staking cylinders on the change in the performance of the cleaner 1XKM-12.

Fig.5 presents a graphical representation of the dependence of the change in the average values of the angular velocities of the staking cylinders on the increase in productivity. At the same time, the subsequent staking cylinders (the third and fourth) experience resistance, both from transporting cotton and from dragging it along the mesh surface. Given the difference of resistance from the cotton $\dot{\varphi}_{3cp}$ decreases from 41.3 s^{-1} to 35.25 s^{-1}, and the $\dot{\varphi}_{4cp}$ will be at (0.5÷0.85) s^{-1} will be more than in the previous staking cylinder. A similar pattern is observed for the 5th to 12th in staking cylinders. Nevertheless, the loads will only be from dragging the cotton along the mesh surface and on average the angular velocity is reduced from 43.6 s^{-1} to 39.7 s^{-1} (see fig. 7, curves 1,2,3,4,5,6). As it can be seen from the analysis of the regularities of changes in the average values of the stake cylinders, each subsequent stake cylinder will rotate at a lower angular speed due to the decreasing load. Therefore, the cleaner actually provides reliable operation and eliminates the faces that occur in the main one in existing machines. At the same time, in order to ensure reliable operation and maintain a high cleaning effect with high performance of the cleaner, it is advisable to reduce the moments of inertia of the staking cylinders as much as possible.

On fig.6 graphical dependences of the variation in the range of angular velocity fluctuations of the staking cylinders on the increase in the productivity of the 1XKM-12 cotton cleaner are presented. The higher the performance, the greater the range of angular velocity fluctuations the patterns will be nonlinear. It should be noted that the range of angular speeds of the cylinders decreases as the cotton is dragged, since the loads in the subsequent cylinders are leveled (see fig.8, curves 5,6).

An increase in the torsion stiffness of the belt drive leads to a decrease in the angular velocity fluctuations according to a non-linear pattern. The higher the performance, the greater the range of oscillations of the angular speeds of the cylinders, and the regularities will be nonlinear. It should be noted that the range of angular speeds of the cylinders decreases as the cotton is dragged, since the loads in the subsequent cylinders are aligned (see fig.6, curves 3,4).

It is important to note that an increase in c_1 and c_2 leads to an increaseM_d, according to a nonlinear pattern. Thus, the torque on the engine shaft increases from 15.7 Nm to 35.3 Nm, and the average torque on the shaft of the fifth ring cylinder increases from 2,=.8 Nm to 8.1 Nm. When transporting and hauling cotton with prick cylinders, the range of fluctuations in their angular velocities will be large due to the corresponding resistances from the cotton. In the beginning, the cotton will be less loosened and then the cotton will be more loosened. Therefore, the rigidity of the belt drives should be reduced in the course of dragging the cotton and the recommended values are: C_1 = (220÷250) Nm/rad; C_2=(270÷330) Nm/rad; C_3=(180÷200) Nm/rad.

In the drive of the first three pairs of staking cylinders, three belts should be installed in parallel and in the next three pairs of staking cylinders, two belts should be installed. Accordingly, the power of the first three electric motors is

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recommended to choose 3.0 kW, and the next three electric motors with a power of 2.2 kW, providing the required modes of movement of the staking cylinders and the necessary effect of cleaning cotton from fine litter. At the same time, the resource of the machine increases to 20 %, and the power consumption is reduced to (5.0÷5.5) kW.

Results of production experiments of the 1XKM-12 cleaner

Production experiments of the recommended fibrous material cleaner 1XKM-12 were conducted in parallel with the seriate versions of the 1XKM machine. During the experiments, the performance of the developed raw cotton cleaner from fine litter, equipped with twelve staking cylinders, with the performance of the control cleaner, that is, the existing raw cotton cleaner from fine litter were compared.

Table: Comparative indicators of the test results of the car 1 XKM-12

The variants of the experiments the	Conditions of experiments	Moisture content of cotton, %	The impuries of cotton, %	Cleaning efficiency, %		Increasing in seed damage, %
				General	on fine litter	
Serial cleaner	1-grade of manual picking	8,6	4,4	45,4	56,1	0,22
	2-grade of manual picking	8,9	5,2	46,7	61,2	0,23
	3-grade of manual picking	8,8	6,7	48,4	64,1	0,22
	5-grade of manual picking	9,3	9,5	49,7	62,8	0,25
The recommended sample of the cotton cleaner from fine litter	1-grade of manual picking	8,6	4,4	55,2	63,8	0,21
	2-grade of manual picking	8,9	5,2	56,8	69,3	0,22
	3-grade of manual picking	8,8	6,7	58,3	72,3	0,2
	5-grade of manual picking	9,3	9,5	60,0	73,4	0,23

Analysis of the results shown in table 1 shows that the efficiency of cotton cleaning increases on average by (10÷11) % relative to the production machine. In this case, the cleaning effect of fine litter increases to (8.0÷10) % relative to the existing fine litter cleaner.

It should be noted that the increase in damage will be less in the recommended machine by (0.1÷0.15) % relative to the serial version. Moreover, with the effect of cleaners for low grades of cotton will also be important by (9.0÷10) % relative to the production machine.

IV. CONCLUSIONS

An effective construction scheme for a fiber material cleaner from fine litter has been developed. Based on the decision of problems of dynamics of machine units' cleaner taking into account the mechanical characteristics of the motors, the elastic-dissipative properties of the elastic transmission delay and processing loads from cleaned fiber material the regularities of change of angular velocity, their irregularity and loading drive built graphical dependence of parameters, proved the best parameter values of the cleaner fibrous material.

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Vol. 7, Issue 5 , May 2020

REFERENCES

[1]. Djuraev A., Radjabov O. I., Omonov M. I. Improving the technology and construction of the working parts of the cotton cleaner from fine litter. Monograph.Ed. "Science and technology", Tashkent, 2020, 152 p.
[2]. Djuraev A., Mavlonov O., daliev sh. Development of structures and methods for calculating the parameters of staking cylinders. Monograph.Ed. LAP LAMBERT, Academic Publishing, 2016, 134 p.
[3]. Djuraev A., B. Turdaliyev, Balametov A., Kholturaev H. Construction and calculation methods for parameters of wavering grids. Monograph.Ed. LAP LAMBERT, Academic Publishing, 2016, 157 PP.
[4]. Kuliyev T. M., Choriev sh. N., Juraev A., Rajapov O. I. Cleaning section of the cotton cleaning unit. IAP patent 2019 0522. 2019.
[5]. Djuraev A., Maksudov R, Theory of mechanisms and machines. Textbook, part II, ed., "Science and technology", Tashkent, 2019, 500 p.
[6]. Djuraev A., Olimov O. T., Abrorov A. S., Anvarov O. M. Dynamics of vibrating working parts of raw cotton cleaners. Monograph.Ed. "Science" UBR.Races'.Tashkent, 2003, 192 p. Rajabov 7.Rajabov O. Analysis of the interaction of Fibrous Material with a Multifaceted Grid of the cleaner.Scopus. International journal of recent technology and engineering (IJRTE) ISSN: 2277-3878, Volume-8, Issue-1, May 2019.
[7]. Djuraev A., Rajabov O. Experimental study of the interaction of multifaceted and cylindrical spinky cylinder in cotton cleaner from small waste. Scopus.International journal of advanced research science.Engineering and technology. Volume-6, Issue-3, March 2019, p. 8382-8387.
[8]. Djuraev A.,Yunusov S.Z., Normatov E.A. Analysis of the surface of the aralias double plastic consolidated collector. Scopus.International journal of advanced research science.Engineering and technology. Volume-5, Issue-12, December 2018, p. 7578-7582.