ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 12 , December 2020

Vibratory Method of Harvesting Raw Cotton

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ABSTRACT*:* This work presents the results of theoretical investigations with the aim to determinate input parameters for synthesis of transmission gear for the vibrator of cotton bushes in a non-spindle cotton harvester of the latest design. The main aim of work is the test of the process of action of vibrator's force choice of rational analysis and ground of its main parameters. The non-spindle cotton harvester separates the cotton from cotton brush with gear for the vibrator. To define input parameters the process of an action of the disturbing vibration forces on the parts of cotton shrub was investigated. In process of investigation of the vibration in working organ of the vibration and low part of cotton shrub input parameters determined.

KEYWORDS: harvesting raw cotton, machine, vibrations, disturbing forces, frequency, amplitude.

I. INTRODUCTION

A lot of works have been devoted to the study of horizontal and vertical spindle cotton pickers [1.2]. However, serial cotton-picking machines with spindle-type harvesting machines do not fully meet agronomic requirements.

Under the guidance of Honored Scientist of Uzbekistan Zakirov G.Sh.Research work is underway to find new methods for harvesting open cotton, providing the required quantitative and qualitative indicators.

A method for cleaning cotton-based complex prefecture exposure perturbing forces: vibration ionization, electro static field and air flow [3,4].

The main objective of the study is to develop a theory of extracting individualhidden lobules from leaflet cases.

One of the solutions to this issue is the implementation of a new method for harvesting raw cotton according to as 1628919 based on the effects of complex perturbing non-mechanical forces: ionization, electrostatic field and air currents. The analysis of this method shows the advisability of adding vibration to this technological process, which leads to a weakening of the bond force of the lobules with the flaps and separation, which increases the extracting effect of the above forces.

II. THEORY

The following questions have been formulated on this issue:

1) the establishment of the laws of transferring the frequency and amplitude of the vibrator to the elements of the cotton bush;

2) the establishment of the law of motion of the suspension point of the boxes.

To study these in the polls, we have developed and manufactured various vibrators.

Studies of the interaction of a double sided vibrator with a cotton bush were carried out on the model of a vibration shock system (Fig. 1).

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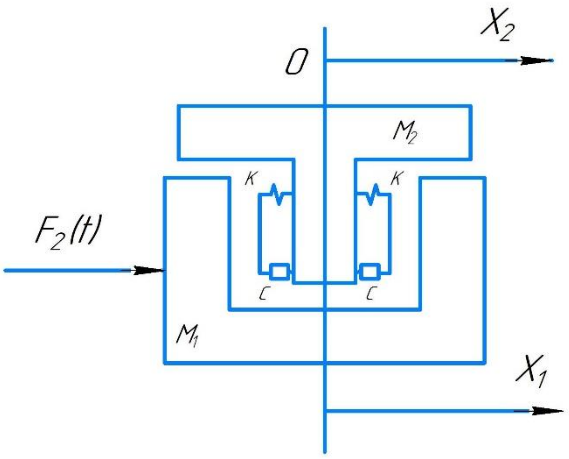

Fig. 1 Diagram of a vibro-shock system

Wherein X_1andX_2- coordinates of the vibrator and the stem relative to point O, K and C are coefficients characterizing the stiffness and resistance of the stem, respectively; M_1- the mass of the working body of the vibrator; M_2- reduced mass of the stem; F (t)-periodic external disturbing force; S is the gap between the working organs and the stem.

Using Lagrange equations of the second kind, we compose the differential equations of motion of this system [4]:

I) at the time of contact:

$$|X_2 - X_1| \geq S$$

$$M_2\ddot{X}_K + c\dot{X}_K + kX_k = M_1\omega^2 X[\sin(\omega t + \varphi_1) + \sin(\omega t + \varphi_2)] \quad (1)$$

where X_K is the compression of the surfaces of the working body of the vibrator and the stem:

$$X_K = X_2 - X_1 - S \text{at} X_2 - X_1 \geq S$$
$$X_K = X_2 - X_1 + S \text{at} X_2 - X_1 < S$$

ω,A and φ - co are the frequency, amplitude and phase of the disturbing effect, respectively;

2) in the absence of contact:

$$M_2\ddot{X}_2 + c\dot{X}_2 + kX_2 = 0 (2)$$

The solution to equation (1) is the sum

$$X_K = X_{K1} - X_{K2}$$

Where X_{K1} - is the general solution of the corresponding equation

$$M_2\ddot{X}_K + c\dot{X}_K + kX_K = 0 (3)$$

X_{K2} - is a particular solution of a linear inhomogeneous differential equation. Denoting $\frac{C}{M_2} = 2n$and $\frac{K}{M_2} = \omega_c^2$, we rewrite equation (3) in the form:

$$\ddot{X}_K + 2n\dot{X}_K + \omega_c^2 X_K = 0 \quad (4)$$

then, for $n<\omega_c$(the case of low resistance), the general solution of this equation has the form:

$$X_{K1} = e^{-nt}\left(A_1 cos\sqrt{\omega_c^2 - n^2}t + A_2 sin\sqrt{\omega_c^2 - n^2}t\right) \quad (5)$$

Where A_1andA_2 - arbitrary constants determined by the initial conditions.

From the expression it is clear that this equation describes the freedoms Noah swing banter la. A particular solution to equation (1) has the form:

$$X_{K2} = B_1 sin\omega t + B_2 cos\omega t \quad (5)$$

Where $B_1$and $B_2$are arbitrary constants, depending on the condition of the initial Wii. Putting (6) in equation (1) and grouping the coefficients for sines and cosines, we obtain

$$[(K - M_2\omega^2)B_1 - c\omega B_2]sin\omega t + [c\omega B_1 + (K - M_2\omega^2)B_2]cos\omega t = F(t) \quad (7)$$

Solving the system relatively B_1, and B_2substituting their values in (6), we obtain the solution

$$X_{K2} = \frac{M_1\omega^2 X}{\sqrt{(K-M_2\omega^2)^2+(c\omega)^2}}\cdot\sin(2\omega t-\psi) \qquad (8)$$

Where $A = \frac{M_1\omega^2 X}{\sqrt{(K-M_2\omega^2)^2+(c\omega)^2}}$and amplitudes of steady oscillations;
$\psi = arctg\frac{c\omega}{K-M_2\omega^2}$-phase lag relative $X_{K2}(t)$ to external disturbance.

Using equations (8), it is possible to determine the amplitude and frequency of oscillations of the bush in the steady state. By differentiating expression (8) twice, one can determine the relative acceleration of the stem in contact with the working bodies of the vibrator.

To solve the second question, we will move the suspension point of the box to a model of a mathematical pendulum with horizontal sinusoidal movement (Fig. 2).

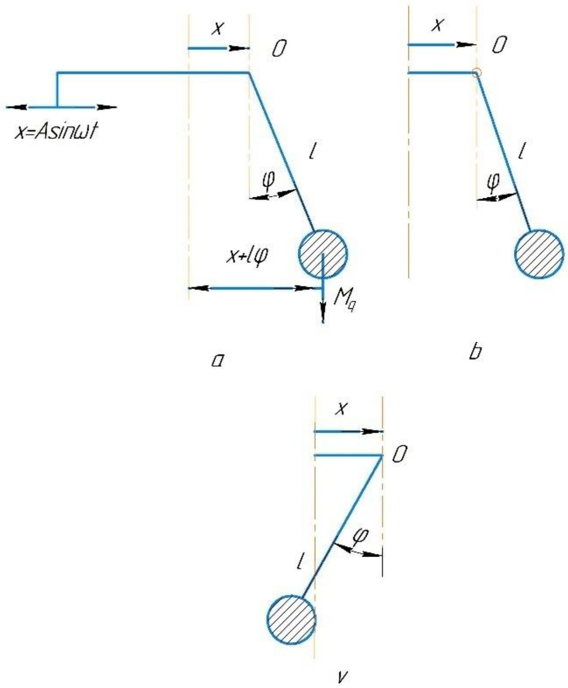

Fig. 2 a) oscillatory system b) *r<1*v)*r>1*

The equation of motion of such a pendulum can be expressed as follows: (relative to the position of the static equilibrium O)

$$Ml^2\ddot{\varphi} + Mgl\varphi = -Ml\ddot{X} = MAl\omega^2 sin\omega t \qquad (9)$$

Where M is the mass of the box; l- the length of the stalk; φ – the angle of the peduncle; A *is the* amplitude of movement of the branches, ω is the frequency of the disturbing effect.

The solution to this fix is written as:

$$\varphi(t) = \left|\frac{\frac{A}{e}\cdot r^2}{1-r^2}\right|\cdot\sin(\omega t-\theta) \qquad (10)$$

where $r = {}^{\omega}/_{\omega_c}$, $\omega_c = \sqrt{\frac{g}{l}}$ - is the natural frequency of the peduncle(θ=0 when r<1; $\theta=180^0$from r>1), whence φ(t) and X(t) coincide in phase for r <1 and have a phase shift of $180^0$for r>1.

The force required for movement of the suspension point, determined by the condition of dynamic equilibrium and inertia horizontal components fi ion:

$$F_x(t) = -M(\ddot{x}+l\ddot{\varphi}) = Mg\varphi = \frac{MA\omega^2}{1-r^2}sin\omega t \qquad (11)$$

The matching of expressions (1-11) allows one to determine the parameters characterizing the vibrations of the elements of the cotton bush.

III. RESULTS AND DISCUSSIONS

Based on an analytical review of theoretical and experimental studies on machines for collecting the uncovered part of the cotton crop and their mechanisms. It was found that the preservation of the natural technological properties of the harvested cotton and the elimination of pre-harvest defoliation of cotton is possible by using the method of extracting open bales without exposure to mechanical disturbing forces.

IV. CONCLUSION

One of the disturbing forces may be the inertia force of the masses of uncovered raw cotton slices, formed due to forced vibrations of the cotton bushes with a special vibrator device and leading to weaken their connection with the flaps or their separation.

The study of the physical-mechanical properties of the object exposed to the vibrator, showed above. The input disturbance of the cotton bushes should be applied to the lower part at a height of 150 mm from the base, and the impact force of the working body should be selected in relation to the stiffness of the stems 1.8., 1.2 N/mm at this height.

A mathematical model is obtained that describes the process of perturbing the open lobes from the action of the working body of the vibrator on the lower part of the cotton stalks and it is established. The input disturbance of the bushes to create the mass inertia force of the masses of raw cotton lobules should be characterized by the following parameters: the amplitude of the vibrations of the stems at the point of application of the impact - 10 ... 15 mm, the frequency of oscillations - 23-30 Hz.

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