Mathematical Model Silovogonagruzheniya Experimental Shoe Roller Spindle

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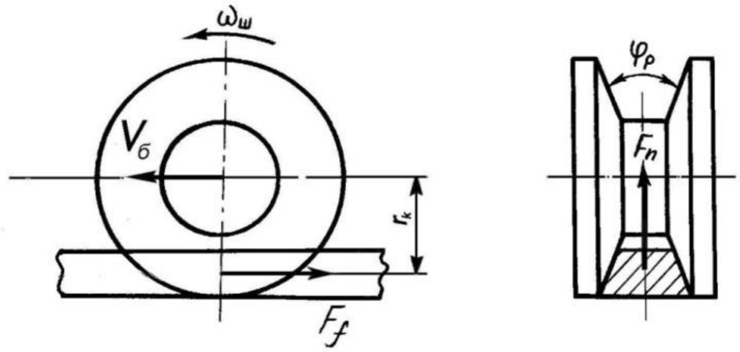
Abstract

The article describes formulas for the calculation of geometric, kinematics and dynamic parameters of the spindle vertical spindle cotton-picking machine, their rolls and pads.

In the process of vertical spindle cotton-picking machine spindle drive rollers in turn interact with seat forward and reverse rotation. The motions of these clips are instant in time phases as acceleration, stable rotation, and free rotation and braking.

It is known [1], the drive rollers cotton-picking machine, attacks with speed $\omega_ш$ to block reverse rotation causes its reaction. It consists of normal F_n and tangential F_f effort, passing on to the rolling circumference of the roller (1).

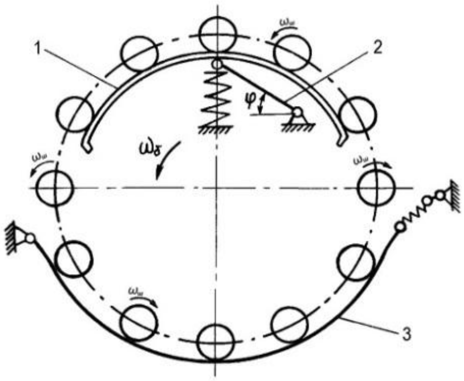


V_b – linear speed of the spindle drum-axis spindles).
φ_p – angle rolls.

Fig. 1. Diagram of the forces acting on the ball in his clash of a shoe

Changes to these efforts are the shock-dynamic, adversely affecting the durability of the pads and rollers. To reduce the impact forces rollers we have proposed (Fig. 2). Shoe with high ductility [2], which contains an elastic spring and leash set at an angle φ.

Experimental spindle drive mechanism consists of a block back from vrascheni1 pedestrian link 2, seat forward rotation 3. It differs from the series that mounting pads on the spindle drum, consisting of the guide rail brackets and flanged bearings replaced link. Pedestrian link - one end of which is pivotally jointed frame block and the other - with the upper body of the drum.



1- block reverse rotation; Flanged 2-link;
3-seat forward rotation.

Fig. 2. The pilot scheme of the drive spindle

Spring and a leash in the interaction of two bodies - "roller-shoe" creates elastic forces $\overline{F}$ and $\overline{S}$, facilitate extinction of the impact force on the roller pad.

Efforts F_f *and* F_n linked dependence $F_f = f'F_n$, *(1)*

$$f' = \frac{f}{sin\frac{\varphi_p}{2}} = \frac{0{,}34}{sin\frac{38}{2}} \approx 1{,}0$$

где f' - reduced coefficient of friction;
f *– 0,34* - coefficient of friction of steel on rubber;
$\varphi_p = 38^o$ – angle rolls.*;*

Then we can take $F_f = F_n$. *(2)*

Equilibrium equation block reverse rotation, the equations sum torques about the center of rotation of the spindle drum and at the point of contact pads and rollers (Figure 3):

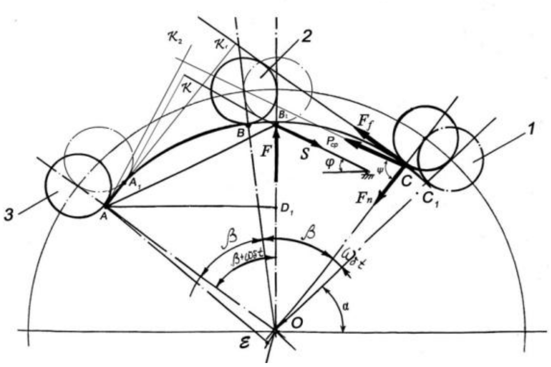


Fig.3. Scheme forces
on a trial
compact block cotton-picking machine

$$(Scos\varphi)\cdot cos\varphi - F_f = 0; \qquad (3)$$

After appropriate transformations of equations (3) and (4) with (2) that

$$F_f = \frac{F\sin(\beta + \omega_б t)\cdot\cos\varphi}{2\sin\left(\frac{\beta+\omega_б t}{2}\right)\sin\left(\varphi + \frac{\beta+\omega_б t}{2}\right) + \left(\sin 2\beta - 2\sin^2\beta\right)\cdot\cos\varphi} \quad (5)$$

Here β - angle alignment of spindles on the periphery of the spindle drum;
$\omega_б t$ - angle of attack of the roller on block;

Equation (5) is the equation of a circle force developed on the axis block reversible clip for vertical-spindle cotton-picking machine. For example, for the device with an 8-spindle drum $(\beta = \frac{2\pi}{8} = 45^0)$ it has the form:

$$F_f = \frac{F\sin(45^\circ + \omega_б t)\cdot\cos\varphi}{\cos\varphi - \cos\left(45^\circ + \omega_б t + \varphi\right)}\ , \quad (6)$$

At the time of clash of clips to a shoe (*t*=0) its circumference is equal to the force

$$F_{f(t=0)} = \frac{\frac{\sqrt{2}}{2}F\cdot\cos\varphi}{\cos\varphi - \cos\left(45^\circ + \varphi\right)} = \frac{\sqrt{2}F\cos\varphi}{2\left(\cos\varphi - \cos(45^\circ + \varphi)\right)}. \quad (7)$$

For series cotton-picking machine with a 12-spindle drums have

$$F_f = \frac{F\cdot\sin\left(2\beta + \omega_б t\right)\cdot\cos\varphi}{2\sin(\beta + 0{,}5\omega_б t)\sin(\varphi + \beta + 0{,}5\omega_б t) + (\sin 4\beta - 2\sin^2 2\beta)\cos\varphi}\cdot \quad (8)$$

Under *(β = 30º)* this equation can be reduced to the form

$$F_f = \frac{F\cdot\sin\left(60^\circ + \omega_б t\right)\cos\varphi}{\frac{\sqrt{3}}{2}\cos\varphi - \cos(60^\circ + \varphi + \omega_б t)}\ , \quad (9)$$

Hence for *t = 0*

$$F_f = \frac{\sqrt{2}F\cdot\cos\varphi}{\sqrt{3}\cos\varphi - 2\cos(60^\circ + \varphi)} \quad (10)$$

As follows from equation (7), φ = 90°, regardless of the value of F, we have $F_f = 0$. This means that the block is not able to develop on an axis of the roller peripheral force, i.e. it is down.

Under φ=0 block into a serial devoid compliance at all. This means that the serial block is a special case of the new pads.

Of particular interest may cause the case where there is at $F_f = F$. Then equation (7)

$$\varphi = arctg\left(\frac{\sqrt{3}+\sqrt{2}-2}{\sqrt{2}}\right) \quad (11)$$

Here φ = 30° block has a normal compliance, in which at the time of the reverse peripheral force on the spindle axis of the drive roller is equal to the power of pressing pads.

At φ>30° we have $F_f<F$ yielding pad increases. But it may be reduced towing capacity pads, raised the belt slipping on the rollers. This can lead to overheating and rapid failure of the belts.

At φ< 30° и F_f>F yielding pads down, and its ability to increase traction. The regularity of district efforts to axis of the roller, developing block in an effort to drive her to the pressing rollers are *F = 100H*, depending on the angle *φ* installation management and flanged corner clash of - $\omega_б t$ it to block, shown in Figure 3. It implies that in the early clash of the roller on block peripheral force F_f reaches its maximum value, which, depending on the angle of the drive disc level -*φ* varies widely. At *φ=30°* его maximum value equal to the contact pressure pads, i.e. $F_f = F$.

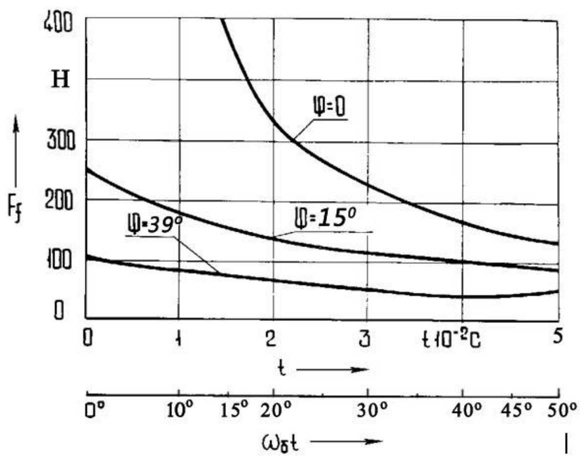


Fig. 3
Change in county efforts on video *(F_f)* depending on the angle of the drive disc level *φ* and angle of the drum *$\omega_б t$*

For preliminary calculations, we adopt the following limits the angle of the drive disc level: $15° \le \varphi \le 30°$, where there is a
F_f= *(1, 0...2, 41) ·F,* (12)

It should be noted that (12) are valid for $f' = 1,0$.

Experiments revealed that the most probable values of the reduced coefficient of friction f 'is within 0.5 ... 0.9.

Given the f' = 0,5…0,9, under $\omega_б t$= 0, β - 45º and β-30° from equation (7) and (10) that for small cotton-picking machines and series respectively: $F_f = \dfrac{F}{0,189 + tg\varphi}$; $F_f = \dfrac{F}{0,517 + tg\varphi}$.

The resulting mathematical model is the basis for the calculation of geometric, kinematic and dynamic parameters of the spindle vertical spindle cotton-picking machine, their rolls and pads.

References

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