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Improving the Design Node of the Shuttle Device and Exploring Methods of Repayment of the Frequency of Oscillation of The Shuttle Shaft Sewing Machine

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ABSTRACT: This article presents the results of an experimental study of the cylindrical shape of the Shuttle allows the shield thin fabric threads of high numbers, which at linear speed, there is a rapid wear of the guide shuttle, in addition to the extreme positions in the driver there are shocks that increase noise, vibration and vibration mechanisms of machines. With the use of bushings-vibration dampers, the breakage of shuttle threads during the formation of the screed is reduced by 15÷17 %, the frequency of vibration of the Shuttle shaft is brought to a minimum of 24 Hz, reliability and durability when working at high speeds of the universal sewing machine increases 30-32%, which makes it possible to increase the number of revolutions of the shuttle shaft to 10,000 rpm.

KEYWORDS: shuttle, needle, sewing machine, thread, Shuttle spout, tie rod, inertia force, moment of forces, reliability, quality, sleeve.

I.INTRODUCTION

Shuttles perform the most complex stages of the weaving process and significantly affect the performance, reliability and quality of sewing machines. The parameters of the Shuttle have wagging on the frequency of changing the spools and the loss of strength of the needle thread due to repeated rubbing it on the needle eye. Shuttle mechanisms often cause increased noise wear of the main parts creates high-frequency vibrations on the shaft and destroys the mechanical characteristics of the machine.

II. SIGNIFICANCE OF THE SYSTEM

Lines with Shuttle weaves practically do not dissolve and require the least amount of threads. However, when they are performed, the needle threads wear out greatly, which increases the breakage of the threads and worsens the quality of the products; in addition, these lines do not always have sufficient flexibility during deformation. Stitches with chain weaves are characterized by greater flexibility and less wear and tear threads, but require more threads, many of which are dissolved.

III. LITERATURE SURVEY

In machines of foreign firms on the example of the widely used singer shuttles to the cylindrical shape allows the shield fine fabric threads high, but due to the large linear velocity, occur rapid wear of the guides of the Shuttle, in addition, in the course of the Shuttle to 80 mm in the extreme positions in pogorelka there are shocks that increase the noise, oscillation and vibration of machines;

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IV. METHODOLOGY

It is known that, of great importance for the loop formation is the coefficient of the working stroke of the Shuttle$K_ч$, which is the ratio of the angle of rotation of the main shaft for the time from the beginning of the capture of the needle loop by the Shuttle spout until it is reset $\varphi_ч$ to the full angle of rotation of the main shaft in one cycle (φ_o):

$$К_ч = \varphi_ч/\varphi_0 \quad (1)$$

To improve the work process of the sewing machine tend to reduce the $K_ч$. In existing machines, it ranges from 0.25÷0.42.

In General, the angle of rotation of the main shaft in the loop

$$\varphi_ч = (180^0 + \alpha)/i_{cp}, \quad (2)$$

where is the coal, which determines the length of the nose of the Shuttle (usually α=30÷400); i_{cp} - the average value of the transmission ratio between the main and the Shuttle shaft during the period of bypass loop:

$$i_{cp} = \frac{\omega_{ч.cp}}{\omega_{г.л.в}}, \quad (3)$$

and $\omega_{ч.cp}$ - the average angular velocity of the Shuttle shaft during the loop;

$\omega_{г.л.в}$ - the angular velocity of the main shaft.

In most sewing machines to ensure uniform rotation, the gear ratio is constant:

$$i = \frac{\omega_ч}{\omega_{г.л.в}} = 2. \quad (4)$$

In order to reduce the coefficient of the working stroke of the Shuttle, various types of acceleration mechanisms are used.

Shuttles rotating evenly at ($\omega_ч = const$) increase the idle speed, which is a disadvantage, but with their proper manufacture of inertial loads are significantly reduced, therefore, increase the durability of their work.

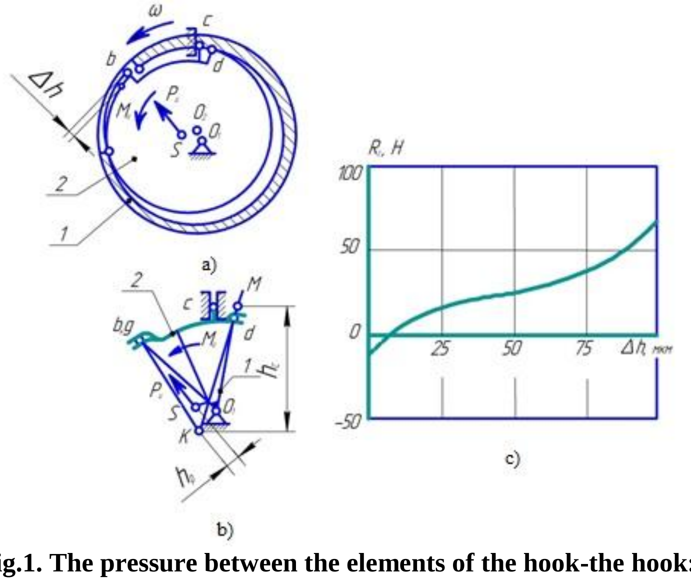

Fig.1. The pressure between the elements of the hook-the hook:

a – the position of the holder relative to the hook on impact; b – scheme of the replacement mechanism; c – graph of the function $R_c(\Delta h)$.

Studies have found that during most of the cycle 2 (Fig.1, a) contacts at two points with the Shuttle 1 and a smaller part of the cycle – at one point with the installation finger and two points with the Shuttle; in the second case, the holder can be considered a basic class III with three translational pairs. The greatest pressures between the elements of the Shuttle device are observed when the point *g* of the Shuttle coincides with the point *b* of the spool holder (Fig.1, b) and its contacts with the setting finger in anguish with and the Shuttle at point *d*. In this position, the pressure in the steam holder – mounting pin:

$$R_c = \frac{1}{h_c}\left(P_и h_p \pm M_и\right) = \frac{1}{h_c}\left(-m_2 a_s h_p \mp J_s\right), \quad (5)$$

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Where $P_и, M_и$ - inertial force and moment of forces of inertia of spiderites; h_c, h_p - shoulder forces $P_и, R_c$ relative to the point of intersection of the lines of action of the pressure of R_b and R_d in the points *b* and *d*; m_2, J_s is the mass and moment of inertia of spiderites; a_s, ε_2 - linear acceleration of the center of gravity of spiderites and its angular acceleration. Acceleration a_s and ε_2 can be found using the special point of the Assur (Fig.1, b).

For fig. 1, the graph shows the dependence of $R_c(\Delta h)$ the pressure between the holder and the mounting finger on the distance (Δh) in the Shuttle device of the singer machine at the speed of the main shaft $n = 8000$ *rpm*. according To the graph, with an increase in Δh, the pressure R_c increases, and the person intensively at $\Delta h > 75$ *μm*. After you define R_c, you can calculate R_b and R_d at points b and d. With an increase in Δh, the pressure R_b also increases, and R_d, on the contrary, decreases. If $\Delta h = 100$ *μm*, $R_c \cong 150$ *H*, $R_b \cong 680$ *H*, $R_d \cong 45$ *H*. To reduce the pressure R_b and R_c should be tends to reduce Δh, which is achieved by the use of vibration damper bushings in the Shuttle shaft.

This is the work of friction $A = \mu \int_0^s R ds$, where R is the pressure in the kinematic pair; μ, s is the coefficient of friction and the path of relative sliding of its elements. Because the links do not transmit payloads, you can accept $R = const$. Then at constant shaft speed

$$A = R\mu \frac{d}{2} \omega t = c\omega t, \qquad (6)$$

where, d and ω are the inner diameter of the vibration damper bushings and its angular velocity; c is the numerical coefficient; t is the duration of operation.

V. EXPERIMENTAL RESULTS

Links details of mechanisms should be checked for strength and durability. The strength calculation is made at the moment, arising from the tension of the thread - holder and at high speeds of the Shuttle, the torque is reached up to 3,5÷5 N*m. in order To avoid overload of the Shuttle mechanism, we recommend a safety clutch with an elastic element "sleeve-vibration damper" for sewing machines of all designs (Fig.2).

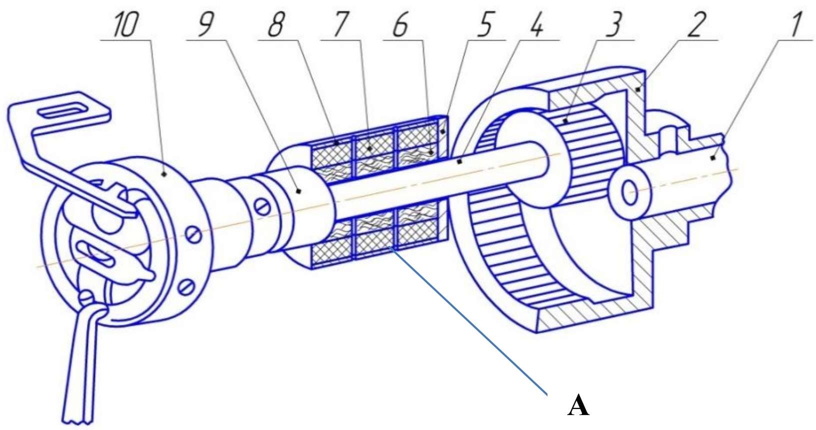

Fig. 2. The constructive scheme of the Shuttle mechanism and the trap of spiderites with fitted sleeve with a vibration damper.

1 – lower shaft; 2,3 – gear wheel and gear; 4 – Shuttle shaft; 5 – support washer; 6– felt; 7 – skin; 8 – outer sleeve; 9 – Shuttle bushing; 10 – Shuttle device, And - bushing-vibration damper.

When calculating the gears and shafts for durability, it is necessary to take into account torsional vibrations and vibrations at high speeds. On the Shuttle universal sewing machine at $\omega = 680$ *1/s,* the torque at oscillations is reached *~1,2 N*m* (Fig.3).

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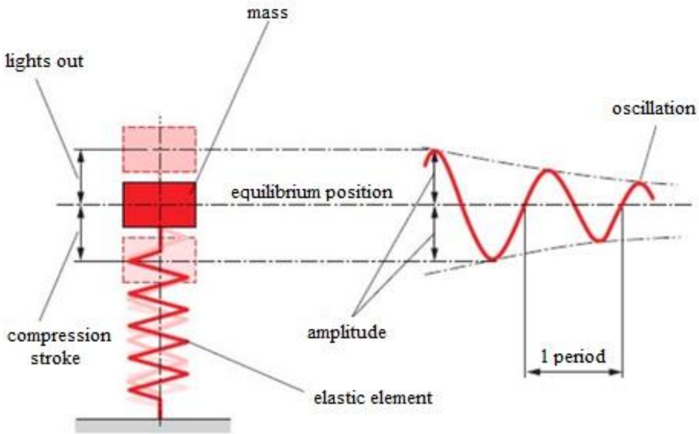

Fig. 3. The natural frequency of the Shuttle shaft.

Shuttle shafts must be checked for resonance; in the transverse bending critical angular velocity of the bushing vibration damper is determined by the formula:

$$\omega_{kp} = \sqrt{\frac{3EJ}{(l_1+l_2)l_2^2 m}}; \qquad (1)$$

where, *E,J* – the modulus of elasticity of the material and the moment of inertia of the cross section of the bushing-vibration damper; l_1, l_2– the distance between the middle of the center of gravity of the Shuttle to the middle of the bushing-vibration damper Shuttle shaft; m – the mass of the Shuttle.

The following values are determined and obtained by theoretical calculations;

$$\omega_{kp\ min} = 486\ r/s; \qquad \omega_{kp\ max} = 780\ r/s$$

VI.CONCLUSION

With the use of bushings-vibration dampers, the breakage of Shuttle threads during the formation of the screed is reduced by 15÷17 %, the frequency of vibration of the Shuttle shaft is brought to a minimum of 24 Hz, reliability and durability when working at high speeds of the universal sewing machine increases 30-32%, which makes it possible to increase the number of revolutions of the Shuttle shaft to 10,000 rpm.

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