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REDUCED VIBRATION AND NOISE EXECUTIVE MECHANISMS OF SEWING MACHINES BY IMPROVING THEIR DESIGN

Abstract. *The article discusses algorithmic and software for the kinematic study of the mechanism for transporting material of sewing machines of base 97 cl with the drive of the chain for lifting the toothed rack from the eccentric and from the three-center cam. A dynamic model of the material movement mechanism in the form of two subsystems with distributed parameters, interconnected by a system with one degree of freedom, is proposed. Algorithmic and software for the analysis of natural and forced vibrations in the material movement mechanism has been developed.*
Keywords: *mechanism, vibration, noise, material movement, vibration, cam.*

The levels of vibroactivity and sound emission are one of the indicators of the competitiveness of both operating and projected industrial equipment.

High speed sewing machines are quite powerful sources of noise and vibration. Sewing production is distinguished by monotony of operations, their frequent repetition, which contributes to operator fatigue, at the same time, work on sewing machines requires increased attention;

The accepted norms of noise at the workplace, equal to 80 95 dB, lead to occupational diseases, at present they no longer meet modern sanitary and hygienic requirements and need to be revised downward, thus, the production has put forward the task of maximizing the intensity of vibration and noise [1].

Experience shows that the effectiveness of measures to reduce the mechanical noise of existing equipment is very limited and is due to the possibility of structural changes in its units, therefore, the mechanical noise of machines should be reduced mainly at the design stage. At the same time, it is not possible to achieve the goal without creating the appropriate dynamic and mathematical models, mathematical and software that allows an analysis of the design being developed.

The analysis shows that with an increase in operating speeds, the level of noise and vibration of individual mechanisms and the machine as a whole increases, and accompanying effects arise that affect the quality of the technological operation performed. Eliminating these phenomena requires an in-depth study of the dynamics of sewing machines, which would allow evaluating the effectiveness of various methods for reducing vibration and noise at the design stage. An important issue is also the study of possible options for the design of mechanisms from the standpoint of improving operations at high-speed ones [2].

Based on the method of closed vector contours, mathematical, algorithmic and software has been developed, which allows performing a kinematic analysis of the basic and proposed systems on a computer. As a result of the kinematic analysis, the dependences of the coordinates of the middle teeth of the racks on the angle of rotation of the main shaft, which determine their trajectories (see fig. 1), were obtained, and the angle of the working stroke of the rack, the disturbing function from the side of the rack to the foot and fabric, the function of moving the rack of the basic and synthesized mechanisms.

For further dynamic calculation, these functions were presented in the form of the corresponding fourier series with the preservation of 6 harmonics.

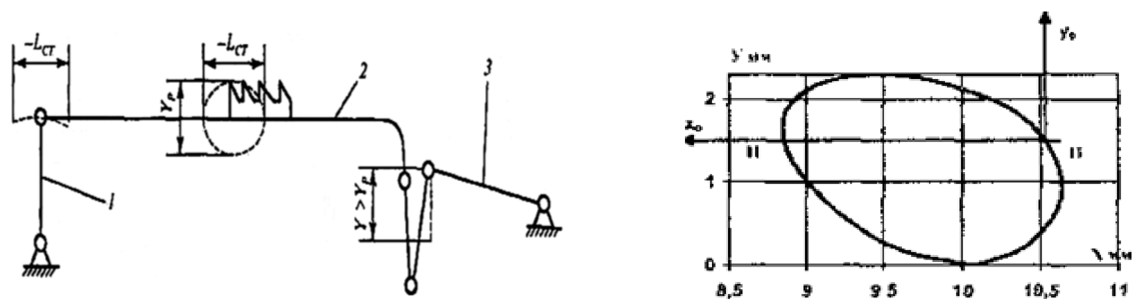

Fig. 1. **Kinematic diagram of the mechanism and the trajectory of the rail**

Comparing the obtained trajectories of the rod movement in the basic design (see fig. 1, a) and in the proposed design with a three-center cam (see fig. 1, b), we can conclude that the mechanism for transporting tissue with a three-center cam in the rack lifting chain is much better meets technological requirements. To fully assess the capabilities of the synthesized mechanism, in addition to analyzing technological requirements, it is necessary to take into account its influence on the dynamics of the system [3,4].

The presser foot of the base machine is pressed against the material by means of a leaf spring. In order to determine the amplitude-frequency characteristics of the system, dynamic and corresponding mathematical models have been developed (see fig. 2,3,4) The model shown in fig. 2 is valid in the time interval corresponding to the joint operation of the toothed rack and the pressure foot. The rest of the cycle time, in the context of the problem being solved, the foot is stationary, and the model splits into two component beam on three supports, simulating the spring of the pressure foot (see fig. 3, a), and a shaft with a disc in the end section corresponding to the rack lifting shaft (see fig. 3, b). If we neglect the elastic properties of the fabric, that is, assume that the rail and the foot move in the vertical direction as a whole, then the model under consideration (see fig. 2) transforms and takes the form of the indications in fig. 4.

In fig. 2,3,4 indicated: 1- the shaft of the lifting chain, having a distributed mass, set in motion according to the kinematic law *f (t)*; 2 - disk simulating the inertial properties of the rocker arm and stone; *J* is the moment of inertia of the mass of the rocker arm assembly, reduced to the axis of rotation of the shaft;

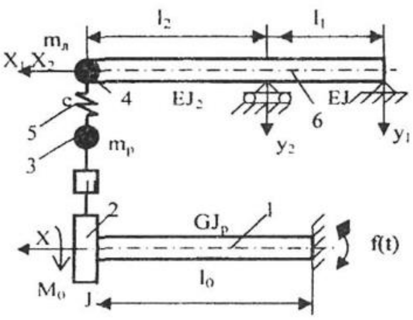

Fig. 2. **Dynamic model taking into account the elasticity of the tissue**

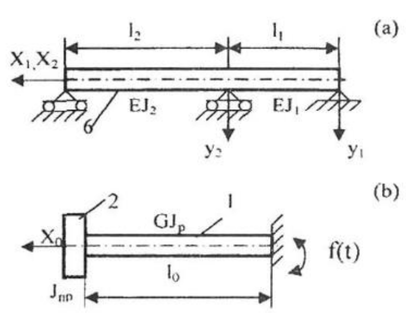

Fig. 3. **Dynamic model (idle rail)**

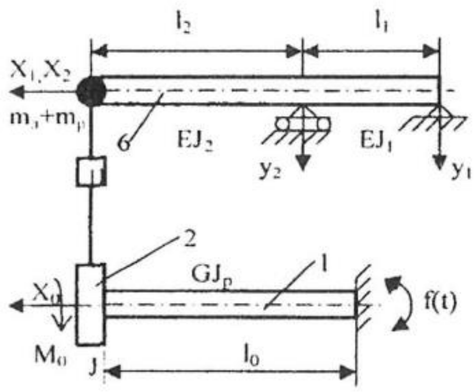

Fig. 4. **Dynamic model without taking into account tissue elasticity (transportation phase)**

3 - concentrated mass, simulating the inertial properties of the assembled fork, reduced to the stage of the assembly; m_p is the mass of the rack of the middle tooth of the rack; 4 - concentrated mass m_l, simulating the inertial properties of the presser foot; 5 - elastic connection with a stiffness coefficient c, which is equivalent to the stiffness coefficient of the transported tissue; 6 - a two-span beam with a distributed mass, simulating the elastic properties of a leaf spring of a pressure foot;. J_{np} is the moment of inertia of the mass of the rocker arm with the stone and the $\Pi=y_3(\varphi_2)$, reduced to the shaft axis. the angular coordinate of the φ_2 arm.

The model of the chain of horizontal movement of the rail is identical to that shown in Fig. 3, b.

In accordance with the technical theory of bending of rods and torsion of shafts, the natural frequencies of the considered models are determined.

Frequency analysis (see Table 1) shows the following chain of horizontal movement of the gear rack of the machine under study can be an emitter of vibration and noise in the octave band of 500 Hz, since during machine operation, accompanying oscillations with a frequency of 624 Hz can be excited in this chain.

The rack lifting circuit can be active in the 1000 Hz octave band. The most active source of vibration and noise in the octave bands of 500, 1000, and 2000 Hz can be the leaf spring of the force-lock of the pressure foot, since it is this spring that determines the presence of four natural frequencies of elastic vibrations in the considered octave bands in the mechanism under study.

Table 1

Natural frequencies p, Hz

Dynamic model	Average geometric frequencies of octave bands, Hz						
	250	500	1000	2000	4000	8000	16000
Mechanism taking into account the elasticity of the fabric (see fig 2)			959 1023	2024 2632	4023	6023 7100	
Leaf spring (see figure 3, a)		318	1044	2020 2616	4050	6023 7102	
Lift chain shaft (see fig. 3, b)			938		4387	8877	
Horizontal chain shaft (see fig. 4, b)		624			5931		11894
Mechanism without taking into account the elasticity of the tissue (see figure 4)	312		1033	2031 2638	4032	6023 7107	

Conclusion. Algorithmic and software for the kinematic study of the mechanism for transporting the material of sewing machines of base 97 cl with the drive of the chain for lifting the toothed rack from the eccentric and from the three-center cam has been developed.

A dynamic model of the material movement mechanism in the form of two subsystems with distributed parameters, interconnected by a system with one degree of freedom, is proposed. Algorithmic and software for the analysis of natural and forced vibrations in the material movement mechanism has been developed.

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