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Analysis of Dynamics and Mechanisms of Fabric Transportation of Sewing Machines

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ABSTRACT: The article discusses the adjustable mechanisms for transporting materials of sewing machines with a rectilinear, parallel to the stitch plate section of the toothed rack motion trajectory, mathematical, algorithmic and software for optimizing their structural, kinematic and dynamic characteristics.

KEYWORDS: toothed rack, fabric transportation, stitch, mechanism, dynamic, mathematical model, fabric deformation, foot, dissipative element, elasticity.

I. INTRODUCTION

In sewing machines, there are mainly three types of fabric conveyor mechanisms: toothed rack, grooved roller and toothed rack, grooved roller and bottom conveyor ring. The transport of the fabric by the rack is carried out due to the forces of adhesion of the teeth of the rack to the material and the pressing of the material by the upper spring-loaded foot or roller. The material of the rack is usually caught by the teeth with each revolution of the main shaft, so the semi-finished product moves intermittently. The quality of the stitching, and, consequently, the quality of the product largely depends on the equipment of the sewing machine with special devices and on the qualifications of the worker.

Transportation by corrugated (toothed) rollers is mainly used for sewing leather parts, while the roller can receive intermittent rotational movement, and if transportation is carried out by a roller and the lower conveying ring, they rotate continuously [1].

Transportation should take place with the smallest deviations from the set value and be completed at certain angles of rotation of the main shaft. It is desirable that the feeding of the fabric starts after tightening the stitch and ends before the needle starts to enter the fabric. In this case, the angle of the working stroke of the rack would be equal to 50-60°. However, in existing machines, this value is approximately 110°. Thus, the stitch tightening occurs after the fabric has been advanced for most of the stitch pitch and the hole in the fabric is offset from the hole in the needle plate.

II. MATERIALS AND METHODS

Mechanical engineering for light industry should ensure the production of sewing machines, automatic machines and automatic lines, the introduction of which in the sewing industry will significantly increase the quality of garments, labor productivity, and reduce the cost of technological processes.

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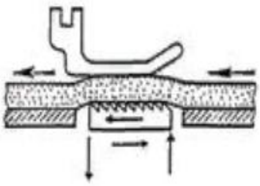
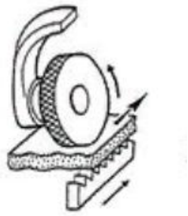
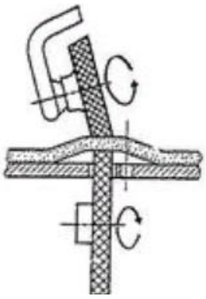


a – rackwithfoot



b –rack and pinion with roller



c – with roller and lower conveyor ring

Fig. 1 Transport mechanisms for sewn parts

When creating new and modernizing existing sewing machines, solving the problems of kinematic and dynamic analysis of their units is of great importance. The use of computers at the indicated stages, the development of mathematical and software for their functioning is important and relevant. Development of mathematical, algorithmic and software for solving problems of kinematic and dynamic analysis of one of the most important and loaded units of the sewing machine - the mechanism for transporting fabric.

Improvement of existing and development of new methods for solving problems of kinematic and dynamic analysis of rack-and-pinion lever mechanisms for transporting fabric of sewing machines, development of appropriate mathematical, algorithmic and software for solving applied problems arising in the process of their development and modernization. Despite research on the mechanisms of tissue transport, the problem of their kinematic structural analysis and synthesis is still insufficiently studied, especially for the mechanisms of tissue transport with a vertical differential.

There is clearly not enough research into the dynamics of the driven lower rack-to-fabric-presser foot system. In the case of mechanisms for transporting tissue with a vertical differential, the task of studying the dynamics of the system "lower toothed rack with a drive - fabric - upper toothed rack with a drive" is added to this problem.

Development of dynamic and mathematical models of sewing machine fabric transportation mechanisms. In the research tasks, three dynamic and corresponding mathematical models of rack and pinion leverage mechanisms for tissue transportation have been developed.

The first dynamic (Fig. 2,3) and mathematical models correspond to the mechanism of tissue transportation with one lower rack. The presser foot with the rod on which it is attached are considered to be an absolutely rigid body (hereinafter referred to as the "foot"), moving $y(t)$ in the direction of the OY axis of the fixed coordinate system OXY under the action of kinematic external influences $\xi(t)$ and $\eta(t)$ through the fabric from the side of the lower rack; $x(t)$ - the direction of movement of the fabric during transportation.

Affects the foot (Fig. 3): G - gravity; F_1 -is the force of an elastically dissipative element installed between the machine body and the "foot", F_2 - is the force acting from the fabric on the “foot” due to the presence of $\xi(t)$, F_3- is the force acting from the side of the fabric on the “foot” from - due to deformation of the fabric Δ at the site s of the entrance of the fabric under the “foot” and the impact $\eta(t)$. Under the assumptions made, the mathematical model of the "foot" has the form:

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$$m\ddot{y} = -F_1 + F_2 + F_2^0 + F_3 - mg$$

where m is the mass of the "foot" , g=9,81m/s^2,

$$F_1 \approx F_{10} + cy + by;\ F_2 \approx \begin{cases} 0\ at\ \Delta \leq 0\ or\ c_1\Delta + b_1\Delta \leq 0, \\ c_1\Delta + b_1\Delta\ at\ 0 < \Delta \leq a\ and\ c_1\Delta + b_1\Delta > 0, \\ c_1 a + c_2(\Delta - a) + b_2\Delta\ at\ \Delta > a; \end{cases}$$

$$F_3 \approx \begin{cases} (c_n\eta + b_n\eta)\Delta\ at\ \Delta > 0, \\ 0\ at\ \Delta \leq 0\ or\ \eta = 0; \end{cases}$$

$$\Delta = \xi - y;$$

F_{10}- preliminary compression; c, c_1, c_2, b, b_1, b_2- stiffness and resistance coefficients, respectively; a - deformation of the tissue, starting from which the main role in the force F_2- is played by the stiffness and dissipative characteristics of the drive of the lower gear rack; c_n, b_n - respectively, the linear stiffness and the coefficient of resistance of the fabric (the fabric between the toothed rack and the presser foot during transportation is considered inextensible in the direction of the *OX* axis). Kinematic external influences £ *(t)* and *rj (t)* should be obtained as a result of the kinematic analysis of the rack and pinion linkage corresponding to the drive from one lower rack. If $F_2 = 0$ at $\Delta > 0$, an equation is added to [2], with$c_1\Delta_0 + b_1\Delta_0 = 0$ they are solved together as long as $\Delta_0 \leq \Delta$..

III. RESULTS AND DISCUSSION

The second dynamic [3] and mathematical models correspond to the mechanisms of tissue transportation with a horizontal differential.

In contrast to the dynamic model shown in Fig. 1 in this case, due to the appearance of the second (additional) toothed rack, kinematic external influences $\xi_1(t), \eta_1(t)$ appear. Comparing fig. 2 and fig. 3 it follows that in this case, due to the presence of an additional lower toothed rack, a new force appears, caused by the presence of an additional rack, the physical meaning of which is similar to the Mathematical model has the form:

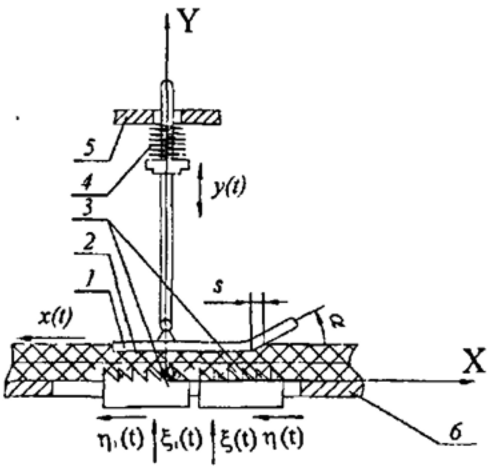

Fig. 2 Structuraldiagram

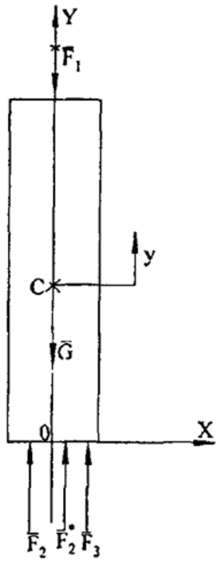

Fig. 3 Dynamicmodel

$$m\ddot{y} = -F_1 + F_2 + F_2^0 + F_3 - mg$$

where the analytical expressions for the forces F_1 and F_2 are similar to [2], the m-mass of the "leg g=9,81м/с^2,

$$F_2^0 = \begin{cases} 0 \; at \; \Delta_1 \leq or \; c_1\Delta_1 + b_1\Delta_1 \leq 0, \\ c_1\Delta_1 + b_1\Delta_1 at \; 0 \leq \Delta_1 < a \; and \; c_1\Delta_1 + b_1\Delta_1 > 0, \\ c_1 a + c_2(\Delta_1 - a) + b_2\Delta_1 \; at \; \Delta_1 > 0; \end{cases}$$

$$F_3 = \begin{cases} (c_n\eta_1 + b_n\eta_1)\Delta_1 \; at \; \Delta_1 > 0, \\ (c_n\eta + b_n\eta)\Delta \; at \; \Delta_1 \leq 0 \; at \; \eta_1 = 0, \\ 0 \; at \; \Delta \leq 0 \; and \; \Delta_1 \leq 0 \; at \; \eta = 0 \; u \; \eta_1 = 0; \end{cases}$$

$$\Delta = \xi - y, \Delta_1 = \xi_1 - \xi + \Delta$$

If $F_2=0$for $\Delta>0$, the equation with$c_1\Delta_0 + b_1\Delta_0 = 0$is added to [3] and they are solved together while $\Delta_0 < \Delta$; if $F_2^0 = 0$for $\Delta_1 > 0$, the equation with$c_1\Delta_1 + b_1\Delta_1 = 0$ is added to and they are solved together while $\Delta_0 < \Delta$;

The third dynamic and mathematical model corresponds to the mechanism of transporting fabric with a vertical differential of the sewing machine.

We only note that it is a system of nonlinear ordinary differential equations of the fourth order, the generalized coordinates of which are selected y - the movement of the "foot" in the direction of the OY axis and φ_1- the angle between the OX axis and the O_1B line corresponding to the displacements of the upper gear rack in the direction of the OY axis. Since in the process of transporting tissue, the upper toothed rack, regardless of its drive, must repeat the movements of the lower toothed rack, an elastically dissipative element is placed in the groove AA_1, acting at point A (in the direction of the OX axis) on the system under consideration with a force F_5 equal to:

$$F_5 \approx \begin{cases} F_{50} + c_y\Delta_2 + b_y\Delta_2 \; at \; \Delta_2 < 0, \\ F_{50} + c_0\Delta_2 + b_0\Delta_2 \; at \; 0 \leq \Delta_2 < a_0 \; and \; c_2\Delta_2 + b_2\Delta_2 \geq -F_{50}, \\ 0 \; at \; 0 \leq \Delta_2 < a_0 \; and \; c_2\Delta_2 + b_2\Delta_2 < -F_{50}, \\ F_{50} + c_0 a_0 + c_y(\Delta_2 - a_0) + b_y\Delta_2 \; at \; \Delta_2 \geq a_0; \end{cases}$$

F_{50}- is preliminary compression, $a_0 -$ is the maximum possible deformation of an elastically dissipative element, $c_0, c_y, b_0, b_y -$ are stiffness and resistance coefficients, respectively. If at $0 \leq \Delta_2 < a_0$ the value $F_5=0$, the equation $c_2\Delta_2 + b_2\Delta_2 + F_{50} = 0$ should be added to the mathematical model and solved together while $\Delta_0 < \Delta$.

IV. CONCLUSION

An analytical study of the periodic oscillations of the "foot" of the tissue transport mechanisms with one lower toothed rack was carried out.

It is shown that in the system under study, due to the non-holding nature of the connection of the presser foot with the fabric, the “foot” can be detached from the fabric when the rotation frequency of the main shaft of the sewing machine is increased. The appearance of sub harmonic resonant oscillations of the "foot" relative to tissues of large amplitude is also possible, which is unacceptable for technological reasons. Ways to combat these modes are proposed:

REFERENCES

1. Tadzhibaev Z. Sh., Tashpulatov S. Sh. Equipment of sewing enterprises, “Voris-nashriyot”, 160 page Toshkent, 2007.
2. ShcherbanYu.Yu., Gorobets V.A. Investigation of mechanisms for moving materials of sewing machines with upper and lower transport rails. // Izv. universities. Light industry technology. 2001 y
3. Mazin L.S., Markovets A.V., Zorya A.V. Study of the dynamics of the presser foot of the sewing machine. Bulletin SPGUTD No. 5. SPb: Publishing house. SPGUTD, 2001 y.