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Experimental Method For Determining The Parameters Of A Device For Applying A Polymer Composition On The Stitches Of Materials

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ABSTRACT

The article provides a device for applying a polymer composition to the lines of the materials being ground. The dynamics of the machine unit is considered, the laws of motion of the rollers of the device are determined, the recommended parameters of the system are substantiated on the basis of the analysis of graphical dependencies.

Keywords Device, roller, elastic sleeve, polymer composition, strength, machine unit, law of motion, parameters, stiffness, frequency, consumption.

I. Introduction

To increase the strength of the lines, polymer compositions are applied to them. Currently, the existing methods of strengthening the seams of materials do not meet the requirements. A device is known for applying a polymer composition along the cuts of parts of garments in the sewing industry instead of overlapping for securing the cuts from sagging. The device contains a system for feeding a liquid-phase polymer, a unit for applying a polymer to sections of parts of a garment, a support for placing a product with a toothed rack for moving it. A liquid-phase polymer is applied to the sections of parts by a contact method using counter rotating rollers, one of which has a special geometry on the rim, and the other, covered with a porous material (spongy polyurethane coating), is signed with a polymer composition[1,2,3].

The disadvantage of the known designs is that these devices apply the polymer composition to only one layer of fabric in order to protect the sections from shedding. This increases the processing time, requires additional equipment and displacement techniques, which increases the duration of the production cycle. The use of this design for securing the threads of the fabric along the seams from being pulled apart is possible (applying a polymer on this installation, and then stitching cut parts on a universal machine), but this will also require additional equipment, displacement techniques and would increase the technological process of making clothes[4].

II. Development of effective design schemes of the device.

This design is improved by the design of the device and forced drying of the coating immediately after its application.

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The device includes a sewing machine body 1, an upper rotating roller 2, a lower rotating roller 3, an upper shaft 4, a lower shaft 5, an upper bath with a polymer composition 8, a lower bath with a polymer composition 9, a feed tube 10, a polymer feed regulator 11, upper and the lower parts to be sewn 12, the applied polymer composite 13, the presser foot of the sewing machine 14, the lower toothed rack of the sewing machine 15, the needle 16 and the stitch plate 17 (Fig. 1). The surface of rollers 2, 3 is covered with porous material 18. Rollers 2, and 3 are installed on the sewing machine body on both sides of the sewing parts 12 behind its presser foot 14 and toothed rack 15 and are interconnected by an overlapping belt drive (not shown in the figure). The upper tank 8, the feed tube 10 connected to it with the feed regulator 11, and the lower tank 9 installed under the working platform of the machine constitute the supply system for the liquid polymer composition 13.

The upper tank 8 is connected to the surface of the upper roller 2 through a feed tube 10. In the lower tank 9, the lower roller 3 is partially immersed. On both sides of the materials 12, covers 6 are installed, rigidly connected to the body 1 of the sewing machine and made by single guides 19, 20. Inside the covers 6, shade 7 is installed, which are powered by electrical energy and have regulators 21.The device works as follows. When sewing, the parts 12 are pressed by the foot 14 against the toothed rack 15 and the needle plate 17. The fabric is advanced by the stitch amount by the toothed rack located in the slot of the needle plate.

The rack feeds materials only under the needle 16, and the direction of movement of materials when sewing is set by the worker. With the interaction of the needle 16 and the shuttle (not shown in the drawing), a shuttle stitch is formed. Further, the materials to be sewn fall under the mutually rotating upper 2 and lower 3 rollers mounted on shafts 4 and 5 connected to the body of the sewing machine 1. In the process of moving fabrics from the upper bath 8 through the feed tube 10, the polymer composite enters the porous surface 18 of the upper roller 2 and is applied to the upper fabric in the form of a film 13.

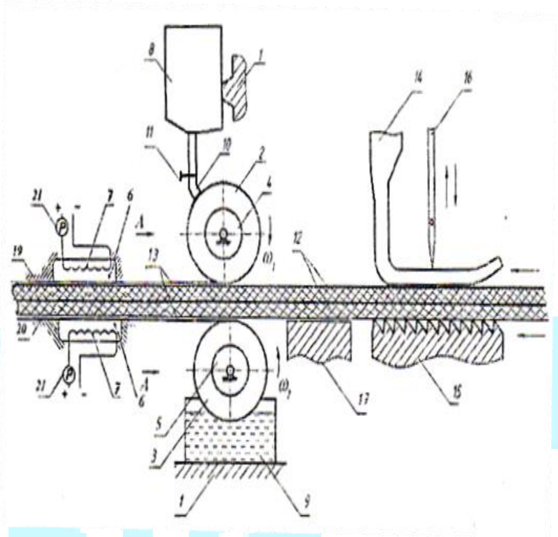

Fig. 1. Devices for applying a polymer composition to the cut parts to be ground

The supply of the polymer composition is regulated by means of the regulator 11. The polymer composition 13 is applied to the lower layer of the fabrics being ground by means of the lower roller 2, which also has a porous surface 18 and is partially recessed in the solution of the polymer composition in the lower Tray 9. During grinding, the polymer composition is applied in a strip 15 20 mm so that the seam is in the center of the strip. The applied polymer coatings 13 are immediately dried by using the shade 7 installed in the casings 6. To regulate the temperature in the cavities of the casings 6 use regulators 21 for changing the voltage in the tissue supply system 7. Guides 19 and 20 ensure reliable advancement of tissues 12. The design improves reliability and

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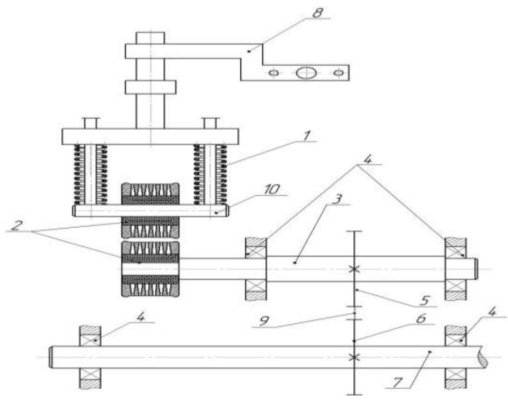
strength thread connections in garments due to timely bulging applied to comparable materials[5].

III. Dynamics of a machine assembly with a roller mechanism of the device.

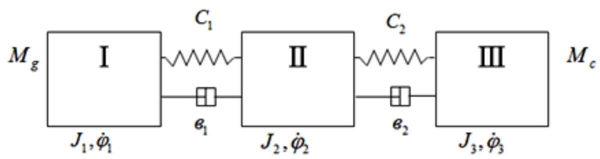
We compose the mathematical model of the dynamics of the roller movement according to the design scheme (see Fig. 2), taking into account the mechanical characteristics of the engine, the elastic-dissipative properties of the belt drive and the elastic roller sleeve, as well as technological resistances from the applied polymer material and grinded materials.

$$\dot{M}_g = 2M_k\omega_c - 2M_k p\dot{\varphi}_1 - \omega_c S_k M_g;$$
$$J_1\ddot{\varphi}_1 = M_g - в_1(\dot{\varphi}_1 - \dot{\varphi}_2) - c_1(\varphi_1 - \varphi_2);$$
$$J_2\ddot{\varphi}_2 = в_1(\dot{\varphi}_1 - \dot{\varphi}_2) + c_1(\varphi_1 - \varphi_2) - в_2(\dot{\varphi}_2 - \dot{\varphi}_3) - c_2(\varphi_2 - \varphi_3); \quad (1)$$
$$J_3\ddot{\varphi}_3 = в_2(\dot{\varphi}_2 - \dot{\varphi}_3) + c_2(\varphi_2 - \varphi_3) - M_c,$$

Where; M_g, M_k the driving moment of the engine and its critical value reduced to the carrying shaft; p - number of pole pairs; ω_c - the circular frequency of the network; S_k - slip and its critical value; $\dot{\varphi}_1$, $\dot{\varphi}_2$, $\dot{\varphi}_3$- angular speeds of the driven shaft, intermediate shaft and outer roller sleeve; M_c- technological resistance from the grinded materials; $c_1, c_2, в_1, в_2$ - coefficients of circular stiffness and dissipation of the belt drive and the elastic roller sleeve.



a – Roller drive kinematic diagram



where, I is the mass of the driven shaft with the drive pulley; II- mass, roller shaft and driven pulley; III- mass of the outer roller sleeve b - Designscheme

Fig. 2 - Rollerdrivescheme

Numerical solution of the problem and analysis of the results of studies of the dynamics of the rollers of the device, the solution of the system of differential equations (1) was carried out on a PC with the following initial and calculated values of the parameters of the machine unit: TYPICAL engine, $N_д$ =0,4 *kW*, *n=2800÷4700 rev/min;* R_p*=0,014 m;* n_p*=46 rev/min;* n_p*=46 rev/min;* I_1*=0,106 Nms*^{2}*;* I_2*=0,0052 Nms*^{2}*;* I_3*=0,0031 Nms*^{2}*;* ω_c*=314 s*$^{-1}$*;* f_c*=50 Hertz;* c_1*=(75÷115) Nm/rad;* c_2*=(6,0÷10) Nm/rad;* $в_1$*=(34÷40) Nms/rad;* $в_2$*=(12÷15) Nms/rad;* M_c *=(0,07÷0,12) Nm.*

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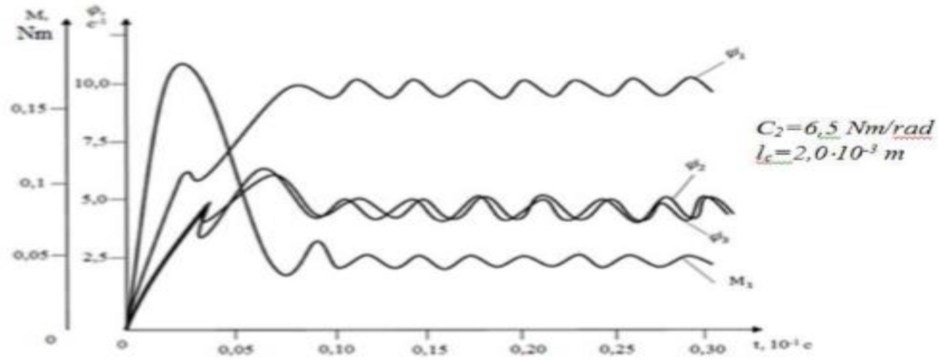
In the studies, the consumption of the polymer composition is included in the reduced moment of inertia of the outer roller sleeve, and the moment of resistance is added up from the materials being ground and from the compressible deformation when interacting with the roller.

In fig. 3 shows the regularities of changes in the angular velocities of the driven shaft, the roller shaft with the drive pulley and the outer roller sleeve, as well as the torque on the driven shaft of the machine unit, taking into account the electromagnetic transient processes between the masses of the machine unit. From the obtained regularities $\dot{\varphi}_{1,}\dot{\varphi}_{2,}\dot{\varphi}_3$ and M_1 it is seen that in the steady state of motion, the angular velocities and the load on the reduced shaft oscillate with a certain amplitude and frequency[6,7].

It should be noted that the vibration frequency corresponds to the number of stitches per revolution of the roller of the device. In fig. 3 stitch length $l_c=2{,}0\cdot10^{-3}$ m. In this case, the vibration amplitude depends mainly on the torsional rigidity of the rubber roller sleeve. In fig. 3 a shows the regularities $\dot{\varphi}_{1,}\dot{\varphi}_{2,}\dot{\varphi}_3$ and M_1 with a torsional stiffness of the rubber roller sleeve of *6,5 Nm/rad* at $l_c=2{,}0\cdot10^{-3}$ m in Fig. 3 b, $c_2=8{,}5$ *Nm / rad*, in Fig. 3 in, $c_2=10{,}5$ *Nm/rad*.

Based on the processing of the obtained laws of motion of the shafts of the machine unit, graphical dependences of the change in the coefficient of unevenness of the angular velocity of the shaft of the outer sleeve on the variation of the moment of inertia of the outer sleeve of the pressure compound roller of the device were constructed (see Fig. 4 a) It can be seen from the graphs that an increase in the moment of inertia of the outer sleeve of the pressure roller from $0{,}5\cdot10^{-3}$ Nms^2 to $6{,}0\cdot10^{-3}$ Nms^2 leads to a decrease in δ_3 from $1{,}6\cdot10^{-1}$ to $0{,}62\cdot10^{-1}$ according to a nonlinear pattern with a stitch length $l_c=4{,}0\cdot10^{-3}$ m, and with a stitch length $l_c=2{,}0\cdot10^{-3}$ m, the coefficient of unevenness of the angular velocity δ_3 of the outer sleeve decreases from $0{,}835\cdot10^{-1}$ to $0{,}23\cdot10^{-1}$ Recommended values of the moment of inertia of the outer roller sleeve taking into account the consumption of the polymer composition is $I_3=(4{,}5\div6{,}0)\cdot10^{-3}$ Nms^2.

a)



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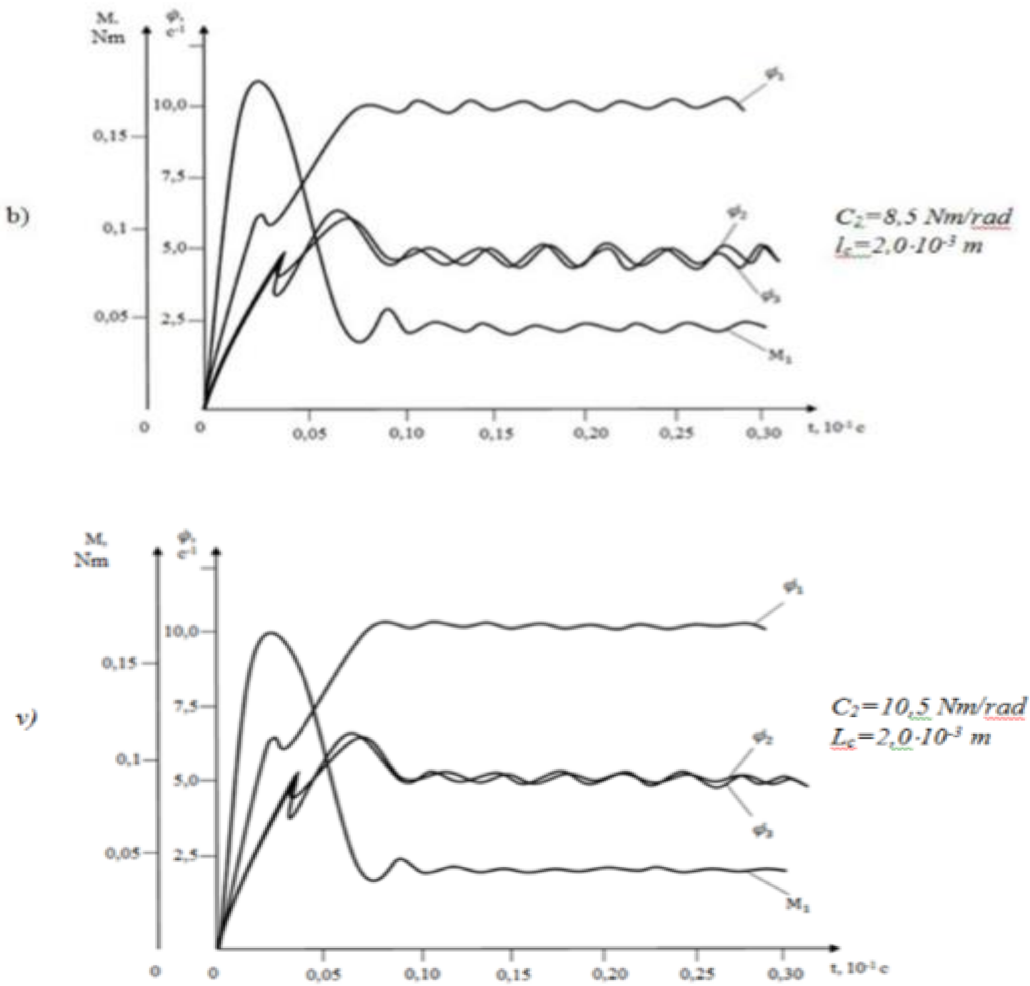

Fig. 3. Regularities of changes in the angular velocities of the reduced shaft, roller shaft and outer sleeve, as well as the torque on the reduced shaft with a stitch length l_c=2,0·10^{-3} m and a rotational speed of the main shaft of the sewing machine 4000 rev/min

It should be noted that to ensure the required value of δ_3 at large values of l_c, it is considered expedient to increase the consumption of the polymer composition. At the same time, the necessary strength of the stitches of the materials to be sewn is additionally provided.

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