

Teoretiko-Experimental Method of Definition of Parameters of the Roller with the Rubber Plug of the Device for Drawing of the Polymeric Composition on Lines of Sewed Materials

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Abstract: In article the device for drawing of a polymeric composition on lines of ground off materials is resulted. Dynamics of the machine unit is considered, laws of movement of rollers of the device are defined, to a basis of the analysis of graphic dependences recommended parameters of system are proved. On a basis full factorial experiments parameters of the device for various sewed materials are recommended.

Keywords : device, a roller, the elastic plug, a polymeric composition, durability, the machine unit, the movement law, parameters, full factor, rigidity, frequency, the expense.

I. INTRODUCTION

At manufacturing on garments are using various types stitches [1,2]. Thus in most cases durability of these stitches the (shuttle and chain) do not meet operational requirements.

For increase of durability of lines compositions are put on them [3,4] polymeric. Currently, existing methods of hardening the seams of materials do not meet the requirements. A device is known for applying a polymer composition over cuts of parts of garments in the tailoring industry instead of swaddling for securing cuts from shedding. The device contains a system for supplying a liquid-phase polymer, a unit for applying polymer to sections of parts of a garment, a support for placing a product with a rack to move it [2]. Liquid-phase polymer is applied to the sections of parts in a contact way 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 polymer composition. A disadvantage of the known constructions is that these devices apply the polymer composition to only one layer of fabric, in

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order to protect the cuts from shedding. This increases the processing time, requires additional equipment and switching methods, which increases the duration of the production cycle. The use of this design for fastening the fabric threads along the seams from retractable is possible (applying the polymer in this installation, and then grinding the cut parts on a universal machine), but this also requires additional equipment, repositioning techniques and would increase the technological process of making clothes.

In the design of the device containing two rotating rollers covered with a porous material, the rollers are mounted on the body of the sewing machines on both sides of the parts to be grinded behind its presser foot and toothed rack and interconnected belt overlap, the power system of the liquid polymer composition contains the upper bath connected to the surface of the upper roller through the supply tube with feed regulator, and installed under the working platform of the machine bottom bath in which the bottom roller is partially immersed.

The main disadvantage of the known constructions is low reliability due to the lack of the process of the applied polymer coating on the seams of the materials being grinded.

Development of effective structural schemes of the device. On fig. 1 it is presented the scheme of the device for drawing of a polymeric composition on lines of sewed materials.

In an offered design for drawing of a polymeric composition on ground off details of clothes [5] the case 1, the top and bottom compound rollers established on shaft 2, and having elastic (rubber) plugs 3, plastic porous plugs 4 with the truncated conic through apertures 5 on their surface and ledges 18, along the edges of plugs 4 and, bearings 6 and 7, the top bath 8 with a polymeric composition, the bottom bath 19 with the polymeric composition, feeding tube 9 with a regulator of 10 giving of polymer (fig. 1 see) contains.

This design is improved device design and forced drying of the coating immediately after its application. The device includes a sewing machine housing 1, the upper rotating roller 2, the lower rotating roller 3, the upper shaft 4, the lower shaft 5, the upper bath with the polymer composition 8, the lower bath with the polymer composition 9, the feeding tube 10, the polymer feed regulator 11, the upper and the lower part to be machined 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 needle plate 17 (Fig. 2).

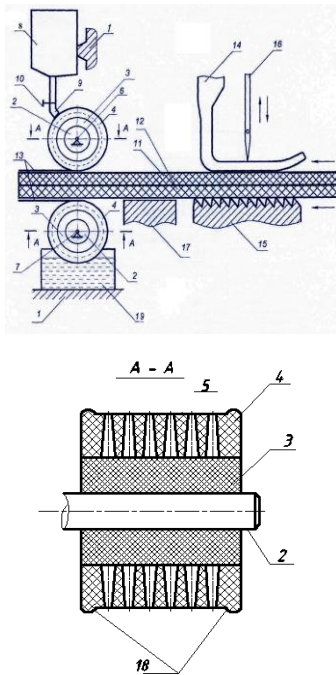


Fig. 1. Devices for drawing of a polymeric composition on ground off details of a cut

The surface of the rollers 2, 3 is covered with porous material 18. Rollers 2, and 3 are mounted on the body of the sewing machine on both sides of the stitched parts 12 behind its presser foot 14 and the toothed rack 15 and are interconnected by a belt drive overlap (not shown in the figure). The upper tub 8, the supply tube 10 connected to it with the feed regulator 11 and the lower tub 9 installed under the working platform of the machine constitute the power supply system for the liquid polymer composition 13. The upper tub 8 is connected to the surface of the upper roller 2 through the supply tube 10. In the lower tub 9, the lower roller 3 is partially immersed.

The sides of the materials 12 are fitted with housings 6, rigidly connected to the body 1 of the sewing machine and made with single guides 19, 20. Inside the housings 6 are installed a shadow 7, which is powered by electric energy and have regulators 21. The device works as follows. When grinding part 12 pressed by the foot 14 to the rack 15 and the needle plate 17. The advancement of the fabric by the stitch size is carried out by a rack, located in the slot of the needle plate. The rake feeds materials only under the needle 16, and the worker sets the direction of movement of materials when the line is executed. When the needle 16 and the shuttle interact (not shown in the drawing), the lock stitch is formed. Further, the materials to be ground 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. B the process of moving tissue from the upper bath 8 through the feeding tube 10 the polymer composite flows to the porous surface 18 of the upper roller 2 and applied to the upper fabric in the form of a film 13. The supply of the polymer composition is controlled by means of the regulator 11. The polymer composition 13 is applied to the lower layer of fabric to be wound with the help of the lower roller 2, which also has a porous surface 18 and is partially embedded in the solution of the polymer composition in the bottom bath 9. In the

process of grinding, the polymer composition is applied in a 15-20 mm so that the seam is in the center of the strip. The applied polymer coatings 13 are immediately dried by using shade 7, installed in housings 6. To regulate the temperature in the cavities of housings 6 creep up regulators 21 voltage changes in the power supply system fabrics 7. The guides 19 and 20 provide reliable promotion of fabrics 12.

The design allows improving the reliability and durability of thread joints in garments due to timely bulging applied to comparable materials.

II. DYNAMICS OF THE MACHINE UNIT WITH THE MECHANISM OF ROLLERS OF THE DEVICE

Mathematical model of dynamics of movement of a roller it is made [6,7] according to the settlement scheme (fig. 2 see) with the account mechanical engine characteristics, it is elastic-dissipation properties belt transfer and the elastic plug of a roller, and also technological resistance from a put polymeric material and ground off materials.

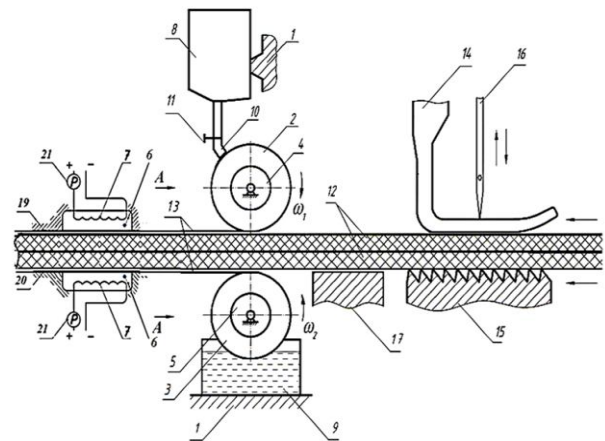


Fig.2. a composition on clothing parts

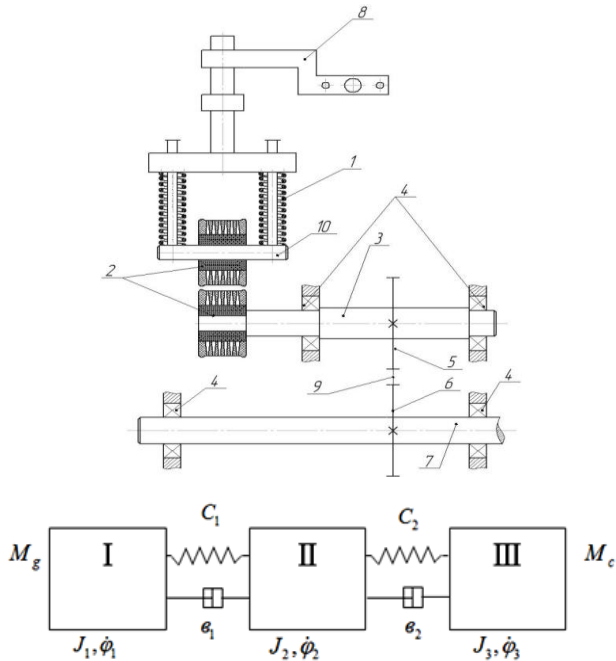
$$\begin{aligned} \dot{M}_g &= 2M_k \omega_c - 2M_k p \dot{\varphi}_1 - \omega_c S_k M_g \\ J_1 \ddot{\varphi}_1 &= M_g - \epsilon_1 (\dot{\varphi}_1 - \dot{\varphi}_2) - c_1 (\varphi_1 - \varphi_2) \\ J_2 \ddot{\varphi}_2 &= \epsilon_1 (\dot{\varphi}_1 - \dot{\varphi}_2) + c_1 (\varphi_1 - \varphi_2) - \epsilon_2 (\dot{\varphi}_2 - \dot{\varphi}_3) - c_2 (\varphi_2 - \varphi_3) \\ J_3 \ddot{\varphi}_3 &= \epsilon_2 (\dot{\varphi}_2 - \dot{\varphi}_3) + c_2 (\varphi_2 - \varphi_3) - M_c \end{aligned} \quad (1)$$

Where: the driving moment of the engine and its critical value the carrying out led to a shaft;

- number of pairs poles;
- circular frequency of a network;
- sliding and its critical value;
- angular speeds of the resulted shaft, intermediate shaft and the external plug of a roller;
- technological resistance from ground off materials;
- factors of circular rigidity and dissipation a belt drive and the elastic plug of a roller.

Numerical the decision of a problem and the analysis of results of researches of dynamics of rollers of the device (1) carried out the decision of system of the differential equations on the personal computer at following initial and settlement values of parametres of the machine unit: the engine “Yamata FY-8500” (Japan), N_d

$=0,4 \text{ kvT}$, $n=2800\div 4700 \text{ rpm}$; $R_p=0,014 \text{ m}$; $n_p=46 \text{ rpm}$; $n_p=46 \text{ rpm}$; $I_1=0,106 \text{ Nms}^2$; $I_2=0,0052 \text{ Nms}^2$; $I_3=0,0031 \text{ Nms}^2$; $c=314 \text{ s}^{-1}$; $f_c=50 \text{ Hz}$; $c_1=(75\div 115) \text{ Nm/rad}$; $c_2=(6,0\div 10) \text{ Nm/rad}$; $b_1=(34\div 40) \text{ Nms/rad}$; $b_2=(12\div 15) \text{ Nms/rad}$; $M_c=(0,07\div 0,12) \text{ Nm}$.



where, I - weight of the resulted shaft with a leading pulley;
II - weight, a shaft of a roller and a conducted pulley;
III - weight of the external plug of a roller
a – the kinematic scheme of a drive of rollers
b - the settlement scheme

Fig. 3 - the Scheme of a drive of rollers

At researches the expense of a polymeric composition is included in the resulted moment of inertia of the external plug of a roller, and the resistance moment develops from ground off materials and from compressed deformations at interaction with a roller.

On fig. 4 laws of change of angular speeds of the resulted shaft, a shaft of a roller with driven a pulley and the external plug of a roller, and also a twisting moment on given are presented a shaft of the machine unit taking into account electromagnetic transients between weights of the machine unit. From the received laws $\dot{\varphi}_1$, $\dot{\varphi}_2$, $\dot{\varphi}_3$ M_1 it is visible that in the established mode of movement angular speeds and loading on resulted to a shaft hesitates with certain amplitude and frequency.

It is necessary to notice that frequency of fluctuations corresponds to number of stitches for one turn of a roller of the device. On fig. 4 length of stitches $l_c=2,0 \cdot 10^{-3} \text{ m}$. Thus the amplitude of fluctuations depends basically from torsional rigidity of the rubber plug of a roller. On fig. 4 a and laws are resulte $\dot{\varphi}_1$, $\dot{\varphi}_2$, $\dot{\varphi}_3$ and M_1 at torsional rigidity of the rubber plug of a roller $6,5 \text{ Nm/rad}$ at $l_c=2,0 \cdot 10^{-3} \text{ m}$ On fig. 3 b, $c_2=8,5 \text{ Nm/rad}$, On fig. 3 v, $c_2=10,5 \text{ Nm/rad}$.

On the basis of processing of the received laws of movement of shaft of the machine unit graphic dependences of change of factor of non-uniformity of angular speed of a shaft of the external plug on a variation of the moment of inertia of the external plug of a clamping compound roller of the device (fig. 4 a see) are constructed of schedules it is

visible that increase in the moment of inertia of the external plug of a clamping roller from $0,5 \cdot 10^{-3} \text{ Nms}^2$ to $6,0 \cdot 10^{-3} \text{ Nms}^2$ leads to reduction 3 from $1,6 \cdot 10^{-1}$ to $0,62 \cdot 10^{-1}$ on nonlinear law at length of a stitch $l_c=4,0 \cdot 10^{-3} \text{ m}$, and at length of a stitch $l_c=2,0 \cdot 10^{-3} \text{ m}$ factor of non-uniformity of angular speed 3 the external plug decreases from $0,835 \cdot 10^{-1}$ to $0,23 \cdot 10^{-1}$ Recommended values of the moment of inertia of the external plug of a roller taking into account the expense of a polymeric composition is $I_3=(4,5\div 6,0) \cdot 10^{-3} \text{ Nms}^2$.

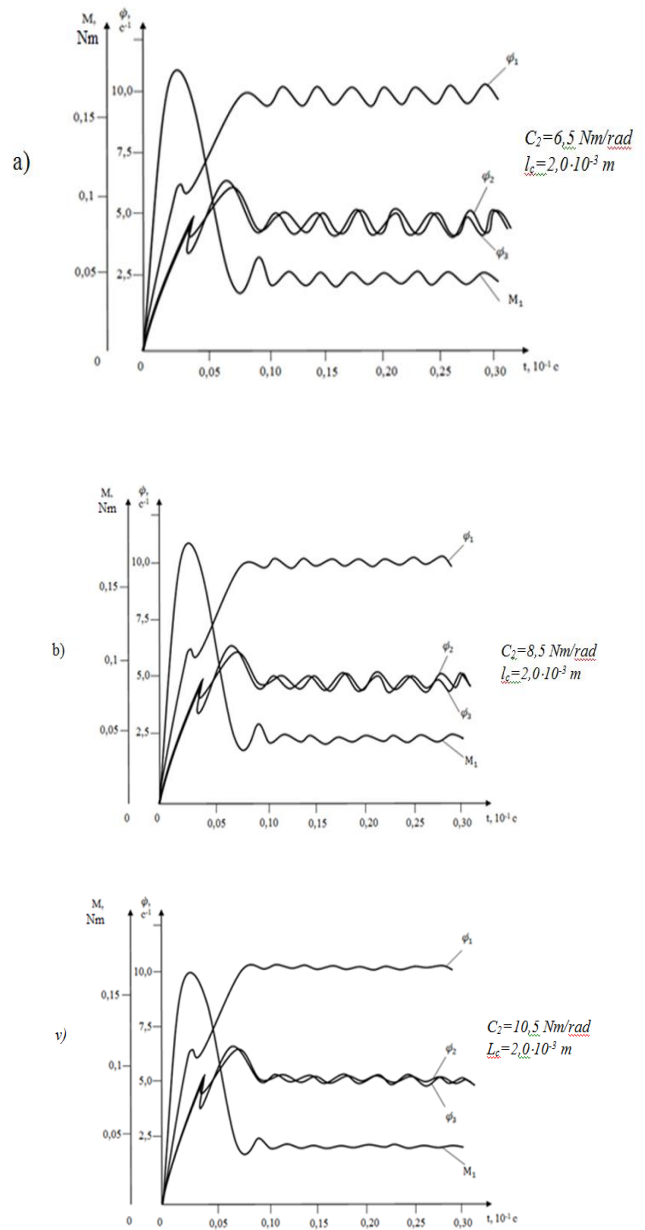


Fig. 4. Laws of change of angular speeds of the resulted shaft, a shaft of a roller and the external plug, also a twisting moment on resulted to a shaft at length of a stitch $l_c=2,0 \cdot 10^{-3} \text{ m}$ and frequency of rotation of the main shaft of the sewing-machine 4000 rpm

It is necessary to notice that for maintenance of necessary value 3 at great values l_c expedient it is considered increase in the expense of a polymeric composition. Thus are in addition provided necessary durability of lines of ground off materials.

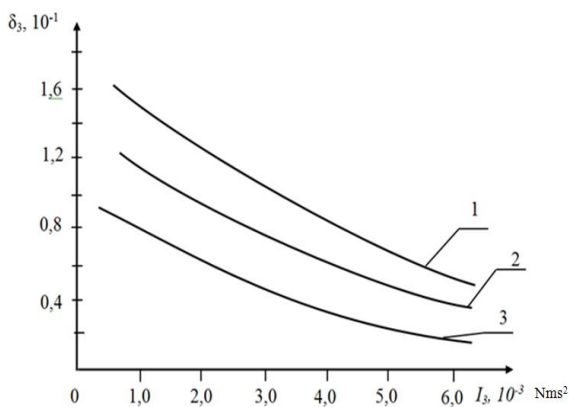
Studying of change of resistance from ground off materials which directly



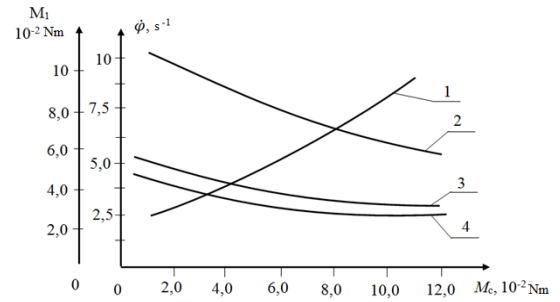
considers the deformations of materials depending on their thickness is important. On fig. 5 b graphic dependences of change of angular speeds of shaft of the machine unit and loading are presented M_1 Reduction shaft. Increase M_c from $1,0 \cdot 10^{-3}$ Nm to $12,0 \cdot 10^{-3}$ Nm leads to twisting moment increase M_1 from $2,25 \cdot 10^{-2}$ Nm to $10,35 \cdot 10^{-2}$ Nm on nonlinear law. Thus angular speed of a shaft of reduction decreases from $10,35 \text{ s}^{-1}$ to $5,40 \text{ s}^{-1}$, and angular speed of a shaft of a roller from $5,15 \text{ s}^{-1}$ to $3,45 \text{ s}^{-1}$ and angular speed φ_3 decreases from $4,85 \text{ s}^{-1}$ to $2,55 \text{ s}^{-1}$. Therefore M_c it is necessary to choose less, than $(6,0 \div 8,0) \cdot 10^{-3}$ Nm, and at sewing together of thicker materials expedient it is considered increase in circular rigidity of the rubber plug of clamping rollers.

On fig. 5 laws of change of angular speeds of shaft of the machine unit and a twisting moment on resulted are presented a system shaft at a variation torsional to rigidity of the rubber plug of a roller for drawing of a polymeric composition on lines with length of stitches $4,0 \cdot 10^{-3}$ m. From them it is visible that the increase in length of stitches leads to reduction of frequency of fluctuations of angular speeds of shaft. It is necessary to notice that with increase torsional to rigidity of the rubber plug of a roller leads to some decrease not only average value loading a shaft of reduction of system, but also to decrease in amplitude of fluctuations of angular speeds of shaft. This results from the fact that at increase torsional rigidity of the rubber plug the second and third weights becomes as though uniform that leads to decrease in non-uniformity of angular speeds of shaft of system.

On fig. 7 a and graphic dependences of change of angular speeds of shaft of the machine unit of the device for drawing of a polymeric composite on lines of sewed materials from length of stitches are presented. The increase in length of stitches results not only in reduction of frequency of fluctuations φ_1 , (φ_2 and φ_3). But also to reduction of their average values (fig. 7 see). So, at increase l_c from $1,0 \cdot 10^{-3}$ m to $4,5 \cdot 10^{-3}$ m speed φ_1 decreases from $10,4 \text{ s}^{-1}$ to $7,9 \text{ s}^{-1}$, and φ_3 decreases from $5,85 \text{ s}^{-1}$ to $3,0 \text{ s}^{-1}$. On fig. 7 dependences of change are resulted M_1 and M_1 from increase in length of stitches.



1-at $l_c=4,0 \cdot 10^{-3}$ m; 2-at $l_c=3,0 \cdot 10^{-3}$ m; 2-at $l_c=7,0 \cdot 10^{-3}$ m;
Fig. 5. a - graphic dependences of change of factor of non-uniformity of angular speed of the external plug of a clamping roller on increase in its resulted moment of inertia



1- $M_1=f(M_c)$; 2- $\dot{\varphi}_1=f(M_c)$; 3- $\dot{\varphi}_3=f(M_c)$; 4- $\dot{\varphi}_2=f(M_c)$;
Fig. 5. – b graphic dependences of change of angular speeds of shaft of the machine unit and a twisting moment on a shaft of reduction of system from change of technological resistance of sewed materials.

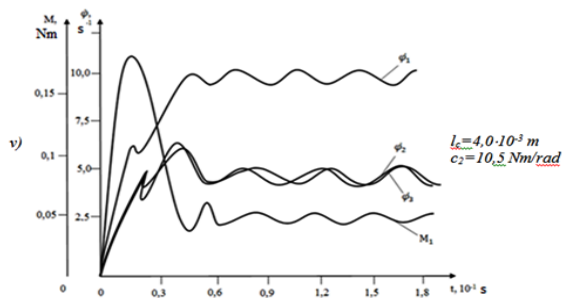
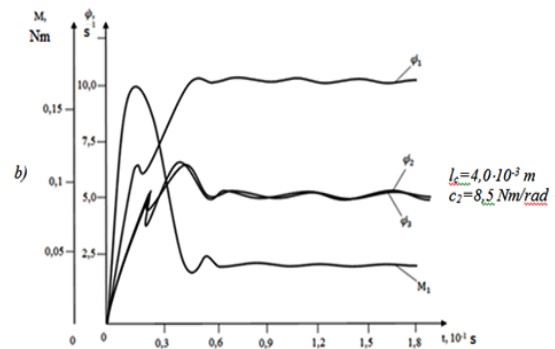
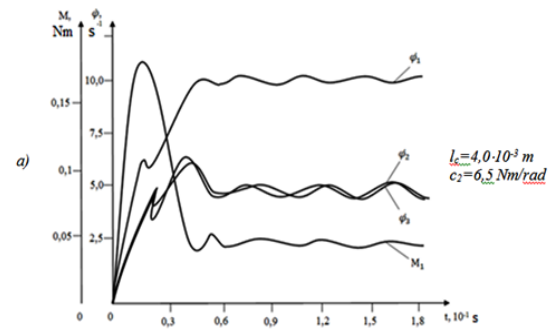
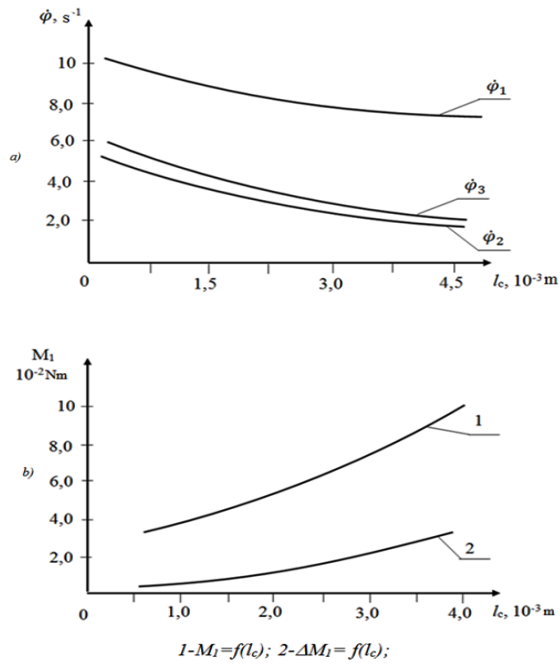
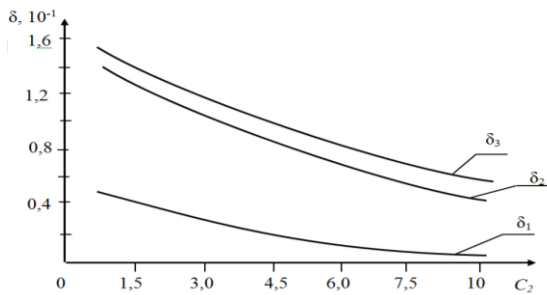


Fig. 6. Laws of change of angular speeds of the resulted shaft, a shaft of a roller and the external plug, also a twisting moment on resulted to a shaft at length of a stitch $l_c=4,0 \cdot 10^{-3}$ m and frequencies of rotation of the main shaft of the sewing-machine 4000 rpm

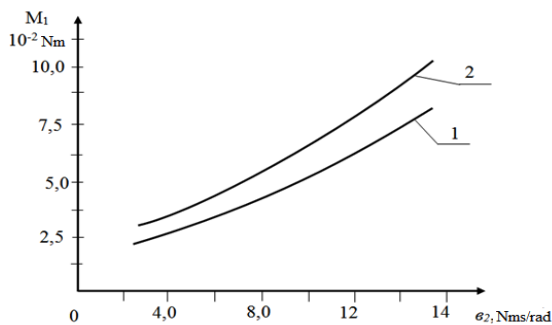


a – Dependences of change of angular speeds of shaft machine units;
b – Dependences of change of a twisting moment on a shaft of carrying out of the machine unit

Fig. 7. Dependences of change $\dot{\varphi}_1$, $\dot{\varphi}_2$, $\dot{\varphi}_3$ and M_1 , from a variation l_c



a – dependences of change of factors irregularities angular speeds of shaft of the machine unit from a variation of values of factor of circular rigidity of the rubber plug of a clamping roller



b – Graphic dependences of change of a twisting moment on a shaft of a ghost of the machine unit from factor dissipation the rubber plug of a clamping roller of installation

Fig. 8. Laws of change of factors unevenness and loading a shaft it is resulted

From them it is visible that increase l_c a little scope of fluctuations of a twisting moment with increase influences also l_c . Average value M_1 Increases from $3,45 \cdot 10^{-2}$ Nm to $9,35 \cdot 10^{-2}$ Nm. The refore at sewing together with more in the length of stitches expedient it is considered increase in

circular rigidity of the rubber plug of a clamping roller. On fig. 8 a and change schedules irregularities angular speeds of shaft of the machine unit from a variation of circular rigidity of the rubber plug are presented.

With increase c_2 from 1,0 Nm/rad to 10,0 Nm/rad Non-uniformity factor 1, decreases from $0,45 \cdot 10^{-1}$ to $0,12 \cdot 10^{-1}$. Thus accordingly 2 decreases from $1,4 \cdot 10^{-1}$ to $0,44 \cdot 10^{-1}$, and The factor non-uniformity of rotation of the external plug of a clamping roller decreases from $1,35 \cdot 10^{-1}$ to $0,72 \cdot 10^{-1}$.

For maintenance of uniformity of rotation 1, 2 and 3 In necessary limits and also for sewing together of thicker materials at drawing of polymeric composites of lines by recommended values of circular rigidity of the rubber plug of a roller are considered (8,5÷13,5) Nm/rad.

Dissipation properties of a belt drive, especially rubber plug of a clamping roller basically influence attenuation of own circular fluctuations of shaft at a mode of start-up of system, and also on loading a shaft of reduction of the machine unit. Thus increase b_2 from 2,25 Nms/rad to 13,75 Nms/rad at $M_c=5,0 \cdot 10^{-2}$ Nm leads to twisting moment increase on driven to a shaft from $1,72 \cdot 10^{-2}$ Nm to $7,54 \cdot 10^{-2}$ Nm, and at $M_c=10 \cdot 10^{-2}$ Nm M_1 Increases from $2,65 \cdot 10^{-2}$ Nm to $10,19 \cdot 10^{-2}$ Nm.

As recommended values of factor dissipation the rubber plug of a clamping roller are considered (4,5÷7,5) Nms/rad, at which are provided necessary attenuation of fluctuations $\dot{\varphi}_1$, $\dot{\varphi}_2$, $\dot{\varphi}_3$, and also increase M_1 will be insignificant.

III. DEFINITION OF EXPLOSIVE FORCES TO A LINE

In table 1 the data of results of the spent researches for the fabrics sewed in a cross-section direction on a duck is cited. Experience was spent with 5 multiple frequency [8]. The analysis of the received results shows that explosive force on directionally a duck for a material of Adras are in limits 28,0÷42,0 N, for a material the Atlas in limits 20,0÷31,2 N, and for a material Silk in limits 25÷42,8 N at change of length of stitches (2,0÷4,0) · 10⁻³ m actually with increase in the expense of a polymeric covering explosive force remains invariable.

At frequency of rotation of a power shaft $n = 2000$ (rpm), Loading on clamping a roller $P = 21$ N

Table 1

Fabric giving U (mm)	The expense emulsion on one sm fabrics are long. W(gr/sm ²)	Explosive force Q ,N.		
		Adras without emulsion	Atlas without emulsion	Silk without emulsion
		14.9	17.0	n 7.4
		Adras with emulsion	Atlas with emulsion	Silk with emulsion
2mm	0.1	33,9	22,9	36,
2mm	0.15	35,0	23,3	37,1
2mm	0.20	35,5	24,1	38,2

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2mm	0.25	36,0	25,0	39,1
2mm	0.30	36,3	26,2	39,6
2mm	0.35	36,8	27,1	40,1
2mm	0.40	37,2	28,1	42,2
3mm	0.1	30,0	21,1	26,1
3mm	0.15	33,0	22,2	27,1
3mm	0.20	34,0	23,4	27,9
3mm	0.25	36,1	25,5	28,5
3mm	0.30	37,1	27,1	29,4
3mm	0.35	39,0	29,0	30,0
3mm	0.40	42,5	31,2	31,2
4mm	0.1	28,0	20,1	25,0
4mm	0.15	29,4	22,2	26,4
4mm	0.20	31,2	2,5	27,3
4mm	0.25	32,0	2,6	28,5
4mm	0.30	33,4	27,3	29,0
4mm	0.35	35,5	290	29,5
4mm	0.40	37,2	30,0	30,1

The analysis of results fullfactor experiments. For a substantiation of recommended parametres of the device have been spent fullfactor experiments [9,10]. A planning matrix it is presented to tab. 2.

Table 2

The factor name.	Designation code	True values of the factor.			Change range
		-1	0	+1	
Frequency of rotation of the main shaft rpm.	X ₁	4000	4500	5000	500
Rigidity of rubber on a roller 10 ⁴ N/m	X ₂	0,100	0,150	0,200	X ₂
The expense emulsion on mgr/sm ²	X ₃	0,15	0,25	0,35	X ₃

For target parametre was to accept explosive force of lines of sewed materials with a polymeric layer. Experiments have spent for fabrics of Adras, the Atlas and Silk. Following equations of regresses are received

The equation of regress for a fabric of Adras.

$$U = 49.8 - 4.175X_1 + 1.325X_2 + 1.675X_3 + 0.029348X_1X_2 - 0.025X_1X_2X_3$$

The equation for a fabric the Atlas.

$$U = 41.43 - 2.66X_1 + 1.0625X_2 + 0.1875X_3 + 0.33X_1X_2 - 1.4125X_1X_3 + 0.1625X_2X_3 + 0.1X_1X_2X_3$$

The equation for a fabric Silk.

$$U = 36.71 - 1.2125X_1 + 1.6875X_2 - 0.7375X_3 - 1.1375X_1X_2 + 0.1875X_1X_3 + 0.0875X_2X_3 + 0.5125X_1X_2X_3$$

IV. CONCLUSIONS

During time full factor experiment following values for the chosen major factors allow to recommend the analysis of the received results:

Influence of frequency of rotation of the main shaft on explosive force: rigidity of rubber on a roller, – 1000 N/m; frequency of rotation of the main shaft, – 5000 rpm; the expense emulsion – 0,15 mgr/sm². At the given values of factors it is observed, explosive force makes effect above 36%.

Influence of rigidity of rubber on explosive force: rigidity of rubber on a roller, – 2000 N/m; frequency of rotation of the main shaft, – 4000 rpm; the expense emulsion – 0,15 mgr/sm². At the given values of factors it is observed, explosive force makes effect above 42 %.

Expense influence emulsion on explosive force: rigidity of rubber on a roller, – 2000 N/m; frequency of rotation of the main shaft, – 5000 rpm; the expense emulsion – 0,35 mgr/sm². At the given values of factors it is observed, explosive force makes effect above 36 %.

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