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Analytical Research of a Tension the Warp Yarns for the Cycle of Work of the Weaving Loom

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ABSTRACT: The paper presents analytical studies of the tension of the warp yarns for the cycle of the loom. On the basis of the differential equation of motion of the moving system, the formula for tension of the warp yarns for the loom operation cycle was obtained. Analyzed changes in the tension of the warp threads for a rotate of the main shaft (work cycle) of the loom.

KEY WORDS: warp yarn, back roller weft yarn, projectile, weaving loom, yarn tension, filling insertion.

I.INTRODUCTION

On a shuttleless loom, the adjustment of the tension of the base during one cycle of the machine is performed using a mobile rock system. More precisely, the increase in the tension of the warp threads during the formation of the throat is compensated by the deviation of the rock. However, the experience of operating looms and a number of studies have shown that the mechanism of rocking rock in serial machines does not fully compensate for deformation of the base during shedding.

The various patterns of repeated loading of the yarn on the loom during the operation in different ways affect the intensity of accumulation of plastic elongations, i.e. on the fatigue of the yarn. The minimal fatigue of the cotton yarn causes multiple loading, in which the maximum load on the filament affects a short time in each cycle, while the greater part of the period goes to rest the yarn in an unloaded state.

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On weaving looms, the tension of the warp yarns during the one cycle of the machine operation is controlled by means of a moving system. More precisely, the increase in the tension of the warp threads during the formation of the shed is compensated by the deviation of the back roller. However, the operating experience of these looms, as well as a number of studies has shown that the mechanism of a swinging back roller in serial looms do not fully compensate for the deformation of the warp when forming shed. Different patterns of repeated loading of yarn on a loom during operation have a different effect on the intensity of accumulation of plastic elongations, i.e. fatigue yarn. The least fatigue of cotton yarn causes repeated loading, in which in each cycle the maximum load on the thread affects a short time, and most of the period is spent on the rest of the yarn in the unloaded state.Therefore, in order to preserve the technologically useful properties of the yarn, the weaving process must be structured so that the change in the tension of the thread in nature is close to that the loading is short in time, and the rest in the unloaded state is relatively long. In

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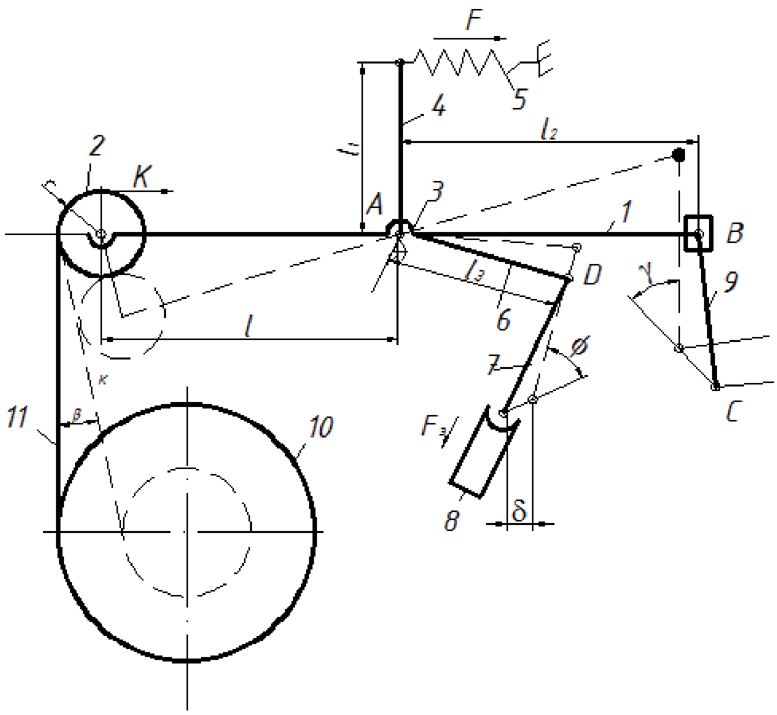
addition, it is necessary to strive to reduce the absolute values of the loads and to reduce the amplitude of their changes. Therefore, it is advisable that the threads during the work cycle of the loom for a smaller part of the time were under relatively high loads, and the minimum load of the thread was experienced only during the shedding process, that is, for a considerable time of the work cycle of the loom. During the period of shedding, a high tension is not necessary, it must be such that, with an opening shed, it's given height is maintained, and there is no sticking of in low tension of threads. One of the methods for obtaining this law for changing the warp tension is the method of forced rolling of a back roller. This method consists in reducing the total initial tension of the warp to the lowest possible value. However, at the time of beat-up process, the tension of the warp is forcibly increased to the level required to create normal weft surf conditions. As a result of work on optimizing the change in the tension of the warp threads on the loom, we proposed a new construction of the moving system.

II. ANALYTICAL RESEARCH

The differential equation of motion of a moving system of the back roll has the following form [2]

$$J\varphi = M_k - M_F - M_M \qquad (1)$$

Where: J - reduced (to the axis of rotation of the scroll) the total moment inertia of the links of the moving roll system; φ - angular acceleration of the scroll; M_k -is the moment of the tension of the warp yarns to the axis of rotation of the scroll; M_F - the moment of spring elasticity with respect to the axis of rotation of the scroll; M_M is the moment of the action force of the electromagnet relative to the axis of rotation of the scroll.



1-three shoulder lever, 2-back roller, 3- scroll, 4,6- levers, 5-spring, 7,9-rods, 8- electromagnet, 10-weaving beam, 11-warp yarrns

Fig.1. To calculate the tension of warp yarns.

From figure 1 we find

$$M_k = K(l+r)\cos\beta - Kr = K[(l+r)\cos\beta - r], \qquad (2)$$

$$M_F = 2Fl_1 = 2(F + C\varphi l_1)l_1 = 2Fl_1 + 2Cl_1^2\varphi, \qquad (3)$$

$$F = C\lambda; \quad M_м = F_м \cdot l_м$$

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where: C - coefficient of spring stiffness, kg / cm; φl_1 - the value of the compression of the spring when the moving system is rotated through an angle φ around the axis of the scroll; K - tension of the warp threads, kg; l_1 - spring action shoulder, cm; l - distance from the axis of the back roll to the axis of the scroll, cm; $l_м$ - the shoulder of the action of the electromagnet on the scroll, cm; r - is the radius of the back roll, cm;
F - spring force, kg; $F_э$ - the force of the electromagnet, kg.
Substituting the value of the moments into equation (1), we obtain

$$J\varphi = K[(l+r)\cos\beta - r] - 2Fl_1 - 2Cl_1^2\varphi - F_м \cdot l_м \quad (4)$$

Or

$$J\varphi + 2Cl_1^2\varphi = K[(l+r)\cos\beta - r] - 2Fl_1 - F_м \cdot l_м \quad (5)$$

By dividing this equation by J we will have

$$\varphi + \frac{2Cl_1^2\varphi}{J} = \frac{K[(l+r)\cos\beta - r] - 2Fl_1 - F_м \cdot l_м}{J}; \quad (6)$$

We denote by

$$P^2 = \frac{2Cl_1^2}{J}$$

$$b = \frac{K[(l+r)\cos\beta - r] - 2Fl_1 - F_м \cdot l_м}{J}$$

Substituting these notations in (4), we obtain

$$\varphi + P^2 \cdot \varphi = b$$

The general solution of this inhomogeneous differential equation with constant coefficients has the following form:

$$\varphi = A\cos Pt + B\sin Pt + \frac{b}{P^2}; \quad (7)$$

where: A and B are integration constants.

Constants A and B are determined from the initial conditions. At the initial moment of time, the moving system is at rest. Therefore the initial conditions have the form
φ=0, φ=0 at t=0
Using the first initial condition φ=0 at t=0 we obtain:

$$A + \frac{b}{P^2}, \quad A = -\frac{b}{P^2}$$

Using the second initial condition

φ=0 at t=0

we have $\varphi = -AP\sin Pt + B\cdot P\cos Pt$; $BP=0$, $B=0$

Substituting the values of the integration constants in the general equation (7), we obtain:

$$\varphi = \frac{b}{P^2}(1-\cos Pt) \quad (8)$$

Substituting equation (8) for the values of the constants b and P, we obtain the equation of motion of the moving back roller system

$$\varphi = \frac{K[(l+r)\cos\beta - r] - 2Fl_1 - F_м \cdot l_м}{2Cl_1^2}\left(1-\cos\sqrt{\frac{2Cl_1^2}{J}}\cdot t\right) \quad (9)$$

Solving the obtained equation of roll motion relative to K, we obtain the following calculation equation for determining the tension of the warp yarns:

$$K = \frac{2Cl_1^2\cdot\varphi + (2Fl_1 + F_м l_м)\left(1-\cos\sqrt{\frac{2Cl_1^2}{J}}\cdot t\right)}{[(l+r)\cos\beta - r]\cdot\left(1-\cos\sqrt{\frac{2Cl_1^2}{J}}\cdot t\right)} \quad (10)$$

Since the tension studies in this chapter are carried out during the cycle of the machine, the rolling angle of the back roll φ is constant, and the angle of the warp threads departure from the coil winding can be taken to be zero, i.e. $\beta = 0$ then equation (10) has the form

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$$K = \frac{2Cl_1^2 \cdot \varphi + (2Fl_1 + F_M l_M)(1-\cos\sqrt{\frac{2Cl_1^2}{J}} \cdot t)}{l \cdot (1-\cos\sqrt{\frac{2Cl_1^2}{J}} \cdot t)} \quad ; \qquad (11)$$

Analysis of the formula shows that the initial tension (F) created by the spring has a minimum value, regardless of the article of the fabric being produced (for example: gauze or calico). This tension is necessary to prevent sticking of the shed during the shedding procces. The tension of the warp threads (F_m) created by the electromagnet will provide the technologically necessary power of the filling insertion procces. For clarity, we will give a calculation of the tension of the yarns for the cycle of operation of the projectile loom.

We take the following initial data: l_1 = 15 cm; l = 15 cm; l_m = 15 cm; r = 6.6 cm; F = 17 kg; F_m = 75 kg, J = 15.3 kg.sm.s^2; C = 15.7 kg / cm; φ = 0.035 rad; α = 0° ÷ 360°; n = 180 min-1;

$$t = \frac{\alpha}{6 \cdot n} \quad P = \sqrt{\frac{2Cl_1^2}{J}} = \sqrt{\frac{2 \cdot 15.7 \cdot 15^2}{15,3}} = \sqrt{462} = 21,5$$

Table 2 shows the results of calculating the change in the tension of the warp threads, per rotation of the main shaft (work cycle) of the machine.

The results of the calculation of the change in the tension of the warp threads during one rotation of the main shaft (work cycle) of the machine.

Table 2

Angle of rotation of the main shaft, degree.	*cosPt*	*1-cos Pt*	*L(1-cos Pt)*	*(2Fl$_1$+F$_M$l$_M$) (1-cos Pt)*	*K*, kg
0	0	1	15,0	510	50,5
10	0,009	0,991	14,87	505	50,6
20	0,017	0,983	14,75	501	50,7
30	0,026	0,974	14,61	1592	126,0
40	0,034	0,966	14,49	1579	126,0
50	0,043	0,957	14,36	1564	126,2
60	0,052	0,948	14,22	1540	126,4
70	0,06	0,94	14,1	1537	126,5
80	0,069	0,931	13,97	475	51,7
90	0,078	0,922	13,83	470	51,8
100	0,086	0,914	13,71	466	52,0
110	0,095	0,905	13,58	462	52,2
120	0,095	0,905	13,58	462	52,2
130	0,112	0,888	13,32	453	52,6
140	0,121	0,879	13,19	448	52,7
150	0,129	0,871	13,07	444	52,9
160	0,138	0,862	12,93	440	53,1
170	0,146	0,854	12,81	436	53,3
180	0,155	0,845	12,68	431	53,5
190	0,164	0,836	12,54	426	53,7
200	0,172	0,828	12,42	422	53,9
210	0,181	0,819	12,29	418	54,1
220	0,189	0,811	12,17	414	54,3
230	0,198	0,802	12,03	409	54,5
240	0,207	0,793	11,9	404	54,7
250	0,215	0,785	11,78	400	54,9
260	0,224	0,776	11,64	396	55,2
270	0,232	0,768	11,52	392	55,5

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280	0,241	0,759	11,39	387	55,7
290	0,25	0,750	11,25	382	55,9
300	0,258	0,742	11,13	378	56,1
310	0,267	0,733	11,0	374	56,5
320	0,276	0,724	10,86	369	56,7
330	0,284	0,716	10,74	365	57,0
340	0,296	0,704	10,56	359	57,4
350	0,301	0,699	10,49	356	57,5
360	0,31	0,69	10,35	352	57,9

It follows from the table that the maximum tension of the warp threads corresponds to the weft surf time (70^o of rotation of the main shaft of the machine). After the weft surf, the electromagnet deviates, and the base tension reaches its minimum value during the shedding process and varies within a small range up to 20^0 of the position of the main shaft of the loom, i.e. until the beginning of the warp threads. Then the electromagnet is turned on and the tension of the warp threads rises up to a maximum value from 30 ° to 70 ° of rotation of the main shaft of the machine.

III. CONCLUSION

1. The formula for the tension of the warp threads for the cycle of the loom for a new construction of a moving system of rock has been developed.
2. The results of the calculation of the change in the tension of the warp threads for a rotate of the main shaft (work cycle) of the machine determine the maximization of the tension of the warp threads in the weft surf and minimizing the tension of the warp threads in the shedding process.

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