AMERICAN JOURNALS
Open Access, Peer Reviewed Journals
American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766| Volume 17, | October., 2023

INFLUENCE OF FORCES ACTING ON THE STRAPS OF THE RING SPINNING MACHINE EXHAUST DEVICES ON THE QUALITY OF THE PRODUCT

Бутовский Петр Михайлович
Ташкентский институт текстильной и легкой промышленности

A B S T R A C T	K E Y W O R D S
In the study of flexible coupling gears and belt conveyors used in various industries, great attention is paid to the forces that arise during their operation. In the strap pairs of the extraction device of spinning machines, forces similar to those arise and their durability depends on the loads that occur in the strap pairs. In the process of operation, strap pairs experience asymmetrical loads, as evidenced by the results of numerous research studies [1,2,3,4].	

Introduction

As is known [5], asymmetrical loads can cause fatigue failure, which manifests itself on straps in the form of cracks. Cracks further lead to the tearing of the fibers from the sliver, which leads to an increase in additional unevenness. If the crack grows to a critical size, the strap fails. Replacing the upper straps of the exhaust units is quite easy, but replacing the lower strap requires stopping the machine and disassembling the reef cylinder line (long downtime). Currently, the bottom strap can be cut in place, then a new strap can be installed by gluing, however, replacing the strap in place is complicated by the correct gluing, which requires special skills and equipment downtime.

Changing some of the elements in the design of the strap pair will help reduce the frequency of cracks and cracks, resulting in longer strap life. Therefore, it is necessary to identify the areas where the forces on the straps contribute to the process of cracking and growing.

For this purpose, we performed a force analysis of the strap pair of the exhaust device. Force analysis will be carried out without taking into account the bending stiffness of the strap. Fig.1 shows a general view of the strap pair, which is most widely used in the exhaust devices of spinning and roving machines. Cylinder 1 (usually 2nd line) and guide bar 2 are covered by strap 3. Strap tension by the most widely used tensioning device in the form of a spring-loaded lever (crutch) 4. Pressure roller 5 is pressed against the cylinder with force Q. The top strap 6 encloses the pressure roller and the leading edge of the cage 7, which is pressed against the guide bar with force RThe tension of the upper strap is carried out by means of the appropriate dimensions of the cage or by means of a special spring.

During the operation of the exhaust device, pulling forces T1 and T2, respectively, occur on the side of the exhaust and feed pairs. Let's analyze the operation of the strap pair element by element.

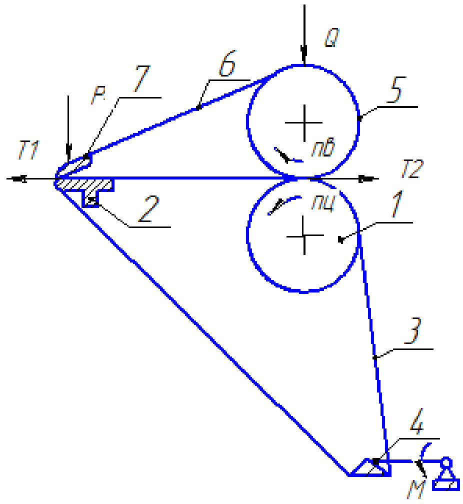


Fig 1 Diagram of the exhaust unit

For force analysis, let's look at various cases. In the first case, let's consider the actions of forces when the lever is tilted.

Figure 2 shows a diagram of the forces acting on the lower strap. In this case, we have a conventional flat-bladed transmission. Let's take a look at the tension of the strap branches in each section when going around it in the direction of travel. Then let's take the notation S0 - the tension of the running branch; S1 - tension after bending the bar; S2 is the tension after bending the crutch, it is also the tension of the oncoming branch relative to the cylinder (leading organ). When bending around the bar and crutch, the strap slides over them. Then the tensions of the running and running branches of the strap can be related by the Euler equation.

$$S_1 = S_0 e^{\mu_1 \alpha_1} \qquad (1)$$

$$S_2 = S_1 e^{\mu_2 \alpha_2} \qquad (2)$$

Where $\mu_1, \mu_2, \alpha_1, \alpha_2$, respectively, are the coefficients of sliding friction and the reduced angles of the strap on the bar and

Let's substitute (1) in (2), then

$$S_2 = S_0 e^{\mu_1 \alpha_1 + \mu_2 \alpha_2} \qquad (3)$$

Looking at the interaction of the strap with the cylinder at the Euler sliding boundary, we find:

$$S_2 = S_0 e^{\mu \alpha} \qquad (4)$$

μ, α - The coefficient of sliding friction and the angle of coverage of the strap on the cylinder.

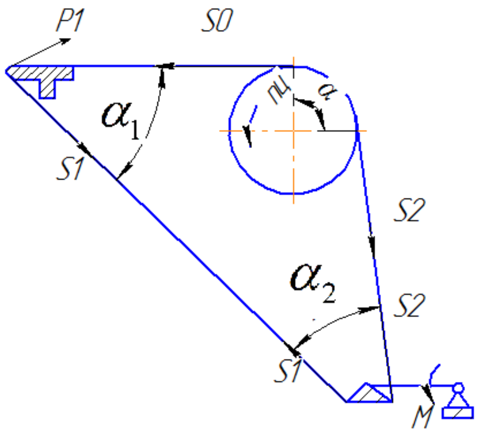


Fig Diagram of the action of forces on the lower strap

Equating (3) to (4), we get

$$\mu\alpha \geq \mu_1\alpha_1 + \mu_2\alpha_2 \tag{5}$$

Expression (5) is the condition under which the strap can be moved. If condition (5) is not met, no movement of the strap will be observed at any tension. This can cause damage to its inner surface at the point of contact with the cylinder grooves.

The tension factor of the strap is not included in the condition of its movement (5) and it is determined only by geometric (α, α_1, α_2) and physical parameters (μ_1, μ_2, μ), the tension here is only needed to overcome the resistance of the bending movement of the strap and bend it with the desired circumference angle α_1 Bar. Tension S_0 Required to go around a corner α_1, the strap bar, can be determined experimentally. To do this, install the strap bar vertically (Fig. 3), put on the strap, insert a roller of a suitable diameter so that after tensioning, an angle is established between the branches of the strap α_1 (Figs. 4 and 5). The weight G is suspended until the strap goes around the spout of the bar, then:

$$S_0 = \frac{G}{2} \tag{6}$$

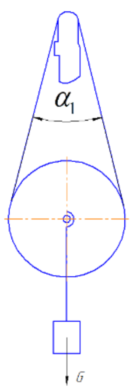


Fig 3 Diagram of the stand for determining the pretension

Based on Figure 4 and formulas (1), (2,2), we find S_1, S_2 and the moment M that the spring must develop to ensure the tension of the strap.

Condition (5) can be achieved by changing the angle of the cylinder () by α moving the crutch Fig.4:

$$S_0 e^{\mu\alpha} = S_0 e^{\mu_1\alpha_1}$$

The strap movement condition is met under the following parameters:

$$\mu\alpha \geq \mu_1\alpha_1 \tag{7}$$

Condition (7) is easier to fulfill than condition (5). There are two main options for tensioning the lower strap using a roller on the rolling or sliding supports (fig. 4).

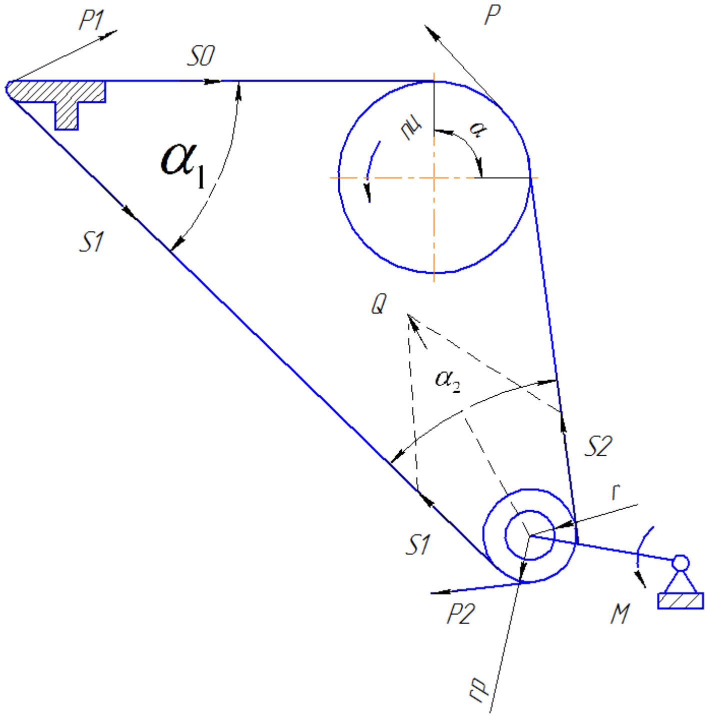
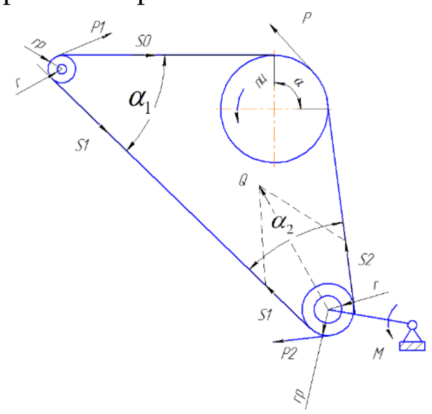


Fig 4 Design Diagram of Forces Using a Tensioner in the Form of a Rotating Roller

In this case, the roller rotates, the strap does not slip on it, and the problem of tension of the branches will be solved through the traction force P on the cylinder, the resistance forces P1 on the bar and P2 on the roller, for which we will replace the spout of the bar with an equivalent rotating roller (Fig. 5):



Rice. 5 Design Diagram of Forces Using the Replacement of Equivalent Rotating Rollers in the Form of a Tensioner and a Bar Tip

$$P_1 = S_1 - S_0 = S_0(1 - e^{\mu_1\alpha_1}) \quad (8)$$

$$P_2 = \frac{\mu_p}{2p} = \frac{Qrf}{r_p} \quad (9)$$

where Q is the reaction of the roller support equal to the geometric sum of the forces *S1* and *S2;*
f is the friction coefficient of the roller sliding along the axis.

Positioning the angle β_2 (structurally) from the cosine theorem, we get:

$$S_2^2 = S_1^2 + Q^2 - 2S_1 \cos\frac{\alpha_2}{2} \quad (10)$$

To find Q, to a first approximation, at S1=S2, then:

$$Q^2 - 2S_1 Q\cos\frac{\alpha_2}{2} = 0 \ \text{ or } \ Q^2 = 2S_1 Q\cos\frac{\alpha_2}{2} \quad (11)$$

Substituting (11) into (9) we get:

$$P_2 = 2S_1\frac{r}{r_p} f\cos\frac{\alpha_2}{2} \quad (12)$$

or

$$P_2 = 2S_0 e^{\mu_1\alpha_1}\frac{r}{r_p} f\cos\frac{\alpha_2}{2} \quad (13)$$

Then the pulling force *P*, which must develop in the zone of contact with
The strap is determined by the expression:

$$P = P_1 + P_2 \quad (14)$$

After substituting the values P1 and P2 of (8) , (13) to (14) in order to ensure the movement of the strap, the force P shall be less than the force developed on the arc Pmax, in other words:

$$P \le P_{\max} = S_0\left(e^{\mu\alpha} - 1\right) \quad (15)$$

If the roller bearing is knocked out and its rotation stops, the strap will begin to slide over the roller and such a tensioning device will turn into an ordinary crutch, that is,

$$P_{2\max} = S_2 - S_1 = S_1\left(e^{\mu_2\alpha_2} - 1\right) = S_0 e^{\mu_1\alpha_1}\left(e^{\mu_2\alpha_2} - 1\right) \quad (16)$$

Where α2 and μ2 are respectively the reduced angle of the tensioner by the strap and the coefficient of friction of the strap on the tensioner, i.e.:

$$2\frac{r}{r_p} f\cos\frac{\alpha_2}{2} < e^{\mu_2\alpha_2} - 1 \quad (17)$$

Substituting in (15) the value P of (17), we find the condition:

$$P_{\max} \ge P_1 + P_2$$

$$S_0\left(e^{\mu\alpha} - 1\right) \ge S_0\left(e^{\mu 1\alpha 1} - 1\right) + 2S_0 e^{\mu 1\alpha 1}\frac{r}{r_p} f cos\frac{\beta_2}{2}$$

Strap Movements
Therefore, under normal conditions, when the roller is rotated,

$$P_2 < P_{2\max}$$

$$2S_0 e^{\mu_1\alpha_1}\frac{r}{r_p} f\cos\frac{\alpha_2}{2} < S_0 e^{\mu_1\alpha_1}\left(e^{\mu_2\alpha_2}-1\right)$$

$$e^{\mu\alpha} \geq e^{\mu_1\alpha_1}\left(1+2\frac{r}{r_p} f\cos\frac{\alpha_2}{2}\right) \quad (18)$$

If the roller stops spinning, then ***P2=P2max*** in equation (18) is reduced to equation (5).
When using a roller instead of a bar and a tension roller instead of a crutch, we get a diagram (Fig. 4), where the rotational resistance force of the roller *P1* is determined by the method used in the derivation of equation (13):

$$P_1 = 2S_0\frac{r_1}{r_{p1}} f_1\cos\frac{\alpha_1}{2} \quad (19)$$

Branch Tension ***S1-f0+Pf-*** when determining the reaction in the roller support to find ***R*** It is accepted, to a first approximation, then:

$$S_1 = S_0\left(1+2\frac{r_1}{r_{p1}} f_1\cos\frac{\alpha_1}{2}\right) \quad (20)$$

Substituting (20) in (12), we get

$$P_2 = S_0\left(1+2\frac{r_1}{r_{p1}} f_1\cos\frac{\alpha_1}{2}\right)2\frac{r}{r_p} f\cos\frac{\alpha_2}{2}$$

In this case, the traction force P required for the movement of the strap will be:

$$P = P_1 + P_2$$

$$P = S_0\left[2\frac{r_1}{r_{p1}} f\cos\frac{\alpha_1}{2} + \left(1+2\frac{r_1}{r_{p1}} f_1\cos\frac{\alpha_1}{2}\right)2\frac{r}{r_p} f\cos\frac{\alpha_2}{2}\right] \quad (21)$$

Substituting (21) to (14) we find the conditions for the movement of the strap

$$e^{\mu\alpha} - 1 \geq \left[2\frac{r_1}{r_{p1}} f\cos\frac{\alpha_1}{2} + \left(1+2\frac{r_1}{r_{p1}} f_1\cos\frac{\alpha_1}{2}\right)2\frac{r}{r_p} f\cos\frac{\alpha_2}{2}\right] \quad (22)$$

It is interesting to note that in equation (22), as well as in equations (26), (5) there is no value of tension of the strap, that is, the movement of the strap is determined only by the geometric and physical parameters of the design, and increasing the tension of the strap beyond what is necessary to ensure the angle will only lead to increased wear.

Returning to (11), I would like to note that the obtained reaction Q is the first approximation, i.e. when calculating the values of P and P according to the given equations$_1$ and P2 is underestimated.

Strength R_2 will be of slightly greater importance in the event that the roller hardly rotates and the strap practically does not slide on the roller, that is:

$$S_2 \leq S_1 e^{\mu_2\alpha_2}$$

Substituting this value in (10), we get

$$S_2 = S_1^2 + Q^2 - 2S_1 Q \cos\frac{\alpha_2}{2} \qquad (24)$$

From where

$$Q = S_1\left(\cos\frac{\alpha_2}{2} \pm \sqrt{\cos\frac{\alpha_2}{2} - 1 + e^{2\mu_2\alpha_2}}\right) \qquad (25)$$

True the value of Q will be greater than the Q found by (11) and less than Qcalculated by (25).

References

1 Dmitrev V.A. Details of Machines – Leningrad "Shipbuilding", 1970, p. 510
Olbrich, A. The AIR-COM-TEX 700 condenser ring spinning machine Volume 6, Issue 1, 2000, Pages 25-29
3 Butovskiy P.M. Stress State of the Lower Straps of SKF Exhaust Devices "Textile Problems" 2009 № 2 .
4. Butovskiy P.M. Issledovanie straps vyduzhnykh priborov sprydilnykh mashina na ustavnostnoe razrazhenie [Study of straps of exhaust devices of spinning machines for fatigue destruction]// Proceedings of the Republican Scientific and Practical Conference Nam MPI Namangan, 2011
5.Chen V.N. Issledovanie zavodstvennosti otdel'nykh elementov vytruzhnogo pribora cottonkopryvnoy mashina [Studies of the performance of individual elements of the exhaust device of the cotton spinning machine]. PhD thesis, Kostroma, 1980.