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Development of an effective thread feeder and a method for calculating the thread tension in a knitting machine

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ABSTRACT: The article provides an analysis of existing patterns of thread givers in knitted machines, their main drawbacks are noted. Presents a new effective threading scheme with intermediate storage. But the basis of theoretically research obtained expressions for determining the tension of the thread in each zone yarn. The specific values of the parameters of the thread yarn zone of the device in knitting machines are substantiated.

KEYWORDS: Knitwear, machine, nitepodchik, tension, regulation, friction, rigidity, turn, drum, peephole, angle of grasp, force, deformation, dish-shaped, tube.

I.INTRODUCTION

In knitting machines, the main element is thread guides, most of the designs of which include yarn accumulators in the form of a drum [1]. Thread guides - devices for feeding the thread under constant tension - can be positive, feed the thread with a constant speed, consistent with the consumption of the thread loop-forming systems, and negative, feed the thread with a constant tension with varying speed of the thread. Positive thread guides are generally not used when knitting knitwear with patterned weaves, for example, jacquard ones, since when they are produced, the length of the thread consumed by each loop-forming system constantly changes in accordance with the pattern cartridge. The most common positive media provider is group tape. It is convenient for knitting knit smooth weaves on multi-system circular knitting machines [1].

Fluctuations of the input tension of the thread, which inevitably arise when winding it from the package, are not transmitted to the output (after the tape and the roller) of the moving thread. The input tension of the thread for the loop-forming system depends on the matching of the speeds of the thread: feed rates and consumption rates. The tension of the thread for each loop-forming system is changed by changing the depth of sticking (by the wedge of the needle lock), i.e. the rate of consumption of the thread needles. Since the feed rate of the thread for all the loop-forming systems is the same and equal to the tape speed, the thread consumption for all the loop-forming systems is also the same, the knitwear density is constant, which prevents the knitwear from being transversely streaked due to different depths in individual systems.

The thread reserve accumulated on the drum, with a negative method of feeding (axial winding) is adjustable. With a full stock of the thread, the drum stops rotating, and when the stock drops to a certain value (number of threads), the drum starts to rotate at a peripheral speed exceeding the average rate of thread consumption by the loop-forming system. Each thread follower with an accumulator has an individual control and serves for rewinding a thread from a reel to a drum — an intermediate package. The thread is reeled off the drum already with minimum and constant tension. When this is achieved a high uniformity of knit loops. There are also thread guides with a toothed wheel, tension compensators, etc. The main disadvantages of these thread guides are changes in the thread tension, which leads to breakage, decrease in machine performance [2,3,4].

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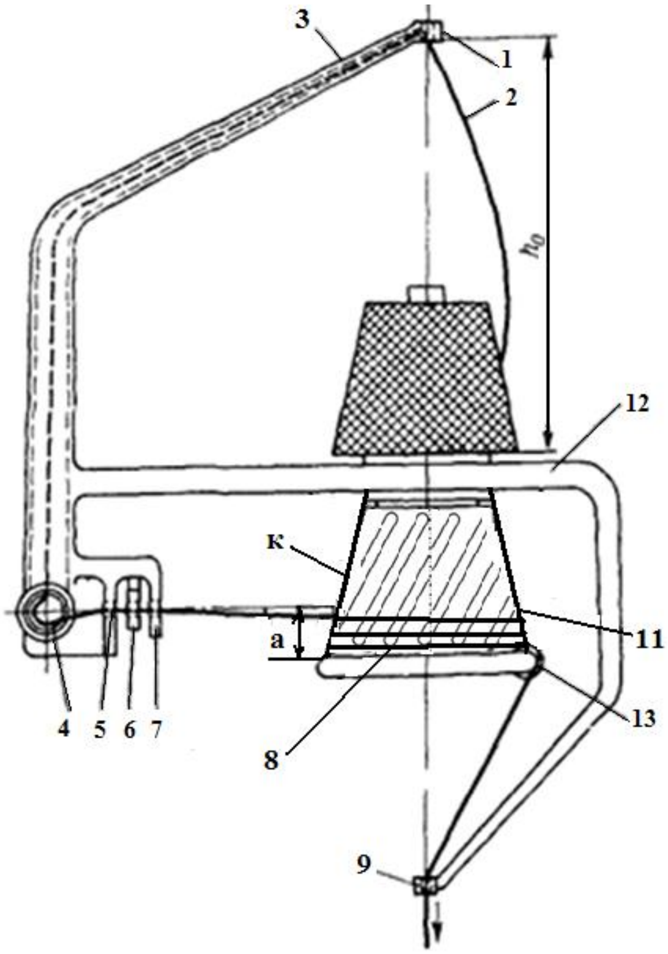

Detail 8 increased
a

b c

Fig.1. General Scheme of the thread reader with intermediate storage (a), nitrate drum (b) and its section aa (c)

Efficient threading design. In order to eliminate thread breaks when sewing in a knitting machine, the design of the knitting machine's thread store has been improved by increasing the friction between the thread and the drum.

The design works as follows (Fig. 1). Thread 1, descending from the reel (not shown in the figure), passes through the upper peephole 2, the thread-guiding tube 3 and enters the plate tensioner 4, which gives it the necessary tension. From here it passes through the thread-guiding eyes 5 and 7, between which the lever 6 of the automatic stop is activated, which is activated when the thread 1 is broken. Then the thread 1 goes to the thread storage drum 8, where a certain

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amount of stock is created. At the same time due to the truncated conical working surface of the drum 8, the thread 1 is retained to a sufficient degree. Inclined through slots 11 also allow the retention of the thread 1 on the working surface of the drum 8 due to the resulting component of the force directed upwards.
The design provides alignment of the tension of the thread 1, reduces its breakage, and also eliminates the premature winding of the thread 1 from the drum 8. This leads to an increase in the reliability of the design.
Determination of the output tension. In the recommended scheme of threading technology in a knitting machine, as noted above [1], the thread from the spool is transmitted through the upper eye, guide tube, dish-shaped tensioner, thread guiding two eyes and thread guide drum, slider and lower eye (see figure 2.). The design scheme for determining the tension of the thread in the recommended thread feeder is shown in Fig.2.

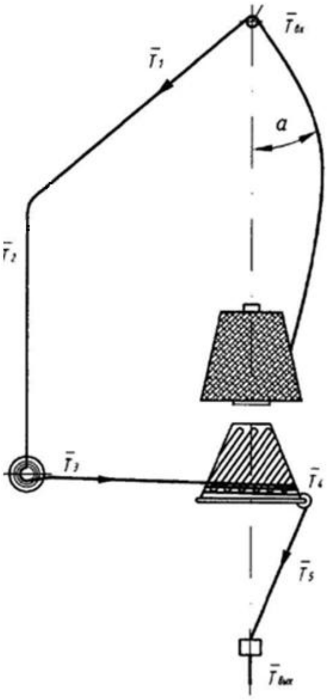


Fig. 2 .. The design scheme for calculating the tension of the thread in the recommended threading

The thread coming off the reel has a variable tension:

$$T_{вх} = \frac{M_к}{r(h)} Sin\omega t \quad (1)$$

where, $M_к$- the moment of force of unwinding of a thread from a conic coil
r(h) is the radius of the circle where the thread turns at the height h of the coil;
ω - frequency of input tension change.
Next, the thread passes through the upper eye, while using the Euler formula [5.], then the tension will be:

$$T_1 = T_{вх} e^{f(2\pi-\alpha)} \quad (2)$$

is the coefficient of friction of the thread on the surface of the upper eye of the thread feeder; α is the angle of the thread around the curved surface of the eye.
The thread after the upper eye passes through a tube having two parts, inclined and vertical, between which there is a curvilinear transitional part (see figure 2.) In this case we have:

$$T_2 = F_{тр1} e^{f(2\pi-\beta)} + F_{тр2} + T_{вх} e^{f(4\pi-\alpha-\beta)} \quad (3)$$

$$F_{тр1} = fg\rho l_{AB} cos\gamma$$

where, g is the acceleration of free fall, the γ-angle of inclination of the zone AB of the tube, l_{AB} is the length of the zone AB; ρ is the linear density of the thread; $F_{тр2}$ - friction of the thread in the vertical zone of the CD tube.
In this case, the total output tension of the thread in the thread-feeder knitted machine we have:

$$T_{вых} = \eta e^{Д_1+E_1}\left[\frac{M_к e^{Д+U}}{r(6)} Sin\omega t + tg\rho l_{AB} Cos\gamma e^{E+U} + e^4(F_{mp2} + c\delta) + KF_{cp\delta}\right] (4)$$

where, β is the angle of the curved portion of the sun tube, c, δ is the stiffness and deformation coefficient of the clamping spring of the yarn tension regulator; α_1 and β_1 are the angles of the curvature of the curved parts of the eyes; M_B is the moment of friction force of the thread coil located on the surface of the accumulation drum; r (h_b) is the radius of the truncated cone of the drum surface at a height hb; K - the number of turns of the thread on the surface of the drum;

M_1, M_2, ... M_k - the moment of friction force of the 1st, 2nd and forth to the second turn of the thread on the surface of the drum with radii r_1, r_2, ... r_k; γ_1 is the angle of circumference of the thread of the curvilinear surface of the slider, η is the coefficient taking into account the friction force during the rotation of the slider, η <1; θ is the wrap angle of the filament on the curved surface of the lower ocell in this case, the following notation is taken into account

$$D= f(4\pi - \alpha - \beta); \quad E = f(2\pi - \beta); \quad U = f(4\pi - \alpha_1 - \beta_1);$$

$$Д = f(2\pi - \gamma); \quad E_1 = f(2\pi - \theta)$$

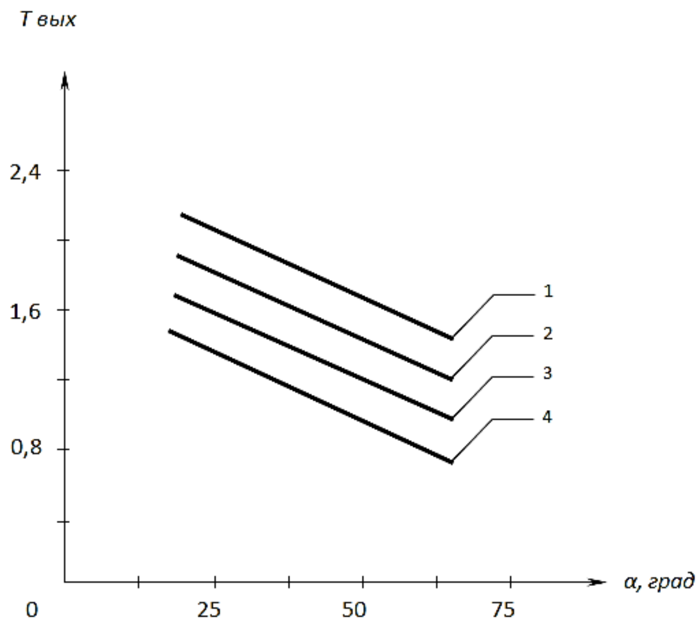
The analysis of the obtained expressions for determining the output tension in the thread feeder, both in the existing and in the recommended thread feeder scheme, the thread tension depends on many parameters. Among them, the main is the input tension, which depends on the technological processes of the feeding thread.

Analysis of the graphs shows (Fig. 3) that an increase in the average value of the input tension of the thread acts in proportion to the output tension. The higher the input tension of the thread, the greater the value of the output tension. Therefore, the graphics in Fig. 3.mutuallyparallel. To ensure the output tension of the thread is not more than (12-15) cN, the recommended values are

$$\alpha \geq (55° \div 62°) и T_{вх} \leq (5{,}0 \div 7{,}0) cH$$

The Kostruktivnaya scheme of the feeder uses a tube with a curved part in the middle. Therefore, the influence of the curvature of the tube on the output thread tension in the thread feeder is important. In fig. 4 shows the graphical dependencies.

Changes in the output tension of the thread depending on the change in angle β.



1 – at$T_{вх}$= 12 cH; 2- at$T_{вх}$= 10 cH;3- at$T_{вх}$= 8,0 cH;4-at$T_{вх}$= 5,0 cH

Fig.3. Graphic dependences of a change in the tension of a thread on a change in the angle of wrap around the thread of a curved surface of the upper eye

The obtained graphs show that the effect of β. On the tension T_exithe greatest.Thus, at T_in = 5.0 cN, an increase in the angle β from 8^0 to 40^0 leads to a decrease in the output tension of the thread from 8.4 cN to 5.3 cN. Therefore, the recommended values for the angle of the curvilinear part of the pipeline are the thread givers selected within $(30^0 - 32^0)$.

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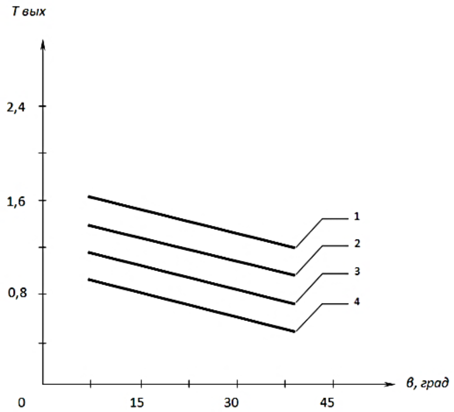
In the design, friction in the pipeline leads to an increase in the friction force of the inclined and vertical parts. Analysis of the graphs in Figure 5 shows that with an increase in the friction force of the thread on the surface of the pipeline, the output tension of the thread increases according to a nonlinear pattern. So in the inclined part of the pipelines, at $T_{вх}$=in = 5.0 cN with an increase in the friction force from 0.8 cN to 4.5 cN, the tension of the thread increases from 5.8 cN to 11.2 cN, and for the vertical part, the tension increases from 5.1 cN to 7.9 CH.

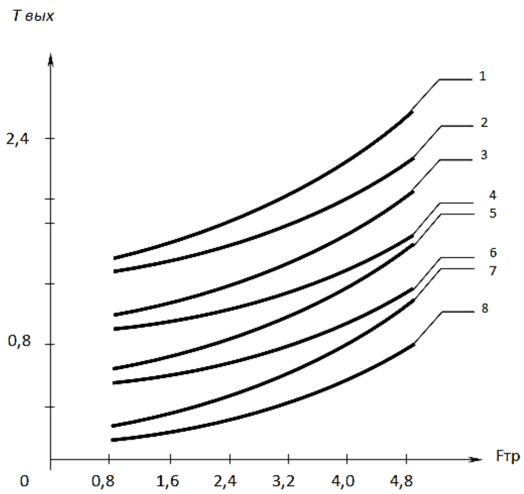


1 – at$T_{вх}$= 12 cH; 2- at$T_{вх}$= 10 cH;3- at $T_{вх}$= 8,0 cH;4-at$T_{вх}$= 5,0 cH
Fig.4. Graph of the change in the angle of the curved part of the tube

With an increase in the input tension of the thread to 12.0 cN, the Tvyh values increase to 25.3 cN for the curvilinear part of the pipeline, as well as to 20.2 cN for the vertical part of the thread giver pipeline.

Here, one should, if possible, change the friction force of the thread in the pipeline by reducing the length of contact with the surface of the pipeline.

In fig. 6 shows the graphical dependences of the change in the tension of the thread on the change in the stiffness coefficient of the disc spring tension regulator.



1,3,5,7-$T_{вых}$=f ($F_{тр1}$); 2,4,6,8-$T_{вых}$=f ($F_{тр2}$); 1,2-at $T_{вх}$=12 cH; 3,4- $T_{вх}$=10 cH; 5,6-at$T_{вх}$=8,0 cH; 7,8- $T_{вх}$=5,0 cH

Fig. 5.Graphic dependences of the change in the output tension of the thread on the change in the friction forces in the pipeline.

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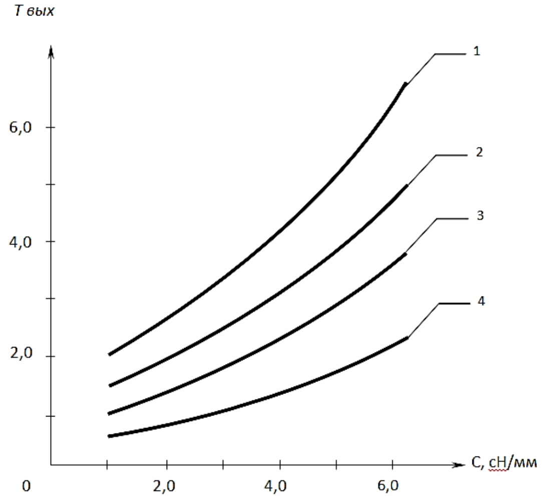
The actual tension of the thread in the recommended thread feeder is regulated by changes in the stiffness (deformation) of the spring of the yarn tension regulator. Based on the analysis of the graphs obtained in Fig. 5, it can be noted that an increase in the rigidity of the spring of the regulator leads to an increase in the tension of the thread according to a nonlinear pattern. So with an increase in the stiffness coefficient from 1.0 cN / mm to 5.56 cN / mm leads to an increase in $T_{вых}$ from 5.7 cN to 20.8 cN at T_{BX}_in = 5.0 cN. When the yarn tension is 12cN, the output tension increases from 19.1cN to 52.3 cN. From the results it can be seen that by adjusting the values of the spring constant of the disc regulator, it is possible to adjust the output tension of the thread in a wide range.



1,2 – at T_{BX}= 12 cH; 2- at T_{BX}= 10 cH; 3- at T_{BX}= 8,0 cH;4-at T_{BX}= 5,0 Cн

Fig. 6.Graphic dependences of the change in the output tension of the thread on the change in the stiffness coefficient of the disk regulator.

Therefore, to obtain the thread tension at the exit from the thread feeder no more than (10–12) cN, it is considered appropriate to select the spring constant of the disc regulator within C≤ (1.3–2.2) cN / mm.

II. CONCLUSION

The technological scheme of the thread giver with the intermediate thread accumulator is completed, which allows decreasing the tension and increasing the uniformity of the thread feeding. Based on the numerical solution of the problem, the graphical dependences of the change in the tension of the thread on the change in the angle of the thread grip around the curve of the surface of the upper eye are constructed. The influence of the friction force of the thread on the surface of the pipeline on the output tension of the thread is studied. The graphic dependences of the change in the tension of the thread on the change in the stiffness coefficient of the disc spring tension regulator are constructed.

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