23,4 m/min. Of course, such speed of sewing operation not achieved usually, but the difference is significant.

The results of experimental studies show that bonded hemming seam stronger than similar sewing seam by 64,3 %. Bonded flat seam stronger than similar sewing seamby 41,7 %. It is depends on high strength of the used thermoplastic film. The elasticity of sewing seams is higher in both cases.

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OPTIMIZATION THE PROCESS OF DISCRETIZATION DURING OBTAINING OF COMBINED FIRE-RESISTANT ELECTRO CONDUCTIVE YARN

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<u>Key words:</u> heat-resistant yarn, electrically conducting yarn, Arselon, antistatic effect.

<u>Ключевые слова</u>: термостойкая пряжа, электропроводящая пряжа, Арселон, антистатический эффект.

Abstract. This article is devoted to optimizing the discretization process in the production of electrically conducting heat-resistant combination yarn. Derringer's partial desirability functions are used to solve a multi-criteria optimization problem - select the type of card clothing for the discretizing drum that will provide the best combination of physical-mechanical properties in this type of yarn.

Аннотация. Данная статья посвящена оптимизации процесса дискретизации при производстве электропроводящей термостойкой комбинированной пряжи. Функция частичной желательности Дерринжера

используется для решения многокритериальной задачи оптимизации - выбор типа гарнитуры дискретизирующего барабанчика, которая обеспечит наилучшеесочетание физико-механических свойств готовой пряжи.

The production of electrically conducting heat-resistant yarn is one of the fastest-growing segments of the textiles industry. Working with Baranovichi Cotton Production Amalgamation (BCPA), the Department of Technology of Textile Materials at Vitebsk State Technological University has developed a new technology for producing electrically conducting heat-resistant yarns that is based on the card system of cotton-spinning and includes a modernized open-end spinning machine PPM-120AM, which has a hollow rotor. Arselon fibers and copper micro-wire are the raw materials in the technology. Figure 1 presents a micrograph of a prototype heat-resistant combination yarn.

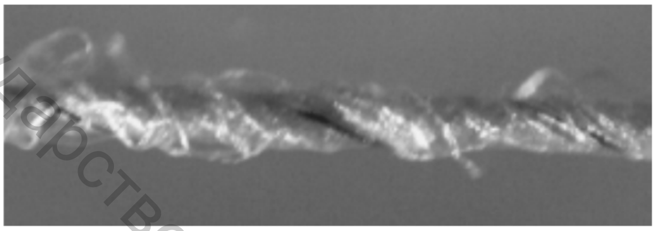

Figure1 – Micrograph of electrically conducting heat-resistant combination yarn

The electrically conducting yarn can be used to produce textiles that have shielding and anti-static properties. It can also be used to make special high-conductance protective clothing for workers exposed to hazardous conditions - in oil refining and gas- and benzene-processing facilities - and to high-power electromagnetic radiation.

The products made from Arselon yarn, which has high heat resistance, can function at 250°C for a period of up to 3 years. These products can be exposed to temperatures of up to 400°C for short periods of time with almost no melting or soot formation. The hygroscopicity of Arselon fibers is close to that of cotton. Arselon yarns' ability to be painted, their low flammability, and the fact that they retain their elastic properties at low temperatures allow them to be used to make fabrics that can be employed in the production of special heat-resistant and low-flammability anti-static and shielding clothing (for firefighters, rescue workers, and equipment technicians), filter cloth for hot gases, and individual protective devices (suits, gloves, mittens).

In the method being proposed here for making such yarn, an additional feeder is used to deliver copper micro-wire to the working zone of the spinning chamber together with the separate flow of Arselon fibers fed from dual-flange reel. The micro-wire has a linear density of 18 tex and envelops the yarn that is formed inside the chamber. The resulting heat-resistant electrically conducting combination yarn is led out of the chamber and wound around bobbin.

One of the main processes that is carried out in open-end spinning is the separation of masses of fibers into individual fibers. This operation is performed by a carding machine.

One feature of the discretization process in the processing of Arselon fibers is that the fibers are subjected to mechanical damage, and this is accompanied by a reduction in their length and rejection of some of the product. These developments lower the strength and quality of the yarn. To stabilize the spinning process and improve the quality of the electrically conducting heat-resistant yarn, it is important to ensure that the discretizing component performs in an efficient manner. The main factors that affect the discretization process are the type of card clothing used on the opening roller and its speed of rotation (Figure. 2). The card cloth should provide for the necessary degree of separation of the fibers from one another while minimizing the damage done to them in the process.

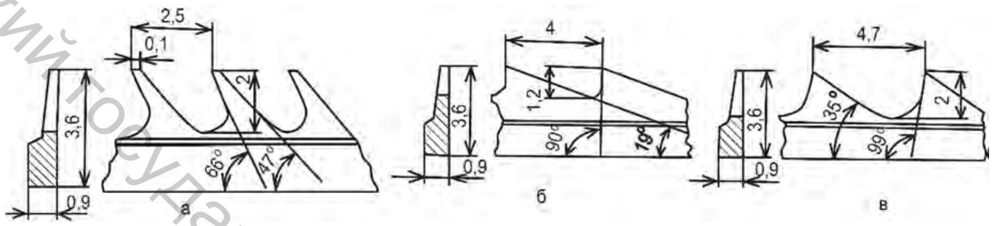

Figure 2 – Card clothing of discretizing drum: a) OK-40; b) OK-36; c) OK-37.

The PPM machines installed at the Baranovichi CPA has three types of card clothing (see Figure 2). Preliminary tests established that the yarn obtained with the use of each of these types of clothing has acceptable physico-mechanical properties. Although pair-wise comparisons were made of these yarns, it was not possible to determine the type of clothing that is best in regard to all of the main physico-mechanical properties (the coefficients of variation for linear density, twist contraction, breaking load, the value of the relative breaking load).

Thus, the given problem needs to be solved by multi-criterional optimization - selection of the type of card clothing which ensures the best combination of physico-mechanical properties in the electrically conducting heat-resistant combination yarn that is produced.The experiments were performed at the Baranovichi CPA on open-end spinning machine PPM-120AM.

The three types of clothing were used in succession on the discretizing drums as the yarns were being processed. The main physico-mechanical indices of the yarn were determined in the industrial laboratory at the Baranovichi plant. The following indices were chosen as the optimization criteria: Pl - the relative breaking load, cN/tex; Cvb - the coefficient of variation for the breaking load, %; Cvd - the coefficient of variation for linear density, %;Cvt - the coefficient of variation for twist contraction, %. The results of the tests are shown in Table 1.

It is apparent from Table 4 that the strongest yarn was obtained using card clothing OK-37 (P_l = 8.3 cN/tex), the yarn with the lowest coefficient of variation for the breaking load was obtained using the OK-36 clothing (C_{vb} = 6.7%), the yarn with the lowest coefficient of variation for twist contraction was obtained with clothing OK-40 (C_{vt} = 2.4%), and the yarn with the lowest coefficient of variation for linear density was obtained with clothing OK-36 (C_{vd} = 2.8%).

Table 1 – Physico-mechanical properties of yarn made using discretizing drums with different types of card clothing

Criteria	Type of card clothing		
	Ок-40	Ок-37	Ок-36
Coefficient of variation of linear density (Y_1), %	3,2	3	2,8
Coefficient of variation of twist contraction (Y_2), %	2,4	2,9	2,7
Coefficient of variation of breaking load (Y_3), %	10	8,1	6,7
Relative breaking load (Y_4), cN/tex	8,1	8,3	7,7

Thus, it is impossible to choose a card clothing that will ensure the best physico-mechanical properties for the electrically conducting heat-resistant yarn based on all of the given criteria simultaneously. We therefore resorted to the method of generalized desirability functions to solve the optimization problem.

In order to jointly examine criteria that have different units of measurement, it is necessary to convert them to dimensionless form by using Derringer's partial desirability functions. Table 2 shows the ranges of values for these functions.

Table 2 – Desirability limits of partial optimization criteria

Criteria	Least desirable (0)	Most desirable (1)
Coefficient of variation of linear density (Y_1), %	3,5	2,5
Coefficient of variation of twist contraction (Y_2), %	3,5	2,5
Coefficient of variation of breaking load (Y_3), %	10,5	5
Relative breaking load (Y_4), cN/tex	7,5	8,5

The generalized desirability function, which calculates the desirability of each partial optimization criterion, has the form:

$$D_{i,j} = \sqrt[n]{\prod_{i=1}^{n} d_{i,j}}, \quad (1)$$

where n is the number of partial optimization parameters that are examined, n being equal to 4 in our case; $d_{i,j}$ is thedesirability of the i-th partial optimization criterion for the j-th card clothing.

Thus, the optimization problem reduces to determining the maximum value of generalized desirability function D.Table 3 shows values of the generalized function calculated for discretizing drums with different types of cardclothing.

Table 3 – Desirability limits of partial optimization criteria

Type of card clothing	Desirability
Ок-40	$D_1 = \left(d_{1,1} \times d_{2,1} \times d_{3,1} \times d_{4,1}\right)^{1/4} = 0{,}35766$
Ок-37	$D_2 = \left(d_{1,2} \times d_{2,2} \times d_{3,2} \times d_{4,2}\right)^{1/4} = 0{,}568873$
Ок-36	$D_3 = \left(d_{1,3} \times d_{2,3} \times d_{3,3} \times d_{4,3}\right)^{1/4} = 0{,}527424$

An analysis of the results shows that the most desirable card clothing is OK-37 (D = 0.56). Its teeth have a negative angle of inclination of 99° and a pitch of 4.7 mm, and this clothing also has the fewest teeth on the surface of the drum (compared to OK-40 and OK-36).

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THREAD CHAIN CUTTING MECHANISM

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Keywords: thread chain cutting, clipper method, automation of cutting process.
Ключевые слова: обрезка цепочки ниток, способ гильотины, автоматизация обрезки.

Annotation. The article reviews the state of technical equipment used in the area of chain thread cutting; it highlights common technological and design features of thread cutting devices and mechanisms; the analysis of advantages and disadvantages of devices having different technical layout is carried out. In accordance with carried out analysis, the mechanism with improved layout is proposed, which implies the use of single actuator (e.g. solenoid stem) for the operation movement of three basic elements of the mechanism: safety fence and pressing element as well as the blade itself.

Аннотация. В статье выполнен обзор состояния технических средств в области обрезки цепочки ниток; выделены характерные технологические и конструктивные признаки устройств и механизмов обрезки цепочек ниток; дан анализ достоинств и недостатков различных технических исполнений устройств. В соответствии с выполненным анализом предложен механизм улучшенной комплектации, позволяющий от одного источника движения (в частности, штока электромагнита) обеспечить работу трех главных элементов механизма: ограждающего и прижимного элемента, а также самого ножа обрезки.

Thread chain cutting is a process necessary for automation of sewing machines; its goal is a provision of reliable separation between thread chain formed as a result of interweaving process in formed seam or shuttle stitch line overlapping the edge of sewn-up materials and thread fragments stuck to operative parts.