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DEVELOPMENT OF SPECIAL CLOTHES WITH HIGH HYGIENIC PROPERTIES

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DEVELOPMENT OF SPECIAL CLOTHES WITH HIGH HYGIENIC PROPERTIES

The monograph is explained by the creation of a science-based technology for the development of special clothing from a new structural fabric with high hygienic properties, taking into account the working conditions for workers in the automotive industry.

In this case, the development of a constructive and technological solution of special clothing, taking into account the physical and mechanical properties of the fabric made of cotton on the body, cotton + modal fiber on the back, and taking into account the rational parameters of the technology of special clothing. As a result, special clothing with high hygienic properties has been developed, which is of great practical importance.

The monograph is intended for senior researchers, doctoral students, independent researchers and specialists of sewing companies, and can be widely used by undergraduate and graduate students.

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INTRODUCTION

In accordance with the Resolution of the President of the Republic of Uzbekistan "On measures to accelerate the development and further improve the management of the automotive industry in 2017-2021" in order to further improve the corporate governance of the automotive industry Uzavtosanoat JSC increase investment in the amount of $ 800 million, reduce the share of imports in production by 12.5%, increase the number of employees in the industry by 1.2 times. Today, there are more than 70 enterprises in the automotive industry, which employ more than 225,000 workers and employees.

The creation of a special clothing package for workers is complicated by the fact that it must be carried out taking into account the factors influencing the environmental climate. The development of special clothing with high hygienic properties is an urgent issue in order to improve the work performance of workers and increase productivity.

Analysis of the existing personal protective equipment for workers in the automotive industry, i.e. special clothing, shows that they do not meet the requirements of the climatic conditions of Uzbekistan. The urgency of creating special clothing that meets the established hygienic requirements is associated with the expansion of the human work environment, working conditions, areas of production activities in different climatic conditions. The expansion of the range of fabrics used for garments with a new set of hygienic properties is significantly changing the traditional approach to the design process.

At the same time, in addition to performing a protective function, special clothing should not interfere with the work of physiological functions of the body (disorders of cardiovascular function, difficulty in heat exchange with the environment, etc.). Today, special attention is paid to the ergonomic aspects that provide a combination of safety and comfort to the worker wearing special clothing [2].

Thus, in the design of special clothing, working conditions are a determining factor in the choice of fabrics and the design of the model. Sweating is

observed in workers under different production conditions, resulting in a negative impact on working conditions [3]. This, in turn, requires that the worker interact with protective clothing and select appropriate clothing that is appropriate.

In view of the above, this monograph is devoted to the analysis of the state of development of special clothing for workers in the automotive industry and the study of requirements for special clothing, as well as the development of new structural fabric with improved hygienic properties, its physical and mechanical properties.

As a result, taking into account the working conditions of workers in the automotive industry, including indoor buildings, the hygienic and protective properties of special clothing were designed based on changes in the fiber content of the fabric and the development of a new model and technical documentation.

CHAPTER 1. ANALYSIS OF THE STATUS OF DEVELOPMENT OF SPECIAL CLOTHES FOR AUTOMOBILE INDUSTRY WORKERS

1.1. Factors affecting the hygienic properties of special clothing

Hygienic requirements are requirements aimed at maintaining human health. The main hygienic indicators of clothing are air permeability, hygroscopicity, heat protection properties, comfort, waterproofing, etc. [4]. Hygienic requirements depend on what the clothing is intended for. Underwear and summer clothes should have good air permeability and hygroscopicity, be easy to wash. Winter clothes should be warm, coats should be waterproof, etc.

The constant development of light industry is characterized by the diversity and complex shape of the structural parts of clothing. In the development stages of new types of clothing, it is important to form the initial data (selection of a suitable fabric package for clothing) [5]. Clothes that are well-fitted to the human body, durable and comfortable in the process of consumption, and maintain a good appearance can have a positive effect on a person's mood and change everyone's opinion of themselves in a positive way. The quality of clothing depends to some extent on the information about the physical and mechanical properties of the fabric, the applied design methods and technological means, as well as the qualifications of the designer. The design of any garment begins with the development of requirements, taking into account the characteristics that come first.

A variety of fabrics are used in the production of garments. The design and technological processing of garments depends on their properties. The design and production of clothing begins with the selection of the appropriate fabric. Analysis of the composition and evaluation of the properties of fabrics used for clothing, helps to solve the problem of choosing the right design and processing of clothing [6].

In the design and manufacture of clothing, as well as in the process of operation, many questions arise related to the properties of the fabric:

- What features of fabrics are chosen for a particular type of clothing;

- What properties of the fabric affect the design of clothing and are taken into account in the execution of design drawings and the preparation of templates;

- What features of the fabric are taken into account when choosing the order and parameters of processing for the manufacture of clothing at the garment factory;

- how the fabrics change during the operation of clothes, cleaning and washing [7].

Currently, the use of foreign-made fabrics, the lack of sufficient information about their quality and properties, significantly complicates the design and production of clothing. The sudden appearance of fabric properties at the stage of garment manufacturing processes affects the quality of clothing and consumption indicators [8].

For light industry products to be competitive, it is desirable to produce quality and at the same time cheap and affordable products. The quality of the product is determined by the physical-mechanical and hygienic properties of the selected fabric.

In order to improve and enhance the quality of clothing, it is important to use cheap local raw materials in the production of garments in accordance with foreign [9] raw material analogues and to improve the properties of fabrics using competitive technologies based on them. In solving the existing problems, it is expedient to improve the properties of the fabric, to analyze the local textile industry to create fabrics with a clear purpose.

Special clothing is a means of personal protection. It is designed to protect employees in the workplace from factors that are harmful and dangerous to their health.

Consumption properties of fabrics and their design are formed in the production process. The leading factors of consumer properties are: fiber

composition, structure of textile yarns, structure of fabrics. In addition, the properties of fabrics are to some extent influenced by the individual technological characteristics of the production operations at all stages of production. The properties of fabrics do not remain constant, they can change during storage, transportation, under the influence of working conditions of products. All factors have a complex effect on the consumer properties of fabrics [10].

Clothing hygiene includes a number of hygienic requirements - the most important of which are: heat protection properties, moisture capacity of the inner layers, low electrification, ease of sewing, lightness, etc. Clothing serves to protect the human body from the harmful effects of the environment (cold, heat, mechanical) and external pollution [11].

Various fibrous fabrics derived from animals and plants have long been used to produce them. By the end of the century, the use of fabrics made of synthetic fibers (viscose, etc.) began.

Currently, synthetic fabrics (kapron, nylon, lavsan, etc.) are widely used, they are produced from waste natural products - chemical fibers derived from coal, oil and gas.

Clothing should be light so that the person does not get tired and waste energy while walking. Also, clothing should be wide enough, not restrict movement, not interfere with breathing, blood circulation and digestive processes, and be comfortable for professional activities. Too tight clothing can impede skin tightening, blood circulation, compression of lymph nodes and nerve fibers, and expansion of chest and bowel movements [13].

The hygienic advantages of clothing depend on the properties of the fabric used in its manufacture, so it is very important to study the thermal and other properties of the fabrics. For reliable protection from the cold, fabrics should have a low thermal conductivity, a feature that determines their porosity. The thicker and softer the fabric, the more air in it, the lower the thermal conductivity. For example, the strength of fur - 96-98%, wool and flannel - up to 92%, leather - up to 95%. Products made of synthetic materials, thin lavsan on the outside and nitron

and polyvinyl chloride fibers have high thermal conductivity properties. It is recommended to combine them with natural fibers. Products made of kapron and viscose are cold [14].

If the garment consists of several layers, air collects between them, increasing the heat-protective properties of the garment. The second hygienic feature is the ability of these tissues to breathe, which is the release of excess air, carbon dioxide and harmful gaseous substances through the evaporation of sweat [15].

Relatively high air permeability is characteristic of lavsan and cotton products, while in kapron and many other synthetic fabrics it has low performance. However, the water absorption and hygroscopic properties of the fabric are also of particular importance. Tissues that are able to retain water after hydration change air, become warmer, and breathe less. Cotton fiber fabrics absorb sweat well. Most synthetic fabrics are not hygroscopic and it is not recommended to use them for underwear and outerwear.

The flexibility of the tissues is of particular importance. The larger it is, the less rubbing the garment will cause, no unpleasant sensations, and the pressure on the surface of the skin will be relieved. Soft wool and cotton fiber fabrics have the greatest flexibility [16].

Synthetic fabrics are characterized by electrical conductivity. When chemical fibers are rubbed into the skin, electrostatic charges appear on their surface, which cause unpleasant, sometimes painful sensations. When wool and cotton are added to synthetic fabrics, the level of electrification can be reduced or even eliminated. Chlorinated underwear containing negative charges is used for therapeutic purposes in joint and peripheral nerve diseases [17].

The color of clothing is important for the summer season, especially in the southern latitudes. In such conditions, it is recommended that the suit and hats be in a bright color to better reflect sunlight.

General clothing, safety shoes and personal protective equipment provided to workers must be of appropriate size, as well as meet the requirements and

reliably protect the worker from the harmful effects of production factors during a certain period of work.

If a worker has defective, dirty, or unrepaired overalls, such a worker is not allowed to work in conditions that require the mandatory use of personal protective equipment [18].

With the help of special clothing, the most optimal microclimate is created for a person with a temperature of 28-32 °C and a relative humidity of 20-40%. Such garments are designed to reduce body heat loss and protect the skin from chemical and mechanical damage [19].

The main hygiene requirements for overalls are adherence to heat capacity, air permeability depending on climatic conditions, labor intensity, health status, etc. [20]. The most desirable feature for the production of such special garments are natural fabrics. However, synthetic fabrics are well suited to the outer layer of clothing, as they are well protected from wind and atmospheric moisture. Excessive heat should be avoided to prevent frostbite, which leads to active sweating, dampening of clothing, and a decrease in its thermal insulation properties [21].

For the hot season, clothes made of fabrics that do not retain heat and absorb sweat well are suitable. To work in temperate climates, summer clothing should contribute to the maximum penetration of ultraviolet rays into the body. From a hygienic point of view, natural fiber fabrics are the most suitable for sewing special clothes [22].

Synthetic fabrics can disrupt the skin’s respiratory functions, accumulate static electricity, and cause allergic reactions. There are sanitary norms and rules governing the use of special clothing [23]:

Hygiene requirements for work clothes:

• In the production of protective clothing should be used natural breathable fabrics that contribute to the natural air and heat exchange of the human body;

• Clothes provided by local garment factories must be hygroscopic for good absorption of sweat;

• this should provide a comfortable environment for workers working at a certain temperature. That is, the work suit should provide heat when working in the cold and conversely, it should be cool when working at high temperatures.

Hygienic work clothes require comfortable movement, which does not restrict movement. If the manufacturer of special clothing does not comply with these hygiene requirements, then its products will have a negative impact on labor productivity.

Performance properties are properties that depend on the service life of the fabric. These include the tensile strength, elongation, abrasion resistance, and more of the fabric [11].

The mass of the fabric describes the consumption of the raw material and determines its purpose. The tensile strength and elongation of the fabric depends on the type of fiber, the quality and density of the yarn. The elongation of the fabric during stretching is determined simultaneously by force (absolute elongation) or as a percentage (elongation).

Fabric penetration is the percentage change in fabric volume after wet heat treatment. Permissible access rates for fabrics are specified in Interstate Standards.

Abrasion resistance characterizes the durability of a fabric during friction on various bodies. This figure depends on the surface texture and size of the fabric. The smoother the surface of the fabric, the higher its abrasion resistance [14].

These properties determine the harmlessness of tissues to the human body and the level of comfort in wearing products made from them. The hygienic properties of fabrics depend on their air and vapor permeability, dust retention ability, thermal conductivity, hygroscopicity, water permeability and so on.

Air permeability - is the air permeability of fabrics. It is characterized by the amount of air in millimeters that passes through one cm^3 of tissue per second. Air permeability depends on the structure and porosity of the fabric.

Dust absorption - is the ability of fabrics to absorb dust. Fabrics with a hairy and rough surface have the highest dust retention ability.

Thermal conductivity - is characterized by the amount of heat that passes through the fabric. The thermal conductivity of a fabric is inversely related to its thickness and porosity, which is determined by the type of fiber and yarn.

Hygroscopicity - is the ability of a fabric to absorb and remove moisture from the environment. This figure depends on the type of fiber, the structure of the fabric, the temperature and humidity of the ambient air. Linen, cotton and wool fabrics have good hygroscopicity, while fabrics made of synthetic fibers have a negative performance [7].

Heat storage - is the ability of tissues to protect the human body from unnecessary heat loss at low ambient temperatures.

1.2. Analysis of the range of clothing available for workers in the automotive industry

Special clothing must meet the complex requirements of a protective, hygienic, operational and aesthetic nature. At the same time it is necessary to maintain the normal functional state and working capacity of the person during working hours. Therefore, the design of special clothing is a topical issue, taking into account the worker's demand for special clothing [24].

The labor activity of workers takes place in a specific production environment, consisting of a number of material, organizational and socio-economic elements, including the objects and means of labor, workplace organization and service, work regime and rest, labor discipline, mental, material incentives and others.

The existing joint and interrelated factors of the production environment determine the working conditions of workers. They are perceived as a set of production factors that affect human health and performance. In this case, certain safety requirements are imposed on working conditions, which means that at-risk workers are exposed to hazardous and harmful production factors [25].

Figure 1.1 shows samples of special clothing available for workers in the automotive industry of the Russian state.

Figure 1.1. Samples of special clothing available for workers in the automotive industry (Russia)

Special clothing should ensure occupational safety, protect from the effects of harmful production factors, ensure the normal functional state of the person, his ability to work during the working day.

Figure 1.2 shows samples of special clothing available for workers in the automotive industry in European countries.

Figure 1.2. Samples of special clothing available for workers in the automotive industry (Europe)

An analysis of Individual Protection Tools (IPT) available in the automotive industry [26] shows that special clothing cannot respond to its exploitation in real conditions. The available special clothing causes discomfort to the body postures,

postures and behaviors performed by the workers due to the energy consumption during the work shift. Due to the diversity of climatic conditions in Uzbekistan and the fluctuations of intense stresses, the design of comfortable special clothing that can ensure the thermal balance of the body remains a difficult task.

The analysis of the available range of special clothing and their ability to protect, which is a key indicator of their quality, is a complex and multifaceted task, and the activity of the worker in technological processes leaves no doubt about the urgency of its solution [27].

Special clothing can be used indoors or outdoors year-round. In this case, harmful production factors can affect all or some parts of the skin of the human body (in the first case, if the clothing consists of a jacket and pants). The above factors will be the basis for the development of special clothing by assortment types. Interstate Standard 17-935-82 specifies the types of special clothing, the season of their operation and each type of special clothing to protect the surface of the human body [28].

In practice, the service life of clothes is much lower than normal. Analyzes show that the jacket becomes unusable within 6 months of operation. The practical life of the pants is 3-4 months [29].

The special clothes used in the shop are constantly washed from time to time (every two weeks), chemically cleaned, dried and ironed. Similarly, there is a change in the linear dimensions of the product, even if the special clothing meets the regulatory requirements for access, it does not fully meet the standards of air permeability from the width of the garment [30].

Types of special clothing for workers of automobile enterprises operating in the country are given in Table 1.1.

Table 1.1

Types of special clothing for automotive workers

Product name	**Appearance**	**Wear Term**

Special clothing for automotive workers		12 month
		12 month
		12 month
		12 month

1.3. Analysis of the range of special clothing fabrics

According to many authors, the most suitable for hot, dry climates are clothes made of cotton fiber fabrics [31]. Studies [32-33-34] have shown that cotton fiber fabrics have a lower under-temperature temperature than garments made from other fabrics.

For workers in the manufacturing plant, mainly natural and mixed fiber fabrics with a surface density of 200-250 g / m^2 are used. The type of weaving is sarja and canvas [35-36].

Cotton fiber natural fabric is very light and durable, its use in the production of special clothing is equally wide. According to Interstate Standard 29298-2005, the surface density of fabric for special clothing should not be less than 145 g / m^2 [37].

The emergence of new gmats, the improvement of garment processing technologies, and the advances in science and technology applied in the garment industry expand the possibilities for designers to select the most optimal solution [38]. An objective approach to solving this task allows the study of the specific properties of the fiber composition. The structure of textile materials is determined by the characteristics of their specificity in the manifestation of their properties in the process of manufacturing and operation of clothing.

Moleskin is the most dense fibrous cotton fabric. Due to the satin weave, the fabric almost does not allow the passage of small particles. In addition, moleskin is one of the tissues designed to protect human skin from biologically active and radiation substances. The surface is easily cleaned of particles and can be used without losing external data and operational properties.

Cloth the fabric is often used to sew work clothes for welders and metallurgists. Due to its surface structure, it provides excellent protection from sparks and metal droplets.

Cotton sheeting 100% lightweight and durable material made of cotton has very high durability and breathability. In the production of special clothing, ice with a surface density higher than 145 g / m^2 is used.

Ti-si the fabric typically contains 65% polyester and 35% cotton, but these figures may vary in production. Ti-si has satisfactory hygienic properties. This fabric is comfortable and the air permeability is positive.

Greta the peculiarity of the fabric is that on the right side of the fabric is dominated by cotton fibers located close to the body, which provide air exchange and create conditions for comfortable wearing. The synthetic fibers on the surface of the fabric, i.e. polyester, are resistant to contamination and at the same time create a sufficiently comfortable environment for the worker.

Fabrics made of mixed raw fibers. Mixed fabrics retain their color and original shape longer, being more resistant to contamination. Given these advantages, most employers focus on garments made from "mixed" fiber fabric, and prices are naturally lower, given the percentage of cotton in them.

Si-Su despite being a relatively thin fabric, it is resistant to abrasion and has a much longer service life. The fabric can withstand strong loads, including repeated washing. Sisu is widely used in the production of clothing for sales and service personnel, medical institutions and research centers.

Diagonal the fabric is divided into two types: cotton and blended. Really ripe fabric. Fiber ratio in the fabric: cotton fiber 45%, polyester 55%.

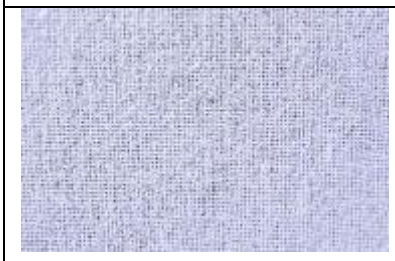
Rip-Stop the fabric is provided with reinforced filaments. With high durability properties, the fabric has good air permeability and hygroscopicity properties. In addition, the fabric retains its shape sufficiently and has a distinctive appearance [39].

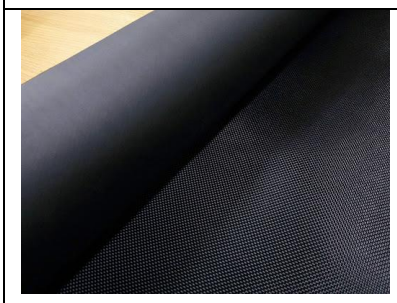
Due to its waterproof coating, it is mainly used as the best material for production: it is used in winter special clothing and suits to protect against industrial pollution at low temperatures [40].

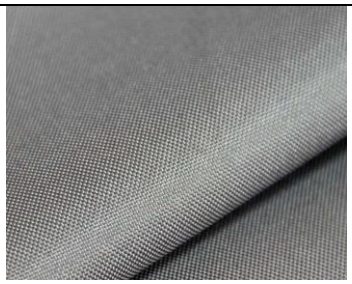
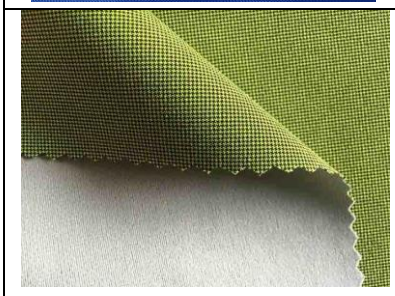
The range of modern fabrics widely used in the production of special clothing is given in Table 1.2 [39].

Table-1.2

Assortment of modern fabrics for the production of special clothing

Fabric type	Fabric name	Advantages of the fabric
	Fibre	good air permeability; absorbs moisture well; elastic; high comfort in wearing.
	Tencel	Eco-friendly fabric made from eucalyptus tree wood. It has excellent strength and assimilation properties. Used as an alternative to cotton in blended fabrics.
	Elastan	flexibility allows it to maintain its shape after physical exertion; resistant to contamination and easy to clean dirt; thin; high resistance to abrasion; light weight; can withstand environmental influences.
	Cotton fiber	comfortable to wear special clothes made of cotton; high ability to absorb moisture; breathable natural fabric; can resist chemical and other influences; Can withstand high temperatures up to +140 degrees.
	Polyurethane	resistant to acids and other harmful liquids; water resistant; very low prices and very high quality.

	Polyester	high power resistant; retains color firmly; resists shrinkage; heat resistant; simple processing; cheap.
	Membrane	Membrane fabric is used as a top layer in waterproof special clothing, which prevents moisture from entering the product and removes sweat.
	Polyamide	stable to high strength and shape; elastic; waterproof; resists bending; light weight; low thermal stability (does not withstand temperatures above 40-60 degrees).
	Fleece	elastic; the clothes fit the body well and retain their shape; the fabric is very light and does not add excess weight to the garment or suit; thermoregulation, good air permeability (the body "breathes" in clothing).
	PVC coated	PVC is resistant not only to water, but also to weakly concentrated acid solutions (30%). PVC coated fabric can withstand water resistance up to 8000 mm water column, and combined with glued seam technology ensures not only the absolute waterproofness of clothes, but also wind resistance.
	Spandex	Spandex elastic (elongation 500-700%); resistant to chemical resistance; durable; light weight; color fastness is good.

	Micro fiber	Microfiber is highly durable. The microfiber fabric has high swelling properties due to its very small diameter. Another distinctive feature of microfiber is its hygroscopicity. Products made from this fabric can absorb large amounts of water.
	Oxford	Synthetic fiber is a durable fabric that is characterized by high strength, resistance to chemicals, abrasion and multiple flexibility.
	Taffeta	Water resistance (water column from 450 to 10000 mm); wind resistant features; Sun protection properties; resistance to body fats and organic solvents.
	Softshell	The upper part of the fabric is able to withstand a water column of up to 10,000 mm; 90% reliably protects against wind blockage; the smooth, durable outer surface prolongs the service life of the product.

Only a complex approach to the selection of fabrics for special clothing will help to correctly solve the task [41-42-43] (Figure 1.1).

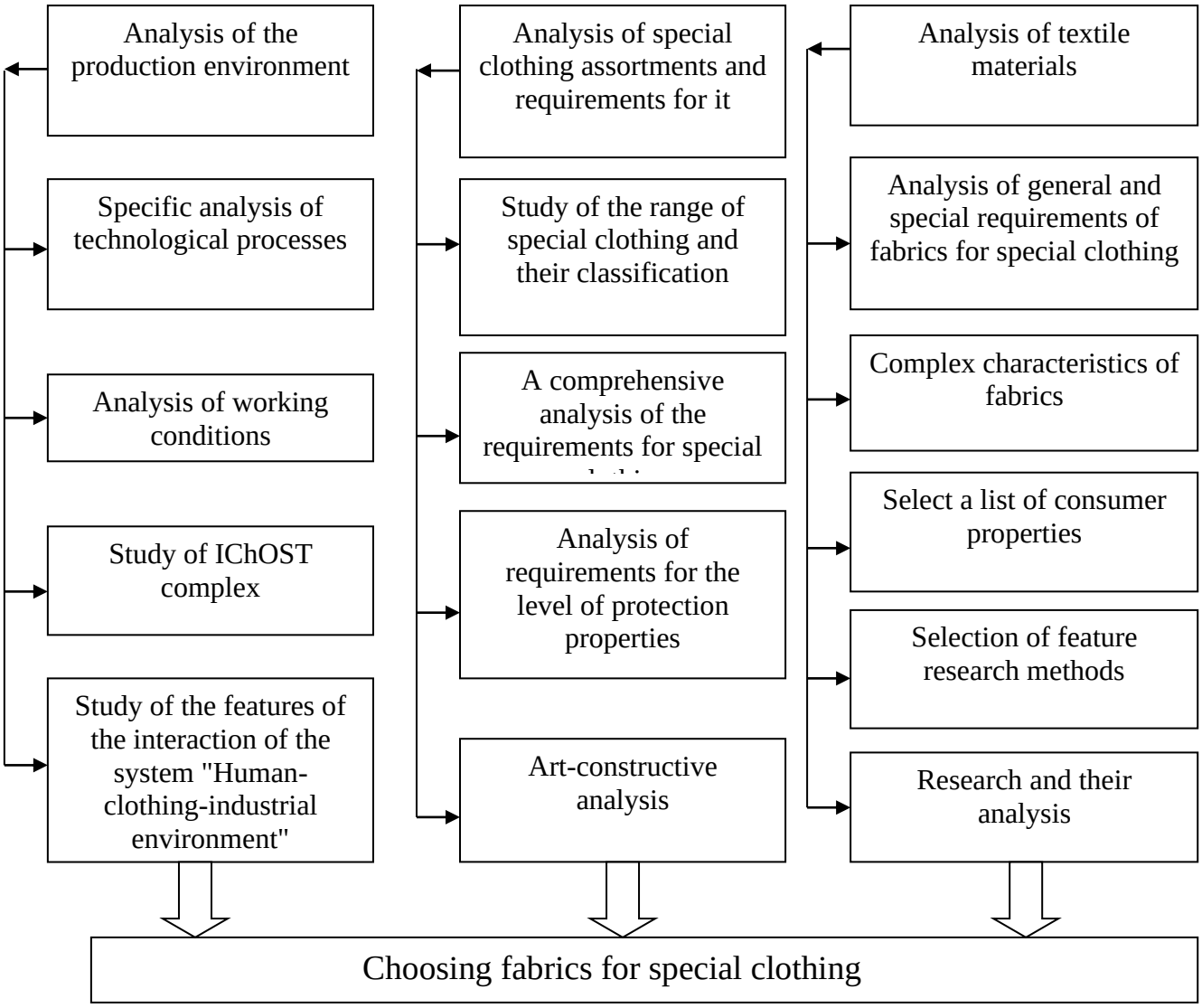


Figure 1.1. A comprehensive approach to the selection of materials

CHAPTER 2. SELECTION AND RESPONSIBILITY OF RESEARCH METHODS

2.1 Experimental methods of research

Standard methods of experimental research in the conditions of the certification laboratory "SENTEX.UZ" at the Tashkent Institute of Textile and Light Industry were used in the research [45-46].

Determining the surface density of the fabric.

The mass of a fabric is expressed using a characteristic called surface density. The surface density of a fabric is a measure of the mass per unit area g / m^2 [47].

This figure depends on the thickness of the body and back yarns, the density of the fabric and the nature of the decoration. Thus, the surface density of coarse fabric decreases after washing, boiling, bleaching, and increases after rolling, appretting, printing, and so on.

The surface density of textile materials varies within large limits: from 12 to 760 g / m^2. It determines the purpose of the material. Fabrics with a low surface density are used for underwear, older ones for suits, and larger ones for coats.

The surface density of textile materials is found by measuring or calculating the scales of the materials. The surface density of the fabric (g / m^2) is found by measuring the fabric sample on a scale and calculating it with the following formula:

$$M = m\text{-}1000—1000 / (LB),$$

here: m – fabric sample mass, g; L – fabric sample length, mm;
B – fabric sample width, mm.

Standard parameters are used to determine the surface density of the fabric by the calculation method: $П_o$ and $П_y$ densities, linear densities of yarns T_o and T_y. When weaving yarns in a fabric, the surface density without taking into account their bending is found by the following formula:

$$MS_p = 0,01* (T_o П_o + T_y П_y)$$

Here: T_o – linear density of body yarns, tex;

T_y – Arqoq linear density of yarns, tex;

$П_o$ – fabric surface density on the body, the number of threads corresponding to 100 mm of fabric;

$Пy$ – Arqoq linear density of yarns, the number of threads corresponding to 100 mm of fabric.

The formula for calculating the surface density of the fabric, taking into account their bending in the weaving of yarns in the fabric, is as follows:

$$MS_p = 0,01* (T_o П_o + T_y П_y)*\delta$$

Here: δ – coefficient found experimentally.

A special cutting scale that measures the surface density of fabrics. This instrument is designed to measure the surface densities of fabrics and knitted fabrics.

Brief description of the device:

Model: GX-400.

Measurement range 0.001 ÷ 410 g.

Measurement accuracy - 0.001 g.

The size of the measuring area is 128x128 mm.

Unit of measurement: gram.

The cutting sample surface area is 100 cm^2.

Power supply - 220 V, 50/60 Gts.

Test the instrument. Using this tool, the surface density of fabrics and knitted fabrics is measured, ie the weight of 1 m^2 of fabric. To do this, a circle-shaped piece is cut from the fabric sample being tested using a cutter.

The surface area of this sample is 100 cm^2. The cut fabric sample is then weighed on a GX-400 scale (Figure 2.1). To find the weight of 1 m^2 of fabric, multiply the scale by 100.

Figure 2.1. GX-400 scales.

Determination of hygroscopic properties of fabrics. Hygroscopicity determines the wet swelling property of the fabric from the environment (air). If necessary, the previous elemental samples with dimensions of 50x200 mm can be used at the same time. The number of samples is three, each of which is placed in a separate measuring cup.

The sampled open beakers are initially kept in an aqueous desiccator for 4 hours at a relative humidity of (98 ± 1)%. The beakers are then closed with a stopper and the measurement accuracy is taken from the desiccator to 0.001 g. The sample open cups are then placed in a drying cabinet, dried until they have a constant mass (107 ± 2) °C (for chlorinated materials (68 ± 2) °C), then frozen in a desiccator with dehydrated calcium chloride and measured to the same accuracy.

In determining the moisture transfer, the sampled beakers are first kept in an aqueous desiccator for 4 hours, then stored for 4 hours in a sulfuric acid medium with a relative humidity of (2 ± 1)%. The cups are then closed with a stopper, removed from the desiccator and weighed to the nearest 0.001 g. The samples are then dried, frozen, and re-measured in the drying cabinet according to the above method until a constant mass is obtained [46].

Gyroscopicity ($W_г$ %) is the relative humidity of the air at 100% and the humidity of the fabric at room temperature.

$$W_r = \frac{m_{100} - m_к}{m_к} \cdot 100,$$

here: m_{100} – the mass of the fabric sample held for 4 hours at 100% humidity, g; $m_к$ – absolute dry sample mass, g.

In assessing the hygroscopic properties of textile materials, their true moisture characteristics are often used.

Actual humidity W_x (%) indicates the amount of moisture in the fabric at the actual humidity of the air and is determined by the following formula:

$$W_x = \frac{m_x - m_к}{m_к} \cdot 100,$$

here: m_x – the mass of the fabric sample at the actual humidity of the air, g; $m_к$ – absolute dry sample mass, g.

Hygroscopicity is very important, especially for underwear and summer wear fabrics. Among such fabrics, the hygroscopicity of linen fabrics is the highest. The hygroscopicity of yarn fabrics, natural silk fabrics, viscose fiber fabrics is also good. The hygroscopicity of synthetic and triacetate fabrics is low, only the hygroscopicity of vinyl fabric is similar to that of yarn matonics. Hygroscopicity of the fabric decreases as a result of impregnation of the water-repellent solution, coating of film and rubber layer, processing with non-washable applets.

Determination of air permeability of fabrics.

One of the most important indicators characterizing the hygienic and heat-retaining properties of fabrics and garments made from them is air permeability.

The air permeability of a fabric is its air permeability, i.e. the air permeability, the ability of a test specimen to conduct air under conditions caused by pressure drops on both sides of the fabric.

The amount of air permeability depends on the density, porosity, diameter of the pores and their distribution along the radius of the fabric volume, types of pores (closed or interlocking), the type of surface finishing of the fabric, and so on. The air permeability of fabrics is determined using an AR-360SM instrument (Figure 2.2) [46].

Figure 2.2. AR-360SM device for determining the air permeability of fabrics.

The air permeability of textile fabrics is characterized by the air permeability coefficient, which indicates the amount of air passing through a cubic meter of fabric in 1 s² per 1 s under the conditions of the pressure difference of the sample. The pressure difference p = p1-p2 (Pa) air permeability coefficient [m³ / (m² · s)] is found by the following formula:

$$B_p = V/(FT)$$

Here: V – amount of air, m^3;

F – sample surface, m^2;

T – time, p.

The strength of the fabric. The tensile strength of the fabric is one of the most important indicators that determine its quality. The minimum breaking force sufficient to break a piece of fabric of a certain size is called the load. To determine the tensile strength, a piece of fabric is inspected on a cutting machine (Figure 2.3).

Rice. 2.3. AUTOGRAPHAG-1 instrument for determining the tensile strength and elongation of fabric

In determining the strength, it is very important that the width of the piece exactly matches the specified size and that all the body threads are complete from the beginning to the end of the piece.

The breaking force is calculated separately for the body and separately for the back. The breaking force of a sample on the body or back is the arithmetic mean of all test results [46].

In assessing the quality of the fabric in the laboratories, the tensile strength is determined and compared with standard norms. According to the International System of Units, the breaking force is represented by Newton. Although the breaking strength of suit yarn fabrics is greater than that of wool fabrics, they wear out faster when worn. This is due to the high elongation and elasticity of wool fabrics.

The tensile strength of fabrics depends on their fiber content, the linear density of the yarn, the type of weaving and dyeing. Fabrics woven from synthetic fibers have the highest tensile strength. The thicker the yarn and the denser the fabric, the tighter it will be. Finishing operations such as pressing, appretting,

steaming increase the firmness of the fabric. Bleaching and dyeing operations slightly reduce the toughness of the fabric.

Elongation of the fabric at break. Along with determining the strength of the fabric on the cutting machine, its elongation is also determined. The increase in the length of the sample during the break - the elongation at the break can be expressed in millimeters (absolute elongation) or expressed as a percentage of the initial length of the sample (relative elongation).

The quality of the fabric depends in many respects on the ratio of the proportions of elastic, elastic and plastic elongations. If the amount of elastic elongation in the fabric is large, it will not wrinkle much, and the wrinkles that appear in it will disappear quickly. The elastic fabric is harder to wet-iron, but the clothes sewn from it keep the shape well. If the elastic elongation at the full elongation of the fabric is more than one percent, the wrinkles that appear during the wearing of the fabric will disappear more slowly.

If the plastic elongation makes up a greater proportion in the full elongation of the fabric, such fabrics will be so wrinkled that the garments sewn from them will quickly lose their shape. Such clothes have to be ironed frequently. During wet ironing, the wrinkles are smoothed and the shape of the garment is partially restored, but after wearing, the garment folds again and the stretched areas lose their shape.

The value of full elongation of the fabric and the proportion of elastic, elastic and plastic elongations in the composition of full elongation depends on the fiber content of the fabric, the finish.

2.2. Determination of physical and mechanical properties of fabrics intended for special clothing

Special clothing is a product that protects the human body from external influences and performs aesthetic functions. It covers more than 80% of the human body and protects it from adverse environmental conditions and production

influences, helping the body to be in a normal healthy state [47]. Depending on the direction of the industry, special suits are made of special fabrics in strict compliance with the requirements of Interstate Standard.

When choosing a fabric for sewing a special garment, it is necessary to take into account not only its appearance, but also its various features, because the comfort and durability of the garment depends on them. Given the climatic conditions of Uzbekistan, one of the most important indicators to consider is the hygroscopicity of the fabric [48].

A survey of employees of Samarkand-based SamAUTO LLC analyzed the quality of existing special clothing and concluded that workers often sweat during the day, which has a negative impact on the work process [49]. Special clothing is made for the workers of the enterprise using imported fabrics available in the domestic market. Physical and mechanical properties of various structural special clothing fabrics to determine the cause of adverse events: studied in the laboratories of the Tashkent Institute of Textile and Light Industry "CENTEX.UZ" and "Sewing Design and Technology" [50] and the results of the study are given in Table 2.1 and 2.2.

Table 2.1

Structural properties of special clothing fabric

№	Fabric name	Fabric code	Fiber content, %		Fabric thickness, mm	Surface density, g /m^2	Introduction, %	
			Warp	Weft			Warp	Weft
1	Special clothing Fabrication	1	32,0-PE, 68-C	100-PE	0,52	210	1,2	2
2		2	100-C	100-C	0,45	218	5,5	3,5
3		3	100-PE	9,4-PE, 90,6-C	0,45	265	1,6	2,2
4		4	81,4-PE, 18,6-C	81,4-PE, 18,6-C	0,4	244	1,2	2
5		5	68,1-PE, 31,9-C	65,7-PE, 34,3-C	0,42	238	0,6	1,2

6		6	53,9-PE, 46,1-C	66,0-PE, 34-C	0,42	240	0,8	1,2
7		7	100-PE	100-PE	0,41	220	0	0
8		8	80,8-PE, 19,2-C	80,3-PE, 19,7-C	0,39	194	0,5	0,8

Table 2.2

Physical and mechanical properties of fabrics available for special clothing

№	Fabric name	Fiber content, %		Surface density, g / m^2	Hygroscopicity, %	Tensile strength, N		Elongation at break, %	
		Warp	Weft			Warp	Weft	Warp	Weft
1	Special clothing fabrics	32,0-PE, 68-C	100-E	210	3,4	961	666	7	12
2		100-C	100-C	218	5,37	693	471	9	10
3		100-PE	9,4-PE, 90,6-C	265	3,09	816	455	7	12
4		81,4-PE, 18,6-C	81,4-PE, 18,6-C	244	1,77	882	683	7	14
5		68,1-PE, 31,9-C	65,7-PE, 34,3-C	238	2,92	802	439	8	12
6		53,9-PE, 46,1-C	66,0-PE, 34-C	240	2,34	862	489	8	15
7		100-PE	100-PE	220	0,72	897	591	9	16
8		80,8-PE, 19,2-C	80,3-PE, 19,7-C	194	2,84	847	505	8	12

Note: PE – polyester fiber, C – cotton fiber.

Analysis of the available fabrics shows that the fiber content of the fabrics consists mainly of polyester and cotton fibers, woven into canvas and yarn, the fabric thickness is 0.4-0.52 mm, the surface density is 194-265 g / m^2. The composition of the fabric is 100% synthetic fiber. In the 7th fabric, the penetration

is 0% on the body and back, in mixed fiber fabrics it is 0.5-1.6% on the body, 0.8-2.2% on the back, 100% cotton. the penetration in the fibrous fabric is 5.5% on the torso and 3.5% on the back. The results show that the hygroscopicity of the fabric containing cotton fiber was 1.77-5.37%.

One of the main physical properties of textile fabrics is their ability to absorb and remove water and moisture, i.e. hygroscopicity.

It was found that the high incidence of sweating during the day at the enterprise "SamAUTO" LLC is mainly due to the fiber content of the fabric [51].

It is known from the literature [52] that the sample performance of textile fabric fibers varies. This depends primarily on the chemical composition of the fiber and the structure of the molecules. Therefore, the hygroscopic properties of cellulose and protein fibers are high. Viscose and modal fibers have a 1.8 times higher moisture absorption than cotton fiber. Most synthetic fibers, including polyester fiber, have low moisture absorption because the hydrophilic group is almost non-existent [53].

The hygroscopicity of fabrics varies with changes in relative humidity and temperature. The relative humidity of indoor air is always lower than that of outdoor. Therefore, the moisture absorption of clothing indoors will also be less than in the open air.

Unlike most synthetic fibers, viscose and modal are environmentally friendly fibers that are derived entirely from wood cellulose. They are completely free of toxic substances and other harmful compounds. High quality and natural wood is used for the production of viscose and modal fibers. Viscose and modal have a number of advantages over natural fabrics: high hygroscopicity and air permeability; lightness; ecological cleanliness; endurance; convenience The set of beneficial properties for the comfort of the body, the high hygroscopicity and air permeability of viscose and modal make such fabrics the most suitable for hot climates.

The issues of rational fabric development for special clothing in Uzbekistan have their own characteristics and require special research. For this

purpose, experiments were conducted to determine the hygienic performance of special clothing fabrics [54].

In the design of special clothing for hot climates, the issue of quantitative assessment of the rate of sweating from the body is of great interest. It is noted that a person sweats easier and more in summer in the same conditions than in winter, moreover, the intensity of skin separation depends on the adaptation of the human body to one or another climatic condition. For example, when the ambient temperature is 35 °C, up to $52 \cdot 10^{-6}$ kg / sec · m^2 of skin can be separated from the skin surface, while at a temperature of 45 °C the amount of moisture released can reach $101.8 \cdot 10^{-6}$ kg / sec · m^2 [55].

The passage of moisture (sweat) through a special garment is a complex process consisting of diffusion of water vapor through the pores, sorption-desorption of steam (or droplet-liquid sweat) by fibers and yarns, and capillary condensation, a difficult process especially for dense fabrics.

2.3. Development and research of new structural mixed fiber fabrics

In the development of a new range of fabrics, special attention was paid to increasing the hygroscopicity of the fabric [56]. The raw material for this is cotton fiber for warp yarn (linear density 15.4x2 tex), synthetic fiber for weft yarn - modal (20x3 tex) on the basis of "cotton + modal" 50/50% (option 1) and viscose fiber 100% (viscose) mixed yarn was made and a new structural special clothing fabric was created in the laboratory of the Tashkent Institute of Textile and Light Industry (Table 2.3). The physical and mechanical properties of the sample of mixed fiber yarns were studied in the laboratory "CENTEX.UZ" (Table 2.4).

Table 2.3

Technological parameters of preparation of mixed fiber yarn

Operations	Parameters	Modes
Wrapping	Thread length of yarn, mm	140-150
	Linear velocity range, min $^{-1}$	100-450
Twisting (cotton + modal)	Number of additions	20,0x3
	Range of turns, turns / m	150-160
	The direction of rotation	“Z”
	Speed, min $^{-1}$	1000-2800
Twisting (polyester + viscose)	Thread length of yarn, mm	140-150
	Linear velocity range, min $^{-1}$	100-450
	Number of additions	20,0x3
	Range of turns, turns / m	150-160
	The direction of rotation	“Z”
	Speed, min $^{-1}$	1000-2800

Table-2.4

Physico-mechanical characteristics of mixed fiber yarns

Name of indicators	Style and equipment	Options	
		I	II
Ip (fiber) type	Visual vision on a stereoscope	Cotton + modal	Polyester + viscose
Linear density, tex	«SK-60 H» scales	20,0x3	20,0x3
Buram size, bur / m	DIN 53831	150	150
Breakage voltage, N	STATIMAT C	1302	1376
Elongation at break, %	STATIMAT C	12,1	13,0

In view of the above, in order to increase its hygroscopicity for special clothing, it is advisable to recommend woven fabrics using a mixture of viscose and modal fibers [57].

The results of the study allowed the development of experimental samples of a new fabric with good hygienic properties, which has a beautiful appearance, soft,

lightness and durability in wear, which allows you to model clothing with a special purpose.

Table 2.5 shows the results of research on the physical and mechanical properties of the designed fabrics.

Table 2.5

Physical and mechanical properties of the designed fabrics

№	Physical and mechanical properties of fabric	Before decorating								After makeup			
	Fiber content of fabric,% Warp Weft	The raw material composition of the fabric, %								The raw material composition of the fabric, %			
		C=100 C/M=50/50				C=100 PE/V=80/20;				C=100 C/M=50/50		C=100 PE/V=80/20	
1	**Linear density of yarn, tex** Warp Weft	15,4x2 20x3				15,4x2 20x3				15,4x2 20x3		15,4x2 20x3	
2		1	2	3	Average	1	2	3	Average	I-A	I-B	III-A	III-B
	Surface density, g /m^2	196	194	195	**195**	192	190	191	**191**	230	240	220	196
3	**Air permeability, cm^3 / cm^2 * s**	22,48	22,65	22,50	**22,54**	14,21	14,12	14,16	**14,17**	14,71	14,71	9,93	17,07
4	**Hygroscopicity, %**	5,2	5,37	5,30	**5,30**	0,32	2,2	1,80	**1,44**	11,0	14,5	9,9	9,0
5	**Friction resistance, cycle**	22500				25500				23000	23300	26000	26000
6	**Tensile strength, N** Warp Weft	 824 498	 813 497	 816 493	 **817,6** **496**	 990 332	 984 321	 992 329	 **988,69** **327,3**	 824 502	 835 505	 925 481	 918 462
7	**Elongation at break,%** Warp Weft	 41 37	 43 40	 43 33	 **42,3** **36,6**	 48 35	 47 33	 46 33	 **47** **33,6**	 43 38	 44 42	 48 41	 48 42

Note: C – cotton fiber, PE– polyester fiber, M – modal fiber, V – viscose fiber.

The structural characteristics of the new fabric are given in Table 2.6.

Table 2.6

Structural characteristics of the new fabric

№	Fabric name	Fiber content,%		Fabric thickness, mm	Weaving	Fabric width, mm	Surface density, g / m^2
		Warp	Weft				
1	Fabric for special clothing	C-100	C-50 M-50	0,4	Cloth	150	230
2	Fabric for special clothing	C-100	PE-80 V-20	0,4	Cloth	150	220

At the next stage, experiments were conducted to study the physical and mechanical properties of the new fabric, which was developed for the production of special purpose clothing [58].

Physical and mechanical properties of the new composite fabric are given in Table 2.7.

Table 2.7

Physical and mechanical properties of the new fabric

Example	Sample code	Fabric thickness, mm	Surface density, g /m^2	Air permeability, sm^3/sm^2 *c	Hygroscopicity, %	Breaking strength, N	
						Warp	Weft
Designed	1-A	0,45	230	14,71	12,0	624	502
	1-B	0,45	235	14,75	14,5	635	505
	1-C	0,44	225	14, 73	13,5	630	504
	Average	0,45	230	14,73	13,3	630	504
	2-A	0,45	230	9,95	7,9	596	375
	2-B	0,45	210	9,94	7,6	590	377
	2-C	0,44	220	9,92	7,8	590	373
	Average	0,45	220	9,93	7,8	592	375
A	3-A	0,45	230	9,4	8,01	626	413

	3-B	0,40	220	7,4	7,64	601	230
	3-C	0,40	210	8,2	7,94	595	327
	Average	0,40	200	7,5	8,20	605	396

Note: 1 - projected pattern - "cotton + cotton / modal" fiber fabric; 2 - projected pattern - "cotton + polyester / viscose" fiber fabric; 3 - Available sample - 100% cotton fiber fabric.

A comparative analysis of the results of the study showed that the fabric sample with the addition of "cotton + modal" fibers showed good results in terms of hygienic properties, ie the relatively soft and irregular structure of the modal fiber showed a high ability to absorb moisture [59].

In terms of durability, the fabric with the addition of "cotton + modal" fibers gave a positive result. "Cotton + polyester / viscose" fabric sample gives way to the sample of the first variant in terms of hygienic properties.

Based on the above conclusions, the studied fabric samples with the addition of "cotton + modal" fibers increase the hygienic properties and were recommended to design a new model of special clothing for workers engaged in production.

2.4. To study the resistance of special clothing fabrics to external influences and their dependence on various factors

Consumers' demands for special clothing are represented by social, functional, ergonomic, aesthetic, and operational groups [60].

Production requirements can be divided into design and technological and economic.

Based on the survey of respondents, the importance of the requirements for the product and their significance were determined, and the indicators are included in Table 2.3.

Significance of quality indicators is determined by the formula [61]:

$$Gi = \frac{Pi}{\sum Pi}.$$

Based on the survey conducted among the automotive workers, the sequence of requirements for this type of product and their relevance for the base fabric were determined.

The most important requirements are indicated by the number 1, the least important by the number 5.

Table 2.8 shows that design and technological requirements are of paramount importance. Fabrics should have properties such as minimal shrinkage, hygroscopicity, stiffness, elasticity, perforation and slippage of the yarns [62].

Table 2.8

The importance of the requirements for the recommended special clothing

Requirements	**Aesthetics**	**Exploitation**	**Constructive-technological**	**Technological**	**Economics**
Significance	3	1	2	5	4
Weight	0,2	0,07	0,13	0,3	0,3

The data show that reliability (service life of the kit depending on the type of workwear is 1-3 years), durability, shaping ability, elongation resistance, peeling, as well as washing or dry cleaning are very important for work clothes and fabrics within the operational requirements. The most important group of requirements for the selected fabric will be operational requirements, but not all of them are equally important. It is necessary to emphasize the most important basic values of indicators in order to determine which features should be taken into account in the selection of fabrics in the first place and, if necessary, they can be ignored. To do this, an expert assessment method should be used [61]. Local cotton fabric was selected as the object of study.

To a group of ten experts X_1, X_2, X_3, X_4, X_5, X_6, X_7 and X_8 asked to determine the importance of the properties of fabrics that ensure the fulfillment of

operational requirements in the production of special clothing:

X_1 – hygroscopicity, %; X_2 – air permeability, cm^3/cm^2*c; X_3 – breaking force, H; X_4 – friction resistance, min^{-1}; X_5 – introduction, %; X_6 – washing resistance, %; X_7 – color stability, score; X_8 – bending resistance.

The most important demand is assessed (R-1), the least important (R-2), the least - (R-8) (Table 2.9).

Table2.9

Expert assessment of factors influencing the design and technological requirements of textile materials for workwear

№	Factors / Experts	1	2	3	4	5	6	7	8	9	10	У
1.	Hygroscopicity	1	3	2	1	4	2	1	3	3	1	21
2.	Air permeability	2	4	1	2	3	1	2	2	1	2	20
3.	Breaking force	3	2	3	3	2	3	3	1	4	3	27
4.	Friction resistance	5	7	7	7	7	5	5	5	5	5	58
5.	Introduction	4	1	4	4	1	4	4	4	2	4	32
6.	Washing resistance	6	5	6	5	6	6	6	6	8	7	63
7.	Color stability	7	6	5	6	8	5	8	8	7	6	69
8.	Bending resistance	8	8	8	8	5	8	7	7	6	8	69
	∑ R	36	36	36	36	36	36	36	36	36	36	

The sum of the ranks of each specialist is determined by the formula [59]:

$$\sum_{i=1}^{n} R = 0{,}5n(n+1), \qquad (1)$$

here n - number of levels.

$$\sum_{i=1}^{n} R = 0{,}5 \cdot 8(8+1) = 36$$

Identification of important factors influencing the design and technological requirements of textile materials for special clothing

Table 2.10

Experts	Factors								∑ $P_{иж}$	$T_ж$
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8		

1	1	2	3	5	4	6	7	8	36	0
2	3	4	2	7	1	5	6	8	36	
3	2	1	3	7	4	6	5	8	36	
4	1	2	3	7	4	5	6	8	36	
5	4	3	2	7	1	6	8	5	36	
6	2	1	3	5	4	6	5	8	36	
7	1	2	3	5	4	8	7	6	36	
8	3	2	1	5	4	6	8	7	36	
9	3	1	4	5	2	8	7	6	36	
10	1	2	3	5	4	7	6	8	36	
$C_ж$	21	20	27	58	32	63	69	69	360	
$\gamma_ж$	0,21	0,22	0,189	0,078	0,171	0,06	0,039	0,039		
мн-$C_ж$	59	60	53		48					
$\gamma_{ж0}$	0,197	0,20	0,18		0,16					
$\delta_{ж0}$	1,24	1,375	1,18		1,0					
$C_ж$-C	-15	-16	-9	22	-4	27	33	33		
$(C_ж – C)^2$	225	256	81	484	16	729	1089	1089	3969	

The relative significance coefficient for each property was determined according to the following formula:

$$\gamma_i = \frac{1}{S_i \sum_{i=1}^{n} \frac{1}{S_i}}, \qquad (2)$$

each *u*- the sum of the levels for a property - S_i

$$\gamma_1 = \frac{1}{S_1 \sum_{i=n}^{n} \frac{1}{S_i}} = \frac{1}{21 \sum_{i=n}^{n} \frac{1}{21} + \frac{1}{20} + \frac{1}{27} + \frac{1}{58} + \frac{1}{32} + \frac{1}{63} + \frac{1}{69} + \frac{1}{69}} = 0{,}21$$

According to experts, X_1, X_2, X_4, X_6 properties are relatively important because they fulfill the following condition

$$\gamma_i \geq \frac{1}{n}. \qquad (3)$$

$$\frac{1}{8} = 0{,}125; \quad \text{then } \gamma_i \geq \frac{1}{n} \geq 0{,}125$$

The significant coefficient for each of these selected properties was also determined by the formula

$$\gamma_к = \frac{1}{S_к \sum_{к=1}^{n} \frac{1}{S_к}}, \qquad (4)$$

$$\gamma_{j0} = \frac{mn - S_{jo}}{mnn_0 - \sum_i^{n_0} s_{jo}}.$$

The relative weight of the remaining properties $\beta_к$, coefficient $\gamma_к$ to the minimum value of the significance coefficients of the remaining properties of the ratio $\gamma_{\min}$ was calculated as:

$$\beta_{ê} = \frac{\gamma_{ê}}{\gamma_{\min}}. \qquad (5)$$

To determine the agreement coefficient W is determined: $(S_i - \bar{S})$ and $(S_i - \bar{S})^2$, here $\bar{S}$ - the average sum of the levels on all indicators.

According to the following formula to determine the consistency of the expert assessment *W* the coefficient of agreement was determined:

$$W = \frac{\sum_{i=1}^{n} \left(S_i - \bar{S}\right)^2}{\frac{1}{12} m^2 \left(n^3 - n\right) - m \sum_{j=1}^{m} T_j} = \frac{3969}{4200} = 0{,}94 \qquad (6)$$

with this in mind $T_j = 0$

W a criterion was found to assess the significance of the agreement coefficient

$$\chi^2 = Wm(n-1), \qquad (7)$$

this $\chi^2_{\text{табл.}}$ - the table value of the criterion was compared with the degree of freedom.

$$\chi^2 = 0{,}94 \cdot 10(8-1) = 65{,}8$$

$S = n - 1 = 7$ $\chi^2_{òàáë} = 14{,}1$.

$\chi^2 = 65{,}8 > 14{,}1$ therefore, the consent of ten experts was obtained.

Table-2.11

$\chi^2_{\text{кр}}$ freedom level indicators

К	н=1 $\chi^2_{кр}$										
	1	2	3	4	5	6	7	8	9	10	11
0,01	6,6	9,2	11,3	13,3	15,1	16,8	18,5	20,1	21,7	23	24
0,05	3,8	6,0	7,8	9,5	11,1	12,6	14,1	15,5	16,9	18	19

The rank sum of each expert was determined according to the following formula:

$$\sum_{i=1}^{n} R = 0{,}5n(n+1),$$

here *n* - number of degrees.

The relative significance coefficient for each property was determined according to the following formula:

$$\gamma_i = \frac{1}{S_i \sum_{i=1}^{n} \frac{1}{S_i}},$$

The sum of the levels for each property S_i

According to experts, the most important X_1, X_2, X_4, X_6 properties because they meet the condition

$$\gamma_i \geq \frac{1}{n}.$$

The significance coefficient for each of these selected properties was also determined by the formula

$$\gamma_к = \frac{1}{S_к \sum_{к=1}^{n} \frac{1}{S_к}},$$

Relative weight of properties $\beta_к$ significance coefficient $\gamma_к$ was calculated as the ratio of the coefficients to the minimum value $\gamma_{\min}$:

$$\beta_{ê} = \frac{\gamma_{ê}}{\gamma_{\min}}.$$

W is set to calculate the agreement coefficient: $(S_i - \bar{S})$ and $(S_i - \bar{S})^2$, here $\bar{S}$ - the average sum of the levels on all indicators.

According to the formula to determine the consistency of expert

assessments *W* the coefficient of agreement was determined:

$$W = \frac{\sum_{i=1}^{n}\left(S_i - \bar{S}\right)^2}{\frac{1}{12}m^2\left(n^3 - n\right) - m\sum_{j=1}^{m}T_j}$$

with this in mind $T_j = 0$

W to assess the significance of the evaluation coefficient χ^2 criteria found

$$\chi^2 = Wm(n-1),$$

this $\chi^2_{\text{табл.}}$ - with the table value of the criterion $S = n-1$ compared with the degree of freedom.

The obtained results allow to create a color diagram of the properties that meet the considered group of requirements.

As can be seen from the diagram (Diagram 2.1), according to experts, the most important indicators of fabrics: X1 - hygroscopicity, X2 - air permeability, X3 - tensile strength, X5 - penetration. The remaining indicators are less important for the features that ensure the fulfillment of design and technological requirements.

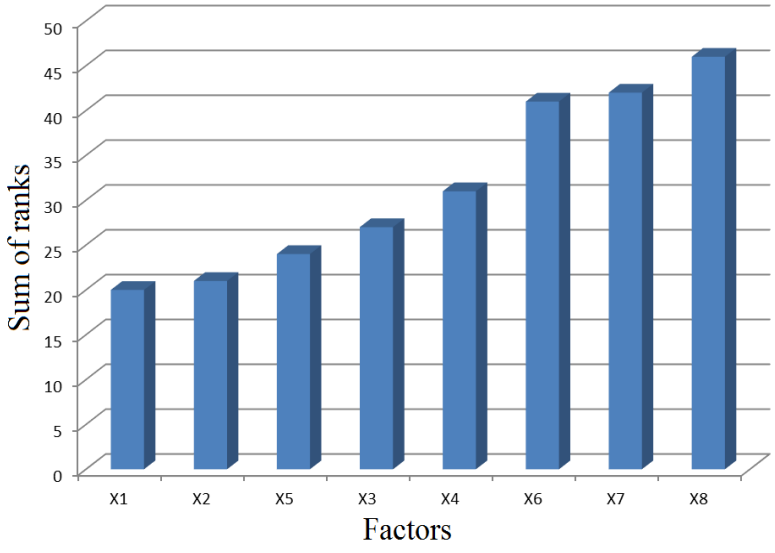


Figure 2.1. Rank diagram of features that ensure the fulfillment of design and technological requirements

CHAPTER 3. DEVELOPMENT OF TECHNOLOGY FOR MANUFACTURING SPECIAL CLOTHES WITH HIGH HYGIENIC PROPERTIES

3.1. Investigation of special clothing in statics and dynamics

Each ergonomic study begins with an analysis of the worker's performance and the function of the equipment. The goal of ergonomic research is to ensure that the worker works safely and evaluates the process effectively. The results of the obtained research and object assessment are used in the development of recommendations, operational recommendations, guidelines for occupational safety [63].

The study examined the movements of workers in the assembly shop of the Samavto automotive industry during the shift (Figure 3.1).

Figure 3.1. The actions of the workers of the assembly shop of the automotive industry

The methodology for mapping ergonomic movements was developed by Central Research Institute of Garment Industry (Moscow), which allows you to quickly provide a complete picture of the working movements of executors over time [64]. Basic position of the worker: 1 (row 1) - standing; 2 (row 2) - sitting; 3 (row 3) - half sitting. Information on the basics is needed to design new custom clothing. Special clothing should not only protect the human body from external factors, but also serve to improve work ability, increase work productivity, which will reduce the sweating conditions of workers. Special clothing with a rational design solution is required when performing medium-weight work in a hot environment (25-38 °C air temperature).

Table 3.1 shows the main labor movements of workers in the production of Samavto automobiles.

As a result of ergonomic studies, it was found that the movement of the worker during the day - his condition, ergonomic movements affect the choice of zones in the design of special clothing and the application of additional protective layers (Table 3.1).

Based on the research, it was found that the following areas undergo significant changes during the work of workers during the technological process: the width of the back, the step seam of the pants, the length of the seam seam, the longest seam seam, the side seam of the jacket.

Table 3.1

Map of ergonomic movements of workers in automobile production

	Working position	**Scheme of cyclical actions of the worker**			**Average time (hours)**		
		1	**2**	**3**	**1**	**2**	**3**
1	Assemble the case				3	1	4
2	Dyeing				3	2	3

3	Chassis assembly				3	2	3
4	Final collection				4	1	3
	Placement in a warehouse				4	-	4

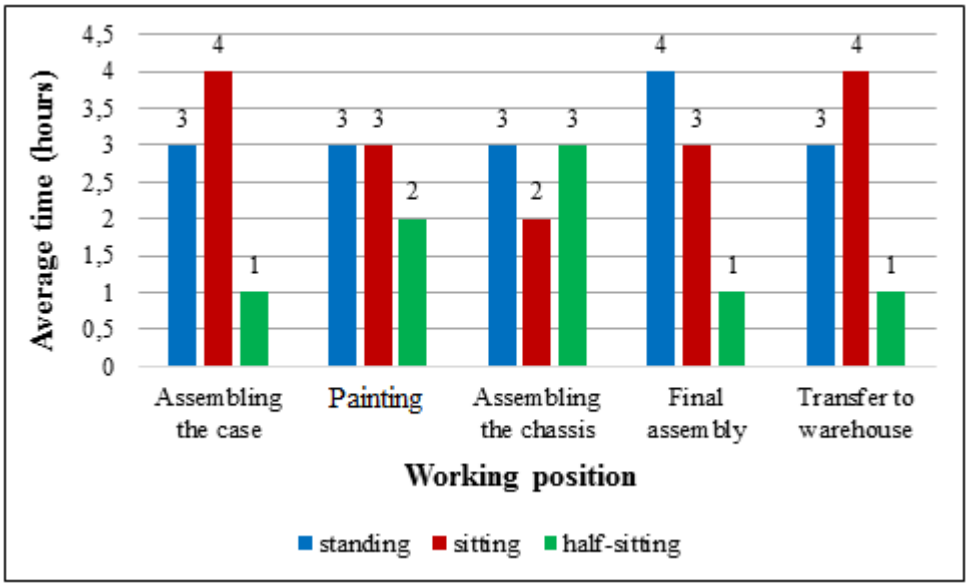


Figure 3.1. Ergonomic movements of workers in the automotive industry

In addition, the study identified the following types of movement - body forward, arm movement - 51%, body sideways - 34%, arms raised - 54%, lumbar rotation - 73.5%, knee joint movement - 39 % [65].

The aim of the study is to design reasonable garments that are distinguished by their functional properties in certain topographic zones and provide a certain level of product quality and to form reasonable types of production of new special garments for workers in manufacturing enterprises.

The results of the study show that as a result of ergonomic movements of workers, their special clothing should be comfortable, not impede the movement of the worker, and not cause the worker to sweat, while not adversely affecting production efficiency.

3.2. Development of a new special clothing project for automotive industry workers

One of the main requirements for special clothing is its ergonomics. Most of the special clothing models developed to date are aimed at improving the ergonomic properties of the garment while ensuring that the garment is comfortable for the wearer to wear [66].

The design of structural elements (pockets, covers, caps, etc.) should be based on safety requirements in determining their shape, size, quantity and location, for example, to exclude the possibility of harmful substances falling into the pocket. Similarly, the nature of labor movements must be taken into account [64].

Special clothing is characterized by the shape and location of individual details and joints. It is very important to properly consider the whole set of requirements to ensure the required level of comfort and safety in the design of special clothing [67].

According to the operating conditions and consumer demand, the garment design should ensure freedom of hand movements due to its professional design in addition to comfort and convenience during wear.

Depending on the production conditions and consumer demand, special clothing:

- with overalls, suits, gowns, half overalls, aprons, caps and hats;
- shoulder straps with attachment collar or tie collar;
- hooded;
- protective layer of different shapes and sizes;
- can be reinforced layered and ventilated element of different appearance and size.

As a result of the research, a special set of clothes made of a new structural fabric with increased hygienic properties was developed for workers in the automotive industry.

This set consists of a jacket and a semi-overalls. Base-shaped, straight-silhouette, center-sided zipper jacket and three-button sash and back collar jacket. The front is coquette, with a cover-lined pocket along the coquette seams. There are two cover pockets on the front. The back piece is coquette, the coquette is finished with a red extra character fabric. Most of a single-stitch transfer, reversible collar, integral seam.

The semi-overalls have two buttons and a knob on one side of the hem. Gulfik with a lightning bolt. The front of the overalls has a lining pocket. The jumpsuit has a side pocket and a flap pocket with a flap. The back of the overalls is lined with rubber.

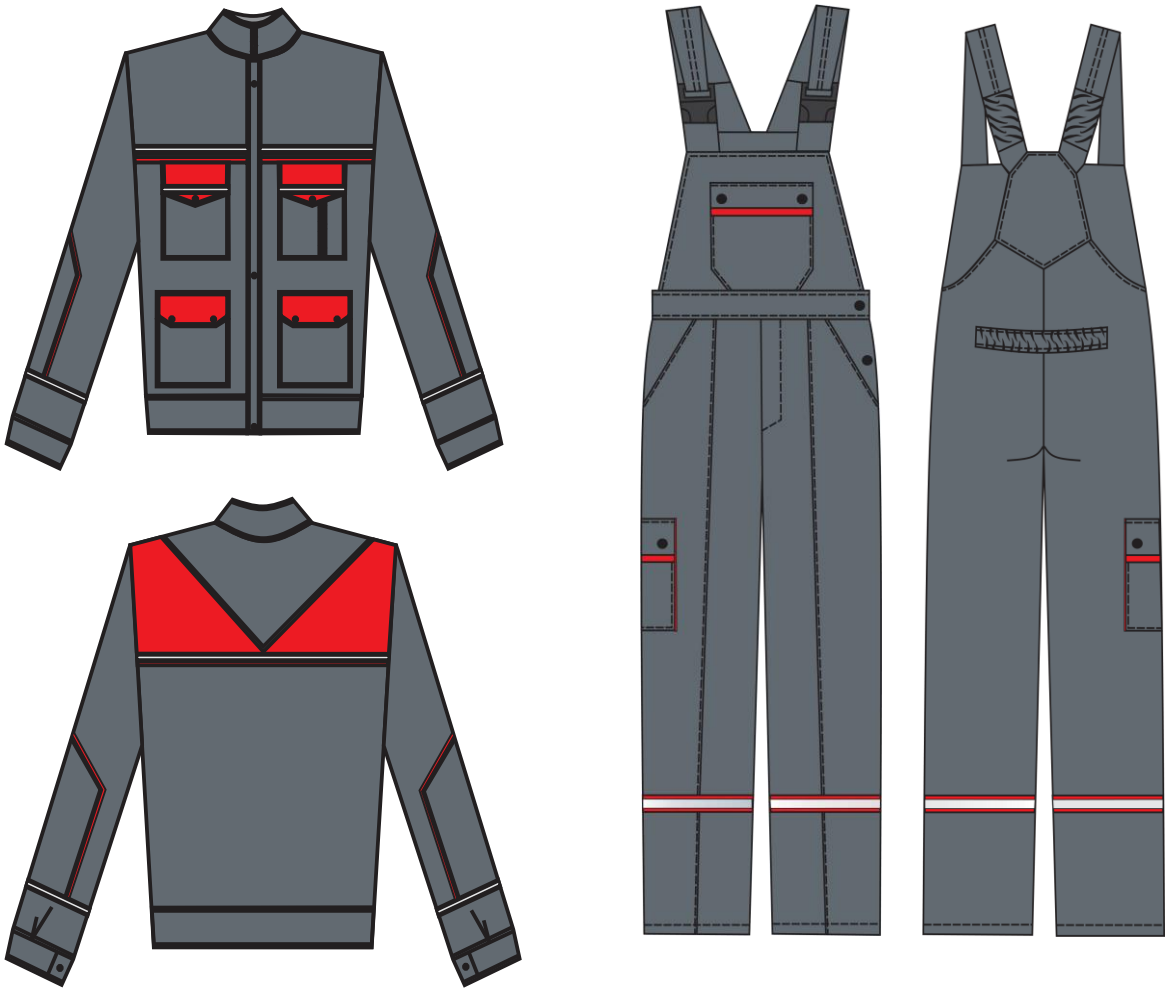


Figure 3.3. Technical appearance of the projected product model

Confection map of fabrics and accessories for the designed product is given in Table 3.2 [68].

Table 3.2

Confection map

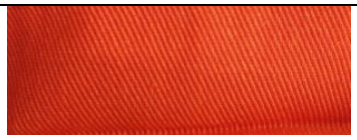
№	Naming	Articles	For example
1.	Basic fabric	Diagonal	
2.	Extra fabric	Diagonal	
3.	Elastic band	Ш$_р$=4,0	
4.	Light reflective tape		
5.	Pins	Plastic	
6.	Lightning bolt	L=80	
7.	Knopka	metal button d=1.4	
8.	Thread	№50	

Figure 3.4. Appearance of the proposed special clothing set

Recommended dimensions and height are regulated. The dimensions of the suit should correspond to the height of the human body and the circumference of the chest in the typical figure shown in Tables 1 and 2. Chest circumference is 88.92 cm. and the height of a typical human body is less than 158, 164 cm and the size of the chest circumference is 120, 140 cm and the height of a typical human body is 182, 188 cm. Suits with more than one are made according to consumer requirements.

Table 3.3

Evaluation of the proposed model on quality indicators (QI)

№	Name of group and individual quality indicators	QI character	Significance of QI			
			RM-1	RM-2	RM-3	Etalon
1.	Consumer QI	I 1	59	59,5	58	63,5
	Social	I 11	10	10,5	10	11,5

	Functional	I 21	10	10	10	11,5
	Aesthetics	I 31	14	14	13	15
	Ergonomic	I 41	13	13	13	13
	Exploitation	I 51	12	12	12	12,5
2.	Feasibility study	I 2	35	36	35	36,5
	Standardization and unification	I 21	11	11	11	11
	Technological design	I 22	14	14	13	14,3
	Economic	I 32	10	11	11	11
	Total		94	95,5	93	100

The general and universal feature of UACM (Unified Apparel Construction Methodology) is the definition of a set of basic constructive sections and the method of their definition. The set of cuts is repeated on any type of garment, divided into inner parts for the upper and lower parts of the body. The set of constructive cuts does not depend on the fashion direction, technology and fabric properties [69].

Any calculation formulas in a set of sections have their place in the structure of numbers. In order to design any type of clothing, a common single sequence is created in a single way:

- Unified system of measurements;
- classification and single system of attachments;
- Classification of formulas and a single system;
- uniformity of formulas and integral sequence of construction structure;
- a single basis of clothing design and the main base of clothing types;
- Unified principles of gradation;
- strict rules of technical drawing of construction;
- identification of the same name and number of constructive points;
- The content of a single volume of design documentation.

This style can be used as a starting point in the design of different garments, which differ in function, function, individually and collectively made of different fabrics. This method is scientifically based, as its primary basis is the use of

anthropometric measurements of the population of influential countries, a system of scientifically based constructive and technological additions, and analytical calculation formulas in construction [70].

Constructive modeling of the project object:

Jacket:

1. The back piece coquette is drawn.
2. The middle vitachka was moved under the coquette.
3. The back has been expanded by adding a folding account to the bottom section.
4. The front piece coquette is drawn.
5. The location of the board line has been determined.
6. The front bar is drawn.
7. The breast vitreous is transferred to the thorax.
8. The anterior lobe was moved to the lower abdomen.
9. The location of the chest and side pockets was determined.
10. Modeled as the most two stitches.
11. The elbow cover is drawn on the shoulder.
12. The position of the connecting belt is drawn on the hem.
13. A vertical collar structure was constructed.

Semi-overalls:

1. The front part of the gulf is marked.
2. The front piece side and cover pocket location is marked.
3. The location of the front piece is determined.

Preliminary data for the construction of the MC (model consctructiron) drawing

Table 3.4

Dimensions of a typical figure

№	Name of dimensions	Conditional symbol	Value, cm

1.	Height	T1	176
2.	Chest circumference	T16	100
3.	Waist circumference	T18	94
4.	The height of the point at the base of the neck	T4	139,9
5.	Waist height	T7	110,3
6.	Knee height	T9	45,4
7.	The height of the neck point	T10	141,0
8.	The height of the lower buttocks	T12	80,8
9.	Neck circumference	T13	37,0
10.	Chest circumference first	T14	91,8
11.	Boxing Circle (Abdominal Line b-n)	T19	100
12.	Chest circumference is second	T15	100,8
13.	Boxing Circle (without belly line)	T20	102,8
14.	The last circle	T21	57,4
15.	From the side to the waist line to the floor	T25	111,4
16.	From the front to the waist line to the floor	T26	110,8
17.	The length of the leg from the inside	T27	81,4
18.	Wrist circumference	T29	18,6
19.	The width of the shoulder slope	T31	15,4
20.	The height of the front spine	T34	28,6
21.	Chest height	T35	36,2
22.	Front waistline height	T36	55,4
23.	A bow that passes through the highest point of the shoulder shape	T38	36,3
24.	Length to back waist	T40	45,3
25.	The length of the back from the waist line to the base of the neck	T43	49,4
26.	The length of the upper part of the body to the point of the base of the neck		
27.	The distance between the centers of the breasts		

Table 3.5

Additions to build MC

№	Name of attachments	Symbols	Value, cm

1.	Chest circumference appendix	C31-37	9,3
2.	The width of the back piece	C31-33	2,55
3.	Front section	C35-37	2,6
4.	The length of the back piece	C11-41	2,35
5.	The width of the back piece	C11-12	1,2
6.	The height of the otter	C33-13	1,7
7.	Height at the withers	C35-15	1,8
8.	Chest center	C46-47	1,3
9.	Chest height	C36-16	2,6
10.	Anterior cervical spine width	C161-16	1,2
11.	Depth of anterior cervical vertebrae	C16-161	1,5
12.	Box width	C51-57	7,25
13.	Waist circumference	C41-470	3,12
14.	Pants back width	C51-58	1,44
15.	Pants front width	C57-58	0,87

Construction and calculation of MC

Table 3.6

Design model MC construction calculation

№	Construction	Formula, calculation	Value, cm
1.	11-91	T40+(T7-T12)+C	76,95
2.	11-21	0,3T40+C	16,0
3.	11-31	T39+C	23,75
4.	11-41	T40+C	47,85
5.	41-51	0,65(T7-T12)+C	18,9
6.	31-33	0,5 T47+C	22,9
7.	33-35	T57+C	16,55
8.	35-37	0,5T45+0,5(T15-0,8-T-14)+C	22,2
9.	31-37	(31-33)+(33-35)+(35-37)	61,65
10.	37-47	T40-T39+C	24,1
11.	47-57	0,65(T7-T12)+C	18,9
12.	47-97	T7-T12+C	30,1
13.	33-13	0,5 T38+C	19,75
14.	35-15	0,44 T38+C	17,7
15.	33-331	C	4,0
16.	35-351	C	4,0

17.	331-341	0,62(33-35)+a_{17}	9,25
18.	351-346	0,38(33-35)-a_{17}	5,3
19.	331-332	0,62(33-35)+a_{19}	11,73
20.	Р332-342	0,62(33-35)+a_{19}	11,73
20.1	Р341-342	0,62(33-35)+a_{19}	11,73
20.2	341-342	К	
20.3	Р332-13	К	
21.	351-352	0,38(33-35)-a_{21}	6,3
22.	Р352-343	0,38(33-35)-a_{21}	6,3
22.1	Р346-343	0,38(33-35)-a_{21}	6,3
22.2	346-352	К	
22.3	Р352-15	К	
23.	111-111	011	
24.	41-411	041	1,5
25.	51-511	051	1,5
26.	91-911	091	1,5
27.	111-12	0,18Т13-П	8,6
28.	111-112	0,25(111-12)	1,5
29.	12-121	0,0Т13+С	2,15
30.	13-14	4,0-0,08Т47	2,75
31.	121-122	0,45(121-14)	0,7
32.	31-32	0,17Т47+ОН+С	
33.	122-22	0,45(122-32)	
34.	122-22-122ъ	β_{34}-1,7$_{тпа}$-0,9 $СС_{31-33}$	
35.	Р122-14ъ	122ъ-14	
36.	Р22-141	22-14ъ	
36.1	Р121-141	121-14	9^{o}
37.	Р22-123	21-123ъ	
38.	121-113	К	
38.1	111-113	К	
39.	Р121-114	(121-113)-a_{39}	a_{39}=1,0
39.1	Р112-114	(121-113)-a_{39}	
40.	121-112	К	
41.	14ъ-342ъ	К	
41.1	332-342ъ	К	
42.	Р14ъ-342	14ъ-342ъ	
42.1	Р332-342”	14ъ-342ъ	
43.	332-14ъ	(121-113)-а39	

44.	47-471ъ	К	1,5
45.	471-46	0,24 Т18-0,5(Т45+Т15-0,8-Т14)	12,65
46.	46-471ъ	К	
47.	46-36	0,5Т46+С	20,7
48.	36-371		
49.	36-372		7,8
50.	Р36-372ъ	36-372	
50.1	372-372ъ	0,5(Т15-0,8-Т14)	0,45
50.2	Р36-371		
51.	371ъ-361	0.18Т13+С	8,9
52.	Р36-16	Т44-(Т40+0,08+Т13-0,7)-(Т36-35)+С	29,4
53.	Р16-14ъъ	121-14	
54.	16-161	0,195Т13+С	9,5
55.	16-171	К	
55.1	17-171	К	
56.	Р16-172	16-171	
56.1	Р17-172	16-171	
59.	Р14ъъ-343ъъ	14ъъ-343ъ	
59.1	Р352-343ъъ	14ъъ-343ъ	
60.	353-14ъъ	К	
61.	411-470	0,5Т18+С	
62.	511-570	0,5Т19+С	59,15
63.1	ДП	$0,95Т38+(С33-13+_{П35-15})+0,57+(Т57+С_{33-35})+2(33-331)$	55,21
63.2	ПОР	N.D.P	1,9
63.3	ДОР	(1+N)·DP	57,2
Sleeve calculation			
64.	331-351(ShP)	33-35	16,55
65.	331-341	$0,62(33-35)+a_{17}$	9,25
66.	351-346	$0,38(33-35)+a_{18}$	5,3
67.	331-332	$0,62(33-35)+a_{19}$	11,75
68.	Р332-342	$0,62(33-35)+a_{19}$	11,75
68.1	Р341-342	$0,62(33-35)+a_{19}$	11,75
68.2	351-352	К	
69.	351-352	$0,38(33-35)+a_{21}$	6,3
70.	Р352-343	$0,38(33-35)+a_{21}$	6,3
70.1	Р346-343	$0,38(33-35)+a_{21}$	6,3
70.2	346-352	К	

71.	351-333(ShOR)	T57+4,0+C	
72.	333-13(VOR)	0,885DOR$\sqrt{0,25 \cdot (\frac{\text{ШОР}}{\text{ДОР}})}$…	22,3
73.	13-14	0,45(351-331)	15,05
74.	13-141	0,73(351-335)	10,05
75.	15-141ъ	15-141	16,3
76.	141-355	0,51(141ъ-345)	
77.	P353-354	353-343	
78.	141-142	141-15	3,9
79.	14-143	0,5(14-141)	
80.	13-131	0,25(333-13)	
82.	131-344	0,5(131-342)	
83.	P344-345	344-342	
84.	13-134	13ъ-133ъ	
85.	133-134	0.5(133-131)	
86.	133-144	0.5(133-44)	
87.	Cotton		2,5
88.	13-333-93	T33-(121-14)+C	65,0
89.	13-333-43	T32-(121-14)+C	37,2
90.	95-931	0,5T29+C	8,5
91.	95-94	0,5(95-931)	
92.	931-932	0,5(93-931)	
Overalls MC account			
94.	41-51	0,65(T7-T12)+CT-3,0	16,5
95.	51-57	0,5T19+C	54,7
96.	51-54	0,53(51-57)	29,0
97.	54Ъ-57	0,47(51-57)	25,7
98.	44Ъ-940	T26-3,0+CT	108,35
99.	940-441Ъ	T25-3,0+CT	108,9
100.	940-440	T8+CT	101,7
101.	940-64	T27+CT	82,2
102.	940-74	T9+CT	49,9
103.	940-94	0,4T1-CCЪ	4,05
104.	51-58	0,665(0,2T19-2,0)+C	13,9
105.	57-58Ъ	0,335(0,2T19-2,0)+C	7,15
106.	58-52	0,5(151-58)+(51-541)	21,45
107.	54Ъ-56	0,5(157-58Ъ)+(51-571)	16,45

108.	72-78	0,275Т22+С	13,35
109.	72-741	0,275Т22+С	13,35
110.	76-743Ъ	0,225Т22+С	10,85
110.	76-78	0,275Т22+С	12,5
111.	92-98	0,275Т51+С	12,5
112.	92-941	0,275Т51+С	9,95
113.	96-941Ъ	0,225Т51+С	9,95
114.	96-98Ъ	0,225Т51+С	9,95
115.	41-410	0,5Т18+С	47,1
116.	72-742Ъ	0,375(151-54)+(51-581)-2,5	13,6
117.	54-44	54-44Ъ	
118.	Р54-441	54Ъ-441	
119.	Р54-511	54-51	
120.	Р44-411	54-51	
121.	Р511-411	51-42	
122.	411-42	51-52	
123.	51-512	0,5(51-511)	
124.	68-681	a_{31}^2	
125.	Р681-582	68-581	
126.	Р511-588	68-581	
127.	681-512	К	
128.	58Ъ-68Ъ	К	
129.	68Ъ-58Ъ	68-58Ъ	
130.	Р68Ъ-582Ъ	68-581Ъ	
130.1	Р57-582Ъ	68-581Ъ	
130.2	68Ъ-57	К	

Creating working documents:

The drawing of the models is prepared in accordance with the Unified System of Design Documents (ESKD) for all the details that make up the product [71]. The pattern drawing is done in the following sequence:

1. The construction drawing is checked in detail.
2. The drawing shall be clarified in relation to the permeability of the fabric.
3. Copies of the detailed drawing are drawn on another piece of paper.
4. The main details are built working drawing of templates.
5. Working drawings of the product and auxiliary templates are constructed.

6. Templates are prepared for use in production.

The mentioned sequence is performed in the following order. In order to check the construction drawing, a copy of the main details, such as the front and back pieces, the side part, the top, the bottom collar, is copied from the drawing on thick paper using a special device, cut by stitching. The cut-out patterns define the chest, waist, buttocks, hips, frontal line, pocket line, and other basic constructive lines. The uniformity of the attached shears, the compatibility of the joints, the compatibility of the control grooves are checked in the patterns.

Templates of basic details are prepared according to the drawings of clothing design.

The main details include: front piece, front piece, side piece, top and bottom, etc.

The basic templates are exactly the same as the working drawings. They are made to base sizes.

Reference templates are prepared by gradation based on basic templates.

Used in the control of working templates stored in the experimental shop. The welds are checked 1 time using the quality measurement table of reference templates.

Working templates are produced on the basis of reference templates and are used directly in the production process to determine the contour of the cuts and details in the construction of the layout.

Templates made on the basis of basic detail templates are called product templates. Product templates include details cut from the base fabric: board, adip, top collar, small details such as visible, all detail templates from lining and folding fabrics. With the help of product templates, garments are decorated with constructive and decorative elements. They are used in the process of ensuring the stability of the shape of the product. Therefore, the dimensions and shapes of the product templates are constructed in relation to the shape of the main templates.

Auxiliary template is used to draw chalk contour lines, to determine the cut of details, to determine the position of the plates, folds, seams, pockets.

Table 3.7

Detail specification

№	The name of the item details	The symbol of the detail code	Quantity		Note
			On the pattern	When cutting	
1	2	3	4	5	6
1.	Front yoke	01	1	2	
2.	Back yoke	02	1	1	fold
3.	Front section	03	1	2	
4.	Back section	04	1	1	fold
5.	Placket (yoke)	05	1	1	fold
6	Lap 1	06	1	2	
7	Pocket 1	07	1	2	
8	Lap 2	08	1	2	
9	Pocket 2	09	1	2	
10	Collar	010	1	2	Fold
11	Braid 1	011	1	1	
12	Sleeve	012	1	2	
13	Elbow coating	013	1	2	
14	Upturn	014	1	2	
15	Closure placket	015	1	2	
16	Open-out for front	016	1	1	
17	Open-out for front	017	1	1	
18	Jacket cuffs	018	1	2	
19	The front of the overalls	019	1	2	
20	The overalls of the overalls	020	1	2	
21	The front of the overalls	021	1	1	
22	Pocket cover 3	022	1	2	
23	Pocket 3	023	1	2	
24	Pocket cover 4	024	1	2	
25	Pocket 4	025	1	2	
26	Gulfik	026	1	1	fold
27	Don't look	027	1	2	
28	Kamari overalls	028	1	1	

29	Overalls belt	029	1	1	
30	Tape 2	030	1	2	
31	Tape 3	031	1	2	

Calculation of the norm of fabric consumption for the designed model

In the distribution of the details of the proposed new model, the amount of emissions between the templates was calculated according to industry standards [72].

Before performing the spread, its initial length is calculated as follows:

$$L_{p1} = H_{0np} / Ш_p = 46440 / 160 = 290$$

$$L_{p2} = H_{0np} / Ш_p = 3228 / 152 = 21$$

Here: H_{0np} - the initial norm of the curl;

$Ш_p$ – width of fabric, cm

The initial rate of fabric used for twisting is determined by the following formula:

$$H_{0np1} = F_л*100 / 100\text{-}B_н = 38081*100 / 100\text{-}18 = 46440$$

$$H_{0np2} = F_л*100 / 100\text{-}B_н = 2744*100 / 100\text{-}15 = 3228$$

Here: $F_л$ – template surface cm ^{2}.

$B_н$ – normative amount of output between templates.

When performing the spread, special technical conditions and requirements for the spread of templates are observed. Particular attention is paid to the flowers of the fabric, the direction of the feathers, the details of the body and the direction of the back when creating a spread.

The percentage of interstitial waste is calculated as follows:

$$B_{ф1} = (H_{0ф} – F_л) / H_{0ф} *100 = 46440\text{-}38081 / 46440*100 = 17,9$$

$$B_{ф2} = (H_{0ф} – F_л) / H_{0ф} *100 = 3228\text{-}2744 / 3228 *100 = 14,9$$

Here: $H_{0ф}$ – the actual norm of the curl, cm ^{2}

Distribution characteristics:

The name of the item is special clothing

Size, height, fullness group - 176-100-88

The texture of the fabric is smooth

The direction of the fabric is the needle

The width of the spread is 160 cm, 152 cm

Bedding type - bare floor

Interdisciplinary real outputs – 17,9 %, 14,9 %

The actual surface area of the spread is 46440 cm ^{2}, 3228cm^2

3.3. Selection of rational parameters of special clothing manufacturing technology taking into account hygienic indicators

According to the results of the study, for the design of special clothing for workers in the automotive industry is recommended cotton fiber woven on the body, cotton + modal fiber woven fabric on the back [73], the structural characteristics of the fabric are given in Table 3.8.

Table 3.8

Structural description of the new structural composite fiber fabric

Name of fabric	Fiber content	Thickness, mm	Width, cm	Weaving	Surface density	Resistance to wrinkling %	Breaking Strenght , H	Breaking elongation, %
Special clothing fabric	100% cotton 50/50% Cotton+ modal	0,4	150	Cloth	230	67	710	25

Choosing the right number and type of sewing needle will determine the quality of the garment. The parameters of the needle used mainly determine the reduction in the tensile strength of the yarns and the fabrics being sewn. In general,

the dependence of the number of needles H on the linear density of the yarns used T is represented by the equation [62].

$$H = 1.9\ T + A$$

here H – needle number;

T – linear density of yarns;

A – taking into account the structure of the yarns, the correction coefficient is 40, 30, 25, respectively, for reinforced, cotton and twisted complex polyester yarns.

Depending on the type and linear density of the sewing threads, it is recommended to select the needle number and set the tension of the upper thread.

Polyamide transparent monofilaments are much thinner than other sewing threads, so it is recommended to use the following needle numbers for 7 kmp, 13 kmp, 20 kmp yarns, respectively: 75 and 85, 85 and 90, 90 and 100 [74].

The characteristics of needles for different local sewing machines are given in Table 3.9 [75].

Table 3.9

Instructions for selecting needles and top thread tension

Linear density of yarn, tex	**Recommended needle number**			**The tension of the upper rope, cH**
	Cotton	**Polyester**	**Armored**	
20,0-25,0	75	65	90	165
25,1-30,0	80	75	90	190
30,1-35,0	90	80	100	210
35,1-40,0	100	90	110	235
40,1-45,0	110	100	120	255
45,1-50,0	110	110	120	280
50,1-55,0	120	110	130	300
55,1-60,0	130	120	140	325

60,1-65,0	140	130	150	345
65,1-70,0	150	150	170	355

Technological processing of clothes has a great impact on their quality. Determines the quality of bonding of details and shears, wet-heat treatment and final processing, the quality of versatile clothing, the quality of its fit, the durability of the fabric and other indicators [76]. In the process of technological processing, the product acquires the required volumetric shape, branded appearance. The quality of garments formed in the process of processing depends largely on the type of technological equipment used, the mode of processing, the diameter of the needle, the type of yarn and its properties [77]. Tables 3.10-3.11 show the processing parameters.

Table 3.10

Threading operations

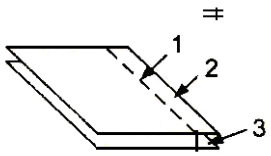
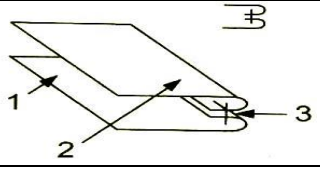
№	The name of the stitches	Weld construction	Needle number	Thread number	Stitch size, mm	Type of equipment
1	Attachment seam		100-110	40/2	3-4	U/M
2	Turnstile seam		100-110	40/2	3-4	U/M

Table 3.11

Wet-heat treatment parameters

№	Product name	Fabric	Wet-heat treatment parameters

		thickness, mm	Pressing temperature, ^{0}C	Pressure, MPa	Duration of pressing, c
1	Special clothing fabric	0,4	130-150	0,04	15-25

40 / 2 polyester yarn, 90-100 numbered needles, and 3-3.5 mm stitich length were selected for 0.4 mm thick mixed fiber fabric when attaching details [78].

The structure and type of fabric are affected by their damage to the needle. The greater the density and stiffness in the fabric structure, the greater the probability of damage to the fabric. In canvas, the threads are easily damaged because the needle is more likely to fall into the thread. In fabrics with a twist, the needle is less likely to come into contact with the yarn due to the slip ability of the yarn, so the damage to such fabrics is less. Dyeing densifies the threads in the fabric, resulting in increased fabric stiffness and an increased number of damages.

Attention should be paid to the compatibility of the needle number and the sewing thread to prevent perforation of the fibers [79].

During the sewing process, the fabric can also be damaged as a result of incorrect selection of sewing threads. For a thin needle, for example, a thick thread cannot be used because it does not fit into a narrow and shallow shaft of a thin needle, and the frictional force between the needle and the fabric causes them to be damaged where they touch each other. In addition, such a thread is rubbed when it passes through the narrow ear of a fine needle at great speed, loses its strength, and begins to break, which is also negatively reflected as a sewing piece.

Fabric damage was performed at 50-200 mm specimens at average pressure response when performing a stitch with different numbered needles. The number of lesions was detected by the needle entering the fabric using a magnifying glass (magnifying glass).

The results are presented in Table 3.12 and Figure 3.5.

Table 3.12

The number of needle damage to the fabric

Fabric name	Fiber content, %		Needle number	The number of damages per 10 cm
	Warp	Weft		
Special clothing fabric	Cotton 100	Cotton + modal 50/50	90	8
			100	6
			110	4
			120	15

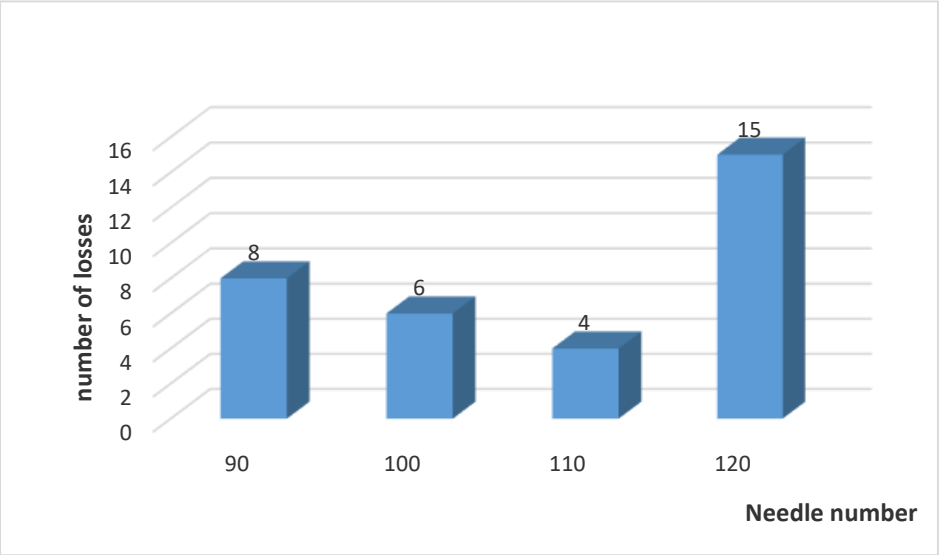


Figure 3.2. The number of damages in the fabric depends on the number of needles

The results of the study show that the fabric of needles 100 and 110 is less damaged than that of needles 90 and 120. When sewing with a 100-digit needle, 6 needles were sewn into the main fabric, when sewn with a 110-digit needle, 4 needles were sewn into the main fabric, and needles 90 and 120 were damaged by making more holes in the fabric. According to the results, these figures were 15 for the 90-digit needle 8 and the 120-digit needle.

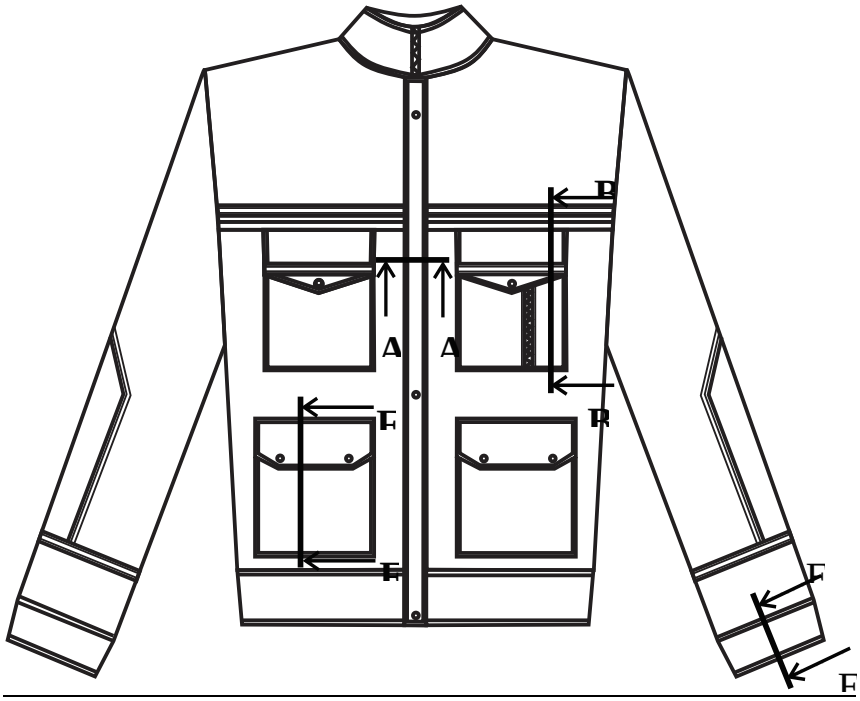
From the results of the study, it can be concluded that the damage of cotton + modal fiber fabric using needles 100 and 110 was less than that of other needles. Therefore, it is recommended to use these needles when sewing special clothes from cotton + modal fiber fabric.

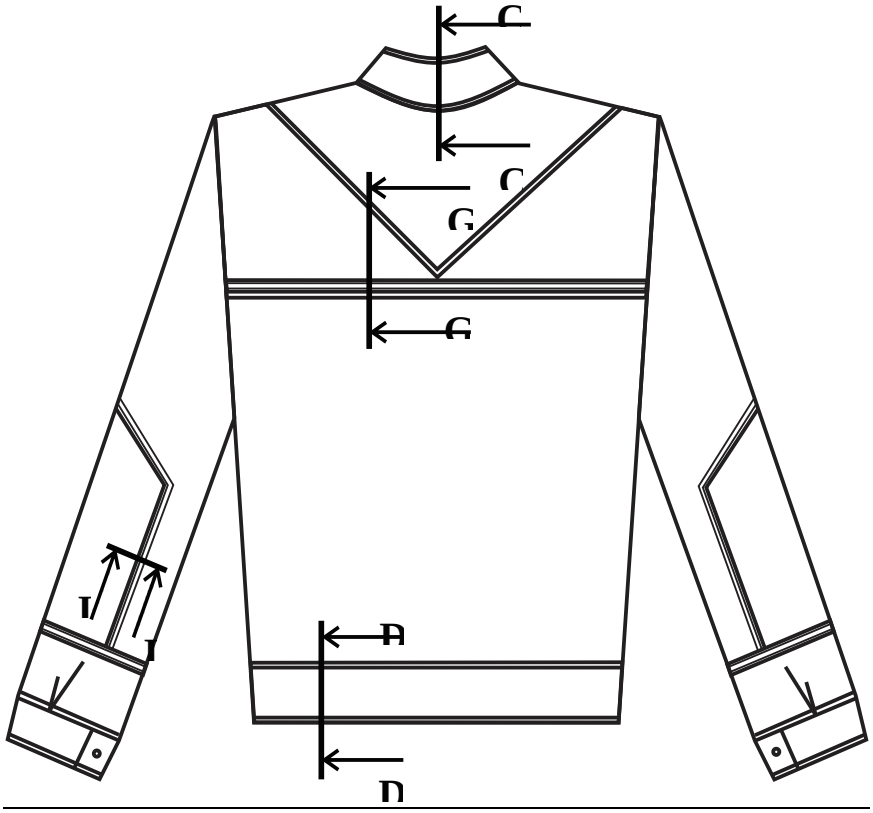
Summarizing the results of the study, the description of the sewing thread and needle suitable for cotton + modal fiber fabric is given in Table 3.13.

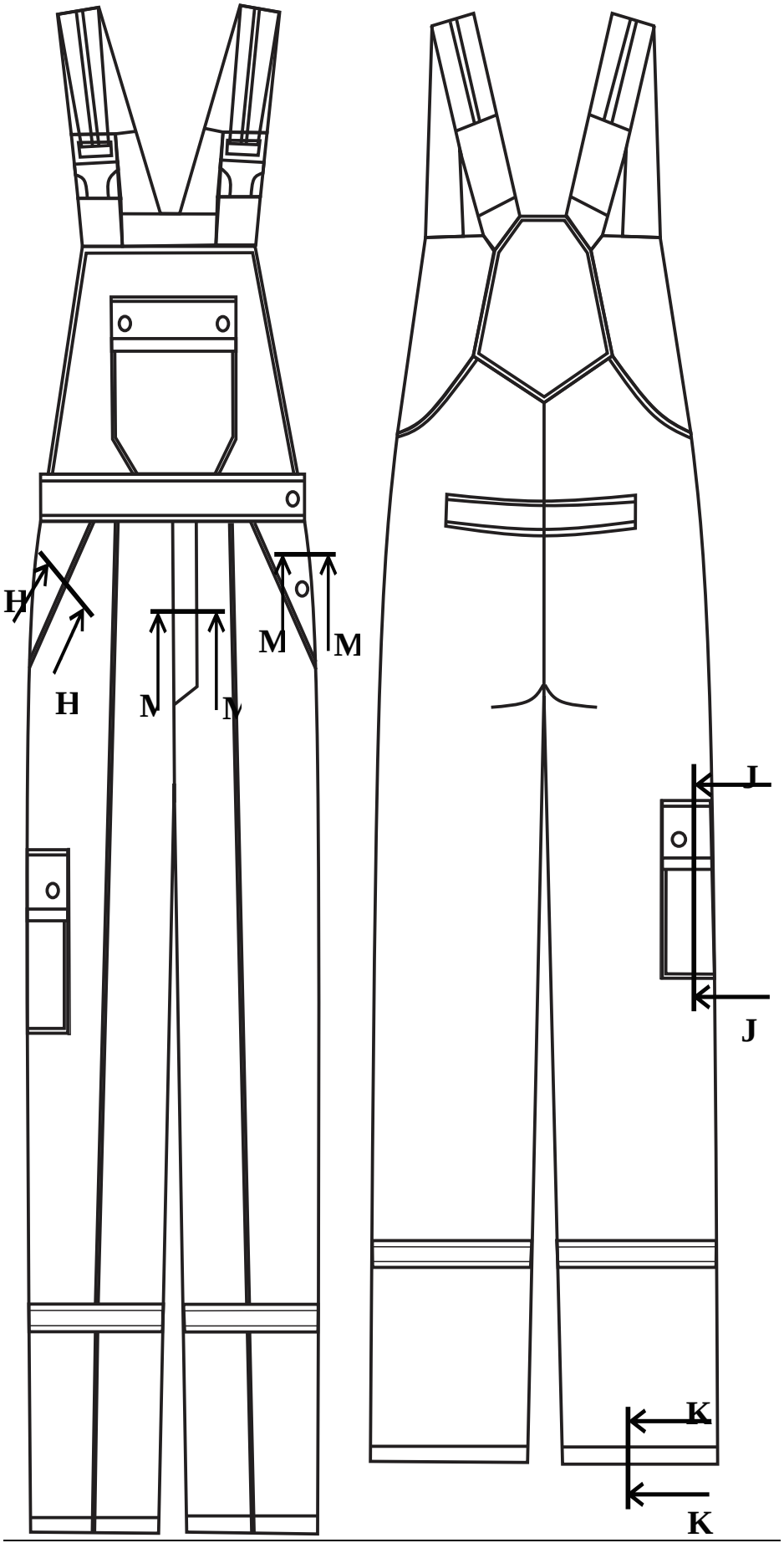
Table 3.13

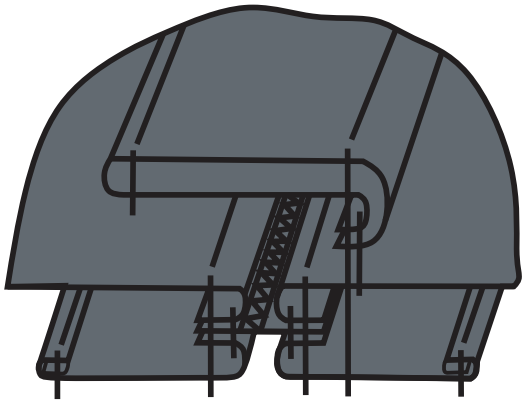
Recommended machine needles and sewing threads for cotton + modal fiber fabric

№	Fabric name	Needle number	The trade number of the threads	
			Polyester	Cotton-lavsan
1	Special clothing	100-110	33 Л	44 LX

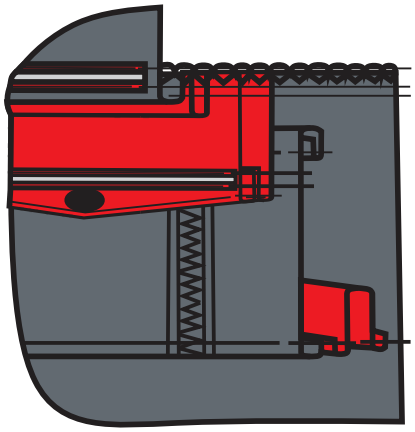



C
G
G
I
I
D
D

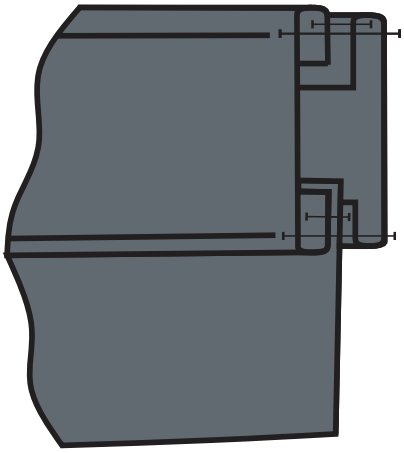

H
H
M
M
M
M
J
J
K
K



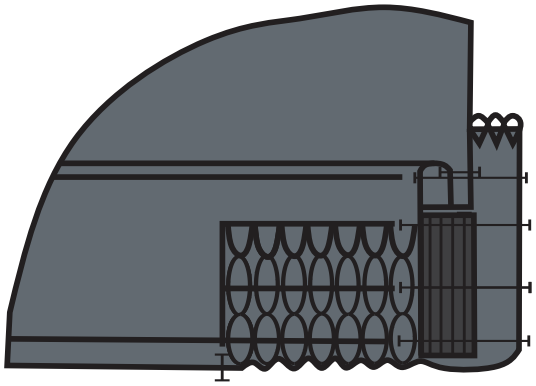
A-A



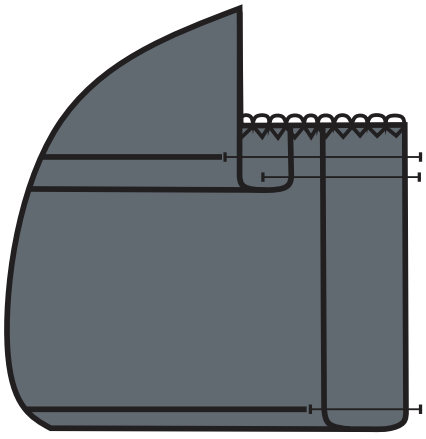
B-B



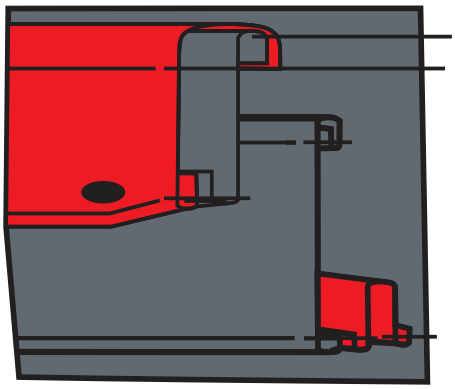
C-C



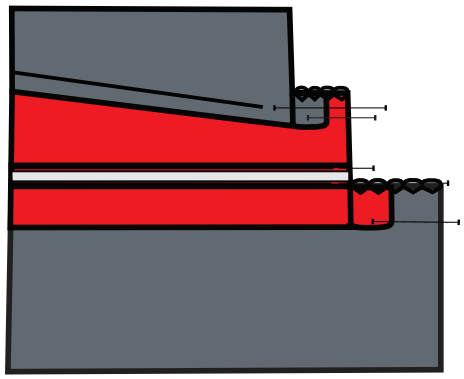
D-D



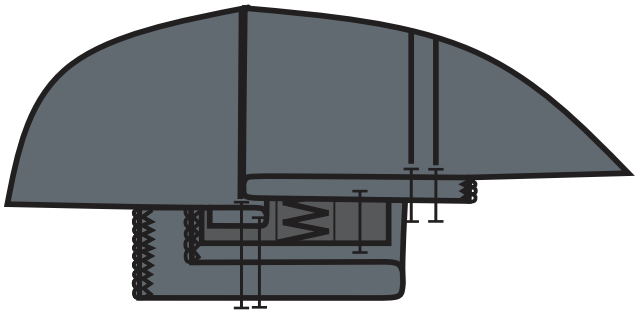
E-E



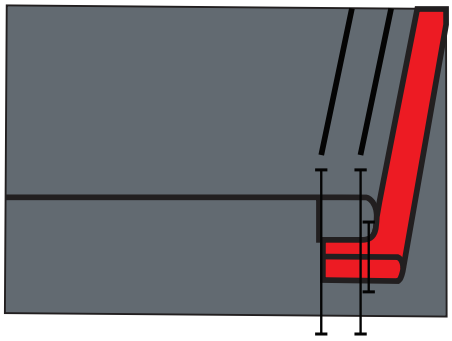
F-F



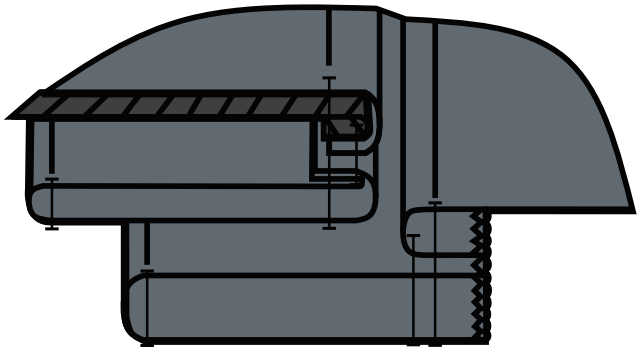
G-G



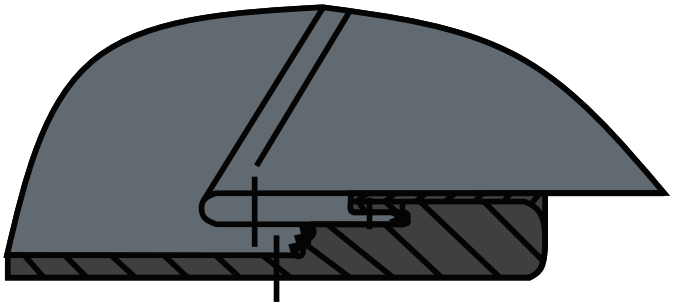
L-L



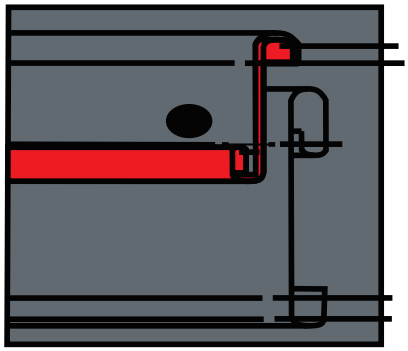
K-K



M-M



H-H



J-J

3.4. Calculation of economic efficiency

The share of costs for basic fabrics in the cost of production of the garment industry is high. The products of this industry are characterized by high consumption of raw materials. In some enterprises, the consumption of raw materials is 65-80% of the cost of production [80]. Regular reduction of material costs is also one of the internal opportunities to reduce the cost of production, improve the performance of the enterprise. The introduction of new advanced technologies and the improvement of production play an important role in improving the use of material resources.

Improving the use of material resources in the enterprise leads to an increase in production, lower costs, increase profits and profitability of the enterprise, improve its performance.

Product quality indicators will depend on the introduction of promising scientific and technological advances [81] and will be increased depending on the manufacturer's interests, as a quality product will be competitive, but this will only happen when price increases can guarantee real and more profitable for the buyer. At the final stage, the cost-effectiveness of new product models will be determined, with 1 kg of modal fiber costing 12,000 soums and 1 kg of cotton fiber costing 8,000 soums. 1 m^2 of fabric consumes 300 g of tan and 220 g of backing. dThe calculation results are shown in Table 3.14.

Table 3.14

Accounting for raw materials and supplies (for 1 product)

№	Consumption of raw materials and fabrics	Unit of measurement	Cost norm	Traditional technologies		New option	
				Fabric price, soums	Body price of the product, soums	Fabric price, Soums	Body price of the product, soums

1	Lining fabric	metre	3,5	25000	87500	20000	70000
2	Edditional fabric	metre	0,7	25000	17500	20000	14000
3	Zipper closure	metre	0,6	10000	6000	10000	6000
4	Button	pieces	3	1500	4500	1500	4500
5	Thread	bobbin	1	1000	1000	1000	1000
	Total costs	soum			116500		95500

The expected cost-effectiveness resulted in the following result in terms of consumption of raw materials and fabrics per item.

$$\Delta З = З_{хом1} - З_{хом2} = 116500 - 95500 = 21500 \text{ soums}$$

The expected cost-effectiveness is 21,500 soums per item due to the consumption of raw materials and fabrics.

CONCLUSION

1. Analysis of the existing personal protective equipment, ie special clothing, for workers in the automotive industry shows that their operating conditions do not meet the requirements of the climatic conditions of Uzbekistan. Taking into account the hygienic and protective properties, the development of the automotive industry, including in the design of special clothing for workers working indoors, is not regulated.

2. A new structural fabric was created in the laboratory to develop a special garment from a fabric with high hygroscopicity, and its physical and mechanical properties were studied. According to the results of the study, a sample of fabric with the addition of "cotton + modal" fibers showed a high ability to absorb moisture in terms of hygienic properties.

3. A map of the movement of workers of the assembly shop of the automobile plant "SamAVTO" during the shift was developed. As a result of the ergonomic movements of the workers, it was found that their special clothing is comfortable, does not interfere with the movement of the worker, and does not cause sweating of the worker, but does not adversely affect production efficiency.

4. The resistance of special clothing fabrics to external influences and their dependence on various factors were studied. According to the results of the study, the most important indicators of the fabric are hygroscopicity, air permeability, tensile strength, tensile strength.

5. A new project of special clothing made of cotton + modal fiber fabric has been developed for workers in the automotive industry. In the selection of rational parameters of the technology of special clothing production, the number of needle damage to the fabric was studied and the parameters of the needle and thread were recommended.

6. The cost-effectiveness of new product models was determined, with 1 kg of modal fiber costing 12,000 soums and 1 kg of cotton fiber costing 8,000 soums. 1 m2 of fabric consumes 300 g of tan and 220 g of backing. The expected cost-

effectiveness is 21,500 soums per item due to the consumption of raw materials and fabrics.

REFERENCES:

1. Resolution of the President of the Republic of Uzbekistan No. PP-3028 of June 1, 2017 "On measures to accelerate the development and further improve the management of the automotive industry in 2017-2021."
2. Assessment of the comfort of workwear for the food industry. The Effects of Environment on Product Design and Evaluation, 2019. https://doi.org/10.1016/B978-0-12-814495-4.00025-8
3. Hiroyuki Ueda, George Havenith. The effect of fabric air permeability on clothing ventilation, 2005.
4. Ermakova. Clothing hygiene. - Vladivostok: VGUES, 2006.
5. Budanova G.N., Roldugina A.E. Disruptive innovative technologies of the textile industry//Advances of modern science. –http://www.natural-sciences.ru/ru/article/view?id=34917.2015, No.1-3 P.468-471;
6. A.S. Zakharchenko, E.V. Melenchuk, O.V. Kozlova. Efficient technology of combined dyeing and finishing of textile materials. News of universities, No. 6 (327). Technology of the textile industry, 2010.- 41-45 p.
7. Tom Wright, Amalid Mahmud-Ali, Thomas Bechtold. Research Institute of Textile Chemistry and Textile Physics. Surface coated cellulose fibres as a biobased alternative to functional synthetic fibres. Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2020.123857
8. Lushan Sun, Li Zhao. Technology disruptions: exploring the changing roles of designers, makers and users in the fashion industry. International Journal of Fashion Design, Technology and Education. March 2018, page 45-46.
9. Marcia Cristina Silva-Santos, Marcelo Silva Oliveira, Alessandra Maria Giacomina, Mariana Costa Laktima, Julia Baruque-Ramos. Flammability on textile of business uniforms: use of natural fibers. 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World, ICNF 2017, 21-23 June 2017, Praga, Portugal.
10. Modestova T.A. etc. Materials science of garment production. Moscow - 1957

11. Luo Zhongxuana, Li Fengzhi, Liu Yingxi, LiYi. Effect of the environmental atmosphere on heat, water and gas transfer within hygroscopic fabrics. Journal of Computational and Applied Mathematics 163 (2004), pages: 199-210. doi:10.1016/j.cam.2003.08.065.
12. R.A.Dell, R.F.Afanasyeva, Z.S.Chubarova Clothing hygiene - M., Legprombytizdat, 1991 -160 p.
13. S.A. Yegupova. Development of non-woven filter material technology for operation in extreme conditions. Candidate of Technical Sciences Dis.: 05.19.02/ Mosk. state text. un-t. them. A.N. Kosygina - M., 2011.–173 pages.
14. Buzov B.A., Modestova T.A., Alymenkova N.D. Materials science of sewing production. / 4th ed., Revised and added. – M., Legprombytizdat, 1991.–424 p.
15. Romanov V.E. A systematic approach to the design of special clothing. -M., "Light and food industry", 1981-128 Art.
16. Kiryukhin S.M., Dodonkin Yu.V. Fabric quality. - M., Legprombytizdat, 1986.
17. Kerry Atkins, Martin Thompson. Effect of textile hygroscopicity on stratum corneum hydration, skin erythema and skin temperature during exercise in the presence of wind and no wind. Discipline of Exercise and Sport Science, The University of Sydney, New South Wales, AUSTRALIA. Exerc Sci Fit • Vol 9 • No 2 • 100–108 • 2011.
18. Law of the Republic of Uzbekistan "On labor protection" No. 839-XII. 1993.
19. P.P. Koketkin, Z.S. Chubarova, R.F. Afanasiev. Industrial design of special clothing. - M., "Light and food industry", 1982-181 pp.
20. Afinogentova N.V., Konopaltseva N.V. Functions of overalls in the system "man - working conditions - object of work". // Actual problems of creating and using new materials and assessing their quality. Materials Science-99:

Proceedings. report International scientific-practical Conf.- Cherkizovo: MGUS, 1999–199-200 pp.

21. Buzov B.A., Modestova T.A., Alymenkova N.D. Laboratory workshop on materials science of garment production. - M., Legprombytizdat, 1986. - 424 p.
22. Solovyov A.N., Kiryukhin S.M. Evaluation and forecasting of the quality of textile materials. – M.; Light and food industry, 1984.
23. Zhernitsyn Yu.V. Guidelines for the implementation of research and laboratory work on testing textile products. T., 2007
24. E.K.Amirova, O.V.Sakulina. Manufacture of special and sportswear. – M., Legprombytizdat, 1985.–255 p.
25. Interstate Standard 12.4.103-83. System of labor safety standards. Special protective clothing, personal protective equipment for legs and arms. Classification.
26. N.V. Afinogentova. Research and development of overalls for workers in the automotive industry: Dis. cand. tech. Sciences: 05.19.04: Moscow, 2004 -230s., Application-115 p.
27. Surzhenko E.Ya. Theoretical foundations and methodological support for the ergonomic design of special clothing: Ph.D. Sciences, 2001.– 416 p.
28. Interstate Standard 12.4.280-2014. Special clothing for protection against general industrial pollution and mechanical influences. General technical requirements.
29. S. Nasrullaeva, M. Rasulova, Sh. Mamasolieva. Basics of designing special clothing based on questionnaires. Proceedings of the Republican scientific-practical conference "Current problems of innovative technologies of cotton ginning, textile, light industry, printing production and their solutions in the context of integration of science, education, production." 2019, Tashkent).
30. Interstate Standard 11209-2014. Fabrics for special clothing. General technical requirements.

31. Handbook of textile fibers. Natural fibers. Woodhead Publishing Series in Textiles. 2001. Pages 171, 173-204.
32. V.V. Zamyshlyaeva, N.A. Smirnova, T.I. Kiseleva. Study of the performance properties of fabrics for special-purpose clothing // Scientific and methodological electronic journal "Concept". – 2016.–T. 3.– S. 11-15.
33. M.K. Rasulova. Ways to improve the operational reliability of overalls for workers in manufacturing enterprises. Monograph T., 2017
34. M.K. Rasulova, S.Sh. Tashpulatov. Research to ensure the operational reliability of overalls under the import substitution program. All-Russian scientific and practical conference (with the participation of citizens of foreign countries). Collection of scientific papers. Novocherkassk - 2019.
35. S. Nasrullaeva, M. Rasulova, Sh. Mamasolieva. Rationale for the choice of materials with hygroscopic properties for overalls. Proceedings of the Republican scientific-practical conference "Current problems of innovative technologies of cotton ginning, textile, light industry, printing production and their solutions in the context of integration of science, education, production", 2019.
36. D.A. Nuriddinova, M.K. Rasulova, Sh.L. Mamasoliyeva. Development of recommendations for special clothing suitable for the climatic conditions of Uzbekistan. Collection of articles of the Republican scientific-practical conference "Current problems of innovative technologies of cotton ginning, textile, light industry, printing production and their solutions in the context of integration of science, education, production." 2019, Tashkent.
37. GOST 29298-2005. Interstate standard. Cotton and mixed household fabrics. General specifications.
38. E.V. Kumpan, V. V. Hammatova. A new technology for improving the protective properties of garments for special purposes. http://cyberleninka.ru/article/n/novaya-tehnologiya-povysheniya-zaschitnyh-svoystv-shveynyh-izdeliy-spetsialnogo naznacheniya#ixzz4b0hTimop.
39. www.tcac.ru

40. Belova I.Yu., Meteleva O.V., Kirova I.A., Sivina V.A.; Patent No. 2396382 of the Russian Federation., MKI B05V1 / 26 Method for the formation of a waterproof thread connection. Ivanovo state text, academy. - No. 2009113375/12; dec. 04/09/2009; publ. 08/10/2010, Bull. 22.-8s.
41. M. Tulaganova, M. Rasulova, Sh. Mamasolieva. Study of the strength of cotton fabric treated with a technological solution for the manufacture of clothing. Proceedings of the scientific-practical conference "Innovative ideas and developments of talented youth in the context of modernization of technology in cotton ginning, textile, light industry, printing." 2018, Tashkent.
42. M.K. Rasulova, Sh.L. Mamasolieva. Creation of a new assortment of fabrics to increase the effectiveness of hygienic properties of special equipment. VIII global science and innovation 2020: Central Asia. International scientific-practical journal. Kazakhstan, 2020
43. M.K. Rasulova, M.Yu. Umarova, Sh.L. Mamasolieva. Recommendation For The Development Of Modified Materials In The Manufacture Of Working Clothes. Journal for Studies in Management and Planning. ISSN: 2395-0463 Volume 05 Issue 06 June 2019.
44. M.K. Rasulova, Sh.L. Mamasolieva. Creating a special clothing fabric with high hygienic properties. The 15th Republican multidisciplinary scientific remote online conference "Scientific and practical research in Uzbekistan". 2020.
45. M.K. Rasulova, Sh.L. Mamasolieva. Studying the characteristics of a new composite fabric for workwear. Proceedings of International Scientific and Technical Conference on “Problems and Prospects of Innovative Technique and Technology in Agri-Food Chain”. International Journal of Innovations in Engineering Research and Technology [IJIERT], 24-25 April, 2020.
46. Yu.V. Zhernitsyn. Guidelines for the implementation of research and laboratory work on testing textile products. T., 2007

47. R.A. Dell, R.F. Afanasiev, Z.S. Chubarova. Clothing hygiene. Moscow "Light industry" 1979.
48. M.K. Rasulova, M.Yu. Umarova, Sh.L. Mamasolieva. Develop recommendations for special clothing, taking into account climatic conditions. NamMTI Scientific and Technical Journal, Issue 4 - № 2, 2019. ISSN 2181-8622
49. Sh. Mamasolieva, M.K. Rasulova, S.K. Nasrullayeva. Design of special clothing on the basis of questionnaires. Collection of articles of the republican scientific-practical conference "Current problems of innovative technologies of cotton ginning, textile, light industry, printing industry and their solutions in the context of integration of science, education, production." 2019, Tashkent.
50. M.K.Rasulova, Sh.L. Mamasolieva. Study of the characteristics of a new composite fabric for the development of workwear. "Trends in the development of the light industry of the Republic of Uzbekistan: problems, analysis and solutions" collection of materials of the international online Conference. Tashkent 2020.
51. M.K. Rasulova, Sh.L. Mamasolieva. Development of fabrics with improved hygienic properties for special clothing. Textile magazine of Uzbekistan. №3 2020 – 51-58 pp.
52. E.V. Kumpan, V.V. Khammatova. A new technology for improving the protective properties of garments for special purposes. 1983
53. Marcia Cristina Silva-Santos, Marcelo Silva Oliveira, Alessandra Maria Giacomina, Mariana Costa Laktima, Julia Baruque-Ramos. Flammability on textile of business uniforms: use of natural fibers. 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World, ICNF 2017, 21-23 June 2017, Braga, Portugal.
54. M.K. Rasulova, Sh.L. Mamasolieva. Features Of Increasing Some Of The Physical And Mechanical Properties Of Fabrics For Workwear. International

Journal of Progressive Sciences and Technologies (IJPSAT). ISSN: 2509-0119. Vol. 24, No. 2 January 2021.

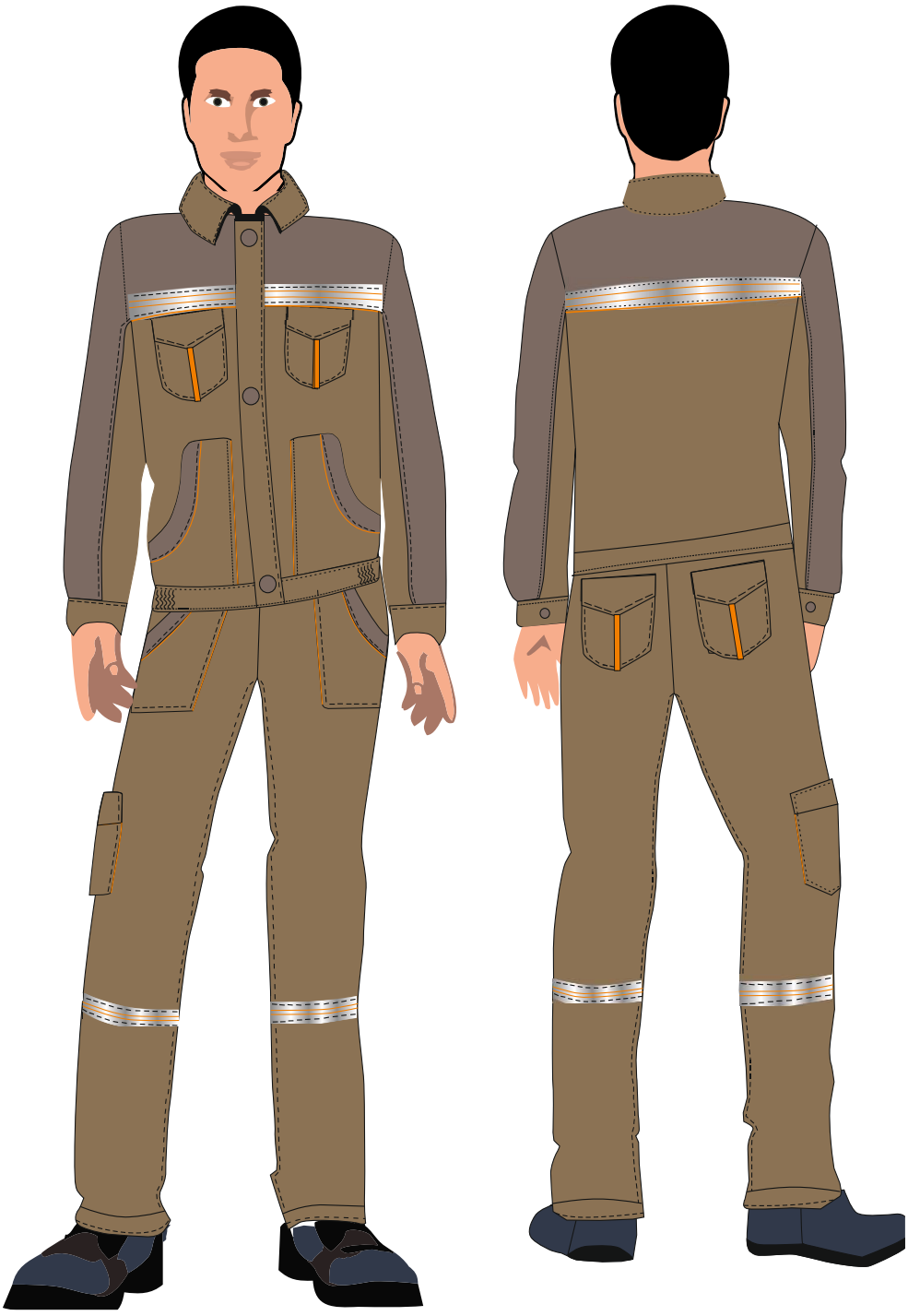
55. I.N. Zhmykhov et al. Processes and equipment for the production of fibrous and film materials. Minsk “High School” 2013
56. G.N. Norboeva, Sh.L. Mamasolieva, M.K. Rasulova. Development of new special clothing for automotive industry workers. Innovative ideas and developments of talented youth in the context of modernization of techniques and technologies of cotton ginning, textile, light industry, printing. Republican collection of scientific and practical online theses. Tashkent-2020.
57. M.K. Rasulova, A. Abdujalilova, G.N. Norboeva. Recommendations for designing special clothing for automotive industry workers. “Innovation and modern technologies in the fashion industry. International scientific-practical conference in the framework of Tashkent Fashion Week. Collection of scientific articles. Tashkent-2019.
58. Rasulova M.K., Tashpulatov S.Sh., Cherunova I.V., Mamasolieva Sh.L. Study of the resistance of textile materials to external influences and its dependence on various factors. Problems of the textile industry and ways to solve them: Collection of scientific papers of the All-Russian round table with international participation - M .: 2021.
59. Rasulova M.K., Tashpulatov S.Sh., Mamasolieva Sh.L. Influence of polymer-composition material on environmental safety of workwears. International conference «Problems of socio-economic transformation of management in the era of digitalization: human potential for sustainable development”. Rostov-on-Don, 2021
60. N.V. Konopaltseva, N.V. Afinogentov. Mathematical analysis of the protective ability of overalls for workers-fitters MSR in order to develop a model design in a specialized system AUTOCAD // Sewing industry.-2004.-№2.-49-51 pp.

61. M.K. Rasulova, Sh.L. Mamasolieva. Application of the method of mathematical analysis for expert evaluation of the choice of the significance of the properties of fabrics for workwear. SamSU Scientific bulletin. 2019, №5.
62. Z.S. Chubarova. Methods for assessing the quality of special clothing. - M .; Legprombytizdat, 1988.-160 pp.
63. R.O. Zhilisbaeva. Methodological bases for the design of special clothing for workers in the metallurgical and metalworking industries. dis.doc. those. Sciences 2007
64. O.A. Oleinikov. Optimization of the designs of heat-shielding clothing packages with bulky materials: thesis of a candidate of technical sciences: Shakhty, 2006–163 pp.
65. M.K. Rasulova, S.Sh. Tashpulatov, I.V. Cherunova. Development of manufacturing technology for workwear with improved performance properties. - Kursk: University Book Publishing House, 2020.
66. M.K. Rasulova, M. Yu. Umarova, Sh.L. Mamasoliyeva. Patent for industrial design. A set of special clothing for service workers. Intellectual Property Agency of the Republic of Uzbekistan. SAP No. 01950. 2019.
67. Koblyakova E.B. Fundamentals of designing rational sizes and shapes of clothing. - M., "Light and food industry", 1984.-208 pp.
68. Rasulova M.K., Mamasolieva Sh.L., Norboeva G.N. A set of special clothes for workers of the assembly shop of car factories. Patent for industrial design. № SAP 02129. 2021.
69. O.K. Terpenova. An integrated method for optimizing the quality of designs of garments on the example of trousers for special purposes: Dis. Candidate of Technical Sciences: 05.19.04 / Mosk. tekhnol.in-t.-M., 1979-203 p.
70. Bokova.S.V. Features of designing waterproof overalls for car service workers: Dis. cand. tech. Sciences. Mines, 2005-152 p.
71. S.Sh. Tashpulatov, T.D. Kadirov, M.K. Rasulova, I.R. Abenova, A.Zh. Talgatbekov. Study of the quality indicators of cotton fabric treated with a

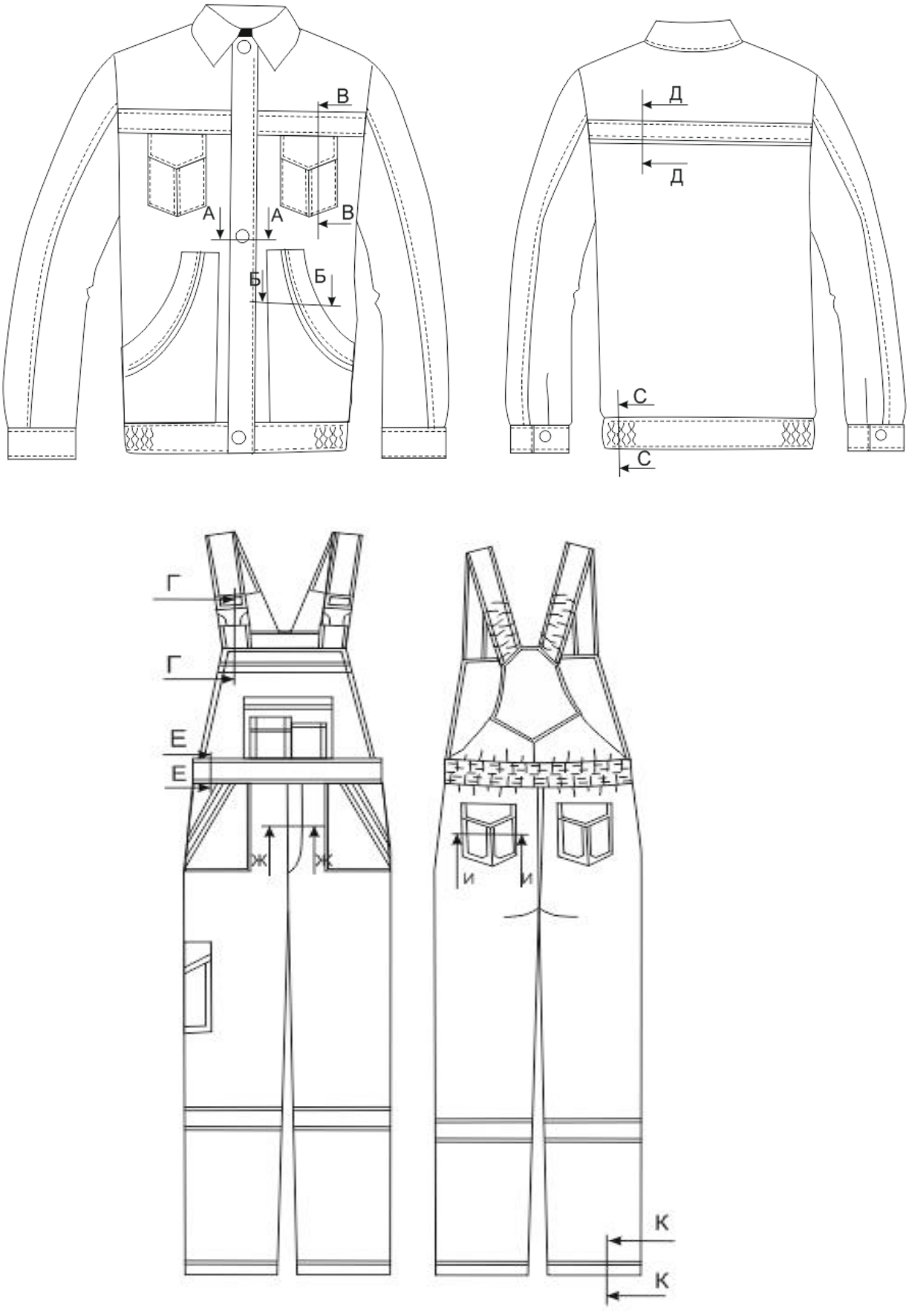
technological solution for the manufacture of workwear. Izvestiya vuzov. No. 5 (383). Textile industry technology 2019.

72. M.Sh. Jabborova and others. Normalize the consumption of fabric for clothing. Methodical instructions. T., TITLI, 1992 y.
73. M.K. Rasulova, SH. L. Mamasolieva, M.A. Babadzhanova, G.N. Norboeva. Selection of sewing thread for connecting details of workwear from fabrics of new structures. AIP Conference Proceedings 2430, 030007 (2022); https://doi.org/10.1063/5.0076965 Published Online: 24 January 2022.
74. Interstate standard 22249-82. Needles for sawing machines. Types and basic sizes.
75. E.A. Popadko. Development of technology for designing acid-protective clothing for employees of chemical enterprises Dis. cand. those. Sciences: -M., 2008.-207 pp.
76. V.F. Shangin. Connecting clothing pieces. M. Light industry. 1976
77. M. Tulaganov, M. Rasulova, M. Umarova, Sh. Mamasolieva. Study of the strength of the seam when connecting parts of workwear. “Young Scientist” international scientific journal. 2018 48th issue.
78. G. Norboeva, N. Ochilova, M. Rasulova. Study of the strength of the sewing thread and the wear of the needle when sewing overalls from fabrics of new structures. International scientific-practical conference remote possibilities and achievements of science. Kiev 2021.
79. Terpenova O.K. An integrated method for optimizing the quality of designs of garments on the example of trousers for special purposes: Dis. cand. those. Sciences: Mosk.technol.in-t.-M., 1979.-263 pp.
80. M. Rasulova, T. Kodirov, S. Tashpulatov, A. Plekhanov, Sh. Mamasolieva, A. Abduzhalilova. A method for imparting low shrinkage to cotton materials. Patent for an invention. 2020 Federal Service for Intellectual Property of the Russian Federation. No. 2739185.

APPENDIX



Drawing. Industrial sample of a set of workwear for employees of the automotive industry



Technical drawing of workwear

А-А

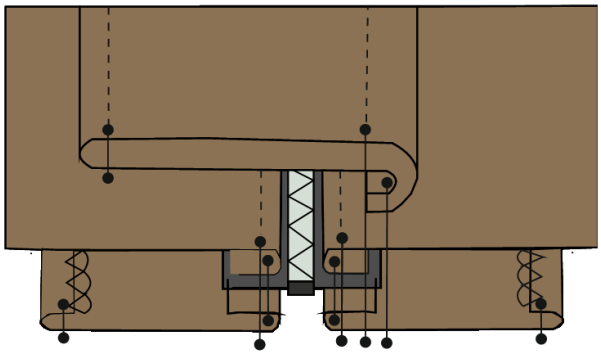


Figure - Assembly diagram for processing a fastener with a strap

Б-Б

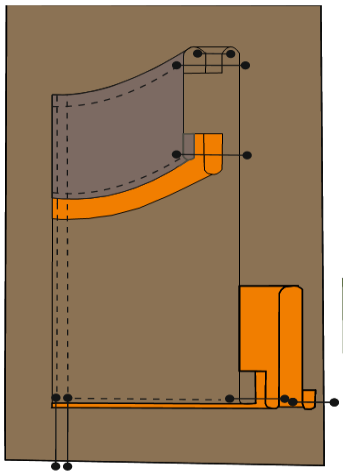


Figure - Assembly diagram for the processing of the patch pocket

В-В

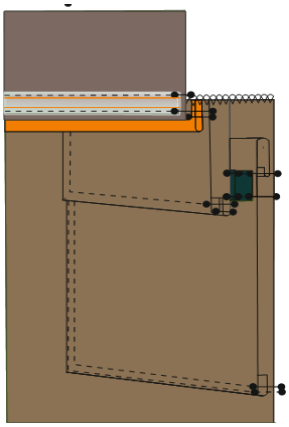


Figure - Assembly diagram for processing a patch pocket with a valve

Д-Д

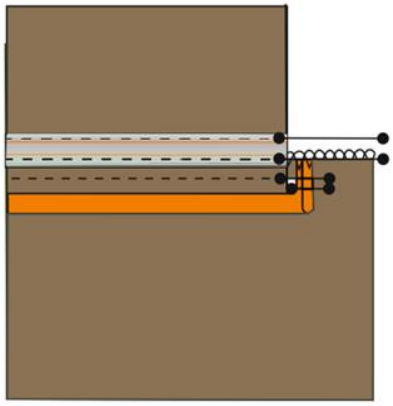


Figure - Assembly diagram for processing the rear yoke

С-С

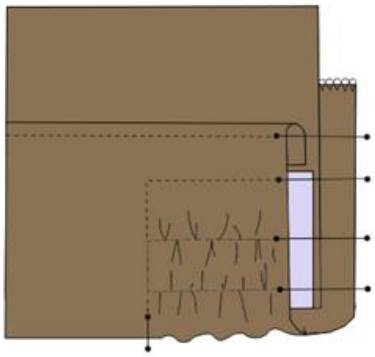


Figure - Assembly diagram for processing the cuff of the shelf

Г-Г

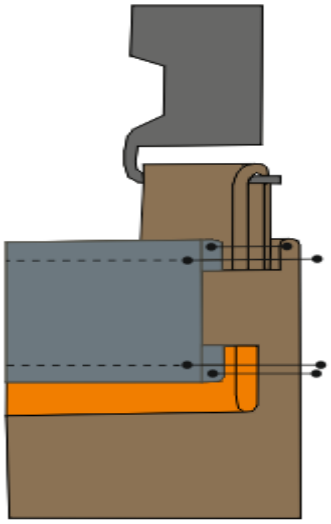


Figure - Assembly diagram for processing the fastener of the overalls

Е-Е

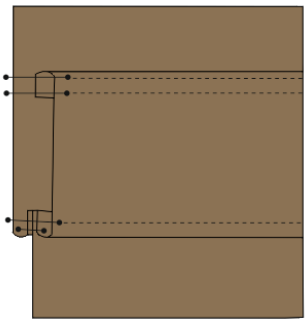


Figure - Assembly diagram for the processing of the half-overalls belt

Ж-Ж

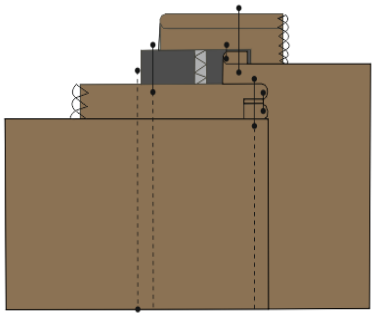


Figure - Assembly diagram for processing the fastener of the overalls

И-И

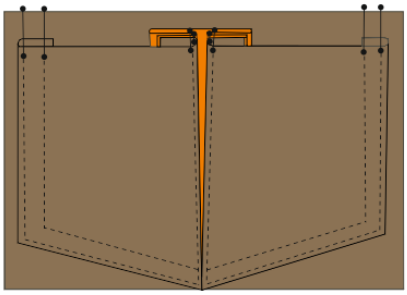


Figure - Assembly diagram for processing the patch pocket of a half-overalls

К-К

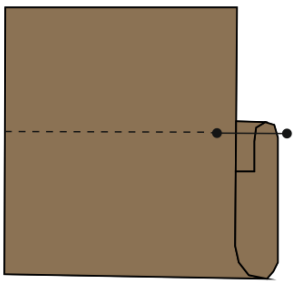
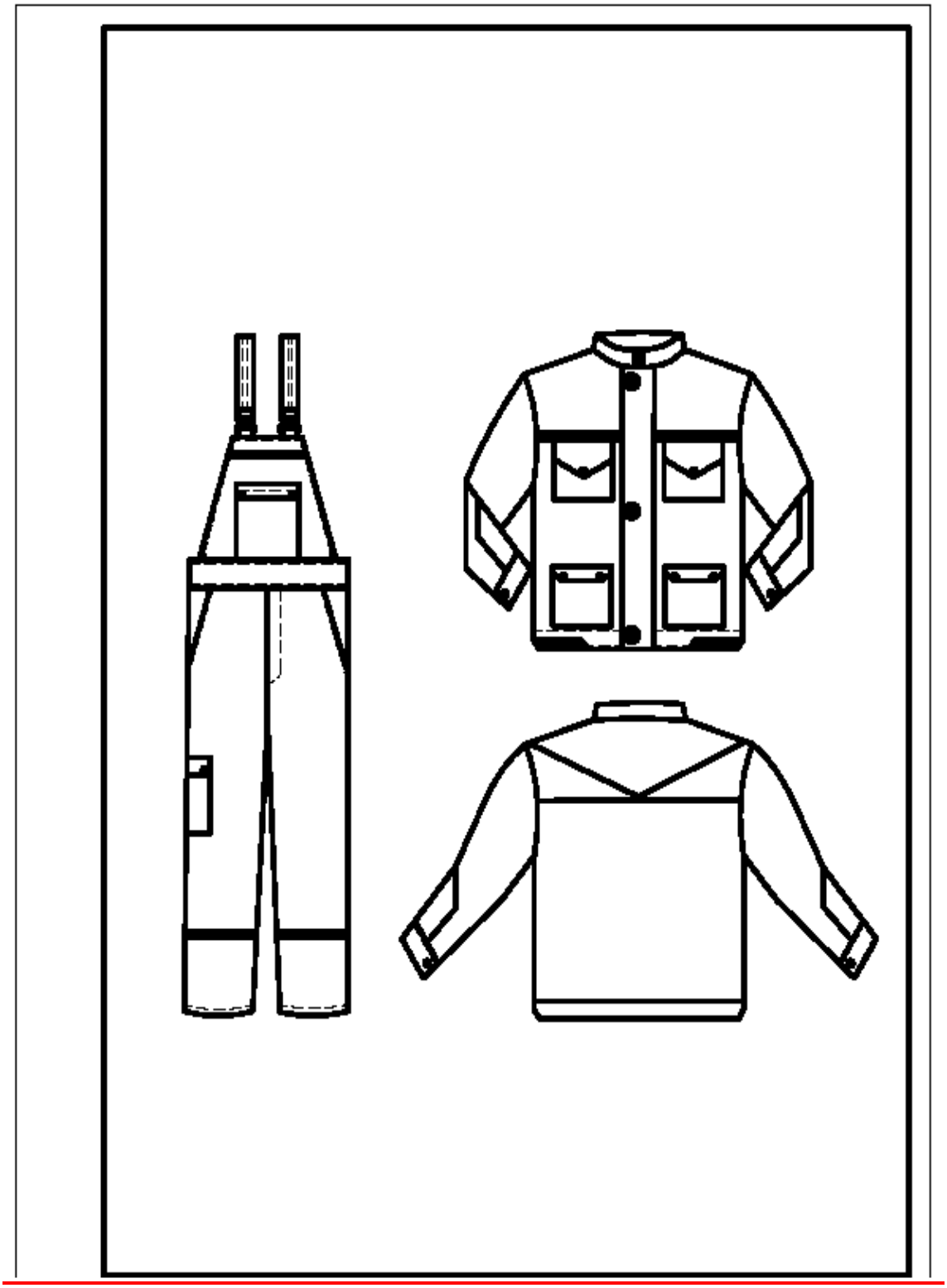
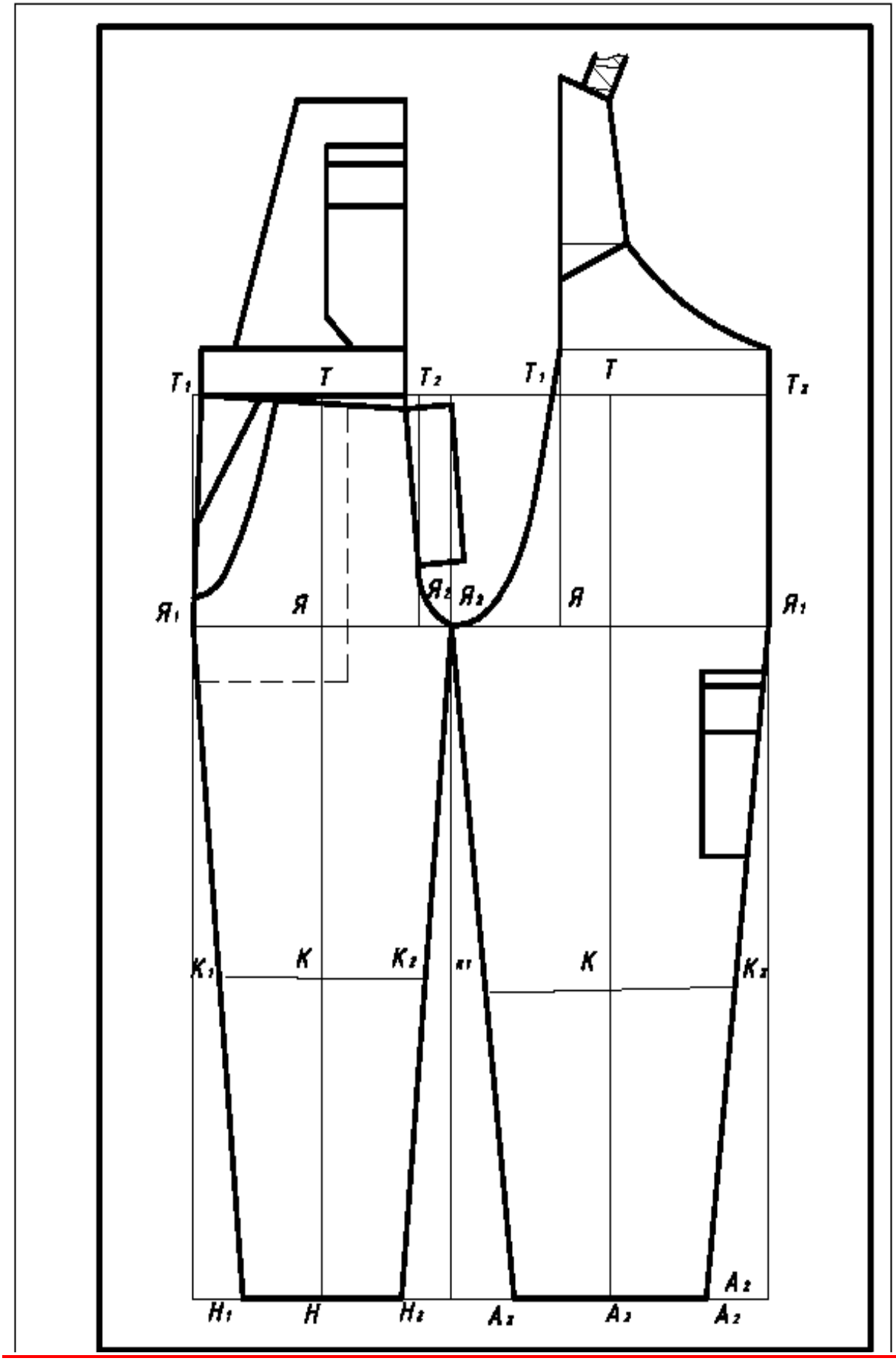


Figure - Assembly diagram for processing the bottom of the overalls

№	Indicator	Units of measurement	Equipment	Interstate Standard (IS)	Sample sizes, shape (mm)
1	Breaking load	Н, даН	Breaking Machine	IS 28073-89 Sewing products. Methods for determining the breaking load, elongation of thread seams, the spreading of fabric threads in seams [62].	50x200
2	Elongation at break	%	Breaking Machine Autograph AG-I	IS 28073-89 Sewing products. Methods for determining the breaking load, elongation of thread seams, the spreading of fabric threads in seams [62]. 50x200	50x200
3	Surface density of the fabric	g/m^2	Scales SK-60M, metal ruler	IS 3811-72. Textile materials. Fabrics, non-woven fabrics and piece products. Methods for determining linear dimensions, linear and surface densities	100x100
4	Bending stiffness	мкНсм2	Device ПТ2	IS 10550-93 Textile materials. Canvases. Methods for determining bending stiffness.	5x(160x30)
5	Thickness	mm	Thickness gauge	IS 12023-2003 Materials textile products made of them. Thickness determination method -	-
6	Change of linear dimensions during grinding	%			100x100
7	Adhesive ability	Н	Device for determining wettability,	IS 15902.3-79 The canvases are non-woven. Methods for determining the	

			Triboadgesiometer TAM-1, TAM-2, Breaking machine RT250	strength of IS 28832-90 Gasket materials with hot-glue coating. Method for determining the bonding strength IS 17317-88 Artificial leather. Method for determining the strength between layers	
8	Shrinkage during wet treatment and dry cleaning	%		IS 30157.0-95 Textile cloths. Methods for determining the size change after wet treatments or dry cleaning. General provisions of IS 30157.1-95 Textile cloths. Methods for determining the size change after wet treatments or dry cleaning	300x300

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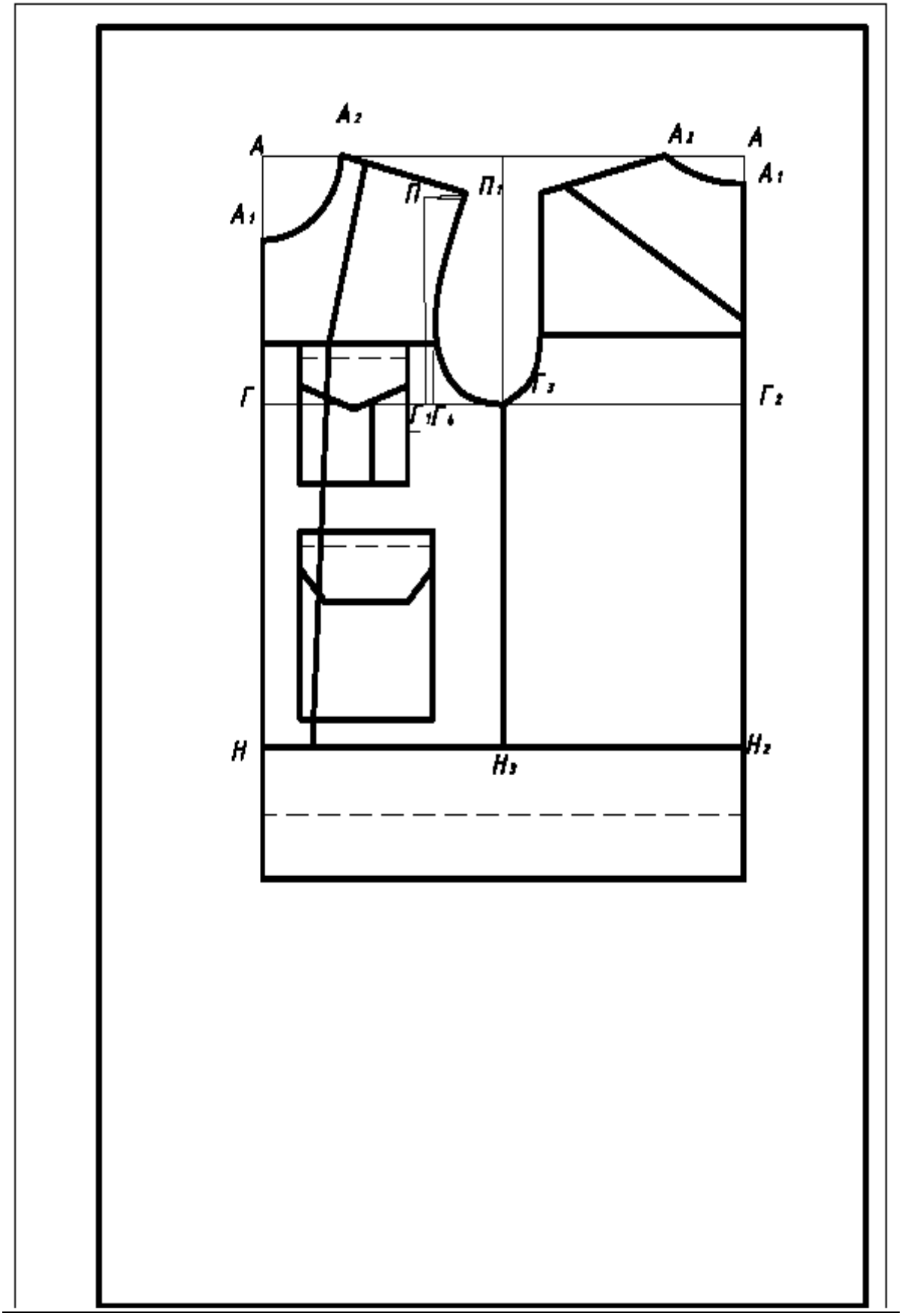
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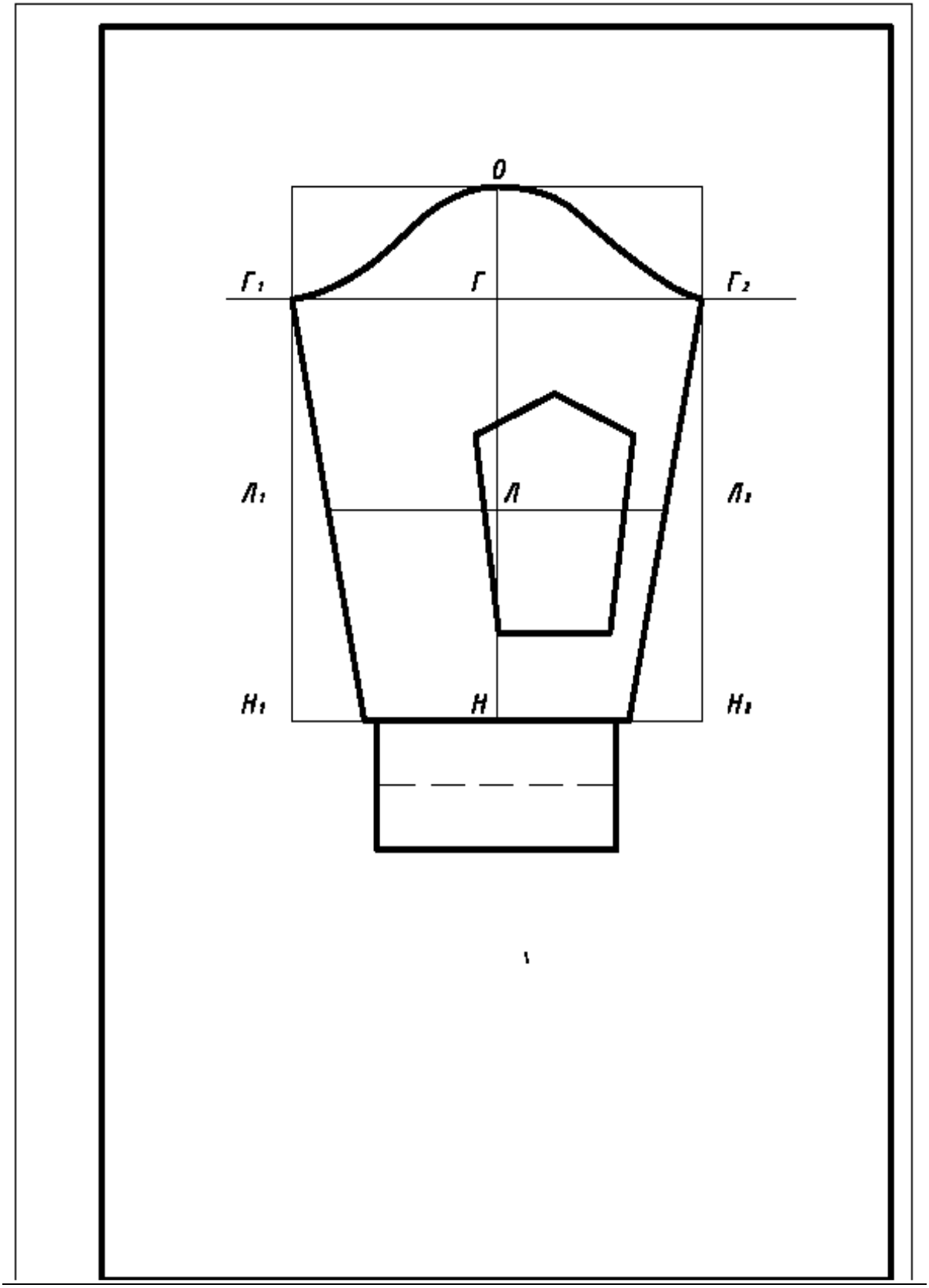
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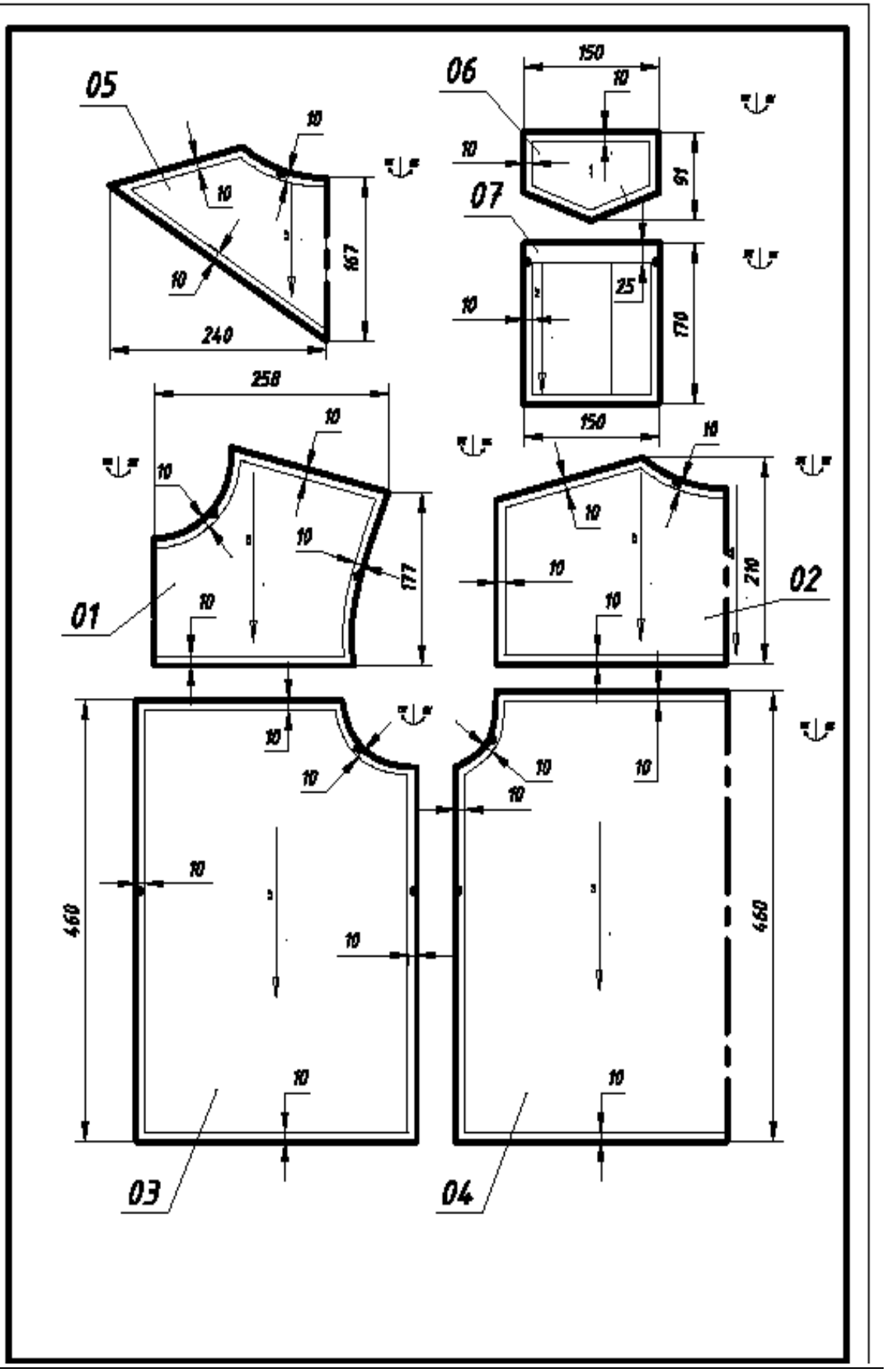
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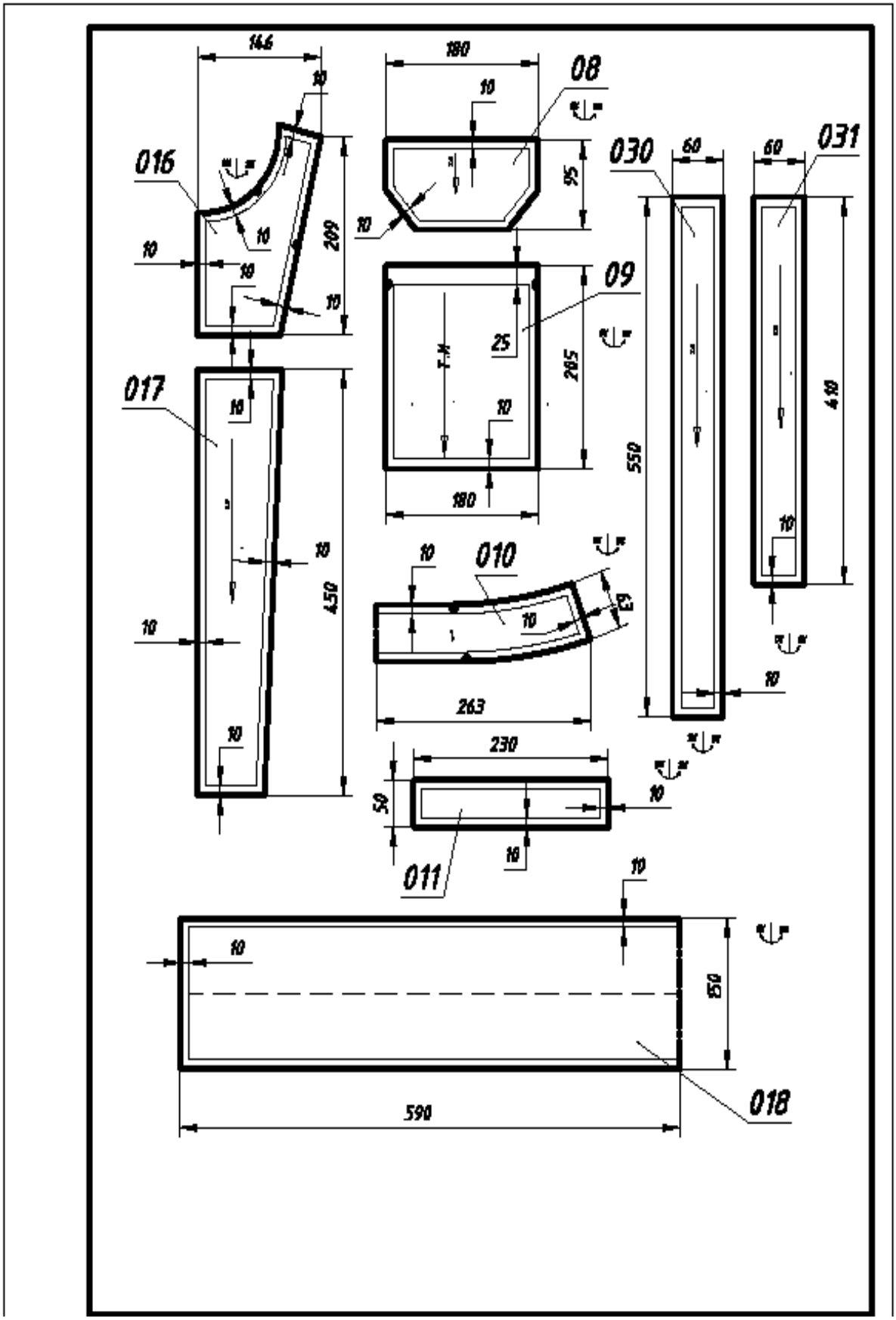
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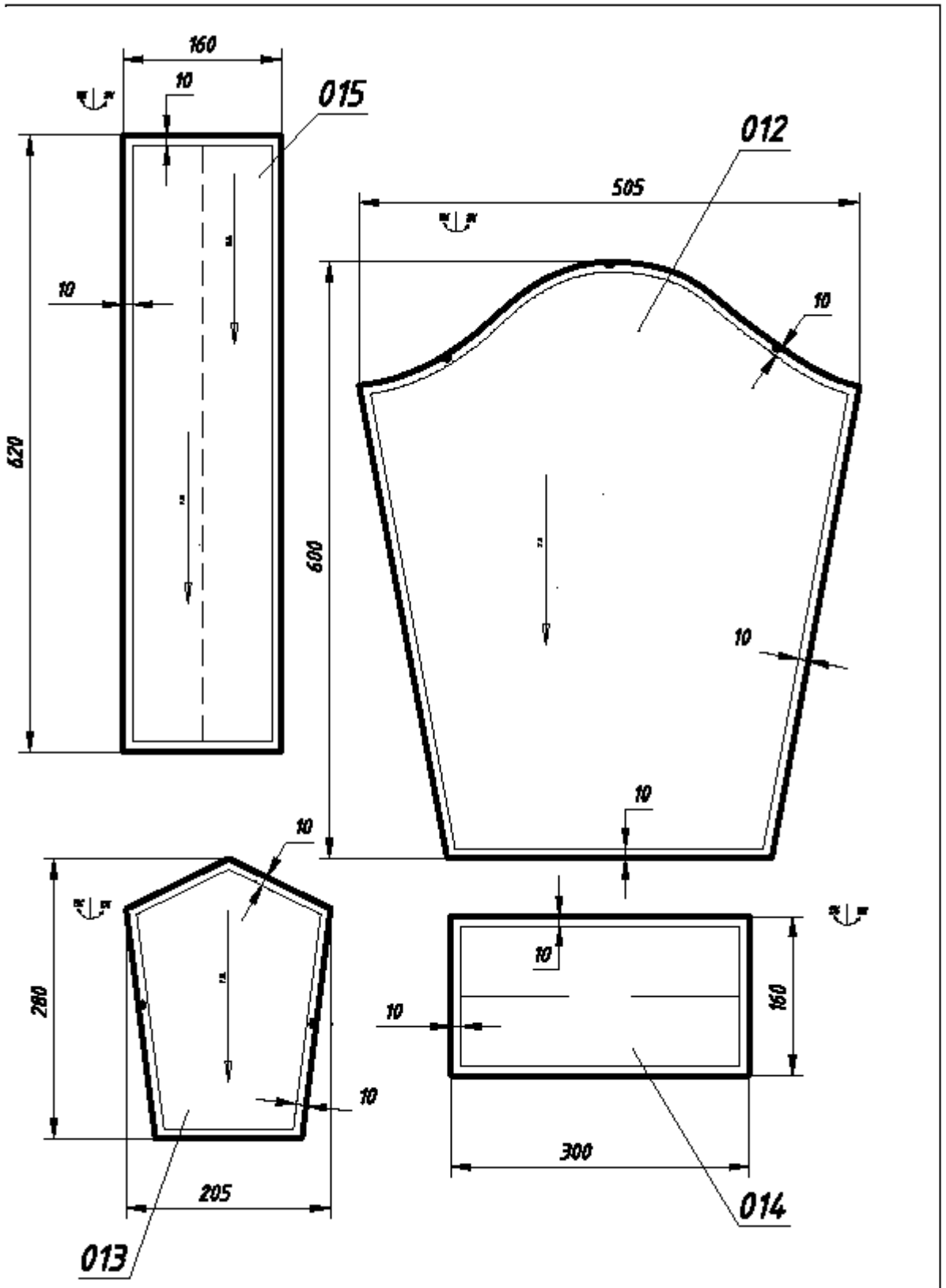
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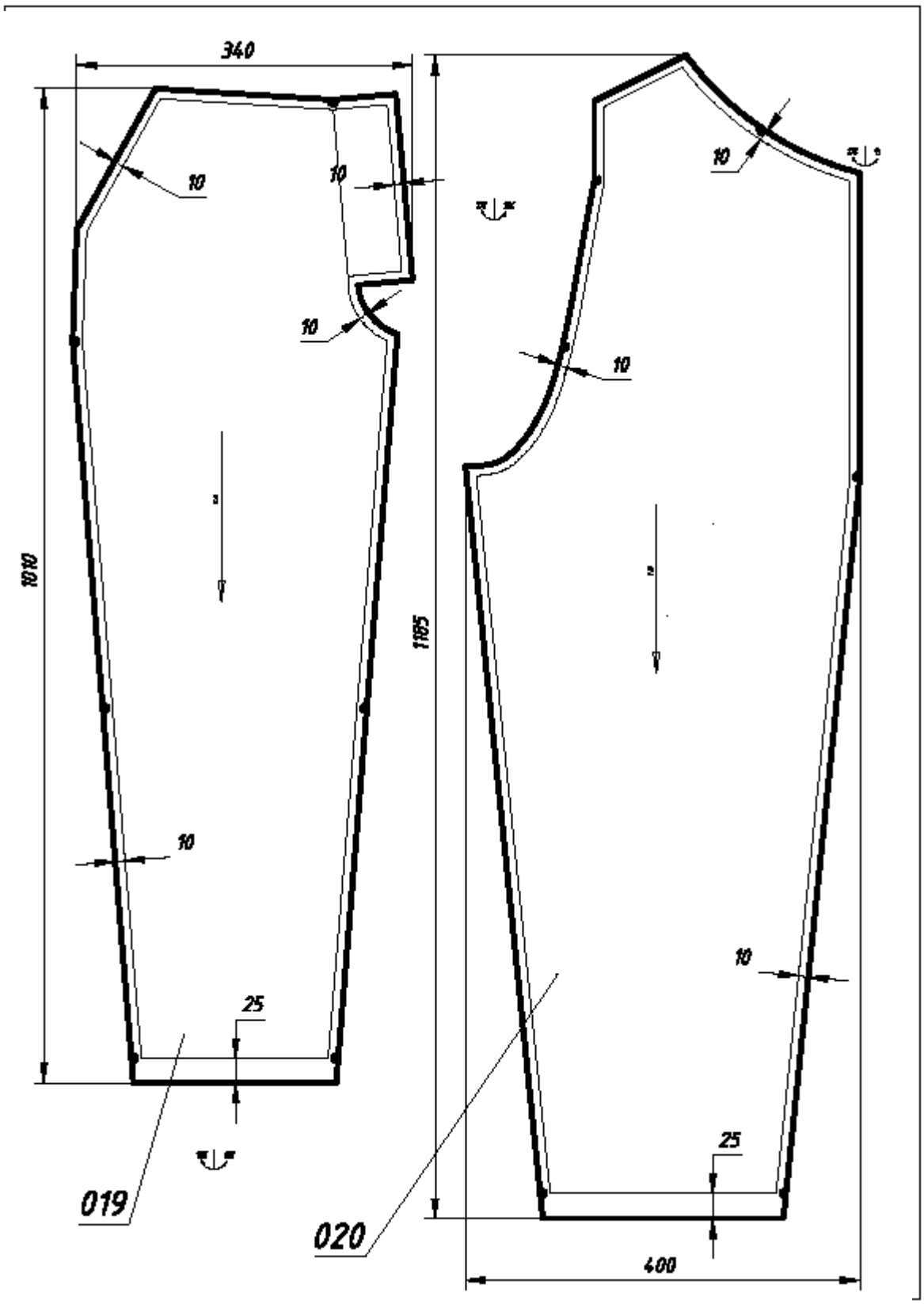
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