3.2. Formation of structure of protective clothing assortment and its elements on the basis of transformation principles

Approach to formation of information base of elements of protective clothing on the basis of transformation principles. The use of protective clothing and its elements on the basis of transformation principles allows the worker to independently control the degree of their safety and comfort in accordance with the conditions of operation, which facilitates the performance of production activities. Consideration is given to the transformation of clothing at the level of consumption, which is reduced to modifying the details of the finished product, in which the employee at his own request and depending on the living situation, combines the details.

It should be noted that the fulfillment of the professional and qualification activity of the employees necessitated the creation of effective protective clothing and its elements based on the principles of transformation.

The absence of systematic information on the varieties of elements based on the principles of transformation on different grounds in particular protective clothing makes it impossible to form their information base.

Constructive and technological solutions of protective clothing in the foreseeable conditions of operation should first of all ensure the maximum possible level of protection of the employee and at the same time not restrict freedom of movement.

An unsatisfactory state of information on the varieties of protective clothing items has been analytically investigated and identified, based on the principles of transformation, determining their shapes and sizes, locations, methods of connection with the product, etc.

Known principles of the method of transformation are assigned a code that combines alphabetic and numeric designation: P1 – "separation – attachment" of clothing elements; P2 – "orientation" of the size, volume and shape of the items of clothing; P3 - "folding - unfolding" of elements of clothing; P4 – "disappearance – appearance" of elements of clothing; Q5 – "replacement" of clothing elements; P6 - "attachment" of clothing elements; P7 – "permutation" of elements of clothing; P8 – "regulation" – "fixation" of clothing items; P9 – "stretching – compression" of clothing items.

The need to create a systematic information base on varieties of protective clothing elements based on the principles of transformation on different grounds is obvious.

Therefore, it is advisable to identify, classify elements of clothing on a functional basis, based on the analysis of modern sources and the range of protective clothing, which will further develop an information base and offer new solutions of elements based on the principles of transformation.[364,365]

We consider it expedient to specify a number of functions with their simultaneous coding: provision of information on the profession, position of the employee, the scope of protective clothing (F1); ensuring the ability to quickly find the worker in conditions of low visibility (smoke, poor lighting, etc.) and good aesthetic perception (F3); ensuring the ability of the materials or parts of the product to withstand the effects of external wear factors (F2); maintenance of extension of service life at the expense of possibility of repair and at the same time expansion of conditions of their use (F8);ensuring the ability of the material or article to maintain a stable size and shape over a predetermined lifetime (F7); providing a comfortable microclimate of the

[364] Ostapenko N. V. Development of an approach to the creation of transformable elements of special clothing. Abstracts of Reports of the 21st International Scientific and Practical Conference ["Actual Problems of Fire Safety"], M.: FSU VNIIPO EMERCOM of Russia, 2010. – P. 4.

[365] Ostapenko N. V. Creation of elements of special thermal protective clothing based on the principle of transformation. Conferinţa Tehnico Ştiinţifică a Colaboratorilor, Doctoranţilor şi Studenţilor. [2011 a Univ. Techn. a Moldovei], (8-12 December) – Ch.: UTM, 2012, Vol. 3. – 420 p. – P. 224-225.

garment space (F6); ensuring the conformity of the product design to the shape and size of the human body (F5); ensuring restriction of movement of product details (F8); ensuring the convenience of dressing and taking off (F4).

The developed classification will allow to develop a matrix of unified structural elements of protective clothing on the basis of transformation principles and to create an information database of such elements with determination of their sizes, locations, ways of connection with the product.

In order to optimize the process of designing the aforementioned clothing, an approach is proposed to create an information base of elements based on the principles of transformation of protective clothing, the basis of which are the methods of systematization and typing of objects.

The solution of this design problem is to search for new parts (nodes), ie elements (E), by means of combinatorial variation of the initial characteristics, among which are selected: function, principle, detail (Fig. 2).

The combination of such components as "Function – Detail", "Principle – Detail", "Detail – Detail", "Function – Detail – Principle", etc., leads to the creation of new solutions. The latter thesis also concerns the professional skill of the scientist, his ability to reasonably combine the specified output data, taking into account the various shapes and sizes of details; different ways and means of connecting the product; different amounts, different materials, etc.

With regard to the component – "function" an attempt was made to combine the existing elements on the basis of the principles of transformation of protective clothing on a functional basis.

The component "details" includes reinforcing or protective overlays in the shoulder area (D1), elbow pads (D2), knee pads (D3), lei (D4), cushioning, insulation, radiation protection (D5), puffs (D6), wristbands (D7), dustproof, windproof, waterproof valves (D8), clasps (D9), backrests (D10), straps (D11), ties (D12), saws (D13), sleeves (D14), coquets (D15), collars (D16), half pants (D17), cuffs (D18), pockets (D19) and more.

According to the proposed systematization, the coded designation of any element has a clear structure - Phi Pj Dk and combines one or more coded functions of Phi, principles of Pj and one or more details of Dk (Fig. 1).

The proposed approach is aimed at optimizing the process of designing protective clothing with the possibility of forecasting, expanding the range of elements based on the principles of transformation (Fig. 2). The further ordering of such details, units, and parts of clothing will allow us to predict, diversify their range and, as a consequence, to propose new structural and technological solutions depending on the purpose of protective clothing and industry.

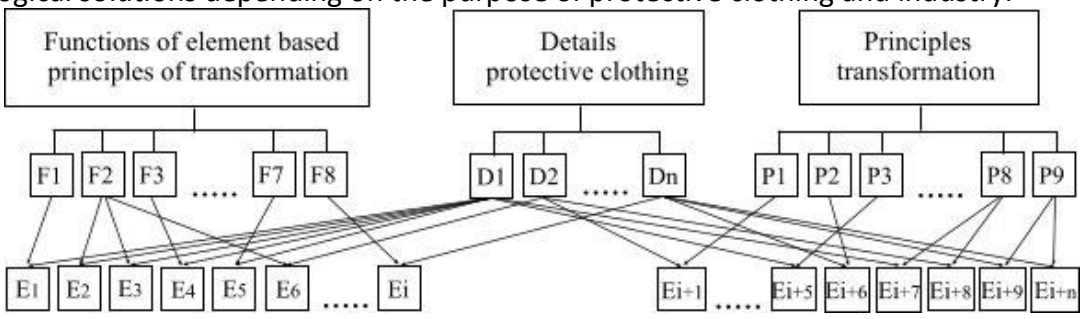

Fig. 1. An approach to creating an information base for designing elements based on the method of transformation of protective clothing

Development of transformer elements of protective clothing on the basis of transformation principles on various grounds. *Functional transformation of elements based on providing a comfortable microclimate of the underfloor space.* When operating protective clothing, it is

necessary and obligatory to take into account the variable parameters of the environment, the nature of the production activity of the worker, the properties of materials and the ability to regulate directly by the employee normal heat and gas exchange of the organism with the environment. The structural and technological solutions of such "closed" elements involve the use of strips, valves, leaflets of various shapes and sizes, methods and means of connection with products, etc. (Figs. 3-7).[366]

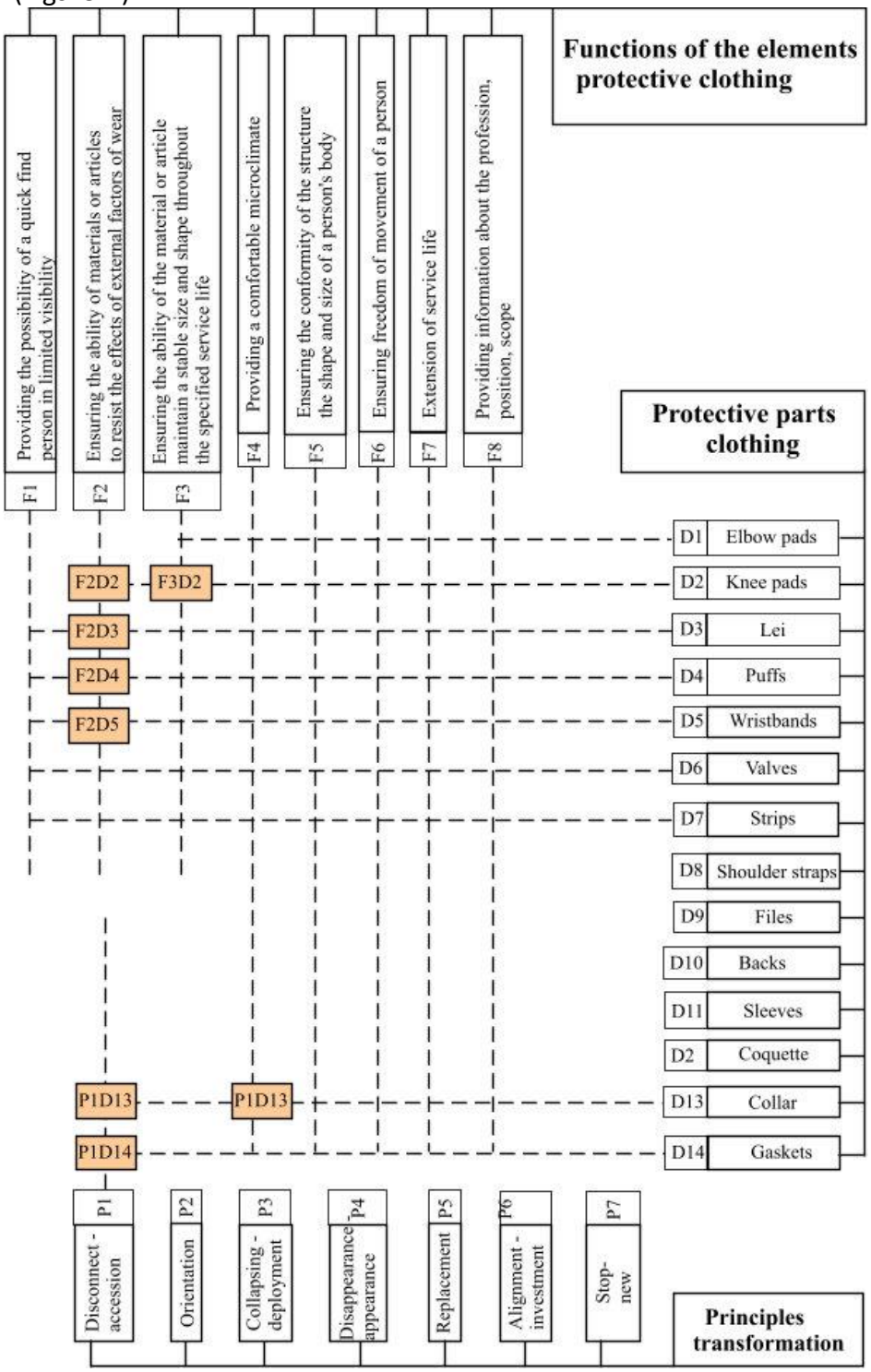

Fig. 2. Approach to designing new elements protective clothing based on the principles of transformation

[366] Development of elements of special protective clothing based on the principles of transformation. The theory and practice of design. Technical aesthetics. – 2015. – № 8. – P. 204-216.

In view of the safety of products for life and human health, it is important to hygienically standardize the comfort of being in clothing, especially in protective clothing. It should be noted that the known elements that allow the worker to independently adjust the parameters of the underwire space in clothing with a passive method of protection, are those located in the step and side seams, in the underarms, in the seams of the flirt, on the nails, the back and the like. Creation of ventilation elements of protective clothing on the basis of transformation principles is based on the developed approach (Fig. 1).[367]

Based on this, elements of protective clothing were proposed and manufactured on the basis of transformation principles based on different functional characteristics. [368]

Therefore, providing a comfortable microclimate of the underwire space is implemented in clothing with a passive method of protection using the element "ventilation valve", the structural and technological solution of which is shown in Figure 3.

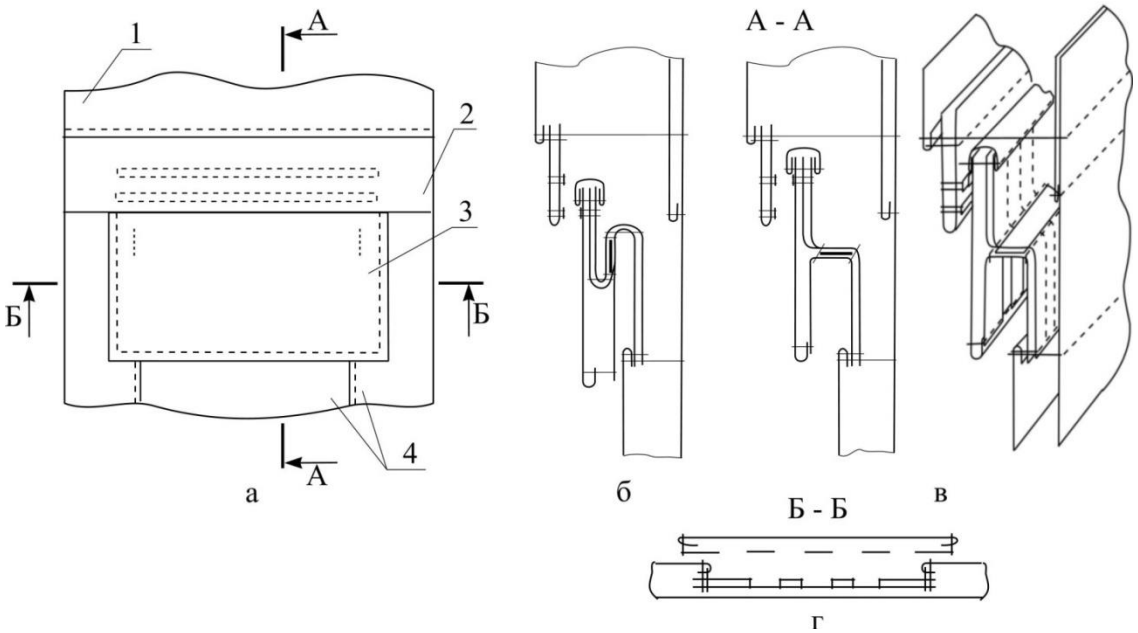

Fig. 3. Design and technological solution of the element of protective clothing "ventilation valve" (Ф4 П2 Д9 Д10): a – appearance of element "ventilation valve"; b – longitudinal section of the element in closed form; in – longitudinal section of the element in open form; g is a cross-section of an element; 1 – coquette files; 2 – bar; 3 – valve; 4 – a file

An element of protective clothing on the basis of the principles of transformation "ventilation valve" for a certain functional feature of "providing a comfortable microclimate of the underworld" is proposed. The use of ventilation elements in protective clothing (Figs. 3-7) is foreseen in both shoulder and waist products, namely in overalls, jackets, overalls, trousers and the like.

The novelty of the proposed solution is the possibility of opening the ventilation openings due to transformation on the basis of the known principle of "orientation". The vents are covered

[367] Ostapenko N. V. Creation of elements of special thermal protective clothing based on the principle of transformation. Conferinţa Tehnico Ştiinţifică a Colaboratorilor, Doctoranţilor şi Studenţilor,. [2011 a Univ. Techn. a Moldovei], (8-12 December) – Ch.: UTM, 2012, Vol. 3. – 420 p. – P. 224-225.

[368] Budchenko O. V. Development of elements of special thermal protective clothing on the basis of transformation principle. Abstracts of the reports of the jubilee All-Ukrainian Scientific Conference of Young Scientists and Students ["Scientific Developments of Young People at the Current Stage"], (April 22-23, 2010) / Ministry of Education and Science of Ukraine, KNUTD. – K.: KNUTD, Volume 1, 2010. – P. 73.

by a valve that is fixed in two positions by a textile clasp. It should be noted that the locking of the valve in the open state is due to the presence of additional "stiffening ribs".[369]

On the basis of this principle of transformation, such elements of protective clothing as the "ventilation pocket" (Fig. 4) and the "ventilation element" (Fig. 5) were also developed and manufactured.

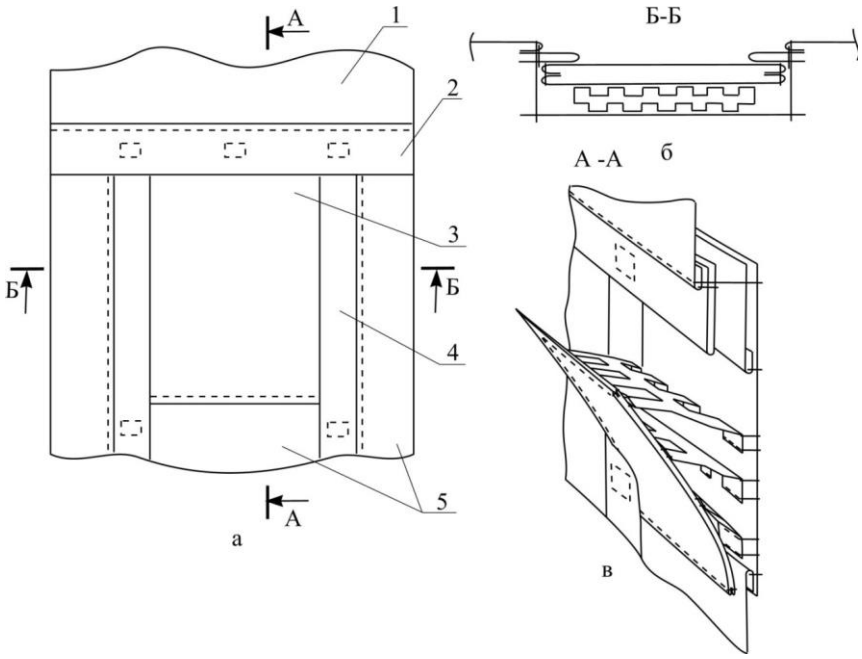

Fig. 4. Design and technological solution of the element of protective clothing "ventilation pocket" (Ф4 П2 Д9 Д10): a – appearance of the element "ventilation pocket"; b – cross-section of the element; c – longitudinal section of the element in the open state; 1 – coquette file; 2 – bar; 3 – patch pocket; 4 – bar; 5 – a file

"Ventilation pocket" looks like an overhead pocket. To prevent the harmful factors from entering the pockets on the sides and from above, cover the strips. The principle of action "ventilation pocket" is to open an extra layer of material with cuts. In the process of fixing the pockets in the extreme lower position with the help of a textile fastener, the cuts diverge, forming openings. It should be noted that the extra layer of material in its structure is sufficiently elastic, thus supporting the pocket in a given position.

The "ventilation element" solution is such that its upper and lower layers consist of cells that overlap. When fastening an element with a textile fastener on another level, their alignment occurs and, as a consequence, the microclimate of the underwire space is regulated. To prevent the detention of dangerous harmful factors per element, the upper "ventilation element" is covered with a strip.[370]

The element of protective clothing "ventilation pocket" shown in Fig. 6, developed on the basis of the principle of transformation "disappearance – appearance".[371]

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[369] Tesla A. P. Development of elements of special clothing on the basis of the principle of transformation on a functional basis. Abstracts of the 10th All-Ukrainian Scientific Conference of Young Scientists and Students ["Scientific Developments of Young People at the Current Stage"], (April 19 – April 20, 2011) / Ministry of Education and Science of Ukraine, KNUTD. – K.: KNUTD, Volume 1, 2011. – P. 76.

[370] Analysis of the composition and design of clothing for railway conductors of Ukraine. Theory and practice of design. Technical aesthetics. – 2015. – № 8. – P. 233-243.

[371] Development of ergonomic and aesthetic protective clothing for civil aviation workers. Theory and practice of design. Technical aesthetics. – 2015. – № 8. – P. 250-256.

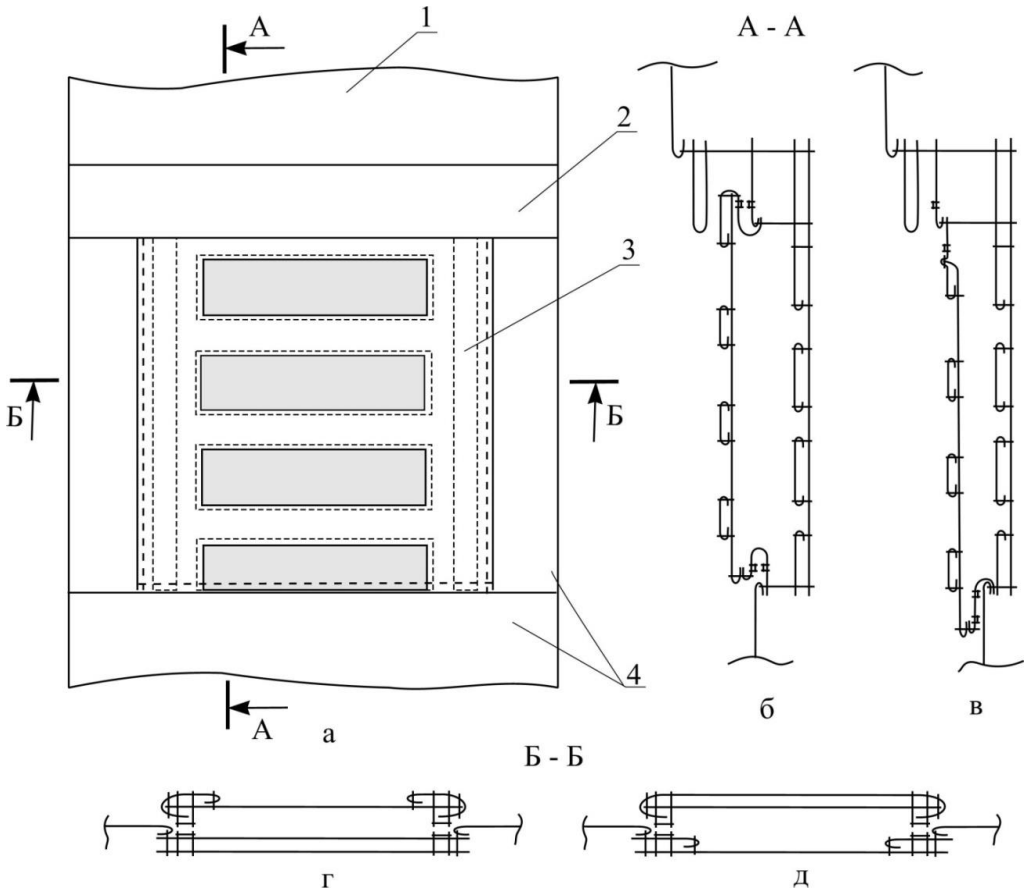

Fig. 5. Design and technological solution of "ventilation element" (Ф4 П2 Д9 Д10): a – appearance of "ventilation element"; b – longitudinal section of the element in the closed state; c – longitudinal section of the element in the open state; d – cross-section of the element in the closed state; d – cross-section of the element in the open state;
1 – coquette files; 2 – bar; 3 – ventilation element; 4 – a file

The novelty of this element is that the microclimate is controlled by opening or closing the ventilation grid. The ventilation grid is inside the pocket, which is sealed on all sides by a zipper.

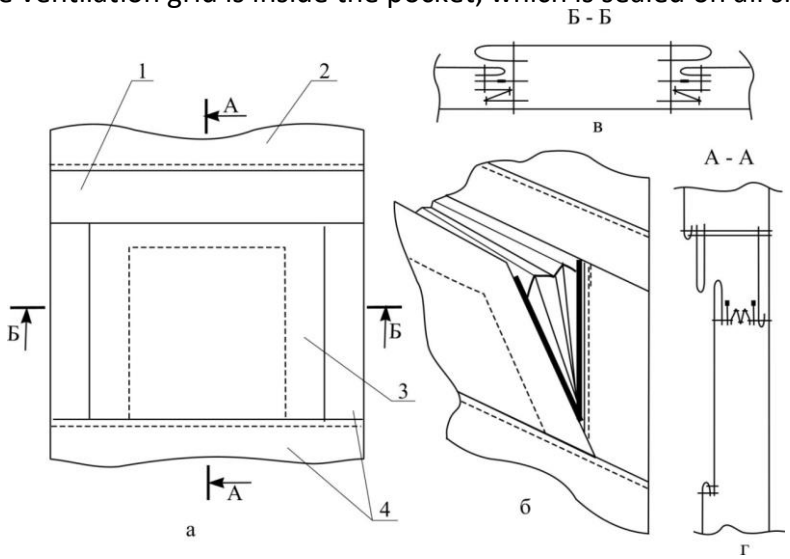

Fig. 6. Design and technological solution of the element "ventilation pocket" (F4 P2 D9 D10):
a – appearance in the closed state; b – appearance in the closed state;
in – cross-section of the element; d – longitudinal section of the element;
1 – bar; 2 – coquette files; 3 – pocket; 4 – a file

The "ventilation element" of protective clothing was developed and manufactured on the basis of the principle of transformation "stretching – compression", structural and technological solution of which is shown in Figure 7.

Transformation is carried out when the elastic band is weakened, which runs along the element and is adjusted to it at a certain interval. In such a lattice position, in unfixed places, the element forms outlets which serve as ventilation openings. Note that the element is additionally fixed at the edges with a textile clasp.

On the basis of the developed approach of creation of elements of protective clothing on the principle of transformation, structural and technological solutions of the elements were developed with the purpose of their perspective for further practical application.

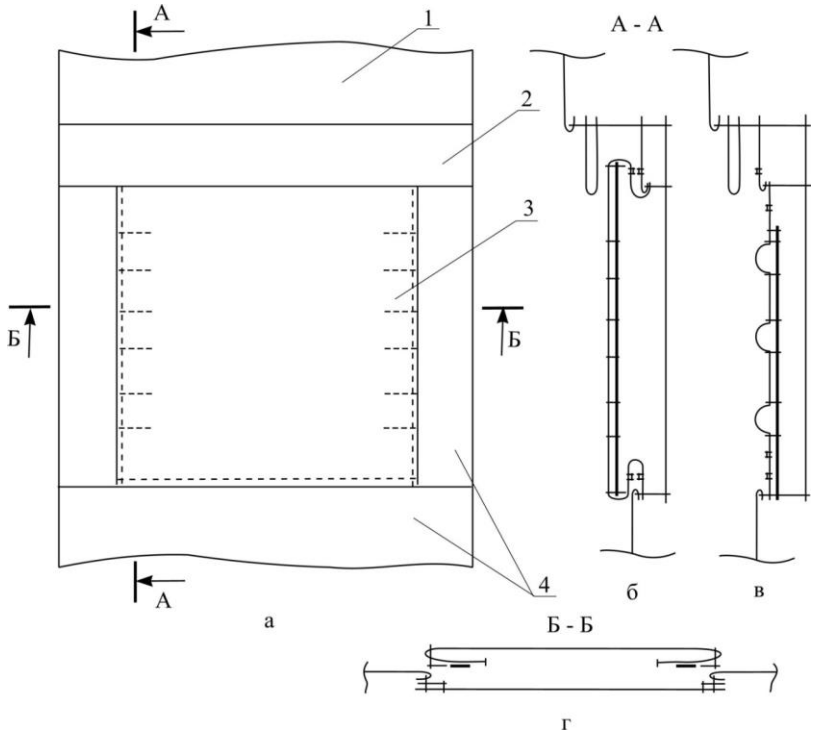

Fig. 7. Design and technological solution of the "ventilation element" (Ф5П3 Д9 Д10): a – appearance; b – longitudinal section of the element in the closed state; d – longitudinal section of the element in the open state;g is a cross-section of an element; 1 – coquette files; 2 – bar; 3 – "ventilation element"; 4 – a file

Elements of protective clothing "ventilation pocket" based on the principles of transformation "replacement", "disappearance – appearance", "stretching – compression" to provide a comfortable microclimate of the underfloor space were designed and manufactured.

The use of developed ventilation elements in protective clothing is appropriate due to the regulation of the thermal state of the body of the employee during physical activity and the removal of products of gas exchange of the body through the skin.[372]

The urgency of further design, manufacture and implementation of elements based on the principles of transformation into protective products with the purpose of creating ergonomic modern clothes.

[372] Slavinskaya A. L. Building a pattern of clothing details of different assortment: textbook. tool. – Khmelnitsky: TUP, 2002 – 142 p.

Functional development of elements based on the principle of transformation - prolongation of life. Extending the life of protective clothing is carried out by replacing the removable parts, which also allows to extend the conditions of their use and the product as a whole.

The development of such elements is based on the study and analysis of the topography of the influence of dangerous and harmful factors of the production environment.[373]

Known are the principles of transformation, by which transform transformation is due to combinatorial variation. Transformation-based item coding uses the "transformation-based approach to creating clothing elements", which is discussed in the first section.

The element "pocket – removable pocket" (F7 P1 D15) was developed and manufactured on the basis of the principle of transformation "disappearance – appearance", the structural and technological solution of which is shown in Figure 8. The front half of the trousers has a slit pocket with a leaf, which is closed by a valve . The snap pocket is secured with textile clasps and clamps that are affixed to the product.

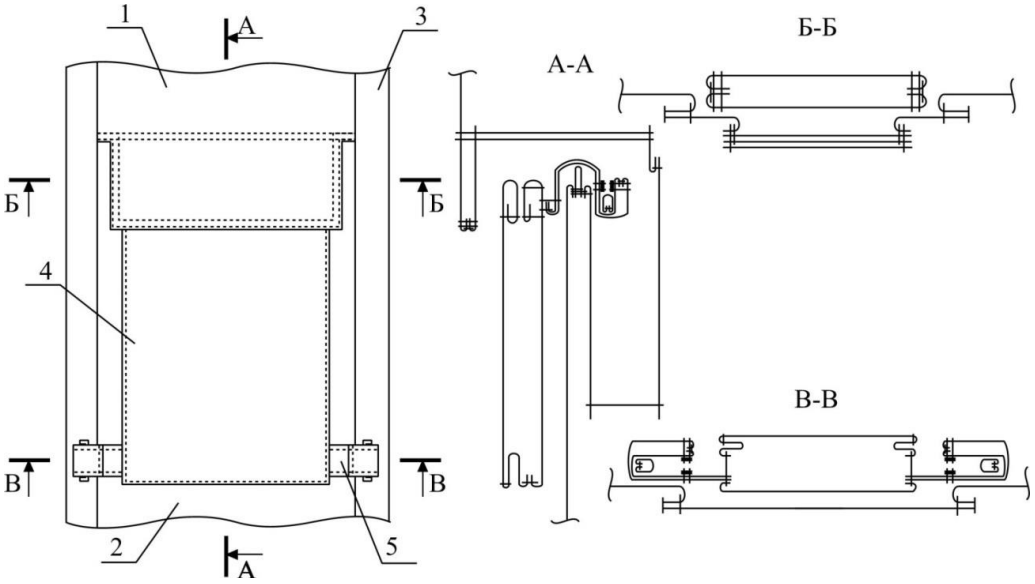

Fig. 8. Design and technological solution of the element "pocket - removable pocket" (Ф7 П1 Д15 Д15): 1 – the upper part of the front half of the trousers is solid with a valve; 2 – the lower part of the front half of the trousers; 3 – back half of trousers; 4 – removable pocket; 5 – a strip with a textile fastener

The principle of transformation "separation – joining" is based on the fact that the basic elements of clothing are attached structural and decorative elements. According to this principle, an element "removable pocket" (F7 P1 D15) is designed and manufactured, the structural and technological solution of which is shown in Figure 9. "Removable pocket" consists of a briefcase-pocket and a patch pocket and attaches to the protective clothing parts for with a textile fastener.

Another example of a developed element for the purpose of prolonging the lifetime for protection against scratches, cuts, punctures, as well as for the use of a cushioning gasket is a structural and technological solution "kneecap - pocket" (F7 P9 D2 D15), the novelty of which is the possibility of transformation by principles "Compartment – attachment" and "disappearance - appearance" of a pocket or a knee pouch with a pocket for laying. The structural and technological

[373]S talemate.102950 Ukraine, IPC A 41D 13/00. Overalls for the military / Avramenko T. V., Ostapenko N. V., Stelmakh M. D., Zavadsky S. L., Kolosnichenko M. V., Vasilyeva I. V., Alexandrov M.E.; applicant and patent holder Kyiv National University of Technology and Design. – No. u201505300, Appl. 29. 05. 2015; publ. 25/11/2015, Bul. № 22.

solution of the element on the basis of the principle of transformation "knee-pocket" is shown in Figure 10.

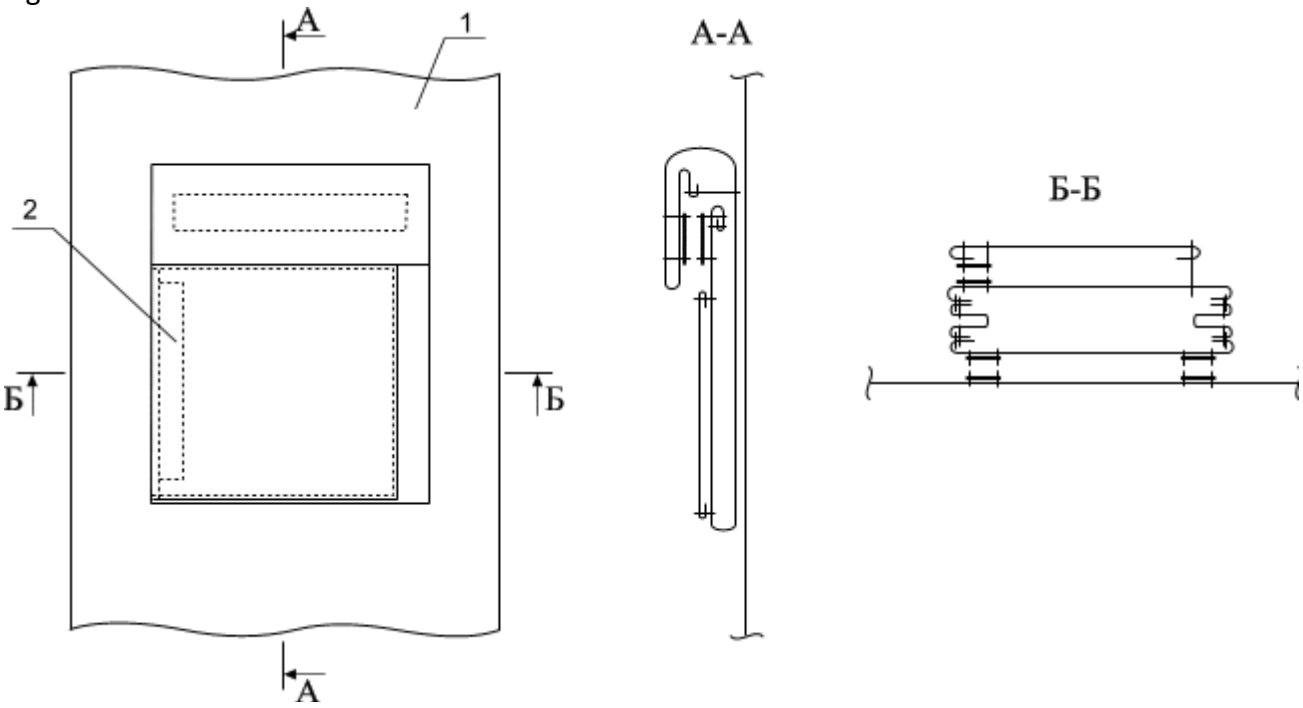

Fig. 9. Structural and technological solution of the element "removable pocket" (Ф7 П1 Д15): 1 – the main detail; 2 – removable pocket

"Knee-pocket" consists of one movable knee pads that can be transformed into a pocket for small items or into a knee pads with a pocket for cushioning pad and two collar pockets. In both positions, the kneecap is fixed with textile fasteners that are closed by valves.

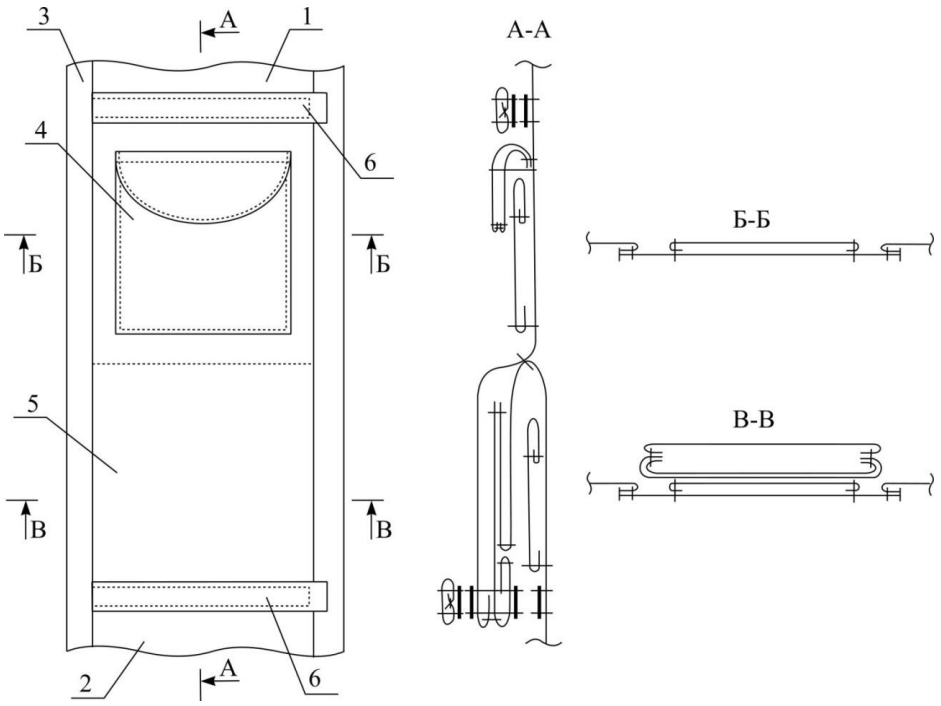

Fig. 10. Structural and technological solution of the element "knee - pocket" (F7 P9 D2 D15): 1 – the upper part of the front half of the trousers; 2 – the lower part of the front half of the trousers; 3 – back half of trousers; 4 – patch pocket with valve; 5 – fly knee pad-pocket; 6 – valve with textile clasp

It consists of a patch pocket with a valve in the upper part of the front half of the trousers, a patch pocket in the lower part of the front half of the pants, and a flywheel with a pocket. The novelty of the proposed structural and technological solution of the element on the basis of the principle of transformation "knee-pocket" is the possibility of transformation on the principle of "regulation-fixation" of the pocket into "knee-pocket" for the insertion of the cushioning pad. In both positions, the knee pads are secured with textile fasteners that are closed by valves.[374]

There are other elements that can be exemplified by this transformation. For example, "arm-pocket" or "back-pocket".

An element based on the "pocket pocket - knee" transformation principle (F7 P1 P4 D2 D15 D15) was also designed and manufactured, the structural and technological solution of which is shown in Figure 11.

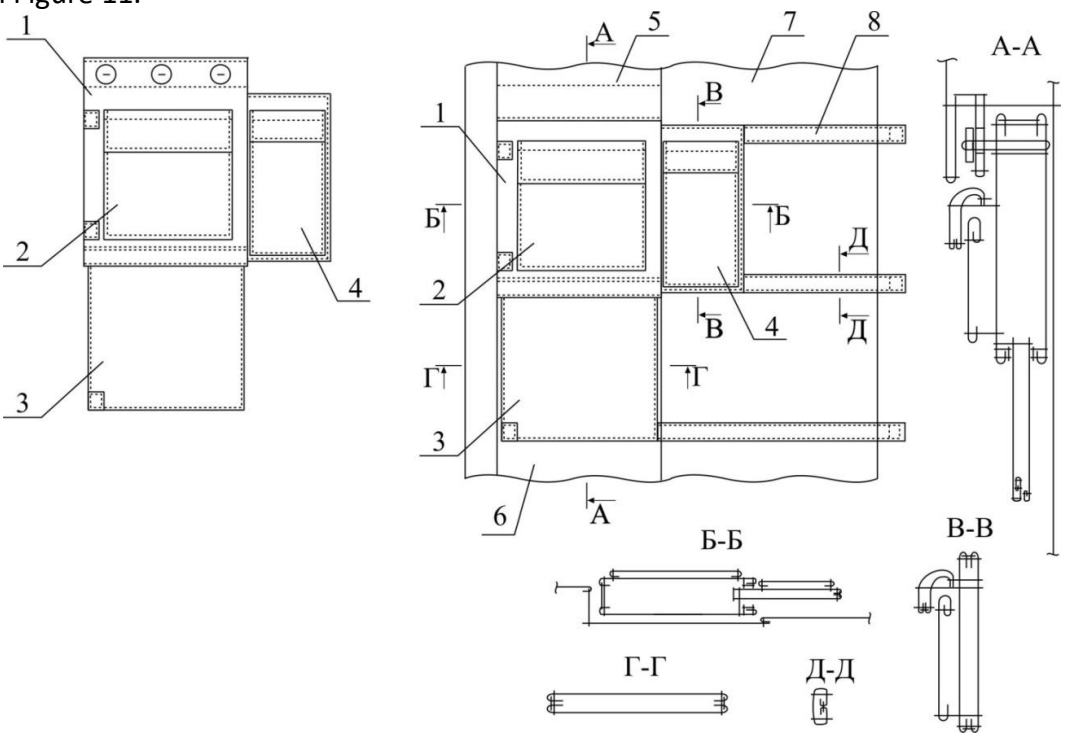

Fig. 11. Design and technological solution of the element "removable pocket – knee pads" (Ф7 П1 П4 Д2 Д15): 1 – removable pocket; 2 – patch pocket; 3 – knee; 4 – side pocket; 5 is the upper part of the front half of the trousers; 6 – the lower part of the front half of the trousers; 7 – back half of trousers; 8 – stripes with a textile fastener

The zipper pocket attaches to the front half of the trousers with the buttons located on the zipper pocket and the loops located on the front half of the trousers. The hinges are closed with a valve that prevents water from entering the dressing area and engaging it with surrounding objects.The striking details of the element are the knee pads attached to the bottom of the removable pocket and the side pocket located on the side of the pants. If necessary, the employee can use the pocket and knee pads together or separately. These parts are secured to the garment by means of stripes with a textile fastener. In Fig. 12 gives the appearance of an element based on the principle of "pocket pocket – kneepad" transformation.

It can be seen from the figure that the front half of the trousers contains an all-round valve with concealed loops. If necessary, you can attach the extra detachable pocket to the product with buttons and a textile clasp. Thus, by combining a simple product with a new functional element, we get a new structural and technological solution of the product.

[374] Stalemate.102935 Ukraine, IPC A41D 13/00.Thermal protective overalls.applicant and patent holder Kyiv National University of Technology and Design. – No. u201505151, Appl. 26. 05. 2015; publ. 25/11/2015, Bul. № 22.

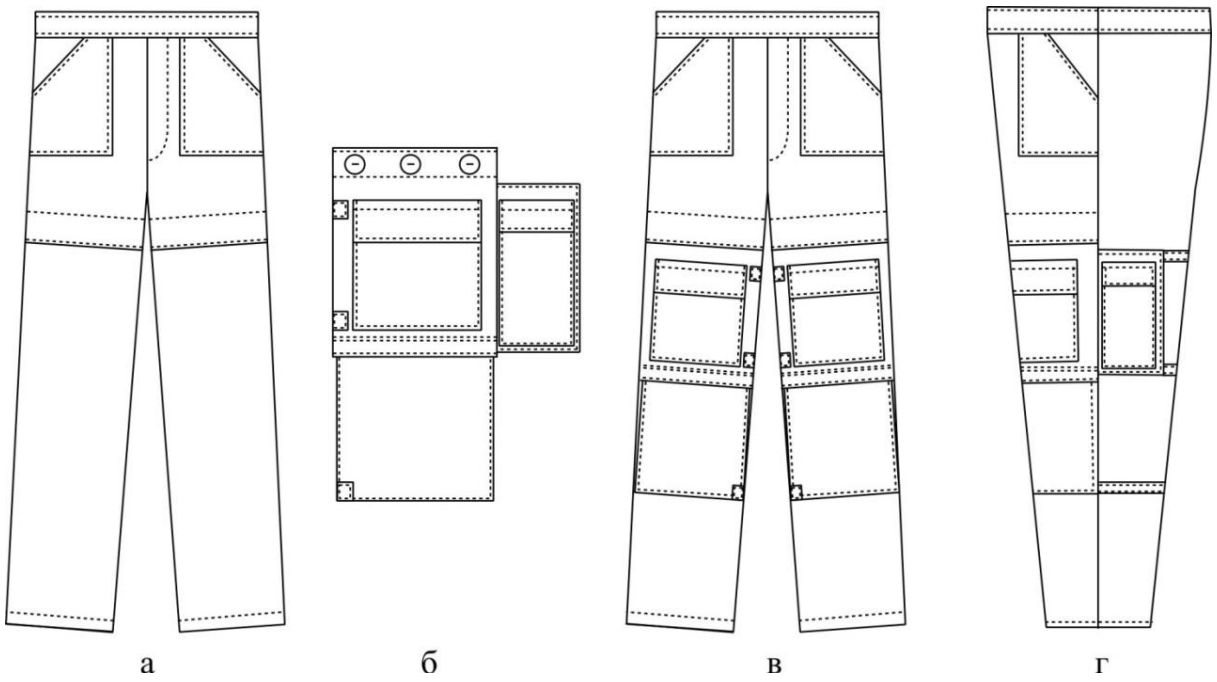

Fig. 12. The appearance of the "removable pocket – knee pads" element (Ф7 П1 П4 Д2 Д15 Д15): a – front pants view; b – the appearance of the element on the basis of the principle of "pocket pocket – knee"; in – the appearance of trousers with an element based on the principle of transformation "removable pocket – knee pads" in the front; d – the appearance of trousers with an element based on the principle of transformation "pocket pocket – knee" on the side

Figure 13 shows the structural and technological solution of the element on the basis of the principle of transformation "pocket – knee" (F7 P4 D2 D15). It consists of a pocket, a side sill pocket, and a sill. The cast parts are secured to the garment by means of stripes with a textile fastener.

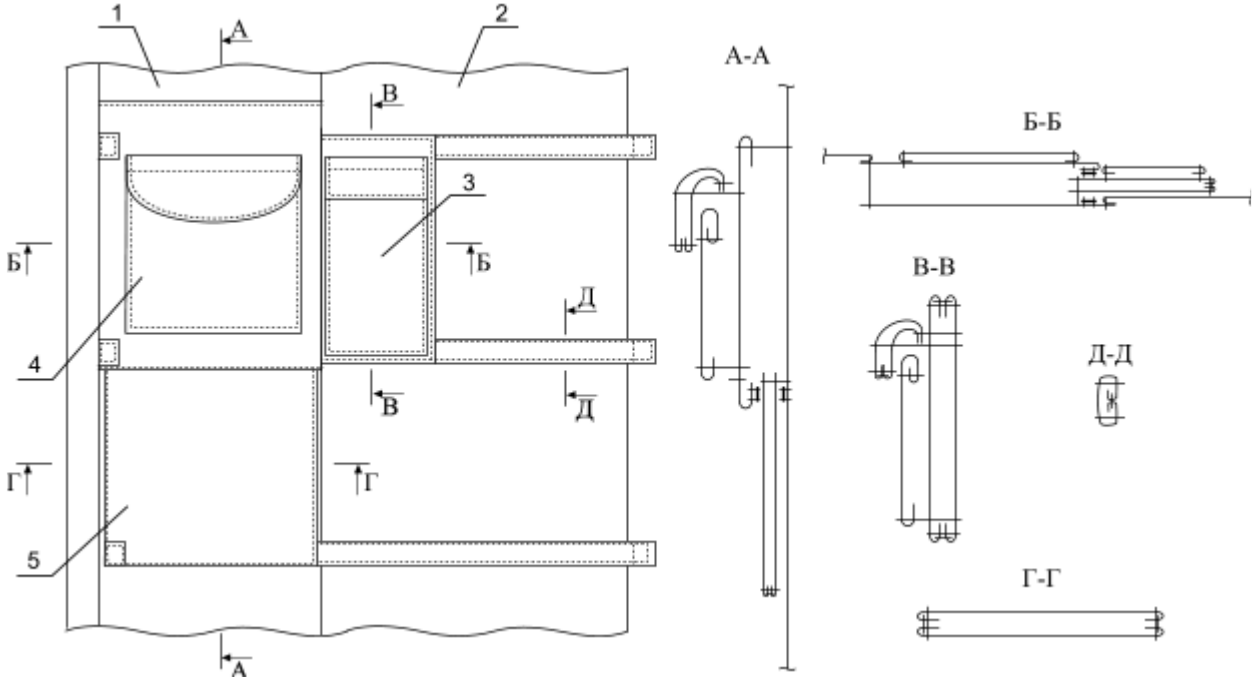

Fig. 13. Design and technological solution of the element "pocket – knee pads" (F7 P4 D2 D15): 1 – front half of pants; 2 – back half of trousers; 3 – side pocket; 4 – pocket; 5 – kneecap

The appearance of the element on the basis of the principle of transformation "pocket-knee" is shown in Figure 14. Its use implies the presence of textile fasteners on the product. It should be noted that this element has an additional side pocket with a valve. Similarly, you can make the element "pocket – armrest".[375]

The elements discussed above are based on the principle of "disappearing pocket" and "pocket knee" and are based on the principle of "extinction – appearance". This principle determines the change of an element by reducing it. An example is a hood that fits in the collar pocket. According to this principle, the element "valve – pocket" (F7 P4 D15 D6) was designed and manufactured.

If necessary, the fly pocket is straightened and fixed with clamps that are adjusted together with the overhead pocket.

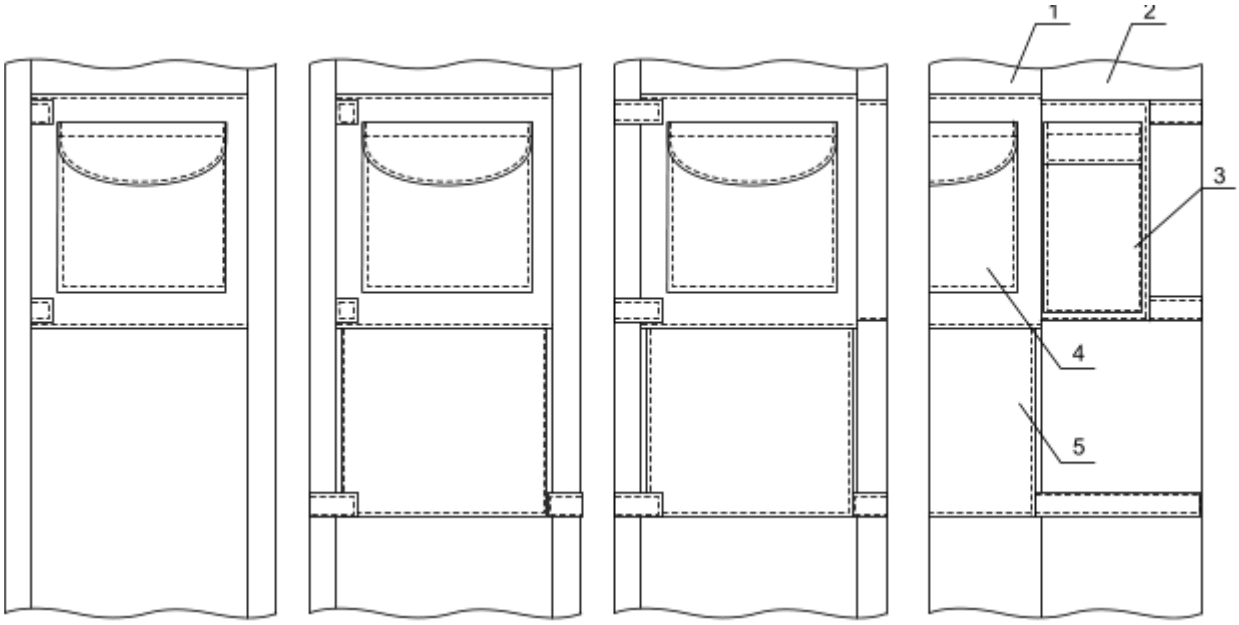

Fig. 14. The appearance of the "pocket-knee" element (F7 P4 D2 D15):
a – front pocket view; b – front view of pocket and knee pads; in – view of pocket, knee pad and side pocket in front; d – view of the pocket, knee pads and side pockets from the side:
1 – front half of the pants; 2 – back half of trousers; 3 – side pocket; 4 – pocket; 5 – kneecap

The knee patch is sewn on the inside of the trousers and the insertion of the shock absorber pad occurs through a slit pocket that is placed inside the patch pocket.

A removable pocket-to-pocket element has been developed, containing two one-on-one valves with one another. The removable element is secured to the product by means of textile fasteners that are tucked into the front half of the trousers and closed with a full-length valve. This principle can be used to make any overhead elements, which will be attached in any place and used when necessary (for example, when performing certain works that are not part of the basic duties of the employee and are performed at a certain frequency).[376]

[375] Tretyakov L. D. Personal protective equipment for self-rescue during a fire. Materials of the XIV International Scientific Method. conf., ["Safety of life and human activity – education, science, practice"], (Kharkiv, May 21 – May 22, 2015) / inst. technol. and education content, Deporte. civilians. of protection, Kharkov. nat. un-t the city. master in it. O. M. Beketova and others. – Kharkiv: KhNUMG them. O. M. Beketova, 2015. – P. 81-83.

[376] Rubanka A. I. Features of the design solution of ergonomic clothing for emergency.["Scientific developments of young people at the present stage"], abstracts of the XIV All-Ukrainian Scientific Conference of Young Scientists and Students, April 23-24, 2015. – K.: KNUTD, 2015. – Vol.1. – P. 36.

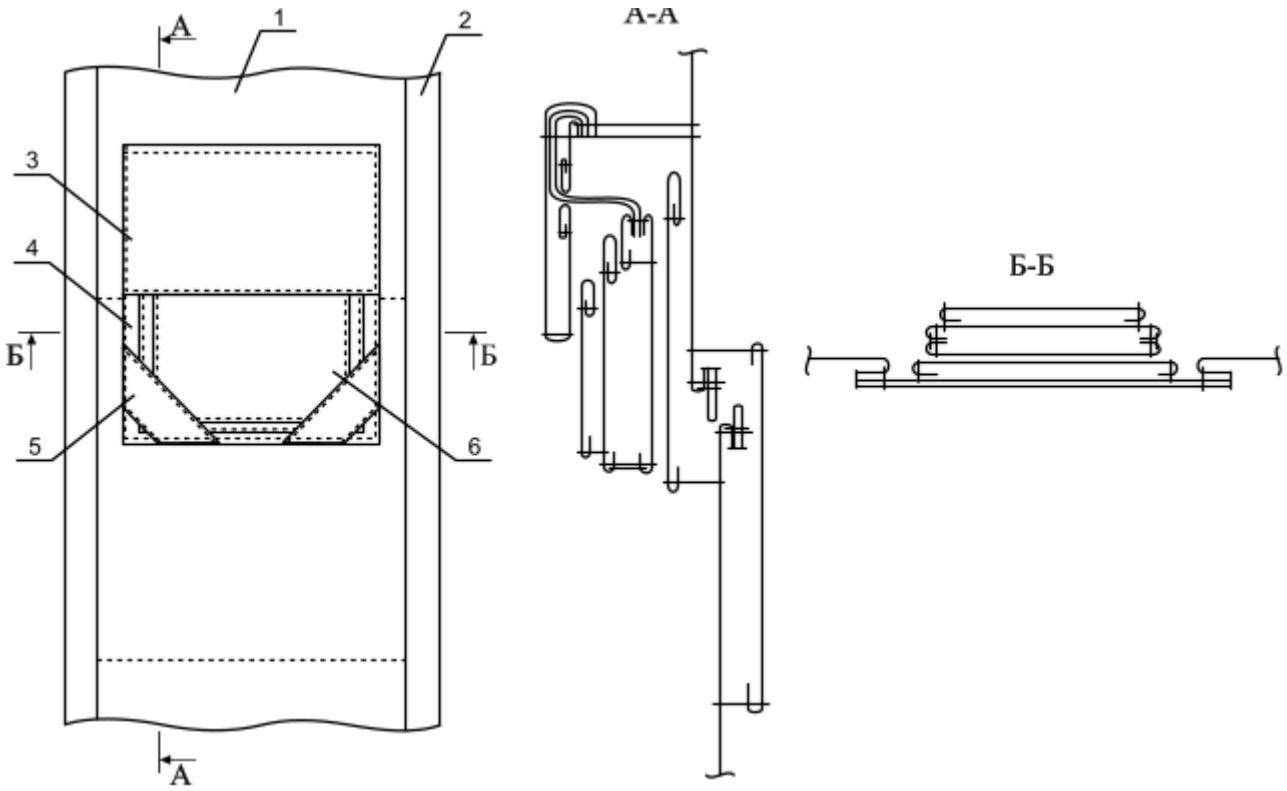

Fig. 15. Design and technological solution of the element "valve - pocket" (F7 P4 D15 D6): 1 – front half of trousers; 2 – back half of trousers; 3 – valve with a fly pocket; 4 – patch pocket; 5 – clamps; 6 – fly pocket

An example of using the "pocket pocket - pocket" element is shown in Fig. 17. Extra functionality is obtained by adding an item with a "pocket pocket".

An example of using a "pocket pocket" is shown in Figure 19. As can be seen from the figure, the pocket can be placed at different heights of the front half pants.

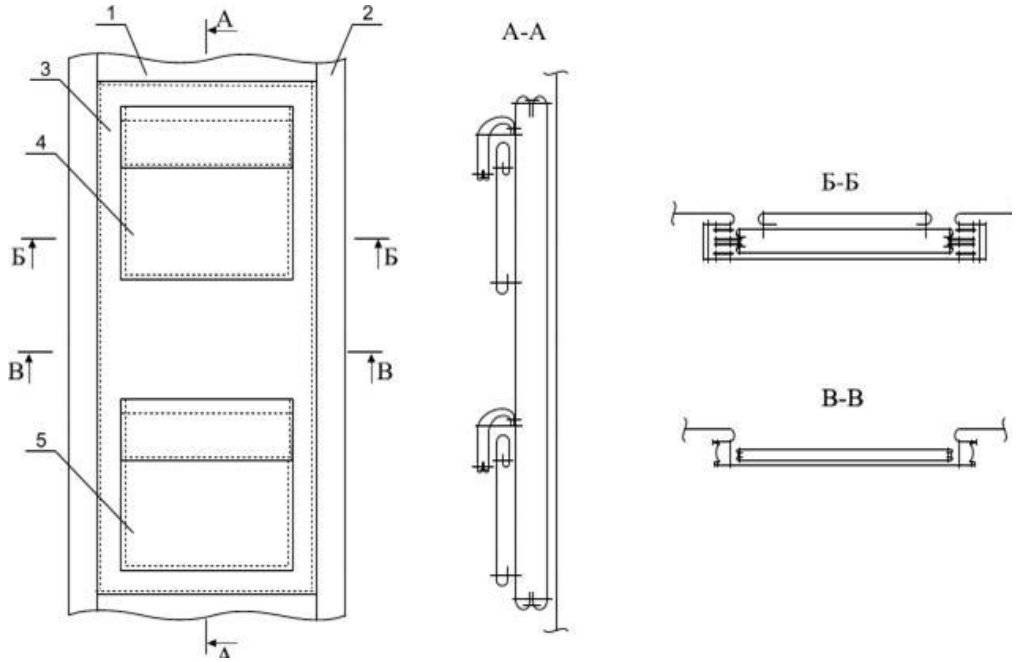

Fig. 16. Design and technological solution of the element "removable pocket – pocket" (Ф7 П1 Д15 Д15): 1 – front half of trousers; 2 – back half of trousers; 3 – removable pocket – pocket; 4 – upper patch pocket with valve; 5 – lower patch pocket with valve

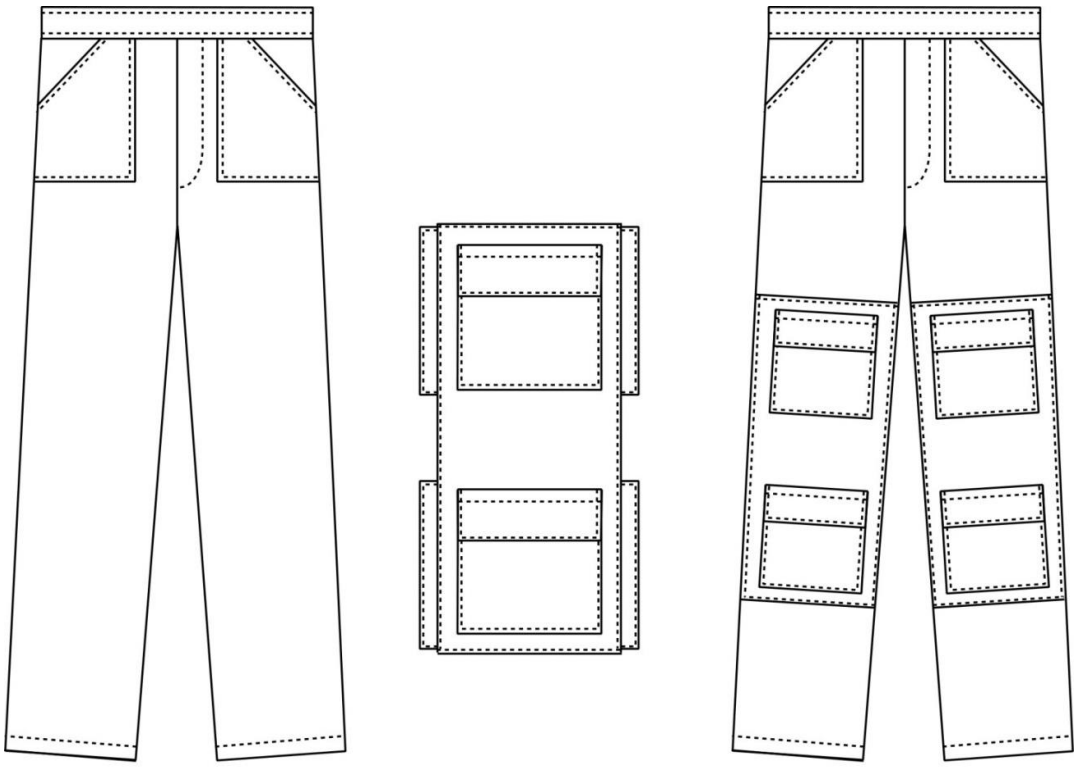

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Fig. 17. Appearance of the "pocket pocket – pocket" element (Ф7 П1 Д15 Д15): a – front view of trousers; b – the appearance of the element based on the principle of transformation "pocket pocket – pocket"; in – the appearance of trousers with an element based on the principle of transformation "pocket-pocket" in front

In some operating conditions, there is a need to use additional overhead elements. These can be knee pads, elbow pads, etc. These elements can be used to extend the service life by providing additional protection against punctures, cuts and abrasion on the plane, and to ensure ergonomics by using removable knee pads and elbow pads with the possibility of inserting additional inserts (such as shock absorbers).

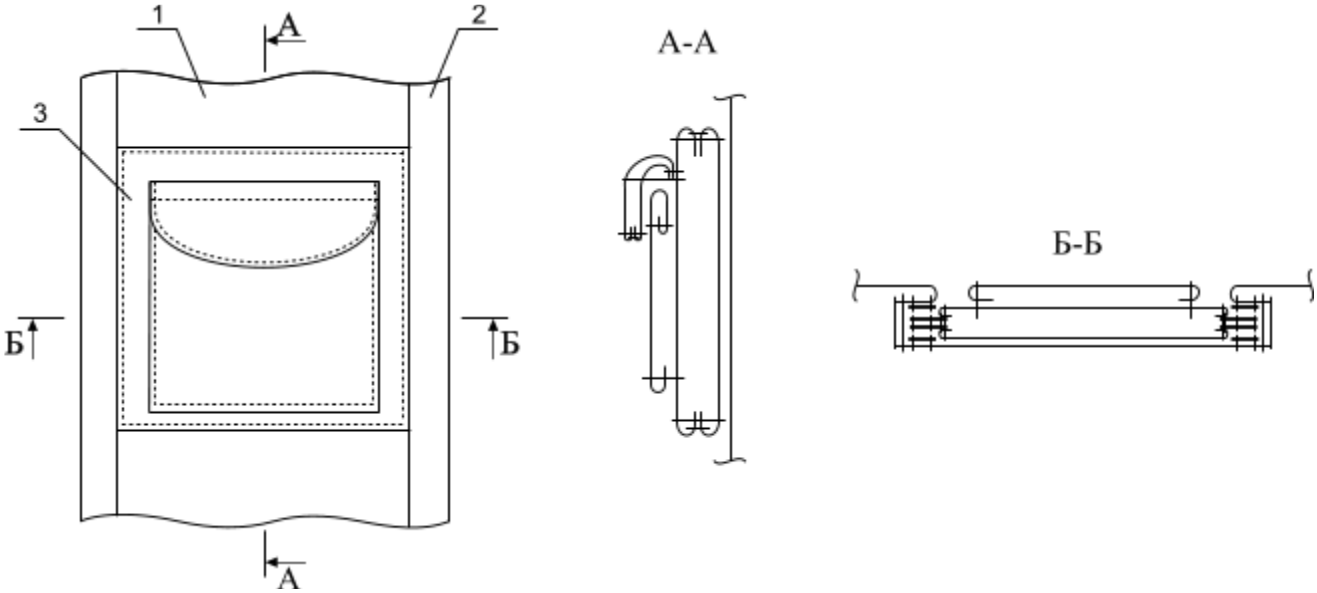

Fig. 18. Structural and technological solution of the element "removable pocket" (Ф7 П1 Д15): 1 – front half of trousers; 2 – back half of trousers; 3 – removable pocket

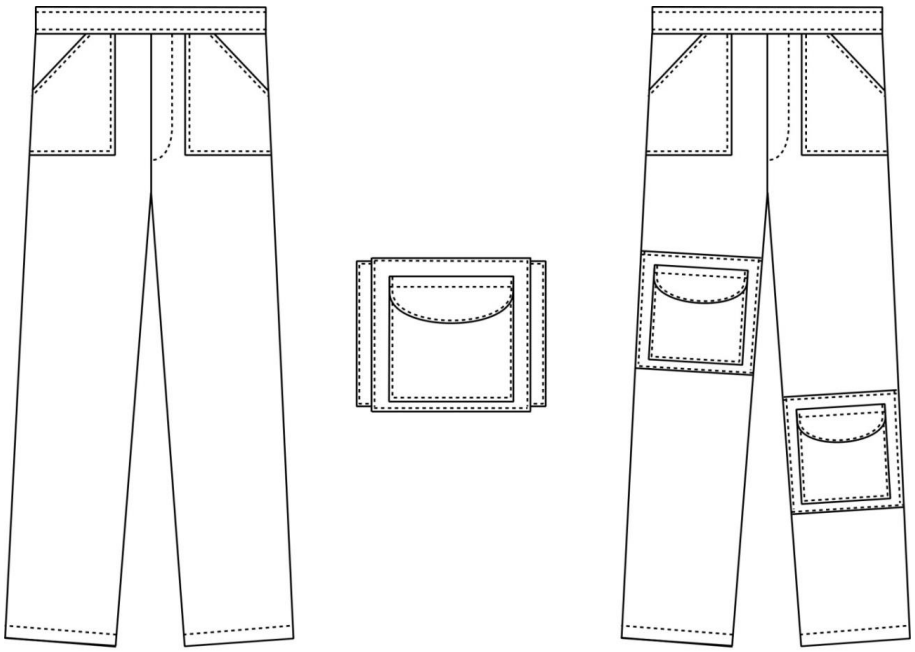

Fig. 19. Appearance of the "pocket pocket" element (Ф7 П1 Д15): a – front view of trousers; b – the appearance of the element on the basis of the principle "transformation of the pocket"; in – the appearance of trousers with an element based on the principle of transformation "pocket pocket" in the front

An example of such an element would be a removable knee brace, a structural and technological solution of which is shown in Fig. 20. It consists of two layers of fabric interconnected and a hole in the bottom for extra linings. The kneecap is attached to the product by textile fasteners.

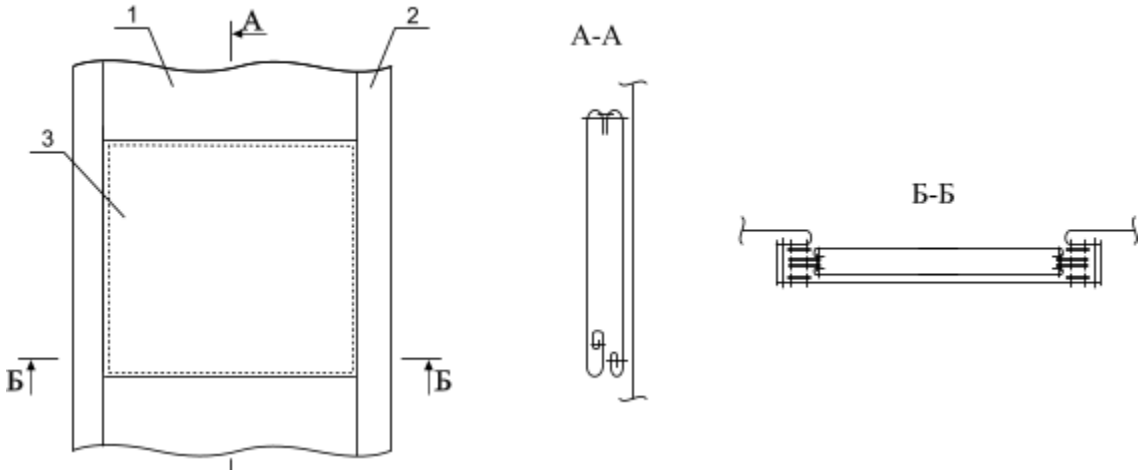

Fig. 20. Structural and technological solution of the item "ground knee pads" (Ф7 П1 Д2): 1 – front half of trousers; 2 – back half of trousers; 3 is a removable knee pads

An example of the use of a "landing gear" is shown in Fig. 21. The seating area is also subject to wear and therefore it is advisable to use a lei that can be removable in this area. Similarly, the item "removable armrest", "removable shoulder pad" and the like can be made.[377]

[377] Ostapenko N. V. Development of multifunctional special thermal protective clothing and its elements on the basis of transformation principle. Collection of Articles of the IX International Scientific and Practical Conference [«Fire Safety – 2009»] – Lviv: LSU BDZ, 2010. – P. 112-114.

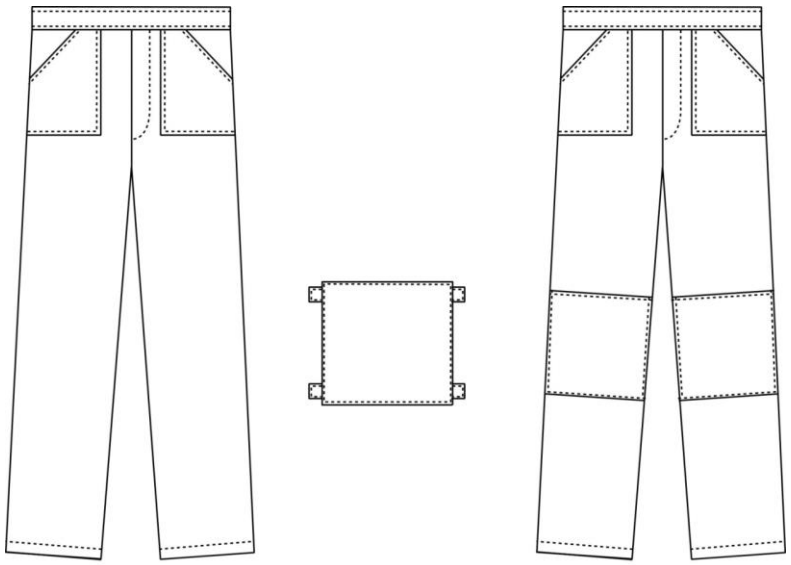

Fig. 21. Appearance of the "earth knee" element (Ф7 П1 Д2):a – front view of trousers; b – the appearance of the element on the basis of the principle of "ground knee"; in – the appearance of trousers with an element based on the principle of transformation "ground knee" in the front

Using a lining is a very promising trend. This is due to the fact that employees in such positions may perform different duties, and therefore different parts of the product will be subject to different degrees of wear. The use of linings in all possible areas will increase the weight of the product and its material consumption, which will significantly increase its value. It is also often necessary to use linings made of materials with specific properties (to protect against cuts, acids of different concentrations, etc.).

In Fig. 22 shows a structural and technological solution of the element "pocket pocket", which is a combination of elements "pocket pocket" and "knee pad". It consists of a removable element containing two layers of fabric interconnected, a lap pocket with a valve and a suture knee with a hole in the bottom for the possibility of inserting additional inserts. The "Knee-Pocket Knee" element is attached to the product with textile fasteners that are adjusted to the product and to the item in the appropriate places.

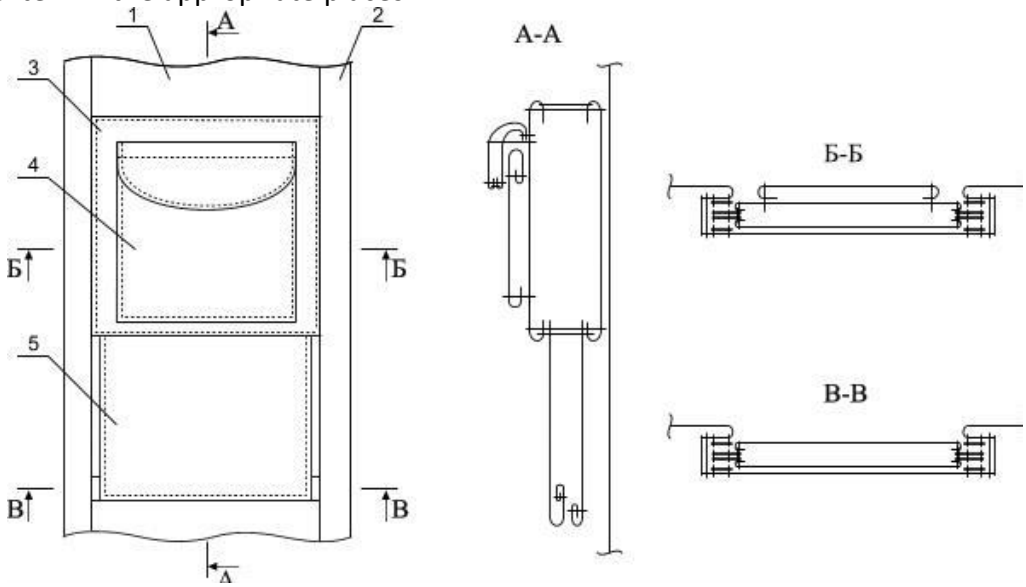

Fig. 22. Constructive and technological solution of the element "removable pocket – knee pads" (Ф7 П1 Д15 Д2): 1 – front half of trousers; 2 – back half of trousers; 3 – removable pocket – knee pads; 4 – patch pocket with valve; 5 – kneecap

An example of the use of the "knee pads" is shown in Fig. 23.

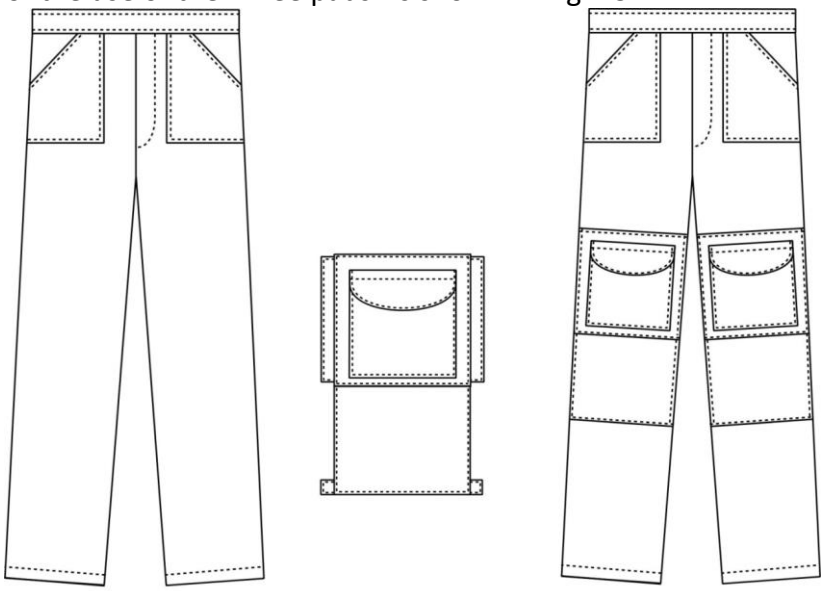

Fig. 23. Appearance of the item "removable pocket - knee pads" (Ф7 П1 Д15 Д2): a – view of trousers in front; b – the appearance of the element on the basis of the principle of "pocket pocket – knee"; in – the appearance of trousers with an element based on the principle of transformation "removable pocket – knee pads"

When using elements based on the principles of transformation, the employee can, at his own request and depending on the situation, perform a combination of parts. According to the principle of "separation – joining" it is possible to add (fasten) or subtract (unfasten) a finished part.

These elements (Figs. 16-23) are attached to the trousers by means of textile fasteners, which are located in the side and step seams of the trousers and on the side of the pocket and / or knee pads. The above elements, based on the principle of transformation, provide protection in the knee area and are an additional element for storing objects.

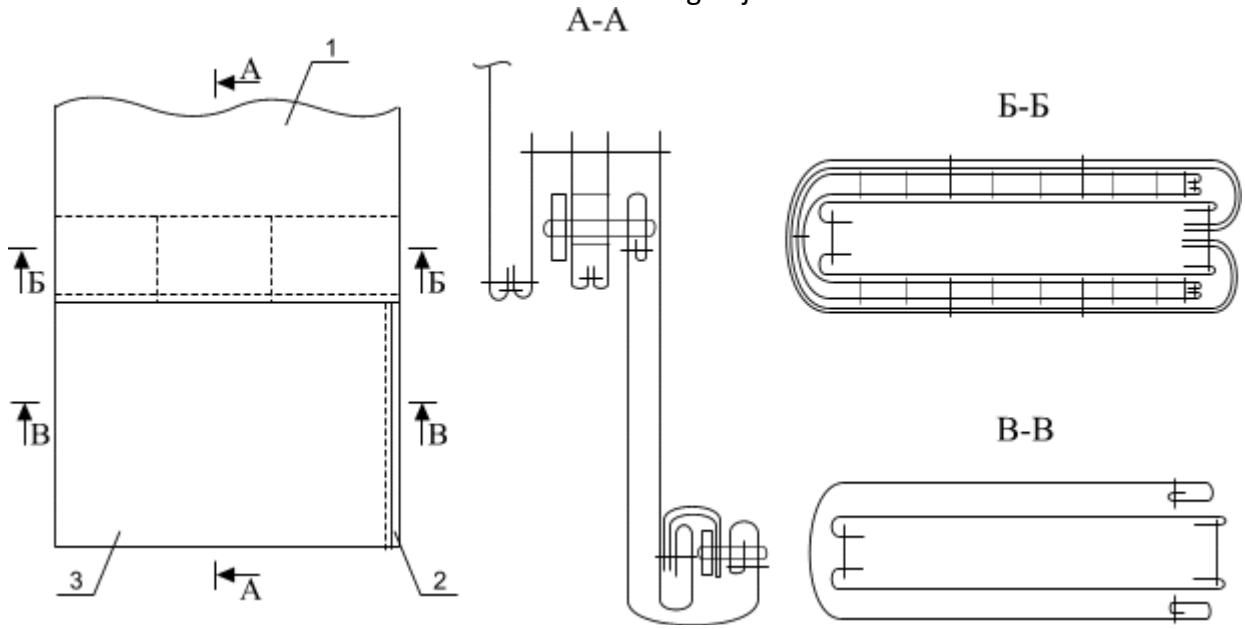

Fig. 24. Structural and technological solution of the element "ground part of the trousers" (Ф7 П1 Д17): 1 – upper part of the front half of the trousers; 2 – the lower part of the front half of the trousers; 3 is a removable pants bottom detail

Knee pads, elbow pads, and shock absorbers provide the ability to withstand external wear and tear while protecting the limbs.

As the bottom of the trousers is subject to wear, an element based on the principle of transformation "ground piece of trousers" (Ф7 П1 Д17), which is shown in Fig. 24. The element is attached to the trousers by means of buttons located at the top and bottom of the ground piece and loops which are located on the trousers and closed by a valve, which prevents water from getting under clothing and engaging clothing with surrounding objects.

To protect the shoulder area, it is advisable to use a removable cape that attaches to the clothing with buttons, buttons, and more. Damage to the material of the cape can be replaced, which will extend the life of the protective clothing.

The advantage of using such elements is the ability to replace them in the event of wear of a removable element. This makes it possible to extend the life of the garment and extend its functionality.

The use of the principle of transformation in protective clothing also leads to the unification of products. Enterprises have the opportunity to provide all employees with the same clothing, changing its functionality with the help of transformable elements, depending on the work performed and the topography of the influence of dangerous and harmful factors in the production environment.

Therefore, the use of elements based on the principles of the transformation of protective clothing allows you to produce ergonomic clothing that will meet the requirements of employees.

Conclusions. New methodological foundations of the process of design and technological development using the principles of transformation are proposed. This method of transformation makes it possible to develop new elements of protective products for certain production conditions, taking into account the requirements of the consumer to limit the influence of harmful production factors.The principles of scientifically grounded layout of various elements by functions into protective clothing products are defined, which provides the necessary combination of protective properties and characteristics that cause sufficient comfort under certain operating conditions. The urgency of further design, manufacture and implementation of elements based on the principles of transformation into protective products with the purpose of creating ergonomic modern clothes. The information base of transformer elements was theoretically substantiated, developed and formed for creation of modern protective clothing according to the types of danger and conditions of operation; experimental designs of clothing and its elements were made.

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