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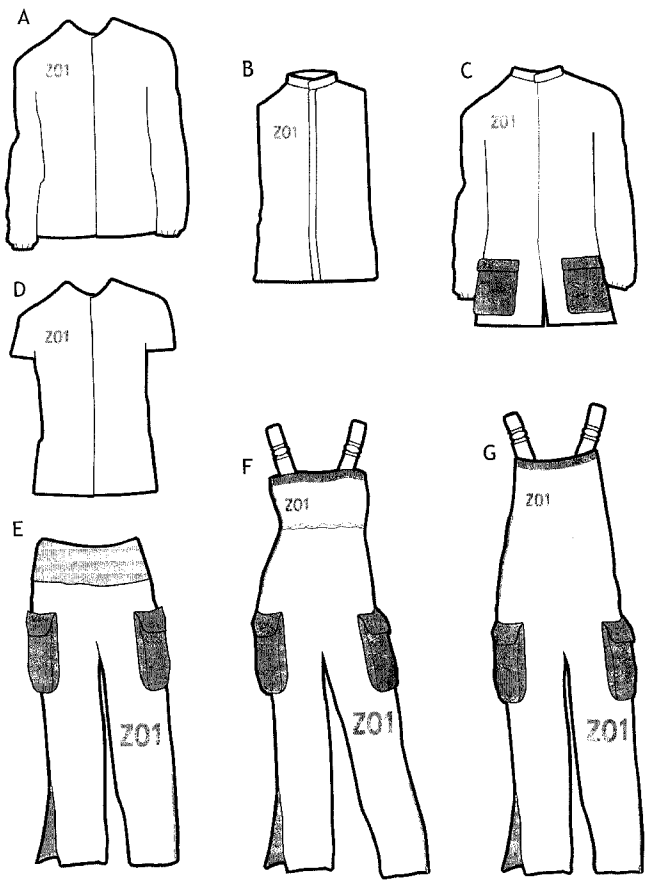

(57) Abstract: A protective apparel article made up of either a single garment or an assembly of multiple components is described. The protective apparel can be disposable and is fabricate in part or in whole from a nonwoven web material and either a woven or knitted fabric, or an elastomeric material. The particular cut and arrangement of the garment components, such as gender specific fits, can provide a distinctive look and feel to the garment.

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METHOD FOR USE OF PROTECTIVE APPAREL

This application claims the benefit of priority from U.S. Provisional Application No. 60/831,558 filed on July 17, 2006, the contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention pertains to protective apparel. In particular, the present invention relates to disposable utilitarian garments that provide improved comfort and fit to the wearer than conventional garments of like kind.

BACKGROUND

There are many types of limited use or disposable protective apparel designed to provide barrier properties. One type of protective apparel is protective coveralls. Coveralls can be used to effectively seal off a wearer from a harmful environment in ways that open or cloak style garments such as, for example, drapes, gowns and the like are unable to do. Accordingly, coveralls have many applications where isolation of a wearer is desirable. Protective apparel keeps clothing clean and keeps dirt and other residue off of the wearer's skin. For a variety of reasons, it is undesirable for hazardous liquids and/or pathogens which may be carried by liquids to pass through protective apparel. It is also highly desirable to use protective apparel to isolate persons from dusts, powders, and other particulates which may be present in a work place or accident site. Generally speaking, protective apparel rely on the barrier properties of the fabrics used in their construction. Some of these fabrics may even have received treatments to enhance barrier properties. However, barrier performance of protective apparel also depends on the design and construction of the apparel.

In general, workers typically change their coverall once a day, or every other day, depending on the requirements or standards of their respective industry. In some situations, workers may change their protective apparel even more frequently. After use, it can be quite costly to decontaminate protective apparel that has been exposed to hazardous substances. Thus, it is important that protective apparel be inexpensive so as to be disposable. Generally speaking, protective coveralls are made from barrier materials/fabrics engineered to be relatively impervious to liquids and/or particulates. The cost of such materials as well as the coveralls' design and construction are important factors affecting cost. Desirably, all

of these factors should be suited for the manufacture of protective apparel, such as coveralls, at such low cost that it may be economical to discard the coveralls after only a single use.

Protective apparel must be worn correctly to reduce the chance of exposure. Workers are more likely to wear protective apparel properly if the apparel is comfortable. One way to increase comfort is to have the apparel fit well. Providing good fit typically means providing a large range of apparel sizes and/or apparel configurations to cover the spectrum of body shapes and sizes. This endeavor generates more complex apparel that is difficult to manufacture quickly. Complex and relatively inefficient manufacturing processes can eliminate the cost advantages provided by inexpensive materials.

Typically disposable, one-use, or non-launderable protective garments are made using fabrics that do not stretch or flex with the movements of the wear's body. Common complaints by users of such garments are many. For instance, the collar is uncomfortable, so many people cut off the collar. Workers sometimes tape the collar down after folding it into the inside of the neckline. Others may tear out the label tag because it is scratchy. Still, for many others the coverall pulls in the crotch region, which forces workers to select a garment of larger size than the person's body size would usually wear. This last complaint results in a baggy, loose fit with too much extra fabric material that necessitates the wearer to pull in the waist and modify the sleeves and ankles, by rolling or taping them against their arms and legs.

A common practice now is that workers often tape the waist for better fit, the wrists and ankles to keep out dust and particulates for better protection, and knees to keep fluids from soaking through the garment material. Due to the nature of certain non-woven fabrics, which do not allow good ventilation for the wearer's enclosed body to breathe, another complaint of full-body coveralls is that wearers become too hot when working. To alleviate this problem, workers opt to wear only protective pants and arm guards rather than a full shirt, vest, or jacket that covers the torso, in order to keep their upper bodies from overheating. Workers also may cut slits in the material for better air flow, but doing so defeats the original protective function and purpose of the garment. Workers may also cut or modify garments so that pant legs are wide enough to fit over work boots. Further, given that the thigh areas of pants or coveralls are frequently used to wipe one's hands, that area of the protective garments would desirably be reinforced or have a covering that is less likely to show dirt.

Generally, a need exists to improve the present state and appearance of protective clothing so that the garments can both fit and function better. Garments, to be more comfortable, need to conform better to the human body, and allow for breathability without compromising overall level of protection. Further, various elements that improve overall fit can also enhance the function and appearance of the garment to enhance the motivation of a worker to wear the full complement of protective apparel. These elements either individually or as an assembly of elements provide adjustable components for improving fit to the human body.

Thus, a need exists for inexpensive protective apparel having desirable barrier properties. There is still a need for such protective apparel suited for high-speed manufacturing and converting processes. For example, a need exists for protective apparel manufactured from an inexpensive barrier material such that the apparel is relatively impermeable to liquids and/or particulates and so inexpensive as to be disposable while also having desirable fit and a distinctive appearance.

SUMMARY OF THE INVENTION

The present invention envisions, in part, a method for ensuring a user properly wears a full compliment of protective apparel, said method comprising providing a protective garment assembly selected from a coverall, a jumper, a vest, a jacket, a shirt, and a pantaloon, said protective garment having least two or more components selected from Group A, at least two or more components selected from Group B, and at least one component selected from Group C, wherein said Group A includes: a non-stretchable barrier fabric, a stretchable barrier fabric or film, a breathable or non-breathable material, impervious barrier or film-coated barrier, and a closure system to the garment; Group B includes the following fit-enhancing features: an elastomeric stretch panel, adjustable wrist wraps, adjustable ankle wraps, elastic wrist cuffs, elastic ankle cuffs, zipper that runs from a upper portion to a lower portion of said garment in a substantially obliquely or diagonal orientation across the general longitudinal configuration of the garment, a vertical zipper along either a front panel or side panel, adjustable closure around a portion of the torso, hook-and-loop style fastening system; and Group C includes: either a male or female gender specific cut of the garment, attached hood, multi-piece components, two-piece garment, single-piece garment, internal pockets, gusseted pockets, leg slit opening, detachable sleeves, detachable leggings, accordion pleats, bellow pleating situated

longitudinally or cross-directional on a back panel, reinforced elbow patches or pads, reinforced knee patches or pads, colored piping or indicator accent along a portion of the garment, a logo, word or symbol scheme; and providing instruction to a user for proper donning and doffing.

Alternatively, the invention relates to a method for providing a protective apparel system assembly, the method comprises: manufacturing or otherwise providing a protective article having a basic form selected from either a coverall, a jumper, a vest, a jacket, a shirt, or a pantaloon that is fabricated from either a nonwoven-based material, a non-stretchable barrier fabric, a stretchable barrier fabric or film, a breathable or non-breathable material, impervious barrier or film-coated barrier, and having a closure system to the garment, and at least two of the following sizing elements or fit-enhancing features: an elastomeric stretch panel, adjustable wrist wraps, adjustable ankle wraps, elastic wrist cuffs, elastic ankle cuffs, zipper that runs from a upper portion to a lower portion of said garment in a substantially obliquely or diagonal orientation across the general longitudinal configuration of the garment, a vertical zipper along either a front panel or side panel, adjustable closure around a portion of the torso, hook-and-loop style fastening system, or having optionally at least a one of the following: either a male or female gender specific cut of the garment, attached hood, multi-piece components, two-piece garment, single-piece garment, internal pockets, gusseted pockets, leg slit opening, detachable sleeves, detachable leggings, accordion pleats, bellow pleating situated longitudinally or cross-directional on a back panel, reinforced elbow patches or pads, reinforced knee patches or pads, colored piping or indicator accent along a portion of the garment, a logo or other word or symbol over a portion of an externally visible surface of the article, assemblying said garment articles together for either a multi-piece or single-piece, unitary suit.

In another feature, the present disposable protective apparel article may have a fastening means for securing the protective apparel article in a disposal configuration that encompasses folding extremities of said article toward a center portion of said apparel article in a manner such that wraps around upon itself. In other words, the garment can be self-stowing in a neat folded bundle either when new and ready to wear or after use and ready for disposal. The fastening means may include at least one or a combination of the following: an adhesive, a hook-and-loop fastener, a tether strap or tie, a snap or conventional button, a belt or latching element.

Additional features and advantages of the present invention will be revealed in the following detailed description. Both the foregoing summary and the following description and examples are merely representative of the invention, and are intended to provide an overview for understanding the invention as claimed.

BRIEF DESCRIPTION OF FIGURES

Figure 1 is a general over view of a number of disposable protective garment articles according to the present invention.

Figure 2 illustrates front and back views of a either a single-piece unitary coverall, or a two-piece protective apparel assembly that can be connected and sealed together to form a single unit suit adapted for a male user.

Figure 3 illustrates front and back views of either a single piece unitary coverall, or a two-piece protective apparel assembly like that shown in Figure 2, but adapted to better fit the body of a female user.

Figure 4 are two views of a pair of trouser pants and a complementary upper garment.

Figure 5 are another two views of protective upper garments worn with a pair of pants. Fig. 5A shows a shirt or jacket, and Fig. 5B shows a collared vest being worn over the shirt.

Figure 6 depicts front and back views of another embodiment of a unitary, single-piece coverall, which however appears to a casual observer to be at least a two-piece protective suit.

Figure 7 shows front and back views of another embodiment of the garment combination in Fig. 6, except that the elastomeric panel on the back now forms a T-shape with a yoke across the back of the wearer's shoulders.

Figure 8 shows a single-piece coverall with a seam diagonally oriented across the front torso. A contrast between the central part of the coverall and the shading along the flanks and inner arms can be used to signify different attributes or properties of the garment, as well as enhance the distinctive appearance of the wearer. Use of light or dark color combinations can either enhance visually or camouflage for a slimming effect the wearer's person. Alternatively, the difference in contrast can be due to a difference in material construction, where the panels along the flanks and inner arms are elastomeric, while the rest of the garment is a nonwoven-based fabric.

Figure 9 shows front and back views of another single-piece coverall with a collar and vertical closure. Fig. 9A shows a fold or pleat that extends longitudinally down the middle of the back of the upper garment, which permits the wearer to stretch and flex more comfortably, horizontally, left and right.

Figure 10 depicts another embodiment of the design of Fig. 9. Fig. 10A shows a rear view of an upper part of the garment, either as part of a coverall or in a jacket, having intersecting folds or pleats, which allows for both horizontal as well as vertical expansion, as when bending or flexing. In Fig. 10A, the waist of the back panel has a seam or band that is re-enforced with a stretchy elastomeric material, while the areas of the under arm, inner legs, inner thighs, and flanks of the torso also have an elastomeric panel or seam similar to that shown in Fig. 8.

Figure 11 illustrates front and back views of a unitary coverall having an attached hood, secured around the neckline. Fig. 11A shows a form fitting, elastomeric panel that extends from the top of the hood to the buttocks and hips. The wrist and ankle opens are gathered and secured by an elastic cuff.

Figure 12 shows two view of a jacket with a so-called "kimono-style" cut, in which one panel of the garment crosses over another and is secured along the slide or flank of the torso.

Figure 13 shows three combination embodiments of protective garments.

Figure 14 depicts male and female-adapted jumper suits.

Figure 15 shows a female-adapted unitary jumper suit with closure flap and fasteners that are selectable, gender specific, right-over-left oriented along a front panel of the suit.

Figure 16 shows a male-adapted unitary jumper suit with the closure flap oriented left over right along a front portion.

DETAILED DESCRIPTION OF THE INVENTION

Section I - Definitions

As used herein, the term "nonwoven-based material" or "nonwoven web" refers to a material or web that has a structure of individual fibers or filaments which are interlaid, but not in an identifiable repeating manner. Nonwoven webs have been, in the past, formed by a variety of processes known to those skilled in the art such as, for example, meltblowing, spunbonding and bonded carded web processes.

As used herein, the term "spunbonded web" refers to a web of small diameter fibers and/or filaments which are formed by extruding a molten thermoplastic material as filaments from a plurality of fine, usually circular, capillaries in a spinnerette with the diameter of the extruded filaments then being rapidly reduced, for example, by non-eductive or eductive fluid-drawing or other well known spunbonding mechanisms. The production of spunbonded nonwoven webs is illustrated in patents such as Appel, et al., U.S. Patent No. 4,340,563; Dorschner et al., U.S. Patent No. 3,692,618; Kinney, U.S. Patent Nos. 3,338,992 and 3,341,394; Levy, U.S. Patent No. 3,276,944; Peterson, U.S. Patent No. 3,502,538; Hartman, U.S. Patent No. 3,502,763; Dobo et al., U.S. Patent No. 3,542,615; and Harmon, Canadian Patent No. 803,714.

As used herein, the term "meltblown fibers" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high-velocity gas (e.g. air) stream which attenuates the filaments of molten thermoplastic material to reduce their diameters, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high-velocity gas stream and are deposited on a collecting surface to form a web of randomly disbursed meltblown fibers. The meltblown process is well-known and is described in various patents and publications, including NRL Report 4364, "Manufacture of Super-Fine Organic Fibers" by V.A. Wendt, E.L. Boone, and C.D. Fluharty; NRL Report 5265, "An Improved device for the Formation of Super-Fine Thermoplastic Fibers" by K.D. Lawrence, R.T. Lukas, and J.A. Young; and U.S. Patent No. 3,849,241, issued November 19, 1974, to Buntin, et al.

As used herein, the term "microfibers" means small diameter fibers having an average diameter not greater than about 100 microns, for example, having a diameter of from about 0.5 microns to about 50 microns, more specifically microfibers may also have an average diameter of from about 1 micron to about 20 microns. Microfibers having an average diameter of about 3 microns or less are commonly referred to as ultra-fine microfibers. A

description of an exemplary process of making ultra-fine microfibers may be found in, for example, U.S. Patent No. 5,213,881, entitled "A Nonwoven Web With Improved Barrier Properties," incorporated herein by reference in its entirety.

As used herein, the term "sheet" refers to a material that may be a film, nonwoven web, woven fabric or knit fabric.

As used herein, the term "disposable" is not limited to single use articles but also refers to articles that can be discarded if they become soiled or otherwise unusable after only a few uses.

As used herein, the term "machine direction" refers to the planar dimension of a nonwoven fibrous web which is in the direction of travel of the forming surface onto which fibers are deposited during formation of the web.

As used herein, the term "cross-machine direction" refers to the planar dimension of a nonwoven fibrous web which is in the direction that is perpendicular to the machine direction defined above.

As used herein, the term "liquid resistant" refers to material having a hydrostatic head of at least about 25 centimeters as determined in accordance with the standard hydrostatic pressure test AATCCTM No. 1998 with the following exceptions: (1) the samples are larger than usual and are mounted in a stretching frame that clamps onto the cross-machine direction ends of the sample, such that the samples may be tested under a variety of stretch conditions (e.g., 10%, 20%, 30%, 40% stretch); and (2) the samples are supported underneath by a wire mesh to prevent the sample from sagging under the weight of the column of water.

As used herein, the term "breathable" refers to material having a Frazier porosity of at least about 25 cubic feet per minute per square foot (cfm/ft^2). For example, the Frazier porosity of a breathable material may be from about 25 to more than 45 cfm/ft^2. The Frazier porosity is determined utilizing a Frazier Air Permeability Tester available from the Frazier Precision Instrument Company. The Frazier porosity is measured in accordance with Federal Test Method 5450, Standard No. 191A, except that the sample size is 8" X 8" instead of 7" X 7".

As used herein, the term "particle resistant" refers to a fabric having a useful level of resistance to penetration by particulates. Resistance to penetration by particulates may be measured by determining the air filter retention of dry particles and can be expressed as particle holdout efficiency. More specifically, particle hold-out efficiency refers to the efficiency of a material at preventing the passage of particles of a certain size range

through the material. Particle holdout efficiency may be measured by determining the air filter retention of dry particles utilizing tests such as, for example, IBR Test Method No. E-217, Revision G (1/15/91) performed by InterBasic Resources, Inc. of Grass Lake, Michigan. Generally speaking, a high particle holdout efficiency is desirable for barrier materials/fabrics. Desirably, a particle resistant material should have a particle hold-out efficiency of at least about 40 percent for particles having a diameter greater than about 0.1 micron. LMS Labs are used to substantiate claims made in catalog. The apparel catalog references air permeability ASTM D737 and Moisture Vapor Transport Rate ASTM E96 as methods related to comfort properties.

As used herein, the term "coverall" refers to a relatively loose fitting, one-piece, protective garment that can be worn over other articles of clothing and protects substantial areas of a wearer's body, typically, from the neck region over the trunk of the body and out to the ends of extremities, such as a wearer's wrists and ankles, which sometimes may include the hands and feet. In some embodiment, the garment may include an attached head cover, such as a hood, or sometimes integrated gloves and socks, boots, or other footwear.

As used herein, the term "jumper" refers to a sleeveless protective garment that leaves a wearer's upper shoulder and arms exposed, but covers a substantial portion of the torso, midriff and legs of the wearer's body.

As used herein, the term "jacket" refers to a short coat or garment that extends usually to the waist or hips, which has typically a collar, sleeves, and a front or side opening.

As used herein, the term "shirt" or "blouse" refers to a close-fitting garment for the upper portion of the human body. It typically may or may not have an open collar, sleeves, and has either a front or side opening, or no opening such as a T-shirt. In the present invention, a shirt typically is worn in closer proximity to the body, under a jacket.

As used herein, the term "pantaloon" or "pants" refers to relatively tight-fitting trousers that extending from waist to ankles and covers the lower portion of the human body, including the lower abdomen, buttocks, thighs, and legs.

As used herein, the term "vest" refers to a short sleeveless garment, either open or fastened in the front or side, worn over a shirt or blouse and often under a jacket.

As used herein, the term "polymer" generally includes, but is not limited to, homopolymers, copolymers, such as, for example, block, graft, random and alternating copolymers, terpolymers, etc. and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" shall include all possible geometrical

configurations of the material. These configurations include, but are not limited to, isotactic, syndiotactic and random symmetries.

As used herein, the term "consisting essentially of" does not exclude the presence of additional materials which do not significantly affect the desired characteristics of a given composition or product. Exemplary materials of this sort would include, without limitation, pigments, antioxidants, stabilizers, surfactants, waxes, flow promoters, particulates or materials added to enhance ability to process of a composition.

Section II - Description

Disposable protective apparel, such as used in various industrial or healthcare environments, often tend not to fit well against all areas of a wearer's body. Given that the materials commonly used to fabricate disposable apparel are not stretchy or flexible, to accommodate for movement, current coverall designs, for example, tend to be larger in the waist and torso regions. This excess material results in baggy, bulky, and uncomfortable garments that can get in the way as the wearer does work. Some wearers use tape to gather excess material and hold it closer to the body. This type of action to compensate for poor body fit is not only time consuming, especially if the worker needs to change or wear several garment articles during the day, but on an aesthetic level not flattering to the wearer, which makes the protective garment appear slovenly. Moreover, the excess material may form folds, creases or other configurations that are readily caught against machinery or torn by obstructions; a feature that is not only poor fitting but potentially dangerous. An aspect of the present invention involves developing a flexible and form-fitting garment or garment assembly that includes a variety of elements or means for the wearer to gather and adjust the fit about the body, around either the chest, waist, arms, wrists, legs, or ankles.

The present invention pertains to a combination of various distinctive style and functional elements that are integrated in a disposable, nonwoven-based protective garment or assembly of multiple component pieces that can be customized for each user and provides for the user a particular level of protection, comfort and fit, as well as appearance that makes the protective garments distinctive to wear. To that effect, the present invention relates to a disposable, protective article designed to be worn over at least a portion of a user's body comprising: a nonwoven web sheet, and optionally at least a film, woven fabric, knit fabric, or elastomeric material extending over a portion of the article,

comprising an externally visible surface comprising an imparted color, symbol, logo, or word scheme, a cinching or mechanical device for closing adjacent panels of the article, and elements adapted to fit the user's body and impart a clean, comfortable, professional appearance when worn. Moreover, there is an emotional benefit of "looking good, feeling good," to the wearer. A better fit will provide a level of confidence in the wearer, making them feel more of being an autonomous individual.

The present invention also relates to a method of providing disposable protective apparel with a distinctive appearance and promoting a professional aesthetic or emotive response in a user. The protective apparel may comprise a variety of symbols, words, or logo provides graphical or color-based indicia, which conveys information to the user about the properties, nature or origin of the protective garment.

A.

Currently available commercial, disposable protective apparel are generally made from non-stretchable nonwoven-based materials or fabrics. To accommodate a range of physical movements, manufacturers of protective garments generally have to make the garment larger than the size that one would normally wear if the materials had some flexibility or stretchiness, hence increase the overall size of the garment and requiring the use of an excess amount of material. This results in baggy, bulky, and uncomfortable garments that do not fit well. To alleviate this situation, and to provide a better, tighter fitting protective garment, panels of elastomeric materials (e.g., Spandex or elastane) are incorporated at strategic placed on a garment, such as the back, shoulders, and sides of the torso, the hips and upper thighs, groin region, or combinations thereof to provide more flexibility for the wearer. The elastomeric material enables the garments to fit different body types and sizes because of the recoverable stretch of the materials.

Further these kinds of disposable apparel offer limited separate garment configurations for users who desire only limited protection. Separate disposable multi-piece, protective garments allow the user to select garments as needed and to mix and match the individual apparel components based on size, comfort, or level of protection for the task or work environment (i.e., dirtiness, climate) such as air-permeation, breathability, or liquid barrier properties. For instance, one may need to use a large-sized upper shirt or vest with heightened fine-particulate barrier properties and a medium-sized lower pant with medium barrier properties. A multi-piece protective garment offering provides the option

to customize the fit of the garments to specific body shapes and sizes. A protective garment that is better fitting reduces the opportunity for the garment to snag or get caught in equipment and machinery, as well as, gives the wearer a more polished, professional look. The individual garments may also be in different colors, indicating different levels of protection, work departments, or for style only. In addition to having an adequate barrier protection, users will have a sense of individuality and desirable appearance that may make them more likely to wear the protective apparel. Finding the garment visually and functionally desirable, wearers are more likely to don the garment articles to drive safety compliance in workplace or hazards-handing situations.

Several kinds of work areas or industries may benefit from the modifications described herein may include healthcare, home improvement do-it-yourself, chemical, industrial, sanitation, or even clean-room applications.

According to the present invention, a limited-use, preferably disposable, non-laundered protective article having elastomeric stretchable panels at particular stress points on the human body is provided. The garment can be made from a material with barrier properties to dust and microparticulates (e.g., ranging in size from about 0.05-0.10 microns or larger (see, e.g., U.S. Patent No. 5,491,753, (cols. 21-22, Tables 7 & 8) incorporated herein by reference)) or light-splash fluids. Meltblown or SMS fabrics may also be electret treated to generate a localized electrostatic charge within the fibers of the nonwoven web (e.g., U.S. Patent 5,401,446 to Tsai *et al.*). In certain preferred embodiments, the garment is breathable. In an embodiment, one may incorporated an elastomeric back panel, such as across the shoulders and along the spine for bending, or with a substantially angled, trapezoidal, triangular, or -V-shaped configuration which permits a wearer to more easily flex his upper torso, arms and shoulders, when bending forward or laterally along longitudinal directions.

Elastomeric materials are placed at the regions of the body that typically experience stress from stretching or flexing. This eliminates the need for oversized garments, since the elastomeric materials allow one to move easily, without feeling confined, in a suit made from conventional non-stretchable materials, and allows for a better, more body-conforming fit. The elastomeric materials have one to two directional stretch properties. To make the garment fit a wearer better without restricting movement, panels of elastomeric material are incorporated into the garment at a location that can be stressed during movement, such as the waist, torso, back of the shoulders, arms, elbows, knees and

buttocks. Additionally, the elastomeric panels can be shaped or colored to add style element to the garment. Elastomeric panels can help reduce the total number of garment sizes needed to fit the range of user body sizes. For instance, currently 6 or 7 discrete individual sizes (e.g., S, M, L, XL, 2XL, 3XL, etc.) are needed. With elastomeric panels, for example, for coveralls, a fewer number of different apparel articles, about 4, can be offered. Each apparel article can be adjusted to serve what was formerly a range of sizes (e.g., S-M, M-L, XL-2XL, 3XL-4XL). Moreover, without the needs for overly large, baggy garments, manufacturers can save on the amount of material needed to produce each garment, reduce fabric costs through reducing the range of different kinds of garment offerings that would be needed to be maintained in inventory and reduced cost to manufacture.

A band of elastomeric material around the waist in a unitary garment, such as a one-piece coverall or jumpsuit can help draw-in, tighten, and define a waist region for a more contouring or form-fitting accent to the body. This feature permits a wearer to bend, stretch and flex in 360 degrees, without restriction or pulling, or the bulky inconvenience of excess material bunching along the sides. On separate garment pieces, the waist of a pant or the bottom hem of a shirt or jacket may also have the elastomeric band for the same function.

In the waist region of the garment, the elastomeric panel may be of various widths and have different stretch properties. The panel(s) in the waist enhances the fit of the garment in the middle region of the wearer's body. A disposable belt made from a nonwoven laminates, such as spunbond-meltblown-spunbond (SMS), or an elastomeric material can be used to cinch the waist of the coverall. According to an embodiment, the belt would be permanently attached to the garment. If untied, the belt does not provide cinching, allowing the garment to be loose fitting at the waist. Alternatively, in another embodiment, the belt may be of various widths depending on the need of breath. Methods such as hook-and-loop fasteners (e.g., VELCRO™), adhesive, and snaps may be used to secure the belt in place. The belt may be modified to include at least one or more permanently suspended storage pouches. Alternatively the pouches can be detached and exchanged with others. The belt may have a symbol, word, color, or other indicia for communication purposes to show, for instance, size, level of protection, or branding. A drawstring and toggle mechanism can be used to gather the excess material of the coverall. The drawstring is enclosed in the material of the garment. The toggle device is easily

accessible by the wearer for quick adjustment and release. Another solution is to incorporate bellowed material at the waist. The excess material at the waist is pleated. The bellowed material opens out when needed and contract back into pleats when not used. In another embodiment, one may have an elastomeric panel down the center of a back panel of a jacket or shirt, stopping at the waist of the garment or extending further down to the buttock area. The elastomeric panels in the back of the garment may be shaped for functional enhancement and styling. Depending on the designed stretch and design, one can configure the elastomeric panel as a yoke cross the shoulders or in V-like, T-like, or hour-glass-like shapes down the back. Wearers often use the same protective garment(s), which they may don or doff several times a day for reasons such as breaks, changing tasks, or to cool off. One flexible feature involves incorporating an obliquely oriented opening with an associated mechanical closure device, such as a zipper or hook-and-loop fastening system, across the front torso region of the garment, instead of a conventional vertical opening for entry into the garment. For example, the zipper can start at the shoulder and proceed diagonally across the torso down to the upper thigh region. This allows the torso of the garment to be opened wide. An angled zipper that starts away from the neck of the wearer is less irritating. The zipper may have a flap covering it. The flap may secured by a variety of fasteners, such as VELCRO brand fastening systems, snap buttons, toggles, or even adhesive tapes.

Colors, symbols, words, or logos may be employed used to communication purposes, such the relative level of protection, or to provide distinctive appearance as a style element. Colors may be applied to the material of the entire apparel, individual garment components, or as fabric piping along seams, around pockets or leggings, or in distinctive patterns. A logo denoting branding or level of protection can be located on the side of the pant leg, or near the waist band. Each article has a mechanical means, such as a zipper, of closing with or connecting to another garment to create a barrier seal. Color may be added to the mechanical closure, such as a zipper, for communication and appearance purposes.

Typically protective upper garments take the form of long-sleeved shirts or jackets. Various embodiments are illustrated in the accompanying figures. Fig. 1A is an embodiment of a generic upper garment, such as a jacket or shirt, having long sleeves and gathered cuffs, a vertically oriented closure system. Fig. 2A is a sleeve-less vest having a stand-up collar. Fig. 1C is a long-sleeve jacket or shirt having multiple relatively large

gusseted pockets with cover flaps situated on the lower front panels of the garment. Alternatively, not shown, pockets also may be placed at chest-level, or the shirt and jacket can be without any pockets. Fig. 2D is short-sleeve shirt. Protective lower garment, such as shown in Fig. 2E, is a pair of trouser pants that may be used with any of the upper garment articles in the foregoing figures. The trousers have a pair of gusseted "cargo-style" pockets on either side of the upper thigh, a wide elastomeric waist band, and a slit along the lower leg adapted for better fit over foot wear, or which can be gathered and secured together for a tight leg cuff.

In certain embodiments, the upper garment can be either a long-sleeve or short-sleeve shirt, with closure mechanism, such as elastic gathered cuff at the wrist (for long sleeve) or upper arm (short sleeve), neck, and/or waist for better barrier protection. One may employ a hook-and-loop fastening system for wrap around features. The hook can be located on the front piece and loop is the rest of the material itself, hence attach anywhere on the garment facing. Adjustable closures that can be attached by hook-and-loop closure, tape, buckle, snap buttons to provide a more contoured or tighter fit against the user's torso when cinching the garment. In certain embodiments, the garment may have no collars, Figure 1A, while some have a distinctive high-collar with a similar fastening feature cross the neck or throat. An upper garment in the form of a jacket or shirt, having front and back panels, can be designed with a high-collar, mandarin-style collar, such as shown in Figure 1B and 1C. Alternatively, the upper garment can have no-collar in a so-called "kimono"-style cut, in which the front panel is fastened under the arm of the wearer and secured along the side of the upper front torso, such as shown in Figures 12 and 13. The collar can be contiguous with a front panel. The kimono-style cut crosses or overlaps two front sections or panels of the garment to form a V-neck.

According to certain embodiment, the garment can have detachable sleeves. Alternatively, the sleeves or pant legs can be in a different color from the rest of the garment so as to indicate that the sleeves or pant legs are made from a second material, having protective or other physical properties different from the materials of the main body of the garment.

A short sleeve shirt may have a method of closing such as elastic or other means, at the arms, neck, or waist to provide barrier protection. Pockets may be situated on the front panels of the garment above the chest. These pockets may have securable cover flaps or may be left open. The long sleeve shirt may have a method of closing such as elastic,

wraps, or other means, at the arms, neck, or waist to provide barrier protection. The sleeves are designed to appear layered (long sleeve under short sleeve shirt). The arms of the shirt may be detachable by means of such as, hook-and-loop system, perforations, zipper, or tape. In a vest, jacket or shirt, the front panel(s) incorporates a mechanical closure, such as a zipper, snap buttons, VELCRO brand fasteners, buckle, or other means that can be opened to don or doff and then reclosed easily. For any of the upper body garments, a logo denoting branding or level of protection can be located on the garment, possibly on a sleeve, at a shoulder, back, or chest.

Each garment article has a means for connecting or fastening (e.g., zipper and flap, adhesive strip) to another garment to create a barrier seal. Pants may have a cinching mechanism in the waist such as, a wide elastic band, or draw string and toggle, or pleats and VELCRO™, to help keep the pants up and snug in the wearer's waist area. The legs of pants may have a closure device or method of closing such as, elastic or wraps, or other means to provide barrier protection. Also illustrated are garments that may have gusseted pockets in the fashion of so-called "cargo-style" pockets located on each side of the upper thigh region, which can provide a convenient place to keep lightweight items, as shown in Figures 1-5, either on pants, jumpers, or jackets. According to certain embodiments, the pockets can be either on the inside or outside of the protective garment. When on the inside, there is a slit opening for access from the outside and the pocket body is formed from a pouch that can be sewn to inner surface of the garment fabric. A gusseted, cargo-style pocket can be sewn directly to the outside surface of the garment. These cargo pockets typically for ease of access and manufacture are attached to the outside of the underlying garment panel, but in certain uses it may be desired to have the pockets place inside the garment so as to have a smooth, uninterrupted look from the outside. In the first case, when the pocket is situated on the outside, the pocket sticks out away from the garment like a bag and may either have a flap to cover and the opening of the pocket or the upper pocket could be left open.

The protective article, according to an embodiment as shown in Figures 2 and 3, has comfort stretch panels arranged along each side of the torso portion of the garment. The panels of stretch material enhance the overall comfort, fit, and conformance of the garment to the wearer's body. Positioning of stretchable fabric material at flexed or stressed areas of the garment provides the elasticity and flexibility for movement. The stretch material accommodates different body shapes, and minimizes the amount of loose fabric in the

garment. The shape of the stretch panels, for instance can be tailored to offer a selectable, gender specific garment option. For instance, garments designed for women may have larger or longer stretch fabric patches that extend from the underarm region to her upper hips and thighs; while, in contrast for men, the stretchable fabric may stop at his waist. Garments made specifically for men and women fit better and have a neat, professional appearance. Wearers are more likely to wear garments that make them feel and look good.

Elastomeric cinches at the wrists and ankles fit comfortably against skin, and provide barrier protection. Mechanical closure devices, such as a standard zipper for barrier protection, can facilitate getting in and out of the garment.

According to certain other embodiments, as depicted in Figures 6 and 7, the garment articles can include comfort stretch panels in the area of the waist and back. The panels have a stretchable material that provides a comfortable fit and conformance in the garment. The elasticity of the material provides flexibility for movement and can accommodate different body shapes, minimizing the amount of loose fabric in the garment. The stretch material accommodates different body shapes, and provides flexibility for movement.

To afford the wearer greater flexibility and comfort, while reducing the overall amount of material used for the garment, comfort stretch panels care situated in waist and back areas of the protective article. The panels of stretch material provide a comfortable fit and conformance in the garment. The elasticity of the material provides flexibility for movement. The stretch material accommodates different body shapes, and minimizes the amount of loose fabric in the garment. The stretch material accommodates different body shapes, and provides flexibility for movement. Elastic wrists and ankles fit comfortably against skin, and provide barrier protection. In Figure 8 an obliquely oriented zipper provides additional area for ease of getting in and out of the garment. A slit or side opening along the lower pant leg provides for ease to get garments over shoes. The opening can either have no closure, or it may be secured closed with a fastening attachment, such as a hook, hook and loop system, adhesive tape, zipper, button or buckle.

The present designs may include various elements that provide better fit and seal, which allow the wearer to either tighten or loosen the sleeve cuffs or plant legs of the garment. For instance, wrist and ankle wraps or straps provide a convenient way to achieve barrier seals when needed. Sealed barrier protection is provided when the wraps are pulled and secured in place with a fastener. The wraps can work a wide range of limb

sizes, which allows a manufacturer to minimize their overall inventory selection. For instance, there is no longer a need to manufacture garments with and without elastic wrists and ankles.

Another feature of the present garments includes an adjustable front closure that allows wearers to customize the fit of the garment. The front closure tabs may be adjusted for a tighter, more defined, or closer fit, and secured in place with a variety of fastening attachments, such as hooks, hook and loop system, adhesive tapes, tie-backs, buckles, buttons or snaps. Elastic cuffs at the wrists and ankles provide a good basic level of closure, but these features can be enhanced with adjustable strips or wraps that can be drawn across the sleeve or pant leg and tightened for an even better barrier closure.

Separate garments can be worn alone or layered together for customized protection. This concept provides versatility in size selection and comfort for the wearer. The individual apparel articles may include elements that have already been described. In another embodiment, one may assemble a single-piece unitary protective suit from two or more separate pieces of upper and lower protective garment components, which can be connected at the waist by either a band of a hook-and-loop system, a substantially horizontally oriented zipper, or other mechanical or adhesive chemical fastening or closure means at the hem of the upper garment and waist of the lower garment. For instance, the upper and lower garments, such as a shirt or jacket and pants, can be fasten to each other with the upper garment slightly overlapping the lower garment, and connected with a single zipper around the waist, and another zipper that connects the jacket to the pant. An elastomeric panel may also connect the upper and lower garments, or each garment may have individual elastomeric panels that can complement and overlap with each other. These elastomeric panels may be situated either on the flanks of the torso and hips or around the waist, or both. Alternatively, one can make a unitary protective garment appear like two or more garment articles.

Rounded strips of cloth used for trimming the garments (i.e., piping) can be color coordinated to provide visual accents or communicates the level of protection and/or branding for the garments. Colored piping or elastomeric material also can either line or outline the various closure openings and seams of the garments, which may contribute to the visual illusion of wearing two or more pieces of protective apparel when there is in reality only a single, unitary garment, such as in Figures 6 and 7. Sometimes the protection that a unitary protective garment provides is more desired than that of a two-piece suit; for

instance, to prevent liquid or dust particulate seepage under the interface between two garment articles. A seam, belt, or distinctive elastomeric hem around the waist or hips can appear to divide the garment into upper and lower portions and generates an illusion of two-piece protective apparel. The upper portion of the garment can be larger, allowing for a slight over hang of the upper portion over or above the lower portion of the coverall. In other words, the upper portion billows slightly and drapes over the lower portion of the garment. In the iteration of Fig. 6A, the upper portion of the garment has a vertically oriented elastomeric panel that extends from the neck region down the middle of the back to the waist region and may connect with a horizontally oriented elastic band around the bottom of the upper garment and upper hip region. In Fig. 6B, the upper garment had a relatively high collar with a buttoned, toggled, or tabbed closure, as well as a series of similar tabbed closures along the front of the jacket. In both Figs. 6a and 6B the sleeves can be made of a kind of material different from the rest of the garment for extra protection, or they may be detachable at the upper arms. A strap or cinching wrap is located at the wrist and ankles, which can be tightened for a better fit or barrier.

Single piece protective garments, such as jumpers or coverall, either with or without hoods, are shown in accompanying Figures 8-11 and 14. To provide ease of getting in and out of the garment, an obliquely or diagonally placed mechanical closure system, such as a standard zipper, is incorporated. A diagonal opening design permits one to have an access opening that is wider and larger, for instance, in a unitary protective suit, such as in Figure 8, than conventional designs allow. Conventional zipper openings are oriented usually vertically either on the back or front panels of a garment article. Ordinarily, a wearer needs to slip one half of his body into the suite and then pivot to insert his other shoulder and torso into the suit. In contrast, the diagonal opening can extend from one side of a shoulder or neck collar, across the front of the garment and chest of the wearer, either to mid-torso, the hip, or even as far as mid-thigh on the opposite side, such as from left to right or vise versa. Such a design opens up the confines of the torso region of the garment. Hence, a user can more easily slip into the protective suit, without having to slip his arm and shoulders into the suit through a narrow opening that may resist his access to the sleeves and shoulder areas of the garment. The zipper can be left exposed or have a cover flap for enhanced barrier protection.

In Figures 9 and 10, the garments are unitary suits with reinforced elbow and knee-pads provide added protection and durability. These pads or patches can be made from a

variety of suitable materials, such as nonwoven webs of the same material as the body of the garment, or leather, simulated leatherette, woven or knitted fabrics, or elastomeric or rubber-like coatings. Also, elastomeric material sections or panels can be incorporated in areas of the garment under the arms, along the inner thighs, inner lower leg, or flanks of the torso. As shown, in Figures 9 and 10, one or more folds or pleats in the back panel provide additional material for flexible movement. It is envisioned that the pleats can be fabricated in a variety of ways. For instance, one way may be to cut the back panel of the garment and then attach a pre-sewn piece of pleated material inside the area of the cut opening. A second way may be to sew stretchable additional pleat material directly to the back panel. Elastic-gathered wrists and ankle openings fit comfortably against skin, and provide barrier protection.

According to an aspect of the present invention, the protective apparel incorporates functional features which make donning or doffing easier. Wearers of protective apparel, such as coveralls, vests or pants, can experience difficulty donning and doffing the apparel because of the limited size of either the opening to the apparel or the garment itself, which inhibits the wearer's entry room. The act of putting on or taking off protective gear can be even more difficult to execute when the wearer has a broad physique or wearers safety boots or shoes. Conventionally, the wearer must first squeeze into the garment opening, slide his legs into the pant portion and then swivel his shoulders to first insert one arm and then the other into the sleeves. Another feature includes widening the pant legs with openings or slits along the side of each lower leg to afford a better fit over bulky foot wear.

All of the components can be worn together or in combination for a layered protection. For instance, a shirt may be worn over and/or in direct contact with the user's body, such as a T-shirt style embodiment. A jacket or vest can then be worn over the shirt if additional levels of protection are desired. Another feature is a two-piece garment configuration that has a wrap-around shirt and pant bottoms. Having two separate pieces of apparel does not require the entire garment to be removed. The wearer may remove just the pants or shirt, or both as needed. One method of wrapping the top is to thread straps attached to the garment through a slit at the waist of the garment, wrap the straps around the waist, and tie the straps together to secure the garment in place. Wrapping the material around provides a double layer of material in the front for added protection. Another method for wrapping the top is the tuck material from one side around the wearer and wrap the outer material in the opposite direction, securing it using mechanisms such as tape,

VELCRO brand fastening systems, snaps or straps. A slit on the outer sides of the pant legs that is closed with reusable methods such as a zipper, VELCRO brand fastening systems, or tape provides more room for wearers to push their feet through the legs of the garment. The pant leg may have may have additional material in the slit. The material may be a different color for distinctive appearance or brand awareness.

Figure 12A shows two rectilinear patches on the front of the jacket, and a wide band across the bottom hem of the jacket. Figure 12B shows the bottom hem of the jacket flipped and folded up, such that the band at the bottom hem is turned inward toward the two rectilinear patches. The patches and wide band can be adhesive strips or complementary elements of a hook-and-loop fastening system. This feature allows the wearer to adjust the length of the upper garment to fit the wearer's body length, and may also create a convenient temporary pocket above the abdomen region.

Fig. 13A shows a pant with a cinching mechanism, such as a drawstring and toggle, and two fastening patches, one on either side of a vertical midline, which may use either a chemical adhesive or a hook-and-loop fastening system to adhere the hem of the garment to either itself or another garment article, such as pants. Fig. 13B shows the pant of Fig. 13A combined with the jacket of Fig. 12. Fig. 13C shows a variation of Fig. 13B.

The protective apparel envisions in certain embodiments either gender-specific or gender-neutral variations. Figures 1F and 1G, respectively, are female and male-adapted versions of jumpers, and Figures 14A and B shows these jumpers with shirts. For instance, for female-adapted embodiments the garments may have a contoured bodice and fuller cut or more stretch in hip and thigh regions. In coveralls or jumpers, the garment may be cut in a specific manner to adapt for gender specific or neutral design as the user may choose to wear. For instance, as in Figure 1F, the garment waist may have a gathered high bodice, that is cut higher (a so-called empire-style bodice) for female wearers, or a regular, more squarish cut for males. The straps on a jumper can be angled for a comfortable fit and adjustable to fit different torso lengths or breadth. A zipper can be located in the front or on the side of the garment to aide with donning/doffing. Zippers along the side of the pant leg can widen the leg cuff opening for easier donning/doffing of the garment. The sleeves may have a method of closing such as elastic, wraps, zipper or other means, at the arms, neck, or waist to provide barrier protection. The closure at the waist is also a means of connecting the garment to another garment (e.g., overalls, pants) for barrier seal.

Extra flaps or strips of material at the waist, wrist, or ankles hand help the user tighten these areas for a better and more secure fit which can better accommodate gloves or foot wear, such as boots or overshoes. These flaps can be secured by a hook and loop system, a buckle, buttons or snaps, or any other suitable garment fastener. In another embodiment of the upper garment, the jacket or shirt has an extra flap of material that wraps over or around the front of the torso, similar to a robe closure. The extra flap can provide extra layer of protection to the front of the wearer's torso once the garment is closed.

Workers often cover their head or hold back their hair with disposable bouffant caps, hoods, baseball caps with cotton jersey cloth, or bandanas. The cotton jersey cloth hangs down from the cap over the neck onto the shoulders and provides protection to the back of the neck. For the development of an integrated hood with a coverall, the elastomeric panel may extend up the back to the back of the head. The panels in the back of the garment provide flexible motion, as well as enhance fit in the waist and torso area. On the flanks or outer sides, elastomeric panels that extend from the wrist, along the underarm, and down the outer sides of the garment helps reduce bulkiness of the garment without restricting the movement of the wearer. The panel may stop at the waist, extend down to cover the knees, or extend down the legs. These panels may have different shapes or textures to denote gender. Another solution is to have a portion of the torso of a garment made from elastomeric materials. The elastomeric panel covering the entire torso of the garment, starts at the upper chest area and ends at or below the waist. In other iterations, only the side panels of the torso may be elastomeric panels. The side panels may have different shapes also to denote gender. For example, a so-called "princess" cut panel that extends just below the waist over the region of the upper hips may denotes females and the panel that stops square at the waist may denote males. Elastomeric panels in the upper torso region will improve the fit of the garment on the wearer as well as add style to the garment.

In certain embodiments, paired fasteners on either side of the opening allow a wearer of either gender to select for their desired gender-specific orientation of the closure flap. As shown in Figures 15 and 16, left or right flap orientation will be determined by the gender of the wearer, in which male-adapted closures open to the right with left panel over right panel, while female-adapted closures are the reverse. In other embodiments, not illustrated, the closure system may have a series of fasteners that are arranged in two or

more parallel columns down the front portion of the garment, on either side of a centerline or front opening, much like a double breasted fashion. Fastening elements, such as hooks-and-loops, snaps, toggles, or other conventional buttons with their counterpart loops or eyelets can be arranged in either parallel or staggered columns (up and down) or rows (lateral across), spaced progressively farther away from the centerline or opening of the garment. One can have two, four (two on each side), or six (three on each side) parallel columns.

Furthermore, the closure flaps can be adjusted to accommodate a person's either larger or smaller girth around the torso. In other words, the closure can be either tightened for a slimmer fit or loosened for a fuller, wider fit. For example, for a tighter fit, the front panel can be pulled to a fastener in a column farther removed from the centerline opening. When this is done, a panel on one side of the garment front will overlap and cover columns or rows of fastening elements that are not used. For a looser fit, more columns or rows of fasteners may be left exposed. Alternatively, an entire face of a front panel one either side of the centerline can be either adhesive to the counterpart panel surface or be susceptible to securing with a hook-and-loop style fastener.

Another embodiment may have a pleated or bellowed area situated in the back panel of an upper garment, such as a jacket or vest, in the shape of a cross-like four pointed star, or alternatively a six or eight pointed star. This kind of configuration allows the upper garment to stretch horizontally sideways as well as vertically up and down, with the movement of the wearer.

Another benefit of these features provides the user with not only protection, but also with an aesthetic sense of professionalism, cleanliness that contributes to an overall sharp, positive appearance, and other similar emotive feelings, which induces in the wearer a motivation to want to wearer the protective garments. These emotive feelings will improve the wearer's compliance and willingness to don a full complement of protective garments.

B.

According to the present invention, in certain embodiments, all materials used in the protective garments have barrier properties that meet industrial standards for their respective designated level of protection. Conventionally, many fabrics used to make protective apparel are actually modified versions of materials also used in packaging and house wrap. It is not surprising that workers find apparel made from such materials hot

and uncomfortable. The material used to form the garment may be selected from a bonded carded web, a web of spunbonded fibers, a web of meltblown fibers, and a film and combinations of the same. The material may be formed from a polymer selected from polyamides, polyolefins, polyesters, polyvinyl alcohols, polyurethanes, polyvinyl chlorides, polyfluorocarbons, polystyrenes, caprolactams, copolymers of ethylene and at least one vinyl monomer, copolymers of ethylene and n-butyl acrylate, and cellulosic and acrylic resins, and mixtures and blends of the same. If the seamless sheet of material is a polyolefin, it may be selected from polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers.

The material used to form the garment may be a laminate. For example, the material may be a laminate of two or more nonwoven webs. As a further example, the material may be a laminate of at least one web of spunbonded fibers and at least one web of meltblown fibers and mixtures thereof. The material may also be a laminate composed of at least one nonwoven web and at least one film layer. Generally speaking, the film layer may range in thickness from about 0.25 mil to about 5.0 mil. For example, the film will have a thickness ranging from about 0.5 mil to about 3.0 mil. Desirably, the film will have a thickness ranging from about 1.0 mil to about 2.5 mil.

Exemplary film layers include films formed from polymers which may include polyamides, polyolefins, polyesters, polyvinyl alcohols, polyurethanes, polyvinyl chlorides, polyfluorocarbons, polystyrenes, caprolactams, copolymers of ethylene and at least one vinyl monomer, copolymers of ethylene and n-butyl acrylate, and cellulosic and acrylic resins. If the film layer is made of a polyolefin, the polyolefin may be polyethylene, polypropylene, polybutene, ethylene copolymers, propylene copolymers and butene copolymers and blends of the above.

According to the invention, the material may have a basis weight ranging from about 15 gsm (i.e., grams per square meter) to about 300 gsm. Desirably, the material may have a basis weight ranging from about 20 gsm to about 75 gsm.

In some embodiments, the material may be made from high-density polyethylene fibers, such as Dupont Tyvek® brand protective material or various forms of calendared nonwoven materials. For instance, Dupont Tyvek® brand protective material offers all the best characteristics of paper, film and fabric in one material. This unique balance of properties, which cannot be found in any other material, makes Tyvek® lightweight yet strong; vapor-permeable, yet water-, chemical-, puncture-, tear- and abrasion-resistant.

Tyvek® is also low-linting, smooth and opaque. Limited-use protective garments and work-wear are among the most important commercial applications to benefit from the unique combination of properties offered by Tyvek®. Garments made of Tyvek® are either used for hazardous environments or for general, non-hazardous, industrial use. Examples of uses for hazardous environments include protection against water-based acids, bases, salts and splashes of certain liquids, such as pesticides and herbicides. The garments also provide a reliable barrier against exposure to harmful dry particles, such as lead dust, asbestos and particles contaminated with radiation. Non-hazardous, industrial uses include wearing the garments for "dirty jobs" at factories, workshops, engineering plants, farms and construction sites.

The hydrohead pressure of the protective articles will depend in part on the particular kind of material from which the article is constructed. According to the present invention, the garments as designed can have a liquid hydrohead barrier pressure of at least about 15, 17 or 20 millibars, up to about 180, 187, or 200 millibars, inclusive of all range combinations thereinbetween. More commonly, the garment had a hydrohead pressure of about 25 or 30 to about 115 millibars, which preferably is about 45 to about 110 millibars, and more preferably about 50 millibars to about 95 millibars.

The air permeability of the garment materials, according certain embodiments, may range from at least about 2 cfm up to about 47 or 50 cfm, inclusive of all range combinations thereinbetween. More typically, the air permeability ranges from about 5 or 10 cfm to about 43 or 45 cfm, and preferably between about 15, 17, 20, or 25 cfm to about 40 or 42 cfm.(cubic feet per meter). The garments of the present invention can also have a moisture vapor transmission rate of up to about 4700 g/m^2/24hours, more typically about between about 2700 or 3600 MVTR to about 4500 or 4600 MVTR. The protective garment articles can protect the wearer resistance of about 9-100% against dry particle barrier intrusion of a particle size of 0.3-05 microns (μm).

Normally if one wished to clip or pin an item to non-woven fabrics, it would be difficult and can cause the fabric to rip or penetrate the barrier properties of the protective article. The presence of piping, not only increased the aesthetic appeal of the garment, but also functions to convey information as an indicator of the level of protection, as well as permit the user to attach or clip other items to the extra fabric material of the piping.

Multiple layers in the material can make the protective material look and feel more garment-like, and permits it to be manufactured in a more form fitting, comfort much like

clothing tailored from conventional cloth materials. The desire for protective wear that resembles in comfort and flexibility regular tailored clothing has been an objective that until the present time has not been easily or readily achieved using polyolefin, non-woven based fabrics.

Replaceable or interchangeable sleeves may have different greater level of protection than the rest of the protective garment. Due to the nature of some tasks that subjected the arms and hands to conditions different from the rest of the body, the arms and hands may need a greater level of protection. Extra over lapping materials provides additional protection, by doubling the layers, adhered with a tackifying adhesive or closure cohesive.

Another feature of the present invention is that the fastening means (e.g., mechanical fastening systems and/or adhesive layer) is applied to one or more openings on the garment. The fastening means may be mechanical fastening means. Such devices typically are composed of two parts which can be joined together. A first part is connected to or contained in or on a panel of the protective garment, while the second part resides on or adjacent to a complementary surface that forms the closure. The second part may be integral with the surface to be contacted or may be attached to the surface or any other object through other mechanical or adhesive means. For example, in the case of hook and loop structures the loop component may be integral with the garment panel and may form the first part of the mechanical fastening means while a strip of hook material is the second part of the mechanical fastening means.

Generally speaking, when an adhesive layer is used, a peel strip of any paper, plastic or similar sheet material which is releasable from the adhesive can cover the adhesive area before it is applied. The peel strip may be coated or impregnated with a conventional release agent so it may be removed without damaging the adhesive. Adhesive layers may be desirable for regions where a high strength attachment is needed such as on a vertical surface or when the garment is subjected to body forces or shear forces may act to move the folds or layers of the garment or disrupt a seal.

The second part of the mechanical fastening means is desirably flat and unobtrusive and does not interfere with the garment or the surface to which it is attached yet is reusable when needed. The fastening means may be small-scale hook and loop structures such as VELCRO™ fasteners, magnetic strips or other magnetic means to join the garment panel to iron steel or other magnetic materials, eyes and hooks wherein a plurality of large eyes

desirably greater than 2 mm in diameter) are joined to a portion of the garment to permit engagement to appropriately spaced and sized hooks or other projections on a surface and the like.

According to the present invention, it is particularly desirable to use mechanical fastening systems that have hook and loop structures such as VELCRO™ fasteners that may include one-sided strips of hook material with a satisfactory adhesive backing to enable one or more strips of hook material to be connected to a desired location where garment panel may be attached later. In such an embodiment, the adhesive is desirably protected with a strip of release paper.

Mechanical fastening systems may utilize two part fastening systems such as clips, snaps, hook and loop structures or the like. The fastening system (e.g., the hook material) may be attached with durable glues or adhesives that can withstand repeated mechanical strain or with permanent or semi-permanent mechanical fastening means such as fabric rivets, pins, or clamps.

In an embodiment of the invention, the mechanical fastening systems may be magnetic strips. These may be elongated and are desirably flexible arrangements of high-Gauss magnetic materials such as rare-earth magnets which can attach to steel or other ferrous materials with sufficient force to hold the garment opening in place preferably. According to an aspect of the invention, the magnetic strip may be a reusable, removable component which slides into an elongated pocket in the garment before use to permit attachment to a ferrous compound and which then permits removal of the strip when the garment article is to be discarded. The strip is desirably flexible to permit arrangement in various forms for best fit. Discrete magnets joined in a continuous plastic or rubber matrix can provide the desired flexibility.

Of course, the present invention encompasses fastening means in which one or more mechanical fastening systems and adhesives may be used separately or together. The presence of both an adhesive strip and mechanical fastening means in a garment gives added options in terms of how the opening panels of the garment can be attached or placed. On one preferred embodiment the mechanical fastening means or systems are not on the same side of the garment panel as the adhesive strip thus permitting a first panel to be adhesively attached to a surface while other garment or protective components may be joined to the first garment article.

The present invention encompasses embodiments of the garment in which the fastening means is solely in the form of adhesive layers or strips at a plurality of locations on the protective article. According to the invention, the adhesive layer may be a continuous layer or it may be discontinuous. The adhesive may be applied in any configuration including a continuous bead, various spray patterns, spatterings, printings, swirl arrangements or the like.

Desirably, the adhesive layer is a pressure sensitive adhesive layer. Suitable pressure sensitive adhesive include, but are not limited to, hot-melt "garment" adhesives of the type applied to personal care products (e.g., feminine care pads, incontinence products, etc.) to adhere the product to the garment of a wearer. As an example, useful hot-melt garment adhesives include those available under the designations 34-5602 (also known as "Easy Melt"); DF-5575; 170-3902; DM-523; 34-5516; 34-5512; MQ 7987; 53-4503 from National Starch, Bridgewater, New Jersey. Other useful hot-melt garment adhesives include those available under the designations HL-8141; D-58; D-3944; HL-8112; HM-5717; HL-1375; and HM-1972 from HB Fuller, St. Paul, Minnesota, and the adhesive available under the designation 910-373 from Ato Findley, Inc., of Wauwatosa, Wisconsin.

While the level of adhesion may be varied and adjusted greatly, in some embodiments it is desirable that the "garment" adhesives provide a level of adhesion that may be measured in the range of about 20 to about 1000 grams for a cotton fabric or nylon fabric substrate generally in accordance with ASTM E 171-87. For example, the "garment" adhesives desirably provide adhesion in the range of about 100 to about 500 grams. Even more desirably, the "garment" adhesives provide adhesion in the range of about 200 to about 400 grams.

In embodiments of the invention, the adhesive layer may be in the form of a strip of adhesive running along the length of fabric. The adhesive strip may have a width ranging from several inches to a relatively thin strand or bead. Generally speaking, the adhesive strip may have a width sufficient to provide good adhesion of the garment fabric surfaces in view of the peel strength or tack of the adhesive. For example, some suitable pressure sensitive adhesives of the type used in self-sealing envelopes and the like can be applied in a strip having a width ranging from about one-quarter of an inch to about 1 or 2 inch to about 4 inches. Another feature of the invention is that when an adhesive strip on the garment material is used to secure the portions of the garment, the adhesive strip and garment material are adapted to conformably and securely adhere. This tight contact

generates a seal, barrier or block that minimizes gaps, spaces, capillaries and the like and reduces leakage of liquid or dust particles past the closure.

The present invention has been described in general and in detail by way of examples. Persons of skill in the art understand that the invention is not limited to the specific embodiments disclosed. Modification and variations of the general concept may be made without departing from the scope of the invention as defined by the following claims or equivalents, including, equivalent components.

CLAIMS

We Claim:

1. A method for providing a protective apparel assembly, the method comprises: manufacturing or otherwise providing a protective article having a basic garment form selected from either: a coverall, a jumper, a vest, a jacket, a shirt, or a pantaloon, each garment a with either a male-adapted or female-adapted gender specific cut of said garment, which is fabricated from either: a nonwoven-based material, a non-stretchable barrier fabric, a stretchable barrier fabric or film, a breathable or non-breathable material, impervious barrier or film-coated barrier, and having a closure system to the garment, and at least two of the following sizing elements or fit-enhancing features: an elastomeric stretch panel, adjustable wrist wraps, adjustable ankle wraps, elastic wrist cuffs, elastic ankle cuffs, zipper that runs from a upper portion to a lower portion of said garment in a substantially obliquely or diagonal orientation across the general longitudinal configuration of the garment, a vertical zipper along either a front panel or side panel, adjustable closure around a portion of the torso, hook-and-loop style fastening system; assemblying garment articles together for either a multi-piece or a single-piece, unitary suit.

2. The method according to claim 15, further comprising: instructing or providing instruction to a user about donning properly said protective apparel.

3. The method according to claim 15, further comprising: at least a one of the following: attached hood, multi-piece components, two-piece garment, single-piece garment, internal pockets, gusseted pockets, leg slit opening, detachable sleeves, detachable leggings, accordion pleats, bellow pleating situated longitudinally or cross-directional on a back panel, reinforced elbow patches or pads, reinforced knee patches or pads, colored piping or indicator accent along a portion of the garment, a color-based or graphical indicia over a portion of an externally visible surface of the article.

4. A method for promoting worker use of protective garment articles to drive safety compliance, the method comprising: a) providing a protective article having a basic form selected from either a coverall, a jumper, a vest, a jacket, a shirt, or a pantaloon

with either a male-adapted or female-adapted gender specific cut of said garment, and a reversible closure system to said article, a majority percentage of said protective article is made from either: a nonwoven web, a non-stretchable barrier fabric, a stretchable barrier fabric, a breathable or non-breathable material, or an impervious barrier or film-coated barrier, and a minority percentage that includes at least one of the following: an elastomeric material or a thin film laminate; b) instructing or providing instruction to a worker about proper donning and doffing safety protocols for said protective articles; and c) inducing said worker to don all protective garment articles required for said workers to perform said worker's job requirements in a safe manner.

5. The method according to claim 18, further comprising evoking in said worker a sense of confidence and professionalism by providing a more customized fit based on a selectable gender-specific overall fit and appearance, or size adjustable fit, or both.

6. The method according to claim 18, further comprising engendering in said worker a feeling of being an autonomous individual by providing a more customized fit based on a selectable gender-specific overall fit and appearance, or size adjustable fit, or both.

7. The method according to claim 18, wherein said protective article includes at least two of the following sizing elements or fit-enhancing features: an elastomeric stretch panel, adjustable wrist wraps, adjustable ankle wraps, elastic wrist cuffs, elastic ankle cuffs, zipper that runs from a upper portion to a lower portion of said garment in a substantially obliquely or diagonal orientation across the general longitudinal configuration of the garment, a vertical zipper along either a front panel or side panel, adjustable closure around a portion of the torso, hook-and-loop style fastening system.

8. The method according to claim 18, wherein said protective article includes at least a one of the following: attached hood, multi-piece components, two-piece garment, single-piece garment, internal pockets, gusseted pockets, leg slit opening, detachable sleeves, detachable leggings, accordion pleats, bellow pleating situated longitudinally or cross-directional on a back panel, reinforced elbow patches or pads, reinforced knee patches or pads, colored piping or indicator accent along a portion of said garment, a

color-based or graphical indicia over a portion of an externally visible surface of the article.

9. A method for promoting a sense of sartorial professionalism and self confidence in a wearer of protective apparel articles, the method comprises: a) providing a garment or assembly of multiple garments, said garments having a portion made from a nonwoven-based web sheet, and optionally at least one of the following: a film, a woven fabric, a knit fabric, or an elastomeric material extending over a portion of said apparel article, said article is adapted to have a gender-specific overall fit and appearance, with either a male or female gender specific cut of the apparel article, an adjustable closure system that is directionally oriented according to a wearer's gender; b) instructing or providing instruction to a wearer about donning and doffing said protective articles.

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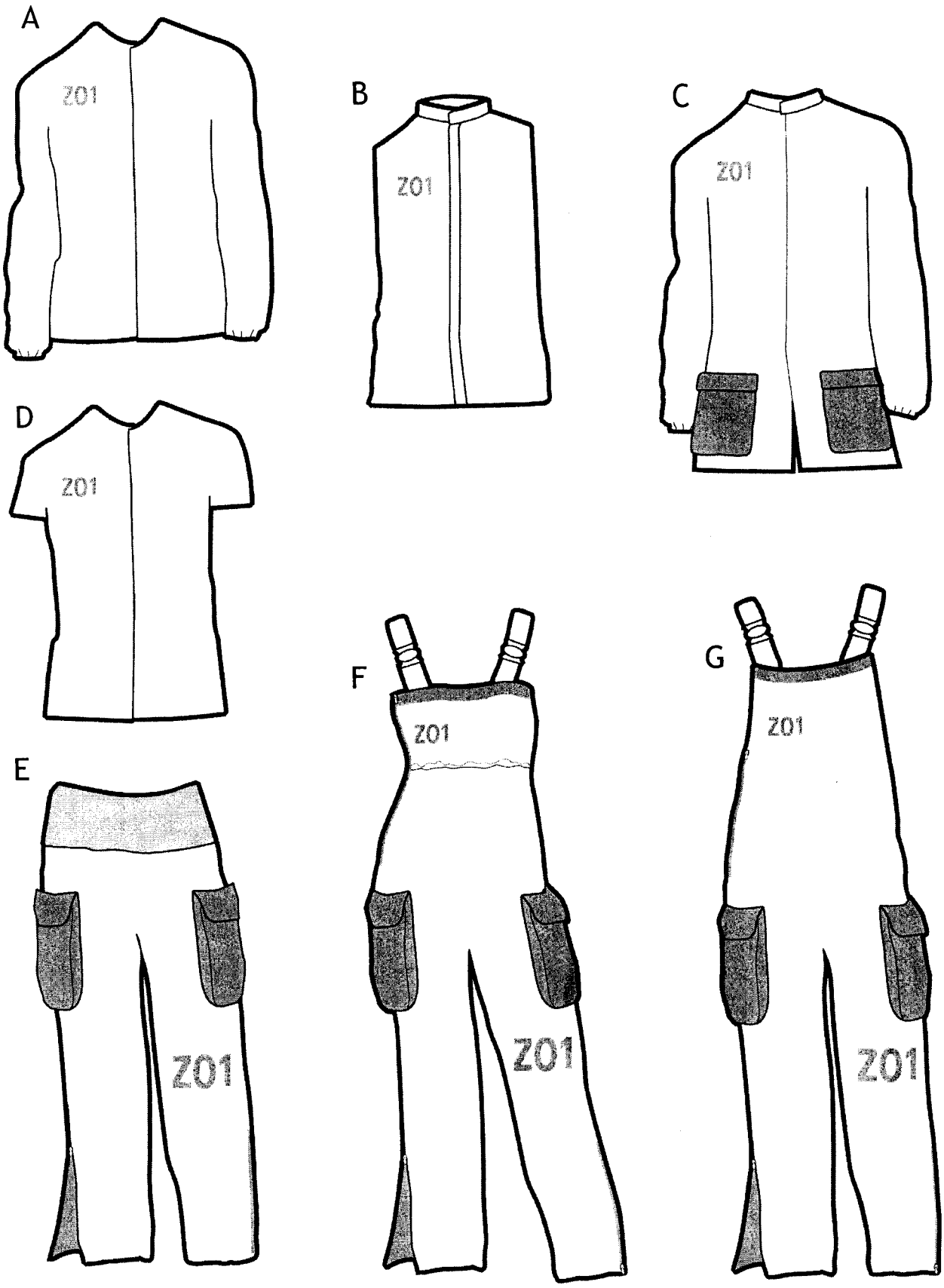


FIG. 1

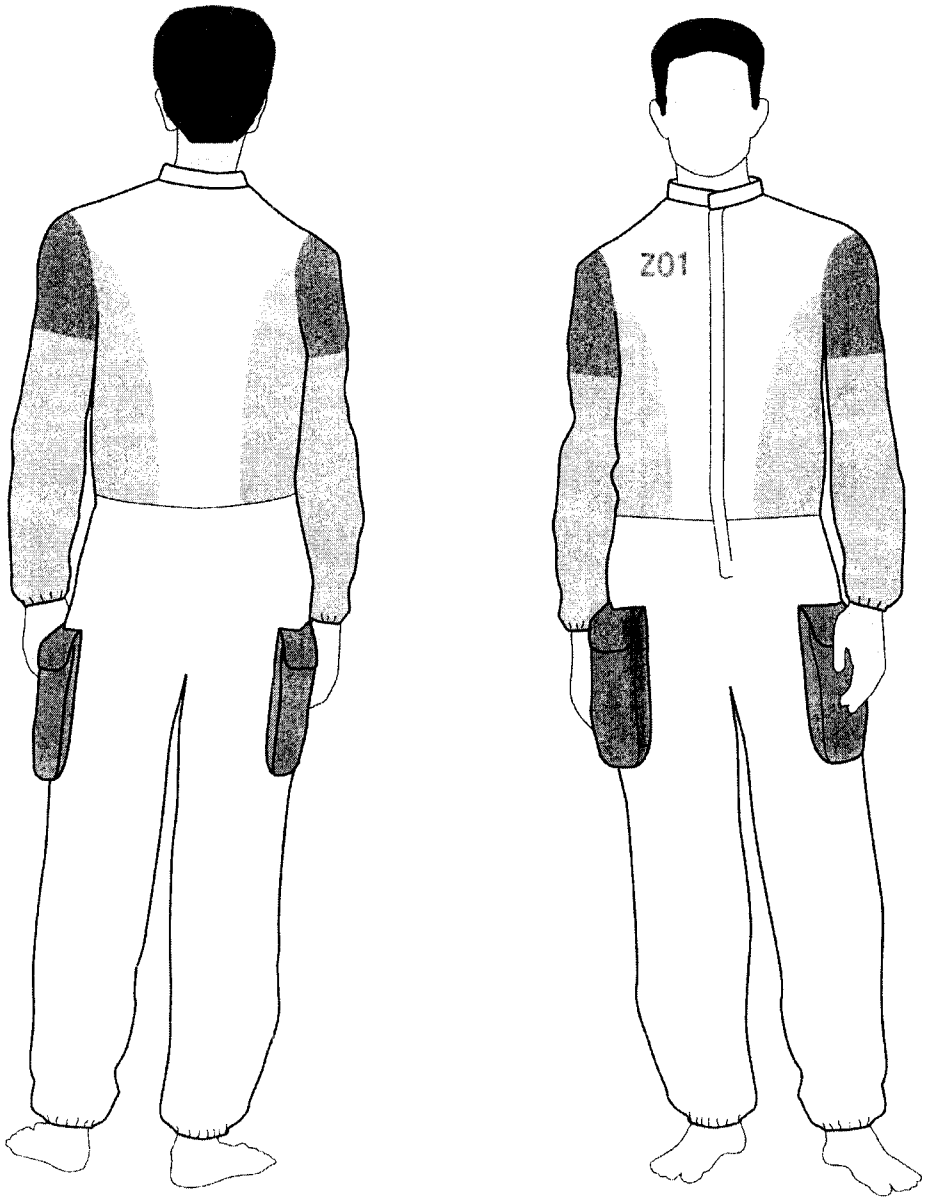


FIG. 2

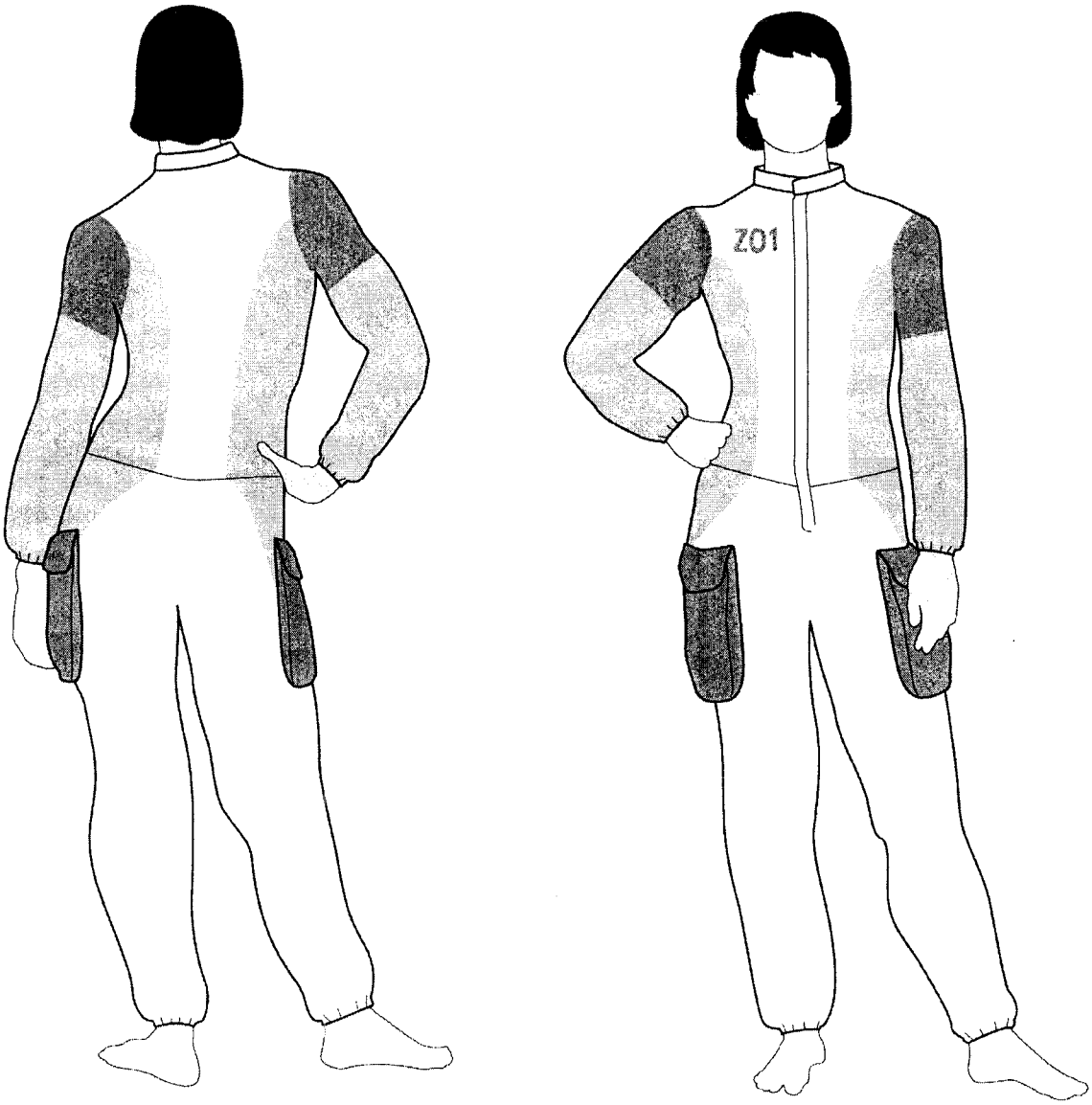


FIG. 3

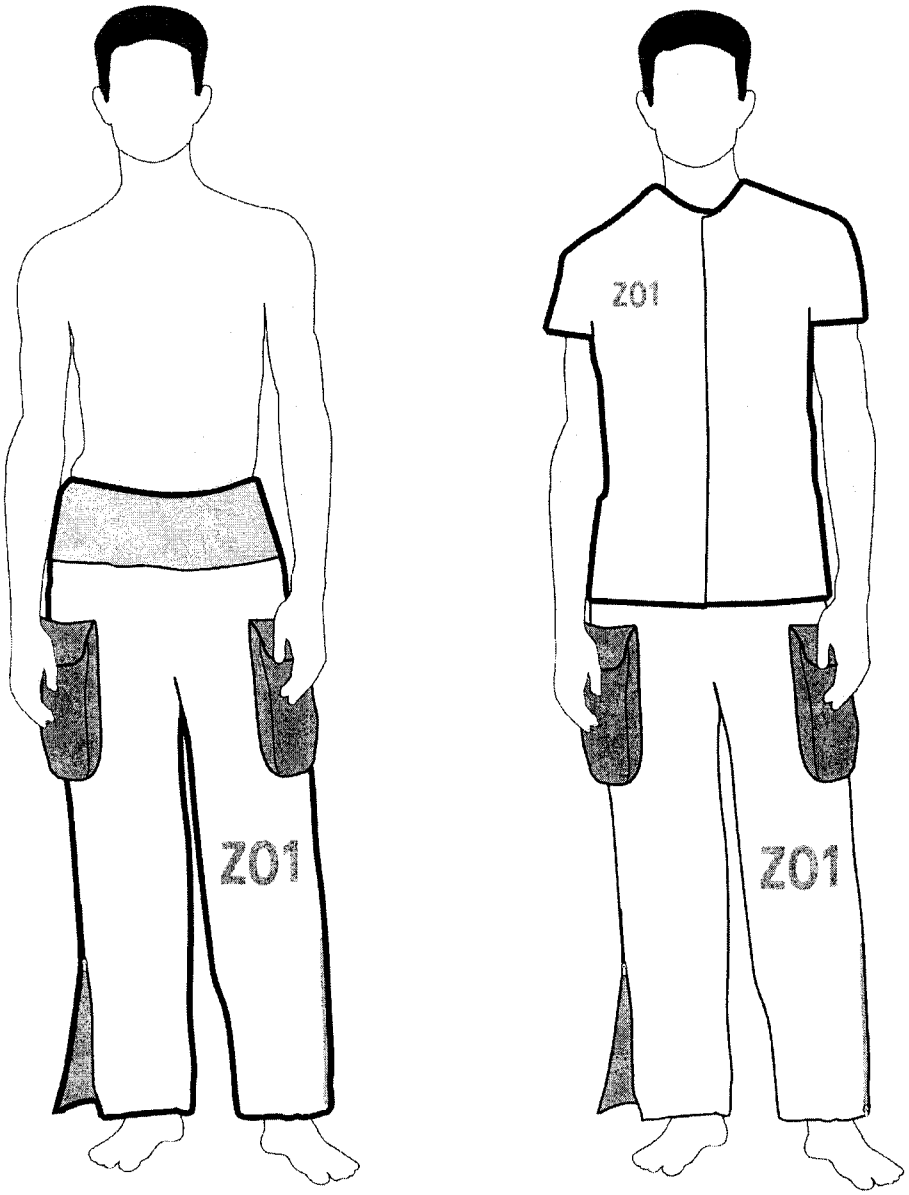
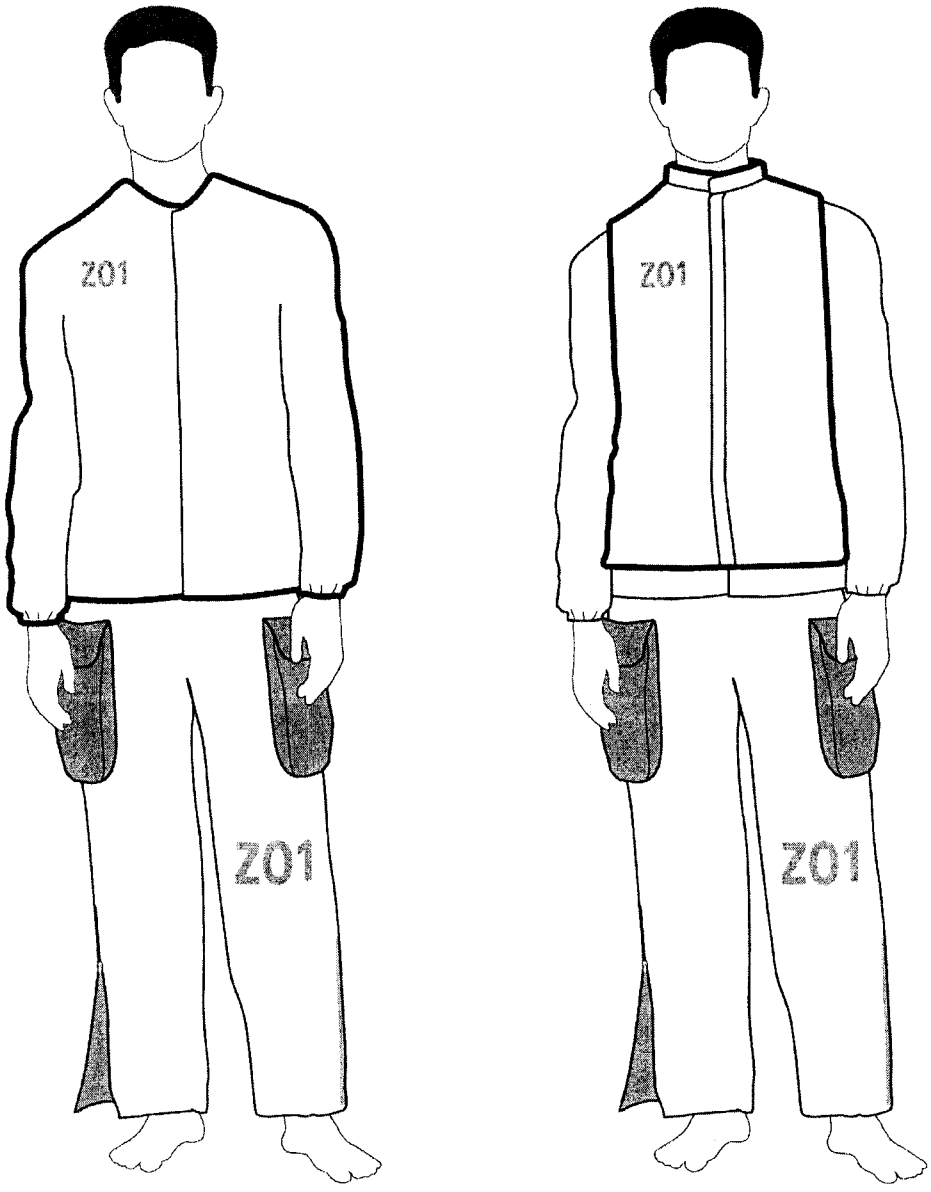


FIG. 4



A B

FIG. 5

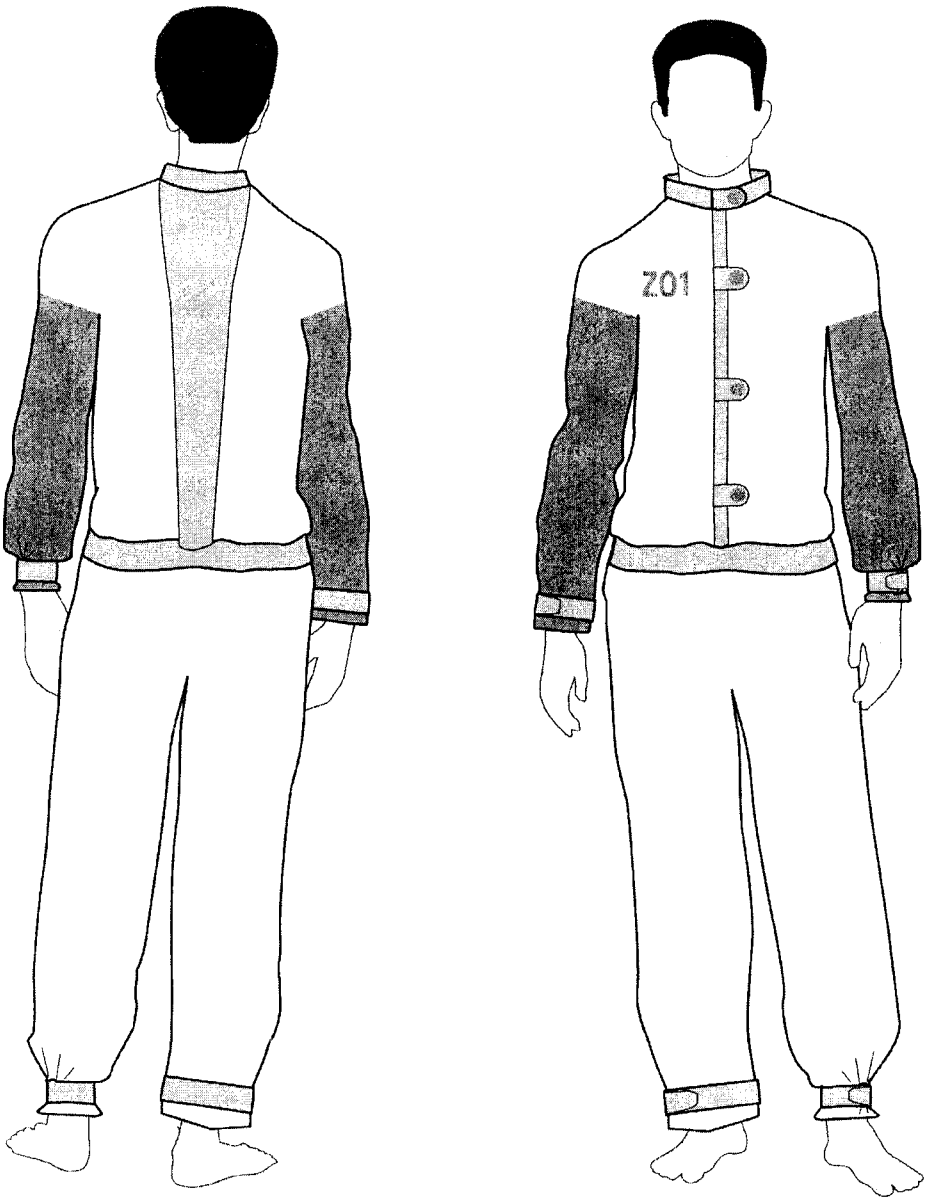


FIG. 6

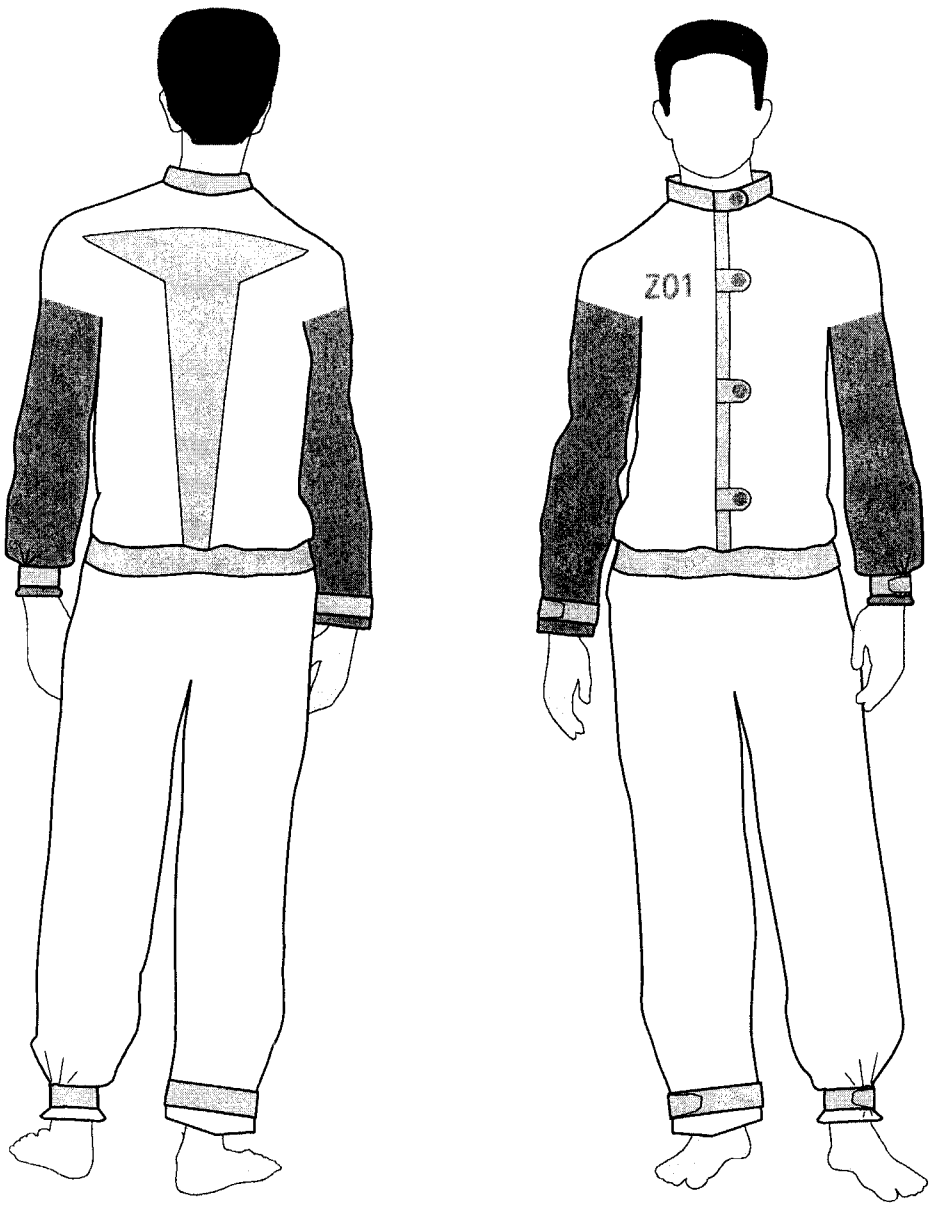


FIG. 7

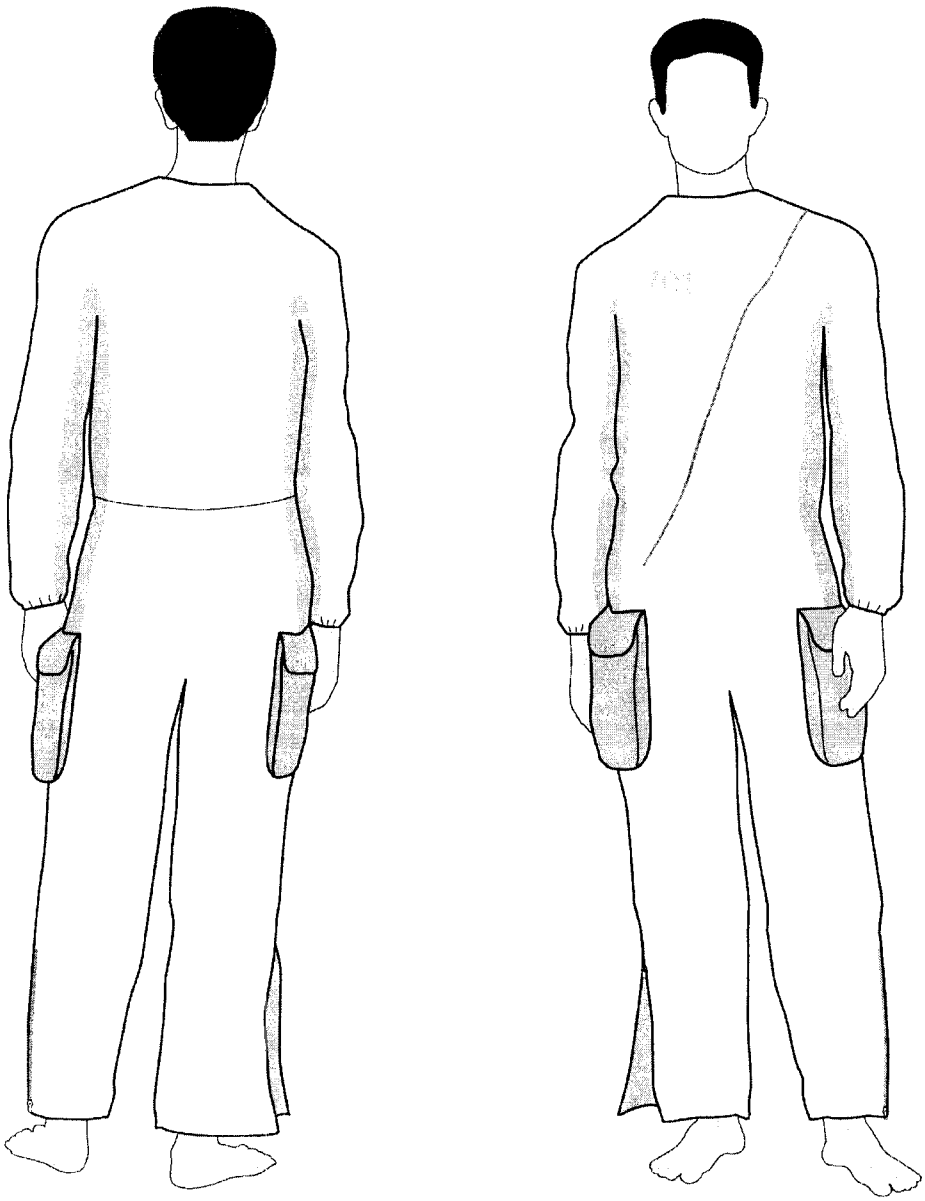
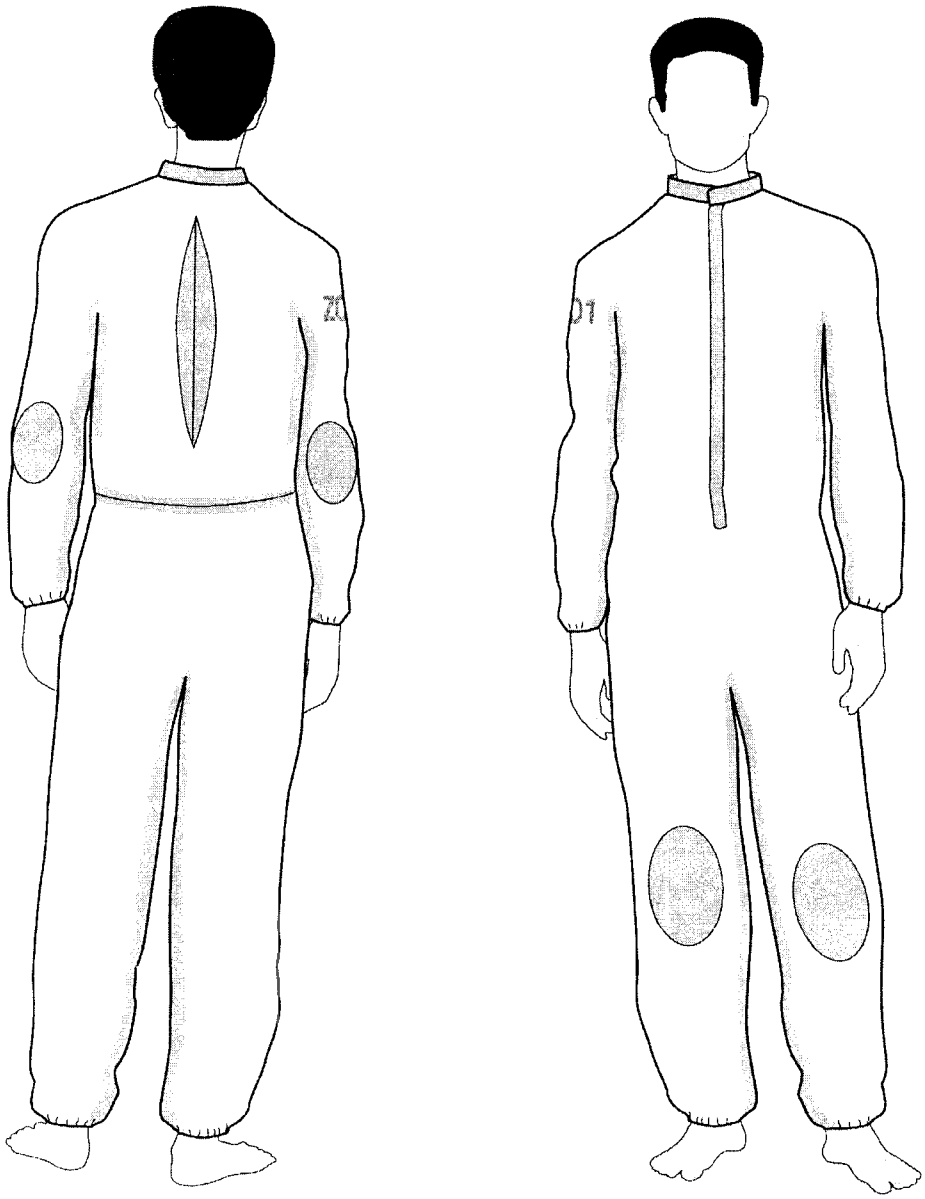
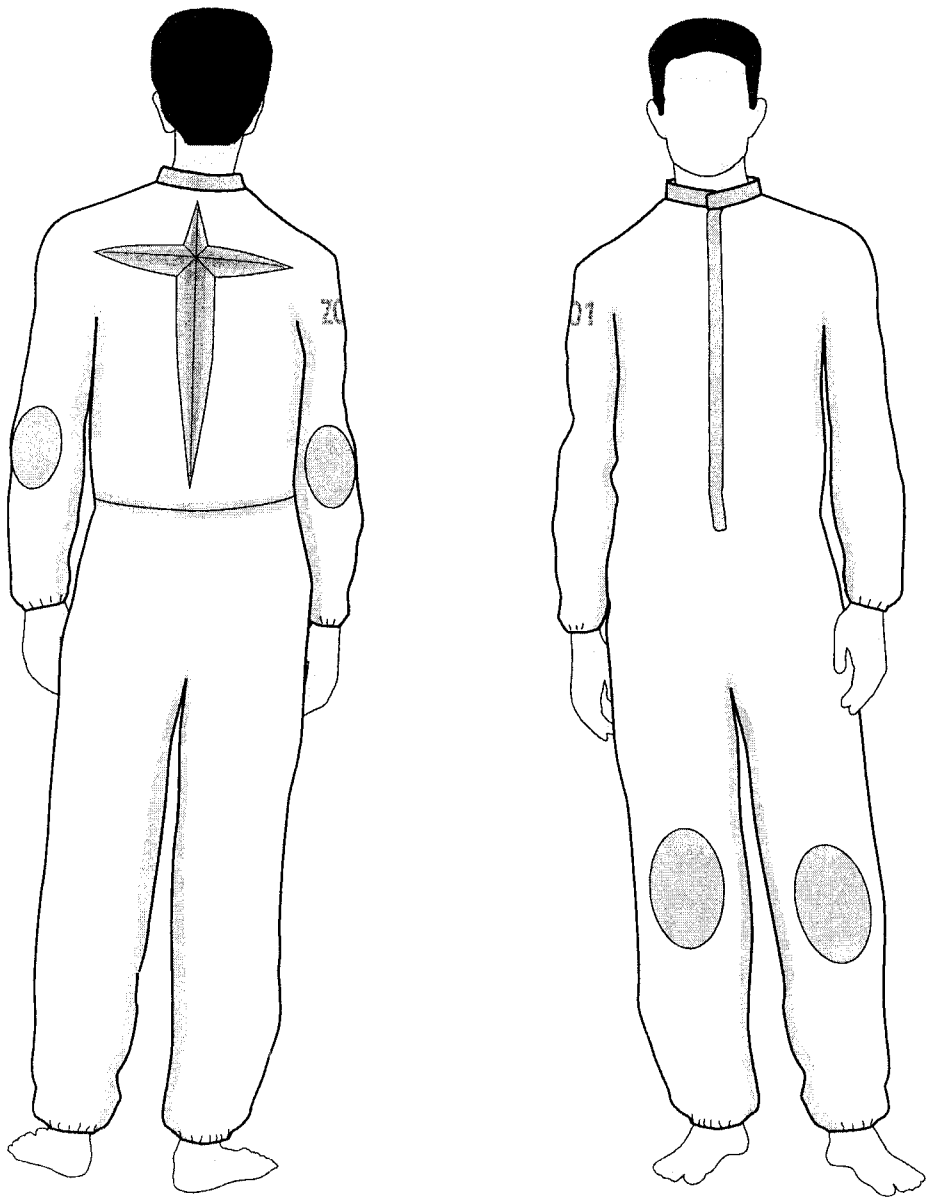


FIG. 8



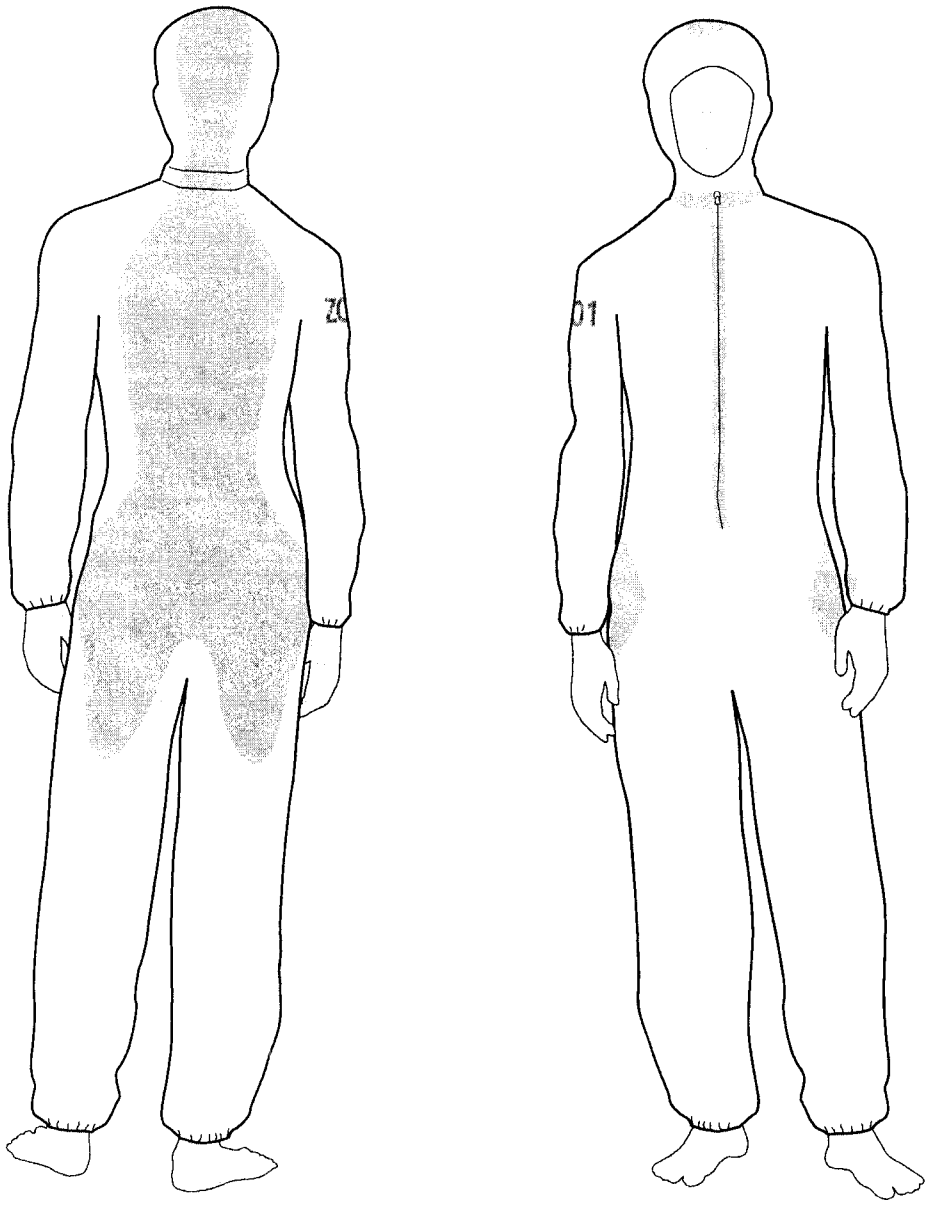
A B

FIG. 9



A B

FIG. 10



A B

FIG. 11

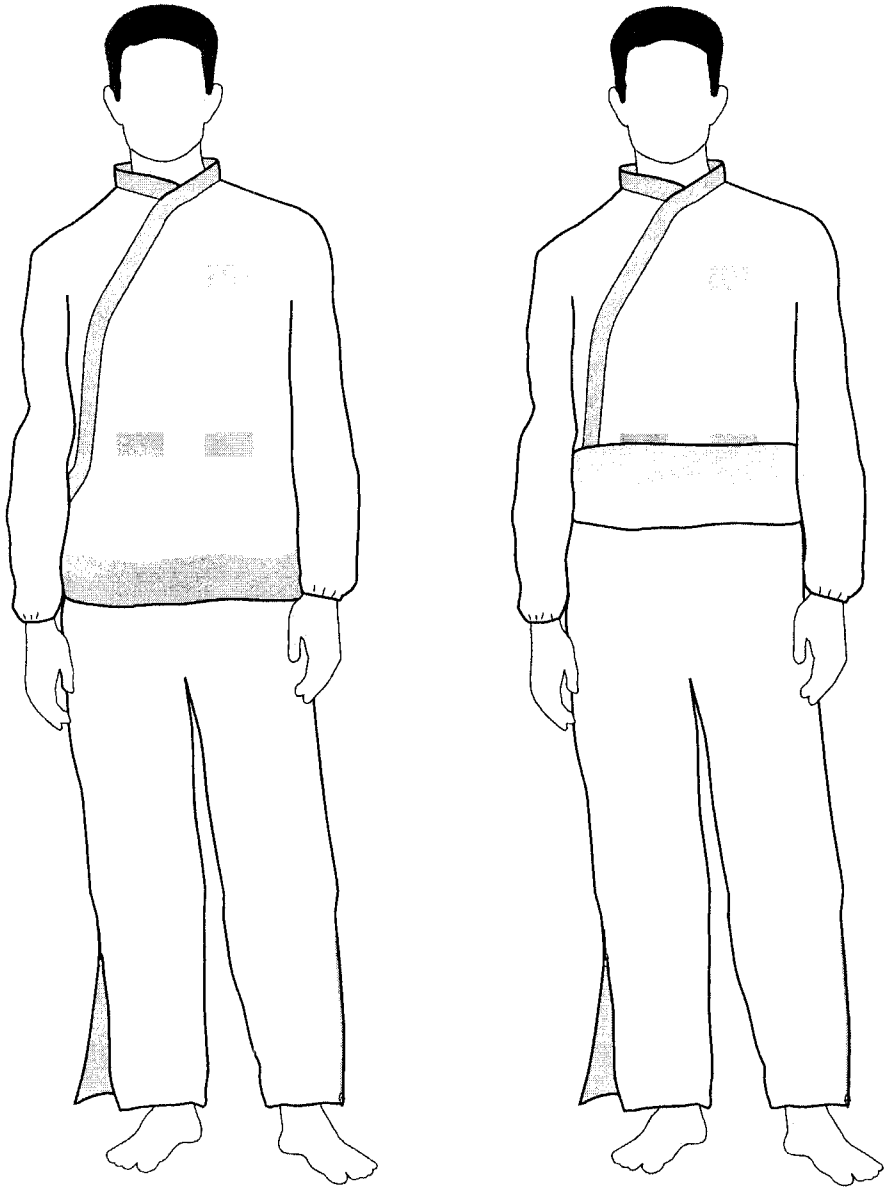


FIG. 12

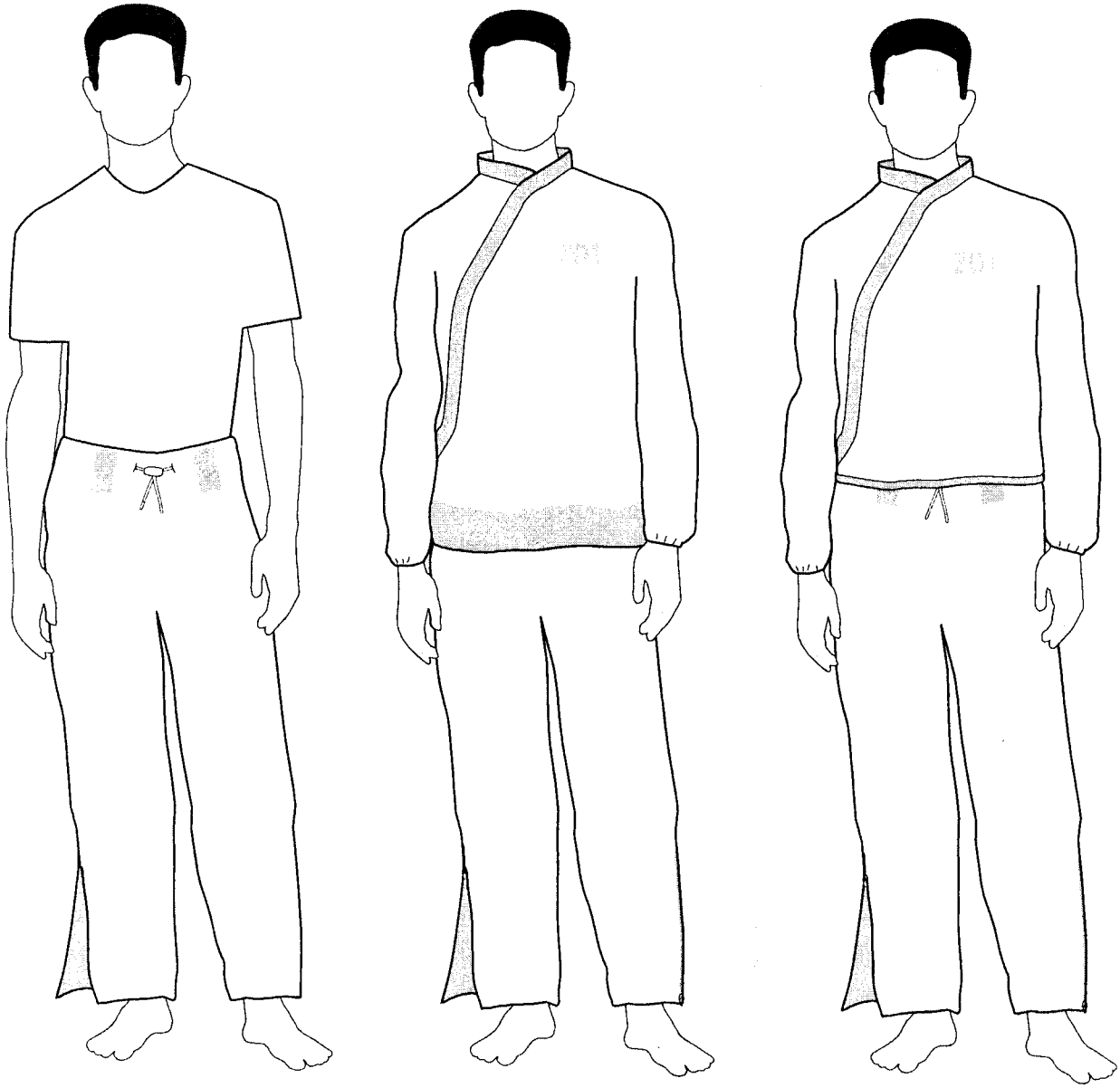


FIG. 13

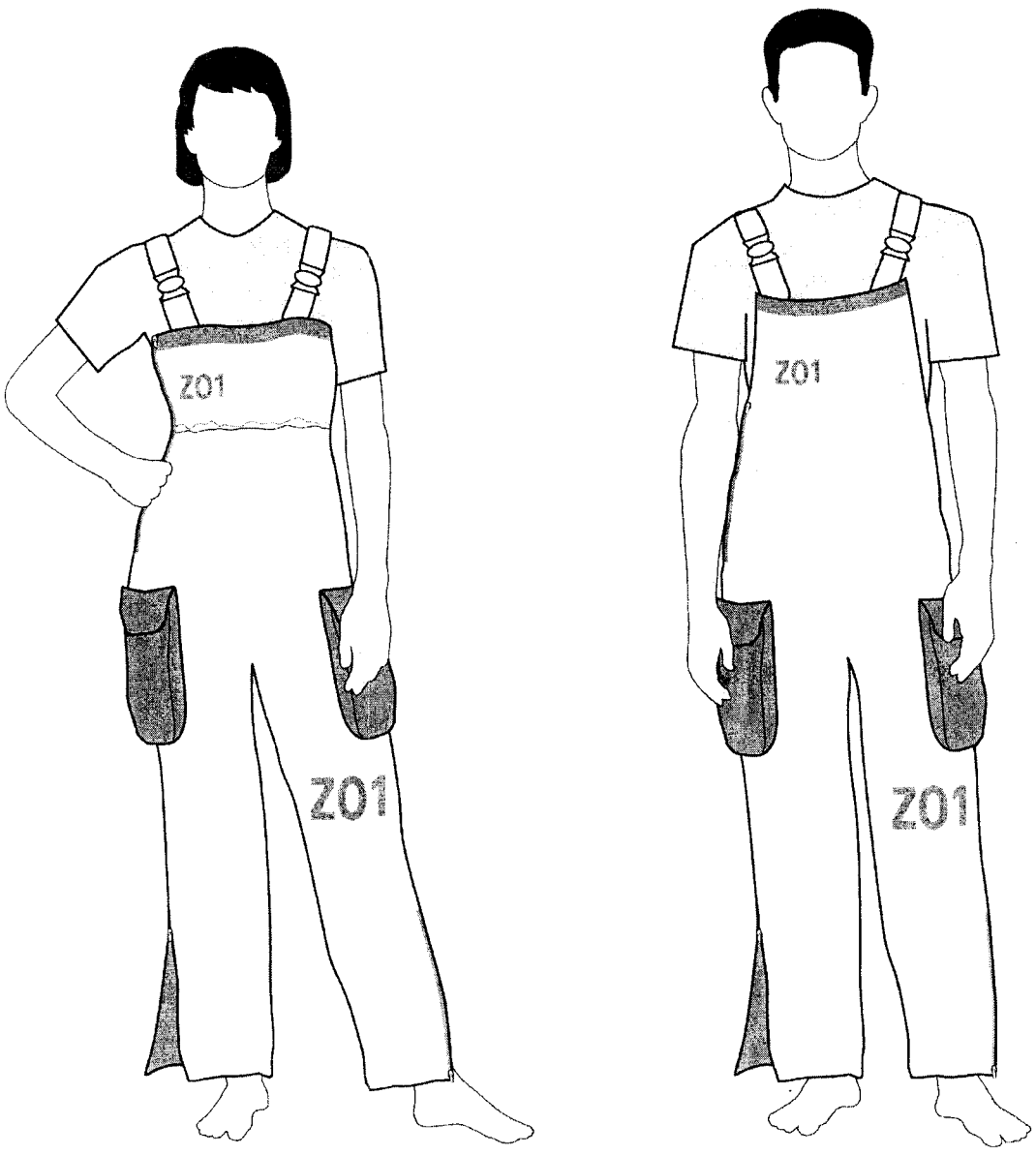


FIG. 14

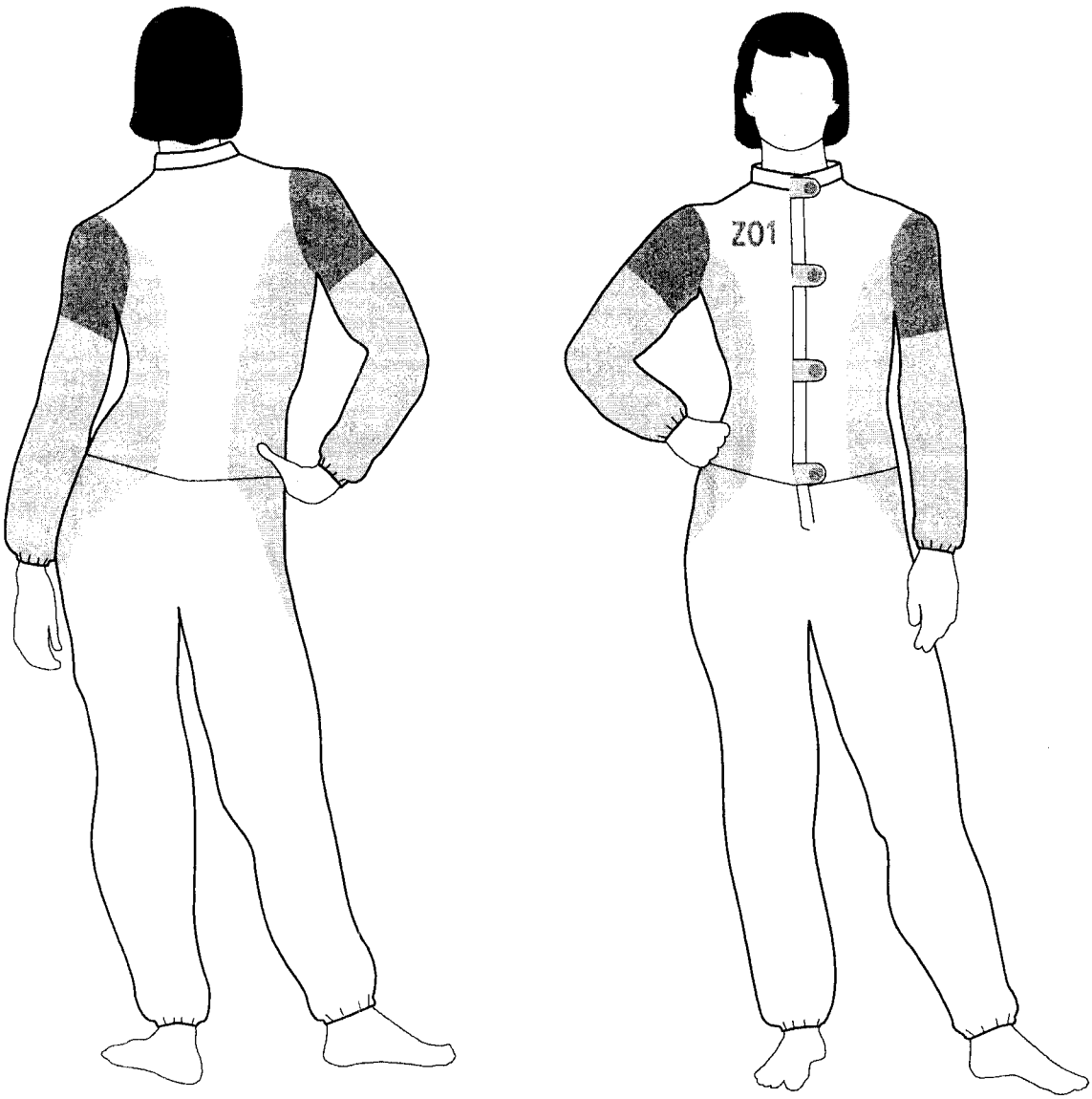


FIG. 15

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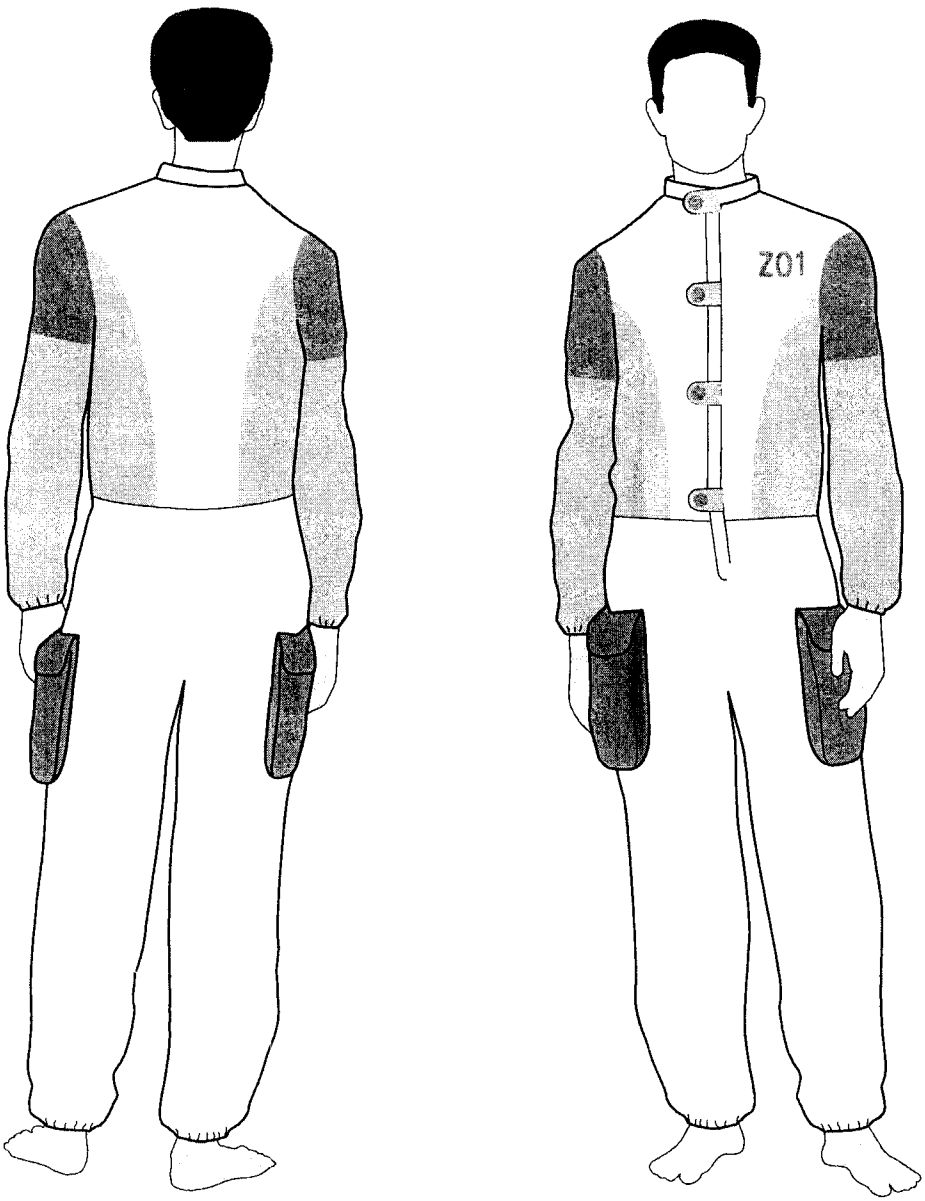

FIG. 16