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(54) **PERSONAL PROTECTIVE GARMENT**

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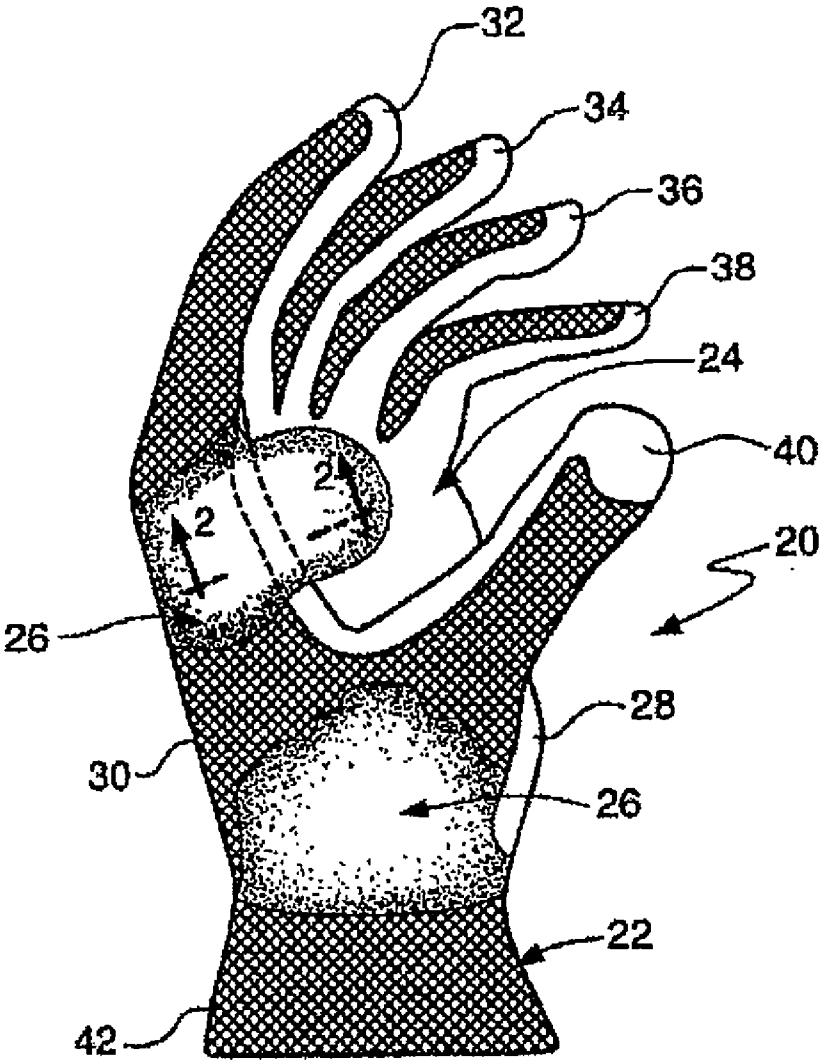
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(57) **ABSTRACT**

A personal protective garment, preferably a glove, for protecting at least a portion of the body of a wearer is disclosed. The garment comprises a liner, an overlayer and at least one covering layer. The liner comprises a flexible material and is adapted to be worn on at least a portion of the body of the wearer. The overlayer comprises a milled polymer and is adapted to cover at least a portion of the liner and is secured to the liner. The covering layer comprises a polymer and is adhering to and covering at least a portion of the overlayer. The milled polymer is preferably milled rubber. Also disclosed is a method of making a personal protective garment, preferably a glove.



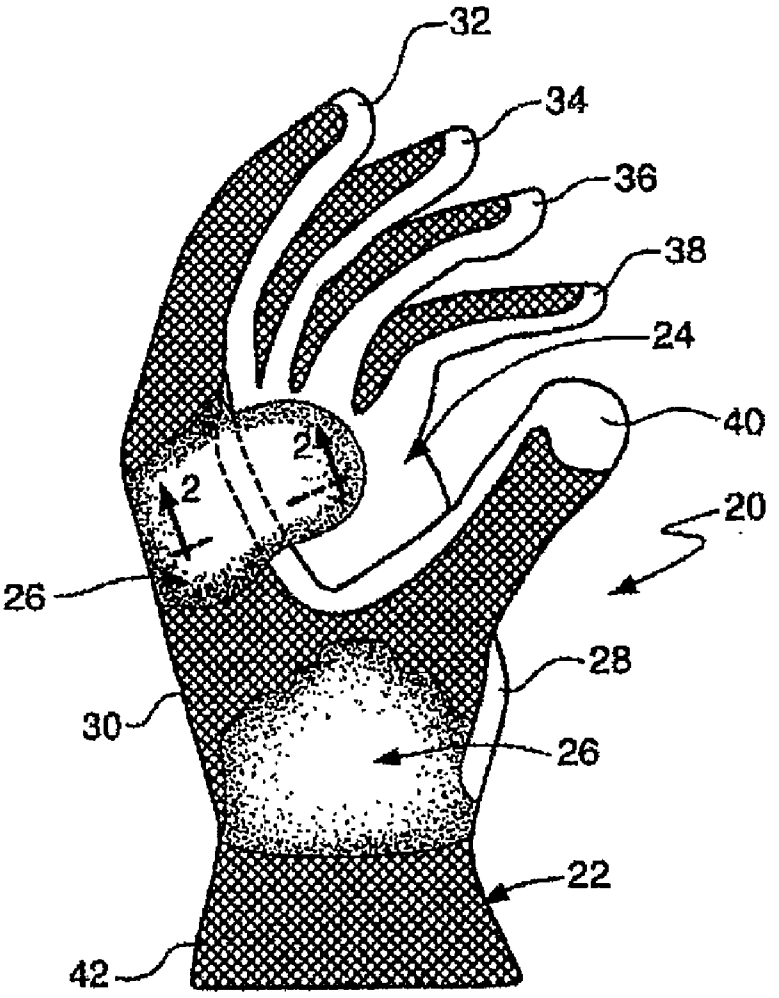


FIG. 1

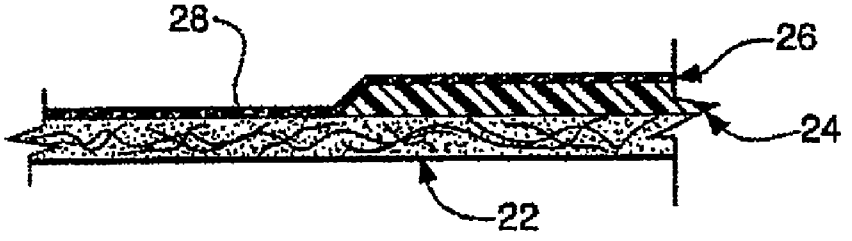


FIG. 2

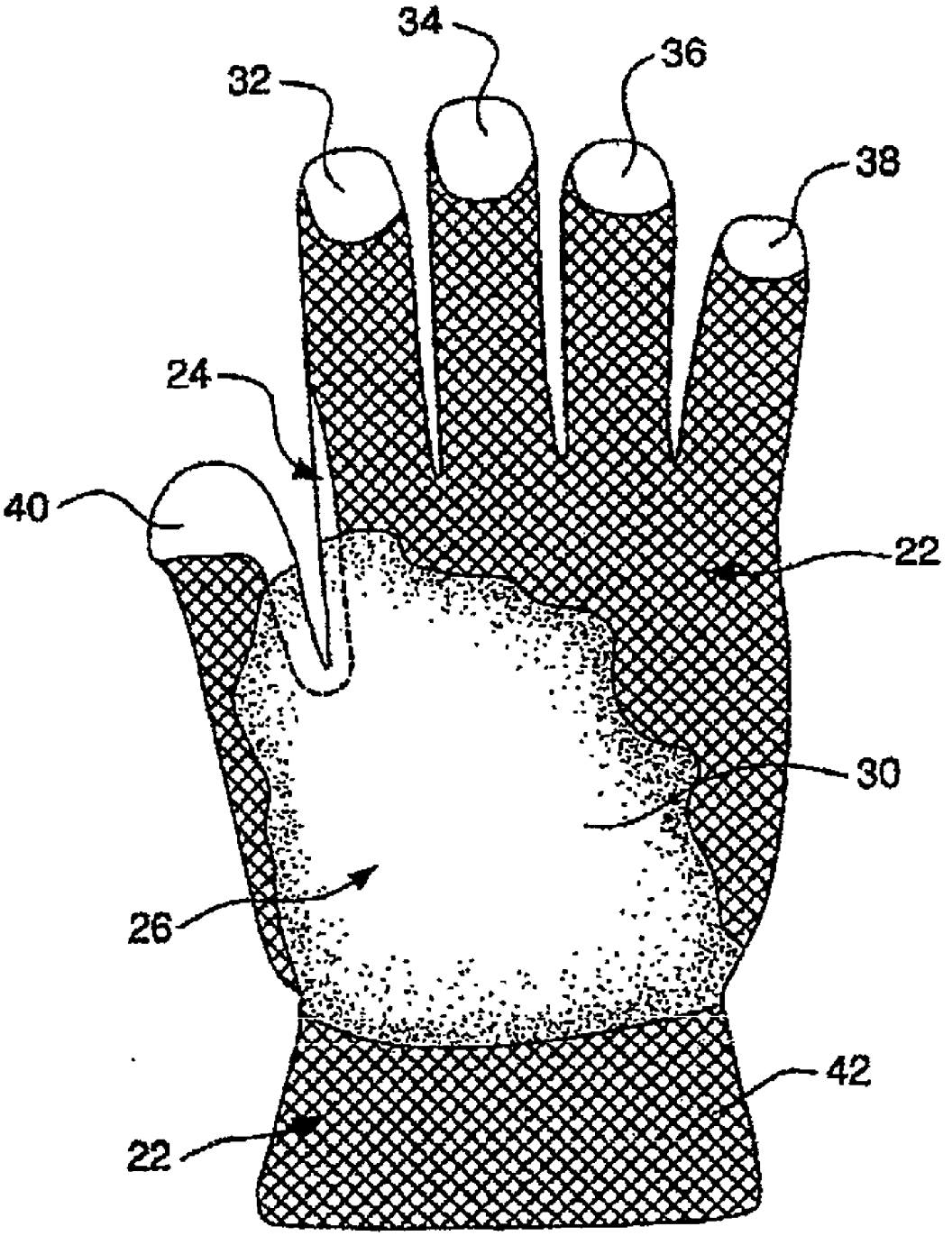


FIG. 3

PERSONAL PROTECTIVE GARMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/972,050, filed Sep. 13, 2007, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to personal protective garments, in particular protective gloves, mittens or gauntlets for protecting the hand of the wearer against abrasion, penetration and cuts.

[0004] 2. Description of the Related Art

[0005] Personal protective garments find use in many areas of activity and, in particular, in industry or agriculture. Personal protective garments for protection of the hand or arm include gloves, mittens or gauntlets. Gloves, typically, have four finger stalls to hold each of the four fingers of the wearer and a thumb stall to hold the thumb. Mittens, typically, have a thumb stall and fewer than four finger stalls, usually a single stall for holding all the fingers of the wearer. Gauntlets may be either gloves or mittens with the wrist portion of the glove or mitten extending up the arm of the wearer to provide enhanced protection.

[0006] Protective gloves are essential items in hazardous handling environments where an important property of the glove is resistance to abrasion, cutting or puncturing. Protective gloves must also be comfortable to wear to maximize the willingness of handlers to wear the gloves during potentially dangerous handling procedures. Additionally, protective gloves should give good grip to maximize safe handling procedures and provide at least some protection against grease, liquid or powder ingress into the glove.

[0007] U.S. Pat. No. 4,094,014 (Schroeder) discloses a workman's glove comprising a sheath, preferably porous, with a knuckle-protecting surface, a palm protecting surface and non-slip finger gripping surfaces facing each other. The added surfaces are preferably of corrugated rubber.

[0008] U.S. Pat. No. 5,231,700 (Cutshall) discloses a penetration resistant hand protector for medical applications comprising a glove with puncture resistant coverings, preferably of leather, on the finger stalls.

[0009] WO 91/10409 (Allied Signal, Inc.) discloses a flexible, uncoated glove for medical applications comprised of Kevlar (™) fibers to provide enhanced cut protection.

[0010] U.S. Pat. No. 6,044,493 (Post) discloses a stretchable protective garment material for gloves especially suitable for law enforcement uses. The material is composed of a stretchable knitted blend of Kevlar (™) and spandex fibers. In one embodiment, the palm surfaces of the glove are provided with an elastomeric coating.

[0011] A popular protective glove, especially in the metal and glass handling industries, comprises a liner of a flexible fabric material and a polymer covering layer over the liner. This glove provides good cut and abrasion resistance and good liquid protection to the wearer whilst also providing excellent grip. There is, nevertheless, is a need for enhanced abrasion resistance and hence durability whilst maintaining the advantages of the known protective garments. It is an aim of this invention to address that need.

BRIEF SUMMARY OF THE INVENTION

[0012] The present invention accordingly provides, in a first aspect, a personal protective garment for protecting at least a portion of the body of a wearer, said garment comprising a liner, an overlayer and at least one covering layer, said liner comprising a flexible material and being adapted to be worn on at least a portion of the body of the wearer, said overlayer comprising a milled polymer and being adapted to cover at least a portion of said liner and being secured to the liner, and said covering layer comprising a polymer and adhering to and covering at least a portion of said overlayer.

[0013] The personal protective garment is preferably for protecting the hand of the wearer.

[0014] The personal protective garment may also be adapted so that it also protects at least a part of the forearm of the wearer.

[0015] Thus, preferably, the garment is selected from the group consisting of glove, mitten and gauntlet.

[0016] Usually, the protective garment will have an overlayer and one covering layer. In some applications, however, more than one covering layer (e.g., 2, 3 or 4 covering layers) may be advantageous.

[0017] As discussed above in relation to the prior art, gloves typically comprise four finger stalls to hold each of the four fingers of the wearer and a thumb stall to hold the thumb. Mittens typically comprise a thumb stall and fewer than four finger stalls, usually a single finger stall for holding all the fingers of the wearer. Gauntlets may be either gloves or mittens where the wrist portion of the glove or mitten extends up the forearm of the wearer to provide enhanced protection. In this specification, references to glove or gloves include within their meaning gloves, mittens or gauntlets unless the context otherwise dictates.

[0018] The liner of the personal protective garment usually comprises a thumb stall for holding a thumb of the wearer. The liner also usually comprises at least one finger stall for holding at least one finger of the wearer. There may be up to four finger stalls depending on whether the personal protective garment is a glove or a mitten.

[0019] The overlayer may cover substantially all of the liner or may cover only a portion of the liner.

[0020] The covering layer, preferably, covers the whole of the overlayer, in particular the palm and finger and thumb stall portions of the overlayer. This is beneficial because the covering layer then provides enhanced grip which is of considerable importance in industrial handling environment and promotes comfort and safety.

[0021] The covering layer may cover at least a portion of any part of the liner which is not covered by the overlayer. The covering layer may cover substantially the whole of the overlayer and the whole of the liner (i.e., the whole of the glove, mitten or gauntlet). This is particularly advantageous in e.g., gloves for outdoor use because it provides added moisture protection. Alternatively, the covering layer may cover the garment only partially. For example, in the case of a glove, the covering layer may cover the palm side of the glove but cover the backhand side only partially from the distal end to just over the knuckles (knuckle-covering).

[0022] The liner usually has a palm (palmar) side and a back hand (dorsal) side and the overlayer, preferably, covers substantially the whole of the palm side of the liner. This is

advantageous because the overlayer provides cut, abrasion and puncture protection and the palm side of the liner is the most vulnerable to abrasion, cutting or puncturing during industrial handling.

[0023] The liner usually comprises at least one finger stall having a proximal end and a distal end and the overlayer is usually adapted to extend over the distal end of the or each finger stall thereby covering the tip of the or each finger stall. This is advantageous because it provides enhanced cut, abrasion or puncture protection to the tips of the user's fingers when the glove is in use. Preferably, the liner comprises a thumb stall which also has a proximal end and a distal end and the overlayer is adapted to extend from the proximal to the distal end and over the distal end of the thumb stall thereby covering the tip of the thumb stall. This is important because handling requires opposition between the fingers and the thumb of the wearer and so the thumb usually also requires enhanced protection from abrasion, cutting, or puncturing.

[0024] The liner, typically, comprises a flexible, fabric material which may be made by generally any method known by the person skilled in the art. The liner may be formed by a cut and sewn process (for example from two pieces of knitted or woven fabric sewn together). Alternatively, the liner may be made by a knitting process. Knitted liners are advantageous because they may be made in a seamless manner using, for example, glove knitting machines. In this case a liner, which is suitable for covering the hand of the wearer, comprises a knitted liner. Knitted liners for use in gloves are often made at 10 gauge (i.e., about 10 stitches per inch) but any other gauge may be used if desired (the machines are usually gauged at 7, 10, 15 and/or 18 gauge; 7 gauge being the heaviest and bulkiest and 18 gauge being the finest).

[0025] The flexible material of the liner may be selected from the group consisting of cotton, polycotton, steel, glass, polyaramid (for example Kevlar (™)), wool, polyamide (for example nylon 66), polyester, polyethylene (for example ultrahigh molecular weight polyethylene, UHMWPE including those fibers sold under the name Dyneema (™)) and combinations thereof. Yarns of these materials may be formed into fabrics for use in the liner using any process known in the textile art (including weaving and/or knitting). The choice of the flexible material will depend to a certain extent on the needs of the wearer as regards comfort and also on the degree of cut, puncturing and abrasion resistance required of the gloves.

[0026] Advantageously, the fabric of the liner may be a Jersey knitted fabric. Jersey knitted fabric is, typically, made from two counts of yarn: a coarse yarn that forms the inner knitted surface of the liner and at least one fine yarn that ultimately forms the smoother outer surface of the liner. The inner coarse yarn is heavily brushed to raise the cotton staples giving a soft, fluffy, comfortable feel to the glove. Jersey fabric is often used in heavy work gloves as the fabric is comfortable and the bulk of the raised staples act as a shock absorber during heavy work.

[0027] The milled polymer of the overlayer may comprise generally any polymer that is suitable for the milling process. The most preferred milled polymer is milled rubber. This is advantageous because rubber, as a resilient and resistant material, is particularly suitable for use in protective garments especially gloves. The milled rubber may be selected from the group consisting from natural rubber, nitrile rubber, neoprene, silicone rubber, butyl rubber and combinations thereof. The preferred milled rubber is milled natural rubber or milled synthetic rubber.

[0028] The milling process will usually involve the thorough mixing, at less than 100° C., preferably less than 95° C., of raw rubber with at least one processing aid (e.g., mineral oils, diethylene glycol), at least one cure initiator/activator (e.g., zinc oxide, stearic acid, lauric acid) and/or at least one accelerator (e.g., MBTS, TMTD). The milling process will also usually involve, in a subsequent step, the thorough mixing of the rubber mixture with a cross-linking agent (e.g., sulfur) at less than 70° C., preferably less than 60° C. After mixing, the rubber will typically be calendared to form a sheet of milled rubber (preferably uncured). It is this sheet of milled rubber than may be cut to shape and used to provide the overlayer.

[0029] The overlayer may be secured to the liner by generally any suitable method (e.g., mechanical fixings) but is preferably adhesively secured to the liner. In the case of a milled rubber overlayer, the adhesive is preferable a mastic comprising rubber mixed with a solvent.

[0030] The polymer used to form the covering layer is a polymer which can be used to film-form from a precursor. The precursor may be a liquid solution, a sol or other forms of polymer dispersions in a liquid. Examples of such polymer dispersions are natural or synthetic latex. The polymer is preferably selected from the group consisting of rubber, polyurethane (PU) and combinations thereof. The preferred polymer is rubber. This is advantageous because rubber provides good grip and also provides good puncture, cutting and abrasion resistance. Preferably, the rubber is selected from the group consisting of nitrile rubber, natural rubber, foam nitrile rubber, butyl rubber, neoprene and combinations thereof.

[0031] In a second aspect, the present invention provides a method of making a personal protective garment for protecting at least a portion of the body of a wearer, the method comprising, providing a liner comprising a flexible material and being adapted to be worn on at least a portion of the body of the wearer, providing an overlayer comprising a milled polymer and being adapted to cover at least a portion of said liner, securing the overlayer to the liner, providing a polymer, and polymer coating at least a portion of said overlayer with the polymer thereby providing a covering layer comprising the polymer on at least a portion of the overlayer.

[0032] Polymer coating is usually selected from the group consisting of dip coating, spray coating, curtain coating (sometimes referred to as shower coating), and screen printing. The preferred method is dip coating because of its simplicity and because it is particularly apt for efficiently coating the required portions of a glove, mitten or gauntlet.

[0033] The gloves, mittens or gauntlets of the present invention provide significantly enhanced abrasion resistance and hence durability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] These and other aspects, features and advantages of the invention will more fully appear in the following description made in connection with the accompanying drawings in which the same reference numbers refer to the same or similar parts throughout the several views and in which:

[0035] FIG. **1** is a side elevational view of a glove embodiment of the protective garment of the present invention,

[0036] FIG. **2** is an enlarged sectional view taken along line **2-2** of FIG. **1** and

[0037] FIG. **3** is a back hand side view of the glove illustrated in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

[0038] The following description is not to be taken in a limiting sense, but is made for describing the general principles of the invention. The scope of the invention should be determined with reference to the claims.

[0039] FIG. **1** illustrates an exemplary glove embodiment of a personal protective garment according to the present invention. Glove **20** comprises a liner **22**, an overlayer **24** and a covering layer **26**. The liner is a knitted fabric which may be, for example, polycotton, polyester, nylon, polyaramid or steel fibre or a combination of two or more of these materials. The liner **22** forms the inner layer of the glove **20** according to the invention and so is in contact with the wearer's hand in use. The covering layer **26** forms the outermost layer of the glove **20** which is in contact with the environment. The covering layer **26** is formed by liquid coating the glove using a polymer. The preferred polymer is a synthetic or natural rubber and the preferred method of liquid coating the glove **20** is by dip coating the glove into natural or synthetic latex. Typically, the covering layer **26** will cover substantially all of the surface of the glove.

[0040] As illustrated in FIG. **2**, the overlayer **24** is situated between the covering layer **26** and the liner **22** and will usually be confined to particular regions of the liner. The liner **22** includes a palm side (palmar side) **28**, a back hand side (dorsal side) **30**, a number of finger stalls **32**, **34**, **36** and **38** and a thumb stall **40**. In use, each of the finger stalls **32**, **34**, **36** and **38** of the glove receives a finger of the wearer's hand, the thumb stall **40** receiving the wearer's thumb.

[0041] In the particular embodiment illustrated in the drawings, the overlayer **24** is shaped to correspond to portions of the palm and palm side of fingers and thumbs of the wearer's hand and is adhesively secured to the corresponding portions of the liner **22**. The overlayer **24** is formed of milled polymer. The preferred milled polymer is milled natural or synthetic rubber. Although, in the embodiment illustrated, the overlayer **24** is adhesively fixed using as adhesive a mastic of uncured rubber in solvent, to the liner **22**, other suitable fixing or securing means (for example, stitching, riveting or other mechanical, chemical or physical fastening means) can be used depending on the intended use of the glove.

[0042] As illustrated in FIGS. **1** and **3**, the overlayer **24** extends, on the palm side **28** of the glove **20**, from the proximal to the distal end of each of the finger stalls **32**, **34**, **36** and **38** and the thumb stall **40**. The overlayer **24** also extends over the tips of the finger stalls **32**, **34**, **36** and **38** and thumb stall **40** and extends, for some distance, on the back hand side **30** of each of the finger and thumb stalls. These extending portions of the overlayer **24** serve to protect the user's fingertips and thumb tip in use.

[0043] The glove **20** includes the covering layer **26** which, as discussed above, is preferably prepared by dip coating the glove, after the overlayer **24** has been secured to the liner **22**, in a polymer. The preferred polymer of synthetic or natural rubber provides some abrasion resistance and, importantly, relatively good grip. An advantage of the covering layer **26** is that it provides protection against liquid or powder ingress into the glove with potentially dangerous consequences for the wearer's hand. It is, thus, preferred if the covering layer covers substantially the whole of the palm side **28** of the glove. The glove may cover the back hand side **30** partially (e.g., from the distal ends of the finger stalls to the knuckle) or wholly.

[0044] In the embodiment illustrated in FIGS. **1** to **3**, the glove also comprises a wrist band **42**. In a gauntlet the wrist band would, in practice, be extended up the forearm of the wearer to provide enhanced protection to the wearer's forearm. This can be of particular importance in industrial handling in the sheet and glass metal industries where wrist and forearm protection is of great importance. If the cut and abrasion resistance of the glove according to the invention is sufficient, such extension of the wrist area of the glove **42** up the forearm may obviate the need for users to wear protective cuffs.

[0045] A glove **20** according to the present invention, and as illustrated in FIGS. **1** to **3**, is typically prepared by knitting the liner **22**, for example, of polycotton using a glove knitting machine.

[0046] The second stage in the manufacture of such a glove is the preparation of the milled rubber to be used for the overlayer **24**.

[0047] The rubber milling process usually involves two mixing stages followed by extrusion. In the first mixing stage, raw, dry rubber is loaded in to cooled roll milling machine where it is masticated for a predetermined period with the addition of processing aids (e.g., mineral oils, diethylene glycol etc), at least one initiator for the cure reaction (e.g., zinc oxide) and one or more accelerators (e.g., MBTS dibenzothiazole disulfide, TMTD/stearic acid, etc.). In the second stage of mixing, the mixture is further cooled to about 60° C. and the cross-linking agent (e.g., sulfur) is added with mixing. After mixing is complete, the mixture is calendared between the rollers to form sheets of the milled, uncured rubber. The sheets may be dusted with an anti-sticking agent (e.g., zinc stearate powder) to reduce sticking during further processing.

[0048] The third stage is the cutting of the milled rubber sheet to shape followed by securing, using an adhesive mastic of rubber in solvent, the milled rubber overlayer **24** to the palm side **28** of the glove, covering each of the finger stalls **32**, **34**, **36** and **38** and the thumb stall **40**.

[0049] The fourth stage is dip coating the glove in a nitrile rubber latex (containing surfactant stabilizers, zinc oxide as initiator, sulfur as cross-linking agent, together with pigment if necessary) to provide the covering layer **26**. The thickness of the covering layer may be controlled by modifying the viscosity of the latex and/or the temperature of the dipping process.

[0050] The final stage of the procedure is drying and curing at about 125 to 130° C. to cure and bond the overlayer **24**, the mastic and covering layer **26**.

[0051] The invention is further illustrated by the following Example.

EXAMPLE

[0052] The following Example is not to be taken in a limiting sense, but is intended to illustrate aspects of the invention.

[0053] The Example is a glove having a liner of polycotton Jersey, an overlayer of milled natural rubber and a covering layer of nitrile rubber formed by dip coating. The milled rubber was prepared by milling, in a two roll mill, a mixture of raw dry natural rubber (100 parts), white oil, DEG and AO

SP oil (7.2 parts together), zinc oxide (5 parts), MBTS, TMTD and stearic acid (2.2 parts together) for 45 minutes at 90-100° C. After cooling the mixture to 60-70° C., sulfur (2 parts) was added, temperature was maintained and the mixture milled for a further 15 minutes. The milled rubber was calendared through the two rolls at a set gap of 1 mm. The milled rubber sheet was dusted with zinc stearate powder.

[0054] The (uncured) milled rubber sheet was cut to the shape of the palm of the glove to form the overlay patch and adhered to the liner using an adhesive of natural rubber mixture in toluene by applying the adhesive to the liner using a brush on the palmar side and up over the finger and thumb tips of the liner. The uncured rubber overlay patch was then placed on to and stuck to the liner using a wall paper roller and heated gently to evaporate the excess solvent from the adhesive.

[0055] The covering layer was produced by dip coating using a nitrile rubber latex at around 45% rubber particles to 65% water containing rubber, accelerators, surfactants, zinc oxide and sulfur. The overlayered liner was loaded on a warm hand-shaped former and left for a short time for the uncured rubber to conform to the shape and also allow the former to cool before dipping. The former was dipped and then positioned in the fingers down position and allowed to drain for about 6 minutes. After draining the former was inverted to the fingers up position and then ramp heated from 80 to 100° C. over 60 minutes before the temperature was gradually increased to 125-130° C. to cure the glove.

Comparative Example

[0056] The Comparative Example is a glove having the same liner and covering layer as the Example but without the milled rubber overlayer.

Abrasion and Cut Resistance

[0057] The abrasion resistance of the Example and Comparative Example were tested according to EN 388:2003 using a Martindale 2000 Abrasion Tester and Oakey Grade F2, Grit 100 abradant. EN 388:2003 specifies 4 levels (the highest being 8000 cycles).

[0058] This abrasion test is standard in the industry but different testing bodies may produce results that are significantly different from one another for the same gloves. Consequently, the abrasion resistance of the Comparative Example was also tested is under the same conditions to give a useful comparison.

[0059] Both the Example and Comparative Example passed the highest, 4^{th} level, Consequently, the standard method of EN388:2003 was modified by replacing the glass paper abradant every 4000 cycles (the same abradant is used throughout in the standard method of EN388) and testing to destruction.

[0060] The Example survived 66,300 cycles of the modified test in total before breakdown, with the outer covering layer showing breakthrough after 10,000 cycles. In comparison, the Comparative Example survived 9,600 cycles before breakthrough. Consequently, gloves according to the invention have a very much higher abrasion resistance than required by the standard abrasion testing method and than the comparison.

[0061] The cut resistance of the Example and Comparative Example were tested according to ASTM 1790-04. The results are presented in the Table.

[0062] As can be seen from the Table, the overlayer results in a significant improvement in the protection to cutting of the glove, of at least 10%, usually of 15% 30 or 20%.

TABLE

	Cut Protection (g)
Example	630
Comparative Example	520

[0063] While the invention has been described in detail and with reference to specific examples thereof, it will be apparent to one skilled in the art that various changes and modifications can be made to the invention without departing from the spirit and scope thereof.

What is claimed is:

1. A personal protective garment for protecting at least a portion of a wearer's body, the garment comprising a liner, an overlayer and at least one covering layer, wherein the liner comprises a flexible material and is adapted to be worn on at least a portion of the body of the wearer, the overlayer comprises a milled polymer and is adapted to cover at least a portion of the liner and is secured to the liner, and the covering layer comprises a polymer and adhering to and covering at least a portion of the overlayer.

2. The personal protective garment as claimed in claim **1**, wherein the garment is for protecting a hand of the wearer.

3. The personal protective garment as claimed in claim **2**, wherein the garment is selected from the group consisting of a glove, a mitten and a gauntlet.

4. The personal protective garment as claimed in claim **3**, wherein the liner comprises a thumb stall for holding a thumb of the wearer.

5. The personal protective garment as claimed in claim **3**, wherein the liner comprises at least one finger stall for holding at least one finger of the wearer.

6. The personal protective garment as claimed in claim **3**, wherein the overlayer covers only a portion of the liner and the covering layer covers substantially the whole of the overlayer and at least a portion of that part of the liner which is not covered by the overlayer.

7. The personal protective garment as claimed in claim **3**, wherein the liner has a palm side and a backhand side and the overlayer covers substantially the whole of the palm side of the liner.

8. The personal protective garment as claimed in claim **7**, wherein the liner comprises at least one finger stall having a proximal end and a distal end and wherein the overlayer is adapted to extend over the distal end of the finger stall thereby covering tip of the finger stall.

9. The personal protective garment as claimed in claim **1**, wherein the liner is a knitted liner.

10. The personal protective garment as claimed in claim **1**, wherein the liner is a cut and sewn liner.

11. The personal protective garment as claimed in claim **1**, wherein the flexible material is selected from the group consisting of cotton, polycotton, steel, polyaramid, wool, polyamide, polyester, polyethylene and combinations thereof.

12. The personal protective garment as claimed in claim **1**, wherein the milled polymer comprises milled rubber.

13. The personal protective garment as claimed in claim **12**, wherein the milled rubber is selected from the group consisting of natural rubber, nitrile rubber, neoprene, silicone rubber, butyl rubber and combinations thereof.

14. The personal protective garment as claimed in claim **1**, wherein the polymer is selected from the group consisting of rubber, polyurethane and combinations thereof.

15. The personal protective garment as claimed in claim **14**, wherein the rubber is selected from the group consisting of nitrile rubber, natural rubber, foam nitrile rubber, butyl rubber, neoprene and combinations thereof.

16. A glove for protecting at least a portion of a hand of a wearer, the glove comprising a liner, an overlayer and at least one covering layer, wherein the liner comprises a flexible material and is adapted to be worn on at least a portion of the hand of the wearer, the overlayer comprises a milled polymer, and the overlayer is adapted to cover at least a portion of the liner and is secured to the liner, and the covering layer comprises a polymer and is adhering to and covering at least a portion of the overlayer.

17. A method of making a personal protective garment for protecting at least a portion of a body of a wearer, the method comprising:

adapting a liner comprising a flexible material to make a cover for at least a portion of the body of the wearer,

adapting an overlayer comprising a milled polymer to cover at least a portion of the liner and securing the overlayer to the liner, and

providing a covering layer comprising a polymer to obtain a polymer coating on at least a portion of the overlayer.

18. The method as claimed in claim **17**, wherein the polymer coating is selected from the group consisting of dip coating, spray coating, curtain coating, and screen printing.

* * * * *