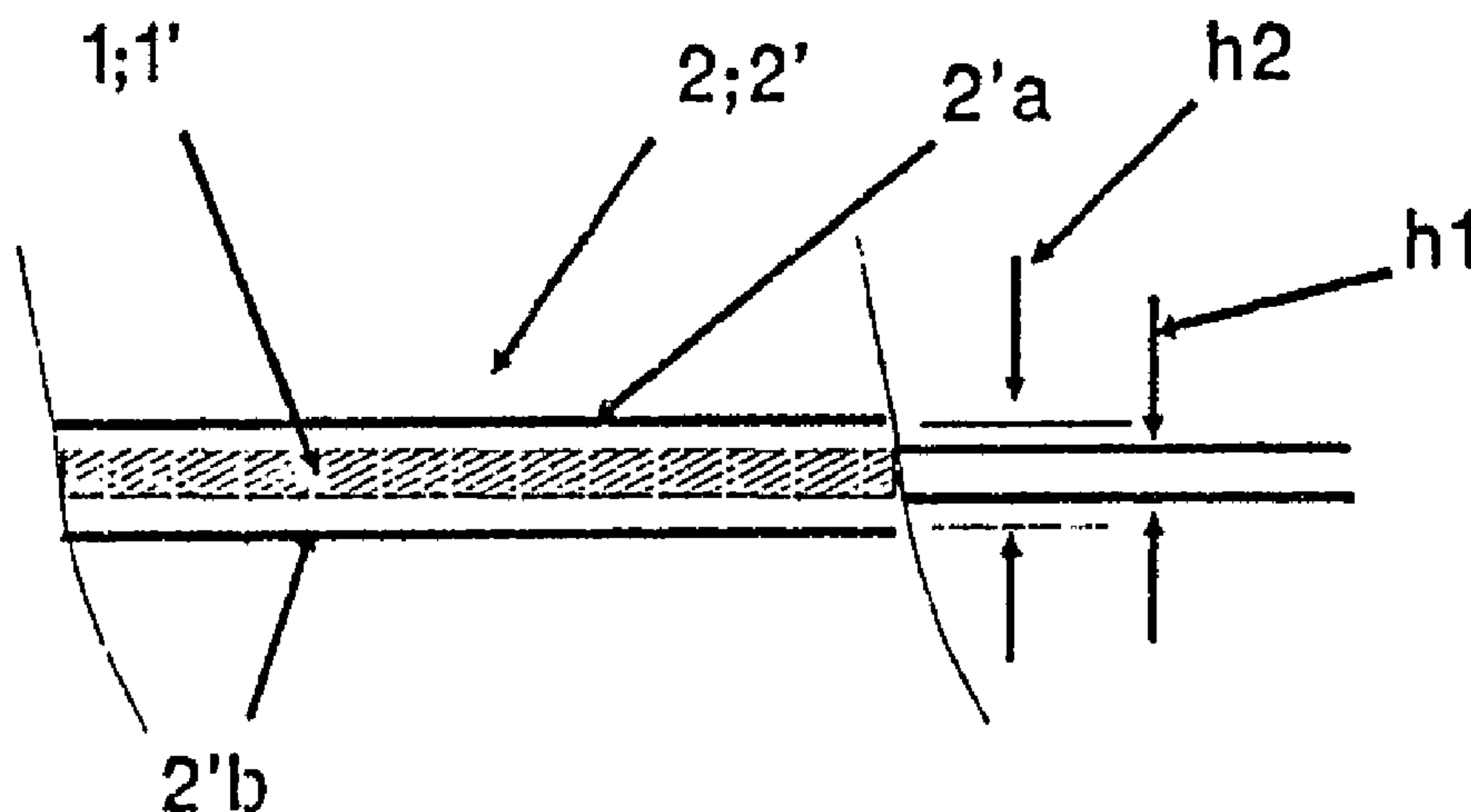




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(54) Titre : PROCEDE DE PRODUCTION D'UNE MATIERE ELASTIQUE PROTECTRICE ET MATIERE ELASTIQUE PROTECTRICE
(54) Title: METHOD FOR PRODUCING ELASTIC PROTECTIVE MATERIAL AND ELASTIC PROTECTIVE MATERIAL



(57) Abrégé/Abstract:

Method for producing an elastic protective material, especially intended for a medical safety glove. The material comprises at least two parts. A core layer (1) is produced by knitting yarn made of high-tenacity polymer fibres; this layer serves to prevent penetration of the glove by a sharp object. The core layer (1) is entirely surrounded by one or several polymer layers (2), which serve to prevent gas or liquid from penetrating the glove. The material is characterized in that, particularly to optimize the sensibility and safety, at least one knitted layer (1') belonging to the core layer (1) is produced to a knitted structure using a machine gauge of at least 10 needles per English inch.



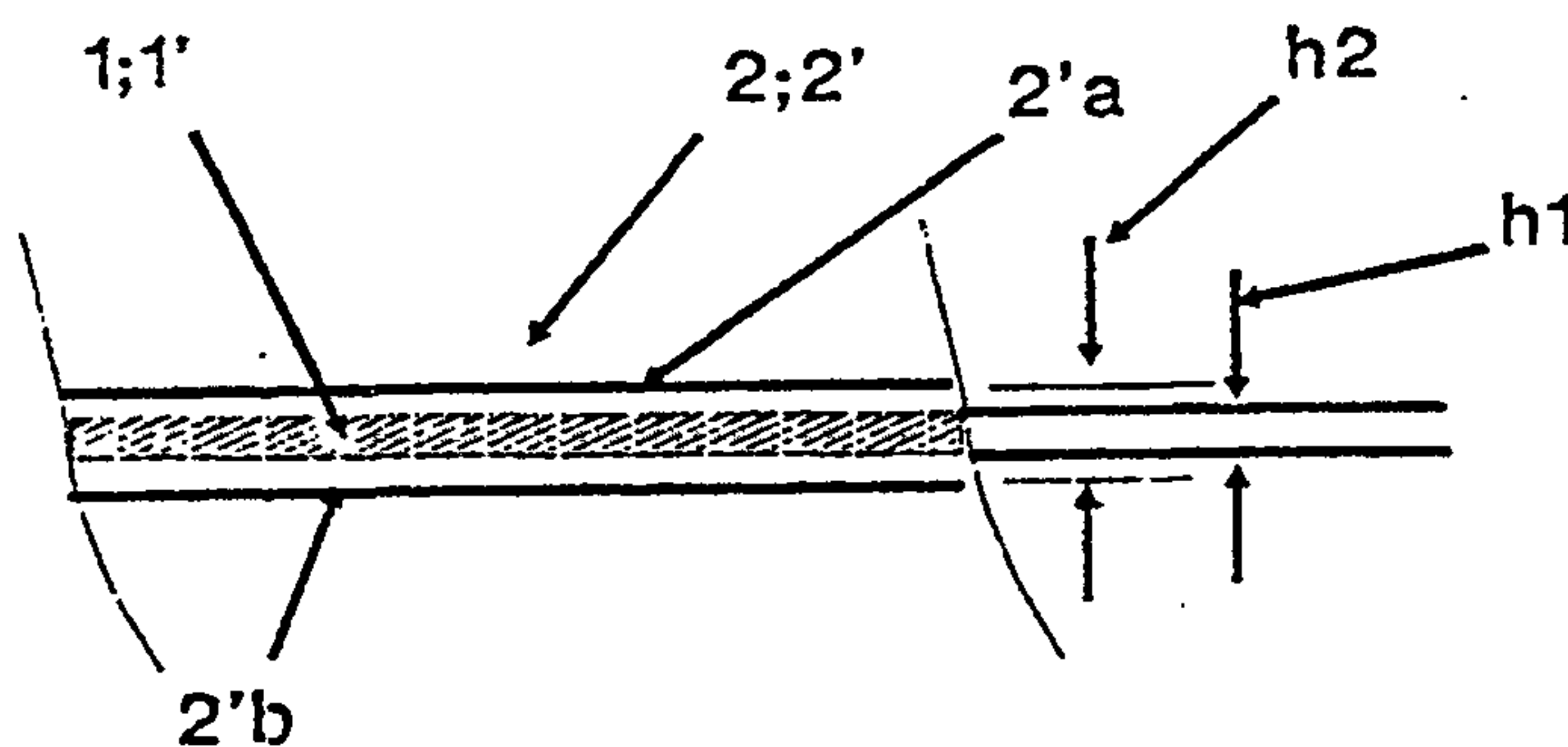
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(54) Title: METHOD FOR PRODUCING ELASTIC PROTECTIVE MATERIAL AND ELASTIC PROTECTIVE MATERIAL**(57) Abstract**

Method for producing an elastic protective material, especially intended for a medical safety glove. The material comprises at least two parts. A core layer (1) is produced by knitting yarn made of high-tenacity polymer fibres; this layer serves to prevent penetration of the glove by a sharp object. The core layer (1) is entirely surrounded by one or several polymer layers (2), which serve to prevent gas or liquid from penetrating the glove. The material is characterized in that, particularly to optimize the sensibility and safety, at least one knitted layer (1') belonging to the core layer (1) is produced to a knitted structure using a machine gauge of at least 10 needles per English inch.



Method for producing elastic protective material and elastic protective material

5 The invention relates to a method for producing elastic protective material, which is formed of at least two part materials being in connection with each other. The first part material is intended particularly to give mechanical protection, such as to prevent a concrete object from breaking through the same, and the second part material is intended particularly to give non-mechanical protection, such as to prevent gas, liquid and/or like from going through the same. To achieve an elastic protective material the first part material is being produced at least partly by knitting preferably from polymer fiber material or like, whereby the second part material, such as one or several polymer material layers or like is being arranged in connection with the knitted layer, that has been produced, at least partly built-in during production.

20 The method according to the invention is applicable for manufacturing of protective material for most heterogeneous purposes. Thus the protective material according to the invention may be advantageously used as manufacturing material particularly for example for protective clothings, such as for safety gloves or the like intended particularly for medical purposes.

30 In the purpose above safety gloves made of most heterogeneous materials are nowadays very generally being used, that are usually made by soaking method or dipping. Particularly because of todays dangerous diseases (e.g. AIDS), that are easily infectious, it is first and foremost important to achieve simultaneously when using a safety glove both adequate hygienic protection to prevent e.g. virus, bacteria infections or the like and mechanical protection e.g.

against unintended cuts and injections. Safety gloves, that are being used in this purpose today do not work well enough, that is why it is very common to use two safety gloves one on another, which naturally makes the use of the safety gloves slower and more difficult. The use of two gloves one on another does not, however, improve mechanical strenght of the basic material of the safety glove decisively particularly considering durability against injections or cuts. This is why in the type of safety gloves in question there has been applied e.g. different kinds of chemical indication arrangements, so that a damage of the safety glove could be revealed e.g. by a change in colour at a wounded point of the safety glove. However, during an operational situation in practice the situation must be considered as a whole so, that when the condition of the patient is critical, the person making an operation is not always able to change the safety glove even if it has got broken. This is why a person making e.g. surgical measures continuously may very often be involved to risk his own health for the sake of the patients' interests.

In the Finnish Patent Application No. 931396, "A Method and apparatus to protect a body or a part of the same and/or make its functioning more effective", there has been presented a solution, that has been developed in certain ways in respect to present safety gloves, particularly when compared to those mentioned before. In the invention in question it is first of all essential, that the clothing to be dressed, such as a protective glove or like is equipped with ducts transmitting energy, such as with light fibers or the like e.g. to lead light to the operating point along fingers.

The safety glove that is included in the solution in question, comprises as an advantageous embodiment an

elastic structure part, that is knitted or woven from high-tenacity fibers made of polymer, whereby as the fiber types different kinds of coal and polyethene fibers, aramid fibers, tissues and/or the like are being used, in which case the protective glove stands further e.g. both autoclaving and ethylene claving, that is performed e.g. in connection of a sterilization of the safety glove enabling re-use of the same.

When making the type of clothing or protective glove in question multi-layered e.g. the inner layer by knitting as said before from strong artificial fibers and the outer layer e.g. from rubber, plastic material or like, that stands chemicals and bacteria, a mechanically strong and well protecting clothing in practice is achieved. In the solution in question e.g. the said lighting effect is achieved by a second structure part, that is attached removeably or in an integrated manner with the inner layer, that has light fibers or like to lead light.

Thus the solution in question comprises as an advantageous embodiment for certain purposes a safety glove or like with a light effect, which is not, however, necessary under all circumstances. Furthermore the principle of the structure represented in the solution above is disadvantageous in that sense, that the knitted layer produced from artificial fibers is, when being placed the way described above, directly against the skin, that is why an adequate sterilization of the same is difficult and expensive to carry out. On the other hand during the product development of the solution in question, a crucial problem that was found at that time was inadequate sensibility of the protective glove, that was being developed in that connection. This is why there had to be stated in the Patent Application about the use of the safety glove for e.g. operative surgical operations of neurosurgery, that

for this kind of purpose the fingertips must be left open to achieve better sensibility.

5 In principle the solution in question is thus a step to the right direction, but it can not as such, however, solve well enough a very common and difficult problem e.g. regarding surgery in practice or other the like purposes, that is to give in every respect simultaneously good enough both mechanical protection and non-mechanical protection for all purposes and under all circumstances.

15 It is the aim of the method according to this invention to achieve a decisive improvement in the problems presented above and thus to raise substantially the level of knowledge in the field. To achieve this aim, the method according to the invention is primarily characterized in, that, particularly to optimize the sensibility and safety enabled by the protective material, at least one knitted layer belonging to the first part material is being produced, preferably from a single jersey knitting or from a derivative of the same by adapting a machine gauge at least 10 needles per English inch.

25 As the most important advantages of the method according to the invention the profitability particularly considering both safety and usability of the protective material enabled by the same may be mentioned. With the protective material being produced according to the invention, it is possible to solve simultaneously the problems concerning both sensibility and adequate mechanical strength as well as non-mechanical protection. After a long period of research and development as well as experimental operations in practice there has been found, that by using a rather fine machine gauge when knitting the knitted layer, it is possible to achieve a thin enough knitted layer particularly

considering sensibility, in which the surface area enabling free penetration is extremely minimal. In the method according to the invention it is further particularly advantageous to take advantage of a rather thin polymer fiber material, whereby when utilizing advantageously a flat knitting machine, being based e.g. on sinker techniques and having preferably a gauge of 13 needles per inch or more, it is possible to achieve a very sensitive and moreover even a completely fully fashioned knitted item. The usual gloves being produced nowadays with automatic machines in practice are in principle one piece knitting, but until now there has been no need in practice to produce completely fully fashioned gloves. This is why concerning gloves produced e.g. by conventional techniques there has always been used always an equal number of needles e.g. in fingers along the whole length of each finger, that is why the stitch density of usual present gloves varies at various points of a glove, inspecially in finger knitting.

The method according to the invention enables thus production of a protective material, which when being used particularly as a manufacturing material for clothing, such as for a safety glove to be used particularly for medical purposes, offers in the same connection significantly better hygienic protection, mechanical protection against cuts, injections or the like as well as sensibility, when compared to present corresponding solutions. When applying the method according to the invention advantageously, the protective material may in this connection furthermore be strengthened in certain respects either by solutions based on knitting techniques or process techniques in connection of the manufacturing process; e.g. the thickness of the safety glove may be varied at various points of the same, e.g. to be thicker from the back side than from the palm side, preferably by adapting

5 e.g. intarsia techniques during knitting. In addition to that the method according to the invention enables that, that the protective material may comprise e.g. a built-in colouring or patterning, that has been arranged during the manufacturing of the same.

Advantageous embodiments of the method according to the invention are presented in the dependent claims directed to the method.

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The invention relates to an elastic protective material, also. The protective material is represented in greater detail in the preamble of the independent claim related to the same. The primary characteristics of the protective material are represented in the characterizing part of the corresponding claim.

20 With the protective material according to the invention it is possible to achieve better protection simultaneously both against mechanical and hygienical strain, than with present materials being used for corresponding purposes. The significantly high numbers of needles per inch being used during production of the knitted layer belonging to the protective material according to the invention combined to the use of significantly fine polymer fiber material, enables furthermore that, that the sensibility of a protective clothing formed of the protective material, such as of a safety glove or a like, is significantly better than those of the same being used nowadays. One primary advantage of the protective material according to the invention is thus, when being used particularly as a manufacturing material for a safety glove, that it is possible to get protected by only one glove well enough under all circumstances during extremely demanding surgical operations, also. The mechanical characteristics of the protective material according to the invention may furthermore be improved e.g. by

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using a knitted layer in the same, the tightness of which, such as cover factor value has been improved by means of process techniques or knitting techniques. With
5 the aid of the protective material according to the invention it is furthermore possible to achieve e.g. a three-dimensional, completely fully fashioned end product, that has been finished to the very end during production of the same, also the colouring, material
10 thickness, total dimensions and/or the like of which are as determined in advance. In this case it is furthermore possible to adjust e.g. the mutual material thicknesses of palm side/back side of the glove.

15 Advantageous embodiments of the protective material according to the invention are represented in the dependent claims related to the same.

In the following description, the invention is
20 illustrated in detail with reference to the appended drawings. In the drawings,

Fig. 1 shows a protective material, that has been produced by means of the method according to the invention, as a principle cross
25 section and

Fig. 2 shows in principle arrangements, that have been used particularly in connection of the knitted layer belonging to the protective material, to improve the
30 characteristics of the same.

According to one aspect of the present invention there is provided a method for making an elastic protective material. The method includes of the steps of knitting a first material part from yarn made of a polymer fiber material, at least one layer of the first material being produced by single jersey knitting to form a three-dimensional fully fashioned structure by adapting a machine gauge of at least 10 needles per inch and forming a second material part having at least one layer of polymer material, made from an antiseptic and sterilizable elastomer or polymer to completely surround both the inside and outside of the first material part.

According to a further aspect of the present invention there is an elastic protective material including a first material part made of a polymer fiber material, at least one layer of said first material part being produced by single jersey knitting to form a three dimensional fully fashioned knitted structure by adapting a machine gauge of at least 10 needles per inch and a second material part, having at least one layer of polymer material, made from an antiseptic and sterilizable elastomer or polymer to completely surround the first material part both outside and inside of the first material part.

As an advantageous embodiment of the method according to the invention the protective material is intended to be used particularly as manufacturing material of a three-dimensional protective equipment that is meant to be dressed. In this case the first part material 1 belonging to the same is being produced from yarn

8a

preferably made of high-tenacity organic polymer fiber material 1a, such as polyethylene fiber (UHMPE), aramid fiber (PPTA), liquid crystal fiber (LCP) and/or like.

5 The knitted structure 1' belonging to the first part material 1 is being produced from thin polymer fiber material 1a, the thickness of which is preferably between 80 - 440 dtex. In this connection preferably a flat knitting machine, being preferably based on sinker
10 techniques and having a gauge of 13 needles per inch or more and enabling a completely fully fashioned knitted structure (1'), is being used. In this connection the definition completely fully fashioned means, that the stitch density is essentially constant at

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various part areas of the three-dimensional knitted clothing, when it is being dressed.

5 As a particularly advantageous embodiment, the method is being adapted in connection, whereby the purpose of the protective material is to serve as manufacturing material for medical purposes, such as to be used for production of protective bandages, safety gloves, protective footwears or headpieces and/or the like. In 10 this case with reference for example to fig. 1 the second part material 2 surrounding the first part material 1 entirely, is being produced preferably from antiseptic and sterilizeable elastomer, polymer and/or like, such as from polyurethane (PUR), ethyl-vinyl- 15 acetate (EVA), polyethene (PE) and/or like. In this connection particularly to increase the efficiency of the protective material considering particularly heavy point loads, such as to prevent penetration of a sharp cut, injection or like, the protective material is 20 being strengthened during manufacturing of the same by means of knitting techniques, process techniques and/or correspondingly, to reduce particularly the surface area of one or several part materials 1, 2 of the protective material enabling free mechanical 25 permeability.

Further as an advantageous embodiment the protective material is being strengthened by means of knitting techniques during production of the same, to reduce 30 particularly the surface area of the knitted layer 1', such as cover factor value of the same or like, belonging to the first part material 1, enabling free mechanical permeability, by adapting whiskers 1a", staple yarns, fibers and/or the like as the polymer 35 fiber material 1a or as part of the same, as shown detail B of fig. 2. In this connection it is possible to act so, also, that plush-loop yarns 1a'", lay-in yarns 1a"" or like complementing the knitted structure

are being used while knitting as shown in detail A of fig. 2.

5 As an advantageous embodiment of the method according to the invention in connection with the knitted layer 1', that has been produced, there is being arranged integratedly an other compound layer 2' belonging to the second part material (2), preferably by a coating method and/or like, such as by dipping, injection, 10 painting, spraying and/or accordingly. In this connection it is possible to strenghten the protective material by means of process techniques during production of the same, to reduce particularly the surface area of the knitted layer 1' belonging to the first part material 1, enabling free mechanical permeability, by adapting as shown in the detail B of fig. 2, 15 preferably metal, ceramic, stone, glass, fiber and/or like based filling materials y as a part of the second part material 2, such as parts of one or several compound layers 2', strenghtening mechanical durability of the same. As a practical embodiment it is possible to take advantage of so called Whiskers y' in this connection as shown in the detail B of fig. 2. In this connection it is naturally possible to adapt yarn 25 material as the polymer fiber material 1a or as part of the same, the cross-sectional surface area of which is extendable preferably by a thermal, pressure, chemical and/or corresponding after-treatment (cf. mercerizing).

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As a particularly advantageous embodiment of the method, the characteristics of the knitted layer 1' belonging to the protective material, such as strenght, colour, thickness and/or like at various 35 part areas of the same, is being varied by forming the knitted layer 1' from part layers I, II, that differ from each other by characteristics of the same. In this connection preferably so called intarsia techni-

ques is being adapted during knitting according to
fig. 2. When adapting intarsia techniques, the knitted
layer 1' is formed of successive part layers I, II, in
which case there are not any so called plush-loop or
5 lay-in yarns at the back side of the knitting. By
adapting the techniques in question it is thus possi-
ble to combine "jointlessly" part areas to the pro-
duct, in which there has been used differing yarn
types 1a", thicknesses 1a, 1a' or even differing
10 structure types at various layers I, II e.g. as shown
in fig. 2.

Furthermore as an advantageous embodiment of the
method, at least one compound layer 2' belonging to
15 the second part material 2 is being arranged in
connection with at least one knitted layer 1' belon-
ging to the first part material 1, by forming a
uniform polymer film or a like three-dimensionally,
preferably by means of positive pressure, such as by
20 blow moulding or accordingly, and/or by means of
negative pressure, such as by vacuum forming or
accordingly, whereby the said layers 2', 1' are being
connected to each other at least partly in an integra-
ted manner preferably by means of e.g. a thermal,
25 pressure and/or chemical lamination treatment.

As explained above the mechanical protection effect of
the protective material according to the invention is
achieved by means of a knitted layer 1' knitted
30 particularly of a thin filament yarn. In practical
tests being performed it has been found profitable to
use furthermore a plane knitting machine based on
sinker techniques and e.g. having a gauge of 13
needles per inch or more, by means of which it is
35 possible to produce as described above a uniform and
exact measured fashion knitting (taylor made). As said
above the various part areas of the knitting may be
strengthened both in the sense of strenght of mate-

rials and fysically as desired if needed e.g. by producing the upper side of the so called safety glove e.g. thicker than the lower side of the same as explained above. In this connection it is advantageous to use as the knitted structure further e.g. a two-dimensional single jersey-structure or a three-dimensional e.g. pique-structure. E.g. in a single jersey-structure an advantageous width of the stitch is proved out to be 1 and the height of the same 1.3.

The protective material according to the invention may be produced as explained above to a three-dimensional shape e.g. in a way, that the polymer material layers 2'a, 2'b, that have been separately integrated to the knitted layer 1' according to the principle as shown in fig. 1, are achieved by dipping and/or by vacuum forming and/or blow moulding as been described before. In this connection one possible way to produce e.g. gloves from protective material according to the invention is e.g. two-stage dipping, whereby first of all the inner surface 2'a of the glove is being formed by using hand mold, whereafter the knitted layer 1' is placed on the coated hand mold. After this the knitted layer will be furthermore integrated throughout inside the polymer material 2 with a second dipping 2'b. In this connection it is possible to use various materials during various dipping stages, in which case inner and outer surfaces having characteristics differing are achieved to the manufactured product.

On the other hand by means of the above mentioned vacuum forming and/or blow moulding methods, a totally or partly integrated end structure of the product may be achieved. In this case as an advantageous embodiment raw material is being formed by means of vacuum forming aided by heat and negative pressure e.g. on a hand mold to achieve the inner surface 2'a of the glove. After this the knitted layer 1' is being placed

on the coated hand mold, whereafter the outer surface 2'b is formed e.g. the same way as the inner surface. In this connection it is possible to adjust the degree of integration by means of heat treatment. On the other hand it is also possible to use blow moulding and vacuum forming in the same connection, whereby a glove preform is being formed first of all by blowing a film on a negative mold, which is thereafter being formed by vacuum on the surface of a positive glove mold.

An elastic protective material according to the invention is formed thus according to fig. 1 of the first part material 1 that gives particularly mechanical protection and of the second part material 2 that gives particularly non-mechanical protection. The first part material 1 is produced by knitting from polymer fiber material 1a, whereby the second part material 2, such as one or several polymer material layers 2' is arranged in connection with the knitted layer 1', that has been produced as explained above partly or totally built-in during production. The knitted layer 1' belonging to the first part material 1 of the protective material according to the invention, is produced, preferably from a single jersey knitting or from a derivative of the same by adapting a machine gauge at least 10 needles per English inch.

Further as an advantageous embodiment, the knitted layer 1' in the protective material to be used particularly as manufacturing material of a three-dimensional protective equipment or a like, that is ment to be dressed, is produced from yarn preferably made of high-tenacity and thin organic polymer fiber material, the thickness of which is preferably between 80 - 440 dtex. In this connection preferably a flat knitting machine, being preferably based on sinker techniques and having a gauge of 13 needles per inch or more, is

being used. As shown in fig. 1 it is possible to produce protective material, in which the thickness h_1 of the knitted layer 1' is for example 100 μ meter, whereby the total thickness h_2 of the protective material is for example 110 μ meter.

On the other hand it is furthermore possible to improve the suitability of the protective material for example for surgical purposes or the like, whereby the protective material is being strengthened during manufacturing of the same by means of knitting techniques, or process techniques, to reduce particularly the surface area of the knitted layer 1' of the same enabling free mechanical permeability. In this connection it is possible to solve the matter by adapting whiskers 1a", staple yarns, fibers and/or the like as the polymer fiber material 1a or as part of the same, as shown detail B of fig. 2, or on the other hand by using plush-loop yarns 1a'", lay-in yarns 1a"" or like complementing the knitting as shown in detail A of fig. 2.

For the above purpose it is possible to strengthen the protective material during production of the same furthermore by means of process techniques. Thus, when adapting for example dipping during production, filling materials y, such as Whiskers y' or like, have been used, as shown in the details A and B of fig. 2, as a part of the second part material 2, such as of one or several compound layers 2', strengthening mechanical durability of the basic material. In this connection it is naturally possible to adapt yarn materials in the knitting, also, the cross section area of which have been expanded by after-treatment.

As a particularly advantageous embodiment, the knitted layer 1' belonging to the protective material, is formed of part layers I, II connected to each other by

intarsia-techniques , the characteristics, such as strength, colour, thickness and/or like of which differ from each other. In this way varying of the characteristics, such as durability, appearance, sensibility and/or the like of the end product being produced from the protective material, is enabled at various part areas of the same. Furthermore this enables attaching of different kinds of product marks in an integrated manner during manufacturing or direct adjustment of the direct sensibility by using differing yarn thicknesses 1a, 1a' or yarn types 1a" in various parts of e.g. a protective or safety glove.

It is obvious, that the invention is not limited to the embodiments presented or described above, but it can be modified within the basic idea even to a great extent. This is due to that, that the method according to the invention may be carried out technically in very many ways, as explained above, by using most heterogeneous manufacturing materials and techniques, in which case the represented guide-like operational measures and pictures show only general principles of certain advantageous embodiments. The method and a protective material being produced by the same according to the invention is thus possible to apply in most heterogeneous connections for most heterogeneous circumstances and purposes.

CLAIMS:

1. A method for producing an elastic protective material, said method comprising the steps of:

knitting a first material part from yarn made of a polymer fiber material, at least one layer of said first material being produced by single jersey knitting to form a three dimensional fully fashioned knitted structure by adapting a machine gauge of at least 10 needles per inch;

forming a second material part, having at least one layer of polymer material, made from an antiseptic and sterilizable elastomer or polymer to completely surround said first material part both outside and inside of the first material part.

2. The method according to claim 1, wherein the knitted structure is produced from thin polymer fiber material, the thickness of which is between 80-440 dtex, by means of a flat knitting machine being based on sinker techniques and having a gauge of 13 needles per inch or more, to a completely fully fashioned knitted structure, in which the stitch density is essentially constant at various part areas of the knitted structure.

3. The method according to claim 1, wherein the protective material is strengthened by means of knitting techniques during production to reduce the surface area of the knitted layer, which enables free mechanical permeability by using plush-loop yarns, or lay-in yarns complementing the knitting.

4. The method according to claim 1, wherein the protective material is strengthened by process techniques during production to reduce the surface area of the knitted layer, which is extendable by an after-treatment.

5. The method according to claim 1, wherein regions of the knitted layer of the protective material are varied by forming the knitted layer from differing part layers by adapting intarsia techniques during knitting.

6. The method according to claim 1, wherein at least one compound layer belonging to the second part material is arranged in connection with the knitted layer of the first part material, by shaping a uniform polymer film three-dimensionally by means of positive pressure or by means of negative pressure, whereby said layers are connected to each other in an integrated manner by means of a thermal, pressurized or chemical lamination treatment.

7. The method according to claim 2, wherein the knitted structure is a three-dimensional safety glove.

8. The method according to claim 4, wherein the after-treatment is thermal, pressure, or chemical.

9. An elastic protective material comprising:
a first material part made of a polymer fiber material, at least one layer of said first material being produced by single jersey knitting to form a three dimensional fully fashioned knitted structure by adapting a machine gauge of at least 10 needles per inch;

a second material part, having at least one layer of polymer material, made from an antiseptic and sterilizable elastomer or polymer to completely surround said first material part both outside and inside of the first material part.

10. The protective material according to claim 9, wherein the knitted structure comprises a completely fully fashioned knitted structure, in which the stitch density is essentially constant at various part areas of the knitted structure, and that is produced by means of a flat knitting machine, being based on sinker techniques and having a gauge of 13 needles per inch or more, from thin polymer fiber material the thickness of which is between 80-440 dtex.

11. The protective material according to claim 9, wherein the protective material is strengthened by means of knitting techniques being adapted during production to reduce the surface area of the knitted layer, which enables free mechanical permeability by using plush-loop yarns, or lay-in yarns complementing the knitting.

12. The protective material according to claim 10, wherein the protective material is strengthened by process techniques adapted during production to reduce the surface area of the knitted layer, which enables free mechanical permeability, by adapting yarn material as the polymer fiber material or as part of the same, the cross-sectional surface area of which is extendable by an after-treatment.

13. The protective material according to claim 9, wherein the knitted layer of the protective material is formed of part layers connected to each other by intarsia-techniques, the part layers differing from each other, at least to enable durability, appearance, or sensibility of a safety glove formed of the protective material to vary at various areas of the safety glove.

14. The protective material according to claim 10, wherein the knitted structure comprises a three-dimensional safety glove.

15. The protective material according to claim 12, wherein the after-treatment is thermal, pressure, or chemical.

