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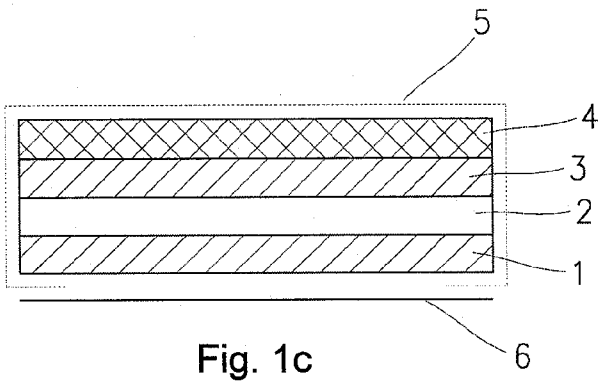

Fig. 1c

(57) Abstract: The invention relates to a multilayer insole with activated carbon, which comprises a supporting layer (1), an active layer (4) with activated carbon and an upper layer (5). Above the supporting layer (1) formed by pressing a mixture of crushed cork and a binder together is arranged at least one damping layer (2), on whose upper side is arranged a intermediate cork layer (3) to form a thermal bridge between the user's foot and the bottom layers of the insole, above the intermediate cork layer (3) is arranged an active layer (4), which is on its upper side covered by an upper layer (5), which is permeable to vapour and liquid moisture, whereby all the layers of the insole are joined together and the insole has spatial shaping, which on its upper side corresponds to the shape of the impression of the lower part of the human foot with planar toe section, with a recess for the big toe joint and a recess for the heel, arid which on the bottom part of the insole corresponds to the shape of the lower part of the human foot with planar toe section The invention also relates to a method of producing this insole and footwear provided with the insole according to the invention.

WO 2017/157357 A2

Multi-layer insole containing activated carbon, method of its production and shoes provided with this insole

Technical field

The invention relates to a multilayer insole with activated carbon, the insole comprising a supporting layer, an active layer containing activated carbon and an upper layer.

The invention also relates to a method of producing this insole.

The invention further relates to footwear provided with the insole according to the invention, whereby the upper of the footwear comprises an outer layer below which a semipermeable membrane is arranged.

Background art

At present, various types of single-purpose insoles for footwear are known. One of them is an insole which is intended to improve comfort of walking since it contains a flexible layer, whose shape adapts to the shape of the lower part of the human sole when used. The disadvantage of this insole is mainly the fact that if the user has a foot which is improperly shaped or if he treads on his foot in an improper manner, the insole shapes itself in such a manner that this defect becomes even worse during wearing.

Another type includes an insole which is designed to improve primarily the quality of walking. This insole has a relief formed by protrusions and recesses on its upper side. The upper side is in contact with the user´s sole and should correspond to the shape of the lower part of his sole. The disadvantage of this insole is the fact that it is shaped according to a unified human foot, disregarding individual foot shape, particularly the shape and inclination of toes, and so during usage toes are forced to adjust to the shape of the insole, which substantially decreases the user´s comfort when walking and could discourage him from using this insole.

Both these types of insoles are sometimes provided with a layer made of antimicrobial or odour-absorbing material based, for example, on impregnation or on a layer containing activated carbon. However, when applying impregnation with activated carbon to the surface layer of the insole, the layer of activated carbon is exposed to abrasion and is therefore of little durability.

CN 103504709 A discloses an insole comprising in direction from upper to bottom side a pure cotton surface layer, an activated carbon middle layer and a PU bottom layer. The disadvantage of the surface layer of cotton is particularly the moisture-retaining ability of cotton or ability to hold liquid moisture, which the surface layer of cotton does not allow to penetrate to the layer with activated carbon. Consequently, the insole in the footwear is constantly humid during use and even after drying it up odours are not completely absorbed, as part of them remains in the surface cotton layer. A similar arrangement of the insole is disclosed also in CN 200966380 Y.

The insole in an arrangement with a surface layer of leather has also the same properties, whether it is natural leather, as is described, for example, in EP 2308335 A1, or artificial leather, because the layer of leather has a relatively great thickness and liquid moisture is retained within the material.

Keeping feet dry is the aim of JP2007289605A. Above a soft bottom part of the insole - with the exception of the heel part - is arranged an upper layer, which is along a part of the insole periphery welded to the bottom part with possibility to open along the rest of the periphery. As a result, a pouch is formed, whereby a bag containing a replaceable moisture absorbent can be put in and out, the absorbent consisting, for example, of silica gel.

CN 104665097 discloses an insole comprising an upper permeable cotton textile layer, and a textile layer with natural vanilla woven in it and a felt layer with activated carbon. Vanilla gives provides aroma and has an important deodorization effect. The disadvantage, on the other hand, is lowfirmness and shape stability of the insole and particularly the fact that moisture is retained in the textile layers, as mentioned above.

The goal of the invention is to propose an insole which would be properly shaped to provide a high level of walking comfort and which would not contribute to improper tread or shaping of the foot and would eliminate the disadvantages of the background art, especially by absorbing odours and liquid moisture. The aim of the invention is also to ensure that moisture is not retained in the textile layers and, at the same time, to ensure that the insole has sufficient antimicrobial and anti-fungal properties with long-term effectiveness.

Principle of the invention

The goal of the invention is achieved by a multilayer insole containing activated carbon, whose principle consists in that above a supporting layer of the insole, which is formed by pressing a mixture of cork granulate and a binder, is arranged at least one damping layer, on whose upper side is arranged a intermediate cork layer to form a thermal bridge between the foot sole of the user and the bottom layers of the insole. Above the intermediate cork layer is arranged an active layer, which is on its upper side covered by an upper layer, which is permeable to both liquid and vapour moisture, whereby all the layers of the insole are joined together and the insole has spatial shaping, which on its upper side corresponds to the shape of the impression of the lower part of the human foot with planar toe section, with a recess for the big toe joint and a recess or depression for the heel, and which on the bottom part of the insole corresponds to the shape of the lower part of the human foot. The supporting cork layer ensures shape stability and low weight of the insole, whereby the insole provides flexible support to the entire foot of the user. In addition, the cork ensures that the other layers of the insole are thermally insulated from the shoe sole, thereby reducing condensation of liquid moisture from vapour which is produced in the footwear above the insole. The non-absorbent upper layer of the insole does not collect moisture in the liquid form, thus adding to the comfort of the wearer.

If the supporting cork layer and the intermediate cork layer are produced during the production of the insole from cork granulate and a binder, the binder also serves to connect these cork layers to the adjacent layers, and therefore it is not necessary to use any other adhesives for connecting the layers, which applies to the embodiment with the active layer arranged on the upper side of the intermediate cork layer.

If a second damping layer is arranged on the upper side of the intermediate cork layer and the active layer is arranged above it, it is necessary to use glue to join the damping layer and the active layer.

For easy and firm fixation on the insole, the upper layer overlaps the circumference of the insole and is folded around this circumference, its folded part being attached to the bottom side of the supporting layer of the insole.

This folded part may be secured by a protective layer glued to the bottom side of the supporting layer of the insole, whereby the protective layer also protects the cork material of the supporting layer from crumbling, breaking and abrasion.

The upper layer is perforated to ensure good passage of both liquid and vapour moisture.

In another embodiment, the upper layer is only permeable to liquid moisture in the direction inwards the active layer.

To further improve the utility properties, the insole comprises a means of beneficial biological effect on humans in a solid or liquid form, which is arranged in the active layer and/or is arranged on the active layer and/or above the active layer.

Also, this means may be arranged below the upper layer or on the upper layer and covered by a non-absorbent auxiliary cover layer, or it may be arranged in a casing arranged on the upper layer of the insole.

The means with a beneficial biological effect on humans may be vitamins, minerals and trace elements, antioxidants, herbs in a solid or liquid form, such as garlic, ginger, nasturtium, etc.

The principle of the method of production of the insole according to the invention consists in that into a mould whose bottom is formed in a shape which corresponds the shape of the lower part of the human foot having a protrusion in the area of the big toe joint, a protrusion in the heel area and planar toe section is inserted an active layer containing activated carbon and after that it is covered by a mixture of crushed cork and a binder in an amount corresponding to the required thickness of the intermediate cork layer, on which is arranged a damping layer, to which is applied a mixture of crushed cork and a binder in an amount corresponding to the required thickness of the supporting layer, whereupon the filled mould, having been covered by a cover part, whose working surface is shaped as an impression of the lower part of the human foot with planar toe section, with a recess in the area of the big toe joint and with a recess or depression in the heel area, is cold-pressed to obtain the resulting spatial shape of the insole, whereupon after the insole is removed from the mould, an upper layer is applied to the active layer, whereby the upper layer conforms to the spatial shape of the upper surface of the insole.

Further increase in the effects of the insole according to the invention is achieved by using it in footwear whose upper comprises an outer layer below which is arranged a semipermeable mebrane, whereby the principle of the footwear consists in that below the semipermeable mebrane is arranged an active layer containing activated carbon, which is from the inner side covered by a non-absorbent inner upper layer permeable to both liquid and vapour moisture.

Description of drawings

Exemplary embodiments of the insole according to the invention are schematically represented in the enclosed drawings, where Fig. 1a shows an insole with an upper layer arranged only on the top, Fig. 1b an insole having an upper layer encircling the sides of the insole and fixed to the bottom side of the supporting layer of the insole, Fig. 1c the insole according to Fig. 1b with a supporting layer covered from the bottom side by a protective layer, Fig. 2 a simplified embodiment of the insole, Fig. 3 an insole with two damping layers, Fig. 4 a shoe provided with the insole, Fig. 5 an insole with an auxiliary cover layer, Fig. 6a a top view of the casing for the means with a beneficial biological effect on humans, and Fig. 6b a cross-section of the casing according to Fig. 6a.

Examples of embodiment

The insole for footwear according to the invention is spatially shaped, whereby it is from its upper side provided with shaping corresponding to the form of the impression of the lower part of the human foot with planar toe section, with a recess for the big toe joint and a heel recess, and on its bottom side is provided with shaping corresponding to the shape of the lower part of the human foot with planar toe section according to CZ patent 298894, or a recess or depression is formed in its heel area from the upper side according to CZ PV 2009-580, in which a heel recess or depression is formed, which is thus the lowest part on the upper side of the insole.

In the basic exemplary embodiment, shown in Figs. 1a to 1c, the insole comprises a supporting layer 1 which is made by cold pressing from a mixture of crushed cork and a suitable binder, such as polyurethane. The supporting

layer 1 supports the entire insole and provides sufficient rigidity and flexibility to the insole, as well as low weight, shape stability and good thermal insulation properties. The bottom side of the supporting layer 1 is intended for the contact with the shoe sole.

On the supporting layer 1 is arranged a damping layer 2 made of a foam material, which softens the contact of the user´s foot sole with the insole and partially absorbs shocks created during walking, which results in further increase in the comfort of using of the insole and at the same time decreases the mechanical stress of other layers of the insole. Due to its thermal insulation properties, the supporting layer 1 forms a thermal bridge between the shoe sole and the upper part of the insole, thus preventing the heat transfer, especially the cold transfer from the shoe sole to the upper part of the insole and the human foot.

On the upper side of the damping layer 2 is arranged a intermediate cork layer 3, which is in the exemplary embodiment made by cold pressing from a mixture of crushed cork and a suitable binder, such as polyurethane. The intermediate cork layer 3 may be made by cutting from cork sheets and gluing to the adjacent layers. Due to its thermal insulation properties, the intermediate cork layer 3 forms a thermal bridge between the user´s foot and the bottom layers of the insole and thus prevents heat and moisture transfer from the wearer´s foot to the bottom layers of the insole, in which the moisture would condense and would cause moistening of the footwear from inside.

On the upper side of the intermediate cork layer 3 is arranged an active layer 4, which contains activated carbon in any suitable form. In a preferred embodiment, the active layer 3 is formed by non-woven fabric or felt, between whose fibres is arranged activated carbon, whereby it is advantageous if the activated carbon is bound to the fibres or between them to reduce risk of loosening from the active layer 4. In a specific example of embodiment, non-woven fabric containing activated carbon made by the company Fibrex Nonwovens, Denmark, with trade name Carbotex was used as the active layer. Owing to the extensive surface of activated carbon (400 to 1500 m^2/g), the active layer 4 ensures absorption of odours and moisture and, in addition, it provides the insole antimicrobial and antifungal properties. Therefore, the insole

is unobjectionable in terms of hygiene and has antimicrobial and antifungal properties.

The active layer **4** is from the upper side covered by a non-absorbent upper layer **5**, which is intended for the contact with the user´s foot and is made of foil, textile or non-woven textile with antifungal and/or antibacterial and/or antistatic treatment. The upper layer **5** is permeable to both liquid and vapour moisture, whereby in a specific embodiment this permeability is ensured by fine perforation. The upper layer **5** and the active layer **4** are joined together by means of a thermal adhesive. In a preferred embodiment, the upper layer **5** is only permeable to liquid moisture in the direction inwards the insole and prevents liquid moisture from passing back to the surface of the insole.

In an example of embodiment according to Fig. 1b, the upper layer **5** is larger, its edges being folded around the circumference of the insole and fixed to the lower side of the supporting layer **1** by gluing or using another suitable method.

In the example of embodiment according to Fig. 1c, the insole according to Fig. 1b is used, but the bottom layer of the supporting layer **1** is covered by the protective layer **6**, preventing cork from crumbling and/or breaking. The material of this layer **6** may be the same as that of the upper layer **5**, but it does not have to be perforated, or it is possible to use another suitable material which would provide sufficient protection to the cork of the supporting layer **1**.

During production of the insole, into a mould of a required size, whose bottom is shaped as the lower part of the human foot with planar toe section, with a protrusion in the area of the big toe joint and a protrusion or elevation in the heel area, which is a negative of the shape of the upper part of the insole, is first of all inserted an active layer **4** of a corresponding size. Then a mixture of crushed cork and a suitable binder in an amount corresponding to the required thickness of the intermediate cork layer **3** is poured over the mould and is spread evenly on the entire area of the active layer **4**. Measuring out the required amount is performed either by volume or by weighing. Subsequently, a damping layer **2** of a corresponding size is arranged on the mixture of crushed cork and a binder of the intermediate cork layer. A mixture of crushed cork and a binder in an amount corresponding to the required thickness of the supporting layer **1** is poured over the damping layer **2** and is spread evenly and the filled

mould is covered by the cover part of the mould, whose surface abutting the insole being produced is shaped as an impression of the lower part of the human foot sole with planar toe section, with a recess in the area of the big toe joint and a recess or depression in the heel area, which is thus a negative of the shape of the lower part of the insole. The two part mould is inserted into a press, where the mixture of crushed cork and the binder stiffens under pressure, whereby it is at the same time connected to the adjacent layers of the insole and is shaped to acquire the resulting shape of the insole.

After removing the insole from the mould, on the upper surface of the active layer **4** is arranged an upper layer **5**, which is provided on its contact surface with a hot melt adhesive, the edges of the upper layer are folded around the edges of the insole and the upper layer **5** is inserted into the respective mould in a thermal press and is fixed to the active layer **4**, as well as to the bottom of the supporting layer **1** around the edge of the insole. Subsequently, a protective layer **6** is arranged on the bottom side of the supporting layer **1** and is hot glued. Both the upper layer **5** and the protective layer conform to the shape of the insole on the respective surface. In an alternative embodiment, the upper layer **5** is fixed only to the bottom side of the supporting layer **1** after folding the upper layer **5** around the edges of the insole.

In cases when the upper layer **5** has the same size as the active layer **4**, or as the entire insole it is advisable after it is glued to the active layer **4** to promote the coherence of the individual layers of the insole by sewing, preferably using Strobel stitching.

A simplified embodiment of the multilayer insole according to the invention is shown in Fig. 2, where the intermediate cork layer is omitted and the insole comprises a supporting layer **1**, a damping layer **2**, an active layer **4** and an upper layer **5** arranged on top of each other. The upper layer **5** may be arranged in any of the methods described in the embodiments according to Figs. 1a to 1c, whereby the arrangement according to Fig. 1c also comprises a protective layer covering the bottom side of the supporting layer **1**.

The insole according to Fig. 3 serves to promote the effect of softening the impact during walking. In comparison to the embodiment according to Figs. 1a and 1c, this insole has a second damping layer **2** inserted between the active layer **4** and the intermediate cork layer **3**.

Further improvement of utility properties of the insole is achieved during the production of the insole by inserting the means **7** with a beneficial biological effect on humans below the upper layer **5** of the insole, which means that the means is either incorporated into the active layer **4**, or arranged on the active layer **4**. The means **7** with a beneficial biological effect on humans is inserted in a suitable solid form, for exampleas a powder, granular material, fractions or in a liquid form, such as a tincture, a solution or an extract, from which, however, the liquid portion must be generally evaporated before using the insole. The means **7** with a beneficial biological effect on humans is selected from a group consisting of vitamins, minerals and trace elements, antioxidants, herbs, such as garlic, ginger, nasturtium, in a solid or liquid form. The effect of these means **7** with a beneficial biological effect on the user of the insole through his foot sole has been experimentally proven, whereby optimal results are obtained during walking. First specific experiments were conducted with herbs, garlic, ginger and nasturtium, whereby the herbs were used both ground and in a liquid extract form. The means **7** with a beneficial biological effect on humans in a liquid form can also be added into the insole through the upper layer **5** without removing it, for example, by dripping or by roller coating, and can be renewed over a required period at specific intervals. In the future it is conceivable that the means **7** will be incorporated into suitable textile layers containing fibres, microfibres and/or nanofibres, whereby the means **7** with a beneficial biological effect on humans may be also drugs.

Placing the means **7** with a beneficial biological effect on humans below the upper layer **5** in a solid form requires the replacement of the entire insole when need arises to replace the means **7**. In order to simplify the replacement of the means **7** with a beneficial biological effect on humans, the means **7** can be inserted above the upper layer **5** and subsequently covered by an auxiliary cover layer **51** which is permeable to both liquid and vapour moisture and which is provided on its bottom surface with a contact adhesive, as is shown in Fig. 5. For the fixation of the auxiliary cover layer **51** it is advantageous if this layer overlaps the edges of the insole and can be fixed to the bottom surface of the supporting layer **1** after it is folded around the edges of the insole. The auxiliary cover layer **51** can be removed, the means **7** below can be replaced by another means and the auxiliary cover layer glued again, or the original layer can be

removed, the means **7** replaced and a new auxiliary cover layer **51** can be glued to the rest of the insole. Also, this solution can be used in a combination with the above-described arrangement of the means **7** below the upper layer **5** during the production of the insole.

In addition, to allow replacement and/or combination of means **7** with a beneficial biological effect on humans, the means can be accommodated in a special closeable or closed casing **50** formed by two layers **501** and **502** permeable to both liquid and vapour moisture, as is shown in Figs. 6a, 6b. The casing **50** can be attached to the upper surface of the upper layer **5** of the insole. For example, it can be glued to the upper surface of the upper layer **5** of the insole (Fig. 6a), or to the bottom surface of the supporting layer **1** of the insole by means of a circumferential welt **500**, which is folded around the edges of the insole (Fig 6b).

The effects of the layered insole according to the invention can be further enhanced by using it in a shoe whose upper **11** comprises an outer layer **12** made from known materials, such as natural leather, artificial leather or textile, the outer layer **12** being perforated to increase its permeability to vapour. Below the outer layer **12** is arranged a semipermeable mebrane **13**, allowing the passage of vapour outwards. On the inner side of the semipermeable mebrane **13** is arranged the active layer **4** containing activated carbon, being the same in a preferred embodiment as in the above-described insole. From the inner side the active layer **4** is covered by an inner non-absorbent upper layer **5**, which is permeable to both liquid and vapour moisture, is intended for the contact with the user´s foot and is formed by foil, textile or non-woven fabric, preferably with antifungal and/or antibacterial and/or antistatic finishing treatment, whereby permeability to both liquid and vapour moisture is in the particular embodiment ensured by fine perforation, as is the case with the upper layer of the insole. In the first step of production the inner upper layer **5**, the active layer **4** and the semipermeable mebrane **13** are sewn together and subsequently the outer layer **12** is sewn to them.

Industrial applicability

The invention is applicable in the footwear industry.

List of references

1	supporting layer
2	damping layer
3	intermediate cork layer
4	active layer with activated carbon
5	upper layer
51	auxiliary cover layer
50	casing
501, 502	layers of the casing
500	circumferential welt of the casing
6	protective layer
11	upper of the footwear
12	outer layer of the upper
13	semipermeable mebrane

PATENT CLAIMS

1. A multilayer insole with activated carbon which contains a supporting layer (1), an active layer (4) with activated carbon and an upper layer (5), **characterized in that** above the supporting layer (1), formed by pressing a mixture of cork granulate and a binder together, is arranged at least one damping layer (2), on whose upper side is arranged a intermediate cork layer (3) to form a thermal bridge between the user´s foot and the bottom layers of the insole, above the intermediate cork layer (3) is arranged the active layer (4), which is on its upper side covered by the upper layer (5), which is permeable to vapour as well as to liquid moisture, whereby all the layers of the insole are joined together and the insole has spatial shape, which corresponds on upper side of the insole to the shape of the impression of the lower part of the human sole with planar toe section, with a recess for the big toe joint and a recess for the heel, and which corresponds on the bottom surface of the insole to the bottom part of the human sole with planar toe section.

2. The multilayer insole according to Claim 1, **characterized in that** the active layer (4) is arranged on the upper side of the intermediate cork layer (3).

3. The multilayer insole according to Claim 1, **characterized in that** on the upper side of the intermediate cork layer (3) is arranged a second damping layer (2) and on its upper side is arranged the active layer (4).

4. The multilayer insole according to any of the preceding claims, **characterized in that** the upper layer (5) overlaps the circumference of the insole, is folded around this circumference and its folded part is fixed to the bottom side of the supporting layer (1).

5. The multilayer insole according to Claim 4, **characterized in that to** the bottom side of the supporting layer (1) is fixed a protecting layer (6), which serves to secure the folded part of the upper layer (5) and to protect the cork material of the supporting layer (1).

6. The multilayer insole according to any of the preceding claims, **characterized in that** the upper layer (5) is at least on the upper side of the insole perforated.

7. The multilayer insole according to one of claims 1 to 5, **characterized in that** the upper layer (5) is permeable to liquid moisture only in the direction inwards the active layer (4).

8. The multilayer insole according to any of the preceding claims, **characterized in that** it contains a means (7) with a beneficial biological effect on humans in liquid or solid form arranged in the active layer (4) and/or arranged on the active layer (4) and/or above the active layer (4).

9. The multilayer insole according to Claim 8, **characterized in that** the means (7) with a beneficial biological effect on humans is arranged below the upper layer (5).

10. The multilayer insole according to Claim 9, **characterized in that** between the upper layer (5) and the means (7) with a beneficial biological effect on humans is arranged a non-absorbent layer (52), which is permeable to both liquid and vapour moisture.

11. The multilayer insole according to Claim 8 **characterized in that** the means (7) with a beneficial biological effect on humans is arranged on the upper layer (5) and covered by a non-absorbent auxiliary cover layer (51) which is permeable to both liquid and vapour moisture.

12. The multilayer insole according to Claim 8, **characterized in that** the means (7) with a beneficial biological effect on humans is arranged in a case (50) arranged on the upper layer (5), whereby both the layers (501, 502) of the case (50) are non-absorbent and are permeable to both liquid and vapour moisture.

13. The multilayer insole according to one of claims 8 to 12, **characterized in that** the means (7) with a beneficial biological effect on humans is selected from a group consisting of vitamins, minerals and trace elements, antioxidants, herbs, such as garlic, ginger, nasturtium, in a solid or liquid form.

14. A method of production of the insole according to Claim 1 or 2, **characterized in that** an active layer (4) is inserted into a form, whose bottom is formed in a shape which corresponds to the shape of the lower part of the human foot with protrusion in the area of the big toe joint, protrusion in the heal area and with planar toe section, whereby onto the active layer (4) is applied a mixture of crushed cork and a binder in an amount corresponding to the

required thickness of the intermediate cork layer (3), on which is arranged a damping layer (2), to which is arranged a mixture of crushed cork and a binder in an amount corresponding to the required thickness of the supporting layer (1) and the filled mould after being covered by its cover part, whose working surface is shaped as an impression of the lower part of the human foot with planar toe section, with a recess in the area of the big toe joint and with a recess or depression in the heel area, is cold-pressed to obtain the resulting spatial shape of the insole, whereby its individual layers are shaped and bonded together, wheraupon after removal from the mould the upper layer (5) is connected to the active layer (4), whereby the upper layer (5) conforms to the spatial shape of the upper surface of the insole.

15. Footwear provided with the insole according to any of Claims 1 to 13, whose upper comprises an outer layer (12), below which a semipermeable mebrane (13) is arranged, **characterized in that** below the semipermeable mebrane (13) is arranged the active layer (4) containing activated carbon, which is on the inner side covered with an inner upper layer (5) permeable to both liquid and vapour moisture.

16. The footwear according to Claim 15, **characterized in that** the inner upper layer (5) is perforated.

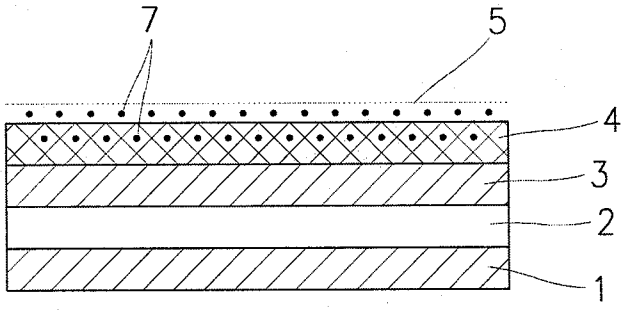

Fig. 1a

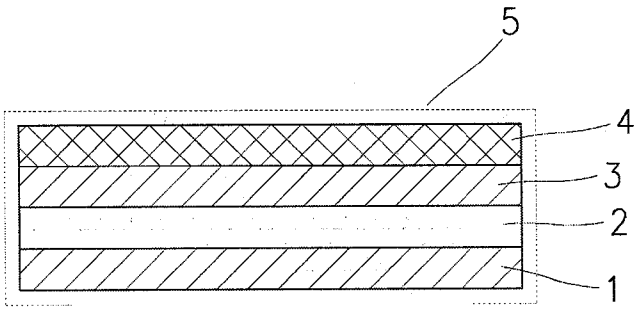

Fig. 1b

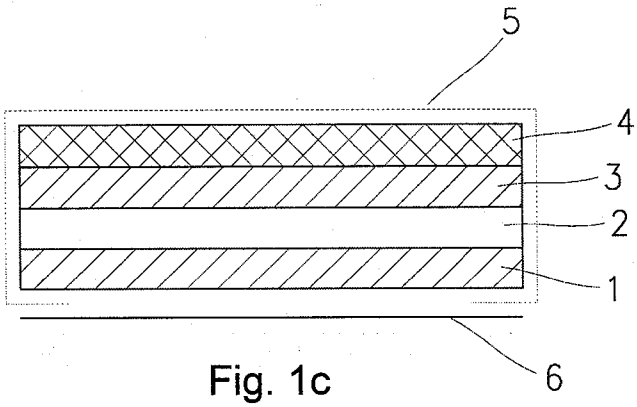

Fig. 1c

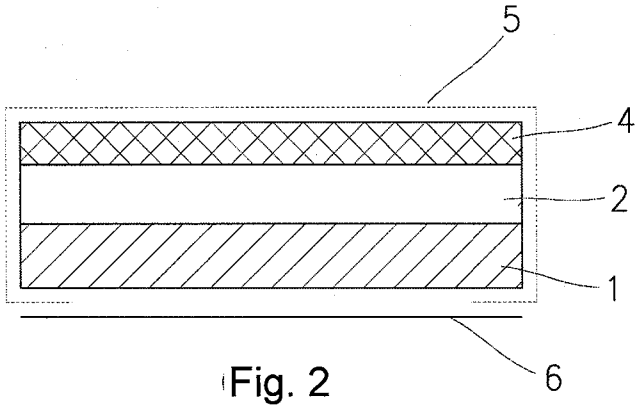

Fig. 2

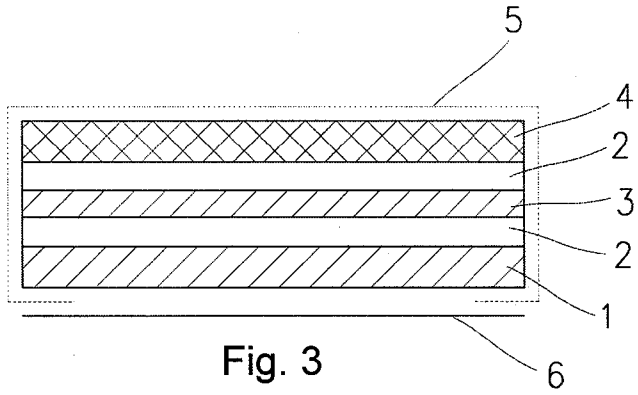

Fig. 3

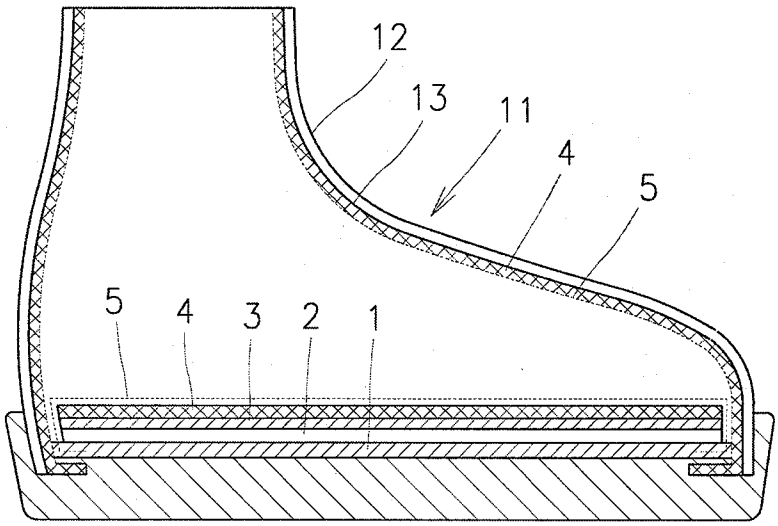

Fig. 4

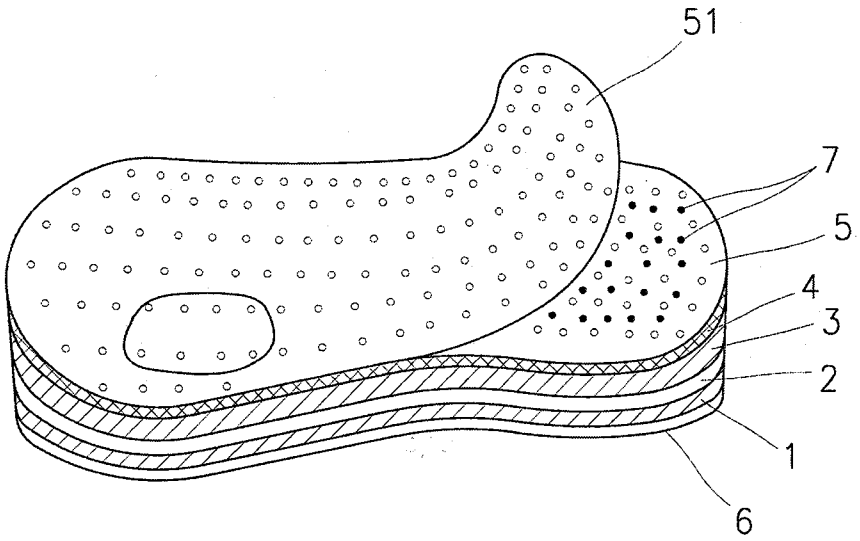

Fig. 5

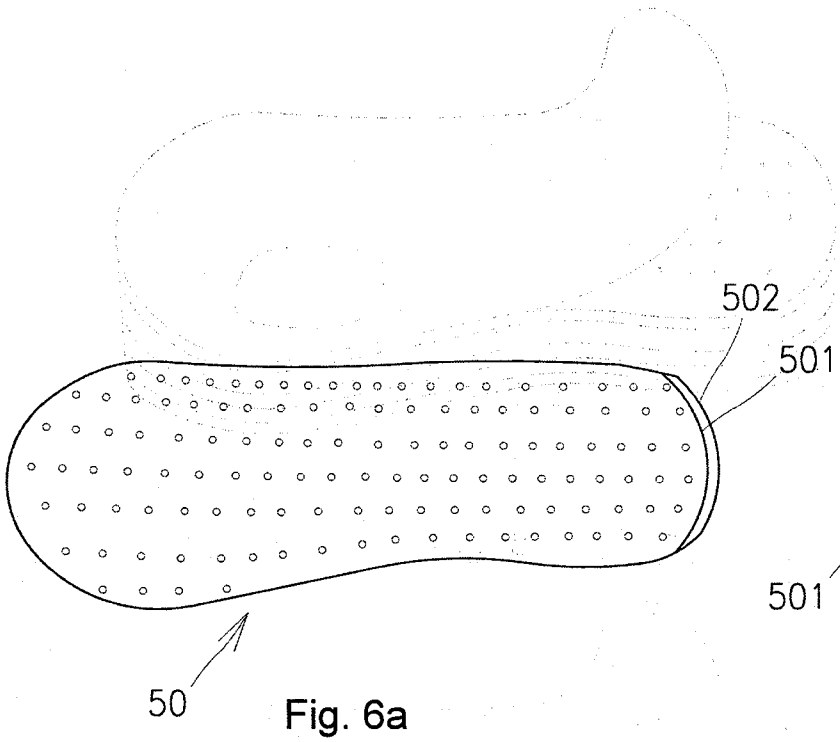

Fig. 6a

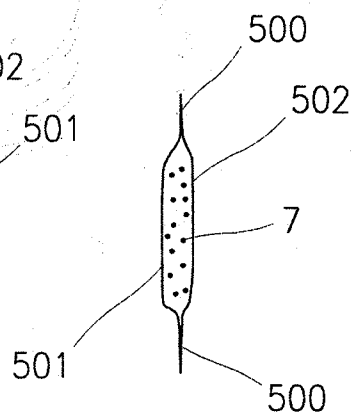

Fig. 6b