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(54) A waterproof sole with high air and vapor permeability.

(57) The present invention relates to a waterproof sole with high air and vapor permeability including an upper layer made of breathable and waterproof material, a lower layer made of breathable and waterproof material, a shaped supporting layer made of rubber-like material between the upper layer and lower layer, and an outsole layer made of rubber-like material below the lower layer. A hollow space and a plurality of channels are connected to the bottom surface of the upper layer. A plurality of supporting projections are provided at the bottom surface of the supporting layer. An outsole layer made of rubber-like material below the lower layer, a plurality of through-holes and the inter-connected horizontal channels are provided in the outsole layer. The sole according to the present invention improves significantly the air and vapor permeability of the sole and therefore the comfortability of the shoes made with such soles and prevents odour build-up as well as much improves the water resistant property of the sole.

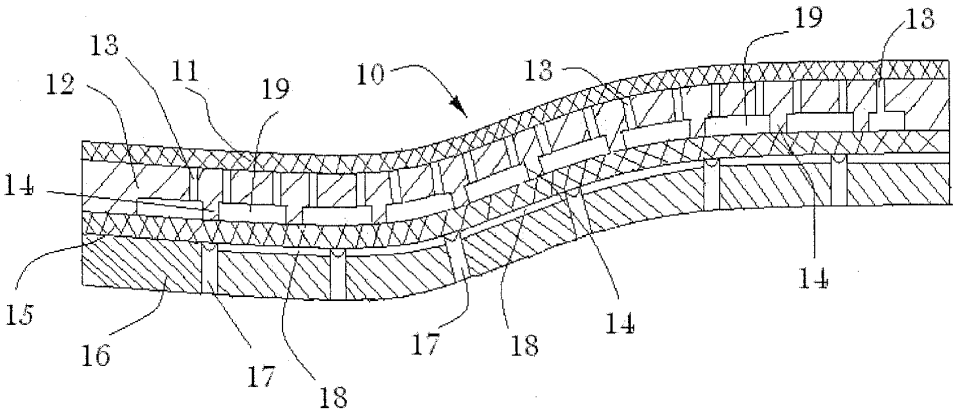


Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a waterproof sole with high air and vapor permeability.

BACKGROUND OF THE INVENTION

[0002] As is known to all, air permeability and water vapor permeability are two critical aspects that affect the comfortability of shoes. The water vapor and sweat in the shoes can be taken away by the air exchange. The exchange of air, water vapor, and heat between the in-shoe microenvironment and the outside environment has been the subject of quite a few inventions. All the efforts are trying to improve these exchange and therefore to reduce the moist in the microenvironment inside shoes and to improve their comfortbility.

[0003] US 6,508,015 disclosed a breathable outsole for footwear, in which the outsole has a two-layer structure. The two-layer structure contains an elastic and water vapor-permeable inner layer and an outer layer that covers less than 70% of the inner layer. The breathing activity of outsole is provided by the microporous structure of inner layer and the configuration of outer layer. The configuration of outer layer is such that the surface of inner layer available for water vapor exchange is restricted as little as possible. A microporous structure of insole is achieved, for example, by a sintered plastic.

[0004] US 6,655,048 disclosed a breathable and waterproof sole for shoes, which comprises, at least along part of its extension, a lower waterproof component, which constitutes the tread; an upper component, with a supporting structure which has chambers which are connected to openings at least on the upper face and the edge; a membrane which is impermeable to water and vapor-permeable and externally surrounds at least the outward-facing regions of the upper component. The lower and upper components and the membrane are joined so as to form a seal at least in the regions where water infiltration is possible.

[0005] A vapor-permeable and waterproof sole for shoes was disclosed in US 6,681,500, which comprising: a lower flat element made of shaped rubber-like material, which has a hollow upper region delimited by a border with air passage openings which extend laterally with respect to the ground resting plane; an upper element; a membrane made of waterproof and vapor-permeable material, which is interposed between said lower and upper element at said hollow region; said lower and upper elements and said membrane being joined hermetically in the perimetric regions of mutual contact.

[0006] US 7,367,141 disclosed a waterproof and breathable sole for shoes, having a structure including a supporting layer which, at least in a preset macroportion, is made of net, felt, or other diffusely perforated material. A membrane made of a material that is impermeable to water and permeable to water vapor is associated above the supporting layer at least in the one preset macroportion made of net, felt or other diffusely perforated material, which it covers. A tread made of plastic material, with at least one through macroperforation at the at least one preset macroportion made of net, felt or other diffusely perforated material, is joined hermetically to the membrane and to the supporting layer at least at the perimeter of the at least one macroportion made of net, felt or other diffusely perforated material.

[0007] Although the above-mentioned soles have been commercially available for years and are able to provide the exchange of heat and water vapor between the in-shoe microenvironment and outside environment, the problem for better air permeability still remains in the shoes with these kinds of soles. In the case of the above soles, the functions of air, water vapor, and heat exchange to outside environment cannot be realized with the desired rate and hence the comfortability is still limited due to the membrane water impermeable materials and the limited space for air and water vapor exchange. These waterproof membrane have the air permeability of 300.000 $kPa \cdot s \cdot m^{-1}$ to 700.000 $kPa \cdot s \cdot m^{-1}$.

SUMMARY OF THE INVENTION

[0008] Due to the problem of the prior art that the soles that only have limited air, water vapor, and heat exchanges, the objective of the present invention is hence to provide a waterproof sole with high air and vapor permeability.

[0009] The objective of the present invention is also to provide a shoe.

[0010] According to one aspect of the present invention, a waterproof sole with high air and vapor permeability is provided herein, which includes:

An upper layer made of breathable and waterproof material;

A lower layer made of breathable and waterproof material;

A shaped supporting layer made of rubber-like material between the upper layer and lower layer with a hollow space and with a plurality of channels connecting to the bottom surface of the upper layer, and with a plurality of supporting projections at the bottom surface of the supporting layer;

An outsole layer made of rubber-like material underneath the lower layer with a plurality of through-holes and a plurality of horizontal channels on the upper side of the outsole layer inter-connecting through-holes.

[0011] Advantageously, the upper layer and/or the lower layer are made of breathable waterproof materials.

[0012] More advantageously, the upper layer and/or the lower layer are made of breathable and waterproof materials with the air permeability of 1.500 $kPa \cdot s \cdot m^{-1}$ to 300.000 $kPa \cdot s \cdot m^{-1}$.

[0013] Advantageously, the plurality of channels are perpendicular to the bottom surface of the supporting layer.

[0014] Advantageously, the plurality of supporting projections are perpendicular to the bottom surface of the supporting layer.

[0015] Advantageously, the plurality of supporting projections are supporting columns.

[0016] Advantageously, the plurality of through-holes are inter-connected to each other with the plurality of horizontal channels on the upper side of the outsole layer.

[0017] More advantageously, the through-holes have their bottom ends at the bottom of outsole layer.

[0018] According to another aspect of the present invention, a shoe including the above-mentioned sole is also provided.

[0019] The waterproof sole with high air and vapor permeability according to the present invention has the improved structure which contains a hollow space in the sole, which makes the air and water vapor flow freely inside it, this free flow of air and vapor will facilitate the balance of the heat generated. Once the sole is depressed by the weight of the shoe wearer, because of the high pressure, the air and water vapor will be forced to pass through the highly air and vapor permeable waterproof material layer to the outside through the through-holes and inter-connecting horizontal channels. When the pressure is released, the fresh air from outside can be sucked into the hollow space through the through-holes and the connecting channels passing through the waterproof material layer due the pressure difference. This way, the air, water vapor, and heat exchanges are more efficient.

[0020] The another advantage of the new design of the sole is that it can prevent the water pressure building up in the through-holes so as to largely improve the water resistance of the sole. It is well know that the distribution of the pressure of feet is non-uniform.[1] When the sole is in contact with water, due to the pressure distribution, certain parts of the sole will have much higher pressure building up, such as those under metatarsals and heel, while other parts such as under the mid-foot would have much less pressure. Once the water pressure increases in the through-holes of the high pressure parts of the sole, water can be directed by the inter-connecting channels to the parts where the pressure is low and the water may even flow out of the outsole through the through-holes in those parts. As a result, the water pressure will not be built up. This way, the water resistance property of the sole can be significantly improved, even with the use of materials such as fluorochemicals surface treated textile fabrics.

[0021] In summary, the design of the sole currently described has the advantage of high air and vapor permeability and facilitate the heat exchange with outside environment. With such sole design, the comforability of the shoe made with the sole would be largely improved. In addition, the design of the sole also prevents the water pressure build-up so that a wide variety of water resistant and water-repellent materials can be used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The accompanying drawings illustrate one or more embodiments of the invention and, together with the written description, serve to explain the principles of the invention. Wherever possible, the same reference numbers are used throughout the drawings to refer to the same or like elements of an embodiment, and wherein:

Fig. 1 is the cross-section view of the waterproof sole with high air and vapor permeability according to the present invention;

Fig. 2 is the exploding perspective view of the waterproof sole with high air and vapor permeability according to the present invention;

Fig. 3 is the bottom perspective view of the supporting layer;

Fig. 4 is the top perspective view of the outsole layer.

Fig. 5 is the top perspective view of the through-holes and the horizontal channel in the outsole layer.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present invention is more particularly described in the following examples that are intended as illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. Various embodiments of the invention are now described in detail. Referring to the drawings, like numbers indicate like components throughout the views. As used in the description herein and throughout the claims that follow, the meaning of "a", "an", and "the" includes plural reference unless the context clearly dictates otherwise. Also, as used in the description herein and throughout the claims that follow, the meaning of "in" includes "in" and "on" unless the context clearly dictates otherwise.

[0024] The terms used in this specification generally have their ordinary meanings in the art, within the context of the invention, and in the specific context where each term is used. Certain terms that are used to describe the invention are discussed below, or elsewhere in the specification, to provide additional guidance to the practitioner regarding the description of the invention. The use of examples anywhere in this specification, including examples of any terms discussed herein, is illustrative only, and in no way limits the scope and meaning of the inven-

tion or of any exemplified term. Likewise, the invention is not limited to various embodiments given in this specification.

[0025] As used herein, the terms "comprising," "including," "having," "containing," "involving," and the like are to be understood to be open-ended, i.e., to mean including but not limited to.

[0026] Fig. 1 is the cross-section view of the waterproof sole with high air and vapor permeability according to the present invention, Fig. 2 is the exploding perspective view of the waterproof sole with high air and vapor permeability according to the present invention, Fig. 3 is the bottom perspective view of the supporting layer, Fig. 4 is the top perspective view of the outsole layer, Fig. 5 is the top perspective view of the through-holes and the horizontal channel in the outsole layer.

[0027] As shown in Fig. 1 and 2, a waterproof sole with high air and vapor permeability 10 is depicted, which contains an upper layer 11, an lower layer 15, a shaped supporting layer 12 located between the upper layer 11 and the lower layer 15 and a outsole layer 16 below the lower layer 15. The upper layer 11 and/or lower layer 15 are made of breathable and waterproof material, for example, cotton fabrics or the polyester fabrics treated with low surface energy materials, such as fluorochemicals, silicone materials, wax, or any other materials with low surface energy and hydrophobic properties. More preferably, the breathable and waterproof materials have the air permeability of 1.500 $kPa \cdot s \cdot m^{-1}$ to 300.000 $kPa \cdot s \cdot m^{-1}$, much lower than the of waterproof materials used in prior art, so as to largely reduce the heat and water vapor building up in the shoe and hence improve the comfortability.

[0028] The shaped supporting layer 12 has a plurality of channels 13 therein, which connect the bottom surface to the top surface of the supporting layer 12 and hence connect the upper layer 11 and the hollow region 19 formed when the supporting layer 12 and the outsole layer 16 are integrated. Furthermore, the shaped supporting layer 12 also has a plurality of supporting projections 14, which are present in the hollow region 19 formed when the sole is integrated. Preferably, the channels 13 and the supporting projections 14 are both perpendicular to the bottom surface of the supporting layer 12, and are therefore substantially perpendicular to all the top and/or surface(s) of the upper layer 11, the lower layer 15, the supporting layer 12 and the outsole layer 16 at least in the certain small areas. More preferably, the supporting projections 14 are supporting columns that are perpendicular to the bottom surface of the supporting layer 12.

[0029] The outsole layer 16 is below the lower layer 15, and has a plurality of through-holes 17 therein. And the plurality of through-holes 17 are connected to each other with the plurality of horizontal channels 18 (see Fig. 4 and Fig. 5). Preferably, the bottom ends of the through-holes 17 are at the bottom of outsole layer (see Fig. 5). The supporting layer 12 and/or the outsole layer 16 are made of, for example, rubber-like material.

[0030] While integrated as one whole, the improved structure of the sole with high air and vapor permeability according to the present invention enhances the air exchange between the in-shoe microenvironment and the outside environment. The high air and vapor permeability through the sole is enabled, and therefore the in-shoe dry microenvironment can be kept and the odours are prevented to be produced.

[0031] The above-mentioned soles can be used in various kinds of shoes and improve the comfortability while people wearing the shoes.

[0032] The foregoing description of the exemplary embodiments of the invention has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in light of the above teaching.

[0033] The embodiments were chosen and described in order to explain the principles of the invention and their practical application so as to activate others skilled in the art to utilize the invention and various embodiments and with various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present invention pertains without departing from its spirit and scope. Accordingly, the scope of the present invention is defined by the appended claims rather than the foregoing description and the exemplary embodiments described therein.

REFERENCE

[0034]

[1] A. B. Putti, G. P. Arnold, L. A. Cochrane and R. J. Abboud, Gait & Posture, 2008, 27, 501.

Claims

1. A waterproof sole with high air and vapor permeability, **characterized in that**, the sole includes:

   An upper layer made of breathable and waterproof material;
   A lower layer made of breathable and waterproof material;
   A shaped supporting layer made of rubber-like material between the upper layer and lower layer with a hollow space and with a plurality of channels connecting to the bottom surface of the upper layer, and with a plurality of supporting projections at the bottom surface of the supporting layer;
   An outsole layer made of rubber-like material underneath the lower layer with a plurality of through-holes and a plurality of horizontal channels on the upper side of the outsole layer inter-

connecting through-holes.

2. The sole according to Claim 1, **characterized in that**, the upper layer and/or the lower layer are made of breathable and waterproof material.

3. The sole according to Claim 2, **characterized in that**, the upper layer and/or the lower layer are made of breathable and waterproof material with the air permeability of 1.500 $kPa \cdot s \cdot m^{-1}$ to 300.000 $kPa \cdot s \cdot m^{-1}$.

4. The sole according to Claim 1, **characterized in that**, the plurality of channels are perpendicular to the bottom surface of the supporting layer.

5. The sole according to Claim 1, **characterized in that**, the plurality of supporting projections are perpendicular to the bottom surface of the supporting layer.

6. The sole according to Claim 5, **characterized in that**, the plurality of supporting projections are supporting columns.

7. The sole according to Claim 1, **characterized in that**, the plurality of through-holes are inter-connected to each other with the plurality of channels.

8. The sole according to Claim 7, **characterized in that**, the through-holes have their bottom ends at the bottom of the outsole layer.

9. A shoe, **characterized in that**, the shoe comprises a waterproof sole with high air and vapor permeability including:

An upper layer made of breathable and waterproof material;
A lower layer made of breathable and waterproof material;
A shaped supporting layer made of rubber-like material between the upper layer and lower layer with a hollow space and with a plurality of channels connecting to the bottom surface of the upper layer, and with a plurality of supporting projections at the bottom surface of the supporting layer;
An outsole layer made of rubber-like material below the lower layer, a plurality of through-holes and the plurality of channels are provided therein.

10. The shoe according to Claim 9, **characterized in that**, the upper layer and/or the lower layer are made of breathable and waterproof material.

11. The shoe according to Claim 10, **characterized in that**, the upper layer and/or the lower layer are made of breathable and waterproof material with the air permeability of 1.500 $kPa \cdot s \cdot m^{-1}$ to 300.000 $kPa \cdot s \cdot m^{-1}$.

12. The shoe according to Claim 9, **characterized in that**, the plurality of channels are perpendicular to the bottom surface of the supporting layer.

13. The shoe according to Claim 9, **characterized in that**, the plurality of supporting projections are perpendicular to the bottom surface of the supporting layer.

14. The shoe according to Claim 13, **characterized in that**, the plurality of supporting projections are supporting columns.

15. The shoe according to Claim 9, **characterized in that**, the plurality of through-holes are inter-connected to each other with the plurality of horizontal channels.

16. The shoe according to Claim 15, **characterized in that**, the through-holes have their bottom ends at the bottom of the outsole layer.

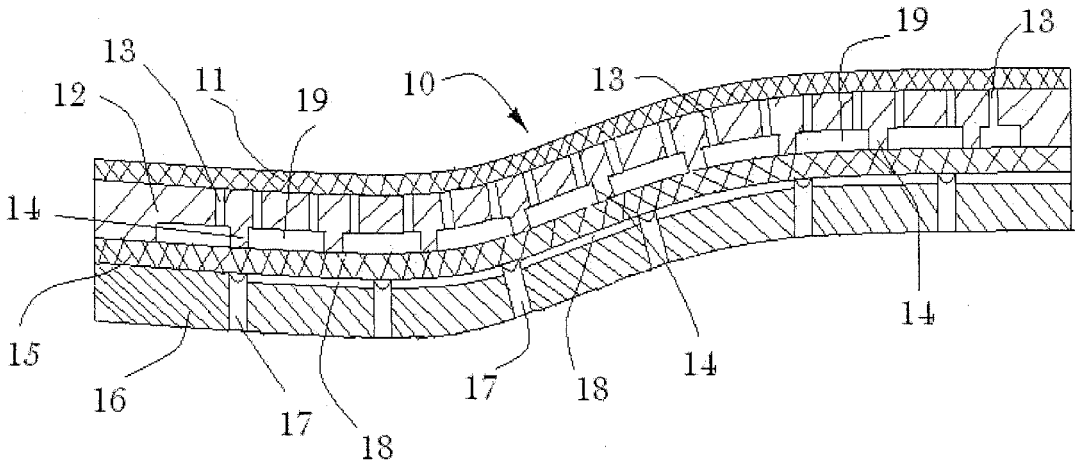


Fig. 1

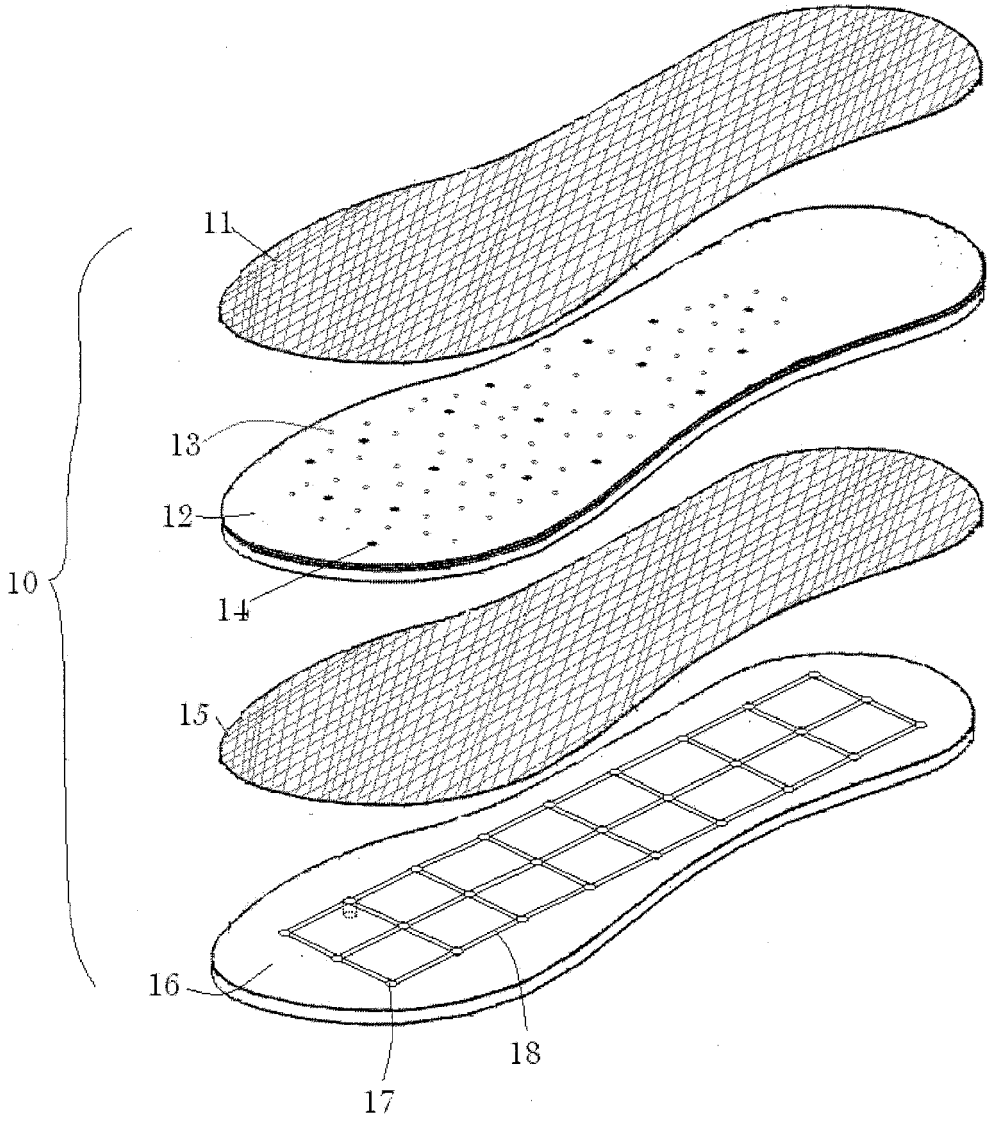


Fig. 2

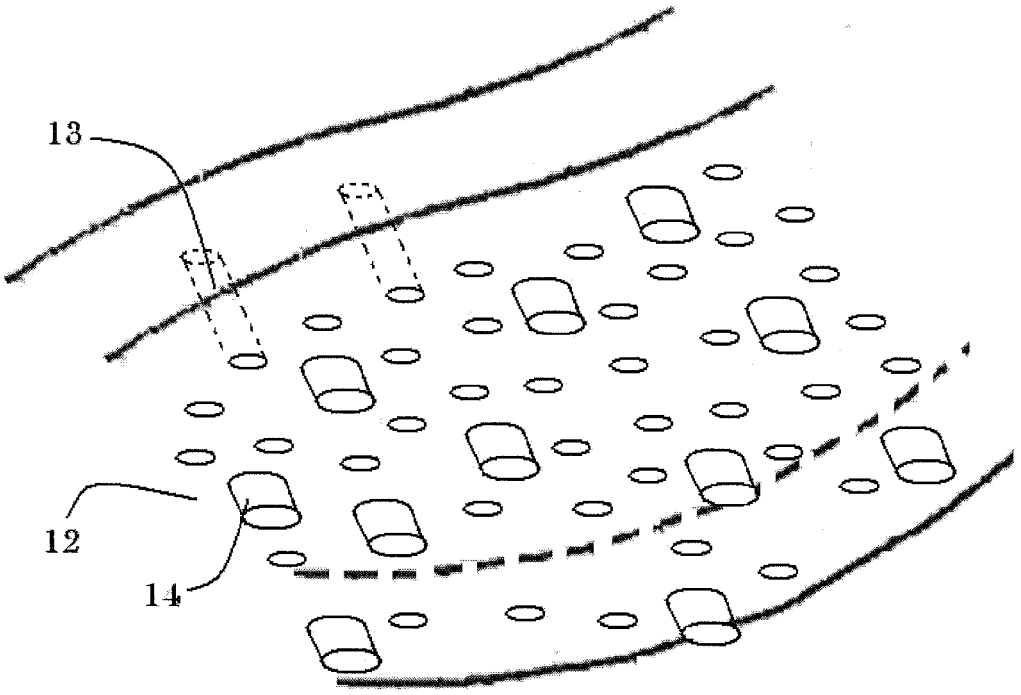


Fig. 3

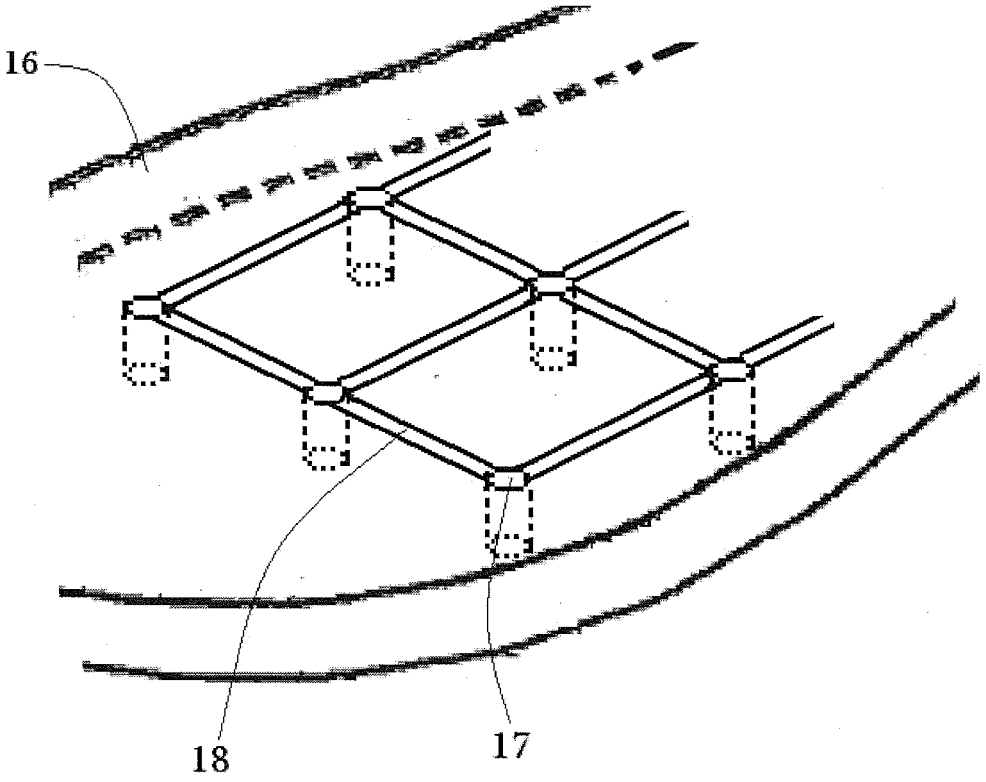


Fig.4

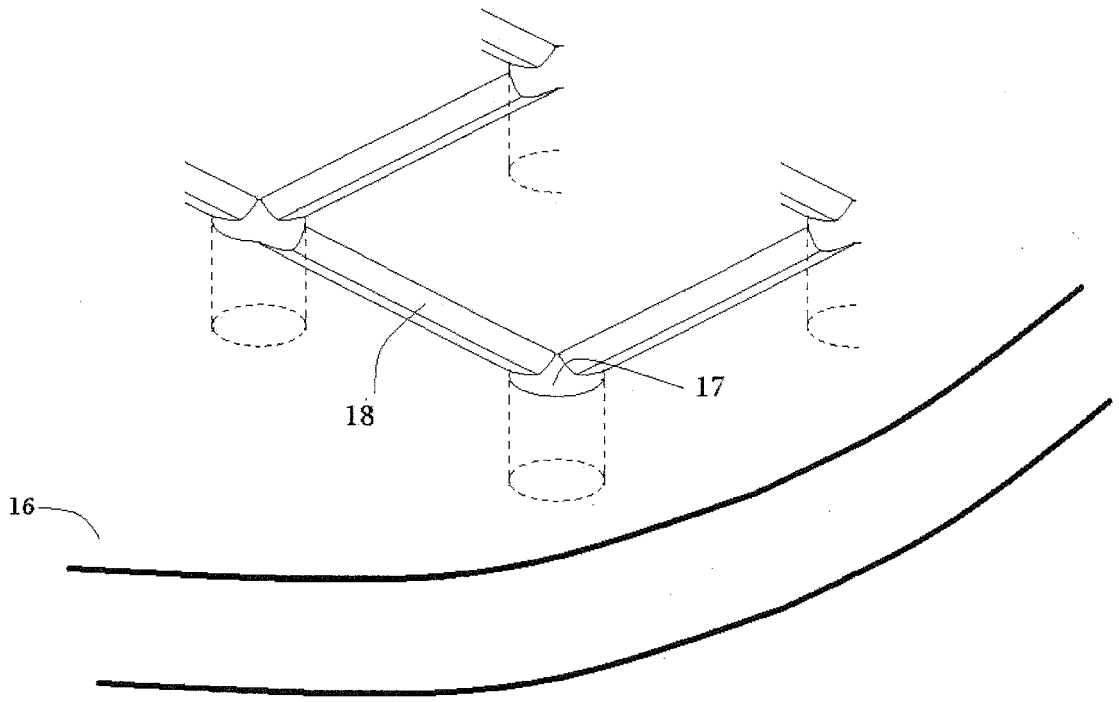


Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 11 18 5182

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31 August 2012	Cianci, Sabino

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