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(54) Flexible light-emitting textile display with floats for covering electronic devices

(57) The invention relates to light-emitting electronic textiles for smart clothing and smart textiles related applications. The two-dimensional flexible light-emitting textile display is designed with floats for covering electronic elements and electronic contacts insulation which at the same time provides an opportunity to develop aesthetic design of the display in the single piece construction of material. The display consists of interwoven conductive yarns (2, 3), insulating yarns (6, 13) and one or more light emitting devices (7) attached to the conductive yarns (2, 3), and may also contain one or more other electronic devices. For display electronic circuits design a matrix display construction is used with conductive yarns in weft (2) and warp (3) systems, some of which are partly integrated into the textile structure and partly form the same or different lengths floats on textile right or left side.

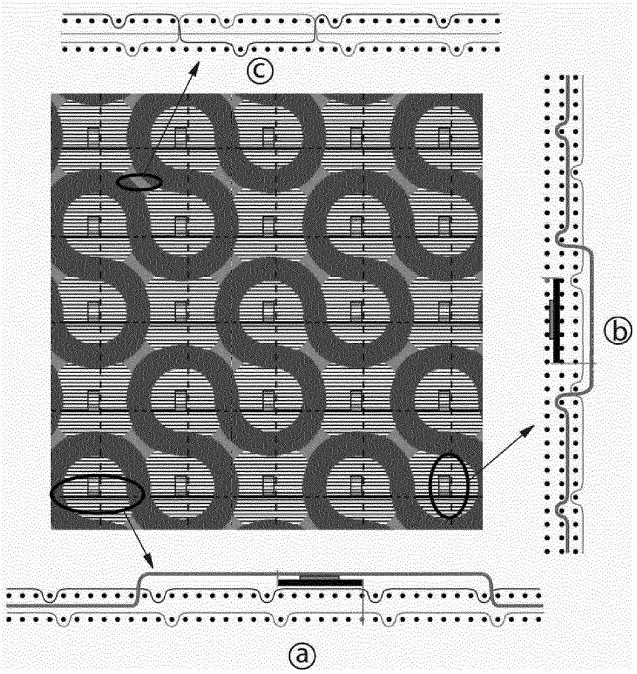

Fig. 2

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Description

Technical Field

[0001] The invention refers to light-emitting electronic textile area, provided for variety of smart clothes and smart textiles-related applications.

Background Art

[0002] Traditional light-emitting displays are widely used in various areas, however printed circuit board base is solid and its integration in textiles reduces quality and comfort properties of a product. The development of electronic textiles opens up opportunities for new innovative products creation and advancement in various smart clothes and smart textiles related fields [1].

[0003] Replacing the traditional electronic media with conductive textile materials, it is possible to create a flexible light-emitting display base, using a variety of textile designing techniques such as weaving or knitting. Designing such fabric conductive yarns can be embedded into fabric structure along with non-conductive yarns in warp or / and weft direction, forming electronic textile circuit to which electronic elements can be added afterwards [2].

[0004] There is known a range of woven electronic textile designing techniques for a flexible light-emitting display, as well as for other applications. Mainly it is multilayer textile fabric. Patent application [3] describes a light-emitting display, formed by textile tapes with integrated in each tape two electrically conductive tracks to which one or more light-emitting diodes (LED) are attached, which textile tapes are sewn or otherwise attached on the surface of the textile. When using this electronic circuit, a display can be controlled by rows or by columns only (depending on the location of the display), so it is not possible to create animated images. To create animated images on a display each LED should be controlled individually. For this reason a matrix display design should be used. There is known a range of such textile design displays. Patent application [4] describes a textile with conductive yarns being interwoven in weft and warp systems, provided for textile capacitor formation - the determination of the functional area on electronic textiles. The fabric consists of 3 layers with two layers of interwoven conductive yarns and one insulating layer between them. The known fabric can also be used for designing of textile LED display. Patent applications [2, 5] describe a two-and three-layer textiles interwoven with conductive yarns in weft and warp systems for fabric display designing. One of the applications is LED display.

[0005] In existing electronic textiles electronic elements (for example LED) are mainly fixed in such a way that they are situated on the top plane of the fabric - they are exposed and visible. To get more textile-like visual appearance and tactile sense, the electronic elements should be covered by additional layer of material, located on top of the display. Patent application [6] describes an electronic textile with an extra layer of non-woven material, which extra layer covers up the display and diffuses light along the surface of the extra layer. Extra layer adding is carried out as a separated operation by sewing or gluing material to display. Conducting this individual operation requires additional time resources. Patent application [7] describes light-emitting display with diffusing layer. A light diffusing layer and a layer covering the electronic equipment in this solution is a part of the electronic textile and so it is not necessary to put separately. It is knitted material with interknitted on conductive yarns. The display consists of three layers and is described as a 3D textile with two X-axis plane layers and one Y-axis plane (thickness) layer. For insertion of electronic devices inside of the textile structure in the display it is necessary to design special openings inside of the textile. The aim of the known invention is to increase thickness of the textile for greater light diffusion on the upper layer of the textile. From this description it may be inferred that the material is quite thick, which means that it can be used only for a individual assortment of clothing. To get a more universal design, textile displays what are provided for integration into clothing should be as close as possible to a two-dimensional structure.

[0006] In prior art examples of electronic textile displays only display structural design (e.g., arrangement of conductive yarns in textile) is solved. In the result displays are obtained, which are located below the additional material layer which forms the aesthetic design. By the development of said 3D textile example [7], it would be possible to create a specific design of the top surface layer, but because of the increased thickness of the textile, there are some restrictions on its application. Consequently, for the expansion of the assortment of interactive/smart clothing it is necessary to develop textile displays ensuring lesser thickness, maintaining the textile physical and mechanical properties (e.g., flexibility) at the same time covering electronics devices and providing an opportunity to address the aesthetic design of the display in the seamless construction of the material.

Disclosure of the Invention

[0007] In the proposed solution a flexible light-emitting textile display with floats for electronic devices covering and electronic contacts insulating is designed. The display comprises of interwoven electrically conductive yarns, insulated (non-conductive) yarns and one or more light emitting devices (e.g. light-emitting diodes), which are connected to the conductive yarns. This display can also contain one or more other electronic devices, such as resistors, sensors and other devices depending on system design. A matrix construction is used for the design of an electronic circuit display, so that the conductive yarns in the textile display are arranged in a weft and warp systems. The activation of the display requires a power supply which voltage depends on the amount of

light-emitting devices being used and their technical characteristics, as well as from data processing methods. The invention also provides for use of the offered flexible light-emitting textile display for producing articles of clothing, curtains, accessories and other goods as well as it can be used in car or building interior (shaped lighting, upholstery, decorative walls).

Brief description of drawings

[0008]

Fig. 1a is a schematic top view of the flexible light-emitting textile display showing location of light-emitting devices, electrically conductive weft yarns and warp yarns and yarn floats covering light-emitting devices; Fig. 1b - is a schematic bottom view of the flexible light-emitting textile display showing location of electrically conductive weft yarns and warp yarns, as well as warp yarns floats;

Fig. 2 - a schematic top view of the flexible light-emitting textile display; a, b, c-schematic cross-sectional views of the respective parts of the flexible light-emitting textile display shown in Fig. 2;

Fig. 3a - schematic cross-sectional (frontal) view of one embodiment of the flexible light-emitting textile display; Fig. 3b - schematic cross-sectional (frontal) view of another embodiment of the display;

Fig. 4a - schematic cross-sectional (side) view of one embodiment of the flexible light-emitting textile display; 4b - schematic cross-sectional (side) view of another embodiment of the display;

Fig. 5a and Fig. 5b - schematic cross-sectional (frontal) views of yet other embodiments of the display;

Fig. 7 - shows schematic cross-sectional 3D view of the display illustrating the weaving of the electrically conductive and non-conductive weft yarns and warp yarns and yarn floats adapted for covering light-emitting devices;

Fig. 8 - is a schematic cross-sectional 3D side view of the display illustrating separated 2,5 layers of the weaving of the electrically conductive and non-conductive weft yarns and warp yarns and yarn floats adapted for covering light-emitting devices.

[0009] The functional design of the developed display is accorded with textile visual design, therefore sizes and distances of display matrix construction are fitted with fabric pattern (Fig. 1a-b). For example, intersection point 1 of electrically conductive warp 3 and weft yarn 2 is hosted inside or outside of each fabric pattern shape or object or in unenclosed spaces covered with floats. Textile is designed as 2 ½ layer fabric which comprises individual areas where all layers are interwoven together (Fig. 2c) and individual areas where layers are not linked together (Fig. 2a-b). Upper and bottom layers of fabric are preferably connected together by interwoven insulating weft yarns 6a, 6b (Fig.6) of upper and bottom layers. In the fabric area, where the conductive weft yarn 2 intended for the contact is being provided, yarn floats are designed on the fabric right side, so ensuring an electrical insulation from the conductive warp yarn 3, which at this stage is designed as a conductive warp float on the fabric left side (Fig. 3a, Fig. 3b, Fig. 4a, Fig. 4b). Non-conductive or insulating weft 6 and warp 13 yarns prevent short circuits in the electric system. To ensure higher electrical insulation layers are not interwoven at the respective areas. In the sections 4 located between the conductive yarn 2 floats, where on the left side of the fabric the conductive warp yarn 3 is not placed, the conductive weft yarn 2 is interwoven into the fabric top layer or is located between the first and the second warp yarn layers 13. In the sections 5 located between warp floats, where on the right side of the fabric the conductive weft yarn 2 is not placed, the conductive warp yarn 3 is interwoven into the fabric.

[0010] The non-conductive weft floats 6 and conductive weft floats 2 are located on the right side of the fabric in certain areas depending on fabric aesthetic and interactive design. The length of float can be shorter or longer, depending on the fabric design (Fig. 5a and Fig. 5b). In each such area on the right side of the fabric there is at least one conductive weft float 2, having non-conductive yarn floats 6 from both its sides, which provides electrical isolation between the conductive weft yarns 2.

[0011] When connecting the light-emitting device 7 to the electrically active fabric 8, it is being attached to the conductive weft float 2 from the right side and to the conductive warp float 3 from the left side. Connecting to the conductive warp float 3 is performed by threading through the fabric the yarn contact 9 being attached to the device and connecting it to the conductive warp float 3. The connection 10 between the conductive weft yarn 2 and the light-emitting device 7 and the connection 11 between the conductive warp yarn 3 and the device 7 can be carried out in different ways, such as creating a soldered or a knot connection.

[0012] According to the display design the electronic device can be located inside the fabric texture without deformation of the textile. The non-conductive yarn floats 6 covering at the respective display areas allow hiding the light-emitting device 7 below the floats, consequently the device 7 is not visually seen and is located inside the textile material 12. The covering layer is a textile structure component and is not added as a separate layer. As a textile cover only weft floats 6 are used, so the layer is less dense and more able to pass through the light. The covering insulating yarn floats 6 allow the display to get visual appearance and tactile sense that is more textile-like. In addition this forms the devices 7 isolation, partly protecting them from mechanical damage.

[0013] This display is designed as a 2 ½ layer textile, so it is not characterized by increased thickness affecting the textile physical properties, such as flexibility.

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Claims

1. A flexible light-emitting textile display, comprising non-conductive weft yarns (6) and warp yarns (13) forming textile fabric, electrically isolated electrically conductive weft yarns (2) and warp yarns (3) and light-emitting devices (7) electrically connected to the electrically conductive yarns (2 and 3), wherein parts of the non-conductive weft yarns (6) or warp yarns (13) forming textile fabric and parts of the electrically conductive weft yarns (2) or warp yarns (3) are forming yarn floats covering light-emitting devices (7).

2. The flexible light-emitting textile display according to claim 1, wherein at intersections (1) of isolated electrically conductive weft yarns (2) and warp yarns (3) the display contains electrically conductive weft (2) floats on one side of the fabric, and electrically conductive warp (3) yarn floats on the other side of the fabric, where conductive weft yarn (2) does not appear on the left side of fabric and conductive warp yarn (3) doesn't appear on the right side of fabric.

3. The flexible light-emitting textile display according to claim 1 or 2, wherein the electrically conductive yarn (2 and 3) is partly interwoven into the fabric texture.

4. The flexible light-emitting textile display according to any preceding claims, wherein the textile fabric contains two: first and second yarn layers and the conductive weft yarn (2) and the conductive warp yarn (3) are partly located between the first and the second yarn layer and partly - form yarn floats on the right or left side of the fabric, such that they are covering light-emitting devices (7) together with the yarn floats forming the textile fabric.

5. Articles of clothing, curtains, accessories, articles of car or building interior made of the flexible light-emitting textile display according to any preceding claims.

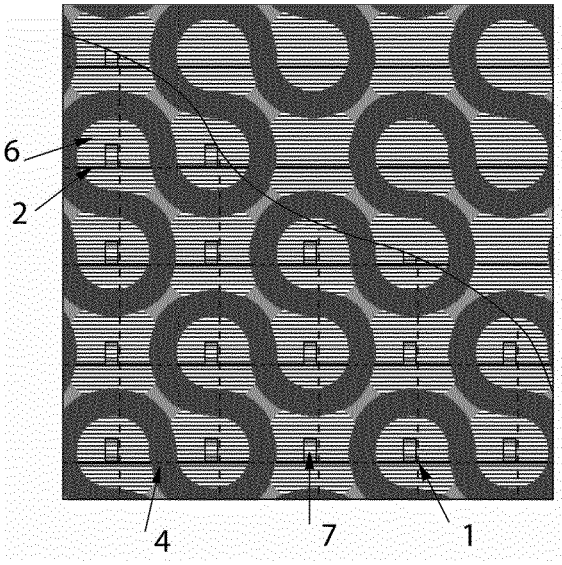

Fig. 1a

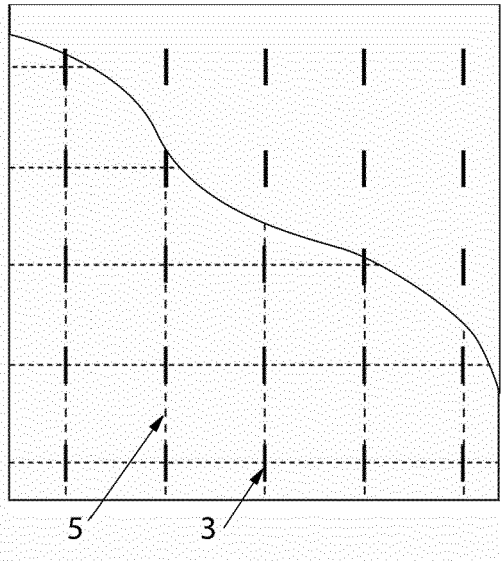

Fig.1b.

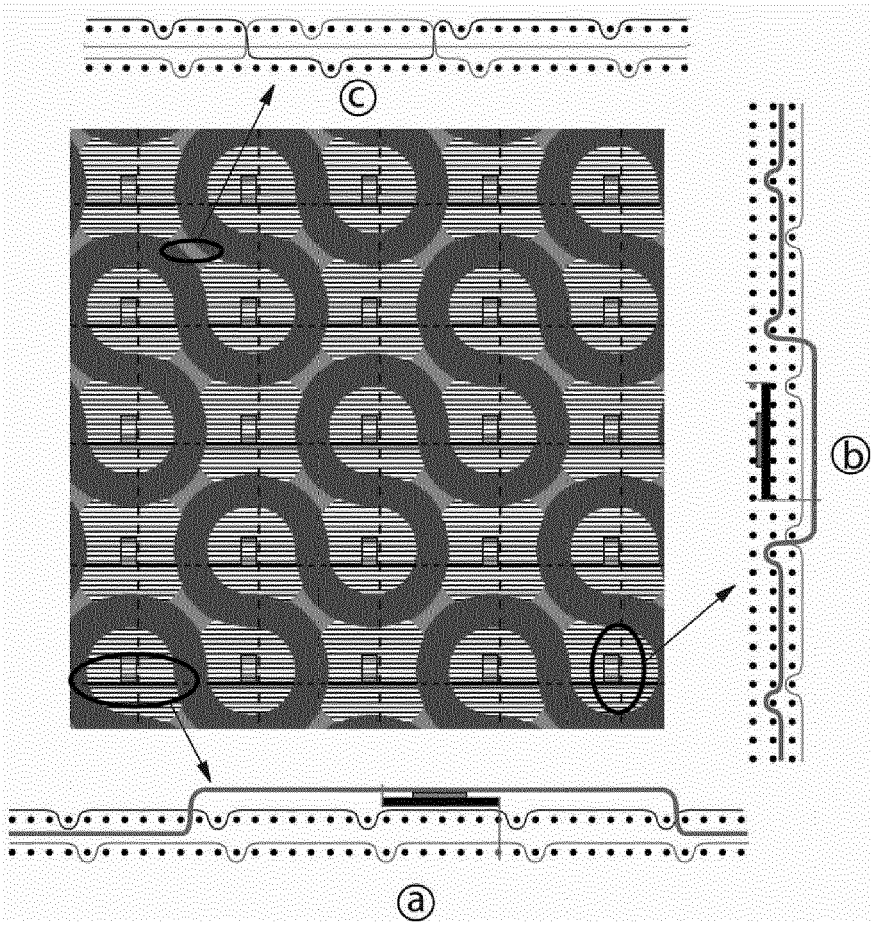

Fig. 2

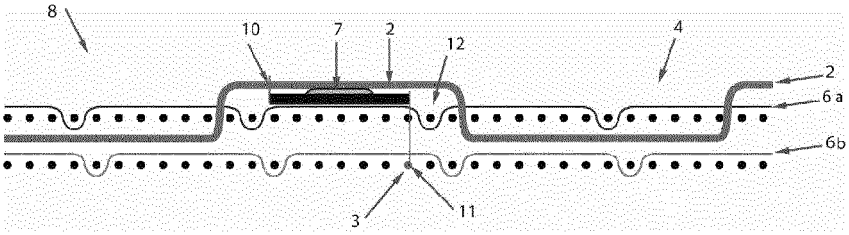

Fig. 3.a

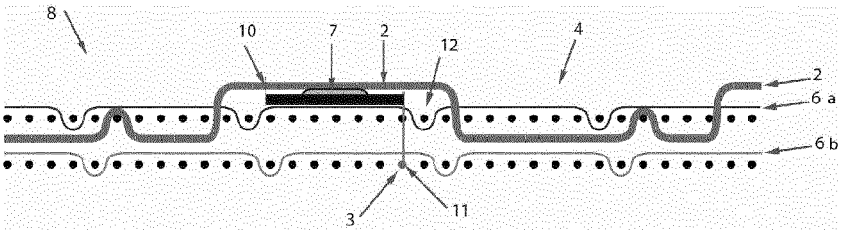

Fig. 3.b

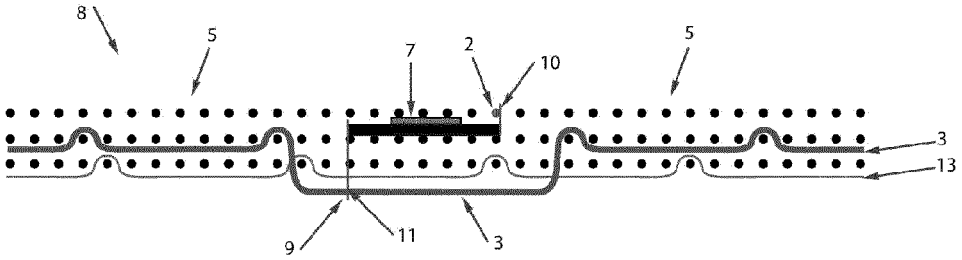

Fig. 4a

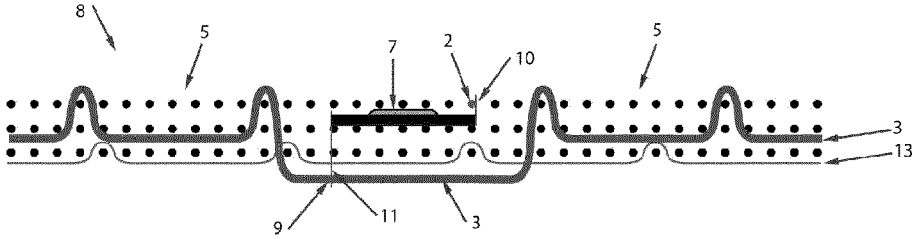

Fig. 4b

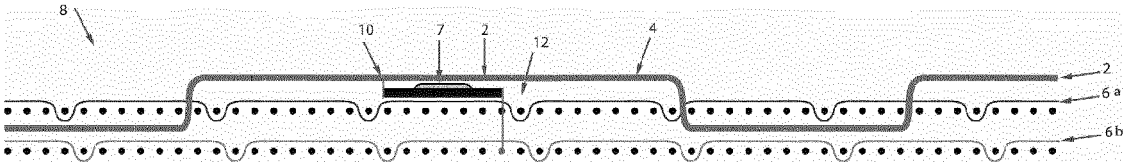

Fig. 5a

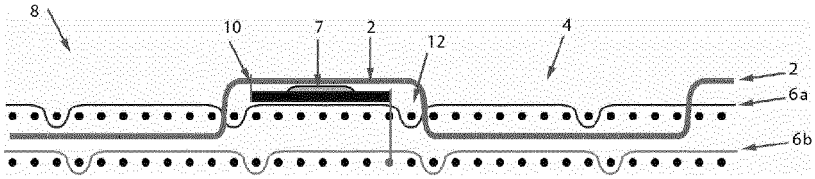

Fig. 5b

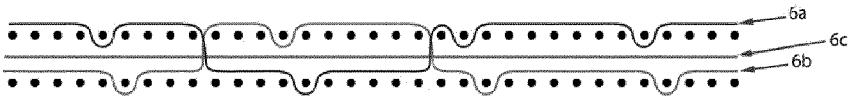

Fig. 6

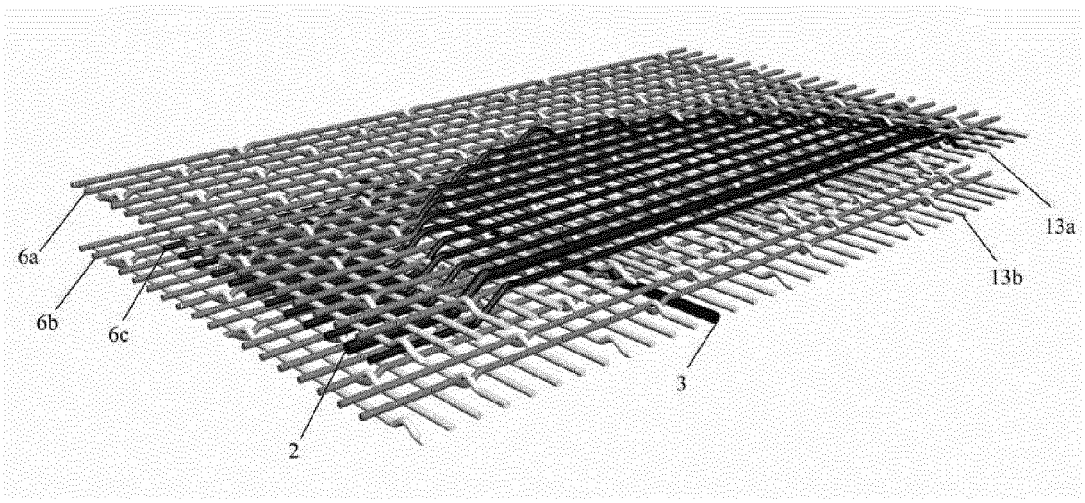

Fig. 7

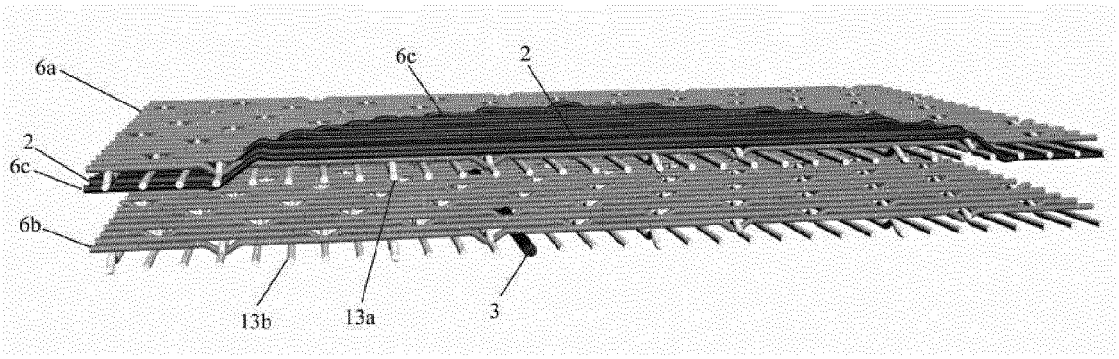

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
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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
Munich	30 June 2014	Hausding, Jan

CATEGORY OF CITED DOCUMENTS

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