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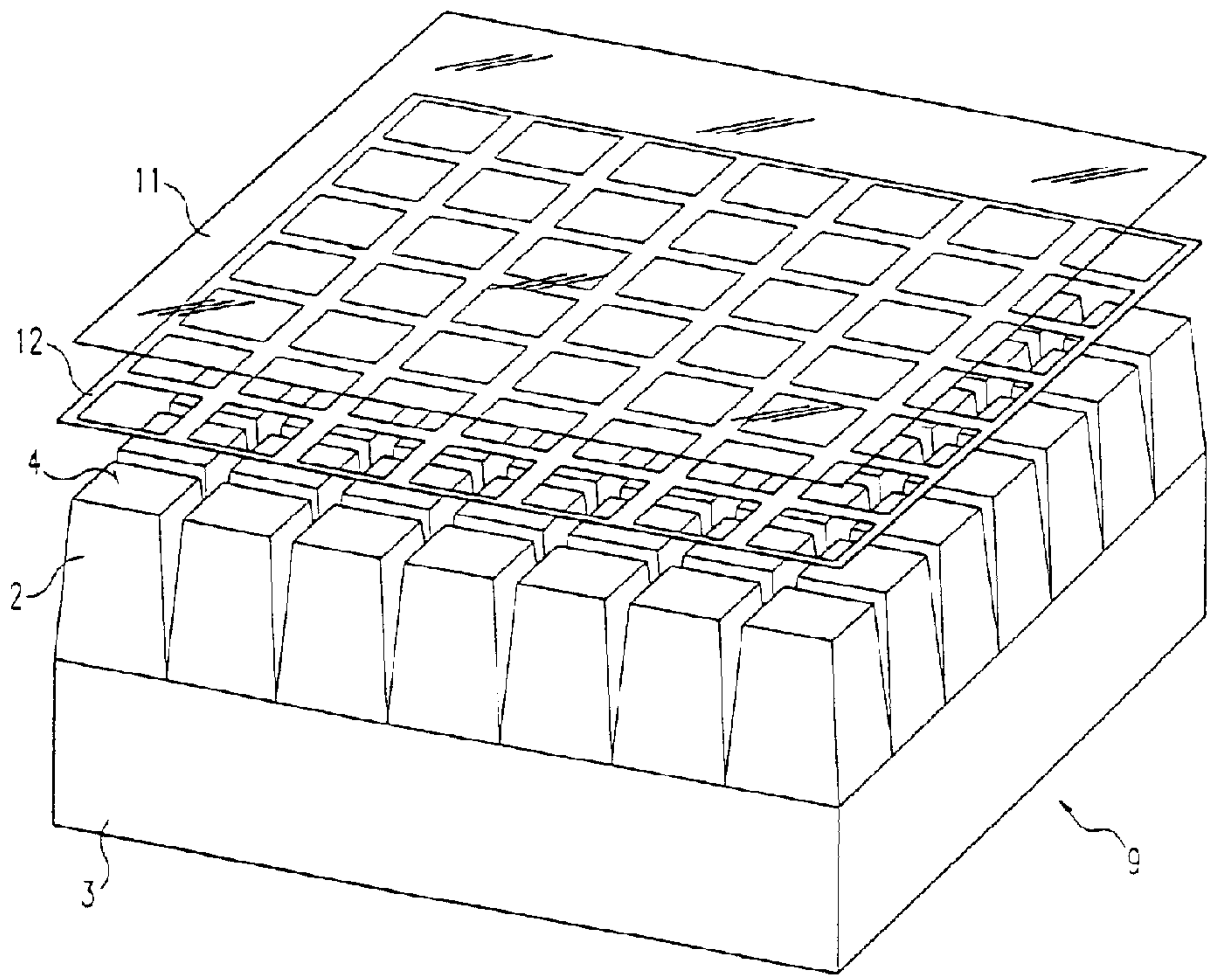
(54) **ELEMENT OPTIQUE DESTINE A LA DEVIATION DE RAYONS LUMINEUX ET SON PROCEDE DE PRODUCTION**

(54) **OPTICAL ELEMENT FOR DEVIATING LIGHT RAYS AND METHOD FOR PRODUCING THE SAME**



(57) The invention relates to an optical element (9) for deviating light rays that are incident upon and then re-emerge from said optical element, in such a way that the angle at which they emerge is limited. Said optical element is suitable for use e.g. as a light cover and comprises a plate-shaped core (1), which consists of a transparent material and which is provided with microprisms (2) on one side. Said microprisms are tapered in such a way as to form furrows (7). The microprisms cover surfaces (4) in their entirety form e.g. the surface upon which the light is incident and the other side of the core (1) forms the surface from which the light emerges, the furrows (7) being covered with a layer (12) that is reflective on at least one side. A film (11) consisting of a transparent material is also provided and is located on the side of the reflective layer (12) that faces away from the core (1) of the element. The invention also relates to methods for producing the optical element (9) and the reflective element (10) with the reflective layer (12).

Abstract

Optical element (9) for deflecting light beams, which enter and re-emerge from the latter, in such a way that their angle of emergence is limited, for use as a luminaire-cover for example, having a plate-like core (1) of transparent material which on one side is occupied by microprisms (2) that taper forming furrows (7), with, for example, all of the top surfaces (4) of the microprisms forming the light-entry face and the other side of the core (1) forming the light-emergence face (3), and with the furrows (7) being covered by a layer (12) that is reflective at least on one side, with, furthermore, a foil (11) of transparent material being provided on the side of the reflective layer (12) that is remote from the element core (1), and also methods for producing the optical element (9) and the reflective element (10) that has the reflective layer (12).

Figure 3.

Optical element for deflecting light beams and method of production

The present invention relates to an optical element for deflecting light beams, which enter and re-emerge from the latter, in such a way that their angle of emergence is limited, for use as a luminaire-cover for example, in accordance with the preamble of claim 1, and a reflective element as a component of the optical element in accordance with the preamble of claim 10, and also corresponding methods for the production of the optical element and the reflective element.

As a result of using optical elements of the kind mentioned by way of introduction, the angle of emergence of light beams, from a luminaire for example, is limited in order to diminish any dazzlement for the viewer. In addition, of course, such an element also provides mechanical protection for the luminaire and in particular for the light source in the interior of the luminaire.

Such an optical element is known, for example, from the Austrian Patent AT-B-403,403. The known element has on its side facing the lamp of the luminaire, pyramidal profiled portions that are arranged in rows and lines, so-called microprisms, which are formed as truncated pyramids and have an upper boundary face (light-entry face) that lies parallel to the base (light-emergence face). An optical element that is known from AT-B-403,403 is shown in Figure 1 for the purposes of explanation. The whole element is made totally of a crystal-clear or transparent material.

A further optical element of the kind mentioned by way of introduction is disclosed, for example, in

WO 97/36131. Various measures are known from this printed specification for preventing light beams from the lamp of the luminaire from penetrating into the intermediate areas or furrows between the top surfaces of the microprisms that form the light-entry faces, since such light beams would not emerge from the optical element at a desired angle of emergence. Figures 16-24 and the associated description of this printed specification, for example, disclose the possibilities of filling up the furrows between the microprisms with a filling compound that has reflective properties, coating the side walls of the microprisms with a reflective material, covering the microprism structure with a reflective mask or a grid, or providing combinations of these measures. Since the dimensions of the microprisms only lie in the range of a few hundred μm, a high level of precision is required when producing such optical elements or luminaire-covers.

Basing considerations on the afore-mentioned prior art it is an object of the present invention to provide an optical element of the kind mentioned by way of introduction that has a reflective layer and which is simple to construct and therefore also to produce and at the same time has a stable structure and a high luminous quality level.

A further object of the present invention is to provide a reflective element for such an optical element that is simple to construct and therefore also to produce and at the same time guarantees a stable structure and a high luminous quality level of the whole optical element.

These objects are achieved by means of an optical element that has the features of claim 1 and by means of a reflective element that has the features of claim 10 and also by means of the corresponding methods of production according to claims 14 and 22, or 27, respectively.

The optical element consists of a plate-like core of transparent material which on one side is occupied by microprisms that taper forming furrows - starting from their root - with, for example, all of the top surfaces of the microprisms forming the light-entry face and the other side of the core forming the light-emergence face, and with the furrows being covered by a layer that is reflective at least on one side. In accordance with the invention, furthermore, a foil of transparent material is provided that is arranged on the side of the reflective layer that is remote from the element core. The foil gives the reflective layer independent stability, something which, on the one hand, facilitates the handling thereof when the whole optical element is produced and, on the other hand, also increases the stability of the element as a whole. Furthermore, the assembly of such a reflective element on the element core of the optical element with the necessarily high level of precision is simpler to effect than the direct application of, for example, a thin metal foil to the intermediate areas of the microprism structure, as necessary in the case of the systems known previously.

The reflective layer is preferably fixedly connected to the transparent foil, in particular is welded together therewith or adhered thereto. In particular, welding has the advantage here that there is no further material component present in the system that has a refractive index which would need to be taken into consideration with regard to the luminous properties of the optical element. It is, however, also possible in the first instance to apply to, preferably vapour-deposit onto, the transparent foil a metal layer in which the desired structure is subsequently formed, something which can be effected both mechanically and by means of laser beams or else chemically.

Furthermore, a reflective layer is also preferably fixedly connected to the element core, in particular adhered thereto or welded together therewith. The connection of the reflective layer can then be effected both subsequently to prefabrication of the reflective element consisting of the reflective layer and the transparent foil and also in a joint method step at the same time as the connection of the reflective layer to the transparent foil.

Further advantageous configurations and further developments of the present invention constitute subject matter of further subclaims.

The invention is described in greater detail in the following with the aid of various preferred exemplary embodiments with reference to the enclosed drawing, in which:

Figure 1 shows a diagrammatic perspective representation of a luminaire-cover, known from the prior art, from the viewing direction of the (imaginary) lamp;

Figure 2 shows a diagrammatic cross-sectional representation of an optical element with components in accordance with the present invention that are shown separately; and

Figure 3 shows a perspective representation of the optical element of Figure 2.

The optical element in accordance with the present invention that is described below is suitable in particular as a covering for luminaires, the angle of emergence of light of which is to be limited in order to avoid dazzlement for a viewer.

Figure 1 shows a perspective view of a known luminaire-cover or a known optical element, as is also used as a component part of the present invention. The known luminaire-cover has, on its side facing the lamp or even the lamps (not shown) of the luminaire, pyramidal profiled portions 2 which are arranged in rows and lines, so-called microprisms, formed as truncated pyramids on a base. The whole luminaire-cover is made totally from a crystal-clear or transparent material, such as, for example, acrylic glass. The known luminaire-cover, which is shown in Figure 1, at the same time constitutes an embodiment of an element core 1 for an optical element 9 in accordance with the invention, as will be described further in greater detail below.

The plate-like, transparent core 1 of the luminaire-cover on one side is occupied by microprisms 2 that taper forming furrows 7 - starting from their root 5 - with all of the top surfaces 4 of the microprisms forming the light-entry face and the other side of the core 1 forming the light-emergence face 3. The angle of emergence of the light beams - emerging downwards from the optical element shown in Figure 1 - is to amount at most to approximately 60-70° relative to the perpendicular of the emergence face 3 in order to avoid or at least to minimize dazzlement for the viewer.

Alternatively, it is also possible for the core 1 to be inserted in such a way that all of the top surfaces 4 of the microprisms form the light-emergence face and the other side of the core forms the light-entry face.

The intermediate areas or furrows between the individual microprisms in the present case are spaced apart from each other by approximately 700 µm and in the plane of the light-entry faces 4 are approximately 150 µm wide.

If light from the lamp penetrates into these furrows 7, it is not possible to guarantee that these beams of light will emerge from the light-emergence face 3 of the optical element at the desired angle of emergence. It is therefore necessary to fill up or cover the furrows 7 between the light-entry faces 4, as already known from WO 97/36131. The material for this filling or covering may not, however, be light-absorptive so that the degree of efficiency of the optical element or the luminaire-cover is not reduced. A reflective material should therefore be used which, as far as possible, gives rise to total reflection of the incident light without light absorption. In this way, the light is reflected back in the direction of the lamp, this generally being provided with reflectors that are arranged at the back so that substantially all of the light radiated from the lamp of the luminaire leaves the optical element through the light-entry and light-emergence faces 4, 3 and a high degree of luminous efficiency is guaranteed. In particular, metals that have a high reflecting power, such as, for example, silver, aluminium or gold, or the like, are therefore suitable as a covering material for the furrows 7.

The embodiment of the optical element 9 in accordance with the invention differs from the known luminaire-cover in accordance with Figure 1 in that a reflective element 10 is applied on the side of the element core 1 that has the microprisms 2, as diagrammatically shown in Figures 2 and 3 in section and in a perspective view respectively. In order to provide a better representation of the structure of the optical element 9 in accordance with the invention, the components are shown separately in Figures 2 and 3. These components are of course directly in contact with each other or connected to each other in the practical realization thereof.

The element core 1 has, for example, the arrangement that is shown in Figure 1. The invention is not, however, restricted to this arrangement of the microprisms in rows and lines (cross structure) and to the microprisms that have a square base. On the contrary, the microprisms 2 can also have an elongated base and just be arranged in rows side by side (longitudinal structure). It is also possible to combine two transparent element cores 1 that have a longitudinal structure and arrange them one on top of the other, with the one longitudinal structure being twisted by 90° in relation to the other longitudinal structure in the plane of the light-emergence face 3 so that all in all a similar effect as in the case of the cross structure is attained. Furthermore, basically any basic forms of the microprisms 2 are also possible, although as far as possible these should be in the form of a uniform polygon or a circle so that the shape of the reflective layer 12 described further below does not become unnecessarily complicated.

The element core 1 of the optical element 9 in accordance with the invention can be produced in various ways from a transparent material, preferably a transparent plastics material, such as acrylic glass. The production by means of a so-called injection-moulding embossing method is to be mentioned first here. This method is similar to the plastics injection-moulding method that is generally known, yet is effected with a comparatively low injection pressure. After the transparent material has been injected into the mould, a mechanical pressure is exerted on the still liquid material so that the latter can penetrate into the structures of the mould. Furthermore, it is also possible to produce the element core 1 by means of a hot-embossing method in which the transparent material in liquid form is poured into a corresponding mould and subsequently pressure is likewise applied thereto in order to realize the embossing.

Furthermore, there is also the possibility of providing a transparent plastics block with the furrows mechanically. This can be effected, for example, by cutting, for example with a diamond cutter, or by means of a laser beam.

A further possibility for producing the transparent core 1 consists in pressing the liquid plastics material through an extrusion head. In this case though it is only possible to produce linear structures of microprisms 2.

A reflective element 10 is applied on the side of the element core 1 that faces the lamp of the luminaire, that is, on the plane of the top surfaces 4 of the microprisms that form the light-entry face. The reflective element 10 substantially consists of a foil or a thin plate 11 made from a transparent material and a layer 12 made from a reflective material. The same material that is used for the element core 1 is preferably used for the foil 11. It is possible to use both a plate, as shown in Figure 2, and also a foil, as shown in Figure 3, as a transparent element 11. In particular, the metals that have already been mentioned above and which have reflective properties or materials that have a similarly high reflecting power come into consideration for the reflective layer 12.

According to a first exemplary embodiment of the present invention, the transparent foil 11 and the reflective layer 12 are two separate components which are fixedly connected together before they are connected to the element core 1. The metal layer 12 having a grid or line structure is, for example, produced galvanically for this or is stamped out of metal foils. The layer 12 is preferably connected to the foil 11 by means of adhesion or welding. Welding the two components together is currently preferred, since in this case no further material in the form of a transparent adhesive substance is contained in the reflective element 10 that has a refractive index that is to be taken into consideration for the optical properties of the optical element 9.

A transparent adhesive, such as, for example an adhesive substance, an adhesive foil or a hot-melt-type adhesive, is used to adhere the two components 11, 12 together. The reflective layer 12 is advantageously heated for the purpose of welding the reflective layer 12 together with the foil 11 and pressure is subsequently applied to the connection. The reflective layer 12 is heated in this connection, for example, by applying a magnetic alternating field to the metal grid

12. Eddy currents are induced in the metal grid 12 by means of the magnetic alternating field and these heat the metal. Alternatively, it is also possible to weld the reflective layer 12 together with the transparent foil 11 by means of laser welding. In this connection, welding is preferably effected locally at the edges of the metal grid 12.

According to a second exemplary embodiment of the reflective element 10, the foil 11 and the layer 12 are produced as a unit. To this end, a reflective metal layer is first applied to, preferably vapour-deposited onto, the transparent foil 11. Subsequently, the desired grid or line structure is introduced into this metal layer 12. This is preferably effected by punching by means of a laser beam or by punching mechanically. The desired structure can, however, also be worked out of the metal layer 12 by means of an etching process.

In comparison with an individual grid 12 or an individual grid foil, the reflective element 10 is substantially more stable and can therefore be handled more easily. This also facilitates the further production of the optical element 9. In addition, the stability of the reflective element 10 also increases the stability of the optical element 9 as a whole. The element 10 in accordance with the invention further guarantees exact application of the reflective layer 12 to the element core 1 or the furrows 7 and, as a result of the support of the foil or plate 11, constant alignment of the element 10 in relation to the microprisms 2 and their furrows 7.

The reflective element 10 or the reflective layer 12 respectively is preferably likewise connected to the transparent core 1 by means of adhesion or welding. In this connection, basically in turn the methods mentioned above for the connection of the reflective element 10 are possible.

In the case of the two-part reflective element 10, instead of prefabricating the element 10 it is also possible to arrange the three individual portions element core 1, metal grid 12 and transparent foil 11 one on top of the other and to align them exactly in relation to one another and subsequently to connect them jointly in one single method step. The same methods that have already been mentioned above for the separate connection steps metal grid - foil and element core - reflective element, that is, in particular welding and adhesion, are suitable for the purposes of connection.

Claims

1. Optical element (9) for deflecting light beams, which enter and re-emerge from the latter, in such a way that their angle of emergence is limited, having a plate-like core (1) of transparent material which on one side is occupied by microprisms (2) that taper forming furrows (7) - starting from their root (5) - with the furrows (7) being covered by a layer (12) that is reflective at least on one side, **characterised by** a foil (11) of transparent material that is arranged on the side of the reflective layer (12) that is remote from the element core (1).

2. Optical element according to claim 1, **characterised in that** the reflective layer (12) has a coherent grid structure.

3. Optical element according to one of the preceding claims, **characterised in that** the reflective layer (12) is substantially made of metal.

4. Optical element according to one of the preceding claims, **characterised in that** the reflective layer (12) is fixedly connected to the transparent foil (11).

5. Optical element according to claim 4, **characterised in that** the reflective layer (12) is adhered to or welded together with the transparent foil (11).

6. Optical element according to claim 4, **characterised in that** the reflective layer (12) is vapour-deposited onto the transparent foil (11).

7. Optical element according to one of the preceding claims, **characterised in that** the reflective layer (12)

is fixedly connected to the core (1).

8. Optical element according to claim 7, **characterised in that** the reflective layer (12) is adhered to or welded together with the core (1).

9. Optical element according to one of the preceding claims, **characterised in that** the transparent element core (1) and the transparent foil (11) are produced from the same material.

10. Reflective element (10) for an optical element (9) according to one of the preceding claims, having a layer (12) that is reflective at least on one side and which is dimensioned in such a way that it covers the furrows (7) of the core (1) and leaves the top surfaces (4) of the microprisms free, **characterised in that** the layer (12) is fixedly connected to a foil (11) of transparent material.

11. Reflective element according to claim 10, **characterised in that** the reflective layer (12) is adhered to or welded together with the transparent foil (11).

12. Reflective element according to claim 10, **characterised in that** the reflective layer (12) is vapour-deposited onto the transparent foil (11).

13. Reflective element according to one of claims 10 to 12, **characterised in that** the reflective layer (12) is substantially made of metal.

14. Method for producing an optical element (9) according to one of claims 1 to 9, **characterised in that** in a first step the reflective layer (12) is

fixedly connected to the transparent foil and subsequently the reflective layer (12) is fixedly connected to the element core (1).

15. Method for producing an optical element (9) according to one of claims 1 to 9, **characterised in that** in a joint step the reflective layer (12) is fixedly connected to the transparent foil (11) and to the element core (1).

16. Method according to claim 14 or 15, **characterised in that** the reflective layer (12) is adhered to the transparent foil (11) and/or to the element core (1).

17. Method according to claim 16, **characterised in that** the adhesion is effected by means of a transparent adhesive.

18. Method according to claim 14 or 15, **characterised in that** the reflective layer (12) is welded together with the transparent foil (11) and/or with the element core (1).

19. Method according to claim 18, **characterised in that** the welding is effected by heating the reflective layer (12).

20. Method according to claim 19, **characterised in that** the reflective layer (12) is heated by applying a magnetic alternating field in order to generate eddy currents in the layer (12).

21. Method according to claim 18, **characterised in that** the welding is effected by means of laser welding.

22. Method for producing a reflective element (10)

according to one of claims 10, 11 or 13, **characterised in that** the reflective layer (12) is adhered to or welded together with the transparent foil (11).

23. Method according to claim 22, **characterised in that** the adhesion is effected by means of a transparent adhesive.

24. Method according to claim 22, **characterised in that** the welding is effected by heating the reflective layer (12).

25. Method according to claim 24, **characterised in that** the reflective layer (12) is heated by applying a magnetic alternating field in order to generate eddy currents in the layer (12).

26. Method according to claim 22, **characterised in that** the welding is effected by means of laser welding.

27. Method for producing a reflective element (10) according to one of claims 10, 12 or 13, **characterised in that** the reflective layer (12) is vapour-deposited onto the transparent foil (11).

28. Method according to claim 27, **characterised in that** the structure of the reflective layer (12) is formed by punching by means of a laser beam or by punching mechanically.

29. Method according to claim 27, **characterised in that** the structure of the reflective layer (12) is formed out of the vapour-deposited layer by means of an etching process.

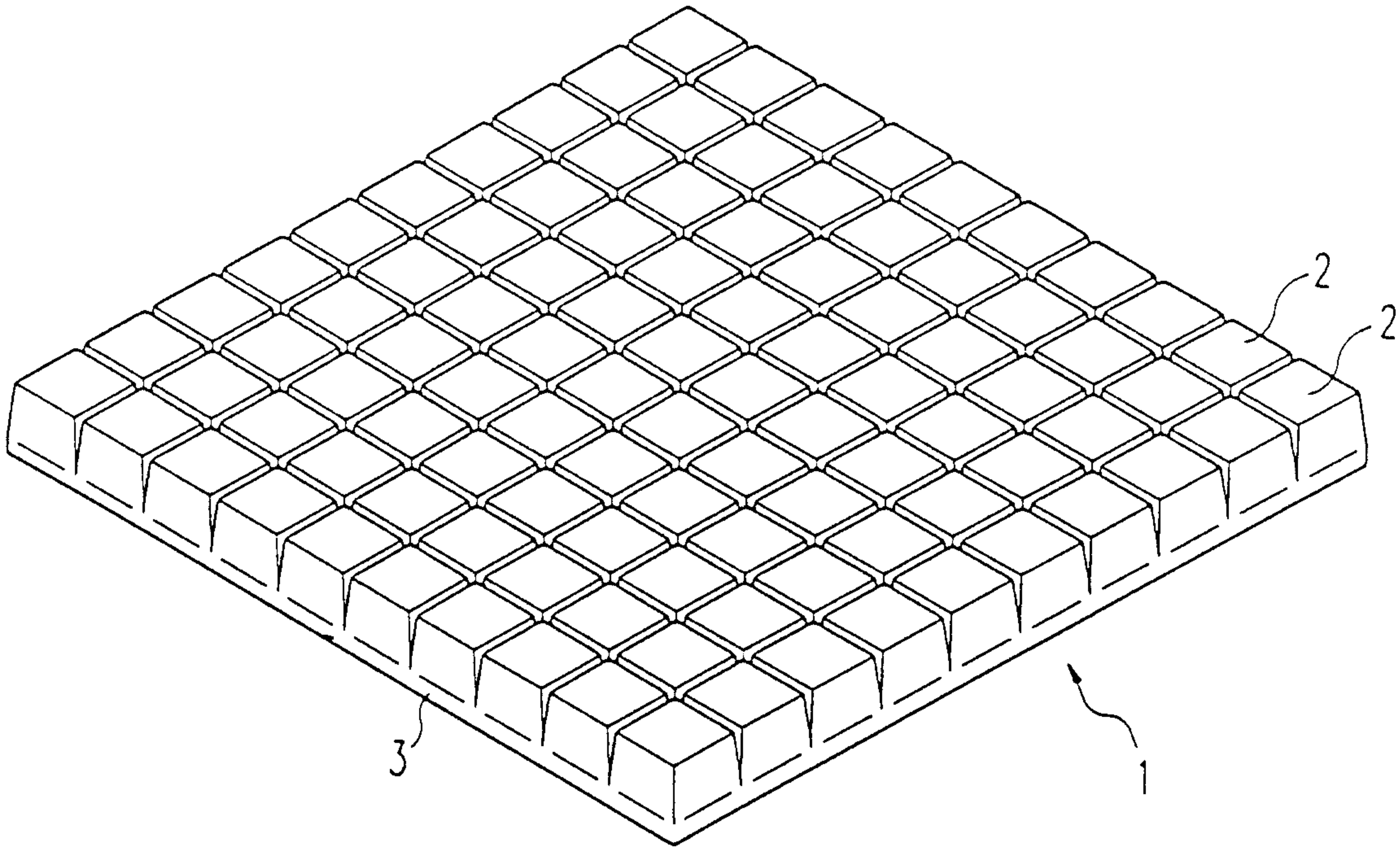


Fig. 1

Prior Art

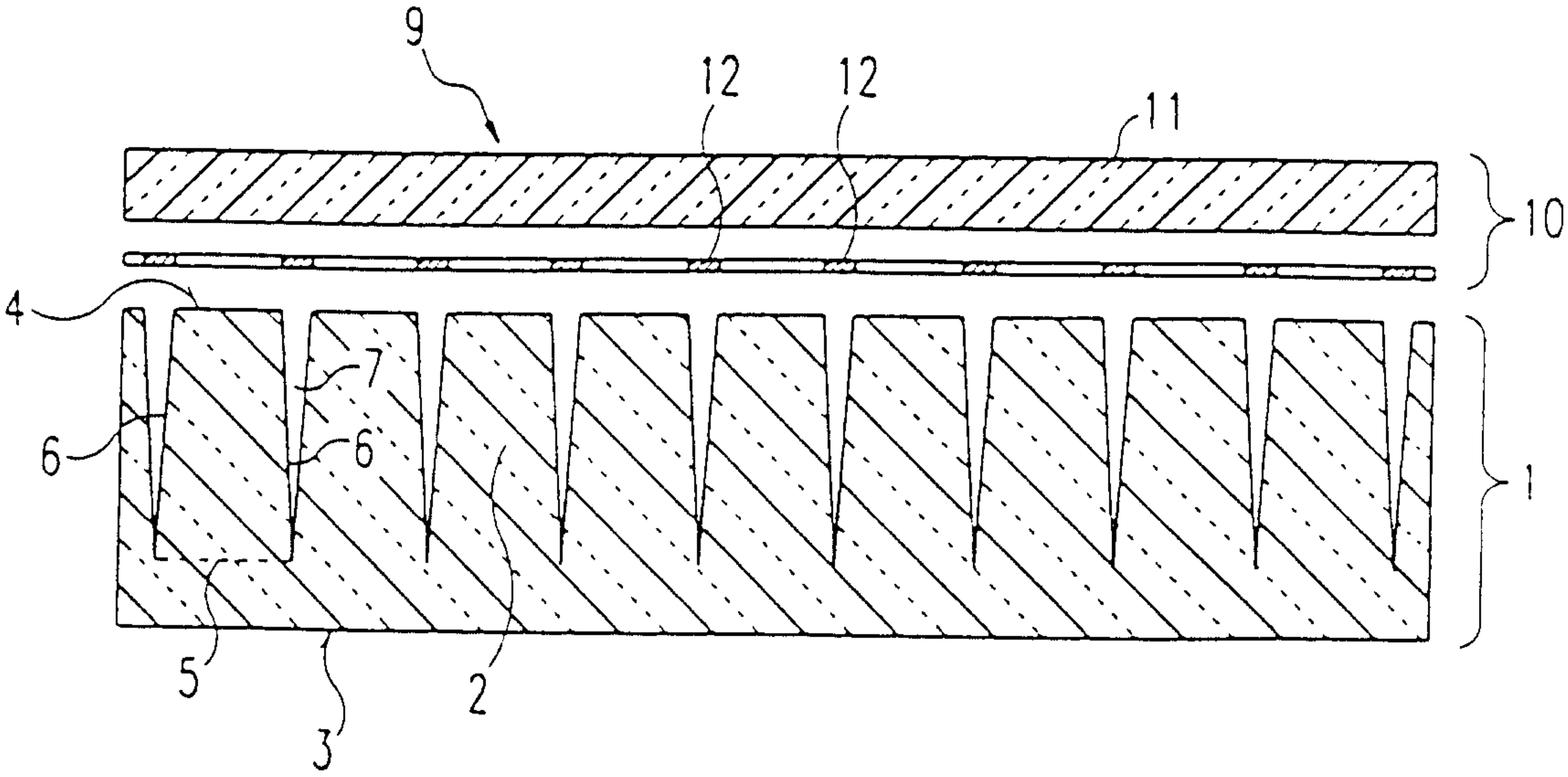


Fig. 2

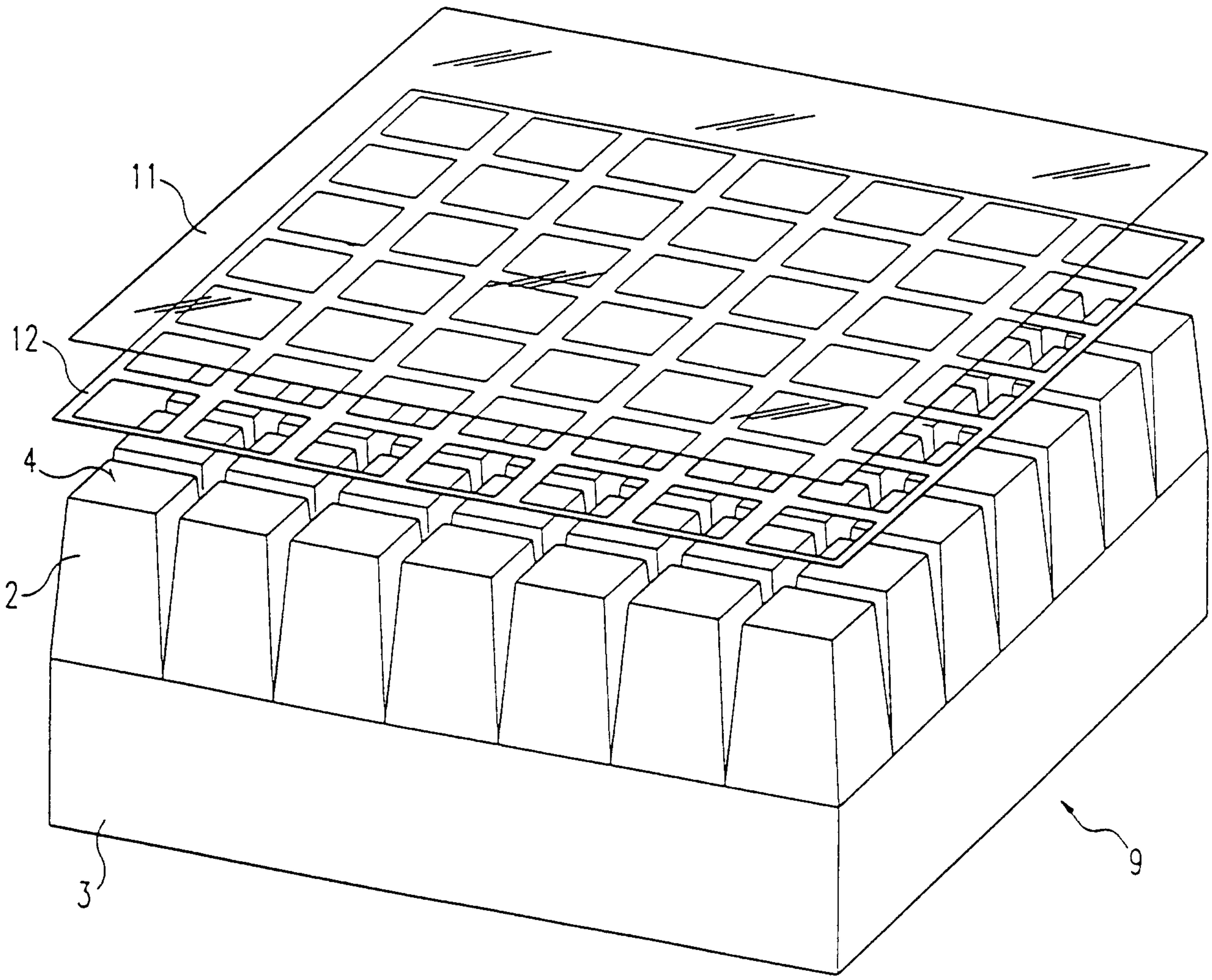
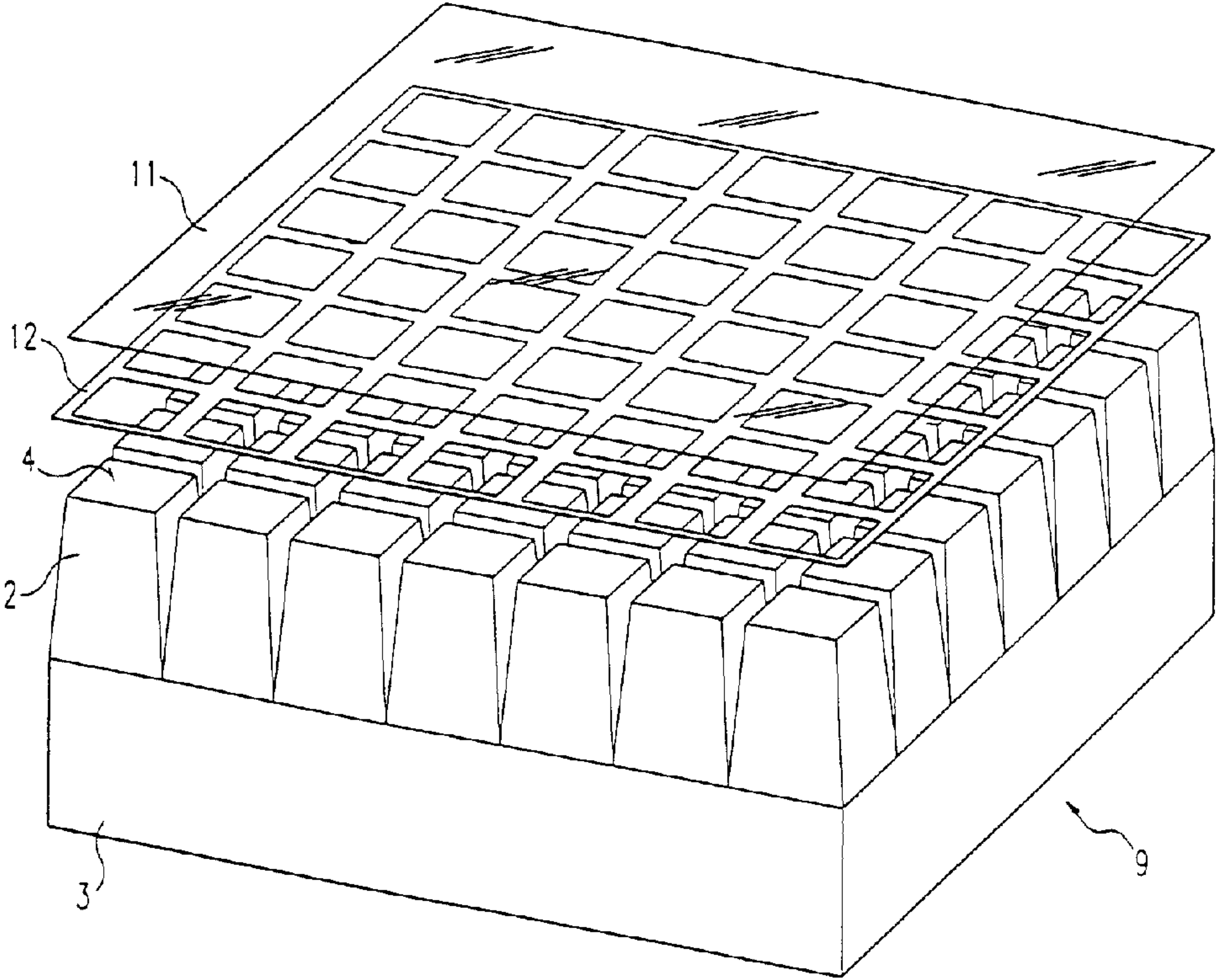


Fig. 3



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