(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 291 714 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
25.12.2024 Bulletin 2024/52

(21) Application number: **22705120.8**

(22) Date of filing: **10.02.2022**

(51) International Patent Classification (IPC):
E01C 3/00 *(2006.01)* ***E01C 9/00*** *(2006.01)*
E01C 11/22 *(2006.01)* ***E01C 13/02*** *(2006.01)*
E01C 13/04 *(2006.01)* ***E01C 13/08*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E01C 3/006; E01C 9/004; E01C 11/225; E01C 13/02; E01C 13/045; E01C 13/08; E01C 13/083; E01C 2201/10; E01C 2201/12; E04F 2290/044

(86) International application number:
PCT/GB2022/050368

(87) International publication number:
WO 2022/172016 (18.08.2022 Gazette 2022/33)

(54) **VOID FORMING MODULE, METHOD OF PREPARING A STRUCTURE AND USE OF SUCH MODULE IN THE PREPARATION OF A STRUCTURE**

HOHLRAUMBILDENDES MODUL, VERFAHREN ZUR HERSTELLUNG EINER STRUKTUR UND VERWENDUNG SOLCH EINES MODULS BEI DER HERSTELLUNG EINER STRUKTUR

MODULE DE FORMATION D'UN VIDE, PROCÉDÉ DE PRÉPARATION D'UNE STRUCTURE ET UTILISATION D'UN TEL MODULE DANS LA PRÉPARATION D'UNE STRUCTURE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **12.02.2021 GB 202101961**

(43) Date of publication of application:
20.12.2023 Bulletin 2023/51

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EP 4 291 714 B1

Description

FIELD

[0001] The present disclosure relates to a void forming module for forming structures for drainage, attenuation and/or aeration, a method of preparing a structure including said void forming module and a use of said void forming module. In particular, although not exclusively, to void forming modules for forming structures and structures including the void forming modules. The structures will typically be a structure in which drainage, attenuation, and/or aeration is required or desired.

BACKGROUND

[0002] In certain applications it is desirable to form structures having voids within the structures. The voids are typically provided for drainage, attenuation, and/or aeration.

[0003] It is desirable to provide such structures more economically. It is also desirable to provide such structures having greater void volumes within the structure.

[0004] It is a nonexclusive aim of this disclosure to provide these desiderata.

[0005] Examples of prior art can be found in documents KR20100036016A, EP2406433A1, WO2019/145985A1, DE202011000496U1 and US9528280B2.

SUMMARY

[0006] There is provided a void forming module having the features of claim 1, a method of preparing a structure including said void forming module having the features of claim 14 and a use of said void forming module having the features of claim 15.

[0007] Further preferred embodiments are defined by the features of dependent claims 2-13.

BRIEF DESCRIPTION OF DRAWINGS

[0008] Embodiments will now be described with reference to the accompanying drawings, in which:

Fig 1 shows an isometric projection from above of an embodiment of a void forming module;
Fig 2 shows a side sectional view of the void forming module of Fig 1;
Fig 3 shows another side sectional view of the void forming module of Fig 1;
Fig 4 shows a plan view from above of the void forming module of Fig 1;
Fig 5 shows a plan view from below of the void forming module of Fig 1;
Fig 6 shows an isometric projection from below of the void forming module of Fig 1; and
Fig 7 shows a schematic sectional view of an embodiment of a pavement structure including an embodiment of a void forming module.

DETAILED DESCRIPTION OF EMBODIMENTS

[0009] There is provided a void forming module, the module including a support surface including a first generally planar upper region, a second generally planar lower region, and a third generally convex region joining the first region and the second region. At least one of the first region, the second region, and/or the third region includes at least one aperture for the passage of fluid through the void forming module. There is also provided a structure including the void forming module, a method of preparing a structure, and the use of the void forming module.

[0010] As shown with reference to Figs 1 to 6, and Fig 1 in particular, there is provided a void forming module, indicated generally at 100. The module 100 includes a support surface 110 including: a first generally planar upper region 112, a second generally planar lower region 114, and a third generally convex region 116 joining the first region 112 and the second region 114. At least one of the first region 112, the second region 114, and/or the third region 116 includes at least one aperture 120,122 for the passage of fluid through the void forming module 100.

[0011] The fluid may be or include a liquid and/or a gas. The fluid may be water.

[0012] The void forming module 100 may be used in the construction of a structure.

[0013] It is thought that by providing a convex third region 116 when e.g. aggregate (e.g. large aggregate) is supported on the support surface 110 the resulting structure including the void forming module 100 and aggregate has good compressive strength, perhaps approaching or exceeding that of aggregate alone. This may be advantageous as substantially less aggregate is used in the structure including the void forming module 100 and aggregate than if aggregate alone was used to provide the same layer height. Accordingly, since the combination of void forming module 100 and aggregate may be provided for a substantially lower cost than a comparable layer height of aggregate alone and, further, since the void forming module 100 and aggregate may be transported for a substantially lower cost than a comparable amount of aggregate which would provide a particular layer height (due to a lower weight), a structure may be provided for a substantial cost saving without reducing the compressive strength of the structure.

[0014] Initial testing of 3D printed prototype void forming modules were conducted using a 30 tonne press and a 300 mm diameter plate to replicate an HGV tyre. The prototype was loosely filled with 6-10mm kiln dried rounded aggregate, to 30mm above the top face of the product. The prototype yielded at a load of 6.3 tonnes with minimal deflection. This performance is regarded as exceptionally good. For comparison, the maximum legal load on

an HGV wheel in the UK is 5.75 tonnes.

[0015] It was expected that production void forming modules would have even better performance than the prototype void forming modules. Further testing of injection moulded production void forming modules did show such improved performance. An array of void forming modules was filled with Type 3 aggregate forming a 150 mm layer above the void forming module. Type 3 aggregate is aggregate conforming to the Type 3 specification of the UK Ministry of Transport. The surface was then compacted with a bomag vibration roller to ensure proper compaction. It was found that the surface prepared in this way (i.e. including the void forming modules) was more stable than a layer of Type 3 aggregate prepared on a flat surface. This effect was immediately apparent to the vibration roller operator. Without wishing to be bound by theory, it is thought that the convex third region forms a plug for the aggregate such that the surface of the aggregate atop the void forming module is improved. The following testing was carried out by an independently UCAS accredited testing contractor. As above, a 300 mm diameter plate was used. The void forming modules and Type 3 aggregate withstood a load of 9 tonnes with minimal deflection. This 9 tonne load was the maximum load of the testing equipment. At no point during the testing did the void forming module show any apparent signs of failure. It is thought that the void forming modules and Type 3 aggregate could withstand a further load if testing equipment capable of providing greater loads was available and used. Seven testing locations above the void forming modules were tested, all provided similar excellent performance.

[0016] Additional testing showed excellent water flow through the void forming module and Type 3 aggregate combination.

[0017] Many other materials may be supported on the support surface 110 of the void forming module 100 and may provide the advantages described, as nonlimiting examples these include concretes, soils, and plastics.

[0018] Additionally, the void forming module 100 has advantages over other known constructions. For example, the structural module disclosed in WO0214608 is an alternative to an aggregate subbase and provides structural modules which occupy an entire layer. The cuboid shape of the modules of WO'608 is such that they must support the entire weight of anything above them. However, the whole void forming module 100 is not subject to the entire force of what is above it in use, as aggregate, which is supported by the support surface 110, provides substantial compressive strength in the shapes formed as a result of the shape of the support surface 110 (specifically, the shape of first, second, and third regions 112,114,116). Accordingly, the void forming module 100 with aggregate atop is thought to be able to withstand greater compressive stress than the void forming module 100 alone. Such an effect is particularly useful where it is desired to make the void forming module 100 economically, for example, it may be made relatively thin or from weaker and cheaper materials, if desired.

[0019] In summary, a key advantage which may be provided by the void forming module 100 is that the void forming module 100 can hold the shape of aggregate (or other subbase or base course) in a shape which provides increased void space and optimised strength from the aggregate (or other subbase or base course).

[0020] An aggregate only subbase or base course typically provides 30% void space for the volume occupied by the aggregate layer. The disclosed void forming modules 100 and aggregate together may provide approximately 65% void space for the volume occupied by the void forming module 100 and aggregate (or other subbase or base course) together.

[0021] As shown with reference to Figs 1, 2, and 3, the third region 116 of the support surface 110 may at least partially conform to a lateral surface of an imaginary curved truncated cone. Alternatively, the third region 116 of the support surface 110 may at least partially conform to a lateral surface of an imaginary curved frustum.

[0022] It is thought that by providing a third region 116 of the support surface 110 having such a shape that when aggregate (e.g. large aggregate) is supported on the support surface 110 the resulting structure including the void forming module 100 and aggregate has particularly good compressive strength, approaching that of aggregate alone. This may be advantageous for the reasons discussed above.

[0023] As shown with reference to Figs 2, 3, 5, and 6 in particular, the void forming module 100 may further include a void forming surface 130 including a first generally planar upper region 132, a second generally planar lower region 134, and a third generally concave region 136 joining the first region 132 and the second region 134. Accordingly, the void forming module 100 may provide a void 140 between the first region 132 of the void forming surface 130 and the second region 134 of the void forming surface 130.

[0024] The presence of the void 140 as empty space or air (and accordingly presence of the void forming surface 130) is optional; in particular, even in the absence of the void 140 as empty space or air, the void forming module 100 can still be considered to form voids in an otherwise complete aggregate layer and provide the above mentioned advantages. However, the presence of the void 140 may provide advantages, in particular, the void 140 may provide for (increased) fluid (e.g. water) attenuation and/or drainage.

[0025] As shown with reference to Figs 2, 3, and 6, the third region 136 of the void forming surface 130 may at least partially conform to a lateral surface of an imaginary curved truncated cone. Alternatively, the third region 136 of the void forming surface 130 may at least partially conform to a lateral surface of an imaginary curved frustum.

[0026] It is thought that by providing a third region 136 of the void forming surface 130 having such a shape that when aggregate (e.g. large aggregate) is supported on the support surface 110 the resulting structure including

the void forming module 100 and aggregate has particularly good compressive strength. In particular, that the void forming module 100 and aggregate together may have good compressive strength for the size of void 140 provided. Additionally, the features may also be advantageous for the reasons discussed above. Additionally, where the third region 136 of the void forming surface 130 has such a shape and the third region 116 of the support surface 110 at least partially conforms to a lateral surface of a (different) imaginary curved frustum or curved truncated cone, as will be apparent, the void forming module 100 may be relatively thin. Accordingly, such a void forming module 100 may be provided relatively cost effectively.

[0027] As shown with reference to Figs 1 and 4, in particular, the second region 114 of the support surface 110 may be generally circular.

[0028] As shown with reference to Figs 1 and 4, in particular, the third region 116 of the support surface 110 may meet the first region 112 of the support surface 110 at a generally circular edge 113.

[0029] As shown with reference to Figs 5 and 6, in particular, the second region 134 of the void forming surface 130 may be generally circular.

[0030] As shown with reference to Figs 5 and 6, in particular, the third region 136 of the void forming surface 130 may meet the first region 132 of the void forming surface 130 at a generally circular edge 133.

[0031] Such features can provide an optimised shape of the void forming module 100. Providing an optimised shape can allow the void forming module 100 filled with aggregate to have good compressive strength for the size of voids 140 provided. In particular, circular shaped features can provide for the retention of aggregate in a form in which the aggregate provides substantial compressive strength, perhaps comparable to the compressive strength of a layer of aggregate alone, without the void forming module 100 having to be capable of such compressive strength when not filled with aggregate. Accordingly, an effective void forming module 100 may be provided economically.

[0032] Such features can also provide a void forming module 100 having mutually compatible support and void forming surfaces 110, 130. Accordingly, the void forming modules 100 so provided may be stackable. This can provide easier to transport void forming modules 100.

[0033] As shown with reference to Figs 5 and 6, in particular, the void forming module 100 may further include a strengthening formation 138 supporting the third region 116 of the support surface 110 and/or the first region 112 of the support surface 110.

[0034] The strengthening formation 138 may be or include a fillet (as shown), protrusion, rib, and/or fin.

[0035] The strengthening formation 138 may extend from the second region 134 of the void forming surface 130 to the first region 132 of the void forming surface 130. As will be apparent from the Figs, although the function of the strengthening formation 138 is to support the support surface 110, the strengthening formation 138 may be provided on the void forming surface 130.

[0036] The strengthening formation 138 may be integrally formed as part of the void forming module 100.

[0037] Providing a strengthening formation 138 having any or all of the above features can provide a more economical void forming module 100. In particular, by providing a void forming module 100 having such a strengthening formation 138, the void forming module 100 can be fabricated from less material. Further, the void 140 formed by the void forming module 100 may be larger relative to the height occupied by the void forming module 100, which in turn means that less aggregate may be used in combination with the void forming module 100, again providing an economic benefit (in that less aggregate is required and any required excavation may be reduced).

[0038] As shown with reference to Figs 1, 4, 5, and 6, in particular, the second region 114 of the support surface 110 and the second region 134 of the void forming surface 130 may be or include a grid having apertures 122. As will be apparent, the apertures 122 of the grid form at least one of the at least one apertures 122 mentioned above. Alternatively, apertures may be provided in the second region 114 of the support surface 110 and the second region 134 of the void forming surface 130 in any other way.

[0039] As shown with reference to Figs 1 to 6, the third region 116 of the support surface 110 and the third region 136 of the void forming surface 130 may, additionally or alternatively, include at least one aperture 120 of the at least one apertures 120,122.

[0040] The first region 112 of the support surface 110 and the first region 132 of the void forming surface 130 may include at least one aperture of the at least one apertures (not shown).

[0041] As will be apparent, the apertures 120,122 may be sized to prevent or inhibit the passage of various specifications of aggregate through the apertures 120,122. For example, the apertures 120,122 may sized and shaped so as not to allow coarse aggregate to pass through the apertures 120,122. Coarse aggregate typically has an average particle diameter of from 6 mm to 20 mm. Therefore, as examples, the apertures 120,122 may be sized and shaped so as not to allow spherical particles of 3 mm, 4 mm, 5 mm, 6 mm, 8 mm, 10, mm, 12 mm, 14 mm, 16 mm, 18 mm, 20 mm, or greater to pass through the apertures 120,122.

[0042] As shown with reference to Figs 1, 4, and 5, in particular, the support surface 110 may further include a plurality of further second generally planar lower regions 114, and a plurality of third generally convex regions 116 joining the first region 112 and the further second regions 114.

[0043] The plurality of second regions 114 of the support surface 110 may form an array.

[0044] The plurality of second regions 114 of the support surface 110 may be coplanar.

[0045] The plurality of third regions 116 of the support surface 110 may form an array.

[0046] As shown with reference to Figs 4, 5, and 6, in particular, the void forming surface 130 may further include a plurality of further second generally planar lower regions 134 and a plurality of third generally concave regions 136 joining the first region 132 and the further second regions 134.

[0047] The plurality of second regions 134 of the void forming surface 130 may form an array.

[0048] The plurality of second regions 134 of the void forming surface 130 may be coplanar.

[0049] The plurality of third regions 136 of the void forming surface 130 may form an array.

[0050] As will be apparent, including a plurality of second regions 114 and/or third regions 116 of the support surface 110 and/or a plurality of second regions 134 and/or third regions 136 of the void forming surface 130 provides the benefits of these regions over a larger surface area. Accordingly, where it is desired to cover a large area, a smaller number of void forming modules 100 may be used. This can facilitate coverage of a larger surface area with a lower installation burden.

[0051] As will be apparent from the Figs, the plurality of second regions 114 and/or third regions 116 of the support surface 110 and/or the plurality of second regions 134 and/or third regions 136 of the void forming surface 130 may be provided in a 3×3 array.

[0052] Each of the additional plurality of second regions 114 and/or third regions 116 of the support surface 110 and/or additional plurality of second regions 134 and/or third regions 136 of the void forming surface 130 may have any or all of the features of the second region 114 and/or the third region 116 of the support surface 110 and/or the second region 134 and/or the third region 136 of the void forming surface 130 described herein, respectively.

[0053] In particular, as shown with reference to Figs 5 and 6, the void forming module 100 may include strengthening formations 138 which support neighbouring third regions 116 of the support surface 110 and/or the first region 112 of the support surface 110 between neighbouring third regions 116 of the support surface 110. In this way, a stronger support surface 110 may be provided; in particular, for a given amount of material forming the void forming module 100.

[0054] As shown with reference to Figs 1 to 6, the void forming module 100 may further include a mating formation 152, 154 adapted to mate with a mating formation of another corresponding module. In this way, a plurality of void forming modules 100 may be assembled to form an array of void forming modules 100. The mating formations 152, 154 can prevent lateral movement of neighbouring void forming modules 100.

[0055] The void forming module 100 may be provided with male formations 152 and female formations 154. Alternatively, the formations may be non-gendered. Where male and female formations 152,154 are provided, the male formations 152 may be provided on adjacent edges and the female formations 154 may also be provided on adjacent edges.

[0056] As shown with reference to Fig 6, where the void forming module 100 includes both a strengthening formation 138 and mating formations 152, 154 the strengthening formation 138 may extend to a mating formation 152, 154. In this way, when a plurality of void forming modules 100 are mated together, the strengthening formation 138 of neighbouring void forming modules 100 extend towards each other. This may result in a stronger array of void forming modules 100 with each void forming module 100 providing strength to neighbouring void forming modules 100.

[0057] As shown with reference to Fig 2 to 5, the void forming module 100 may have a width X of at most 2000 mm, 1800 mm, 1600 mm, 1400 mm, 1200 mm, 1000 mm, 800 mm, 600 mm, 400 mm, or 200 mm. Additionally or alternatively, the void forming module 100 may have a width X of at least 200 mm, 400 mm, or 600 mm. A width X of around 600 mm may be preferred for particular applications.

[0058] The void forming module 100 may have a depth Y of at most 2000 mm, 1800 mm, 1600 mm, 1400 mm, 1200 mm, 1000 mm, 800 mm, 600 mm, 400 mm, or 200 mm. Additionally or alternatively, the void forming module 100 may have a depth Y of at least 200 mm, 400 mm, or 600 mm. A depth Y of around 600 mm may be preferred for particular applications.

[0059] The void forming module 100 may have a height Z of at most 500 mm, 400 mm, 300 mm, 200 mm, 150 mm, 100 mm, or 50 mm. Additionally or alternatively, the void forming module 100 may have a height Z of at least 20 mm, 40 mm, 60 mm, 80 mm, 100 mm, or 150 mm. A height Z of around 100 mm may be preferred for particular applications.

[0060] The second region 114 of the support surface 110 may have a diameter of at most 400 mm, 300 mm, 250 mm, 200 mm, or 100 mm. Additionally or alternatively, the second region 114 of the support surface 110 may have a diameter of at least 50 mm, 100 mm, 150 mm, or 200 mm. A second region 114 of the support surface 110 having a diameter of around 100 mm may be preferred for particular applications.

[0061] The edge 113 at which the third region 116 of the support surface 110 meets the first region 112 of the support surface 110 may have a diameter of at most 800 mm, 600 mm, 500 mm, 400 mm, or 200 mm. Additionally or alternatively, the edge 113 at which the third region 116 of the support surface 110 meets the first region 112 of the support surface 110 may have a diameter of at least 100 mm, 200 mm, 300 mm, or 400 mm. A void forming module 100 in which the edge 113 at which the third region 116 of the support surface 110 meets the first region 112 of the support surface 110 has a diameter of around 200 mm may be preferred for particular applications.

[0062] The second region 134 of the void forming sur-

face 130 may have a diameter of at most 400 mm, 300 mm, 250 mm, 200 mm, or 100 mm. Additionally or alternatively, the second region 134 of the void forming surface 130 may have a diameter of at least 50 mm, 100 mm, 150 mm, or 200 mm. A second region 134 of the void forming surface 130 having a diameter of around 100 mm may be preferred for particular applications.

[0063] The edge 133 at which the third region 136 of the void forming 130 surface meets the first region 132 of the void forming surface 130 may have a diameter of at most 800 mm, 600 mm, 500 mm, 400 mm, or 200 mm. Additionally or alternatively, the edge 133 at which the third region 136 of the void forming surface 130 meets the first region 132 of the void forming surface 130 may have a diameter of at least 100 mm, 200 mm, 300 mm, or 400 mm. A void forming module 100 in which the edge 133 at which the third region 136 of the void forming surface 130 meets the first region 132 of the void forming surface 130 has a diameter of around 200 mm may be preferred for particular applications.

[0064] The void forming module 100 may be manufactured from conventional materials and using conventional techniques. For example, the void forming module 100 may be of or comprise plastics. The void forming module 100 may be manufactured using conventional injection moulding techniques.

[0065] Alternatively, the void forming module 100 may be manufactured using 3D printing techniques.

[0066] The void forming module 100 may be of or comprise an impermeable material (save for the apertures 120,122, if present).

[0067] As shown with reference to Fig 7, there is also provided a structure 200 including a void forming module 100 as described above. The structure 200 is typically a framework or fabric of assembled material parts. The structure 200 may be any man-made construction. The structure will typically be a structure in which drainage, attenuation, and/or aeration is required or desired.

[0068] As shown in Fig 7, the structure 200 is a pavement structure, however the structure 200 may be another structure, for example, a structure for providing an environment for plants, wherein the upper layers will typically include soil having plants growing therein; a sports pitch, where the upper layers will typically be playing surface including, for example, natural or artificial grass or some other playing surface; a field; a green roof, typically a roof having plants growing thereon; an urban tree supporting structure; a plant environment; a gas ventilation system; or a soil aeration system; for example.

[0069] The structure 200 may include a subbase 210. The subbase 210 may have an upper surface 212. The void forming module 100 may be supported by the subbase 210.

[0070] The structure 200 may further include a permeable or impermeable base course 220 supported by the first, second, and/or third regions 112,114,116 of the support surface 110. The base course 220 may be provided as a layer. The base course 220 may be within, and optionally on top, of the void forming module 100. The base course 220 may be coarse aggregate, as described above.

[0071] In other structures 200 (not shown), the void forming module 100 may be part of the subbase layer. In such a case the, subbase layer will be supported on the void forming module 100.

[0072] As the subbase or base course 220 may be impermeable, it will be apparent that the apertures 120,122 may be omitted. Accordingly, there is also provided a void forming module 100 without apertures 120,122.

[0073] The structure 200 may further include a surface course 230. The surface course 230 may be permeable or impermeable. The surface course 230 may be provided as a layer. The surface course 230 may provide a pavement surface 232; for example, a trafficable pavement surface (as shown). Alternatively, the surface course 230 may provide an environment for plants; a sports pitch surface, including, for example, natural or artificial grass or some other playing surface; a field surface; a green roof surface, typically a surface providing an environment for living plants; an urban tree supporting surface; a plant environment surface; a surface of a gas ventilation system; or a surface of a soil aeration system; for example.

[0074] There is also provided a method of preparing a structure 200. The method includes providing a void forming module 100. The void forming module 100 provided by the method may have any of the features of the void forming module 100 described above. The method further includes providing a permeable or impermeable subbase layer or base course layer 220 on the first, second, and/or third regions 112,114,116 of the support surface 110. Alternatively, the method may include providing a permeable or impermeable subbase layer on the first, second, and/or third regions 112,114,116 of the support surface 110.

[0075] There is also provided use of the void forming module 100 described above in the preparation of a structure 200.

Claims

1. A void forming module (100) for forming structures for drainage, attenuation and/or aeration, the module (100) including a support surface (110) including:

   a first generally planar upper region (112),
   a second generally planar lower region (114), and
   a third generally convex region (116) joining the first region (112) and the second region (114), wherein the third region (116) of the support surface (110) at least partially conforms to a lateral surface of an imaginary curved frustum or curved truncated cone;

wherein at least one of the first region (112), the second region (114), and/or the third region (116) includes at least one aperture (120, 122) for the passage of fluid through the void forming module (100).

2. The void forming module (100) of claim 1, wherein the module (100) further includes a void forming surface (130) including:

a first generally planar upper region (132),
a second generally planar lower region (134), and
a third generally concave region (136) joining the first region (132) and the second region (134);

wherein the module (100) provides a void (140) between the first region (132) of the void forming surface (130) and the second region (134) of the void forming surface (130).

3. The void forming module (100) of claim 2, wherein the third region (136) of the void forming surface (130) at least partially conforms to a lateral surface of an imaginary curved frustum or curved truncated cone.

4. The void forming module (100) of any preceding claim, wherein either:

(a) the second region (114) of the support surface (110) is generally circular;
(b) the third region (116) of the support surface (110) meets the first region (112) of the support surface (110) at a generally circular edge; or
(c) the second region (114) of the support surface (110) is generally circular, and wherein the third region (116) of the support surface (110) meets the first region (112) of the support surface (110) at a generally circular edge.

5. The void forming module (100) of any preceding claim when directly or indirectly dependent on claim 2, wherein either:

(a) the second region (134) of the void forming surface (130) is generally circular;
(b) the third region (136) of the void forming surface (130) meets the first region (132) of the void forming surface (130) at a generally circular edge; or
(c) the second region (134) of the void forming surface (130) is generally circular, and wherein the third region (136) of the void forming surface (130) meets the first region (132) of the void forming surface (130) at a generally circular edge.

6. The void forming module (100) of any preceding claim, further including either:

(a) a strengthening formation (138) supporting the third region (116) of the support surface (110) and/or the first region (112) of the support surface (110); or
(b) a strengthening formation (138) supporting the third region (116) of the support surface (110) and/or the first region (112) of the support surface (110), wherein the strengthening formation (138) is or includes a fillet, protrusion, rib, and/or fin.

7. The void forming module (100) of claim 6 when directly or indirectly dependent on claim 2, wherein the strengthening formation (138) extends from the second region (134) of the void forming surface (130) to the first region (132) of the void forming surface (130).

8. The void forming module (100) of any preceding claim when directly or indirectly dependent on claim 2, wherein the second region (114) of the support surface (110) and the second region (134) of the void forming surface (130) is or includes a grid having apertures (122) being at least one of the at least one apertures (120, 122).

9. The void forming module (100) of any preceding claim when directly or indirectly dependent on claim 2, wherein either:

(a) the third region (116) of the support surface (110) and the third region (136) of the void forming surface (130) includes at least one aperture (120) of the at least one apertures (120, 122);
(b) the first region (112) of the support surface (110) and the first region (132) of the void forming surface (130) includes at least one aperture of the at least one apertures; or
(c) the third region (116) of the support surface (110) and the third region (136) of the void forming surface (130) includes at least one aperture (120) of the at least one apertures (120, 122), and wherein the first region (112) of the support surface (110) and the first region (132) of the void forming surface (130) includes at least one aperture of the at least one apertures.

10. The void forming module (100) according to any preceding claim, wherein the support surface (110) further includes either:

(a) a plurality of further second generally planar lower regions (114), and
a plurality of third generally convex regions (116) joining the first region (112) and the further sec-

ond regions (114);
(b) a plurality of further second generally planar lower regions (114), and
a plurality of third generally convex regions (116) joining the first region (112) and the further second regions (114), wherein the plurality of second regions (114) of the support surface (110) form an array;
(c) a plurality of further second generally planar lower regions (114), and
a plurality of third generally convex regions (116) joining the first region (112) and the further second regions (114) wherein the plurality of third regions (116) of the support surface (110) form an array; or
(d) a plurality of further second generally planar lower regions (114), and

a plurality of third generally convex regions (116) joining the first region (112) and the further second regions (114), wherein the plurality of second regions (114) of the support surface (110) form an array, and wherein the plurality of third regions (116) of the support surface (110) form an array.

11. The void forming module (100) according to any preceding claim when directly or indirectly dependent on claim 2, wherein the void forming surface (130) further includes either:

(a) a plurality of further second generally planar lower regions (134), and
a plurality of third generally concave regions (136) joining the first region (132) and the further second regions (134); or
(b) a plurality of further second generally planar lower regions (134), and
a plurality of third generally concave regions (136) joining the first region (132) and the further second regions (134), wherein the plurality of second regions (134) of the void forming surface (130) form an array;
(c) a plurality of further second generally planar lower regions (134), and
a plurality of third generally concave regions (136) joining the first region (132) and the further second regions (134), wherein the plurality of third regions (136) of the void forming surface (130) form an array; or
(d) a plurality of further second generally planar lower regions (134), and

a plurality of third generally concave regions (136) joining the first region (132) and the further second regions (134), wherein the plurality of second regions (134) of the void forming surface (130) form an array, and wherein the plurality of third regions (136) of the void forming surface (130) form an array.

12. The void forming module (100) of any preceding claim, further including a mating formation (152, 154) adapted to mate with a mating formation of another corresponding module.

13. A structure (200) including either:

(a) a void forming module (100) according to any preceding claim; or
(b) a void forming module (100) according to any preceding claim, further including a permeable or impermeable subbase layer (210) or base course layer (220) supported by the first, second, and/or third regions (112, 114, 116) of the support surface (110).

14. A method of preparing a structure (200) including:

providing a void forming module (100), the module (100) including a support surface (110) including:

a first generally planar upper region (112),
a second generally planar lower region (114), and
a third generally convex region (116) joining the first region (112) and the second region (114), wherein the third region (116) of the support surface (110) at least partially conforms to a lateral surface of an imaginary curved frustum or curved truncated cone;
wherein at least one of the first region (112), the second region (114), and/or the third region (116) includes at least one aperture (120, 122) for the passage of fluid through the void forming module (100),

and providing a permeable or impermeable subbase layer (210) or base course (220) on the first, second, and/or third regions (112, 114, 116) of the support surface (110).

15. Use of the void forming module (100) according to any of claims 1 to 12 in the preparation of a structure (200).

Patentansprüche

1. Hohlraum bildendes Modul (100) zur Bildung von Strukturen zur Entwässerung, Dämpfung und/oder Belüftung, wobei das Modul (100) eine Trägeroberfläche (110) umfasst, die umfasst:

Einen ersten allgemein ebenen oberen Bereich (112),
einen zweiten allgemein ebenen unteren Bereich (114), und

einen dritten allgemein konvexen Bereich (116), der den ersten Bereich (112) und den zweiten Bereich (114) verbindet, wobei der dritte Bereich (116) der Trägeroberfläche (110) zumindest teilweise einer Seitenfläche eines imaginären gekrümmten Stumpfes oder gekrümmten Kegelstumpfes entspricht;
wobei mindestens einer des ersten Bereichs (112), des zweiten Bereichs (114) und/oder des dritten Bereichs (116) mindestens eine Öffnung (120, 122) für den Durchgang von Flüssigkeit durch das Hohlraum bildende Modul (100) umfasst.

2. Hohlraum bildendes Modul (100) nach Anspruch 1, wobei das Modul (100) außerdem eine Hohlraum bildende Oberfläche (130) umfasst, die umfasst:

Einen ersten allgemein ebenen oberen Bereich (132),
einen zweiten allgemein ebenen unteren Bereich (134), und
einen dritten allgemein konkaven Bereich (136), der den ersten Bereich (132) und den zweiten Bereich (134) verbindet;
wobei das Modul (100) einen Hohlraum (140) zwischen dem ersten Bereich (132) und der Hohlraum bildenden Oberfläche (130) und dem zweiten Bereich (134) der Hohlraum bildenden Oberfläche (130) bereitstellt.

3. Hohlraum bildendes Modul (100) nach Anspruch 2, wobei der dritte Bereich (136) der Hohlraum bildenden Oberfläche (130) mindestens teilweise einer Seitenfläche eines imaginären gekrümmten Stumpfes oder gekrümmten Kegelstumpfes entspricht.

4. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wobei entweder:

(a) der zweite Bereich (114) der Trägerfläche (110) allgemein kreisförmig ist;
(b) der dritte Bereich (116) der Trägeroberfläche (110) den ersten Bereich (112) der Trägeroberfläche (110) an einem allgemein kreisförmigen Rand trifft; oder
(c) der zweite Bereich (114) der Trägeroberfläche (110) allgemein kreisförmig ist, und wobei der dritte Bereich (116) der Trägeroberfläche (110) den ersten Bereich (112) der Trägeroberfläche (110) an einem allgemein kreisförmigen Rand trifft.

5. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wenn direkt oder indirekt von Anspruch 2 abhängig, wobei entweder:

(a) Der zweite Bereich (134) der Hohlraum bildenden Oberfläche (130) allgemein kreisförmig ist;
(b) der dritte Bereich (136) der Hohlraum bildenden Oberfläche (130) den ersten Bereich (132) der Hohlraum bildenden Oberfläche (130) an einem allgemein kreisförmigen Rand trifft; oder
(c) der zweite Bereich (134) der Hohlraum bildenden Oberfläche (130) allgemein kreisförmig ist, und wobei der dritte Bereich (136) der Hohlraum bildenden Oberfläche (130) den ersten Bereich (132) der Hohlraum bildenden Oberfläche (130) an einem allgemein kreisförmigen Rand trifft.

6. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, das außerdem entweder umfasst:

(a) Eine verstärkende Formation (138), die den dritten Bereich (116) der Trägeroberfläche (110) und/oder den ersten Bereich (112) der Trägeroberfläche (110) unterstützt; oder
(b) eine verstärkende Formation (138), die den dritten Bereich (116) der Trägeroberfläche (110) und/oder den ersten Bereich (112) der Trägeroberfläche (110) unterstützt, wobei die verstärkende Formation (138) eine Anrundung, ein Vorsprung, eine Rippe und/oder eine Lamelle ist oder umfasst.

7. Hohlraum bildendes Modul (100) nach Anspruch 6, wenn direkt oder indirekt von Anspruch 2 abhängig, wobei sich die verstärkende Formation (138) aus dem zweiten Bereich (134) der Hohlraum bildenden Oberfläche (130) zum ersten Bereich (132) der Hohlraum bildenden Oberfläche (130) erstreckt.

8. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wenn direkt oder indirekt von Anspruch 2 abhängig, wobei der zweite Bereich (114) der Trägeroberfläche (110) und der zweite Bereich (134) der Hohlraum bildenden Oberfläche (130) ein Gitter mit Öffnungen (122) ist oder umfasst, die mindestens eine der mindestens einen Öffnungen (120, 122) sind.

9. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wenn direkt oder indirekt von Anspruch 2 abhängig, wobei entweder:

(a) der dritte Bereich (116) der Trägeroberfläche (110) und der dritte Bereich (136) der Hohlraum bildenden Oberfläche (130) mindestens eine Öffnung (120) der mindestens einen Öffnungen (120, 122) umfasst;
(b) der dritte Bereich (112) der Trägeroberfläche (110) und der dritte Bereich (132) der Hohlraum bildenden Oberfläche (130) mindestens eine

Öffnung (120) der mindestens einen Öffnungen umfasst; oder
(c) der dritte Bereich (116) der Trägeroberfläche (110) und der dritte Bereich (136) der Hohlraum bildenden Oberfläche (130) mindestens eine Öffnung (120) der mindestens einen Öffnungen (120, 122) umfasst, und wobei der erste Bereich (112) der Trägeroberfläche (110) und der erste Bereich (132) der Hohlraum bildenden Oberfläche (130) mindestens eine Öffnung der mindestens einen Öffnungen umfasst.

10. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wobei die Trägeroberfläche (110) außerdem entweder umfasst:

(a) Eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (114), und
eine Vielzahl von dritten allgemein konvexen Bereichen (116), die den ersten Bereich (112) und die weiteren zweiten Bereiche (114) verbinden;
(b) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (114), und
eine Vielzahl von dritten allgemein konvexen Bereichen (116), die den ersten Bereich (112) und die weiteren zweiten Bereiche (114) verbinden, wobei die Vielzahl von zweiten Bereichen (114) der Trägeroberfläche (110) eine Anordnung bilden;
(c) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (114), und
eine Vielzahl von dritten allgemein konvexen Bereichen (116), die den ersten Bereich (112) und die weiteren zweiten Bereiche (114) verbinden, wobei die Vielzahl von dritten Bereichen (116) der Trägeroberfläche (110) eine Anordnung bilden; oder
(d) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (114), und

eine Vielzahl von dritten allgemein konvexen Bereichen (116), die den ersten Bereich (112) und die weiteren zweiten Bereiche (114) verbinden, wobei die Vielzahl von zweiten Bereichen (114) der Trägeroberfläche (110) eine Anordnung bilden, und wobei die Vielzahl von dritten Bereichen (116) der Trägeroberfläche (110) eine Anordnung bilden.

11. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, wenn direkt oder indirekt von Anspruch 2 abhängig, wobei die Hohlraum bildende Oberfläche (130) außerdem entweder umfasst:

(a) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (134), und
eine Vielzahl von dritten allgemein konkaven Bereichen (136), die den ersten Bereich (132) und die weiteren zweiten Bereiche (134) verbinden; oder
(b) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (134), und
eine Vielzahl von dritten allgemein konkaven Bereichen (136), die den ersten Bereich (132) und die weiteren zweiten Bereiche (134) verbinden, wobei die Vielzahl von zweiten Bereichen (134) der Hohlraum bildenden Oberfläche (130) eine Anordnung bilden;
(c) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (134), und
eine Vielzahl von dritten allgemein konkaven Bereichen (136), die den ersten Bereich (132) und die weiteren zweiten Bereiche (134) verbinden, wobei die Vielzahl von dritten Bereichen (136) der Hohlraum bildenden Oberfläche (130) eine Anordnung bilden; oder
(d) eine Vielzahl von weiteren zweiten allgemein ebenen unteren Bereichen (134), und

eine Vielzahl von dritten allgemein konkaven Bereichen (136), die den ersten Bereich (132) und die weiteren zweiten Bereiche (134) verbinden, wobei die Vielzahl von zweiten Bereichen (134) der Hohlraum bildenden Oberfläche (130) eine Anordnung bilden, und wobei die Vielzahl von dritten Bereichen (136) der Hohlraum bildenden Oberfläche (130) eine Anordnung bilden.

12. Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, das außerdem eine Passformation (152, 154) umfasst, die dazu geeignet ist, mit einer Passformation eines weiteren entsprechenden Moduls zusammenzupassen.

13. Struktur (200), die entweder umfasst:

(a) Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch; oder
(b) Hohlraum bildendes Modul (100) nach irgendeinem vorhergehenden Anspruch, das außerdem eine durchlässige oder undurchlässige Unterbauschicht (210) oder eine Tragschicht (220) umfasst, die von den ersten, zweiten und/oder dritten Bereichen (112, 114, 116) der Trägeroberfläche (110) gestützt wird.

14. Verfahren zur Herstellung einer Struktur (200), umfassend:

Bereitstellen eines Hohlraum bildenden Moduls (100), wobei das Modul (100) eine Trägeroberfläche (110) einschließt, die umfasst:

Einen ersten allgemein ebenen oberen Bereich (112),

einen zweiten allgemein ebenen unteren Bereich (114), und
einen dritten allgemein konvexen Bereich (116), der den ersten Bereich (112) und den zweiten Bereich (114) verbindet, wobei der dritte Bereich (116) der Trägeroberfläche (110) mindestens teilweise einer Seitenfläche eines imaginären gekrümmten Stumpfes oder gekrümmten Kegelstumpfes entspricht;
wobei der mindestens eine erste Bereich (112), der zweite Bereich (114), und/oder des dritten Bereichs (116) mindestens eine Öffnung (120, 122) für den Durchgang von Flüssigkeit durch das Hohlraum bildende Modul (100) umfasst,

und Bereitstellen einer durchlässigen oder undurchlässigen Unterbauschicht (210) oder einer Tragschicht (220) auf den ersten, zweiten und/oder dritten Bereichen (112, 114, 116) der Trägeroberfläche (110).

15. Verwenden des Hohlraum bildenden Moduls (100) nach irgendeinem der Ansprüche 1 bis 12 bei der Herstellung einer Struktur (200).

Revendications

1. Module de formation d'un vide (100) pour former des structures de drainage, d'atténuation et/ou d'aération, le module (100) comprenant une surface de support (110) comportant :

une première région supérieure généralement plane (112),
une deuxième région inférieure généralement plane (114), et
une troisième région généralement convexe (116) joignant la première région (112) et la deuxième région (114), dans lequel la troisième région (116) de la surface de support (110) est au moins en partie conforme à une surface latérale d'un tronc courbé ou d'un cône tronqué arrondi imaginaire;
dans lequel au moins l'une de la première région (112), de la deuxième région (114) et/ou de la troisième région (116) comprend au moins une ouverture (120, 122) pour permettre le passage de fluide à travers le module de formation d'un vide (100).

2. Module de formation d'un vide (100) selon la revendication 1, dans lequel le module (100) comprend en outre une surface de formation d'un vide (130) comportant :

une première région supérieure généralement plane (132),
un deuxième région inférieure généralement plane (134), et
une troisième région généralement concave (136) joignant la première région (132) et la deuxième région (134) ;
dans lequel le module (100) fournit un vide (140) entre la première région (132) de la surface de formation d'un vide (130) et la deuxième région (134) de la surface de formation d'un vide (130).

3. Module de formation d'un vide (100) selon la revendication 2, dans lequel la troisième région (136) de la surface de formation d'un vide (130) est au moins en partie conforme à une surface latérale d'un tronc courbé ou d'un cône tronqué arrondi imaginaire.

4. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, dans lequel soit

(a) la deuxième région (114) de la surface de support (110) est généralement circulaire ;
(b) la troisième région (116) de la surface de support (110) entre en contact avec la première région (112) de la surface de support (110) à hauteur d'un bord généralement circulaire ; soit
(c) la deuxième région (114) sur la surface de support (110) est généralement circulaire, et dans lequel la troisième région (116) de la surface de support (110) entre en contact avec la première région (112) de la surface de support (110) à hauteur d'un bord généralement circulaire.

5. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes lorsque relevant directement ou indirectement de la revendication 2, dans lequel soit

(a) la deuxième région (134) de la surface de formation d'un vide (130) est généralement circulaire ;
(b) la troisième région (136) de la surface de formation d'un vide (130) entre en contact avec la première région (132) de la surface de formation d'un vide (130) à hauteur d'un bord généralement circulaire ; soit
(c) la deuxième région (134) de la surface de formation d'un vide (130) est généralement circulaire, et dans lequel la troisième région (136) de la surface de formation d'un vide (130) entre en contact avec la première région (132) de la surface de formation d'un vide (130) à hauteur d'un bord généralement circulaire.

6. Module de formation d'un vide (100) selon l'une quel-

conque des revendications précédentes, comprenant en outre soit

(a) une formation de renforcement (138) supportant la troisième région (116) de la surface de support (110) et/ou la première région (112) de la surface de support (110) ; soit
(b) une formation de renforcement (138) supportant la troisième région (116) de la surface de support (110) et/ou la première région (112) de la surface de support (110), dans lequel la formation de renforcement (138) est ou inclut un filet, une saillie, une nervure et/ou un aileron.

7. Module de formation d'un vide (100) selon la revendication 6, lorsque relevant directement ou indirectement de la revendication 2, dans lequel la formation de renforcement (138) part de la deuxième région (134) de la surface de formation d'un vide (130) jusqu'à la première région (132) de la surface de formation d'un vide (130).

8. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, lorsque relevant directement ou indirectement de la revendication 2, dans lequel la deuxième région (114) de la surface de support (110) et la deuxième région (134) de la surface de formation d'un vide (130) sont ou comprennent une grille dotée d'ouvertures (122) comprenant au moins une ouverture des au moins une ouverture (120, 122).

9. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, lorsque relevant directement ou indirectement de la revendication 2, dans lequel soit

(a) la troisième région (116) de la surface de support (110) et la troisième région (136) de la surface de formation d'un vide (130) comprennent au moins une ouverture (120) des au moins une ouverture (120, 122).
(b) la première région (112) de la surface de support (110) et la première région (132) de la surface de formation d'un vide (130) comprennent au moins une ouverture des au moins une ouverture ; soit
(c) la troisième région (116) de la surface de support (110) et la troisième région (136) de la surface de formation d'un vide (130) comprennent au moins une ouverture (120) des au moins une ouverture (120, 122), et dans lequel la première région (112) de la surface de support (110) et la première région (132) de la surface de formation d'un vide (130) comprennent au moins une ouverture des au moins une ouverture.

10. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, dans lequel la surface de support (110) comprend en outre soit :

(a) une pluralité d'autres deuxièmes régions inférieures généralement planes (114), et
une pluralité de troisièmes régions généralement convexes (116) joignant la première région (112) et les autres deuxièmes régions (114) ;
(b) une pluralité d'autres deuxièmes régions inférieures généralement planes (114), et
une pluralité de troisièmes régions généralement convexes (116) joignant la première région (112) et les autres deuxièmes régions (114), dans lequel la pluralité des deuxièmes régions (114) de la surface de support (110) forme un réseau ;
(c) une pluralité d'autres deuxièmes régions inférieures généralement planes (114), et
une pluralité de troisièmes régions généralement convexes (116) joignant la première région (112) et les autres deuxièmes régions (114), dans lequel la pluralité des troisièmes régions (116) de la surface de support (110) forme un réseau, soit
(d) une pluralité d'autres régions inférieures généralement planes (114), et

une pluralité de troisièmes régions généralement convexes (116) joignant la première région (112) et les autres deuxièmes régions (114), dans lequel la pluralité des deuxièmes régions (114) de la surface de support (110) forme un réseau, et dans lequel la pluralité des troisièmes régions (116) de la surface de support (110) forme un réseau.

11. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, lorsque relevant directement ou indirectement de la revendication 2, dans lequel la surface de formation d'un vide (130) comprend en outre soit :

(a) une pluralité d'autres deuxièmes régions inférieures généralement planes (134), et
une pluralité de troisièmes régions généralement concaves (136) joignant la première région (132) et les autres deuxièmes régions (134) ; soit
(b) une pluralité d'autres deuxièmes régions inférieures généralement planes (134), et
une pluralité de troisièmes régions généralement concaves (136) joignant la première région (132) et les autres deuxièmes régions (134), dans lequel la pluralité des deuxièmes régions (134) de la surface de formation d'un vide (130) forme un réseau ;
(c) une pluralité d'autres deuxièmes régions in-

férieures généralement planes (134), et
une pluralité de troisièmes régions généralement concaves (136) joignant la première région (132) et les autres deuxièmes régions (134), dans lequel la pluralité des troisièmes régions (136) de la surface de formation d'un vide (130) forme un réseau, ou
(d) une pluralité d'autres deuxièmes régions inférieures généralement planes (134), et

une pluralité de troisièmes régions généralement concaves (136) joignant la première région (132) et les autres deuxièmes régions (134), dans lequel la pluralité des deuxièmes régions (134) de la surface de formation d'un vide (130) forme un réseau, et dans lequel la pluralité des troisièmes régions (136) de la surface de formation d'un vide (130) forme un réseau.

12. Module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, comprenant en outre une formation de couplage (152, 154) conçue pour être raccordée à une formation de couplage d'un autre module correspondant.

13. Structure (200) comprenant soit

(a) un module de formation d'un vide (100) selon l'une quelconque des revendications précédentes ; soit
(b) un module de formation d'un vide (100) selon l'une quelconque des revendications précédentes, comprenant en outre une sous-couche perméable ou imperméable (210) ou une couche de base (220) que supportent les première, deuxième et/ou troisième régions (112, 114, 116) de la surface de support (110).

14. Procédé de préparation d'une structure (200), consistant à :

fournir un module de formation d'un vide (100), le module (100) comprenant une surface de support (110), comportant :

une première région supérieure généralement plane (112),
une deuxième région inférieure généralement plane (114), et
une troisième région généralement convexe (116) joignant la première région (112) et la deuxième région (114), dans lequel la troisième région (116) de la surface de support (110) est au moins en partie conforme à une surface latérale d'un tronc courbé ou d'un cône tronqué arrondi imaginaire;
dans lequel au moins l'une de la première région (112), de la deuxième région (114) et/ou de la troisième région (116) comprend au moins une ouverture (120, 122) pour permettre le passage de fluide à travers le module de formation d'un vide (100), et

fournir une sous-couche perméable ou imperméable (210) ou une couche de base (220) que supportent les première, deuxième et/ou troisième régions (112, 114, 116) de la surface de support (110).

15. Utilisation du module de formation d'un vide (100) selon l'une quelconque des revendications 1 à 12 dans la préparation d'une structure (200).

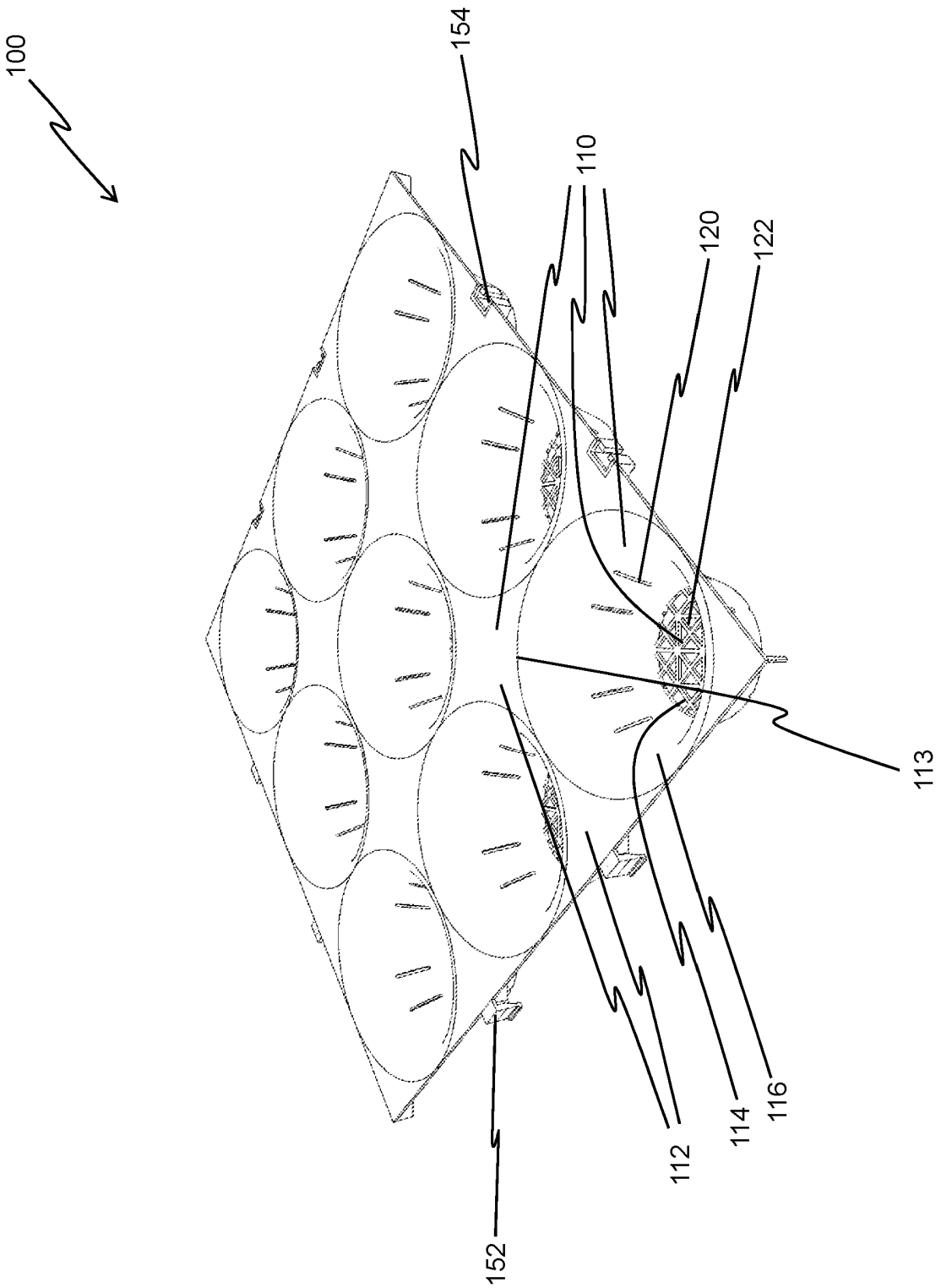

FIG 1

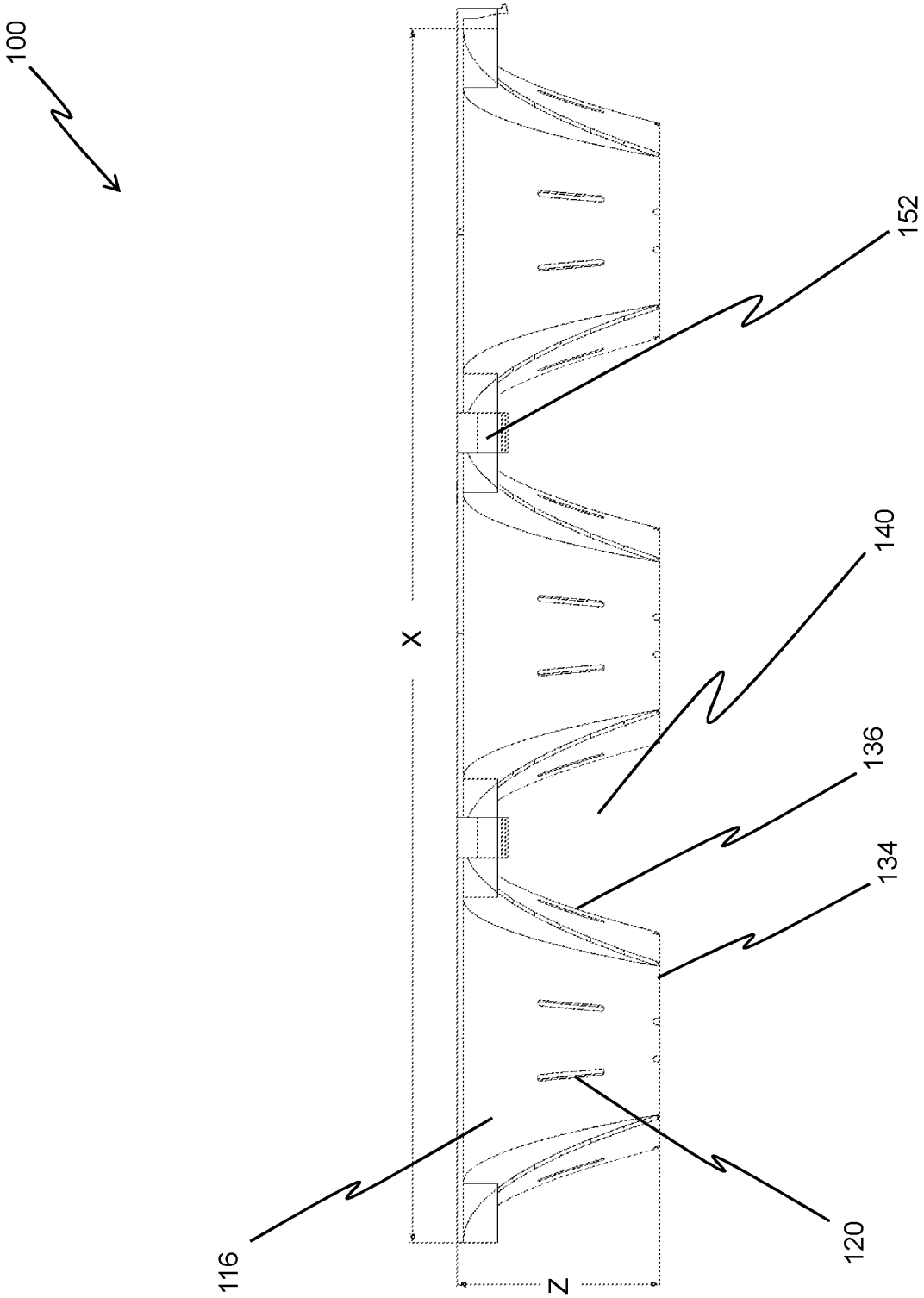

FIG 2

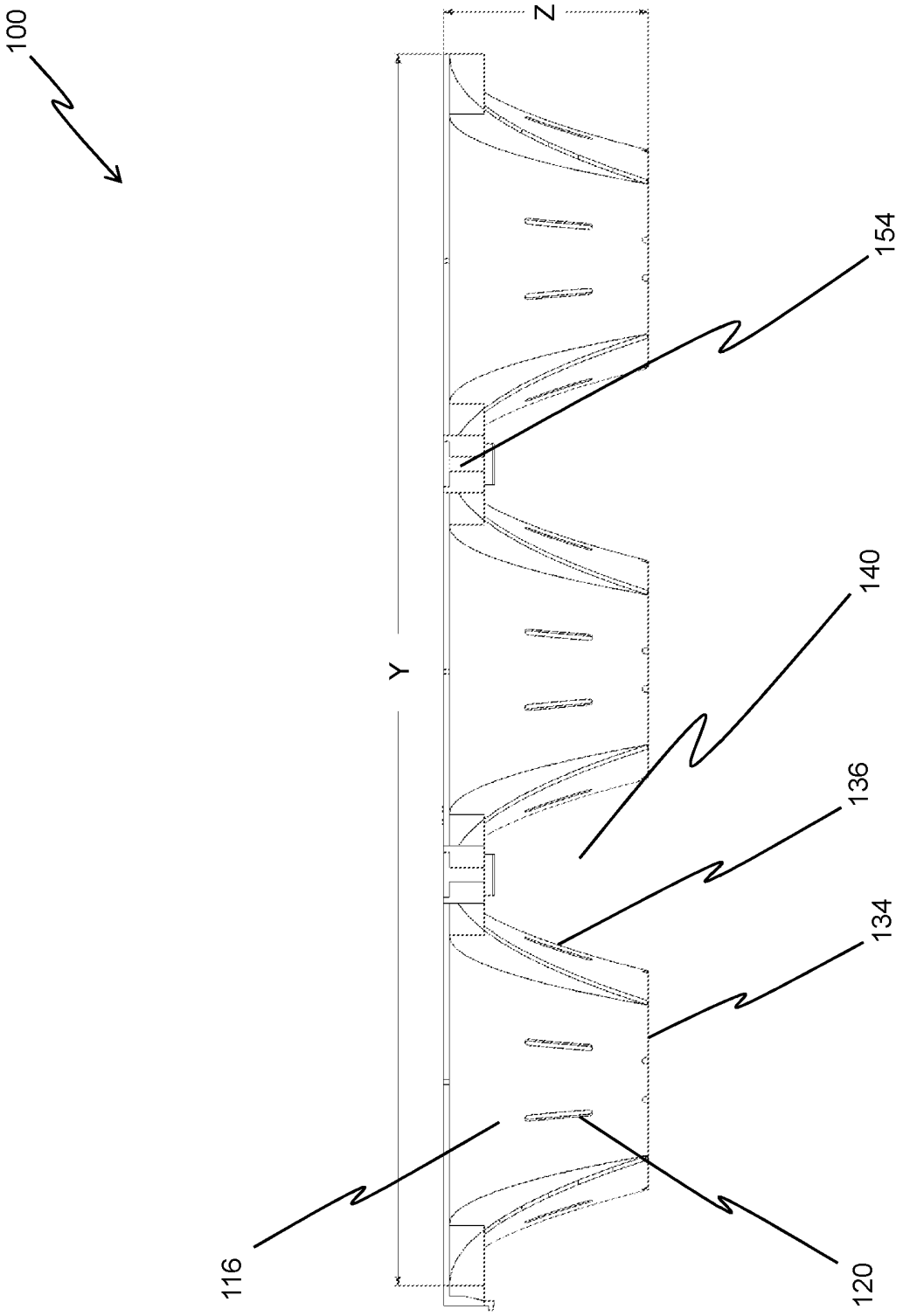

FIG 3

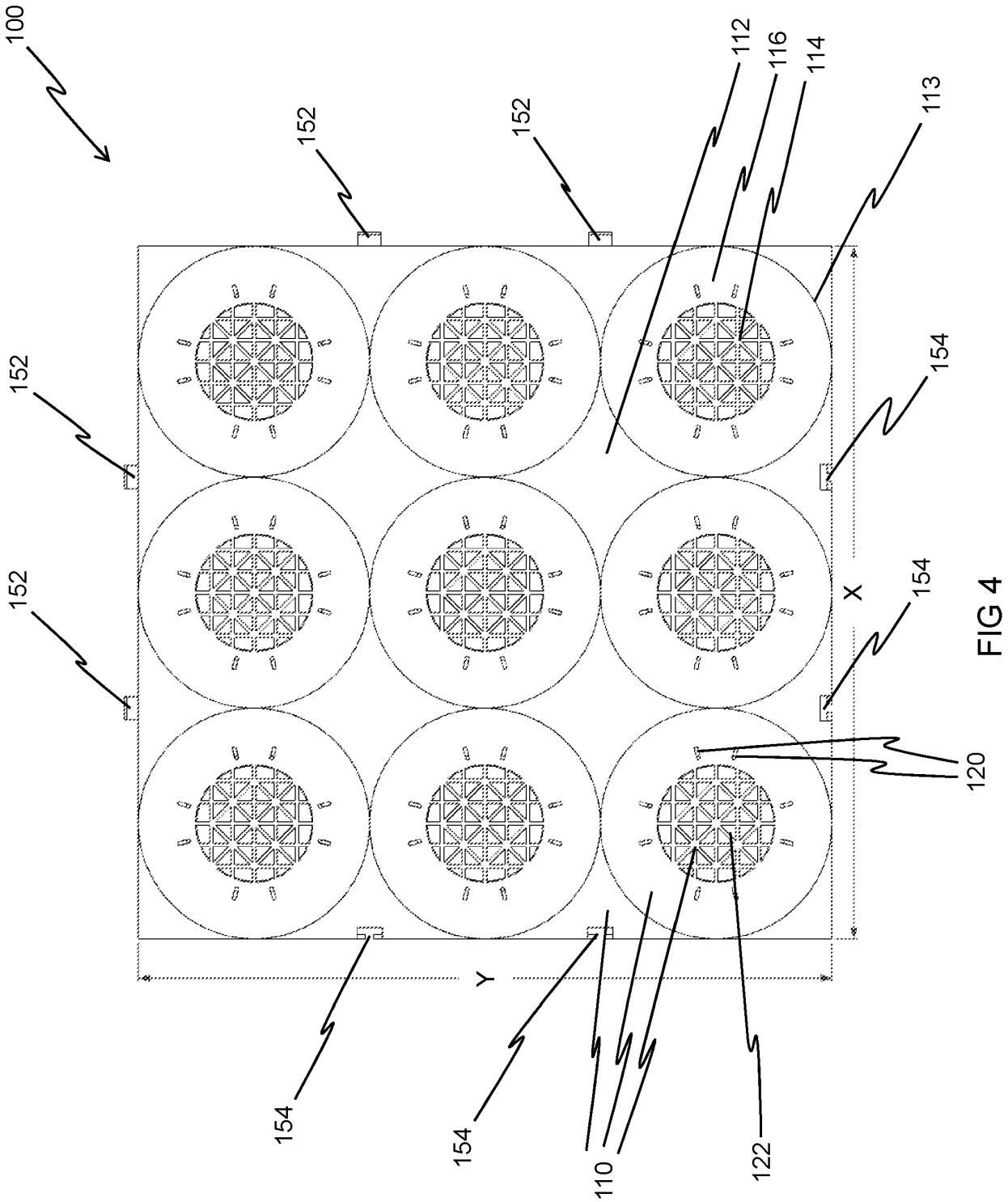
100
152
152
112
116
114
113
152
154
152
154
X
120
154
154
Y
110
122

FIG 4

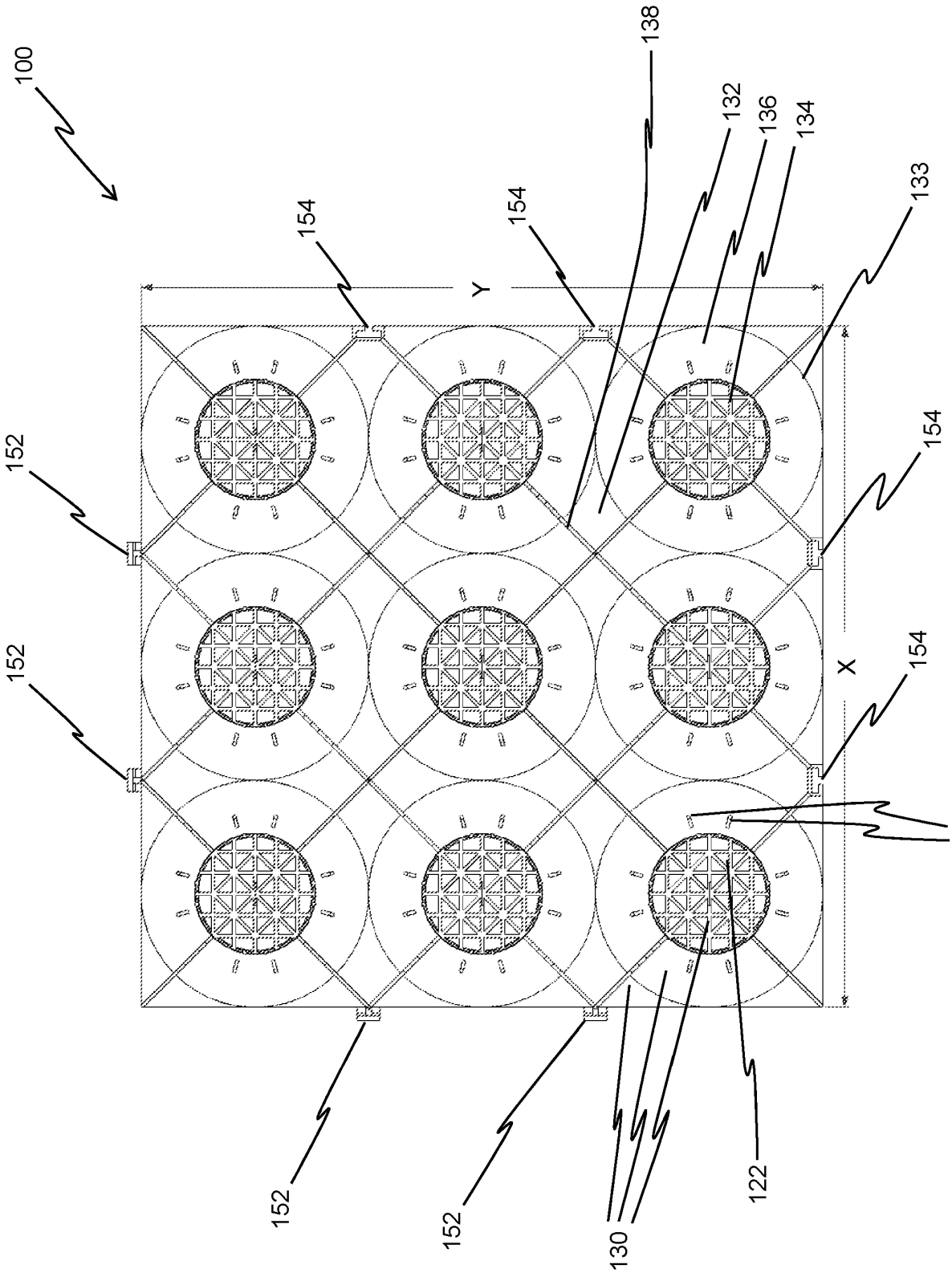
100
138
132
136
134
133
154
154
Y
152
154
152
X
154
120
152
152
130
122

FIG 5

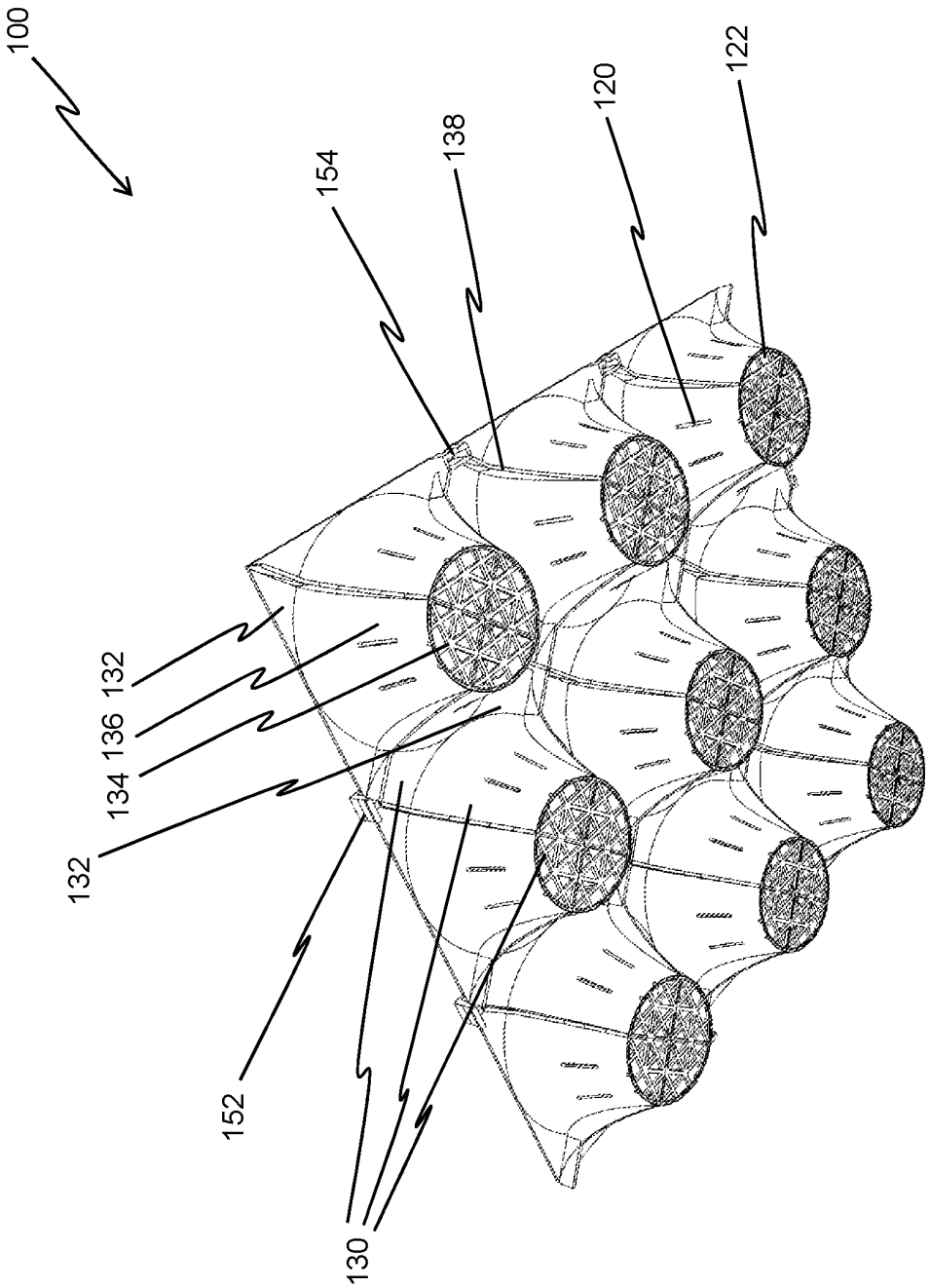

FIG 6

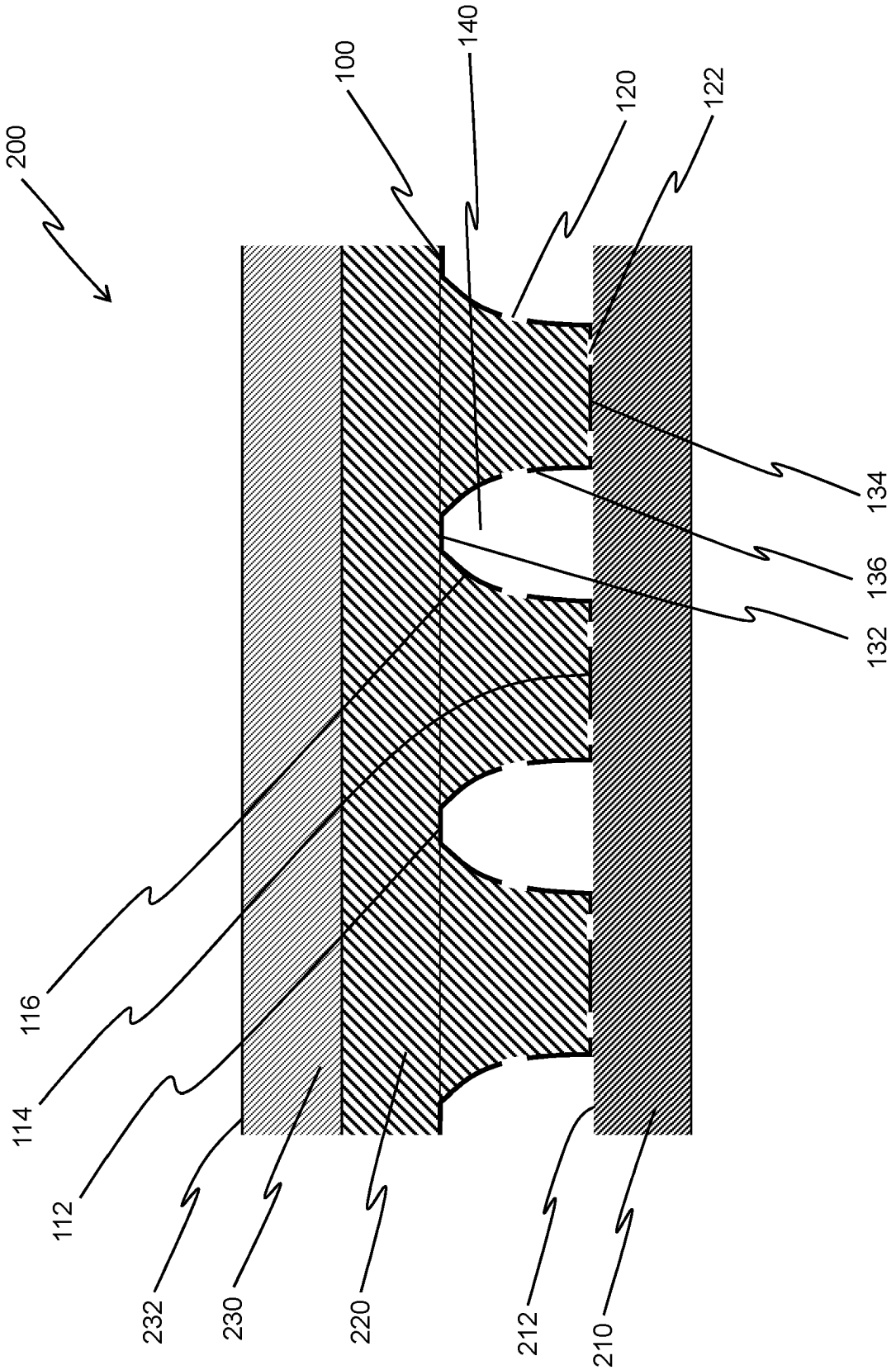

FIG 7

REFERENCES CITED IN THE DESCRIPTION

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