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(54) **INTERLOCKING CELLULAR POROUS PAVING GRIDS**

POROESE VERBUNDGITTERPLATTEN FUER BOEDEN

GRILLES DE PAVAGE AUTOBLOQUANTES ET DRAINANTES

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Description

TECHNICAL FIELD

[0001] Embodiments of the presently-disclosed invention relate generally to cellular paving grids (e.g., porous paving grids) including a plurality of open cell structures and a plurality of first connection members that interconnect the plurality of open cell structures. The cellular paving grids may be configured to interlock with each other to form an interlocked reinforcing grid. Embodiments of the presently-disclosed invention also relate to cellular paving systems including a plurality of the cellular paving grids. Embodiments of the presently-disclosed invention also relate to methods of reinforcing a ground surface.

BACKGROUND

[0002] Ground-reinforcing paving grids have many applications, such as for the reinforcement or stabilization of areas subjected to repeated pedestrian and/or vehicular traffic. Over time, for instance, repeated pedestrian and/or vehicular traffic can wear away the trafficked surface forming undesirable ruts. Ever increasing applications for ground-reinforcing grids together with ever increasing expectations of good protection from ground-reinforcing grids have led to demands for improved designs with respect to, for example, performance, ease of installation, and robustness.

[0003] There at least remains a need in the art for porous paving grids that provide improved water drainage and interlocking means for formation of a sturdy ground base for ground-reinforcement.

[0004] WO2010130968A1 discloses a ground-reinforcing grid formed of a plurality of open cell structures interconnected by rib members. The grid also comprises male and female open cell structures on its outer sides for interconnecting the grids.

[0005] DE102013103122A1 discloses a floor panel comprising male and female connecting parts.

SUMMARY

[0006] One or more embodiments of the invention may address one or more of the aforementioned problems. In one aspect of the present invention, a paving grid according to claim 1 is provided.

[0007] In another aspect the present invention provides a cellular paving system according to claim 10. The cellular paving system comprises a plurality of CPGs as discussed and disclosed herein. In accordance with certain embodiments of the invention, the cellular paving system may also include one or more marking caps. In accordance with certain embodiments of the invention, the marking caps may be configured to snap-fit (e.g., snap-fit clips) into the open cell structures and/or an interfacing cellular structure defined by the interlocking of a plurality of CPGs.

[0008] A plurality of CPGs are interlocked together to define an interlocked network of CPGs. In accordance with certain embodiments of the invention, the marking caps may be flush with a trafficked surface of the modular unit of CPGs.

[0009] In yet another aspect, the present invention provides a method of reinforcing a ground surface according to claim 13.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0010] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Like numbers refer to like elements throughout, and wherein:

Figure 1 illustrates an CPG in accordance with certain embodiments of the invention;

Figure 2 illustrates a bottom portion of a CPG showing an external row of open cell structures having an external-female open cell structure in accordance with certain embodiments of the invention;

Figure 3 illustrates a first retaining-connection member of a one CPG engaged with a first connection member of a second CPG in accordance with certain embodiments of the invention;

Figure 4 illustrates a view from the underneath of two interconnected CPGs in accordance with certain embodiments of the invention;

Figure 5 illustrates a view from the underneath of four interconnected CPGs including a marking cap engaged with an interfacing cellular structure defined by the interlocking of the four CPGs in accordance with certain embodiments of the invention; and Figure 6A and 6B illustrate a marking cap in accordance with certain embodiments of the invention.

DETAILED DESCRIPTION

[0011] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. As used in the specification, and in the appended claims, the singular forms "a", "an", "the", include plural referents unless the context clearly dictates otherwise.

[0012] The presently-disclosed invention relates generally to individual CPGs that may be interlocked (e.g., via one or more snap-fit clips) to form an interlocked network of CPGs that may be used to reinforce and/or stabilize a ground surface. In accordance with certain embodiments of the invention, a first CPG may be easily

and securely interlocked with one or more additional CPGs and filled with a filler-material to provide a reinforced surface that mitigates erosion and/or wearing-away of the ground due to pedestrian traffic, vehicular traffic, and/or running water (e.g., rain). In accordance with certain embodiments of the invention the CPGs may have a relatively low areal density to provide a lightweight, sturdy, and easily interlocked ground-reinforcing option for a variety of applications.

[0013] The terms "substantial" or "substantially" may encompass the whole amount as specified, according to certain embodiments of the invention, or largely but not the whole amount specified (e.g., 95%, 96%, 97%, 98%, or 99% of the whole amount specified) according to other embodiments of the invention.

[0014] The terms "polymer" or "polymeric", as used interchangeably herein, may comprise homopolymers, copolymers, such as, for example, block, graft, random, and alternating copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" or "polymeric" shall include all possible structural isomers; stereoisomers including, without limitation, geometric isomers, optical isomers or enantiomers; and/or any chiral molecular configuration of such polymer or polymeric material. These configurations include, but are not limited to, isotactic, syndiotactic, and atactic configurations of such polymer or polymeric material. The term "polymer" or "polymeric" shall also include polymers made from various catalyst systems including, without limitation, the Ziegler-Natta catalyst system and the metallocene/single-site catalyst system. The term "polymer" or "polymeric" shall also include, in accordance with certain embodiments of the invention, polymers produced by fermentation process or biosourced.

[0015] All whole number end points disclosed herein that can create a smaller range within a given range disclosed herein are within the scope of certain embodiments of the invention. By way of example, a disclosure of from about 10 to about 15 includes the disclosure of intermediate ranges, for example, of: from about 10 to about 11; from about 10 to about 12; from about 13 to about 15; from about 14 to about 15; etc. Moreover, all single decimal (e.g., numbers reported to the nearest tenth) end points that can create a smaller range within a given range disclosed herein are within the scope of certain embodiments of the invention. By way of example, a disclosure of from about 1.5 to about 2.0 includes the disclosure of intermediate ranges, for example, of: from about 1.5 to about 1.6; from about 1.5 to about 1.7; from about 1.7 to about 1.8; etc.

[0016] The present invention provides a CPG including a plurality of open cell structures interconnected by a plurality of first connection members. The CPGs include a plurality of secondary openings defined by the plurality of open cell structures and the plurality of first connection members. The CPGs are configured to interlock (e.g., via one or more snap-fit clips) with each other to provide

a network of interlocked CPGs. The plurality of open cell structures each comprise (a) a top edge defining a top open area, (b) a bottom surface comprising at least one bottom opening, and (c) at least one side-wall extending from the top edge to the bottom surface. The CPGs also comprise at least a first external row of the plurality of open cell structures, in which the first external row of the plurality of open cell structures comprises first external-male open cell structures. The CPGs also include at least a second external row of the plurality of open cell structures comprising external-female open cell structures, in which at least two adjacent external-female open cell structures are connected together via a first retaining-connection member. The first retaining-connection member is configured to engage and/or support a connection member from a second CPG, for example, via a snap-fit clip thereon. The external-female open cell structure is configured to (a) receive a complementary external-male open cell structure from a second cellular paving grid and (b) receive a connection member from a second cellular paving grid.

[0017] Figure 1, for instance, illustrates a CPG 1 including a plurality of open cell structures 3 each comprising (a) a top edge 4 defining a top open area, (b) a bottom surface 5 (shown in Figure 2) comprising at least one bottom opening 6 (shown in Figure 2), and (c) at least one side-wall 8 (shown in Figure 2) extending from the top edge to the bottom surface. The CPG comprises a plurality of first connection members 10 that interconnect the plurality of open cell structures 3. The plurality of first connection members may comprise a variety of cross-sectional shapes, lengths, and/or thicknesses. In accordance with certain embodiments of the invention, the structural features (e.g., cross-sectional shapes, lengths, and/or thicknesses) of the first connection members may independently be selected to impart a desired level of rigidity and/or flexibility. For example, a CPG may include a group of relatively larger first connection members and a second group of relatively smaller first connection members, in which the group of relatively larger first connection members provide a localized region of increased rigidity as compared to a different localized region provided by the second group of relatively smaller first connection members. The ease of interlocking of the CPG with additional CPGs to provide a network of interlocked CPGs, for instance, may be improved by the incorporation of one or more regions of increased flexibility due, at least in part, by the presence of the second group of relatively smaller first connection members while the relatively larger first connection member provide an overall level of rigidity.

[0018] CPGs, as shown in Figure 1, also include a plurality of secondary openings 12 defined by the plurality of open cell structures 3 and the plurality of first connection members 10. In accordance with certain embodiments of the invention a ratio between a total second-open-area of the aggregate of the secondary openings to a total top open area of the aggregate of the open cell

structures 3 may range from about 10:1 to about 1:10, such as from at least about any of the following: 1:10, 1:8, 1:6, 1:4, 1:2, and 1:1 and/or at most about any of the following: 10:1, 8:1, 6:1, 4:1, 2:1, and 1:1.

[0019] The CPGs, as shown in Figure 1, also comprise at least a first external row 15 of the plurality of open cell structures comprising first external-male open cell structures 17. For example, the CPGs may include two external rows 15 each including external-male cell structures. The CPGs also comprise at least a second external row 20 of the plurality of open cell structures comprising an external-female open cell structure 22, in which at least two adjacent external-female open cell structures are connected via a first retaining-connection 24 (shown in Figure 2) member configured to engage and/or support a second connection member from a second CPG. In accordance with the invention, the external-female open cell structures 22 are configured to (a) receive a complementary external-male open cell structure from a second CPG that is identical to the first external-male open cell structure, and (b) receive a connection member from a second CPG

[0020] Figure 2 illustrates a bottom portion of a CPG 1 showing an external row of open cell structures having an external-female open cell structure 22 in accordance with certain embodiments of the invention. As shown in Figure 2, at least two adjacent external female open cell structures 22 comprise open slots 26 configured for receiving a second connection member from a second CPG. In accordance with the invention, the open slots 26 extend from respective bottom sections of the at least one side walls 8 of the at least two adjacent external female open cell structures 22 and terminate at respective intermediate positions 27 along the respective at least one side-walls of the at least two adjacent external-female open cell structures. In accordance with the invention, the open slots 26 are configured (e.g., sized) to accommodate a second connection member from a second CPG. For instance, an external-male open cell structure of a second CPG may be inserted within the external-female open cell structure 22 and the connection members connected to the external-male open cell structure of a second CPG may slide into and remain within the open slots 26. In accordance with the invention, the open slots 26 terminate at respective intermediate surfaces 28 that may be, for example, substantially parallel to the bottom surfaces 5 of the plurality of open cell structures 3. For instance, the connection members connected to the external-male open cell structure of a second CPG may abut against the intermediate surfaces 28 when the external-male open cell structure of a second CPG is inserted with the external-female open cell structure 22. In accordance with certain embodiments of the invention, the external-female open cell structures 22 may be configured to overlap and encircle the complementary external-male open cell structure along an interface (e.g., I - I) of two interlocked CPGs as best shown in Figure 4.

[0021] In accordance with certain embodiments of the

invention and as shown in Figure 3, the first retaining-connection member 24 may comprise (a) a rib-portion 30 extending in a first direction and connecting the at least two adjacent external-female open cell structures 22, and (b) a retaining-portion 32 extending in a second direction and projection outwardly with respect to the first direction. As shown in Figure 3, the combination of the retaining-portion 32 and the open slots 26 provide a snap-fit configuration for interlocking two CPGs together. In accordance with certain embodiments of the invention, the second direction in which the retaining-portion 32 extends is substantially perpendicular to the first direction. In accordance with certain embodiments of the invention, the retaining-portion 32 includes a top surface 33 (shown in Figure 2) that is proximate to the open slots 26. In accordance with certain embodiments of the invention the top surface 33 and the intermediate surfaces 28 of the open slots 26 define a therebetween, in which the retaining-distance comprises a value that is within, for example, 10% or 5% of a thickness of a second connection member from a second CPG.

[0022] Figure 4 illustrates a view from the underneath of interconnected CPGs forming a network of interlocked CPGs in accordance with certain embodiments of the invention. In the particular example embodiment of Figure 4, three interlocking clips formed from the open slots 26 and first-retaining connection members 24 (as best illustrated in Figure 3) interlock two adjacent CPGs together along interface I - I. As also illustrated in Figures 3 and 4, the external female open end structures overlap or encircle the external male open structures to form a completed open cell structure between adjacent CPGs.

[0023] In accordance with certain embodiments of the invention, the CPG may include varying number of open cell structures. For example, the CPG may comprise from about 10 to about 100 open cell structures, such as from at least about any of the following: 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, and 50 open cell structures and/or at most about any of the following: 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, and 50 open cell structures. In accordance with certain embodiments of the invention, the open cell structures may comprise a shape comprising a circle, an oval, an elliptical, a square, a rectangle, a pentagon, a hexagon, a heptagon, an octagon, or any combinations thereof. In accordance with certain embodiments of the invention, the open cell structures comprise a wall thickness from about 2 to about 6 mm, such as from at least about any of the following: 2, 2.2, 2.5, 2.8, 3, 3.2, 3.5, 3.8, 4, 4.2, and 4.5 mm and/or at most about any of the following: 6, 5.8, 5.5, 5.2, 5, 4.8, and 4.5 mm. In accordance with certain embodiments of the invention, the top open area of each open cell structure can independently from the others comprise from about 450 to about 8000 mm², such as from at least about any of the following: 450, 500, 750, 1000, 1250, 1500, 1750 and 2000 mm² and/or at most about any of the following: 8000, 7500, 7000, 6500, 6000, 5500, 5000, 4500, 4000, 3850, 3500, 3250, 3000, 2750, 2500,

2250, and 2000 mm².

[0024] In accordance with certain embodiments of the invention, the second external row of the plurality of open cell structures (e.g., external-female open cell structures) comprises a plurality of first retaining-connection members. For example, the second external row of the plurality of open cell structures may comprise from at least about 2 to about 10 first retaining-connection members, such as at least about any of the following: 2, 3, 4, 5, and 6 first retaining-connection members and/or at most about any of the following: 10, 9, 8, 7, 6, and 5 first retaining-connection members. In accordance with certain embodiments of the invention, the second external row of the plurality of open cell structures (e.g., external-female open cell structures) comprises a first retaining-connection member located between each female open cell structure of the first external row of the plurality of open cell structures.

[0025] In accordance with certain embodiments of the invention, the CPG may comprise an aggregate top surface open area, which may be defined by the individual top open areas of each open cell structure and each secondary opening, from about 80% to about 98%, such as at least about any of the following: 80, 82, 84, 86, 88, 90, and 92% and/or at most about any of the following: 98, 96, 94, 92, and 90%. In accordance with certain embodiments of the invention, the CPG may comprise an aggregate base open area that is less than the top surface open area. For example, the base open area, which may be defined by the individual bottom openings of each open cell structure, each cut-out portions of each open cell structure (shown in Figure 2), and each secondary opening, may be from about 50% to about 90% of the aggregate top open area, such as at least about any of the following: 50, 55, 60, 65, 70, and 75% of the aggregate top open area and/or at most about any of the following: 90, 85, 80, 78, 76, and 75% of the aggregate top open area.

[0026] In accordance with certain embodiments of the invention, at least one of the plurality of open cell structures comprise a castellated side wall. For example, one or more of the plurality of open cell structures may have top portions having castellations 9 as shown in Figure 1. The gaps in the castellations may form fixing locations, for example, for U-pin connectors for fixing the CPGs onto slopes or onto surfaces prone to flooding. The gaps in the castellations may also provide grip locations for pedestrians and vehicles, and allowing grass to grow through the castellations to help connect the CPGs together and aid the sustainability of healthy growth when CPGs (e.g., interlocked network of CPGs) are trafficked.

[0027] In accordance with certain embodiments of the invention and as shown in Figure 2, the at least one side-wall 8 of the open cell structures 3 may comprise one or more cut-out portions 40 located adjacent or proximate to the bottom surface. The cut-out portions 40 may facilitate complete and/or efficient filling and anchoring of the CPGs when installed to reinforce a ground surface as

well as facilitate water drainage through the CPGs.

[0028] In accordance with certain embodiments of the invention, one or more CPGs may optionally include one or more integral ground-engaging spikes. The ground-engaging spikes may provide lateral stabilization, for example, for helping to stop lateral movement as may occur when the interlocked network of CPGs is driven over by vehicles. The ground-engaging spikes may also provide vertical stabilization, for example, by stopping the interlocked network of CPGs sinking too far into soft ground or a bedding layer, with the ground-engaging spikes being able to extend through the soft ground or the bedding layer and rest on firmer lower ground or a base construction.

[0029] In accordance with certain embodiments of the invention, the CPGs may comprise an areal density from about 2 kg/m² to about 7 kg/m², such as at least about any of the following: 2, 2.2, 2.5, 2.8, 3, 3.2, 3.5, 3.8, 4, 4.2, 4.5, and 4.8 kg/m² and/or at most about any of the following: 7, 6.8, 6.5, 6.2, 6, 5.8, 5.5, 5.2, 5, and 4.8 kg/m².

[0030] CPGs, in accordance with certain embodiments of the invention, may comprise a generally planar configuration (in an unstressed condition) and may include one or more recessed corner portions 50 as shown in Figure 5. Figure 5, for instance, illustrates a view from the underneath of four interconnected CPGs including a marking cap 60 engaged with an interfacing cellular structure 70 defined by the interlocking of the four CPGs in accordance with certain embodiments of the invention. For example, the respective recessed corner portions 50 from the four CPGs form the interfacing cellular structure when the CPGs are interlocked together. In accordance with certain embodiments of the invention, the recessed corner portions may have a recessed shape, such as a concave shape. For instance, the recessed corner portions may comprise a concave semi-circle (e.g., one quarter of a circle).

[0031] CPGs, in accordance with certain embodiments of the invention, may be configured such that they are able to overlap each other by at least one cell in any direction. Other constructions, however, may be employed. If the CPGs are able to overlap each other by at least one cell in any direction, then the CPGs are able to be moved in increments of complete open cell structures. In accordance with certain embodiments of the invention, there is no need to cut out parts of the CPGs as occurs with known ground-reinforcing grids.

[0032] In accordance with certain embodiments of the invention, the CPGs may be formed from a polymeric material. The polymeric material may comprise one or more synthetic polymers and/or one or more natural or biodegradable polymers. In accordance with certain embodiments of the invention, the polymeric material may comprise a polyolefin, such as a polyethylene or a copolymer thereof and/or a polypropylene or a copolymer thereof. In accordance with certain embodiments of the invention, the polymeric material may comprise a biodegradable polymer comprising a polyhydroxyalkanote

(PHA), a polylactic acid (PLA), a starch blend, or a cellulosic material.

[0033] In one aspect, the present invention provides a cellular paving system. The cellular paving system may comprise a plurality of CPGs as discussed and disclosed herein. In accordance with certain embodiments of the invention, the cellular paving system may also include one or more marking caps. In accordance with certain embodiments of the invention, the marking caps may be configured to snap-fit (e.g., snap-fit clips) into the open cell structures and/or an interfacing cellular structure defined by the interlocking of a plurality of CPGs. Figures 6A and 6B illustrate a marking cap 60 in accordance with certain embodiments of the invention. As shown in Figures 6A and 6B the marking cap 60 may include a top-cap portion 62 that may be flush with a trafficked surface when installed onto a CPG or an interlocked network of CPGs. The marking caps 60 may be configured to snap-fit into respective recessed corner portions 50 of at least two interlocked cellular paving grids. In accordance with certain embodiments of the invention, four CPGs may be interlocked together along interfaces I-1 - I-1 and I-2 - I-2 such that the respective recessed corner portions 50 define an interfacing cellular structure 70 as illustrated in Figure 5. The marking caps 60, for instance, may be configured to snap-fit into the interfacing cellular structure 70 as shown in Figure 5.

[0034] In accordance with certain embodiments of the invention, the marking caps 60 may comprise a top-cap portion 62 that corresponds in shape to the top open area of an open cell structure 3 and/or an interfacing-top-open area of an interfacing cellular structure 70. The marking caps 60 may include at least one downward leg portion 64 (e.g., 1, 2, 3, or 5, etc.) including a retaining clip portion 66 located distal to the top portion 62 as illustrated in Figures 6A and 6B. In accordance with certain embodiments of the invention, the retaining clip portion 66 may be configured to engage a cut-out portion 40 of at least one side-wall of an open cell structure, a second cut-out portion of a recessed corner portion, and/or lowermost surface of the grid.

[0035] In another aspect, the present invention provides a ground-reinforcing grid comprising a plurality of CPGs interlocked together to define an interlocked network of CPGs. In accordance with certain embodiments of the invention, the ground-reinforcing grid may further include one or more marking caps engaged with the interlocked network of CPGs. In accordance with certain embodiments of the invention, the marking caps may be flush with a trafficked surface of the modular unit of CPGs.

[0036] In yet another aspect, the present invention provides a method of reinforcing a ground surface, in which the method includes positioning a plurality of CPGs (e.g., as described and disclosed herein) onto a sub-base or a section of existing soil. The method further comprises a step of interlocking the plurality of CPGs to form an interlocked network of CPGs (e.g., a modular unit), and filling the interlocked network of CPGs with a filler-mate-

rial. In accordance with certain embodiments of the invention, filler-material may comprise a variety of different materials. For example, the filler-material may comprise an aggregate, such as an angular aggregate. Additionally or alternatively, the filler-material may comprise soil, grass, gravel, sand, or any combination thereof.

[0037] These and other modifications and variations to embodiments of the invention may be practiced by those of ordinary skill in the art without departing from the claimed invention, which is as set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and it is not intended to limit the invention as further described in such appended claims.

Claims

1. A cellular paving grid (1), comprising:

- (i) a plurality of open cell structures (3) each comprising (a) a top edge (4) defining a top open area, (b) a bottom surface (5) comprising at least one bottom opening (6), and (c) at least one side-wall (8) extending from the top edge to the bottom surface;
 - (ii) a plurality of first connection members (10) that interconnect the plurality of open cell structures;
 - (iii) a plurality of secondary openings (12) defined by the plurality of open cell structures and the plurality of first connection members;
 - (iv) at least a first external row (15) of the plurality of open cell structures comprising first external male open cell structures (17); and
 - (v) at least a second external row (20) of the plurality of open cell structures comprising external female open cell structures (22);
- wherein at least two adjacent external female open cell structures are connected via a first retaining-connection member (24) configured to support a connection member interconnecting complementary external male open cell structures from a second of such a cellular paving grid;
- wherein the external female open cell structures are configured to receive a complementary external male open cell structure from the second cellular paving grid, and
- characterised in that** the at least two adjacent external female open cell structures comprise open slots (26) that extend from respective bottom sections of the at least one side walls of the at least two adjacent external female open cell structures and terminate at respective intermediate positions (27) along the respective at least

- one side-walls (8) of the at least two adjacent external female open cell structures, the open slots being configured for receiving the connection members from the second cellular paving grid, and wherein the first retaining-connection member (24) comprises (a) a rib-portion (30) extending in a first direction and connecting the at least two adjacent external female open cell structures, and (b) a retaining-portion (32) extending in a second direction and projection outwardly with respect to the first direction; wherein the second direction is substantially perpendicular to the first direction and the retaining-portion includes a top surface (33) that is proximate to the open slots.
2. The cellular paving grid (1) of claim 1, wherein the open slots (26) ; wherein the open slots are sized to accommodate the connection member from the second cellular paving grid.
 3. The cellular paving grid (1) of claim 2, wherein the open slots (26) terminate at respective intermediate surfaces (28) that are substantially parallel to the bottom surfaces of the plurality of open cell structures.
 4. The cellular paving grid (1) of any one of claims 1-34, wherein the external female open cell structures (22) are configured to encircle a complementary external male open cell structure from the second cellular paving grid.
 5. The cellular paving grid (1) of claim 3-4, further comprising a retaining-distance between the top surface (33) of the retaining-portion (32) and the intermediate surfaces (28) of the open slots (26); wherein the retaining-distance comprises a value that is within 10% of a thickness of a second connection member from a second cellular paving grid.
 6. The cellular paving grid (1) of any one of claims 1-5, wherein the cellular paving grid comprises from about 10 to about 100 open cell structures (4), such as from at least about any of the following: 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, and 50 open cell structures (4) and/or at most about any of the following: 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, and 50 open cell structures (4).
 7. The cellular paving grid (1) of any one of claims 1-6, wherein the second external row (20) of the plurality of open cell structures comprises a plurality of first retaining-connection members (24), such as at least about any of the following: 2, 3, 4, 5, and 6 first retaining-connection members (24) and/or at most about any of the following: 10, 9, 8, 7, 6, and 5 first retaining-connection members (24).
 8. The cellular paving grid (1) of any one of claims 1-7, wherein at least one of the plurality of open cell structures (4) comprise a castellated side wall (9), at least a first open cell structures comprises a first side-wall comprising one or more cut-out portions (40) located adjacent or proximate to the bottom surface (5) of the first open cell structure, or both.
 9. The cellular paving grid (1) of any one of claims 1-8, wherein the cellular paving grid (1) is formed from a polymeric material, and the cellular paving grid has an areal density from about 2 kg/m² to about 7 kg/m², such as at least about any of the following: 2, 2.2, 2.5, 2.8, 3, 3.2, 3.5, 3.8, 4, 4.2, 4.5, and 4.8 kg/m² and/or at most about any of the following: 7, 6.8, 6.5, 6.2, 6, 5.8, 5.5, 5.2, 5, and 4.8 kg/m².
 10. A cellular paving system, comprising a plurality of cellular paving grids (1) according to any one of claims 1-9.
 11. The cellular paving system of claim 10, further comprising one or more marking caps (60) including a top-cap portion (62) that is flush with a trafficked surface of an installed grid, wherein the marking caps (60) are configured to snap-fit into the open cell structures.
 12. The cellular paving system of claim 11, wherein the marking caps (60) are configured to snap-fit to into respective recessed corner portions (50) of at least two interlocked cellular paving grids (1).
 13. A method of reinforcing a ground surface, comprising:
 - (i) positioning a plurality of cellular paving grids (1) according to any one of claims 1-9 onto a sub-base or a section of existing soil;
 - (ii) interlocking the plurality of cellular paving grids (1) to form an interlocked network of cellular paving grids; and
 - (iii) filling the interlocked network of cellular paving grids with a filler-material; wherein the filler material may optionally comprise an aggregate, such as angular aggregate, soil, grass, gravel, sand, or any combination thereof.

Patentansprüche

1. Zellenförmiges Pflastergitter (1), umfassend:

- (i) eine Vielzahl offenzelliger Strukturen (3), die jeweils (a) eine obere Kante (4), die einen oberen offenen Bereich definiert, (b) eine untere Oberfläche (5), die mindestens eine untere Öffnung (6) umfasst, und (c) mindestens eine Sei-

tenwand (8), die sich von der oberen Kante zu der unteren Oberfläche erstreckt, umfassen;
 (ii) eine Vielzahl erster Verbindungselemente (10), die die Vielzahl offenzelliger Strukturen miteinander verbinden;
 (iii) eine Vielzahl sekundärer Öffnungen (12), die durch die Vielzahl offenzelliger Strukturen und die Vielzahl erster Verbindungselemente definiert sind;
 (iv) mindestens eine erste äußere Reihe (15) der Vielzahl offenzelliger Strukturen, die erste äußere steckerförmige offenzellige Strukturen (17) umfasst; und
 (v) mindestens eine zweite äußere Reihe (20) der Vielzahl offenzelliger Strukturen, die äußere buchsenförmige offenzellige Strukturen (22) umfasst; wobei mindestens zwei benachbarte äußere buchsenförmige offenzellige Strukturen über ein erstes Halteverbindungselement (24) verbunden sind, das dazu konfiguriert ist, ein Verbindungselement zu stützen, das komplementäre äußere steckerförmige offenzellige Strukturen von einem zweiten eines solchen zellenförmigen Pflastergitters verbindet;
 wobei die äußeren buchsenförmigen offenzelligen Strukturen dazu konfiguriert sind, eine komplementäre äußere steckerförmige offenzellige Struktur von dem zweiten zellenförmigen Pflastergitter aufzunehmen, und
dadurch gekennzeichnet, dass
 die mindestens zwei benachbarten äußeren buchsenförmigen offenzelligen Strukturen offene Schlitze (26) umfassen, die sich von jeweiligen unteren Bereichen der mindestens einen Seitenwände der mindestens zwei benachbarten äußeren buchsenförmigen offenzelligen Strukturen erstrecken und an jeweiligen Zwischenpositionen (27) entlang der jeweiligen mindestens einen Seitenwände (8) der mindestens zwei benachbarten äußeren buchsenförmigen offenzelligen Strukturen enden, wobei die offenen Schlitze zum Aufnehmen von Verbindungselementen von dem zweiten zellenförmigen Pflastergitter konfiguriert sind, und wobei das erste Halteverbindungselement (24) (a) einen Rippenabschnitt (30), der sich in einer ersten Richtung erstreckt und die mindestens zwei benachbarten äußeren buchsenförmigen offenzelligen Strukturen verbindet, und (b) einen Halteabschnitt (32) umfasst, der sich in einer zweiten Richtung erstreckt und in Bezug auf die erste Richtung nach außen vorragt; wobei die zweite Richtung im Wesentlichen senkrecht zu der ersten Richtung ist und der Halteabschnitt eine obere Oberfläche (33) enthält, die in der Nähe der offenen Schlitze liegt.

2. Zellenförmiges Pflastergitter (1) nach Anspruch 1,

wobei die offenen Schlitze (26); wobei die offenen Schlitze so dimensioniert sind, dass sie das Verbindungselement von dem zweiten zellenförmigen Pflastergitter unterbringen.

3. Zellenförmiges Pflastergitter (1) nach Anspruch 2, wobei die offenen Schlitze (26) an jeweiligen Zwischenoberflächen (28) enden, die im Wesentlichen parallel zu den unteren Oberflächen der Vielzahl offenzelliger Strukturen sind.
4. Zellenförmiges Pflastergitter (1) nach einem der Ansprüche 1-34, wobei die äußeren buchsenförmigen offenzelligen Strukturen (22) dazu konfiguriert sind, eine komplementäre äußere steckerförmige offenzellige Struktur von dem zweiten zellenförmigen Pflastergitter zu umgeben.
5. Zellenförmiges Pflastergitter (1) nach Anspruch 3-4, ferner einen Halteabstand zwischen der oberen Oberfläche (33) des Halteabschnitts (32) und den Zwischenoberflächen (28) der offenen Schlitze (26) umfassend; wobei der Halteabstand einen Wert umfasst, der innerhalb von 10 % einer Dicke eines zweiten Verbindungselements von einem zweiten zellenförmigen Pflastergitter liegt.
6. Zellenförmiges Pflastergitter (1) nach einem der Ansprüche 1-5, wobei das zellenförmige Pflastergitter von etwa 10 bis etwa 100 offenzellige Strukturen (4) umfasst, wie etwa von mindestens etwa einem der Folgenden: 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48 und 50 offenzellige Strukturen (4) und/ oder höchstens etwa eines der Folgenden: 100, 95, 90, 85, 80, 75, 70, 65, 60, 55 und 50 offenzellige Strukturen (4).
7. Zellenförmiges Pflastergitter (1) nach einem der Ansprüche 1-6, wobei die zweite äußere Reihe (20) der Vielzahl offenzelliger Strukturen eine Vielzahl erster Halteverbindungselemente (24) umfasst, wie etwa mindestens etwa eines der Folgenden: 2, 3, 4, 5 und 6 erste Halteverbindungselemente (24) und/oder höchstens etwa eines der Folgenden: 10, 9, 8, 7, 6 und 5 erste Halteverbindungselemente (24).
8. Zellenförmiges Pflastergitter (1) nach einem der Ansprüche 1-7, wobei mindestens eine der Vielzahl offenzelliger Strukturen (4) eine gezahnte Seitenwand (9) umfasst, mindestens eine erste offenzellige Strukturen eine erste Seitenwand umfasst, die einen oder mehrere ausgeschnittene Abschnitte (40) umfasst, die sich benachbart zu oder in der Nähe der unteren Oberfläche (5) der ersten offenzelligen Struktur oder beides befinden.
9. Zellenförmiges Pflastergitter (1) nach einem der Ansprüche 1-8, wobei das zellenförmige Pflastergitter

- (1) aus einem Polymermaterial gebildet ist und das zellenförmige Pflastergitter eine Flächendichte von etwa 2 kg/m² bis etwa 7 kg/m² aufweist, wie etwa mindestens etwa eines der Folgenden: 2, 2,2, 2,5, 2,8, 3, 3,2, 3,5, 3,8, 4, 4,2, 4,5 und 4,8 kg/m² und/oder höchstens etwa eines der Folgenden: 7, 6,8, 6,5, 6,2, 6, 5,8, 5,5, 5,2, 5 und 4,8 kg/m². 5
10. Zellenförmiges Pflastersystem, umfassend eine Vielzahl zellenförmiger Pflastergitter (1) nach einem der Ansprüche 1-9. 10
11. Zellenförmiges Pflastersystem nach Anspruch 10, ferner eine oder mehrere Markierungskappen (60) umfassend, die einen oberen Kappenabschnitt (62) enthalten, der bündig mit einer befahrenen Oberfläche eines installierten Gitters ist, wobei die Markierungskappen (60) dazu konfiguriert sind, in die offenzelligen Strukturen einzuschnappen. 15
12. Zellenförmiges Pflastersystem nach Anspruch 11, wobei die Markierungskappen (60) dazu konfiguriert sind, in in jeweilige vertiefte Eckabschnitte (50) mindestens zweier ineinandergreifender zellenförmiger Pflastergitter (1) einzuschnappen. 20
13. Verfahren zum Verstärken einer Bodenoberfläche, umfassend: 25
- (i) Positionieren einer Vielzahl zellenförmiger Pflastergitter (1) nach einem der Ansprüche 1-9 auf einem Unterbau oder einem Bereich vorhandenen Bodens; 30
- (ii) Ineinandergreifenlassen der Vielzahl zellenförmiger Pflastergitter (1), um ein ineinandergreifendes Netzwerk aus zellenförmigen Pflastergittern zu bilden; und 35
- (iii) Füllen des ineinandergreifenden Netzwerks aus zellenförmigen Pflastergittern mit einem Füllmaterial; wobei das Füllmaterial optional einen Zuschlagstoff umfassen kann, wie etwa kubischen Zuschlagstoff, Erde, Gras, Kies, Sand oder eine beliebige Kombination davon. 40

Revendications

1. Grille de pavage cellulaire (1), comprenant :

- (i) une pluralité de structures cellulaires ouvertes (3) comprenant chacune (a) un bord supérieur (4) définissant une zone ouverte supérieure, (b) une surface inférieure (5) comprenant au moins une ouverture inférieure (6), et (c) au moins une paroi latérale (8) s'étendant du bord supérieur à la surface inférieure ; 50
- (ii) une pluralité de premiers éléments de raccordement (10) qui raccordent la pluralité de 55

structures cellulaires ouvertes entre elles ;

(iii) une pluralité d'ouvertures secondaires (12) définies par la pluralité de structures cellulaires ouvertes et la pluralité de premiers éléments de raccordement ;

(iv) au moins une première rangée externe (15) de la pluralité de structures cellulaires ouvertes comprenant des premières structures cellulaires ouvertes mâles externes (17) ; et

(v) au moins une seconde rangée externe (20) de la pluralité de structures cellulaires ouvertes comprenant des structures cellulaires ouvertes femelles externes (22) ;

au moins deux structures cellulaires ouvertes femelles externes adjacentes étant raccordées par l'intermédiaire d'un premier élément de raccordement de retenue (24) conçu pour supporter un élément de raccordement raccordant entre elles des structures cellulaires ouvertes mâles externes complémentaires provenant d'une seconde grille de pavage cellulaire de ce type ;

lesdites structures cellulaires ouvertes femelles externes étant conçues pour recevoir une structure cellulaire ouverte mâle externes complémentaires provenant de la seconde grille de pavage cellulaire, et

caractérisée en ce que lesdites au moins deux structures cellulaires ouvertes femelles externes adjacentes comprennent des fentes ouvertes (26) qui s'étendent des sections inférieures respectives de ladite au moins une paroi latérale desdites au moins deux structures cellulaires ouvertes femelles externes adjacentes et se terminent au niveau de positions intermédiaires respectives (27) le long de ladite au moins une paroi latérale respective (8) desdites au moins deux structures cellulaires ouvertes femelles externes adjacentes, lesdites fentes ouvertes étant conçues pour recevoir les éléments de raccordement provenant de la seconde grille de pavage cellulaire, et ledit premier élément de raccordement de retenue (24) comprenant (a) une partie nervure (30) s'étendant dans une première direction et raccordant lesdites au moins deux structures cellulaires ouvertes femelles externes adjacentes, et (b) une partie de retenue (32) s'étendant dans une seconde direction et une saillie vers l'extérieur par rapport à la première direction ; ladite seconde direction étant sensiblement perpendiculaire à la première direction et ladite partie de retenue comprenant une surface supérieure (33) qui se trouve à proximité des fentes ouvertes.

2. Grille de pavage cellulaire (1) selon la revendication 1, lesdites fentes ouvertes (26) ; lesdites fentes ouvertes étant dimensionnée pour s'adapter à l'élément de raccordement provenant de la seconde

grille de pavage cellulaire.

3. Grille de pavage cellulaire (1) selon la revendication 2, lesdites fentes ouvertes (26) se terminant au niveau de surfaces intermédiaires respectives (28) qui sont sensiblement parallèles aux surfaces inférieures de la pluralité de structures cellulaires ouvertes. 5
4. Grille de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 34, lesdites structures cellulaires ouvertes femelles externes (22) étant conçues pour entourer une structure cellulaire ouverte mâle externe complémentaire provenant de la seconde grille de pavage cellulaire. 10
5. Grille de pavage cellulaire (1) selon les revendications 3 à 4, comprenant en outre une distance de retenue entre la surface supérieure (33) de la partie de retenue (32) et les surfaces intermédiaires (28) des fentes ouvertes (26) ; ladite distance de retenue comprenant une valeur qui se trouve dans l'intervalle de 10 % par rapport à l'épaisseur d'un second élément de raccordement provenant d'une seconde grille de pavage cellulaire. 15 20
6. Grille de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 5, ladite grille de pavage cellulaire comprenant d'environ 10 à environ 100 structures cellulaires ouvertes (4), tels que d'au moins environ l'un quelconque des suivants : 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48 et 50 structures cellulaires ouvertes (4) et/ou au plus environ l'un quelconque des suivants : 100, 95, 90, 85, 80, 75, 70, 65, 60, 55 et 50 structures cellulaires ouvertes (4). 25 30 35
7. Grille de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 6, ladite seconde rangée externe (20) de la pluralité de structures cellulaires ouvertes comprenant une pluralité de premiers éléments de raccordement de retenue (24), tels qu'au moins environ l'un quelconque des suivants : 2, 3, 4, 5 et 6 premiers éléments de raccordement de retenue (24) et/ou au plus environ l'un quelconque des suivants : 10, 9, 8, 7, 6 et 5 premiers éléments de raccordement de retenue (24). 40 45
8. Grille de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 7, au moins l'une de la pluralité de structures cellulaires ouvertes (4) comprenant une paroi latérale crénelée (9), au moins une première structure cellulaire ouverte comprenant une première paroi latérale comprenant une ou plusieurs parties de découpe (40) situées adjacentes ou à proximité de la surface inférieure (5) de la première structure cellulaire ouverte, ou les deux. 50 55
9. Grille de pavage cellulaire (1) selon l'une quelconque

des revendications 1 à 8, ladite grille de pavage cellulaire (1) étant formée d'un matériau polymère, et ladite grille de pavage cellulaire comportant une densité surfacique d'environ 2 kg/m² à environ 7 kg/m², tel qu'au moins environ l'une quelconque des suivantes : 2, 2,2, 2,5, 2,8, 3, 3,2, 3,5, 3,8, 4, 4,2, 4,5 et 4,8 kg/m² et/ou au plus environ l'une quelconque des suivantes : 7, 6,8, 6,5, 6,2, 6, 5,8, 5,5, 5,2, 5 et 4,8 kg/m².

10. Système de pavage cellulaire, comprenant une pluralité de grilles de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 9.
11. Système de pavage cellulaire selon la revendication 10, comprenant en outre un ou plusieurs capuchons de marquage (60) comprenant une partie de capuchon supérieur (62) qui affleure une surface circulée d'une grille installée, lesdits capuchons de marquage (60) étant conçus pour s'emboîter par pression dans les structures cellulaires ouvertes. 15 20
12. Système de pavage cellulaire selon la revendication 11, lesdits capuchons de marquage (60) étant conçus pour s'emboîter par pression dans les parties de coin évidées respectives (50) d'au moins deux grilles de pavage cellulaires (1) verrouillées entre elles. 25
13. Procédé de renforcement d'une surface au sol, comprenant : 30
 - (i) le positionnement d'une pluralité de grilles de pavage cellulaire (1) selon l'une quelconque des revendications 1 à 9 sur une sous-base ou une section de sol existante ;
 - (ii) le verrouillage de la pluralité de grilles de pavage cellulaire (1) entre elles pour former un réseau verrouillé de grilles de pavage cellulaire ; et
 - (iii) le remplissage du réseau verrouillé de grilles de pavage cellulaire avec un matériau de remplissage ; ledit matériau de remplissage pouvant éventuellement comprendre un agrégat angulaire, de la terre, de l'herbe, du gravier, du sable ou toute combinaison de ceux-ci. 35 40 45

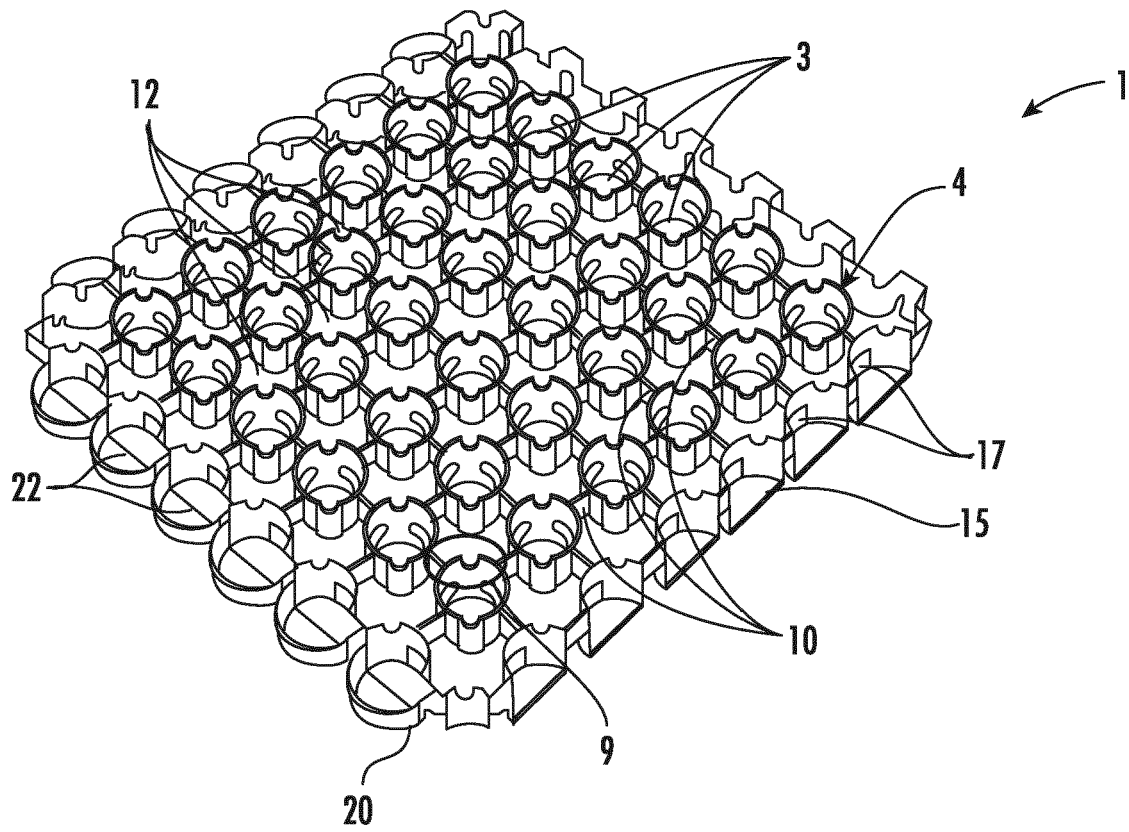


FIG. 1

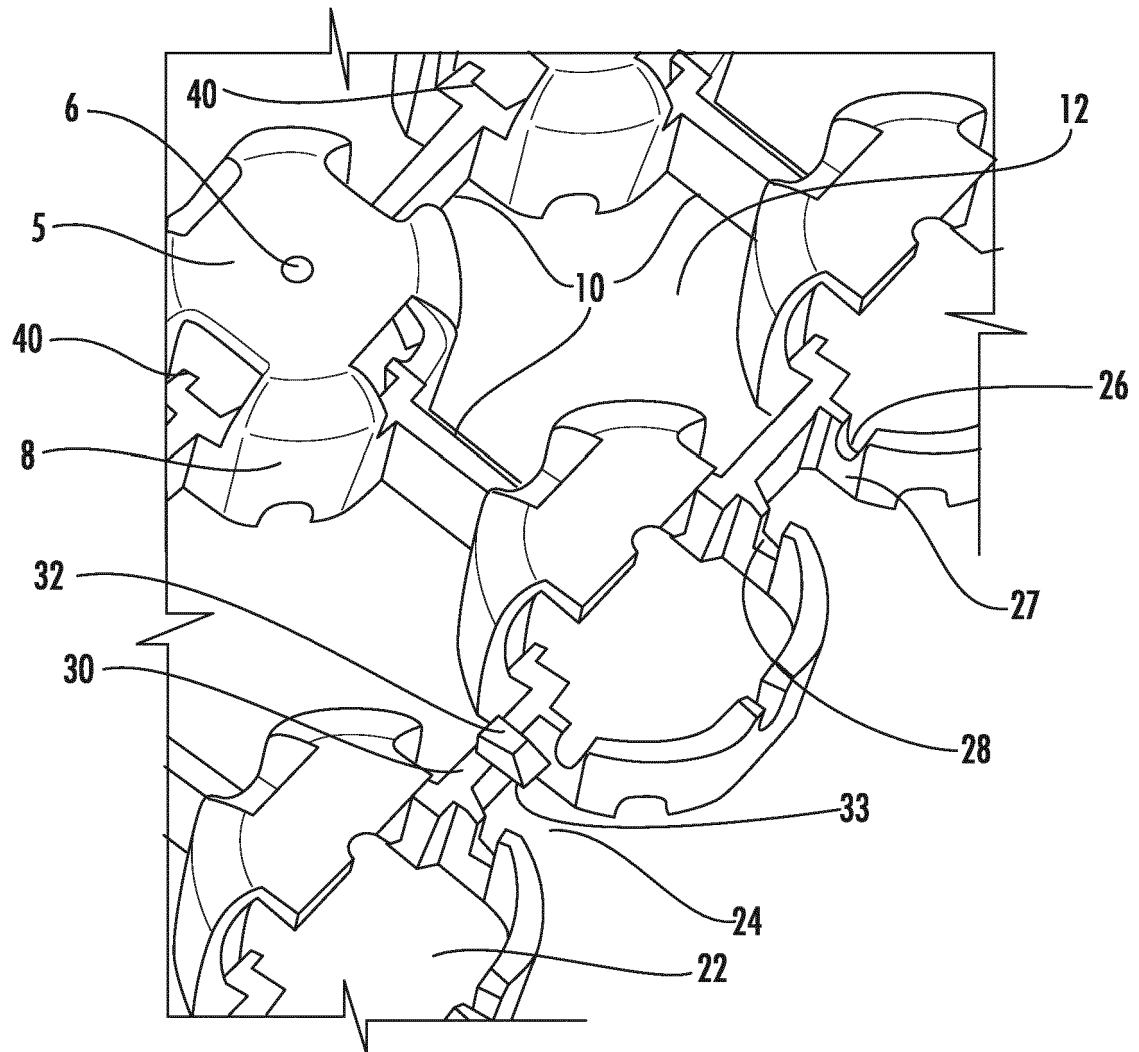


FIG. 2

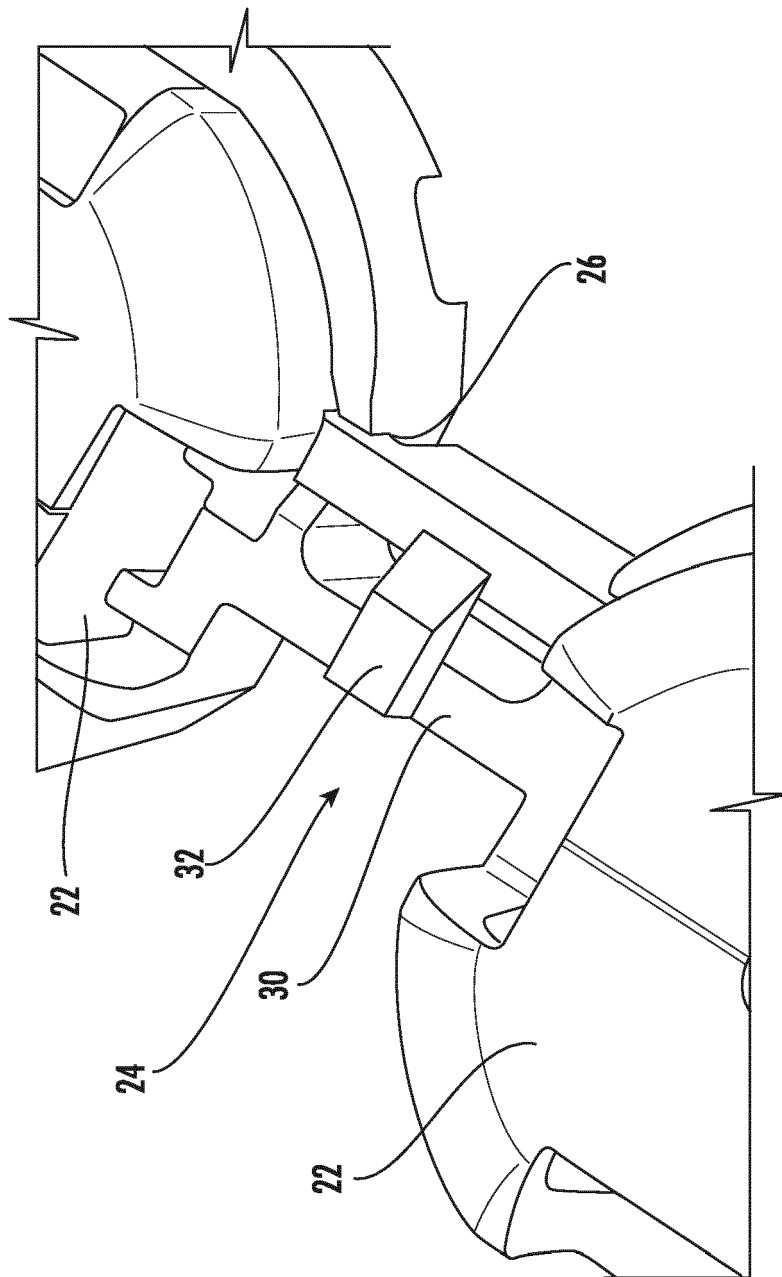


FIG. 3

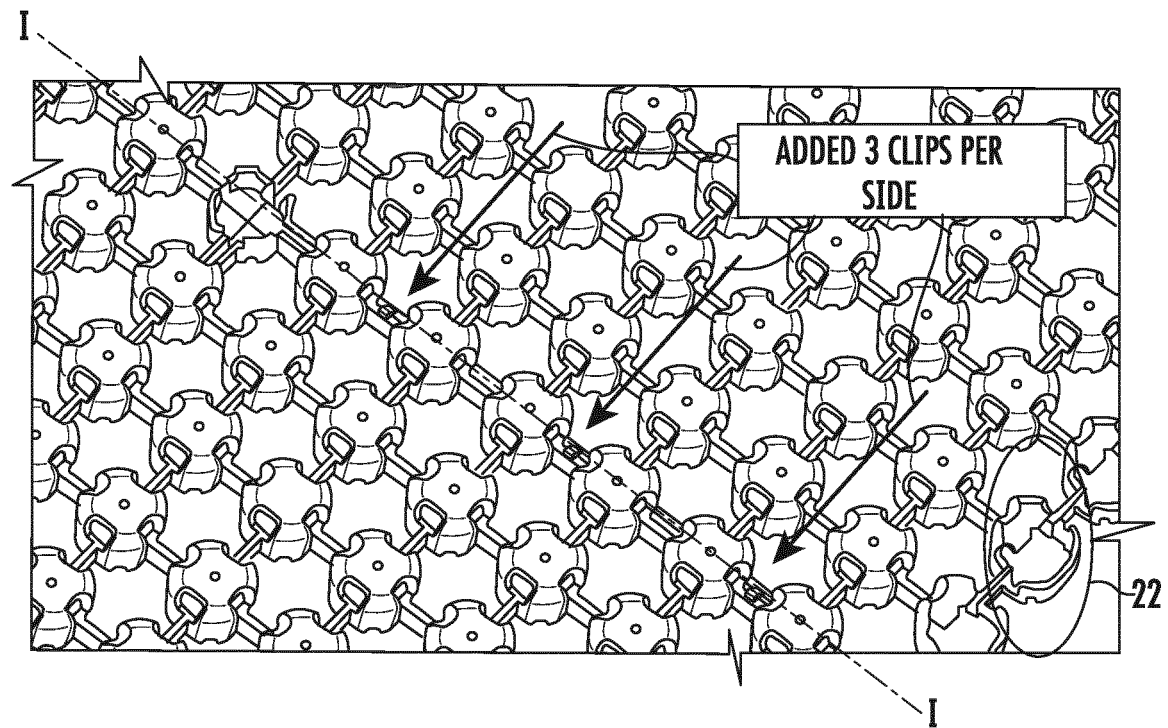


FIG. 4

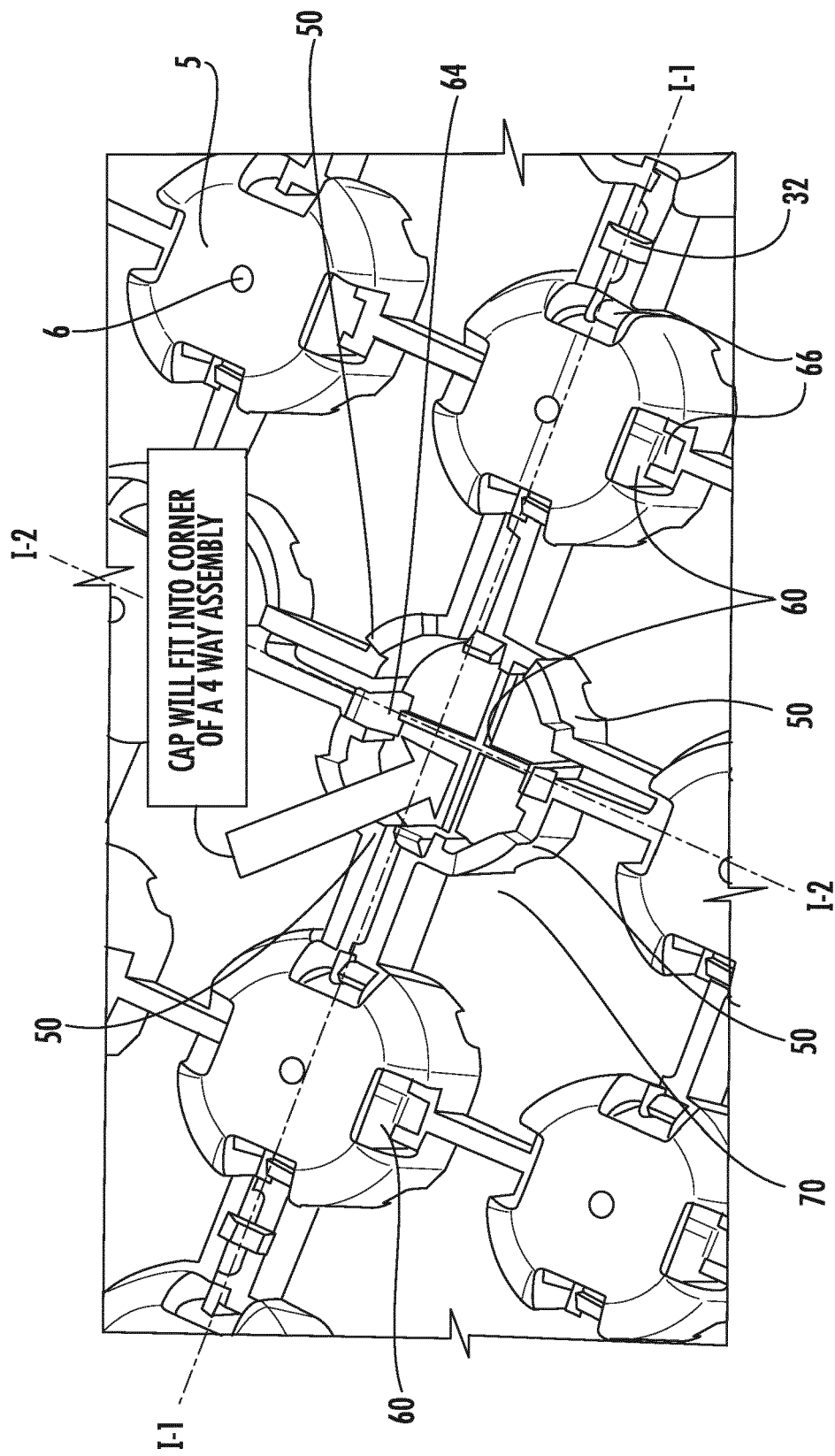


FIG. 5

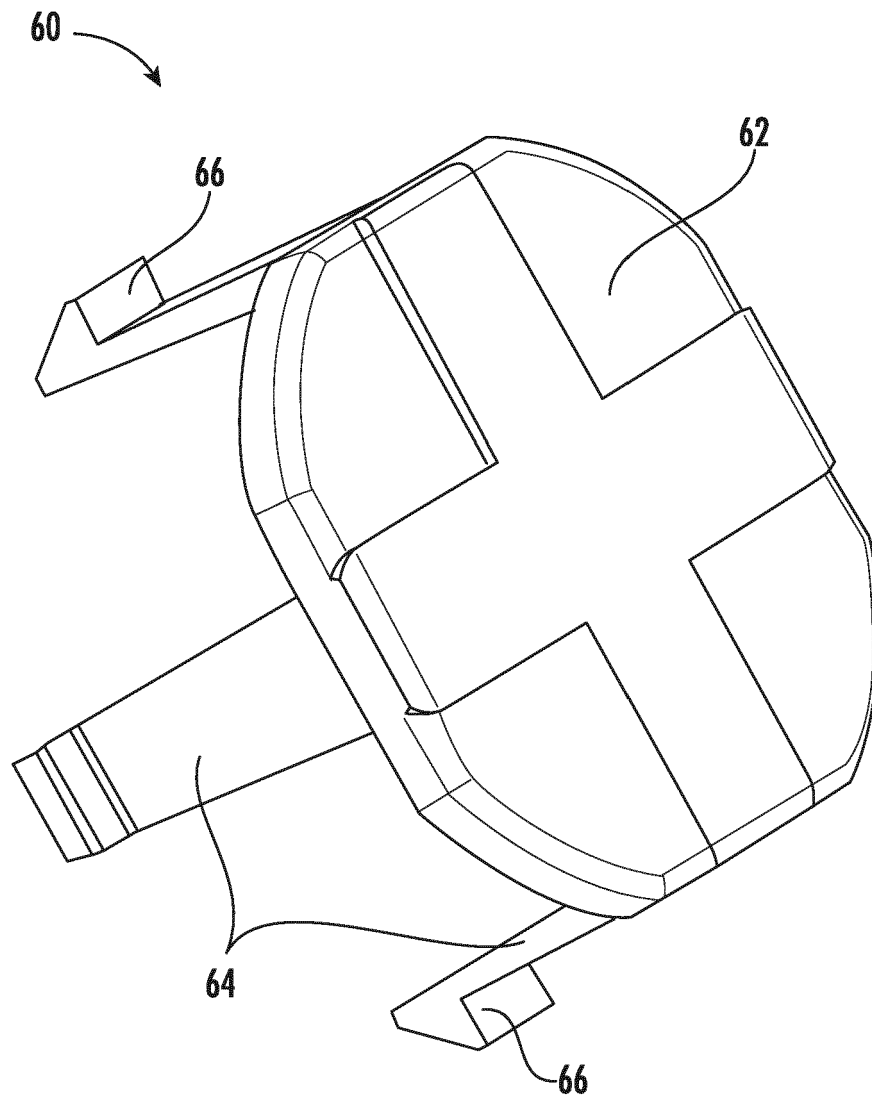


FIG. 6A

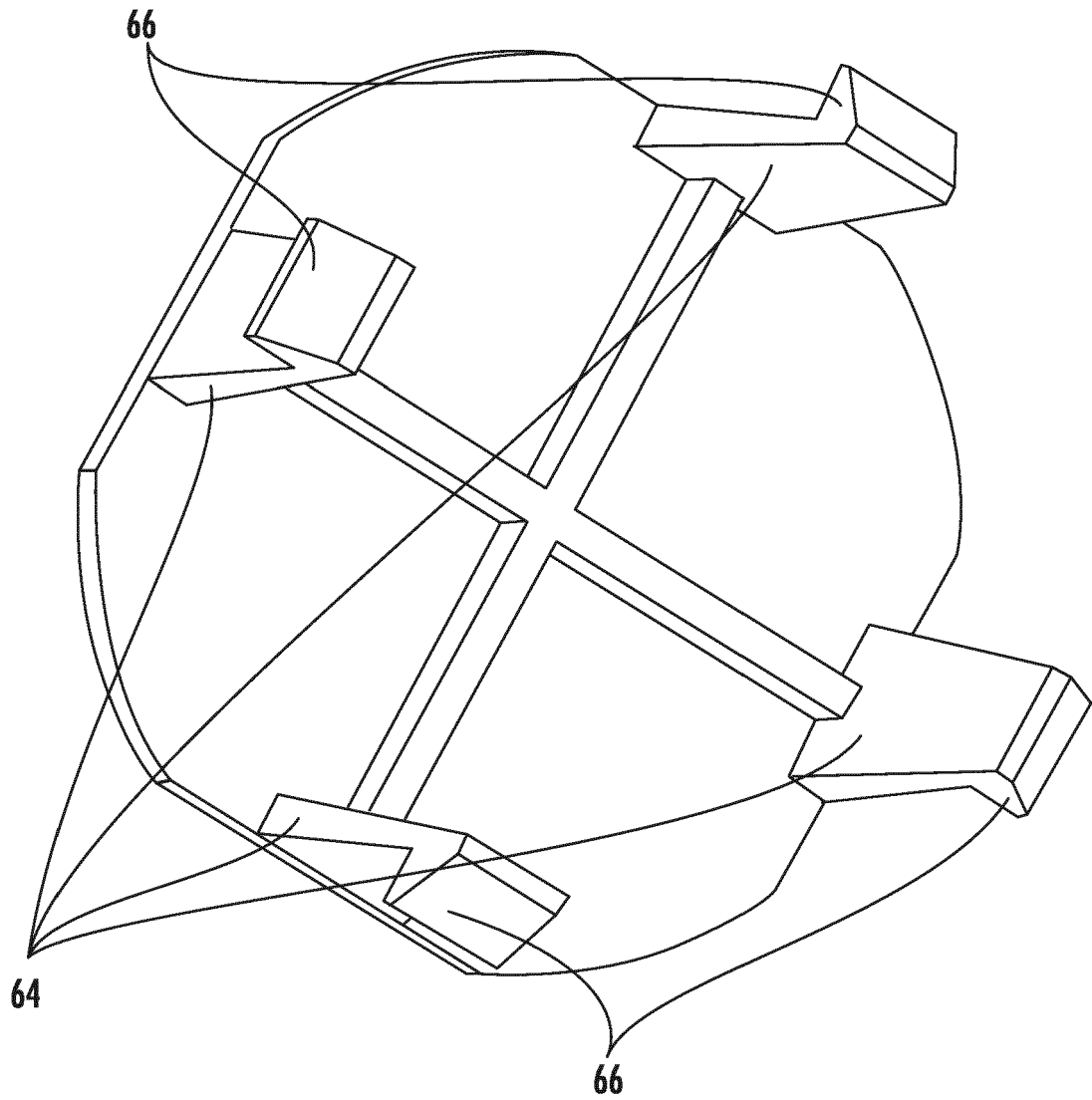


FIG. 6B

REFERENCES CITED IN THE DESCRIPTION

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