

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.

SUMMARY

[0004] One or more embodiments of the invention may address one or more of the aforementioned problems. Certain embodiments according to the invention provide a cellular paving grid (CPG) including a plurality of open cell structures interconnected by a plurality of first connection members. CPGs may also include a plurality of secondary openings defined by the plurality of open cell structures and the plurality of first connection members. In accordance with certain embodiments of the invention, the CPGs may be configured to interlock (e.g., via one or more snap-fit clips) with each other to provide a network of interlocked CPGs. In accordance with certain embodiments of the invention, the plurality of open cell structures may 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 may 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 may comprise a first external-male open cell structure. The CPGs may also include at least a second external row of the plurality of

open cell structures comprising an external-female open cell structure, in which at least two adjacent external-female open cell structures may be connected together via a first retaining-connection member. In accordance with certain embodiments of the invention, the first retaining-connection member may be configured to engage and/or support a second connection member from a second CPG, for example, via a snap-fit clip thereon. In accordance with certain embodiments of the invention, the external-female open cell structure may be configured to (a) receive a complementary external-male open cell structure from a second cellular paving grid (e.g., that may be identical to the first external-male open cell structure, and (b) receive a second connection member from a second cellular paving grid.

[0005] 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.

[0006] 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 on or more marking caps engaged with the modular unit 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.

[0007] 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 may further comprise 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-material.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0008] 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; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. 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

[0009] 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; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. 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.

[0010] 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.

[0011] 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.

[0012] 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 to certain embodiments of the invention, polymers produced by fermentation process or biosourced.

[0013] 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.

[0014] Certain embodiments according to the invention provide a CPG including a plurality of open cell structures interconnected by a plurality of first connection members. CPGs may also include a plurality of secondary openings defined by the plurality of open cell structures and the plurality of first connection members. In accordance with certain embodiments of the invention, the CPGs may be configured to interlock (e.g., via one or more snap-fit clips) with each other to provide a network of interlocked CPGs. In accordance with certain embodiments of the invention, the plurality of open cell structures may 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 may 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 may comprise a first external-male open cell structure. The CPGs may also include at least a second external row of the plurality of open cell structures comprising an external-female open cell structure, in which at least two adjacent external-female open cell structures may be connected together via a first retaining-connection member. In accordance with certain embodiments of the invention, the first retaining-connection member may be configured to engage and/or support a second connection member from

a second CPG, for example, via a snap-fit clip thereon. In accordance with certain embodiments of the invention, the external-female open cell structure may be configured to (a) receive a complementary external-male open cell structure from a second cellular paving grid (e.g., that may be identical to the first external-male open cell structure, and (b) receive a second connection member from a second cellular paving grid.

[0015] 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 may comprise 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.

[0016] CPGs, as shown in Figure 1, may 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.

[0017] The CPGs, as shown in Figure 1, may also comprise at least a first external row 15 of the plurality of open cell structures comprising a first external-male open cell structure 17. For example, the CPGs may include two external rows 15 each including one or more external-male cell structures. The CPGs may 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-fe-

male 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 certain embodiments of the invention, the external-female open cell structures 22 may be configured to (a) receive a complementary external-male open cell structure from a second CPG that may be, for example, identical to the first external-male open cell structure, and (b) receive a second connection member from a second CPG.

[0018] 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 certain embodiments of the invention, for example, 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 certain embodiments of the invention, the open slots 26 may be 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 certain embodiments of 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.

[0019] 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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.

[0028] 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).

[0029] 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.

[0030] 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 polyhydroxyalkanoate (PHA), a polylactic acid (PLA), a starch blend, or a cellulosic material.

[0031] 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 1-1 + I-1 and 1-2 - 1-2 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.

[0032] 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.

[0033] 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.

[0034] 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 may further comprise 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-material. 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.

[0035] 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 spirit and scope of the invention, which is more par-

ticularly 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. Therefore, the spirit and scope of the appended claims should not be limited to the exemplary description of the versions contained herein.

Claims

1. A cellular paving grid, comprising:

- (i) a plurality of open cell structures each comprising (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;
- (ii) a plurality of first connection members that interconnect the plurality of open cell structures;
- (iii) a plurality of secondary openings defined by the plurality of open cell structures and the plurality of first connection members;
- (iv) at least a first external row of the plurality of open cell structures comprising a first external male open cell structure; and
- (v) at least a second external row of the plurality of open cell structures comprising an external female open cell structure; wherein at least two adjacent external female open cell structures are connected via a first retaining-connection member configured to support a second connection member from a second cellular paving grid;

wherein 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 second connection member from a second cellular paving grid.

- 2. The cellular paving grid of claim 1, wherein the at least two adjacent external female open cell structures comprises open slots configured for receiving a second connection member from a second cellular paving grid.
- 3. The cellular paving grid of claim 2, wherein the open slots 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 along the respective at least one side-walls of the at least two adjacent external female open cell structures; wherein the open slots are sized to accommodate a second connection member from a second cellular

paving grid.

- 4. The cellular paving grid of claim 3, wherein the open slots terminate at respective intermediate surfaces that are substantially parallel to the bottom surfaces of the plurality of open cell structures.
- 5. The cellular paving grid of any one of claims 1-4, wherein the external female open cell structure is configured to encircle the complementary external male open cell structure from a second cellular paving grid.
- 6. The cellular paving grid of any one of claims 1-5, wherein the first retaining-connection member comprises (a) a rib-portion extending in a first direction and connecting the at least two adjacent external female open cell structures, and (b) a retaining-portion 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 that is proximate to the open slots.
- 7. The cellular paving grid of claim 6, further comprising a retaining-distance between the top surface of the retaining-portion and the intermediate surfaces of the open slots; 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.
- 8. The cellular paving grid of any one of claims 1-7, wherein the cellular paving grid comprises 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.
- 9. The cellular paving grid of any one of claims 1-8, wherein the second external row of the plurality of open cell structures comprises a plurality of 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.
- 10. The cellular paving grid of any one of claims 1-9, wherein at least one of the plurality of open cell structures comprise a castellated side wall, at least a first open cell structures comprises a first side-wall comprising one or more cut-out portions located adjacent or proximate to the bottom surface of the first open cell structure, or both.

11. The cellular paving grid of any one of claims 1-10, wherein the cellular paving grid 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. 5
12. A cellular paving system, comprising a plurality of cellular paving grids according to any one of claims 1-11. 10
13. The cellular paving system of claim 12, further comprising one or more marking caps including a top-cap portion that is flush with a trafficked surface of an installed grid, wherein the marking caps are configured to snap-fit into the open cell structures. 15
14. The cellular paving system of claim 13, wherein the marking caps are configured to snap-fit to into respective recessed corner portions of at least two interlocked cellular paving grids. 20
15. A method of reinforcing a ground surface, comprising: 25
- (i) positioning a plurality of cellular paving grids according to any one of claims 1-11 onto a sub-base or a section of existing soil; 30
 - (ii) interlocking the plurality of cellular paving grids 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. 35

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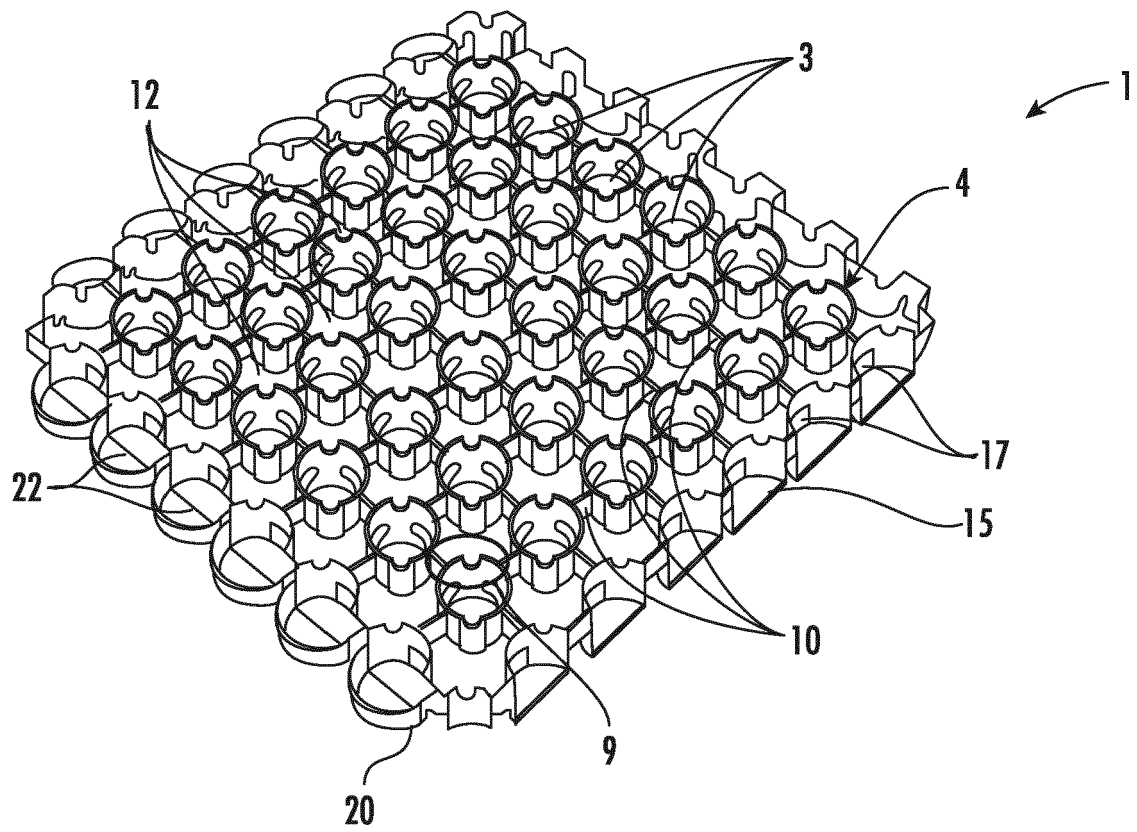


FIG. 1

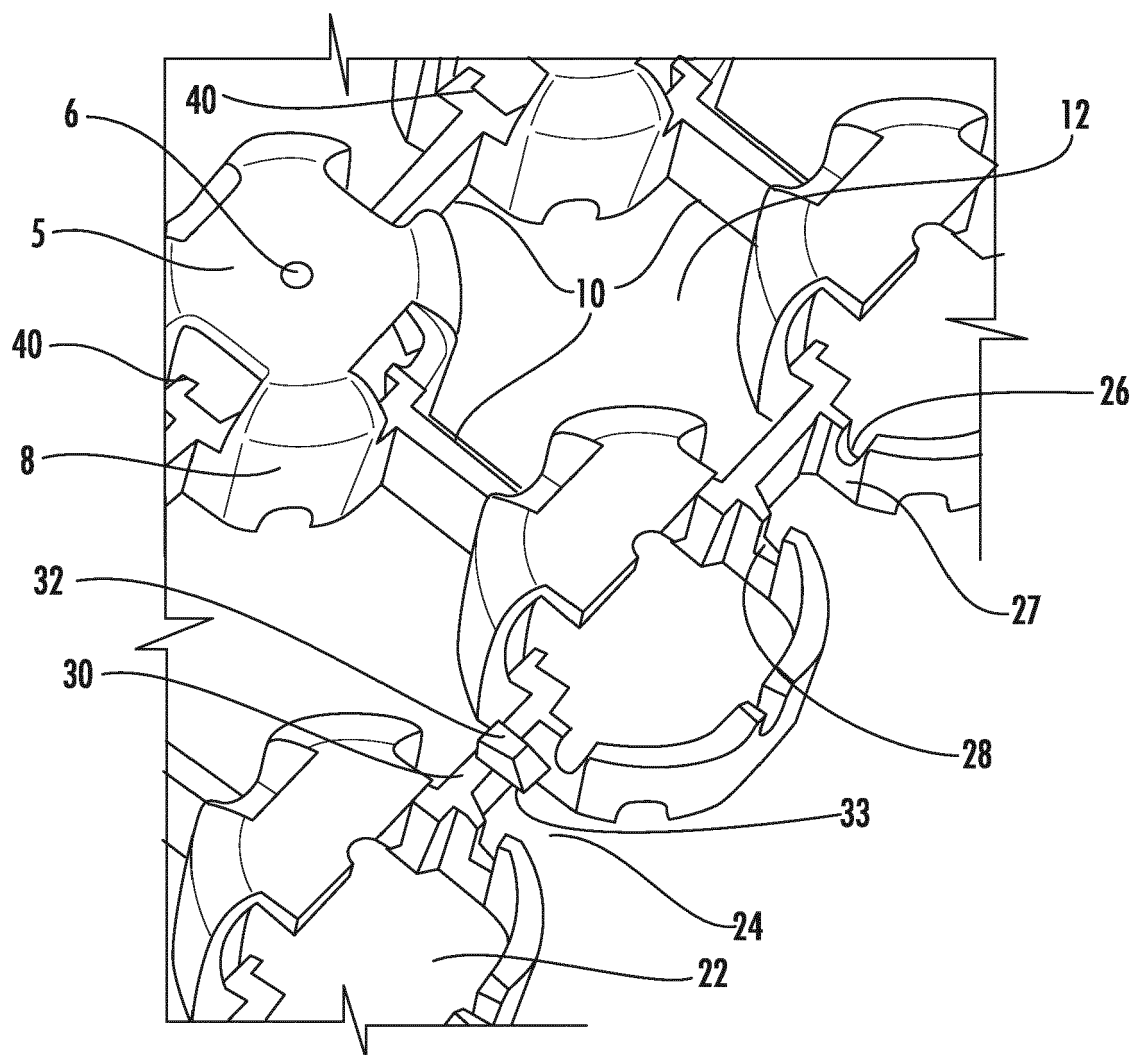


FIG. 2

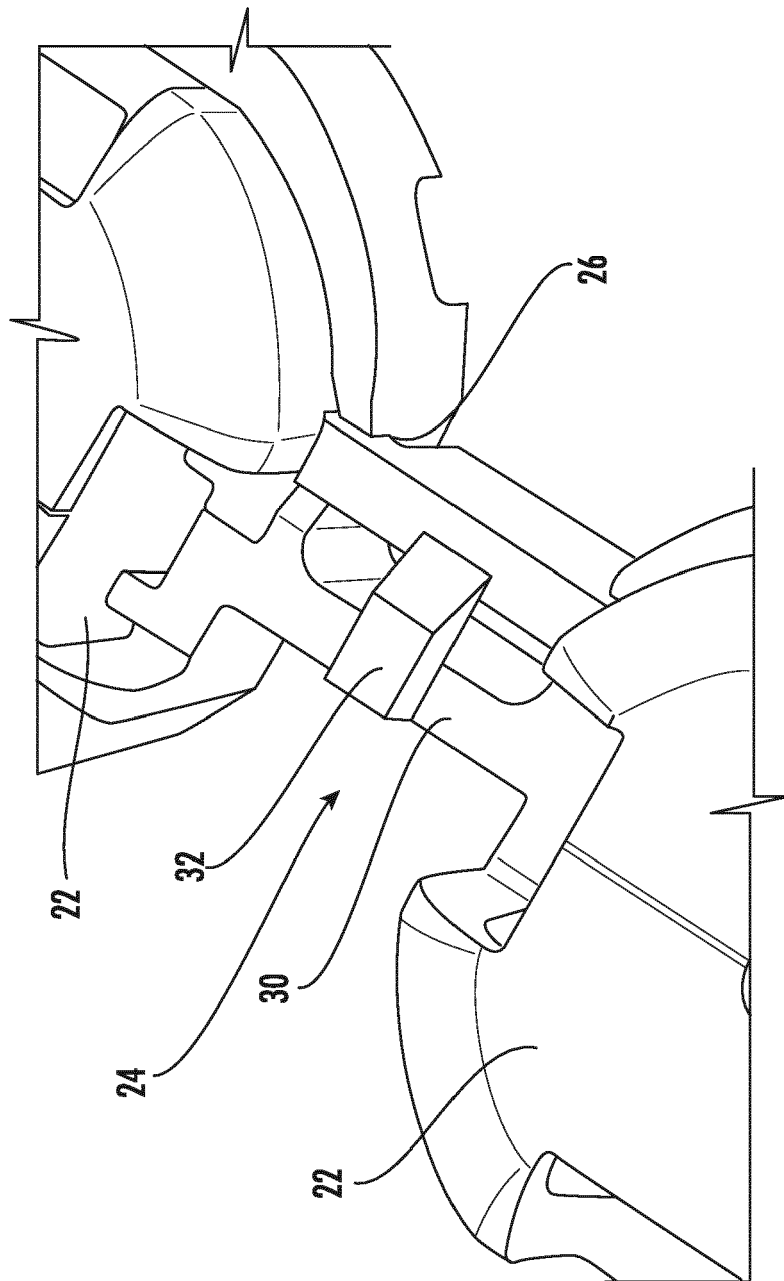


FIG. 3

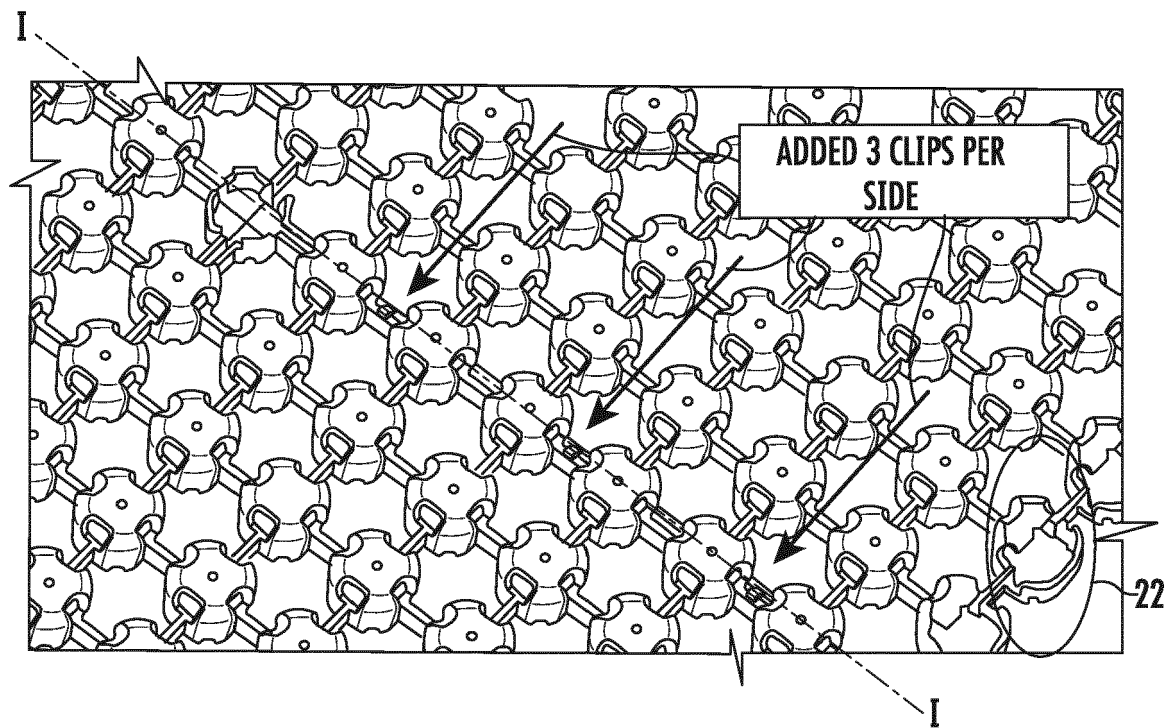


FIG. 4

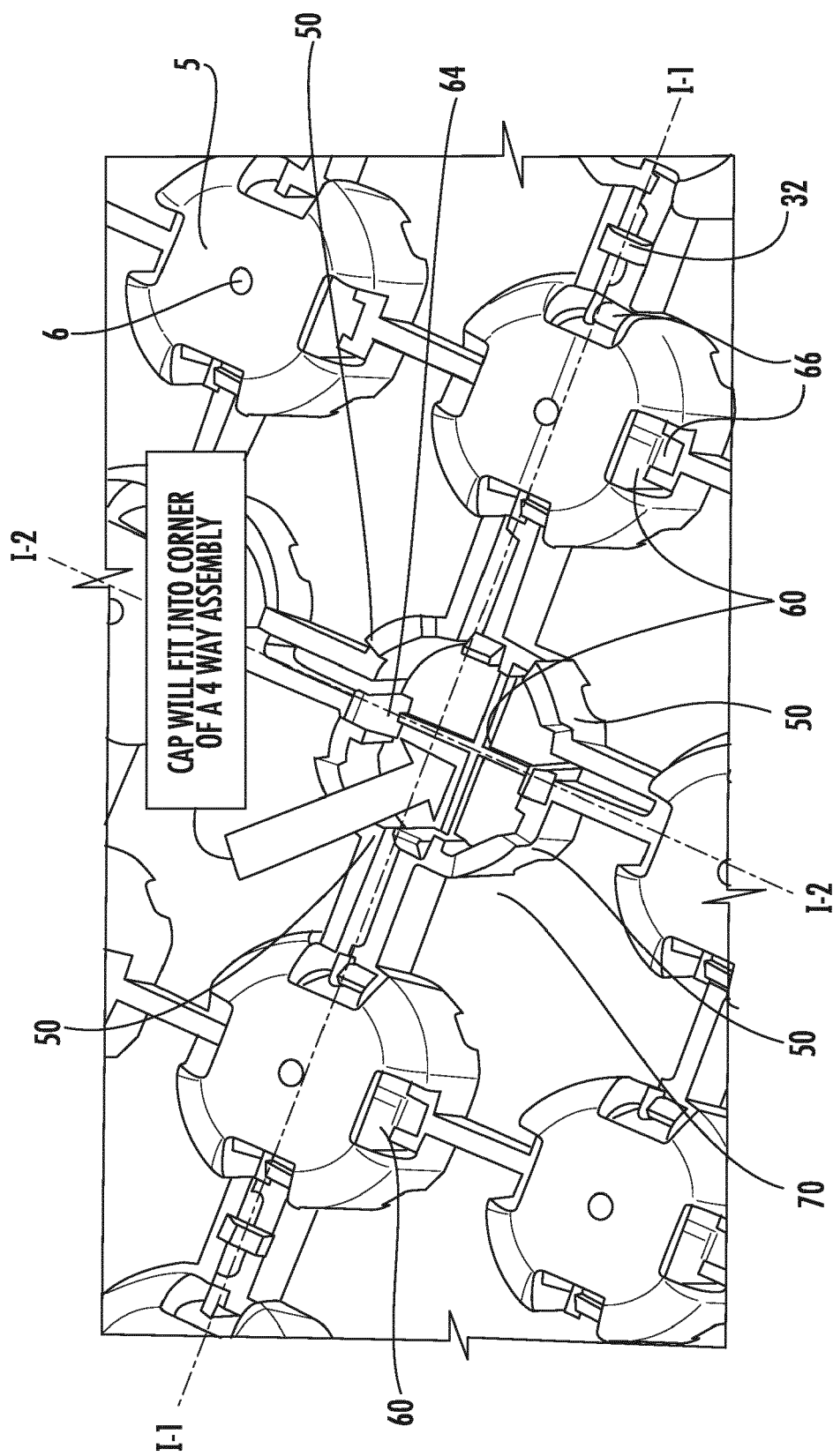


FIG. 5

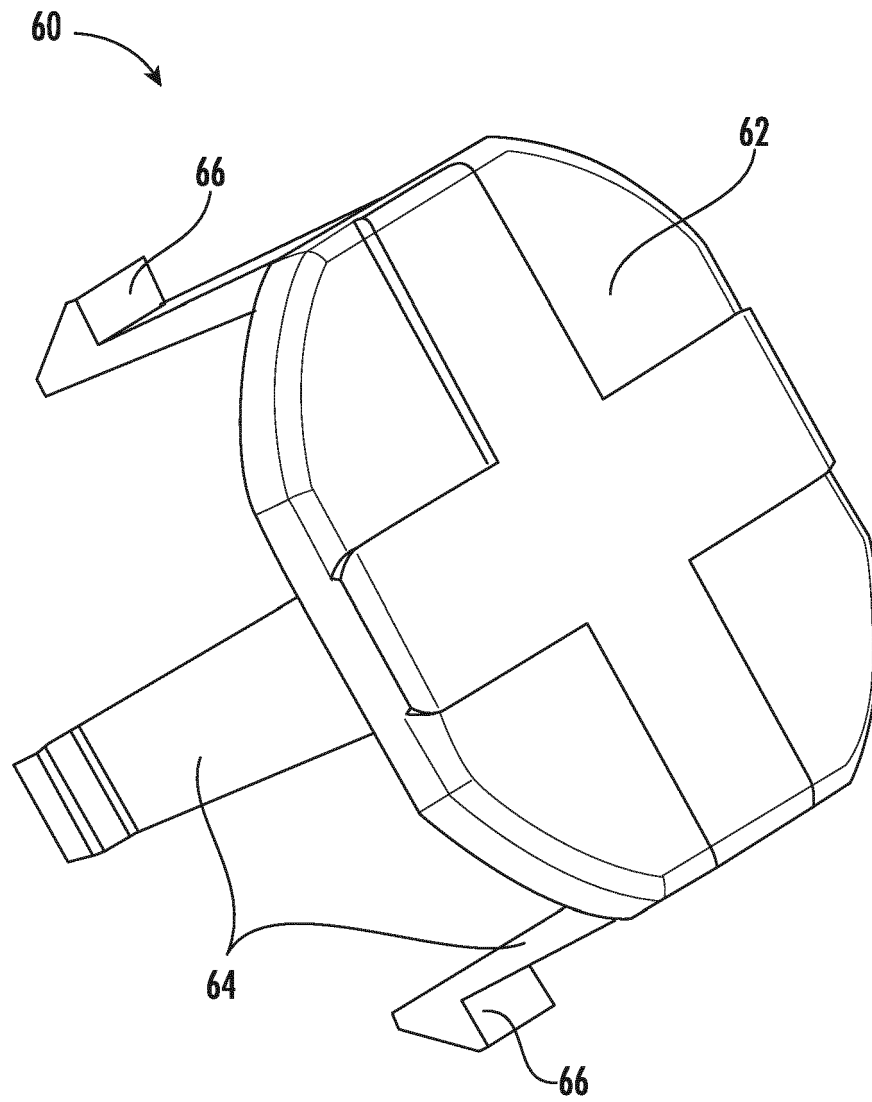


FIG. 6A

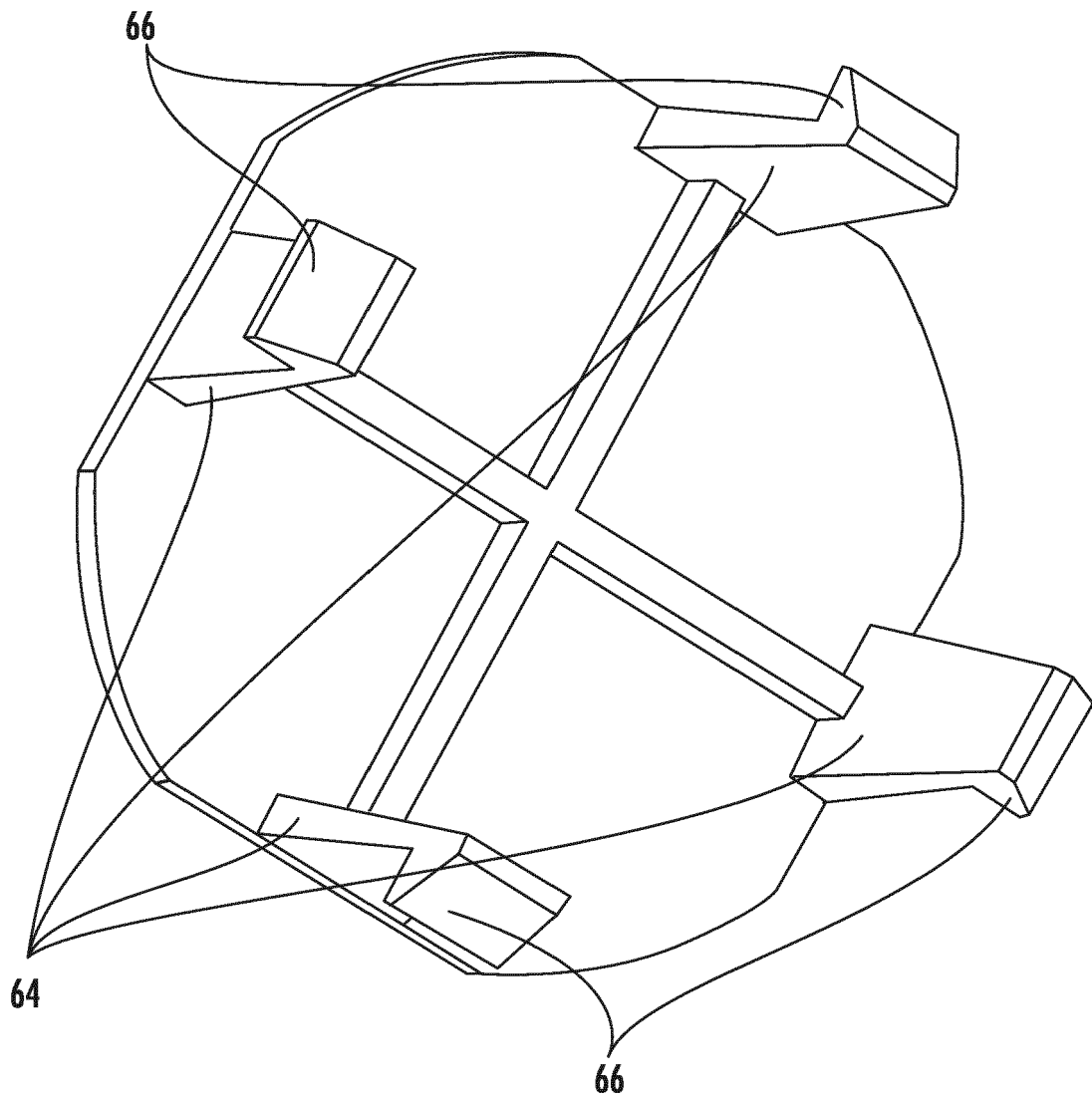


FIG. 6B



EUROPEAN SEARCH REPORT

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A			
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC) E01C E01F E02D E04D
Place of search Munich		Date of completion of the search 26 August 2021	Examiner Kerouach, May
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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