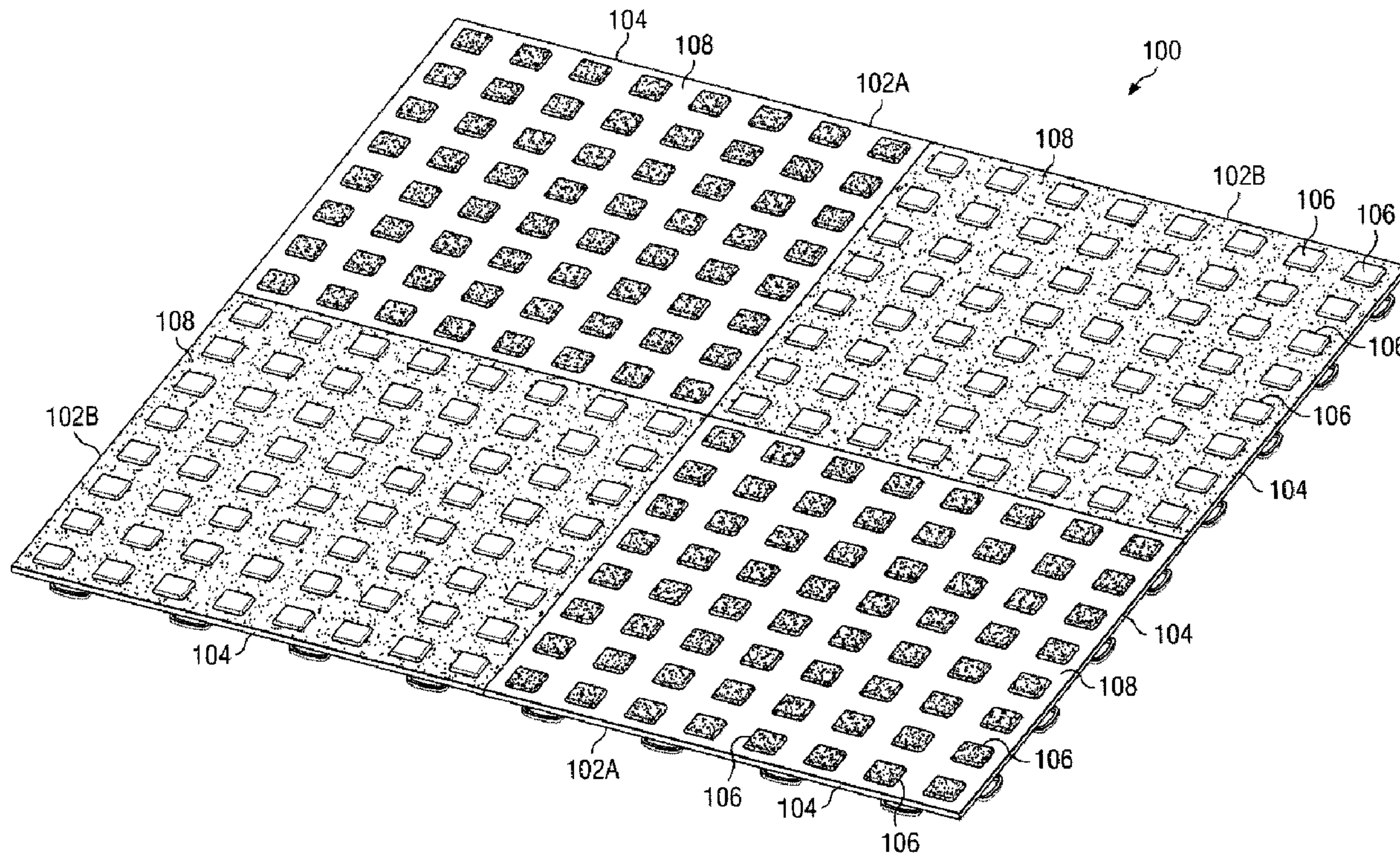




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(57) Abrégé/Abstract:

Modular plastic floor tiles have elongate drainage vents formed to extend from the general upper surfaces of the tiles to general lower surfaces thereof. In a two-shot injection molded embodiment, the vents are laterally spaced from locations of overmolded features, and may be disposed within channels defined by downwardly depending support ribs. In one embodiment, groups of elongate vents are disposed around respective fill points in radiant fashion, so as to minimize the impedance to polymer flow within the injection mold. The vents may be radiussed at the tile's upper surface to enhance their fluid collecting capability.

INJECTION MOLDED FLOOR TILES WITH DRAINAGE VENTS**ABSTRACT OF THE DISCLOSURE**

Modular plastic floor tiles have elongate drainage vents formed to extend from the general upper surfaces of the tiles to general lower surfaces thereof. In a two-shot injection molded embodiment, the vents are laterally spaced from locations of overmolded features, and may be disposed within channels defined by downwardly depending support ribs. In one embodiment, groups of elongate vents are disposed around respective fill points in radiant fashion, so as to minimize the impedance to polymer flow within the injection mold. The vents may be radiussed at the tile's upper surface to enhance their fluid collecting capability.

INJECTION MOLDED FLOOR TILES WITH DRAINAGE VENTS

BACKGROUND OF THE INVENTION

[0001] Conventional modular injection-molded tiles are known in the art for laying across upper surfaces of garage floors, sports surfaces, outdoor surfaces and other substrates. These tiles typically are twelve to thirteen inches square and can be manually assembled and disassembled. A common feature of these tiles is their ability to be snapped together, with few or no tools, using male and female connectors molded into each tile for the purpose.

[0002] Conventional single tiles are molded to be a single, uniform color such as all-black or all-red. The consumer typically can choose different tiles in different colors. The consumer or contractor will often choose two or more colors for a particular floor, for assembly into an aesthetically pleasing pattern. But manufacturing an injection-molded plastic tile that has two or more perceptible colors per tile is more difficult and to date no such tile has been provided that has proven to be acceptable to the consumer.

[0003] Many conventional modular plastic tiles are easily dislodged from their positions on the floor (particularly where wheeled vehicles are driven onto and off of them) and require a rubber sheet or the like as a substrate. It would therefore be advantageous to furnish a floor tile, for applications in which a large displacing lateral force may be applied to the tile, and which does not require a nonslip sheet as a substrate.

[0004] Previous attempts have been made to produce plastic modular tiles that have cushioning characteristics. U.S. Patent Application Publication No. US 2009/0031658 A1 discloses modular athletic floor tiles that have a plurality of premolded rubber inserts which, after molding, are physically inserted into receiving holes in a molded plastic substrate. In one embodiment each rubber insert has a face that is stands up from the surrounding top floor surface. The body of each

rubber insert extends all the way through the plastic substrate or base and well below its bottom. The rubber inserts are selectively compressed when an athlete stands on them, giving a cushioning effect. But it is believed that the separate molding of these inserts, flash removal from them and physical insertion of them into respective receiving holes in the plastic tile substrate is time-consuming and greatly increases the cost of manufacture of the resultant tile.

[0005] A need therefore persists in the industry for modular plastic tiles which can sustain heavy loads but have non-slip characteristics, which will be effectively joined together, which can be provided in a plurality of colors per tile, and which can be manufactured quickly and inexpensively.

SUMMARY OF THE INVENTION

[0006] According to one aspect of the invention, a modular floor tile is provided which may be used to create a flooring surface including a plurality of like tiles. A first polymer compound is used to mold a body of the tile. The body has at least one feature overmolded onto the upper surface of the body from a second polymer compound which is different from the first polymer compound. A second polymer compound gate is disposed to be adjacent a lower surface of the tile body and to be remote from the upper surface thereof. The gate communicates to the upper feature through a through-hole which extends from the lower surface to the upper surface. A vent hole, laterally spaced from the through-hole, extends from the upper surface back to the lower surface and is in communication with the upper feature. During the injection of the second polymer compound, molten polymer makes its way from the gate, through the through hole and into the cavity in which the upper feature will be created. The vent hole permits gas or other fluid to be displaced out of the upper feature cavity, thereby obviating or minimizing any void in the as-molded upper feature which might otherwise occur. In one embodiment a portion of the upper pad extends through the vent hole to be disposed below or protrude onto the lower surface. Preferably, the tile has many such pads on its upper surface, and many such support members downwardly

depending from its lower surface. Groups of these pads and support member portions may be molded together in a continuous phase of the second polymer compound.

[0007] The second polymer compound may differ from the first polymer compound in rigidity, coefficient of friction, color, or some or all of these, and in one embodiment the upper feature constitutes a nonslip pad. In one embodiment a spaced-apart plurality of such upper features are formed as connected to one gate, through a plurality of through-holes, with at least one vent hole accorded to each of the upper features. In one embodiment the vent hole is laterally positioned to be maximally spaced from the through hole and still be within the periphery of the upper feature. In one embodiment the periphery of the upper feature is defined by a smoothly finished crush ring which prevents flash of the second polymer compound.

[0008] In another aspect of the invention, a modular floor tile of the above construction further has at least one lower feature overmolded onto the lower surface of the tile body from the second polymer compound. The gate communicates directly with this lower feature by a path which does not pass through the body. The lower feature may, for example, be a "skin" overmolded over a support member core, the skin and core constituting a support member. A portion of the second polymer compound may extend from the upper feature, through the vent hole and onto the lower surface of the body, and in such embodiment it is preferred that the lower feature as-molded be spaced from such portion. This may be accomplished by forming a crush pad completely laterally around such portion and also around the lower feature.

[0009] There may be a plurality of such lower features, all connected to a single gate. In one embodiment, groups of upper features and associated lower features all connect to respective fill points or gates, with the tile having a plurality of these groups.

[0010] In a further aspect of the invention, a method of forming a plastic modular floor tile includes molding a body of a first thermoplastic polymer compound, and then overmolding the body using a second polymer compound that has different characteristics from the first, such as differences in rigidity, coefficient of friction and/or color. The step of overmolding includes the substeps of positioning a gate adjacent the lower surface of the tile body and remote from an upper surface thereof; flowing polymer from the gate through a vent-hole to form an upper feature on the upper surface; and displacing a fluid (such as a gas) out of the volume of the upper feature cavity through a vent hole extending from the upper surface to the lower surface thereof, thereby minimizing or obviating any void which might otherwise appear in the upper feature as molded.

[0011] In one embodiment, the method further includes flowing the molten second polymer compound from the gate, by a path which does not pass through the tile body, to a lower feature which is overmolded on the lower surface of the body. The method may also include the step of flowing molten second polymer compound through the vent hole such that a portion thereof protrudes onto the lower surface of the tile body. In this last instance the method further preferably includes spacing such portion from the lower feature as by a crush pad, so that the flow of polymer creating the lower feature won't conflict with the flow of polymer creating the upper feature, and so that any gas or fluid will be positively displaced from the upper surface through the vent hole. In one embodiment, groups of upper and lower features are each formed from polymer flowing from a single respective gate or fill point. The method may be used to overmold nonslip pads on the tile upper surface and, in one embodiment, to simultaneously overmold support member nonslip skins on the lower surface of the tile.

[0012] In a further embodiment, a plurality of elongate drainage vents are formed in the body of the tile from its general upper surface to its general lower surface. Where the tile is injection molded from at least first and second thermoplastic materials, the drainage vents are laterally spaced from

each feature created by overmolding the first-shot body with the second thermoplastic material. In those embodiments employing crush rings and/or crush pads to respectively prevent flash from the overmolded features, the drainage vents are laterally spaced from the crush rings and/or crush pads. In one embodiment, respective ribs laterally surround the overmolded feature groups. These ribs project downwardly from the general lower surface of the tile and may be discontinuous, so as to permit fluid drained by the vents to pass to the points exterior to the volume enclosed by the respective ribs. The drainage vents may be disposed in channels defined by adjacent ones of these ribs. The vents may be radiussed at the body upper surface, and/or beveled, to greatly increase the surface area thereat, thereby enhancing the vents' capability to collect and drain fluid.

[0013] In one embodiment, the floor tile is injection molded using a plurality of spaced-apart gates. Groups of elongate drainage vents are arranged around respective gates/fill points, in a substantially radiant fashion. As so disposed, the impedance of the drainage vents to polymer flow will be minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and further aspects of the invention and their advantages can be discerned in the following detailed description, in which like characters denote like parts and in which:

[0015] FIGURE 1 is an isometric view of four modular floor tiles according to the invention, as assembled into a portion of a flooring surface;

[0016] FIGURE 2 is a front isometric view of one of the modular floor tiles shown in FIGURE 1;

[0017] FIGURE 3 is a back view of the modular floor tile shown in FIGURE 2;

[0018] FIGURE 4 is an isometric detail of the back of the floor tile shown in FIGURE 3, illustrating a tile body prior to overmolding with a second polymer compound;

[0019] FIGURE 5 is an isometric detail of the same tile region shown in FIGURE 4, shown after overmolding has been completed;

[0020] FIGURE 6 is a detail of the upper surface of a tile according to the invention prior to overmolding, showing flow-through points and crush rings;

[0021] FIGURE 7 is a detail of the same region illustrated in FIGURE 6, shown after top surface pads have been overmolded;

[0022] FIGURE 8 is a magnified sectional detail of two adjoining tiles showing internal structure of the support members;

[0023] FIGURE 9 is a magnified sectional detail of a tile showing the relationship of the overmolded features on the tile's lower and upper surfaces;

[0024] FIGURE 10 is magnified bottom view detail of a tile according to the invention;

[0025] FIGURE 11 is a magnified sectional view of two tiles being assembled together;

[0026] FIGURE 12 is a magnified sectional view of two joined tiles taken through cooperating loop and latch structure;

[0027] FIGURE 13 is a diagram showing nonlinear interference between a latch and a loop according to the invention;

[0028] FIGURE 14 is a schematic flow diagram illustrating steps in a manufacturing process according to the invention;

[0029] FIGURE 15 is an isometric magnified detail view of a corner of a tile body according to a second embodiment of the invention, prior to overmolding a peripheral seal thereon;

[0030] FIGURE 16 is the tile body corner seen in FIGURE 15, after overmolding;

[0031] FIGURE 17 is a magnified sectional detail through a lateral edge of the tile illustrated in FIGURE 16;

[0032] FIGURE 18 is a magnified sectional detail showing joined lateral edges of adjacent tile, taken through two cooperating peripheral seals;

[0033] FIGURE 19 is a schematic isometric view of a tile according to a third embodiment of the invention, wherein a second polymer compound is injected into a gate on an upper surface of the tile;

[0034] FIGURE 20 is a top isometric view of a modular floor tile according to a fourth embodiment of the invention;

[0035] FIGURE 21 is a magnified sectional view of two tiles according to a fifth embodiment of the invention;

[0036] FIGURE 22 is a magnified sectional view of the two tiles shown in FIGURE 21, taken through cooperating latch and loop structure; and

[0037] FIGURE 23 is a back view of a modular floor tile according to another embodiment;

[0038] FIGURE 24 is an isometric detail of the back of the floor tile shown in FIGURE 23, illustrating the tile body prior to overmolding with a second polymer compound;

[0039] FIGURE 25 is an isometric detail of the same tile region shown in FIGURE 24, shown after overmolding has been completed;

[0040] FIGURE 26 is a detail of the upper surface of the tile shown in FIGURE 23 prior to overmolding, showing through-holes, vent holes, and crush rings;

[0041] FIGURE 27 is a magnified sectional detail of the tile shown in FIGURE 23, showing the relationship of the overmolded features on the tile's upper and lower surfaces;

[0042] FIGURE 28 is a schematic flow diagram illustrating steps in an alternative manufacturing process according to the invention;

[0043] FIGURE 29 is a perspective view of a sixth embodiment of the invention, incorporating drainage vents in a two-shot tile;

[0044] FIGURES 30A and 30B are front and rear details, respectively, of the embodiment shown in FIGURE 29;

[0045] FIGURE 30C is a sectional view taken substantially along line 30C – 30C of FIGURE 30A;

[0046] FIGURE 31 is a perspective view of a seventh embodiment of the invention, incorporating drainage vents in a one-shot tile;

[0047] FIGURES 32A and 32B are front and rear details, respectively, of the embodiment shown in FIGURE 31;

[0048] FIGURE 32C is a sectional view taken substantially along line 32C – 32C of FIGURE 32A;

[0049] FIGURE 33 is a plan view of an eighth embodiment of the invention, featuring drainage vents substantially radiating from injection mold gate locations;

[0050] FIGURES 34A and 34B are front and rear details, respectively, of the embodiment shown in FIGURE 33;

[0051] FIGURE 34C is a sectional view taken substantially along line 34C – 34C of FIGURE 34A;

[0052] FIGURE 35 is a plan view of a ninth embodiment of the invention, featuring drainage vents with reinforcing cross ribs;

[0053] FIGURE 36A is a rear detail of the embodiment shown in FIGURE 35;

[0054] FIGURE 36B is a sectional view taken substantially along line 36C – 36C of FIGURE 36B; and

[0055] FIGURE 37 is a schematic block diagram of a method for designing and manufacturing a vented floor tile.

DETAILED DESCRIPTION

[0056] Modular floor tiles according to the invention can be used to form a flooring surface, a representative portion 100 of which is shown in FIGURE 1. In this illustrated embodiment, the flooring surface 100 is made up of tiles 102, including first floor tiles 102A and second floor tiles 102B, which are identical except as to color. The floor tiles 102A each have a body 104 injection-molded from a first polymer compound, preferably comprising a polymer which is relatively rigid when solidified and which can be selected from the group consisting of polyolefins including polypropylene and high molecular weight polyethylene, rigid thermoplastic polyurethane (TPU),

acrylonitrile butadiene styrene (ABS) and rigid polyvinyl chloride (PVC). The first polymer compound may further include filler such as talc to aid in achieving surface flatness, and a pigment. Floor tiles 102B have bodies 104 which preferably are made of a polymer compound identical to that forming bodies 104 of tiles 102A, except possibly for the choice of pigment or colorant. Each floor tile 102 preferably has an array of features 106, or raised pads, on its upper surface 108. The pads 106, which preferably are spaced apart on the upper surface 108, are overmolded onto the upper surface 108 using a second polymer compound, which has different characteristics from the first.

[0057] The differences between the first and second polymer compounds can include color and/or hardness. In one embodiment the second polymer compound, once solidified, is softer or less rigid than the first (once solidified), and has a higher coefficient of friction with respect to most objects than does the first. In another embodiment the hardness of the first and second compounds (once solidified) is about the same, but the colors are distinctly different. In a third embodiment, the hardness (once solidified) of the second compound is greater than that of the first. In a preferred embodiment, the second polymer compound can be selected from the group consisting of styrene ethylene butylene styrene based thermoplastic elastomer (SEBS TPE), other TPEs, soft TPU, or soft PVC. Polypropylene as the principal polymer in the first compound, and SEBS TPE as the principal polymer in the second polymer, are particularly preferred and have demonstrated good adherence to each other.

[0058] One aesthetic advantage of the invention is that the first and second polymers can be provided in contrasting colors, and that because of the molding techniques used in the invention, pads 106 can be colored differently than upper surface 108 yet present a sharp, commercially acceptable appearance.

[0059] A top isometric view of one tile 102 is shown in FIGURE 2. The body 104 of tile 102 is in main part a substantially horizontal and planar web 200 that has a plurality of lateral edges 202, 204. Each of the web edges 202, 204 downwardly depends from the upper surface 108 to a lower surface (not shown in FIGURE 2). In the embodiment illustrated in FIGURE 2, edges 202, 204 are orthogonal to surface 108, are planar and are at right angles to each other. But the tile 102, and the edges 202, 204 of it, can take other shapes. For example, the tile 102 can be hexagonal or triangular, and the edges 202, 204 could be wavy or curved instead of straight. Instead of edges 202, 204 being planar, as shown, they could be stepped or have tongues and corresponding grooves (see FIGURES 15 – 16 for an embodiment in which the lateral edges are stepped). It is preferred, however, that the shape and profile of each web edge 202 be complementary to the shape and profile of each web edge 204, such that when adjacent tiles are joined together, edges 202 and 204 will fit together closely.

[0060] The illustrated embodiment has a two-dimensional array of sixty-four raised pads 106 as located on a square surface of about twelve inches in length and width. Alternatively there could be as few as one pad 106, which preferably would be larger and possibly elongated and branched and/or sinuous. It is preferred to have a regular pattern of the pads 106 so that sub-units of the tile 102 can be trimmed off of it, in a manner to be explained below, and so that as trimmed the tile 102 will retain an aesthetically pleasing appearance. The illustrated pads 106 are rounded squares but could take other shapes such as circles, ovals, hexagons, triangles, distinctive logos or other shapes.

[0061] The first edges 202 each are equipped with at least one, and preferably several, latches 206. The second edges 204 each have at least one, and preferably several, loops 208. It is preferred that the number of latches 206, distributed in spaced relation along first edge 202, equal the number and position of loops 208, which are distributed in like spaced relation along each second edge 204.

In the illustrated embodiment the latches 206 are pressed downward and snapped into loops 208, in a manner which will be described in further detail below.

[0062] In the bottom view of tile 102 shown in FIGURE 3, there can be seen sixteen groups 300 of support members 302. According to one aspect of the invention, each support member 302 is formed in part by a skin 304 of a relatively soft polymer compound such as once comprising TPE, and has a core that is molded as part of the body 104 from a polypropylene-based compound or other relatively rigid polymer composition. Some of the support members 302 are annular and take the shape of squares with empty centers. Other support members 302 in each group 300 are short linear segments. The support members will be discussed in further detail below. Preferably the general lower surface 306 also has, depending downwardly from it, a plurality of elongate rigid support ribs 308 that have no TPE or other soft polymer skin. The support ribs are integrally molded with the web 200 of body 104.

[0063] In the illustrated embodiment, the rigid support ribs 308 form partial outlines of rounded squares, each one of which contains one of the groups 300 of the support members 302. The rigid support ribs 308 are so positioned that one or more of them are not very far away from any group 300 of support members 302. This permits the rigid support ribs 308 to accept most of the load of heavy objects (such as vehicles) imposed on the upper surface 108 of tile 102.

[0064] The elongate ribs 308 also define and delimit linear channels 310, one set of which are aligned along a length of the tile 102, and another set of which are at right angles to these and are aligned along a width of the tile 102. The channels 310 are disposed between, rather than through, the support member groups 300 and (on the upper surface) the pads 106. This provides the consumer a trim guide for cutting apart tile 102 in a lengthwise or widthwise direction, or both, in predetermined increments such as three inches or twenty-five percent of tile 102's length or width.

As projected onto the single horizontal plane occupied by web 200, the center line of each channel 310 will substantially exactly bisect the distance between the centers of adjacent pads 106 on either side of the center line. The distance from the center line of the channel 310 to a center of a pad 106 is one-half of the distance from one center of a pad 106 to a next adjacent pad 106. Since pads 106, support member groups 300, latches 206 and loops 208 repeat in a regular pattern, such as on three-inch centers, and since the pads 106 are exactly twice as far apart from each other as the closest of them are to the edge 202 and/or 204 (see FIGURE 2) or a channel 310, the consumer may use trimmed tiles on the periphery of the flooring surface to extend the flooring surface by another three, six or nine inches, or alternatively 25%, 50%, or 75% of the length or width of tile 102. The regular pattern and spacing of raised pads 106 will continue over from untrimmed tiles onto such trimmed peripheral tiles without visually noticeable interruption and therefore the result will be aesthetically pleasing.

[0065] FIGURES 4 and 5 are details of the tile lower surface, showing a single group 300 of support members 302 before and after a second polymer compound is overmolded onto the body 104 of the tile 102. In FIGURE 4 there can be seen a plurality of support member cores 400 which depend downwardly (in this view, extending toward the top of the paper) from a general lower surface 306 of the substantially horizontal web 200 that makes up most of the tile body 104. The cores 400 do not downwardly depend as far as the support ribs 308. Ribs 308 are not overmolded. In the illustrated embodiment there are provided, in each group 300 of support members 302, four annular cores 402 and eight cores 404 formed as short linear segments and in parallel pairs nearby the annular cores 402. Also seen here is, for this group 300, a crush pad 406 which in use is slightly lower than the general surface 306 (in this bottom view, pad 406 is slightly raised relative to general surface 306). The crush pad 406 is formed to be closely adjacent all of the support member cores 400 and laterally surrounds all of the cores 400 and the runners 502 connecting the support

members. The crush pad 406 is finished to have a smooth surface (general lower surface 306 can instead be textured) and is used as a shutoff surface to prevent the flashing of the second polymer compound during a "second shot" or overmolding step of fabrication.

[0066] FIGURE 5 shows the same area after overmolding. A skin 304 of the second polymer now appears on the bottom surfaces and sides of each of the cores 400, and in this embodiment completes the support members 302. While in one embodiment the skins 304 could be overmolded separately on each core 400, in the illustrated embodiment the skins 304 within the support member group 300 are part of a continuous phase. To save cost, the area covered by skins 304 is limited and, as seen in FIGURES 3 and 5, does not include a majority of the tile body lower surface 306. The skins 304 preferably do not extend to cover the centers of the annular cores 402 or other regions outside of crush pads 406. Lateral runners 502 connect a common fill point 504 to each of the skins 304. It has been found that as the second of a double-shot injection, skins 304 molded of a SEBS TPE compound have excellent adherence to the preferably polypropylene compound cores 400 (FIGURE 4). As completed, the composite support members 302 are of approximately the same depth (in a direction orthogonal to the web 200) as the support ribs 308. The support members 302 provide further structural support to the web 200 but at the same time act as a friction surface to grip the surface upon which the tiles are laid.

[0067] FIGURES 6 and 7 are details of a similarly sized area on the top of tile 102, before and after overmolding, illustrating one group of pads 106, which are interconnected in a continuous phase of solidified second polymer compound. In the illustrated embodiment, each of the overmolded pads 106 resides in a shallow recess or receptacle 600 whose surface is lower than that of the general upper surface 108. For each recess 600 there is provided at least one through-hole 602 which communicates the top surface of the tile web 200 to a lower surface thereof. In the illustrated embodiment the through-holes are a small fraction (about 5%) of the bottom of the

recesses 600, as the viscosity (at molding temperature) of the preferred second polymer compound is low enough, and the second-shot temperature and injection pressure are high enough, that no larger through-holes are necessary to flow molten polymer from the lower side of the tile body 104 to the upper side thereof, nor is more than one through-hole per recess 600 necessary in the preferred embodiment. Limiting the size of through-holes 602 enhances the structural integrity of the tile 102. However, in alternative embodiments, the size and/or number of the through-holes 602 may be increased to accommodate more highly viscous second-shot polymer compounds.

[0068] The recesses 600 are each laterally surrounded by a crush ring 604. Each crush ring 604 is finished to be smooth (in contrast, the general upper surface 108 of the body 104 is preferred to be textured) and is slightly raised relative to the general upper surface 108. The crush rings 604 provide a tight overmold shutoff that prevents the flashing of the second polymer compound outside the confines of the crush rings 604.

[0069] FIGURE 7 is a detail of the tile upper surface after the overmolding step. The second polymer compound is injected into the mold at one or more points adjacent the lower surface of body 104, flows through each of the through-holes 602, and occupies cavities in the second-shot mold to create the raised pads 106. A top surface of the pads 106 is raised above that of general surface 108, creating a nonslip surface characteristic. Through this methodology overmolding artifacts on the upper surface of the tile 102 are avoided, producing a more pleasing appearance.

[0070] FIGURE 8 is a sectional view of two tiles 102 joined together, taken through annular support members 800, linear support members 802 and rigid ribs 308. Each skin 304 completing a support member 800, 802 has a portion 810 which is formed on the lower end or bottom surface of each core 400, 402. Preferably, each skin 304 also includes portions 812 which cover all or portions of adjoining side walls of the cores 400, 402.

[0071] The rounded square or annular support members 800 are each in approximate registration or alignment with the edges or lateral periphery of a respective raised pad 106 on the upper surface 108 of the tile 102. The support members 800 will receive any weight placed particularly on the raised pads 106 and will prevent any shear stress from developing in nearby regions of the horizontal web 200. The support members 800 and 802 each help support weight placed on the upper surface 108 of tile 102, while at the same time providing a friction or nonslip surface that will engage the substrate on which the tile is placed. The rigid members 308 provide rigid support of the entire tile 102 and delimit any compression of the TPE skin 500, the lower surface of which is preferably in the same plane as the lowest portion of ribs 308. FIGURE 8 also shows the preferred profile of lateral edges 202, 204, which is planar and orthogonal to the plane of web 200. The components of the adjacent tiles 102 in FIGURES 8 and 9 have been stippled differently to illustrate that they can be of different colors.

[0072] FIGURE 9 is a magnified diagonal cross section (lower side up) of part of a tile 102, taken through two raised pads 106, support members 800 underneath and in approximate registry with respective ones of the raised pads 106, a central fill point 504 and two runners 502. In this illustrated embodiment, one central second-shot polymer compound fill point 504 is provided for the skins of an entire group 300 of twelve support members 800, 802, and four associated raised pads 106 on the upper surface 108 of the tile 102. This illustrated embodiment has sixteen fill points 504 on tile 102, one for each interconnected group 300 of support members 302 and associated pads 106. In an alternative embodiment the polymer compounds used for different ones of the fill points could be in different colors, producing groups of pads 106 on the upper surface 108 which are colored differently than other groups of pads 106.

[0073] The central fill point 504 is connected by a set of runners 502 which extend laterally from the fill point 504, and on the lower surface of the web 200, to each of the support members 800, 802

in the group 300 where the fill point 504 is located. In the illustrated embodiment, there are four main runners 502 that are separated by ninety degrees from each other. At its end remote from the fill point 504, each runner 502 branches into three branches 900 that respectively connect to an annular support member 800 and two flanking linear support members 802. As can be seen in the sectioned runners 502, one of the branches 900 of each runner 502 is continuous with a through-hole 602, providing a conduit for the second polymer compound to the upper side 108 of the tile 102.

[0074] FIGURE 9 also shows a latch 206 which has been inserted into a respective loop 208. The loop 208 is preferably molded as an extension of a rigid rib 308 in an adjacent tile 102. The latch 206 is integrally formed with web 200 and is formed in a gap between two ribs 308 that are adjacent an edge 202. The gap forming the discontinuity in linearly aligned rib segments 308 is large enough to have the latch 206 and the loop 208 disposed therebetween.

[0075] FIGURE 10 is a bottom plan view of a one-sixteenth portion 998 of a tile 102, the illustrated portion 998 occupying an outer corner of tile 102. This corner 998 has three ribs 308 that surround the group 300 of support members 302. A rib segment 1000 is aligned with and positioned slightly laterally inwardly from an edge 204 of the tile 102. Rib segment 1000 continuously curves on its left side (as seen in this FIGURE) to form a boundary for a channel 1002. Rib segment 1000 has a section 1004 which continuously curves from the right side of rib section 1022 to become parallel and laterally inwardly offset from lateral edge 202, terminating at a gap 1006. A rib segment 1008 defines an upper right hand boundary of the portion or cell 998 and includes a portion 1010 that is in parallel with the lateral edge 202, a portion 1012 which helps define a boundary for a trim channel 1014, and a curved portion in between these. A third rib segment 1016, defining an interior corner of the cell 998, includes a portion 1018 that helps define channel 1002, a portion 1020 that helps define channel 1014, and a curved transition between them.

[0076] A portion 1022 of the rib segment 1000 that is near and parallel to lateral edge 204 has a loop 208 integrally formed with it. The loop 208 is connected to the rest of tile 102 only by a pair of widely spaced-apart and limited connection points 1024 and 1026. A cross-section of loop 208 and its length between connection points 1024 and 1026 are so preselected that loop 208 will be relatively flexible in comparison to the latch 206. The latch 206 may be a solid plug (not shown) or, as appears in the illustrated embodiment, may include a downwardly depending, inwardly facing convex wall 1028, connected at both of its ends to a downwardly depending, laterally outwardly facing wall 1030. The entire wall 1028, and a substantial portion of the wall 1030, are attached to the general lower surface 306 of the tile 102. Neither arcuate wall 1028 nor wall 1030 is as long as loop 208. These differences in size and degree of attachment to the rest of the tile 102 make the latch 206 substantially rigid relative to loop 208. In any interference between them, therefore, the loop 208 will flex or expand and the latch 206 will not substantially deform.

[0077] FIGURE 11 is a highly magnified sectional view showing how a male latch 206 is snapped into a receiving female loop 208 of an adjacent tile 102. The outer wall 1030 of the latch 206 has a surface 1100 which is beveled or sloped so that it will cam against an upper corner 1102 of the lateral edge 204. The inner wall 1028 of the latch 206 has a sloped or beveled surface 1104 which will cam against an upper interior corner or ridge 1106 of the loop 208. As the latch 206 is pressed downward into the loop 208, an interference will develop between the inner facing wall 1028 of the latch 206 and the loop 208, as shown by the hatched region 1108. Since wall 1028 of latch 206 is substantially more rigid than loop 208, the loop 208 will elastically expand along its length and will flex laterally outwardly from the tile 102 to which it is attached (in FIGURE 11, rightward). Once the latch 206 is driven down far enough, a horizontal ledge 1110 of the outer latch wall 1030 will snap past a lower corner 1112 of the lateral edge 204 and will slide to the left along the general lower surface 306 of the adjacent tile 102. Even after this happens the loop 208

will remain under tension. This biases lateral edge 204 against mating lateral edge 202, producing a tight fit of these two surfaces and the tiles of which they are a part. As shown, the depth (in a direction orthogonal to the plane of web 200) of walls 1028, 1030 is slightly less than the depth of the walls of rib segment 1022 and loop 208, permitting a degree of overdrive when snapping the latch 206 into the loop 208. FIGURE 12 is an isometric sectional view of two adjacent tiles taken through a loop 208 and an inserted latch 206, again illustrating the interference fit between the two.

[0078] FIGURE 13 is a schematic detail, from a bottom view, showing a latch 206 as it is received into a loop 208. The loop 208 is illustrated here in its unstretched and unflexed condition. As so superimposed a region 1108 of interference will exist between loop 208 and an inner wall 1028 of the latch 206, and this region 1108 will be of variable depth as measured in a lateral inward/outward direction. The inner wall 1028 has an inwardly-facing surface 1300 which has on it a point 1302 which is innermost and is farthest away from the lateral edge 202 of body 104 (see FIGURES 11 and 12) with which it is most closely associated. Preferably the inwardly-facing surface 1300 is arcuate and convexly so relative to the center of the tile 102. Surface 1300 can be more sharply curved than is shown. As one travels away from the innermost point 1302 along the surface 1300 (to the left or right in this FIGURE), the depth of interference region 1108 decreases, until the interference region 1108 vanishes altogether as one approaches either end 1304, 1306 of the surface 1300. Preferably the inner surface 1308 of the loop 208 is arcuately concave. More preferably the degree of concavity of the inner surface 1308 is less than the degree of convexity of the inward facing surface 1300 of the latch 206, that is, the surface 1308 is more gradually curved than surface 1300. In this way, the interference is minimized at the attachment points 1024, 1026, preventing the loop 208 from becoming over-stressed at its attachment points 1024, 1026 and reducing the likelihood of loop failure. It is relatively easy for loop 208 to stretch and flex at its middle, opposite innermost latch wall point 1302, as the length to either point 1026 or point 1024 is

long. But the resistance to such stretching and flexing will increase as one approaches point 1024 or point 1026, as the points of attachment are closer. Varying the degree of interference in the manner shown therefore reduces the stress at the attachment points 1024, 1026. The attachment points 1024, 1026 may be reinforced with gussets 2502 (see FIGURE 25) to prevent loop breakage.

[0079] FIGURE 14 is a schematic block diagram illustrating steps in a floor tile manufacturing process according to the invention. Step 1400 is a mold design step including many substeps, of which three are pertinent here. The mold (and the part produced thereby) should have certain characteristics, and these include the provision of flow-through holes at substep 1402. The flow-through holes are positioned to communicate the recesses 600 for the pads 106 (see FIGURE 6), on the upper surface 108, to the central second polymer compound fill points 504 adjacent the lower surface 306. The second shot of polymer compound will use these flow-through holes (602 in FIGURE 9) to access the cavities 600 in which the pads 106 are to be created. The size and number of through-holes 602 will be dictated in part by the viscosity of the second polymer compound at molding temperature, and the injection molding pressure to be used.

[0080] The designer also, at substep 1404, provides for crush rings 604 (FIGURE 6) on the top surface 108 of the tile 102, and crush pads 406 (FIGURE 8) on the bottom surface 306 of the tile 102. These surfaces preferably are flat, smooth, and slightly raised or outward in relation to the rest of the surfaces of which they are a part. The crush rings 604 and crush pads 406 closely laterally surround the regions into which the second polymer compound is to flow, creating a clean shutoff of the second polymer compound and preventing flashing. This is particularly important on the upper surface 108 as it will affect the aesthetic acceptability of the tile 102.

[0081] At substep 1406, the designer provides runners 502 (see FIGURE 9) to communicate the central fill points 504 with the support members 800, 802 and the through-holes 602. The result of

step 1400 will be tooling that can be used in a two-shot injection molding process according to the invention.

[0082] The mold is placed in an injection molding press and a first shot of polymer compound is injected into the mold at step 1408. As explained above, this first polymer compound is thermoplastic and preferably is relatively rigid, and can comprise polypropylene. Then, at step 1410, the mold is prepared for a second injection shot, in which further molding structure is used to define surfaces of pads 106, skins 304 and runners 502. A second shot of polymer compound is then injected into the mold, using a second polymer compound which has different characteristics than the first polymer compound, such as being harder or softer or being of a different color. Preferably the second polymer is elastomeric and for example can be constituted by SEBS TPE or another TPE. A preferred result of molding steps 1408 and 1410 is a composite floor tile which includes a body capable of withstanding a large amount of weight (such as might be imposed by a vehicle wheel) but still has nonslip characteristics on both its upper and lower surfaces.

[0083] FIGUREs 15 – 18 illustrate an embodiment of the invention in which the overmolded structure includes a peripheral seal that is used to seal to adjoining tiles when a floor surface is assembled. FIGURE 15 is an isometric view of a floor tile body 1500 that is similar to body 104 (FIGURE 2) but with lateral edges 1502, 1504 that are stepped rather than orthogonal to the web 200 and planar. This view is taken after molding the first polymer compound but prior to overmolding. In this illustrated embodiment, stepped lateral edge 1502 has a laterally inwardly disposed vertical surface 1506 which extends downwardly from general upper surface 108 to a horizontal shelf 1508. The horizontal shelf extends laterally outwardly from vertical surface 1506 to a second, laterally outwardly disposed vertical surface 1510. Vertical surface 1510 extends from the shelf 1508 to the lower surface 306 of the tile body 1500.

[0084] In the illustrated embodiment a lateral edge 1504 is similar in form to lateral edge 1502. A first, laterally inwardly disposed vertical surface 1512 extends from general upper surface 108 of the tile body 1500 to a shelf 1514. The shelf 1514 extends laterally outwardly from the vertical surface 1512 to a second, laterally outwardly disposed vertical surface 1516. The vertical surface 1516 extends from the shelf 1514 to the general lower surface 306 of the tile body 1500. Surfaces 1506, 1508 and 1510 define a recess (more particularly, a step) 1518 which can be subsequently occupied by an overmolded peripheral seal. Similarly, surfaces 1512, 1514 and 1516 define a step 1520 which can be subsequently occupied by an overmolded peripheral seal, preferably continuous with the seal occupying step 1518. While this illustrated embodiment uses steps 1518, 1520 as locations which can be occupied by a peripheral seal, other profiles are possible, such as curved or keyed profiles and/or ones which include a physical interference to the delamination of the peripheral seal from the body 1500. As before, it is preferred to mold the body 1500 from a relatively strong and rigid polymer compound such as one comprising polypropylene.

[0085] FIGURE 16 shows the view shown in FIGURE 15, but after at least one overmolding step in which a peripheral seal 1600 has been overmolded into the steps 1518, 1520 to laterally surround the body 1500. The creation of the seal 1600 can take place during, before, or after the creation of the raised pads 106 and skins 304 (FIGURE 9), and the seal 1600 can be constituted by a polymer compound which is the same as or which is different from the polymer compound constituting pads 106 and skins 304, in terms of composition, hardness, and/or color. It is preferred that the seal 1600 be constituted by a compound comprising SEBS TPE or other elastomeric compound.

[0086] A top surface 1602 of the seal 1600 is preferred to be coplanar with the general surface 108 of the body 1500. On one side of the tile body 1500, the horizontal surface 1602 extends from vertical surface 1506 laterally outwardly to a vertical surface 1604 of the seal. The vertical surface 1604 of the seal extends from seal horizontal surface 1602 until it meets with vertical surface 1510

of the body 1500, with which it is coplanar. As better seen in FIGURE 17, the otherwise planar vertical surface 1604 is interrupted by a bump 1606 which is convex in section.

[0087] On an adjacent side of the body 1500, a horizontal surface 1608, which is continuous with the surface 1602 and preferably coplanar with upper surface 108 of body 1500, extends laterally outwardly from the lateral edge of vertical surface 1512 to a vertical surface 1610 of the seal 1600. The vertical surface 1610, which in general is orthogonal to surface 108 and planar, is interrupted by a convex bump 1612. Otherwise, surface 1610 meets and is coplanar with vertical surface 1516 of the body 1500. Surfaces 1604, 1610 form a ninety degree corner at their junction.

[0088] As shown in FIGURE 18, when adjacent tiles 1800 are assembled such that a latch 206 is inserted into a loop 208, the bumps 1606, 1612 are in interference with each other, as shown by hatched interference region 1614. This creates a substantially watertight peripheral seal of each tile to the other tiles in the floor surface.

[0089] A further embodiment of the invention is shown in FIGURE 19, in which certain structure adjacent the lower surface 306 of a tile 1900 is shown in phantom. This embodiment is similar to that shown in FIGURE 2, with the difference that the second shot of polymer compound is introduced at upper surface 108 of the body 104, rather than at lower surface 306 thereof. For each of a group 300 of pads 106 and skins 304, a gate 1902 is formed to extend from the upper surface 108 of body 104 to the lower surface 306 thereof. The gate 1902 is continuous with runners 502 on the lower surface, which in turn communicate with the skins 304, the through-holes 602 and the cavities 600 in which are molded the pads 106. In making the second-shot injection, the second polymer compound flows through the gates 1902 to the lower surface 306, thence through runners 502 to the skins 304 and the through-holes 602, and finally back through the body 104 to the cavities 600 to mold the pads 106. In an alternative embodiment, the pads 106 are omitted and only

structure adjacent lower surface 306 is molded, except for dots on the upper surface that result from the gates 1902.

[0090] It is possible to overmold certain features on the bottom surface of the tile without creating raised pads from the second polymer compound on the top surface thereof. A top surface of such an embodiment can be seen in FIGURE 20, in which the entire top surface 2000 of a tile 2002 is molded of the first polymer compound. While the top surface 2000 can be featureless except for texturing, in this illustrated embodiment an array of features 2004, which can be rounded squares or which can take any other desired shape, are upstanding from a general top surface 2006. A bottom surface of this illustrated embodiment can be exactly as it appears in FIGURES 3, 5, 10, 12 and 13. In this embodiment there are no through-holes or gates between the upper and lower surfaces of the tile 2002. This embodiment and the embodiment shown in FIGURES 1 – 13 can be made using much the same molding apparatus, by swapping out a cavity-side mold insert adjacent the top surface 108, 2000 and leaving a core side (adjacent the lower surface) alone. This illustrated embodiment will still exhibit non-slip properties relative to the substrate on which it is placed, may have better chemical and wear resistance, and may cost less to produce.

[0091] Considering together the embodiment illustrated by the combination of FIGUREs 3, 5, 10, 12, 13 and 20, raised features 2004 are more likely to receive a disproportionate amount of weight from a vehicle or other heavy object superimposed on the tile 2002. It is therefore preferred that some of the support members, such as members 800 (FIGURE 8), receive all or some of the columnar load placed on any raised feature 2004. In the illustrated embodiment, each annular support member 800 (see FIGURE 8) is in approximate registration with a respective raised feature 2004 and as such will militate against shearing between the boundary of the raised feature 2004 and the surrounding general surface 2006.

[0092] FIGURES 21 and 22 show a fifth embodiment of the invention in which modifications to the latch and loop structure have been made. In this embodiment an undercut or trench 2100 is made behind (laterally inwardly from) the lateral edge 204, but laterally outwardly from the rib segment 1022, to approximately fifty percent of the thickness of web 200. The undercut 2100 extends in parallel to edge 204 for the interior length of the wall segment 1022 between its attachment points (1024, 1026; FIGURE 10) with female loop 208. The undercut 2100 leaves a downwardly depending flange 2102 which, when surface 2104 of outer wall 2106 slides vertically downward along surface 204, will flex inward (to the left in this picture) in approximately the direction of arrow 2108. The depth of the undercut 2100 is chosen to get a sufficient flexure of the flange 2102 upon snapping the tiles together, and may be more or less deep than shown depending on the flexural modulus of the polymer used to mold tile body 104. Flexing flange 2102 permits latch 206 to more easily snap into loop 208 and places less stress on loop 208 while joining two adjacent tiles. The inner latch wall 2110 may be made thicker and preferentially has a preferably flattened, inner ramped surface 2112 which cams against corner 1106 as the right tile 102C is pressed downward to join it with left tile 102D, until ledge 2120 clears lower edge 2116 of flange 2102. Ramped surface 2112 preferably extends downwardly and laterally outwardly from innermost limit 1302 of latch 2118. After the tiles 102C, D are snapped together, there will remain a hatched interference region 2114 between inner latch wall 2110 and outer female loop 208, keeping the tiles 102C, 102D biased together or in compression with each other; the physical position of loop 208 will actually be displaced rightward from that shown in FIGURE 21.

[0093] Preferably a lower edge 2116 of the flange 2102 is slightly relieved (or upwardly displaced) from the plane of the general lower surface 306. This permits an easier overdrive of male latch 2118 into female loop 208 and better assures an audible click when horizontal ledge 2120 snaps beyond lower edge 2116.

[0094] FIGUREs 23 through 27 show another embodiment of the invention. In this embodiment, the bottom view of a tile 2301, shown in FIGURE 23, shows sixteen groups 2300 of support members 2302. The body 2303 may be molded from a first polymer compound and have an upper surface 2602 (see FIGURE 26) and a general lower surface 2306. One or more upper features 106 (FIGURE 2), such as pads, may be formed or overmolded into the upper surface 2602 with a second polymer compound. As completed, the upper features or pads 106 on upper surface 2602 (FIGURE 26) may look identical to the ones of embodiments previously described herein. One or more lower features 2302 (FIGURE 23), such as support members or skins, may be overmolded onto the lower surface 2306 of the body 2303 from the second polymer compound. As above, the second polymer compound preferably has a higher coefficient of friction than the first polymer compound so that the upper features 106 and the lower features 2302, or skins, act as nonslip surfaces. Alternatively or additionally, they may be made in a color different from that of the tile body 2303.

[0095] FIGUREs 24 and 25 show the details of the tile lower surface 2306. Specifically, these FIGUREs show a single group 2300 of support members 2302 before (FIGURE 24) and after (FIGURE 25) the second polymer compound is overmolded onto the body 2303 of the tile 2301. FIGURE 24 shows there can be seen a plurality of support member cores 400 which depend downwardly (in this view, extending toward the top of the paper) from the general lower surface 2306 of the substantially horizontal web 200 that makes up most of the tile body 2303. One or more through-holes 602 connect the upper surface 2602 (see FIGURE 26) with the lower surface 2306. Similarly, one or more vent holes 2402 connect the upper surface 2602 with the lower surface 2306 of the tile 2301. Preferably, each vent hole 2402 is in a location that is laterally interior to and within a periphery of a respective upper feature 106. Each upper feature 106 has a through-hole 602 and a vent hole 2402 communicating to it and these are laterally spaced from each other. Preferably the vent hole 2402 for any particular pad 106 should be positioned at a location that is

farthest from the through-hole 602 therefor, while still being laterally within the periphery of the cavity that will form the pad or upper feature 106.

[0096] FIGURE 26 shows the details of an area on the top of tile 2301, prior to overmolding. Each overmolded pad 106 (see FIGURE 7) may reside in a shallow recess or receptacle 2600 whose surface is lower than that of the general upper surface 2602. For each recess 2600, there is provided at least one through-hole 602 and at least one vent hole 2402, each of which communicates the top surface of the tile web 200 to a lower surface thereof. In the illustrated embodiment, the through-holes 602 and vent holes 2402 make up a small fraction (about 5% each) of the bottom of the recesses 2600. Each of the recesses 2600 form respective lower portions of the cavities in which upper features or pads 106 will be formed, the remainder of the surfaces thereof being constituted by the other mold half. Limiting the size of through-holes 602 and vent holes 2402 enhances the structural integrity of the tile 2301. However, in alternative embodiments, the size and/or number of the through-holes 602, and even vent holes 2402, may be increased to accommodate more highly viscous second-shot polymer compounds.

[0097] The recesses 2600 are each laterally surrounded by a crush ring 604. See FIGURE 26. Each crush ring 604 is finished to be smooth (in contrast, the general upper surface 2602 of the body 2303 can be textured) and can be slightly raised relative to the general upper surface 2602. The crush rings 604 each adjoin the periphery of a respective upper feature 106 and provide a tight overmold shutoff that prevents the flashing of the second polymer compound outside the confines of the crush rings 604. FIGURE 25 further shows that a portion 2310 of at least one upper feature, or pad, 106 (see FIGURE 7) may extend through the vent hole 2402 below the general lower surface 2306. As shown in FIGURES 23 and 25, the portion 2310 extending through the vent hole 2402 may be discontinuous with or spaced from the second polymer compound of the lower support

member 2302. As described in more detail below, this spacing may be accomplished by providing a portion of the crush pad 2406 between the vent hole 2402 and the cores 400.

[0098] The crush pad 2406 is formed into the body 2303 in a manner similar to the crush ring 604 to be slightly lower than the general surface 2306 (in this bottom view, is slightly raised relative to general surface 2306). The crush pad 2406 is formed to be closely adjacent all of the support member cores 400 and to laterally surround all of the cores 400, the runners 502 connecting the lower features 304, the through-holes 602, and the vent holes 2402 (and therefore portions 2310). The crush pad 406 is finished to have a smooth surface and is used as a shutoff surface that prevents the flashing of the second polymer compound during a “second shot” or overmolding step of fabrication.

[0100] In an arrangement similar to that illustrated and described previously (see FIGURE 19), a second polymer compound gate 1902 is disposed to be adjacent to the lower surface 2306 and remote from the upper surface 2602. The gate 1902 communicates with the upper feature 106 through fill point 504 and a through-hole 602 that extends from the lower surface 2306 to the upper surface 2602. The gate 1902 is in direct communication with each lower feature 2302 by a path which does not pass through the body 2303.

[0101] FIGURE 25 shows the same area after overmolding. The second polymer compound now appears on the bottom surfaces and sides of each of the cores 400 as a lower feature 2302 or skin. While the second polymer skin could be overmolded separately on each core 400, in the illustrated embodiment, the second polymer within the support member group 2300 is part of a continuous phase. The second polymer preferably does not extend to regions outside of, and is contained by, the crush pads 2406.

[0102] FIGURE 27 shows that a plurality of upper features 106 and lower features 800, 802 can be formed from one gate 1902 (FIGURE 19). It can be seen that the molten second polymer flows from the gate 1902 (see FIGURE 19) to the fill point 504 and directly to the lower surface 2306 to form the lower features 800, 802. This path does not go through the first-shot tile body 2303. FIGURE 27 also shows that each upper feature 106 is in communication with a respective vent hole 2402. The second polymer flows from the gate 1902, to the fill point 504, and through the through-hole 602 to form a respective upper feature 106. For each feature or pad 106, the second polymer flows from the through-hole 602 and flows into and fills a respective mold cavity formed in part by a recess 2600, and back through the vent hole 2402. In this way, any gas in the polymer flow-path is displaced, and defects or voids at the end-of-fill point in the overmolded upper feature 106 caused by trapped gas can be minimized or prevented. This trapped gas otherwise can cause burn marks, short shots, and/or poor adhesion of the upper features 106 to the body 2303.

[0103] The structure shown in FIGURE 24 is one possible first-shot body structure that promotes the displacement of any gas out of the upper feature cavity. Each core 400 may be interrupted or truncated to provide lateral separation from the vent hole 2402, which is preferably placed at a position farthest away from the through-hole. Where, as here, the upper feature 106 takes on a roughly square or rectangular shape, the through-hole 602 and the vent hole 2402 can be disposed in opposite corners of the upper feature. The positioning of vent hole 2402 preferably should be such that the molten second-shot polymer flowing from the through-hole 602 will reach the vent hole 2402 only after reaching the rest of the cavity defined in part by recess 2600. After molding (FIGURE 25), the separation between core skin 2302 and portion 2310 is maintained by the crush pad 2406, which seals the portion 2310 of the upper feature 106 or pad extending through the vent hole 2402 from the lower features 2302 or skins molded onto the cores 400. This separation of the top flow (through the through-hole 602, over the recessed area 2600, and through the vent hole

2402) and the bottom flow (from the fill point 504, to the runner 502, to the lower feature 2302 or skin) prevents the top and bottom flows from interfering with one another in correctly filling the volumes into which the second polymer is to be overmolded.

[0104] FIGURE 28 illustrates a method 2800 of manufacturing a modular floor tile 2301 according to the invention. At 2802, the first-shot injection mold is formed, including forming (2804) structures which will make one or more through-holes 602, and forming (2806) one or more vent holes 2402. Optionally structures which will form one or more recesses 2600 can be formed at step 2808, the recesses 2600 then acting as portions of the cavities in which the upper features or pads 106 will be later molded. At step 2810, structure defining the crush ring(s) 604 are formed on the upper surface 2602 of the first-shot body 2303, so as to laterally surround each upper feature and preferably to be elevated above the general upper surface. For each such upper feature, at least one through-hole and at least one vent hole is made, and these preferably are spaced to be at opposite ends of the upper features to which they communicate. At step 2812, crush pad(s) 2406 are defined on the lower surface 2306 of first-shot body 2303, so as to laterally surround each lower feature to be molded in the second shot, and also to laterally surround each vent hole 2402.

[0105] At step 2814, the second-shot mold half is created. The structures formed in this step include a fill point or gate 504, 1902, which is located to be adjacent the lower surface 2306 of the first-shot body 2303 and remote from the upper surface 2602 thereof. Cavities for the second-shot runners 502 (FIGURE 27) are also formed at this step.

[0106] The first polymer compound is injected into the first-shot injection mold at step 2820; this will form a first-shot tile body 2303 as seen in FIGUREs 24 and 26.

[0107] The second polymer compound is injected into a second-shot injection mold at step 2822, to overmold upper features 106, and preferably also lower features 800, 802, onto the respective

upper and lower surfaces of the tile body. The second polymer compound is introduced (2824) to the mold at a gate 1902 and fill point 504, for each connected group of upper and lower features. In one embodiment, there are 16 such gates and fill points on one tile. The second polymer flows by runners 502 to the through-hole(s) at step 2824. At step 2826, the second polymer flows in each connected through-hole 602 from the lower surface to the upper surface, reaching the cavity(ies) which each define respective upper feature(s). The upper feature cavity(ies) are filled at step 2828. At step 2830, the crush ring(s) shut off the second polymer compound from flashing across the upper surface of the part. The second polymer compound pushes any gas through vent hole(s) 2402, minimizing or obviating any defects in the upper feature(s). To positively assure that this is accomplished, at step 2832 second polymer compound may flow through each vent hole 2402 to protrude onto the lower surface 2306. The crush pad 2406 and associated mold half isolate this second polymer portion 2310 from next-adjacent lower features 800.

[0108] While the second polymer compound is molding the upper feature(s) at steps 2824 – 2832, it can also create lower feature(s) at steps 2834 – 2840. At step 2834, second polymer compound flows from gate 1902 and fill point 504 into and through one or more runners 502. At step 2836, the runners 502 permit second polymer compound to reach each of the lower feature(s) 800, 802, where the cavity(ies) defining them are filled (2838). At step 2840, the crush pad(s) 2406, in conjunction with the mating second-shot mold half (not shown), shut off the molten second polymer compound, preventing the flash of same over the lower surface 2306. The mold half and crush pad(s) 2406 also isolate second polymer portion 2310 from the second polymer compound flowing in to form feature(s) 800, 802. In this way, there is no hydraulic interference between the molten polymer compound flowing into and forming the upper feature(s) and the molten polymer compound flowing into and forming the lower feature(s), and any air or inert gas will be expelled from the upper surface features.

[0109] The embodiment shown in FIGURES 29 – 30C is in general similar to the embodiment shown in FIGURES 23 – 27, with the following changes. A set of elongate drainage vents 2902 is formed such that each drainage vent 2902 extends from the general top surface 2904 of the body 2906 to the general lower surface 2908 thereof (FIG. 30B). In this illustrated embodiment the drainage vents 2902 occupy only a small fraction of the surface area of lower surface 2908, as the illustrated tile 2910 is meant to take on the weight of a vehicle as transmitted by a vehicle tire (or even a jack stand), and as such too many voids in the tile body 2906 would compromise its integrity. In the particular embodiment illustrated here, the drainage vent surface area as measured at the general lower surface 2908 is about 3% of the total. Preferably the collective surface area of the vents, as measured at the general lower surface 2908, should be no more than about 11% of the surface area of the general lower surface 2908.

[0110] In this embodiment, pads or features 106 are formed to upwardly extend from the general upper surface 2904 by a small amount. As before, the pads or features 106 are formed by a second-shot injection molding operation of a material which can be softer and/or more elastomeric than the first-shot material forming the body 2906. The features 106 can be formed on smooth, flat, slightly proud crush rings 604 so as to provide a complete shutoff and avoid flash on the general upper surface 2904 of the part. Each group of pads 106 can be considered to be a single feature which is injection-molded in a continuous phase from a common fill point (seen, for example, at 3001 in Figure 30B).

[0111] The drainage vents 2902 can be laterally spaced from the upper second-shot features 106 and the crush rings 604 on which they are formed. Where, as here, the tile 2910 is composed of sixteen (four by four) portions 2912, some of which can be trimmed off by a consumer, the drainage vents 2902 conveniently can be located at the borders of these portions 2912 and their directions of elongation can conform to the border between the portions 2912.

[0112] Details of this embodiment are best seen in FIGURES 30A-C. Each elongate drainage vent 2902 is radiussed (2914) at its junction with the general upper surface 2904. The radiussing 2914 does not continue all of the way through the depth of the tile body 2906 (which, for example, can be 1/8 in.), but extends less than half way. Thereafter, the vent 2902 is defined by sloped sidewalls 2916 which extend to their junction with the general lower surface 2908. The degree of bevel or slope of sidewalls 2916 relative to the vertical can be 30 degrees. This permits each drainage vent 2902 to collect more moisture from the top surface 2904 and funnel it to the volume below the body 2906. In the illustrated embodiment, the radiussing 2914 and beveling expands the vent's surface area by more than 300% relative to its surface area at the plane of the bottom surface 2908.

[0113] As seen in FIGURE 30B, the drainage vents 2902 can be laterally spaced from the support member groups 2300 and the crush pads 2406 on which they are formed. As before, an interrupted circumferential rib 3000 laterally surrounds each support member group 2300. This rib 3000 is molded with and depends from first-shot body 2906 and can be in the shape of a rounded square, as shown; it delimits a one-sixteenth portion 2912 of the tile 2910. The rib 3000 is made of several components. A u-shaped rib portion 3002 starts at a point on an interior side of portion 2912, bends to be parallel to exterior tile side 3004, and then bends up again to be parallel to an exterior tile side 3006. Rib section 3002 includes two curved transitions between longitudinal and transverse segments. A loop 3007, in general similar to the loops previous described, is molded to be continuous with the rib portion 3002 and is attached thereto by loop connection points 3008 and 3010. In the illustrated embodiment, these have been strengthened by fillets 3012 and 3014, respectively, which extend between the vertical external surfaces of rib portion 3002 and loop 3007 at their points of attachment.

[0114] Rib portion 3002 terminates prior to latch 2118, which takes the form previously described. A rib portion 3016 forms (in this FIGURE) the upper right-hand corner of the rib 3000 and includes a curved transition at its corner. Rib portion 3016 is discontinuous with upper left rib portion 3018, which is in mirror image to the rib portion 3016. The discontinuity of the rib 3000 permits fluid which the vents 2902 collect and drain to flow from the volume delimited by rib 3000 to points exterior to that volume.

[0115] The rib portions 3002, 3016, 3018 are laterally spaced from similar rib portions which are disposed in neighboring tile portions 2912. The lateral spacing, which for example can be 0.17 in., defines a channel 3020 between neighboring tile portions 2912. In this embodiment the elongate drainage vents 2902 are disposed within these channels 3020. The collocation of the vents 2902 within the channels 3020 makes it easier for a consumer to trim off selected one-sixteenth squares 2912 from the tile 2910; the consumer can use the channels 3020 as a cutting guide.

[0116] While the illustrated tile 2910 has sixteen portions 2912, other, smaller tiles can be molded that consist of fewer portions 2912. For example, a tile (not shown) can be molded which includes only one portion 2912. There can be 1 x 2, 2x2, 2x3, 3x3, 4x1, etc. sizes which then would include two, four, six, nine, or four portions, respectively; the repeating pattern of tile 2910 makes it convenient to assemble to these smaller tiles to fit to an actual floor area. In one embodiment each portion 2912 is 3 in. by 3 in., while the largest tile 2910 is one foot square, or 12 in. by 12 in.

[0117] In general, the locations of the drainage vents 2902 are chosen so as to be laterally displaced from both the features 106 (which may include overmolded components both on top of and on the bottom of the tile body 2906) and from the crush rings 604 and the crush pads 2406 which laterally surround these overmolded features.

[0118] FIGUREs 31 – 32C illustrate an embodiment which is similar to the one shown in FIGUREs 29 – 30C, but without the second thermoplastic material being overmolded on the body. In this “single shot” embodiment, a floor tile 3100 has a general upper surface 3102 and a general lower surface 3104 (see FIGURE 32B). A set of raised pads 2004 extend upwardly from the general upper surface 3102, but these are formed at the same time as the body 3106, of the same material. As before, a set of elongate drainage vents 2902 extend from the general upper surface 3102 to the general lower surface 3104.

[0119] As best seen in FIGURE 32B, an interrupted or discontinuous circumferential rib 3000 delimits a one-sixteenth portion 3200 of the tile 3100. The rib 3000 has a u-shaped portion 3002 from which extends a loop 3007. Corner rib portions 3016 and 3018 complete the rib 3000, which can take the form of a rounded square. Adjacent ones of the ribs 3000 define channels 3020 therebetween, and the drainage vents 2902 are disposed in these channels 3020. The part is completed with the addition of four internal corner ribs 3202 that are disposed among the group of pads 2004. As best seen in FIGURE 32C, the drainage vents 2902 continue to be radiussed at 2914 and beveled at 2916, such that their surface area as measured at the plane of the general upper surface 3102 is more than 300% of their surface area as measured at the plane of the general lower surface 3104.

[0120] The drainage vents 2912 may be incorporated into any of the embodiments shown in FIGUREs 1 – 14 or 19 – 28.

[0121] In the embodiment shown in FIGUREs 33 – 34C, a tile 3300 has a general upper surface 3302 without any upstanding pads. This embodiment is injection-molded from a single thermoplastic material and its composition can be similar to that used to make the first-shot tile bodies as above described. Four arrays or groups 3304 of elongate drainage vents 3306 – 3310 are

formed to extend from the upper surface 3302 to the general lower surface 3312 of the tile (see FIGURE 34B). The drainage vents 3306 – 3310 are of uniform width (such as 1/8 in. as measured at lower surface 3312) but of varying length. The cumulative surface area of the drainage vents 3306 – 3310, as measured at the lower surface 3312, is only a small fraction of the surface area of the tile 3300 (such as about eleven percent), as the tile 3300 is meant to receive the weight of a portion of a motor vehicle and as such care must be taken not to compromise the strength of the tile 3300.

[0122] The lateral positions of fill points 3314, at which molten polymer is introduced into the mold, are denoted by crosses. The fill points 3314 preferably are on the lower tile surface 3312 and correspond to the injection mold gates. In this embodiment, the drainage vents 3306 – 3310 within any array 3304 are arranged in a somewhat radiant fashion around their respective fill points 3314. That is, the axes of elongation of each of the drainage vents 3306 – 3310 are more in alignment with a radius from a respective fill point 3314, than they are transverse to it. The longest vents 3306 have axes which exactly coincide with radii from an associated fill point 3314, but in the illustrated embodiment, and for reasons of aesthetics and uniformity of distribution, the axes of vents 3308 and 3310 are less so aligned, and instead have been selected to be parallel to the axis of the long drainage vent 3306 with which they are most closely associated.

[0123] In the mold, the drainage vents 3306 – 3310 correspond to solid structures around which the molten polymer must flow in order to fill the mold. Molten polymer will flow radially away from each of the fill points 3314. As disposed in FIGURE 33, the impedance of the drainage vents 3306 – 3310 to the flow of molten polymer is reduced if not minimized, and this aids in the successful filling of the mold. In other embodiments (not shown) the vents 3306 – 3310 can be so arranged that their axes of elongation are completely in alignment with respective radii with an associated fill point 3314, creating a star pattern.

[0124] As in previous embodiments, tile 3300 has fillet-augmented loops 3007 which engage latches 2118 of adjacent tiles, in a manner previously described.

[0125] Referring particularly to FIGURE 34B, a set of straight, elongate, supporting ribs 3400 – 3402 are molded with tile body 3404 to depend from the general lower surface 3312. In this embodiment the ribs 3400 – 3402 are disposed to be in parallel with the straight, elongate drainage vents 3306 – 3310. Ribs 3400 flank the long vent 3306 and are respectively positioned to be midway between the long vent 3306 and the medium-length vents 3308. Here, they are chosen to be of a length similar to that of the medium-length vents 3308. Ribs 3402 are shorter than ribs 3400, and are positioned midway between medium-length ribs 3308 and short ribs 3310. As so distributed, the ribs 3400, 3402 equally support a load placed on top surface 3302 across any of the vents 3306 – 3310, so that there will be no shear force which develops in the body 3404 across any of the vents 3306 – 3310.

[0126] The rib support structure for the web 3406 of the body 3404 further includes a u-shaped rib 3002, which (in FIGURE 34B) starts on an interior side of a $1/16^{\text{th}}$ portion 3407 of the tile 3300, proceeds along a side 3408, and curves along side 3410 until it ends near latch 2118. The u-shaped portion 3002 includes two rounded corners of a square. A third rounded corner of this square is defined by rib portion 3016, in (in this FIGURE) the upper right-hand corner. The upper left hand corner is defined by straight rib portions 3412. Straight rib portions 3412 are not conjoined so as to avoid the fill point 3314. Rib portions 3002, 3016 and 3412, in combination with similar rib portions of adjacent tile portions 3407, define channels 3020 which may be used by a consumer to trim one or more portions 3407 off of the rest of the tile body 3404. Loops 3007 are formed with rib portions 3002 and are used to attach the modular tile 3300 to the latches 2118 of other, similar tiles.

[0127] As seen in FIGURE 34C, and per previously described embodiments, each drainage vent 3306 -- 3310 is radiussed (2914) at its junction with general upper surface 3302. Sidewalls 2916 of the drainage vents 3306 – 3310 are beveled, as at thirty degrees to the vertical. The radiussing and beveling expands, by more than 300%, the surface area of those vents at the general upper surface 3302, relative to the surface area which the vents define at the general lower surface 3312.

[0128] The embodiment shown in FIGURES 35 – 36B is similar to the embodiment shown in FIGURES 33 – 34C, with the exception that the elongate ribs provided to reinforce the drainage vents 3306 – 3310 are now transverse to the vents 3306 – 3310 rather than parallel to them. Similar to previously disclosed embodiments, the tile 3500 has sixteen square portions 3502, each of which has drainage vents and supporting ribs. The supporting ribs are molded with the tile body 3506 and depend from a general lower surface 3505 of the tile body 3506. In each portion 3502, a long central rib 3504 is molded to extend completely across drainage vents 3310, 3308 and 3306. Spaced apart from and disposed in parallel to rib 3504 are two, flanking, shorter ribs 3508, each of which span vents 3308 and 3306. Even shorter ribs 3510 are disposed adjacent to and in parallel to respective ribs 3508, so as to be opposed to long rib 3504. Ribs 3510 span the central vent 3306 only. As so disposed, the ribs 3504 – 3510 resist tensile and shear forces across the longer sides 3512 of the vents 3306 – 3310; they resist any tendency for these vents 3306 – 3310 to be opened or for their longer sides 3512 to be pulled apart from each other. Forces like this might occur if a load is placed on top of the tile 3500 on one side of a particular drainage vent, but not on the other.

[0129] FIGURE 37 illustrates successive steps in a design and manufacturing method which will produce the vented floor tiles shown in FIGURES 33 – 36. At step 3700, the designer determines where the gates and the corresponding fill points will be on the tile. Once these locations are known, at step 3702 the vents can be added to the design. The elongate vents are arranged in groups around respective gates/fill points, so that they will be substantially radiant to those fill

points; that is, their axes of elongation will be more in alignment with respective radii from that fill point than they will be transverse to them. At step 3704, and in the completed mold, molten polymer is flowed through the gates and around the structures which will make the drainage vents. Because these drainage vents are disposed to be substantially radiant to the fill points, the impedance to the molten polymer as it flows by and around the vent-making structures will be minimized.

[0130] While embodiments of the present invention have been described in the above detailed description and illustrated in the appended drawings, the present invention is not limited thereto but only by the scope and spirit of the appended claims.

WE CLAIM:

1. A modular floor tile injection-molded of at least first and second thermoplastic materials, comprising:
 - a body injection-molded from the first thermoplastic material and having a general upper surface and a general lower surface;
 - a plurality of features overmolded from the second thermoplastic material onto the body, ones of the features being laterally spaced apart from others of the features; and
 - a plurality of drainage vents formed in the body to extend from the general upper surface to the general lower surface, each drainage vent being laterally spaced from adjacent ones of the features.
2. The floor tile of Claim 1, wherein each feature includes at least one pad overmolded on the body to upwardly extend from a plane containing the general upper surface.
3. The floor tile of Claim 2, wherein each feature includes a plurality of pads overmolded on the body to upwardly extend from a plane containing the general upper surface, the pads of the feature connected to a common fill point and injection-molded from the second thermoplastic material in a continuous phase.
4. The floor tile of Claim 2, wherein at least one crush ring is formed on the body to be disposed upwardly from the general upper surface, said at least one crush ring having a flat surface and laterally surrounding said at least one pad so as to prevent flash of the second thermoplastic material.

5. The floor tile of Claim 4, wherein each pad is laterally surrounded by a respective crush ring, each drainage vent being laterally spaced from adjacent ones of the crush rings.

6. The floor tile of Claim 2, wherein each feature further includes at least one support member extending below the general lower surface of the body, at least one through-hole formed through the body to communicate said at least one support member to said at least one pad, said at least one pad and said at least one support member injection-molded from a continuous phase of the second thermoplastic material.

7. The floor tile of Claim 1, and further comprising a plurality of elongate ribs formed on the body of the first thermoplastic material to downwardly depend from the general lower surface of the body, each feature being laterally surrounded by a respective rib, channels being defined by adjacent ones of the ribs, the drainage vents being disposed in the channels.

8. The floor tile of Claim 7, wherein each rib is discontinuous so as to permit flow of drained fluid from a volume laterally interior to the rib to points laterally exterior to the rib.

9. The floor tile of Claim 1, wherein each feature includes at least one support member formed of the second thermoplastic material to downwardly extend from the general lower surface of the body.

10. The floor tile of Claim 9, wherein each feature includes a group of support members each formed of the second thermoplastic material to downwardly extend from the general lower surface of the body, each group of support members connected to a common fill point.

11. The floor tile of Claim 9, and further comprising a crush pad formed in a plane lower than the general lower surface of the body, the crush pad laterally surrounding said at least one support member and providing a flat surface to prevent flash of the second thermoplastic material.

12. The floor tile of Claim 10, wherein, for each group of support members, a crush pad is formed on the body to be disposed in a plane lower than the general lower surface of the body, the crush pad laterally surrounding the group of support members, next adjacent ones of the drainage vents being laterally spaced from the crush pads.

13. The floor tile of Claim 1, wherein each drainage vent has a surface area in the plane of the general lower surface, a surface area of the drainage vent at the general upper surface being more than 300% of the surface area of the vent taken at the general lower surface.

14. The floor tile of Claim 1, wherein the surface area of the vents taken at the general lower surface of the body is no more than about eleven percent of the surface area of the general lower surface of the body.

15. The floor tile of Claim 14, wherein said surface area of the vents is about three percent of the surface area of the lower surface of the body.

16. A modular floor tile injection-molded from a thermoplastic material, comprising:
a body having a general upper surface and a general lower surface;
a plurality of fill points spaced apart on the body, each fill point associated with a gate of an injection mold used to manufacture the floor tile, the gates introducing molten thermoplastic

material into the mold at the fill points, molten polymer spreading from the fill points throughout the mold to define the body; and

a plurality of elongate, spaced-apart drainage vents formed in the body to extend from the general upper surface to the general lower surface, groups of the drainage vents arranged around respective fill points in substantially radiant fashion so as to reduce the impedance of each vent to the flow of molten polymer from the fill points throughout the mold.

17. The tile of Claim 16, wherein each vent defines a surface area taken at the general lower surface of the body, a surface area of the last said vent taken at the general upper surface of the body being more than 300% of the surface area of the last said vent taken at the general lower surface of the body.

18. The tile of Claim 16, and further comprising a plurality of elongate ribs extending from the general lower surface of the body, the ribs laterally spaced from the vents.

19. The tile of Claim 16, and further comprising a plurality of elongate ribs extending from the general lower surface of the body, ones of the ribs laterally intersecting ones of the vents to resist tensile or shear forces experienced across the vent sides.

20. The tile of Claim 16, wherein the surface area of the vents taken at the general lower surface of the body is no more than about eleven percent of the surface area of the general lower surface of the body.

21. A method for manufacturing a modular floor tile, comprising the steps of:

defining a plurality of gates in a floor tile injection mold to be laterally spaced apart from each other;

defining locations for each of a plurality of elongate vents which extend from a general upper surface of the tile to a general lower surface of the tile, the locations being laterally spaced from the gates;

disposing the vents in groups around respective ones of the gates such that the axes of elongation of the gates are substantially radiant relative to the locations of the gates;

flowing polymer through the gates to fill a volume of the mold; and

responsive to the last said step of disposing, minimizing the impedance to polymer flow caused by the vents.

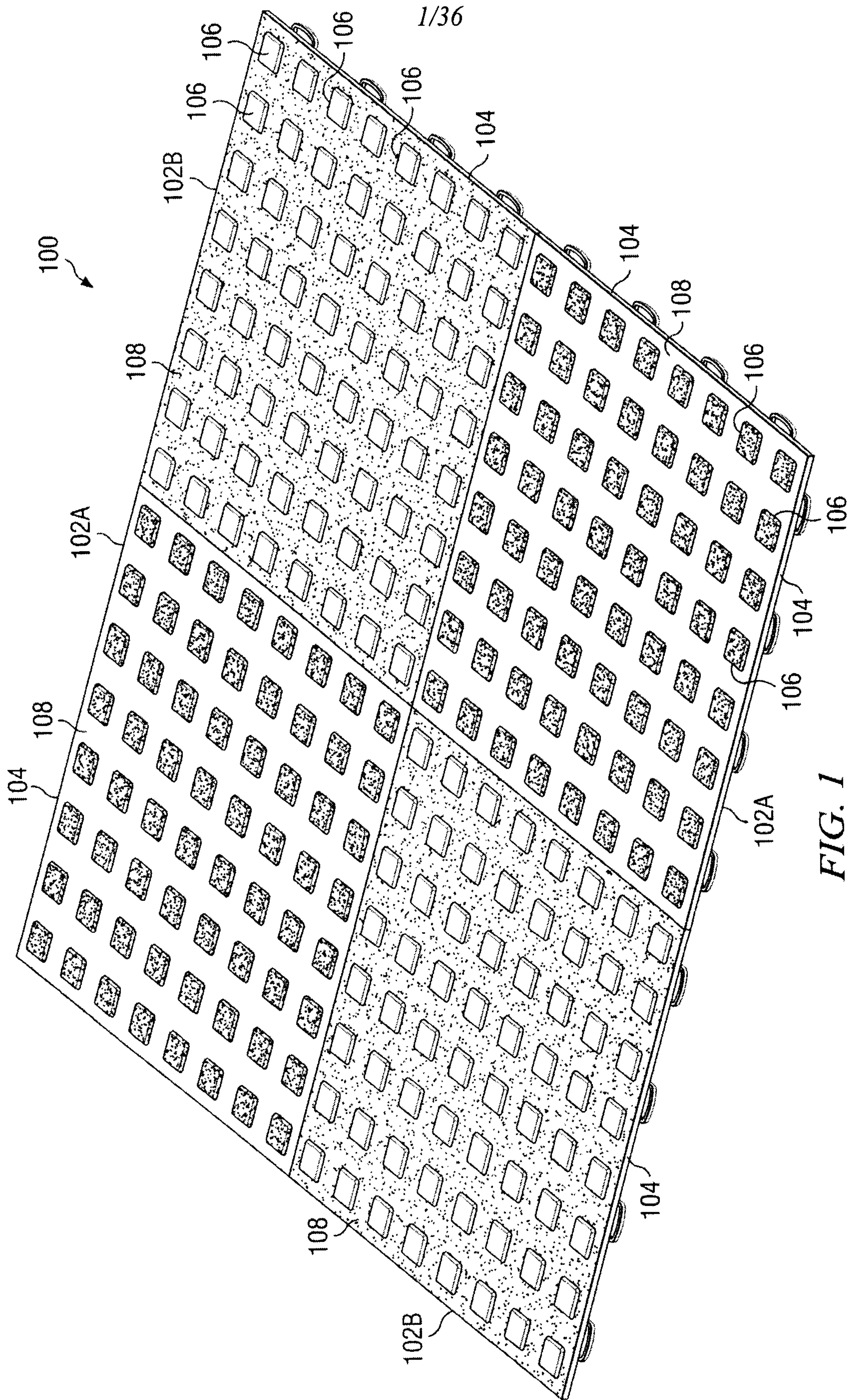


FIG. 1

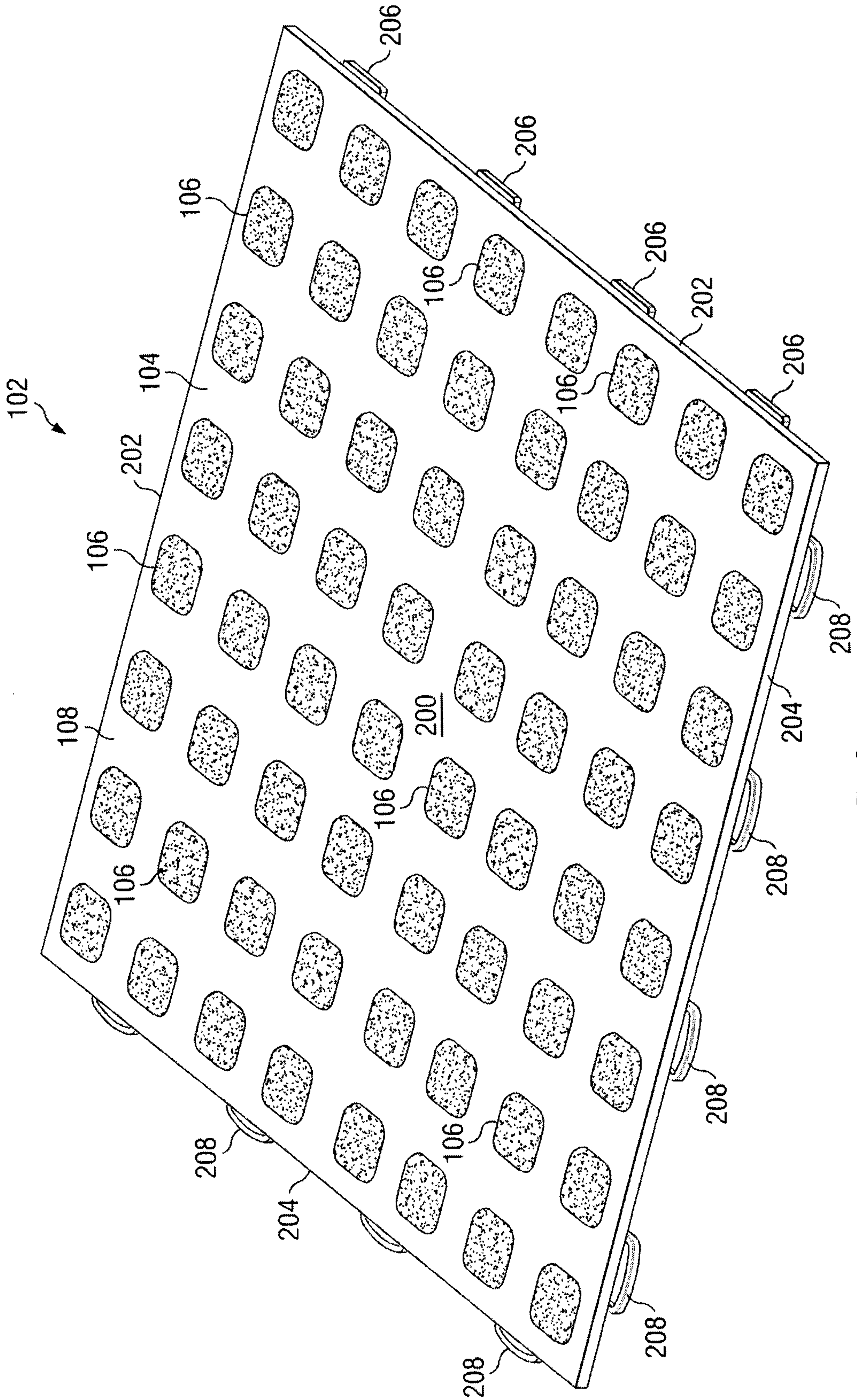


FIG. 2

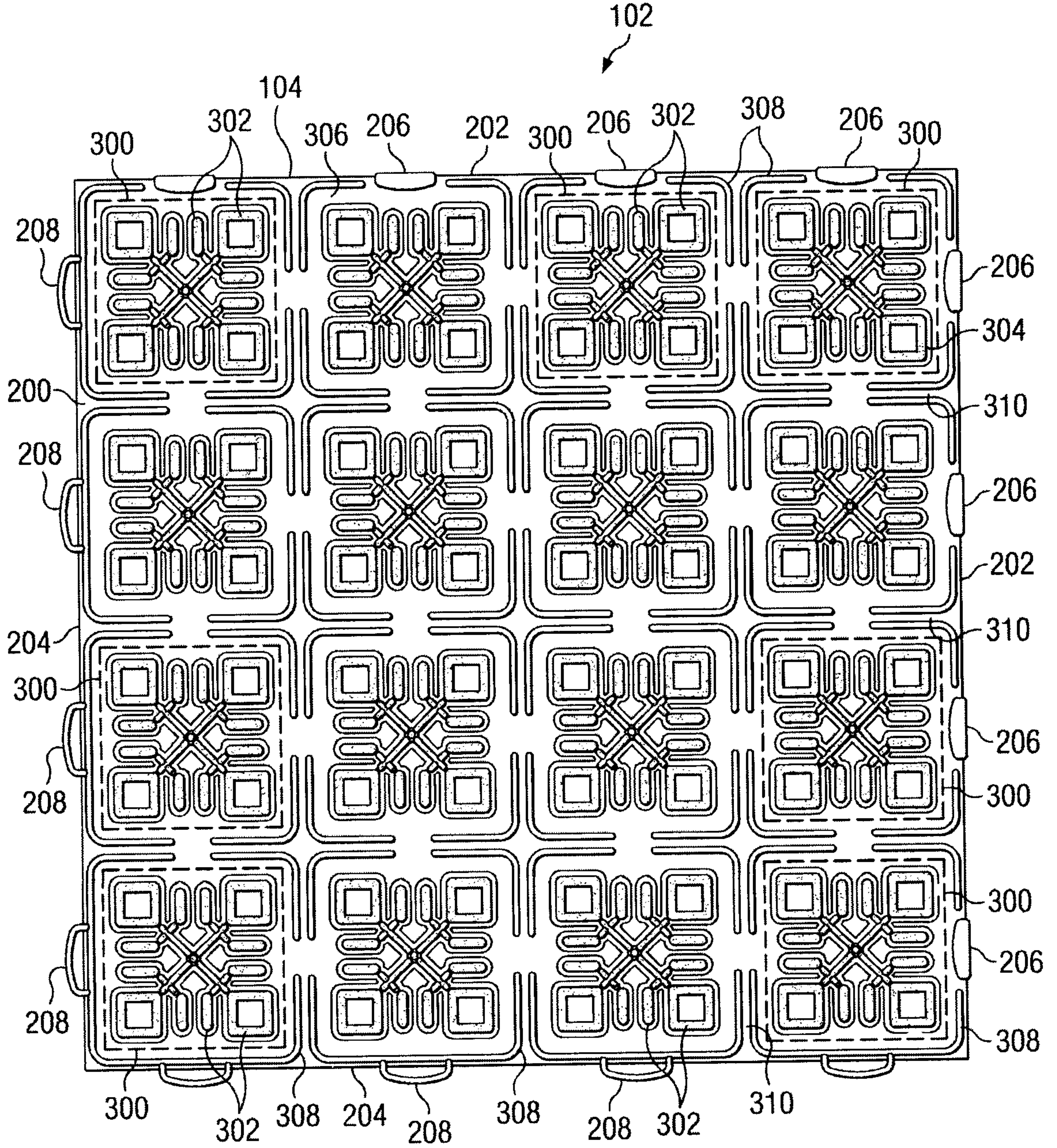


FIG. 3

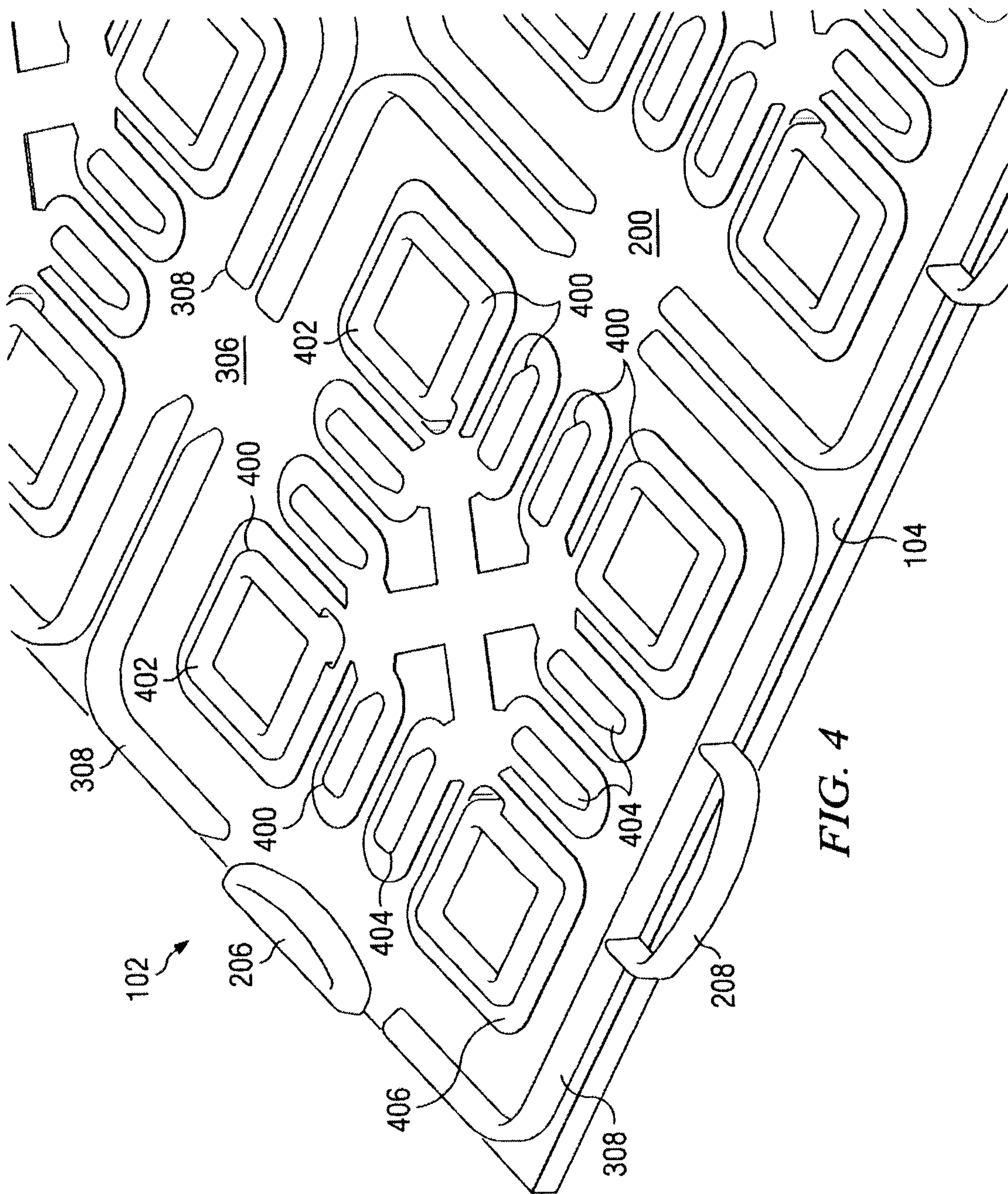


FIG. 4

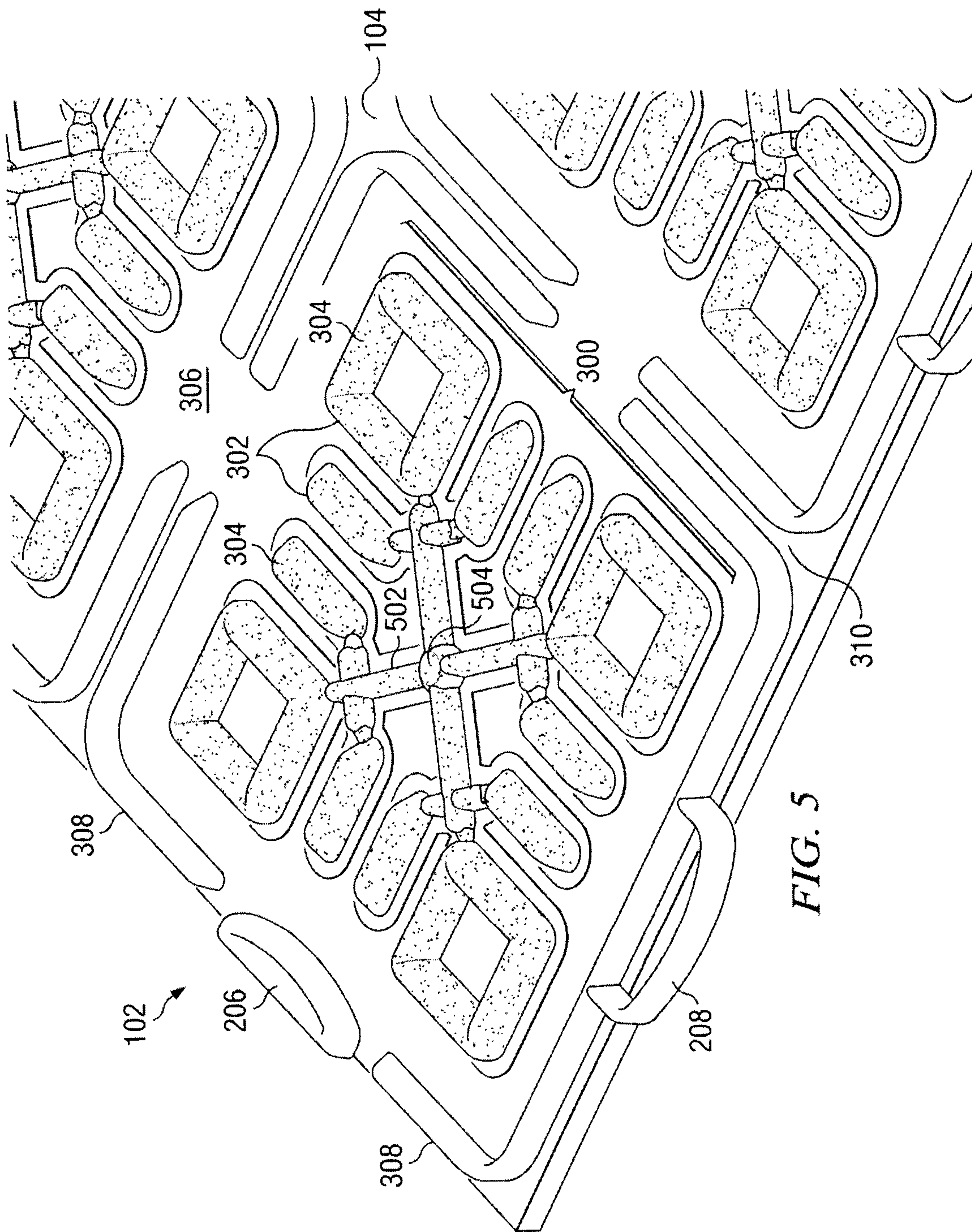
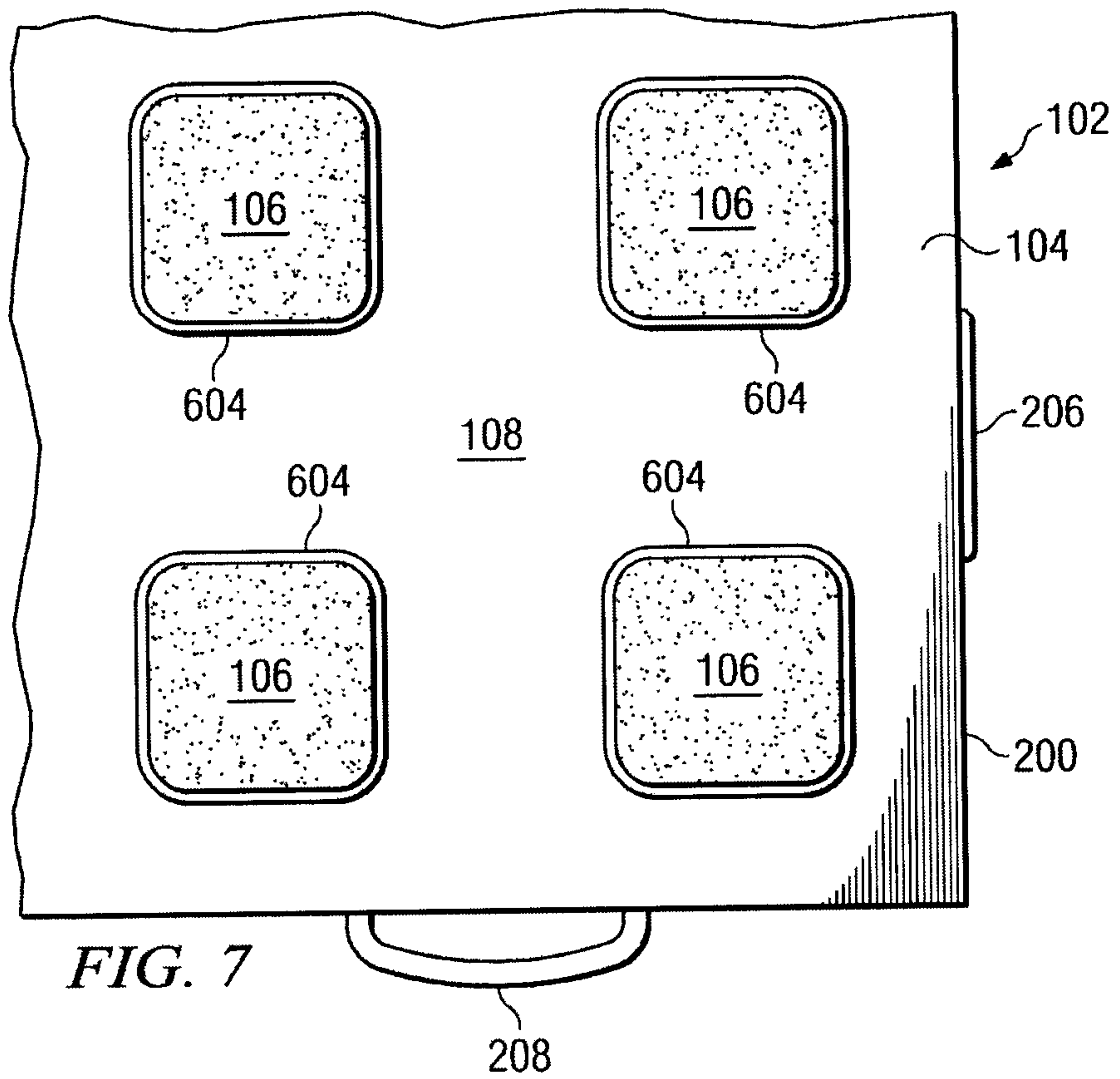
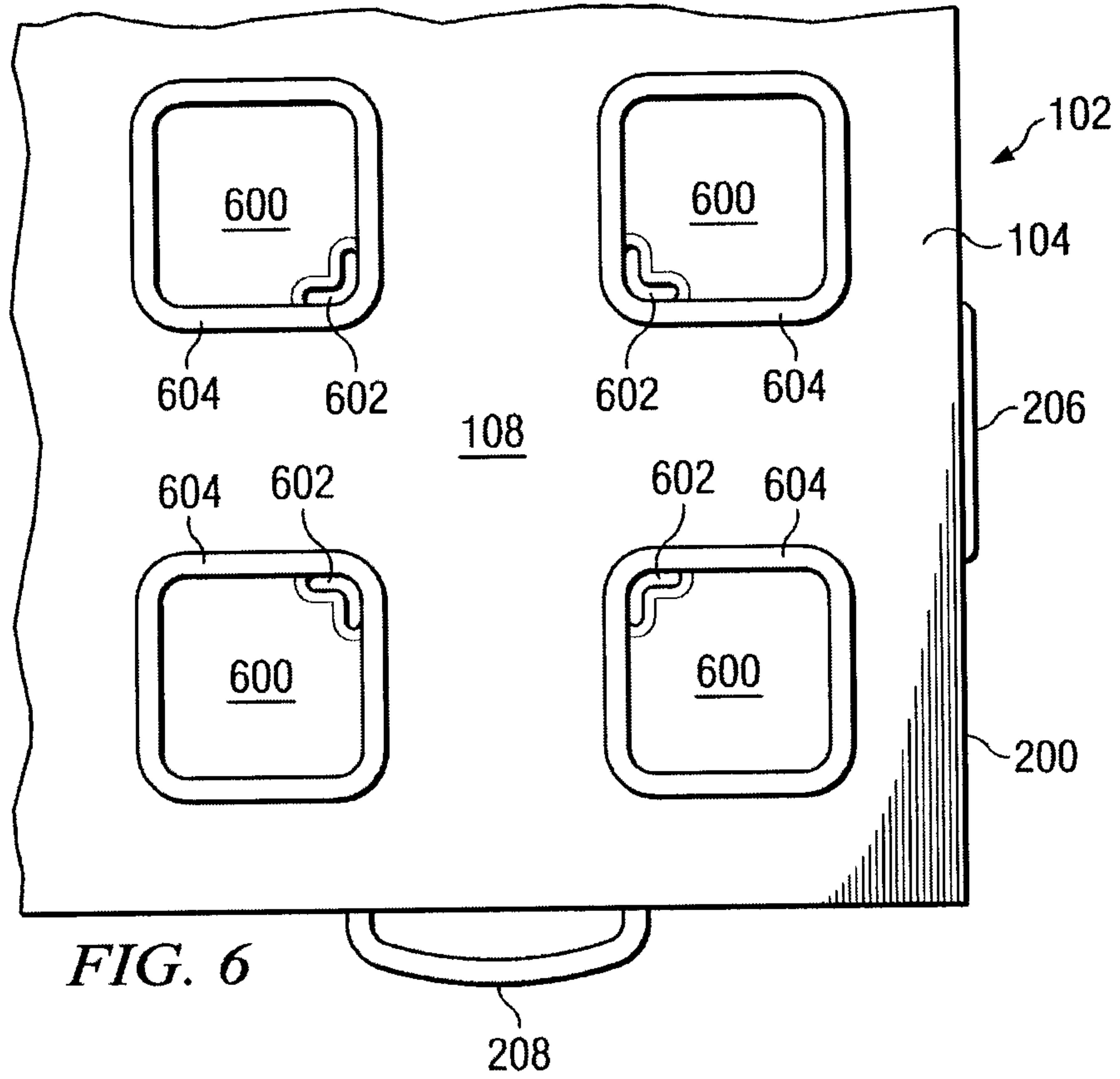


FIG. 5

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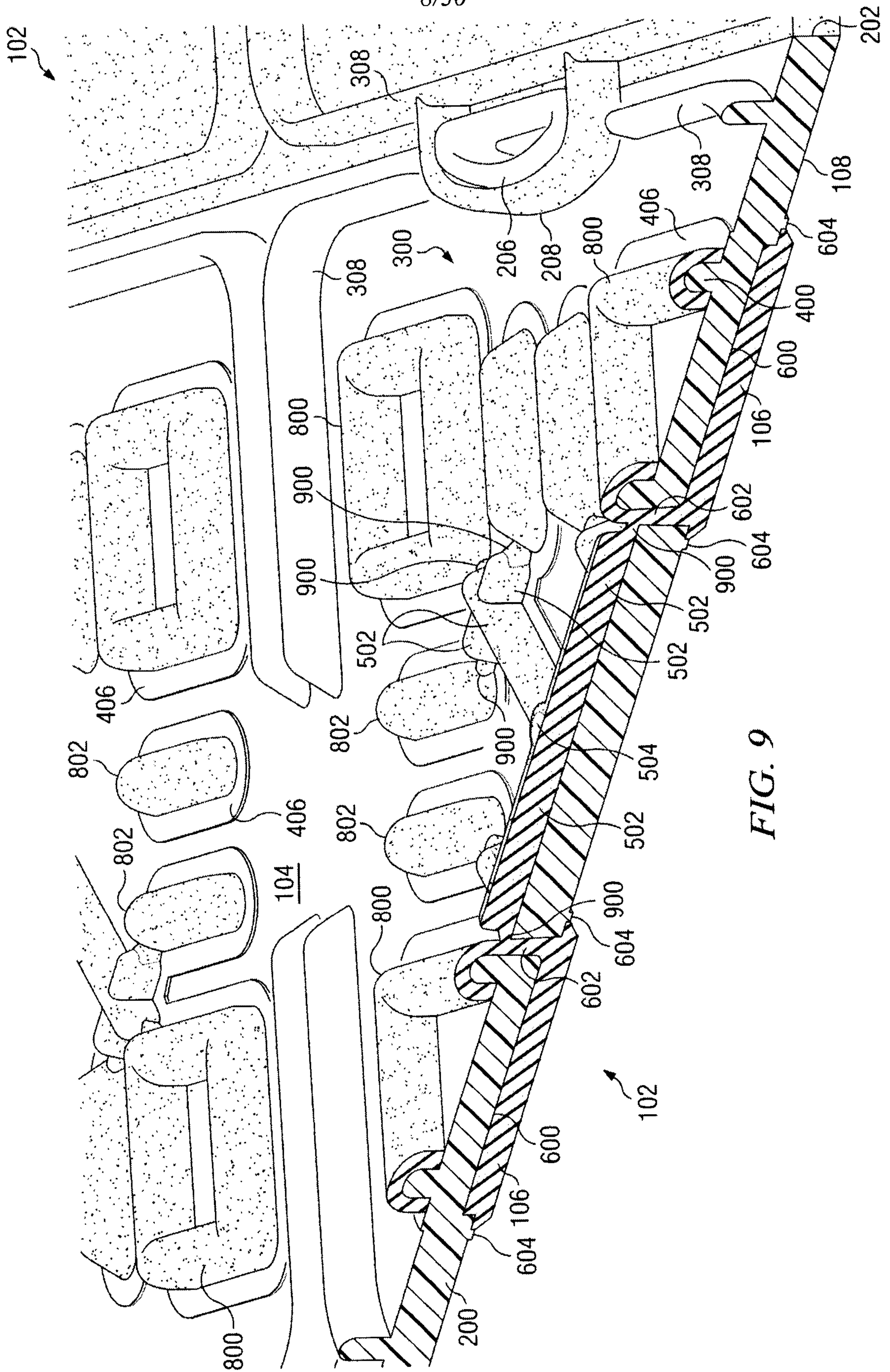


FIG. 9

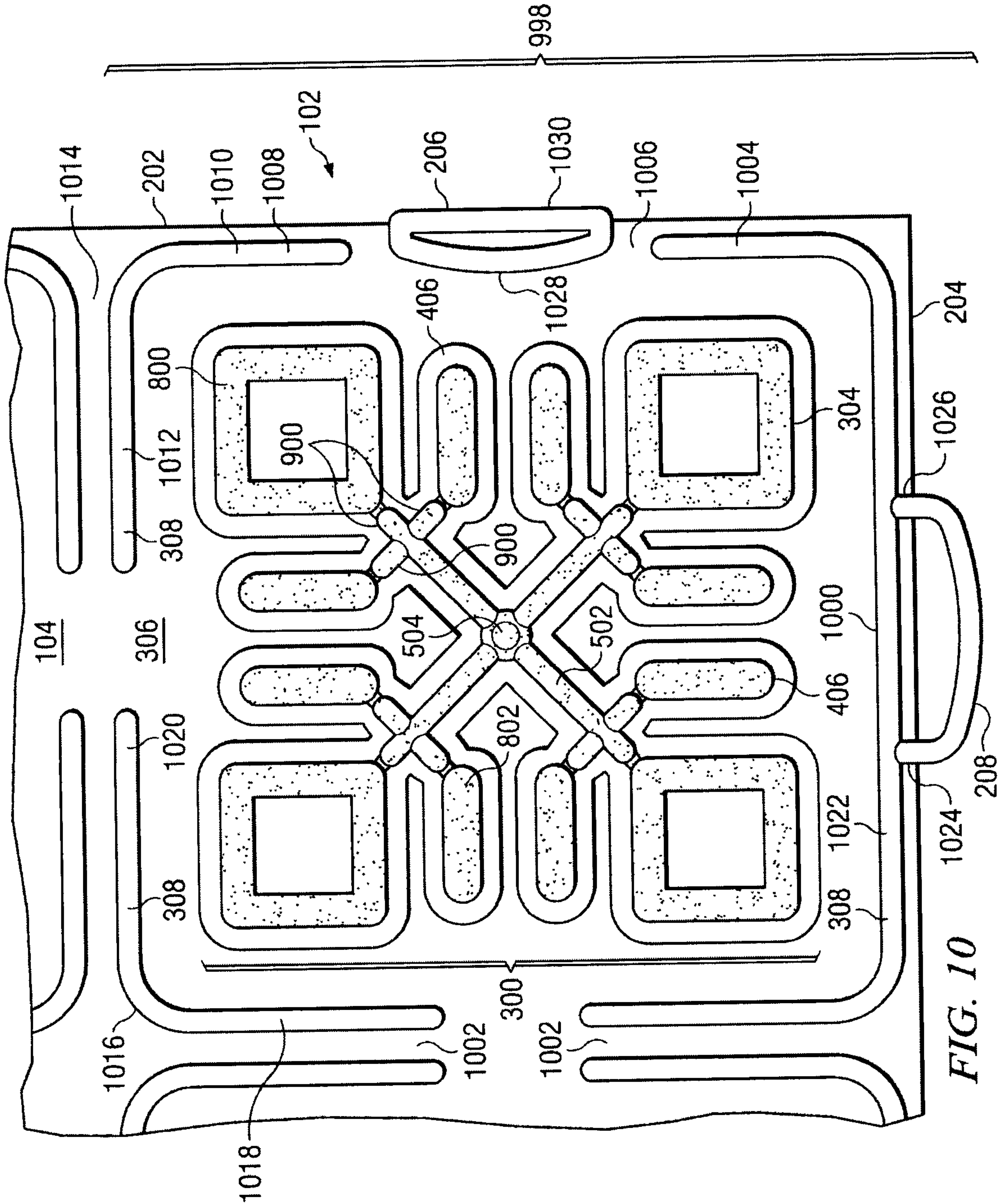


FIG. 10

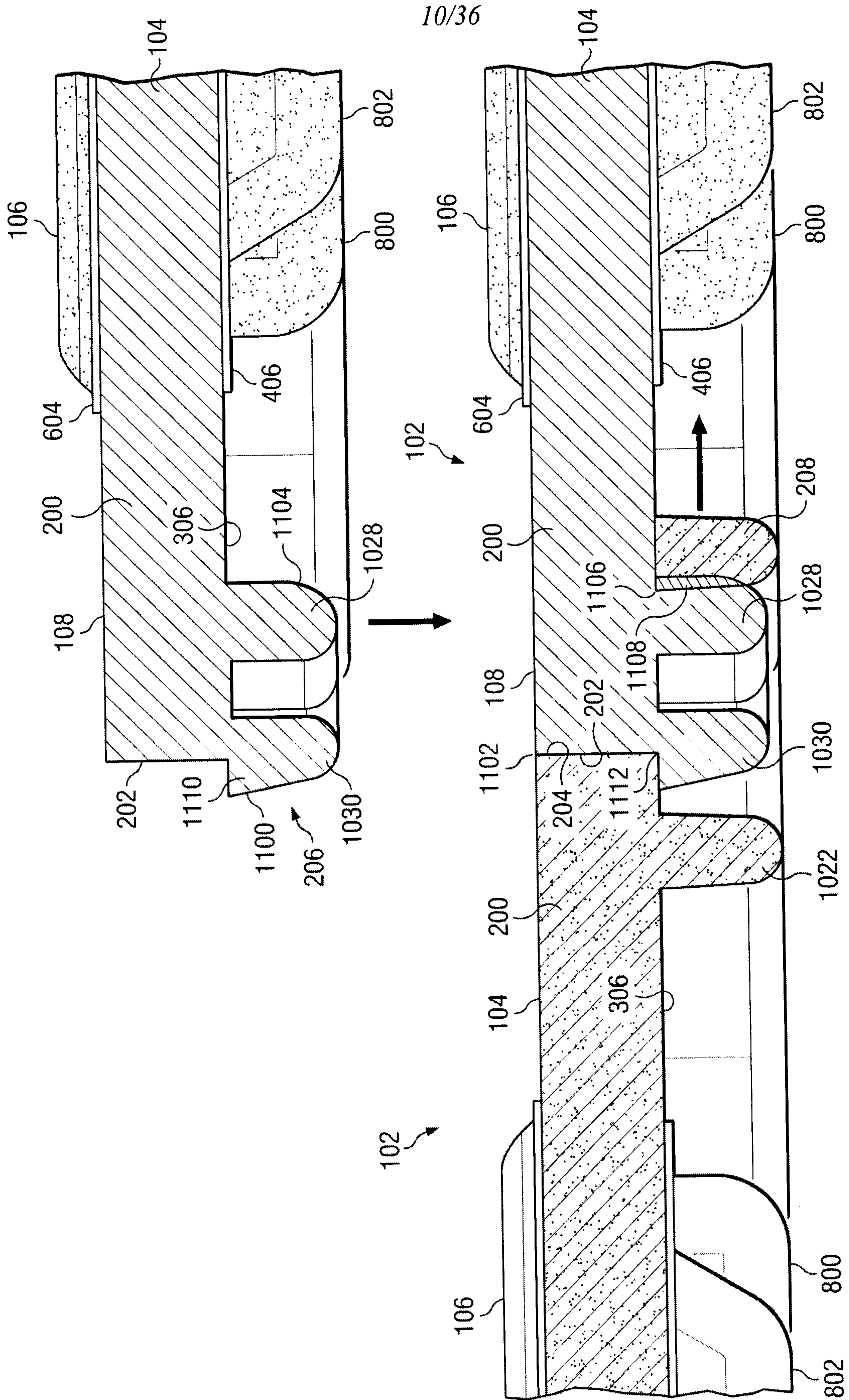


FIG. 11

11/36

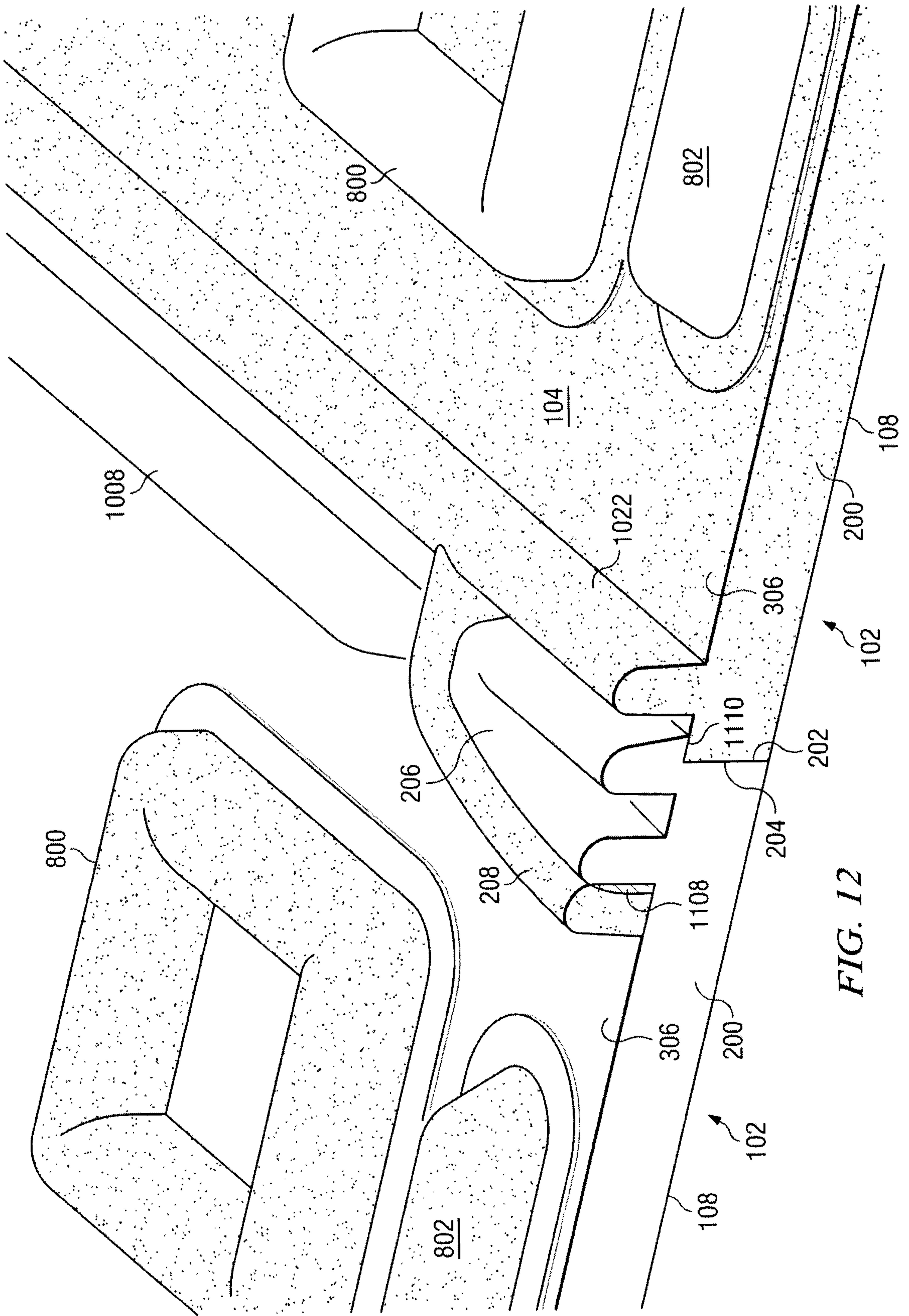


FIG. 12

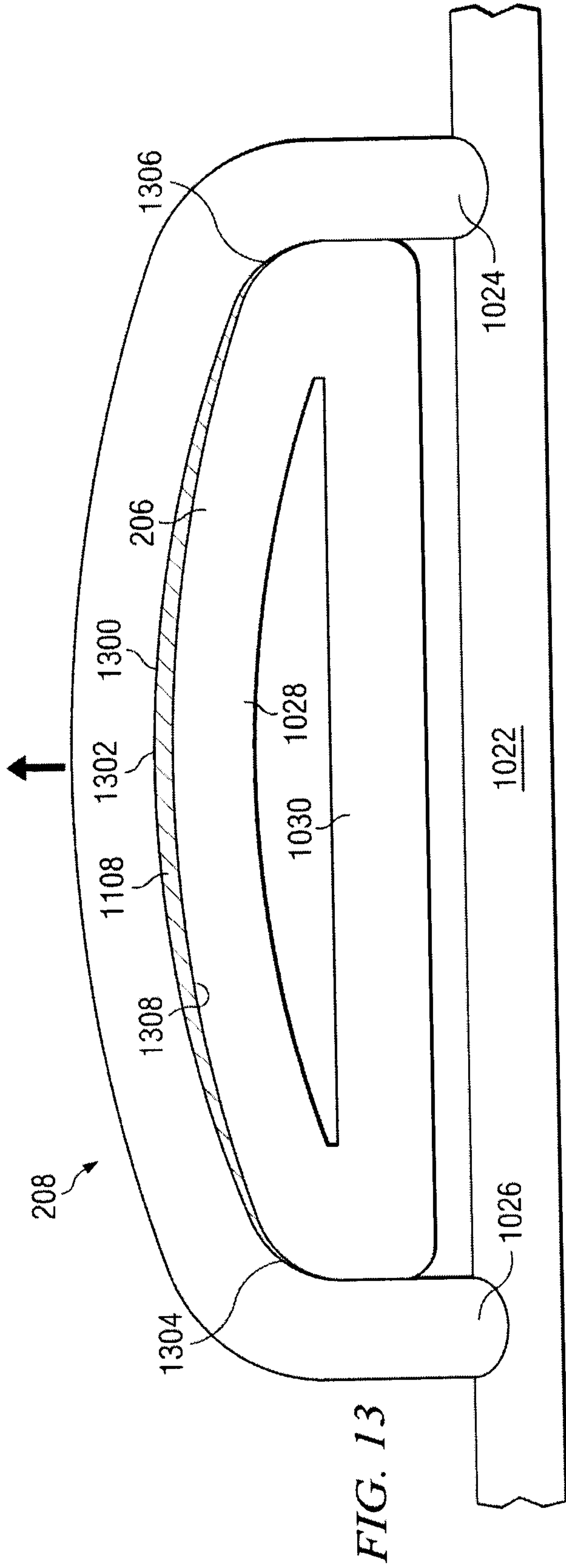


FIG. 13

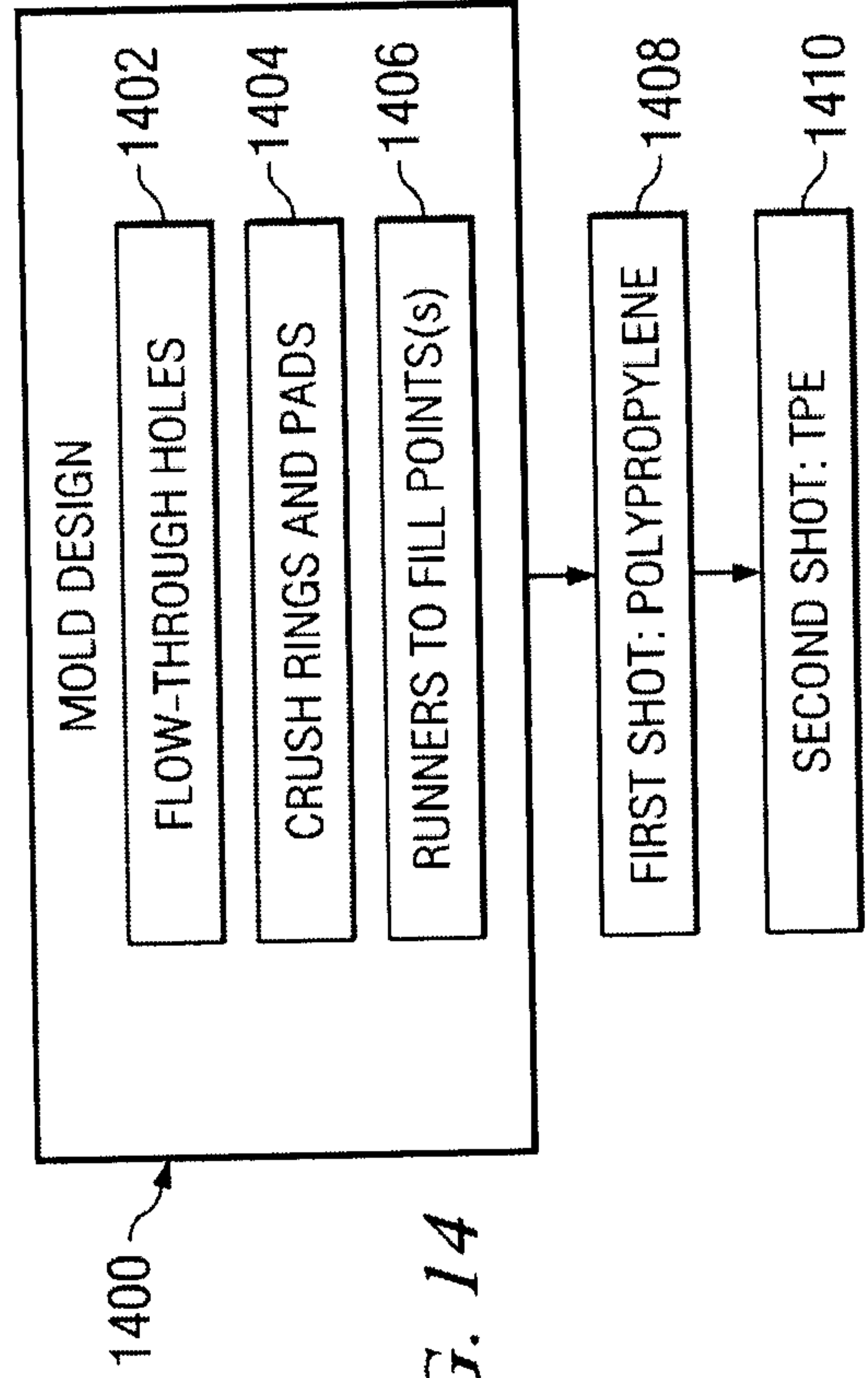


FIG. 14

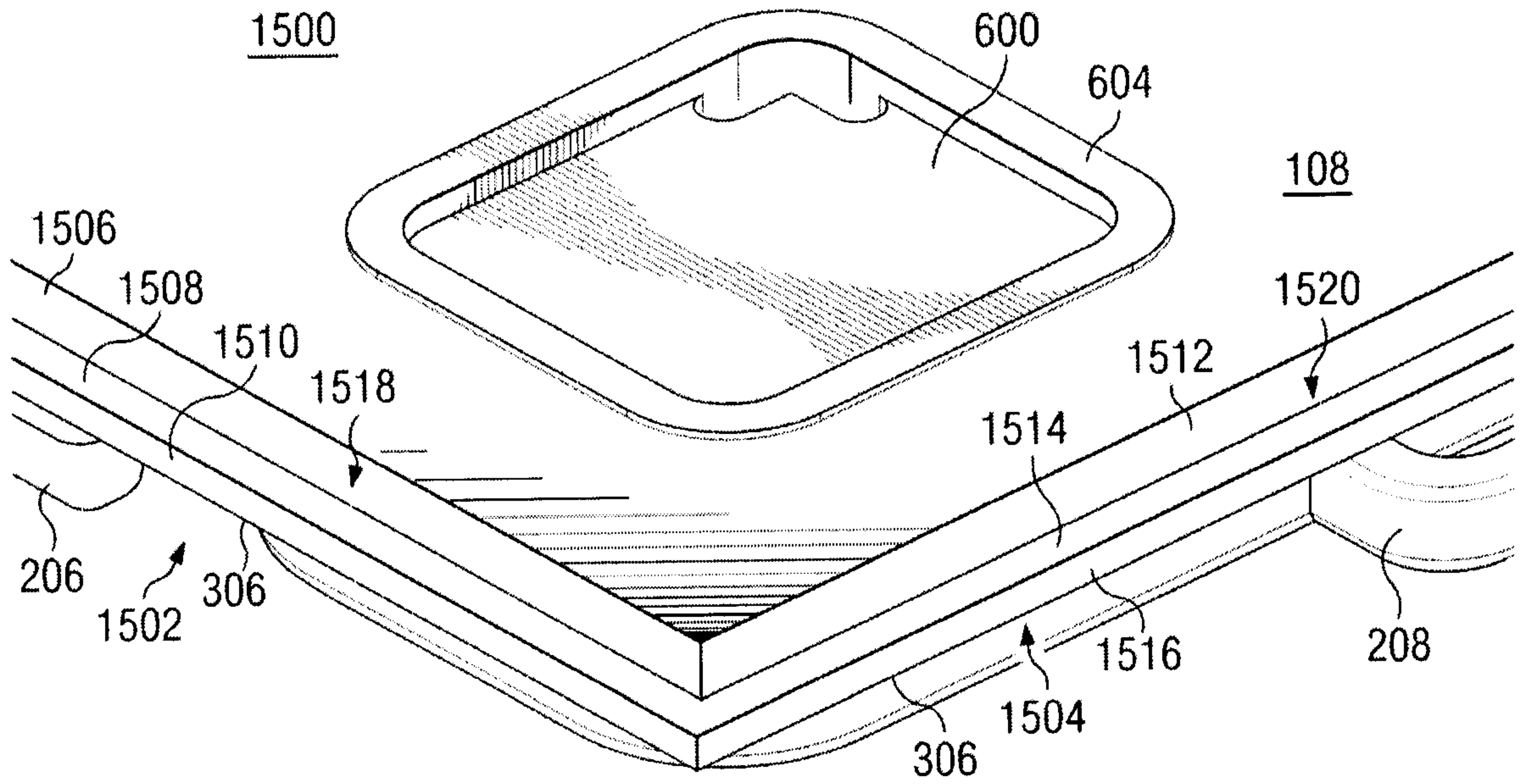


FIG. 15

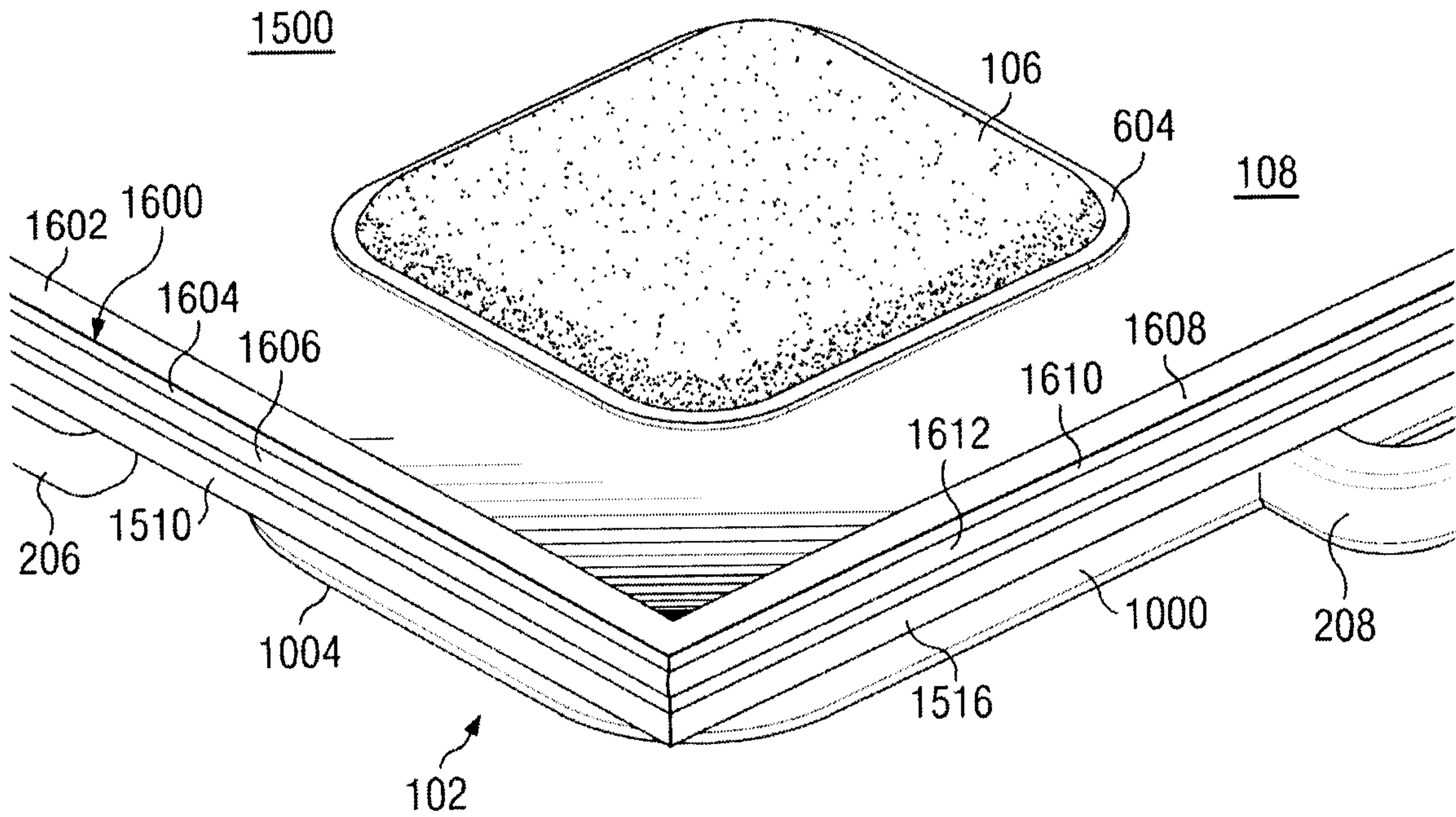


FIG. 16

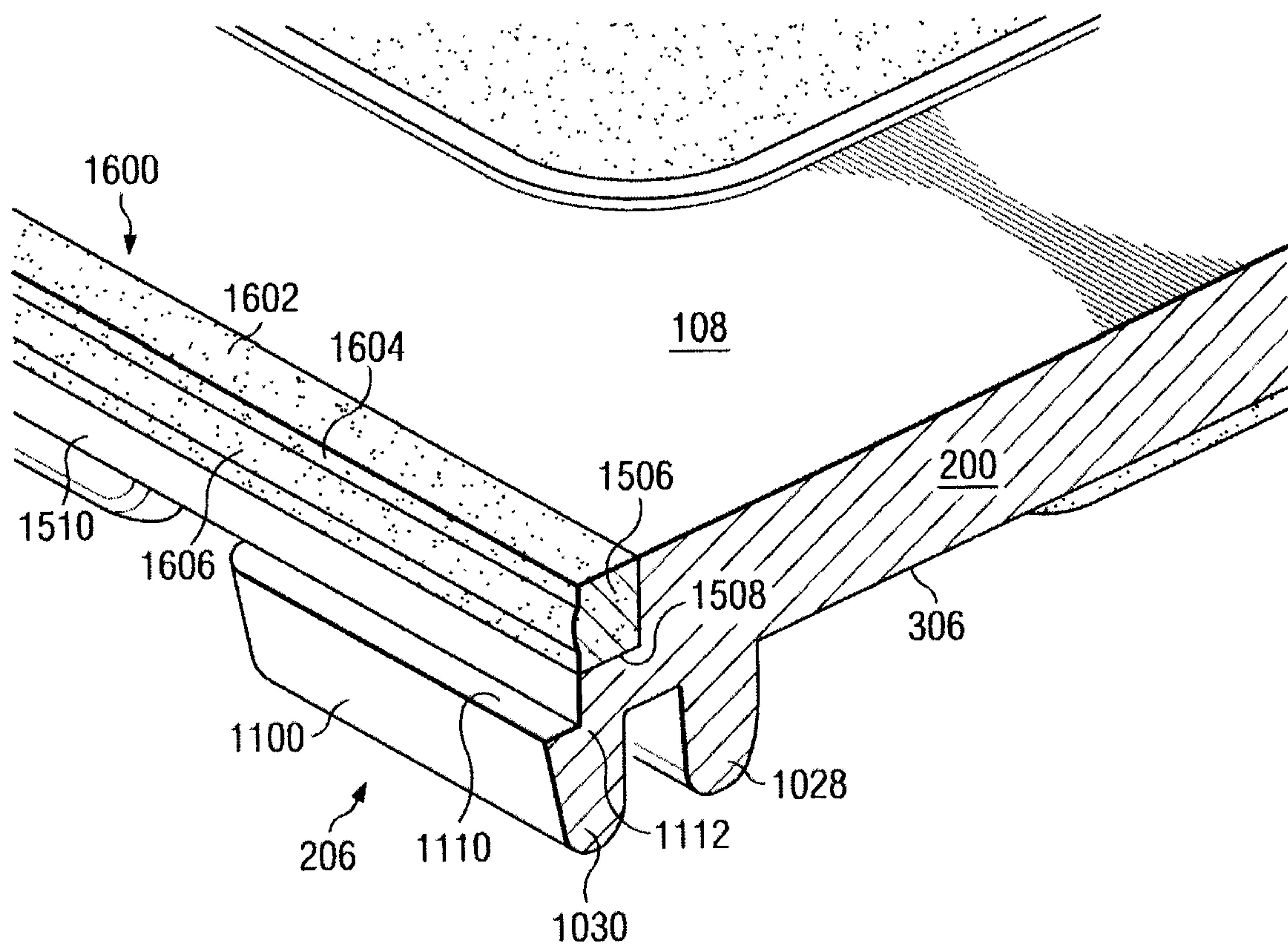


FIG. 17

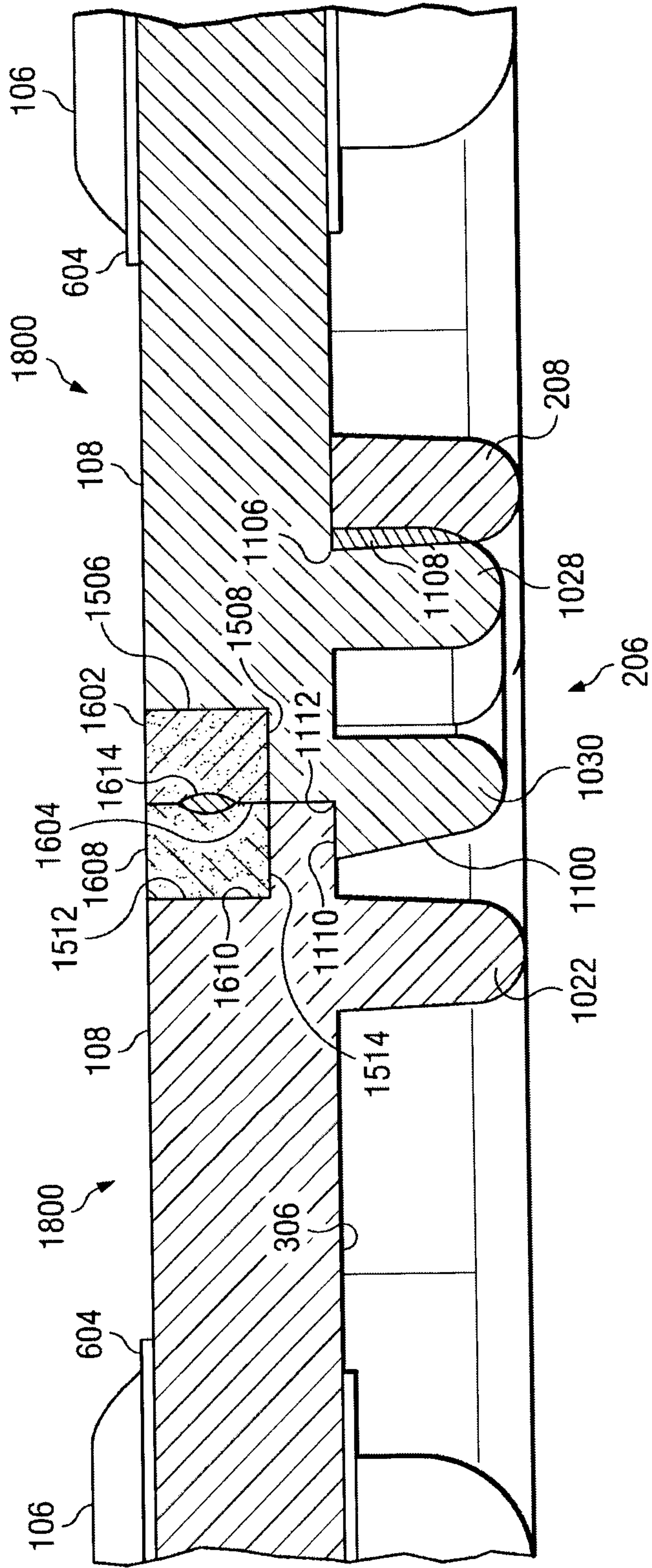


FIG. 18

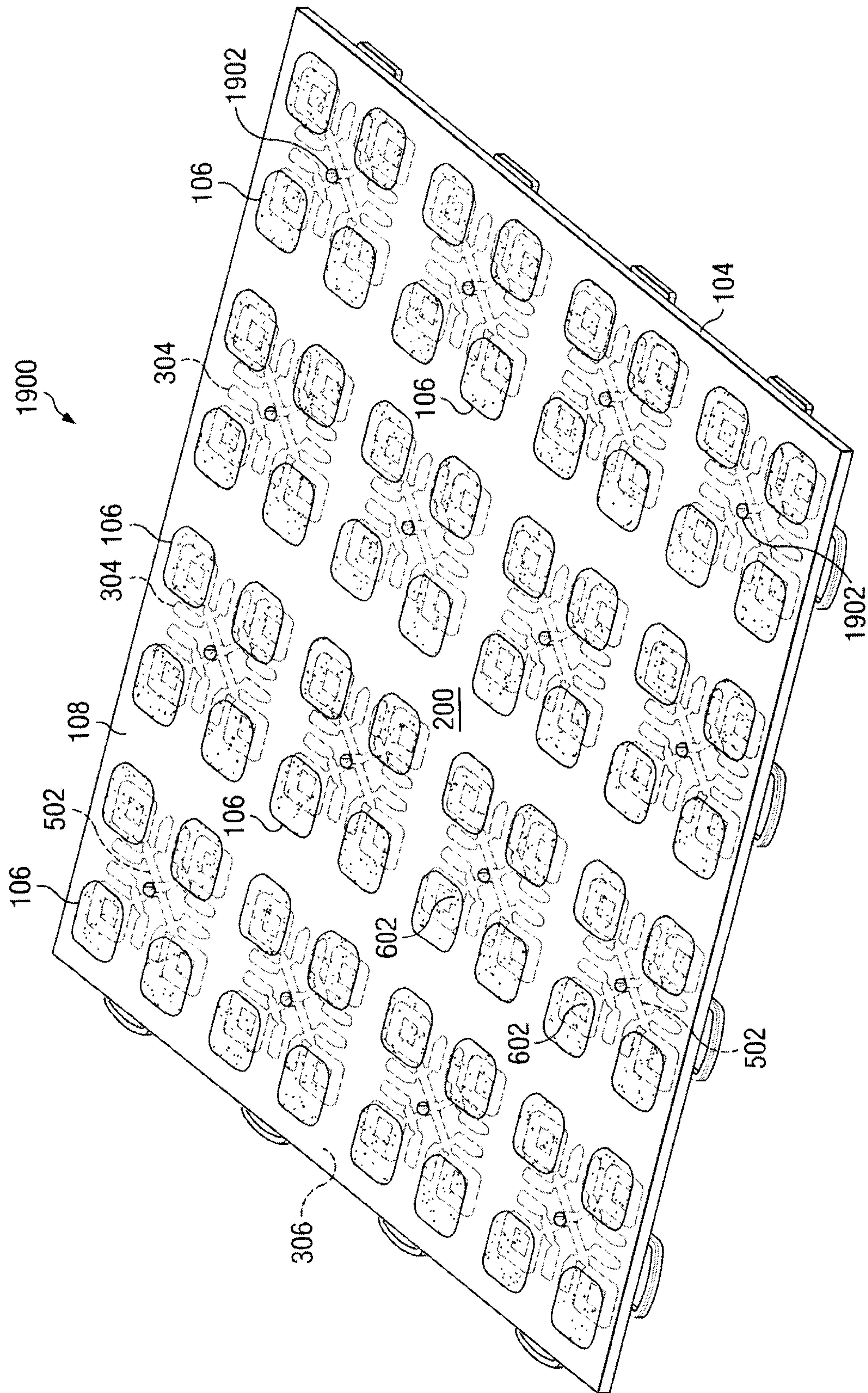


FIG. 19

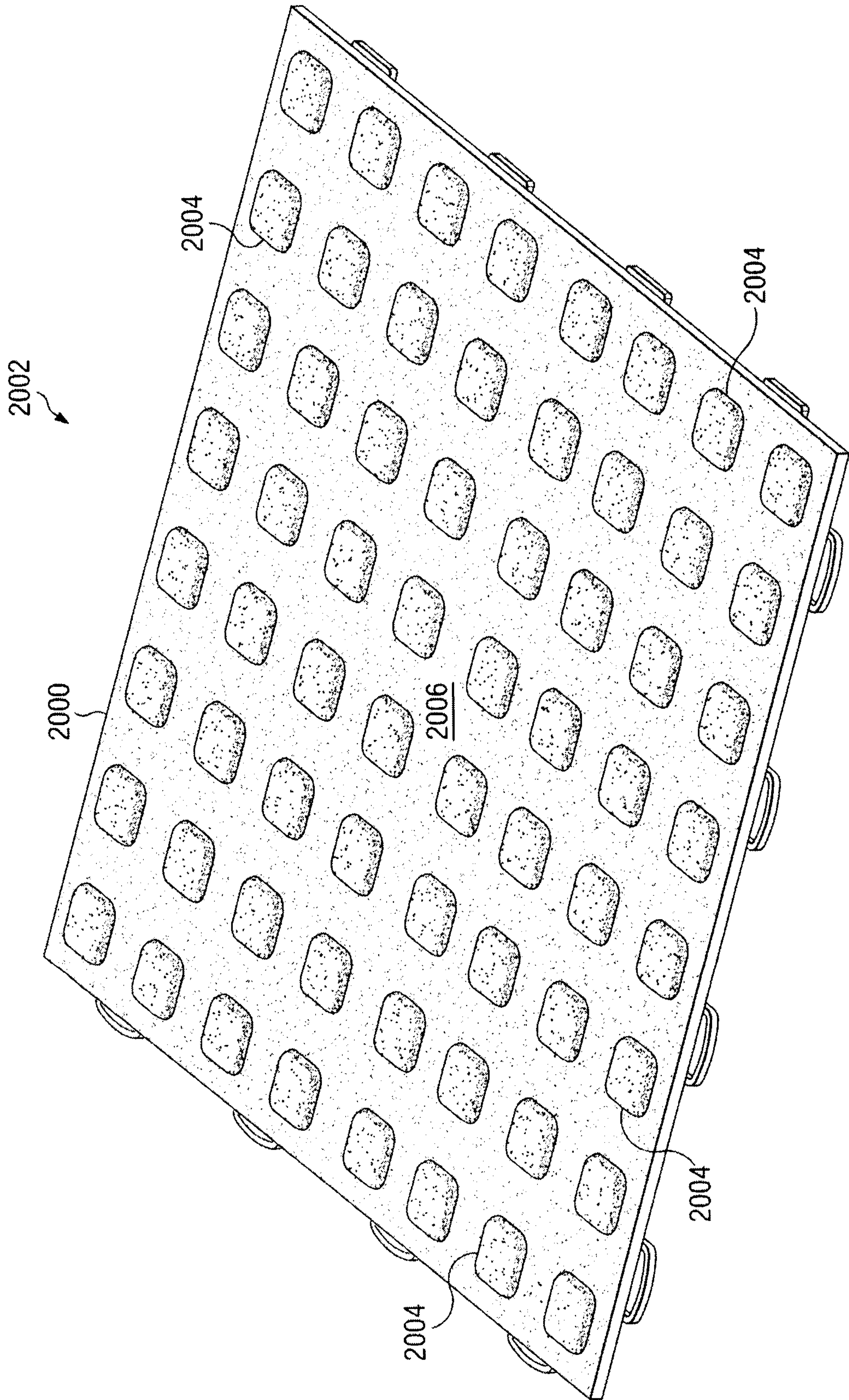


FIG. 20

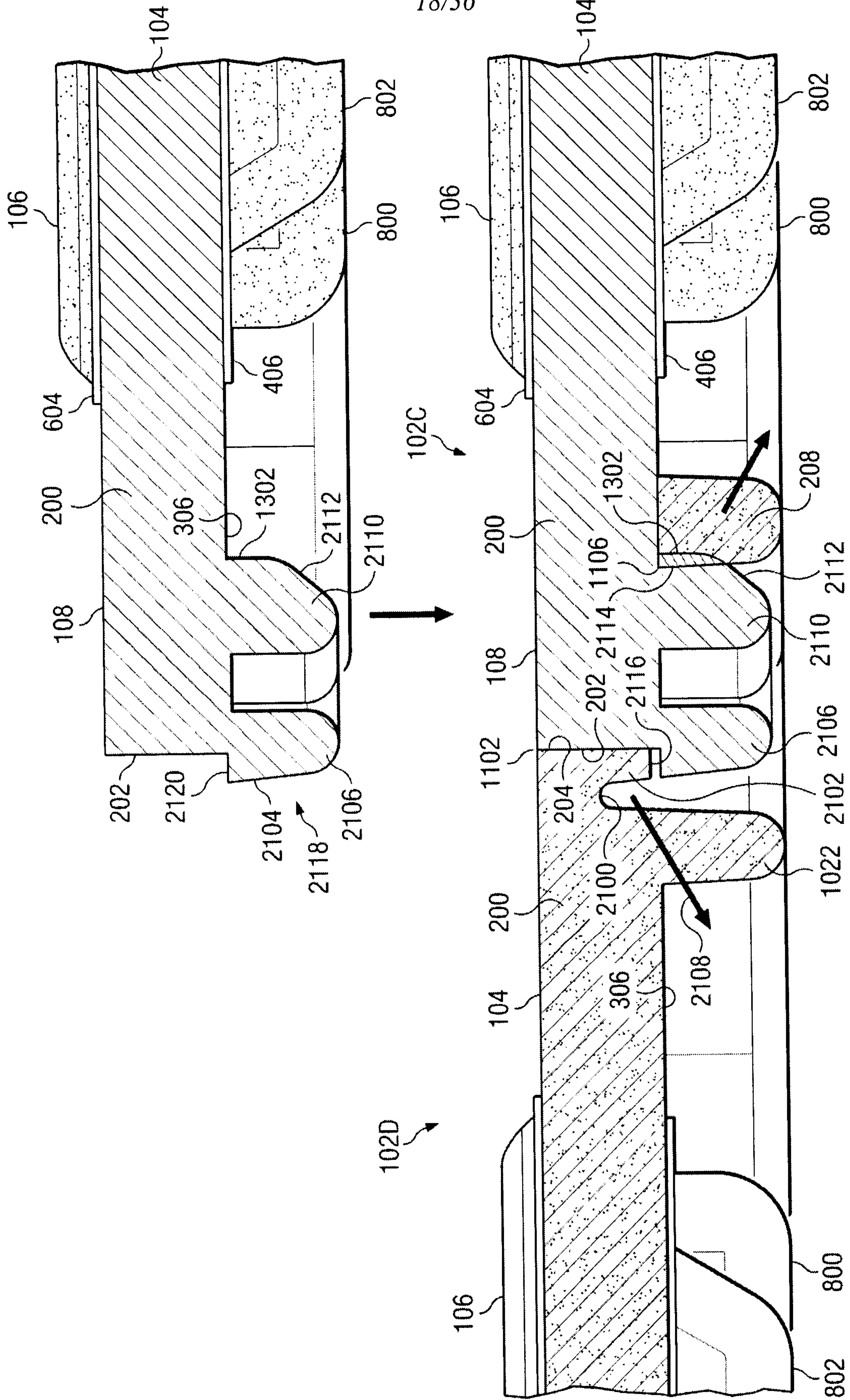


FIG. 21

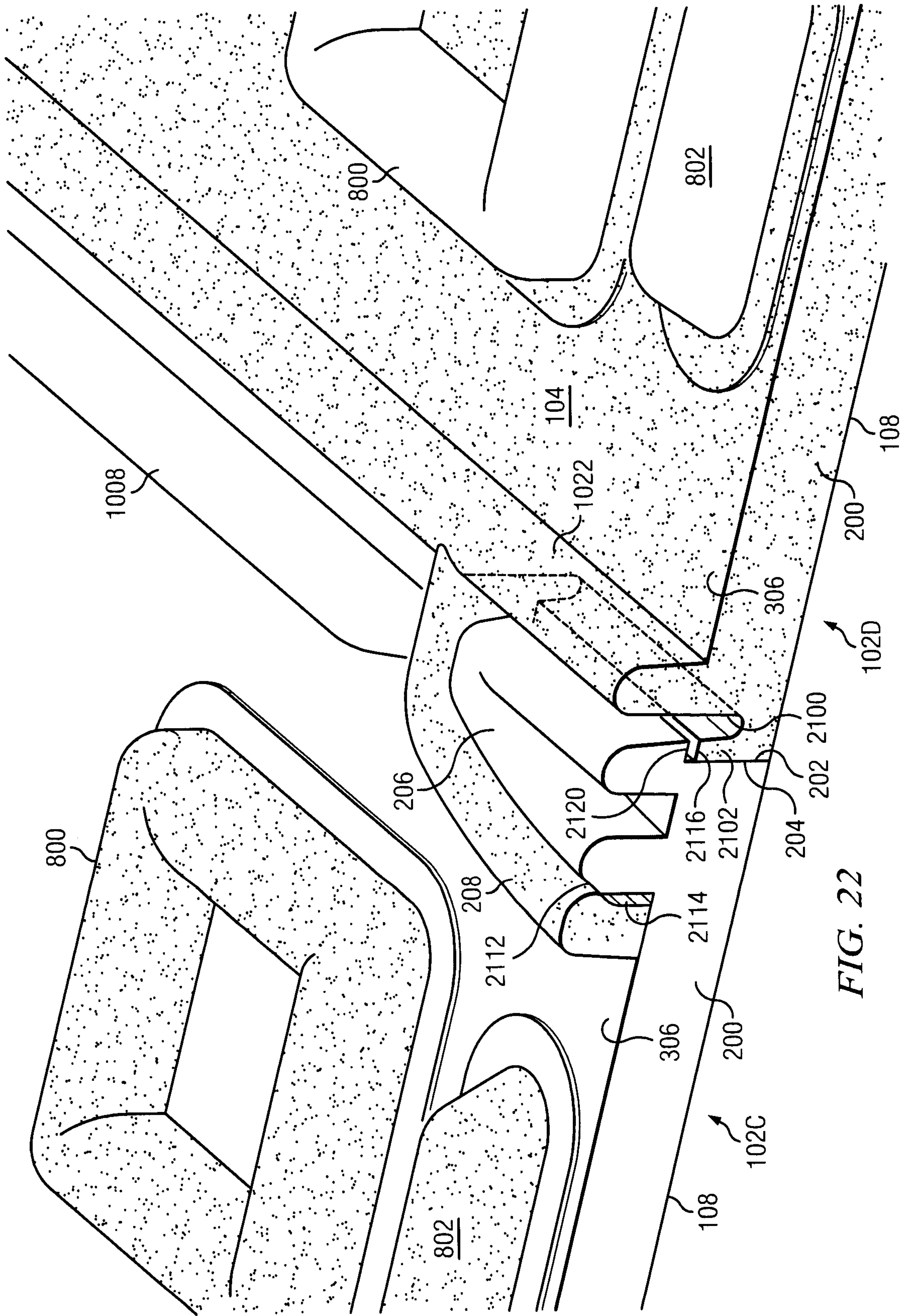


FIG. 22

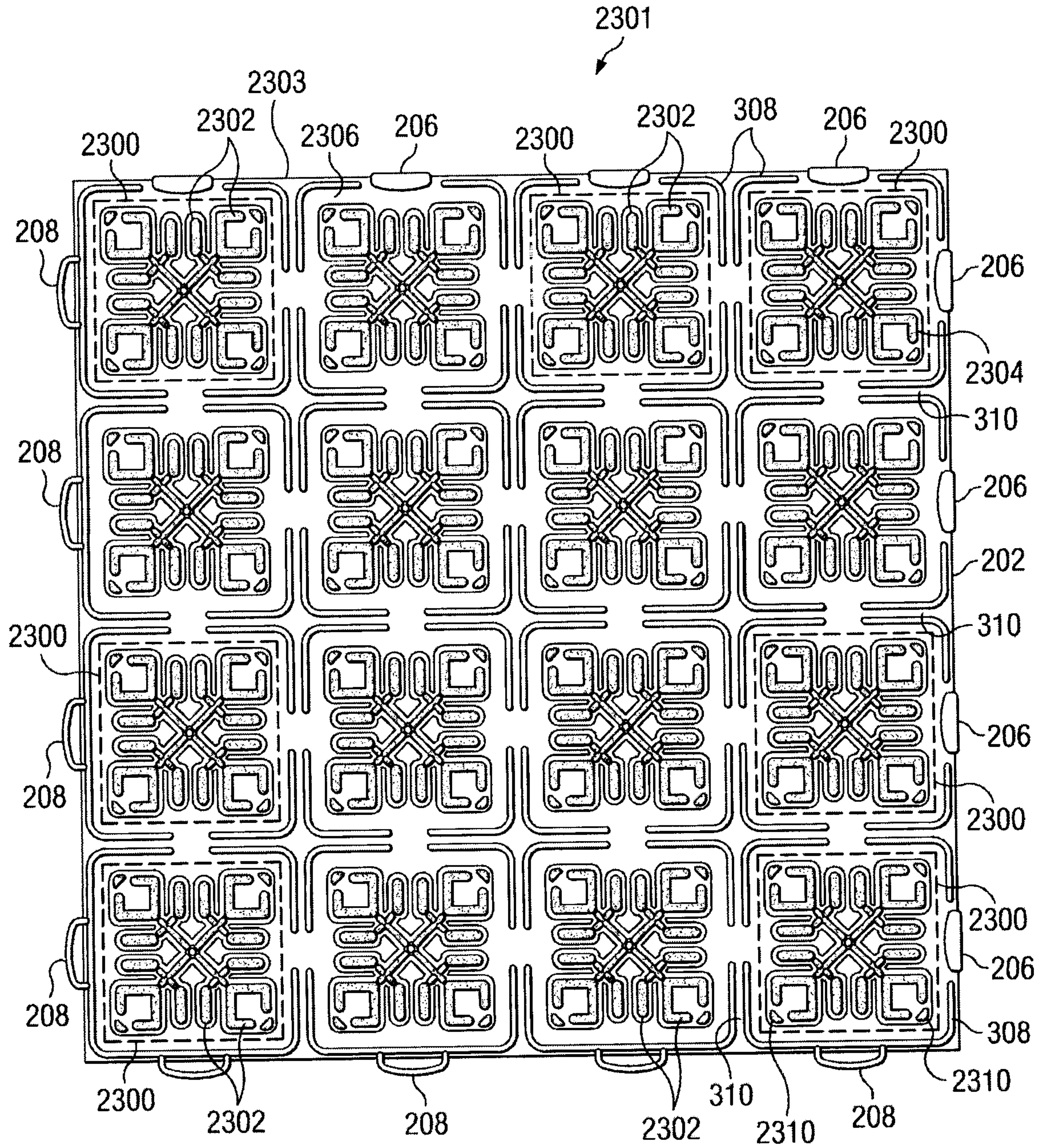


FIG. 23

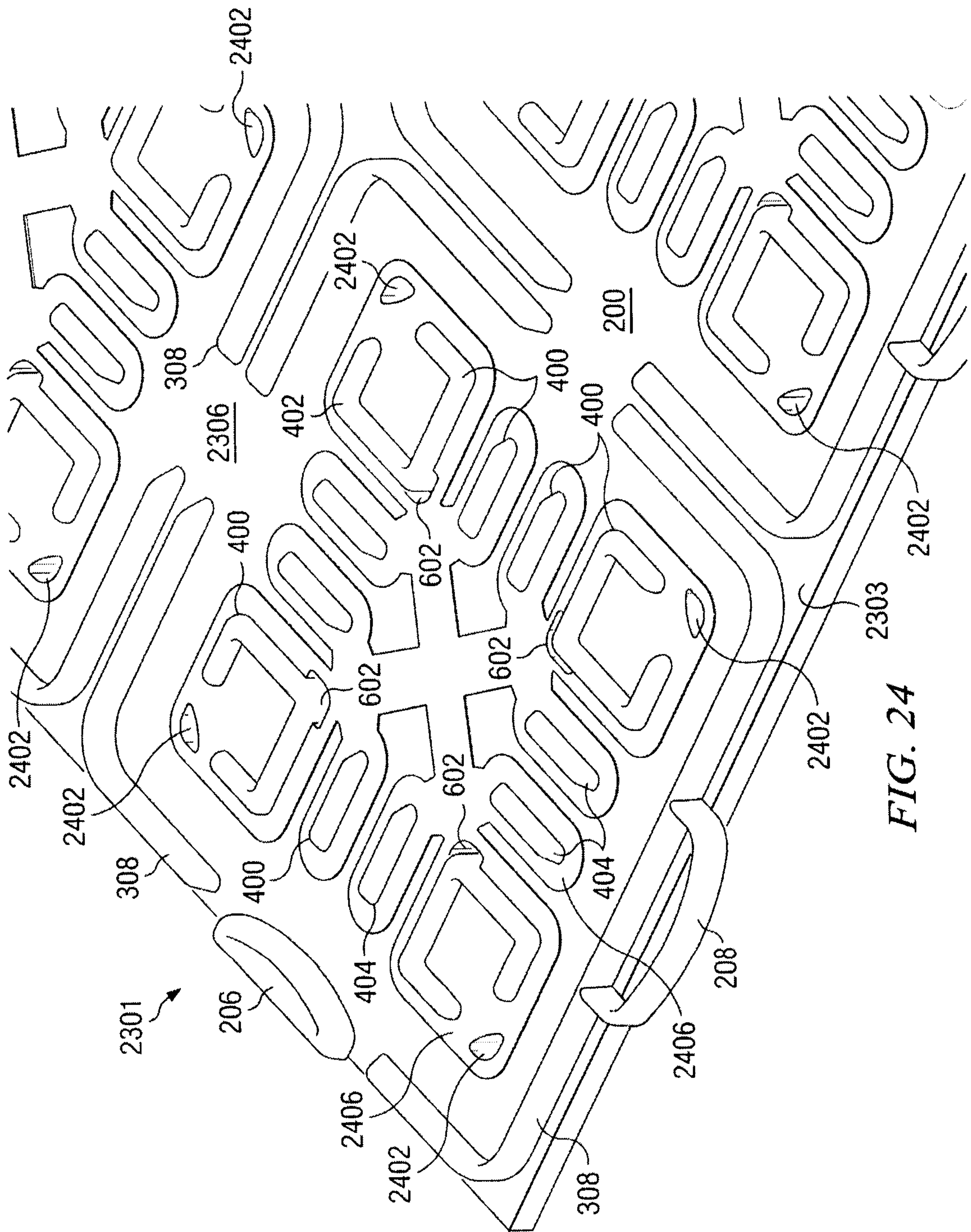


FIG. 24

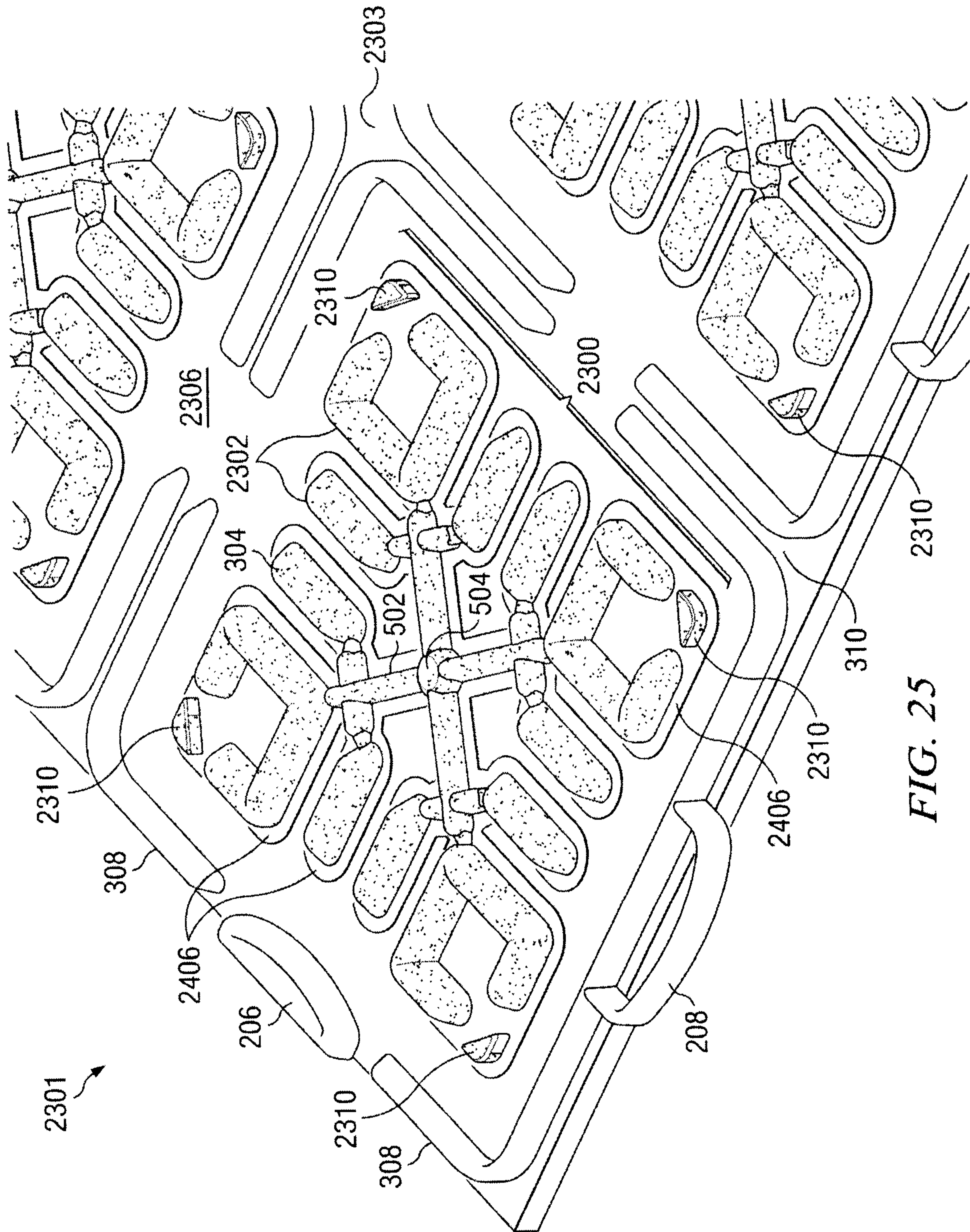


FIG. 25

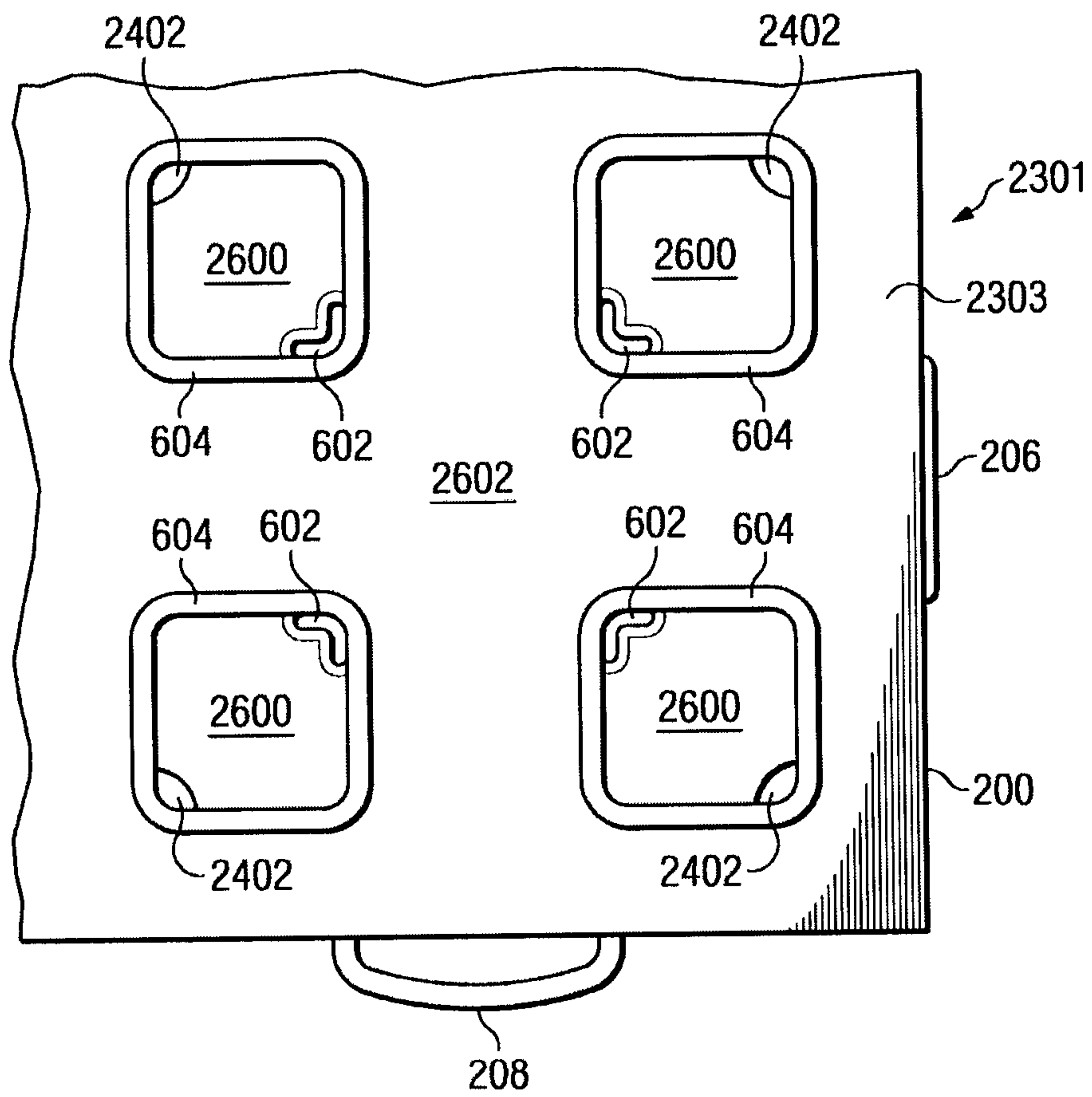


FIG. 26

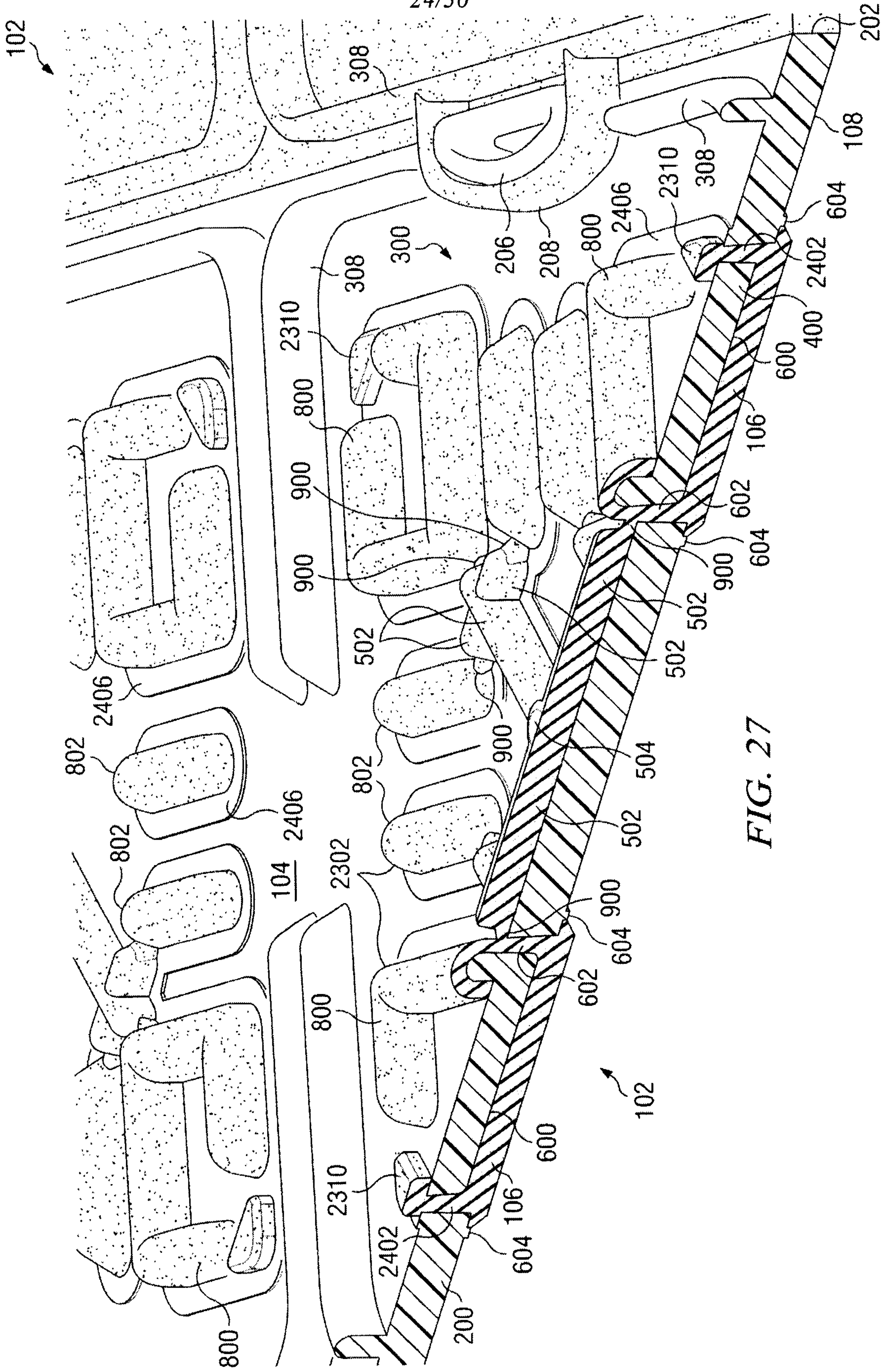


FIG. 27

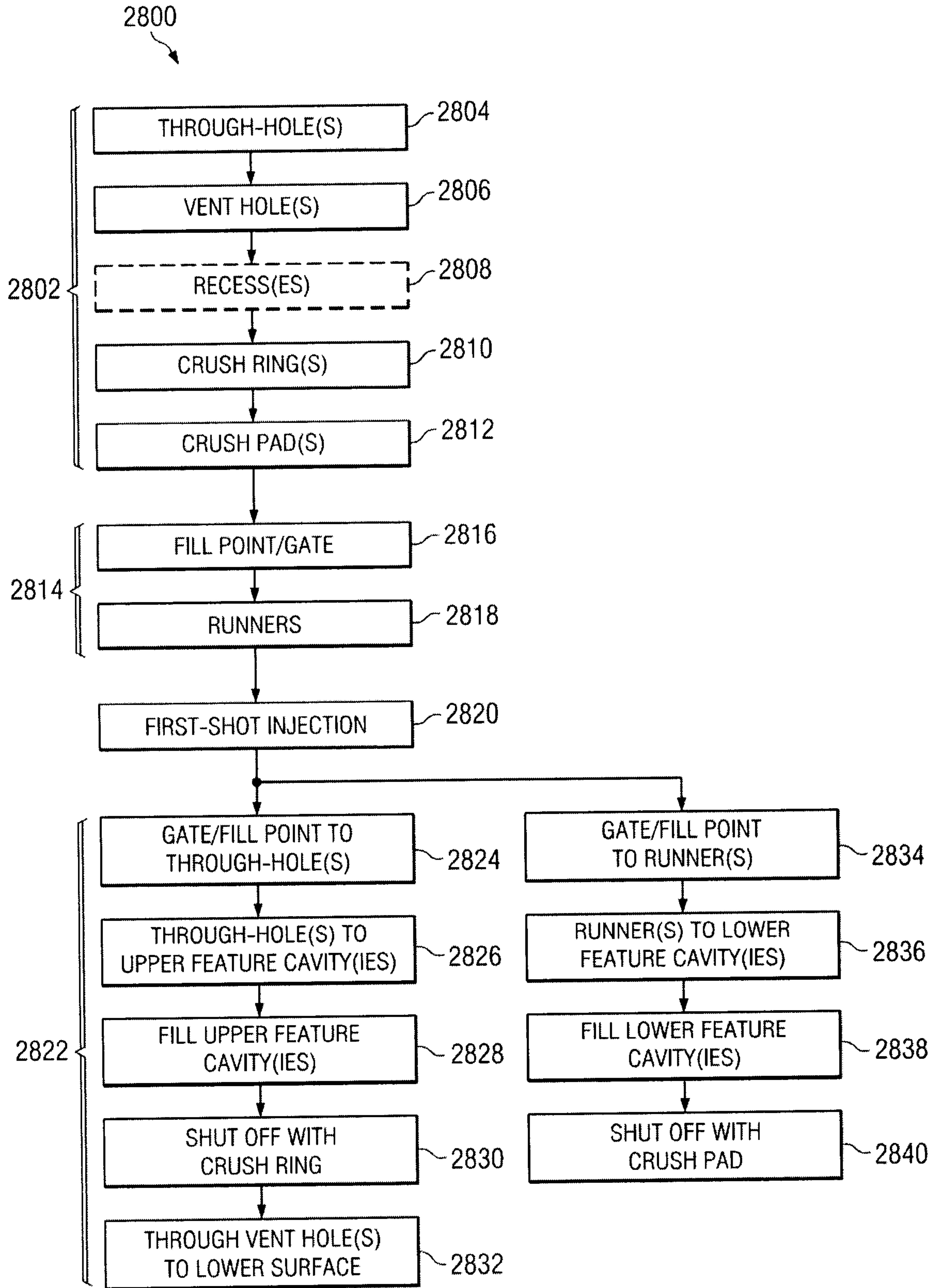


FIG. 28

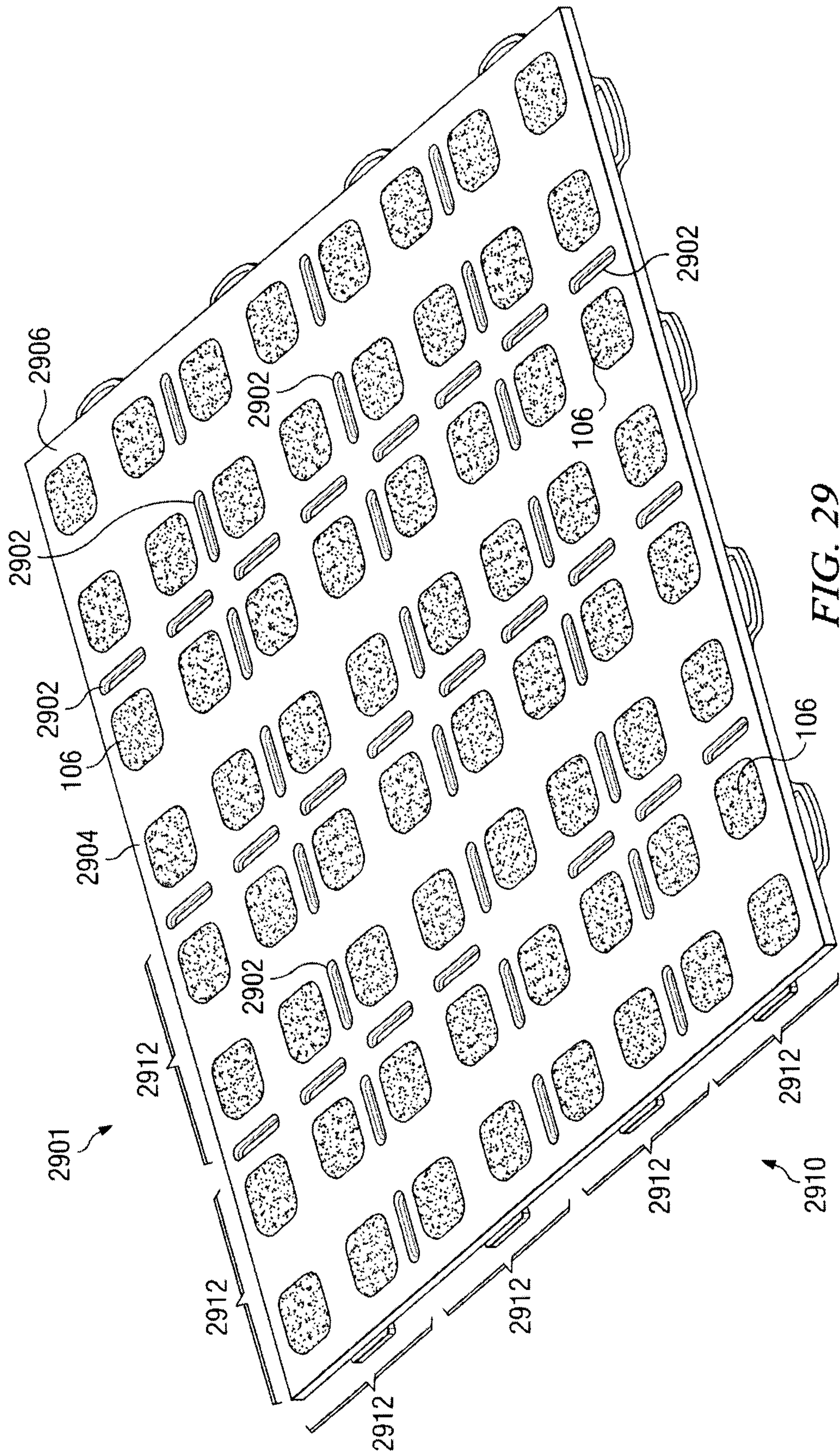


FIG. 29

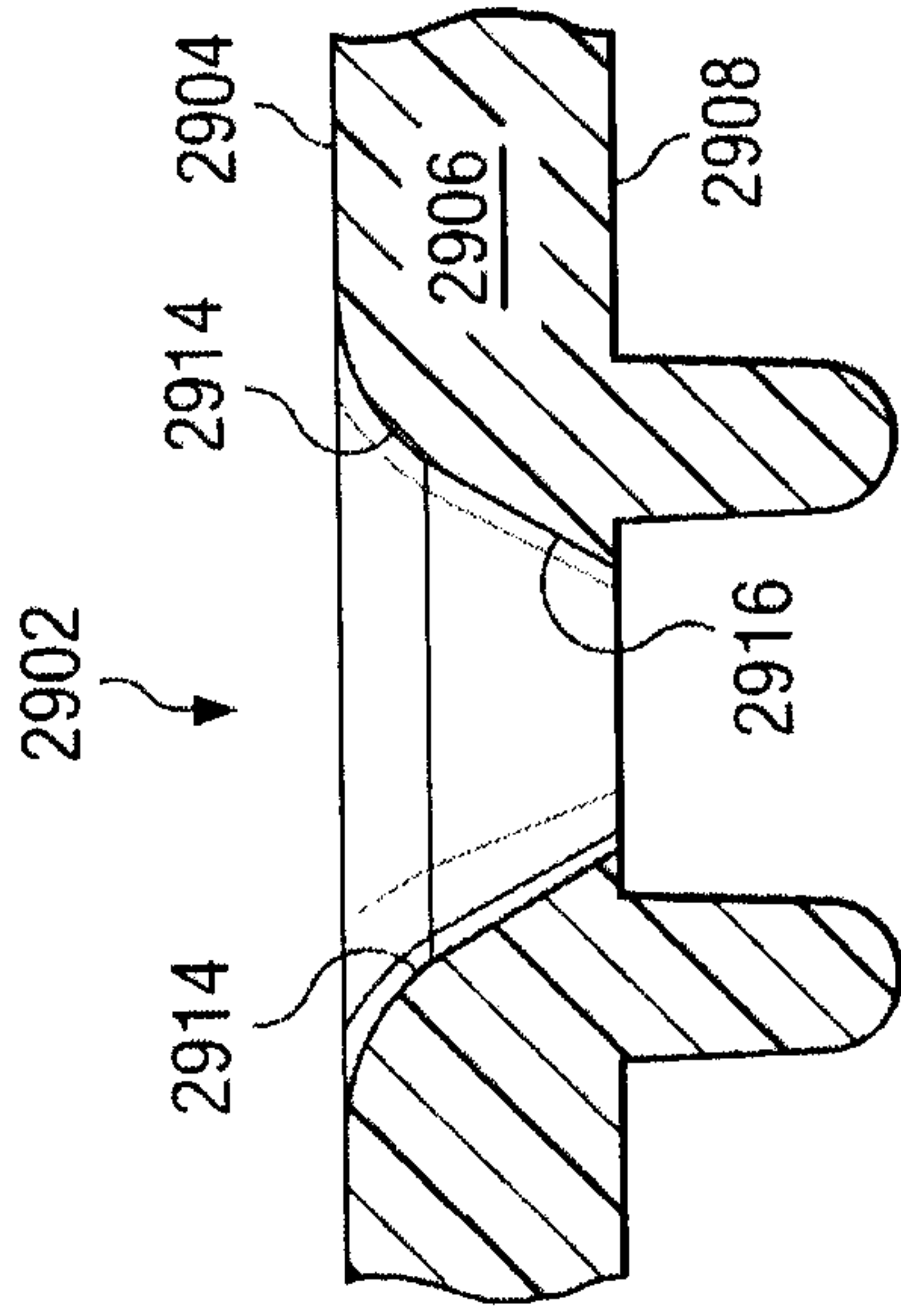


FIG. 30C

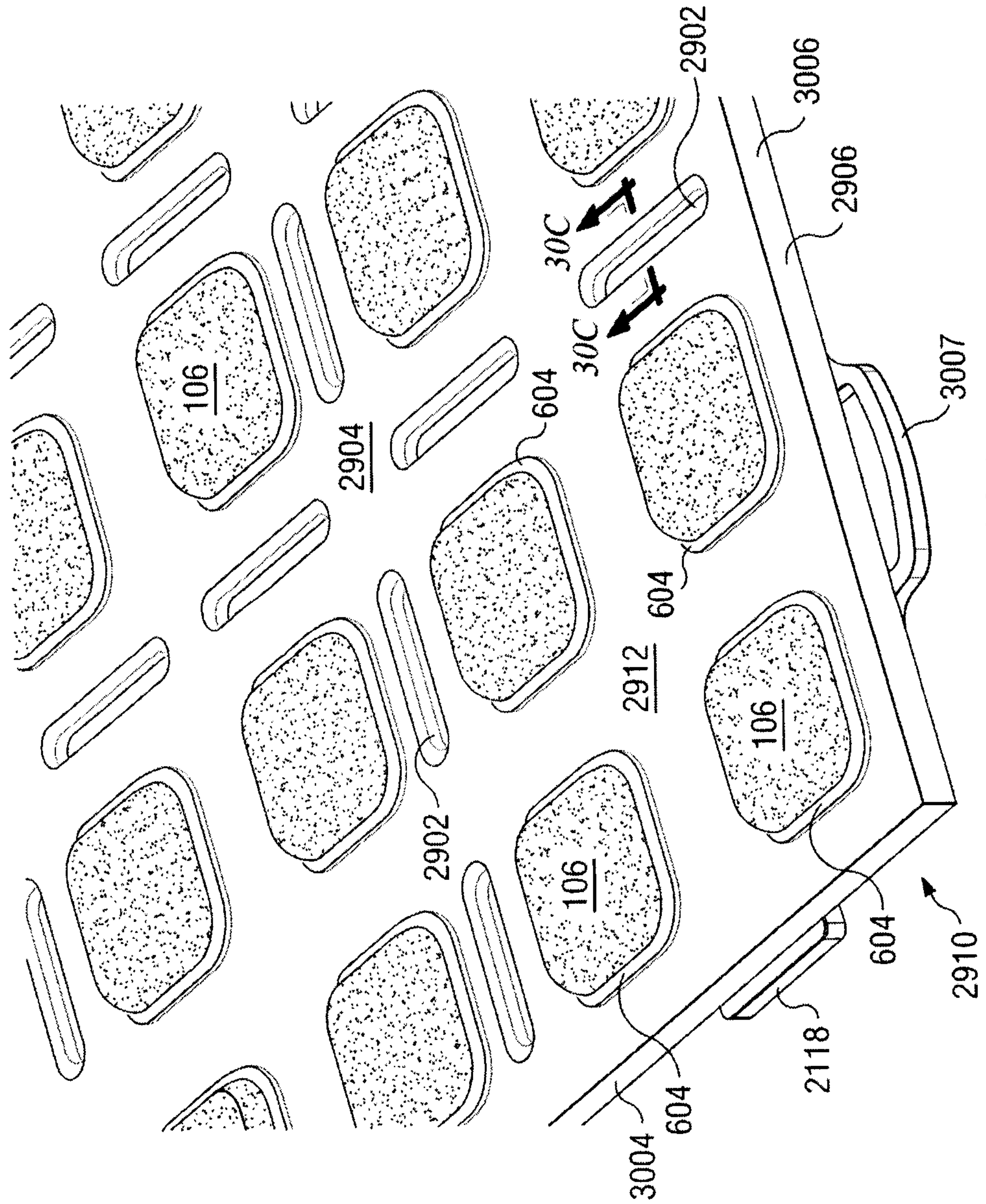


FIG. 30A

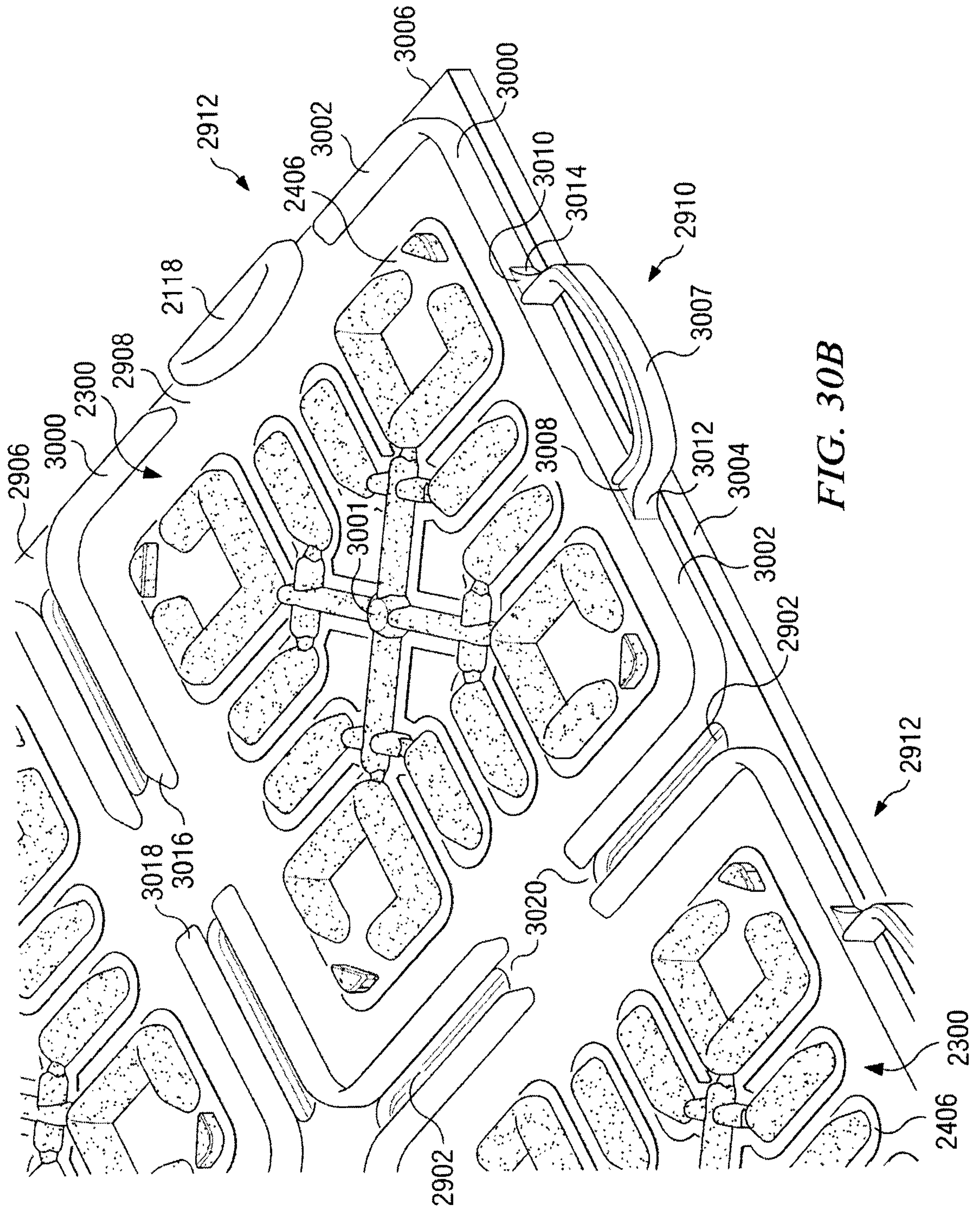


FIG. 30B

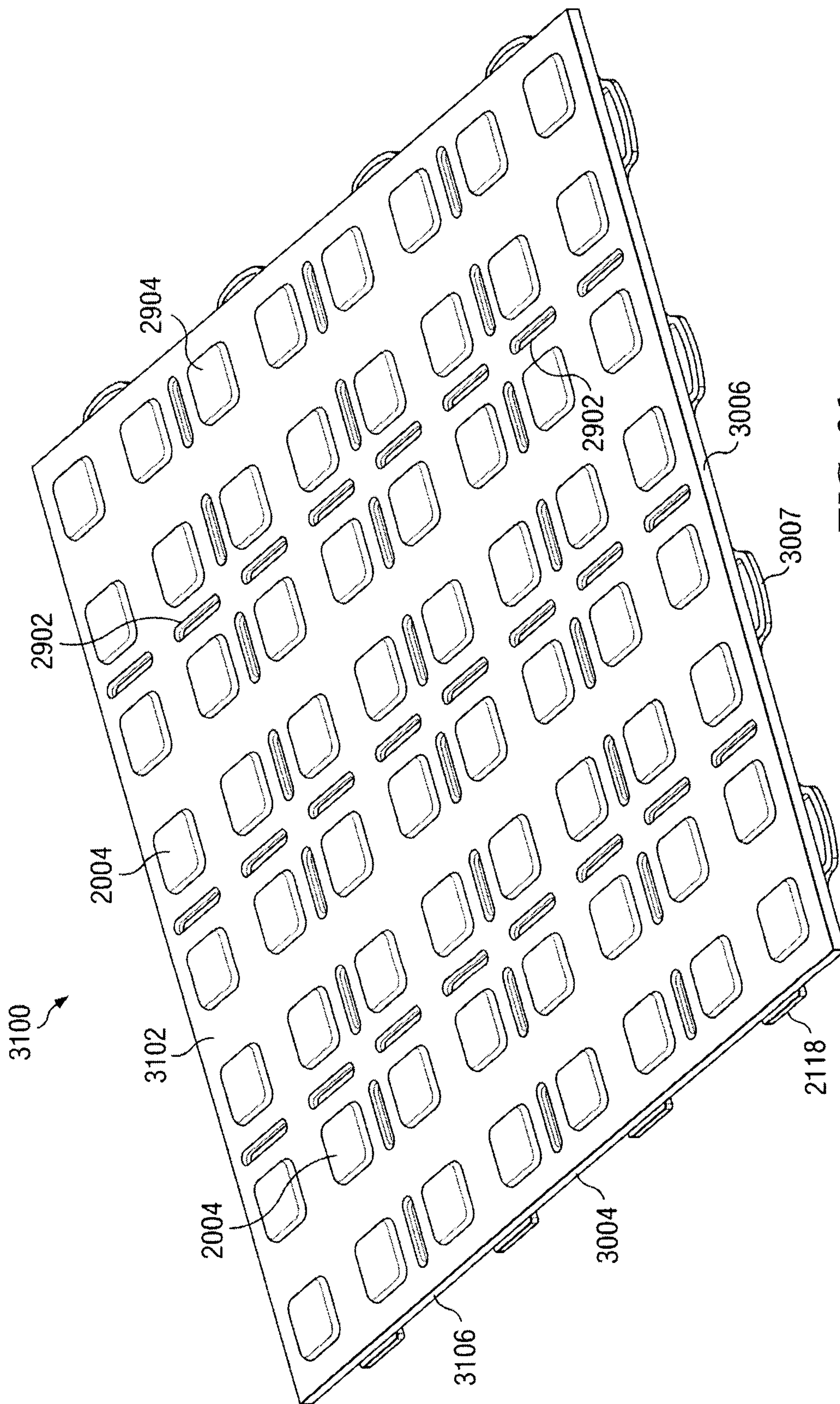


FIG. 31

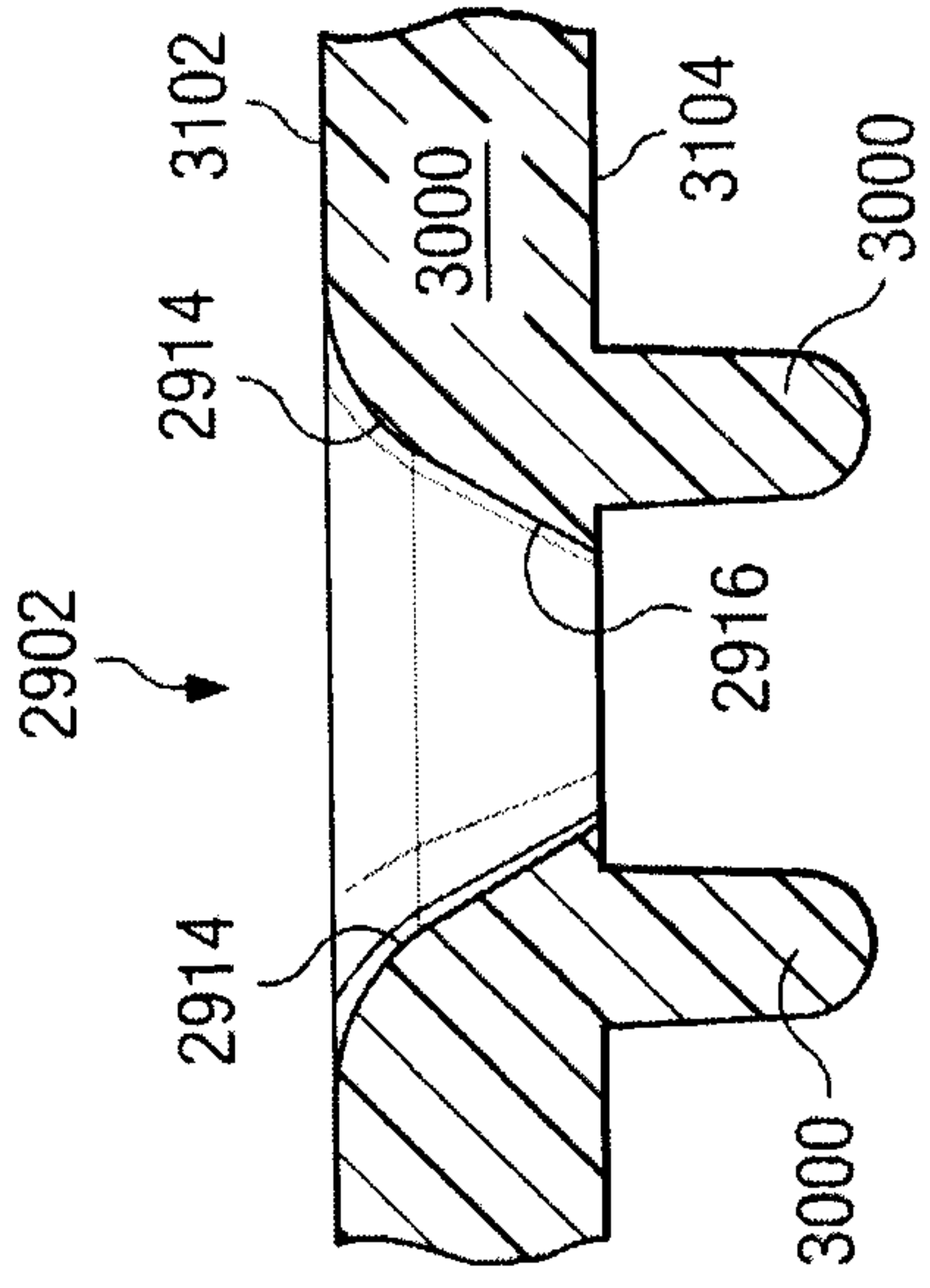


FIG. 32C

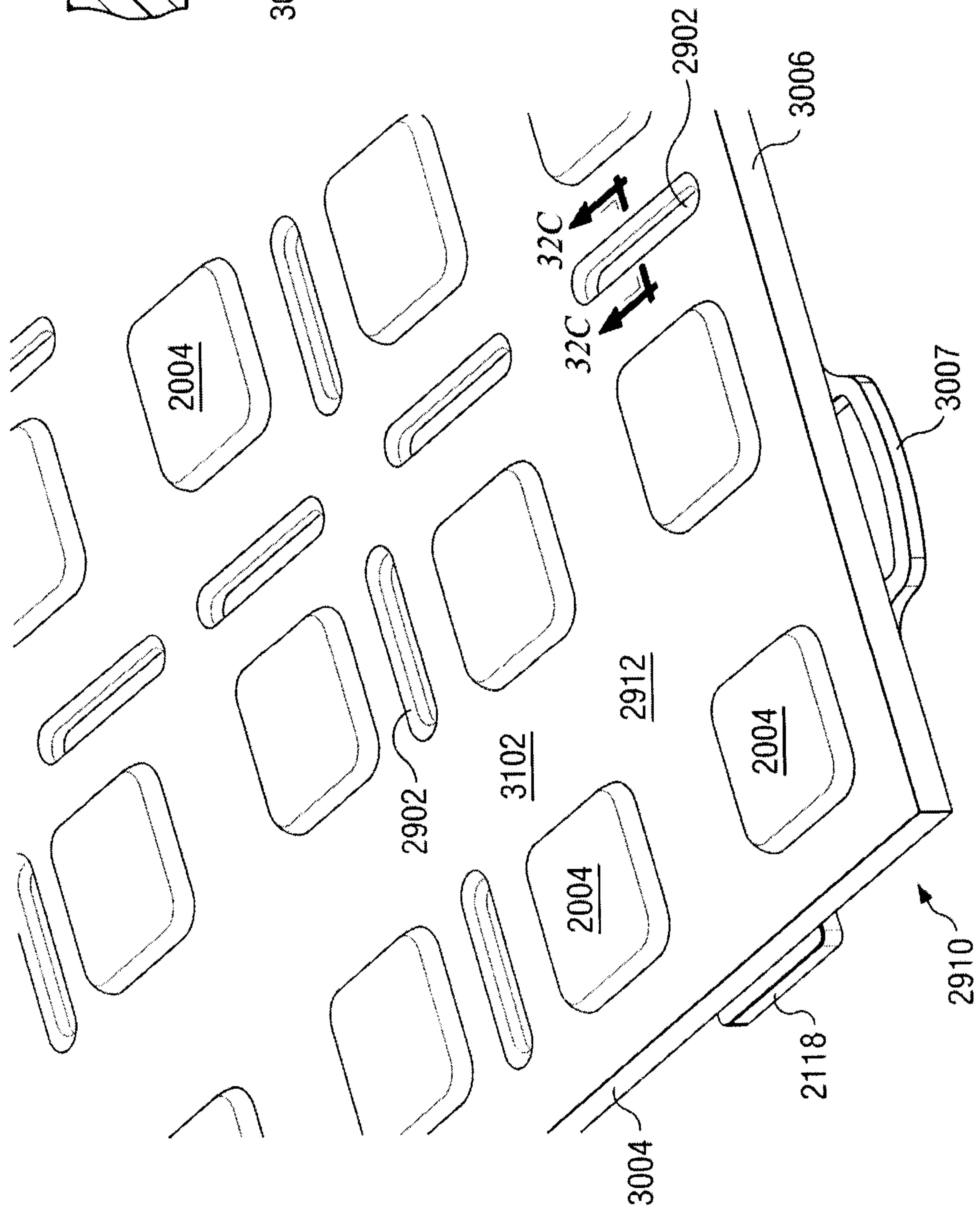


FIG. 32A

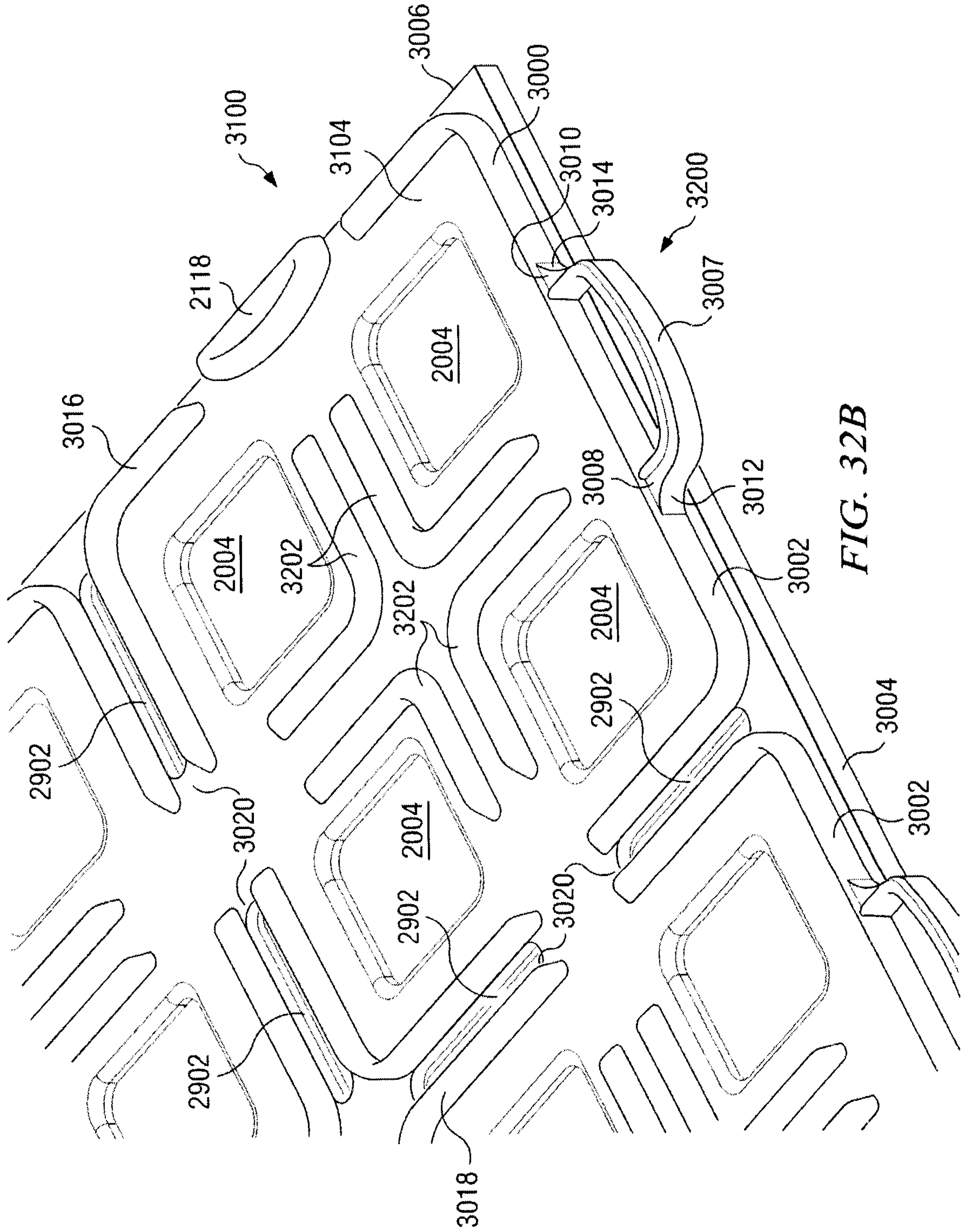
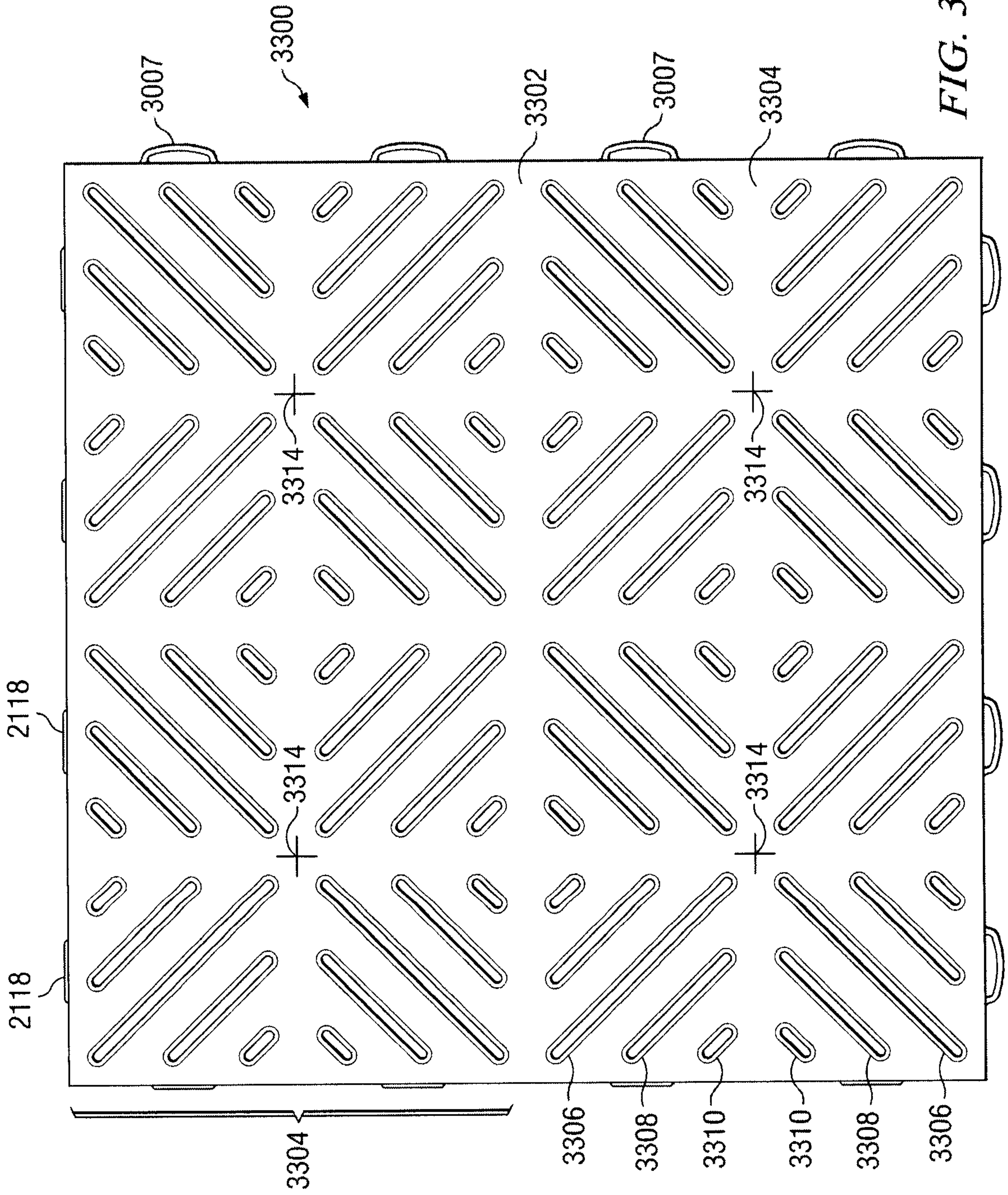


FIG. 32B



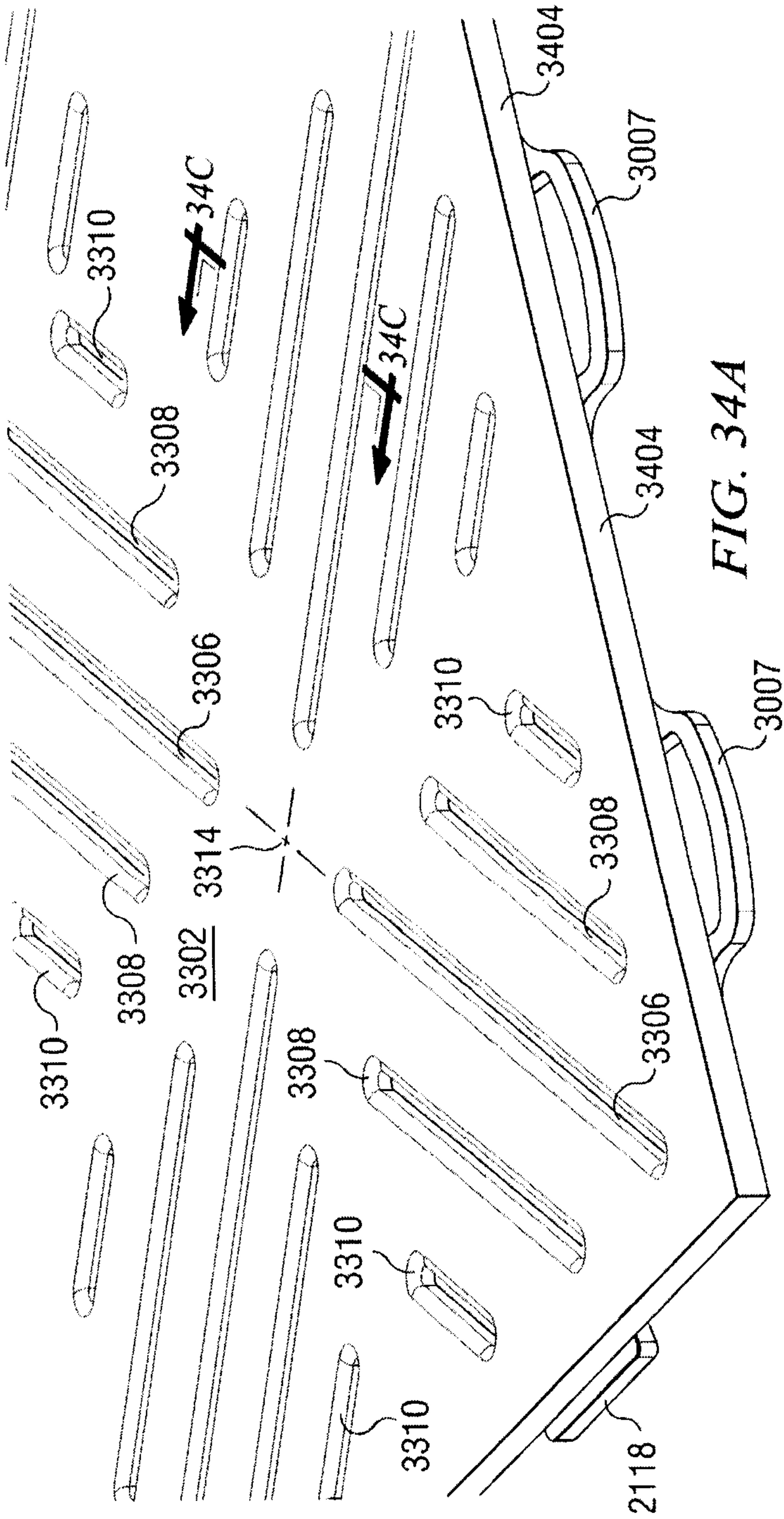


FIG. 34A

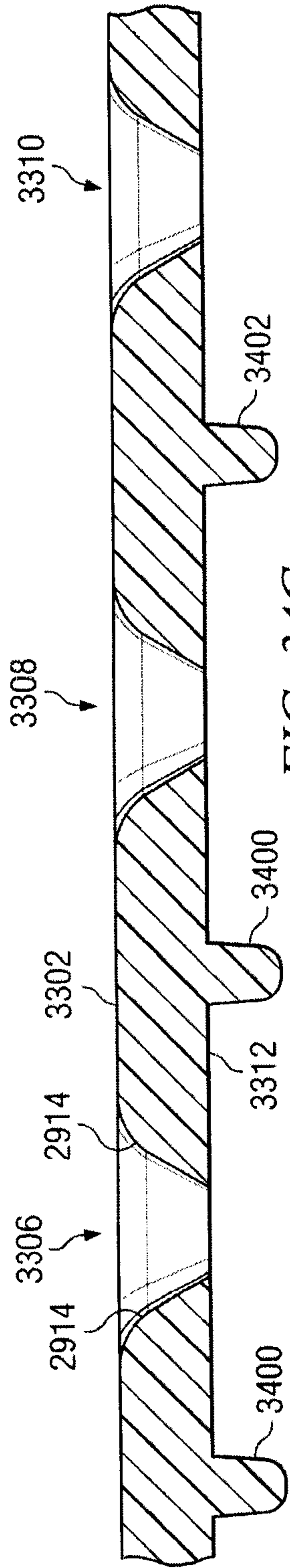


FIG. 34C

