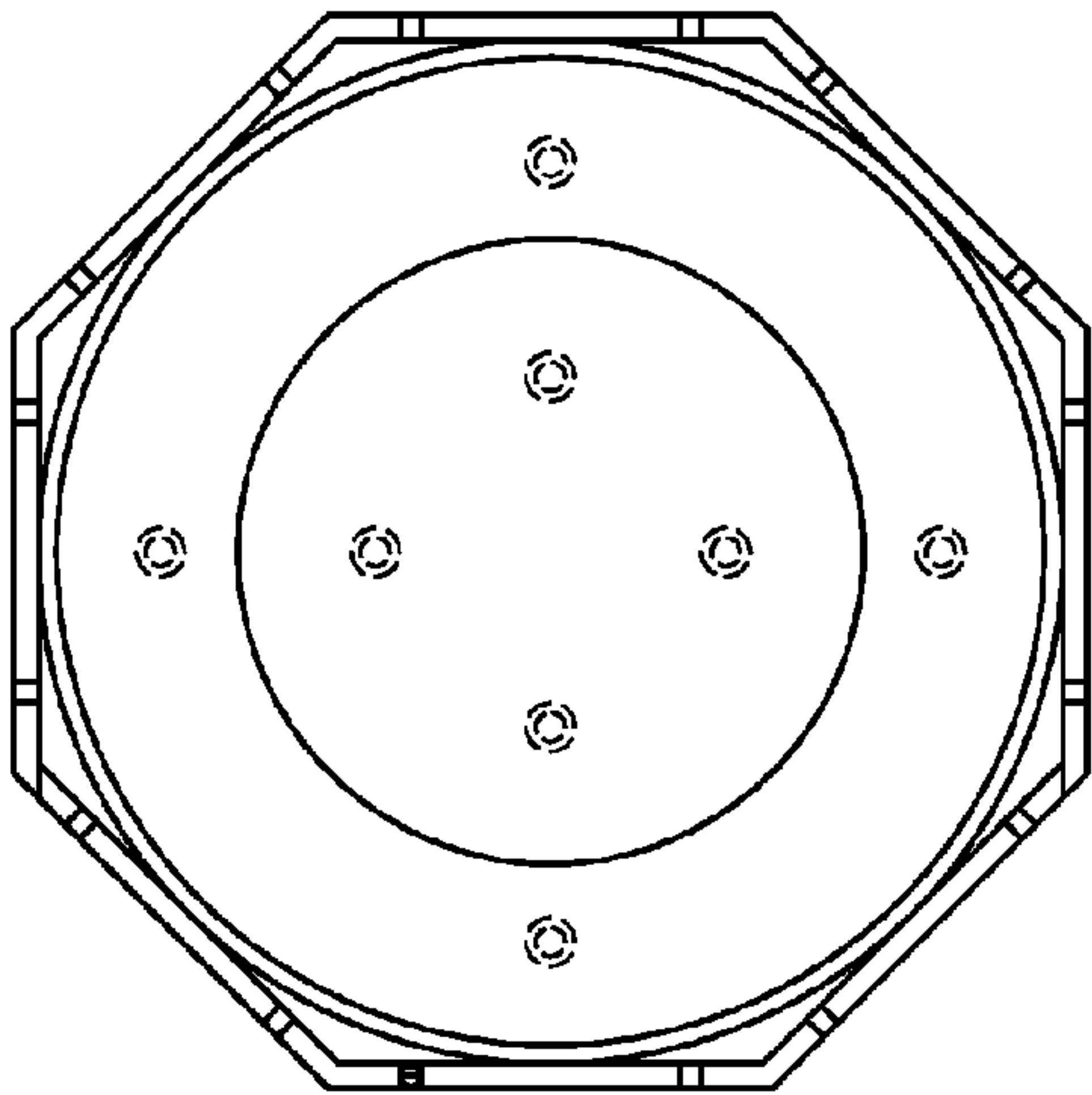




(86) Date de dépôt PCT/PCT Filing Date: 2014/10/29 (87) Date publication PCT/PCT Publication Date: 2015/05/14 (45) Date de délivrance/Issue Date: 2018/12/18 (85) Entrée phase nationale/National Entry: 2016/05/09 (86) N° demande PCT/PCT Application No.: US 2014/062916 (87) N° publication PCT/PCT Publication No.: 2015/069518 (30) Priorité/Priority: 2013/11/11 (US61/902,420)	(51) Cl.Int./Int.Cl. <i>F16F 15/02</i> (2006.01), <i>E01D 19/04</i> (2006.01), <i>E04B 1/36</i> (2006.01) (72) Inventeurs/Inventors: MORENO, GIL A., US; HUBBARD, DONALD A., US (73) Propriétaire/Owner: WORKSAFE TECHNOLOGIES, US (74) Agent: GOWLING WLG (CANADA) LLP
---	---

(54) Titre : SYSTEMES D'ISOLATION SISMIQUE POLYGONAUX
(54) Title: POLYGONAL SEISMIC ISOLATION SYSTEMS



(57) **Abrégé/Abstract:**
The invention is drawn to a methods and systems employing at least one seismic isolation bearing having a substantially polygonal shape in a top and/or bottom view. Preferably the polygonal shape is other than a square shape; preferably the shape is other than a rectangular shape. Such polygonal isolation bearings can be easily and securely joined to other components o the flooring or platform, and are of particular use in modular seismic isolation systems, in which the floor or platform can be assembled tp suit the available space. In preferred systems the polygonal isolation bearings may be used in low profile systems, for example, in locations having restricted headroom.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau(10) International Publication Number
WO 2015/069518 A1(43) International Publication Date
14 May 2015 (14.05.2015)

(51) International Patent Classification:

F16F 15/02 (2006.01) *E01D 19/04* (2006.01)
E04B 1/36 (2006.01)

(21) International Application Number:

PCT/US2014/062916

(22) International Filing Date:

29 October 2014 (29.10.2014)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

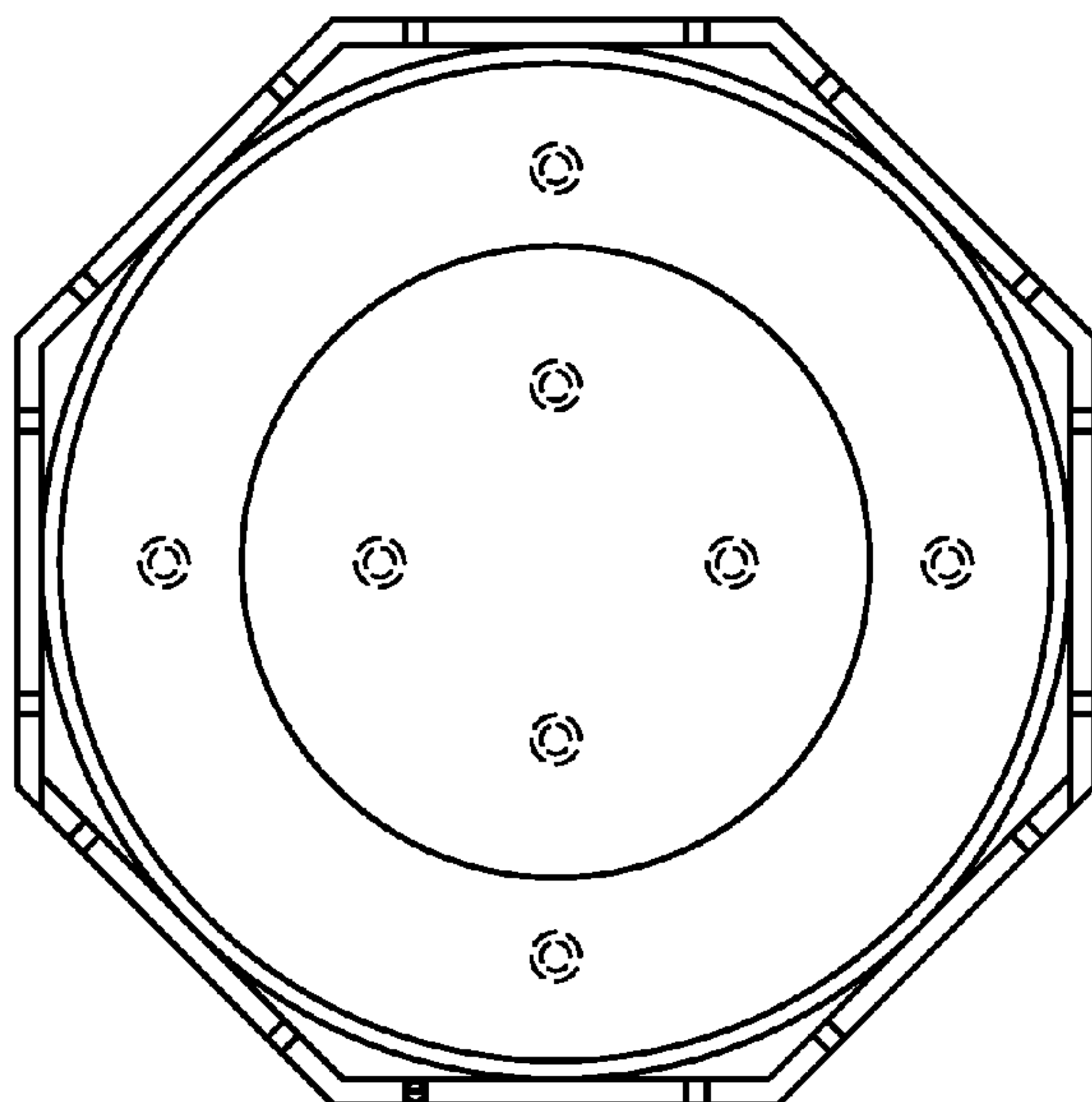
61/902,420 11 November 2013 (11.11.2013) US

(71) Applicant: **WORKSAFE TECHNOLOGIES** [US/US];
25133 Avenue Tibbitts, Bldg. F, Valencia, CA 91355
(US).(72) Inventors: **MORENO, Gil, A.**; 1206 Calle Toledo, San
Clemente, CA 92673 (US). **HUBBARD, Donald, A.**;
25133 Avenue Tibbitts #f, Valencia, CA 91355 (US).(74) Agent: **FISHER, Carlos, A.**; Stout, Uxa, Buyan &
Mullins, LLP, 4 Venture, Suite 300, Irvine, CA 92618
(US).(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- with amended claims and statement (Art. 19(1))

(54) Title: POLYGONAL SEISMIC ISOLATION SYSTEMS

FIG. 5

(57) Abstract: The invention is drawn to a methods and systems employing at least one seismic isolation bearing having a substantially polygonal shape in a top and/or bottom view. Preferably the polygonal shape is other than a square shape; preferably the shape is other than a rectangular shape. Such polygonal isolation bearings can be easily and securely joined to other components of the flooring or platform, and are of particular use in modular seismic isolation systems, in which the floor or platform can be assembled to suit the available space. In preferred systems the polygonal isolation bearings may be used in low profile systems, for example, in locations having restricted headroom.

POLYGONAL SEISMIC ISOLATION SYSTEMS

Background of the Invention

5

Although minor earthquakes are common, with thousands of smaller earthquakes occurring daily, larger magnitude seismic events can cause personal injury, death and property and environmental damage, particularly in heavily populated areas.

Two approaches have been traditionally utilized to prevent or limit damage or injury to objects or payloads due to seismic events. In the first approach, used particularly with structures themselves, the objects or payload articles are made strong enough to withstand the largest anticipated earthquake. However, in addition to the relative unpredictability of damage caused by tremors of high magnitude and long duration and of the directionality of shaking, use of this method alone can be quite expensive and is not necessarily suitable for payloads to be housed within a structure. Particularly for delicate, sensitive or easily damaged payload, this approach alone is not especially useful.

In the second approach, the objects are isolated from the vibration such that the objects fail to experience the

full force and acceleration of the seismic shock waves. Various methods have been proposed for accomplishing isolation or energy dissipation of a structure or object from seismic tremors, and these methods may depend in some
5 measure on the nature of the object to be isolated.

Thus, buildings and other structures may be isolated using, for example, passive systems, active systems, or hybrid systems. Such systems may include the use of one or more of a torsional beam device, a lead extrusion device, a
10 flexural beam device, a flexural plate device, and a lead-rubber device; these generally involves the use of specialized connectors that deform and yield during an earthquake. The deformation is focused in specialized devices and damage to other parts of the structure are
15 minimized; however the deformed devices often must be repaired or replaced after the seismic event, and are therefore largely suitable for only one use.

Active control systems require an energy source and computerized control actuators to operate braces or dampers
20 located throughout the structure to be protected. Such active systems are complex, and require service or routine maintenance.

For objects other than buildings, bridges and other structures, isolation platforms or flooring systems may be
25 preferable to such active or deformable devices. Thus, for protection of delicate or sensitive equipment such as manufacturing or processing equipment, laboratory equipment, computer servers and other hardware, optical equipment and the like an isolation system may provide a

simpler, effective, and less maintenance-intensive alternative. Isolation systems are designed to decouple the objects to be protected (hereinafter the "payload") from damage due to the seismic ground motion.

5 Isolators have a variety of designs. Thus, such systems have generally comprised a combination of some or all of the following features: a sliding plate, a support frame slidably mounted on the plate with low friction elements interposed therebetween, a plurality of springs
10 and/or axial guides disposed horizontally between the support frame and the plate, a floor mounted on the support frame through vertically disposed springs, a number of dampers disposed vertically between the support frame and the floor, and/or a latch means to secure the vertical
15 springs during normal use.

Certain disadvantages to such pre-existing systems include the fact that it is difficult to establish the minimum acceleration at which the latch means is released; it is difficult to reset the latch means after the floor
20 has been released; it may be difficult to restore the floor to its original position after it has moved in the horizontal direction; the dissipative or damping force must be recalibrated to each load; there is a danger of rocking on the vertical springs; and since the transverse rigidity
25 of the vertical springs cannot be ignored with regard to the horizontal springs, the establishment of the horizontal springs and an estimate of their effectiveness, are made difficult.

Ishida et al., U.S. Pat. No. 4,371,143 have proposed a

sliding-type isolation floor that comprises length adjustment means for presetting the minimum acceleration required to initiate the isolation effects of the flooring in part by adjusting the length of the springs.

5 Yamada et al., U.S. Patent No. 4,917,211 discloses a sliding type seismic isolator comprising a friction device having an upper friction plate and a lower friction plate, the friction plates having a characteristic of Coulomb friction, and horizontally placed springs which reduce a
10 relative displacement and a residual displacement to under a desired value. The upper friction plate comprises a material impregnated with oil, while a lower friction plate comprises a hard chromium or nickel plate.

Stahl (U.S. Pat. No. 4,801,122) discloses a seismic
15 isolator for protecting e.g., art objects, instruments, cases or projecting housing comprising a base plate connected to a floor and a frame. A moving pivoted lever is connected to a spring in the frame and to the base plate. The object is placed on top of the frame. Movement of the
20 foundation and base plate relative to the frame and object causes compression of the lever and extension of the spring, which then exerts a restoring force through a cable anchored to the base plate; initial resistance to inertia is caused due to friction between the base plate and the
25 frame.

Kondo et al., U.S. Pat. No. 4,662,133 describes a floor system for seismic isolation of objects placed thereupon comprising a floor disposed above a foundation, a plurality of support members for supporting the floor in a

manner that permits the movement of the floor relative to the foundation in a horizontal direction, and a number of restoring devices comprising springs disposed between the foundation and the floor member. The restoring members
5 comprise two pair of slidable members, each pair of slidable members being movable towards and away from each other wherein each pair of slidable members is disposed at right angles from each other in the horizontal plane.

Stiles et al., U.S. Pat. No. 6,324,795 disclose a
10 seismic isolation system between a floor and a foundation comprising a plurality of ball and socket joints disposed between a floor and a plurality of foundation pads or piers. In this isolation device, the bearing comprises a movable joint attached to a hardened elastomeric material
15 (or a spring); the elastic material is attached on an upper surface of the ball and socket joint and thus sandwiched between the floor and the ball and socket joint; the bearing thus tilts in relation to the floor in response to vertical movement. The floor is therefore able to adjust to
20 buckling pressure due to distortion of the ground beneath the foundation piers. However, the device disclosed is not designed to move horizontally in an acceleration-resisting manner.

Fujimoto, U.S. Pat. No. 5,816,559 discloses a seismic
25 isolation device quite similar to that of Kondo, as well as various other devices including one in which a rolling ball is disposed within the tip of a strut projecting downward from the floor in a manner similar to that of a ball point pen.

Bakker, U.S. Pat. No. 2,014,643, is drawn to a balance block for buildings comprising opposed inner concave surfaces with a bearing ball positioned between the surfaces to support the weight of a building
5 superstructure.

Kemeny, U.S. Pat. No. 5,599,106 discloses ball-in-cone bearings.

Kemeny, U.S. Patents No. 7,784,225 and 8,104,236 discloses seismic isolation platforms containing rolling
10 ball isolation bearings.

Hubbard and Moreno, U.S. Patents No. 8,156,696 and 8,511,004 discloses apparatus and methods involving raised access flooring structure for isolation of a payload placed thereupon.

15 Moreno and Hubbard, U.S. Patent No. 8,342,752 disclose isolation bearing restraint devices.

Isolation bearings are disclosed in Hubbard and Moreno, U.S. Patent Publication US 2013/0119224 filed on September 25, 2012.

20 Moreno and Hubbard, U.S. Patent Publication No. U.S. 2011/0222800 disclose methods and compositions for isolating a payload from vibration.

Chen, U.S. Patent No. 5,791,096 discloses a raised floor system.

25 Denton, U.S. Patent No. 3,606,704 discloses an elevated floor structure suitable for missile launching installations with vertically compressible spring units to

accommodate vertical displacements of the subfloor.

Naka, U.S. Patent No. 4,922,670 is drawn to a raised double flooring structure which is resistant to deformation under load. The floor employs columnar leg members that
5 contain a pivot mounting near the floor surface, which permits the floor to disperse a load in response to a side load.

10

Summary of the Invention

15

The present invention is directed in part to an improved seismic isolation system. The system may comprise isolation flooring and/or seismic isolation platforms. Although not exclusively, preferred examples of the
20 invention may involve, or may be used in conjunction with, a "low rise" platform or flooring system such as that disclosed in International Patent Application No. PCT/US2013/028621, filed on March 1, 2013.

Isolation bearings and systems such as, without
25 limitation, those disclosed in e.g., U.S. Patents No. 5,599,106; 7,784,225; 8,104,236; 8,156,696 and 8,511,004 provide seismic isolation through the utilization of isolation bearings comprising at least one (and usually two) horizontally extending bearing plate(s) with a first

generally concave surface and a second surface. A cross-sectional profile through a midline vertical axis of such a bearing plate shows that the generally concave surface comprises a shape, generally symmetrical around a central vertical axis, comprising a substantially conical shape, a substantially spherical shape, or a shape, comprising a linked combination of linear and radial shapes. When the generally concave surface of the bearing plate is a top surface of the bearing plate the bearing plate shall be considered "upward" facing, whereas when this surface is the bottom surface of the bearing plate, the concave surface shall be considered "downward" facing.

Generally at least one bearing plate supports, or is supported by a rolling ball, such as a ball bearing. In preferred rolling ball isolation bearing systems a rolling ball is between opposing upward-facing and downward-facing isolation bearing plates in such a manner that when a seismic event occurs, horizontal ground movement of the floor or foundation is isolated from the payload supported by the isolation bearings. Horizontal ground movement of the lower bearing plate is attenuated by the inertia of the payload mass on the upper bearing plate so that the rolling ball, located at rest in the center of the bearing plates, is free to move out of the center of the lower plate as the plate moves under it in any direction (relative to the lower plate) opposite to the direction of lower plate movement.

A major advantage to such a bearing is that, since it is substantially equally free to move the same distance in any horizontal direction (i.e., along the x and y axes)

given a constant force, the bearing does not require additional means to translate and isolate non-linear forces, or forces having both x and y components, as is necessary with isolation equipment using rollers, springs, skids or the like as the primary means of isolating the payload. Additionally, because of the use of a generally concave, generally symmetrical bearing surface, the bearing is "self-initializing", with the rolling ball returning to the center of the bearing plate following a seismic tremor, thus restoring the bearing to its initial resting position.

However, this advantage also means that shape of the bearing plate(s) is usually circular; in this manner the rolling ball is free to travel the same distance in any direction, and thus the bearing will work equally well regardless of the direction of the seismic force. However, circular seismic bearing plates can possess practical disadvantages. Shipping, storage, manufacturing and assembly of isolation systems can all be at least somewhat made more difficult using bearing plates having a circular plan view. Such bearing plates need to be stacked horizontally for storage; when placed side-by-side, the bearing plates only touch at a single point, and this substantially storage space is wasted. Furthermore, assembly of isolation equipment using circular bearing plates often requires specialized and somewhat inflexible designing, and this customizing design requirement lends itself less than optimally to, for example, a flexible modular isolation system that can be configured in many different ways. Finally the actual assembly of circular bearings in a system is difficult, and attachment of such

bearing plates to frame elements may not be as robust as desired or may be necessary.

The present invention is directed to methods and apparatus which involve improved seismic isolation bearings and systems utilizing such seismic isolation bearings, as well as methods of making and using such bearings and systems. In particular examples, the present invention involves seismic isolation systems utilizing one or more "rolling ball" isolation bearing comprising a bearing plate having a polygonal shape. That is, the isolation bearing comprises at least one payload-supporting "pan" or bearing plate having a polygonal shape in a plan view comprising a load-bearing surface having a cross-sectional profile comprising a generally conical shape, a generally spherical shape, or a shape, generally symmetrical around a central vertical axis, comprising a linked combination of linear and radial shapes.

The pan or bearing plate extends horizontally, generally radiating symmetrically about a central point, for example a central apex (or inverted apex). In the presently described examples, the pan or bearing plate is polygonal in shape when seen in plan view; for example, the plan view of the pan (and/or its frame) may comprise a triangle, a square, a pentagon, a hexagon, a heptagon, an octagon or another polygonal shape. In other examples, the bearing plate may be substantially circular in plan view and surrounded by a polygonal frame. Preferably, the polygonal shape is other than a square; preferably the polygonal shape is other than a triangle. Preferably, the polygonal shape is a hexagon or an octagon.

In preferred examples, each seismic isolation bearing comprised in a seismic flooring or platform system may comprise at least two opposing bearing plates, separated by a rigid ball, such as a metallic ball bearing. The rigid balls of two or more such bearings support the payload upon a frame, flooring element, or platform. In particularly preferred examples a seismic isolation bearing comprised in a seismic flooring or platform system comprises two bearing plates, separated by a rigid ball, such as a metallic ball bearing; in such arrangements an upper bearing plate may be joined to a frame, flooring element, or platform, while a lower bearing plate may be placed upon or affixed to a floor, foundation, or other similar support surface. A lower bearing plate may be oriented "upward", so that when the system is at rest the rigid ball is nested at a central point on the bearing surface of the lower bearing plate. An upper bearing plate may be oriented "downward", so that when the system is at rest the rigid ball rests within a central point on the bearing surface of the upper bearing plate.

Preferably, at least a lower bearing plate comprises a polygonal outline shape in a plan view. A polygonal shape, particularly preferably (but not necessarily) an octagonal shape, can add to the stability of the seismic isolation system in at least two ways.

First, polygonal seismic isolation bearings may be assembled so that straight sides of the upper and/or lower polygonal bearing plates of at least two adjoining upper or lower isolation bearings may be joined or linked together, thereby reinforcing the stability of these bearings during

a seismic event. In certain examples, a single upper or lower polygonal bearing plate may be joined to more than one adjoining bearing plate and/or to a flooring, frame, or platform element. Furthermore, when three or more isolation
5 bearings are used in a single platform or flooring system, the frame, platform and/or flooring elements and the bearings may thus be linked together into a single reinforced structure or network in which the entire upper and/or lower bearing element array is locked together as
10 one.

Secondly, the polygonal shape facilitates linking the bearing plates to the frame, platform and/or flooring elements. For example, a circular isolation bearing plate has only one point (the point of tangency) at which it
15 makes contact with a straight-edged surface. Thus, even in cases in which upper and/or lower polygonal bearing plates are not linked to each other, the joint between framing, platform, and/or flooring element and the bearing plate is made much more strong and firm when a straight edged
20 segment of the perimeter of the bearing plate (or the bearing plate frame) is joined to a straight segment of such element.

Each of these advantages make the manufacture and assembly of seismic isolation systems comprising polygonal
25 isolation bearings substantially easier than systems employing circular isolation bearings. Due to the straight edges of the isolation bearing plates of the present invention, seismic isolation systems can be designed to fit together more strongly and precisely than those having
30 circular bearing plates.

Furthermore, when an isolation system employs an array of three or more, or four or more, or five or more, or six or more, isolation bearings having the same or complementary polygonal shapes, these bearings can be
5 arranged in various ways depending on factors including, without limitation, the payload location, size, mass, and the size and/or and shape of the space in which the seismic isolation system is to be installed, in order to optimally support the load or conform with space limitations.

10 The polygonal bearing plates of the present invention may either be manufactured as circular bearing plates with a polygonal "frame" joined thereto by, for example, welds, appropriate fasteners (such as screws, bolts and the like). In another example, the polygonal bearing plates may be
15 manufactured as a polygon, again, preferably surrounded by a polygonal frame.

It will be understood that the polygonal frames, bearing plates and the like may have rounded or "radiused" corners without departing from the scope of the invention.
20 Thus the term "polygonal" or "polygon" shall be interpreted to mean "generally polygonal"; that is, comprising at least two (and preferably at least three) straight sides wherein the sum of all curves and angles totals 360°.

The use of polygonal bearing plates greatly
25 facilitates the manufacture and assembly of seismic isolation systems. For example, connector components can be fabricated easily of, for example, metal tubing, flat plates, or angle iron with standardized placement of connection fittings such as (without limitation) screw or

bolt holes, or brackets, for being joined to the polygonal bearing plate(s) and/or framing, flooring or platform elements. These connector component/bearing plate assemblies can thus be extended for the desired length or
5 width of the isolation system, with the length of connectors and number of bearing plates being determined, at least in part, by the anticipated mass of the payload. In particular examples each of opposing sets of polygonal top and bottom bearing plates are linked by, and joined to,
10 connector components to form top and bottom flooring or platform assemblies. Additionally, or alternatively, two or more adjacent polygonal top and/or bottom bearing plates may be joined to each other to form a strong and rigid isolation assembly.

15 In other possible configurations, the top and/or bottom isolation assembly may be constructed without the use of separate connector components. For example, the polygonal shape of the seismic bearing plates facilitates directly joining one bearing plate to at least one
20 adjacent bearing plate, which is joined, in turn, to at least one additional bearing plate to form a firm, mutually stabilized structure.

One or more of the bottom bearing plates may also be directly or indirectly joined to a foundation or floor.
25 For example, one or more bearing plate may be fastened directly to the foundation using, for example, concrete anchored fasteners or an adhesive for fastening plastics or metals to concrete, such as the 3M Scotch-Weld® brands of urethane, acrylic and epoxy adhesives.

One or more of the top bearing plates are preferably directly or indirectly fastened to a platform or flooring element. For example, a top bearing plate may be fastened directly to one or more flooring support "tile" or region
5 using bolts, screws or other similar fasteners, or may be joined to a frame for supporting the payload, bearing plate, or tiles.

In one example, the present invention is drawn to a polygonal seismic isolation bearing plate comprising:

10 a) a recessed hardened load-bearing surface component; and,

b) a hardened frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an
15 earthquake, said frame component being directly or indirectly joined to said load bearing surface component; wherein, in top view, the frame component comprises a polygonal shape, and wherein said frame component is structured to be joined along at least one straight edge to
20 at least one other component of said isolation platform or flooring system.

In such a system the load-bearing surface component may be welded or otherwise securely joined to a circumferential ring (for this purpose considered part of
25 the load bearing surface), which can then be joined to a frame component, or may be joined directly to the frame component. The frame component is preferably polygonal in shape, and is structured to be joined to other bearing

plate assemblies, or to other components of the isolation flooring or platform assembly. In a particularly preferred embodiment the polygonal shape is not a square, or not a rectangle.

5 In another example, the invention is drawn to a polygonal seismic isolation bearing assembly comprising:

- a) a hardened ball disposed between
- b) a top isolation bearing plate, and
- c) a bottom isolation bearing plate;

10 wherein each said top and bottom isolation bearing plates comprise:

i) a recessed hardened load-bearing surface component; and,

15 ii) a hardened frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said frame component being directly or indirectly joined to said load bearing surface component;

20 wherein, in top view, the frame component comprises a polygonal shape, and wherein said frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform or flooring system.

25 Preferably the frame element of one or both of the top bearing plate or the bottom bearing plate is welded or

otherwise joined to its respective load-bearing surface component. As above, the frame component is preferably polygonal in shape, and is structured to be joined to other bearing plate assemblies, or to other components of the
5 isolation flooring or platform assembly. In a particularly preferred embodiment the polygonal shape is not a square, or not a rectangle.

Additionally, either or both the top and bottom isolation bearing plates may be directly or indirectly
10 joined to one or more other isolation bearing plate in substantially the same plane. An example of indirect joining is by each bearing plate in substantially the same plane being joined to the same connector component. Another example of indirect joining is by each bearing
15 plate in substantially the same plane being joined to a common flooring or platform component.

In another example, the present invention is directed to a seismic isolation floor or platform assembly comprising a plurality of polygonal isolation bearing
20 assemblies, each such bearing assembly comprising:

- a) a hardened ball disposed between
- b) a top isolation bearing plate, and
- c) a bottom isolation bearing plate;

wherein each said top and bottom isolation bearing plates
25 comprise:

- i) a recessed hardened load-bearing surface component; and,

ii) a hardened frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said frame component being directly or
5 indirectly joined to said load bearing surface component;
wherein, in top view, the frame component comprises a polygonal shape, and wherein said frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform
10 or flooring system.

In the seismic isolation floor or platform assembly at least two of said plurality of polygonal isolation bearing assemblies may be joined in a manner selected from the group consisting of:

15 i) said top isolation bearing plates are directly or indirectly joined together, or

ii) said bottom isolation bearing plates are directly or indirectly joined together, or

20 iii) both said top isolation bearing plates are directly or indirectly joined together and said bottom isolation bearing plates are directly or indirectly joined together.

The inventions shall now be described by detailing specific, non-limiting examples.

25

Brief Description of the Drawings

Fig. 1 shows one example of a finished polygonal (octagonal) isolation bearing plate of the present invention.

5 Fig. 2 shows an intermediate stage in the fabrication of the polygonal (octagonal) isolation bearing plate of Fig. 1, showing certain of the components.

Fig. 3 shows a cross sectional view of the finished of a polygonal (octagonal) isolation bearing plate of Fig.
10 1.

Fig. 4 shows another example of a finished polygonal (octagonal) isolation bearing plate of the present invention.

Fig. 5 shows an intermediate stage in the fabrication
15 of the polygonal (octagonal) isolation bearing plate of Fig. 4, showing certain of the components.

Fig. 6 shows a cross sectional view of the finished of a polygonal (octagonal) isolation bearing plate of Fig.
4.

20 Fig. 7A shows an example of a top view of an example of a connector component.

Fig. 7B is an end view of the connector component of Fig. 7A.

Fig. 8A shows an example of a top view of another
25 example of a connector component.

Fig. 8B is an end view of the connector component of

Fig. 8A.

Fig. 9A shows an example of a top view of another example of a connector component.

Fig. 9B is an end view of the connector component of
5 Fig. 9A.

Fig. 10A shows a side view of an example of an L bracket for securing the bearing plate of Fig. 1.

Fig. 10B shows a end view of the bracket of Fig. 10A.

Fig. 11 is an example of an arrangement of polygonal
10 bearings and connector components in an isolation platform or flooring system.

Fig. 12 is another example of an arrangement of polygonal bearings in an isolation platform or flooring system.

15 Fig. 13 is another example of an arrangement of polygonal bearings and connector components in an isolation platform or flooring system.

Fig. 14 is another example of an arrangement of polygonal bearings and connector components in an isolation
20 platform or flooring system.

Fig. 15 is an example of an arrangement of polygonal bearings and connector components in an isolation platform or flooring system.

Detailed Description of the Invention

The following examples provide details concerning various arrangements of polygonal bearing plates, isolation bearing assemblies and configurations of such bearings in a platform or flooring arrangement. It will be understood that the invention is limited only by the claims at the end of this specification.

Referring now to the drawings, **Fig. 1** shows one example of a finished polygonal bearing plate of the present invention, while **Fig. 2** shows the same bearing plate at an intermediate state of construction and **Fig. 3** is a cross section of the bearing plate of **Fig. 1**. In this example, the load bearing surface component **100** is preferably fashioned from a metal (such as stainless steel) as a circular, symmetrical item, having a central area **102** comprising a radius in cross section; see **Fig. 3**. Surrounding this central area is a annular area comprising a region of constant slope **104**. The bearing surface in this example is drilled and tapped with screw holes **106** for later securing of the bearing plate to an underlying or overlaying surface, if desired. The load bearing surface **100** is welded to a circular steel band **110** and a flat bottom plate **112**; this assembly is then joined, for example welded, to a frame component **114** comprising lengths of a hardened material (cold rolled steel ("CRS") in this case) formed, for example, by welding, into an octagon. As shown, each side of the frame is drilled and tapped **118** for joining to, for example, framing or connector components or other bearing plates with screws or bolts.

The assembly shown in **Fig. 2** comprises eight spaces **116** (appearing substantially as triangles in the two dimensional top view) between the steel band **110** and the frame component **114**. Filler pieces of metal are then
5 welded to the assembly to fill in the spaces, and the load-bearing surface **100** is polished to form the assembly shown in **Fig. 1**.

Fig. 5 shows another example of a finished polygonal (in this case octagonal) bearing plate of the present
10 invention, while **Fig. 4** shows the same bearing plate at an intermediate state of construction and **Fig. 6** is a cross section of the bearing plate of **Fig. 4**. The construction and structure of this bearing plate example is similar in principle to that of the bearing plate shown in **Fig. 1, 2,**
15 and **3**. The dimensions of the bearing plate are different, and four drilled and tapped connector holes are shown within the central area of the bearing plate surface (see **Fig. 4** and **Fig. 5**).

Fig. 7A shows a top view of a connector component;
20 this connector component comprises lengths of steel tubing joined (for example, by welding) into a rectangular structure having two equally sized short end pieces **703**, each joined to two equally sized longer spacer pieces **701**. Those of ordinary skill in the art will immediately
25 recognize that various other connector component arrangements can be envisioned, for example, a connector component in which all sides are of equal length. **Fig. 7B** shows an end view of the same connector component, in which two holes **705** are drilled and tapped in the two end pieces
30 of the connector component for connection to, for example,

the polygonal frame component (see e.g., 114 of **Fig. 1**) surrounding the bearing plates.

Fig. 8A shows an alternative arrangement of connector components, in which the side pieces are replaced with flat plates 801; as in **Fig. 7A**, the spacer pieces of this example are made of tubing, for example, stainless steel tubing. **Fig. 8B** shows an end view of the connector component assembly shown in **Fig. 8A**, with holes drilled for connection with the frame component of the bearing plate, as before.

Fig. 9A is yet another example of a connector component. In this example, the spacer pieces 901 are fashioned of lengths of angle iron, while the end pieces 902 are flat plates, as in **Fig. 8A**. **Fig. 9B** shows an end view of this connector component assembly; the outline of the angle iron spacer pieces 901 is shown.

Fig. 10A shows a top view of an L bracket component for connecting to the frame component of the bearing plate assembly of e.g., **Fig. 1**. **Fig. 10B** shows an end view of the same bracket assembly.

Fig. 11 shows an exemplary arrangement of polygonal bearing plate assemblies in an isolation flooring or isolation platform assembly. As can be seen in this example, pairs of octagonal isolation bearing plates 1101 are joined (for example bolted) together along shared flat sides. Each bearing plate is also joined to a connector component 1103 and to at least one side of a frame 1105 surrounding the flooring or platform assembly. Similar or different configurations may be used for top and bottom

bearing plates. Bearing plates may also be joined to an underlying or overlying surface, such as a floor or foundation (for bottom bearing plates) or a platform or frame (for the top bearing plates).

5 **Fig. 12** shows another exemplary arrangement of polygonal bearing plates in an isolation flooring or isolation platform assembly. In this example, three pairs of isolation bearing plates **1201** are joined (for example bolted) together along shared flat sides; each pair of
10 these and separated by single isolation bearing plates **1203** not joined together and either resting or joined to an underlying or overlying surface, such as a floor or foundation (e.g., for the bottom bearing plates) or a platform or frame (e.g., for the top bearing plates).
15 Similar or different configurations may be used for top and bottom bearing plates.

Fig. 13 shows another exemplary arrangement of polygonal bearing plates in an isolation flooring or isolation platform assembly. In this example, each of four
20 polygonal isolation bearing plates **1301** are joined to two sides of a frame **1303** surrounding the flooring or platform assembly. Each isolation bearing plate is also joined to a connector component **1305**. As shown, each connector component is joined to two isolation bearing plates.

25 **Fig. 14** shows another exemplary arrangement of polygonal bearing plates in an isolation flooring or isolation platform assembly. In this example, each of four polygonal isolation bearing plates are joined to two sides of a frame surrounding the flooring or platform assembly,

and to one other isolation bearing plate. Each isolation bearing plate is also joined to a connector component. As shown, each connector component is joined to two isolation bearing plates.

5 **Fig. 15** shows another exemplary arrangement of polygonal bearing plates in an isolation flooring or isolation platform assembly. In this example, each of four polygonal isolation bearing plates are joined to two sides of a frame surrounding the flooring or platform assembly,
10 and to one other isolation bearing plate. Each isolation bearing plate is also joined to a connector component. As shown, each connector component is joined to two isolation bearing plates. This arrangement is similar to that shown in **Fig. 14**, except the connector components are elongated
15 in comparison.

Although the foregoing invention has been exemplified and otherwise described in detail for purposes of clarity of understanding, it will be clear that modifications, substitutions, and rearrangements to the explicit
20 descriptions may be practiced within the scope of the appended claims. For example, the inventions described in this specification can be practiced within elements of, or in combination with, other any features, elements, methods or structures described herein. Additionally, features
25 illustrated herein as being present in a particular example are intended, in other aspects of the present invention, to be explicitly lacking from the invention, or combinable with features described elsewhere in this patent application, in a manner not otherwise illustrated in this
30 patent application or present in that particular example.

Solely the language of the claims shall define the invention. All publications and patent documents cited herein are hereby incorporated by reference in their entirety for all purposes to the same extent as if each
5 were so individually denoted.

What is claimed is:

1. A seismic isolation bearing plate comprising:
 - a) a recessed hardened load-bearing surface component; and,
 - b) a hardened bearing plate frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said bearing plate frame component being joined to said load bearing surface component by at least one weld, bolt or screw;wherein, in top view, the frame component comprises an octagonal, and wherein said bearing plate frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform or flooring system.
2. The bearing plate of claim 1 wherein said bearing plate frame component is welded to said load-bearing surface component.
3. The bearing plate of claim 1 wherein the load-bearing surface component thereof has a cross sectional profile comprising a shape which is:
 - i) a combination of linear and curved shapes;
 - ii) a combination of different linear shapes, or
 - iii) a combination of different curved shapes.
4. The bearing plate of claim 1 wherein the bearing plate frame component comprises a series of holes for joining to at least one other component of said isolation platform or flooring system.
5. The bearing plate of claim 1 wherein said at least one component of said isolation platform or flooring system is:
 - i) another isolation bearing plate,
 - ii) a connecting component,
 - iii) a frame element of said isolation platform or flooring system, or
 - iv) a floor or foundation.

6. The bearing plate of claim 1 wherein said load-bearing surface component comprises a substantially circular shape in a top view.
7. The bearing plate of claim 1 wherein said load bearing surface component comprises a substantially octagonal shape in a top view.
8. A seismic isolation bearing assembly comprising:
- a) a hardened ball disposed between
 - b) a top isolation bearing plate, and
 - c) a bottom isolation bearing plate;
- wherein each said top and bottom isolation bearing plates comprise:
- i) a recessed, hardened load-bearing surface component; and,
 - ii) a hardened bearing plate frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said bearing plate frame component being joined to said load bearing surface component by at least one weld, bolt or screw;
- wherein, in top view, the bearing plate frame component comprises an octagonal shape, and wherein said frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform or flooring system.
9. The isolation bearing assembly of claim 8 wherein the bearing plate frame component of at least one of said top bearing plate and said bottom bearing plate is welded to its respective load-bearing surface component.
10. The isolation bearing assembly of claim 8 wherein the bearing plate frame component of both said top bearing plate and said bottom bearing plate is welded to its respective load-bearing surface component.
11. The isolation bearing assembly of claim 9 wherein the load-bearing surface component thereof has a cross sectional profile comprising a shape which is:
- i) a combination of linear and curved shapes;
 - ii) a combination of different linear shapes, or

iii) a combination of different curved shapes.

12. The isolation bearing assembly of claim 8, wherein the bearing plate frame component(s) comprises a series of holes for joining to at least one other component of said isolation platform or flooring system.

13. The isolation bearing assembly of claim 12 wherein at least one said component(s) is:

- i) another isolation bearing plate in substantially the same plane,
- ii) a connecting component,
- iii) a frame element of said isolation platform or flooring system, or
- iv) a floor or foundation.

14. The isolation bearing assembly of claim 8, wherein said load-bearing surface component comprises a substantially circular shape in a top view.

15. The isolation bearing assembly of claim 8 wherein said load bearing surface component comprises a substantially octagonal shape, in a top view.

16. A seismic isolation floor or platform assembly comprising a plurality of isolation bearing assemblies, each such bearing assembly comprising:

- a) a hardened ball disposed between
- b) a top isolation bearing plate, and
- c) a bottom isolation bearing plate;

wherein each said top and bottom isolation bearing plates comprise:

- i) a recessed hardened load-bearing surface component; and,
- ii) a hardened bearing plate frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said bearing plate frame component being joined to said load bearing surface component by at least one weld, bolt or screw;

wherein, in top view, the bearing plate frame component comprises an octagonal shape, and wherein said bearing plate frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform or flooring system.

17. The seismic isolation floor or platform assembly of claim 16 wherein, in at least two of said plurality of polygonal isolation bearing assemblies are joined as follows:

- i) said top isolation bearing plates are directly or indirectly joined together,
- ii) said bottom isolation bearing plates are directly or indirectly joined together, or
- iii) both said top isolation bearing plates are directly or indirectly joined together and said bottom isolation bearing plates are directly or indirectly joined together.

18. The seismic isolation floor or platform assembly of claim 17 wherein at least two of said bearing plates are joined along straight edges of each bearing plate.

19. The seismic isolation floor or platform assembly of claim 17 wherein at least two of said bearing plates are each joined to a connector component along straight edges of each bearing plate.

20. The seismic isolation floor or platform assembly of claim 17 wherein at least two bearing plates are joined to at least one component which is:

- i) another isolation bearing plate in substantially the same plane,
- ii) a connecting component,
- iii) a frame element of said isolation platform or flooring system, or
- iv) a floor or foundation.

21. The seismic isolation floor or platform assembly of claim 16 wherein at least two bearing plates are joined to at least one component which is:

- i) another isolation bearing plate in substantially the same plane,
- ii) a connecting component,
- iii) a frame element of said isolation platform or flooring system, or
- iv) a floor or foundation.

22. A method of seismically isolating a payload comprising:

supporting said payload on a seismic isolation floor or platform assembly, said seismic isolation floor or platform assembly comprising a plurality of polygonal isolation bearing

assemblies, each such bearing assembly comprising:

- a) a hardened ball disposed between
- b) a top isolation bearing plate, and
- c) a bottom isolation bearing plate;

wherein each said top and bottom isolation bearing plates comprise:

- i) a recessed hardened load-bearing surface component; and,
- ii) a hardened bearing plate frame component, sufficiently strong to support said load-bearing surface component during use in an isolation platform or flooring system during an earthquake, said bearing plate frame component being joined to said load bearing surface component by at least one weld, bolt or screw;

wherein, in top view, the bearing plate frame component comprises an octagonal shape, and wherein said bearing plate frame component is structured to be joined along at least one straight edge to at least one other component of said isolation platform or flooring system.

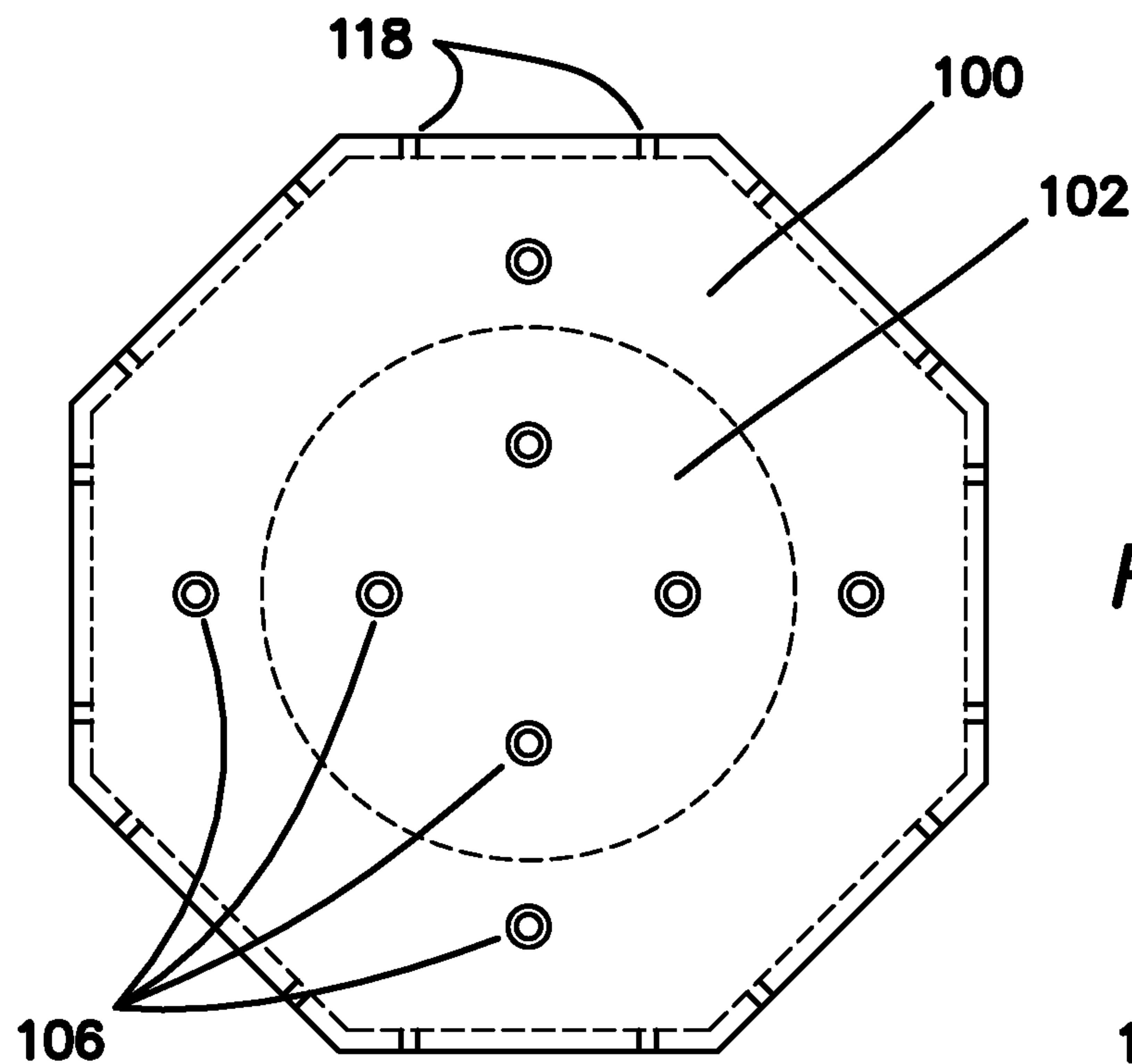


FIG. 1

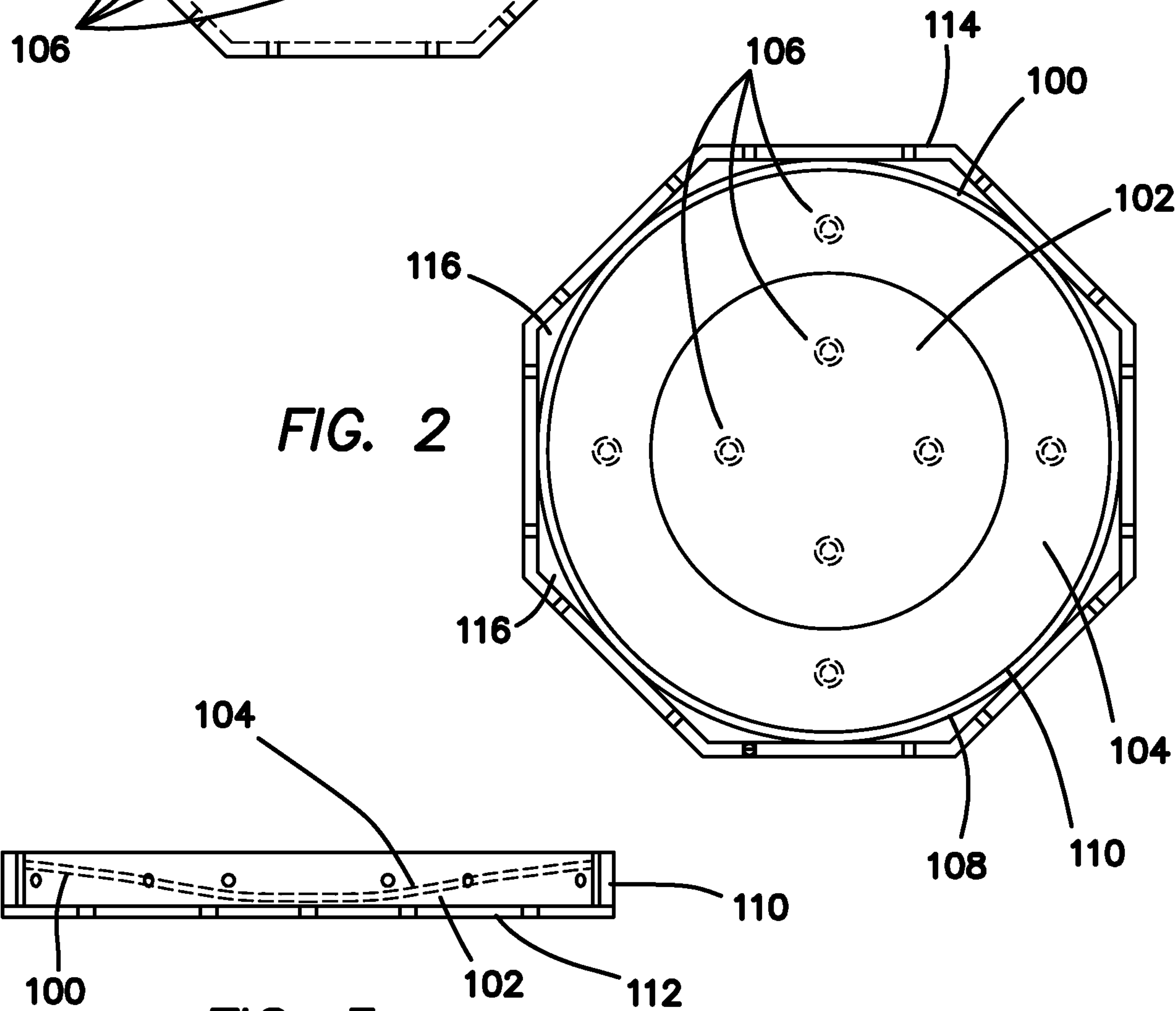


FIG. 2

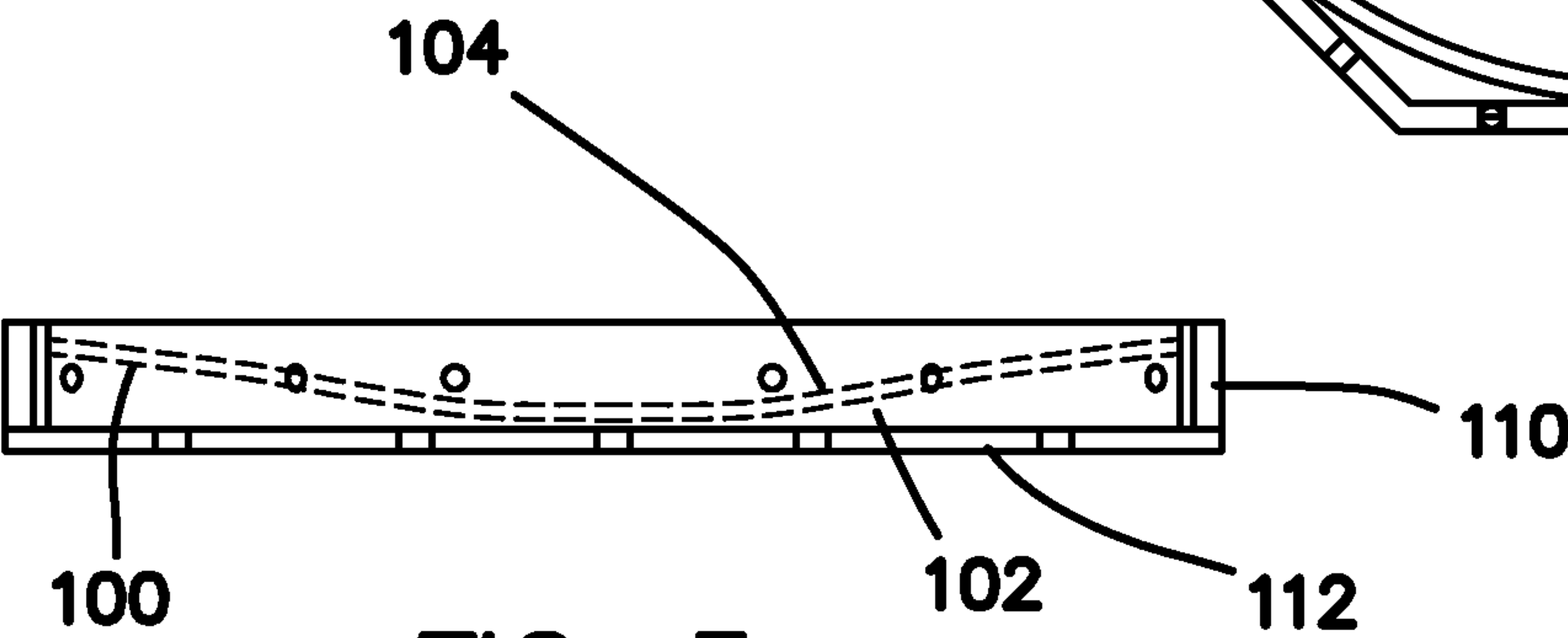
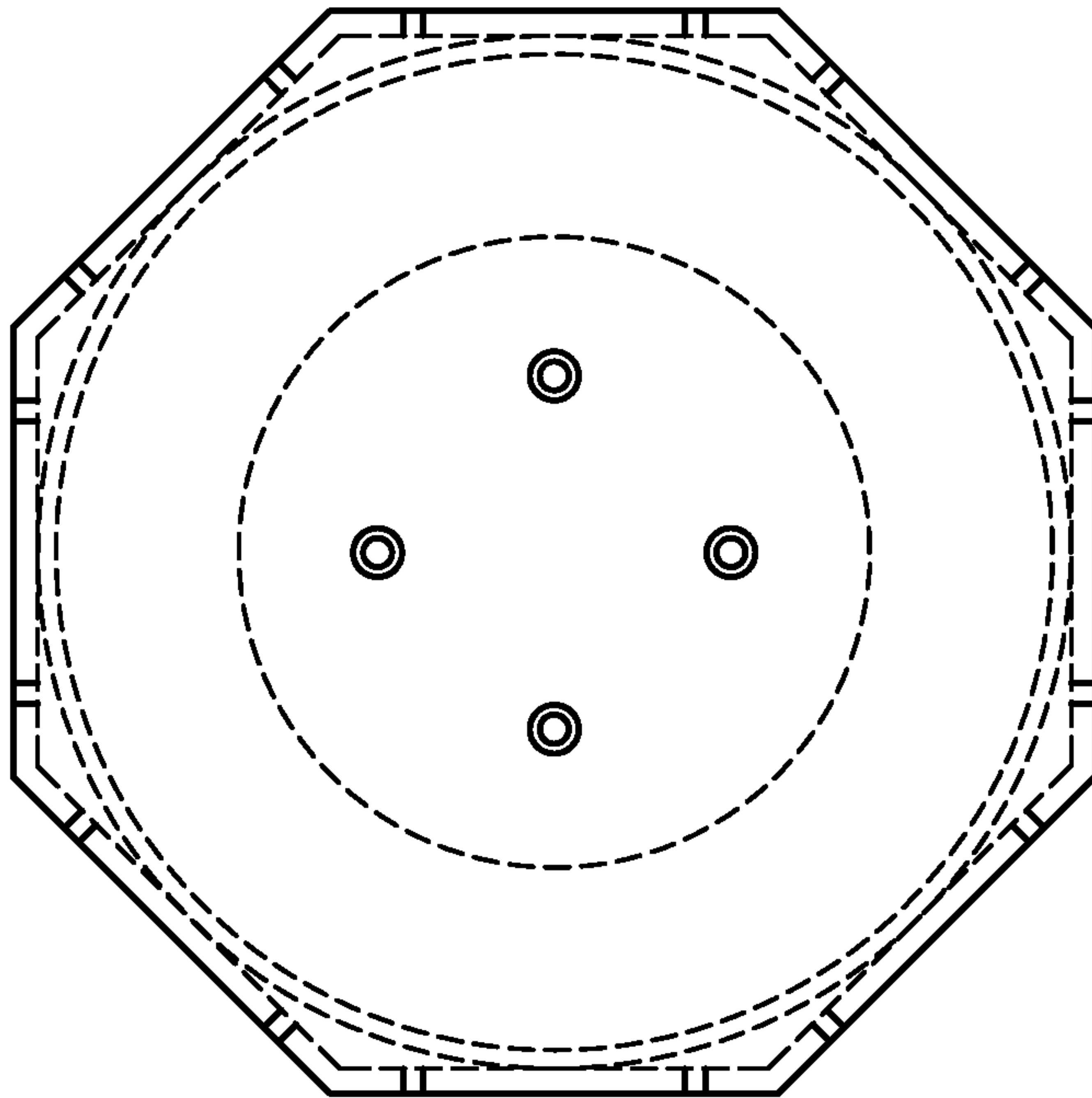
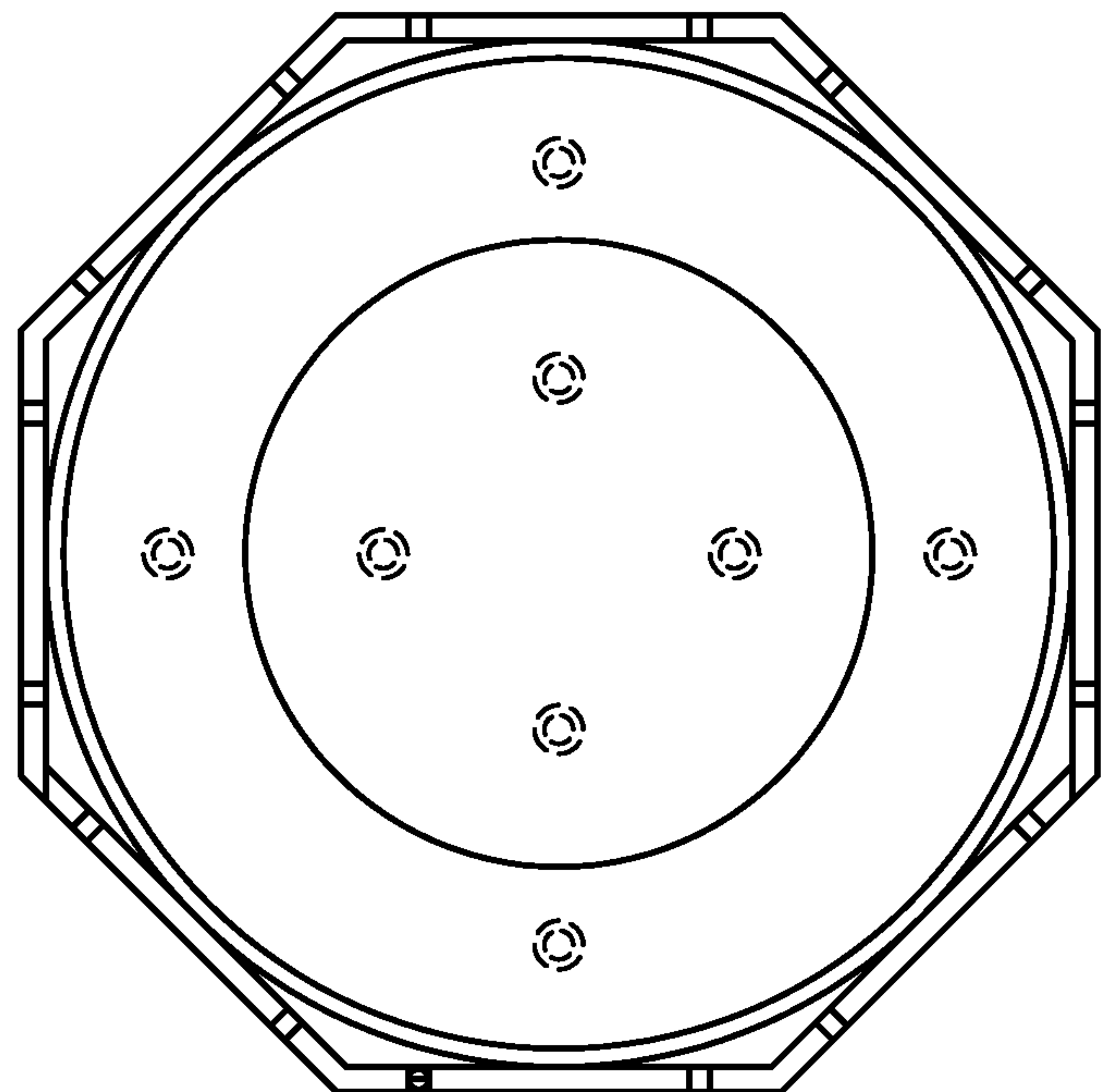
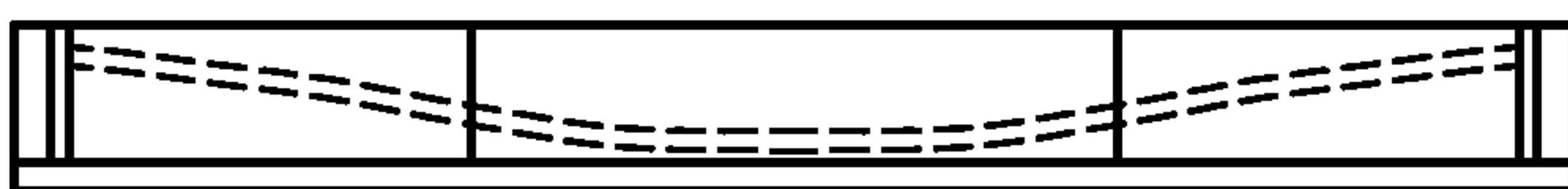


FIG. 3

**FIG. 4****FIG. 5****FIG. 6**

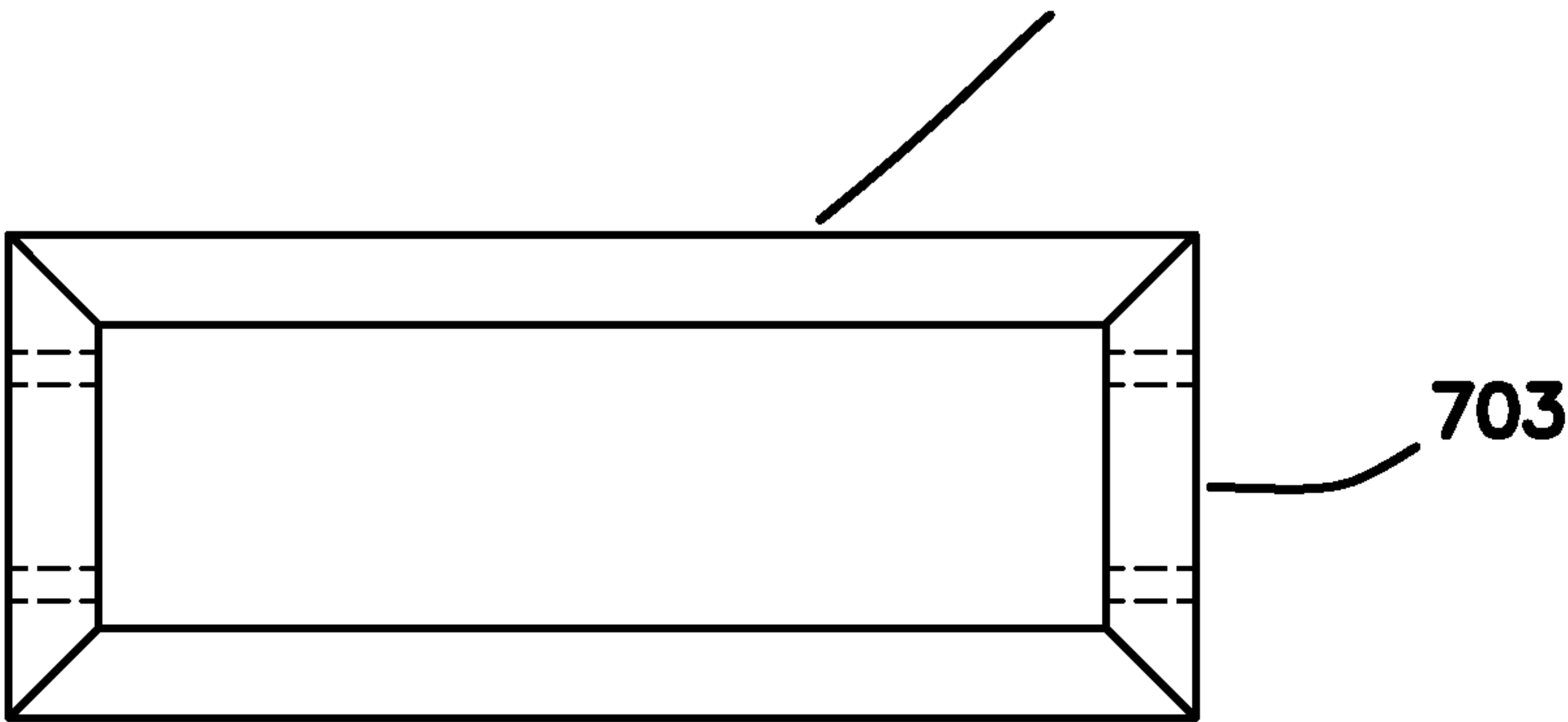


FIG. 7A

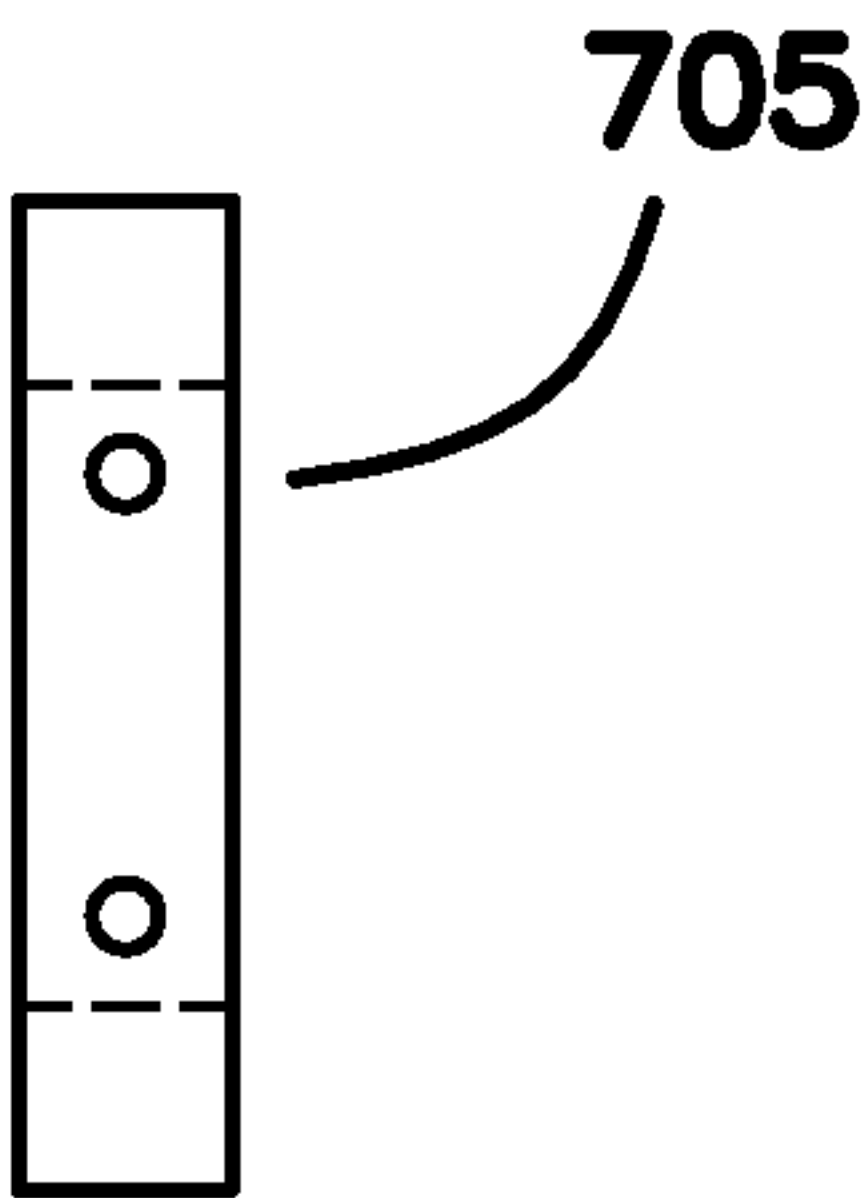


FIG. 7B

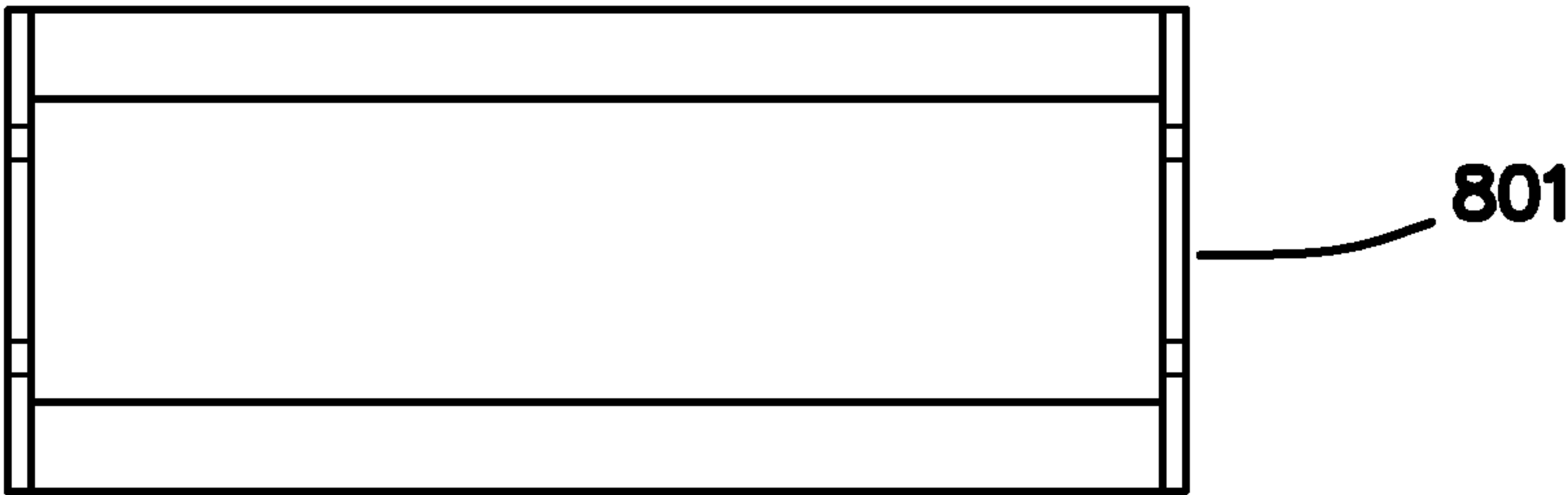


FIG. 8A

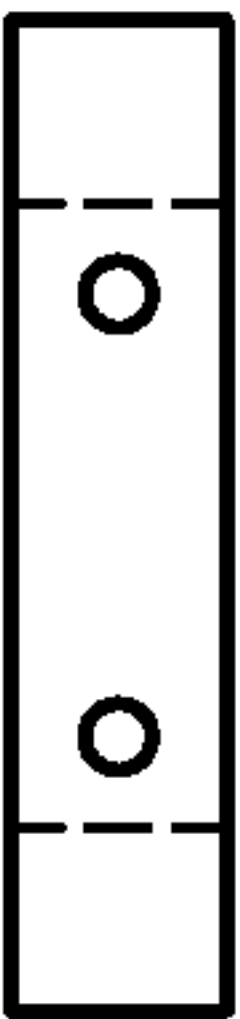


FIG. 8B

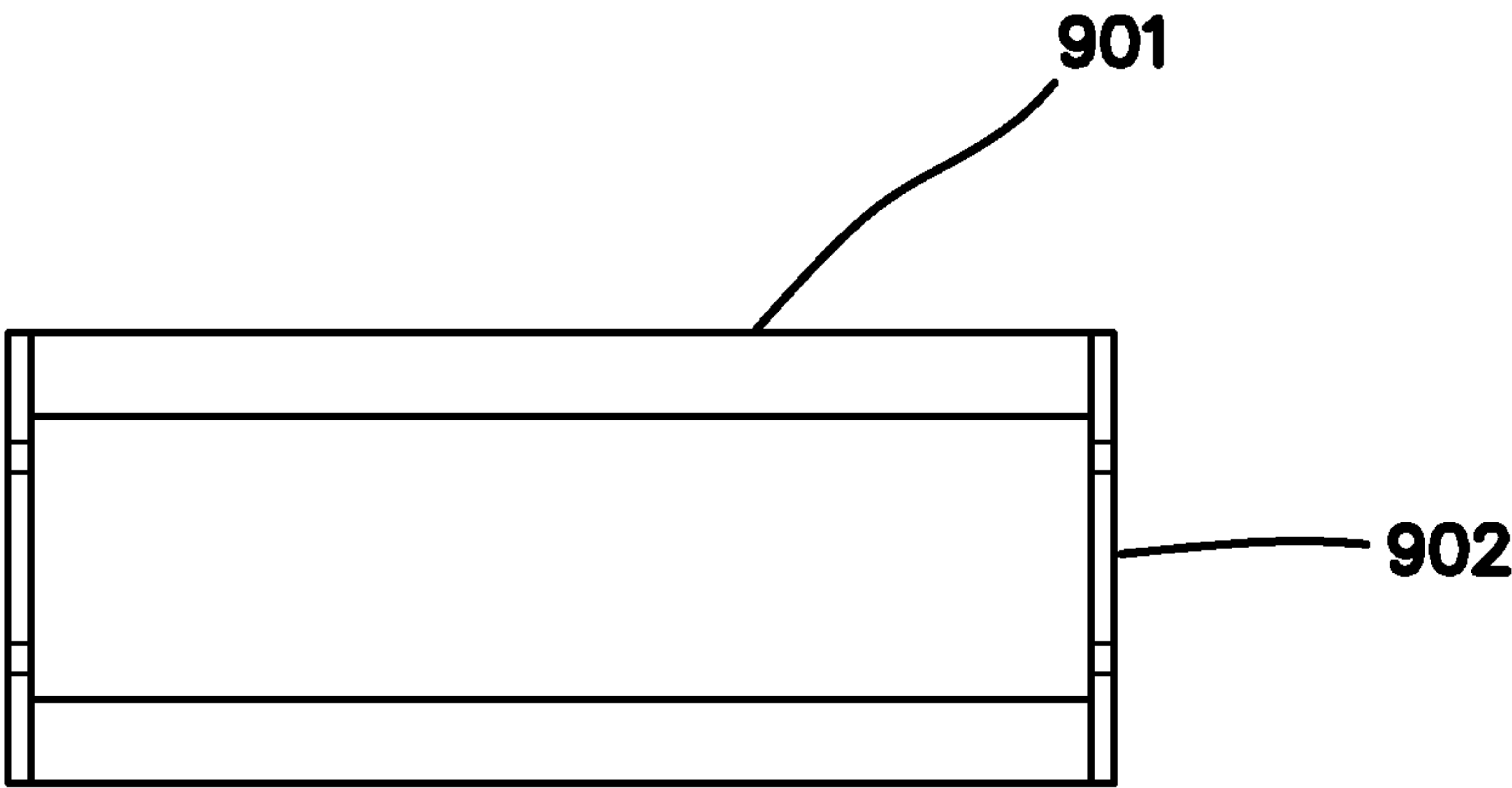


FIG. 9A

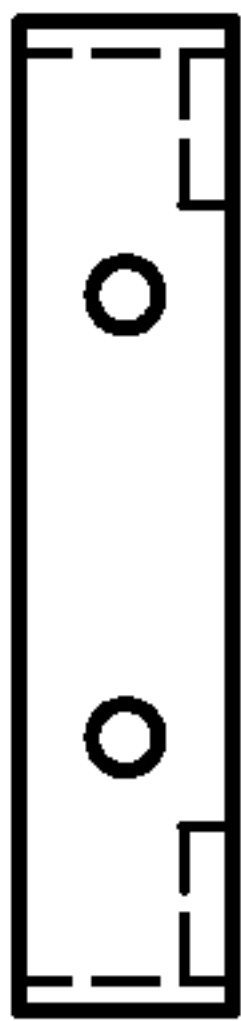


FIG. 9B

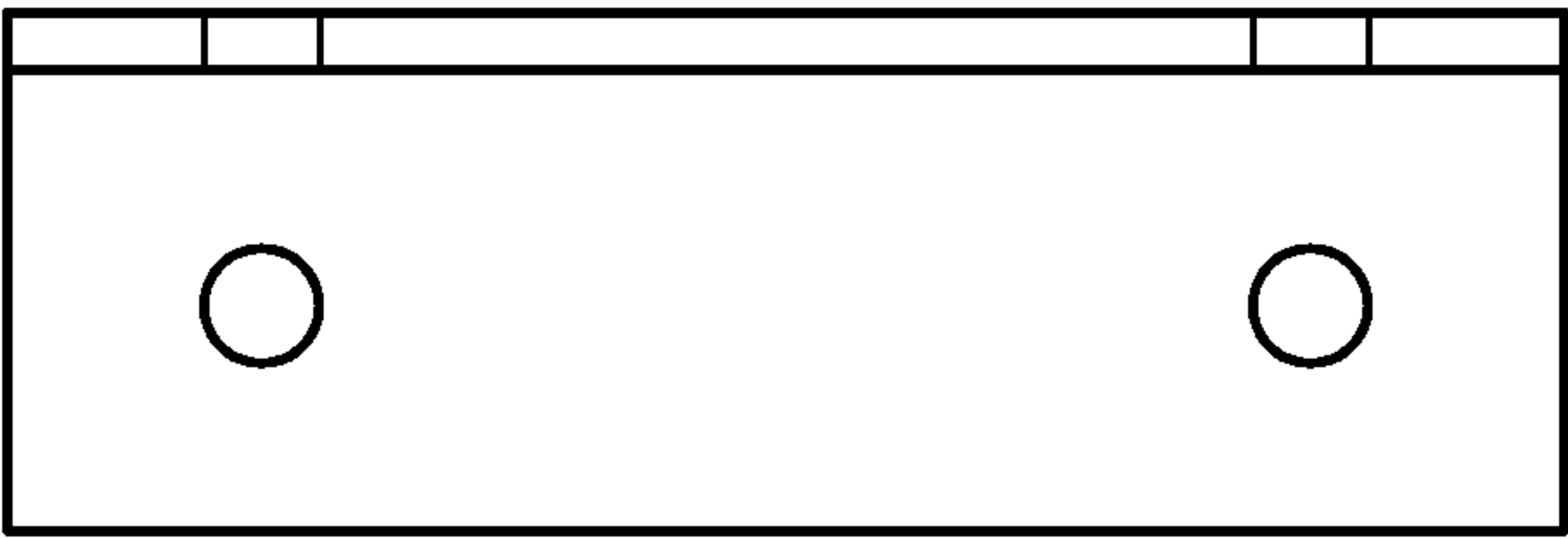


FIG. 10A

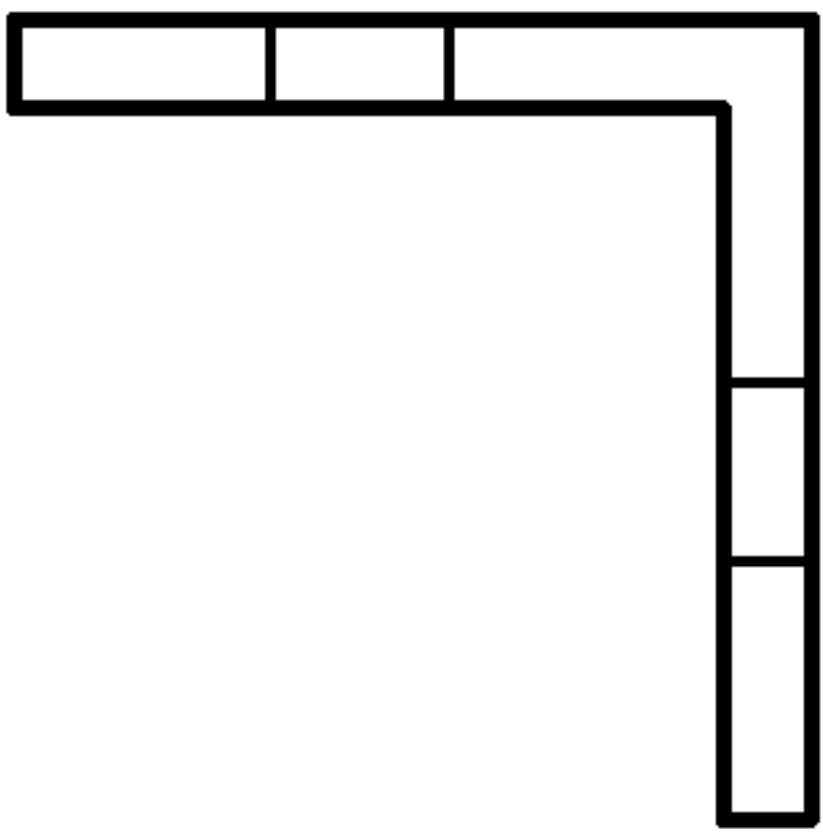


FIG. 10B

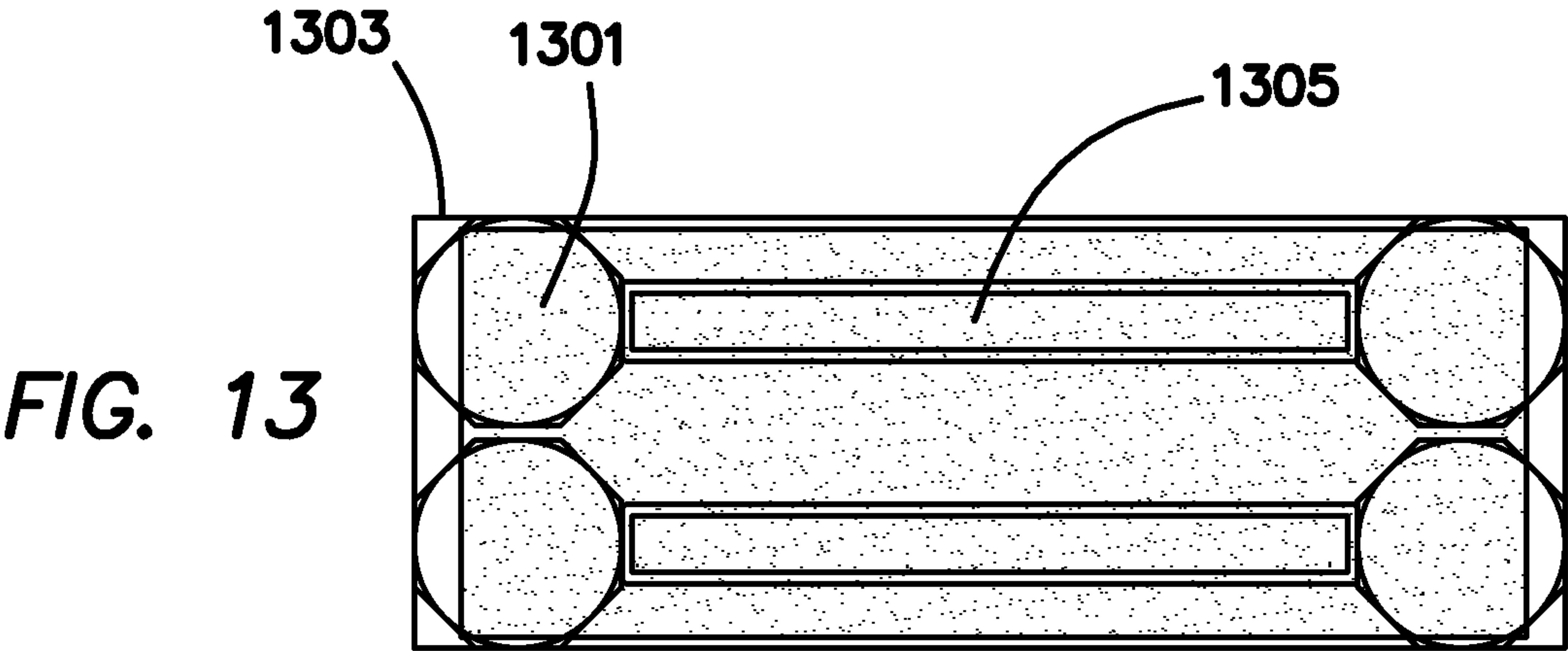


FIG. 13

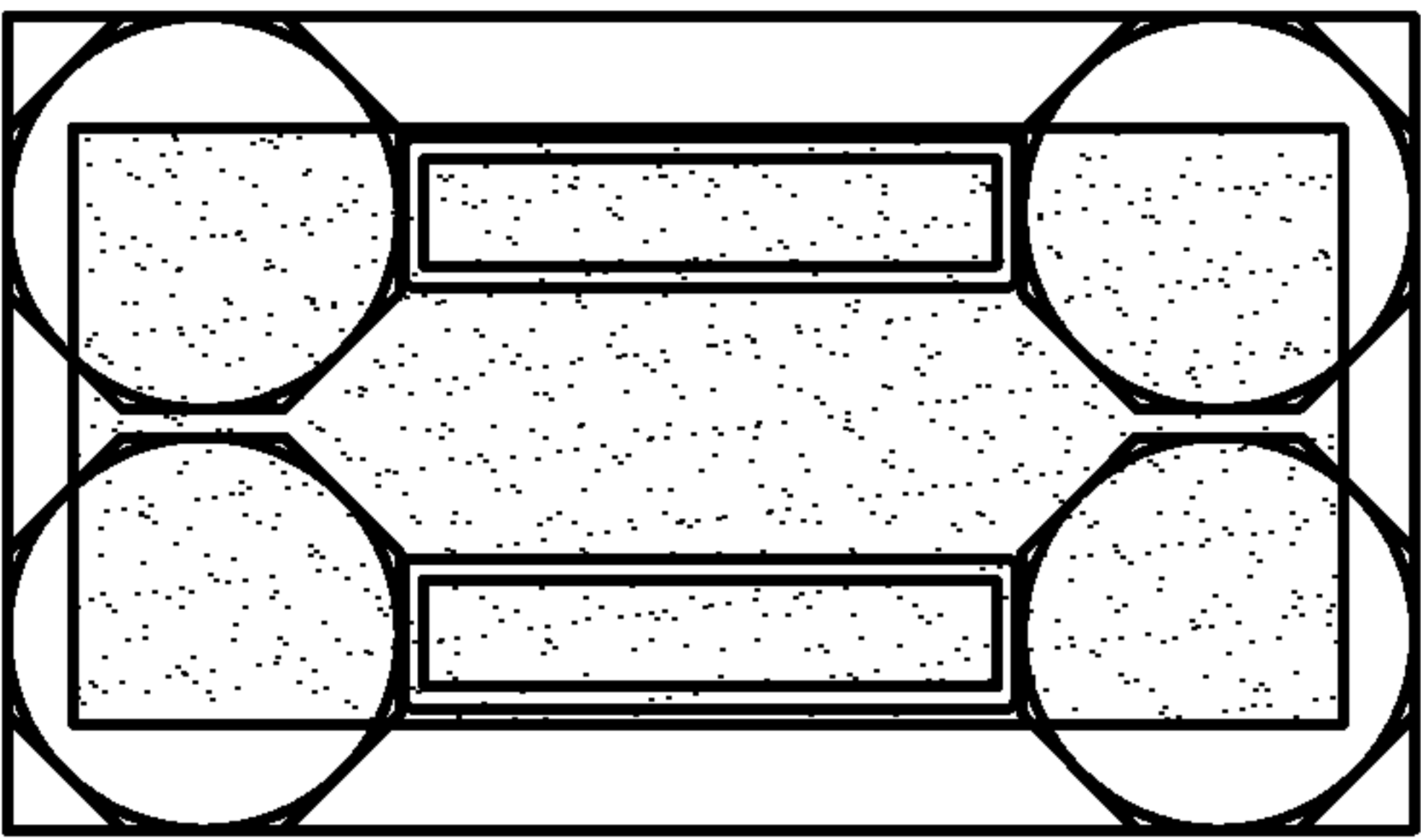


FIG. 14

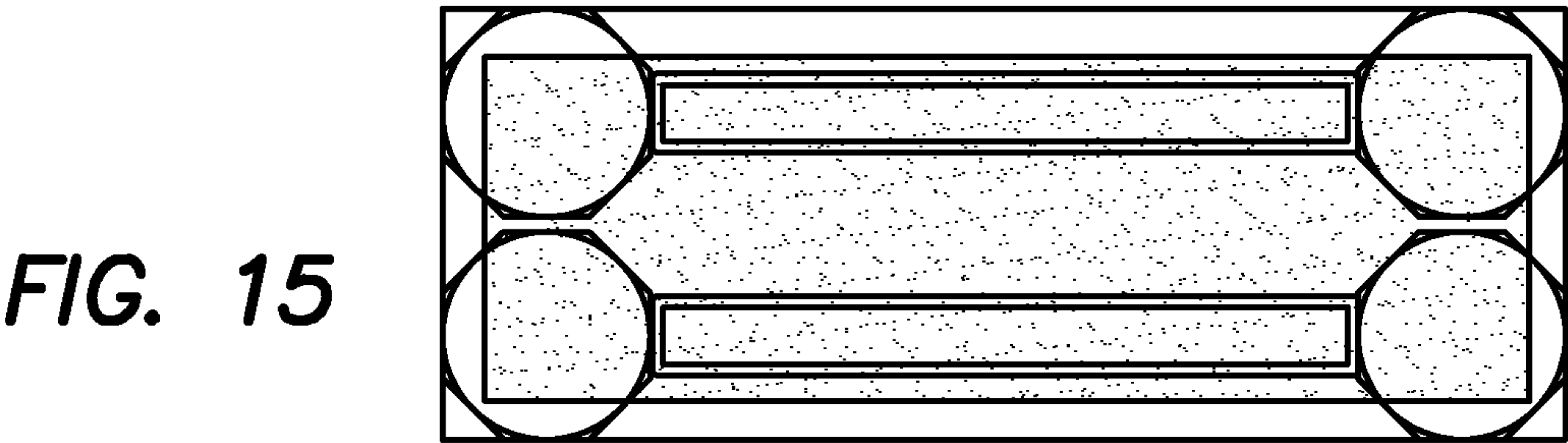


FIG. 15

