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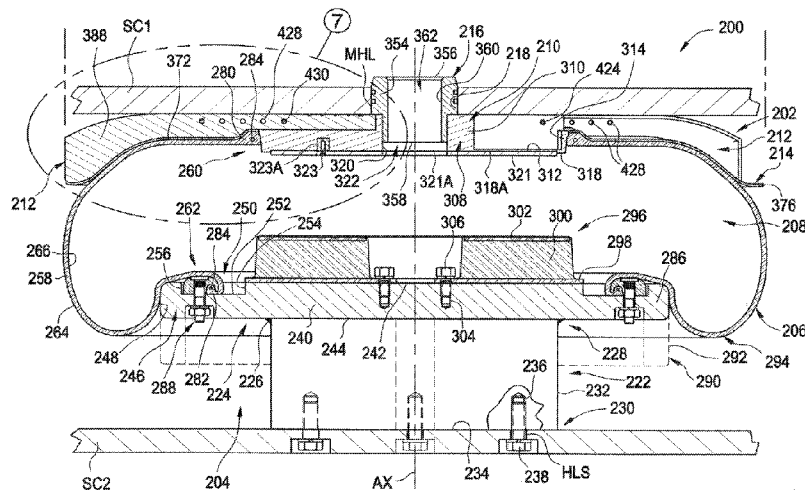


FIG. 5

(57) Abstract: End member assemblies that are dimensioned for use in forming a gas spring assembly can include an end member core that is dimensioned for securement to a flexible spring member to at least partially form the gas spring assembly. The end member assemblies can also include a plurality of rib members that are supported on the core body. The plurality of rib members are disposed in spaced relation relative to one another and include an end disposed radially outward beyond the core body. A skirt body can be supported on the core body in operative engagement with the plurality of rib members. The skirt body can include at least one surface operative to engage the flexible spring member. Gas spring assemblies, suspension systems and methods are also included.

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**END MEMBER ASSEMBLIES AS WELL AS GAS SPRING ASSEMBLIES,  
SUSPENSION SYSTEMS AND METHODS INCLUDING SAME**

**BACKGROUND**

**[0001]** The subject matter of the present disclosure broadly relates to the art of spring devices and, more particularly, to end member assemblies that are constructed using modular components such that common components can be used to manufacture end member assemblies of different sizes and/or configurations. Gas spring assemblies including such end member assemblies and suspension systems including one or more of such gas spring assemblies as well as methods of assembly are also included.

**[0002]** The subject matter of the present disclosure is capable of broad application and use in connection with a variety of applications and/or environments. For example, the subject matter of the present disclosure could be used in connection with gas spring assemblies of non-wheeled vehicles, support structures, height adjusting systems and actuators associated with industrial machinery, components thereof and/or other such equipment. In some cases, the subject matter of the present disclosure may find particular application and use in conjunction with rail vehicles, and will be described herein with particular reference thereto. However, it is to be appreciated that the subject matter of the present disclosure is amenable to use in other applications and environments, and that the specific uses shown and described herein are merely exemplary. Accordingly, the subject matter of the present disclosure is not intended to be limited to use associated with gas spring assemblies of suspension systems for wheeled (e.g., rail) vehicles.

**[0003]** Suspension systems, such as may be used in connection with motorized vehicles and/or rolling-stock rail vehicles, for example, can include one or more spring elements for accommodating forces and loads associated with the operation and use of the corresponding apparatus (e.g., motorized vehicle, rail vehicle) to which the suspension system is operatively connected. In such applications, it is often considered desirable to utilize spring elements that operate at a lower spring rate, as a reduced spring rate can favorably influence certain performance characteristics of the apparatus. That is, it is well understood in the art that the use of a spring element having a higher spring rate (i.e. a stiffer spring) will transmit a greater magnitude of inputs (e.g., inputs

due to variations in the rails of a track) to the sprung mass of the apparatus and that, in some applications, this could undesirably affect the sprung mass, such as, for example, by resulting in a rougher, less-comfortable ride of a vehicle. Whereas, the use of spring elements having lower spring rates (i.e., a softer or more-compliant spring) will transmit a lesser amount of the inputs to the sprung mass but can also, undesirably, permit increased deflection under load.

**[0004]** In some cases, the spring devices can take the form of gas spring assemblies that utilize pressurized gas as the working medium. Gas spring assemblies of various types, kinds and constructions are well known and commonly used. Typical gas spring assemblies can include a flexible spring member that is secured between comparatively rigid end members and/or end member assemblies. The end members or end member assemblies are fixedly secured to a flexible spring member (e.g., a convoluted bellows or an elongated flexible sleeve) such that a substantially fluid-tight spring chamber is formed within the gas spring assembly.

**[0005]** Gas spring assemblies are known to be constructed in a variety of sizes, configurations and arrangements that utilize flexible spring members and end members or end member assemblies of different sizes and/or constructions. In some cases, a given type and/or construction of gas spring assembly may be used in applications that have different size constraints, mounting conditions and/or load requirements. In such cases, multiple variations of the gas spring assembly may be designed, manufactured and sometimes inventoried to meet the demand for these different variations of the gas spring assembly. In many cases, such variations may include numerous common or otherwise substantially identical components. In such situations, however, numerous different versions of those components that are not common to such assemblies are typically manufactured and inventoried for later assembly as one of the variations of gas spring assembly. This can lead to inefficiencies in manufacturing processes as well as increased costs and/or inventory levels.

**[0006]** Notwithstanding the broad usage and overall success of the wide variety of end member assemblies as well as gas spring assemblies and methods that are known in the art, it is believed that a need exists to confront one or more of these competing goals and/or to overcome other disadvantages of known constructions while still

retaining comparable or improving factors such as performance, ease of manufacture, ease of assembly, ease of installation and/or reduced cost of manufacture. Thus, it is believed to be generally desirable to develop new constructions and/or designs that may advance the art of spring devices.

#### BRIEF SUMMARY

**[0007]** One example of an end member assembly in accordance with the subject matter of the present disclosure can have a longitudinal axis and can be dimensioned for securement to an associated flexible spring member to at least partially form an associated gas spring assembly. The end member assembly can include a core body that includes a core wall extending peripherally about the longitudinal axis. The core wall can include an outer mounting surface that is dimensioned to receivingly engage an associated flexible spring member such that a substantially fluid-tight seal can be formed therebetween. A plurality of rib members can be supported on the core body. The plurality of rib members can be disposed in spaced relation relative to one another about the longitudinal axis. The plurality of rib members can include a rib wall extending in a lengthwise direction between a first end disposed along the core body and a second end disposed radially outward beyond the outer mounting surface of the core body. The end member assembly can also include a skirt body disposed along the core body. The skirt body can include a skirt wall with an inner edge, an outer edge disposed radially outward of the inner edge, a first surface disposed in facing relation to the plurality of rib member and a second surface dimensioned to operatively engage the associated flexible spring member.

**[0008]** One example of a gas spring assembly in accordance with the subject matter of the present disclosure can include a flexible spring member having a longitudinal axis. The flexible spring member can include a flexible wall that can extend peripherally about the longitudinal axis and longitudinally between opposing ends to at least partially define a spring chamber. An end member can be secured across one end of the flexible spring member such that a substantially fluid-tight seal is formed therebetween. An end member assembly according to the foregoing paragraph can be secured across the

other end of the flexible spring member such that a substantially fluid-tight seal is formed therebetween.

**[0009]** One example of a suspension system in accordance with the subject matter of the present disclosure can include a pressurized gas system including a pressurized gas source and a control device in fluid communication with the pressurized gas source. At least one gas spring assembly in accordance with the foregoing paragraph can be disposed in fluid communication with the pressurized gas source with the control device disposed in fluid communication therebetween.

**[0010]** One example of a method of assembling a gas spring assembly in accordance with the subject matter of the present disclosure and having a longitudinal axis can include providing a core body that includes a core wall extending peripherally about the longitudinal axis. The core wall can include an outer mounting surface dimensioned to receivingly engage an associated flexible spring member such that a substantially fluid-tight seal can be formed therebetween. The method can also include providing a plurality of rib members that have a length and include a rib wall extending in a lengthwise direction between a first end and a second end. The method can further include positioning the plurality of rib member on the core body such that the plurality of rib members are disposed in spaced relation relative to one another about the longitudinal axis with the first end disposed along the core body and a second end disposed radially outward beyond the core body. The method can further include providing a skirt body that can include a skirt wall with an inner edge, an outer edge disposed radially outward of the inner edge, a first surface and a second surface opposite the first surface. The method can also include positioning the skirt body along the core body such that the first surface of the skirt body is disposed in facing relation to the plurality of rib members and the second surface is exposed for operative engagement with the associated flexible spring member.

**[0011]** In some cases, a method of assembling a gas spring assembly in accordance with the foregoing paragraph can further include providing a flexible spring member that has a longitudinal axis. The flexible spring member can include a flexible wall that can extend peripherally about the longitudinal axis and longitudinally between opposing ends to at least partially define a spring chamber. The method can further include

securing the end member assembly to the flexible spring member such that a substantially fluid-tight seal is formed along one of the opposing ends.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a schematic representation of one example of a rail vehicle including a suspension system in accordance with the subject matter of the present disclosure.

[0013] FIG. 2 is a schematic representation of one example of a pneumatic gas system operatively associated with the suspension system in FIG. 1.

[0014] FIG. 3 is a side elevation view of one example of a gas spring assembly including one example of an end member assembly in accordance with the subject matter of the present disclosure.

[0015] FIG. 4 is a top plan view of the gas spring assembly in FIG. 3.

[0016] FIG. 5 is a cross-sectional side view of the gas spring assembly in FIGS. 3 and 4 taken from along line 5-5 in FIG. 4, and shown in a first condition of use.

[0017] FIG. 6 is a cross-sectional side view of the gas spring assembly in FIGS. 3-5 shown in a second condition of use.

[0018] FIG. 7 is an enlarged view of the portion of the gas spring assembly in FIGS. 3-6 that is identified as Detail 7 in FIG. 5.

[0019] FIG. 8 is a top perspective view of the exemplary end member assembly shown in FIGS. 3-7.

[0020] FIG. 8A is a bottom perspective view of the exemplary end member assembly shown in FIGS. 3-8.

[0021] FIG. 9 is an exploded view of the end member assembly in FIGS. 8 and 8A.

[0022] FIG. 10 is a top plan view of an exemplary core member of the end member assembly in FIGS. 3-8, 8A and 9.

[0023] FIG. 11 is a cross-sectional side view of the core member in FIG. 10 taken from along line 11-11 thereof.

[0024] FIG. 12 is a top perspective view of an exemplary rib member of the end member assembly in FIGS. 3-8, 8A and 9.

[0025] FIG. 13 is a bottom perspective view of the rib member in FIG. 12.

[0026] FIG. 14 is a side elevation view of the rib member in FIGS. 12 and 13.

[0027] FIG. 15 is a top plan view of the rib member in FIGS. 12-14.

[0028] FIG. 16 is an enlarged view of the portion of the end member assembly in FIGS. 3-8, 8A and 9 that is identified as Detail 16 in FIG. 3.

[0029] FIG. 17 is an enlarged view, in partial cross section, of the portion of the end member assembly in FIGS. 3-8, 8A and 9 that is identified as Detail 17 in FIG. 4.

[0030] FIG. 18 is an enlarged view of an alternate construction of the portion of the end member assembly shown in FIG. 16.

[0031] FIG. 19 is an enlarged view, similar to that of FIG. 17, of showing the alternate construction in FIG. 18.

#### DETAILED DESCRIPTION

[0032] Turning now to the drawings, it is to be understood that the showings are for purposes of illustrating examples of the subject matter of the present disclosure and are not intended to be limiting. Additionally, it will be appreciated that the drawings are not to scale and that portions of certain features and/or elements may be exaggerated for purposes of clarity and/or ease of understanding.

[0033] FIG. 1 illustrates one example of a vehicle including a suspension system in accordance with the subject matter of the present disclosure, such as a rail vehicle **100** that is adapted for movement or otherwise displaceable along a track **TRK** that is at least partially formed by rails **RLS** of an indefinite length. It will be appreciated that the subject matter of the present disclosure is broadly applicable for use in a wide variety of applications, and that rail vehicle **100** merely represents one example of a suitable application. Rail vehicle **100** is shown being representative of rolling stock (e.g., a railcar) rather than an engine or traction-drive vehicle. However, this representative use is merely exemplary and not intended to be limiting.

[0034] Rail vehicle **100** includes a vehicle body **102** supported on one or more frame and wheel assemblies **104**, two of which are shown in FIG. 1. In some cases, frame and wheel assemblies **104** may be referred to in the art as “trucks,” “rail bogies” or simply “bogies,” and such terms may be used herein in an interchangeable manner. Bogies **104** are shown as being disposed toward opposing ends **106** and **108** of rail vehicle **100**.

[0035] Bogies **104** are shown in FIG. 1 as including a frame **110** as well as one or more wheel sets **112** that are typically formed by an axle **114** and a pair of spaced-apart wheels **116**. Normally, bogies **104** include at least two wheel sets, such as is shown in FIG. 1, for example, that are operatively connected to the frame in manner suitable to permit the wheels to roll along rails **RLS** of track **TRK**. In many cases, a primary suspension arrangement (not shown) is operatively connected between the wheels sets and the frame to permit relative movement therebetween. Bogies **104** are also shown as including a secondary suspension system **118** that includes at least one gas spring assembly. In the exemplary arrangement shown in FIGS. 1 and 2, bogies **104** include two gas spring assemblies **120** that are operatively disposed between frame **110** and vehicle body **102** to permit relative movement therebetween.

[0036] Rail vehicles, such as rail vehicle **100**, for example, typically include a braking system with one or more brakes operatively associated with each wheel set. In the exemplary arrangement in FIG. 1, two brakes **122** are shown as being operatively associated with each of wheel sets **112** with one brake disposed adjacent each of wheels **116**. It will be appreciated, however, that other arrangements could alternately be used.

[0037] Additionally, rail vehicles, such as rail vehicle **100**, for example, typically include at least one pneumatic system that is operatively associated therewith. In many cases, components of the one or more pneumatic systems can be distributed along the length of a train that is formed from a plurality of rail vehicles, such as one or more traction-drive engines and one or more rolling stock vehicles, for example. In such cases, each individual rail vehicle will include one or more portions of the pneumatic system. Usually, these one or more portions are serially connected together to form an overall pneumatic system of a train.

[0038] Typical pneumatic systems include two or more separately controllable portions, such as a pneumatic braking system that is operatively associated with the vehicle brakes (e.g., brakes **122**) and a pneumatic supply system that is operatively associated with the other pneumatically-actuated devices of the rail vehicle, such as the secondary suspension system, for example. As such, rail vehicles typically include a dedicated conduit for each of these two systems. Such conduits normally extend

lengthwise along the vehicle body and are often individually referred to as a brake pipe and a supply pipe.

**[0039]** FIG. 2 illustrates one example of a pneumatic system **124** that is operatively associated with rail vehicle **100** and includes a braking system (not numbered) with a brake pipe **126** in fluid communication with at least brakes **122** (FIG. 1) and a pneumatic supply system (not numbered) with a supply pipe **128** in fluid communication with at least gas spring assemblies **120** of secondary suspension system **118**. It will be recognized and appreciated that pneumatic system **124** will include a wide variety of other components and devices. For example, the braking system can include one or more isolation valves **130** that can be fluidically connected along brake pipe **126**. As other examples, the pneumatic supply system can include one or more isolation valves **132**, one or more filters **134** and/or one or more non-return valves **136** (which may be alternately referred to as one-way or check valves). The pneumatic supply system can also include one or more reservoirs or other pressurized gas storage devices. In the arrangement shown in FIG. 2, for example, the pneumatic supply system includes a reservoir **138** that is operative to store a quantity of pressurized gas for use in supplying gas spring assemblies **120** of the secondary suspension system, and a reservoir **140** that is operative to store a quantity of pressurized gas for use as an auxiliary reservoir of the braking system.

**[0040]** Generally, certain components of the braking system, such as brakes **122**, for example, as well as certain components of the pneumatic supply system are supported on or otherwise operatively associated with one of bogies **104** of rail vehicle **100**. For example, supply lines **142** can fluidically interconnect bogies **104** with the pneumatic supply system. Supply lines **142** are shown as being fluidically connected with one or more leveling valves **144** that are operatively connected with gas spring assemblies **120**, such as by way of gas lines **146**, and are selectively operable to transfer pressurized gas into and out of the gas spring assemblies. In some cases, a pressurized gas storage device or reservoir **148** can, optionally, be fluidically connected along gas line **146** between leveling valve **144** and gas spring assembly **120**. Additionally, a cross-flow line **150** can, optionally, be connected in fluid communication between two or more of gas lines **146**. In some cases, a control valve **152**, such as a

duplex check valve, for example, can be fluidically connected along cross-flow line **150**, such as is shown in FIG. 2, for example.

**[0041]** One example of a gas spring assembly in accordance with the subject matter of the present disclosure, such as may be suitable for use as one or more of gas spring assemblies **120** in FIGS. 1 and 2, for example, is shown as gas spring assembly **200** in FIGS. 3-7. The gas spring assembly has a longitudinal axis **AX** and includes an end member (which may alternately referred to herein as an end member assembly) **202**, an end member (which may alternately referred to herein as an end member assembly) **204** spaced longitudinally from end member **202** and a flexible spring member or sleeve **206** that extends peripherally about the longitudinal axis and is secured between the end members to at least partially define a spring chamber **208**.

**[0042]** Gas spring assembly **200** can be disposed between associated sprung and unsprung masses of an associated vehicle in any suitable manner. For example, one end member can be operatively connected to an associated sprung mass with the other end member disposed toward and operatively connected to an associated unsprung mass. In the arrangement shown in FIGS. 3-7, for example, end member **202** is secured on or along a structural component **SC1**, such as an associated vehicle body **102** in FIG. 1, for example, and can be secured thereon in any suitable manner. As another example, end member **204** is secured on or along a structural component **SC2**, such as an associated rail bogie **104** in FIG. 1, for example, and can be secured thereon in any suitable manner.

**[0043]** In the exemplary arrangement in FIGS. 3-8, 8A and 9, end member assembly **202** is shown as being one example of an end member assembly in accordance with the subject matter of the present disclosure. End member assembly **202** can include a core body **210** and a plurality of rib members **212** that are disposed in operative engagement with the core body. End member assembly **202** can also include a skirt body **214** that can be disposed along core body **210** and can operatively engage one or more of rib members **212**. In some cases, core body **210** can include a projection or boss that is integrally formed therewith. In other cases, end member assembly **202** can include a connector fitting **216** that can be operatively disposed on or along core body **210**.

[0044] As mentioned above, one or more securement devices can be used to secure or otherwise interconnect the end members of the gas spring assembly with corresponding structural components. For example, one or more threaded fasteners (not shown) and/or other features (not shown) could operatively secure the end member to the associated structural component. Additionally, or in the alternative, connector fitting **216** can include an outer surface **218** (FIGS. 5 and 6) that is dimensioned for receipt within a passage or mounting hole **MHL** that extends into or through structural component **SC1**. Additionally, one or more sealing elements **220** can, optionally, be included that are disposed between or otherwise at least partially form a substantially fluid-tight connection between the end member and the structural component, such as between connector fitting **216** and the inside surface (not numbered) of structural component **SC1** through which mounting hole **MHL** extends, for example. In some cases, structural component **SC1** can, optionally, at least partially define an external reservoir suitable for storing a quantity of pressurized gas.

[0045] End member **204** is shown as taking the form of an assembly that includes a support base or pedestal **222** and a base plate **224** that is secured on or along the pedestal in a suitable manner, such as by way of a flowed-material joint **226**, for example. Pedestal **222** extends axially between opposing ends **228** and **230**, and includes an outer surface **232** that extends peripherally about axis **AX** and an end surface **234** that is disposed along end **230** and is dimensioned or otherwise configured for operative engagement with an associated structural component, such as structural component **SC2**, for example. It will be appreciated that end member **204** can be secured on or along the associated structural component in any suitable manner. As one example, pedestal **222** can include a plurality of securement features **236**, such as threaded passages that extend inwardly into the pedestal from along end surface **234**, for example. In some cases, a corresponding number of one or more holes or passages **HLS** can extend through structural component **SC2** that are dimensioned for receipt of a securement device **238**, such as a threaded fastener, for example. It will be appreciated, however, that other configurations and/or arrangements could alternately be used.

[0046] Base plate **224** can have a plate wall **240** that has opposing surfaces **242** and **244** such that a plate height (not identified) is at least partially defined therebetween. Base plate **224** is shown as being generally planar and extending outwardly to an outer periphery **246**. In some cases, base plate **224** can have a generally circular shape such that an outer peripheral surface **248** extending in a heightwise direction can have a generally cylindrical shape. Additionally, in some cases, base plate **224** can, optionally, include an endless annular recess or groove **250** that extends axially inwardly into the base plate from along surface **242** thereof. It will be appreciated that such a groove, if provided, can be of any suitable size, shape, configuration and/or arrangement. For example, groove **250** is shown as being at least partially defined by a bottom surface **252**, an inner side surface **254** and an outer side surface **256**. In a preferred arrangement, groove **250** can be dimensioned to at least partially receive a portion of flexible spring member **206** and one or more retaining elements, such as may be used to secure the flexible spring member on or along the base plate, for example.

[0047] Flexible spring member **206** can be of any suitable size, shape, construction and/or configuration. As one example, flexible spring member **206** can include a flexible wall **258** that extends in a longitudinal direction between opposing ends **260** and **262**. It will be appreciated that flexible spring member **206** and flexible wall **258** thereof can be formed in any suitable manner and from any suitable material or combination of materials, such as by using one or more fabric-reinforced, elastomeric plies or layers and/or one or more un-reinforced, elastomeric plies or layers, for example. Typically, one or more fabric-reinforced, elastomeric plies and one or more un-reinforced, elastomeric plies will be used together and formed from a common elastomeric material, such as a synthetic rubber, a natural rubber or a thermoplastic elastomer. In other cases, however, a combination of two or more different materials, two or more compounds of similar materials, or two or more grades of the same material could be used.

[0048] As shown in FIGS. 3-7, for example, flexible wall **258** can include an outer surface **264** and an inner surface **266** that can at least partially define spring chamber **208**. Additionally, as identified in FIGS. 7, flexible wall **258** can include an outer or cover ply **268** that at least partially forms outer surface **264** and an inner or liner ply **270** that at

least partially forms inner surface **266**. In a preferred arrangement, flexible wall **258** can also include one or more reinforcing plies disposed between outer and inner surfaces **264** and **266**. The one or more reinforcing plies can be of any suitable construction and/or configuration. For example, the one or more reinforcing plies can include one or more lengths of filament material that are at least partially embedded therein. It will be appreciated that the one or more lengths of filament material can be of any suitable type, kind and/or construction, such as monofilament polymeric strands, braided cotton yarn or bundled carbon fibers, for example. Furthermore, such one or more lengths of filament material could optionally be coated or otherwise treated, such as, for example, to improve adhesion with the adjacent plies or other surrounding material. For example, the filament material could be rubber coated, such that upon applying a layer of rubber over the filament material improved adhesion between the various layers could result during and/or after vulcanization or another curing process, for example.

**[0049]** Additionally, it will be appreciated that the one or more lengths of filament material, if provided, can be oriented in any suitable manner. As one example, flexible wall **258** is shown in FIG. 6 as including a plurality of filament segments **272** of one reinforcing ply **274** disposed at one bias angle **BA1** and a plurality of filament segments **276** of another reinforcing ply **278** disposed at another bias angle **BA2**. It will be appreciated that any suitable bias angles can be used, such as bias angles within a range of from approximately 3 degrees to approximately 87 degrees, for example. In some cases, the filament segments can be disposed at approximately the same bias angle but oriented in the opposing direction, such as is represented in FIG. 6 by reference dimensions **BA1** and **BA2**, for example.

**[0050]** In some cases, flexible wall **258** can, optionally, include a mounting bead disposed along either one or both of ends **260** and **262**. In the arrangement shown in FIGS. 3-7, mounting beads **280** and **282** are shown as being respectively disposed along ends **260** and **262**. In some cases, one or more of the mounting beads can, optionally, include a reinforcing element, such as an endless, annular bead core **284**, for example, that is at least partially embedded therein and is substantially inextensible in comparison with at least one or more materials of flexible wall **258**.

[0051] It will be appreciated, that the ends of flexible spring member **206** can be secured on, along or otherwise interconnected between end members **202** and **204** in any suitable manner. As one example, gas spring assembly **200** can include one or more bead retaining elements that engage at least a portion of the flexible spring member and maintain the flexible spring member in substantially fluid-tight engagement with the corresponding end member (e.g., end member **204**). In the arrangement shown in FIGS. 5 and 6, end **262** of flexible wall **258** is disposed in abutting engagement with bottom surface **252** of groove **250** in base plate **224**. A bead retaining element **286**, such as in the form of an endless, annular ring, for example, can capture at least a portion of mounting bead **282** and is shown as being secured on or along base plate **224** by way of a plurality of securement devices **288**, such as, for example, threaded fastener (not numbered) and threaded nut (not numbered) combinations that extend through at least approximately aligned holes or slots (not numbered) in the base plate and in the bead retaining element.

[0052] Typically, at least a portion of flexible spring member **206** will extend radially outward beyond outer periphery **246** of base plate **224**. In some cases, end member **204** can include an outer support wall **290** that can, optionally, extend peripherally around or otherwise along base plate **224**, such as from along the plate wall of the base plate and in a direction toward end **230** of pedestal **222**. In such cases, flexible spring member **206** can extend along an outer surface **292** of outer support wall **290** such that a rolling lobe **294** is formed along the flexible spring member. Outer surface **292** is shown in FIGS. 5 and 6 as having a generally cylindrical shape, and rolling lobe **294** can be displaceable along the outer surface as the gas spring assembly is axially displaced between extended and compressed conditions, such as may occur during dynamic use in operation. It will be appreciated that other shapes and/or configurations of outer support wall **290** and/or outer surface **292** can alternately be used, such as may be useful to provide desired performance characteristics, for example.

[0053] As is well known in the art, it is generally desirable to avoid or at least minimize contact between end members of a gas spring assembly, such as may occur due to variations in load conditions and/or upon deflation of the gas spring assembly, for example. Additionally, or in the alternative, it may be desirable to support a sprung

mass (e.g., vehicle body **102**) at a predetermined height or distance (or within a predetermined range of heights or distances) relative to the unsprung mass (e.g., bogies **104**) during uninflated, underinflated or other such condition of the gas spring assembly. As such, gas spring assembly **200** is shown as including a jounce bumper **296** that is disposed within spring chamber **208** and supported on end member **204**. As identified in FIGS. 5 and 6, jounce bumper **296** is shown as including a mounting plate **298** that is disposed in abutting engagement with end member **204**, a bumper body **300** supported on the mounting plate, and a wear or slide plate **302** that is supported on, and in some cases at least partially embedded or otherwise received within, bumper body **300**.

[0054] It will be appreciated that jounce bumper **296** can be secured on or along an end member in any suitable manner. As identified in FIGS. 5 and 6, for example, base plate **224** of end member **204** is shown as including one or more securement features **304**, such as may take the form of a plurality of threaded holes, for example. In such case, a corresponding number of one or more securement devices **306**, such as one or more threaded fasteners, for example, can extend through one of a corresponding number of holes, openings or other features of the jounce bumper or a component thereof (e.g., mounting plate **298**) to secure the jounce bumper on or along the end member.

[0055] End member assembly **202** is shown in FIGS. 3-8, 8A and 9 as including core body **210** that includes a core wall **308**. It will be appreciated that core body **210** and core wall **308** thereof can include any suitable number of one or more walls and/or wall portions. Furthermore, it will be appreciated that the one or more walls and/or wall portions can be formed from any suitable material or combination of materials, such as metal materials (e.g., steel, aluminum) and/or polymeric materials (e.g., polyethylene, polyurethane and/or polyamide).

[0056] As one example, core wall **308** is shown in FIGS. 10 and 11 as including an inner wall portion **310**, a base wall portion **312** and an outer peripheral wall portion **314**. Inner wall portion **310** extends axially between surfaces **316** and **318**. The inner wall portion also includes an inner surface **320** that at least partially defines a passage **322** extending through core body **210**. Base wall portion **312** extends radially outward from

along inner wall portion **310** and can at least partially form surface **318**. In some cases, core body **210** and/or core wall **308** can be constructed such that surface **318** extending along base wall portion **312** can abuttingly engage jounce bumper **296** and/or a component thereof (e.g., wear plate **302**).

**[0057]** Gas spring assembly **200** can also, optionally, include one or more additional features and/or that may be dimensioned to or otherwise suitable for abuttingly engaging the jounce bumper or a component thereof (e.g., wear plate **302**). In some cases, such features and/or components can be integrally formed on or along one or more components of end member assembly **202**, such as surface **318** of core body **210**, for example. In other cases, such features and/or components can be provided separately and attached or otherwise secured on or along core body **210** or another component of end member assembly **202**. For example, in the arrangement shown in FIGS. 5-7, 8A and 9-11, a wear or slide plate **321** can, optionally, be supported on or along core body **210** in facing relation to bumper body **300** and/or wear or slide plate **302**. In some cases, wear or slide plate **321** can include a central opening **321A** dimensioned to fluidically communicate with passage **322**.

**[0058]** It will be appreciated that wear or slide plate **321** can be disposed on or along core body **210** in any suitable manner. As one example, the wear or slide plate could be disposed in abutting engagement with surface **318** of core wall **308**. As another example, core wall **308** can include a recess surface **318A** that is offset from surface **318** to at least partially form a recess (not numbered) dimensioned to at least partially receive wear or slide plate **321**. It will be appreciated that wear or slide plate **321**, if included, can be secured on or along core body **210** in any suitable manner. As one example, wear or slide plate **321** can include a plurality of holes or passages (not numbered) formed therethrough that are dimensioned to receive securement devices **323**, such as threaded fasteners, for example. In some cases, securement devices **323** can directly operatively engage the material from which core wall **308** is formed. In other cases, core body **210** can include a plurality of securement inserts **323A** that can be at least partially embedded or otherwise received in core wall **308**. In such case, securement devices **323** can take the form of threaded fasteners and securement

inserts **323A** can include threaded passages that are complimentary and dimensioned to receivingly engage the threaded fasteners.

[0059] Base wall portion **312** can also include one or more surfaces **324** that face generally opposite surface **318**. Outer peripheral wall portion **314** extends axially from along base wall portion **312** to a distal edge surface **326**. The outer peripheral wall portion can also include one or more inner surfaces **328** and an outer peripheral surface **330**. In some cases, outer peripheral wall portion **314** can also include a mounting surface **332** that is disposed in axially-spaced relation to outer peripheral surface **330**. If provided, mounting surface **332** can be dimensioned to receivingly engage an end of the flexible spring member such that a substantially fluid-tight seal is formed therebetween.

[0060] As discussed above, it will be appreciated, that the ends of flexible spring member **206** can be secured on, along or otherwise interconnected between end members **202** and **204** in any suitable manner. As mentioned above, for example, gas spring assembly **200** can include one or more bead retaining elements that engage at least a portion of the flexible spring member and maintain the flexible spring member in substantially fluid-tight engagement with the corresponding end member (e.g., end member **202**). In some cases, a bead retaining element, such as bead retaining element **286**, for example, could be used. Alternately, one or more bead retaining features can be formed on or along another component of the gas spring assembly.

[0061] As another alternative, end **260** of flexible spring member **206** can be dimensioned for receipt and retention on or along core wall **308**. In the arrangement shown in FIGS. 3-7, for example, mounting bead **280** is dimensioned to abuttingly engage mounting surface **332** of outer peripheral wall portion **314** such that a substantially fluid-tight seal can be formed therebetween. It will be appreciated that end **260** can be assembled onto core body **210** in any suitable manner. As one example, end **260** can be position adjacent the intersection of base wall portion **312** and outer peripheral wall portion **314**. End **260** of flexible wall **258** can then be urged, pressed or otherwise forced into abutting engagement with one or more of surfaces **330** and **332** of outer peripheral wall portion **314**.

[0062] Core wall **308** can also include a plurality of groove or slot wall portions **334** and **336** that together at least partially define a plurality of grooves or slots **338**. Groove wall portions **334** and **336** are shown as projecting axially from along base wall portion **312** into approximate alignment with surface **316**. Additionally, groove wall portions **334** and **336** extend radially between inner wall portion **310** and outer peripheral wall portion **314**. Groove wall portions **334** and **336** are disposed in spaced relation to one another and include opposing surfaces **340** and **342**. Surfaces **340** of groove wall portions **334** and **336** together with one or more outer surfaces **344** of inner wall portion **310**, one or more surfaces **324** of base wall portion **312** and one or more inner surfaces **328** of outer peripheral wall portion **314** can at least partially form a plurality of recesses **345** within core body **210**. Recesses **345** can be disposed in radially-spaced relation to one another between adjacent pairs of groove wall portions **334** and **336**.

[0063] Grooves **338** can be at least partially formed by surfaces **342** of groove wall portions **334** and **336**. In some cases, grooves **338** can also be at least partially defined by one or more bottom surfaces **346**. Grooves **338** can extend radially inward from an open end **348** disposed along outer peripheral wall portion **314** to an end surface **350** disposed along inner wall portion **310**. As such, grooves **338** can have a groove length extending from end surface **350** in a generally radial direction to an end point, such as may be formed along outer peripheral surface **330** and/or mounting surface **332**, as is represented in in FIG. 11 by reference dimension **GLT**. Grooves **338** are shown in FIGS. 3-11 as including an open side **352** (FIG. 11) that is disposed generally opposite bottom surface **346**. As such, it will be appreciated that grooves **338** include groove length **GLT**, a width (i.e., a distance between surfaces **342** of adjacent groove wall portions **334** and **336**) and a height (i.e., a distance between **316** and **346**), and are dimensioned to receive at least a portion of one of rib members **212**.

[0064] As shown in FIGS. 3-8, 8A and 9, connector fitting **216** can include a fitting wall **354** that can include any suitable number of one or more walls and/or wall portions. Furthermore, the one or more walls and/or wall portions of fitting wall **354** can be formed from any suitable material or combination of materials, such as metal materials (e.g., steel, aluminum) and/or polymeric materials (e.g., polyethylene, polyurethane and/or polyamide). Fitting wall **354** is shown as extending longitudinally between end surfaces

**356** and **358**, and includes an inner surface **360** extending between end surfaces **356** and **358**. Inner surface **360** at least partially defines a fitting passage **362** extending through connector fitting **216**. Fitting wall **354** also includes an outer surface **364** that has a first cross-sectional dimension (e.g., diameter) and extends from along end surface **356** in a direction toward end surface **358**. Fitting wall further includes an outer surface **366** that has a second cross-sectional dimension (e.g., diameter) and extends from along end surface **358** in a direction toward end surface **356**. In a preferred arrangement, outer surface **364** is greater than outer surface **366** such that a shoulder surface **368** extends between and operatively interconnects outer surfaces **364** and **366**.

[0065] Connector fitting **216** can be secured on or along core body **210** in any suitable manner. For example, a flowed-material joint could be formed between the connector fitting and the core body. Additionally, or as alternatives, a pressed-fit or threaded connection could be used to secure the connector fitting on the core body. In this manner, fitting passage **362** can be disposed in fluid communication with passage **322**. In a preferred arrangement, outer surface **364** and the inside surface of mounting hole **MHL** of structural component **SC1** are cooperatively dimensioned such that at least a portion of connector fitting **216** can extend into and/or through mounting hole **MHL** of the structural component. In some cases, one or more annular grooves **370** can extend radially into or otherwise provided along outer surface **364**, such as may be dimensioned to receivingly engage sealing elements **220**, for example. Additionally, in a preferred arrangement, outer surface **366** and inner surface **320** of passage **322** are cooperatively dimensioned such that a press-fit connection can be formed between the connector fitting and the core body. It will be appreciated, however, that other configurations and/or arrangements could alternately be used for operatively connecting the connector fitting and the core body, such as have been described above, for example.

[0066] In an assembled condition, connector fitting **216** can be positioned on or along core body **210** such that outer surface **364** projects radially outward beyond end surface **350** of grooves **338**. In such case, shoulder surface **368** can at least partially cover a portion of open side **352** of grooves **338**. In a preferred arrangement, shoulder

surface **368** can, optionally, be positioned in abutting engagement with at least a portion of surface **316** or otherwise across the top surfaces of groove wall portions **334** and **336**. In this manner, shoulder surface **368** together with surfaces **342**, **346** and **350** can at least partially form a closed end of grooves **338**.

**[0067]** As shown in FIGS. 3-8, 8A and 9, end member assembly **202** includes a lateral support element in the form of skirt body **214**, which is supported on or along core body **210** and is dimensioned to operatively engage flexible spring member **206**. Generally, lateral support elements are operative to engage a flexible spring member and influence the lateral stiffness rate of the associated gas spring assembly as the same undergoes lateral and/or axial displacement during dynamic use in operation. An example of lateral movement is shown in FIGS. 5 and 6 in which end member assemblies **202** and **204** are shown in FIG. 5 in an approximately coaxial or aligned condition. After undergoing lateral displacement, the end member assemblies are shown in FIG. 6 as being moved in a lateral direction relative to one another into an offset or laterally-shifted condition, which is represented in FIG. 6 by reference arrow **MVT**. It will be appreciated that lateral support elements with cross-sectional profiles of a variety of shapes, sizes and configurations have been developed and are commonly used, such as may be suitable for contributing to certain performance characteristics of a gas spring assembly. As such, it will be appreciated that a lateral support element (e.g., skirt body **214**) having a cross-sectional profile of any suitable size, shape and/or configuration could be used, and that the exemplary arrangement shown in FIGS. 3-8, 8A and 9 is not intended to be limiting.

**[0068]** Additionally, it will be appreciated that a lateral support element (e.g., skirt body **214**) can be formed from any suitable number of one or more elements and/or components, and can include any suitable number of one or more walls and/or wall portions. Furthermore, it will be appreciated that the one or more walls and/or wall portions can be formed from any suitable material or combination of materials, such as metal materials (e.g., steel, aluminum) and/or polymeric materials (e.g., polyethylene, polyurethane and/or polyamide).

**[0069]** Skirt body **214** can include a skirt wall **372** that extends between an inner edge or surface **374** and an outer edge or surface **376** that is disposed radially outward

of inner edge **374**. In some cases, inner edge **374** and outer edge **376** can be axially offset from one another, such as is shown in FIGS. 3-8, 8A and 9, for example. As indicated above, skirt body **214** and skirt wall **372** can include any suitable number of one or more walls and/or wall portions. In the exemplary arrangement shown, skirt wall **372** includes an inner wall portion **378** disposed along inner edge **374**, an outer wall portion **380** disposed along outer edge **376** and an intermediate wall portion **382** that extends between and operatively interconnects inner and outer wall portions **378** and **380**.

[0070] As indicated above, skirt body **214** can be formed from any suitable material or combination of materials. As one example, skirt wall **372** can be formed from a thin-walled material such that opposing surfaces **384** and **386** have an approximately common cross-sectional shape, profile and/or configuration. Surface **384** is oriented in a direction facing away from flexible spring member **206**. Surface **386** is disposed in facing relation with the flexible spring member. In alternate constructions, surfaces **384** and **386** may differ in shape, profile and/or configuration from one another. In either case, a desired shape, profile and/or configuration of at least surface **386** can be used to influence the desired performance characteristics of the gas spring assembly, such as has been discussed above.

[0071] Skirt body **214** is dimensioned to be supported on or along core body **210** and can be operatively engaged with the core body in any suitable manner. As one example, inner edge **374** and outer peripheral surface **330** are cooperatively dimensioned such that inner wall portion **378** of skirt wall **372** can be disposed on or along outer peripheral wall portion **314** of core wall **308**. In such case, inner wall portion **378** can be configured to receive and engage at least a portion of mounting bead **280** formed along end **260** of flexible wall **258** as the mounting bead is seated on or along mounting surface **332**. In a preferred arrangement, outer wall portion **380** can be configured to permit flexible wall **258** of flexible spring member **206** to smoothly transition off of and on to surface **386** of skirt wall **372**, such as without encountering edges or corners, for example. As indicated above, intermediate wall portion **382** can include one or more different sections with any suitable combination of shapes, profiles

and/or configurations for generating or at least contributing to desired performance characteristics of gas spring assembly **200**.

[0072] With further reference to FIGS. 3-8, 8A and 9, plurality of rib members **212** are operatively engaged with core body **210** such that the core body provides at least orientation, positioning and support to the rib members. Rib members **212** extend outwardly beyond core body **210** and provide support to skirt body **214** as the skirt body experiences forces and loads associated with use of gas spring assembly **200**. Rib members **212** are shown as being disposed in spaced relation to one another about axis **AX** such that support is distributed across the peripheral extent of at least inner wall portion **378** and intermediate wall portion **382** of skirt wall **372**. In a preferred arrangement, rib members **212** can be configured to provide support across the peripheral extent of outer wall portion of skirt wall **372** as well.

[0073] It will be appreciated that rib members **212** can be formed from any suitable number of one or more elements and/or components, and can include any suitable number of one or more walls and/or wall portions. Furthermore, it will be appreciated that the one or more walls and/or wall portions can be formed from any suitable material or combination of materials, such as metal materials (e.g., steel, aluminum) and/or polymeric materials (e.g., polyethylene, polyurethane and/or polyamide). As shown in FIGS. 12-19, rib members **212** include a rib member wall **388**, and extend lengthwise between a proximal end **390** and a distal end **392**. Rib members **212** are shown as having a cross-sectional shape approximating an I-beam such that rib member wall **388** includes a web wall portion **394** extending between and operatively connecting flange wall portions **396** and **398**, all of which can be integrally formed with one another, such as by being molded or otherwise formed from a thermoplastic material, for example. It will be appreciated, however, that other configurations and/or constructions could alternately be used.

[0074] Rib members **212** include a mounting portion or section **400** disposed toward proximal end **390** and a support portion or section **402** disposed toward distal end **392**. In an installed condition, mounting section **400** can be disposed in operative engagement with core body **210** and support section **402** can extend outwardly beyond the core body to buttress or otherwise support skirt body **214**. Flange wall portions **396**

and **398** are disposed in spaced relation to one another, which can at least partially define a height of the rib members. Additionally, rib member wall **388** includes side surfaces **404** and **406** that extend lengthwise along the rib members in spaced relation to one another to at least partially define a width of the rib members. In a preferred arrangement, mounting section **400** of rib members **212** is dimensioned for receipt within grooves **338**. In some cases, mounting section **400** can be dimensioned to be received within the closed end of grooves **338** and thereby engage one or more of surfaces **342**, **346** and **368**.

[0075] Rib members **212** include a mounting surface **408** that is disposed along mounting section **400** of flange wall portion **396**, and an exposed surface **410** that is disposed along support section **402** of the rib members. Rib members **212** can also include a mounting surface **412** that is disposed along mounting section **400** of flange wall portion **398**, and a support surface **414** disposed along support section **402** of flange wall portion **398**. It will be appreciated that mounting surface **412** is dimensioned to abuttingly engage bottom surface **348** of grooves **338**. Additionally, it will be appreciated that support surface **414** includes a cross-sectional shape, profile and/or configuration that is cooperative with the cross-sectional shape, profile and/or configuration of at least a portion of skirt body **214**. In such case, support surface **414** can abuttingly engage surface **384** of skirt wall **372**.

[0076] In some cases, rib member wall **388** can include an end wall portion **416** disposed along proximal end **390** and/or an end wall portion **418** disposed along distal end **392**. In a preferred arrangement, mounting section **400** has a length that is cooperative with groove length **GLT** such that support surface **414** is positioned on or along corresponding contours of surface **384** of skirt wall **372**. In some cases, rib members **212** may be of an overall size, shape and construction that would be suitable for use with core bodies and/or skirt bodies of a variety of sizes (e.g., having different diameters or other cross-sectional dimensions). In such case, it may be desirable to alter the length of mounting section **400** to better fit the size of the particular combination of core body and skirt body of the end member assembly. As such, a method of assembling an end member assembly in accordance with the subject matter of the present disclosure can include altering the length of one or more rib members

(e.g., rib members **212**). It will be appreciated that the length of the rib members can be altered in any suitable manner. As one example, one or more geometric indicia **420** and/or one or more symbolic or alphanumeric indicia **422** can be disposed in spaced relation to one another along mounting surface **408** of mounting section **400** of flange wall portion **396**. If provided, indicia **420** and/or **422** can correspond to preferred lengths for mounting section **400**, such as may correspond to certain predetermined combinations of the core body and the skirt body. In such case, the length of mounting section **400** of a plurality of rib members **212** can be reduced by a desired amount prior to assembly. It will be appreciated, however, that other equivalent techniques could alternately be used.

**[0077]** Rib members **212** can, optionally, be secured or otherwise operatively connected on or along core body **210**, such as in a manner suitable for retaining the rib members an approximately fixed position relative to the core body, such as may be useful for handling purposes during assembly and/or installation and/or for providing additional strength or support during use in operation. It will be appreciated that any suitable configuration, arrangement and/or combination of features and/or components can be used. For example, one or more securement devices can extend between and operatively interengage one or more of rib members **212** and core body **210**. For example, in some cases, a single securement device can extend between and operatively interengage the core body and a plurality of rib members. In other cases, one or more securement devices can extend between and operative interengage the core body and one of the plurality of rib members.

**[0078]** In a preferred arrangement, at least one hole or opening can extend through the rib members and at least one hole or opening can extend through at least one of the groove wall portions of the core body. In an assembled condition of the rib members on the core body, two or more of the holes can be at least approximately aligned with one another to receive a securement device. For example, in the arrangement shown in FIGS. 3, 5-8 and 9-17, groove wall portions **334** and **336** can each include at least one hole or opening **424** and **426**, respectively. Additionally, rib members **212** can include at least one hole or opening **428** extending therethrough, such as through web wall portion **394**, for example.

[0079] In cases in which rib members **212** are configured for use in assemblies of various sizes, shapes and/or configurations by reducing the length thereof, as discussed in detail above, either one or both of core body **210** and rib members **212** can include a plurality of holes or openings that are spaced apart from one another in a lengthwise direction of the rib members. For example, groove wall portions **334** and **336** can, optionally, include a plurality of holes or openings disposed in spaced relation to one another in the lengthwise direction of the rib members, such as are represented by dashed lines **OPN** in FIG. 11, for example. Additionally, or in the alternative, rib members **212** can include a plurality of openings **428** disposed in spaced relation to one another in the lengthwise direction of the rib members.

[0080] In an assembled condition, at least one of the openings in the rib members preferably are at least approximately aligned with at least one of the openings in one of the groove wall portions of the core body. In which case, at least one securement device can be provided that can extend into and operatively engage the core body and at least one of the plurality of rib members. In a preferred arrangement, a plurality of securement devices **430** can be provided with at least one of securement devices **430** extending between and operatively interengaging core body **210** and one of rib members **212**. Securement devices **430** are shown as taking the form of elongated, substantially-cylindrical pins that can be disposed within or otherwise extend through opening **428** and one or more of openings **424** and **426**. In some cases, securement devices **430** can be pressed or otherwise friction fit into engagement with at least one of openings **424**, **426** and/or **428** such that securement devices **430** are substantially self-retained within the one or more openings.

[0081] An alternate arrangement is shown in FIGS. 18 and 19 in which a plurality of securement devices **432** are used in place of securement devices **430**. It will be appreciated that securement devices **432** differ from securement devices **430** in that securement devices **432** can include an elongated pin portion **434** that extends between an end **436**, which includes an enlarged head **438**, and an end **440** disposed opposite end **436** in a lengthwise direction. Elongated pin portion **434** can include a passage **442** extending therethrough along end **440** that is oriented transverse to the lengthwise direction of elongated pin **434**. A retaining element **444** can extend through passage

**442** for retaining elongated pin **434** in operative engagement between core body **210** and rib member **212**. In such an arrangement, securement devices **434** can, optionally, form a clearance or transition fit with openings **424**, **426** and/or **428** rather than a friction or press fit, as discussed above. It will be appreciated, however, that the foregoing constructions are merely exemplary and that other securement devices, such as threaded fasteners, for example, would alternately be used.

**[0082]** As used herein with reference to certain features, elements, components and/or structures, numerical ordinals (e.g., first, second, third, fourth, etc.) may be used to denote different singles of a plurality or otherwise identify certain features, elements, components and/or structures, and do not imply any order or sequence unless specifically defined by the claim language. Additionally, the terms “transverse,” and the like, are to be broadly interpreted. As such, the terms “transverse,” and the like, can include a wide range of relative angular orientations that include, but are not limited to, an approximately perpendicular angular orientation. Also, the terms “circumferential,” “circumferentially,” and the like, are to be broadly interpreted and can include, but are not limited to circular shapes and/or configurations. In this regard, the terms “circumferential,” “circumferentially,” and the like, can be synonymous with terms such as “peripheral,” “peripherally,” and the like.

**[0083]** Furthermore, the phrase “flowed-material joint” and the like, if used herein, are to be interpreted to include any joint or connection in which a liquid or otherwise flowable material (e.g., a melted metal or combination of melted metals) is deposited or otherwise presented between adjacent component parts and operative to form a fixed and substantially fluid-tight connection therebetween. Examples of processes that can be used to form such a flowed-material joint include, without limitation, welding processes, brazing processes and soldering processes. In such cases, one or more metal materials and/or alloys can be used to form such a flowed-material joint, in addition to any material from the component parts themselves. Another example of a process that can be used to form a flowed-material joint includes applying, depositing or otherwise presenting an adhesive between adjacent component parts that is operative to form a fixed and substantially fluid-tight connection therebetween. In such case, it will

be appreciated that any suitable adhesive material or combination of materials can be used, such as one-part and/or two-part epoxies, for example.

**[0084]** Further still, the term “gas” is used herein to broadly refer to any gaseous or vaporous fluid. Most commonly, air is used as the working medium of gas spring devices, such as those described herein, as well as suspension systems and other components thereof. However, it will be understood that any suitable gaseous fluid could alternately be used.

**[0085]** It will be recognized that numerous different features and/or components are presented in the embodiments shown and described herein, and that no one embodiment may be specifically shown and described as including all such features and components. As such, it is to be understood that the subject matter of the present disclosure is intended to encompass any and all combinations of the different features and components that are shown and described herein, and, without limitation, that any suitable arrangement of features and components, in any combination, can be used. Thus it is to be distinctly understood claims directed to any such combination of features and/or components, whether or not specifically embodied herein, are intended to find support in the present disclosure.

**[0086]** Thus, while the subject matter of the present disclosure has been described with reference to the foregoing embodiments and considerable emphasis has been placed herein on the structures and structural interrelationships between the component parts of the embodiments disclosed, it will be appreciated that other embodiments can be made and that many changes can be made in the embodiments illustrated and described without departing from the principles hereof. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. Accordingly, it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the subject matter of the present disclosure and not as a limitation. As such, it is intended that the subject matter of the present disclosure be construed as including all such modifications and alterations.

## CLAIMS:

1. An end member assembly having a longitudinal axis and dimensioned for use in forming an associated gas spring assembly, said end member assembly comprising:
  - a core body including a core wall extending peripherally about said longitudinal axis, said core wall including an outer mounting surface dimensioned to receivingly engage an associated flexible spring member such that a substantially fluid-tight seal can be formed therebetween;
  - a plurality of rib members supported on said core body, said plurality of rib members disposed in spaced relation relative to one another about said longitudinal axis, said plurality of rib members including a rib wall extending in a lengthwise direction between a first end disposed along said core body and a second end disposed radially outward beyond said core body; and,
  - a skirt body disposed along said core body, said skirt body including a skirt wall with an inner edge, an outer edge disposed radially outward of said inner edge, a first surface disposed in facing relation to said plurality of rib members and a second surface dimensioned to operatively engage the associated flexible spring member.
2. An end member assembly according to claim 1, wherein said core wall includes a passage surface that at least partially defines a passage extending through said core wall in approximate alignment with said longitudinal axis.
3. An end member assembly according to claim 2 further comprising a connector fitting operatively secured to said core body in fluid communication with said passage.
4. An end member assembly according to any one of claims 1-3, wherein said rib wall of said plurality of rib members includes a mounting surface portion extending in said lengthwise direction, said mounting surface portion disposed toward said first end of said plurality of rib members with at least some of said mounting surface portion disposed radially inward of said outer mounting surface of said core body.

5. An end member assembly according to any one of claims 1-4, wherein said core body includes plurality of slots disposed in spaced relation to one another about said longitudinal axis, said plurality of slots dimensioned to receive at least a portion of said first end of one of said plurality of rib members.
6. An end member assembly according to claim 5, wherein said plurality of slots include a bottom surface and opposing side surfaces with an open end formed adjacent said outer mounting surface.
7. An end member assembly according to claim 6, wherein said plurality of slots include an end surface disposed radially inward of said outer mounting surface by a first distance that is less than or approximately equal to a length of a mounting surface portion of said rib wall disposed toward said first end of said plurality of rib members.
8. An end member assembly according to any one of claims 1-7, wherein said first surface of said skirt body has cross-sectional profile extending between said inner edge and said outer edge of said skirt wall.
9. An end member assembly according to claim 8, wherein said skirt wall is formed from a thin-walled material such that said second surface of said skirt body has a cross-sectional profile that has at least approximately the same shape as said cross-sectional profile of said first surface.
10. An end member assembly according to claim 9, wherein said thin-walled material includes at least one of a metal material and a polymeric material.

11. An end member assembly according to any one of claims 1-10, wherein said rib wall of said plurality of rib members includes a support surface portion extending in said lengthwise direction, said support surface portion disposed toward said second end of said plurality of rib members and radially outward of said outer mounting surface of said core body.

12. An end member assembly according to claim 11, wherein said support surface portion of said rib wall of said plurality of rib members is dimensioned to abuttingly engage said first surface of said skirt body.

13. An end member assembly according to any one of claims 1-12, wherein said rib wall of said plurality of rib members includes an outer surface portion facing away from said skirt body with said plurality of rib members including a plurality of indicia disposed in lengthwise spaced relation to one another toward said first end of said plurality of rib members.

14. An end member assembly according to any one of claims 1-13 further comprising at least one securement device operatively interconnecting said core body and at least one of said plurality of rib members.

15. An end member assembly according to any one of claims 1-14 further comprising a plurality of securement devices with at least one of said plurality of securement devices operatively interconnecting one of said plurality of rib members and said core body.

16. An end member assembly according to claim 14, wherein said plurality of rib members include an opening extending therethrough and one of said plurality of securement devices extends through said opening and operatively engages said core body.

17. An end member assembly according to claim 16, wherein said plurality of rib members include a plurality of openings extending therethrough, said plurality of openings disposed in spaced relation to one another in said lengthwise direction.

18. An end member assembly according to any one of claims 1-17, wherein said core body includes a plurality of groove wall portions that at least partially form at least one elongated groove dimensioned to at least partially receive one of said plurality of rib members.

19. An end member assembly according to claim 18 further comprising at least one securement device operatively interconnecting said one of said plurality of rib members and at least one of said plurality of groove wall portions.

20. An end member assembly according to any one of claims 1-19, wherein said core body includes a plurality of groove wall portions that at least partially form a plurality of elongated grooves disposed in peripherally spaced relation to one another about said longitudinal axis, said plurality of elongated grooves dimensioned to at least partially receive one of said plurality of rib members.

21. An end member assembly according to claim 20, wherein at least one of said plurality of groove wall portions adjacent plurality of elongated grooves includes an opening formed therethrough dimensioned to receivingly engage an associated securement device operatively interconnecting one of said rib members to said core body.

22. An end member assembly according to claim 21, wherein at least one of said plurality of groove wall portions and said plurality of rib members include a plurality of openings formed therethrough, said plurality of openings disposed in spaced relation to one another in said lengthwise direction of said plurality of rib members.

23. A gas spring assembly comprising:

a flexible spring member having a longitudinal axis and including a flexible wall extending peripherally about said axis and longitudinally between opposing first and second ends to at least partially define a spring chamber;

an end member extending across said first end of said flexible spring member and secured thereto such that a substantially fluid-tight seal is formed therebetween; and,

an end member assembly according to any one of claims 1-22 extending across said second end of said flexible spring member and secured thereto such that a substantially fluid-tight seal is formed therebetween.

24. A suspension system comprising:

a pressurized gas system that includes a pressurized gas source and a control device; and,

at least one gas spring assembly according to claim 23, said at least one gas spring assembly disposed in fluid communication with said pressurized gas source through said control device such that pressurized gas can be selectively transferred into and out of at least said spring chamber of said at least one gas spring assembly.

25. A method of assembling a gas spring assembly having a longitudinal axis, said method comprising:

providing a core body that includes a core wall extending peripherally about said longitudinal axis, said core wall including an outer mounting surface dimensioned to receivingly engage an associated flexible spring member such that a substantially fluid-tight seal can be formed therebetween;

providing a plurality of rib members that have a length and include a rib wall extending in a lengthwise direction between a first end and a second end;

positioning said plurality of rib member on said core body such that said plurality of rib members are disposed in spaced relation relative to one another about said longitudinal axis with said first end disposed along said core body and a second end disposed radially outward beyond said outer mounting surface of said core body;

providing a skirt body including a skirt wall with an inner edge, an outer edge disposed radially outward of said inner edge, a first surface and a second surface opposite said first surface; and,

positioning said skirt body along said core body such that said first surface of said skirt body is disposed in facing relation to said plurality of rib members and said second surface is exposed for operative engagement with the associated flexible spring member.

26. A method according to claim 25 further comprising reducing said length of said plurality of rib members prior to positioning said plurality of rib members on said core body.

27. A method according to either one of claims 25 and 26 further comprising providing a flexible spring member that extends longitudinally between opposing first and second ends to at least partially define a spring chamber, and securing said first end of said flexible spring member on said core body such that a substantially fluid-tight seal is formed therebetween.

28. A method according to claim 27 further comprising providing an end member, and securing said end member across said second end of said flexible spring member such that a substantially fluid-tight seal is formed therebetween.

29. A method according to any one of claims 25-28 further comprising securing at least one of said plurality of rib members to said core body using at least one securement device extending between and operatively connecting said core body and said at least one of said plurality of rib members.

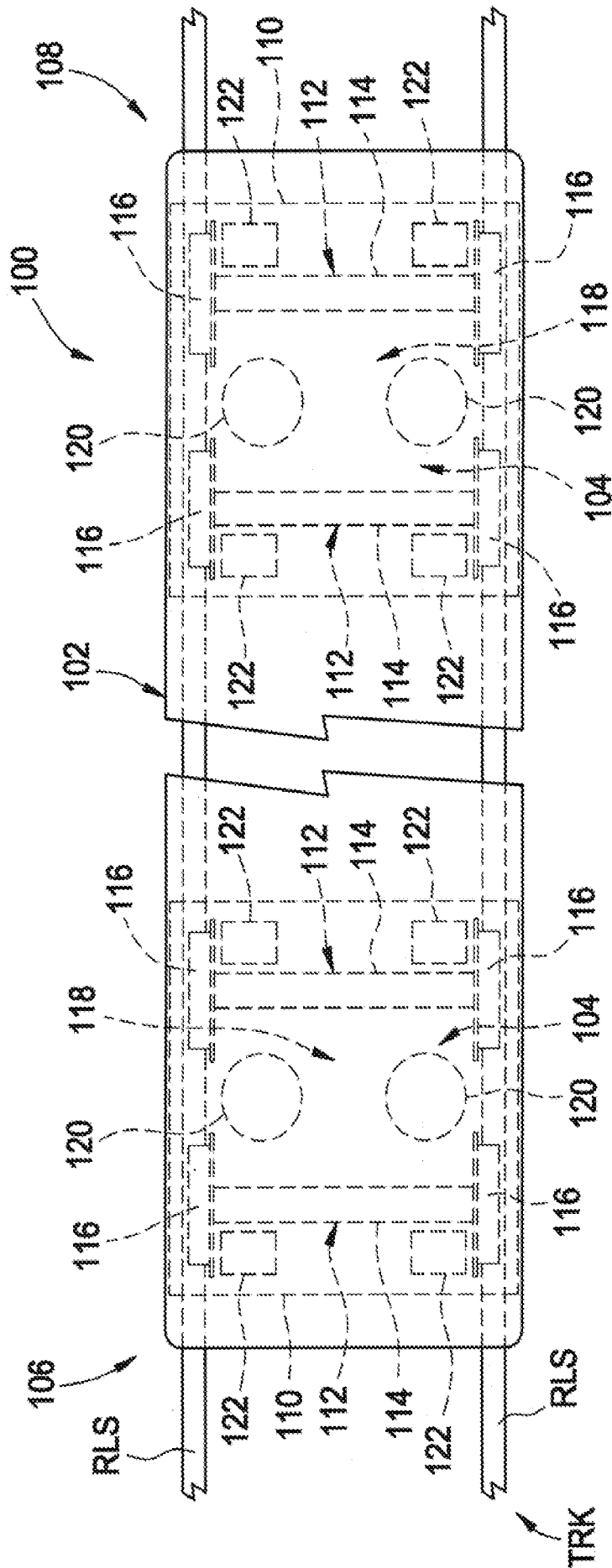


FIG. 1

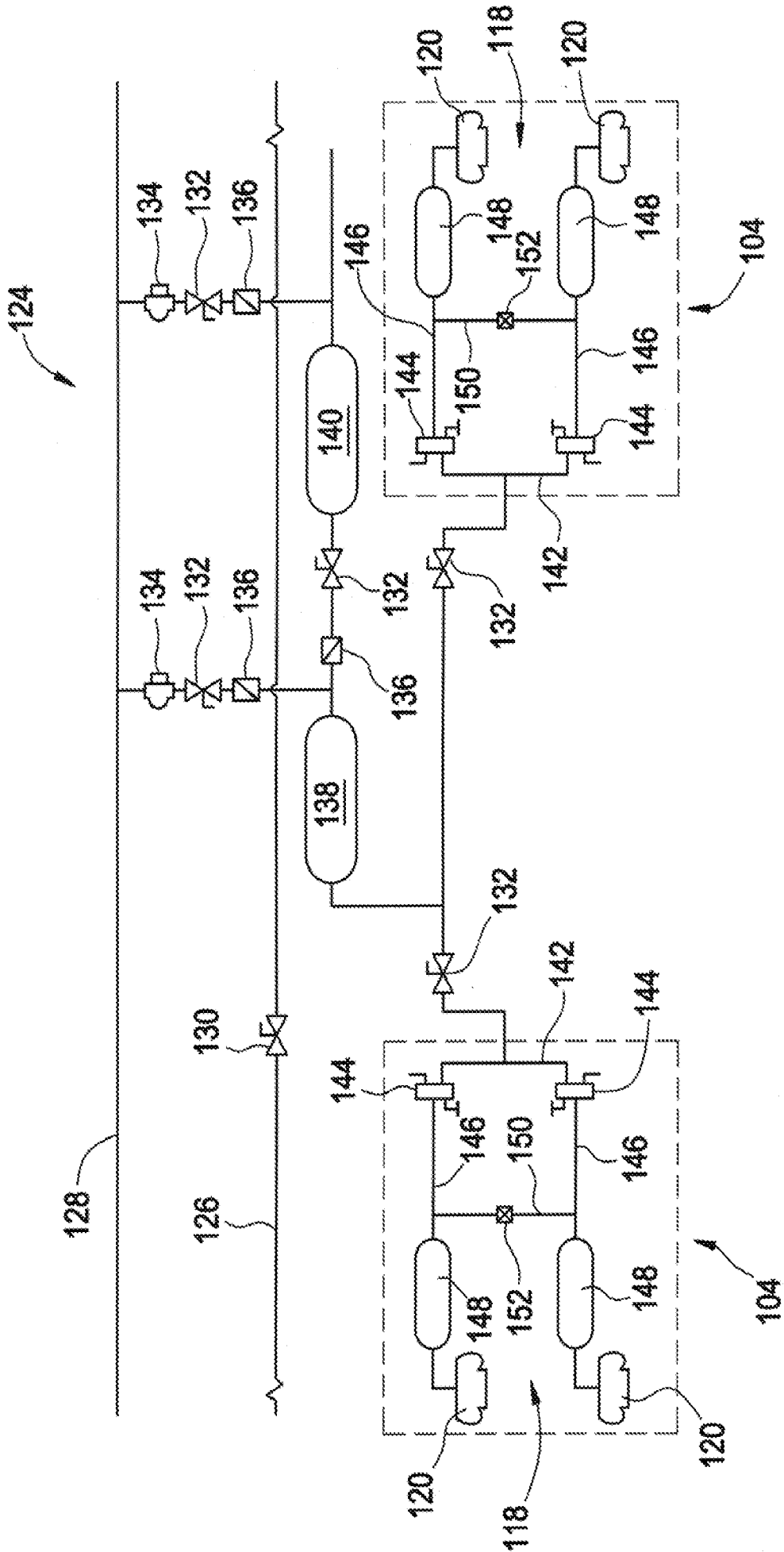


FIG. 2

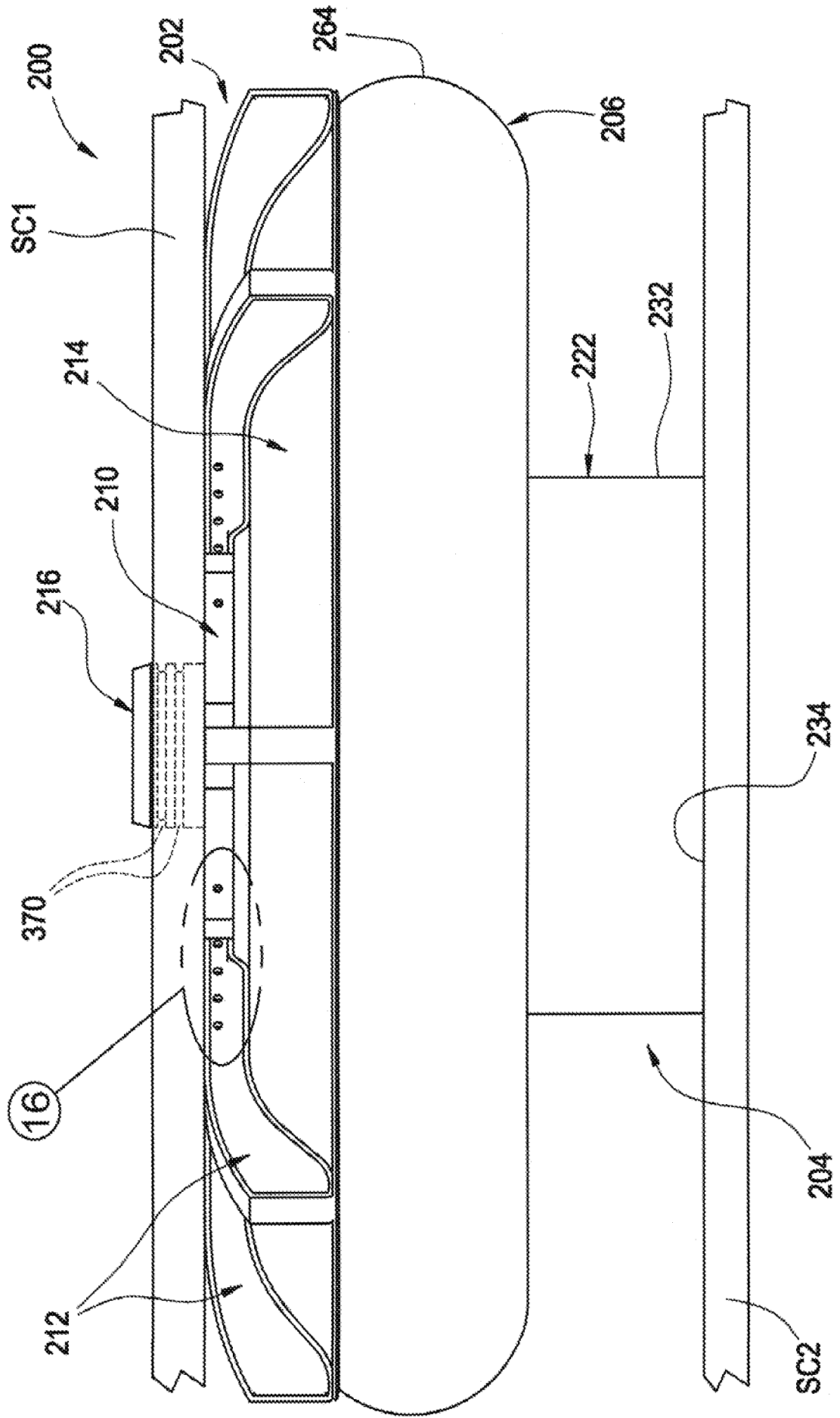


FIG. 3

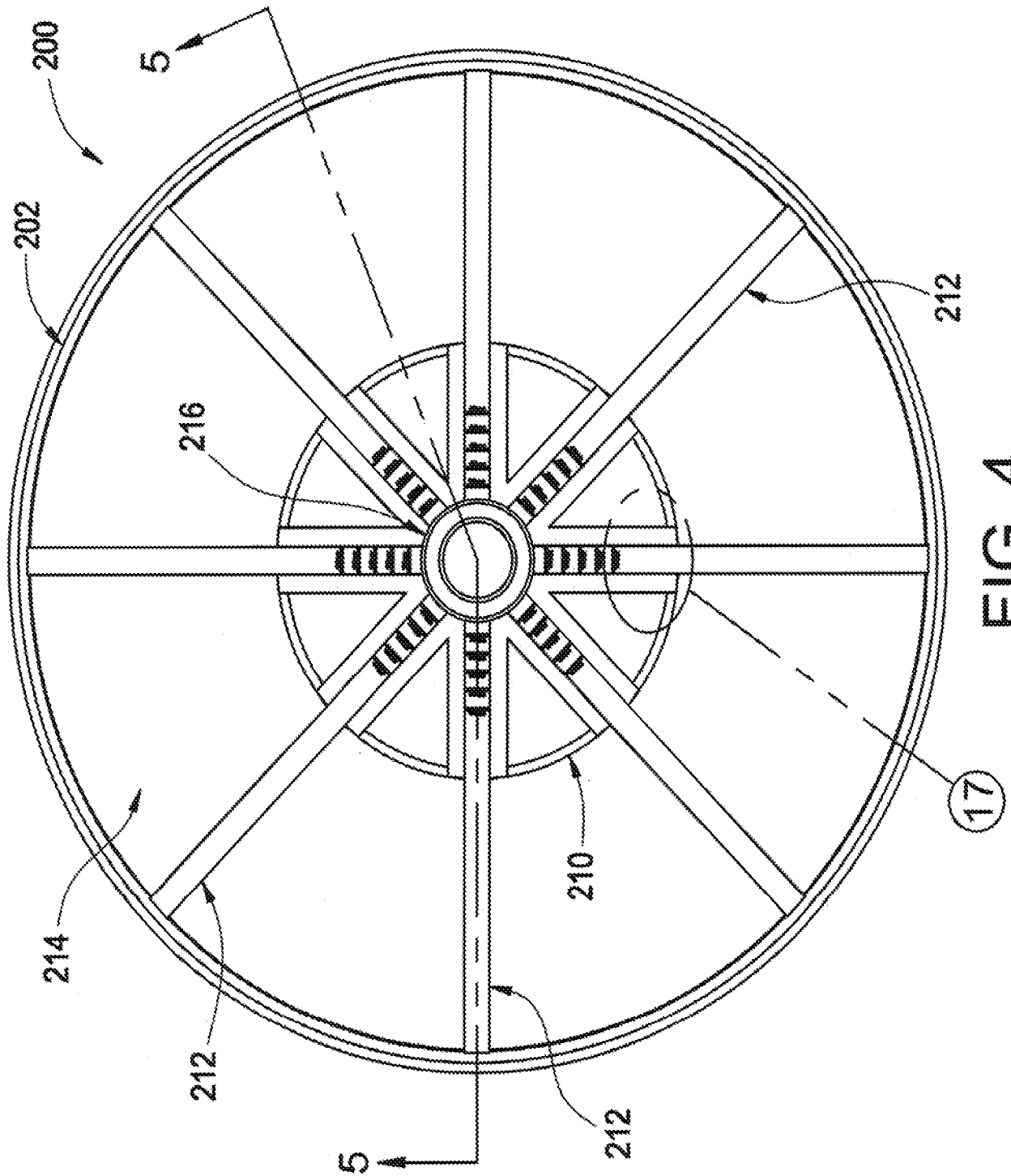


FIG. 4

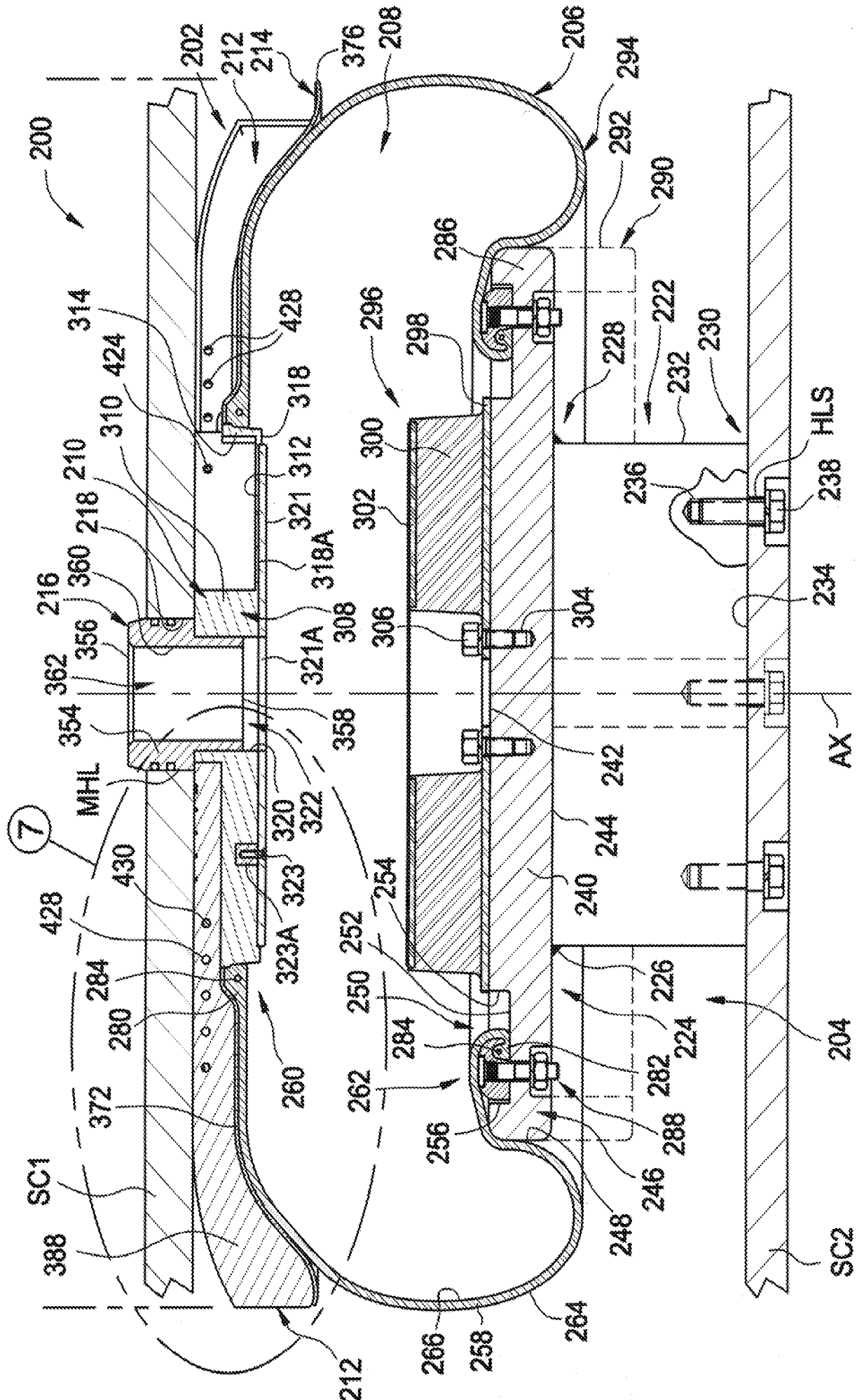


FIG. 5

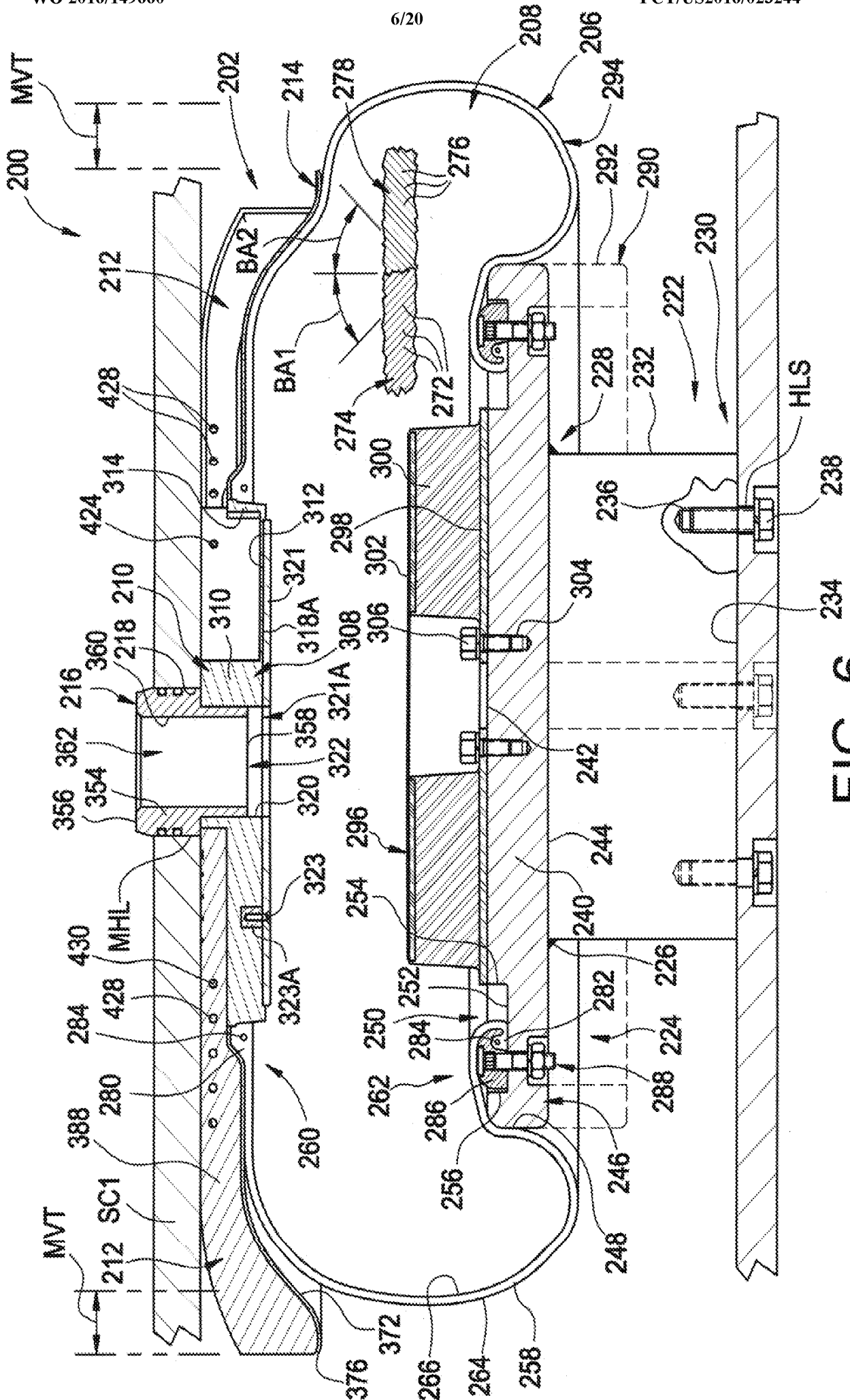


FIG. 6



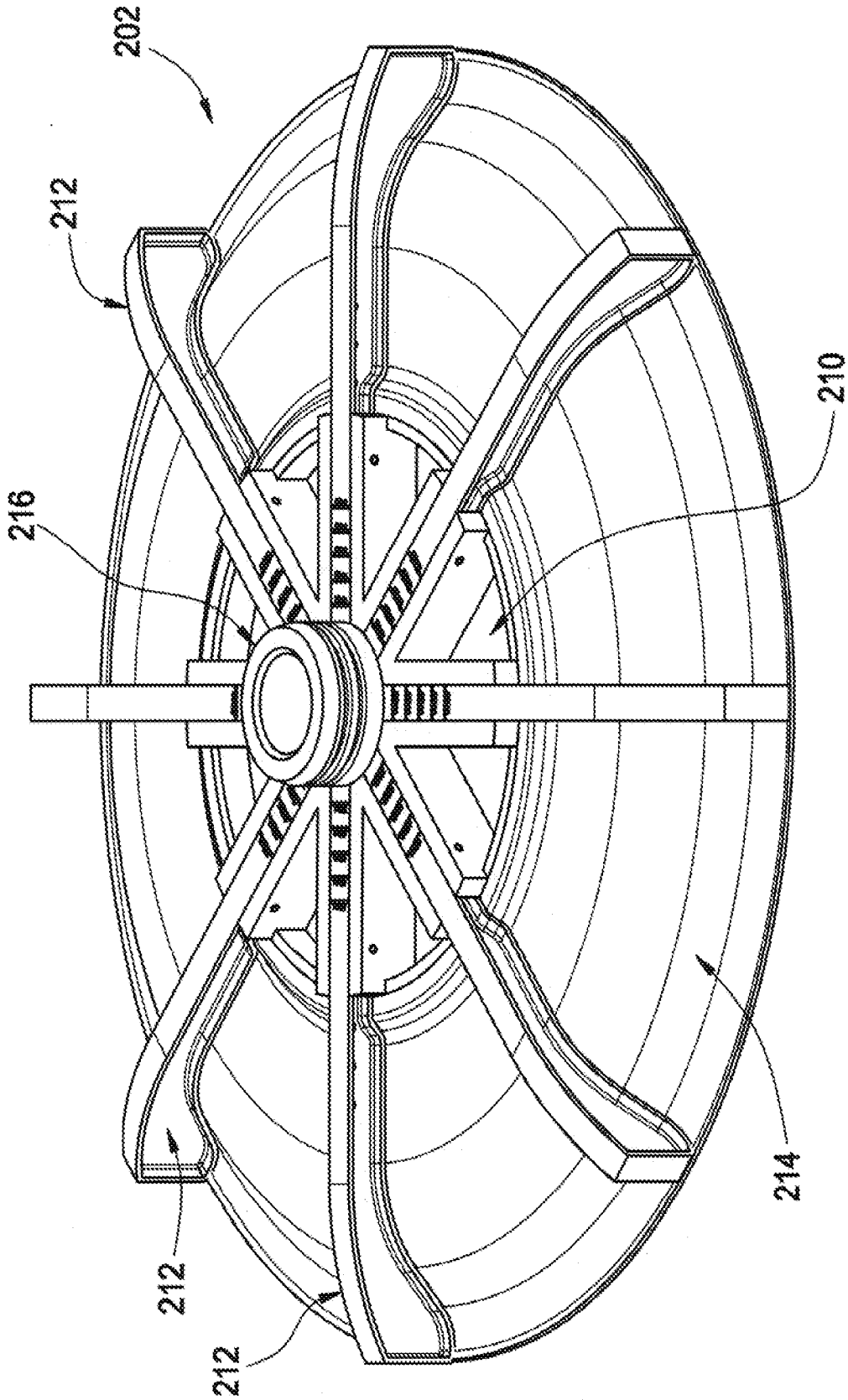


FIG. 8

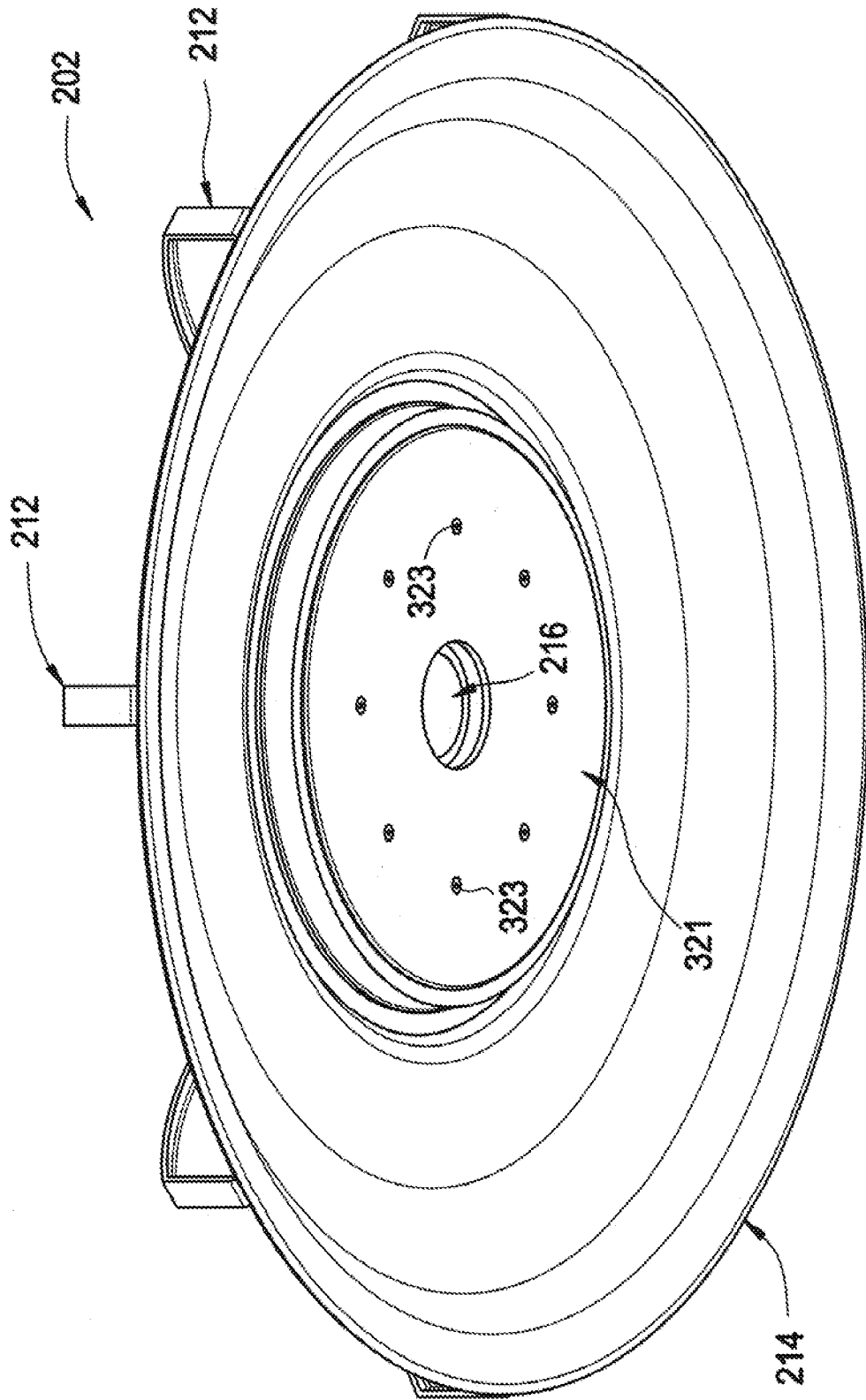


FIG. 8A

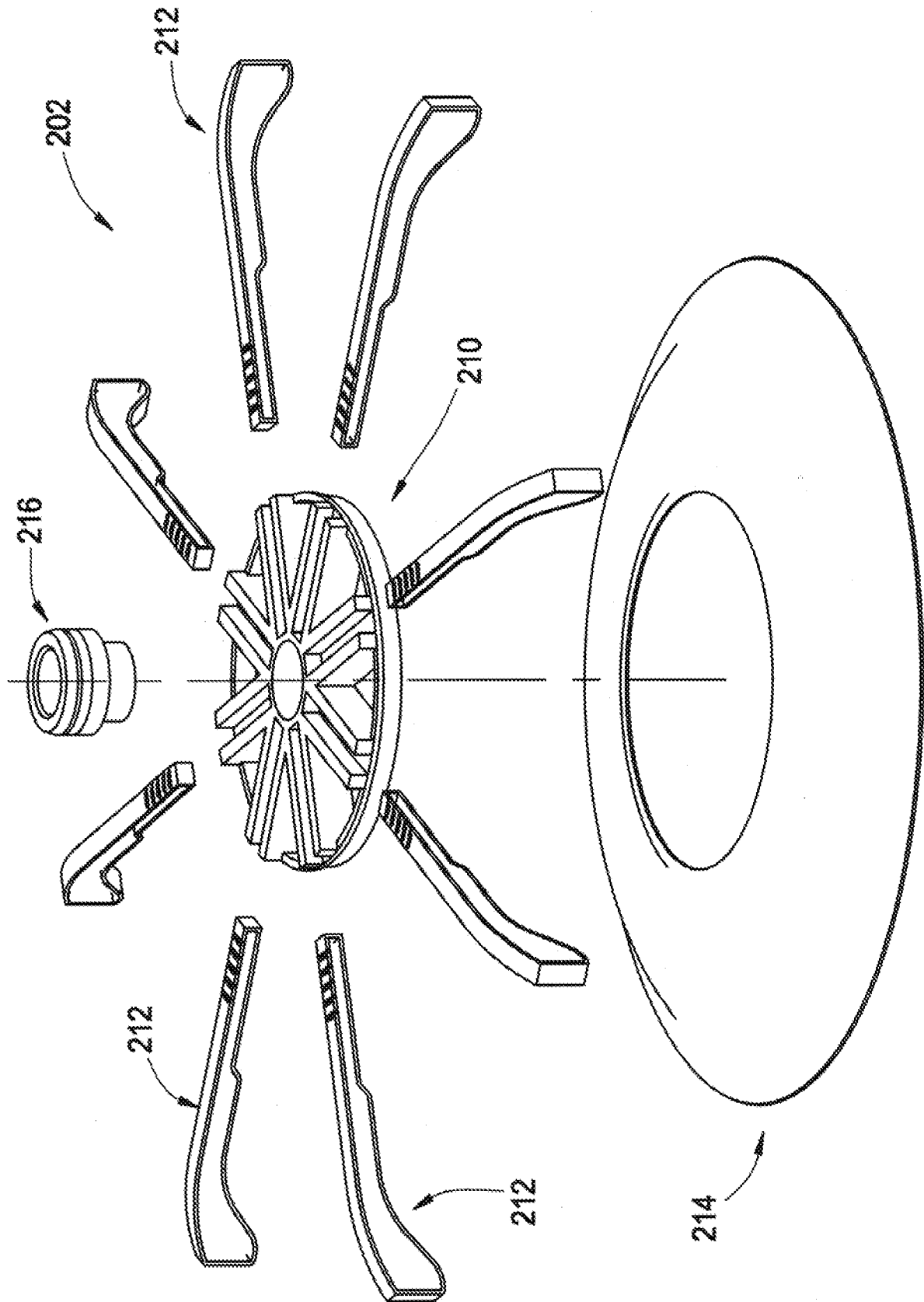


FIG. 9

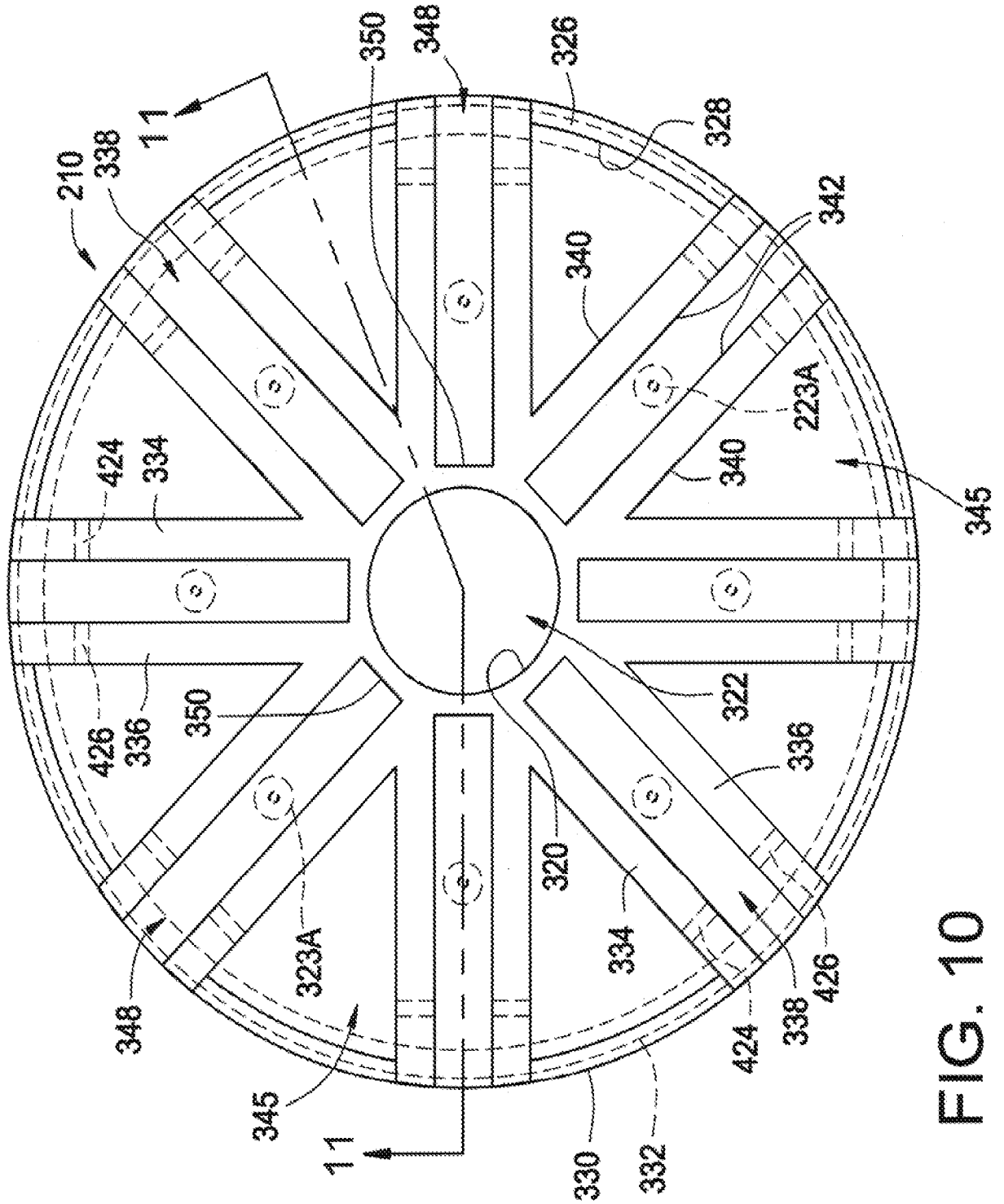


FIG. 10



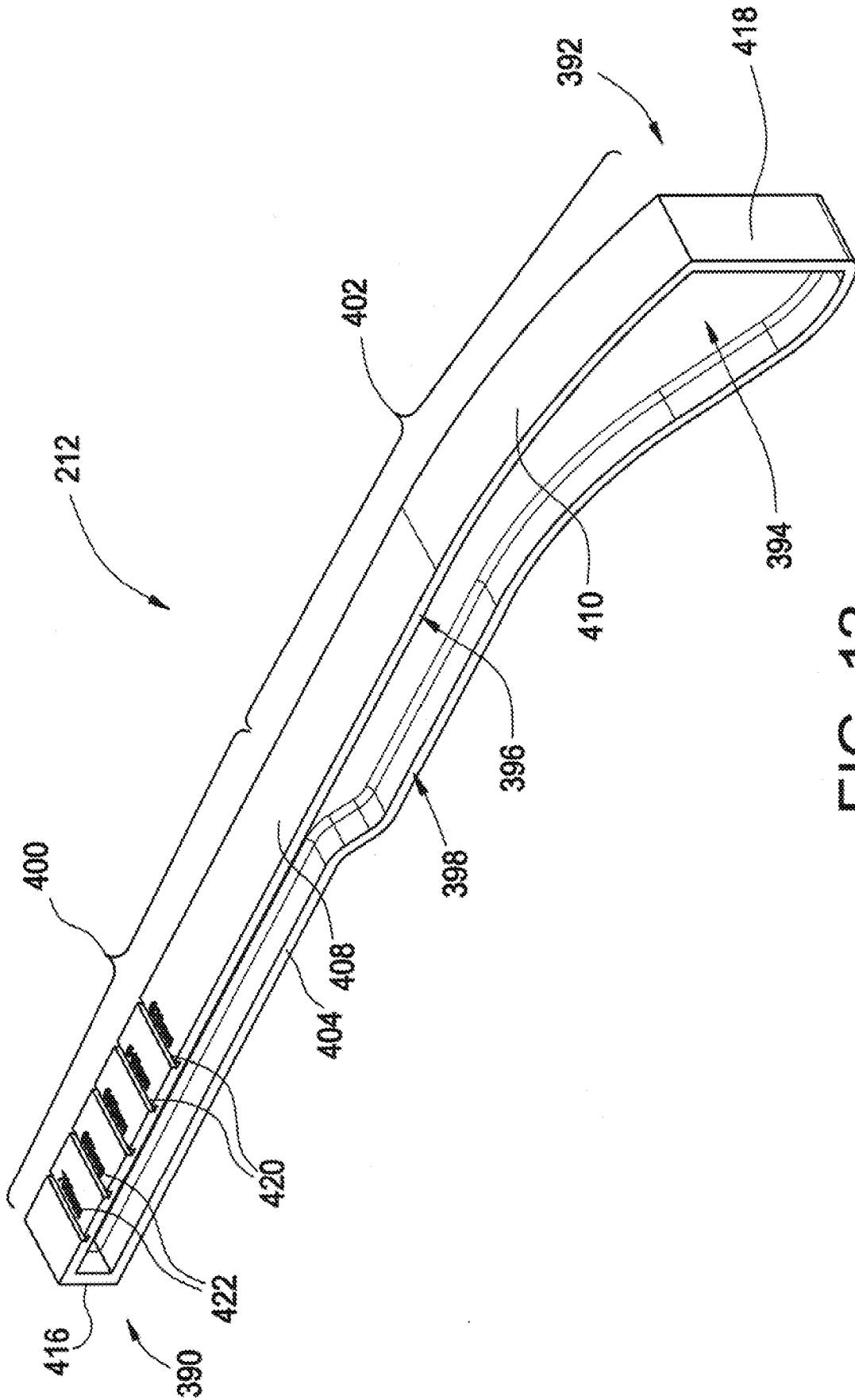


FIG. 12

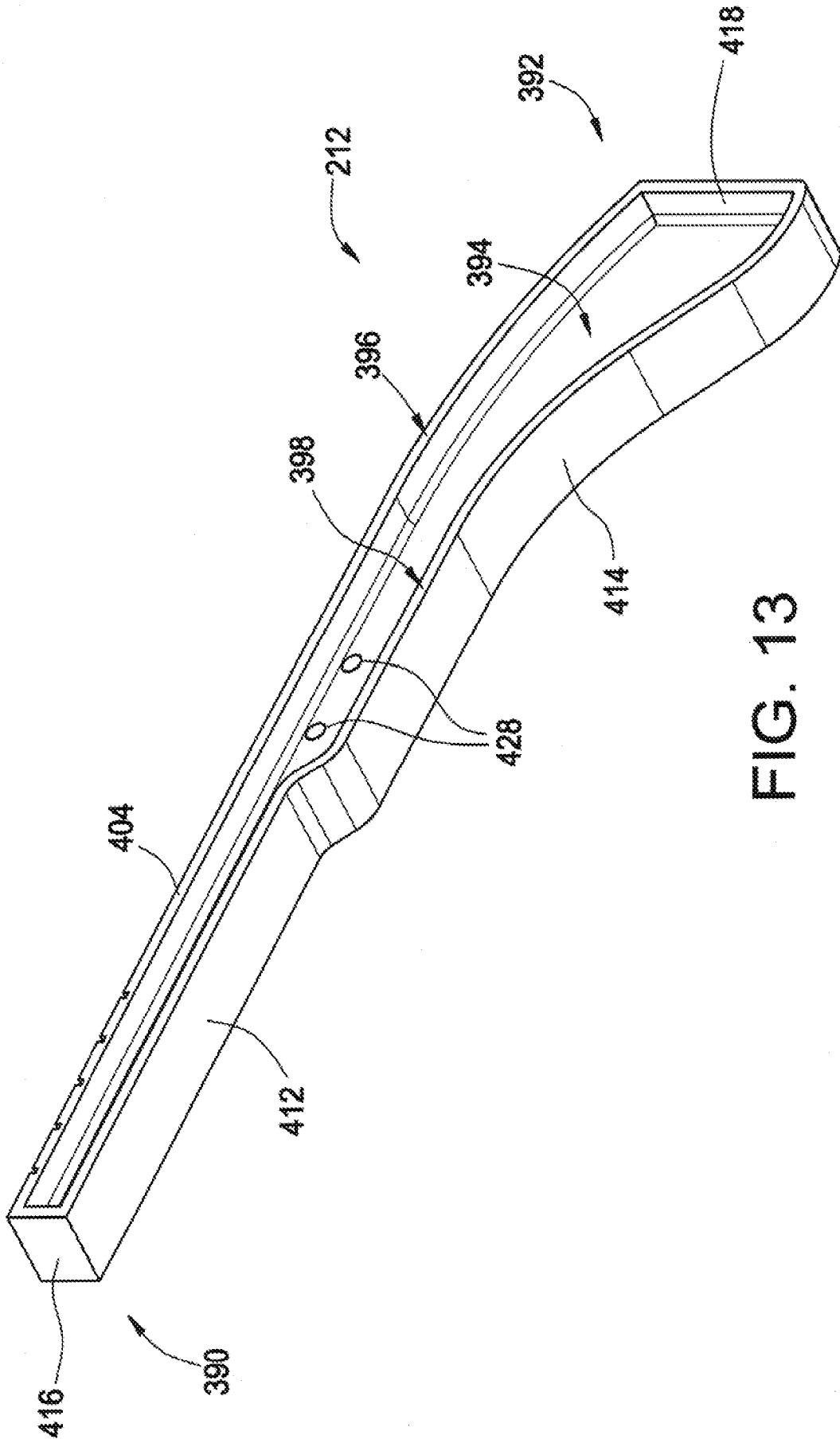


FIG. 13

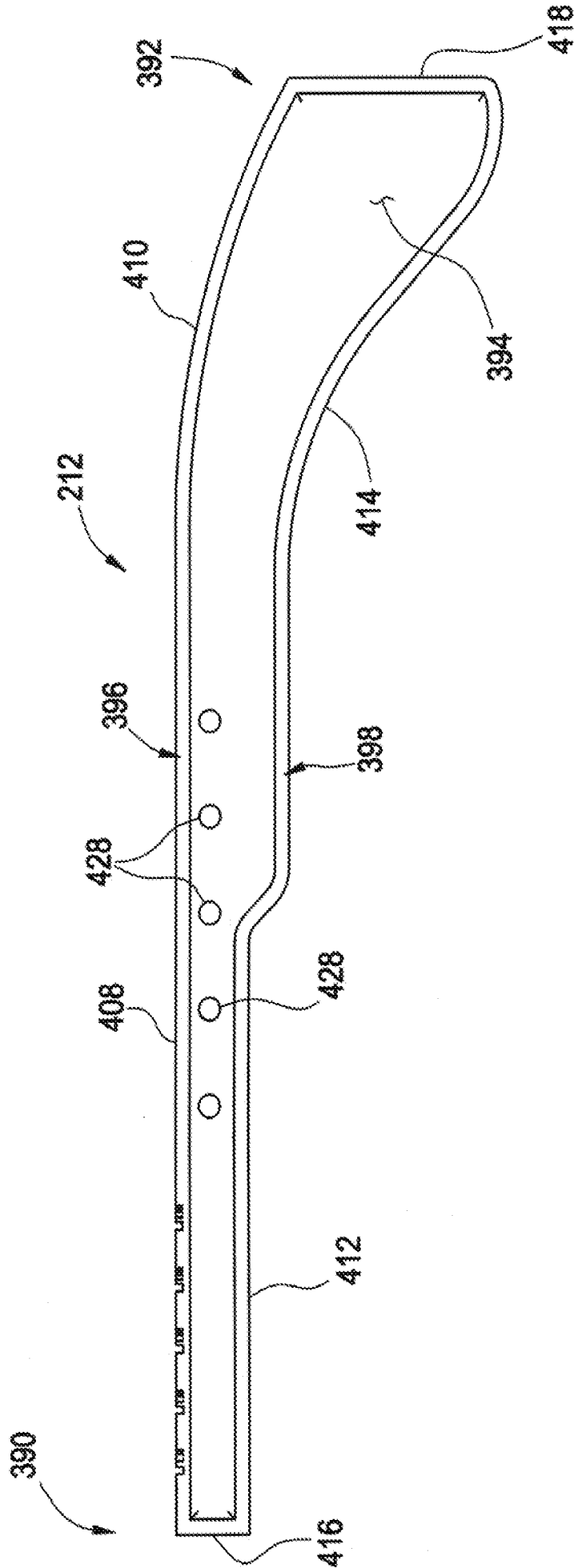


FIG. 14

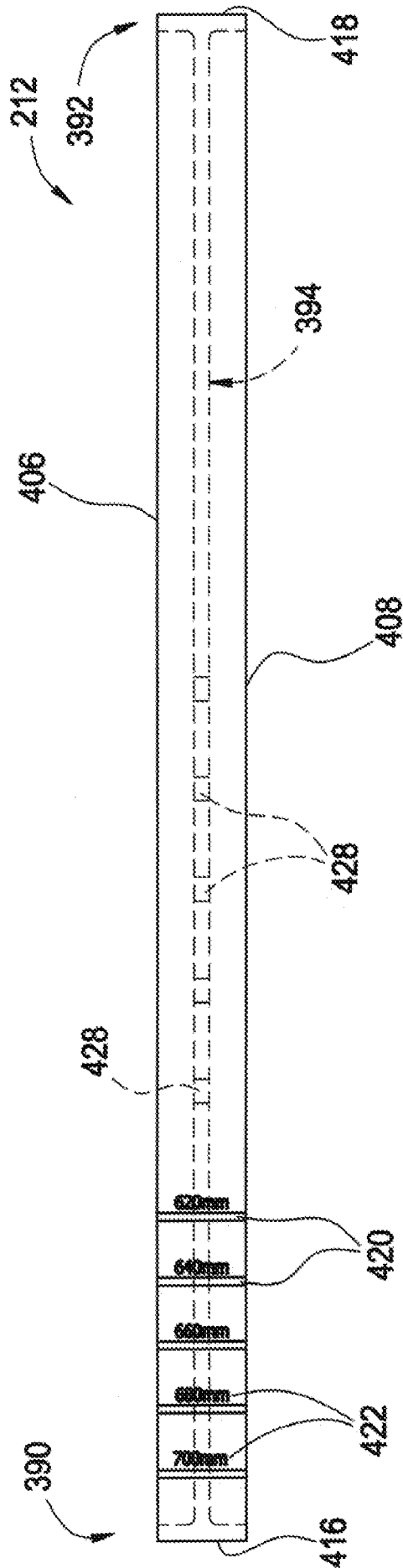


FIG. 15

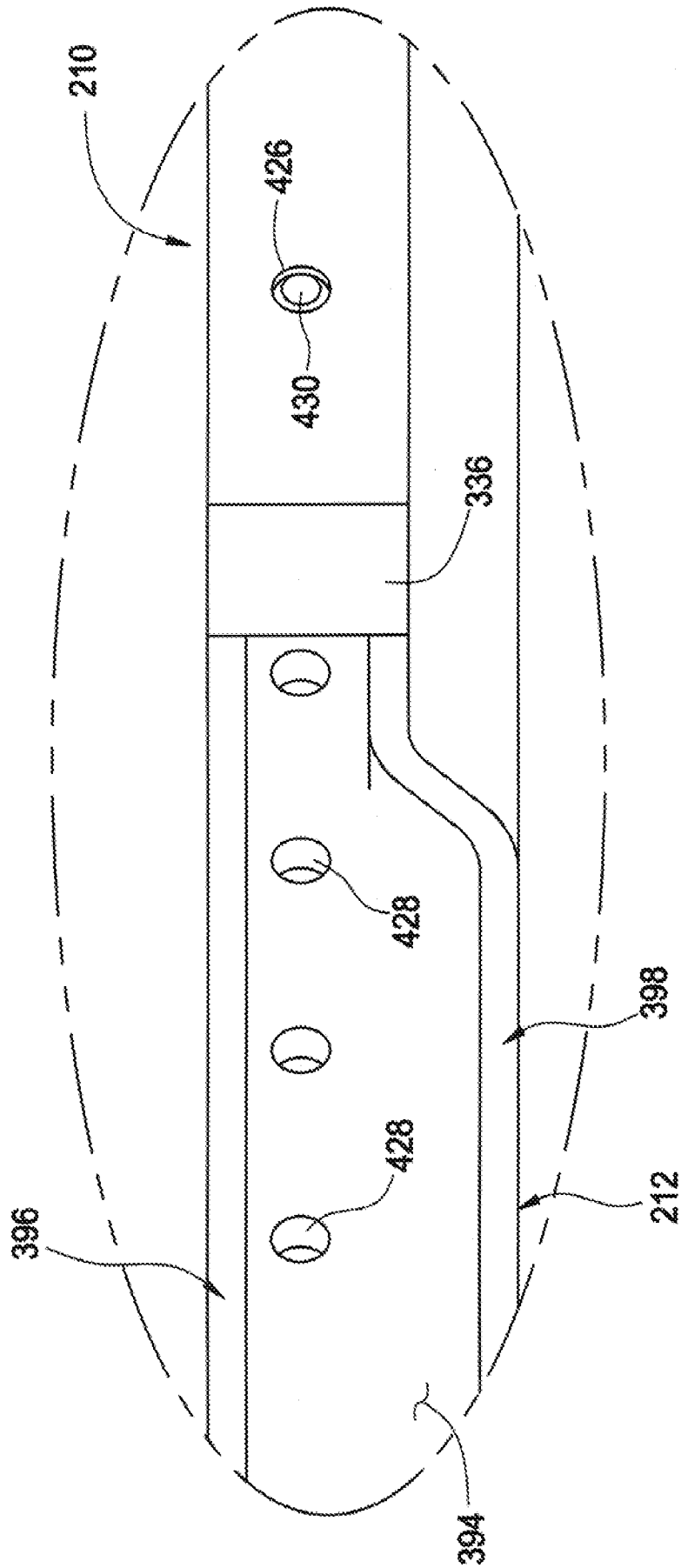


FIG. 16

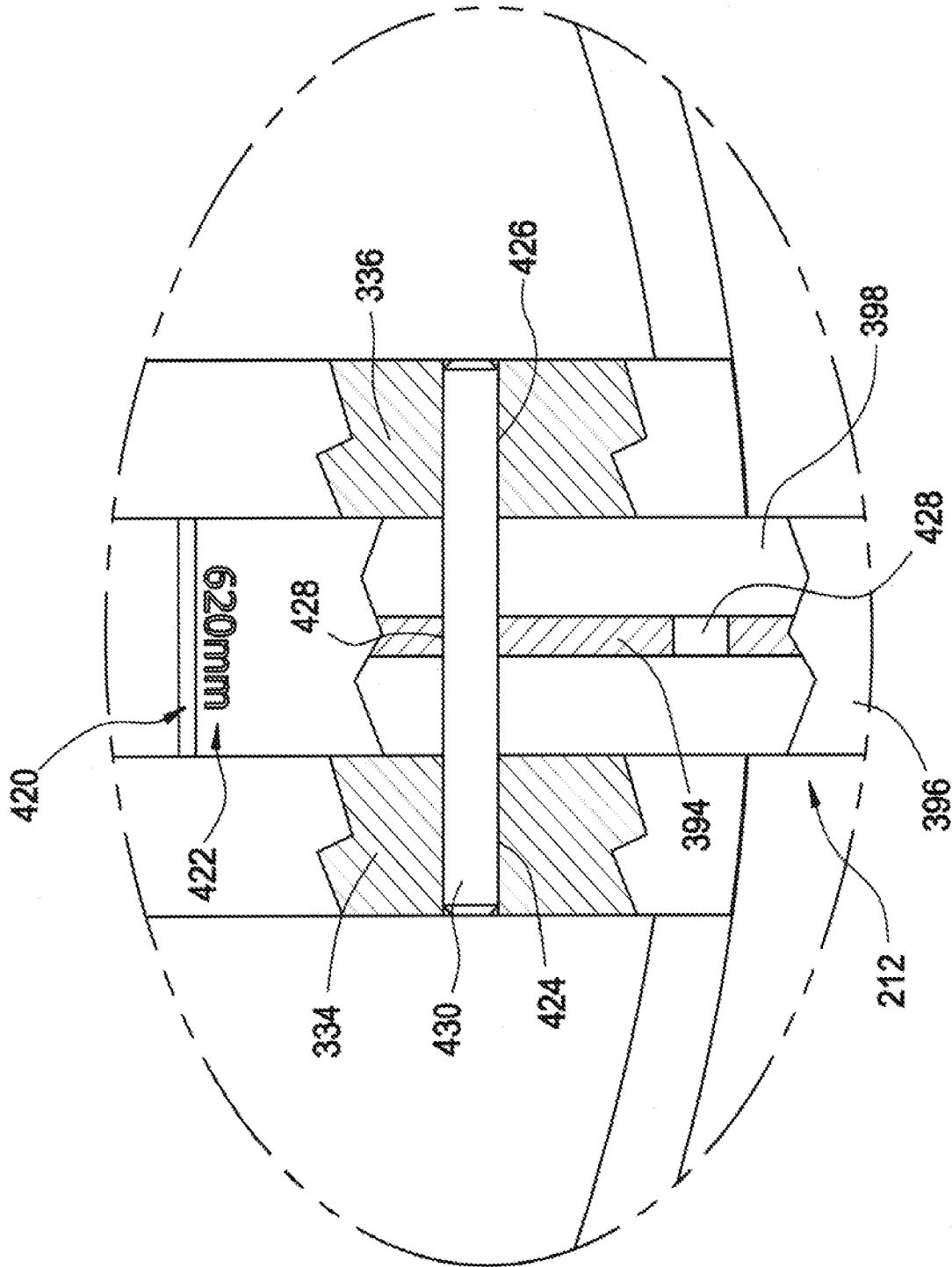


FIG. 17

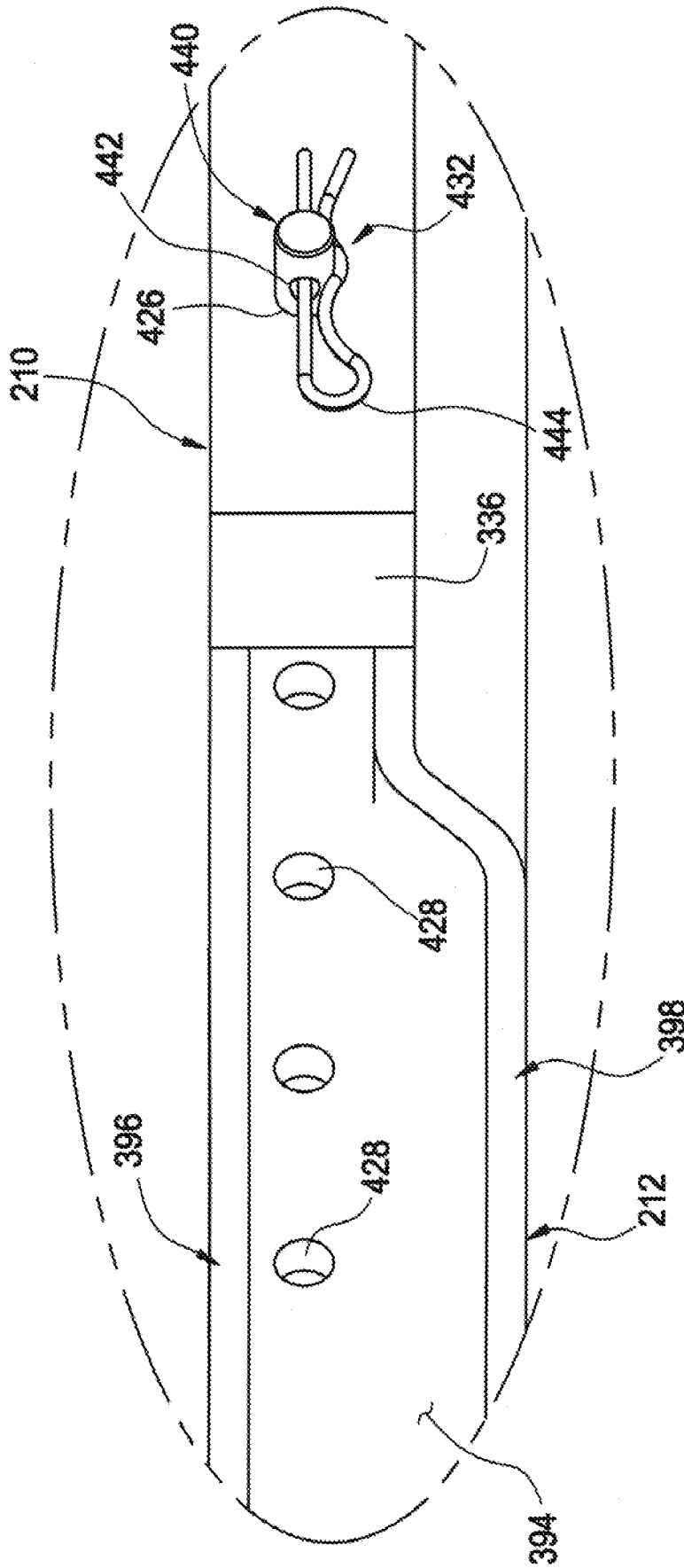


FIG. 18

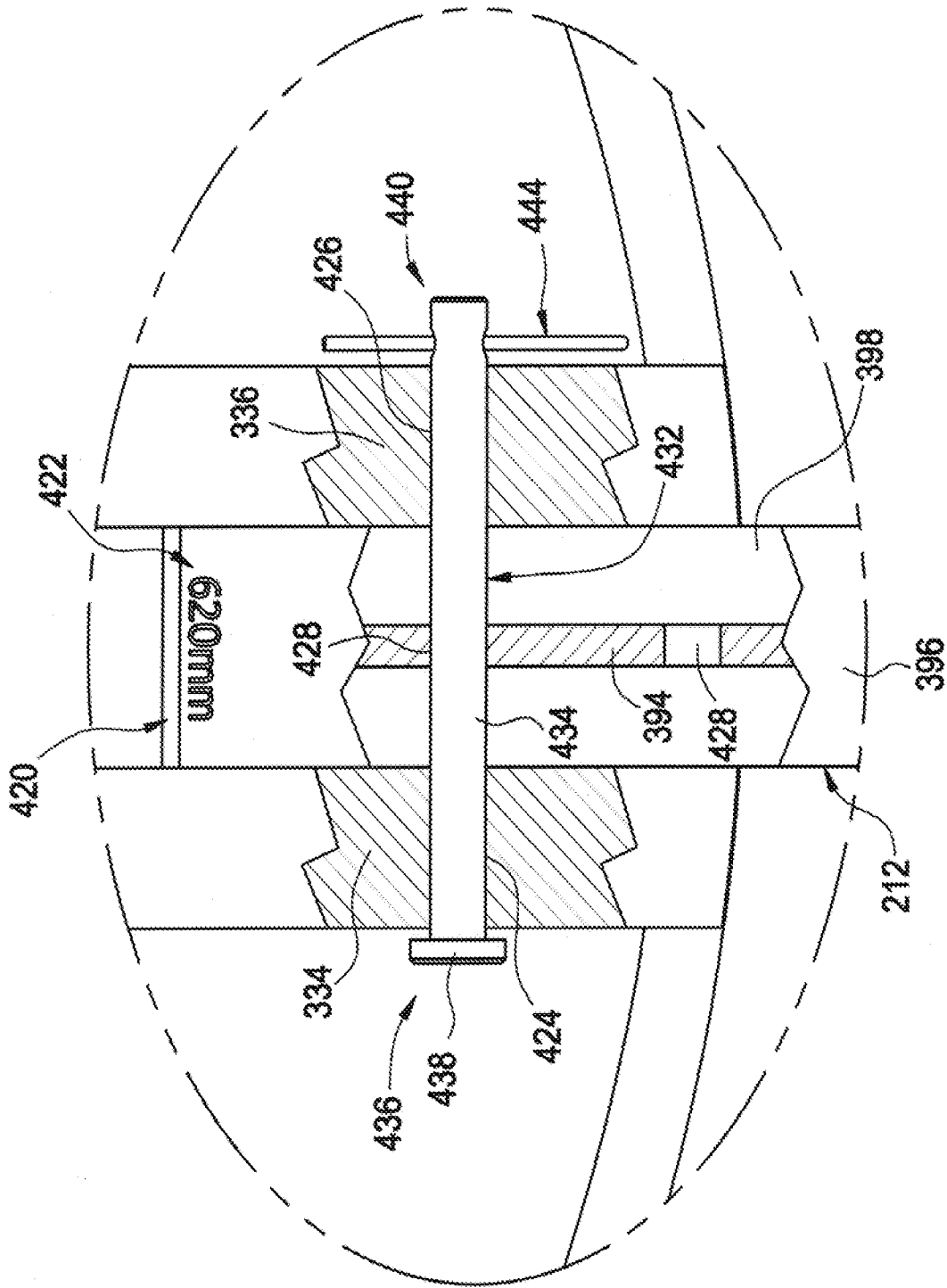


FIG. 19

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/US2016/023244

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. F16F9/05  
ADD.  
  
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**  
Minimum documentation searched (classification system followed by classification symbols)  
F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	WO 2014/011575 A1 (FIRESTONE IND PRODUCTS CO LLC [US]) 16 January 2014 (2014-01-16) figures 7,8	1,8-10, 23-25 4-7, 11-22, 26-29
X	----- US 2014/091548 A1 (RATZ MICHAEL E [US] ET AL) 3 April 2014 (2014-04-03) figure 10	1-3
X	----- US 2014/175717 A1 (JACKSON JR DAVID D [US]) 26 June 2014 (2014-06-26) figures 5,6,8 -----	1

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search  19 May 2016	Date of mailing of the international search report  27/05/2016
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Beaumont, Arnaud
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2016/023244
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