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(71) Applicant: **STRYKER CORPORATION** [US/US]; 2825 Airview Boulevard, Kalamazoo, Michigan 49002 (US).

(72) Inventors: **BRUBAKER, Michael T.**; 1225 Odell Farm Ln., Vicksburg, Michigan 49097 (US). **PETERS, Stephen F.**; 13700 Kelly Rd., Hickory Corners, Michigan 49060 (US). **MARTEL, Benoit**; 4300 The Wood Drive, Apt. 1402, San Jose, California 95136 (US).

(74) Agents: **COLLINS, Catherine S.** et al.; Warner Norcross & Judd LLP, 900 Fifth Third Center, 111 Lyon Street, NW, Grand Rapids, Michigan 49503-2487 (US).

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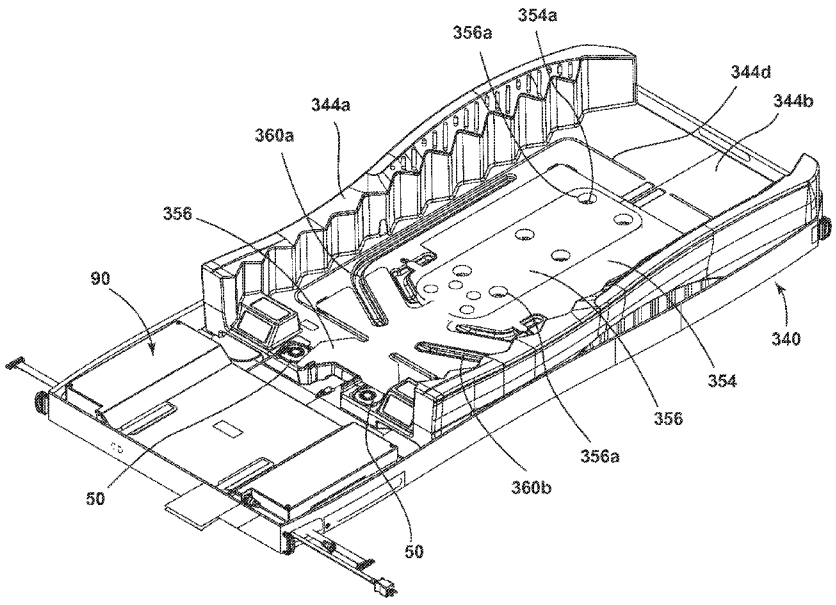

FIG. 27

(57) Abstract: A patient support includes a bladder layer with a plurality of bladders, a pneumatic supply system, and a plurality of tubes in fluid communication with pneumatic supply system. The tubes are coupled to and guided by the bladder layer so that the tubes and bladder layer may remain in close registry when being handled, for example, either during the assembly process or cleaning process.

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PATIENT SUPPORT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional application Ser. No. 61/874,165, entitled PATIENT SUPPORT, filed on September 5, 2013, which is incorporated by reference herein in its entirety.

This application is related to U.S. utility application Ser. No. 14/019,353 (P405E) filed September 5, 2013, entitled PATIENT SUPPORT, U.S. utility application Ser. No. 14/308,131 (P405B) filed June 18, 2014, entitled PATIENT SUPPORT COVER, U.S. utility application Ser. No. 13/548,591 (P-376A), filed Jul. 13, 2012, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. utility application Ser. No. 13/022,326 (P-257A), filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. utility application Ser. No. 13/022,372 (P-257B), filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. utility application Ser. No. 13/022,382 (P-257C), filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. utility application Ser. No. 13/022,454 (P-257D), filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. utility application Ser. No. 12/640,770 (P-239A) filed Dec. 17, 2009, entitled PATIENT SUPPORT; and U.S. utility application Ser. No. 12/640,643 (P-239B), filed Dec. 17, 2009, entitled PATIENT SUPPORT, all of which are incorporated by reference herein in their entireties.

TECHNICAL FIELD AND BACKGROUND OF THE INVENTION

[0001] The present invention generally relates to a patient support, and more particularly to a patient mattress for a hospital bed.

SUMMARY OF THE INVENTION

[0002] The present disclosure provides a mattress for supporting a patient with one or more cushioning layers that provide immersion and pressure distribution to a patient supported on the mattress, as well as a low air loss system.

In one embodiment, a patient support includes a plurality of cushioning layers arranged such that their upper cushioning layer forms a support surface for a patient. The upper cushioning layer comprises a bladder layer with a plurality of bladders with at least two zones, with each zone being configured to be separately inflatable. Located beneath the upper cushioning layer are a pneumatic supply system and a plurality of supply tubes, which are in communication with the pneumatic supply system and coupled to and guided by the bladder layer for inflating the bladders.

In one aspect, the bladder layer forms a carrier for the supply tubes. For example, the bladder layer may include a plurality of supports for coupling the supply tubes to the bladder layer. For

example, the supports may comprise channels that are formed or attached at or to the bottom surface of the bladder layer. Suitable supports may be formed from patches of sheet material that are adhered or welded at or to the bottom surface of the bladder layer. For example, the bladder layer may be formed by an upper sheet and a lower sheet, which are joined together, for example, by welding, with the supports mounted to the lower sheet. For example, the supports may be adhered or welded to the lower sheet. Alternatively, an additional sheet may be provided and joined with the lower sheet, with the supports mounted to the additional sheet.

According to yet another aspect, the bladder layer may include a harness for supporting the tubes. For example, as noted, the bladder layer may be formed by an upper sheet and a lower sheet, with the harness formed by the upper sheet. Alternately, the harness may be formed by the lower sheet or both sheets.

In a further aspect, the harness comprises an extension of the respective sheet or sheets of the bladder layer, for example, in the form of a flange, which is adapted to support the supply tubes. For example, the flange may have openings through which the supply tubes may be routed or passed through and which are sized to hold the tubes in place. For example, the openings may comprise a pair of slits, which are spaced to form loops between the slits so that the loops will frictionally hold the supply tubes in place.

[0003] In another embodiment, a patient support includes a plurality of cushioning layers arranged such that their upper cushioning layer forms a support surface for a patient. The upper cushioning layer comprises a bladder layer with a plurality of bladders with at least two zones, with each zone being configured to be separately inflatable. Located beneath the upper cushioning layer is a sensing system with a plurality of sensing tubes, which are coupled to and guided by the bladder layer and coupled to the respective zones for sensing the pressure in the zones.

[0004] In one aspect, the bladder layer forms a carrier for the supply tubes. For example, the bladder layer may include a plurality of supports for coupling the sensing tubes to the bladder layer. For example, the supports may comprise channels that are formed or attached at or to the bottom surface of the bladder layer. Suitable supports may be formed from patches of sheet material that are adhered or welded at or to the bottom surface of the bladder layer. For example, the bladder layer may be formed by an upper sheet and a lower sheet, which are joined together, for example, by welding, with the supports mounted to the lower sheet. For example, the supports may be adhered or welded to the lower sheet. Alternatively, an additional sheet may be provided and joined with the lower sheet, with the supports mounted to the additional sheet.

[0005] According to yet another aspect, the bladder layer may include a harness for supporting the sensing tubes. For example, as noted, the bladder layer may be formed by an upper

sheet and a lower sheet, with the harness formed by the upper sheet. Alternately, the harness may be formed by the lower sheet or both sheets.

[0006] In a further aspect, the harness comprises an extension of the respective sheet or sheets of the bladder layer, for example, in the form of a flange, which is adapted to support the sensing tubes. For example, the flange may have openings through which the sensing tubes may be routed or passed through and which are configured to hold the tubes in place. For example, the openings may comprise a pair of slits, which are spaced to form loops between the slits so that the loops can frictionally hold the sensing tubes in place.

[0007] According to yet another aspect, in any of the above patient supports, the bladder layer may include transverse openings allowing air to pass through the bladder layer to direct air flow through the at least one cushioning layer.

[0008] In any of the above supports, the patient support may include a gel layer adjacent the inflatable bladders. For example, the gel layer may interlock with adjacent bladders of the inflatable bladders.

[0009] In another aspect, each of the bladders has a hexagonal cross-section. In addition or alternately, the gel layer may include a plurality of hexagonal gel footings. For example, each of the gel footings may be disconnected from its adjacent gel footings. Optionally, each of the gel footings may be internally reinforced by a plurality of gel wall structures.

[0010] According to yet another aspect, the cushioning layers are supported on a foam crib.

[0011] In addition, the support optionally includes turning bladders positioned below the foam crib, with the foam crib including at least two hinged panels to allow turning of a patient supported on the patient support.

[0012] In another aspect, the support includes a cover and is configured to flow air through the support beneath the cover to manage moisture that may build up under the cover, which is formed from a material that prevents liquid intrusion but allows gas and moisture to flow through the cover.

[0013] For example, the foam crib may include a plurality of channels extending there through for directing air through the foam crib and into at least one of the cushioning layers. Additionally, the foam crib may support or house one or more blowers to direct air though the channels.

[0014] In another aspect, the support cover includes a mesh panel that permits air to be drawn into the cover by the blower units.

In another embodiment, a patient support includes a plurality of cushioning layers arranged such that their supporting surfaces when unloaded are generally arranged in a plane. Each cushioning layer is interlocked with each adjacent cushioning layer wherein each cushioning layer provides lateral and longitudinal support to each of its adjacent cushioning layers.

[0015] In one aspect, the cushioning layers include a bladder layer.

[0016] In another aspect, the cushioning layers include a gel layer.

[0017] According to yet another aspect, at least one of the cushioning layers includes transverse openings allowing air to pass through the at least one cushioning layer to direct air flow through the at least one cushioning layer.

[0018] In any of the above supports, the patient support may include a plurality of inflatable bladders and a gel layer adjacent the inflatable bladders. For example, the gel layer may interlock with adjacent bladders of the inflatable bladders.

[0019] In another aspect, each of the bladders has a hexagonal cross-section. In addition or alternately, the gel layer may include a plurality of hexagonal gel footings. For example, each of the gel footings may be disconnected from its adjacent gel footings. Optionally, each of the gel footings may be internally reinforced by a plurality of gel wall structures.

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[0023] For example, the foam crib may include a plurality of channels extending there through for directing air through the foam crib and into at least one of the cushioning layers. Additionally, the foam crib may support or house one or more blowers to direct air though the channels.

[0024] In another aspect, the support cover includes a mesh panel that permits air to be drawn into the cover by the blower units.

[0025] Accordingly, a support surface is provided the offers pressure distribution and optionally improved moisture management for a patient.

[0026] Accordingly, a support surface is provided that offers a patient with pressure distribution and optionally improved moisture management.

[0027] Before the embodiments of the invention are explained in more detail below, it is to be understood that the invention is not limited to the details of operation or to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention may be implemented in various other embodiments and is capable of being practiced or being carried out in alternative ways not expressly disclosed herein. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and

should not be regarded as limiting. The use of "including" and "comprising" and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items and equivalents thereof. Further, enumeration may be used in the description of various embodiments. Unless otherwise expressly stated, the use of enumeration should not be construed as limiting the invention to any specific order or number of components. Nor should the use of enumeration be construed as excluding from the scope of the invention any additional steps or components that might be combined with or into the enumerated steps or components.

DESCRIPTION OF THE FIGURES

[0028] FIG. 1 is a perspective view a patient support shown mounted to a patient support apparatus, for example, a hospital bed;

[0029] FIG. 2 is a perspective view of the patient support of FIG. 1;

[0030] FIG. 2A is an exploded fragmentary view of the patient support illustrating the various cushioning layers and components that may be incorporated into the patient support;

[0031] FIG. 3 is a similar view to FIG. 2 with the cover removed to show the internal cushioning layers;

[0032] FIG. 3A is a plan view of the patient support illustrating the different areas or zones of the patient support;

[0033] FIG. 4 is a perspective view of the bladder layer of the patient support;

[0034] FIG. 4A is a perspective view of the bladder layer with a partial cut-away illustrating the construction of at least some of the bladders;

[0035] FIG. 5 is a perspective view of the foam crib that supports the bladder layer;

[0036] FIG. 6 is a bottom perspective view the foam crib of FIG. 5 illustrating the foam crib with a hinged panel;

[0037] FIG. 7 is a perspective view of the base of the patient support;

[0038] FIG. 8 is a perspective view of a pair of turning bladders;

[0039] FIG. 9 is a perspective view of the gel layer of the patient support;

[0040] FIG. 9A is an enlarged plan view of a gel footing of the gel layer of FIG. 9;

[0041] FIG. 10 is a similar view to FIG. 3 illustrating a patient supported on the surface and illustrating the immersion of the patient's body into the surface;

[0042] FIG. 11 is a perspective view of another embodiment of a bladder layer of the patient support apparatus;

[0043] FIG. 12 is a plan view of the bladder layer of FIG. 11;

[0044] FIG. 13 is an enlarged view of detail X111 of FIG. 12;

[0045] FIG. 14 is an enlarged view of detail XIV of FIG. 12;

[0046] FIG. 15 is similar view to FIG. 13 but with the tubes inserted;

[0047] FIG. 16 is a bottom perspective view of the bladder layer of FIG. 11;

[0048] FIG. 17 is a similar view to FIG. 16 with the tubing removed for clarity;

[0049] FIG. 18 is an exploded perspective view of the bladder layer of FIG. 17;

[0050] FIG. 19 is an enlarge plan view of the supports mounted at or to the bottom surface of the bladder layer;

[0051] FIG. 20 is a perspective view of the foam and gel layer of the patient support;

[0052] FIG. 21 is a side view of the foam and gel layer of the patient support;

[0053] FIG. 22 is a perspective view of the portion of the foam crib that supports the bladder layer;

[0054] FIG. 22A is a schematic drawing illustrating the pneumatic system of the patient support;

[0055] FIG. 23 is a perspective view of the portion of the foam crib that supports the gel layer inverted and placed on the bladder layer to show the connection between the foot end of the foam crib and the head/body end of the foam crib;

[0056] FIG. 24 is a perspective view of the foot portion of the foam crib folded showing the hinge formed by the gel layer;

[0057] FIG. 25 is a perspective view of the foam crib of FIG. 20 with the bladder layer and gel layer removed;

[0058] FIG. 26 is a plan view of the foam crib of FIG 25;

[0059] FIG. 27 is a similar view to FIG. 25 with a cover over the low air loss fluid flow channels; and

[0060] FIG. 28 is a plan view of the foam crib of FIG 25.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0061] Referring to FIG. 1, the numeral 10 generally designates a patient support. While described as a “patient” support, it should be understood that “patient” is to be construed broadly to include not only people undergoing medical treatment, but also invalids and other persons, such as long term care persons, who may or may not be undergoing medical treatment. Further, while patient support 10 is illustrated as a mattress, it will be understood that patient support 10 may take on other forms, such as pads, cushions, including cushions for a wheelchair or a stationary chair pads. As will be more fully described below, patient support 10 provides support to a patient’s body and, further, may be adapted to provide therapy or treatment to the patient, for example, rotation therapy, percussion therapy, and/or vibration therapy or the like. Additionally, the support surface of the patient support may be configured to provide a low air loss system and/or a control system that automatically determines a suitable immersion level for each individual patient that is positioned on the support, thereby creating an individualized immersion level that is tailored to that specific individual. For further

details of a suitable immersion control system reference is made to copending application U.S. Ser. No. 13/836,813, filed March 15, 2013, entitled INFLATABLE MATTRESS AND CONTROL METHODS (Attorney Docket No. 143667.150316(P400A)), which is incorporated by reference herein in its entirety.

[0062] Referring again to FIG.1, patient support 10 is supported on a patient support apparatus 12 that, in this particular embodiment, is a hospital bed. However, patient support apparatus 12 may take on other forms besides a hospital beds, such as, but not limited to, long term care, cots, stretchers, operating tables, gurneys, wheelchairs, and the like. Further, patient support apparatus 12 may be a conventional support apparatus that is commercially available and that merely provides a supporting function for patient support 10.

[0063] For example, patient support apparatus 12 may include one or more controls that are integrated therein and which are used in controlling one or more functions of patient support 10, as will be discussed in greater detail below. For example, electrical connectors may be provided for establishing an electrical link between a user interface that is positioned on, or integrated into, the barrier of patient support apparatus 12. The user interface may take on a variety of different forms, such as, but not limited to, a touch screen, a Liquid Crystal Display (LCD), a plurality of buttons, switches, knobs, or the like, or any combination of these components, which allows a user to control the operation of patient support 10. The connection between the interface and patient support 10 may take on different forms, including a direct electrical cable that runs from the footboard to patient support 10, for example by way of electrical connectors that electrically couple the user interface to circuitry supported on or in the frame of the bed, and/or by wireless communication, such as disclosed in commonly assigned, U.S. patent application Ser. 13/802,855, filed March 14, 2013, by applicants Michael Hayes et al. and entitled COMMUNICATION SYSTEMS FOR PATIENT SUPPORT APPARATUSES, the complete disclosure of which is hereby incorporated herein by reference. For more exemplary details of a suitable hospital bed reference is made to the beds described in U.S. Patent Nos. 8,006,332; 7,690,059; 7,805,784; 7,962,981; and 7,861,334, all commonly owned by Stryker Corporation of Kalamazoo, Michigan, which are herein incorporated by reference in their entireties.

[0064] Referring to FIG. 2, patient support 10 includes a cover 14, which provides a plurality of optional features. For example, cover 14 may be formed from a flexible knit material, such as a flexible knit nylon or a nylon-like fabric, which provides a high breathability rate to facilitate moisture management. Additionally, cover 14 may be formed with the knit fibers on the patient facing side of the cover and with an inner surface formed by a stretchy elastomeric membrane that is stretchable so as not to reduce, if not eliminate, any interference with the patient immersion into support 10, as will be more fully described below. Furthermore, as will be more full described below, because cover 14

optionally encloses one or more blowers or fans for circulating air through the support, as part of a low air loss system, cover 14 may incorporate an open mesh panel to allow air to be drawn into the cover 14.

[0065] In another aspect, cover 14 may include one or more indicia on its surface. For example, cover 14 may include indicia to define the preferred location for a patient on patient support 10. The indicia may include a demarcation 16, such as a line, that defines the overall general area in which the patient should be positioned in the supine position and additional demarcations 18, 20, 22, and 24, also for example lines, that define the foot area, the thigh and seat areas, the back areas, and the head area of the patient support. In this manner, when a patient is located in the general area and also generally aligned with the sub-areas, the patient will be properly aligned with the support cushioning layers and turning bladders that are configured to provide the appropriate cushioning and functionality to that region of the patient's body.

[0066] In addition to the demarcation lines that identify the different areas/sections of the support, other indicia may be applied for example, graphical instructions, representations of the underlying cushioning layers (e.g. the gel or bladders), as well as the location of optional percussion/vibration and/or turning bladders to again facilitate the proper positioning of the patient.

[0067] The various demarcations, which for example indicate the different areas of support, i.e. thigh and back support areas, foot support areas, and head support areas, may be applied to the underlying sheet that forms the cover using a heat transfer process. For example, ink that is applied to a carrier sheet may be transferred onto the fabric that forms the cover using heat. In this manner, the ink does not simply coat the fabric, as is the case with silk screening, and instead merges with the fabric (and optionally underlying elastomeric membrane) which provides the sheet with generally constant properties. This tends to reduce the wear and provide increased longevity to the demarcations.

[0068] To provide appropriate cushioning and immersion for the patient, patient support 10 includes several cushioning layers, including a bladder layer 26 with a plurality of bladders 26a, 26b, which provide support to the patient's thighs, seat, back, and head, and a gel layer 28, which provides support to the patient's heels. Bladder layer 26 may be formed from a sheet of gelatinous elastomeric material, which is configured, such as by molding, including injection molding, blow molding, thermoforming, or cast molding, to include a plurality of sacs or cavities, which form upper wall 26c and side walls 26d of each bladder 26a, 26b, which is then joined with a bottom sheet 26e to form the closed chambers of the bladders (see FIG. 4A). The two sheets are joined together around their respective perimeters and around each of the sacs to form an array of discrete bladders. At least some regions of the sheets may be left un-joined (for example see in FIG. 4A) to form fluid passageways

between some or all of the adjacent bladders so that a network of passageways can be formed in the bladder layer to allow air flow between at least some of the bladders, which reduces the amount of tubing that is require to inflate the bladders and to maintain the pressure in the bladders at the desired pressure value. As noted below, some bladders may be grouped together in that they are in communication with each other through the above-noted air passageways, or through tubing, so that the bladders form zones.

[0069] Referring to FIG. 2, bladder layer 26 and gel layer 28 are supported so that their top or patient facing surfaces are adjacent each other and positioned generally in the same plane and at the same height (when not loaded with a patient) to form a generally continuous layer of cushioning. Though as noted below, at the interface between the gel layer and the bladders layer, the gel layer may be slightly angled downwardly to provide a more comfortable transition between the adjacent cushion layers.

[0070] In the illustrated embodiment, bladders 26a, 26b are arranged in zones, which optionally may be independently controlled with the inflation/deflation of each zone independent of the other zone or zones. For example, the zones may include a head zone at the head end 10a of support 10, a back zone at the back section 10c of support 10, seat and thigh zones at the seat and thigh sections 10d, and a heel zone at the foot end 10b of patient support 10. Further, each zone may be divided, for example into a left sub-zone and a right sub-zone so that when a patient is being turned, the pressure on the bladders on one side may be adjusted (e.g. increased or decreased) to accommodate the motion of the patient. For example, in the illustrated embodiment, the seat zone includes a right seat zone and a left seat zone to facilitate turning the patient. In the illustrated embodiment, the back zone and the head zone are grouped together and, further, positioned so that they will generally be aligned together when the patient is positioned on support 10

[0071] Referring to FIGS. 3 and 4, bladders 26a are arranged in rows and columns (rows are transverse to the long axis of the patient support, with columns extending generally parallel to the long axis of the patient support), with each bladder 26a in each row offset longitudinally from the adjacent bladder 26a to form an alternating pattern in each row so that the bladders are nested with the bladders of the adjacent rows. Further, the lateral center line of each bladder 26a extends between its respective adjacent bladders. In the illustrated embodiment, bladders 26a each have a hexagonal cross-section so that each bladder edge is offset from the corresponding edge of the adjacent bladder. For further details of the bladder arrangement, materials, and construction, reference is made to copending U.S. patent applications Ser. No. 13/022,326, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT (Attorney Docket No. STR03A P-257A); Ser. No. 13/022,372, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT (Attorney Docket No. STR03A P-257B); Ser.

No. 13/022,382, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT (Attorney Docket No. STR03A P-257C); Ser. No. 13/022,454, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT(Attorney Docket No. STR03A P-257D) ; Ser. No. 13/548,591, filed Jul. 13, 2012, entitled PATIENT/INVALID HANDLING SUPPORT (Attorney Docket No. STR03A P-376A), all of which are incorporated by reference herein in their entireties.

[0072] Referring again to FIGS. 3 and 4, head section bladders 26b have a generally block-shaped configuration with the side of bladders 26b facing bladders 26a having recesses that correspond to the shape of bladders 26a to provide a smooth transition between the head end and back section bladders. Bladders 26b may also incorporate a cover 26c to tie both left side head end bladder and right side head end bladder together to provide uniform support to the patient's head except when the patient is being turned, as described below.

[0073] Gel layer 28 is formed from a gelastic material. Suitable gelastic materials include a SEB, SEBS, SEP, SEPS, SEEP, SEEPS polymer combined with a mineral oil, such as disclosed in U.S. Pat. Nos. 3,485,787; 3,676,387; 3,827,999; 4,259,540; 4,351,913; 4,369,284; 4,618,213; 5,262,468; 5,508,334; 5,239,723; 5,475,890; 5,334,646; 5,336,708; 4,432,607; 4,492,428; 4,497,538; 4,509,821; 4,709,982; 4,716,183; 4,798,853; 4,942,270; 5,149, 736; 5,331,036; 5,881,409; 5,994,450; 5,749,111; 6,026,527; 6,197,099; 6,865,759; 7,060,213; 6,413,458; 7,730,566; and 7,964,664, which are all incorporated herein by reference in their entireties.

[0074] As one example, the gelatinous elastomeric material may be formulated with a weight ratio of oil to polymer of approximately 3.1 to 1. The polymer may be Kraton 1830 available from Kraton Polymers, which has a place of business in Houston, Texas, or it may be another suitable polymer. The oil may be mineral oil, or another suitable oil. One or more stabilizers may also be added. Additional ingredients—such as, but not limited to—dye may also be added. In another example, the gelatinous elastomeric material may be formulated with a weight ratio of oil to copolymers of approximately 2.6 to 1. The copolymers may be Septon 4055 and 4044 which are available from Kuraray America, Inc., which has a place of business in Houston, Texas, or it may be other copolymers. If Septon 4055 and 4044 are used, the weight ratio may be approximately 2.3 to 1 of Septon 4055 to Septon 4044. The oil may be mineral oil and one or more stabilizers may also be used. Additional ingredients—such as, but not limited to—dye may also be added. In addition to these two examples, as well as those disclosed in the aforementioned patents, still other formulations may be used.

[0075] In the illustrated embodiment, gel layer 28 includes a plurality of gelastic footings that are disconnected from each other so that each footing can compress independently from its adjacent surrounding footing. The term footing is used in the sense that the overall gel structure (defined by gel wall 30) is wider than it is tall. Referring to FIG. 4A, each footing is formed by an outer perimeter wall

30, having a generally hexagonal shape, which is then supported internally by six internal hexagonal-shaped walls, which are arranged in a circular pattern to form a central hexagonal-shaped wall, which is formed by the respective inner walls of the six internal hexagonal-shaped walls, which in turn share walls with the outer perimeter wall 30. In other words, the central hexagonal-shaped wall is not a separate wall and instead is defined by the inwardly facing walls of each internal hexagonal-shaped wall. Similarly, the outer wall of each internal hexagonal-shaped wall is provided or formed by a portion of the outer perimeter wall 30.

[0076] For example, the height of each wall may be in a range of about 1" to 4", or in a range of about 2" to 3", and the thickness of each wall may be in a range of about 1/32" to 3/8" or in a range of about 1/16" to ¼". The width of each footing may be in a range of about 3" to 6" or in a range of about 4" to 5", with each internal hexagonal-shaped wall in a range of about 1" to 2" or in a range of about ¾ to 1 ½ ". To facilitate injection molding, the walls are slightly tapered, for example, to create a draft angle. For example, the draft angle may fall in a range of about 1 degrees to 10 degrees or in a range of about 3 degrees to 8 degrees.

[0077] In this manner, each gel footing 30 provides a nested set of interconnected gel walls that tend to buckle under the weight of a patient and continue to provide cushioning support to the patient's heels over the full range of collapse of each group of the internal walls. By spreading the load across multiple walls that are interconnected, but arranged in isolated groups, each grouping will allow greater immersion and provide better redistribution of stress or pressure across the patient's heel then when all the walls are tied together.

[0078] In addition, each gel wall of each gel footing may be joined at their lowermost edges by a base sheet of gel, which is relatively thin, like a skin, which is used in the molding process to help distribute the gel material across the full width of the gel layer.

[0079] Further, the gel forming gel layer 28 may be selected to very soft, but with the interconnection of the adjacent inner walls still provide adequate support and cushioning to the patient's heel. For examples of other gel configurations that may be used, including gel columns (where the gel structures have a greater height than their width), reference is again made to U.S. Pat. Nos. 3,485,787; 3,676,387; 3,827,999; 4,259,540; 4,351,913; 4,369,284; 4,618,213; 5,262,468; 5,508,334; 5,239,723; 5,475,890; 5,334,646; 5,336,708; 4,432,607; 4,492,428; 4,497,538; 4,509,821; 4,709,982; 4,716,183; 4,798,853; 4,942,270; 5,149, 736; 5,331,036; 5,881,409; 5,994,450; 5,749,111; 6,026,527; 6,197,099; 6,843,873; 6,865,759; 7,060,213; 6,413, 458; 7,730,566; 7,823,233; 7,827,636; 7,823,234; and 7,964,664, which are all incorporated herein by reference in their entireties.

[0080] As best seen in FIG. 3, bladder layer 26 and gel layer 28 are supported by a foam crib 40. Crib 40 optionally includes a first portion 40a that extends under bladder layer 26 from the head

end to the thigh region of the patient and a second portion 40b that extends under the gel layer from below the thigh region to foot end 10b of patient support 10. Crib 40 tends to keep the softer cushion layers of the bladders and gel in place while also providing a firmer rail along both sides of support 10.

[0081] Foam crib portion 40a includes a base wall 42 and a pair of upwardly extending sidewalls 44, which as noted form a foam rail along opposed sides of bladder layer 26 to facilitate entry to and exit from the bed, and to cradle the patient when they are in the supine position. Referring to FIGS. 5 and 6, base wall 42 of crib 40 includes a plurality of channels that form a branching or tree-like configuration with a central channel 46 and a plurality of laterally extending branch channels 48, which are in fluid communication with central channel 46. Central channel 46 is in fluid communication with inlet or feeder channels 46a formed at the base of central channel 46. And, each inlet channel 46a includes a recess 46b for receiving a blower unit 50, whose output is directed toward the central channel 46 through inlet or feeder channel 46a and whose intake extends through the lower edge of base wall 42 so that when blower units 50 are covered by bladder layer 26, the blower units can draw in air from the space adjacent the lower end of foam crib 40, as will be more fully described below. These channels also facilitate the bending of foam crib, described below.

[0082] Blower units 50, when operated, blow air into channels 46a and 46, which in turn distribute the air into branch channels 48 to generate air flow into the bladder layer 26 from beneath. To allow the air to flow through bladder layer 26, the base sheet of bladder layer 26 includes a plurality of openings so that air can flow up through the bladder layer 26 and between the bladders 26a as indicated by the arrows in FIG. 3. To better focus the flow of air, base layer 42 may incorporate a sheet of non-woven material 54 (FIGS. 2A and 6) adhered to its surface, which extends over inlet channels 46a, central channel 46, and portion of branch channels 48 to leave the distal end of each branch channel open so that they direct air into the bladder layer 46 at discrete space locations.

[0083] Referring again to FIG. 5, each sidewall 44 of crib 40 has an upper wedge-shaped portion 60 adjacent at least the shoulder area of a patient supported on patient support 10. Wedge-shaped portions 60 form angled surfaces facing the patient, at the patient's shoulder region, which extend above the upper surface of bladder layer 26 when inflated and unloaded, and extend above bladder layer 26 at an even greater height when a patient is placed on bladder layer 26. Therefore, wedge-shaped portions 60 provide lateral support to a patient at their shoulders, but are sufficiently resilient to collapse down to the underlying base of sidewall 44 when a patient exits the bed.

[0084] Inwardly facing sides of sidewalls 44 optionally include a plurality of recesses 62 that at least generally follow the contour of each adjacent bladder 26a to thereby provide lateral support to each adjacent bladder both in the lateral and longitudinal direction. As a result, bladders 26a are held in place and, to a certain extent, somewhat interlocked with each other given their own interlocking

arrangement. Similarly, as seen in FIG. 3, the inwardly facing edge of gel layer 28 may include a plurality of recesses to receive the bladders adjacent the gel layer so that the foot end bladders are similarly laterally and longitudinally supported by the adjacent gel layer.

[0085] As best seen in FIG. 6, foam crib portion 40b similarly has a base wall 64 with a pair of upwardly extending sidewalls 66 that similarly include recesses that generally match the shape of the respective gel footings and recesses formed between each gel footing. In a similar manner to the bladders, sidewalls 66 therefore provide lateral and longitudinal support to each of the adjacent gel footings that run along the edge of the gel layer 28. In this manner, each layer is interlocked with its adjacent layer so that all three materials (foam, air-filled bladder, and gel) form a cushioning system.

[0086] Further, foam base wall 66 of foam crib section 40b includes a plurality of recesses to receive the lower ends of each bladder at the foot end of bladder layer 26 and, further, provide downwardly tapered upper surfaces adjacent each recess so that the gel footings at the thigh end of gel layer 28 are sloped downwardly to provide a smooth transition between the adjacent gel layer and bladder layer. This transition is optionally aligned generally between the knee and thigh of the patient supported on patient support 10.

[0087] As best seen in FIG. 2A, patient support 10 optionally includes a pair of turning bladders 70a and 70b. Turning bladders 70a, 70b are positioned beneath crib 40. Referring to FIG. 5, bladders 70a and 70b are aligned under sectioned portions 42a and 42b of base wall 42 of crib 40, which are detached from the remainder of the crib along three sides to form hinged panels, which are hinged at the center of crib 40 so that they can lift up when one of the turning bladders is inflated. To prevent the hinged panel from falling into the crib, each panel optionally includes an L-shaped rim that generally aligns with a corresponding L-shaped sill in the balance of the crib that extends around the detached panels.

[0088] To deliver air to bladders 26a and 26b and to turning bladders 70a and 70b, support 10 includes a pneumatic system. In this illustrated embodiment, and referring to FIG. 2A, the pneumatic system includes a pneumatic harness 80, which includes a plurality of tubing sections 84 that are supported and secured to a fabric carrier 82 that secures the various tubing sections and associated connectors 86 in their desired configuration and locations. In this manner, when harness 80 is placed over crib 40, the tubing and its associated connectors can be easily aligned with the appropriate inlets for inflating the respective bladders. Together, the tubing and fabric carrier form a flexible manifold that can be easily located in a position with an inlet end (where the tubing exits the carrier) positioned and aligned for coupling to the pump or pumps (of the pneumatic supply system) that supply the air to the respective bladders. The pump or pumps that supply air to the tubing are optionally located in a box at the foot end of the support, more fully described below.

[0089] As noted above, the various tubing that supplies the bladders with air are coupled to a pump or pumps 90a, which in the illustrated embodiment are located in a pump box 90 shown in FIG. 7. Pump box 90 is preferably located at the foot end 10b of the patient support 10 and further beneath the crib portion 40b under gel layer 28. Pump box 90, for example, may be formed from a polymeric material and has a centrally located recess typically located under the heels of a patient to provide increased immersion depth for the heels of the patient when the patient is lying on patient support 10. In addition to storing or holding the pump or pumps 90a, pump box 90 may also include a CPR manifold, which when opened allows the air from the bladders to be dumped so that the patient is then supported directly on the crib beneath the bladders, which provides a firmer surface to allow CPR to be administered to the patient. In addition to a pump or pumps 90a, box 90 may also house various controls and circuitry for controlling the pump or pumps and for other devices that may be incorporated into patient support.

[0090] As noted above, bladders 26a, 26b are inflated, or deflated, in groups or zones as described above under the control of box 90 and its associated pumps and control circuitry. The fluid connections between the bladders and box 90 (and the pump or pumps 90a contained therein) are established by the tubing 84 that run between box 90 (the pump or pumps 90a housed in box 90) and the various bladders and which connect to inlets on the bladders by connectors 86. As noted above, tubing 84 is attached to fabric carrier 82, which together forms the flexible manifold 80.

[0091] Similarly, manifold 80 may support the tubing for turning bladders 70a, 70b, which extend generally longitudinally in a direction from the head end 10a to foot end 10b, and as noted are positioned underneath foam crib 40 and are used to help turn a patient positioned on top of patient support 10. To that end, turning bladders 70an 70b are each separately and independently inflatable and deflatable, which is also controlled by box 90 and its associated circuitry.

[0092] For example, as discussed in reference to copending application U.S. Ser. No. 13/836,813, filed March 15, 2013, entitled INFLATABLE MATTRESS AND CONTROL METHODS (Attorney Docket No. 143667.150316(P400A)), patient support 10 may incorporate sensors, such as depth sensor plates 92 (FIG. 7), for sensing the immersion of a patient into the surface. Based on the sensed immersion, the controller, which also may be located in box 90 or elsewhere, including for example in recesses 94 formed in foam crib 40 (FIG. 5), may be used to optimize the immersion of a patient into the surface based on the individual needs of a patient. In order to assist depth sensor plates 92, support 10 incorporates a conductive fabric 102 (FIG. 2A), which together function as capacitive sensors whose output changes as a patient moves closer or farther away from them. More specifically, conductive fabric 102 functions in a manner similar to the top plate of a parallel plate capacitor, while depth sensor plates 92 form the bottom plates of the parallel plate capacitor. Thus, as

the vertical distance between conductive fabric 102 and any of the depth sensor plates 92 changes, the capacitance between the fabric 102 and the plate(s) 92 will change. This change is detected by a detector circuit that is electrically coupled between fabric 102 and each of the depth sensor plates 92. That is, one or more wires (not shown) are electrically coupled to fabric 102 and the detector circuits, while one or more other wires (not shown) are connected between each plate 92 and the detector circuit. Conductive fabric 102 may be any commercially available fabric that is electrically conductive, or it may be an electrically conductive foil, or any other material that is electrically conductive, and that is flexible enough to not significantly alter the flexibility of patient support 10 in that region.

[0093] As best seen in FIG. 2A, fabric 102 is positioned on top of bladder layer 26 but over a fire sock or barrier 100, which wraps around bladder layer 26 and is made of any suitable material that resists the spread of fire. Such materials may vary. In one embodiment, fire barrier 100 may be made of, or include, Kevlar® (poly-paraphenylene terephthalamide), or other brands of para-aramid synthetic fibers. Other materials may alternatively be used. Cover 14, which includes an upper cover portion 14a and a lower cover portion 14b, therefore encloses fabric 102, sock 100, bladder layer 26, gel layer 28, crib 40, turning bladders 70a, 70b, and plates 92, as well as pump box 90 and the pneumatic manifold. For example, upper cover portion 14a and a lower cover portion 14b may be secured together by a zipper, which allows access to the various components inside support 10.

[0094] As noted above, when one of the turning bladders is inflated, the corresponding hinged panel of foam crib will raise up. At the same time, the air in the bladders above the rising panel may either be maintained or increased, while the pressure on the bladders on the opposite side may be reduced or even deflated.

[0095] In addition to turning a patient, sections of patient support 10 may be folded to accommodate the Fowler being raised or the leg section of being lowered. For example, support 10 may be supported on a bed with an articulating deck, with a head section, a back section, a seat section and a leg section, with one or more sections being pivotable to raise the Fowler or leg sections as noted. To accommodate the articulating deck, foam crib 40 may include a corresponding gatch for each point of articulation (see FIG. 3). Further, cover 14 may include a V-shaped section (no shown) which extends into its underside and into one of the gatches to similarly accommodate the bending of support when one of the deck sections is pivoted. For example, the open mesh that was noted above may be located in the V-shaped section to allow air to be drawn into the cover when blower units are running to circulate air through the cover. Though it should be understood that the mesh panel may also be located elsewhere, including on a bottom side of cover 14.

[0096] When assembled, therefore, patient support 10 not only includes a cushioning layer or layers that provide a pressure redistribution system to enhance the support of a patient lying upon

support 10 but also optionally provides a moisture management system, as well as an immersion control system. As noted above, additional functionalities may be provided in a form of configuring some of the bladders as percussion and/or vibration bladders, such as described in the referenced copending applications. It should be understood that patient support 10 may be modified to include one or more bladders in the foot zone in lieu of the gel layer and, therefore, the air pressure inside of these bladders could be monitored and controlled by the same system that controls the thigh, seat and head section bladders.

[0097] Referring to FIG. 11 , the numeral 226 generally designates another embodiment of a bladder layer. Bladder layer 226 similarly includes a plurality of bladders 226a, 226b that provide support to the patient's thighs, seat, back, and head. Similar to the bladder layer described above, bladder layer 226 may be used in combination with a gel layer, which provides support to the patient's feet/heels, and a foam crib, which supports both the bladder layer and the gel layer and provides other functions described above and below. For additional details not mentioned below of a suitable gel layer and a foam crib reference is made herein to the above embodiment.

Referring to FIG. 18, bladder layer 226 may be formed from an upper sheet 228 and a lower sheet 230. As best seen in FIGS. 16 and 17, upper sheet 228 and lower sheet 230 are joined together, such as by an adhesive or by welding or the like, to form bladders 226a and 226b, and further in a manner to form a plurality of zones where groups of bladders are in fluid communication with each other but not with the bladders of the other zones. For example, in the illustrated embodiment, bladders 226a and 226b are grouped into left and right head and back zones 232, 234 and seat zones 236 and 238.

[0098] Again referring to FIG. 18, bladders 226a and 226b are first formed in their extended configurations, for example, by thermoforming, and then joined with lower sheet 230. When formed in their extended configurations, each bladder forms a "pod" which is configured with a hexagonal cross-section so that the pods can be more closely nested than, for example, round or can shaped bladders. Further, the bladders can be arranged so that their edges do not align and instead are offset between adjacent bladders, which as described above, reduces the ability of a patient to detect the edges of each bladder and hence improve their comfort.

[0099] Referring to FIG. 16, bladder 226a and 226b are inflated by a pneumatic system 240, which is controlled by a control system described above. Pneumatic system 240 includes a pneumatic supply system, in the form of a pump 90a and a manifold 350 (which are housed in a pump box, such as pump box 90 described above), and a plurality of supply tubes 242. Tubes 242 extend under bladder layer 226 and couple thereto and are in communication with each of the respective zones of the bladder layer via couplers 246a (FIG. 17). Couplers 264a connect to inlet ports 248a provided in

bladder layer 226 so that each zone can be separately or independently inflated. Tubes 242 also couple to the turning bladders beneath the foam crib. Additionally, the control system includes a plurality of sensing tubes 244 that extend under bladder layer 226 and couple to and are in communication with each of the respective zones of the bladder layer via couplers 246b (FIG. 17). Couplers 246b connect to inlet ports 248b provided in bladder layer 226 so that the pressure in each zone can be independently measured by sensors mounted remotely from the bladders, for example, in the control compartment or pump box (90) described in the above. As will be more fully described below, bladder layer 226 is adapted to support and guide the supply and sensing tubes to the respective zones. Optionally, therefore, the bladder layer may form a carrier for the tubes, which can facilitate the assembly of the patient support.

As best seen in FIGS. 16 and 17, bladder layer 226 includes a plurality of supports 250 for mounting support tubes 242 and 244 to bladder layer 226. For example, supports 250 may comprise channels that are formed or attached at or to the bottom surface of bladder layer 226. Suitable supports may be formed from patches of sheet material that are adhered or welded at or to the bottom surface of bladder layer 226. As best seen in FIG. 19, supports 250 may be formed from circular patches 252 of material, for example, nylon, which are attached by welds 254 at or to the bottom or underside of bladder layer 226, for example to lower sheet 230. Alternately, an additional sheet may be provided and joined with the lower sheet, with the supports mounted to the additional sheet. It should be understood that supports 250 may be used to support both tubes 242 and tubes 244, or separate supports may be provide for tubes 242 and 244. Thus, bladder layer 226 and the tubes may remain in close registry when being handled, for example, either during the assembly process or cleaning process.

[00100] Referring to FIGS. 12, 13,and 15-17, bladder layer 226 may include a harness 260 for supporting and optionally holding tubes 242 and/or 244. For example, harness 260 may be formed by the upper sheet 228 or the lower sheet 230 of the bladder layer or both. Alternatively, harness 260 may be formed from a section of sheet that is attached to one or both of the bladder layer sheets, for example by stitching adhesive, or welding or the like.

[00101] In the illustrated embodiment, harness 260 comprises an extension of the respective sheet or sheets of the bladder layer, for example, in the form of a flange 262, which is adapted to support the supply tubes. Optionally, upper sheet 228 of bladder layer has a greater thickness than lower sheet 230 to accommodate the stretching that may occur when forming bladders 226a and 226b. For example, the upper sheet (228) may have a thickness in a range of about 40/1000 to 120/1000 of an inch, or about 60/1000 to 100/10000 of an inch, or about 80/1000 of an inch. The bottom sheet (230) may have a thickness in a range of about 10/1000 to 35/1000 of an inch, or about 15/1000 to

30/1000 of an inch, or about 20-25/1000 of an inch. In this manner, the flange may be formed from the thicker of the two sheets or the two sheets combined to provide increased strength.

[00102] As best seen in FIGS. 13 and 15, flange 262 may have openings 264 through which the supply tubes may be routed or passed through and which are sized to hold the tubes in place. For example, the openings may comprise a pair of slits, which are spaced to form loops 266 (FIG. 13) between the slits so that the loops can frictionally hold the tubes in place. Optionally, each pair of tubes 242 and 244 may be supported in the same opening, such as shown in FIG. 15. Alternately, flange 262 may have openings of different sizes to support each tube separately.

[00103] As noted above, bladder layer 226 is formed by, for example, two sheets that are joined together. The sheets may be joined around their respective perimeters and around each of the bladders or pods to form an array of discrete bladders. As noted above, at least some regions of the sheets may be left un-joined (for example see in FIG. 16) to form fluid passageways between some or all of the adjacent bladders so that a network of passageways can be formed in the bladder layer to allow air flow between at least some of the bladders, which reduces the amount of tubing that is require to inflate the bladders and to maintain the pressure in the bladders at the desired pressure value. As noted below, some bladders may be grouped together in that they are in communication with each other through the above-noted air passageways, or through tubing, so that the bladders form zones. In addition, as seen in FIG. 14, bladder layer 226 includes a plurality of transverse openings 268 located between bladders 226a to allow air to flow from beneath the bladder layer through the bladder layer.

[00104] As described above, to deliver air to bladders 226a and 226b and to the turning bladders (e.g. bladders 70a, 70b shown in FIGS. 2A and 8), support 210 includes pneumatic system 240 (FIG. 22A) with a plurality of supply tubes 242 in communication with a pneumatic supply system in the form of one or more pumps (e.g. pumps 90a in pump box 90 described above) and a control system with a plurality of sensing tubes 244. Supply tubes 242, as described, are harnessed by bladder layer 226 so that they can then be directed to the pump of the pneumatic supply system, described above, which may be supported in a compartment (e.g. pump box 90) at the foot end of the support beneath the gel layer and foam crib. Additionally, sensing tubes 244 may be similarly harnessed and directed to sensors, also mounted in the compartment, which sense the pressure in each zone to form part of a closed loop feedback control system, which is described more fully in U.S. Pat. Application Ser. No. 13/836,813, entitled INFLATABLE MATTRESS AND CONTROL METHODS, filed on March 15, 2013, which is incorporated by reference herein in its entirety.

[00105] When assembled, therefore, a patient support incorporating bladder layer 226 and pneumatic system 240 not only includes a cushioning layer that provides a pressure redistribution system to enhance the support of a patient lying upon the patient support but also optionally provides a

line management system for the pneumatic tubes of the inflation and control system. It should be understood that the patient support may be modified to include one or more bladders in the foot zone in lieu of the gel layer and, therefore, the air pressure inside of these bladders could be monitored and controlled by the same system that controls the head and back section bladders, and the thigh and seat section bladders.

[00106] Referring to FIGS. 20-24, bladder layer 226 and a gel layer 328, similar to gel layer 28, are supported by a foam crib 340, which is of similar construction to foam crib 40 described above. Therefore, for additional details not noted herein, reference is made to foam crib 40 and gel layer 28. Crib 340 includes a head/body end 344 and a foot end 346 that are joined together at a joint 342, which is configured to allow the foot end 346 of foam crib 340 to be raised relative to the head/body end (or vice versa to allow the head/body end to be raised relative to the foot end).

[00107] As best seen in FIG. 22, one side of joint 342 may include a recessed region with line management channels 348 that, for example, direct supply tubing 242 from bladder layer 226 to the pneumatic supply system. As best seen in FIG. 22A, tubes or tubing 242 are in fluid communication with the respective bladders 226a of bladder layer 226 and with a CPR valve manifold 350 of pneumatic system 240. Sensor tubes or tubing 244 are in fluid communication with the respective bladders 226a of bladder layer 226 and sensors 351a of a sensor assembly 351, which are optionally located at the foot end in a control compartment (e.g. pump box 90) located beneath the foot end portion of the foam crib. Additionally, foam crib 340 may include channels 354 (FIG. 22) extending into its respective sides for line management purposes.

[00108] Referring to FIGS. 22 and 23, joint 342 is formed by complementary stepped profiles formed by wedge shaped blocks 342a (FIG. 25) on the head/body end 344 of foam crib 340 and angled blocks 342b (FIG. 23) formed on foot end 346 of foam crib 340, which are joined by releasable fasteners, such as VELCRO patches 358 so that the foot end 346 may be disconnected from head/body end 344 to allow access to the control compartment (e.g. pump box 90). Further, when at least some of the patches are unhooked, joint 342 may form a hinge.

[00109] As best seen from FIG. 20, 22, and 24, the joint is formed by overlapping portions of the foot end of the crib and the head/body end of the crib. Referring to FIG. 21, foot end 346 includes a base wall 346b and two opposing side walls 346a. Side walls 346a generally align with the side walls 344a of head/body end 344 of crib 340. Base wall 346b extends between side walls 346a and includes a portion that extends beyond the ends of side walls 346a to form a tongue 346c that overlaps with the base wall 344b of head/body end 344 to thereby form joint 342. In this manner, the foot end of the foam crib projects beyond and into the end of the head/body end of the foam crib and further meshes with the head/body end to form joint 342. Further, tongue 346c supports and is joined with the

gel layer, which also extends into the head/body portion so that it too meshes with the bladders of the bladder layer and is connected to the head/body end when the fasteners noted above align and are coupled.

[00110] The joint 342 further includes hinge 345, which is formed by the foot end and the head/body portion. As noted above, base wall 346b of foot end 346 includes a tongue 346c which projects into and over the base wall 344b of head/body end 344. Tongue 346c is separated and divided from the balance of base wall 346b to form a moving part of the hinge. Tongue 346c is joined to both base wall 346b of foot end 346 and base wall 344b of head/body end 344 by gel layer 328, which is adhered to base wall 346b of foot end and base wall 344b of head/body end 344 by a sheet of non-woven material and an adhesive. Gel layer 328, therefore, acts as the hinge so that foot end 346 can be pivoted about hinge 345 and then be flipped over onto the head/body end 344 (FIG. 24) to allow access to the pump box and pneumatic tubes that run from the head/body end of crib 340 to the foot end of crib 340. Further gel layer 328 may include a score line or cut (FIG. 24) that extends from its lower side into some of the walls forming the gel footing to minimize the changes of the gel wall from tearing when foot end is pivoted about tongue 346c and head/body end 344.

[00111] As described above, blower units 50 may be supported in the foam crib and further may be supported in recesses formed between blocks 342a and 342b. Optionally, foot end 346 of foam crib may incorporate rigid supports 360, for example, in the form of plastic flanged channels, which align over and cover the blowers to protect them from interference from the foam. Further, the channels may be joined together by a web 360a (see FIG 24) so that they also provide protection to the tubing that extends through the joint from the head/body end to under the foot end of the foam crib. For further detail of gel layer 328 and crib 340, reference is made to the gel layers and foam cribs described above.

[00112] Referring now to FIG. 25-29, similar to crib 40, crib 340 may include in its base wall 344b a low air loss system in the form of a plurality of channels 348. Channels 348 also form a branched or tree-like configuration with a central channel 348a and a plurality of arcuate branch channels 348b, which project outwardly on either side of channel 348a and are in fluid communication with central channel 348a. Central channels 348a in fluid communication with inlet or feeder channels 348c formed at the base of central channel 348a. Each inlet channel 348c includes a recess 348d 46b for receiving a blower unit 50, whose output is directed toward the central channel 348a through inlet or feeder channel 348c and whose intake extends through the lower edge of base wall 344b so that when blower units 50 are covered by bladder layer 226, the blower units can draw in air from the space adjacent the lower end of foam crib 340. These channels also facilitate the bending of foam crib 340.

[00113] Blower units 50, when operated, blow air into channels 348c and 348a, which in turn distribute the air into branch channels 348b to generate air flow into the bladder layer 226 from beneath. To allow the air to flow through bladder layer 226, the base sheet of bladder layer 226, as noted above, includes a plurality of openings 268 so that air can flow up through the bladder layer 226 and between the bladders 226a. To better focus the flow of air, base layer 344b may incorporate a sheet of non-woven material 354, such as nylon (FIGS. 27 and 28), adhered to its upper surface, which extends over inlet channels 348c, central channel 348a, and over the entire length branch channels 348b.

[00114] To direct air flow form the channels to beneath the bladder layer, sheet 354 includes a plurality of openings 354a that direct the air flow from the channels to discrete and clustered locations at the underside of bladder layer 226. To accommodate variations in the surface topology of the underside of bladder layer 226, a second sheet or panel 356 of resilient material overlies the region of sheet 354 with openings 354a, which includes also openings 356a that align with openings 354a.

[00115] Sheet 356 is formed from a resilient material so that it can absorb the variations due to the uneven surface topology of the underside of the bladder layer. For example, a suitable material includes a foam or a structural gel. Sheet 356 may have a thickness, for example, in range of 1/8" to 2 inches or 1/4" to 1.5 inches or ½" to 1.0 inch. The width of sheet 356 may be in range of 2 to 35 inches (in other words the full width of the mattress). The length of sheet 356 may be in range of 15 to 80 inches (in other words the length width of the mattress). As a result, sheet 356 effectively seals the openings on sheet 354 against the underside of the bladder layer 226 to thereby form a gasket. Further, the openings 268 in bladder layer 226 may also be centralized so that the air flow can be more effectively distributed through the bladder layer, thereby possibly reducing air loss between the bladder layer and the channels.

[00116] Similar to crib 40, crib 340 may also have cutouts 344d through its base wall 344b to form panels that can be raised by, for example, turning bladders, such as turning bladders 70a and 70b, to be located under the crib to lift and turn one side of the bladders to turn a patient support thereon. In addition to channels 348a-d, base wall 344b may include line management channels 360a and 360b, which may further facilitate to keep the tubes in their proper alignment with the bladder layer. Additionally, line management channels 360a and 360b facilitate a closer fit between bladder layer 226 and the base wall of the foam crib to further reduce potential air loss leakage from the low air loss system.

[00117] Accordingly, the present invention provides a patient support that provides a mattress with inflatable support bladders that offer improved immersion of the patient into the surface of the mattress and, therefore, improved pressure distribution to the patient. With the independent discrete

bladder arrangement, it has been found that a more balanced contact (see FIG. 10) can be achieve in both the x and y- axes. Further, given the unitary nature of the support bladders, the need for tubing can be significantly reduced, and for some functions eliminated. Further, the present invention provides a patient support that provides a mattress with inflatable support bladders that can offer improved immersion in combination with a line management system that facilitates assembly and handling of the patient support.

[00118] While several forms of the invention have been shown and described, other changes and modifications will be appreciated by those skilled in the relevant art. Therefore, it will be understood that the embodiments shown in the drawings and described above are merely for illustrative purposes, and are not intended to limit the scope of the invention which is defined by the claims which follow as interpreted under the principles of patent law including the doctrine of equivalents.

I claim:

1. A patient support comprising:

a bladder layer with a plurality of bladders; a pneumatic supply system; and

a plurality of tubes in fluid communication with pneumatic supply system, the tubes coupled to and guided by the bladder layer.

2. The support of claim 1, wherein the tubes comprise supply tubes.

3. The support of claim 1, wherein the tubes comprise sensing tubes.

4. The support of claim 3, wherein the tubes comprise sensing tubes and supply tubes.

5. The support of claim 1, wherein the bladder includes a plural supports, the supports comprising channels.

6. The support of claim 5, wherein the supports are formed from patches of sheet material attached at or to the bottom surface of the bladder layer.

7. The support of claim 6, wherein the patches are attached to the bottom surface of the bladder layer.

8. The support of claim 1, wherein the bladder layer includes at least two zones, with each zone being configured to be separately inflatable.

9. The support of claim 1, wherein the bladder layer includes a harness for harnessing the tubes.

10. The support of claim 9, wherein the harness comprises flange.

11. The support of claim 10, wherein the bladder comprises an upper sheet and a lower sheet, the harness comprises a portion of the upper sheet and/or the lower sheet.

12. The support of claim 1, wherein the bladder layers includes an array of bladders and a plurality of transverse openings allowing air to pass through the bladder layer to direct air flow through the bladder layer.

13. The support of claim 1, wherein each of said bladders has a hexagonal cross-section.

14. A patient support comprising:

a foam crib having first and second sections; and

a gel layer supported on the foam crib and joined to the foam crib, and the gel bladder layer forming a hinge for the two sections of the foam crib.

15. The support of claim 14, wherein the first section comprises a head/body end and the second section comprises a foot end, the gel layer forming a hinge between the foot end and the head/body end. foot end, the head/body end supporting a bladder layer.

16. The support of claim 15, wherein the foot end is releasably coupled to the head/body end.

17. The support of claim 16, wherein the foot end is releasably coupled to the head/body end by VELCRO strips.

18. The support of claim 15, wherein the foot end is releasably coupled to the head/body end a joint, the joint forming line management channels.

19. A patient support comprising:

a bladder layer with a plurality of bladders;

a pneumatic supply system; and

a plurality of tubes in fluid communication with the pneumatic supply system and the bladder layer, the bladder layer including a manifold holding and harnessing the tubes.

20. The support of claim 19, wherein the harness comprises a flange.

21. The support of claim 20, wherein the bladder layer comprises an upper sheet and a lower sheet, the flange formed by a portion of the upper sheet and/or the lower sheet.

22. A patient support comprising:

a bladder layer with a plurality of bladders;

a blower unit having an output;

a foam crib supporting the bladder layer, the foam crib having channels formed therein and in fluid communication with the output of the blower; and

a cover extending over the channels to close the channels, the cover having openings for directing air flow from the channels to the underside of the bladder layer.

23. The support of claim 22, wherein said bladder layer has a plurality of openings therethrough to allow air flow from the channels to pass through the bladder layer.

24. The support of claim 22, wherein the cover is adapted to seal against the underside of the bladder layer to reduce air loss between the bladder layer and the channels.

25. The support of claim 24, wherein the cover supports a resilient pad, the pad including openings aligning with the openings of the cover.

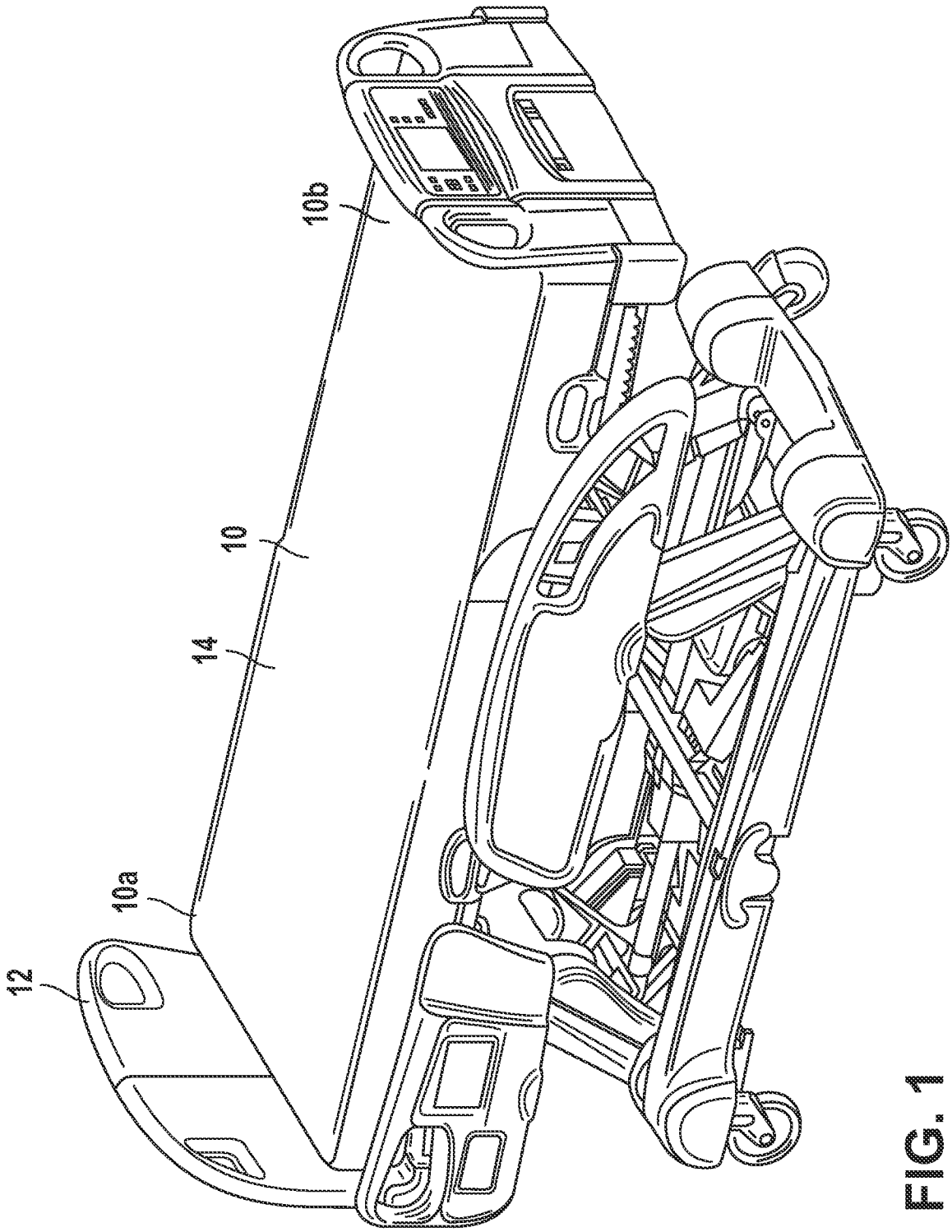

FIG. 1

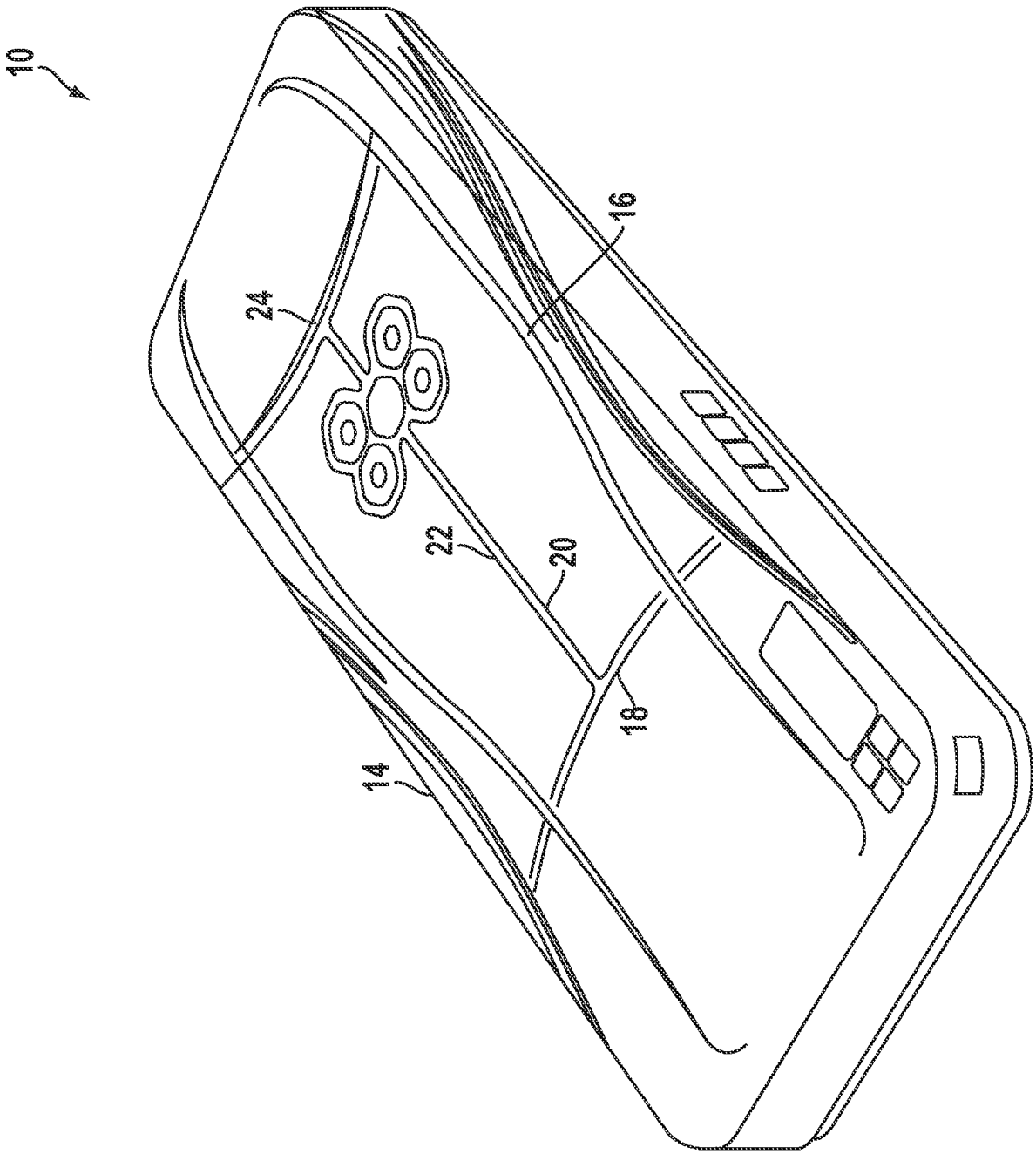

FIG. 2

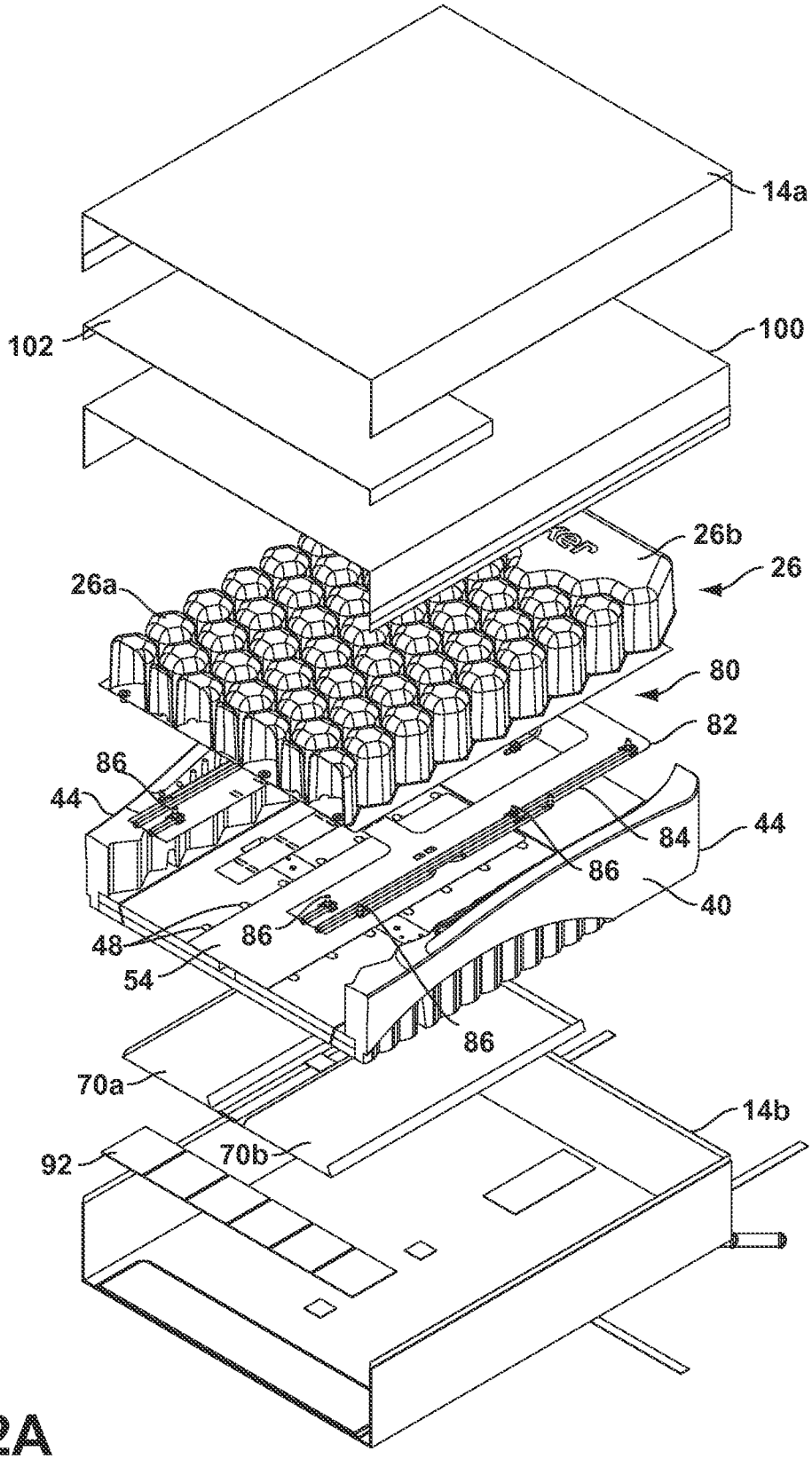
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FIG. 2A

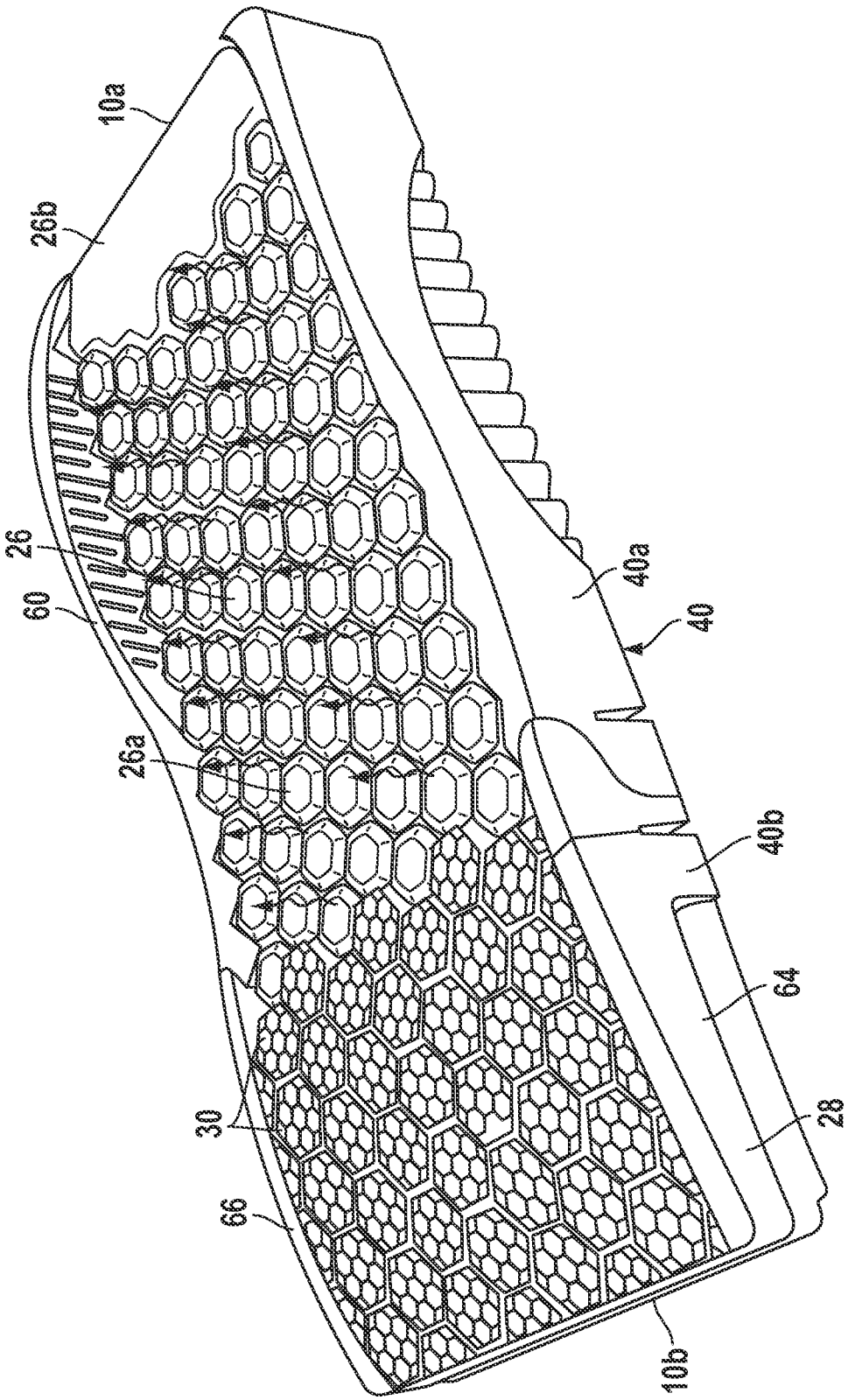

FIG. 3

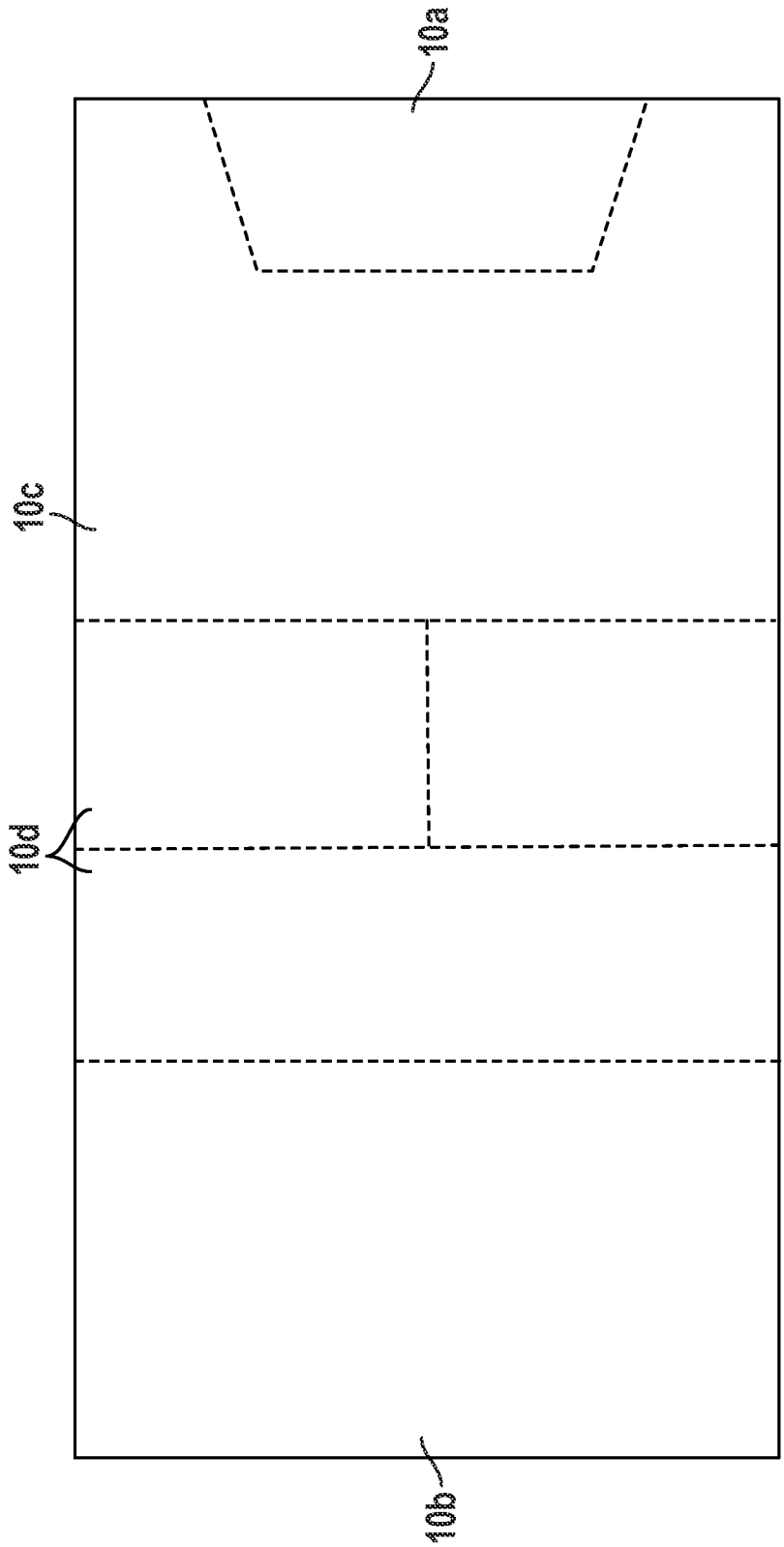

FIG. 3A

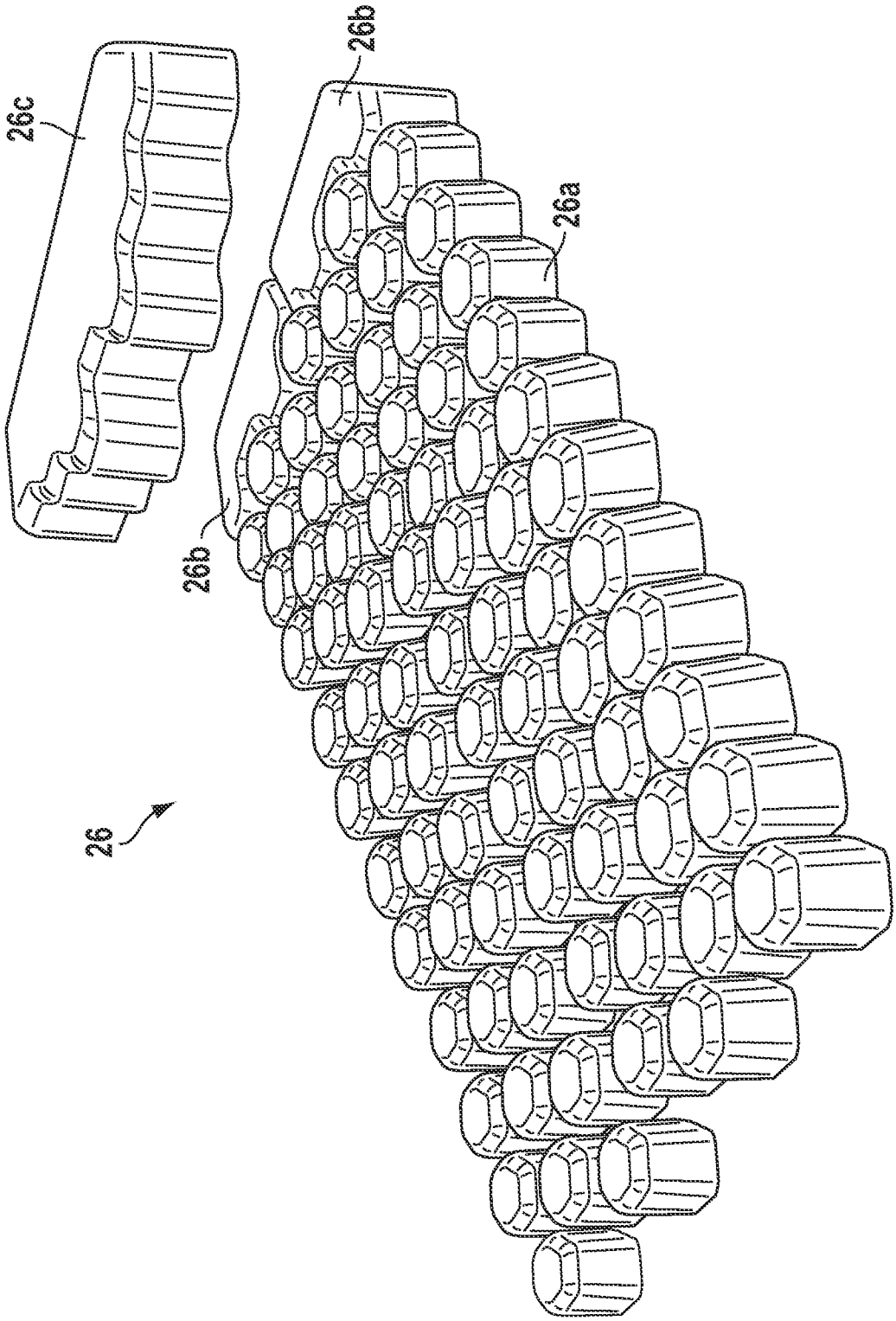

FIG. 4

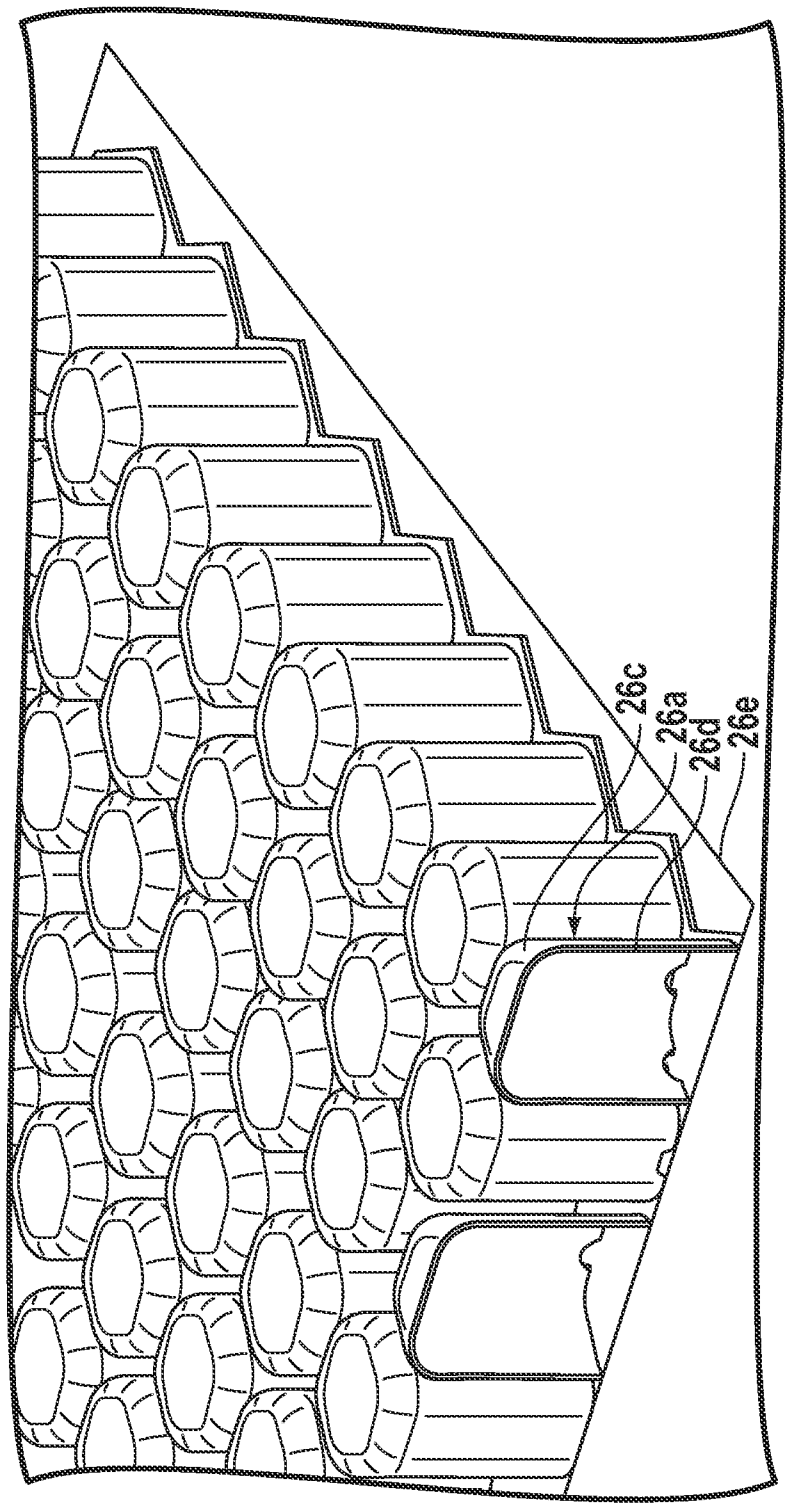

FIG. 4A

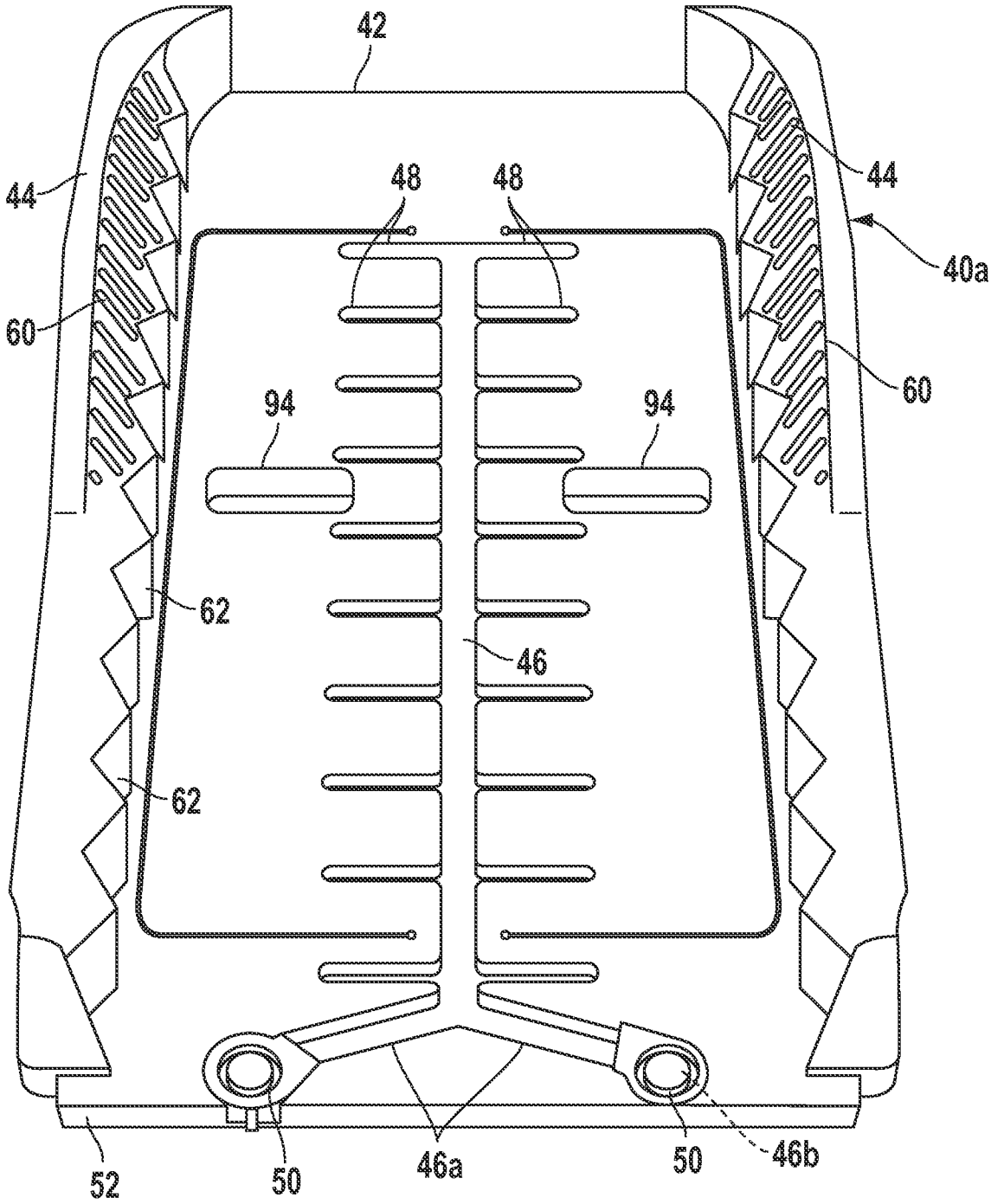

FIG. 5

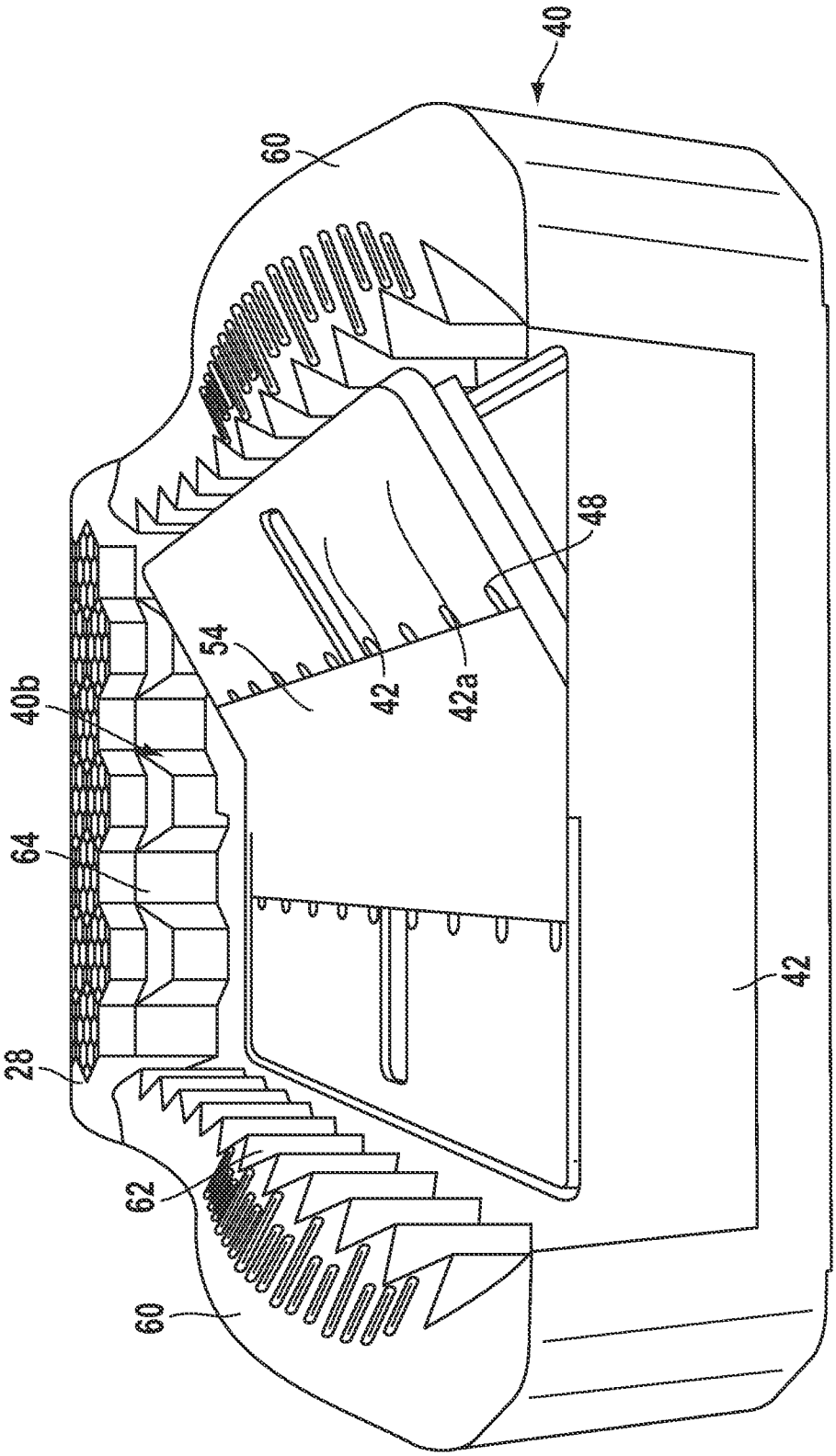

FIG. 6

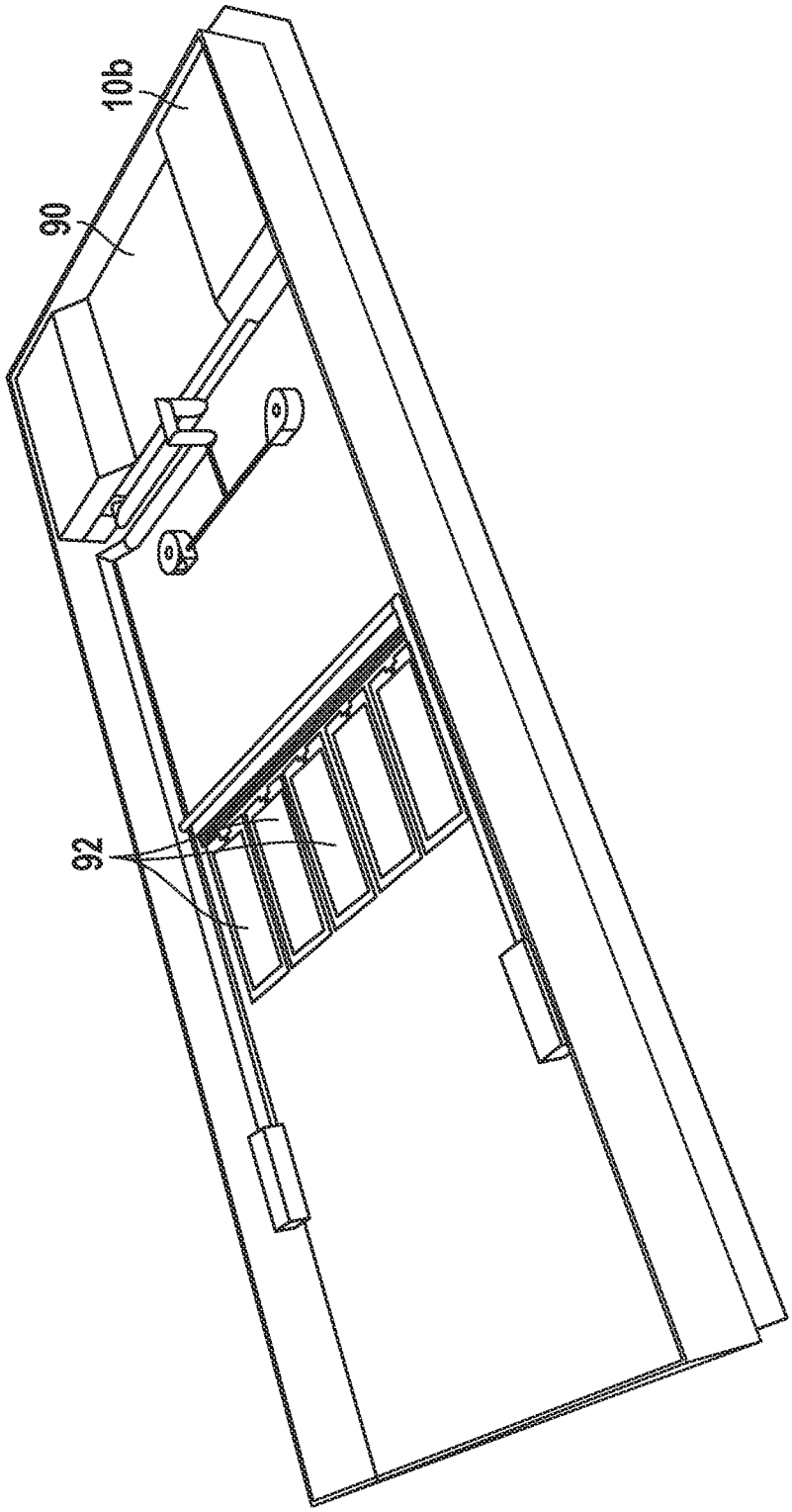

FIG. 7

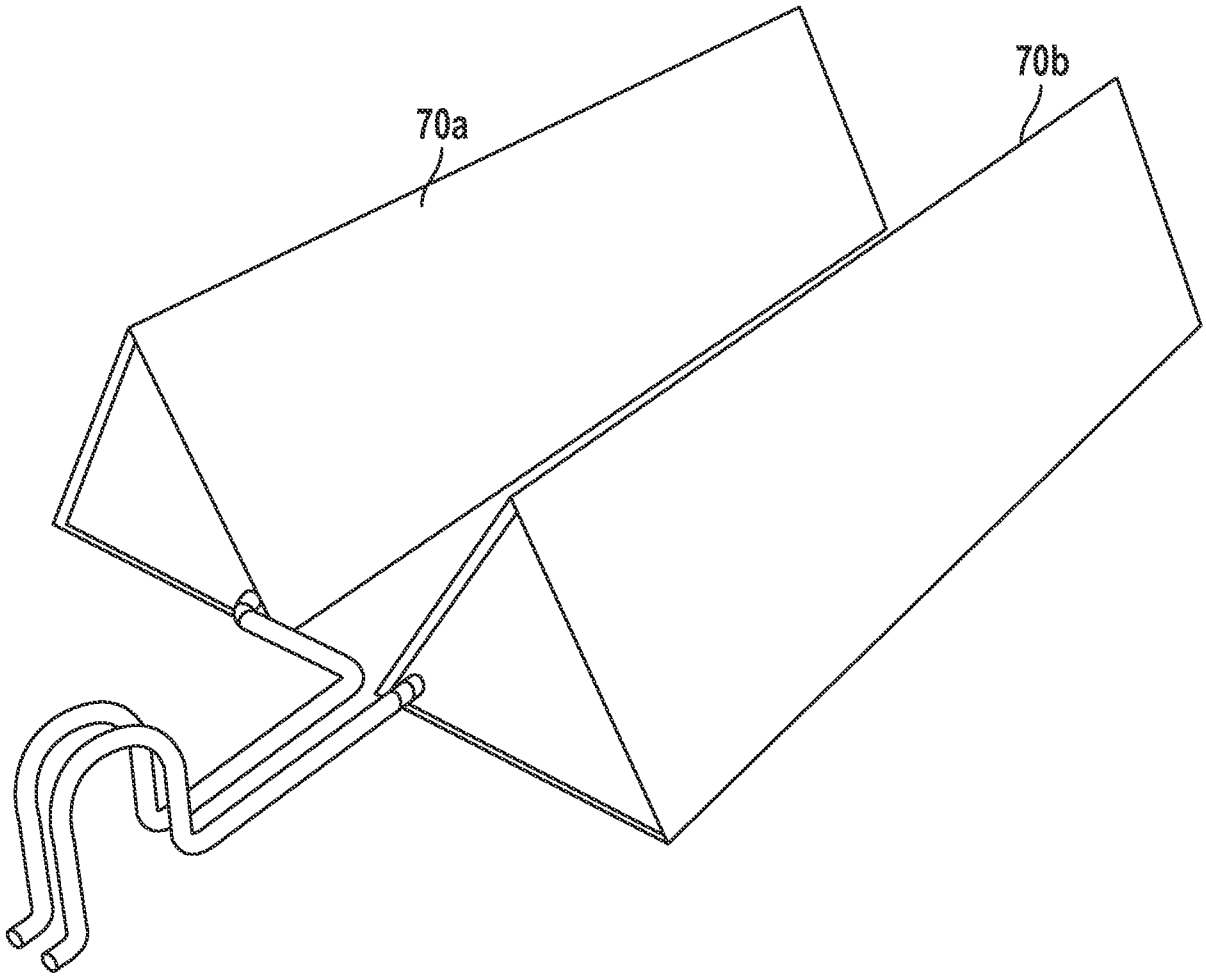

FIG. 8

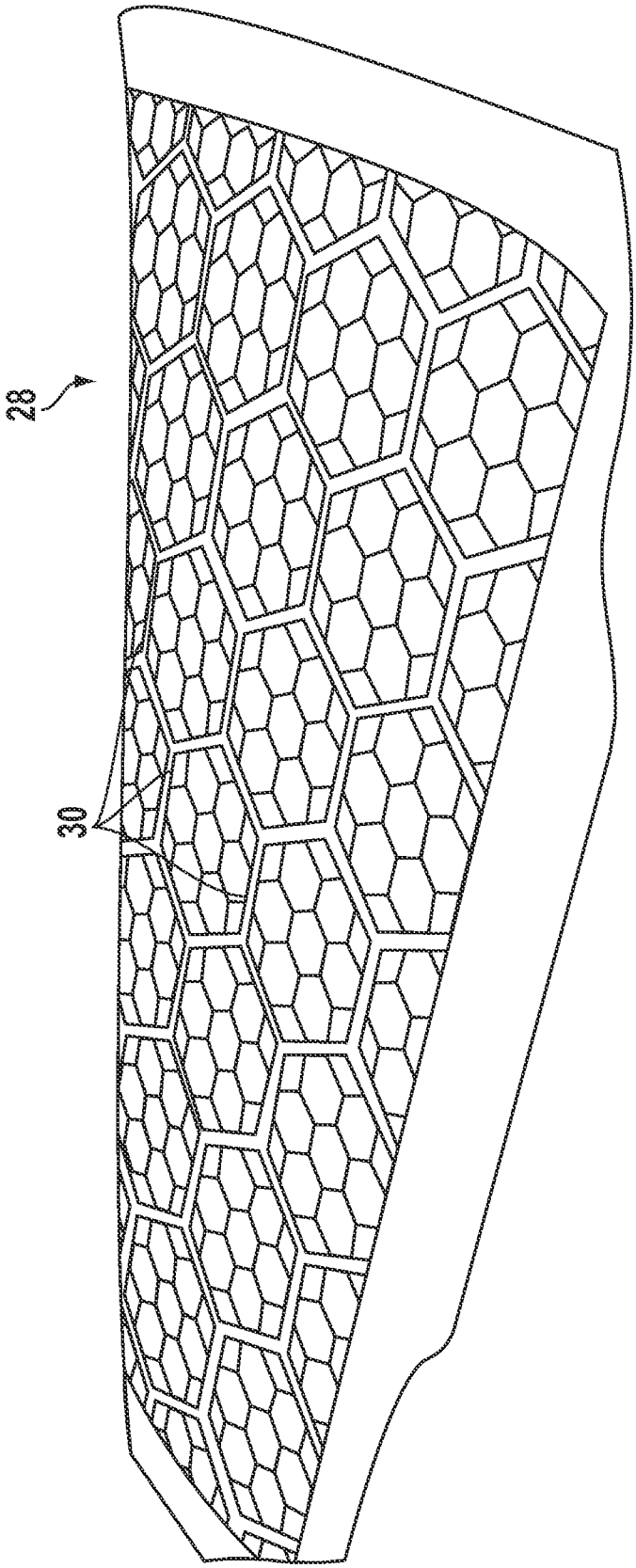

FIG. 9

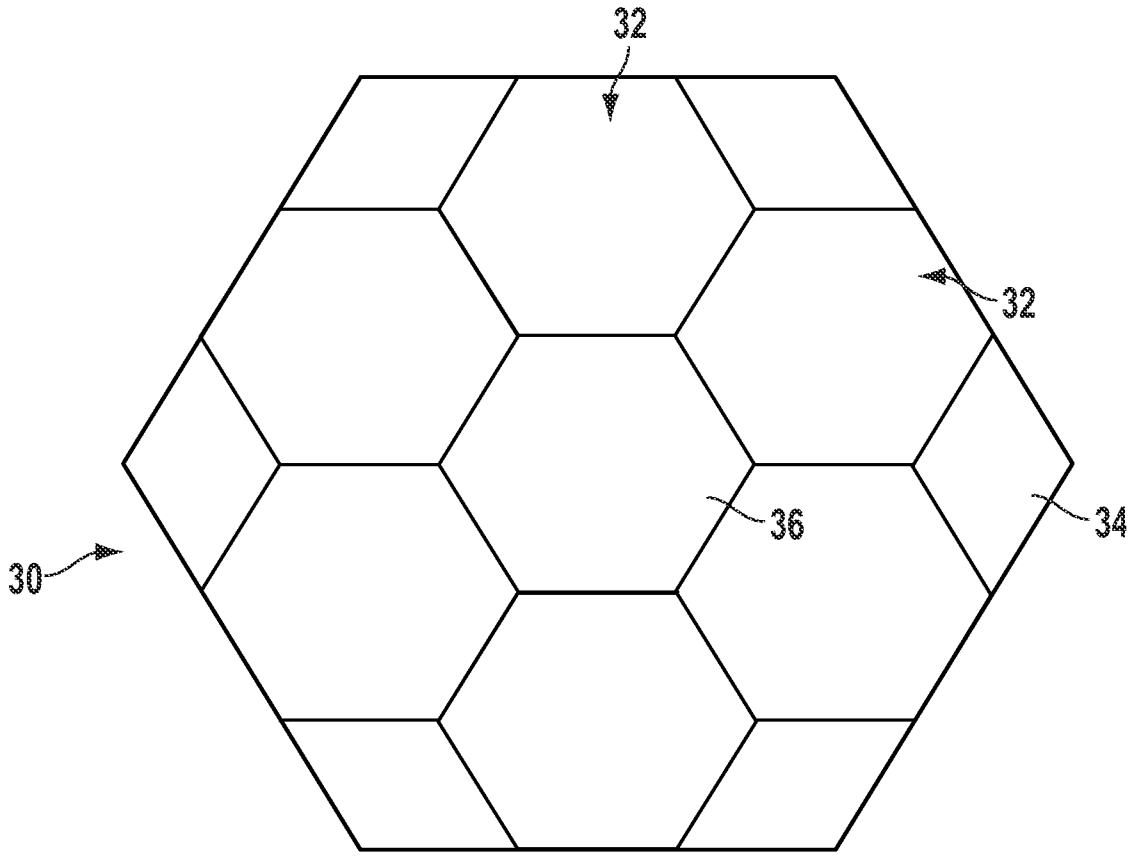

FIG. 9A

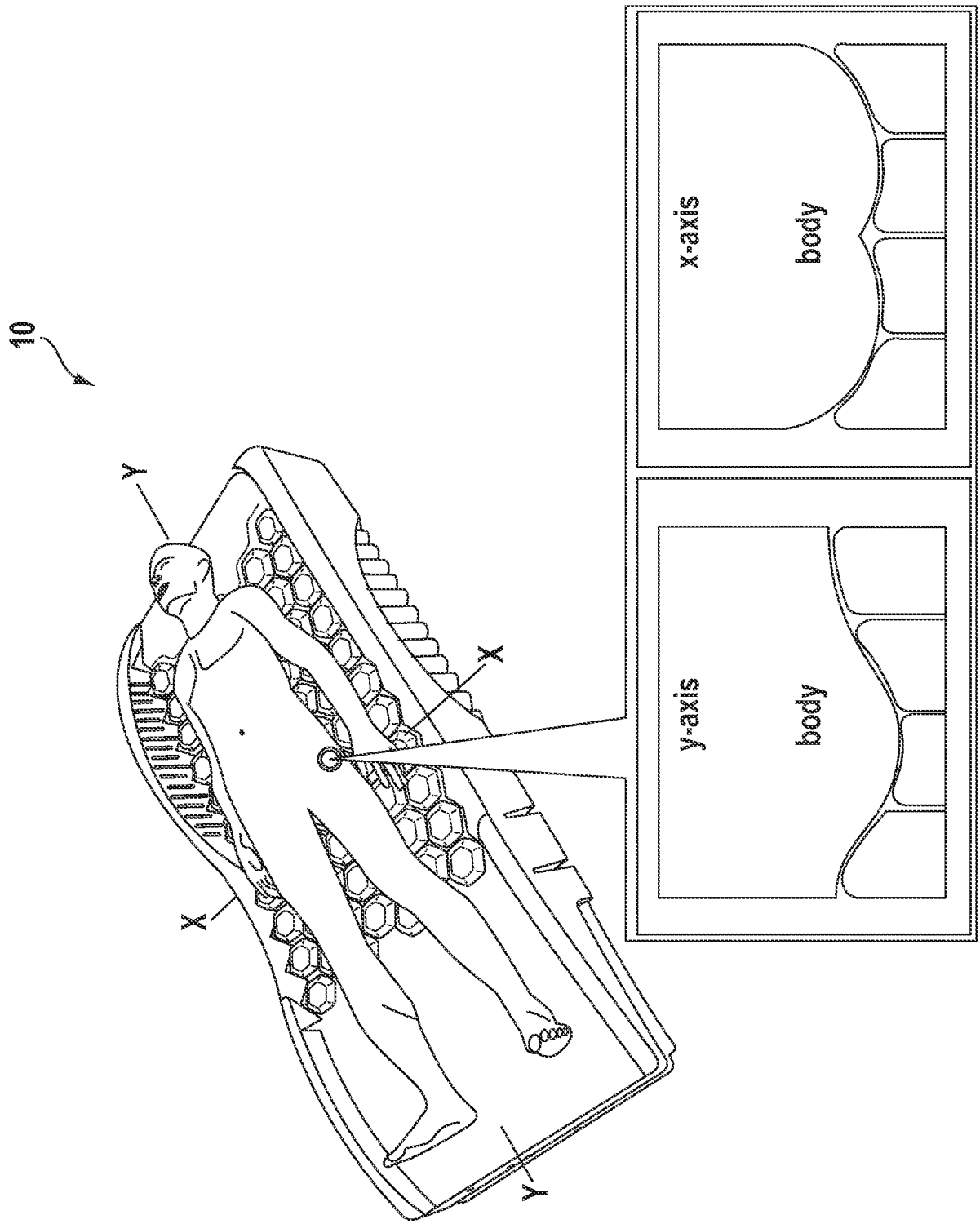

FIG. 10

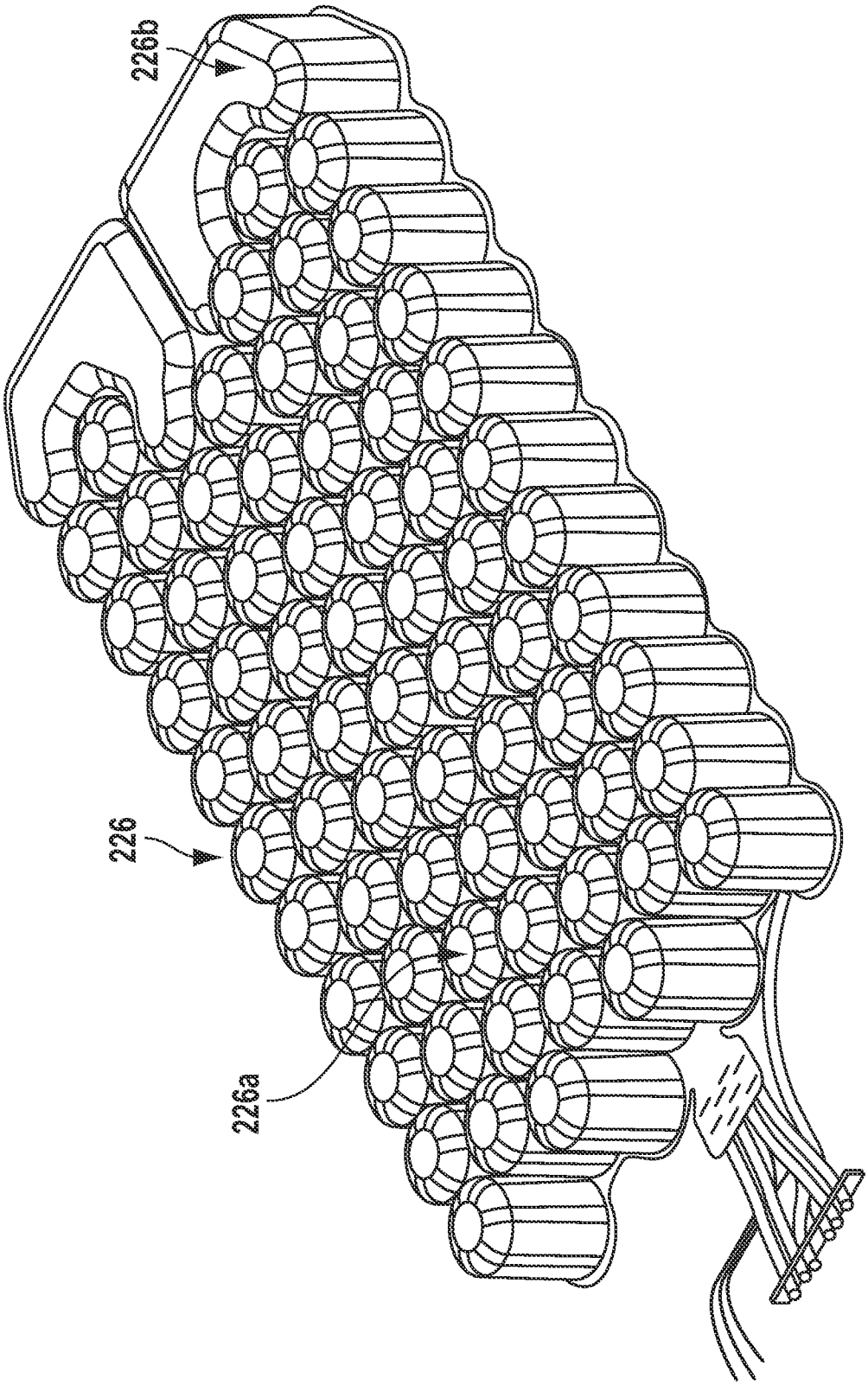

FIG. 11

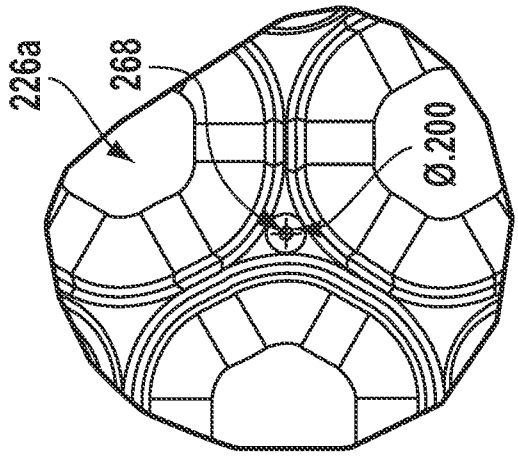

FIG. 14

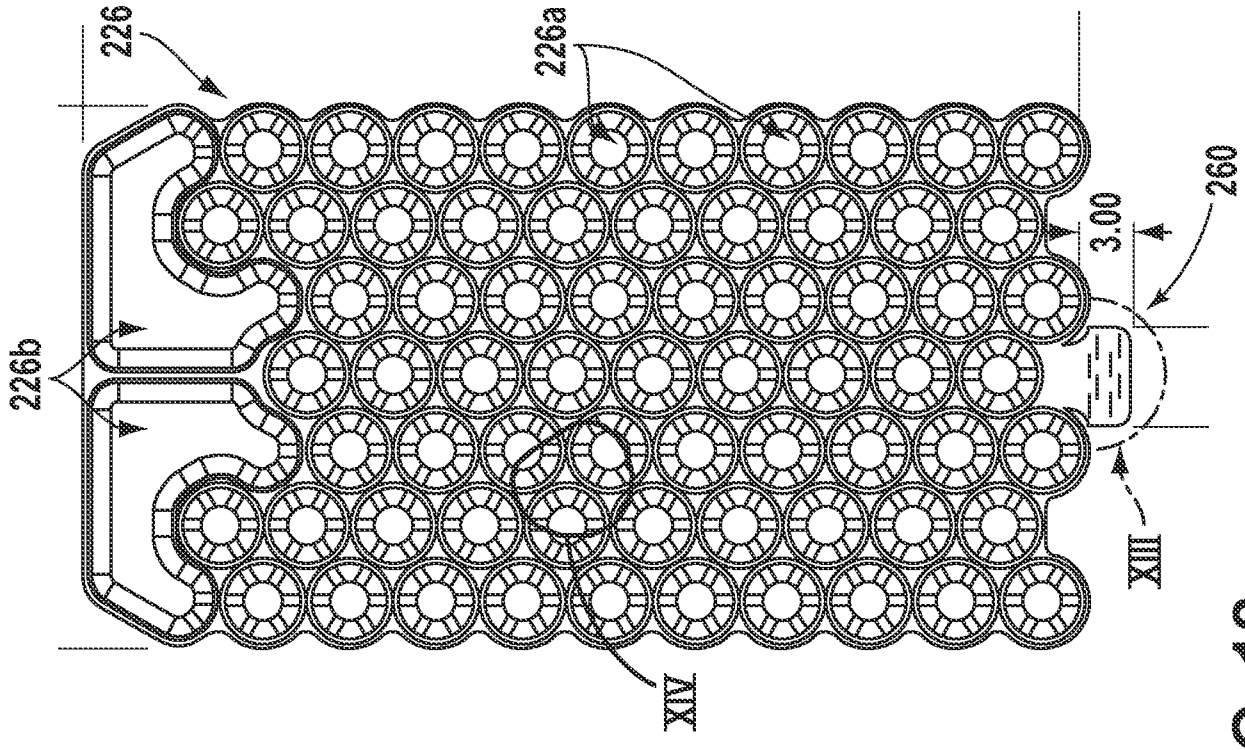

FIG. 12

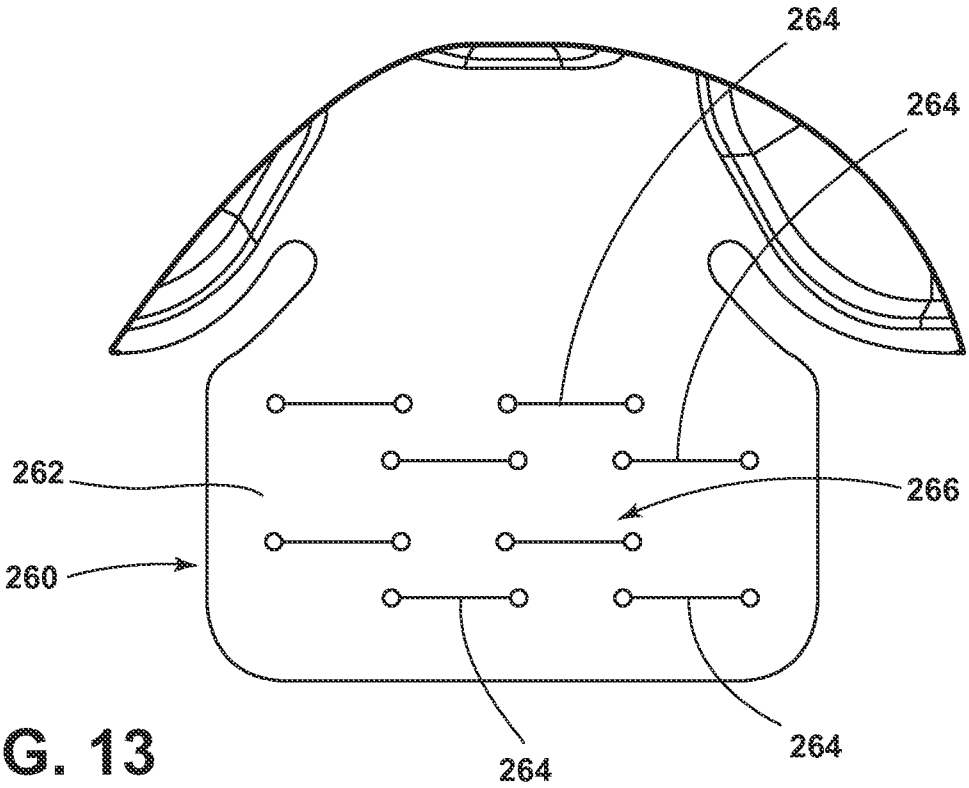

FIG. 13

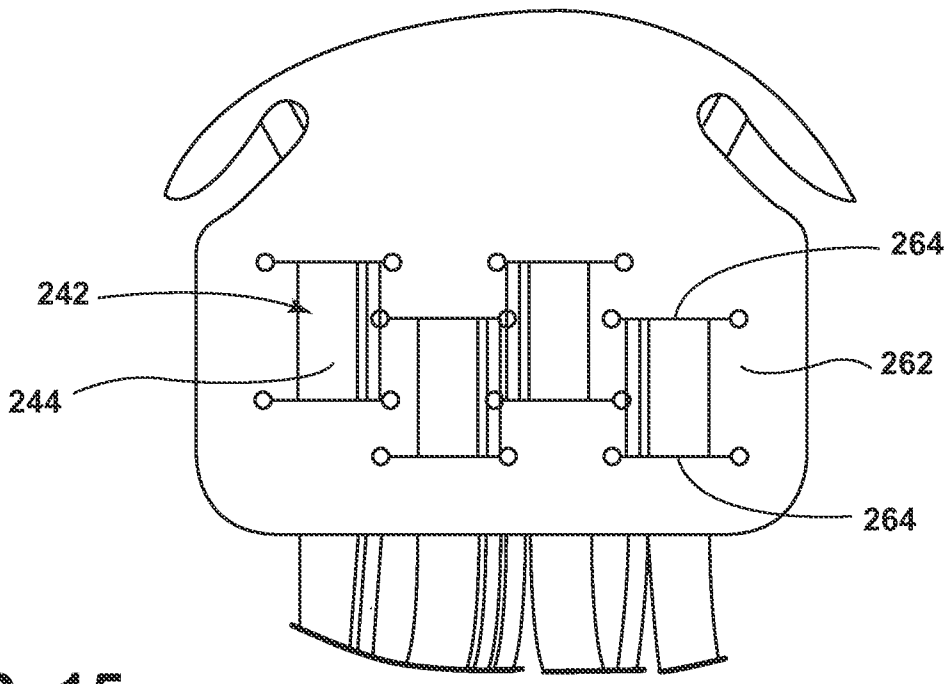

FIG. 15

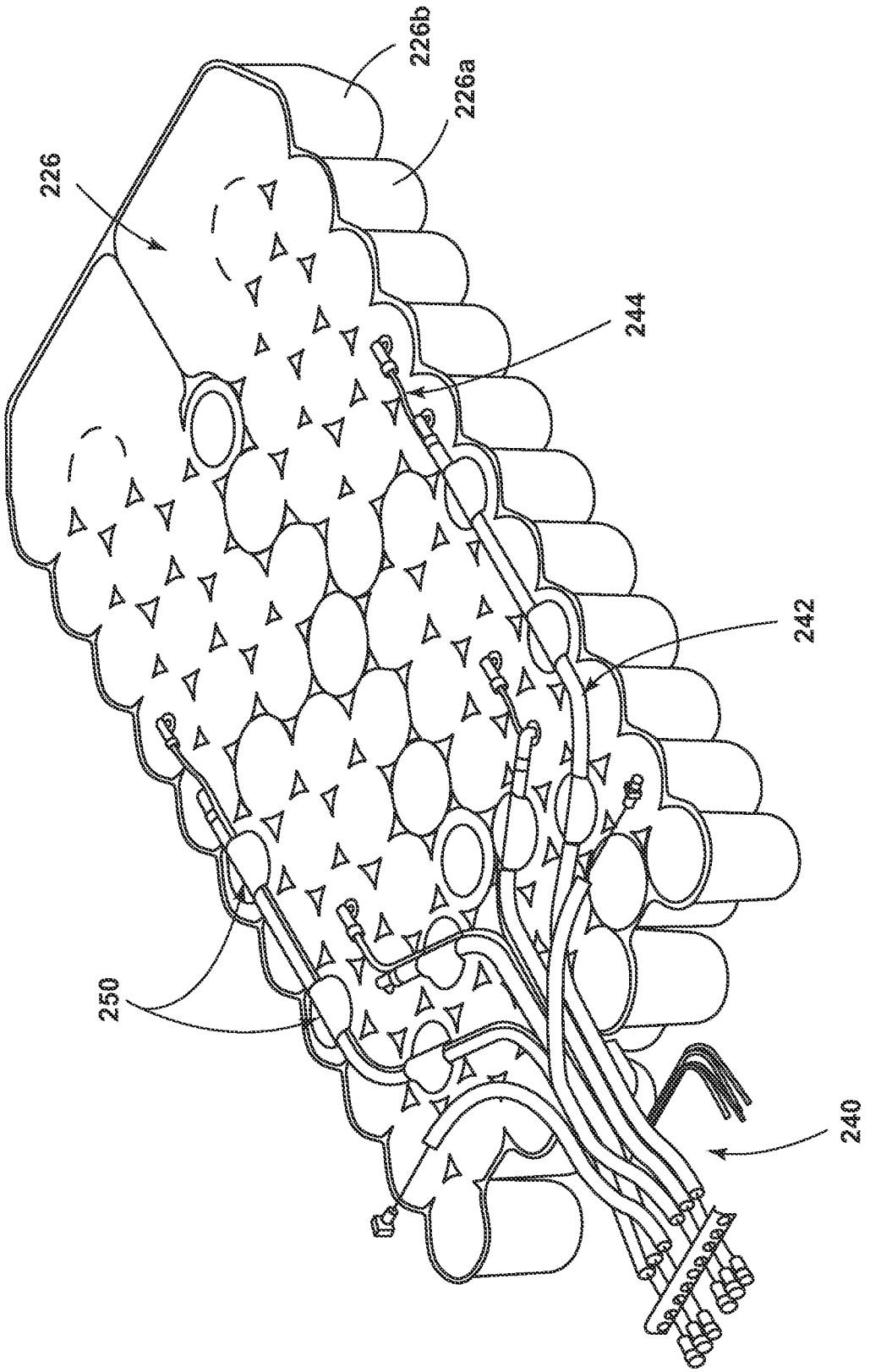

FIG. 16

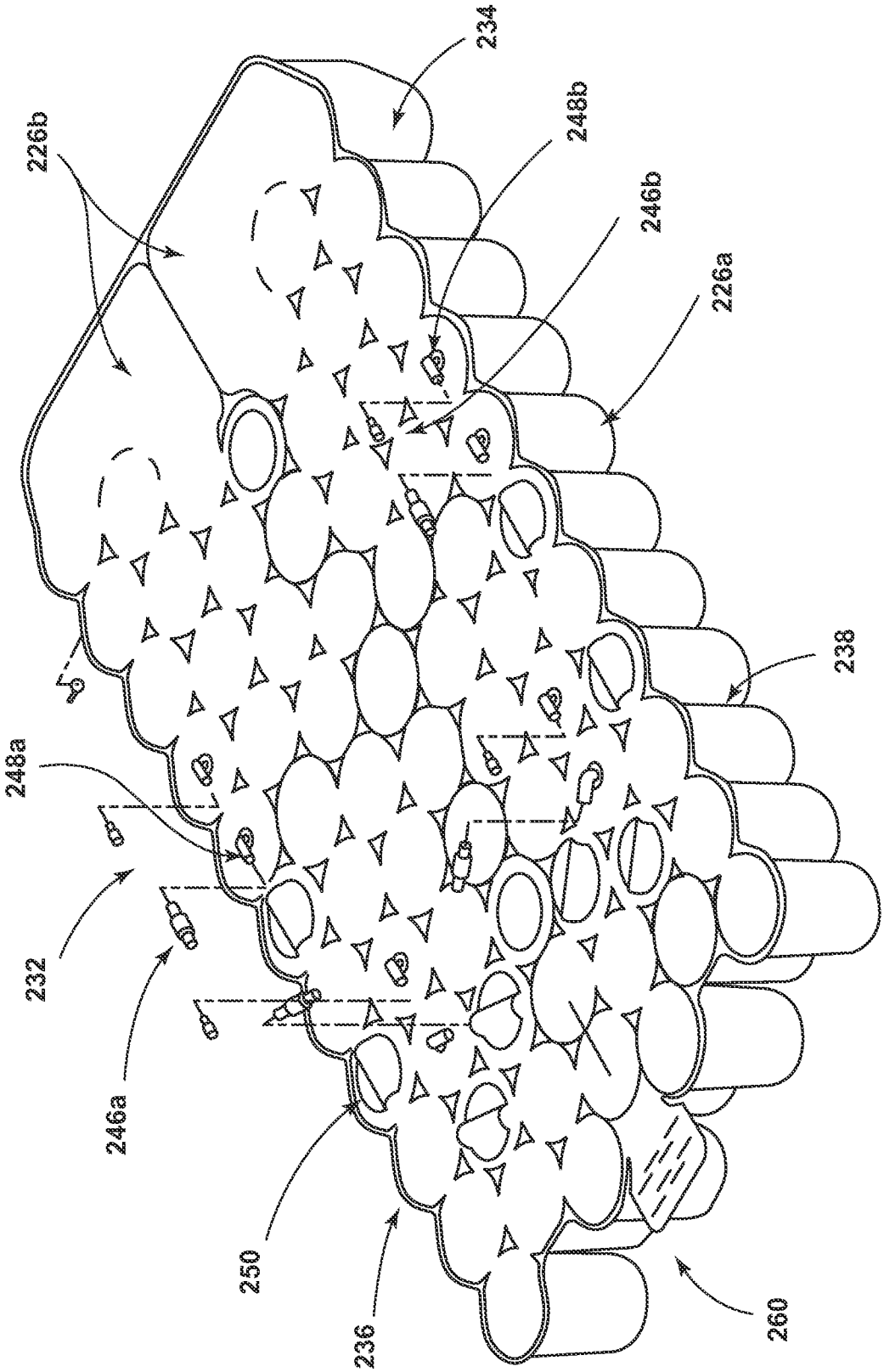

FIG. 17

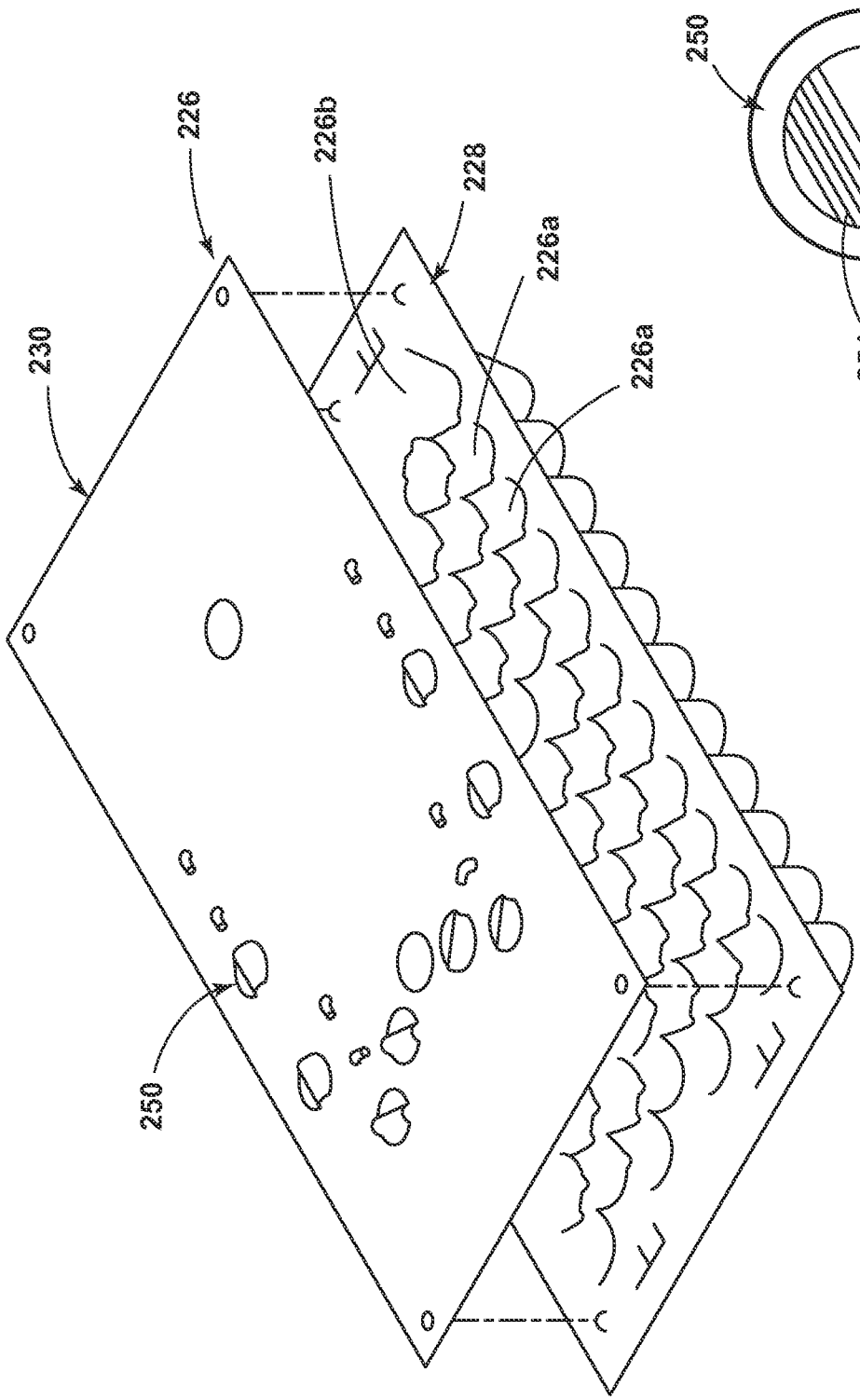

FIG. 18

FIG. 19

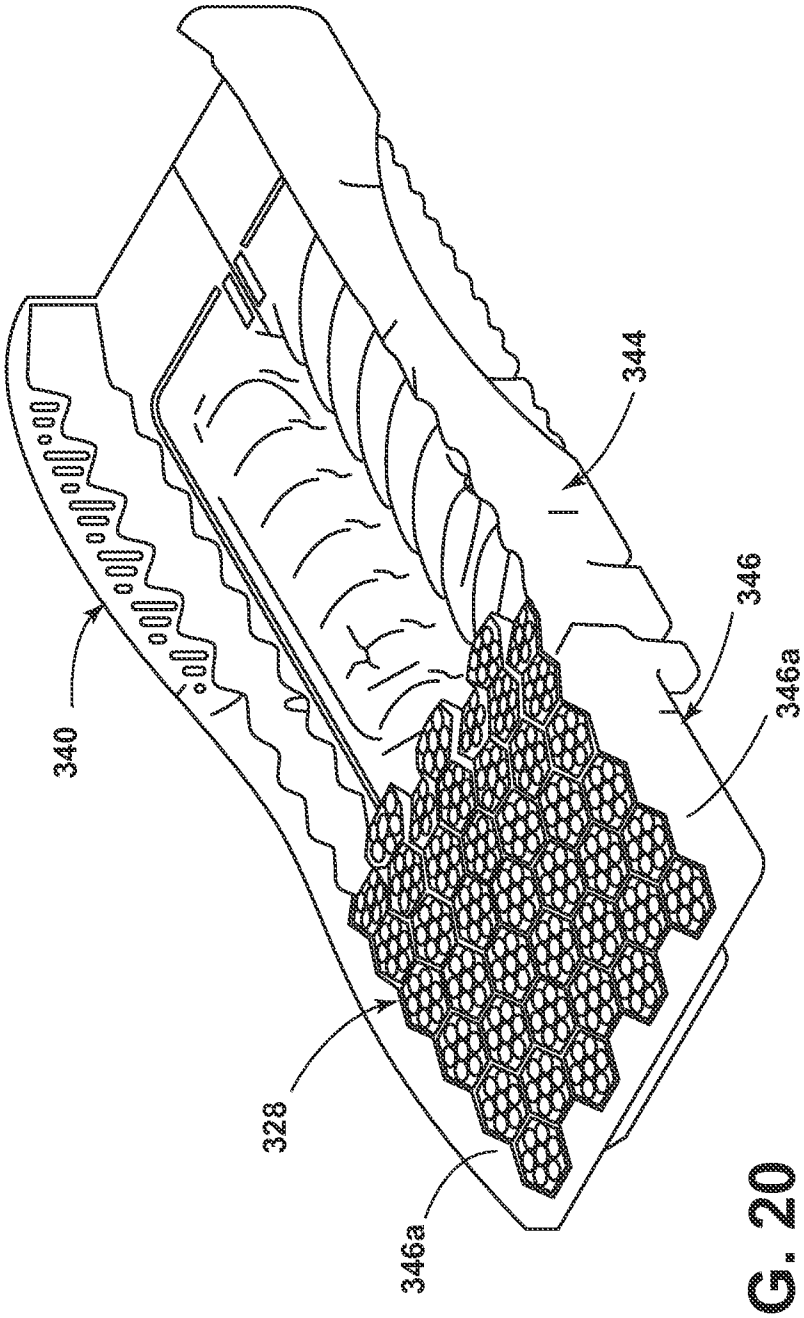

FIG. 20

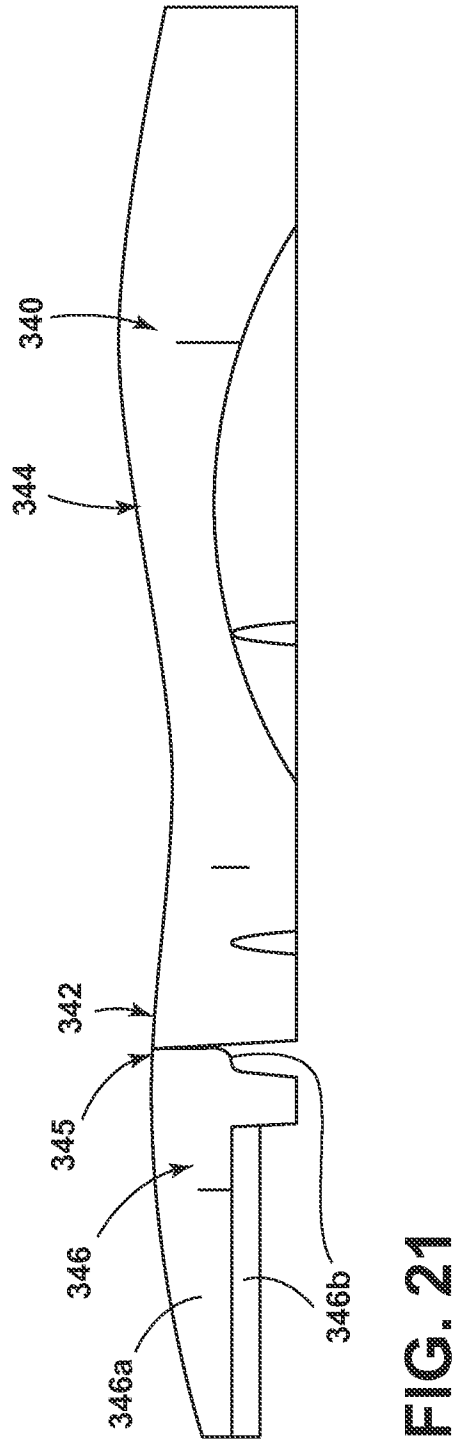

FIG. 21

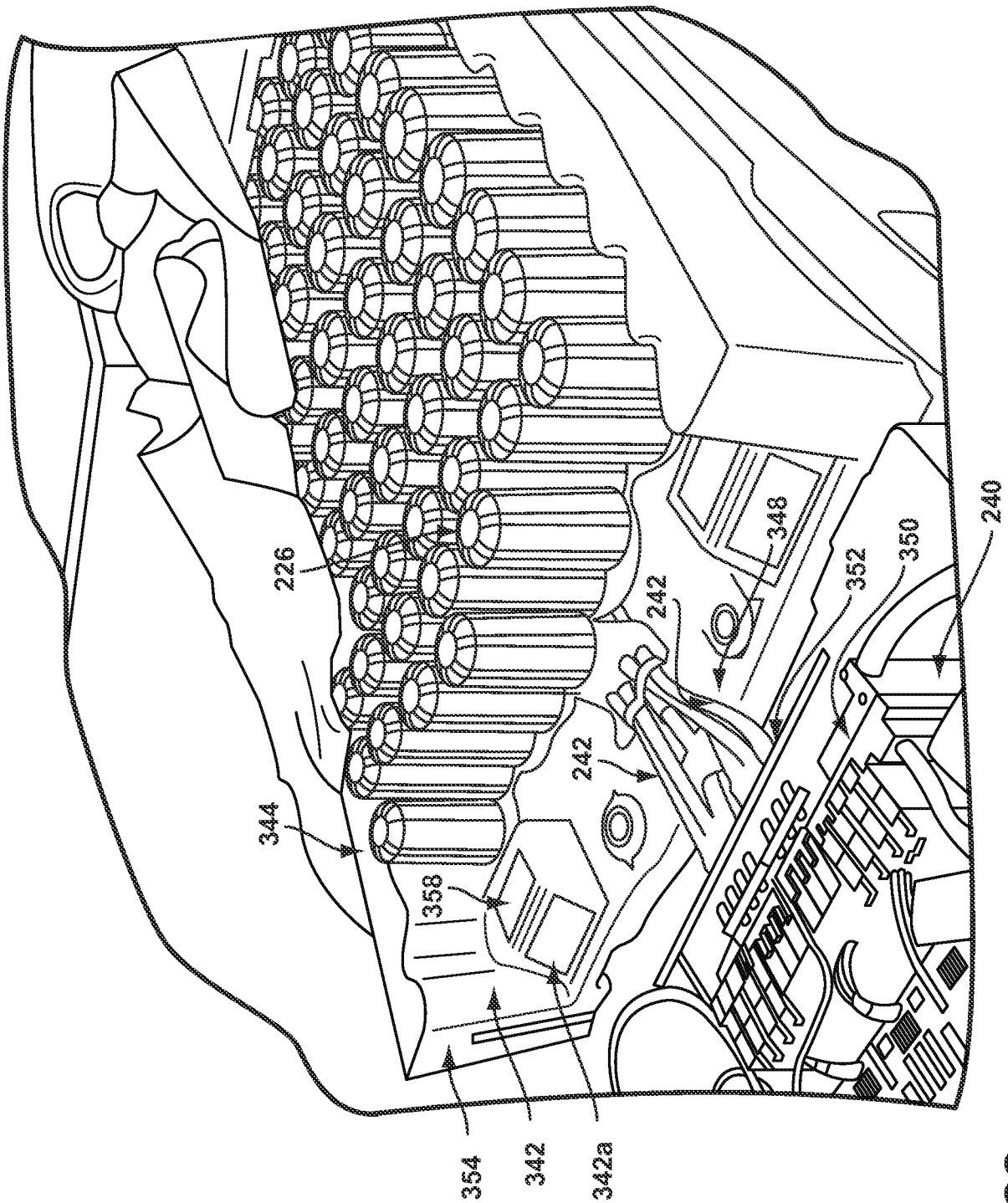

FIG. 22

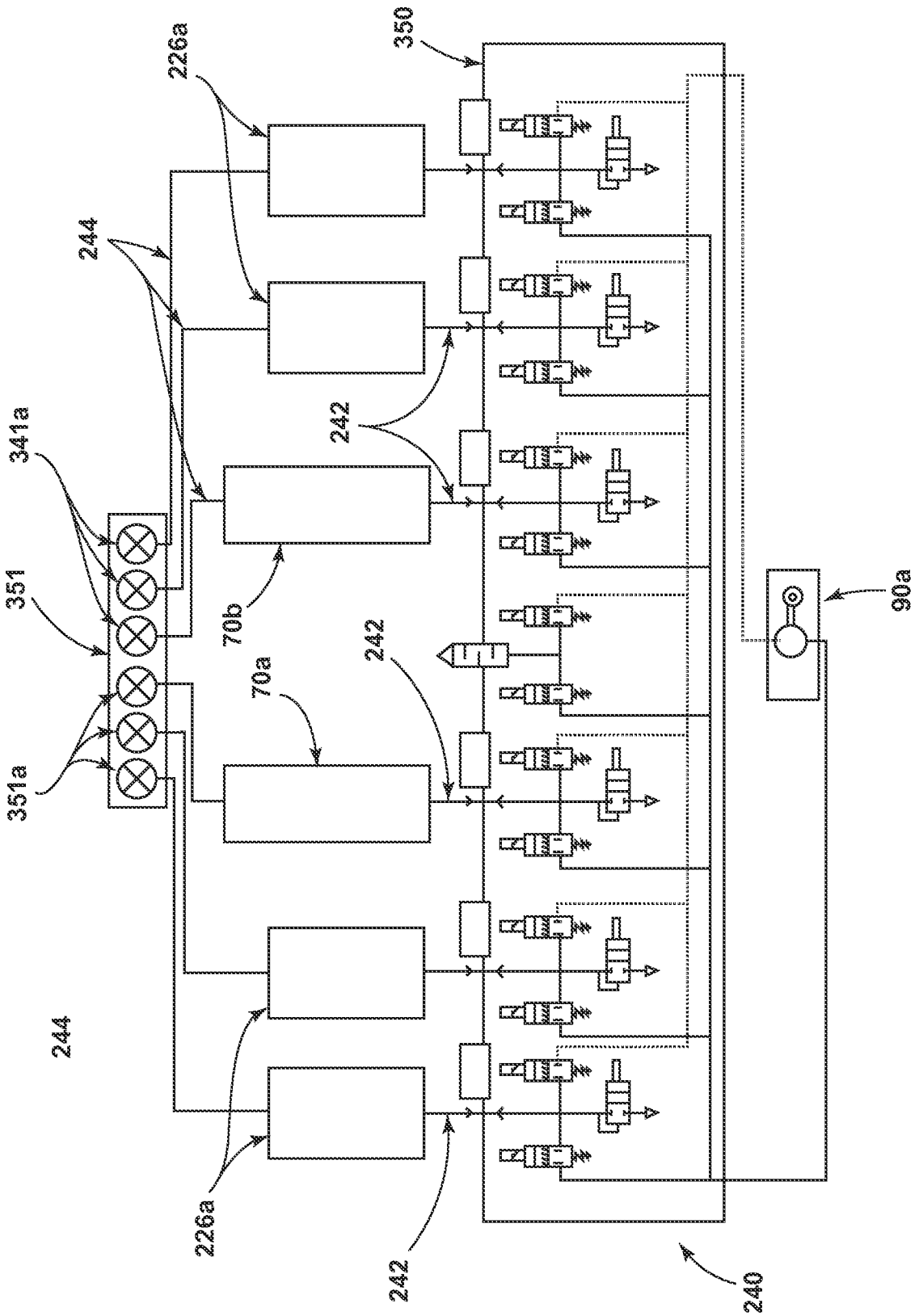

FIG. 22A

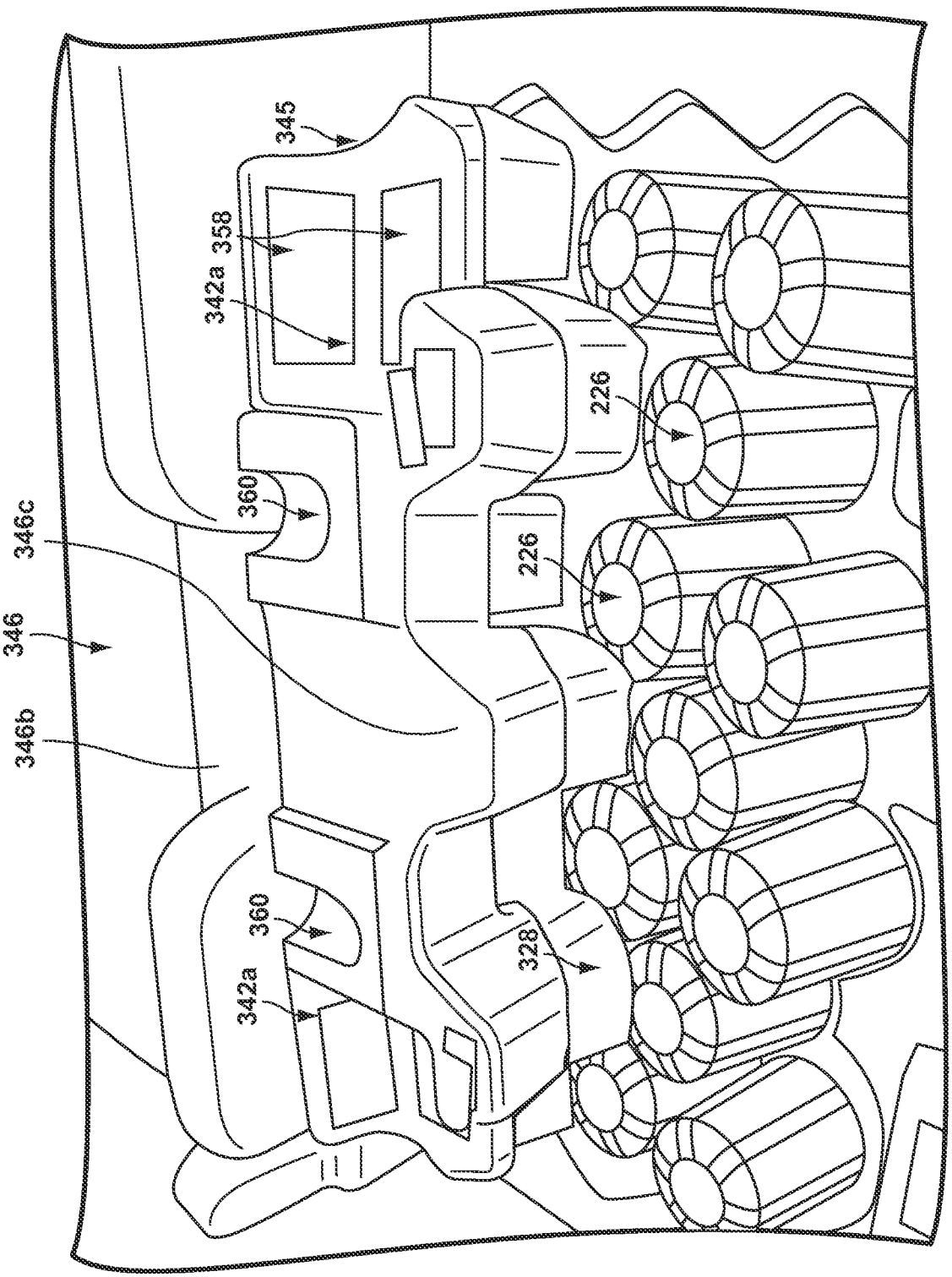

FIG. 23

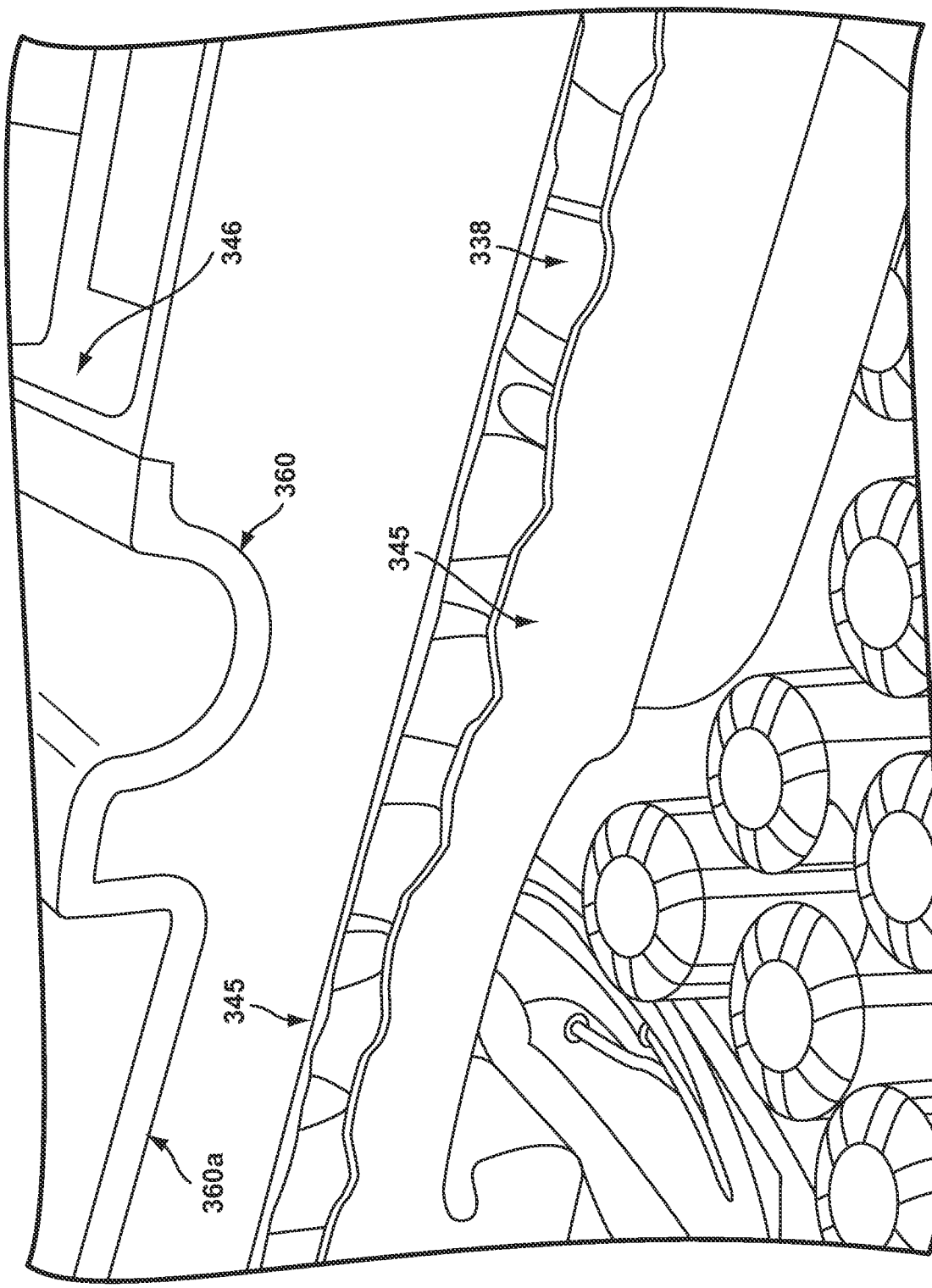

FIG. 24

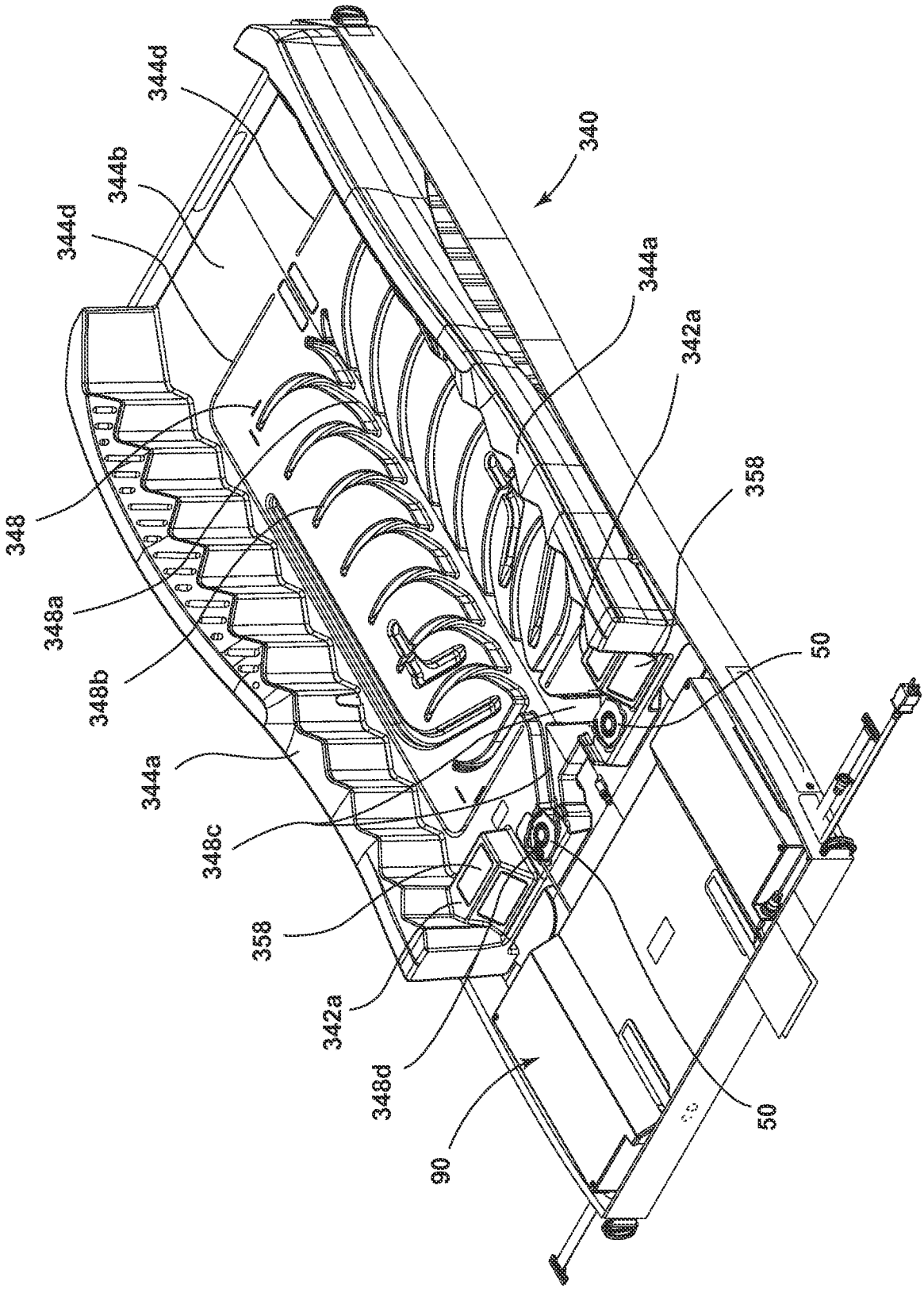
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FIG. 25

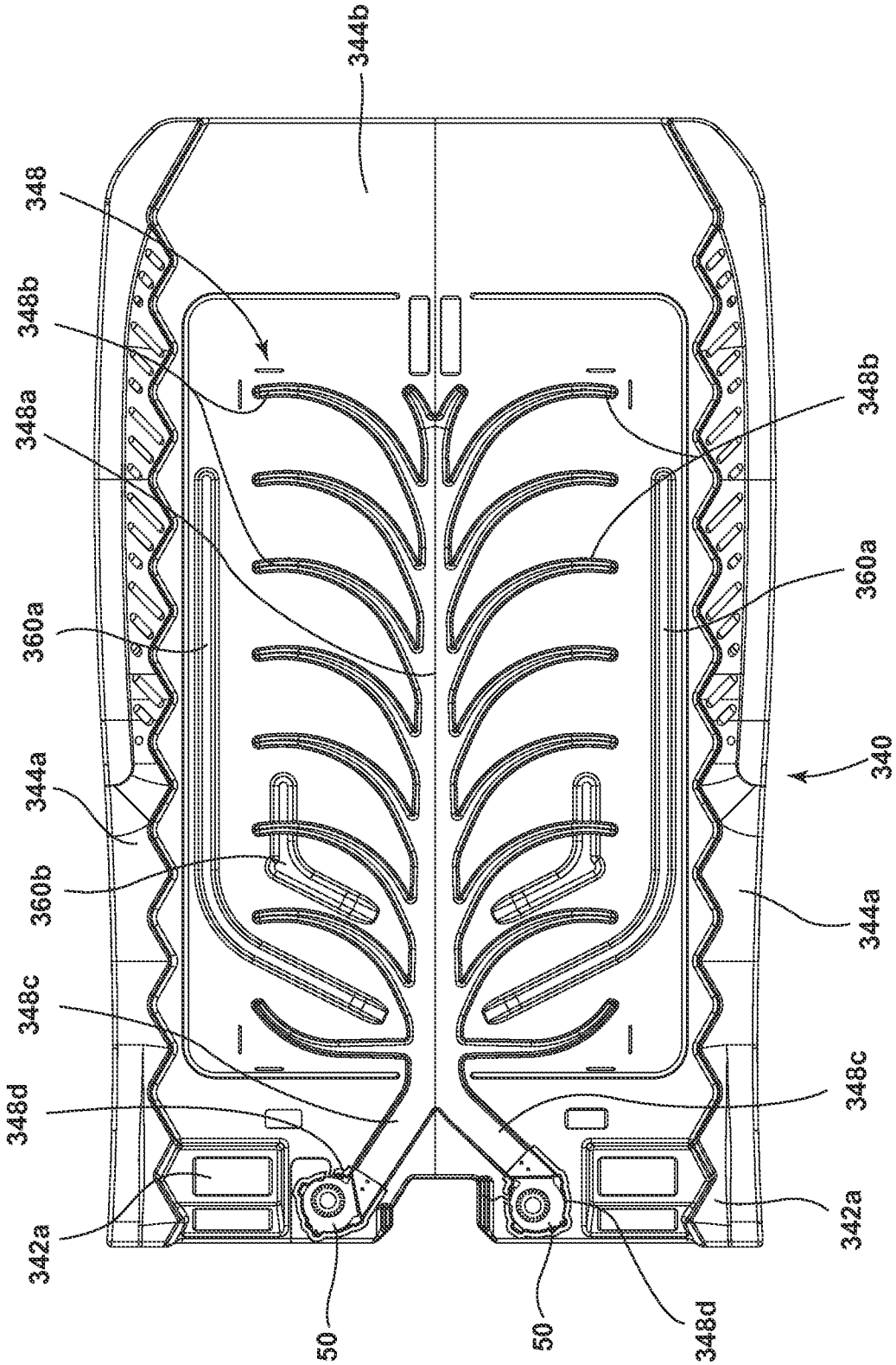
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FIG. 26

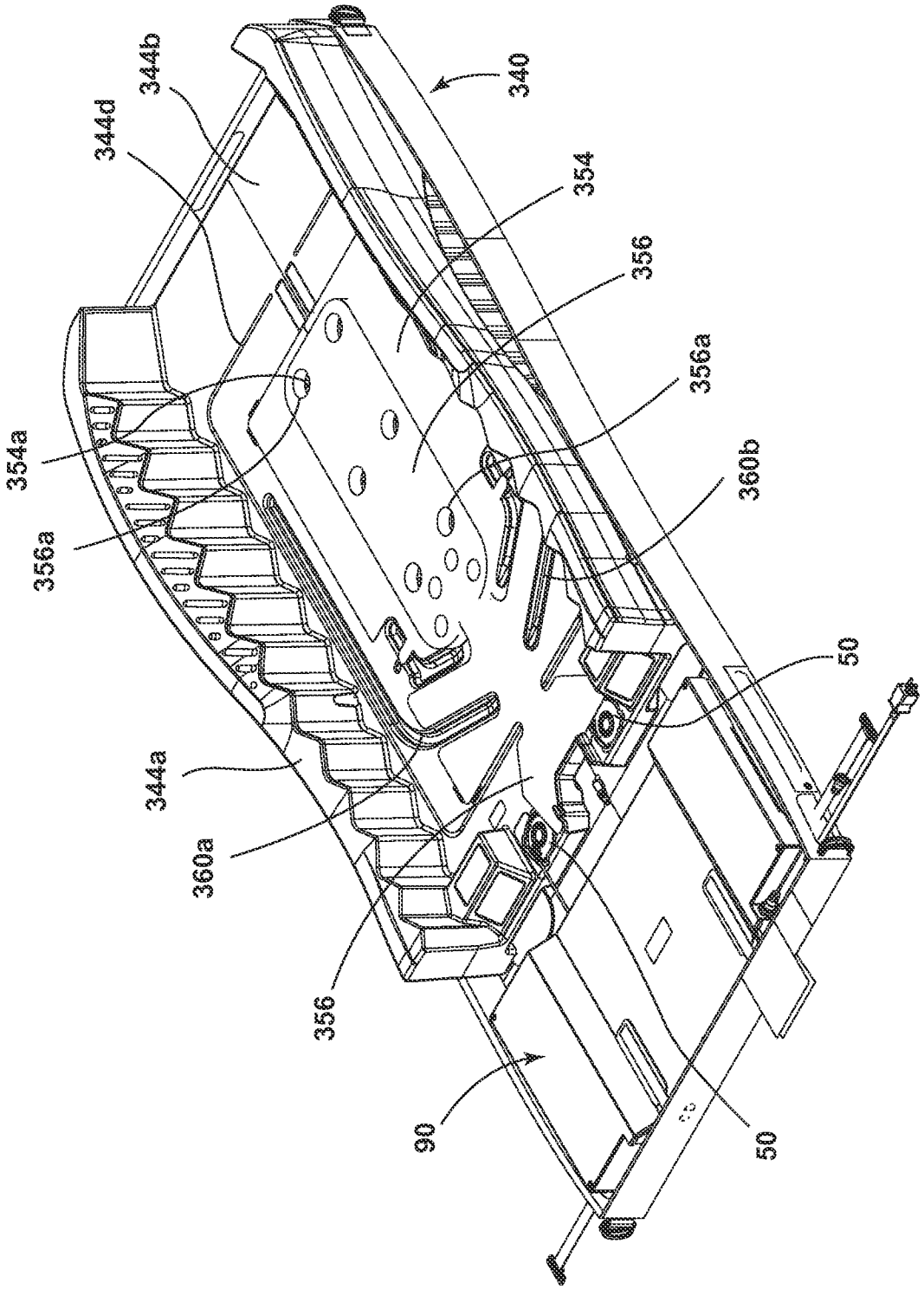
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FIG. 27

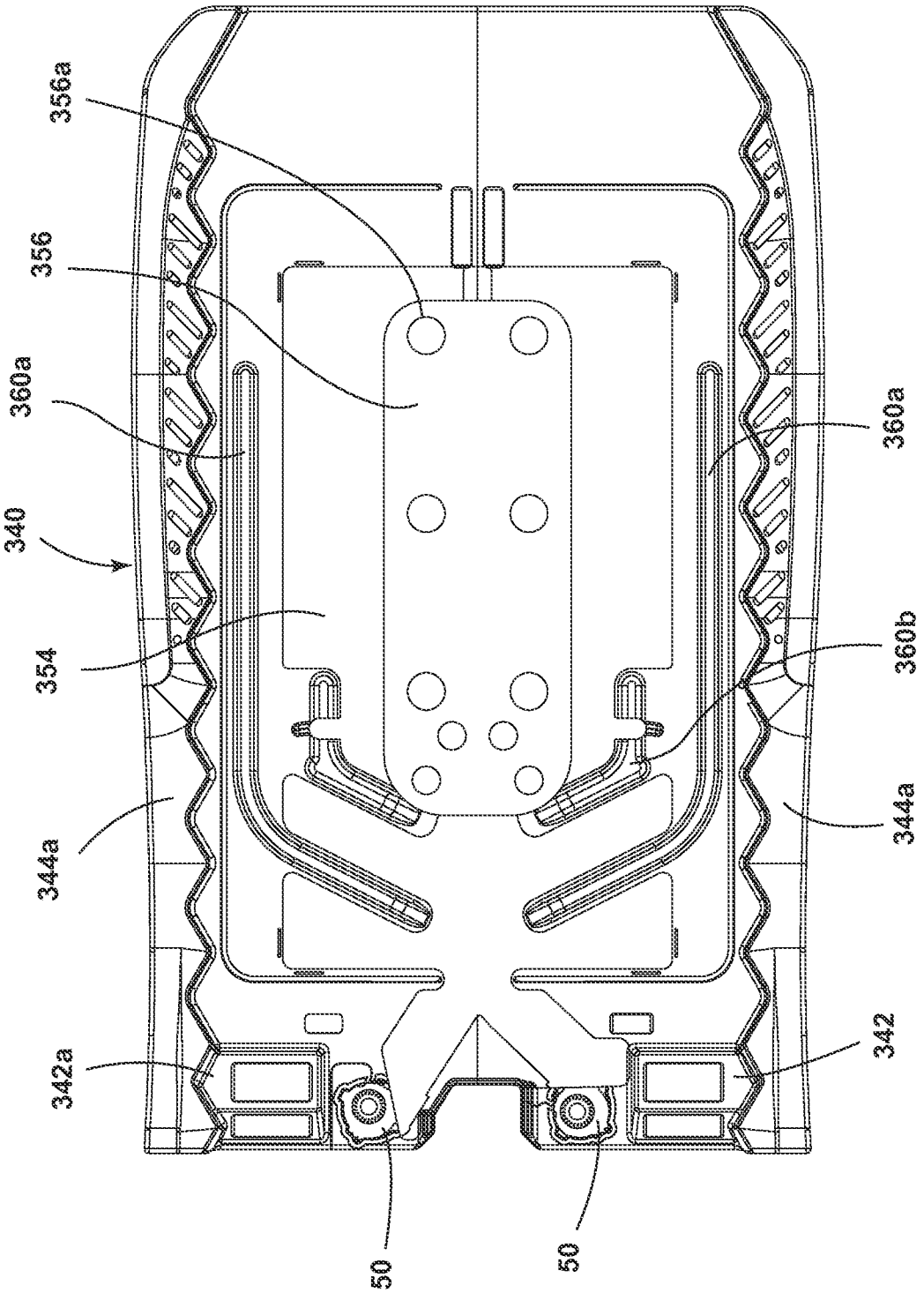

FIG. 28

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/054023

A. CLASSIFICATION OF SUBJECT MATTER

A61G 7/057(2006.01)i, A47C 27/10(2006.01)i, A47C 27/14(2006.01)i

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)
A61G 7/057; A47C 27/10; A47B 7/02; A47C 27/08; A47B 71/00; A61G 7/05; A47C 16/00; A61G 7/00; A47B 7/00; A47C 27/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: patient bed, patient support, bladder, gel, cushion, pneumatic, air, blow, foam crib, frame

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013-0061396 A1 (LAFLECHE, P. et al.) 14 March 2013 See abstract, claim 1, paragraphs [0070]-[0073], [0092]-[0097], [0123], [0149], [0162]-[0173], and figures 1-3A, 4, 18, 20, 27-28.	1-15,19-25
A		16-18
A	US 8108957 B2 (RICHARDS, S. M. et al.) 7 February 2012 See entire document.	1-25
A	US 2006-0075559 A1 (SKINNER, A. F. et al.) 13 April 2006 See entire document.	1-25
A	WO 2010-044843 A1 (PAPAIOANNOU, G.) 22 April 2010 See entire document.	1-25
A	US 7398573 B2 (ELLIS, C. D. et al.) 15 July 2008 See entire document.	1-25

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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	Date of mailing of the international search report
24 December 2014 (24.12.2014)	**26 December 2014 (26.12.2014)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
Han, Inho
Telephone No. +82-42-481-3362

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2014/054023

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2014/054023

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