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(54) **PATIENT SUPPORT**

(57) A patient support for supporting a patient includes a plurality of cushioning layers arranged such that their supporting surfaces when unloaded are generally arranged in a plane, and with each cushioning layer interlocked with each adjacent cushioning layer wherein each cushioning layer provides lateral and longitudinal support to each of its adjacent cushion layer.

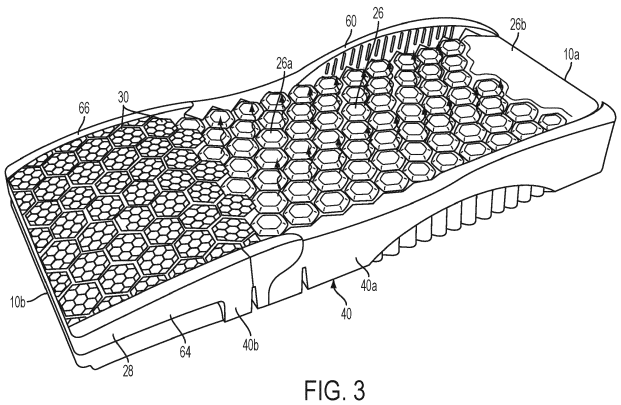

FIG. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to U.S. provisional application Ser. No. 61/507,371, filed Jul. 13, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; copending U.S. application Ser. No. 13/548,591, filed Jul. 13, 2012, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. copending application Ser. No. 13/022,326, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. copending application Ser. No. 13/022,372, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. copending application Ser. No. 13/022,382, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. copending application Ser. No. 13/022,454, filed Feb. 7, 2011, entitled PATIENT/INVALID HANDLING SUPPORT; U.S. copending application Ser. No. 12/640,770, filed Dec. 17, 2009, entitled PATIENT SUPPORT; and U.S. copending application Ser. No. 12/640,643, 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

[0002] The present invention generally relates to a patient support, and more particularly to a patient mattress for a hospital bed.

SUMMARY OF THE INVENTION

[0003] The present invention 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.

[0004] In one form of the invention, 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 cushion layers.

[0005] In one aspect, the cushioning layers include a bladder layer.

[0006] In another aspect, the cushioning layers include a gel layer.

[0007] 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.

[0008] 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.

[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 hexagonal 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.

[0015] Accordingly, the present invention provides a support surface that provides a patient with pressure distribution and optionally improved moisture management.

[0016] According to aspect, the present invention provides a cover for a patient support, such as a mattress, for supporting a patient on a bed, such as a hospital bed. The cover is adapted to provide a generally smooth upper surface that extends over the mattress while still accommodating the movement of portions of the mattress or changes in thickness of the mattress, for example, when turning the patient. Optionally, the cover may be configured to follow the surface topology of the mattress, including a mattress with raised bolsters and/or a mattress with a raised head end.

[0017] In one form, a patient support includes a cushioning layer and a cover with an upper panel of flexible fabric extending over an upper side of the cushioning layer and two side panels joined with the upper panel. The side panels extend along the sides of the cushioning layer and are secured at the bottom side of the cushioning layer. The side panels are configured to contract or expand to accommodate variations in height of the cushioning layer to allow the upper panel to remain generally smooth even when the cushioning layer undergoes a change in its surface topology.

[0018] In one aspect, the cushioning layer comprises a cushioning system. For example, the cushioning system may include a plurality of bladders.

[0019] In a further aspect, the side panels are secured at the bottom side of the cushioning layer by a bottom

panel that extends under the bottom side of the cushioning layer.

[0020] In another form of the invention, a patient support includes a cushioning layer and a cover with an upper side for extending over the cushioning layer and two sides joined extending downwardly from the upper side. The sides extend along the sides of the cushioning layer and are secured at the bottom side of the cushioning layer. The sides of the cover are configured to contract or expand to accommodate variations in height of the cushioning layer to allow the upper side to remain generally smooth even when the cushioning layer undergoes a change in its surface topology.

[0021] In one aspect, the cover is formed from an upper panel, which forms the upper side, and the sides are formed by side panels that are joined with the upper panel. The cover further includes a bottom panel that is joined with the side panels to thereby secure the side panels at the lower side of the cushioning layer.

[0022] In any of the above, the sides or side panels may be formed from a liquid impermeable fabric. Further, the upper panel may be formed from a liquid impermeable material.

[0023] In yet another form of the invention, a cover includes an upper panel of flexible fabric for extending over a top side of a mattress, a lower panel for extending under a bottom side of a mattress, and end panels and side panels joined with the upper panel and with the lower panel. The side panels extend along the sides of the mattress and have upper and lower edges. The upper edges are joined with the upper panel, and the lower edges are joined with lower panel. The side panels are configured to prevent liquid intrusion into the mattress and further so that their upper and lower edges separate and/or diverge to accommodate variations in height of the mattress to allow the upper panel to remain generally smooth even when the mattress undergoes a change in its surface topology.

[0024] In any of the above, the cover may include a zipper. In addition, each of the side panels includes an upper side panel portion and a lower side panel portion. The upper side panel portions are joined with the upper panel. The lower panel portions are joined with the lower panel, and the zipper joins the upper side panel portions with the lower side panel portions.

[0025] In a further aspect, each of the upper side panel portions includes a flap of fabric extending over the zipper when the zipper is closed. For example, the flap of fabric may be formed by a folded loop of fabric.

[0026] In yet another aspect, each of the upper side panel portions includes a fold, which includes at least a portion that at least partially unfolds from an unexpanded configuration to an expanded configuration when the respective side of cushioning layer or mattress to which the fold is adjacent increases in height, for example, when it is raised to turn a patient.

[0027] In yet a further aspect, the folds are biased in its non-expanded configuration such that when the mattress or cushioning layer increases in height, at least a portion of each fold will at least partially unfold but when the mattress or cushioning layer decreases in height, the respective fold will generally return to its non-expanded configuration.

[0028] In another aspect, each fold may be biased in its un-expanded configuration by one or more elastic strands. For example, the strand or strands may extend between the upper panel and the lower panel. In this manner when the upper side of the mattress or cushioning layer rises relative to the lower side, the strand or strands are stretched and the upper side panel portion at least partially unfolds. When the mattress or cushioning layer is no longer in a raised position, the strand or strands pull on the upper panel to return it its un-raised position allowing the upper side panel portion to return its unexpanded configuration.

[0029] In any of the above, the cushioning layer or mattress may include a plurality of inflatable bladders.

[0030] According to yet another aspect, the inflatable bladders may be supported on a foam crib, also enclosed in the cover.

[0031] In addition, the cushioning layer or mattress optionally includes turning bladders positioned in the cover to allow turning of a patient supported on the patient support. For example, the turning bladders may be located beneath the foam crib.

[0032] In another aspect, the cover is configured to flow air 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.

[0033] In yet another form, a patient support includes a plurality of cushioning layers arranged such that their upper cushion 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 pneumatic system with a plurality of supply tubes, which are supported and guided by the bladder layer and coupled to the respective zones for inflating the zones.

[0034] 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 supporting the supply tubes. 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 by for example by welding, with the supports mounted to the lower sheet. For example, the supports may be adhered to 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.

[0035] 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.

[0036] 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.

[0037] In another form of the invention, a patient support includes a plurality of cushioning layers arranged such that their upper cushion 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 supported and guided by the bladder layer and coupled to the respective zones for sensing the pressure in the zones.

[0038] 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 supporting the sensing tubes. 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 by for example by welding, with the supports mounted to the lower sheet. For example, the supports may be adhered to 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.

[0039] 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.

[0040] 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 there 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 will frictionally hold the sensing tubes in place.

[0041] 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.

[0042] 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. 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 hexagonal gel wall structures. According to yet another aspect, the cushioning layers are supported on a foam crib. 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.

[0043] 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.

[0044] 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.

[0045] In another aspect, the support cover includes a mesh panel that permits air to be drawn into the cover by the blower units.

[0046] 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

[0047]

FIG. 1 is a perspective view a patient support shown mounted to a patient support apparatus, for example, a hospital bed;
FIG. 2 is a perspective view of the patient support of FIG. 1;
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;
FIG. 3 is a similar view to FIG. 2 with the cover removed to show the internal cushioning layers;
FIG. 3A is a plan view of the patient support illustrating the different areas or zones of the patient support;
FIG. 4 is a perspective view of the bladder layer of the patient support;
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;
FIG. 5 is a perspective view of the foam crib that supports the bladder layer;
FIG. 6 is a bottom perspective view the foam crib of FIG. 5 illustrating the foam crib with a hinged panel;
FIG. 7 is a perspective view of the base of the patient support;
FIG. 8 is a perspective view of a pair of turning bladders;
FIG. 9 is a perspective view of the gel layer of the patient support;
FIG. 9A is an enlarged plan view of a gel footing of the gel layer of FIG. 9;
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;
FIG. 11 is a perspective view a patient support and cover shown mounted to a patient support apparatus, for example, a hospital bed;
FIG. 12 is an exploded perspective view of the patient support and cover of FIG. 11;
FIG. 13 is similar view to FIG. 12;
FIG. 14 is a similar view to FIG. 13 illustrating optional cover tie downs;
FIG. 15 is a perspective view of the cover shown over a patient showing the optional tie down locations;
FIG. 16 is a perspective view of a head end of the patient support, which is shown with bladders, with a head cushion mounted to the head end;
FIG. 17 is a plan view of the head end of the patient support in FIG. 16;
FIG. 18 is a similar view to FIG. 16 with the patient support and cushion shown in phantom to illustrate an anchoring system for the cushion; and
FIGS. 19A-19C illustrates various strap configurations for securing the head end cushion to the underlying bladders;
FIG 19D is a plan view of the head end of the bladder layer;
FIG. 20 is a perspective view a patient support apparatus, for example, a hospital bed;
FIG. 20A is a perspective view of a bladder layer of the patient support apparatus of FIG. 20;
FIG. 21 is a plan view of the bladder layer of FIG. 20A;
FIG. 21A is an enlarged view of detail XXIA of FIG. 21;
FIG. 21B is an enlarged view of detail XXIB of FIG. 21;
FIG. 21C is similar view to FIG. 21B but with the tubes inserted;
FIG. 22 is a bottom perspective view of the bladder layer of FIG. 20A;
FIG. 23 is a similar view to FIG. 22 with the tubing removed for clarity;
FIG. 24 is an exploded perspective view of the bladder layer of FIG. 23;
FIG. 25 is an enlarge plan view of the supports mounted at or to the bottom surface of the bladder layer;
FIG. 26 is a perspective view of the foam and gel layer of the patient support;
FIG. 27 is a side view of the foam and gel layer of the patient support;
FIG. 28 is a perspective view of the portion of the foam crib that supports the bladder layer; and
FIG. 29 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; and
FIG. 30 is a perspective view of the foot portion of the foam crib folded showing the hinge formed by the gel layer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0048] Referring to FIG. 1, the numeral 10 generally designates a patient support of the present invention. 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, or vibration therapy or the like. Additionally, the support surface of the patient support may be configured to

provide 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. 61/696,819, filed Sept. 5, 2012, entitled INFLATABLE MATTRESS AND CONTROL METHODS (Attorney Docket No. 143667.150316(P400)), which is incorporated by reference herein in its entirety.

[0049] 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, 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.

[0050] 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. No. 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] To provide appropriate cushioning and immersion for the patient, patient support 10 includes 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.

[0056] 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.

[0057] 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

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] In the illustrated embodiment, gel layer 28 in-

cludes a plurality of gelastic footings that are disconnected from each other so that each footing can compress independently from its adjacent surrounding footing. The tern 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.

[0063] 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 % 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

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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 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 channels 46 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.

[0069] 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 36 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.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] 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.

[0074] 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.

[0075] 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, 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 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 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.

[0076] As noted above, the various tubing that supplies the bladders with air are coupled to a pump or pumps, 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, 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, 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.

[0077] 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 are established by the tubing 84 that run between 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 or housed in a fabric carrier which together form the flexible manifold 80.

[0078] 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, turn bladders and are each separately and independently inflatable and deflatable, which is also controlled by box 90 and its associated circuitry.

[0079] For example, as discussed in reference to copending application U.S. Ser. No. 61/696,819, filed Sept. 5, 2012, entitled INFLATABLE MATTRESS AND CONTROL METHODS (Attorney Docket No. 143667.150316(P-400)), patient support 10 may incorporate sensors, such as depth sensor plates 92, 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, 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.

[0080] 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.

[0081] 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.

[0082] 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 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.

[0083] When assembled, therefore, patient support 10 not only includes a cushioning layer that provides 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 feet section bladders, thigh and seat section bladders, and head section bladders.

[0084] Referring to FIG. 11, the numeral 110 generally designates a patient support of the present invention. As will be more fully described below, patient support 110 includes a cover 114 that is adapted to accommodate a patient's immersion into the support and expansion of the patient support, for example, when used to turn a patient but while still maintaining a smooth surface that does not bunch up.

[0085] Referring to FIG. 12, cover 114 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 114 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 110. Furthermore, as described in copending U.S. patent application Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405), which is incorporated by reference herein in its entirety, cover 114 optionally encloses one or more blowers or fans for circulating air through the support, as part of a low air loss system. Therefore, cover 114 may incorporate one or more open mesh panels to allow air to be drawn into or blown out of the cover 114.

[0086] In another aspects, also described in copending U.S. patent application Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405), cover 114 may include one or more indicia on its surface. For example, cover 114 may include indicia to define the preferred location for a patient on patient support 110. The indicia may include a demarcation, such as a line, that defines the overall general

area in which the patient should be positioned in the supine position and additional demarcations, 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.

[0087] 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.

[0088] 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.

[0089] To provide cushioning and immersion for the patient, patient support 110 includes one or more cushioning layers for supporting a patient's body. Optionally, patient support 110 includes a cushioning system formed from a plurality of cushioning layers that are configured to be mechanically interconnected at least in one degree or more so that the layers work together at least on one or more directions. In the illustrated embodiment, patient support 110 includes a bladder layer 126 with a plurality of bladders, which provide support to the patient's thighs, seat, back, and head, and an optional gel layer, for example, which provides support to the patient's heels. Bladder layer 126 and gel layer may be supported by a foam crib 130, which together may form a cushioning system for patient support 110. Crib 130 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 110. Optionally, the bladders of bladder layer 126, the gel layer and foam crib each have surfaces or structure that interconnect them together at least in one direction so that the bladders, gel layer, and foam crib may work in unison in one degree or another. Additionally, the side rails of the foam crib, which form bolsters, may be raised or angled upwardly relative to the top surface of the bladder layer, over at least a portion of the bladder layer, to form a cradle so that when the patient is lying on the bladder and gel layers, the foam crib will cradle the patient and further provide lateral support to the patient to reduce the risk of the patient rolling or falling from the patient support even when the side rails are lowered. For further details of optional bladder layers, gel layers, and foam cribs, and, for example, how they are mechanically connected, reference is made to copending U.S. patent application Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405).

[0090] The cushioning system may have multiple zones. For example, the bladders themselves may be arranged in zones, which optionally may be independently controlled with the inflation/deflation of each zone independent of the other zone or zones. The zones may include a head zone at the head end of support 110 formed by one group of bladders, a back zone at the back section of support 110 formed by another group of bladders, seat and thigh zones at the seat and thigh sections formed by a third group of bladders, and a heel zone at the foot end of patient support 110 formed by the gel layer. 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 110. For further details of the bladder arrangement, materials, and construction, reference is made to copending U.S. patent applications Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405); 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.

[0091] Optionally, as described in copending U.S. patent applications Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405), patient support 110 may include a pair of turning bladders. The turning bladders are positioned beneath crib 130 but within cover 114. To reduce friction between the bladders and crib 130, which is formed from a foam material, optionally, portions of crib may include a fabric overlay or wrap 132 (see FIGS. 12 and 13). The

fabric may comprise a low friction material, such as nylon, to reduce the drag on the bladders and also reduce the wear on the foam. The pump or pumps that supply air to the turning bladders as well as the support bladders tubing are optionally located in a box 140 at the foot end of the support, and further beneath the foot end of crib 130 under gel layer 128. Again for further details of support cushioning layer and the components that may be located in cover 114, reference is made to copending U.S. patent application Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405).

[0092] Referring again to FIG. 12, cover 114 includes an upper cover portion 150 and a lower cover portion 152 that are joined together by a zipper 154, which allows access to the various components inside support 110. Upper cover portion 150 includes an upper side, which may be formed from a separate panel, and upper side portions that depend downwardly (as view in FIGS. 12-15) from upper side and optionally are formed from separate panels that are joined with the upper panel, for example by welding, stitching or the like. Similarly, lower cover portion 152 includes a lower side, which may be formed from a separate lower panel, and lower side portions that extend upwardly (as view in FIGS. 12-15) from the lower side and optionally are formed from separate panels that are joined with the lower panel, for example by welding, stitching or the like. In the lustrated embodiment, the upper side of the cover is configured to follow the surface topology of the underlying cushion or cushioning system to provide a smooth surface, which can facilitate cleaning.

[0093] However, to accommodate the increase in thickness in the cushioning system, for example, when one of the turning bladders is inflated, one or more of sides 114a, 114b, as well as head end 114c, of cover 114 are adapted or configured to contract or expand to allow the upper side or panel to remain generally smooth even when the patient support undergoes a change in its surface topology. It has been found that covers with loosely fitting top sheets, which accommodate the change in shape of the underlying cushioning system or layer by providing excess material on the top sheet, for example, when turning a patient, tend to bunch up, which can make them hard to clean and, moreover, result in the excess fabric shifting to one side. As a result, the excess fabric may no longer be available to provide slack for the other side of the mattress.

[0094] Referring to FIGS. 12-14, each side 156 and 158 and end 160 and 162 of cover 114 is joined with the upper side 164 and lower side 66 of cover 114. As noted above each upper side 164, lower side 166, sides 156, 158, and ends 160, 162 may be formed from panels. The sides 156 and 158 extend along the sides of the patient support and cushioning system, with the ends 160, 162 extending there between. Each of side 156 and 158 and each end 160 and 162 has an upper edge joined with the upper panel and a lower edge joined with lower panel. Though it should be understood that some of the panels may be formed from an extension or extensions of the upper or lower panels and therefore are formed from the same material forming the upper or lower panels rather than comprises separate panels. Further, the side panels and head end panels are configured so that their upper and lower edges separate and/or diverge to lengthen and extend the respective side panels and head end panel so that cover 114 can accommodate variations in height of the mattress to allow the upper panel to remain generally smooth, as noted, even when the mattress undergoes a change in its surface topology.

[0095] Further, as noted, each side panel 156, 158 may include an upper side panel portion 156a, 158a and a lower side panel portion 156b, 158b, where the upper side panel portions 156a, 158a are joined with the upper panel 166, and the lower side panel portions 156b, 158b are joined with the lower panel 168 . Similarly, the end panels 160 and 162 may have upper end panel portions 160a, 162a and lower end panel portions 162a, 162b that respectively are joined with the upper and lower panels 166, 168. Zipper 154 then joins the upper side panel portions with the lower side panel portions, and joins the upper end panel portions to their respective lower end panel portions.

[0096] In addition, the upper side panel portions 156a, 158a and upper end panel portions 160a, 162a may each include a flap or panel 170, 172 (only two shown, but it should be understood that the other side and end also has a similar flap or panel) of fabric extending over the zipper when the zipper is closed. For example, the flap may be formed by a folded loop of fabric, including the same fabric that is used to form the upper end panel portions and upper side panel portions. In this manner, flaps 170 and 172 each form a watershed over the zipper to limit liquid intrusion through the zipper.

[0097] In the illustrated embodiment, each side and the head end further includes a fold 174 that unfolds (or at least partially unfolds) when the cushioning layer increases in height to allow the upper side of cover 114 to raise with the upper surface of the cushion layer and also allows it to remain generally smooth and move with the upper surface of the cushion layer unencumbered by the sides. In this manner, the sides and head end unfold from an unexpanded configuration to an expanded configuration when the cushioning layer increases in height, for example, when it is raised to turn a patient. Further, it should be understood that depending in the increase in height in the cushioning layer, it may be that only a portion of one of the folds partially unfolds.

[0098] In the illustrated embodiment the folds are provided on the upper side panel potions and upper head end panel portion. For example, the folds may be made from the material that forms the upper side panel portions and upper head end panel portion or may be formed by separate panels or sheets of material that are attached, for example by stitching, welding, or the like.

[0099] Optionally, the folds may be biased in their non-

expanded configuration such that when the cushioning layer decreases in height, the folds will generally return to their non-expanded configuration. "Generally return to its non-expanded configuration" means that the fold may not assume the exact same fold, but it will resume to a non-expanded, folded configuration that is generally similar to its original non-expanded configuration.

[0100] For example, again referring to FIG. 12 and 13, the folds may be biased in their un-expanded configuration by one or more elastic strands 176. A suitable elastic strand may be in form of a fabric covered elastic or rubber cord, such as a bungee. The strand or strands may extend between the upper panel and the lower panel. In the illustrated embodiment, strand 176 is threaded through upper and lower straps or panels 178, 180, which are respectively joined to upper panel 166 and lower side panel portions 156b, 158b and to lower head end panel portion 160b. For example, panels 178 may be secured to upper panel 166 by an adhesive, removable fasteners, such as hook and loop patches (e.g. VELCRO patches) or snaps, stitching or welding, depending on the materials. Lower panels 180 are joined to upper portion 154a of zipper 154 so that when upper portion of zipper is joined with lower portion 154b of zipper 154, strand 176 extends between the upper and lower panels 166, 168 of cover 114 to thereby bias folds 174. In this manner when the upper side of the mattress raises relative to the lower side, the strand of strands are stretched and fold 174 in the upper side panel portion that is adjacent the side of the mattress that is being raised at least partially unfolds. When the mattress is no longer in a raised position and the strand or strands pull on the upper panel 166 to return it its un-raised position, the stand or strands also urge the folds in the upper head end panel portion and the upper side panel portion (on the side that is deflating) to generally return their unexpanded configuration.

[0101] Referring again to FIG 12, strand 176 may be threaded though grommets 182 mounted in panels 178 and 180 and further is anchored at its ends to panels 178 and 180 by cord or barrel locks 176a. While illustrated as being formed by a single stand that threads through the grommets in panels 178 and 180, it should be understood that two or more strand may be used.

[0102] To further facilitate the retention of the corners of cover 114 during a turning event, for example, each corner may incorporate an anchor or anchoring assembly 190. Optionally, to facilitate the anchoring of the corners, the corners may be stiffened or reinforced. For example, as best seen in FIG 15, anchoring system 190 includes a reinforcing member 192, such as plastic tube, which is configured with a rounded angle shape. The reinforcing member may be mounted to upper panel 166, for example, in a loop or loops of material which form a channel through which member 192 can be inserted. The loop or loops may then be attached, for example by way of stitching, an adhesive, welding or the like to a plurality of tie downs such as straps 196, which are then secured at their opposed ends to lower cover portion 152, for example, to lower panel 168, either by stitching, welding, releasable fasteners, such as hook and loop fasteners or snaps. In this manner, when the cushioning system is raised by the turning bladder or bladders, the corner on the side that is being lifted will generally remain at a fixed height as controlled by the length of straps 196. Straps 196 may be non-stretching or may have some limited elasticity, or a combination of both may be used. For example the straps or tie downs that are closer to the corner may be non-stretchy, while the tie downs or straps that are located at the sides may have some elastic characteristics.

[0103] As noted above, crib 130 may be wrapped or covered with a layer of fabric. The fabric may also protect the foam from the strands and tie downs, which may also form wear points on the foam if not protected.

[0104] Referring to FIGS. 16-18, patient support 110 may optionally incorporate a cushioning layer 198 on top of bladder layer 126. For example, in the illustrated embodiment, cushioning layer 198 may be configured as a head end cushion and secured to head end of bladder layer 126 by straps 200. Cushioning layer 198 may be formed from a soft foam, such as a urethane foam. A suitable urethane foam includes a 2.5 lb. expanded urethane foam.

[0105] Cushioning layer 198 is contoured to provide raised or sloping sides 198a, 198b, which cradle and help support a patient's head, especially during a turn. The central portion 198c of cushioning layer 198 may be generally flat or form a slight concave region, which transitions to the sides with a smooth curve. The upper end of cushioning layer 198, which is closer to the head end of bladder layer 126, may be slightly raised (see FIGS. 19A-19C), while the lower end, which would be generally aligned under the neck of a patient, may also be slightly raised. In this manner, the head of the patient is cradled by cushioning layer 198.

[0106] In addition to securing layer 198 to bladder layer 126 by straps 200, which extend through cushioning layer 198 (see FIGS. 19A-19C for optional configuration), cushioning layer 198 may also be configured so that its lower surface follows the surface topology of one or more bladders 126a of bladder layer 126 to further secure the position of the cushioning layer. For example, referring to FIGS. 19A-19C, the underside of cushioning layer 198 may have one or more recesses 198d, for example, formed in the lower surface of the foam, which generally follow the surface topology of one or more of the bladders. As a result the lower surface also forms portions 198e that depend from the lower surface to extend between at least two of the bladders to thereby form a mechanical coupling between cushioning layer 198 and the bladder layer.

[0107] Optionally, as best seen in FIG. 19D, bladder layer 126 includes enlarged bladders 126b at the head end to form right side and left side bladders. Additionally, each bladder 126b may include a releasable fastener 202, such as hook and loop (e.g. VELCRO) patches,

which engages similar patches provided on the underside of cushioning layer 198 to further secure cushioning layer 198 in place.

[0108] Referring again to FIGS. 19A-19C, strap 200 may form a loop around a portion of cushioning layer 198 which is then anchored, for example, to the under of bladder layer 126. As shown, cushioning layer 198 may include one or more channels 198f formed therein for the strap 200 to pass through and secure it in place.

[0109] In addition, as best see and understood from FIG. 16, the sides 198g of cushioning layer 198 may be configured to follow the shape of the sides of bladder layer 126 so that cushioning layer 198 also mechanically couples to the foam crib as described in copending U.S. patent application Ser. No. 61/697,010, filed Sept. 5, 2012, entitled PATIENT SUPPORT (Attorney Docket No. STR03A P-405). Thus, the cushioning system provides a series of layers that are mechanically interconnected or coupled so that the system can operate together to provide support to the patient.

[0110] Referring to FIG. 20, the numeral 210 generally designates another embodiment of a patient support of the present invention, which is illustrated supported on a patient support apparatus 212 that, in this particular embodiment, is a hospital bed. However, patient support apparatus 212 may take on other forms besides a hospital beds, such as, but not limited to, long term care, cots, stretchers, operating tables, gurneys, and the like. Further, patient support apparatus 212 may be a conventional support apparatus that is commercially available and that merely provides a supporting function for patient support 210.

[0111] For example, patient support apparatus 212 may include one or more controls that are integrated therein and which are used in controlling one or more functions of patient support 210. 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 212. 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 210. The connection between the interface and patient support 210 may take on different forms, including a direct electrical cable that runs from the footboard to patient support 210, 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. No. 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.

[0112] Referring to FIG. 20A, patient support 210 includes a bladder layer 226 with a plurality of bladders 226a, 226b, which provide support to the patient's thighs, seat, back, and head. As described above, bladder layer 226 may be used in combination with a gel layer, which provides support to the patient's heels, and a foam crib, which supports both the bladder layer and the gel layer, as well as providing other functions. For additional details of a suitable gel layer and foam crib reference is made herein to the incorporated application and to further optional details provided below.

[0113] Referring to FIG. 24, bladder layer 226 may be formed from an upper sheet 228 and a lower sheet 230. As best seen in FIGS. 22 and 23, upper sheet 228 and lower sheet 230a are joined together, such as by adhesive or welded or the like, to form bladders 226a and 226b and further in a manner to form a plurality of 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.

[0114] Again referring to FIG. 24, bladders 226a and 226b are first formed in their extended configurations, for example, by thermoforming, and then joined with lower sheet 228. 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 and further can be arranged so that their edges do not align and instead are offset between adjacent bladders, which as described in the incorporated application, reduces the ability of a patient to detect the edges of each bladder and hence improve their comfort.

[0115] Referring to FIG, 22, bladder 226a and 226b are inflated by a pneumatic system 240, which is controlled by a control system, such as described above. In the illustrated embodiment, pneumatic system 240 includes a plurality of supply tubes 242. Supply tubes 242 extend under bladder layer 226 and couple to and are in communication with each of the respective zones of the bladder layer via couplers 246a that connect to inlet ports 248a provided in bladder layer 226 so that each zone can be separately or independently inflated, and also couple to the turning bladders beneath the foam crib. Additionally, the control system may include a plurality of sensing tubes 244, which 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 that connect to inlet ports 248a 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 described 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.

[0116] As best seen in FIGS. 22 and 23, bladder layer 226 may include 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. 25, supports 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 tubes 242 and/or tubes 244 or separate supports may be provide for tubes 242 or 244.

[0117] Referring to FIGS. 21, 21A, 21C, and 23, 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 or the lower sheet 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.

[0118] 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, from about 60/1000 to 100/10000 of an inch, and optionally 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, from about 15/1000 to 30/1000 of an inch, and optionally 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.

[0119] As best seen in FIGS. 21A and 21C, 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 between the slits so that the loops will 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. 21C. Alternately, flange 262 may have openings of different sizes to support each tube separately.

[0120] 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 in the referenced applications, at least some regions of the sheets may be left unjoined (for example see in FIG. 22) 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. 21B, bladder layer 226 includes a plurality of transverse openings 268, which are located between bladders 226a to allow air to flow from beneath the bladder layer through the bladder layer.

[0121] As described above, to deliver air to bladders 226a and 226b and to the turning bladders (not shown herein), support 210 includes pneumatic system 240, with a plurality of supply tubes 242 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 system, which as described in P405 and P400, may be supported in a compartment 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.

[0122] When assembled, therefore, patient support 210 not only includes a cushioning layer that provides a pressure redistribution system to enhance the support of a patient lying upon support 210 but also optionally provides a line management system for the pneumatic tubes of the inflation and control system. It should be understood that patient support 210 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.

[0123] Referring to FIGS. 26-30, bladder layer 226 and a gel layer 328 are supported by a foam crib 340. Crib 340 includes a head/body end 344 and a foot end 346 which are joined together at a joint 342, which is configured to allow the gel and foot end 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). As best seen in FIG. 28, one side of joint 342 may include a recessed region with line management chan-

nels 348 that, for example, direct supply tubing 242 from bladder layer 226 to the air manifold 350 via a CPR valve 352, which are optionally located at the foot end in a control compartment (or pump box) located beneath the foot end portion of the foam crib, and direct sensing tubing 244 to sensors also located in the control compartment. Additionally, foam crib 340 may include channels 354 (FIG. 28) extending into its respective sides for line management purposes.

[0124] Referring to FIGS. 28 and 29, joint 342 is formed by complementary stepped profiles formed by wedge shaped blocks 342a on the head/body end 344 of foam crib 340 and angled blocks 342b formed on foot end 346 of foam crib 340, which are joined by releasable fasteners, such as VELCRO patches 358 so the foot end 346 may be disconnected from head/body end 344 to allow access to the control compartment. Further, when at least some of the patches are unhooked, joint 342 may form a hinge.

[0125] As best seen understood from FIG. 26, 28, and 30, the foot end portion of the joint extends over and meshes with the head/body portion of the joint and further supports the gel layer so that it too meshes with the bladders of the bladder layer and is connected to the head/body end when the fasteners align and are coupled. The foot end of joint 342 further includes hinge 346, which is formed by two sections of the foot end. The two sections may be joined by the gel layer 328 via a sheet of non-woven material and adhesive interface, which 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. 30). To form the hinge, the sheet of non-woven material and an adhesive coating or layer that attaches gel layer 328 to the foot end of the foam crib is cut so that the sheet is divided into two sections, one attached to the gel layer and the first section of the foot end of the foam crib and the second attached to the gel layer and the second section of the foot end of the foam crib so that the gel layer can fold and therefore form the hinge (see FIG. 30).

[0126] As described above, the blower units 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 (see FIG 30) so that they also provide protection to the tubing that extends through the joint from the head/body end to under the foot end 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.

[0127] Accordingly, the present invention provides a patient support that provides a mattress with inflatable support bladders that can offer improved immersion of the patient into the surface of the mattress and, therefore, improved pressure distribution to the patient, in combination with an optional line management system that facilitates assembly and handling of the patient support. With the independent discrete bladder arrangement, it has been found that a more balance contact (see FIG. 10) can 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.

[0128] 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.

Claims

1. A patient mattress comprising:

a bladder layer forming a patient support surface, said bladder layer formed from a plurality of inflatable bladders, and each bladder having a contour; and

a crib, said crib being formed from foam and having a base wall and upwardly extending sidewalls, said sidewalls forming foam rails along opposed sides of said bladder layer, and each side wall of said sidewalls having an inwardly bladder facing surface with plurality of recesses, each recess generally following the contour of and receiving therein an adjacent bladder of said bladder layer wherein said sidewalls provide lateral and longitudinal support to said bladders.

2. The patient mattress according to claim 1, further comprising a gel layer forming a patient support surface adjacent said patient support surface of said bladder layer, said bladder layer and said gel layer arranged such that their patient supporting surfaces when unloaded are generally arranged in a plane.

3. The patient mattress according to claim 2, said crib having a base wall extending under said gel layer and upwardly extending sidewalls on opposed sides of said gel layer, said gel layer having a plurality of gel footings, each gel footing having a contour, each side wall of said sidewalls on opposed sides of said gel layer having an inwardly gel facing surface with plurality of recesses, each recess of said inwardly gel facing surface generally following the contour of and receiving therein an adjacent gel footing wherein said sidewalls on opposed sides of said gel layer provide lateral and longitudinal support to said gel footings.

4. The patient mattress according to claim 2 or 3, wherein said gel layer interlocks with adjacent bladders of said inflatable bladders.

5. The patient mattress according to any above claim, wherein each of said bladders has a hexagonal cross-section to form said contour.

6. The patient mattress according to claim 3, wherein said gel footings comprise hexagonal gel footings.

7. The patient mattress according to claim 3 or 6, wherein each of said gel footings is disconnected from its adjacent gel footings.

8. The patient mattress according to any above claim, further comprising turning bladders beneath said base wall, and wherein said base wall includes at least two hinged panels to allow said turning bladders to turn a patient supported on said patient mattress.

9. The patient mattress according to any above claim, wherein said base wall includes a plurality of channels extending there through for directing air through said foam crib and into at least one of said cushioning layers.

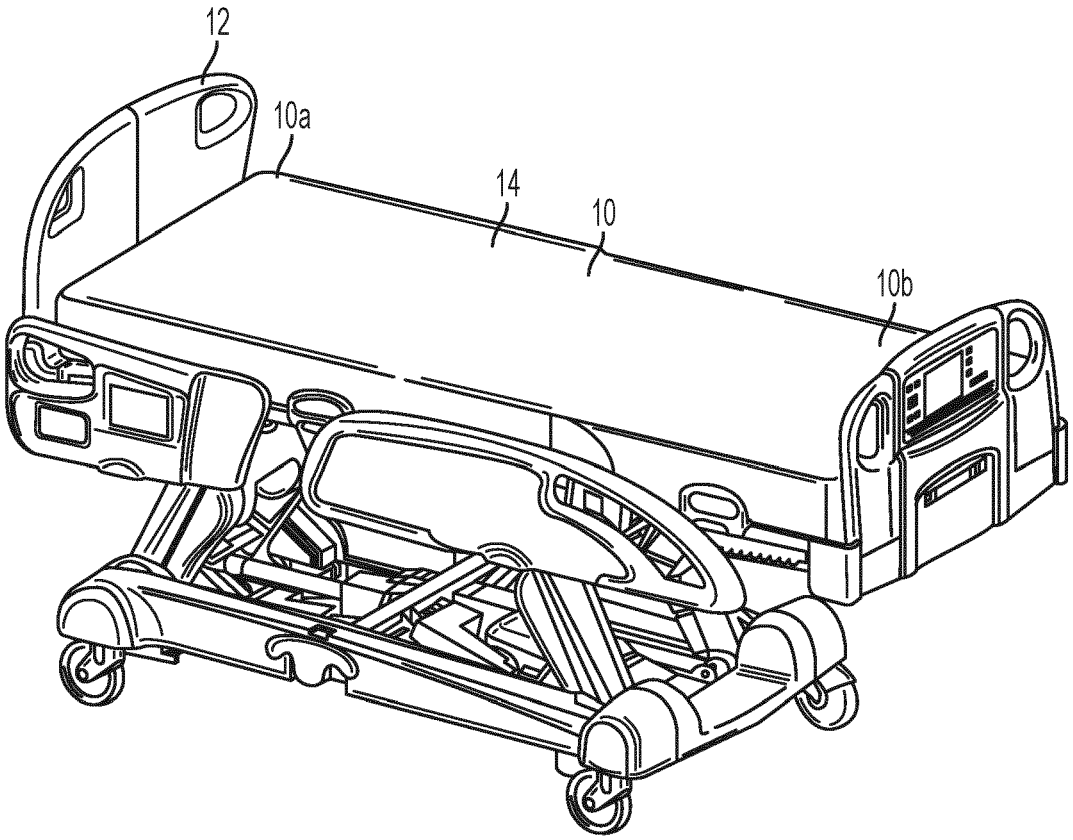


FIG. 1

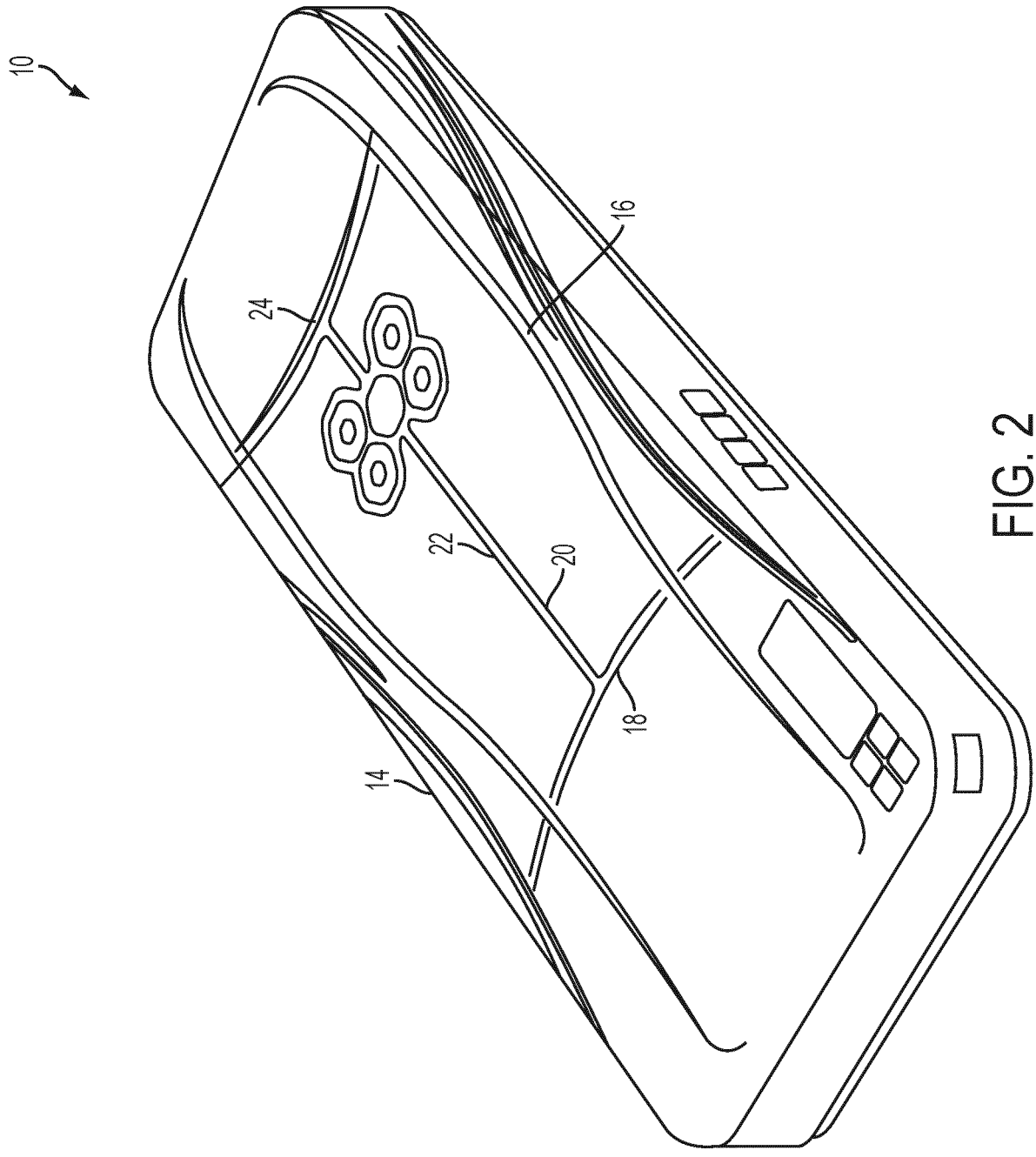
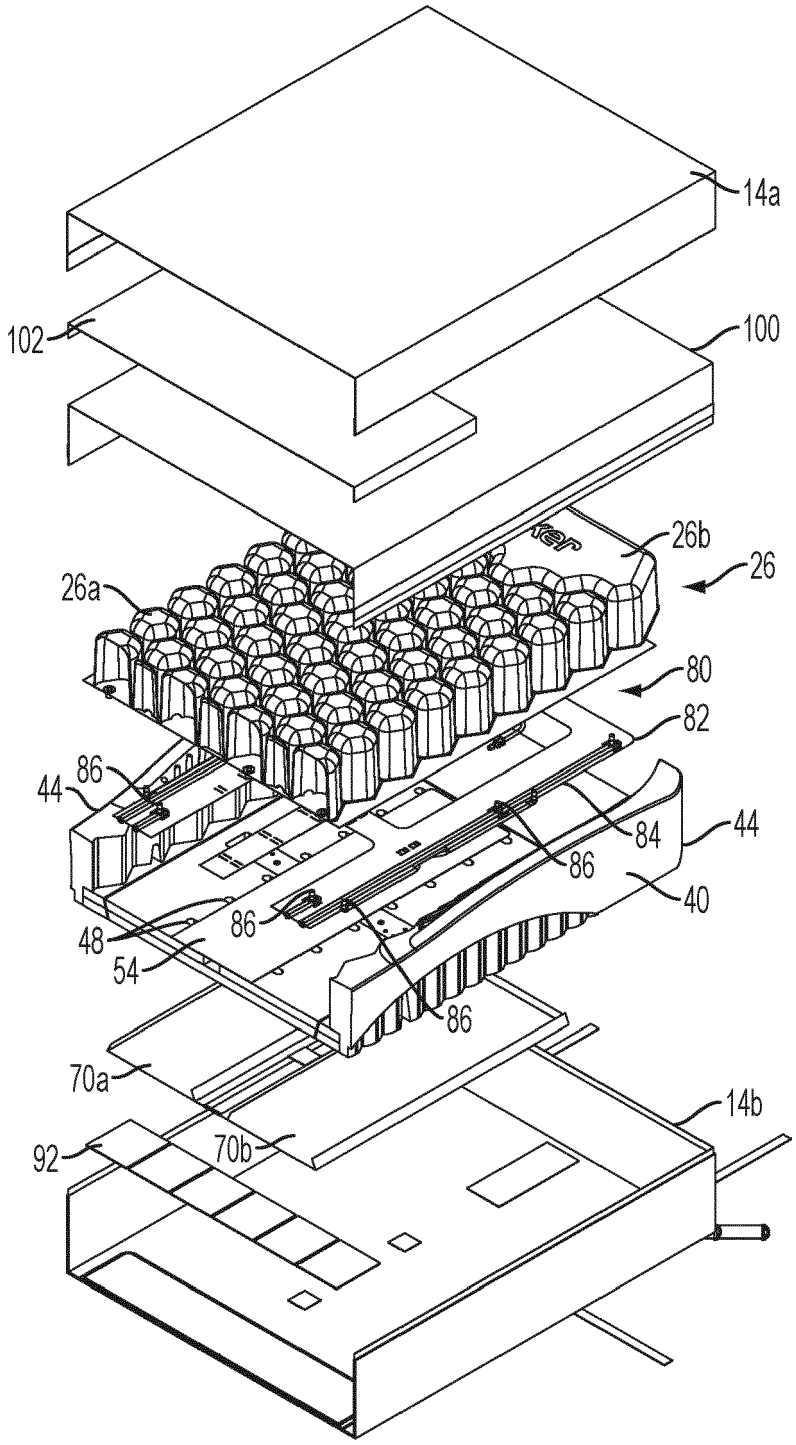


FIG. 2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26b
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70a
14b
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70b

FIG. 2A

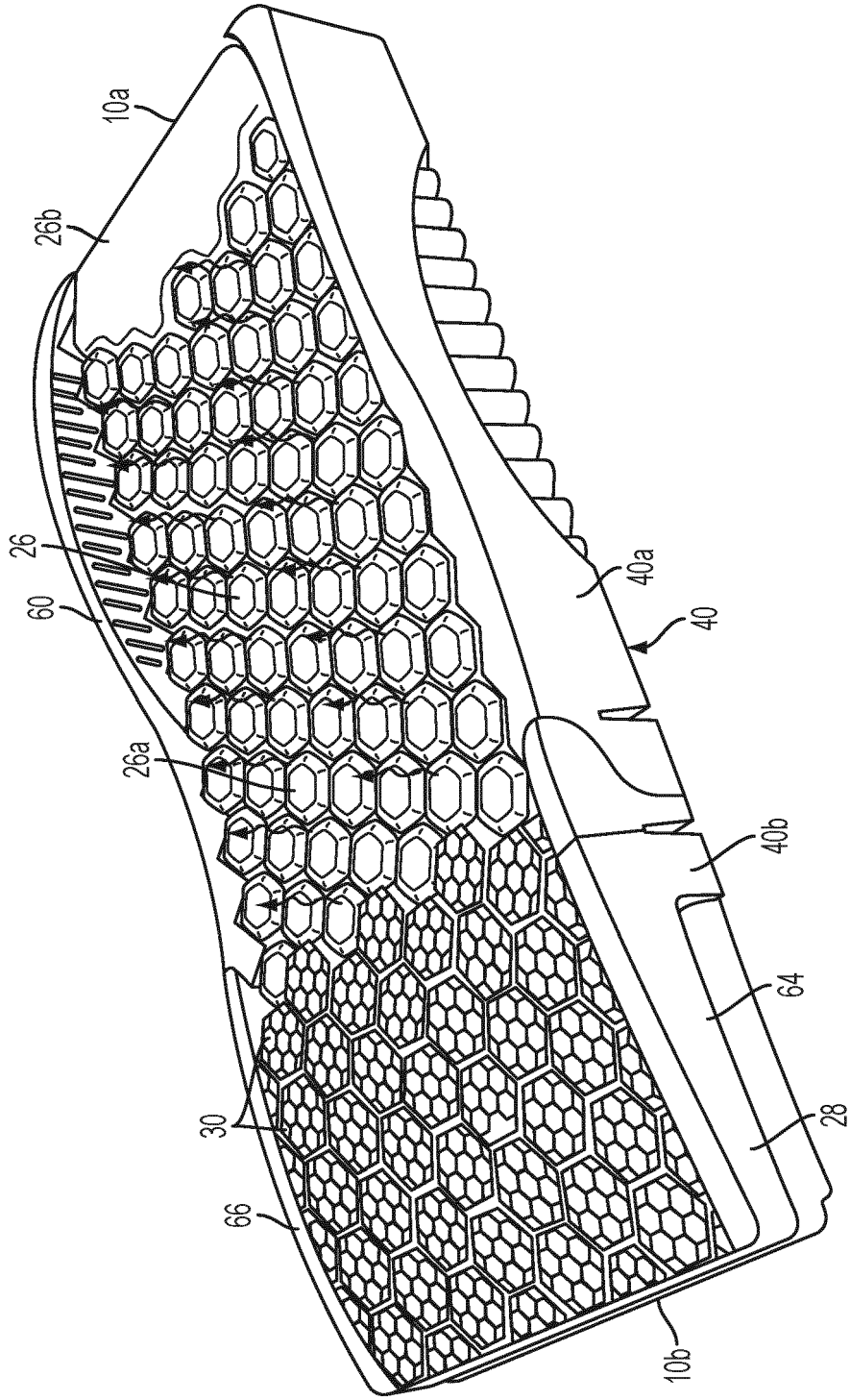


FIG. 3

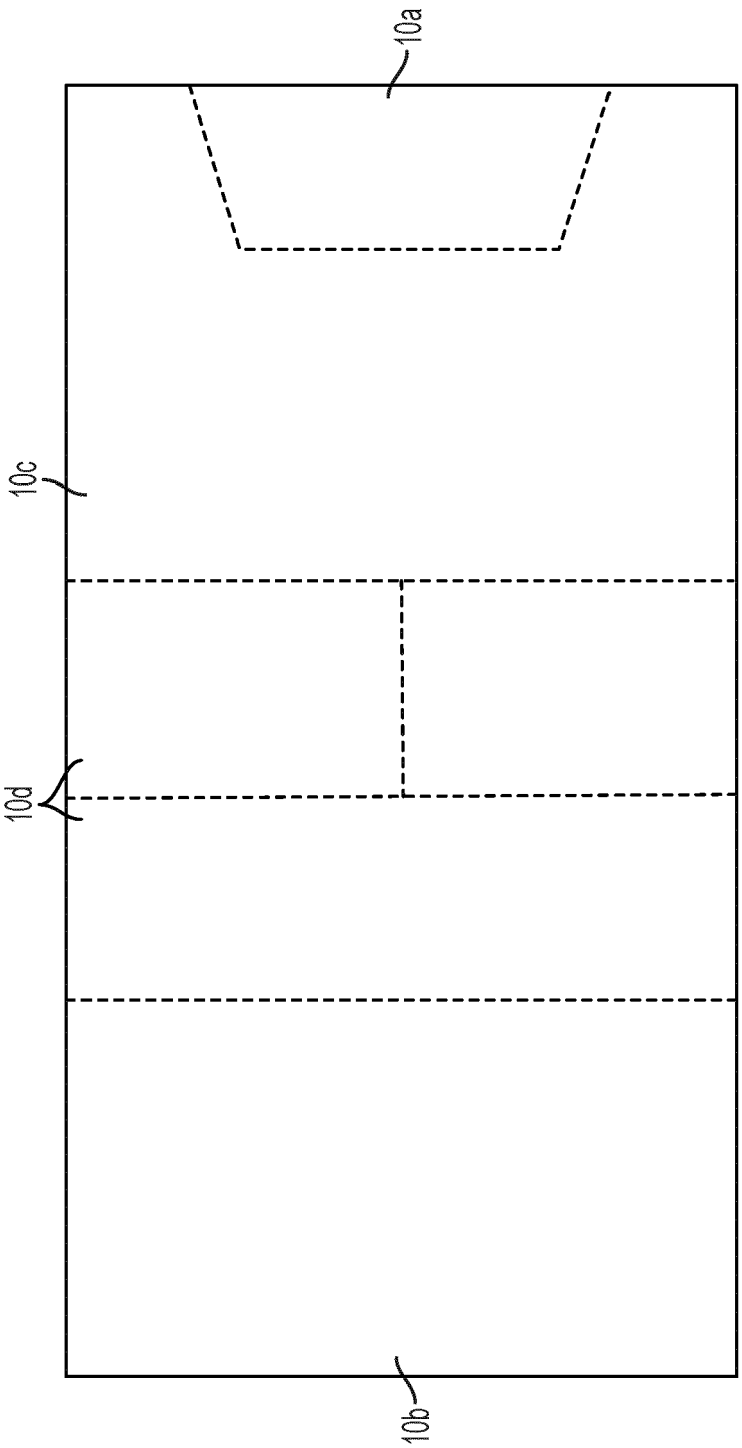


FIG. 3A

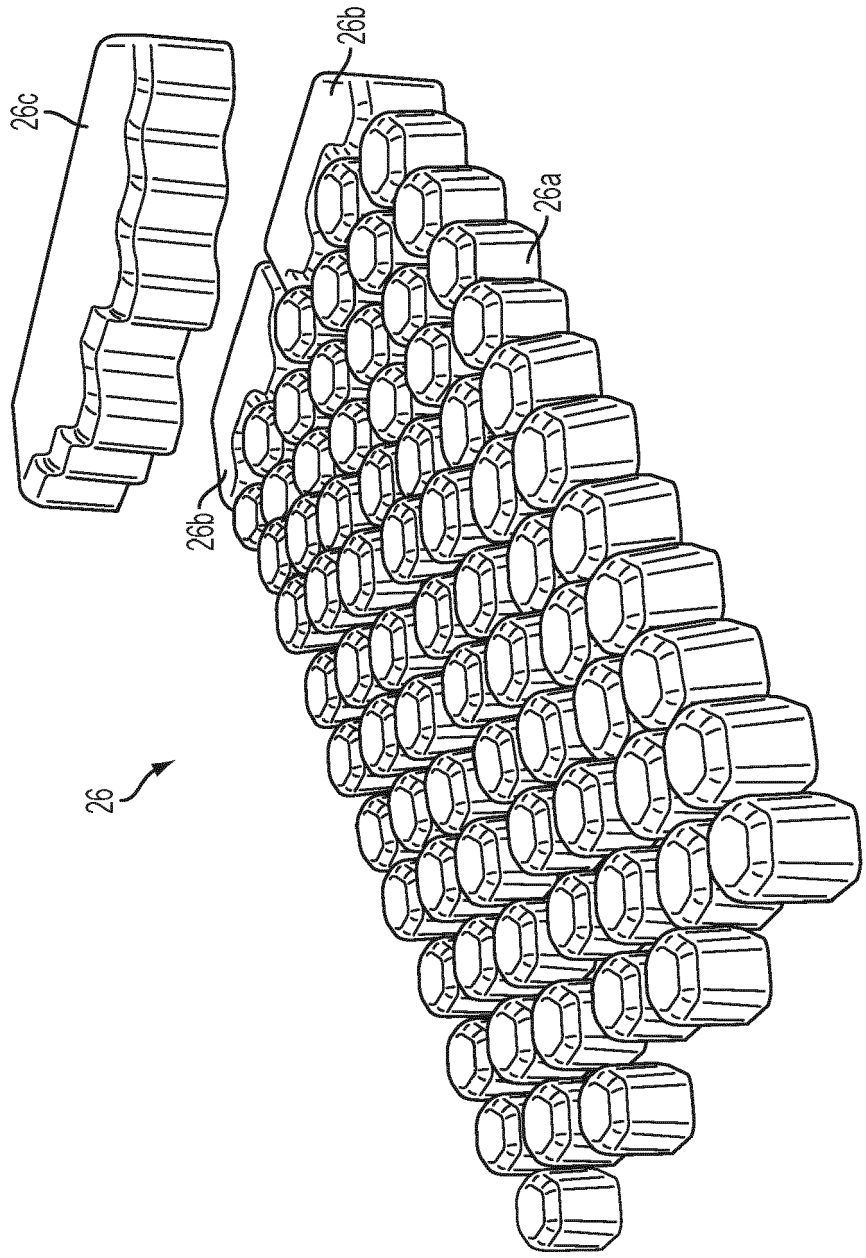


FIG. 4

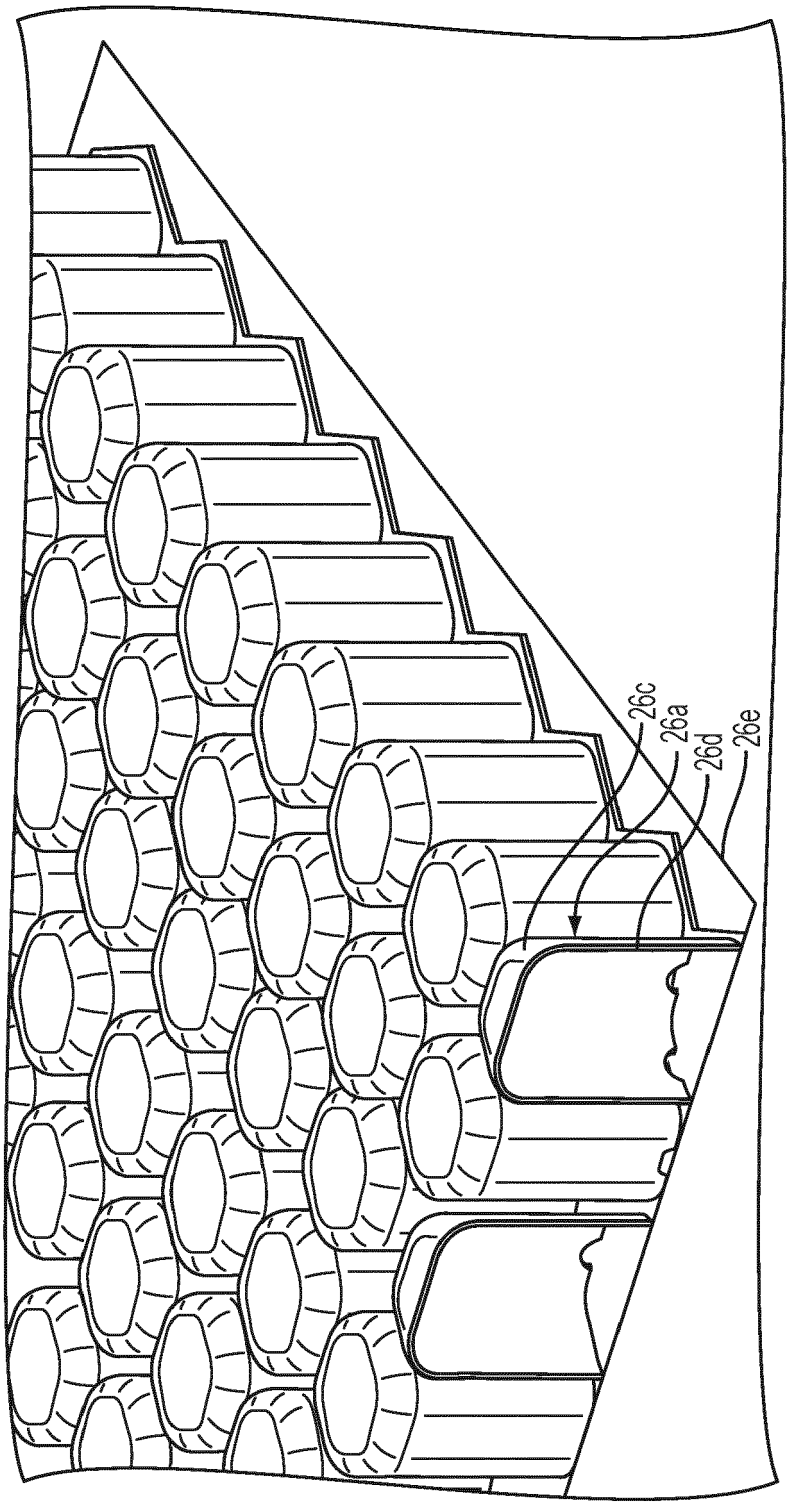


FIG. 4A

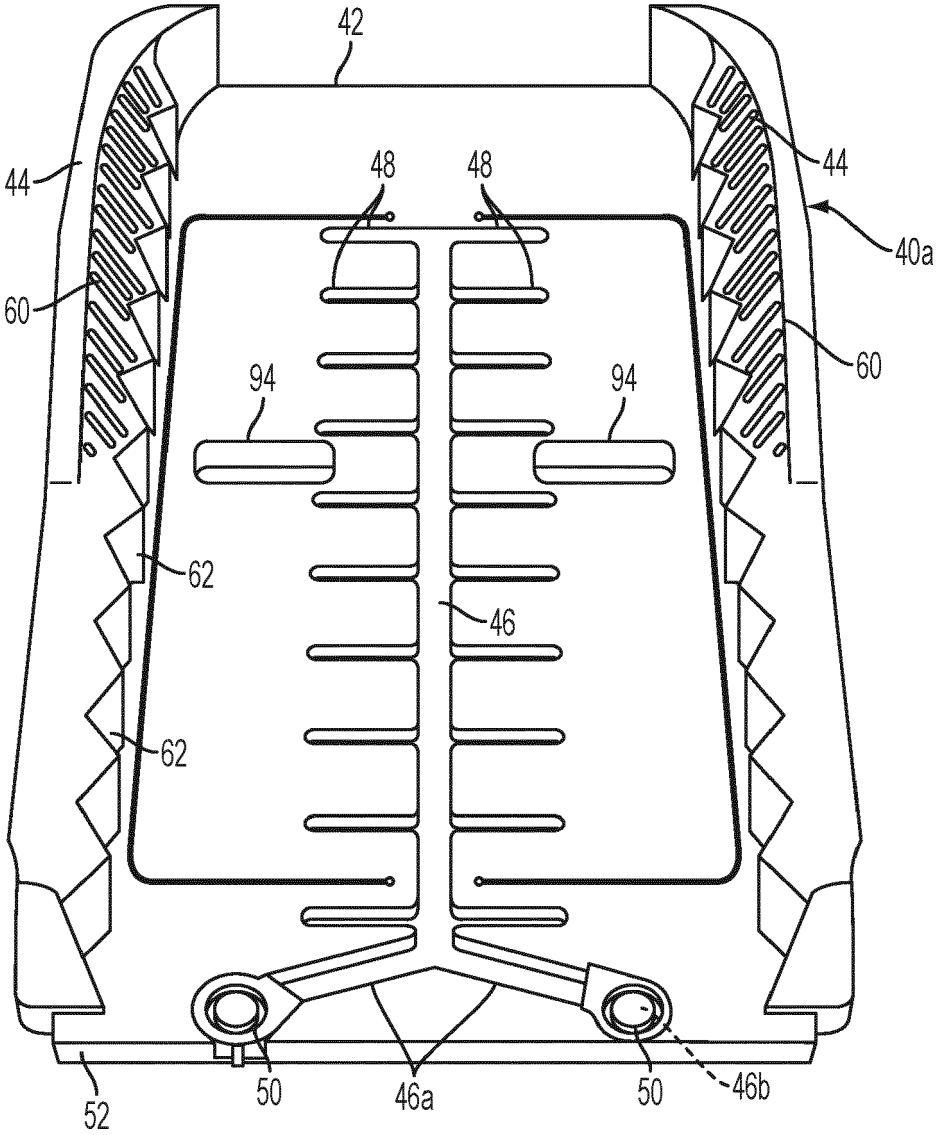


FIG. 5

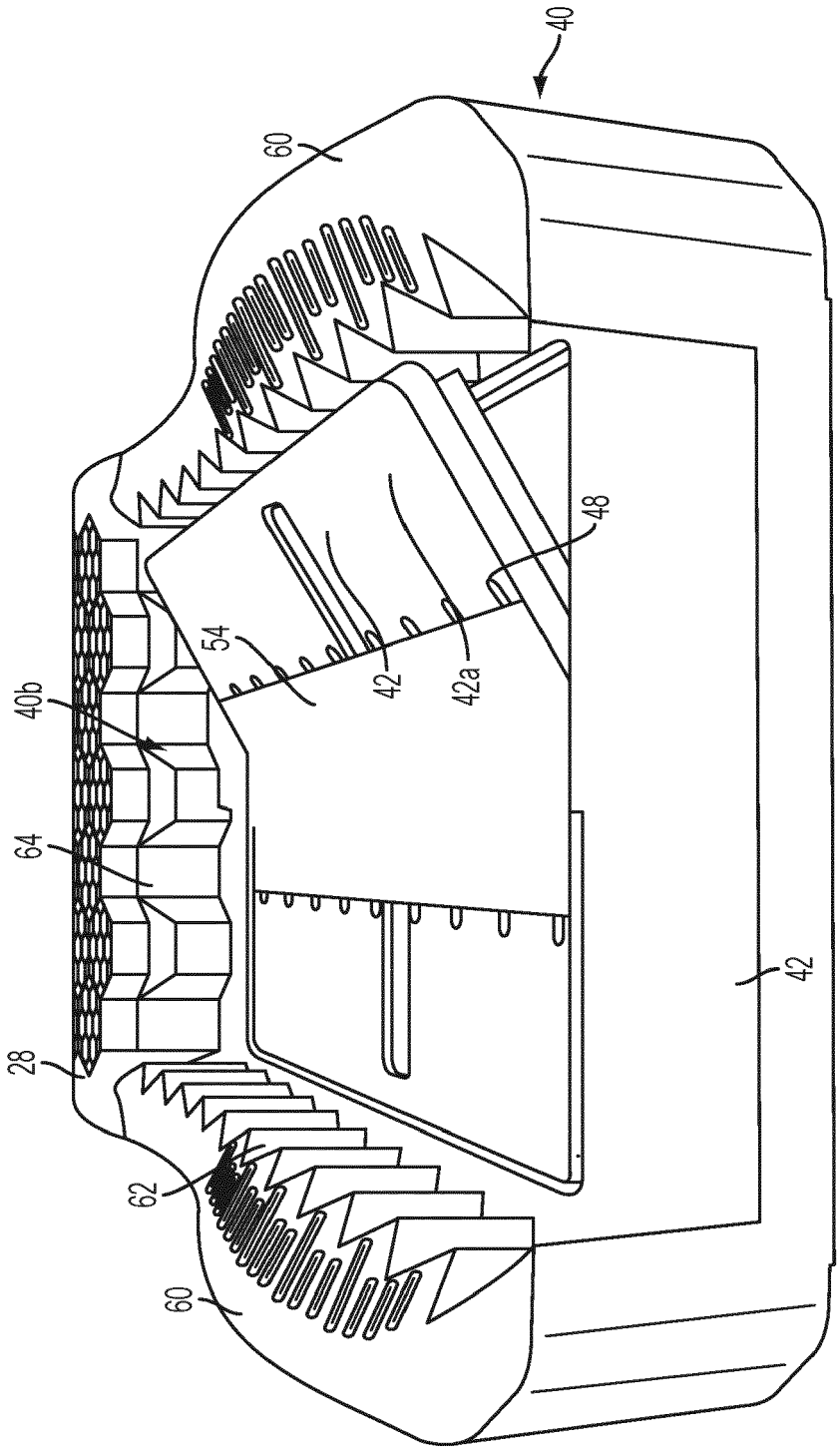


FIG. 6

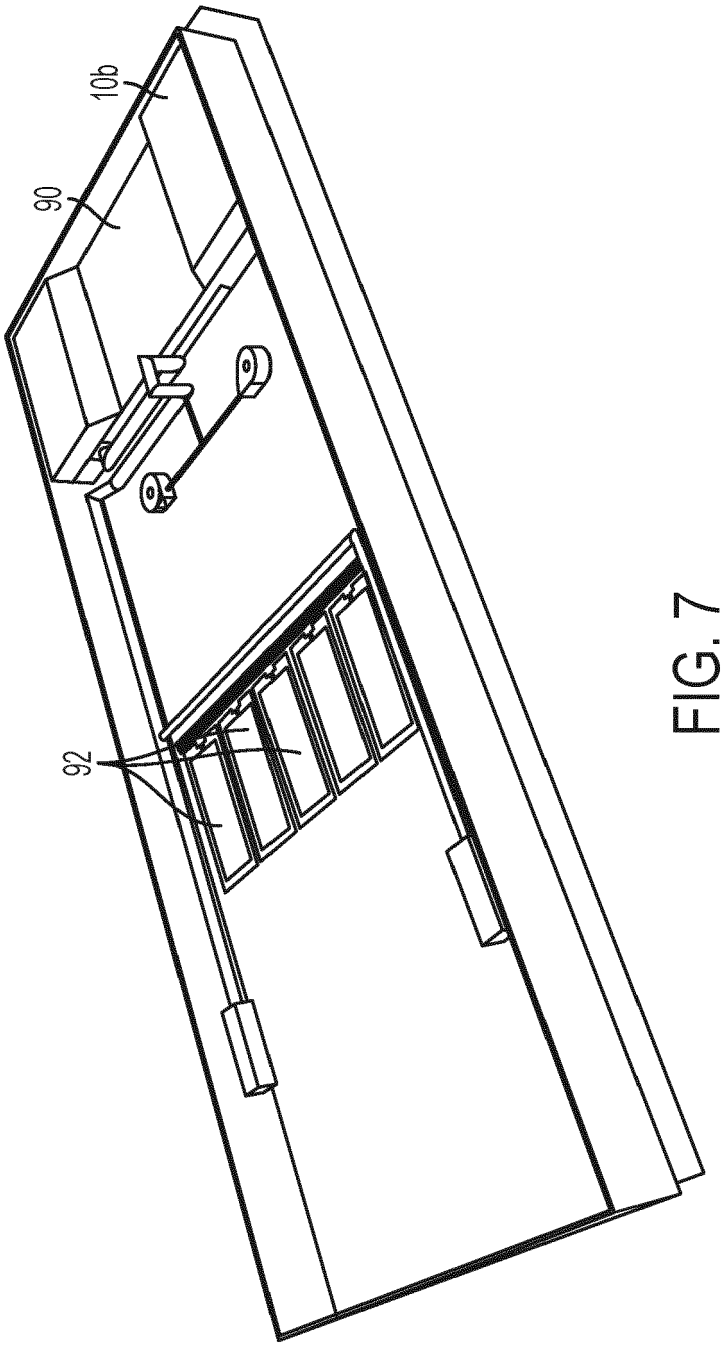


FIG. 7

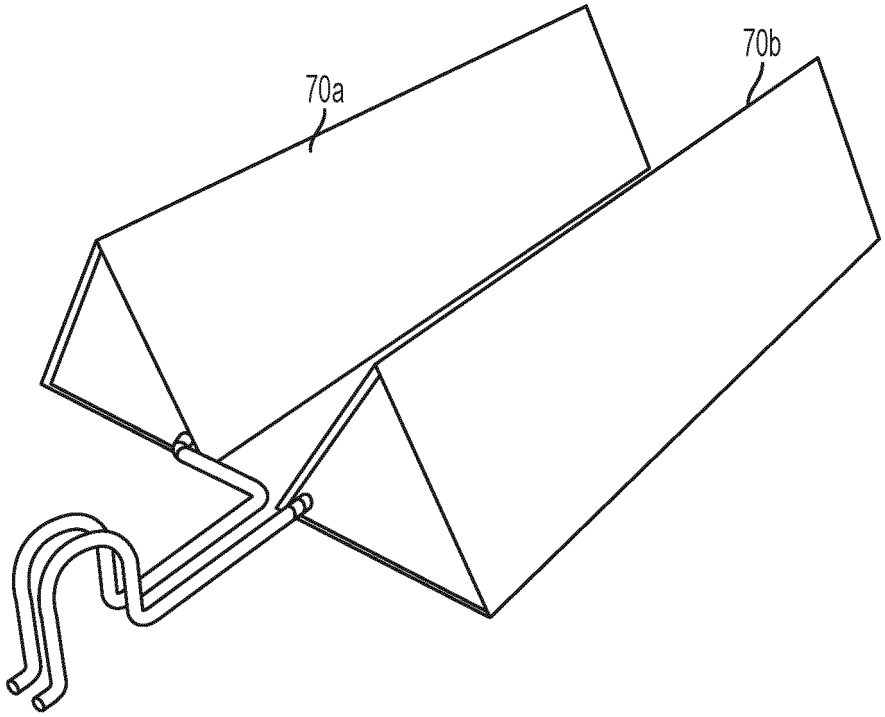


FIG. 8

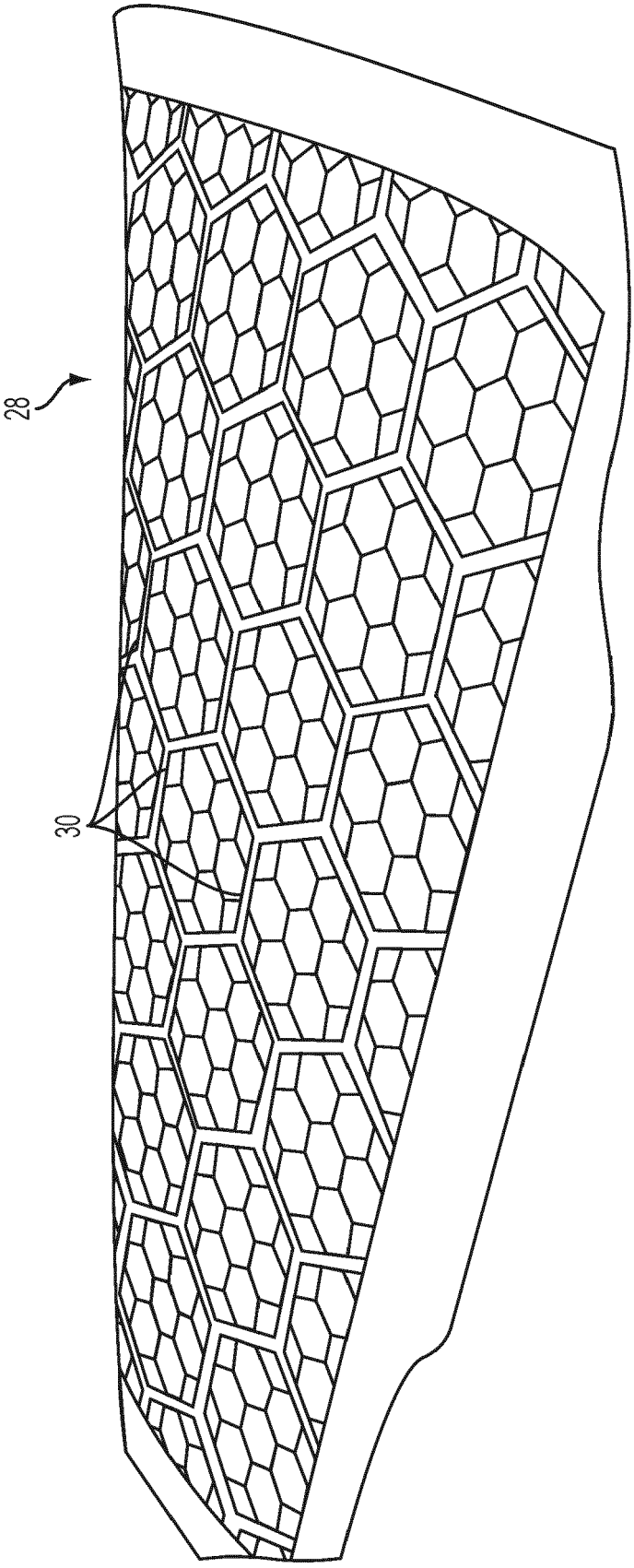


FIG. 9

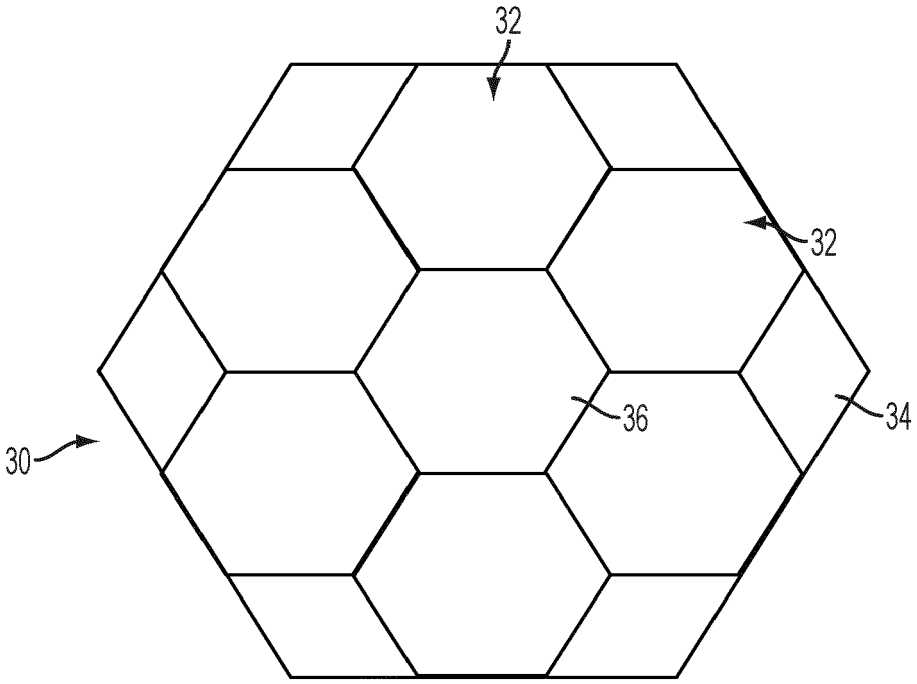


FIG. 9A

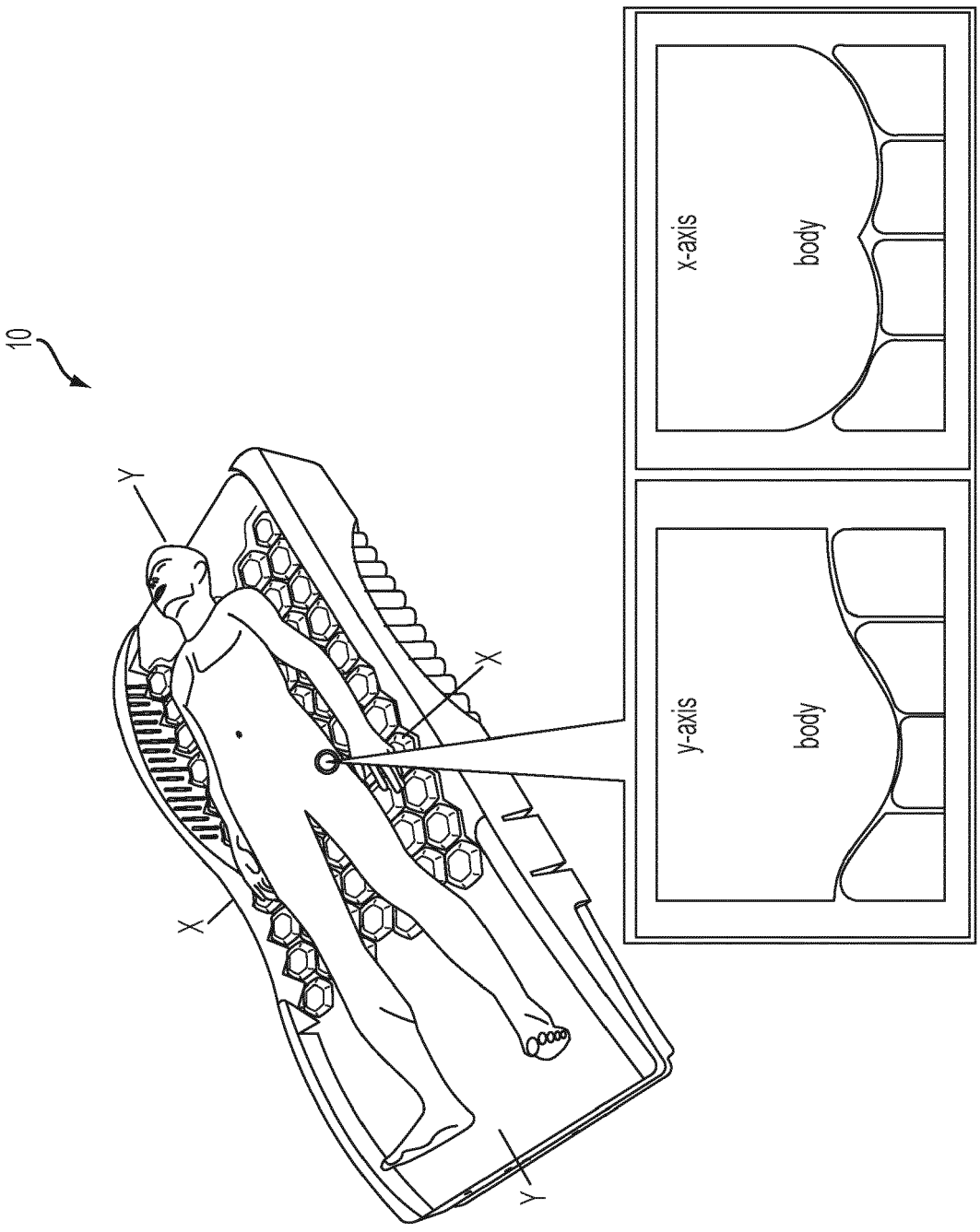


FIG. 10

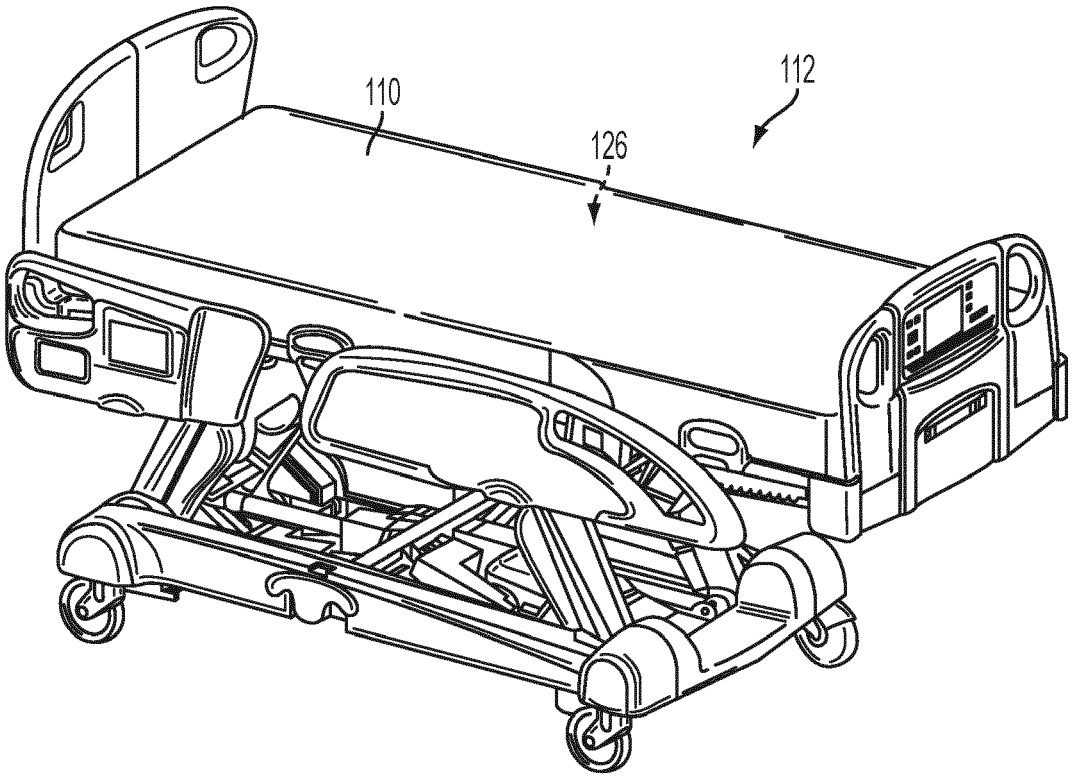
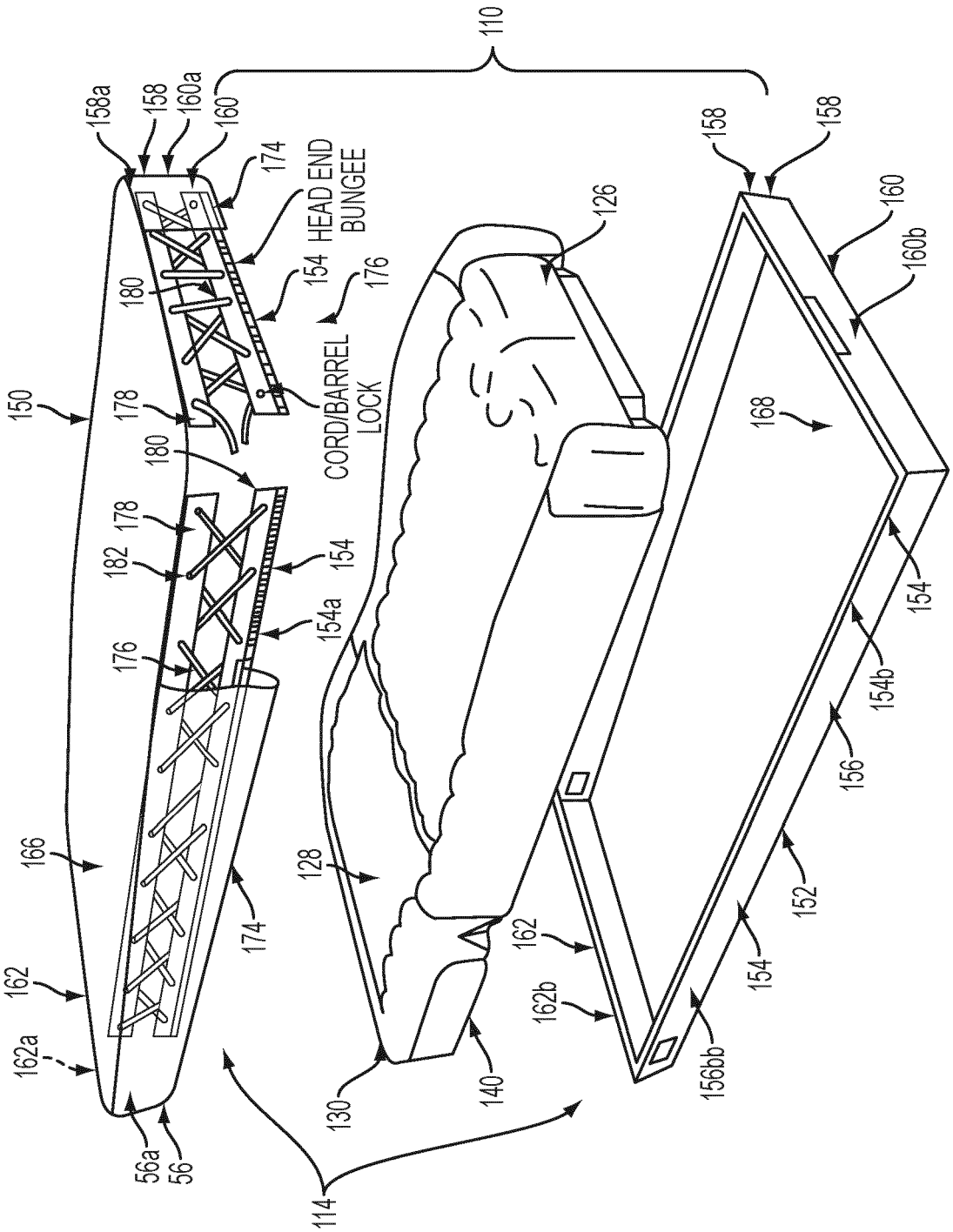


FIG. 11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158a
158
160a
160
174
HEAD END
BUNGEE
154
176
CORD/BARREL
LOCK
180
178
150
182
154a
166
162
162a
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114
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126
162b
156bb
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160b
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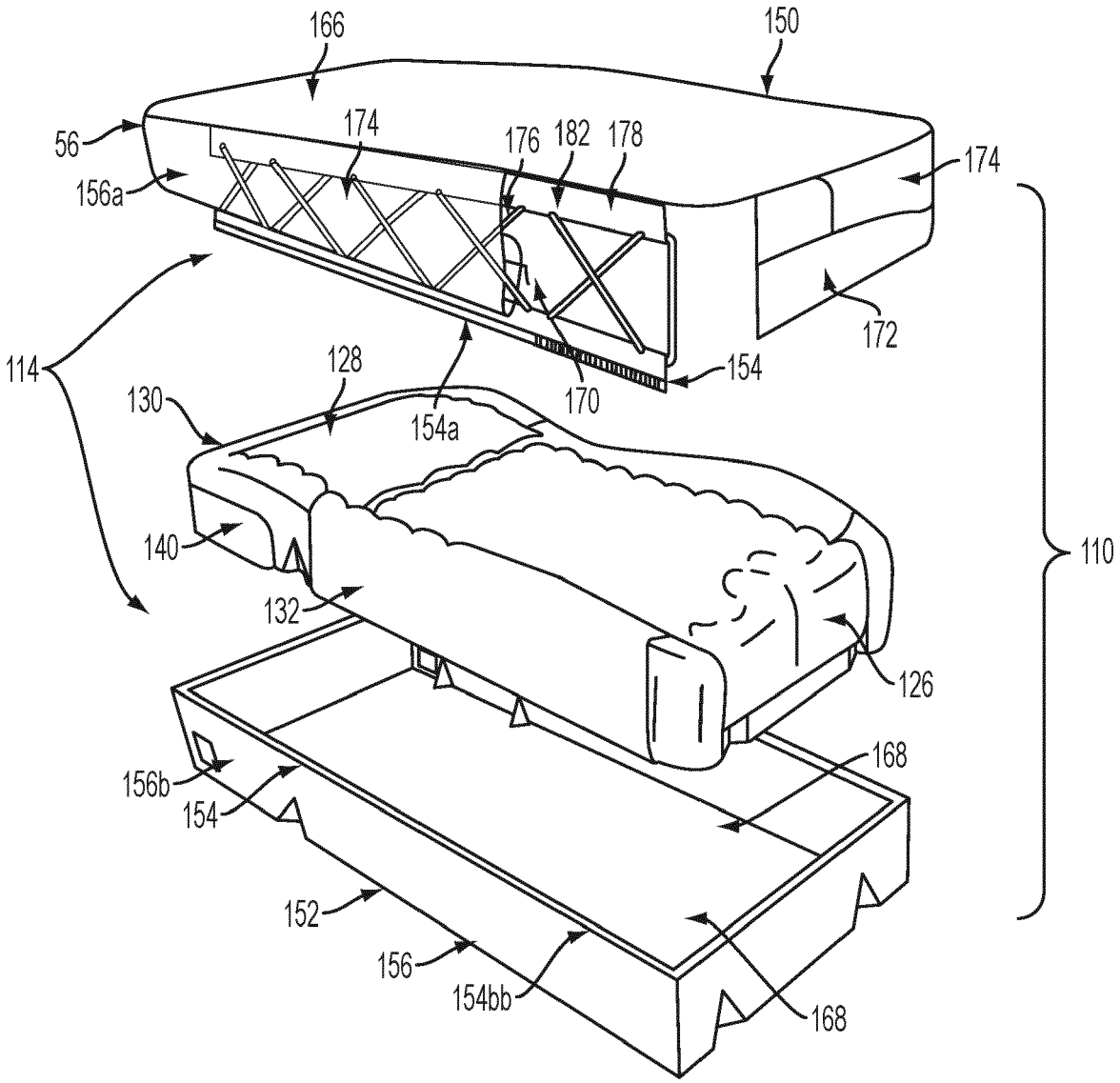
156
152
154

FIG. 12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156b
154
152
156
154bb
168

FIG. 13

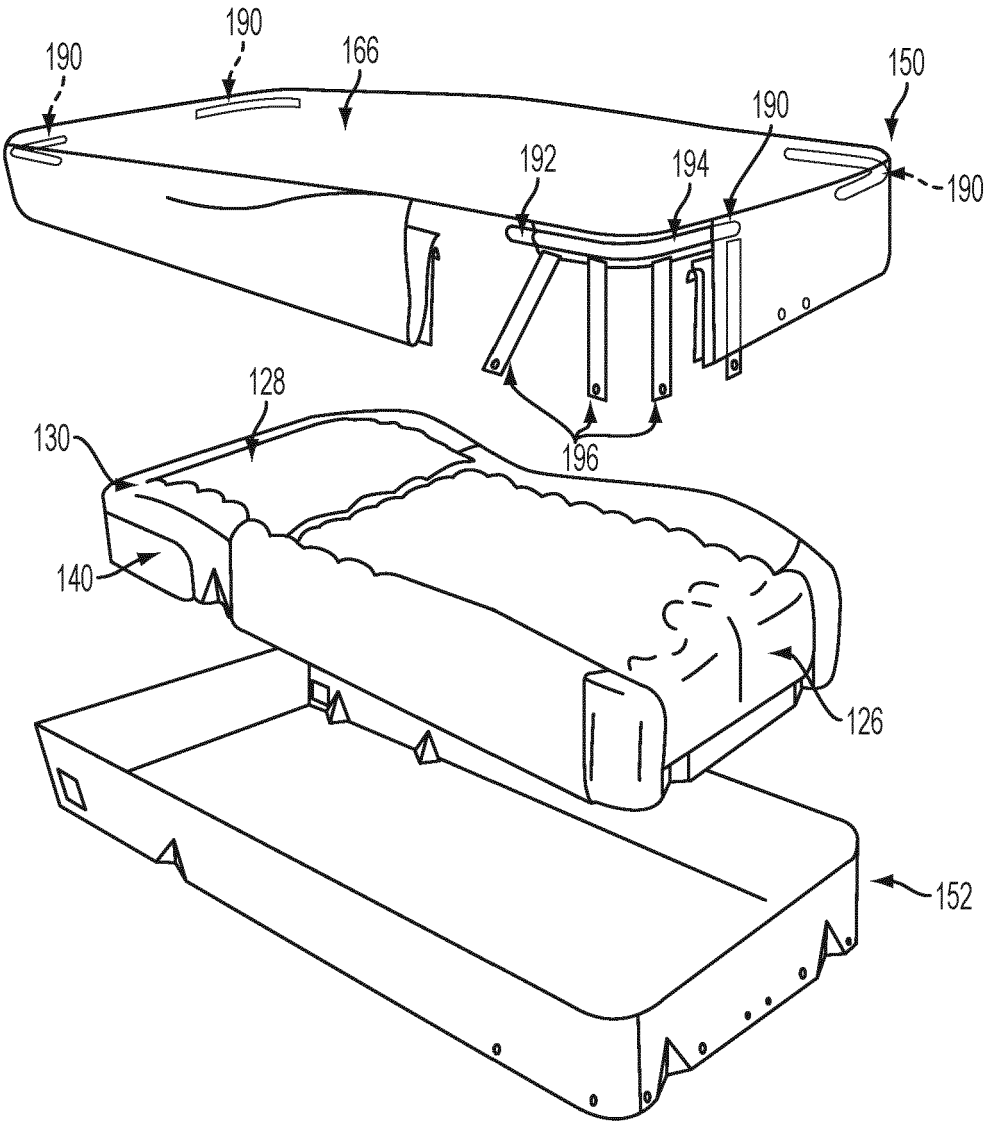


FIG. 14

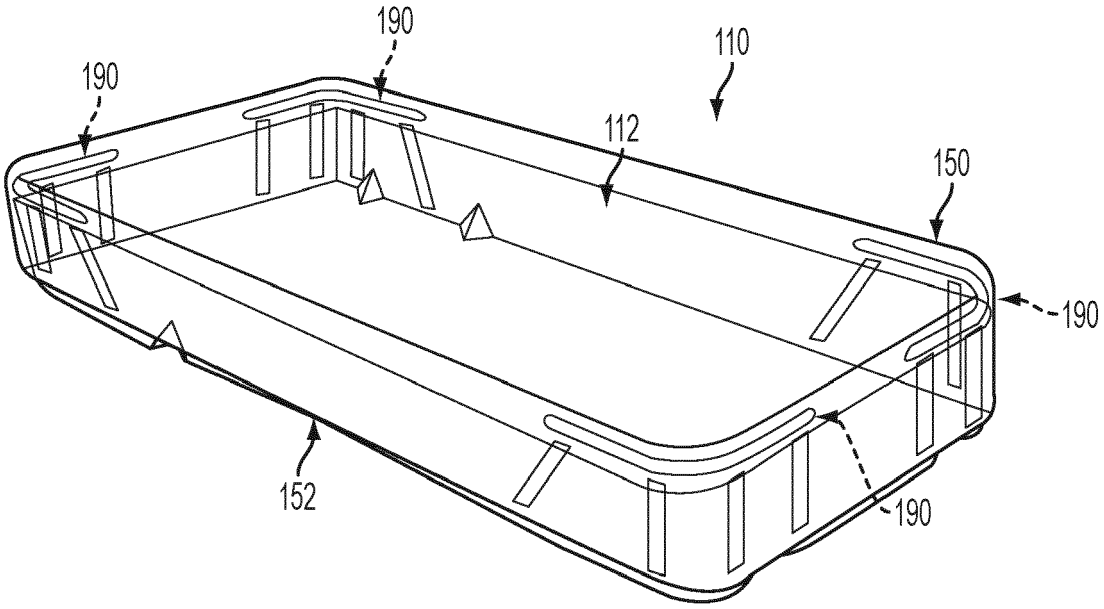


FIG. 15

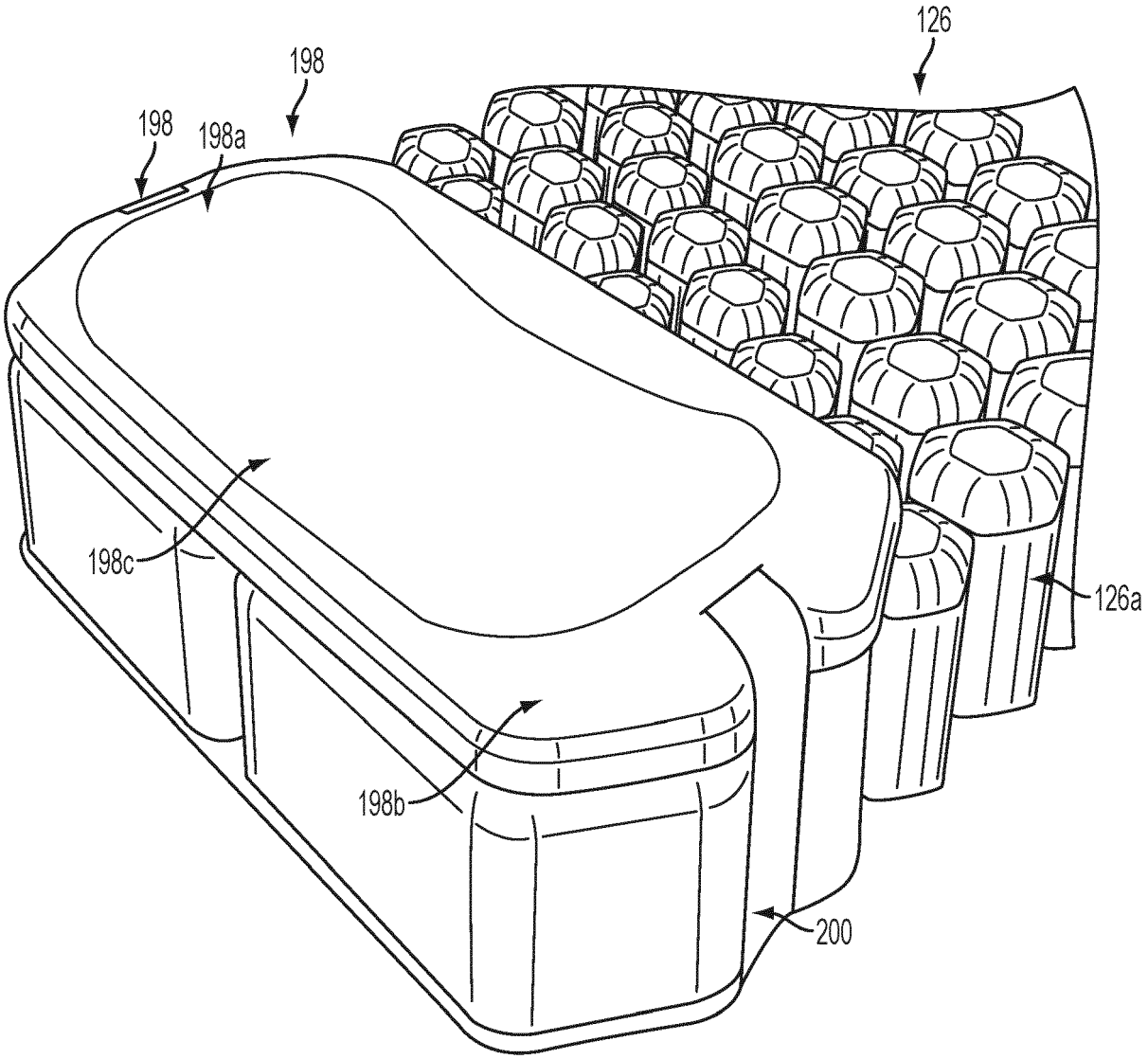


FIG. 16

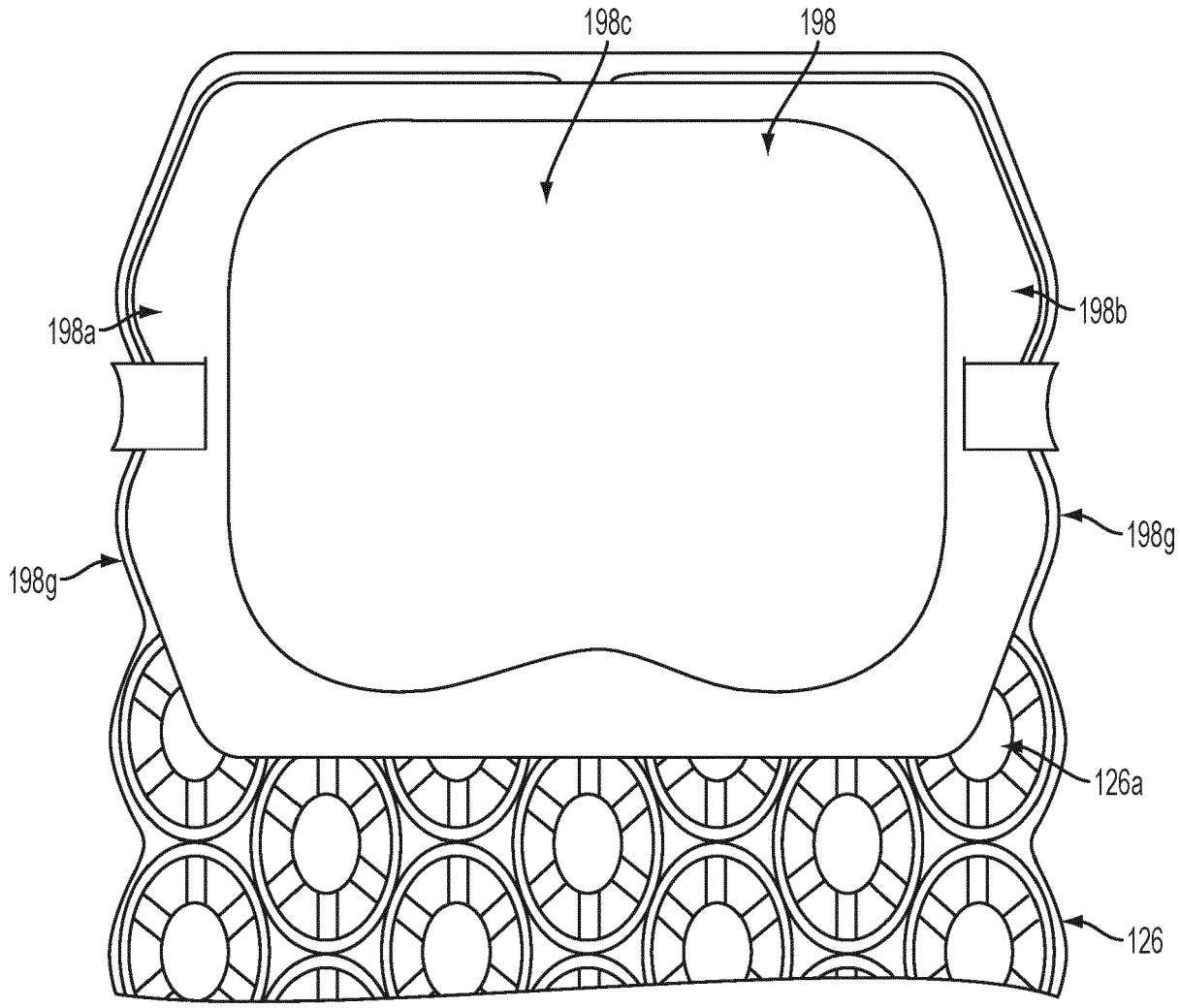


FIG. 17

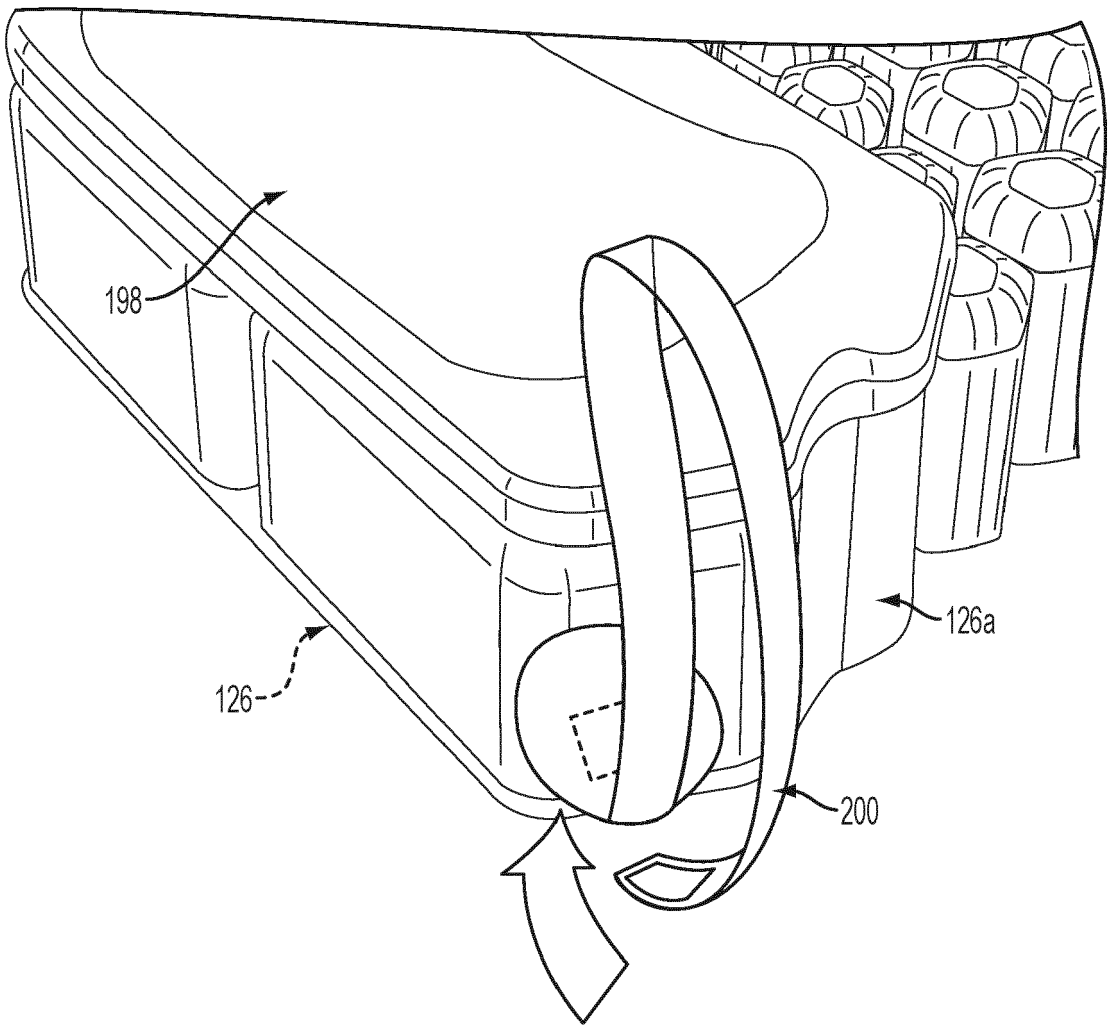


FIG. 18

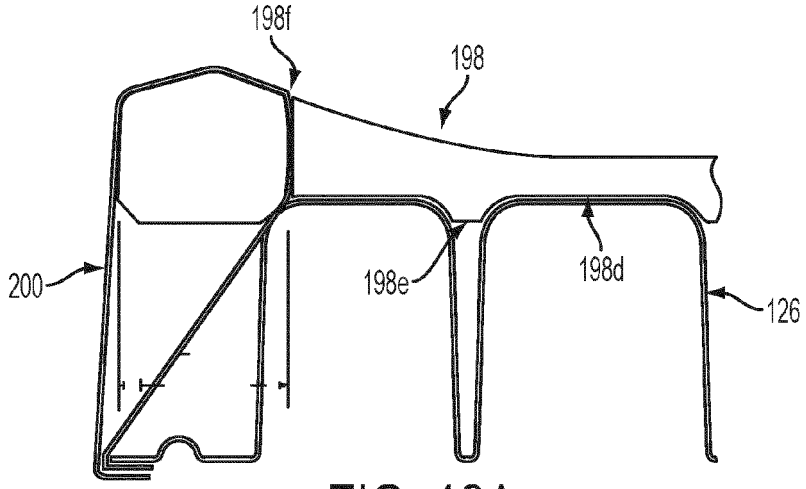


FIG. 19A

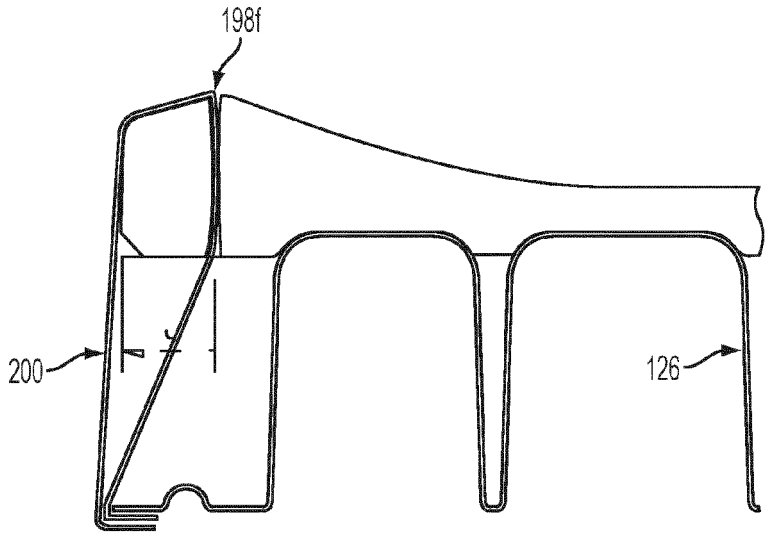


FIG. 19B

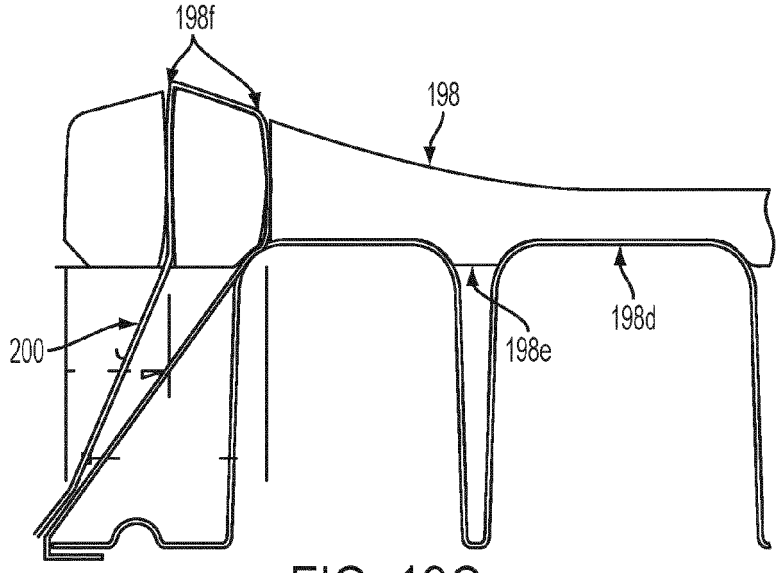


FIG. 19C

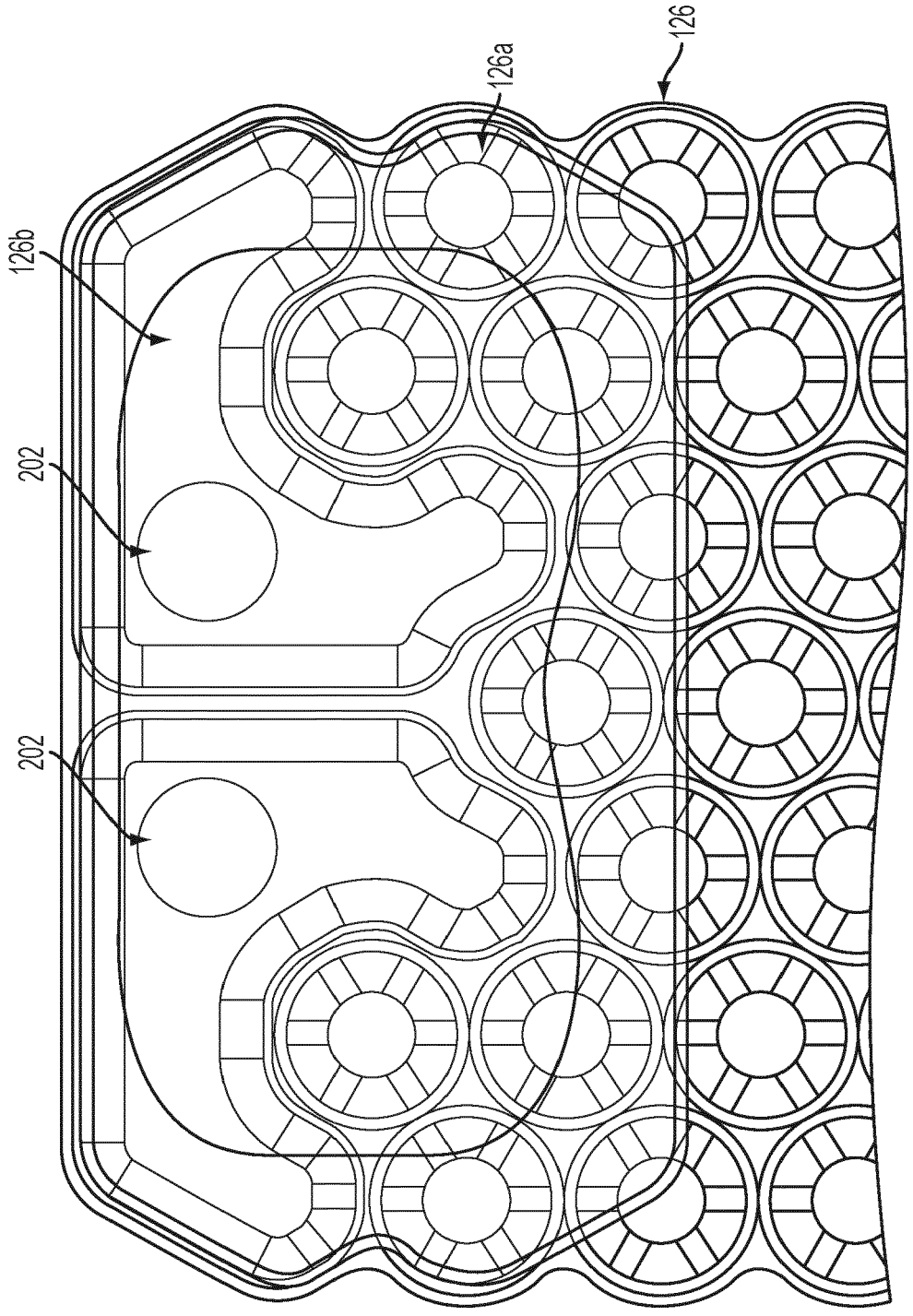


FIG. 19D

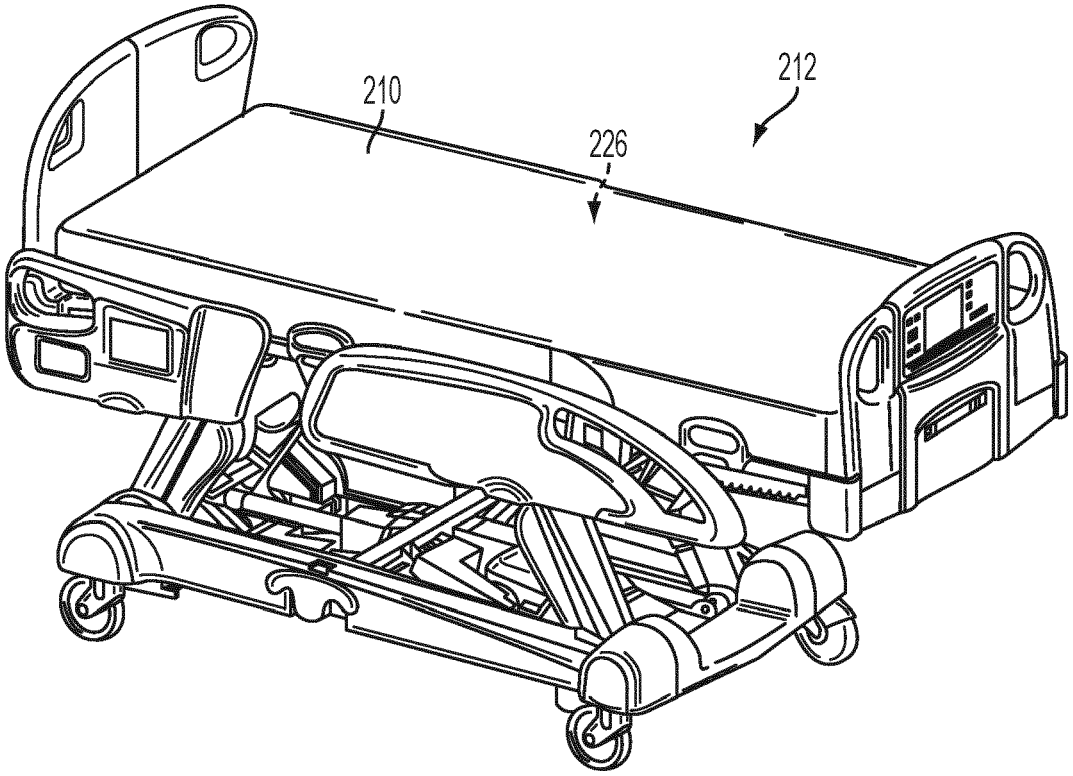


FIG. 20

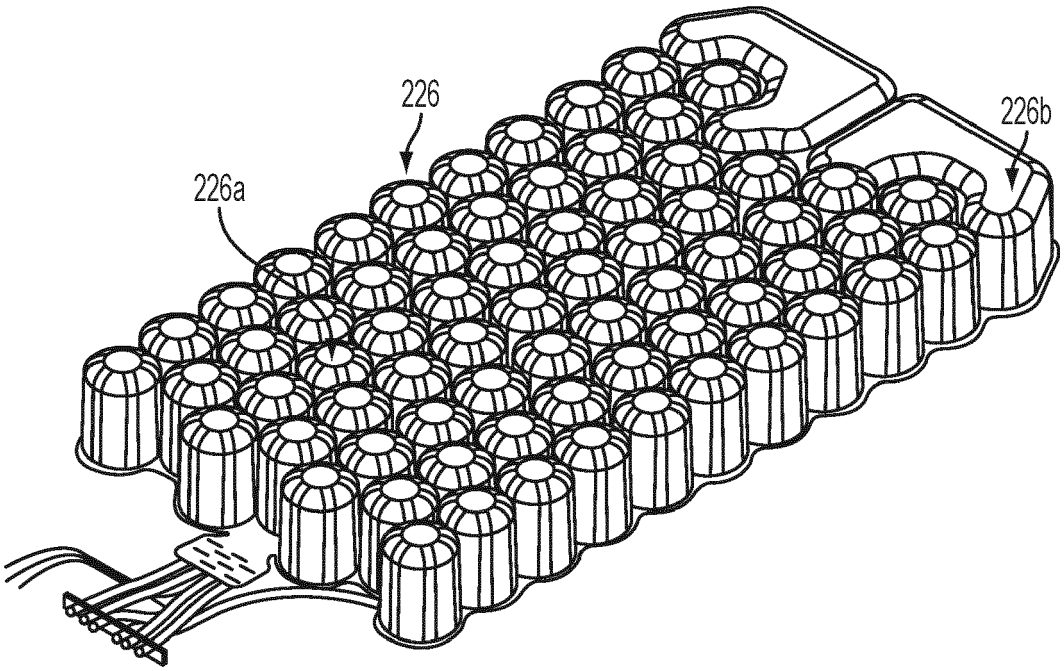


FIG. 20A

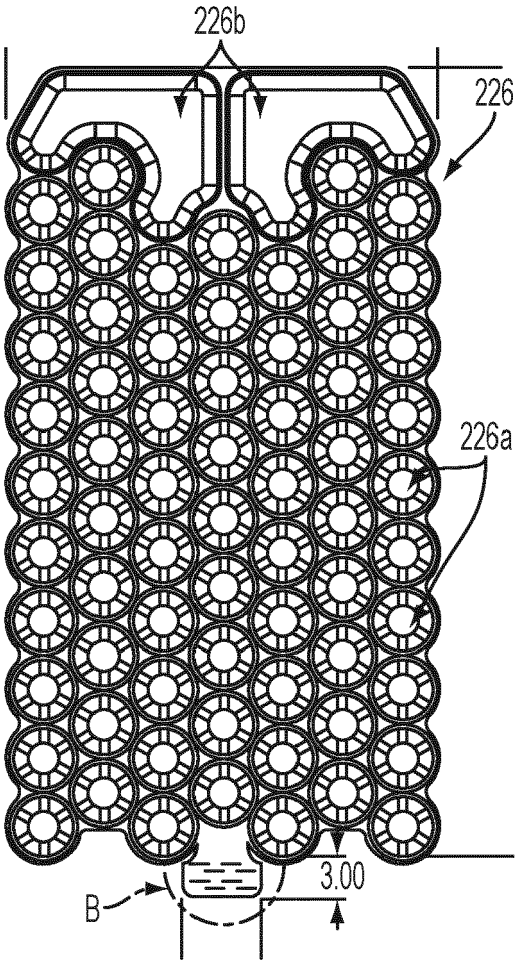


FIG. 21

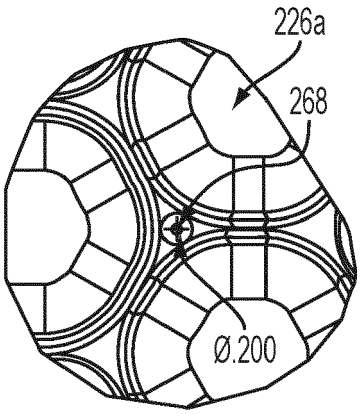


FIG. 21B

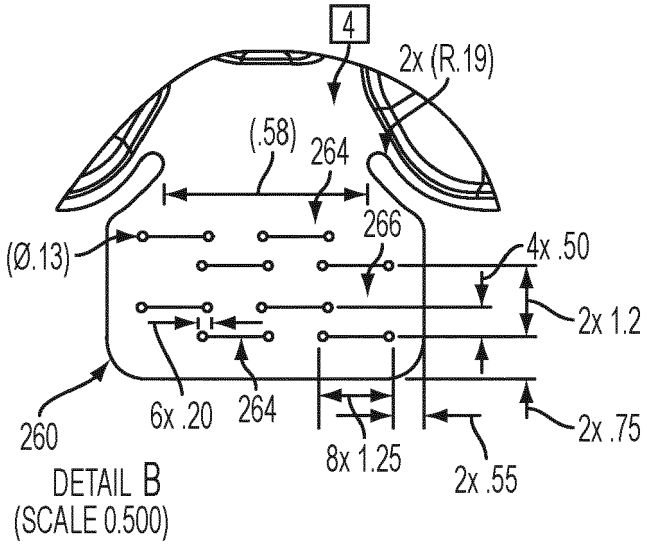


FIG. 21A

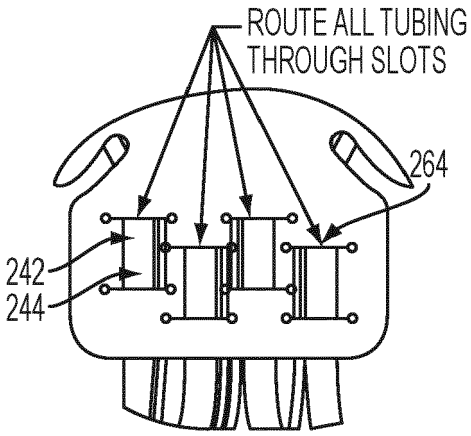
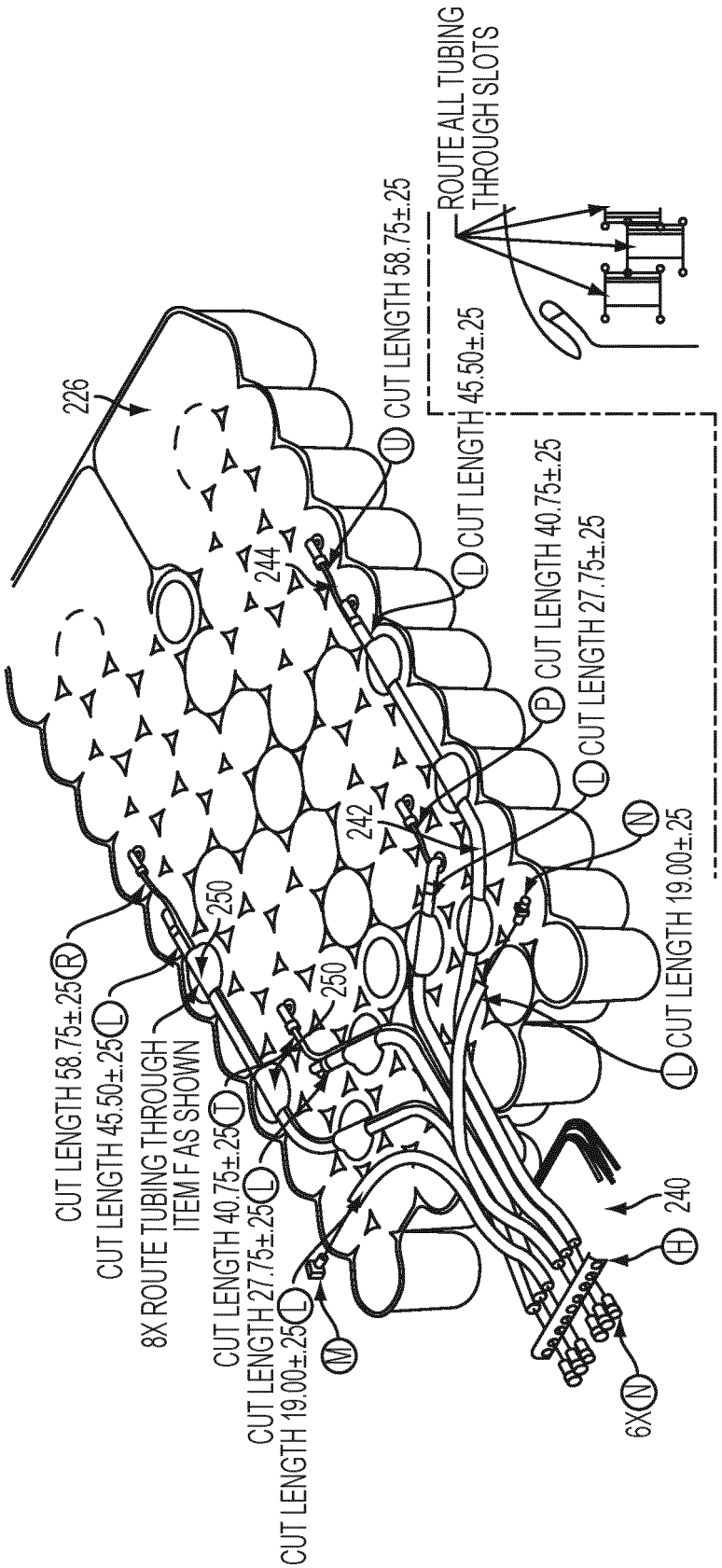


FIG. 21C


226
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CUT LENGTH 45.50±.25 (L)
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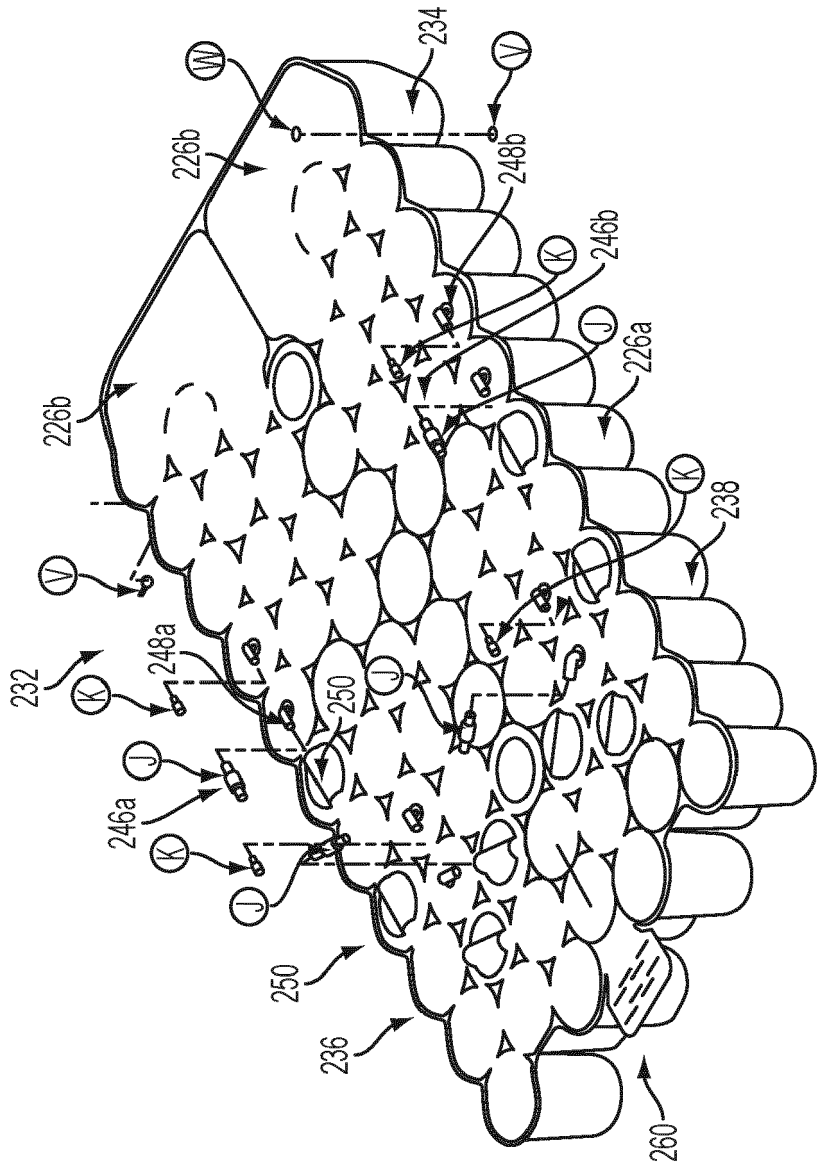
CUT LENGTH 40.75±.25 (T)
CUT LENGTH 27.75±.25 (L)
CUT LENGTH 19.00±.25 (L)
(M)
(U) CUT LENGTH 58.75±.25
(L) CUT LENGTH 45.50±.25
ROUTE ALL TUBING THROUGH SLOTS
(P) CUT LENGTH 40.75±.25
(L) CUT LENGTH 27.75±.25
(N)
(L) CUT LENGTH 19.00±.25
(H)
6X (N)

FIG. 22


234
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248b
246b
K
J
226a
226b
K
238
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248a
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J
246a
K
J
250
236
260

FIG. 23

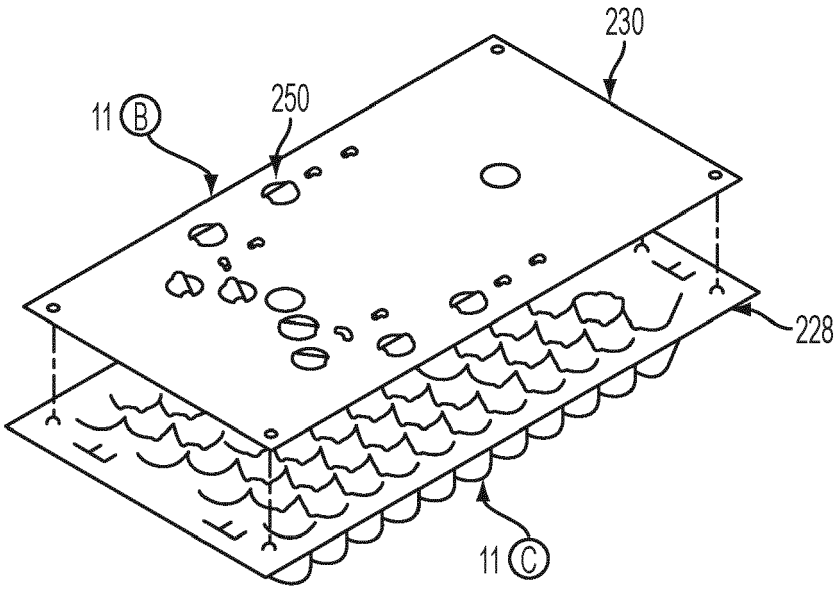

FIG. 24

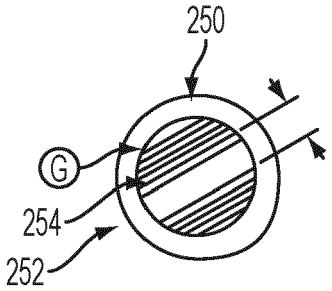

FIG. 25

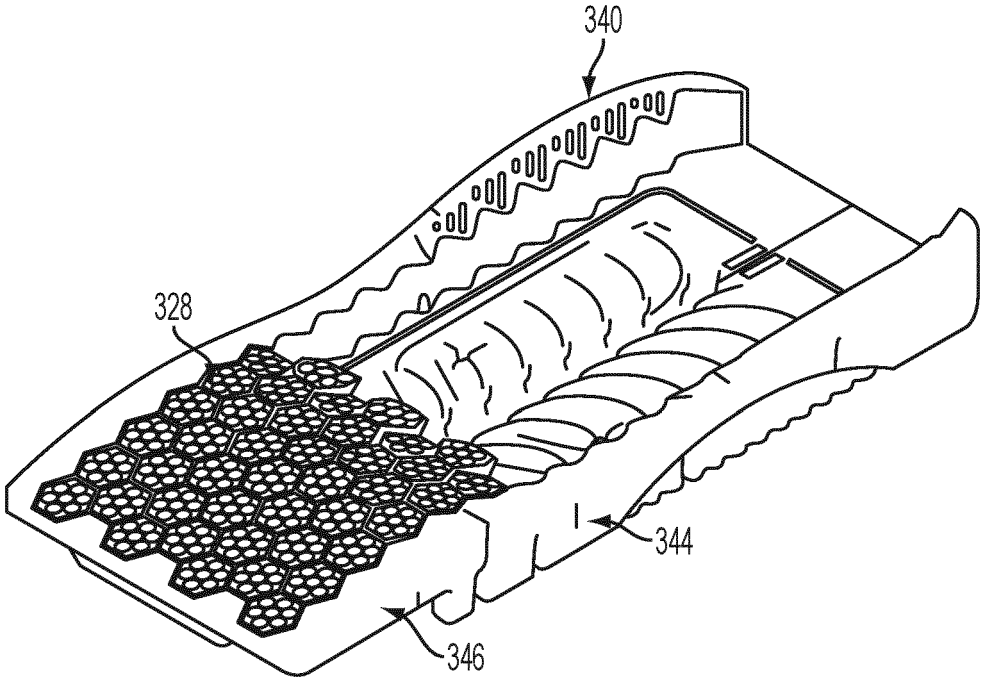

FIG. 26

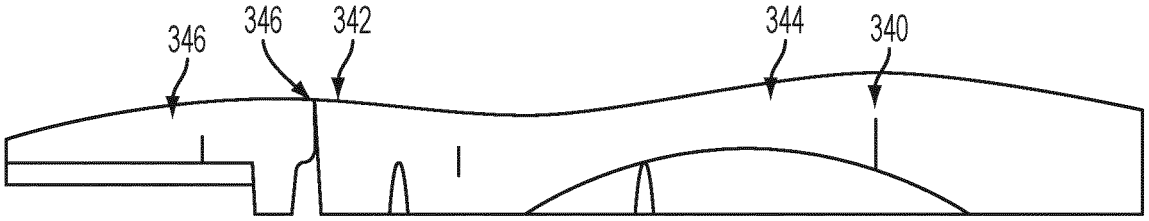

FIG. 27

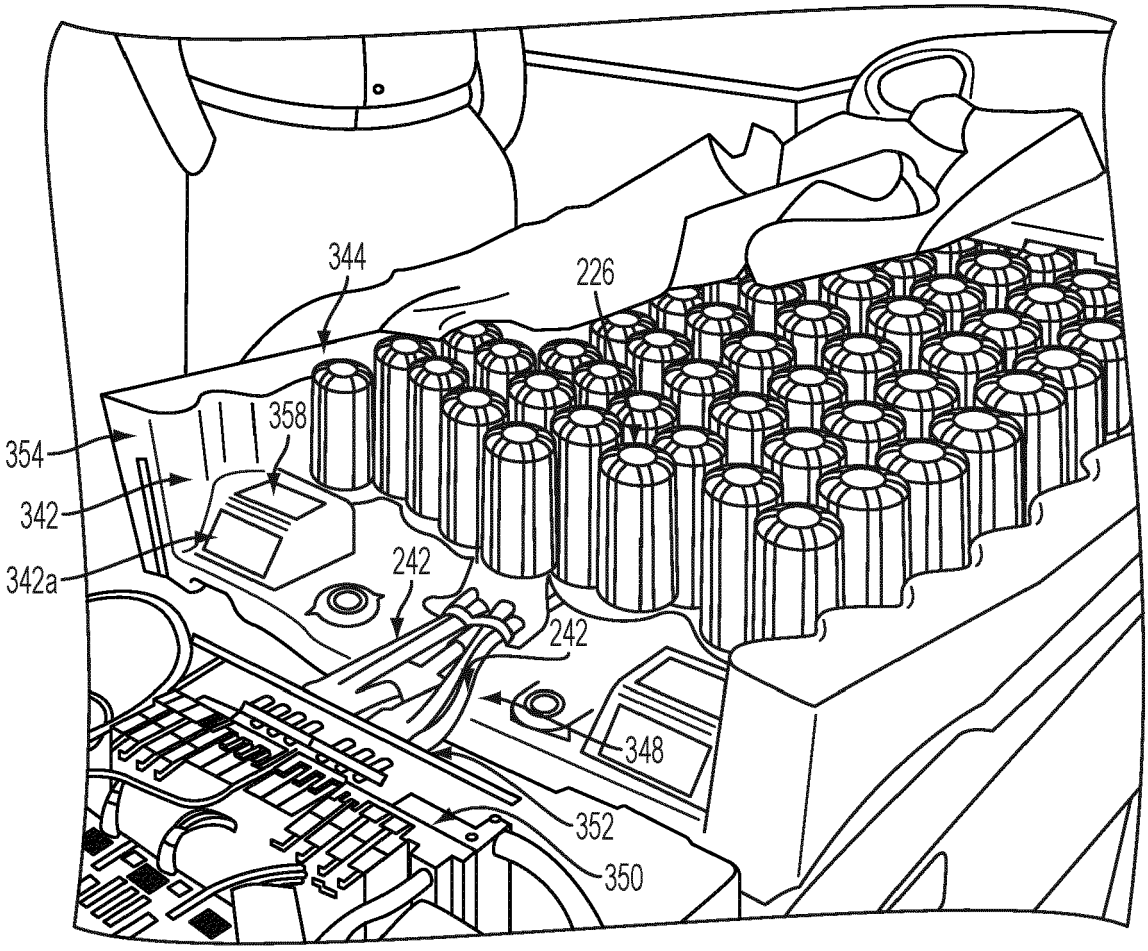

FIG. 28

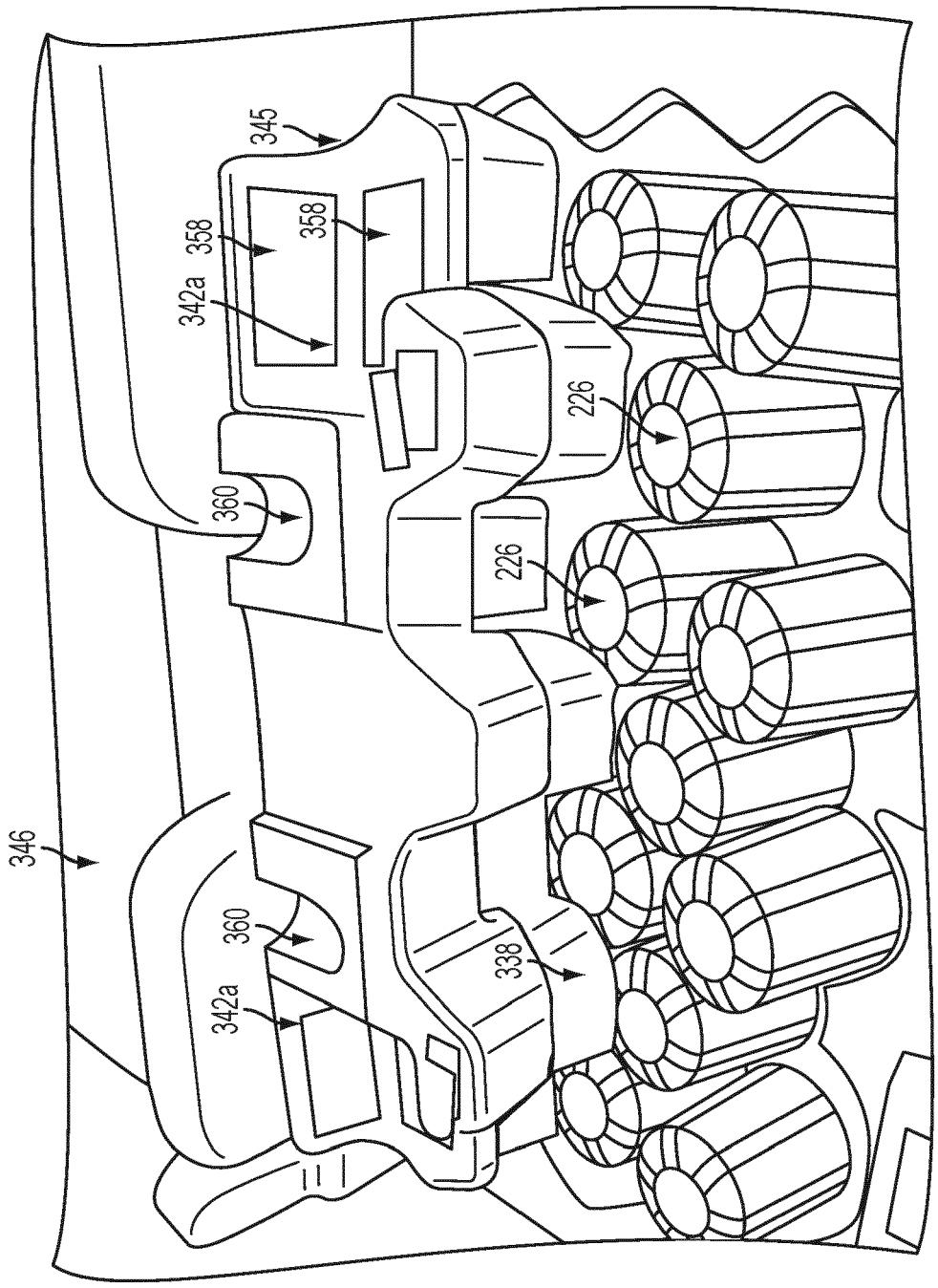

FIG. 29

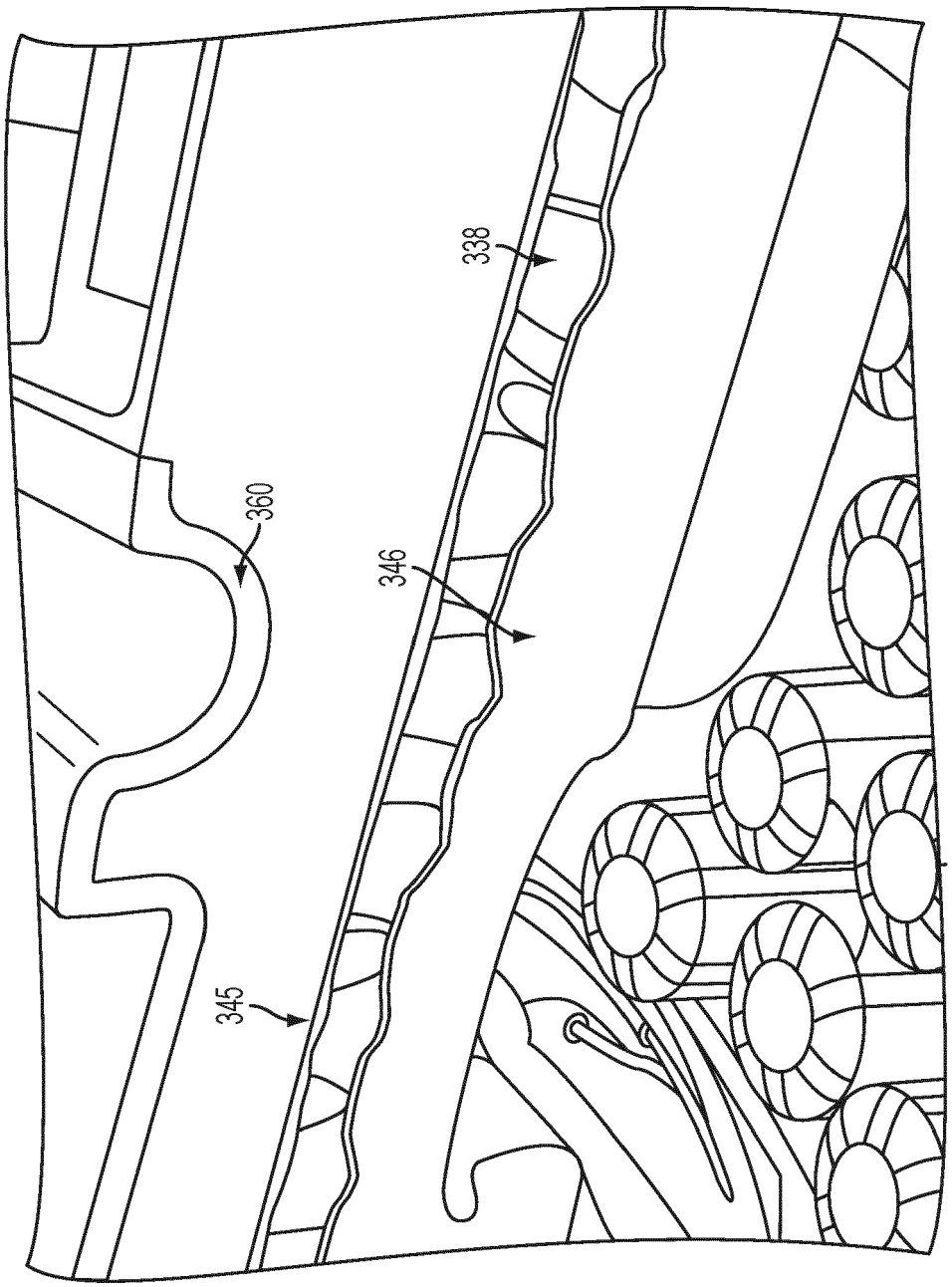

FIG. 30

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EUROPEAN SEARCH REPORT

Application Number
EP 20 17 3041

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A61G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 January 2021	Mammeri, Damya

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