

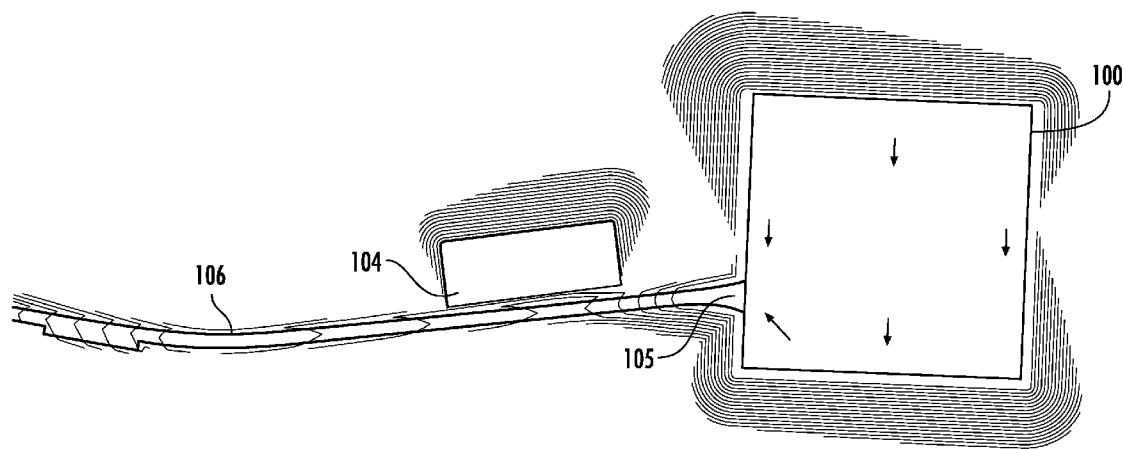


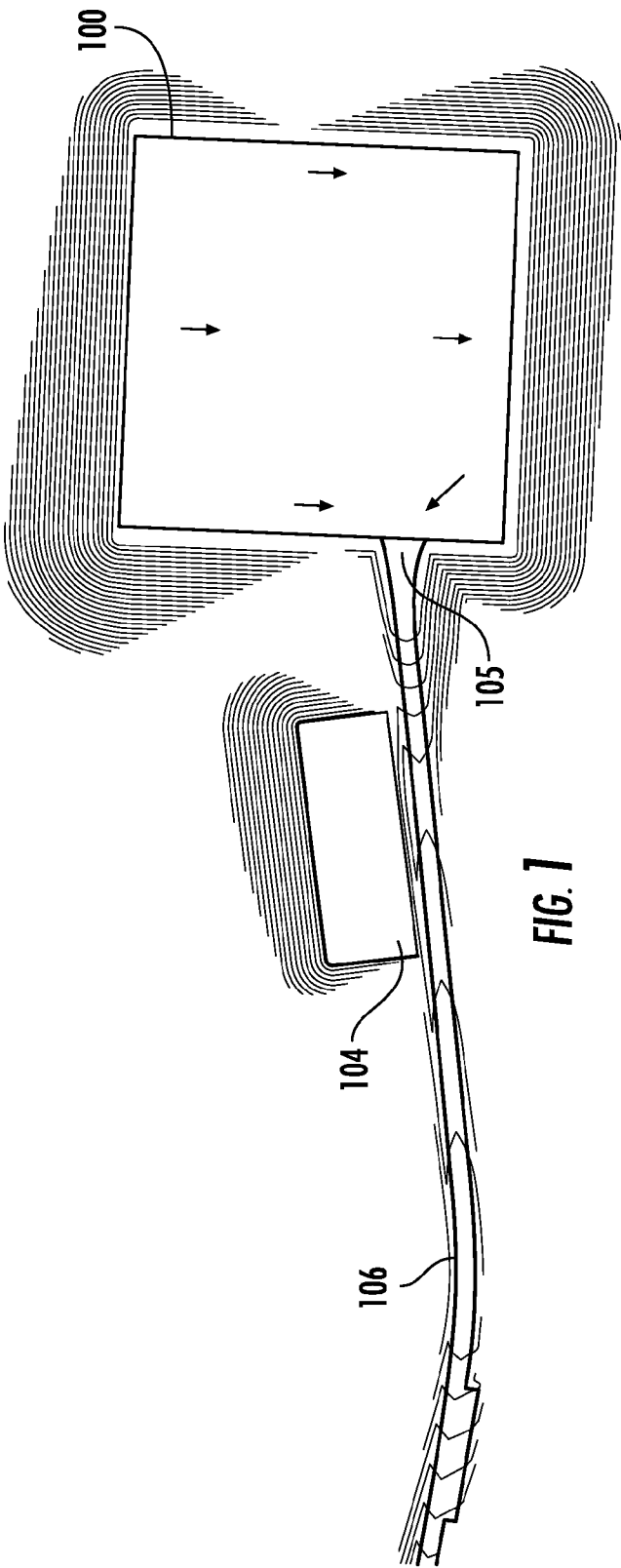
US 20140248085A1

(19) **United States**(12) **Patent Application Publication**
Zajicek et al.(10) **Pub. No.: US 2014/0248085 A1**(43) **Pub. Date: Sep. 4, 2014**(54) **MODULAR, SCALABLE, PORTABLE AND
REUSABLE PRIMARY AND SECONDARY
SPILL CONTAINMENT LINING SYSTEMS
AND METHOD OF ASSEMBLING, SHIPPING
AND INSTALLING SUCH SYSTEMS**(52) **U.S. Cl.**
CPC **E02D 31/004** (2013.01)
USPC **405/129.75**; 29/428(71) Applicant: **Penda Corporation**, Portage, WI (US)(72) Inventors: **Jason D. Zajicek**, Portage, WI (US);
Heidi J. Bulgrin, Portage, WI (US);
Anthony C. Wangelin, DeForest, WI
(US)(21) Appl. No.: **14/213,097**(22) Filed: **Mar. 14, 2014****Related U.S. Application Data**(63) Continuation-in-part of application No. 13/598,846,
filed on Aug. 30, 2012.(60) Provisional application No. 61/789,545, filed on Mar.
15, 2013, provisional application No. 61/529,167,
filed on Aug. 30, 2011.**Publication Classification**(51) **Int. Cl.**
E02D 31/00 (2006.01)(57) **ABSTRACT**

A distribution assembly and associated system for assembling, shipping, and installing a modular, scalable primary or secondary spill containing lining system is provided.

The system includes a method of assembling, shipping and installing a modular, scalable containment lining system for an industrial site including the steps of coupling together a plurality of panels to form a reel of panels, which may include side wall panels and corner panels, rolling the reel of panels about at least one core to form a wound reel of panels, placing at least one wound reel of panels upon a transportation vehicle, transporting the at least one wound reel of panels to an installation site, unloading the at least one wound reel of panels from the transportation vehicle, positioning the at least one wound reel of panels at a desired location at the installation site, and unrolling the at least one wound reel of panels at the desired location at the installation site. In a reel of panels including base panels, wall panels and corner panels the system includes the further steps of raising the wall panels and folding and attaching the corner panels to the wall panels, and buttressing the wall panels to provide a secondary containment facility for retaining a depth of liquid.





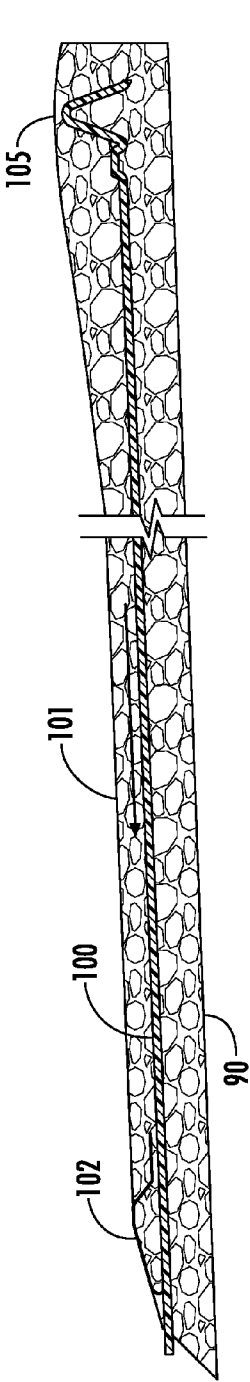


FIG. 2

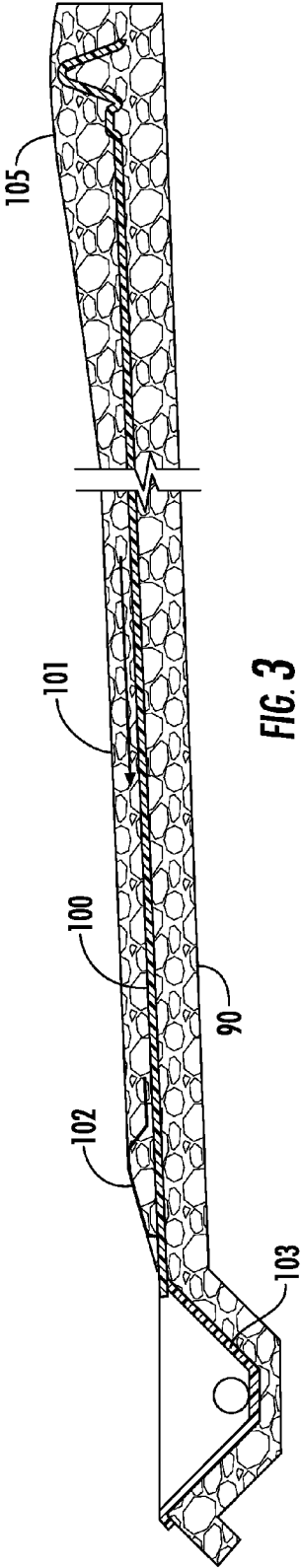
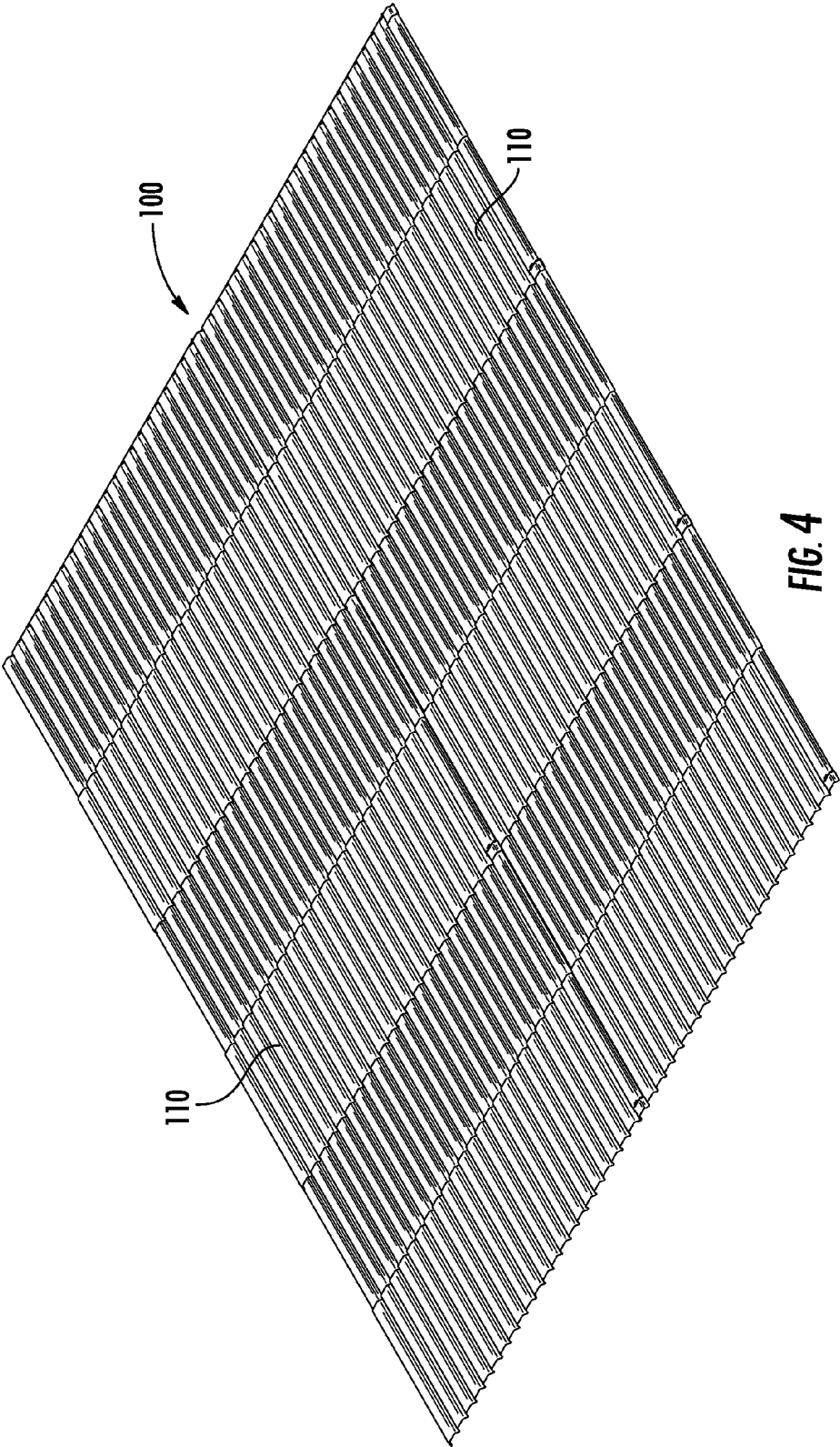
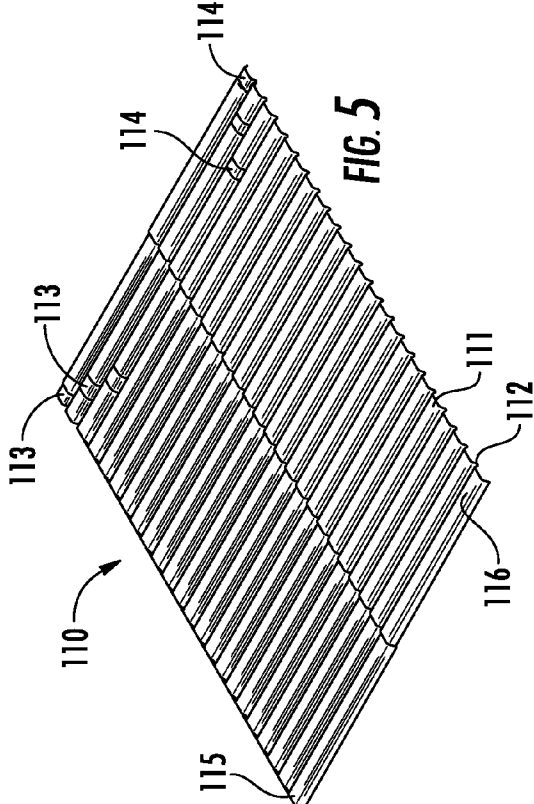
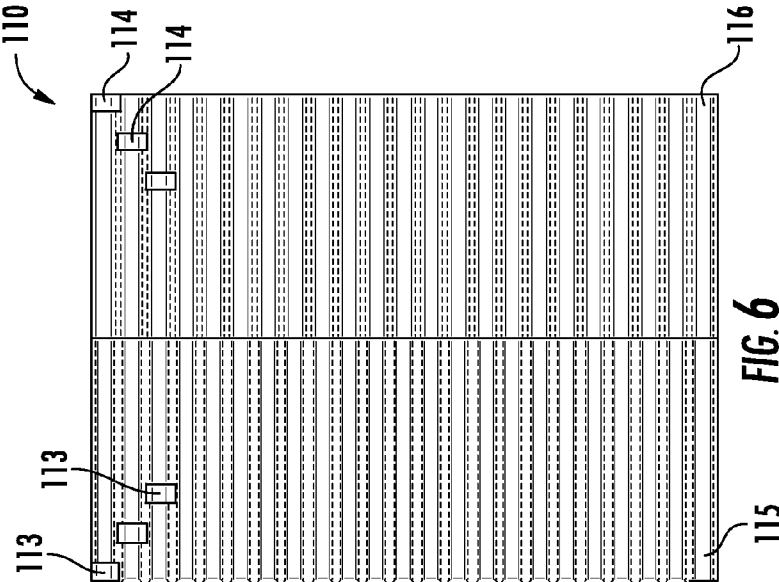
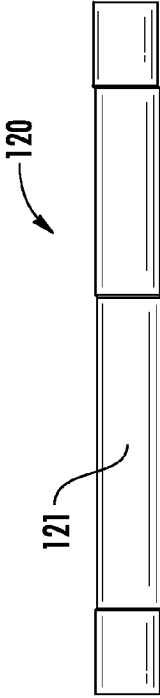
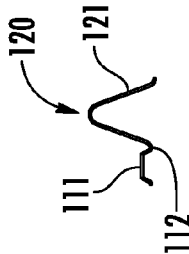
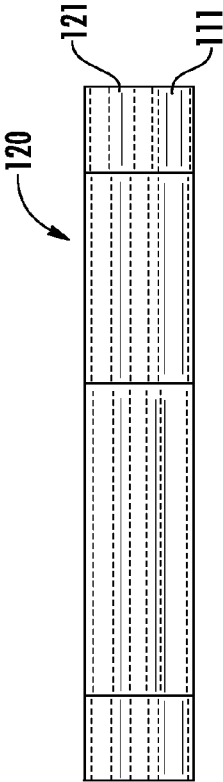
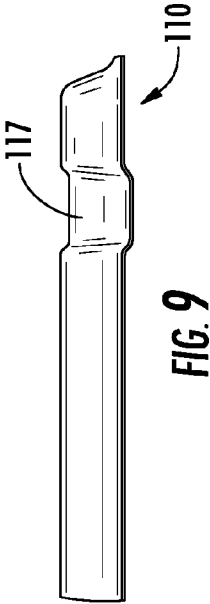
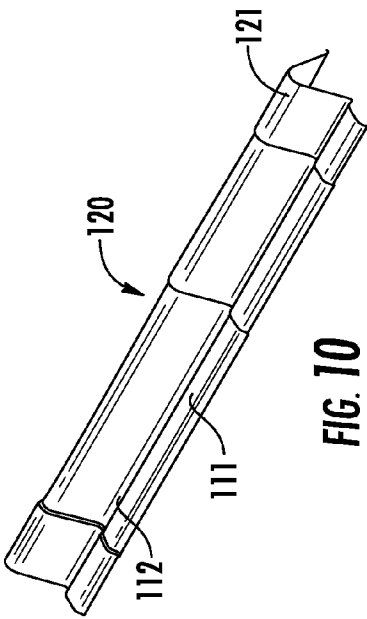


FIG. 3







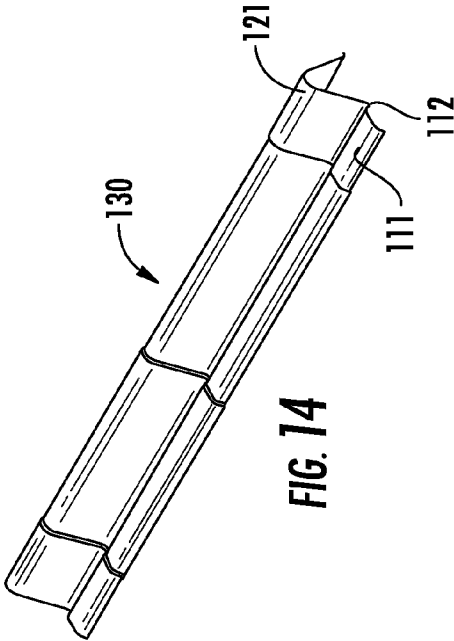


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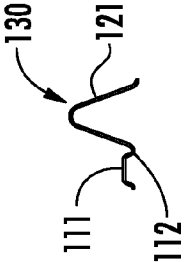


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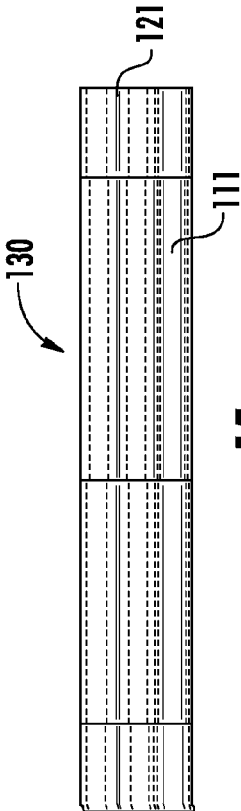


FIG. 15

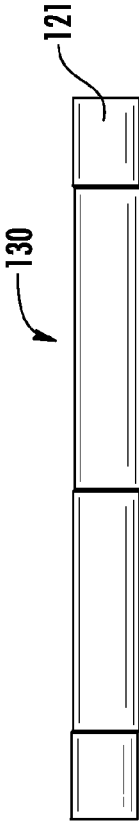


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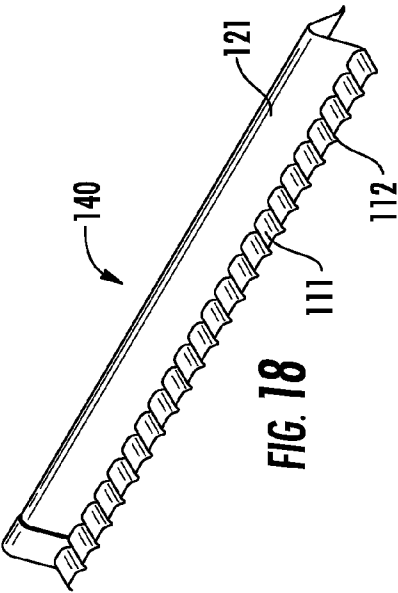


FIG. 18

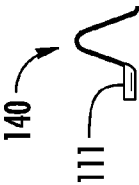


FIG. 21

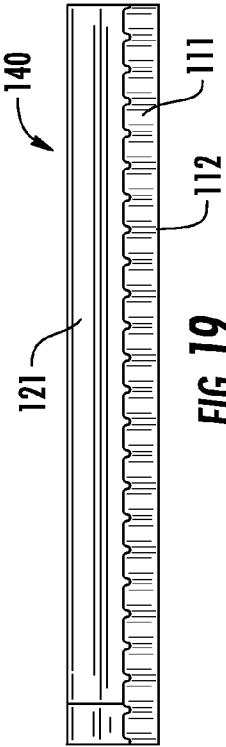


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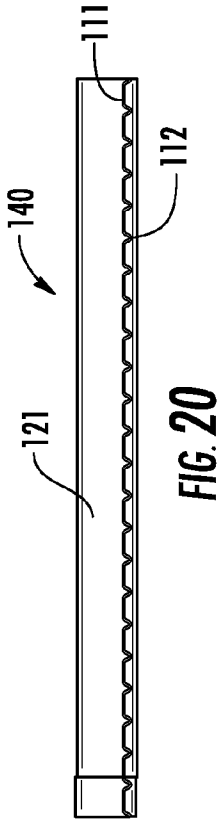
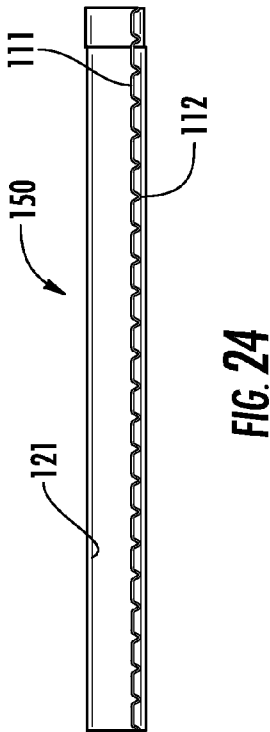
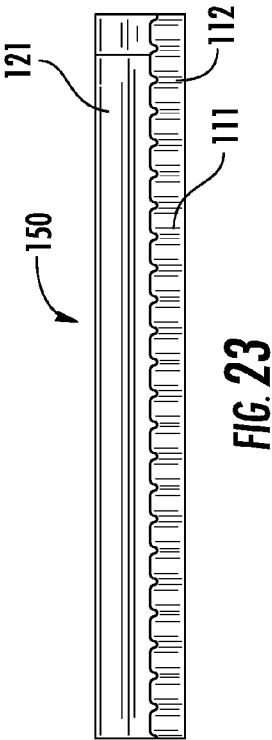
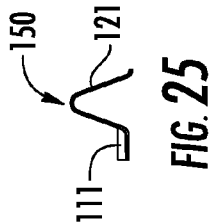
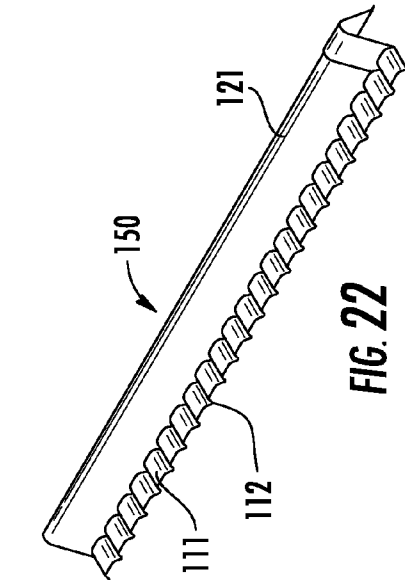


FIG. 20



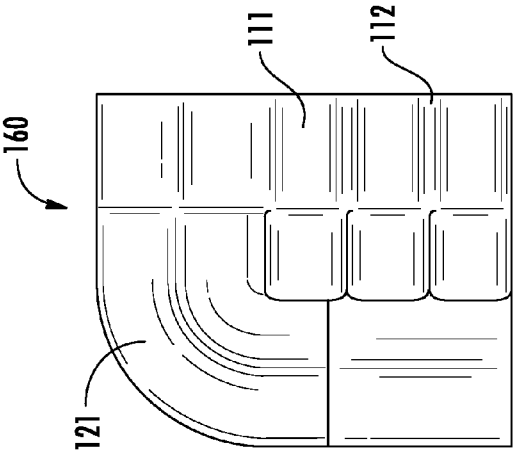


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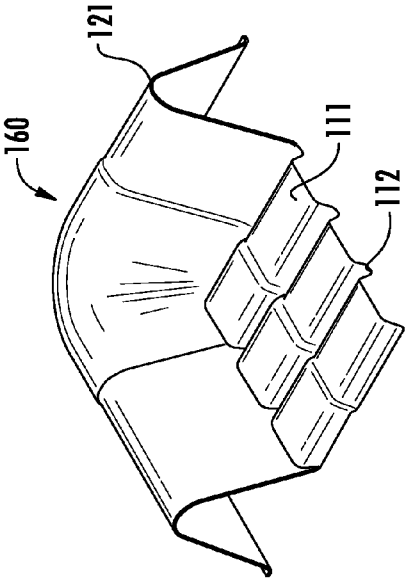


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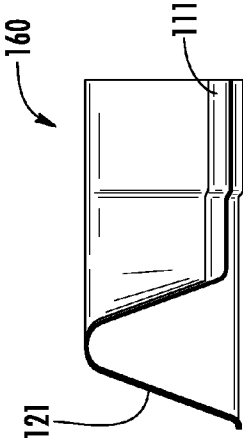


FIG. 28

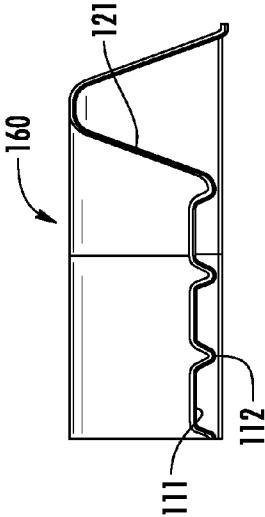


FIG. 29

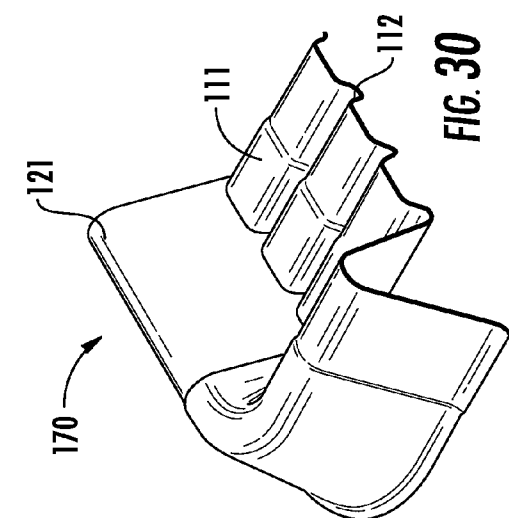


FIG. 30

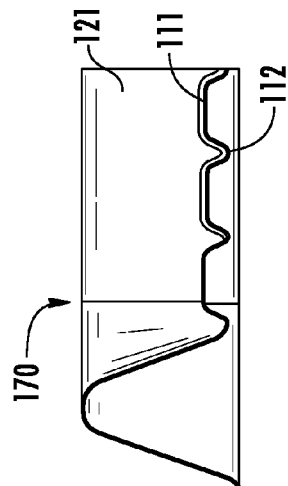


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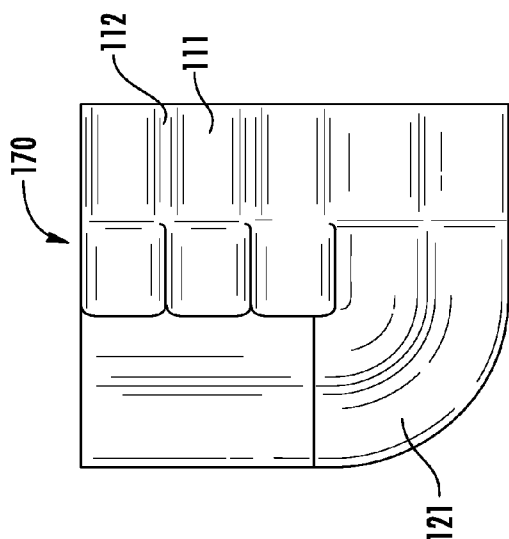


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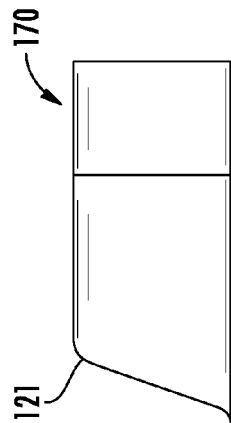


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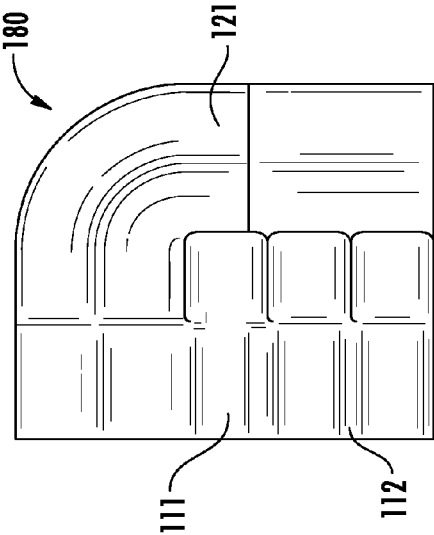


FIG. 35

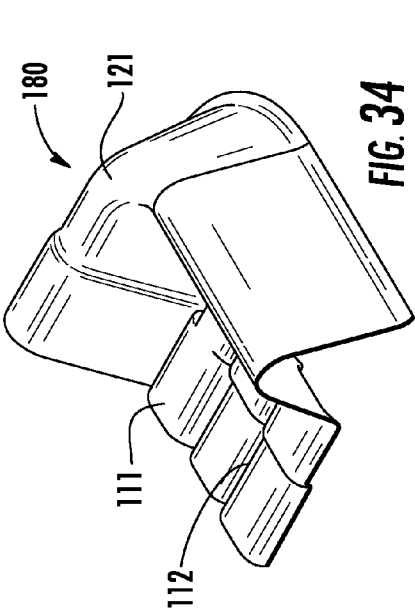


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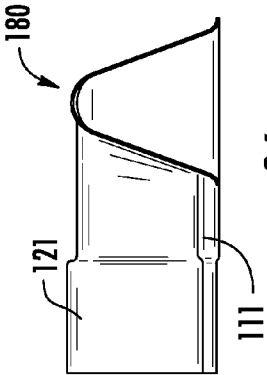


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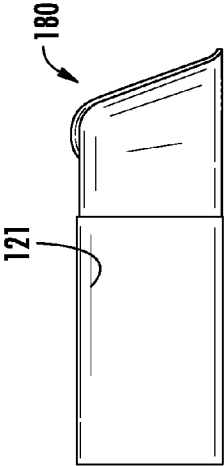


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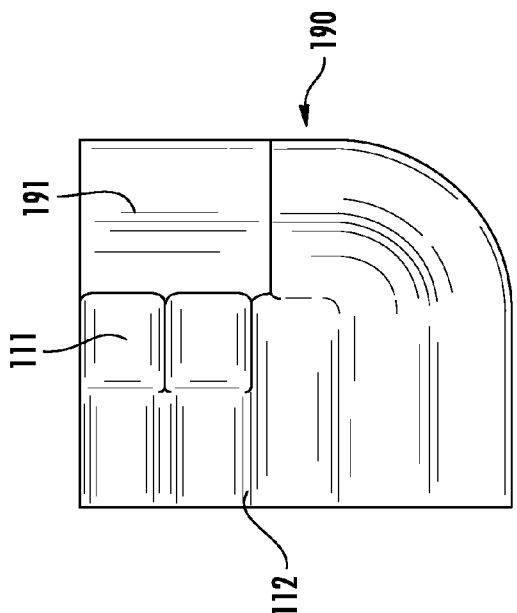


FIG. 39

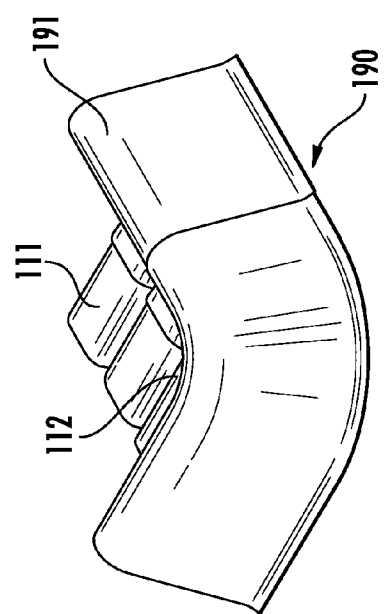


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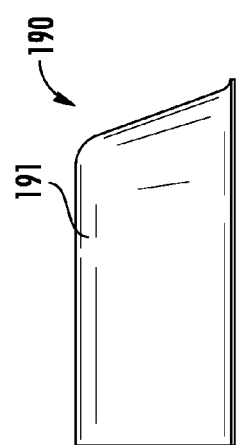


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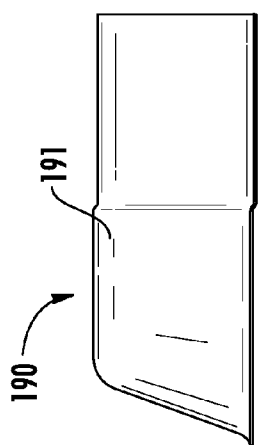
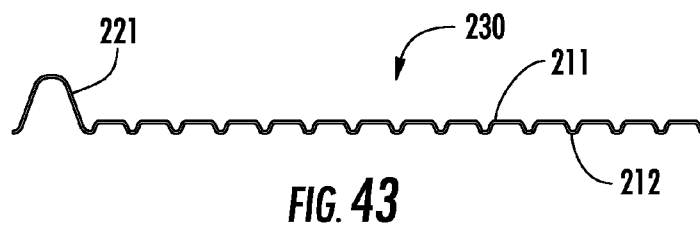
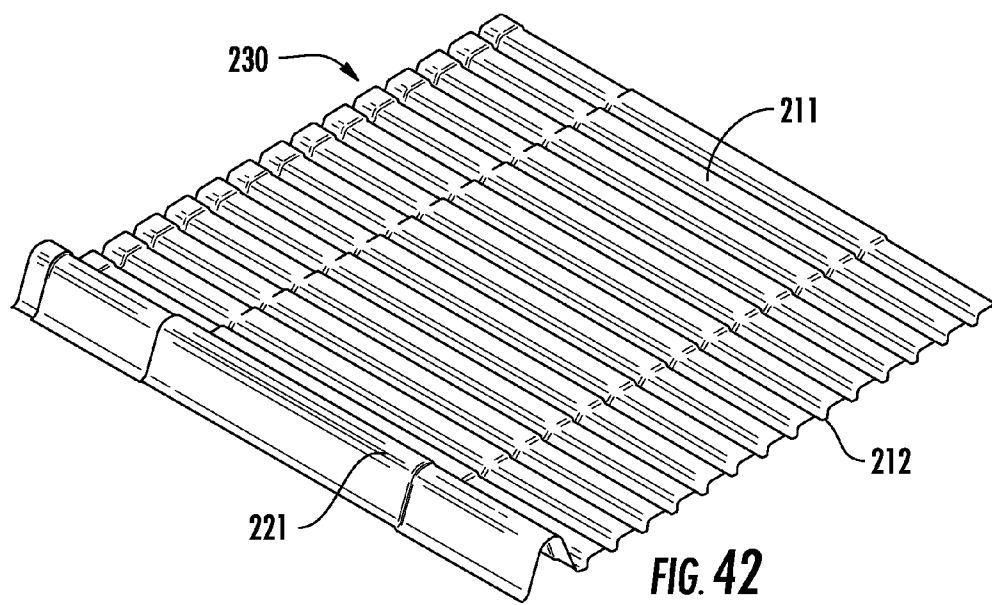
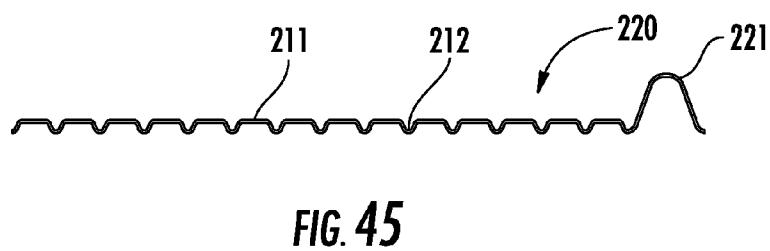
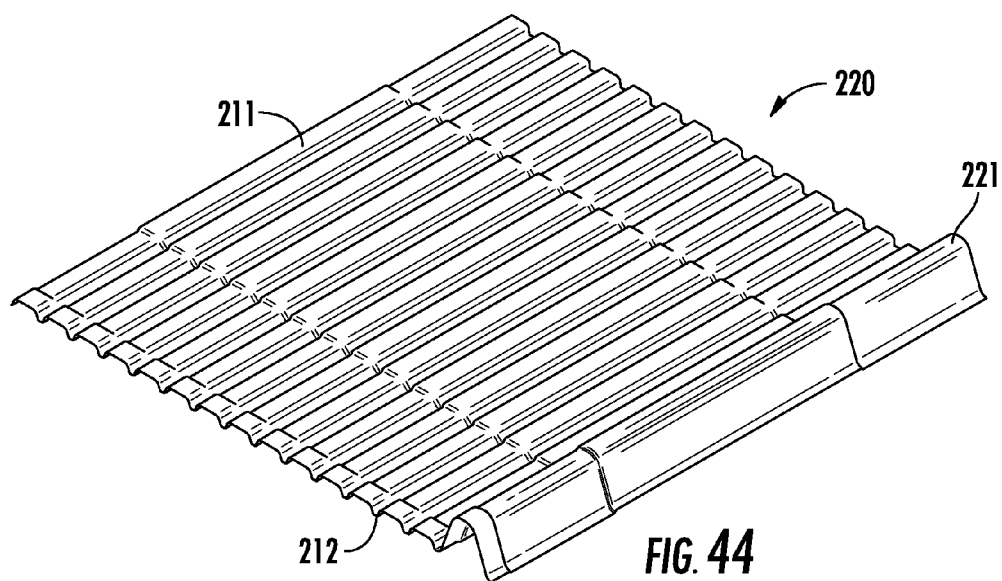
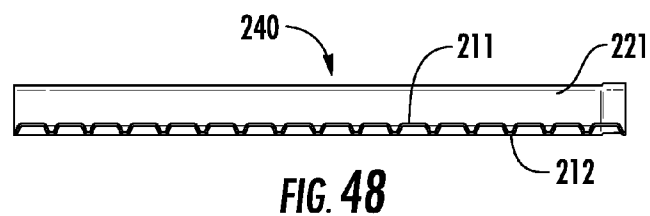
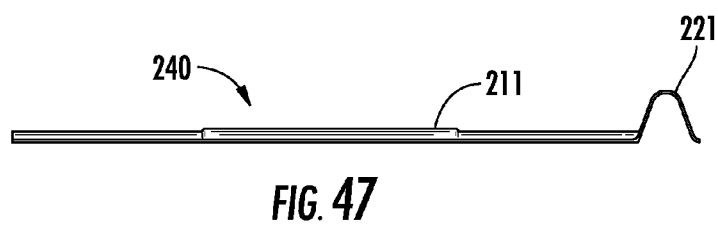
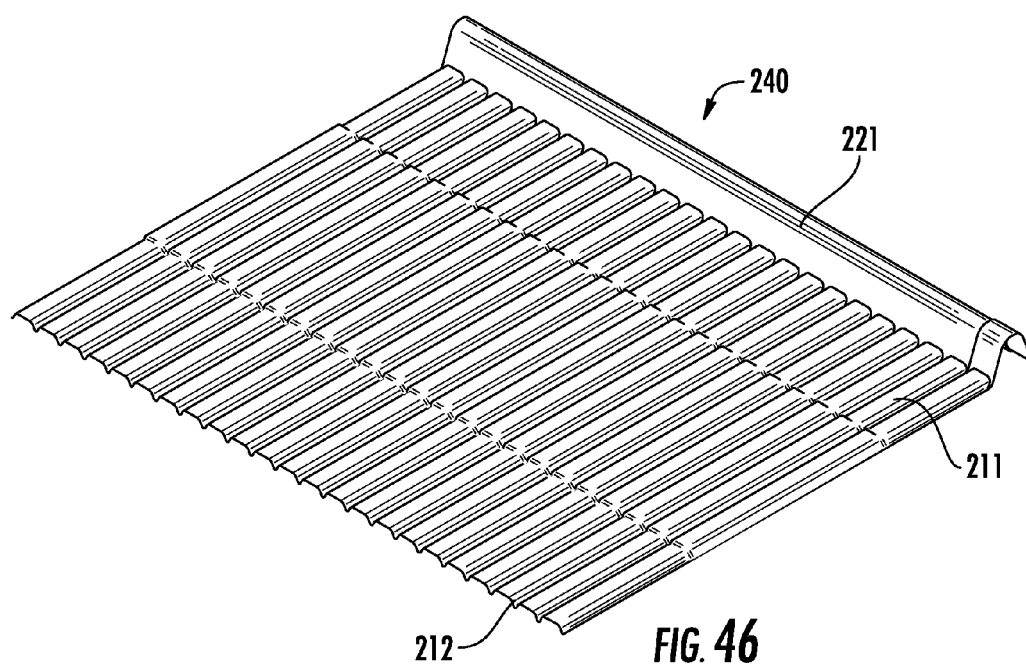
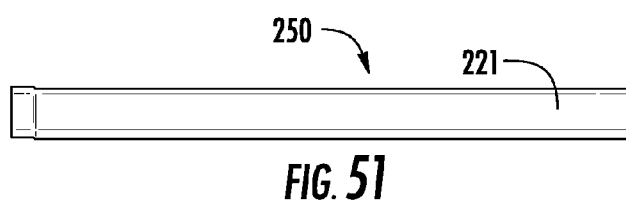
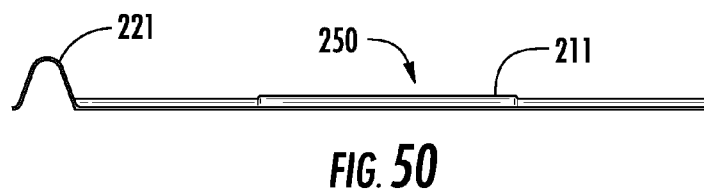
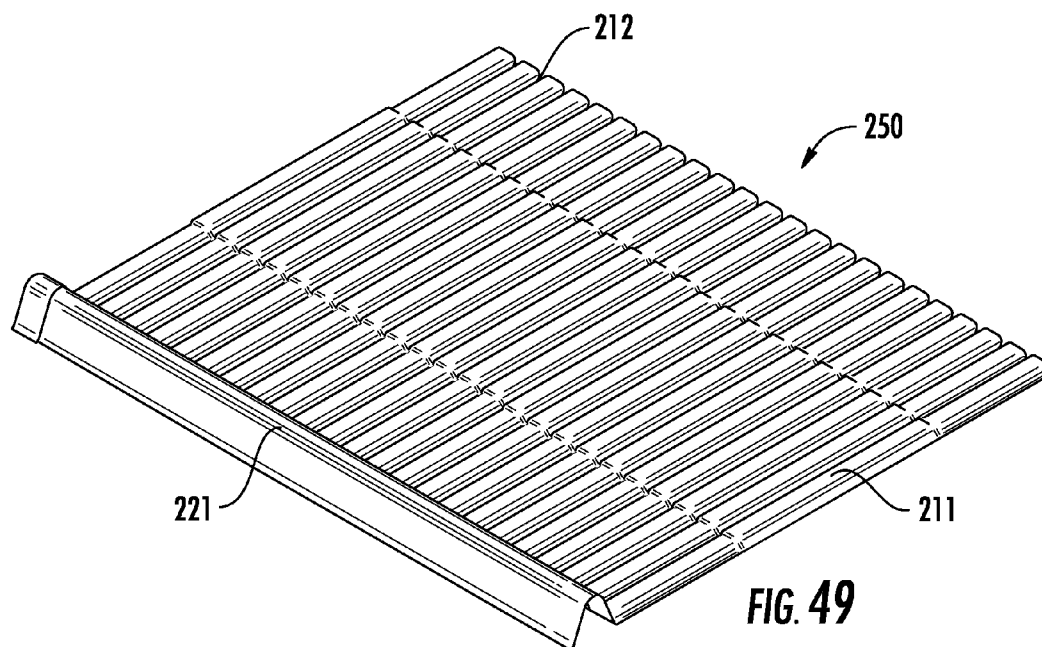


FIG. 41









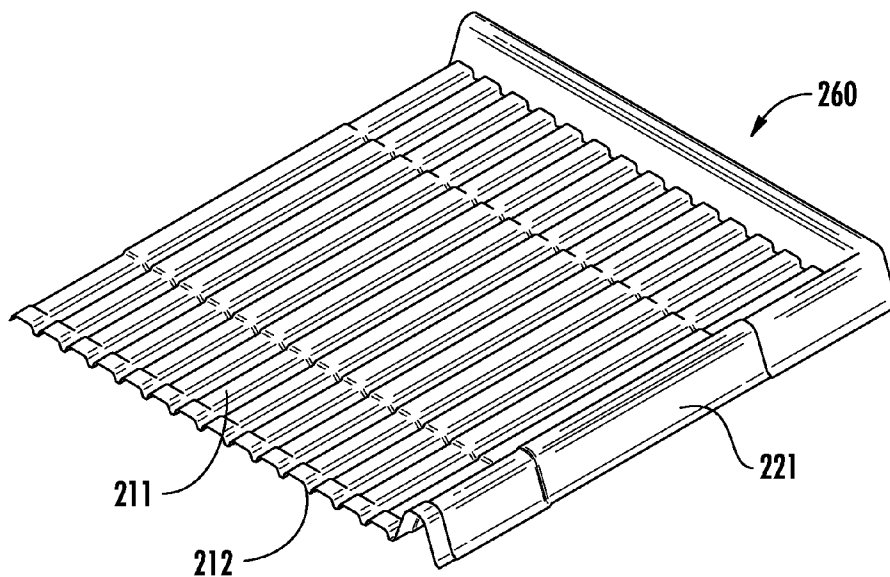


FIG. 52

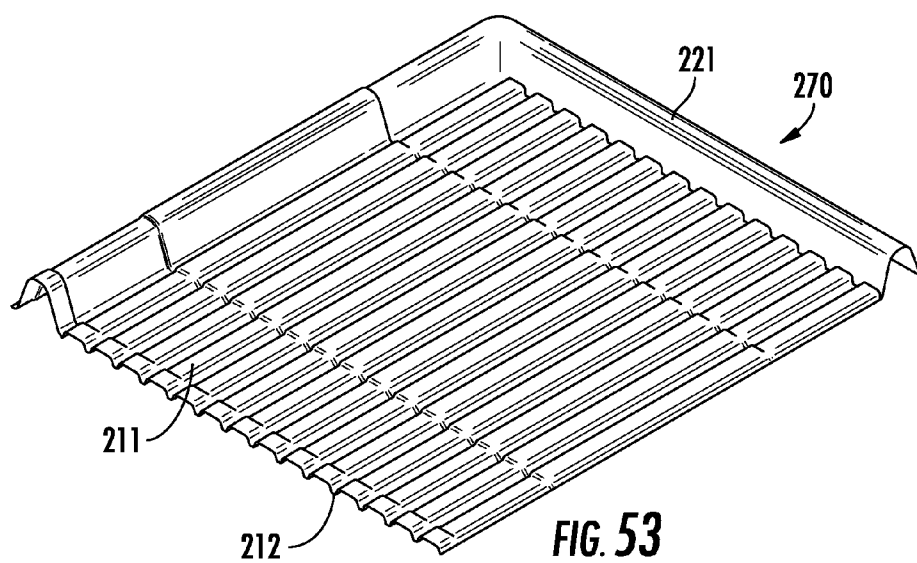
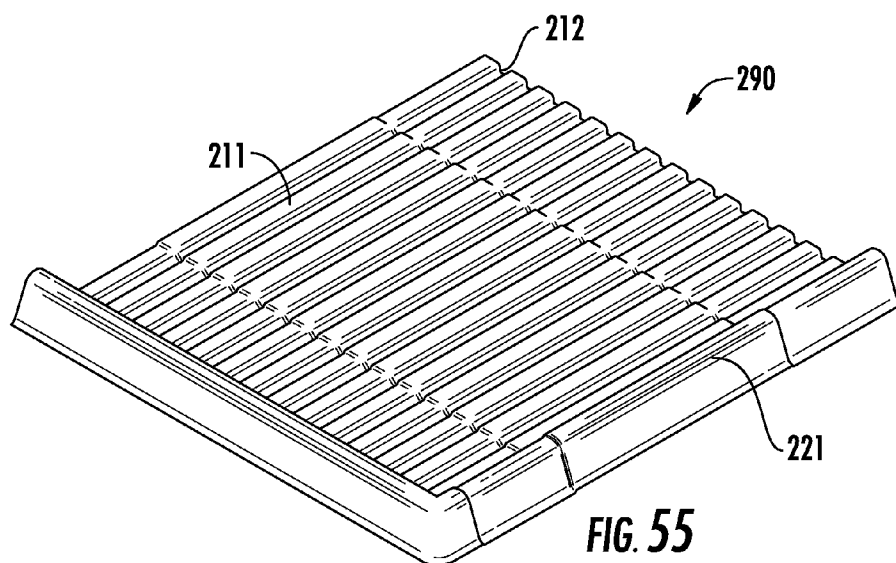
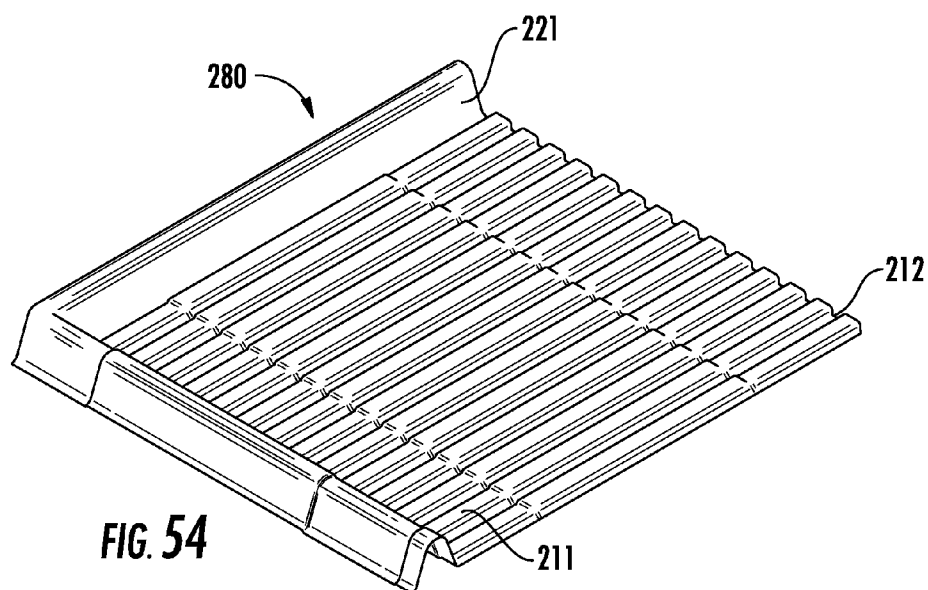


FIG. 53



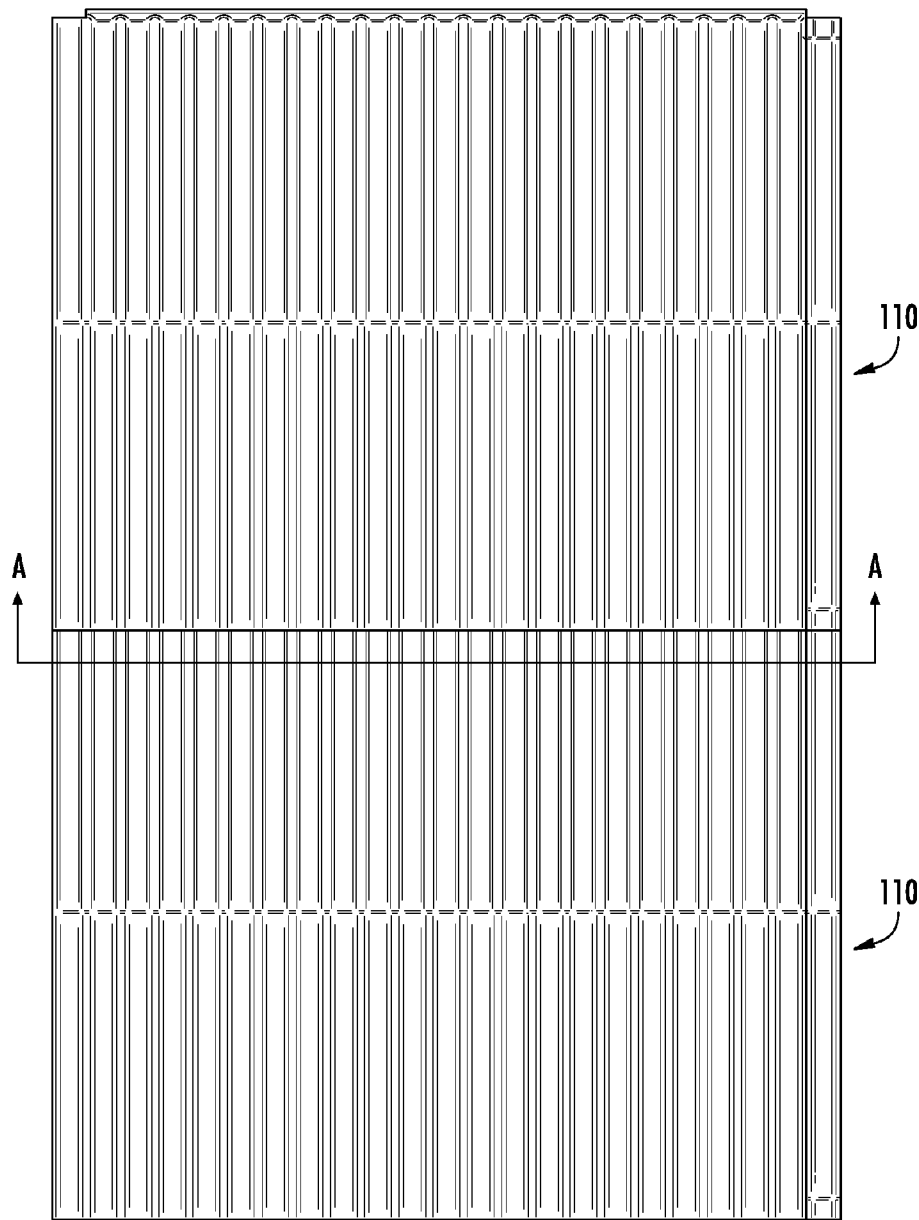


FIG. 56

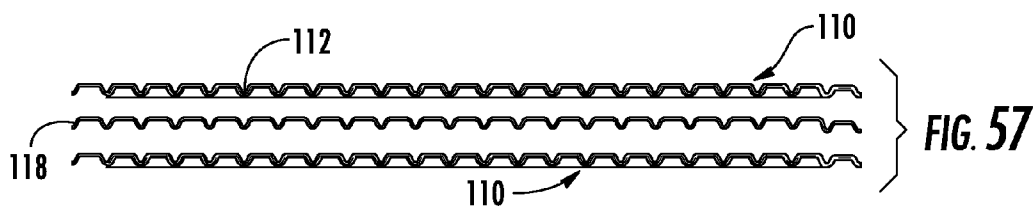


FIG. 57

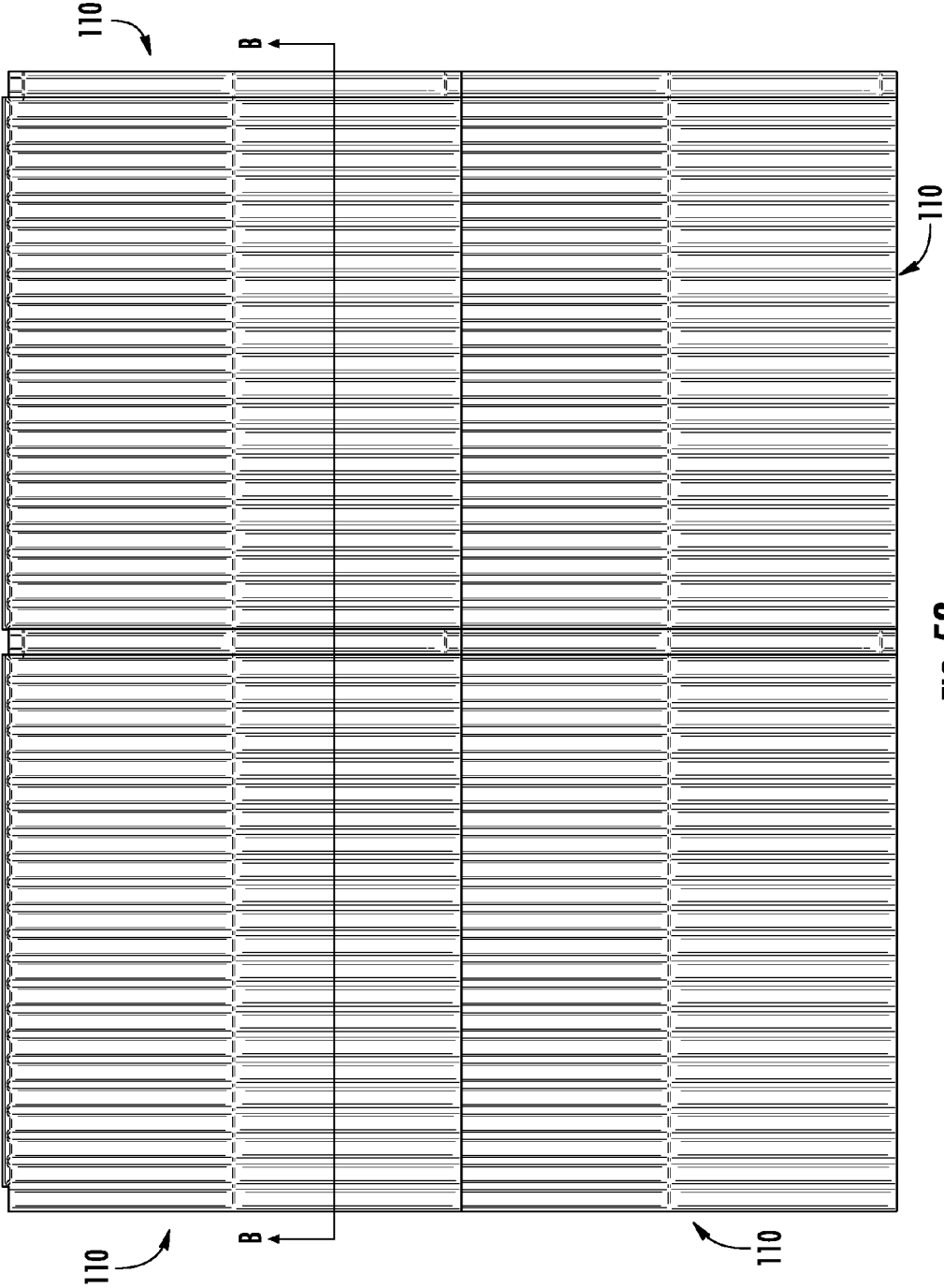
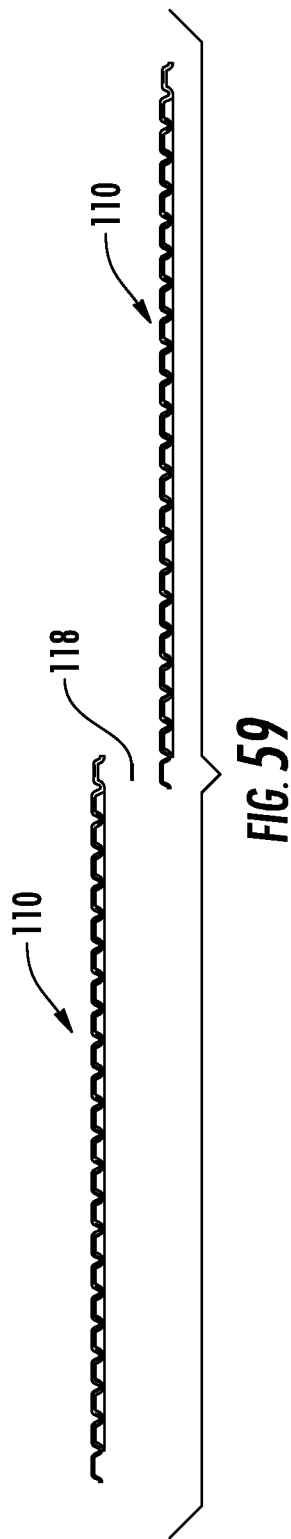
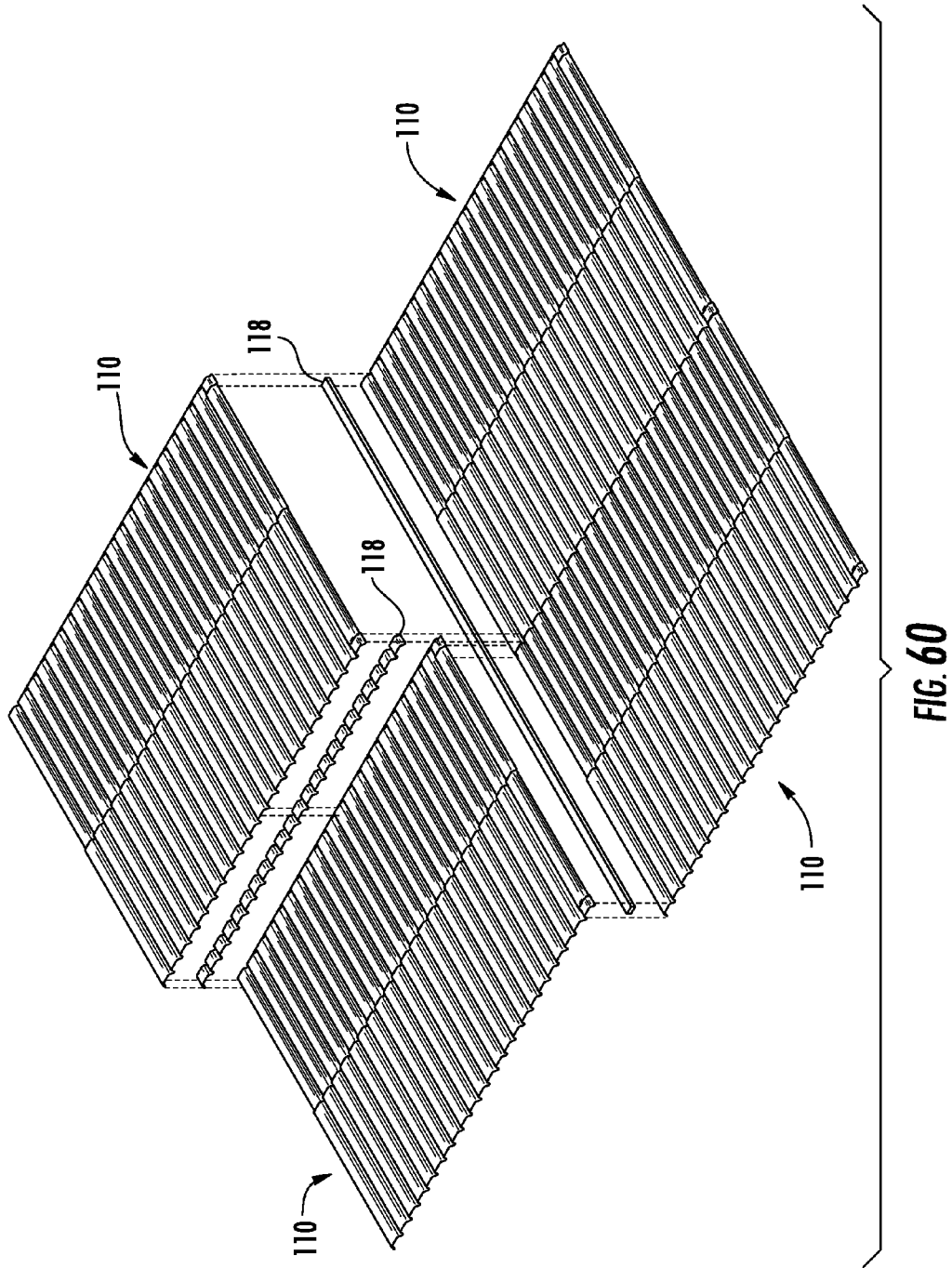


FIG. 58





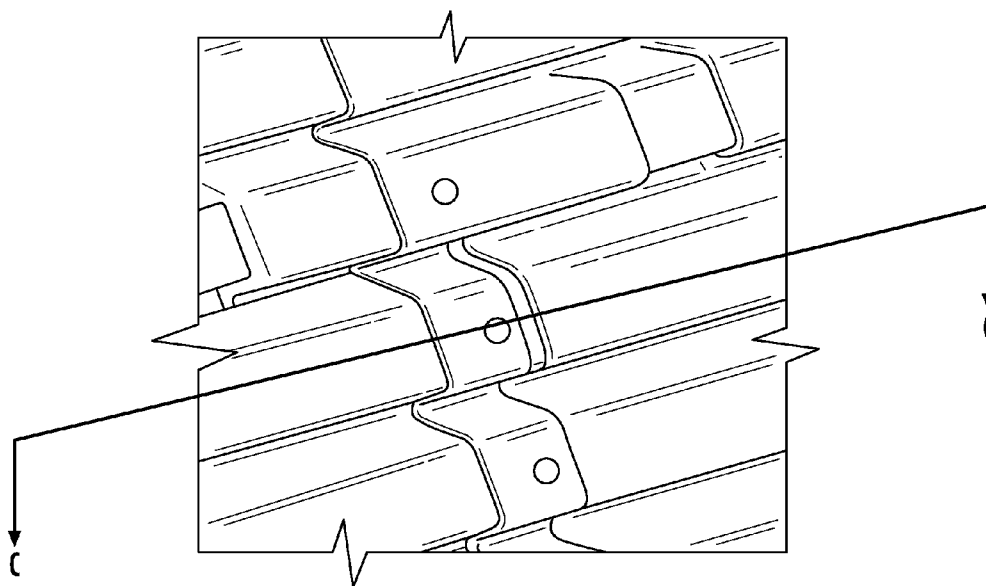


FIG. 61

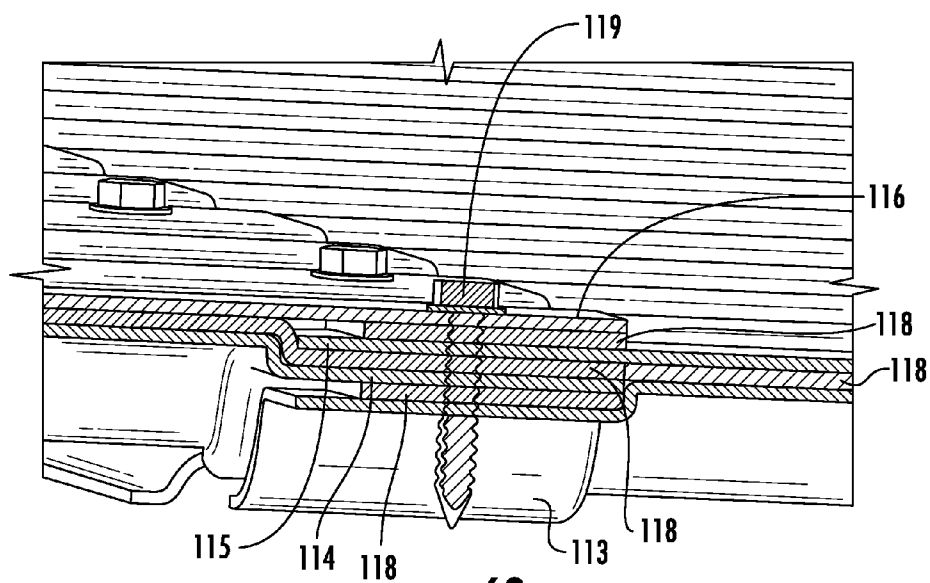


FIG. 62

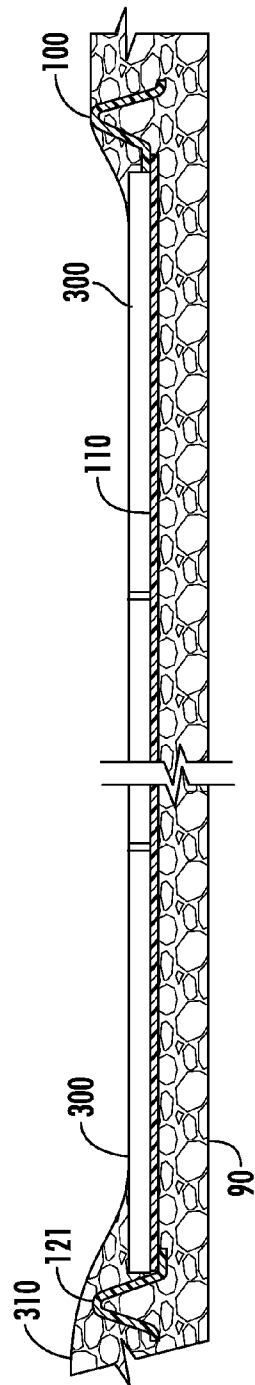


FIG. 63

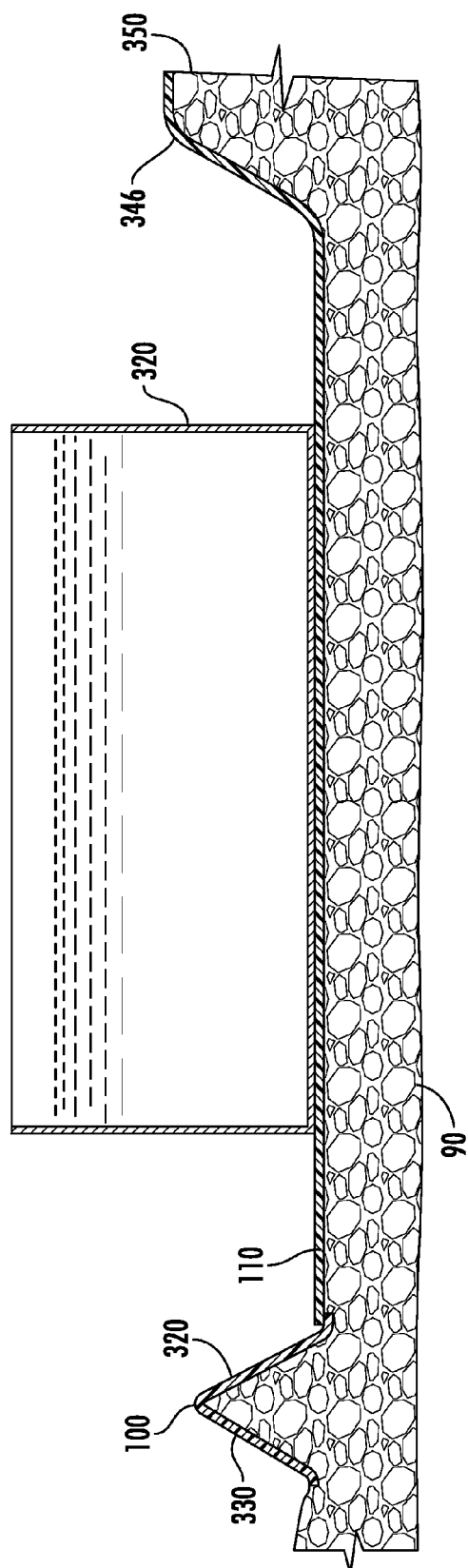


FIG. 64

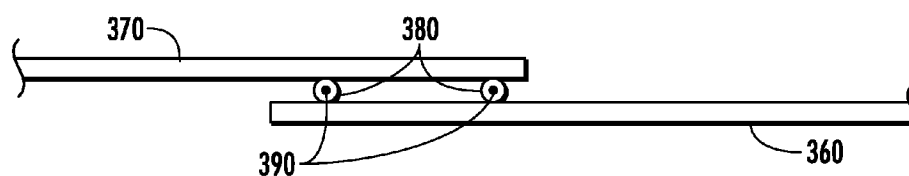


FIG. 65

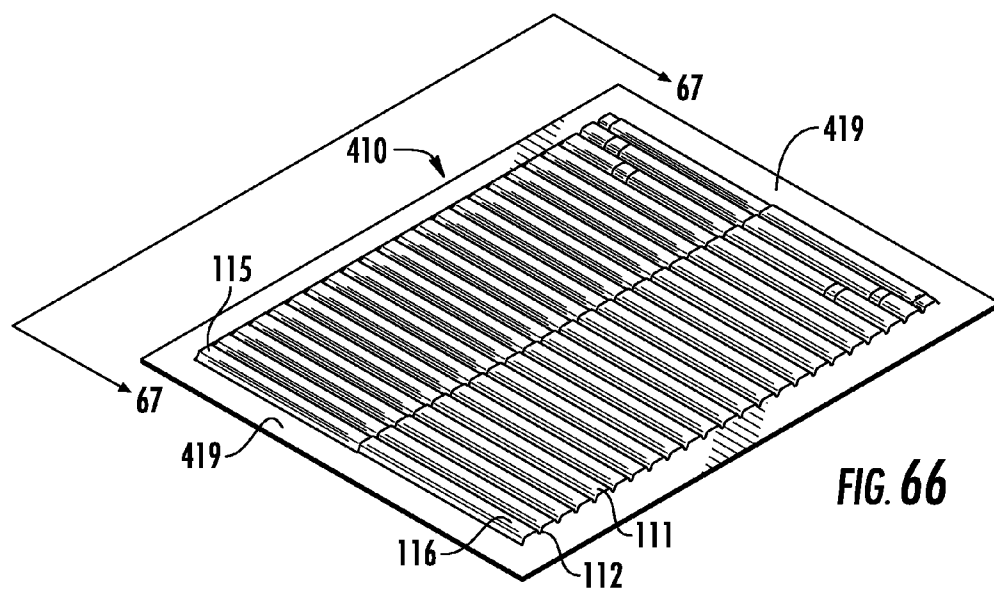
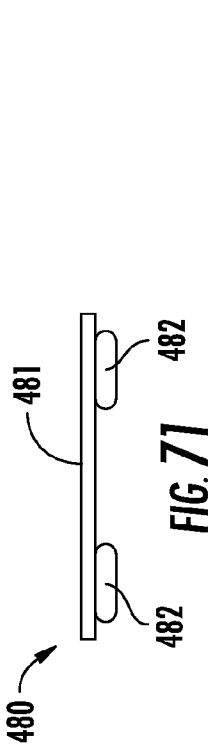
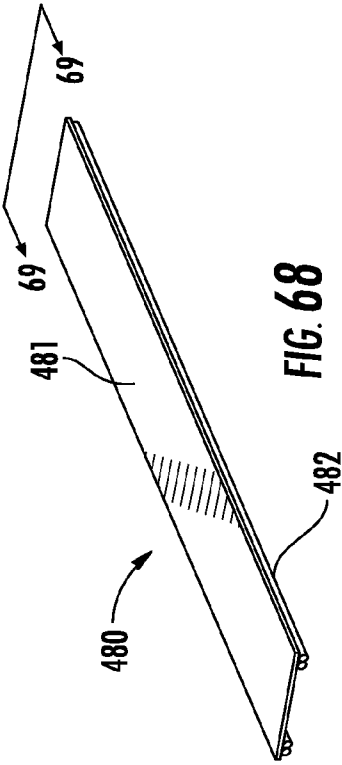
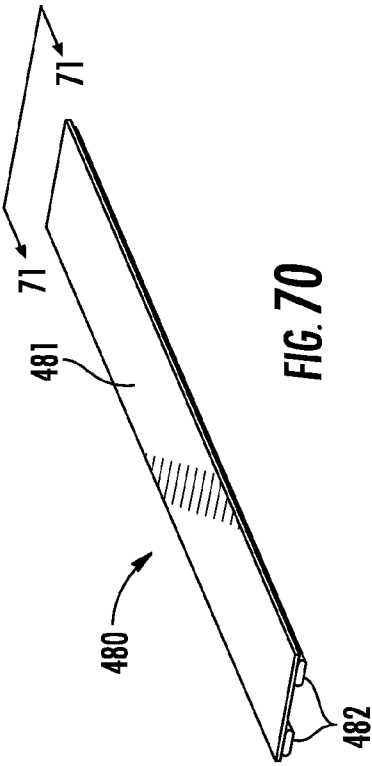
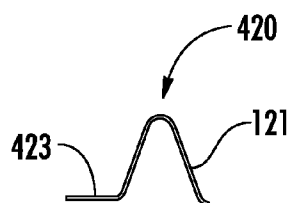
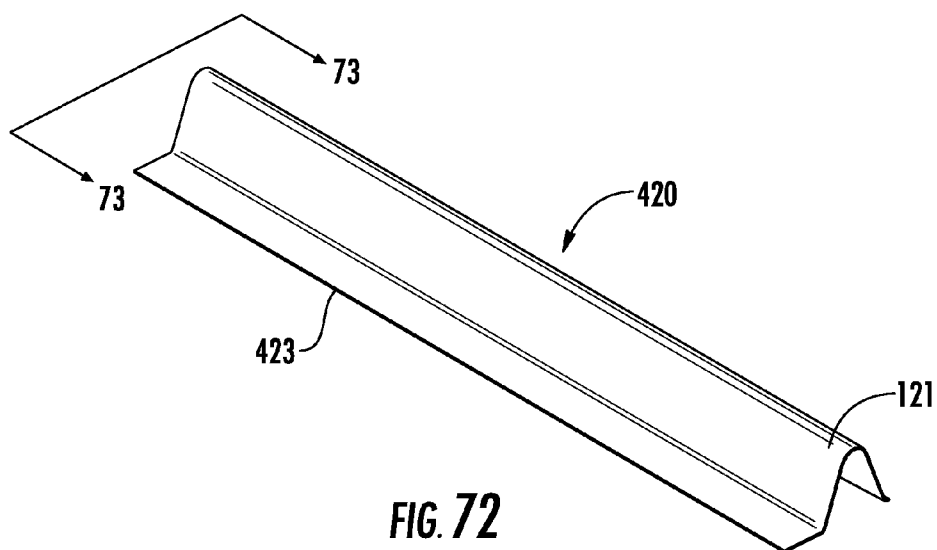


FIG. 67





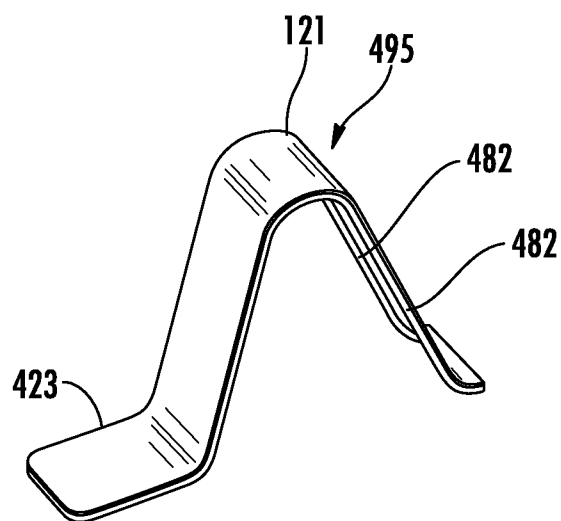


FIG. 74

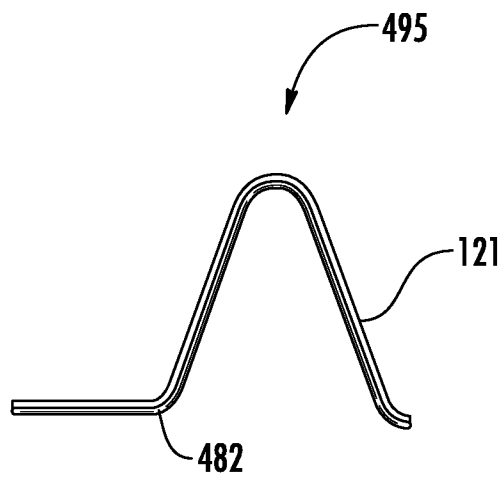


FIG. 75

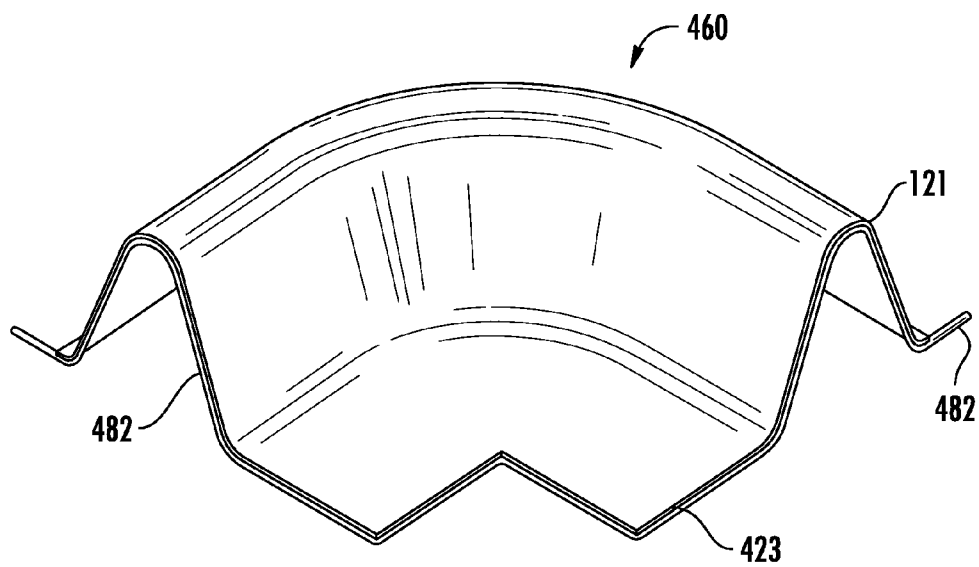


FIG. 76

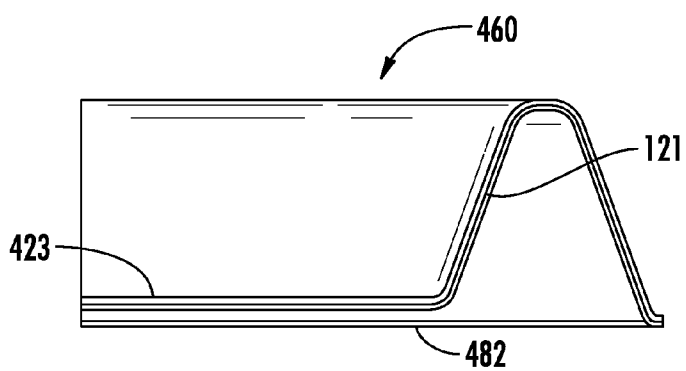
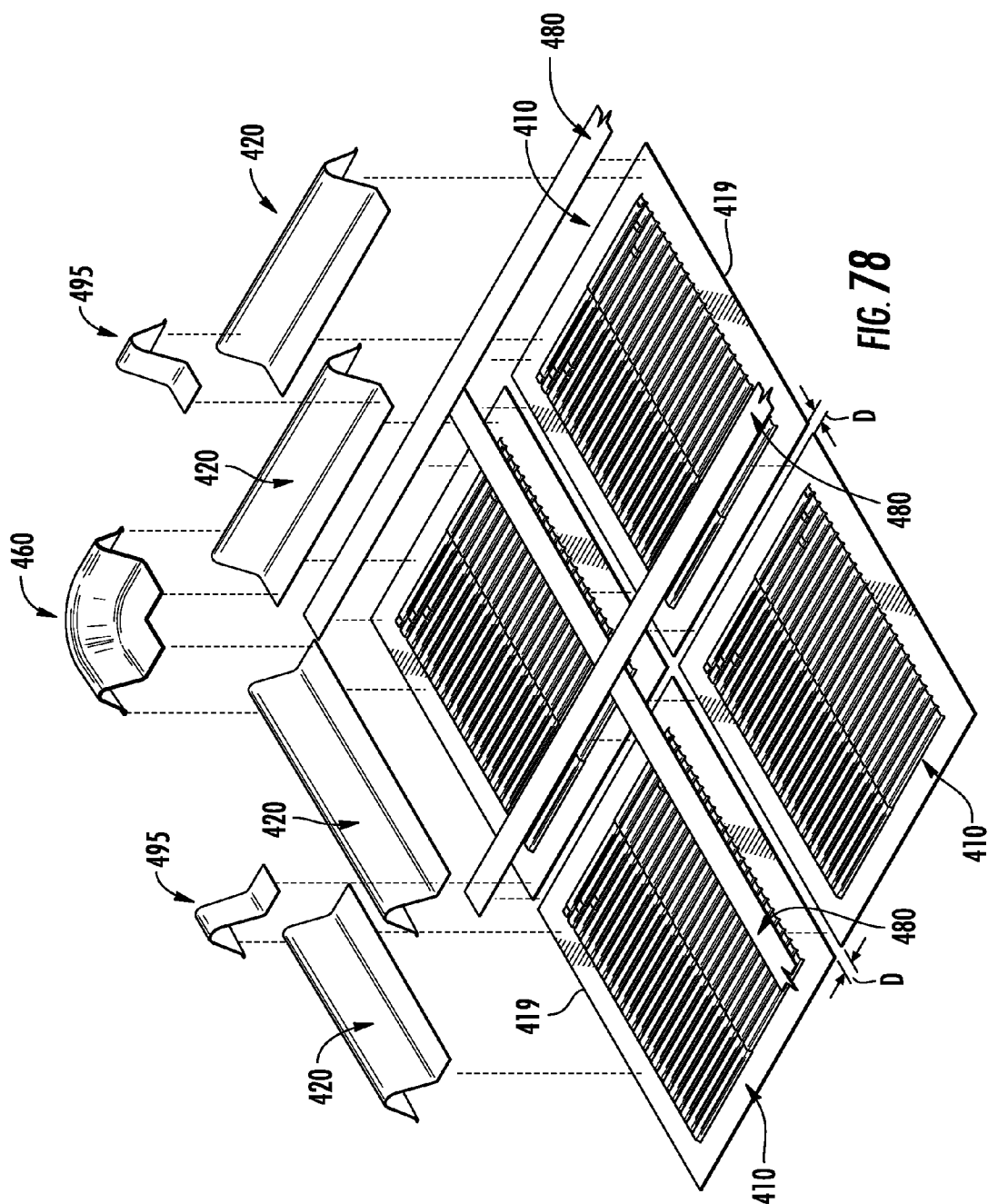
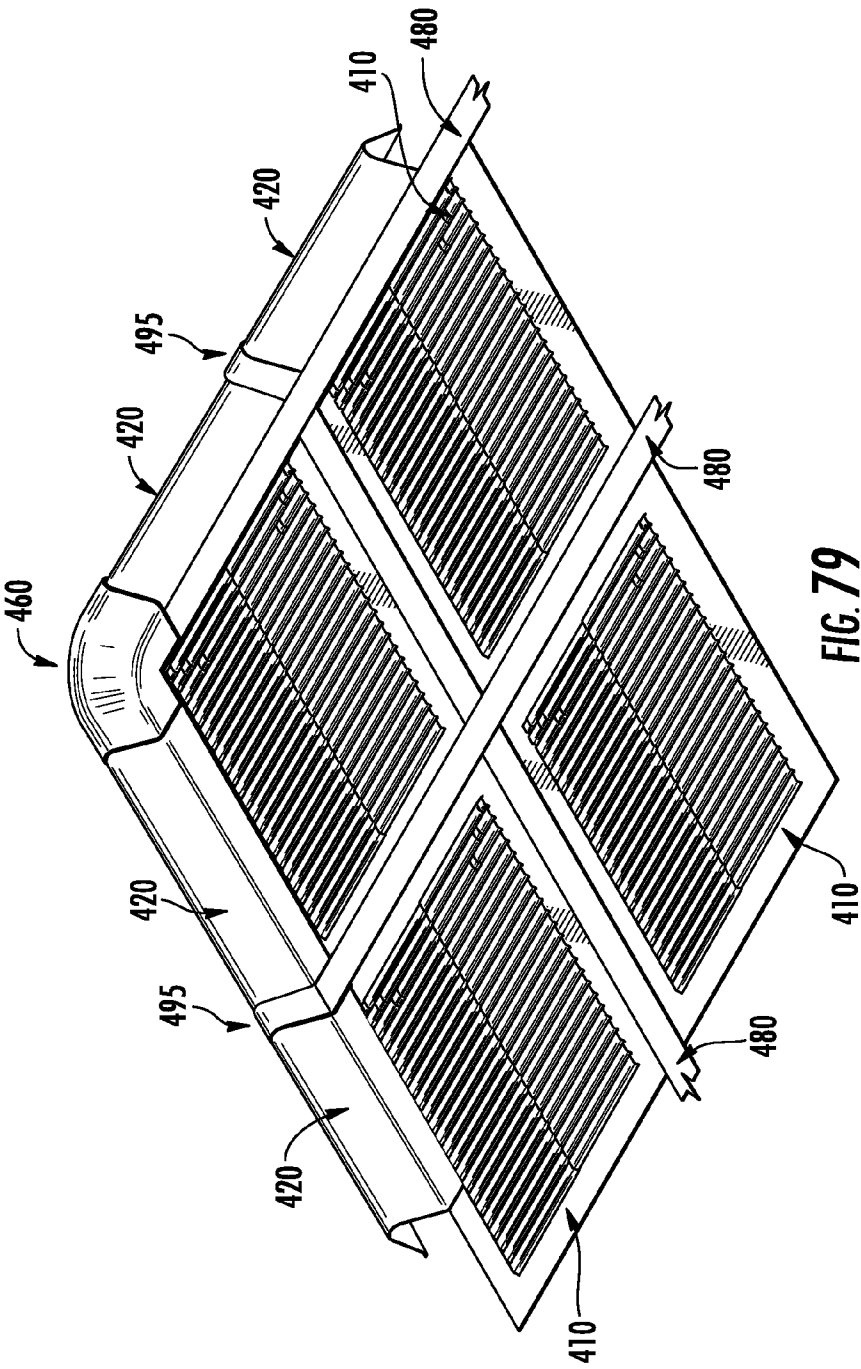


FIG. 77





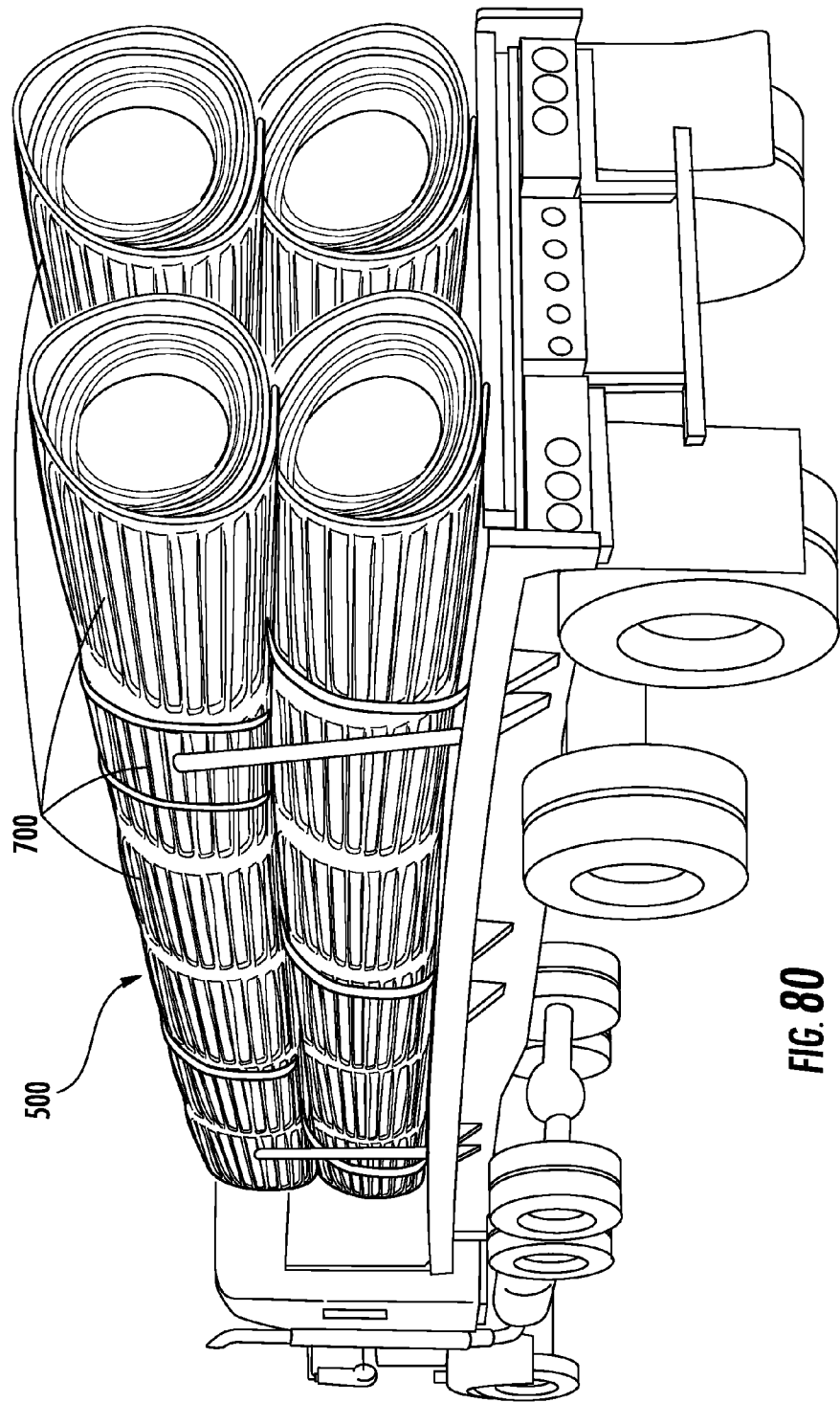
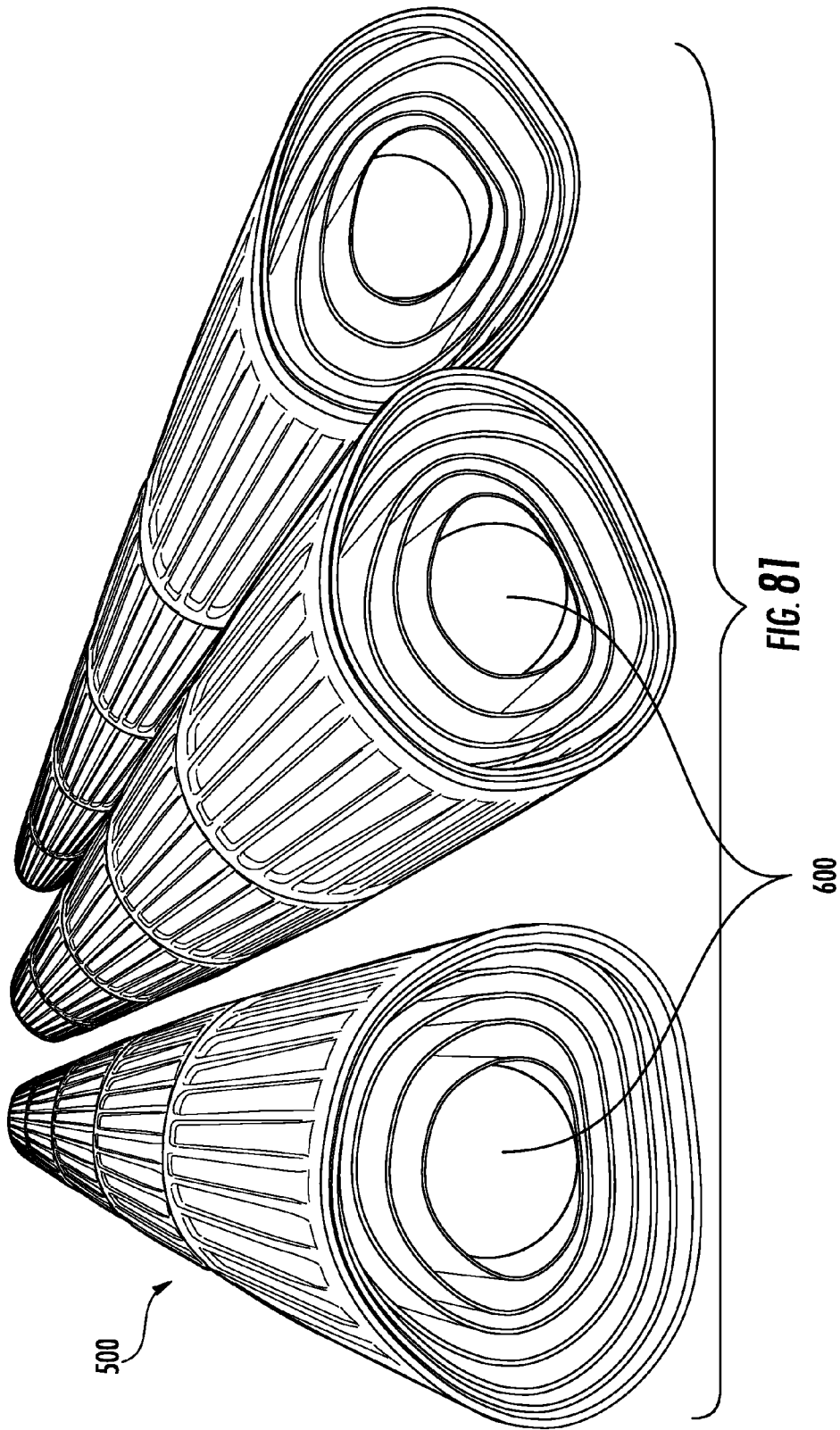
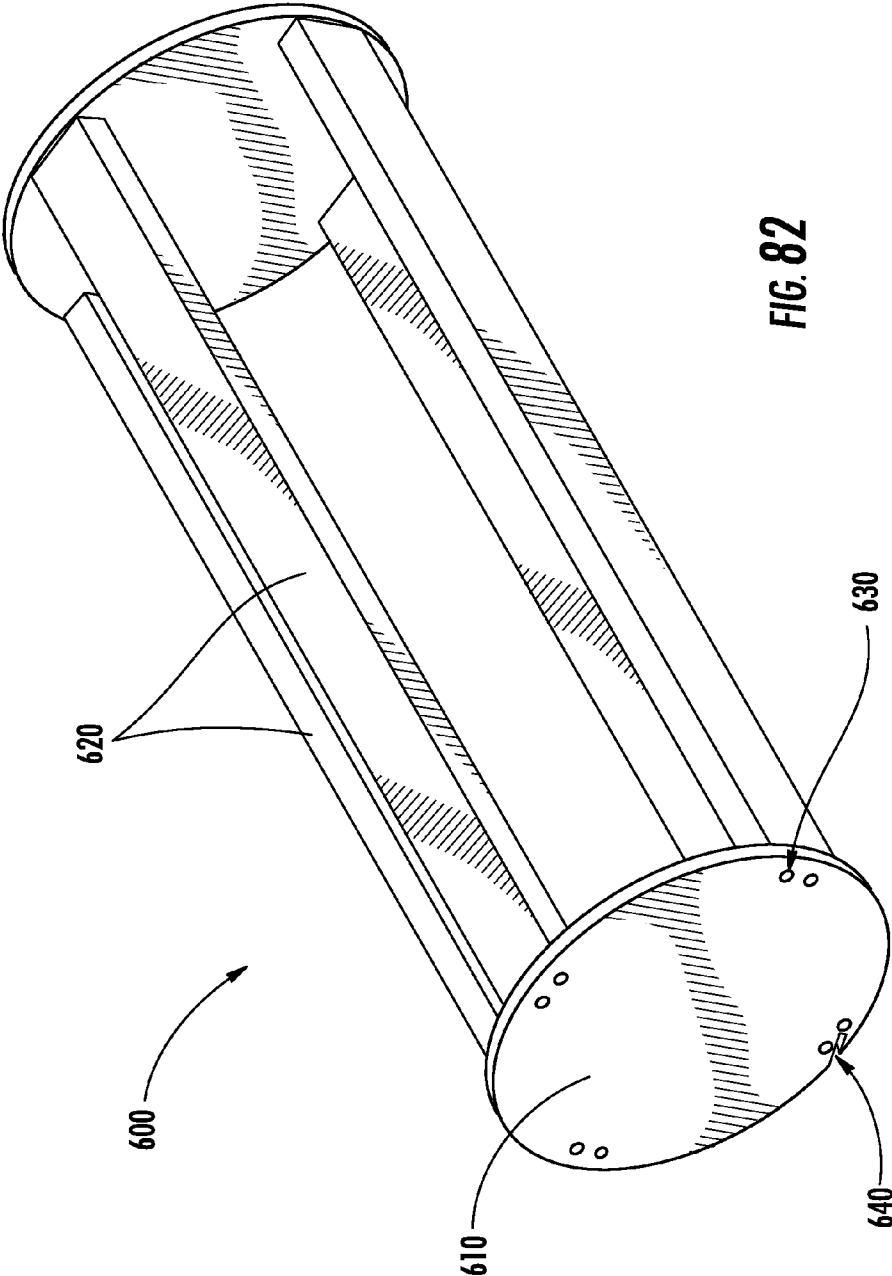
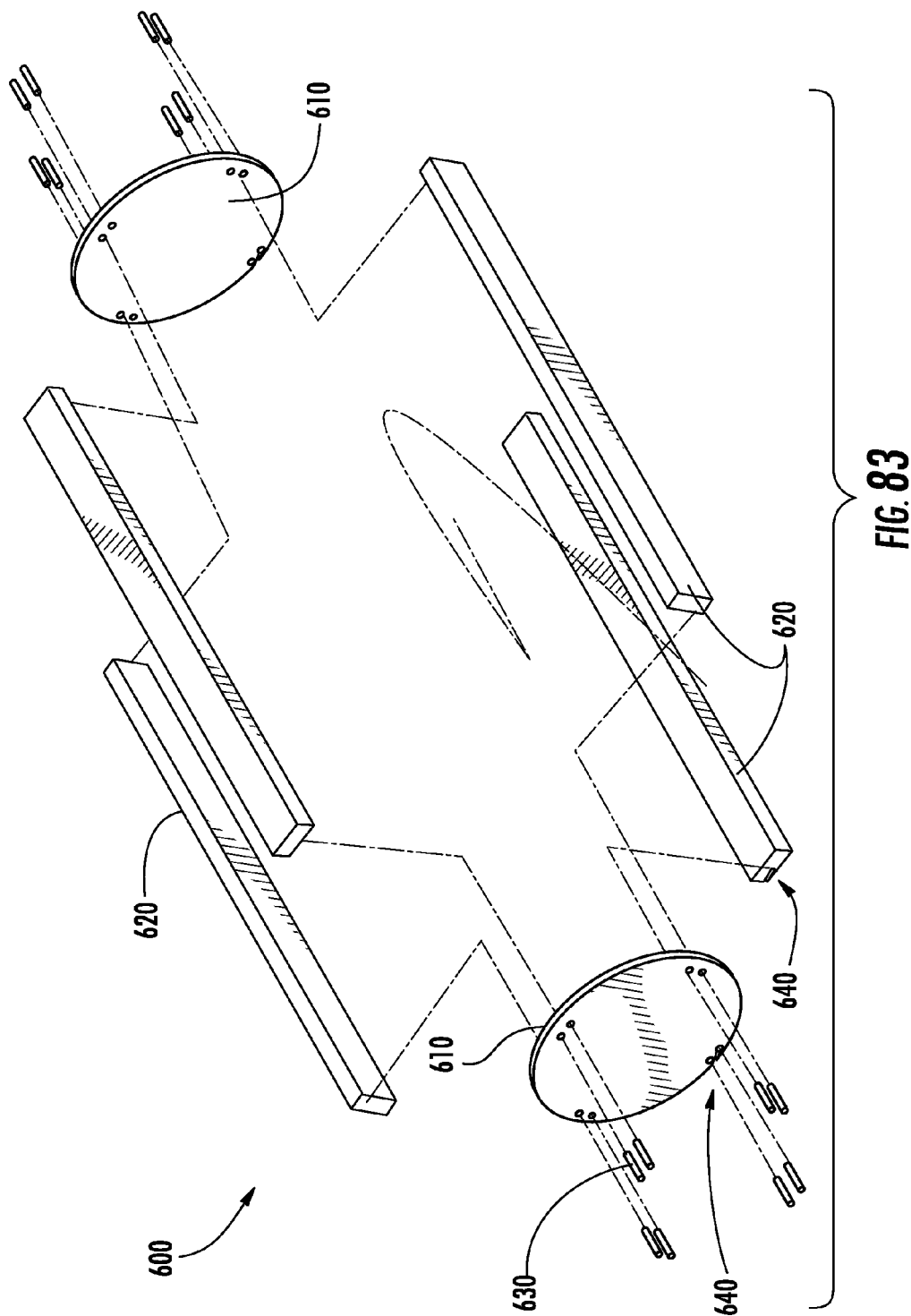
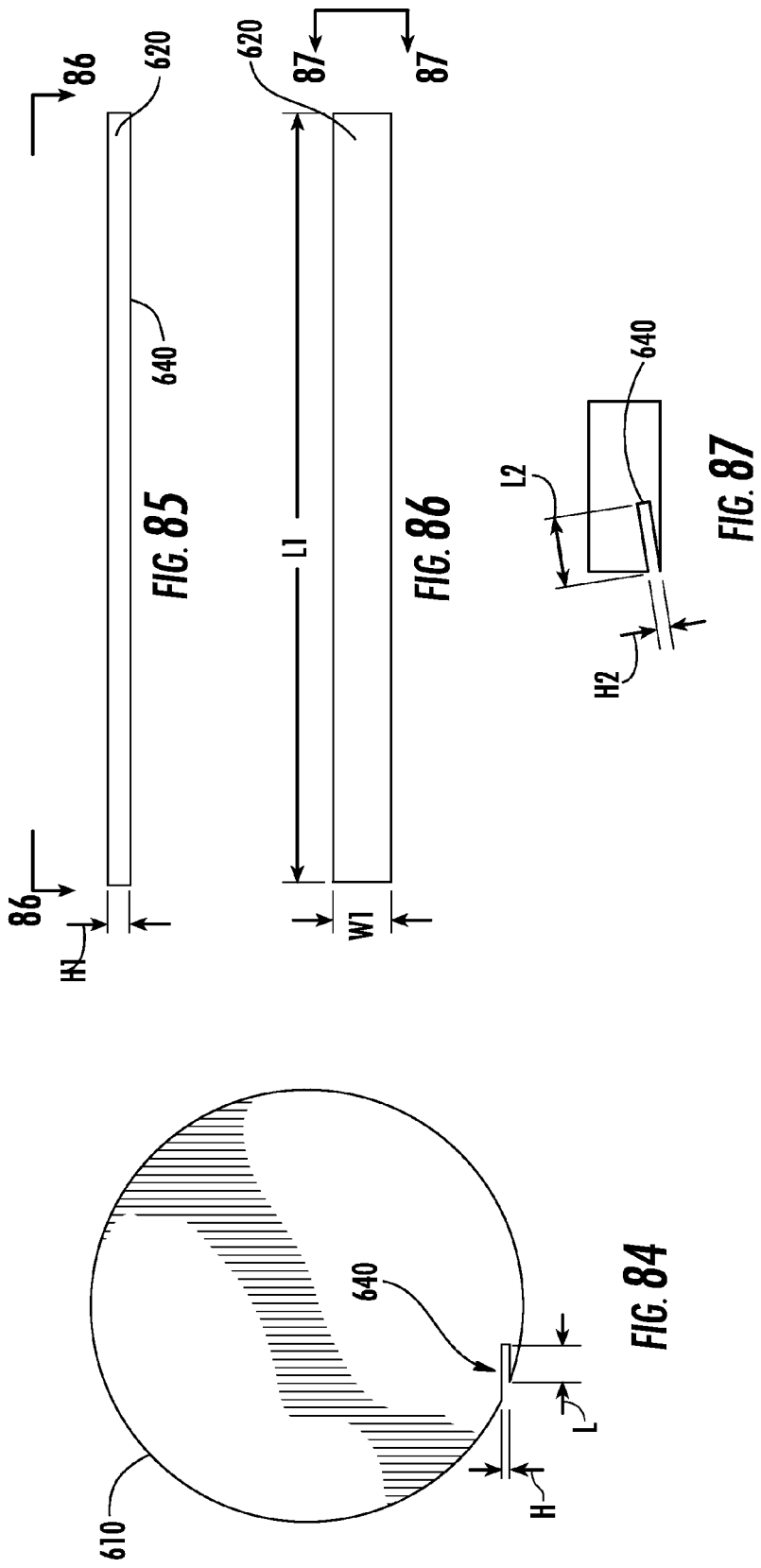


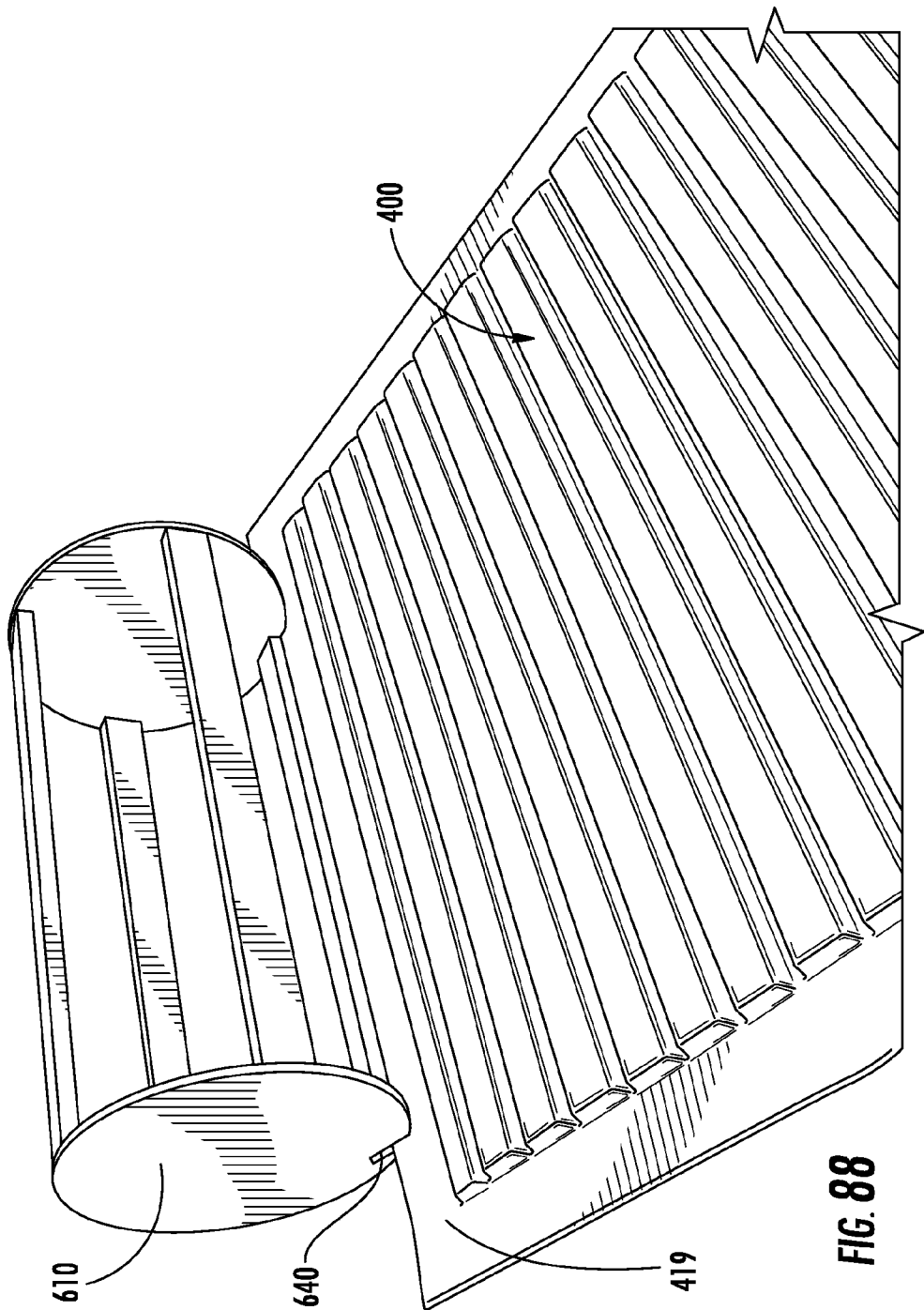
FIG. 80











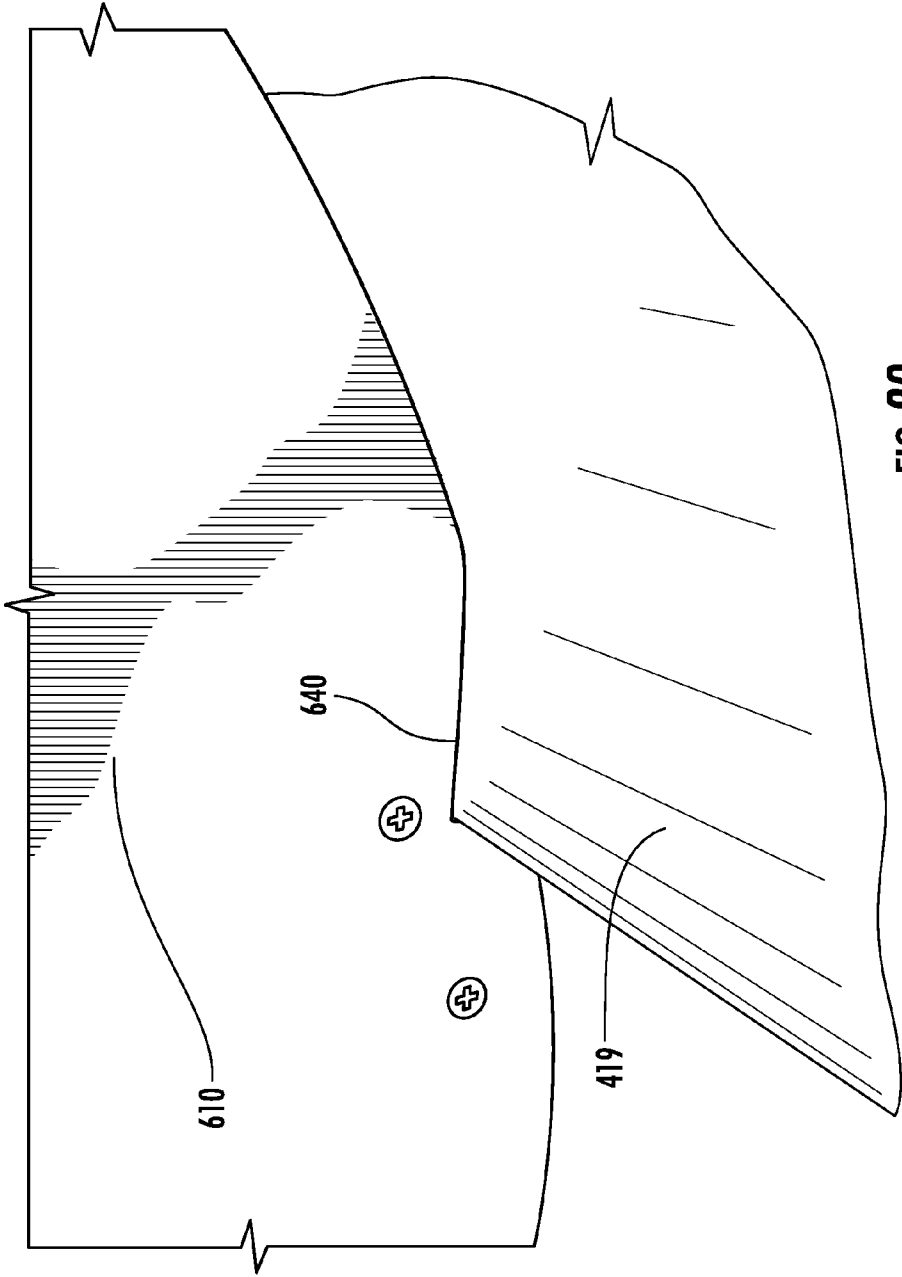


FIG. 89

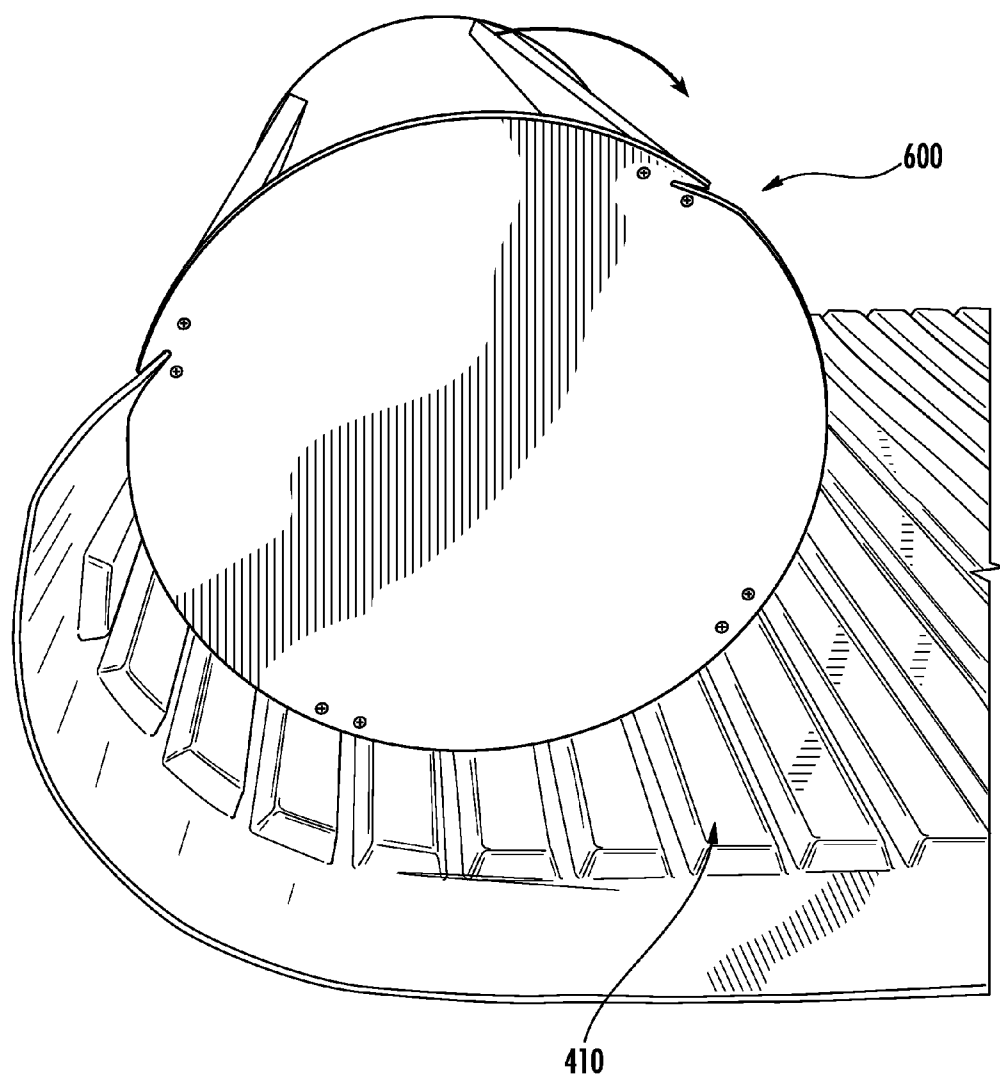


FIG. 90

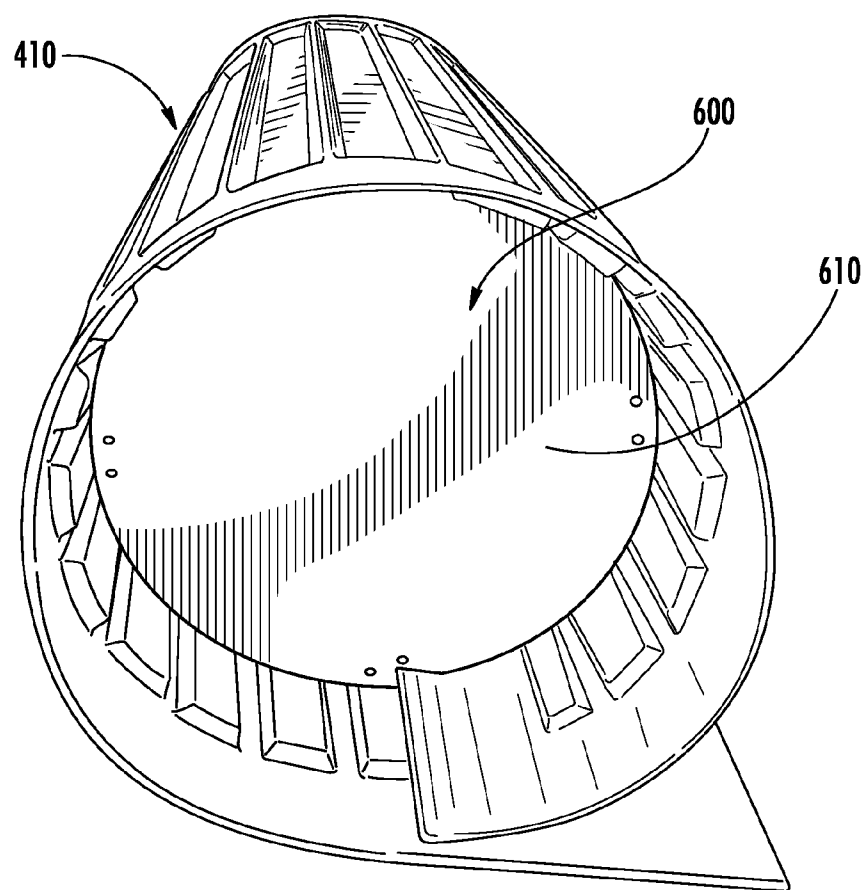


FIG. 91

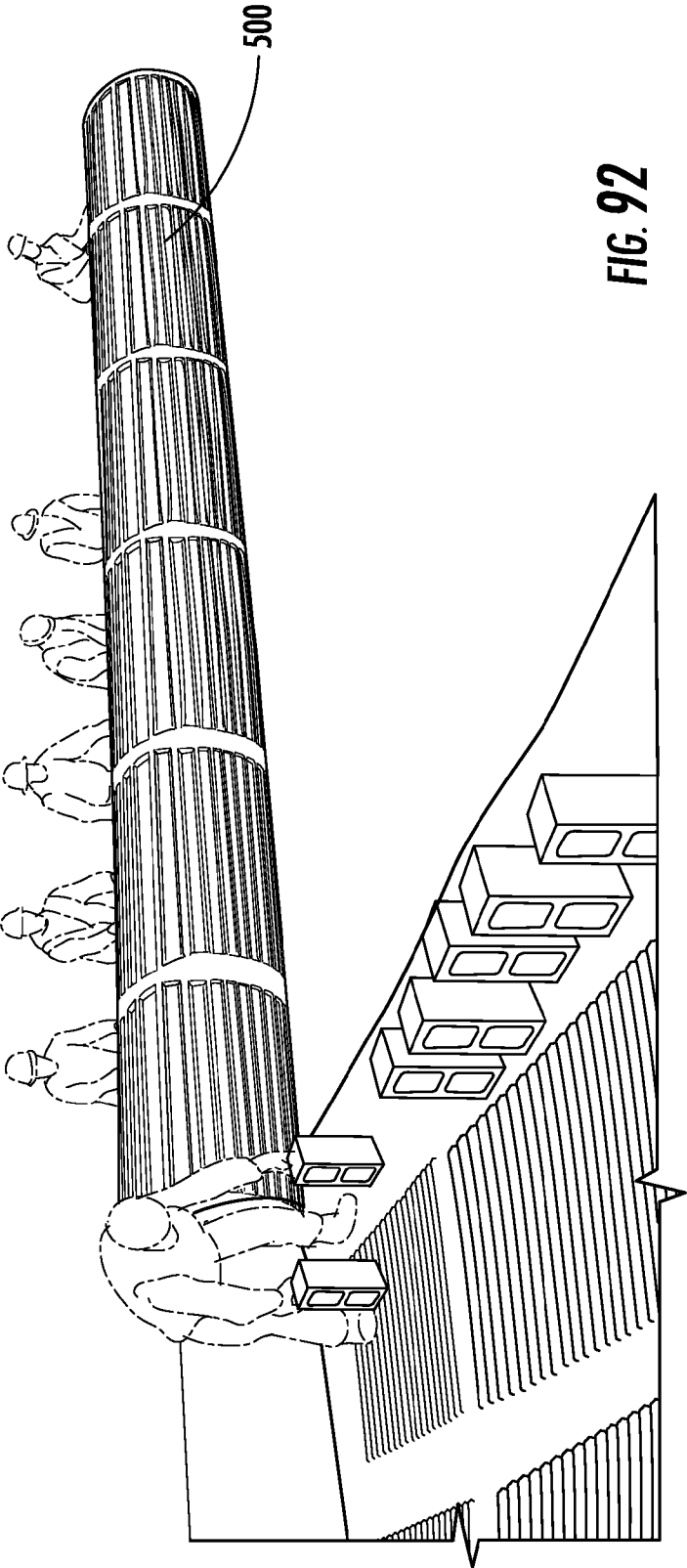


FIG. 92

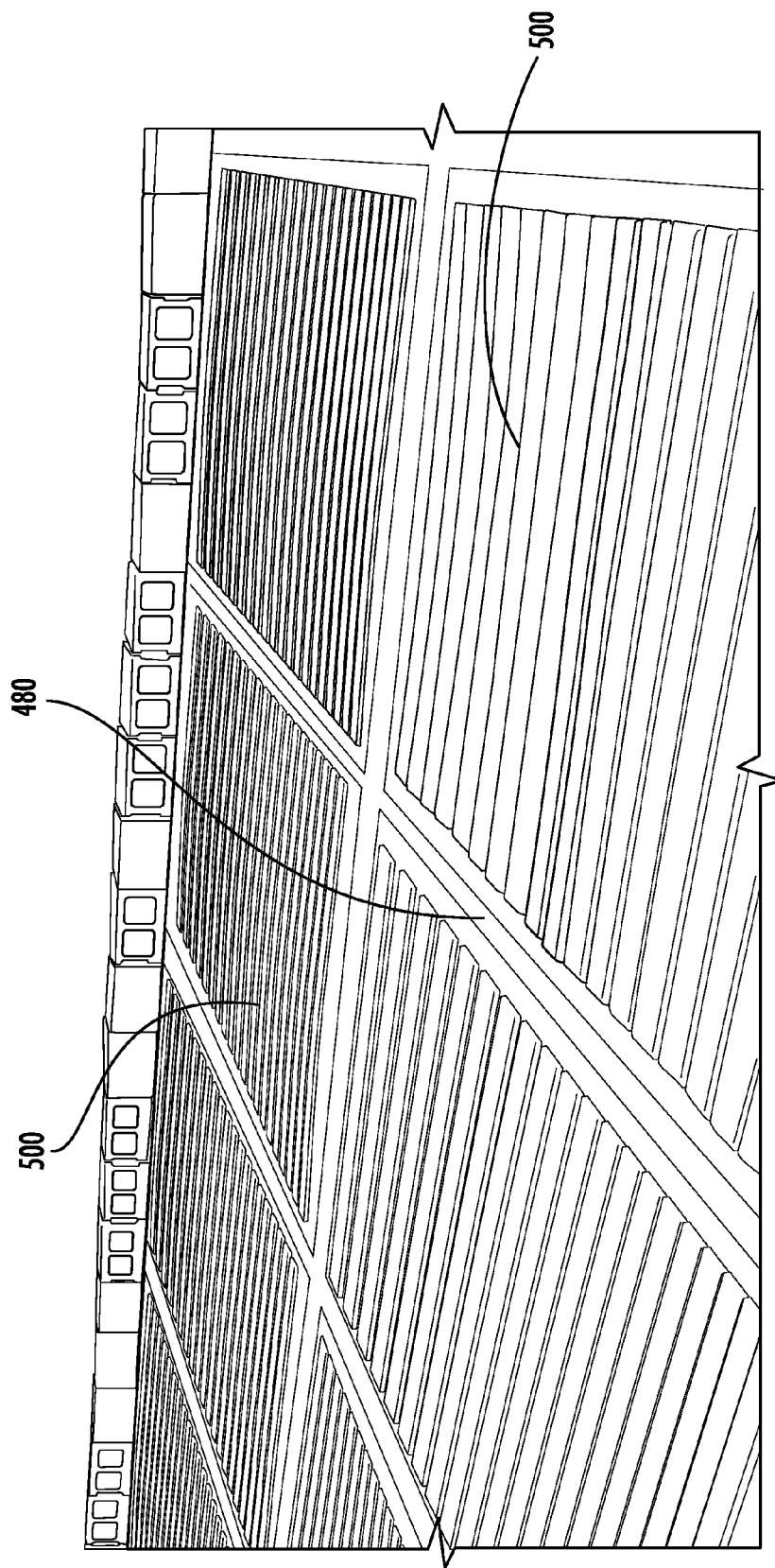


FIG. 93

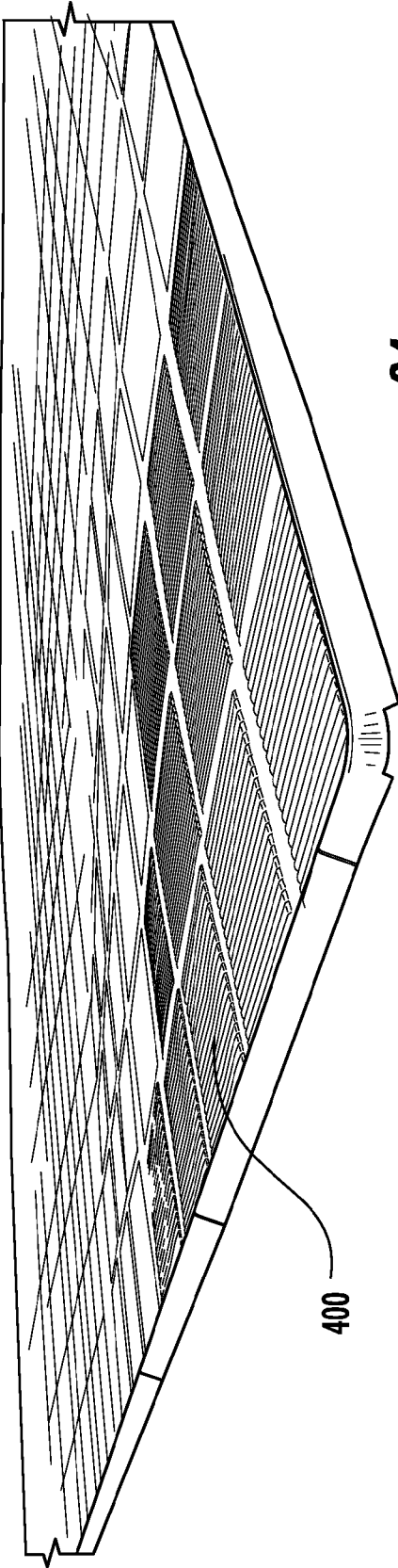
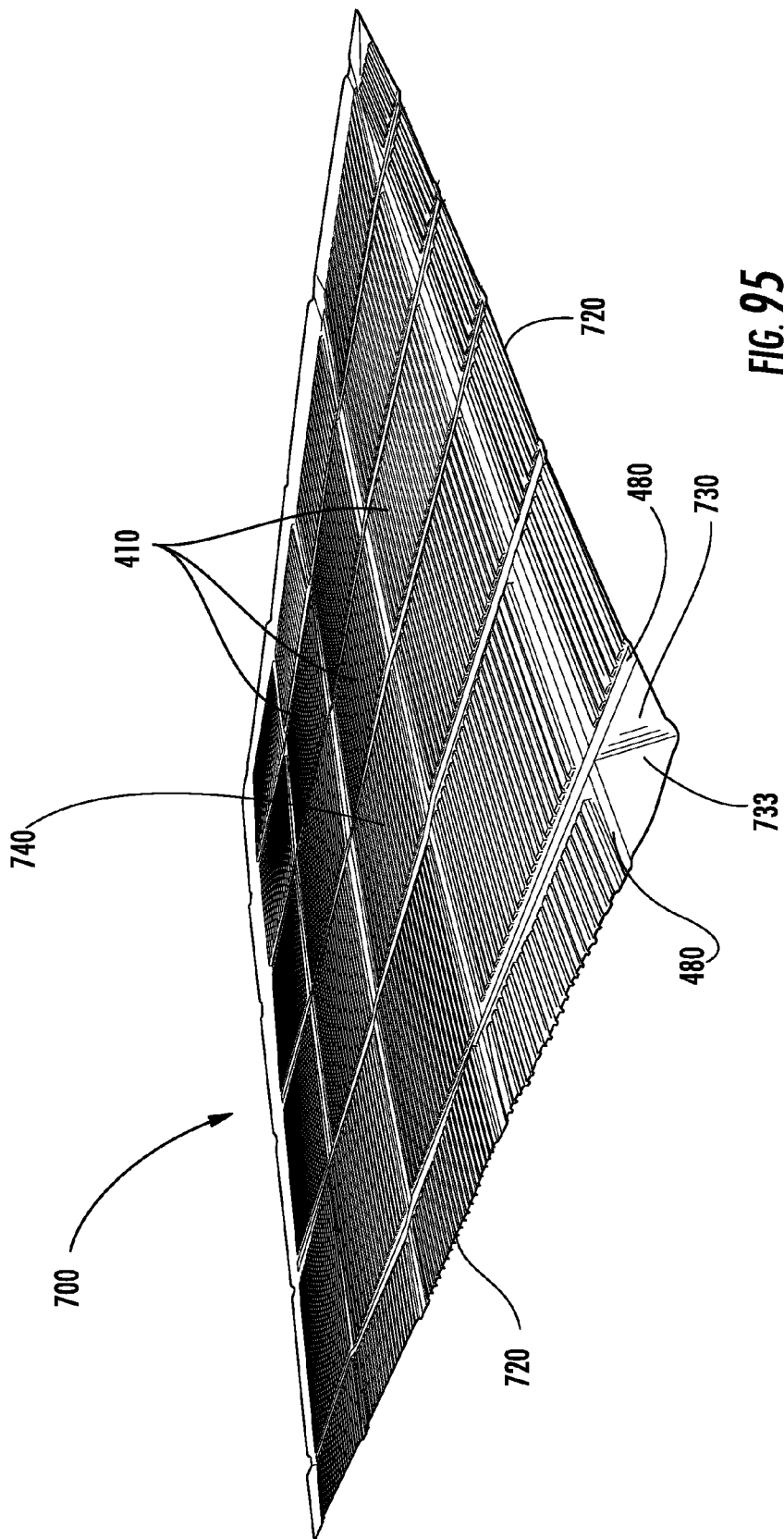
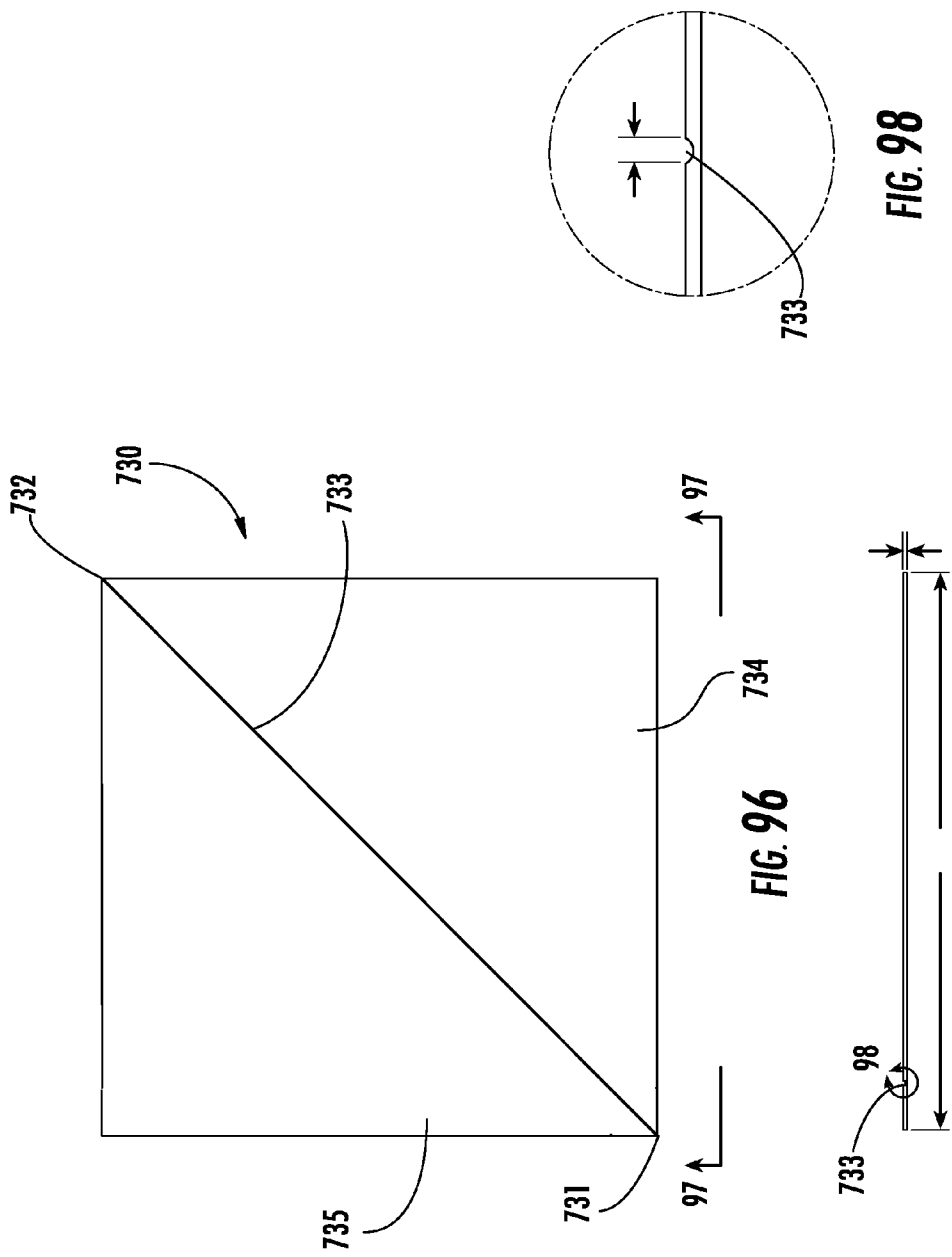


FIG. 94

400





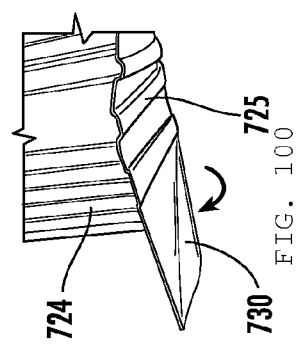
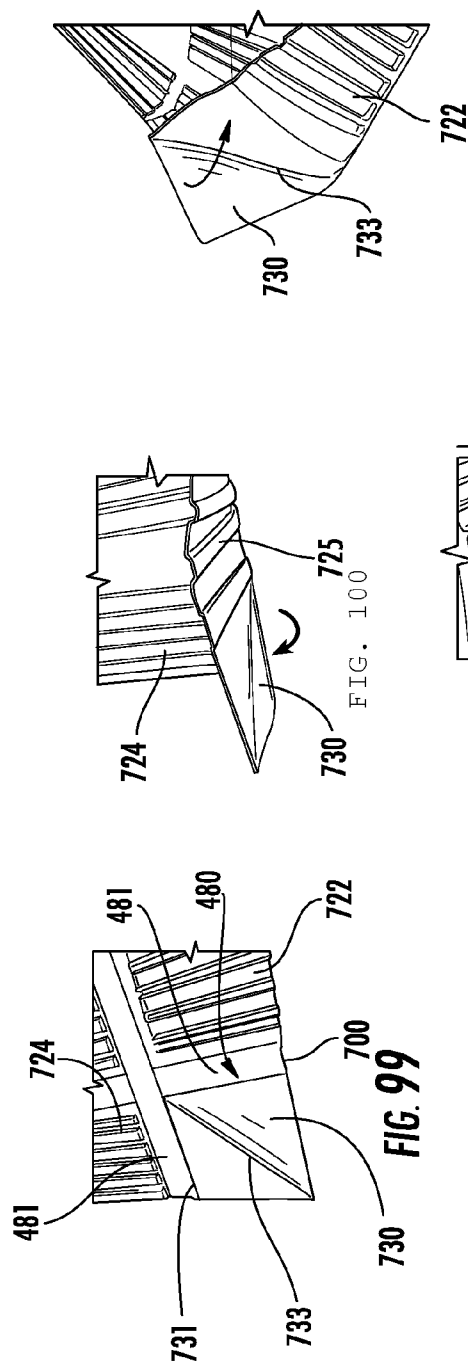
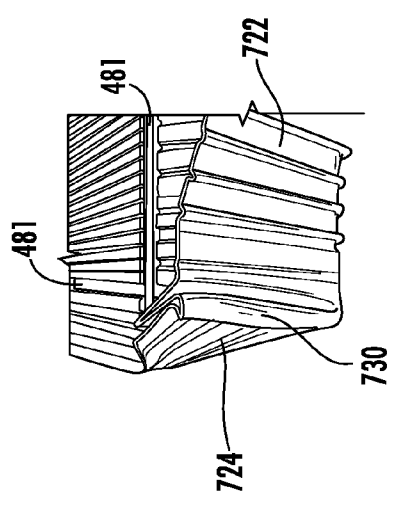
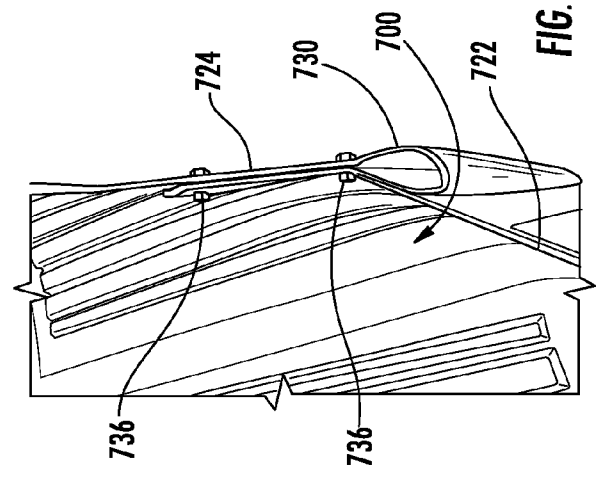
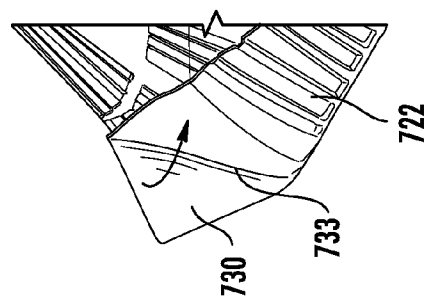
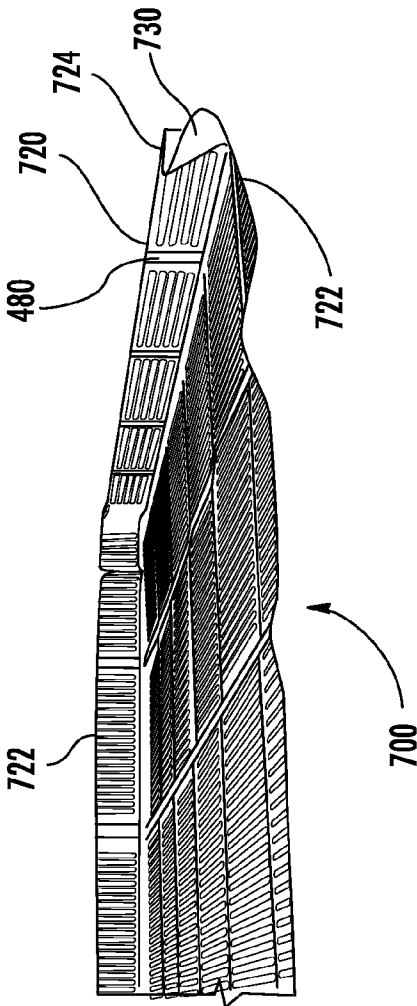
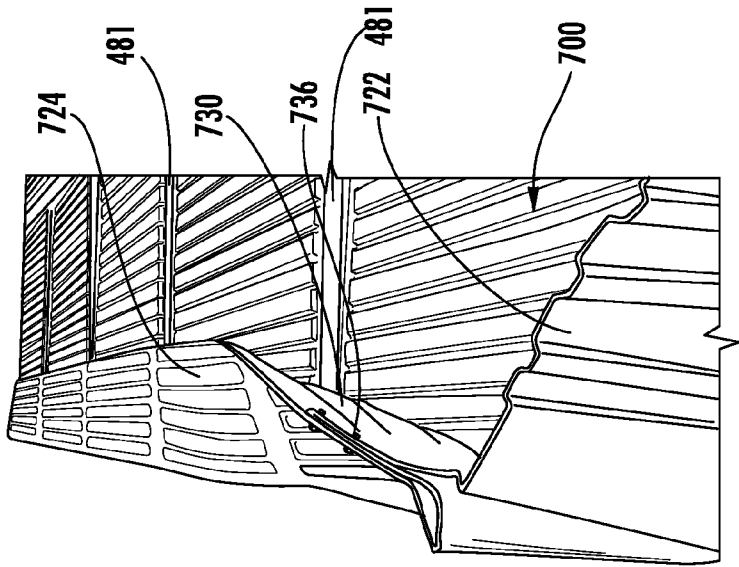
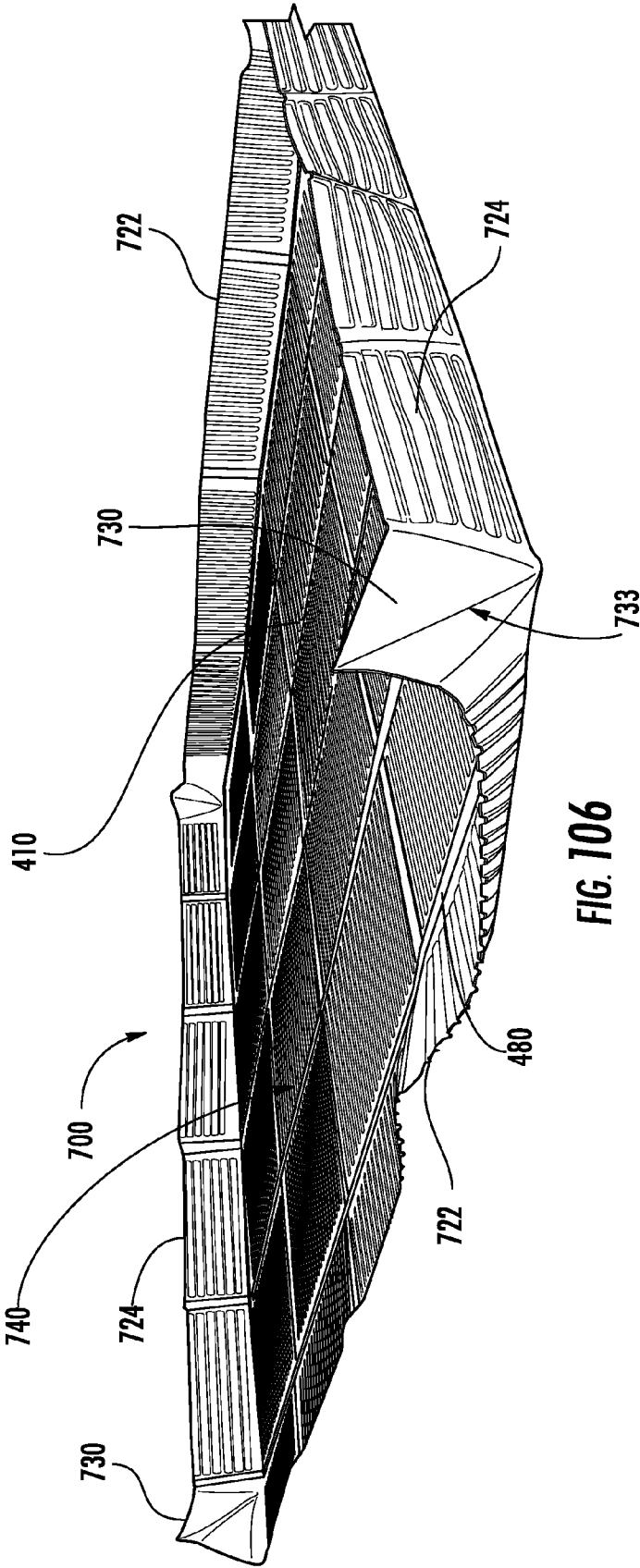
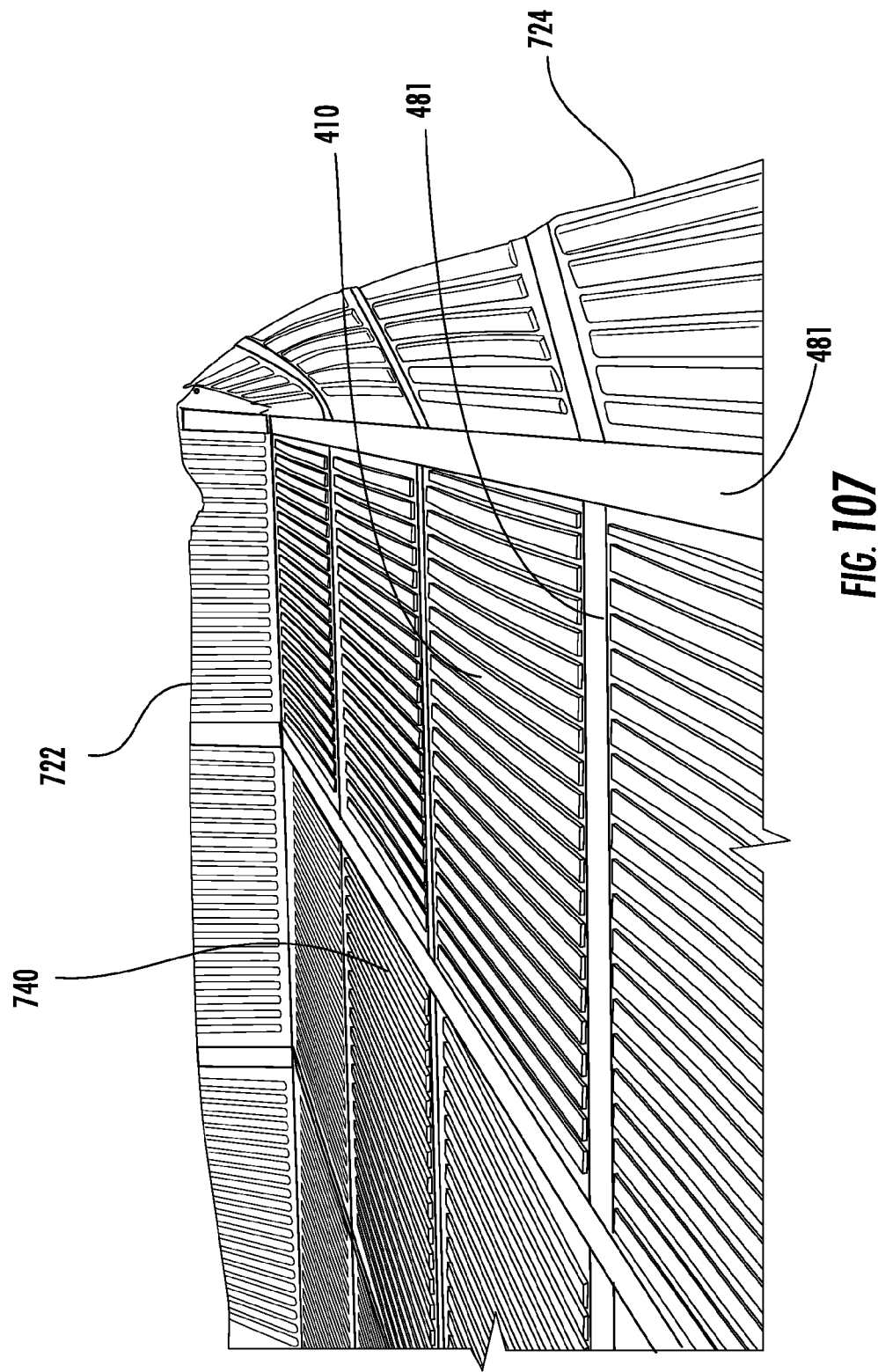


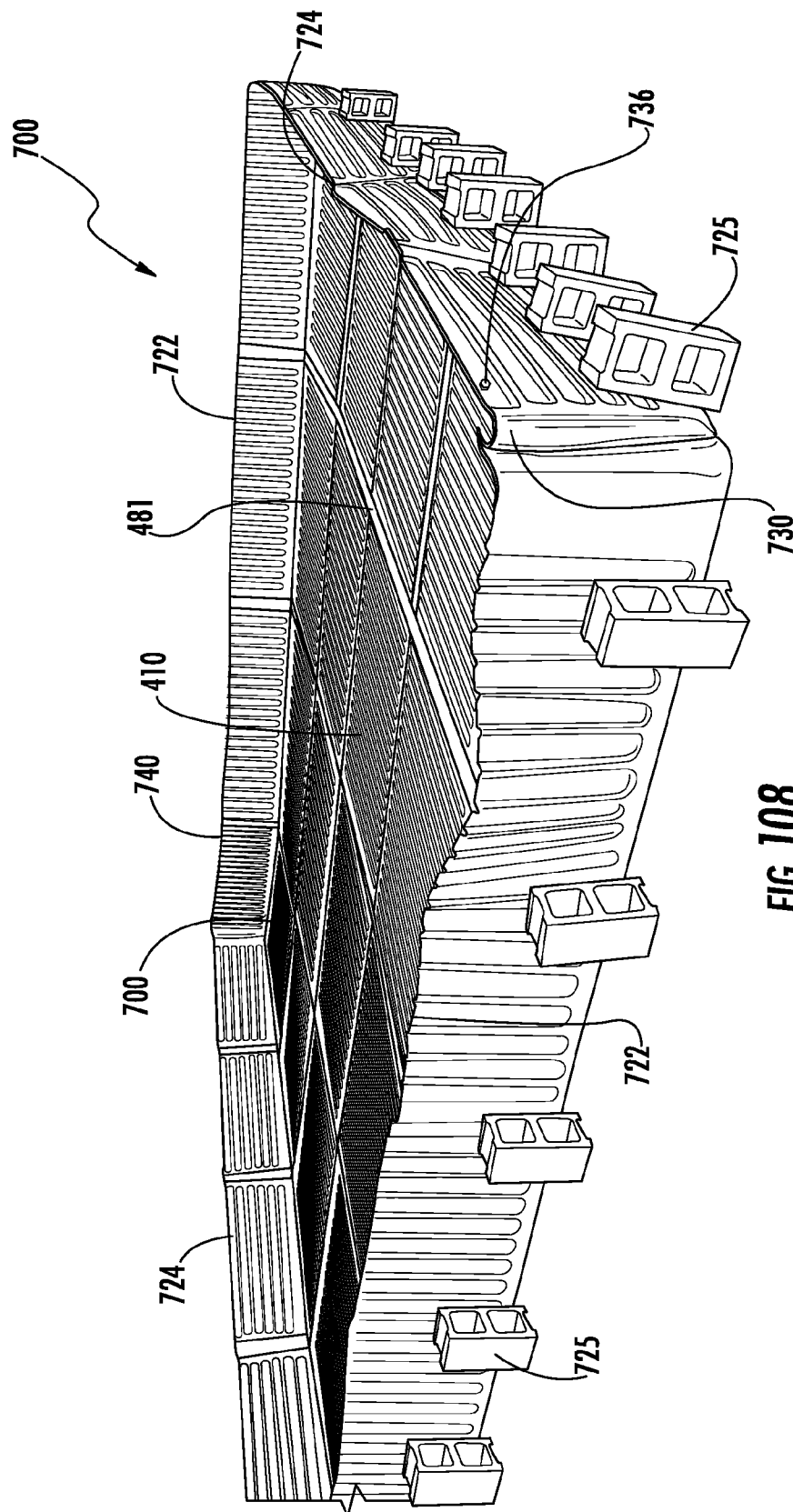
FIG. 101











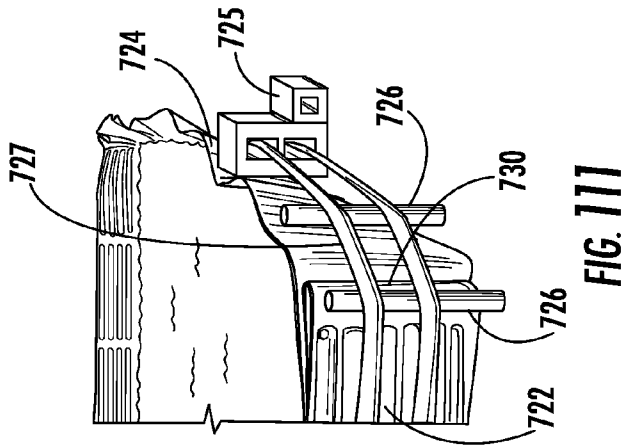


FIG. 111

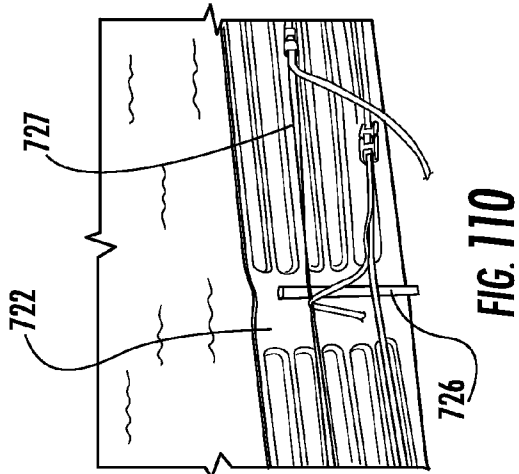


FIG. 110

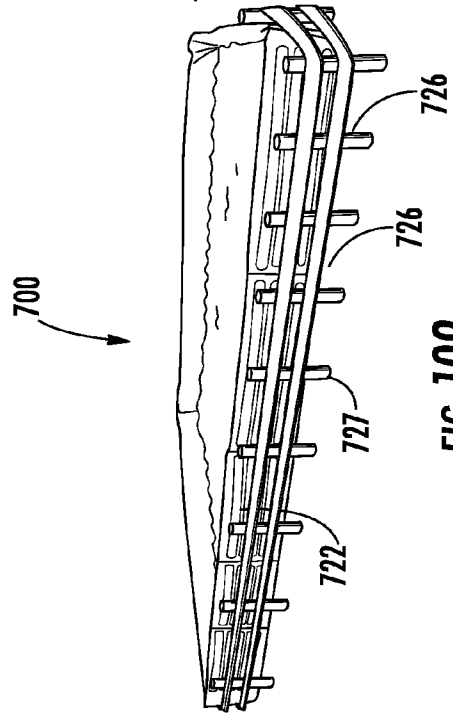
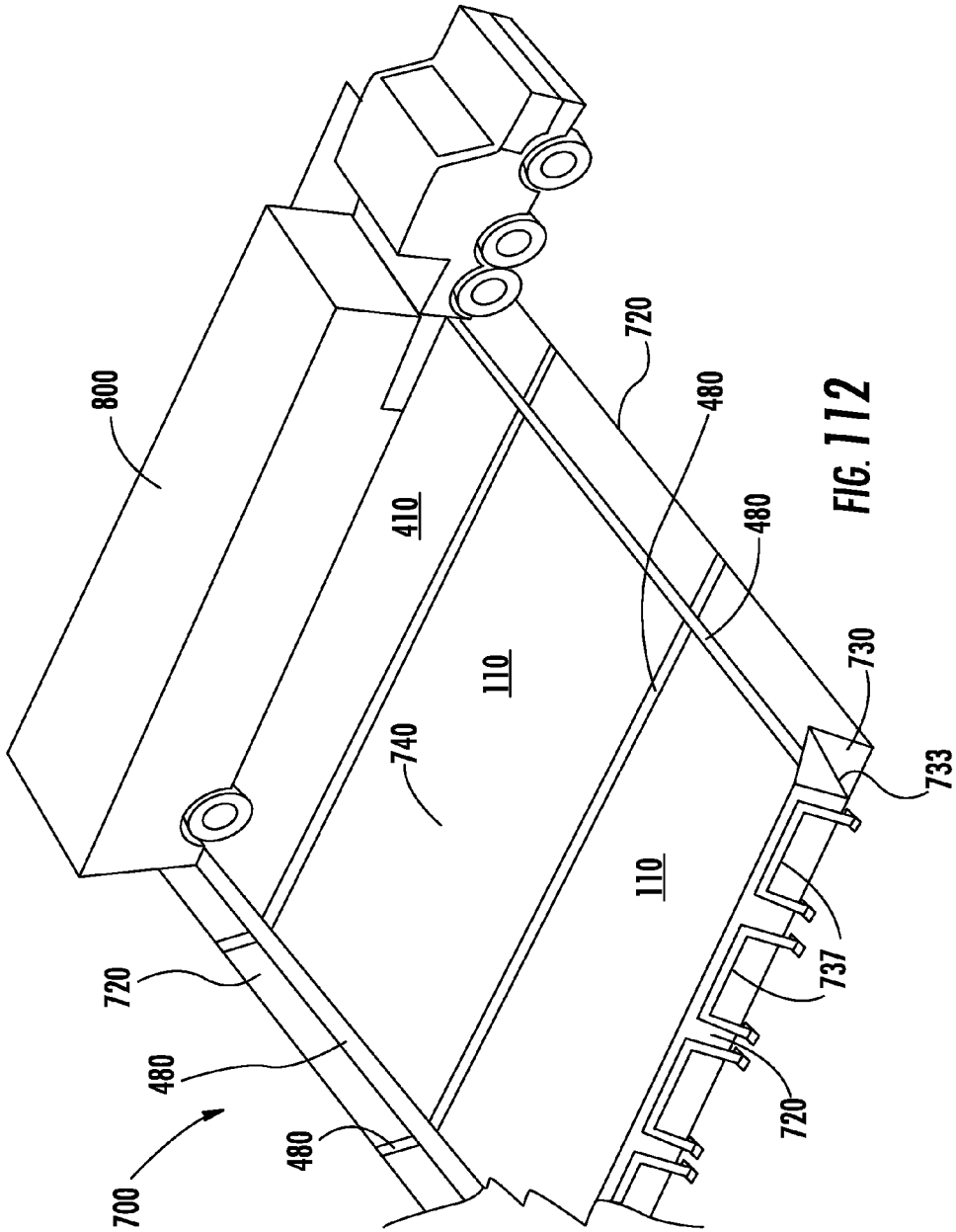
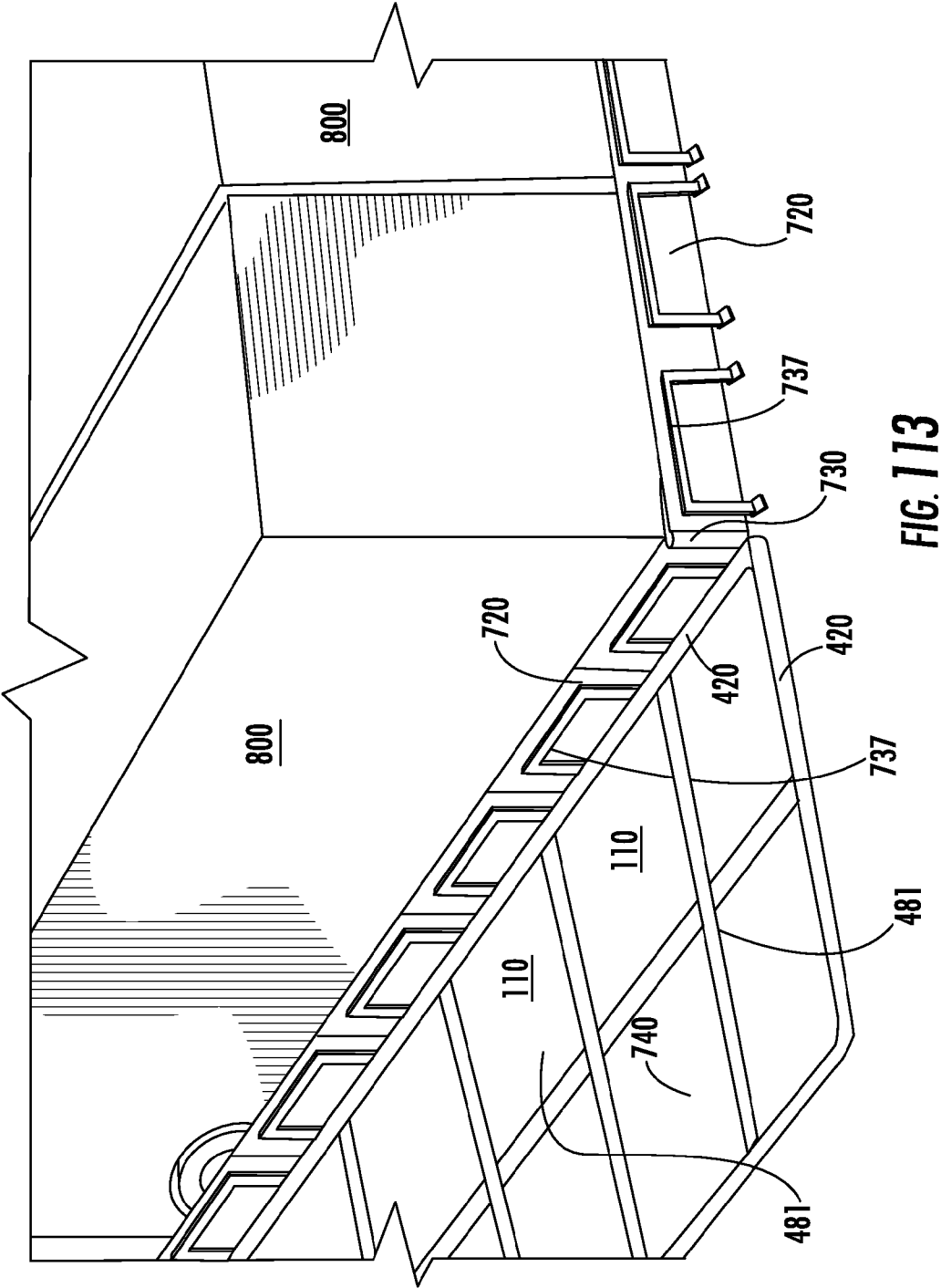


FIG. 109





**MODULAR, SCALABLE, PORTABLE AND
REUSABLE PRIMARY AND SECONDARY
SPILL CONTAINMENT LINING SYSTEMS
AND METHOD OF ASSEMBLING, SHIPPING
AND INSTALLING SUCH SYSTEMS**

**CROSS-REFERENCE TO RELATED
APPLICATIONS**

[0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 61/789,545, filed Mar. 15, 2013, entitled "Distribution Assembly and System for Assembling, Shipping, and Installing a Modular, Scalable Spill Containment Lining System," and is a Continuation-In-Part application of U.S. patent application Ser. No. 13/598,846, filed Aug. 30, 2012, entitled "Modular, Scalable Spill Containment Lining System," which claims priority to U.S. Provisional Patent Application Ser. No. 61/529,167, filed Aug. 30, 2011, the contents of each of which is hereby incorporated by reference in its entirety herein.

BACKGROUND

[0002] 1. Field of the Invention

[0003] The present disclosure relates to modular, scalable, reusable and portable primary and secondary spill containment lining systems for natural gas and oil well sites, electrical utility substation sites, industrial work sites, material and vehicle storage sites, and the like.

[0004] 2. Related Art

[0005] Recent geological discoveries and advances in technology have made it possible to access many new sources of natural gas. For example, deep shale deposits containing natural gas are found across much of the U.S. The Marcellus shale formation is a black, low density, carbonaceous (organic rich) shale that occurs in the subsurface beneath much of Ohio, West Virginia, Pennsylvania, and New York as well as parts of other states including Maryland, Kentucky, Tennessee, and Virginia. The formation was previously thought to contain about 1.9 trillion cubic feet of natural gas, a significant deposit but too diffuse to justify drilling. However, the formation is now believed to contain at least 500 trillion cubic feet of natural gas. Extracting just ten percent of it would be sufficient to meet current nationwide demand for two years and be worth about 1 trillion U.S. dollars. In Pennsylvania alone there are reported to be over 1,400 Marcellus shale natural gas wells sites currently drilling or producing with permits issued for over 4,800 additional sites.

[0006] Mineral resource extraction (e.g., mining and drilling) is a heavily regulated industry. For example, drilling sites are required to contain fluids and drilling residue and control surface water runoff in order to effectively minimize pollution and prevent soil erosion.

[0007] Under current practices, drilling sites are typically covered with a nylon tarp material. Prior to placing the tarp, a level surface is created by forming a base layer of large rip rap covered with small rip rap and then pea gravel. The nylon tarp is supplied in twelve foot rolls that are heat treated on site to seal them side to side. Because the nylon tarp can be slippery, a "felt" material may be added for better footing, but this can create a trip hazard. This can be a long and expensive process as drilling sites typically range from one to five acres in size. Also, this system is only usable on a flat surface. Most drilling sites have areas that cannot be covered in this manner, such as slopes around the perimeter of the site, where runoff and soil

erosion still occur. Increasingly, other outdoor industrial sites, such as electric utility substations, vehicle parking sites, material storage sites, and other sites are required to have primary or secondary liquid containment capability.

[0008] Generally, secondary containment is a second barrier or an outer wall of a double enclosure provided to contain any leak, spill, or associated run-off from a storage container or other source of an environmental contaminant. Typically, secondary containment helps to protect surface water, groundwater, and soil from exposure to environmental contaminants. In addition, secondary containment may assist in reducing worker exposure or primary containment systems to contaminants which may be regulated substances.

[0009] Secondary containment systems are typically required by law when certain regulated substances or environmental contaminants are being handled or stored. For example, local, state, and/or federal environmental regulations may mandate the use of secondary containment systems to reduce the risk of environmental exposure to certain contaminants.

[0010] Known secondary containment systems vary in complexity. A secondary containment system may be a detached building, an underground vault, or a dedicated portion of a larger space. The system may also incorporate liquid-tight storage cabinets, berms, curbs, sills, sunken floors, liners, drip pans, double-walled tanks, or other structures. However, these known secondary containment systems have certain disadvantages.

[0011] For example, known secondary containment systems are typically not mobile. Instead, they are typically a fixed construction permanently placed at a desired location. Many of these constructions utilize concrete and other permanent building materials due to desired slow wear properties of these materials. While these materials have a long lifespan and degrade slowly when exposed to certain chemicals or environmental conditions, they do not allow for simple and efficient teardown, transportation, and subsequent reuse at a different location.

[0012] In addition, known secondary containment systems are typically not scalable. Known secondary containment systems typically have to be constructed to a predetermined size based upon the end use of the system. What constructed, these known systems cannot be easily or efficiently increased or decreased in size without substantial construction efforts. In addition, increasing or decreasing the size of the system can negatively impact containment effectiveness of the system.

[0013] Further, known secondary containment systems are typically not recyclable. Since known secondary containment systems are typically permanently or semi-permanently installed, the associated materials from which known systems are constructed cannot be easily removed and reused. Instead, upon removal, the materials used to construct the known systems are typically placed in refuse.

[0014] Therefore a need is perceived to provide a secondary containment facility which is mobile, reusable, easily scalable for different sizes, and is recyclable when placed out of service.

SUMMARY

[0015] Exemplary embodiments of the invention relate to liquid containment lining systems comprising a plurality of planar or corrugated formed plastic body panels, perimeter panels, and corner panels. The tough but resilient plastic

panels are adapted for overlapping end-to-end connection and overlapping side-to-side connection to provide a continuous sealed “membrane” suitable for substantial liquid containment. The perimeter and corner panels are molded with raised perimeter ribs adapted to provide containment in at least a portion of the perimeter of the lining.

[0016] Another exemplary embodiment relates to a containment lining system comprising a main portion comprising a plurality of planar and/or corrugated formed plastic body panels that are connected in overlapping or coupled fashion to form a corrugated sealed liner. The liner further comprises a plurality of overlapped or otherwise coupled perimeter panels with a raised perimeter rib to provide sealed containment on at least a portion of the perimeter of the lining.

[0017] Another exemplary embodiment relates to a method of constructing sub-assemblies of planar and or corrugated formed plastic body panels that are connected together in overlapping or coupled fashion and shipping, installing and further connecting multiples of such sub-assemblies and accessory components to provide a lining system covering extensive outdoor areas for primary and or secondary spill containment.

[0018] Another exemplary embodiment provides an improved secondary containment facility for the secondary containment of leaks, spills, and/or associated run-off of environmental contaminants. The improved secondary containment facility is reusable and mobile, as it can easily be transported, rolled-out and positioned at a desired location, and then cleaned, rolled-up, and moved to another location for reuse. The secondary containment facility can also be provided with easy-take-down-easy-up perimeter edge portions which can be lowered flat to a support surface to permit vehicle access across the edge portion to the interior of the facility for temporary vehicle containment or easy delivery or pick-up of material containers or industrial equipment, and easy raising and securing of the side wall to provide fluid-tight secondary containment for articles within the facility. In addition, the improved secondary containment facility is easily scalable for different sized areas requiring secondary containment. The improved facility may be readily increased or decreased in size without weakening the containment properties of the facility. In addition, once the improved secondary containment facility is taken out of service, the facility is 100% recyclable.

[0019] These and other features and advantages of various embodiments of systems and methods according to this invention are described in, or are apparent from, the following detailed description of various exemplary embodiments of various devices, structures, and/or methods according to the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Various exemplary embodiments of the systems and methods according to the present disclosure will be described in detail, with reference to the following figures, wherein:

[0021] FIG. 1 is a top plan view of an exemplary gas or oil drill site with an exemplary embodiment of a modular, scalable spill containment lining system having a perimeter of a desired shape schematically shown in rectangular form by solid lines, according to the present disclosure;

[0022] FIG. 2 is a cross-sectional not-to-scale side view of the lining system of FIG. 1;

[0023] FIG. 3 is a partial cross-sectional side view of the lining system of FIG. 1 and exemplary embodiments of an erosion control system with a drainage trench according to the present disclosure;

[0024] FIG. 4 is an isometric view of a body portion of the lining system of FIG. 1;

[0025] FIG. 5 is an isometric view of an exemplary embodiment of a containment liner body panel according to the present disclosure;

[0026] FIG. 6 is a top view of the panel of FIG. 5;

[0027] FIG. 7 is an end view of the panel of FIG. 5;

[0028] FIG. 8 is a side view of the panel of FIG. 5;

[0029] FIG. 9 is a partial end view of the panel of FIG. 5;

[0030] FIG. 10 is an isometric view of a first exemplary embodiment of a containment liner right perimeter section according to the present disclosure;

[0031] FIG. 11 is a top view of the right perimeter section of FIG. 10;

[0032] FIG. 12 is a side view of the right perimeter section of FIG. 10;

[0033] FIG. 13 is an end view of the right perimeter section of FIG. 10;

[0034] FIG. 14 is an isometric view of an exemplary embodiment of a pad liner right perimeter section according to the present disclosure;

[0035] FIG. 15 is a top view of the left perimeter section of FIG. 14;

[0036] FIG. 16 is a side view of the left perimeter section of FIG. 14;

[0037] FIG. 17 is an end view of the left perimeter section of FIG. 14;

[0038] FIG. 18 is an isometric view of an exemplary embodiment of a containment liner upstream perimeter section according to the present disclosure;

[0039] FIG. 19 is a top view of the upstream perimeter section of FIG. 18;

[0040] FIG. 20 is a side view of the upstream perimeter section of FIG. 18;

[0041] FIG. 21 is an end view of the upstream perimeter section of FIG. 18;

[0042] FIG. 22 is an isometric view of an exemplary embodiment of a containment liner downstream perimeter section according to the present disclosure;

[0043] FIG. 23 is a top view of the downstream perimeter section of FIG. 22;

[0044] FIG. 24 is a side view of the downstream perimeter section of FIG. 22;

[0045] FIG. 25 is an end view of the downstream perimeter section of FIG. 22;

[0046] FIG. 26 is an isometric view of an exemplary embodiment of a containment liner upper right upstream corner section according to the present disclosure;

[0047] FIG. 27 is a top view of the right upstream corner section of FIG. 26;

[0048] FIG. 28 is a left side view of the upper left corner of FIG. 26;

[0049] FIG. 29 is an end view of the upper left corner of FIG. 26;

[0050] FIG. 30 is an isometric view of an exemplary embodiment of a containment liner right downstream corner section according to the present disclosure;

[0051] FIG. 31 is a top view of the right downstream corner section of FIG. 30;

[0052] FIG. 32 is a right side view of the right downstream corner section of FIG. 30;

[0053] FIG. 33 is an end view of the right downstream corner section of FIG. 30;

[0054] FIG. 34 is an isometric view of an exemplary embodiment of a containment liner left upstream corner section according to the present disclosure;

[0055] FIG. 35 is a top view of the left upstream corner section of FIG. 34;

[0056] FIG. 36 is a right side view of the left upstream corner section of FIG. 34;

[0057] FIG. 37 is an end view of the left upstream corner section of FIG. 34;

[0058] FIG. 38 is an isometric view of an exemplary embodiment of a containment liner left downstream corner section according to the present disclosure;

[0059] FIG. 39 is a top view of the left upstream corner section of FIG. 38;

[0060] FIG. 40 is a side view of the left upstream corner section of FIG. 38;

[0061] FIG. 41 is an end view of the left upstream corner section of FIG. 38;

[0062] FIG. 42 is an isometric view of a first exemplary embodiment of a containment liner right perimeter panel according to the present disclosure;

[0063] FIG. 43 is an end view of the right perimeter panel of FIG. 42;

[0064] FIG. 44 is an isometric view of an exemplary embodiment of a containment liner left perimeter panel according to the present disclosure;

[0065] FIG. 45 is an end view of the left perimeter panel of FIG. 44;

[0066] FIG. 46 is an isometric view of an exemplary embodiment of a containment liner upstream perimeter panel according to the present disclosure;

[0067] FIG. 47 is an end view of the upstream perimeter panel of FIG. 46;

[0068] FIG. 48 is a side view of the upstream perimeter panel of FIG. 46;

[0069] FIG. 49 is an isometric view of an exemplary embodiment of a containment liner downstream perimeter panel according to the present disclosure;

[0070] FIG. 50 is an end view of the downstream perimeter panel of FIG. 49;

[0071] FIG. 51 is a side view of the downstream perimeter panel of FIG. 49;

[0072] FIG. 52 is an isometric view of an exemplary embodiment of a containment liner right upstream corner panel according to the present disclosure;

[0073] FIG. 53 is an isometric view of an exemplary embodiment of a containment liner left upstream corner panel according to the present disclosure;

[0074] FIG. 54 is an isometric view of an exemplary embodiment of a containment liner left downstream corner panel according to the present disclosure;

[0075] FIG. 55 is an isometric view of an exemplary embodiment of a containment liner right downstream corner panel according to the present disclosure;

[0076] FIG. 56 is a top view of two of the panels of FIG. 5 connected end-to-end according to the present disclosure;

[0077] FIG. 57 is an exploded end cross-sectional view of the panels of FIG. 56, taken along the line A-A, showing an intermediate gasket;

[0078] FIG. 58 is a top view of two of the bi-panel assemblies of FIG. 56 connected side-to-side according to the present disclosure;

[0079] FIG. 59 is an exploded end cross-sectional view of the bi-panel assemblies of FIG. 58 along the line B-B;

[0080] FIG. 60 is an exploded isometric view of the bi-panel assemblies of FIG. 58;

[0081] FIG. 61 is a partial isometric view of the junction of the four panels of FIG. 58; and

[0082] FIG. 62 is a cross-sectional view of the junction of the four panels of FIG. 61 along the line C-C.

[0083] FIG. 63 is a cross-sectional not-to-scale view of another exemplary containment lining system.

[0084] FIG. 64 is a cross-sectional not-to-scale view of still another exemplary containment lining system.

[0085] FIG. 65 is a schematic end view of a pair of body panel edge portions for a containment lining system positioned for electro-fusion plasma welding with plasma welding rods extending between the panels prior to welding.

[0086] FIG. 66 is an isometric view of one or more examples of embodiments of a containment liner body panel.

[0087] FIG. 67 is a cross sectional view of the panel of FIG. 66, taken along line 67-67 of FIG. 66.

[0088] FIG. 68 is an isometric view of one or more examples of embodiments of a sheet coupling assembly for use in coupling containment liner body panels shown in FIG. 66.

[0089] FIG. 69 is a cross sectional view of the sheet coupling assembly of FIG. 68, taken along line 69-69 of FIG. 68.

[0090] FIG. 70 is an isometric view of one or more examples of embodiments of a sheet coupling assembly, wherein each thermoplastic weld rod has greater surface area than the weld rods illustrated in FIG. 68.

[0091] FIG. 71 is a cross sectional view of the sheet coupling assembly of FIG. 70, taken along line 71-71 of FIG. 70.

[0092] FIG. 72 is an isometric view of one or more examples of embodiments of a perimeter panel adapted to be coupled to an outer edge portion of the containment liner body panel of FIG. 66.

[0093] FIG. 73 is a cross sectional view of the perimeter panel of FIG. 72, taken along line 73-73 of FIG. 72.

[0094] FIG. 74 is an isometric view of one or more examples of embodiments of a perimeter panel coupling assembly for use in coupling perimeter panels shown in FIG. 72.

[0095] FIG. 75 is a cross sectional view of the perimeter panel coupling assembly of FIG. 74, taken along line 75-75 of FIG. 74.

[0096] FIG. 76 is an isometric view of one or more examples of embodiments of a corner perimeter panel adapted to be coupled to the outer edge portions of an outer corner of a liner body panel shown in FIG. 66.

[0097] FIG. 77 is an end view of the corner perimeter section of FIG. 76.

[0098] FIG. 78 is an isometric exploded view of a portion of a lining system, specifically including an outer perimeter corner panel and associated perimeter panels, wherein a plurality of panels of FIG. 66 are being coupled together, the ends of the sheet coupling assemblies being shown in broken lines to demonstrate they can extend further than the illustrated panels.

[0099] FIG. 79 is an isometric view of a portion of a lining system of FIG. 78, illustrating the one or more embodiments

of the various elements coupled together to form a liquid tight and/or water tight sealed lining system.

[0100] FIG. 80 is an isometric schematic view of a plurality of reels of panels arranged on a transportation vehicle.

[0101] FIG. 81 is an isometric schematic view of a plurality of reels of panels, each of the reels of panels rolled about at least one core.

[0102] FIG. 82 is an isometric view of one or more examples of a core.

[0103] FIG. 83 is an exploded view of the core of FIG. 82.

[0104] FIG. 84 is a side view of an end plate of the core of FIG. 82.

[0105] FIG. 85 is a side view of member of the core of FIG. 82, the member having a slot provided therein.

[0106] FIG. 86 is a top down view of the member of FIG. 85, taken along line 86-86 of FIG. 85.

[0107] FIG. 87 is a side view of the member of FIG. 85, taken along line 87-87 of FIG. 86.

[0108] FIG. 88 is an isometric view of a panel engaging the slot of the core of FIG. 82.

[0109] FIG. 89 is a close up view of the panel engaging the slot of the core of FIG. 82.

[0110] FIG. 90 is an isometric view of a panel partially wound about the core of FIG. 82.

[0111] FIG. 91 is an isometric view of a panel wound about the core of FIG. 82.

[0112] FIG. 92 is an isometric view of a wound reel of panels being partially unwound at a desired location to form a lining system.

[0113] FIG. 93 is an isometric view of a plurality of unwound reel of panels coupled together at a desired location to form a lining system.

[0114] FIG. 94 is an isometric view of a completed lining system comprised of a plurality of reel of panels coupled together.

[0115] FIG. 95 is an isometric view of an example of an embodiment of a modular secondary containment facility of the present invention after being rolled out and prior to deployment of the sidewalls.

[0116] FIG. 96 is a top down view of a corner portion or corner assembly for use in the modular secondary containment facility of FIG. 95.

[0117] FIG. 97 is a side profile view of the corner portion of FIG. 96.

[0118] FIG. 98 is a zoomed in side profile view of one or more scores provided in the corner portion of FIG. 96, taken along line 4-4 of FIG. 97.

[0119] FIG. 99 is an elevation view of a corner portion as shown in FIGS. 96-98, as positioned for use in the near left corner of the modular secondary containment facility of FIG. 95, between adjacent wall or edge portions.

[0120] FIG. 100 is an isometric view of the corner portion of FIG. 99, provided in a raised position with an attached edge portion.

[0121] FIG. 101 is an isometric view of the corner portion of FIG. 99, wherein the corner portion is being folded along a third score.

[0122] FIG. 102 is an isometric view of the corner portion of FIG. 99, wherein the folded corner portion is folded against a first edge portion to form the near left corner portion of the modular secondary containment facility of FIG. 95.

[0123] FIG. 103 is an isometric view of a corner portion as shown in FIGS. 96-98, as positioned to form the near right corner portion of the modular secondary containment facility

of FIG. 95, wherein the corner portion is folded and connected to the adjacent second edge portion, creating a water tight seal.

[0124] FIG. 104 is another isometric view of the corner portion of FIG. 99, wherein the corner portion is folded and connected to the adjacent first edge portion, creating a water tight seal.

[0125] FIG. 105 is an isometric view of a portion of the modular secondary containment facility of FIG. 95 having two of the edge portions deployed into a containment position.

[0126] FIG. 106 is an isometric view of a portion of the modular secondary containment facility of FIG. 95 having three of the edge portions deployed into a containment position, and further illustrating a folded near right corner portion without connecting members.

[0127] FIG. 107 is an isometric view of a portion of the modular secondary containment facility of FIG. 95, wherein a connecting member is installed in a folded far right corner portion.

[0128] FIG. 108 is an isometric view of a portion of the modular secondary containment facility of FIG. 95 wherein all of the corner portions are connected to corresponding edge portions deploying the modular secondary containment facility.

[0129] FIG. 109 is an isometric view of a portion of the modular secondary containment facility of FIG. 95 illustrating a liquid provided therein and having optional supports, which include a plurality of fence posts interconnected by tensioned cable.

[0130] FIG. 110 is an isometric view of a portion of the modular secondary containment facility of FIG. 95, illustrating a liquid provided therein and having optional supports including fence posts interconnected by tensioned ratchet straps.

[0131] FIG. 111 is an isometric view of a portion of the modular secondary containment facility of FIG. 95, illustrating a liquid provided therein and having optional supports including a combination of a plurality of fence posts interconnected by tensioned cables and cinder blocks.

[0132] FIG. 112 is an isometric view of a modular secondary containment facility of the invention wherein an edge portion is shown in a horizontal ground-level position to allow a semi-trailer and tractor to be positioned on the base panels and edge panel of the facility during delivery and dropping of the trailer on the base panels, and further showing an alternative example of embodiments having substantially flat panels and optional supports including a plurality of posts connected by horizontal rails and with bases extending in opposed directions from the posts and perpendicular to the plane of the rails.

[0133] FIG. 113 is an isometric view of the modular secondary containment facility of FIG. 112, after placement of a plurality of trailers on the base panels of the facility, and the edge panels of the facility have been raised to vertical position to form a wall, and all four walls of the facility have been reinforced by optional supports including a plurality of steel posts connected by horizontal steel rails, and with steel bases extending in opposed directions from the posts and perpendicular to the plane of the rails, and further showing an adjacently coupled assembly including a base panel assembly and raised perimeter ribs.

[0134] It should be understood that the drawings are not necessarily to scale. In certain instances, details that are not

necessary to the understanding of the invention or that render other details difficult to perceive may have been omitted. It should be understood, of course, that the invention is not necessarily limited to the particular embodiments illustrated herein.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0135] The present disclosure relates to a scalable, modular spill containment lining system for containing and controlling the flow of water and/or other fluids, whether from natural rain, snow, or man-made sources, on industrial sites, such as oil and natural gas wells, electric utility substations, vehicle parking areas, and the like. Natural gas drilling areas are typically one to five square miles in size. A single well site is typically one to four acres in size containing the drilling equipment, materials and supplies, vehicles for transporting supplies and personnel, and other equipment. The containment lining system of the present disclosure is substantially installed below the top surface of a well site to prevent seepage and contain any fluid contaminants, fluid-borne contaminants or precipitation.

[0136] In various exemplary embodiments, the disclosed system comprises a plurality of corrugated ground covering molded plastic panels coupled together in overlapping fashion. In some exemplary embodiments, the system may include one or more molded plastic ditches that comprise one or more coupled components. In such embodiments, the ditch components are coupled or juxtaposed in overlapped relation to the ground cover components and the system to channel liquids on the ground cover components into the ditches. The ditches may provide or discharge to a conduit to an outlet or destination like a retention pond or treatment facility. In various exemplary embodiments, the disclosed system has a peripheral rib or wall extending from all margins of the ground cover components, to permit contained liquids to be pumped from the containment area for treatment or proper disposal.

[0137] In various exemplary embodiments, the disclosed liner comprises a plurality of various interconnected panels **110** which may be advantageously extruded or molded from high density polyethylene (HDPE), or other suitably tough, flexible, durable, moldable or extrudable plastic materials. FIGS. 1 and 2 show a simplified exemplary embodiment of a drill site (many of the features necessary for drilling or operating a well are not shown). Prior to installation of a drill pad spill containment lining system **100**, the site may be prepared by grading it to a suitable grade and/or by creating an appropriate base subsurface **90** (e.g., large and/or small riprap, gravel, pea gravel, and/or sand or other small granular material). The subsurface **90** is laid on an underlying natural soil or fill material (not shown) prepared and graded or shaped by conventional methods and materials. The lining system **100** is assembled and installed on the subsurface **90**. As shown in FIGS. 2 and 3, the lining system **100** may be installed at a slight slope (e.g., of about a 1 to 2% grade) to direct water flow to a desired outlet location or side of the lining system **100**. In various exemplary embodiments, as illustratively shown in FIGS. 63 and 64, the lining system may be installed in a flat, level condition with raised perimeter panels extending continuously around all sides and margins of the lining system to contain fluids which might be received by the lining system. As shown in FIG. 4, the lining system **100** may be assembled by connecting a plurality of panels **110**, which may be corru-

gated, in an overlapping manner. In an exemplary embodiment, gasket strips **118** may be placed between overlapping panel edges, which may be connected by screws and/or adhesives, as shown in FIGS. 57-62, or by plasma welding, as shown in FIG. 65, all as described below.

[0138] FIG. 1 also shows a production pad **104** located near the drill site to accommodate vehicles, equipment, personnel and/or oil/gas tanks for temporary storage of well production products. The lining system **100** described herein for the well pad can be equally well utilized for the production site **104**.

[0139] In various exemplary embodiments, as illustrated in FIGS. 2 and 3, the liner **100** may be covered by a gravel pad **101**. The gravel pad **101** provides a flat load-bearing surface for supporting walking equipment or vehicles. In various exemplary embodiments, the gravel pad will be at least about 6 to 12 inches deep. The gravel pad **101** preferably comprises small rip rap or similarly sized stone that is large enough to provide interstitial space for the passage of water and small enough for foot or vehicle traffic. In various exemplary embodiments, the depth of the gravel pad may be varied. For example, the depth of the gravel pad may be increased to provide a crown or "bridge" **105** at a vehicle access point along the perimeter to facilitate passage of vehicles onto or off from the lining system **100** via service road **106**, without damage to the perimeter structure of the lining system.

[0140] In various exemplary embodiments, as shown in FIG. 3, liquids travel down the inclined lining system **100** to an optional trench or ditch **103**. In various exemplary embodiments, the corrugated panels **110** are installed such that the predominant direction of the corrugations and water flow is downstream, generally parallel to the ribs **111**, but more complicated flow patterns may include flows in different directions. For purposes of this description, the referenced "upstream" and "downstream" directions will extend parallel to the ribs **111** and valleys **112** as identified in FIGS. 5 and 8. The ditch **103** may then convey the liquids to an outlet or destination, such as a retention pond or water treatment facility. In various other exemplary embodiments, the lining system **100** may be installed such that liquids drain toward one or more interior outlets, such as a sumps or drainage pipes. In various exemplary embodiments, the main panels **110**, which may be corrugated or flat planar panels, may be installed level, as shown in FIGS. 63 and 64, with pumps (not shown) used to pump out any leaked or accumulated fluids for further use or proper disposal.

[0141] In various exemplary embodiments, an erosion control system **102** is used to prevent material from the gravel pad **101** from falling into the ditch **103**. The ditch is comprised of one or more molded plastic components coupled together to form a generally V-shaped or U-shaped ditch, as more fully identified below. The erosion control system **102** is made of a "blanket" of porous geotextile fabric **102** sheet material that allows water and other liquids, but not aggregate, to pass from the gravel pad **101**. In various exemplary embodiments, as shown in FIG. 3, the geotextile fabric **102** sheet material is placed around a quantity of aggregate with the ends secured in place under additional aggregate.

[0142] In various exemplary embodiments, the ditch **103** comprises a plurality of coupled ditch segments (not shown). In some embodiments, each ditch segment is a single, integral unit forming a ditch **103**. In other embodiments, the ditch segments may comprise multiple components coupled together to form ditch segments. In various exemplary embodiments, the ditch component comprises alternating

ribs and valleys or corrugations similar to body panel 110, as described below, except the ribs will generally run transversely to the axis of the ditch segments. In various exemplary embodiments, the ribs and valleys of the ditch 103 and lining system 100, or body panels 111, may be adapted for tight, overlapping connection. An exemplary modular, sealable ditch is disclosed in U.S. patent application Ser. No. 12/962,323, published as 2011/0135392 A1, the entire disclosure of which is incorporated herein by reference. The size and shape of the ditch 103 may be varied as needed to accommodate the needs of a given site and application.

[0143] In various exemplary embodiments, as illustrated in FIG. 4, the lining system 100 is assembled from a plurality of panels 110. FIG. 4 shows an exemplary liner section 100 comprised of six liner panels 110 in a 2x3 configuration.

[0144] In various exemplary embodiments, the main body of the lining system is assembled from a plurality of individual body liner panels 110, shown in FIGS. 5-8. In various exemplary embodiments, body panel 110 is generally rectangular in shape and corrugated with alternating relatively wide, flat ribs or ridges 111 and narrow valleys 112. In various exemplary embodiments, the ribs 111 may be about 1.0 inch tall and 4.0 inches wide (measured between adjacent valley 112 bottoms). In various exemplary embodiments, side walls of ribs 111 are angled or sloped at about 25 degrees from vertical, but the sidewall angle may be varied. The corrugated pattern provides greater strength and rigidity to the body panels 110 and other components. It should be noted that size and shape of the ribs may vary within the scope of the present disclosure and claims to meet the design needs of the targeted user group.

[0145] In various exemplary embodiments, the body panel 110 may be about 100 inches long (i.e., the dimension perpendicular to the ribs) by about 75 inches wide (i.e., the dimension parallel to the ribs). In various exemplary embodiments, the body panel 110 corrugations are about 1.15 inches high. In various exemplary embodiments, the valleys 112 are approximately 4.16 inches apart (i.e., distance between the bottom points of adjacent valleys) and the sides of the valleys 112 are inclined at an angle of about 115 degrees from horizontal (at the base). In various exemplary embodiments, the panels will be formed from high-density polyethylene (HDPE) sheets having a thickness of 0.125 inch, but thinner or thicker sheet materials ranging generally from about 0.060 to about 0.250 inches may be used depending upon the application, required useful panel life or conditions of use.

[0146] HDPE is a highly crystalline lightweight thermoplastic material having outstanding characteristics of chemical resistance, toughness (even at low temperatures), dielectric properties, water vapor impermeability, and relatively high softening temperature. The HDPE sheet material may be formed from virgin HDPE or recycled HDPE and/or other compatible blended thermoplastic materials which are known to share or enhance the properties of HDPE for particular site conditions or requirements. Accordingly, all or substantial portions of the panels may be comprised of recycled material.

[0147] In various exemplary embodiments, the body panels 110 have an offset upstream right corner 113 and an offset downstream right corner 114. As discussed in more detail below, the offset corners facilitate overlapping connection of body panels 110. In various exemplary embodiments, the body panel 110 is formed with multiple offsets 113 and 114, as shown in FIGS. 6 and 7. As described in detail below, the panels 110 are overlapped and connected with fasteners.

Once the lining system 100 is no longer needed (e.g., after wells are in operation, or are no longer producing), all or part of the lining system 100 may be removed by cutting away overlapped panel portions such that an interior pair of offsets 113 and 114 are adjacent to the new upstream and downstream edges. This facilitates reuse of the body panels 110 at another well pad or production pad site. The cut-away scrap portions may be cleaned, shredded, reheated and reformed for use in new body panels 110 or other unrelated thermoplastic applications to substantially eliminate waste. Likewise, the used body panels 110 themselves may be cleaned, shredded, reheated, reformed and thus recycled, into new body panels or other useful formed articles.

[0148] In various exemplary embodiments, as shown in FIG. 9, body panel 110 may include a gasket trench 117 extending across the width of the body panel 110 crossing the ridges 111 and valleys 112. The gasket trench 117 provides a space for placement of a flexible, resilient gasket strip (not shown in FIG. 9) or other compressible material (e.g., sponge cell foam) which may be placed or secured to provide a more watertight connection between overlapped body panels 110, as discussed in more detail below. In various exemplary embodiments, the trench 117 is sized to accommodate a one inch wide by 0.25 inch thick sealing strip 118 (See FIG. 57) that will be compressed to about 0.125 inches in thickness when positioned and fastened between overlapping panels 110.

[0149] FIGS. 10-13 show an exemplary embodiment of a left perimeter panel 120. In various exemplary embodiments, a left perimeter panel 120 is generally rectangular in shape and corrugated with at least one edge portion comprising a flat rib 111 and narrow valley 112 substantially matching the corrugations of body panel 110. In various exemplary embodiments, a right perimeter panel 120 also comprises a raised perimeter rib 121 along its opposite edge portion comprising a similar flat rib 111 edge. In various exemplary embodiments, the right perimeter panel 120 is attachable to a body panel 110 by overlapping edge portion flat rib 111 of the right perimeter panel 120 and the rightmost edge portion rib edge 111 of the body panel 110, preferably with a gasket or other sealant placed between the two components. The raised perimeter rib 121 provides peripheral containment for the aggregate of the gravel pad 101 loaded on top of the lining system 110, wherein the edge portions of the right perimeter panels 120 are attached to the edge portions of the body panels 110 forming the right side of the assembled main body lining system 100 (as referenced as if looking upstream toward the assembled lining system from the downstream end of the lining system). Typically, the lining system will be constructed starting at the downstream end. Each next succeeding upstream panel showed overlap the adjacent downstream panel. If the system is constructed on level ground, the starting end would be considered the "downstream" end for construction purposes.

[0150] FIGS. 14-17 show an exemplary embodiment of a left perimeter panel 130. In various exemplary embodiments, a left perimeter panel 130 is generally rectangular in shape and with a corrugated edge portion having at least one flat rib 111 and narrow valley 112 substantially matching the corrugations of body panel 110. In various exemplary embodiments, a left perimeter panel 130 also comprises a raised perimeter rib 121 along its left edge opposite the flat rib 111. In various exemplary embodiments, a left perimeter section 130 is attachable to a body panel 110 by overlapping edge

portion flat rib 111 of a left perimeter section 130 and the leftmost rib 111 of the body panel 110 (as referenced looking downstream), preferably with a gasket or other sealant placed between the two components, in the same manner as the right perimeter panel 120 is attached on the right side of the lining system 100, and serves the same peripheral containment function as the right peripheral panels 120. Although the left and right perimeter sectional panels 120 and 130 may be structurally the same, they are assembled in the lining system 100 with their downstream oriented ends each overlapping the upstream ends of the next downward positioned perimeter panel.

[0151] FIGS. 18-21 show an exemplary embodiment of an upstream perimeter panel 140. In various exemplary embodiments, upstream perimeter panel 140 is generally rectangular in shape and corrugated along its downstream side with an edge portion having alternating short flat ribs 111 and narrow valleys 112 substantially matching the ribs 111 and valleys 112 of body panel 110. In various exemplary embodiments, an upstream perimeter panel 140 also comprises a raised perimeter rib 121 along its upstream edge. In various exemplary embodiments, an upstream perimeter panel 140 is attachable to a body panel 110 by overlapping the short flat ribs 111 and valleys 112 of the downstream edge portion of the upstream perimeter section 140 with the matching ribs 111 and valleys 112 at the upper edge of the body panel 110, preferably with a gasket or other sealant placed between the two components. The raised perimeter 121 of the upstream perimeter panel 140 provides the same peripheral containment function along the upstream edge of the lining system 110 as the previously described perimeter ribs 121.

[0152] FIGS. 22-25 show an exemplary embodiment of a downstream perimeter section 150. In various exemplary embodiments, downstream perimeter section 150 is generally rectangular in shape and corrugated with alternating flat ribs and narrow valleys substantially matching the corrugations of body panel 110. In various exemplary embodiments, a downstream perimeter panel 150 also comprises a raised perimeter rib 121 along all or part of its downstream edge for similar containment purposes. In various exemplary embodiments, a downstream perimeter panel 150 is attachable to a body panel 110 by overlapping the short flat ribs 111 and valleys 112 of the upstream edge portion of the downstream perimeter panel 150 with the ribs 111 and valleys 112 at the downstream edge of the first adjacent upstream body panel 110, preferably with a gasket or other sealant placed between the two components.

[0153] FIGS. 26-29 show an exemplary embodiment of a right upstream corner panel 160. In various exemplary embodiments, right upstream corner panel 160 is generally rectangular in shape and corrugated with alternating flat ribs and narrow valleys substantially matching the adjacent corrugations of body panel 110. Right upstream corner panel 160 also comprises a continuous raised perimeter rib 121 along its top edge and right edge.

[0154] FIGS. 30-33 show an exemplary embodiment of a right downstream corner panel 170. In various exemplary embodiments, a right downstream corner panel 170 is generally rectangular in shape and corrugated with an edge portion having alternating flat ribs 111 and narrow valleys 112 substantially matching the corrugations of body panel 110. A right downstream corner panel 170 also comprises a continuous raised perimeter rib 121 along its bottom edge and right edge.

[0155] FIGS. 34-37 show an exemplary embodiment of a left upstream corner panel 180. In various exemplary embodiments, left upstream corner panel 180 is generally rectangular in shape and corrugated with an edge portion having alternating flat ribs and narrow valleys substantially matching body panel 110. Left upstream corner panel 180 also comprises a continuous raised perimeter rib 121 along its top edge and left edge.

[0156] FIGS. 38-41 show an exemplary embodiment of a left downstream corner panel 190. In various exemplary embodiments, a left downstream corner panel 190 is generally rectangular in shape and corrugated with an edge portion having alternating flat ribs and narrow valleys substantially like body panel 110. Left downstream corner panel 190 also comprises a continuous raised perimeter rib 121 along its bottom edge and left edge.

[0157] It should be noted that although the right upstream corner panel 160, right downstream corner panel 170, left upstream corner panel 180, and a left downstream corner panel 190 are named and described in connection for their use on an outside corner (90° of pad), variations thereof may also be molded for use on inside corners (270° of pad) by forming ribs and valleys on exterior sides of continuous, angled perimeter ribs 121 in an obvious manner. Thus, it should also be noted that although the lining system is shown herein as rectangular in shape, more complex shapes may be assembled using the disclosed systems and methods within the meaning of the appended claims.

[0158] FIGS. 42 and 43 show an exemplary embodiment of a right perimeter panel 230. In various exemplary embodiments, a right perimeter panel 230 is generally rectangular in shape and corrugated with alternating flat ribs 111 and narrow valleys 112 substantially matching the corrugations of body panel 110. In various exemplary embodiments, a right perimeter panel 230 also comprises a raised perimeter rib 221 along its right edge. In various exemplary embodiments, a right perimeter panel 230 is attachable to a body panel 110 by overlapping flat rib 211 of a right perimeter panel 230 and the rightmost rib 111 of a body panel 110, preferably with a gasket or other sealant placed between the two components. In various exemplary embodiments, a right perimeter panel 230 is substantially similar to the right perimeter section 130 except for the increased number of ribs 211 and valleys 212 across the width of the panel.

[0159] FIGS. 44 and 45 show an exemplary embodiment of a left perimeter panel 220. In various exemplary embodiments, a left perimeter panel 220 is generally rectangular in shape and corrugated with alternating flat ribs 111 and narrow valleys 112 substantially matching the corrugations of body panel 110. In various exemplary embodiments, a left perimeter panel 220 also comprises a raised perimeter rib 221 along its left edge. In various exemplary embodiments, a left perimeter panel 220 is attachable to a body panel 110 by overlapping flat rib 211 of a left perimeter section 220 and the leftmost rib 111 of the body panel 110, preferably with a gasket or other sealant placed between the two components. In various exemplary embodiments, a left perimeter panel 220 is substantially similar to the left perimeter section 120 except for the increased number of ribs 211 and valleys 212.

[0160] FIGS. 46-48 show an exemplary embodiment of an upstream perimeter panel 240. In various exemplary embodiments, upstream perimeter panel 240 is generally rectangular in shape and corrugated with alternating short flat ribs 111 and narrow valleys 112 substantially matching the corruga-

tions of body panel 110. In various exemplary embodiments, an upstream perimeter panel 240 also comprises a raised perimeter rib 221 along its top edge. In various exemplary embodiments, an upstream perimeter panel 240 is attachable to a body panel 110 by overlapping the short flat ribs 111 and valleys 112 of the upstream perimeter panel 240 and the ribs 111 and valleys 112 at the upper edge of the body panel 110, preferably with a gasket or other sealant placed between the two components. In various exemplary embodiments, the upstream perimeter panel 240 is substantially similar to the upstream perimeter section 140 except for the increased length of the ribs 211 and valleys 212, extending downstream from the raised perimeter rib 221.

[0161] FIGS. 49-51 show an exemplary embodiment of a downstream perimeter panel 250. In various exemplary embodiments, downstream perimeter panel 250 is generally rectangular in shape and corrugated with alternating flat ribs and narrow valleys substantially matching the corrugations of body panel 110. In various exemplary embodiments, a downstream perimeter panel 250 also comprises a raised perimeter rib 221 along its bottom edge. In various exemplary embodiments, a downstream perimeter panel 250 is attachable to a body panel 110 by overlapping the short flat ribs 211 and valleys 212 of the downstream perimeter panel 250 with the ribs 111 and valleys 112 at the lower edge of the body panel 110, preferably with a gasket or other sealant placed between the two components. In various exemplary embodiments, the downstream perimeter panel 250 is substantially similar to the downstream perimeter section 150 except for the increased length of the ribs 211 and valleys 212.

[0162] FIG. 52 shows an exemplary embodiment of a right upstream corner panel 260. In various exemplary embodiments, right upstream corner panel 260 is generally rectangular in shape and corrugated with alternating flat ribs 211 and narrow valleys 212 substantially matching the corrugations of body panel 110. Right upstream corner panel 260 also comprises a continuous raised perimeter rib 221 along its upstream edge and right edge. In various exemplary embodiments, the right upstream corner panel 260 is substantially similar to the right upstream corner section 160 except for overall size and the number and length of ribs 211 and valleys 212.

[0163] FIG. 53 shows an exemplary embodiment of a left upstream corner panel 270. In various exemplary embodiments, left upstream corner panel 270 is generally rectangular in shape and corrugated with alternating flat ribs 211 and narrow valleys 212 substantially matching the corrugations of body panel 110. Left upstream corner panel 270 also comprises a continuous raised perimeter rib 221 along its top edge and left edge. In various exemplary embodiments, the left upstream corner panel 270 is substantially similar to the left downstream corner section 170 except for overall size and the number and length of ribs 211 and valleys 212.

[0164] FIG. 54 shows an exemplary embodiment of a left downstream corner panel 280. In various exemplary embodiments, left downstream corner panel 280 is generally rectangular in shape and corrugated with alternating flat ribs and narrow valleys substantially matching the corrugations of body panel 110. Left downstream corner panel 280 also comprises a continuous raised perimeter rib 221 along its downstream edge and left edge. In various exemplary embodiments, the left downstream corner panel 280 is substantially

similar to the left downstream corner section 180 except for overall size and the number and length of ribs 211 and valleys 212.

[0165] FIG. 55 shows an exemplary embodiment of a right downstream corner panel 290. In various exemplary embodiments, right downstream corner panel 290 is generally rectangular in shape and corrugated with alternating flat ribs and narrow valleys substantially like body panel 110. Right corner panel 290 also comprises a continuous raised perimeter rib 221 along its downstream edge and right edge. In various exemplary embodiments, the right downstream corner panel 290 is substantially similar to the right downstream corner section 190 except for overall size and the number and length of ribs 211 and valleys 212.

[0166] In various exemplary embodiments, the perimeter rib 121 or 221 is taller than the ribs 112 and 113. In one exemplary embodiment, the perimeter rib 121 or 221 is about 4 inches tall and 6 inches wide at the base. In other exemplary embodiments, the perimeter ribs 121 or 221, or portions of them, may be of greater height, such as 7 to 10 inches, or greater, depending on containment needs. Depending upon the height of ribs 121 or 221, it may be advantageous and practical in some areas, particularly for upstream perimeter panels 240, to facilitate vehicle entry points on the gravel pad 101 when passing over the perimeter edge of the lining system 100, by removing portions of the peripheral ribs 121 or 221. In various exemplary embodiments, the panels 110 are installed such that the predominant downstream direction of flow is generally parallel to the ribs 111 but more complicated flow patterns may include flows in different directions.

[0167] In various exemplary embodiments, one or both of the ribs 111 at an edge of a body panel 110 or other components 120, 130, 140, 150, 160, 170, 180, 190, 220, 230, 240, 250, 260, 270, 280, or 290 may be offset to facilitate overlapping connection of panels. In various exemplary embodiments, the offset rib is larger or smaller than standard rib 111 by about the thickness of the component material (e.g., 0.075 inches) so that it will fit closely with rib 111. In some exemplary embodiments, more than one offset rib may be provided to facilitate reuse of the component.

[0168] In various exemplary embodiments, all of the components 110, 120, 130, 140, 150, 160, 170, 180, and 190 and/or 220, 230, 240, 250, 260, 270, 280, and 290 may be produced using a single mold. For example, the mold may be designed to produce a panel with a perimeter rib 121 around its entire perimeter. Such a part may then be trimmed to form one or more desired components. Alternatively, by way of example, inserts may be placed in the mold to selectively reduce the mold to form a selected component with or without a perimeter rib on selected side(s) and with selected shape and dimensions. The liner components are preferably and typically formed from a recyclable thermoplastic material, such as HDPE, particularly if part of the liner component is to be removed so that the trimmed or removed portion may be shredded, reheated, reformed, and thereby recycled back in to the production process. In various exemplary embodiments, the panel 110 includes molded-in trim guides to assist in removing scrap sheet. The panels may be trimmed with a cutting tool such as, for example, a router or a circular saw.

[0169] FIGS. 56 and 57 illustrate an overlapping end-to-end connection of two body panels 110. In various exemplary embodiments, the downstream end of one panel 110 is aligned over the upstream end of a second panel 110 for end-to-end coupling of panels 110. In various exemplary

embodiments, a liquid-tight or leak-resistant connection is obtained by placing a gasket **118** or other sealant between the overlapped panels **110**. Fasteners (not shown in FIGS. **56** and **57**), such as, for example, self-tapping screws, may be used to securely couple the liner panels **110**. In various exemplary embodiments, the fastener is preferably installed in the bottom of the crevice **112** between two ribs **111**.

[0170] FIGS. **58-60** illustrate an overlapping side-to-side connection of four body panels **110** (two sets of the connected body panels **110** shown in FIGS. **56** and **57**). As shown in FIG. **59**, the ribs **111** to the rightmost edge of panels **110** are overlapped with the ribs **111** to the leftmost edge of other panels **110**. In various exemplary embodiments, a seal or gasket **118** placed between the panels **110** to provide a liquid tight or leak resistant connection. Although the body panels **110** to the left are shown above the panels **110** to the right, either panel **110** may be placed above or below the other.

[0171] FIGS. **61** and **62** illustrate an overlapping connection of four panels **110** at their respective corners **113**, **114**, **115**, and **116** (see FIGS. **5** and **6**). In various exemplary embodiments, as shown in FIGS. **5** and **6**, the upstream right corner **113** and the downstream right corner **114** of a body panel **110** are offset to facilitate connections. In various exemplary embodiments, as shown in FIG. **62**, taken along section line the four corners **113**, **114**, **115**, and **116** are overlapped with upstream right corner **113** as the lowest component. A downstream right corner **114** is placed above corner **113** with gasket **118** between. An upstream left corner **115** is placed above corner **114** with gasket **118** between. A downstream left corner **116** is placed above corner **115** with a gasket **118** between. As shown in FIG. **60**, in various exemplary embodiments, the gaskets **118** extend along the entire junction of any two overlapped panels **110**. In various exemplary embodiments, where the offset corners **113** and **114** are reduced and/or lowered corners, such as shown in the figures, they are placed below the non-offset corners. In various other exemplary embodiments, raised or enlarged offset corners may be provided and would be adapted for connection above non-offset corners.

[0172] In various exemplary embodiments, other components **120**, **130**, **140**, **150**, **160**, **170**, **180**, **190**, **220**, **230**, **240**, **250**, **260**, **270**, **280**, or **290** connect with body panel **110** and each other in substantially the same manner as described above for multiple body panels **110**.

[0173] In various exemplary embodiments, as shown in FIGS. **63** and **64**, the containment lining system **100** may include a plurality of interconnected main panels **110** in a level installation with connected sections providing a continuous perimeter rib **121** extending substantially around the periphery of the lining system **100** for effective containment of fluid contaminants. The system panels may be connected with each other as previously described, or may be connected by plasma welding as shown in the exemplary embodiment of FIG. **65** and disclosed in more detail below. The lining system **100** is supported on subsurface aggregate **90** which is shown to have been graded substantially level, but could also be slightly sloped as desired. A plurality of load bearing mats **300** are shown extending across the surface of the liner body panels **110** for the purpose of supporting operating equipment and wheeled vehicles (not shown.) Gravel bridges **310** are schematically shown for bearing the vehicles over the perimeter rib **121** and onto the mats **300** without damage to the structure of the rib **121**. Alternatively, or additionally, suitable structural bridges may be constructed over the rib for the

same purpose and for personnel walkways and the like. Main liner panels **110**, which may be corrugated or flat planar HDPE panels, as previously described, are both well suited for bearing the distributed loads transferred by the mats **300**. The mats **300** can be selected from SteelLock Interlocking Mats, WebLock® Composite Mats and WorkSafe Rig Mats being currently offered commercially by Strad Engineering Services, of Denver, Colo., and Fibergrate molded grating mats and other grating products being currently offered commercially by Fibergrate of Dallas, Tex. Other suitable load bearing matting currently being marketed or which may be manufactured and marketed in the future can effectively be employed on the lining system.

[0174] FIG. **64** shows an exemplar containment lining system **100** in which flat planar thermoplastic HDPE body liner panels **110** are connected by plasma welding, as schematically shown in FIG. **65** and described below. A storage tank **320** for containing liquid as shown is supported on the lining system **100**. The tank **320** may additionally be supported by a gravel pad or load bearing mats placed on top of the main body panels **110** as described above. Additionally, any working surface or area of the main body panels of the containment lining system **100** of FIG. **64** surrounding or adjacent to the liquid storage tank **320** may additionally be covered by a load bearing surface such as gravel or load bearing mats (not shown in FIG. **64**) as desired. A peripheral rib or wall **321** of sufficient height to contain the liquid contents of the storage tank **320** and other possible water or industrial fluids which might leak or spill onto the liners system is shown in two configurations. In one configuration, a large formed plastic rib **330** which is similar to the perimeter ribs previously shown, but larger, is connected to the main body of the liner about its periphery in fluid-tight relation, such as by plasma welding. In another configuration, an angled outer wall **340** may be laid up on and supported by a gravel or earthen berm **350** constructed around all or part of the containment system. Where the main body connected panels **110** are flat and may be sheet extruded in greater lengths and supplied in roll form, the extruded sheets **110** may be rolled out to the top of the berm **350** and connected together by plasma welding in fluid-tight relation to provide an impermeable wall **340** as shown on the right side of FIG. **64**.

[0175] FIG. **65** shows a schematic illustration of a pair of overlapping HDPE or other suitable thermoplastic sheet materials suitable for comprising the described lining system **100**, and the connected described components thereof, positioned for electro-fusion plasma welding. A pair of spaced POWERCORE welding rod sections **380**, available from Powercore International, Ltd., of Ottawa, Ontario, Canada, are placed between the overlapped HDPE sheets **360** and **370**. The thermoplastic welding rod sections **380** include electrical conductors and conductive end terminals **390**. When in place, an electrical current is run through the welding rods for a controlled period to heat the thermoplastic material of the welding rod and the two opposed sheets to fuse the two sheets together and form strong structural thermoplastic welded bonds between the two sheets which are impermeable to liquids.

[0176] An alternative embodiment of the lining system **400** is illustrated in FIGS. **66-79**. The lining system **400** includes features which are substantially as described herein in association with lining system **100**. Operation, particular components, and materials described herein are substantially the same and like numbers have been used to illustrate the like

components. In this embodiment, the lining system 400 includes a plurality of panels 410. FIGS. 66 and 67 illustrate an individual panel 410. Panel 410 may include a plurality of corrugations having alternating ribs 111 and valleys 112. An edge portion 419 may be provided between the corrugations and the outer perimeter of panel 410. Generally, edge portion 419 has a height which is less than the height of the corrugations. Panel 410 may be generally rectangular in shape. However, in one or more exemplary embodiments, panel 410 may be any suitable or desired shape. In one or more exemplary embodiments, ribs 111 may have a height of about 1.0 inch tall, and may have a width of about 4.0 inches wide (as measured between the bottoms of adjacent valleys 112). In one or more exemplary embodiments, side walls of ribs 111 may be angled or sloped at about 25 degrees from vertical, however the sidewall angle may be varied. It should be noted that size and shape of the ribs may vary within the scope of the present disclosure and claims to meet the design needs of the targeted user group. Further, in one or more exemplary embodiments, panel 410 may not include any corrugations. While the corrugated pattern provides greater strength and rigidity to body panels 410 and other components, in certain applications of lining system 400, corrugations may not be desirable.

[0177] In various exemplary embodiments, body panel 410 may be about 100 inches long (i.e., the dimension perpendicular to ribs 111) and about 75 inches wide (i.e., the dimension parallel to ribs 111). In various exemplary embodiments, body panel 410 corrugations are about 1.15 inches high. In various exemplary embodiments, valleys 112 are approximately 4.16 inches apart (i.e., distance between the bottom points of adjacent valleys) and the sides of the valleys 112 are inclined at an angle of about 115.00 degrees from horizontal (at the base). In various exemplary embodiments, the panels will be formed from HDPE sheets having a thickness ranging between 0.060 to 0.300 inches, and more specifically between 0.080 to 0.250 inches, and more specifically approximately 0.170 inches. However, in one or more examples of embodiments, thinner or thicker sheet materials may be used depending upon the application, required useful panel life, or conditions of use.

[0178] FIGS. 68 to 69 illustrate one or more embodiments of a sheet coupling assembly 480. Sheet coupling assembly 480 is adapted to couple separate body panels 410 through a thermoplastic weld. Sheet coupling assembly 480 may include a bridge connecting strip 481 having a plurality of weld rods 482 provided on one side. As illustrated in FIGS. 68 and 69, two pairs of weld rods 482 extend approximately parallel to each other along one side of the bridge strip 481. The tubular weld rods 482 have a generally circular cross sectional shape.

[0179] FIGS. 70 and 71 illustrate one or more examples of additional embodiments of sheet coupling assembly 480. In this embodiment, two tubular weld rods 482 are provided on one side of bridge strip 481 and extend approximately parallel to each other. The rods 482 have a generally oval cross sectional shape and larger surface area than each of the weld rods illustrated in FIGS. 68-69.

[0180] Weld rods 482 may be a flexible elongate thermoplastic material embedded with one or more resistance wires similar to those comprising terminals 390 in FIG. 65 that extend substantially coaxially with the elongate thermoplastic material. Weld rods 482 are suitable for welding together two separate thermoplastic materials. One suitable flexible

thermoplastic weld rod 482 for use in accordance with the disclosed embodiments is a POWERCORE Welding Rod available from Powercore International, Ltd. of Ottawa, Ontario, Canada. The thermoplastic material used for the weld rods 482 may be selected to match the material of the body panels 410, perimeter sections 420, and/or corner perimeter sections 460, for example HDPE, or may be selected of a compatible material separate from the body panels 410, perimeter sections 420, and/or corner perimeter sections 460, for example linear low-density polyethylene (LLDPE).

[0181] In one or more examples of embodiments, sheet coupling assembly 480 may be any length and/or width suitable for coupling two or more separate body panels 410 together by a thermoplastic weld. Further, bridge strip 481 may have a thickness ranging between 0.030 to 0.120 inches, and more specifically between 0.050 to 0.100 inches, and more specifically approximately 0.080 inches. However, in one or more examples of embodiments, thinner or thicker sheet materials may be used depending upon the application, required useful weld life, or conditions of use.

[0182] FIGS. 72 and 73 illustrate one or more examples of embodiments of a perimeter panel section or side wall 420. Perimeter panel 420 may include a raised perimeter rib 121 coupled to an edge portion 423. Lip portion 423 may correspond to and be adapted to engage edge portion 419 of one or more panels 410. More specifically, one or more perimeter panels 420 may be provided about the outer perimeter of lining system 400 to provide peripheral containment of materials within lining system 400.

[0183] In one or more examples of embodiments, perimeter panel 420 may be formed strips of any length and/or width suitable for providing peripheral containment of certain materials within lining system 400. In addition, raised perimeter rib 121 of perimeter panel 420 may be any height suitable for providing peripheral containment of certain materials within lining system 400. Perimeter panel 420 may have a thickness ranging between 0.060 to 0.300 inches, and more specifically between 0.080 to 0.250 inches, and more specifically approximately 0.170 inches. However, in one or more examples of embodiments, thinner or thicker sheet materials may be used depending upon the application, required useful panel life, or conditions of use. Perimeter panel 420 may be manufactured of similar materials and using similar manufacturing processes as body panels 410.

[0184] FIGS. 74 and 75 illustrate one or more examples of embodiments of a perimeter panel coupling assembly or side wall coupling assembly 495. Perimeter panel coupling assembly 495 may include a raised formed perimeter rib 121 coupled to an edge portion 423. The raised perimeter rib 121 and edge portion 423 generally have dimensions which correspond to the raised perimeter rib 121 and edge portion 423 of perimeter panel 420. Perimeter panel coupling assembly 495 has a width generally smaller than the width of perimeter panel 420 and serves as a bridge or connecting strip between perimeter panels 420 and 460. In addition, perimeter section coupling assembly 495 includes a plurality of weld rods 482 provided on one side. As illustrated in FIGS. 74 and 75, at least one or more tubular weld rods 482 extend around a portion of the under surface of coupling assembly 495 to engage and weld the perimeter panel 420 to matching surfaces of adjacent perimeter panels 420.

[0185] FIGS. 76 and 77 illustrate one or more examples of embodiments of a corner perimeter panel 460. Corner perim-

eter panel 460 may include a continuous raised perimeter rib 121 which includes an approximate arcuate portion to form an "angle" of the containment system peripheral wall. An edge portion 423 may be coupled to rib 121. Edge portion 423 may correspond to and be adapted to engage edge portion 419 of a panel 410. More specifically, corner perimeter panel 460 may be provided in one or more corners along the outer perimeter of lining system 400 to assist in providing peripheral containment of materials within lining system 400. In one or more examples of embodiments, corner perimeter panel 460 may be manufactured of similar materials and using similar manufacturing processes as body panels 410 and/or perimeter panels 420. In addition, corner perimeter panel 460 may have similar heights and/or thicknesses as perimeter panels 420.

[0186] As illustrated in FIGS. 76 and 77, corner perimeter panel 460 includes a plurality of weld rods 482 provided on one side. More specifically, tubular weld rod 482 may extend around a portion of the under surface of corner perimeter panel 460, including the under surface of continuous raised perimeter rib 121 and edge portion 423.

[0187] FIGS. 78 and 79 illustrate a portion of lining system 400. The illustrated portion of lining system 400 includes an outer perimeter corner of the lining system 400. It should be appreciated that the illustrated components of lining system 400 are for illustration only and include only a portion of the components necessary for a complete lining system 400. Additional panels 410, perimeter panels 420, corner perimeter panels 460, sheet coupling assemblies 480, and/or perimeter panel coupling assemblies 495 would be necessary to form a complete lining system.

[0188] Referring to FIGS. 78 and 79, a plurality of body panels 410 are illustrated being coupled to one another by a plurality of sheet coupling assemblies 480. Additional panels 410 not shown may be provided, extending at the edge portions of illustrated panels 410 furthest away from illustrated corner perimeter panel 460. The sheet coupling assemblies 480 are coupled to a plurality of consecutive panels 410 along associated edge portions 419. As shown in FIG. 78, the sheet coupling assemblies 480 are aligned to overlap portions of edge portions 419 in order to seal any gaps between consecutive body panels 410. Referring specifically to FIG. 79, the sheet coupling assemblies 480 are illustrated as engaged and welded to portions of edge portions 419 of consecutive panels 410, coupling the consecutive panels 410 to one another. The weld rods 482 of sheet coupling assemblies 480 will interact with the thermoplastic material of edge portions 419 of adjacent panels 410, forming a liquid tight weld and/or seal between panels 410. It should be appreciated that the body panels 410 illustrated in FIGS. 78 and 79 are spaced a distance D from each other. Distance D is illustrated as a distance between consecutive panels 410. Effectively, distance D illustrates a seam between body panels 410. Distance D may be any suitable distance to allow for the panels to be coupled by sheet coupling assembly 480 and provide for the suitable and/or desired containment lining characteristics as disclosed herein. In one or more examples of embodiments, distance D may be zero in that body panels 410 contact each other along the respective edge portions or perimeter portions of panels 410. In addition, it should be appreciated that sheet coupling assembly 480 may couple a plurality of panels 410 along two or more of the outer edge portions or outer perimeter portions of lining system 400. This allows for a plurality of panels 410

to be coupled together in a liquid tight manner to form lining system 400 of the desired size.

[0189] FIGS. 78 and 79 also illustrate a plurality of perimeter panels 420 coupled to lining system 400. More specifically, perimeter panels 420 are consecutively provided about the outer perimeter of lining system 400. More specifically, edge portions 423 of perimeter panels 420 are consecutively provided about and coupled to edge portions 419 of body panels 410 corresponding to the outer perimeter of lining system 400. The weld rods 482 of perimeter sections 420 will interact with the thermoplastic material of edge portions 419 of panels 410, forming a liquid tight weld and/or seal with edge portions 419 of panels 410.

[0190] In addition, consecutive perimeter panels 420 may be coupled together by perimeter section coupling assemblies 495. Perimeter panel coupling assemblies 495 may receive a portion of consecutive perimeter panels 420, for example in the bottom or under side, overlapping portions of consecutive perimeter panels 420. In addition, edge portion 423 of perimeter panel coupling assembly 495 may overlap edge portions 423 of perimeter panels 420, and portions of body panel edge portions 419. As such, weld rods 482 of perimeter panel coupling assemblies 495 will interact with the thermoplastic material of perimeter panels 420 and edge portions 419 of body panels 410, forming a liquid tight weld and/or seal between perimeter panel coupling assemblies 495 and the coupled perimeter panels 420 and edge portions 419 of body panels 410.

[0191] It should be appreciated in one or more examples of embodiments, consecutive perimeter panels 420 may have a distance there between. Effectively, the distance illustrates a potential seam between perimeter panels 420. The distance may be any suitable distance to allow for the panels to be coupled by perimeter panels coupling assemblies 495 and provide for the suitable and/or desired containment lining characteristics as disclosed herein. In one or more examples of embodiments, distance D may be zero in that perimeter panels 420 contact each other along the respective edge portions of perimeter panels 420.

[0192] FIGS. 78 and 79 also illustrate a corner perimeter panel 460 coupled to lining system 400. More specifically, corner perimeter panel 460 is provided in a corner of the outer perimeter of lining system 400. More specifically, corner perimeter panel 460 is provided about and coupled to edge portions 419 in a corner of body panel 410 corresponding to the outer perimeter corner of lining system 400. The weld rods 482 of corner perimeter panel 460, including edge 423, will interact with the thermoplastic material of edge portions 419 of panels 410, forming a liquid tight weld and/or seal between corner perimeter panel 460 edge portions 423 and panels 410.

[0193] In addition, corner perimeter panel 460 may be coupled to adjacent perimeter panels 420. Corner perimeter panel 460 may receive a portion of bordering perimeter panels 420, for example in the bottom or under side, thus overlapping portions of bordering perimeter panels 420. Weld rods 482 providing on corner perimeter panel 460 will interact with the thermoplastic material of perimeter panels 420, forming a liquid tight weld and/or seal between corner perimeter panel 460 and bordering perimeter panels 420.

[0194] In addition, referring to FIGS. 78 and 79, sheet coupling assemblies 480 may be provided over top of portions of perimeter panels 420 and perimeter panel coupling assemblies 495, for example over the edge portions 423. The

sheet coupling assemblies 480 will overlap a portion of perimeter panels 420 and perimeter panel coupling assemblies 495 and edge portions 419 of body panels 410. This allows weld rods 482 of sheet coupling assemblies 480 to interact with thermoplastic material of perimeter panels 420, perimeter panel coupling assemblies 495, and edge portions 419 of body panels 410, forming a liquid tight weld and/or seal between the perimeter panels 420, perimeter panel coupling assemblies 495, and edge portions 419 of panels 410. It should be appreciated in one or more embodiments that sheet coupling assemblies 480 may be provided either over top or underneath portions of corner perimeter panels 460, depending upon various desired factors, including, but not limited to, the liquid tight weld and/or seal desired.

[0195] Referring to FIGS. 80 and 81, a method or system is disclosed whereby a plurality of panels 410 (as shown in FIGS. 66 and 67) may be coupled together or connected to form a reel of panels or panel sub-assembly 500 for utilization in a lining system 400. FIGS. 80 and 81 represent partially schematic views with respect to the reel of panels. The panels are illustrated in a loosely wound manner. In the alternative, the panels may be tightly wound, nesting within each other as described herein. As illustrated, the exemplary reel of panels 500 may be six panels wide and seventeen panels long. In an exemplary embodiment this forms a reel 500 having a length of 136 feet and a width of 37.5 feet. In one or more examples of embodiments, reel 500 may have a length greater than 136 feet, or less than 136 feet. In addition, in one or more examples of embodiments, reel 500 may have a width greater than 37.5 feet, or less than 37.5 feet. For example, a single panel 410 may have the dimensions of 8 feet long and 6.25 feet wide. Should the size of a single panel 410 change, the associated dimensions of the reel 500 may change. Similarly, if the spacing between consecutive panels is maximized prior to attachment of sheet coupling assembly 480 (as shown in FIGS. 68 to 71), the total width and/or length may be increased. In addition, the length and/or width may be limited by certain technologies for forming one or more panels and/or fusing together one or more panels. For example, the maximum length for a sheet coupling assembly 480 (as shown in FIGS. 68 to 71) may be limited by certain technological factors, such as power requirements to heat weld rods 482. Should certain technological factors be overcome, the size of reel 500 may change accordingly.

[0196] The reel of panels 500 may be produced by extruding thermoplastic sheet and cutting the extruded sheet to desired lengths to produce a plurality of dimensioned panels 410. The sheets may be hot rolled over textured roller surfaces to produce a desired surface texture. The sheets or panels may also be textured by extruder rollers. The panels 410 may be formed as a textured surface, such as in one example a leather grain appearance. The surface texture may be provided, in one or more examples of embodiments, to break up surface tension, and in alternative or additional examples of embodiments to increase traction on the surface of the panel. In one example of embodiments, the surface is provided with a slip-resistant surface. For example, the slip-resistant surface may be a slip resistant co-extruded LLDPE, such as SUPERSKID RESISTANT ("SSR") material provided by PendaForm Corporation of New Concord, Ohio. The sheets may also be provided with an anti-static surface or material, which may be applied, for example by co-extrusion. The sheets may be co-extruded in a known manner to provide a surface film having a greater co-efficient of friction than conventional

HDPE plastic material. The panels 410 may then be thermoformed to produce a desired structural configuration, such as corrugations, or ribs, or selectively provided as flat panels without thermoformed structure. The thermoplastic panels may be connected to form a sub-assembly of panels 520, for example by using a plurality of sheet coupling assemblies 480, as required. Such a sub-assembly of panels 520 will include a plurality of panels 410. More specifically, an exemplary sub-assembly of panels 520 may be six panels wide and five panels in length. Stated otherwise, sub-assembly of panels 520 may be 37.5 feet wide and 40 feet in length. Three sub-assemblies of panels 520 may be connected together across the width, for example using sheet coupling assemblies 480, to form a reel having a length greater than the sub-assembly of panels 520. The underlying combination of sub-assemblies of panels 520 would have a width of 37.5 feet and a length of 120 feet. A sub-sub assembly of panels 525, which are connected to have six panels wide and two panels in length, may then be coupled to one or more of the sub-assemblies of panels 520 to form a reel of panels 500 which is 37.5 feet wide and 136 feet in length. It should be appreciated that the reel of panels 500, sub-assembly of panels 520, and/or sub-sub assemblies of panels 525 may have different lengths and/or width depending upon a variety of factors, including, but not limited to, the width of the extruder die, the size of the utilized thermoforming machine, the desired size of the reel of panels 500, and/or the size of the location of a lining system 400 made up by one or more of the reels of panels 500, as required.

[0197] The sub-assembly of panels 520 and/or sub-sub assembly of panels 525 may be coupled together or connected prior to shipping. This advantageously reduces the amount of time for interconnecting panels 410 in a lining system 400 at the desired location of system deployment. In addition, this advantageously allows for the sub-assembly of panels 520 and/or sub-sub assembly of panels 525 to be interconnected in a quality controlled environment rather than at the desired location of system deployment, which is outdoors and exposed to the elements.

[0198] Once the sub-assembly of panels 520 and/or sub-sub assembly of panels 525 are interconnected to form a reel of panels 500, the reel of panels 500 may be rolled around one or more cores 600. Referring to FIGS. 82-83, an exemplary core 600 is illustrated. Core 600 may include opposing end plates 610 which are spaced apart by a plurality of lineal members 620. Members 620 may be coupled to end plates 610 by one or more connection members 630. A slot 640 may be provided through end plates 610. Slot 640 may be provided at an oblique angle to the perimeter of each end plate 610. Similarly, and referring to FIG. 83, one of members 620 may include a slot 640 along the length of member 620. As such, member 620 having slot 640 will generally be in alignment with slots 640 of the opposing end plates 610 such that the slots 640 are in alignment as one slot along the length of core 600. In one or more exemplary embodiments, connection members 630 may be wood screws, bolts, or any other suitable or desired connection device. In one or more exemplary embodiments, cores 600 may be made of wood, metal, rubber or any suitable or desired material. In addition, in one or more examples of embodiments, cores 600 may be reusable or may be disposable.

[0199] FIG. 84 is a side view of end plate 610 illustrating slot 640. As shown in FIG. 84, slot 640 may be provided oblique to the perimeter of end plate 610. In addition, slot 640

may include a height H. Height H may correspond to the thickness of panel 410 and/or reel of panels 500. For example, height H may be 0.25 inches. Slot 640 may also include a length L, which is the length slot 640 extends into end plate 610. Length L may be any suitable or desired length to receive and/or retain a portion of a panel 410 and/or reel of panels 500. For example, length L may be 1.5 inches. End plate 610 may have a diameter of eighteen inches, and a thickness of 0.75 inches. However, end plate 610 may have any desired or suitable diameter and/or thickness for use in accordance with the disclosure provided herein.

[0200] FIGS. 85-87 illustrate lineal member 620 having a slot 640. Member 620 may nominally be a standard wooden 2×4 plank having a height H1 which is approximately 3.5 inches, a width W1 which is approximately 1.5 inches, and a length L1 which is approximately 48.0 inches. Slot 640 of member 620 may be provided oblique to the perimeter of member 620. Slot 640 of member 620 may also have a height H2 and length L2 which corresponds to height H and length L of slot 640 in end plate 610. It should be appreciated in one or more exemplary embodiments that H1, W1, and L1 may be any suitable or desired height, width, and/or length for use of member 620 in accordance with the disclosure provided herein. In addition, H2 and L2 may be any suitable height or length to receive and/or retain a portion of a panel 410 and/or reel of panels 500.

[0201] In operation and use of core 600, core 600 may be aligned with an edge of one or more panels 410. As illustrated in FIGS. 88 and 89, edge portion 419 may be received in slot 640 of member 620 and end plates 610. Referring to FIG. 90, core 600 may be rolled or rotated around a portion of one or more panels 410. With a portion of panels 410 retained by slot 640, the one or more panels 410 will wind about core 600. Panel 410 will continue to wind around core 600, as shown in FIG. 91, until the entire panel 410 is wound about core 600.

[0202] While FIGS. 88-91 illustrate use of core 600 with a single wind panel 410, a plurality of cores 600 may be used with a reel of panels 500 to form the associated reel. For example, a plurality of cores 600, and more specifically at least four cores 600, may be used with a reel of panels 500. The reel of panels 500 may be rolled about the plurality of cores 600 in the same manner described above in association with FIGS. 88-91. An example of a reels of panels 500 having a plurality of cores 600 is illustrated in FIGS. 80-81. When wound about a plurality of cores 600, the reels of panels 500 may have a diameter of forty inches, but may have a diameter as large as or in excess of forty-eight inches. The diameter of each wound reel of panels 500 (i.e. a reels of panels 500 wound about a plurality of cores 600) is minimized for formed panels having ribs 111 on one side and corresponding recesses 413 on the opposite side, as shown, because the winding of the reel of panels 500 on the cores 600 produces a nesting effect. More specifically, and as illustrated in FIGS. 80-81, the underside of each panel 410 has a plurality of recesses 413. Recesses 413 correspond with the ribs 111 on the opposite side of each formed panel 410. Stated otherwise, recesses 413 are provided on the side of panel 410 opposite the plurality of ribs 111 and valleys 112. The plurality of ribs 111 which extend above panel 410 have a corresponding recess 413 provided on the opposite side of panel 410. Thus, when one or more panels 410 are rolled, for example about cores 600, the ribs 111 on a first side of panels 410 may be received in recesses 413 provided on a second side, opposite the first side of panels 410. Thus, ribs 111 nest within recesses

413 of panels 410. This advantageously provides a reduced diameter of one or more panels 410 rolled about one or more cores 600, as the ribs 111 do not create excess thickness or bulk which may unnecessarily increase the diameter of each wound reel of panels 500.

[0203] A plurality of reels of panels 500 of the type described and shown, each wound about a plurality of cores 600, advantageously provides efficiencies in shipping and distribution. As illustrated in FIG. 80, a plurality of such wound reels of panels 500, more specifically four wound reels of panels 500, may be loaded upon a flat bed truck, semi-truck, or other suitable transportation vehicle, with the aid of a fork lift truck or other lifting mechanism and transported to the site of lining system 400 installation. The cores 600 may be advantageously located within the wound liner such that the times of an available fork lift will engage the reel of panels 500 beneath an internally located core(s) at a balance point of the reel to lift the reel on or off of the truck without damage to or distortion of the wound reel of panels.

[0204] Each of the wound reels of panels 500 may be removed from the transportation vehicle and positioned in a desired location for installation of the designed lining system 400. As illustrated in FIG. 92, each wound reel of panels 500 may be optimally positioned and subsequently unwound. For example, one or more workers may unwind the wound reel of panels 500 at a desired location. As shown in FIG. 93, once unwound, the unwound reel of panels 500 may be connected or coupled to one or more adjoining reel of panels 500, as well as for example through sheet coupling assembly 480 (as described and shown in FIGS. 68-78). Once the plurality of reels of panels 500 are interconnected, a lining system 400, similar to a 50,000 square foot pad of the type shown in FIG. 94, may be provided for use.

[0205] Such lining systems may advantageously include other previously described components including, without limitation, flat extruded sheets 110, panels 410, sheet coupling assemblies 480, perimeter sections 420, perimeter corner sections 460, bridge strips 481, etc. as may be advantageously employed. Areas of the lining system intended for vehicular access, for example, may advantageously utilize flat extruded sheets 110. Various perimeter portions of the lining system may not have perimeter sections to provide designed natural drainage for the lining system, while other lining systems may have a continuous raised perimeter all around and be emptied by pumping, or drain outlets and pipes extending exteriorly of the pad from a drain outlet located within the periphery of the lining system.

[0206] FIGS. 95-113 illustrate one or more embodiments of an improved secondary containment facility. The modular secondary containment facility is formed of a plurality of panels 410, as variously previously described and illustrated herein, or flat extruded sheets of desired width and extended length cut to desired size 742, as described below. Any of the panels and sheets disclosed and otherwise considered herein may be utilized in the modular secondary containment facility. In addition, in one or more examples of embodiments, panels may be formed of different sizes or dimensions than previously disclosed while still having the desired disclosed physical properties to allow for construction of customized modular secondary containment facilities for desired uses. As illustrated in FIG. 95, the plurality of panels may be panels 410, as illustrated in FIGS. 66-67.

[0207] By forming the modular secondary containment facility with a plurality of panels 410 or sheets 742, the

modular secondary containment facility advantageously has scalability for numerous secondary containment sizes. Each of the plurality of panels 410 or sheets 742 may be connected to an adjoining or adjacent panel by electro-fusion plasma welding (i.e. fusion welding), as previously disclosed above with respect to FIGS. 65-71 and 78-79. Sheet coupling assemblies 480, comprised of bridge connecting strips 481 and attached POWERCORE brand welding rods 482, may be used to fuse adjoining or adjacent panels 410 to form strong, fused thermoplastic welded bonds, with molecular bonding between the panels 410 or sheets 742 and the bridge connecting strips 481, which are impermeable to liquids. Bridge connecting strips 481 having a plurality of welding rods 482 provided on one side may be utilized as described above, and illustrated in FIGS. 68-69, to connect adjacent panels 410 and or connecting strips 481 together in fluid-tight relation to form a continuous base or floor of whatever dimensions are desired. Alternatively, POWERCORE brand welding rods may use directly between adjacent panels 410 or sheets 742. This allows for any number of such panels or sheets to be indirectly or directly fused to adjoining panels or sheets to form a modular secondary containment facility 700 of a desired size.

[0208] As illustrated in FIG. 95, the modular secondary containment facility 700 may have a base area 740 comprised of connected panels 410 with dimensions of approximately twenty-four (24) feet by thirty-one and one-quarter (31.25) feet (24 feet x 31.25 feet). However, in one or more examples of embodiments, the modular secondary containment facility 700 may have a larger or smaller area, larger or smaller volume, and/or may be formed with asymmetrical side lengths. In addition, the size of an existing modular secondary containment facility 700 may be increased by adding one or more sheets 742, panels 410 or rows of panels, or decreased by removing one or more sheets, panels or rows of panels. This modular arrangement allows for ease of customization of the size and dimensions of the modular secondary containment facility 700. In addition, it allows for ease in scalability, allowing the modular secondary containment facility 700 to be increased or decreased in size over time. Thus, as secondary containment needs change, an existing modular secondary containment facility 700 may be increased or reduced in size without the need to purchase or construct an entirely new secondary containment facility.

[0209] Referring back to FIG. 95, the outer perimeter of the modular secondary containment facility 700 includes wall portions 720. The wall portions 720 may be formed by cutting individual panels 410 to selectively form two end wall portions 722 of desired height from each full individual panel 410, or two side wall portions 724 of desired width (wall height) from each full panel 410, depending upon whether a panel 410 was respectively cut crosswise to form two end wall portions 722, or was cut lengthwise to form two side wall portions 720. Each such wall portion 722, 724, so cut, can be seen from FIG. 95 to have planar edge portions 419 extending about three sides of the outer perimeter of the wall portions 722 and 724. As a result, the middle edge portion 419 of each cut end wall portion 722 will match the length of an end edge portion 419 of a base panel 410. Likewise, the middle edge portion 419 of each cut side wall portion 724 will match the length of a side edge portion 419 of a full panel 410. Alternatively, planar sheets without ribs or corrugations may be cut to provide wall portions 722 and 724 of a length and height required for such secondary containment facilities. Such

“flat” planar sheets may be provided in rolls or reels of sheet 8' wide by 60 feet long or other desired dimensions, on cores 600 as described above or otherwise, and cut to fit as suitable wall portions 720 at a distribution site or job site. FIGS. 112 and 113 illustrate a secondary containment facility in which the plastic container portion is constructed from extruded flat, planar plastic sheet 110 supplied in roll form as described, wherein the flat plastic sheet 742 is used to form both the base 740 and the individual side wall portions 720 of the modular, secondary containment facility 700. Such plastic sheets 742 can be plasma welded together using sheet coupling assemblies 480, as described above, to form the base 740, attach the individual flat plastic sheet wall portions 720, and such components are further welded in further connection with corner portions 730 to form the modular secondary containment facility of FIGS. 112 and 113, which is suitable for temporary or extended placement of container vehicles, utility vehicles, industrial equipment or other container or liquid containing apparatus for which secondary containment is required or desirable.

[0210] The planar edge portion 419 of each wall portion 720 or sheet 742 is adapted to bend about the plurality of base panels 410, 742, to enable the wall portion 720 to provide containment for any liquid deposited on the base panels 410 within the containment facility 700. The edge portions 419 may be coupled to the plurality of panels and/or sheets by electro-fusion plasma welding, either directly between overlapping edge portions 419 of the full panels 410 and the wall portions 720, or by the use of the bridge connecting strips 481 of the sheet coupling assemblies 480, welded to adjacent edge portions of the base panels 410 or sheets 742 and the wall portions 720. Typically, the edge portion will form or traverse in a radial manner an approximate angle of less than one-hundred eighty degrees (180°) and more specifically approximately ninety degrees (90°) between the plurality of base panels or sheets 740 and the attached substantially vertical wall portions 720 (as illustrated in FIGS. 104-113). Any panel, sheet or portion of the secondary containment facility 700 which is to be advantageously bent to pass from horizontal to vertical position, or form a portion of a closed corner portion 730, may be scored along a desired bend line by an appropriate cutting tool such as a router in the manner of the score line 733 as shown in FIGS. 96-98, taking care to avoid cutting or other removal of material along the new score line in excess of a depth of about 0.03 inch or a width of about 1/8 inch to prevent piercing or so weakening the material along the score as to risk rupture or such thinning or weakening of the panel or sheet material as might cause loss of liquid during use of the modular secondary containment facility. The sheet may be scored on site or pre-scored at a manufacturing facility.

[0211] Referring back to FIG. 95-103, and particularly FIGS. 96-98, a corner portion 730 is provided to connect or otherwise couple adjacent wall portions 720 at each of the corners of the rectangular modular secondary containment facility 700. A score line 733 may extend diagonally across the corner portions 730 from the near corner 731 to the opposite far corner 732 of the corner portion 730. The first and second border portions 734 and 735, are coupled by electro-plasma welding to a portion of a corner panel 410 or corner sheet 742 of the base 740 of the modular secondary containment facility 700, and to adjacent edge portions 419 of an end wall portion 722 and a side wall portion 724, respectively. In the event that the base portion 740 and or wall portions 720 of the modular,

secondary containment facility 700 are assembled from planar strips or sheets 742 of flat plastic material of substantial length, cut to desired size at the distribution or job site, and electro-fusion welded together to form the desired sized secondary containment facility 700, each corner portion 730 is interfitted with adjacent edge portions 419 of the flat sheets to provide a liquid resistant seal between adjacent connected and fused edge portions. As shown in FIG. 99, first and second sheet coupling assemblies 480 preferably extend continuously over and respectively connect, by electro-fusion welding, the abutting or adjacent edge portions 419 of panels 410. Likewise, the sheet coupling assemblies 480 can be similarly used to connect side wall portions 724, which can be cut to selected length and selected width (wall height) to the panels 410 forming the base area 740 of the modular secondary container facility 700. In addition, the sheet coupling assemblies 480 can be utilized to connect the corner portions 730 to the ends of adjacent side wall portions 724, and connect the base panels and the edge portions of the end wall portions 724, which may be formed by the ends the flat sheets 742 of extended length, as extended to form the end wall portions 724. The bending of the corner portions along the score line 733 provides an inwardly folded corner portion which can be fastened to an adjacent end wall portion 722 or side wall portion 724 to form a water-tight corner between the wall portions 722 and 724 of the modular secondary container facility 700 as illustrated in FIGS. 99-104. The modular secondary container facilities 700 of FIGS. 112 and 113, which are shown to be comprised of flat sheets 742, cut from sheet plastic material of extended length to desired size as explained in the brief descriptions of those drawings above, and more further below, can be connected together in strong, fused relationship in the same manner as described above.

[0212] Each of the panels, wall portions 720, corner portions 730, bridge connecting strips 481 and flat plastic sheet forms 742 may be formed of high-density polyethylene (HDPE). HDPE is a highly crystalline lightweight thermoplastic material having chemical resistance, toughness, rigidity but significant flexibility through a broad range of temperatures, does not conduct electricity (i.e. has dielectric properties), is impermeable to water and water vapor, and has a relatively high softening temperature. In addition, HDPE is advantageously recyclable. As such, once the HDPE panels and sheets of the modular secondary containment facility 700 are taken out of service, they may be cleaned and then completely recycled.

[0213] Referring now to FIGS. 97 and 98, a side view of the corner portion 730 and associated section view of the score 733 is shown. It should be appreciated that the score line 733 may have approximately the same uniform cross-sectional dimensions along its entire length to facilitate folding of the corner portion 730. In one or more examples of embodiment, the panel may be a flat or substantially flat panel as described herein having a thickness of approximately 0.12 inch. A corner portion 730 coupled thereto may have a thickness "z" of approximately 0.08 inch. For a corner portion 730 having a sheet thickness "z" as shown in section in FIG. 98 of approximately 0.08 inch, such score 733 may be a channel having a depth of approximately less than one-half the thickness of the corner portion 730. In FIG. 98 an exemplary embodiment is shown to have an approximate depth "y" of 0.02 inch, plus or minus 0.01 inch; the surface width "x" of the score is approximately 1/8 inch or 0.13 inch, plus 0.05 or minus 0.02 inch. This is to facilitate folding of the corner portion 730

while maintaining the structural rigidity of the corner portion. In one or more examples of embodiments, the score depth and width may be less than or more than the example provided so long as the score 733 facilitates bending along the score line without weakening or rupturing the corner portion along the score line.

[0214] The score line 733 may be provided to facilitate folding of the corner portion 730 in order to provide a novel, water tight seal of adjacent edge portions. Referring now to FIGS. 99-103, deployment and use of the corner portion is illustrated to demonstrate connection of the corner portion to adjacent wall portions 720 in order to provide a water tight seal in the modular secondary containment facility 700. As shown in FIG. 99, the corner portion 730 is provided between adjacent wall portions, referenced as a first end wall portion 722 and a second side wall portion 724 in FIG. 99. The corner portion 730 is coupled to the second side wall portion 724, by electro-fusion welding. In addition the corner portion is coupled to the first end wall portion 722, by electro-fusion welding. The corner portion may be coupled to the wall portion and/or the base panel by sheet coupling assemblies 480.

[0215] Referring now to FIG. 100, the side wall portion 724 and corner portion 730 are shown positioned off the ground, effectively being pivoted or bent along the bridge connecting strip 481. In this position, the side wall portion 724 and corner portion 730 are provided at an angle of less than to one-hundred eighty degrees (180°) to first end wall portion 722.

[0216] Next, as shown in FIG. 101, corner portion 730 is folded along the score line 733. Specifically, the back side of corner portion, that is the side of corner portion which contacts the ground when the modular secondary containment facility 700 is rolled out (as shown in FIG. 95), is folded along the score line 733 such that the back side folds onto itself about the score line 733. Stated in another way, the back side of corner portion 730 is folded along the score 733 such that the back side surfaces contact each other on opposite sides of the score line 733.

[0217] Referring now to FIG. 102, the folds of the folded corner portion (from FIG. 101), which is connected to the adjacent first end wall portion 722, are coupled together. More specifically, the folds of the folded corner portion are coupled together by a plurality of connecting members 736. The connecting members 736 are best illustrated in FIG. 103 as two bolts having associated nuts. The connecting members 736 couple together the folds of the folded corner portion and an adjacent wall portion 720 near the top margin of the wall portion so that holes in the folded corner portion sides and the wall portion are well above any expected level which might be reached by any contained liquid during use of the secondary containment facility 700. A completed corner portion connecting the adjacent end and side wall portions, and wherein the folds are coupled together with a side wall portion 724 by connecting members 736, is shown in FIG. 103, which shows the corner at the opposite side of the facility 700 from the corner illustrated in FIG. 102.

[0218] FIGS. 104-107 illustrate the modular secondary containment facility having one or more wall portions 720 deployed into an upright position and connected to corner portions 730. In one example, wall portions 720 may be deployed into an upright position by folding or bending of the attached sheet coupling assembly which joins the wall portion 720 to the panels. In the alternative, wall portions 720 may be formed of or deployed into an upright position by

folding or bending or otherwise raising an end portion or side portion of the panel so as to extend the respective edge above the ground a distance sufficient to form a wall of suitable height. To facilitate bending or folding, score lines may be provided or added in the desired location. Referring specifically to FIG. 106, a folded corner portion is illustrated ready for connection to adjacent edge portions, but prior to installation of the plurality of connecting members 736 shown in FIG. 103.

[0219] Referring now to FIG. 108, the modular secondary containment facility 700 is deployed into a secondary containment system, as all of the wall portions 720 are connected to corresponding corner portions 130, creating a water-tight, sealed secondary container. In addition, the modular secondary containment facility may include a plurality of optional supports. The supports are illustrated as a plurality of cinder blocks 725. The optional support members may provide additional buttressing support to the side wall portions 720 when a liquid is provided in the modular secondary containment facility.

[0220] Referring now to FIGS. 109-111, the modular secondary containment facility is deployed into a secondary containment system, and the modular secondary containment facility contains a liquid. In addition, the modular secondary containment facility may include alternative optional supports. As shown in FIG. 109, the optional supports include a plurality of fence posts 726 interconnected by tensioned cables 727. In FIG. 110, the optional supports include a plurality of fence posts 726 interconnected by tensioned ratchet straps 728. In FIG. 111, the optional supports include a combination of a plurality of fence posts 725 interconnected by tensioned cables 727 and cinder blocks 725. It should be appreciated in one or more examples of embodiments that any combination of the disclosed or other suitable optional supports may be used individually or in combination to provide optional support to the modular secondary containment facility.

[0221] FIG. 112 illustrates a modular secondary containment facility wherein one side wall portion has been lowered to permit a container trailer 800 to be positioned on the base panels 410 of the facility by a semi-tractor. In this facility, the base panels and side wall panels 410 are flat planar HDPE panels, with no formed ribs or corrugations, to facilitate access by wheeled vehicles.

[0222] FIG. 113 illustrates the modular secondary containment facility of FIG. 112, wherein a plurality of containment trailers 800 have been positioned within the secondary containment facility and the side wall portion has been raised to a vertical position to provide containment of any potentially spilled liquids or precipitation. In addition, all visible walls have been reinforced by optional supports 737. In the illustrated embodiment, the supports 737 are formed of a post having a base extending in an opposed direction from the post. More specifically, the supports 737 comprise a plurality of posts connected by a horizontal rail or plurality of horizontal rails, and having bases extending in opposed directions from the posts and generally perpendicular to the plane of the rails. In one example of embodiments, the plurality of posts are steel posts connected by horizontal steel rails, and with steel bases. It is understood that "steel" is provided for purposes of example only, and that alternative materials of sufficient strength and rigidity to accomplish the purposes provided may also be acceptable. Also shown in the illustrated embodiment of FIG. 113 is an adjoining or adjacent second-

ary containment facility 740 formed of panels 410 which may be flat panels as described above, or corrugated as also described above. The panels in the adjoining secondary containment facility are joined by sheet coupling assemblies 480 (illustrated by bridge connecting strips 481 in FIG. 113). The panels may be further joined to raised perimeter ribs 420 and corresponding elements in the manner described previously herein.

[0223] It should be appreciated that the modular secondary containment facility described herein may be assembled and transported in accordance with the disclosure above with reference to FIGS. 80-94. Accordingly, the plastic body of the modular secondary containment facility can be completely assembled at a manufacturing or distribution facility, rolled or otherwise arranged for shipment by truck or other means to a secondary containment site, and laid out and assembled as disclosed herein with such wall support structure as disclosed or as otherwise is appropriate for the facility 700. Similarly, the facility can be taken down and corner portions 730 unbolted and unfolded from the wall portions to regain the flat condition shown in FIG. 95, rolled up and transported to a new site for further use as described herein. In addition, where secondary containment sites have dimensions exceeding the length available on flat bed trucks or other available transport equipment, the secondary containment facility plastic container component can be constructed offsite in two or more transportable parts, shipped to the installation site and the components welded as described at the site to completed the facility and installation. Likewise, as previously disclosed, a secondary containment facility 700 of the invention may be increased or decreased in size by adding or subtracting base and wall panels, or rows of such panels, or planar sheets of extended length, in accordance with the invention.

[0224] The technical effects and technical problems in the specification are exemplary and are not limiting. It should be noted that the embodiments described in the specification may have other technical effects and can solve other technical problems.

[0225] As utilized herein, the terms "approximately," "about," "substantially," and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the invention as recited in the appended claims.

[0226] It should be noted that references to relative positions (e.g., "upstream," "downstream," "left," and "right") in this description are merely used to identify various elements as are oriented in a typical installed system. It should be recognized that the orientation of particular panels may vary greatly depending on the application in which they are used.

[0227] For the purpose of this disclosure, the term "coupled" means the joining of two members directly or indirectly to one another. Such joining may be stationary in nature or moveable in nature. Such joining may be achieved with the two members or the two members and any additional intermediate members being integrally formed as a single

unitary body with one another or with the two members or the two members and any additional intermediate members being attached to one another. Such joining may be permanent in nature or may be removable or releasable in nature.

[0228] It should be appreciated that the construction and arrangement of the site pad lining system, as shown in the various exemplary embodiments, is illustrative only. While the site pad lining system, according to this invention, has been described in conjunction with the exemplary embodiments outlined above, various alternatives, modifications, variations, improvements, and/or substantial equivalents, whether known or that are or may be presently unforeseen, may become apparent. Accordingly, the exemplary embodiments of the site pad lining system, according to this invention, as set forth above, are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention. Therefore, the description provided above is intended to embrace all known or later-developed alternatives, modifications, variations, improvements, and/or substantial equivalents.

What is claimed is:

1. A method of assembling, shipping and installing a modular, scalable containment lining system for an industrial site comprising:

- coupling together a plurality of plastic panels to form a reel of panels;
- rolling the reel of panels about at least one core to form a wound reel of panels;
- placing at least one wound reel of panels upon a transportation vehicle;
- transporting the at least one wound reel of panels to an installation site;
- unloading the at least one wound reel of panels from the transportation vehicle;
- positioning the at least one wound reel of panels at a desired location at the installation site; and
- unrolling the at least one wound reel of panels at the desired location at the installation site.

2. The method of assembling, shipping and installing a modular, scalable containment lining system of claim 1, further comprising:

- engaging an edge of the reel of panels into a slot provided in the at least one core before performing the rolling step.

3. The method of assembling, shipping and installing a modular, scalable containment lining system of claim 1, further comprising:

- unloading a second at least one wound reel of panels from the transportation vehicle;
- positioning the second at least one wound reel of panels at a second desired location at the installation site;
- unrolling the second at least one wound reel of panels at the second desired location at the installation site; and
- coupling the second at least one wound reel of panels to the at least one wound reel of panels to form a lining system.

4. The method of assembling, shipping and installing a modular, scalable containment lining system of claim 1, wherein the reel of connected panels includes base panels, wall panels and corner panels, and further comprising:

- raising the wall panels to an approximately vertical position and folding and fastening the corner panels to adjacent portions of the wall panels; and

placing support structure against the exteriorly facing surfaces of the wall panels to provide a secondary containment facility for retaining a depth of liquid within the facility.

5. A lining system comprising:

- a plurality of interconnected panels of extruded plastic material, the plurality of panels being formed by consecutive body panels interconnected with a sheet coupling assembly;
- raised perimeter panels extending continuously around all sides of the plurality of interconnected panels, the raised perimeter panels being interconnected to the plurality of interconnected panels; and
- a foldable corner panel coupled to the plurality of interconnected panels and raised perimeter panels so as to join substantially perpendicular edges of the lining system.

6. The lining system of claim 5, wherein the sheet coupling assembly comprises a bridge connecting strip and welding rod for electro-fusion welding of the bridge connecting strip to adjacent consecutive body panels.

7. The lining system of claim 5, wherein a raised perimeter panel of the raised perimeter panels comprises a portion of a body panel coupled to the plurality of interconnected panels by an additional sheet coupling assembly.

8. The lining system of claim 7, wherein the raised perimeter panel is formed by a bend about a bridge connecting strip forming a portion of the additional sheet coupling assembly.

9. The lining system of claim 5, wherein the raised perimeter panels are formed by portions of the consecutive body panels.

10. The lining system of claim 5, wherein the foldable corner panel has a score line arranged for folding of the corner panel along the score line.

11. The lining system of claim 5, further comprising support structure positioned against exteriorly facing surfaces of the raised perimeter panels.

12. The lining system of claim 11, wherein the support structure comprises a plurality of posts connected by horizontal rail and having a base extending in an opposed direction from the post generally perpendicular to the plane of the rail.

13. The lining system of claim 5, wherein the body panels are substantially flat planar sheets.

14. The lining system of claim 13, wherein the body panel has a textured surface.

15. A modular, secondary containment facility comprising:

- a plurality of planar sheets of substantially flat plastic material having first sheet coupling assemblies which extend continuously over and respectively connect adjacent edge portions of the plurality of planar sheets;
- a plurality of wall portions coupled to the plurality of planar sheets by second sheet coupling assemblies;
- a plurality of corner portions, each corner portion interfitted with adjacent edge portions of the flat sheets and adjacent side wall portions, the corner portions being coupled by third sheet coupling assemblies;
- wherein the sheet coupling assemblies electro-fusion welded together adjacent portions to provide a liquid resistant seal between adjacent connected and fused portions.

16. The modular, secondary containment facility of claim 15, wherein the corner portion has a score line and is adapted to bend so as to provide an inwardly folded corner portion which is fastened to an adjacent wall portion to form a water tight corner.

17. The modular, secondary containment facility of claim 16, wherein the second sheet coupling assemblies are adapted to bend such that the wall portions extend upwards at an angle from the plurality of planar sheets.

18. The modular, secondary containment facility of claim 15, wherein the wall portions comprise side walls and end walls.

19. The modular, secondary containment facility of claim 15, wherein the first, second, and third sheet coupling assemblies comprise a bridge connecting strip and a welding rod.

20. The modular, secondary containment facility of claim 15, further comprising a support structure positioned against exteriorly facing surfaces of the walls to provide a buttressing support.

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