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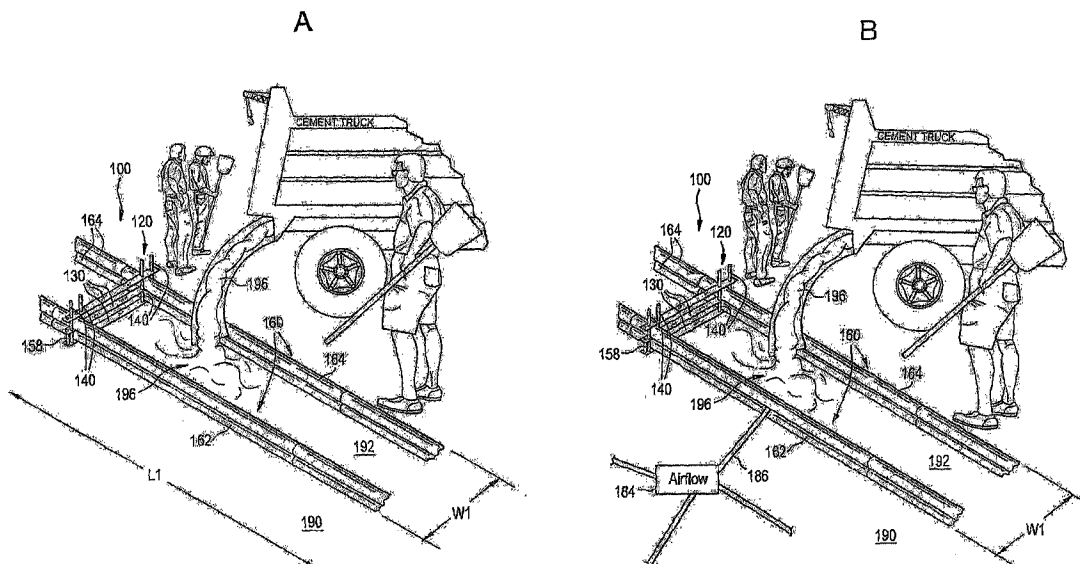
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(54) **Titre : FORMATION, DRAINAGE ET SYSTEME DE VENTILATION POUR LES TERRAINS DESTINES A L'AGRICULTURE, A L'IRRIGATION ET AUX SPORTS**

(54) **Title: FORMING, DRAINAGE AND VENTILATION SYSTEM FOR AGRICULTURE, IRRIGATION AND ATHLETIC FIELDS**



(57) **Abrégé/Abstract:**

A drainage and ventilation system includes a plurality of drainage cores. Each core includes a sheet having a first and a second end, a first and a second side, and a plurality of dimples disposed between the ends and the sides. The dimples extend outwardly from the sheet and define a plurality of passages. The passages include passages extending from end to end and passages extending from side to side. The system also includes a fabric attached to each core. The passages of the cores receive and convey a flow of at least one of liquid, air and gas through the drainage cores. In one embodiment, the cores are disposed in soil, and the dimples are filled with an adhesive to enhance the shock absorbing properties of the soil. In another embodiment, the dimples are filled a cement-based material for adhering a finish material to the cores.



ABSTRACT

A drainage and ventilation system includes a plurality of drainage cores. Each core includes a sheet having a first and a second end, a first and a second side, and a plurality of dimples disposed between the ends and the sides. The dimples extend outwardly from the sheet and define a plurality of passages. The passages include passages extending from end to end and passages extending from side to side. The system also includes a fabric attached to each core. The passages of the cores receive and convey a flow of at least one of liquid, air and gas through the drainage cores. In one embodiment, the cores are disposed in soil, and the dimples are filled with an adhesive to enhance the shock absorbing properties of the soil. In another embodiment, the dimples are filled a cement-based material for adhering a finish material to the cores.

FORMING, DRAINAGE AND VENTILATION SYSTEM FOR AGRICULTURE, IRRIGATION AND ATHLETIC FIELDS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application Ser. Nos. 63/162,765, filed March 18, 2021, and 63/275,648, filed November 04, 2021. This application is also a Continuation-in-Part of and claims the benefit under 35 U.S.C. §120 of U.S. Patent Application Ser. No. 17/133,748, filed December 24, 2020, which is a continuation application of U.S. Patent Application Ser. No. 16/793,458, filed on February 18, 2020, now abandoned, which claims the benefit as a continuation of International Patent Application Ser. No. PCT/US2018/000367, filed on August 20, 2018, which claims the benefit of U.S. Non-Provisional Patent Application Ser. No. 15/971,247, filed on May 04, 2018, now U.S. Patent No. 11,008,750, issued on May 18, 2021, and of U.S. Provisional Patent Application Ser. No. 62/547,441, filed on August 18, 2017. The disclosures of each of the aforementioned patent documents are incorporated herein by reference in their entireties.

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BACKGROUND OF THE INVENTION

1. Field of the Invention

[0003] This invention relates generally to a form system used to build structural components such as, for example, a footing or foundation for a structure, by retaining a volume of at least partially liquid and curable building material, and when cured, the form system is integral within the structural component to provide drainage, ventilation and/or mitigation or remediation of unhealthily conditions cause by poor air flow, unwanted gases, moisture and the like, around and within the structure. In some aspects, the form system, and components included therein,

provides a conduit or duct that acts as a thermal barrier and/or passage for air and liquid flow to improve drainage, insulation and ventilation. In embodiments, the form system and its components, used within the form system and as standalone components, provide forming, drainage and ventilation in applications that include, for example, agriculture, irrigation, bridges, sidewalks, roadways, mining, athletic fields, playgrounds, and special purpose landscapes such as a golf course or so called “green roofs” for structures that comprise at least partially vegetation and a growing medium.

2. Description of Related Art

[0004] As noted in commonly owned U.S. Patent No. 7,866,097, commonly owned U.S. Patent No. 8,627,615, and commonly owned U.S. Patent No. 9,228,365, conventional form systems are known to receive and to maintain a volume of concrete and/or other at least partially liquid building material in place while the building material cures over time. Once cured, the form system is typically removed from the cured building material to expose the formed structural component for use as, for example, a foundation or portion thereof, supporting a building or like structure of interest.

[0005] As is generally known in the art of building construction, an area is excavated, and a form system is assembled therein to match dimensions of a desired foundation or footing. Conventional forms typically comprise panels constructed of steel, wooden boards, planks or sheet material (e.g., plywood) and the like, that are arranged in parallel side-by-side configurations to define side walls and a channel between the side walls along one or more lengths of the excavated area. The panels are staked or otherwise secured in place to prohibit deformation of the side walls as concrete is poured in the channel between the side walls. As can be appreciated, dimensions (e.g., height, thickness, length and shape) of foundations and footings (and thus the form system) vary depending on the structure being built as well as applicable building codes and standards of the industry.

[0006] Accordingly, while some aspects of conventional forms and components thereof can be standardized, some degree of customization is typically needed to meet the requirements of the structure being built and/or the building codes and standards employed at the particular job or project site. In addition, some building codes require that a drainage system be installed around

the formed structural component such as, for example, a foundation for a structure of interest. Typically, drainage tiles, gravel, crushed stone, perforated pipe or other systems or materials are installed at or below the formed structural component to facilitate discharge of fluids such as, for example, ground water, by gravity or mechanical means into an approved drainage system and away from the structural component.

[0007] Conventional drainage systems are also employed to remove excess ground or subsurface water from athletic fields, golf courses, and the like. The fields themselves may include a crown, slope or pitch (e.g., one to two percent (1-2%) or more incline) from the center portion to sideline portions to assist in directing ground water off the field and to drainage systems at sidelines thereof. In some instances, a crown, slope or pitch can influence game play, so are not desirable. In such cases or as an additional feature to crowned fields, the drainage system may include additional sub-surface pipes, conduits or drains, below the surface of the field of play, that capture, retain, and move ground water below the surface of the field to the drainage system. Moreover, it is preferable that areas or fields used for athletic sports have good footing and traction to promote performance and safety for athletes. Soil quality (e.g., organic matter and nutrients) and proper irrigation that promote growth for natural turf, and drainage for both natural and synthetic turfs, are important factors in maintaining a good quality field. A quality field provides not only for better athletic performance but also lessens injury and fatigue as the turf is more impact resistant.

[0008] Radon is a cancer-causing natural radioactive gas and can cause lung cancer. The radon and other gases such as, for example, carbon dioxide, methane, and the like, can permeate the soil beneath a formed structural component (e.g., a foundation or footing) and often enter the supported building or like structure of interest through cracks in the foundation, windows, doors, or the HVAC system itself. The gas can be drawn into the building because the pressure inside the building is typically lower than the pressure in the soil around and beneath the foundation. Gas mitigation systems can be installed after construction; however, such systems are often costly, aesthetically displeasing, cumbersome and difficult to install. Additionally, if installation is not properly performed after construction, the installation can compromise the structure.

[0009] In view thereof, the inventor has recognized that a need exists for a relatively inexpensive and easily configured form system to build structural components such as, for example,

a foundation or footing for a building or portions thereof. The inventor has further recognized that a need exists for a similarly inexpensive and easily configured drainage and ventilation system, which can include thermal insulating characteristic, installed around the formed structural component of a structure of interest such as a building or portion thereof as well as installed within pathways, driveways, athletic fields, playgrounds, golf courses, areas of natural or synthetic turf, and the like, to improve drainage and enhance ventilation thereof.

SUMMARY OF THE INVENTION

[0010] The present invention resides in one aspect in a system for retaining a flowable and curable building material such as, for example, concrete, to form a portion of a foundation or footing for a structure of interest. The system includes side walls receiving and retaining the building material in a channel formed therebetween. The side walls are disposed in a predetermined configuration defining the foundation or the footing within soil. The side walls include a first side wall and a second side wall. The first side wall includes a first drainage core wrapped in a first fabric. The first drainage core has a plurality of first passages extending therethrough. The second side wall includes a second drainage core wrapped in a second fabric. The second drainage core has a plurality of second passages extending of therethrough.

[0011] The system also includes a bracket assembly that retains the side walls in the predetermined configuration in the soil. The bracket assembly includes a first reinforcement post disposed proximate the first drainage core, which retains the first drainage core in a first interior position within the bracket assembly. The bracket assembly also includes a second reinforcement post disposed proximate the second drainage core, which retains the second drainage core in a second interior position within the bracket assembly. The bracket assembly also includes a separator bar having a first end, a second end opposed from the first end, and a plurality of apertures disposed along a length of the separator bar between the first end and the second end. The apertures are sized to receive and retain each of the reinforcement posts. The first and the second interior positions define a width of the channel.

[0012] The system also includes a third drainage core wrapped in a third fabric. The third drainage core is disposed against and outwardly bounds the bracket assembly and the channel from the soil. The third drainage core has a plurality of third passages extending therethrough. The third

drainage core prevents backfill of the soil from filling a volume between the third drainage core and the side walls. The first drainage core, the second drainage core, and the third drainage core of the system are retained in the foundation or footing after the building material cures such that the plurality of first passages, second passages, and third passages form respective first, second and third cavities that receive, capture and convey a flow of at least one of liquid, air and gas from the soil.

[0013] In one embodiment, the system further includes a first spacer and a second spacer. The first spacer is disposed between the first drainage core and the first reinforcement post. The first spacer provides at least one of a vertical and a horizontal offset to the first side wall. The second spacer is disposed between the second drainage core and the second reinforcement post. The second spacer provides at least one of a vertical and a horizontal offset to the second side wall. The at least one vertical and horizontal offsets form sidewalls of a predefined cross-section. In one embodiment, the predefined cross-section is a trapezoidal cross-section.

[0014] The present invention resides in one aspect in a standalone drainage and ventilation system. The system includes a plurality of drainage cores. Each drainage core is comprised of a sheet having a first end, a second end, a first side, a second side, and a plurality of dimples disposed between the first end, the second end, the first side, and the second side. The plurality of dimples extend outwardly from the sheet and define a plurality of passages about the perimeter thereof. The plurality of passages includes first passages extending from the first end to the second end, and second passages extending from the first side to the second side. The drainage and ventilation system also includes a fabric attached to each of the plurality of drainage cores. The plurality of first passages and the plurality of second passages receive and convey a flow of at least one of liquid, air and gas through the plurality of drainage cores.

[0015] In one embodiment, at least one of the first end, the second end, the first side, and the second side of the sheet of each of the drainage cores includes a flat section. The flat section facilitates attachment of one of the drainage cores to an adjacent one of the drainage cores. In one embodiment, the fabric is wrapped around and individually encloses each of the plurality of drainage cores. The fabric further includes an extending portion that extends beyond at least one of the first end, the second end, the first side, and the second side of the drainage cores to facilitate attachment of one of the drainage cores to an adjacent one of the drainage cores. In one

embodiment, a plurality of eyelets are included in the extending portion of the fabric. The eyelets are adapted to receive a fastener to secure the attachment of one drainage core to the adjacent drainage core. In still another embodiment, the drainage and ventilation system further includes a fabric ribbon coupled to one of the drainage cores. The fabric ribbon facilitates attachment of one of the drainage cores to an adjacent one of the drainage cores.

[0016] In yet another embodiment of the drainage and ventilation system, the plurality of drainage cores is disposed in soil. The flow of the at least one of liquid, air and gas through the plurality of drainage cores is received from the soil. In one embodiment, a plurality of drainage conduits is also disposed in the soil. At least one of the plurality of drainage conduits is coupled to one of the plurality of drainage cores to receive and convey the flow of the at least one of liquid, air and gas through the plurality of drainage conduits. In one embodiment, the drainage and ventilation system further includes an air exchange unit in communication with at least one of the plurality of drainage cores.

[0017] In still another embodiment of the drainage and ventilation system, the plurality of drainage cores is disposed in soil. The plurality of dimples each include an interior cavity. A portion of the interior cavities of the dimples is filled with an adhesive to enhance the shock absorbing properties of the soil having the drainage cores disposed therein. In one embodiment, the portion of the interior cavities of the dimples are filled with a mixture of the adhesive and a granular rubber. In another embodiment, the portion of the interior cavities of the dimples are filled with the adhesive and a surface of the drainage core is coated with the adhesive. In yet another embodiment, the drainage and ventilation system further includes a pad disposed in the soil above the plurality of drainage cores. In one aspect of the present invention, the filled dimples, coated cores and/or pad are seen to improve performance in GMAX or Head Impact/Injury Criterion (HIC) testing (e.g., improvement in shock absorbing properties) of the soil.

[0018] In yet another embodiment of the drainage and ventilation system, the plurality of drainage cores is disposed in a structure. The plurality of dimples each include an interior cavity. A portion of the interior cavities of the dimples is filled with at least one of an adhesive and a cement-based material. The adhesive and the cement-based material receives and adheres a finish material to the drainage cores. In one embodiment, the finish material includes at least one of plaster, stucco, tile, brick, and masonry veneer.

[0019] In still another embodiment of the drainage and ventilation system, the plurality of drainage cores is disposed in a structure. The system further includes a lath sheet affixed to each of the plurality of drainage cores on a surface opposite from the attached fabric. The lath sheet receives and retains at least one of an adhesive and a cement-based material. The adhesive and the cement-based material receive and adhere a finish material to the plurality of drainage cores. In one embodiment, the drainage cores are disposed in an interior of a structure, and the drainage cores provide portions of at least one of walls, floors, and ceilings for the structure. In one embodiment, the drainage cores are coupled to at least one of a heating, venting and air conditioning (HVAC) system and a fire suppression system to distribute a flow of at least one of conditioned air and fire retardant material therefrom throughout the structure.

[0020] In yet another embodiment of the drainage and ventilation system, the drainage cores are disposed in an exterior of a structure, and the drainage cores provides at least one of exterior sheathing, a rain screen, and roofing underlayment thereof.

[0021] As described herein, in applications of use the present invention provides an open area or passage within a structure or building envelope that allows convection of air, liquid and gases passively or in large volumes with mechanical help. The inventor has discovered that the area or passage can be employed, and in some embodiments, to increase thermal conductivity, flow, fire and impact resistance, insulating and fire retardant characteristics. The inventor envisions application within numerous construction-Divisions defined by the Construction Specifications Institute (CSI), including uses in foundations, slab walls (interior and exterior), improved agriculture and irrigation systems, drainage, storm water management, septic leaching fields, and in indoor and outdoor sports fields, playgrounds, golf courses, landscaping soft and hard scape.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1A is a perspective view of an inventive form system, configured in accordance with one embodiment of the present invention;

[0023] FIG. 1B is a perspective view of an inventive form system configured in accordance with another embodiment of the present invention;

[0024] FIG. 2 is a perspective view of components of the form system configured in accordance with one embodiment of the present invention;

[0025] FIG. 3 is a cross-sectional view of the components of FIG. 2, taken along line 3-3;

[0026] FIG. 4 is a perspective view of components of the form system configured in accordance with one embodiment of the present invention;

[0027] FIG. 5 is a cross-sectional view of the components of FIG. 4, taken along line 5-5;

[0028] FIG. 6 is a perspective view of components of the form system configured in accordance with one embodiment of the present invention;

[0029] FIG. 7 is a cross-sectional view of the components of FIG. 6, taken along line 7-7;

[0030] FIG. 8A is a plan view and FIG. 8B is a side view, respectively, of a separator bar configured in accordance with one embodiment of the present invention;

[0031] FIG. 9A is perspective view and FIG. 9B is a side view, respectively, of a reinforcement post configured in accordance with one embodiment of the present invention;

[0032] FIGS. 10A to 10E illustrate components of the form system configured in accordance with one embodiment of the present invention;

[0033] FIGS. 11A to 11D depict uses of the form system used to construct a foundation, configured in accordance with one aspect of the present invention;

[0034] FIG. 12A is a partial plan view of components of the form system configured in accordance with one embodiment of the present invention;

[0035] FIG. 12B is a cross-sectional view of the components of FIG. 12A, taken along line 12B-12B;

[0036] FIG. 12C is partial cross-sectional views of the components of FIG. 12A, configured in accordance with one embodiment of the invention;

[0037] FIG. 12D is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0038] FIG. 12E is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0039] FIG. 12F is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0040] FIG. 12G is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0041] FIG. 12H is a partial cross-sectional view of the components of the form system of FIG. 12D having a barrier installed therein, in accordance with one embodiment of the present invention;

[0042] FIG. 12I is a partial cross-sectional view of the components of the form system of FIG. 12E having a barrier installed therein, in accordance with one embodiment of the present invention;

[0043] FIG. 12J is a partial cross-sectional view of the components of the form system of FIG. 12F having a barrier installed therein, in accordance with one embodiment of the present invention;

[0044] FIG. 12K is a partial cross-sectional view of the components of the form system of FIG. 12G having a barrier installed therein, in accordance with one embodiment of the present invention;

[0045] FIG. 12L is a partial cross-sectional view of the components of the form, drainage, gas remediation, leaching field system, configured in accordance with embodiments of the present invention;

[0046] FIG. 12M is a detail view of a component of the form system of FIG. 12L;

[0047] FIG. 12N is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0048] FIG. 12O is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0049] FIG. 12P is a depiction of several components of the form system of FIG. 12N prior to assembly for installation in the form system, in accordance with one embodiment of the present invention;

[0050] FIG. 12Q is a sectional view of a drainage core of the form system of FIG. 12N;

[0051] FIG. 13 is a plan view of a separator bar, configured in accordance with one embodiment of the present invention;

[0052] FIGS. 14A and 14B are an elevation view and a plan view of reinforcement posts, configured in accordance with one embodiment of the present invention;

[0053] FIG. 15A is a partial cross-sectional view of a form system having an integral ventilation system formed therein, in accordance with one embodiment of the present invention;

[0054] FIGS. 15B and 15C are partial cross-sectional views of a form system having an integral ventilation system formed therein in accordance with one embodiment of the present invention;

[0055] FIGS. 15D and 15E are partial cross-sectional views of another embodiment of the form system of FIG. 15A;

[0056] FIG. 16 is a partial cross-sectional view of the components of the form system, configured in accordance with one embodiment of the present invention;

[0057] FIG. 17 is a partial cross-sectional view of a drainage and ventilation system, configured in accordance with one embodiment of the present invention;

[0058] FIG. 18A is detail view of a component of the form system of FIG. 16 and the drainage and ventilation system of FIG. 17, configured in accordance with embodiments of the present invention;

[0059] FIG. 18B is a depiction of several components of the form system of FIG. 16 and the drainage and ventilation system of FIG. 17 prior to assembly for installation in the form system, configured in accordance with embodiments of the present invention;

[0060] FIG. 18C is a chart illustrating example characteristics of components, a geotextile fabric and a core, of the form system of FIG. 16 and the drainage and ventilation system of FIG. 17, configured in accordance with embodiments of the present invention;

[0061] FIG. 18D depicts views of another embodiment of a component of the form system of FIG. 16 and the drainage and ventilation system of FIG. 17, configured in accordance with embodiments of the present invention;

[0062] FIG. 18E depicts another embodiment of a component of the form system of FIG. 16 and the drainage and ventilation system of FIG. 17, configured in accordance with embodiments of the present invention;

[0063] FIG. 19 is a depiction of several methods of use of the form system of FIG. 16, the drainage and ventilation system of FIG. 17, and a drainage and ventilation system in a mat configuration, configured in accordance with embodiments of the present invention;

[0064] FIG. 20 is an elevation view of a conventional foundation footing and accompanying drainage components;

[0065] FIG. 21 is an elevation view of a gravel-less foundation footing integrally formed with a drainage and ventilation system, configured in accordance with one embodiment of the present invention;

[0066] FIG. 22 is an elevation view of a bracket assembly, configured in accordance with one embodiment of the present invention;

[0067] FIGS. 23A and 23B are elevation views of a gravel-less foundation footing and slab wall integrally formed with drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0068] FIGS. 24A, 24B, 24C and 24D are elevation views of a gravel-less drainage and ventilation system, configured in accordance with embodiments of the present invention;

[0069] FIGS. 25A and 25B are a plan view and a detailed elevation view of gravel-less drainage and ventilation systems employed within a putting green, configured in accordance with embodiments of the present invention;

[0070] FIGS. 26A is an elevation view, FIG. 26B is an end view, FIG. 26C is a cross section view and 26D is a detailed elevation view of gravel-less drainage and ventilation systems employed within athletic fields, configured in accordance with embodiments of the present invention;

[0071] FIGS. 27A, 27B and 27C are cross section views of gravel-less drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0072] FIG. 28A is an elevation view and FIG. 28B is a plan view of a drain member component of the drainage and ventilation system of FIG. 26C, configured in accordance with an embodiment of the present invention;

[0073] FIG. 29 is an elevation view of an expansion joint portion of a drainage core, configured in accordance with an embodiment of the present invention;

[0074] FIG. 30 is an elevation view of a joining and restricting member, configured in accordance with an embodiment of the present invention;

[0075] FIG. 31 illustrates cross section views and a plan view of components of drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0076] FIG. 32 is an elevation view of a gravel-less foundation footing and slab wall integrally formed with drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0077] FIG. 33 is a partial cross-sectional view of the components of a form system, configured in accordance with one embodiment of the present invention;

[0078] FIG. 34 is a cross-section view of a drainage core, configured in accordance with one embodiment of the present invention;

[0079] FIG. 35 is a plan view of a plurality of drainage cores configured in an end to end and side by side assembly, in accordance with one embodiment of the present invention;

[0080] FIG. 36 is a cross-section view of one of the plurality of drainage cores of FIG. 35, in accordance with one embodiment of the present invention;

[0081] FIG. 37 are plan views of a plurality of drainage cores configured in an end to end and side by side assembly, in accordance with one embodiment of the present invention;

[0082] FIG. 38 is a cross-section view of one of the plurality of drainage cores of FIG. 37, in accordance with one embodiment of the present invention;

[0083] FIG. 39 is an elevation view of gravel-less drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0084] FIGS. 40 to 42 are cross section views of gravel-less drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0085] FIG. 43 is a perspective and a side view of gravel-less drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0086] FIG. 44 is a cross section view of a gravel-less drainage and ventilation systems, configured in accordance with an embodiment of the present invention;

[0087] FIG. 45 illustrates exemplary embodiments of drainage and ventilation systems employed within above-ground and below-ground configurations on interior and exterior portions of a structure, in accordance with aspects of the present invention;

[0088] FIG. 46 illustrates exemplary embodiments of drainage and ventilation systems employed within below-ground configurations, in accordance with aspects of the present invention;

[0089] FIGS. 47A and 47B illustrates GMAX and HIC test results for drainage and ventilation systems, configured in accordance with an embodiment of the present invention; and

[0090] FIGS. 48A and 48B illustrates GMAX and HIC test results for drainage and ventilation systems, configured in accordance with an embodiment of the present invention.

[0091] In these figures like structures are assigned like reference numerals but may not be referenced in the description of all figures.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

General Overview:

[0092] As taught and described herein, aspects of present invention include: (1) improved form systems for building structural components, for example, footing, foundations and portions thereof; (2) integral ventilation systems included within the form systems, which introduce conditioned air (e.g., heated, cooled, humidity controlled air) into the systems and/or remove and remediate gas, moisture, and the like, from the systems and soil surrounding the structural component formed with the same; (3) integral drainage systems, which in embodiments include gravel-less features, and which capture, retain, and direct (e.g., convey) a flow of liquid, such as ground and subsurface water, air, and gas, away from a structure, athletic fields, playgrounds, golf courses, and the like; (4) in embodiments, one or more of the above described form, ventilation and drainage systems provide a barrier including thermal insulating and fire retardant characteristics in above-ground and below-ground installations as well as lath and/or backing systems to support plaster, stucco, tile, stone, brick, masonry veneers, or like materials installed on interior or exterior surfaces; and (5) in still further embodiment, one or more of the above described ventilation and drainage systems may be disposed in soil of an area of interest such as, for example, athletic fields, playgrounds, golf courses and like areas including natural or synthetic turf, to provide improved ventilation, drainage, airflow and thermal conductive below the surface of the soil, and decrease impact resistance (e.g., improve shock absorbing properties) of the soil, and in certain application and improve soil retainment characteristics by preventing, or at least minimizing, soil erosion.

[0093] As described herein, the present invention includes improved drainage, air, gas (radon, methane, and the like) mitigation or remediation systems, promoting thermal conductivity, insulation, and barrier characteristics. When used in drainage mat applications, the invention provides improved impact resistance and soil retainment characteristics, as described herein.

Form System:

[0094] As shown in FIGS. 1A, 1B and 2, in one embodiment of the present invention, an inventive form system 100 includes a bracket assembly 120 configured and operating to retain side walls 160, for example a first side wall 162 and a second side wall 164, in a spaced relation apart from one another over a predetermined configuration (e.g., height H1, width W1, length L1 and shape S1) within an excavated area 190. For example, the bracket assembly 120 retains the first side wall 162 at a configuration that includes a position parallel to and horizontally spaced apart from (e.g., distant from) the second side wall 164 along at least a portion of the length L1 of and/or partially within the excavated area 190. As shown in FIG. 1A, the bracket assembly 120 and side walls 160 cooperate to define a channel 192 that receives and retains a flowable and at least partially liquid building material 196 such as, for example, concrete, poured into the channel 192. As described herein, the channel 192 is configured to be of a predetermined configuration (e.g., height H1, width W1, length L1 and shape S1) suitable for a footing and/or wall of a foundation supporting a structure of interest, or portion thereof.

[0095] It should be appreciated that while FIGS. 1A and 1B illustrate only one bracket assembly 120 retaining the side walls 160, it is within the scope of the present invention to employ one or more bracket assemblies 120 at varying intervals along the length L1 of and/or the configuration within the excavated area 190 to keep the side walls 160 from moving (e.g., being displaced) by pressure exerted thereon by the flowing concrete 196 introduced to the channel 192. It should also be appreciated that the side walls 160 may be constructed from one single, or two or more stacked components as needed to form the predetermined configuration. The components include a section or sections (e.g., pieces) of elongated building materials such as, for example, wooden boards, planks or sheet materials such as plywood, tubular members such as round drain or drainage pipe, square or rectangular pipe or conduit, drainage cores, and the like, and combinations thereof.

[0096] For example, FIGS. 2, 4 and 6 illustrate two bracket assemblies 120A and 120B disposed at opposite ends and retaining components of the two side walls 162 and 164 within the configuration, or portion thereof. As shown in FIGS. 2 and 3, two stacked sections of elongated building material, for example, drain pipe 162A and 162B, comprising the first side wall 162, are

retained in a vertically stacked orientation and a horizontally distant relation from two stacked sections of drain pipes 164A and 164B, comprising the second wall 164 of the configuration. FIGS. 4 and 5 illustrate two bracket assemblies 120A and 120B disposed at opposite ends and retaining pieces of elongated wooden planks 162C and 164C, comprising the first side wall 162 and the second side wall 164, in a vertical orientation and horizontally distant relation. FIGS. 6, 7 and 12G illustrate two bracket assemblies 120A and 120B disposed at opposite ends and retaining two pieces of elongated rectangular conduit 162D and 162E of the first side wall 162 in a vertically stacked orientation and a horizontally distant relation from two pieces of elongated rectangular conduit 164D and 164E of the second wall 164.

[0097] Referring again to FIG. 2, in one embodiment, the bracket assembly 120 (e.g., each of bracket assemblies 120A and 120B) includes one or more separator bars 130 and two or more reinforcement posts 140, illustrated in greater detail at FIGS. 8, 9A and 9B, 10D and 10E, respectively. The separator bars 130 and the reinforcement posts 140 cooperate to retain the side walls 160, and components 162A-162E and 164A-164E thereof, in the vertical orientation and the horizontally spaced apart (e.g., distant) relation of the predetermined configuration or portion thereof. As shown in FIGS. 1 to 7, the separator bars 130 and a first pair of reinforcement posts 140 cooperate to retain a portion of the first side wall 162 in the substantially vertical orientation and the horizontally distant relation from the second side wall 164 retained by the separator bars 130 and a second pair of the reinforcement posts 140.

[0098] As illustrated in FIGS. 8A and 8B, in one embodiment, each of the one or more separator bars 130 include a plurality of apertures 132 and 134 disposed at predetermined locations along a length L2 of the separator bar 130. In one embodiment, the apertures 132 are disposed at opposing ends 136 and 138 of each of the separator bars 130 and are sized to receive a stake or post 158 (FIG. 1A) for securing the bracket assembly 120 at a location within the excavated area 190. The apertures 134 are disposed (as described below) at predetermined locations along the length L2 of the separator bar 130 and are sized to receive the reinforcement posts 140. As illustrated in FIGS. 9A and 9B, in one embodiment each of the reinforcement posts 140 includes serrations 144 disposed along at least a portion of a length L3 of sides 142 of the reinforcement post 140. The plurality of apertures 134 of the separator bars 130 and the serrations 144 of the reinforcement posts 140 are sized to frictionally engage one another whereby placement of a

reinforcement bar 140 within an aperture 134 provides frictional engagement between the serrations 144 and the separator bar 130 to prevent displacement. In one embodiment, the reinforcement posts 140 include apertures 146 through the sides 142 of the posts. The apertures 146 provide means whereby a length of line (e.g., a level line) can be inserted through one or more reinforcement posts 140 and additional articles (e.g., rebar, the separator bars 130) can be tethered to and/or supported by the reinforcement post 140. In one embodiment, wire, pins, fasteners may be disposed within the apertures 146 to support the separator bar 130 in a vertical orientation between the reinforcement posts 140. In one embodiment, the separator bar 130 is otherwise clamped, fastened or secured in the vertical orientation between the reinforcement posts 140. In one embodiment, the separator bar 130 may include a plurality of tabs that are selectively extendable into the apertures 134 to lock the reinforcement post 140 to the separator 130. Other embodiments of the separator bar 130 and reinforcement post 140 are shown in FIG. 10D and FIG. 10E, respectively.

[0099] In one aspect of the invention, the predetermined locations of the apertures 134 of the separator bars 130 correspond to nominal widths of elongated building material required, recommended or preferred, for use as components to construct the side walls 160. For example, when a first pair of the reinforcement posts 140 are placed within corresponding ones of the apertures 134 proximate end 136 of the separator bar 130 the first side wall 162 is retained in place between the first pair of posts 140, and when a second pair of the reinforcement posts 140 are placed within corresponding ones of the apertures 134 proximate the opposing end 138 of the separator bar 130 the second side wall 164 is retained in place between the second pair of posts 140. As shown in FIG. 8A, in one embodiment, the separator bar 130 is stamped, labeled or otherwise marked with indicia, shown generally at 135, to identify nominal widths of typical building materials, required, recommended or preferred, for use as components to construct the side walls 160. For example, the separator bar 130 includes such indicia 135 proximate its ends 136 and 138 to correspond to locations to construct each of the side walls. In one embodiment, a first set of indicia 135A proximate the end 136 corresponds to the location for constructing the first side wall 162 and a second set of indicia 135B proximate the end 138 corresponds to the location for constructing the second side wall 164.

[0100] As shown in FIGS. 2 and 3, during construction of the first side wall, for example, a first post 140A of the first pair of reinforcement posts 140 is placed within an aperture 134 proximate the end 136 of the separator bar 130 such that the first reinforcement post 140A is disposed externally with respect to the channel 192 (e.g., disposed at a location shown generally at 192A), and a second post 140B of the first pair of reinforcement posts 140 is placed within an aperture 134 inwardly from the end 136 such that the second reinforcement post 140B is disposed internally with respect to the channel 192 (e.g., disposed at a location shown generally at 192B) to externally and internally bound the components used to construct the first side wall 162 between the first pair of reinforcement posts 140A and 140B. Similarly, during construction of the second side wall a first post 140C of the second pair of reinforcement posts 140 is placed within an aperture 134 proximate the end 138 of the separator bar 130 such that the reinforcement post 140C is disposed externally with respect to the channel 192 (e.g., disposed at a location shown generally at 192C), and a second post 140D of the second pair of reinforcement posts 140 is placed within an aperture 134 inwardly from the end 138 such that the reinforcement post 140D is disposed internally with respect to the channel 192 (e.g., disposed at about location 192B), to externally and internally bound the components used to construct the second side wall 164 between the second pair of reinforcement posts 140C and 140D.

[0101] In one embodiment, the indicia 135 are comprised of a coding system such as, for example, a numeric coding system. For example, a first one of the apertures 134 proximate each of the ends 136 and 138 of the separator bar 130 is identified by a “1” marking and a second one of the apertures 134 disposed inwardly from the first aperture is identified by a “2” marking, where the first and second apertures are disposed at locations that correspond to a nominal width of a wooden board (e.g., stock “two-by” board materials having a nominal width of about one and one half inch (1.5 in.; 3.81 cm)); the first aperture (marked “1”) and a third one of the apertures 134 inwardly from the second aperture (marked “2”) is identified by a “3” marking, where the first and third apertures are disposed at locations that correspond to a nominal width of a rectangular conduit (e.g., a stock rectangular conduit having a nominal width of about two inches (2 in.; 5.08 cm)); and the first aperture (marked “1”) and a fourth one of the apertures 134 inwardly from the third aperture (marked “3”) is identified by a “4” marking, where the first and fourth apertures are disposed at locations that correspond to a nominal width or diameter of a round drain pipe (e.g., a

stock drain pipe having a nominal diameter of about four inches (4.0 in.; 10.16 cm), six inches (6.0 in.; 15.24 cm) or other dimensions as would be required, recommended or preferred by one skilled in the art). While the present invention expressly discloses a numeric coding system for the apertures 134, it should be appreciated that it is within the scope of the present invention to employ other coding systems including, for example, a scale illustrating measurements in English (fraction or inch based), Metric (decimal based) and other measurement systems as would be used in the art. While not shown, it should be appreciated that spacers or shims may be used to increase or decrease the distance between two or more of the apertures 134 for securing building materials of nonstandard widths between corresponding pairs of reinforcement posts 140.

[0102] In one embodiment, shown in FIG. 10A, a conduit 170 is illustrated for use as a component to construct the side walls 160. The conduit 170 includes a corrugated-shaped wall 172 defining an interior cavity 174. As shown in FIG. 10A, in one embodiment the conduit 170 includes a male end 176 and a female end 178. The male end 176 and the female end 178 are configured to permit an end-to-end coupling of a plurality of the conduits 170. In one embodiment, underground utilities may be carried within the interior cavity 174. In another embodiment, plumbing may be carried within the interior cavity 174. As shown in FIGS. 10B and 10C, in one embodiment, one or both of a plurality of straps 150 and spreaders 155 may be positioned about the side walls 160 and cooperate with the bracket assembly 120 to assist in retaining the components of the side walls 160 in place as the concrete is received and cures within the inventive form system 100.

Ventilation System:

[0103] As illustrated in FIGS. 11A to 11D, the inventive form system 100 receives and retains concrete 196 being cured for use in constructing a foundation 200 including a footing 202 and walls 204 for a structure of interest such as, for example, a residential or commercial building or portion thereof. For example, a plurality of the bracket assemblies 120 may be operated to retain a plurality of the side walls 160 in the predetermined configuration, including the height H1 (extending in a plane vertically out of the drawing sheet), width W1, length L1 (including legs L1A, L1B, L1C, etc.) and shape S1 within the excavated area 190, to receive the concrete 196 to form one or both of the footing 202 and walls 204 of the foundation 200 for the structure of interest.

As shown in FIG. 11B, components of the side walls 160 (e.g., sections of elongated building materials such as wooden boards, planks or sheet materials, tubular members such as round drain or drainage pipe, square or rectangular pipe or conduit, drainage core, and the like) are assembled, interconnected or interlocked in end-to-end fashion by, for example, one or more connectors 210, to form walls for retaining the concrete or other building material 196.

[0104] As described in further detail below, when the side walls 160 are comprised of tubular, square or rectangular members having interior cavities 166 and 174, such as pipe or conduit (as shown in FIGS. 2, 3, 6 and 7), the assembled, interconnected or interlocked side wall components are integrally formed within the structure and cooperate to define one or more passages 180 within the side walls 160 for air flow around at least an exterior (e.g., within area 192A) and interior (e.g., within area 192C) of the formed footing 202 and the walls 204, and/or for air flow within the footing 202 or walls 204 themselves (e.g., with area 192B). For example, the inventor has found that when accessed after construction, the one or more passages 180 of the side walls are conducive to providing ventilation for effective and efficient transfer (e.g., removal and/or remediation) of a flow of radon or other unwanted gas such as, for example, carbon dioxide, methane, from the structure constructed, and during construction, one or more passages 180 are conducive for providing air flow (e.g., conditioned air such as cool and/or warm air with or without humidity control, for example) to assist in curing the building material 196. In still another embodiment, the inventor has discovered that the passages 180 allow a transfer of conditioned air, for example, heated or cooled air, naturally by thermal effects of the sun on the structural components or soil surrounding the structure or by mechanical condition (an HVAC system). The transfer within the system improves environmental, living conditions within the building envelope of the structure, and in some cases can minimize costs of maintain the environmental conditions.

[0105] In one embodiment, the transfer of gas may be aided by an additional volume of air flow introduced by, for example, an in-line force air system. In one embodiment the flow rate is a minimum of three hundred fifty to four hundred cubic feet per minutes (350-400 cfm) through a one and a half inch (1/2 in.; 1.27 cm) drainage core described below. Of course, flow rate may increase significantly in large systems, e.g., four inch pipes for example. In one embodiment, illustrated in FIGS. 1B, 11C and 11D, the inventor has found that the one or more passages 180 of the side walls may be used to provide heated or cooled air from an air exchange unit 184, such as

for example a heating and/or cooling unit 184A, via passages 186 in communication with at least one of the passages 180, to the interior and/or exterior areas about and/or within the footing 202 and walls, e.g., the aforementioned areas 192A, 192B and 192C, to remove moisture, condensation, humidity or the like in the areas, to aid cure time during construction, to permit construction in unfavorable weather and/or air or soil conditions (e.g., heat the building material and/or surrounding soil to permit construction in cold temperatures by permitting a passive flow and/or cure without freezing, and/or vice versa, to cool the building material and/or the surrounding soil to permit construction and stable curing during hot weather conditions), and to remove moisture that may lead to mold and/or other hazards. It should be appreciated that the passage 180 may be continuous, for example, provide for air flow about substantially all of an exterior perimeter, interior perimeter or both the exterior and interior perimeter of the formed footing 202 and the walls 204 (e.g., areas 192A, 192B and/or 192C). Alternatively, one or more portions of the exterior and interior perimeter of the formed footing 202 and the walls 204 may include the integrally formed side walls that provide one or more of the passages 180 that can be accessed to transfer, e.g., remove and/or remediate radon or other unwanted gas such as, for example, carbon dioxide, methane, and other gases, moisture or the like, and/or introduce heated and/or cooled conditioned air, from the areas (e.g., areas 192A, 192B, and/or 192C) proximate the building constructed.

[0106] As noted above, the inventive form system 100 may be used to construct the foundation 200 including one or both of the footing 202 and the walls 204 for the structure of interest. For example, a plurality of the bracket assemblies 120 and 220 (described below) may be operated to retain a plurality of the side walls 160 and 260, and components thereof, in the predetermined configuration to receive the concrete 196 to form one or both of the footing 202 and walls 204 of the foundation 200 for the structure of interest. When the components used to construct the side walls 160 and 260 are comprised of tubular, square or rectangular members having the interior cavity 166 and 174, the interior cavities 166 and 174 of the interconnected components cooperate to define one or more of the passages 180 within the side walls 160 and 260 for air flow around at least a portion of an exterior perimeter (e.g., within area 192A) and/or interior perimeter (e.g., within area 192C) of the formed footing 202 and the walls 204. The inventor has found that when accessed after construction, the one or more passages 180 are conducive to providing ventilation for effective and efficient transfer (e.g., removal and/or remediation) of radon

or other unwanted gas such as, for example, carbon dioxide, methane, moisture or the like, and/or introduce heated or cooled condition air, from exterior or interior portions of the structure constructed. In one embodiment, the additional conditioned air through the passages 180 may supplement and enhance the conventional HVAC system and improve its performance.

[0107] Turning now to FIGS. 12A and 12B, in one embodiment the inventive form system 100 includes one or more bracket assemblies 220 disposed at varying intervals along the length L1 of the predetermined configuration within the excavated area 190 (similar to bracket assemblies 120) to keep side walls 260 from moving (e.g., being displaced) by pressure exerted thereon by the flowing concrete 196 introduced to the channel 192 formed between the side walls 260. In one embodiment, each of the one or more bracket assemblies 220 includes one or more separator bars 230 and two or more reinforcement posts 240, illustrated in greater detail at FIGS. 13, 14A and 14B, respectively. As with the separator bars 130 and the reinforcement posts 140 described above, the separator bars 230 and the reinforcement posts 240 cooperate to retain the side walls 260, and components thereof (e.g., the aforementioned single or stacked components of elongated building materials such as, for example, wooden boards, planks or sheet materials, tubular members such as round drain or drainage pipe, square or rectangular pipe or conduit, drainage cores, and combinations thereof), in the vertical orientations and the horizontally spaced apart (e.g., distant) relation of the predetermined configuration. As illustrated in FIG. 13, each of the one or more separator bars 230 include a plurality of apertures 232 and 234 disposed at predetermined locations along a length L4 of the separator bar 230. In one embodiment, the apertures 232 are disposed at opposing ends 236 and 238 of each of the separator bars 230 and are sized to receive the stake or post 158 (FIG. 1A) for securing the bracket assembly 220 at a location within the excavated area 190. The apertures 234 are disposed (as described below) at predetermined locations along the length L4 of the separator bar 230 and are sized to receive one or more of the reinforcement posts 240. In one embodiment, the apertures 234 may be used to support structural members such as, for example, rebar supports 157.

[0108] As illustrated in FIGS. 14A and 14B, in one embodiment each of the reinforcement posts 240 includes protrusions or serrations 244 disposed along at least a portion of a length L5 of one or more sides 242 of the reinforcement post 240. The sides 242 terminate at an end 246. In one embodiment, the end 246 is comprised of a foot extending outwardly from the sides 242. In

one embodiment, the foot may include an aperture for receiving a stake to retain the reinforcement post 240 in position within the excavated area 190. Alternatively, the end 246 is tapered to conclude at a point or edge to retain the reinforcement post 240 in position. The plurality of apertures 234 of the separator bars 230 and the protrusions or serrations 244 of the reinforcement posts 240 are sized to frictionally engage one another whereby placement of a reinforcement bar 240 within an aperture 234 provides frictional engagement between the protrusions or serrations 244 and the separator bar 230 to prevent displacement. In one embodiment, the separator bar 230 may include a plurality of tabs that are selectively extendable into the apertures 234 to lock the reinforcement post 240 to the separator 230.

[0109] In one embodiment, the reinforcement posts 240 are comprised of U-shaped or rectangular tubular members (e.g., polymer U-channel or tubing) having a wall of a thickness to provide a relatively rigid structure (e.g., about 0.125 in (3.175 mm) thickness). In one embodiment, the reinforcement posts 240 are of uniform sizes and thus, are selectively interchangeable with and nestable within one another. For example, as shown in FIG. 14B, two posts 240A and 240B of the reinforcement posts 240 may be nested such that the reinforcement post 240A is vertically adjustable over a height H2 within the reinforcement post 240B. As can be appreciated by one skilled in the art, this vertical adjustment over the height H2 of the nested reinforcement posts 240A and 240B provides a leveling feature when the grade of at least a portion of the excavated area 190 is uneven. It should also be appreciated that nested ones of reinforcement posts 240 provide for a selectively adjustable height as needed to retain the separator bars 230 and/or components of the side walls 260 (described below) within the predetermined configuration, as the configuration is being constructed. In one embodiment, the nested reinforcement posts 240A and 240B include means for securing a relative vertical relation between them such as, for example, apertures for receiving a fastener or pin, a hook and/or ratchet arrangement, or like coupling mechanism.

[0110] In one aspect of the invention, the predetermined locations of the apertures 234 of the separator bars 230 correspond to nominal widths of elongated building material required, recommended or preferred, for use as components to construct the side walls 260 as well as widths of side walls 260 to be constructed. For example, as with the bracket assembly 120, when a first pair of the reinforcement posts 240 of the bracket assembly 220 are placed within corresponding

ones of the apertures 234 proximate end 236 of the separator bar 230 a first side wall 262, and components thereof, are retained in place between the first pair of posts 240, and when a second pair of the reinforcement posts 240 are placed within corresponding ones of the apertures 234 proximate the opposing end 238 of the separator bar 230 a second side wall 264, and components thereof, are retained in place between the second pair of posts 240. Similar to the separator bar 130, as shown in FIG. 13, in one embodiment the separator bar 230 is stamped, labeled or otherwise marked with indicia, shown generally at 235, to identify nominal widths of typical building materials, required, recommended or preferred, for use as components to construct the side walls 260 and/or of the side walls 260 themselves. For example, the separator bar 230 includes such indicia 235 proximate its ends 236 and 238 to correspond to locations to construct each of the side walls 160 and 260. For example, a first set of indicia 235A proximate the end 236 corresponds to the location for constructing the first side wall 162 or the first side wall 262, and a second set of indicia 235B proximate the end 238 corresponds to the location for constructing the second side wall 164 or the second side wall 264.

[0111] In one aspect of the invention, the bracket assembly 220 permits construction of footings 202 and walls 204 of the foundation 200 having the substantially vertical side walls 162 and 164 of a generally rectangular or square cross-section (e.g., as shown in FIGS. 3 and 6), as well as the side walls 262 and 264 of a generally trapezoidal cross-section, and/or of combinations and variations thereof such as, for example, a footing or wall having a first side wall (e.g., the walls 262) approximating a leg of a trapezoid (e.g., a trapezoidal cross-section with an angular incline of less than ninety degrees (90°)) and a second side wall (e.g., the walls 164) approximating a leg of a rectangle (e.g., a rectangular cross-section with an angular incline of ninety degrees (90°)) as shown in, e.g., FIGS. 12B and 12C. In one embodiment, the bracket assembly 220 includes one or more spacers 280 that mount over or are coupleable to the reinforcement posts 240 at a desired vertical location about the post 240 to permit an offset in the configuration (e.g., a horizontal offset HOF1 and a vertical offset VOF1) of one or more components used to construct the side walls 260 configured to approximate a leg of a trapezoid (FIG. 12B). As shown in FIG. 12D, the one or more components used to construct the sidewalls 260 themselves may be configured to approximate a leg of a trapezoid by, for example, stacking a larger diameter component above a smaller diameter component.

[0112] As shown in FIGS. 12A and 12B, during construction of a first side wall 262, the first reinforcement post 240A is nested within the second reinforcement post 240B and the nested posts are disposed within an aperture 234 proximate the end 236 of the separator bar 230 such that the nested reinforcement posts 240A and 240B are disposed externally with respect to the channel 192 (e.g., disposed at about location 192A). A third post 240C is then placed within another aperture 234 inwardly from the end 236 such that the third reinforcement post 240C is disposed internally with respect to the channel 192 (e.g., disposed at about location 192B) to externally and internally bound a first component 262A and a second component 262B (e.g., tubular members) used to construct the first side wall 262 between the nested, externally disposed reinforcement posts 240A and 240B and the internally disposed reinforcement post 240C. As shown in FIG. 12B, a spacer 280A is disposed over the nested, externally disposed reinforcement posts 240A and 240B and cooperates with a fourth reinforcement post 240D to maintain an offset relation between the first component 262A and the second component 262B of the first side wall 262, for example, the horizontal offset HOF1 and the vertical offset VOF1. Similarly, during construction of the second side wall 264, a fifth reinforcement post 240E is nested within a sixth reinforcement post 240F and the nested posts are disposed within an aperture 234 proximate the end 238 of the separator bar 230 such that the nested reinforcement posts 240E and 240F are disposed externally with respect to the channel 192 (e.g., disposed at about location 192C). A seventh reinforcement post 240G is then placed within an aperture 234 inwardly from the end 238 such that the seventh reinforcement post 240G is disposed internally with respect to the channel 192 (e.g., disposed at about location 192B) to inwardly bound a first component 264A and a second component 264B (e.g., tubular members) used to construct the second side wall 264 between the nested, externally disposed reinforcement posts 240E and 240F and the internally disposed reinforcement post 240G. As shown in FIG. 12B, a spacer 280B is disposed over the nested, externally disposed reinforcement posts 240E and 240F and cooperates with an eighth reinforcement post 240H to maintain an offset relation between the first component 264A and the second component 264B of the second side wall 264; for example, the horizontal offset HOF1 and the vertical offset VOF1. One skilled in the art, when viewing FIGS. 12A, 12B and 12D, would appreciate that the illustrated configuration of the bracket assembly 220 permits construction of side walls 262 and 264 forming a footing or foundation having generally trapezoidal cross-section.

[0113] It should be appreciated that a plurality of spacers 280 having varying lengths (distance as measured from its coupling with a reinforcement post) and a plurality of reinforcement posts 240 having varying heights may be employed to form footings and/or walls of a predetermined height and a generally trapezoidal cross-section over at least a portion of the predetermined height. For example, as shown in FIG. 12C, a partial cross-sectional view, a spacer 280C is disposed over the nested, externally disposed reinforcement posts 240A and 240B and cooperates with a ninth reinforcement post 240I to maintain an offset relation between the first component 262A, the second component 262B and a third component 262C of the first side wall 262, for example, the horizontal offset HOF1 and the vertical offset VOF1 between the first component 262A and the second component 262B, and a horizontal offset HOF2 between the first component 262A and the third component 262C and a vertical offset VOF2 between the second component 262B and the third component 262C. In one embodiment, a plurality of spacers of similar length as the spacer 280C (e.g., spacers 280C1 and 280C2) may be employed to maintain a common offset as fourth and fifth components 262D and 262E are added to increase the height of the first side wall 262. Accordingly, the first side wall 262 of FIG. 12C includes a lower portion having a generally trapezoidal cross-section, and an upper portion having a generally rectangular cross-section.

[0114] While FIGS. 12A to 12C illustrate for clarity, relatively similar vertical and horizontal offsets (e.g., HOF1, HOF2, VOF1, VOF2) between components (e.g., 262A, 262B, 262C, 264A, 264B, 264C) of the side walls 260, it is within the scope of the present invention to vary one or more such offsets as may be required, recommend, or preferred to achieve side walls of various configurations. As such, the recited offset relation between components of the side walls 260 should be considered broadly to include various horizontal and vertical spacing of the components of the side walls 260. For example, while not illustrated in FIGS. 12A to 12C, it is also within the scope of the present invention to dispose one or more of the spacers 280 over one or more of the internally positioned (with respect to the channel 192) reinforcement posts 240 such as, for example, the reinforcement post 240C, that inwardly bounds the components of the side wall 260 (e.g., the second component 262B). In one embodiment, the spacers 280 may both internally and externally offset the components such that a cross section of the side walls 260 is configured to approximate a ribbed or corrugated side wall. It should be appreciated that the

inventor recognizes that the ribbed or corrugated configuration of the side walls 260 can assist in the flow of water around the side walls 260 and the structure constructed thereon and, as such, may be an integral part of a drainage system or other water remediation system for the structure.

[0115] It should also be appreciated that as the height H1 of the side walls 162, 164, 262 and 264 increases, two or more of the bracket assemblies 120 and 220 may be stacked and coupled together. For example, apertures 134 and 234 may be used to receive posts or ties for coupling two or more stacked bracket assemblies 120 and 220. In addition, one or more of the reinforcement posts 140 and 240 may be coupled, interconnected or nested, to support the stacked arrangement.

[0116] It should also be appreciated that while the vertical and horizontal offsets (e.g., HOF1, HOF2, VOF1, VOF2) between components (e.g., 262A, 262B, 262C, 264A, 264B, 264C) of the side walls 260 are described above as being achieved with one or more of a plurality of spacers 280 coupled to reinforcement posts 240 and having varying lengths, in one embodiment, the components themselves may provide one or more of the desired vertical and horizontal offsets. For example, as shown in FIG. 12D, large diameter conduits 462B and 464B (e.g., a six inch (6") / (15.24 cm) O.D. pipe) are stacked on top of smaller diameter conduits 462A and 464A (e.g., a four inch (4") / (10.16 cm) O.D. pipe), the conduits being held in place between outwardly bounding and inwardly bounding reinforcement posts 440A, 440B, 440C and 440D. In one embodiment, mating pairs of the reinforcement posts (e.g., outwardly bounding post 440A and inwardly bounding post 440B, and outwardly bounding post 440C and inwardly bounding post 440D) are coupled by respective feet portions, and retained in place by separator bars 430. Alternatively, the pairs of reinforcement posts may be formed of a one-piece construction. In still another embodiment, illustrated in FIG. 12E, the plurality of spacers 280 are replaced with conventional building materials 450 such as, for example, lumber, elongated plastics or foam members, and the like, to provide one or more of the desired vertical and/or horizontal offsets between one or more components, such as the conduits 562A and 564A.

Barrier provides Thermal Conductivity, Insulating and/or Fire Resistant Characteristics:

[0117] In still another embodiment, illustrated in FIG. 12F, a barrier 510 is disposed between the outwardly bounding and inwardly bounding posts, e.g., 440A and 440B, and 440C

and 440D, to support the conduits 462A, 462B, 464A and 464B. For example, in one embodiment shown in FIG. 12F, the barrier 510 may be comprised of a foam insulation board 510A such as a STYROFOAM® brand foam or other polystyrene foam board, or any other suitably rigid synthetic or organic material (“Styrofoam” is a registered trademark of Dow Chemical Company, Midland, MI USA). As shown in FIG. 12H, the barrier 510 may be comprised of a fabric or sheet material 510B such as a landscape fabric. In one embodiment, the fabric or sheet material 510B is comprised of or treated to provide fire resistant properties. In one embodiment, the fabric 510B is secured to the soil via, for example, stakes 512. In the embodiment shown in FIG. 12H, the fabric 510 is wrapped around large diameter conduits 462B and 464B and proximate smaller diameter conduits 462A and 464A thereby forming the channel 192. In the embodiment shown in FIG. 12I, the fabric 510B is wrapped around large diameter conduits 462B and 464B and proximate building materials 450. In one embodiment as shown in FIG. 12J, the foam board 510A and the sheet material 510B cooperate to form a first layer and a second layer of the barrier 510 wherein the fabric 510B is wrapped around conduits 462A and 462B and proximate the foam board 510A. In one embodiment as shown in FIG. 12K, the fabric 510B is wrapped around conduits 162D and 162E.

[0118] It should be appreciated that, in one embodiment, the barrier 510 functions to prevent backfill, e.g., gravel, from inadvertently filling the channel 192, as well as increases an air flow and/or drainage area in a volume 520 about the conduits 462A, 462B, 464A and 464B (FIG. 12H). For example, the barrier 510 prevents backfill from entering the volume 520 between the outwardly bounding post (e.g., 140A, 440A) and the inwardly bounding post (e.g., 140B, 440B). In one embodiment, the barrier 510 surrounds or envelops the conduits 462A, 462B, 464A and 464B to prevent backfill from entering the volume 520. In one embodiment, illustrated in FIGS. 12L and 12M, one or more of the conduits 462A, 462B, 464A and 464B may be comprised in a gravel-less conduit configuration 652 wherein an outside diameter of the conduit has protrusions 654 extending therefrom.

[0119] As shown in FIGS. 15A and 15B, sectional views of embodiments of the inventive form 100 are illustrated for use in forming elements of the foundation 200, namely, a footing 202A having a generally rectangular cross-section and a footing 202B having a generally trapezoidal cross-section. The side walls 160 of the footing 202A are formed of the spaced apart conduits 170

having the corrugated walls 172 and the interior cavity 174, and the side walls 260 of the footing 202B are formed of the stacked, offset conduits (e.g., components 162A, 162B, 164A, 164B, 262A, 262B, 264A and 264B) having the interior cavity 166. One or more of the plurality of straps 150 and spreaders 155 are disposed about the side walls 160 and 260 to prevent a spreading apart of connected conduits as the concrete 196 is being poured. Once the concrete 196 cures, the straps 150 and the spreaders 155 also assist in maintaining the integrally formed footing 202 and, components thereof, in position. For example, once cured, the straps 150 and the spreader 155 can be used in a permanent installation for example, to support rebar supports 157 placed in the channel 192 prior to pouring the cement.

[0120] As noted above, the interior cavity 174 of interconnected conduits 170 and the interior cavity 166 of the interconnected components 262A, 262B, 264A and 264B cooperate to provide the passage 180 for air flow around the interior and exterior of the footings 202 when the passage is accessed by means of, for example, another pipe or other conduit 310 either exteriorly or interiorly (e.g., through a floor or slab 206) after the structure has been completed and unacceptable levels of radon or other gases are detected to vent the radon laden air or other unwanted gas such as, for example, carbon dioxide, methane, into the atmosphere. In one embodiment, one or both of the conduit 170 and components 262A, 262B, 264A and 264B include means for receiving gases from the soil 194 within the areas 192A and 192C external and internal to footing 202 and under the slab 206. For example, the corrugated walls 172 of the conduit 170 include apertures or slots 175 to receive gases permeating from soil 194 within the areas 192A and 192C external and internal to footing 202 and under the slab 206. Similarly, one or more of the stacked components 262A, 262B, 264A, 264B include apertures or slots 168 to receive the gases permeating from the soil 194 within the areas 192A and 192C proximate the footing 202 and under the slab 206.

[0121] As shown in FIGS. 15A to 15E, one or more cross-venting pipes or conduits 320 may be installed during construction communicating between the two corrugated conduits 170 and/or components 262A, 262B, 264A, 264B of the footing 202 to provide the passage 180 for air flow communication between the corresponding conduits 170 and/or components 262A, 262B, 264A, 264B to facilitate venting and/or removal of gases, moisture and the like (FIGS. 15A, 15B, and 15D) and/or the addition of heated or cooled air within, and when coupled to conduit 310,

outside the structure (FIGS. 11C, 11D, 15C and 15E). Thus, the cross-venting pipes or conduits 320 provide for a reverse air flow. Such reverse air flow provides for directing outside air to an area under a slab or similar foundation base. As a result, the temperature can be equalized to substantially reduce or eliminate condensation and moisture from forming in the area under a slab or similar foundation base. Accordingly, mold and other harmful microorganisms are prevented from forming. In one embodiment, an in-line force air system 330 is coupled to the pipe 310 to increase the volume of air flow within the passage 180 and facilitate remediation of the unwanted gases and/or the addition of desirable air (e.g., heated or cooled air).

Drainage:

[0122] As seen in FIGS. 20 and 21, a conventional foundation footing system 1000 (FIG. 20), including accompanying drainage components, is compared to a gravel-less foundation footing system 10 (FIG. 21) integrally formed with a drainage and ventilation system in accordance with one embodiment of the present invention. In the conventional system 1000 shown in FIG. 20, conventional building forms are installed and a foundation footing 1012 is formed to support a wall 1013 and slab 1014 of a structure of interest. After the footing 1012 is formed, gravel 1016 is used to backfill an excavated area proximate the footing 1012. Gravel is conventionally used to promote drainage of liquid, e.g., ground and subsurface water, away from the foundation. Typically, a pipe 1018 is installed proximate to and inwardly from the footing 1012 beneath the slab 1014 to receive, capture and thereby mitigate radon and/or other unwanted gas (e.g., carbon dioxide, methane, and the like) from entering the building. Typically, a drainage pipe 1020 is installed proximate to and outwardly from the footing 1012 to receive, capture and thereby drain water away from the structure. Additional gravel 1016 is used as backfill around the drainage pipe 1020 and over the footing 1012 to further promote drainage of water away from the foundation. In some cases, a fabric is positioned over the gravel 1016 and pipe 1020 to prevent silt and debris from entering and blocking passages through the gravel 1016 and pipe 1020. As can be appreciated, installing the conventional foundation footing system 1000 including the accompanying drainage components is a multi-step, time-consuming process that requires a variety of building materials, both of which increases the cost of construction.

[0123] Alternatively and as shown in FIG. 21, the foundation footing system 10 integrally formed with a drainage and ventilation system enables the formation of a footing 12 to support a wall 13 and slab 14 of the structure without the need to backfill or place gravel beneath the slab 14 or around the footing 12 to assist drainage. The foundation footing system 10 is a gravel-less foundation footing system and includes a first form assembly 16A and a second form assembly 16B that form sidewalls forming the footing 12, for example by cooperating with the bracket system 220 to form the sidewalls 260 of FIGS. 15B and 15C, while integrally forming a drainage system 18 and a ventilation system 20 as further described herein below.

[0124] One embodiment of a gravel-less form system 500 according to the present invention is shown in FIGS. 12N and 12O and includes a first form assembly 502 and a second form assembly 504 that form sidewalls, for example the sidewalls 260 of FIGS. 15B and 15C. Referring first to FIG. 12N, the barrier 510 includes the sheet material 510B disposed around a first drainage core 550, a second drainage core 560, and a conduit such as, for example, conduits 562A and 564A. In one embodiment, conduits 562A and 564A are perforated conduits such that a flow of ground or subsurface water can be received therein. In one embodiment, the sheet material 510B is formed into a sleeve or pocket 563 thereby eliminating the need for a conduit wrapped by a barrier material. Alternatively, conduits 562A and 564A extend through the sleeve 563. An open volume or drainage cavity 570 is thereby formed bounded by the first drainage core 550, the second drainage core 560, and the respective conduit 562A and 564A. In one embodiment, the first drainage core 550 is a single-drainage core 550A (e.g., permits passage of a flow of liquid through the core in one direction) and the second drainage core 560 is a dual-drainage core 560A (e.g., permits passage of liquid through the core in two directions). Thus, a passageway is created through the dual-drainage core 560A in the direction indicated by the arrows X1 at a penetration point in the foundation wherein the footing intersects the wall to advantageously create a flow away from the penetration point into the drainage cavity 570. As a result, water (e.g., ground or subsurface water) can enter the drainage cavity 570 via the respective fabric-wrapped conduit 562A and 564A and the respective dual-drainage core 560A and be transferred away from the structure along a perimeter thereof (e.g., in a direction into and out of the drawing sheet). In one embodiment, the first drainage core 550 and the second drainage core 560 are in fluid communication, or are joined at a connection point 555, so that water may pass from one drainage

core to the other. The liquid that enters the drainage cavity 570 may pass to the first drainage core 550 in the direction indicated by arrows X2 and to the second drainage core 560 in the direction indicated by arrows X3 and thereby equalize the volume of liquid (e.g., ground or subsurface water) in the first and second drainage cores 550 and 560 and in the drainage cavity 570 flowing along the perimeter of the structure. In one embodiment, the second drainage core 560 provides a passageway for seeping air and other gases such as, for example, carbon dioxide, radon, methane, and the like, as well as water.

[0125] In one embodiment and as shown in FIG. 12O, the first drainage core 550 is configured as an extended first drainage core 550B extending to an upper point 550X proximate the top of the respective conduit 562A or 564A. In one embodiment, the second drainage core 560 is an extended second drainage core 560B extending to an upper point 560X proximate the top of the respective conduit 562A or 564A. In one embodiment, both the extended first drainage core 550B and the extended second drainage core 560B are employed.

[0126] The bottom portion of the illustrated form system defines an overall length L_{FORM} . A first length L_{FORM1} is defined by the combined thicknesses of each of the first drainage core 550 and the second drainage core 560. A second length L_{FORM2} is defined by the horizontal distance traversed by the first drainage core 550. A third length L_{FORM3} is defined by the distance between drainage cores assemblies, or from one second length L_{FORM2} defined by one first drainage core 550 to another second length L_{FORM2} defined by another first drainage core 550. Thus, as shown in FIG. 12O, the overall length L_{FORM} is a summation of L_{FORM1} , L_{FORM2} , L_{FORM3} , L_{FORM2} and L_{FORM1} . In one embodiment, the overall length L_{FORM} is up to about thirty-six (36) inches (91.44 cm). In one embodiment, the overall length L_{FORM} is about twenty-eight (28) inches (71.12 cm). In one embodiment, each of the first drainage core 550 and the second drainage core 560 define a thickness T1 of about one (1) inch (2.54 cm); thus, the first length L_{FORM1} is about two (2) inches (5.08 cm). In one embodiment, the second length L_{FORM2} is about six (6) inches (15.24 cm). In one embodiment, the third length L_{FORM3} is about twelve (12) inches (30.48 cm).

[0127] As shown in FIGS. 12N and 12O, the configuration of the first drainage core 550, the second drainage core 560, and the respective conduit 562A and 564A form a channel 592 and provide for the elimination of a dual-reinforcement post configuration. As shown in FIGS. 12N and 12O, such a configuration includes only outwardly bounding reinforcement posts 440A and

440D and does not require respectively corresponding inwardly bounding reinforcement posts 440B and 440C. However, the use of respectively corresponding inwardly bounding reinforcement posts 440B and 440C with the configuration of the first drainage core 550, the second drainage core 560, and the respective conduit 562A and 564A is another embodiment of said configuration and is considered within the scope of the present invention.

[0128] The configuration of the first drainage core 550, the second drainage core 560, and the respective conduit 562A and 564A further provide for installing said configuration at varying height/depth and having varying width/conduit diameter. Thus, effective gravel-less drainage can be configured for a wide variety of drainage applications.

[0129] As shown in FIG. 12P, one embodiment of the first drainage core 550, the second drainage core 560 and the conduit 564A includes individually wrapping the components with the barrier 510 or a sheet material 510C of the fabric 510B and setting the components in relation to one another as shown in FIG. 12P, namely, the first drainage core 550 and the second drainage core 560 disposed proximate to one another and substantially flat in one plane (e.g., horizontally or vertically), and the conduit 564A disposed proximate to the second drainage core 560 on the opposite side of the position of the first drainage core 550. The wrapped first drainage core 550 is rotated in the direction indicated by the arrow R from a first position R1 to a second position R2. The wrapped conduit 564A is moved toward the first and second drainage cores 550 and 560 in the direction indicated by the arrow Q from a first position Q1 to a second position Q2.

[0130] One embodiment of a drainage core 580 for use as the first and/or second drainage cores 550 and 560 is shown in FIG. 12Q. The drainage core 580 includes a base 582 and protrusions 584 extending outwardly from at least one side thereof. In one embodiment, the protrusions 584 extend outwardly from both sides thereof. In one embodiment, the base 582 is permeable and defines one or more apertures 583 extending therethrough for increased drainage through the core 580. In one embodiment, one or more of the protrusions 584 includes an aperture 585 extending therethrough for increased drainage through the core 580. In one embodiment, the aperture 585 is in fluid communication with one of the apertures 583 for increased drainage through the core 580.

[0131] In one embodiment, the core 580 is fabricated from a plastic or thermoplastic material such as, for example, polyethylene, polypropylene, polystyrene, high-impact polystyrene

(HIPS), or the like. In one embodiment, the core 580 is a structural foam polyethylene. In one embodiment, the core 580 is a dimpled polymeric core. In one embodiment, the core 580 is a dimpled high-impact polystyrene core. In one embodiment, the wrapped first and second drainage cores 550 and 560 are formed using geo-composite materials such as for example a geotextile-geonet composite, a geotextile-geomembrane composite, a geomembrane-geogrid composite, and a geotextile-polymer core composite. In one embodiment, the wrapped first and second drainage cores 550 and 560 are formed using a polystyrene core wrapped by polypropylene filter fabric.

[0132] One embodiment of a gravel-less form system 600 according to the present invention is shown in FIG. 16 and includes a first form assembly 602 and a second form assembly 604 that form sidewalls, for example the sidewalls 260 of FIGS. 15B and 15C. A barrier 610 includes an inner layer 611A wrapped by an outer layer 611B. In one embodiment, the inner layer 611A includes a first drainage core 650 and a second drainage core 660. In one embodiment, the outer layer 611B is a fabric 610B. The fabric 610B is wrapped around the first drainage core 650, the second drainage core 660, and a conduit such as for example conduits 662A and 664A. In one embodiment, conduits 662A and 664A are perforated conduits. In one embodiment, the fabric 610B is formed into a sleeve or pocket 663 through which the conduits 662A and 664A extend. An open volume or drainage cavity 670 is thereby formed bounded by the first drainage core 650, the second drainage core 660, and the respective conduit 662A and 664A.

[0133] One embodiment of a gravel-less foundation footing drainage and ventilation system and, more generally, a gravel-less drainage and ventilation system 700, employable according to aspects of the present invention without the aforementioned bracket assemblies 120 and 220, is shown in FIG. 17. A barrier 710 includes an inner layer 711A wrapped by an outer layer 711B. In one embodiment, the inner layer 711A includes a first drainage core 750 and a second drainage core 760. In one embodiment, the outer layer 711B is a fabric 710B. The fabric 710B is wrapped around the first drainage core 750, the second drainage core 760, and a conduit 762. In one embodiment, conduit 762 is a perforated conduit. In one embodiment, the fabric 710B is formed into a sleeve or pocket 763 through which the conduit 762 extends. An open volume or drainage cavity 770 is thereby formed bounded by the first drainage core 750, the second drainage core 760 and the conduit 762. As described below, the inventor has discovered a plurality of innovative uses of the drainage and ventilation system 700, and other components described above,

in athletic field, golf courses and other applications, in addition to the uses within and proximate to building structural components.

[0134] In one embodiment and as shown in FIGS. 16 and 17, one or both of the first and second drainage cores 650, 660 and/or 750, 760 include a plurality of surface elevations 652 and/or depressions therein that form a plurality of respective passages 655 and 755 extending vertically and horizontally through the respective drainage cores. As a result, water (e.g., ground or sub-surface water) and seeping air and other gases can enter the drainage cavity 670, 770 via the respective fabric-wrapped drainage core 650 and/or 660, and 750 and/or 760. In one embodiment, one or both of the first and second drainage cores 650, 660 and/or 750, 760 include one or more apertures 583 and 585 extending therethrough for increased drainage and air flow through the core as shown with respect to the core 580 in FIG. 12Q. FIG. 18A illustrates one embodiment of a drainage core 850 for use with any of the systems described herein. Similar to some embodiments of the drainage cores 650, 660, 750 and 760, the drainage core 850 is comprised of a sheet 852 having a plurality of cusps or dimples 854 formed therein, for example by stamping, punching or molding. In one embodiment, the dimples 854 are formed in a row-column configuration defining, about their perimeter, a first plurality of passages 855A extending in a first direction through the core 850 (e.g., along a row of dimples 854), and a second plurality of passages 855B extending in a second direction through the core 850 in a substantially orthogonal orientation to the first plurality of passages 855A (e.g., along a column of dimples 854). It should be appreciated that depending on orientation of the drainage core 850, the passages 855A and 855B permit liquid and gas to vertically and horizontally traverse the core 850.

[0135] In one embodiment, each of the dimples 854 extends upwardly from a surface 853 of the sheet 852 a height H_{DIMPLE} and terminates at an end 858. In one embodiment, the height H_{DIMPLE} is about 0.437 inch (1.110 cm). As shown in FIG. 18A, each dimple 854 extends from the surface 853 of the sheet 852 as a substantially cylindrical form having an inner diameter D_{DIMPLE} . In one embodiment, the inner diameter D_{DIMPLE} is in a range between about 0.250 inch (0.635 cm) to about 1.00 inch (2.54 cm). It should be appreciated that varying (e.g., increasing or decreasing) the height H_{DIMPLE} and/or inner diameter D_{DIMPLE} of the dimples 854 varies (e.g., proportionally increases or decrease) the volume of air, gas and/or liquid captured, retained and moved, carried or conveyed in the drainage core 850. For example, a larger height H_{DIMPLE} , such as for example,

0.500 inch (1.27 cm) or a smaller inner diameter D_{DIMPLE} such as, for example, 0.250 inch (0.635 cm) increases the flow capacity of the drainage core 850 by, for example, expanding a height and/or width of the first plurality of passages 855A and the second plurality of passages 855B. Alternatively, a smaller height H_{DIMPLE} , such as for example, 0.250 inch (0.635 cm), or a larger inner diameter D_{DIMPLE} such as, for example, up to 1.00 inch (2.54 cm) decreases the flow capacity of the drainage core 850 by, for example, reducing the height and/or width of the first passages 855A and the second passages 855B. It should be appreciated that the present invention is not limited to a specific height H_{DIMPLE} and/or inner diameter D_{DIMPLE} and that the height and/or inner diameter may be varied to accommodate certain drainage design and application specific parameters for good water management practices. For example, in some embodiments the inventor has discovered that a height H_{DIMPLE} , of 1.00 inch (2.54 cm) and inner diameter D_{DIMPLE} of 0.437 inch (1.109 cm) are preferred.

[0136] FIG. 18C shows generally, at 870, various characteristics of example geotextile fabric (described below at 860) that wraps at least a portion of the core 850 as well as various characteristics, at 880, of example dimple heights (H_{DIMPLE}) referred to as “Cusp Height” and corresponding liquid flow rates (gals/min per foot of width). FIG. 18D depicts an alternative embodiment of the sheet 852 of the plurality of cusps or dimples 854, shown as a sheet 852' having a plurality of cusps or dimples 854' extending from a surface 853' of the sheet 852' as a cone or tapered cylindrical form having a first inner diameter $D1_{\text{DIMPLE}}$ at an end proximate the surface 853' of the sheet 852' and extending to a second inner diameter $D2_{\text{DIMPLE}}$ at an opposite end 858' from the surface 853'. Similar to the inner diameter D_{DIMPLE} , the first inner diameter $D1_{\text{DIMPLE}}$ and the second inner diameter $D2_{\text{DIMPLE}}$ are in a range between about 0.250 inch (0.635 cm) to about 1.00 inch (2.54 cm).

[0137] As should be appreciated, in either embodiment described herein of the core 850, the plurality of cusps or dimples 854 and 854' form an interior cup or cavity 856 and 856' defined by and within the cylindrical or tapered cylindrical form as the form extends from an opened end 857 and 857' at the surface 853 and 853' of the sheet 852 and 852' and terminates at a closed platform end 858 and 858' opposite the opened end 857 and 857'. In one embodiment, for example, the platform end 858 and 858' is configured as a flat surface, extending above (e.g., at the height H_{DIMPLE}) the first plurality of passages 855A and the second plurality of passages 855B defined by

and at the perimeter of the dimples 854 and 854'. As illustrated in FIGS. 18A and 18D, the platform end 858 and 858' supports the geotextile fabric (described below at 860) that wraps at least a portion of the core 850. In embodiments described herein, a plurality of the interior cups or cavities 856 and 856' may be filled as shown generally at 859 with, for example, a cement material or an adhesive in wall or floor applications. As can be appreciated, varying (e.g., increasing or decreasing) the dimple height H_{DIMPLE} and/or dimple inner diameters D_{DIMPLE} , $D1_{\text{DIMPLE}}$ and $D2_{\text{DIMPLE}}$, of the dimples 854, 854' varies (e.g., proportionally increases or decrease) a volume of the cement material and/or adhesive held within the plurality of the interior cups or cavities 856 and 856'.

[0138] As described below, the cement material within the interior cups or cavities 856 and 856' may accept masonry components such as a stone veneer applied thereto, and the adhesive, such as a pressure sensitive, hot melt adhesive, within the interior cups or cavities 856 and 856' may seal a penetration (e.g., provide a substantially watertight and/or airtight seal) of the core 850 from a fastener passing through the interior cavity 856 and 856' to affix the core 850 to a substrate, such as a wall or floor, during installation. In one embodiment, the adhesive includes any adhesive having similar characteristics of a hot melt, pressure sensitive adhesive when cured such as, for example, a Hot Melt 1066 product commercially available from Tailored Chemical Products, Inc. and/or a modified rubber based polymer, having a viscosity of about 7500 cps +/- about 100 at 350°F, which in one embodiment, meets composition requirements of indirect food additives regulation 21 CFR 175.105 for Adhesives.

[0139] In still a further embodiment, illustrated for example in FIGS. 18D and 18E and described in detail below, a substantial plurality of the interior cavity 856 and 856', and in some embodiments portions of the sheet 852 and 852', may be filled or covered with a mixture 890 of the adhesive 892 and a granular rubber 894 such as, for example, a crumb rubber comprised of recycled rubber from tires (e.g., styrene-butadiene rubber (SBR)) and the like. Examples of suitable particle sizes of the granular crumb rubber 894 mixed with the adhesive 892 include, for example, a thirty-five (35) or sixty (60) sieve or mesh, although it is within the scope of the present invention to utilize other particles sizes. The inventor has discovered improved performance in GMAX or Head Impact/Injury Criterion (HIC) testing (e.g., improvement in shock absorbing properties), when a core 850 so configured (e.g., with interior cavities 856 and 856' filled and/or

portions of the sheet 852 and 852' coated with the mixture 890) is disposed beneath turf or another surface material of athletic fields, playgrounds, golf courses, areas of natural or synthetic turf, and the like. It should be appreciated that GMAX and/or HIC testing refers to testing done to evaluate impact attenuation of a turf and/or synthetic turf playing field in accordance with, in one embodiment of GMAX testing, for example, ASTM F1936-19 Standard Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field. It should be appreciated that other standards establish acceptable performance requirements for systems tested. For example, in one embodiment, ASTM F1292 establishes minimum performance requirements for the impact attenuation of playground surfacing materials used in proximity to playground equipment.

[0140] For example, FIGS. 47A, 47B, 48A, and 48B provide ASTM F1292 test results for exemplary configurations of a drainage core (e.g., core 850) wrapped in a geotextile fabric (e.g., fabric 860) at varying dimple heights H_{DIMPLE} yielding a core and fabric assembly of about, for example, eight millimeter (8 mm), ten millimeter (10 mm) and twelve millimeter (12 mm) thickness. FIGS. 47A and 47B illustrates GMAX and HIC test results for drainage core and fabric assemblies where interior cavities of dimples of the core are not filled, and FIGS. 48A and 48B illustrates GMAX and HIC test results for drainage core and fabric assemblies where interior cavities of dimples of the core are filled with a mixture of adhesive and a granular rubber (e.g., a crumb rubber). The exemplary drainage core and fabric configurations are disposed under a first layer of synthetic turf and a second layer of infill (e.g., sand and/or 50/50 mix of sand and SBR (50% by weight)), and over two (2) differing substrates. The substrates include a concrete substrate (e.g., Test Configuration 1) and a compacted soil substrate (e.g., Test Configuration 2) as described in FIGS. 47A, 47B, 48A, and 48B. As shown in these figures, HIC and GMAX performance improves when the interior cavities of dimples of the core are filled with the mixture of adhesive and a granular rubber. In some embodiments, illustrated herein, when the core 850 is configured with the interior cavities 856 and 856' filled and/or portions of the sheet 852 and 852' coated with the mixture 890, and the core 850 is disposed beneath turf or another surface material of athletic fields, playgrounds, golf courses, areas of natural or synthetic turf, and the like, GMAX testing of a field with a fifty to fifty percent (50/50%) infill of turf and core 850 layers averages a GMAX rating well below an acceptable performance levels of about two hundred (200), a HIC rating well

below an acceptable performance levels of about one thousand (1,000), while having thermal conductivity with an R-Value about 0.1958.

[0141] It should be appreciated that the introduction of these specific ASTM standards and exemplary test results are merely to illustrate some perceived benefits of use of the present invention in various exemplary embodiments and is not intended to limit performance obtained through use of the present invention only to exemplary embodiments, configurations, and/or ranges stated in such standards or the test results referenced herein.

[0142] Referring briefly to FIGS. 11C and 11D, it should be appreciated that in various embodiments the inventor has found that the first plurality of passages 855A and the second plurality of passages 855B of the drainage core 850 of the gravel-less drainage and ventilation system installed in proximity to the foundation 200, may be used to provide heated or cooled air from the air exchange unit 184 (FIGS. 11C and 11D) such as, for example, a heating and/or cooling unit 184A, to remove moisture, condensation, humidity or the like, to aid cure time of the cement material or the adhesive within the interior cavity 856 and 856' or covering portions of the sheet 852 and 852' during construction and/or optimize conditions during use and operation (e.g., keep the adhesive at a softened condition to permit more fluid sealing of penetrations and the like). As noted in embodiments described herein, the passages 855A and 855B in the core 850 may also be utilized not only to stabilize conditions during construction and operation (e.g., provide cool air during hot weather and warm air during cold and freezing weather); but also to remove moisture that may lead to mold and/or other hazards within the core 850. It should be appreciated that, like other embodiments described herein, the passages 855A and 855B may continuously provide for air flow to capture and convey or transfer, e.g., remove and/or remediate, radon or other unwanted gas such as, for example, carbon dioxide, methane, and other gases, moisture or the like, and/or introduce and permit circulation of heated and/or cooled conditioned air. It should also be appreciated that the passages 855A and 855B of the core 850 promote thermal conductive throughout the drainage and ventilation system by allowing circulation of, for example, heated or cooled air, naturally by thermal effects of the sun on the soil in which the drainage core 850 is installed, or of thermal energy radiating from soil below the drainage core 850.

[0143] Referring again to FIG. 18B, one embodiment of forming system, the barrier 610, 710 includes providing a sheet 610C of the fabric 610B integrally formed with the sleeve 663

extending between portions 610D and 610E of fabric sheet 610C wherein such portions respectively envelope or wrap the respective drainage core, for example first drainage core. In one embodiment, one of the conduits, for example conduit 662A, is disposed within the sleeve 663 (FIG. 16). In one embodiment, the fabric 610B is a thermally bonded nonwoven geotextile that exhibits a high grab tensile strength and elongation as set forth in ASTM D4632, Grab Breaking Load and Elongation of Geotextiles. In one embodiment, the fabric 610B exhibits a grab tensile strength greater than 100 lbs. and an elongation that is greater than fifty percent (50%). In one embodiment, the fabric 610B provides for hydraulic conductivity therethrough as set forth in ASTM D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity. In one embodiment, the fabric 610B exhibits a permittivity greater than 1s^{-1} and a permeability of at least 0.05 cm/s. In one embodiment, the fabric 610A is Typar® SF geotextile commercially available from E. I. du Pont de Nemours and Company ("Typar" is a registered trademark of E. I. du Pont de Nemours and Company).

[0144] The inventor has discovered that in some embodiments, the barriers 510, 610 and 710 form a thermal break when disposed as an interface between, for example, a slab wall or floor and fill (e.g., vertical and/or horizontal configuration), and/or as a drainage blanket or mat (e.g., vertical and/or horizontal configuration of the core without a conduit) disposed at or below the surface of backfill. For example, as shown FIGS. 18A and 18B, the barriers 610 and 710 are comprised of an inner drainage cores 650 or 660, and 750 or 760, shown generally at 850, wrapped by an outer fabric 610B and 710B, shown generally at 860, such that the fabric 610B and 710B (fabric 860) encloses the cores 650 or 660 and 750 or 760 (core 850). The inventor has recognized that in this fabric-core-fabric "layered" or "sandwich" configuration forms a thermal break between the surfaces that it is disposed between. For example, the opposing fabric layers at least partially, if not fully, isolate temperature of the abutting materials. On one side, the slab wall or floor, and on the opposing side, the fill of gravel or soil. The inner drainage cores 650 or 660, and 750 or 760 (e.g., core 850) permit an air flow that further acts to isolate temperature differentials between the opposing fabric layers 610B and 710B (fabric 860) and the abutting materials. The inventor has also discovered that this isolation may be further enhanced, supplemented, or controlled, as desired, by introducing conditioned air or liquid within the drainage cores 650 or 660 and 750 or 760 (core 850). For example, warm or cool air or liquid may be passed through the

drainage cores 650 or 660 and 750 or 760 to regulate the temperature differential between the abutting materials.

[0145] In one embodiment, the drainage cores 550, 560, 650, 660, 750, 760 and/or 850 are fabricated by, for example: (i) continuous thermal forming of the core; (ii) perforating the core; (iii) cutting the core to a desired width; and (iv) laminating the fabric 610B, 710B or fabric sheet 610C (e.g., fabric 860) to the core in the desired configuration. In one embodiment, a sleeve (e.g., sleeve 663) may be sewn within the fabric sheet into which the core is installed. In one embodiment, an adhesive 654 is disposed on one or both outer surfaces of the plurality of surface elevations 652 of the respective drainage core 650, 660 prior to applying the fabric 610B or fabric sheet 610C (FIGS. 16 and 18B). In one embodiment, the adhesive 654 is compliant with the composition requirements set forth in 21 C.F.R. §175.105 (“Indirect Food Additives: Adhesives and Components of Coatings; Adhesives”). In one embodiment, the adhesive 654 exhibits an open time (i.e., the time after the adhesive is applied during which a serviceable bond is made) of greater than thirty (30) seconds. In one embodiment, the adhesive 654 is Hot Melt 1066 commercially available from Tailored Chemical Products, Inc.

Exemplary Applications of Use:

[0146] FIG. 19 shows a number of methods of use of the gravel-less forming system 600 of FIG. 16, the gravel-less drainage and ventilation system 700 of FIG. 17, and a gravel-less forming system 2100 of FIG. 33. As described hereinabove and illustrated in FIG. 19, construction of a building or other structure of interest includes forming a foundation footing 2 to support foundation walls 4 and a slab floor 6 extending therebetween. In one embodiment, the forming system 600 is employed to form a new foundation footing 2A having an integrally formed drainage and ventilation system therein as described hereinabove. In one embodiment, one form assembly 602A, configured similarly to form assembly 602, is employed to further provide drainage and ventilation capacity beneath the slab floor 6. In one embodiment, one form assembly 602B is configured such that first and second cores 750 and 750 extend substantially horizontally outwardly from conduit 762 to further provide drainage and ventilation capacity beneath the slab floor 6. In one embodiment, the form assemblies of the present invention are employed to provide drainage and ventilation capacity around an existing foundation footing 2B. In one such

embodiment, one form assembly 602C is positioned on an inward side 2C of footing 2B; and a second form assembly 602D is positioned on an outward side 2D of footing 2B. In one embodiment, first drainage core 650 and second drainage core 660 can be positioned proximate the existing foundation footing 2B. While FIG. 19 shows a number of methods of use of the forming system 600 and the ventilation system 700, it should be appreciated that all of the embodiments of a forming system and/or a drainage blanket or mat (e.g., horizontal and/or vertical configuration without a conduit) of the drainage cores in accordance with the present invention can be employed as shown in FIG. 19.

[0147] As described herein, in one aspect the present invention provides a concrete forming system for building foundations, and portions thereof, wherein walls of the foundation are constructed using building material sections that interlock end-to-end to form a passage (e.g., the passage 180). The passage 180 is conducive to provide ventilation for effective and efficient radon or other unwanted gas such as, for example, carbon dioxide, methane, mitigation or remediation from the structure being constructed. The inventive forming system permits construction of footings and walls of the foundation that may have substantially vertical side walls of a generally rectangular or square cross-section, side walls of a generally trapezoidal cross-section, and/or combinations and variations thereof. The inventor has recognized that the forming system permits construction of, for example, a sub-slab depressurization system (e.g., with the introduction of conditioned air and/or removal of air and other gases) with a minimum of about fifty percent (50%) more mitigation than is seen with prior art systems.

[0148] In one aspect of the present invention, when installing footing forms that need to be leveled, the present invention (e.g., the bracket assembly 220) provides a relatively easy leveling feature to minimize labor needed to level the form prior to use.

[0149] In yet another aspect of the present invention, once concrete has cured, there is no need to remove components of the forms as the components are integrally formed within the footings or walls to provide additional structural support. In one embodiment, self-leveling reinforcement posts act as a vertical brace if material is needed to block concrete from flowing out from under form.

[0150] In yet another aspect, components of the inventive form system are vertically stackable and horizontally expandable to accommodate footings and/or walls of various heights and widths.

[0151] Some perceived benefits of constructing footings and/or walls having a trapezoidal cross section include, for example:

[0152] A. Increases bearing with standard footing sizes.

[0153] B. Decrease amount of material used with standard footing sizes.

[0154] C. The standard footing sizes are reduced, but a same bearing is achieved.

[0155] D. Decreasing amount of material in reduced size achieving same bearing.

[0156] For example, a typical rectangular footing of dimensions of about twenty four inches (24 in.; 60.96 cm) in width, twelve inches (12 in.; 30.48 cm) in height and ten feet (10 ft.; 3.048 m) in length provides a cubic volume of twenty cubic feet (20 cu. ft.), while a trapezoidal footing may be constructed to carry the same bearing by have dimensions of about sixteen inches (16 in.; 40.64 cm) in upper width and twenty four inches (24 in.; 60.96 cm) in lower width, twelve inches (12 in.; 30.48 cm) in height and ten feet (10 ft.; 3.048 m) in length provides a cubic volume of sixteen cubic feet (16 cu. ft.).

[0157] The barrier and a form system for forming a foundation footing integrally formed with a drainage and ventilation system according to the present invention provides for retaining a flowable and curable building material to form a portion of a foundation of at least a portion of a structure of interest. The system includes side walls receiving and retaining the building materials therebetween. The side walls are disposed in a predetermined configuration suitable for the portion of the foundation and include a first side wall and a second side wall. At least one of the first side wall and the second side wall is comprised of at least one component having an interior cavity. A bracket assembly retains the side walls in the predetermined configuration. The bracket assembly includes a first outwardly bounding reinforcement post disposed proximate the first side wall, and a second outwardly bounding reinforcement post disposed proximate the second side wall. A separator bar includes a first end, a second end opposed from the first end, and a plurality of apertures disposed along a length of the separator bar. The plurality of apertures includes a first set of apertures disposed proximate the first end and a second set of apertures disposed proximate the second end. The first set apertures and the second set of apertures are sized to receive and retain

each of the reinforcement posts at locations corresponding to nominal widths of the at least one component. A barrier is disposed between the outwardly bounding posts. The barrier is defined by an inner layer wrapped by an outer layer, and the barrier being permeable. The barrier and the at least one component are retained in the foundation after the building material cures, and the barrier prevents backfill from filling a volume between the portion of the foundation and the outwardly bounding posts.

[0158] In one embodiment, the barrier inner layer includes a first drainage core having a first end, a second end, and a plurality of passages extending therethrough; and a second drainage core having a first end, a second end, and a plurality of passages extending therethrough. In one embodiment, the system includes a drainage cavity bounded by the at least one component and the first and second drainage cores wherein the second drainage core is disposed substantially vertically and proximate at least one of the first and second outwardly bounding reinforcement posts, the second end of the second drainage core being disposed proximate the second end of the first drainage core, and the first end of the first drainage core is positioned upwardly from the second end of the first drainage core and inwardly from the at least one of the first and second outwardly bounding reinforcement posts, and wherein the at least one component is disposed on the first end of each of the first and second drainage cores.

[0159] In one embodiment, the barrier outer layer is a fabric. In one embodiment, the barrier outer layer is a geotextile exhibiting a grab tensile strength greater than 100 lbs. and an elongation that is greater than fifty percent (50%). In one embodiment, the barrier outer layer is a geotextile exhibiting a permittivity greater than 1s^{-1} and a permeability of at least 0.05 cm/s. In one embodiment, the barrier further comprises an adhesive disposed between the barrier inner layer and the barrier outer layer. In one embodiment, the at least one component is a perforated conduit.

[0160] A drainage and ventilation system in accordance with the present invention includes a conduit, a first drainage core having a first end, a second end, and plurality of passages extending therethrough; and a second drainage core having a first end, a second end, and plurality of passages extending therethrough. A fabric is wrapped around each of the conduit, the first drainage core and the second drainage core. A drainage cavity is bounded by the conduit and the first and second drainage cores wherein the second drainage core is disposed substantially vertically and proximate

a first side of the conduit, the second end of the second drainage core being disposed proximate the second end of the first drainage core, wherein the first end of the first drainage core is positioned upwardly from the second end of the first drainage core and proximate a second side of the conduit; and wherein the at least one component is disposed on the first end of each of the first and second drainage cores.

[0161] A drainage and ventilation system, includes a conduit; a first drainage core having a first end, a second end, a first plurality of passages extending therethrough and a second plurality of passages extending therethrough substantially orthogonal to the first plurality of passages; a second drainage core having a first end, a second end, a first plurality of passages extending therethrough and a second plurality of passages extending therethrough substantially orthogonal to the first plurality of passages; a fabric wrapped around each of the conduit, the first drainage core and the second drainage core; wherein the conduit is disposed proximate the first end of each of the first and second drainage cores, and the second end of each of the first and second drainage cores extends outwardly from the conduit.

[0162] In one embodiment, the conduit is perforated. In one embodiment, the first and second drainage cores are permeable. In one embodiment, the fabric is permeable. In one embodiment, the fabric comprises a geotextile exhibiting a grab tensile strength greater than 100 lbs. and an elongation that is greater than fifty percent (50%). In one embodiment, the fabric comprises a geotextile exhibiting a permittivity greater than 1s^{-1} and a permeability of at least 0.05 cm/s. In one embodiment, an adhesive is disposed between the fabric and the first and second drainage cores.

Additional Embodiments.

[0163] The inventor has discovered that the aforementioned bracket and form systems as well as the drainage and ventilation systems, can be utilized in novel and non-obvious manners to provide and improve drainage, air and gas barriers, as air and thermal insulating sheathing, drywall and ceiling tiles to provide remediation and improve air flow (into and out of a system), to provide and improve conditions within the building/structure's envelope, irrigation, septic leaching fields, and the like, some with gravel-less embodiments. Applications of such systems may include, but are not limited to, agriculture, indoor and outdoor athletic sport fields, and building structures of a variety of uses, as well as open air structures and environments including, but not limited to,

driveways, parking lots, sidewalks, parking garages, airport runways, bridges, mining, roofing systems, and the like.

[0164] The inventor has discovered that the aforementioned systems can be used together, and individually, in a number of commercial products. For example, the bracket assembly 220, including one or more of the separator bars 230 and two or more of the reinforcement posts 240, may be purchased under a trademark Dri-Bracket as illustrated generally at 1220 in FIG. 22. As described herein, the Dri-Bracket system 1220 may be used as a form system to support components of side walls 262 and 264 (not shown in FIG. 22), as well as rebar supports 157. As shown in FIGS. 16, 19, 21, 32, and 33, the Dri-Bracket system 1220 can be used to form building structural components such as footings and foundations for a structure of interest. When used with components such as conduits 662A and 664A, and drainage cores 650 and 660, the Dri-Bracket system 1220 provides an integral ventilation and drainage forming system that may be purchased under the trademark Dri-Form (e.g., as shown in FIGS. 16 and 19). In some embodiment, the conduits 662A and 664A may be replaced with drainage cores 2110, 2120, 2130, and 2140, and provided with the Dri-Bracket system 1220 under the trademark Dri-Form (e.g., as shown in FIG. 33). As shown in FIG. 17, conduits 762A and drainage cores 750 and 760 provide the standalone drainage and ventilation system 700 that may be purchased under a trademark Dri-Drain. Dri-Bracket, Dri-Form, and Dri-Drain are trademarks of DRFF, LLC, Shelton, CT USA.

[0165] As shown in FIGS. 23A and 23B, the barriers 610 and 710 including drainage cores 650, 660, 750, 760, 850 and outer fabric 610B, 710B, 860 (FIGS. 16, 17, 18A and 18B) may be employed as an interface between a slab wall 1004 or floor 1006 and fill (e.g., vertical and/or horizontal, and interior and/or exterior configurations), and/or as a drainage and ventilation blanket or mat (e.g., vertical and/or horizontal configurations without a conduit) disposed above, at, or below the surface of backfill or the footing 12, and additionally as a ceiling tile, subfloor component, or the like within the structure. For example, as shown FIGS. 16, 17, 18A and 18B, the barriers 610 and 710 are comprised of the inner drainage cores 650 or 660, and 750 or 760, 850 wrapped by the outer fabric 610B, 710B and 860 such that the fabric 610B, 710B and 860 encloses the cores 650 or 660, 750 or 760, and 850. As described above, the inventor has recognized that in this fabric-core-fabric “layered” or “sandwich” configuration forms a thermal break between the surfaces that it is disposed between. For example, the opposing fabric layers at

least partially, if not fully, isolate temperature of the abutting materials; on one side, the slab wall or floor, and on the opposing side, the fill of gravel or soil. The inner drainage cores 650, 660, 750, 760, 850 permit an air flow that further acts to isolate temperature differentials between the opposing fabric layers 610B, 710B, 860 and the abutting materials. The inventor has also discovered that this isolation may be further enhanced, supplemented, or controlled, as desired, by introducing conditioned air or liquid within the drainage cores 650 or 660 and 750 or 760. For example, warm or cool air or liquid may be passed through the drainage cores 650, 660, 750, 760, 850 to regulate the temperature differential between the abutting materials. In one embodiment, where the inventive “layered” or “sandwich” configuration is installed from below grade (e.g., as a drainage and ventilation mat or footing form) to a ridge or upper most roof component of the interior of the building structure (FIGS. 32 and 45), the air continuously traversing the passage formed by the drainage cores 650, 660, 750, 760, 850 promotes a healthier environment within the structure by moving stagnant air or gas within the building envelope. In another embodiment, the fabric 660, 760, 860 is installed only on one side of the layer configuration, e.g., leaving an expose surface of the drainage core 650, 750, 850 that can provide an interior or exterior “lath system” for applying plaster, stucco (scratch or finish coat), tile, stone, brick, masonry veneers, or the like. For example, as noted above, the interior cavities 856 and 856’ of the plurality of dimples 854 and 854’ of the core 850 (FIGS. 18A and 18D) can accept the plaster, stucco, mortar or other adhesive for bonding the tile, stone, brick, or masonry veneer, and the like.

[0166] In yet another embodiment, the inventor has recognized that liquid, foam, or a fire suppression chemistry, may be provided from, for example, a sprinkler or other fire suppression system disposed within a structure (FIG. 45) through the passages 655 and 755 of the barriers 610 and 710 (e.g., cores 650, 660, 750, 760, 850), such that the barriers 610 and 710 may enhance fire retardance of the structure to assist in containing or extinguishing a structure fire. Still further, in one embodiment, fire retardant materials may be applied to the fabric 610B, 710B, 860 to assist in the fire retardance of the barriers 610, 710. In still another embodiment, the barriers 610, 710 may include only one fabric layer 610B, 710B to leave a surface of the drainage core 650, 660, 750, 760, 850 exposed. In this embodiment, the fabric layer 610B, 710B is installed facing the abutting surface, for example an interior or exterior face of the slab wall 1004, so that the opposing surface

of the drainage core 650, 660, 750, 760, 850 (without the fabric) receives a plaster, stucco, or mortar to bond a stone veneer thereto.

[0167] As shown in FIGS. 17 and 19, the conduit 762 and drainage cores 750 and 760 wrapped in the fabric 710B provide the standalone drainage and ventilation system 700 also referred to as Dri-Drain. Similarly, the drainage core 850 wrapped in the fabric 860 provides another embodiment of the standalone Dri-Drain branded drainage and ventilation system without the use of the conduit 762, described below with reference to FIG. 33. The inventor has discovered that in various configurations (illustrated in FIGS. 24A to 24D), the system 700 including substantially flat and/or sloped horizontal 700A and vertical 700B configured fabric-wrapped drainage cores 750, 760 and the conduit 762 may be employed in agricultural, athletic field, golf course, playground applications, and the like, to provide an improved, integral aeration, irrigation, drainage and ventilation system. In this standalone embodiment, the system 700 is offered under the trademark Dri-Turf. For example, in one embodiment, a putting green 1100 is illustrated in FIGS. 25A and 25B and includes a subsurface configuration 1160 of interconnected drainage and ventilation system 700, a Dri-Turf system (e.g., the drainage cores 750 and 760 and conduit 762 wrapped in the fabric 710B). Dri-Turf is a trademark of DRFF, LLC, Shelton, CT US. As shown in FIG. 25B, the putting green 1100 includes a relatively short (in height) grass or synthetic material top layer 1110, a soil layer 1120 and the subsurface drainage and ventilation layer 1130, including the configuration 1160 of interconnected drainage and ventilation system 700. As shown in FIG. 25B, various portions of the subsurface configuration 1160 of the interconnected drainage and ventilation system 700 can carry a drain or flow capacity such that the system 700 can capture, retain and move away a volume of water, e.g., ground and subsurface water, to an attached drainage system, containment area, retention pond or the like (not shown).

[0168] As shown in FIG. 25B, a point A where the drainage and ventilation mat (horizontal) configuration of the drainage cores 750 and 760 meets the vertical configuration of the drainage core 750 and 760 has a drain capacity of about twenty to fifty gallons per minute (20 to 50 gals./min.; 75.71 to 189.27 liters/min.), the drainage cavity 770 has a drain capacity of about one hundred twenty to four hundred eighty gallons per minutes (120 to 480 gals./min.; 454.25 to 1817 liters/min.), and the conduit 762 has a drain capacity of about two hundred forty to nine hundred gallons per minute (240 to 900 gals./min.; 908.50 to 3,406.87 liters/min.). In some embodiments,

the overall drain capacity is seen to be of about three hundred and twenty to one thousand one hundred and ninety gallons per minute (320 to 1,190 gals./min.) and the system is seen to have a thirty thousand pounds per foot compressive strength (30,000 lbs./ft.). Some perceived benefits of the increased subsurface air flow and drainage is seen to include less use of lime and other fertilizers or soil nutrients on natural turf fields resulting in less of an adverse environmental impact and lower overall maintenance cost while achieving improved turf growth conditions, e.g., improved root growth, uptake in nitrogen and potassium from improved drainage and ventilation as well as a reduction in fungus and other harmful diseases that form in overly moist soil.

[0169] Similarly, and as shown in FIGS. 26A to 26D, the interconnected drainage and ventilation system 700, Dri-Turf, may be employed with a plurality of drainage conduits 1240 in a subsurface configuration below an athletic field 1200. In one embodiment, illustrated in FIGS. 26A and 26B, the athletic field 1200 is two hundred twenty feet (220 ft.; 67.06 meters) in width W_{FIELD} from one sideline 1202 to an opposing sideline 1204, and has a centerline 1201 at one hundred ten feet (110 ft.; 33.53 meters). The athletic field 1200 further includes opposing ends 1206 and 1208 over a length L_{FIELD} of the athletic field 1200. In this embodiment, the inventor has discovered that an effective drainage and ventilation system would include interconnected runs of the drainage and ventilation system 700, Dri-Turf, arranged at the opposing ends 1206 and 1208 of the athletic field 1200 and in a plurality of rows 1210 spanning the length L_{FIELD} and across its width W_{FIELD} . Each of the systems 700 is coupled to conduits 1242, within the plurality of conduits 1240, disposed in a plurality of columns 1220 along the length L_{FIELD} of the field 1200 from end 1206 to end 1208. At an intersection of each of the respective rows 1210 and columns 1220, the drainage and ventilation system 700, Dri-Turf, is arranged in a stack configuration as shown in FIG. 26D. In one embodiment illustrated in FIGS. 26A and 26B, the plurality of rows 1210 of the drainage and ventilation system 700 are spaced eight feet (8 ft.; 2.44 meters) apart at the centerline 1201 of the athletic field 1200 and then equally spaced sixteen feet (16 ft.; 4.88 meters) apart between centerlines of the respective systems 700 traveling from the centerline 1201 to each of the opposing sidelines 1202 and 1204 of the field 1200. In one embodiment, a last of the rows 1210 proximate to each respective sideline 1202 and 1204 is six feet (6 ft.; 1.83 meters) from the sideline 1202 or 1204. In one embodiment, the plurality of columns 1220 of the conduits 1242 are comprised of, for example, four to six inch (4 to 6 in.; 10.16 cm to 15.24 cm) solid (non-perforated)

pipes, and are spaced sixty feet (60 ft.; 18.29 meters) apart (centerline of stack to centerline of stack) along the length L_{FIELD} of the field 1200 from end 1206 to end 1208. In one embodiment, the plurality of conduits 1240 includes at least one conduit 1244 disposed at one or both of the sidelines 1202 and 1204 and coupled to each of the plurality of columns 1220 of the conduits 1242. In one embodiment, the conduit 1244 is comprised of, for example, a twelve inch (12 in.; 30.48 cm) solid (non-perforated) pipe that runs along the length L_{FIELD} of the athletic field 1200 to carry or drain a volume of water, e.g., ground and subsurface water, and/or air flow captured, retained, and conveyed or moved by the drainage and ventilation system 700, to an attached drainage system, containment area, reserve 1246, or the like.

[0170] A cross-section view (along line 26C-26C) of one embodiment of the athletic field 1200 is illustrated in FIG. 26C. In some embodiments, the athletic field 1200 may be a soccer field, football field, baseball field, golf course (e.g., fairways and greens), or the like. As shown in FIG. 26C, in one embodiment, the athletic field 1200 includes a crown or elevated portion at the centerline 1201 and tapers downwardly from the centerline 1201 to respective sidelines 1202 and 1204. As illustrated in FIGS. 26C and 26D, a stack configuration of the drainage and ventilation system 700 are disposed at each intersection of a respective row 1210 and a column 1220. As shown in FIG. 26D, as with previous embodiments, the drainage and ventilation system 700 includes the drainage cores 750 and 760 and conduit 762 wrapped in the fabric 710B. In one embodiment, the drainage cores 750 and 760 are wrapped in a single or multiple layer of the fabric 710B and facilitate subsurface water and air flow. The inventor has discovered that multiple layers of fabric 710B provide a dynamic thermal barrier to sustain a relatively consistent radiating ground temperature below and above the fabric layers and throughout the drainage and ventilation system 700 that can provide for cooler temperatures within the drainage cores 750 and 760 during warm weather to reduce water evaporation in the ground and within any containment tank or area, retention pond, or the like (not shown), coupled to the drainage and ventilation system 700. Additionally, in cold weather months, transmitting the radiating ground temperature below the drainage and ventilation system 700, throughout the system 700 is seen to reduce ice and snow formation on the field 1200 and within the conduits 1240, 1242 and 1244 and drainage cores 750 and 760.

[0171] In one embodiment, each of the stacks includes the system 700 coupled to one of the conduit 1242 arranged vertically at the intersection of one of the plurality of rows 1210 and one of the plurality of columns 1220, which is then coupled to one of the conduits 1242 arranged horizontally and defining one of the plurality of columns 1220. As shown in FIG. 26A and 26C, each of the conduits 1242 arranged horizontally within the plurality of columns 1220 is coupled to the conduit 1244 at one or both of the sidelines 1202 and 1204 (shown at 1204). As shown in FIGS. 26C and 26D, in one embodiment, the athletic field 1200 includes a top layer 1260 including a sod or synthetic turf, a soil layer 1270 and a subsurface drainage and ventilation layer, including the stack of a respective one of the drainage and ventilation systems 700 and conduit 1242. As shown in FIG. 26D, the stacked drainage and ventilation system 700 is disposed in a trench 1300 forming the rows 1210 in, for example, the compacted soil 1290. In one embodiment, once the system 700 is installed, the trench 1300 is backfilled with sand 1280 or other media to permit, if needed, subsequent access to the system 700.

[0172] FIGS. 27A to 27C illustrated examples of embodiments of the drainage and ventilation systems 700 that may be disposed within the trench 1300 of the athletic field 1200 or in other embodiments, under pathways, sidewalks, driveways, parking lots, and the like. In FIG. 27A, for example, the drainage and ventilation systems 700 is configured where the conduit 762 is wrapped about its circumference by the drainage core 750 and fabric 710B, and where the drainage core 850 is disposed in a substantially horizontal drainage mat configuration above the wrapped conduit 762. In FIG. 27B, for example, the drainage and ventilation systems 700 is configured where the conduit 762 is wrapped about its circumference by the drainage cores 750 and 760, and the fabric 710B, which then extend vertically and upwardly from the conduit 762 toward the top surface at a sloped angle. The drainage cores 750 and 760 are then horizontally configured, in a similar manner as is illustrated in FIG. 24B. Alternatively, the vertically and upwardly extending drainage cores 750 and 760 wrapped in the fabric 710B, terminate at the drainage core 850 that is disposed in a substantially horizontal drainage mat configuration above the wrapped cores 750 and 760. In still another embodiment, illustrated in FIG. 27C, for example, the drainage and ventilation systems 700 is configured where the conduit 762 is wrapped about its circumference by the drainage cores 750 and 760, and the fabric 710B, which then extend vertically and upwardly from the conduit 762 toward the top surface parallel to sidewalls of the

trench 1300 (e.g., substantially vertical at no angle). A center portion 1302 of the trench 1300 above the conduit 762 and between the drainage cores 750 and 760 is then filled with a side-by-side or back-to-back arrangement of the drainage cores 750 and 760. The substantially vertical and side-by-side or back-to-back arrangements of the drainage cores 750 and 760 wrapped in the fabric 710B, terminate at the drainage core 850 that is disposed in a substantially horizontal drainage mat configuration above the wrapped cores 750 and 760. In one embodiment, as with the embodiment of FIG. 26D, once the system 700 is installed in either of the example embodiments illustrated in FIGS. 27A to 27C, the trench 1300 is backfilled with sand 1280 or other media to permit, if needed, subsequent access to the system 700. The inventor has discovered that the example embodiment of FIG. 27C can be particularly useful for accessing the drainage and ventilation systems 700 after initial installation, for example, for maintenance or repair.

[0173] The inventor has further discovered that improved drainage, ventilation, thermal conductivity, soil shock absorption, and other characteristics can be achieved with one or more arrangements, e.g., a side-by-side and/or back-to-back configuration of drainage cores 650, 750, and 850 as illustrated in, for example, FIGS. 31 and 40 to 44. For example, cores 850 may be stacked on surfaces 858 of dimples 854 to increase the capacity of passages 855A and 855B and fluid and/or air flow therethrough (FIG. 18A). As shown in FIG. 31, in one embodiment, the drainage cores 650, 750, 850 include a flat sheet 1852, constructed of material similar to the sheet 852, 852' that has the plurality of dimples 854, 854' formed therein, but with no dimples 854, 854' formed in the flat sheet 1852. The flat sheet 1852 may be affixed to portions (e.g., surfaces 858) of the dimples 854, 854' in the sheet 852, 852' to bound the passages (e.g., passages 855A and 855B illustrated in FIG. 18A) formed between and about the perimeter of the dimples 854, 854'.

[0174] In still another embodiment, a mesh or grid sheet 1860 is added to the "layered" or "sandwich" configuration of, for example, the core 850 and the fabric 860. In one embodiment, the mesh or grid sheet 1860 may be coupled to a low voltage source (not shown). The grid sheet 1860 may conduct low voltage across the sheet in a row and column manner, for example, and provide a notification system when, for example, a change of conductivity and/or impedance is detected at a point (intersection of a respective row and column) on the grid sheet 1860. The inventor has recognized that when the drainage core 650, 750, 850 including the grid sheet 1860 is disposed proximate a slab wall, for example, the change in conductivity or impedance can

indicate a leak of liquid, e.g., ground water, through the slab wall. In this embodiment, the drainage core acts as a notification and/or detection system for a defect in a foundation, for example. As noted above, and described in further detail below, in one embodiment, a metal lath 1880 may be coupled to the “layered” or “sandwich” configuration of, for example, the core 850 and the fabric 860, with or without dimples 854, 854’, and when disposed proximate a slab wall or floor (not shown) provides a mounting surface for finish materials such as, for example, plaster, stucco, tile, brick, stone, and masonry veneers.

[0175] Referring again to FIGS. 26A and 26C, a larger conduit, for example, the conduit 1244, may be disposed at one or both of the sidelines 1202 and 1204 of the athletic field 1200. In one embodiment, a plurality of drain members 1250 (illustrated in FIG. 28A and 28B) are disposed at one or both of the sidelines 1202 and 1204 in a stacked configuration, wherein one of the conduits 1242 arranged vertically, couples a respective drain member 1250 to the conduit 1244. In one embodiment, the drain member 1250 includes a drain grate or screen 1252 having a plurality of apertures 1253 and drain containment chamber 1254 to assist in inhibiting a flow of debris into the subsurface configuration of drainage systems 700 and drainage conduits 1240 below the athletic field 1200.

[0176] The inventor has discovered that certain environmental conditions, for example, high temperature days and colder temperature nights, allows for heat to radiate to and through the drainage cores 750, 760, 850 that may lead to thermal expansion of the cores 750, 760 and 850 during heat exposure and subsequent contraction at night when the heat dissipates. The cycle of thermal expansion and contraction can buckle or otherwise displace the cores 750, 760 and 850 if this movement is not otherwise accommodated in the installation of the drainage and ventilation system 700. In one embodiment, illustrated in FIG. 29, an expansion joint 1400 is configured within the structure of the drainage cores 750, 760 and 850. As illustrated above with reference to FIGS. 18A and 18B, the drainage core 850 is comprised of the sheet 852 having the plurality of dimples 854 formed therein, in for example a row-column configuration. As shown in FIG. 29, a portion 1410 of the sheet 852 includes no dimples 854 and is comprised of a thinner, more flexible wall that permits and otherwise accommodates expansion and contraction by, for example, bending or folding inwardly and upwardly in response to expansion. In one embodiment, the portion 1410 may include a configuration, pattern, or profile to more readily accommodate

expansion and contraction, for example, include a series of raised portions forming a jagged or zig-zagged cross section.

[0177] In one embodiment, one or more of the vertical and/or horizontal drainage mat configured drainage cores 750, 760 and 850 are joined or coupled using a joining and restricting member 1450 illustrated in FIG. 30. In one embodiment, the joining and restricting member 1450 includes an upper flange 1452 and a lower flange 1454 joined by a central wall 1456 and defining a first interior cavity 1458A and a second interior cavity 1458B therebetween. The interior cavities 1458A and 1458B of the joining and restricting member 1450 adapted to receive a vertically and/or horizontally configured drainage cores 850. In one embodiment illustrated in FIG. 30, the joining and restricting member 1450 joins adjacent drainage cores 850A and 850B, and restricts a flow of liquid, air, gas and the like, between the cores 850A and 850B. In one aspect of the invention, the joining and restricting member 1450 prevents flow across the cores 850 and can be utilized to allow uniform drainage.

[0178] In further embodiments, some illustrated in FIGS. 32 and 45, the inventive drainage and ventilation system is seen to provide not only the aforementioned footing, drainage, and ventilation, and gas (e.g., radon) remediation in above-ground (AG) and below-ground (BG) applications (e.g., the above-described Dri-Drain systems), but also provide a rain screen, exterior and interior sheathing for a structure, as well as a replacement for sheetrock and ceiling tiles within the structure. The drainage cores 750, 760, 850 provided as drainage and ventilation system for use within a structure may be purchased under a trademark Dri-Drain Wall. Dri-Drain Wall is trademark of DRFF, LLC, Shelton, CT USA. Installation of the Dri-Drain Wall systems as replacements for conventional systems, are easier and faster due, in part, to the relative light weight in comparison to conventional systems. The Dri-Drain Wall system is seen to have a less environmental impact, provides for shipment of larger quantities per truck load, with enhancements to accommodate different building divisions or industries. As described herein, embodiments provide improved fire resistance, thermal conductivity and/or barrier, improved ventilation to remove poor air quality or gases in residential, commercial, industrial applications of use.

[0179] Additionally, in applications involving athletic fields, playgrounds, golf courses, areas of natural or synthetic turf, and the like (FIGS. 40 to 44), the present invention and its

inventive drainage and ventilation system provides for a decreased impact and improved shock absorbing properties (as measured by GMAX or Head Impact/Injury Criteria (HIC) testing) on these areas, resulting in less injuries, fatigue and wear and tear on an athlete's or child's body, as well as higher drainage flow and a thermal conductivity and/or barrier to extend a seasonal use of the areas. Moreover, the inventor has seen additional improvements when the inventive drainage and ventilation system includes drainage cores 850 employing dimples at least partially filled with an adhesive and/or a mixture of an adhesive and granular rubber. For example, as described above with reference to FIGS. 18A to 18E, when a drainage core 850 is configured with a substantial plurality of the interior cavity 856 and 856' of dimples 854 and 854', and in some embodiments portions of the sheet 852 and 852' of the core 850, filled and/or covered with the mixture 890 of the adhesive 892 and the granular rubber 894 (e.g., crumb rubber), and the core 850 is then disposed beneath turf or another surface material of athletic fields, playgrounds, golf courses, areas of natural or synthetic turf, and the like, improved GMAX and HIC performance is realized.

[0180] Additionally, the systems described herein provide an increase in water and soil retainment capabilities, thermal conductivity and/or barrier in irrigation and agriculture, thus solving many irrigation and environmental issues in agricultural and mining. When used with a low voltage applied across the core, the system can be used as a leak detection system for below grade applications. The systems can be used as ceiling tiles, as an improvement/supplement to HVAC systems, air remediation and venting systems and the like. The systems described herein may be used as interior sheathing or sheetrock that have properties of being light weight, faster and easier to install, permit larger quantities shipped per truckload, are environmentally friendly, can enhance HVAC air vent, air remediation, moisture resistant and the like. The systems may also be used as exterior sheathing and/or siding, lath and rain screen, each having light weight, thermal conductivity and/or barrier, and moisture resistant characteristics.

[0181] Still further embodiments of the present invention are illustrated in FIGS. 32 to 45. For example, FIGS. 32 to 36 illustrates one embodiment and exemplary applications of use, where a geo-composite core assembly, shown generally at 2000 in FIG. 34, is used vertically and horizontally on a side of a footing or foundation, and in above-ground (AG) and below-ground (BG) applications within and about interior and exterior portions of a structure. As illustrated in FIG. 34, the geo-composite core assembly 2000 includes a drainage core 2050, configured

similarly as the drainage cores 750, 760 and 850, and includes a sheet 2052 having a plurality of dimples or cusps 2054 formed therein and extending therefrom. The plurality of dimples or cusps 2054 form first and second passages 2055A and 2055B (e.g., similarly to passage 855A and 855B of the core 850) adapted to receive and conduct a flow of one of liquid (e.g., water), air, and gas to horizontally and vertically traverse the drainage core 2050. The drainage core 2050 is wrapped in fabric 2060, configured similarly as the fabric 710B and 860. In some embodiments, the fabric 2060 may be of varying thicknesses and lengths extending beyond an outer portion or end of the geo-composite core 2000. For example, in one embodiment, the geo-composite core assembly 2000 includes a first end portion and second end portion, shown generally at 2002 and 2004, respectively. The fabric 2060 is closed at each of the respectively end portions 2002 and 2004, as shown at 2062 by, for example, being sewn or glued, enclosing the drainage core 2050 in a sleeve portion. In one embodiment, the fabric 2060 extends beyond the closure 2062 to, for example, facilitate installation of the geo-core assembly 2000.

[0182] For example and as illustrated in FIG. 33, when used within a gravel-less form system 2100 (e.g., similar to the gravel-less form 600 of FIG. 16, without conduits 662A and 662B), the geo-composite core assembly 2000 is disposed vertically, as shown at 2110, and horizontally, as shown at 2120, to bound an exterior and a lower perimeter of the form system 2100 from soil in which the form system 2100 is disposed. The gravel-less form system 2100 includes one or more of the bracket assemblies 220 that include two or more of the reinforcement posts 240 and two or more of the separator bars 230, as described above for example with reference to the bracket assembly 1220 of FIG. 22. A first interior one of the geo-composite core assemblies 2000, shown generally at 2130, and a second interior one of the geo-composite assemblies 2000, shown generally at 2140, are disposed within outer reinforcement posts 240 of the bracket assemblies 220 and provide side walls (similar to side walls 602 and 604 of FIG. 16) to form the channel 192 of a footing or foundation being formed with the gravel-less form system 2100 in the soil. In one embodiment, a block or spacer 2180 (similar to the spacer 280 of FIG. 12A, or conventional building material 450 of FIG. 12E) provides a desired vertical and/or horizontal offset of the first and the second interior geo-composite cores 2130 and 2140 permitting construction of, for example, a footing or foundation having a predefined cross-section such as, for example, a trapezoidal cross-section. It should be appreciated that other blocks or spacers may be used to

provide other desirable cross-sections as described herein. As shown generally at 2132 and 2142, the fabric 2060 extending beyond the closures 2062 of the first and the second interior geo-composite cores 2130 and 2140 are fastened to the blocks or spacers 2180 at one end and to the reinforcement post 240 or lower separator bars 230 at the other end to facilitate installation of the first and the second interior geo-composite cores 2130 and 2140 within the gravel-less form system 2100.

[0183] It should be appreciated that a footing or foundation, such as a trapezoidal footing 1900 of FIG. 32, may be formed with the gravel-less form system 600 of FIG. 16, which employs conduits 662A and 662B and with the gravel-less form system 2100, which replaces the conduits 662A and 662B with the geo-composite core assemblies 2000 shown at 2130 and 2140. The inventor has discovered that the trapezoid footing 1900 meets and exceeds ACI-318 Building Code for concrete construction, section 15.5.2 “shear in Footing.” The inventor has also discovered that forming footings and foundations with the gravel-less form 600 of FIG. 16 and the gravel-less form system 2100 employing the bracket assembler 1220 of FIG. 22 (e.g., the Dri-Bracket System) to securely hold components in place, reduces the size of lumber needed to form as a waler support beam used to retain the building material (e.g., concrete) until it cures. As should also be appreciated, once formed, the geo-composite core assemblies 2000 and passages 2055A and 2055B therein, receive and conduct a flow of one of liquid (e.g., subsurface and ground water), air and gas to traverse the drainage core 2050 (e.g., the vertical and horizontal bounding cores 2110 and 2120 as well as the first and the second interior geo-composite cores 2130 and 2140) providing previously described benefits of thermal conductivity, radon remediation, and the discharge of water away from the footing or foundation, for example. In one embodiment, one of the geo-composite core assemblies 2130 and 2140 may be coupled to a discharge outlet 2150 to move the remediated gas and/or discharged water further away from the footing or foundation and, for example, the structure the footing or foundation support.

[0184] As described herein, in one aspect of the present invention the gravel-less form 600 of FIG. 16 and the gravel-less form system 2100 may be utilized, in embodiments, as a footing form and rebar support system, below-grade (subsurface) radon and air flow remediation system, and as a support system that, after curing of building materials forming a footing, foundation, or retaining wall, provides drainage and ventilation from integrally formed conduits (e.g., the

conduits 662A and 662B of the form system 600, and the geo-composite core assemblies 2110, 2120, 2130, and 2140 of the form system 2100) similar to so-called curtain, French and strip drains. The inventor has also discovered that in standalone embodiments (without the bracketing system) the inventive drainage and ventilation systems 700 (FIGS. 17, 24A, 24B) may be utilized, in embodiments, within applications including landscape, playground, athletic fields (e.g., golf, soccer, football, baseball, and the like of FIGS. 25A, 25B, 26A to 26D), swimming pool drainage, parking decks and lots, sidewalks, terraces and patio drains (FIGS. 27A to 27C), and drainage and ventilation for green roofs and planters. Perceived benefits include soil consolidation, and when used in below-grade (subsurface) under slab systems, an evacuation system for radon and other undesirable gases that provides a 20+ mil air barrier with capabilities of exceeding, for example, ASTM E 1745, Class A requirements.

[0185] As noted above, in some embodiments, one or more of the vertical and/or horizontal drainage mat configured drainage cores 750, 760, and 850, as well as the geo-composite core assembly 2000 (FIG. 34), may be joined or coupled using the joining and restricting member 1450 illustrated in FIG. 30. Alternatively, and as illustrated in FIGS. 35 and 36, the drainage cores 750, 760, and 850 and the geo-composite core assembly 2000 are configured to facilitate attachment, connection, overlapping, and/or stacking of components to meet certain building or other codes, for example, for minimum or recommended drainage capacity and the like. In one embodiment, the sheet 852 portion of the drainage cores 850 may include a flat or recessed section 853 including an extended portion (e.g., in the length or width of the sheet 852) that does not include the dimples or cusps 854. Drainage cores 850 having one or more of the flat or recessed sections 853 may overlap across their lengths 850A and/or widths 850B as illustrated in FIG. 35. As also illustrated in FIG. 35 and shown in FIG. 36, a fastener 900 (e.g., rivet, screw, or the like) may be used to secure the connection of overlapping and/or stacked cores 750, 760, 850, 2000.

[0186] In still another embodiment illustrated in FIGS. 37 and 38, the connection and/or overlapping of cores 2000 may be achieved by securing, e.g., with the fastener 900, glue or by sewing, the fabric 2060 extending from ends 2002 and 2004 of two or more adjacent ones of the geo-composite core assemblies 2000 (e.g., cores 2000A and 2000B). In one embodiment, an additional fabric ribbon 2070 may be added to the cores 750, 850, 2000 to be used to overlap and to connect the adjacent cores, e.g. cores 2000A and 2000B. In one embodiment, a plurality of

eyelets or grommets 910 are included in the fabric 2060 and/or fabric ribbon 2070 to receive the fastener 900. The eyelets or grommets 910 reinforce and/or shield a hole through the fabric 2060 and/or fabric ribbon 2070 made to receive the fastener from any sharp edges of the fastener 900 and to prevent tearing of the fabric 2060 or ribbon 2070 during use and/or deflection of materials, expansion and contraction due to, for example, changing thermal conditions and the like. In some embodiment, the core 2000 is secured at a lower surface, shown generally at 2000L of FIG. 38, and/or in relatively central area 2000C of the cores 2000 (FIG. 37) so as to reduce, and at least minimize, restricting the expansion and the contraction of the cores 2000 due to, for example, changing thermal conditions and the like.

[0187] As illustrated in FIGS. 39 to 44, the connection and/or overlapping of cores 2000 are used as sub-surface drainage and ventilation systems below pavement 2202 or block 2204 driveways or walkways applications 2200 directly or below a base material 2206 such as crushed stone, gravel, sand or the like (FIGS. 39 and 44), to an application area 2210 adjacent to a retaining wall 2220 (FIG. 39), as well as in applications 2300 under synthetic turf 2302 and/or natural turf 2304 fields (FIGS. 40 to 43). In some of the field embodiments, for example as illustrated in FIG. 40, a mat or pad 2310 may be installed above the drainage core 2000 to enhance GMAX or HIC performance (as described herein) of the system. In other embodiments, the drainage core 2000 is installed under fill 2306 or other soil medium 2308 below the synthetic turf 2302 or natural turf 2304 (FIGS. 41 and 42).

[0188] It should be appreciated that in embodiments where the drainage and ventilation cores 750, 760, 850, 2000 include, for example, the mesh sheet 1860 and/or the metal lath 1880 (FIG. 31), the fastener 900 is positioned so as not to interfere with a scratch-base coat or other cement or adhesive layer applied to secure finish materials such as, for example, plaster, stucco, and/or masonry veneers applied to the mesh sheet 1860 or metal lath 1880. Additionally, it should be appreciated that the fasteners 900 are used in a manner that does not compromise the water resistant, if not substantially, watertight, nature of the drainage cores 750, 850, 2000.

[0189] In accordance with some embodiments of the present invention, the standalone drainage and ventilation system 700 including the drainage cores 750, 760 as well as the drainage cores 850 and 2000 may be used with a galvanized metal, glass or other material lath sheet (e.g., the metal lath 1880 of FIG. 31), for example, attached thereto. In one embodiment, this

configuration is referred to as a Dri-Drain AG Lok n' Kote Metal Lath with WRB system. The lath sheet 1880 accepts cement based or adhesive based material for above-grade plaster, stucco and/or adhering tile, brick, or masonry veneer finishes thereto. Some exemplary technical data and installation instructions for the Dri-Drain AG Lok n' Kote Metal Lath with WRB include, for example, providing cores 750, 750, 850, and 2000 that are comprised of a moisture-impermeable polystyrene molded into a high compressive strength sheet (e.g., withstanding about 15,000 psi) having dimples or cusps (e.g., sheet 852 with dimples 854). The cores 750, 750, 850, and 2000 are laminated to a galvanized diamond shaped expanded metal lath (e.g., metal lath 1880) and a weather resistant barrier (WRB) of, for example, a geotextile fabric 860 (e.g., DuPont SF 40 geotextile).

[0190] In one embodiment, the molded sheet of dimples measures about twenty-six to twenty-nine inches (26 to 29 ins.; 66.04 to 73.66 cm) in width and about ninety-six inches (96 ins.; 243.84 cm) in length and has about six to eight (6 to 8) fittings or brackets about the dimples or cusps formed in the molded sheet (e.g., sheet 852 with dimples 854) that the metal lath 1880 is affixed to. The fittings extend above an upper portion of the dimples or cusps to provide an about one quarter of an inch (0.25 in.; 6.35 mm) depth gauge for a base coat of cement or adhesive. In one embodiment, the dimples or cusps of the sheet extend outwardly from the sheet about seven sixteenths of an inch (7/16 in.; 11.11 mm) and provide an interior cavity of each dimple (e.g., the interior cavity 856). When the interior cavity is filled with a cement-based material, the dimples form a series of pedestals that support the lath and establish a high strength and permanent standoff between the lath sheet and the building envelope.

[0191] In one embodiment, the lath sheet measures about twenty-seven inches (27 ins.; 68.58 cm) in width and about ninety-seven inches (97 ins.; 246.38 cm) in length. The lath sheet is laminated to the open dimple or cusps face of the molded sheet with an end and a side extending beyond the molded sheet. The extensions are seen to provide a simple way to lap or seam adjoining sheets together in compliance with industry and/or governmental standards or codes. The pattern of dimples allows for the locking together, in a shiplap method, for example, the edge and end of an adjoining sheet, thereby creating the equivalent of a monolithic and continuous water barrier.

[0192] In one embodiment, the weather resistant barrier (WRB) sheet (e.g., fabric sheet 860) measures about twenty-seven inches (27 ins.; 68.58 cm) in width and about ninety-seven

inches (97 ins.; 246.38 cm) in length. The weather resistant barrier (WRB) sheet is similarly laminated to the open dimple or cusps face of the molded sheet with an end and a side extending beyond the molded sheet. In one embodiment, weather resistant barrier (WRB) sheet extends from the molded sheet in an opposite side and end direction as compared to the extending lath sheet. The extension is seen to assist in the shiplap method of assembly. Spacing established between the building envelope and the exterior finish by the use of the drainage cores 750, 760, 850, and 2000, lath sheet, and the weather resistant barrier (WRB) sheet provides an about eight percent (80%) open and thermal break, water drainage plane, and cavities for air flow to promote more efficient drying of areas in proximity to the building structure.

[0193] Perceived benefits of the above-described installation method include, for example:

[0194] - three layers of water resistant materials (e.g., the base coat, the molded sheet having dimples, and the WRB sheet);

[0195] - efficient water wicking and drainage;

[0196] - a thoroughly keyed base coat behind the metal lath with a depth of about seven sixteenths of an inch (0.437 in.; 11.11 mm);

[0197] - an about one quarter of an inch (0.25 in.; 6.35 mm) gauged base coat depth over the face of the metal lath;

[0198] - a dedicated and dimensionally stable space for the free flow of water between the lath assembly and the building structure;

[0199] - a dedicated and dimensionally stable vented space for drying the cavity space between the lath assembly and the building structure;

[0200] - an opaque and UV protective cover for weather-and-water resistant air barrier materials; and

[0201] - a practical assembly that provides for inspection for base coat dimensional compliance.

[0202] Exemplary installation instructions include, for example:

[0203] 1. Mark framed and sheathed walls to identify framing and blocking member locations. These markings may be used for placement of metal lath fasteners (markings not needed for masonry walls).

[0204] 2. As applies, install the following accessories with related self-adhered flashing material before installing Dri-Drain AG Lok n' Kote Metal Lath with WRB, including for example, a Weep Vent Starter TWF Strips; window and door Head Weep Vent Square TWF casings and apron flashings.

[0205] 3. Install Dri-Drain AG Lok n' Kote Metal Lath with WRB sheet assembly, with the bottom edge along the outbound leg of the Weep Vent Starter Strip, window and door Head Weep Vent Square casing or apron counter flashing and with the WRB sheet against the building. Installing from left to right, and bottom to top of wall is deemed the best practice for placement.

[0206] 4. Fasten each sheet of structural members at a maximum of about six inches (6 ins.; 152.4 mm) vertical spacing, and not greater than sixteen inches (16 ins.; 406.4 mm) horizontal spacing. Embed each fastener per local building code or registered engineer requirement. Use code approved galvanized or corrosion resistant fasteners.

[0207] 5. As applies, install square casing, corner beads, double "V" expansion joints over Dri-Drain AG Lok n' Kote Metal Lath with WRB sheets.

[0208] 6. Install the cement base coat and related exterior finish (e.g., plaster, stucco, or masonry veneer).

[0209] In one embodiment, the lath sheet is comprised of a diamond expanded metal lath constructed of carbon steel hot dipped galvanized G60 finish meeting ASTM C847 expanded metal lath specification, and ASTM A653 sheet hot-dip zinc coated process, and ASTM C1062 standard specification for installation of lathing and furring to receive cement-based plaster.

[0210] In one embodiment, the WRB sheet includes an apparent thermal conductivity ASTM C518-15 0.0587 (W/m*K) R-value ($\text{m}^2\text{K/W}$) 0.1958.

[0211] In one embodiment, the polystyrene dimple or cusp sheet is comprised of puncture strength ASTM D4833 65 psi, having a Compressive Strength ASTM D1621 Mod 15,000 lbs./ft² ($72 \times 10^3 \text{ kg/m}^2$), Flow Capacity ASTM D4716 16 gpm/ft of width (200L/min/m of width).

[0212] It should be appreciated however, that the invention is not limited to this data and embodiments.

[0213] FIG. 45 illustrates multiple applications and configurations of the drainage and ventilation cores 750, 850, 2000 used within and throughout an entire building envelope of a

structure of interest 2400, including above-ground (AG) and below-ground (BG) applications to provide drainage and ventilation, passively or with mechanical assistance. For example, in below-ground (BG) applications, the drainage and ventilation cores 750, 850, 2000 are used to provide drainage and ventilation about exterior 2412 and interior 2414 portions of the structure's foundation 2410, to provide drainage and ventilation about exterior sheathing of and/or a rain screen 2422 for the structure 2400, to provide replacements for the structure's sheetrock walls 2432, underlayment for flooring 2434, ceiling tiles 2436, attic/roof insulation and/or roofing plywood 2438. In one embodiment, one or more of the cores installed in walls 2432, flooring 2434, ceiling tiles 2436, insulation and/or roofing 2438 may be coupled to other systems within the structure 2400 such as, for example, a Heating, Ventilation, and Air Conditioning (HVAC) system 2460 or fire suppression system. For example, the drainage and ventilation cores 750, 850, 2000, and passages thereof, can improve and/or supplement air flow of the HVAC systems 2460 to assist in conditioning and/or balancing the overall temperature within the structure. The cores 750, 850, 2000 can also assist in remediating moisture build up within the structure. Similarly, the drainage and ventilation cores 750, 850, 2000, and passages thereof, can improve and/or supplement disbursement of fire retardant materials from a fire suppression system to assist in containing or extinguishing a fire within the structure 2400. It should be appreciated that the cores 750, 850, 2000 are typically constructed of materials that have properties of being light weight, faster and easier to install, permit larger quantities shipped per truckload, and that are environmentally friendly.

[0214] As described herein the drainage and ventilation cores 750, 850, 2000 may be used in different thickness and configurations to achieve improved thermal conductivity, R-value (e.g., a measure of the capacity of an insulating material to resist heat flow), air flow, strength, and fire resistance (in certain applications or products as needed) resulting in lighter and more efficient convection in systems, with products utilizing all directions of flow for retainment and/or dispersion. In some embodiment, the drainage and ventilation cores 750, 850, 2000 may be stacked and connected or locked together to achieve load benefits for the soil in which the cores are installed. For example, the inventor has discovered stacked drainage and ventilation cores 750, 850, 2000 (FIG. 46) can achieve a minimum of a H-25 load rating per the American Association of State Highway and Transportation Officials (AASHTO) requirements. In still further

embodiments, as illustrated in FIGS. 45 and 46, the drainage and ventilation cores 750, 850, 2000 may be stacked and connected or locked together to form, for example, a septic tank or chamber 2500, leaching bed or field 2510, a drywell 2520, drainage gallery 2530, and/or retainment system providing more stability to surrounding soil 2550 as effluent or ground and surface water is captured, retained and/or gradually released by the systems 2500, 2510, 2520, and 2530 to the surrounding soil 2550.

[0215] It should be appreciated that the drainage and ventilation systems of the present invention, including the drainage and ventilation cores 750, 850, 2000, can be utilized in applications of use including, but not limited to:

[0216] - Construction - The Divisions defined by the Construction Specifications Institute (CSI)

[0217] - Agriculture

[0218] - Irrigation

[0219] - Landscaping

[0220] - Mining

[0221] - Sports Fields (playgrounds)

[0222] - Bridges - Roads - Sidewalks

[0223] - Green Roofs

[0224] - Civil and Geotechnical Engineering

[0225] - HVAC

[0226] The terms “first,” “second,” and the like, herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. In addition, the terms “a” and “an” herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

[0227] Although the invention has been described with reference to particular embodiments thereof, it will be understood by one of ordinary skill in the art, upon a reading and understanding of the foregoing disclosure, that numerous variations and alterations to the disclosed embodiments will fall within the spirit and scope of this invention and of the appended claims.

What is claimed is:

1. A system for retaining building material to form a foundation or a footing in soil, the system comprising:

side walls receiving and retaining a flowable and curable building material in a channel formed therebetween, the side walls disposed in a predetermined configuration defining a foundation or a footing within soil, the side walls including a first side wall and a second side wall, wherein the first side wall includes a first drainage core wrapped in a first fabric, the first drainage core having a plurality of first passages extending therethrough, and wherein the second side wall includes a second drainage core wrapped in a second fabric, the second drainage core having a plurality second passages extending of therethrough;

a bracket assembly retaining the side walls in the predetermined configuration in the soil, the bracket assembly including:

a first reinforcement post disposed proximate the first drainage core and retaining the first drainage core in a first interior position within the bracket assembly;

a second reinforcement post disposed proximate the second drainage core and retaining the second drainage core in a second interior position within the bracket assembly; and

a separator bar having a first end, a second end opposed from the first end, and a plurality of apertures disposed along a length of the separator bar, the plurality of apertures including apertures sized to receive and retain each of the reinforcement posts;

wherein the first and the second interior positions define a width of the channel;
and

a third drainage core wrapped in a third fabric and disposed against and outwardly bounding the bracket assembly and the channel from the soil, the third drainage core having a plurality of third passages extending therethrough, and wherein the third drainage core prevents backfill of the soil from filling a volume between the third drainage core and the side walls;

wherein the first drainage core, the second drainage core and the third drainage core are retained in the foundation or footing after the building material cures; and

wherein the plurality of first passages, the plurality of second passages and the plurality of third passages form respective first, second and third cavities that receive, capture and convey a flow of at least one of liquid, air and gas from the soil.

2. The system of claim 1, further comprising:

a first spacer disposed between the first drainage core and the first reinforcement post, the first spacer providing at least one of a vertical and a horizontal offset to the first side wall; and

a second spacer disposed between the second drainage core and the second reinforcement post, the second spacer providing at least one of a vertical and a horizontal offset to the second side wall;

wherein the at least one vertical and horizontal offsets form sidewalls of a predefined cross-section.

3. The system of claim 2, wherein the predefined cross-section is a trapezoidal cross-section.

4. A drainage and ventilation system, the system comprising:

a plurality of drainage cores, each drainage core is comprised of a sheet having a first end, a second end, a first side, a second side, and a plurality of dimples disposed between the first end, the second end, the first side, and the second side, the plurality of dimples extending outwardly from the sheet and defining a plurality of passages, the plurality of passages including first passages extending from the first end to the second end and second passages extending from the first side to the second side; and

a fabric attached to each of the plurality of drainage cores;

wherein the plurality of first passages and the plurality of second passages receive and convey a flow of at least one of liquid, air and gas through the plurality of drainage cores.

5. The drainage and ventilation system of Claim 4, wherein at least one of the first end, the second end, the first side, and the second side of the sheet of each of the plurality of drainage cores includes a flat section facilitating attachment of one of the plurality of drainage cores to an adjacent one of the plurality of drainage cores.
6. The drainage and ventilation system of Claim 4, wherein the fabric is wrapped around and individually encloses each of the plurality of drainage cores, the fabric further including an extending portion that extends beyond at least one of the first end, the second end, the first side, and the second side to facilitating attachment of one of the plurality of drainage cores to an adjacent one of the plurality of drainage cores.
7. The drainage and ventilation system of Claim 6, further comprises a plurality of eyelets included in the extending portion of the fabric, wherein the plurality of eyelets are adapted to receive a fastener to secure the attachment of the one drainage core to the adjacent drainage core.
8. The drainage and ventilation system of Claim 4, further comprises a fabric ribbon coupled to one of the plurality of drainage cores, the fabric ribbon facilitating attachment of the one of the plurality of drainage cores to an adjacent one of the plurality of drainage cores.
9. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in soil, and wherein the flow of the at least one of liquid, air and gas through the plurality of drainage cores is received from the soil.
10. The drainage and ventilation system of Claim 9, further comprising:
a plurality of drainage conduits disposed in the soil, at least one of the plurality of drainage conduits is coupled to one of the plurality of drainage cores to receive and convey the flow of the at least one of liquid, air and gas through the plurality of drainage conduits.
11. The drainage and ventilation system of Claim 4, further comprising:
an air exchange unit in communication with at least one of the plurality of drainage cores.

12. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in soil, and wherein the plurality of dimples each include an interior cavity, a portion of the interior cavities of the plurality of dimples is filled with an adhesive to enhance the shock absorbing properties of the soil having the plurality of drainage cores disposed therein.
13. The drainage and ventilation system of Claim 12, wherein the portion of the interior cavities of the plurality of dimples are filled with a mixture of the adhesive and a granular rubber.
14. The drainage and ventilation system of Claim 12, wherein the portion of the interior cavities of the plurality of dimples are filled with the adhesive and a surface of the drainage core is coated with the adhesive.
15. The drainage and ventilation system of Claim 12, further including a pad disposed in the soil above the plurality of drainage cores.
16. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in a structure, and wherein the plurality of dimples each include an interior cavity, a portion of the interior cavities of the plurality of dimples is filled with at least one of an adhesive and a cement-based material, the at least one of the adhesive and the cement-based material receiving and adhering a finish material to the plurality of drainage cores.
17. The drainage and ventilation system of Claim 16, wherein the finish material includes at least one of plaster, stucco, tile, brick, and masonry veneer.

18. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in a structure, and the system further includes a lath sheet affixed to each of the plurality of drainage cores on a surface opposite from the attached fabric, the lath sheet receiving and retaining at least one of an adhesive and a cement-based material, the at least one of the adhesive and the cement-based material receiving and adhering a finish material to the plurality of drainage cores.

19. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in an interior of a structure, and wherein the plurality of drainage cores provides portions of at least one of walls, floors, and ceilings for the structure.

20. The drainage and ventilation system of Claim 19, wherein at least one of the plurality of drainage cores is coupled to at least one of a heating, venting and air conditioning (HVAC) system and a fire suppression system to distribute a flow of at least one of conditioned air and fire retardant material therefrom throughout the structure.

21. The drainage and ventilation system of Claim 4, wherein the plurality of drainage cores is disposed in an exterior of a structure, and wherein the plurality of drainage cores provides at least one of exterior sheathing, a rain screen, and roofing underlayment thereof.

1/65

FIG. 1A

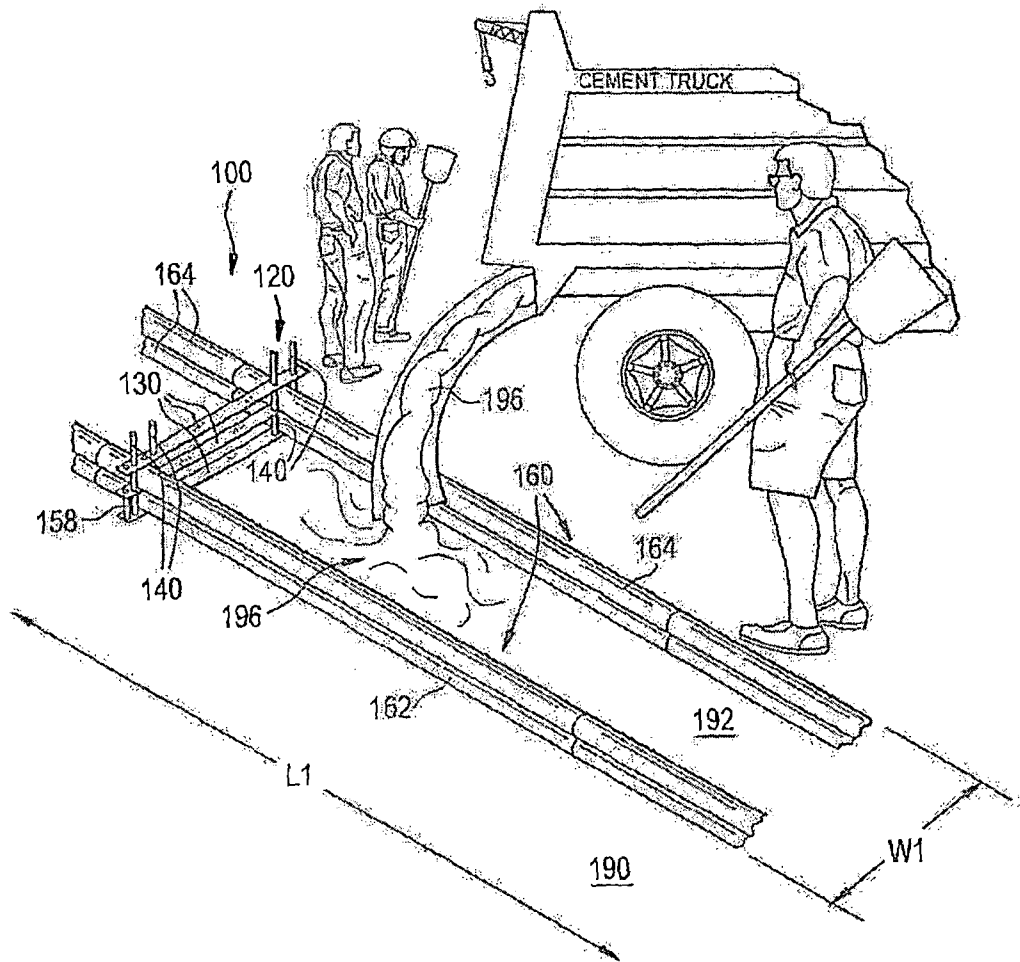
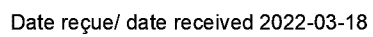


FIG. 1B



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FIG. 2

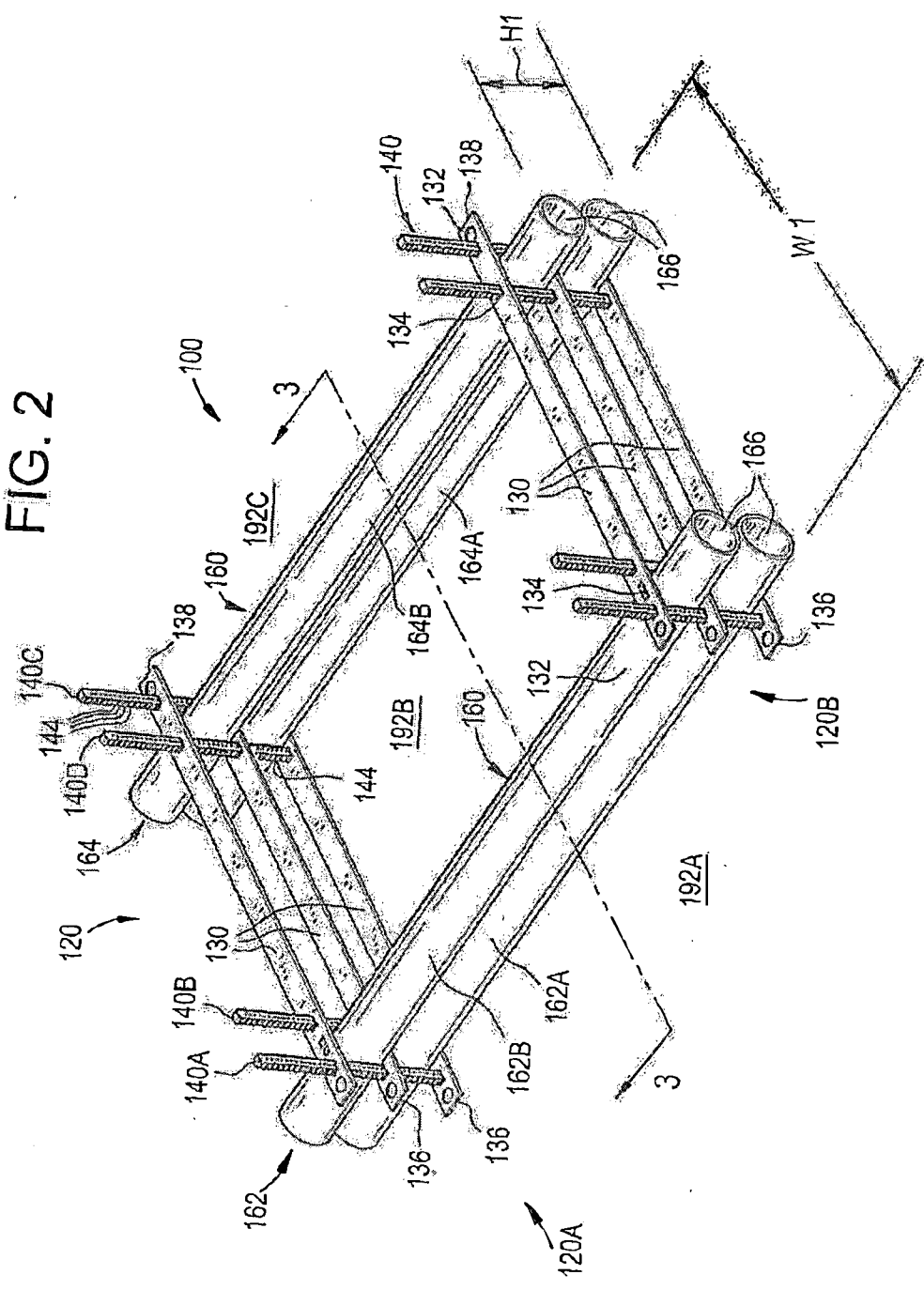


FIG. 3

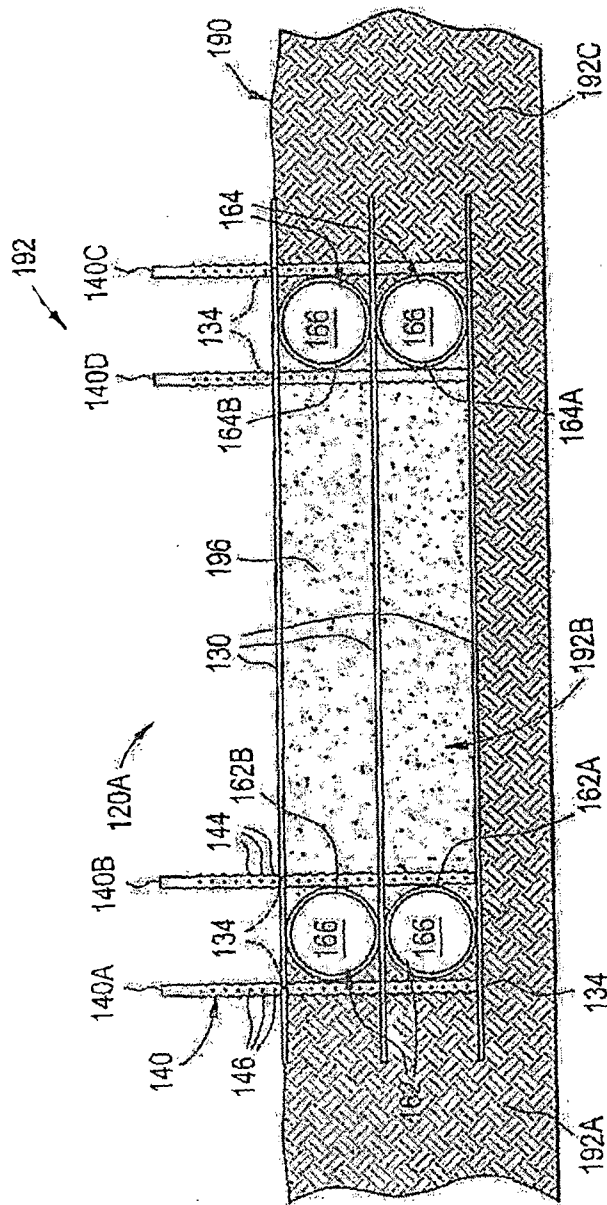
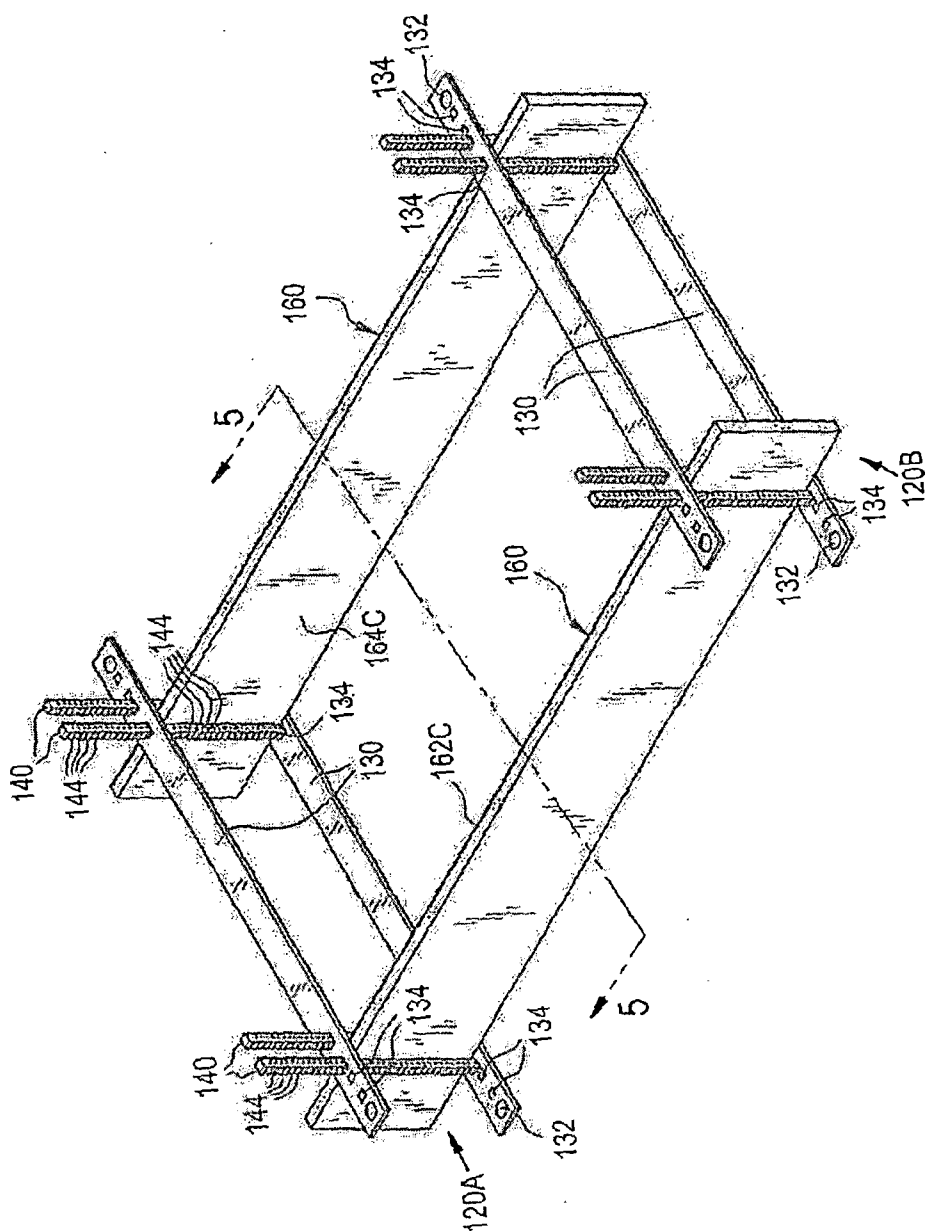
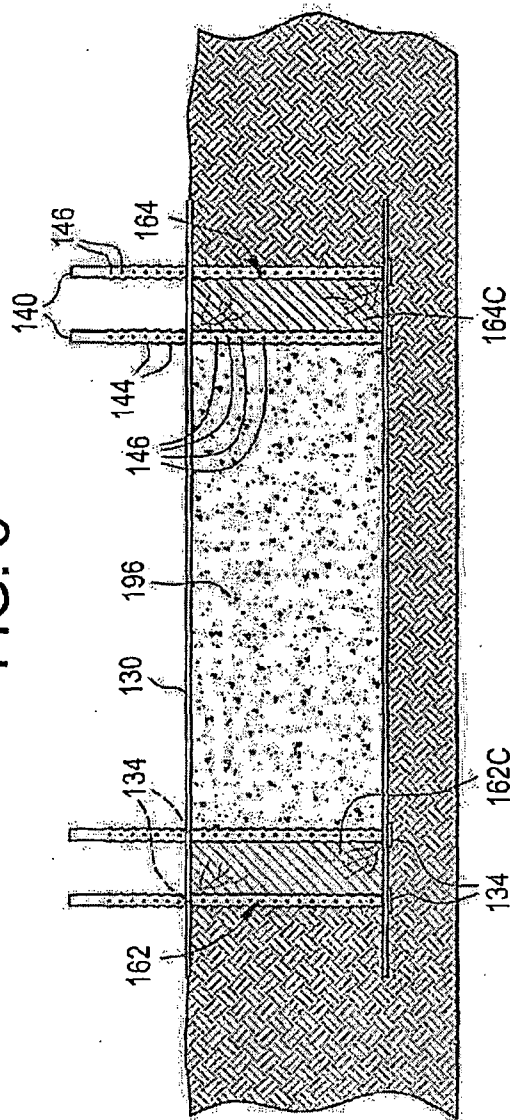


FIG. 4



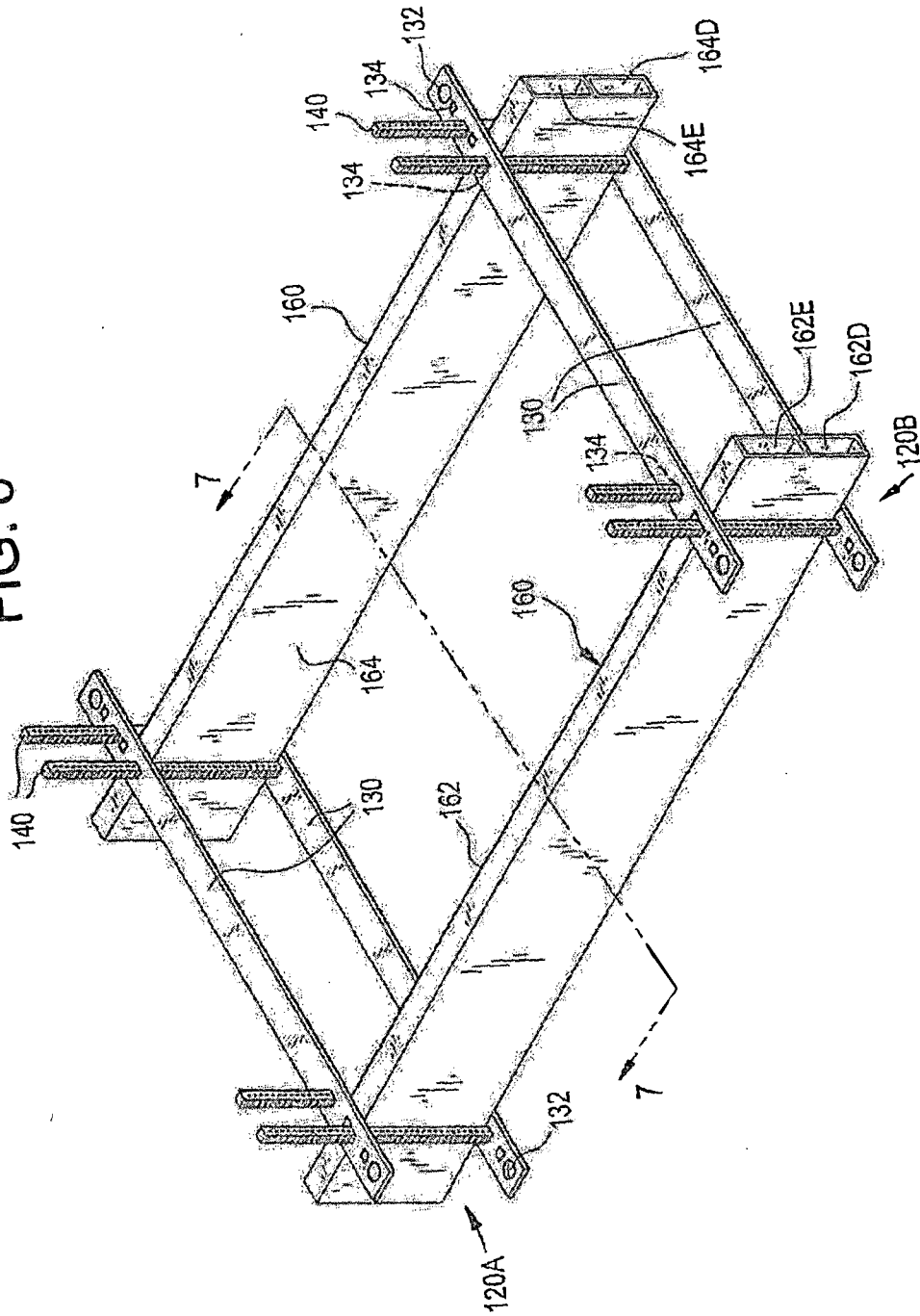
6/65

FIG. 5



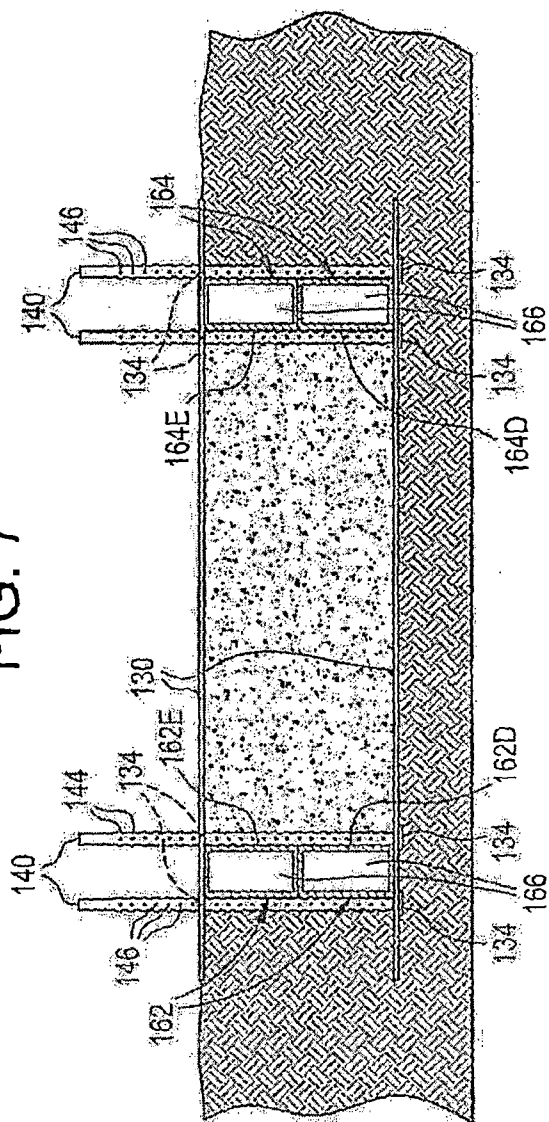
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১৬৫



[illegible]

FIG. 7



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FIG. 8A

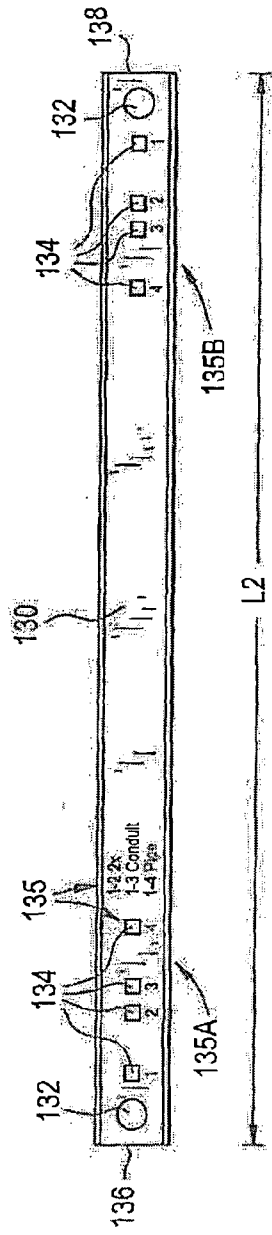
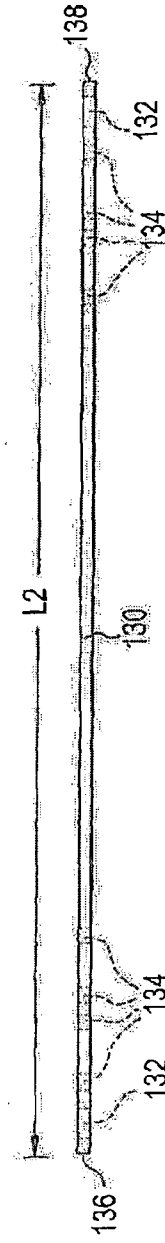


FIG. 8B



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FIG. 9A

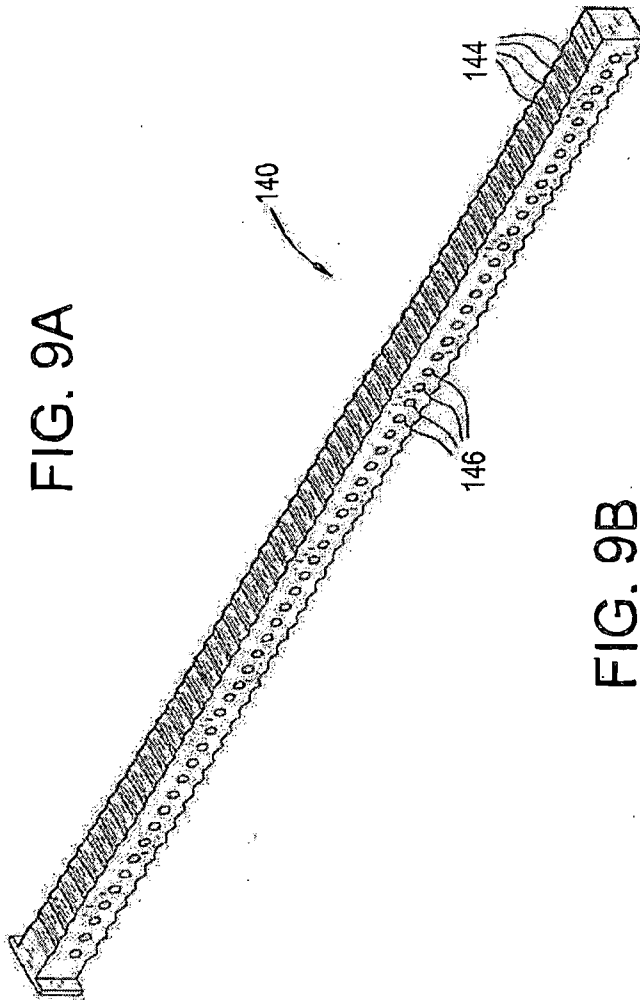
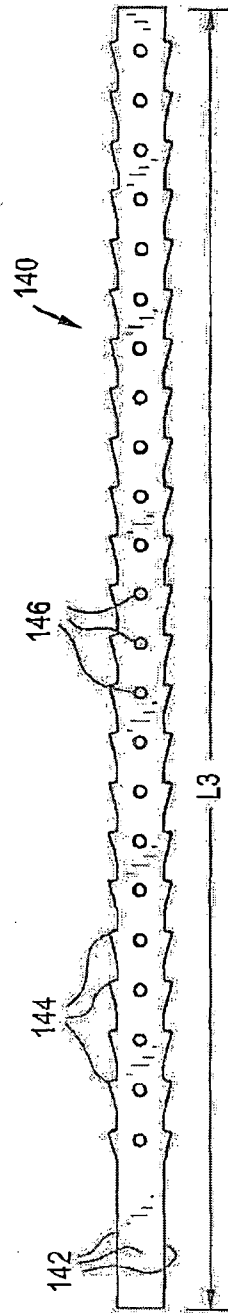


FIG. 9B



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FIG. 10B

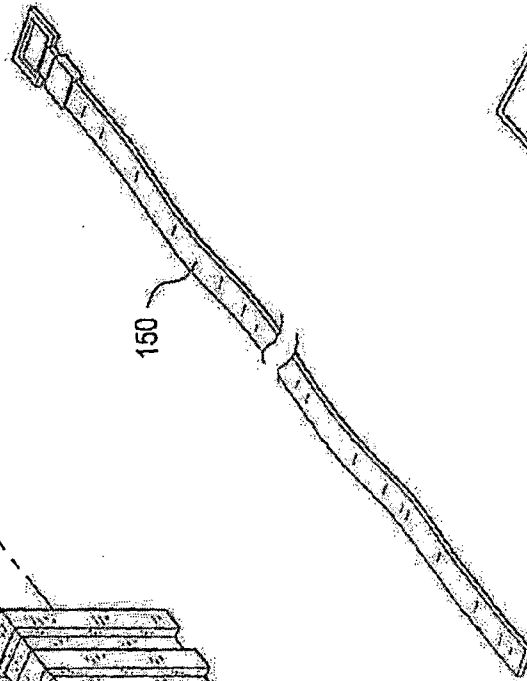


FIG. 10C

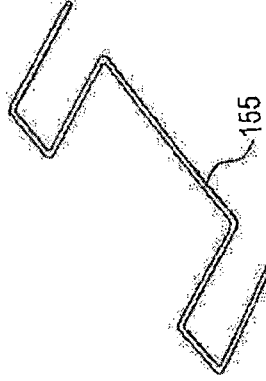


FIG. 10A

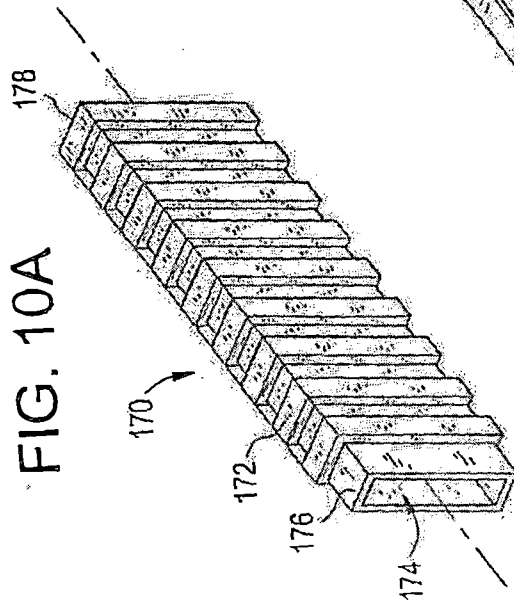


FIG. 10D

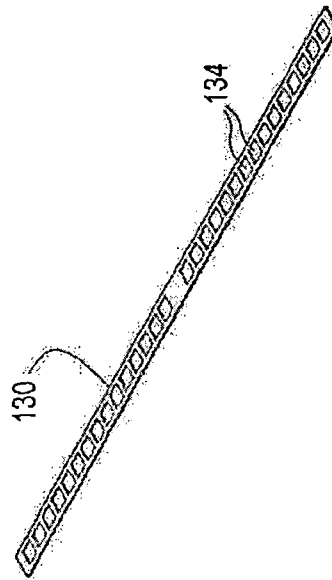
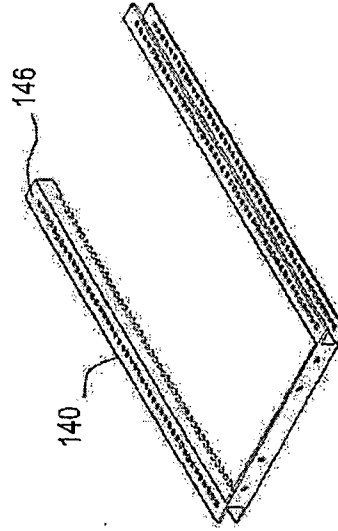


FIG. 10E



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FIG. 11B

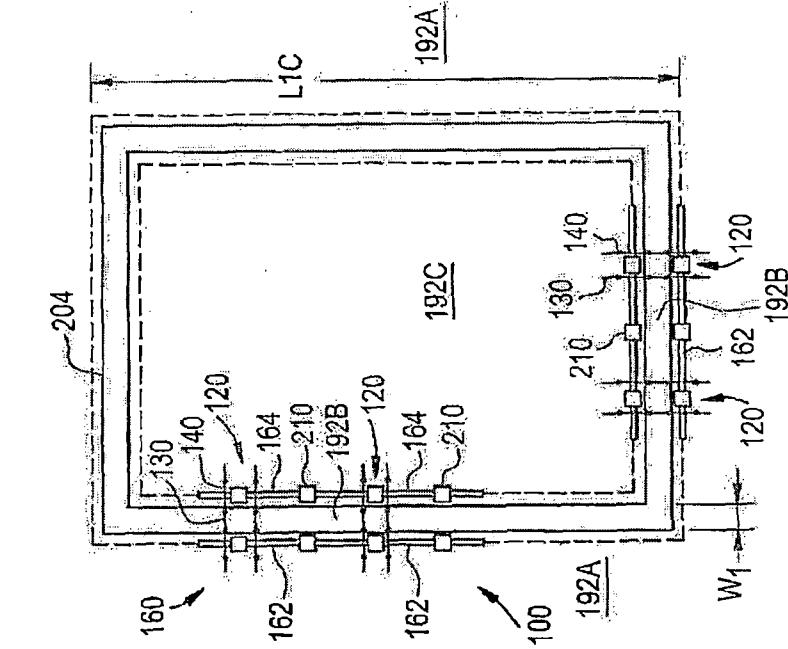
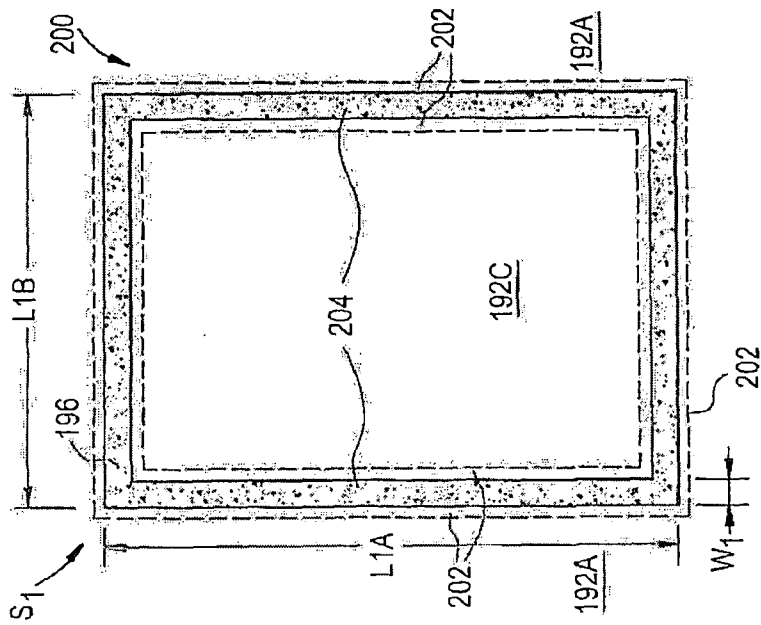


FIG. 11A



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FIG. 11D

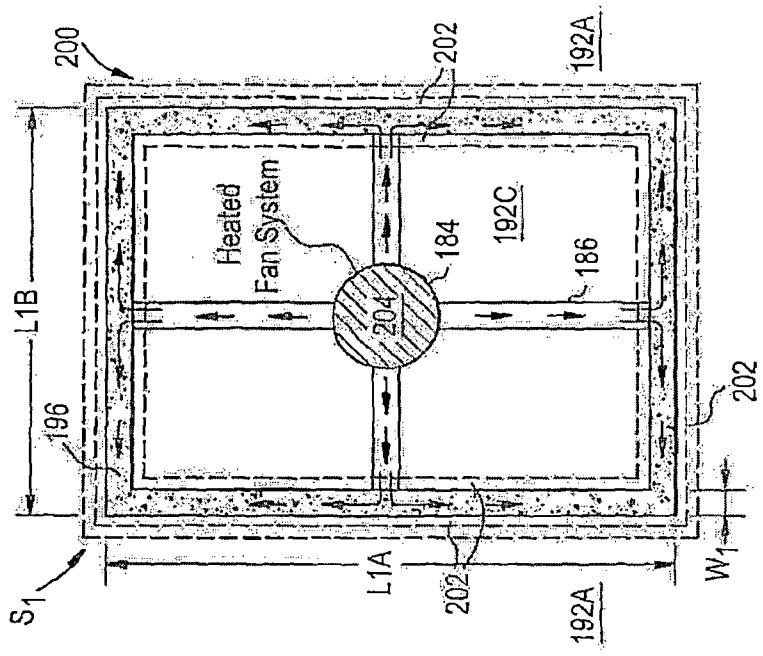
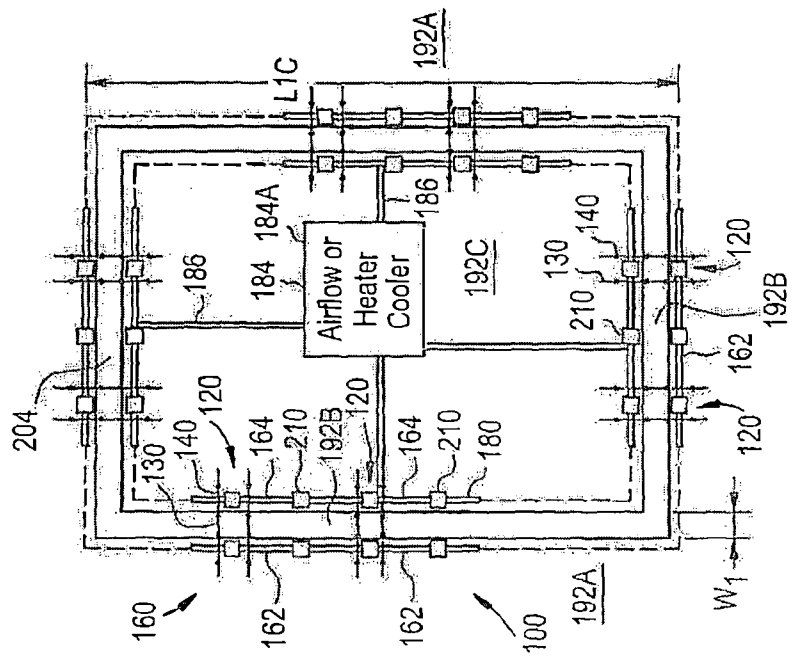


FIG. 11C



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FIG. 12A

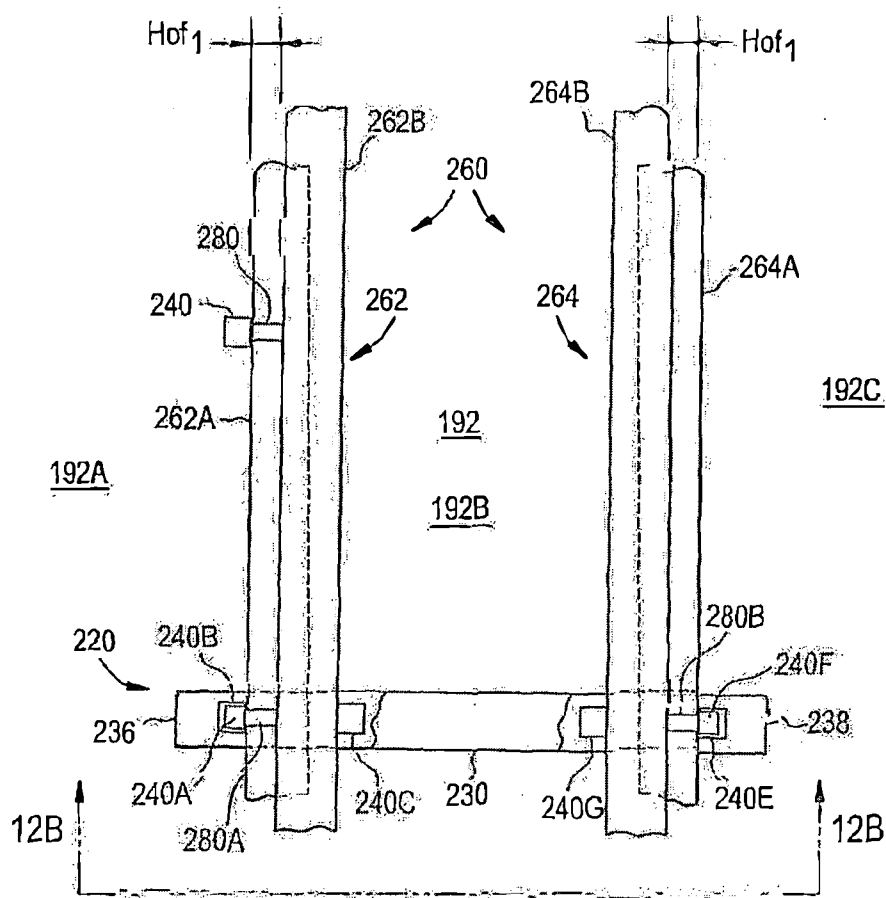
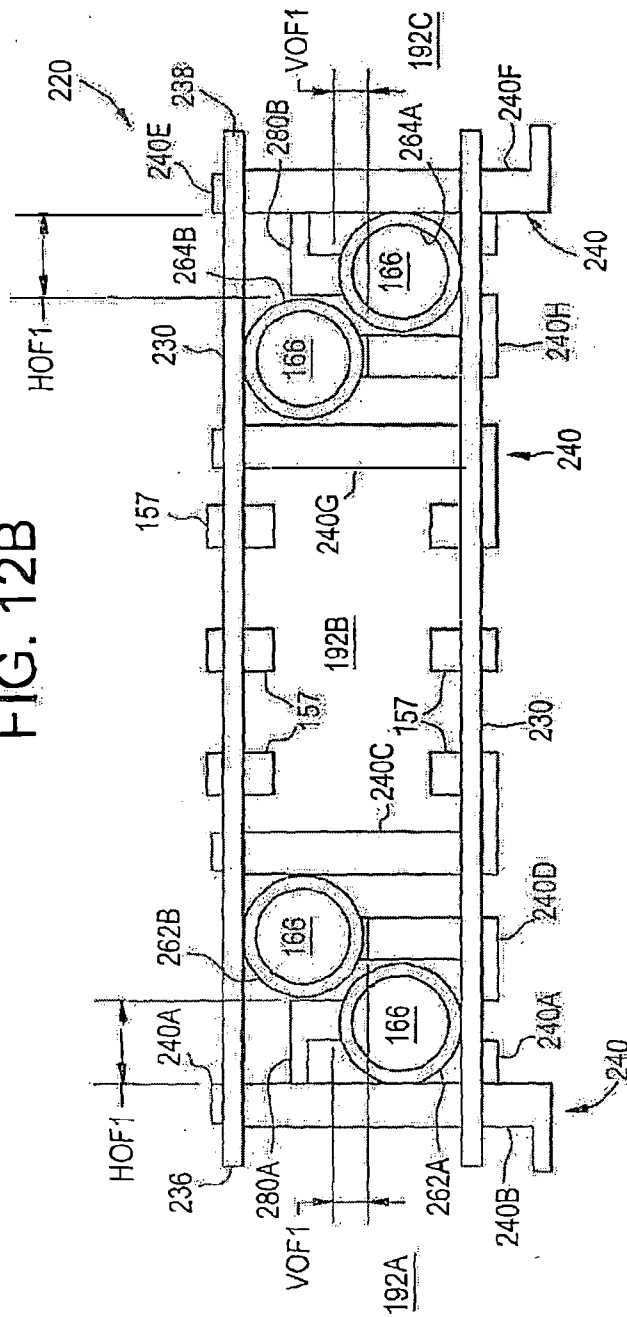
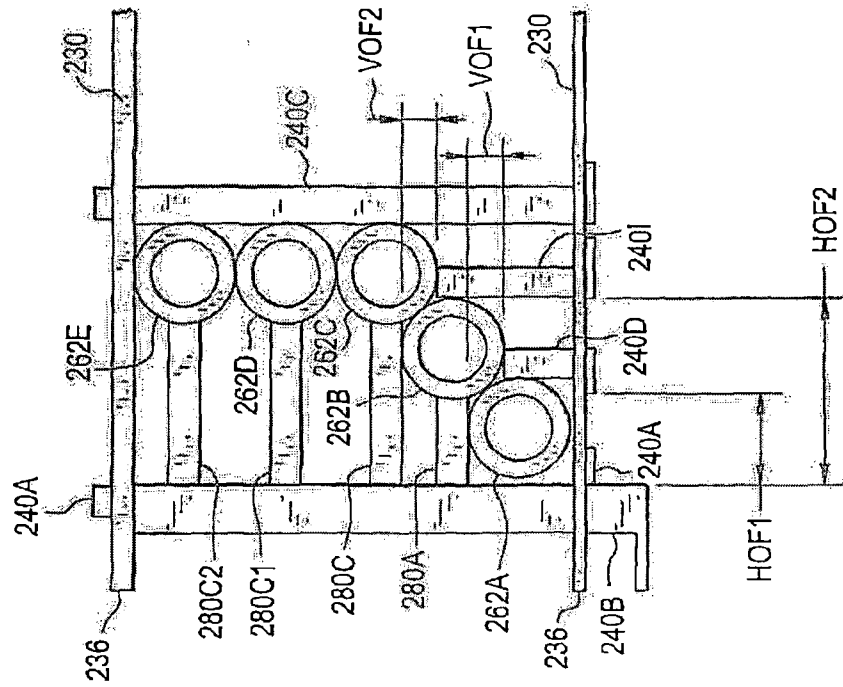


FIG. 12B



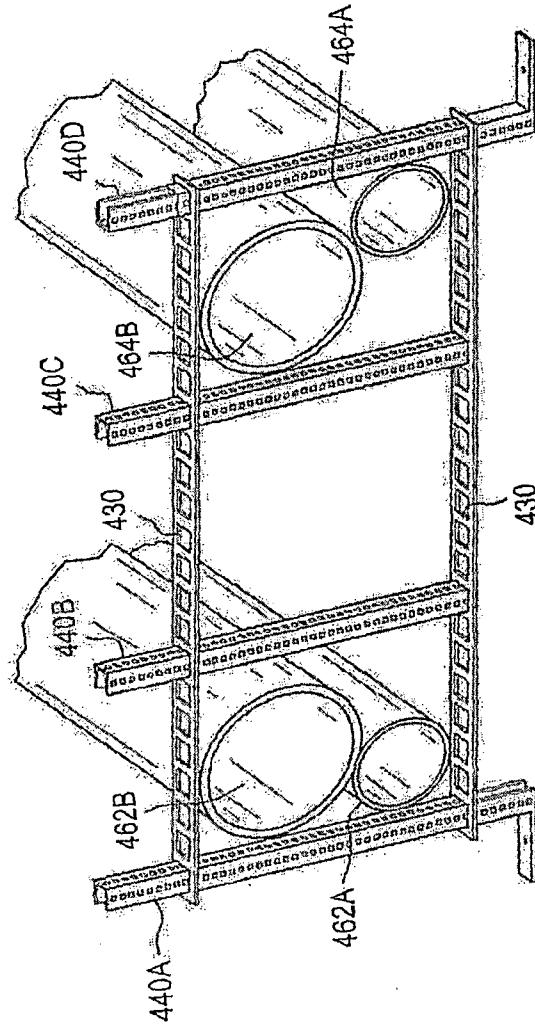
17/65

FIG. 12C



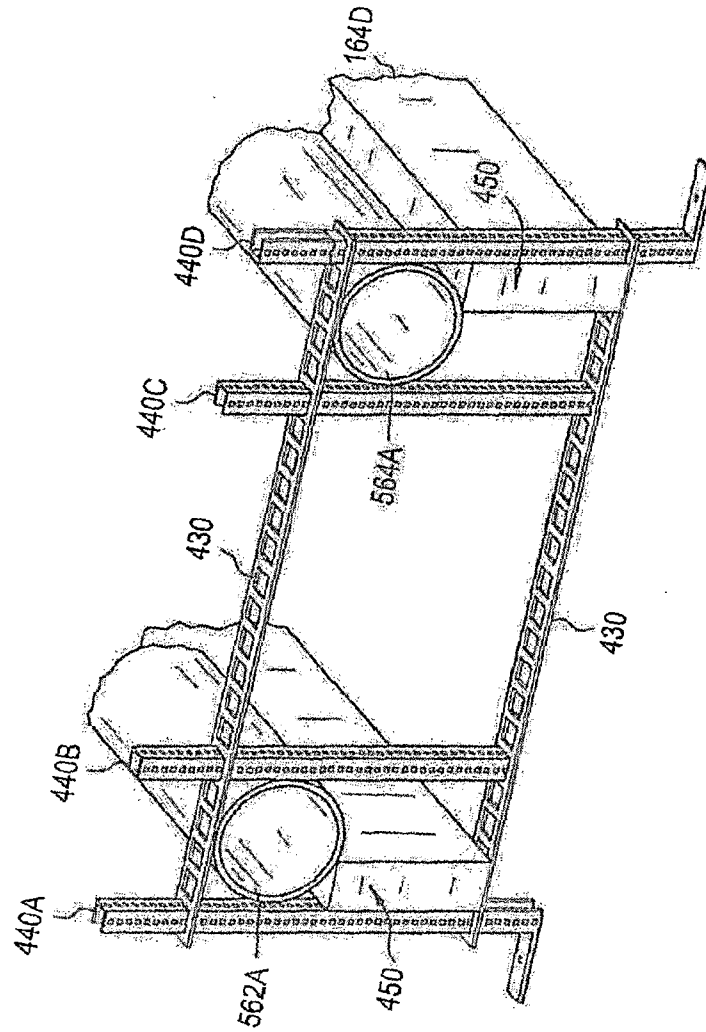
18/65

FIG. 12D



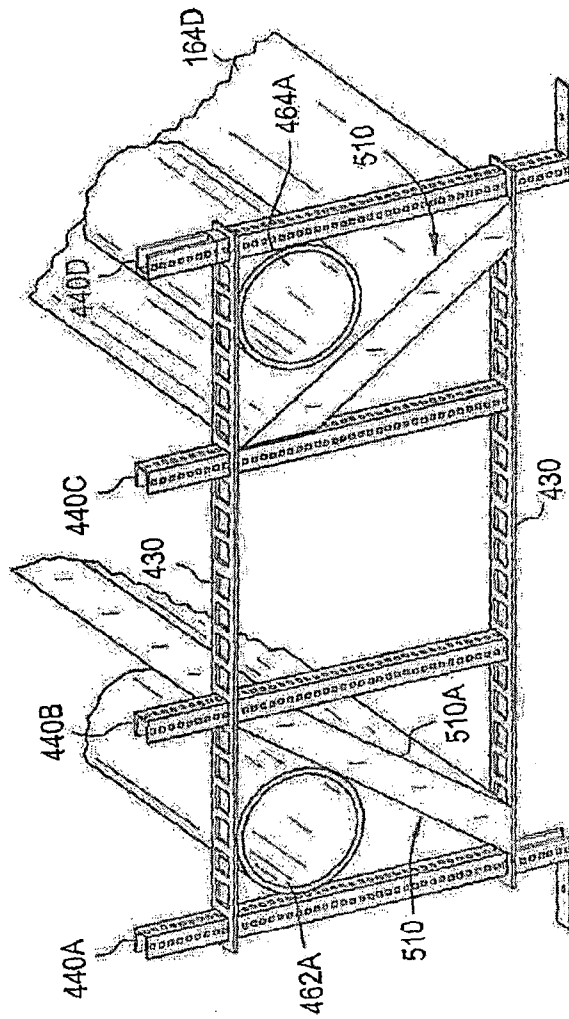
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FIG. 12E



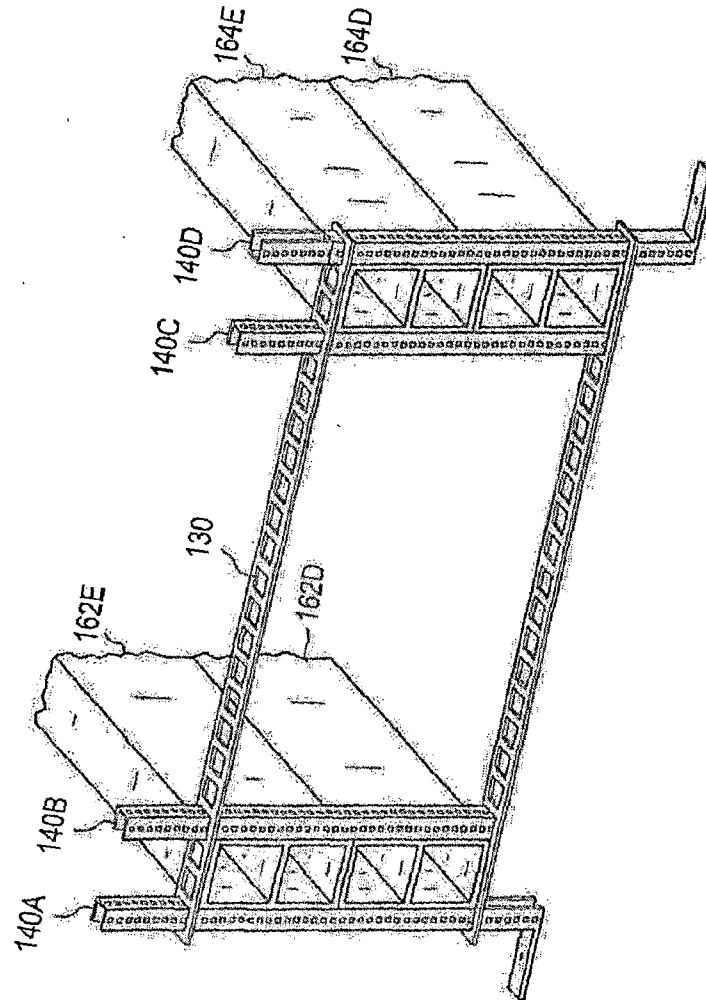
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FIG. 12F



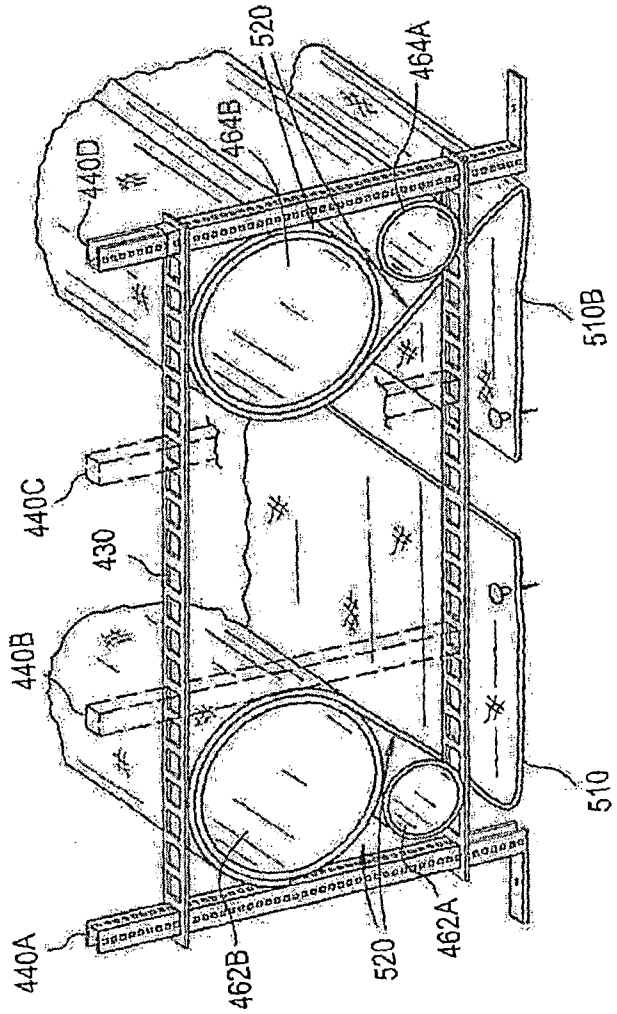
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FIG. 12G



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FIG. 12H



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FIG. 12I

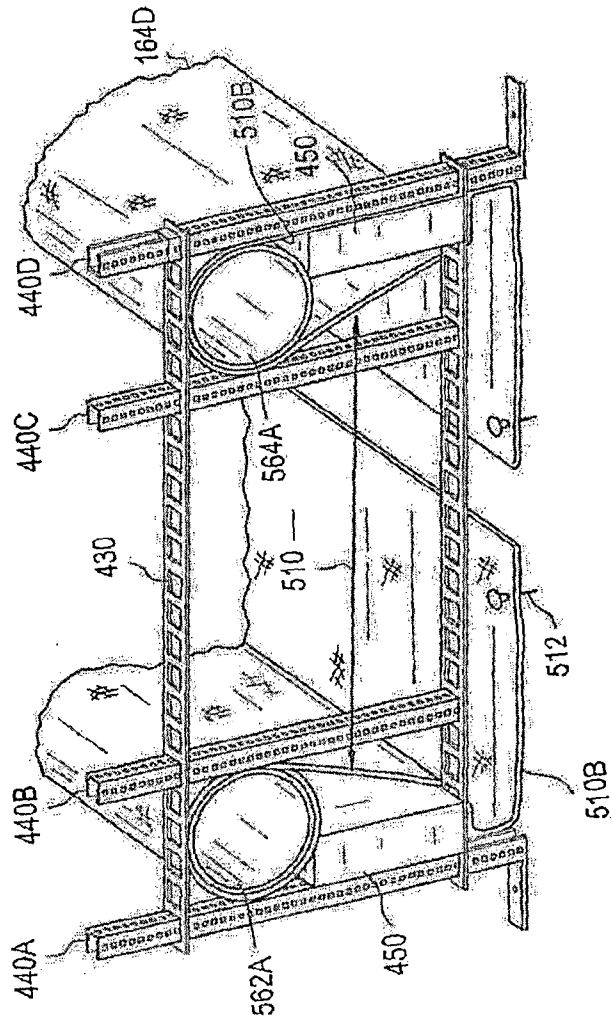
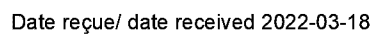
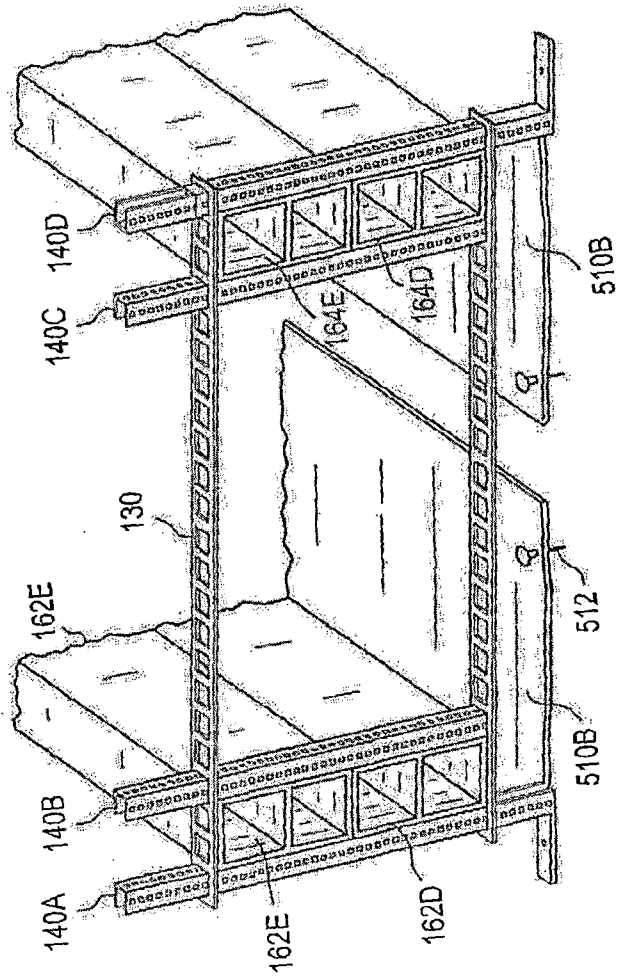


FIG. 12J



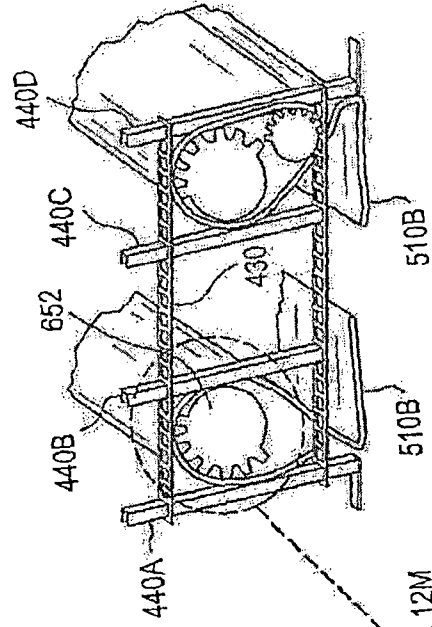
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FIG. 12K



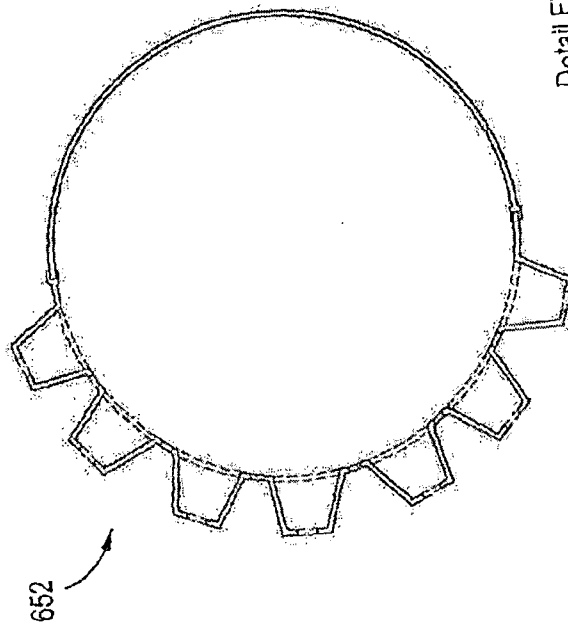
26/65

FIG. 12L



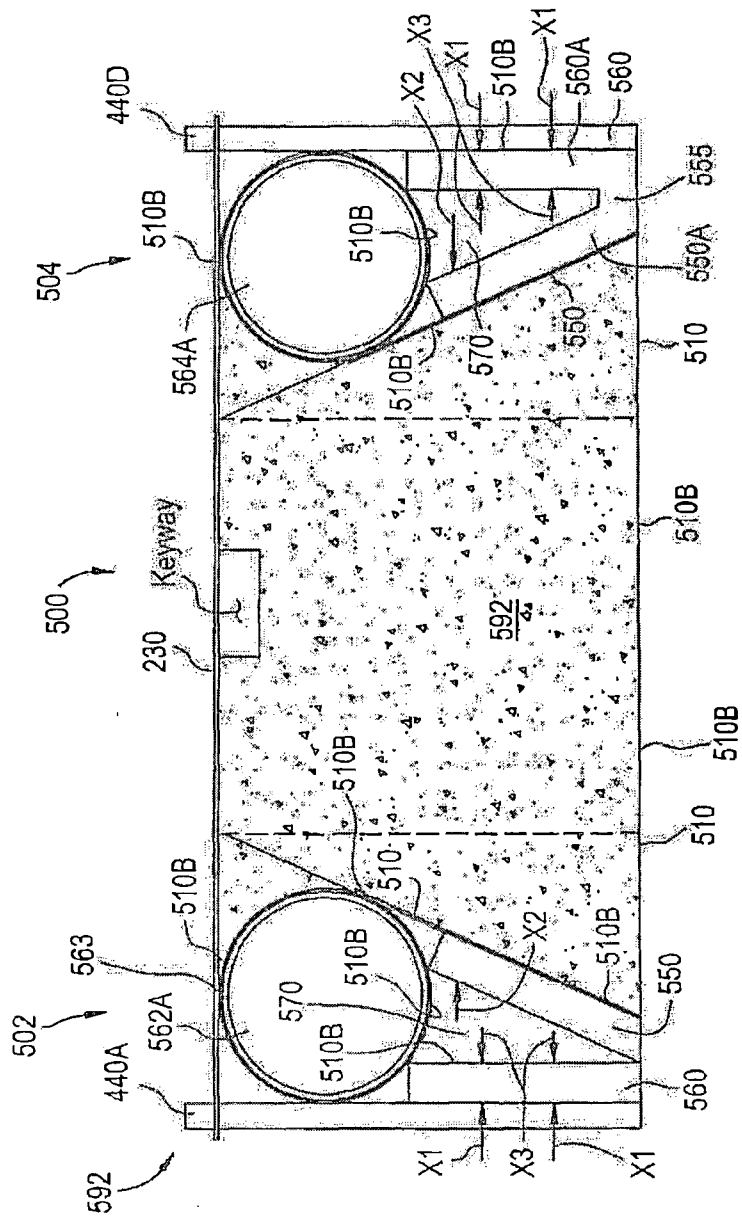
Detail FIG. 12M

FIG. 12M



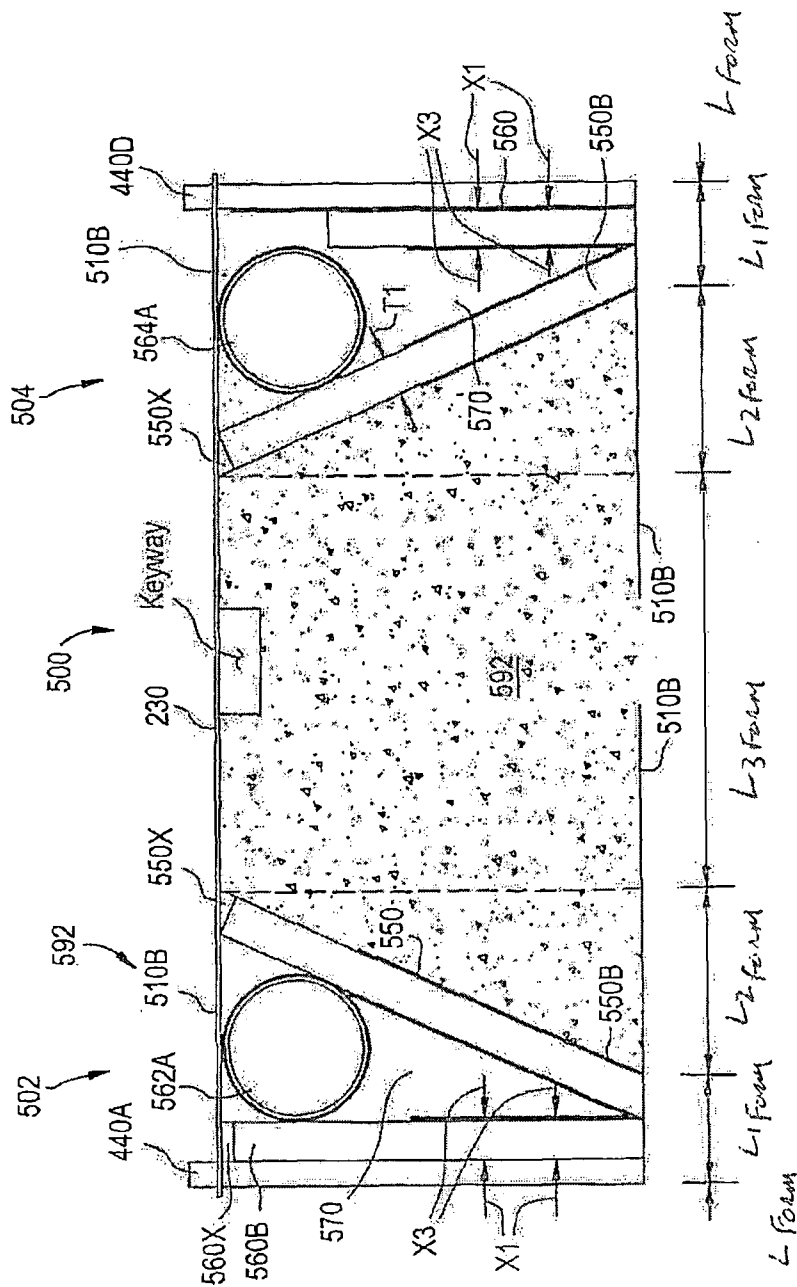
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FIG. 12N



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FIG. 120



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FIG. 12P

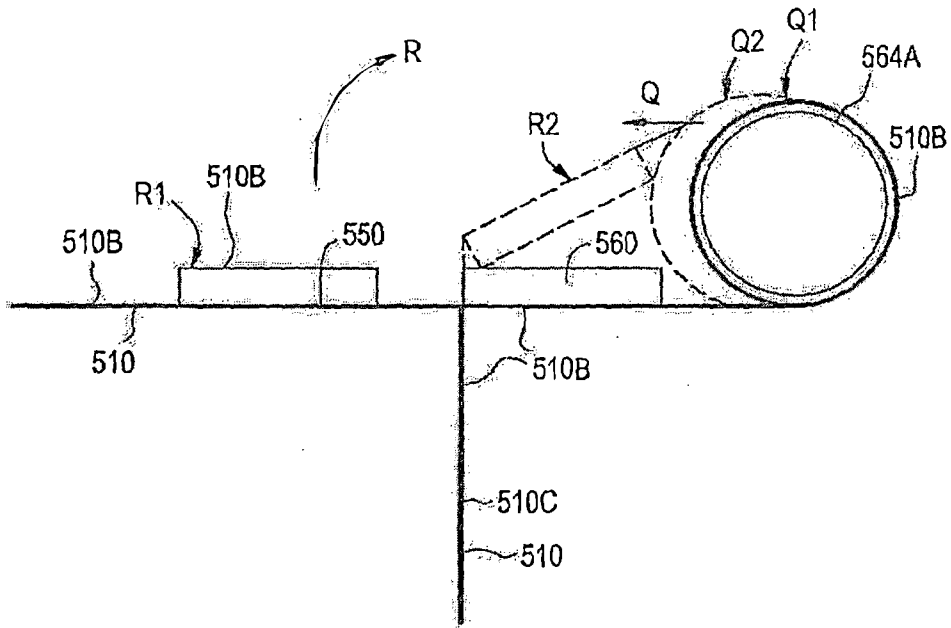
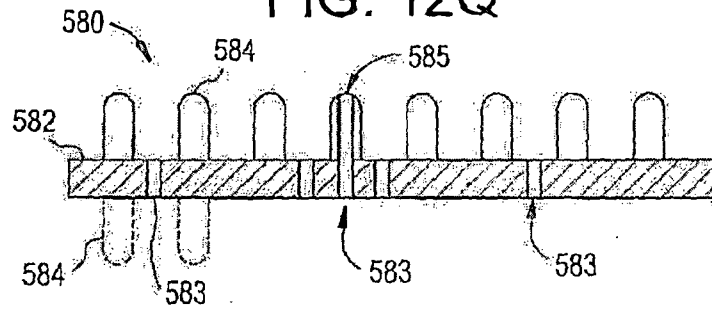
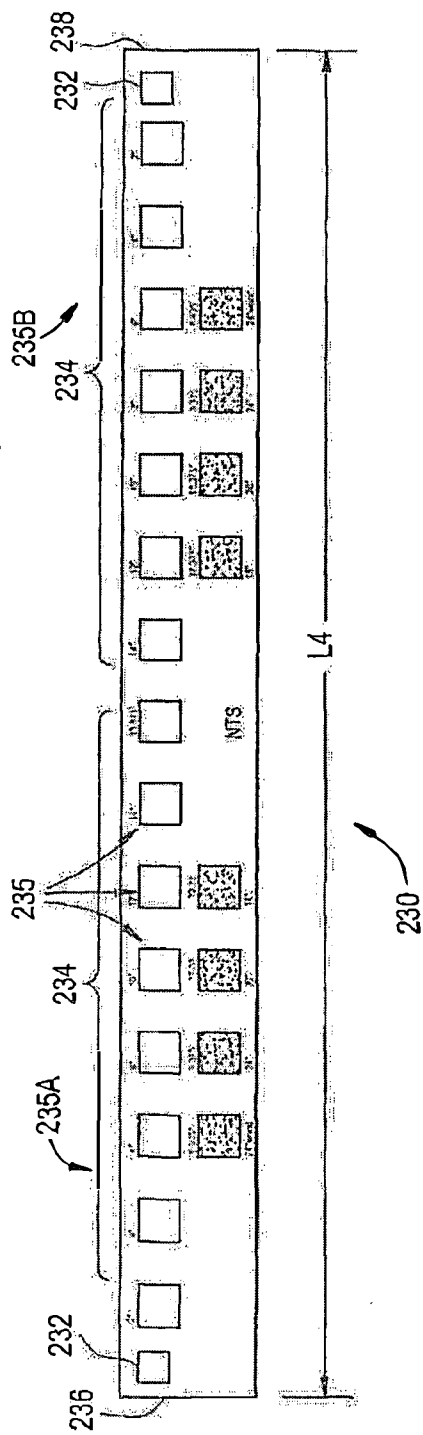


FIG. 12Q



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FIG. 13



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FIG. 14A

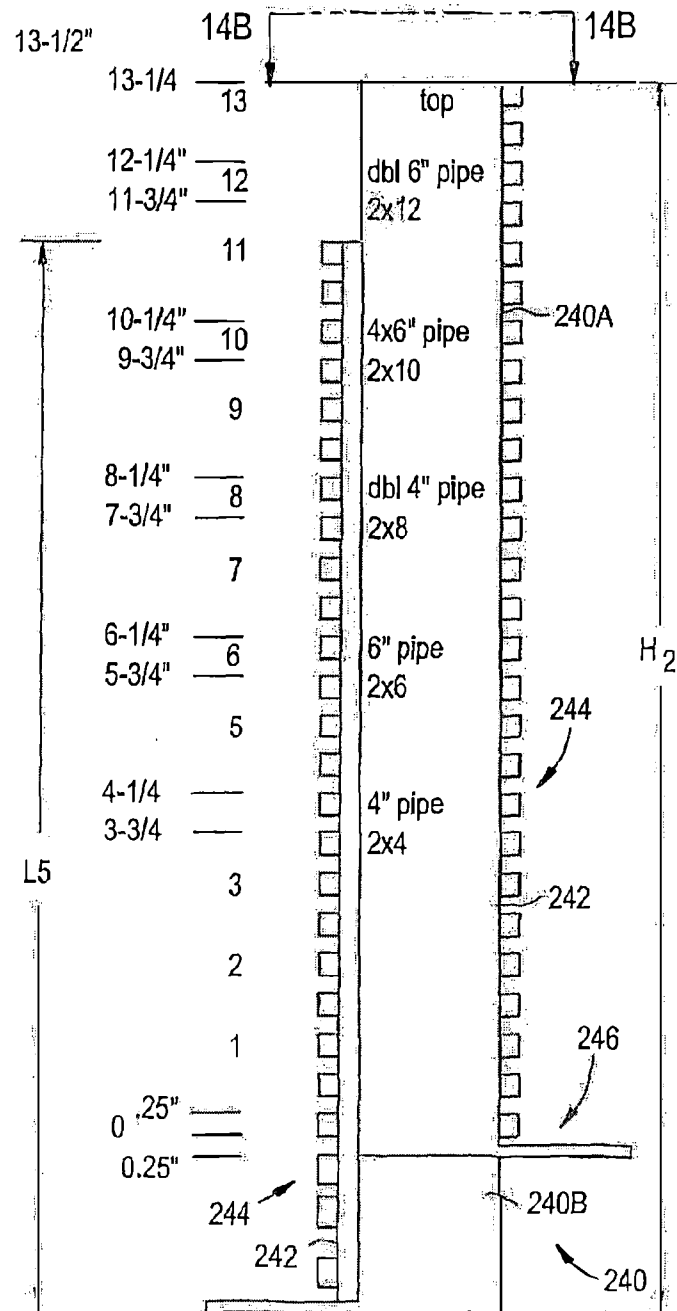
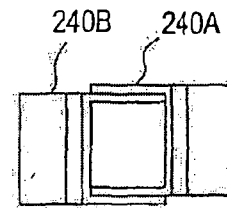


FIG. 14B



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FIG. 15A

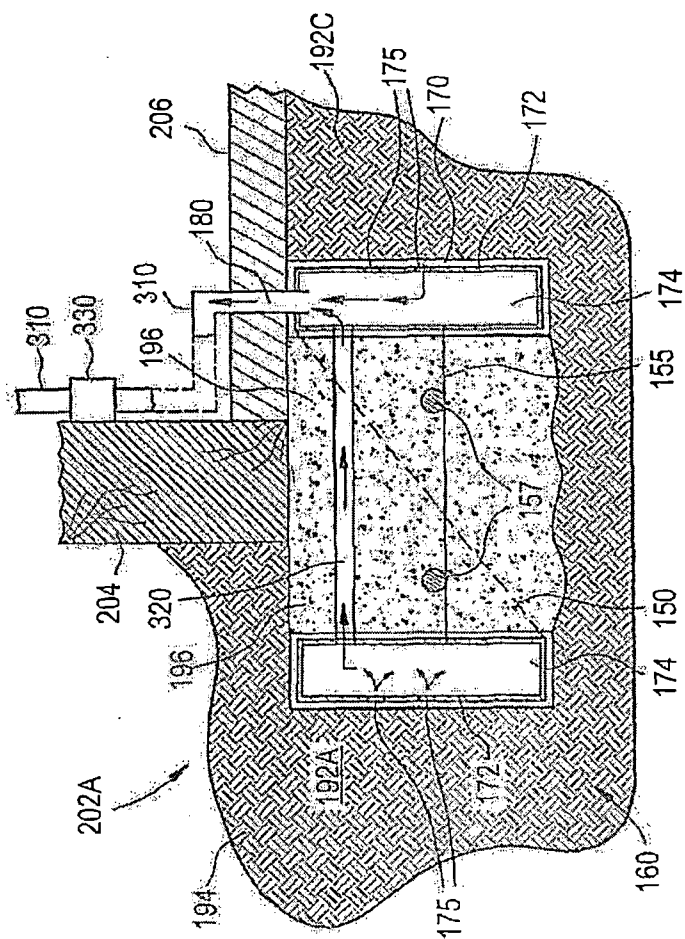
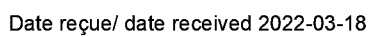
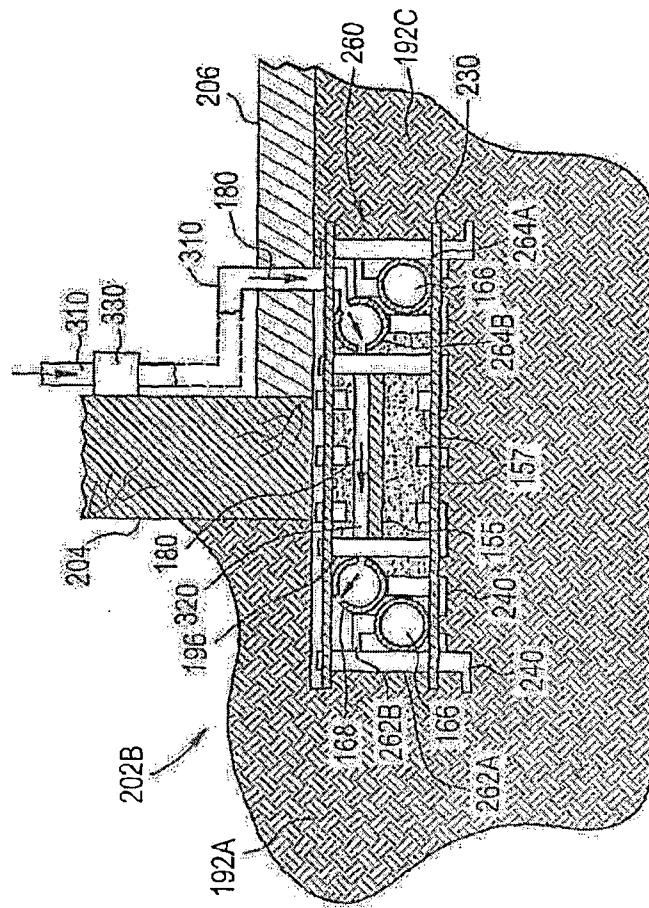


FIG. 15B



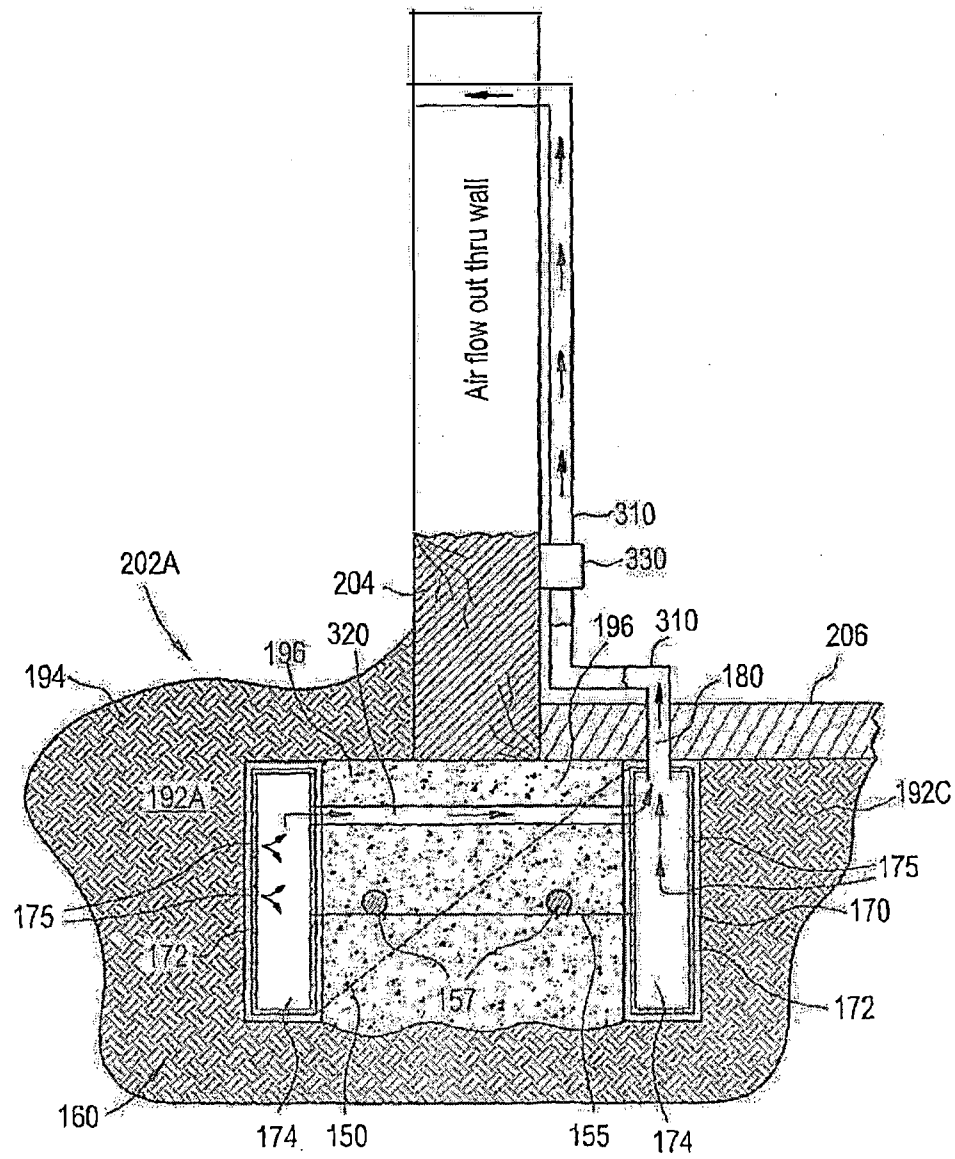
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FIG. 15C



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FIG. 15D



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FIG. 16

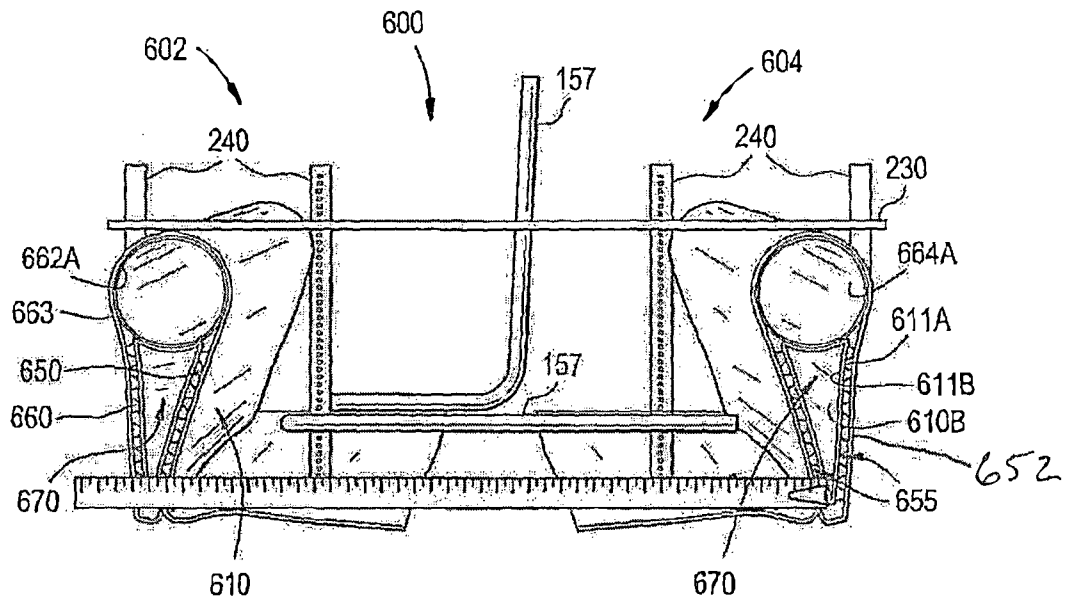
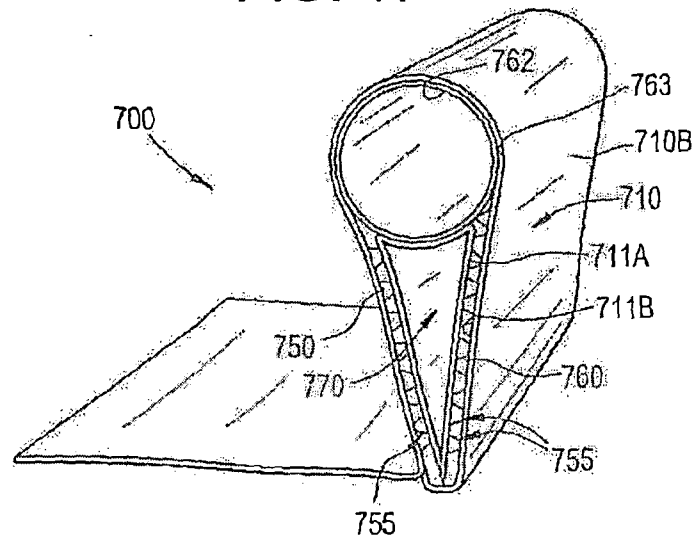
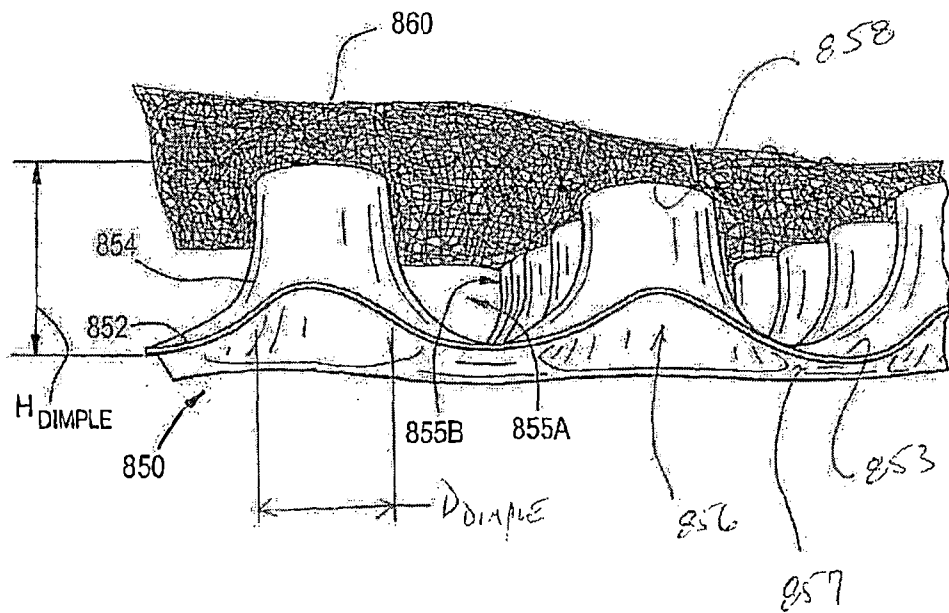


FIG. 17



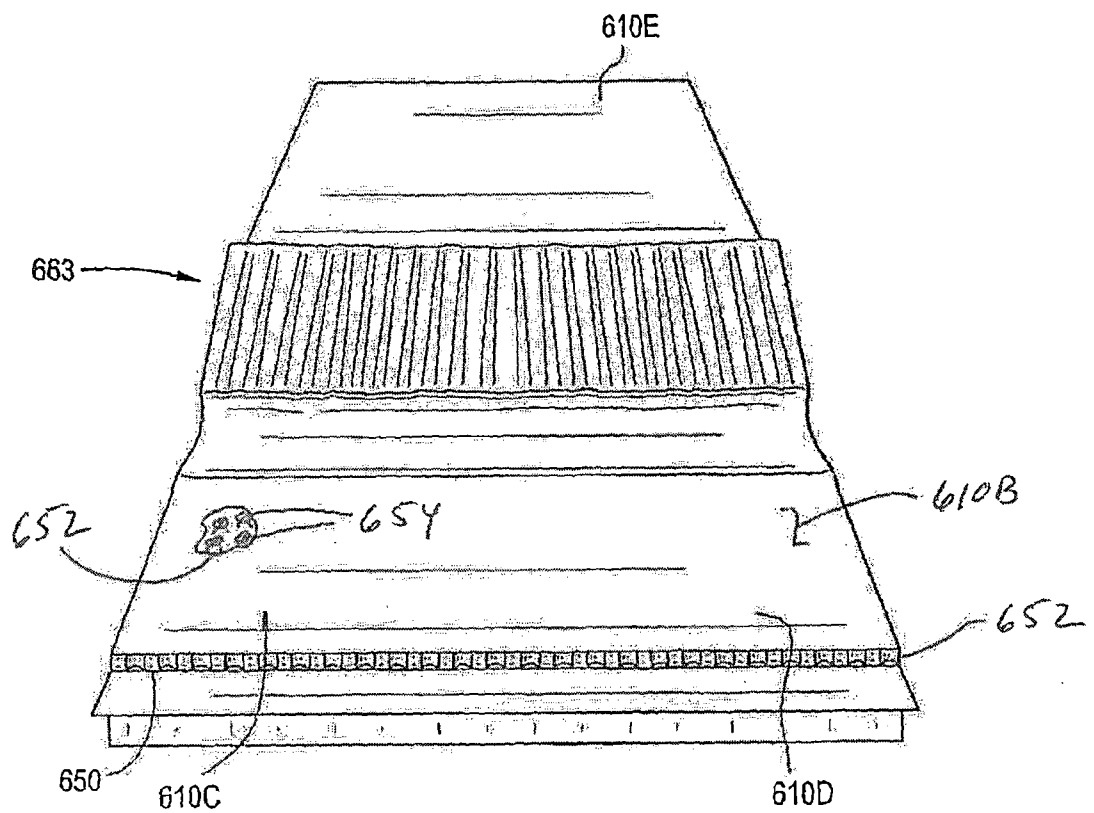
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FIG. 18A



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FIG. 18B



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FIG. 18C

Example Filter Geotextile Properties (FABRIC 610B, 710B, 860)				
Grab Tensile Properties (strength)	ASTM D4632	pounds force	MD: >100 TD: > 100	
Grab tensile Properties (elongation at maximum load)		%	MD: >50 TD: >50	
CBR Puncture Strength	ASTM D6241	pounds force	>200	
Apparent Opening Size	ASTM D4751	mm	<0.400	
		US Standard Sieve Size	40	
Permittivity	ASTM	sec ⁻¹	>1.8	
Flow Rate	D4491	gal/min/ft ²	>140	
Permeability		cm/sec	>0.08	
Example Cusped Core Hydraulic Properties (Core 650,660,750,760,850)				
Cusp Height (in)	Hydraulic Gradient (slope)	L/s	LPM	Gal/min/ft width
0.5	0.025	0.22	13.3	3.5
	0.05	0.31	18.7	4.9
	0.1	0.45	27.1	7.2
	0.25	0.71	42.9	11.3
	0.5	1.05	63	16.7
	1	1.50	90	23.8
1	0.01	0.28	16.7	4.4
	0.025	0.43	26	6.9
	0.04	0.58	35	9.2
	0.12	1.05	63.2	16.7
	0.5	2.21	132	35
	1	3.14	188	49.5

870

880

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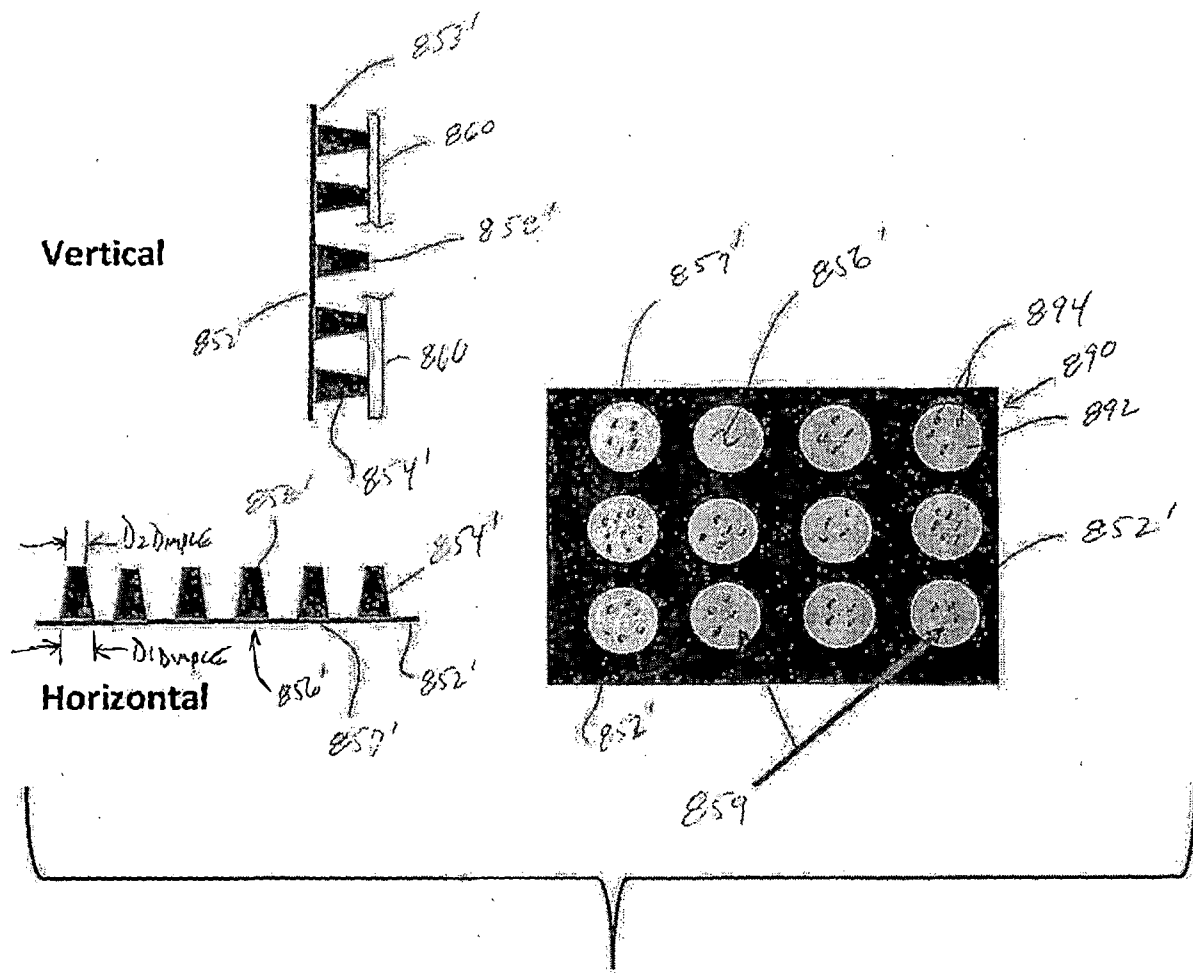


FIG. 18D

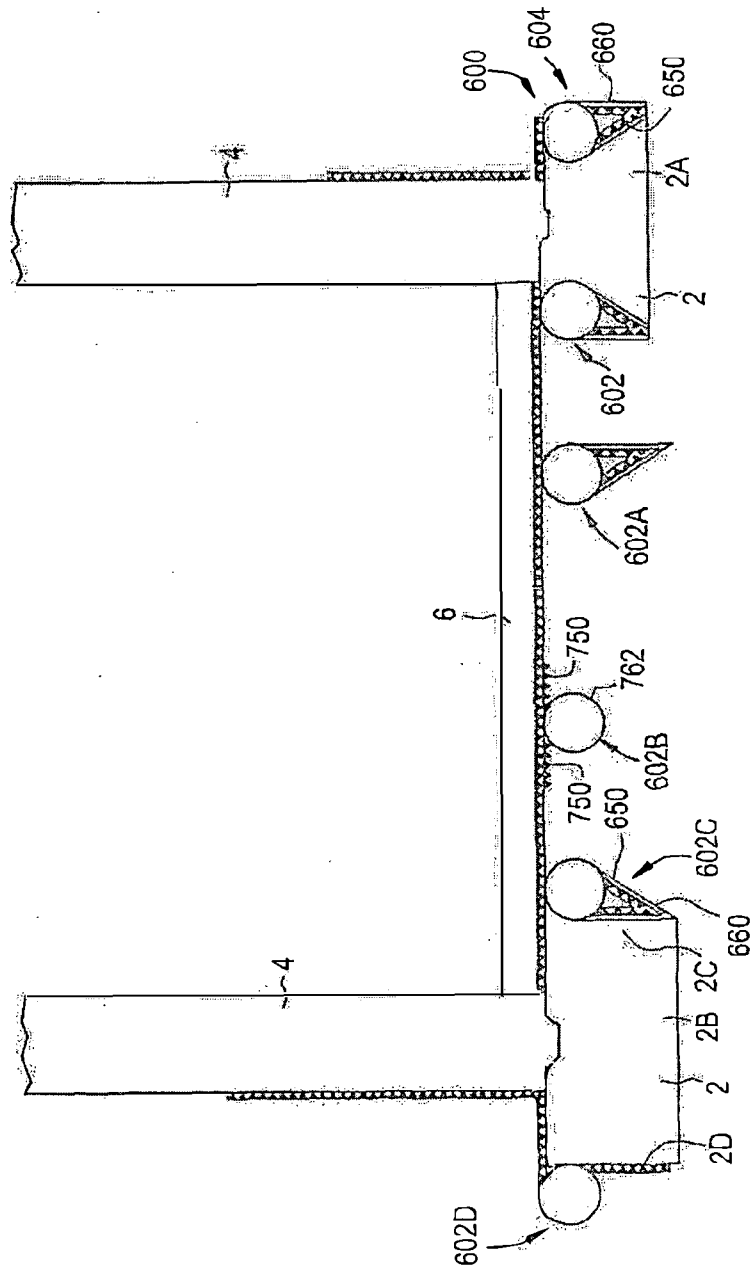
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Fig. 18E

892

FIG. 19



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FIG. 20
PRIOR ART

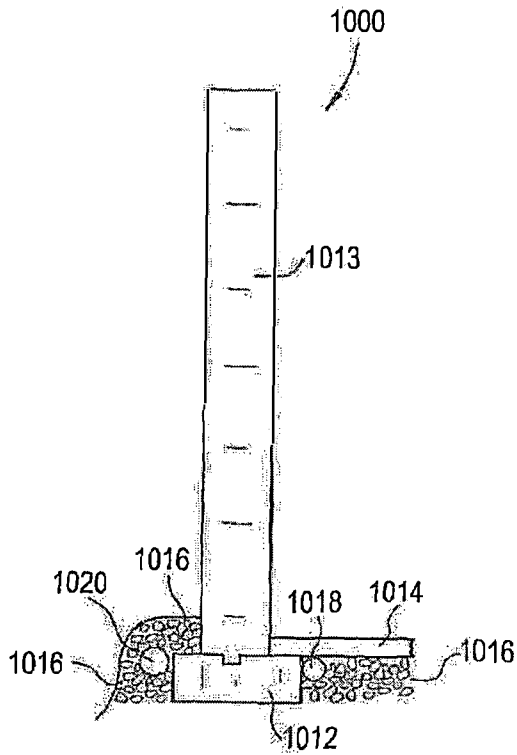
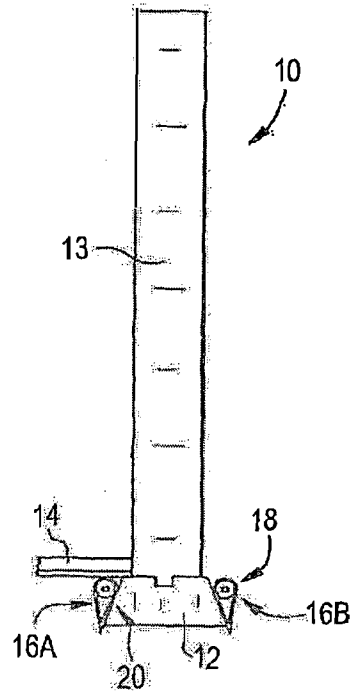
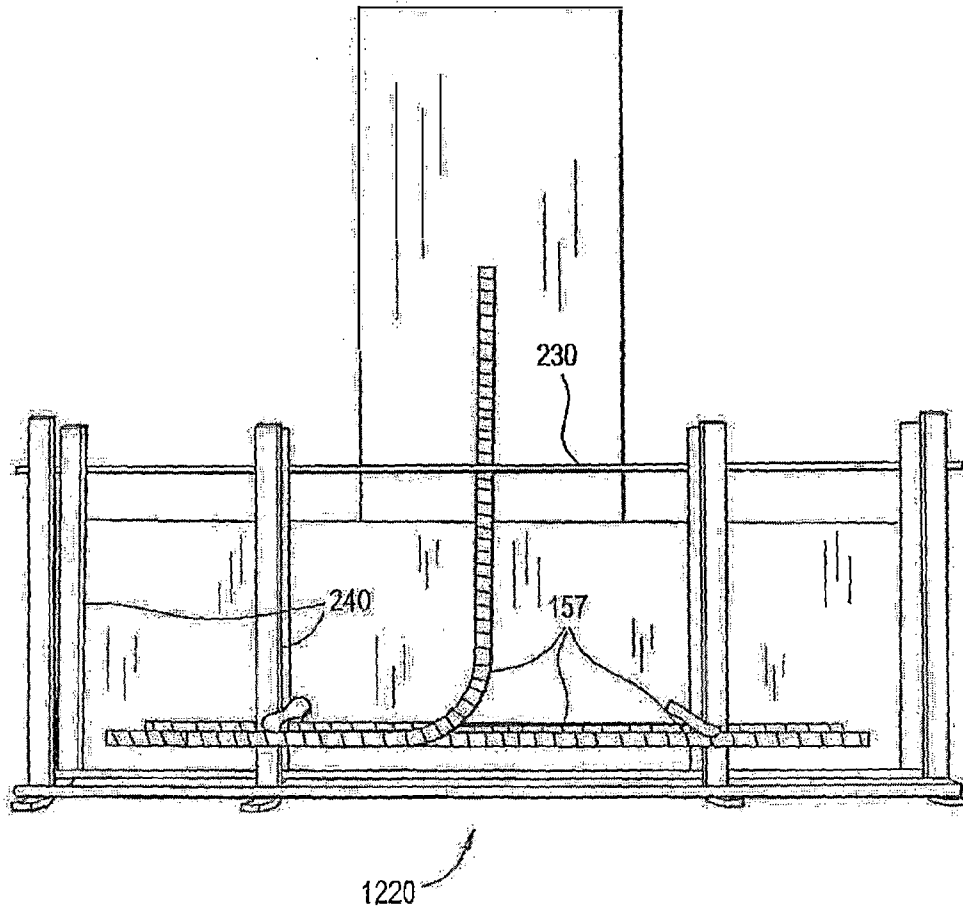


FIG. 21



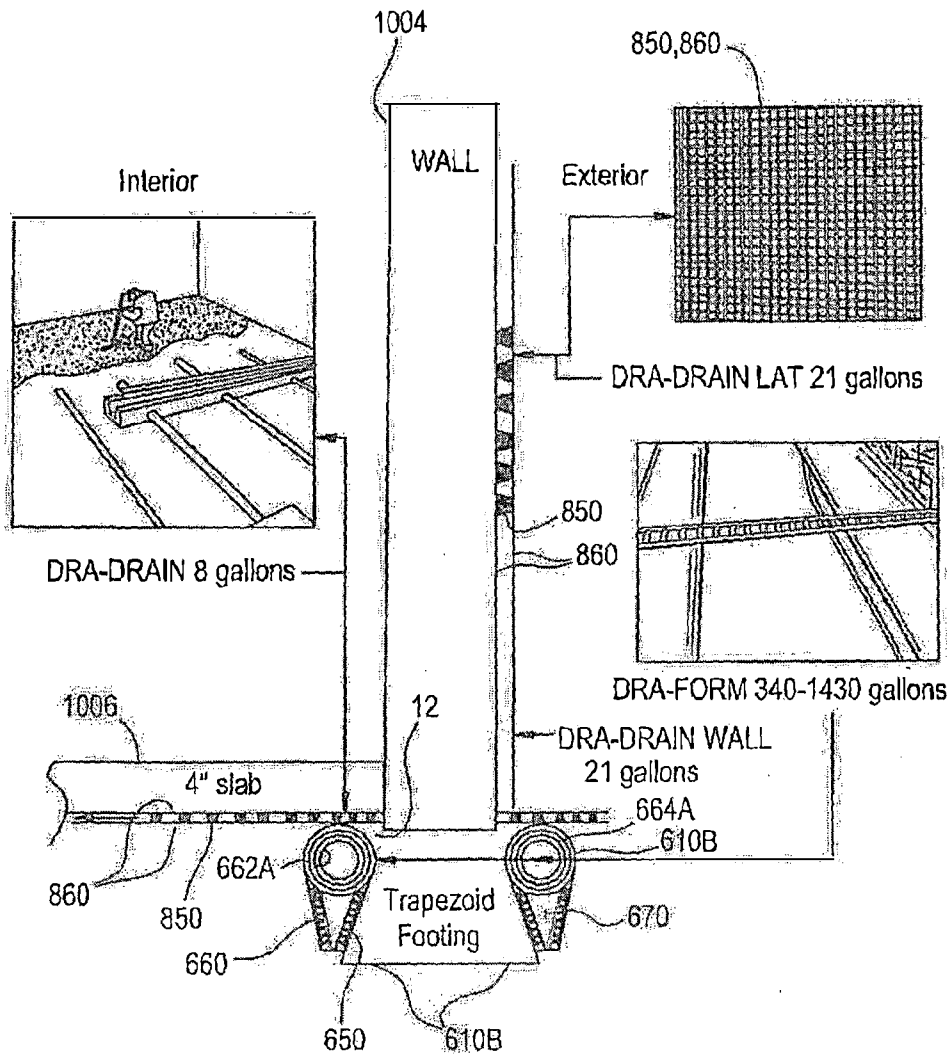
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FIG. 22



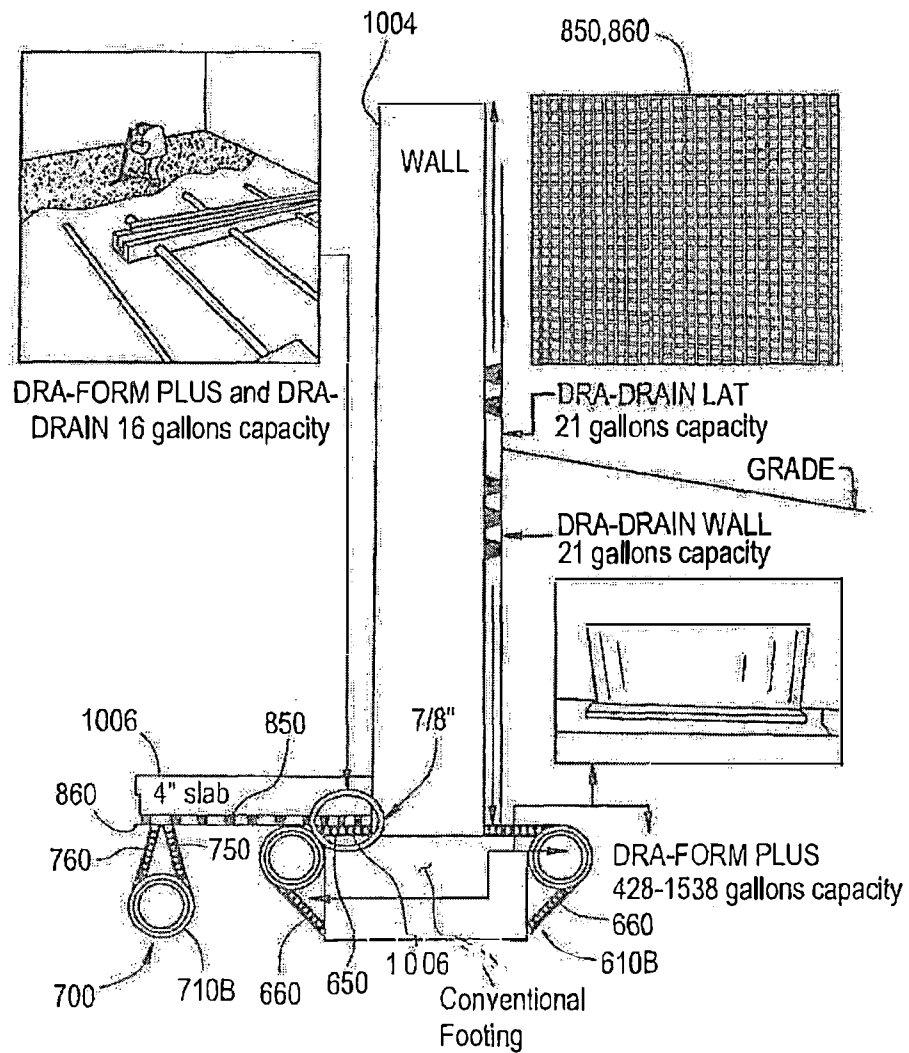
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FIG. 23A



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FIG. 23B



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FIG. 24A

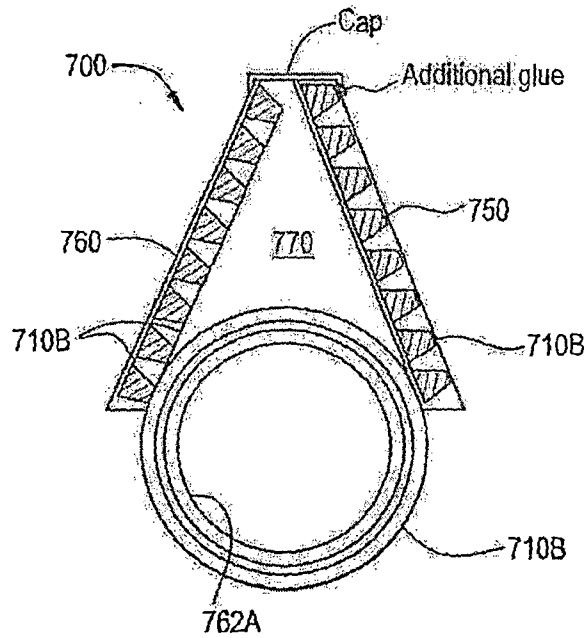
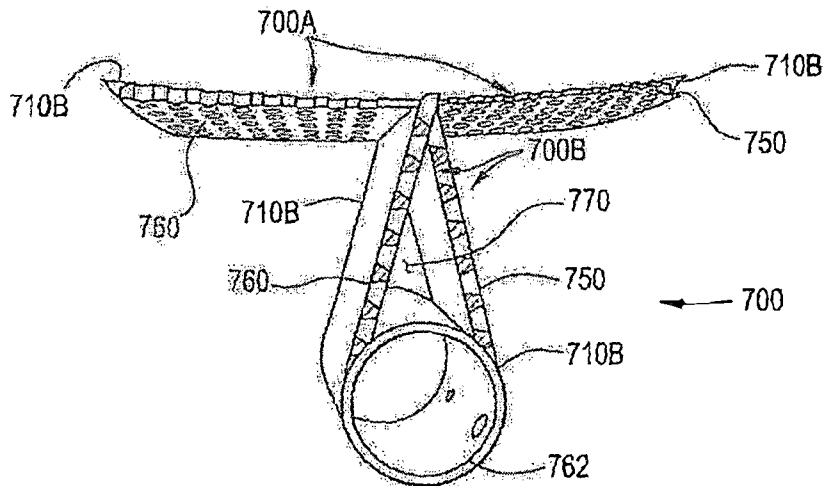


FIG. 24B



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FIG. 24C

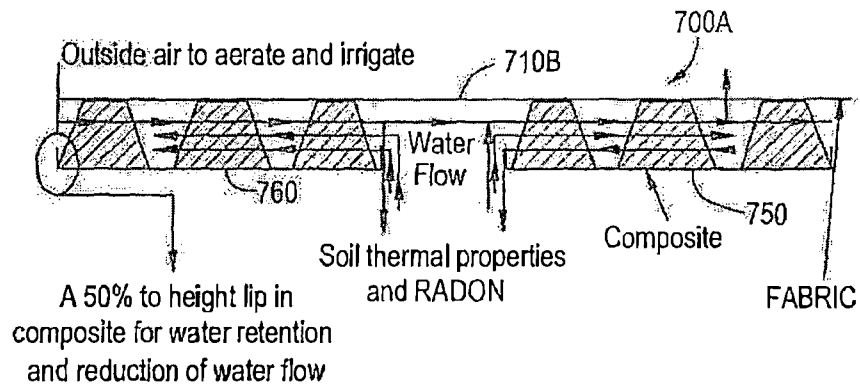
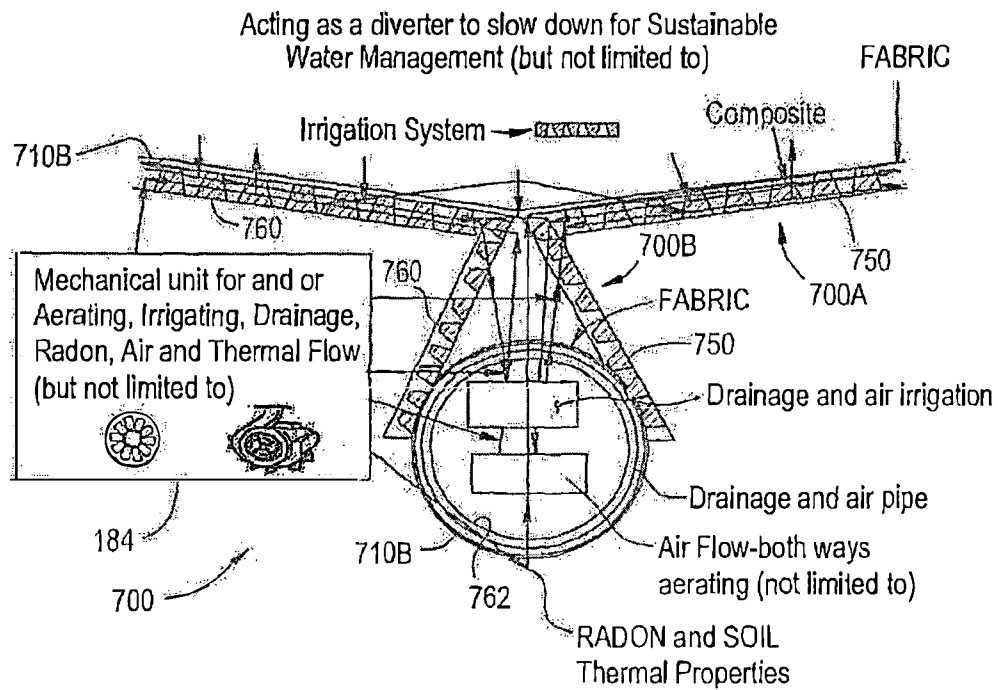


FIG. 24D

Agriculture, Golf Courses, Synthetic Fields (but not limited to)



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FIG. 25A

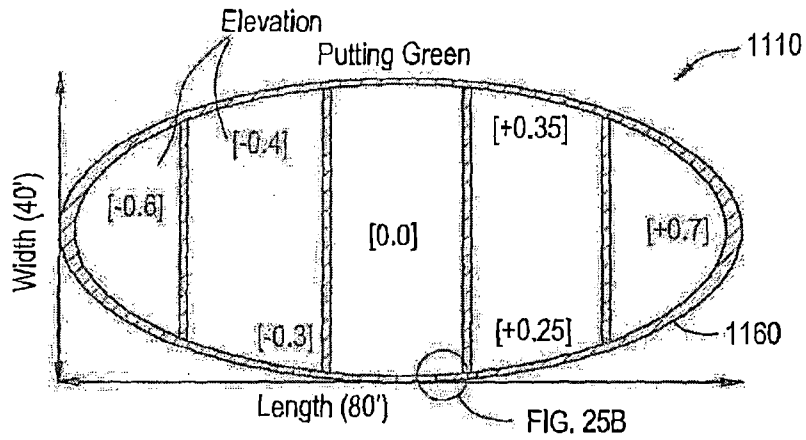
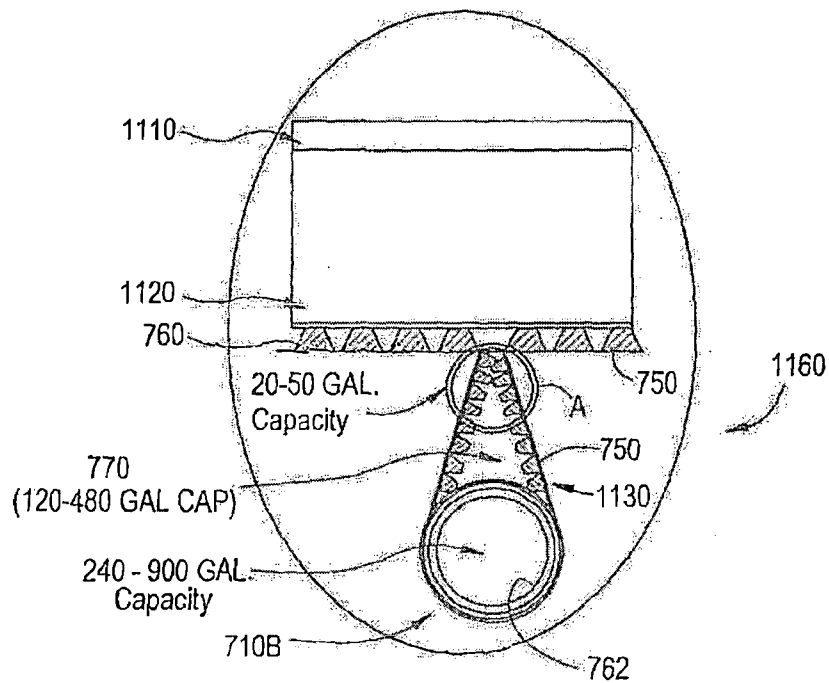


FIG. 25B



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FIG. 26A

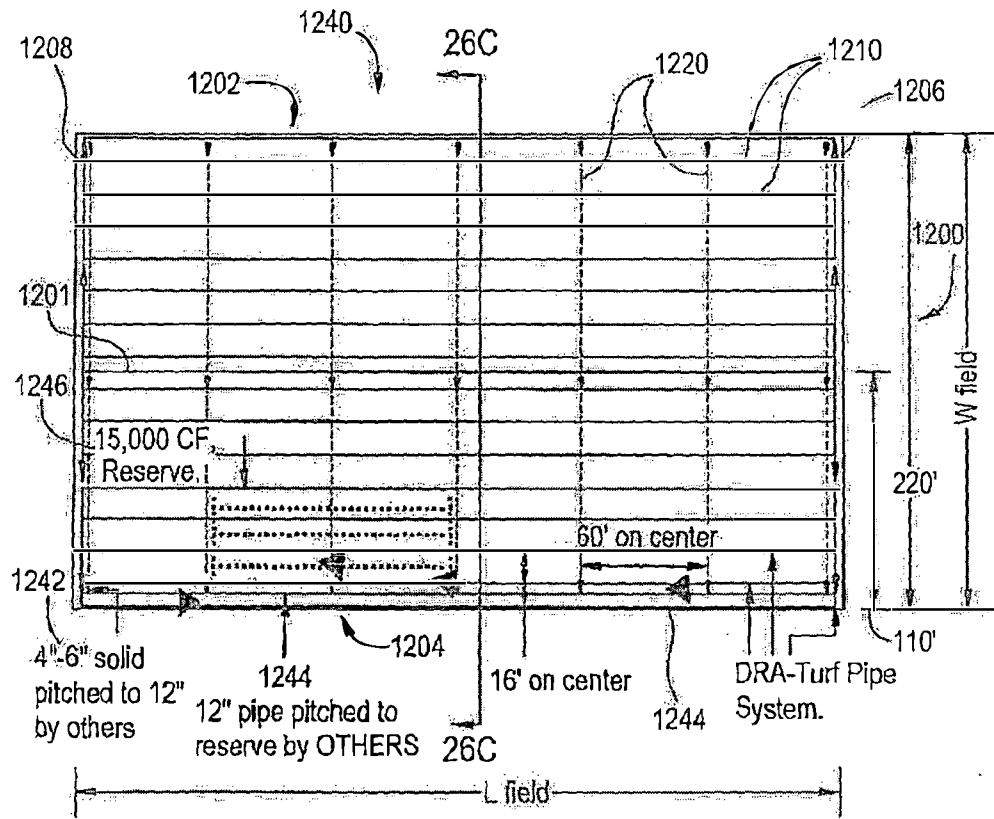
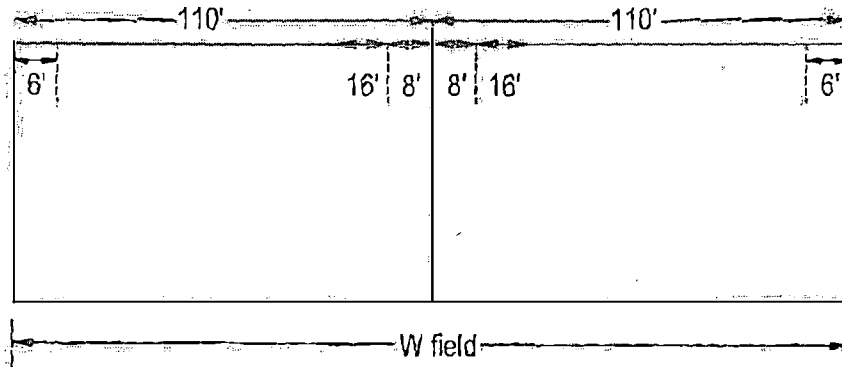


FIG. 26B

220' long - Centerline at 110', expansion starts at centerline.
Then 8' each way off center line
*approx 6' off both ends last expansion joint.



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FIG. 26C

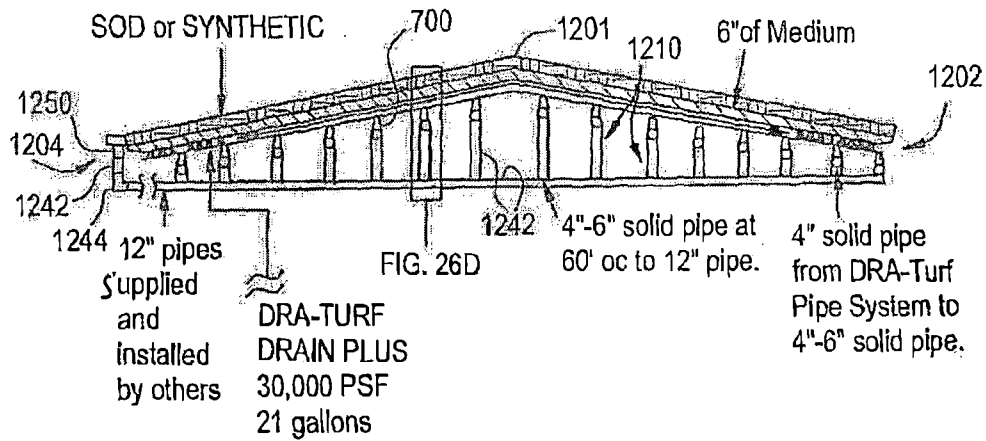
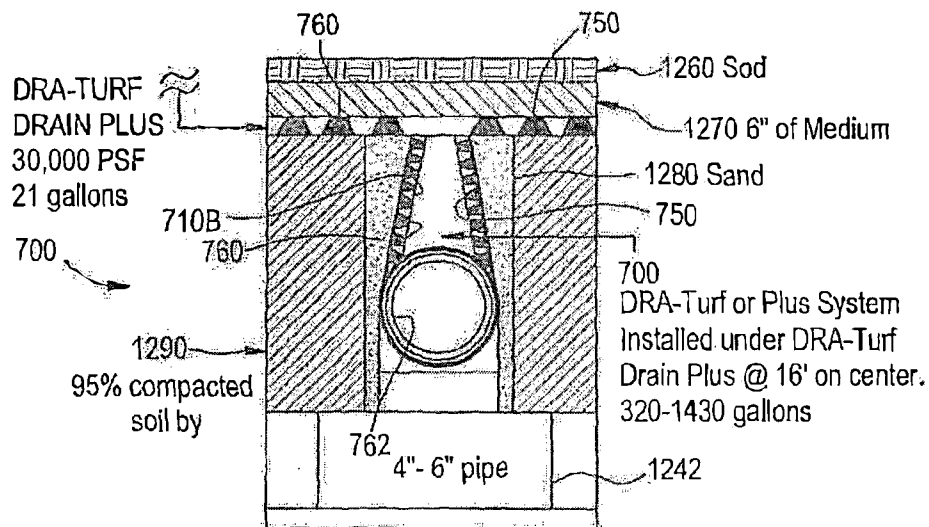


FIG. 26D



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FIG. 27A

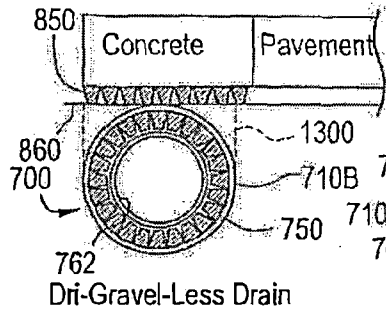


FIG. 27B

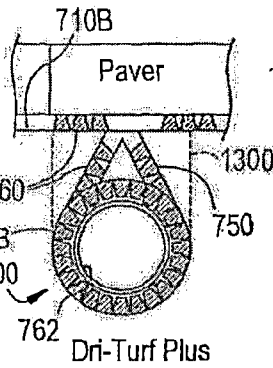


FIG. 27C

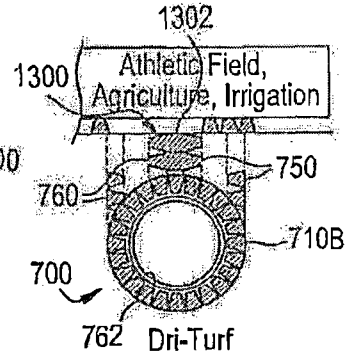


FIG. 28A

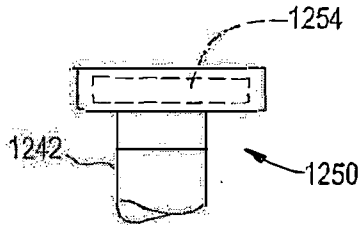


FIG. 28B

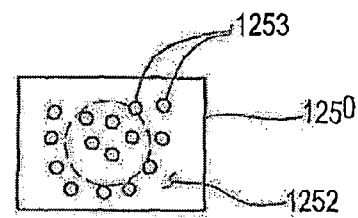


FIG. 29

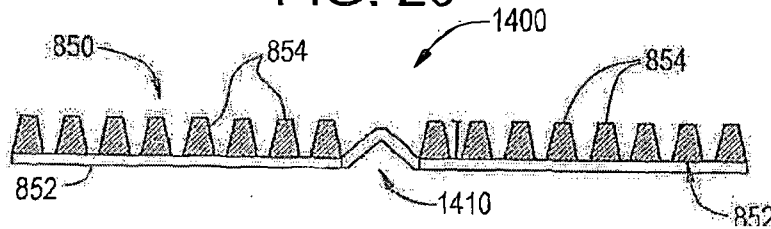
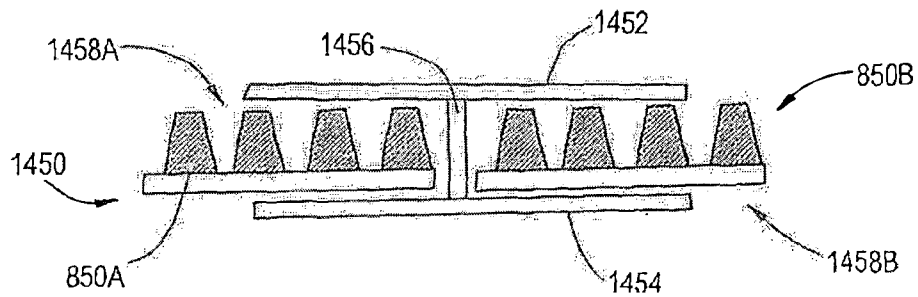
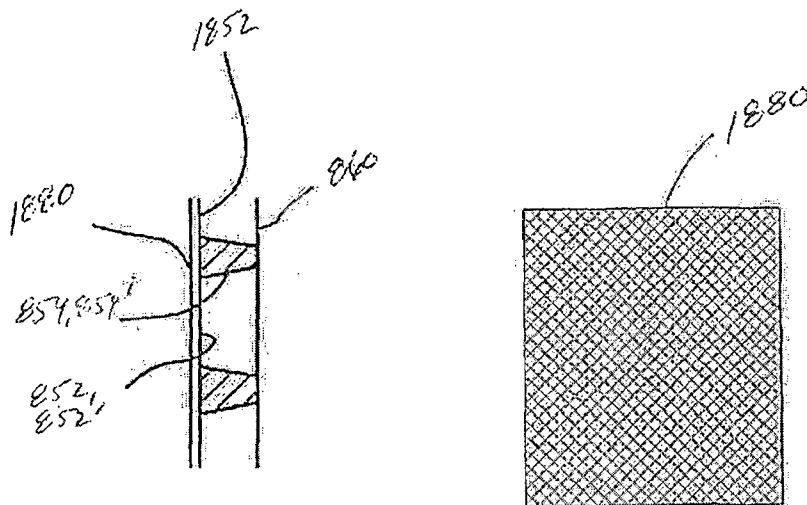
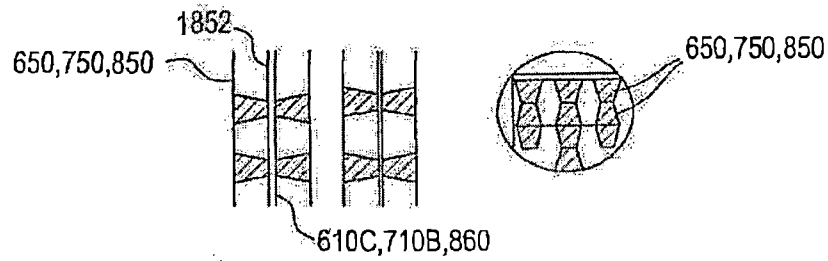
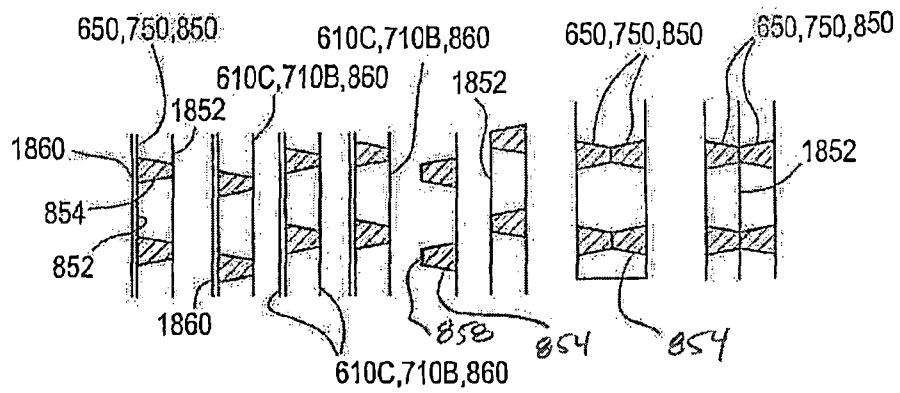


FIG. 30



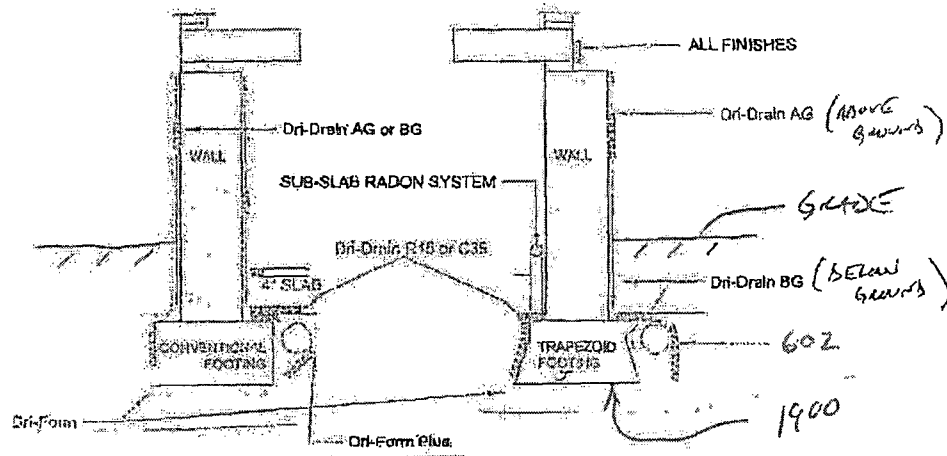
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FIG. 31



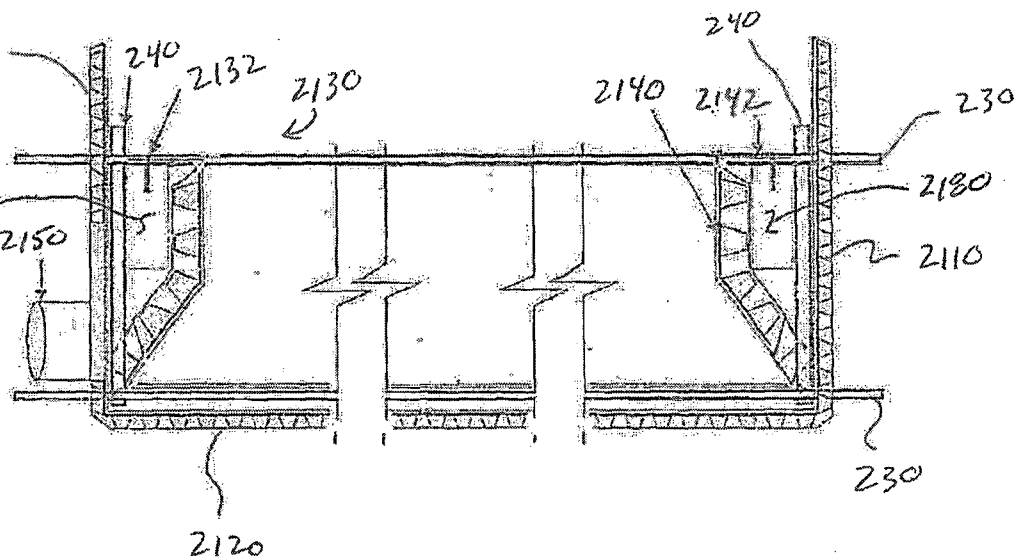
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Fig. 32

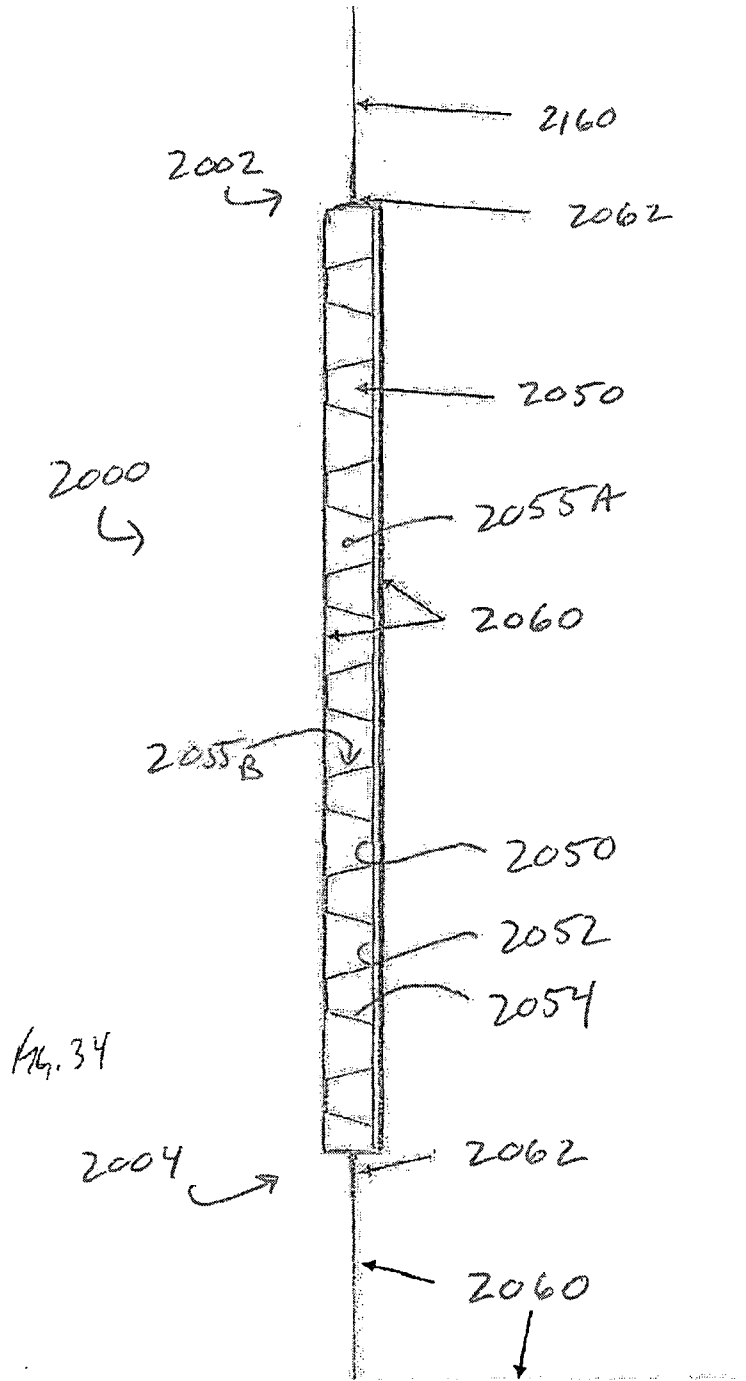


2100

Fig. 33



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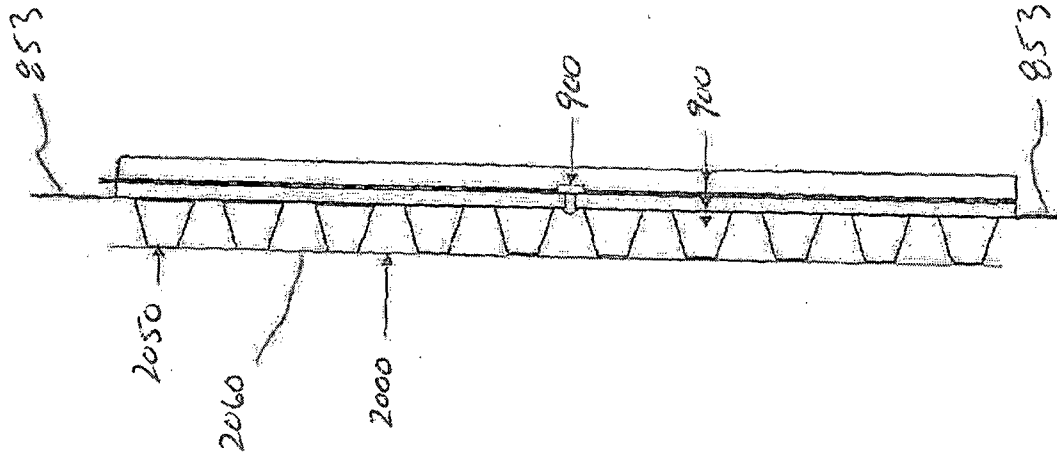
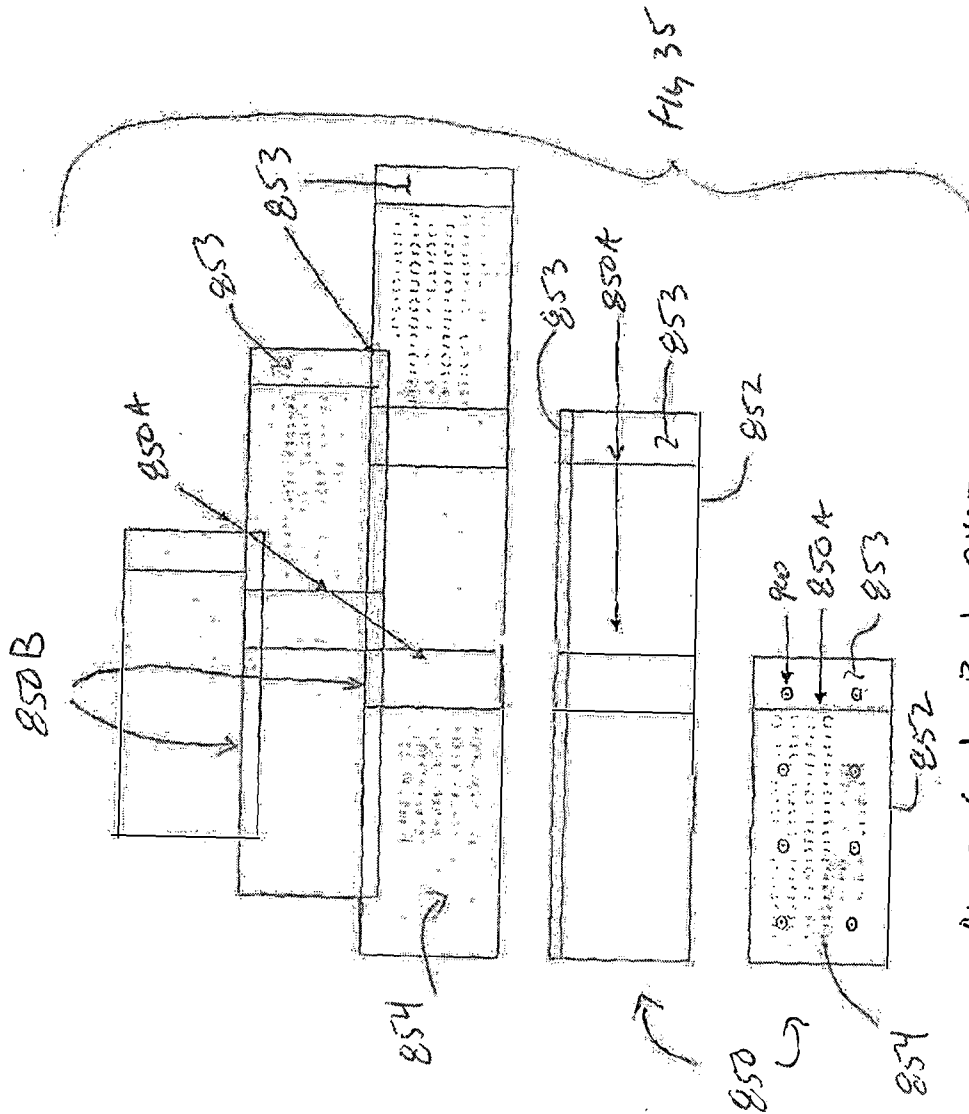
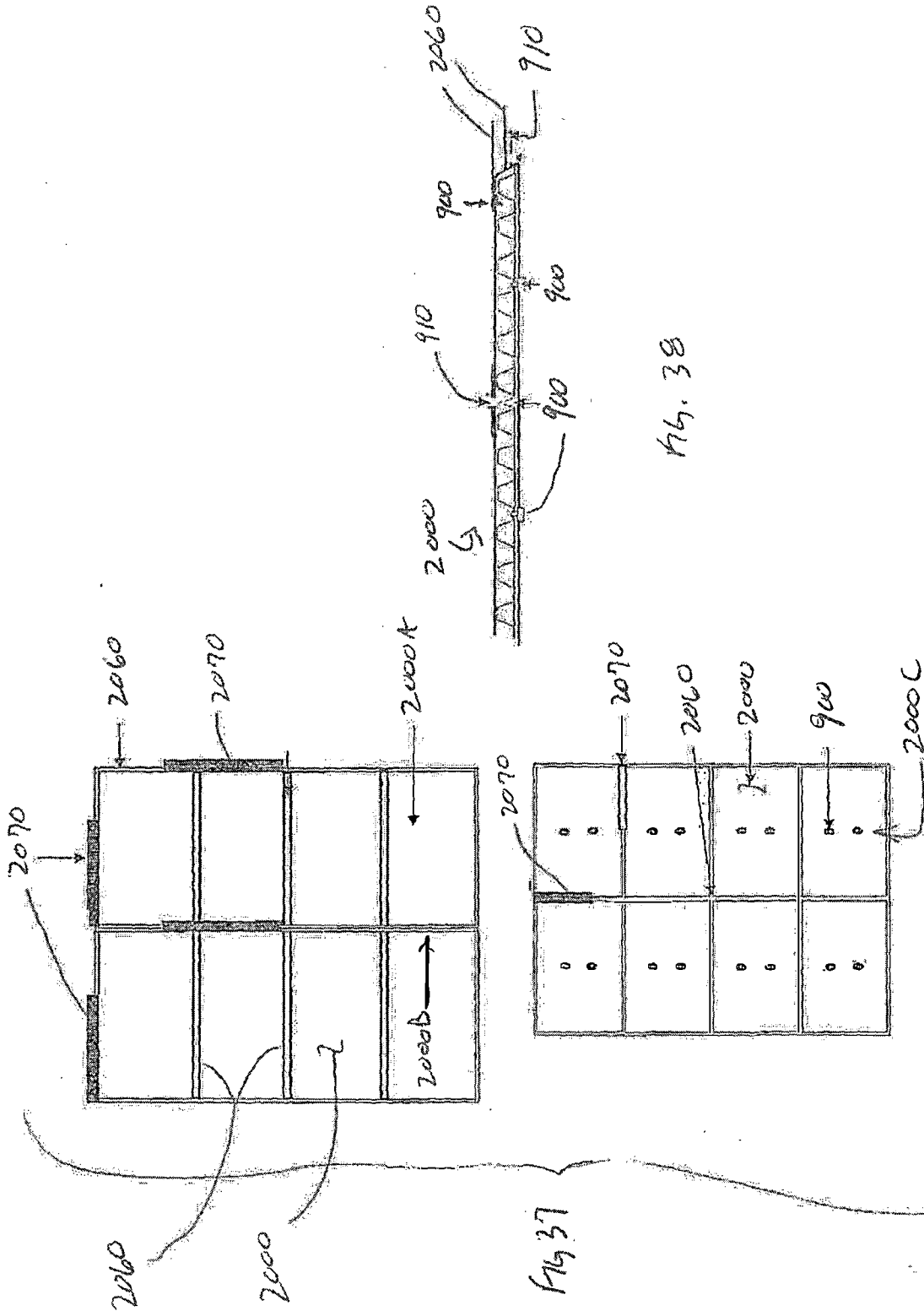


Fig. 36



ABOVE GRADE PANEL SYSTEM

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Dai-Turf System

Roll and Flow ~ Drain

Made 24" to fit block spacing

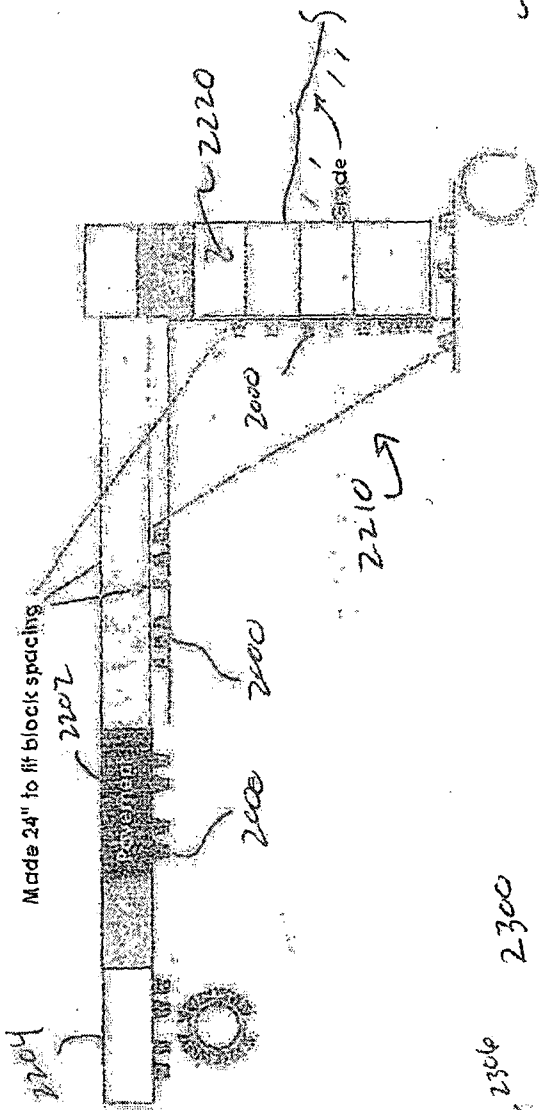


Fig. 39

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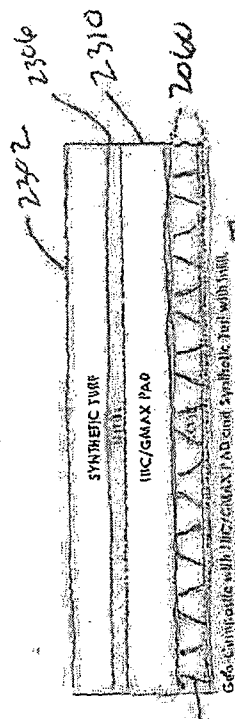


Fig. 40

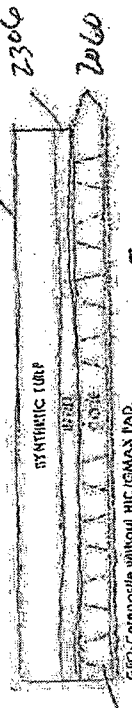


Fig. 41

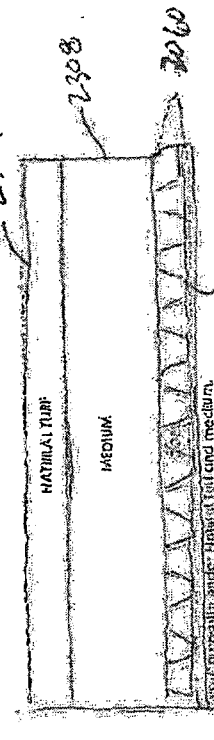


Fig. 42

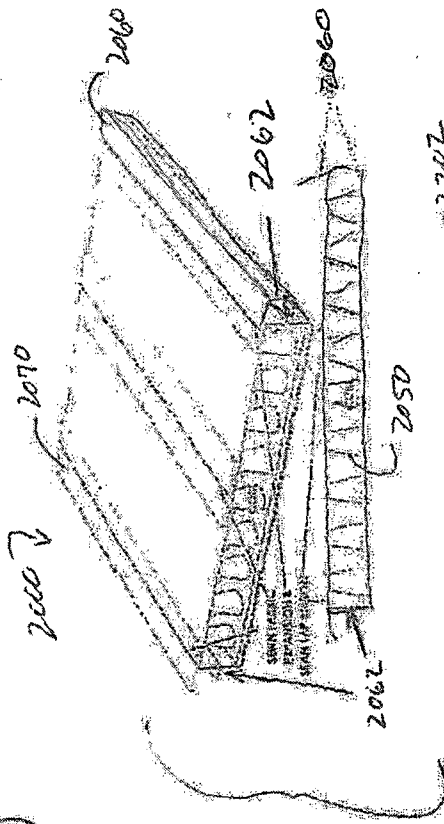


Fig. 43

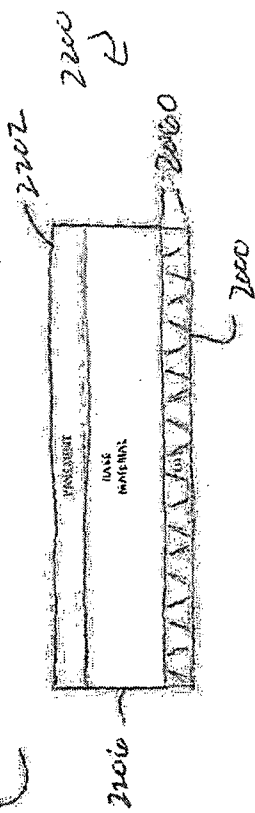
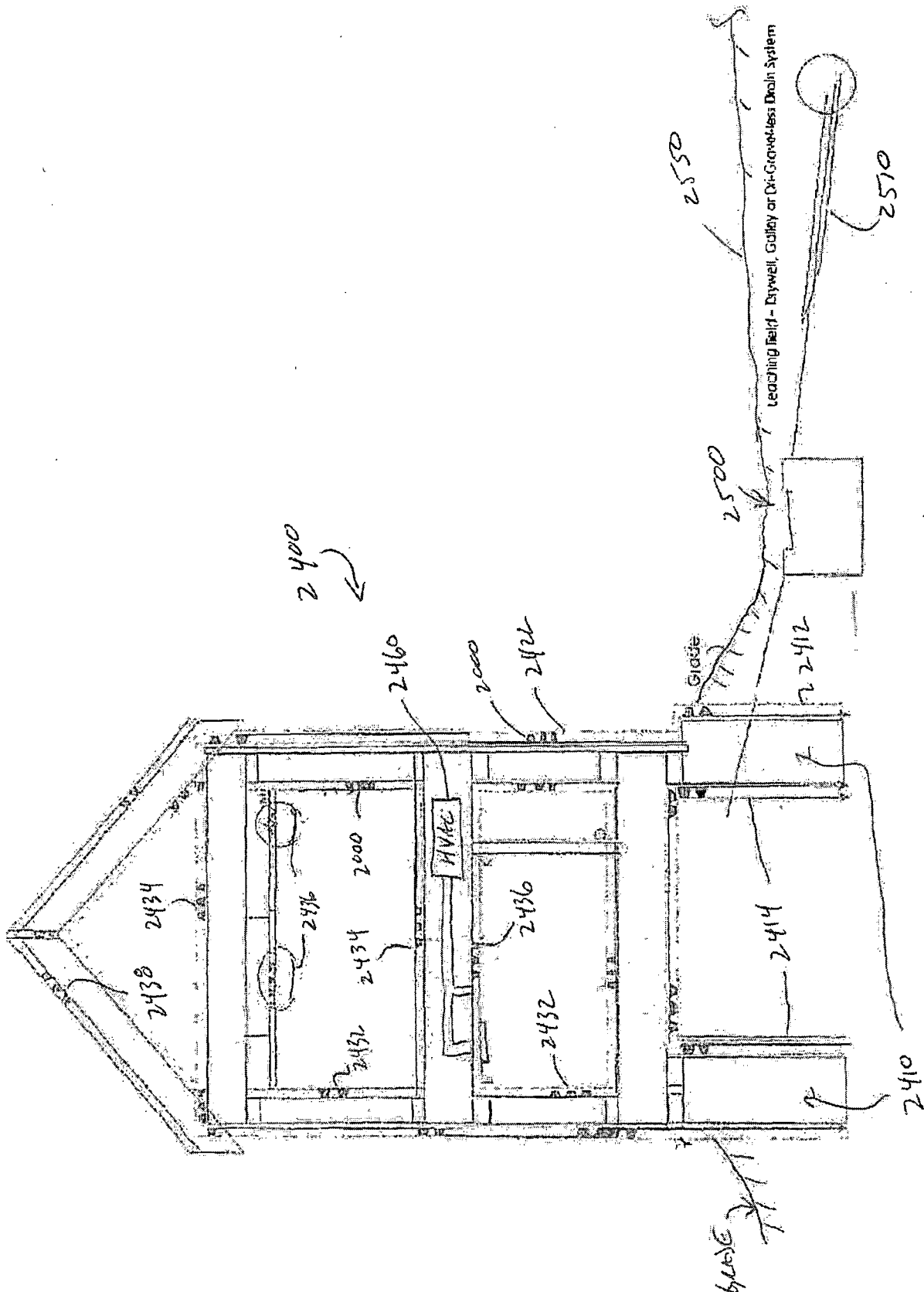
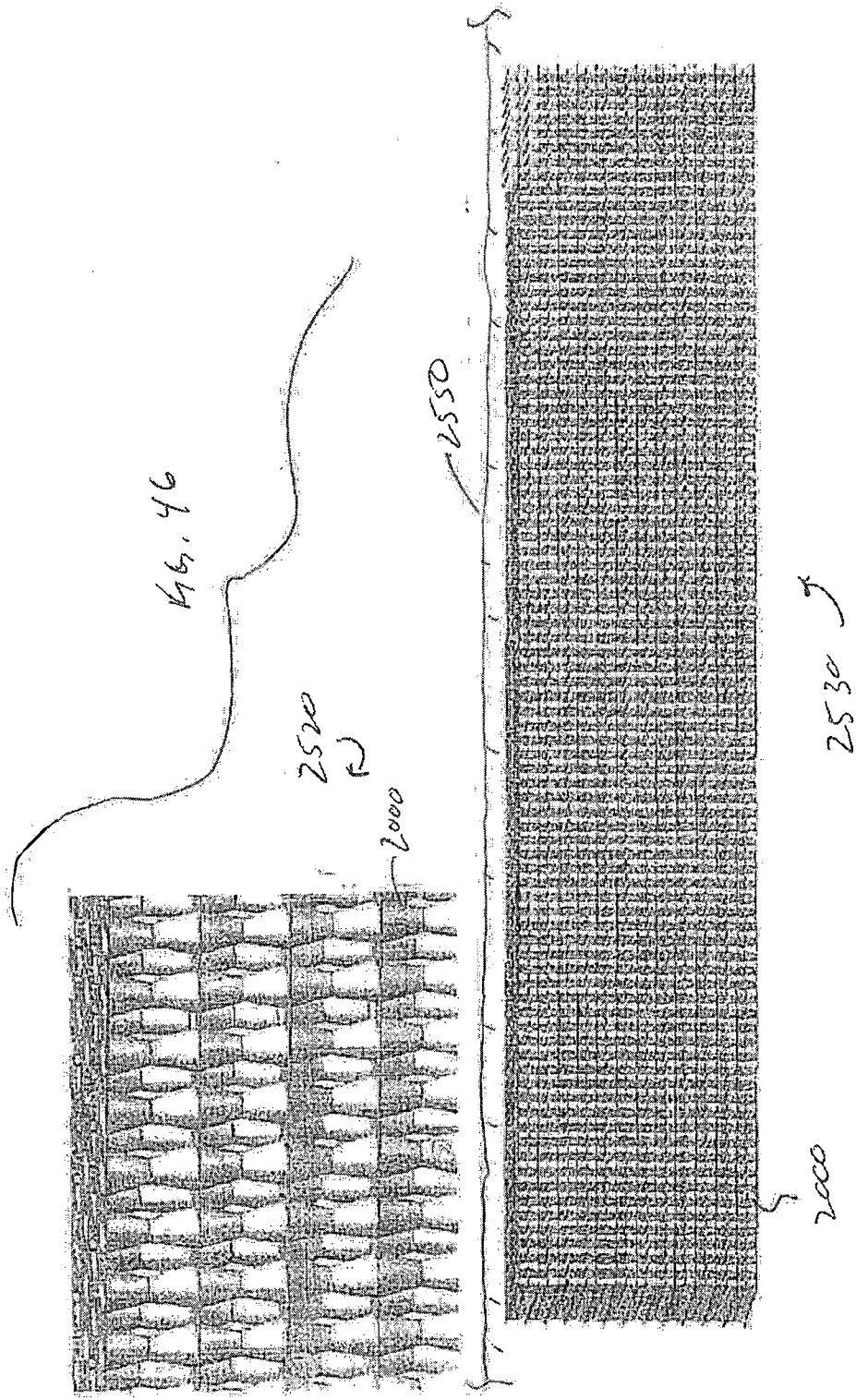


Fig. 44

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Test Configuration 1

2 inch (5.08 cm) Synthetic Turf
1 inch (2.54 cm) 50/50 SBR and Sand (SBR= styrene-butadiene rubber)
Core & Fabric Pad
Concrete Substrate

Dimples unfilled

Test Configuration 1	Drainage Core and Fabric Configuration -- 8 mm					
	Theoretical		Theoretical			
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	3.02	14.25	3.16	157	640
	Drop 2	3.02	14.34	3.20	172	737
	Drop 3	3.02	14.37	3.21	169	713
	Mean Results			3.19	166	697

Test Configuration 1	Drainage Core and Fabric Configuration -- 10 mm					
	Theoretical		Theoretical			
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	3.02	14.32	3.19	147	581
	Drop 2	3.02	14.37	3.21	158	652
	Drop 3	3.02	14.17	3.12	168	810
	Mean Results			3.17	158	681

Test Configuration 1	Drainage Core and Fabric Configuration -- 12 mm					
	Theoretical		Theoretical			
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	4.01	16.18	4.07	154	738
	Drop 2	4.01	16.21	4.08	181	919
	Drop 3	4.01	16.25	4.10	187	965
	Mean Results			4.08	174	874

FIG. 47A

Test Configuration 2

2 inch (5.08 cm) Synthetic Turf
 1 inch (2.54 cm) 50/50 SBR and Sand (SBR= styrene-butadiene rubber)
 Core & Fabric Pad
 2 inch (5.08 cm) Compacted Soil Substrate **Dimples unfilled**

Drainage Core and Fabric Configuration -- 8 mm Theoretical						
Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result	
Drop 1	6.00	19.63	5.99	145	775	
Drop 2	6.00	19.65	6.00	151	830	
Drop3	6.00	19.68	6.02	162	916	
Mean Results			6.00	153	840	

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Drainage Core and Fabric Configuration -- 10 mm Theoretical						
Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result	
Drop 1	6.01	19.72	6.04	147	831	
Drop 2	6.01	19.79	6.09	157	900	
Drop3	6.01	19.84	6.12	156	888	
Mean Results			6.08	153	873	

Drainage Core and Fabric Configuration -- 12 mm Theoretical						
Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Impact Height (ft)	Gmax Result	HIC Result	
Drop 1	6.01	19.74	6.06	147	803	
Drop 2	6.01	19.79	6.09	155	869	
Drop3	6.01	19.82	6.11	158	892	
Mean Results			6.09	153	855	

FIG. 47B

Test Configuration 1

2 inch (5.08 cm) Synthetic Turf
1 inch (2.54 cm) Sand
Core & Fabric Pad
Concrete Substrate

Dimples filled with mixture of adhesive and crumb rubber

Drainage Core and Fabric Configuration -- 8 mm						
Test Configuration 1	Test Iteration		Theoretical			
	Drop Height	Impact Velocity	Impact Height	Gmax Result	HIC Result	
	(ft)	(ft/s)	(ft)			
	Drop 1	14.05	3.07	182	713	
	Drop 2	14.02	3.06	182	735	
Drop3	14.09	3.09		181	717	
Mean Results			3.07	182	722	

Drainage Core and Fabric Configuration -- 10 mm						
Test Configuration 1	Test Iteration		Theoretical			
	Drop Height	Impact Velocity	Impact Height	Gmax Result	HIC Result	
	(ft)	(ft/s)	(ft)			
	Drop 1	14.02	3.06	182	764	
	Drop 2	13.98	3.04	180	729	
Drop3	14.01	3.05		180	719	
Mean Results			3.05	181	737	

Drainage Core and Fabric Configuration -- 12 mm						
Test Configuration 1	Test Iteration		Theoretical			
	Drop Height	Impact Velocity	Impact Height	Gmax Result	HIC Result	
	(ft)	(ft/s)	(ft)			
	Drop 1	16.08	4.02	194	928	
	Drop 2	16.05	4.00	199	979	
Drop3	16.09	4.02		193	917	
Mean Results			4.01	195	941	

FIG. 48A

Test Configuration 2 2 inch (5.08 cm) Synthetic Turf
 1 inch (2.54 cm) Sand
 Core & Fabric Pad
 2 inch (5.08 cm) Compacted Soil Substrate

Dimples filled with mixture of adhesive and crumb rubber

Drainage Core and Fabric Configuration -- 8 mm						
Test Configuration 2	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	7.04	21.24	7.01	152	835
	Drop 2	7.00	21.26	7.02	165	952
	Drop 3	7.00	21.23	7.01	170	982
	Mean Results			7.01	162	923

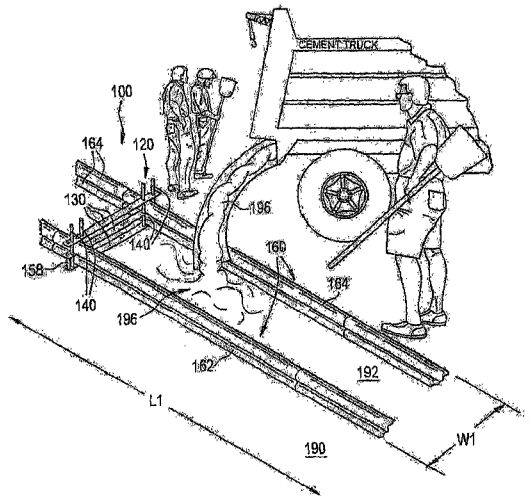
Drainage Core and Fabric Configuration -- 10 mm						
Test Configuration 2	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	7.04	21.27	7.03	165	878
	Drop 2	7.08	21.31	7.06	169	915
	Drop 3	7.09	21.38	7.10	175	982
	Mean Results			7.06	170	925

Drainage Core and Fabric Configuration -- 12 mm						
Test Configuration 2	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	7.00	21.32	7.06	155	853
	Drop 2	7.11	21.39	7.11	159	928
	Drop 3	7.12	21.34	7.08	162	957
	Mean Results			7.08	159	913

FIG. 48B

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A



B

