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

(71) Applicant: **DRFF, LLC**, Shelton, CT (US)

(72) Inventor: **Charles Moyher**, Cheshire, CT (US)

(73) Assignee: **DRFF, LLC**, Shelton, CT (US)

(21) Appl. No.: **18/787,487**

(22) Filed: **Jul. 29, 2024**

Related U.S. Application Data

(63) Continuation of application No. 17/697,332, filed on Mar. 17, 2022, now abandoned, which is a continuation-in-part of application No. 17/133,748, filed on Dec. 24, 2020, now Pat. No. 11,668,066, which is a continuation of application No. 16/793,458, filed on Feb. 18, 2020, now abandoned, which is a continuation of application No. PCT/US2018/000367, filed on Aug. 20, 2018, which is a continuation of application No. 15/971,247, filed on May 4, 2018, now Pat. No. 11,008,750.

(60) Provisional application No. 63/162,765, filed on Mar. 18, 2021, provisional application No. 63/275,648, filed on Nov. 4, 2021, provisional application No. 62/547,441, filed on Aug. 18, 2017.

Publication Classification

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E02D 27/01 (2006.01)

(52) **U.S. Cl.**
CPC ***E02D 31/02*** (2013.01); ***E02D 27/01*** (2013.01)

(57) **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.

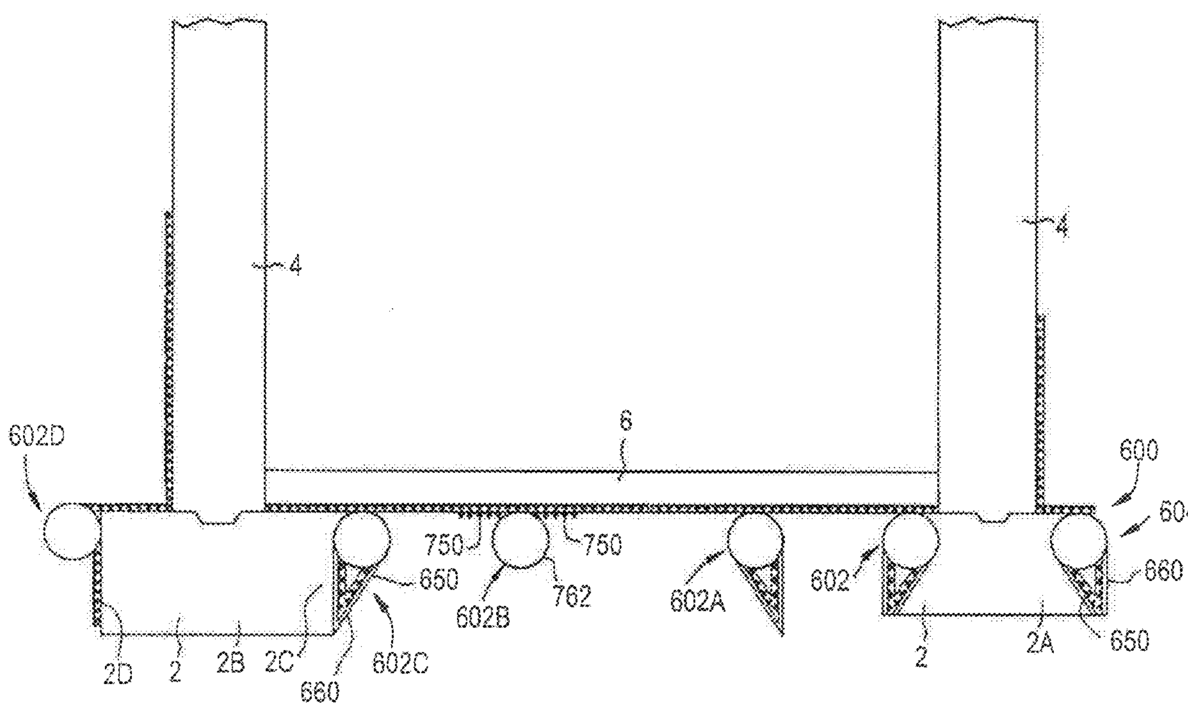


FIG. 1A

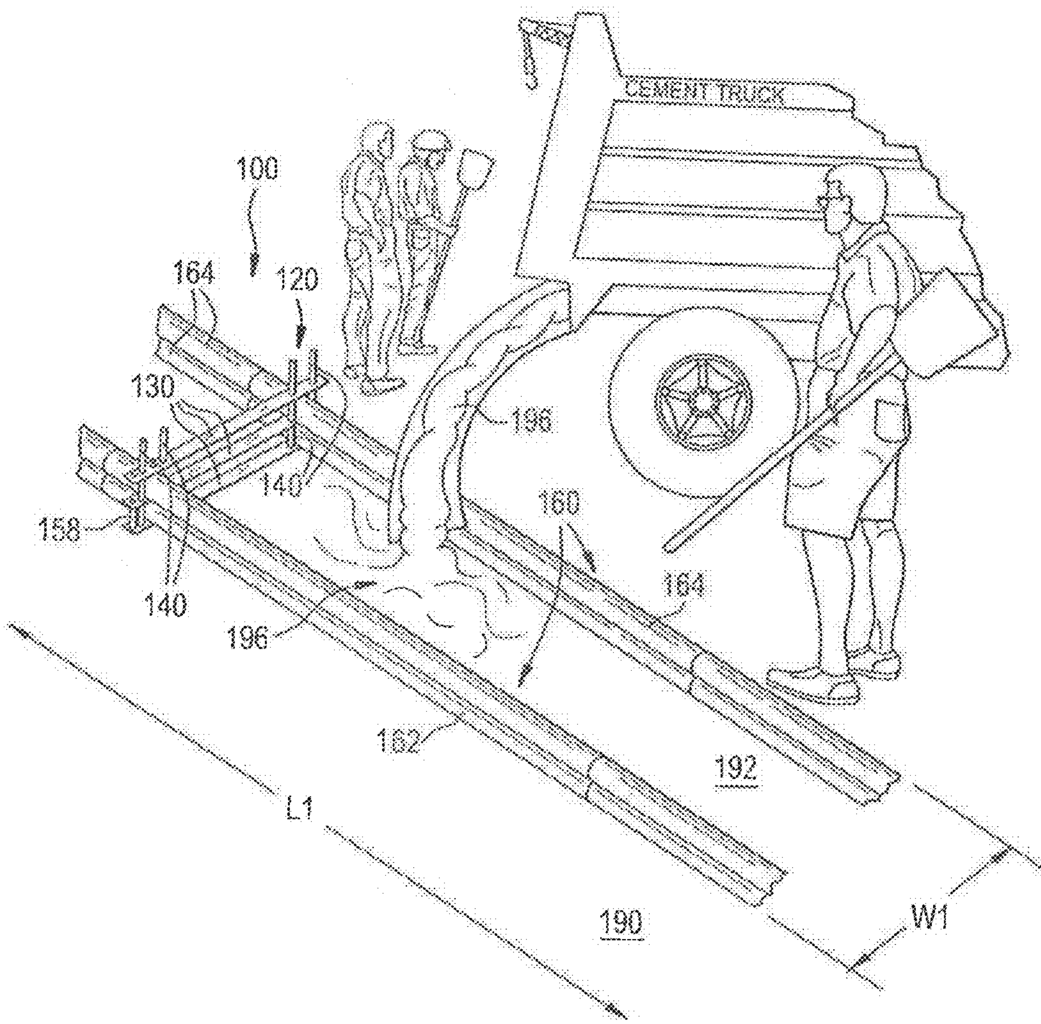

CEMENT TRUCK
100
164
120
130
196
140
160
158
140
196
164
162
192
L1
W1
190

FIG. 1B

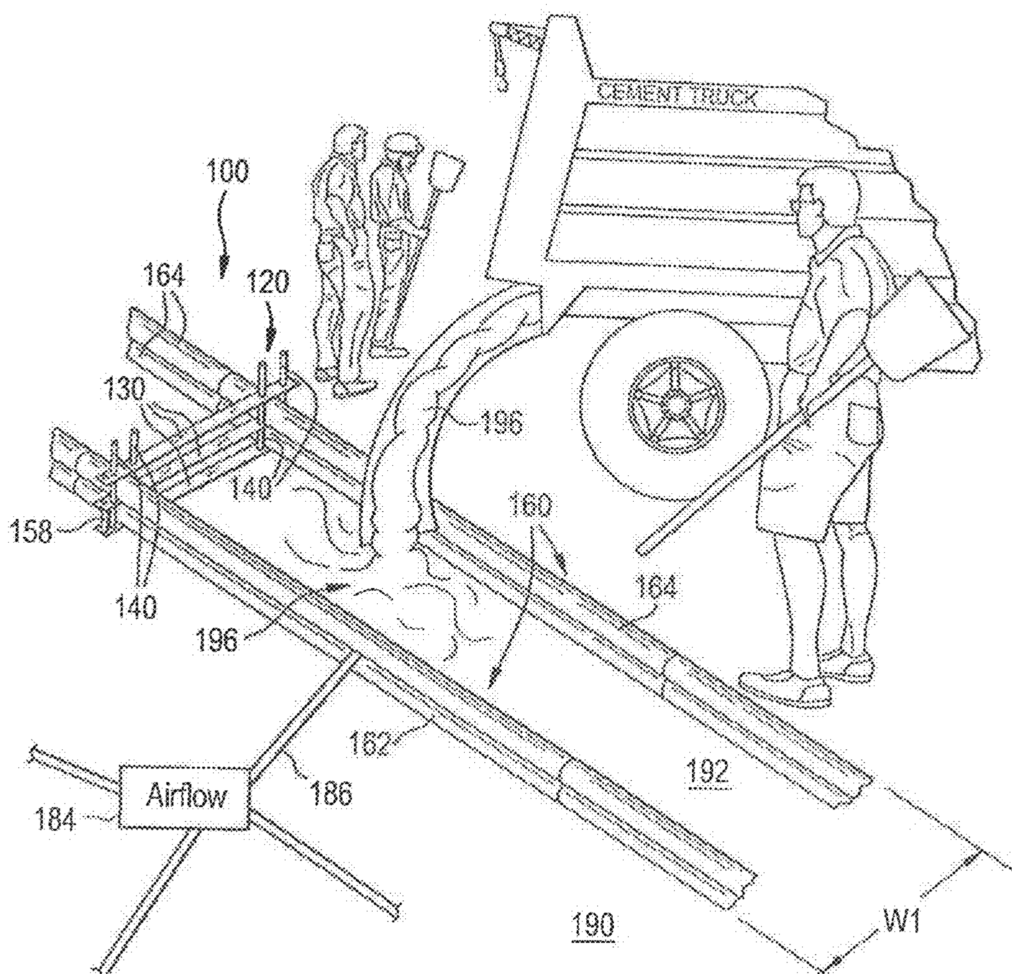
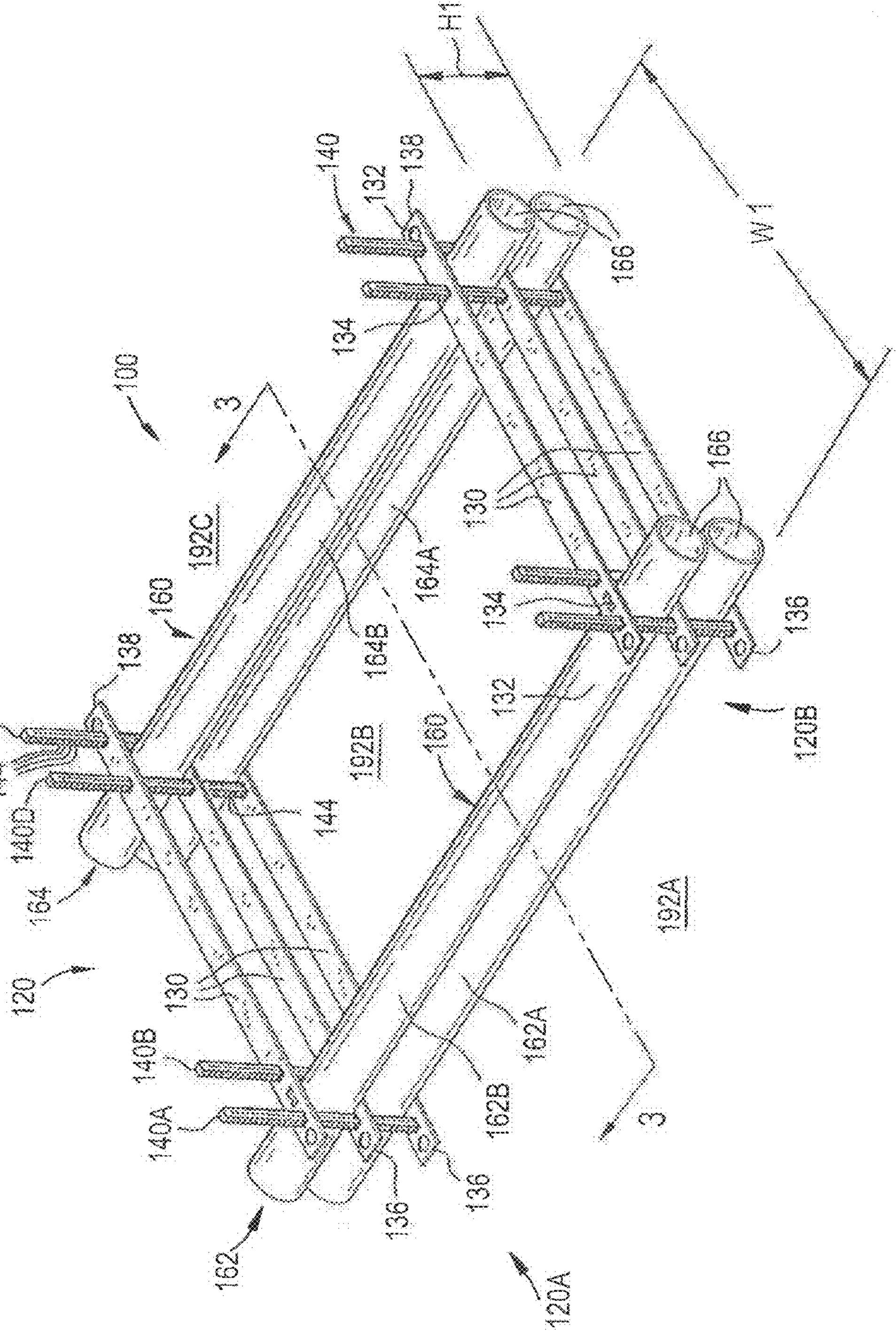

CEMENT TRUCK
100
164
120
130
196
140
160
158
164
140
196
162
192
Airflow
186
184
W1
190

FIG. 2


100
120
120A
120B
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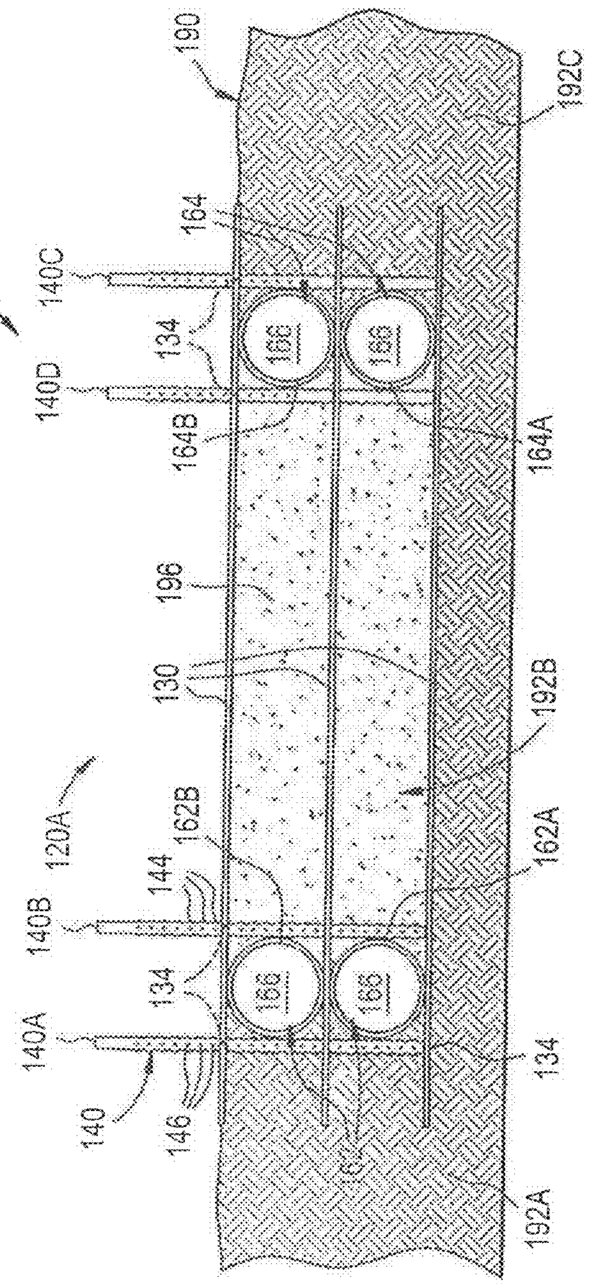
132
134
136
138
140
140A
140B
140C
140D
144
160
162
162A
162B
164
164A
164B
166
192A
192B
192C
3
H1
W1

FIG. 3


190
192C
192
164
140C
134
166
166
140D
164B
164A
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130
192B
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162B
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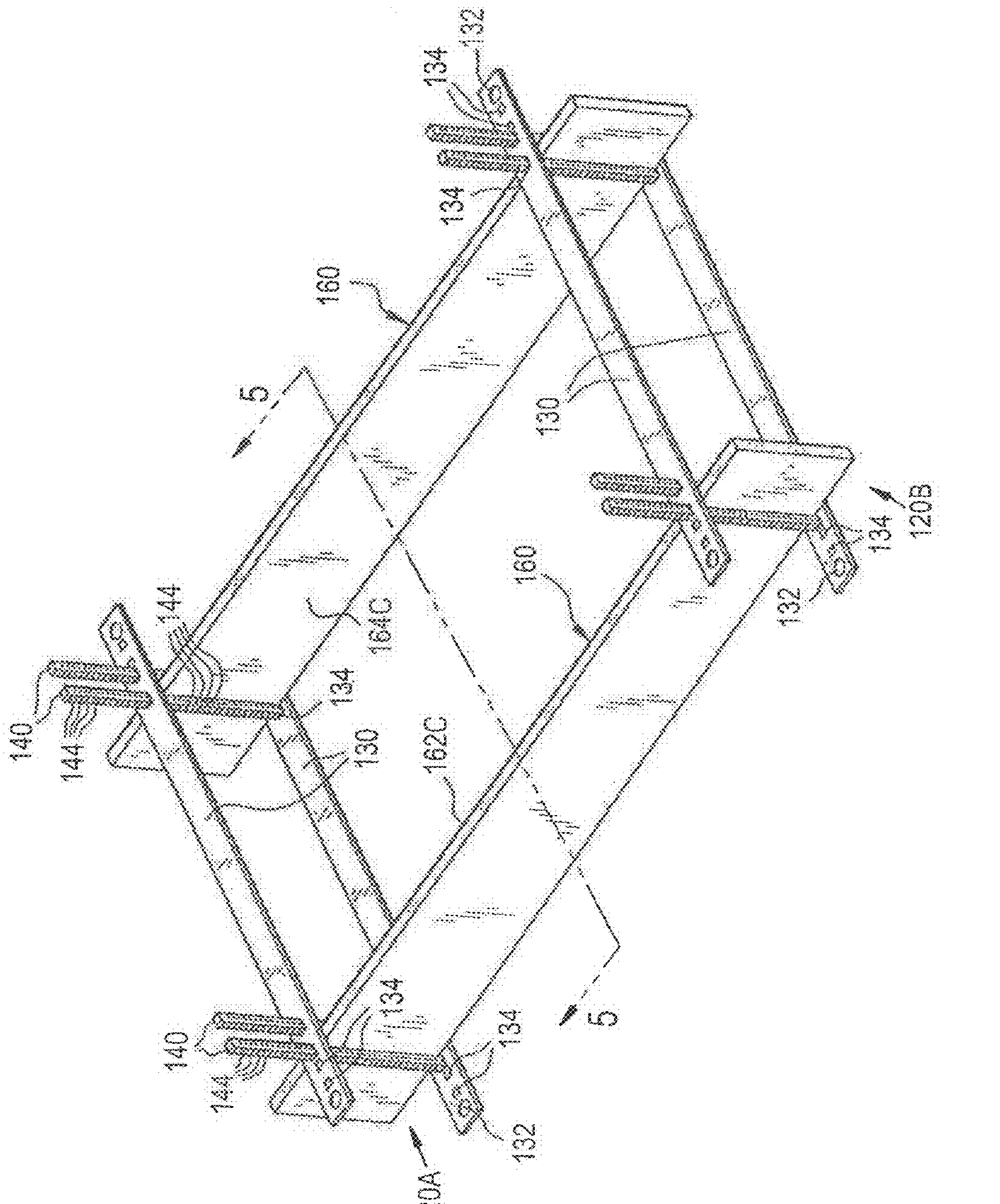
140B
162A
134
166
165
140A
134
140
146
192A

FIG. 4


132
134
134
160
5
130
144
164C
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120B
132
140
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130
162C
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134
134
140
144
5
132
120A

FIG. 5

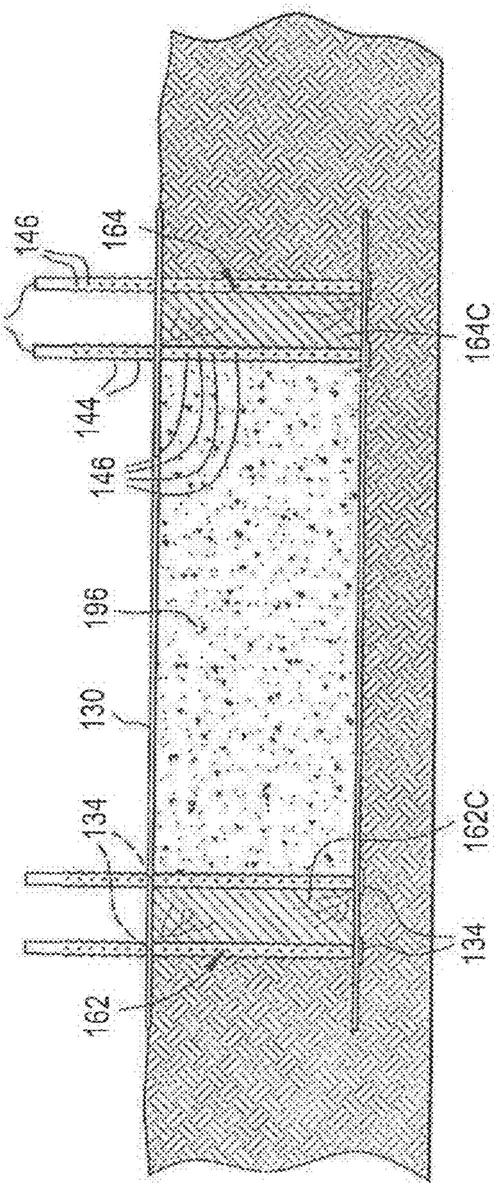
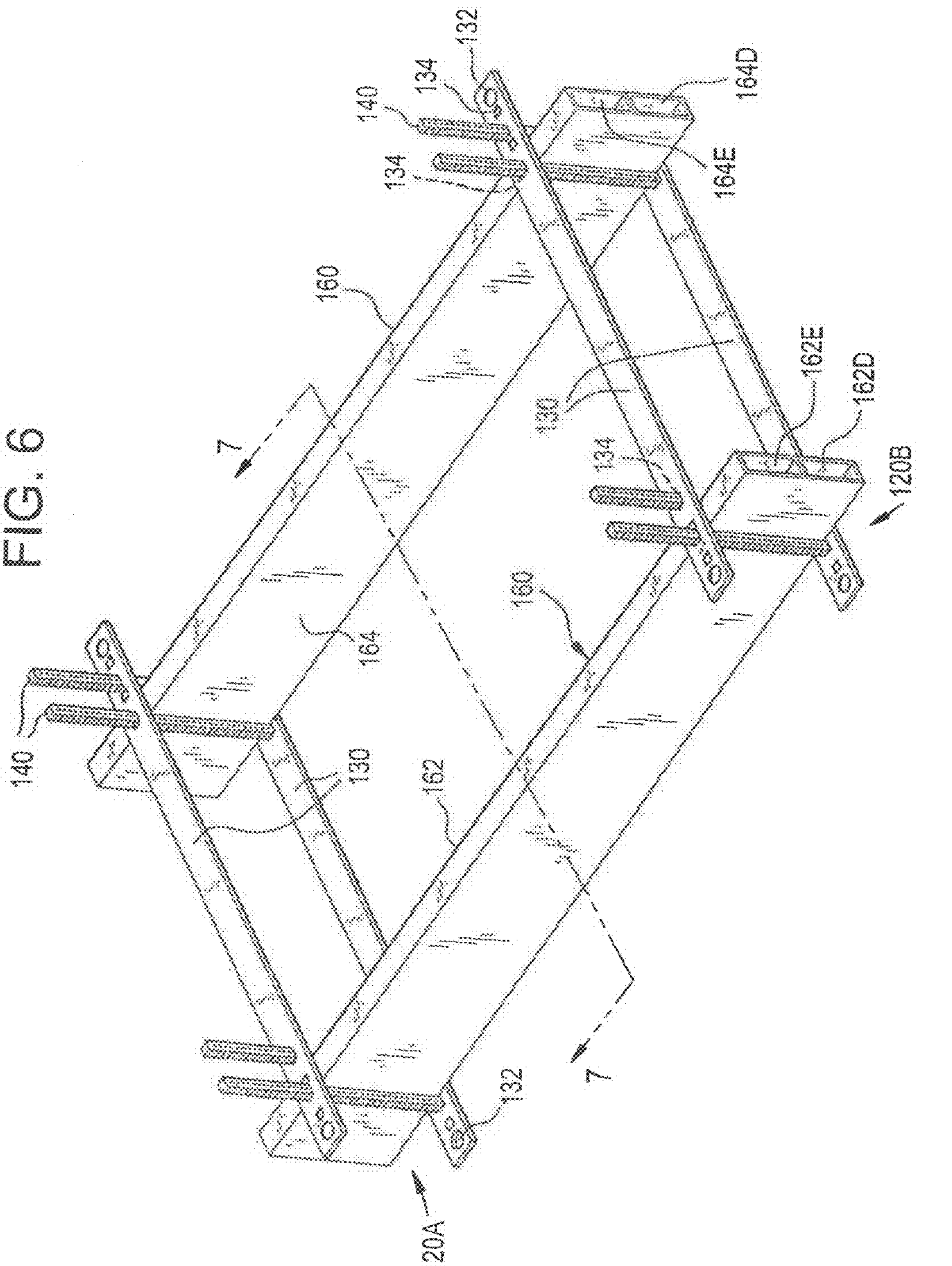


FIG. 6


132
134
140
134
164D
164E
160
7
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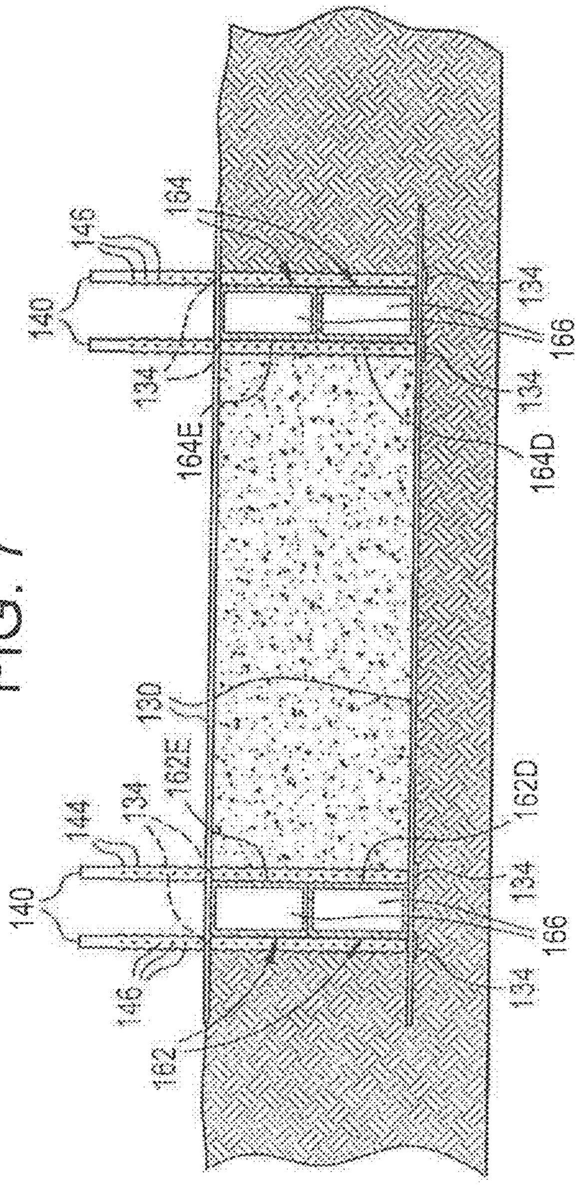
162E
162D
134
120B
164
160
140
130
162
7
132
120A

FIG. 7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164E
164D
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162E
134
144
140
146
162
162D
134
166
134

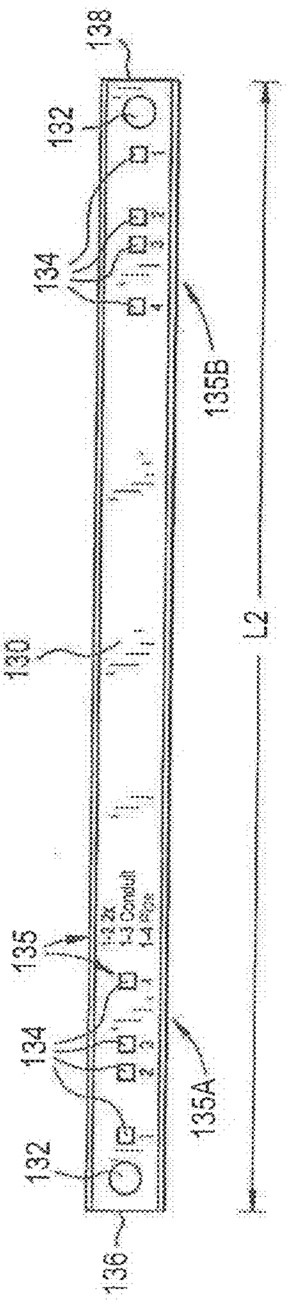

138
132
134
135B
130
L2
135
134
132
135A
136

FIG. 8A

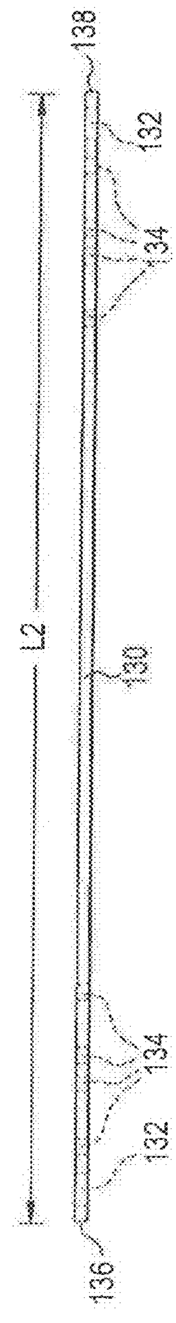

138
132
134
L2
130
134
132
136

FIG. 8B

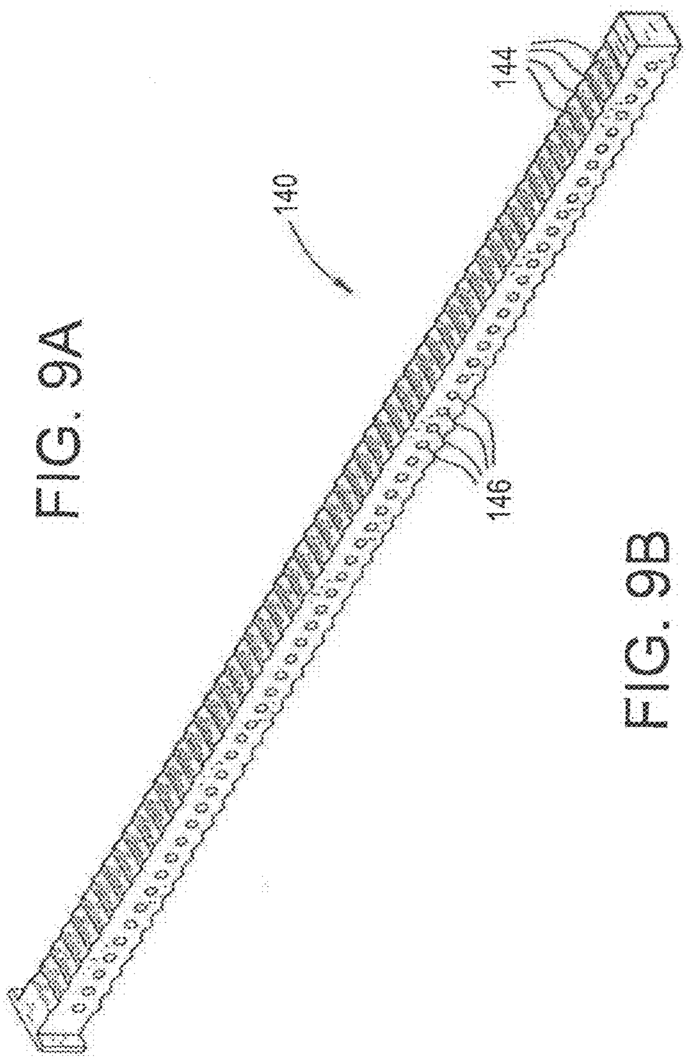


FIG. 9A

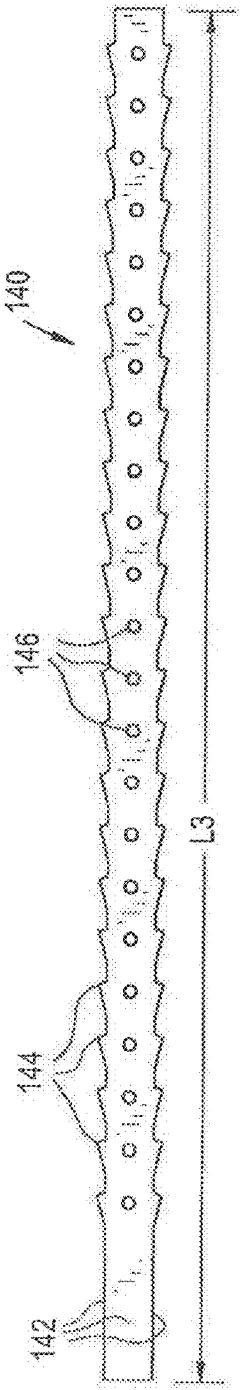


FIG. 9B

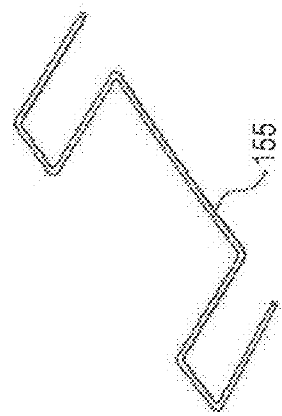


FIG. 10C

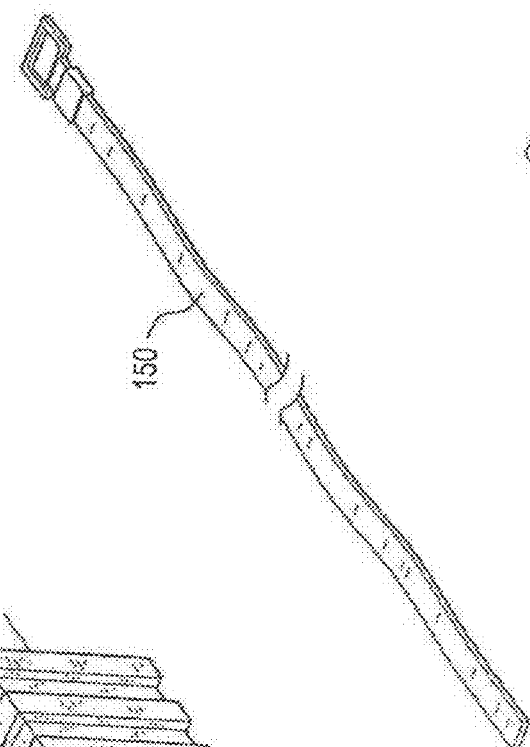


FIG. 10B

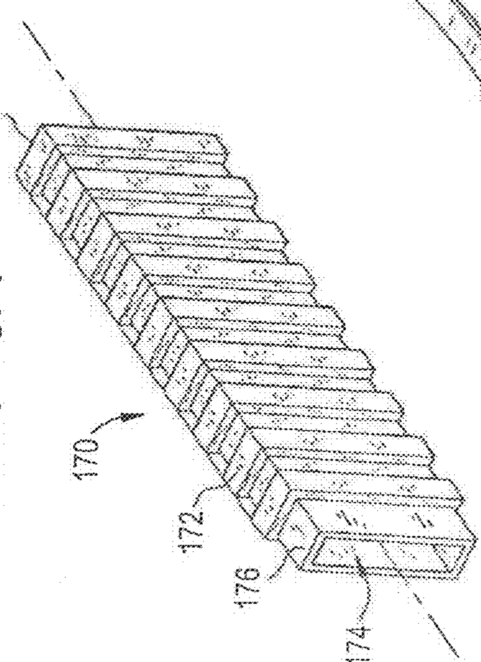


FIG. 10A

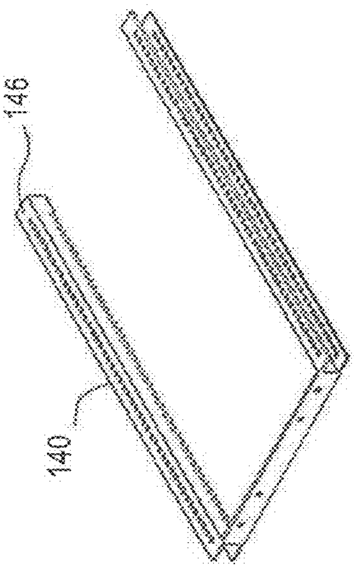


FIG. 10E

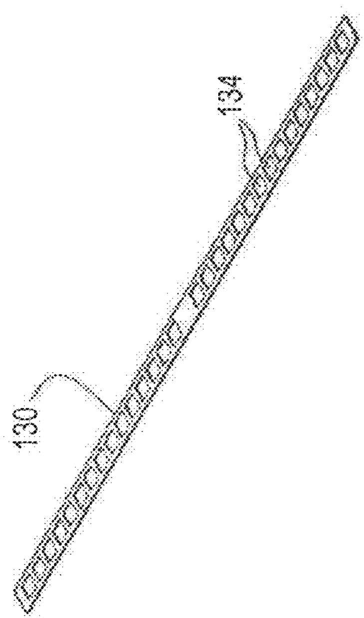


FIG. 10D

FIG. 11B

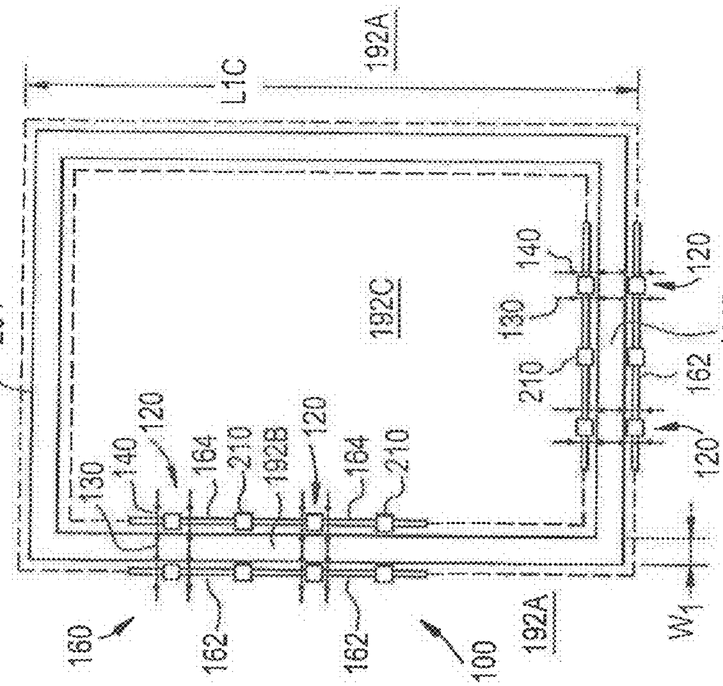


FIG. 11A

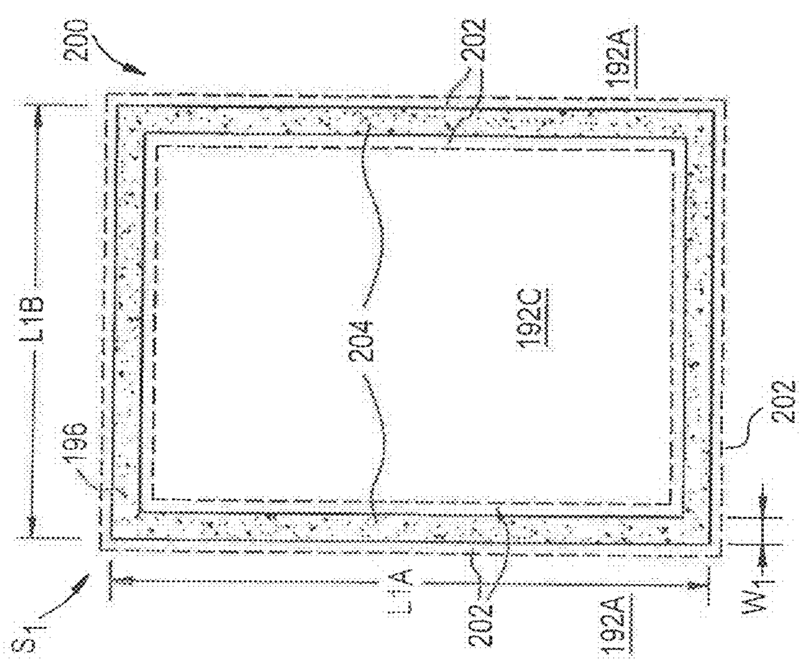


FIG. 11D

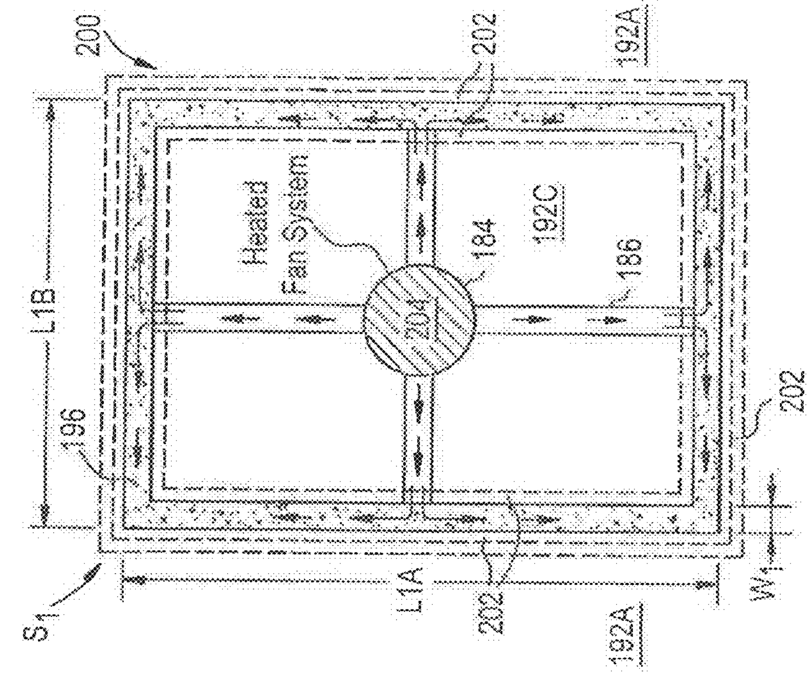


FIG. 11C

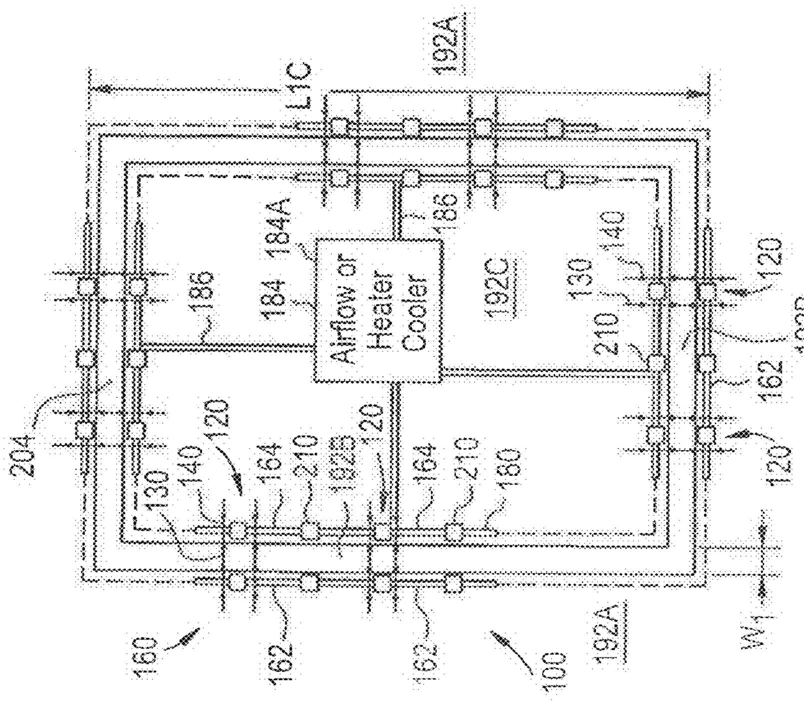
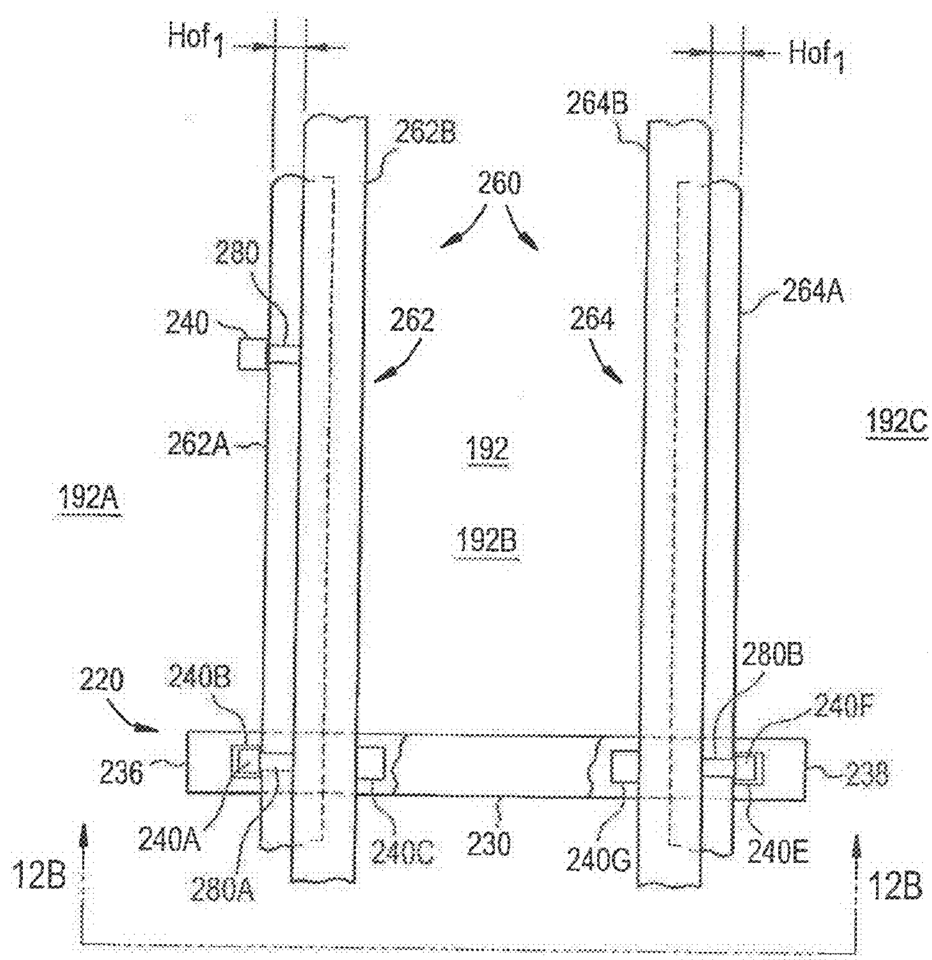


FIG. 12A



Hof1
Hof1
262B
264B
260
280
264A
240
262
264
192C
262A
192
192A
192B
280B
220
240B
240F
236
238
240A
240C
230
240G
240E
12B
280A
12B

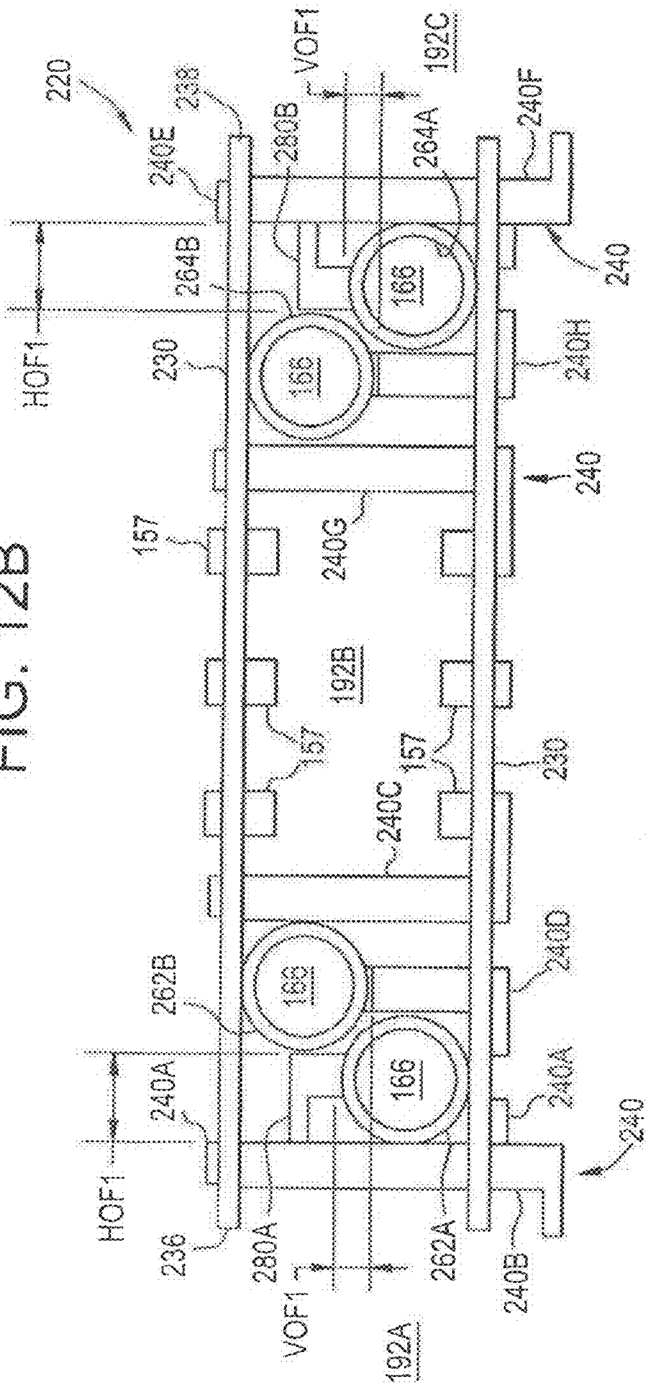

220
238
240E
280B
264A
VOF1
192C
240F
240
264B
HOF1
230
166
240H
157
240G
192B
157
157
230
240C
262B
240D
240A
240A
HOF1
236
280A
VOF1
262A
240B
192A

FIG. 12B

FIG. 12C

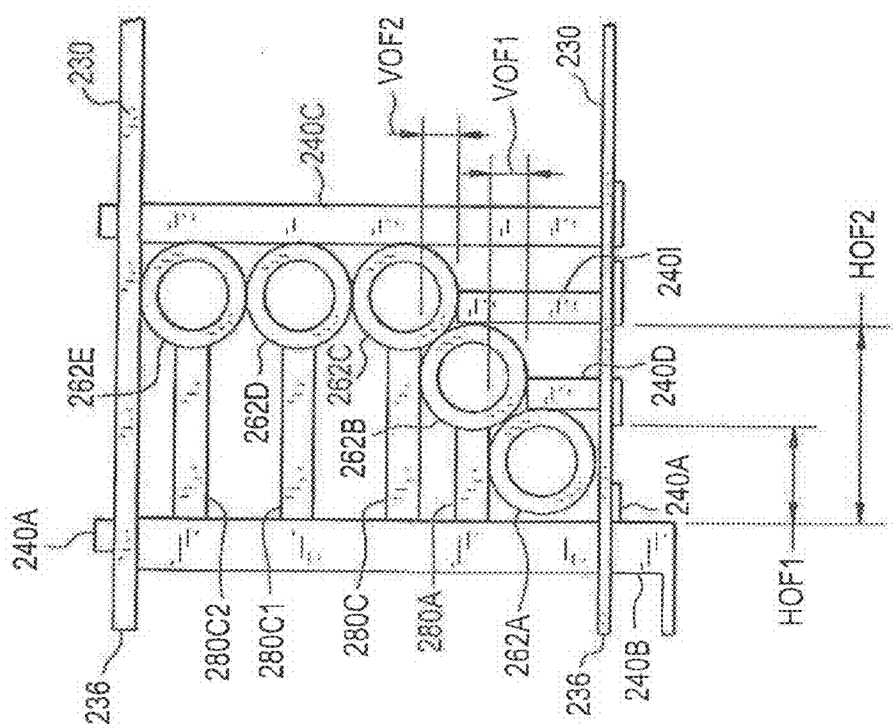

230
240C
VOF2
VOF1
230
262E
262D
262C
262B
240I
240D
HOF2
240A
240A
HOF1
280C2
280C1
280C
280A
262A
236
236
240B

FIG. 12D

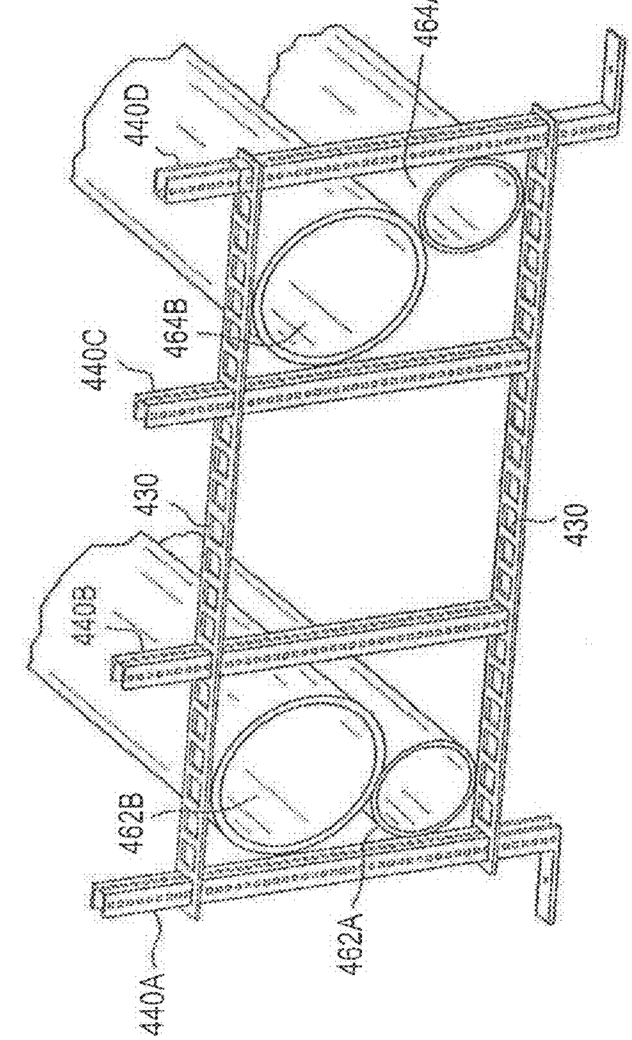


FIG. 12E

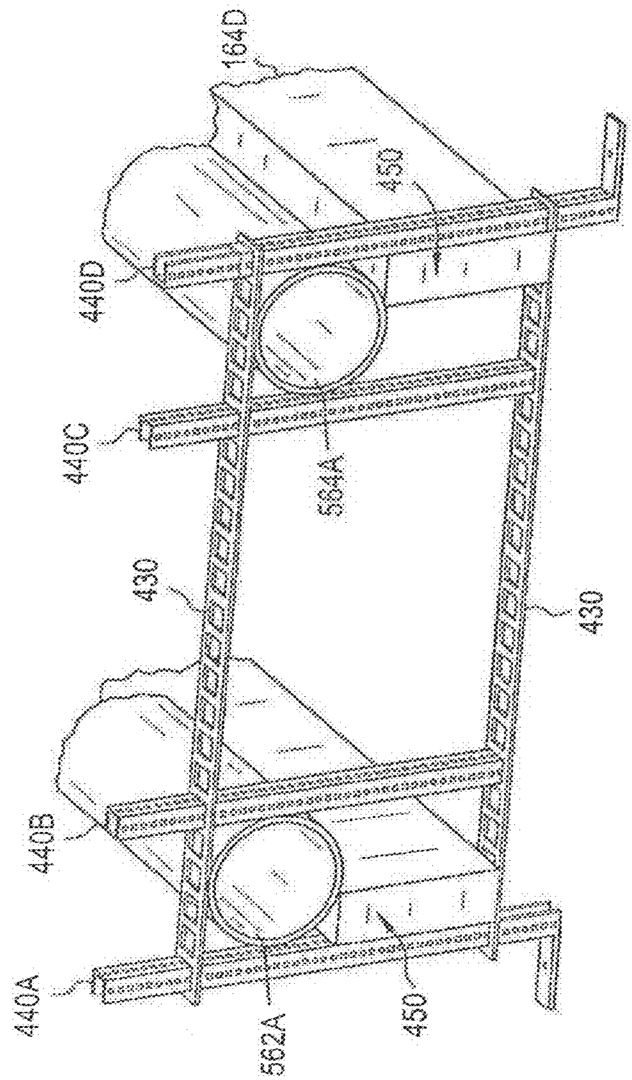


FIG. 12F

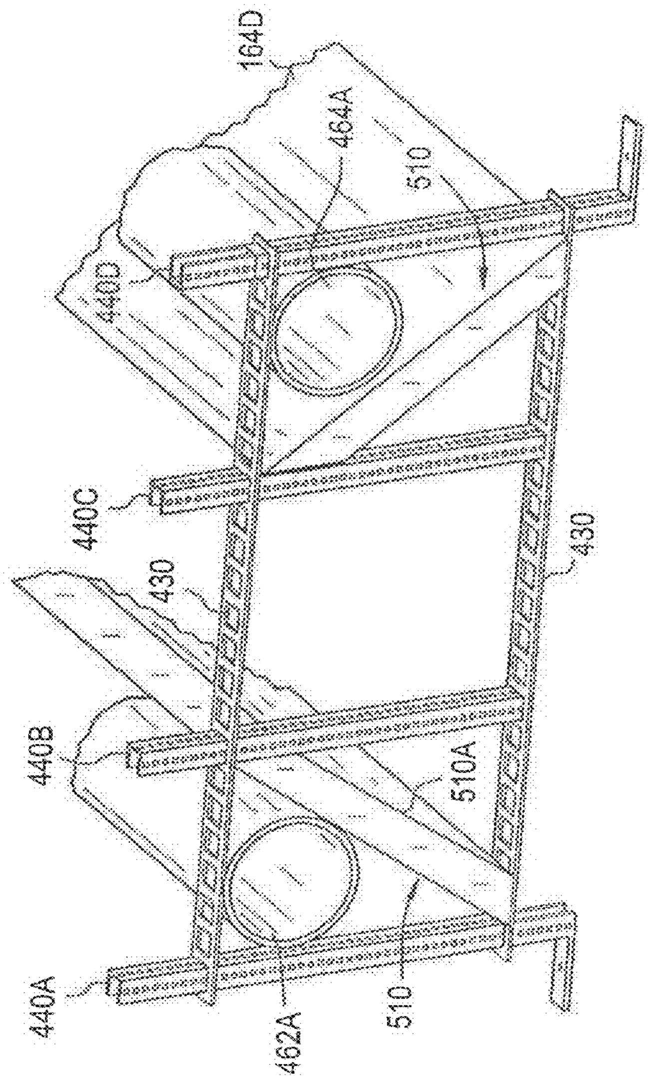


FIG. 12G

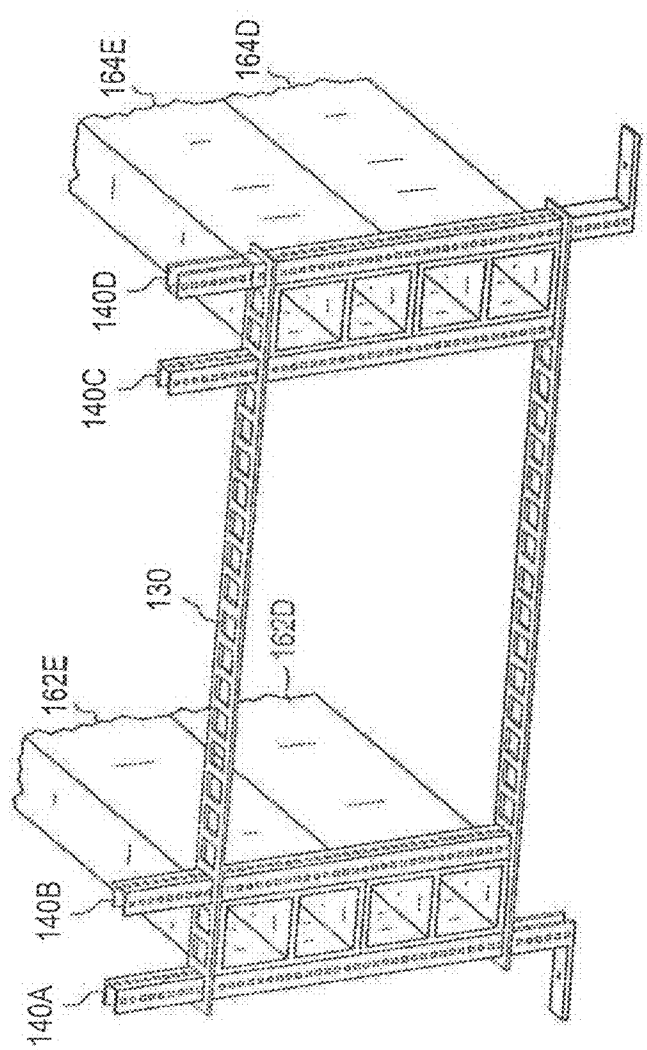


FIG. 12H

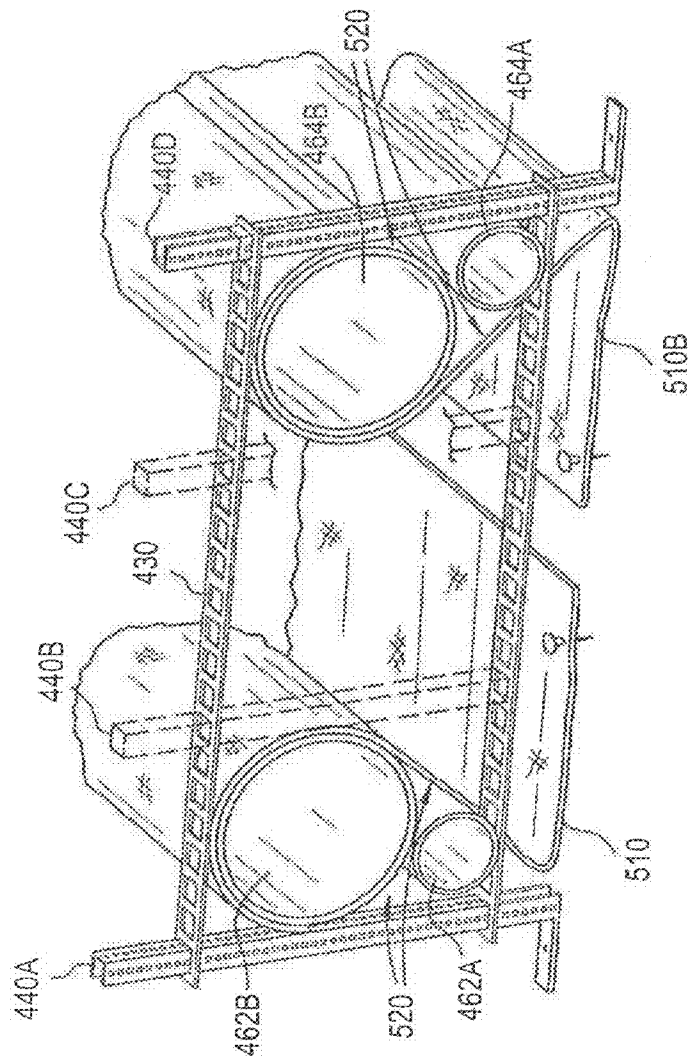


FIG. 12I

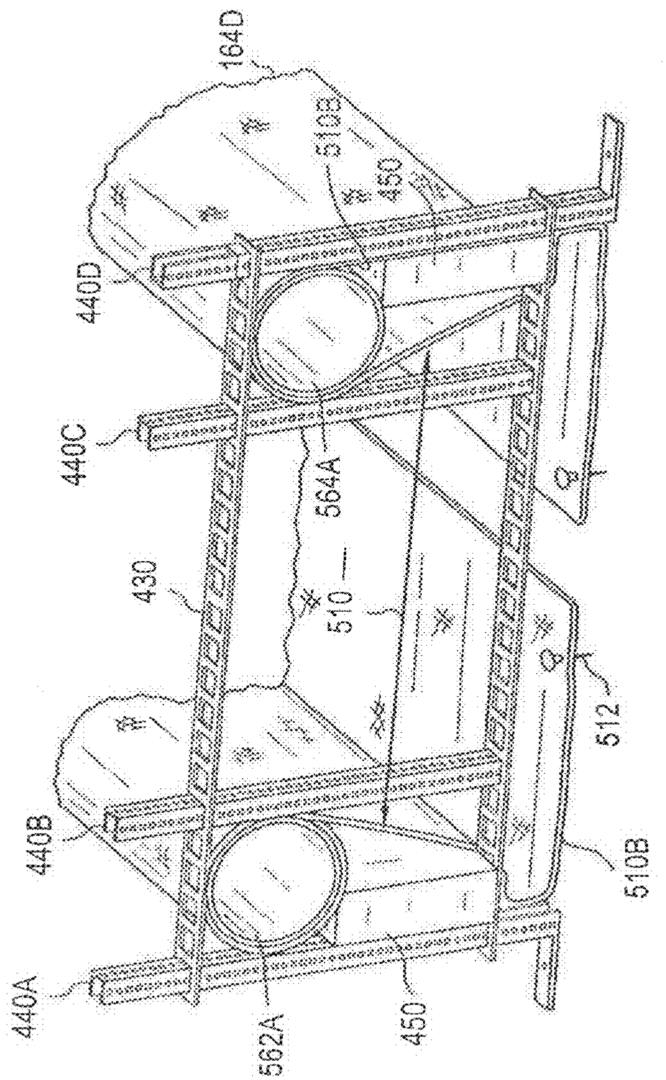

164D
510B
450
440D
440C
564A
430
510
512
440B
510B
440A
562A
450

FIG. 12J

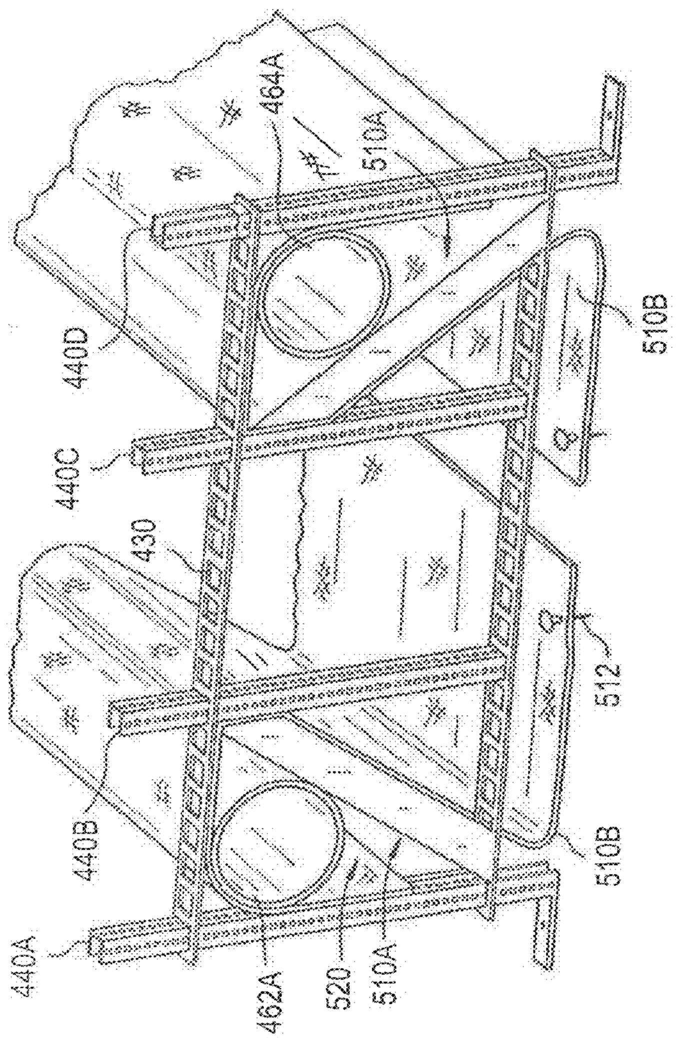


FIG. 12K

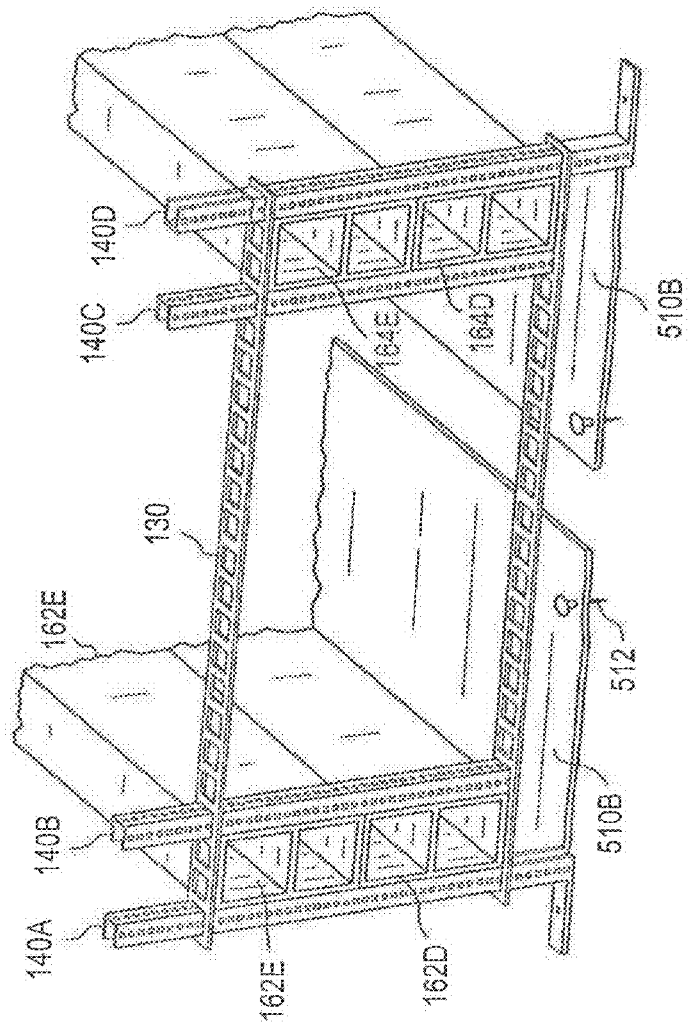

140D
140C
164E
164D
510B
130
162E
512
140B
140A
162E
162D
510B

FIG. 12L

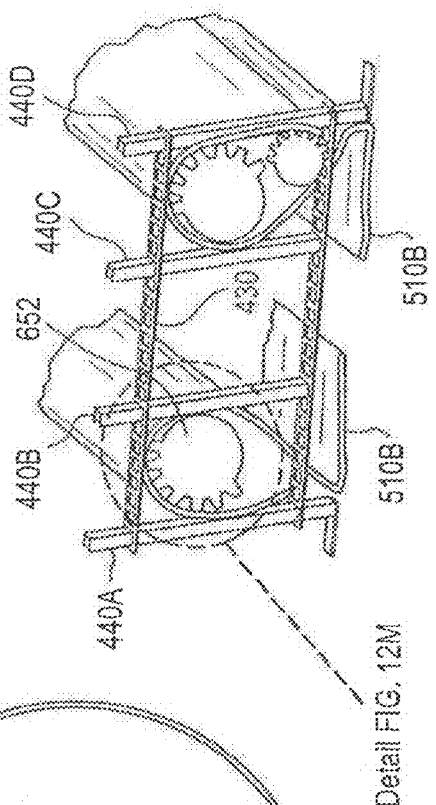


FIG. 12M

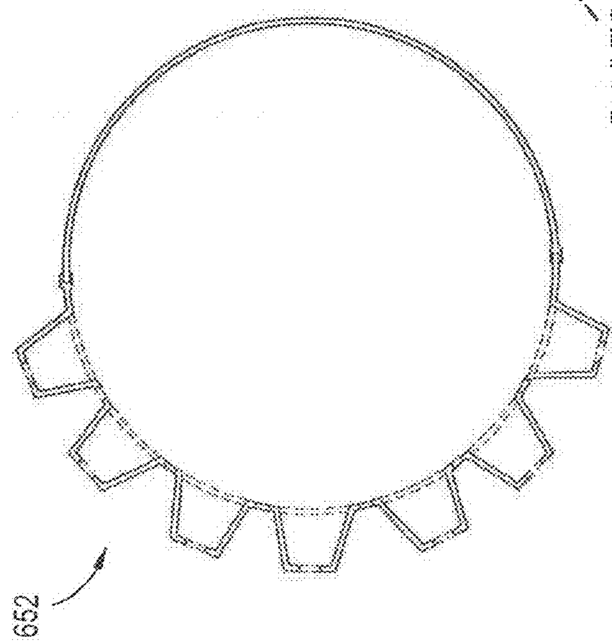
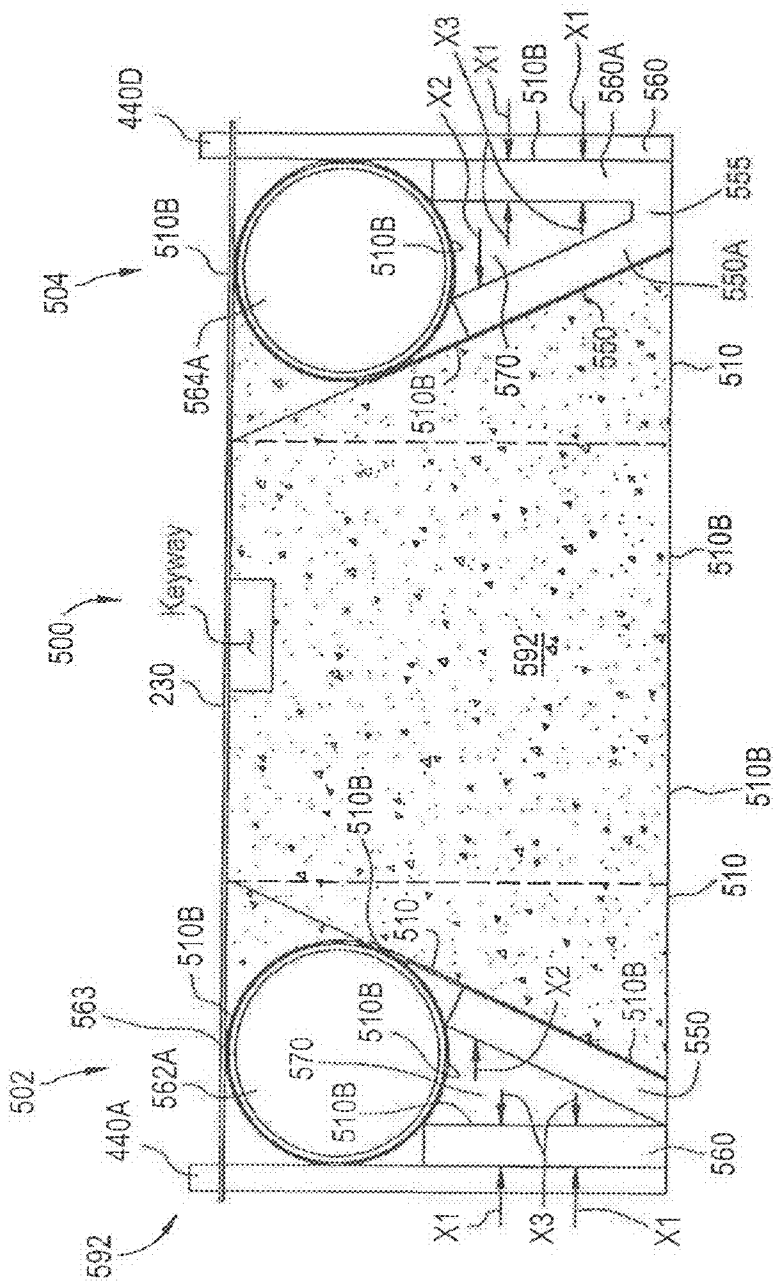
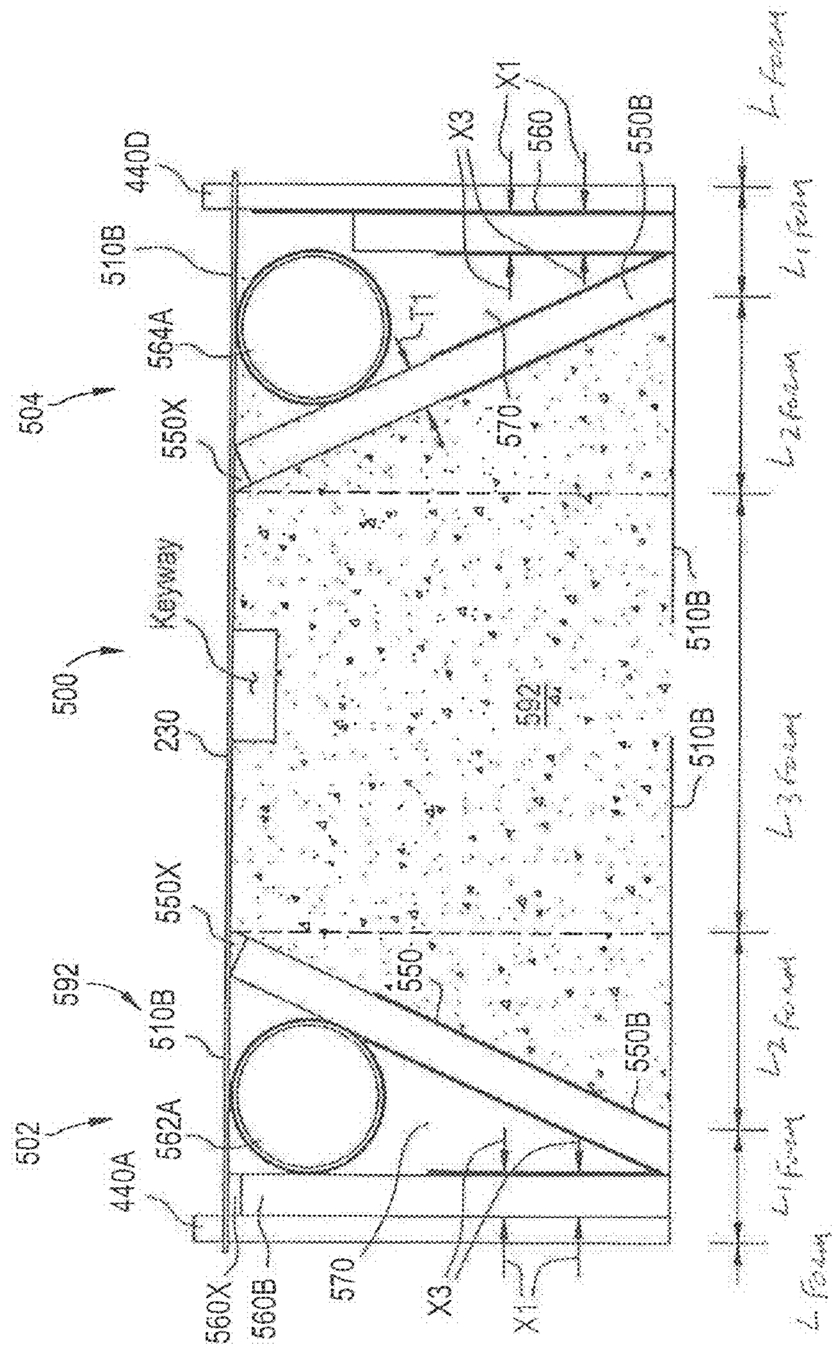


FIG. 12N



500
Keyway
230
592
502
504
440A
440D
562A
563
564A
510B
510
550
550A
555
560
560A
570
X1
X2
X3

FIG. 12O


500
502
504
592
440A
440D
510B
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564A
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550B
230
Keyway
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560X
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570
X1
X3
T1
592

FIG. 12P

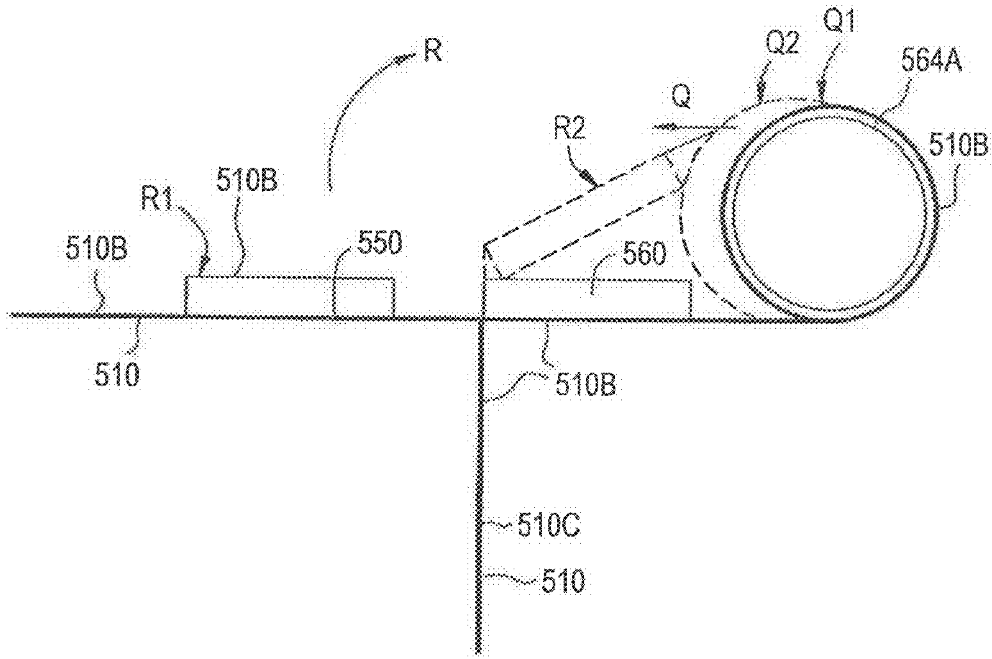
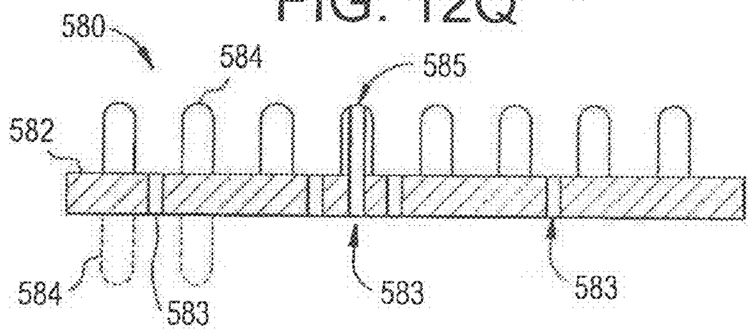


FIG. 12Q



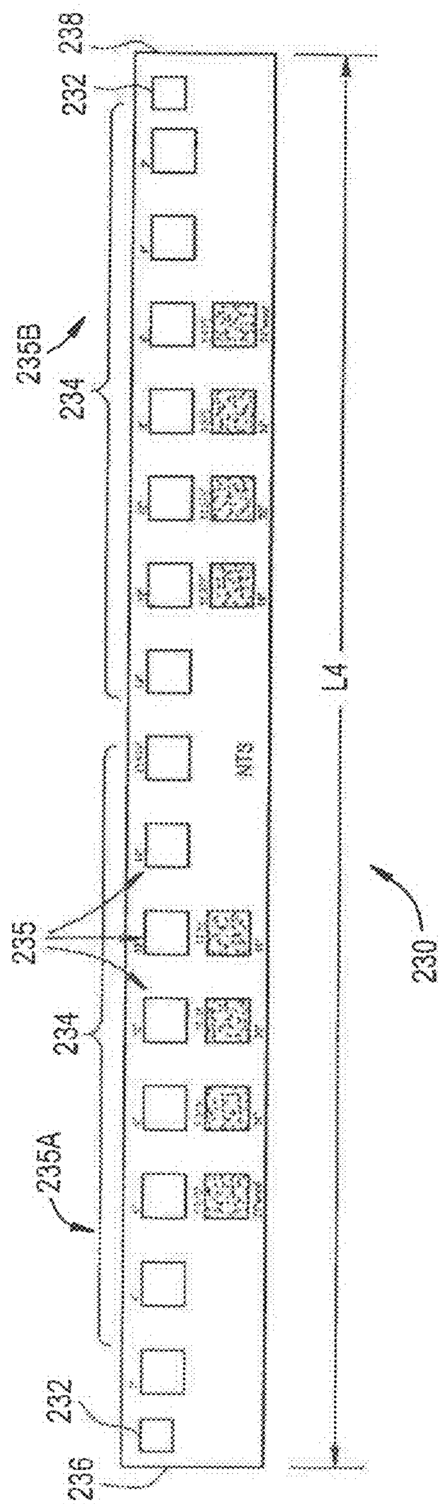


FIG. 13

FIG. 14A

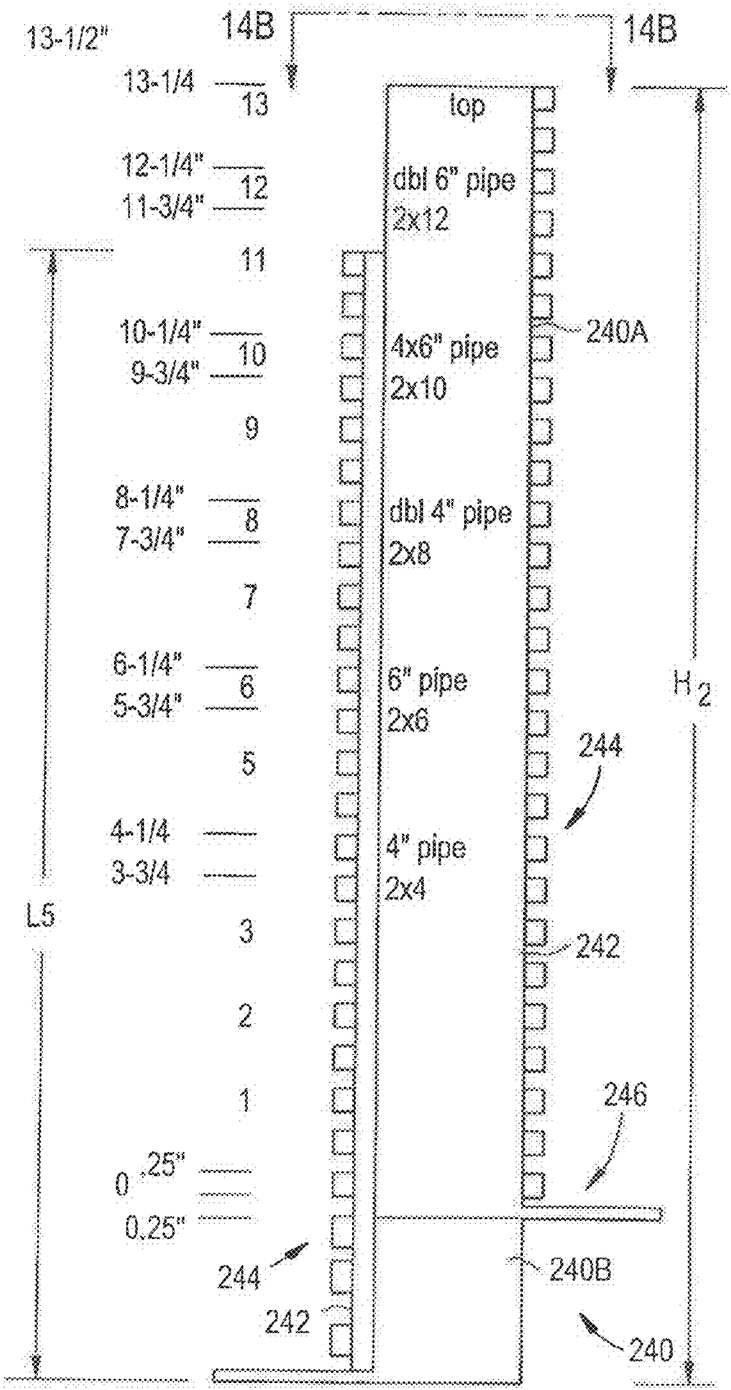


FIG. 14B

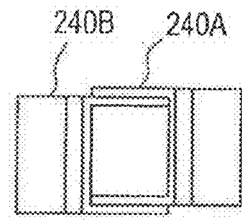


FIG. 15A

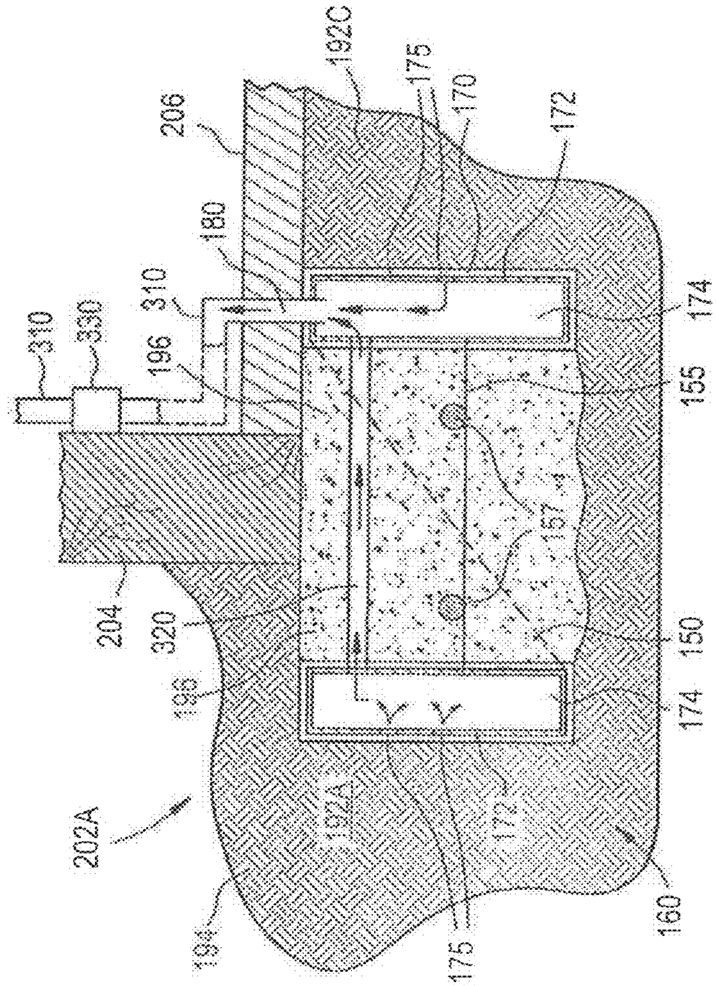

310
330
310
196
180
206
192C
175
170
172
174
155
157
150
174
160
175
172
192A
202A
194
195
320
204

FIG. 15B

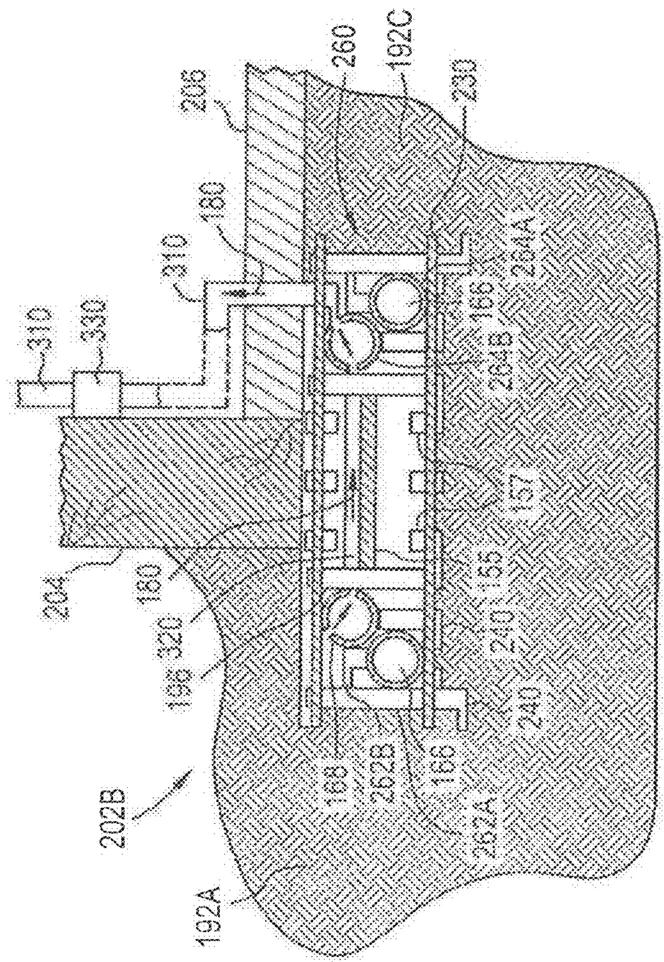

310
330
310
180
206
260
192C
230
264A
166
264B
157
155
240
240
166
262B
168
262A
202B
192A
196
320
180
204

FIG. 15C

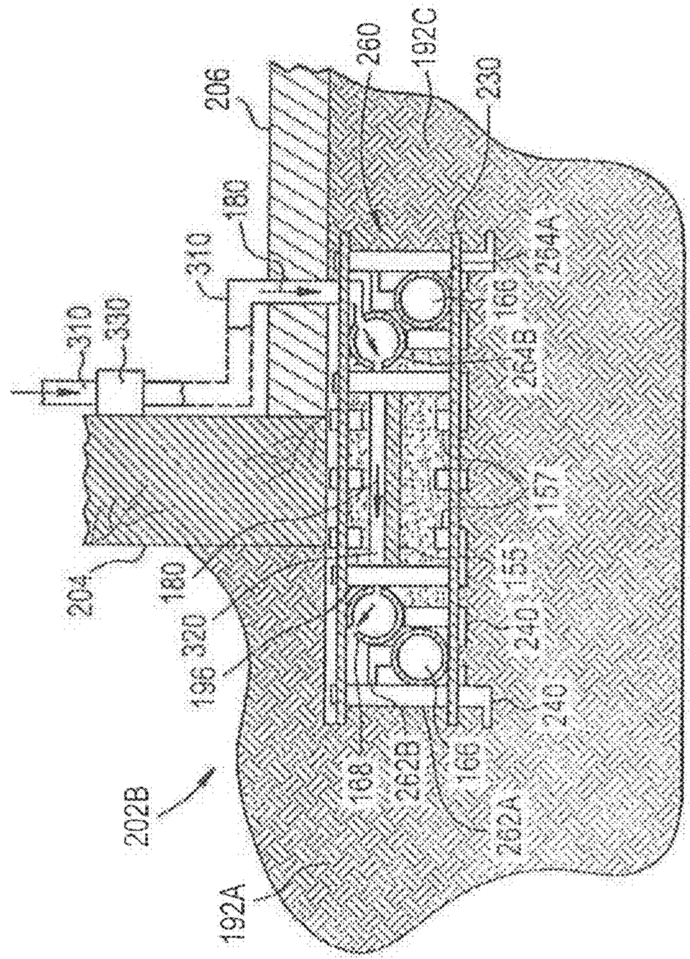

310
330
310
180
206
260
192C
230
254A
166
264B
157
155
240
240
166
262B
168
262A
202B
192A
196
320
180
204

FIG. 15D

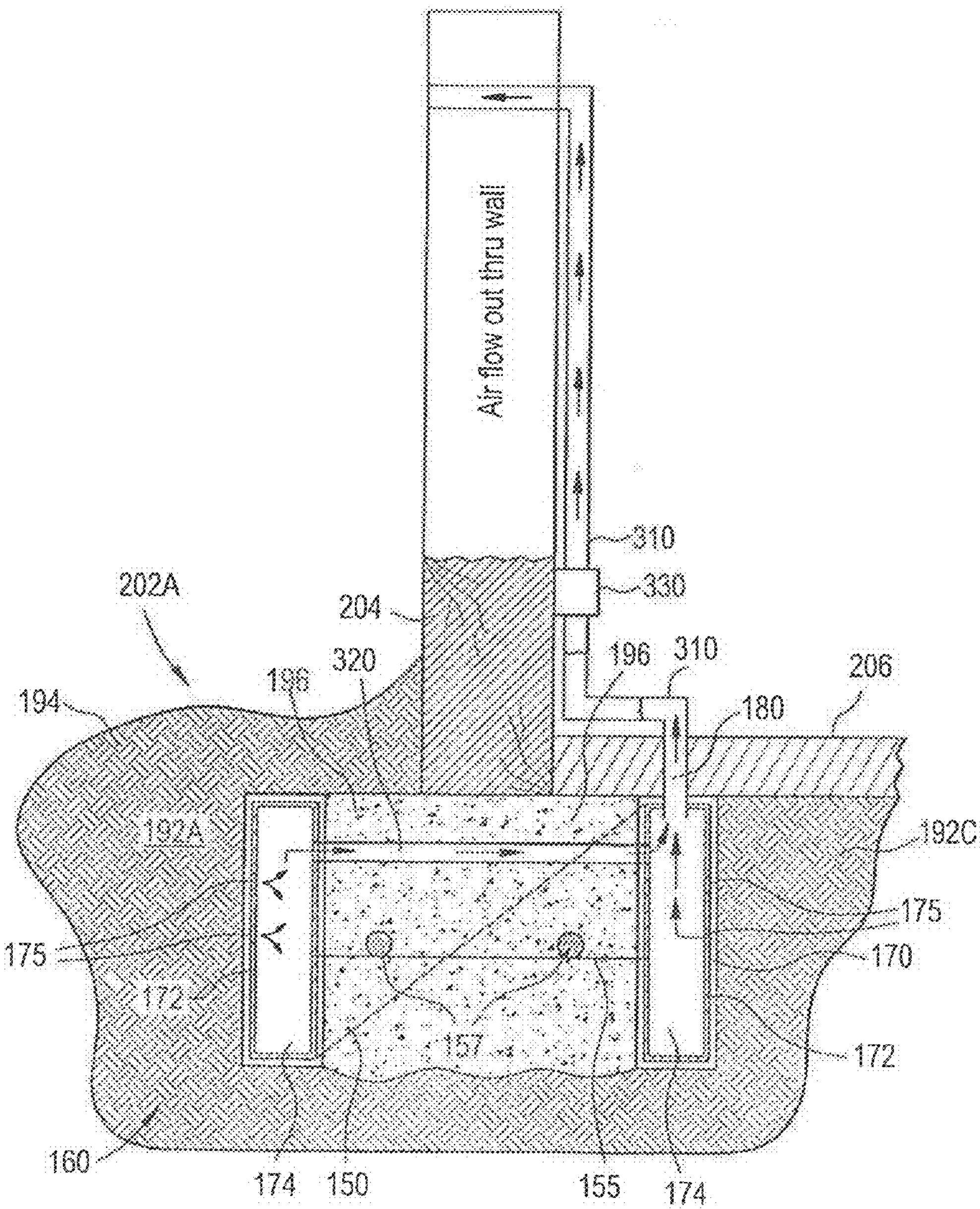

Air flow out thru wall
310
330
202A
204
320
196
196
310
206
194
180
192A
192C
175
175
170
172
172
157
160
174
150
155
174

FIG. 15E

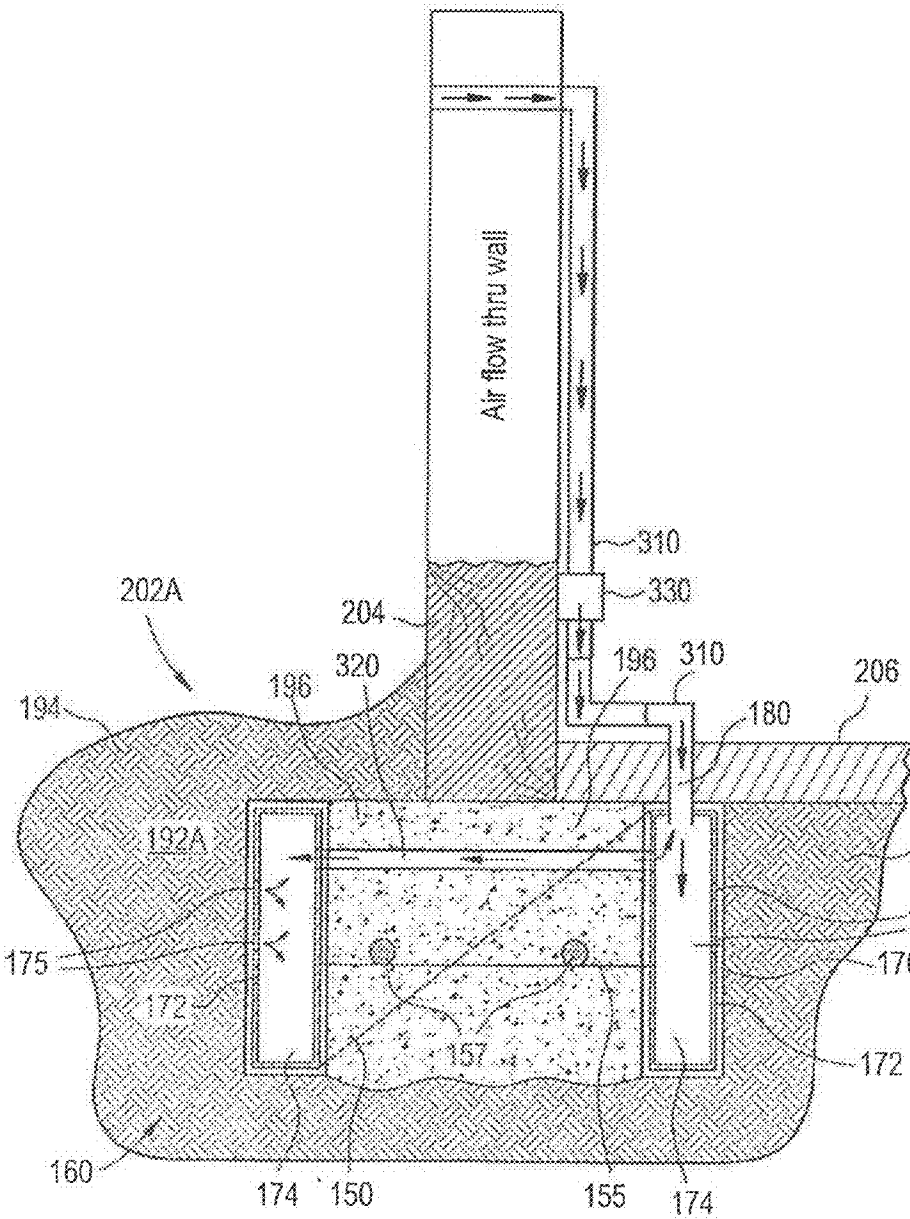

Air flow thru wall
310
330
202A
204
320
196
196
310
206
194
180
192A
192C
175
175
170
172
172
157
160
174
150
155
174

FIG. 16

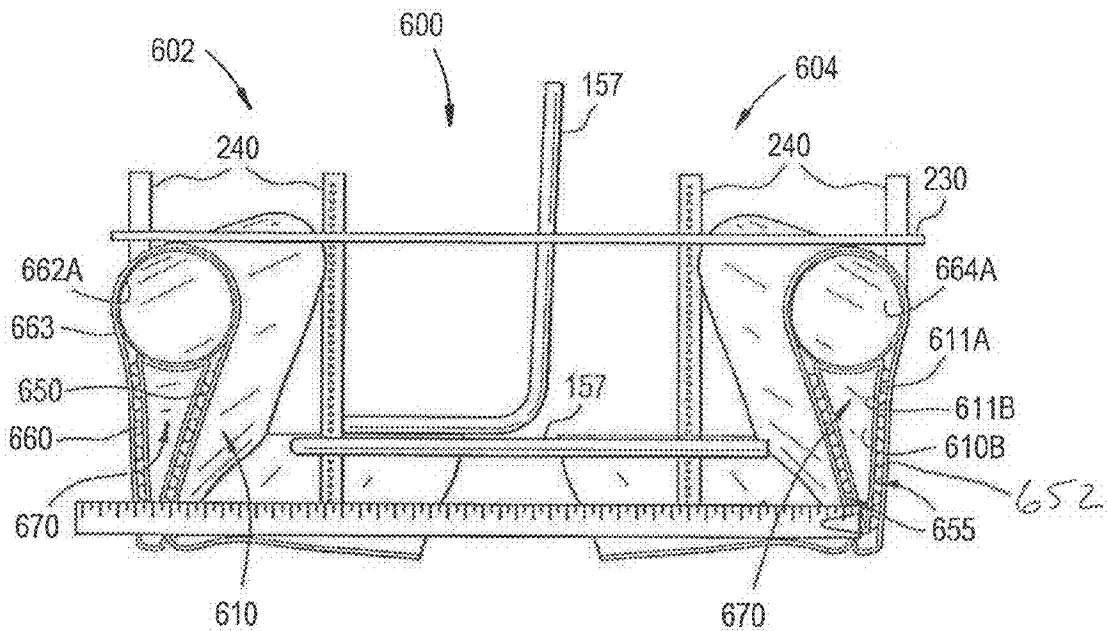

602
600
157
604
240
240
230
662A
664A
663
611A
650
157
611B
660
610B
652
670
655
610
670

FIG. 17

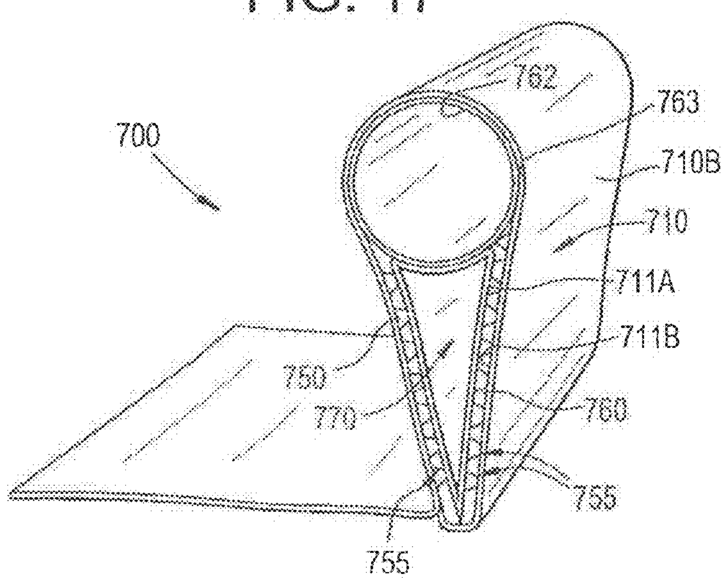

762
763
700
710B
710
711A
711B
750
770
760
755
755

FIG. 18A

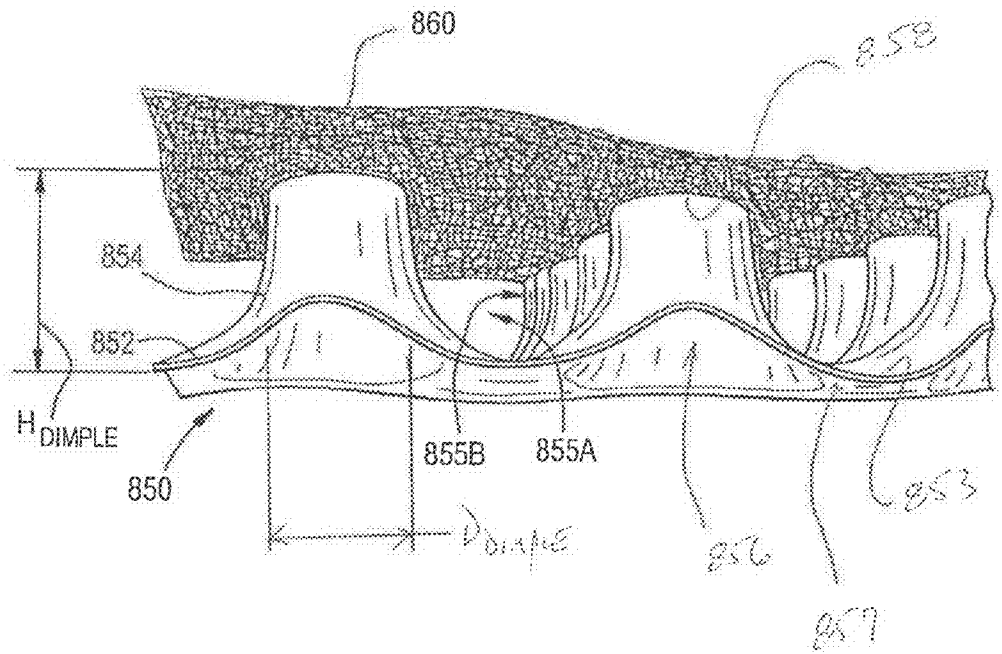


FIG. 18B

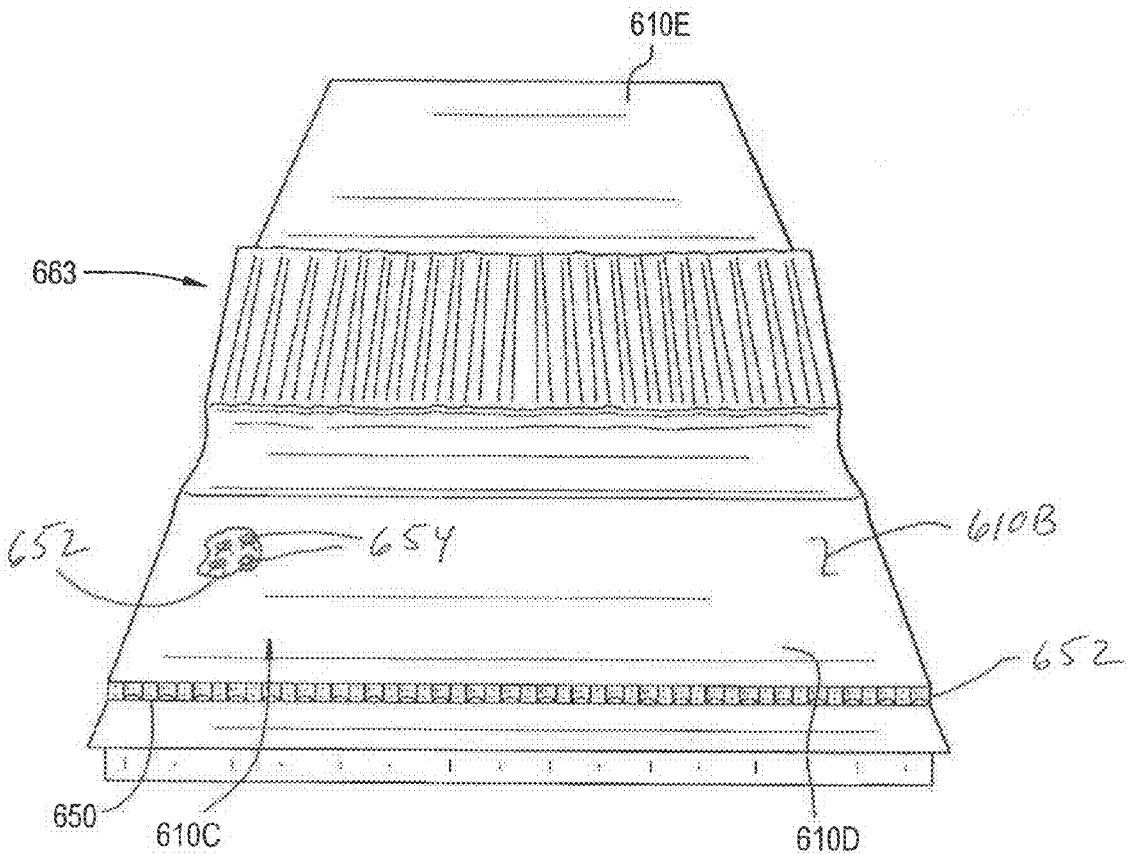


FIG. 18C

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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 D4491	sec^{-1}	>1.8
Flow Rate		$gal/min/ft^2$	>140
Permeability		cm/sec	>0.08

880

Example Cuspated 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

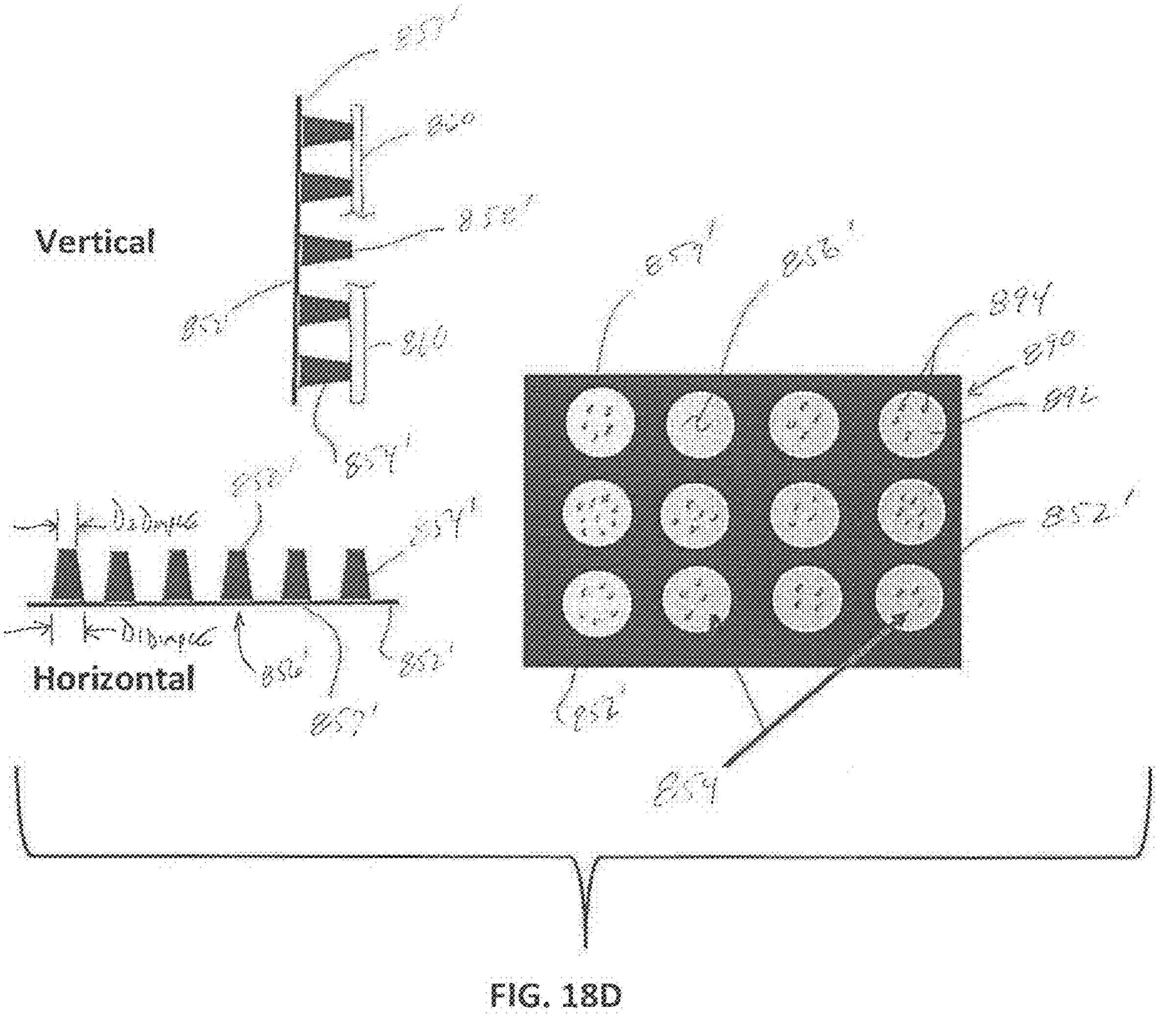

Vertical
Horizontal
857'
860
858'
852'
857'
857'
858'
894
890
892
852'
852'
854

FIG. 18D

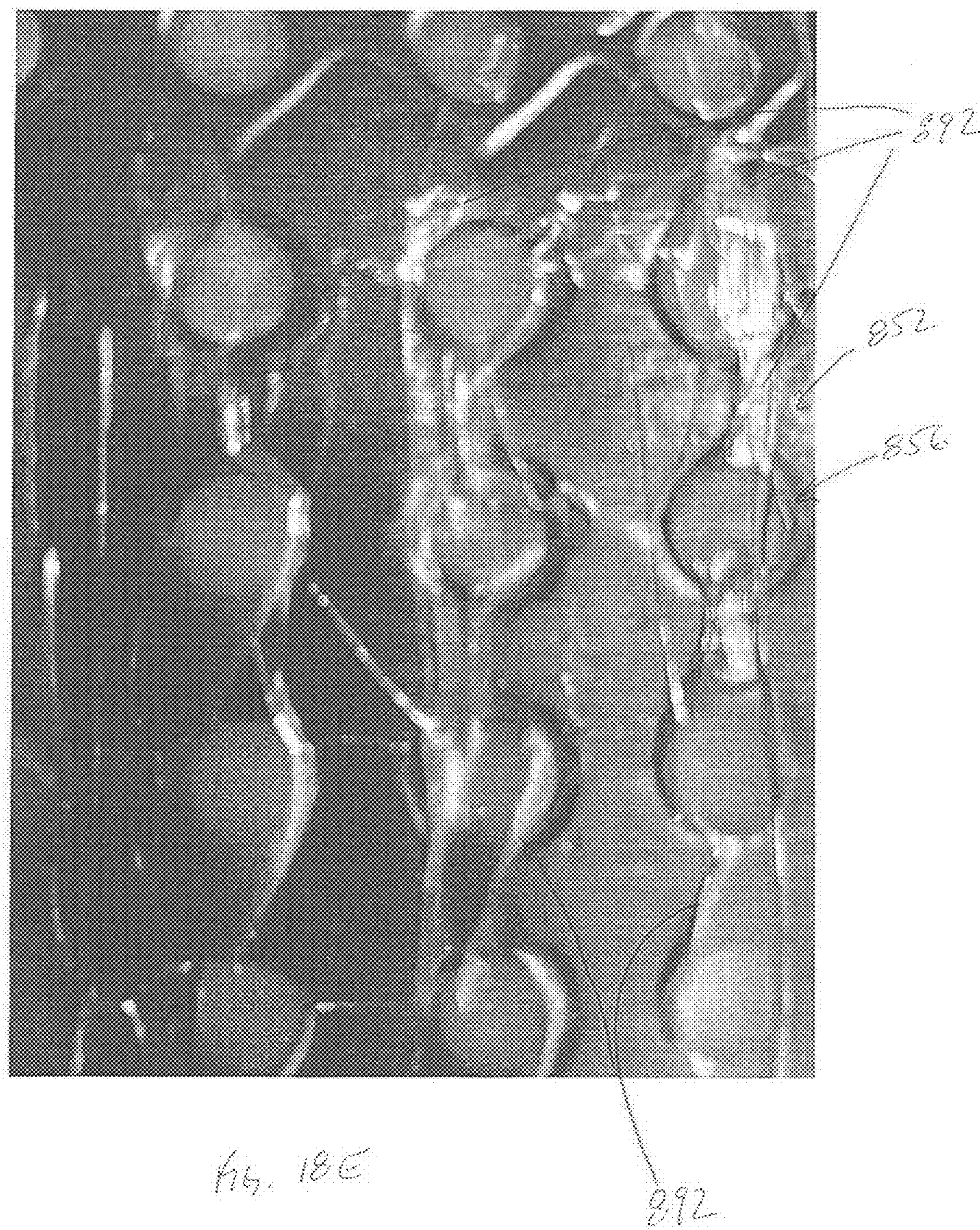


FIG. 18E

FIG. 19

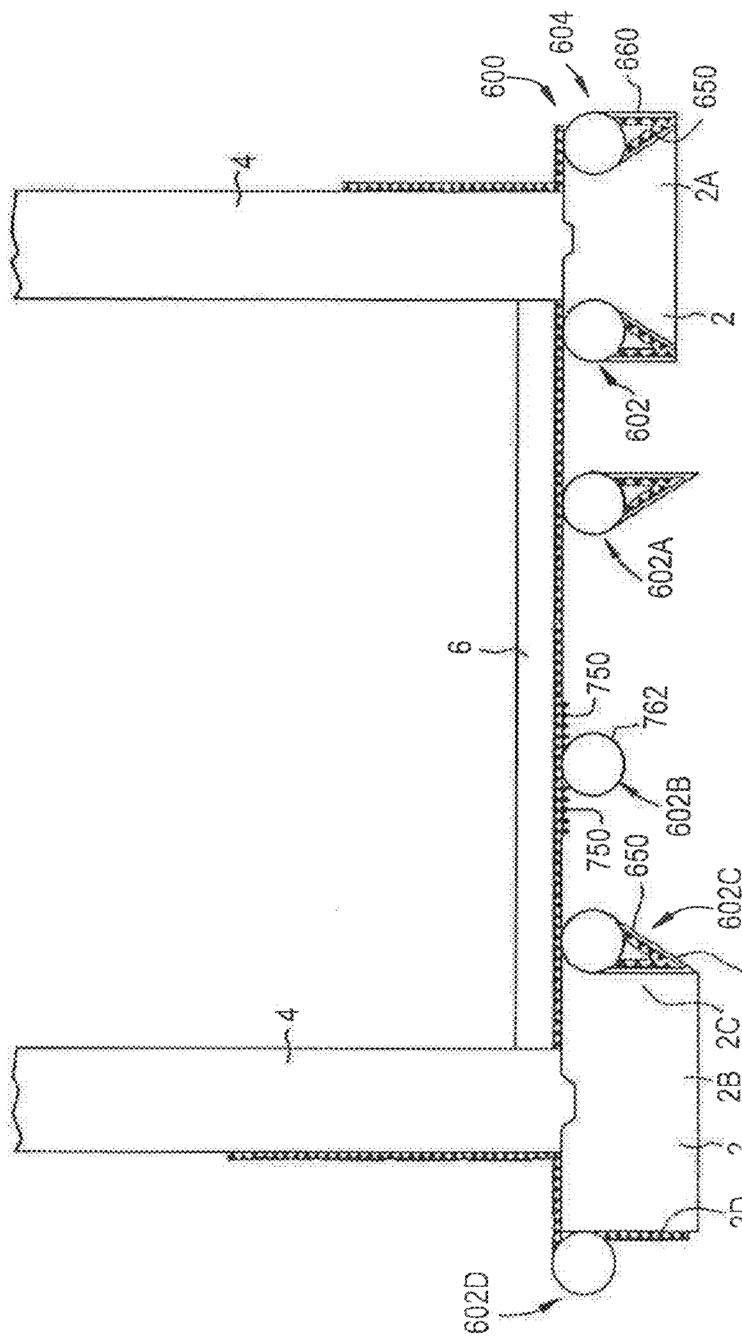

600
604
660
650
4
2A
2
602
602A
6
750
762
602B
750
650
602C
660
2C
4
2B
2
2D
602D

FIG. 20
PRIOR ART

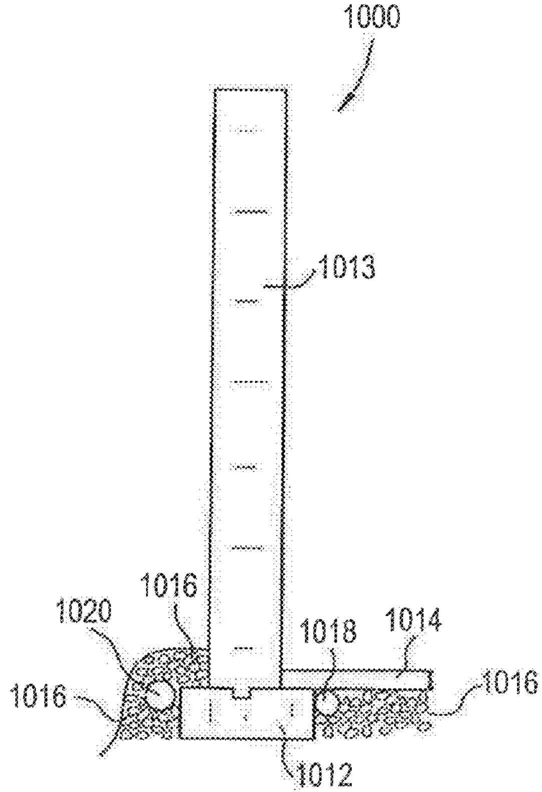


FIG. 21

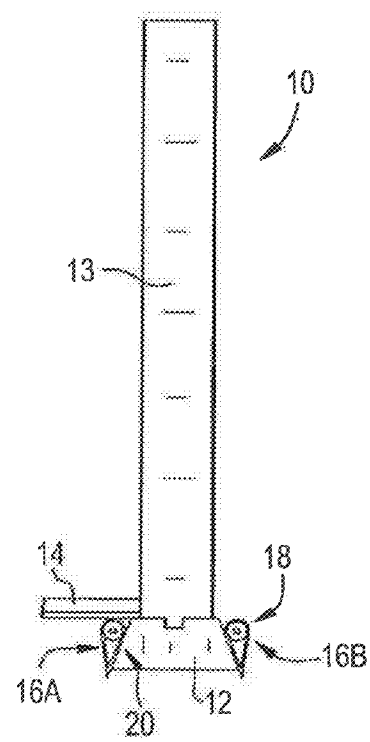


FIG. 22

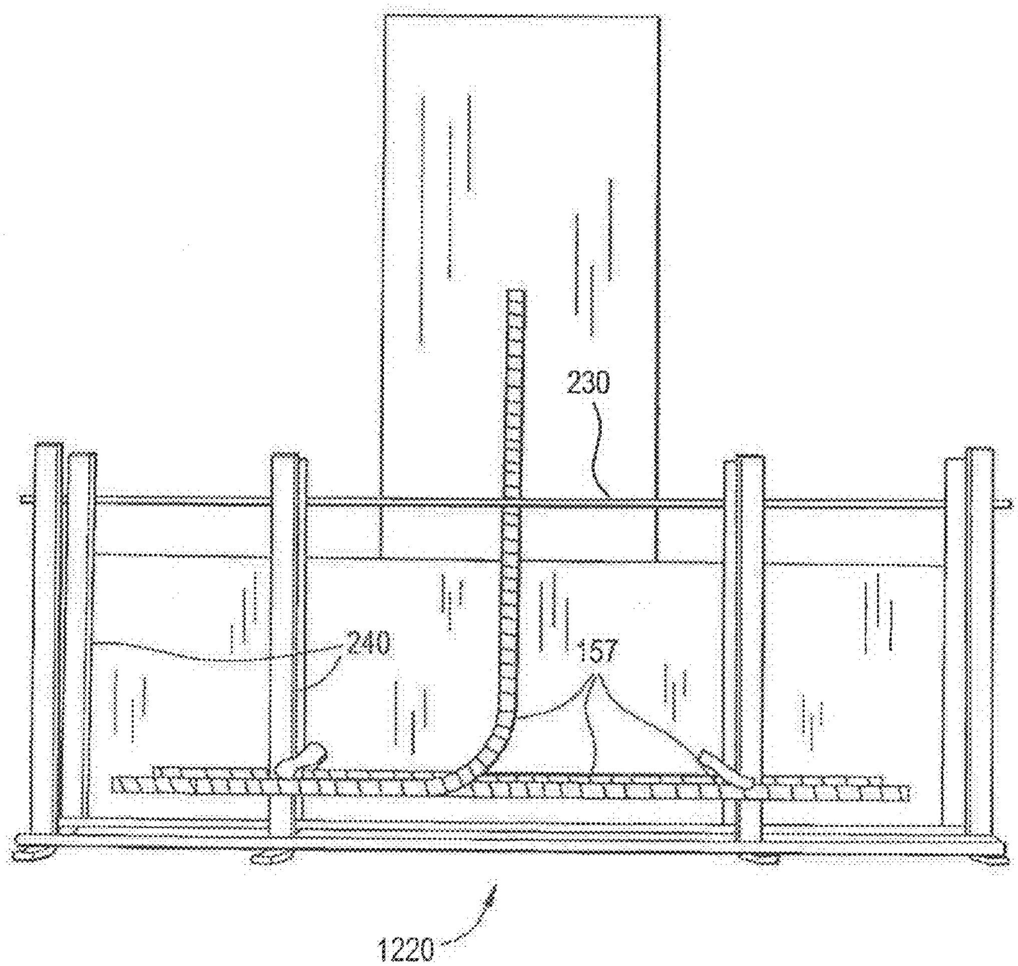


FIG. 23A

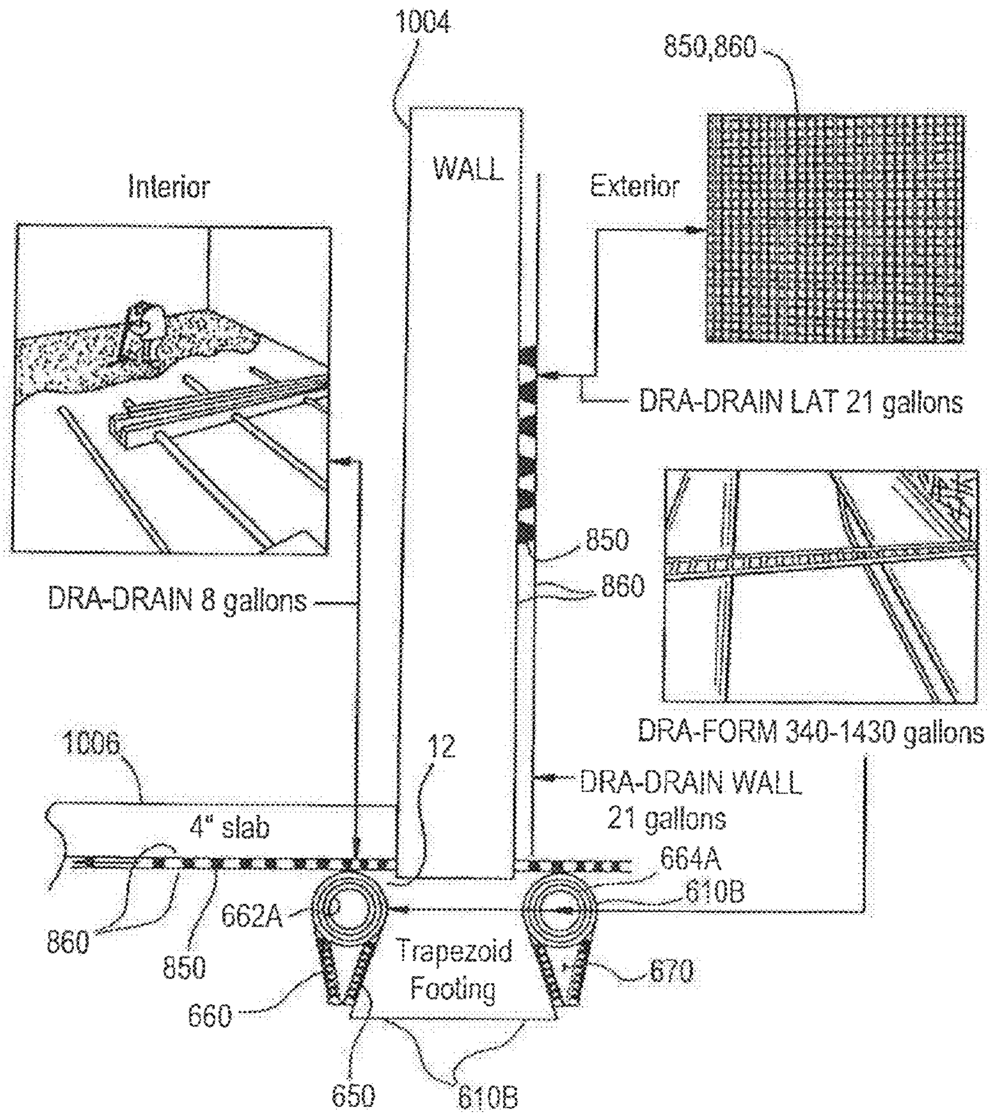

1004
850,860
WALL
Interior
Exterior
DRA-DRAIN LAT 21 gallons
850
860
DRA-DRAIN 8 gallons
DRA-FORM 340-1430 gallons
1006
12
DRA-DRAIN WALL
21 gallons
4" slab
664A
610B
662A
860
850
Trapezoid
Footing
670
660
650
610B

FIG. 23B

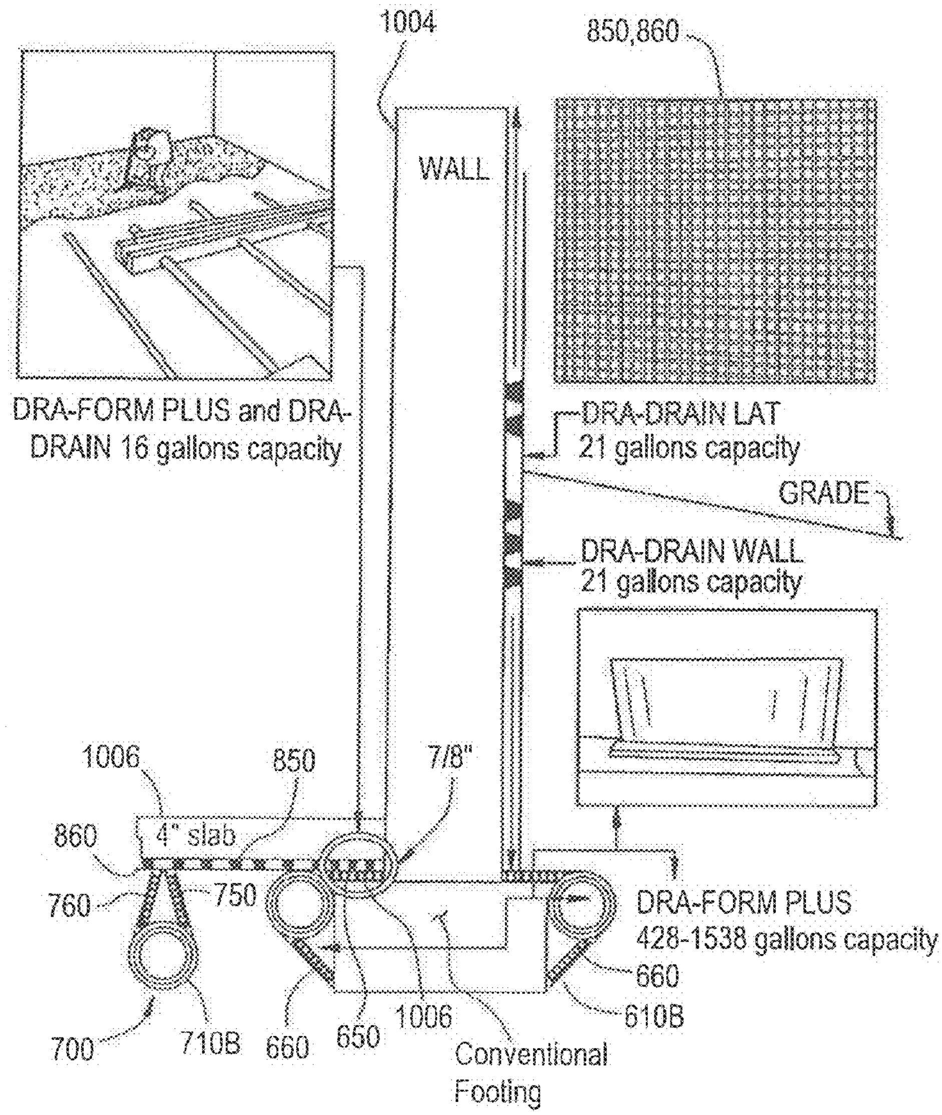

1004
850,860
WALL
DRA-FORM PLUS and DRA-
DRAIN 16 gallons capacity
DRA-DRAIN LAT
21 gallons capacity
GRADE
DRA-DRAIN WALL
21 gallons capacity
1006
850
7/8"
4" slab
860
760
750
DRA-FORM PLUS
428-1538 gallons capacity
660
610B
700
710B
660
650
1006
Conventional
Footing

FIG. 24A

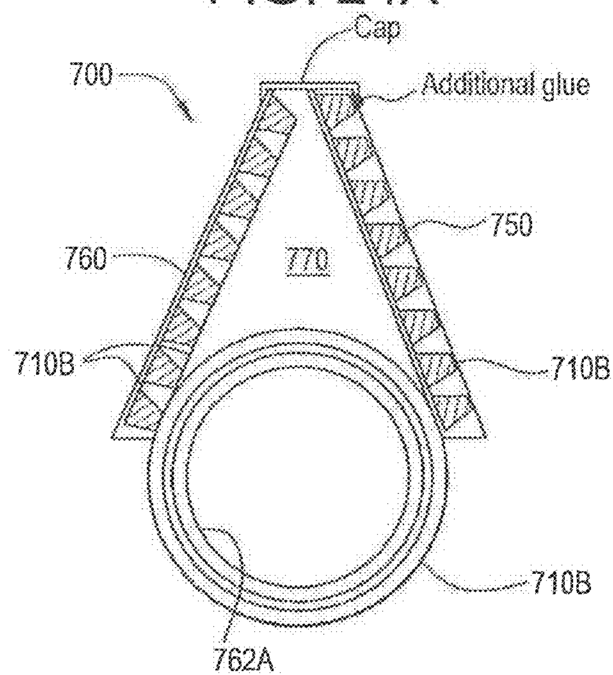


FIG. 24B

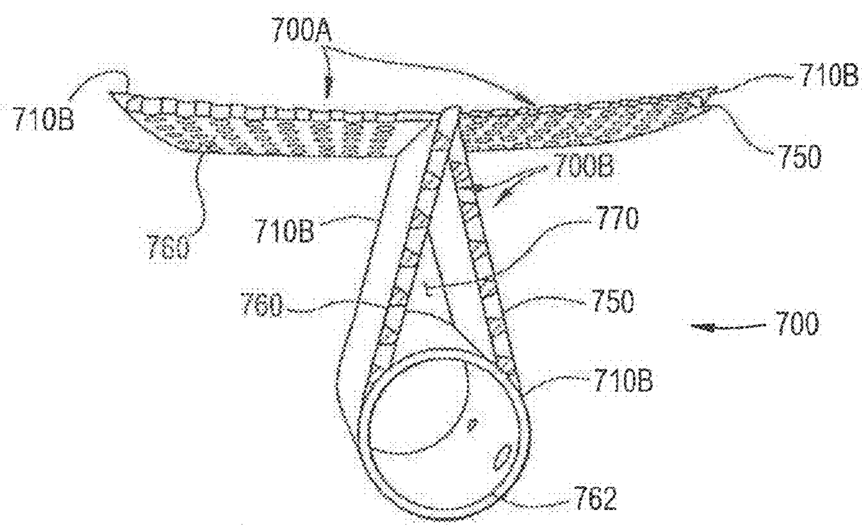


FIG. 24C

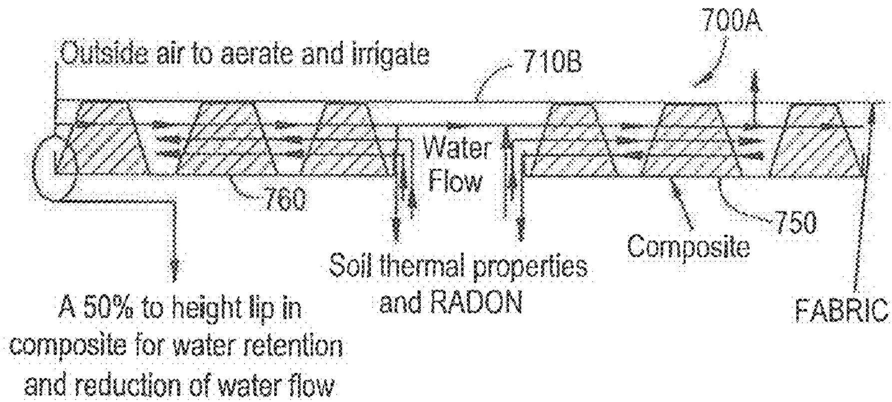


FIG. 24D

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

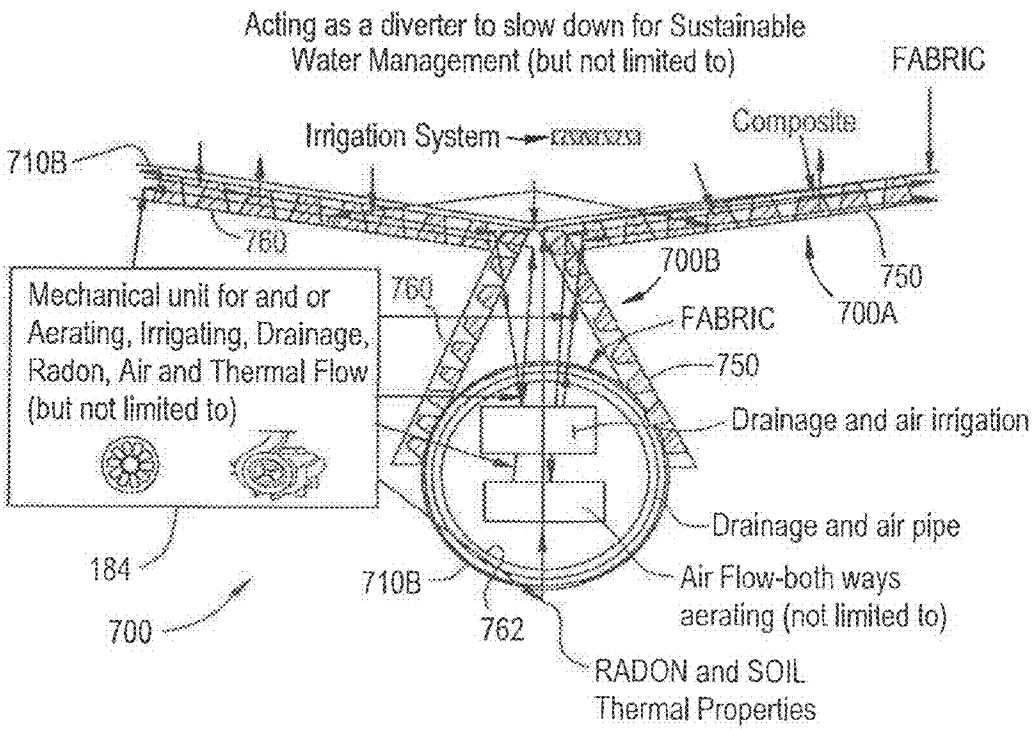


FIG. 25A

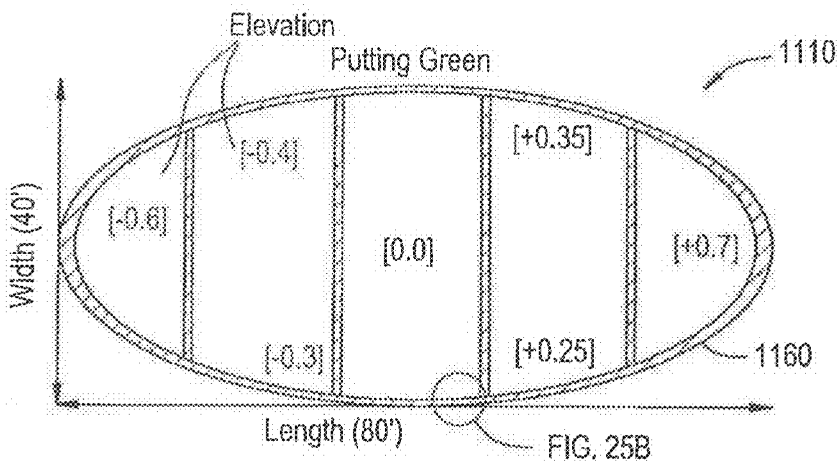


FIG. 25B

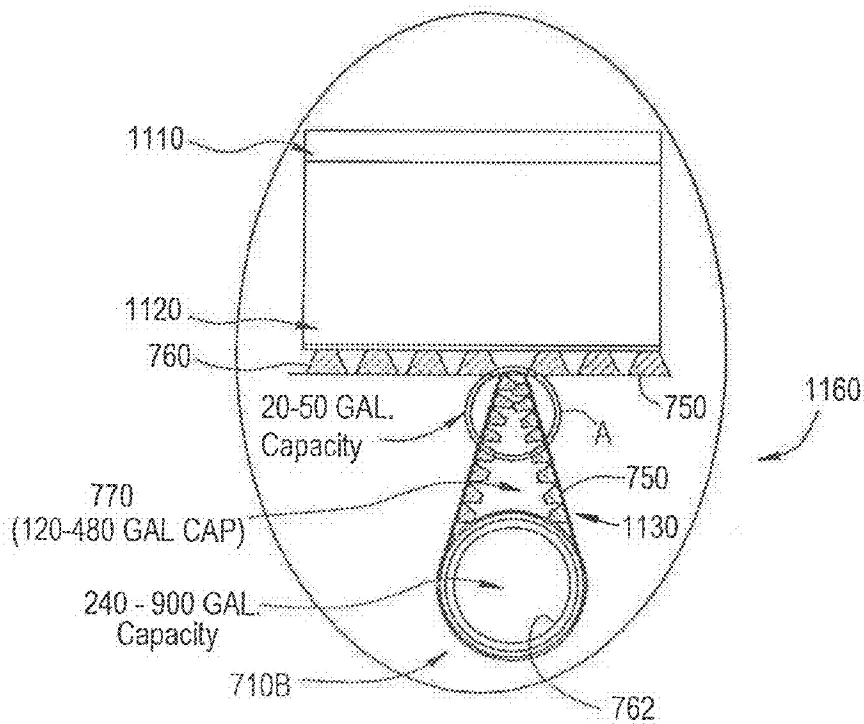


FIG. 26A

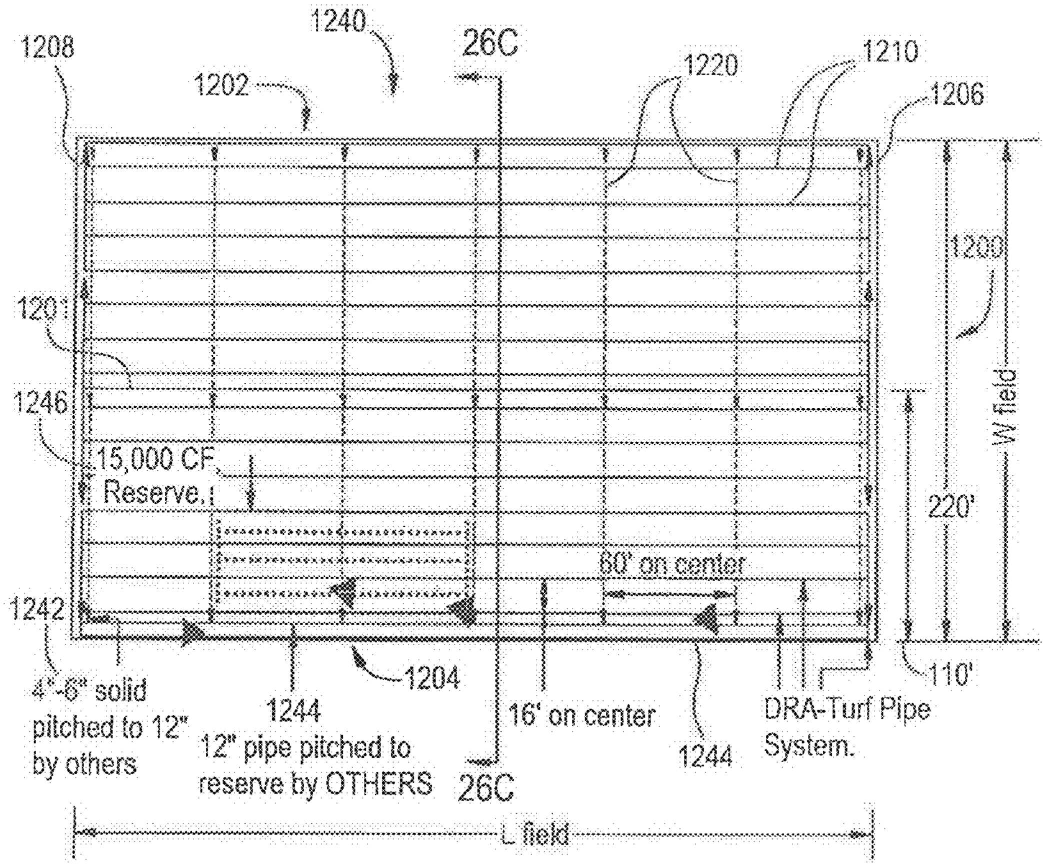


FIG. 26B

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

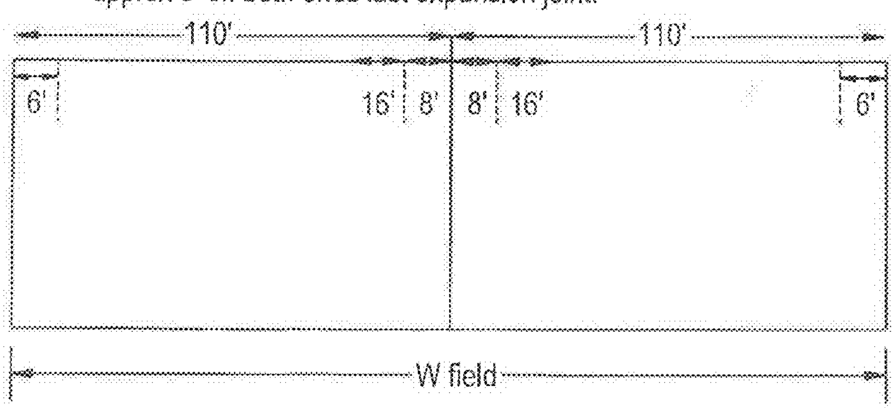


FIG. 26C

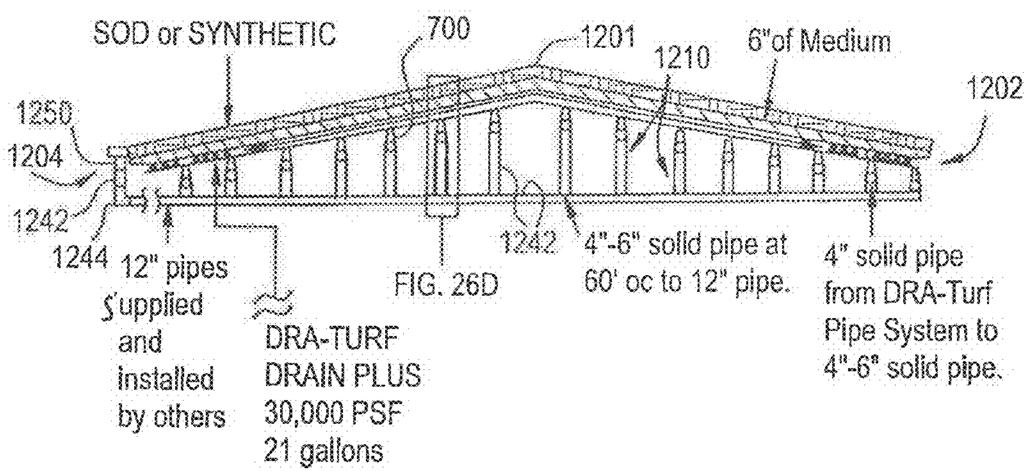


FIG. 26D

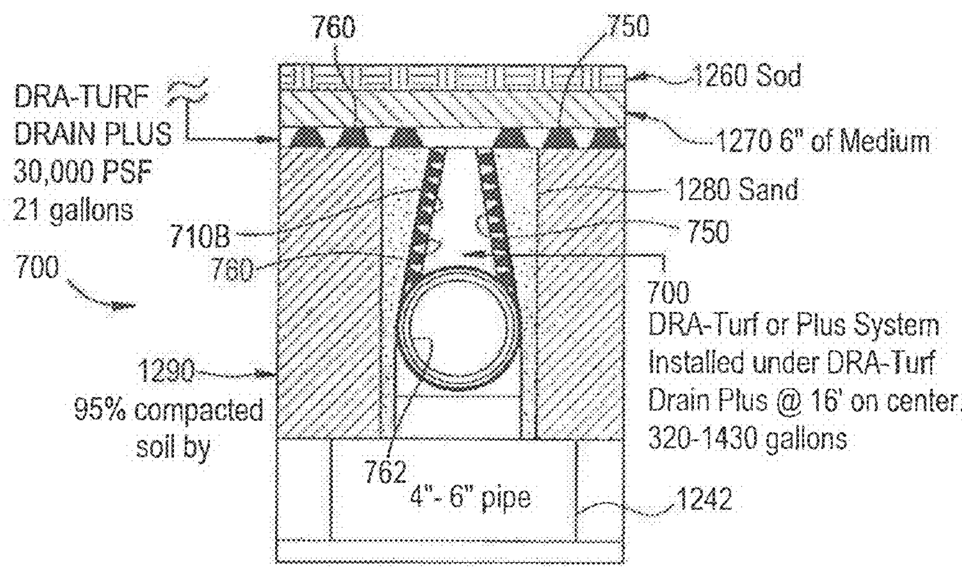


FIG. 27A FIG. 27B FIG. 27C

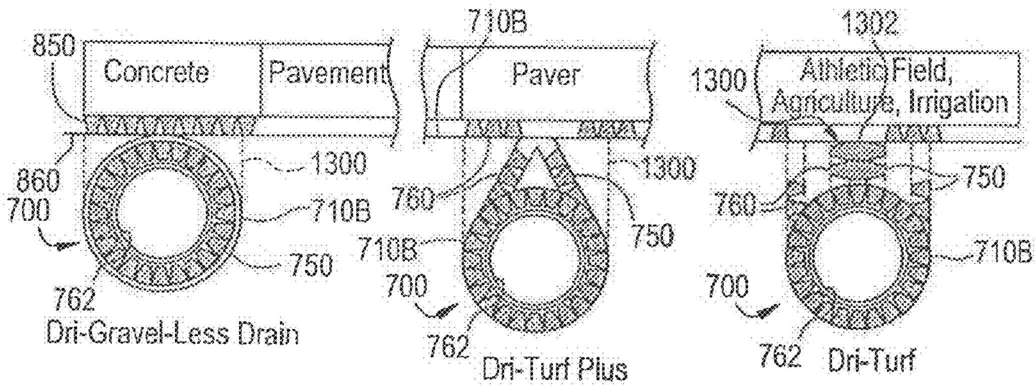


FIG. 28A

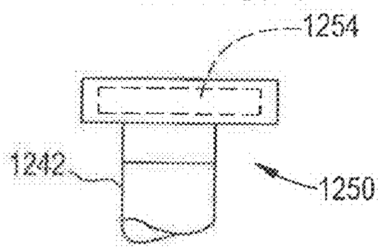


FIG. 28B

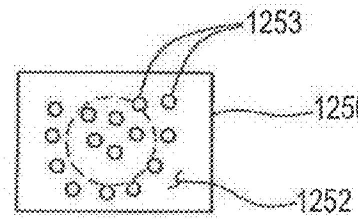


FIG. 29

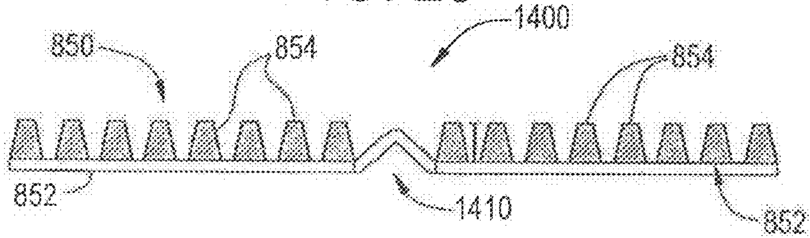


FIG. 30

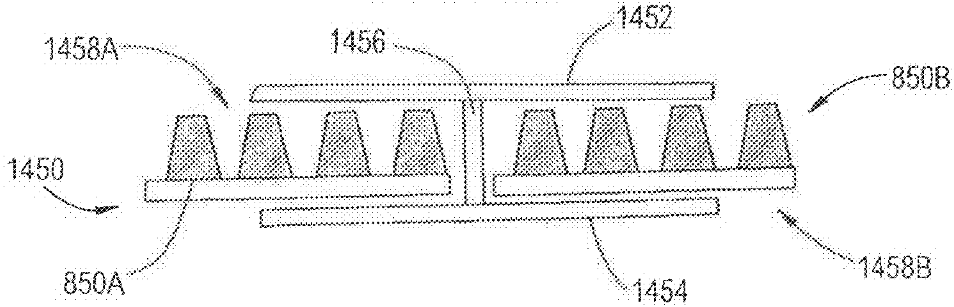


FIG. 31

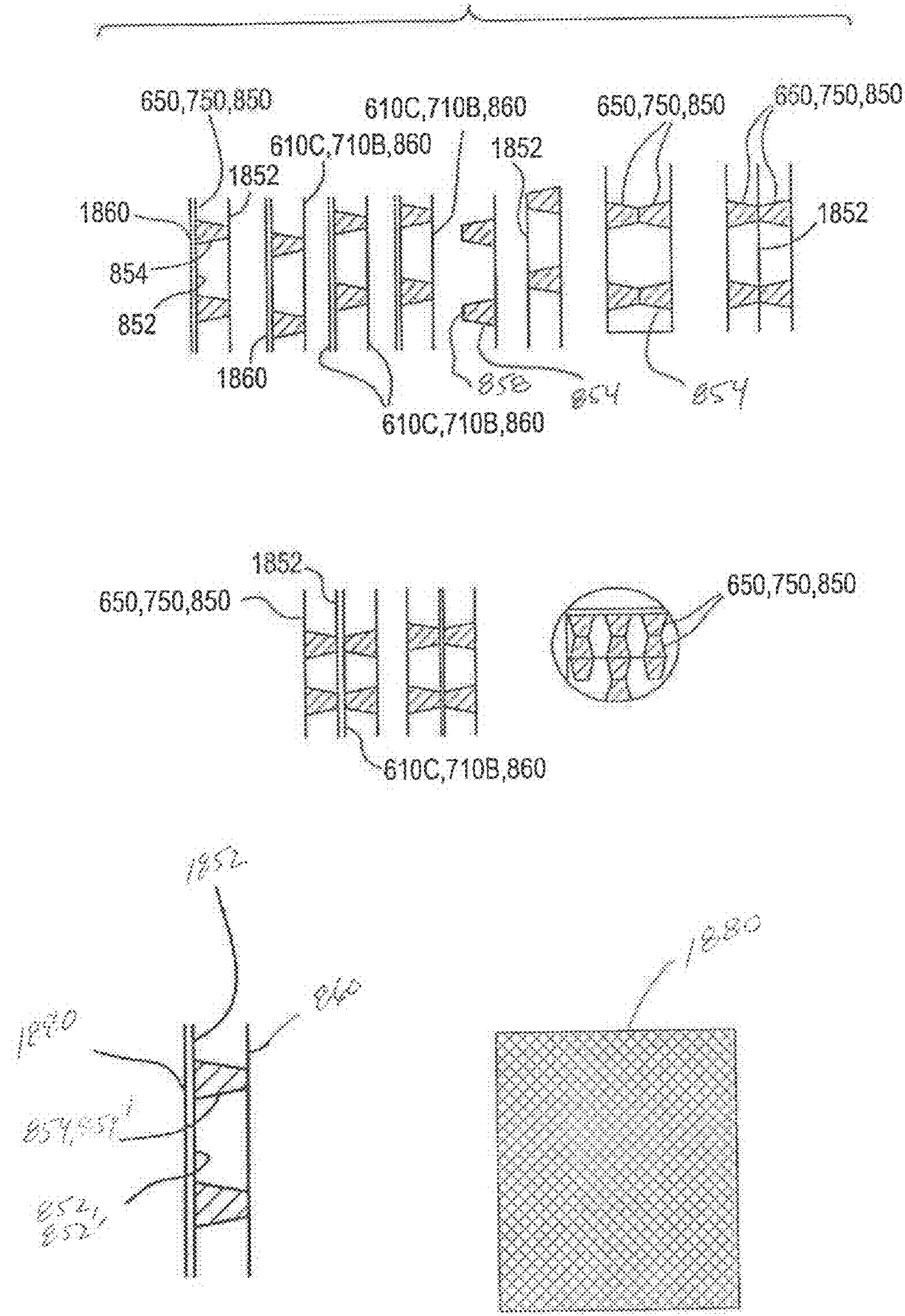

650,750,850
1852
1860
854
852
610C,710B,860
1860
610C,710B,860
1852
858
854
650,750,850
854
650,750,850
1852
1852
650,750,850
650,750,850
610C,710B,860
1852
1880
860
1880

Fig. 32

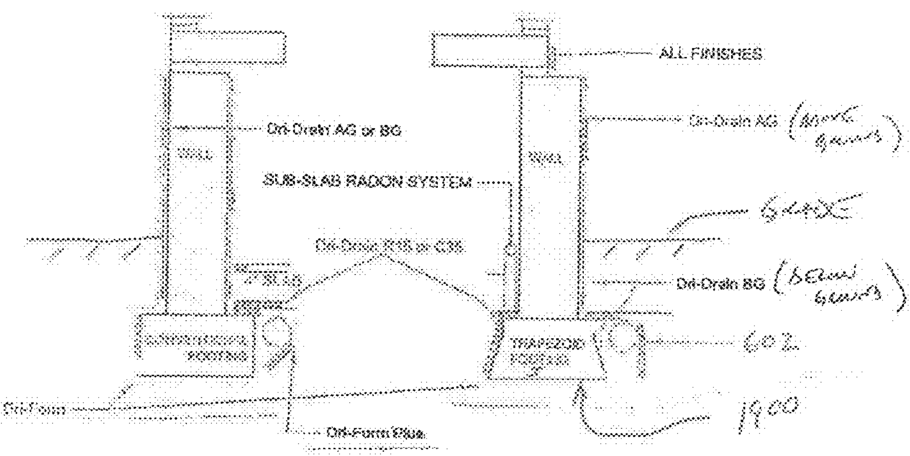
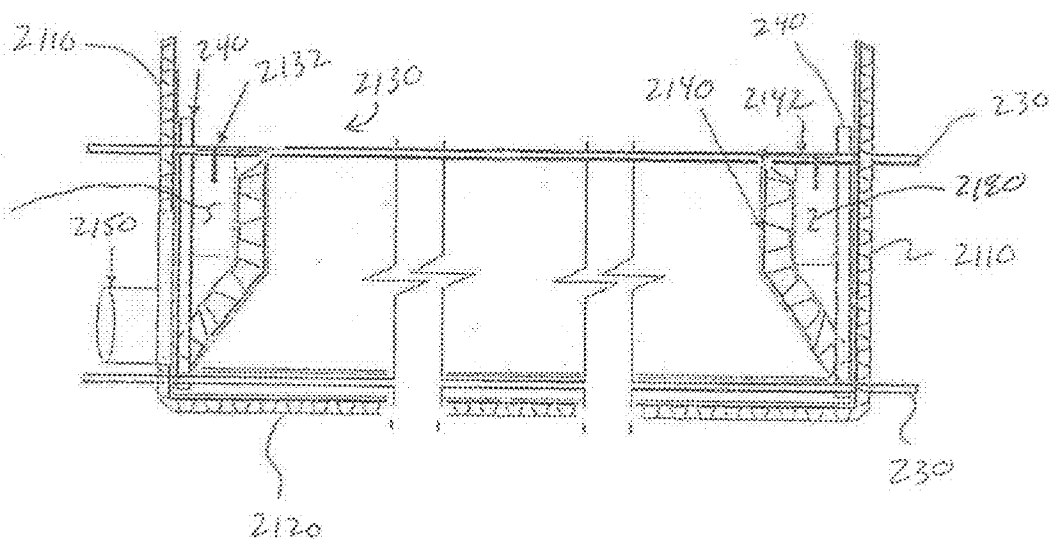

ALL FINISHES
Dri-Drain AG or BG
Dri-Drain AG (above grade)
SUB-SLAB RADON SYSTEM
GRADE
Dri-Drain BG (below grade)
TRAPEZOID FOOTING
602
Dri-Form
Dri-Form Plus
1900

Fig. 33


2110
240
2132
2130
2100
2140
2142
230
2180
2150
2120

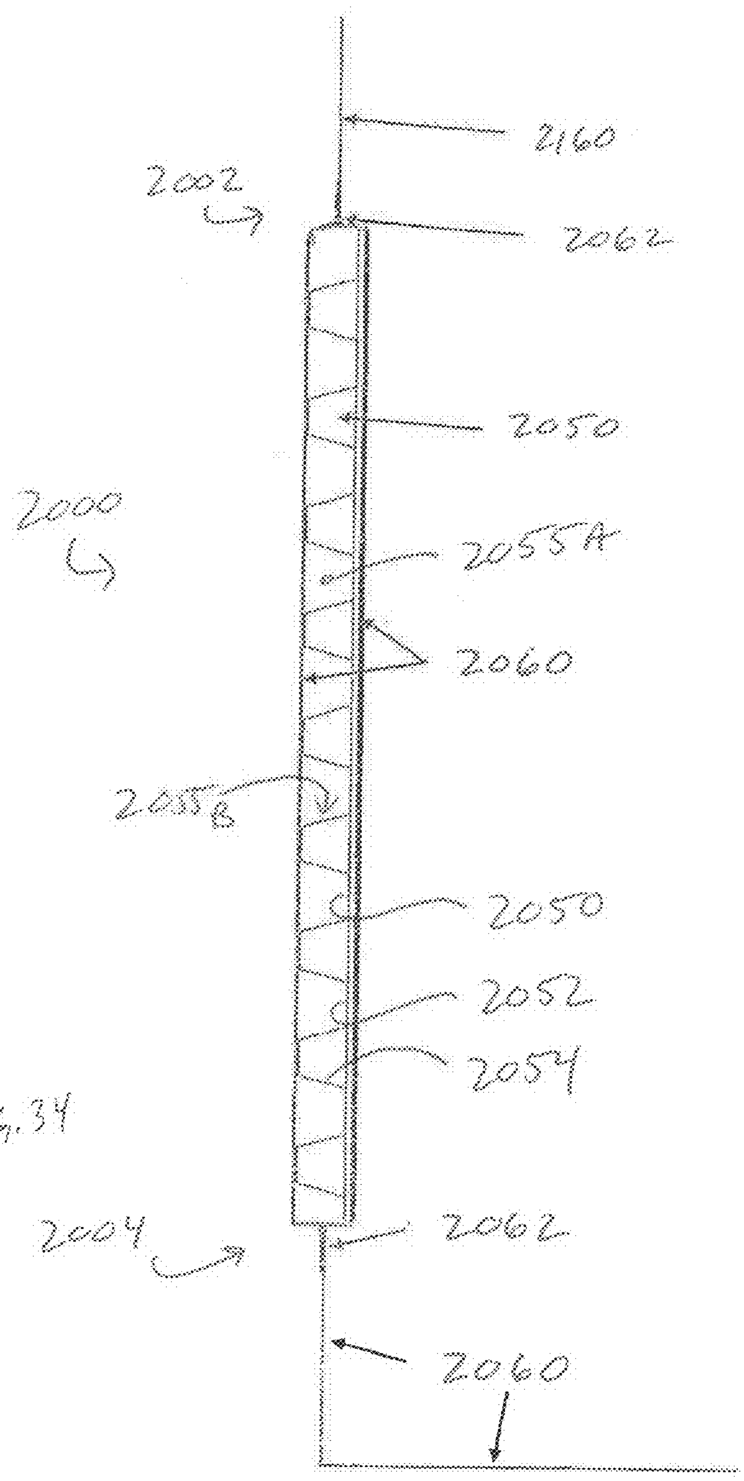

2160
2002
2062
2050
2000
2055A
2060
2055B
2050
2052
2054
2004
2062
2060

Fig. 34

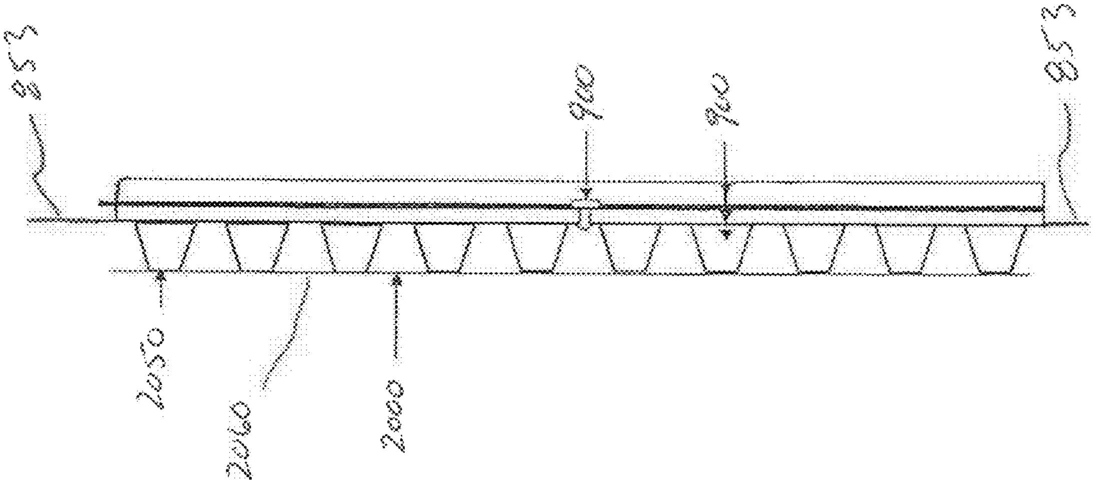

853
900
900
853
2050
2060
2000

Fig. 36

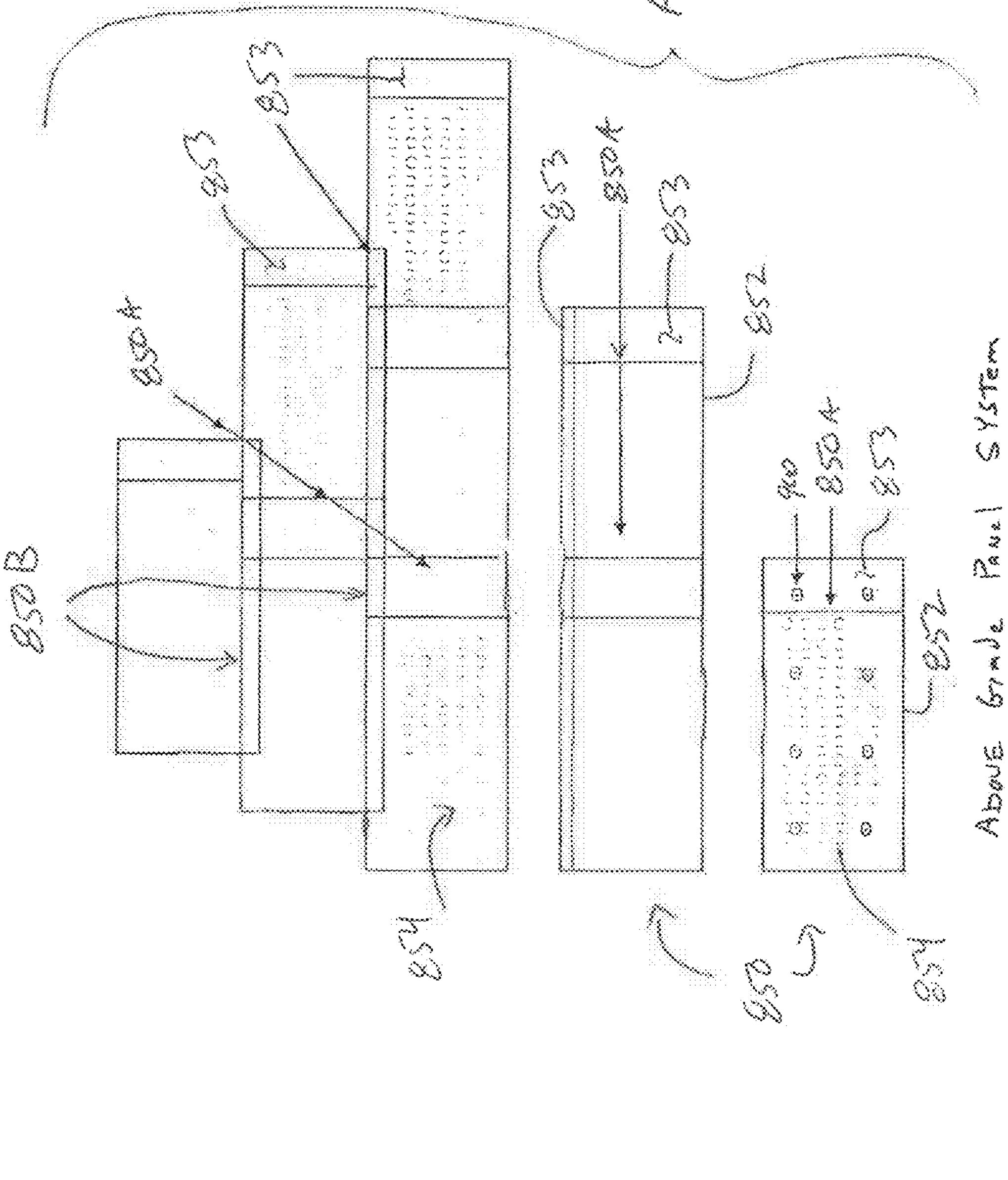

850B
850A
853
853
853
850A
853
852
854
850
900
850A
853
852
854
Above Grade Panel System

Fig 35

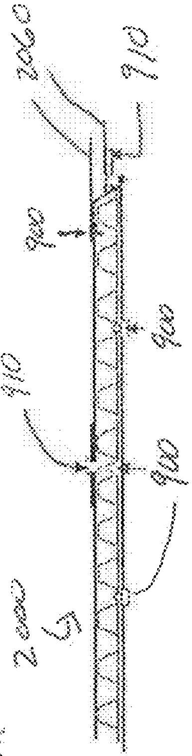

2060
910
900
900
910
900
2000
900

Fig. 38

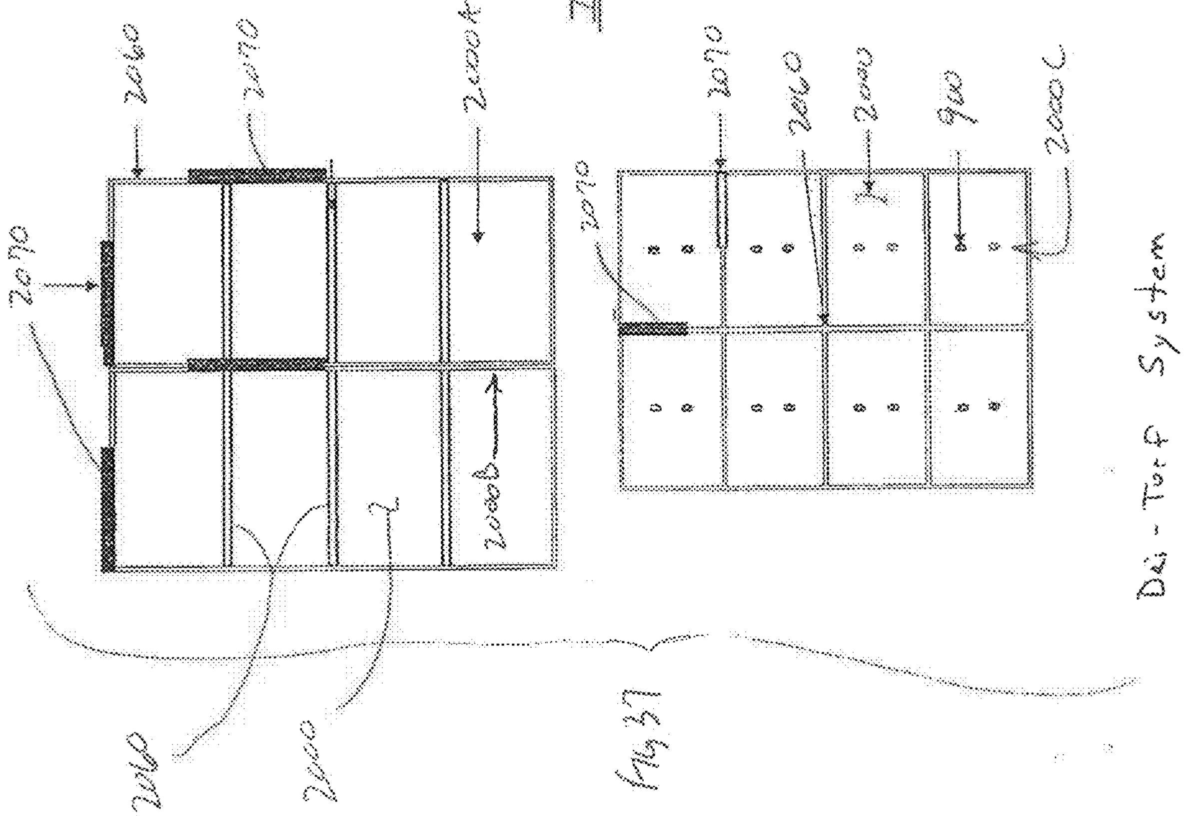
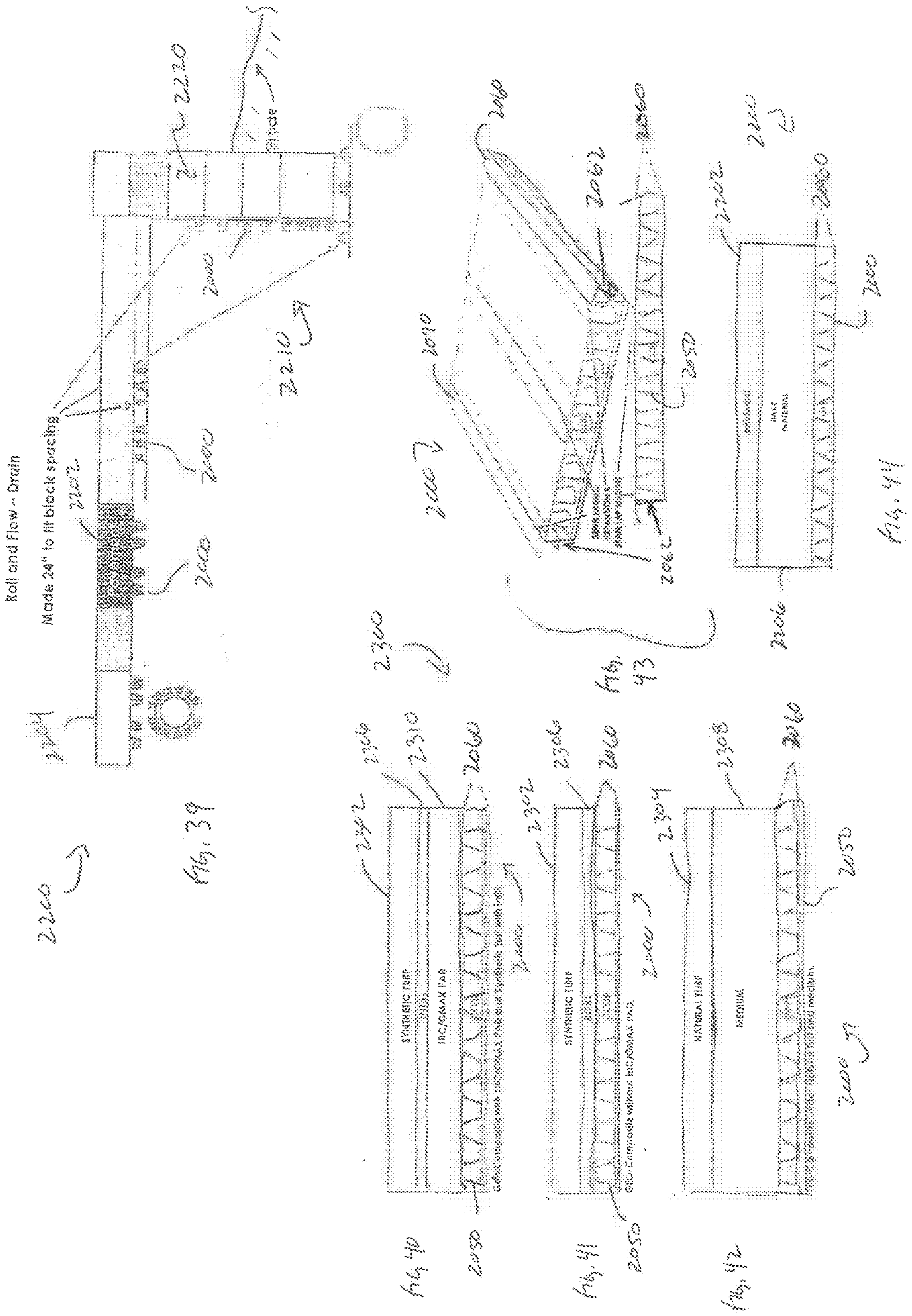

2070
2060
2070
2000A
2000B
2060
2000
2070
2070
2060
2000
900
2000C
Dri-Turf System

Fig 37


Roll and Flow – Drain
Made 24" to fit block spacing
Grade
SYNTHETIC TURF
IRC/ZOMAX PAD
SYNTHETIC TURF
NATURAL TURF
MEDIUM
BASE MATERIAL

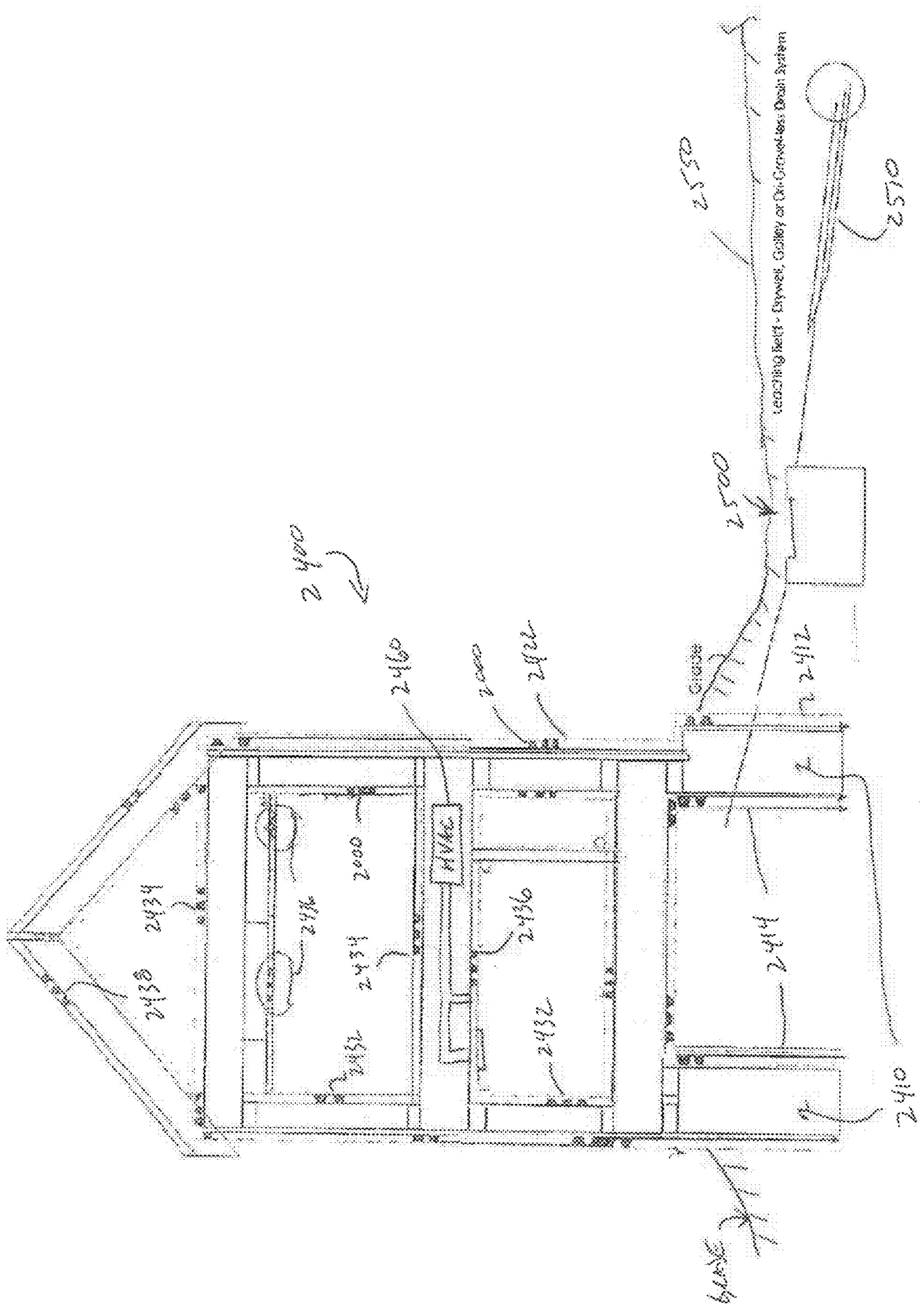

Leaching Bed - Drywell, Gallery or On-Gravel-less Drain System
HVAC
Grade
Grade

Fig. 45

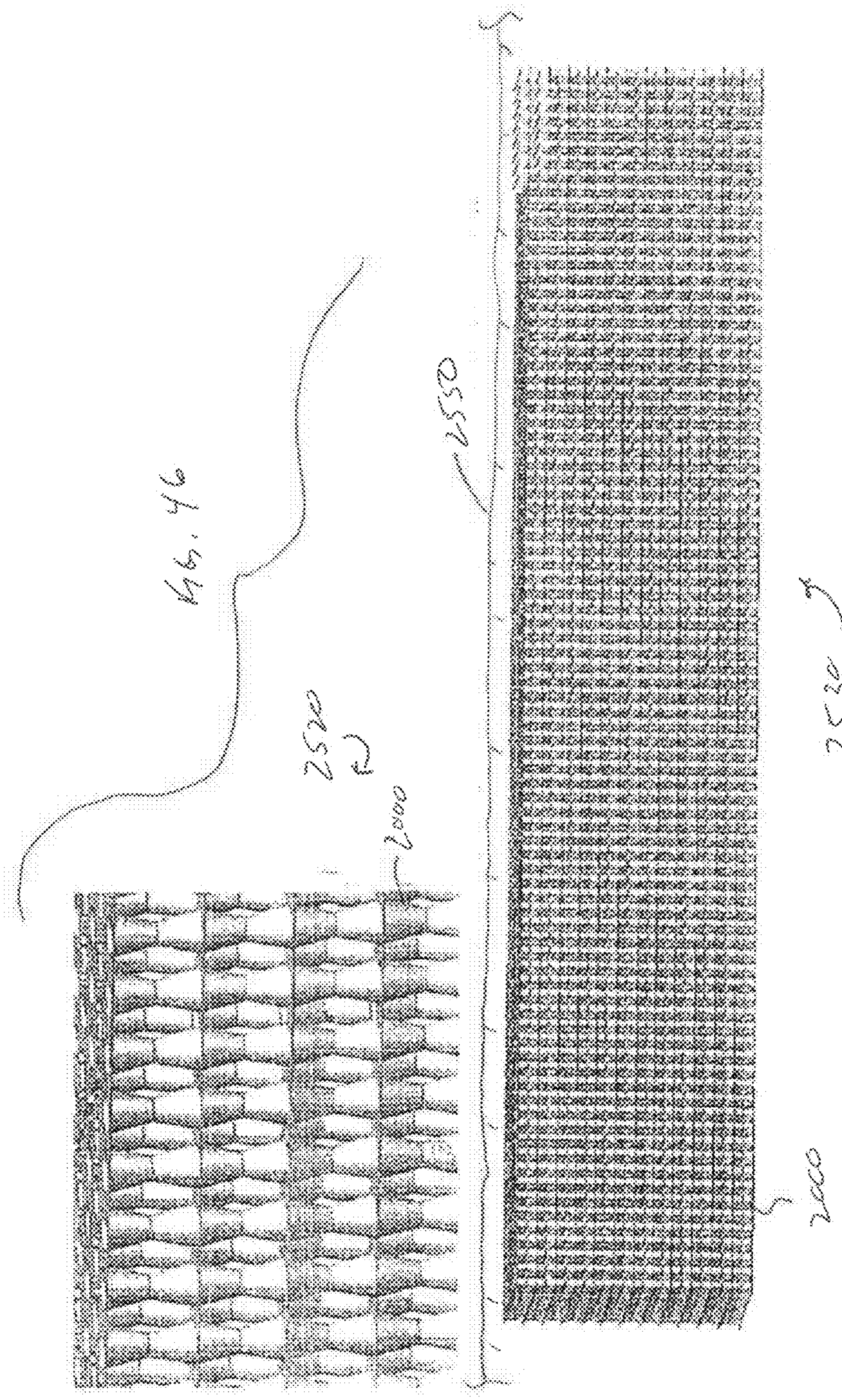


Fig. 46
2550
2520
2000
2530
2000

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 Subtrate — **Dimples unfilled**

Test Configuration 1	Drainage Core and Fabric Configuration -- 8 mm					
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical 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
	Drop3	3.02	14.37	3.21	169	713
	Mean Results			3.19	166	697

Test Configuration 1	Drainage Core and Fabric Configuration -- 10 mm					
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical 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
	Drop3	3.02	14.17	3.12	168	810
	Mean Results			3.17	158	681

Test Configuration 1	Drainage Core and Fabric Configuration -- 12 mm					
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical 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
	Drop3	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					
Test Configuration 2	**Test Iteration**	**Drop Height (ft)**	**Impact Velocity (ft/s)**	**Theoretical 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

	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	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					
Test Configuration 2	**Test Iteration**	**Drop Height (ft)**	**Impact Velocity (ft/s)**	**Theoretical 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 Subtrate

Dimples filled with mixture of adhesive and crumb rubber

Test Configuration 1	Drainage Core and Fabric Configuration -- 8 mm					
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	3.00	14.05	3.07	182	713
	Drop 2	3.01	14.02	3.06	182	735
	Drop3	3.01	14.09	3.09	181	717
	Mean Results			3.07	182	722

Test Configuration 1	Drainage Core and Fabric Configuration -- 10 mm					
	Test Iteration	Drop Height (ft)	Impact Velocity (ft/s)	Theoretical Impact Height (ft)	Gmax Result	HIC Result
	Drop 1	3.03	14.02	3.06	182	764
	Drop 2	3.04	13.98	3.04	180	729
	Drop3	3.05	14.01	3.05	180	719
	Mean Results			3.05	181	737

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

Test Configuration 2	Drainage Core and Fabric Configuration -- 8 mm					
	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
	Drop3	7.00	21.23	7.01	170	982
	Mean Results			7.01	162	923

Test Configuration 2	Drainage Core and Fabric Configuration -- 10 mm					
	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
	Drop3	7.09	21.38	7.10	175	982
	Mean Results			7.06	170	925

Test Configuration 2	Drainage Core and Fabric Configuration -- 12 mm					
	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
	Drop3	7.12	21.34	7.08	162	957
	Mean Results			7.08	159	913

FIG. 48B

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

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of co-pending U.S. Continuation patent application Ser. No. 17/697,332, filed on Mar. 17, 2022, which claims the benefit under 35 U.S.C. § 119 (c) of U.S. Provisional Patent Application Ser. Nos. 63/162,765, filed Mar. 18, 2021, and 63/275,648, filed Nov. 4, 2021. The '332 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 Dec. 24, 2020, which is a continuation application of U.S. patent application Ser. No. 16/793,458, filed on Feb. 18, 2020, now abandoned, which claims the benefit as a continuation of International Patent Application Ser. No. PCT/US2018/000367, filed on Aug. 20, 2018, which claims the benefit of U.S. Non-Provisional patent application Ser. No. 15/971,247, filed on May 4, 2018, now U.S. Pat. No. 11,008,750, issued on May 18, 2021, and of U.S. Provisional Patent Application Ser. No. 62/547,441, filed on Aug. 18, 2017. The disclosures of each of the aforementioned patent documents are incorporated herein by reference in their entireties.

COPYRIGHT NOTICE

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. Pat. No. 7,866,097, commonly owned U.S. Pat. No. 8,627,615, and commonly owned U.S. Pat. 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 vencer.

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

[0023] FIG. **1**B 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. **8**A is a plan view and FIG. **8**B is a side view, respectively, of a separator bar configured in accordance with one embodiment of the present invention;

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

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

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

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

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

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

[0037] FIG. **12**D 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. **12**E 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. **12**F 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. **12**G 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. **12**H is a partial cross-sectional view of the components of the form system of FIG. **12**D having a barrier installed therein, in accordance with one embodiment of the present invention;

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

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

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

[0045] FIG. **12**L 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. **12**M is a detail view of a component of the form system of FIG. **12**L;

[0047] FIG. **12**N 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. **12**O 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. **12**P is a depiction of several components of the form system of FIG. **12**N prior to assembly for installation in the form system, in accordance with one embodiment of the present invention;

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

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

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

[0053] FIG. **15**A 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. **15**B and **15**C 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. **15**D and **15**E are partial cross-sectional views of another embodiment of the form system of FIG. **15**A;

[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. **18**A 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. **18**B 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. **18**C 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. **18**D 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. **18**E 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. **23**A and **23**B 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. **24**A, **24**B, **24**C and **24**D are elevation views of a gravel-less drainage and ventilation system, configured in accordance with embodiments of the present invention;

[0069] FIGS. **25**A and **25**B 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] FIG. **26**A is an elevation view, FIG. **26**B is an end view, FIG. **26**C is a cross section view and **26**D 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. **27**A, **27**B and **27**C are cross section views of gravel-less drainage and ventilation systems, configured in accordance with embodiments of the present invention;

[0072] FIG. **28**A is an elevation view and FIG. **28**B is a plan view of a drain member component of the drainage and ventilation system of FIG. **26**C, 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. **47**A and **47**B illustrates GMAX and HIC test results for drainage and ventilation systems, configured in accordance with an embodiment of the present invention; and

[0090] FIGS. **48**A and **48**B 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. **1**A, **1**B 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 H**1**, width W**1**, length L**1** and shape S**1**) 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 L**1** of and/or partially within the excavated area **190**. As shown in FIG. **1**A, 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 H**1**, width W**1**, length L**1** and shape S**1**) 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. **1**A and **1**B 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 L**1** 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 **120**A and **120**B 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 **162**A and **162**B, 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 **164**A and **164**B, comprising the second wall **164** of the configuration. FIGS. **4** and **5** illustrate two bracket assemblies **120**A and **120**B disposed at opposite ends and retaining pieces of elongated wooden planks **162**C and **164**C, comprising the first side wall **162** and the second side wall **164**, in a vertical orientation and horizontally distant relation. FIGS. **6**, **7** and **12**G illustrate two bracket assemblies **120**A and **120**B disposed at opposite ends and retaining two pieces of elongated rectangular conduit **162**D and **162**E of the first side wall **162** in a vertically stacked orientation and a horizontally distant relation from two pieces of elongated rectangular conduit **164**D and **164**E of the second wall **164**.

[0097] Referring again to FIG. **2**, in one embodiment, the bracket assembly **120** (e.g., each of bracket assemblies **120**A and **120**B) includes one or more separator bars **130** and two or more reinforcement posts **140**, illustrated in greater detail at FIGS. **8**, **9**A and **9**B, **10**D and **10**E, respectively. The separator bars **130** and the reinforcement posts **140** cooperate to retain the side walls **160**, and components **162**A-**162**E and **164**A-**164**E 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. **8**A and **8**B, 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 L**2** 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. **1**A) 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 L**2** of the separator bar **130** and are sized to receive the reinforcement posts **140**. As illustrated in FIGS. **9**A and **9**B, in one embodiment each of the reinforcement posts **140** includes serrations **144** disposed along at least a portion of a length L**3** 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. **10**D and FIG. **10**E, 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. **8**A, 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 **135**A proximate the end **136** corresponds to the location for constructing the first side wall **162** and a second set of indicia **135**B 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 **140**A 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 **140**A is disposed externally with respect to the channel **192** (e.g., disposed at a location shown generally at **192**A), and a second post **140**B 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 **140**B is disposed internally with respect to the channel **192** (e.g., disposed at a location shown generally at **192**B) to externally and internally bound the components used to construct the first side wall **162** between the first pair of reinforcement posts **140**A and **140**B. Similarly, during construction of the second side wall a first post **140**C 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 **140**C is disposed externally with respect to the channel **192** (e.g., disposed at a location shown generally at **192**C), and a second post **140**D of the second pair of reinforcement posts **140** is placed within an aperture **134** inwardly from the end **138** such that the reinforcement post **140**D is disposed internally with respect to the channel **192** (e.g., disposed at about location **192**B), to externally and internally bound the components used to construct the second side wall **164** between the second pair of reinforcement posts **140**C and **140**D.

[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 with 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. **10**A, 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. **10**A, 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. **10**B and **10**C, 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. **11**A to **11**D, 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 H**1** (extending in a plane vertically out of the drawing sheet), width W**1**, length L**1** (including legs LIA, LIB, LIC, etc.) and shape S**1** 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. **11**B, 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 **192**A) and interior (e.g., within area **192**C) 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 **192**B). 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 (½ 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. **1**B, **11**C and **11**D, 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 **184**A, 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 **192**A, **192**B and **192**C, 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 **192**A, **192**B and/or **192**C). 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 **192**A, **192**B, and/or **192**C) 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 **192**A) and/or interior perimeter (e.g., within area **192**C) 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. **12**A and **12**B, in one embodiment the inventive form system **100** includes one or more bracket assemblies **220** disposed at varying intervals along the length L**1** 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**, **14**A and **14**B, 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 L**4** 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. **1**A) 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 L**4** 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. **14**A and **14**B, in one embodiment each of the reinforcement posts **240** includes protrusions or serrations **244** disposed along at least a portion of a length L**5** 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. **14**B, two posts **240**A and **240**B of the reinforcement posts **240** may be nested such that the reinforcement post **240**A is vertically adjustable over a height H**2** within the reinforcement post **240**B. As can be appreciated by one skilled in the art, this vertical adjustment over the height H**2** of the nested reinforcement posts **240**A and **240**B 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 **240**B 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 **235**A 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 **235**B 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. **12**B and **12**C. 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 HOF**1** and a vertical offset VOF**1**) of one or more components used to construct the side walls **260** configured to approximate a leg of a trapezoid (FIG. **12**B). As shown in FIG. **12**D, 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. **12**A and **12**B, during construction of a first side wall **262**, the first reinforcement post **240**A is nested within the second reinforcement post **240**B 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 **240**A and **240**B are disposed externally with respect to the channel **192** (e.g., disposed at about location **192**A). A third post **240**C is then placed within another aperture **234** inwardly from the end **236** such that the third reinforcement post **240**C is disposed internally with respect to the channel **192** (e.g., disposed at about location **192**B) to externally and internally bound a first component **262**A and a second component **262**B (e.g., tubular members) used to construct the first side wall **262** between the nested, externally disposed reinforcement posts **240**A and **240**B and the internally disposed reinforcement post **240**C. As shown in FIG. **12**B, a spacer **280**A is disposed over the nested, externally disposed reinforcement posts **240**A and **240**B and cooperates with a fourth reinforcement post **240**D to maintain an offset relation between the first component **262**A and the second component **262**B of the first side wall **262**, for example, the horizontal offset HOF**1** and the vertical offset VOF**1**. Similarly, during construction of the second side wall **264**, a fifth reinforcement post **240**E is nested within a sixth reinforcement post **240**F 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 **240**E and **240**F are disposed externally with respect to the channel **192** (e.g., disposed at about location **192**C). A seventh reinforcement post **240**G is then placed within an aperture **234** inwardly from the end **238** such that the seventh reinforcement post **240**G is disposed internally with respect to the channel **192** (e.g., disposed at about location **192**B) to inwardly bound a first component **264**A and a second component **264**B (e.g., tubular members) used to construct the second side wall **264** between the nested, externally disposed reinforcement posts **240**E and **240**F and the internally disposed reinforcement post **240**G. As shown in FIG. **12**B, a spacer **280**B is disposed over the nested, externally disposed reinforcement posts **240**E and **240**F and cooperates with an eighth reinforcement post **240**H to maintain an offset relation between the first component **264**A and the second component **264**B of the second side wall **264**, for example, the horizontal offset HOF**1** and the vertical offset VOF**1**. One skilled in the art, when viewing FIGS. **12**A, **12**B and **12**D, 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. **12**C, a partial cross-sectional view, a spacer **280**C is disposed over the nested, externally disposed reinforcement posts **240**A and **240**B and cooperates with a ninth reinforcement post **240**I to maintain an offset relation between the first component **262**A, the second component **262**B and a third component **262**C of the first side wall **262**, for example, the horizontal offset HOF**1** and the vertical offset VOF**1** between the first component **262**A and the second component **262**B, and a horizontal offset HOF**2** between the first component **262**A and the third component **262**C and a vertical offset VOF**2** between the second component **262**B and the third component **262**C. In one embodiment, a plurality of spacers of similar length as the spacer **280**C (e.g., spacers **280**C**1** and **280**C**2**) may be employed to maintain a common offset as fourth and fifth components **262**D and **262**E are added to increase the height of the first side wall **262**. Accordingly, the first side wall **262** of FIG. **12**C includes a lower portion having a generally trapezoidal cross-section, and an upper portion having a generally rectangular cross-section.

[0114] While FIGS. **12**A to **12**C illustrate for clarity, relatively similar vertical and horizontal offsets (e.g., HOF**1**, HOF**2**, VOF**1**, VOF**2**) between components (e.g., **262**A, **262**B, **262**C, **264**A, **264**B, **264**C) 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. **12**A to **12**C, 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 **240**C, that inwardly bounds the components of the side wall **260** (e.g., the second component **262**B). 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 H**1** 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., HOF**1**, HOF**2**, VOF**1**, VOF**2**) between components (e.g., **262**A, **262**B, **262**C, **264**A, **264**B, **264**C) 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. **12**D, large diameter conduits **462**B and **464**B (e.g., a six inch (6")/(15.24 cm) O.D. pipe) are stacked on top of smaller diameter conduits **462**A and **464**A (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 **440**A, **440**B, **440**C and **440**D. In one embodiment, mating pairs of the reinforcement posts (e.g., outwardly bounding post **440**A and inwardly bounding post **440**B, and outwardly bounding post **440**C and inwardly bounding post **440**D) 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. **12**E, 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 **562**A and **564**A.

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

[0117] In still another embodiment, illustrated in FIG. **12**F, a barrier **510** is disposed between the outwardly bounding and inwardly bounding posts, e.g., **440**A and **440**B, and **440**C and **440**D, to support the conduits **462**A, **462**B, **464**A and **464**B. For example, in one embodiment shown in FIG. **12**F, the barrier **510** may be comprised of a foam insulation board **510**A 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. **12**H, the barrier **510** may be comprised of a fabric or sheet material **510**B such as a landscape fabric. In one embodiment, the fabric or sheet material **510**B is comprised of or treated to provide fire resistant properties. In one embodiment, the fabric **510**B is secured to the soil via, for example, stakes **512**. In the embodiment shown in FIG. **12**H, the fabric **510** is wrapped around large diameter conduits **462**B and **464**B and proximate smaller diameter conduits **462**A and **464**A thereby forming the channel **192**. In the embodiment shown in FIG. **12**I, the fabric **510**B is wrapped around large diameter conduits **462**B and **464**B and proximate building materials **450**. In one embodiment as shown in FIG. **12**J, the foam board **510**A and the sheet material **510**B cooperate to form a first layer and a second layer of the barrier **510** wherein the fabric **510**B is wrapped around conduits **462**A and **462**B and proximate the foam board **510**A. In one embodiment as shown in FIG. **12**K, the fabric **510**B is wrapped around conduits **162**D and **162**E.

[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 **462**A, **462**B, **464**A and **464**B (FIG. **12**H). For example, the barrier **510** prevents backfill from entering the volume **520** between the outwardly bounding post (e.g., **140**A, **440**A) and the inwardly bounding post (e.g., **140**B, **440**B). In one embodiment, the barrier **510** surrounds or envelops the conduits **462**A, **462**B, **464**A and **464**B to prevent backfill from entering the volume **520**. In one embodiment, illustrated in FIGS. **12**L and **12**M, one or more of the conduits **462**A, **462**B, **464**A and **464**B 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. **15**A and **15**B, sectional views of embodiments of the inventive form **100** are illustrated for use in forming elements of the foundation **200**, namely, a footing **202**A having a generally rectangular cross-section and a footing **202**B having a generally trapezoidal cross-section. The side walls **160** of the footing **202**A 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 **202**B are formed of the stacked, offset conduits (e.g., components **162**A, **162**B, **164**A, **164**B, **262**A, **262**B, **264**A and **264**B) 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 **262**A, **262**B, **264**A and **264**B 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 **262**A, **262**B, **264**A and **264**B include means for receiving gases from the soil **194** within the areas **192**A and **192**C 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 **192**A and **192**C external and internal to footing **202** and under the slab **206**. Similarly, one or more of the stacked components **262**A, **262**B, **264**A, **264**B include apertures or slots **168** to receive the gases permeating from the soil **194** within the areas **192**A and **192**C proximate the footing **202** and under the slab **206**.

[0121] As shown in FIGS. **15**A to **15**E, one or more cross-venting pipes or conduits **320** may be installed during construction communicating between the two corrugated conduits **170** and/or components **262**A, **262**B, **264**A, **264**B of the footing **202** to provide the passage **180** for air flow communication between the corresponding conduits **170** and/or components **262**A, **262**B, **264**A, **264**B to facilitate venting and/or removal of gases, moisture and the like (FIGS. **15**A, **15**B, and **15**D) and/or the addition of heated or cooled air within, and when coupled to conduit **310**, outside the structure (FIGS. **11**C, **11**D, **15**C and **15**E). 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 **16**A and a second form assembly **16**B that form sidewalls forming the footing **12**, for example by cooperating with the bracket system **220** to form the sidewalls **260** of FIGS. **15**B and **15**C, 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. **12**N and **12**O and includes a first form assembly **502** and a second form assembly **504** that form sidewalls, for example the sidewalls **260** of FIGS. **15**B and **15**C. Referring first to FIG. **12**N, the barrier **510** includes the sheet material **510**B disposed around a first drainage core **550**, a second drainage core **560**, and a conduit such as, for example, conduits **562**A and **564**A. In one embodiment, conduits **562**A and **564**A are perforated conduits such that a flow of ground or subsurface water can be received therein. In one embodiment, the sheet material **510**B is formed into a sleeve or pocket **563** thereby eliminating the need for a conduit wrapped by a barrier material. Alternatively, conduits **562**A and **564**A 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 **562**A and **564**A. In one embodiment, the first drainage core **550** is a single-drainage core **550**A (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 **560**A (e.g., permits passage of liquid through the core in two directions). Thus, a passageway is created through the dual-drainage core **560**A 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 **562**A and **564**A and the respective dual-drainage core **560**A 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. **12**O, the first drainage core **550** is configured as an extended first drainage core **550**B extending to an upper point **550**X proximate the top of the respective conduit **562**A or **564**A. In one embodiment, the second drainage core **560** is an extended second drainage core **560**B extending to an upper point **560**X proximate the top of the respective conduit **562**A or **564**A. In one embodiment, both the extended first drainage core **550**B and the extended second drainage core **560**B 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. **12**O, 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 Tl 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. **12**N and **12**O, the configuration of the first drainage core **550**, the second drainage core **560**, and the respective conduit **562**A and **564**A form a channel **592** and provide for the elimination of a dual-reinforcement post configuration. As shown in FIGS. **12**N and **120**, such a configuration includes only outwardly bounding reinforcement posts **440**A and **440**D and does not require respectively corresponding inwardly bounding reinforcement posts **440**B and **440**C. However, the use of respectively corresponding inwardly bounding reinforcement posts **440**B and **440**C with the configuration of the first drainage core **550**, the second drainage core **560**, and the respective conduit **562**A and **564**A 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 **562**A and **564**A 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. **12**P, one embodiment of the first drainage core **550**, the second drainage core **560** and the conduit **564**A includes individually wrapping the components with the barrier **510** or a sheet material **510**C of the fabric **510**B and setting the components in relation to one another as shown in FIG. **12**P, 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 **564**A 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 R**2**. The wrapped conduit **564**A 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. **12**Q. 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. **15**B and **15**C. A barrier **610** includes an inner layer **611**A wrapped by an outer layer **611**B. In one embodiment, the inner layer **611**A includes a first drainage core **650** and a second drainage core **660**. In one embodiment, the outer layer **611**B is a fabric **610**B. The fabric **610**B is wrapped around the first drainage core **650**, the second drainage core **660**, and a conduit such as for example conduits **662**A and **664**A. In one embodiment, conduits **662**A and **664**A are perforated conduits. In one embodiment, the fabric **610**B is formed into a sleeve or pocket **663** through which the conduits **662**A and **664**A 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 **662**A and **664**A.

[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 **711**A wrapped by an outer layer **711**B. In one embodiment, the inner layer **711**A includes a first drainage core **750** and a second drainage core **760**. In one embodiment, the outer layer **711**B is a fabric **710**B. The fabric **710**B 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 **710**B 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. **12**Q. FIG. **18**A 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 **855**A extending in a first direction through the core **850** (e.g., along a row of dimples **854**), and a second plurality of passages **855**B extending in a second direction through the core **850** in a substantially orthogonal orientation to the first plurality of passages **855**A (e.g., along a column of dimples **854**). It should be appreciated that depending on orientation of the drainage core **850**, the passages **855**A and **855**B 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. **18**A, 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 **855**A and the second plurality of passages **855**B. 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 **855**A and the second passages **855**B. 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. **18**C 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. **18**D 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 $D1_{DIMPLE}$ at an end proximate the surface **853'** of the sheet **852'** and extending to a second inner diameter $D2_{DIMPLE}$ at an opposite end **858'** from the surface **853'**. Similar to the inner diameter D_{DIMPLE}, the first inner diameter $D1_{DIMPLE}$ and the second inner diameter $D2_{DIMPLE}$ 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 **855**A and the second plurality of passages **855**B defined by and at the perimeter of the dimples **854** and **854'**. As illustrated in FIGS. **18**A and **18**D, 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}, $D1_{DIMPLE}$ and $D2_{DIMPLE}$, 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. **18**D and **18**E 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. **47**A, **47**B, **48**A, and **48**B 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. **47**A and **47**B 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. **48**A and **48**B 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. **47**A, **47**B, **48**A, and **48**B. 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. **11**C and **11**D, it should be appreciated that in various embodiments the inventor has found that the first plurality of passages **855**A and the second plurality of passages **855**B 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. **11**C and **11**D) such as, for example, a heating and/or cooling unit **184**A, 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 scaling of penetrations and the like). As noted in embodiments described herein, the passages **855**A and **855**B 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 **855**A and **855**B 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 **855**A and **855**B 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. **18**B, one embodiment of forming system, the barrier **610**, **710** includes providing a sheet **610**C of the fabric **610**B integrally formed with the sleeve **663** extending between portions **610**D and **610**E of fabric sheet **610**C 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 **662**A, is disposed within the sleeve **663** (FIG. **16**). In one embodiment, the fabric **610**B 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 **610**B exhibits a grab tensile strength greater than 100 lbs. and an elongation that is greater than fifty percent (50%). In one embodiment, the fabric **610**B 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 **610**B exhibits a permittivity greater than 1 s^{-1} and a permeability of at least 0.05 cm/s. In one embodiment, the fabric **610**A 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. **18**A and **18**B, 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 **610**B and **710**B, shown generally at **860**, such that the fabric **610**B and **710**B (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 **610**B and **710**B (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 **610**B, **710**B or fabric sheet **610**C (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 **610**B or fabric sheet **610**C (FIGS. **16** and **18**B). 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 **2**A having an integrally formed drainage and ventilation system therein as described hereinabove. In one embodiment, one form assembly **602**A, 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 **602**B 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 **2**B. In one such embodiment, one form assembly **602**C is positioned on an inward side **2**C of footing **2**B; and a second form assembly **602**D is positioned on an outward side **2**D of footing **2**B. In one embodiment, first drainage core **650** and second drainage core **660** can be positioned proximate the existing foundation footing **2**B. 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 1 s^{-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 1 s^{-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 **662**A and **664**A, 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 **662**A and **664**A 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 **762**A 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. **23**A and **23**B, the barriers **610** and **710** including drainage cores **650**, **660**, **750**, **760**, **850** and outer fabric **610**B, **710**B, **860** (FIGS. **16**, **17**, **18**A and **18**B) 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**, **18**A and **18**B, 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 **610**B, **710**B and **860** such that the fabric **610**B, **710**B 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 **610**B, **710**B, **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. **18**A and **18**D) can accept the plaster, stucco, mortar or other adhesive for bonding the tile, stone, brick, or masonry vencer, 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 **610**B, **710**B, **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 **610**B, **710**B to leave a surface of the drainage core **650**, **660**, **750**, **760**, **850** exposed. In this embodiment, the fabric layer **610**B, **710**B 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 vencer thereto.

[0167] As shown in FIGS. **17** and **19**, the conduit **762** and drainage cores **750** and **760** wrapped in the fabric **710**B 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. **24**A to **24**D), the system **700** including substantially flat and/or sloped horizontal **700**A and vertical **700**B 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. **25**A and **25**B 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 **710**B). Dri-Turf is a trademark of DRFF, LLC, Shelton, CT US. As shown in FIG. **25**B, 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. **25**B, 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. **25**B, 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. **26**A to **26**D, 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. **26**A and **26**B, 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. **26**D. In one embodiment illustrated in FIGS. **26**A and **26**B, 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 **26**C-**26**C) of one embodiment of the athletic field **1200** is illustrated in FIG. **26**C. In some embodiments, the athletic field **1200** may be a soccer field, football field, baseball field, golf course (e.g., fairways and greens), of the like. As shown in FIG. **26**C, 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. **26**C and **26**D, 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. **26**D, as with previous embodiments, the drainage and ventilation system **700** includes the drainage cores **750** and **760** and conduit **762** wrapped in the fabric **710**B. In one embodiment, the drainage cores **750** and **760** are wrapped in a single or multiple layer of the fabric **710**B and facilitate subsurface water and air flow. The inventor has discovered that multiple layers of fabric **710**B 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 FIGS. **26**A and **26**C, 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. **26**C and **26**D, 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. **26**D, 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. **27**A to **27**C 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. **27**A, 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 **710**B, and where the drainage core **850** is disposed in a substantially horizontal drainage mat configuration above the wrapped conduit **762**. In FIG. **27**B, 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 **710**B, 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. **24**B. Alternatively, the vertically and upwardly extending drainage cores **750** and **760** wrapped in the fabric **710**B, 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. **27**C, 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 **710**B, 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 **710**B, 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. **26**D, once the system **700** is installed in either of the example embodiments illustrated in FIGS. **27**A to **27**C, 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. **27**C 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 **855**A and **855**B and fluid and/or air flow therethrough (FIG. **18**A). 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 **855**A and **855**B illustrated in FIG. **18**A) 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. **26**A and **26**C, 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 FIGS. **28**A and **28**B) 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. **18**A and **18**B, 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 **1458**A and a second interior cavity **1458**B therebetween. The interior cavities **1458**A ad **1458**B 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 **850**A and **850**B, and restricts a flow of liquid, air, gas and the like, between the cores **850**A and **850**B. 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. **18**A to **18**E, 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 **2055**A and **2055**B (e.g., similarly to passage **855**A and **855**B 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 **710**B 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 **662**A and **662**B), 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. **12**A, or conventional building material **450** of FIG. **12**E) 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 **662**A and **662**B and with the gravel-less form system **2100**, which replaces the conduits **662**A and **662**B 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 cores. As should also be appreciated, once formed, the geo-composite core assemblies **2000** and passages **2055**A and **2055**B 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 any 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 **662**A and **662**B 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**, **24**A, **24**B) may be utilized, in embodiments, within applications including landscape, playground, athletic fields (e.g., golf, soccer, football, baseball, and the like of FIGS. **25**A, **25**B, **26**A to **26**D), swimming pool drainage, parking decks and lots, sidewalks, terraces and patio drains (FIGS. **27**A to **27**C), 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 **850**A and/or widths **850**B 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 **2000**A and **2000**B). 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 **2000**A and **2000**B. 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 **2000**L of FIG. **38**, and/or in relatively central area **2000**C 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 vencer).

[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 meth 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 (m^2*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./ft^2 (72×10^3 kg/m^2), Flow Capacity ASTM D4716 16 gpm/ft of width (200 L/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.

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