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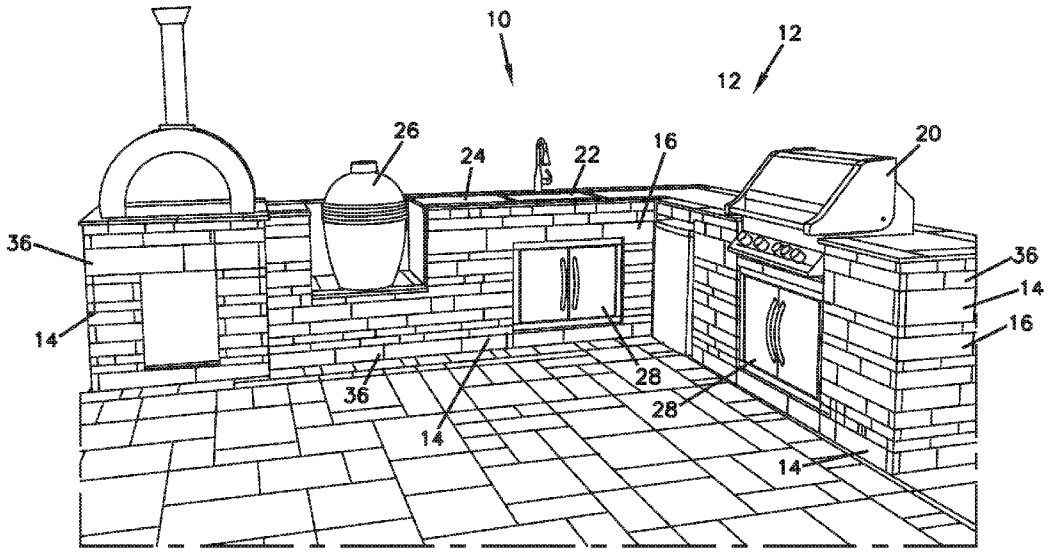
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(54) Title: OUTDOOR STRUCTURE

FIG. 1



(57) Abstract: An outdoor structure includes a plurality of vertically extending walls joined together to form a standing structure surrounding an interior volume. Each of the walls includes a structural polymer panel and a veneer directly adhered to the structural polymer panel. The standing structure can be frameless and supportless. The standing structure can bear at least 90% of a load of the standing structure.

WO 2018/075355 A1

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OUTDOOR STRUCTURE

This application is being filed on 13 October 2017, as a PCT International patent application, and claims priority to U.S. Patent Application No. 15/296,727, filed October 18, 2016, the disclosure of which is hereby incorporated by reference herein in its entirety.

Technical Field

This disclosure relates to a structure and methods of assembling the structure. Specifically, this disclosure relates to the use of structural polymer, adhesive, and veneer for a structure, such as an outdoor structure, e.g., a modular outdoor kitchen.

Background

Outdoor kitchens have grown in popularity. Outdoor kitchens can be labor intensive and expensive to assemble, particularly if there is a desire to complement the appearance of the outdoor kitchen with the appearance of an adjacent house. Skilled masons, who can be needed to make the outdoor kitchen from brick or to apply a brick or stone face, are expensive.

What is needed is a product that reduces the amount of time and skill needed to construct an outdoor kitchen. Further, systems are needed that remain adaptable to individual needs, are lightweight, durable, and constructed from easy to handle materials. The product should be usable for the person who wishes to do it themselves.

Summary

In general, an outdoor structure is provided that includes a plurality of vertically extending walls joined together to form a standing structure surrounding an interior volume. Each of the walls includes a structural polymer panel with a thickness of at least 1 inch and veneer directly adhered to the structural polymer panel. The standing structure will have a compressive strength of at least 25 psi, and the structural

polymer panel and veneer of the walls bears at least 90% of a load on the standing structure.

In many cases, the thickness of the structural polymer and veneer together is not greater than 6 inches.

The outdoor structure may further include a base horizontally supporting the standing structure. The base can include at least one structural polymer panel with a thickness of 1-6 inches.

In example embodiments, each of the walls includes the structural polymer panel, a plurality of veneer members, and structural bond adhesive. The structural bond adhesive is between the structural polymer panel and each of the veneer members, and between adjacent veneer members.

In example embodiments, the standing structure defines an opening in communication with the interior volume. The outdoor structure further includes a frame and door assembly held in the opening.

In some examples, the outdoor structure further includes a grill assembly mounted on top of the standing structure and at least partially inside the interior volume.

In example embodiments, the outdoor structure further includes a counter top mounted on top of the standing structure.

In one or more example embodiments, the outdoor structure further includes a sink mounted on top of the standing structure and at least partially inside of the interior volume.

In example embodiments, the structural polymer panel comprises graphite polystyrene.

In another aspect, a kit for an outdoor structure is provided. The kit includes at least one structural polymer panel with a thickness of at least 1 inch, opposite top and bottom edges, and opposite side edges. The kit includes a plurality of veneer members and structural bond adhesive for directly adhering the veneer members onto the at least one structural polymer panel. A plurality of structural polymer panels with veneer members adhered to them can be used to form a frameless standing structure surrounding an interior volume, the standing structure having a compressive strength of at least 25 psi.

In another aspect, a panel arrangement for construction of a structure is provided. The panel arrangement includes a structural polymer panel having a thickness of at least 1 inch, the panel having a panel face and perimeter edges surrounding the panel face. Structural bond adhesive substantially covers the panel face. A plurality of veneer members each has a front surface, a back surface, and an outer periphery surrounding the front and back surfaces, and a thickness between the front and back surfaces of not greater than 4 inches. The plurality of veneer members are adhered directly to the panel face along the back surfaces with the structural bond adhesive, the veneer members also being adhered to adjacent veneer members along the outer periphery.

Methods of construction and use are provided herein.

Brief Description of the Drawings

The accompanying drawings, which are incorporated herein, constitute a part of the description and illustrate several aspects of the present disclosure. In the drawings:

FIG. 1 is a perspective view of outdoor structures, utilizing structural polymer panels and veneer, constructed in accordance with the principles of this disclosure;

FIG. 2 is a perspective of the structural polymer panels of FIG. 1 being assembled, and before the veneer has been attached;

FIG. 3 is a perspective view of a portion of FIG. 1 depicting the step of attaching veneer to the structural polymer panels; and

FIG. 4 illustrates a kit of structural polymer panels that can be used to assemble the outdoor structure of FIG. 1.

Detailed Description

FIG. 1 illustrates a structure 10, which can be constructed using the materials and methods described herein. The structure 10, in this example, is an

outdoor structure, specifically, an outdoor kitchen 12. The structure 10 can be an indoor structure, as well.

The outdoor kitchen 12, in this example, includes a plurality of vertically extending walls 14 joined together to form a plurality of standing structures 16 surrounding an interior volume 18 (FIG. 2). In this example, the outdoor kitchen 12 includes a grill assembly 20 mounted on top of a standing structure 16 and at least partially inside of the interior volume 18. A sink 22 is mounted on top of a standing structure 16 and at least partially inside of the interior volume 18. A countertop is 24 mounted on top of a standing structure 16. The counter top 24 can be granite, quartz, marble, or any type of commercially available countertop.

Still in reference to FIG. 1, the outdoor kitchen 12 can also include a smoker 26 supported by a standing structure 16, and it may include a frame and door assembly 28 held within an opening 30 (FIG. 2) in the standing structure 16 in communication with the interior volume 18. Many embodiments of the outdoor structure 10 are possible, and the example shown in FIG. 1 is just one of many possible embodiments. The standing structure 16 can support internal frames 56 (FIG. 3), which can be used for the door assembly 28 and/or windows.

Referring now to FIG. 2, each of the walls 14 includes a structural polymer panel 32. The panel 32 can include any structure that is stable, durable, breathable, adaptable to all climate zones, and resource efficient. For example, usable material for the structural polymer panel 32 can include cast or extruded polyisocyanurate (rigid urethane) or extruded polystyrene, polyethylene or polypropylene foam; particle foams including expanded polystyrene EPS, expanded polypropylene EPP, and expanded polyethylene EPE; or any extrudable, moldable or castable polymer or polymer foam.

One preferred example material for the polymer panel 32 is structural foam including, for example, graphite polystyrene. Graphite polystyrene is adaptable in size, thickness, shape, and density. It comes in a variety of thicknesses. It is versatile, in that it can be shaped or formed to the design needed. For example, the structural polymer panel 32 can be designed on a computerized design package and then cut to an exact form using CNC tooling. Graphite polystyrene is breathable and semipermeable,

which is helpful in moisture management. It is adaptable to all climate zones, meaning that it can be used outdoors through both hot summers and cold winters. One preferred graphite polystyrene is available under the tradename NEOPOR from BASF Corporation.

The structural polymer panel 32 utilized for outdoor structures 10 can be made with a thickness that is appropriate for the outdoor structure 10. The greater the thickness is, the greater the compressive strength and the less likelihood of structural failure through crushing or buckling. The thinner the foam panel 32 is, the easier it is to handle and the less expensive it is. It has been found that for use in an outdoor kitchen to support things such as grill assemblies 20, sinks 22, granite countertops 24, smokers 26, etc., the structural polymer panel 32 should have a thickness of at least 1 inch. It has been found that the structural polymer panel 32, to work well in the outdoor kitchen 12, need not have a thickness any greater than 6 inches.

Each of the walls 14 includes veneer members 34 directly adhered to the structural polymer panel 32. The veneer members 34 can have an aesthetically pleasing appearance, to simulate the look of stone or brick. The veneer members 34 may be selected to complement the appearance of an adjacent house. By the term "directly adhered" it is meant that there is nothing in between the veneer members 34 and the structural polymer panel 32 other than structural bond adhesive that is used to attach the veneer members 34 to the structural polymer panel 32. One preferred embodiment of the veneer members 34 is a lightweight concrete veneer, but any type of veneer is usable.

Each of the veneer members 34 has a decorative front 80, an opposite back surface, and an outer periphery 82 (surrounding edges). Typical, usable veneer members 34 will have a thickness between the front 80 and back surface of not more than 4 inches, often 0.5-2 inches.

The structural bond adhesive is applied between the structural polymer panel 32 and each of the veneer members 34, along a vertical plane on the back surface, where the veneer members 34 are placed against the panel 32. The structural bond adhesive is also applied between all of the peripheral edges 82 of adjacent veneer members. This results in a composite panel 36, comprising the structural polymer panel

32, structural bond adhesive, and veneer members 34. In some embodiments, the composite panel 36 "consists of" or "consists essentially of" the structural polymer panel 32, structural bond adhesive, and veneer members 34.

Many different types of structural bond adhesives, or their equivalent, may be used. One type is polyurethane, for example, an aerosol dispensed, single part, moisture cured polyurethane adhesive. One structural bond adhesive useable herein is commercially available from Tremco under the name "ILLBRUCK masonry adhesive for brick and stone." The ILLBRUCK adhesive is PU700 rapid curing gun grade polyurethane foam adhesive and includes the following properties: polyurethane foam; fire class B3 using a test method DIN 4102; limits canister temperature of +10°C to +30°C; limits of ambient temperature of +5°C to +35°C; density of 20 - 30 kg/m3; open time of 8 minutes using a test method of 3 cm in width at 23°C and 50% RH; tack free time of 8 minutes using a test method of 3 cm in width at 23°C and 50% RH; cutting time of 24 hours using a test method of 3 cm in width at 23°C and 50% RH; loading time of 24 hours; tensile strength of 10,000 kPa using a test method of DIN 53455; thermal conductivity of 40 mW/m.K; temperature resistance short term of -40°C to +130°C; temperature resistance long term of -40°C to +90°C; storage in shaded dry conditions between +10°C and +25°C with canisters upright; and a shelf life of 12 months when stored in original unopened containers. The structural bond adhesive, or its equivalent, has rapid curing (joint can be handled within 10 minutes and cure fully within 24 hours); is easy to use with no mixing, no water, no dust, and no specialized tools or equipment necessary; and has long term resistance to seawater, limewater, dilute acids and caustic solutions.

The thickness of the composite panel 36, being the structural polymer panel 32 plus the veneer member 34 and adhesive, will not be greater than about 6 inches, in order to have both sufficient strength, but without excessive weight or cost. Often, the thickness of the composite panel 36 will be 3-6 inches thick.

The composite panel 36, formed of the structural polymer panel 32, veneer members 34 and adhesive for each of the walls 14 of the standing structure 16 is load bearing. By "load bearing," this means that other structure, typically used to bear the load in like structures, is not needed. For example, standing structure 16 is free of

internal frames (is frameless) and free of any other supports (is supportless). In particular, the composite panel 36 would bear at least 90%, for example, at least 95%, and preferably 98% - 100% of a load of the standing structure 16. This leads to advantage, in the simplicity of the construction of the standing structure 16, the overall weight, and the inexpensiveness. In many examples, the standing structure 16 has walls 14 with load bearing capability that "consist of" or "consist essentially of" the composite panel 36.

In reference now to FIG. 4, a kit is shown at 40. The kit 40 includes at least one of the structural polymer panels 32, which can be used to make the standing structure 16. The at least one foam panel 32 can be cut into a plurality of the panels 32, such as four panels 32. Alternatively, the kit 40 can include a pre-cut plurality of the foam panels 32. The kit 40 will often also include a plurality of the veneer members 34 and the structural bond adhesive. In FIG. 4, it can be seen how the foam panels 32 can be cut to specific unique shapes for whatever is the final structure 10 to be made.

The structural polymer panels 32, as shown in FIG. 4, are often precut for building the desired structure, such as outdoor kitchen 12. The structural polymer panels 32 can include a plurality of projections 42 alternating with recesses 44, such that the panels 32 can be easily mated together with the projections 42 from one panel 32 being received into recesses 44 of another panel 32 to form the standing structure 16. The panels 32 have opposite top and bottom edges 46, 48 and opposite side edges 50, 51. The projections 42 and recesses 44, in this embodiment, are formed along the side edges 50, 51.

The structural polymer panels 32 can be fitted together along the side edges 50, 51 and stood along the bottom edges 48 to form a frameless standing structure 16 surrounding the interior volume 18. Adhesive can be used between the side edges 50, 51 to secure the panels 32 together to form the standing structure 16.

The outdoor structure 10 may include a base 60 (FIGS. 2 and 4) horizontally supporting the standing structure16. The base 60 can include at least one structural polymer panel 32 with a thickness of 1-6 inches.

After the structural polymer panels 32 are fitted together to form the vertically extending walls 14 and the standing structure 16, the face 54 (FIGS. 2 and 3)

of the panel 32 can receive the structural bond adhesive. In some instances, the structural bond adhesive can substantially cover the panel face 54. The veneer members 34 can then be applied to the panel face 54 against the structural bond adhesive. The structural bond adhesive is also applied between the edges of adjacent veneer members. The structural bond adhesive will adhere or bond the veneer members 34 to the panel face 54, as well as bond adjacent veneer members 34 to each other. FIG. 3 illustrates the step of applying the veneer members 34 to the panel face 54 of the structural polymer panels 32.

In one example, the resulting outdoor structure 10, which includes the standing structure 16, plus the grill assembly 20, plus the granite countertop 24, plus the steel frame and door assembly 28 weighed about 1,100 lbs. A prior art structure including the same grill assembly, countertop, and door, using concrete blocks adhered together instead of the composite panels 36, weighed about 3,500 lbs.

The panels 32 can be provided in the kit form 40, or they can be pre-assembled. The panels 32 can be made on the fly with a CNC tool, and they do not need to be molded.

When making outdoor structures 10, the panels 32 can have a thickness of 1-6 inches. Many types of structures can be constructed using composite panels 36 including, for example, columns, fountains, retaining walls, seawalls, tool sheds, animal shelters, etc. When the panels 32 are used for retaining walls or seawalls, the panels 32 will have a thickness of 6-12 inches.

Experimental

A test column was assembled using Neopor graphite Expanded Polystyrene EPD panels with a foam thickness of 2 inches; foam density of 2.0 lbs./CF; and outside dimensions of: 26.375" x 36" (without veneering) with a 2" x 22.375" x 22.375" matching Neopor square panel glued in place to the inside walls and at the bottom of the test box. The weight testing includes an OSB panel with attached 2 x 4 cross members that was placed on top of the assembled test boxes to accommodate the test load pallet placement. Testing weight increments: (10) 4" x 8" x 12" units.

Test 1: structural polymer panel alone

The test column had a 3681 lbs. load (which included 61 lbs. platform and 50 lbs. pallet weight) placed on it, and it remained fully intact with no signs of cracking, breaking or damage. Under the 3681 lbs. load, the box compressed 1/8". At 3381 lbs., the compression was not measurable. The test column was calculated to have failed at 17.4 psi (compressive strength).

Test 2: structural polymer panel and veneer with adhesive only along the back surface of the veneer

The text column as described above was used. Adhesive used with the veneer was Oldcastle Structural bond adhesive (aerosol Urethane). This adhesive is available commercially under the brand name Illbruck PU700, as described above. The test column had concrete veneer (1.5 inches thick) glued to it with the structural bond adhesive. The structural bond adhesive was not applied between edges of adjacent veneer members.

With a 6502 lbs. load (which includes 61 lbs. platform, a 51 lbs. pallet and 50 lbs. pallet weight), the column remained fully intact, but revealed some vertically cracked units on all 4 sides, which was deemed to have failed. At the 6212 lbs. loading vertical cracks were not visible. The test column was calculated to have failed at 21.2 psi (compressive strength).

Test 3: structural polymer panel and veneer with adhesive along the back surface of the veneer and between edges of adjacent veneer members

The test column as described above was used. Adhesive used with the veneer was Oldcastle Structural bond adhesive (aerosol Urethane). The test column had concrete veneer (1.5 inches thick) glued to it with the structural bond adhesive. The structural bond adhesive was also applied along between the edges of adjacent veneer members.

With 10,666 lbs. load (which includes a 61 lbs. platform, a 51 lbs. pallet and two 51 lbs. pallets weight) the column remained fully intact with no cracking, breaking or damage of any kind. For safety reasons, the testing was terminated due to height concerns. The test column was calculated to have at least a 34.8 psi (compressive strength).

Conclusion:

Using structural polymer with veneer attached to the structural polymer and attached along adjacent veneer edges with structural bond adhesive results in a structure that is at least 3 times as strong when using only structural polymer, and more than 1.5 times as strong when only applying the adhesive between the foam and the veneer. Using structural polymer with veneer attached to the foam and attached along adjacent veneer edges with structural bond adhesive results in a structure that has a compressive strength of greater than 21.2 psi; indeed, greater than 25 psi, 30 psi, and 34 psi. The upper limit was not determined, as testing had to be stopped for safety reasons.

What is claimed is:

1. An outdoor structure comprising:

a plurality of vertically extending walls joined together to form a standing structure surrounding an interior volume;

each of the walls comprising a structural polymer panel with a thickness of at least 1 inch and veneer directly adhered to the structural polymer panel;

wherein the standing structure has a compressive strength of at least 25 psi, and wherein the structural polymer panel and veneer of the wall bears at least 90% of a load on the standing structure.

2. The outdoor structure of claim 1 wherein the thickness of the structural polymer and veneer together is not greater than 6 inches.

3. The outdoor structure of claim 1 further including a base horizontally supporting the standing structure, the base comprising at least one structural polymer panel with a thickness of 1-6 inches.

4. The outdoor structure of claim 1 wherein each of the walls includes the structural polymer panel, a plurality of veneer members, and structural bond adhesive: (i) between the structural polymer panel and each of the veneer members; and (ii) between adjacent veneer members.

5. The outdoor structure of claim 4 wherein: the structural polymer panels each has a thickness not greater than 2 inches; and the standing structure has a compressive strength of at least 34 psi.

6. The outdoor structure of claim 1 wherein:

(a) the standing structure defines an opening in communication with the interior volume; and

(b) the outdoor structure further includes a frame and door assembly held in the opening.

7. The outdoor structure of claim 1 further including a grill assembly mounted on top of the standing structure and at least partially inside of the interior volume.

8. The outdoor structure of claim 1 further including a countertop mounted on top of the standing structure.

9. The outdoor structure of claim 1 further including a sink mounted on top of the standing structure and at least partially inside of the interior volume.

10. The outdoor structure of claim 1 wherein each structural polymer panel comprises graphite polystyrene.

11. The outdoor structure of claim 1 wherein the structural polymer panel and veneer of each of the wall bears at least 95% of a load on the standing structure.

12. A kit for an outdoor structure, the kit comprising:

(a) at least one structural polymer panel with a thickness of at least 1 inch, opposite top and bottom edges, and opposite side edges;

(b) a plurality of veneer members; and

(c) structural bond adhesive for directly adhering the veneer members onto the structural polymer panel; and

wherein the at least one structural polymer panel can be used to form a frameless standing structure surrounding an interior volume, the standing structure having a compressive strength of at least 25 psi.

13. The kit of claim 12 wherein the at least one structural polymer panel includes a plurality of foam panels that can be fitted together along the side edges and stood along bottom edges to form the frameless standing structure.

14. A panel arrangement for construction of a structure, the panel arrangement comprising:

(a) a structural polymer panel having a thickness of at least 1 inch, the panel having a panel face and perimeter edges surrounding the panel face;

(b) structural bond adhesive substantially covering the panel face; and

(c) a plurality of veneer members each having front surface, a back surface, and an outer periphery surrounding the front and back surfaces, and a thickness between the front and back surfaces of not greater than 4 inches, the plurality of veneer members being adhered directly to the panel face along the back surfaces with the structural bond adhesive, the veneer members also being adhered to adjacent veneer members along the outer periphery.

15. The panel arrangement of claim 14 wherein the structural polymer panel comprises graphite polystyrene.

16. The panel arrangement of claim 14 consisting essentially of the structural polymer panel, structural bond adhesive, and veneer members.

17. A structure comprising:

a plurality of vertically extending walls joined together to form a standing structure surrounding an interior volume;

each of the walls comprising a structural polymer panel with a thickness of at least 1 inch and veneer directly adhered to the panel; and

wherein the standing structure is frameless and supportless.

18. The structure of claim 17 wherein each of the walls includes the structural polymer panel, a plurality of veneer members, and structural bond adhesive: (i) between the structural polymer panel and each of the veneer members; and (ii) between adjacent veneer members.

19. The structure of claim 17 wherein:

(a) the standing structure defines an opening in communication with the interior volume; and

(b) the structure further includes a frame and door assembly held in the opening.

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20. The structure of claim 17 wherein the standing structure has a compressive strength of at least 25 psi.

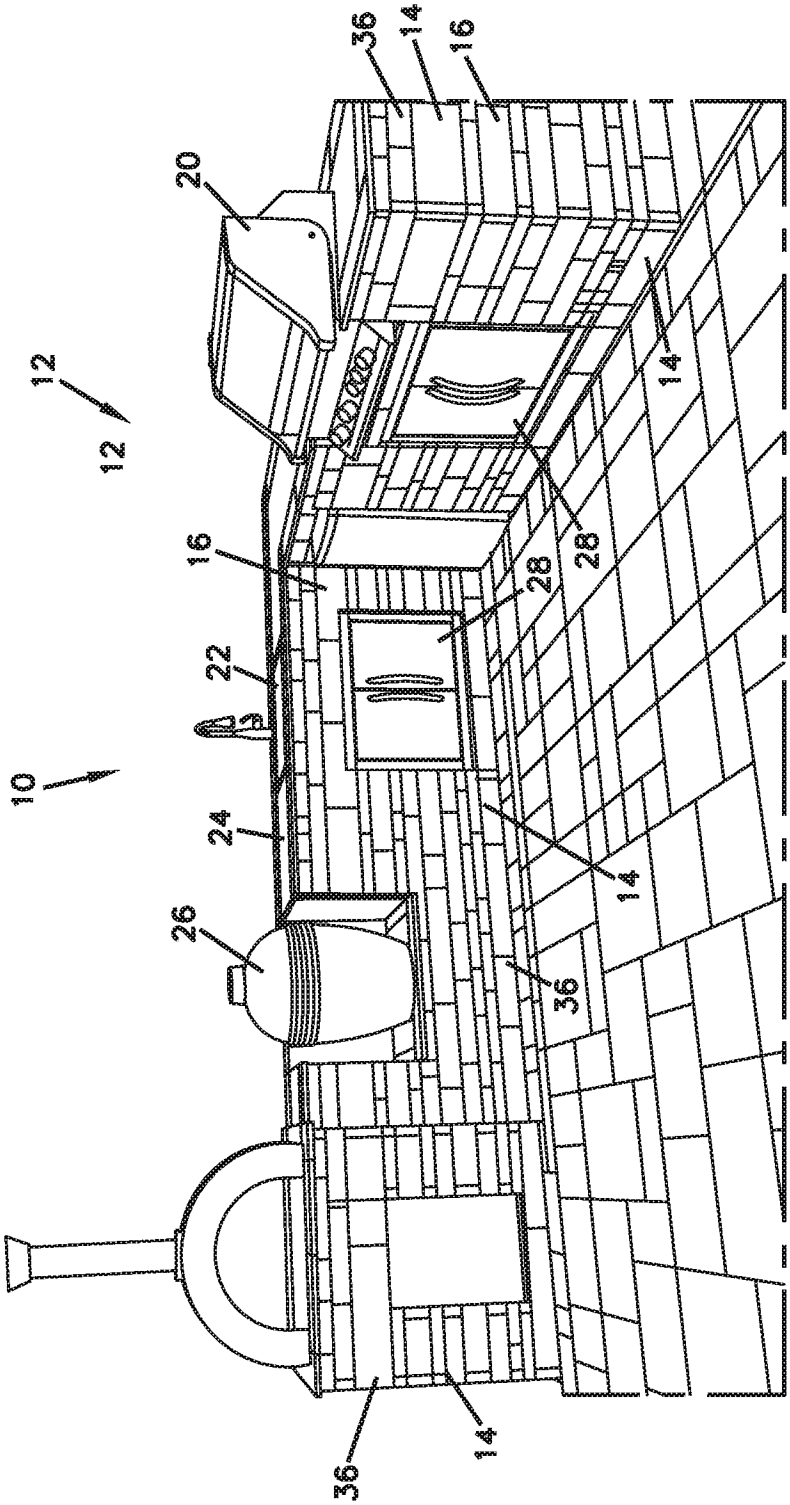


FIG. 1

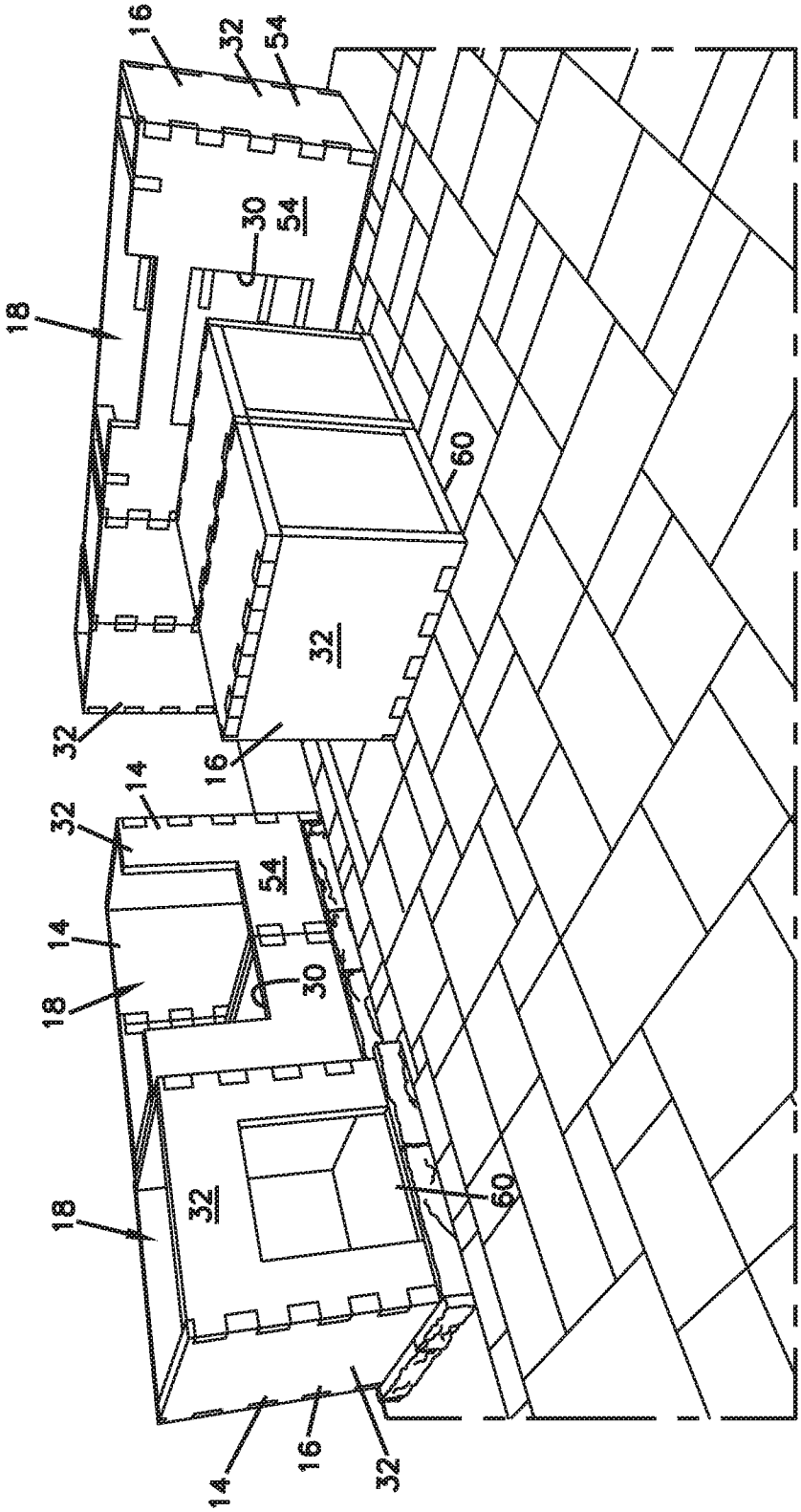


FIG. 2

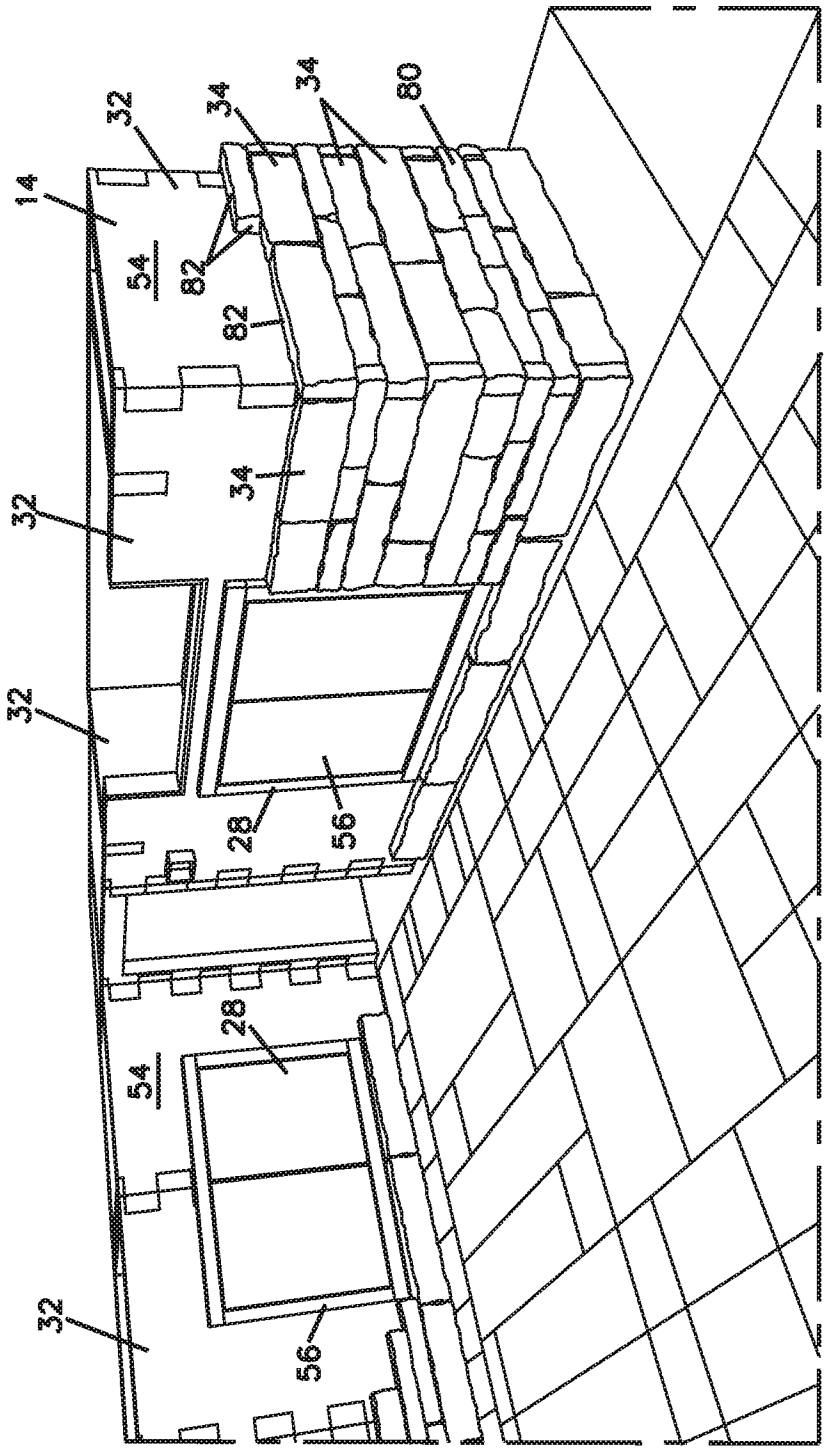
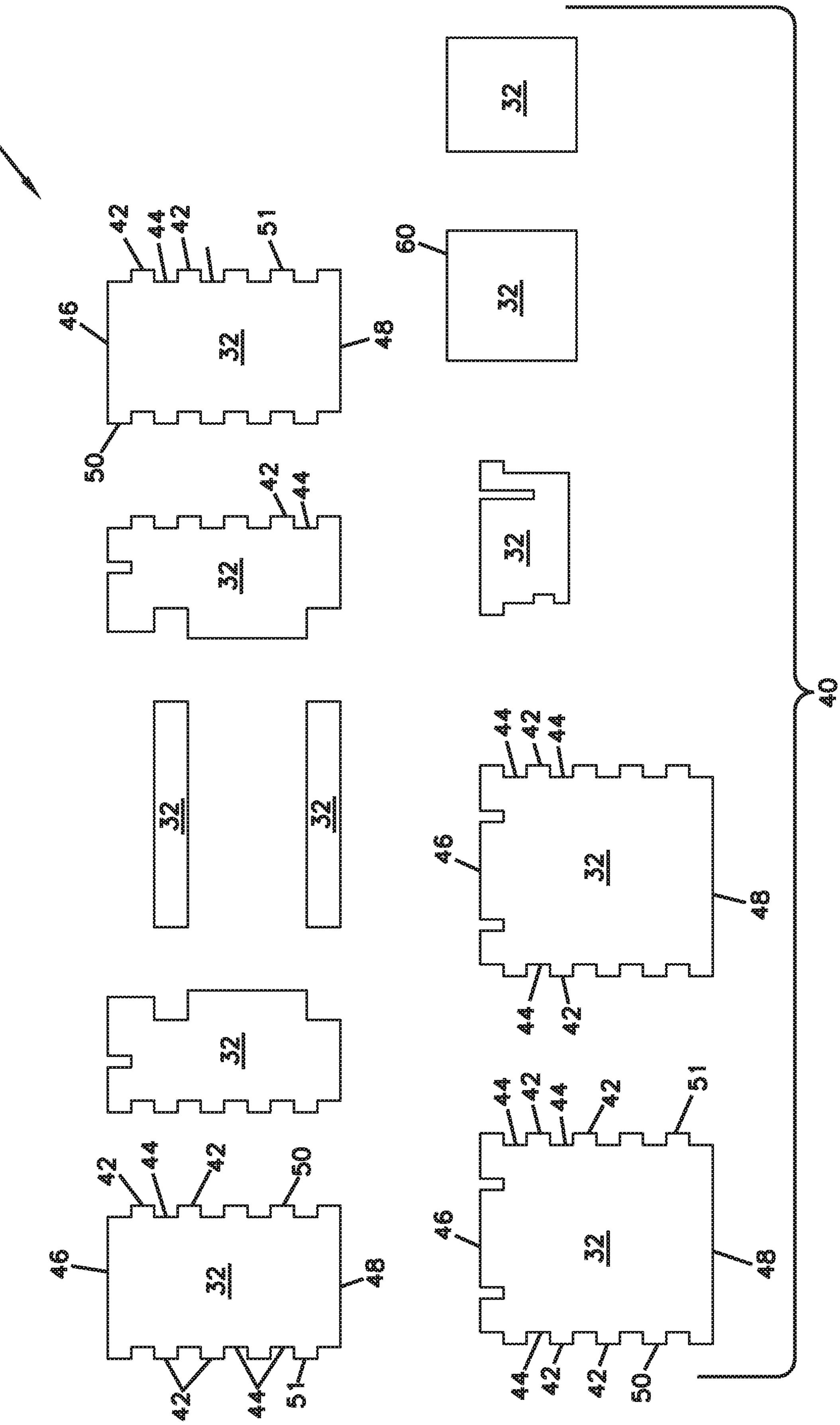


FIG. 3

FIG. 4



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/056545

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47J37/07 A47B77/02 E04H1/12 A47B47/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A47J E04H A47B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/213961 A1 (GRAHAM ROBERT [US] ET AL) 23 August 2012 (2012-08-23) figures 1-8 paragraphs [0015], [0018], [0021], [0023], [0024], [0029]	1-20
X	US 2006/202594 A1 (DEMARS ROBERT [US]) 14 September 2006 (2006-09-14) figures 1-12,58,59 paragraphs [0008], [0009], [0118], [0122], [0180]	1-20
A	US 2004/065313 A1 (THOMPSON ARTHUR CHARLES [US]) 8 April 2004 (2004-04-08) figures 1-15 paragraphs [0025] - [0027], [0033]	1-20

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2018	23/01/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schnedler, Marlon

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/056545

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/148641 A1 (EHMKE ROBERT [US]) 17 June 2010 (2010-06-17) the whole document -----	1-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/056545

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012213961 A1	23-08-2012	EP 2675958 A1	25-12-2013
		US 2012213961 A1	23-08-2012
		US 2015017377 A1	15-01-2015
		WO 2012112789 A1	23-08-2012
US 2006202594 A1	14-09-2006	NONE	
US 2004065313 A1	08-04-2004	US D475552 S	10-06-2003
		US 2004065313 A1	08-04-2004
		US 2014145566 A1	29-05-2014
US 2010148641 A1	17-06-2010	NONE	