

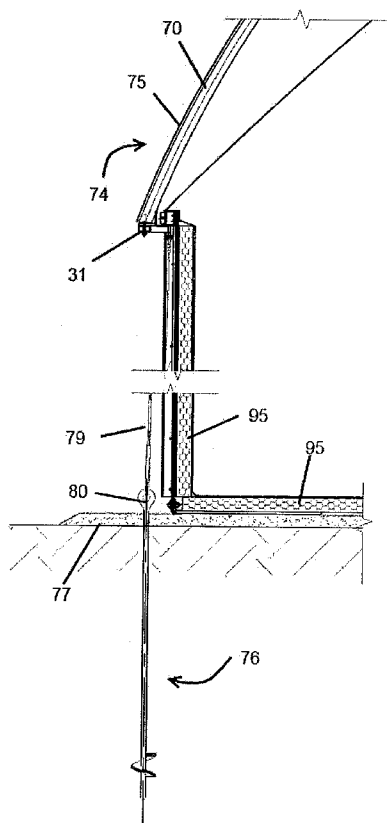


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(54) Title: A STRUCTURE AND METHOD OF CONSTRUCTION

FIGURE 12



(57) Abstract: This invention relates to a tank, including: a tank shell having a top edge, a liner inside the tank shell, wherein an edge of the liner extends over the top edge of the tank shell, a clamp, characterised in that the clamp secures the liner to the tank shell.



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A STRUCUTRE AND METHOD OF CONSTRUCTION

STATEMENT OF CORRESPONDING APPLICATIONS

This application is based on the Provisional specification filed in relation to New Zealand Patent
5 Application Number 598233, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

A structure and method of construction.

BACKGROUND ART

Tanks are used to hold fluids, gases, and particulate matter. There are a number of different
10 methods of constructing tanks, all of which differ in their components and properties. Those differences are intended to ensure that a tank is suitable for an intended purpose.

Kitset demountable tanks are becoming more important commercially. These tanks are manufactured and sold as a kitset of parts. The kitset nature of the tank may reduce the transportation component of its total cost as it is smaller than a fully constructed tank.

15 However, tanks and particularly kitset tanks have a number of problems which need to be addressed.

One type of tank includes a liner positioned within a shell. The liner ensures that the tank is able to hold a fluid or particulate matter yet removes the need to make the tank shell itself fluid tight. In addition, using a liner may facilitate manufacturing a tank shell using fewer
20 components/materials.

However, securing the liner inside of the tank shell can be difficult, often requiring specialist components. In addition, fluid or particulate matter inside the tank exerts pressure on the liner. This can tear the liner from the tank shell.

Furthermore, some kitset tanks are exposed to extreme environmental conditions. Even low
25 intensity winds can damage or release the fasteners holding a liner in place. The forgoing problems are a serious limitation on the known kitset tanks.

Another important commercial use of tanks is as a vessel for manufacturing processes, such as digesting methane from effluent. This application requires a sealed tank to capture the methane produced, which is a volatile gas. Therefore sealed tanks for digestion are becoming
30 more widespread.

Often, it would be useful to convert a tank from one purpose into suitability for use in the manufacturing process. The steps required in the conversion depend on the configuration of

the initial tank. For instance, effluent tanks often have open tops because evaporation is an important method of reducing the effluent's liquid fraction. Alternatively, many tanks are open because a cover is not required to comply with local government Regulations. Therefore, manufacturers or purchasers of the tank decide not to include a cover to minimise costs.

- 5 Some water tanks do have a roof. However, those roofs do not provide a fluid tight seal. They are simply to stop animals or debris entering the tank. As methane is a volatile gas it simply escapes from the unsealed tank (thereby negating the entire purpose of the methane digester). Accordingly, many water tanks can not be used as a methane digester.

- 10 Tanks are available which have sealed bladders secured within a tank shell. However, the configurations of the tank shells and bladders are such that an open (non-sealed) tank cannot be easily converted to a sealed tank.

It would therefore be advantageous to have a tank, kitset of parts, and/or method which enables the easy conversion of a tank to suitability for use in a new function.

- 15 In addition, it would be advantageous to have a tank, kitset of parts, and/or method of construction which easily and/or securely attaches a liner into a tank, to thereby facilitate provision of a tank.

Furthermore, it would be advantageous to have a tank, method of construction, and/or kitset of parts which can provide a fluid tight seal for a tank.

It is yet a further object of the present invention to provide a more easily constructed kitset tank.

- 20 Alternatively, it is an object of the present invention to address the problems with the known tanks and methods of construction or to at least to provide the public with a useful choice.

- All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

- 30 Throughout this specification, the word "comprise", or variations thereof such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF THE INVENTION

According to one aspect of the present invention there is provided a tank, including

a tank shell having a top edge,

a liner inside the tank shell,

5 wherein an edge of the liner extends over the top edge of the tank shell,

a clamp,

characterised in that

the clamp secures the liner to the tank shell.

10 According to another aspect of the present invention there is provided a kit set of parts for constructing a tank, the kit set including

a plurality of components which when assembled and secured together form a tank shell,

a liner,

and wherein when the components of the kitset are assembled the liner is inside the tank shell extends over a top edge of the tank shell,

15 a clamp,

characterised in that

when the kitset is assembled the clamp secures the liner to the tank shell.

According to another aspect of the present invention, there is provided a method of constructing a tank,

20 wherein the tank includes a tank shell having a top edge, a liner, and a clamp,

the method including the following steps in any order:

(a) constructing the tank shell;

(b) positioning the liner inside the tank shell;

25 (c) arranging the liner so that an edge of the liner extends over the top edge of the tank shell;

(d) positioning the clamp with respect to the tank shell and the liner;

the method characterised by step:

(e) causing the clamp to engage the liner so as to secure the liner to the tank shell.

According to another aspect of the present invention there is provided a frame component of a tank shell, including

a body having a length,

a channel extending along the body's length, wherein

- 5 in use a plurality of the frame components form part of the tank shell,
characterised in that

in use a clamp can force a liner into the channel to secure the liner to the frame component and thereby to the tank shell.

- 10 In a preferred embodiment, the present invention relates to improvements to the construction of cylinder shaped tanks. Accordingly, reference herein will be made to as such.

Throughout the present specification reference to the term "tank shell" should be understood as meaning a plurality of components connected together so as to form a structure that can support a liner.

- 15 The components may be a plurality of base elements, wall modules, and/or other components that can be assembled so as to construct the tank.

- It is also envisaged that the tank shell may include a plurality of flexible ties that extend around the entire circumference of the tank shell. In-use, each flexible tie is positioned and configured to impart hoop strength to the tank shell. The flexible ties are vertically spaced apart from each other and impart hoop strength to the tank shell. Therefore, the flexible ties assist in securing
20 the components of the tank shell together and to withstand the outward forces exerted on the tank shell by matter within the tank.

- In one preferred embodiment the present invention is intended for use with the demountable tank described in New Zealand Patent No. 560570. Accordingly, the components of the tank shell are as substantially described in New Zealand Patent No. 560570. Therefore, the
25 contents of New Zealand Patent No. 560570 is hereby incorporated in its entirety by reference.

However, the forgoing should not be seen limiting on the scope of the present invention and alternatives are envisaged. Those include embodiments where the tank shell is an integral (one piece) corrugated material with external bracing members.

- Throughout the present specification reference to the term "liner" should be understood as
30 meaning a material through which a fluid cannot permeate. The liner is preferably a sheet of rubber, plastics, or other flexible material.

In one preferred embodiment, the liner is a sheet material.

In use, the liner is positioned within the tank shell and secured in position (as is discussed below). The liner ensures that the tank is able to hold a fluid. Accordingly, the use of the liner ensures that the tank is able to hold particulate or fluid, This also removes the need for the tank shell to be fluid tight. However, the foregoing should not be seen as limiting.

- 5 In a preferred embodiment the liner is sealed, so that the material can only exit from the liner via a valve or outlet in a controlled manner.

In these embodiments, the liner may be a bladder having a sealed cavity therein. The bladder may be formed from a single sheet of material.

- 10 In a particularly preferred embodiment, two or more sheets of material may be secured together so as to define a sealed bladder having a cavity. In this embodiment, the sheets of material may be secured together using the clamp(s) and frame component(s) as is discussed below.

- However, the foregoing should not be seen as limiting on the scope of the present invention. It is also envisaged that the bladder may include flanges or edges which can be clamped to the tank shell to secure the liner thereto. It is also envisaged that the bladder could be formed by
15 using techniques such as welding or adhesives secure two sheets of material together so as to define the sealed cavity. The bladder could then be secured within a tank shell.

Throughout the present specification, reference to the term "frame component" should be understood as meaning a component to which the clamp can press the liner.

- 20 In a preferred embodiment, the frame component includes a plurality of fasteners to engage with the tank shell, and thereby secure the frame component to the tank shell.

In the preferred embodiment, the fasteners are channels. In use, a top part of the tank shell such as a edge of a wall module(s) are inserted into the channel. Screws are then inserted through the wall module(s) and the frame component.

- 25 However, the foregoing should not be seen as limiting on the scope of the present invention. The fasteners may also include or be only button fasteners or adhesive materials.

The fasteners are beneficial as they facilitate provision of a kitset tank.

- Furthermore the fasteners may facilitate use of the frame components (and thereby the preferred embodiments of the clamp) is retrofit applications. That is, the frame components can be secured to existing tanks, whether such as those disclosed in the present specification,
30 or any other form of tank. The frame components then provide a surface and preferably channels, into which a clamp can force a liner.

In a preferred embodiment, the frame component has a length sufficient that it can overlap adjacent wall modules of the tank shell. The frame component may therefore assist in assembling the tank.

The body of the frame component may be formed from plastic materials, extruded metallic materials such as aluminium, or any other materials. Those materials are as should be understood by one skilled in the art.

5 In a particularly preferred embodiment, the frame component includes a second channel extending along its length.

The second channel is configured to interact with a second clamp so as to secure a second sheet of material to the tank shell. This therefore helps to provide a sealed bladder within the tank shell.

10 In a particularly preferred embodiment, the first and second channels are vertically spaced apart wherein the frame component in its normal orientation in use. This helps to ensure that the channels can interact with a strap fastener so as to secure the liner and roof cover to the tank shell and provide a fluid tight seal.

15 Throughout the present specification, reference to the term "clamp" should be understood as referring to a component that can clamp the liner to the tank shell, and preferably the frame component.

In particularly preferred embodiments the clamp is configured to squeeze the liner onto an outer surface of the tank shell.

20 In a preferred embodiment, the clamp is at least one rigid member and at least one screw thread actuator. In-use, rotation of the screw thread actuator in a first direction moves the rigid member towards and into an outer surface of the tank shell. The action of the screw thread actuator and rigid member forces the liner into the channel, thereby securing the liner to the frame component and tank shell.

25 Rotation of the screw thread actuator in a second direction moves the rigid member away from the frame component. That may be useful to release the liner from the tank shell to facilitate adjusting its position in the tank shell. Alternatively, it may be beneficial where a person wishes to disassemble the tank to enable that its relocation, or at the end of its intended use.

30 However, the foregoing should not be seen as limiting on the scope of the present invention. In alternate embodiments the clamp may be a plurality of lengths of hollow members, each having a cavity. A rope, cable, wire or other element is disposed in the cavity so as to extend around the circumference of the tank shell.

In use, the rope or similar can be tensioned so as to push the member into a channel. Accordingly, tightening of the rope causes the hollow members and frame component to interact so as to clamp the liner into the frame component, and thereby to the tank shell.

The inventor has found that the use of clamps to secure a liner to a tank shell is particularly

beneficial.

In contrast the prior art tanks use fasteners such as snap fasteners or similar to secure a liner directly to the tank shell. Those articles can be difficult to engage, requiring direct alignment between complementary components on the liner and the tank shell.

- 5 Furthermore, the fasteners are prone to failing or disengaging when in-use. Accordingly, they provide an unsatisfactory way to secure the liner within the tank shell.

In contrast, the present inventions do not suffer from the foregoing disadvantages.

In a preferred embodiment, the present invention includes at least one anchor.

- 10 Throughout the present specification reference to the term "anchor" should be understood as meaning a component that provides resistance to lifting of the tank shell and/or bladder.

- In the preferred embodiment, the anchor is an auger and a strap. In-use the auger is rotated so as to bore into ground adjacent to that on which the tank shell bears. The strap is connected to an end of the auger and to the tank shell. The auger blades provide resistance to the liner and tank shell being drawn upwards. However, the foregoing should not be seen as limiting on the scope of the present invention. Alternatives for the anchor are also envisaged, including tent
15 peg style anchors, weights, or bolts inserted into a concrete base.

In a preferred embodiment, the present invention includes a web.

- Throughout the present specification reference to the term "web" should be understood as meaning a lattice that is positioned above and within at least a portion of, the tank shell's footprint. In a particularly preferred embodiment, the web is formed from lengths of flexible
20 material such as plastic straps that are welded together. The web is positioned so as to extend over top of the top edges of the tank shell. In-use the web provides resistance to lifting of the bladder within the tank shell.

- In a particularly preferred embodiment, the web is manufactured from polyester straps which are secured together to form the lattice using plastic welding techniques. The grade of
25 polyester is selected to ensure that the web has sufficient strength to perform its function.

- The inventor has discovered that in some tanks wind can lift the bladder, which in turn exerts significant pressure on the tank shell. However, the use of the web restricts the range of motion of the bladder thereby minimising the forces exerted on the tank shell. The web
30 therefore reduces the strength with which the tank must be constructed. Accordingly, this aspect may facilitate provision of a more versatile kitset tank, a lighter weight kitset tank, or a tank better suited for use in particular locations.

However, the foregoing should not be seen as limiting on the scope of the present invention. It is also envisaged that a lattice formed by securing aluminium or carbon fibre rods together

could be used with the present invention.

In a preferred embodiment, the tank shell includes insulation material.

Throughout the present specification reference to the term "insulation material" should be understood as meaning a material that prevents and/or reduces transfer of heat from within the bladder to the environment surrounding the tank shell.

In a particularly preferred embodiment the insulation material is a solid.

In one embodiment the insulation materials are high density foam.

In a particularly preferred embodiment the insulation materials are PVH (polystyrene very hard) having a density in the range of 20kg/m³ 30kg/m³, and more preferably 28kg/m³.

Alternatively, the insulation materials may be polystyrene or other materials which prevent or limit transfer of heat from inside the liner to the environment surrounding the tank shell.

In a particularly preferred embodiment, the insulation materials are secured to wall panels, floor panels and roof panels forming part of the tank shell.

In kitset embodiments, the insulation materials are secured to the panels prior to sale of the kitset to an end user.

Alternatively, the insulation materials may be provided as separate components, which are connected to the tank shell during construction of the tank.

Therefore, the foregoing should not be seen as limiting on the scope of the present invention.

The inventors have identified that the use of insulation materials may be beneficial to facilitating the present invention's suitability for use in certain applications. For instance, the insulation materials may assist in maintaining a constant temperature within the bladder, which is necessary for applications such as methane digester from effluent.

Furthermore, the inventor has found that use of insulation materials in the form of solids, and preferably sheets, facilitates manufacture of a kitset tank.

Furthermore, the kitset tank may be easily transportable, and can be assembled on site than the prior art tank.

In contrast, some prior art insulated tanks use a complex double skin system whereby warm air is inserted into a cavity defined between two layers of the skin. This is with the intention of controlling the temperature within a cavity defined by the inner layer of the skin. However, this requires complex pumping and heating systems. Furthermore, the systems are expensive to run, requiring significant amounts of heat. Conversely, the present inventions do not have these limitations.

Other prior art tanks containing insulation materials generally include a tank shell manufactured from concrete materials as a single piece as tanks are difficult to manufacture and install on site. The present inventions do not have those same problems and therefore provide a solution needed by the public.

5 **BRIEF DESCRIPTION OF DRAWINGS**

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

- 10 Figure 1 is a side cross sectional view of the first embodiment of a tank according to the present invention;
- Figure 2 is a plan view of a floor panel secured to a base element;
- Figure 3 is an end on view of a base element;
- Figure 4 is a plan view of a connection member forming part of a wall module;
- 15 Figure 5A is a perspective view of a section of a tank shell according to the present invention;
- Figure 5B is a plan cross sectional view of section (C) in Figure 5A.
- Figure 6 is a perspective view of a section of an assembled tank shell;
- Figure 7 is a cross sectional view of section (A) in Figure 1;
- 20 Figures 8A-8C are cross sectional views of section (B) in Figure 1 showing the steps in securing a reinforcing component to a tank shell and clamping a liner to the tank shell;
- Figure 9 is a plan view of a section of a tank showing first and second reinforcing components.
- Figure 10A is a perspective view of a wall panel with insulation secured thereto;
- 25 Figure 10B is a side view of Figure 10A;
- Figure 11 is a side cross sectional view showing clamping of a second liner to a tank shell according to the present invention and a web secured to the tank shell;
- Figure 12 is a side cross sectional view of a section of a third embodiment of the tank according to the present invention;
- 30 Figure 13A is a close up cross sectional view of detail (D) shown in Figure 12;
- Figure 14 is a side view of an anchor;
-

Figure 15 is a top perspective view of a roof structure forming part of a third embodiment of the present invention;

Figure 16A is a side cross sectional view of a roof;

Figure 16B is a view through line A-A in Figure 16A;

- 5 **Figure 17A** is a side view of an alternate embodiment of the clamp according to the present invention;

Figure 17B is a plan view of 17A.

BEST MODES FOR CARRYING OUT THE INVENTION

- 10 The present invention provides improvements to demountable structures for use as storage tanks. The demountable structures according to the present invention have different configurations and components according to the intended use. Accordingly, representative examples of demountable structures will be described herein.

Open (non-sealed) Structure

- 15 Referring first to Figure 1, which shows a side cross sectional view of a demountable structure according to the present invention in the form of a cylinder shaped tank (1).

The tank shell (1) is sold as a kitset of parts which includes any or all of the components from which the tank (1) is constructed. In addition, the kitset may include instructions outlining the steps to assemble the components and thereby form tank (1). The components of the kitset
20 are made from high density polyethylene plastic, aluminium extrusions, other plastic materials and/or a combination of materials. The components of the kitset will now be described with reference to the method of assembling the tank (1).

The tank (1) includes a tank shell (2).

The tank shell (2) is constructed generally using the following steps in any order:

- 25 (a) Constructing a base by positioning a base element (3) and floor panels (6) with respect to where the tank (1) is to be constructed.
- (b) Forming a plurality of wall modules (10) and connecting these to the base elements (3).
- (c) Securing top frame components (22) to a top edge (36) of wall modules (10).
- (d) Repeating steps (a) – (d) so as to substantially form the tank shell (2).

The base elements (3) are aluminium extrusions that have recesses (4 and 5) which are orientated so as to face perpendicularly to each other.

5 The base elements (3) are substantially straight when formed by extruding techniques. However, a curve is formed into base element (3) by the application of pressure to bend the extrusion around a mandible. This can occur on site, or prior to the kit set of parts being shipped to a customer or retailer.

The curve corresponds to the tank's circumference, and therefore each base element (3) is a segment of the tank's circumference.

10 A floor panel (6) is inserted into recess (4) so that it overlaps the end (7) of the base element (3). The side edges (8, 9) of the floor panel (6) are shaped so that they can sit against a side edge (8 or 9) of an adjacent floor panel (6) in the tank shell (2).

Preferably each floor panel (6) is secured to one of the base elements (3) using a plastic weld or other technique known to one skilled in the art. This occurs prior to sale of the kitset.

15 Securing the floor panel (6) to a base element (3) prior to sale offers a number of advantages and assists a person in constructing the tank (1) with minimal tools and effort.

Each wall module (10) is constructed from a connection member (11) and a wall panel (12).

Figure 4 shows a plan view of the connection member (11). The connection member (11) has channels (13, 14) and recesses (15, 16).

20 The wall panel (12) is inserted into the channel (13) of the connection member (11). The wall panel (12) has ridges (not shown) which correspond to the recess (15). The ridges provide resistance to the wall panel (12) being inserted entirely into the channel (13). Once inserted, the ridges sit in recess (15). This helps to retain the wall panel (12) in position once inserted into the channel (15) and may improve the stability of the tank shell (2) during its assembly.

25 The wall panel (12) is secured to the connection member (11) via a plastic weld prior to sale of the kitset.

A bottom edge (12B) of wall panel (12) is inserted into recess (5) in base element (3). Screws (27B) are used to secure the base element (3) and wall panel (12) together:

30 The kitset includes a plurality of identical base elements (3), floor panels (6) and wall modules (10). The number depends on the diameter of the tank being constructed and/or desired sizes to make transportation easier.

Sheets of insulation material (95) can also be secured to the floor panels (6) and wall panels (12). The insulation materials prevent or reduce transmission of heat from within, into or out from the tank shell (2). A representative example of a wall panel (12) having insulation material (95) secured thereto are shown in Figures 10A and 10B.

Preferably the insulation materials (95) are secured to the wall panels (12) and floor panels (6) prior to sale of the kitset.

Constructing the tank (1) using insulation materials will facilitate its conversion for use in applications such as methane digestion as is discussed in more detail below under the heading third embodiment.

It is also envisaged that the tank (1) can be manufactured without insulation material secured thereto. Therefore, reference to insulation material should not be seen as limiting on the scope of the present invention.

Referring now to Figures 5A and 5B which show a first wall module (12) secured to a second wall module that for clarity is referred to as (17).

The second wall module (17) is formed from a wall panel (18) and a connection member (19) in an identical manner to how wall module (10) is formed.

The second wall module (17) is positioned adjacent the first wall module (10) and moved so that a side edge (18A) of wall panel (18) of is inserted into the channel (14). A bottom edge (20) of wall panel (18) is inserted into channel (5) in base element (3).

A top frame component (22) is shown in Figures 9A and 9B. The top frame component (22) is formed from an aluminium extrusion and includes a main body having a first channel (23) extending along the length of main body, and a second channel (24) spaced apart from first channel (23) and extending along the length of main body.

The top frame component (22) also includes a channel (26) configured to secure the top frame component (22) to one or more wall modules (10 and/or 17).

The top frame component (22) is positioned so that it overlaps the edges of adjacent wall modules (10,17). A top edge (25) of a wall panels (12, 18) is inserted into the channel (26).

Screws (27A) are inserted through the top frame component (22) and a wall panels (12, 18) to secure these together.

The above process is repeated to form a cylindrical structure.

Wire ropes (28) are threaded through apertures in the connection members (11, 19). The wire ropes (32) are vertically spaced from each other. This stage of construction is shown in Figure 6.

Referring now to Figures 8 A – C and Figure 9

A first reinforcing component indicated generally by (29) is provided. The reinforcing component (29) is a rigid hoop that is spaced apart from an outer surface of the tank shell (2). The rigid hoop (29) is concentric with the circumference of the tank shell (2).

The tank may also include an inner hoop to which the rigid hoop (29) is secured. In the embodiment shown in the Figures the inner hoop is provided by the top frame components (22) of the tank shell (2).

Ribs (30) are secured to the tank shell (2), and preferably top frame components (22), by screws (not shown). The ribs extend away from the outer surface of the tank shell (2).

The rigid hoop (29) is formed from a plurality of individual rigid members (31) to the ribs (30). This is achieved by inserting an end of each rib (30) through an aperture in one of the members (31). This process is repeated around the circumference of the tank shell (2).

Adjacent members (31) are secured to each other. This may be achieved using interconnecting detents. Alternatively, the members (31) may overlap and be secured together using clamp fasteners, screws and bolts, welding or other techniques known to those skilled in the art. This forms the rigid hoop (29).

It is also envisaged that the inner hoop and rigid hoop (29) could be provided by integral components, components other than the top frame components (22) etc.

A second reinforcing component, indicated generally as (33) in Figure 7 is attached to the tank shell (2). This is achieved in a similar way to first reinforcing component. The second reinforcing component (33) includes an inner hoop that is provided by the base elements (3). Ribs (36) are inserted into apertures (not shown) in base elements (3).

The second reinforcing component includes an outer hoop (35) formed by securing a plurality of individual members (37) to ribs (36). Adjacent members (47) are connected to each other so as to form a rigid hoop.

The first and second reinforcing components (29, 33) are each a double rim spoke structure, in which the ribs (30, 36) provide spokes to hold the rims (the inner and outer hoops) in a fixed position with respect to each other.

The first and second reinforcing components (29, 33) are vertically spaced apart from each other.

A liner (34) in the form of a sheet of flexible material is positioned inside the tank shell (2). The liner is impervious to fluids, ensuring that when the tank (1) is constructed it is capable of holding a fluid or fine particulate matter. The liner (34) is arranged so that it extends over a top edge (35) which is defined by top frame component (22).

A clamp indicated generally as (36) is positioned around the circumference of the tank shell (2). The clamp is formed from a plurality of rigid members (37) which cooperates with a plurality of screw thread actuators (38A) positioned at points around the circumference of the tank shell (2). Each screw thread actuator (38) includes a mounting (39) that is secured to one of the ribs (30). Each mounting (39) includes a first internal screw thread (40).

A first member (42) has an external screw thread (44) that corresponds to the first internal screw thread (40) on mounting (39).

In-use, the internal and external screw threads (44, 40) are configured to interact with each other. Rotation of the member (42) in a first direction causes a bearing surface (46) on the end of the first member (42) to move towards or away from mounting (39). When the bearing surface (46) moves away from mounting (39) towards top frame component (22) it pushes rigid members (37) towards and into the first channel (23).

The configuration of the top frame components (22) and interaction with the clamp is particularly advantageous for a number of reasons, including:

- The inventions are a simple and secure way to secure a liner in a tank shell. That is robust enough that the liner will not be ripped lose when the tank is exposed to harsh environmental conditions.
- The top frame components and strap fasteners are an easy way to convert an unsealed or open top tank into a sealed tank suitable for use in holdings gases or in methane digestion.
- Can be easily manufactured.
- Facilitate provision of a compact kit set of parts which can be easily transported.
- Do not require specialist tools for construction of the tank.

The tank (1) may include a plurality of anchors (not shown in Figures 1- 8C). The anchors suitable for use with the tank (1) are identical to the anchors discussed in relation to a third embodiment of the present invention discussed below.

Second Embodiment

Referring now to Figure 1, which shows a side cross sectional view of a second embodiment of a tank (60) according to the present invention.

The tank (60) is constructed using the methods and components as described above in relation to the tank (1). Therefore like numerals will be used to refer to like components, and construction of similar aspects will not be reiterated. Tank (60) differs to tank (1) in that it includes a sealed bladder. The sealed bladder is formed by securing a second sheet of flexible material (61) to the tank shell (2) as is discussed below. The second sheet of material (61) is

positioned inside the tank shell (2) and arranged so that it extends over the top edge (35) of the tank shell (2). Note that the second sheet of material (61) lies over top of second channel (24) in the top frame component (22).

5 The second clamp is used to secure the liner to the top frame component (22) and thereby to the tank shell (2). The second clamp is formed by a plurality of second screw thread actuators (38B). Second member (43) has an external screw thread (45) that engages with an internal screw thread (41) on mounting (39). Rotating the second members (43) with respect to mounting (39). That rotation causes the internal screw thread (41) and the external screw thread (45) to engage with each other. This causes a bearing surface (47) on members (43) to
10 be moved towards or away from the second channel (24) and top frame component (22).

A rigid member (63) is positioned between bearing surface (47) and second sheet material (61). Rotation of the second member (43) causes bearing surface (47) to move towards or away from second channel (24).

Continued rotation of the second members (43) forces rigid members (63) into the second
15 channel (24). This secures the second liner (61) within the second channel (24).

The tank (60) may include a web indicated generally as (64).

The web (64) is a lattice formed by welding individual strands of polyester or other plastic strap materials together.

20 The web (64) is positioned inside the tank shell (2) above the second layer of material (61) and extends over the top edge (35) of the tank shell (2).

The web (64) is fastened to the tank shell (2) using web fastening members (65).

The web fastening members (65) are L shaped brackets that are secured to the members (31) using fasteners (66) such as screws, rivets, or clamps.

25 Each end of the individual strands of plastic strap materials forming the web (64) includes a loop (not visible in the figures).

The loops can be positioned over top of the web fastening members (65).

Ratchets (not shown) are positioned between selected loops and web fastening members (65). The ratchets may be used to remove slack from the web (64) and to ensure that it is held taut in position over top of the tank shell (2).

30 In-use the web (2) restricts lifting of the second sheet of material (61) above the top edge (35) of the tank shell (2).

The inventor has identified the prevented lifting of the tank is particularly beneficial to improving its operation in different conditions.

For instance, the web reduces the stresses on the tank shell (2) which it experiences due to flapping of the second layer of sheet material (61) in the wind.

The web (64) is also lighter weight and more cost effective to manufacture than complex roof structures requiring frames formed of rigid members such as aluminum extrusions.

- 5 Accordingly, the web according to the present invention is lighter weight and more easily transportable.

Furthermore, the web (64) is more compact than a frame of rigid members which facilitates easy transport of the kitset of parts.

- 10 *Third embodiment* Referring now to Figures 12 and 13, showing an alternate embodiment of a tank (65) according to the present invention.

The tank (65) is constructed using the methods and components as described above in relation to the tank (1). Therefore like numerals will be used to refer to like components, and construction of similar aspects will not be reiterated. A second sheet of flexible and fluid impervious material (67) has a manhole ring (not shown) secured within its circumference.

- 15 The second sheet of material (67) is positioned within tank shell (2) so as to overlap top edge (35) of the tank shell (2).

The second sheet of material (67) is secured to tank shell using second members (43) and top frame components (22) as is discussed above.

A roof frame indicated generally as (74) is assembled.

- 20 The roof frame is better shown in Figures 15, and 16A and 16 B.

A roof frame (indicated generally as 68) is formed from a manhole ring (69), ribs (70), and circumference sections (71).

To assemble the roof frame (68) the ribs (70) are secured to the manhole ring (69) by screws (not visible).

- 25 The ribs (70) are metal extrusions having a curve corresponding to the desired curve for a roof (68) of the tank (65). The shape of the ribs (70) creates a dome like structure for the roof frame (68).

Circumference sections (71) are secured to the ribs (71) at distal end (72) to the manhole ring (69). This is achieved using screws (not shown).

- 30 Each of the ribs (70) has a series of apertures transverse to the longitudinal axis of the rib (70).

Wire ropes (73) can be threaded through the apertures in ribs (70) and be tied so as to fix them in position.

Sheets of insulation material (90) in the form of high density foam are positioned between a pair of adjacent ribs (70) and to bear down onto the wire ropes (73).

The roof (68) is positioned over top of the tank shell (2). The circumference sections (71) bear down on the members (31) forming the rigid hoop (29).

- 5 The circumference sections (71) and rigid hoop (29) are secured together using clamps (not shown in the figures).

The manhole ring (not shown) is raised so as to be adjacent to manhole ring (69).

The manhole rings (not shown and 69) can be secured together.

- 10 A lid (not shown) can be used to seal manhole ring (69). This provides a fluid tight seal such that the cavity between the liners provides a sealed bladder the tank (65).

An outer skin layer (75) can be positioned over top of roof frame (68). The outer skin layer (75) assists in holding the insulation material in position in the roof (74)

- 15 Anchors (76) are used to help secure the tank (69) to the ground (77) on which it is constructed. Each anchor (76) is an auger style device, having a blade portion (78), a main body (79) and a head (80) distal to the blade portion (78). In use, an anchor (76) is positioned so that blade portion abuts grounds adjacent to the tank (69). The anchor (76) is rotated so that blade portion (78) bites into the ground in a cork screw type action, causing the blade portion (78) to be burrow into the ground.

- 20 A strap (79) is connected to head (80) and then tied to the tank shell (2) at an appropriate position such as to one of the ribs (30). The above process is repeated to secure a plurality of anchors (76) around the circumference of the tank (65).

In use, the blade portion (78) provide resistance to anchors (76) being pulled upwards, and therefore anchor the tank (65) to the ground (69).

Alternate Clamps

- 25 Referring now to Figures 17A and 17B that show an alternate embodiment of a clamp according to the present invention.

Like reference numerals will be used to refer to like components.

In the embodiment shown in Figures 17A and 17B the clamp does not utilise rotating members to move a bearing surface towards or away from the first or second channels (23, 24).

- 30 To secure a liner formed by a sheet of flexible material to the tank shell (2) the liner (34) is first positioned in the tank shell (2) so as to overlap the top edge (35) of the tank shell (2).

A plurality of rigid members (81) are positioned around the circumference of the tank shell (2). Each rigid member (81) includes a rubber detent (84) inserted into an end (85) of the member (81). Force is applied to each rigid member (81) so as to push the detent towards and into first channel (21) each secured to a rib (30) and members (31) forming rigid hoop (29). A first
5 fastener (82) and a second fastener (83) secure each rigid member (81) to a rib (30) and member (31) forming rigid hoop (29).

A plurality of rigid members (81) are positioned so as that rubber detents (84) abut the liner (34) on a side of the liner (34) that is distal to the first channel (23).

Bolts (84, 85) can be used to engage fasteners (82, 83) to secure the rigid members (81) with
10 respect to the ribs (30) and rigid hoop (29). This is provided a clamping action to secure liner (34) to the tank shell (2)..

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

WHAT I CLAIM IS:

1. A tank, including:
 - a tank shell having a top edge,
 - a liner inside the tank shell,
 - wherein an edge of the liner extends over the top edge of the tank shell,
 - a clamp,
 - characterised in that
 - the clamp secures the liner to the tank shell.
2. The tank as claimed in claim 1, wherein the tank shell includes a frame component that comprises:
 - a body having a length,
 - a channel extending along the length of the body,
 - and wherein the clamp forces the liner into the channel to thereby secure the liner to the tank shell.
3. The tank as claimed in either one of claims 1 or 2, wherein the tank shell comprises:
 - at least one wall module.
4. The tank shell as claimed in claim 3, wherein the frame component engages a top edge of a wall module.
5. The tank as claimed in any one of claims 1 to 4, wherein the frame component includes a second channel.
6. The tank as claimed in any one of claims 1 to 5, including a second sheet of material, and a second clamp that forces the second sheet of material into a second channel in the frame component.
7. A kit set of parts for constructing a tank, the kit set including
 - a plurality of components which when assembled and secured together form a tank shell,
 - a liner which when the kit set is assembled is positioned in the tank shell and extends over a top edge of the tank shell,

a clamp,

characterised in that

when assembled the clamp secures the liner to the tank shell.

8. A method of constructing a tank,

wherein the tank includes a tank shell having a top edge, a liner inside the tank shell that extends over the top edge of the tank shell, a strap fastener that extends around the tank shell and clamps the liner to the shell,

the method including the following steps in any order:

- (f) constructing the tank shell;
- (g) positioning the liner inside the tank shell;
- (h) arranging the liner so that an edge of the liner extends over the top edge of the tank shell;
- (i) positioning the strap fastener with respect to the tank shell and the liner;

the method characterised by step:

- (j) tightening the clamp so as to secure the liner to the tank shell.

9. The tank as substantially described herein by reference to the best modes section of attached specification and accompanying drawings.

10. The kit set of parts as substantially described herein by reference to the best modes section of attached specification and accompanying drawings.

11. The method of constructing a tank as substantially described herein by reference to the best modes section of attached specification and accompanying drawings.

FIGURE 1

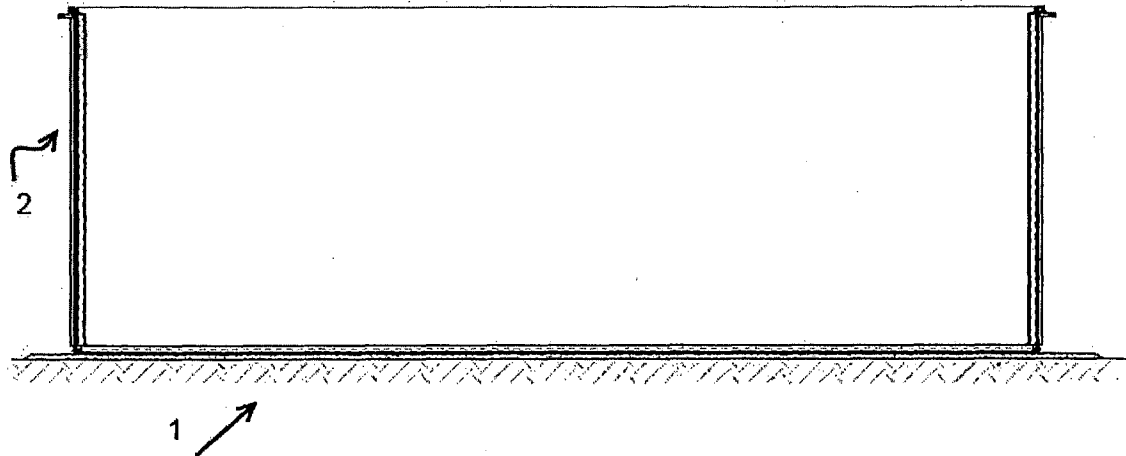


FIGURE 2

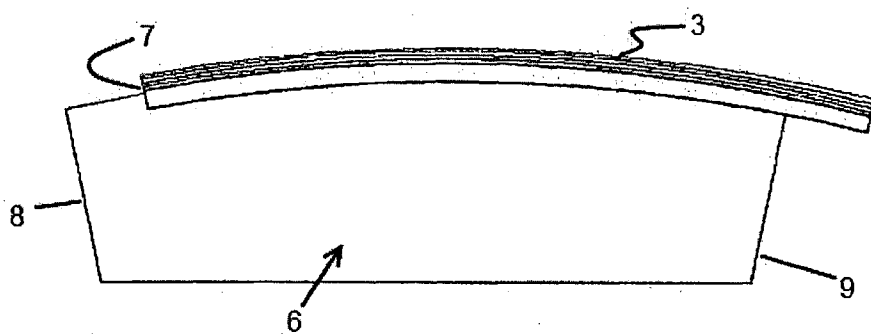


FIGURE 3

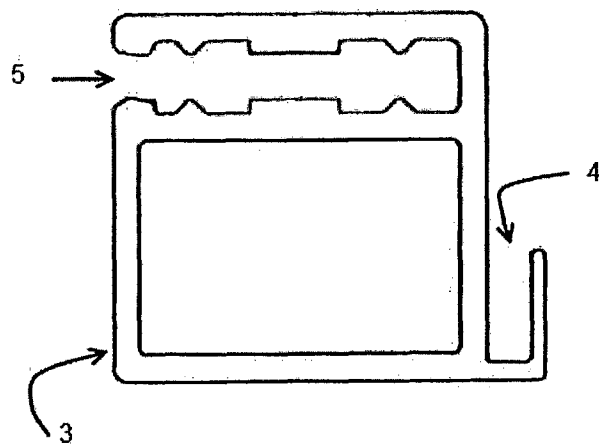


FIGURE 4

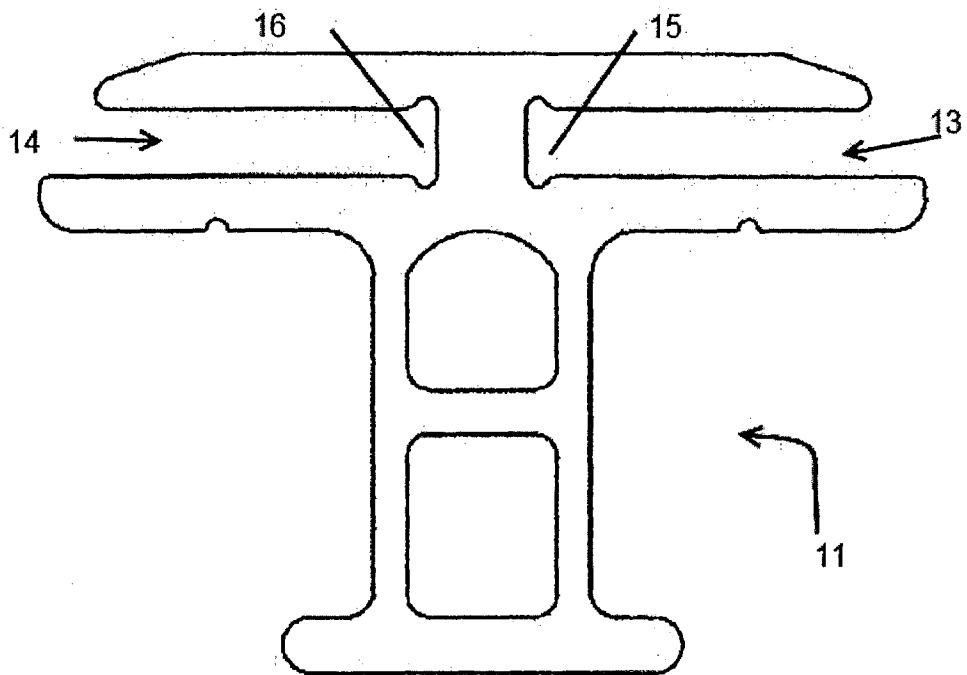


FIGURE 7

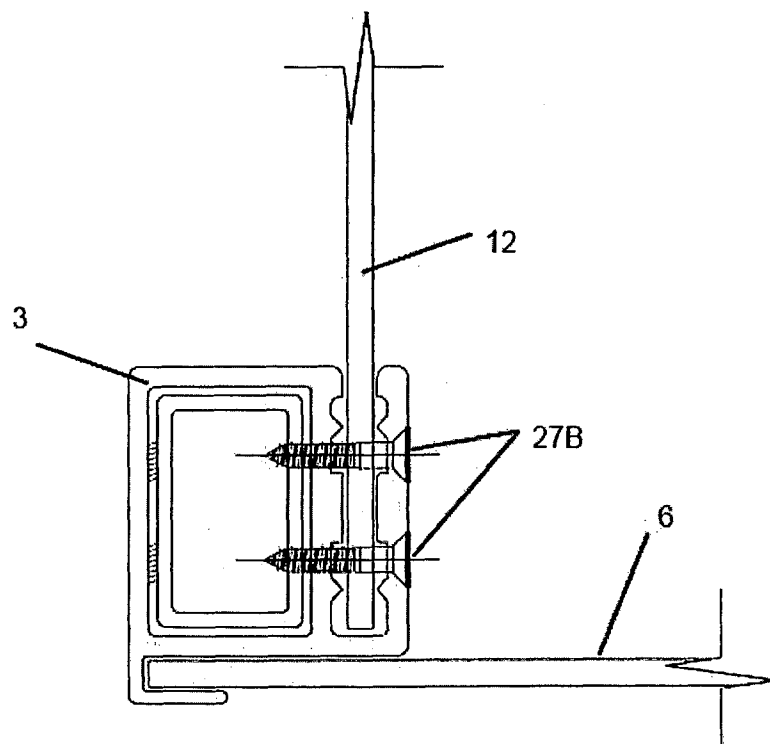


FIGURE 5A

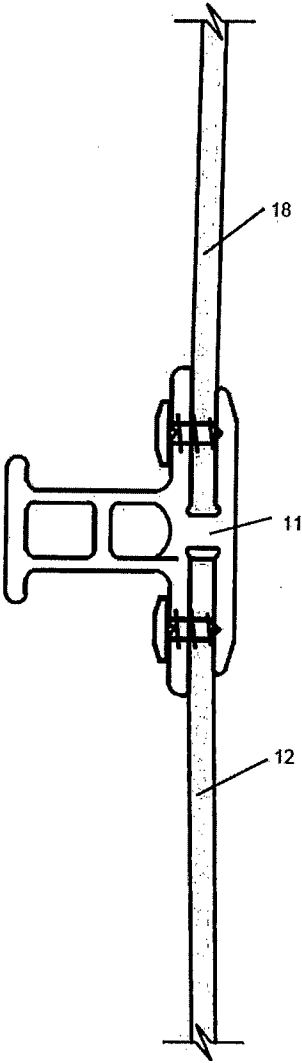
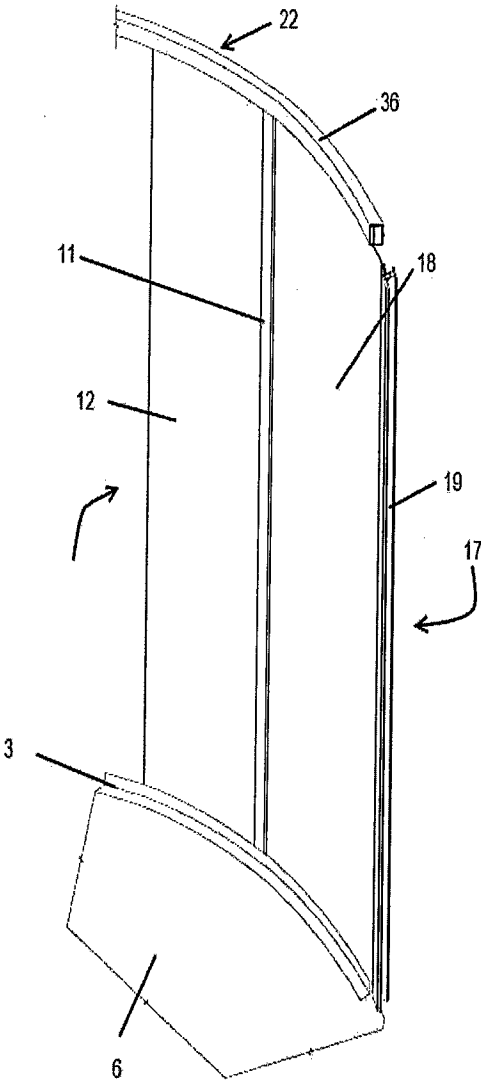


FIGURE 5B

FIGURE 6

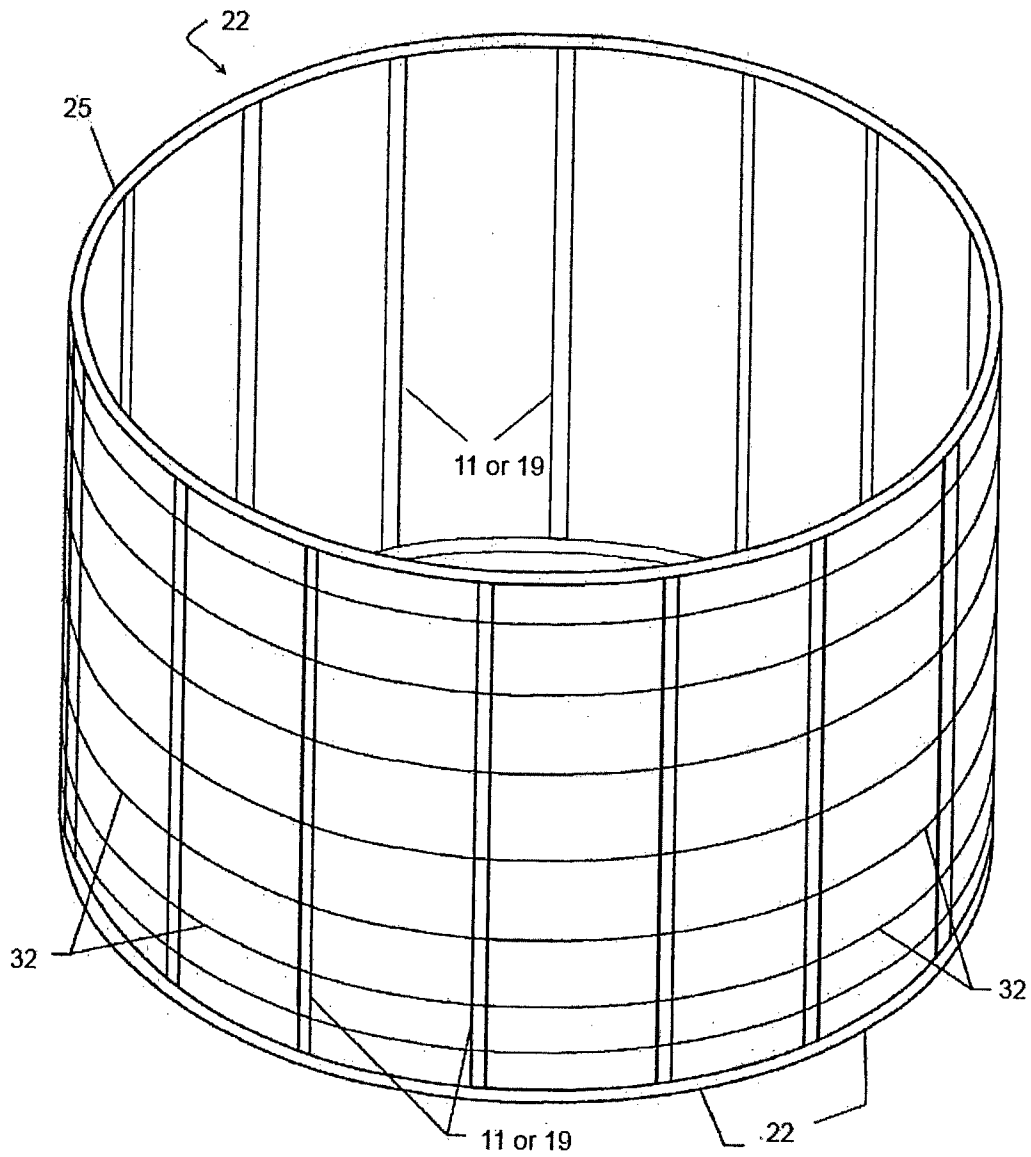


FIGURE 8A

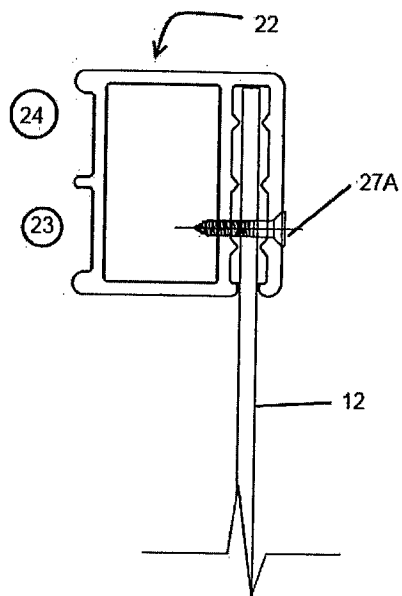


FIGURE 8B

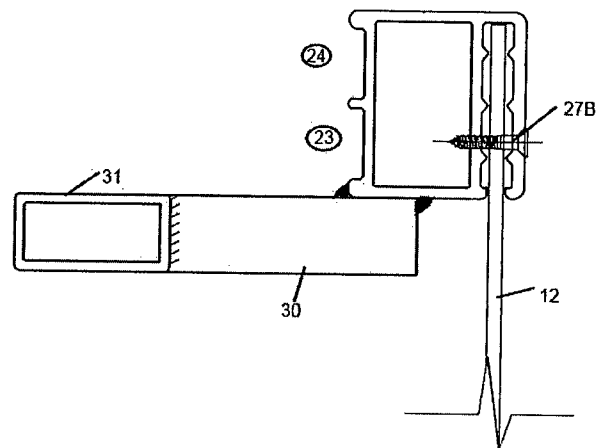


FIGURE 8C

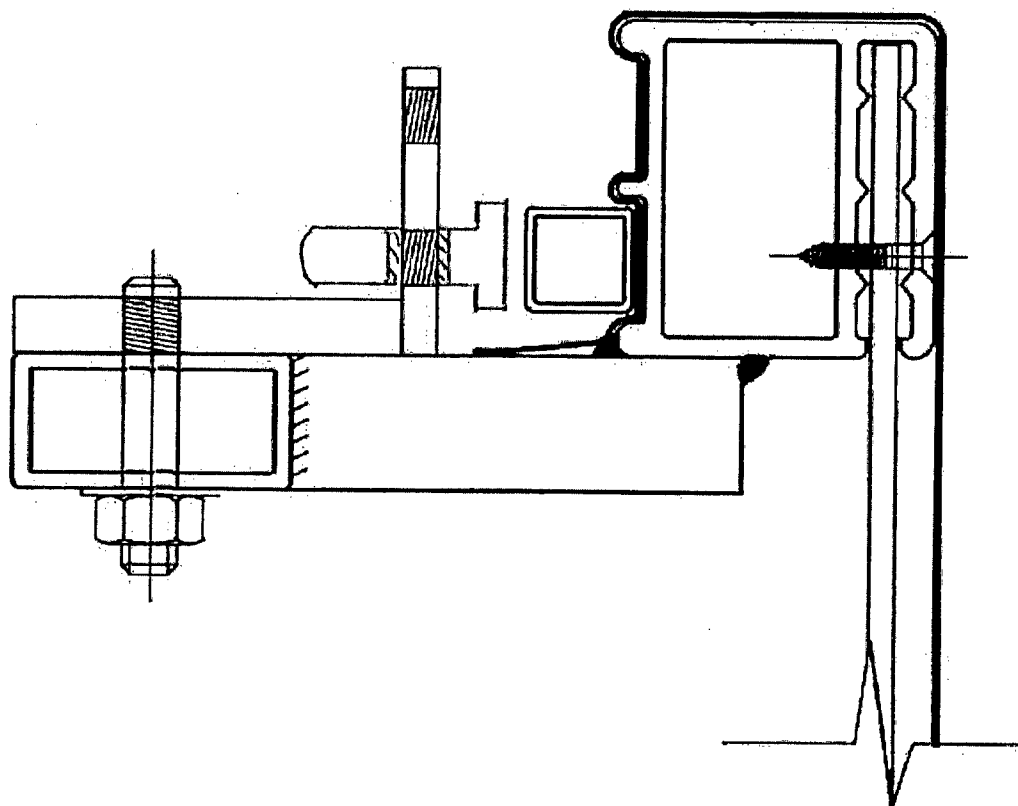


FIGURE 9

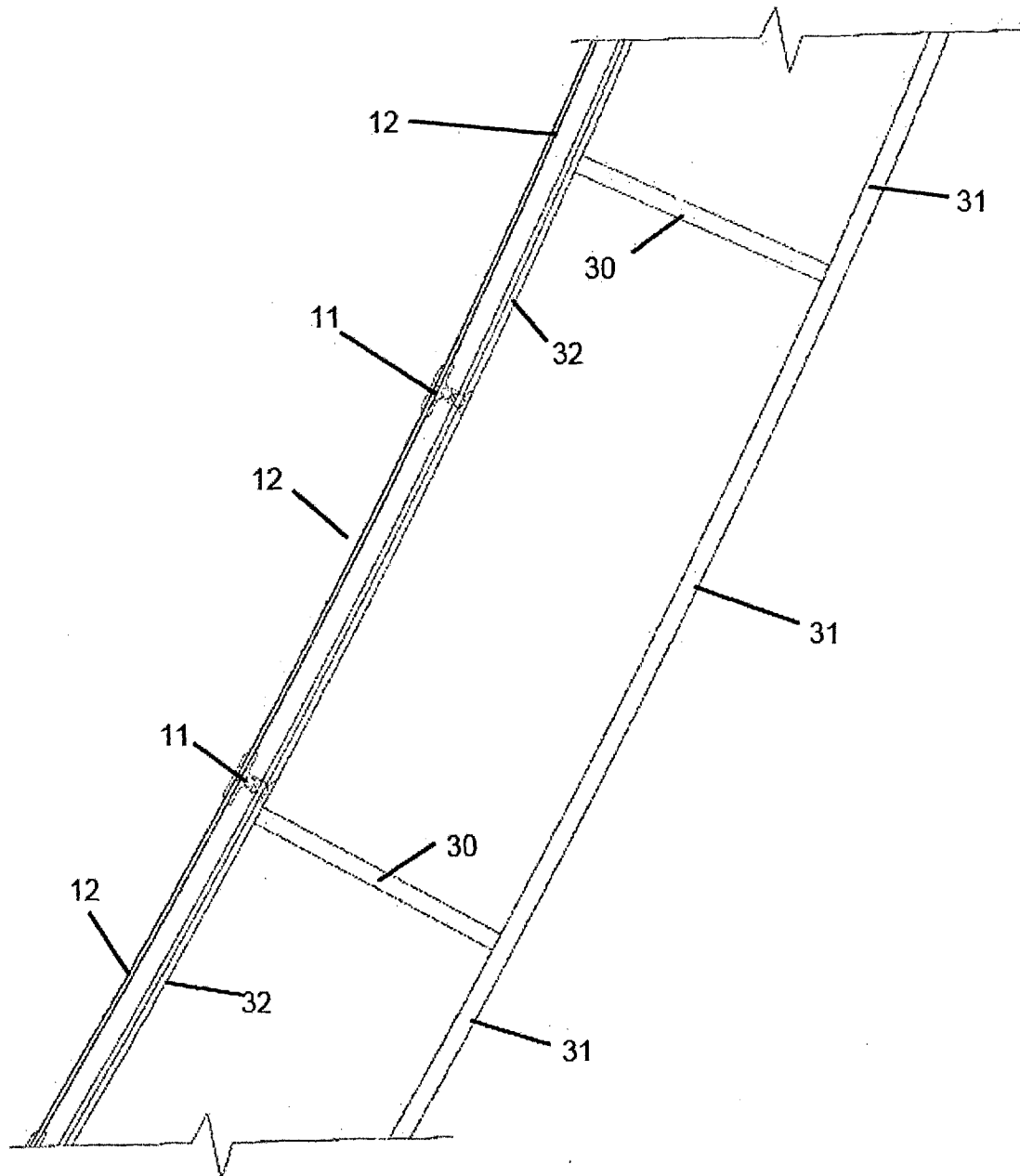


FIGURE 10A

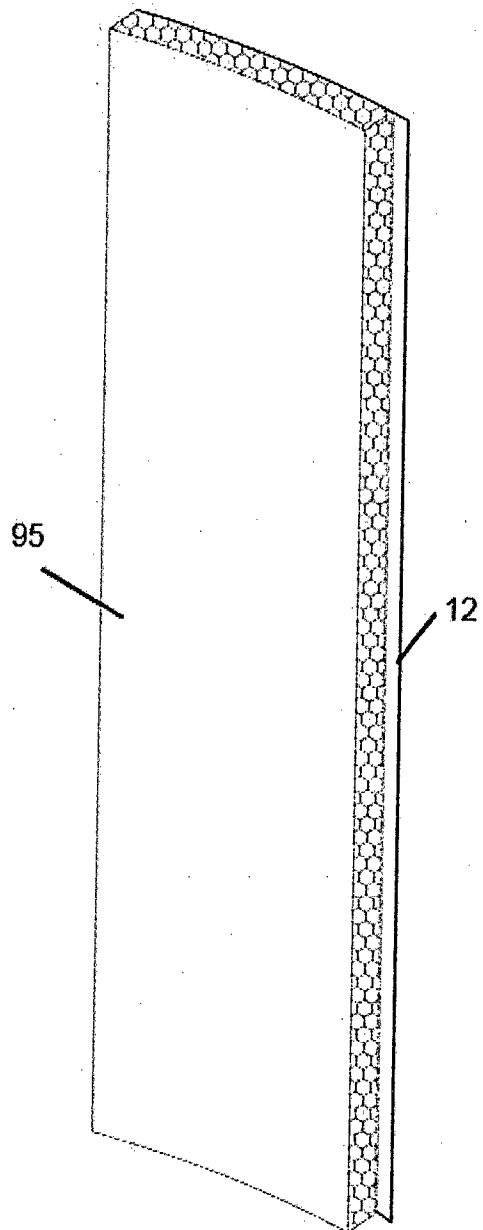


FIGURE 10B

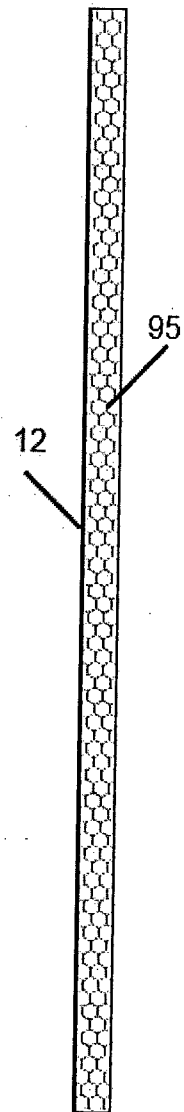


FIGURE 11

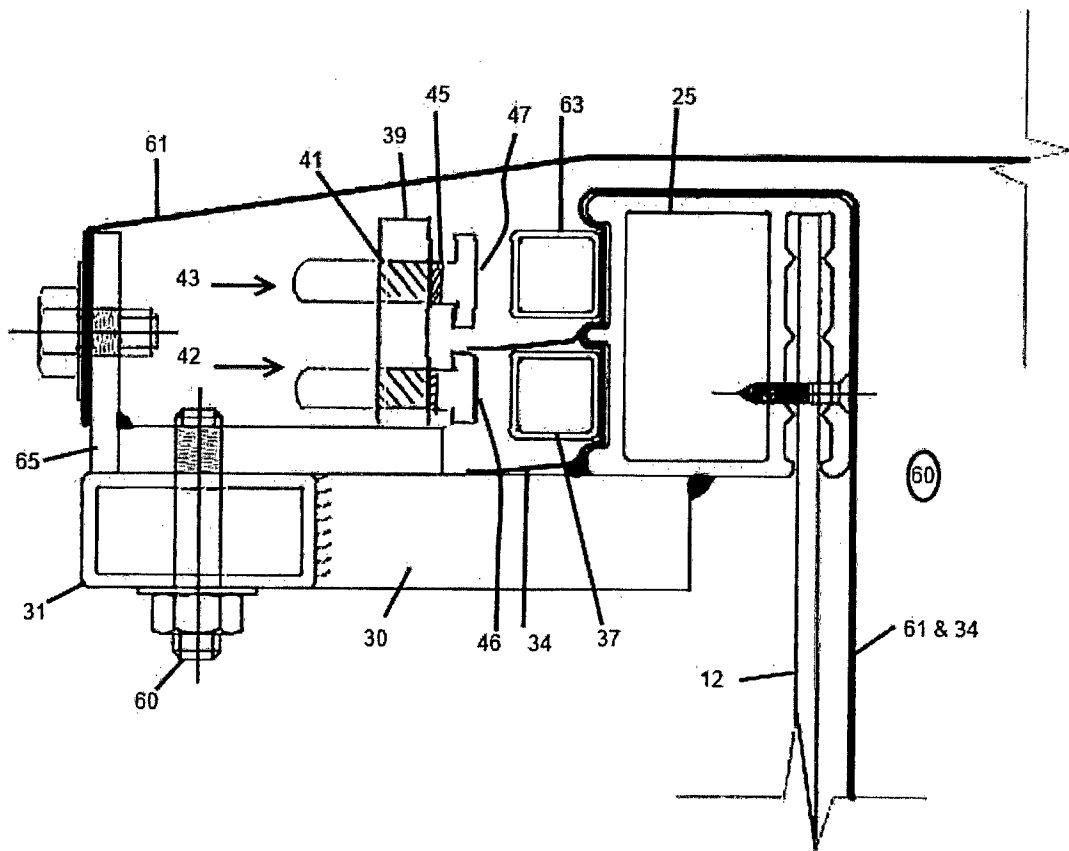


FIGURE 12

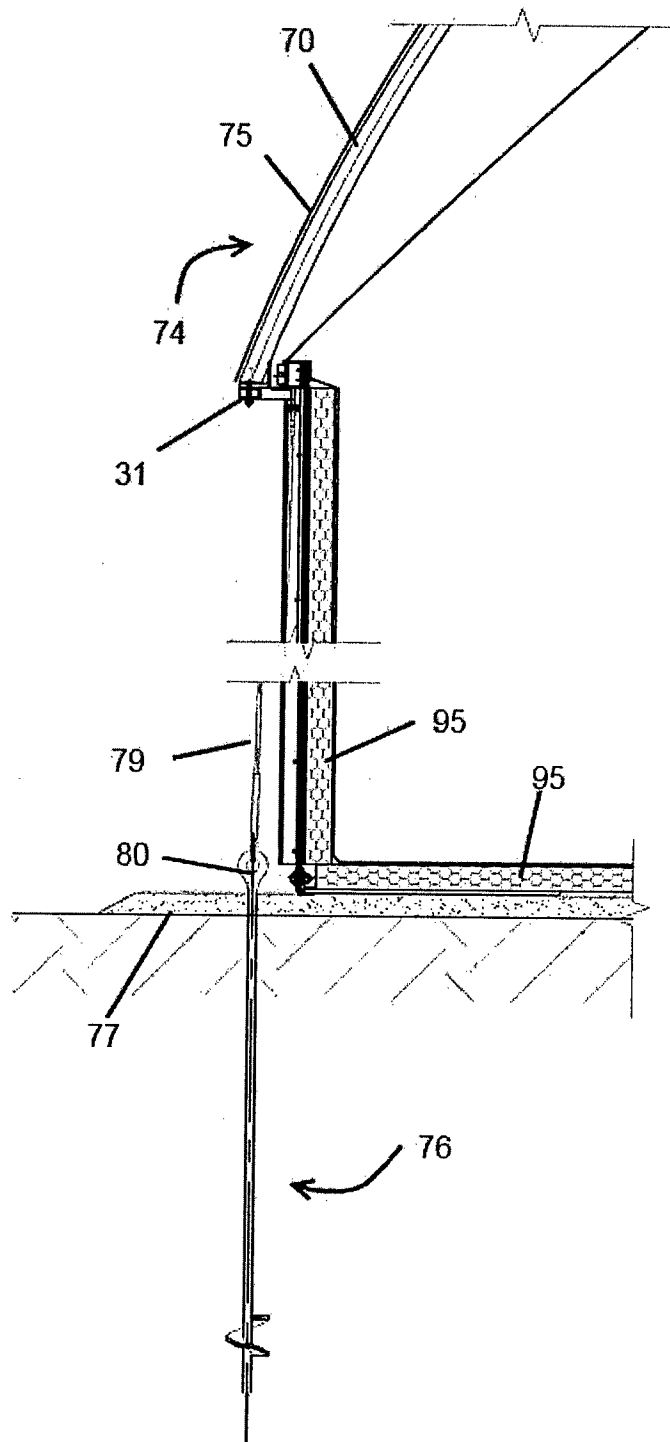


FIGURE 13

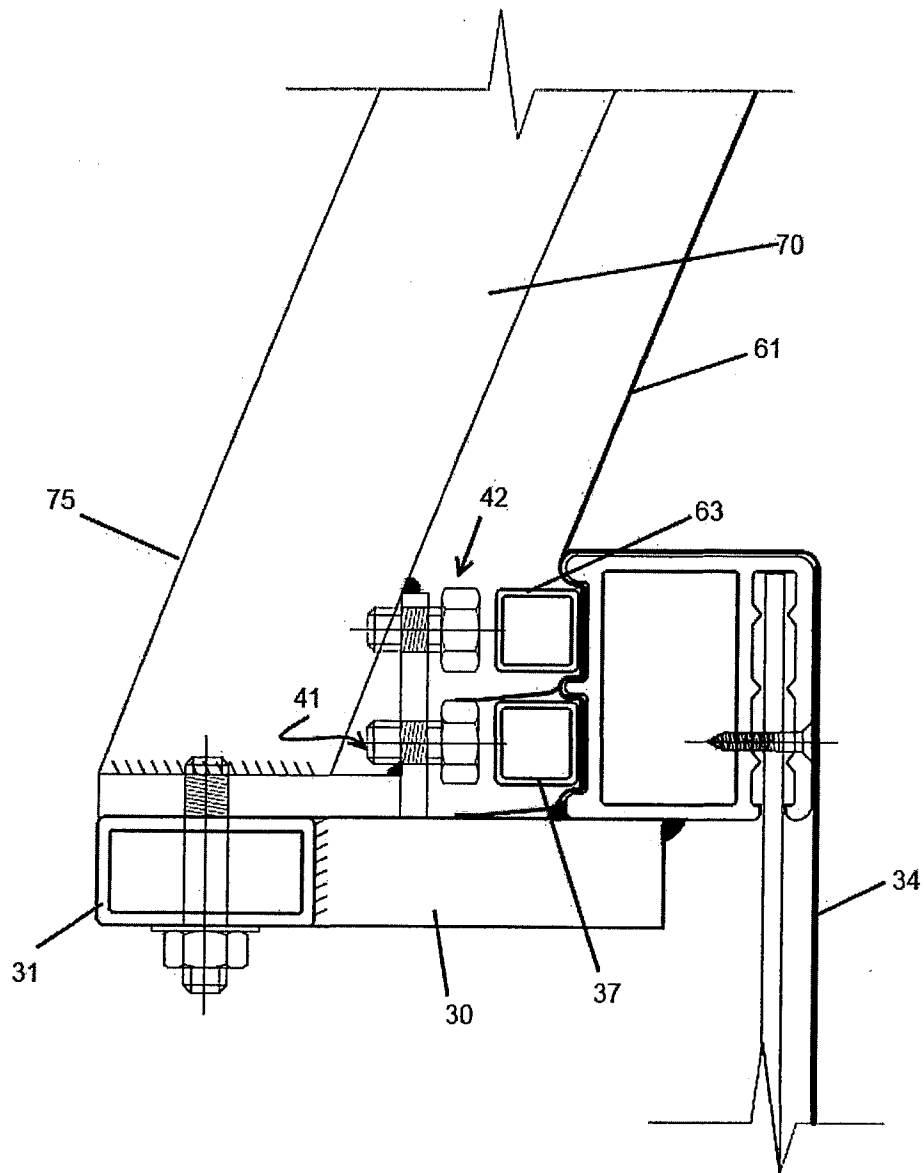


FIGURE 14

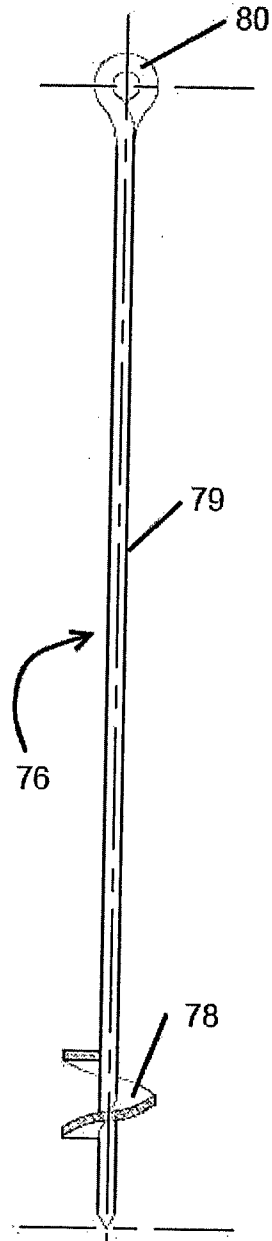


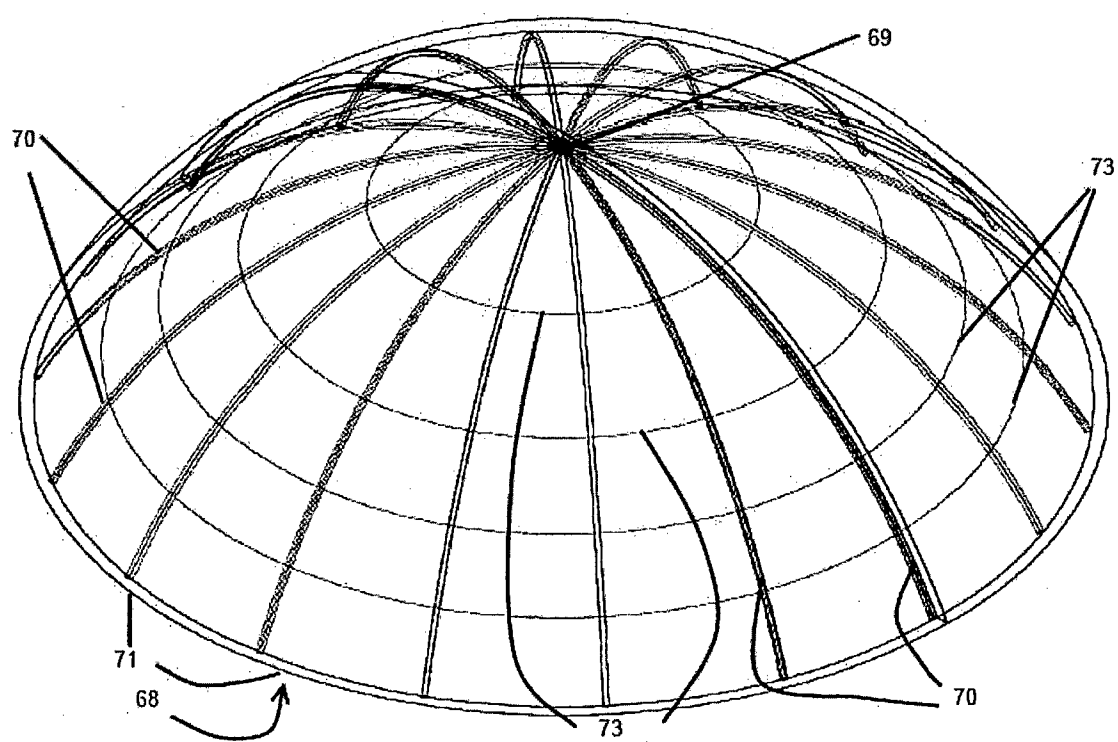
FIGURE 15

FIGURE 16A

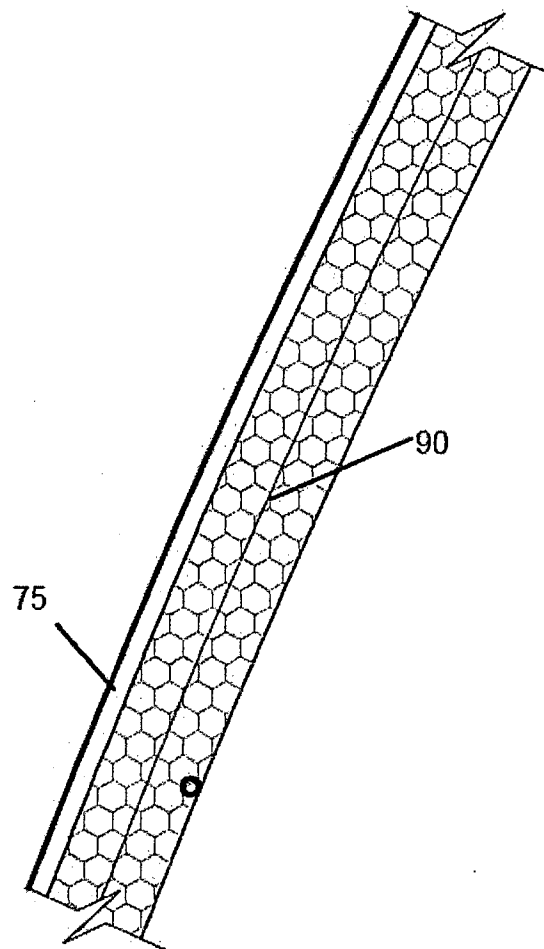


FIGURE 16B

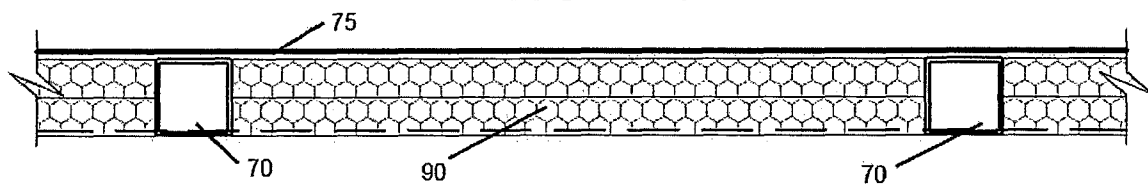


FIGURE 17A

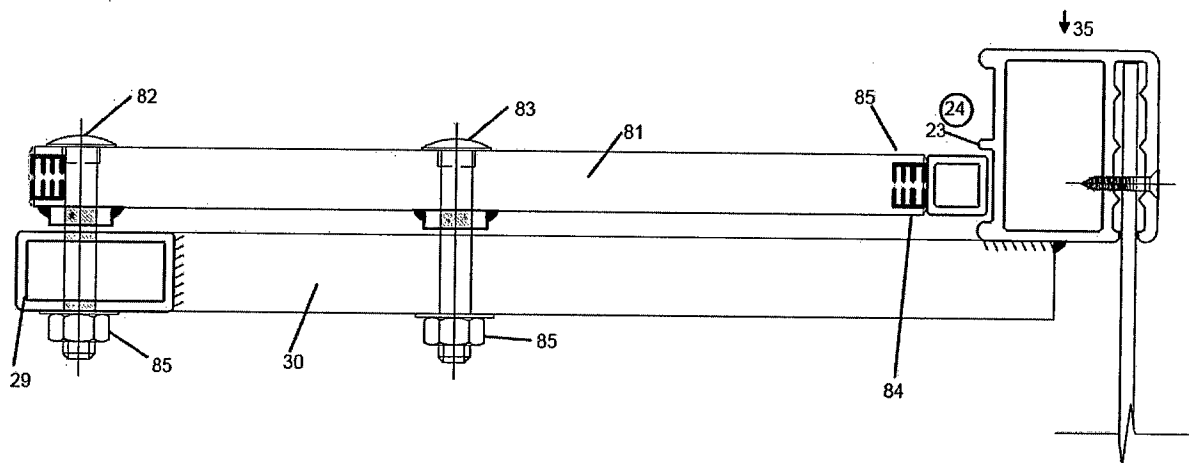
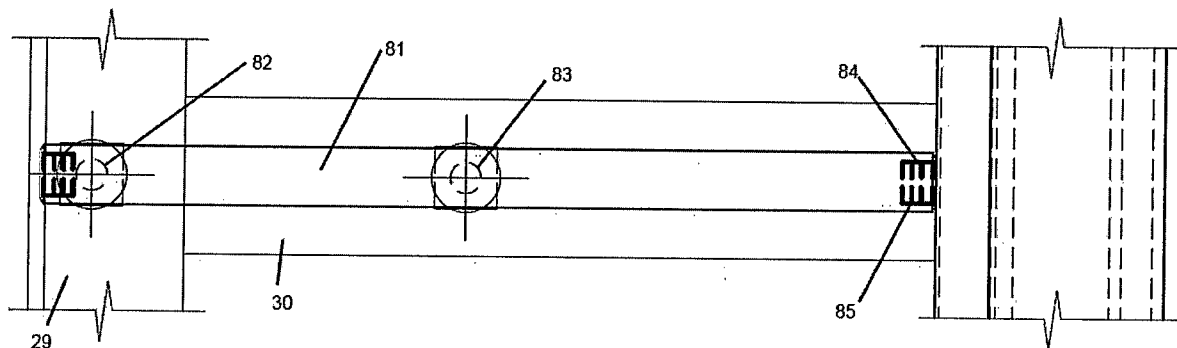


FIGURE 17B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ2013/000015

A. CLASSIFICATION OF SUBJECT MATTER

B65D 88/52 (2006.01) B65D 90/04 (2006.01) E03B 11/00 (2006.01) E04H 7/02 (2006.01)

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)

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)

EPODOC, WPI: IPC Marks- B65D88/LOW, B65D90/04, E03B11/00, E04H7/02 with Key Words- LINER?, LINING?, BLADDER?, MODULE+, PANEL?, SHEET? WALL?, CLAMP+, CONNECTOR?, BRACKET?, MOUNT+, SECUR+, SUPPORT+, HOLDER?, FIXTUR+, DEMOUNT+, CONSTRUCT+, ASSEMBL+, KIT+, COLLAPS+, BUILD+, PORTABLE, VESSEL?, TANK?, REACTOR?

GOOGLE PATENTS: Word Search-TANK, SHELL, LINER, CLAMP/ BRACKET/ MOUNT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
1 July 2013

Date of mailing of the international search report
01 July 2013

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/NZ2013/000015
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3648303 A (STEWART et al.) 14 March 1972 column 2, lines 41-56; column 3, lines 43-50; figs 1, 3, 8	1-8
A	NZ 560570 A (NEIL TERRY PETERKEN et al.) 29 October 2010 abstract; figs 1-6	
A	US 2004/0118844 A1 (BENNETT et al.) 24 June 2004 abstract; figs 1-4	
A	CA 1207970 A (COLUMBIA RESERVOIR SYSTEMS (1977) LTD.) 22 July 1986 page 19, line 19-page 21, line 6; figs 1-3, 8	

Form PCT/ISA/210 (fifth sheet) (July 2009)

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/NZ2013/000015	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
US 3648303 A	14 Mar 1972	None	
NZ 560570 A	29 Oct 2010	None	
US 2004/0118844 A1	24 Jun 2004	US 2004118844 A1	24 Jun 2004
		US 7188747 B2	13 Mar 2007
CA 1207970 A	22 Jul 1986	None	
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			