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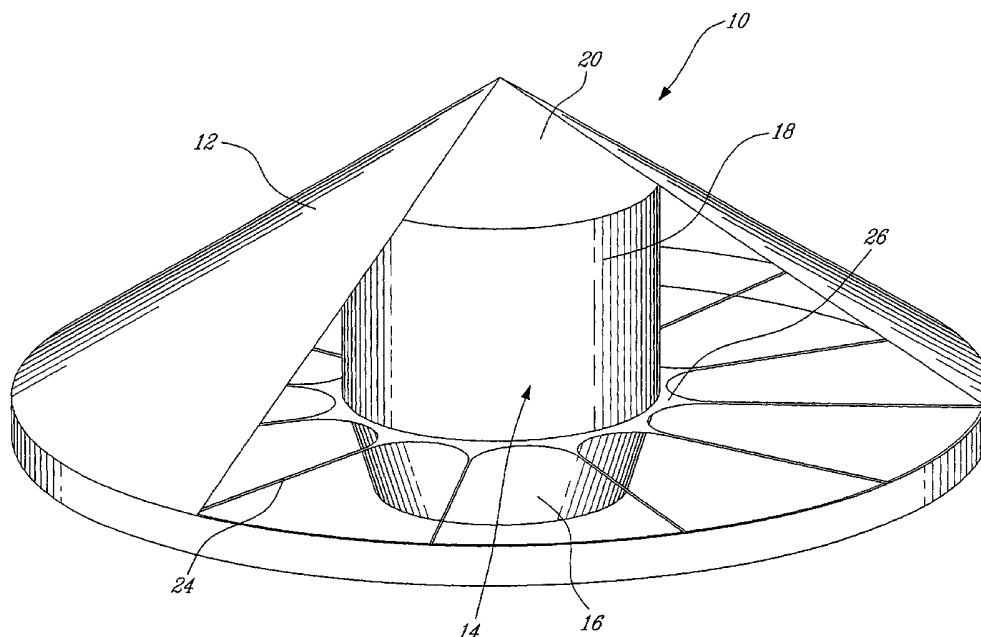
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(54) Title: ROOF STRUCTURE



(57) **Abstract:** A roof structure (10) for covering a reservoir (R), such as a liquid manure reservoir, comprises a roof membrane (12) adapted to be secured at a periphery thereof to the reservoir (R), and an inflatable mast (14) adapted to float on the slurry contained in the reservoir (R) to stretch the roof membrane (12) in a tent-like configuration over the reservoir (R). The inflatable mast (14) comprises an inverted frusto-conical base portion (16) adapted to gradually collapse as the level of slurry raises within the reservoir (R) thereby maintaining the position of the roof structure (10) irrespective of the level of slurry.



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ROOF STRUCTURE

BACKGROUND OF THE INVENTIONField of the Invention

5 The present invention relates to roof structures and, more particularly, to roof structures suited for covering reservoirs, such as liquid manure reservoirs.

Description of the Prior Art

10 Inflatable roof structures are relatively economical to manufacture and install and, thus, they are often used to cover large reservoirs, such as liquid manure reservoirs. However, the fact that this type of roof has to be maintained under positive
15 pressure limits access to the interior of the sheltered reservoir. For instance, the size of the opening necessary to introduce a pump into the reservoir in order to agitate or recover the slurry contained in the reservoir is such that the blowing
20 system used to maintain the roof membrane in an inflated state is not sufficient to compensate for the air leaking from the roof structure through the opening, thereby resulting in the deflation of the roof structure. Therefore, straps have been used to
25 support the roof membrane and prevent the same from falling into the liquid manure. Typically, the straps are assembled to each other to form a latticework across the top surface of the reservoir or, alternatively, the straps radiate from a central rigid
30 mast. Nevertheless, the depressurization of the roof membrane renders the same vulnerable to the lifting power of the wind.

 There is thus a need for a new roof structure which, while being economical to manufacture
35 and install, remains in an erected state when it is

desired to have access to the interior of the reservoir on which the roof structure is installed.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to provide a new roof structure for covering a reservoir.

It is also an aim of the present invention to provide a roof structure that provides for the complete filling of the reservoir.

Therefore, in accordance with the present invention, there is provided a roof structure for a reservoir of the type containing a slurry, comprising a roof membrane adapted to be mounted over a reservoir, an inflatable mast of variable length having a top end portion and a bottom base portion, the inflatable mast being adapted to be mounted in the reservoir with the bottom base portion floating on the slurry contained in the reservoir and the top end portion projecting upwardly out of the reservoir to support the roof membrane in a stretched state thereover, the bottom base portion being movable relative to the top end portion along a longitudinal axis of the inflatable mast so that the length thereof varies with the level of slurry within the reservoir.

In accordance with a further general aspect of the present invention, there is provided a roof structure comprising a central mast supporting a roof membrane in a stretched tent-like configuration, the central mast having a top end portion and a bottom buoyant base portion, the bottom buoyant base portion being movable relative to the top end portion along a longitudinal axis of the central mast to provide for adjustment of a length of the central mast in response to raising and lowering movements of the buoyant base portion thereof.

In accordance with a further general aspect of the present invention, there is provided a roof structure for a reservoir of the type containing a slurry, the roof structure comprising a roof membrane adapted to be secured at a periphery thereof to a reservoir, an inflatable mast being adapted to float on the slurry contained in the reservoir to stretch the roof membrane over the reservoir, the inflatable mast comprising an inverted frusto-conical base portion adapted to gradually collapse as the level of slurry raises within the reservoir.

In accordance with a further general aspect of the present invention, there is provided a floating mast for supporting a roof membrane over a reservoir containing slurry. The floating mast comprises an upper end portion adapted to support a roof membrane at a constant elevation irrespective of a level of slurry within the reservoir, and a buoyant base vertically compressible under the hydrostatic pressure when the level of slurry raises within the reservoir, thereby providing a self-adjusting length mast.

In accordance with a further general aspect of the present invention, there is provided a roof structure comprising a central inflatable mast, a roof membrane made of a structural fabric material and adapted to be secured at a periphery thereof to a surrounding structure. The roof membrane is maintained in a stretched state by said central inflatable mast. As will be seen hereinafter, the combination of an inflatable structure with a tensile structure in the construction of a roof structure has numerous advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration
5 a preferred embodiment thereof, and in which:

Fig. 1 is a perspective view of a roof structure comprising a roof membrane supported over a slurry reservoir by an inflatable mast in accordance with an embodiment of a the present invention

10 Fig. 2 is a schematic cross-sectional elevation view of the roof structure of Fig. 1;

Fig. 3 is a top plan view of the roof structure;

15 Figs. 4a-4c are schematic cross-sectional elevation views of the roof structure illustrating the behavior of the inflatable mast when the level of slurry in the reservoir changes; and

Fig. 5 is an enlarged cross-sectional view of the detail of the attachment of the roof membrane
20 to the reservoir.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to the drawings, and in particular to Fig. 1, a roof structure embodying the elements of the present invention and generally
25 designated by numeral 10 will be described.

More particularly, the roof structure 10 comprises a roof membrane 12 and an inflatable central mast 14. In accordance with an embodiment of the present invention, the roof membrane 12 is made of
30 polyethylene. As shown in Fig. 1, the roof membrane 12 is adapted to extend over a reservoir R to prevent precipitation, i.e. rain and snow, from falling into the reservoir R. In the illustrated embodiment, the roof membrane 12 is provided in the form of a circular
35 sheet of structural fabric material and the reservoir

R is cylindrical. The roof membrane 12 is attached at its periphery to the exterior surface of the cylindrical sidewall of the reservoir R (see Fig. 5). The roof membrane 12 is stretched in a tent-like configuration over the reservoir by the inflatable mast 14.

The inflatable mast 14 includes an inverted frusto-conical section 16, an intermediate cylindrical base section 18 and a conical top end section 20. The top end section 20 of the inflatable mast 14 does not necessarily have to be conical. For instance, it could have a dome, an ogival or a trumpet shape.

According to an embodiment of the present invention, the diameter A at the lower end of the conical top end section 20 is 10m, whereas the diameter B of the small base of the frusto-conical base section 16 is 8m.

The pressure in the inflatable mast 14 is about 100 K/m². A conventional blowing system (not shown) is provided to maintain the inflatable mast 14 into an inflated or erected state.

The inflatable mast 14 is maintained centrally of the reservoir by means of a plurality of positioning cables or straps 24 extending radially outwardly from a catenary band 26 extending about the lower end portion of the intermediate section 18 of the inflatable mast 14 at the level of the top surface of the reservoir R. The straps 24 are attached at their distal ends to the sidewall of the reservoir R. The catenary band 26 can be secured to the mast 14 or simply tightly fitted thereover. As seen in Fig. 3, the positioning straps 24 can also be arranged in a star-shaped configuration about the mast 14.

As shown in Figs. 4a-4c, the inflatable mast 14 floats on the liquid or slurry S contained in the reservoir R and adjusts its length in accordance with the level of liquid or slurry S in the reservoir R.

5 The inflatable mast 14 acts as a piston to continuously maintain the roof membrane 12 in tension over the reservoir R. As the base section 16 has a frusto-conical shape, the diameter of the bottom end thereof is smaller than the diameter of its top end

10 and consequently the bottom end of the base section 16 offers less resistance. This is because the internal pressure of the mast 14 is applied on a smaller surface. Since an inflatable structure always tends to occupy the largest volume available, it is always the

15 collapsing of the base section 16 that will provide the smallest reduction of volume for a given vertical displacement. Therefore, as illustrated in Figs. 4a-4c, the base end section 16 will gradually collapse against the surface of the slurry as the level thereof

20 increases within the reservoir R. By so compressing the mast 14 along its longitudinal axis, the compression folds 27 resulting from the collapsing of the base section 16 will always be where the mast diameter is smaller, i.e. at the bottom surface of the

25 base section 16. The base section 16 will rest on or near the surface of the slurry S depending on the hydrostatic pressure maintained in the inflatable mast 14. The vertical thrust exerted by the mast 14 on the roof membrane 12 will be equal to the force generated

30 by the pressure applied on the horizontal contact surface of the base section 16 with the slurry S. The top end section 20 of the inflatable mast 14 will always remain at the same elevation since the roof membrane 12 limits its vertical movement. Accordingly,

35 the length of the inflatable mast 14 will be

automatically adjusted by the movement of the base section 16 with the level of slurry S relative to the top end section 20 of the mast 14 along the longitudinal axis thereof. As the mast 14 floats atop
5 of the slurry S, the mast 14 does not take up part of the volume of the reservoir R.

In addition of permitting the provision of access openings (not shown) in the roof membrane 12, the present invention also offers other advantages,
10 such as the introduction of a dynamic tension in the roof membrane 12 as opposed to a static pressure exerted by a rigid mast. This allows to significantly reducing flapping of the roof membrane 12 under the thrust of the wind. Furthermore, since the mast 14 has
15 a dynamic behavior, it is always seeking for equilibrating the tensions. Therefore, the tension induced in one side of the roof membrane 12 by the wind will always result in an equivalent tension on an opposite side of the roof membrane 12 and the chock
20 will be limited and absorbed by the force induced by the mast 14. By combining a tension structure with an inflatable structure in the construction of a roof structure, a smaller blowing system can be used to maintain the inflatable structure in an inflated
25 state, as compared to blowing systems used for conventional inflatable roofing structures. As only the mast 14 is inflated, there can be openings in the roof membrane 12 without causing the roof structure 10 to deflate.

30 Fig. 5 illustrates one point of attachment of the roof membrane 12 to the reservoir R. It is understood that similar points of attachment are distributed along the circumference of the reservoir R. Each point of attachment includes a C-shaped
35 bracket 28 secured to an exterior surface of the

sidewall of the reservoir R by means of threaded fasteners, such as screws 30. The bracket 28 is preferably extruded from aluminum material. The peripheral portion of the roof membrane 12 is folded
5 over so as to form a peripheral loop into which a rope 32 is passed. The rope 32 is wedged into the bracket 28 by means of a wedge 34 having a lower end defining a recess 36 for receiving a locking lip 38 extending upwardly from the lower end of the mouth of the
10 bracket 28. The wedge 34 is provided opposite its lower end with a head portion 40 having a curved peripheral surface 42. The wedge 34 is preferably extruded from polyethylene material. The wedge 34 is releasably locked into the bracket 28 by first
15 introducing its head 40 into the bracket 28 so that the curve peripheral surface 42 thereof abuts against the base wall of the bracket 28 between the head of the screw 30 and the rope 32, and then the wedge 34 is pivoted in a counterclockwise direction to bring the
20 recess 36 over the lip 38.

It is contemplated to maintain a slight positive pressure under the roof membrane 12. In this way, it would be possible to have a fully conical roof membrane. The pressure under the roof membrane 12
25 could be provided by a controlled leak of air from the inflatable mast 14 or by an independent blowing unit. The pressurization of the roof membrane 12 is suitable in that it contributes to increase its structural stability and bearing capacity. Furthermore, the
30 conical shape is less subject to pounding problem resulting from localized accumulation of water or snow.

CLAIMS:

1. A roof structure for a reservoir of the type containing a slurry, comprising a roof membrane adapted to be mounted over a reservoir, an inflatable mast of variable length having a top end portion and a bottom base portion, said inflatable mast being adapted to be mounted in the reservoir with said bottom base portion floating on the slurry contained in the reservoir and said top end portion projecting upwardly out of the reservoir to support said roof membrane in a stretched state thereover, said bottom base portion being movable relative to said top end portion along a longitudinal axis of said inflatable mast so that the length thereof varies with the level of slurry within the reservoir.

2. A roof structure as defined in claim 1, further comprising a plurality of positioning members attached to said inflatable mast to center the same relative to said roof membrane.

3. A roof structure as defined in claim 2, wherein said positioning members includes a number of cables extending laterally outwardly from said inflatable mast.

4. A roof structure as defined in claim 3, wherein said cables radiate from said inflatable mast and have respective distal ends adapted to be attached to the reservoir.

5. A roof structure as defined in claim 4, wherein said cables are attached to said inflatable mast via a catenary member extending about a

circumference of said inflatable mast above said bottom base portion thereof.

6. A roof structure as defined in claim 1, wherein said bottom base portion has an inverted frusto-conical shape.

7. A roof structure as defined in claim 6, wherein said inflatable mast includes an intermediate cylindrical section extending axially between said bottom base portion and said upper end portion.

8. A roof structure as defined in claim 7, wherein said upper end portion is conical.

9. A roof structure as defined in claim 1, wherein said upper end portion is conical.

10. A roof structure as defined in claim 9, wherein a hole is defined in said roof membrane for receiving a portion of said upper end portion of said inflatable mast such that said inflatable mast extends partly upwardly beyond said roof membrane.

11. A roof structure comprising a central mast for supporting a roof membrane in a stretched tent-like configuration, said central mast having a top end portion and a bottom buoyant base portion, said bottom buoyant base portion being movable relative to said top end portion along a longitudinal axis of said central mast to provide for adjustment of a length of said central mast in response to raising and lowering movements of said buoyant base portion thereof.

12. A roof structure as defined in claim 11, wherein said bottom buoyant base portion has an inverted frusto-conical shape.

13. A roof structure as defined in claim 12, wherein said central mast is an inflatable support structure.

14. A roof structure as defined in claim 13, wherein said inflatable support structure is of unitary construction.

15. A roof structure as defined in claim 11, further comprising positioning members attached to said mast to maintain the mast in a desired position relative to said roof membrane.

16. A roof structure as defined in claim 15, wherein said positioning members includes a number of cables extending laterally outwardly from said mast.

17. A roof structure as defined in claim 16, wherein said cables radiate from said mast and have respective distal ends adapted to be attached to the reservoir.

18. A roof structure as defined in claim 17, wherein said cables are attached to said mast via a catenary member extending about a circumference of said inflatable mast above said bottom base portion thereof.

19. A roof structure as defined in claim 11, wherein said top end portion is conical, and wherein

said roof membrane defines a hole for receiving part of said top end portion therethrough.

20. A roof structure for a reservoir of the type containing a slurry, said roof structure comprising a roof membrane adapted to be secured at a periphery thereof to a reservoir, an inflatable mast being adapted to float on the slurry contained in the reservoir and to stretch said roof membrane over the reservoir, said inflatable mast comprising an inverted frusto-conical base portion adapted to gradually collapse as the level of slurry raises within the reservoir.

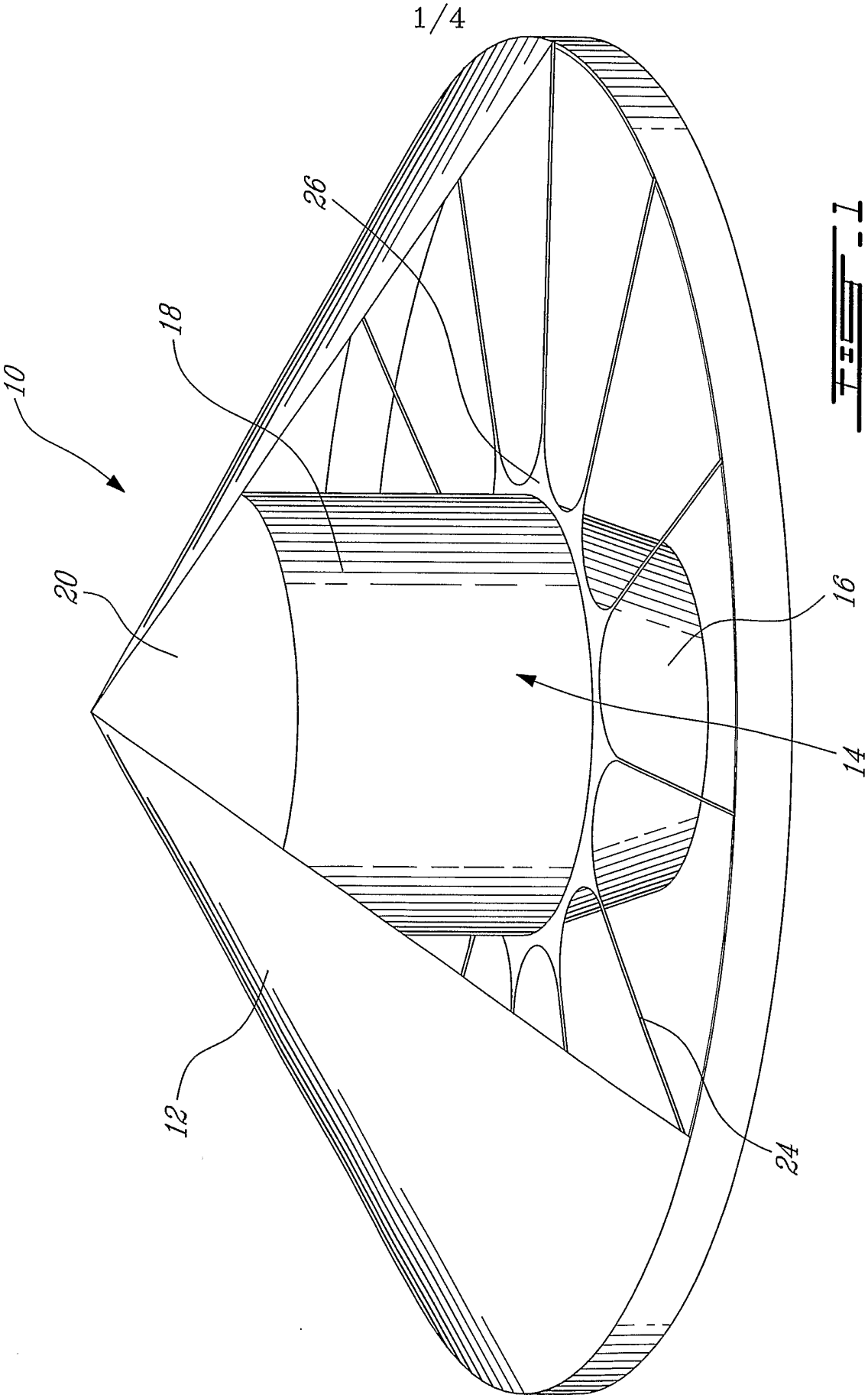
21. A roof structure as defined in claim 20, further comprising positioning members attached to said mast to maintain the mast in a desired position relative to said roof membrane.

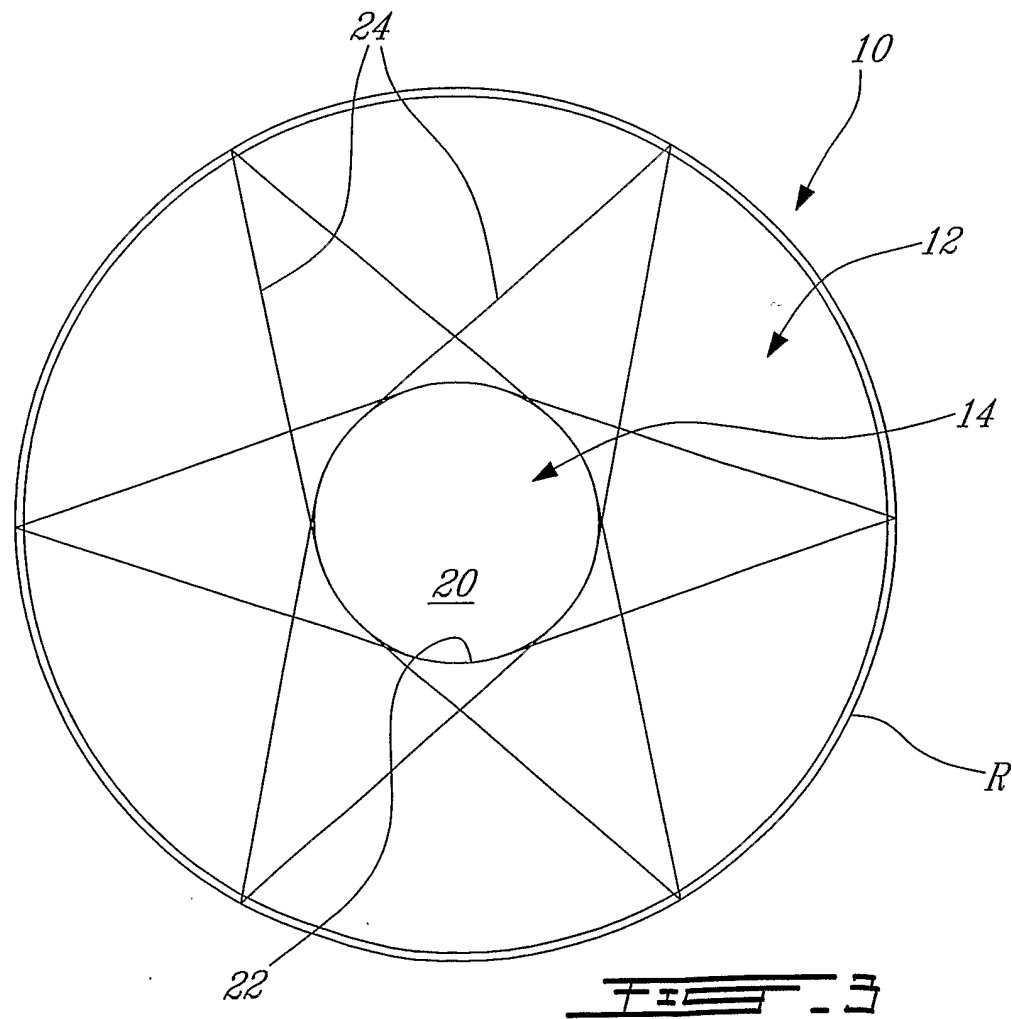
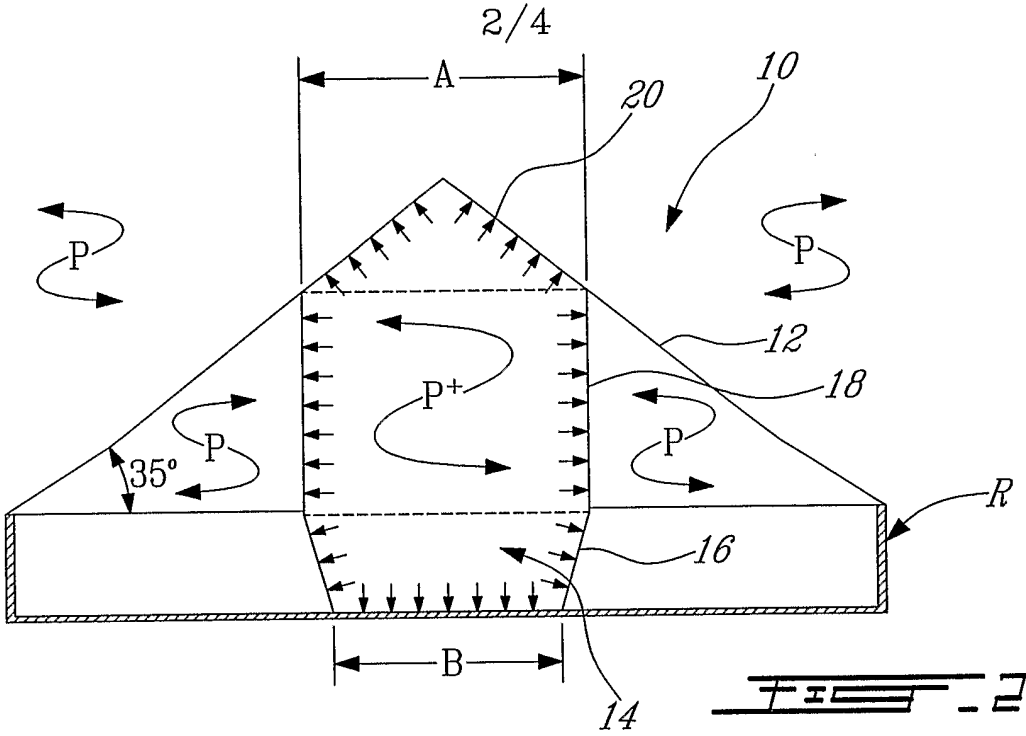
22. A floating mast for supporting a roof membrane over a reservoir containing a slurry, said floating mast comprising an upper end portion adapted to engage a roof membrane at a constant elevation irrespective of a level of slurry within the reservoir, and a buoyant base vertically compressible under the hydrostatic pressure when the level of slurry raises within the reservoir, thereby providing a self-adjusting length mast.

23. A floating mast as defined in claim 22, wherein said buoyant base has an inverted frusto-conical shape.

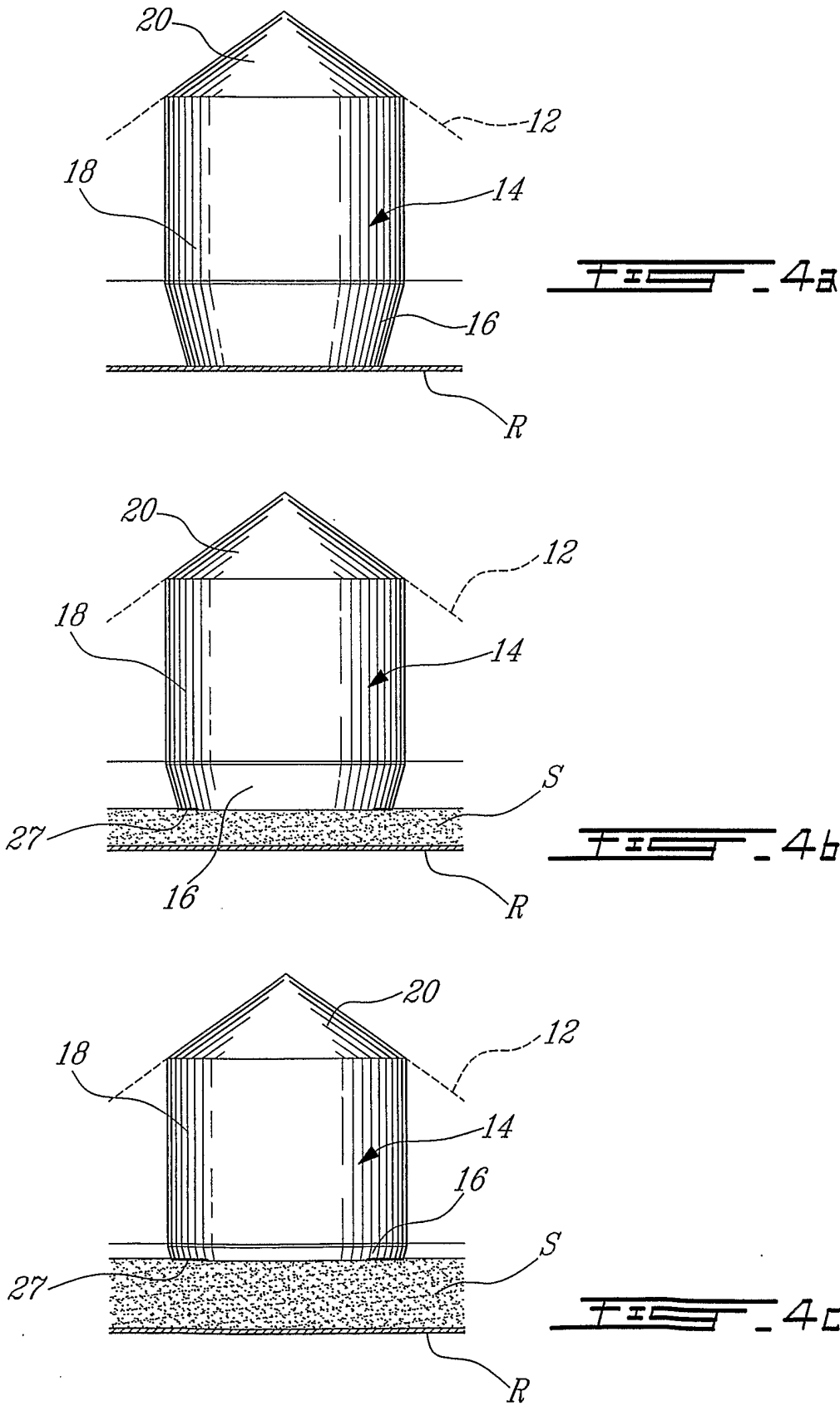
24. A floating mast as defined in claim 23, wherein said buoyant base is inflatable.

25. A roof structure comprising a central inflatable mast, a roof membrane made of a structural fabric material and adapted to be secured at a periphery thereof to a surrounding structure, said roof membrane being maintained in a stretched state by said central inflatable mast.





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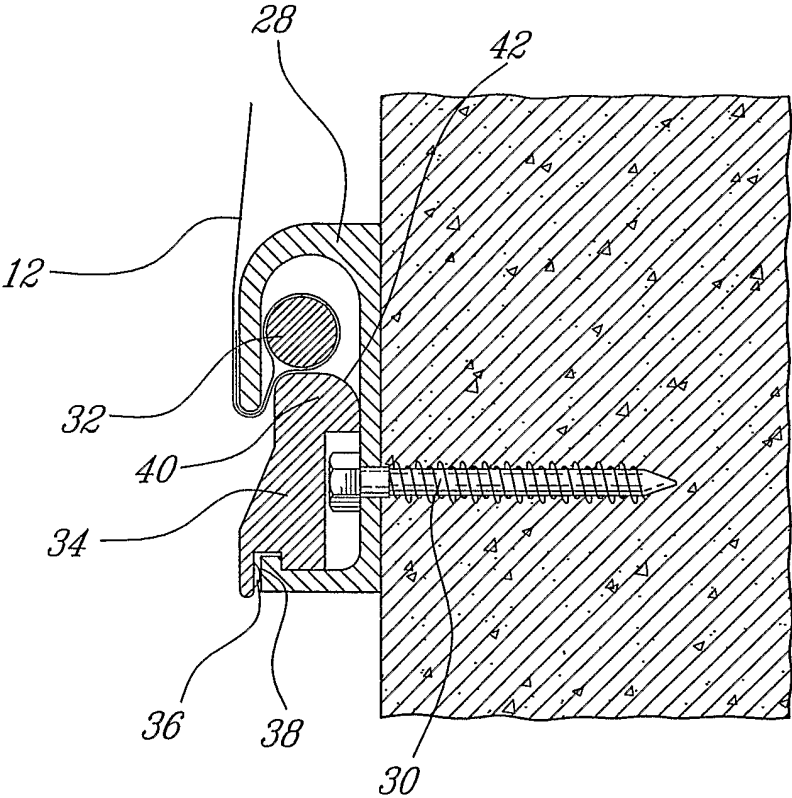


FIG. 5

INTERNATIONAL SEARCH REPORT

Int. Application No

PCT/CA 02/01307

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B65D88/34 E04H4/10

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)

IPC 7 B65D E04H

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 practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 801 994 A (BROWN G) 9 April 1974 (1974-04-09) the whole document ---	1-4, 8-10, 12, 14-19, 21-23, 25, 26
X	US 4 685 254 A (TERRERI CLAUDE J) 11 August 1987 (1987-08-11) abstract; claims; figures --- -/--	1-5, 9, 10, 12-19, 21-26

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

In International Application No

PCT/CA 02/01307

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	DE 299 09 144 U (MAJEWSKI HERBERT) 27 January 2000 (2000-01-27) the whole document -----	1,7,8, 12-15, 21,23-26
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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US 4685254	A	11-08-1987	NONE	
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