Jan. 29, 1963 R. REESE 3,075,668

RESILIENT FOAM SEAL FOR FLOATING ROOF

Filed April 21, 1960 3 Sheets-Sheet 1

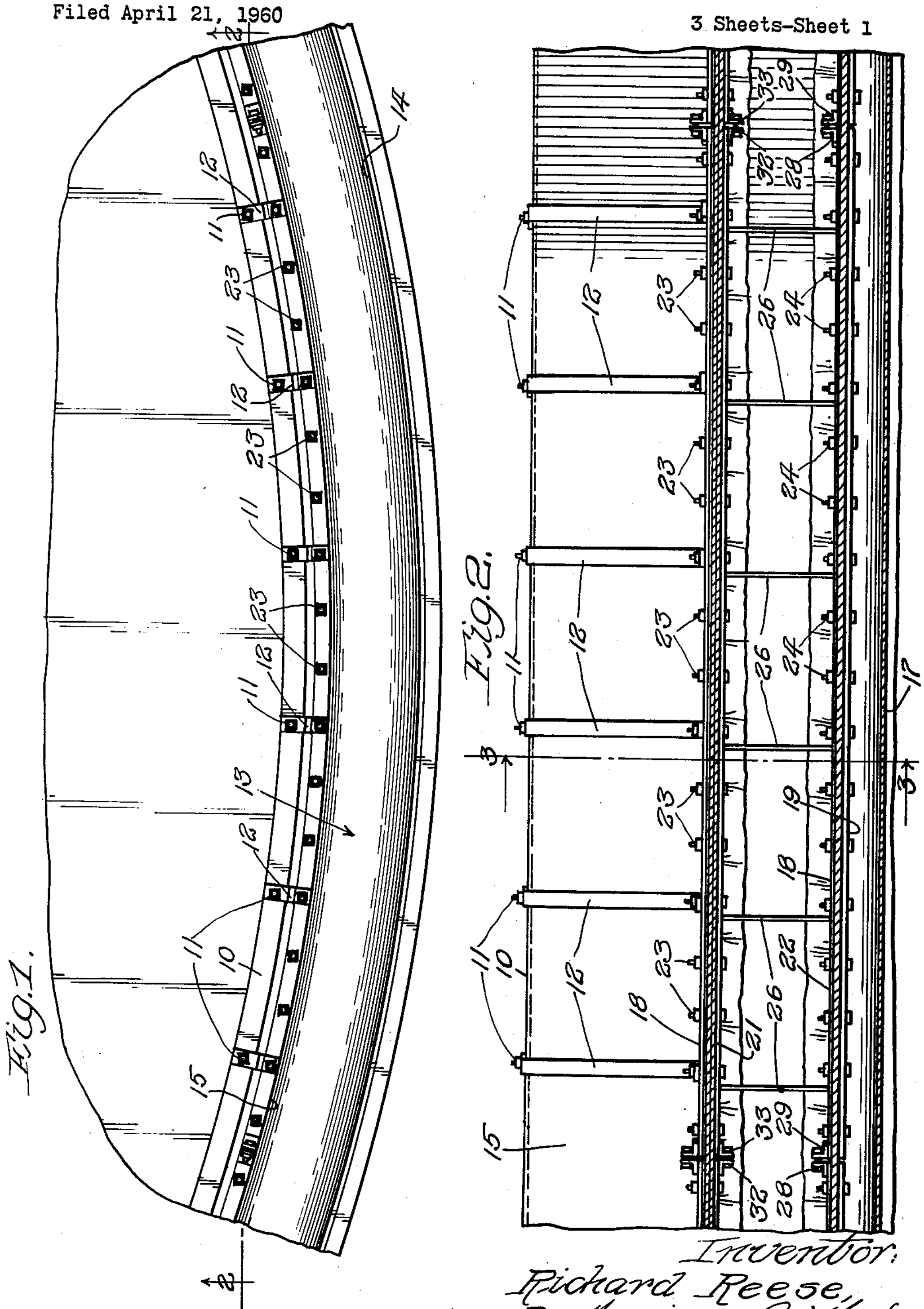

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Fig. 3.

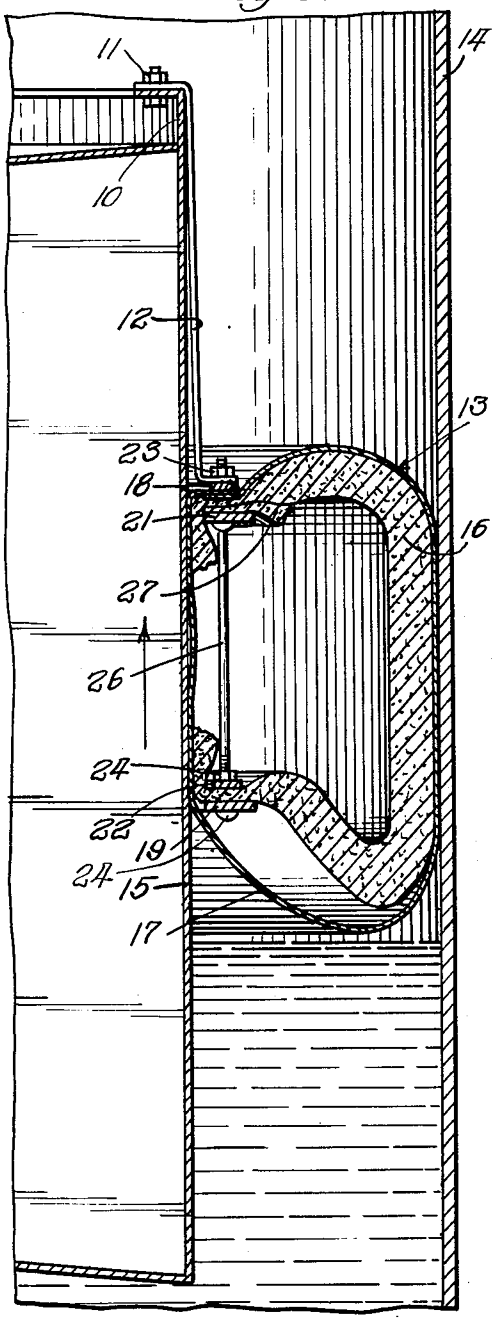

Fig. 4.

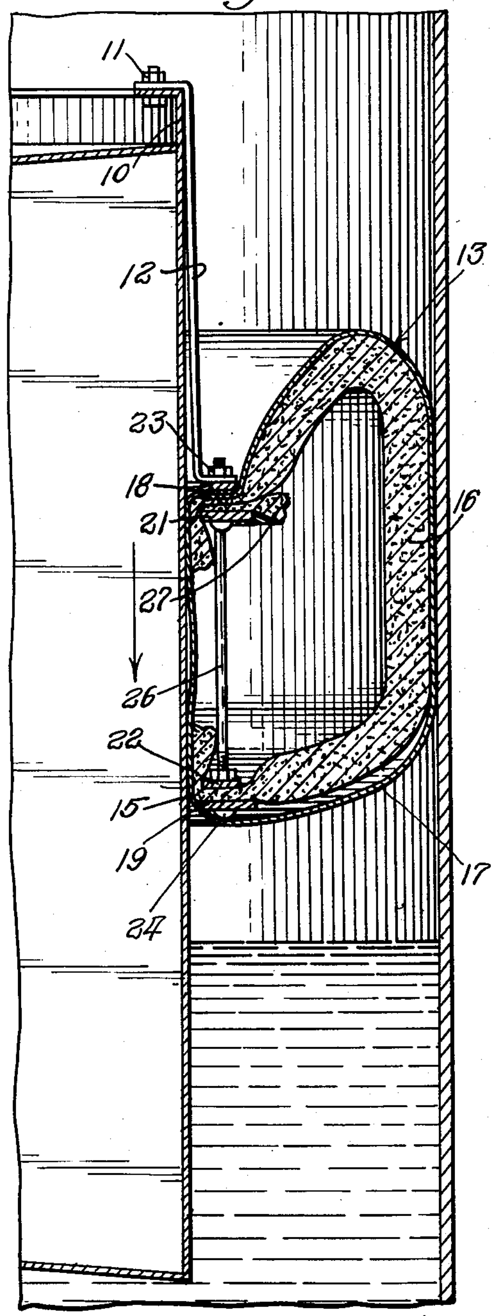

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Fig. 5.

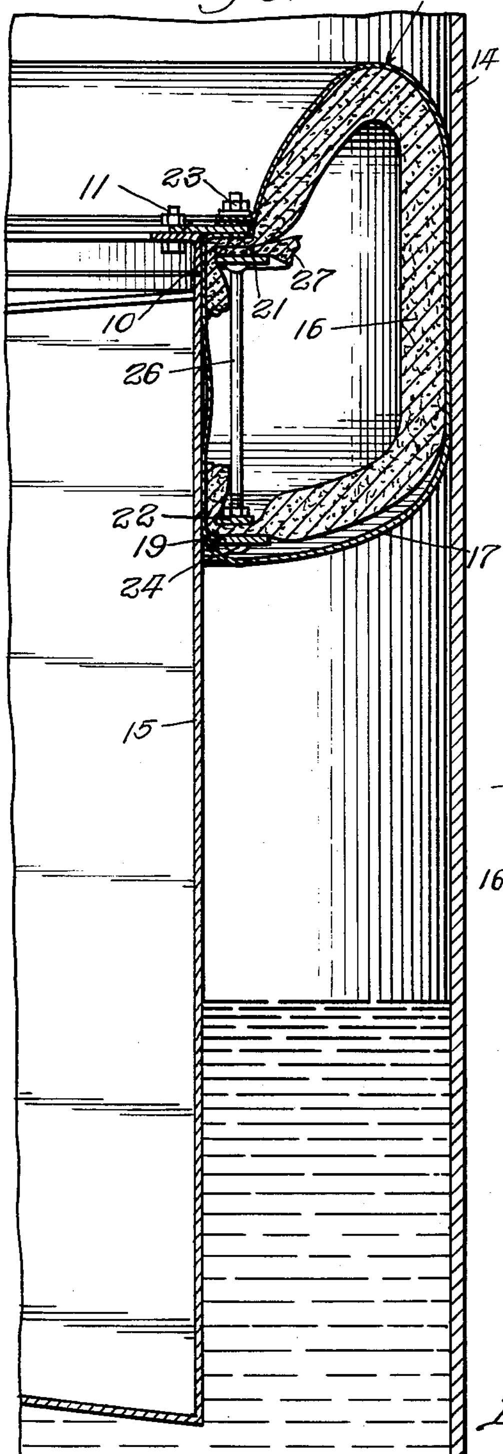


Fig. 6.

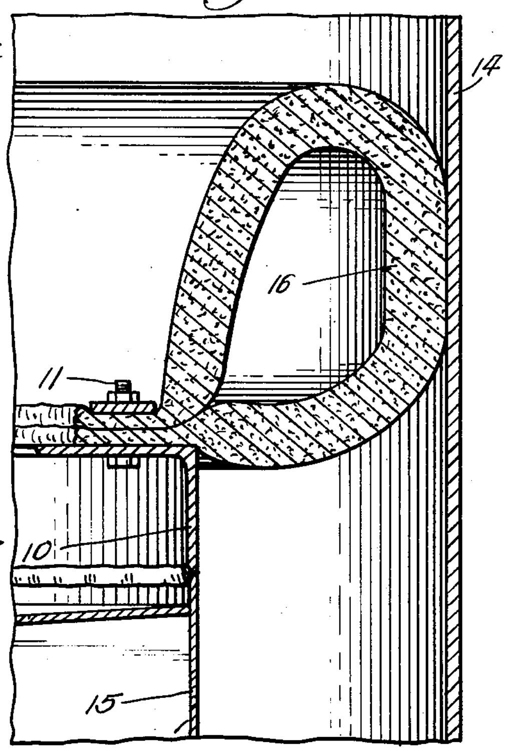
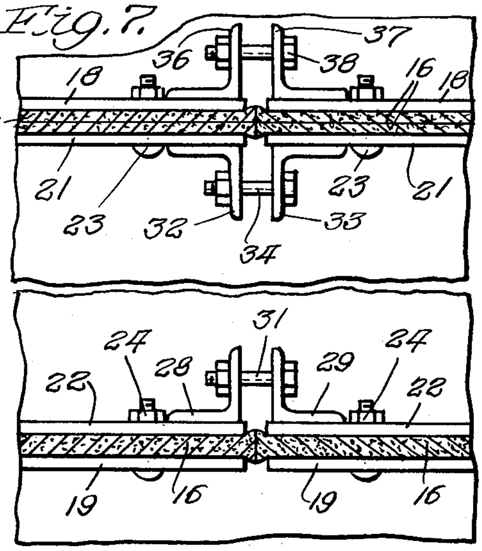


Fig. 7.



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RESILIENT FOAM SEAL FOR FLOATING ROOF

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This invention concerns an improvement in floating roof tanks for the storage of petroleum products and other volatile liquid materials and in particular relates to an improved primary seal for a floating roof.

In a conventional floating roof tank the floating roof is of somewhat smaller radial dimension than the tank in which it floats, because it is necessary to provide clearance space between the rim of the floating roof and the shell of the tank for accommodating local dimensional variations in the tank shell, commonly called out-of-roundness, which may result from uneven foundation settlement, imprecise fabrication or erection, or unusual live loads such as high winds and the like. In order to prevent costly and sometimes dangerous losses of volatile fractions of the stored product, it is necessary to provide a seal in the space between the floating roof rim and the tank shell and also to provide some means for maintaining the floating roof in a centered position within the tank shell. A large number of such sealing and centering devices are well known to the art. Included among these are non-metallic sealing and centering devices such as liquid- or gas-filled fabric tubes which are positioned in the rim space and bear against both the rim of the roof and the interior surface of the tank shell.

It is obvious that the liquid-or gas-filled types of sealing devices mentioned above require a positively tight envelope for an effective seal. Any leak which may develop, for example, as a result of wear of the envelope material, allows the confined fluid to escape, thus reducing or destroying the effectiveness of the seal.

In accordance with this invention there is provided a seal having inherent resiliency which is not dependent on the internal pressure of a gas or liquid as in the heretofore known types. The seal utilizes a resilient foam material, such as polyether urethane foam, in relatively thin, normally planar, slab or block form held in an arcuate or tube-like shape and preferably covered with a protective envelope of a vapor impervious film material. The natural tendency of the block of foam material to resume its normal planar form increases the resiliency thereof and thus increases the effectiveness of the seal created against the tank wall. In addition, the seal has enough resiliency so that the tank roof is self-centering. In one of its embodiments it is also possible to use the seal of the invention as a combination-weather shield and primary seal without the necessity for a conventional weather shield.

The invention will be better understood from the following detailed description thereof taken with the accompanying drawings, in which:

FIGURE 1 is a top view of a section of a floating roof showing the seal of the invention in place;

FIGURE 2 is a sectional view along the line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view along the line 3—3 of FIGURE 2 showing the conformation assumed by the seal when the floating roof is ascending;

FIGURE 4 is a view similar to that of FIGURE 3, showing the conformation of the seal when the floating roof is descending;

FIGURE 5 is an embodiment of the invention used both as a weather shield and a primary seal for a floating roof tank;

FIGURE 6 is another embodiment of a combination weather shield and primary seal; and

FIGURE 7 is a detailed view showing the clamping means used to join adjacent sections of resilient material such as those shown in FIGURE 2.

In the figures, the same numerals are used to represent like elements in the several views.

Referring now to FIGURES 1, 2, and 3, the uppermost portion of the rim of a floating roof is represented by an angle 10, the horizontal flange of which is intermittently drilled to receive bolts 11. Bolts 11 are used to hold metal straps 12 which in turn support the primary seal 13 in position between the edge of the floating roof and the tank wall 14. The seal 13 comprises a resilient foam material 16, typically a polyether urethane foam, which is clamped in such a way that the foam material, which is in its unstressed condition a relatively thin, planar block or slab, assumes roughly the shape of the letter C with the opening therein facing the floating roof. The resilient material 16 is surrounded by a vapor impervious flexible film 17. It will be appreciated that in the absence of the restriction afforded by the tank wall, the foam material 16 bent and held in the manner shown would assume in cross-section a roughly circular shape. The diameter of this circle, however, is larger than the available space between the edge of the floating roof and the tank wall, so that the outermost edge of the seal material is deformed and presses firmly against the tank wall, thereby forming a vapor-tight seal. It will be further noted that regardless of the direction of travel of the floating roof (i.e., whether up or down) the effectiveness of the seal is not diminished. When the roof is ascending the seal assumes the configuration shown in FIGURE 3; when the roof is descending, the seal assumes the configuration shown in FIGURE 4. In both cases, however, at all times an effective seal is maintained.

The clamping system used to hold the resilient seal material in place at each of its upper and lower edges consists of a top washer bar 18 and a bottom washer bar 19 (FIGURE 3), which are opposed on the opposite side of the resilient material by upper spacer assembly bar 21 and a lower spacer assembly bar 22.

The edge of the polyurethane foam material is clamped between these sets of bars (bar 18 and bar 21 forming one set and bar 22 and bar 19 forming another set) and the assembly is held together by means of bolts 23 and 24 which pass through the bars and the foam material. Bars 18, 19, 21, and 22, are curved, as shown in FIGURE 1, to follow a radius approximately equal to that of the roof. The upper and lower edges of the polyurethane material are held at a fixed distance apart by means of spacer rods 26 which are connected to both the upper and lower clamping assemblies by any suitable means such as welding. It will be noted that the lower bar of each set used to clamp the edges of the foam material is wider than the upper bar (i.e., bar 21 is wider than bar 18 and bar 19 is wider than bar 22). This inward offset of the upper clamping element of each set gives rise to a shelf effect which gives the foam an initial upward tilt. This initial upward slope contributes to making the primary seal self-supporting, thereby preventing sagging which would reduce the firmness of contact between the foam material and the tank wall and thus the efficiency of the seal itself. In order to further accentuate this upward tilt of the foam material, it is preferred to include within the upper clamp (bars 18 and 21) an additional piece 27 of foam material placed below the edge of the foam slab itself. The same effect can alternatively be achieved by folding back the free edge of the main foam slab so as to achieve a double thickness within the clamp or by making the foam slab with an additional thickness integrally formed at the edge thereof.

It will be seen that the foam material protrudes inwardly of the clamps at both the upper and lower edges of the foam material, thus creating a soft, resilient seal at the wall 15 of the floating roof which prevents the escape of volatile vapors along a pathway adjacent the floating roof.

As shown in the figures, the foam material 16 is surrounded by a sheet of thin, flexible envelope material which may be polyurethane or other plastic film or a fabric coated with a natural or synthetic elastomer, such as polyvinyl chloride, Buna N, etc. The specific identity of the envelope material is not important, the only requirements being that it be tough, flexible, and impervious to and unaffected by the vapors in contact therewith. Attachment of the protective envelope is suitably made by connecting one edge thereof under bar 18, passing the sheet clockwise around the seal, and connecting the other end under bar 18 before bolts 23 are installed.

It will be seen that the efficiency of the seal formed as described above is not seriously affected by a tear or worn spot in the protective envelope. In contrast, however, such a defect in a seal in which the resiliency is supplied by means of a liquid or a gas under pressure results in the loss of the sealing fluid, and thus the loss of the seal. Although it is preferable to surround the foam material with a vapor impervious film, as described above, a local tear in this envelope material has only a minor effect, if any, on the sealing efficiency of the entire assembly. For this reason the seal of the invention will keep its effectivensss over a long period of time without the close inspection and preventive maintenance required by the other types of fluid activated primary seals.

The foam material used in the invention is usually supplied in the form of slabs, a slab for a typical floating roof being 6′ long x 1½″ thick x 3′ wide, and being formed of polyether urethane having a density of about 1½–2½ lb. per cubic foot. These slabs of foam material are joined together to form a continuous seal without the necessity for cementing the ends thereof by butting the adjacent ends together using in the butt sections a length of foam greater than the bolt spacing between the sections, thereby causing the material to compress at the butt and thus form in effect an integral unit of foam material.

The individual bar sections (i.e., 18, 19, 21, and 22) used to clamp the foam material are joined together to form a continuous clamping system by means of angles as shown in detail in FIGURE 7, which also shows butt joints between adjacent sections of foam slab. In the lower joint two opposed angles 28 and 29 are attached as by welding to adjacent sections of lower spacer assembly bar 22 and connected together by means of bolts 31. Similar assemblies consisting of angles 32, 33, 36, and 37 and bolts 34 and 38 are supplied for the upper joint and are used to connect adjacent sections of upper spacer assembly bar 21 and top washer bar 18 respectively. As a first step in assembling the seal of the invention, only the joints between the upper and lower spacer assembly bars 21 and 22, described above, are completed around the circumference of the tank and adjusted so that the entire seal assembly narrowly clears the roof and can be lowered into the annular space between the tank wall and the wall of the floating roof, in which position it is supported by straps 12. After the seal is in position, angles 36 and 37 connected to sections of top washer bar 18 are then tightened by means of bolts 38 so that bars 18 and 21 and the foam material clamped between them press firmly against the roof wall, thus forming an effective seal at this point against the passage of vapors.

It is intended that the normal position of the seal of the invention be above the product level at a small distance below the rim of the floating roof, as shown in FIGURE 3. An installation of this type will normally require a conventional weather shield at the top of the annular space between the tank wall and the roof. It

is possible, however, to use the seal of the invention as both a primary seal and a weather shield as shown in FIGURE 5. This is accomplished by attaching the upper edge of the foam material to the rim 10 of the roof so that the upward slope of the resilient material tends to return rain to the center of the floating roof for collection and disposal. The seal of FIGURE 5 is identical to that of FIGURE 3 except for the absence of hanger straps 12.

Many variations of the above-described preferred embodiment of the invention may be made without changing the basic function of the seal. The clamped ends of the seal may be separated or they may be clamped together if the contact height of the contact seal is relatively unimportant, as in a floating roof tank within a cone roof. An installation of this type is depicted in FIGURE 6, which as shown is a simpler installation than that described above, in which both edges of the foam material are clamped to the rim of the roof. In a seal of this type, however, the contact area and the resiliency of the seal against the tank wall are somewhat reduced.

It will be apparent to those skilled in the art from the preceding description that the seal of the invention is an effective, economical type of seal which requires a minimum of attention and maintenance. The use of a planar slab of resilient material which is deformed and clamped in position as described provides a desirable combination of resiliency for adequate sealing and for making the floating roof self-centering with a desirable degree of adaptability in sealing effectiveness for rim spaces ranging from 3 to 13 inches or more. Such adaptability cannot be obtained, for example, in a construction using a solid foam material without developing undesirably high stresses.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. In a cylindrical tank for the storage of a volatile liquid, a floating roof having a diameter less than the internal diameter of said tank and adapted to float on said liquid, and a seal disposed between said floating roof and said tank, said seal comprising:
  a thin, flexible, impervious protective envelope;
  and a relatively thin slab, bent into a C-shaped configuration, within said envelope;
  said slab having vertically spaced upper and lower edge portions;
  means for clampingly engaging the upper and lower edge portions of said C-shaped slab in fixed relation to said roof;
  said slab being composed of a compressible resilient foam material for urging the C-shaped slab to return to a normally planar configuration.

2. The floating roof and seal of claim 1 in which said resilient material is a polyurethane foam.

3. The floating roof and seal of claim 1 in which said protective envelope is formed of a fabric coated with an elastomer.

4. In a cylindrical tank as recited in claim 1 wherein said clamping means for a respective edge portion of the slab comprises:
  a lower horizontal surface;
  and an upper clamping portion offset inwardly from said lower horizontal surface so that the latter forms a shelf extending beyond the clamping means radially outwardly of said roof.

5. In a cylndrical tank as recited in claim 4 and comprising a vertical rigid member extending between the upper and lower clamping means.

6. In a cylindrical tank as recited in claim 4 and comprising an additional slab portion between the upper end portion of said first-recited slab and the lower horizontal surface of the clamping means for the upper edge portion.

7. In a cylindrical tank as recited in claim 1 and comprising free unclampjed treminal parts at each edge portion of the slab, each terminal part including means for pressing the inner portion of the envelope against the outer peripheral surface of said roof to effect a seal thereagainst.

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