

PATENTS ACT 1977

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DESCRIPTION OF INVENTION

Improvements in or relating to floating roof storage tanks

THIS INVENTION relates to floating roof tanks used for the storage of petroleum products and other volatile liquid materials, i.e. storage tanks incorporating a roof which floats on the surface of the liquid in the tank and which may rise and fall with the level of the liquid in the tank. More particularly, this invention provides novel floating roof clearance space seals, or rim seals, which function as vapor and weather shields and sun screens.

In a conventional floating roof tank, with which the seal of the present invention may be used, there is provided a clearance space or rim space between the tank side wall and the vertical rim of the floating roof. It is necessary to provide a clearance space to permit unrestrained vertical travel of the roof within the tank. The clearance space is of sufficient size that local dimensional variations in the circularity of the tank sidewall or shell, commonly called out-of-roundness, which can result from uneven foundation settlement, imprecise fabrication or erection or unusual loads such as high winds and the like, do not hamper vertical travel of the roof.

The clearance space in essentially all floating roof tanks is covered in one way or another to prevent the escape of vapor from the stored liquid through the clearance or rim space to the atmosphere. Various types of seals are used for this purpose. Many

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of the seals are intended not only to prevent vapor escape but also to center the roof so that it moves vertically relatively freely and prevents enlargement of the clearance space on one side of the roof since that could lead to the escape of vapor due to the dis-
5 engagement of the seal from the tank wall.

Kinghorn et al U.S. Patent 4,116,358 and Thiltgen et al U.S. Patent 4,308,968 disclose floating
10 roof clearance space seals made of metal sections. However, the seals include a gas impermeable fabric which extends continuously around the perimeter of the roof. The installation and maintenance of the fabric is expensive and time consuming but is essential to keep
15 vapor from escaping between adjacent metal sections.

Kinghorn et al U.S. Patent 4,191,303 also dis- closes a seal made of metal sections. However, the adjacent metal sections have overlapping edge portions
20 with elongated holes. Fastening means, such as bolts, extend through the holes but permit the metal sections to slide laterally to accommodate dimensional changes in the clearance or rim space. Even though a gasket is provided between the overlapping edge portions of the
25 metal sections, to prevent vapor escape through the elongated holes to the atmosphere large washers are needed to cover the elongated holes. Additionally, installation of the seal is time consuming because of the many bolts used, each of which requires precise
30 tightening so as to permit lateral movement while keeping the gasket slightly compressed.

An additional problem with prior art seals is that the metal sections are made straight or flat and
35 only become arced or bent when pressure is applied to them when installed or when the space between the roof edge and the tank wall is reduced during lateral move-

ment of the roof during use. When the top edge of a metal section hits a protrusion, such as a weld or rivet in the tank wall, as the roof rises the metal section can buckle upwards and may become lodged in position against the protrusion. The bending of one or more of the metal sections in this manner is undesirable since it can damage the sections and open the seal.

Because of the described disadvantages and shortcomings in the previously available seals, a need exists for alternative seals for floating roof tanks.

According to the present invention there is provided a liquid storage tank having a floating roof of smaller dimension than the tank thereby defining a clearance space between the roof edge and the tank wall; a seal joined to the roof and extending upwardly therefrom into slidable contact with the tank wall; the seal completely covering the clearance space and comprising a plurality of individual flexible sections of sheet material positioned in substantially side-by-side arrangement but with adjacent section side edge portions overlapping each other with a gasket being provided between the overlapping side edge portions, there being a clip attached to each section adjacent its edge portion which is overlapped by the edge portion of an adjacent section; the clip having a wing spaced upward from the section to which it is attached and extending over the edge portion of the adjacent section to press the edge portions together but permit the edge portions to slide laterally with respect to each other; and a flexible elastomeric tip joined to the outer end of the sections and in slidable contact with the tank wall.

The clip wing can be substantially planar, have a planar base attached to the section, and the wing and base can be located in parallel spaced apart planes.

More specifically, the clip wing and base can be integral with a lateral shoulder portion, with the wing and base extending in opposite directions.

5 The overlapping edge portions of the sections desirably have continuous surfaces free of holes with no fasteners penetrating therethrough.

10 Each section and clip are desirably made of a suitable metal, particularly a suitable grade of stainless steel. Polymeric materials, however, which are stable under the conditions of use, can also be employed for the sections and clips.

15 Although the seal sections can be made of any suitable material, they are desirably made of a material having resilient or spring properties so that they can press firmly, but in a flexible manner, against the tank wall. The material used is desirably metal although
20 polymeric materials which are stable in the tank environment can also be used. Polyethylene, polypropylene and copolymers of ethylene and propylene can be used for storage of some liquids. The elastomeric tip desirably is an integral elongate member or strip with
25 its inner side portion secured to a plurality of sections to hold it in place.

 Each section can have a clamping bar along its outer end. The elastomeric tip can be held in place, on
30 each section, by and between the clamping bar and the section. The clamping bar can form a pocket into which the inner side portion of the elastomeric tip can fit in retaining contact.

35 Alternatively, the elastomeric tip can comprise an elastomeric strip constituting a core covered by an abrasion resistant flexible sheet material envelope joined to the outer end of each section.

Flow of vapor past the adjoining edges of the sections to the atmosphere can be prevented by use of any suitable means, including a continuous fabric layer over the top of the seal. However, it is preferred to use the gasket arrangement described above and herein. Nevertheless, the gasket arrangement is not limited to use with bent flexible sections but can be suitably employed with unbent sections and permanently arced flexible sections.

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Elastomeric tips such as described above can be used in all the described seals.

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In order that the present invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described by way of example with reference to the accompanying drawings, in which:

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FIGURE 1 is an isometric view of a liquid storage tank having a floating roof;

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FIGURE 2 is a vertical radial sectional view of the floating roof in the tank shown in Figure 1;

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FIGURE 3 is an elevational exploded view of a portion of a floating roof seal according to the invention;

FIGURE 4 is a sectional view of the seal shown in the Figure 3 but with adjoining edges of two metal sections overlapped and secured by a clip;

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FIGURE 5 is an isometric view of the seal portion shown in Figure 4;

FIGURE 6 is an enlarged sectional view of an unbent elastomeric tip at the outer end of a sheet metal section;

FIGURE 7 is a sectional view of an alternative elastomeric tip which can be used on the outer ends of the sheet metal sections;

5 FIGURE 8 is an exploded end view of a sheet metal section and elastomeric tip clamping bar;

10 FIGURE 9 is a schematic view of the way a prior art seal made of unbent flexible sections reacts when the seal hits a protrusion on a tank wall; and

15 FIGURE 10 is a schematic view of the way the bent flexible sections shown in Figures 2 and 3 react when they hit a protrusion on a tank wall.

20 Whenever it is reasonable and practical the same or similar elements which appear in the various views of the drawings will be identified by the same numbers.

25 The liquid storage tank 20 shown in Figure 1 has a vertical cylindrical circular wall 22 which is joined at its lower edge to a flat circular metal bottom, not shown, which rests on a support base 24. A floating roof 26 moves up and down in the tank 20 with the rise and fall of the liquid stored in the tank.

30 The floating roof 26 is circular and is of conventional construction except for the novel seals, positioned on its upper peripheral edge and which span a rim space 30 to contact the inner surface 28 of the tank wall 22. The floating roof 26 has a top deck plate 32 and a vertical circular peripheral side wall 34 which extends above the deck plate 32. An inwardly extending horizontal circular flange 36 is joined to the top edge of the roof side wall 34 (Figure 2).

The rim space or clearance space 30 is completely covered by a seal 401 joined to the floating roof flange 36 and extending upwardly therefrom into slidable contact with the inner surface 28 of the tank wall 22 (Figure 2).

The seal 401 includes a plurality of individual, identical flexible sections 421 of sheet metal in substantially side-by-side arrangement (Figure 3). The flexible metal sections 421 are substantially rectangular. However, the sections 421 are each bent at bend lines 44 and 46 at an inner, lower portion of the section, the bend lines 44 and 46 being parallel to each other and to the inner edge 48 (Figure 2). The metal section portion between edge 48 and bend line 44 constitutes a horizontal clamping strip 50 which is secured to the flange 36 by a plurality of side-by-side C-clips 70. The metal section portion between bend lines 44 and 46 is a transition band 52, while the portion between bend line 46 and the outer or top edge 56 constitutes a primary body portion 54. The bend line 46 gives each metal section 421 a permanent concave shape when viewed from above. This shape prevents the sections from buckling upwardly when a section upper edge engages a protrusion, such as a weld or rivet (Figures 12 and 13) in the wall 22 of the tank 20. The reasons for this behaviour will be described hereinafter. The transition band 52 forms a stiff shallow cone which acts as a short cantilever to carry the bending load. The primary body portion 54 carries the membrane compression load against the shell. The outer edge 56 has a short downwardly directed lip 58 which is interrupted by spaced apart cuts or slits 60 (Figure 3). The slits 60 are provided so that the lip 58 does not prevent the outer edge 56 from curving to approximate the curvature of the tank wall.

At least one side edge of a section 421 is provided with a gasket strip 110 attached on the top or bottom surface such that the adjacent side edge of an adjacent section 421 slidably rests in contact with the gasket 110. Also, both adjoining side edges of adjacent sections 421 can have a gasket applied thereto so that both gaskets become sandwiched between the side edges of sections 421 when they are overlapped. A clip 112 holds the edges in this slidable arrangement so that vapor is prevented from flowing between the overlapped edges.

The clip 112 is joined or attached to an edge portion of each of the sections 421, and desirably is secured to the edge portion to which the gasket is fixedly applied. The metal clip 112 has a wing 114 spaced upward from the section 421 to which it is attached. The clip wing 114 is substantially planar. Also, the clip has a planar base 116 attached to the section 421. The wing 114 and base 116 are in parallel spaced apart planes and are integral with a lateral shoulder portion 118 (Figure 5). The wing 114 and base 116 extend in opposite directions away from the shoulder portion 118. The wing 114 extends over the edge portion of the adjacent section 421 to press the edge portions, which have continuous surfaces, together but permits the edge portions to slide laterally with respect to each other.

The clip may be mounted in position prior to assembly in the field, thus allowing the use of spot welding. Some field installations do not allow any work at elevated temperatures and thus welds could not be used if clips were used and installed in the field.

The outer end of each metal section 421 supports a flexible elastomeric tip 80 which is removably secured in place by a clamping bar 82 which is attached to the body portion 54 by bolts 84 or by welding. For convenience of illustration the elasto-

meric tip has not been included in Figure 3. The clamping bar 82 forms a pocket into which the inner side portion 88 of the elastomeric tip fits in retaining contact. The lip 58 on the end of each section 421 also
5 aids in securing the tip 80 in place. Spaced apart slits 86 can be cut in the clamping bar 82 to permit it to flex readily.

The flexible elastomeric tip 80 is desirably
10 made as long as can be conveniently handled so as to reduce the number of joints required to extend it around the roof seal. Accordingly, the elastomeric tip 80 is fabricated to be an elongated member with its inner side
15 portion 88 secured to a plurality of sections 421. When the tip is fabricated in sections, the adjoining ends of sections can be cut and contoured to overlap to produce a joint with good sealing capability.

It should be understood that Figure 6 shows a
20 cross-sectional view of the tip 80 in an as-extruded shape and before any pressure is applied to it when the seal is installed. Some initial pressure must be placed on the seal 401 to cause the sections 421 and tip 80 to curve upwardly when the seal is installed so as to keep
25 the tip in contact with the tank inner surface 28 when the roof moves as far away therefrom as it can. This initial pressure will cause the tip to curve upwardly. When the roof moves closer to the inner surface 28 of the tank wall, the curve of the sections 421 and the tip
30 80 will change and the sections 421 and the tip 80 will extend higher up the inner surface of the tank wall to a more upright position.

Figure 7 illustrates an alternative elastomeric tip 100 which can be used on the seal 401. In this
35 embodiment, the outer edge of the primary body portion 54 has a flange 581 bent downwardly about 45° and pro-

vided with radial slits to allow ready flexing of the portion 54. An elongated elastomeric strip 102, constituting a core, is covered by an abrasion resistant elastomeric sheet material envelope 104. The strip may be solid, hollow, foamed or cellular. The longitudinal edges of envelope 104 are gathered together on the upper surface of the body portion 54 and are secured in place by a clamping bar 106 which is bolted by means of bolts 108 to the body portion 54 with the envelope edges therebetween. A seal of this structure is particular useful when the tank inner surface is rough or has protrusions, such as rivet heads or overlapping plate joints. Also, this embodiment lends itself to the use of more exotic and expensive materials. The volume of the sheet envelope is small and therefore reduces the amount of chemically resistant material required so it would be especially useful if an expensive material, i.e. Viton, were required. Viton is roughly six times more expensive than other seal materials.

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It should be understood that either of the elastomeric tips 80 or 100 can be used in the seal 401.

Figure 9 illustrates how a prior art flexible metal section 150 can react when the upper edge hits a protrusion 160, such as a rivet or weld, on the tank wall. The prior art metal section 150 is not prebent or curved from where it joins the roof to its upper edge. It is essentially a flat sheet over that area. When installed on a tank roof it acquires an arced shape because of the pressure applied by it against the tank wall.

As shown in Figure 9, when the upper edge of a section 150 hits a protrusion 160, the section can buckle downwardly as shown by line 150A. However, it can also buckle upwardly as shown by line 150B. An

upward buckle is very undesirable since it can deform the seal structure and allow vapor to escape.

5 Figure 10 illustrates how the metal flexible sections provided by the invention react when they encounter a protrusion, such as a rivet or weld, on the tank wall. Because of the bend line 46, the bent metal section 421 having initial angle X will have a natural tendency to curve or bend down to a smaller angle Y
10 which will favour or promote upward movement of the outer section edge or the elastomeric tip over the protrusion. Upward buckling of the section is thereby avoided.

15 The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications may be made within the scope of the invention.

CLAIMS:

1. A liquid storage tank having a floating roof of smaller lateral dimension than the corresponding dimension of the tank thereby defining a clearance space between the roof edge and the tank wall; a seal joined to the roof and extending upwardly therefrom into slidable contact with the tank wall; the seal completely covering the clearance space and comprising a plurality of individual flexible sections of sheet material positioned in substantially side-by-side arrangement but with adjacent section side edge portions overlapping each other with a gasket being provided between the overlapping side edge portions, there being a clip attached to each section adjacent its edge portion which is overlapped by the edge portion of an adjacent section; the clip having a wing spaced upward from the section to which it is attached and extending over the edge portion of the adjacent section to press the edge portions together but permit the edge portions to slide laterally with respect to each other; and a flexible elastomeric tip joined to the other end of the sections and in slidable contact with the tank wall.
2. A storage tank according to claim 1 in which the clip wing is substantially planar, the clip having a planar base attached to the section, and the wing and base being located in parallel spaced apart planes.
3. A storage tank according to claim 2 in which the clip wing and base are integral with a lateral shoulder portion, and the wing and base extend in opposite directions.
4. A storage tank according to any one of claims 1 to 3 in which the section overlapping edge portions present continuous surfaces.



5. A storage tank according to claim 4 in which the continuous surfaces contain no fasteners penetrating therethrough.
- 5 6. A storage tank according to any one of claims 1 to 5 in which the sections are metal.
- 10 7. A storage tank according to any one of claims 1 to 5 in which the sections are made of polymeric material.
8. A storage tank according to any one of claims 1 to 7 in which the clips are metal.
- 15 9. A storage tank according to any one of claims 1 to 8 in which the elastomeric tip is an elongate member with the inner edge secured to a plurality of sections.
- 20 10. A storage tank according to any one of claims 1 to 9 in which each section has a clamping bar along its outer end and the elastomeric tip is held in place, on each section, by and between the clamping bar and the section.
- 25 11. A storage tank according to claim 10 in which the clamping bar forms a pocket into which the inner edge of the elastomeric tip fits in retaining contact.
- 30 12. A storage tank according to any one of claims 1 to 11 in which the elastomeric tip comprises an elastomeric strip constituting a core covered by an abrasion resistant, flexible sheet material envelope joined to the outer end of each section.
- 35 13. A storage tank according to any one of the preceding claims in which tank is a vertical, cylindrical tank and the roof is a circular roof.



14. A storage tank substantially as herein described with reference to and as shown in the accompanying drawings.

