The present invention relates to cylindrical storage tanks for petroleum products employing a cylindrical floating roof and is concerned more particularly with a sealing mechanism therefor wherein the seal is suspended or supported on the floating roof to extend into the liquid in the tank and to also be maintained in sliding contact with the side wall of the tank to minimize evaporation losses.

It is a general object of the invention to provide an improved sealing mechanism between the upright cylindrical side wall and the cylindrical wall structure or rim of a floating roof of a storage tank for petroleum products and the like.

Another object of the invention is to provide a seal of the above character of low cost yet providing effective sealing action.

A further object of the invention is to provide a sealing mechanism of the above character which has multiple strata laminated construction at the sealing area to provide a yieldable annular sealing structure including a rugged foam stratum, which stratum acts at all times as a horizontal load or bearing distribution member by compression stress and acts intermittently as a vertical load transmission member by shearing stress when the floating roof moves up or down in the tank. Special conditions are when ice is broken or when the seal must ride over horizontal or vertical lines of rivets under which conditions the shearing stress may be very great.

Still another object of the invention is to provide a seal of the above character which has a supporting means from the floating roof and which has means for exerting pressure axially on the seal to urge it into engagement with the cylindrical tank wall, which seal provides for effective ice-breaking action or the like, both during the rising movement of the floating roof and during the lowering movement of the floating roof.

Further objects and advantages of the invention will be apparent from the following description of certain preferred embodiments thereof, as illustrated in the accompanying drawings, in which:

FIG. 1 is a fragmentary vertical sectional view through a storage tank of the floating roof type. In this figure the parts are shown with a wide separation of the floating roof and the side wall of the tank. The parts are also shown in the condition where the floating roof is descending with reference to the side wall of the tank;

FIG. 2 is a view similar to FIG. 1 but showing the parts as positioned when the floating roof is rising with respect to the side wall of the tank.

FIG. 3 is a view similar to FIG. 1 but showing a modified form of the structure wherein springs provide the sole supporting connection of the seal from the floating roof. In this view the seal is shown in stationary relation to the side wall of the tank.

FIG. 4 is a view similar to FIG. 1 but showing a further modified form with the parts positioned with the roof rising with respect to the side wall and with a pivoted spring connection to the shoe.

FIG. 5 is a fragmentary elevational view taken in a plane indicated by the line 5—5 in FIG. 1 passing through the sealing mechanism and looking toward the wall of the cylindrical tank, the view being shown as a developed view rather than as true sectional elevation.
appropriate bonding material, as best shown in FIG. 7, so that the three elements of the laminated seal structure, including the annular fabric 21a, a series of annular segments 31 of plastic foam, and a series of annular bonding plates 32 for the annular segments 31 provide a bonded laminated seal construction for distributing the horizontal compression load applied to it throughout the surface or area of contact between the fabric 21 and the cylindrical wall 10, and also for transmitting certain shelf stresses vertically during the rising and descending of the seal with the roof.

Each metal backing member 32 (FIGS. 1, 5 and 6) is provided with one or more lips or ledges 33, each of which is adapted to receive the lower end of a spring beam and column member 34 to provide a one-way drive. The members 34 extends upwardly and is attached to the upper edge of the annular wall structure 13 at its upstanding portion 13a by means of the calmping strips 22 and the bolts 23. It will be seen that the lower end 34b of the spring and beam and column member 34 is free to move with respect to the laminated seal structure, both laterally and vertically, it being shown as transmitting downward thrust in FIG. 1 and as being free of its downward thrust transmitting function during rising of the roof, as shown in FIG. 2.

As seen in FIG. 1, moisture can collect and produce ice in cold weather, inside of the tank in the V-shaped crevice between the wall 10 and the fabric 21, as shown at 36, for example, and this ice must be broken to allow free movement of the roof and seal structures with respect to the cylindrical outer wall. When the roof is descending, as illustrated in FIG. 1, for example, it will be seen that the downward thrust transmitted by the spring and beam and column member 34 imparts a substantial clockwise moment to the sandwich-type seal structure, as indicated by the arrows 35, so that the upper portion of the seal structure tends to pull away from the outer wall 10, and the lower portion of the seal structure is pressed more firmly against the outer wall. This action of pulling the upper part of the seal structure away from the wall 10 at the same time that the middle or foam layer of the seal is distorted, as shown in FIG. 1, pulls the fabric 21 downward and away from the ice indicated at 36, and breaks the ice bond.

When the roof is rising, as shown in FIG. 2, there is no distortion of the seal structure, because there is no vertical shear in the foam at this time, and the ice indicated at 36, is broken by the stretching of the fabric 21 under tension.

Referring to FIG. 3, there is shown a modified form of the invention wherein the annular fabric 21a is attached in the usual manner at its lower edge by means including the plates 24, but has its upper edge looped over and cemented to the inner side of the backing members 32a. The backing members or shoes 32a are provided with pivot lugs 38, which are connected to the spring and beam member 34a by a looped lower end 39 and a pin 41. In FIG. 3 the roof is shown at rest, i.e., neither rising or lowering, and the foam member 31 is relatively undistorted, having no vertical forces applied to it. In this condition the sole forces transmitted through the seal are the outward spring pressures of the springs 34a and the plate or shoe 32a (as well as the plate or shoe 32 in FIG. 1) which serve to evenly distribute this pressure over the entire area so that the laminated seal construction provides a full distribution of the load or outward spring pressures permitting the annular seal structure seal element to be designed for providing a series of upright segmental annular metal-like circumferential limber shoe members arranged in closely spaced-apart end-to-end relation about a vertical axis, an annular fabric envelope for closing said space and having an intermediate annular strip portion secured to said shoes and engaging said side wall and also having a lower cir-
cumferential portion of said cylindrical wall structure, said annular fabric envelope having an upper portion extending upwardly and radially inwardly from said annular strip portion and secured to an upper circumferential portion of said cylindrical wall structure, and a circumferential series of spring and beam and column members carried by said cylindrical wall structure and extending downwardly and radially outwardly therefrom and having sliding engagements with upper portions of said respective shoe members, each of said shoe members having a ledge disposed below the upper portion therefor for operative one-way driving engagement by the associated one of said spring and beam and column members, said spring beam and column members sliding upwardly on said shoe members during rising movement of said roof and said fabric drawing taut and serving to lift said sealing mechanism upon such rising movement of said roof, said spring beam and column members sliding downwardly on said shoe members during falling movement of said roof and serving to press against said ledges to push said sealing mechanism downwardly upon such falling movement of said roof.

2. In a tank for storing liquids such as petroleum products, including an upstanding substantially cylindrical side wall, and a floating roof arranged in said tank and including an upstanding substantially cylindrical wall structure spaced radially inwardly from said tank side wall and defining an upstanding substantially annular space therebetween; sealing mechanism for said annular space comprising a substantially annular sealing element arranged in said annular space and carried by said wall structure and movable therewith with respect to said tank side wall; said sealing element comprising a combined bearing distribution and load transmission member of bonded laminated construction for horizontally directed bearing loads and for vertically directed operating loads, said member including a circumferential series of upright segmental annular and circumferentially limber metal shoes, a corresponding circumferential series of upright segmental blocks of foamed plastic material respectively located radially outwardly of and respectively bonded to said shoes, an annular fabric enveloping for closing said annular space and bonded to the adjacent outer surfaces of said shoes and said blocks, and means connecting said sealing element to said wall structure to provide for both raising and lowering movements of said sealing element and also to provide for outwardly pressing of said sealing element against said tank side wall under control of said wall structure, said means connecting said sealing elements to said wall structure including a plurality of circumferentially spaced apart leaf spring and column and beam members carried by said wall structure, each one of said leaf spring and column and beam members having its upper end comprising the leaf spring portion thereof and attached to said roof structure and having its lower end comprising the beam and column portion thereof and engaging in a corresponding one of said shoes by abutting the top surface of a ledge provided on said one shoe, each one of said ledges being located intermediate the vertical height of the corresponding one of said shoes to impart a twisting movement to said one shoe, thereby to distort the corresponding one of said blocks during outward thrusting movement of the corresponding one of said spring beam and beam and column members upon lowering of said floating roof in said tank.

5. In a tank for storing liquids such as petroleum products, including an upstanding substantially cylindrical side wall, and a floating roof arranged in said tank and including an upstanding substantially cylindrical wall structure spaced radially inwardly from said tank side wall and defining an upstanding substantially annular space therebetween; sealing mechanism for said annular space comprising a substantially annular radially thin sealing element arranged in said annular space and carried by said wall structure and movable therewith with respect to said tank side wall; said sealing element comprising a combined bearing distribution and load transmission member of bonded laminated construction, said bearing member comprising a plurality of upright segmental annular metal-like circumferentially limber shoes arranged in closely circumferentially spaced apart and end-to-end relation and disposed about a vertical axis, a corresponding series of upright segmental blocks of foamed plastic material, each one of said blocks being substantially coextensive with the associated one of said shoes, an annular fabric envelope for closing said annular space and having an annular strip bonded as a laminating to the outer surfaces of said series of blocks, said annular fabric having a lower portion looped downwardly and inwardly from said annular strip of said fabric and secured to a lower circumferential portion of said cylindrical wall structure of said floating roof, said annular fabric having an upper portion extending inwardly and upwardly from said annular strip of said fabric and secured to an upper circumferential portion of said cylindrical wall structure, a corresponding series of spring and beam and column members carried by said cylindrical wall structure and extending downwardly and outwardly therefrom to positions respectively adjacent to said shoes, and a corresponding series of ledges respectively carried by said shoes, each one of said ledges being disposed below and in operative one-way driving relation with a corresponding one of said spring beam and column members, said fabric serving to lift said sealing mechanism upon rising movement of said roof and said spring beam.
and column members serving to lower said sealing mechanism upon descending movement of said roof.

References Cited

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Date</th>
<th>Inventor(s)</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,513,043</td>
<td>10/1924</td>
<td>Huff</td>
<td>220—26</td>
</tr>
<tr>
<td>2,089,645</td>
<td>8/1937</td>
<td>Dickmann</td>
<td>220—26</td>
</tr>
<tr>
<td>2,803,371</td>
<td>8/1957</td>
<td>Edens</td>
<td>220—26</td>
</tr>
<tr>
<td>2,991,901</td>
<td>7/1961</td>
<td>Wiggins</td>
<td>220—26</td>
</tr>
<tr>
<td>3,043,468</td>
<td>7/1962</td>
<td>Harner</td>
<td>220—26</td>
</tr>
<tr>
<td>3,119,510</td>
<td>1/1964</td>
<td>Wiggins</td>
<td>220—26</td>
</tr>
<tr>
<td>3,185,335</td>
<td>5/1965</td>
<td>Lecler</td>
<td>220—26</td>
</tr>
<tr>
<td>3,204,809</td>
<td>9/1965</td>
<td>Cadwell</td>
<td>220—26</td>
</tr>
</tbody>
</table>

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