# United States Patent

[11] 3,618,813


[72] Inventors **Martin A. Nishkian**
**Long Beach;**
**Wayne E. Nuttall, San Gabriel, both of Calif.**



[21] Appl. No. **879,022**
[22] Filed **Nov. 24, 1969**
[45] Patented **Nov. 9, 1971**
[73] Assignee **United States Steel Corporation**


[54] **FLEXIBLE SEAL FOR A VAPOR CAVITY**
**5 Claims, 21 Drawing Figs.**


[52] **U.S. Cl.** ..... **220/26**
[51] **Int. Cl.** ..... **B65d 87/18**
[50] **Field of Search** ..... 220/26 S, 26 SA



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,921,617 | 8/1933 | Hanffstengel | 220/26 S |
| 2,554,497 | 5/1951 | Moyer | 220/26 S |
| 2,936,925 | 5/1960 | Moyer et al. | 220/26 S |
| 3,204,808 | 9/1965 | Cadwell | 220/26 S |
| 3,204,809 | 9/1965 | Cadwell | 220/26 S |
| 3,325,041 | 6/1967 | Wiggins | 220/26 S |
| 3,434,619 | 3/1969 | Nelson | 220/26 S |

FOREIGN PATENTS

| | | | |
|---|---|---|---|
| 217,888 | 11/1957 | Australia | 220/26 S |



*Primary Examiner*—M. Henson Wood, Jr.
*Assistant Examiner*—Thomas C. Culp, Jr.
*Attorney*—Robert J. Leek, Jr.



**ABSTRACT:** A flexible seal is disclosed for a vapor cavity between a tank shell and a floating roof. The seal has a quadrilateral type linkage on the floating roof which linkage has a fixed link and movable links. A flexible wear cover member is on the floating roof. A contact member is mounted on one of the movable links, adjacent the wear cover member, the contact member having a mounting plate, a cover member and a flexible core member between the mounting plate and the cover member. A counterweight means is on one of the movable links and is operable to force the contact member into contact with the wear cover member so that the wear cover member seals the vapor cavity.

Further, a flexible seal is disclosed having a support member secured at one end to the floating roof, and a tubular-sealing member having a wear cover member provided with flanges at each end and a flexible core member. The sealing member has one flange secured to the free end of the support member and the other flange secured to the other end of the floating roof. The sealing member is operable to seal the vapor cavity.

In addition, a seal is disclosed having a mounting member pivoted on the floating roof and a sealing member carried by the free end of the mounting member for sealing the vapor cavity. The sealing member has a rigid core member, a flexible core member surrounding the rigid core member, a wear cover member disposed about the flexible core member, and a support member extending through the sealing member and secured to the rigid core member and to the wear cover member.

Also, a rectangular self-energizing seal is disclosed having a sealing member provided with a rigid inner core member; a flexible inner core member disposed about the rigid inner core member; a rigid outer core member disposed about the flexible inner core member; rigid end section members covering the rigid outer core member, the flexible inner core member, and the rigid inner core member; a flexible outer core member disposed about the rigid outer core member, and the rigid end section members; a wear cover member covering the flexible outer member and the rigid end section members; a support rod extending through the sealing member and secured to the rigid end section members, a pair of generally diagonally disposed scuff pads projecting from the wear cover member, and generally diagonally disposed sealing surfaces on the outer flexible layer. A mounting rod is pivoted on the floating roof and pivotably connected to one of the scuff pads. A counterweight rod is pivotable on the other scuff pad, and a counterweight means is carried by the counterweight rod to force the sealing surfaces into sealing engagement with the tank shell and the floating roof.

Again, a flexible substantially square seal is disclosed having a mounting member pivoted on the floating roof and depending into the vapor cavity, a sealing member connected to the mounting member and having a flexible inner core member; a rigid inner core member disposed about the flexible inner core member; rigid end section members covering the rigid inner core member and the flexible inner core member; a flexible outer core member adjacent the rigid end section members and the rigid inner core member; and a scuff pad surrounding the rigid end section members and the flexible outer core member; a support rod extending through the sealing member and connected to the rigid end section members and to the mounting member. The scuff pad and the flexible outer core member are deformable to seal the vapor cavity.

Further, a rotary circular seal is disclosed having a mounting member pivoted at one end of the floating roof, an annular member carried by the other end of the mounting member and rotatable in the mounting member, and a sealing member on the annular member and having a rigid inner core member disposed about the annular member; a flexible outer core member surrounding the rigid inner core member; and a scuff pad about the flexible outer core member.

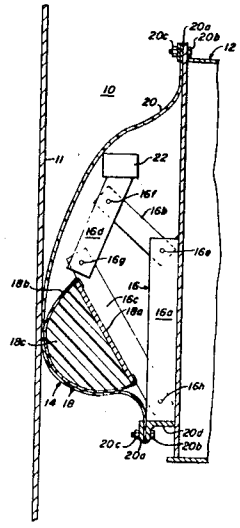



FIG. 1

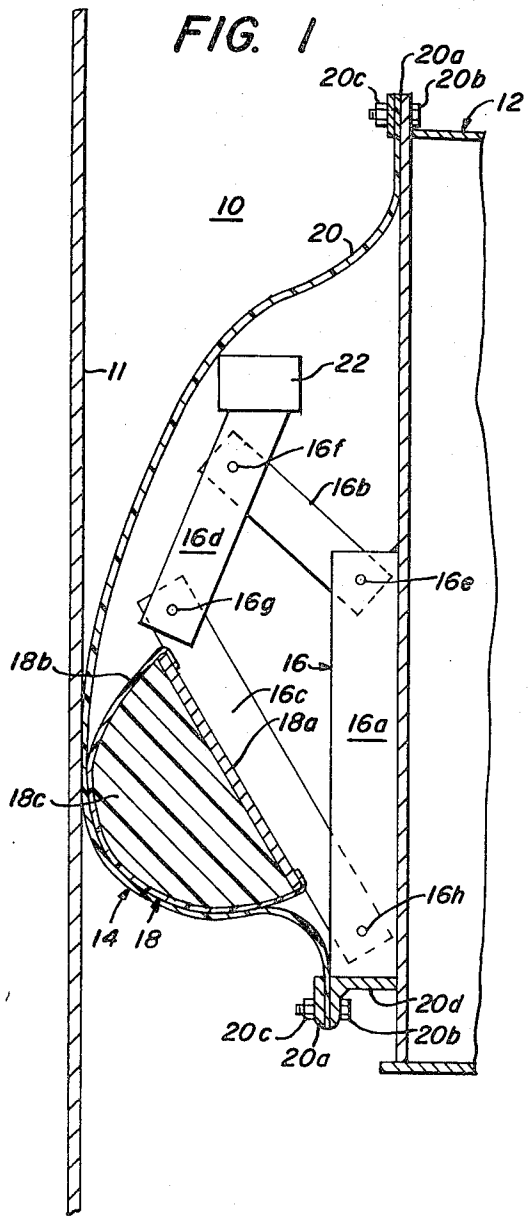
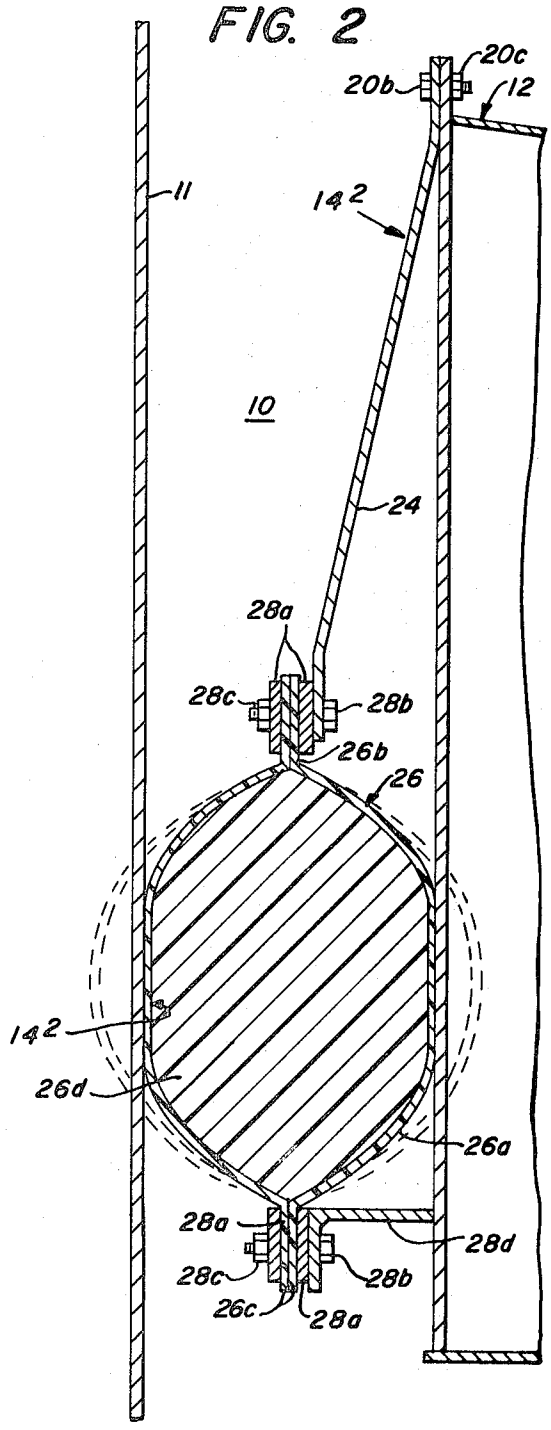



FIG. 2




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL

By

Attorney

FIG. 3




FIG. 4

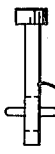



FIG. 6

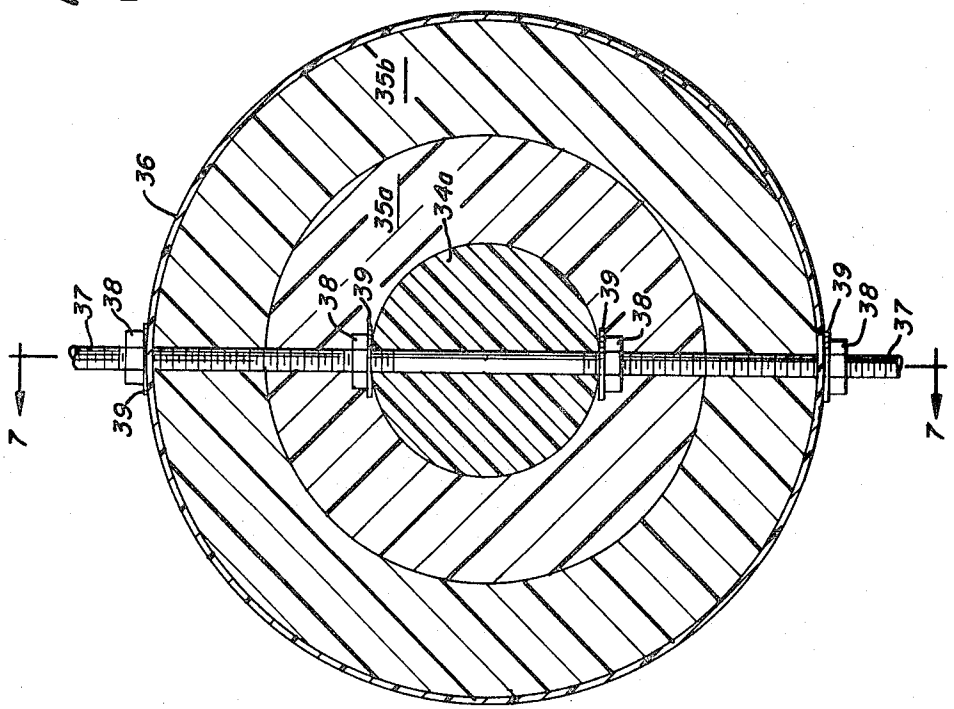
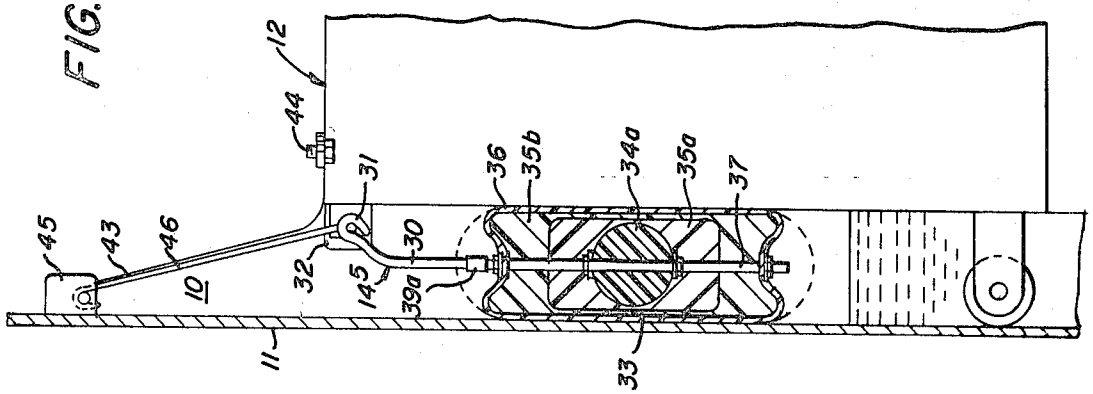



FIG. 5




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL

By

Attorney

FIG. 7

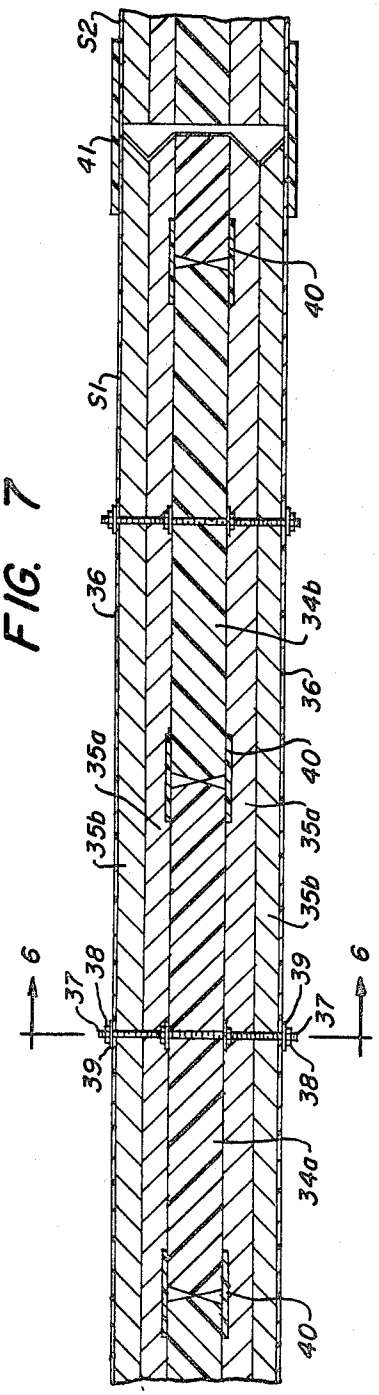



FIG. 8C

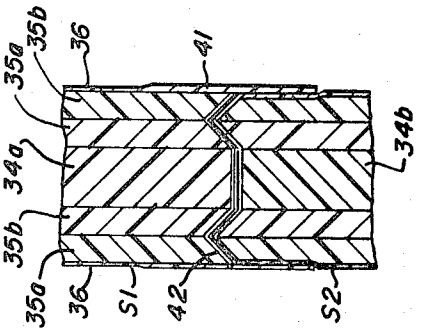



FIG. 8B

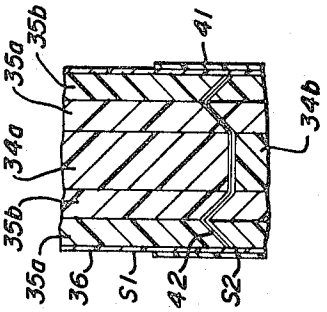
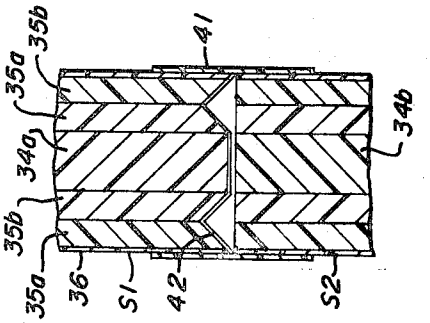



FIG. 8A




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTTALL

By

Attorney

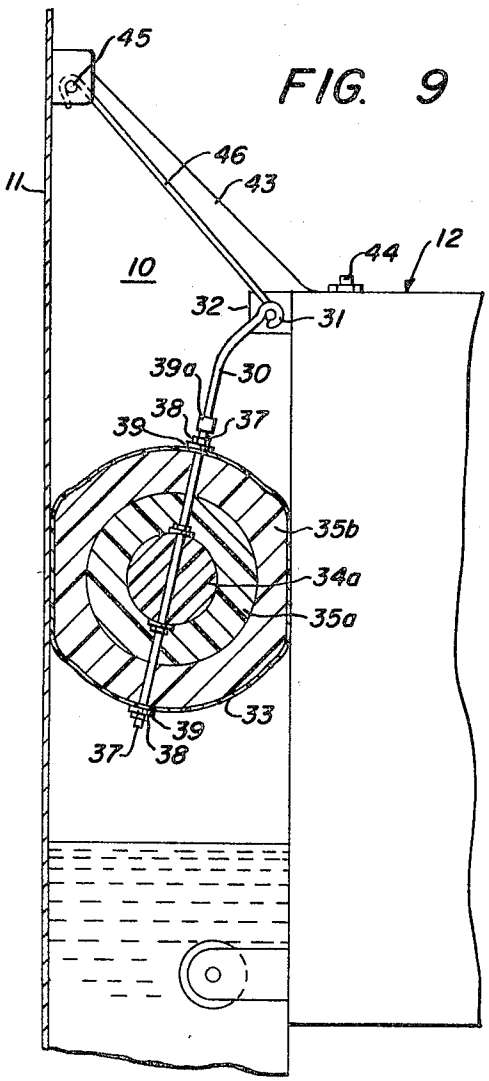



FIG. 9

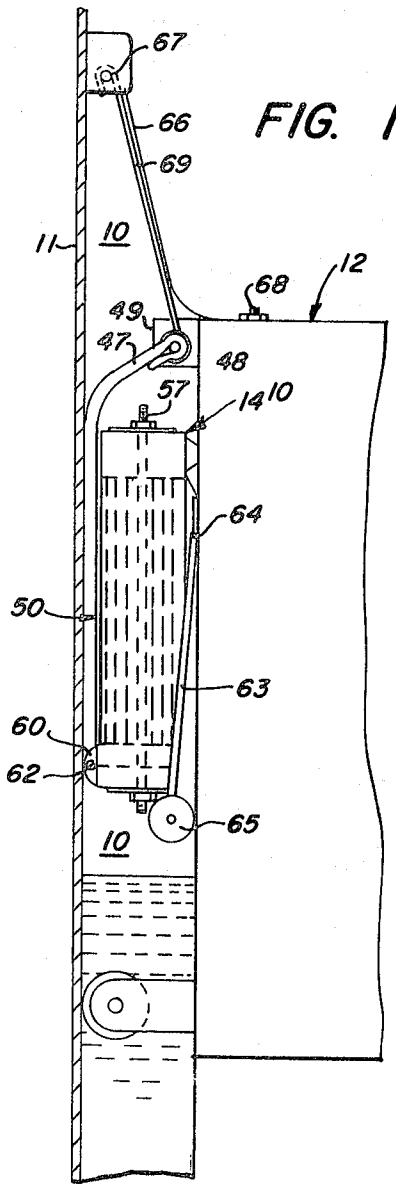



FIG. 10

INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTTALL

By

Attorney

FIG. 11

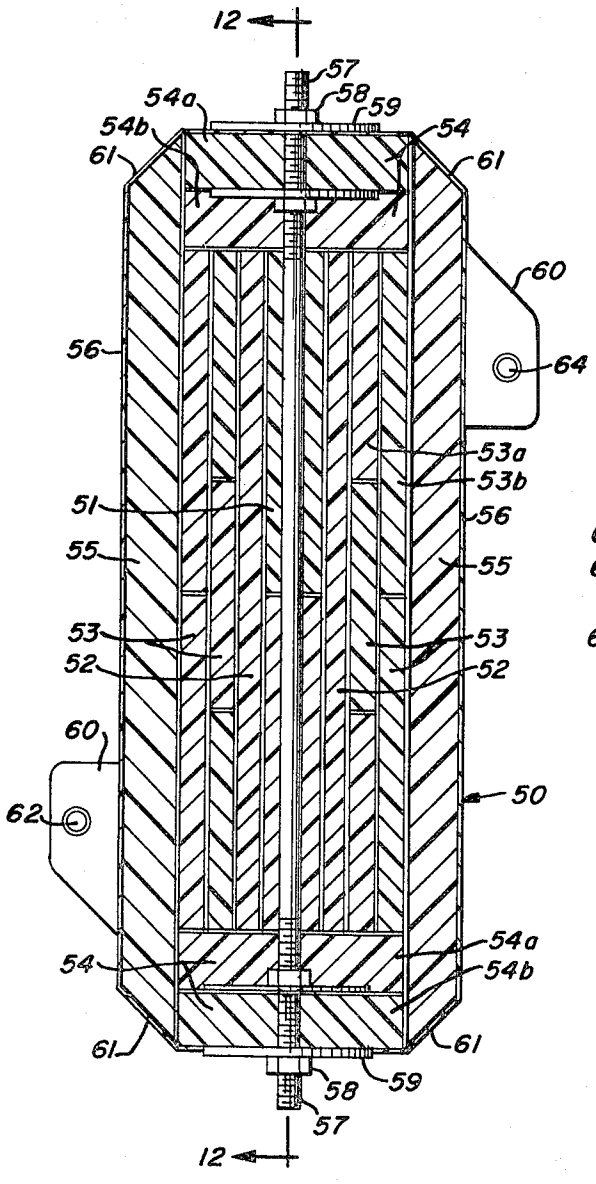
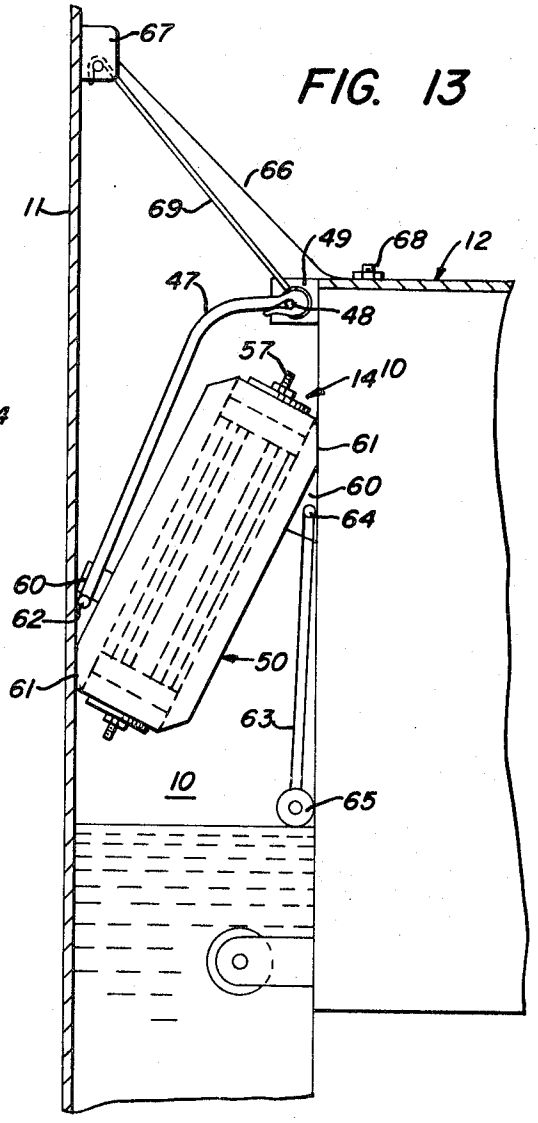



FIG. 13




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL
By
Attorney

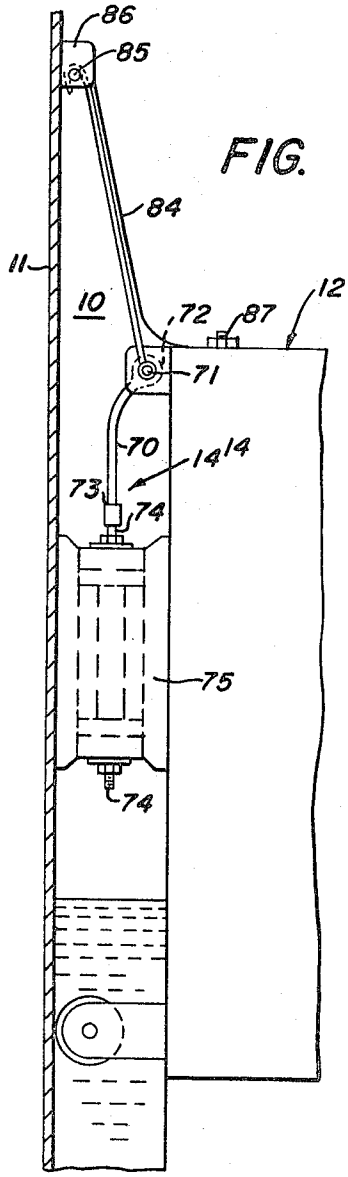



FIG. 14

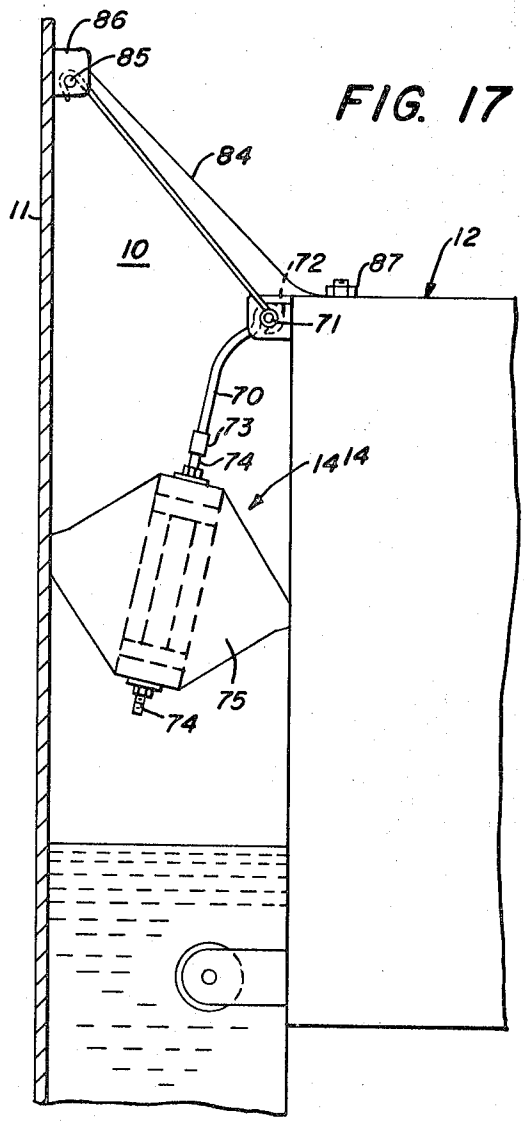



FIG. 17

INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL

By

Attorney

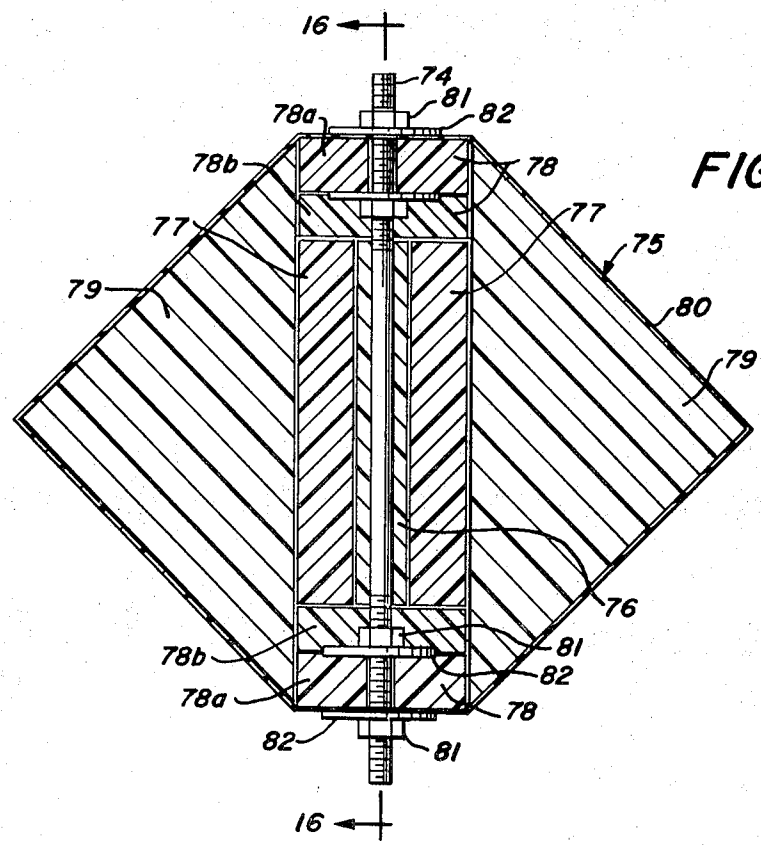
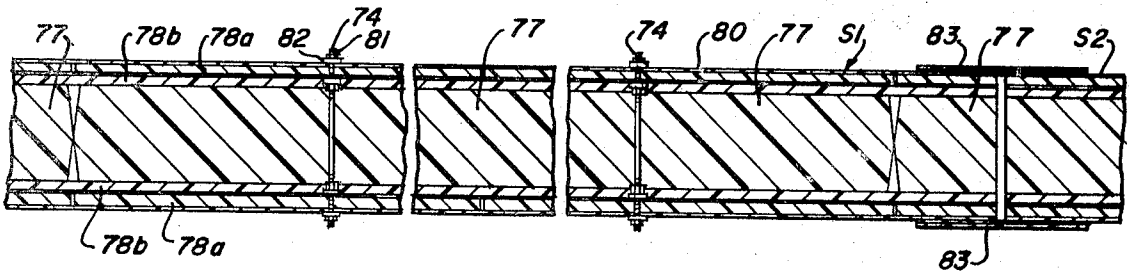



FIG. 15

FIG. 16




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL

By

Attorney

FIG. 19

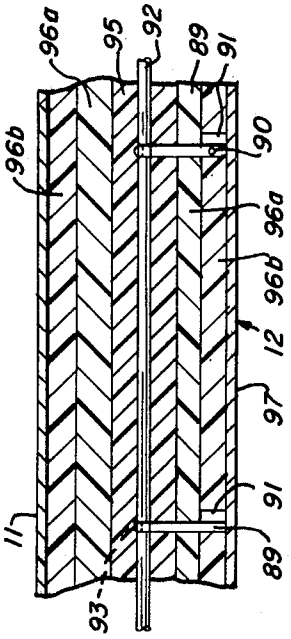



FIG. 12

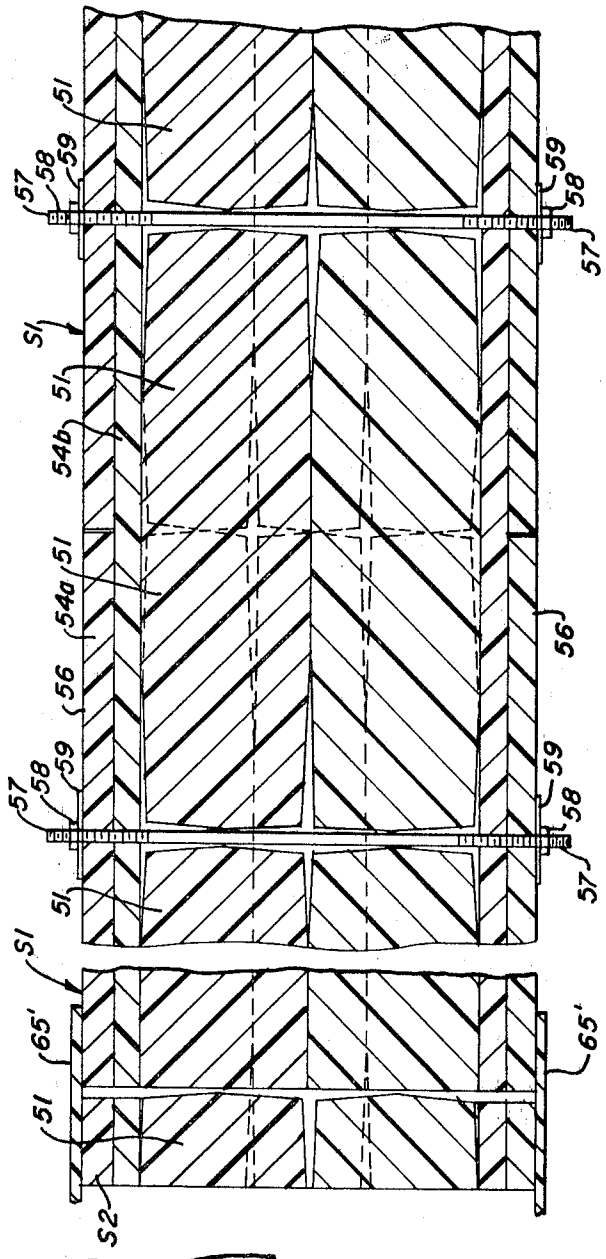
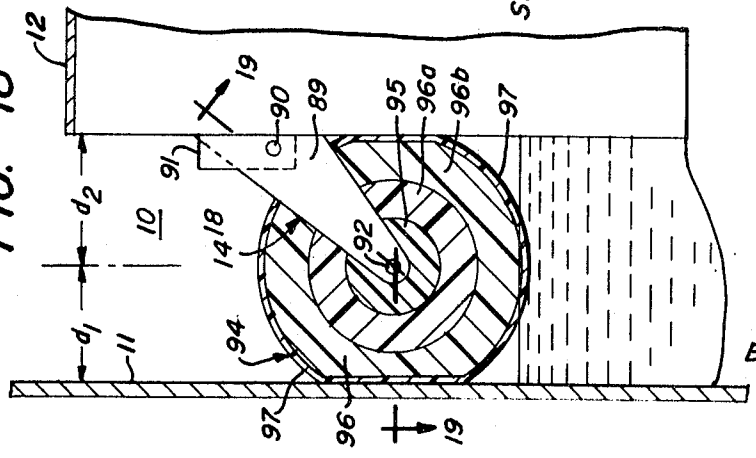



FIG. 18




INVENTORS
MARTIN A. NISHKIAN
& WAYNE E. NUTALL

By

Attorney

# FLEXIBLE SEAL FOR A VAPOR CAVITY

## BACKGROUND OF THE INVENTION

For economic and air pollution reasons the storage of volatile liquids requires a tank that will minimize breathing losses. An effective tank design for this purpose is a tank of the floating roof type. This design consists of an essentially cylindrical tank fitted with an internal buoyant roof that floats on the surface of the stored product, with a sealing device within the annular space between the floating roof and the tank wall, thus minimizing the vapor lost due to evaporation.

The efficiency of this type of tank depends on the tightness of the roof-to-tank seal. This seal has been accomplished in the past using metal shoes attached to the roof and sliding on the inside of the tank wall. The shoe is connected to the roof with a flexible curtain. The rigidity of the metal shoes, however, prevents a tight seal because of the tank shell curvature and irregularities in the tank shell.

Other types of seals have been devised in which a flexible membrane is filled with either a liquid, granular material, or other compressible material. This seal is attached to the roof ad deviations in the tank shell contour are overcome by the flexibility of the seal. These seals are built so they wear in the area of contact between the seal and the tank shell and after this area is worn through the seal is ineffective. Also, since the membrane is not integral with the core of the seal, it is possible for the membrane to wrinkle excessively and develop considerable wear.

Such conventional seals are show in the following patents:

| U.S. Pat. No. | Inventor | Issued |
|---|---|---|
| 1,693,468 | Schurmann | 11/27/68 |
| 2,056,857 | Imboden et al. | 10/6/36 |
| 2,057,682 | Horton et al. | 10/20/36 |
| 2,145,812 | Einbeck | 1/31/39 |
| 2,360,734 | Smith | 10/17/44 |
| 2,523,292 | Goldsby et al. | 9/26/50 |
| 2,531,424 | Goldsby et al. | 11/28/50 |
| 2,981,436 | Fino et al. | 4/25/61 |
| 2,997,200 | Giannini et al. | 8/22/61 |
| 3,043,468 | Horner | 7/10/62 |
| 3,059,805 | Joor | 10/23/62 |
| 3,075,668 | Reese | 1/29/63 |
| 3,116,850 | Anderson et al. | 1/7/64 |
| 3,136,444 | Moyer | 6/9/64 |
| 3,185,335 | Lecler | 5/25/65 |
| 3,204,809 | Cadwell | 9/7/65 |
| 3,255,914 | Nelson | 6/14/66 |
| 3,288,322 | Marshall et al. | 11/29/66 |
| 3,307,733 | De Bock | 3/17/67 |
| 3,338,454 | Nelson | 8/29/67 |
| 3,325,041 | Wiggins | 6/13/67 |

## OBJECTS OF THE INVENTION

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of a flexible seal between a tank shell and a floating roof which:

a. has its wear cover integrally bonded to the core or filler material to prevent bunch-up or wrinkling of the cover,
b. has a wear cover which is readily reapplied or repaired,
c. is reversible when the wear on one side of the wear cover is excessive,
d. has a uniform pressure exerted on the seal,
e. compensates for any out-of-round condition in the tank shell,
f. adjusts for any variation in dimension between the tank shell and the floating roof,
g. provides a vaportight seal between the tank shell and the floating roof, and
h. can be repaired or maintained without draining and cleaning the tank.



## BRIEF SUMMARY OF THE INVENTION

The aforesaid objects of this invention, and other objects which will become apparent as the description proceeds, are achieved by providing (NUI) a flexible seal for a vapor cavity between a tank shell and a floating roof. The seal has a quadrilateral type linkage on the floating roof, which linkage has a fixed link and movable links; and a contact member mounted on one of the movable links, adjacent the wear cover member. The contact member has a mounting plate, a cover member and a flexible core member between the mounting plate and the cover member. Counterweight means are on one of the movable links and are operable to force the contact member into contact with the wear cover member so that the wear cover member seals the vapor cavity.

A flexible seal is also provided having a support member secured at one end to the floating roof and a tubular-sealing member having a wear cover member provided with flanges at each end and a flexible core member. The sealing member has one flange secured to the free end of the support member and the other flange secured to the other end of the floating roof. The sealing member is operable to seal the vapor cavity.

Further, a seal is provided having a mounting member pivoted on the floating roof and a sealing member carried by the free end of the mounting member for sealing the vapor cavity. The sealing member has a rigid core member, a flexible core member surrounding the rigid core member, a wear cover member disposed about the flexible core member, and a support member extending through the sealing member and secured to the rigid core member and to the wear cover member.

In addition, a rectangular self-energizing seal is provided having a sealing member provided with a rigid inner core member; a flexible inner core member disposed about the rigid inner core member; a rigid outer core member disposed about the flexible inner core member; rigid end section members covering the rigid outer core member, the flexible inner core member, and the rigid inner core member; a flexible outer core member disposed about the rigid outer core member, and the rigid end section members; a wear cover member covering the flexible outer member and the rigid end section members; a support rod extending through the sealing member and secured to the rigid end section members; and a pair of generally diagonally disposed scuff pads projecting from the wear cover member, and generally diagonally disposed sealing surfaces on the outer flexible layer. A mounting rod is pivoted on the floating roof and pivotably connected to one of the scuff pads. A counterweight rod is pivotable on the other scuff pad, and counterweight means is carried by the counterweight rod to force the sealing surfaces into sealing engagement with the tank shell and the floating roof.

Also, a flexible substantially square seal is provided having a mounting member pivoted on the floating roof and depending into the vapor cavity, and a sealing member connected to the mounting member and having a flexible inner core member, a rigid inner core member disposed about the flexible inner core member; rigid end section members covering the rigid inner core member and the flexible inner core member; a flexible outer core member adjacent the rigid end section members and the rigid inner core member; a scuff pad surrounding the rigid end section members and the flexible outer core member; and a support rod extending through the sealing member and connected to the rigid end section members and to the mounting member. The scuff pad and the flexible outer core member are deformable to seal the vapor cavity.

In addition, a rotary circular seal is provided having a mounting member pivoted at one end of the floating roof, an annular member carried by the other end of the mounting member and rotatable in the mounting member, and a sealing member on the annular member and having a rigid inner core member disposed about the annular member; a flexible outer core member surrounding the rigid inner core member, and a scuff pad about the flexible outer core member.

## BRIEF DESCRIPTION OF THE SEVERAL VIEW(S) OF THE DRAWING(S)

For a better understanding of this invention reference should be had to the accompanying drawings, wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a fragmentary sectional view of a self-energizing seal between a tank shell and a floating roof;

FIG. 2 is a view similar to FIG. 1 of an alternative reversible seal;

FIG. 3 is a side elevational view of hooked pin for anchoring one end of the seal shown in FIG. 2;

FIG. 4 is a view similar to FIG. 3 of a key bolt for anchoring one end of the seal shown in FIG. 2;

FIG. 5 is a view similar of FIG. 1 of an alternative seal, in its minimum spacing position,

FIG. 6 is a cross sectional view of the sealing member shown in FIG. 5 taken along the line 6—6 of FIG. 7 in the direction of the arrows;

FIG. 7 is a longitudinal sectional view of the sealing member taken along the line 7—7 of FIG. 6 in the direction of the arrows;

FIGS. 8A–8C are fragmentary sectional views of various forms of sectional joints between adjacent sections of the sealing member;

FIG. 9 is a view similar to FIG. 5 showing the sealing member in its maximum sealing position;

FIG. 10 is a view similar to FIG. 5 of an alternative rectangular seal in its minimum spacing position;

FIG. 11 is an enlarged vertical sectional view of the sealing member shown in FIG. 10;

FIG. 12 is a vertical sectional view of the sealing member taken along the line 12—12 of FIG. 11 in the direction of the arrows;

FIG. 13 is a view similar to FIG. 10 showing the seal in its maximum spacing position;

FIG. 14 is a view similar to FIG. 10 of an alternative square seal in its minimum spacing position;

FIG. 15 is an enlarged sectional view of the sealing member shown in FIG. 14;

FIG. 16 is a vertical sectional view of the sealing member taken along the line 16—16 of FIG. 15 in the direction of the arrows;

FIG. 17 is a view similar to FIG. 14 of the seal in its maximum spacing position;

FIG. 18 is a view similar to FIG. 14 of an alternative rotary generally a circular seal, and

FIG. 19 is a fragmentary sectional view of the seal shown in FIG. 18 taken along the line 19—19 of FIG. 18 in the direction of the arrows.

Although the principles of this invention are broadly applicable to seals in general this invention is particularly adapted for use in conjunction with a flexible seal between a tank shell and a floating roof, and hence it has been so illustrated and will be so described.

## DETAILED DESCRIPTION

With specific reference to the form of this invention illustrated in the drawings, and referring particularly to FIG. 1, a self-energizing flexible seal for a vapor cavity **10** between a tank shell **11** and floating roof **12** is indicated generally be the reference numeral **14**.

This self-energizing seal **14** has a plurality of spaced quadrilateral type linkages **16**, mounted (as by welding) by means of a fixed **16***a* to the floating roof **12** and, in addition to the fixed link **16***a*, has movable links **16***b*, **16***c*, **16***d* pivoted at **16***e*, **16***f*, **16***g*, **16***h*. A contact member **18** is mounted by means of its mounting plate **18***a* to one of the movable links **16***b*, **16***c*, **16***d* (in this case the movable link **16***c*) and also has a cover member **18***b*, suitably neoprene or the like and a flexible core member **18***c*, suitably urethane or the like, between the cover member **18***b* and the mounting plate **18***a*. The cover member **18***b* is bonded to the mounting plate **18***a* at its edges by an adhesive, suitably Type AC Cement as manufactured by Goodyear Rubber Co., San Francisco, Cal.

A flexible wear cover member **20**, suitably neoprene or the like, is mounted on the floating roof **12** at one end by a contact bar **20***a*, bolt **20***b* and nut **20***c* and at the other end by a contact angle **20***d*, contact bar **20***a*, bolt **20***b* and nut **20***c*.

Counterweight means, such as a counterweight **22**, is carried by one of the movable links **16***a*, **16***b*, **16***c*, (in this case movable link **16***d*) to force the contact member **18** into contact with the wear cover member **20** so that the wear cover member **20** seals the vapor cavity at S.

The contact member **18** may be semicircular, as shown in FIG. 1, triangular, semihexagonal or the like in cross section.

## ALTERNATIVE EMBODIMENTS

It will be understood by those skilled in the art that alternatively as shown in FIG. 2 the flexible reversible seal **14²** has a support member **24** secured at one end, the top end as viewed in FIG. 2, to the floating roof **12** by a bolt **20***b* and nut **20***c*. The seal **14²** a tubular sealing member **26** of the seal **14²** has a wear cover member **26***a*, suitably two hemispherical sheets, for example neoprene, urethane or the like, vulcanized on both sides, and provided with flanges **26***b*, **26***c* and a flexible core member **26***d*, suitably urethane or the like. This sealing member **26** has one set of flanges (i.e., flanges **26***b*) secured, as by contact plates **28***a*, bolt **28***b* and **28***c* to the free end of the support member **24** and the other set of flanges (i.e., flanges **26***c*) secured by angle **28***d*, contact plates **28***a*, bolt **28***b* and nut **28***c* to the other end (i.e., lower end, FIG. 2) of the floating roof **12**.

The reversible sealing member **26** seals the vapor cavity **10**. Alternatively, as shown in FIGS. **3** and **4**, the bolts **28***b* and nuts **28***c* may be replaced by a hooked pin **28***e* or the key bolt **28***f*.

Referring to the round flexible seal **14⁵** shown in FIGS. **5–9**, such seal **14⁵** has a mounting member **30** (FIGS. **5,9**) pivoted at **31** on a lug **32** extending from the floating roof **12**. A sealing member **33** (FIGS. **5,7**) is carried by the free end of the support member **30** (as hereinafter described), for sealing the vapor cavity **10**. This sealing member **33** has a rigid core member **34***a*, **34***b* (FIGS. **7,8***a* **–8***c*); suitably polyurethane or the like; a flexible core member, suitably two concentric flexible cores **35***a*, **35***b* (FIGS. **5,6,7,8***a***–8***c*,**9**) of urethane foam or the like, surrounding the rigid core members **34***a*, **34***b*; wear cover member **36** (FIGS. **5,6,7,8***a***–8***c*,**9**), suitably a replaceable spray coat of dense urethane; and a threaded support member **37** (FIGS. **5,6,7,9**) extending through the sealing member **33** and secured by nuts **38** and washers **39** to the wear cover member **36** and to the rigid core member **34***a*. A coupling **39** *a* (FIGS. **5,9**) connects the support member **37** to the mounting member **30**.

The seal **14⁵** has the sectioned rigid core member **34***a*, **34***b* (FIG. 7) connected together by a core tube connector **40**, suitably polyurethane or the like, secured thereto by an adhesive, such as one of the following:

| Trademark or Trade Name | Manufacturer |
|---|---|
| "Surlyn" A ionomer resin | E. I. Du Pont de Nemours & Co. |
| "Bakelite" phenoxy resins PKHH and PAHJ | Union Carbide Corporation |
| "Scotch-Hold" brand structural adhesives adhesives | 3M Company |
| A-1103-B adhesive | B. F. Goodrich Industrial Products Company |
| USS "Nexus" PQE-1 polymeric material | United States Steel Corporation |

In addition, the sealing member **33** is sectioned into sections **S1**, **S2** (FIGS **7,8***a***–8***c*) which sections **S1**, **S2** are connected together by a boot **41**, suitably of dense urethane or the like, with (FIG. **8B**) or without (FIG. **8A**) one of the above adhesives. The joints between sections **S1**, **S2** may have one section

S1 (FIG. 8A) provided with a tongue and groove 42 or both sections S1, S2 (FIGS. 8B, 8C) provided with tongue and groove 42. In FIG. 8C the registering tongue and grooves 42 are cemented together with one of the above adhesives.

As shown in FIGS. 5,9 the seal $14^5$ is provided with a flexible weather shield 43, suitably neoprene, urethane elastomer or the like, secured to the floating roof 12 at 44 and to the tank wall 11 at 45 and supported by a plurality of support rods 46 extending from anchor 45 to pivot 31. The seal $14^5$ moves from the minimum spacing position (FIG. 5) to the maximum spacing position (FIG. 9).

The seal $14^{10}$ shown in FIGS. 10–13 has a mounting member 47 (FIGS. 10,13) pivoted at 48 on a bracket 49 projecting from the top of the floating roof 12 and extends arcuately downwardly into the vapor cavity 10. The seal $14^{10}$ also has a sealing member 50 (FIGS. 10,11,13) having a rigid inner core member 51 (FIG. 11, suitably polyurethane foam or the like); an inner flexible core member 52, suitably urethane elastomer or the like disposed about the rigid inner core member 51, an outer rigid core member 53, suitably polyurethane foam or the like, disposed about the flexible inner core member 52; rigid end section members 54, suitably polyurethane foam or the like, and covering the outer rigid core member 53, the flexible inner core member 52 and the rigid inner core member 51; a flexible outer core member 55, suitably an O-type elastomer of the type 2,069 manufactured by CPR Division of Upjohn Co. or the like, covering the outer rigid core member 53 and the end section members 54; a wear cover member 56, suitably urethane elastomer or the like, covering the flexible outer core member 55 and the rigid end section members 54; a support rod 57 (FIGS. 10–13) extending through the rigid end sections 54 and rigid inner core member 51 of the sealing member 50 and secured to the rigid end section member 54 by nuts 58 and washers 59; a pair of generally diagonally disposed scuff pads 60, suitably dense urethane or the like, (FIGS. 10,11,13) projecting from the wear cover member 56; and generally diagonally disposed sealing surfaces 61 (FIGS. 11,13) on the flexible outer core member 55.

The mounting rod 47 is pivoted at 62 on the left hand scuff pad 60 (as viewed in FIGS. 10,13). A counterweight rod 63 (FIGS. 10,13) is pivoted at 64 on the right hand scuff pad 60 (FIGS. 10,13) and carries a counterweight 65 (FIGS. 10,13) for moving the sealing member 50 into the minimum space-sealing position shown in FIG. 10 and the maximum space-sealing position shown in FIG. 13 where the sealing surfaces 61 seal against the tank wall 11 and floating roof 12.

As shown in FIGS. 11,12 the rigid outer core member 53 has a pair of rigid outer cores 53*a*, 53*b*, each of which is step-butt laminated. The butted sections are secured together with or without one of the following adhesives:

| Trademark or Trade Name | Manufacturer |
|---|---|
| "Surlyn" A ionomer resin | E. I. Du Pont de Nemours & Co. |
| "Bakelite" phenoxy resins PKHH and PAHJ | Union Carbide Corporation |
| "Scotch-Hold" brand structural | 3M Company |
| A-1103-B adhesive | B. F. Goodrich Industrial Products Company |
| USS "Nexus" PQE-1 polymeric material | United States Steel Corporation |

In addition, the rigid end section core member 54 has a pair of end sections 54*a*, 54*b* with a washer 59 and nut 58 disposed therebetween. As shown in FIG. 11, the rigid inner core member 51 is also sectioned and held together with or without one of the above-mentioned adhesives. Referring to FIG. 12 it will be noted that the sealing member 50 is also sectioned at S1, S2, the sections S1, S2 being connected together by a connector boot 65', suitably polyurethane or the like. One of the above-mentioned adhesives may be used to secure the boot 65' to wear cover members 56.

As shown in FIGS. 10,13 a weather shield 66, suitably of neoprene, urethane elastomer or the like, extends from pivot 67 on the tank wall 11 to securement point 68 on the floating roof 12 and is supported by a plurality of telescoping rods 69 extending between the pivot 67 on the tank wall 11 to the pivot 48 on the lug 49 on the floating roof 12. The weather shield 66 covers the vapor cavity 10.

The flexible substantially square seal $14^{14}$ shown in FIGS. 14–17, has a plurality of spaced mounting members 70 (FIGS. 14,17) each pivoted at 71 on a bracket 72 extending from the top of the floating roof 12. This member 70 extends into the vapor cavity 10 and is threadably connected at 73 to a support rod 74 extending through a sealing member 75.

The sealing member 75 has a flexible inner core member 76 (FIG. 15), suitably urethane or the like, disposed about the support rod 74; a rigid inner core member 77, suitably polyurethane or the like, disposed about the flexible inner core member 76, rigid end section members 78, suitably urethane elastomer or the like covering the flexible inner core member 76 and rigid inner core member 77; a flexible outer core member 79, suitably urethane or the like and of triangular cross section or the like, adjacent the rigid inner core member 77 and rigid end section members 78; and a scuff pad 80, suitably polyurethane foam or the like, covering the flexible outer core members 79 and rigid end section members 78.

The support rod 74 is connected to the rigid end section members 78, as by nuts 81 and washers 82.

In FIG. 15 the rigid end section members 78 each have at least two rigid end sections 78*a*, 78*b*. The sealing member 75 is sectioned (FIG. 16) into sections S1, S2 which sections S1, S2 are connected by connector boots 83, suitably polyurethane or the like. One of the following adhesives or the like may be used to adhere the boot 83 to the scuff pad 80.

| Trademark or Trade Name | Manufacturer |
|---|---|
| "Surlyn" A ionomer resin | E. I. Du Pont de Nemours & Co. |
| "Bakelite" phenoxy resins PKHH and PAHJ | Union Carbide Corporation |
| "Scotch-Hold" brand structural adhesives | 3M Company |
| A-1103-B adhesives | B. F. Goodrich Industrial Products Company |
| USS "Nexus" PQE-1 polymeric material | United States Steel Corporation |

In addition, a weather shield 84 (FIGS. 14,17), suitably neoprene, urethane elastomer or the like, extends from a pivot 85 on a lug 86 projecting from tank wall 11 to a securement point 87 on the floating roof 12 and is supported by a plurality of rods 88 each extending between pivot point 85 on lug 86 to pivot point 71 on bracket 72.

The rotary generally circular seal $14^{18}$ shown in FIGS. 18,19 has mounting members 89, each pivoted at 90 on a bracket 91 projecting from the top, as viewed in FIG. 18, of the floating roof 12. An annular metal member 92 is carried by the other ends (i.e., the depending ends, as viewed in FIG. 18) of the mounting members 89 in suitable holes 93 therein, and is rotatable in such holes 93. A sealing member 94 has a rigid inner core member 95, suitably polyurethane or the like, surrounding the annular member 92; a flexible outer core member 96, suitably urethane or the like, disposed about the rigid inner core member 95; and a scuff pad 97, suitably polyurethane or the like, surrounding the flexible outer core member 96.

As shown in FIG. 18, the flexible outer core member 96 has at least two flexible outer cores 96*a*, 96*b*. The mounting member 89 extends into the vapor cavity 10 so that the annular member 92 is closer to the tank shell 11 than to the floating roof 12, ($cd_1$,$cd_2$) thereby compressing the sealing surface of the scuff pad 97 adjacent the tank shell 11 more than the sealing surface of the scuff pad 97 adjacent the floating roof 12.

## SUMMARY OF THE ACHIEVEMENT OF THE OBJECTS OF THE INVENTION

It will be recognized by those skilled in the art that the objects of this invention have been achieved by providing of a flexible seal **14** (FIG. **1**), **14²** (FIGS. **2–4**), etc., between a tank shell **11** and a floating roof **12**, which seal has its wear cover integrally bonded to the core or filler material to prevent bunch-up or wrinkling of the cover; has a wear cover which is readily reapplied or repaired, is reversible when the wear on one side of the wear cover is excessive; has a uniform pressure exerted on the seal; compensates for any out-of-round condition in the tank shell; adjusts for any variation in dimension between the tank shell and the floating roof; provides a vapor-tight seal between the tank shell and the floating roof; and can be repaired or maintained without draining and cleaning the tank.

While in accordance with the patent statutes preferred and alternative embodiments of this invention have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

**1**. A flexible seal for a vapor cavity between a tank shell and a floating roof, said seal having:

a. A quadrilateral type linkage on said floating roof having a fixed link and movable links pivotable on said fixed link and on each other,

b. A flexible wear over member on said floating roof,

c. a contact member mounted on one of said movable links, adjacent said wear cover member,

1. said contact member having a mounting plate secured to said one link, a cover member secured to said mounting plate, and a flexible core member between said mounting plate and said cover member,

d. counterweight means on one of said movable links operable to force said cover member of said contact member into slidable contact with said wear cover member so that said wear cover member seals said vapor cavity.

**2**. The seal recited in claim **1** wherein said contact member is semicircular in cross section.

**3**. The seal recited in claim **1** wherein said wear cover member seals against said tank shell in substantially tangential line contact.

**4**. The seal recited in claim **1** wherein said contact member is triangular in cross section.

**5**. The seal recited in claim **1** wherein said contact member is semihexagonal in cross section.

* * * * *

# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,618,813 Dated November 9, 1971

Inventor(s) Martin A. Nishkian, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet in the ABSTRACT, line 64, "of" should read -- on -- . Column 1, line 24, "ad" should read -- and -- ; line 36, under "issued", "11/27/68" should read -- 11/27/28 -- . Column 3, line 63, "be" should read -- by -- . Column 4, line 27, before "28c", insert -- nut -- ; line 66, delete "adhesives". Column 5, line 60, under "Trademark or Trade Name" column, after "structural" insert -- adhesives -- .

Signed and sealed this 14th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.