

Aug. 30, 1966

A. F. FINO

3,269,583

FLOATING ROOF SEAL

Filed Dec. 19, 1962

4 Sheets-Sheet 1

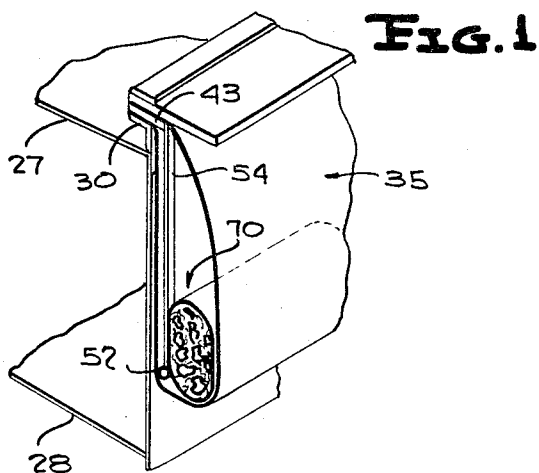
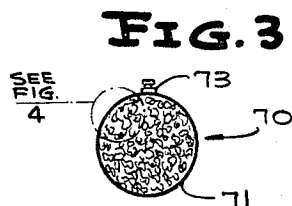
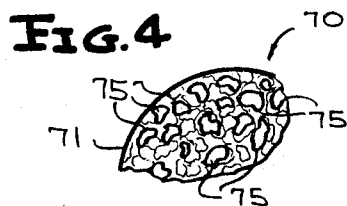
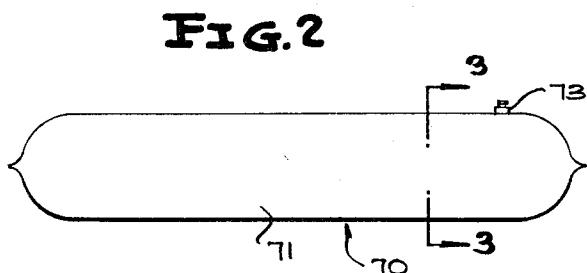
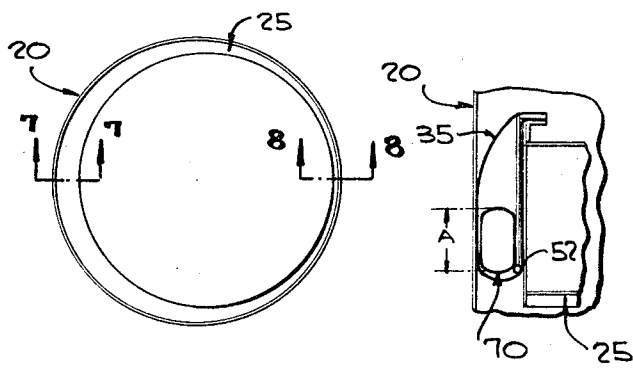
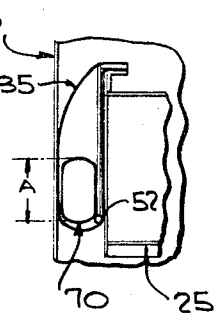
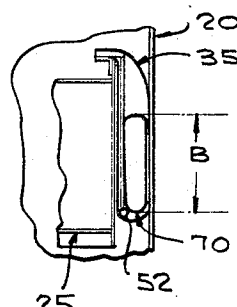


FIG. 6

Fig. 7

FIG. 8

INVENTOR.

ALEXANDER F. FINO

BY

Shoemaker and Mattare

ATTORNEYS

Aug. 30, 1966

A. F. FINO

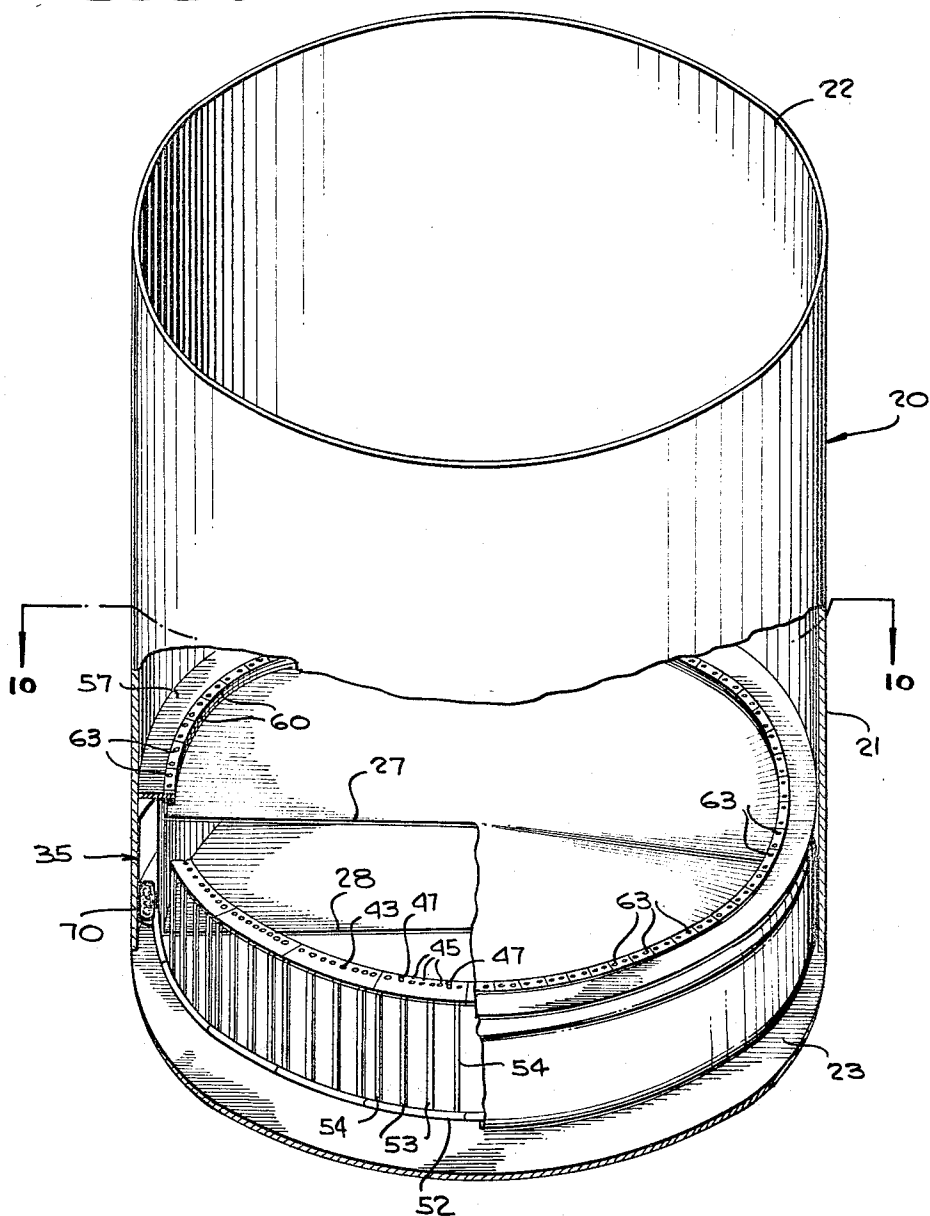
3,269,583

FLOATING ROOF SEAL

Filed Dec. 19, 1962

4 Sheets-Sheet 2

FIG. 9



INVENTOR
ALEXANDER F. FINO

BY

Shemaker and Mattare
ATTORNEYS

Aug. 30, 1966

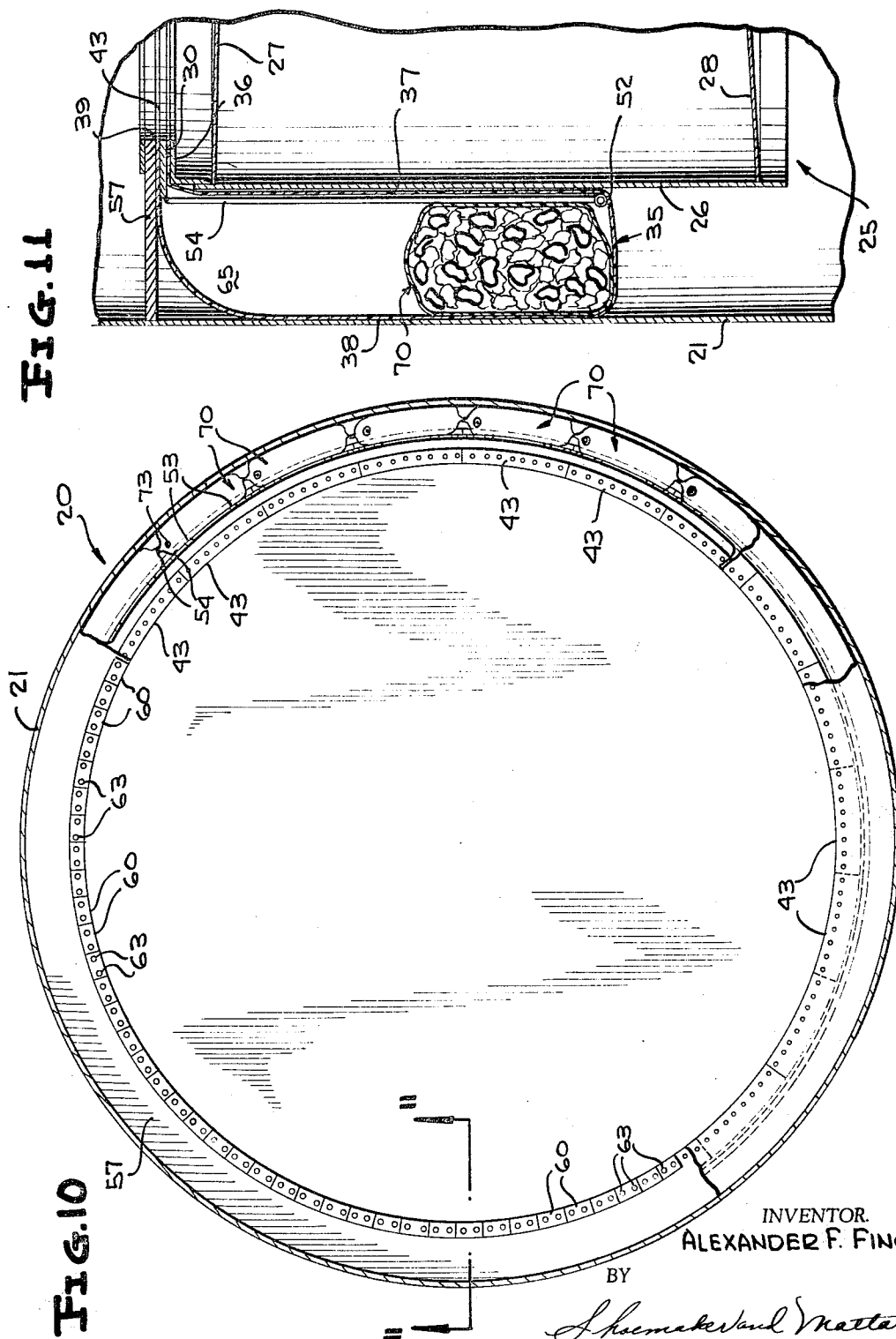
A. F. FINO

3,269,583

FLOATING ROOF SEAL

Filed Dec. 19, 1962

4 Sheets-Sheet 3



INVENTOR.
ALEXANDER F. FINO

BY

Shemaker and Mattare
ATTORNEYS

Aug. 30, 1966

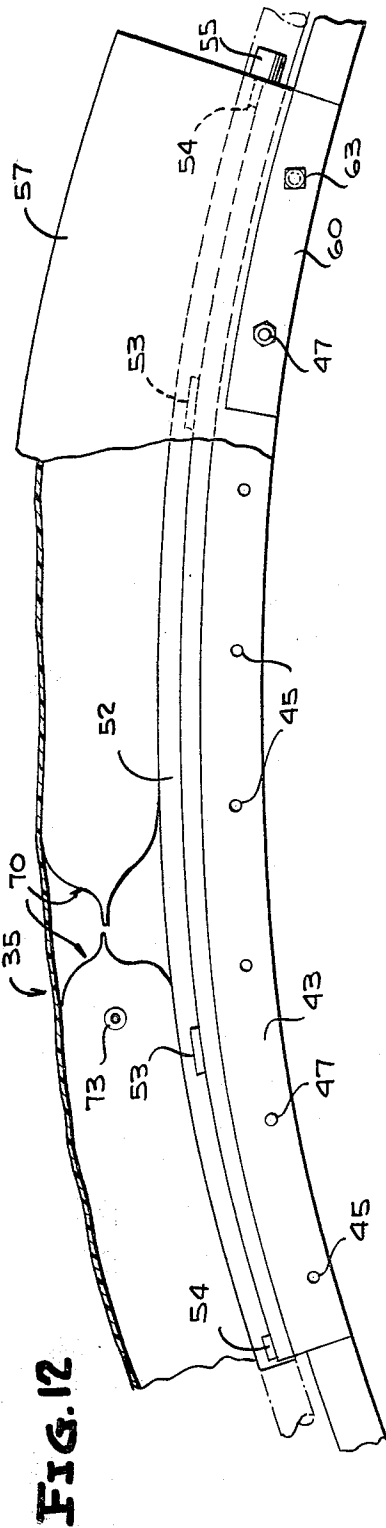
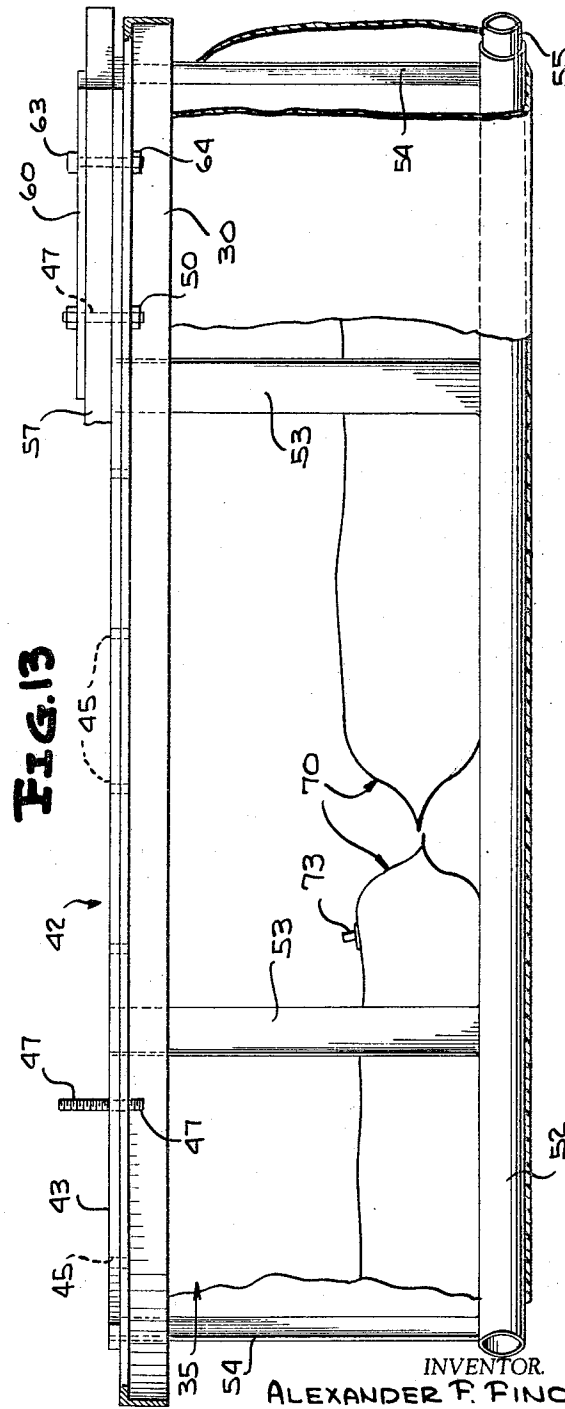
A. F. FINO

3,269,583

FLOATING ROOF SEAL

Filed Dec. 19, 1962

4 Sheets-Sheet 4



INVENTOR
ALEXANDER P. FINO
BY
Shoemaker and Mattare
ATTORNEYS

1

2

3,269,583

FLOATING ROOF SEAL

Alexander F. Fino, Warren, Pa., assignor to Dorcon Incorporated, Warren, Pa., a corporation of Delaware
 Filed Dec. 19, 1962, Ser. No. 245,719
 4 Claims. (Cl. 220-26)

The present invention relates to a new and novel floating roof seal, and more particularly to sealing means associated with the floating roof in a liquid storage tank.

The invention is directed to improvements in large storage tanks utilized for storing various liquids wherein the floating roof is supported on the upper surface of the liquid within the tank and rises and falls within the tank in accordance with the liquid level therewithin. The floating roof in these instances is of a lesser diameter than the interior of the tank which is substantially cylindrical in configuration, thereby providing an annular space between the roof and the tank. The sealing means of the present invention is directed to the structural arrangement for sealing this annular space.

In storing certain types of volatile substances such as gasoline and the like, it is important to provide a very good seal between the roof and the tank to prevent the escape of fumes from the tank or the entry of undesired foreign matter into the tank.

The present invention is particularly designed to provide a very effective seal for use with such substances and one which furthermore will adapt itself to the irregularities normally encountered on the interior of the tank and will bridge these irregularities in such a manner as to provide an effective seal at all times regardless of the presence of these irregularities.

A feature of the present invention is the fact that the structure of the sealing means may be incorporated with conventional floating roofs now in use with only certain minor modifications to the structure of the roof to accommodate the particular sealing arrangement utilized in the present invention. These modifications are indeed of a very minor nature and conventional roof structures may be modified simply by removing certain channels or portions of channels now utilized on the exterior surfaces of these roof structures for supporting the conventional sealing arrangement.

Since the dimensions involved in large storage tanks are relatively great, it is an important problem in the art to provide a means for effectively centering the roof with respect to the interior of the tank. The novel constructional arrangement of the present invention does effectively provide such a strong centering force and as a result minimizes wear in any local spots of the seal and further ensures uniformity of sealing engagement completely therearound.

In certain instances, the sealing arrangement of the present invention may be utilized in applications where there is a rim area between the roof and the interior of the tank which is substantially less than that normally encountered. Accordingly, the present invention incorporates means for adapting the sealing arrangement for use in such narrow rim area applications.

A further important feature of the present invention is the fact that the malfunction or injury of any single element of the arrangement will not destroy the over-all seal of the entire annular space between the roof and the tank, and furthermore, any element of the arrangement of the present invention can be readily and easily changed from the top side of the roof without disturbing the other elements or other portions of the same element.

In the prior art, seals for floating roofs have generally been actuated by a mechanical spring arrangement, by utilizing a tubular member filled with a liquid or air,

or a tubular member filled with a resilient material. The materials utilized for filling tubular members in the prior art has been free to expand or contract without any restriction of the volume thereof.

In contrast to the above-mentioned prior art structural arrangements, the present invention utilizes the novel concept of confining a spongy material capable of retaining gas such as air therewithin and releasing such gas when compressed within a hermetically sealed unit. A plurality of these units are utilized around the exterior of the roof and are retained within a wearing band means supported by the roof. The spongy material utilized within each of the hermetically sealed units is in the form of a plurality of discrete portions of the material, and it has been found that with this arrangement when the hermetically sealed unit is compressed between the roof and the inner wall of the tank, strong inner pressures will be produced within the hermetically sealed units due to release of the air entrapped in the discrete portions of spongy material which in turn produces excellent sealing characteristics as discussed above.

A weather shield means is also supported by the roof in overlying relationship to the aforementioned sealing means so as to protect the sealing means from the elements and thereby enhance the efficiency and prolong the life of the sealing means.

In order to permit installation of the hermetically sealed units of the sealing means of the present invention in place where the space between the roof and the inside of the tank may be less than usual, valve means is provided in each of the hermetically sealed units for selectively releasing a desired quantity of air so as to permit ready installation of the units in operative position.

Novel hold-down means is also provided in association with the wearing band means for holding the wearing band means in operative position during rising and falling movement of the roof. The hold-down means comprises a substantially rigid framework which is supported by the roof and disposed within the wearing band means and in engagement with a lower portion thereof. This hold-down means in particular serves to retain the wearing band means in operative position when the roof is moving downwardly with respect to the tank and prevents excessive movement and deformation of the wearing band means which might otherwise occur if it were not restrained at the lower inner portion thereof.

An object of the present invention is to provide a new and novel sealing means for use with the floating roofs of liquid storage tanks and which will provide good sealing characteristics as are required with tanks containing volatile substances.

Another object of the invention is to provide a floating roof sealing means which can be utilized with existing roof structures with only minor modifications of the roof structure and further which is capable of bridging irregularities normally encountered on the interior of a liquid storage tank.

A further object of the invention is to provide a sealing means for a floating roof in a liquid storage tank which creates strong centering forces on the roof thereby providing uniformity of seal around the roof and minimizing wear in any local areas of the sealing means.

Still another object of the invention is to provide a floating roof seal employing a wearing band means and incorporating novel means for holding said wearing band in position, the seal also including hermetically sealed units which are provided with means for selectively removing trapped air therewithin when installing the seal in narrow rim areas.

A still further object of the invention is to provide a sealing means for the floating roof of a liquid storage tank wherein damage to any single element of the sealing

means will not destroy the seal entirely around the roof and further wherein any elements of the sealing means can be easily changed from the top side of the roof without disturbing the other elements or other portions of the same element.

Still a further object of the invention is to provide a new and novel floating roof seal which is quite simple and inexpensive in construction, and yet which is sturdy and reliable in use.

Other objects and many attendant advantages of the invention will become more apparent when considered in connection with the specification and accompanying drawings, wherein:

FIG. 1 is a cutaway perspective sectional view through a floating roof incorporating the sealing means of the present invention;

FIG. 2 is a front view of a hermetically sealed unit according to the present invention;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2 looking in the direction of the arrows;

FIG. 4 illustrates an enlarged view of the portion indicated in FIG. 3 in one state;

FIG. 5 illustrates a view similar to FIG. 4 showing the spongy material in a different state;

FIG. 6 is a top view illustrating somewhat schematically the manner in which a floating roof may be disposed eccentrically within an associated storage tank;

FIG. 7 is a view taken substantially along line 7—7 of FIG. 6 looking in the direction of the arrows;

FIG. 8 is a view taken substantially along line 8—8 of FIG. 6 looking in the direction of the arrows;

FIG. 9 is a top perspective view partially broken away and partially in section illustrating a storage tank and an associated floating roof employing the sealing means of the present invention;

FIG. 10 is a sectional view taken substantially along line 10—10 of FIG. 9 looking in the direction of the arrows;

FIG. 11 is a sectional view taken substantially along the line 11—11 of FIG. 10 looking in the direction of the arrows;

FIG. 12 is an enlarged view looking downwardly at an edge portion of the roof and illustrating sealing means associated therewith partly broken away; and

FIG. 13 is an elevational view of the structure shown in FIG. 12.

Referring firstly to FIGS. 9, 10 and 11, a conventional liquid storage tank is indicated generally by reference numeral 20, and includes a substantially cylindrical vertically extending side wall 21, the tank having an open top 22 and a closed bottom 23 as is conventional in the art.

Disposed within the tank is a floating roof or cover indicated generally by reference numeral 25 in FIG. 11, and as seen most clearly in this figure, the roof includes a conventional peripheral substantially cylindrical wall 26 and an upper deck 27 and a lower deck 28 as is conventional. In order to adapt the roof so as to support the sealing means in operative position, bolting angle means is provided at the upper portion of the roof, and this bolting angle means preferably comprises a plurality of bolting angle segments 30 having a plurality of spaced openings formed through the upper or horizontally extending leg portion thereof while the lower or vertically extending leg portion thereof is suitably secured as by welding to the peripheral wall of the roof as illustrated.

In a typical example wherein the storage tank may have an inner diameter of 60 feet, and wherein the outer diameter of the peripheral wall of the floating roof may be approximately 59 feet so as to leave a clearance of approximately 6 inches all the way around the roof, 8 such bolting angles may be employed with the upper leg of the individual bolting angle sections being approximately two inches wide and having 23 spaced openings formed therethrough, each of these openings being spaced approximately 12.03 inches apart.

A wearing band means indicated generally by reference numeral 35 has one end portion 36 thereof supported on the upwardly facing surface of bolting angle means 30, the aforesaid end portion of the wearing band means being clamped in operative position as hereinafter described. The wearing band means includes a portion 37 which extends down closely adjacent the outer surface of the peripheral wall 26 of the roof, the wearing band means then extends outwardly to provide a portion 38 which is adapted to frictionally engage and contact the inner wall of the tank throughout a substantial area thereof, the opposite end portion 39 of the wearing band means also being clamped in operative position as hereinafter described. The wearing band means is formed of a suitable flexible material which is resistant to wear and which is adapted to accommodate itself to various irregularities in the interior surface of the tank. For example, the wearing band means may comprise a sheet of material such as synthetic rubber identified as Buna-N provided with nylon reinforcing.

The hold-down means provided for retaining the wearing band means in operative position may be understood most clearly from an inspection of FIGS. 12 and 13 of the drawings wherein one of the segments of the hold-down means is illustrated. Each of the hold-down means segments is indicated generally by reference numeral 42 and includes a top plate 43 having a plurality of openings 45 formed therethrough, these openings being shown as 6 in number and a pair of studs 47 are fixed to this plate and extend upwardly therefrom, the studs being provided with screw threads on the outer surface thereof and additionally including a depending portion 47'.

The openings 45 and studs 47 are spaced from one another the same distance as the openings provided through the bolting angle means previously described, one of the bolting angle segments being seen in FIG. 13 and indicated by reference numeral 30. It will be noted that the openings provided through the upper leg portion of the bolting angle segment are aligned with the openings 45 in the top plate 43 of the hold-down means and that the depending stud portions 47' of studs 47 are adapted to fit through aligned openings in the bolting angle segment. As seen at the righthand portion of FIG. 13, a nut 50 may be threaded on the downwardly extending portion 47' of the stud for securing the hold-down means to the bolting angle segment. Additional nut and bolt assemblies are utilized for clamping the various components together as will hereinafter appear.

The hold-down means also includes an arcuate portion of pipe 52 which is supported at the lower ends of a first pair of arms 53 and a second pair of arms 54, the upper ends of these arms being suitably secured as by welding to the plate 43 of the hold-down segment. A short bar member 55 is secured at one end of the pipe 52 and extends therebeyond, bar 55 having an outer diameter substantially the same as the inner diameter of the pipe. With this arrangement, adjacent segments of the hold-down means may be placed adjacent one another with the bars 55 of adjacent units fitting within the open end of the pipe at the lower portion of the next adjacent hold-down segment.

When the hold-down segments are suitably bolted in operative position, they will be disposed within the wearing band means as seen in FIG. 12 with the lower pipe portion 52 thereof engaging the lower portion of the wearing band means and holding this portion down and preventing upward movement thereof as will be apparent.

It will be seen in FIG. 11 that the end portion 39 of the wearing band means is disposed on the upper surface of plate 43 of the hold-down means. Disposed in overlying relationship to this end portion of the wearing band means is an annular weather seal indicated by reference numeral 57. This weather shield means may be of rela-

5

tively conventional construction extending completely around the roof and being formed of a slightly resilient material such as neoprene since it is designed to rub against the inside of the tank as the roof rises and falls. This weather shield means will serve to protect the underlying sealing means from damage due to the elements and to protect it from direct impingement of the sun's rays. The weather shield means is held in position by a plurality of clamping bars 60 which are seen most clearly in FIG. 10. Each of the clamping bars 60 is provided with two openings therethrough, these openings being provided at approximately 1 foot spacing from one another. In the case of the instant example, 23 hold-down segments as described above may be employed with each of these hold-down segments having the holes and studs thereon spaced apart on 12.03 inch centers. Accordingly, when the entire assembly is bolted in position, a plurality of bolts 63 are passed through the aligned openings in the clamping bars 60, the plate 43 of the hold-down means and the aligned openings in the upper leg of the bolting angle means. Suitable nuts 64 are threaded onto the lower end of these bolts 63 so as to maintain the assembled structure in the clamped relationship as seen most clearly in FIG. 12.

The wearing band means comprises several separate sections, and any number of sections may be employed as is convenient, the adjacent end portions of the sections of the wearing band means lapping over one another. It is not important as to how these sections engage one another since it is not desired to provide a hermetic seal between the various sections of the wearing band means.

It will be noted that the wearing band means as seen in FIG. 11 in cross section actually forms a loop which defines an annular enclosed area indicated by reference numeral 65, the hermetically sealed units of the present invention being supported within this enclosed area.

Referring now particularly to FIGS. 1-5 of the drawings, the construction and mode of operation of the hermetically sealed units of the present invention will be more clearly understood. The hermetically sealed units are all identical with one another, and a typical one is illustrated by reference numeral 70 in the drawings, these hermetically sealed units in the present example being approximately 8 feet long and corresponding in number to the hold-down bar assemblies. Each of the hermetically sealed units includes an outer casing 71 formed of a flexible material such as neoprene, Buna-N or other synthetic material, the casing forming an elongated hollow closed member. A valve means 73 is mounted in the wall of the casing of each hermetically sealed unit for selectively releasing air from the unit when desired.

As seen most clearly in FIG. 4, there are provided within the casing 71 of the hermetically sealed unit a plurality of discrete portions or masses of sponge-like material indicated by reference numeral 75. For example, the spongy material may be urethane or latex foam in a granular, shredded or chunked form. The invention is not limited to these specific materials, and the basic characteristic that the material must exhibit is the ability to be capable of retaining gas such as air within the cellular structure thereof and to release this gas when the cells or the structure thereof is compressed or collapsed. In the present instance, the cellular structure of the material will form air pockets which normally trap air therewithin which is released upon compression and collapsing of the cellular structure.

As seen in FIG. 9, in producing the hermetically sealed unit 70, approximately $\frac{1}{2}$ of the hollow tubular casing is packed with foam or other suitable material while the remaining $\frac{1}{2}$ of the tubular member is void with the void collapsed prior to sealing the tubular member. This provides sufficient self-contained expansion space within the completed hermetic unit which is understood to have been compressed or collapsed so as to release the air from the cellular structure thereof, but trapping such air within

6

the confined volume of the hermetically sealed unit. This air pressure then exerts a firm positive pressure on the side of the hermetically sealed unit which will in turn urge the outer portion 38 of the wearing band means into engaging sealing contact with the inner wall of the storage tank. It has been found that this firm positive pressure will serve to cause the wearing band means to bridge the irregularities normally encountered in the interior of such tanks.

When installing the seal in narrow rim areas, it has been found desirable to release quantities of excess trapped air, and for this purpose valve 73 is provided which may be selectively operated. The amount of released air may be adjusted to compensate for thermal expansion or contraction of the air within the hermetically sealed units.

Referring now to FIGS. 6, 7 and 8, the manner in which the sealing means of the present invention provides a strong centering force is illustrated. As seen in FIG. 6, the roof indicated generally by reference numeral 25 is disposed in eccentric relationship with respect to the storage tank 20. In the narrow rim space as indicated in FIG. 8, the seal will be greatly compressed thereby causing the hermetically sealed unit 70 to deform as illustrated, thereby bringing the large area designated by the letter B under a pushing pressure which tends to urge the adjacent portion of the roof away from the tank wall. On the other hand, at the other side of the tank as indicated in FIG. 7, the hermetically sealed unit 70 is not under great compression and the area indicated by letter A which is under a pushing pressure is much less than that at the opposite side of the tank. Accordingly, the hermetically sealed units 70 as shown in FIG. 8 will exert a greater force on the roof than those illustrated in FIG. 7 thereby urging the roof to a centered position.

This develops an equalizing centering force that tends to maintain uniformity of seal around the roof and minimize wear in any local tight spot.

It is apparent from the foregoing that there is provided a new and novel floating roof seal which is particularly adapted for use with floating roofs of liquid storage tanks wherein good sealing characteristics are required as when storing volatile substances such as gas and the like. The arrangement of the present invention can be utilized with existing roof structures with only minor modifications therein, and the sealing arrangement is capable of bridging irregularities which are normally encountered on the interior of the tank.

The sealing means of the present invention provides a strong centering force on the roof which tends to make it assume a central position whereby uniformity of sealing will be obtained around the roof and wear on any local tight spot will be minimized. The valve means incorporated in each of the individual hermetically sealed units allow the excess trapped air within these units to be selectively released as desired when installing in narrow rim areas or when it is desired to compensate for thermal expansion or contraction.

The hold-down means provides a simple and effective means for holding the lower inner portion of the wearing band means adjacent to the peripheral wall of the roof, and it is apparent by so holding this portion of the wearing band means, the distortion and upward movement of the wearing band means will be limited upon relative downward movement of the roof with respect to the tank.

The utilization of a plurality of individual and separate hermetically sealed units as well as the utilization of segmented hold-down means and also segmented bolting angle means and bolting bars offers a number of advantages which are further enhanced by the fact that the wearing band means is also constructed of segmented portions, while the weather shield means may be further formed in segmented portions which can be separately removed. With this arrangement, damage to any single element of the sealing arrangement will not destroy the seal of the roof all the way therearound, and in fact may

not severely impair the sealing at all. The rupture of any single hermetically sealed element will only affect a small portion of the entire roof if at all. Furthermore, it is apparent that the various elements can be easily changed from the top side of the roof without disturbing other elements spaced a substantial distance therefrom or for that matter without disturbing other portions of the same element. As an example, any of the bolting bars or bolting angle segments as well as any of the hold-down segments and the individual segments of the wearing band means or the individual hermetically sealed units can be removed and replaced in a simple and effective manner without removing different other ones of similar elements.

It is apparent that the structure of the present invention provides a very simple and inexpensive arrangement, yet one which is quite sturdy and reliable in use.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, and since the scope of the invention is defined by the appended claims, all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents are therefore intended to be embraced by those claims.

I claim:

1. A liquid storage tank including a substantially cylindrical side wall and a bottom and having a floating roof movably disposed therewithin and adapted to rise and fall within the tank in accordance with the liquid level in the tank, said roof having a smaller diameter than the inside of the tank to provide an annular space between the roof and the tank, sealing means for sealing said annular space, said sealing means including a wearing band means comprising a number of separate overlapping sections which cooperate to define an annular enclosed area, said wearing band means being formed of deformable wear resistant material adapted to engage the inside of the tank, hold-down means supported by said roof and disposed within said annular enclosed area and engaging the lower portion of the wearing band means for limiting upward movement thereof, said hold-down means comprising a plurality of segments which are separate and individual units, said hold-down means being removably supported by said roof, an annular weather shield means supported at the upper portion of said roof in overlying relationship to said sealing means and adapted to engage the inside of the tank to protect the sealing means from the weather, a plurality of clamping means for retaining the weather shield means and the wearing band means in operative position, means for removably retaining said clamping means in operative position, a plurality of hermetically sealed units disposed within said annular enclosed area within the wearing band means, each of said hermetically sealed units being deformable and being substantially filled with a plurality of discrete portions of a sponge-like material capable of retaining air therewithin and releasing such air when compressed, each of said hermetically sealed units being provided with valve means for selectively controlling the amount of gas in said units.

2. Apparatus as defined in claim 1 wherein said hermetically sealed units are of elongated construction with the long dimension thereof extending circumferentially of the roof, said hermetically sealed units being disposed in substantially end to end relationship with one another and defining an annularly extending resilient means for centering the roof within the tank.

3. A liquid storage tank including a substantially cylindrical side wall and a bottom and having a floating roof movably disposed therewithin and adapted to rise and fall within the tank in accordance with the liquid level in the tank, said roof having a peripheral wall of a smaller diameter than the inside of the tank to provide an annular space between the peripheral wall of the roof and the tank, sealing means for sealing said annular space, said sealing means including a wearing band means comprising a number of separate freely overlapping loop-like sections supported by said roof at the upper edge thereof and which depend downwardly into said annular space and cooperate to define an annular enclosed area, said wearing band means being formed of deformable wear resistant material adapted to engage the inside of the tank, hold-down means supported by said roof at the upper edge of said peripheral wall and depending downwardly closely adjacent the outer surface of said peripheral wall and disposed within said annular enclosed area and engaging the lower portion of the wearing band means for limiting upward movement thereof, an annular weather shield means supported at the upper portion of said roof in overlying relationship to said sealing means and adapted to engage the inside of the tank to protect the sealing means from the weather, a plurality of clamping means for retaining the weather shield means and the wearing band means in operative position, means for removably retaining said clamping means in operative position, a plurality of hermetically sealed units freely disposed within said annular enclosed area within the wearing band means, each of said hermetically sealed units being deformable and being substantially filled with a plurality of discrete portions of a sponge-like material capable of retaining gas such as air therewithin and releasing such air when compressed.

4. Apparatus as defined in claim 3, wherein each of said hermetically sealed units is provided with valve means for selectively controlling the amount of gas in said unit.

References Cited by the Examiner

UNITED STATES PATENTS

1,650,340	11/1927	Glass	220—26
2,085,752	7/1937	Horton et al.	220—26
2,523,292	9/1950	Goldsby	220—26
3,002,828	10/1961	Fino et al.	220—26
3,014,613	12/1961	Anderson	220—26
3,043,468	7/1962	Horner	220—26

THERON E. CONDON, *Primary Examiner.*

J. R. GARRETT, *Assistant Examiner.*