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(54) Title: COMPOSITE THIEF HATCH SYSTEMS

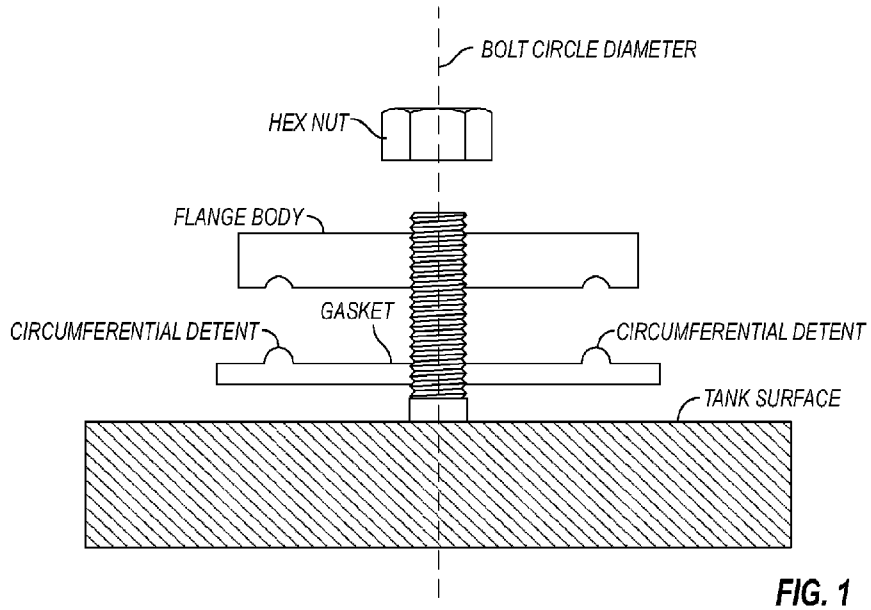

FIG. 1

(57) Abstract: The present disclosure refers to a system and components for a thief hatch. The thief hatch may include a flange body comprising a first composite material. The flange is configured to attach to a tank roof. A lid is operably connected to the flange body. The lid comprises a second composite material. The lid comprises a hinge operably connected to allow for at least partial opening and closing of the lid. The first composite material and the second composite material are the same material or different materials.

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[Continued on next page]

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Published:

— *with international search report (Art. 21(3))*

COMPOSITE THIEF HATCH SYSTEMS

Inventors: Joe Etheridge, James Timmins

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Provisional Application Number 63/308,286 filed February 9, 2022 which application is incorporated herein by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure relates to thief hatch systems used, for example, in covers or closures of low pressure holding tanks for fluids such as hydrocarbons, production fluids, byproducts of oil and gas, etc.

BACKGROUND AND SUMMARY

[0003] Throughout the oil and gas industry, atmospheric stock tanks are used to collect produced formation fluids, such as crude oil, natural gas condensate, and brine, at the surface for sales and/or disposal. Hatches are designed to remain closed to prevent fugitive emissions but occasional access may be required to, for example, gauge fluid levels within the tanks. Tank access is often controlled by what is known in the industry as a "thief hatch". Such hatches are typically a round or capsule-shaped flange with a hinged lid and a latch to keep the lid closed.

[0004] All produced fluids carry some amount of entrained hydrocarbon gases (i.e., methane) and/or volatile organic compounds (VOCs) into the stock tanks as a single phase. Therefore, if the hatch were to remain open, these volatile gases would eventually evolve (phase change) out of the fluid and vent to the atmosphere. Local, state, and federal regulations often limit the amount of such gases that may be emitted from a particular site. Thus, uncontrolled venting

could potentially expose the operator to penalties in additional to presenting a personnel safety risk. Additionally, such gases are detrimental to air quality, human health, and are potent greenhouse gases (e.g., methane has a global warming potential (GWP) of 27 times that of carbon dioxide). Therefore, these hatches often have a sealing element such as a gasket that is designed to prevent gases from venting to atmosphere, except during over pressurization events, before they can be recovered and either recycled back into the product pipeline or destroyed by other means, such as a flare.

[0005] Unfortunately, the hatches and sealing elements are subject to failure. Such failures may be due to many different reasons. In some cases failures may be due to dissimilar metals used in thief hatch construction which can cause various types of corrosion. Such corrosion may cause, for example, degradation of the gasket sealing (mechanical) interface. This may eventually lead to a partial or even an entire loss of seal integrity. This can result in the hatch venting hydrocarbon gases to the atmosphere even when it is properly closed and latched.

[0006] What is needed are new systems and components for thief hatches which do not substantially degrade or corrode. It would further be advantageous if such new systems and components did not substantially degrade or corrode even when exposed to, for example, weather, UV light, chemicals such as hydrocarbons and/or brine, Advantageously, the systems described herein may meet one or more up to all of the aforementioned needs.

[0007] The present disclosure refers to a system and components for a thief hatch. The thief hatch may comprise a flange body comprising a first composite material. The flange is configured to attach to a tank roof. A lid is operably connected to the flange body. The lid comprises a second composite material. The lid comprises a hinge operably connected to allow for at least partial opening and closing of the lid. The first composite material and the second composite material are the same material or different materials.

[0008] In another embodiment the thief hatch comprises a flange body comprising a first composite material. The flange is configured to attach to a tank roof. A lid is operably connected to the flange body. The lid comprises a second composite material and the lid comprises a hinge operably connected to allow for at least partial opening and closing of the lid. The first composite material and the second composite material may be the same material or different materials.

[0009] These and other features and advantages of the exemplary embodiments of the present disclosure will become apparent upon reading the following detailed description of the exemplary embodiments of the present disclosure, when taken in conjunction with the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Various embodiments of the present disclosure, together with further objects and advantages, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

[0011] Figure 1 shows a cross-sectional view of a circumferential detent.

[0012] Figure 2 shows a top view of a gasket showing an inner and an outer circumferential detents.

[0013] Figure 3 shows an underside of a flange surface grooved to accept a circumferential detent.

[0014] Figure 4A shows a schematic top view of a representative thief hatch described herein.

[0015] Figure 4B shows a schematic bottom view of a representative thief hatch described herein wherein an instrument boss is shown on the bottom center.

DETAILED DESCRIPTION

[0016] The following description of embodiments provides a non-limiting representative examples referencing numerals to particularly describe features and teachings of different aspects of the invention. The embodiments described should be recognized as capable of implementation separately, or in combination, with other embodiments from the description of the embodiments. A person of ordinary skill in the art reviewing the description of embodiments should be able to learn and understand the different described aspects of the invention. The description of embodiments should facilitate understanding of the invention to such an extent that other implementations, not specifically covered but within the knowledge of a person of skill in the art having read the description of embodiments, would be understood to be consistent with an application of the invention.

Thief Hatch

[0017] The thief hatch systems described herein generally comprise at least three components, e.g., a flange body, a closeable lid, and, if desired, a gasket. It should be understood that the gasket may be integral or separate from the flange body and/or closeable lid. The specific configurations, dimensions, and materials may differ depending upon the tank on which it is to be employed, the elements to which the components will be exposed, the type of materials to be stored in the tank, and other factors. In some embodiments at least some up to all the materials employed are comprised of an anti-static material to prevent sparks arising from static discharge.

[0018] Generally, the flange body and the lid are each comprised of a composite material. The composite material for each may be the same or different. The specific composite material is not particularly limited and is typically selected from composite materials that will not substantially corrode or degrade in the presence of weather, chemicals (e.g., hydrocarbons and/or brine), and/or ultraviolet rays. In some cases the flange body, the lid, or both may

comprise substantially no metal that would make the component susceptible to corrosion. This substantially removes the potential for accelerated oxidation, substantially retains seal integrity thereby reducing unwanted tank venting emissions over a longer period than, for example, cast metal options.

[0019] In some cases the composite material for the lid, flange body or both may be a suitable polymer that does not substantially corrode or degrade in the presence of weather, chemicals (e.g., hydrocarbons and/or brine), and/or ultraviolet rays. Such polymer may include, for example, a thermoplastic, a thermoset, or a combination thereof. Such polymers include, for example, an acrylic, an ABS, a nylon, a PLA, a polybenzimidazole, a polycarbonate, a polyether sulfone, a polyoxymethylene, a polyether ether ketone, a polyetherimide, a polyethylene, a polyphenylene oxide, a polyphenylene sulfide, a polyphenylene sulfide (PPS), a polypropylene, a polystyrene, a polyvinyl chloride, a polyvinylidene fluoride, a polytetrafluoroethylene (Teflon), a polyester, a polyurethane, an epoxy resin, a polyimide, a silicon, a vinyl ester, or any combination thereof.

[0020] In some cases, it may be desirable to employ a fiber reinforced polymer for the flange body and/or lid. Such fiber reinforced polymers include, for example, one of the aforementioned polymers reinforced with glass (fiberglass), carbon, aramid, basalt, or any combination thereof. The amount of fiber in the reinforced polymer may vary and in some cases is from about 20% to about 40% by weight fiber based on the total weight of the polymer and glass. Particularly suitable composites include, for example, a polyetherimide reinforced with from about 20 to about 40% by weight glass such as the ULTEM™ line of resins available from SABIC, e.g., ULTEM™2300.

[0021] The flange body and lid are configured such that they may be attached to a storage tank in a manner which allows one to at least partially open and close the lid to inspect the interior of the tank and/or any sensors that may be employed within the tank. The specific type

of attachment may vary depending upon the size of the tank, the desired size of the opening, the frequency of potential access required, chemicals in the tank, and other factors. Typically, the flange body is configured to attach to a tank roof. The lid may be operably connected to the flange body. The flange body may be attached to the roof of the tank in any convenient manner. In some embodiments the flange assembly may use an industry standard bolt pattern, for example, API 12F or ANSI 150.

[0022] A hinge may be operably connected to the lid such that it allows for at least a partial opening and closing of the lid for tank access when desired. The hinge is not particularly critical and may comprise a spring-loaded hinge mechanism made of composite, aluminum, or some combination thereof. If desired, a spring of a desired rating may be employed which can also act as an internal pressure relief device. Such a spring may be comprised of composite, aluminum, or a combination thereof. Such a device may allow for positive and/or negative pressure (vacuum) relief. That is, a spring of a desired rating may be useful to relieve pressure at a predetermined setting which setting could be changed by a user by removing and reinstalling a spring of the desired rating.

[0023] A latch mechanism may be employed to keep the lid securely closed. The type of latch is not particularly limited so long as it secures the lid and prevents unwanted gases from escaping the tank. The latch may be comprised of the same composite described previously, aluminum, or some combination thereof.

[0024] If desired, a gasket may be employed between the flange body and the lid. The gasket may comprise any suitable material which material is preferably not subject to corrosion or degradation when operating in a hydrocarbon and/or other corrosive environment. In some embodiments the gasket comprises an elastomer configured such that the gasket is substantially concentric with the flange body. The gasket may be attached in a manner similar to the flange body. That is, the gasket may comprise bolt holes around the circumference using the same or

similar pattern as the flange body attachment, e.g., an industry standard bolt pattern such as API 12F or ANSI 150. In this manner the same bolts may be used to secure both the flange body and gasket.

[0025] In some embodiments the gasket may comprise bolt holes around the circumference and/or the top of the gasket may comprise an outside circumferential detent and/or an inside circumferential detent. If employed, the outside circumferential detent and/or the inside circumferential detent may be configured to ensure substantial concentricity of the gasket with the flange body. That is, the elastomer gasket may comprise two semicircular and/or radiused circumferential detents (one inside and one outside the bolt circle diameter). The optional detents may provide additional gasket surface area without substantially increasing the gasket footprint, may increase a maximum pressure rating which may help to prevent fugitive emissions, and/or may assist in ensuring gasket concentricity with the flange body up to and throughout the life of the gasket material. This may assist in preventing one or more leaks as a material degrades due to, for example, exposure to elements and thus may possibly extend gasket service life.

[0026] The thief hatch may comprise one or more sensors such as, for example, a thermometer, a volatile organic compound detector such as a methane detector, a lid closure sensor, or any combination thereof. Suitable lid closure sensors may include, for example, an inclinometer and/or an accelerometer configured to detect whether the hatch is open or closed. Another potential sensor may be employed that indicates whether the lid has been closed and/or latched properly. A boss may be configured to hold the one or more sensors. For example, a flat boss can be threaded to accept any of the aforementioned sensors in a sensor package to measure, record, and/or transmit conditions and/or operations within the vapor space of the tank or other enclosure associated with the thief hatch system. The one or more sensors employed may be configured to transmit (wired or wirelessly) data to a remote operator. In addition, a magnetic

or infrared trip sensor and/or switch may be employed. One or more robots may be configured to take various actions based on the data from the sensors. For example, venting of one or more gases may be adjusted from the thief hatch based on sensor data.

[0027] The systems and components described herein may be manufactured in any convenient manner. For example, methods of manufacture may include Computer Numerical Control (CNC) machining, 3D printing, injection molding, or any other method by which the contemplated composite materials and components can be rendered into their desired shape.

[0028]

[0029] Figure 1 shows a cross-sectional view of a circumferential detent of a gasket mating with a corresponding circumferential detent of a flange body. While referred to as a circumferential detent it should be understood that the shape of the gasket and/or flange body and detent need not be limited to a circular shape. Any other desired shape may be employed. Similarly, while figure 1 shows a threaded post and hex nut other fasteners may be employed so long as they do not interfere with the desired sealing and non-corrosive nature of the system.

[0030] Figure 2 shows a top view of a gasket showing the circumferential detents inside the bolt hole pattern (inner detent) and outside the bolt hole pattern (outer detent). While Figure 2 shows a bolt circle diameter it should be understood that the bolt pattern is not limited to circular shaped just as the gasket, flange, and detent are not limited. The shape is not particularly critical so long as the proper seal is obtained.

[0031] Figure 3 shows an underside of a flange surface grooved to accept a circumferential detent. The result is a hatch which, due to, for example, the novel material selection and configuration of components, retains its seal integrity (and therefore reduces unwanted tank venting emissions) over a longer period than the current cast metal options. The designs described herein are superior in sealing and less corrosive than even coated metals or added

chemical resistant materials. The designs described herein in some embodiments replaces metal entirely thereby removing the potential for accelerated oxidation and unwanted venting.

[0032] Figure 4A shows a schematic top view of a representative thief hatch described herein while Figure 4B shows a schematic bottom view of a representative thief hatch described herein. As shown in Figure 4B an instrument boss is shown on the bottom center.

[0033] **Embodiments**

[0034] 1. A thief hatch comprising:

[0035] a flange body comprising a first polymer reinforced with glass wherein the flange is configured to attach to a tank roof;

[0036] a lid operably connected to the flange body wherein the lid comprises a second polymer reinforced with glass and wherein the lid comprises a spring-loaded hinge operably connected to allow for at least partial opening and closing of the lid;

[0037] an internal pressure relief device comprised of a composite, an aluminum, or combination thereof, wherein the internal pressure relief device is configured to allow for positive pressure relief, negative pressure relief, or both; and

[0038] a gasket between the flange body and the lid and wherein the gasket comprises an elastomer and wherein the gasket is substantially concentric with the flange body;

[0039] wherein the first polymer and the second polymer are the same material or different materials.

[0040] 2. The thief hatch of embodiment 1 wherein the gasket comprises bolt holes around the circumference and wherein the top of the gasket comprises an outside circumferential detent and an inside circumferential detent.

[0041] 3. The thief hatch of embodiment 2 wherein the outside circumferential detent and the inside circumferential detent are configured to ensure substantial concentricity of the gasket with the flange body.

[0042] 4. The thief hatch of embodiment 1 which further comprises one or more sensors.

[0043] 5. The thief hatch of embodiment 4 wherein the one or more sensors comprise a thermometer, a volatile organic compound detector, a lid closure sensor, or any combination thereof.

[0044] 6. The thief hatch of embodiment 4 which further comprises a boss to hold the one or more sensors.

[0045] 7. The thief hatch of embodiment 1 which further comprises one or more robots configured to adjust venting of one or more gases from the thief hatch.

[0046] 8. The thief hatch of embodiment 1 wherein the first polymer, the second polymer, or both comprises a polyetherimide.

[0047] 9. The thief hatch of embodiment 1 wherein the flange body comprising the first polymer reinforced with glass comprises from about 20% to about 40% by weight of glass based on the total weight of the first polymer and glass.

[0048] 10. The thief hatch of embodiment 1 wherein the lid comprising the second polymer reinforced with glass comprises from about 20% to about 40% by weight of glass based on the total weight of the second polymer and glass.

[0049] 11. A thief hatch comprising:

[0050] a flange body comprising a first composite material wherein the flange is configured to attach to a tank roof; and

[0051] a lid operably connected to the flange body wherein the lid comprises a second composite material and wherein the lid comprises a hinge operably connected to allow for at least partial opening and closing of the lid;

[0052] wherein the first composite material and the second composite material are the same material or different materials.

[0053] 12. The thief hatch of embodiment 21, wherein the flange body comprises substantially no metal that is subject to corrosion.

[0054] 13. The thief hatch of embodiment 11, wherein the lid comprises substantially no metal that is subject to corrosion.

[0055] 14. The thief hatch of embodiment 11, wherein the first composite material, the second composite material, or both comprise a polymer.

[0056] 15. The thief hatch of embodiment 11, wherein the first composite material, the second composite material, or both comprise a reinforced polymer.

[0057] 16. The thief hatch of embodiment 14, wherein the polymer comprises a polyetherimide.

[0058] 17. The thief hatch of embodiment 15, wherein the polymer comprises a polyetherimide.

[0059] 18. The thief hatch of embodiment 11, wherein the thief hatch further comprises a gasket between the flange body and the lid and wherein the gasket is substantially concentric with the flange body.

[0060] 19. The thief hatch of embodiment 18 wherein the gasket comprises bolt holes around the circumference and wherein the top of the gasket comprises an outside circumferential detent and an inside circumferential detent.

[0061] 20. The thief hatch of embodiment 19 wherein the outside circumferential detent and the inside circumferential detent are configured to ensure substantial concentricity of the gasket with the flange body.

[0062] In the preceding specification, various embodiments have been described with references to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the

claims that follow. The specification and drawings are accordingly to be regarded as an illustrative rather than restrictive sense.

WE CLAIM:

1. A thief hatch comprising:

a flange body comprising a first polymer reinforced with glass wherein the flange body is configured to attach to a tank roof;

a lid operably connected to the flange body wherein the lid comprises a second polymer reinforced with glass and wherein the lid comprises a spring-loaded hinge operably connected to allow for at least partial opening and closing of the lid;

an internal pressure relief device comprised of a composite, an aluminum, or combination thereof, wherein the internal pressure relief device is configured to allow for positive pressure relief, negative pressure relief, or both; and

a gasket between the flange body and the lid and wherein the gasket comprises an elastomer and wherein the gasket is substantially concentric with the flange body;

wherein the first polymer and the second polymer are the same material or different materials.

2. The thief hatch of claim 1 wherein the gasket comprises bolt holes around the circumference and wherein the top of the gasket comprises an outside circumferential detent and an inside circumferential detent.

3. The thief hatch of claim 2 wherein the outside circumferential detent and the inside circumferential detent are configured to ensure substantial concentricity of the gasket with the flange body.

4. The thief hatch of claim 1 which further comprises one or more sensors.

5. The thief hatch of claim 4 wherein the one or more sensors comprise a thermometer, a volatile organic compound detector, a lid closure sensor, or any combination thereof.

6. The thief hatch of claim 4 which further comprises a boss to hold the one or more sensors.

7. The thief hatch of claim 1 which further comprises one or more robots configured to adjust venting of one or more gases from the thief hatch.

8. The thief hatch of claim 1 wherein the first polymer, the second polymer, or both comprises a polyetherimide.

9. The thief hatch of claim 1 wherein the flange body comprising the first polymer reinforced with glass comprises from about 20% to about 40% by weight of glass based on the total weight of the first polymer and glass.

10. The thief hatch of claim 1 wherein the lid comprising the second polymer reinforced with glass comprises from about 20% to about 40% by weight of glass based on the total weight of the second polymer and glass.

11. A thief hatch comprising:

a flange body comprising a first composite material wherein the flange is configured to attach to a tank roof; and

a lid operably connected to the flange body wherein the lid comprises a second composite material and wherein the lid comprises a hinge operably connected to allow for at least partial opening and closing of the lid;

wherein the first composite material and the second composite material are the same material or different materials.

12. The thief hatch of claim 21, wherein the flange body comprises substantially no metal that is subject to corrosion.

13. The thief hatch of claim 11, wherein the lid comprises substantially no metal that is subject to corrosion.

14. The thief hatch of claim 11, wherein the first composite material, the second composite material, or both comprise a polymer.

15. The thief hatch of claim 11, wherein the first composite material, the second composite material, or both comprise a reinforced polymer.

16. The thief hatch of claim 14, wherein the polymer comprises a polyetherimide.

17. The thief hatch of claim 15, wherein the polymer comprises a polyetherimide.

18. The thief hatch of claim 11, wherein the thief hatch further comprises a gasket between the flange body and the lid and wherein the gasket is substantially concentric with the flange body.

19. The thief hatch of claim 18 wherein the gasket comprises bolt holes around the circumference and wherein the top of the gasket comprises an outside circumferential detent and an inside circumferential detent.

20. The thief hatch of claim 19 wherein the outside circumferential detent and the inside circumferential detent are configured to ensure substantial concentricity of the gasket with the flange body.

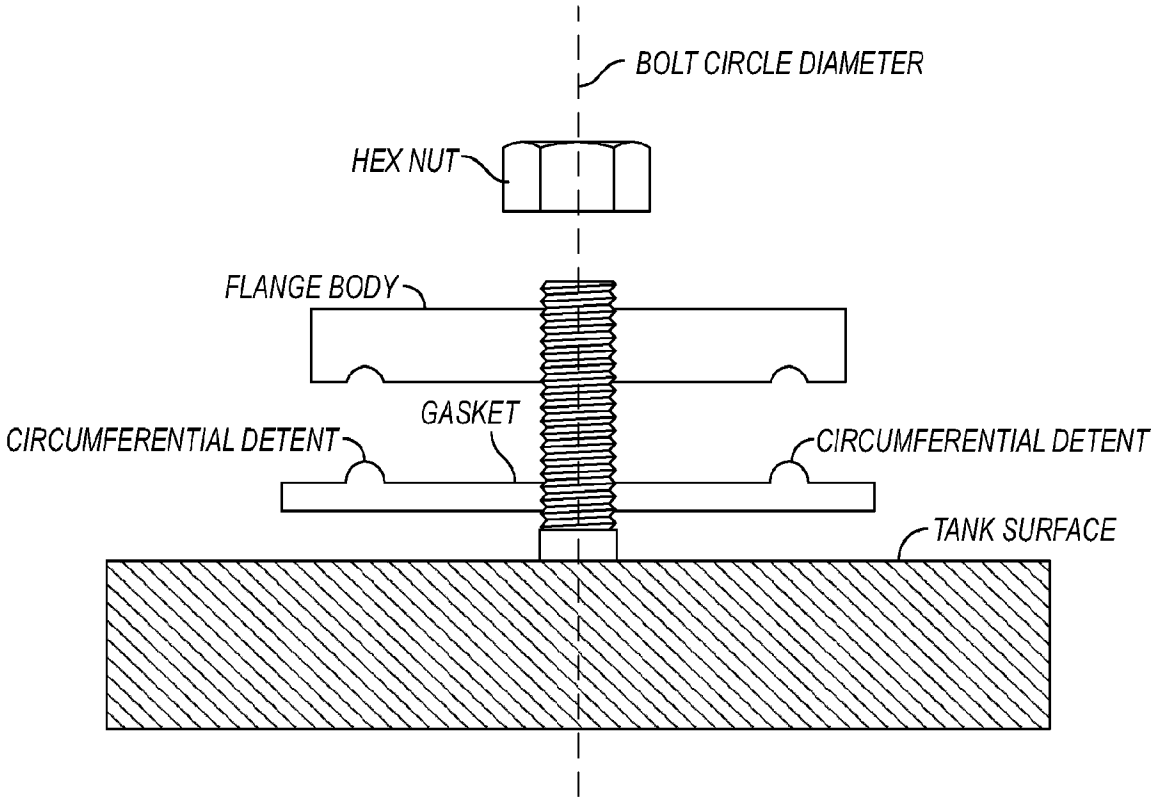
BOLT CIRCLE DIAMETER
HEX NUT
FLANGE BODY
GASKET
CIRCUMFERENTIAL DETENT
CIRCUMFERENTIAL DETENT
TANK SURFACE

FIG. 1

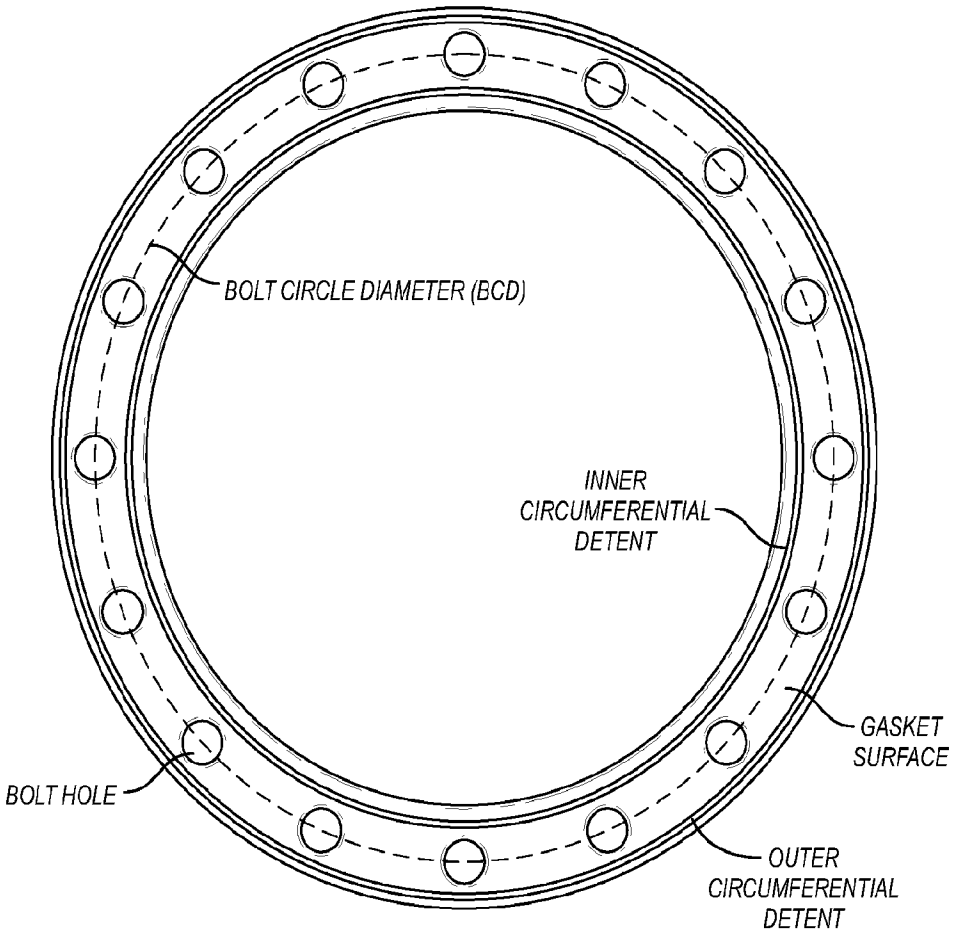
BOLT CIRCLE DIAMETER (BCD)
INNER CIRCUMFERENTIAL DETENT
GASKET SURFACE
BOLT HOLE
OUTER CIRCUMFERENTIAL DETENT

FIG. 2

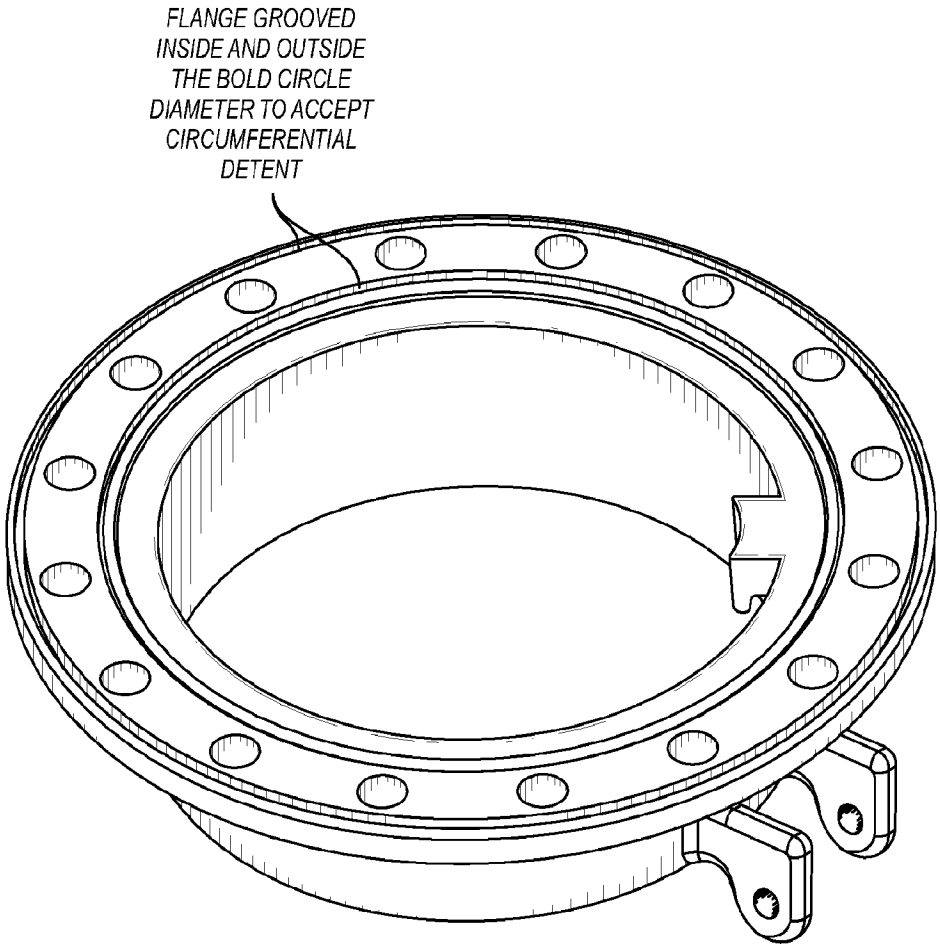
FLANGE GROOVED
INSIDE AND OUTSIDE
THE BOLD CIRCLE
DIAMETER TO ACCEPT
CIRCUMFERENTIAL
DETENT

FIG. 3

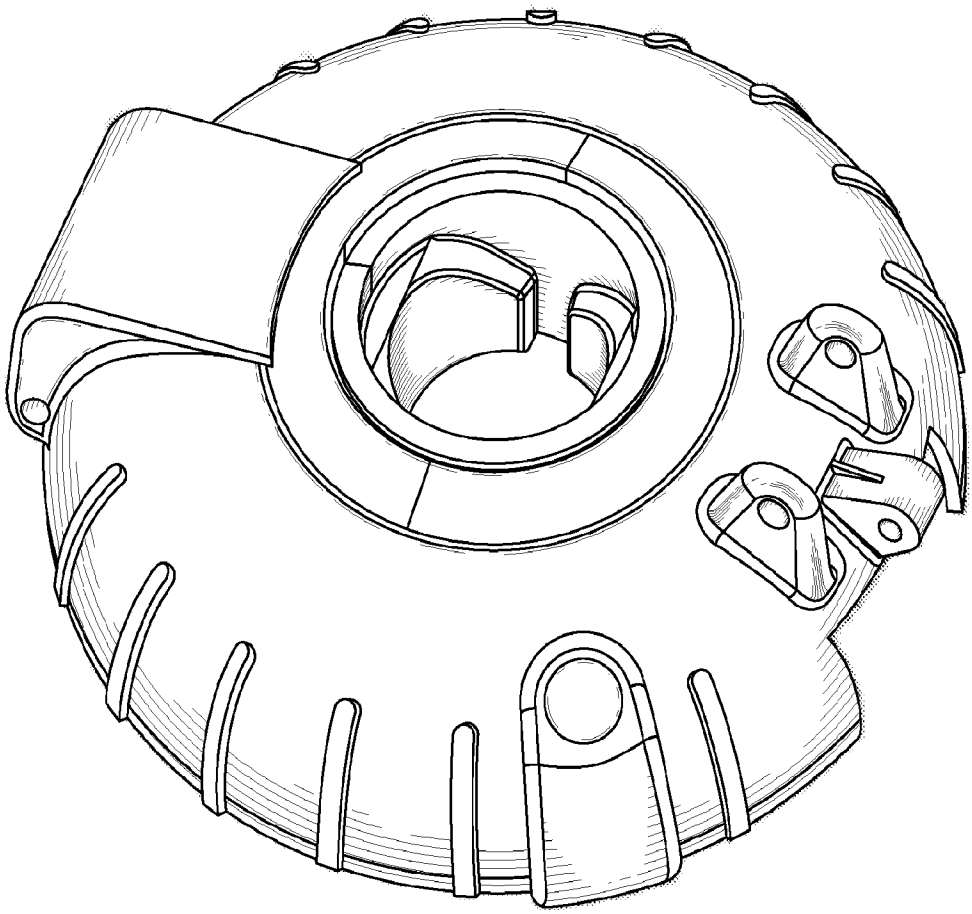

FIG. 4A

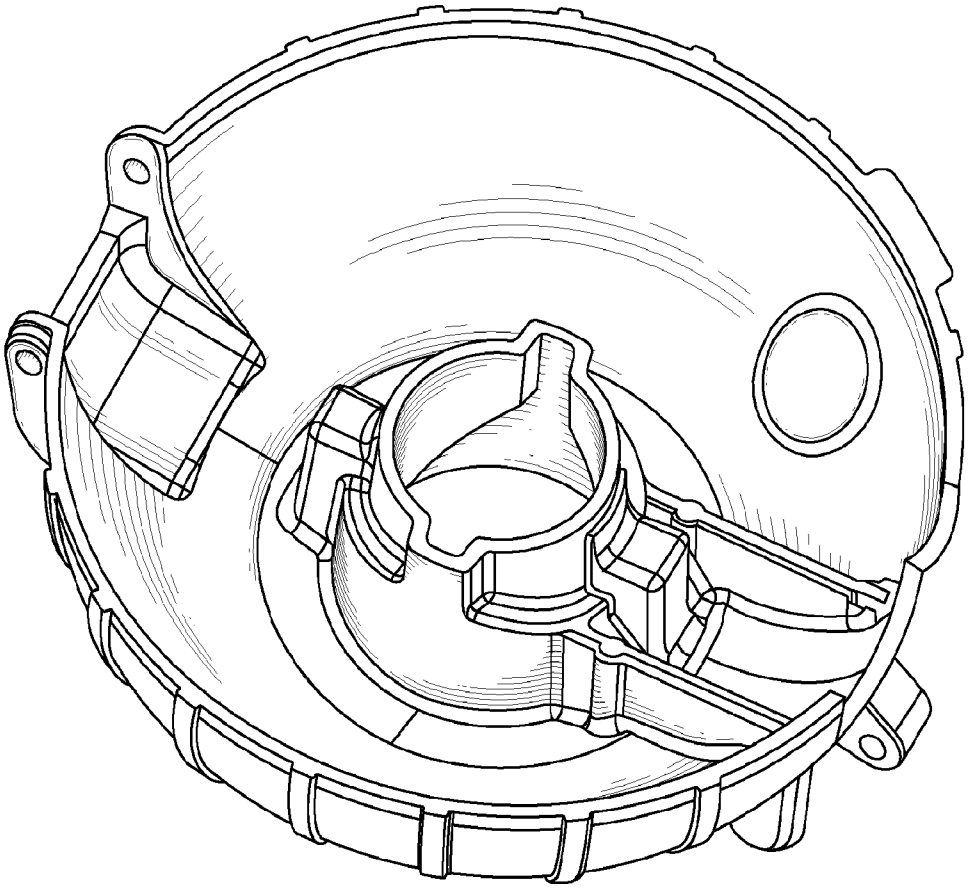

FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 23/12687

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. F16K 17/19, F16K 17/196, F16K 27/00, F16K 27/07, F16K 27/12, B65D 90/10 (2023.01)
ADD. B65D 90/34, B65D 90/22, B65D 90/32, F16K 24/00, F16K 24/04, F16K 24/06 (2023.01)

CPC - INV. F16K 17/19, F16K 17/196, F16K 27/00, F16K 27/07, F16K 27/12, B65D 90/10
ADD. B65D 90/105, B65D 90/34, B65D 90/22, B65D 90/32, F16K 24/00, F16K 24/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 2010/0044374 A1 (Thorwesten), 25 February 2010 (25.02.2010), entire document, especially Figs 1-11	11-15 --- 1, 4-5, 8-10, 16-20 --- 2-3, 6-7
Y --- A	US 9,764,893 B1 (Westmoreland , III), 19 September 2017 (19.09.2017), entire document, especially Figs 1-10C	1, 4-5, 8-10, 18-20 --- 2-3, 6-7
Y --- A	US 2013/0264341 A1 (ENARDO LLC), 10 October 2013 (10.10.2013), entire document, especially Figs 1-6	1, 4-5, 8-10 --- 2-3, 6-7
Y	CN 101870815 B (POLYMER SCI SHENZHEN NEW MAT), 28 December 2011 (28.12.2011), entire document,	8, 16-17
A	US 4,576,308 A (Sullivan), 18 March 1986 (18.03.1986), entire document	2-3, 19-20
A	US 2005/0199626 A1 (Gilbert et al), 15 September 2005 (15.09.2005), entire document,	7
A	US 3,401,647 A (Ingram), 17 September 1968 (17.09.1968), entire document	1-20
A	US 2016/0001934 A1 (Baier Marine Company, Inc), 07 January 2016 (07.01.2016), entire document	1-20

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 April 2023	MAY 02 2023
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 23/12687

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	'Fiberglass – Types, Properties, and Applications Across Industries' (Phelps), 24 July 2021 (24.07.2021), [online], retrieved from <URL:https://web.archive.org/web/20210724020519/https://www.phelpsgaskets.com/blog/fiberglass--types-properties-and-applications-across-industries>, entire document	1, 14, 15

INTERNATIONAL SEARCH REPORT

International application No.

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Continuation of CLASSIFICATION OF SUBJECT MATTER

IPC(8):
ADD. B65D 47/32, F16J13/24 (2023.01)

CPC:
ADD. F16K 24/06, B65D 47/32, F16J13/24