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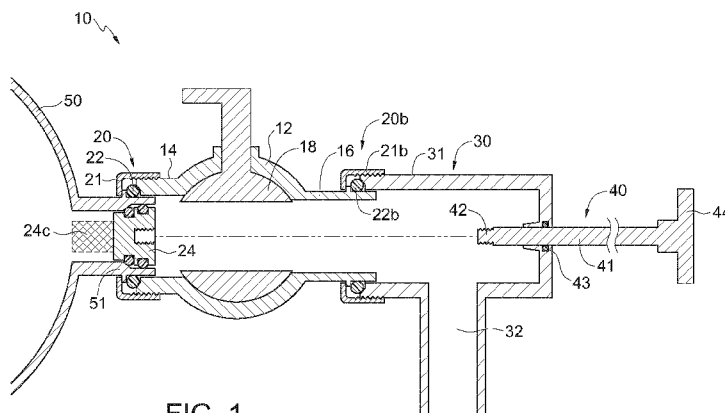


FIG. 1

(57) Abstract: An apparatus for servicing a tank, a plug, or both is provided. The apparatus comprises a valve having a first port sealingly couplable onto a tank port surrounding the plug, a second port, and a valve member operable between an open position providing a pathway between the first and second ports, and a closed position providing a sealed barrier between the first and second ports. The apparatus further comprises an adapter sealingly couplable to the second port, and a plug displacement tool couplable to the adapter for displacing the plug relative to the tank when the first port is coupled to the tank port, the adapter is coupled to the second port, and the valve member is in the open position. Methods for removing and installing a plug and servicing a tank are also provided.



## METHOD AND APPARATUS FOR SERVICING A TANK, A PLUG, OR A TANK AND PLUG

### TECHNICAL FIELD

[0001] The present disclosure is directed, at least in part, towards a method  
5 and apparatus for servicing a tank, a plug that seals the tank, or both the tank and the  
plug. The present invention also provides a method and apparatus for servicing a  
tank, a plug or both the tank and plug while preserving a pressure within the tank.

### BACKGROUND

[0002] Tanks are sealed enclosures used to store fuel and other fluids prior to  
10 being withdrawn for use in industrial processes. One example is a gas tank for an  
internal-combustion engine, where gasoline is stored before being drawn into a fuel  
system and vaporized into ignitable fuel for combustion by the engine. In the case of  
cryogenic fuels, double-walled tanks are often used, comprising an inner enclosure for  
holding liquefied fuel, and an outer enclosure surrounding the inner enclosure to form  
15 an insulation space therebetween. The insulation space can be kept at a vacuum level  
to prevent heat transfer with the fuel, which in turn prevents vaporization to keep the  
fuel in a liquefied state. For some applications, the tank, insulation space, or both, can  
be maintained under a positive pressure. A vacuum rated plug can be used to seal the  
tank contents or maintain the insulation space at the vacuum level. The plug can also  
20 be rated for maintaining a positive pressure. Over time however, the plug can require  
servicing due to scratches, indentations, or wear and tear on its seals. Servicing the  
plug can require removing it from the tank. Current methods for removing a vacuum  
rated plug however, involve pressurizing the tank with nitrogen gas, and pulling the  
plug in atmosphere, which exposes the tank and its contents to external contaminants  
25 and compromises the vacuum level in the tank. Analogous methods can be used to  
service a positive pressure rated plug in that the pressure within the tank can be  
brought to atmosphere prior to the plug being pulled, which exposes the tank and its  
contents to external contaminants.

**SUMMARY**

[0003] A method and apparatus for servicing a tank, a plug that seals the tank, or both the tank and the plug are described herein. Also described, is a method and apparatus for servicing a tank, a plug or both the tank and plug while preserving a  
5 pressure within the tank.

[0004] The present invention provides an apparatus for servicing a tank, a plug, or both, comprising: a valve assembly comprising a first port sealingly couplable onto a tank port surrounding the plug, a second port, and a valve member operable between an open position providing a pathway between the first and second  
10 ports, and a closed position providing a sealed barrier between the first and second ports; an adapter sealingly couplable to the second port; and a plug displacement tool couplable to the adapter for displacing the plug relative to the tank when the first port is coupled to the tank port, the adapter is coupled to the second port, and the valve member is in the open position. The adapter can further comprise an outlet port for  
15 removing or supplying air or a pressurized fluid.

[0005] The plug displacement tool of the apparatus described above can further comprise an attachment mechanism at a contact end for engagably coupling the plug to the contact end. The plug displacement tool can further comprise a handle at an opposite end to the contact end, and can comprise a substantially elongate rod of  
20 sufficient length for engagably coupling with the plug.

[0006] The valve assembly of the apparatus described above can be selected from the group of a ball valve, a gate valve, and a butterfly valve.

[0007] The present invention also provides a method (A) for removing a plug sealing a tank while also preserving a pressure within the tank, the method  
25 comprising:

i) sealingly coupling a first port of a valve assembly onto a tank port surrounding the plug, and sealingly coupling an adapter to a second port of the valve assembly, the adapter, the valve assembly, and the plug defining an interior cavity therebetween;

ii) pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity using an outlet port connected to, and in fluid communication with, the adapter;

5      iii) displacing the plug from the tank beyond a valve member of the valve assembly;

iv) actuating the valve member to a closed position to provide a sealed barrier between the first and second ports; and

v) decoupling the adapter from the second port to remove the plug.

[0008]      The present invention also provides a method (B) for servicing a tank  
10      while also preserving a pressure within the tank, the method comprising:

i) sealingly coupling a first port of a valve assembly onto a tank port surrounding a plug, and sealingly coupling an adapter to a second port of the valve assembly, the adapter, valve assembly, and the plug defining an interior cavity therebetween;

15      ii) pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity using an outlet port connected to, and in fluid communication with, the adapter;

iii) displacing the plug from the tank beyond a valve member of the valve assembly;

20      iv) actuating the valve member of the valve to a closed position to provide a sealed barrier between the first and second ports;

v) removing the plug from the adapter;

25      vi) introducing a servicing tool into the adapter, and sealing coupling the adapter to the second port of the valve assembly to define a secondary cavity between the valve member in closed position, the second port, and adapter.

vii) pressurizing the secondary cavity using the outlet port, and opening the valve member to provide access for the servicing tool to service the tank.

[0009] The tank can comprise a singled walled tank, a doubled wall tank, an insulation space outside of the tank or other multi-walled tank. If the pressure within the tank (either a single, double, or multi-walled tank) in methods (A) or (B) is a vacuum, then the step of pressurizing the interior cavity comprises removing fluid, such as air, from the interior cavity sufficient to maintain a standing vacuum within the interior cavity. Alternatively, the pressure within the tank (either a single, doubled, or multi-walled tank) can be a positive pressure, then the step of pressurizing the interior cavity comprises adding fluid, such as air, into the interior cavity sufficient to maintain the required pressure within the interior cavity.

10 [0010] The present invention also provides the method (A) or method (B) as described above, wherein the step of displacing is performed with a plug displacement tool. The plug displacement tool can be a substantially elongate rod with attachment mechanism, and the method can further comprise a step of engagably coupling the plug to the elongate rod prior to the step of displacing the plug from the tank. The valve can be a two port valve, and selected from the group of a ball valve, a gate valve, or a butterfly valve.

[0011] The method (A) can further comprises a step of decoupling the plug from the plug displacement tool prior to a step of decoupling the adapter.

20 [0012] The present disclosure also provides a method (A) or (B) as described above, further comprising a step of servicing the plug through inspection, cleaning, conditioning, patching, bonding, replacing seals, or replacing the plug.

[0013] The present disclosure provides a method (B) as described above, wherein the tank servicing tool is selected from the group of a cleaning tool, a stereoscope, a camera, a radiation emitting device, and a sampling device.

25 [0014] The present invention also provides the method (A) as described above, further comprising installing the plug by:

vi) introducing the plug into the adapter, and sealingly coupling the adapter to the second port of the valve assembly, to define a secondary cavity between the valve member in closed position, the second port, and adapter

vii) pressurizing the secondary cavity using the outlet port and actuating the valve member of the valve assembly to an open position to provide a pathway between the first and second ports; and

viii) installing the plug into the tank port.

5 [0015] The method (A) as just described can further comprise a step (step ix) of removing the valve assembly from the tank port.

[0016] The present invention also provides a method (B) as described above further comprising installing the plug by:

ix ) withdrawing the servicing tool from the tank and past the valve assembly;

10 x) actuating the valve member of the valve to a closed position to provide a sealed barrier between the first and second ports;

xi) removing the servicing tool from the adapter and introducing the plug into the adapter to define a secondary cavity between the valve member in closed position, the second port, and adapter;

15 xii) pressurizing the secondary cavity using the outlet port and actuating the valve member of the valve assembly to an open position to provide a pathway between the first and second ports; and

xiii) installing the plug into the tank port.

[0017] The method (B) as just described can further comprise a step (step xiv)  
20 of removing the valve assembly from the tank port.

[0018] The present invention also provides a method (C) of removing a plug installed in a port of a vessel, the plug employed to preserve a pressure of an interior space on one side of the plug comprising:

25 i) creating an enclosing space on a second side of the plug opposite the one side of the plug, such that a pressure of the enclosing space equals the pressure of the interior space within a predetermined range;

ii) removing the plug from the port away from the interior space whereby the pressure of the interior space remains within said predetermined range;

iii) isolating a portion of the enclosing space containing the plug from the interior space; and

5 iv) exposing the plug to atmosphere;

wherein the pressure of the interior space remains within the predetermined range.

[0019] As described herein, the present invention provides an apparatus and method for removing a plug from a tank, servicing the tank, or a combination thereof, while at the same time maintaining the pressure present within the tank. The tank can  
10 be a single walled tank, a double walled tank, or a multi-walled tank, the volume comprising the pressure can be an insulation space surrounding the tank. By maintaining pressure within the tank prior to plug removal and during servicing, adverse effects associated with altering the pressure of the tank are reduced. Such adverse effects associated with altered pressure can include vaporization of fuel that is  
15 in a liquefied state, exposing the tank and its contents to external contaminants, compromising the vacuum level in the tank.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0020] Figure 1 is a cross-sectional side view of an apparatus for servicing a plug or a tank, according to an embodiment.

20 [0021] Figure 2 is a cross-sectional side view of an apparatus for servicing a plug or a tank, according to another embodiment.

[0022] Figure 3 is a cross-sectional side view of an apparatus for servicing a plug or a tank, according to another embodiment.

[0023] Figure 4 is a flow chart illustrating a method for removing a plug on a  
25 tank for servicing, according to an embodiment.

[0024] Figure 5 is a flow chart illustrating a method for installing a serviced plug onto a tank, according to an embodiment.

**DETAILED DESCRIPTION**

[0025] An apparatus and method for servicing a tank, a plug that seals the tank, or both the tank and the plug while at the same time preserving a pressure within the tank, are described herein.

5 [0026] The pressure can be a positive pressure (for example, above atmospheric pressure), or a negative pressure (for example, a vacuum pressure below atmosphere), that is maintained in the tank, the insulation space, for example of a double-walled tank, or both the tank and the insulation space. The apparatus can be used on conventional fuel tanks and double-walled, or multi-walled tanks, and allows  
10 for removal and installation of the plug without exposing the tank contents and interior, insulation space, or both the tank interior and insulation space to atmosphere. Following removal of the plug, the plug can be serviced through inspection, repair, replacement, or a combination thereof. The tank can also be serviced through inspecting, cleaning, or repairing the tank interior, or by sampling the tank contents,  
15 while the plug is removed. After servicing any or both of the plug and tank, the plug can be installed back onto the tank using the apparatus while still maintaining the original pressure in the tank. Accordingly, the disclosed apparatus and method precludes the need to expose the tank interior, insulation space or both the tank interior and the insulation space to atmospheric conditions, which could contaminate  
20 its contents, or compromise the pressure level in the tank interior or insulation space.

[0027] Referring to Fig. 1, apparatus 10 is shown for servicing tank 50 and plug 24 installed on tank 50 while also preserving a vacuum within tank 50. However, it is to be understood that a similar apparatus can also be used to preserve a positive pressure within tank 50 as required.

25 [0028] Apparatus 10 comprises valve or valve assembly 12 (for example, a vacuum valve), and a valve operator comprising adapter 30 (for example a vacuum adapter), and plug displacement tool 40. Valve assembly 12, for example a vacuum valve, comprises first port 14, second port 16, and valve member 18. First port 14 is sealingly couplable to tank 50 through fitting 20 (for example a vacuum fitting).  
30 Valve member 18 is operable between an open position which permits a fluid pathway between first and second ports (14, 16), and a closed position that provides a

sealed barrier between first and second ports (14, 16). An adapter 30, for example a vacuum adapter, comprises inlet 31 sealingly couplable to second port 16 of valve 12, and outlet 32. Plug displacement tool 40 comprises elongate rod 41 with attachment mechanism 42 at a contact end, and handle 44 on an end opposite contact end. Any attachment mechanism can be used for example but not limited to, a ball and socket connection, a snap-fit connection, a hook and loop connection, a magnet, a threaded receptor, a clamp, a pressure clip or key removal tool, or a combination thereof, as would be known in the art. As shown in Fig. 1, elongate rod 41 extends through an aperture of adapter 30, and is slidingly and sealingly coupled to adapter 30 via seal 43. Seal 43 can be any suitable seal, for example an O-ring, gasket, grease, or other seal, for example a bellow arrangement between tool 40 and adapter 30 can be employed, as would be known to one of skill in the art. The dimensions of elongate rod 41 can vary according to the size and shape of adapter 30 and valve assembly 12, but has a sufficient length for engagably coupling plug 24 when sliding through the aperture. When first port 14 of valve 12 is coupled to tank 50 to surround plug 24, and adapter 30 is coupled to second port 16, the longitudinal axis of elongate rod 41 is substantially axially aligned with the outer plane of plug 24 to displace plug 24. It is noteworthy that plug 24 is shown for a negative pressure application in Fig. 1, as well as in Figs. 2 and 3, whereby pressure external to tank 50 secures plug 24 to tank port 51. When plug 25 is employed in a positive pressure application plug 24 would be secured to tank port 51 by way of a mechanical securing apparatus (not shown) such that the positive pressure inside tank 50 does not force plug 24 out of tank port 51.

#### Plug Removal

[0029] Still referring to Fig. 1, the first step in servicing tank 50 or plug 24 involves removal of plug 24. To do this, first port 14 of valve 12 is sealingly coupled onto tank port 51 surrounding plug 24. Plug 24 comprises seals on its circumference for example an O-ring, a gasket, grease, or other seal, for example a bellow arrangement between tool 40 and adapter 30 can also be employed, as would be known to one of skill in the art, and is press-fit inside tank port 51 of tank 50 to form a sealed barrier across tank port 51 for maintaining a pressure in the insulation space of tank 50. Pressure fitting 20, such as a slip nut fitting comprising nut portion 21 with internal threads, and a seal 22 for example an O-ring or other seal as described above,

is used to sealingly couple first port 14 to tank port 51. As nut portion 21 is screwed onto corresponding external threads of first port 14, it compresses seal 22, which radially expands to engage a groove (not shown) on the outer circumference of the tank port 51 to couple tank 50 and first port 14 together and provide a sealing engagement sufficient for maintaining positive or negative pressures inside tank 50. Inlet 31 of adapter 30 is also sealingly coupled onto second port 16 of valve 12 with another pressure fitting 20b comprising nut portion 21b and seal 22b. As shown in Fig. 1, an interior cavity is defined between plug 24, valve 12, and adapter 30, which is a singular continuous cavity when valve member 18 is in the open position to provide a fluid pathway between first and second ports (14, 16).

[0030] If a vacuum is to be maintained, air is removed from the adapter 30 via outlet 32 prior to valve 12 being opened. When valve 12 is opened air can be removed from the whole of the interior cavity, via outlet 32 of adapter 30 to maintain a standing vacuum in the interior cavity. The standing vacuum can comprise a pressure equal to or lower than the vacuum in tank 50 (for example, the vacuum level in the insulation space) in order to at least preserve the original vacuum level in tank 50.

[0031] Once a standing vacuum is maintained in the interior cavity, plug 24 is displaced from tank 50 with plug displacement tool 40. As will be explained below, plug 24 is displaced beyond valve member 18 towards adapter 30. When valve member 18 is in the open position as shown in Fig. 1, elongate rod 41 can slide through the interior cavity via sliding coupling with seal 43 to engagably couple plug 24 through attachment means 42. While attachment means 42 can comprise any known means sufficient to engagably couple elongate rod 41 to plug 24, it is shown in Fig. 1 as a threaded coupling that screws into a corresponding threading on plug 24. Once coupled, plug 24 can be displaced by simply pulling handle 44 to pull plug 24 away from tank port 51 of tank 50.

[0032] Once plug 24 has been displaced beyond valve member 18, valve member 18 can be actuated to the closed position to provide a vacuum sealed barrier between first and second ports (14, 16). In this way, valve 12 acts to seal tank port 51 to maintain the vacuum within tank 50 in place of plug 24. As valve assembly 12 now directly seals tank port 51, plug 24 can be removed for servicing by decoupling adapter 30 from second port 16, and detaching, for example unscrewing, plug 24 from

the elongate rod 41. Servicing can comprise inspection of plug 24 for damage or wear, testing or replacement of seals, patching, bonding, or conditioning of plug 24 surface, or replacement of plug 24.

[0033] By defining an interior cavity next to plug 24 prior to removal of the  
5 plug, using valve 12 and adapter 30, and then removing air from the interior cavity to maintain a standing vacuum, an isolated vacuum chamber is formed outside plug 24 allowing it to be displaced without compromising the vacuum inside tank 50 or exposing tank 50 contents to external contamination. Accordingly, after displacing  
10 plug 24 beyond valve member 18, valve member 18 can be actuated to the closed position to directly seal tank port 51 and maintain the vacuum level inside tank 50. This procedure allows plug 24 to be removed for servicing without compromising the vacuum level of tank 50, including the insulation space within tank 50.

[0034] As noted above, in some embodiments tank 50 can define a space for  
15 holding a fluid at a positive pressure and apparatus 10 can also be used to service plug 24 when installed in such tanks, allowing for removal and installation of plug 24 without compromising the positive pressure level inside tank 50. In such  
20 embodiments, removal of plug 24 is performed analogously to that described above for tank 50 with a negative pressure environment, except instead of removing air from the interior cavity, or if required, in addition to removing air from the interior cavity, a  
25 pressurized fluid is added to form a standing pressure in the interior cavity. This can be accomplished by adding pressurized fluid through outlet 32 of adapter 30 with a compressor or pump (not shown). The pressurized fluid can comprise an inert gas, such as nitrogen or helium, or can comprise the same fluid stored in tank 50, or insulation space where for example a double walled tank is employed, (not shown).  
When the standing pressure has been maintained in the interior cavity, plug 24 can be displaced, and valve member 18 can be actuated to the closed position to directly seal tank port 51 and maintain the positive pressure level inside tank 50, including insulation space, or other multi-walled space within tank 50.

#### Tank and Plug servicing

30 [0035] After removal of plug 24, it can be inspected or serviced as required. Plug servicing can comprise cleaning plug 24, conditioning or patching of plug 24

surface, replacement of plug 24 seals or rings, or any combination thereof. Plug 24 can also be replaced in the case of severe damage or wear.

[0036] Tank 50 interior, including insulation space, or other multi-walled space, can also be inspected or serviced while plug 24 has been removed with apparatus 10. To service tank 50, plug displacement tool 40 can be replaced with tank servicing tool (not shown) and coupled to adapter 30. Inlet 31 of adapter is then sealingly coupled to second port 16 of valve 12 with fitting 20b. This defines a secondary cavity between valve member 18 in closed position, second port 16, and adapter 30. The secondary cavity is then pressurized, or for negative pressure applications, air can be removed, via outlet 32 to maintain a secondary pressure inside the secondary cavity. Once secondary pressure has been maintained in the secondary cavity, valve member 18 is actuated to the open position to provide a pathway between second port 16 and first port 14, to allow tank servicing tool to enter through tank port 51 to access tank 50 interior for inspection or servicing.

[0037] As will be further described below, the secondary cavity provides a sealed and isolated environment, that when sufficiently pressurized, allows valve member 18 to actuate back to the open position without compromising the pressure inside tank 50 or exposing its contents to external contamination. When valve member 18 is actuated to the open position, tank servicing tool can be inserted through the open pathway created between first and second ports (14, 16) to inspect or service tank 50 interior. After the tank has been serviced, tank servicing tool can be withdrawn from tank 50, and valve member 18 can be actuated to the closed position to seal the tank port 51 and preserve the tank 50 pressure. Accordingly, apparatus 10 allows servicing of tank 50 without compromising the pressure level maintained in tank 50, or exposing tank 50 contents to external contamination. As will be described later below, after servicing tank 50, the tank servicing tool can be replaced by plug displacement tool 40 for installing serviced plug 24 back into tank 50. In alternate embodiments adapter 30 is removed when valve 12 is closed and an assembly dedicated to the servicing tool is coupled to second port 16 with fitting 20b. The service tool assembly can have an outlet similar to outlet 32 to maintain the desired condition in the secondary cavity so that valve 12 can be opened to allow the service tool to enter tank 50.

[0038] Similar to when removing plug 24, tank servicing can be performed with apparatus 10 when tank 50 maintains either a positive or a negative pressure. For negative pressure applications, the step of pressurizing the secondary cavity comprises removing air from the secondary cavity, and the secondary pressure  
5 comprises a pressure equal or less than the pressure in tank 50. For positive pressure applications, the step of pressurizing the secondary cavity comprises injecting pressurized fluid into the secondary cavity, and the secondary pressure comprises a positive pressure equal to or greater than the pressure in tank 50.

[0039] Tank servicing tool can comprise plug displacement tool 40 or an  
10 extension device, with a servicing device coupled (not shown). Servicing device can comprise any device used for performing a specific servicing task. For example, the servicing device can comprise a cleaning tool for cleaning the tank port 51, or tank 50 interior, including the insulation space. Servicing device can also comprise a stereoscope or camera for inspecting the tank 50 insulation space. Servicing device  
15 can also comprise a tank treatment, for example but not limited to a treatment using a radiation emitting device, such as a UV source, for disinfecting tank 50 or energizing contaminants inside the tank 50 to be later absorbed by reactive material such as a getter, as would be known to one of skill in the art. Servicing device can also  
20 comprise a sampling device used to sample tank 50 contents, including any contaminants inside tank 50.

[0040] In certain embodiments, sampling can also be performed using apparatus 10 without any specific servicing device. For example, after removing plug 24 as described above, gasses in tank 50 will expand into the interior cavity. Plug 24 can be reinserted into tank port 51 to seal tank 50, and valve member 18 can be  
25 actuated to closed position to capture gasses from tank 50 in the secondary cavity between valve member 18 in closed position, second port 16, and adapter 30. First port 14 of valve 12 can then be uncoupled from tank port 51, and apparatus 10 can be brought to an analyzer to analyze trapped gases in the secondary cavity. Outlet 32 can be used to transfer gases from the secondary cavity to the analyzer, and can have a  
30 valve (not shown) attached for facilitating transfer.

#### Plug Installation

[0041] To re-install plug 24, and with reference to Fig. 1 where tank 50 is maintaining, for example a vacuum environment, plug 24 is attached to, for example screwed onto the threading of, elongate rod 41. The plug displacement tool 40 is inserted within adapter 30, and inlet 31 of the adapter 30 is then aligned with second port 16 such that removed plug 24 is aligned between the tank port 51 and the adapter 30. Inlet 31 is then sealingly coupled to second port 16 with fitting 20b. A secondary cavity is now defined between valve member 18 in closed position, second port 16, and adapter 30. Air can be removed from secondary cavity via outlet 32 in order to maintain a secondary vacuum inside the secondary cavity. Similar to when removing plug 24, the secondary vacuum can also comprise a pressure equal to or lower than the vacuum inside tank 50 to at least preserve its original vacuum level. Once a secondary vacuum is maintained within the secondary cavity, valve member 18 is actuated to the open position to provide a pathway between second port 16 and first port 14, and expose plug 24 to tank port 51. The elongate rod 41 can slide through valve 12 to install plug 24 back into tank port 51 to seal the tank 50 and maintain its vacuum. Elongate rod 41 can then be detached, for example unscrewed, from installed plug 24 by turning handle 44, and first port 14 can be uncoupled from tank port 51 to remove apparatus 10 from tank 50.

[0042] Similar to the interior cavity, the secondary cavity also provides a pressure sealed environment that allows valve member 18 to actuate back to the open position without compromising the vacuum within tank 50 or exposing its contents to external contamination. Actuating valve member 18 to the open position provides an open pathway between first and second ports (14, 16) to install serviced plug 24 back into tank port 51. Once installed into tank port 51, plug 24 directly seals tank 50 in place of valve 12. First port 14 can then be uncoupled from tank port 51 to remove apparatus 10 from tank 50. Accordingly, apparatus 10 allows plug 24 to be serviced without compromising the pressure level maintained in tank 50, or exposing tank 50 contents to external contamination. Sometimes plug seals can deteriorate or be otherwise compromised causing the pressure level in tank 50 to be higher than desired in the case of a negative pressure space (or lower than desired in the case of a positive pressure space). This is often the reason for requiring removal, inspection and servicing of plug 24. In such cases prior to re-installation of plug 24, the apparatus 10 can be employed to restore pressure in tank 50 to the desired pressure.

[0043] As would be understood the same method as just described can also be performed using a positive pressure in place of a vacuum.

[0044] Referring to Fig. 2, shown is another example of apparatus 10 similar to that of Fig. 1, and also operable to service plug 24 in tank 50 and maintain a negative or positive pressure environment. However, the embodiment in Fig. 2 differs in that fittings 20c and 20d comprise flange fittings, adapter 30 comprises a substantially planar plate, and outlet 32 has been relocated to second port 16 of valve 12. Flange fittings 20c and 20d comprise clamps 23c and 23d, and seals 22c and 22d, such as an O-ring, diaphragm, or the like. As shown in Fig. 2, flange fittings are used to sealingly couple flange 14a of first port 14 to flange 51a of tank port 51, and adapter 30 to flange 16a of second port 16. Seal 22c is provided between tank flange 51a and flange 14a of first port 14, and seal 22d is provided between flange 16a of second port 16 and adapter 30. Clamp 23c is then positioned over flanges 51a, 14a, and tightened to compress seal 22c and lock flanges 51a, 14a together to provide a vacuum sealed coupling between tank 50 and first port 14. Similarly, clamp 23d is also positioned over flange 16a of second port, and adapter 30, and tightened to compress seal 22d therebetween and provide a vacuum sealed coupling between second port 16 and adapter 30. As shown in Fig.2, flange fittings can be used to provide a vacuum or pressure rated sealed coupling between respective flanges or coupling points, and provides greater structural rigidity and reliability than slip nut fitting. Flange fittings 20c and 20d can comprise any suitable vacuum or pressure rated flange fitting for example but not limited to KF flanges, CF flanges, threaded flanges, mechanically secured flanges for example, bolted flanges as would be known to one of skill in the art. Also, use of a substantially planar adapter 30, and relocation of outlet 32 to second port 16, allows apparatus 10 to be reduced to a smaller form-factor while having the same overall functionality and performance to that shown in Fig. 1. Flange fitting 20d can also facilitate a more modular design for removing plug displacement tool 40 and installing a servicing tool module for use to service tank 50, and then removing the servicing tool and replacing plug displacement tool 40 to reinstall plug 24.

[0045] Referring to Fig. 3 is yet another example of an apparatus 10, having features similar to that shown in Figs. 1 and 2. However, the embodiment in Fig. 3

differs in that valve 12b comprises a gate valve with valve member 18b comprising a movable gate. Tank flange 51e is removable and sealingly coupled to tank port 51 via slip nut fitting 20 illustrating that apparatus 10 can comprise adapter couplings for attachment to tanks with different coupling means. If tank 50 had a flanged coupling, then flange 14e could be coupled directly to tank 50. Plug 24 further comprises getter material 24c mounted on its side that sits inside tank 50 when installed. Getter material 24c comprises a deposit of reactive material that combines or absorbs molecules striking the getter material 24c to help achieve and maintain a vacuum environment. Accordingly, when plug 24 seals a vacuum insulation space use of getter material 24c on plug 24 can remove small amounts of gas from the insulation space of tank 50. Plug 24 in the embodiments of FIGS. 1 and 2 can also comprise getter material 24c. Getter material 24c can be removed from tank 50 by way of apparatus 10 for inspection and/or replacement, or getter material 24c can be added by way of apparatus 10 to tank 50.

[0046] While particular examples of apparatus 10 are shown above, it is understood that many variations known to those skilled in the art are possible, and included in other embodiments. For example, valves 12 and 12b can comprise any one of a number of suitable vacuum rated, or positive pressure rated, valves including a ball valve, a gate valve, a butterfly valve, or any other suitable type of valve having a similar function to that described above. Attachment mechanism 42 can comprise any one of a number of mechanism used to sufficiently couple displacement tool 40 to plug 24, including a ball and socket connection, a snap fit connection, a hook and loop connection, an adhesive connection, magnetic, clip, clamp, or any other type of mechanical connection capable of performing the same function. Plug displacement tool 40 can comprise a telescopic rod, a flexible arm, a lever, a torque multiplier extraction tool, an electrically assisted extraction tool, or any pneumatic or hydraulic device sufficient to displace the plug 24. Adapter 30 can also comprise a tee fitting. Fittings 20, 20b, 20c, 20d, 20e, 20f can also comprise any one of a pipe clamp, a bayonet clamp, a threaded coupling, a bolted flange connection, or any other type of device sufficient to provide a sealed vacuum or pressure rating coupling. Seal 43 can comprise a bellows for sealingly coupling adapter 30 to plug displacement tool 40. Plug 24 can comprise threading for screwing into tank port 51, or can be mechanically attached to tank port 51 in order to fasten plug 24 when tank 50 maintains a positive

pressure. Finally, the step of removing air or adding pressurized fluid to the interior cavity or secondary cavity (via outlet 32) can be performed through any suitable device, such as a high pressure vacuum pump, compressor, or injector, that can remove air or add fluid to maintain a sufficient pressure level. All of these variations  
5 are known to one skilled in the art and are included in alternative embodiments not shown above.

[0047] Referring to Fig. 4, a flow chart is provided that describes a method 100 for removing plug 24 for servicing while maintaining a pressure in a tank 50. Method 100 is described in relation to FIGS. 1 and 2 and a similar method is  
10 understood with reference to FIG. 3. At step 110, first port 14 of valve 12 is sealingly coupled to tank port 51 surrounding plug 24; at step 120, adapter 30 is sealingly coupled to second port 16 of valve 12, thereby defining an interior cavity between plug 24, valve 12, and adapter 30 when valve member 18 is in an opened position; at  
15 step 130, the interior cavity is pressurized to maintain a standing pressure in the interior cavity; at step 140 plug 24 is displaced from tank 50 beyond the valve member 18 of valve 12; at step 150 valve member 18 is actuated to a closed position to provide a sealed barrier between first and second ports (14, 16); and at step 160, adapter 30 is decoupled from second port 16 to expose displaced plug 24 for servicing or replacement.

20 [0048] As described above, the pressure in tank 50 can be a positive or negative pressure. Accordingly, for negative pressure applications, the step of pressurizing the interior cavity comprises removing air from the interior cavity, and the standing pressure comprises a vacuum pressure equal or less than the original pressure in tank 50. For positive pressure applications, the step of pressurizing the  
25 interior cavity comprises injecting pressurized fluid into the interior cavity, and the standing pressure comprises a positive pressure equal to or greater than the original pressure in tank 50. Furthermore, the step of displacing plug 140 can be performed through plug displacement tool 40. Plug displacement tool 40 can comprise elongate rod 41 with a male or female threading as attachment means 42 for coupling onto a  
30 corresponding threading on plug 24. Adapter 30 can comprise outlet 32 by which interior cavity can be pressurized by connection to a pump, compressor, or any suitable vacuum device to pressurize the interior cavity to the standing pressure.

[0049] Referring to Fig. 5, a flow chart is provided that describes a method 200 for installing plug 24, which can be performed after removing plug 24 via method 100 in Fig. 4 and servicing plug 24. Method 200 is described in relation to FIGS. 1 and 2 and a similar method is understood with reference to FIG. 3. At step 210, plug 24 is aligned between the valve member 18 and adapter 30; at step 220 the adapter 30 is sealingly coupled to second port 16 of valve 12 to thereby define a secondary cavity between adapter 30 and valve member 18 in closed position which encloses aligned plug 24; at step 230, the cavity is pressurized to sufficiently maintain a secondary pressure substantially the same as the pressure in tank 50 or the opposite side of valve 12; at step 240, valve member 18 is actuated to an open position to provide a pathway between first and second ports (14, 16); and at step 250, plug 24 is installed into tank port 51. Apparatus 10 can be optionally removed from tank 50 at step 260 by decoupling first port 14 from tank port 51, or decoupling adapter 30 from second port 16.

[0050] Similar to that described for removing plug 24, method 200 for installing plug 24 can apply to tank 50 having either positive or negative pressures. For negative pressure applications, the step of pressurizing the secondary cavity comprises removing air from the secondary cavity, and the secondary pressure comprises a pressure equal or less than the pressure in tank 50. For positive pressure applications, the step of pressurizing the secondary cavity comprises injecting pressurized fluid into the secondary cavity, and the secondary pressure comprises a positive pressure equal to or greater than the pressure in tank 50. In certain embodiments, at step 210, plug 24 can be aligned by screwing plug 24 onto elongate rod 41 coupled to adapter 30. At step 250, plug 24 can be installed onto tank 50 by sliding elongate rod 41 to position plug 24 into tank port 51. The method 200 can further comprise decoupling plug 24 from displacement tool 40 prior to decoupling apparatus 10 from tank 50 in optional step 260.

[0051] The disclosed method and apparatus 10 allows tank 50 and plug 24 to be serviced by conveniently removing plug 24 from tank 50 without exposing contents held within tank 50 to external contaminants or atmospheric pressures. Accordingly, the tank pressure level can be maintained during servicing, which can extend the life of the tank, and can reduce repair and servicing costs. The method and

apparatus 10 can also reduce the need for inert gases, such as Nitrogen, that can otherwise be required for introduction into tank 50 when plug 24 is directly removed in atmosphere. After servicing tank 50 or plug 24, apparatus 10 can be used to install plug 24 into tank 50 without compromising the tank pressure level or exposing the  
5 tank contents to external contaminants or atmospheric pressure.

[0052] While particular embodiments have been described in the foregoing, it is to be understood that other embodiments are possible and are intended to be included herein. It will be clear to any person skilled in the art that modifications of and adjustments to the foregoing embodiments, not shown, are possible. The scope of  
10 the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

**CLAIMS**

1. An apparatus for servicing a tank, a plug, or both, comprising:
  - a. a body with a first port couplable onto a tank port associated with the plug, and a second port opposite to the first port;
  - 5       b. a valve proximal to the first port, comprising a valve member operable to an open position providing a pathway between the first and second ports in which the pathway is sized to allow passage of the plug therethrough, and a closed position providing a sealed barrier between the first and second ports; and
  - 10       c. a plug displacement tool associated with the second port, the plug displacement tool comprising a member that is extendable through the opening to engage with the plug for removal or re-installation of the plug in the tank port.
2. The apparatus of claim 1 wherein said second part comprises a sealable opening  
15 that can be opened to access an attachment mechanism of said plug displacement tool to remove said plug therefrom, or to attach a serviced or new plug for re-installation.
3. The apparatus of claim 1 wherein said body is separable into two parts, with a first part comprising a coupling for attachment to said tank port and a housing for said valve; and a second part providing an adapter in the form of a housing for said plug  
20 displacement tool.
4.       The apparatus of claim 3 wherein the plug displacement tool comprises an attachment mechanism at a contact end for engagably coupling the plug to the contact end.
5.       The apparatus of claim 4 wherein the plug displacement tool further comprises  
25 a handle at an opposite end to the contact end.
6.       The apparatus of any one of claims 3 to 5 wherein the plug displacement tool is a substantially elongate rod of sufficient length for engagably coupling with the plug when said apparatus is coupled to said tank port.

7. The apparatus of any one of claims 4 to 6 wherein the attachment means comprises a male or female threading.
8. The apparatus of any one of claims 6 to 7 wherein a longitudinal axis of the elongate rod is substantially axially aligned with the plug when the first port is coupled to the tank port and the adapter is coupled to the second port.
9. The apparatus of any one of claims 6 to 8 wherein the elongate rod is slidingly coupled to the adapter and is slidable for engagably coupling with the plug, and for displacing plug when engagably coupled.
10. The apparatus of any of claims 3 to 9 wherein the adapter comprises an outlet port for removing or supplying air or a pressurized fluid.
11. The apparatus of any of claims 3 to 10 wherein the valve is a two port valve.
12. The apparatus of any one of claims 3 to 11 wherein the valve is selected from the group of a ball valve, a gate valve, and a butterfly valve.
13. The apparatus of any one of claims 3 to 12 further comprising fittings for sealingly coupling the adapter to the second port, and the tank port to the first port.
14. The apparatus of claim 13 wherein the fittings are selected from the group consisting of a slip nut adapter, a pipe clamp, a bayonet clamp, a KF flange clamp, a CF flange clamp, a threaded coupling, and a bolted flange connection.
15. The apparatus of claim 3 wherein the apparatus services a getter material connected with the plug.
16. A method for removing a plug from a sealing tank while preserving a pressure within the tank, the method comprising:
- sealingly coupling a first port of a valve onto a tank port surrounding the plug;
  - coupling an adapter to a second port of the valve to form a seal between the adapter and the second port, the adapter, valve, and the plug defining an interior cavity therebetween;

- pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity;
- displacing the plug from the tank beyond a valve member of the valve;
- actuating the valve member of the valve to a closed position to provide a  
5 sealed barrier between the first and second ports; and
- decoupling the adapter from the second port to remove the plug.

17. The method of claim 16 wherein a getter material is connected with the plug and the plug is removed from the tank such that the getter material can be inspected or replaced.
- 10 18. The method of claim 16 wherein the pressure within the tank is a vacuum, and the step of pressurizing the interior cavity comprises removing air from the interior cavity sufficient to maintain a standing vacuum within the interior cavity.
19. The method of any one of claims 16 to 18 wherein the step of displacing the plug from the tank is performed with a plug displacement tool.
- 15 20. The method of claim 18 wherein the plug displacement tool is a substantially elongate rod with attachment mechanism, and the method further comprises engagably coupling the plug to the elongate rod prior to the step of displacing the plug from the tank.
21. The method of claim 20 wherein the plug comprises a male or female  
20 threading, and the attachment means comprises a corresponding threading.
22. The method of any one of claims 20 to 21 wherein the elongate rod is slidingly coupled to the adapter, and the plug is displaced by sliding the elongate rod away from the tank when engagably coupled to the plug.
23. The method of any one of claims 16 to 22 wherein the adapter comprises an  
25 outlet port, and the interior cavity is pressurized to a standing pressure through the outlet port.
24. The method of any one of claims 16 to 23 wherein the valve is a two port valve.

25. The method of any one of claims 16 to 22 wherein the valve is selected from the group of a ball valve, a gate valve, or a butterfly valve.
26. The method of claim 18 wherein the standing vacuum comprises a pressure equal to or lower than the vacuum within the tank.
- 5 27. The method of any one of claims 16 to 26 wherein fittings are used for sealingly coupling the adapter to the second port, and the tank port to the first port.
28. The method of claim 27 wherein the fittings are selected from the group consisting of a slip nut adapter, a pipe clamp, a bayonet clamp, a KF flange clamp, a CF flange clamp, a threaded coupling, and a bolted flange connection.
- 10 29. The method of claim any one of claims 16 to 28 further comprising installing the plug by:
- introducing the plug into the adapter, and aligning the plug between the valve member and the adapter;
- sealingly coupling the adapter to the second port of the valve to define a  
15 secondary cavity between the adapter and the valve member that encloses the plug;
- pressurizing the secondary cavity to sufficiently maintain a secondary pressure within the secondary cavity;
- actuating the valve member of the valve to an open position to provide a  
20 pathway between the first and second ports; and
- installing the plug into the tank port.
30. The method of claim 29 wherein the pressure within the tank is a vacuum, and the secondary pressure comprises a pressure equal to or lower than the vacuum within the tank.
- 25 31. The method of any of claims 29 to 30 further comprising decoupling the plug from the plug displacement tool prior to the step of decoupling the first port from the tank.

32. The method of any of claims 29 to 31 wherein the step of aligning the plug between the valve member and the adapter comprises coupling the plug to the plug displacement tool.
33. The method of any of claims 29 to 32 wherein the step of installing the plug onto the tank is performed with the plug displacement tool.
34. The method of claim any one of claims 16 to 28 further comprising servicing the plug through inspection, cleaning, conditioning, patching, bonding, replacing seals, or replacing the plug.
35. A method for servicing a tank while also preserving a pressure within the tank, the method comprising:
- i) sealingly coupling a first port of a valve assembly onto a tank port surrounding a plug, and sealingly coupling an adapter to a second port of the valve assembly, the adapter, valve assembly, and the plug defining an interior cavity therebetween;
  - ii) pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity using an outlet port connected to, and in fluid communication with, the adapter;
  - iii) displacing the plug from the tank beyond a valve member of the valve assembly;
  - iv) actuating the valve member of the valve to a closed position to provide a sealed barrier between the first and second ports;
  - v) removing the plug from the adapter;
  - vi) introducing a servicing tool into the adapter, and sealingly coupling the adapter to the second port of the valve assembly to define a secondary cavity between the valve member in closed position, the second port, and adapter.
  - vii) pressurizing the secondary cavity using the outlet port, and opening the valve member to provide access for the servicing tool to service the tank.

36. The method of claim 35 further comprising a step of servicing the tank with the servicing tool.
37. The method of claim 35 wherein the pressure within the tank is a vacuum, and the secondary pressure comprises a pressure equal to or lower than the vacuum within  
5 the tank.
38. The method of any one of claims 35 to 36 wherein the servicing tool is selected from the list consisting of: a cleaning tool, a stereoscope, a camera, a radiation emitting device, and a sampling device.
39. The method of claim 35 further comprising installing the plug by:  
10
- viii) removing the servicing tool from the tank
  - ix) actuating the valve member of the valve to a closed position, and removing the servicing tool from the adapter;
  - x) introducing the plug into the adapter, and aligning the plug between the valve member and the adapter;
  - 15 xi) pressurizing the secondary cavity to sufficiently maintain a secondary pressure within the secondary cavity;
  - xii) actuating the valve member of the valve to an open position to provide a pathway between the first and second ports; and
  - xiii) installing the plug into the tank port.
- 20 40. A method of removing a plug installed in a port of a vessel, the plug employed to preserve a pressure of an interior space on one side of the plug comprising:
- i) creating an enclosing space on a second side of the plug opposite the one side of the plug, such that a pressure of the enclosing space equals the pressure of the interior space within a predetermined range;
  - 25 ii) removing the plug from the port away from the interior space whereby the pressure of the interior space remains within said predetermined range;

iii) isolating a portion of the enclosing space containing the plug from the interior space; and

iv) exposing the plug to atmosphere;

wherein the pressure of the interior space remains within the predetermined range.

**AMENDED CLAIMS****received by the International Bureau on 21 March 2014 (21.03.2014)**

1. An apparatus for servicing a tank, a plug, or both, comprising:
  - a. a body with a first port couplable onto a tank port associated with the plug, and a second port opposite to the first port;
  - 5 b. a valve proximal to the first port, comprising a valve member operable to an open position providing a pathway between the first and second ports in which the pathway is sized to allow passage of the plug therethrough, and a closed position providing a sealed barrier between the first and second ports; and
  - 10 c. a plug displacement tool associated with the second port, the plug displacement tool comprising a member that is extendable through the valve in the open position to engage with the plug for removal or re-installation of the plug in the tank port.
2. The apparatus of claim 1 wherein the second port comprises a sealable  
15 opening that can be opened to access an attachment mechanism of said plug displacement tool to remove said plug therefrom, or to attach a serviced or new plug for re-installation.
3. The apparatus of claim 1 wherein said body is separable into two parts, with a  
20 first part comprising a coupling for attachment to said tank port and a housing for said valve; and a second part providing an adapter in the form of a housing for said plug displacement tool.
4. The apparatus of claim 3 wherein the plug displacement tool comprises an attachment mechanism at a contact end for engagably coupling the plug to the contact end.
- 25 5. The apparatus of claim 4 wherein the plug displacement tool further comprises a handle at an opposite end to the contact end.

6. The apparatus of any one of claims 3 to 5 wherein the plug displacement tool is a substantially elongate rod of sufficient length for engagably coupling with the plug when said apparatus is coupled to said tank port.
7. The apparatus of any one of claims 4 to 6 wherein the attachment means  
5 comprises a male or female threading.
8. The apparatus of any one of claims 6 to 7 wherein a longitudinal axis of the elongate rod is substantially axially aligned with the plug when the first port is coupled to the tank port and the adapter is coupled to the second port.
9. The apparatus of any one of claims 6 to 8 wherein the elongate rod is slidingly  
10 coupled to the adapter and is slidable for engagably coupling with the plug, and for displacing plug when engagably coupled.
10. The apparatus of any of claims 3 to 9 wherein the adapter comprises an outlet port for removing or supplying air or a pressurized fluid.
11. The apparatus of any of claims 3 to 10 wherein the valve is a two port valve.
12. The apparatus of any one of claims 3 to 11 wherein the valve is selected from  
15 the group of a ball valve, a gate valve, and a butterfly valve.
13. The apparatus of any one of claims 3 to 12 further comprising fittings for sealingly coupling the adapter to the second port, and the tank port to the first port.
14. The apparatus of claim 13 wherein the fittings are selected from the group  
20 consisting of a slip nut adapter, a pipe clamp, a bayonet clamp, a KF flange clamp, a CF flange clamp, a threaded coupling, and a bolted flange connection.
15. The apparatus of claim 3 wherein the apparatus services a getter material connected with the plug.
16. A method for removing a plug from a sealing tank while preserving a pressure  
25 within the tank, the method comprising:
- sealingly coupling a first port of a valve onto a tank port surrounding the plug;

coupling an adapter to a second port of the valve to form a seal between the adapter and the second port, the adapter, valve, and the plug defining an interior cavity therebetween;

5 pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity;

displacing the plug from the tank beyond a valve member of the valve;

actuating the valve member of the valve to a closed position to provide a sealed barrier between the first and second ports; and

decoupling the adapter from the second port to remove the plug.

10 17. The method of claim 16 wherein a getter material is connected with the plug and the plug is removed from the tank such that the getter material can be inspected or replaced.

15 18. The method of claim 16 wherein the pressure within the tank is a vacuum, and the step of pressurizing the interior cavity comprises removing air from the interior cavity sufficient to maintain a standing vacuum within the interior cavity.

19. The method of any one of claims 16 to 18 wherein the step of displacing the plug from the tank is performed with a plug displacement tool.

20 20. The method of claim 19 wherein the plug displacement tool comprises a substantially elongate rod with attachment mechanism, and the method further comprises engagably coupling the plug to the elongate rod prior to the step of displacing the plug from the tank.

21. The method of claim 20 wherein the plug comprises a male or female threading, and the attachment mechanism comprises a corresponding threading.

25 22. The method of any one of claims 20 to 21 wherein the elongate rod is slidingly coupled to the adapter, and the plug is displaced by sliding the elongate rod away from the tank when engagably coupled to the plug.

23. The method of any one of claims 16 to 22 wherein the adapter comprises an outlet port, and the interior cavity is pressurized to a standing pressure through the outlet port.
24. The method of any one of claims 16 to 23 wherein the valve is a two port  
5 valve.
25. The method of any one of claims 16 to 22 wherein the valve is selected from the group of a ball valve, a gate valve, or a butterfly valve.
26. The method of claim 18 wherein the standing vacuum comprises a pressure equal to or lower than the vacuum within the tank.
- 10 27. The method of any one of claims 16 to 26 wherein fittings are used for sealingly coupling the adapter to the second port, and the tank port to the first port.
28. The method of claim 27 wherein the fittings are selected from the group consisting of a slip nut adapter, a pipe clamp, a bayonet clamp, a KF flange clamp, a CF flange clamp, a threaded coupling, and a bolted flange connection.
- 15 29. The method of any one of claims 16 to 28 further comprising installing the plug by:
- introducing the plug into the adapter, and aligning the plug between the valve member and the adapter;
  - 20 sealingly coupling the adapter to the second port of the valve to define a secondary cavity between the adapter and the valve member that encloses the plug;
  - pressurizing the secondary cavity to sufficiently maintain a secondary pressure within the secondary cavity;
  - 25 actuating the valve member of the valve to an open position to provide a pathway between the first and second ports; and
  - installing the plug into the tank port.

30. The method of claim 29 wherein the pressure within the tank is a vacuum, and the secondary pressure comprises a pressure equal to or lower than the vacuum within the tank.

31. The method of any one of claims 29 to 30 further comprising decoupling the  
5 plug from the plug displacement tool prior to the step of decoupling the first port from the tank.

32. The method of any one of claims 29 to 31 wherein the step of aligning the plug between the valve member and the adapter comprises coupling the plug to the plug displacement tool.

10 33. The method of any one of claims 29 to 32 wherein the step of installing the plug onto the tank is performed with the plug displacement tool.

34. The method of any one of claims 16 to 28 further comprising servicing the plug through inspection, cleaning, conditioning, patching, bonding, replacing seals, or replacing the plug.

15 35. A method for servicing a tank while also preserving a pressure within the tank, the method comprising:

i) sealingly coupling a first port of a valve assembly onto a tank port surrounding a plug, and sealingly coupling an adapter to a second port of the valve assembly, the adapter, valve assembly, and the plug defining an interior cavity  
20 therebetween;

ii) pressurizing the interior cavity to sufficiently maintain a standing pressure within the interior cavity using an outlet port connected to, and in fluid communication with, the adapter;

25 iii) displacing the plug from the tank beyond a valve member of the valve assembly;

iv) actuating the valve member of the valve to a closed position to provide a sealed barrier between the first and second ports;

v) removing the plug from the adapter;

vi) introducing a servicing tool into the adapter, and sealing coupling the adapter to the second port of the valve assembly to define a secondary cavity between the valve member in closed position, the second port, and adapter.

vii) pressurizing the secondary cavity using the outlet port, and opening the  
5 valve member to provide access for the servicing tool to service the tank.

36. The method of claim 35 further comprising a step of servicing the tank with the servicing tool.

37. The method of claim 35 wherein the pressure within the tank is a vacuum, and the secondary cavity pressure comprises a pressure equal to or lower than the vacuum  
10 within the tank.

38. The method of any one of claims 35 to 36 wherein the servicing tool is selected from the list consisting of: a cleaning tool, a stereoscope, a camera, a radiation emitting device, and a sampling device.

39. The method of claim 35 further comprising installing the plug by:  
15 viii) removing the servicing tool from the tank

ix) actuating the valve member of the valve to a closed position, and removing the servicing tool from the adapter;

x) introducing the plug into the adapter, and aligning the plug between the valve member and the adapter;

20 xi) pressurizing the secondary cavity to sufficiently maintain a secondary pressure within the secondary cavity;

xii) actuating the valve member of the valve to an open position to provide a pathway between the first and second ports; and

xiii) installing the plug into the tank port.

25 40. A method of removing a plug installed in a port of a vessel, the plug employed to preserve a pressure of an interior space on one side of the plug comprising:

i) creating an enclosing space on a second side of the plug opposite the one side of the plug, such that a pressure of the enclosing space equals the pressure of the interior space within a predetermined range;

5 ii) removing the plug from the port away from the interior space whereby the pressure of the interior space remains within said predetermined range;

iii) isolating a portion of the enclosing space containing the plug from the interior space; and

iv) exposing the plug to atmosphere;

wherein the pressure of the interior space remains within the predetermined range.

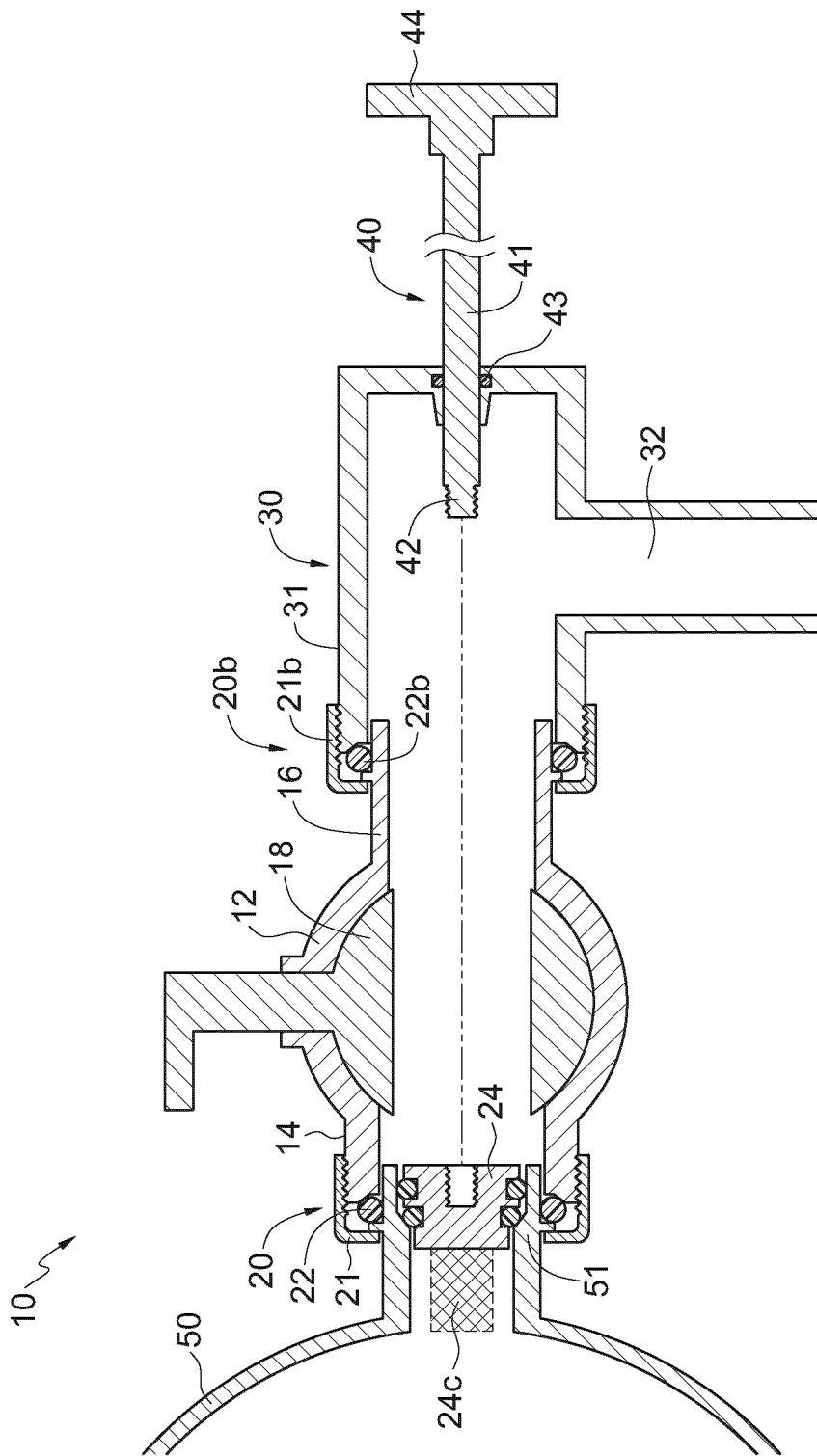


FIG. 1

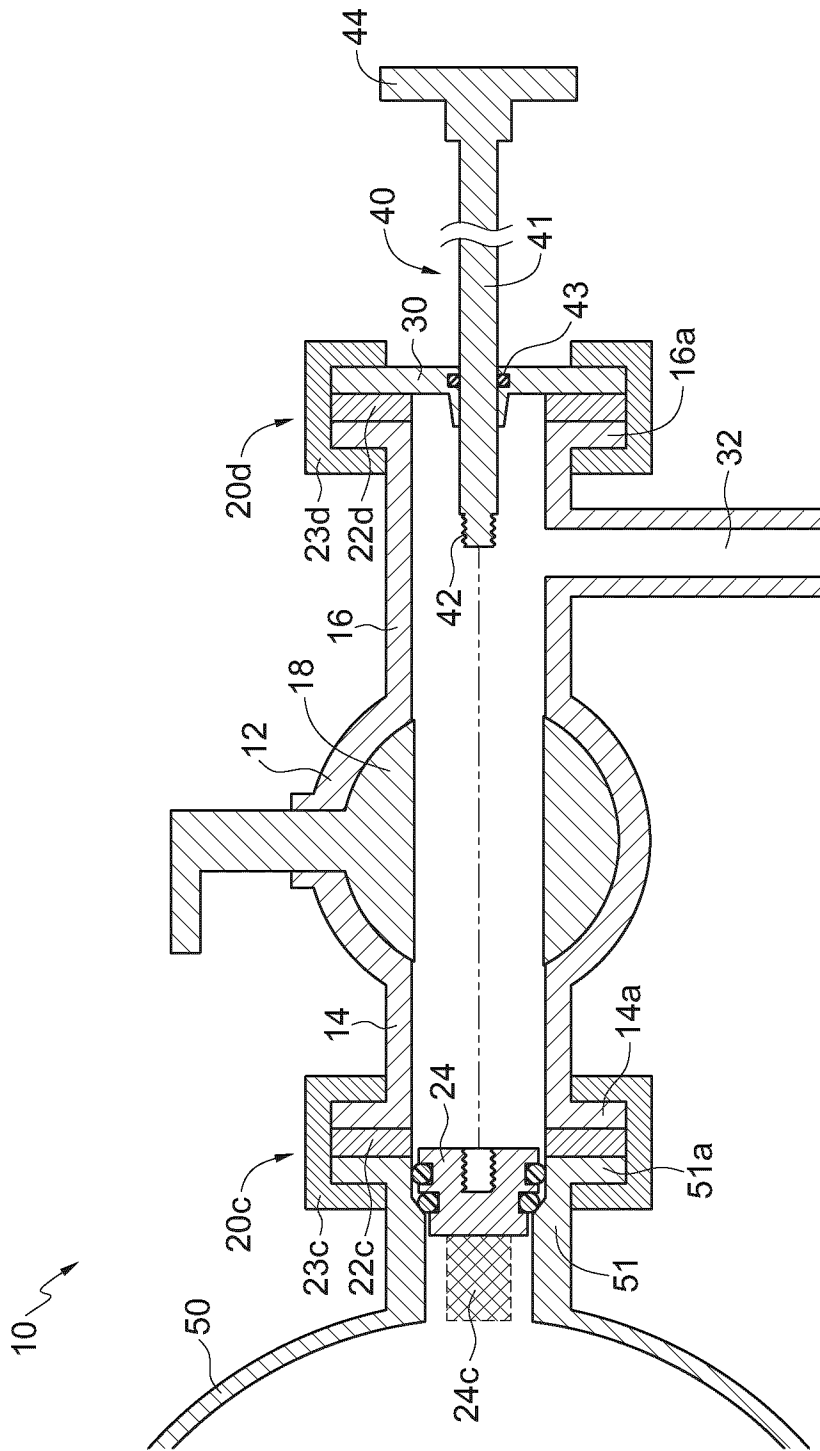


FIG. 2

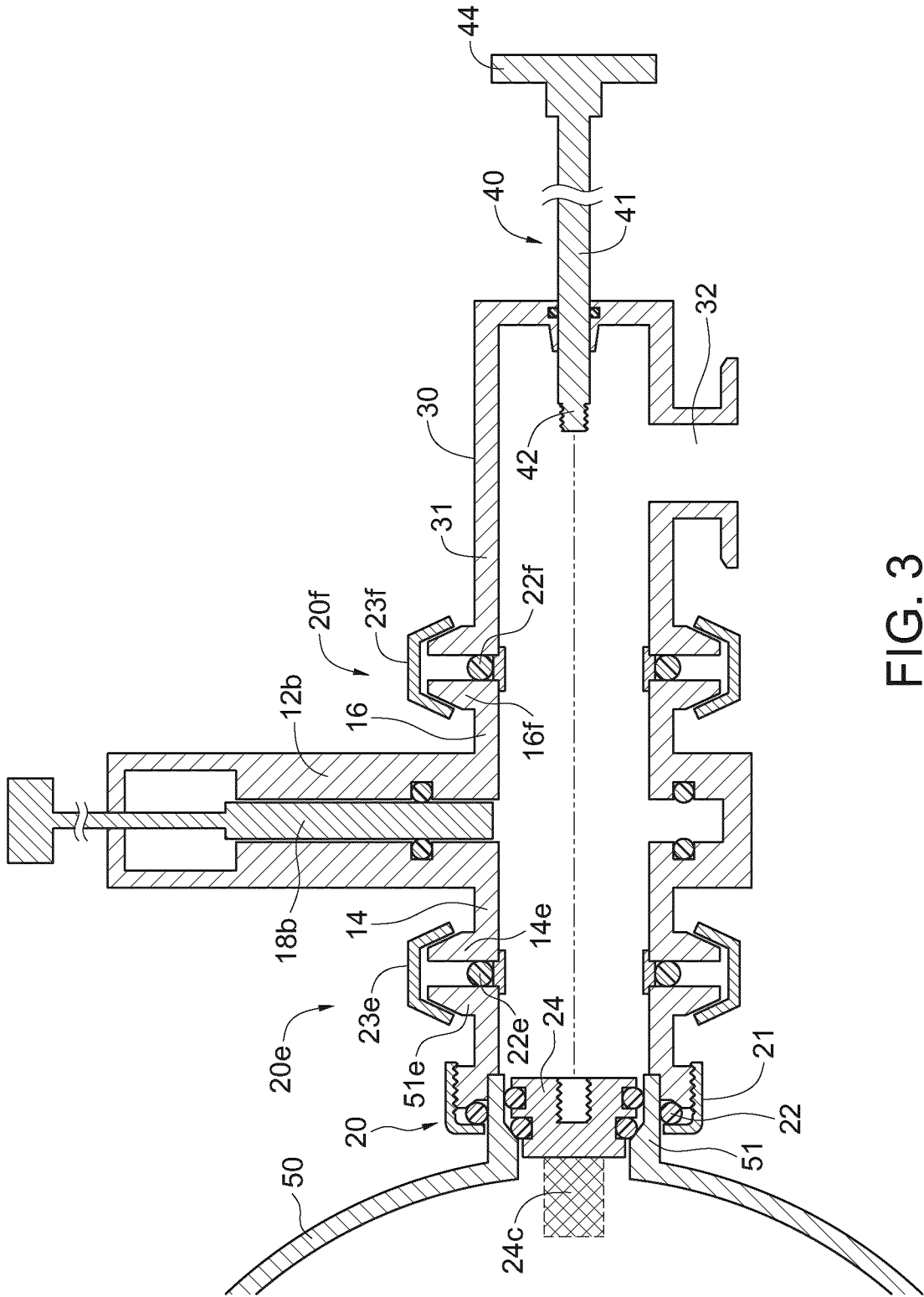


FIG. 3

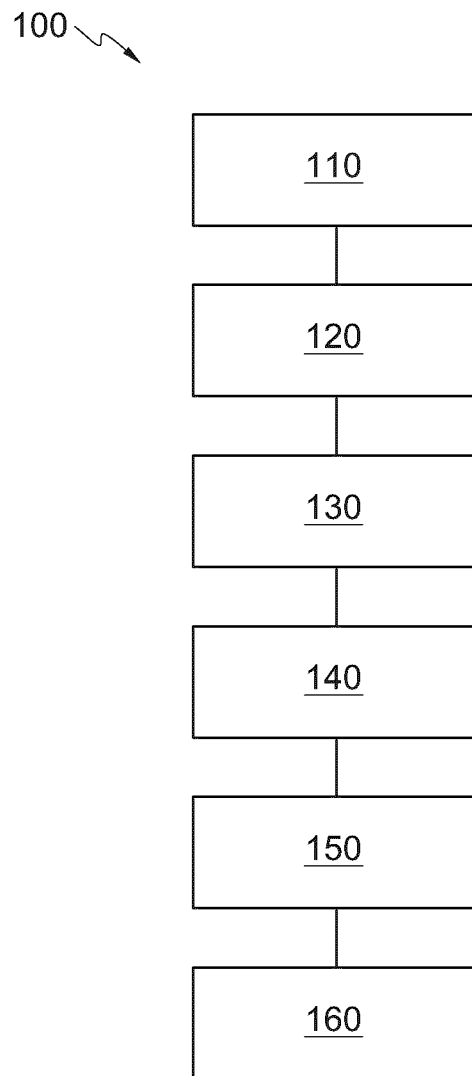


FIG. 4

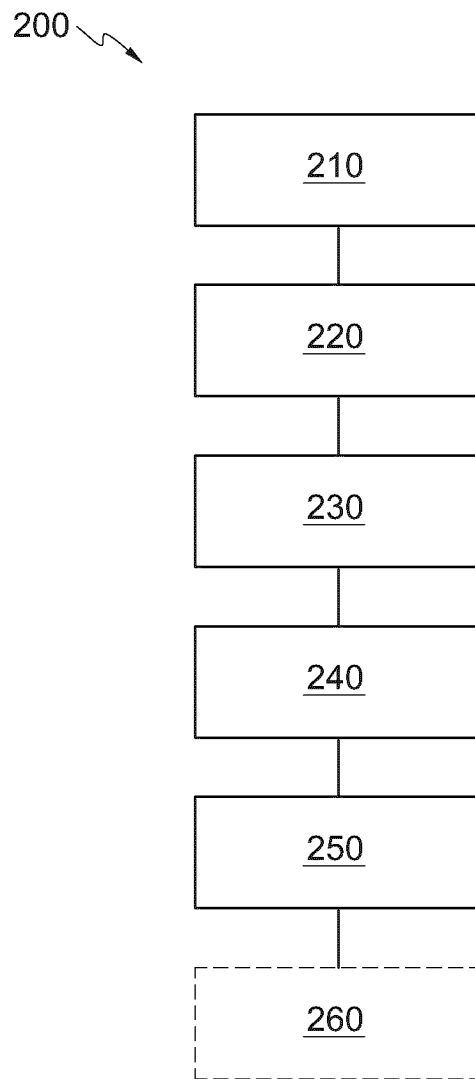


FIG. 5

**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/CA2013/050909

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC: **F17C 13/04** (2006.01) , **B65D 90/00** (2006.01) , **F16K 43/00** (2006.01) , **F16L 55/00** (2006.01)  
 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)  
 IPC: **F17C 13/04** (2006.01) , **B65D 90/00** (2006.01) , **F16K 43/00** (2006.01) , **F16L 55/00** (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)  
 Databases: EPOQUE (EPODOC and Fulltext).  
 Keywords: tank, cylinder, vessel, container, valve, port, tool, wrench, rod, stem, remove, displace, replace, plug and similar words.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4194523 A (LUBIENIECKI, E.), 25 March 1980 (25-03-1980)	

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

* Special categories of cited documents :	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search 10 February 2014 (10-02-2014)	Date of mailing of the international search report 11 February 2014 (11-02-2014)
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/CA2013/050909**

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