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(54) **TANK CONTAINER**

TANKBEHÄLTER

CONTENEUR CITERNE

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**CN-A- 104 356 734 CN-U- 203 190 021**

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## Description

### TECHNICAL FIELD

[0001] The disclosure relates to the field of logistics transportation, more specifically to a storage and transportation container and even more specifically to a tank container.

### BACKGROUND

[0002] A storage and transportation container is mainly used for storing and transporting material, e.g. liquefied petroleum gas, ammonia, refrigerant and other non-refrigeration gas. The storage and transportation container can be a tank container.

[0003] The tank container is usually designed to meet the standard of ISO tank container according to the international transport regulation (e.g. IMDG-International Maritime Dangerous Goods Code, ADR- European Agreement on the international carriage of dangerous goods, China standard JB/T 4781- "liquefied gas tank container", etc.).

[0004] ISO tank container generally includes a frame and a tank located in the frame. The tank includes a cylinder body and two sealing heads configured to seal two ends opening of the cylinder body respectively. To meet the standard of the ISO, the tank itself and all the connecting piece and device must be arranged within the range of ISO standard specified size. For example, the size of outside frame of 20 feet tank container is 8 feet (2438 mm) in width, 20 feet in length and 8.5 feet in height.

[0005] When the medium in the tank container is the liquefied gas, which is marked in domestic and international standards and specifications (international standards-"IMDG", "ADR", and China standard JB/T 4781), eg. liquefied petroleum gas, refrigerant, etc, the cylinder body should have enough thickness to bear the maximum allowable working pressure(MAWP). As this kind of liquefied gas in the sealed tank is generally under saturated gas-liquid mixed state, with the temperature going up, the pressure of the saturated state goes up, and the pressure within the tank will rise accordingly.

[0006] The minimum thickness of the cylinder body is usually calculated according to the standard of the pressure vessel (eg. according to ASME Section VIII, Division 2, AD 2000 Merkblatt, EN 13445, CODAP 2005 or others).

[0007] The formula recorded in ASME Section VIII, Division 2 is as following:

$$t = \frac{D}{2} \left( \exp \left[ \frac{P}{SE} \right] - 1 \right)$$

[0008] The "t" represents minimum thickness of the cylinder body. The "D" represents inner diameter of the cylinder body.

The "P" represents design pressure. The "E" represents welding coefficient, with its value between 0.85 to 1. The "S" represents the value of allowable stress under design temperature.

[0009] The design pressure "P" of the cylinder body should not be less than the maximum allowable working pressure (MAWP). The value of maximum allowable working pressure (MAWP) is related to absolute steam pressure of non refrigerant liquefied gas under the design reference temperature. The lower of the design reference temperature, the lower the absolute steam pressure of non refrigerant liquefied gas will be, the lower maximum allowable working pressure will be, and the lower the design pressure will be.

[0010] As stipulated in regulations of IMDG-International Maritime Dangerous Goods Code, without heating insulating layer or shading device, the design reference temperature of the cylinder body should be designed to 60 °C. Having shading device, the design reference temperature of the cylinder body should be designed to 55 °C. Having heating insulating layer, the design reference temperature of the cylinder body should be designed to 50 °C.

[0011] Conventionally, as shown in Fig.1, a shading plate 102 is disposed on the top of the tank 101 to shade the tank 101 from direct sunshine and avoid the temperature rising in the tank. According to international regulations, having shading device, the design reference temperature of the cylinder body should be designed to 55 °C, that is, the design pressure of the cylinder body decreases compared with the cylinder body without shading device.

[0012] This design reference temperature can be reduced to 50 °C by employing a complete tank insulation.

[0013] However, the weight of the shading plate is more than 80kg, which increases the net weight of the tank container and a suitable insulation (including insulation and an insulation cladding) adds an additional weight of about 200 kg.

[0014] Therefore the problem exists to provide a tank container for non-refrigerated liquefied gases with a low weight and a high volume which is on the one hand designed for a design reference temperature which allows for higher strength values of the tank material but on the other hand without adding additional components to achieve such a lower design reference temperature.

CN 203 190 021 U discloses a tank container, an outer surface of which is coated with a sunshade layer. The sunshade layer comprises three layers. The bottom layer is an adhesive layer, the middle layer is an anticorrosion layer, and the outer layer is reflective layer. The adhesive layer is used to bond the tank body and the sunshade layer. The anticorrosion layer has a function of anti-corrosion to ensure that the entire reflective layer can effectively cover the body of the tank body after a long period of use, and that no part of the sunshade layer is uncovered by the sunshade layer with a part of the body of the tank body corroded.

CN 104 356 734 A discloses a novel nano ceramic re-

flective insulation paint. A nano rare-earth material and hollow ceramic microspheres are combined to form a nano rare-earth film on the surface of the hollow ceramic microspheres. The nano film has high reflection actions on both infrared light and ultraviolet light.

## SUMMARY

**[0015]** According to an aspect of the present disclosure, a storage and transportation container, includes a tank and a heat insulation and reflective layer. The tank includes a cylinder body and two sealing heads configured to seal two end openings of the cylinder body respectively; The heat insulation and reflective layer is disposed on the outer surface of the tank. The heat insulation and reflective layer at least covers an upper surface of the cylinder body including a top surface of the cylinder body and a part of side surface extending from the top surface. The heat insulation and reflective layer covers an area of the cylinder body at least one third of the total area.

**[0016]** The technical solution of the present disclosure has advantageous effects as following:

A heat insulation and reflective layer is coated on the tank, the heat insulation and reflective layer at least covers the upper surface, the coverage area of the heat insulation and reflective layer at least covers one third of the total area of the cylinder body. The heat insulation and reflective layer has high reflectivity to sunshine, the sunshine shining on the surface of the tank may be well reflected back. Whereby, the technical solution provided in this disclosure may totally replace the shading device used in the prior art. Meanwhile, the heat insulation and reflective layer has good heat insulating effect, which may obviously reduce heat transmission between the tank and outerspace, thereby reduce liquid vaporization as the rise of the temperature within the tank, keeping the pressure from rising, and avoiding potential risk caused by high pressure within the tank. Therefore, compared to the traditional shading plate, the heat insulation and reflective layer is thinner and lighter, accordingly the net weight of the storage and transportation container reduces obviously.

**[0017]** Further aspects and features result from the dependent claims, the attached drawings and the following description of embodiments of the present invention. Embodiments are described by way of example in relation to the attached drawings.

**[0018]** It should be understood that the above general description and the following detail description is just exemplary, not to limit the present disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]**

Fig. 1 is a perspective view showing a shading plate disposed on the top of a tank container in the prior art.

Fig. 2a is a perspective view of a tank container according to the first embodiment of the present disclosure.

Fig. 2b is a view showing partial enlargement of A district of Fig.2a.

Fig. 3a is perspective view of a tank container according to the second embodiment of the present disclosure.

Fig. 3b is a view showing partial enlargement of B district of Fig.3a.

Fig. 4a is perspective view of a tank container according to the first arrangement of the present disclosure.

Fig. 4b is a view showing partial enlargement of C district of Fig.4a.

Fig. 5a is perspective view of a tank container according to the second arrangement of the present disclosure.

Fig. 5b is a view showing partial enlargement of D district of Fig.5a.

## DETAILED DESCRIPTION

**[0020]** Prior to a detailed description of the embodiments and arrangements according to Figs. 2 to 5b general explanations are provided with regard to general embodiments.

**[0021]** The present invention provides a tank container according to independent claims 1 and 7. Preferred embodiments are defined by the dependent claims.

**[0022]** A freight container may comprise a vessel for retaining the pressurized liquid within a shell comprising a cylindrical section and heads enclosing opposite ends of the cylindrical section, a frame connected to the vessel to transmit operational loads between the vessel and handling devices at least one opening for filling and/or discharging the vessel, a thermal system covering not less than the upper third of an outer surface of the shell, wherein the thermal system provides an insulation effect which is at least equivalent to the insulation effect of a shield separated from the outer surface of the shell by an airspace of not less than 40 mm, and the thermal system comprises a thermal coating comprising a heat-reflective, heat-absorbing and/or insulating liquid based material containing insulating, heat-absorbing and/or reflecting particles.

**[0023]** In such a freight container the thermal system is provided which achieves an insulation effect which is at least equivalent to the insulation effect of a shield separated from the outer surface of the shell by an airspace of not less than 40 mm. And specifically, this thermal system is achieved by a thermal coating comprising a liquid based material containing insulating, heat-absorbing and/or reflective particles. Therefore the thermal properties are achieved by a material, which is added and/or included into a painting material (matrix). The particles provide insulating, heat-absorbing and/or reflecting properties.

**[0024]** The particles may comprise ceramic and/or nano-particles. Such particles or nano-particles may comprise silicate or tombarthite particles, which increase the insulating quality of such a coating.

**[0025]** The coating may comprise irregular silicate particles 5 to 100  $\mu\text{m}$  in size.

**[0026]** The coating may comprise fine non-metallic hollow microspheres which have a high reflectivity for light and/or infrared radiation and form numerous small cavities inside the coating layers (similar to a foam structure) which decrease the thermal conduction of the coating. Such hollow beads or spherical beads therefore combine reflecting and insulating features.

**[0027]** The insulating/reflecting particles may contain thermochromic dyes, particularly in the form of microcapsules, containing special dyes which changes its colour due to a change of temperature and/or radiation. Such thermochromic dyes may for example change their colour from dark (low reflective) to bright (high reflective) under the influence of sun radiation and/or an increase of the surface temperature due to such radiation.

**[0028]** The insulating/reflecting/thermo-active particles may contain particles with a latent heat storage function by exploiting the enthalpy of a reversible thermodynamic state, in particular solid to liquid or vice versa. They take up a lot of heat energy (irradiated by the sun) and convert it into the so called "heat of fusion" without changing the temperature. This process is reversible and the storage medium releases the same amount of heat energy during solidification (e.g. during the night). Latent heat storage material is available in the form of microencapsulated particles containing a latent heat storing substance (e.g. based on a paraffin wax).

**[0029]** The thermal coating may be based on a white or translucent matrix based on a component selected from epoxy resins, polyurethanes, acrylates, styrene acrylates, silicone polymers, polyester resins, and/or natural resins and other components suitable of forming a coating matrix.

**[0030]** The thermal insulating coating may comprise an outer surface having a high emissivity, which allows for a high irradiation of heat from the container vessel itself, i. e. from the container vessel surface. Such a surface having a high emissivity can be formed by a special coating layer and/or may be formed by a sheet layer and/or a membrane layer which is applied to the coating in a wrapping and/or plating process.

**[0031]** Such a sheet layer may be formed by a thin, highly reflective metal foil (e.g. aluminium foil) and/or by a metalized plastic tape or foil. It may also be formed by a fiber reinforced foil or membrane having increased mechanically properties.

**[0032]** Such a membrane sheet and/or membrane layer may also contain an adhesive layer, which is suitable to fix the layer or sheet onto the coating layer.

**[0033]** The outer surface may also be formed from a non-metallic bead coating with high reflective bead components.

**[0034]** The thermal system provides an insulation effect which is at least equivalent to the insulation effect of a complete cladding of the vessel having a thermal conductance of not more than  $0,67 \text{ Wm}^{-2}\text{K}^{-1}$ . Such a thermal system is able to replace a complete thermal insulation, which usually comprises an insulation layer of more than 20 mm. If the thermal system is designed accordingly it is possible to gain an diameter increase which results in an additional volume for a 20' ISO container.

**[0035]** Hereinafter, the disclosure will be further explained with reference to the accompanying drawings.

**[0036]** The storage and transportation container of the present disclosure may be applied to transportable pressure vessel, more specifically to the vessel for transporting non-refrigeration liquid gas. In the following embodiments, the disclosure will be explained by exemplifying of a tank container for transporting liquefied petroleum gas.

### Embodiment One

**[0037]** Fig. 2a is a perspective view of a tank container according to the first embodiment of the present disclosure. The tank container 10 includes a frame 11 and a tank 12 disposed in the frame 11. The tank 12 includes a cylinder body 121 and two sealing heads 122 for sealing the two end openings of the cylinder body 121 respectively.

**[0038]** The upper surface of the cylinder body 121 is covered by a heat insulation and reflective layer 13. The area of the upper surface represents one third of the total area of the cylinder body 121, that is, the coverage area of the heat insulation and reflective layer 13 represents one third of the total area of the cylinder body 121. The upper surface of the cylinder body includes a top surface of the cylinder body and a portion of side surface extending from the top surface. The total area of the top surface and the part of side surface represents one third of the total area of the cylinder body 121.

**[0039]** The heat insulation and reflective layer 13 has heat insulation and reflective function. The heat insulation and reflective layer 13 is a single layer structure. The single layer structure includes a plurality of non-metal hollow microspheres 131 having heat insulation and reflective function. The matrix of the heat insulation and reflective layer 13 may be a high polymer material layer. The heat insulation and reflective layer 13 may be composed of resin matrix and non-metal hollow microspheres filled in the resin matrix. The non-metal hollow microspheres 131 may produce sphere prism reflection effect, which may reduce sunshine energy invading into the tank, thus achieving the reflecting effect to sunshine. Meanwhile, a large number of hollow structures of non-metal hollow microspheres 131 form a heat insulation layer to stop heat conduction, thereby achieving the heat insulation effect.

**[0040]** As non-metal hollow microspheres 131 may reflect sunshine, the non-metal hollow microspheres 131 disposed on the upper surface of the cylinder body 121

may reflect visible light and infrared ray. Therefore the heat insulation and reflective layer 13 may have function of the shading plate.

[0041] The diameter of the non-metal hollow microsphere 131 may be between 100nm to 100μm. The non-metal hollow microsphere 131 may be a glass hollow microsphere, a ceramic hollow microsphere or other non-metal hollow sphere. These hollow spheres 131 perform as insulating and reflecting particles. The hollow space, which is filled by a gas, increases the insulating capacity of the reflective layer 13 because the thermal conductance of gases is much lower than the thermal conductance of a solid or liquid. The hollow spheres 131 also reflect visible light and/or infrared irradiation at their outer and/or inner surfaces and therefore keep the radiation away from the cylinder body 121 and therefore operate like an internal sunshield.

[0042] The heat insulation and reflective layer is a coating layer formed on the cylinder body 121 by brush coating or spray coating. The thickness of the coating layer is between 0.1mm to 2mm.

[0043] The heat insulation and reflective layer may be a thin pasting-film or a thin blanket (e.g. a sheet layer or membrane layer formed from a metallic or metallized foil with high reflectivity/emissivity). The thin pasting-film or the thin blanket is bonded to the cylinder body 121 by pasting. The thickness of the pasting-film or the thin blanket is between 0.1mm to 10mm.

[0044] In addition, to further reinforce the reflecting property of the the heat insulation and reflective layer 13, titanium dioxide may be added into the resin matrix.

## Embodiment Two

[0045] Referring to Fig. 3a is perspective view of a tank container according to the second embodiment of the present disclosure. Fig. 3b is a view showing partial enlargement of B district of Fig.3a. The tank container 20 includes a frame 21 and a tank 22 disposed in the frame 21. The tank 22 includes a cylinder body 221 and two sealing heads 222 configured to seal the two end openings of the cylinder body 221 respectively.

[0046] The upper surface of the cylinder body 221 is covered by a heat insulation and reflective layer 23. The area of the upper surface represents one third of the total area of the cylinder body 221, that is, the coverage area of the heat insulation and reflective layer 23 represents one third of the total area of the cylinder body 221. The upper surface of the cylinder body 221 includes a top surface of the cylinder body and a portion of side surface extending from the top surface. The total area of the top surface and the part of side surface represents one third of the total area of the cylinder body 221.

[0047] The heat insulation and reflective layer 23 has heat insulation and reflective function. The heat insulation and reflective layer 23 is a double-layer structure. The heat insulation and reflective layer 23 includes a heat insulation inner layer 232 and a reflective outer layer 233.

The heat insulation inner layer 232 is made of heat-preservation material, and the heat-preservation material may be selected from any one from silicate, rare earth and aerogel. But not limited to these kinds of material, the heat-preservation material may also be other material with function of heat preservation or heat insulation.

[0048] The reflective outer layer 233 may form a reflecting surface on the surface of the heat insulation inner layer 232 to achieve reflecting effect.

[0049] In addition, the reflective outer layer 233 may be made of reflective material. The reflective material may be fluorocarbon coating. The fluorocarbon coating may be composed of 4F type fluororesin and special heat insulation material. In case that the fluorocarbon coating forms a film, a coating film which has high reflectivity and high thermal resistance is formed. When the sunshine shines on the coating film, major of energy of the sunshine will be reflected back, and is prevented from transmitting into the tank.

[0050] In addition, the reflective material is not limited to the fluorocarbon coating, but other reflective material.

[0051] The heat insulation inner layer 232 and the reflecting layer 233 may be coated on the tank 22 by many kinds of manners.

[0052] In one manner, the heat insulation inner layer 232 is a coating layer formed on the cylinder body 121 by brush coating or spray coating of heat-preservation material. The reflective outer layer 233 is a thin pasting-film or a thin blanket made of fluorocarbon material, which may be bonded to the heat insulation inner layer 232 by pasting. The total thickness of the heat insulation inner layer 232 and the reflective outer layer 233 is between 0.1mm to 10mm.

[0053] In another manner, the heat insulation inner layer 232 is a thin pasting-film or a thin blanket made of heat-preservation material, which may be bonded to the cylinder body 121 by pasting. The reflective outer layer 233 is a coating layer formed on the heat insulation inner layer 232 by brush coating or spray coating of fluorocarbon material. The total thickness of the heat insulation inner layer 232 and the reflective outer layer 233 is between 0.1mm to 10mm.

[0054] In further another manner, the heat insulation inner layer 232 is a coating layer formed on the cylinder body 121 by brush coating or spray coating of heat-preservation material. The reflective outer layer 233 is a coating layer formed on the heat insulation inner layer 232 by brush coating or spray coating of fluorocarbon material. The total thickness of the heat insulation inner layer 232 and the reflective outer layer 233 is between 0.1mm to 2 mm.

[0055] In further another manner, the heat insulation inner layer 232 is a thin pasting-film or a thin blanket made of heat-preservation material, which may be bonded to the cylinder body 121 by pasting. The reflective outer layer 233 is a thin pasting-film or a thin blanket made of fluorocarbon material, which may be bonded to the heat insulation inner layer 232 by pasting. The total

thickness of the heat insulation inner layer 232 and the reflective outer layer 233 is between 0.1mm to 10 mm

**[0056]** In the above two embodiments, A heat insulation and reflective layer is coated on the tank, the heat insulation and reflective layer at least covers the upper surface, the coverage area of the heat insulation and reflective layer at least covers one third of the total area of the cylinder body. The heat insulation and reflective layer has high reflectivity to sunshine, the sunshine shining on the surface of the tank may be well reflected back. Whereby, the technical solution provided in this disclosure may totally replace the shading device used in the prior art. Meanwhile, the heat insulation and reflective layer has good heat insulating effect, which may obviously reduce heat transmission between the tank and outerspace, thereby reduce liquid vaporization as the rise of the temperature within the tank, keeping the pressure from rising, and avoiding potential risk caused by high pressure within the tank.

**[0057]** As coated on the surface of the tank in the present disclosure, the heat insulation and reflective layer is not easy to be damaged, and the durability of the heat insulation and reflective layer increases at least 30%.

**[0058]** According to relevant standard, in case of having shading device, the design reference temperature of the tank may reduce from 60°C to 55 °C. The design reference temperature has reduced, the design pressure also has reduced, and accordingly the safety of the tank increases.

**[0059]** Moreover, as the heat insulation and reflective layer itself is thin, of which the thickness is between 0.1mm to 10 mm, compared to the conventional shading plate of the weight of 80kg, the net weight of the tank reduces obviously. For some higher density goods, the tank may carry more goods.

**[0060]** In the conventional art, the height of the shading plate is beyond the tank, which is not easy to transport. However, the heat insulation and reflective layer directly covers on the tank in present disclosure, which overcomes the shortcoming of the shading plate caused by the excessive height.

**[0061]** In the above two embodiments, the tank is coated by a heat insulation and reflective layer, and the coverage area of the heat insulation and reflective layer represents one third of the total area of the cylinder body. But not limit to this ratio, the coverage area at least represents one third of the total area of the cylinder body, e.g. the coverage area may represent two third. Moreover, the coverage area includes not only the surface of the cylinder body, but also a portion of or all of surface of the sealing heads.

## Arrangement One

**[0062]** Referring to Fig. 4a and Fig.4b, Fig. 4a is perspective view of a tank container according to the first arrangement of the present disclosure. Fig. 4b is a view

showing partial enlargement of C district of Fig.4a. The tank container 30 includes a frame 31 and a tank 32 disposed in the frame 31. The tank 32 includes a cylinder body 321 and two sealing heads 322 for sealing the two end openings of the cylinder body 321 respectively.

**[0063]** The outer surface of the tank 32 (including the outer surface of the cylinder body 321 and the sealing heads 322) is coated by a heat insulation and reflective layer 33 completely. The heat insulation and reflective layer 33 covers the whole tank 32, that is, all the outer surface of the tank 32 is coated by the heat insulation and reflective layer 33, as to form an entire heat insulation layer to clad the whole tank 32. The heat insulation effect of the entire heat insulation layer may achieve the level of "having heat insulation layer" regulated in the regulation of IMDG-"International Maritime Dangerous Goods Code".

**[0064]** The heat insulation and reflective layer 33 has heat insulation and reflective function. The heat insulation and reflective layer 33 may be a single layer structure. The heat insulation and reflective layer 33 with single layer structure includes a plurality of non-metal hollow microspheres 331 with heat insulation and reflective function.

**[0065]** The matrix of the heat insulation and reflective layer 33 may be a high polymer material layer. The heat insulation and reflective layer 33 may be composed of resin matrix and non-metal hollow microspheres 331 filled in the resin matrix. The non-metal hollow microspheres 331 may produce sphere prism reflection effect, which may reduce sunshine energy invading into the tank, as to achieve the reflecting effect to sunshine. Meanwhile, a large number of hollow structures of non-metal hollow microspheres 331 form a heat insulating layer to stop heat conduction, thereby achieving the heat insulation effect.

**[0066]** As non-metal hollow microspheres 331 may reflect sunshine, the non-metal hollow microspheres 331 disposed on the the tank32 may reflect visible light and infrared ray. Therefore, the heat insulation and reflective layer 33 may have function of the shading plate.

**[0067]** The diameter of the non-metal hollow microsphere 331 may be between Sum to 100um. The non-metal hollow microsphere 331 may be a glass hollow microsphere, a ceramic hollow microsphere or other non-metal hollow sphere.

**[0068]** The heat insulation and reflective layer 33 is a coating layer formed on the tank 32 by brush coating or spray coating. The thickness of the coating layer is between 0.1mm to 2mm.

**[0069]** The heat insulation and reflective layer 33 may be a thin pasting-film or a thin blanket. The thin pasting-film or the thin blanket is bonded to the tank 32 by pasting. The thickness of the pasting-film or the thin blanket is between 0.1mm to 10mm.

**[0070]** In addition, in order to further reinforce the reflecting property of the the heat insulation and reflective layer 33, titanium dioxide may be added into the resin

matrix.

## Arrangement Two

**[0071]** Referring to Fig. 5a and Fig.5b, Fig. 5a is perspective view of a tank container according to the second arrangement of the present disclosure. Fig. 5b is a view showing partial enlargement of D district of Fig.5a. The tank container 40 includes a frame 41 and a tank 42 disposed in the frame 41. The tank 42 includes a cylinder body 421 and two sealing heads 422 for sealing the two end openings of the cylinder body 421 respectively.

**[0072]** The outer surface of the tank 42 (including the outer surface of the cylinder body 421 and the sealing heads 422) is coated by a heat insulation and reflective layer 43 completely. The heat insulation and reflective layer 43 covers the whole tank 42, that is, all the outer surface of the tank 42 is coated by the heat insulation and reflective layer 43, as to form an entire heat insulation layer to clad the whole tank 42. The heat insulation effect of the entire heat insulation layer may achieve the level of "having heat insulation layer" regulated in the regulation of IMDG-"International Maritime Dangerous Goods Code".

**[0073]** The heat insulation and reflective layer 43 has heat insulation and reflective function. The heat insulation and reflective layer 43 is a double-layer structure. The heat insulation and reflective layer 43 includes a heat insulation inner layer 432 and a reflective outer layer 433.

**[0074]** The heat insulation inner layer 432 is made of heat-preservation material, and the heat-preservation material may be selected from any one of silicate, rare earth, aerogel. But not limited to this, the heat-preservation material also may be other material with a function of heat preservation or heat insulation.

**[0075]** The reflective outer layer 433 may form a reflecting surface on the surface of the heat insulation inner layer 432 to achieve reflecting effect.

**[0076]** In addition, the reflective outer layer 433 may be made of reflective material. The reflective material may be fluorocarbon coating. The fluorocarbon coating may be composed of 4F type fluororesin and special heat insulation material. After the fluorocarbon coating forms a film, a coating film is formed which has high reflectivity and high thermal resistance. When the sunshine shines on the coating film, major of energy of the sunshine will be reflected back, and is prevented from transmitting to the inner of the tank.

**[0077]** In addition, the reflective material is not limited to the fluorocarbon coating, but also may be other reflective material.

**[0078]** The heat insulation inner layer 432 and the reflecting layer 433 may be coated on the tank 42 by many kinds of manners.

**[0079]** In one manner, the heat insulation inner layer 432 is a coating layer formed on the tank 42 by brush coating or spray coating of heat-preservation material. The reflective outer layer 433 is a thin pasting-film or a

thin blanket made of fluorocarbon material, which may be bonded to the heat insulation inner layer 432 by pasting. The total thickness of the heat insulation inner layer 432 and the reflective outer layer 433 is between 0.1mm to 10mm.

**[0080]** In another manner, the heat insulation inner layer 432 is a thin pasting-film or a thin blanket made of heat-preservation material, which may be bonded to the tank 22 by pasting. The reflective outer layer 433 is a coating layer formed on the heat insulation inner layer 432 by brush coating or spray coating of fluorocarbon material. The total thickness of the heat insulation inner layer 432 and the reflective outer layer 433 is between 0.1mm to 10mm

**[0081]** In further another manner, the heat insulation inner layer 432 is a coating layer formed on the tank 42 by brush coating or spray coating of heat-preservation material. The reflective outer layer 433 is a coating layer formed on the heat insulation inner layer 432 by brush coating or spray coating of fluorocarbon material. The total thickness of the heat insulation inner layer 432 and the reflective outer layer 433 is between 0.1mm to 2 mm.

**[0082]** In further another manner, the heat insulation inner layer 432 is a thin pasting-film or a thin blanket made of heat-preservation material, which may be bonded to the tank 42 by pasting. The reflective outer layer 433 is a thin pasting-film or a thin blanket made of fluorocarbon material, which may be bonded to the heat insulation inner layer 432 by pasting. The total thickness of the heat insulation inner layer 432 and the reflective outer layer 433 is between 0.1mm to 10 mm.

**[0083]** In above arrangements one and two, the outer surface of the tank is coated by a heat insulation and reflective layer, which covers the whole tank, as to make an entire heat insulation layer formed on the outside of the tank, which has a good heat insulation effect. Compared to the manner of "a heat-preservation material layer is coated on the outer of the tank, and fixed to the tank by an outer packing sheet (the total weight of the heat-preservation material layer and the outer packing sheet is 200kg)" in the traditional technique, the thickness and the weight of the heat insulation and reflective layer in the present disclosure are reduced obviously.

**[0084]** The heat insulation and reflective layer has a good heat insulation and reflecting effect, which may achieve the heat insulation level of "having heat insulation layer" regulated in the IMDG-"International Maritime Dangerous Goods Code" or other laws and regulations.

**[0085]** Therefore, according to regulations of the IMDG-"International Maritime Dangerous Goods Code", the design reference temperature may decrease to 50°C. Accordingly, the maximum allowable working pressure (MAWP) of the cylinder body also decreases, and the design pressure decreases as well, thereby avoiding potential safe risk caused by high pressure within the tank.

**[0086]** It should be noted that, the examples in the above embodiments are all tank container. But not limited to tank container, the storage and transportation contain-

er in this disclosure may be other transportable pressure vessel, eg. a pressure vessel without frame.

[0087] Therefore, the embodiments described above are merely some preferable ones, and the disclosure is not limited to any specific details of these embodiments. An ordinary person skilled in the art would readily appreciate that modifications or changes based on the principles of the disclosure. Accordingly, the scope of the present invention should be limited solely by the appended claims.

## Claims

1. Tank container (10, 20, 30, 40), comprising:

a tank (12, 22, 32, 43) comprising a cylinder body (121, 221, 321, 421) and two sealing heads (122, 222, 322, 422) configured to seal two end openings of the cylinder body (121, 221, 321, 421) respectively;

a heat insulation and reflective layer (13, 23, 33, 43) disposed on the outside of the tank, wherein the heat insulation and reflective layer (13, 23, 33, 43) covers at least an upper surface of the cylinder body (121, 221, 321, 421) comprising a top surface of the cylinder body and a part of side surface extending from the top surface, and the heat insulation and reflective layer (13, 23, 33, 43) covers at least one third of total area of the cylinder body (121);

**characterized in that** the heat insulation and reflective layer comprises (13, 33) non-metal hollow microspheres (131, 331) with heat insulation and reflective function, the diameter of the non-metal hollow microspheres (131, 331) is between 5 $\mu$ m and 100 $\mu$ m, and the heat insulation and reflective layer (13, 23, 33, 43) further comprises resin matrix, in which the non-metal hollow microspheres (131, 331) are filled.

2. Tank container (30, 40) according to claim 1, **characterized in that** the heat insulation and reflective layer (33, 43) covers the outer surfaces of the cylinder body (321, 421) and the sealing heads (322, 422) to make the whole tank body (32, 42) in the coverage.

3. Tank container (10, 20, 30, 40) according to claim 1 or 2, **characterized in that** the heat insulation and reflective layer (13, 33) is a coating layer formed on the tank by brush coating or spray coating.

4. Tank container (10, 20, 30, 40) according to claim 3, **characterized in that** the thickness of the coating layer is between 0.1mm and 2mm.

5. Tank container (10, 20, 30, 40) according to claim 1 or 2, **characterized in that** the heat insulation and

reflective layer (13, 33) is a thin pasting-film or a thin blanket, the thickness of the pasting-film or the thin blanket is between 0.1mm and 10mm.

6. Tank container (10, 30) according to claim 1, **characterized in that** the non-metal hollow microspheres (131, 331) comprise glass hollow microspheres and/or ceramic hollow microspheres.

7. Tank container (10, 20, 30, 40), comprising:

a tank (12, 22, 32, 43) comprising a cylinder body (121, 221, 321, 421) and two sealing heads (122, 222, 322, 422) configured to seal two end openings of the cylinder body (121, 221, 321, 421) respectively;

a heat insulation and reflective layer (13, 23, 33, 43) disposed on the outside of the tank, wherein the heat insulation and reflective layer (13, 23, 33, 43) covers at least an upper surface of the cylinder body (121, 221, 321, 421) comprising a top surface of the cylinder body and a part of side surface extending from the top surface, and the heat insulation and reflective layer (13, 23, 33, 43) covers at least one third of total area of the cylinder body (121);

**characterized in that** the heat insulation and reflective layer (23, 43) comprises a heat insulation inner layer (232, 432) being made of a heat preservation material and a reflective outer layer (233, 433) being made of a reflective material;

Wherein the total thickness of the heat insulation inner layer (232, 432) and the reflective outer layer (233, 433) is between 0.1mm and 10mm; the reflective outer layer (233, 433) forms a reflecting surface on the surface of the heat insulation inner layer (232, 432), and the heat insulation inner layer (232, 432) is a coating layer formed on the cylinder body (121, 221, 321, 421).

8. Tank container (20, 40) according to claim 7, **characterized in that** the heat insulation inner layer (232, 432) is a coating layer, a pasting-film or a thin blanket, and the reflective outer layer (233, 433) is a coating layer, a pasting-film or a thin blanket.

9. Tank container (20, 40) according to one of claims 7 to 8, **characterized in that** the heat-preservation material is selected from any one of silicate, rare earth and aerogel.

10. Tank container (20, 40) according to one of claims 7 to 8, **characterized in that** the reflective material is a fluorocarbon coating.

## Patentansprüche

### 1. Tankcontainer (10, 20, 30, 40), umfassend:

einen Tank (12, 22, 32, 43) umfassend einen Zylinderkörper (121, 221, 321, 421) und zwei Dichtköpfe (122, 222, 322, 422), die so konfiguriert sind, dass sie jeweils zwei Endöffnungen des Zylinderkörpers (121, 221, 321, 421) abdichten;

eine wärmedämmende und reflektierende Schicht (13, 23, 33, 43), die an der Außenseite des Tanks angeordnet ist, wobei die wärmedämmende und reflektierende Schicht (13, 23, 33, 43) mindestens eine obere Fläche des Zylinderkörpers (121, 221, 321, 421) bedeckt, die eine Deckfläche des Zylinderkörpers und einen Teil einer Seitenfläche umfasst, der sich von der Deckfläche aus erstreckt, und die wärmedämmende und reflektierende Schicht (13, 23, 33, 43) mindestens ein Drittel der Gesamtfläche des Zylinderkörpers (121) bedeckt;

**dadurch gekennzeichnet, dass** die wärmedämmende und reflektierende Schicht (13, 33) nichtmetallische Mikrohohlkugeln (131, 331) mit wärmedämmender und reflektierender Funktion umfasst, der Durchmesser der nichtmetallischen Mikrohohlkugeln (131, 331) zwischen 5  $\mu\text{m}$  und 100  $\mu\text{m}$  liegt, und die wärmedämmende und reflektierende Schicht (13, 23, 33, 43) ferner eine Harzmatrix umfasst, in welche die nichtmetallischen Mikrohohlkugeln (131, 331) gefüllt sind.

### 2. Tankcontainer (30, 40) nach Anspruch 1, **dadurch gekennzeichnet, dass** die wärmedämmende und reflektierende Schicht (33, 43) die Außenflächen des Zylinderkörpers (321, 421) und der Dichtköpfe (322, 422) bedeckt, um den gesamten Tankkörper (32, 42) zu bedecken.

### 3. Tankcontainer (10, 20, 30, 40) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die wärmedämmende und reflektierende Schicht (13, 33) eine Beschichtungsschicht ist, die auf dem Tank durch Bürstenbeschichtung oder Sprühbeschichtung gebildet wird.

### 4. Tankcontainer (10, 20, 30, 40) nach Anspruch 3, **dadurch gekennzeichnet, dass** die Dicke der Beschichtungsschicht zwischen 0,1 mm und 2 mm beträgt.

### 5. Tankcontainer (10, 20, 30, 40) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die wärmedämmende und reflektierende Schicht (13, 33) ein dünner Klebefilm oder eine dünne Lage ist, wobei die Dicke des Klebefilms oder der dünnen Lage zwi-

schen 0,1 mm und 10 mm liegt.

### 6. Tankcontainer (10, 30) nach Anspruch 1, **dadurch gekennzeichnet, dass** die nichtmetallischen Mikrohohlkugeln (131, 331) Mikrohohlkugeln aus Glas und/oder Mikrohohlkugeln aus Keramik umfassen.

### 7. Tankcontainer (10, 20, 30, 40), umfassend:

einen Tank (12, 22, 32, 43) umfassend einen Zylinderkörper (121, 221, 321, 421) und zwei Dichtköpfe (122, 222, 322, 422), die so konfiguriert sind, dass sie jeweils zwei Endöffnungen des Zylinderkörpers (121, 221, 321, 421) abdichten;

eine wärmedämmende und reflektierende Schicht (13, 23, 33, 43), die an der Außenseite des Tanks angeordnet ist, wobei die wärmedämmende und reflektierende Schicht (13, 23, 33, 43) mindestens eine obere Fläche des Zylinderkörpers (121, 221, 321, 421) bedeckt, die eine Deckfläche des Zylinderkörpers und einen Teil einer Seitenfläche umfasst, der sich von der Deckfläche aus erstreckt, und die wärmedämmende und reflektierende Schicht (13, 23, 33, 43) mindestens ein Drittel der Gesamtfläche des Zylinderkörpers (121) bedeckt;

**dadurch gekennzeichnet, dass** die wärmedämmende und reflektierende Schicht (23, 43) eine wärmedämmende Innenschicht (232, 432), die aus einem Wärmeermhaltungsmaterial hergestellt ist, und eine reflektierende Außenschicht (233, 433), die aus einem reflektierenden Material hergestellt ist, umfasst;

wobei die Gesamtdicke der wärmedämmenden Innenschicht (232, 432) und der reflektierenden Außenschicht (233, 433) zwischen 0,1 mm und 10 mm liegt;

die reflektierende Außenschicht (233, 433) eine reflektierende Oberfläche auf der Oberfläche der wärmedämmenden Innenschicht (232, 432) bildet, und die wärmedämmende Innenschicht (232, 432) eine auf dem Zylinderkörper (121, 221, 321, 421) gebildete Beschichtungsschicht ist.

### 8. Tankcontainer (20, 40) nach Anspruch 7, **dadurch gekennzeichnet, dass** die wärmedämmende Innenschicht (232, 432) eine Beschichtungsschicht, ein Klebefilm oder eine dünne Lage ist, und die reflektierende Außenschicht (233, 433) eine Beschichtungsschicht, ein Klebefilm oder eine dünne Lage ist.

### 9. Tankcontainer (20, 40) nach einem der Ansprüche 7 bis 8, **dadurch gekennzeichnet, dass** das Wärmeermhaltungsmaterial aus einem Silikat, einer seltenen Erde oder einem Aerogel ausgewählt ist.

10. Tankcontainer (20, 40) nach einem der Ansprüche 7 bis 8, **dadurch gekennzeichnet, dass** das reflektierende Material eine Fluorkohlenstoffbeschichtung ist.

## Revendications

1. Conteneur citerne (10, 20, 30, 40) comprenant :

une citerne (12, 22, 32, 43) comprenant un corps cylindrique (121, 221, 321, 421) et deux têtes de scellage (122, 222, 322, 422) configurées pour sceller respectivement deux ouvertures d'extrémité du corps cylindrique (121, 221, 321, 421);

une couche d'isolation thermique et de réflexion (13, 23, 33, 43) disposée à l'extérieur de la citerne, où la couche d'isolation thermique et de réflexion (13, 23, 33, 43) couvre au moins une surface supérieure du corps cylindrique (121, 221, 321, 421) comprenant une surface de dessus du corps cylindrique et une partie d'une surface latérale s'étendant à partir de la surface de dessus, et la couche d'isolation thermique et de réflexion (13, 23, 33, 43) couvre au moins un tiers de la surface totale du corps cylindrique (121);

**caractérisé en ce que** la couche d'isolation thermique et de réflexion comprend (13, 33) des microsphères creuses non métalliques (131, 331) ayant une fonction d'isolation thermique et de réflexion, le diamètre des microsphères creuses non métalliques (131, 331) est compris entre 5  $\mu\text{m}$  et 100  $\mu\text{m}$ , et la couche d'isolation thermique et de réflexion (13, 23, 33, 43) comprend en outre une matrice de résine, dans laquelle les microsphères creuses non métalliques (131, 331) sont remplies.

2. Conteneur citerne (30, 40) selon la revendication 1, **caractérisé en ce que** la couche d'isolation thermique et de réflexion (33, 43) couvre les surfaces extérieures du corps cylindrique (321, 421) et des têtes de scellage (322, 422) pour que l'ensemble du corps de la citerne (32, 42) soit recouvert.

3. Conteneur citerne (10, 20, 30, 40) selon la revendication 1 ou 2, **caractérisé en ce que** la couche d'isolation thermique et de réflexion (13, 33) est une couche de revêtement formée sur la citerne par enduction à la brosse ou enduction par pulvérisation.

4. Conteneur citerne (10, 20, 30, 40) selon la revendication 3, **caractérisé en ce que** l'épaisseur de la couche de revêtement est comprise entre 0,1 mm et 2 mm.

5. Conteneur citerne (10, 20, 30, 40) selon la revendication 1 ou 2, **caractérisé en ce que** la couche d'isolation thermique et de réflexion (13, 33) est une fine couche d'encollage ou une fine couverture, l'épaisseur de la couche d'encollage ou de la fine couverture étant comprise entre 0,1 mm et 10 mm.

6. Conteneur citerne (10, 30) selon la revendication 1, **caractérisé en ce que** les microsphères creuses non métalliques (131, 331) comprennent des microsphères creuses en verre et/ou des microsphères creuses en céramique.

7. Conteneur citerne (10, 20, 30, 40) comprenant :

une citerne (12, 22, 32, 43) comprenant un corps cylindrique (121, 221, 321, 421) et deux têtes de scellage (122, 222, 322, 422) configurées pour sceller respectivement deux ouvertures d'extrémité du corps cylindrique (121, 221, 321, 421);

une couche d'isolation thermique et de réflexion (13, 23, 33, 43) disposée à l'extérieur de la citerne, où la couche d'isolation thermique et de réflexion (13, 23, 33, 43) couvre au moins une surface supérieure du corps cylindrique (121, 221, 321, 421) comprenant une surface de dessus du corps cylindrique et une partie d'une surface latérale s'étendant à partir de la surface de dessus, et la couche d'isolation thermique et de réflexion (13, 23, 33, 43) couvre au moins un tiers de la surface totale du corps cylindrique (121);

**caractérisé en ce que** la couche d'isolation thermique et de réflexion (23, 43) comprend une couche intérieure d'isolation thermique (232, 432) constituée d'un matériau de conservation de la chaleur et une couche extérieure réfléchissante (233, 433) constituée d'un matériau réfléchissant;

où l'épaisseur totale de la couche intérieure d'isolation thermique (232, 432) et de la couche extérieure réfléchissante (233, 433) est comprise entre 0,1 mm et 10 mm;

la couche extérieure réfléchissante (233, 433) forme une surface réfléchissante sur la surface de la couche intérieure d'isolation thermique (232, 432), et la couche intérieure d'isolation thermique (232, 432) est une couche de revêtement formée sur le corps cylindrique (121, 221, 321, 421).

8. Conteneur citerne (20, 40) selon la revendication 7, **caractérisé en ce que** la couche intérieure d'isolation thermique (232, 432) est une couche de revêtement, une couche d'encollage ou une fine couverture, et la couche extérieure réfléchissante (233, 433) est une couche de revêtement, une couche

d'encollage ou une fine couverture.

9. Conteneur citerne (20, 40) selon l'une des revendications 7 à 8, **caractérisé en ce que** le matériau de conservation de la chaleur est choisi parmi un silicate, une terre rare ou un aérogel. 5
10. Conteneur citerne (20, 40) selon l'une des revendications 7 à 8, **caractérisé en ce que** le matériau réfléchissant est un revêtement en fluorocarbone. 10

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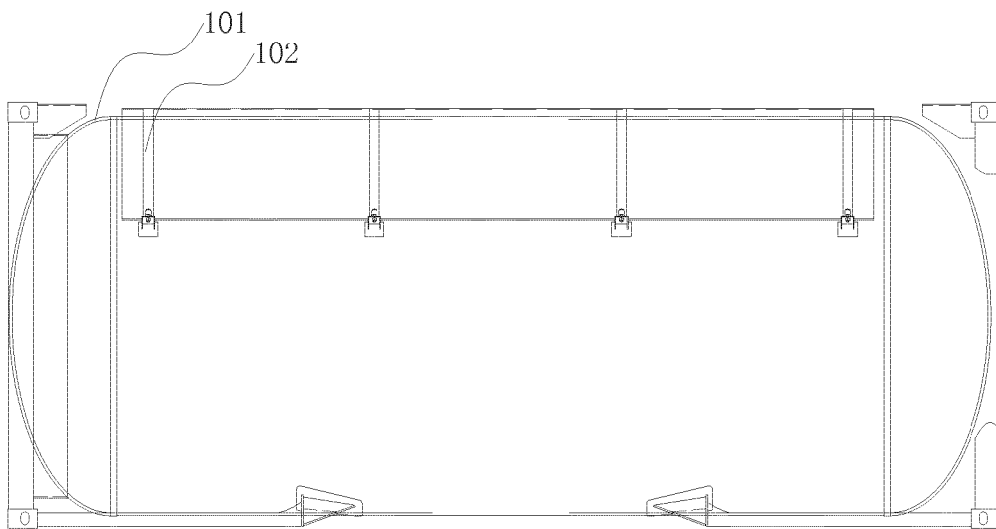


FIG.1

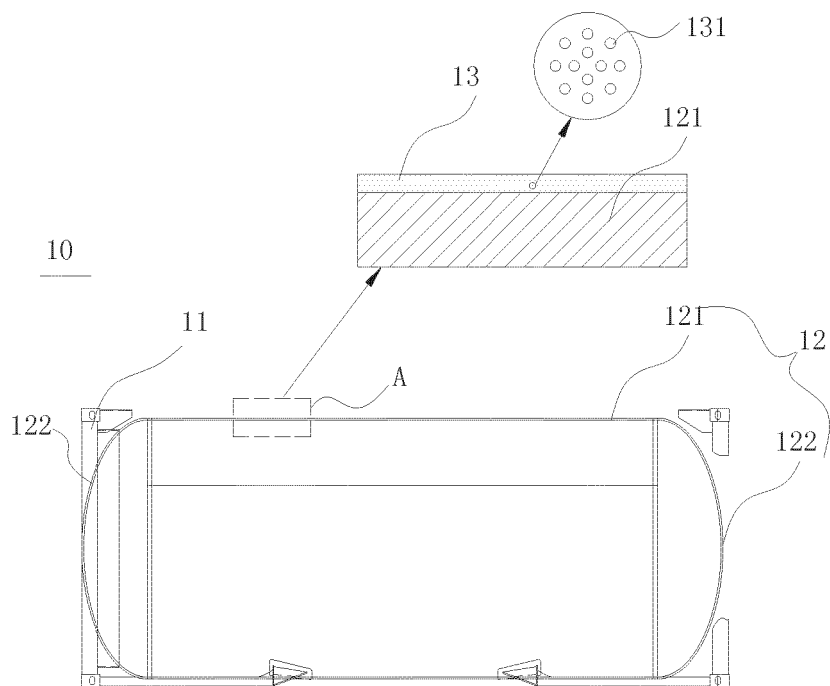


FIG. 2a

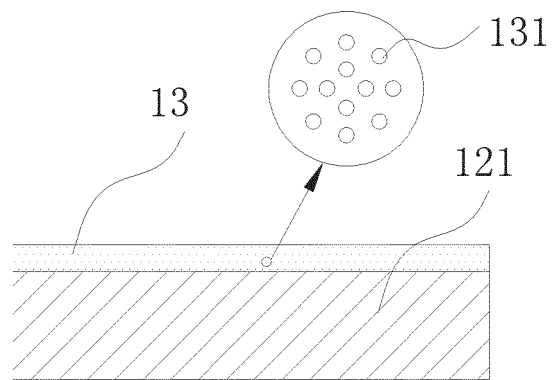


FIG. 2b

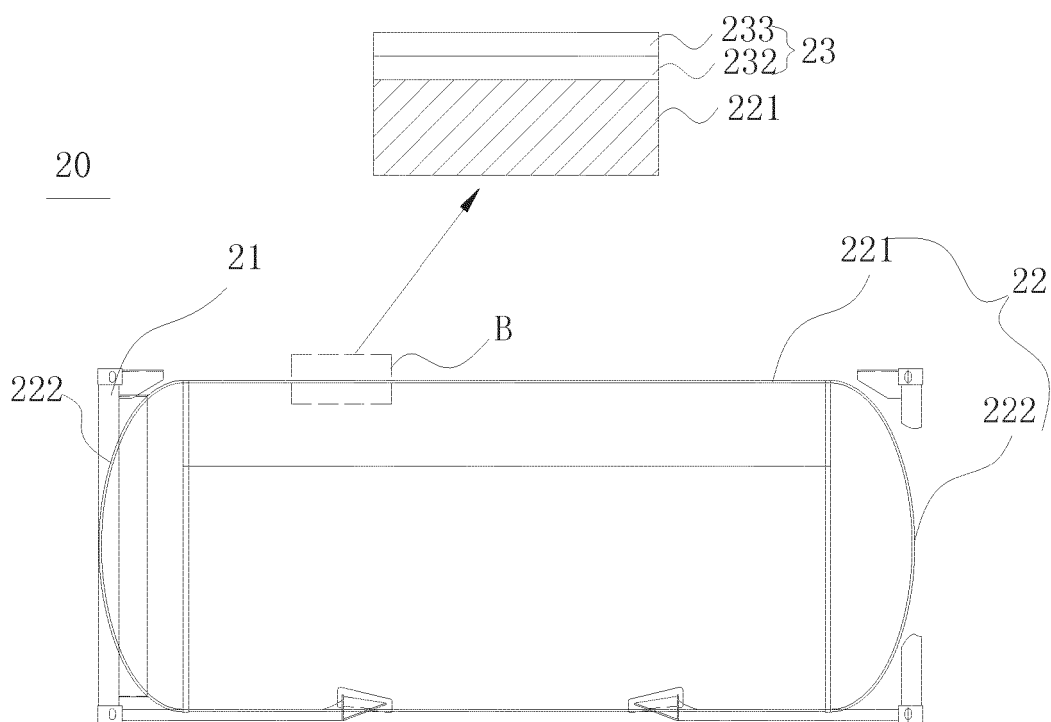


FIG. 3a

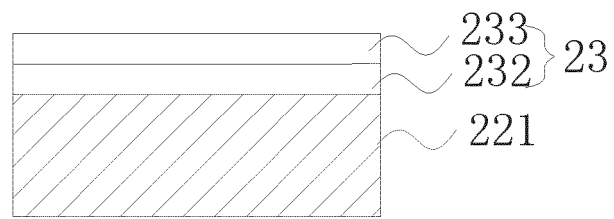


FIG. 3b

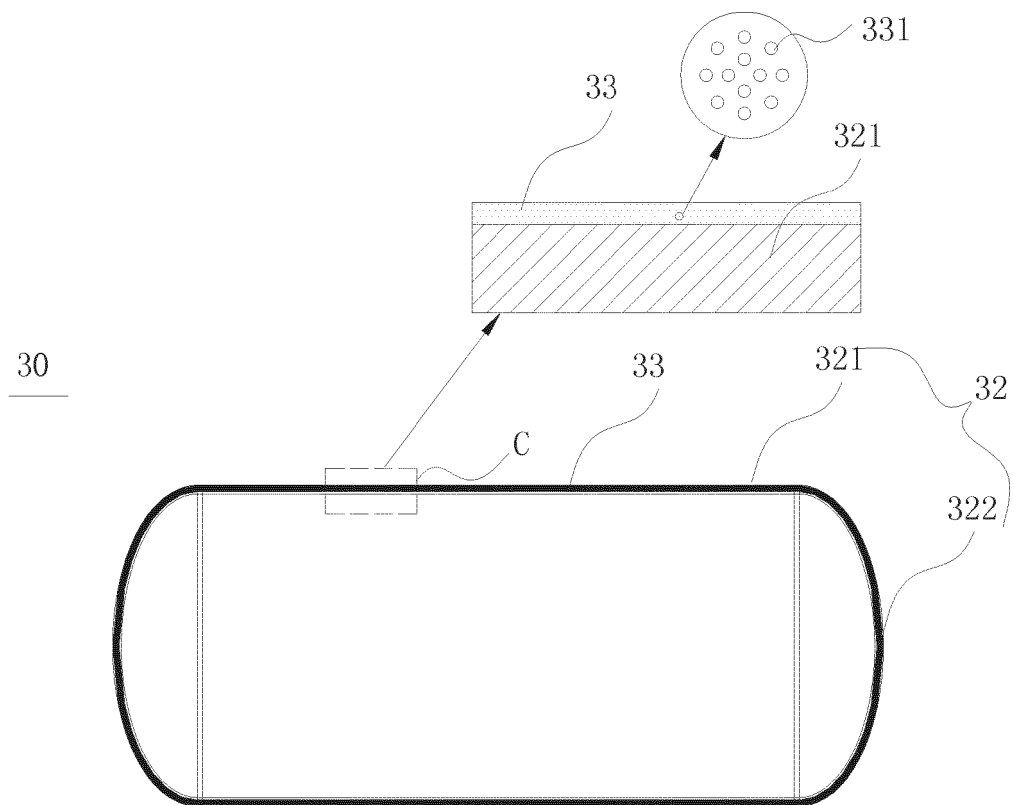


FIG. 4a

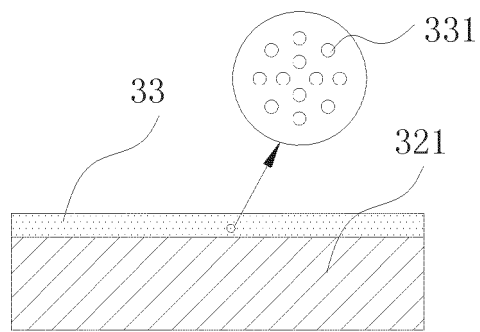


FIG. 4b

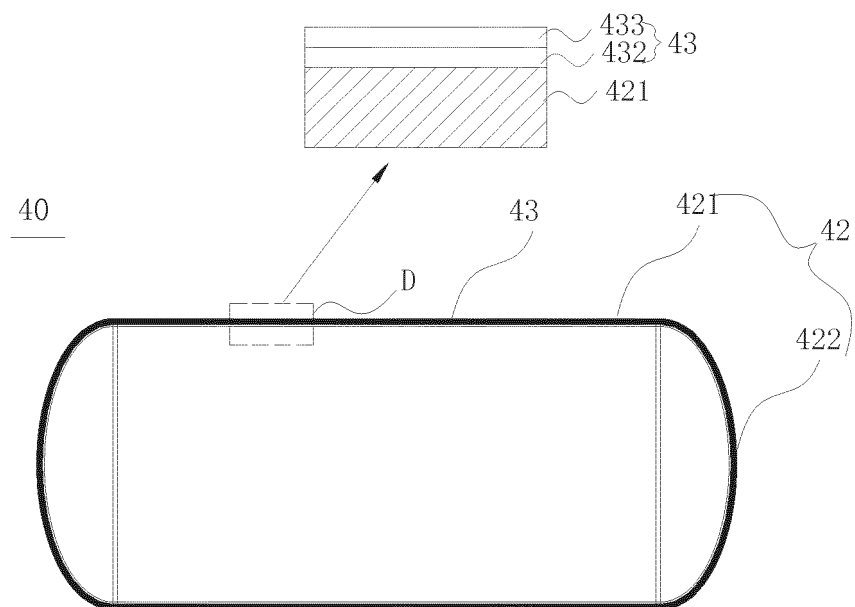


FIG. 5a

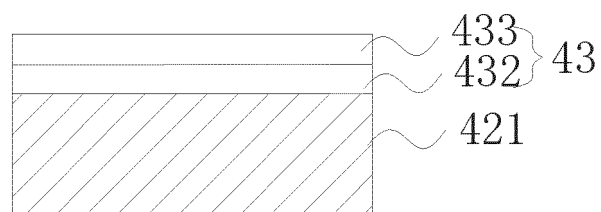


FIG. 5b

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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