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(54) Boss structure

(57) The present invention relates to the boss structure (1) of the CNG (compressed natural gas) tanks. The boss structure (1), which is manufactures in a single stage, can resist the forces created by the pressure of compressed natural gas in the axial direction of the tank. The boss structure (1) of the present invention has a boss part (4) which can be fixed on an outer apparatus during torquing and tightening of the valve and which thus enables to prevent transmission of the resulting torque to the internal liner which has a weak strength.

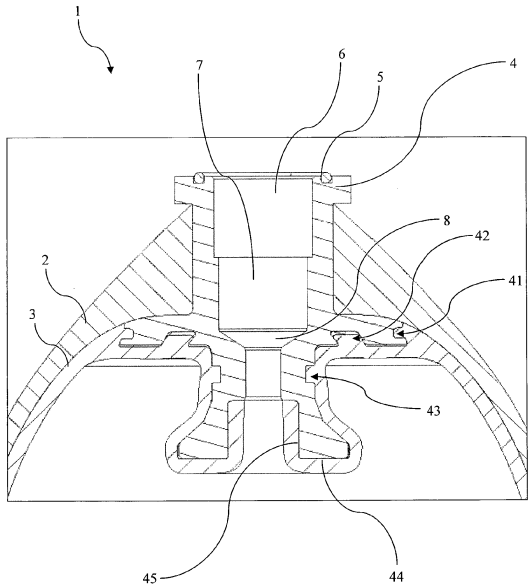

Figure 1

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Description

Field of the Invention

[0001] The present invention relates to a boss structure of compressed natural gas tanks which enable to store natural gas on vehicles.

Background of the Invention

[0002] The storage method that is most widely used for storing natural gas on vehicles is storage via compression. Storage in CNG (Compressed Natural Gas) tanks is made in cylindrical tanks under 200-250 bar pressure.

[0003] There are four types of compressed natural gas tanks:

1. Metal tanks made of high quality steel.
2. Hoop wrapped filament resin matrix composite tanks with steel or aluminum metal internal liner.
3. Fully wrapped filament resin matrix composite tanks with steel or aluminum metal internal liner.
4. Fully wrapped filament resin matrix composite tanks similar to type-3 but with non-metallic internal liner.

[0004] When Composite Type-4 CNG Tanks are examined, it is seen that they are comprised of the following sub-layers of different materials.

- Plastic internal liner
- Boss section metal part
- Composite wrap layer

[0005] In Composite Type-4 CNG Tanks, a boss section part made of a metallic material is used for providing a gastight (sealing) connection with a valve to be coupled at the boss section. In order to enable safe storage of natural gas under high pressure in the tank, the metal boss section part should be rigidly fixed into the plastic internal liner.

[0006] The first one of the forces that will act on the metal boss section part is the pressure of the compressed natural gas that will act on in the axial direction of the tank. The second force is the rotation force that will act on in composite winding process and torquing and tightening the valve to the boss section metal part. A solution should be provided to the problem by developing solutions of integration with the plastic internal liner so as to provide strength of the metal boss section part against these forces.

[0007] When solutions of integration with plastic internal liner of the metal boss section part of Composite Type-4 CNG Tanks are reviewed, it is seen that different patents have developed different solutions.

[0008] The most widely used applications are filling the gaps of different forms provided on the metal boss section part by the molten plastic material during production of the plastic internal liner and thereby providing integration. The most critical points here are the form of the gaps, ability to produce this form with gaps in the metal boss insert (1) by the selected production method, and ability to fill these gaps by the production method selected during production of the plastic internal liner. It is expected that the integration form provided after the production ensures the expected strength criteria.

[0009] It is observed that casting method is used in production of the metal boss section part, while plastic blow-molding method is widely used for production of plastic internal liner. Another application used in production of plastic internal liner (3) is producing the boss section parts via plastic injection and then welding it with the middle cylindrical part produced by extrusion via plastic butt welding.

[0010] The United States patent document no. US5476189, an application in the state of the art, discloses a pressure vessel for holding fluidized gases. The vessel comprises an outer shell fabricated of a composite material. A damage mitigating material is used in the outer shell, and its design is made different for safety purposes.

[0011] The European patent document no. EP0550951A1, an application in the state of the art, discloses a boss region having a polar opening in a pressure vessel. The boss comprises a filament wound outer shell and a non-metallic internal liner.

[0012] The United States patent document no US5979692, an application in the state of the art, discloses a boss section pressure vessel. The boss includes an outer reinforcing shell and an inner liner having a radially extending flange.

Summary of the Invention

[0013] The objective of the present invention is to provide a boss structure which can be produced in a single stage.

[0014] Another objective of the present invention is to provide a boss structure which can resist the forces created by the pressure of compressed natural gas in the axial direction of the tank.

[0015] A further objective of the present invention is to provide a boss structure which can be fixed on an outer apparatus during torquing and tightening of the valve and which thus enables to prevent transmission of the resulting torque to the internal liner which has a weak strength.

[0016] Another objective of the present invention is to provide a boss structure which provides strength in the rotation direction since it does not rotate independent of the internal liner.

Detailed Description of the Invention

[0017] "Boss structure" developed to fulfill the objectives of the present invention is illustrated in the accom-

panying figures wherein

Figure 1 is the front view of the boss structure.
Figure 2 is the top view of the upper part of the boss structure.
Figure 3 is the bottom view of the lower part of the boss structure.

[0018] The components given in the figures are assigned reference numbers as follows:

1. Boss structure
2. Outer shell
3. Internal liner
4. Boss part
    41. First recess
    42. Second recess
    43. Third recess
    44. Lower surface
    45. Inner wall
5. Sealing gasket
6. Valve mounting surface
7. Sealing surface
8. Flow surface

[0019] The boss structure (1) of the present invention comprises:

- at least one outer shell (2),
- at least one internal liner (3) which contacts the outer shell (2) from its inner surface,
- at least one boss part (4) which is located in the outer shell (2) at the entrance part of the tank,
- a sealing gasket (5) which ensures gastight connection of the boss part (4) with the valve,
- at least one valve mounting surface (6) to which the valve is mounted,
- a sealing surface (7) which provides sealing by interference fitting with the gaskets on the valve,
- at least one flow surface (8) which is designed to enable natural gas flow.

[0020] The invention relates to a coated or uncoated metal boss structure (insert) which is used in composite type CNG (compressed natural gas) tanks.

[0021] The outer shell (2) is manufactured from a composite material. In the preferred embodiment of the invention, resin and carbon fiber filament material are used as composite material for producing the outer shell (2). The main function of the outer shell (2) is to provide strength against the high pressure load produced by the compressed natural gas (CNG) stored in the tank.

[0022] The internal liner (3) enables sealing for the high pressure compressed natural gas stored therein and provides a surface for the outer shell (2) that is wrapped thereon. In the preferred embodiment of the invention, the internal liner (3) can be produced with different plastic materials such as HDPE (high density polyethylene), XPE (cross-linked polyethylene), PP (Polypropylene) and PA (polyamide) and mixtures thereof by using rotational molding method. In order to further improve the feature of gas-tightness (sealing), "fluoridation" can also be applied to the tanks produced with rotational molding method.

[0023] The boss part (4) enables a sealing connection with the valve that is mounted to the tank for controlling natural gas flow. When performing this function, the boss part (4), which is preferably made of a metal material, should be rigidly integrated with the internal liner (3) so that it can maintain its position under high pressure.

[0024] The boss part (4) should also be resistant against the rotational forces acting thereon.

[0025] The boss part (4) is preferably made of aluminum material considering the strength and weight criteria. It can be produced coated or uncoated in order to provide different features. All of the integration solutions used in the design are provided so as to allow production of the boss part (4), which is preferably made of aluminum material, by machining (metal cutting) methods in an economical manner. In mass production conditions, the part can be economically produced at higher numbers by casting method. The boss part (4) can be produced completely during production of the internal liner (3) via rotational molding method, by being processed directly in the internal liner (3) mold by providing integration with the internal liner (3).

[0026] The first recess (41), which is located at the parts where the boss part (4) enters into the internal liner (3) at the large diameter area where the boss part (4) is connected with the internal liner (3) at the side surfaces, is filled with internal liner (3) material preferably produced of plastic and thereby enhances strength of the boss part (4) in the axial direction.

[0027] The second recess (42) in the form of a half dovetail, which is located at the area where the boss part (4) contacts the internal liner (3) on its lower surface at the large diameter area, is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

[0028] The third recess (43), which is located on the outer surface of the small diameter area of the boss part (4), is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

[0029] The lower surface (44), which is located at the area of the boss part (4) where its diameter expands, is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

[0030] The inner wall (45), which is located on the inner surface of the wide lower area of the boss part (4) and which is preferably threaded, is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

[0031] At the outermost part of the boss structure (1)

where it is opened to the atmosphere, there is provided a sealing gasket (5) which enables gas-tightness of the valve that will be mounted to the tank. The valve (4) can be tightened to the boss part (4) under torque by using a sealing gasket (5).

[0032] In addition to the ability of being produced in an economical manner, the boss structure (1) of the present invention brings along integration solutions, different aspects and advantages.

[0033] Solutions which protect the metal boss part (4) against the force created by the pressure of the compressed natural gas in the axial direction of the tank are as follows:

1. The first recess (41) at the end part of the large diameter area,
2. Second recess (42) in the form of a half dovetail at the lower part of the large diameter area,
3. Third recess (43) at the outer surface of the small diameter area,
4. Lower surface (44) on the wider diameter bottom area,
5. Threaded inner wall (45) on the inner surface of the wide bottom area.

[0034] Solutions which protect the metal boss part (4) against the forces that force the tank to rotate in rotational direction are as follows:

1. The outermost surface of the boss part (4) is designed such that it will be flat from two sides at diameter. These flat surfaces enable the boss part (4) to be fixed on an outer apparatus when the valve is torqued and tightened to the boss part (4) and enables to prevent transmission of the torque to the plastic internal liner (3) material which has weak strength.

2. The diameter on the lowermost surface of the boss part (4) is designed such that it will be flat on four sides. These flat surfaces are coated with a plastic material and prevent the boss part (4) from rotating independent of the plastic internal liner (3) and thereby enable strength in the rotation direction.

[0035] In composite type CNG tanks, composite resin outer shell (2), plastic internal liner (3) and metal boss part (4) are used together in harmony and thereby the tank is enabled to fulfill the expected targets.

Claims

1. A boss structure (1), which is a member of the tank structure that enables to store compressed natural gas on vehicles, and which basically **comprises**

- at least one outer shell (2),
- at least one internal liner (3) which is located in the inner surface of the outer shell (2) which is gripped by the outer shell (2),
- at least one boss part (4) which is located in the outer shell (2) at the entrance part of the tank,
- a sealing gasket (5) which ensures gastight connection of the boss part (4) with the valve,
- at least one valve mounting surface (6) to which the valve is mounted,
- a sealing surface (7) which provides sealing by interference fitting with the gaskets on the valve,
- at least one flow surface (8) which is designed to enable natural gas flow.

2. A boss structure (1) according to Claim 1, **characterized by** a first recess (41), which is filled with internal liner (3) material preferably produced of plastic and thereby enhances strength of the boss part (4) in the axial direction, and which is located at the parts where the boss part (4) enters into the internal liner (3) at the large diameter area where the boss part (4) is connected with the internal liner (3) at the side surfaces.

3. A boss structure (1) according to Claim 1 and Claim 2, **characterized by** a second recess (41) in the form of a half dovetail, which is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction, and which is located at the area where the boss part (4) contacts the internal liner (3) on its lower surface at the large diameter area.

4. A boss structure (1) according to any one of the preceding claims, **characterized by** a third recess (43), which is located on the outer surface of the small diameter area of the boss part (4) and which is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

5. A boss structure (1) according to any one of the preceding claims, **characterized by** a lower surface (44), which is located at the area of the boss part (4) where its diameter expands, and which is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction.

6. A boss structure (1) according to any one of the preceding claims, **characterized by** a preferably threaded inner wall (45), which is filled with internal liner (3) material and thereby enhances strength of the boss part (4) in the axial direction, and is located on the inner surface of the wide lower area of the boss part (4).

7. A boss structure (1) according to Claim 1, **characterized by** the outer shell (2), which is made of composite material, and for production of which resin and

carbon fiber filament are used as composite material in the preferred embodiment of the invention.

8. A boss structure (1) according to Claim 7, **characterized by** the outer shell (2) which provides strength against the high pressure load produced by the compressed natural gas (CNG) stored in the tank.

9. A boss structure (1) according to Claim 1, **characterized by** the internal liner (3) which provides sealing for the high pressure compressed natural gas stored therein and forms a surface for the outer shell (2) that is wrapped thereon.

10. A boss structure (1) according to Claim 9, **characterized by** the internal liner (3) which, in the preferred embodiment of the invention, can be produced with different plastic materials such as HDPE (high density polyethylene), XPE (cross-linked polyethylene), PP (Polypropylene) and PA (polyamide) and mixtures thereof by using rotational molding method.

11. A boss structure (1) according to Claim 1, **characterized by** the boss part (4) which provides a sealing connection with the valve that is mounted to the tank for controlling natural gas flow.

12. A boss structure (1) according to Claim 11, **characterized by** the boss part (4) which is rigid enough to maintain its position under high pressure, enables integration with the internal liner (3) and is also resistant against the rotational forces acting thereon and which is preferably made of metal material.

13. A boss structure (1) according to Claim 12, **characterized by** the boss part (4) which is produced coated or uncoated preferably of aluminum material in order to provide different features taking into account the strength and weight criteria.

14. A boss structure (1) according to Claims 11 to 13, **characterized by** the boss part (4) which can be produced during production of the internal liner (3) via rotational molding method, by being processed directly in the internal liner (3) mold integral with the internal liner (3).

15. A boss structure (1) according to any one of the preceding claims, **characterized by** the sealing gasket (5) which, at the outermost part of the boss structure (1) where it is opened to the atmosphere, enables gas-tightness of the valve that will be mounted to the tank and the ability to tighten the said valve under torque to the boss part (4).

16. A boss structure (1) according to any one of the preceding claims, **characterized by** the composite resin outer shell (2), plastic internal liner (3) and metal boss part (4) in the preferred embodiment of the invention.

17. A boss structure (1) according to Claim 12, **characterized by** the boss part (4), which is fixed on an outer apparatus during torquing and tightening of the valve, and which thus enables to prevent transmission of the torque to the internal liner (3) material which has a weak strength.

18. A boss structure (1) according to any one of the preceding claims, **characterized by** the flow surface (8), which, in the preferred embodiment of the invention, is produced in a conical shape and thereby conveniently provides natural gas flow.

19. A boss structure (1) according to any one of the preceding claims, **characterized by** the valve mounting surface (6), which, in the preferred embodiment of the invention, is threaded allowing mounting of the valve to the metal boss part (4).

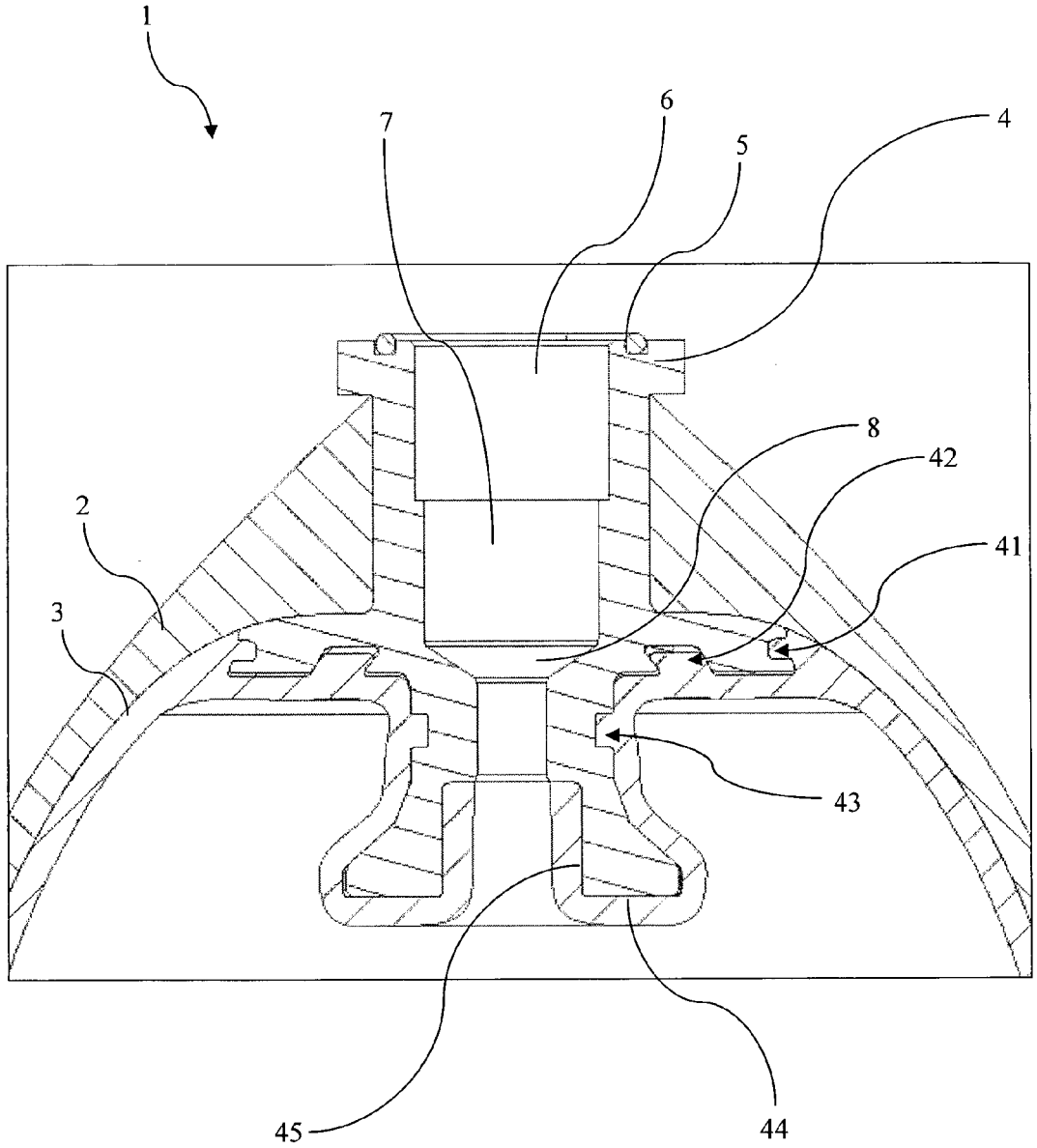

Figure 1

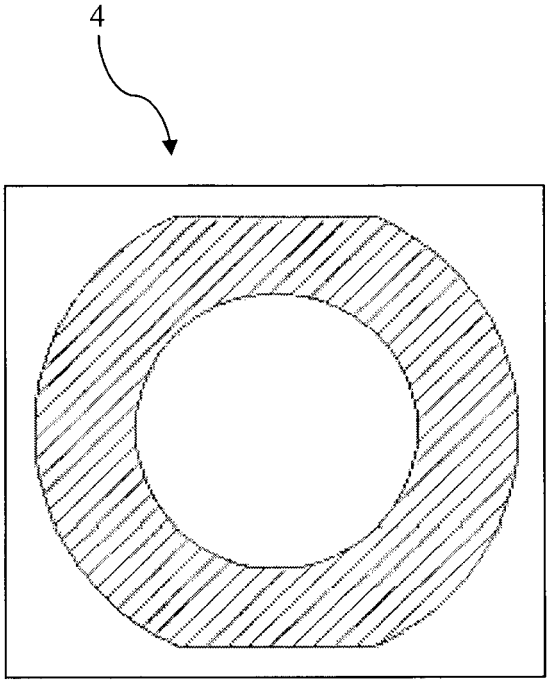

Figure 2

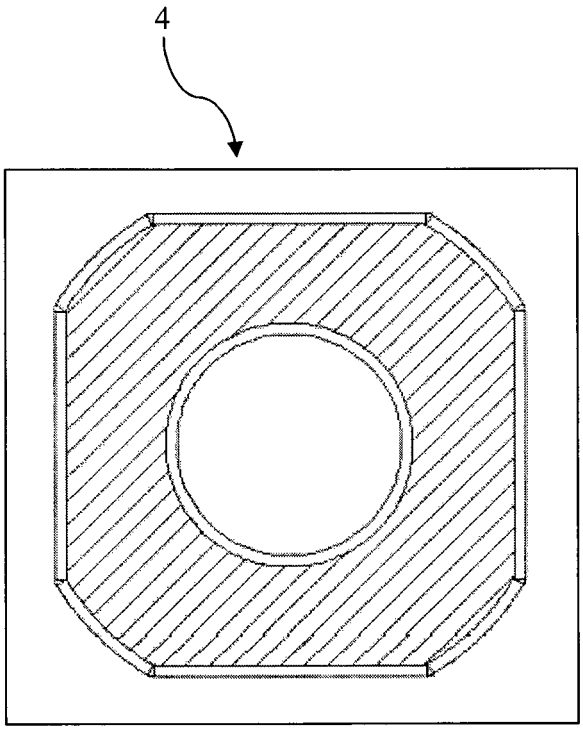

Figure 3

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Application Number
EP 14 15 8941

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 July 2014	Stängl, Gerhard

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