United States Patent Application Publication	20250257850
Kind Code	A1
Publication Date	August 14, 2025
Inventor(s)	SAWAI; Osamu et al.

METHOD OF PRODUCING A HYDROGEN TANK, HYDROGEN TANK

Abstract

The hydrogen tank is manufactured more easily. The cap is formed by connecting the first cap structure and the second cap structure arranged in the circumferential direction, the first cap structure projections, the second cap structure has a recess, projections are deformed It is pushed into the recess.

Inventors: **SAWAI; Osamu (Okazaki-shi Aichi-ken, JP), NAKASHIMA; Tomoki (Nagoya-shi Aichi-ken, JP), KAI; Yuki (Nagoya-shi Aichi-ken, JP), YATSUKURA; Masato (Fuji-shi Shizuoka-ken, JP), KOYAMA; Kohei (Odawara-shi Kanagawa-ken, JP), MATSUZAWA; Yuki (Nerima-ku Tokyo-to, JP), ASAHINA; Noriyoshi (Shizuoka-shi Shizuoka-ken, JP)**

Applicant: **TOYOTA JIDOSHA KABUSHIKI KAISHA** (Toyota-shi Aichi-ken, JP)

Family ID: **96660689**

Assignee: **TOYOTA JIDOSHA KABUSHIKI KAISHA (Toyota-shi Aichi-ken, JP)**

Appl. No.: **19/033653**

Filed: **January 22, 2025**

Foreign Application Priority Data

JP	2024-017727	Feb. 08, 2024

Publication Classification

Int. Cl.: **F17C13/00** (20060101)

U.S. Cl.:

CPC **F17C13/00** (20130101); F17C2205/0311 (20130101); F17C2209/2154 (20130101); F17C2221/012 (20130101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2024-017727, filed on Feb. 8, 2024, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a method of manufacturing a hydrogen tank and a hydrogen tank.

BACKGROUND

[0003] In Patent Document 1, in a mouthpiece mounting step (S24) of manufacturing a high pressure container, a mouthpiece **20** is attached to an outer peripheral surface of an opening end portion **14** by fixing a plurality of mouthpiece structures **22** to each other, and in a resin impregnation molding step (S26), a resin is impregnated into a fiber layer while flowing a resin in a groove **36** serving as a resin flow path provided at a contact point with a fiber layer of a plurality of mouthpiece structures **22** Here rivets and bolts are cited as means for connecting a plurality of mouthpiece configurations.

CITATION LIST

Patent Literature

[0004] Patent Document 1: JP 2023-27912 A

SUMMARY

Technical Problem

[0005] When using rivets or bolts as a measure for securing a plurality of die structures to each other, the process increases because it requires a hole processing or the like after molding of the die.

[0006] In view of the above problems, the present disclosure provides a method of manufacturing a hydrogen tank which can be more easily manufactured. It also provides its hydrogen tank.

Solution to Problem

[0007] The present application discloses a method of manufacturing a hydrogen tank having a mouthpiece, wherein a fiber winding step of winding a fiber around a liner, and a mouthpiece attaching step of attaching a mouthpiece to a liner wrapped with the fiber are provided. The mouthpiece is formed by connecting a first mouthpiece structure and a second mouthpiece structure arranged in a circumferential direction, wherein the first mouthpiece structure has a protrusion and the second mouthpiece structure has a concave portion, and in the mouthpiece attaching step, the protrusion is deformed and pushed into the concave portion to be connected.

[0008] Further, the present application discloses a hydrogen tank having a liner, a reinforcing layer disposed on an inner periphery of the liner, and a mouthpiece disposed on an outer periphery of the reinforcing layer, wherein the mouthpiece is formed by connecting a first mouthpiece structure and a second mouthpiece structure disposed in a circumferential direction, wherein the first mouthpiece structure has a protrusion, and the second mouthpiece structure has a recess, and the protrusion is connected by being disposed inside the recess.

Effects

[0009] According to the present disclosure, when a plurality of cap members fixed to each other to

a single cap, it is only necessary to deform a part of the cap member, it is not necessary to perform hole machining, it is possible to more easily produce a hydrogen tank.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0010] FIG. **1** is an external view of the hydrogen tank **10**.

[0011] FIG. **2** is a diagram showing a portion of a cross section of the hydrogen tank **10**.

[0012] FIG. **3** is a cross-sectional view taken along the line A-A of FIG. **2**.

[0013] FIG. **4** is an exploded cross-sectional view of the base **30**.

[0014] FIG. **5** is a cross-sectional view illustrating the attachment of the base **30**.

DESCRIPTION OF EMBODIMENTS

[0015] An example of an embodiment according to the present disclosure will be described below with reference to the accompanying drawings.

[0016] FIG. **1** shows an external view of a hydrogen tank **10** according to one embodiment produced by the hydrogen tank manufacturing method of the present disclosure. Further, FIG. **2** is a cross-section along the axis O of the hydrogen tank **10**, the side where the sealing member **18** is disposed (left side of the paper surface of FIG. **1**). FIG. **3** is an end view taken along A-A of FIG. **2**.

1. Configuration of Hydrogen Tank

[0017] The hydrogen tank **10** is a member for holding hydrogen to be stored inside thereof. The hydrogen tank is provided, for example, in a hydrogen consuming device comprising a fuel cell, to provide hydrogen as a fuel to the fuel cell for power generation. As can be seen from FIG. **2**, the hydrogen tank **10** includes a liner **11** as a container body in which hydrogen is stored, a reinforcing layer **15** for reinforcing by covering the outer surface of the liner **11**, and a mouthpiece **30** disposed at both axial ends.

1.1. Liner

[0018] The liner **11** is a container-like member formed into a substantially cylindrical shape using a resin material such as a polyamide synthetic resin. Specifically, the liner **11** has a body portion **12**, a shoulder portion **13**, and an open end portion **14**.

[0019] The body portion **12** is a cylindrical portion in which the inner diameter and outer diameter are constant in the central portion in the direction of the axis O.

[0020] The shoulder portion **13** constitutes both side portions of the body portion **12** in the direction of the axis O, and is a dome-like portion which is separated from the body portion **12** and narrows so as to decrease in diameter.

[0021] Open end portion **14**, from the end opposite the body portion **12** side of the shoulder portion **13**, is a cylindrical portion extending in a direction away from the body portion **12** along the axis O. The open end portion **14** has a smaller inner diameter and outer diameter than the body portion **12** and the shoulder portion **13**, and is made constant.

1.2. Reinforcement Layer

[0022] The reinforcing layer **15** is made of fiber-reinforced resin, and the fiber bundle is wound over a plurality of layers over the entire outer surface of the liner **11**. Further, in the reinforcing layer **15**, a resin is impregnated into the layer of the wound fiber bundle.

[0023] The thickness of the reinforcing layer **15** in this form has a configuration that becomes thicker toward the open end portion **14** side from the body portion **12** side of the liner **11** as can be seen from FIG. **2**. Furthermore, the reinforcing layer **15** disposed on the open end portion **14** of the liner **11** has its outer diameter as substantially constant. In this form, a carbon-fiber-reinforced resin (CFRP) is used as an exemplary fiber-reinforced resin (FRP).

1.3. Mouthpiece

[0024] A mouthpiece **30** is disposed on the outer periphery of the reinforcing layer **15** that covers

the open end portion **14** of the liner **11**. As can be seen from FIG. **3**, the mouthpiece **30** in the present embodiment is formed of a metal formed in a cylindrical shape (annular). FIG. **4** shows only the mouthpiece **30** in FIG. **3** represented by disassembling the mouthpiece **30** together with the indication.

[0025] In this form, the mouthpiece **30** has a first mouthpiece member **31** and a second mouthpiece member **32** arranged in the circumferential direction. In this form has two first mouthpiece members **31** and two second mouthpiece member **32**, the first mouthpiece member **31** and the second mouthpiece member **32** are alternately arranged in the circumferential direction. Since the first mouthpiece member **31** and the second mouthpiece member **32** are combined to form a cylindrical (annular), the first mouthpiece member **31** and the second mouthpiece member **32** are a curved arcuate member.

[0026] As shown in FIGS. **2** to **4**, the first mouthpiece member **31**, the inner peripheral surface of the second mouthpiece member **32** (inner surface), the locking claw **36** is a plurality of projections are formed. The locking claw **36**, the inner peripheral surface of the first mouthpiece member **31** and the second mouthpiece member **32** is knurled shape. Each locking claw **36**, the tip of the protruding direction in a cross-sectional view cut along the direction and the radial direction of the axis O (radial direction inside) is formed in a pointed saw blade shape. The tip of the locking claw **36**, by biting into the outer peripheral portion of the reinforcing layer **15** covering the outer peripheral surface of the opening end portion **14** (locking), the mouthpiece **30** is firmly held (non-rotatably) to the reinforcing layer **15** formed on the outer periphery of the opening end portion **14**.

[0027] As shown in FIG. **2**, the outer peripheral surface of the first mouthpiece member **31** and the second mouthpiece member **32** (outer surface), a male screw groove **38** is formed (FIG. **3**, in FIG. **4** male screw groove **38** is omitted). The male screw groove **38** is combined with the female screw groove **18***a* formed on the inner surface of the sealing member **18**.

[0028] Further, FIG. **3**, as can be seen from FIG. **4**, at the circumferential end of the first mouthpiece member **31**, the protrusion **40** is disposed at the site to be coupled with the second mouthpiece member **32**. Similarly, at the circumferential end of the second mouthpiece member **32**, a recess **41** is disposed at the site to be coupled with the first mouthpiece member **31**.

[0029] Then, the projection **40** by the adjacent first mouthpiece member **31** and the second mouthpiece member **32** is connected by entering the recess **41**.

[0030] According to such a connecting structure, with rivets and bolts or the like is not required, since it is not necessary to form a hole for that, it is possible to simplify the structure and steps.

[0031] Further, the first mouthpiece member **31** and the second mouthpiece member **32**, as shown in FIG. **4**, the inner peripheral surface of the mouthpiece **30** (inner surface), a plurality of grooves **33** serving as a resin flow path in the manufacturing process described later is formed.

[0032] More specifically, the groove **33** is a groove extending in a direction parallel to the axis O in the inner peripheral surface of the mouthpiece **30** (inner surface), from one end in the axial direction O of the mouthpiece **30** to the other end is formed in a straight line. Thus a plurality of grooves **33** are arranged at predetermined intervals in the circumferential direction of the mouthpiece **30**. Although there is no particular limitation on the number of grooves **33**, at least one, or two, is provided in each of the first mouthpiece member **31** and the second mouthpiece member **32**.

1.4. Sealing Member, Opening and Closing Valve

[0033] The sealing member **18** is attached to the base **30**. Thus, the open end **14** on one side of the liner **11** is closed by the sealing member **18**.

[0034] On the other hand, the other side of the open end of the liner **11** in which the mouthpiece **30** is on, the opening and closing valve **20** is disposed, the hydrogen tank **10** via the on-off valve **20** is connectable to the pipe.

2. Method of Manufacturing a Hydrogen Tank

[0035] Next, a method of manufacturing a hydrogen tank according to one form of the method of

manufacturing a hydrogen tank of the present disclosure will be described. In particular the process of attaching the mouthpiece **30** to the open end portion **14** of the liner **11**.

[0036] A method for producing a hydrogen tank according to the present embodiment is a method for producing a hydrogen tank **10** by a RTM (Resin Transfer Molding, resin pouring) molding method, and includes a liner forming step (S21), a fiber winding step (S22), a mouthpiece placing step (S23), a mouthpiece attaching step (S24), a sealing member attaching step (S25), a resin impregnating molding step (S26), and a CFRP forming step (S27) as a step.

[0037] In the liner forming step (S21), the liner **11** described above is formed. The formation of the liner **11** is not particularly limited, and examples thereof include making a body portion **12** by extrusion molding, making a shoulder portion **13** and an open end portion **14** by injection molding, and joining (welding) the body portion **12** and the shoulder portion **13**.

[0038] In the fiber winding step (S22), a band-shaped fiber bundle is wound around an outer surface of the liner **11**.

[0039] Examples of the fibers constituting the fiber bundle include carbon fibers (CF). By winding the fiber bundle around the liner **11**, a layer of the fiber bundle is formed on the outer surface of the liner **11**. Incidentally, at this time, the fiber bundle is wound so that the layer of the fiber bundle at the open end portion **14** is thicker than that of the body portion **12** and the shoulder portion **13**.

[0040] In the mouthpiece arrangement step (S23), placing the mouthpiece **30** on the outer peripheral side of the open end portion **14** of the liner **11** (the outer peripheral side of the layer by the fiber bundle). That is, placing the first mouthpiece member **31** and the second mouthpiece member **32** in the circumferential direction of the open end **14**. Thus, the tips of the plurality of locking claws **36** provided in the first mouthpiece member **31** and the second mouthpiece member **32** are arranged so as to contact the layer by the fiber bundle.

[0041] Incidentally, at the time of this step, as shown in FIG. **5**, the first mouthpiece member **31** and the second mouthpiece member **32** is combined to circular, but at this time the protrusion **40** of the first mouthpiece member **31** does not enter the inside of the recess **41** of the second mouthpiece member **32** is not connected.

[0042] In the cap mounting step (S24), the first mouthpiece member **31** and the second mouthpiece member **32** is reduced in diameter so as to press the layers by the fiber bundle. That is, the first mouthpiece member **31** and the second mouthpiece member **32** is moved radially inwardly, holding against the outer peripheral portion of the layer by the fiber bundle a plurality of locking claws **36** of the inner peripheral surface thereof. Thus, the locking claw **36** is locked to the layer by the fiber bundle.

[0043] Then, deformed by pressing the protrusion **40** toward the recess **41** as shown by a straight arrow in FIG. **5** (caulking). Thus, the protrusion **40** as shown in FIG. **3** enters the inside of the recess **41**, the first mouthpiece member **31** and the second mouthpiece member **32** is connected.

[0044] In the sealing member attaching step (S25), the sealing member **18** is attached to the mouthpiece **30**. When the mouthpiece **30** is attached to the open end **14**, since the male screw groove **38** is formed on the outer peripheral portion of the first mouthpiece member **31** and the second mouthpiece member **32**, the internal thread formed on the inner surface of the sealing member **18** to this by screwing, it is possible to attach the sealing member **18** to the open end portion **14** of the liner **11**.

[0045] In the resin impregnation molding step (S26), a liner **11** having a mouthpiece **30** and a sealing member **18** attached to an open end portion **14** is set in a mold, and a reinforcing layer **15** made of a fiber-reinforced resin is molded by impregnating a layer of a fiber bundle with a resin by injecting a resin into the mold.

[0046] In this embodiment, in the resin impregnation and molding step (S26), the resin (matrix resin) flows into the layer of the fiber bundle through the groove **33**, and the resin from the inlet side of RTM mold to the opposite side can be smoothly and substantially uniformly impregnated, and the plurality of locking claws **36** are locked to the reinforcing layer **15**.

[0047] In CFRP step (S27), by removing the liner **11** to which the reinforcing layers **15** are formed from the mold (releasing), the hydrogen tank **10** is manufactured.
[0048] According to the method of manufacturing a hydrogen tank of the present embodiment, the connection of the first mouthpiece member **31** and the second mouthpiece member **32** as described above, since it is performed by pushing the inside of the protrusion **40** in the recess **41**, rivets and bolts or the like becomes unnecessary, since it is not necessary to form a hole for that, it is possible to simplify the process.
REFERENCE SIGNS LIST
[0049] **10** . . . Hydrogen tank, **11** . . . liner, **14** . . . open end portion, **15** . . . reinforcing layer, **18** . . . sealing member, **30** . . . mouthpiece, **31** . . . first mouthpiece member, **32** . . . second mouthpiece member, **36** . . . locking claw, **40** . . . projection, **41** . . . recess

Claims

1. A method of manufacturing a hydrogen tank having a mouthpiece, the method comprising: winding a fiber around a liner; and attaching a mouthpiece to the liner around which the fiber is wound, wherein the mouthpiece is formed by coupling at least one first mouthpiece component and at least one second mouthpiece component to each other, the first and second mouthpiece components being arranged in a circumferential direction, the first mouthpiece component having projections, the second mouthpiece component having depressions, and in said attaching, shapes of the projections are changed and the projections are pushed into the depressions whereby the first and second mouthpiece components are coupled to each other.
2. A hydrogen tank comprising: a liner; a reinforcing layer disposed around a periphery of the liner; and a mouthpiece disposed at a periphery of the reinforcing layer, wherein the mouthpiece is formed by coupling at least one first mouthpiece component and at least one second mouthpiece component to each other, the first and second mouthpiece components being arranged in a circumferential direction, the first mouthpiece component having projections, the second mouthpiece component having depressions, and the projections are arranged inside the depressions whereby the first and second mouthpiece components are coupled to each other.