(19) Europäisches Patentamt
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(11) **EP 4 488 567 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
08.01.2025 Bulletin 2025/02

(21) Application number: **23382686.6**

(22) Date of filing: **04.07.2023**

(51) International Patent Classification (IPC):
F17C 1/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F17C 1/00; F17C 2201/0109; F17C 2203/014; F17C 2203/0304; F17C 2203/0329; F17C 2203/0391; F17C 2203/0629; F17C 2203/0639; F17C 2203/0663; F17C 2209/228; F17C 2209/232; F17C 2221/011; F17C 2221/012; F17C 2221/014; F17C 2223/0161; (Cont.)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(54) **DOUBLE WALLED CRYOGEN TANK**

(57) The tank is formed by an inner container (1) that houses the liquefied gases and an outer container (2), between which is defined an insulating chamber (3), where the containers (1, 2) are formed by bodies of composite material. A constructive assembly solution is proposed that uses metallic rings (8, 9, 10, 11) that expand for their coupling to the outlet of each of the bodies (4, 5, 6, 7, 13, 14, 15, 16) that form each container (1, 2), where said metallic rings (8, 9, 10, 11) are linked to each other, establishing a metal-to-metal closure between the bodies (4, 5, 6, 7, 13, 14, 15, 16) of each container (1, 2), thus avoiding weakening the composite material of said bodies (4, 5, 6, 7, 13, 14, 15, 16).

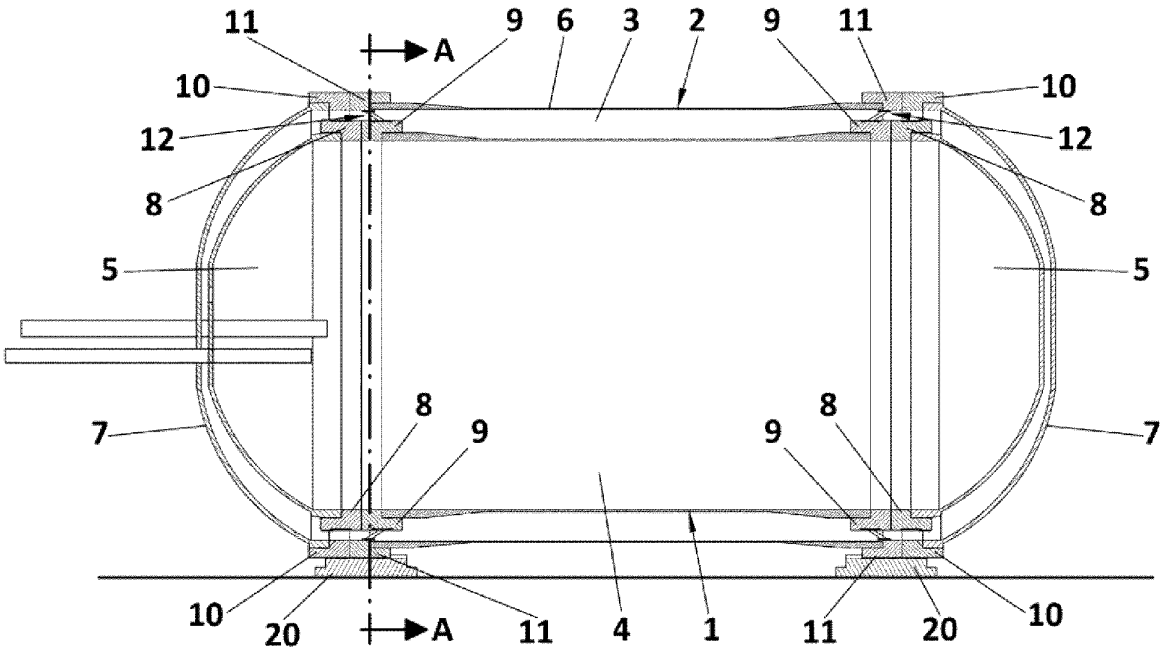

FIG. 2

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(52) Cooperative Patent Classification (CPC): (Cont.)
F17C 2260/011

Description

OBJECT OF THE INVENTION

[0001] The present invention relates to a double containment tank for liquefied gases at cryogenic temperature, formed by an inner container that houses the liquefied gases and an outer container, in which each container is formed by bodies of composite material. A constructive assembly solution is proposed that uses metallic rings that expand for their coupling to the outlet of each of the bodies that form each container, where said metallic rings are linked to each other, establishing a metal-to-metal closure between the bodies of each container, thus avoiding weakening the composite material of said bodies.

BACKGROUND OF THE INVENTION

[0002] The use of double-walled tanks for the storage of liquefied gases at cryogenic temperature and low pressure is known, such as liquid nitrogen, liquid oxygen or liquid hydrogen, which are provided with an inner container in contact with the cryogenic liquid, an outer container in contact with the atmosphere that is coaxial to the inner container, and an insulating chamber defined between both containers.

[0003] Each one of the containers is normally formed by bodies that are joined together, normally the inner container exhibits a central body with an essentially cylindrical configuration and covers with a partially spherical configuration, and the outer container exhibits a similar configuration, defining the insulating chamber between them, which can be filled with an insulating material and/or be subjected to a vacuum.

[0004] The function of the outer container and the chamber is to thermally insulate the inner container to keep it cold, avoiding undesired heating that can cause an increase in pressure in the inner container.

[0005] The inner and outer containers are normally made of thermosetting or thermoplastic composite material, preferably carbon fiber, including in each case the body of the container and its covers. To establish the connection between the body and the cover, the use of fixing means and the machining and drilling of the body and/or the cover is required, which means that, since they are made of composite material, their structure is weakened, which can lead to cracks and therefore leaks.

[0006] On the other hand, the support elements of the inner container on the outer container must be screwed directly onto the composite of which the containers are formed, which means that holes have to be drilled into this material, also weakening the surface of the containers in this zone.

DESCRIPTION OF THE INVENTION

[0007] The double containment tank for cryogenic liquids that is the object of this invention satisfactorily solves the stated problem, by means of a constructive solution that uses metallic rings as a connection means between the bodies of composite material that form each container, without the need to weaken said bodies with undesired perforations.

[0008] The tank comprises an inner container and an outer container that define an insulating chamber between them, where the inner container is formed by at least two inner bodies comprising composite material, each of them provided with at least one outlet with an outer diameter and an inner diameter, and the outer container is formed by at least two outer bodies of composite material, each of them provided with at least one outlet with an outer diameter and an inner diameter.

[0009] The inner bodies can be formed by two skins of composite material and a structural inner thermal insulation core of a material selected from cork and expanded plastic.

[0010] Starting from this basic configuration, the tank object of this invention proposes the incorporation, in the inner container, of at least one pair of metallic inner rings, in which each metallic inner ring of the pair of metallic inner rings has an outer diameter and an inner diameter, where the inner diameter of each metallic inner ring is smaller than the outer diameter of the outlet of the inner body, and has a coefficient of expansion that is greater than the coefficient of expansion of the material of the inner body in order to expand and hold the outlet of each inner body externally once the metallic inner ring has been subjected to sufficient heating to expand said dimension.

[0011] In the same way, the outer container incorporates at least one pair of metallic outer rings, in which each metallic outer ring of the pair of metallic outer rings has an outer diameter and an inner diameter, where each metallic outer ring has an inner diameter that is smaller than the outer diameter of the outlet of the outer body, and has a coefficient of expansion that is greater than the coefficient of expansion of the material of the outer body in order to expand and hold the outlet of each outer body externally once the metallic outer ring has been subjected to sufficient heating to expand said dimension.

[0012] In this way, by mounting said rings while hot, an expansion is achieved that facilitates their subsequent mounting on the bodies, which once cold, and especially in cryogenics, contract, ensuring the tightness of the container.

[0013] In both containers, it is envisaged to incorporate fixing means that link the metallic inner rings of the pair of metallic inner rings to each other and that link the metallic outer rings of the pair of metallic outer rings to each other. In this way, a tight metal-to-metal closure is achieved between the bodies of the container, without the need to drill or weaken the composite material.

[0014] Preferably, the fixing means between metallic rings are screws.

[0015] On the other hand, these metallic rings are used

as anchoring points for a plurality of thermal insulating supports that are distributed radially between an outer ring of the outer container and an inner ring of the inner container and are used to facilitate the support of the inner container on the outer container, breaking the thermal bridge between containers and thus guaranteeing the thermal insulation of the inner container.

[0016] Preferably, it is envisaged that the insulating supports are distributed radially and positioned at a distance of approximately 10° from the nearest.

[0017] On the other hand, the temperatures, and especially the pressure that can be reached in the inner container, or the dynamic stresses to which the container can be subjected could eventually cause the disassembly of the bodies that form the inner container, with it being intended to incorporate safety straps that ensure the closure of the inner container.

[0018] More specifically, in the event that the containers are formed by a central inner body and respective lateral covers, it is provided that the body of the container has, in the vicinity of one of the rings, laminated ties to which are attached some fixing elements to which in turn are linked the safety straps that are positioned around the covers holding them.

DESCRIPTION OF THE DRAWINGS

[0019] As a complement to the description provided herein, and for the purpose of helping to make the features of the invention more readily understandable, in accordance with a preferred practical exemplary embodiment thereof, said description is accompanied by a set of drawings constituting an integral part of the same, wherein by way of illustration and not limitation, the following has been represented:

Figure 1.- Shows an elevation view of the double containment tank for a first embodiment in which each container is formed by a cylindrical body and respective lateral covers located on the sides of that body.

Figure 2.- Shows a sectional view through the middle of the tank of Figure 1.

Figure 3.- Shows a view of the inner container of the tank of the previous figures in which the insulating supports linked to the rings are seen, in which the safety straps have also been represented.

Figure 4.- Shows a perspective view of a possible embodiment of the insulating support.

Figure 5.- Shows a sectional view according to the A-A section in Figure 2.

Figure 6.- Shows a sectional detail view of the connection between rings by the fixing means.

Figure 7.- Shows a sectional view of a second embodiment of the tank in which each container is formed by two bodies.

PREFERRED EMBODIMENT OF THE INVENTION

[0020] In view of the figures, two preferred embodiments of the double containment tank for cryogenic liquids are described below, a first embodiment represented in Figures 1, 2, 3 and 5 and a second embodiment represented in Figure 7.

[0021] In general, the tank is of the type that is configured by an inner container (1) and an outer container (2) that define an insulating chamber (3) between them, in which the inner container (1) is formed by at least two inner bodies (4, 5, 13, 14) of composite material, and in which the outer container is formed by at least two outer bodies (6, 7, 15, 16) of composite material, each of them provided with at least one outlet.

[0022] For both embodiments, the inner container (1) of the tank comprises at least one pair of metallic inner rings (8, 9), in which each metallic inner ring of the pair of metallic inner rings (8, 9) is heated and expands to the point of holding the outlet of each inner body (4, 5, 13, 14) externally.

[0023] Likewise, in both embodiments, the outer container (2) comprises at least one pair of metallic outer rings (10, 11), in which each metallic outer ring of the pair of metallic outer rings (10, 11) is heated and expanded to the point of holding the outlet of each outer body (6, 7, 15, 16) externally.

[0024] In both containers (1, 2), it is additionally envisaged to incorporate fixing means, consisting of screws (19) that link the metallic inner rings of the pair of metallic inner rings (8, 9) to each other, as can be seen in Figure 6, and that link the metallic outer rings of the pair of metallic outer rings (10, 11) to each other.

[0025] In the first embodiment, as can be seen in Figure 2, it is envisaged that the inner bodies (4, 5, 13, 14) comprise a cylindrical inner body (4) provided with two outlets and two inner covers (5) located on both sides of the cylindrical inner body (4), and has two pairs of metallic inner rings (8, 9) in which each pair of metallic inner rings (8, 9) links one of the outlets of the cylindrical inner body (4) with the outlet of an inner cover (5).

[0026] Likewise, it can be seen in that same Figure 2 that the outer bodies (6, 7, 15, 16) comprise a cylindrical outer body (6) provided with two outlets and two outer covers (7) on both sides of the cylindrical outer body (6), and has two pairs of metallic outer rings (10, 11) in which each pair of metallic outer rings (8, 9) links one of the outlets of the cylindrical outer body (6) with the outlet of an outer cover (7).

[0027] According to the second embodiment shown in Figure 7, the inner bodies (4, 5, 13, 14) comprise a first inner body (13) and a second inner body (14) that are the same, each of them provided with a single outlet, and the outer bodies (6, 7, 15, 16) comprise a first outer body (15)

and a second outer body (16) that are the same, each of them provided with a single outlet.

[0028] On the other hand, the tank incorporates, as can be seen in Figure 5, thermal insulating supports (12) that are distributed radially between an outer ring (11) of the outer container (2) and an inner ring (9) of the inner container (1).

[0029] A detail can be seen in Figure 3 of how the insulating supports (12) are fixed to the inner ring (9) of the inner container (1).

[0030] On the other hand, in the same Figure 3, it can be seen that the first cylindrical body (5) of the inner container (1) incorporates some laminated ties (21) in the vicinity of the second inner ring (9), to which are attached some fixing elements (17) via which are linked the ends of safety straps (18) that hold each inner cover (5).

[0031] Some supports (20) can be seen in Figure 2 on which rest the outer rings (11) that couple via the cylindrical outer body (2).

Claims

1. - A double containment tank for liquefied gases at cryogenic temperature comprising an inner container (1) and an outer container (2) that define an insulating chamber (3) between them, in which the inner container (1) is formed by at least two inner bodies (4, 5, 13, 14) comprising composite material, each of them provided with at least one outlet with an outer diameter and an inner diameter, and the outer container (2) is formed by at least one least two outer bodies (6, 7, 15, 16) of composite material, each of them provided with at least one outlet with an outer diameter and an inner diameter, **characterized in that**:

the inner container (1) comprises

at least one pair of metallic inner rings (8, 9), in which each metallic inner ring of the pair of metallic inner rings (8, 9) has an outer diameter and an inner diameter, where each metallic inner ring (8, 9) has an inner diameter that is smaller than the outer diameter of the outlet of the inner body (4, 5, 13, 14) and a coefficient of expansion that is greater than the coefficient of expansion of the material of the inner body (4, 5, 13, 14) in order to expand and hold the outlet of each inner body (4, 5, 13, 14) externally once the metallic inner ring (8, 9) has been subjected to sufficient heating to expand said dimension,
fixing means that link the metallic inner rings of the pair of metallic inner rings (8, 9) to each other,

and **in that** the outer container (2) comprises:

at least one pair of metallic outer rings (10, 11), in which each metallic outer ring of the pair of metallic outer rings (10, 11) has an outer diameter and an inner diameter, where each metallic outer ring (10, 11) has an inner diameter that is smaller than the outer diameter of the outlet of the outer body (6, 7, 15, 16) and a coefficient of expansion that is greater than the coefficient of expansion of the material of the outer body (6, 7, 15, 16) in order to expand and hold the outlet of each outer body (6, 7, 15, 16) externally once the metallic outer ring (10, 11) has been subjected to sufficient heating to expand said dimension,
fixing means that link the metallic outer rings of the pair of metallic outer rings (10, 11) to each other.

2. The tank of claim 1 in which the inner bodies (4, 5, 13, 14) comprise a cylindrical inner body (4) provided with two outlets and two inner covers (5) located on both sides of the cylindrical inner body (4), and has two pairs of metallic inner rings (8, 9) in which each pair of metallic inner rings (8, 9) links one of the outlets of the cylindrical inner body (4) with the outlet of an inner cover (5), and
in which the outer bodies (6, 7, 15, 16) comprise a cylindrical outer body (6) provided with two outlets and two outer covers (7) on both sides of the cylindrical outer body (6), and has two pairs of metallic outer rings (10, 11) in which each pair of metallic outer rings (8, 9) links one of the outlets of the cylindrical outer body (6) with the outlet of an outer cover (7).

3. - The tank of claim 1 in which the inner bodies (4, 5, 13, 14) comprise a first inner body (13) and a second inner body (14) that are the same, each of them provided with a single outlet, and
in which the outer bodies (6, 7, 15, 16) comprise a first outer body (15) and a second outer body (16) that are the same, each of them provided with a single outlet.

4. - The tank of claim 1, which additionally comprises insulating supports (12) of thermally insulating material that are distributed radially between at least one outer ring (11) of the outer container (2) and an inner ring (9) of the inner container (1) to facilitate the support of the inner container (1) on the outer container (2).

5. - The tank of claim 1 which further comprises supports (20) on which rest the outer rings (11) that couple via the cylindrical outer body (2).

6. - The tank of claim 1 in which the fixing means comprise screws (19).

7. - The tank of claim 2 in which the cylindrical inner body (4) of the inner container (1) incorporates laminated ties (21) in the vicinity of the inner ring (9), to which are attached some fixing elements (17) via which are linked the ends of safety straps (18) that hold each inner cover (5).

8. - The tank of claim 2 in which the cylindrical outer body (6) of the outer container (2) incorporates laminated ties (21) in the vicinity of the outer ring (11), to which are attached some fixing elements (17) via which are linked the ends of safety straps (18) that hold each outer cover (7).

9. - The tank of claim 1 in which the inner bodies (4, 5, 13, 14) are formed by two skins of composite material and a structural inner thermal insulation core.

10. - The tank of claim 9 in which the structural inner core is made of a material selected from a cork and an expanded plastic.

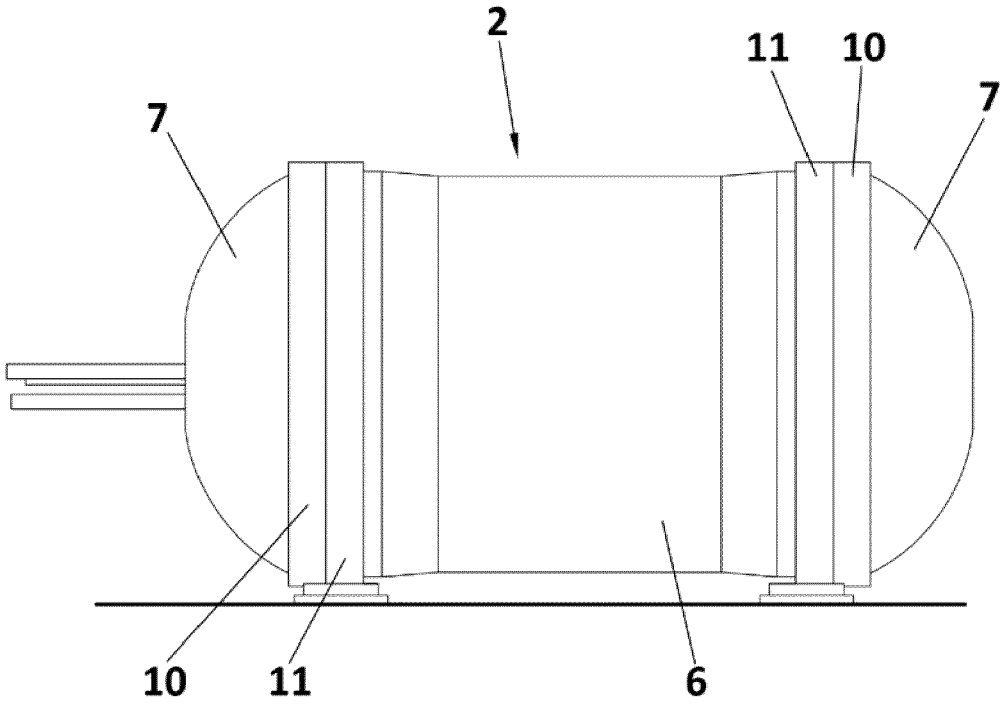

FIG. 1

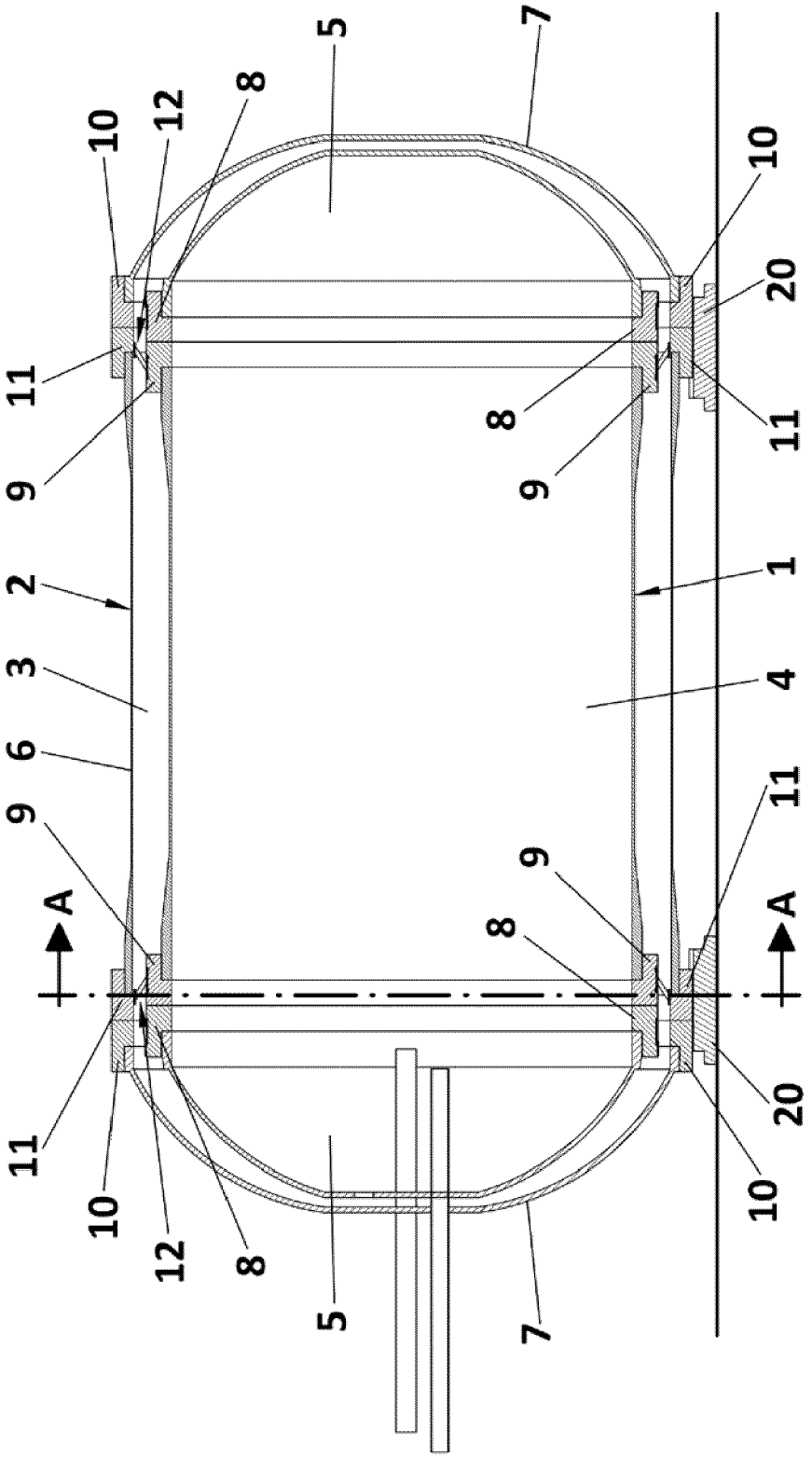

FIG. 2

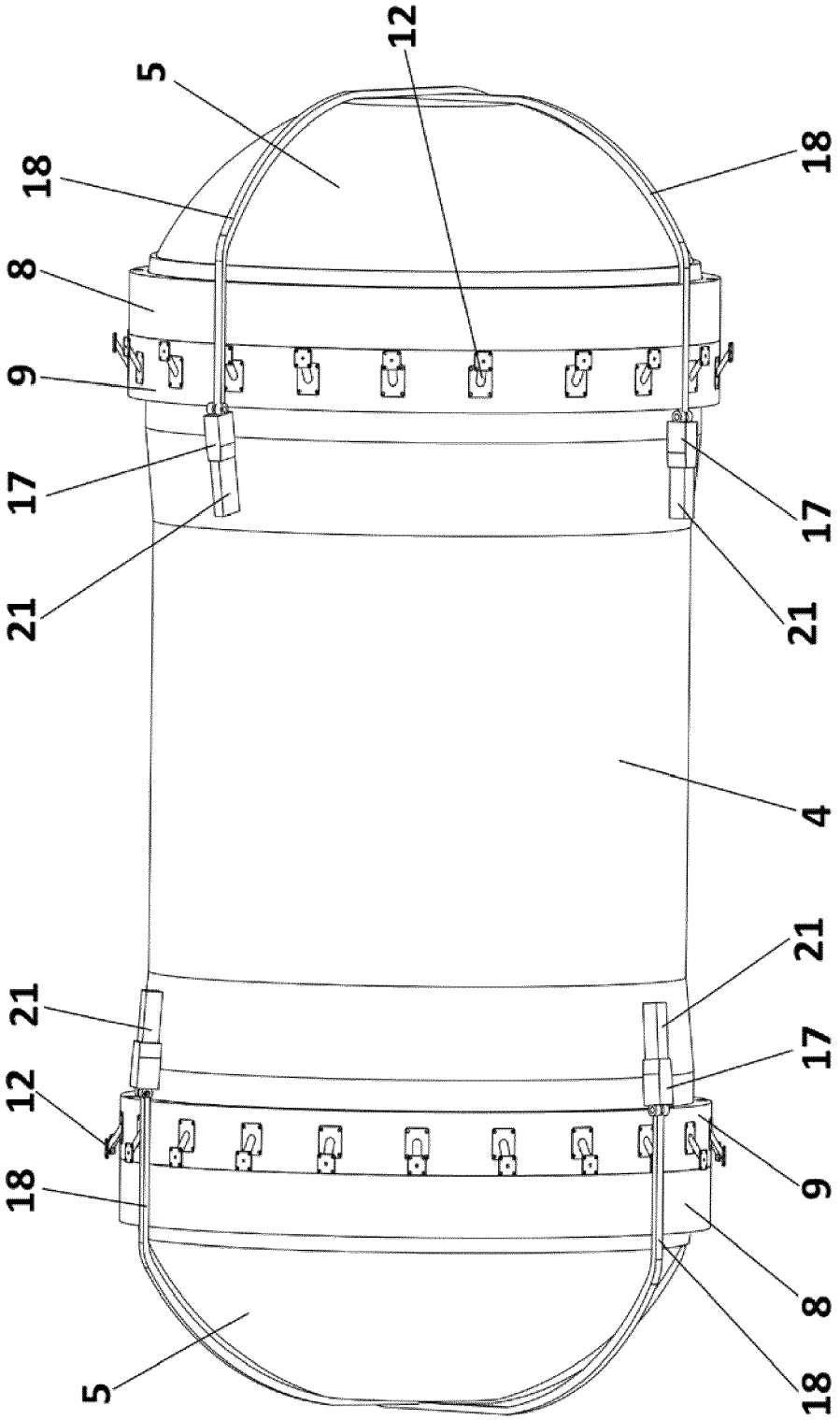

FIG. 3

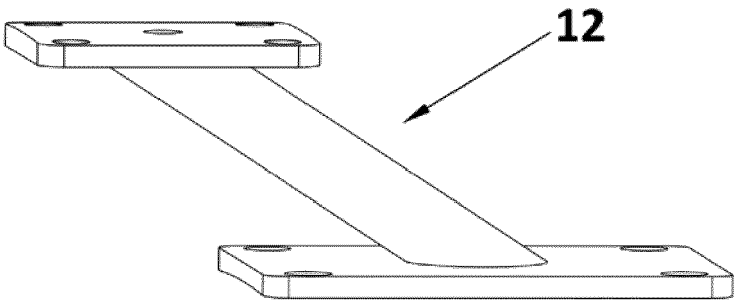

FIG. 4

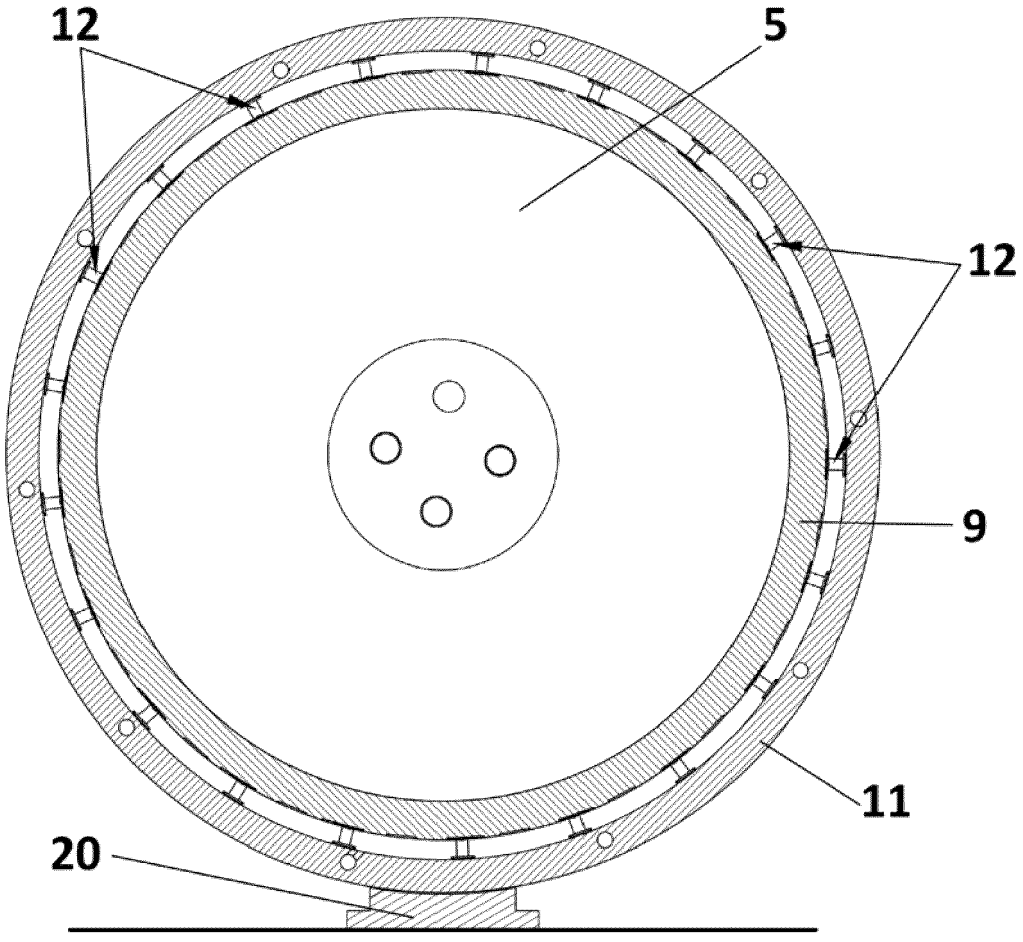

FIG. 5

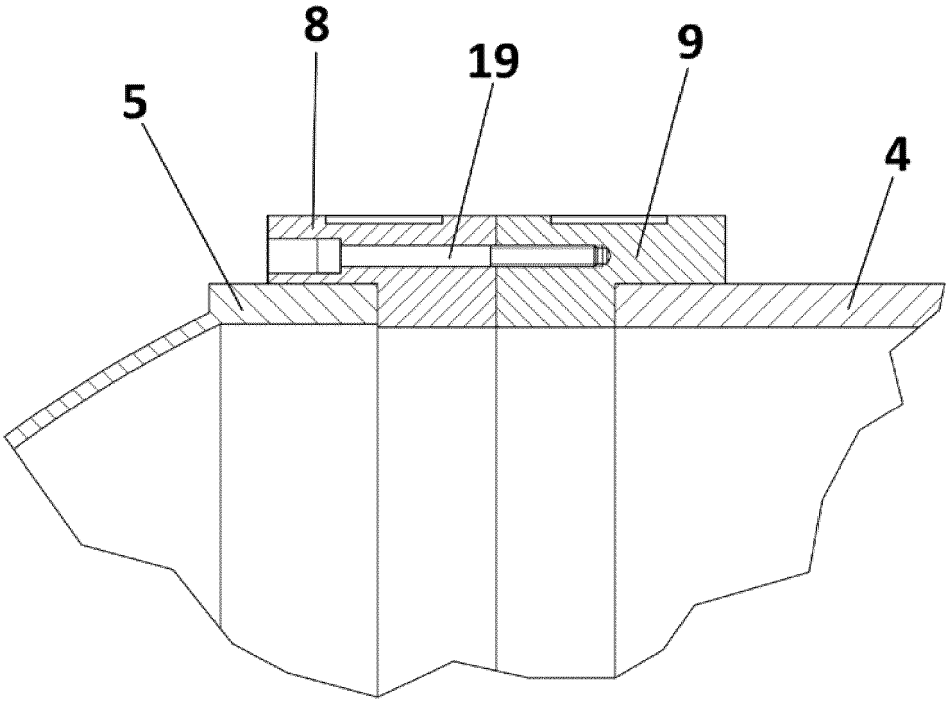

FIG. 6

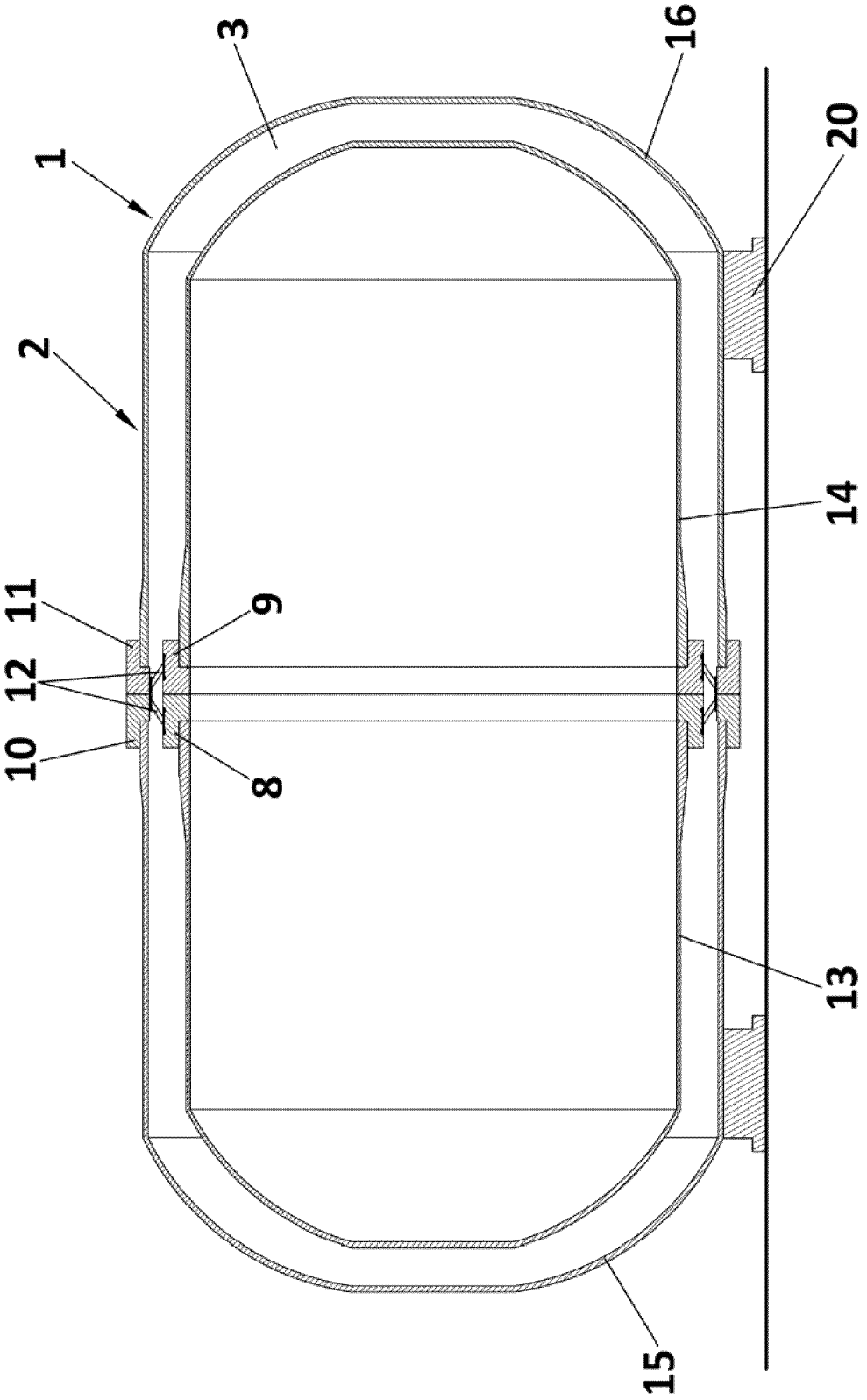

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 23 38 2686

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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	28 November 2023	Ott, Thomas

CATEGORY OF CITED DOCUMENTS

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