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(54) **COMPOSITE HYDROGEN TANK FOR AN AIRCRAFT**

(57) The invention refers to a composite hydrogen tank (1) for an aircraft, comprising first and second halves (2, 3) of a tank, each half (2, 3) having an elongated tubular shape with an open end (2a, 3a) and a joining area (2b, 3b) comprising the open end (2a, 3a); at least one bonding layer (4) laid on at least one joining area (2b, 3b) of one of the halves of the tank (2, 3) to perform

their bonding; and a joint (5) formed by the bonding of the first and second halves (2, 3) at their open ends (2b, 3b). The joint (5) further comprises at least one joining profile (6) cocured or cobonded at the joining area (2b, 3b) of at least one of the halves of the tank (2, 3) to reinforce their bonding.

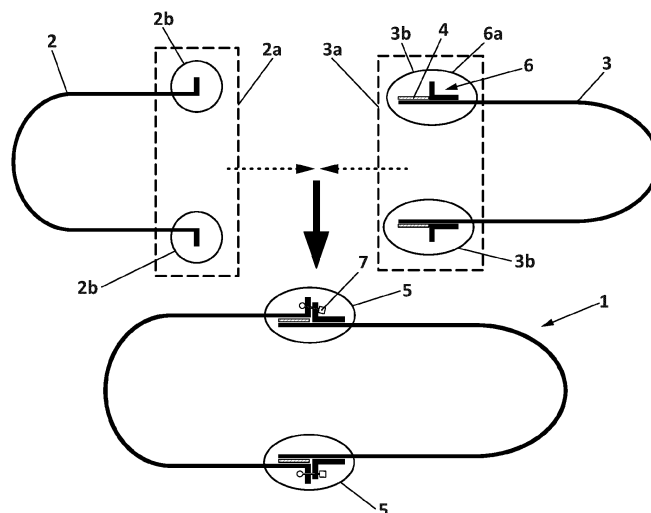


FIG. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention refers to a composite hydrogen tank for an aircraft designed to fulfill the debonding requirements specified for the certification of an aircraft.

BACKGROUND OF THE INVENTION

[0002] Current vessels for hydrogen are not designed for aircraft flying conditions and they are divided in two groups, gaseous and liquid hydrogen (GH2 and LH2): Tanks vessels GH2: They are built to store gas hydrogen and designed with a high thickness to support great pressures (~700 bar) mainly used in industries where vessel weight is not key.

[0003] Tanks vessels LH2: They are built to store liquid hydrogen and designed with small thicknesses as they do not support great pressures (~5 bar). They are mainly used in the aero spatial sector where weight is key for the launch vehicle.

[0004] In applications for aircrafts, the LH2 tank solution is the most suitable due to the weight condition, but in addition to the many challenges that LH2 tanks solve for launch vehicles, additional requirements must be solved to integrate LH2 tanks in aircrafts systems. In particular:

Flight maneuvers: An aircraft has a larger range of maneuvers than a launch vehicle which mainly has accelerations in Z axis which could be reacted by the vehicle rings. For aircraft applications, an additional protection to the LH2 vessel is required to attach the tank to the aircraft and withstand flight loads.

[0005] **Insulation:** Due to different mission conditions, the dormancy time for an aircraft application compared to a launch vehicle is longer. This implies that the tank insulation requires additional complexity including vacuum in between the additional protection and the inner vessel, in contrast to the space application wherein vacuum is not required.

[0006] **Pressure load:** The use of flat panels as integrated elements of tanks vessels is subjected to pressure loads, which induce compression loads in the panel, presenting one of the worst cases for buckling conditions.

[0007] The manufacturing of a CFRP pressure vessel for H2 that has to contain different systems and structures (as anti-sloshing walls or pipes/sensors), will be provided with one or more bonding/co-bonding processes to form the final air-tight vessel. In this case, the airworthiness regulations requires considering the failure of such bonding. This bonding failure must not lead to a catastrophic event, and the continuation of the flight must be ensured.

[0008] In addition, as no rivets are allowed in the construction of a Hydrogen tight vessel (to avoid that the H2 escapes through the space between the bolt/fastener and the CFRP), specially when loaded, bonding or co-

bonding process shall be used to join the different parts needed for the complete vessel. In this case, debonding failures case must be considered.

[0009] Therefore, there is a need for a composite hydrogen tank that secures the bondings, such that the requirements specified by the airworthiness regulations for the certification of the aircraft are met.

SUMMARY OF THE INVENTION

[0010] The present invention overcomes the above mentioned drawback by providing a composite hydrogen tank for an aircraft formed by the joint of parts that meets the debonding failures requirements for the aircraft certification.

[0011] The present invention refers to a composite hydrogen tank for an aircraft that comprises first and second halves of a tank, each half having an elongated tubular shape with an open end and a joining area comprising the open end, at least one bonding layer laid on at least one joining area of one of the halves of the tank to perform their bonding, and a joint formed by the bonding of the first and second halves at their joining areas.

[0012] According to the invention, the joint further comprises at least one joining profile cured or cobonded at the joining area of at least one of the halves of the tank to reinforce their bonding.

[0013] Since hydrogen may escape through the space between the bolt/fastener and the CFRP parts, specially when loaded, no rivets are allowed in the construction of an hydrogen tank. In this context, the invention provides a tank that combines the bonding and the curing or cobonding of a joining profile that permits a safe joint of parts where debonding failures are avoided.

[0014] This way, the invention allows the manufacturing of an hydrogen tight vessel in separated parts that meets the airworthiness regulations, and thus can be included in the aircraft. The manufacturing of the vessel in separated parts are needed for the installation of pipes, walls, and any other components needed inside the vessel before closing tight the whole part.

DESCRIPTION OF THE FIGURES

[0015] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate preferred embodiments of the invention. The drawings comprise the following figures.

Figure 1 shows a schematic view of a composite hydrogen tank according to a first preferred embodiment of the invention.

Figure 2 shows a schematic view of a composite hydrogen tank according to a second preferred embodiment of the invention.

Figure 3 shows a schematic view of a composite hydrogen tank according to a third preferred embodiment of the invention.

Figure 4 shows a schematic view of a composite hydrogen tank according to a fourth preferred embodiment of the invention.

Figure 5 shows a schematic view of a composite hydrogen tank according to a fifth preferred embodiment of the invention.

Figure 6 shows a schematic view of a composite hydrogen tank according to a sixth preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Figure 1 shows a composite hydrogen tank (1) for an aircraft that comprises:

- first and second halves (2, 3) of a tank, each half (2, 3) having an elongated tubular shape with an open end (2a, 3a) and a joining area (2b, 3b) comprising the open end (2a, 3a),
- at least one bonding layer (4) laid on at least one joining area (2b, 3b) of one of the halves of the tank (2, 3) to perform their bonding, and
- a joint (5) formed by the bonding of the first and second halves (2, 3) at their joining areas (2b, 3b),
- wherein the joint (5) further comprises at least one joining profile (6) cocured or cobonded at the joining area (2b, 3b) of at least one of the halves of the tank (2, 3) to reinforce their bonding.

[0017] According to a first preferred embodiment of the invention, in Figure 1, the joining profile (6) is cocured to the second half of the tank (3) and has a L-shaped configuration to receive attachments (7) at its web (6a). This mechanical attachment (7) will work only in the event of a disbanding.

[0018] In addition, the open end (2a, 3a) of the first half (2) of the tank (1) has a L-shaped configuration providing an easy attach to the profile web (6a).

[0019] According to a second preferred embodiment of the invention, Figure 2 shows a tank (1) wherein the joining profile (6) is cocured to each one of the halves of the tank (2, 3), and wherein one of these joining profiles (6) protrudes from the open end (2a, 3a) of the half (2, 3) of the tank in which is cocured to provide an easy attach between the profiles (6). To reinforce this joint (5), attachments (7) are provided between the profiles (6).

[0020] According to a third preferred embodiment of the invention, Figure 3 shows a tank (1) in which the joining profile (6) has a I-shaped configuration, and is cobonded to the first and second halves of the tank (2, 3).

[0021] According to a fourth preferred embodiment of the invention, Figure 4 shows a tank (1), similar to the

one shown in Figure 3, but comprising a pair of bonding layers (4', 4'') laid on the joining areas (2b, 3b) of both halves of the tank (2, 3), separated by a gap to resist potential de-bondings.

[0022] According to a fifth preferred embodiment of the invention, Figure 5 shows a tank (1) further comprising attachments (8) to join the at least one joining profile (6) to one of the halves of the tank (2, 3).

[0023] According to a sixth preferred embodiment of the invention, Figure 6 shows a tank (1) further comprising an extra profile (6') extended along the joining area (2b, 3b) of both the first and second halves of the tank (2, 3), and at least one extra bonding layer (10) laid between the open ends (2a, 3a) of the first and second halves of the tank (2, 3) and the extra profile (6') to reinforce the bonding of the halves (2, 3).

Claims

1. Composite hydrogen tank (1) for an aircraft, comprising:

- first and second halves (2, 3) of a tank, each half (2, 3) having an elongated tubular shape with an open end (2a, 3a) and a joining area (2b, 3b) comprising the open end (2a, 3a),
- at least one bonding layer (4) laid on at least one joining area (2b, 3b) of one of the halves of the tank (2, 3) to perform their bonding, and
- a joint (5) formed by the bonding of the first and second halves (2, 3) at their joining areas (2b, 3b),
- wherein the joint (5) further comprises at least one joining profile (6) cocured or cobonded at the joining area (2b, 3b) of at least one of the halves of the tank (2, 3) to reinforce their bonding.

2. Composite hydrogen tank (1) for an aircraft, according to claim 1, wherein the joining profile (6) is cocured to at least one of the halves of the tank (2, 3) and has a L-shaped, U-shaped or T-shaped configuration to receive attachments (7) at its web (6a).

3. Composite hydrogen tank (1) for an aircraft, according to claim 2, wherein the joining profile (6) is cocured to one half of the tank (2, 3), and wherein the open end (2a, 3a) of the other half (2, 3) of the tank (1) has a L-shaped configuration to be easily attached to the profile web (6a).

4. Composite hydrogen tank (1) for an aircraft, according to claim 2, wherein one joining profile (6) is cocured to each one of the halves of the tank (2, 3), and wherein one of these joining profiles (6) protrudes from the open end (2a, 3a) of the half (2, 3) of the tank in which is cocured to provide an easy

attach between the profiles (6).

5. Composite hydrogen tank (1) for an aircraft, according to any preceding claim, comprising a pair of bonding layers (4', 4'') laid on at least one joining area (2b, 3b) of one of the halves of the tank (2, 3), separated by a gap to resist potential de-bondings. 5
6. Composite hydrogen tank (1) for an aircraft, according to any of claims 1 or 4-5, further comprising attachments (8) to join the at least one joining profile (6) to one of the halves of the tank (2, 3). 10
7. Composite hydrogen tank (1) for an aircraft, according to claim 1, further comprising an extra profile (6') extended along the joining area (2b, 3b) of both the first and second halves of the tank (2, 3), and at least one extra bonding layer (10) laid between the open ends (2a, 3a) of the first and second halves of the tank (2, 3) and the extra profile (6') to reinforce the bonding of the halves (2, 3). 15 20
8. Composite hydrogen tank (1) for an aircraft, according to claim 7, comprising a pair of extra bonding layers (10) laid along both extremes of the extra profile (6'). 25
9. Composite hydrogen tank (1) for an aircraft, according to any preceding claim, wherein one of the first and second halves (2, 3) has lower cross-sectional size than the other half (2, 3) to allow its introduction and overlap at their joining areas (2b, 3b). 30

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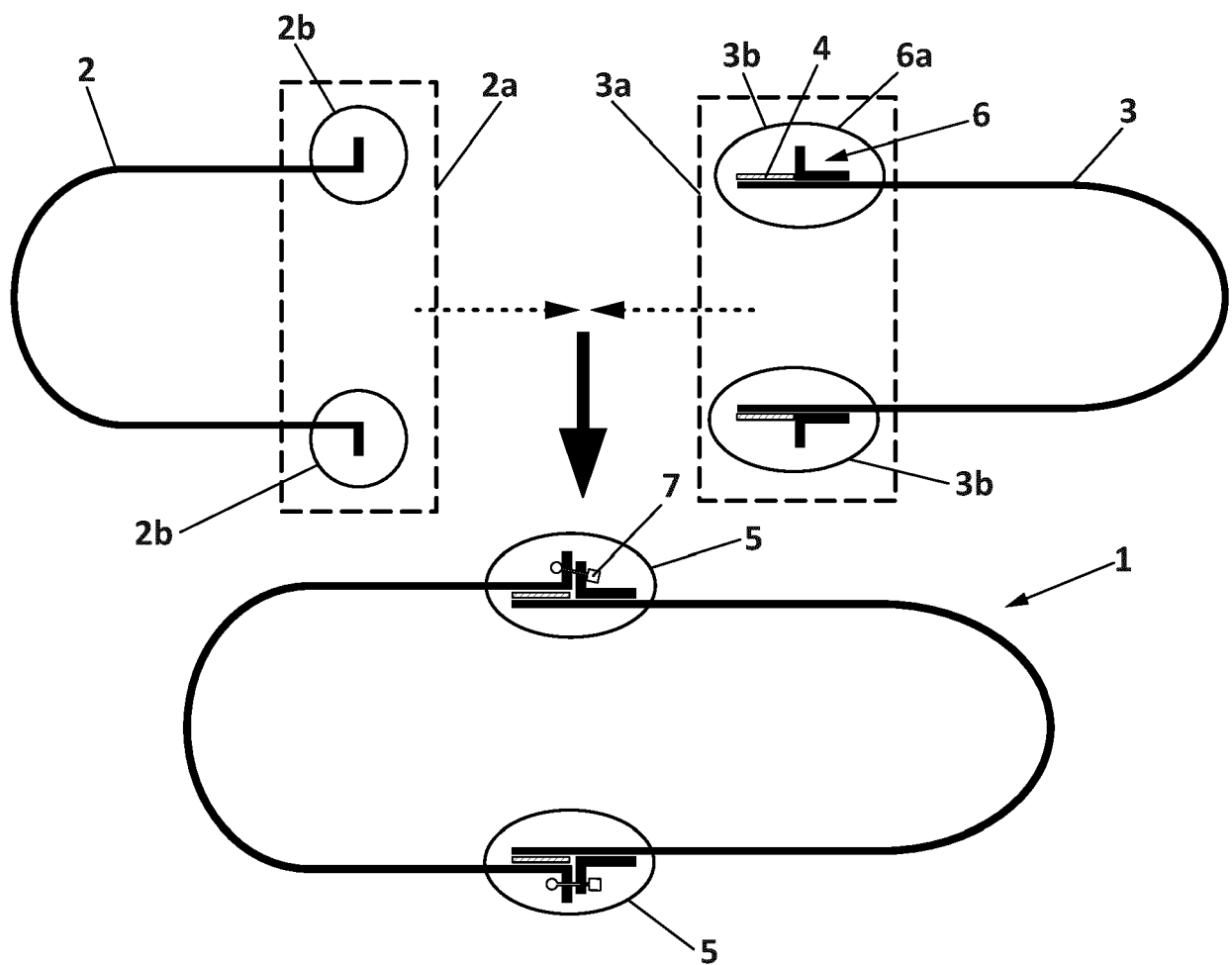


FIG. 1

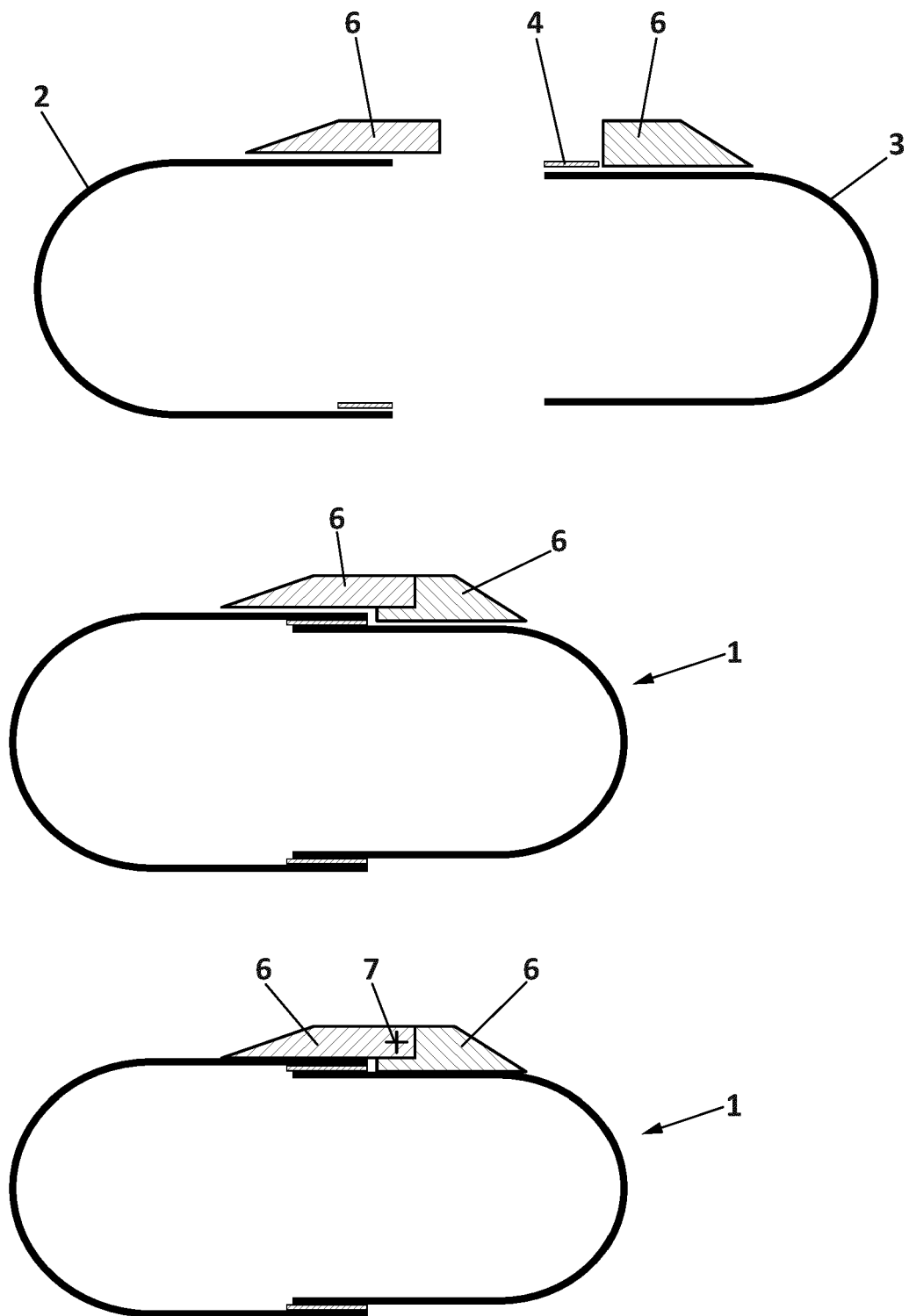


FIG. 2

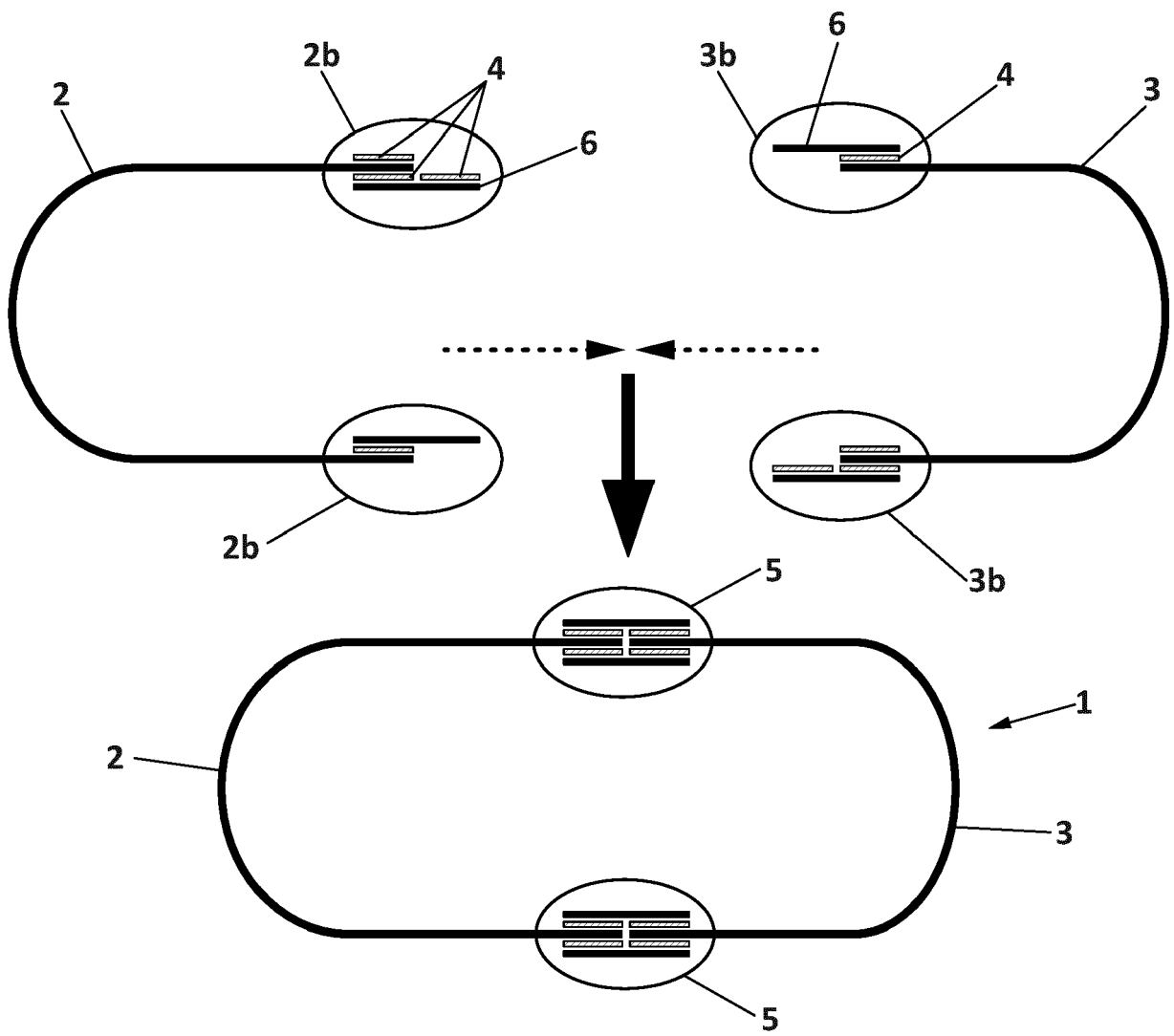


FIG. 3

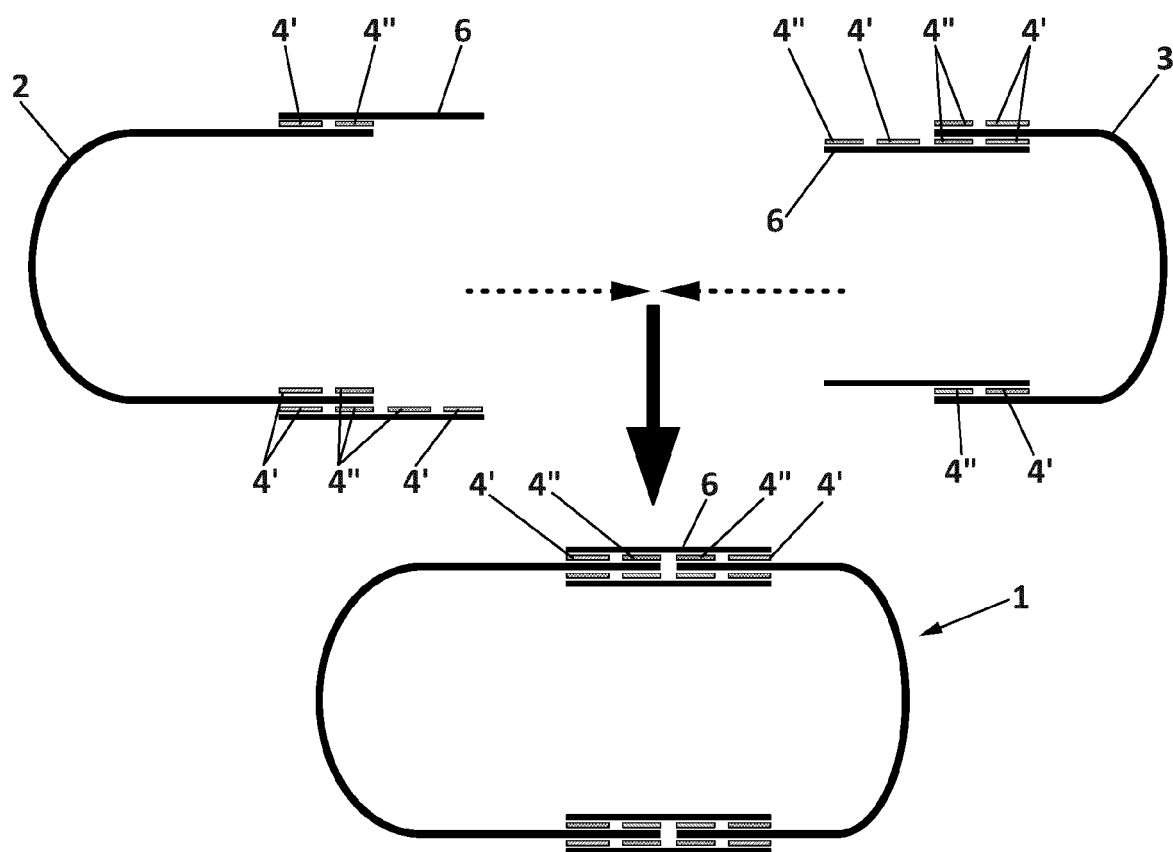


FIG. 4

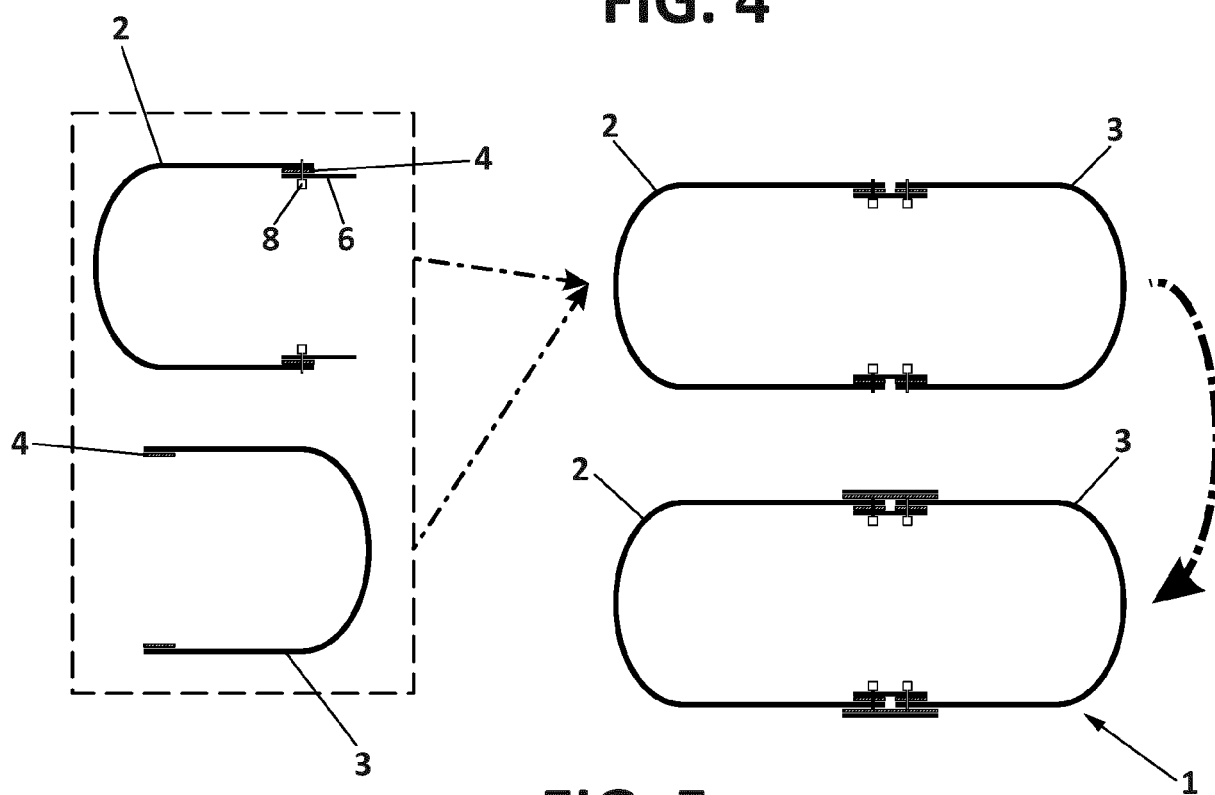


FIG. 5

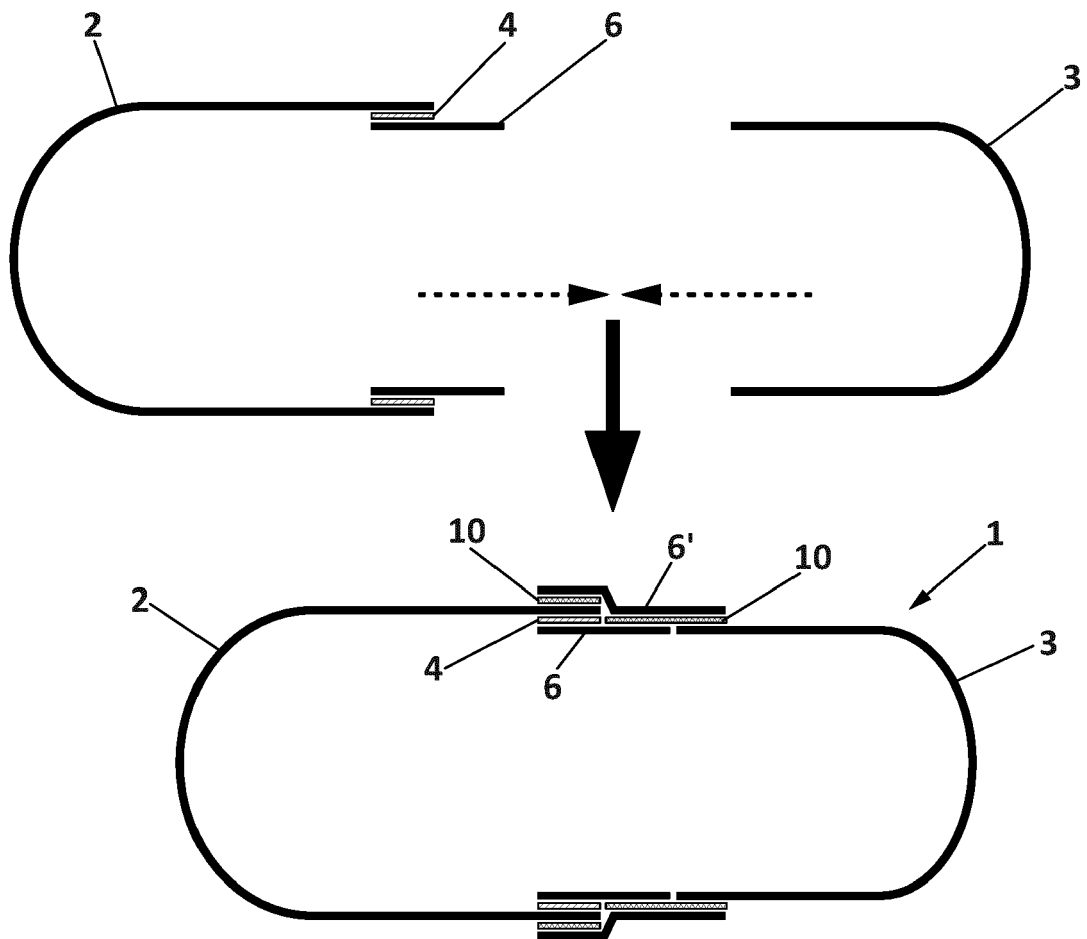


FIG. 6



EUROPEAN SEARCH REPORT

Application Number

EP 22 38 2527

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EPO FORM 1503 03.82 (P04C01)

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Place of search Munich		Date of completion of the search 9 November 2022	Examiner Fritzen, Claas
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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