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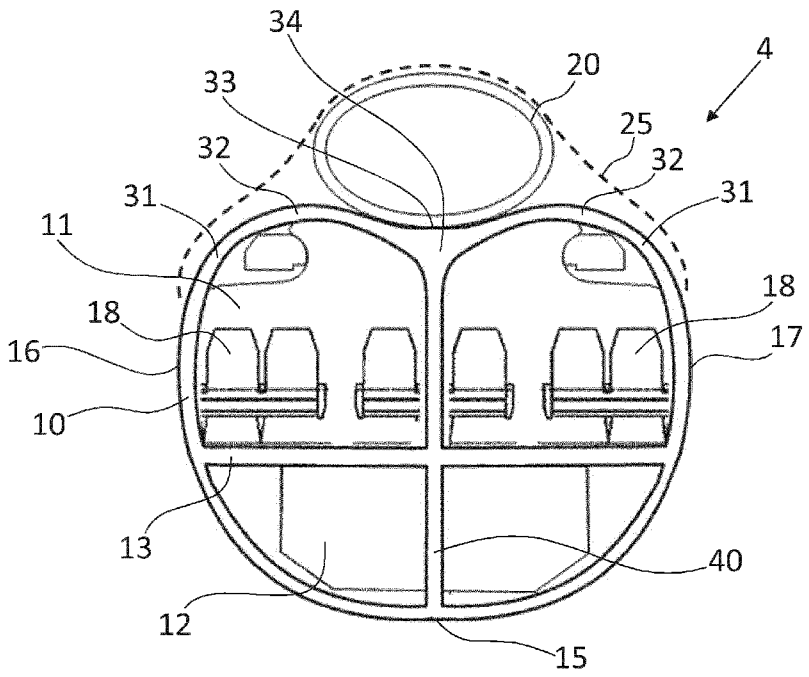


FIG. 4

(57) Abstract: An aircraft fuselage comprising a fuselage shell; and a fuel tank outside the fuselage shell, wherein the fuselage shell has a double-lobed cross section and at least part of the fuel tank is located in a channel between the two lobes.

WO 2021/148335 A1

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AN AIRCRAFT FUSELAGE

FIELD OF THE INVENTION

[0001] The present invention relates to an aircraft fuselage having a fuselage shell and a fuel tank, and an aircraft comprising the aircraft fuselage.

BACKGROUND OF THE INVENTION

[0002] There is a drive to provide aircraft that can meet future emissions targets. One approach to tackling this challenge is the use of alternative fuels, such as liquid hydrogen. A difficulty in providing aircraft that are powered by these alternative fuels is that they may need to be stored in pressurised fuel tanks, which are ideally circular or elliptical cross section tubes in order to withstand the pressure forces.

[0003] Currently, conventional aircraft fuel tanks are primarily located in the wings, at least partly so that their weight counters the aerodynamic lift generated during flight. However, it will be difficult to accommodate fuel tanks that are big enough for the proposed alternative fuels, such as liquid hydrogen, as the shape of the tubular pressurised tanks does not fit well with the shape of the wings. One option is to locate the fuel tank on the fuselage, but there is also a need to design the fuselage to have a low frontal area and thereby minimise drag.

SUMMARY OF THE INVENTION

[0004] According to a first aspect of the invention, there is provided an aircraft fuselage comprising a fuselage shell; and a fuel tank outside the fuselage shell, wherein the fuselage shell has a double-lobed cross section and at least part of the fuel tank is located in a channel between the two lobes.

[0005] Whilst the most structurally efficient cross-section for a fuselage shell is a perfect circle, the addition of a fuel tank on the outside of the fuselage shell means that the frontal area of the fuselage is significantly increased. This can result in a substantial increase in drag. By providing a fuselage shell with two lobes, and arranging the fuel tank in a channel between the lobes, the frontal area of the aircraft is reduced. This particular shape allows the frontal area to be reduced without significantly impacting the usable area inside the fuselage shell.

[0006] According to a second aspect of the invention, there is provided an aircraft fuselage comprising a fuselage shell and a fuel tank on top of the fuselage shell, and a load bearing structure extending generally vertically through the interior of the fuselage shell for supporting at least a portion of the load of the fuel tank.

[0007] Placing the fuel tank on top of the fuselage provides many benefits, which include allowing it to be protected from the ground upon landing, and allowing some degree of gravity feed when displacing fuel from the fuel tank to the engines.

[0008] The fuselage shell may be a pressure shell, pressurisable above ambient atmospheric pressure. The fuselage shell may comprise a thin skin reinforced by a reinforcement structure. The reinforcement structure may comprise a plurality of transverse frames and longitudinal stringers. The fuselage shell may be a composite or metallic construction. The skin may be stressed, forming a semi-monocoque construction. The fuselage shell may need to be reinforced to withstand the weight of the fuel tank. One way in which this can be achieved is to extend a load bearing structure generally vertically through the interior of the fuselage shell. This can reduce the stresses at the top of the fuselage shell, helping to prevent buckling of the fuselage shell or excessive peel stresses developing. Here, top, bottom, etc. refers to the normal aircraft orientation on the ground with z axis vertical, x axis longitudinal fore-aft along the aircraft centreline, and y axis perpendicular to x and z axes.

[0009] According to a further aspect of the invention, there is provided an aircraft comprising the aircraft fuselage.

[0010] The channel of the first aspect may be located on top of the fuselage shell.

[0011] The first aspect of the invention may include a load bearing structure that extends generally vertically from the channel through the interior of the fuselage shell, wherein the load bearing structure is configured to support at least a portion of the load of the fuel tank.

[0012] The fuselage shell may include a first lobe and a second lobe with a channel located between the first and second lobes, and at least a part of the fuel tank is located in the channel.

[0013] With this arrangement, the frontal area including the fuel tank may be reduced without substantially affecting the usable interior volume of the fuselage shell.

[0014] The load bearing structure may extend along a plane of symmetry of the fuselage shell (i.e. the vertical x-z plane). The fuel tank may have a plane of symmetry. The plane of symmetry of the fuel tank may align with the plane of symmetry of the fuselage shell.

[0015] This provides an efficient structure for bearing loads.

[0016] The fuselage shell may include a first apex and a second apex. The first apex and second apex may be spaced from the load bearing structure. The first apex and second apex may be equally spaced from the load bearing structure. The channel may be between the first and second apexes. The first apex may be on a first lobe and the second apex may be on a second lobe.

[0017] The channel may be shaped to correspond to the shape of at least a portion of the fuel tank. The channel may be shaped to correspond to the shape of substantially half of the fuel tank.

[0018] The fuselage shell may comprise an upper section and a lower section separated by a floor, wherein the load bearing structure extends from the top of the fuselage shell to the floor.

[0019] With this arrangement, the load bearing structure may react its load against the floor.

[0020] The upper section may be a passenger cabin. The lower section may be a cargo bay. The upper and/or lower section may be pressurised.

[0021] The load bearing structure may extend from the top of the fuselage shell to the bottom of the fuselage shell.

[0022] The load bearing structure may be a wall. The wall may extend substantially along the length of the fuel tank. The wall may extend along the entire length of the fuel tank.

[0023] With this arrangement, the load bearing structure is able to support the weight of the fuel tank along its length.

[0024] The wall may divide the fuselage shell into adjacent port and starboard sections. The port and starboard sections may be substantially the same volume. The wall may include an opening extending between the port and starboard sections. The wall may include more than one opening, for example two opening or three openings. The openings may be configured as gangways between the port and starboard sections of the fuselage shell.

[0025] With this arrangement, access is provided between the port and starboard sections.

[0026] The load bearing structure may include one or more beams.

[0027] The load bearing structure may be a lattice wall.

[0028] The outer shape of the fuselage shell may be formed by a first ellipse and a second ellipse that overlap. An ellipse is a structurally efficient shape that is able to react loads, such as those resulting from cabin pressurisation.

[0029] The major axis of the first ellipse and the major axis of the second ellipse may intersect.

[0030] The fuselage shell may be generally heart-shaped. A heart-shape may be defined as having two equal curves rounded at the top and meeting at a channel. The curves meet at the bottom. The fuselage shell may be shaped to have a double rounded top, wherein two equal curves are rounded at the top and meet at a channel, and the curves smoothly transition into one another so that there is no cusp at the bottom.

[0031] The aircraft fuselage may comprise a fairing. The fairing may be blended between the fuselage shell and the fuel tank.

[0032] The fuel tank may be enveloped between the fuselage shell and the fairing.

[0033] The fuel tank may include a plurality of separate fuel tank elements separated from each other. The fuel tank elements may separate the fuel in each fuel tank element. The fuel tank elements may be separated longitudinally and/or laterally.

[0034] At least two of the fuel tank elements may be separated to provide a gap in the fuel tank in the disk burst zone of an engine.

[0035] The fuel tank and/or fuel tank elements may have an elliptical or circular cross-section.

[0036] The fuel tank may be configured to carry cryogenic fuel. The cryogenic fuel may be one of liquid hydrogen, liquid methane, liquid ammonia, and liquid natural gas. The fuel tank may be thermally insulated.

[0037] The aircraft may further comprise an engine. The fuel tank may be configured to supply fuel to the engine.

[0038] The engine may be a main engine for forward propulsion of the aircraft.

[0039] The engine may be mounted on wing of the aircraft. The engine may be mounted on the fuselage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

[0041] Figure 1 shows a schematic of an existing aircraft;

[0042] Figure 2 shows a cross section of the fuselage of the aircraft of Figure 1;

[0043] Figure 3 shows a first example of an aircraft having a fuel tank on the fuselage;

[0044] Figures 4 & 5 shows a first example of a fuselage according to the aircraft of Figure 3;

[0045] Figure 6 shows a second example of a fuselage according to the aircraft of Figure 3;

[0046] Figure 7 shows a third example of a fuselage according to the aircraft of Figure 3;

[0047] Figure 8 shows the disk burst zone of the engine of the aircraft of Figure 3;

[0048] Figure 9 shows a second example of an aircraft having a fuel tank on the fuselage;

[0049] Figure 10 shows a first example of a fuselage according to the aircraft of Figure 9;

[0050] Figure 11 shows a first example of a load bearing structure;

[0051] Figure 12 shows a second example of a load bearing structure;

[0052] Figure 13 shows a third example of a load bearing structure.

[0053] Figure 14 shows a fourth example of a load bearing structure.

DETAILED DESCRIPTION OF EMBODIMENT(S)

[0054] Figure 1 shows an existing aircraft 1 with port and starboard fixed wings 2, 3, engines 9, a fuselage 4 with a nose end 5 and a tail end 6, the tail end 6 including horizontal and vertical stabilising surfaces 7, 8. The aircraft 1 is a typical jet passenger transonic transport aircraft but the invention is applicable to a wide variety of fixed wing aircraft types, including commercial, military, passenger, cargo, jet, propeller, general aviation, etc. with any number of engines attached to the wings or fuselage.

[0055] Each wing 2, 3 of the aircraft 1 has a cantilevered structure with a length extending in a span-wise direction from a wing root to a wing tip, the wing root being joined to the aircraft fuselage 4.

[0056] A cross-section of the fuselage 4 is shown in Figure 2. The fuselage 4 includes a fuselage shell 10 forming the outer aerodynamic shell of the fuselage 4. Inside the fuselage shell 10 is an upper section 11 and a lower section 12 separated by a floor 13. The fuselage shell 10 is substantially symmetric about a plane of symmetry extending between a top 14 and bottom 15 of the fuselage shell 10.

[0057] In the particular example shown in Figure 2, the floor 13 is positioned below a central horizontal plane 51 (i.e. x-y plane of the aircraft 1) of the fuselage shell 10 that extends through the aircraft 1 centreline between port 16 and starboard 17 extremities of the fuselage shell 10, such that the lower section 12 is smaller than the upper section 11.

[0058] In this particular example, the upper section 11 of the fuselage shell 10 is a passenger deck that includes rows of seats 18 supported by the floor 13, with the rows of seats 18 separated by an aisle extending along the longitudinal axis of the aircraft. The lower section 12 of the fuselage shell 14 is a cargo bay, arranged to hold luggage and/or cargo. It will be understood that the upper section 11 and lower section 12 may

not be sections of a passenger aircraft 1, and may instead be sections of other aircraft types, such as those listed above.

[0059] Endeavours to reduce the use of fossil fuels, and in particular decrease aircraft carbon emissions, mean that improvements to existing aircraft are continuously being made, with one such solution being the use of cryogenic fuels such as liquid hydrogen. However, liquid hydrogen has a lower specific energy content (i.e. energy per volume of fuel) and the pressurised fuel tanks are generally heavier (due at least in part to the insulation require to insulate cryogenic fuels) so the fuel tanks required to carry the necessary amount of fuel are correspondingly larger than for conventional kerosene powered aircraft.

[0060] Figure 3 shows a first example of an aircraft 1 in which the fuel tank 20 is located on the fuselage 4, specifically on top of a fuselage shell 10 of the fuselage 4. As shown in Figure 4, the fuel tank 20 is covered by a fairing 25, such that the fuel tank 20 is enveloped between the fuselage shell 10 and the fairing 25.

[0061] In order to minimise the aerodynamic impact of the fuel tank 20, as the fuel tank 20 adds a significant frontal area that adds a drag penalty, the fuselage shell 10 is specially designed with a substantially heart-shaped frontal profile, when viewed along the longitudinal axis of the aircraft 1.

[0062] The heart-shaped profile is formed by a pair of lobes 31, arranged to be symmetric about a vertical plane of symmetry. Each lobe 31 has an apex 32 at its upper extremity, with a channel 33 between the apexes 32. It will be noted that each apex 32 of the fuselage shell 10 defines a local top of the fuselage shell 10, with the plane of symmetry of the heart-shaped profile extending between the bottom of the fuselage 15 and the channel 33. Due to the heart-shaped profile of the fuselage shell 10, the fuselage shell 10 does not have a horizontal plane of symmetry.

[0063] The fuel tank 20 is located in the channel 33 such that a portion of the height of the fuel tank 20 is recessed into the fuselage shell 10 within the channel 10. In order to accommodate this channel 33, the inner volume of the upper section 11 of the fuselage shell 10 is slightly reduced, as shown in Figure 4. In this particular example, an advantage of the heart-shaped profile is that it maintains the amount of head room

available to a passenger next to the window, with respect to the fuselage configuration shown in the example of Figure 2, whilst reducing the overall height of the fuselage 4 (including the fuel tank 20) in comparison to a fuselage 4 without a heart-shaped profile.

[0064] Below the channel 33 is a reinforced section 34 of the fuselage shell at the intersection of the lobes 31.

[0065] Each of the lobes 31 can be approximated by an ellipse 35, as shown in Figure 5. The ellipses 35 overlap and are angled such that their major axes 36 (i.e. the longest diameter of the ellipse) meet at an intersection point 37 near to or at the bottom 15 of the fuselage shell 10. In the particular example shown in Figure 5, the intersection point 37 is located slightly above the bottom 15 of the fuselage shell 10.

[0066] By moving the fuel tank 20 from the wings 2, 3, the interior area of the wings 2,3 is now free to fit extra aircraft systems, such as avionic systems, electrical systems, hydraulic systems, and landing gear (not shown). This may increase the available space for passengers, cargo, or other payloads within the fuselage 4.

[0067] The fuel tank 20 can be quite heavy, especially when full, and the fuel tank 20 therefore applies a significant load to the fuselage shell 10 on which it sits. In some instances, the fuselage shell 10 may need to be supported in order to avoid excessive peel stresses developing between the apexes 32 due to the recess forming the channel 33. These peel stresses may also develop due to other loads within the fuselage, such as the pressurisation loads, as well as aerodynamic and ground loads acting on the aircraft.

[0068] To provide this support, a load bearing structure 40 extends generally vertically from the channel 33 through the interior of the fuselage shell 10. The load bearing structure 40 supports at least a portion of the load of the fuel tank 20. The load bearing structure 40 extends from the channel 33 to the bottom 15 of the fuselage, along the vertical plane of symmetry of the fuselage shell 10 between the bottom of the fuselage 15 and the channel 33, such that the load bearing structure 40 is offset from the apexes 32 of the lobes 31. The load bearing structure 40 reacts the load of the fuel tank against the bottom 15 of the fuselage shell 10, although a portion of that load may be reacted against the floor 13 that separates the upper section 11 and lower section 12 of the fuselage shell 10. The load of the fuel tank 20 may also at least partially be supported

by the upper lobes 31, particularly when the cabin is pressurised. The load bearing structure 40 crosses through the floor 13 as it extends to the bottom 15 of the fuselage shell 10.

[0069] The load bearing structure 40 is a rigid, solid wall that extends vertically and divides the fuselage shell into port and starboard sections. As the wall 40 extends through the fuselage shell 10, the cabin arrangement is altered so as to have two aisles in between the rows of seats 18, as shown best in Figure 4.

[0070] A second example of an aircraft fuselage 4' in which the fuel tank 20 is located on the fuselage 4, is shown in Figure 6.

[0071] The fuselage 4' is substantially the same as the fuselage 4 shown in the first example of Figures 4 & 5. The fuselage 4' differs in that the fuel tank 20 is not enveloped between the fuselage shell 10 and a fairing 25. Instead, the fuel tank 20 is integrated into the fuselage shell 10, such that the fuel tank 20 is entirely enveloped by a section of the fuselage shell 10.

[0072] A third example of an aircraft fuselage 4" in which the fuel tank 20 is located on the fuselage 4", is shown in Figure 7.

[0073] The fuselage 4" is substantially the same as the fuselage 4 shown in the first example of Figures 4 & 5. The fuselage 4" differs in that the load bearing structure 40 does not extend entirely from the channel 33 to the bottom 15 of the fuselage 4", but instead extends from the channel 33 to the floor 13 that separates the upper section 11 and lower section 12 of the fuselage shell 10. The load bearing structure 40 reacts the load of the fuel tank 20 against the floor 13, although load of the fuel tank 20 may also at least partially be supported by the upper lobes 31, particularly when the cabin is pressurised.

[0074] The fuel tank 20 of the aircraft 1 may be separated into multiple fuel tank elements 21.

[0075] Figure 8 shows the fuel tank 20 separated into two fuel tank elements 21a, 21b, separated longitudinally. This is to provide a gap in the fuel tank 20 in the disk burst zone of each engine 9, which is a zone adjacent to the engine 9 that is at risk of being

impacted in the event of an engine failure. The disk burst zone of the engine 9 on the port wing 2 is shown in Figure 8.

[0076] Figure 9 shows a further example of an aircraft 1 in which the fuel tank 20 is separated into multiple fuel tank elements 21.

[0077] The fuel tank 20 is separated into three fuel tank elements 21a, 21b, 21c. Each fuel tank element 21a, 21b, 21c is tubular with an elliptical cross section, although it will be clear that the cross section may be circular. The fuel tank elements 21a, 21b, 21c are tessellated so that they are closely packed to minimise the volume they occupy, but may provide benefits in terms of isolating parts of the fuel system (e.g. one of the fuel tank elements 21) or distribution of the weight of the fuel.

[0078] The close-packed stacking arrangement of the fuel tank elements 21a, 21b, 21c is shown in cross-sectional view in Figure 10, in which it is seen that the fuel tank elements are supported by the fuselage shell 10 at two points 19. This distribution of the fuel tank weight may help to reduce the peel stresses that develop between the apexes 32.

[0079] In the previous examples shown, the engines 9 are mounted to the wings 2, 3 of the aircraft. Alternatively, the engines 9 may be mounted to a different part of the aircraft. For example, the engines 9 may be mounted to a section of the fuselage 4.

[0080] In the previous examples shown, the load bearing structure 40 is a solid wall that extends down from the channel 33.

[0081] Figure 11 shows a cross-section of the fuselage shell 10, in particular showing an alternative example of a load bearing structure 40.

[0082] The load bearing structure 40 includes a first set of load bearing beams 41a extending from a reinforced section 34 of the channel 33 to the floor 13, and a second set of load bearing beams 41b extending from the floor 13 to the bottom 15 of the fuselage shell 10.

[0083] The beams 41a, 41b provide a number of openings 43 between the port and starboard sections of the fuselage shell 10. These openings 43 provide access between the port and starboard sections and can be used to provide gangways for passengers.

[0084] Each of the beams 41a, 41b is inclined with respect to the vertical axis between top and bottom of fuselage. In order to ensure that the beams 41a, 41b are utilised efficiently in bearing the weight of the fuel tank 20, the beams 41a, 41b are inclined no more than 45 degrees to the vertical axis, and preferably 30 degrees or less.

[0085] In some examples, the beams 41 may form a lattice wall.

[0086] Figure 12 shows a cross-section of the fuselage shell 10, in particular showing a further alternative example of a load bearing structure 40.

[0087] In this example, the load bearing structure 40 includes a solid wall 42 extending from the channel 33 to the floor 13, and a set of load bearing beams 41 extending from the floor 13 to the bottom 15 of the fuselage shell 10.

[0088] Figure 13 shows a cross-section of the fuselage shell 10, in particular showing a further alternative example of a load bearing structure 40.

[0089] In this example, the load bearing structure 40 includes a first wall 42a extending from the reinforced section 34 of the fuselage shell 10 to the channel 33 to the floor 13, and a second wall 42b extending from the floor 13 to the bottom 15 of the fuselage shell 10. The first wall 42a includes two openings 43 that form gangways between the respective sides of the fuselage shell 10.

[0090] Figure 14 shows a cross-section of the fuselage shell 10, in particular showing a further alternative example of a load bearing structure 40.

[0091] In this example, the load bearing structure 40 includes a includes a set of load bearing beams 41 extending from a reinforced section 34 of the channel 33 to the floor 13, and a wall 42 extending from the floor 13 to the bottom 15 of the fuselage shell 10. The set of load bearing beams 41 includes two openings 43 that form gangways between the respective sides of the fuselage shell 10.

[0092] It will be clear to the skilled person that the examples described above may be adjusted in various ways. In the examples shown, the intersection point 37 of the ellipses 35 is near to or at the bottom 15 of the fuselage shell 10. The location of the intersection point may be varied to change the shape of the fuselage shell. The fuselage shell 10 may

not include an intersection point 37, in which case the major axes 36 of the ellipses 35 may meet at an imaginary point below the fuselage shell 10.

[0093] The lobes 31 may not be perfectly elliptical. The lobes may be ovular or egg shaped.

[0094] The load bearing structure 40 may be any structure that extends generally vertically to provide support to at least a portion of the fuel tank. The load bearing structure 40 may be, for example, a wall, one or more beams, or a combination of walls and beams. The load bearing structure may include openings providing access between port and starboard sections of the fuselage. The load bearing structure may extend continuously between the top and bottom of the fuselage shell 10, or the load bearing structure 40 may comprise multiple sections, for example separated by a floor 13 of the fuselage 4. The load bearing structure 40 may extend towards, and react against, one or more keel beams that extend along the longitudinal axis of the aircraft 1. The keel beam(s) generally helps to transfer loads between the fuselage and the centre wing box.

[0095] In some examples, the fuel tank 20 may not be located at the top of the fuselage shell 10. Instead, the fuel tank 20 may be located on a side of the fuselage shell 10, at the bottom of the fuselage shell 10, or any other suitable location. The fuel tank 20 and/or fuel tank elements 21 may include one or more baffles, or other known means, to help to prevent fuel sloshing. The fuel tank 20 and/or fuel tank elements 21 may be partially integrated into the fuselage shell 10, such that a skin of the fuselage shell 10 is also a skin of the fuel tank 20 and/or fuel tank elements 21. The fuel tank 20 may be double-walled, particularly in vulnerable regions such as where it is adjacent an outer aerodynamic surface.

[0096] The fuel tank 20 is described in relation to its storage of cryogenic fuels, in particular liquid hydrogen. In alternative examples, the cryogenic fuel is liquid methane, liquid natural gas, liquid ammonia, or any cryogenic fuel known in the art. In further examples the fuel is not a cryogenic fuel, for example the fuel is a kerosene based aviation fuel or other aviation fuel known in the art.

[0097] Where the word 'or' appears this is to be construed to mean 'and/or' such that items referred to are not necessarily mutually exclusive and may be used in any appropriate combination.

[0098] Although the invention has been described above with reference to one or more preferred embodiments, it will be appreciated that various changes or modifications may be made without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. An aircraft fuselage comprising a fuselage shell; and a fuel tank outside the fuselage shell, wherein the fuselage shell has a double-lobed cross-section and at least part of the fuel tank is located in a channel between the two lobes.

2. An aircraft fuselage according to claim 1, wherein the channel is located on top of the fuselage shell.

3. An aircraft fuselage according to claims 1 or 2, wherein a load bearing structure extends generally vertically from the channel through the interior of the fuselage shell, wherein the load bearing structure is configured to support at least a portion of the load of the fuel tank.

4. An aircraft fuselage comprising a fuselage shell and a fuel tank on top of the fuselage shell, and a load bearing structure extending generally vertically through the interior of the fuselage shell for supporting at least a portion of the load of the fuel tank.

5. An aircraft fuselage according to claim 4, wherein the fuselage shell includes a first lobe and a second lobe with a channel located between the first and second lobes, and at least a part of the fuel tank is located in the channel.

6. An aircraft fuselage according to any one of claims 3 to 5, wherein the load bearing structure extends along a plane of symmetry of the fuselage shell.

7. An aircraft fuselage according to anyone of claims 3 to 6, the fuselage shell comprising an upper section and a lower section separated by a floor, wherein the load bearing structure extends from the top of the fuselage shell to the floor.

8. An aircraft fuselage according to any one of claims 3 to 7, wherein the load bearing structure extends from the top of the fuselage shell to the bottom of the fuselage shell.

9. An aircraft fuselage according to any one of claims 3 to 8, wherein the load bearing structure is a wall.

10. An aircraft fuselage according to claim 9, wherein the wall extends substantially along the length of the fuel tank.

11. An aircraft fuselage according to claim 9 or 10, wherein the wall divides the fuselage shell into adjacent port and starboard sections, and wherein the wall includes one or more openings extending between the port and starboard sections.

12. An aircraft fuselage according to any one of claims 3 to 11, wherein the load bearing structure includes one or more beams.

13. An aircraft fuselage according to any preceding claim, wherein the outer shape of the fuselage shell is formed by a first ellipse and a second ellipse that overlap.

14. An aircraft fuselage according to claim 13, wherein the major axis of the first ellipse and the major axis of the second ellipse intersect.

15. An aircraft fuselage according to any preceding claim, comprising a fairing blended between the fuselage shell and the fuel tank.

16. An aircraft fuselage according to any preceding claim, wherein the fuel tank includes a plurality of separate fuel tank elements separated from each other.

17. An aircraft fuselage according to claim 16, wherein at least two fuel tank elements are separated to provide a gap in the fuel tank in the disk burst zone of an engine.

18. An aircraft fuselage according to any preceding claim, wherein the fuel tank and/or fuel tank elements have an elliptical or circular cross-section.

19. An aircraft fuselage according to any preceding claim, wherein the fuel tank is configured to carry cryogenic fuel.

20. An aircraft fuselage according to claim 19, wherein the cryogenic fuel is one of liquid hydrogen, liquid methane, liquid ammonia and liquid natural gas.

21. An aircraft comprising the aircraft fuselage of any preceding claim.

22. An aircraft according to claim 21, further comprising an engine, wherein the fuel tank is configured to supply fuel to the engine.

23. An aircraft according to claim 22, wherein the engine is a main engine for an aircraft.

24. An aircraft according to claim 22 or 23, further comprising a wing, wherein the engine is mounted on the wing.

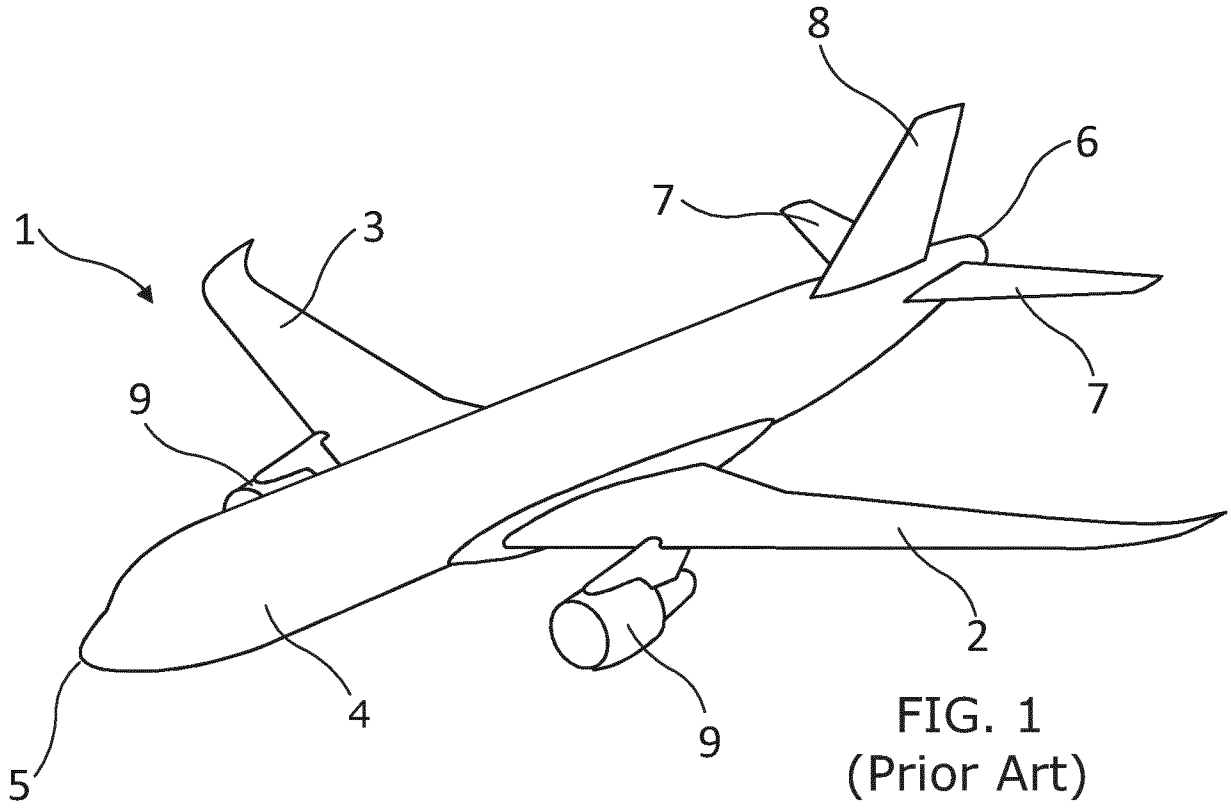


FIG. 1
(Prior Art)

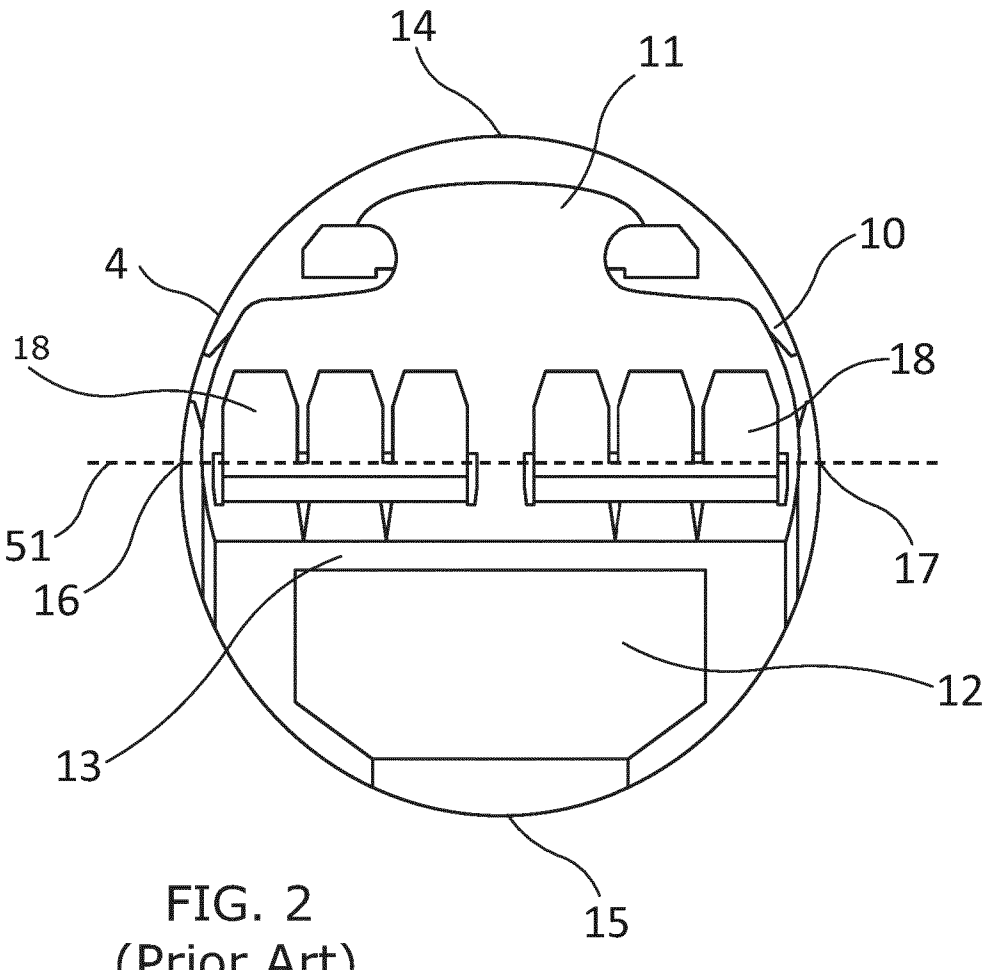


FIG. 2
(Prior Art)

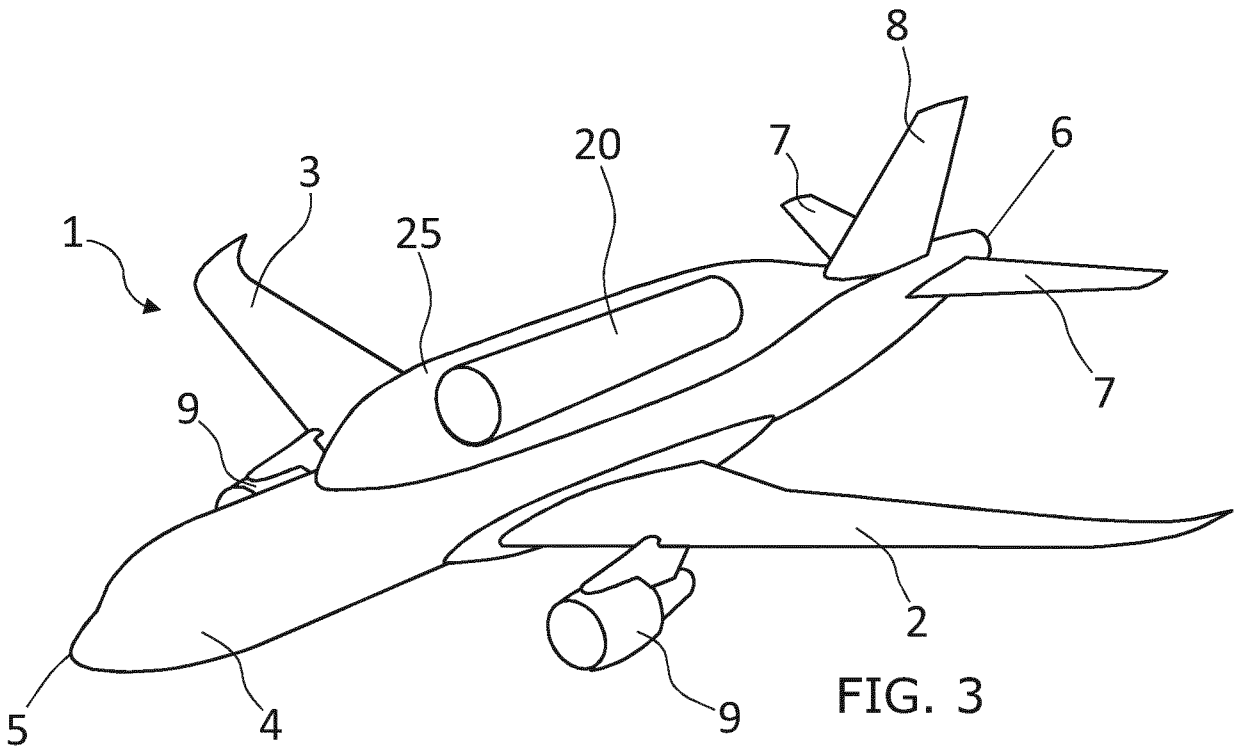

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FIG. 3

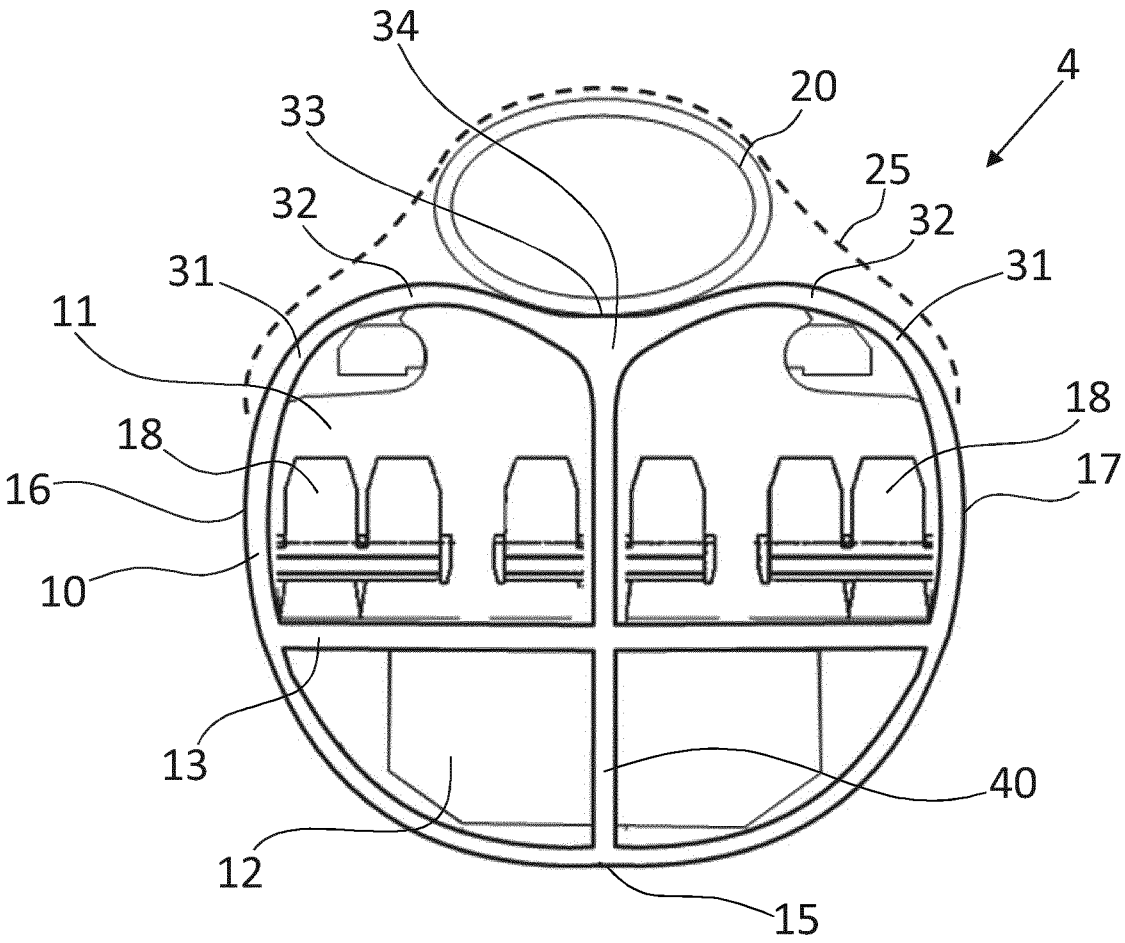

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FIG. 4

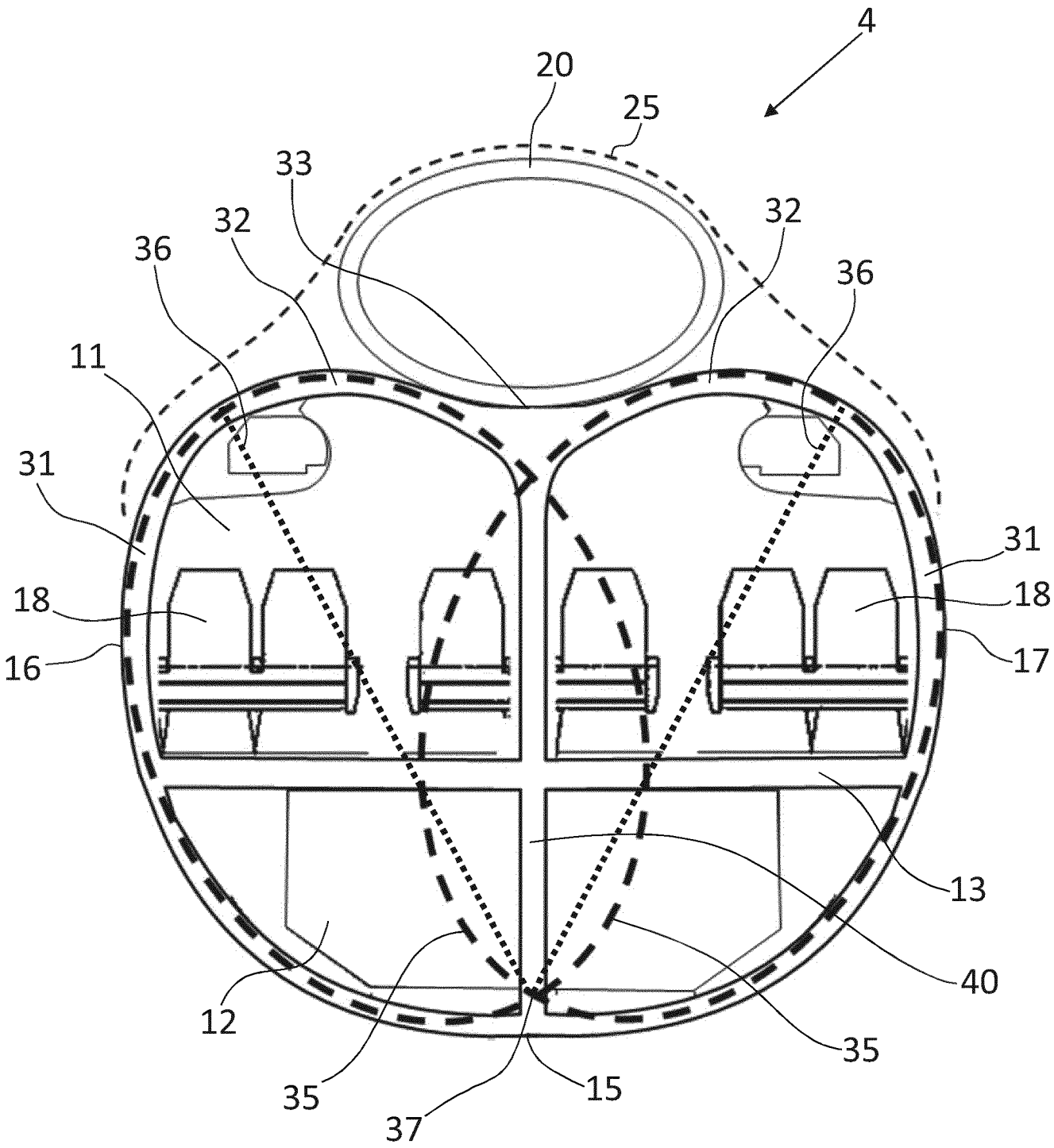


FIG. 5

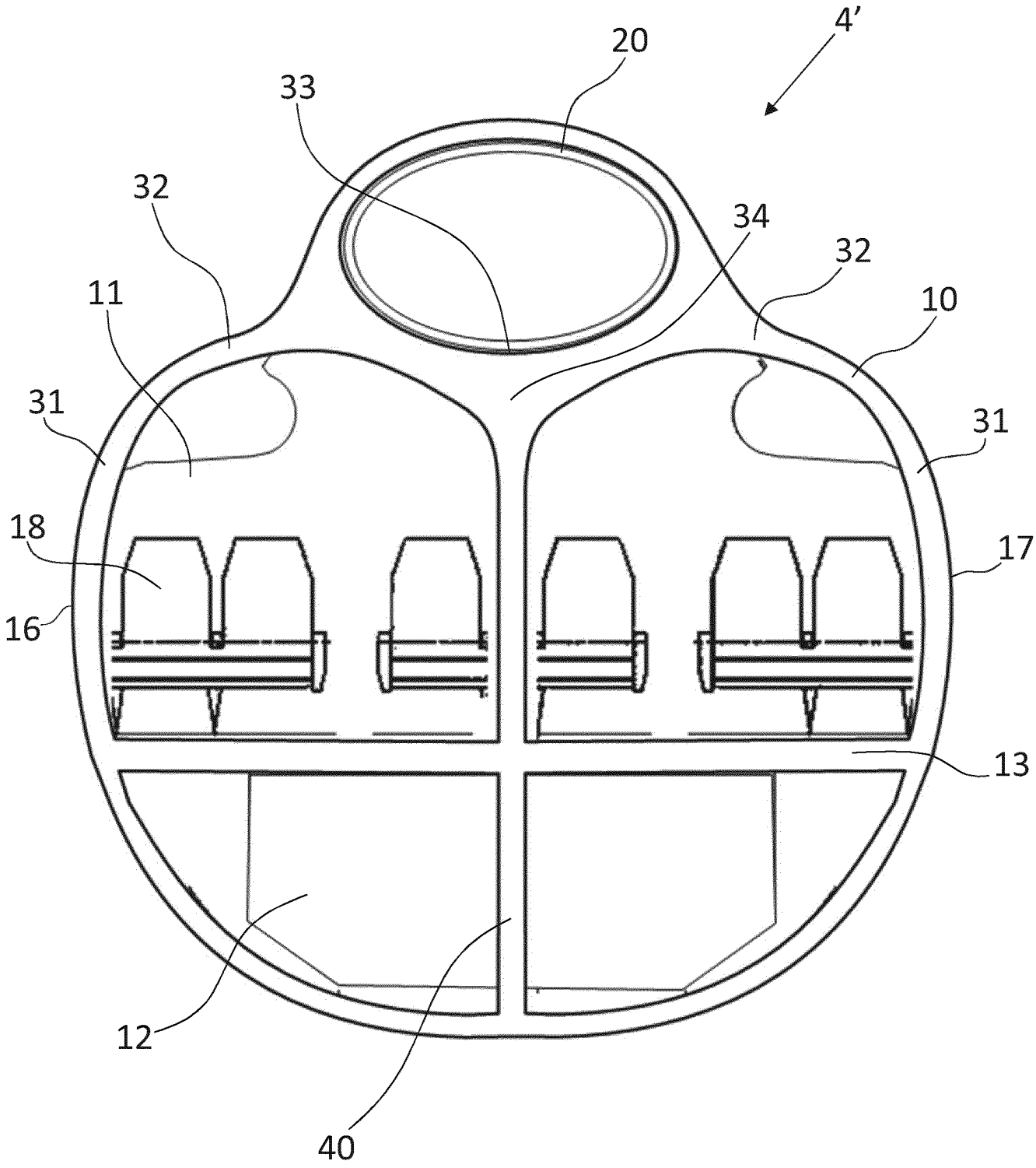


FIG. 6

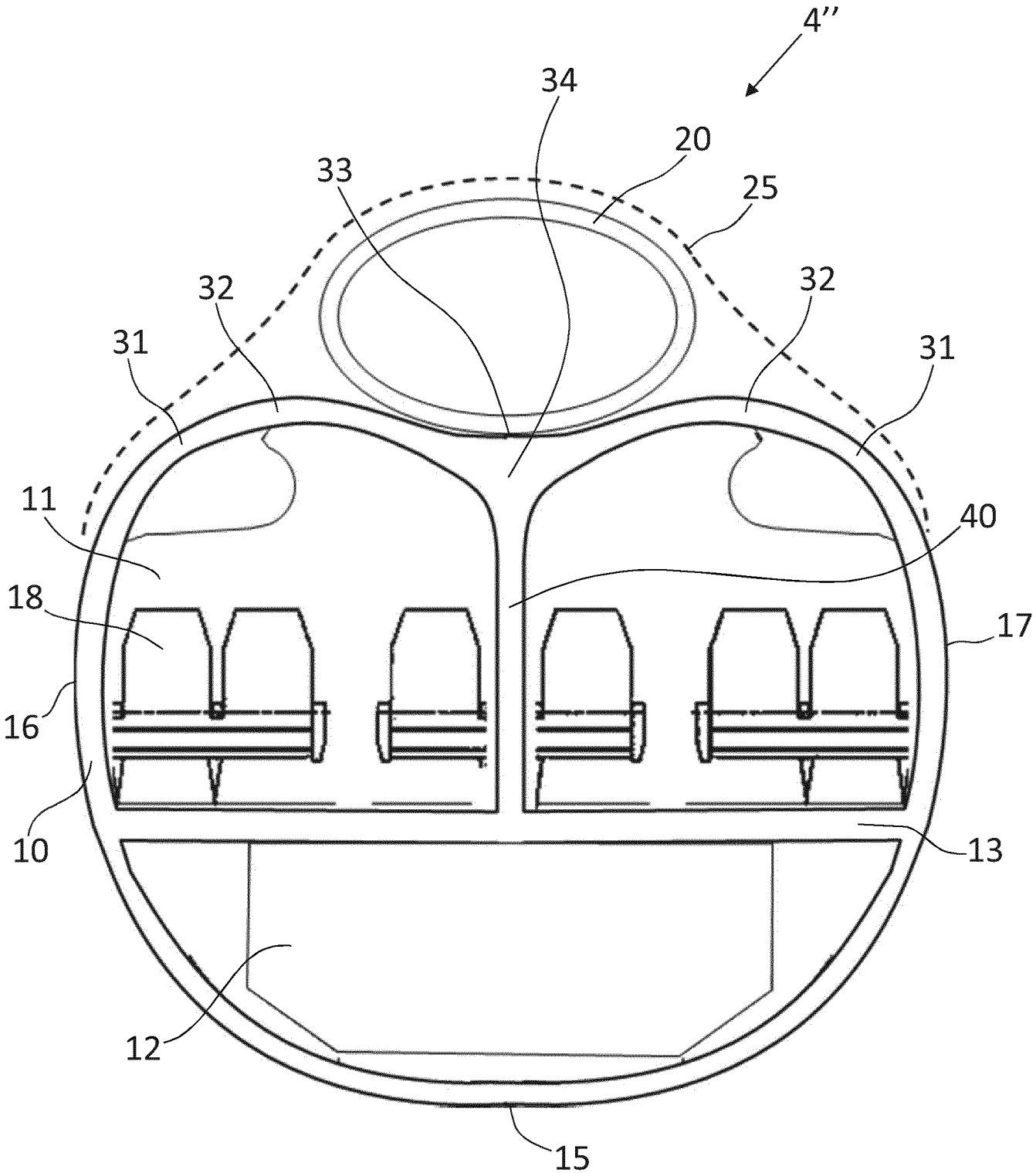


FIG. 7

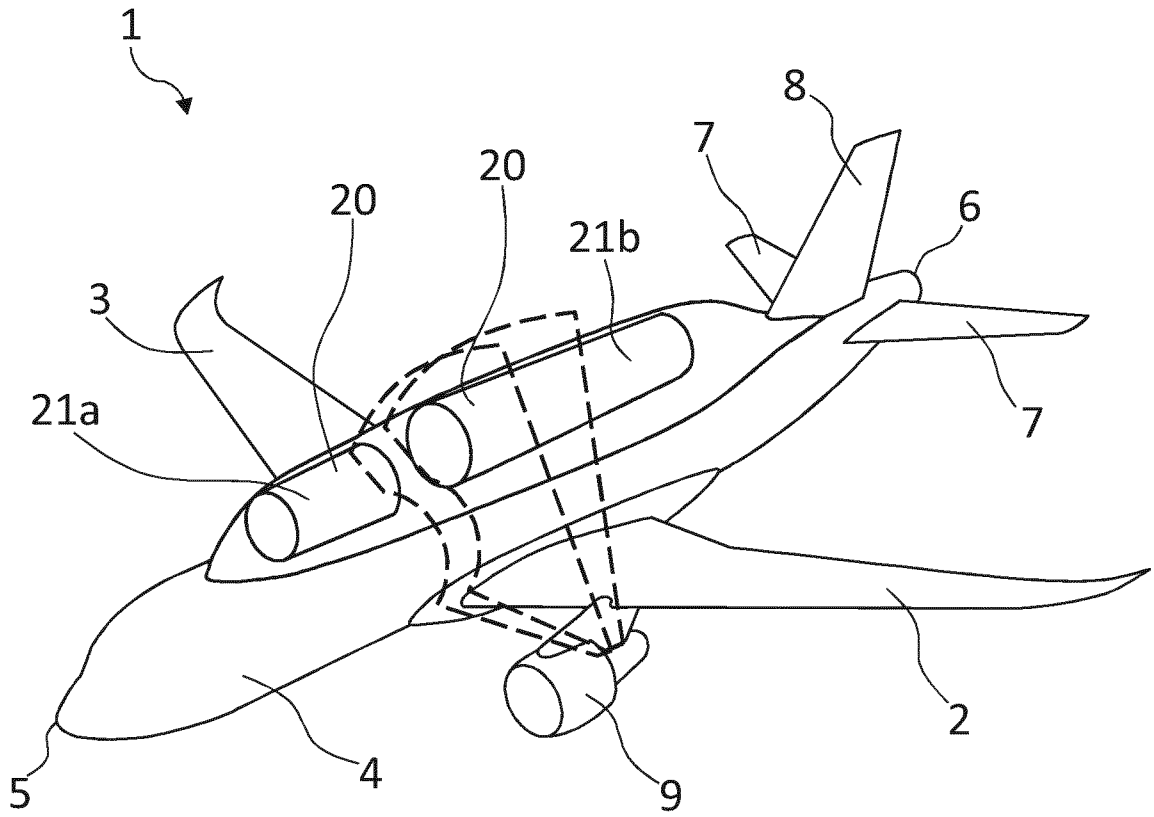


FIG. 8

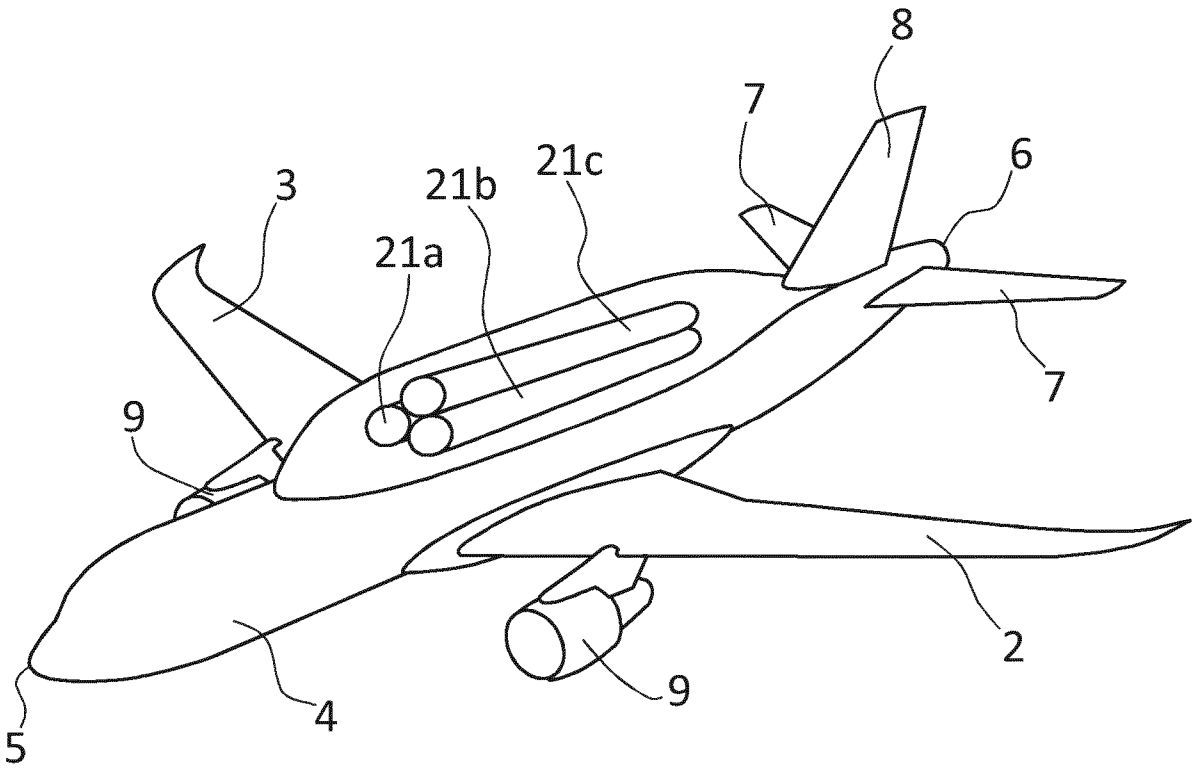


FIG. 9

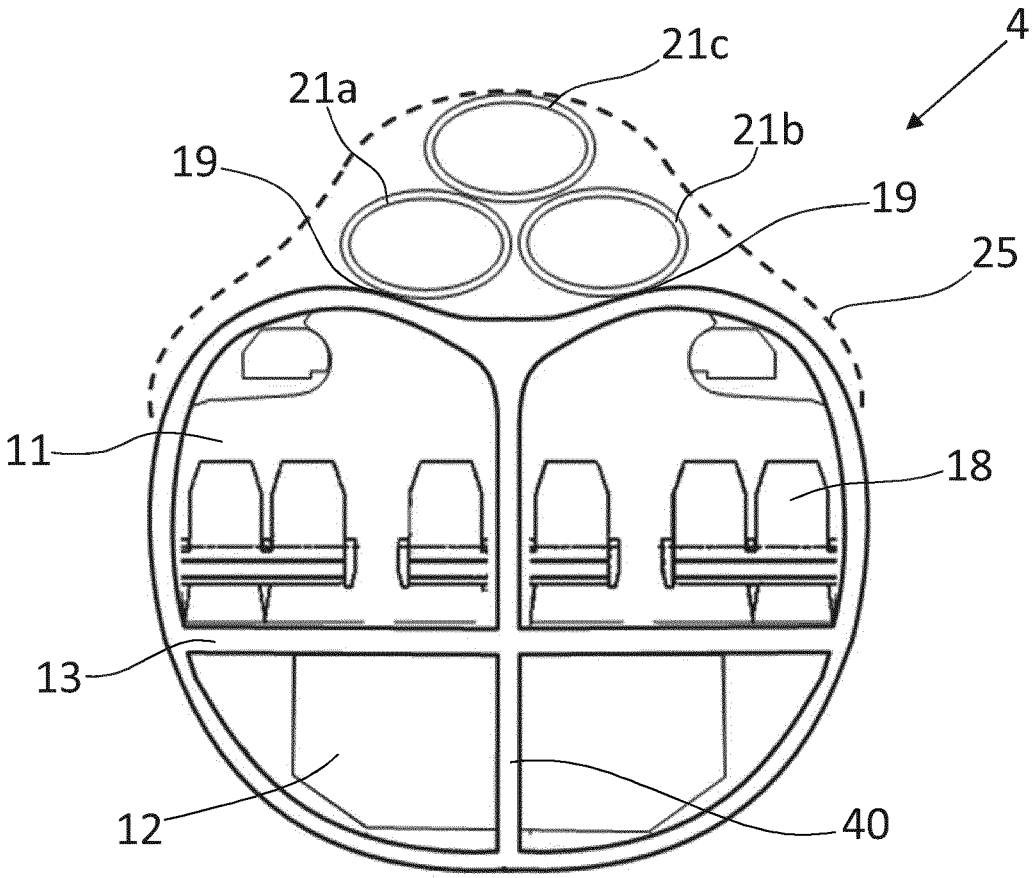


FIG. 10

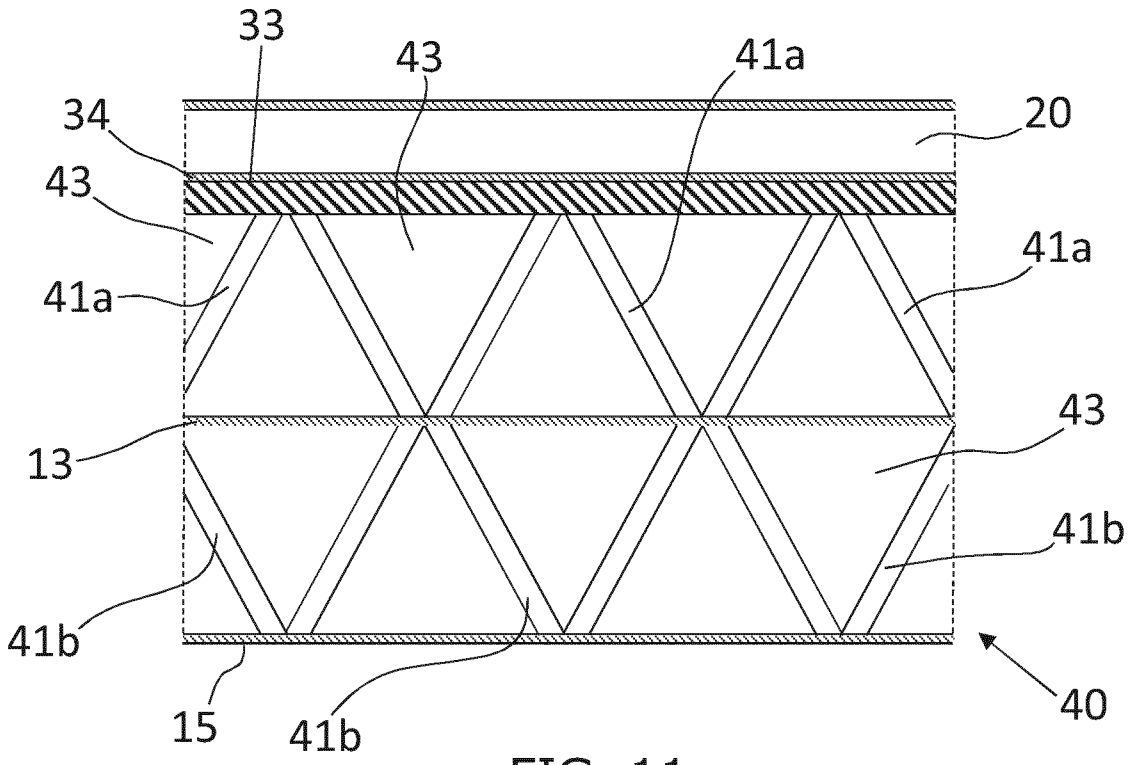

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FIG. 11

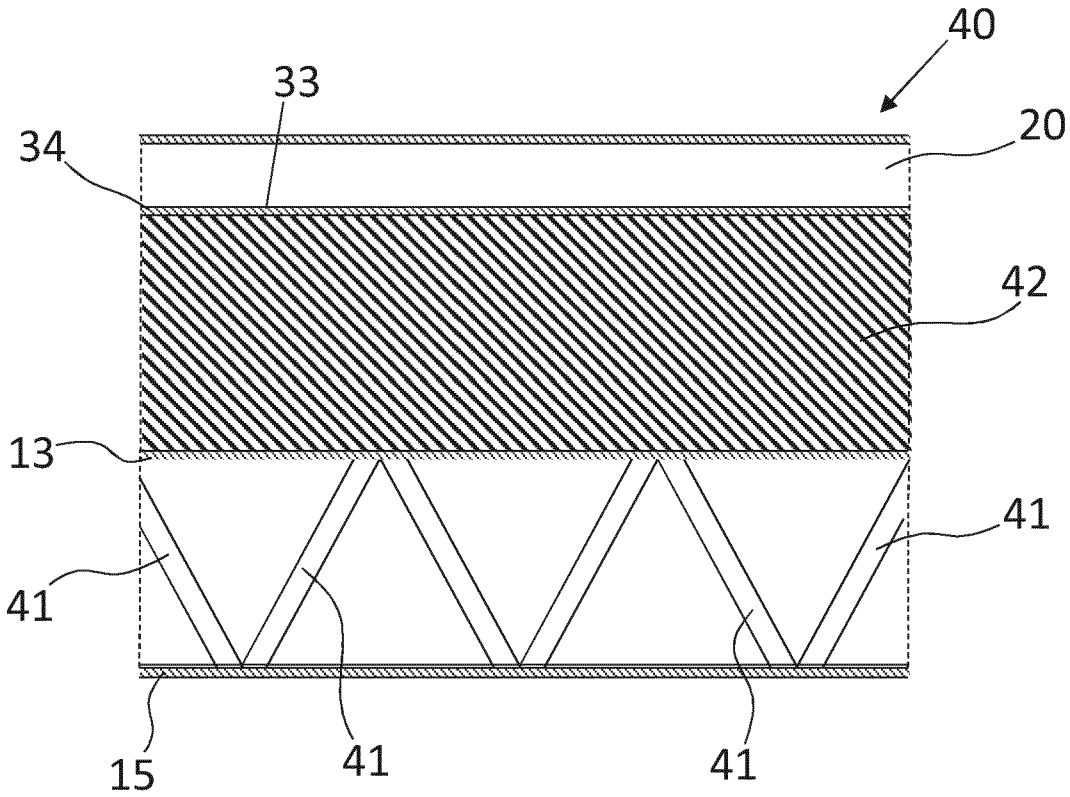

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FIG. 12

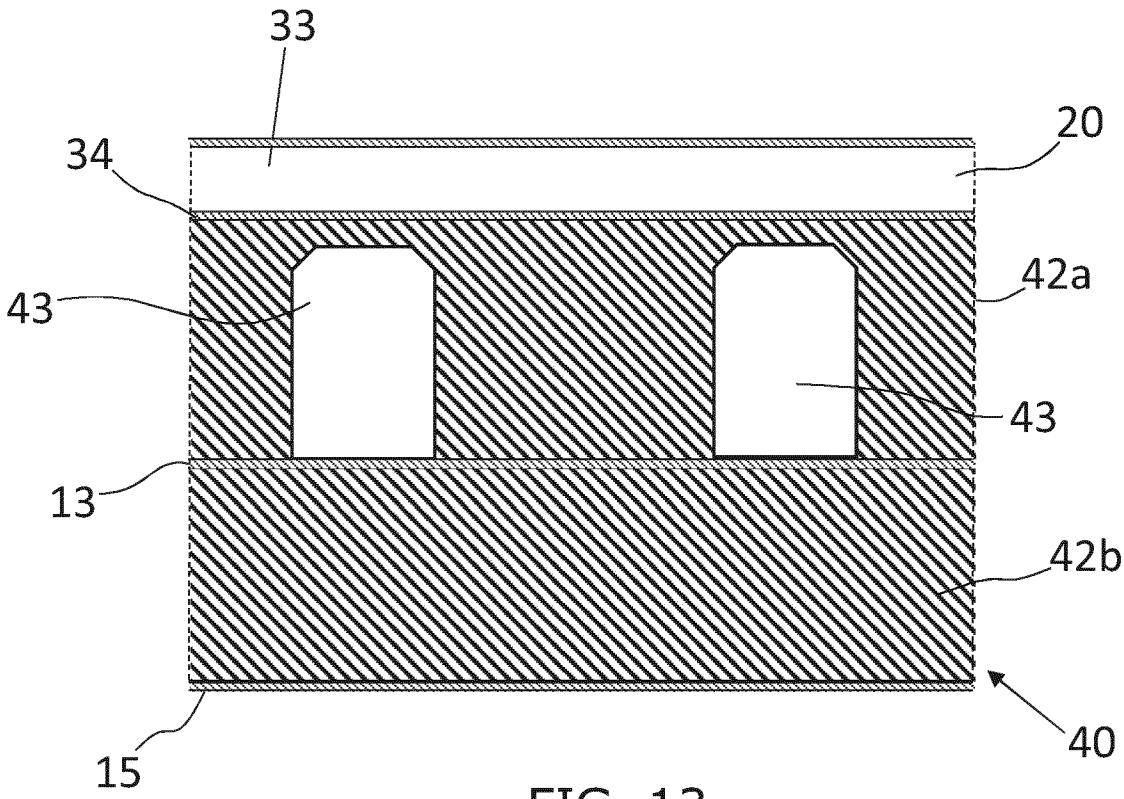


FIG. 13

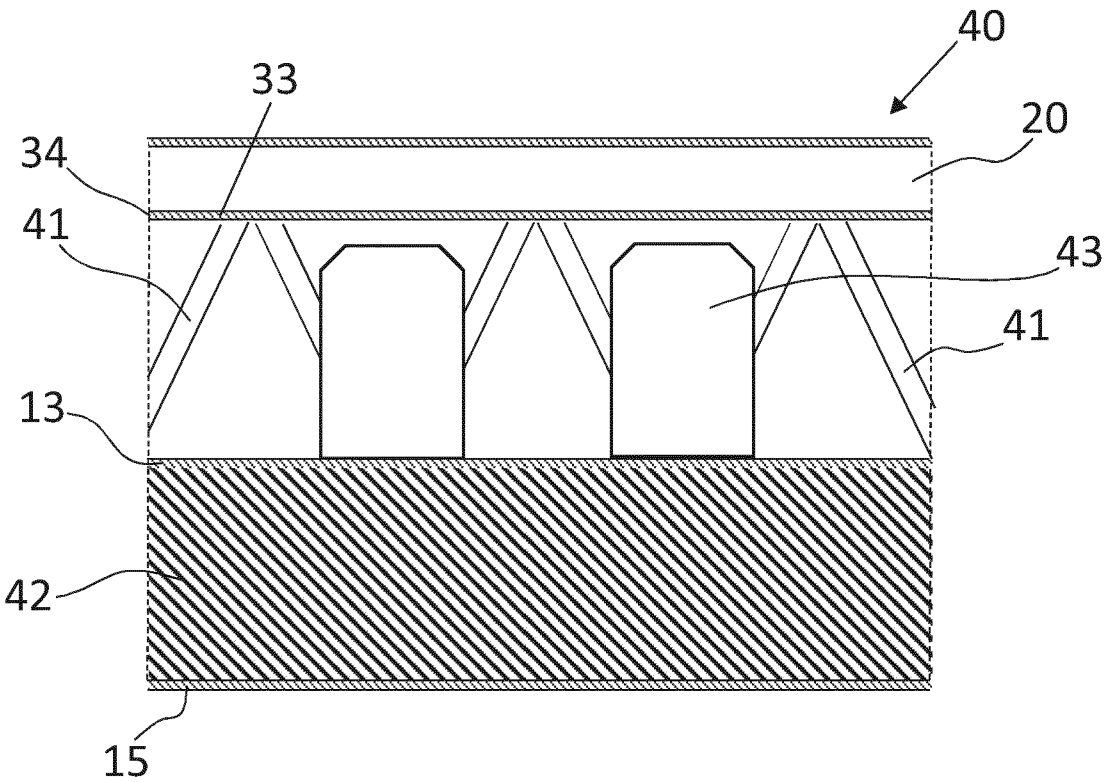


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/050885

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64D37/04 B64D37/30
ADD. B64C1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B64C B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/102278 A2 (YAVILEVICH MICHAEL [IL]) 28 August 2008 (2008-08-28) paragraphs [0056] - [0063]; figures 1-9 -----	1-8, 12-18, 21-24
X	RU 2 614 443 C1 (FED GOSUDARSTVENNOE UNITARNOE PREDPRIYATIE TSENTRALNYJ AEROGIDRODINAMI) 28 March 2017 (2017-03-28) paragraphs [0014] - [0018]; figures 1, 2 -----	1,3-5, 7-14, 16-23
X	WO 97/30893 A1 (TRIMBACH TURBINE LTD [US]) 28 August 1997 (1997-08-28) page 3, line 9 - page 4, line 19; figure 2 -----	1-5, 7-16, 21-24

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 March 2021	23/03/2021

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Lambert, Brice

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2021/050885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2004 015319 A1 (AIRBUS GMBH [DE]) 20 October 2005 (2005-10-20) paragraph [0020]; figures 3, 4	4,16-24
A	US 2004/129836 A1 (SEIDEL GERHARD E [US]) 8 July 2004 (2004-07-08) paragraphs [0021] - [0027]; figure 7	1-24

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2021/050885

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008102278 A2	28-08-2008	US 2010187352 A1	29-07-2010
		WO 2008102278 A2	28-08-2008
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		WO 9730893 A1	28-08-1997
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US 2004129836 A1	08-07-2004	NONE	