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(54) APPARATUS AND METHOD FOR MINIMIZING AND/OR ELIMINATING DILUTION AIR LEAKAGE IN A COMBUSTION LINER ASSEMBLY

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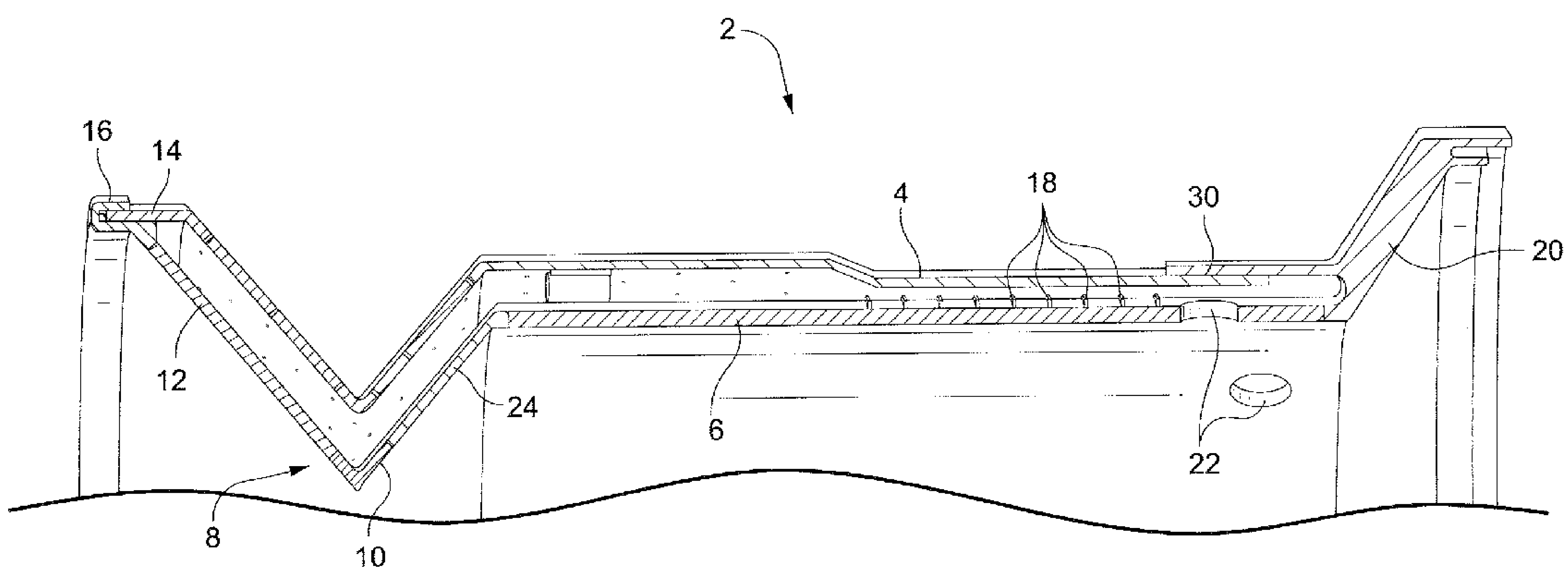
(57) **ABSTRACT**

A combustion liner assembly for a gas turbine includes an outer liner, the outer liner having a flange at a forward end. An inner liner is disposed within the outer liner. The inner liner has a first inner wall. A venturi includes a second inner wall, a venturi throat, and the first inner wall of the inner liner. A slip joint is connected to the second inner wall. The slip joint receives the flange of the outer liner. Alternatively, or additionally, the combustion liner assembly includes a slip joint between the inner or outer liner and an aft section.



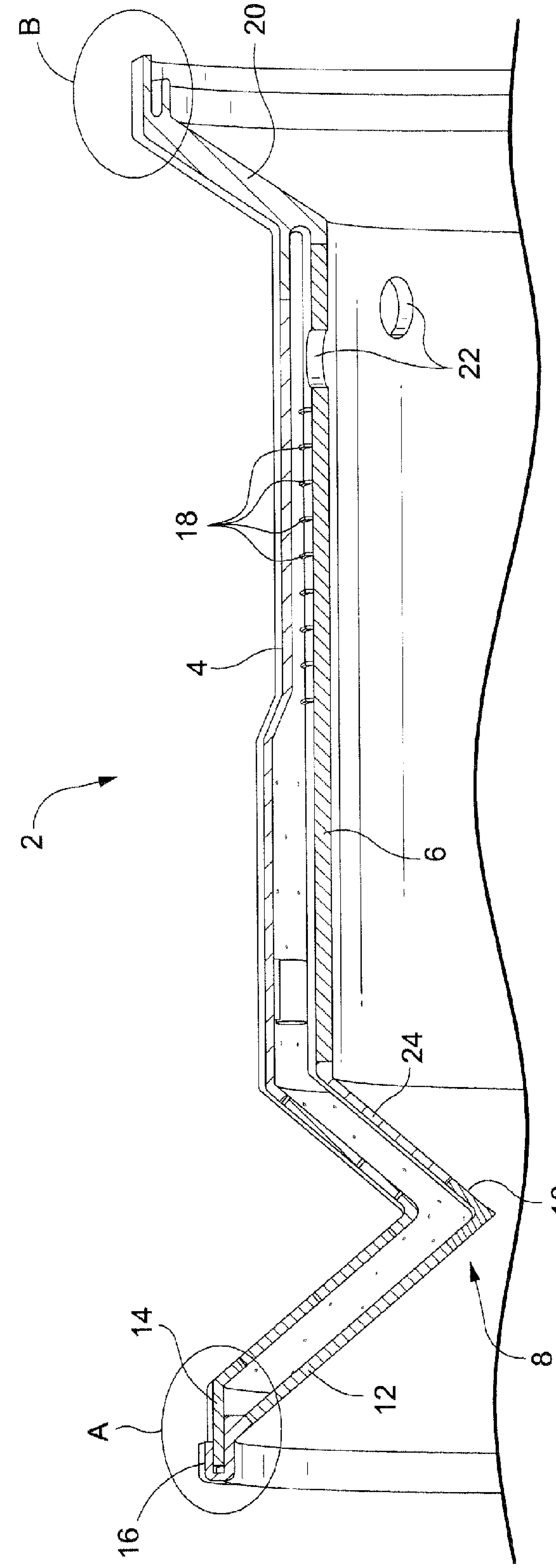


Fig. 1

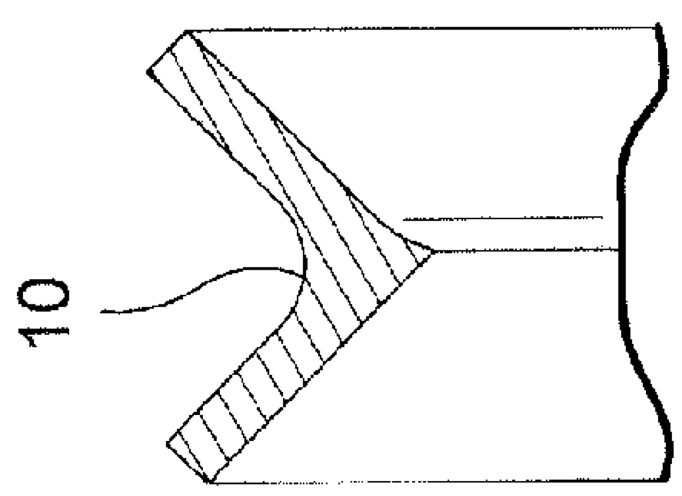


Fig. 2

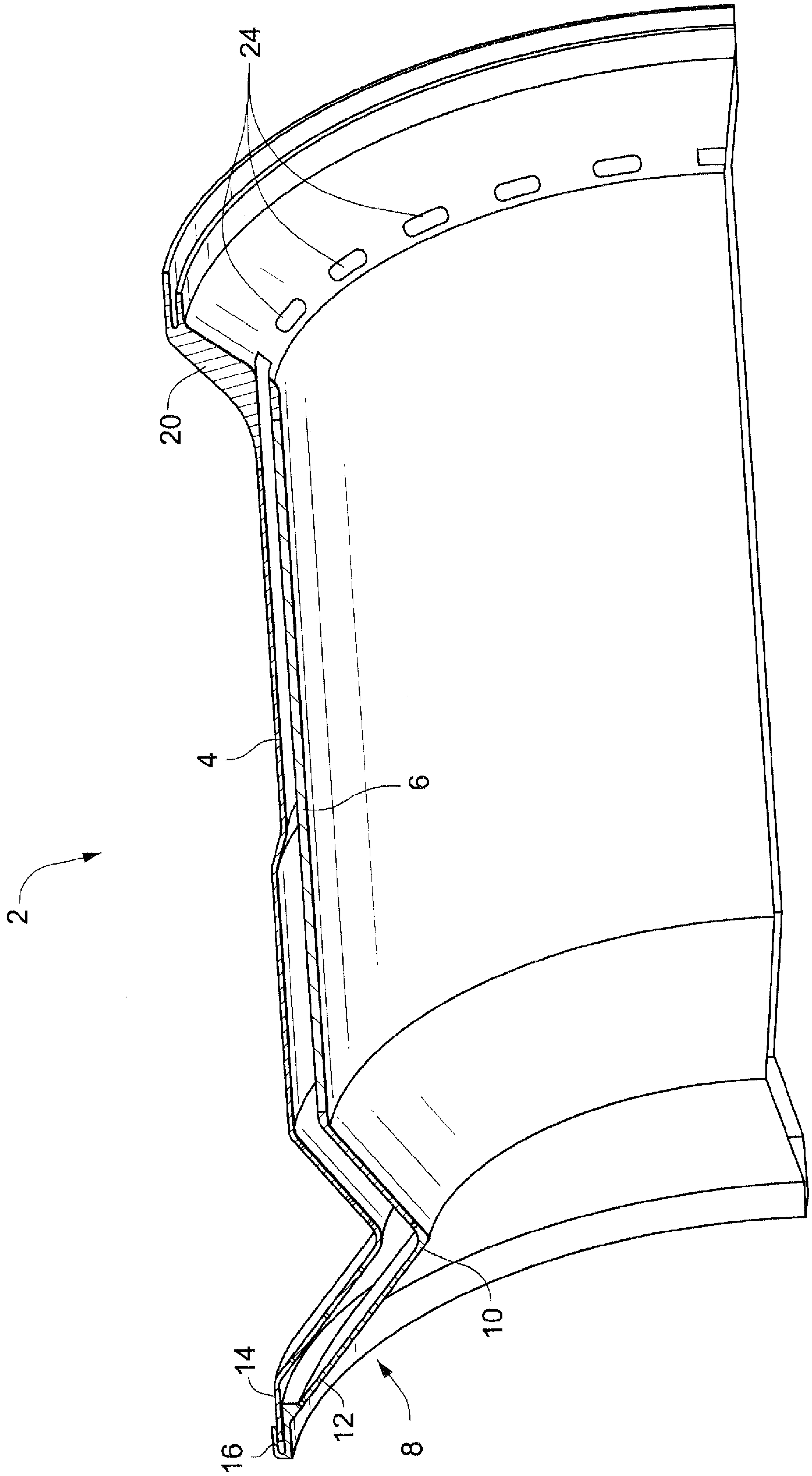


Fig. 3

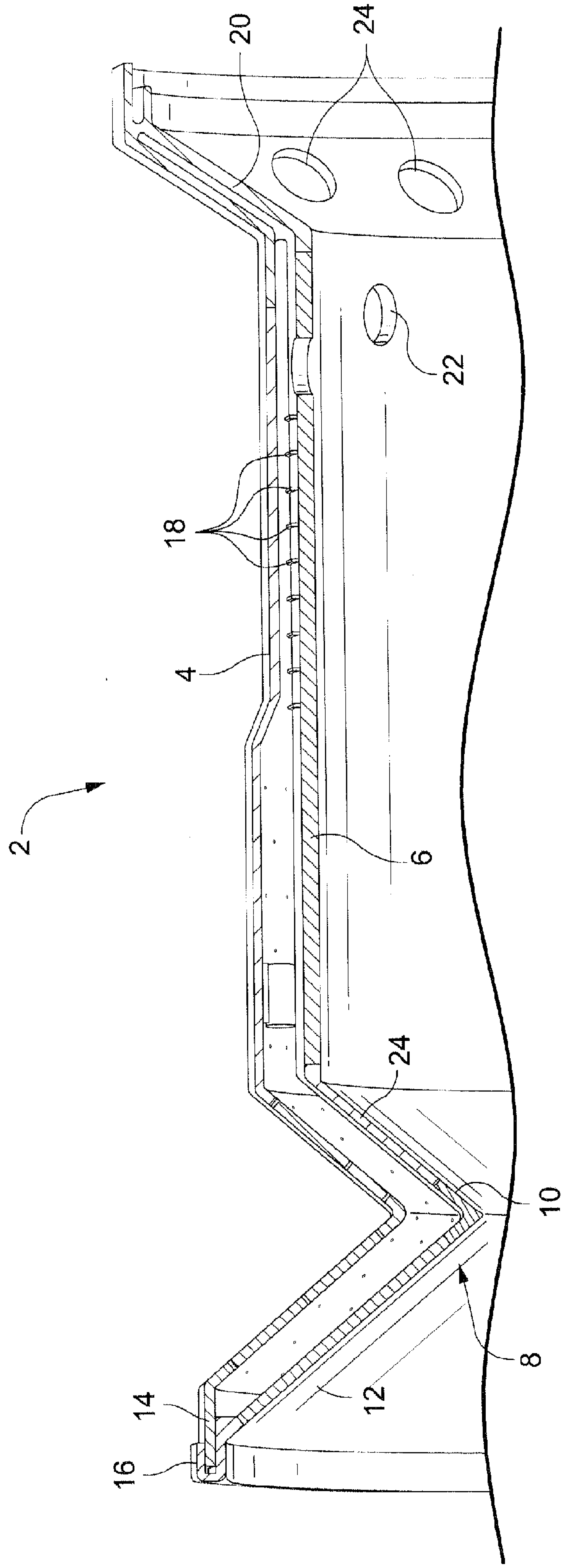


Fig. 4

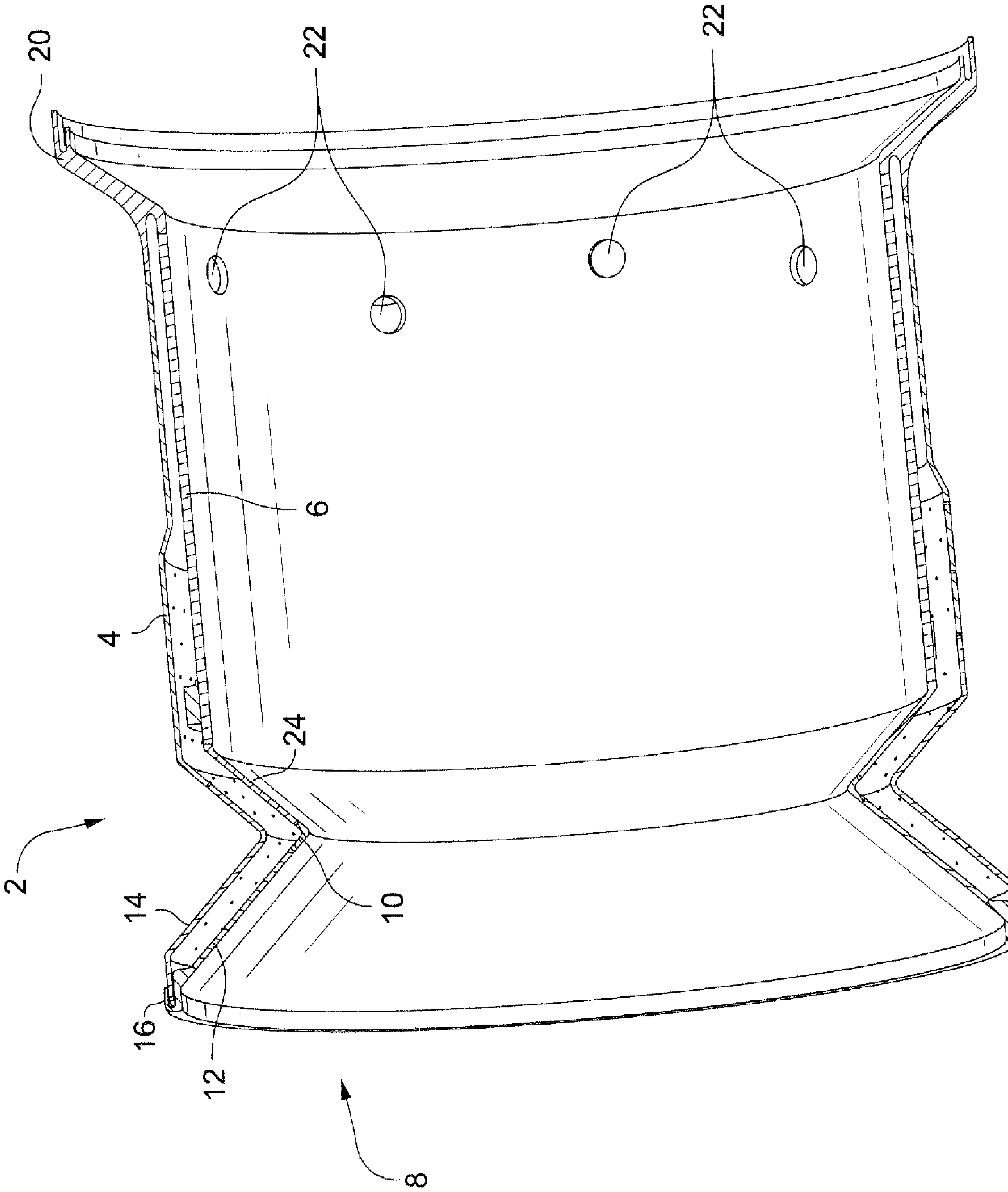


Fig. 5

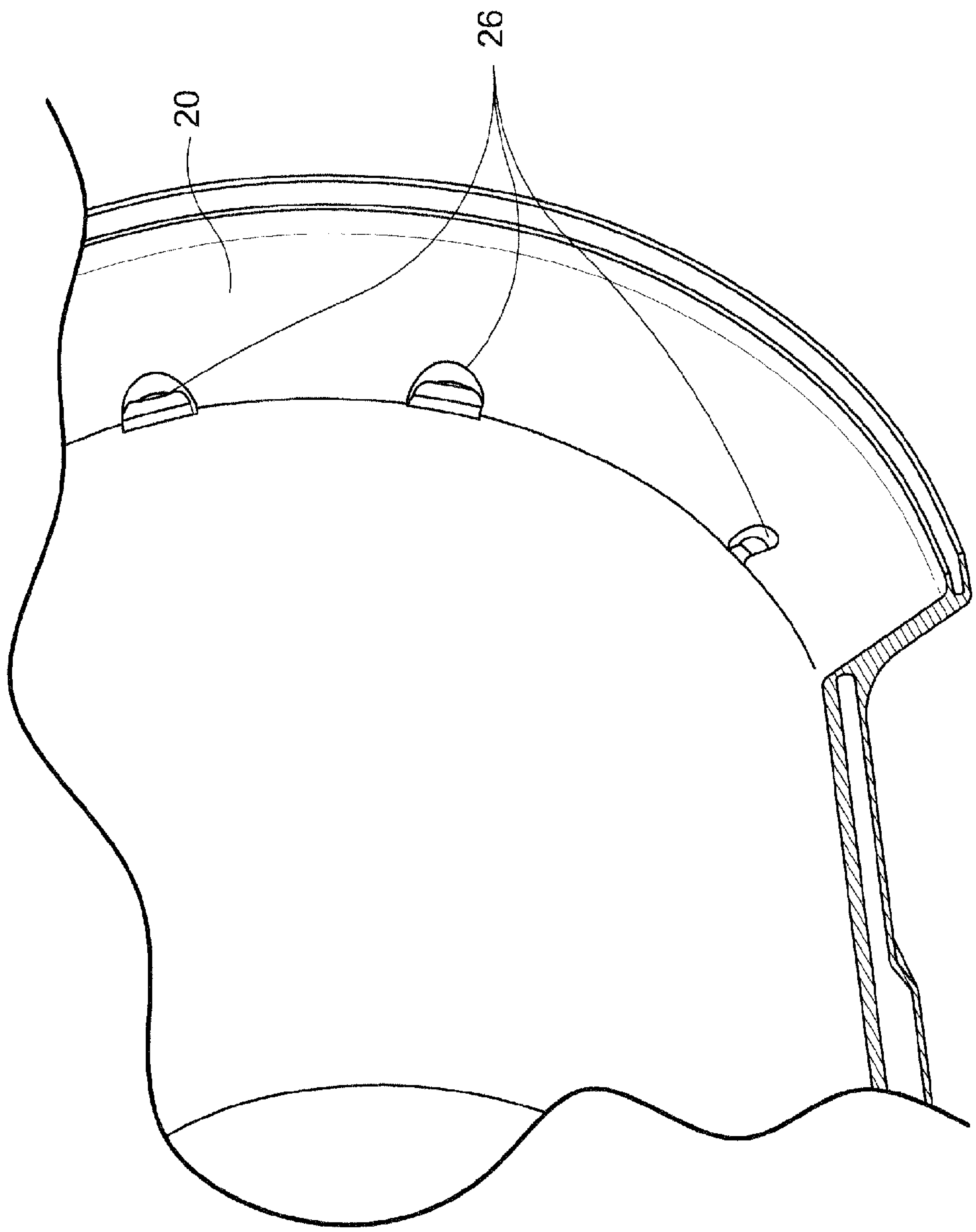


Fig. 6

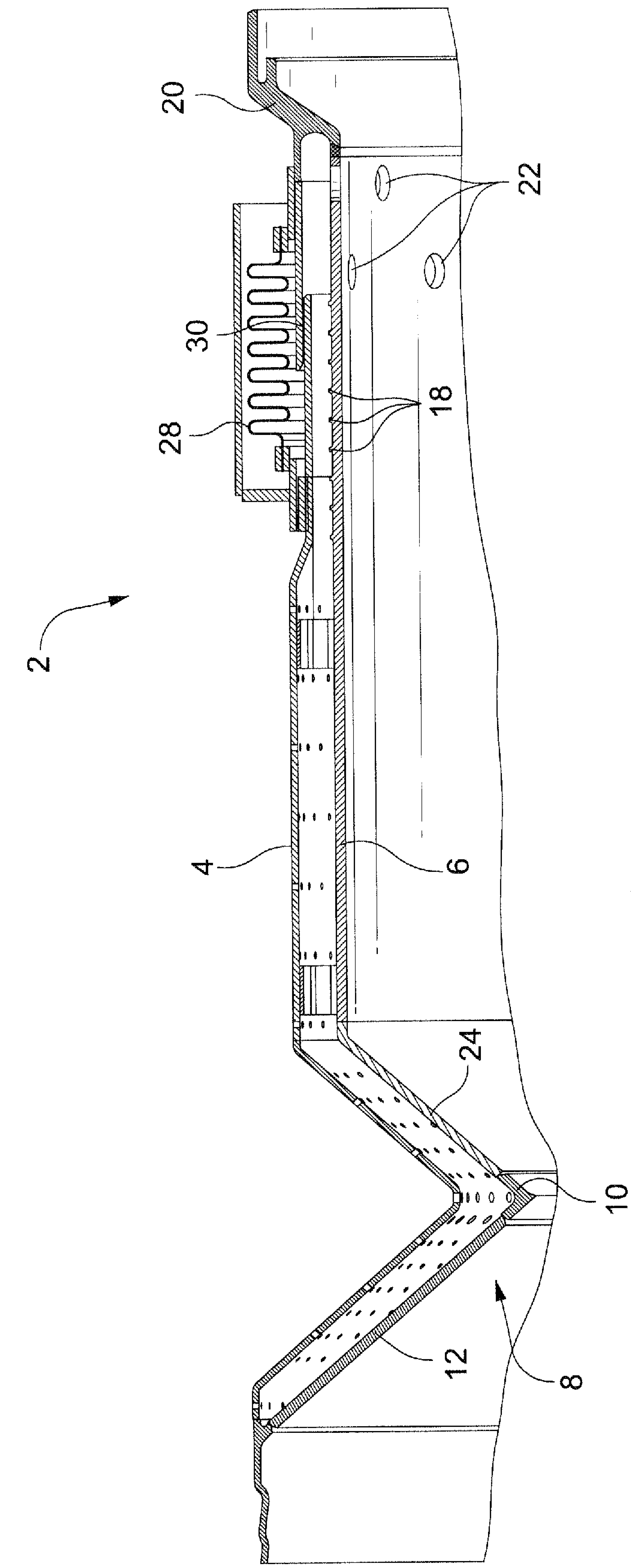


Fig. 7

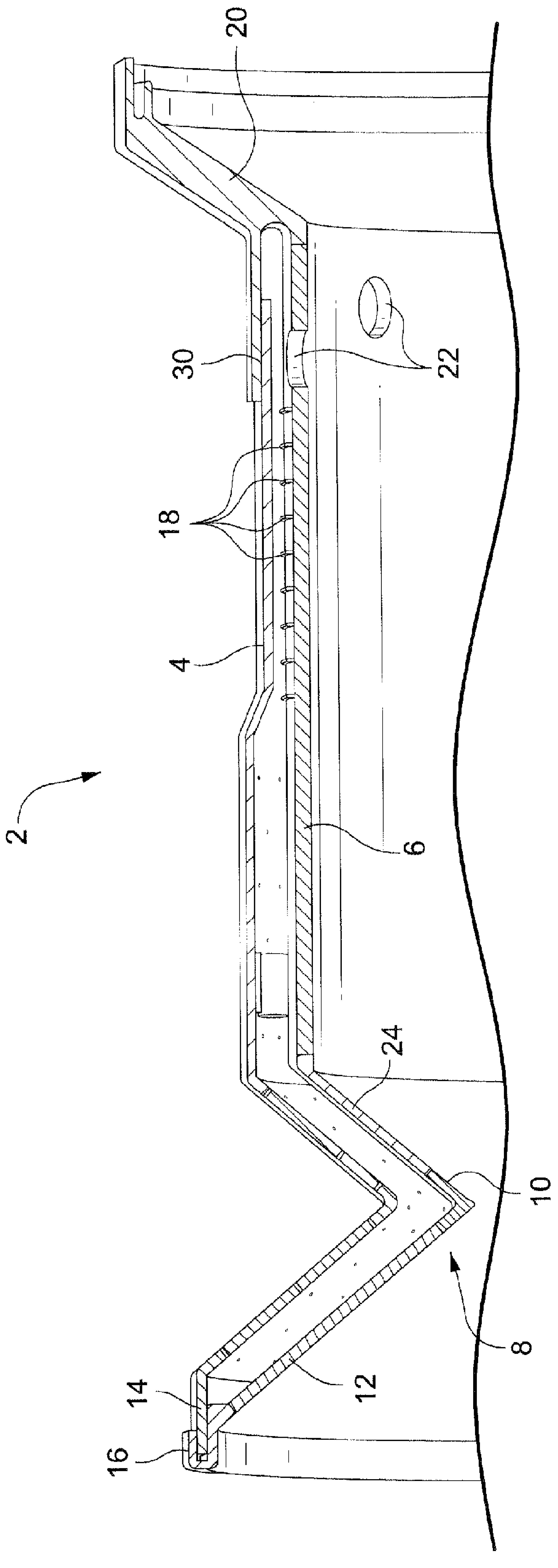


Fig. 8

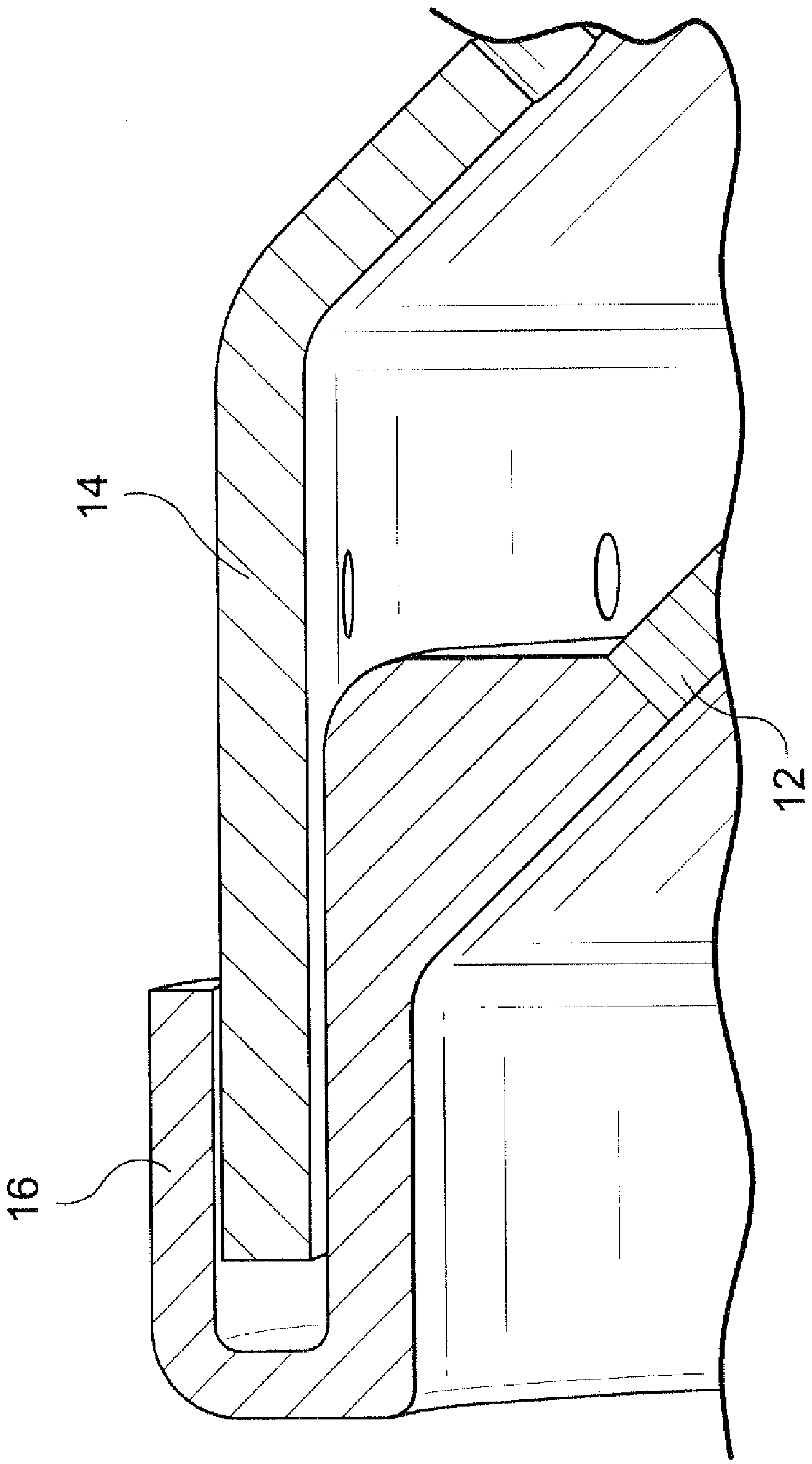


Fig. 9

APPARATUS AND METHOD FOR MINIMIZING AND/OR ELIMINATING DILUTION AIR LEAKAGE IN A COMBUSTION LINER ASSEMBLY

[0001] The present invention relates to apparatus and methods for minimizing or eliminating dilution air leakage paths in a gas turbine combustor and particularly relates to apparatus and methods for managing dilution air leakage to achieve lower emission levels.

BACKGROUND OF THE INVENTION

[0002] Significant products of combustion in gas turbine emissions are oxides of nitrogen, i.e., NO and NO_2 collectively called NO_x, carbon monoxide CO, and unburned hydrocarbons as well as other particulates. Various systems have been proposed and utilized for reducing emissions. For example, water or steam injection into the burning zone of the gas turbine combustor, catalytic clean-up of NO_x and CO from the gas turbine exhaust and dry low NO_x combustors have been used in the past. Compressor discharge dilution air introduced into the liner sleeve of the combustor and transition piece has also been utilized to reduce emissions.

BRIEF DESCRIPTION OF THE INVENTION

[0003] According to an embodiment of the invention, a combustion liner assembly for a gas turbine comprises an outer liner, the outer liner having a flange at a forward end; an inner liner disposed within the outer liner, the inner liner having a first inner wall; a venturi comprising a second inner wall, a venturi throat, and the first inner wall of the inner liner; and a slip joint connected to the second inner wall, the slip joint receiving the flange of the outer liner.

[0004] According to another embodiment of the invention, a combustion liner assembly for a gas turbine comprises an outer liner; an inner liner disposed within the outer liner, the inner liner having a first inner wall; a venturi comprising a second inner wall, a venturi throat, and the first inner wall of the inner liner; an aft section connected to aft ends of the outer liner and the inner liner; and a slip joint provided between the aft section and the inner liner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a schematic illustration of a gas turbine combustion liner assembly according to an embodiment of the invention;

[0006] FIG. **2** is a schematic illustration of a venturi throat of the combustion liner assembly of FIG. **1**;

[0007] FIG. **3** is a schematic illustration of a combustion liner assembly according to another embodiment of the invention;

[0008] FIG. **4** is a schematic illustration of a combustion liner assembly according to another embodiment of the invention;

[0009] FIG. **5** is a schematic illustration of a combustion liner assembly according to another embodiment of the invention;

[0010] FIG. **6** is a schematic illustration of an aft, or goose neck, section of the combustion liner assembly according to another embodiment of the invention;

[0011] FIG. **7** is a schematic illustration of a combustion liner assembly according to another embodiment of the invention;

[0012] FIG. **8** is a schematic illustration of a combustion liner assembly according to another embodiment of the invention; and

[0013] FIG. **9** is a schematic illustration of a flange of the outer liner and slip joint according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring to FIG. **1**, a combustion liner assembly **2** comprises an outer liner **4** and an inner liner **6**. A venturi **8** is provided at a forward end of the combustion liner assembly **2** and includes a venturi throat **10** which is provided between the inner liner **6** and an inner wall **12**. A flange **14** may be integrally formed with the outer liner **4** and is received in a slip joint **16** that is connected to the inner wall **12** of the venturi **8**.

[0015] The inner liner **6** includes an inner wall **24** and turbulators **18** provided on an outer surface. An aft section, or gooseneck section, **20** is connected to the aft portion of the outer liner **4** and the inner liner **6**. Radial drain or dump holes **22** are provided in the inner liner at an area adjacent to the aft section **20**.

[0016] The combustion liner assembly **2** may be welded to a liner sleeve at areas A and B corresponding to the slip joint **16** and the end of the aft section **20**, respectively. The combustion liner assembly **2** may be circumferentially welded to the liner sleeve, rather than riveted as in prior art arrangements.

[0017] Referring to FIG. **2**, the venturi **10** may be circumferentially welded to the inner wall **12** and the inner wall **24** of the inner liner **6**. The thickness of the inner wall **24** and the thickness of the inner wall **24** of the inner liner **6** at the portion containing the circumferential weld may be thicker than prior art combustion liner assembly inner liners to increase the structural integrity of the venturi, as the venturi will be welded to the liner sleeve as opposed to riveted.

[0018] The radial drain or dump holes **22** of the embodiment shown in FIGS. **1** and **2** provides a radial discharge of cooling flow into the flame zone. The embodiments shown in FIGS. **1** and **2** may also have an increased impingement cooling area combined with the turbulators **18**. A small controlled leak may be provided into the cooling channel between the outer liner **4** and the inner liner **6** as an alternative to a bellows.

[0019] Referring to FIG. **3**, according to another embodiment of the invention, the combustion liner assembly **2** includes the aft section, or gooseneck section **20** which comprises axial drain or dump holes **24**, rather than radial drain or dump holes. It has been found that the use of radial drain or dump holes, as shown in the embodiment of FIGS. **1** and **2**, may trigger high frequency combustion instability, or screech, during transfer to the premix combustion and at the turndown when the flame temperature is reduced. However, the axial drain or dump holes **24** do not trigger high frequency instability with the integral venturi of the embodiment shown in FIG. **3**.

[0020] As shown in FIGS. **1** and **2**, the venturi cooling is rerouted to have an axial discharge with the same effective area as the radial discharge of the venturi of the embodiment shown in FIG. **3**.

[0021] Referring to FIGS. **4** and **5**, a combustion liner assembly **2** according to another embodiment comprises an outer liner **4** and an inner liner **6**. The outer liner **4** includes a flange **14** that is received in a slip joint **16** that is connected to an inner wall **12** of a venturi **8** that comprises a venturi throat **10** that connects the inner wall **12** and a portion of the inner liners **6** having axial drain or dump holes **24**. At the aft section or, gooseneck section **20**, the combustion liner assembly **2** comprises radial drain or dump holes **22** formed in the inner liner **6**.

[0022] Referring to FIG. **6**, according to another embodiment, the dump holes **26** may be provided as holes on the face of the aft section **20**, i.e. at the intersection of the cylindrical and conical portions of the aft section **20**.

[0023] Referring to FIG. **7**, a combustion liner assembly according to another embodiment comprises an outer liner **4** and an inner liner **6**. A venturi **8** is provided at a forward section of the combustion liner assembly **2** and includes a venturi throat **10** and an inner wall **12**. The venturi **8** also includes an inner wall **24** connected between the venturi throat **10** and the inner liner **6**. An aft section **20** is connected to the outer liner **4** and the inner liner **6** by an aft slip joint **30**. The combustion liner assembly **2** comprises radial drain or dump holes **22** provided in the inner liner **6**.

[0024] The aft end of the combustion liner assembly **2** comprises a bellows **28**, as well as a slip joint **30** as disclosed in the previous embodiments.

[0025] Referring to FIG. **8**, according to another embodiment of the invention, a combustion liner assembly **2** includes an outer liner **4** and an inner liner **6**. A venturi **8** comprises a venturi throat **10** welded to an inner wall **12** and an inner wall **24** connected to the inner liner **6**. A flange **14** of the outer liner **4** is received in a slip joint **16** at the forward end of the combustion liner assembly **2**. An aft section **20** of the combustion liner **2** is connected to the outer liner **4** and the inner liner **6** by an aft slip joint **30**.

[0026] Referring to FIG. **9** the slip joint **16** may be formed of, for example, an alloy of primarily nickel, such as Hastelloy®, and the flange **14** may be formed of, for example, stainless steel. The slip joint **16** may also be provided with a wear resistant coating. The slip joint **16** provides a double seal on both sides of the flange **14** and may be machined to tight tolerances. As the temperature of the combustion liner assembly **2** increases during operation of the gas turbine, the small leakage area between the flange **14** and the slip joint **16** decreases as the flange **14** expands into the slip joint **16**.

[0027] The combustion liner assemblies reduce, or eliminate, airflow losses in between the venturi wall and the liner wall so that airflow can be used and more evenly dispersed. Reduction, or elimination, of variance to air flow will allow more consistent air flow to be utilized in fuel air mixture in the head end combustion zone rather than leak air flow into direct "stream". The combustion liner assemblies are relatively easy to manufacture and produce a more repeatable air flow from can to can and in turn help to create better fuel air mixture pattern than current design and lower combustion emissions. These are improvements to variation and mixing fuel air better through the mixing holes than would happen through the current design.

[0028] The combustion liner assemblies reduce, or eliminate, leaks so airflow in more non-critical areas is conserved and made more consistent, i.e. can to can variation is lowered. The combustion liner assemblies also increase airflow in useable areas in a more dispersed and even mixing through the mixing holes than would happen through current designs.

[0029] The combustion liner assemblies can be replaced in the field easily. The existing liners can be pulled out and replaced with the combustion liner assemblies disclosed herein. The combustion liner assemblies may also use current production methods and machining to produce. The combustion liner assemblies do not change the fit, form or function of the overall liner assembly.

[0030] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A combustion liner assembly for a gas turbine, comprising:
- an outer liner, the outer liner having a flange at a forward end;
- an inner liner disposed within the outer liner, the inner liner having a first inner wall;
- a venturi comprising a second inner wall, a venturi throat, and the first inner wall of the inner liner; and
- a slip joint connected to the second inner wall, the slip joint receiving the flange of the outer liner.

2. A combustion liner assembly according to claim **1**, further comprising an aft section provided at aft ends of the outer liner and the inner liner.

3. A combustion liner assembly according to claim **1**, further comprising:
- a second slip joint connecting the aft section and the outer liner or the inner liner.

4. A combustion liner assembly according to claim **1**, wherein the outer liner comprises a plurality of radial drain or dump holes.

5. A combustion liner assembly according to claim **2**, wherein the aft section comprises a plurality of radial drain or dump holes.

6. A combustion liner assembly according to claim **5**, wherein the aft section further comprises a plurality of axial drain or dump holes.

7. A combustion liner assembly according to claim **2**, wherein the aft section comprises a plurality of axial drain or dump holes.

8. A combustion liner assembly according to claim **2**, wherein the aft section comprises a plurality of holes at an intersection of a cylindrical section of the aft section and a conical section of the aft section.

9. A combustion liner assembly according to claim **1**, wherein the slip joint is formed of a nickel alloy and the flange is formed of stainless steel.

10. A combustion liner assembly according to claim **1**, wherein the slip joint comprises a wear coating.

11. A combustor for a gas turbine, comprising:
- a liner sleeve; and
- a combustion liner assembly according to claim **1**, wherein the combustion liner assembly is welded to the liner sleeve at least at the slip joint.

12. A combustion liner assembly for a gas turbine, comprising:
- an outer liner;
- an inner liner disposed within the outer liner, the inner liner having a first inner wall;
- a venturi comprising a second inner wall, a venturi throat, and the first inner wall of the inner liner;

an aft section connected to aft ends of the outer liner and the inner liner; and

a slip joint provided between the aft section and the inner liner.

13. A combustion liner assembly according to claim **12**, wherein the aft section further comprises a bellows.

14. A combustion liner assembly according to claim **12**, wherein the outer liner comprises a plurality of radial drain or dump holes.

15. A combustion liner assembly according to claim **12**, wherein the aft section comprises a plurality of radial drain or dump holes.

16. A combustion liner assembly according to claim **15**, wherein the aft section further comprises a plurality of axial drain or dump holes.

17. A combustion liner assembly according to claim **12**, wherein the aft section comprises a plurality of axial drain or dump holes.

18. A combustion liner assembly according to claim **12**, wherein the aft section comprises a plurality of holes at an intersection of a cylindrical section of the aft section and a conical section of the aft section.

19. A combustion liner assembly according to claim **12**, wherein the slip joint comprises a wear coating.

20. A combustor for a gas turbine, comprising:

a liner sleeve; and

a combustion liner assembly according to claim **12**, wherein the combustion liner assembly is welded to the liner sleeve.

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