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(54) **GAS BURNER FOR A HEATER**

(57) A gas burner (1) for a heater comprises a planar metal frame portion (2) with an elongated opening (3) defined by two longitudinal edges (5) and by two transversal end edges (6), as well as a combustion membrane (7) in the form of a tridimensional shell, connected to the frame portion (2) along the longitudinal (5) and transversal (6) edges, wherein the combustion membrane (7) has a diffuser layer (8), which forms an outer combustion sur-

face (9) made of a perforated metal sheet, and which extends between the two longitudinal edges (5) with a single curvature out of the plane of the frame portion (2), and two closure portions (11) made of metal sheet extending from the transversal edges (6) out of the plane of the frame portion (2) and which close end areas (12) between the diffuser layer (8) and the transversal edges (6) of the frame portion (2).

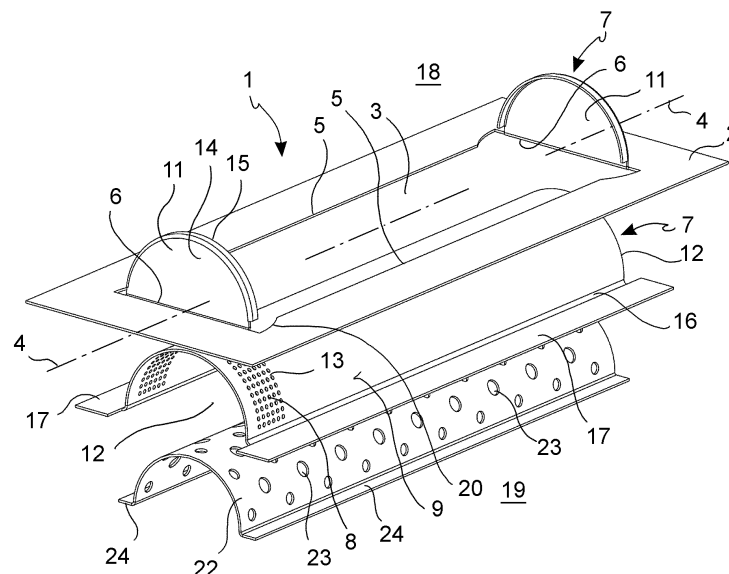


FIG. 4

Description

[0001] The present invention relates to a burner for a gas heater.

[0002] Gas heaters of the prior art comprise a combustion chamber with a heat exchanger, a burner either connected to or inside the combustion chamber for producing heat by combusting a mixture of fuel gas and combustion supporting air within the combustion chamber, a feeding pipe for feeding the gas and air mixture to the burner, as well as a frame for supporting and connecting the burner to the combustion chamber.

[0003] The burners of the prior art comprise a combustion membrane having:

- an inner surface in flow communication with the feeding pipe or with a mixing and/or distribution chamber of the fuel gas mixture, and
- a diffuser layer, which forms an outer surface (or combustion surface) of the membrane, facing the combustion chamber,

and the mixture is conveyed through the combustion membrane into the combustion chamber where the combustion occurs, in the form of a flame pattern on the combustion surface.

[0004] The diffuser layer consists of a wall with a plurality of through openings. According to the type of combustion membrane, such a wall may be a perforated sheet, a fabric, a mesh (for brevity, meshes and fabrics will be indicated hereinafter by the term "meshes") or a porous or perforated wall of ceramic material.

[0005] Furthermore, a distributor may be provided upstream of the diffuser layer (with reference to the flow direction of the gas-air mixture) with the aim of distributing the mixture in a desired manner towards the diffuser wall. The known distributors are generally made as walls with a plurality of through openings, e.g. made of a perforated sheet, and which may form an "inner" layer of the combustion membrane or, alternatively, a component spaced apart from the combustion membrane.

[0006] The heat produced by the combustion is carried by means of the hot combustion gases (by convection) and by means of thermal radiation to the heat exchanger for heating a fluid, e.g. water, which is then conveyed to a user, e.g. to a heating system of an industrial process, of living spaces or the like and/or of sanitary water.

[0007] For a targeted, safe use of the heater, it is desirable to control and be able to vary in a controlled manner the heating power of the burner and the local and total flow rate of the fuel mixture through the combustion membrane.

[0008] Indeed, the flow rate of the fuel mixture affects flame temperature, combustion membrane temperature, overall thermal power, and flame stability, but regrettably even the onset of undesired instability phenomena and detachment of the flame from the combustion surface.

[0009] In addition to the local flow rate of the fuel mix-

ture, flame stability also depends on the local temperature of the combustion membrane, which local temperature is, in turn, affected by geometry and weight distribution in the combustion membrane and in the supporting frame. For this reason, combustion membranes are often made of metal meshes or fabrics which facilitate a tridimensional, double-curvature shaping.

[0010] While the perforated sheet may be easily folded about a single axis (or about multiple parallel axes), a shaping with curvature about several non-parallel axes results in a stretching on the plane of the sheet with uncontrollable, unrepeatable deformations of the holes and possible breakage of the sheet "bridges" between adjacent holes.

[0011] On the other hand, metal fiber meshes are expensive and dimensionally poorly stable, and therefore are often used in combination with a supporting metal mesh which further increases the burner cost. Moreover, the properties (permeability, thickness, density) of the metal fiber meshes have a statistic distribution with high standard deviation. This makes it difficult to control the parameters which affect the combustion and results in uncertainties in the ignition, flame detection, fuel flow load and specific thermal power of the burner.

[0012] A very common type of burner has a flat metal frame with an elongated opening with two parallel rectilinear longitudinal edges and two semi-circular end edges, to which a combustion membrane is fixed with a diffuser layer made of metal mesh having a "cannoli" or semi-cigar shape with a central portion which is cylinder-segment shaped and two end portions which are spherical-segment-shaped.

[0013] This type of known burner shows the advantages and disadvantages of the prior art in an exemplary manner: the use of metal meshes to facilitate the formation of complex tridimensional shapes while keeping the perforation or porosity features of the mesh nearly unchanged, but at the expense of higher cost and greater statistic variability of the properties (weight distribution, permeability, mechanical strength and thermal expansion) of the metal mesh with respect to sheets and porous ceramic layers.

[0014] Therefore, it is the object of the present invention to provide a burner with a tridimensional geometry with features such as to avoid at least some of the drawbacks of the prior art.

[0015] It is another particular object of the invention to better conciliate the needs of better controlling the combustion parameters and manufacturing the combustion membrane at low costs.

[0016] It is a further particular object of the invention to provide a burner of the cannoli-shaped type which is improved in terms of manufacturing, cost and combustion property repeatability. These and other objects are achieved by means of a gas burner for a heater according to claim 1. The dependent claims relate to advantageous embodiments.

[0017] In accordance with the invention, a gas burner

for a heater comprises:

- a planar, metal frame portion with an elongated opening defined by two opposite longitudinal edges and two transversal end edges,
- a combustion membrane in the form of a tridimensional shell, connected to the metal frame along the longitudinal and transversal end edges, said combustion membrane having:
- a diffuser layer forming an outer combustion surface made of a perforated metal sheet, said surface extending with a single curvature out of the plane of the frame portion between the two longitudinal edges,
- two closure portions made of metal sheet which extend from the transversal end edges out of the plane of the frame portion and which close otherwise free end spaces between the combustion layer and the frame portion.

[0018] This allows to simplify the manufacturing of the tridimensional membrane by virtue of an easier forming of the perforated sheet of the diffuser layer by means of simple folding (about a single axis), e.g. in a press, and of the use of simple sheet "plug" portions for closing the end zones of the burner, which in the prior art required to form spherical caps of metal mesh.

[0019] The construction of the combustion surface made of a perforated metal sheet and its single curvature shape, thus without hole distortion, result in highly accurate, constant and repeatable properties (permeability, weight distribution, thermal capacity, thermal conductivity, mechanical strength, thermal expansion), which allow the combustion parameters to be better controlled. The construction of the combustion surface and of the entire tridimensional combustion membrane of metal sheet obviates the need to use expensive materials, such as metal meshes or porous ceramic materials, and facilitates the connection of the combustion membrane made of metal sheet to the frame made of metal sheet.

[0020] In the scope of the present description and of the claims, the term "single curvature" means a curvature or a folding of a sheet, layer or tridimensional curved plane about a single axis or about multiple parallel axes, such as not to result in a distortion of the curved plane with respect to the initially flat shape. The term "single curvature" itself does not exclude the presence of flat zones (infinite curvature radius) which can be formed in combination, e.g. in an alternating manner, with curved zones.

[0021] In order to better understand the invention and appreciate the advantages thereof, a description of some embodiments of the burner of the invention will be provided below by way of non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 is a top view of a burner according to an embodiment of the invention,

- figure 2 is a perspective view of the burner in figure 1,
- figure 3 is a partial front view of the burner in figure 1,
- figure 4 is an exploded view of a burner according to a further embodiment,
- figure 5 is a view of the burner in figure 4 in an assembled configuration,
- figure 6 shows a frame with two closure end portions of a combustion membrane according to an embodiment,
- figure 7 is a cross-section view of a burner according to a further embodiment,
- figure 8 shows various embodiments of a diffuser layer of the burner seen in cross section,
- figure 9 shows embodiments of the burner seen in longitudinal section.

[0022] With reference to the figures, a gas burner 1 for heaters comprises a planar metal frame portion 2 with an elongated opening 3 (e.g. extended along a longitudinal axis 4) defined by two longitudinal edges 5 extending in the direction of a longitudinal axis 4 and mutually opposite and facing each other, and by two end edges 6 which are transversal to the longitudinal axis 4 and also mutually opposite and facing each other.

[0023] Burner 1 further comprises a combustion membrane 7 in the form of a tridimensional shell, connected to the frame portion 2 along the longitudinal edges 5 and transversal edges 6. The combustion membrane 7 has a diffuser layer 8 which forms an outer combustion surface 9 made of a perforated metal sheet, and which extends between the two longitudinal edges 5 with a single curvature out of the plane 10 of the frame portion 2. In other words, the diffuser layer 8 made of a perforated metal sheet is connected to the two longitudinal edges 5 and extends from the longitudinal edges as an arched bridge with single curvature over opening 3. The combustion membrane 7 further has two closure portions 11 made of metal sheet which extend from the transversal edges 6 out of the plane 10 of the frame portion 2 and which close (otherwise free) end areas 12 between the diffuser layer 8 and the transversal edges 6 of the frame portion 2.

[0024] This allows the manufacturing and forming of the tridimensional membrane 7 as a tridimensional shell or box to be simplified by virtue of an easier forming of the perforated sheet of the diffuser layer 8 by means of simple folding (about a single axis), e.g. in a press, and by virtue of the use of simple sheet "plug" portions for closing the end areas of burner 1, which in the prior art required to form spherical caps of metal mesh.

[0025] The construction of the combustion surface 9 made of a perforated metal sheet and its single curvature shape, thus without distortion of the holes 13, result in highly accurate, constant and repeatable properties (permeability, weight distribution, thermal capacity, thermal conductivity, mechanical strength, thermal expansion), which allow the combustion parameters to be better controlled.

[0026] The construction of the combustion surface 9 and of the entire tridimensional combustion membrane 7, including the closure portions 11, of metal sheet avoids the need to use expensive materials, such as metal meshes or porous ceramic materials, and facilitates the connection of the combustion membrane 7 made of metal sheet to the metal sheet frame 2. According to an embodiment, the diffuser layer 8 with the combustion surface 9 made of metal sheet has a sectional shape on a section plane transversal to the longitudinal axis 4 in the form of:

- arc (Fig. 8a),
- circular arc (Fig. 8b),
- circular arc tapering or flattened in the direction of the frame (Fig. 8c),
- arc composed of a plurality of curved lengths with different curvature radiuses (Fig. 8c),
- arc composed of one or more curved lengths and one or more alternating straight lengths (Figs. 8d,e),
- arc composed of multiple rectilinear lengths which are mutually inclined (Fig. 8h),
- arc with a flattened or rectilinear apical length (Fig. 8d),
- arc with two opposite flattened or rectilinear side lengths (Figs. 8e,f),
- arc with two opposite flattened or rectilinear side lengths and a flattened or rectilinear apical length and two curved rounded lengths arranged between the side lengths and the apical length (Fig. 8g),
- wavy (Fig. 8i).

[0027] In a preferred embodiment, the diffuser layer 8 with the combustion surface 9 has a constant cross section along the longitudinal extension of the combustion surface 9, i.e. along the longitudinal axis 4, similar to an extruded shape.

[0028] Various possible tridimensional shapes of the combustion surface 9 made of metal sheet are thus possible:

- a half pipe, in which the opening angle α of the profile of the combustion surface may vary according to the embodiment within reasonable limits, e.g. $180^\circ \pm 30^\circ$ (Fig. 8k),
- a circular half pipe,
- a half pipe tapering or flattened in the direction of frame 2,

or more generally a shape with constant cross section along the longitudinal axis 4, in which such a cross section may consist of:

- one or more curved lengths and one or more straight lengths in an alternating manner,
- a plurality of curved lengths with different curvature radiuses,
- an arc with a flattened or rectilinear apical length,

- an arc with two opposite flattened or rectilinear side lengths,
- a wavy shape.

[0029] According to an embodiment, the closure portions 11 have a wall 14 which is substantially flat and transversal to the plane 10 of the frame portion 2 and a folded edge 15 which connects the flat wall 14 to the diffuser layer 8.

[0030] This facilitates the manufacturing of the closure portions 11 by means of a press and ensures the continuity of the combustion membrane 7 even in the presence of thermal expansions. The folded edge 15 of the closure portion 11 may have an arched shape which is substantially compatible with the arched shape of the diffuser layer 8.

[0031] The closure portions 11 may each form a wall 14 which is substantially flat and perpendicular to the plane 10 of the frame portion 2 (Figures 2, 5, 6). Alternatively, the flat walls 14 may be inclined with respect to the plane 10 of the frame portion 2 towards opening 3 (in a converging manner, Fig. 9a) or away from opening 3 (in a diverging manner, Fig. 9b).

[0032] The closure portions 11 and/or the transversal edges 6 may comprise one or more folds or stiffening ribs, e.g. bulges, which could extend from frame 2 through the transversal edge 6 up into the closure portion 11 (Fig. 6).

[0033] Thereby, the longitudinal thermal expansions of the diffuser membrane 7 can be prevented from spreading irreversibly, thus deforming the closure portions 11 and creating unplanned gas passage zones.

[0034] According to an embodiment, at least one of the closure portions 11 and the diffuser layer 8 is formed together with the frame portion 2 in a single piece of metal sheet (Figs. 4,6). It is particularly advantageous to form at least one or both of the closure portions 11 together with the frame portion 2 in a single piece of metal sheet, e.g. by folding the closure portions 11 out of the plane 10 of frame 2 along the transversal edges 6 of opening 3 (Figs. 4, 6).

[0035] This saves material and connection costs and increases the tightness of the connection between the combustion membrane 7 and the frame 2.

[0036] In this embodiment, the construction of the folded edge 15 may include a cut-out 20 of the sheet in the frame portion 2 at the ends of the longitudinal edges 5 in the corner zone with the transversal edges 6 (Figs. 4, 5). These cut-outs 20 may be advantageously sealed by means of localized welds 21 which create four irreversible fixing points between the diffuser layer 8 and the frame 2.

[0037] Alternative fastenings between the closure portions 11 and the transversal edges 6 of the frame comprise, for example, welds, crimping, fitting, gluing or folding.

[0038] Alternatively or additionally, at least one of the closure portions 11 and the diffuser layer 8 is connected

to the frame portion 2 by means of an elastic fit, preferably a snap fit. For this purpose, it is advantageous to form a stop groove 16 in at least one of the two components made of metal sheet and an edge 17 in the other one, which is adapted to be snapped fit or generally placed in the stop groove 16 (Fig. 7).

[0039] Such a fitting could be completed later by means of spot or seam welding to make the connection irreversible.

[0040] The fixing between the combustion membrane 7 (in particular the diffuser layer 8) and the frame portion 2 may be made by means of a fixing edge 17 which protrudes from an outer periphery of the combustion membrane 7 (in particular from the diffuser layer 8) and which is fixed, e.g. welded, crimped, fitted, glued or sandwiched, to the corresponding edge (in particular the longitudinal edge 5) of the frame portion 2. The fixing edge 17 may be made of the same metal sheet of the combustion membrane 7 (in particular of the diffuser layer 8), e.g. by bending a peripheral region thereof, but is superimposed on the frame portion 2 on the combustion side 18 or preferably on the feeding side 19 (figure 4) and does not allow the passage of fuel mix or the formation of flame. Therefore, in the present description, the fixing edge 17 is not considered within the definition of "diffuser layer 8".

[0041] Advantageously, the diffuser layer 8 can be inserted from the feeding side 19 into the opening 3 of the frame portion 2 to engage the fixing edge 17 and/or a stop groove 16 with a longitudinal edge 5 of the opening 3, and place the end portions against the folded edges 15 of the closure portions 11 (Fig. 4).

[0042] In accordance with a further embodiment, burner 1 comprises a distributor 22 for distributing the fuel mix in a desired manner towards the diffuser layer 8. Distributor 22 comprises one or more walls made of metal sheet with a plurality of through openings 23 and may form an inner layer (feeding side 19) of the combustion membrane 7 or, alternatively, a component spaced apart from the diffuser layer 8.

[0043] Distributor 22 may be connected to the frame portion 2 or to the diffuser layer 8 by means of an elastic fit, preferably a snap fit. For this purpose, it is advantageous to form a stop groove in at least one of the two components made of metal sheet and an edge in the other, which is adapted to be snap fit or generally placed in the stop groove. The snap fitting could be completed later by means of spot or seam welding to make the connection irreversible.

[0044] In an embodiment, burner 1 comprises one or more folded tabs, formed in at least one of or in all the components (frame 2, diffuser layer 8, closure portions 11 or distributor 22) and which engage one or more of said other components to block the burner assembly 1 in a permanent manner. Distributor 22 may also comprise a fixing edge 24 configured in a manner identical or similar to that described with reference to the fixing edge 17 of the diffuser layer 8, and may be inserted from the feed-

ing side 19 into the opening 3 of the frame portion 2 to engage the fixing edge 24 and/or a stop groove with a corresponding edge of the opening 3 or of the combustion membrane 7 (Fig. 4).

[0045] According to a further embodiment, the distributor 22 and the diffuser layer 8 are formed together in a single piece of metal sheet. In this example, the metal sheet may be folded so as to form a double wall structure extending as an arc out of the plane 10 of the frame portion 2 and further forming a connection edge with the frame portion 2 (Fig. 7).

[0046] In a preferred embodiment, the longitudinal edges 5 are rectilinear and parallel to each other and parallel to the longitudinal axis of opening 4 and burner 1. The transversal edges 6 are also rectilinear, parallel to each other and preferably perpendicular to the longitudinal edges 5. Thereby, opening 3 has an elongated rectangular shape. The closure portions 11 are preferably free from holes or are gas-impermeable, even if in particular embodiments a perforation and flame formation could also be contemplated in the closure portions 11. The entire combustion membrane 7 is preferably free from metal mesh or fabric.

[0047] Those skilled in the art can make further changes and variants all within the scope of protection defined by the claims in order to satisfy contingent, specific needs.

30 Claims

1. A gas burner (1) for a heater, comprising:

- a planar, metal frame portion (2) with an elongated opening (3) defined by two longitudinal edges (5) extending in the direction of a longitudinal axis (4) of the burner (1) and mutually opposite and facing, and by two end edges (6) transversal to the longitudinal axis (4),
- a combustion membrane (7) in the form of a tridimensional shell, connected to the frame portion (2) along the longitudinal edges (5) and transversal (6) edges, said combustion membrane (7) having:
 - a diffuser layer (8) forming an outer combustion surface (9) made of a perforated metal sheet, and extending between the two longitudinal edges (5) with a single curvature out of the plane (10) of the frame portion (2),
 - two closure portions (11) in metal sheet extending from the transversal edges (6) out of the plane (10) of the frame portion (2) and which close end areas (12) between the diffuser layer (8) and the transversal edges (6) of the frame portion (2),

characterized in that both closure portions (11) and the frame portion (2) are formed in a single piece of

metal sheet, by folding the closure portions (11) along the transversal edges (6) of the opening (3).

2. The burner (1) according to claim 1, wherein the diffuser layer (8) with the combustion surface (9) has a sectional shape transversal to the longitudinal axis (4) selected from the group consisting in the shapes as follows:

- arch,
- circular arch,
- circular arch tapering in the direction of the frame,
- arch composed of alternate curved and rectilinear lengths,
- arch composed of a plurality of curved lengths with different curvature radiuses,
- arch composed of multiple rectilinear lengths inclined to each other,
- arch with a rectilinear apical length,
- arch with two opposite rectilinear side lengths,
- arch with two opposite rectilinear side lengths and a rectilinear apical length and two curved rounded lengths arranged between the side lengths and the apical length,
- wavy.

3. The burner (1) according to claim 1 or 2, wherein the diffuser layer (8) with the combustion surface (9) has a uniform cross section along the longitudinal extension of the combustion surface (9).

4. The burner (1) according to one of the preceding claims, wherein the closure portions (11) form:

- a wall (14) substantially planar and transversal to the plane (10) of the frame portion (2), and
- a folded edge (15) connecting the planar wall (14) to the diffuser layer (8), said folded edge (15) having an arched shape substantially compatible with the arched shape of the diffuser layer (8).

5. The burner (1) according to one of the preceding claims, wherein the closure portions (11) each form a wall (14) substantially planar and perpendicular to the plane (10) of the frame (2) portion.

6. The burner (1) according to one of the preceding claims, comprising one or more stiffening ribs extending from the frame (2) through the transversal edge (6) up into the closure portion (11).

7. The burner (1) according to one of the preceding claims, wherein at least a part of the combustion membrane (7) is formed together with the frame portion (2) in a single piece of metal sheet.

8. The burner (1) according to the claims 4 and 7, wherein cut-outs (20) of the frame portion (2) at the ends of the longitudinal edges (5) in the corner areas with the transversal edges (6) are sealed by local welds (21) which create irreversible securing points between the diffuser layer (8) and the frame (2).

9. The burner (1) according to one of the preceding claims, wherein at least one portion of the combustion membrane (7) is connected to the frame portion (2) by elastic fit, in particular by snap fit.

10. The burner (1) according to one of the preceding claims, comprising a distributor (22) in metal sheet with a plurality of through openings (23) arranged on a feeding side of the diffuser layer (8) to distribute the fuel mix in a desired manner towards the diffuser layer (8).

11. The burner (1) according to claim 10, wherein said distributor (22) is connected to the frame portion (2) or the diffuser layer (8) by elastic fit.

12. The burner (1) according to claim 10, wherein said distributor (22) and said diffuser layer (8) are formed together in a single piece of metal sheet.

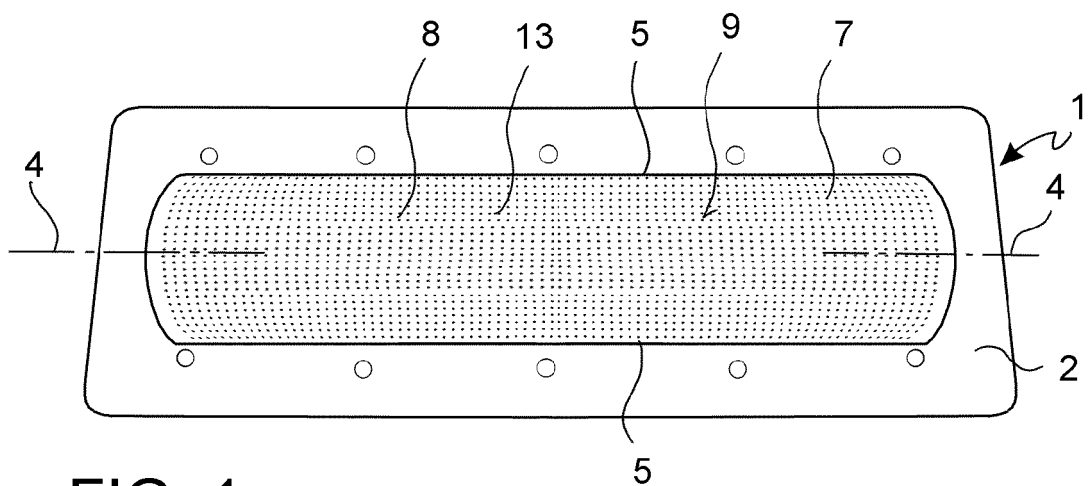


FIG. 1

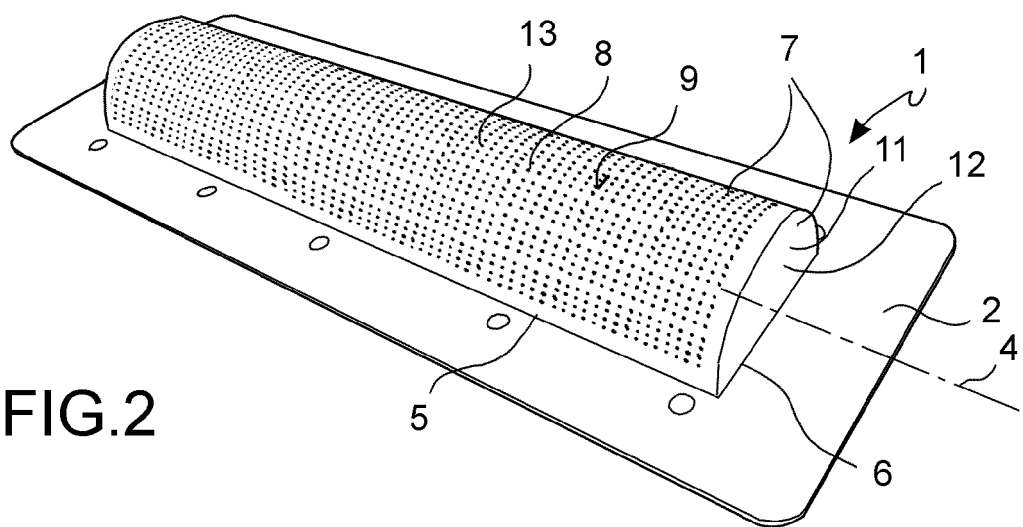


FIG. 2

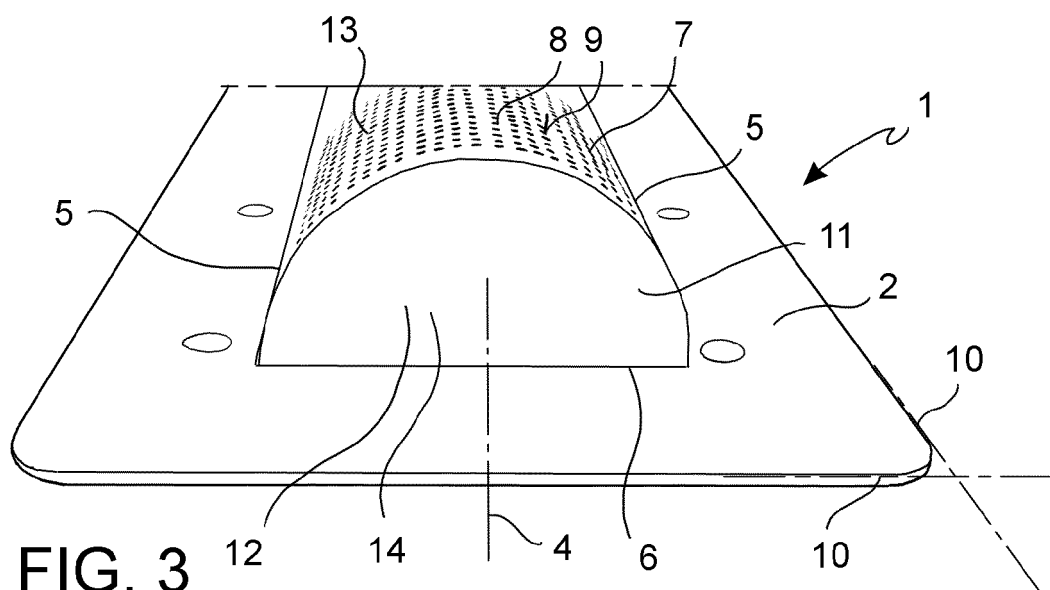


FIG. 3

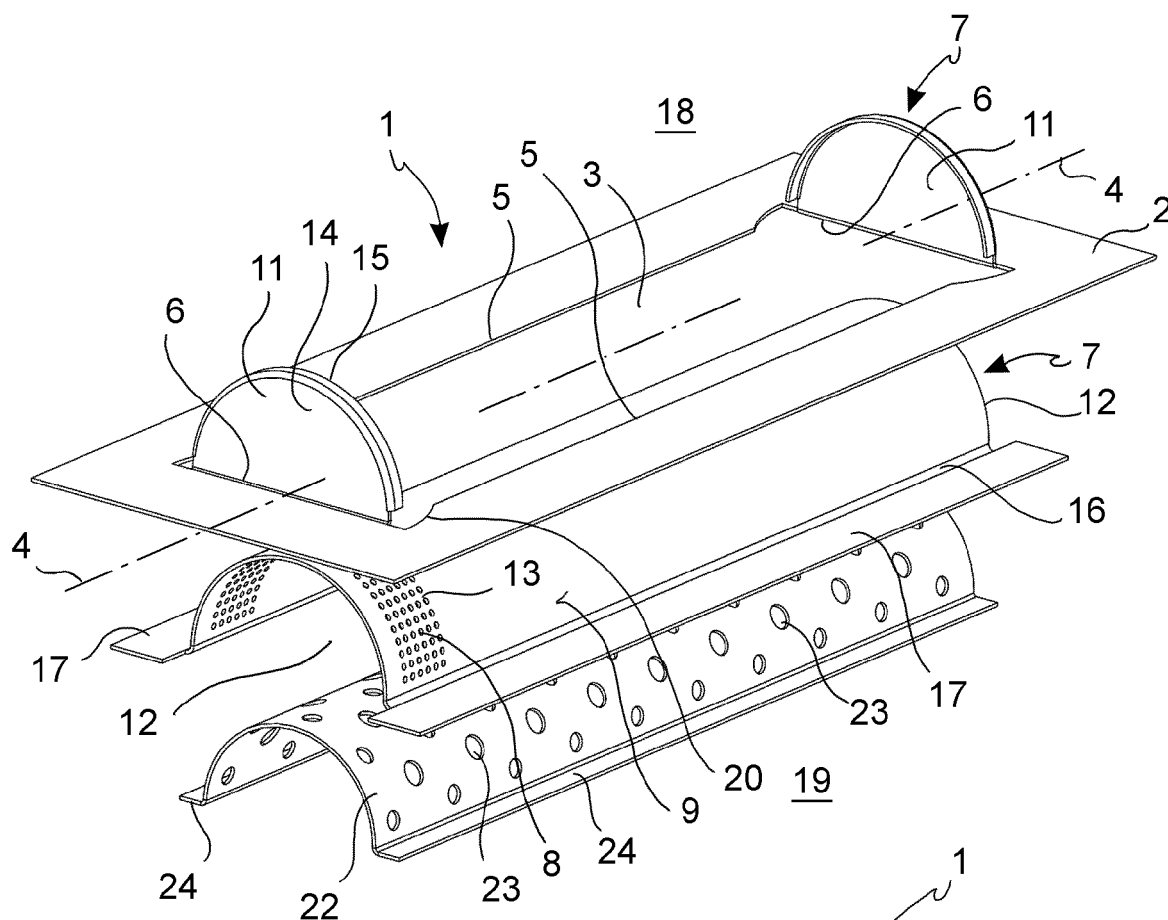


FIG. 4

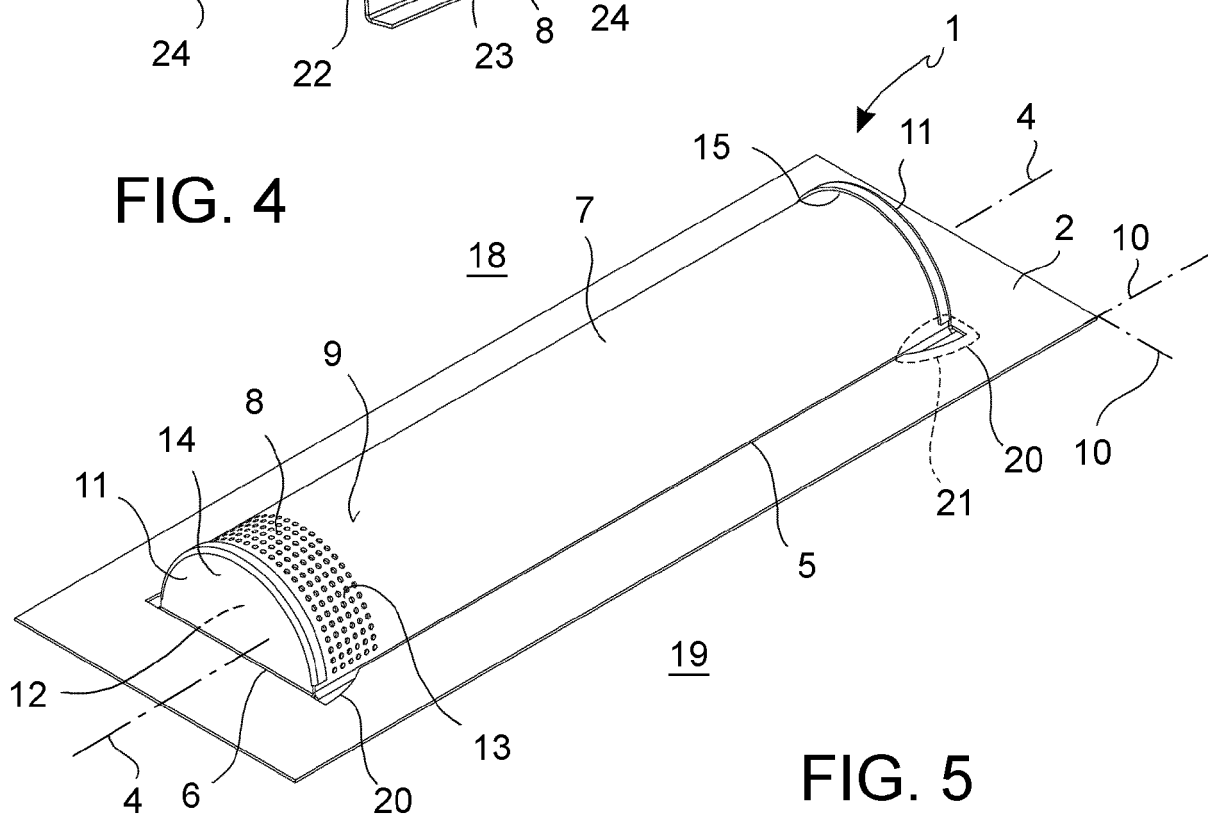


FIG. 5

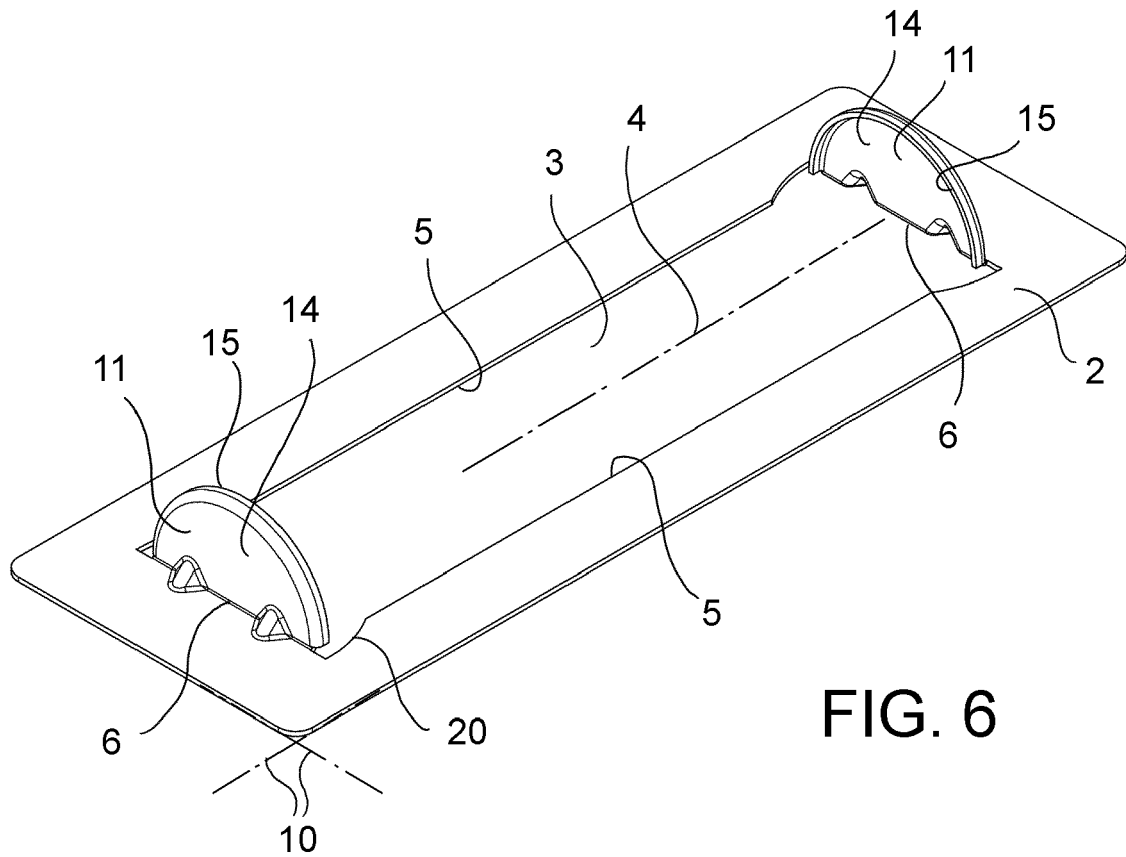


FIG. 6

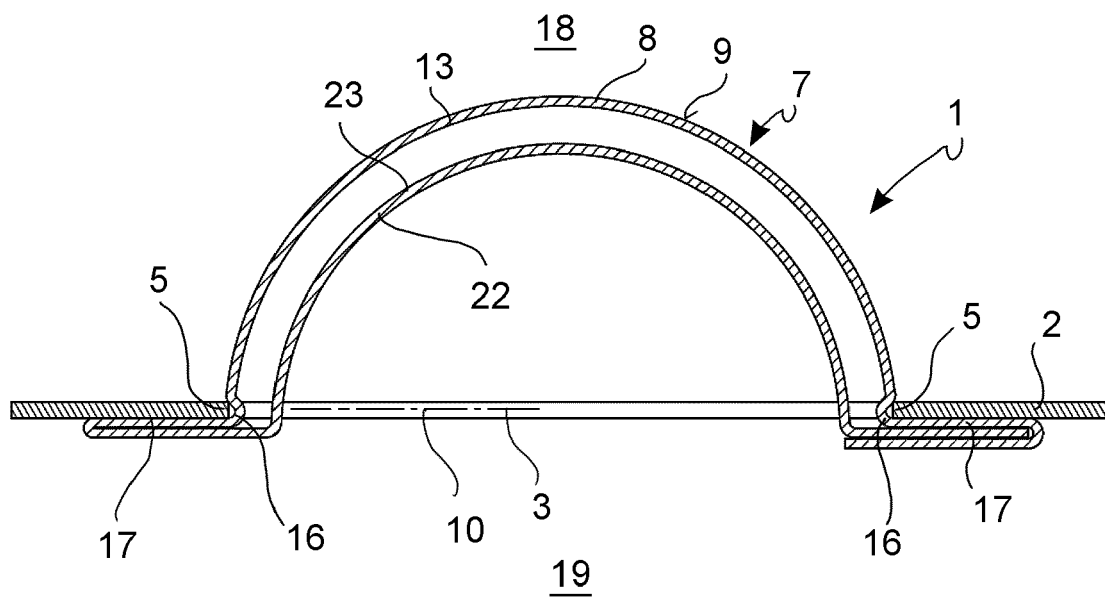


FIG. 7

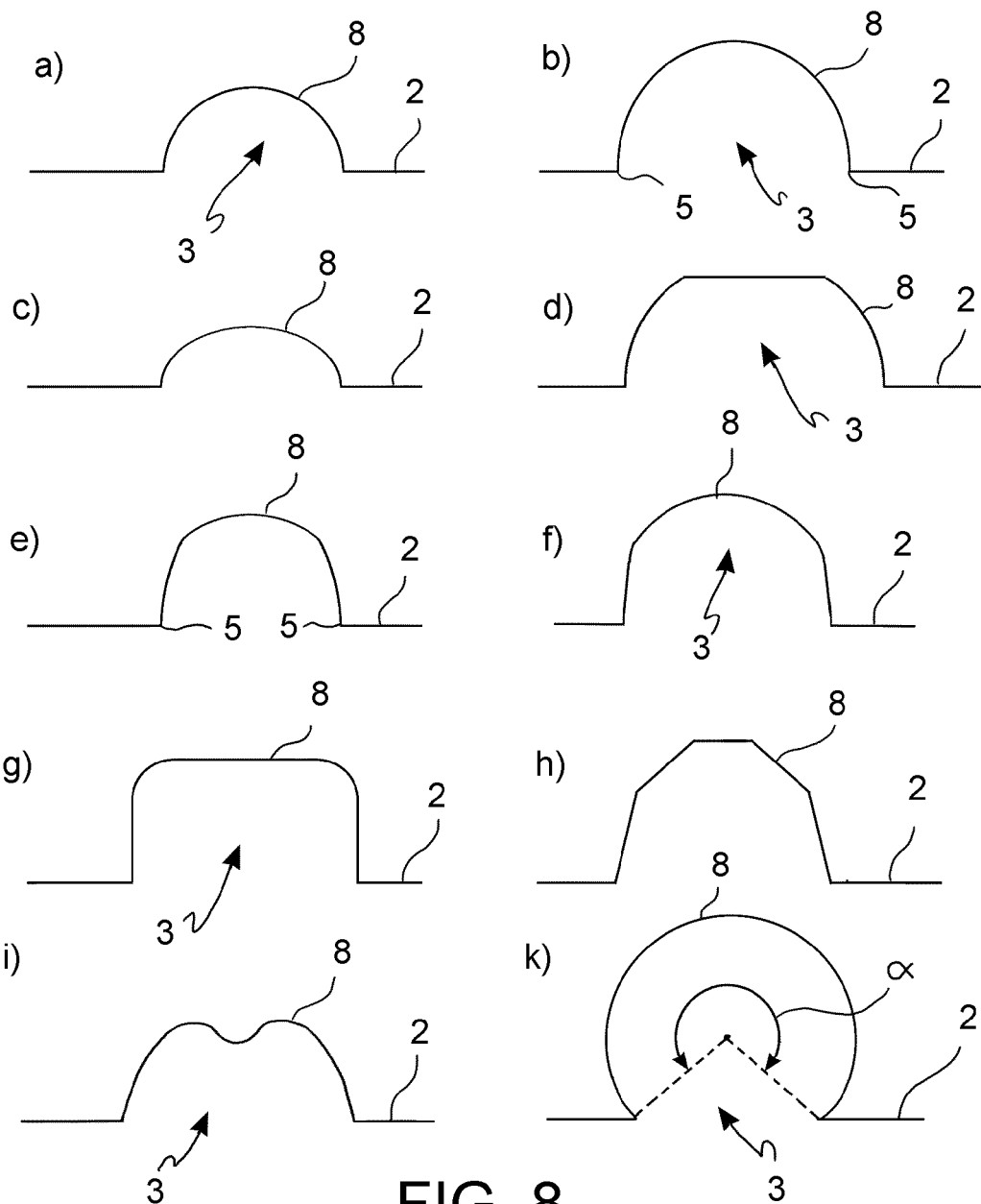


FIG. 8

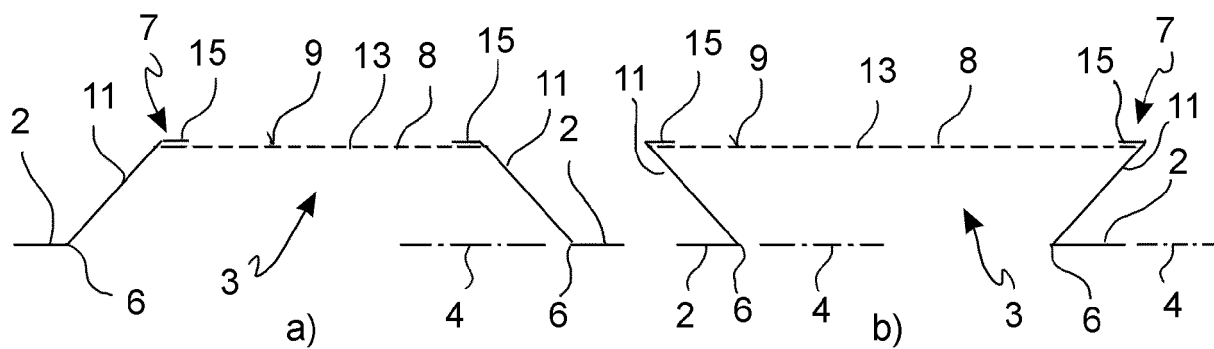


FIG. 9



EUROPEAN SEARCH REPORT

Application Number
EP 16 15 3084

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			F23D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 14 June 2016	Examiner Vogl, Paul
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 16 15 3084

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