(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 628 004 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**22.02.2006 Bulletin 2006/08**

(21) Application number: **05107559.6**

(22) Date of filing: **17.08.2005**

(51) Int Cl.:
***F02C 7/24*** *(2006.01)* ***F01N 1/04*** *(2006.01)*
***F01N 1/10*** *(2006.01)* ***F01N 1/24*** *(2006.01)*
***F23J 13/00*** *(2006.01)*

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR**
Designated Extension States:
**AL BA HR MK YU**

(30) Priority: **19.08.2004 NL 1026879**

(71) Applicant: **Aarding Thermal Acoustics B.V.**
**8071 CS Nunspeet (NL)**

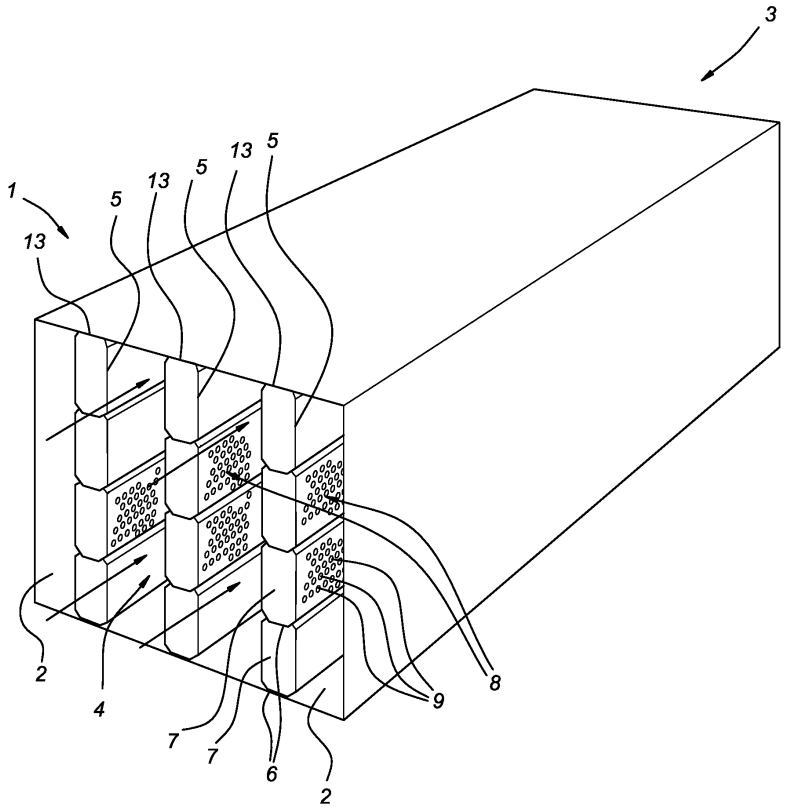
(72) Inventor: **Pranger, Willem Martin**
**3862 MB Nijkerk (NL)**

(74) Representative: **van Westenbrugge, Andries**
**Nederlandsch Octrooibureau**
**Postbus 29720**
**2502 LS Den Haag (NL)**

## (54) Sound damper, sectional component and method for the production of a splitter

(57) A sound damper (2) for an exhaust (1) of a gas turbine comprises at least one splitter (5) in which a sound damping material, such as mineral wool, is accommodated. The splitter (5) comprises several sectional components (6). The splitter (5) is at least partially delimited by perforations (9) for transmitting sound. Said sectional components (6) are stacked on top of one another and the perforations (9) are made in said sectional components (6).

*Fig 1*




EP 1 628 004 A1

## Description

**[0001]** The invention relates to a sound damper for an exhaust, comprising at least one splitter, in which a sound-damping material, such as mineral wool, is accommodated, wherein the splitter comprises several sectional components, the splitter being at least partially provided with perforations for the transmission of sound.

**[0002]** Such a sound damper for an exhaust is known. This sound damper is used, for example, in a gas turbine. A gas turbine comprises and inlet, a compressor, a combustion chamber, a turbine and an exhaust. The compressor increases the pressure of air fed from the inlet, which then flows into the combustion chamber. In the combustion chamber this compressed air mixes with an injected fuel, such as gas. The mixture ignites so that combustion takes place. As a result expansion occurs, which makes a turbine rotate. The rotating turbine produces power. The turbine is linked by a shaft to the compressor, that is to say some of the generated power is used to drive the compressor. Downstream of the turbine an exhaust is provided, which in a power station opens into a chimney. The air that flows from the turbine into the exhaust can still have speeds of 50 - 70 m/s.

**[0003]** A gas turbine creates an enormous noise, which has to be damped by a sound damper. The known sound damper comprises several splitters (German: Kulissen) which are arranged in the longitudinal direction of the exhaust. The air flows essentially parallel to the sound-damping splitters.

**[0004]** Each splitter is made up of a framework of U-shaped sectional components that are joined to one another and run in the longitudinal direction and height direction of the splitter. The framework provides the splitter with the necessary strength. Mineral wool is accommodated in the compartments of the framework, that is to say between the U-shaped sectional components, to damp sound.

**[0005]** The side walls of the framework are covered by perforated sheets, which are welded to the framework. On the one hand, the perforated sheets form a side wall permeable to sound, that is to say the sound can penetrate through the perforations into the sound-damping wool within the framework. On the other hand, these sheets prevent the sound-damping wool being sucked out of the compartments of the framework by the air flowing past.

**[0006]** Appreciable sudden changes in temperature arise when the gas turbine is in use. For example, the temperature of the air that enters the exhaust is approximately 250 °C when the gas turbine is idling. When the gas turbine is switched to power generation the temperature of said incoming air rises to 600 °C or more within a short timeframe.

**[0007]** The framework and the perforated sheets are usually made of stainless steel. Moreover, the dimensions of a gas turbine for a power station are large - the exhaust has, for example, a length of 10 metres. As a result of the sudden rise in temperature not only does the temperature of a given location in the splitter change over time, but a temperature gradient is also produced between the front and the back of the splitter. This gives rise to local expansion and therefore severe thermal stressing of the splitter, which can lead to fracture or cracking. The weld by means of which the perforated sheets are fixed to the framework can also rupture, as a result of which the sound-damping wool disappears out of the framework.

**[0008]** The object of the invention is to provide a sound damper where the temperature resistance is improved.

**[0009]** Said object is achieved according to the invention in that said sectional components are stacked on top of one another and the perforations are made in said sectional components.

**[0010]** According to the invention the splitter is made up of sectional components which bear directly on one another. Furthermore, the sectional components are provided with the perforations at the location of the side walls of the splitter. The functions of the provision of the requisite strength and rigidity and the transmission of sound are thus integrated in a single component, i.e. the sectional components stacked on top of one another. Therefore there is no separate framework - the known U-shaped sectional components in the longitudinal direction and in the height direction that make up the framework have been replaced by the sectional components stacked on top of one another. As a result of the lack of this framework the flexibility of the splitter is increased. The sound-damping splitter according to the invention is able to give if stresses arise as a consequence of temperature differences, local expansion not leading to cracking. As a result the splitter is better able to withstand thermal stresses.

**[0011]** A further advantage is that the splitter according to the invention is less expensive. The splitter has fewer components, so that the construction time is reduced. In addition a saving in material is achieved.

**[0012]** Although the invention is particularly suitable for an exhaust for a gas turbine, the invention is not restricted to this. The sound damper according to the invention can be used for any exhaust system, for example also the exhaust of a diesel engine.

**[0013]** It is preferable that the sectional components each have a first stacking end and a second stacking end, wherein said stacking ends have shaped parts engaging in one another for engaging the first stacking end of a first sectional component in the second stacking end of a second sectional component that is stacked adjacent to the first sectional component. The stacking ends are, for example, formed by a bottom side and a top side of a sectional component, respectively. The bottom side and top side then have shapes such that the top side of a lower sectional component and the bottom side of an adjacent upper sectional component, which is stacked in the height direction on the lower sectional component, engage in one another. The sectional components

stacked on top of one another are sideways confined with respect to one another. If a weld by means of which sectional components are welded to one another fails, the stacked sectional components will not immediately separate from one another. After all, the sectional components are already linked to one another with some degree of interlocking due to corresponding shapes.

**[0014]** It is possible that the sectional components are provided with a base that has slanted side edges on either side thereof, wherein the base is joined at the slanted side edges to two respective upright side walls, which each have a slanted top edge at the end facing away from the base, wherein the slanted top edges are oriented towards one another. In this case the bottom side of the upper sectional component is formed by the base and the top side of the underlying sectional component is formed by the top edges. With this arrangement the base is at least partially accommodated between the top edges. This is one example of an interlocking join between the stacked sectional components. Furthermore, the slanted edges of the sectional components reinforce the splitter. As a result the splitter is better able to absorb lateral forces.

**[0015]** Furthermore, a sectional component according to the invention can have a capping plate, which joins the top edges of the side walls to one another. Such a sectional component is suitable for the top sectional component, viewed in the height direction. The capping plate then forms a cover for closing off the top side of the splitter. In this case the splitter is delimited by a closed housing.

**[0016]** In one embodiment according to the invention the side walls are provided with the perforations and the slanted side edges and/or the slanted top edges are unperforated. The unperforated edges form a welding surface, over which several welds, made some distance apart in the longitudinal direction can join two stacked sectional components.

**[0017]** The fact that perforation is only local has a further advantage. The sectional components are each made from a flat sheet. A punching machine first punches out the perforations in the sheet at the location of the portions that will form the side walls of the splitter. During this operation local stress concentrations are introduced into the sheet. The sheet provided locally with perforations is then bent, the slanted side edges and/or the slanted top edges being produced. Because said edges are not perforated, that is to say there are no perforations along the bend line, bending can take place along a straight line. After all, because of the stress concentrations bending along perforations would proceed out of true and not in a fully controlled manner.

**[0018]** The invention also relates to a sectional component clearly intended for use with a splitter as described above.

**[0019]** Furthermore, the invention relates to a gas turbine, comprising an inlet, a compressor, a combustion chamber, a turbine as well as an exhaust, in which a sound damper as described above has been fitted.

**[0020]** In addition the invention relates to a method for the production of a splitter as described above, comprising the provision of a sheet with a length dimension L and a width dimension B, for example standard dimensions available commercially, converting the sheet into a sectional component with a number of section walls, where the sum of the dimensions of the section walls corresponds to the length dimension L or the width dimension B of the sheet. This method leads to a minimum of waste.

**[0021]** The invention will now be explained in more detail with reference to the appended drawing. In the drawing:

Figure 1 shows a diagrammatic perspective view of an exhaust for a gas turbine in which a sound damper according to the invention has been fitted;
Figure 2 shows a side view of a splitter of the sound damper shown in Figure 1;
Figure 3 shows a cross-sectional view according to III-III in Figure 2;
Figures 4a, 4b show, diagrammatically, exploded views in cross-section of embodiments according to the invention of splitters with a streamlining piece;
Figure 5a shows a flat sheet that is locally provided with perforations to form a sectional component according to the invention;
Figure 5b shows a cross-sectional view of a sectional component made from the flat sheet shown in Figure 5a.

**[0022]** With reference to Figure 1, an exhaust 1 of a gas turbine has a feed end 2 and a discharge end 3. The exhaust 1 can be arranged either horizontally or vertically. Air enters the exhaust 1 from the turbine of the gas turbine at the feed end 2, for example at a speed of 50 - 70 m/s. The air flows through the exhaust 1 and leaves this through the discharge end 3, which, for example, opens into a discharge channel or a chimney of a power station (not shown).

**[0023]** The rotating components of the gas turbine create enormous noise. The sound power at the feed end 2 of the exhaust 1 can be 150 dB or more. In order to absorb this sound a sound damper 4 has been accommodated in the exhaust 1. Although the sound damper 4 shown in Figure 1 has three splitters 5 (German: Kulissen), a greater or smaller number of splitters can, of course, be provided.

**[0024]** Each splitter 5 is made up of several sectional components 6, which bear directly on one another (see also Figure 3). Each sectional component 6 comprises a thin-walled, trough-shaped bar. This trough-shaped bar is open on one longitudinal side. By stacking the sectional components 6 on top of one another the panel has tubular shapes adjoining one another in cross-section. This results in a lightweight splitter that is flexible in the transverse direction but is still adequately rigid. Stacking of

this illustrative embodiment will be described in more detail below.

**[0025]** "Thin-walled" must be understood to mean a wall thickness that enables flexibility of the splitter. This wall thickness is, for example, 1 - 4 mm, such as 2 or 3 mm.

**[0026]** Such a splitter 5 has a greater flexibility than a conventional splitter that is made up as a framework. In contrast to a framework construction, the splitter according to the invention is able to give under the influence of lateral stress on the splitter. As a result the splitter according to the invention will be less liable to crack as a consequence of sudden changes in temperature.

**[0027]** The trough-shaped sectional components 6 each surround an interior 7 in which a sound-damping material, such as mineral wool, is accommodated. It is also possible that this sound-damping material is arranged in a closed envelope to form a sound-damping cushion. Filling the interior 7 of the sectional components 6 with cushions instead of loose mineral wool prevents irritation of the hands as a result of contact with said wool.

**[0028]** The side walls 8 of the splitters 5 are provided with perforations 9. The perforations 9 preferably each have a diameter of between 2 and 4 mm. The sound can penetrate through the perforations 9 into the interior 7 of the sectional components 6, where the mineral wool damps the sound.

**[0029]** A splitter 5 according to the invention is made up as follows. First of all a bottom sectional component 6 is placed on a bearing surface. The sound-damping material is then placed via the open longitudinal side of said trough-shaped sectional component 6 in the interior 7 thereof. A further sectional component 6 is then stacked on top of the bottom sectional component 6 so that the interior 7 thereof is closed off. This further sectional component 6 can then be filled, etc. It is also possible first to fill several or all sectional components 6 required for the splitter 5 and then to stack the sectional components 6 on top of one another.

**[0030]** The stacking according to this illustrative embodiment is shown most clearly in Figure 3. In this case the sectional components 6 have shaped parts, which engage with one another, at the stacking ends 20, 21 stacked on top of one another. The bottom of the sectional component 6 forms the first stacking end 20, whilst the top of the sectional component 6 forms the second stacking end 21.

**[0031]** The sectional components 6 each have a base 10, which has slanted side edges 11 on either side thereof. The side edges 11 are joined to respective upright side walls 12, which at the top thereof each pass into a slanted top edge 14.

**[0032]** The slanted top edges 14 are oriented towards one another, the side edges 11 of a sectional component 6 on top of them being enclosed between said top edges 14. The base 10 of the sectional component 6 on top is thus arranged between the top edges 14 of the underlying sectional component 6 to some extent in the interior 7 thereof. As a result the sectional components 6 stacked on top of one another are held interlocked with respect to one another in the lateral direction.

**[0033]** Of course, the shapes of the top and bottom of the sectional components engaging in one another can be of different design.

**[0034]** The side edges 11 and top edges 14 form stacking edges of the sectional component 6. In addition, the edges 11, 14 act as reinforcing flanges that increase the strength and rigidity of the splitter 5 according to the invention.

**[0035]** The top sectional component 6 (see Figures 1, 4a, 4b) is closed off by a flat capping plate 13. The capping plate 13 forms a lid so that the sound-damping material is not able to escape from the top sectional component.

**[0036]** Figures 2 and 3 furthermore show that the side edges 11 and the top edges 14 are unperforated. The sectional components 6 are welded to one another by welds 16 at the location of said unperforated side edges 11 and top edges 14.

**[0037]** As shown in Figure 2, the sectional components 6 can be fitted in an essentially rectangular guide frame 17. This frame 17 has two vertical uprights as well as two longitudinal sections on the top and bottom of the frame 17, respectively. The frame 17 guarantees that the sectional components are stacked aligned with respect to one another.

**[0038]** In the illustrative embodiment shown in Figs 1 - 3 the sectional components 6 extend in the longitudinal direction of the splitter 5, which means that the air flows from the feed end 4 to the discharge end 3 essentially in the longitudinal direction of the sectional components 6. According to the invention the exhaust 1 can also be arranged vertically, the sectional components 6 being arranged with the end faces thereof between the upright side walls of the exhaust (not shown). With this arrangement the air flow is oriented transversely with respect to the longitudinal direction of the sectional components. The longitudinal direction of the sectional components and the longitudinal direction of the exhaust can then be perpendicular with respect to one another, such as essentially horizontal and vertical, respectively.

**[0039]** The approach side of the splitter 5 can therefore be formed either by the end faces of the sectional components 6 or by the top or bottom of the sectional components 6. According to the invention the approach side can be provided with a rounded streamlining piece 18 (see Figures 4a, 4b). This rounded shape has five angularly offset segments 19. Incidentally, the streamlining piece 18 can also have another shape. In Figure 4a the streamlining piece 18 is fitted against the base of the bottom sectional component 6. In this illustrative embodiment the approach to the splitter 5 is thus from bottom to top according to arrow A. Figure 4b shows that the streamlining piece 18 can also be integrated with the bottom sectional component 6. In this case the bottom sectional component 6 itself has a rounded shape.

**[0040]** The splitter 5 can also have a streamlining piece on the outflow side facing away from the approach side, close to the outflow opening.

**[0041]** The streamlining piece 18 is particularly advantageous in the case of high air speeds. The streamlined front edge reduces the disturbance of the airflow, as a result of which the resistance is lower and the air warms up to a lesser extent as a result of collision with the front edge. A streamlined rear wall has a corresponding advantageous effect.

**[0042]** The sectional components 6 are preferably made of a bent sheet or plate, for example stainless steel, steel or aluminium. This sheet has a thickness of, for example, 3 mm. Figure 5a shows a flat, rectangular sheet that has been made from stainless steel. In this illustrative embodiment the sheet has a length dimension L of 3000 mm and a width dimension B of 1500 mm. First of all longitudinal bands of perforations 30, 31 are punched or stamped in the sheet in the longitudinal direction, leaving unperforated longitudinal bands 32-36. After perforation, the sheet is bent along the bend lines 40 to give the sectional component 6 shown in Figure 5b. Because there are no perforations along the bend lines 40, bending can take place in a controlled manner and in a straight line.

**[0043]** The sectional component 6 according to Figure 5b has a base 44, two slanted side edges 43, 45, two side walls 40, 41 and two top edges 42, 46. This sectional component is trough-shaped, a slot-shaped opening having been formed at the end facing away from the base. Stacking of such sectional components is shown in Figures 1 - 3.

**[0044]** The longitudinal bands with perforations 30, 31 correspond to the side walls 40, 41 of this sectional component, whilst the other longitudinal bands 32-36 correspond to the top edge 42, the side edge 43, the base 44, the side edge 45 and the top edge 46 of this sectional component, respectively. The sum of the dimensions of the base 44, two slanted side edges 43, 45, two side walls 40, 41 and two top edges 42, 46 is equal to the width dimension of the sheet, in this case 1500 mm. This sectional component 6 has therefore been formed without loss of material.

**[0045]** According to the invention it is possible to produce sectional components with different shapes and/or dimensions starting from a sheet with different dimensions LxB. The dimensions LxB are, for example, standard dimensions available commercially, such as 1000 x 1000 mm, 2000 x 1000 mm or 1500 x 3000 mm. However, the dimensions LxB according to the invention can also be dimensions that are not available commercially but are ordered to size. The dimensions of the sheet can be chosen by the designer depending on the total length of the exhaust.

**[0046]** Although the sound damper has been described above for the exhaust for a gas turbine, the sound damper according to the invention is suitable for any application where sound has to be absorbed. According to the invention the sound damper described above can, for example, also be installed in the exhaust of a diesel engine.

## Claims

1. Sound damper (2) for an exhaust (1), comprising at least one splitter (5), in which a sound-damping material, such as mineral wool, is accommodated, wherein the splitter (5) comprises several sectional components (6), the splitter (5) being at least partially delimited by perforations (9) for the transmission of sound, **characterised in that** said sectional components (6) are stacked on top of one another and the perforations (9) are made in said sectional components (6).

2. Sound damper according to Claim 1, wherein the sectional components (6) each comprise a trough-shaped bar.

3. Sound damper according to Claim 1 or 2, wherein the sectional components (6) are thin-walled, wherein, for example, the wall thickness of the sectional components (6) is between 1 and 5 mm and is preferably approximately 2 mm.

4. Sound damper according to one of the preceding claims, wherein the sectional components (6) are each formed by a bent sheet, which is at least partially provided with the perforations (9).

5. Sound damper according to Claim 4, wherein the sheet comprises stainless steel.

6. Sound damper according to one of the preceding claims, wherein the sectional components (6) each have a first stacking end (20) and a second stacking end (21), wherein said stacking ends (20, 21) have shaped parts engaging in one another for engaging the first stacking end (20) of a first sectional component (6) in the second stacking end (21) of a second sectional component (6) that is stacked adjacent to the first sectional component (6).

7. Sound damper according to Claim 6, wherein the sectional components (6) are provided with a base (10) that has slanted side edges (11) on either side thereof, wherein the base (10) is joined at the slanted side edges (11) to two respective upright side walls (12) which each have a slanted top edge (14) at the end facing away from the base (10).

8. Sound damper according to Claim 7, wherein the slanted top edges (14) are oriented towards one another and face away from the base (10).

9. Sound damper according to Claim 7 or 8, wherein

the first stacking end (20) comprises the base (10) and the second stacking end (21) comprises the top edges (14).

**10.** Sound damper according to Claim 9, wherein one sectional component (6) has a capping plate (13) that joins the top edges (14) of the side walls (12) to one another.

**11.** Sound damper according to one of Claims 7 - 10, wherein the side walls (12) are provided with perforations (9) and the slanted side edges (11) and/or the slanted top edges (14) are unperforated.

**12.** Sound damper according to one of the preceding claims, wherein two sectional components (6) stacked on top of one another are joined to one another by welds (16).

**13.** Sound damper according to Claim 12, wherein the welds (16) extend at the location of the slanted side edges (11) and the slanted top edges (14).

**14.** Sound damper according to one of the preceding claims, wherein the splitter (5) has a rounded streamlining piece (18) on an approach side and/or an outflow side.

**15.** Sound damper according to one of the preceding claims, wherein several splitters (5) are provided that are arranged adjacent to one another with leaving clear a gap.

**16.** Sectional component clearly intended for use in a splitter according to one of the preceding claims.

**17.** Gas turbine comprising a compressor, a combustion chamber, a turbine as well as an exhaust, **characterised in that** the exhaust (1) comprises a sound damper (2) according to one of Claims 1 - 15.

**18.** Method for the production of a splitter according to one of Claims 1 - 15, comprising:

- the provision of a sheet with a length dimension L and a width dimension B
- converting the sheet into a sectional component (6) with a number of section walls (10, 11, 12, 14), where the sum of the dimensions of the section walls (10, 11, 12, 14) corresponds to the length dimension L or the width dimension B of the sheet.

Fig 1

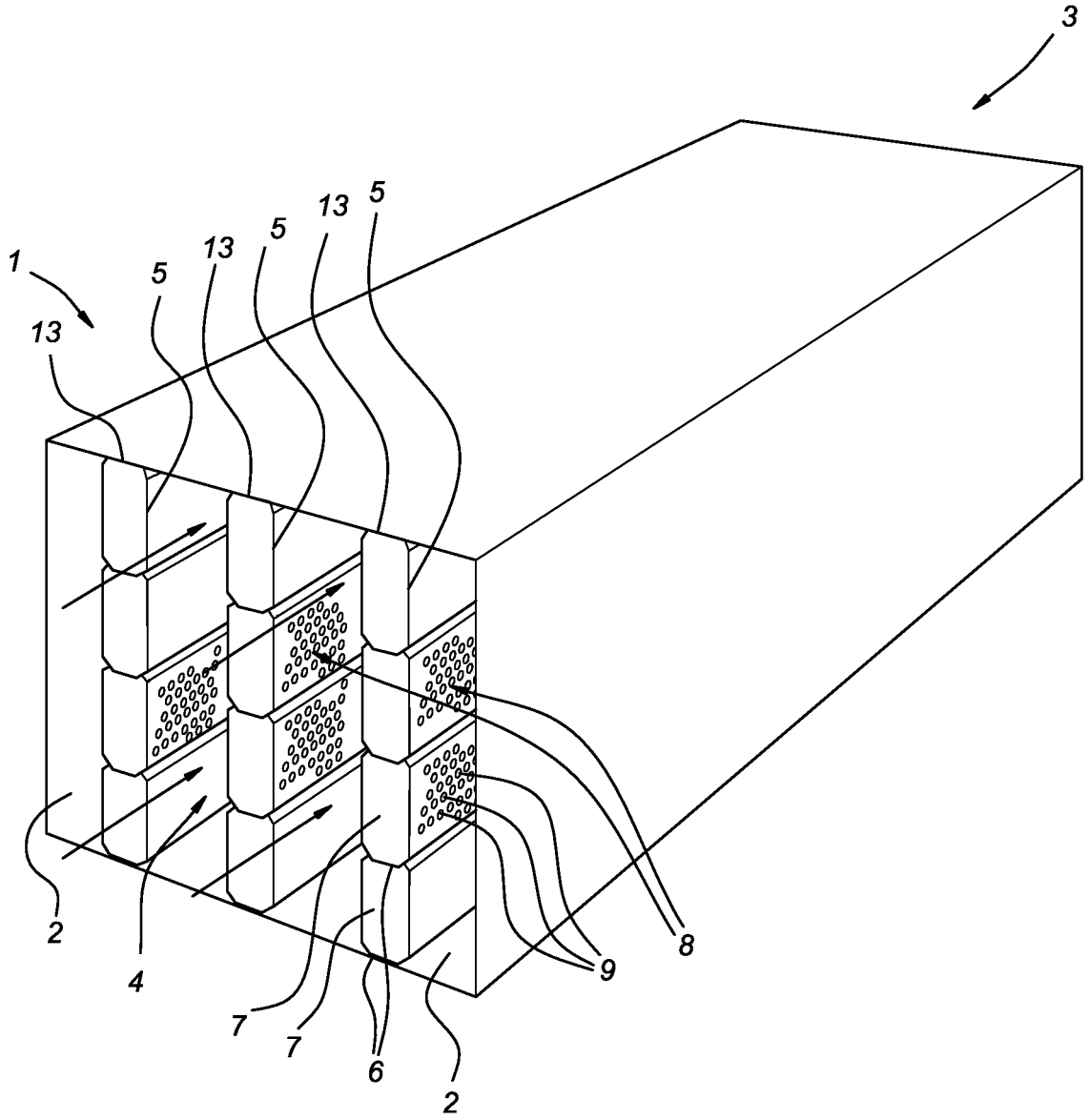


Fig 2

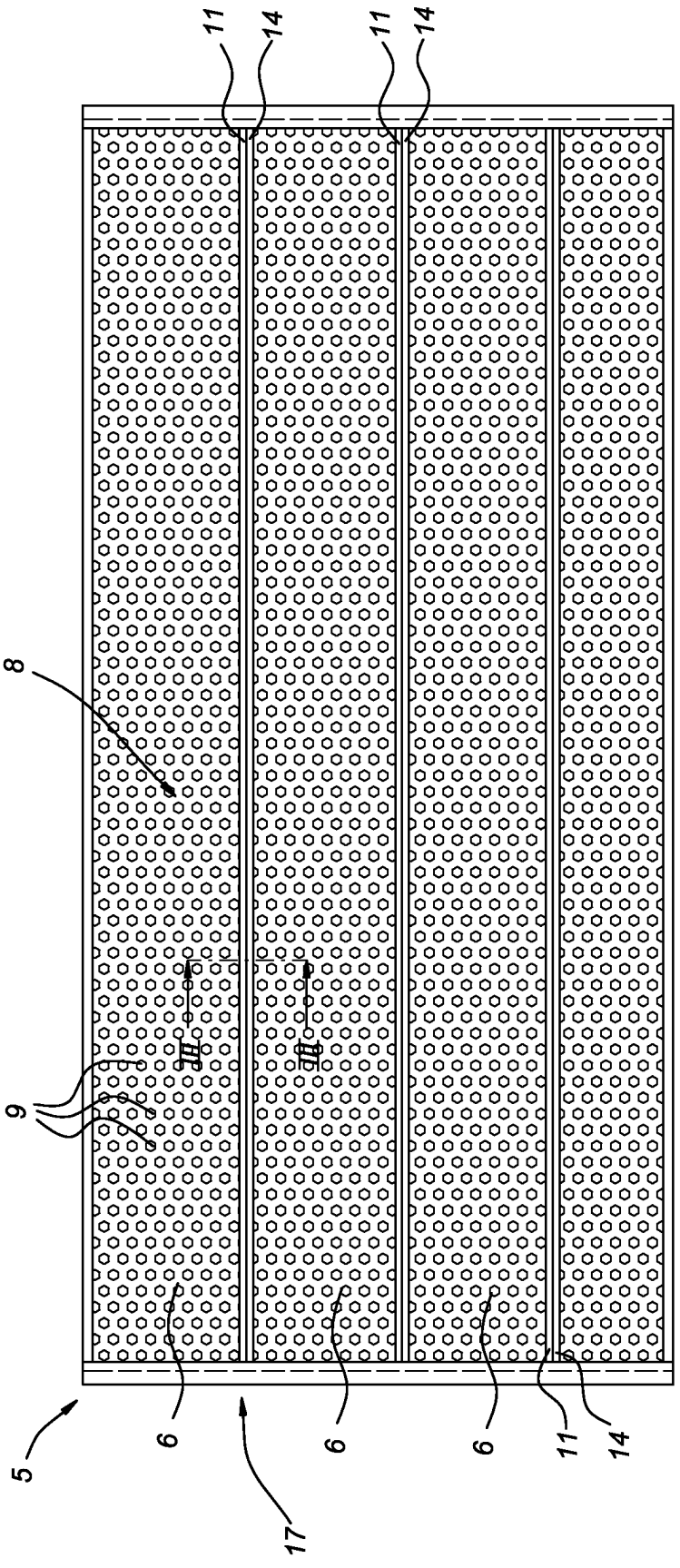


Fig 3

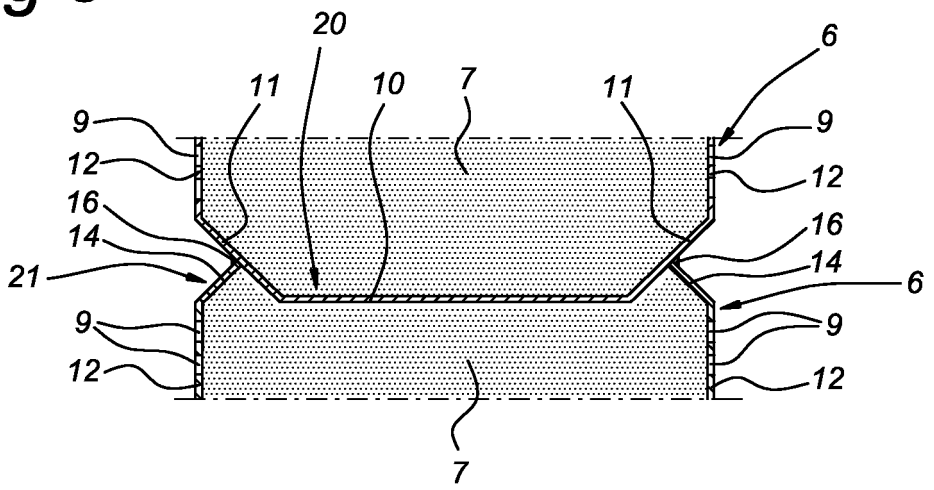



Fig 4a

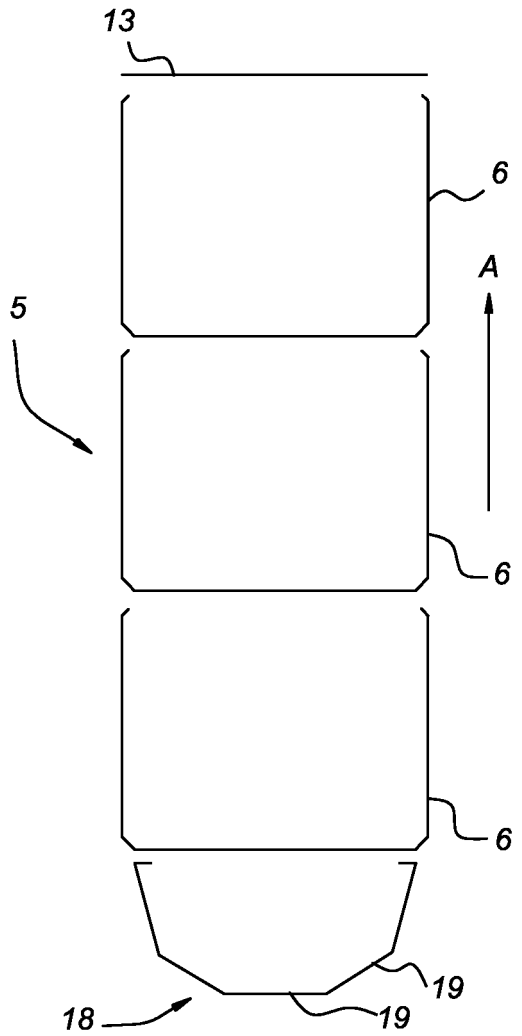



Fig 4b

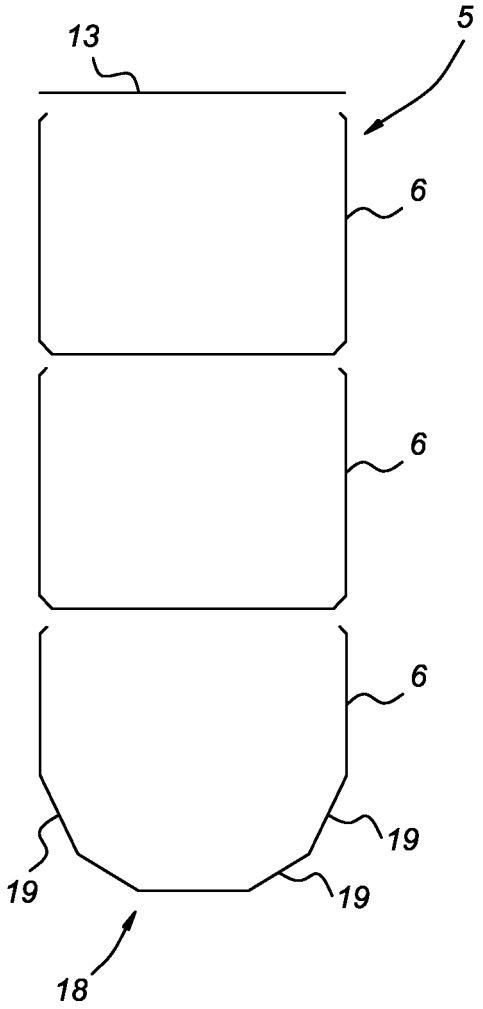


Fig 5a

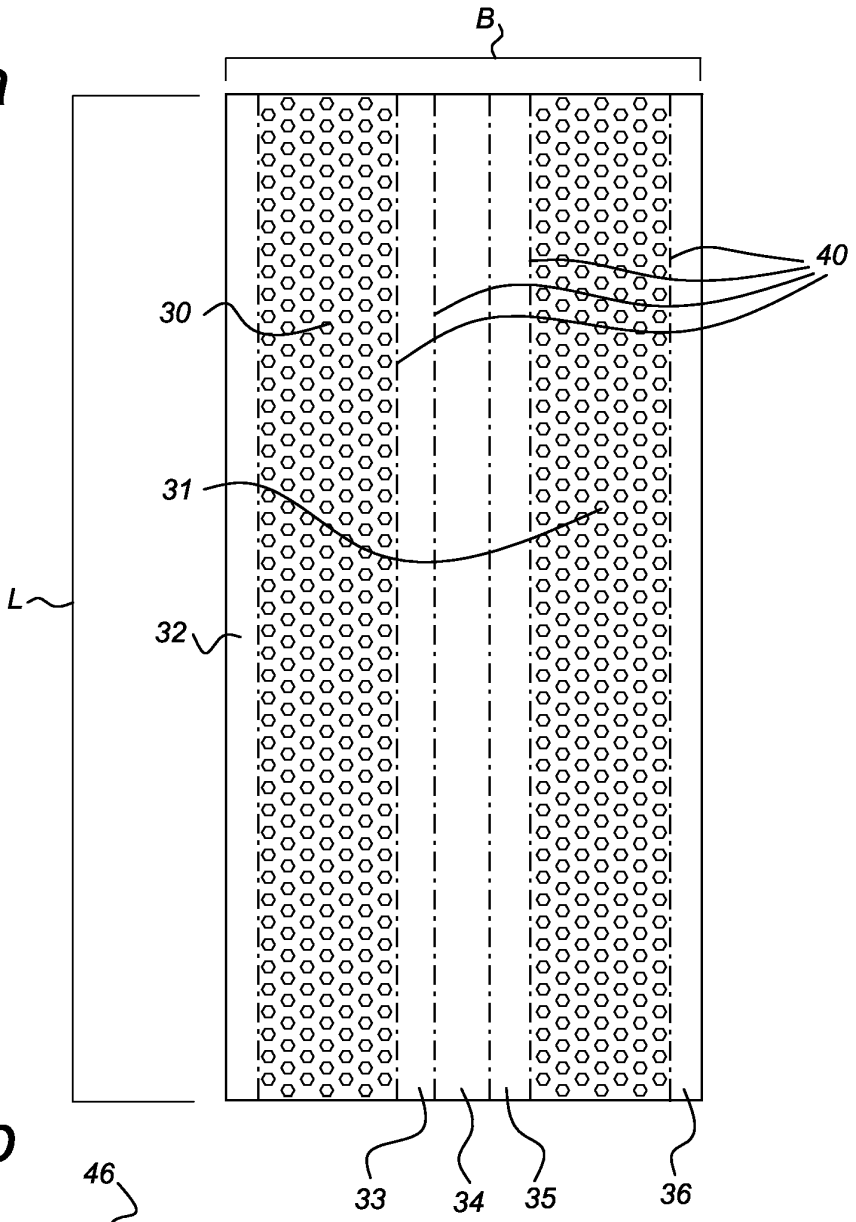
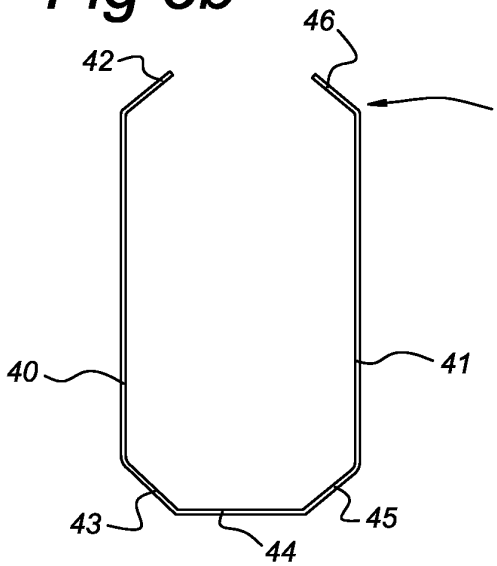



Fig 5b



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 05 10 7559

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | DE 29 32 439 A1 (LUEFA-WERKE GMBH) 26 February 1981 (1981-02-26) * the whole document * | 1-6, 15-18 | F02C7/24 F01N1/04 F01N1/10 F01N1/24 |
| X | DE 23 03 611 A1 (VASILJEVIC, COSTA SILARD, DIPL.ING. DR., 7400 TUEBINGEN; VASILJEVIC, C) 15 August 1974 (1974-08-15) * page 6, paragraph 1; figure 5 * | 1,2,6, 14-17 | F23J13/00 |
| A | US 2003/072648 A1 (HAN MING HUI ET AL) 17 April 2003 (2003-04-17) * figures 1-15 * * abstract * * page 5, paragraph 48 - paragraph 49 * * page 6, paragraph 59 * * page 6, paragraph 65 * * claims 1-18 * | 1,3,4, 17,18 | |
| A | WO 99/35378 A1 (SILENTOR NOTOX A/S; FREDERIKSEN, SVEND; BINGHAM, D., W) 15 July 1999 (1999-07-15) * figure 1 * * abstract * | 1,17,18 | TECHNICAL FIELDS SEARCHED (IPC) F02C F01N F23J F23M |
| A | FUCHS H V ET AL: "NICHTPOROSER SCHALLABSORBER FUR DEN EINSATZ IN RAUCHGASREINIGUNGSANLAGEN" 1 November 1989 (1989-11-01), VGB KRAFTWERKSTECHNIK, VGB KRAFTWERKSTECHNIK GMBH. ESSEN, DE, PAGE(S) 1102-1110 , XP000083750 ISSN: 0372-5715 * page 1106; figure 10 * * page 1108; figures 12-15 * | 1-6 | |

-/--

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 10 November 2005 | Schmitter, T |

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

EPO FORM 1503 03.82 (P04C01)

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 05 10 7559

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| A | FR 2 447 069 A1 (WESTEEL GUY)<br>14 August 1980 (1980-08-14)<br>* figures I-1,II-2,II-3 *<br>* claims 1-4 * | 1-6 | |
| A | US 2003/039595 A1 (GEISE C. JOSEPH)<br>27 February 2003 (2003-02-27)<br>* figures 1-11 *<br>* abstract * | 1-6 | |
| A | DE 198 18 415 A1 (RAICHLE, GERD, 73252 LENNINGEN, DE; RAICHLE, RALF, 73252 LENNINGEN, DE)<br>14 January 1999 (1999-01-14)<br>* figures 1,2 *<br>* abstract *<br>* claims 1-15 * | 1-6 | |
| | | | TECHNICAL FIELDS SEARCHED (IPC) |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 10 November 2005 | Schmitter, T |

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

EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 10 7559

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-11-2005

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE 2932439 A1 | 26-02-1981 | NONE | |
| DE 2303611 A1 | 15-08-1974 | NONE | |
| US 2003072648 A1 | 17-04-2003 | CA 2363895 A1 | 30-11-2002 |
| | | EP 1262666 A2 | 04-12-2002 |
| | | US 2002182061 A1 | 05-12-2002 |
| WO 9935378 A1 | 15-07-1999 | AT 224003 T | 15-09-2002 |
| | | AU 1869699 A | 26-07-1999 |
| | | DE 69807942 D1 | 17-10-2002 |
| | | DE 69807942 T2 | 30-04-2003 |
| | | EP 1060328 A1 | 20-12-2000 |
| FR 2447069 A1 | 14-08-1980 | NONE | |
| US 2003039595 A1 | 27-02-2003 | NONE | |
| DE 19818415 A1 | 14-01-1999 | NONE | |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82