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of the composite porous substrate shaped into conical shape. The rim is directed to the outside of the conical shape. The conical shape has a first cone angle. The burner comprises an annular porous section. The annular porous section is connected to the conical shape at the cross section of the conical shape having the largest diameter. The annular porous section is flat or the annular porous section is frusto-conical with a cone angle larger than the first cone angle.

## Conical premix gas burner

### Description

#### Technical Field

[1] The invention relates to conical premix gas burners at which combustion occurs on a fiber  
5 based burner deck, positioned onto a perforated plate or woven wire mesh.

#### Background Art

[2] Surface stabilized premix gas burners exist in a plurality of different shapes. Although  
10 US6065963 is entitled "Conical surface burner", the document rather shows a burner with  
a frusto-conical shape. The combustion is stabilized on a knitted structure comprising  
heat-resistant stainless steel fibers. The knitted structure is supported by a net. The  
knitted structure can be attached to the net, e.g. by means of spot welds.

[3] EP2713105A1 discloses a surface stabilized premix burner having a conical or frusto-  
15 conical combustion surface. Combustion occurs at the inside of the cone or the frusto-  
cone. The combustion surface is formed by at least one sheet-shaped plate which has a  
plurality of openings. Such burner can be advantageously used in so-called two-pass  
boilers, also called flame-inversion type boilers.

#### Disclosure of Invention

[4] It is the objective of the invention to provide a conical premix gas burner that can be  
20 manufactured more easily.

[5] The first aspect of the invention is a premix gas burner comprising a composite porous  
25 substrate. The composite porous substrate comprises a fiber based textile fabric and a  
porous metal structure. The fiber based textile fabric is provided onto and contacting the  
porous metal structure. The fiber based textile fabric is provided for combustion of premix  
gas onto the fiber based textile fabric after the premix gas has flown through the  
composite porous substrate. Thus, the fiber based textile fabric provides a burner deck in  
the burner. The composite porous substrate comprises a conical shape. A rim is provided  
30 along the length of the conical shape. The rim is provided by contact of the internal sides  
or of the external sides of the two end strips of the composite porous substrate shaped  
into conical shape. The internal side of the composite porous substrate is the side internal  
to the conical shape. The rim comprises fiber based textile fabric and porous metal  
structure. The fiber based textile fabric is located at the inside of the conical shape. The  
porous metal structure is located at the outside of the conical shape. The rim is provided  
35 by contact of the internal sides of the two end strips of the composite porous substrate  
shaped into conical shape. The rim is directed to the outside of the conical shape. The  
conical shape has a first cone angle. The burner comprises an annular porous section.  
The annular porous section is connected to the conical shape at the cross section of the  
conical shape having the largest diameter. The annular porous section is flat or the  
annular porous section is frusto-conical with a cone angle larger than the first cone angle.

- [6] The second aspect of the invention is a method for manufacturing a premix gas burner as in the first aspect of the invention. The method comprises the steps of
- providing a fiber based textile fabric and a porous metal structure;
  - attaching - preferably by means of welding - the fiber based textile fabric and the porous metal structure to each other, thereby creating a composite porous substrate;
  - folding the composite porous substrate such that the folded structure comprises a conical shape and such that a rim is provided along the length of the conical shape, wherein the rim is provided by contact of the internal sides or of the external sides of the two end strips of the composite porous substrate shaped into conical shape. The internal side of the composite porous substrate is the side internal to the conical shape; and
  - bonding the two end strips in the rim to each other, preferably by means of welding.
- [7] It has been shown to be difficult to make a burner deck having a conical shape. However, The invention provides an improved way to manufacture a premix gas burner having a conical burner deck. It is particularly more easy to shape the point of the cone correctly.
- [8] In a preferred burner, the two end strips in the rim are bonded to each other, preferably by means of welds. As an example, capacitor discharge welding can be used to weld the two end strips in the rim to each other.
- [9] Preferably, the fiber based textile fabric is bonded by means of welds onto the porous metal structure. More preferably, the welds are provided on discrete points, preferably spread over the surface of the fiber based textile fabric, even more preferably according to a regular pattern. As an example, capacitor discharge welding can be used to bond the fiber based textile fabric onto the porous metal structure.
- [10] Preferably, the porous metal structure comprises or consists out of a woven wire mesh, a perforated metal plate or an expanded metal mesh.
- [11] Preferably, the fiber based textile fabric comprises or consists out of a woven, knitted, braided or nonwoven fabric. Preferably, the fiber based textile fabric comprises or consists out of yarns, more preferably, the yarns comprise metal fibers, even more preferably stainless steel fibers. A particularly preferred fiber based textile fabric is a weft knitted fabric.
- [12] Yarns for the fiber based textile fabric used in the invention can e.g. be spun from stretch broken fibers (such as bundle drawn stretch broken fibers) or e.g. yarns made from shaved or machined fibers. The yarns can be plied yarns, e.g. two ply, three ply... Preferred fabrics made from metal fibers have a weight of between 0.6 and 3 kg/m<sup>2</sup>; preferably between 0.7 and 3 kg/m<sup>2</sup>, even more preferred between 1.2 and 2.5 kg/m<sup>2</sup>.
- [13] The fiber based textile fabric can comprise or consist out of metal fibers. Examples of preferred ranges of metal fibers are stainless steel fibers. A specifically preferred range of stainless steel fibers are chromium and aluminium comprising stainless steel fibers as in DIN 1.4767, e.g. as are known under the trademark FeCrAlloy. Preferred are fibers with equivalent diameter less than 40 µm. With equivalent diameter of a fiber is meant the diameter of a circle with the same surface area as the cross sectional area of that fiber.

- [14] Metal fibers for the fiber based textile fabric, e.g. stainless steel fibers, e.g. with an equivalent diameter less than 40 micrometers, e.g. less than 25 micrometers, can be obtained by a bundle drawing technique. This technique is disclosed e.g. in US-A-2050298, US-A-3277564 and in US-A-3394213. Metal wires are forming the starting material and are covered with a coating such as iron or copper. A bundle of these covered wires is subsequently enveloped in a metal pipe. Thereafter the thus enveloped pipe is reduced in diameter via subsequent wire drawing steps to come to a composite bundle with a smaller diameter. The subsequent wire drawing steps may or may not be alternated with an appropriate heat treatment to allow further drawing. Inside the composite bundle the initial wires have been transformed into thin fibers which are embedded separately in the matrix of the covering material. Such a bundle preferably comprises not more than 2000 fibers, e.g. between 500 and 1500 fibers. Once the desired final diameter has been obtained the covering material can be removed e.g. by solution in an adequate pickling agent or solvent. The final result is the naked fiber bundle.
- [15] Alternatively metal fibers for the fiber based textile fabric, such as stainless steel fibers can be manufactured in a cost effective way by machining a thin plate material. Such a process is disclosed e.g. in US-A-4930199. A strip of a thin metal plate is the starting material. This strip is wound around the cylindrical outer surface of a rotatably supported main shaft a number of times and is fixed thereto. The main shaft is rotated at constant speed in a direction opposite to that in which the plate material is wound. A cutter having an edge line extending perpendicularly to the axis of the main shaft is fed at constant speed. The cutter has a specific face angle parallel to the axis of the main shaft. The end surface of the plate material is cut by means of the cutter.
- [16] Yet an alternative way of producing metal fibers for the fiber based textile fabric is via extracting or extrusion from a melt.
- [17] Another alternative way of producing metal fibers is machining fibers from a solid block of metal.
- [18] As an alternative for or in combination with metal fibers, ceramic fibers can be used in the fiber based textile fabric.
- [19] Preferably, the annular porous section comprises or consists out of a second fiber based textile fabric and a second porous metal structure. The second fiber based textile fabric is positioned onto the second porous metal structure. The second fiber based textile fabric is provided for combustion of premix gas onto the second fiber based textile fabric after the premix gas has flown first through the second porous metal structure and then through the second fiber based textile fabric. Thus, the second fiber based textile fabric forms another burner deck of the burner. The annular porous section is provided for stabilization of the combustion on the surface of the burner as the annular porous section anchors the flames well onto the burner and effectively prevents flame lift off.
- More preferably, the second fiber based textile fabric is integrally part of the fiber based

textile fabric, e.g. as an annular rim to the part of the fiber based textile fabric shaped into conical shape. The second porous metal structure can be an integral part of the porous metal structure, but is preferably a separate part, e.g. comprising or consisting out of a perforated plate structure. Even more preferably, the porosity of the second porous metal structure – e.g. a perforated plate structure - is lower than the porosity of the porous metal structure. The porosity determines the rate of flow of premix gas: a lower porosity results in a lower flow rate (per unit of time and per unit of surface area) of premix gas.

[20] In a preferred embodiment, the burner comprises a main body, a gas mixing chamber delimited by the main body and by the external surface of the conical shape; and an entrance for introducing a premix of combustible gas and air into the gas mixing chamber. In a preferred embodiment, the main body is cylindrical in shape or comprises a segment which is cylindrical in shape.

[21] A third aspect of the invention is a premix gas combustion system comprising a combustion chamber having lateral walls; and a premix gas burner as in the first aspect of the invention. The premix gas burner is provided at a first longitudinal end of the combustion chamber. The second longitudinal end of the combustion chamber is closed by a wall. The combustion chamber is provided for combustion of the premix gas after the premix gas has flown from the gas mixing chamber through the composite porous substrate. An exit for combustion products is provided in the combustion chamber at the first longitudinal end of the combustion chamber.

[22] A fourth aspect of the invention is a heat cell comprising a premix gas burner as in any embodiment of the first aspect of the invention or comprising a premix gas combustion system as in the third aspect of the invention.

#### **Brief Description of Figures in the Drawings**

[23] Figure 1 shows a premix gas burner according to the invention.  
Figure 2 shows a cross section of the burner of figure 1.  
Figure 3 shows a premix gas combustion system comprising a premix gas burner according to the invention.

#### **Mode(s) for Carrying Out the Invention**

[24] Figure 1 shows an example of a premix gas burner 10 according to the invention. Figure 2 shows a cross section of the burner of figure 1 along plane II-II of figure 1. The premix gas burner 10 comprises a composite porous substrate 12. The composite porous substrate comprises a fiber based textile fabric 14 and a porous metal structure 16. In the example, the porous metal structure consists out of a woven wire mesh. The fiber based textile fabric is a weft knitted fabric knitted from yarns comprising heat resistant stainless steel fibers.

[25] The fiber based textile fabric 14 is provided onto and contacting the porous metal structure 16. The fiber based textile fabric is provided for combustion of premix gas onto the fiber based textile fabric after the premix gas has flown through the composite porous

substrate. The fiber based textile fabric is bonded onto the porous metal structure by means of spot welds 24.

[26] The composite porous substrate comprises a conical shape having a cone angle. The fiber based textile fabric 14 is located at the inside of the conical shape and the porous metal structure 16 is located at the outside of the conical shape. A rim 18 is provided along the length of the conical shape. The rim is provided by contact of the internal sides of the two end strips 20, 22 of the composite porous substrate shaped into conical shape. The rim comprises fiber based textile fabric and porous metal structure. In the rim the two end strips are bonded to each other by means of welds. The rim is directed to the outside of the conical shape.

[27] The fiber based textile fabric shaped into conical shape of the burner of the example comprises – although not essential for the invention - as an integral part of the fiber based textile fabric an annular rim 30 at the largest diameter of the cross section of the conical shape. The function of this annular rim will be explained when describing figure 3 which shows a premix gas combustion system comprising the premix gas burner of figure 1.

[28] The burner of figure 1 can be made in a simple and reliable way. A weft knitted fabric knitted from yarns comprising stainless steel fibers; and a woven wire mesh are provided. Both are cut to the required shape. The weft knitted fabric is spot welded at several positions over its surface to the woven wire mesh, thereby creating the composite substrate. Subsequently, the composite porous substrate is folded and shaped – with the weft knitted fabric to the inside – into conical shape and such that a rim is provided along the length of the conical shape. The rim is provided by contact of the internal sides of the two end strips of the composite porous substrate shaped into conical shape. The two end strips are bonded to each other in the rim by means of welding.

[29] Figure 3 shows a premix gas combustion system 40 comprising the premix gas burner 10 of figure 1, with the annular rim 30 of the fiber based textile fabric 14. The rim of the premix gas burner is not shown in figure 3. The composite porous substrate of the burner comprises a conical shape having a cone angle  $\alpha$ .

[30] The burner comprises an annular porous section 32. The annular porous section is connected to the conical shape at the cross section of the conical shape having the largest diameter. In the example, the annular porous section is flat. The annular porous section consists out of the annular rim 30 of the fiber based textile fabric positioned onto a perforated plate 34 having an annular shape. The porosity of the perforated plate 34 having an annular shape is lower than the porosity of the woven wire mesh. Therefore, when the premix gas burner is in use the flow rate (per unit of time and per unit of surface area) of premix gas will be higher through the woven wire mesh than through the perforated plate having an annular shape.

[31] The burner further comprises a cylindrical main body 42, a gas mixing chamber 44 delimited by the main body and by the external surface of the conical shape; and an

entrance 46 for introducing a premix of combustible gas and air into the gas mixing chamber.

[32] The premix gas combustion system 40 further comprises a combustion chamber 48 having lateral walls 50. The premix gas burner is provided at a first longitudinal end of the combustion chamber 48. The second longitudinal end of the combustion chamber is closed by a wall 52. The combustion chamber is provided for combustion (see flames 53) of the premix gas after the premix gas has flown from the gas mixing chamber through the composite porous substrate.

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[33] The annular rim 30 of the fiber based textile fabric is provided for combustion of premix gas onto it after the premix gas has flown first through the perforated plate having an annular shape and then through the second fiber based textile fabric. Thus, the annular rim forms another burner deck of the burner. The annular rims is specifically provided for stabilization of the flames on the burner.

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[34] The flow of the combustion products is represented by flow lines 54. An exit 56 for combustion products is provided in the combustion chamber at the first longitudinal end of the combustion chamber.

**Claims**

1. Premix gas burner,  
comprising a composite porous substrate;  
wherein the composite porous substrate comprises a fiber based textile fabric and a porous  
5 metal structure;  
wherein the fiber based textile fabric is provided onto and contacting the porous metal  
structure;  
wherein the fiber based textile fabric is provided for combustion of premix gas onto the fiber  
based textile fabric after the premix gas has flown through the composite porous substrate;  
10 wherein the composite porous substrate comprises a conical shape;  
wherein a rim is provided along the length of the conical shape, wherein the rim is provided by  
contact of the internal sides or of the external sides of the two end strips of the composite  
porous substrate shaped into conical shape; wherein the internal side of the composite porous  
substrate is the side internal to the conical shape;  
15 wherein the rim comprises fiber based textile fabric and porous metal structure;  
wherein the fiber based textile fabric is located at the inside of the conical shape;  
wherein the porous metal structure is located at the outside of the conical shape;  
wherein the rim is provided by contact of the internal sides of the two end strips of the  
composite porous substrate shaped into conical shape;  
20 and wherein the rim is directed to the outside of the conical shape;  
wherein the conical shape has a first cone angle;  
wherein the burner comprises an annular porous section;  
wherein the annular porous section is connected to the conical shape at the cross section of  
the conical shape having the largest diameter;  
25 and wherein the annular porous section is flat or wherein the annular porous section is frusto-  
conical with a cone angle larger than the first cone angle.
2. Burner as in claim 1, wherein in the rim the two end strips are bonded to each other, preferably  
by means of welds.
3. Burner as in any of the preceding claims, wherein the fiber based textile fabric is bonded by  
30 means of welds onto the porous metal structure.
4. Burner as in any of the preceding claims, wherein the porous metal structure comprises or  
consists out of a woven wire mesh, a perforated metal plate or an expanded metal mesh.
5. Burner as in any of the preceding claims, wherein the fiber based textile fabric comprises or  
consists out of a woven, knitted, braided or nonwoven fabric.
- 35 6. Burner as in any of the preceding claims,  
wherein the annular porous section comprises or consists out of a second fiber based textile  
fabric and a second porous metal structure, wherein the second fiber based textile fabric is  
positioned on the second porous metal structure;  
wherein the second fiber based textile fabric is provided for combustion of premix gas onto the

second fiber based textile fabric after the premix gas has flown first through the second porous metal structure and then through the second fiber based textile fabric.

7. Burner as in claim 6, wherein the second fiber based textile fabric is integrally part of the fiber based textile fabric.
- 5 8. Burner as in claim 6 or 7, wherein the porosity of the second porous metal structure is lower than the porosity of the porous metal structure.
9. Burner as in any of the preceding claims, comprising
- a main body;
  - a gas mixing chamber delimited by the main body and by the external surface of the conical shape; and
  - 10 - an entrance, for introducing a premix of combustible gas and air into the gas mixing chamber.
10. Premix gas combustion system, comprising
- a combustion chamber having lateral walls; and
  - a premix gas burner as in claim 9;
- 15 wherein the premix gas burner is provided at a first longitudinal end of the combustion chamber;
- wherein the second longitudinal end of the combustion chamber is closed by a wall;
- wherein the combustion chamber is provided for combustion of the premix gas after the premix gas has flown from the gas mixing chamber through the composite porous substrate; and
- 20 wherein an exit for combustion products is provided in the combustion chamber at the first longitudinal end of the combustion chamber.
11. Heat cell comprising a premix gas burner as in any of the preceding claims 1 – 9 or comprising a premix gas combustion system as in claim 10.
12. Method for manufacturing a premix gas burner as in any of the claims 1 – 9, comprising the
- 25 steps of
- providing a fiber based textile fabric and a porous metal structure;
  - attaching - preferably by means of welding - the fiber based textile fabric and the porous metal structure to each other, thereby creating a composite porous substrate;
  - folding the composite porous substrate such that the folded structure comprises a conical shape and such that a rim is provided along the length of the conical shape, wherein the rim is
  - 30 provided by contact of the internal sides or of the external sides of the two end strips of the composite porous substrate shaped into conical shape; wherein the internal side of the composite porous substrate is the side internal to the conical shape; and
  - bonding the two end strips in the rim to each other, preferably by means of welding.

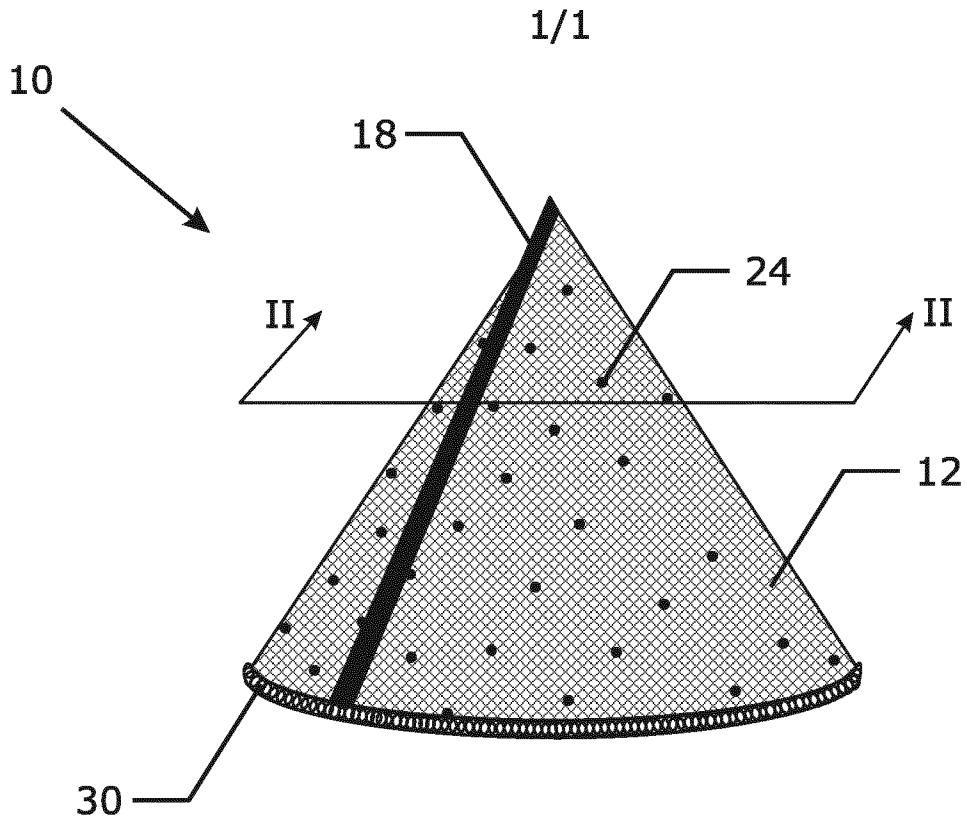


Fig. 1

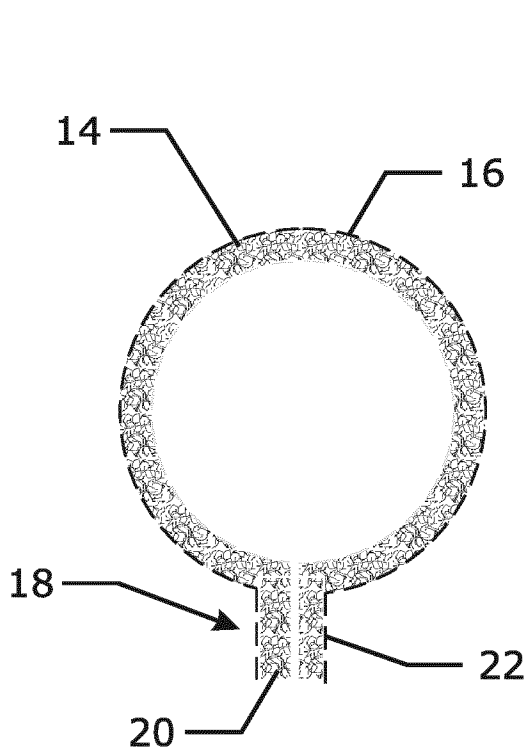


Fig. 2

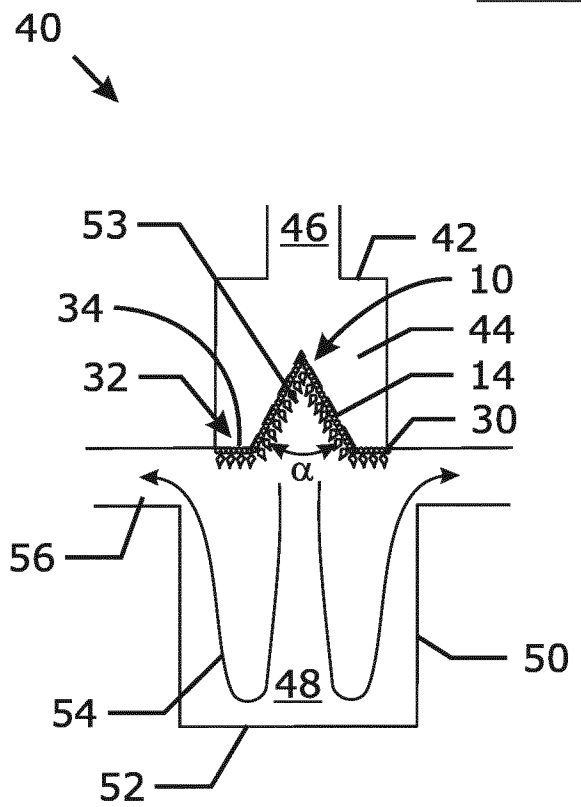


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2019/058350

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F23D14/14  
ADD.  
  
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)  
F23D

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.
Y	JP 3 098381 B2 (RINNAI KK; JAPAN CERAMICS KK) 16 October 2000 (2000-10-16) machine translation; paragraphs [0004], [0008], [0013] figure 3	1-12
Y	US 3 391 983 A (SHINICHI HARAZONO ET AL) 9 July 1968 (1968-07-09) column 6, line 16 - line 18 column 7, line 54 - column 8, line 28 figures 1-3	1-12
A	US 2003/005892 A1 (BAESE DAVID C [US] ET AL) 9 January 2003 (2003-01-09) page 5, paragraph 77 - page 6, paragraph 97 figure 6	1,10-12
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Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search  22 May 2019	Date of mailing of the international search report  31/05/2019
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Gavriliu, Costin
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/EP2019/058350

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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