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

(11) **EP 2 510 281 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
25.10.2017 Bulletin 2017/43

(21) Application number: **10782307.2**

(22) Date of filing: **26.11.2010**

(51) Int Cl.:
F23D 14/10 *(2006.01)*

(86) International application number:
PCT/EP2010/068284

(87) International publication number:
WO 2011/069839 (16.06.2011 Gazette 2011/24)

(54) BURNER WITH LOW POROSITY BURNER DECK

BRENNER MIT BRENNERDECK MIT GERINGER POROSITÄT

BRÛLEUR POURVU D'UNE PLATEFORME DE BRÛLEUR À FAIBLE POROSITÉ

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **11.12.2009 EP 09178982**

(43) Date of publication of application:
17.10.2012 Bulletin 2012/42

(60) Divisional application:
17191076.3

(73) Proprietors:
- **Bekaert Combustion Technology B.V.**
  9403 AR Assen (NL)
- **NV Bekaert SA**
  8550 Zwevegem (BE)

(72) Inventors:
- **TEN HOEVE, Dirk**
  NL-7961 LD Ruinerwold (NL)
- **LAMBERTS, Dinand**
  NL-9403 ZA Assen (NL)
- **HOGENBIRK, Camillo Marino Josef**
  NL-9403 JK Assen (NL)
- **DE JAGER, Bram**
  NL-9403 KJ Assen (NL)
- **VANOVERBERGHE, Koen**
  B-1700 Dilbeek (BE)
- **ZWIGGELAAR, Gertjan**
  NL-7913 TP Hollandscheveld (NL)

(74) Representative: **Messely, Marc**
NV Bekaert SA
IPD - PC6030
Bekaertstraat 2
8550 Zwevegem (BE)

(56) References cited:
WO-A1-95/23315
WO-A1-2009/065733
DE-A1-102008 000 010
FR-A1- 2 914 396
US-A1- 2004 132 607

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 510 281 B1

Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to a premix burner, more in particular a burner having a flameholder made of perforated metal plate material. Preferably, the burner is a tubular burner having a cylindrical shape. These burners are especially suitable for use in combustion boilers.

Background Art

[0002] One known type of premix burner consist of one or more of the following components: a) an end cap located at the top of the burner, b) a burner deck, the burner deck consists of a blind piece at the bottom, a perforated piece, with a regular (circular) pattern, with sometimes locally an additional modification for ignition purposes, in the centre part and a blind piece at the top. The pattern is mostly circumferential, and mostly repeating itself in height after a pitch of 1-10 mm; c) a distributor, having a blind piece at the bottom, a perforated part in the centre and a blind piece at the top; d) a distributor end cap; e) a flange; f) an anti noise tube which is a device located in or nearby the flange to adjust the pressure distribution. Such premix burners are described in e.g. EP 1337789, EP2037175, WO2009/077333, WO2009/065733, WO2009/059933. As can be seen in most of above referenced documents, these burners are provided with devices in the mixing chamber, such as e.g. an inner liner, also called distributor and/or anti-noise tube or other devices such as swirls or perforated disks in or nearby the flange. These devices are needed for stabilization of flames on these burners, which has an effect on noise and emissions. The need of using these devices implies a considerable complication for making the burner and for the assemblage and implies a considerable cost.

Disclosure of Invention

[0003] The object of the present invention is to obviate the drawbacks mentioned above.

[0004] An object of the present invention is to provide a premix burner which does not need such devices in the mixing chamber of the burner to obtain a good stability of the flames and to reduce or even eliminate noise problems.

[0005] A further object of the present invention is to provide a premix burner with a good stability over the full operating range of high to low CO_2, and for the full band of customary or natural gas qualities.

[0006] This full band of customary and natural gas qualities covers all gases selected from hydrocarbons such as methane, ethane, propane, butane, ethene, propene, butene, acetylene, and the like. In contrast with WO 95/23315, the present invention does not relate specifically to high reactive fuel gases, which are a mixture of hydrogen and customary fuel gases.

[0007] A further object of the present invention is to provide a premix burner producing low NOx levels.

[0008] An aspect of the claimed invention provides a gas burner as described in claim 1.

[0009] In a further aspect, the present invention provides a gas burner as described above wherein the burner further comprises an end cap connected to the perforated metal plate substantially opposite to said gas inlet port.

[0010] In a preferred aspect, the present invention provides a gas burner as described in paragraph 8, wherein the end cap is also provided with perforations. These perforations thereby enlarge and are part of the burner deck. In a preferred aspect, the end cap is made of metal plate material. In a further preferred aspect, the perforation patterns in the end cap and in the perforated metal plate are equal. In an alternative further aspect, the perforation patterns in the end cap and in the perforated metal plate are different. In a further preferred aspect, the perforations, such as e.g. slots and holes, in the end cap and in the perforated metal plate are equal. In an alternative further aspect, the perforations in the end cap and in the perforated metal plate are different.

[0011] Conventional premix burners have a porosity in the range of 14 to 18%. It was surprisingly found that lowering the porosity of the burner deck decreased acoustic time-lag of the flames formed on the burner deck, which enabled us to make a burner which did not need a diffuser anymore. It was also surprisingly found that this burner had an unstable burning when this burner was operated in open air, but when applied inside a heat exchanger, this burner had a stable flame and burning pattern. This burner also had a more stable response on the first Helmholtz resonance of the heat exchanger and its peripheral parts, which therefore made that the burner did not provoke low frequency thermo-acoustic instabilities, often referred to as humming. However, during start sequences under cold conditions with this burner build in, the boiler sometimes suffered a humming sound which sometimes makes the burner still needing an anti-noise device in its mixing chamber. The use of the anti-noise device in this burner also has a positive effect on the CO emission. Also it was found that lowering the porosity did not dampen thermo-acoustic instabilities with a higher frequency than the first Helmholtz resonance of the boiler, often referred to as whistling or howling. To cancel these frequencies, the anti-noise device was necessary again.

[0012] The burner of claim 1 has a burner deck wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein upto 50% of the burner deck has a porosity being higher than 11 % and with an overall porosity which is equal to or lower than 11 %. This modification of the perforation pattern of the burner deck provided a burner which, next to the effect of the deletion of the diffuser and the removal of the humming noise, also had a more stable response on the sec-

ond and higher Helmholtz or instable acoustic resonances of the heat exchanger, which therefore made that the boiler, with this build in burner did not provoke a whistling sound anymore. Next to that, during start sequences under cold conditions, the humming sound was eliminated and therefore the use of anti-noise devices in the mixing chamber of the burner could be omitted. Furthermore, this provided a stabilized deck over the full operating range of high to low CO_2, and for a broad range of gas qualities.

[0013] Another aspect of the claimed invention provides a gas burner as described in [0007], [0008], [0009] or [0011] wherein the burner deck has different patterns of perforations. Adding more patterns with different pitches showed an increased stability for a broader range of gas qualities and induced less NOx-emissions. In a preferred aspect, the burner is provided with an abrupt and stepwise variation of the perforation pattern in the burner deck.

[0014] In a preferred aspect, the present invention provides a burner with gradually increasing or decreasing perforation pattern or gradually increasing or decreasing pitches in between the perforation pattern of the burner deck. This grading can go in axial or circumferential direction. Gradually increasing or decreasing the perforation of the decks allows an almost step less variety of the perforation, and thus creating a varying perforation of the surface of the deck. In another preferred embodiment of the present invention, the burner has a completely random deck with no repeatability over the full height or circumference of the burner deck which provides a stabilized deck without the additional devices as mentioned above.

[0015] Most preferably, in order to improve flame stability, there is a decreased porosity when going downstream. In an embodiment, the part with a porosity higher than 11 % is closest to the gas inlet. The part with a porosity equal to or lower than 9% is most remote, i.e. downstream, from the gas inlet.

Definitions

[0016] The term "burner deck" is to be understood, in the light of this invention, to be that part of the burner where the totality of perforations are present. In case two or more distinct regions of perforations can be detected on the burner surface, the burner deck is defined as being the surface spanning of all regions with perforations.

[0017] The term "overall porosity of the burner deck" is to be understood, in the light of this invention, as ratio of the surface of the holes, slots or other openings divided by the surface of the burner over which the perforated part(s) is(are) located.

[0018] The term "perforation pattern" is to be understood, in the light of this invention, to be a recurring scheme of perforations.

Brief Description of Drawings

[0019]

- Figure 1 shows an example of a gas burner.
- Figures 2A and 2B show an example of a gas burner. Figure 2C shows an example perforation pattern according to an aspect of the present invention.
- Figure 3 shows an example embodiment according to an aspect of the present invention.
- Figure 4 shows an example embodiment according to the present invention.
- Figure 5 shows an example embodiment according to a further aspect of the present invention.
- Figure 6 shows an example embodiment according to a further aspect of the present invention.
- Figure 7 shows an example embodiment according to a further aspect of the present invention.
- Figure 8 shows an example embodiment according to a further aspect of the present invention.
- Figure 9 shows an example embodiment according to a further aspect of the present invention.
- Figure 10 shows a further example embodiment according to an aspect of the present invention.
- Figure 11 shows a further example embodiment according to an aspect of the present invention.

Reference numbers

[0020]

10	gas burner
12	support or flange
14	central gas inlet port
16	gas supply or mixing chamber
18	end cap
20	burner deck
22	perforated metal plate
24	perforation
30	perforation

Mode(s) for Carrying Out the Invention

[0021] Figure 1 shows a gas burner 10, preferably a premix burner, comprising a support or flange 12 which has a central gas inlet port 14 for supply of gas into a gas supply or mixing chamber 16. The gas supply chamber 16 is enclosed by a perforated metal plate 22. The perforated metal plate 22 is connected at the bottom to the support or flange 12 through a base section. The perforations 24 in the perforated metal plate 22 provide the burner deck 20. The burner deck 20 has an overall porosity which is equal to or lower than 11 %, preferably lower than 10%, even more preferably lower than 9%.

[0022] Figure 2A shows a perspective view of a burner. Figure 2B shows a cross sectional view taken along the line II-II' in Figure 2A. Figures 2A and 2B shows a gas burner 10, preferably a premix burner, comprising a sup-

port or flange 12 which has a central gas inlet port 14 for supply of gas into a gas supply or mixing chamber 16. The gas supply chamber 16 is enclosed by a perforated metal plate 22 and an end cap 18 substantially opposite to said gas inlet port 14. The perforations 24 in the perforated metal plate 22 provide the burner deck 20. The end cap 18 is connected to the top of the perforated metal plate 22 and the perforated metal plate 22 is connected at the bottom to the support or flange 18 through a base section. The burner deck 20 has an overall porosity which is equal to or lower than 11%, preferably lower than 10%, even more preferably lower than 9%. In an exemplary embodiment, a burner 10, with a perforation pattern as shown in figure 2C, has a length of 102,4mm and diameter of 70,4mm. The burner deck has a length of 81,2 mm and has a porosity of 7,7%. The perforation pattern in the perforated plate is a combination of slits and round holes. For a thickness of the perforated plate of 0,6 mm, the slits being 4,0x0,5mm, the holes having a diameter of 0,8mm. The perforations are grouped in a pattern of 4,8 mm and this pattern is repeated over the burner deck in an equal division. As explained above, this burner still needed an anti-noise device, but no pressure divider or distributor anymore.

[0023] An aspect of the present invention provides a burner 10 wherein the end cap 18 is also provided with perforations. Figure 3 shows an exemplary burner wherein the end cap is provided with perforations 30. The burner deck of this burner is as shown by reference number 20.

[0024] The present invention provides a burner 10 with a burner deck wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein 10 to 50% of the burner deck has a porosity being higher than 11 %. The burner deck has an overall porosity which is equal to or lower than 11%. In an exemplary embodiment, a burner 10 as shown in figure 4 has a length of 94,8mm and diameter of 70,4mm. The burner deck 20 has a length of 93,6mm. The perforation pattern in the perforated plate 22 is a combination of slits and round holes. The thickness of the perforated plate 22 is 0,6 mm, the slits being 4,0x0,5mm, the holes having a diameter of 0,8mm. The perforations are grouped in a pattern as shown in fig. 4, wherein the first 11,8mm of the burner deck length has a porosity of 15%, thereafter is a zone of 46,8mm of the burner deck length with a porosity of 7,3% and the last zone with a length of 5.8mm of the burner deck length having a porosity of 16,5%. This pattern is repeated over the burner deck on the circumference of the burner. This provides a burner deck which has an overall porosity of 9,8%. This modification of the perforation pattern of the burner deck provided a burner which, next to the effect of the deletion of the diffuser and the removal of the humming noise, also had a more stable response on the second and higher Helmholtz or instable acoustic resonances of the heat exchanger, which therefore made that the burner did not provoke a whistling sound anymore. Next to that, during start sequences under cold conditions, the humming sound was eliminated and therefore the use of anti-noise devices in the mixing chamber of the burner could be omitted. Furthermore, this provided a stabilized deck over the full operating range of high to low CO2's, and for a broad range of gas qualities. Furthermore, for this specific example of fig. 4, the use of the relatively high porosity at the beginning and end of the burner deck 20 provide an even more stable flame pattern of the burner.

[0025] An example embodiment according to a further aspect of the claimed invention provides a gas burner with a perforated metal plate 22 with a perforation pattern as shown in fig. 5. The shown perforation pattern is repeated over the circumference of the burner. Here the burner deck 20 has different patterns of perforations. Adding more patterns with different pitches showed an increased stability for a broader range of gas qualities and induced less NOx-emissions. The exemplary perforation pattern of fig. 5 is an abrupt and stepwise variation of the perforation pattern in the burner deck 20.

[0026] Figure 6 shows another example of a perforation pattern of burner deck 20 according to a preferred aspect of the present invention, wherein the porosity of the burner deck 20 decreases stepwise in downstream direction. The shown perforation pattern is repeated in the perforated metal plate 22 over the circumference of the burner.

[0027] Figure 7 shows an example of a perforation pattern of burner deck 20 according to a preferred aspect of the present invention, wherein the porosity is gradually increasing. This perforation pattern is repeated in the perforated metal plate 22 over the circumference of the burner.

[0028] Figure 8 shows an exemplary perforation pattern of the burner deck 20, which is repeated lengthwise over the perforated metal plate 22.

[0029] Figure 9 shows a further exemplary perforation pattern which is repeated on the circumference of a burner. The perforation pattern is such that no repeat of pattern is occurring along the length of the burner deck 20. An exemplary burner with a length of 91,2mm and diameter of 70,4mm. The burner deck has a length of 70,4mm. The perforation pattern in the perforated plate 22 is a combination of slits and round holes as shown in figure 9. For a thickness of the perforated plate 22 of 0,6 mm, the slits being 4,0x0,5mm, the holes having a diameter of 0,8mm, this burner deck has an overall porosity of 7.5%.

[0030] The person skilled in the art will acknowledge that any perforation pattern or set of perforation patterns can be repeated lengthwise or over the circumference to obtain the burner according to the present invention.

[0031] Another preferred embodiment of the present invention is shown in figure 10. The burner 10 made out of perforated metal plate 22 has a completely random perforated burner deck 20 with no repeatability over the full height or circumference of the burner deck which provides a stabilized deck without the additional devices as

mentioned above.

[0032] Figure 11 shows another exemplary embodiment of the present invention. This burner has a perforated end cap 24 with different perforation pattern than the perforated metal plate 22. The perforations 30 together with the perforations 24 provide the burner deck 20.

Claims

1. A gas burner (10), preferably a premix burner, comprising a support (12) having a central gas inlet port (14) for supply of gas into a gas supply chamber (16), said gas supply chamber (16) being enclosed by a cylindrical perforated metal plate (22), said cylindrical perforated metal plate (22) connected at the bottom to said support (12) through a base section, said perforation (24) in said cylindrical perforated metal plate (22) providing a burner deck (20), **characterised in that** said burner deck (20) has an overall porosity being equal to or lower than 11 %;
wherein more than 50% of the burner deck has a porosity being equal to or lower than 9% and wherein up to 50% of the burner deck has a porosity being higher than 11%.

2. A gas burner (10), as in claim 1, said burner further comprising an end cap (18) substantially opposite to said gas inlet port (14), said end cap (18) being connected to said perforated metal plate (22).

3. A gas burner as in claim 2, wherein said end cap (18) is also provided with perforations (30), said perforations (30) thereby enlarging said burner deck (20).

4. A gas burner as in any of the previous claims, wherein said burner deck has different patterns of perforations.

5. Gas burner as in claim 4, wherein said burner deck has at least two different patterns of perforations.

6. Gas burner as in claim 4, wherein said burner deck has a gradually changing porosity.

7. Gas burner as in claim 4, wherein said burner deck (20) has a substantially completely random porosity.

8. Gas burner as in any of the preceding claims, wherein said gas burner is devoid of a gas diffuser between the gas inlet port (14) and the perforated metal plate (22).

9. Use of the gas burner as in any of the preceding claims, in a heat exchanger.

10. Use of the gas burner as in any of the claims 1 to 8, in a furnace or air heater.

Patentansprüche

1. Gasbrenner (10), vorzugsweise Vormischgasbrenner, der einen Träger (12) umfasst, der einen mittigen Gaseinlassanschluss (14) besitzt, um einer Gaszufuhrkammer (16) Gas zuzuführen, wobei die Gaszufuhrkammer (16) von einer zylindrischen, gelochten Metallplatte (22) umschlossen ist, wobei die zylindrische, gelochte Metallplatte (22) an der Unterseite mit dem Träger (12) über einen Basisabschnitt verbunden ist, wobei die Lochung (24) in der zylindrischen, gelochten Metallplatte (22) eine Brennerabdeckung (20) bereitstellt, **dadurch gekennzeichnet, dass** die Brennerabdeckung (20) eine Gesamtporosität besitzt, die gleich oder niedriger als 11 % ist;
wobei mehr als 50 % der Brennerabdeckung eine Porosität besitzt, die gleich oder niedriger als 9 % ist, und
wobei bis zu 50 % der Brennerabdeckung eine Porosität besitzt, die höher als 11 % ist.

2. Gasbrenner (10) nach Anspruch 1, wobei der Brenner ferner eine Stirnkappe (18) besitzt, die sich im Wesentlichen gegenüber dem Gaseinlassanschluss (14) befindet, wobei die Stirnkappe (18) mit der gelochten Metallplatte (22) verbunden ist.

3. Gasbrenner nach Anspruch 2, wobei die Stirnkappe (18) ebenfalls mit Lochungen (30) versehen ist, wobei die Lochungen (30) die Brennerabdeckung (20) vergrößern.

4. Gasbrenner nach einem der vorhergehenden Ansprüche, wobei die Brennerabdeckung unterschiedliche Lochmuster besitzt.

5. Gasbrenner nach Anspruch 4, wobei die Brennerabdeckung wenigstens zwei unterschiedliche Lochmuster besitzt.

6. Gasbrenner nach Anspruch 4, wobei die Brennerabdeckung eine sich allmählich ändernde Porosität besitzt.

7. Gasbrenner nach Anspruch 4, wobei die Brennerabdeckung (20) eine im Wesentlichen vollkommen zufällige Porosität besitzt.

8. Gasbrenner nach einem der vorhergehenden Ansprüche, wobei der Gasbrenner zwischen den Gaseinlassanschluss (14) und der gelochten Metallplatte (22) keinen Gasdiffusor besitzt.

9. Verwendung des Gasbrenners nach einem der vor-

hergehenden Ansprüche in einem Wärmetauscher.

10. Verwendung des Gasbrenners nach einem der Ansprüche 1 bis 8 in einem Ofen oder einer Luftheizeinrichtung.

Revendications

1. Brûleur (10) à gaz, de préférence brûleur à pré-mélange, comprenant un support (12) doté d'un orifice central (14) d'entrée de gaz délivrant du gaz dans une chambre (16) d'alimentation en gaz,
ladite chambre (16) d'alimentation en gaz étant enfermée dans une plaque métallique perforée (22) de forme cylindrique,
ladite plaque métallique perforée (22) de forme cylindrique étant raccordée à sa base audit support (12) par une section de base,
ladite perforation (24) ménagée dans ladite plaque métallique perforée (22) de forme cylindrique formant un plafond (20) de brûleur,
caractérisé en ce que
ledit plafond (20) du brûleur présente une porosité globale égale ou inférieure à 11 %,
en ce que plus de 50 % du plafond de brûleur présentent une porosité égale ou inférieure à 9 % et
en ce qu'au plus 50 % du plafond de brûleur présentent une porosité supérieure à 11 %.

2. Brûleur à gaz selon la revendication 1, ledit brûleur comprenant en outre un capuchon d'extrémité (18) situé essentiellement face audit orifice (14) d'entrée de gaz, ledit capuchon d'extrémité (18) étant raccordé à ladite plaque métallique perforée (22).

3. Brûleur à gaz selon la revendication 2, dans lequel ledit capuchon d'extrémité (18) est également doté de perforations (30), lesdites perforations (30) agrandissant ledit plafond (20) de brûleur.

4. Brûleur à gaz selon l'une quelconque des revendications précédentes, dans lequel ledit plafond de brûleur présente différents motifs de perforations.

5. Brûleur à gaz selon la revendication 4, dans lequel ledit plafond de brûleur présente au moins deux motifs de perforations différents.

6. Brûleur à gaz selon la revendication 4, dans lequel ledit plafond de brûleur présente une porosité qui varie progressivement.

7. Brûleur à gaz selon la revendication 4, dans lequel ledit plafond (20) de brûleur présente une porosité essentiellement entièrement aléatoire.

8. Brûleur à gaz selon l'une quelconque des revendications précédentes, dans lequel ledit brûleur à gaz ne présente pas de diffuseur de gaz entre l'orifice (14) d'entrée de gaz et la plaque métallique perforée (22).

9. Utilisation de brûleur à gaz selon l'une quelconque des revendications précédentes dans un échangeur de chaleur.

10. Utilisation de brûleur à gaz selon l'une quelconque des revendications 1 à 8 dans un four ou un réchauffeur d'air.

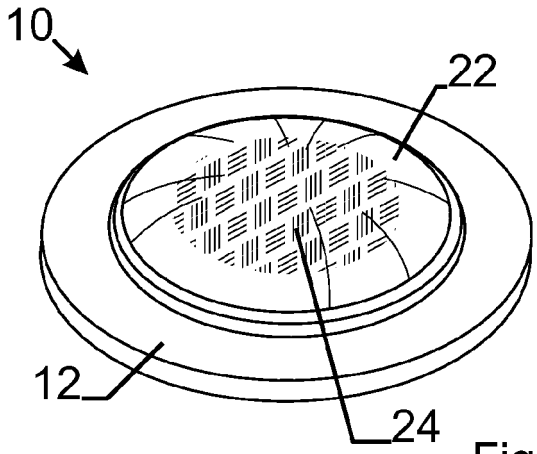


Fig. 1

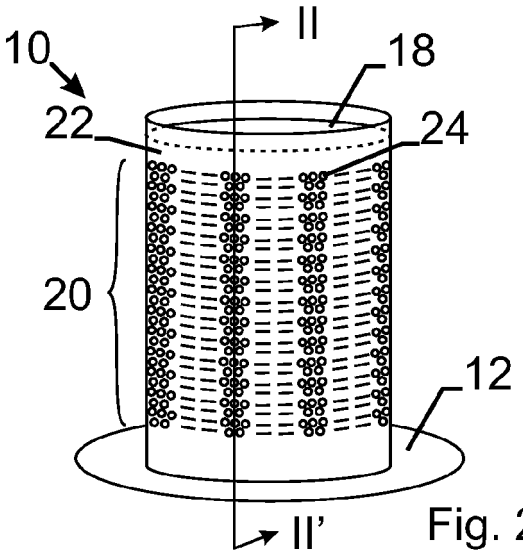


Fig. 2a

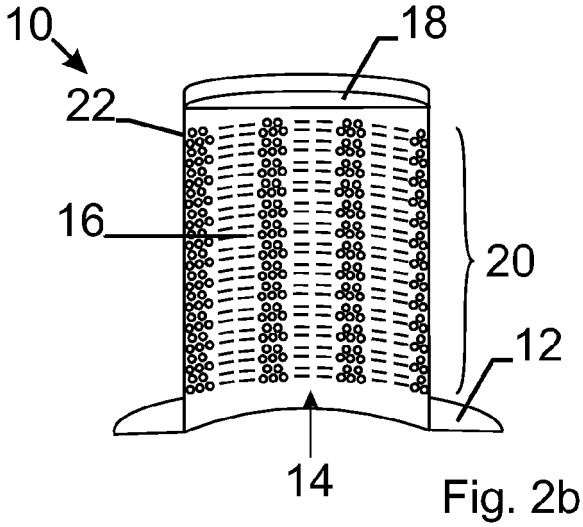


Fig. 2b

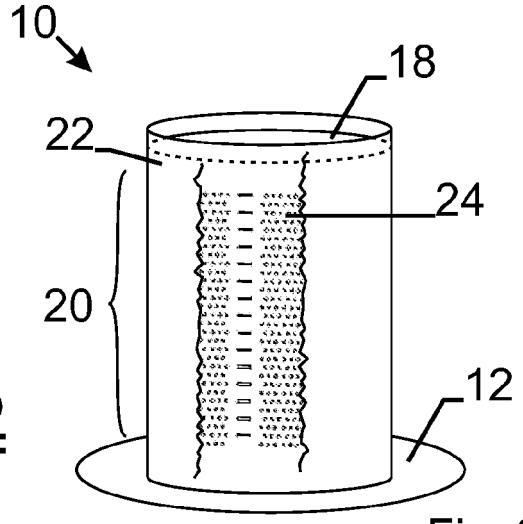


Fig. 2c

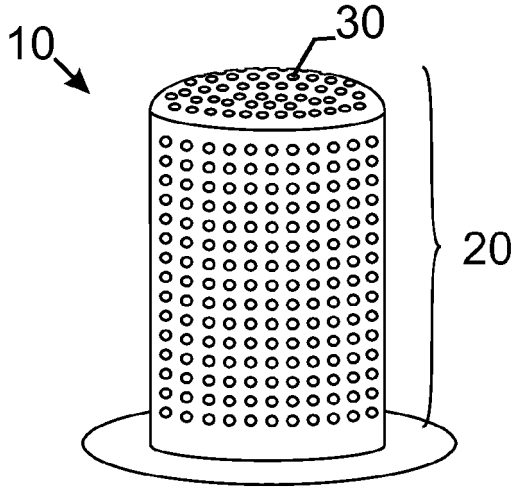


Fig. 3

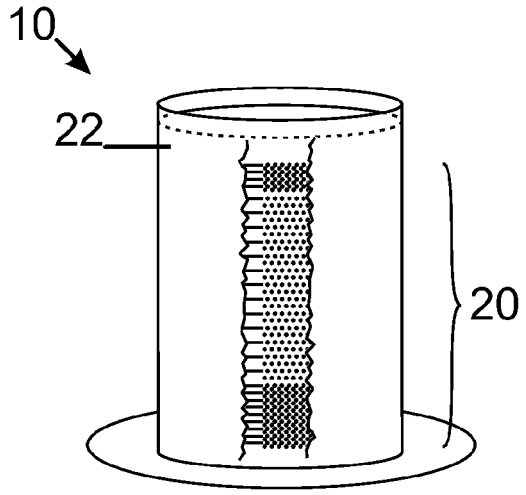


Fig. 4

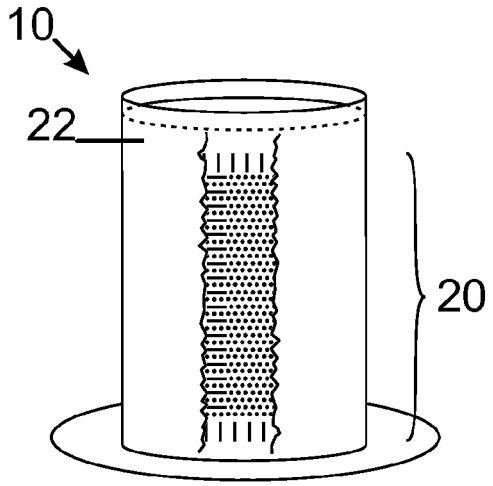


Fig. 5

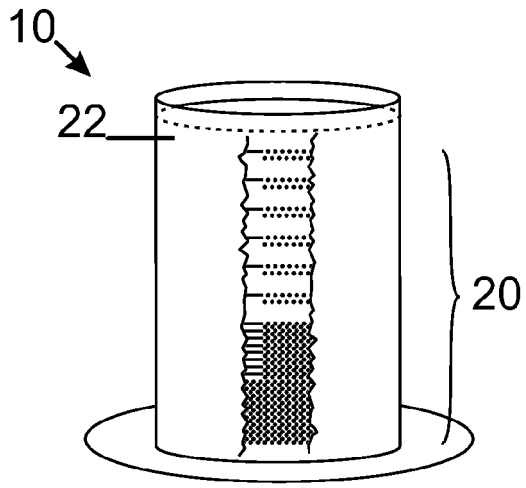


Fig. 6

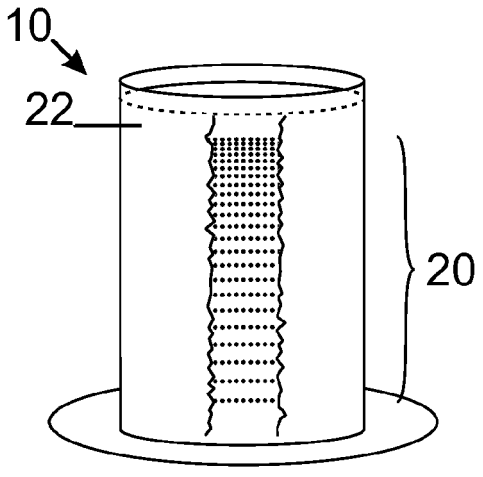


Fig. 7

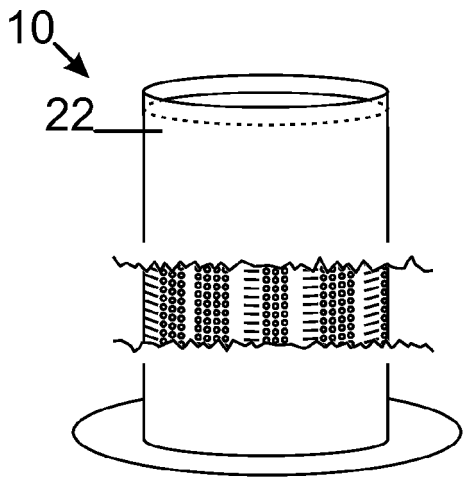


Fig. 8

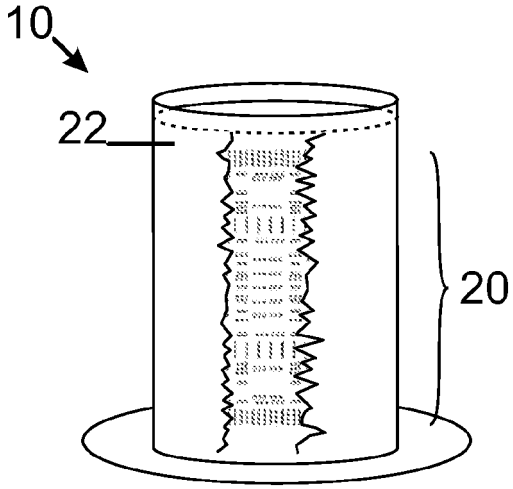


Fig. 9

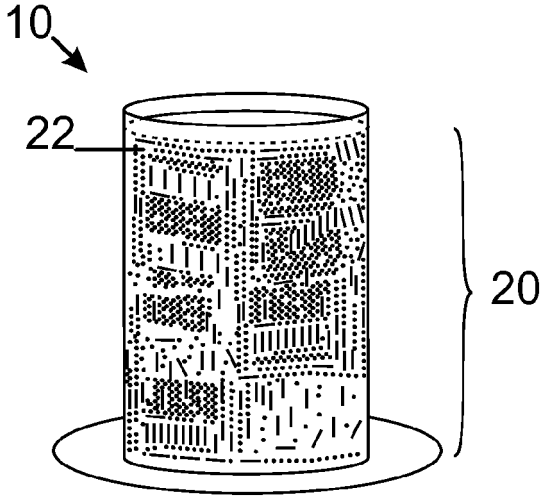


Fig. 10

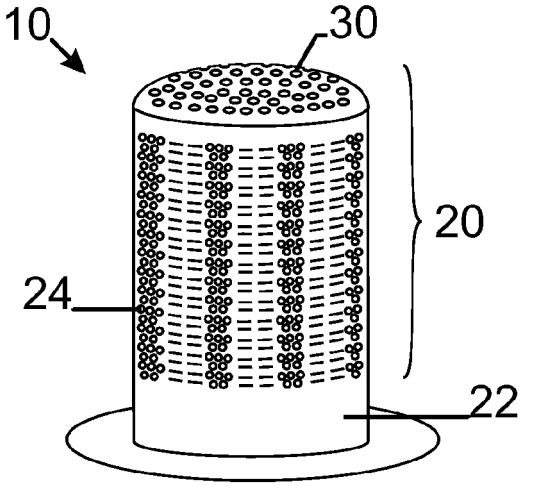


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1337789 A **[0002]**
- EP 2037175 A **[0002]**
- WO 2009077333 A **[0002]**
- WO 2009065733 A **[0002]**
- WO 2009059933 A **[0002]**
- WO 9523315 A **[0006]**