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(71) Applicants:
- **Edilkamin S.p.A.**
  20123 Milano (IT)
- **Università Degli Studi Di Padova**
  35122 Padova (IT)

(72) Inventors:
- **MEZZALIRA, Claudio**
  31030 ALTIVOLE TV (IT)
- **CANU, Paolo**
  35131 PADOVA (IT)
- **PERUZZI, Francesco**
  35100 PADOVA (IT)
- **FABRO, Jessica**
  33036 MERETO DI TOMBA UD (IT)

(74) Representative: **Modiano, Micaela Nadia et al**
Modiano & Partners
Via Meravigli, 16
20123 Milano (IT)

(54) **SOLID FUEL STOVE**

(57) A solid fuel stove which comprises an outer enclosure (2), which defines internally a combustion chamber (3) which is provided, on the bottom, with a hearth (4), for placing the solid fuel, and, in an upper region, with an outlet (5) for the exhaust gases; at least one catalyst is arranged in the combustion chamber (3) and is adapted to facilitate an oxidation reaction of particulate precursors.

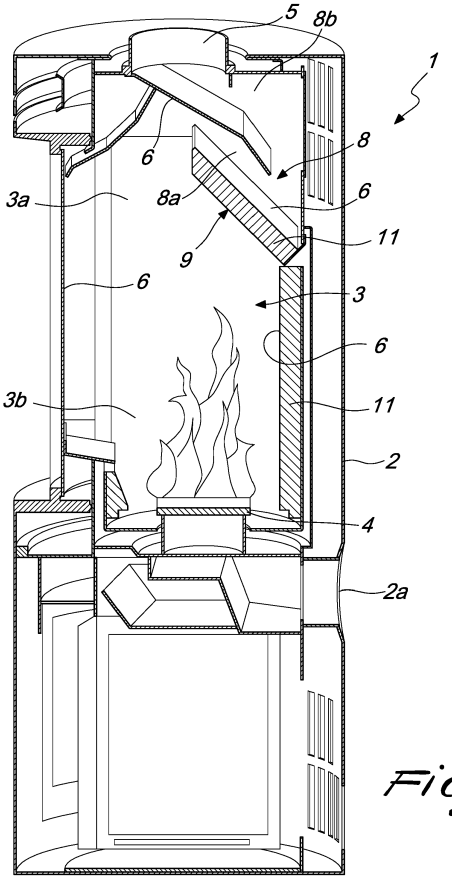

Fig. 1

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Description

[0001] The present invention relates to a solid fuel stove.

[0002] Solid fuel stoves are known which comprise an outer enclosure, which defines internally a combustion chamber or furnace, which has a lateral access opening that can be closed by way of a door, and is provided, in the lower part, with a hearth for placing the solid fuel, such as wood or pellets, which is subjected to combustion for the development of heat.

[0003] Furthermore, an inlet, for the entry of combustion air, is defined in the outer enclosure while the combustion chamber is connected to an outlet, for the exit of combustion gases, which is also defined in the outer enclosure and is connected to an exhaust pipe or flue that conveys the exhaust gases to the outside environment.

[0004] As is known, the combustion of wood develops, in addition to gases, such as carbon dioxide, carbon monoxide, NOx and OGC, carbonaceous dust or particulate and polycyclic aromatic hydrocarbons (PAHs).

[0005] The dust is constituted by various different chemical compounds, among which there is also a carbonaceous fraction constituted by organic carbon (OC), which is toxic, and by elementary carbon (EC), which is a climate-altering substance.

[0006] The quantity of pollutant emissions emitted by stoves depends on the quality of the combustion, which is difficult to control in current stoves as a result of several factors, such as, for example, the quality of the wood, the frequency of loading the fuel into the stove, the draw of the barrel of the flue, the operating temperatures of the stove and so on.

[0007] In pellet-fired stoves, in order to seek to reduce the negative impact of such factors, an electronic regulation system has been introduced which, by way of measuring the temperature of the exhaust gases and controlling the fan that regulates the flow-rate of the combustion air and of the device for feeding the fuel which automatically loads the pellets into the combustion chamber, allows to automatically compensate for any construction defects in the stoves that are capable of negatively influencing the quality of combustion of the pellets.

[0008] However, such electronic regulation systems have limitations on their intervention, such that they are often ineffective.

[0009] In wood-fired stoves, the possibility of conducting control by way of electronic systems is difficult in that these are usually lacking active components, such as fans or devices for feeding the fuel.

[0010] However, the more sophisticated wood-fired stoves of the latest generation are fitted with a system for controlling the incoming air which, as a function of the temperature of the exhaust gases, allows more or less combustion air into the combustion chamber.

[0011] In order to be able to abate the dust and the pollutant gases, such as CO, NOx and OGC, that are emitted by stoves, the practice has been introduced of using noble metal catalysts, derived from the automotive sector.

[0012] To increase the contact surface between the catalyst and the mass of exhaust gases, the catalysts are provided in alveolar form and, more specifically, they are generally constituted by an alveolar support made of ceramic, so that it can be easily made by molding, and on which a covering of noble metals is subsequently applied. The alveolar support has a plurality of passages for the exhaust gases, which can be of different sizes, according to requirements.

[0013] Since the alveolar catalysts described above, in order to be able to correctly carry out their function, need to be able to work in a region of the stove where the temperature is high but not excessively high, in order not to compromise the integrity of their alveolar support and the catalytic activity of the catalyst, they are traditionally positioned outside the combustion chamber and, more precisely, they are arranged in the first portion of the exhaust pipe so as to provide a filter for the exhaust gases that transit through the exhaust pipe.

[0014] A problem that was immediately encountered following the introduction of these catalysts in wood-fired stoves is constituted by the fact that, since the stoves generally lack forced exhaust gas evacuation systems and typically operate on the free discharge principle, i.e. with natural draft, the filter provided by the catalyst constitutes an obstacle to the discharge of the exhaust gases.

[0015] To solve this problem, stoves have been fitted with pipes that bypass the catalyst, but which have to be opened manually when lighting the stove, i.e. just when the stove emits more dust and pollutant substances.

[0016] Another problem that has been found over time is that the dust clogs up the filter, making the stove unusable.

[0017] These problems have led to a progressive reduction in the use of the solution with alveolar catalysts.

[0018] Other solutions exist using electrostatic filters, in which a bar of preset length is positioned in contact with the exhaust gases and is electrostatically charged, so as to attract the dust contained in the exhaust gases proper by electrostatic force.

[0019] Since, in order to be able to work correctly, such bar needs to be positioned very far from the combustion chamber, because the speed of the exhaust gases that brush against it must be very low in order to allow it to correctly attract the dust, it is usually placed inside the chimney stack on the roof of the building to which the exhaust pipe of the stove is connected.

[0020] A drawback, therefore, of this solution is due to the fact that, once a season, a specialist technician has to climb onto the roof of the building to clean the bar.

[0021] Furthermore, this solution, in addition to being very expensive, requires a flow of electric current for its operation, which entails a fire risk.

[0022] The aim of the present invention is to provide a solid fuel stove which is capable of improving the known

art in one or more of the above mentioned aspects.

[0023] Within this aim, an object of the invention is to provide a solid fuel stove that is capable of abating emissions of dust without resorting to complicated electronic systems or to expensive electrically-powered devices.

[0024] Another object of the invention is to provide a solid fuel stove that is not easily subject to clogging or obstruction of the exhaust outlet.

[0025] Another object of the present invention is to provide a stove that, owing to its peculiar implementation characteristics, is capable of offering the widest guarantees of reliability and safety in use.

[0026] Furthermore, another object of the present invention is to overcome the drawbacks of the known art in an alternative manner to any existing solutions.

[0027] Another object of the invention is to provide a solid fuel stove that is simple in terms of construction so as to be competitive from a purely economic viewpoint as well.

[0028] This aim and these and other objects which will become better apparent hereinafter are achieved by a solid fuel stove according to claim 1, optionally provided with one or more of the characteristics of the dependent claims.

[0029] Further characteristics and advantages of the invention will become better apparent from the description of some preferred, but not exclusive, embodiments of the stove according to the invention, which are illustrated for the purposes of non-limiting example in the accompanying drawings wherein:

Figure 1 is a schematic cross-sectional view of a stove according to the invention;
Figure 2 is a cross-sectional view of a part of the stove according to the invention;
Figure 3 is a schematic view of an enlarged-scale portion of Figure 2;
Figure 4 is a schematic view of another enlarged portion of Figure 2;
Figures 5 and 6 are views similar to Figures 3 and 4 of other embodiments of the invention.

[0030] With reference to the figures, the solid fuel stove according to the invention, generally designated by the reference numeral 1, comprises an outer enclosure 2 which defines internally a combustion chamber 3, which has, on the bottom, a hearth 4, on which is placed the solid fuel to be burned, such as, in particular, wood, so as to produce a flame inside the combustion chamber 3.

[0031] In an upper region, the combustion chamber 3 is provided with an outlet 5 for the exhaust gases, which is, conveniently, connected to an exhaust pipe, not shown, which is connected to the chimney in order to convey the combustion gases to the outside environment.

[0032] In practice, the combustion chamber 3 can be ideally divided into a lower portion 3a in which the flame develops and an upper portion 3b for conveying the exhaust gases, which is connected to the outlet 5.

[0033] Conveniently, in the lower part of the outer enclosure 2, preferably below the hearth 4, at least one inlet 2a for the combustion air is defined.

[0034] At least one catalyst is arranged in the combustion chamber 3 and is adapted to facilitate an oxidation reaction of particulate precursors.

[0035] More specifically, such catalyst favors the completion of the oxidation reaction of the intermediate products of the combustion of the wood which potentially constitute the solid particulate precursors that emanate from the stove, so as to reduce the formation of fine particles and, more generally, pollutant emissions, both gaseous and particulate, of the stove proper.

[0036] The precursors that the catalyst helps to oxidize include carbon monoxide and unburned materials, such as, for example, volatile unsaturated and aromatic hydrocarbons.

[0037] Preferably, the catalyst used is chosen from the group that comprises transition metal oxides, post-transition metal oxides, rare earths, and mixtures thereof, which are chemically stable at high temperature.

[0038] Advantageously, the catalyst is applied on one or more inner surfaces 6 of the combustion chamber 3.

[0039] In particular, the inner surfaces of the combustion chamber 3 on which the catalyst is applied can, conveniently, comprise at least one of the walls for the lateral delimitation of the combustion chamber 3.

[0040] Advantageously, the inner surfaces 6 with the catalyst applied can be located in the upper portion 3a of the combustion chamber 3, so that the catalyst can come into contact with the hotter gases, and, according to an embodiment, these surfaces can define a convoluted path 8 for the combustion gases, which is interposed between the hearth 4 and the outlet 5.

[0041] Conveniently, such convoluted path 8 has a first portion 8a which extends downward and which is delimited above and below by inner surfaces 6 with the catalyst applied, and is followed by a second portion 8b which extends upward and ends substantially at the outlet 5 of the combustion chamber 3.

[0042] Advantageously, at least one inner surface 6 with the catalyst applied can provide a firewall 9 arranged in an upward region facing the hearth 4, so as to provide a greater catalyzing surface in contact with the hot combustion gases.

[0043] It should be noted that the inner surfaces 6 of the combustion chamber 3 on which the catalyst is applied can be made of metallic material and, in such case, they are constituted by at least one face of a metallic sheet 10 or, alternatively, they can be made of refractory material and, in such case, they can be constituted by at least one face of a panel 11 of refractory material, such as for example vermiculite or the like.

[0044] Conveniently, as in the example shown, a panel 11 of refractory material with the catalyst applied on one or both of its faces can be fitted in the combustion chamber 3 so as to provide, with one face of the panel 11, the

firewall 9 and, with its opposite face, a wall of the convoluted path 8.

[0045] Advantageously, the catalyst is in granular or powder form and is applied to the inner surfaces 6 of the combustion chamber 3 by way of the interposition of at least one layer of binder material 12, which can be, conveniently, provided by at least one coat of paint.

[0046] For example, in order to provide the layer of binder material 12 a paint can be used chosen from the group that comprises high-solid silicone paints.

[0047] According to an embodiment, the catalyst is perfused, for example by way of blow molding, spraying or the like, onto the layer of binder material 12. More specifically, the particles of catalyst, indicated in the figures with the reference numeral 13, can, in essence, be distributed by spraying on a still-fresh coat of paint, applied on an inner surface 6 of the combustion chamber 3, so that the particles 13 of catalyst can adhere stably to the inner surface 6, once the coat of paint has dried, gripping the inner surface 6 of the combustion chamber 3.

[0048] According to a different embodiment, the catalyst is embedded in the layer of binder material 12. In such case, the particles 13 of catalyst can first be mixed with a paint, which provides the binder material, and subsequently applied, together with the paint, on an inner surface 6 of the combustion chamber 3, so that, after the paint has dried, it adheres to such surface.

[0049] According to an additional embodiment, it is likewise possible to incorporate the particles of catalyst 13 in a refractory material with which one or more inner surfaces 6 of the combustion chamber 3 can be made. In such case, the particles of catalyst 13 can be added to the mixture of the refractory material in order to obtain panels 11 in which the catalyst is dispersed.

[0050] Operation of the stove according to the invention is the following.

[0051] The combustion of the wood placed on the hearth 4 of the combustion chamber produces exhaust gases that are channeled in the convoluted path 8 until they reach the outlet 5, flowing over the inner surfaces 6 of the combustion chamber 3 on which the catalyst is applied.

[0052] The catalyst-favored oxidation reactions of the particulate precursors will be extremely fast by virtue of the high temperatures to which the catalyst is exposed in the combustion chamber 3.

[0053] The chemical compounds to be oxidized can reach the inner surfaces 6 with the catalyst applied thereto by virtue of flows produced by gradients of concentration in zones where the exhaust gases tend to stagnate, such as for example proximate to spaces characterized by acute corners and by way of mixing the exhaust gases in sections where their motion is turbulent.

[0054] In practice it has been found that the invention fully achieves the intended aim and objects by providing a solid fuel stove which by virtue of the presence of the catalyst in the combustion chamber allows to reduce the formation of particulates in the exiting exhaust gases.

[0055] Another advantage of the invention is that it ensures, with respect to the known art, a more efficacious catalytic action, in that the catalyst, being positioned in the combustion chamber, is capable of operating at high temperatures, in particular above 400°C.

[0056] Furthermore, the positioning of the catalyst in the combustion chamber allows not to interfere with an optimal draw of the stove.

[0057] It has likewise been found that the action of the catalyst in the stove according to the invention is effective even in the presence of high humidity, as in the case of using wood that has not been adequately dried.

[0058] All the characteristics of the invention, indicated above as advantageous, convenient or similar, may also be missing or be substituted by equivalent characteristics.

[0059] The invention, thus conceived, is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims. Moreover, all the details may be substituted by other, technically equivalent elements.

[0060] In practice the materials employed, provided they are compatible with the specific use, and the contingent dimensions and shapes, may be any according to requirements and to the state of the art.

[0061] The disclosures in Italian Patent Application No. 102017000114081 from which this application claims priority are incorporated herein by reference.

[0062] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A solid fuel stove comprising an outer enclosure (2) which defines internally a combustion chamber (3) which is provided, on the bottom, with a hearth (4), for placing the solid fuel, and, in an upper region, with an outlet (5) for the exhaust gases, **characterized in that** it comprises at least one catalyst arranged in said combustion chamber (3) and adapted to facilitate an oxidation reaction of particulate precursors.

2. The stove according to claim 1, **characterized in that** said catalyst is applied on at least one inner surface (6) of said combustion chamber (3).

3. The stove according to one or more of the preceding claims, **characterized in that** said at least one inner surface (6) comprises at least one wall for the lateral delimitation of said combustion chamber (3).

4. The stove according to one or more of the preceding claims, **characterized in that** said at least one inner surface (6) defines a convoluted path (8) for the exhaust gases which is interposed between said hearth (4) and said outlet (5).

5. The stove according to one or more of the preceding claims, **characterized in that** said at least one inner surface (6) comprises a firewall (9) which in an upper region faces said hearth (4).

6. The stove according to one or more of the preceding claims, **characterized in that** said catalyst is in granular or powder form and is applied to said at least one inner surface (6) by way of the interposition of at least one layer of binder material (12).

7. The stove according to one or more of the preceding claims, **characterized in that** said at least one layer of binder material (12) comprises at least one coat of paint.

8. The stove according to one or more of the preceding claims, **characterized in that** said catalyst is perfused on said layer of binder material (12).

9. The stove according to one or more of the preceding claims, **characterized in that** said catalyst is at least partially embedded in said layer of binder material (12).

10. The stove according to one or more of the preceding claims, **characterized in that** said at least one inner surface (6) is made of metallic material.

11. The stove according to one or more of the preceding claims, **characterized in that** said at least one inner surface (6) is made of refractory material.

12. The stove according to one or more of the preceding claims, **characterized in that** said catalyst is incorporated in said refractory material.

13. The stove according to one or more of the preceding claims, **characterized in that** said catalyst is chosen from the group that comprises transition metal oxides, post-transition metal oxides, rare earths, and mixtures thereof.

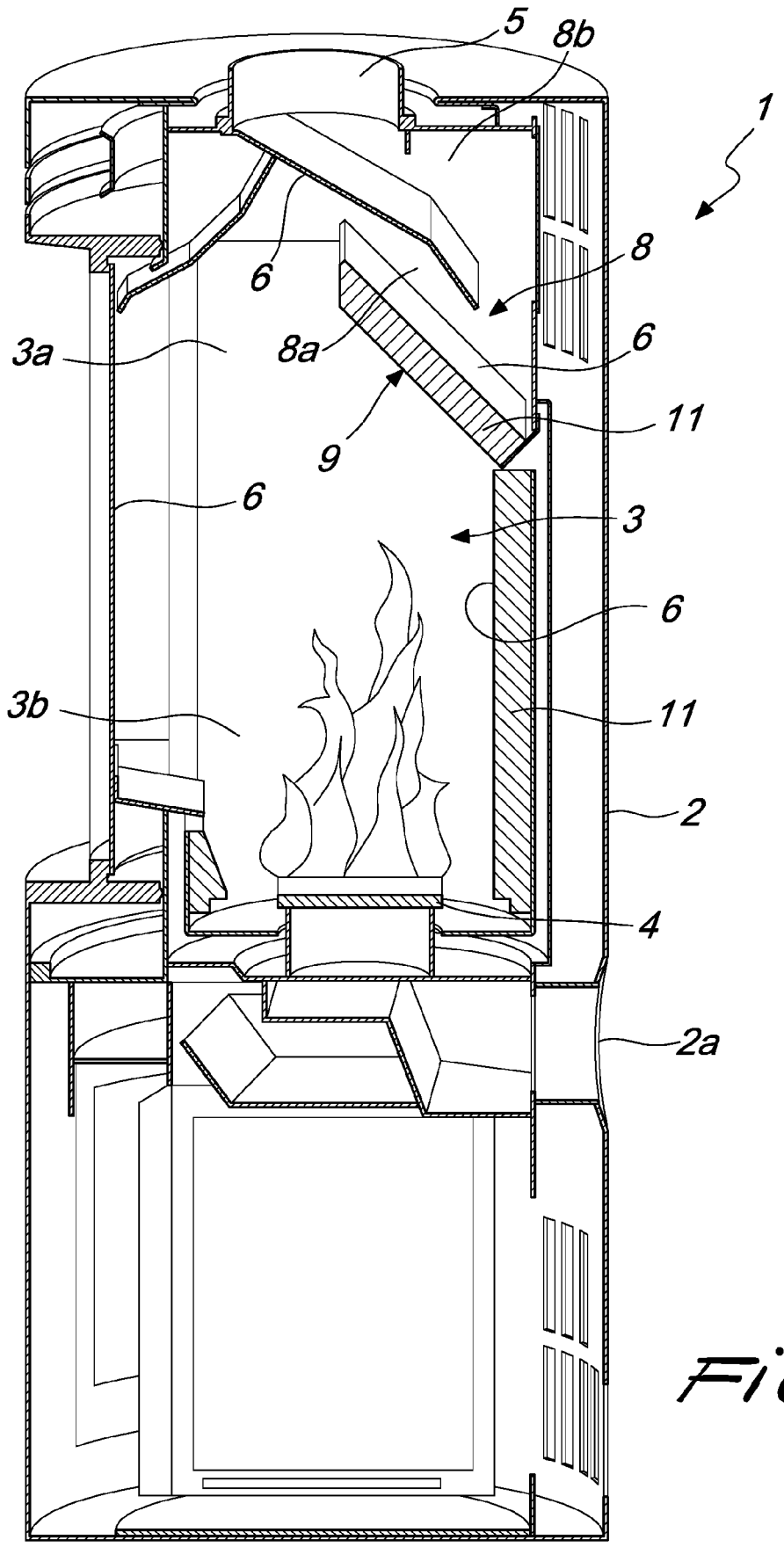

Fig. 1

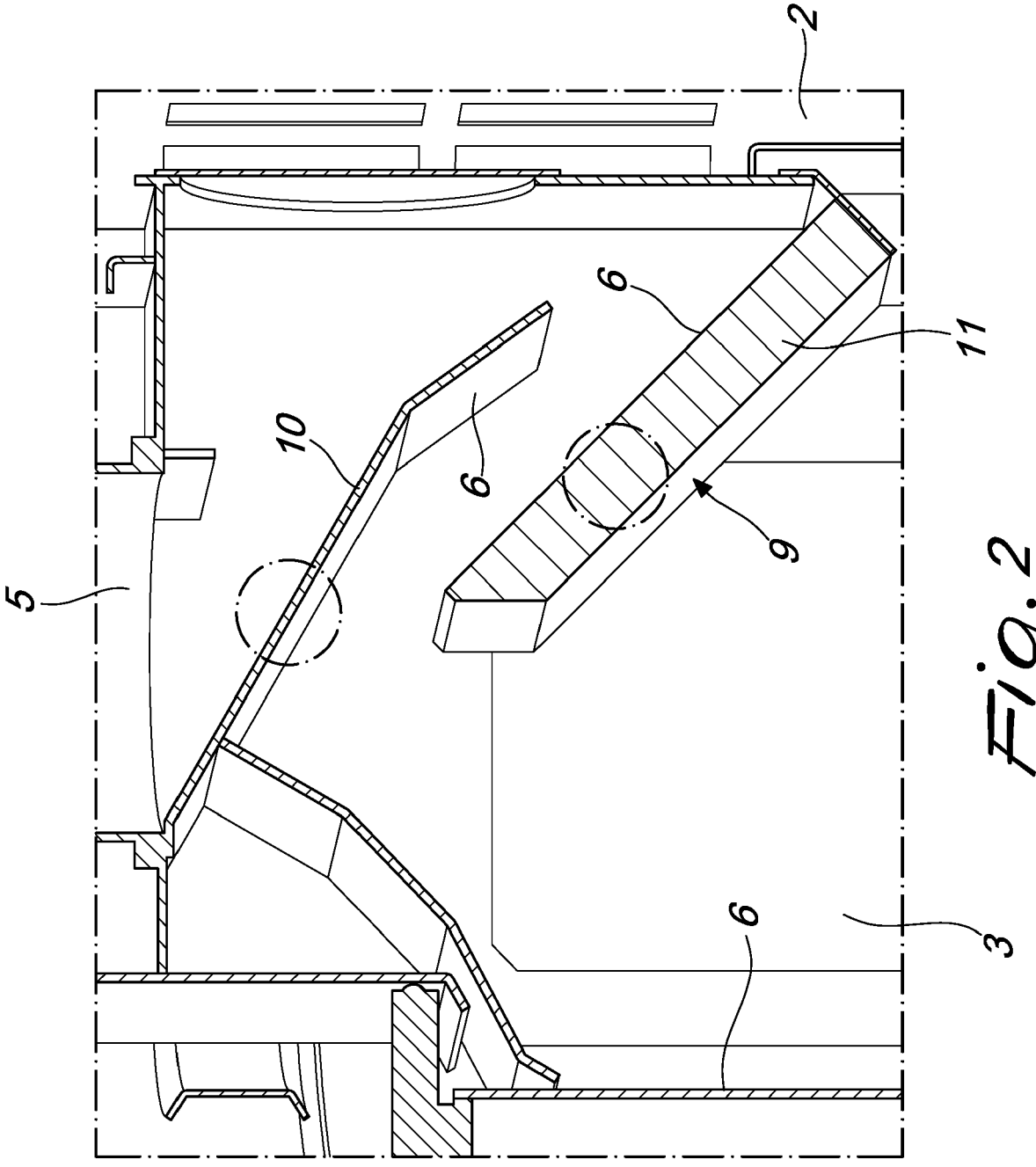

Fig. 2

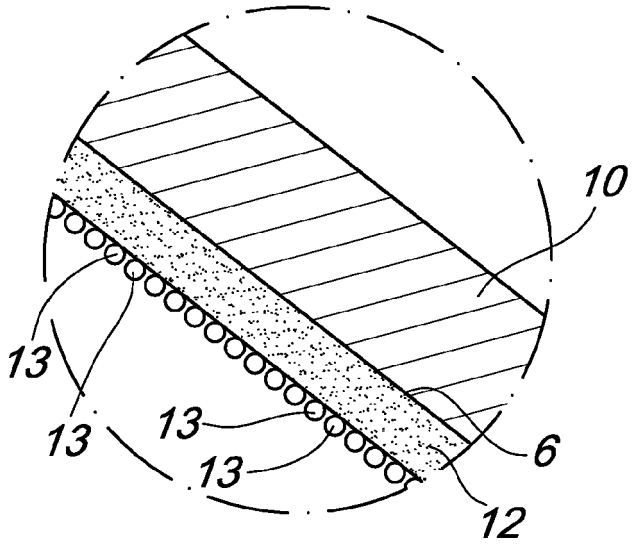

Fig. 3

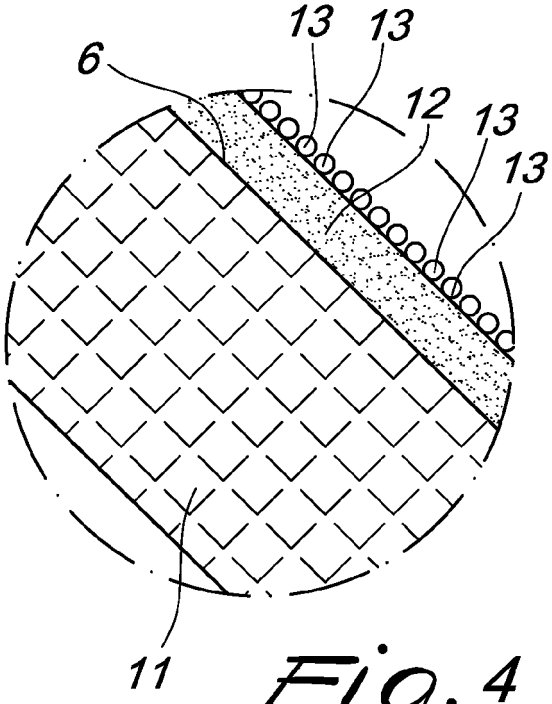

Fig. 4

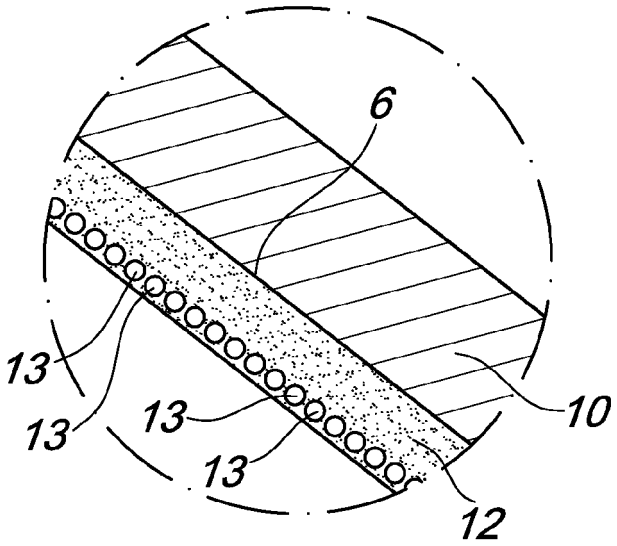

Fig. 5

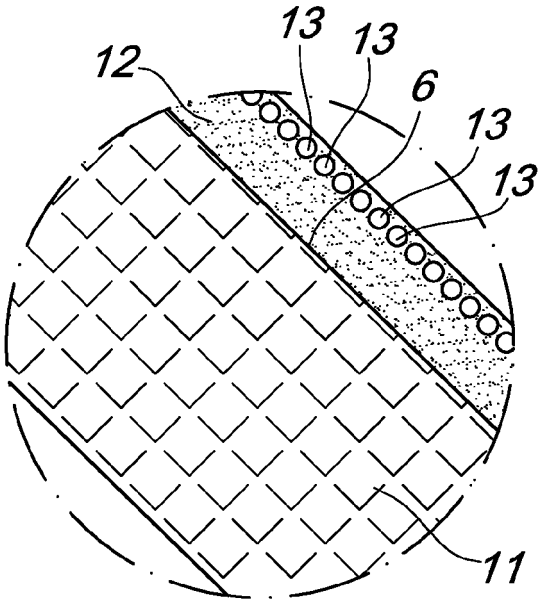

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 8120

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 February 2019	Fest, Gilles

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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