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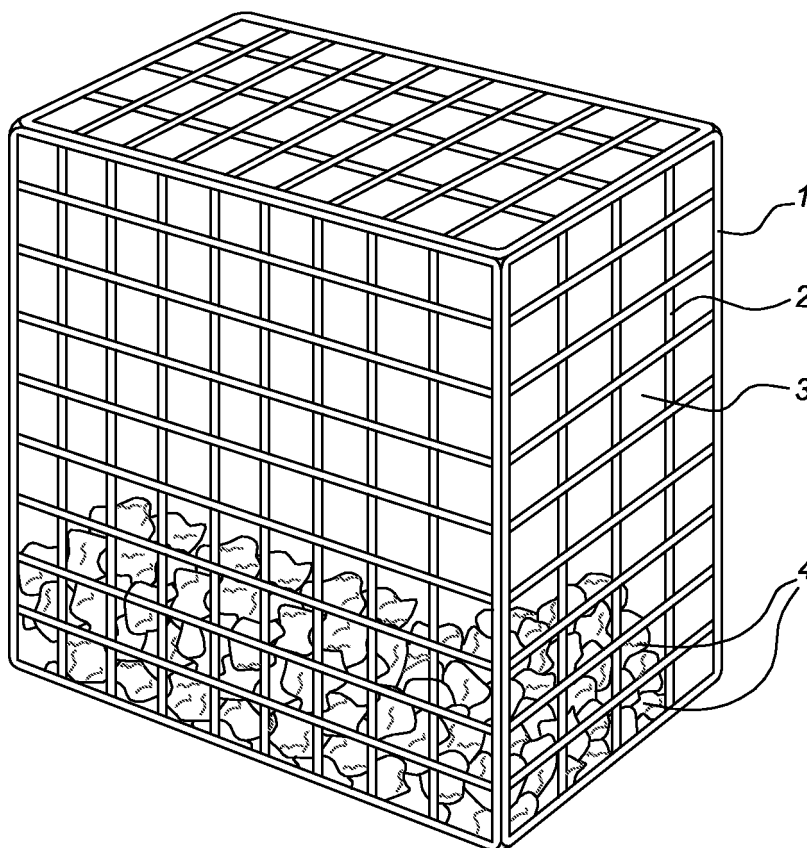
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(54) **Air purifying panel**

(57) The present invention relates to an air purifying panel comprising a plurality of porous bodies (1) comprising a slag material (4) selected from the group consisting of blast furnace slag, steel slag and MSW/MSWI bottom ash and the use of said air purifying panel for removing noxious gases, dust and soot particles from the atmosphere.

sisting of blast furnace slag, steel slag and MSW/MSWI bottom ash and the use of said air purifying panel for removing noxious gases, dust and soot particles from the atmosphere.

Fig 1



Description**Field of the invention**

[0001] The present invention relates to a air purifying panel capable of removing noxious gases that are present in the atmosphere. In addition, the air purifying panel is also capable of adsorbing and filtering soot and dust particles from the atmosphere. Preferably, the air purifying panel has also road sound absorbing capacity.

Background of the invention

[0002] Pavement and concrete structures comprising a photocatalytic material, e.g. titanium dioxide, capable of removing nitrogen oxides, in particular NO_x , from the atmosphere, are well known in the art. Reference is made to for example JP 8196902, JP 11071701 and JP 2003026486. However, such structures are not suitable for removing other noxious gases such as sulphur dioxide from the atmosphere. In addition, such structures have a low activity under dusky and dark conditions.

[0003] JP 11061708 discloses a NO_x -removing concrete product comprising inorganic material members that are coated with the photocatalyst titanium oxide. The inorganic material members may be selected from a wide range of materials having different properties, e.g. blast furnace slag. However, due to titanium oxide coating, the inorganic material member is unlikely to have any catalytic effect. It may have a function in neutralizing the nitric acid which is formed upon the catalytic oxidation of NO_x .

[0004] EP A 919.667 discloses a NO_x -cleaning paving structure comprising a surface layer, said surface layer comprising titanium oxide and optionally a blast surface slag. The blast surface slag is added as a powder and acts as a pozzolan material, which promotes the hardening of the paving structure.

[0005] Slag, e.g. blast furnace slag, is a waste material consisting of basic metal oxides as main components and is used in industrial purification processes of exhaust gases, in particular for removing nitrogen oxides and sulphur oxides. For example, JP 52050985 discloses a dry process for the simultaneous removal of SO_x and NO_x by using slag as adsorbent. JP 52094862 discloses a process for the removal of SO_x and NO_x by using waste materials such as waste sand, converter slag, supola slag or red mud (a material comprising aluminium oxide, iron oxide and silicon oxide as main components). JP 1284324 disclose the a process for simultaneously removing SO_x and NO_x from a gas by passing the gas through a bed packed with a moulded composition comprising Fe_2O_3 and granulated slag consisting of 41 - 43 % CaO , 32 - 34 % SiO_2 , 13 - 16 % Al_2O_3 , 5 - 8 % MgO , 0.4 - 0.6 % MnO , 0.2 - 0.7 % FeO and 0.8 - 0.1 % S as a carrier. US 4.073.864 discloses the use of an aqueous suspension of pulverized blast furnace slag principally composed of $\text{Ca}_2\text{Al}_2\text{SiO}_7$ for the removal of sulphur dioxide from exhaust gas. However, such industrial processes are conducted under relatively severe conditions, e.g. high temperatures. In addition, exhaust gases comprise relatively high amounts of noxious gases.

[0006] Sound absorbing panels comprising a photocatalyst for removing NO_x from the atmosphere are also known in the art. Reference is for example made to JP 2000257185 and JP 2000262864. More in particular, JP 2000257185 discloses a sound absorbing panel comprising a metal plate provided with a plurality of openings, the metal plate being supported by a metal structure, wherein a cloth-like sound absorbing material carrying a photocatalyst is arranged between the metal plate and the metal structure. Within the structure, light is provided by lamps. JP 2000262864 discloses a sound insulating wall comprising plates that are coated with a photocatalyst.

[0007] It is an object of the present invention to provide a robust air purifying panel that is capable of removing NO_x as well as SO_x from the atmosphere, in particular also under dusky or dark conditions.

[0008] It is a further object of the present invention to provide a air purifying panel that is capable of adsorbing and filtering soot and dust particles from the atmosphere.

[0009] It is a further object of the present invention to provide an air purifying panel that also has road sound absorbing capacity.

Subject of the invention

[0010] The present invention relates to a air purifying panel comprising a plurality of porous bodies comprising a slag material selected from the group consisting of blast furnace slag, steel slag and MSW/MSWI bottom ash. The present invention further relates to the use of the air purifying panel for removing noxious gases, soot and dust particles from the atmosphere. Finally, the present invention relates to a process for removing noxious gases, soot and dust particles from the atmosphere, wherein the panel according to the invention is contacted with noxious gases, soot and dust particles containing atmosphere.

Brief description of the drawings**[0011]**

Figure 1 shows a preferred embodiment of the porous body according to the invention.
 Figure 2 shows another, though less preferred embodiment according to the present invention.
 Figure 3 shows another preferred embodiment of the air purifying panel comprising slag material which is mixed with a light weight carrier, e.g. rock wool.
 Figure 4 shows the embodiment of Figure 3, but then provided with a means for draining rain water.
 Figure 5 shows the embodiment of Figure 3, but then provided with a sprinkling system.
 Figure 6 shows the time course of the NO₂ concentration if air with an increased NO₂ concentration flows through the panel, during light and dark periods.

Detailed description of the invention

[0012] According to the invention, the porous bodies comprising the slag material may have various embodiments. According to a first embodiment, the porous body may comprise a solid porous body that is formed from an adhesive or binding material such as concrete or mortar. By varying the ratio of binding material and slag, a more or less loose structure is obtained. However, it is preferred according to the present invention that the porous body comprises a hollow body having a gauzy or grid-shaped surface. These hollow bodies are preferably manufactured from a durable material such as steel, preferably stainless steel, or synthetic polymeric materials. Alternatively, the hollow bodies could be made of bricks or concrete with interspacings.

[0013] The grid-shaped surface has preferably a plaiting wherein the openings may have various forms, e.g. square or hexagonal. Preferably, the mesh size of the grid-shaped surface has a mesh size of 10 to 100 mm, that is that the diameter of the openings is 10 to 100 mm.

[0014] The size of the bodies may vary as well as will be apparent to the person skilled in the art. For example, a suitable size is a length of about 2 m, a width of about 1 m and a depth of about 0.5 m.

[0015] According to the invention, the porous bodies may be cube-, box-, cylinder or cone-shaped. However, it is preferred that the porous bodies are cube- or box shaped since these forms are more easily to stack to a plurality of bodies having a sufficient stability.

[0016] A preferred porous body according to the invention is shown in Figure 1. Porous body 1 having a box-like shape has a grid-like surface 2, wherein the grid-like surface 2 comprises a plurality of openings 3. The porous body is provided with a plurality of slag material 4.

[0017] The slag material can be directly used in the form as delivered by the supplier. If necessary, sieving and crushing are applied to obtain an optimal grading of the material. The reactivity of the material increases if the specific surface area becomes larger. However, fine material causes clogging, so air will not flow through the construction. Furthermore, fine material will not be retained by the grid-like surface of the construction. A preferred grading of the slag is 40 - 150 mm. A more preferred grading is 50 - 130 mm. However, other dimensions are obviously also possible, depending upon the mesh of the grid-shaped surface.

[0018] Alternatively, the slag material is shaped into other forms, e.g. bricks. Forming the slag material into bricks enables a more easy stacking of the slag material, in particular when the bricks are piled upon one another in a compact fashion, e.g. as in brick walls. In addition, the porosity can easily be regulated by piling or bricklaying the bricks with greater or smaller interspacings. Suitably and preferably, the bricks are bricklaid, wherein an adhesive material is used to increase the solidity of the bricklaid stacking of the bricks. This embodiment is illustrated in Figure 2, wherein porous body 1 having a box-like shape which has grid-like surface 2 comprising a plurality of openings 3 if filled with stack of a plurality of bricks 4 made from slag material. However, this embodiment is less preferred since the specific surface is relatively small which reduces the efficiency of the removal of the noxious gases, soot and dust particles.

[0019] According to an alternative embodiment of the present invention, the air purifying panel may comprise a stacking of the slag material, that preferably is formed or shaped into bricks, wherein in front of the stacking, that is on the road-side of the stacking, the sound panel comprises a grid-like fence or screen. According to this embodiment, it is likewise preferred that the fence or screen has a grid-like surface as is described for the porous body. If necessary, the road sound panel may comprise more fences or screens, e.g. four, so that a box-like porous body is formed. According to this embodiment, the porous body is formed by the stacked bricks themselves, wherein the porosity of the porous body can be adjusted by the interspaces between the bricks or paving stones. Additionally, the porous body can be filled with the slag material.

[0020] According to another preferred embodiment of the present invention, the air purifying panel comprises a mixture of a light weight carrier, preferably rock wool or glass wool, and slag material. The mixture of the light weight carrier and the slag material is embodied in a hollow body having a gauzy or grid-shaped surface as described above. Rock wool,

glass wool and like materials have the advantage that they have good sound adsorbing properties. Furthermore, the large specific surface area of the rock wool and glass wool will improve the capability of removing soot and dust particles by adsorption and filtering. An important advantage of this embodiment is the light weight, so it can be used on places with little bearing capacity or in combination with existing constructions.

[0021] Figure 3 shows a preferred embodiment of the present invention, wherein a porous body 1 having a box-like shape has a grid-like surface 2, wherein the grid-like surface 2 comprises a plurality of openings 3. The porous body is provided with a mixture of rock wool 4 and slag 5. Combination of the porous bodies provides a panel with the required height and length.

[0022] According to another preferred embodiment of the present invention, the air purifying panel comprises plants. Plants have the advantage that they consume greenhouse gases such as carbon dioxide and that they produce oxygen. The leaf surface of the plants also contributes to the entrapping of fine dust and soot particles formed during combustion of diesel fuel.

[0023] According to another preferred embodiment of the present invention, the air purifying panel comprises means for draining and collecting rain water. Since the slag material converts noxious gases such as NO_x into water soluble nitrite and nitrate, the latter can be removed from the air purifying panel by the rain water which is then drained to a sewer system, a treatment system or collected in a storage tank and used as a source for sprinkling water. Alternatively or additionally, the air purifying panel may be provided with a sprinkler systems for sprinkling water on the panel and the slag material, wherein the water trickles through the slag material. This may be necessary if the panel is constructed in a dry place and cleaning by rain water does not take place or is insufficient.

[0024] Figure 4 shows a preferred embodiment of the invention including a means for draining rain water, whereas Figure 5 shows the same preferred embodiment, but then with a sprinkler system. In Figure 4, the means for draining rain water is indicated by reference numerals 6 and 7, wherein reference numeral 6 indicates a collection system with a gutter and reference numeral 7 a storage tank. In Figure 5, the storage tank 7 is connected to a pumping means 8 which feeds the sprinkling system via pipe 11, wherein the sprinkling system comprises a sprinkling bar 10 comprising nozzles 11.

[0025] Preferably, the air purifying panel comprises benthic algae. In particular when the air purifying panel comprises a sprinkling system for sprinkling water as described above, naturally occurring algae will settle on the surfaces of the slag material. Alternatively, the algae can be grafted onto the surface of the slag material.

[0026] As described above, the present invention also relates to a process for removing noxious gases, soot and dust particles from the atmosphere, wherein the panel according to the present invention is contacted with the noxious gases, soot and dust particles containing atmosphere.

[0027] According to a preferred embodiment of the process according to the invention, a side, preferably a vertical side, of the panel is cooled, for example by cooling water or wind. The advantage of cooling is that temperature gradients are established which promotes the circulation of air through the panel. According to another preferred embodiment of the process according to the invention, a side, preferably a vertical side or the top side of the panel is heated. This can be accomplished by selective positioning the panel, i.e. that at least one surface is intensively subjected by sunlight whereas the other sides are protected from sunlight, i.e. are in the shade.

[0028] It further appeared that when the panel is installed the efficiency of the process diminishes after a certain period of time. However, the efficiency can be restored by rinsing the panel and the slag material with water, which can conveniently be accomplished by natural rain fall or by spraying with collected rain water or fresh water. As described above, the water can for example be divided over the panel by the sprinkling system.

[0029] The panel according to the present invention has also road sound absorbing capacity. The invention therefore also relates to an air purifying panel having road sound absorbing capacity.

Examples

Example 1

[0030] A mixture of air, NO_2 and NO passes a layer of steel slag of 18 cm thickness. The removal of NO_2 and NO is (nearly) complete, cf. Table 1. Conditions: Removal of NO_2 and NO after passage of a layer of steel slag of 18 cm thickness. Residence time 7 sec.

Table 1

	NO_2	NO
Concentration in (ppmv)	14,6	0,62
Concentration out (ppmv)	<0,01	0,01

(continued)

	NO ₂	NO
Removal efficiency (%)	>99,9	98,4

Example 2

[0031] Table 2 shows that lowering the residence time at conditions comparable with Example 1, has a negligible effect on the removal efficiency. Conditions: Removal of NO₂ en NO after passage of a layer of steel slag of 18 cm thickness. Residence time 1,2 sec.

Table 2

	NO ₂	NO
Concentration in (ppmv)	8	0,34
Concentration out (ppmv)	<0,01	0,05
Removal efficiency (%)	>99,9	85

Example 3

[0032] In time the removal of NO₂ remains complete but the concentration of NO increases. Apparently, NO is formed as an intermediate product. The concentration of NO starts to increase after cumulative removal of about 100 mg NO₂ /kg of slag material. The activity of the material can be regenerated completely by flushing with water. Table 3 shows the effect of flushing. Conditions: Removal of NO₂ en NO after passage of a layer of steel slag of 18 cm thickness, before and after flushing with water. Residence time 7 sec.

Table 3

	NO ₂	NO
Concentration in (ppmv)	8	0,34
Concentration out (ppmv) before flushing with water	<0,01	0,88
Concentration out (ppmv) after flushing with water	<0.01	0,01

Example 4

[0033] Contrary to systems which make use of photocatalytic conversion of NO₂ with TiO₂, the present process is independent of light. Figure 6 shows that the removal of NO₂ during day and night periods remains the same. Conditions: Concentration of NO₂ after passage of a layer of steel slag of 18 cm thickness. Dark periods are between 18.00 and 07.00 h. Ingoing concentration of NO₂ is 8 ppmv.

Example 5

[0034] The removal of dust and soot particles is investigated by passing smoke through a layer of steel slag. The results are summarized in table 4, which shows that the removal of these particles is nearly 100%. Conditions: Removal of smoke and soot particles after passage of layer of steel slag of 35 cm thickness. Residence time 8 sec.

Table 4

Gas mixture	Removal efficiency (%)
Tobacco smoke	About 100
Soot particles containing smoke of burning rubber	About 100

Claims

1. Air purifying panel comprising a plurality of porous bodies comprising a slag material selected from the group consisting of blast furnace slag, steel slag and MSW/MSWI bottom ash.
2. Air purifying panel according to claim 1, wherein the porous bodies comprise hollow bodies having grid-shaped surfaces.
3. Air purifying panel according to claim 1 or claim 2, wherein the grid-shaped surface has a mesh size of 10 to 100 mm.
4. Air purifying panel according to any one of the preceding claims, wherein the porous bodies are cube-, box-, cylinder or cone-shaped.
5. Air purifying panel according to any one of the preceding claims, wherein the slag material is shaped into bricks or comparable forms, with or without addition of adhesives like cement.
6. Air purifying panel according to claim 5, wherein the bricks are piled upon one another.
7. Air purifying panel according to claim 5 or claim 6, wherein the bricks are bricklaid.
8. Air purifying panel according to any one of the preceding claims, wherein the sound panel comprises a grid-like fence or screen
9. Air purifying panel according to claim 2, comprising a mixture of rock wool or comparable materials and slag.
10. Air purifying panel according to any one of the preceding claims comprising plants.
11. Air purifying panel according to any one of the preceding claims comprising benthic algae.
12. Air purifying panel according to any one of the preceding claims, wherein the air purifying panel is an air purifying panel having road sound absorbing capacity.
13. Use of a panel according to any one of claims 1 - 12 for removing noxious gases, dust and soot particles from the atmosphere.
14. A process for removing noxious gases, soot and dust particles from the atmosphere, wherein a panel according to any one of claims 1 - 12 is contacted with noxious gases, soot and dust particles containing atmosphere.
15. The process according to claim 14, wherein a side of the panel is cooled.
16. The process according to claim 14 or claim 15, wherein a side of the panel is heated.

Fig 1

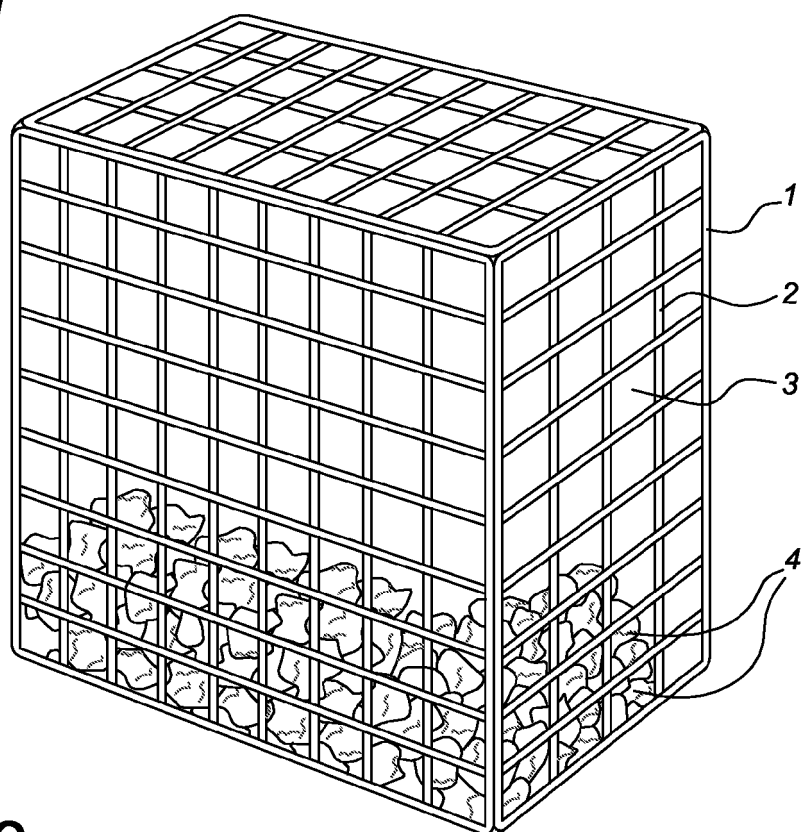


Fig 2

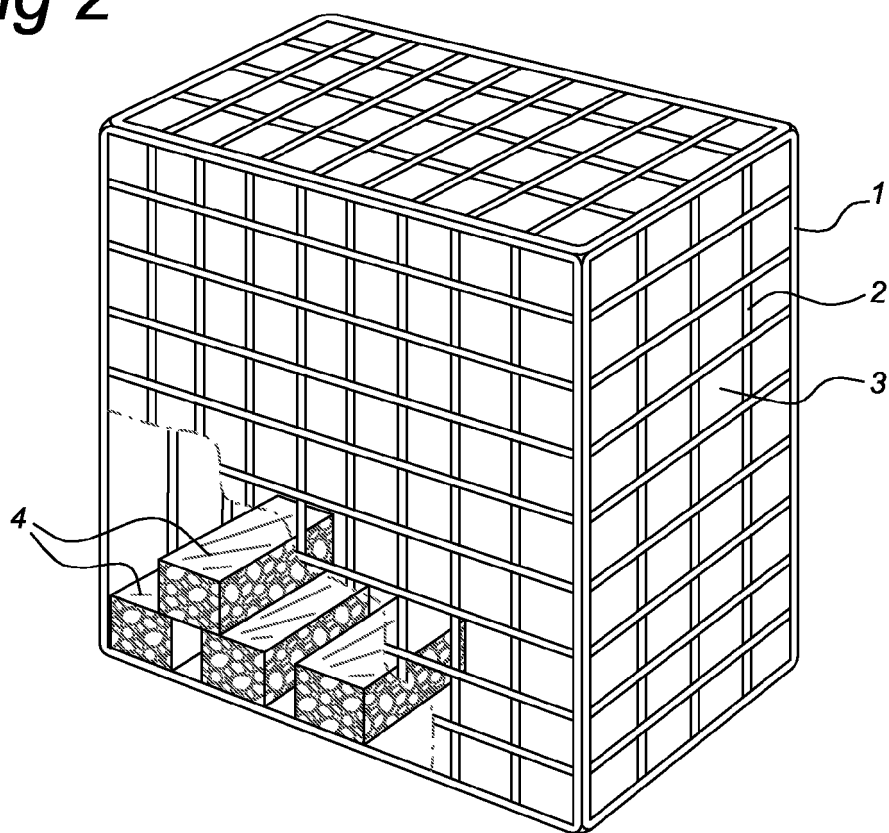


Fig 3

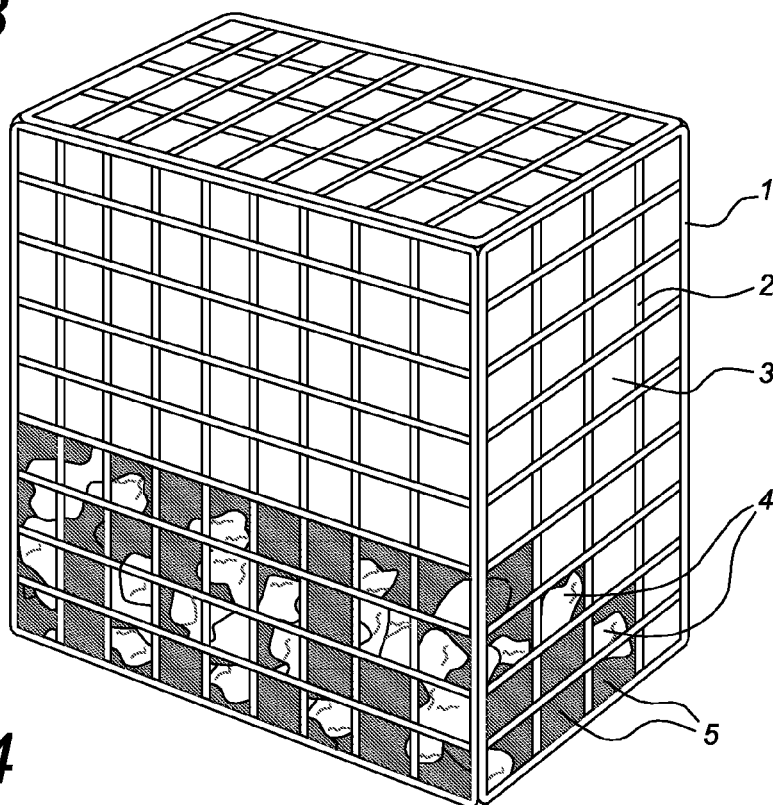
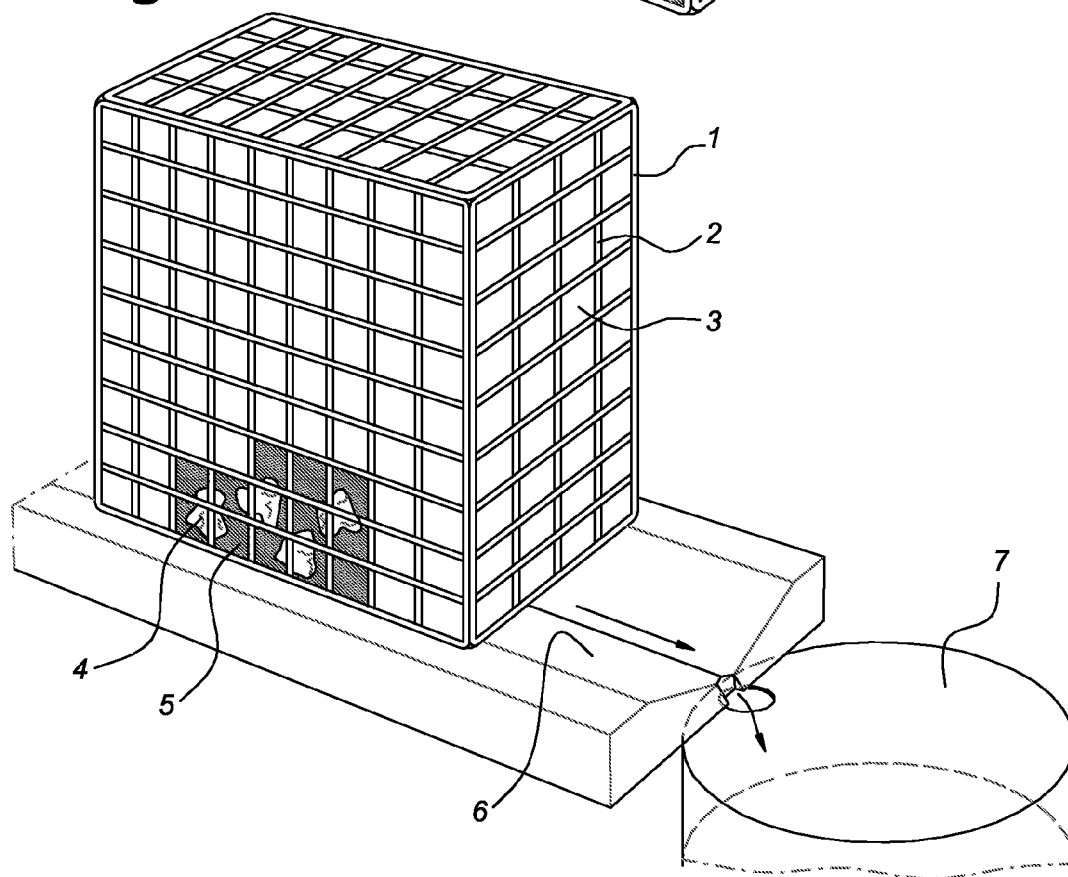


Fig 4



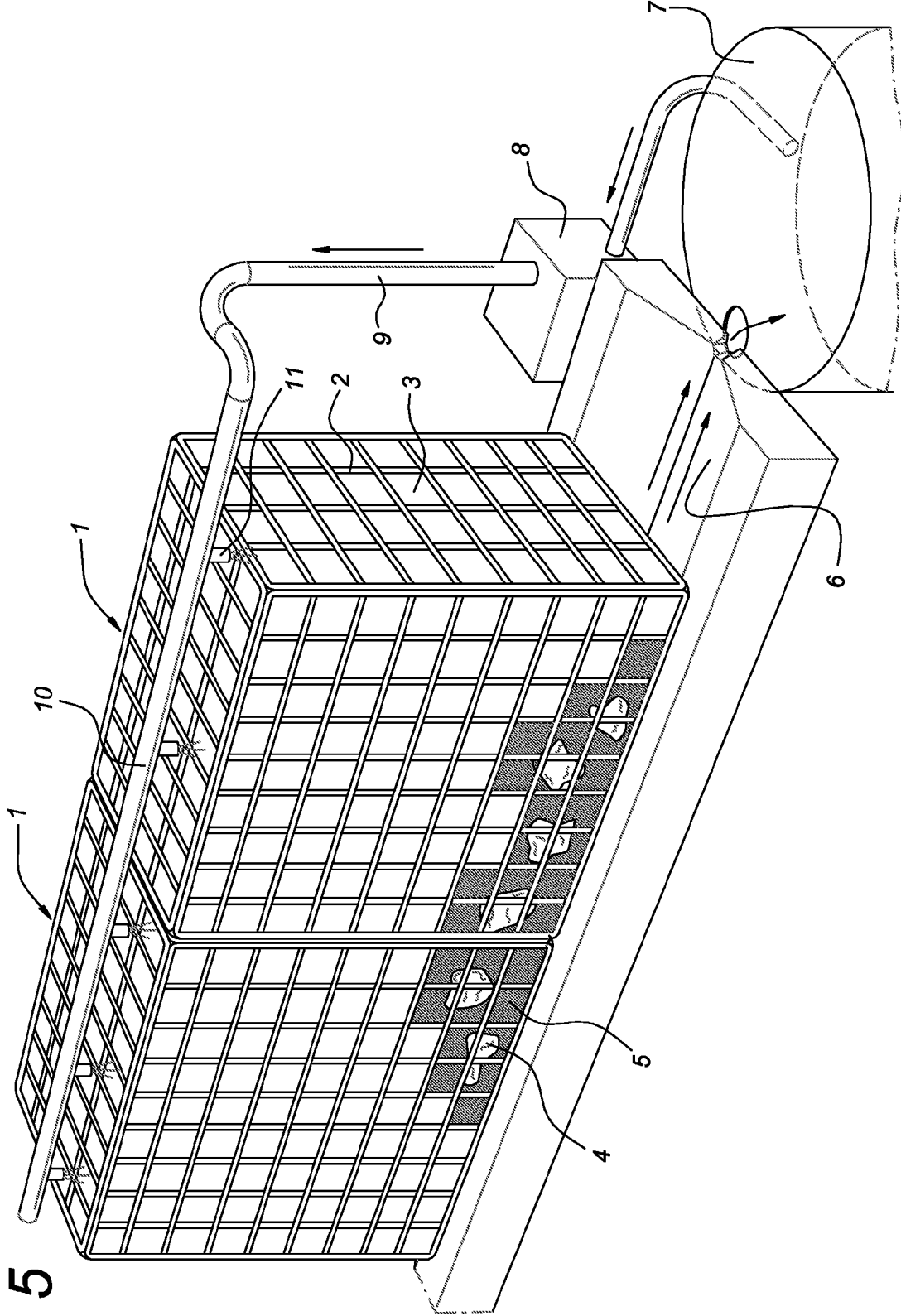
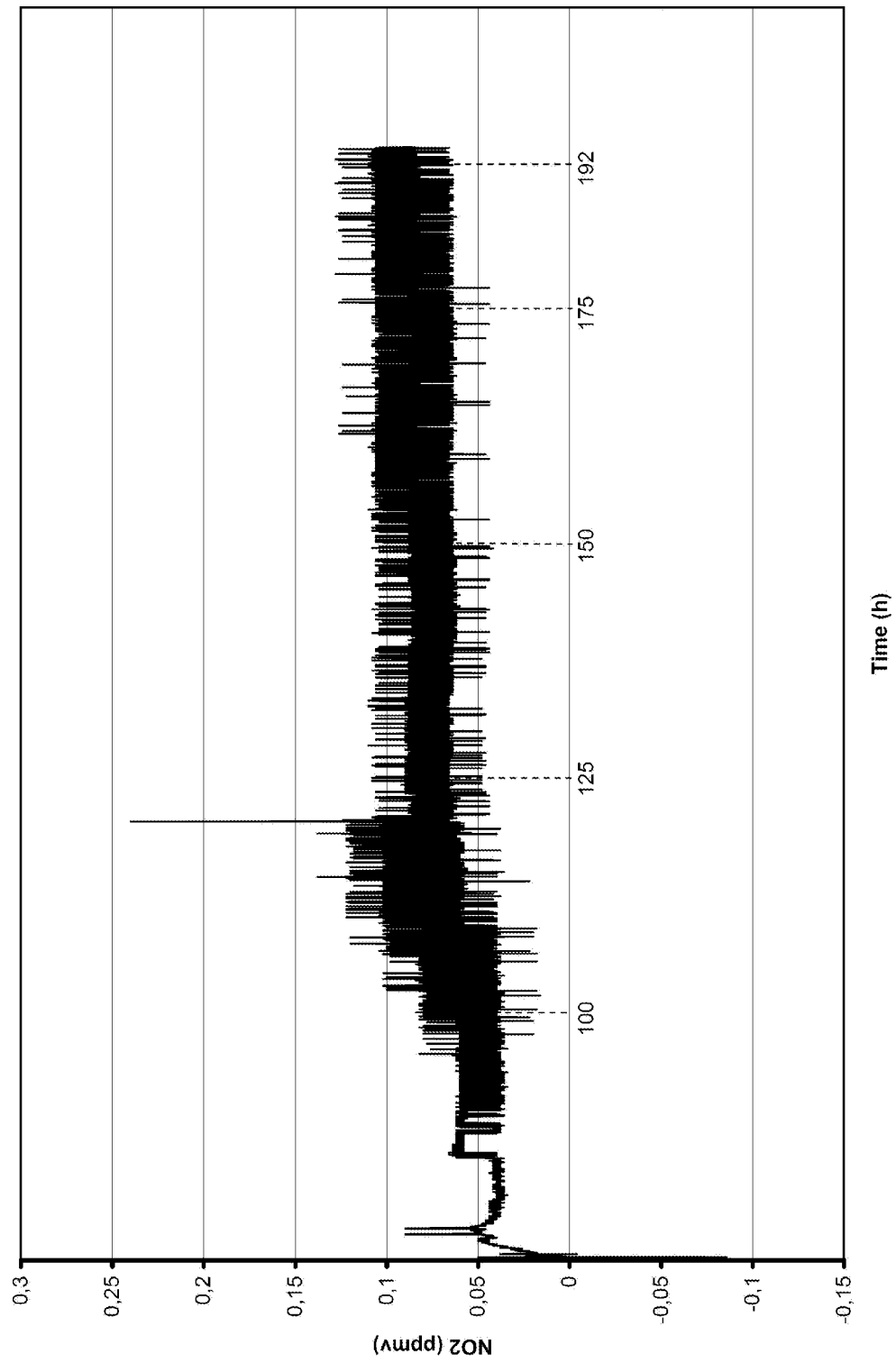


Fig 5

Fig 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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