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(54) **EXHAUST GAS PURIFICATION MEMBER, THE OUTER DIMENSIONS OF WHICH ARE STANDARDIZED**

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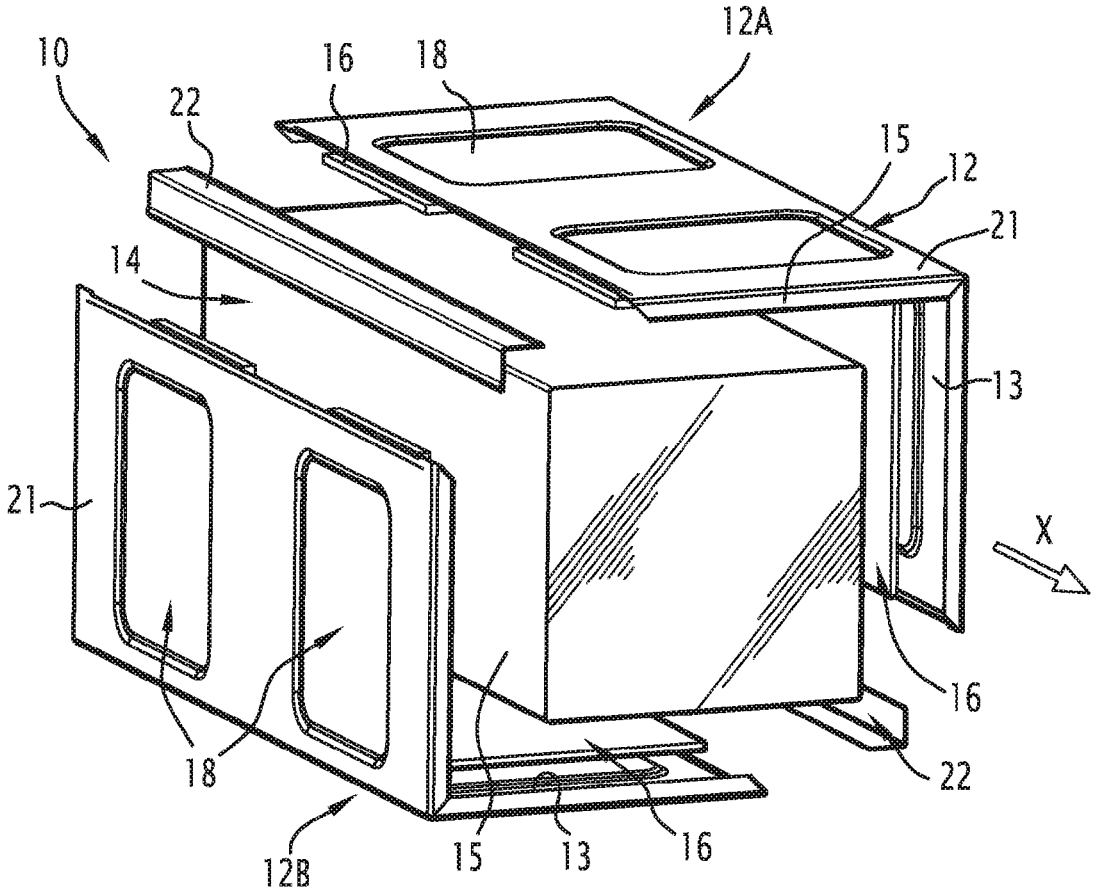
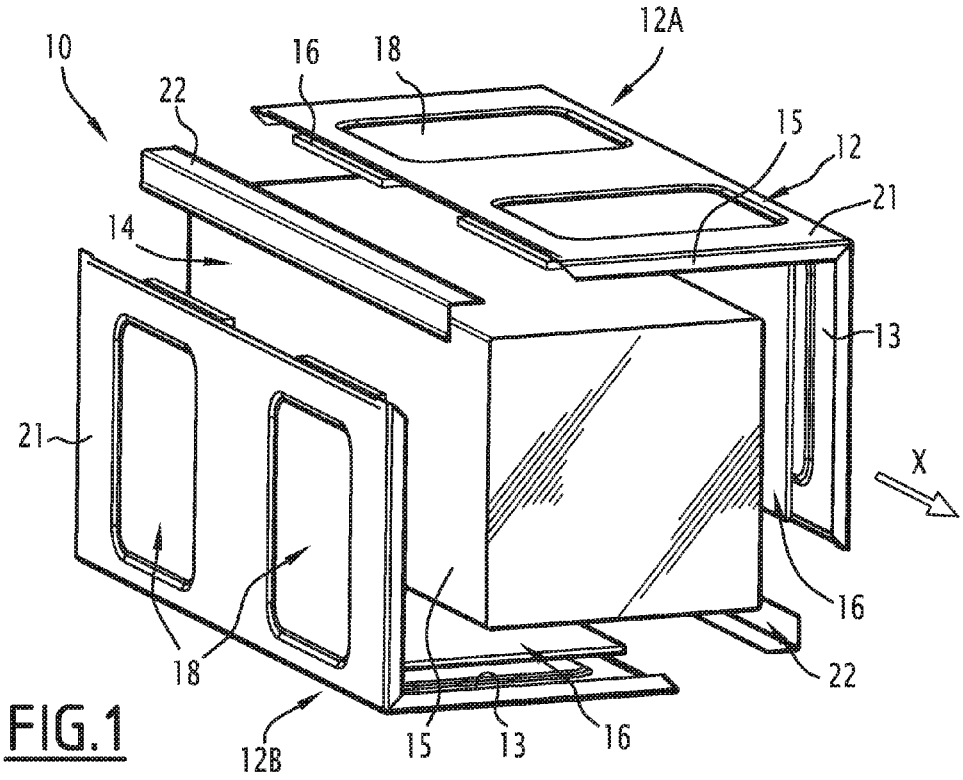
(57) **ABSTRACT**

An exhaust gas purification member includes at least one block to purify exhaust gases and a casing having an inner surface surrounding the purification block and delimiting a channel for circulating the exhaust gases. At least one element supports the purification block, and is interposed between the inner surface of the casing and a side wall of the purification block. The inner surface of the casing includes at least one portion protruding towards the purification block. The supporting element is interposed between the side wall of the purification block and the protruding portion.




10
22
16
18
12A
15
12
21
14
13
21
X
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18
22
12B
15
13
16

FIG.1

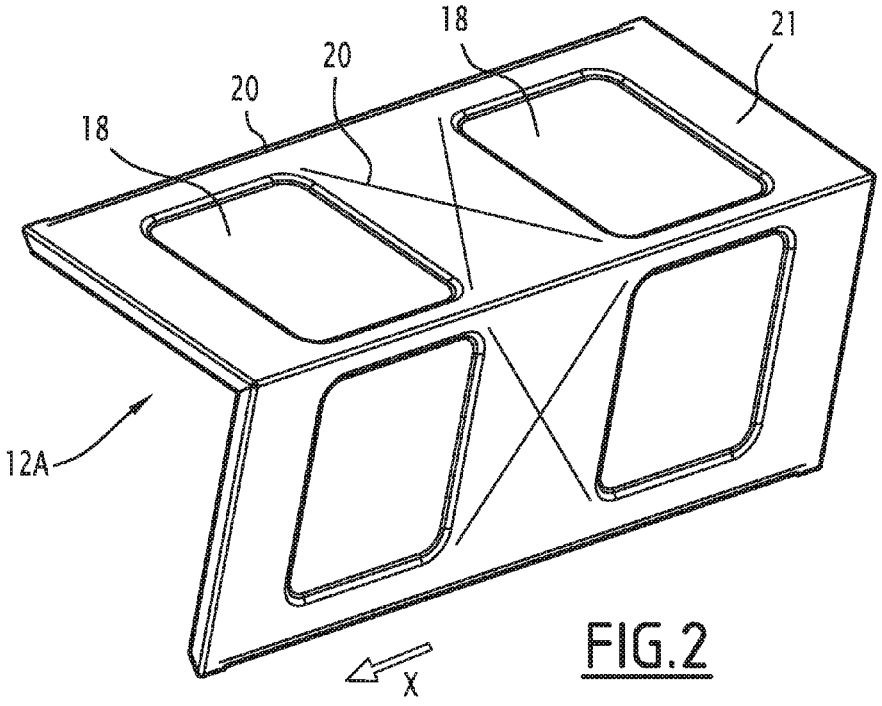
18
21
20
20
18
12A
X

FIG.2

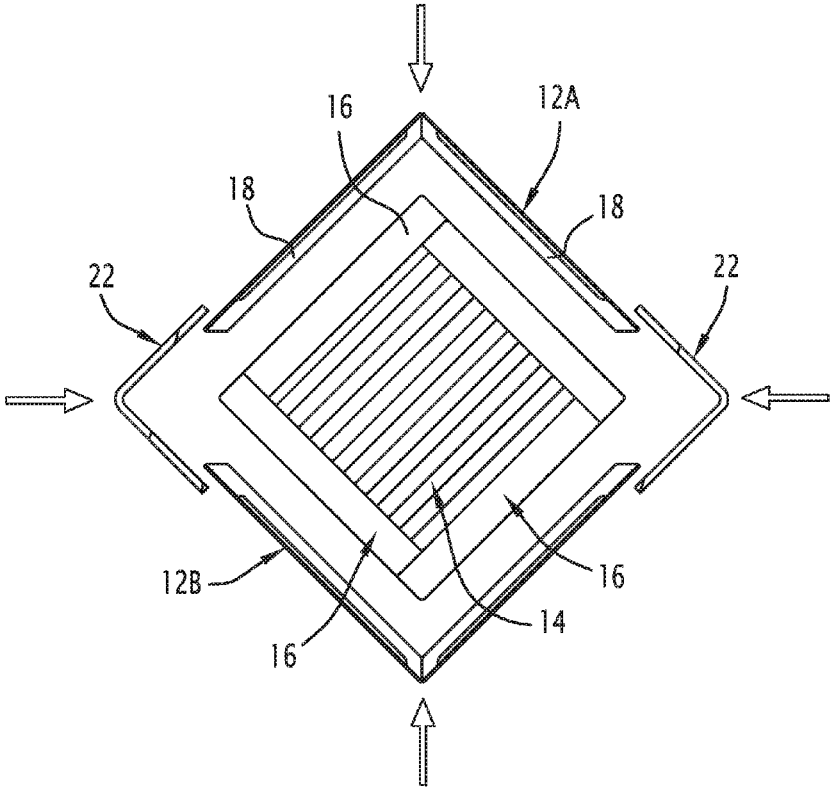

FIG.3

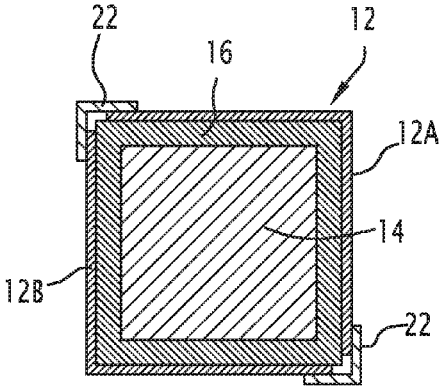

FIG.4

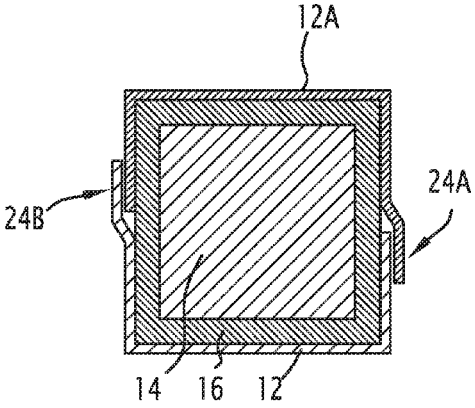

FIG.5

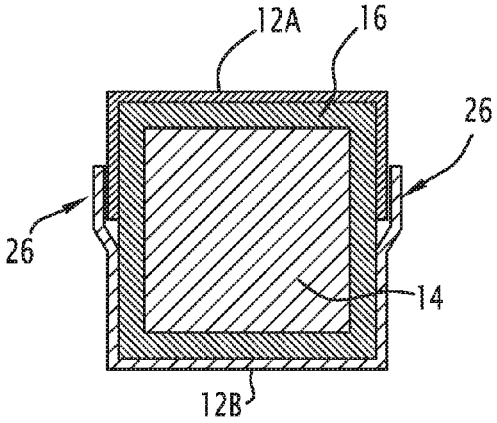

FIG.6

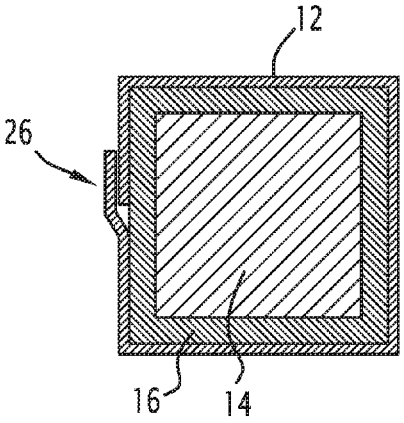

FIG.7

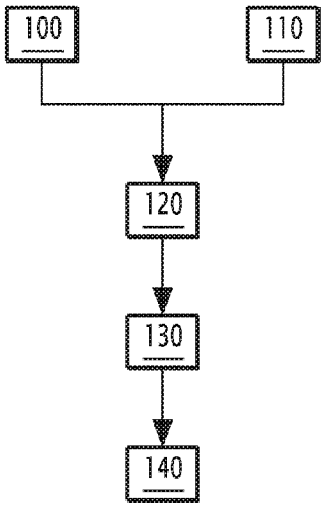

FIG.8

EXHAUST GAS PURIFICATION MEMBER, THE OUTER DIMENSIONS OF WHICH ARE STANDARDIZED

RELATED APPLICATION

[0001] This application claims priority to FR 15 54644, filed May 22, 2015.

TECHNICAL FIELD

[0002] The present invention relates to a member for purifying exhaust gases, for which the outer dimensions are standardized.

BACKGROUND

[0003] A purification member is intended to be inserted into an exhaust line, for example of a marine vehicle, of an automobile vehicle, notably of a truck, of a specialized vehicle, notably of a building site vehicle, or of a stationary engine, notably a decontamination station engine of an electric thermal power plant.

[0004] The purification member notably includes a casing delimiting a channel for circulating exhaust gases and a block for purifying exhaust gases housed in the casing.

[0005] The purification block is, for example, a particle filter or a catalytic purification member. More particularly, a particle filter is made in a filtration material formed by a monolithic ceramic or silicon carbide structure having sufficient porosity for allowing the passing of exhaust gases, but for which the diameter of the pores is sufficiently small for ensuring retention of the particles, notably soot particles, on the upstream face of the filter.

[0006] The purification member also includes elements for supporting the purification block, interposed between the casing and the purification block.

[0007] It should be noted that the dimensions of the purification block are difficult to control, so that these dimensions may vary from one purification block to another.

[0008] On the other hand, for properly inserting the purification member into the exhaust line, the outer dimensions of the casing should be constant from one purification member to another.

[0009] Thus, it is necessary to provide supporting elements of various dimensions, in order to adapt to the dimensions of the supporting elements according to the dimensions of the purification block, which involves complex logistics. Moreover, such supporting elements are generally relatively expensive. Thus, the price cost of a conventional purification member may be relatively high.

SUMMARY

[0010] The purpose of the invention is notably to find a remedy to this drawback, by providing a purification member having reduced cost.

[0011] For this purpose, the object of the invention is notably a member for purifying exhaust gases, including:

[0012] at least one block to purify exhaust gases,

[0013] a casing having an inner surface surrounding the purification block and delimiting a channel for circulating the exhaust gases, the casing being housed in the purification block, and

[0014] at least one element to support the purification block, the element being interposed between the inner surface of the casing and a side wall of the purification block, and wherein the inner surface of the casing includes at least one portion protruding towards the purification block, the supporting element being interposed between the side wall of the purification block and the protruding portion.

[0015] According to the invention, the differences in dimensions between various purification blocks are compensated by the protruding portions made on the inner surface of the casing.

[0016] Such protruding portions may be made in a simple, economical and accurate way, depending on the dimensions of the purification block and on the corresponding supporting elements. For example, in a preferred embodiment, the protruding portions are made by stamping.

[0017] Thus, the invention does not require adaptation of the supporting elements to the purification block, which gives the possibility of substantially reducing the manufacturing cost, generally by dividing it by three.

[0018] A purification member according to the invention may further include one or several of the following features, taken alone or according to all the technically conceivable combinations.

[0019] Each protruding portion is a deep-drawn area.

[0020] The purification block and the casing have cross-sections with generally similar shapes, notably with polygonal shapes, preferably tetrahedral shapes, for example square, rectangular or trapezoidal shapes.

[0021] Each protruding portion extends as a protrusion over a height of less than 3.5 mm.

[0022] The casing includes stiffening ribs, preferably laid out on the outer surface of the casing.

[0023] The casing includes two half-casings connected together.

[0024] The half-casings are covered at their connection with connecting elements, for example by welding.

[0025] The inner surface of the casing includes several walls separated with corners, each wall including at least one protruding portion.

[0026] The inner surface of the casing includes at least two protruding portions, with these protruding portions extending as a protrusion over different heights.

[0027] The invention also relates to a method for manufacturing a purification member as defined earlier, and including:

[0028] a step for measuring the dimensions of the purification block, and

[0029] a step for producing each protruding portion, each over a respective height depending on the measured dimensions of the purification block.

[0030] A manufacturing method according to the invention may include either one of the following features, taken alone or as a combination.

[0031] The manufacturing method further includes a step for weighing each supporting element, the height of each protruding portion being each dependent on the respective measured mass of each supporting element.

[0032] The manufacturing method includes a step for assembling each supporting element on the purification block, notably by adhesive bonding, followed by a step for assembling the casing around the purification block, so that each supporting element is clamped between the purification block and a corresponding protruding portion.

[0033] These and other features may be best understood from the following drawings and specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The invention will be better understood upon reading the description which follows, only given as an example and made with reference to the appended figures, wherein:

[0035] FIG. **1** is an exploded perspective view of a purification member according to an exemplary embodiment of the invention;

[0036] FIG. **2** is a perspective view of a half-casing of the purification member of FIG. **1**;

[0037] FIG. **3** is a cross-sectional view of the purification member of FIG. **1**, as an exploded view;

[0038] FIG. **4** is a cross-sectional view of the purification member of FIG. **1** when it is assembled;

[0039] FIGS. **5** to **7** are views similar to FIG. **4**, illustrating three respective alternatives of casings fitting out the purification member;

[0040] FIG. **8** schematically illustrates the steps of a method for manufacturing the purification member of FIG. **1**.

DETAILED DESCRIPTION

[0041] A member **10** for purifying exhaust gases is illustrated in FIG. **1**. The member **10** is intended to be inserted into an exhaust line of a marine vehicle.

[0042] The purification member **10** includes a casing **12**, generally a metal casing, formed in this embodiment with two half-casings **12**A and **12**B that are intended to be assembled together.

[0043] In this example, each half-casing **12**A, **12**B has a general elongated shape in a longitudinal direction X, and an L-shaped section in a transverse plane perpendicular to the longitudinal direction X. Each half-casing **12**A, **12**B is therefore formed with two walls, each extending perpendicularly to the longitudinal direction X, between a free longitudinal edge and an edge bound to the other wall. These half-casings **12**A, **12**B are assembled by connecting each free longitudinal edge of a wall of one of the half-casings with the respective one of the free longitudinal edges of a wall of the other of the half-casings.

[0044] The casing **12** includes an inner surface **13** delimiting a channel for circulating the exhaust gases. The casing **12** is intended to be connected on the upstream side of the exhaust line to a divergent cone defining an inlet for exhaust gases, and towards the downstream side to a convergent cone defining an outlet for the exhaust gases. The inlet is connected to a manifold of the exhaust line, which captures the exhaust gases leaving combustion chambers of the engine. The outlet is connected to a cannula through which the exhaust gases are released into the atmosphere after purification. The upstream and downstream sides are meant here relatively to the normal circulation direction of the exhaust gases.

[0045] The purification member **10** moreover includes a block **14** for purifying exhaust gases, generally a particle filter or a catalytic purification member.

[0046] A catalytic purification member is generally formed by a structure pervious to gases, for example covered with catalytic metals promoting oxidation of the combustion gases and/or reduction of the nitrogen oxides.

[0047] A particle filter is made in a filtration material formed by a monolithic ceramic or silicon carbide structure having sufficient porosity for allowing the passing of the exhaust gases. As this is known per se, the diameter of the pores is selected to be sufficiently small for ensuring retention of the particles, and notably of soot particles, on the upstream face of the filter. The particle filter may also be formed by a cartridge filter or a sintered metal filter.

[0048] In the example described, the purification block **14** has a cross-section of a general square shape. Alternatively, the purification block **12** may have a cross-section of any polygonal shape, preferably tetrahedral, for example rectangular or trapezoidal.

[0049] The purification block **14**, having reduced transverse dimensions relatively to those of the casing **12**, is housed in said circulation channel. The casing **12** therefore interiorly defines a passage for circulation of the exhaust gases from the inlet as far as the outlet, through the purification block **14**, the exhaust gases being purified upon passing through this purification block **14**.

[0050] The purification block **14** is delimited by side walls **15** turned towards the casing **12** and delimiting a peripheral space with the inner surface **13** of this casing **12**.

[0051] The casing **12** has a cross-section of a shape similar to that of the purification block **14**. Thus, the side walls **15** of the purification block **14** are substantially parallel to the inner surface **13** of the casing **12**.

[0052] The purification member **10** moreover includes supporting elements **16**, intended to be interposed between the purification block **14** and the casing **12**.

[0053] More particularly, the supporting elements **16** are positioned in said peripheral space, with each supporting element **16** being interposed between the inner surface **13** of the casing **12** and a side wall **15** corresponding to the purification block **14**. More particularly, at least one assembly of supporting elements **16** is positioned for encircling the purification block **14**, as this is notably illustrated in FIG. **3**. Advantageously, a plurality of such assemblies of supporting elements **16** is distributed over the length of the purification block **14**.

[0054] Each supporting element **16** is, for example, formed with a metal knit or a web. In the case of a web, the latter is notably made in intumescent material, or alternatively in a non-intumescent material.

[0055] Each supporting element **16** bears outwards upon the casing **12** and bears inwards upon the purification block **14**. It therefore exerts a transverse pressure on the purification block **14**.

[0056] The supporting elements **16** contribute to maintaining the purification block **14** in position, when the latter is subject to a longitudinal force parallel to the longitudinal direction X, and/or also when the latter is subject to a transverse force perpendicularly to the longitudinal direction X. When the purification block **14** is subject to a longitudinal force, the frictions between this purification block **14** and the supporting elements **16**, and between the supporting elements **16** and the casing **12**, are such that the displacement of the purification block **14** relative to the casing **12** is very limited.

[0057] In order to obtain this effect, it is necessary to mount the supporting elements **16** in the peripheral space with an adequate mounting density. Mounting density refers to the density of the supporting elements **16** at room temperature. Mounting density is also called "Gap Bulk Density" (GBD).

[0058] This density should not be too low, since the purification block **14** would then be poorly maintained in position relative to the casing **12** under the effect of a

longitudinal stress, in particular at a high temperature because of the differential expansion between the casing **12** and the purification block **14** which leads to an increase in the thickness of the peripheral space. It should be noted that such a differential expansion is generally due to the fact that the casing **12** expands much more than the purification block **14**.

[0059] The mounting density should not either be too high, in order to avoid damaging the purification block **14**, notably in the long run.

[0060] In order to obtain an adequate mounting density, the inner surface **13** of the casing **12** includes at least one protruding portion **18** towards the circulation channel for the exhaust gases, therefore towards the purification block **14**, so that each supporting element **16** is interposed between the corresponding side wall **15** of the purification block **14** and a protruding portion **18** laid out facing this side wall **15**.

[0061] These protruding portions **18** give the possibility of controlling the mounting density, without modifying the general dimensions of the casing **12**. Thus, regardless of the dimensions of the purification block **14**, the casing **12** has standard outer dimensions.

[0062] Each protruding portion **18** is for example a deep-drawn area, which may be made in a simple, economical and accurate way by a conventional stamping process. Thus, each protruding portion **18** forms a recess on the outer surface **21** of the casing **12**.

[0063] Each protruding portion extends as a protrusion over a predetermined height, depending on the dimensions of the purification block **14** and on the supporting elements **16**. Considering variations in the dimensions of one purification block to another, said predefined height is generally less than 3.5 mm, for example about equal to 1.5 mm.

[0064] It should be noted that each wall of the casing **12** at least includes one protruding portion **18**. More particularly, two opposite walls, one facing the other, of the casing **12** are generally both provided with protruding portions **18**, the heights of these protruding portions **18** being determined so as to allow together the blocking of the purification block **14**. These protruding portions **18** facing each other do not necessarily have identical heights.

[0065] Moreover, the protruding portions **18** made on two adjacent walls of the envelope **12**, generally extend over different heights.

[0066] Advantageously, as this is illustrated in FIG. **2**, the casing **12** preferably includes stiffening ribs **20**, notably laid out on an outer surface **21** of this casing **12**. In the described example, stiffening ribs **20** are laid out along the longitudinal edges of each half-casing **12**A, **12**B, and stiffening ribs **20** are laid out, for example by forming a cross, between two adjacent protruding portions **18** in the longitudinal direction X on a same wall of the casing **12**.

[0067] As indicated earlier, the casing **12** is formed with two half-casings **12**A, **12**B, assembled together, for example by welding.

[0068] In order to reinforce the seal at the junction between the half-casings **12**A, **12**B, connecting elements **22** are preferably laid out by covering this connection, and assembled to the half-casings **12**A, **12**B, for example by welding. Each connecting element **22**, for example has the shape of a ruler with an L section, intended to cover a corner of the casing, and to more particularly cover the longitudinal edges of the half-casings **12**A, **12**B.

[0069] It will be noted that the shape of the casing **12** described earlier is only a non-limiting example, and that other shapes may be contemplated.

[0070] In particular, according to a first alternative embodiment, illustrated in FIG. **5**, the half-casings **12**A and **12**B do not have any L-shaped sections, but U-shaped sections. In this case, in order to improve the seal, each half-casing **12**A, **12**B has a longitudinal overlapping edge **24**A, **24**B partly covering the corresponding longitudinal edge of the other half-casing.

[0071] According to a second alternative embodiment, illustrated in FIG. **6**, one of the half-casings **12**A or **12**B includes two longitudinal overlapping edges, each respectively covering the longitudinal edges of the other half-casing.

[0072] According to a third alternative embodiment, illustrated in FIG. **7**, the casing **12** is formed in a single portion encasing the block **14** and the supporting elements **16**. In this case, this casing **12** includes a longitudinal edge **26** which will cover an opposite longitudinal edge.

[0073] It is also possible to provide other alternative embodiments. For example, provision may be made for a casing **12** in a single portion encasing the block **14**, having two longitudinal edges assembled to a corner, and covered with a connecting element **22** in the same way as in the alternative of FIG. **4**.

[0074] A method for manufacturing the purification member **10** will now be described.

[0075] This manufacturing method first of all includes a step **100** for measuring the dimensions of the purification block **14**. Advantageously, the method further includes a step **110** for weighing each supporting element **16**.

[0076] The method then includes a step **120** for producing each protruding portion **18** over a height notably depending on the measured dimensions of the purification block **14**. This height advantageously also depends on the measured mass of each supporting element **16**.

[0077] Thus, an adequate height of the protruding portions **18** is ensured in order to obtain an optimum mounting density. One skilled in the art will easily be able to select the height of the protruding portions **18** depending on the dimensions of the purification block **14** and on the masses of the supporting elements **16**.

[0078] An example calculation of the height of the protruding portions **18** is specified hereafter.

[0079] In this calculation:

[0080] the purification block **14** is a parallelepiped and it has a length L in the longitudinal direction X, a first width **11** in a first transversal direction perpendicular to the longitudinal direction X, and a second width **12** in a second transversal direction perpendicular to the longitudinal direction X and perpendicular to the first transversal direction;

[0081] the casing **12** has a first external dimension H_1 in the first transversal direction and a second external dimension H_2 in the second transversal direction;

[0082] the casing **12** is made of walls having a thickness Ep;

[0083] the casing has at least one first protruding portion **18** on each side in the first transversal direction, each having a height h_1;

[0084] the casing has at least one second protruding portions **18** on each side in the second transversal direction, each having a height h_2;

[0085] each supporting element **16** has a Basis Weight BW;

[0086] the member **10** has a Gap Bulk Density GBD;

[0087] there is a first respective gap g_1, in the first transversal direction, between the purification block **14** and each first protruding portions **18**, each gap receiving a respective supporting element **16**,

[0088] there is a second respective gap g_2, in the second transversal direction, between the purification block **14** and each second protruding portions **18**, each gap receiving a respective supporting element **16**.

[0089] It should be noticed that the Basis Weight BW of a supporting element may be a given nominal value, or may be measured as

$$BW = \frac{m}{s}$$

where m is the mass or the supporting element and s is the area of this supporting element.

[0090] In the first transversal direction:

$$H_1 = l_1 + 2 \times g_1 + 2 \times E_p + 2 \times h_1$$

Thus:

$$h_1 = \tfrac{1}{2}(H_1 - l_1 - 2 \times g_1 - 2 \times E_p)$$

[0091] It should be noticed that

$$GBD = \frac{BW}{g_2}$$

[0092] GBD is a given value, corresponding to said adequate mounting density. So,

$$g_1 = \frac{BW}{GBD}$$

[0093] Thus,

$$h_1 = \frac{1}{2}\left(H_1 - l_1 - 2 \times \frac{BW}{GBD} - 2 \times E_p\right)$$

In the same manner, in the second transversal direction:

$$h_2 = \frac{1}{2}\left(H_2 - l_2 - 2 \times \frac{BW}{GBD} - 2 \times E_p\right)$$

[0094] The method moreover includes a step **130** for assembling each supporting element **16** onto the purification block **14**, notably by adhesive bonding. Advantageously, each supporting element **16** also has adhesive on the face turned towards the casing.

[0095] The method then includes a step **140** for assembling the casing **12** around the purification block **14**, so that each supporting element **16** is found clamped between the purification block **14** and a corresponding protruding portion **18**.

[0096] This assembling step **140** is, for example, carried out by closing the casing **12** directly around the purification block **14**.

[0097] Alternatively, the casing **12** is assembled separately, the purification block **14** provided with supporting elements **16** being then forcibly introduced into the channel for circulation of gases delimited by the casing **12**.

[0098] It will be noted that the invention is not limited to the embodiment described earlier, but may have various alternatives.

[0099] For example, a purification member may be provided, including several purification blocks assembled by rows and/or by layers, so as to form a purification element consisting of several blocks. In this case, the making of the purification member is similar to the one described earlier, by treating said purification element in the same way as the purification block **14** described previously.

[0100] It will also be noted that the purification member according to the invention may be used in a context other than a marine vehicle, for example in an automobile vehicle.

[0101] Although an embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this disclosure. For that reason, the following claims should be studied to determine the true scope and content of this disclosure.

1. A purification member for purifying exhaust gas, comprising:

at least one purification block to purify exhaust gas, the purification block having a side wall;

a casing having an inner surface surrounding the purification block, the casing delimiting a channel for circulating exhaust gases, the purification block being housed in said channel; and

at least one supporting element to support the purification block, wherein the inner surface of the casing comprises at least one protruding portion protruding towards the purification block, the supporting element being interposed between said side wall of the purification block and said protruding portion.

2. The purification member according to claim **1**, wherein each protruding portion is an embossed protrusion.

3. The purification member according to claim **1**, wherein the purification block and the casing have cross-sections of similar polygonal shapes.

4. The purification member according to claim **1**, wherein each protruding portion extends and protrudes over a height of less than 3.5 mm.

5. The purification member according to claim **1**, wherein the casing includes an outer surface, and the casing comprises stiffening ribs, laid out on the outer surface of the casing.

6. The purification member according to claim **1**, wherein the casing includes two half-casings connected to each other.

7. The purification member according to claim **6**, wherein the half-casings are covered at a connection interface with connecting elements.

8. The purification member according to any claim **1**, wherein the inner surface of the casing includes several walls separated by corners, each wall including at least one protruding portion.

9. The purification member according to claim **1**, wherein the inner surface of the casing includes at least two protruding portions that extend and protrude over various heights.

10. The purification member according to claim **1**, wherein:

the purification block is a parallelepiped and has a length L in a longitudinal direction, a first width l_1 in a first transversal direction perpendicular to the longitudinal direction, and a second width l_2 in a second transversal direction perpendicular to the longitudinal direction and perpendicular to the first transversal direction,

the casing has at least one first protruding portion on each side in the first transversal direction,

the casing has at least one second protruding portion on each side in the second transversal direction,

and wherein in the first transversal direction:

$$h_1=F_1(H_1;l_1;BW;GBD;E_p)$$

and, in the second transversal direction:

$$h_2=F_2(H_2;l_2;BW;GBD;E_p)$$

with:

h_1 is a height of each first protruding portion of the casing in the first transversal direction;

h_2 is a height of each second protruding portion of the casing in the second transversal direction;

F_1 is a first function;

F_2 is a second function;

H_1 is a first external dimension of the casing in the first transversal direction, and H_2 is a second external dimension of the casing in the second transversal direction;

Ep is a thickness of walls forming the casing;

BW is a Basis Weight of each supporting element;

GBD is a given Gap Bulk Density of the purification member.

11. The purification member according to claim **10**, wherein:

in the first transversal direction:

$$h_1 = \frac{1}{2}\left(H_1 - l_1 - 2\times\frac{BW}{GBD} - 2\times E_p\right)$$

and, in the second transversal direction:

$$h_2 = \frac{1}{2}\left(H_2 - l_2 - 2\times\frac{BW}{GBD} - 2\times E_p\right)$$

12. A manufacturing method for manufacturing a purification member for purifying exhaust gas, comprising:

at least one purification block to purify exhaust gas, the purification block having a side wall;

a casing having an inner surface surrounding the purification block, the casing delimiting a channel for circulating exhaust gases, the purification block being housed in said channel; and

at least one supporting element to support the purification block, wherein the inner surface of the casing comprises at least one protruding portion protruding towards the purification block, the supporting element being interposed between said side wall of the purification block and said protruding portion,

wherein the manufacturing method comprises:

measuring dimensions of the purification block, and

making each protruding portion to have a respective height depending on the measured dimensions of the purification block.

13. The manufacturing method according to claim **12**, further comprising weighing each supporting element, the height of each protruding portion also being dependent on the respective measured mass of each supporting element.

14. The manufacturing method according to claim **12**, further comprising assembling each supporting element on the purification block, followed by assembling the casing around the purification block, so that each supporting element is clamped between the purification block and a corresponding protruding portion.

* * * * *