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(54) **NOISE & VIBRATION REDUCTION UNIT**

(57) A noise and vibration reduction unit (101) comprises an air inlet (117), an elongate encasing body (108), a cancellation medium (121) and an air outlet (118). The inlet (117) allows influx of air from a compressor into an internal volume of the elongate encasing body (108) that is filled with the cancellation medium (121). The air passes through the cancellation medium (121) and the associated sound and vibrational disturbances that are produced by the compressor are dampened by the medium (121). The air then passes out of the elongate encasing body (108) by way of the air outlet (118) and is transferred downstream via tubing to an apparatus or environment for oxygen uptake.

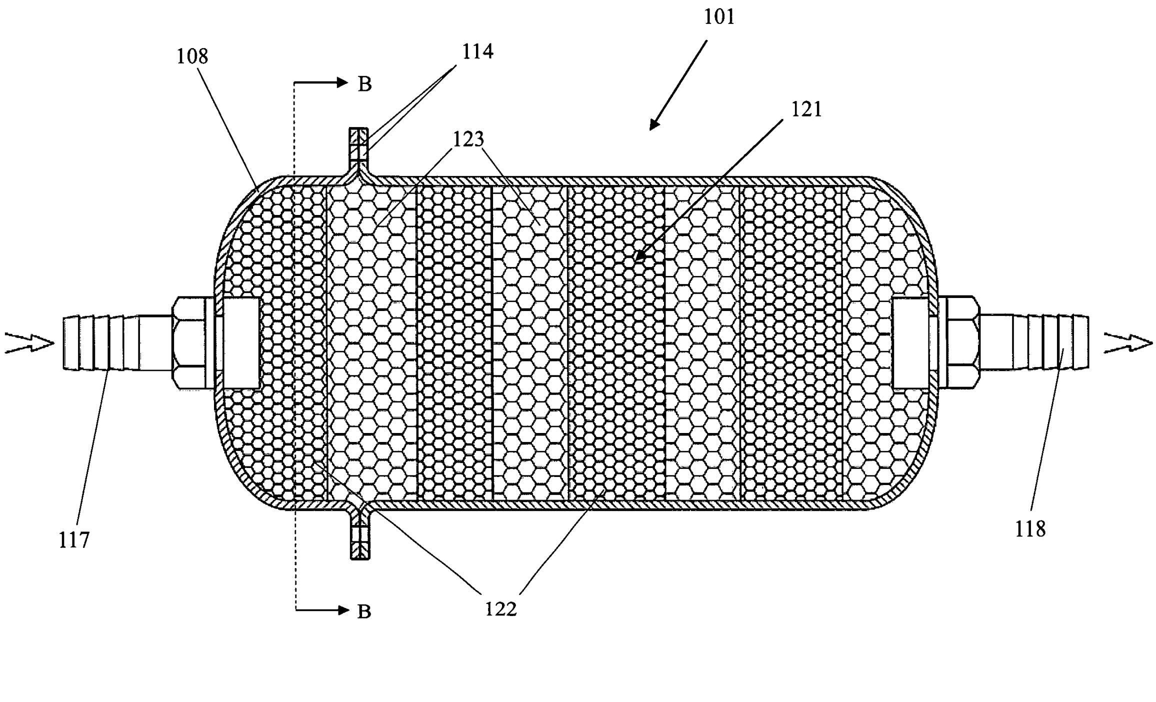

Figure 1c

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to the field of equipment for the reduction of noise pollution. More particularly, it relates to equipment to reduce noise and vibrational pollution caused by compressors that are used to transfer air to apparatus' or an environment, such as to a waste suspension treatment apparatus or to a domestic fish pond respectively.

Description of the Related Art

[0002] Compressors are frequently used in domestic or small-scale industrial environments so as to produce a consistent flow of air to a given environment or apparatus. One such example of an environment / arrangement in which a compressor might be used is in the temporary residential sector, for providing air to a small-scale waste suspension treatment apparatus, thus facilitating aerobic microbial digestion. Such an apparatus can be used to service the waste disposal needs of a caravan or a series of caravans. In such an environment, the waste suspension treatment apparatus is often situated beneath the caravan, installed within a small hole in the ground, or within close proximity to a series of caravans and connected by way of a pipe network. Compressors of typical design known in the art vibrate strongly and produce a considerable amount of noise (circa 60-70 decibels). Accordingly, when a compressor is attached to such an apparatus in the above example, unwanted noise and vibrations are produced which can lead to localised noise pollution and discomfort to the inhabitants of the dwelling(s).

[0003] Another example of an environment in which such compressors might be used is for domestic fish pond operation and maintenance. In such an example, owners of a small domestic pond typically connect a compressor so as to facilitate aeration of the pond, improving the quality of the water for the species kept therein, as well as helping to prevent stagnation, mosquito breeding and debris build-up. In the same manner as for the waste suspension treatment apparatus example, high levels of noise pollution and vibrational disturbances are not desirable.

[0004] Current solutions for the above issues include encasing the compressor within an acoustic cancellation chamber or wrapping it in an acoustic blanket. The chamber provides a high degree of noise cancellation, but in a number of environments (including those noted above) there is not sufficient space to install such a chamber, or such a chamber adds an unnecessary level of cost and is unsightly. As for the acoustic blanket, such blankets do not resolve the issue of downstream vibrations and noises induced within apparatus, such as the aforementioned waste suspension treatment apparatus. Here in particular, even if the compressor were to be wrapped in an acoustic blanket, the vibrations caused by the compressor still arrive downstream at the apparatus, thus causing the entire apparatus to vibrate, causing noise pollution and vibrational disturbances.

[0005] It has therefore been known for some time within the field that there is a need for a means by which the noise and vibrational pollution caused by such compressors may be significantly reduced, at a low cost and with minimal additional installation requirements.

[0006] Accordingly, it is an object of the present invention to address and obviate the aforementioned issues known in the art. In particular, it is an object to provide a unit for the reduction of noise and vibrational disturbances caused by compressors, that is back compatible with existing compressors and is more readily installable than existing alternatives. It is further an object to provide such a unit that does not have a downstream effect on aeration or an upstream effect on back-pressure.

BRIEF SUMMARY OF THE INVENTION

[0007] According to the present invention, there is provided a noise & vibration reduction unit comprising: elongate encasing body means, having first and second remote ends and provided with air inlet means and air outlet means; characterised in that said body means comprises a rigid shell means, defining an internal volume that is substantially filled by at least one cancellation medium.

[0008] Preferably, the air inlet means is situated adjacent the first end of said body means and the air outlet means is situated adjacent the second end of said body means.

[0009] This allows passage of air from the first end of the unit through to the second end of the unit and out of said unit.

[0010] Preferably, the or each at least one cancellation medium comprises an open cell polyurethane foam.

[0011] Most preferably, the or each at least one cancellation medium comprises an acoustic foam.

[0012] Advantageously, the unit comprises a plurality of cancellation media.

[0013] More advantageously, the plurality of cancellation media are arranged in layers, each layer having a cylindrical profile to match the internal circumference of the elongate encasing body means, forming a resistance fit therein.

[0014] Preferably, each layer of cancellation medium possesses a Noise Reduction Coefficient (NRC) different to that of adjacent layer(s).

[0015] Preferably, each layer of cancellation medium possesses a density different to that of the adjacent layer(s).

[0016] Preferably, each layer of cancellation medium possesses a Noise Reduction Coefficient (NRC) between 0.05 and 1.1 across a range of 100-5000Hz.

[0017] Preferably, each layer of cancellation medium has a density between 0.75 and 0.95kg/m^3.

[0018] Advantageously, the layers of cancellation media are arranged sequentially from a high NRC grade or density to a low NRC grade or density.

[0019] Most advantageously, the layers of cancellation media are arranged sequentially from a first layer having a density between 0.85 and 0.95kg/m^3, through to a final layer having a density between 0.75 and 0.85kg/m^3.

[0020] Preferably, the first and second ends of the elongate encasing body means are domed in shape.

[0021] More preferably, the elongate encasing body means comprises a dome ended cylindrical container.

[0022] This assists the unit with passage of air therethrough and obviating back-pressure build up.

[0023] Advantageously, the elongate encasing body means comprises a first encasing body section and a second encasing body section separable from the first.

[0024] More advantageously, the first and second encasing body sections are releasably attached to one another.

[0025] This allows the unit to be opened for maintenance and for selective exchange of layers of cancellation media.

[0026] Preferably, the elongate encasing body means comprises either a rigid plastics material or resins.

[0027] This provides improved vibrational damping to the unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The invention will now be described by way of example only with reference to the accompanying drawings, which are purely schematic and not to scale, of which:

Figure 1a is a schematic illustration of a first noise & vibration reduction unit embodying the present inventionshown in use in a perspective view;
Figure 1b is a plan view in isolation of the first noise & vibration reduction unit shown in Figure 1a;
Figure 1c is a cross-sectional plan view of the first noise & vibration reduction unit shown in Figure 1a, taken along line A-A;
Figure Id is a cross-sectional plan view of the first noise & vibration reduction unit shown in Figure 1a, taken along line B-B;
Figure 2 is a cross-sectional plan view of a second noise & vibration reduction unit embodying the present invention;
Figure 3 is a cross-sectional plan view of a third noise & vibration reduction unit embodying the present invention; and
Figure 4 is a cross-sectional plan view of a fourth noise & vibration reduction unit embodying the present invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

Figure 1a

[0029] Referring now to the Figures, and to Figure 1a in particular, an example of an environment in which a first noise & vibration reduction unit (indicated generally at 101) can be used is shown. The noise & vibration reduction unit 101 is operatively connected at a first end 102 to an air compressor (indicated generally at 103) by way of a first length of tubing 104, and is further operatively connected at a second end 105 to a waste suspension treatment apparatus (indicated generally at 106) by way of a second length of tubing 107. In such an environment, the noise & vibration reduction unit 101 is arranged so as to be within 0.1 to 5.0 metres of the air compressor 103 so that it can appropriately act upon the noises and vibrations caused by such compressors 103 upstream of the apparatus 106. In the example environment, the waste suspension treatment apparatus 106 is situated further away from the noise & vibration reduction unit 101 than is the compressor 103. The specifics of the noise & vibration reduction unit 101 and the manner in which it achieves its intended function will be discussed later with respect to Figures 1b to 1d.

[0030] It shall be understood that whilst Figure 1a depicts the noise & vibration reduction unit 101 in an environment where it is engaged with a waste suspension treatment apparatus 106 downstream, in an alternative environment, it may also be used for the same effect, but upstream of a domestic fish pond. In such an environment, the noise & vibration reduction unit 101 will still be operatively connected at its first end 102 to a compressor 103 by way of the first tubing 104, and it shall also be connected to the second tubing 107 at its second end 105. However, the second tubing 107 will instead run toward a domestic fish pond, where it shall be used for aeration of the pond water.

[0031] In both aforementioned environments, the noise and vibrations caused by compressors 103 that are known in the art are disturbing to and, in some instances, destructive to local ecosystems. Accordingly, the noise & vibration reduction unit 101 is operatively connected within 0.1 to 5.0 metres of such a compressor 103 by utilising an appropriate length of first tubing 104, so as to act upon it, reducing the noise and vibration produced both locally at the compressor 103 and further downstream at the subsequent piece of apparatus 106 or domestic fish pond that it is supplying air to.

Figures 1b to 1d

[0032] Figures 1b to 1d are intended to assist in illustrating the general structure of the first noise & vibration reduction unit 101. In particular, the internal and external components of the unit 101 and the way in which these achieve the desired technical effect of significantly reducing noise and vibrational disturbances locally at the compressor 103 and further downstream at the point where air is delivered via the second length of tubing 107.

[0033] The noise & vibration reduction unit is represented generally at 101. The unit 101 comprises an elongate encasing body (indicated generally at 108). The elongate encasing body 108 comprises a first encasing body section 109 and a second encasing body section 110 that are releasably attached to one another by way of fixings (indicated generally at 111, such as steel nut and bolt fixings). The first encasing body section 109 comprises a first connective flange 112 and the second encasing body section 110 comprises a second connective flange 113. These connective flanges (112 & 113) extend the entire outer circumference of their respective encasing body section (109 & 110) and have a mutual profile, forming a flush airtight seal when brought together. Each connective flange (112 & 113) is provided with a plurality of apertures 114 distributed equally about their profile. Each said aperture 114 is dimensioned and adapted to receive a first component 115 of the fixings 111 (such as a steel bolt) therethrough, and for a second component 116 of such fixings 111 (such as a steel nut) to be operatively connected with the first 115 and tightened until the first and second encasing body sections (109 & 110) are brought together and form an airtight seal. A layer of sealant, such as silicon sealant, may also be applied about the circumference of the seal between the two connective flanges. The first and second encasing body sections (109 & 110) each have a dome ended profile and upon releasable attachment to one-another, form a rigid and generally cylindrical elongate casing or shell (referred to herein as the elongate encasing body 108).

[0034] The elongate encasing body 108 is further provided with an air inlet adaptor 117 and an air outlet adaptor 118. The air inlet adaptor 117 is situated adjacent a first end 119 of the encasing body 108 and the air outlet adaptor is situated adjacent a second end 120 of the encasing body 108 remote from the first 119. More particularly, the air inlet adaptor 117 is attached at the tip of the dome end of the first encasing body section 109, forming a pathway therethrough, and the air outlet adaptor 118 is attached at the tip of the dome end of the second encasing body section 110, forming a pathway from one remote end 119 to the other 120 of the elongate encasing body 108. Accordingly, the first length of tubing 104 (comprising typical flexible rubber hosing), having first and second ends, may be engaged with the compressor 103 at its first end, and may then be engaged with (pushed over) the air inlet adaptor 117 at its second end, forming an air tight pathway therethrough. The air inlet and outlet adaptors (117 & 118) are of typical design, allowing rubber tubing to be passed over them. Accordingly, the unit 101 is designed so as to be back-compatible with any compressor designed to be connected to a downstream entity via tubing.

[0035] The second length of tubing 107, also having first and second ends, may then engage with (be pushed over) the air outlet adaptor 118 at its first end, and subsequently run a pre-determined distance (through adjusting its length) to appropriately situate its second end for connection to the aforementioned apparatus 106 or domestic pond outlet. Consequently, when the first and second encasing body sections (109 & 110) are releasably attached to one another, and the unit 101 is operatively connected to the compressor 103 and the downstream entity (either aforementioned apparats 106, domestic pond or other environment for delivery of air) by way of the first and second lengths of tubing (104 & 107), there is an airtight pathway formed through the unit 101. Said airtight pathway runs from the first end of the unit 119 to the second 120, with no observable escape of air pressure at the point at which where the first and second encasing body sections (109 & 110) are releasably brought together.

[0036] The elongate encasing body 108 acts as a rigid shell, defining an internal volume for filling / occupation with a cancellation medium (indicated generally at 121 in Figure 1c). In this embodiment, the elongate encasing body 108 is substantially filled with open celled polyurethane foam. More particularly, it is filled with a specific form of open celled polyurethane foam that is known in the art as acoustic foam. Acoustic foam is used for acoustic treatment, attenuating soundwaves through increasing air pressure, thereby reducing the amplitude of the waves. Acoustic foams come in different grades, presenting with different densities and Noise Reduction Coefficients (NRCs), thereby altering the subsequent air pressure. In the present embodiment, a first cancellation medium 122 (a first grade of acoustic foam) and a second cancellation medium 123 (a second grade of acoustic foam) are employed. The higher grade of acoustic foam, presenting with the higher NRC or higher density, is situated adjacent the air inlet adaptor 117, whilst the lower grade acoustic foam, presenting with the lower NRC or lower density, is situated adjacent the air outlet adaptor 118. The first and second cancellation media (122 & 123) each present with NRCs ranging between 0.05 to 1.1 across a frequency range of 100Hz to 5000Hz and with densities between 10 and 100kg/m^3. More specifically, with NRCs ranging between; 0.1 and 0.2 across 100-200Hz; 0.2 to 0.4 across 200-400Hz; 0.4 to 0.7 across 400-1000Hz; 0.7 to 1.0 across 1000-4000Hz; and 1.0 to 1.1 across 4000-5000Hz. The preferred range of density of the first and second media 122 & 123 for utilisation in the present embodiment is within 75-95kg/m^3. As noted, the first cancellation medium 122 presents with the highest density and NRC, preferably with density between 85-95kg/m^3 and average NRC across the 100-5000Hz range between 0.5 and 1.1. As noted, the second cancellation medium 123 presents with the lower density and NRC, preferably with density between 75-85kg/m^3 and an average NRC across the 100-5000Hz range between 0.05 and 0.5. The acostic foam utilised is also fire retardant and complies to BS476

Part 6: Class O, and BS476 Part 7: Class1, UL94-HF1 and F.M.V.S.S 302.

[0037] In the present embodiment, the first and second cancellation media (122 & 123) are longitudinally arranged in layers, one on top of the other as a repeating unit, extending the length and internal volume of the elongate encasing body 108. Accordingly, the substantial volume, if not entire volume, of the elongate encasing body 108 is filled with the first and second media (122 & 123). This occupation of the entire length and breadth of the unit 101 is further evidenced in the end-on sectional view of Figure Id, showing the transverse section of the first media 122 spanning the entire inner circumference of the encasing body 108. Accordingly, air passing through the elongate encasing body 108 fluctuates from a high air pressure to a low air pressure several times in accordance with the multitude of layers. The result of passing the air through the elongate encasing body 108 of the unit 101 (effectively as a cancellation chamber or silencer) is not complete soundproofing, but instead, significant nullification of sound and vibrations produced by the compressor 103.

[0038] In this regard, if a compressor 103 is attached directly to the downstream entity (either aforementioned apparatus 106, domestic pond or other) by way of a single length of tubing, significant levels of noise and vibrational pollution are prevalent, both stemming from direct connection of the downstream entity to the compressor 103. However, when the unit 101 is arranged in between the compressor 103 and the downstream entity (either aforementioned apparatus 106, domestic pond or other), there is a reduction in the sound and vibrations produced by the compressor 103 locally, as well as a reduction in the sound waves and vibrations that are transmitted to the downstream entity and are detected locally at the entity. In particular, the unit 101 achieves a 55% reduction in the sound and vibrations produced by the compressor 103, as well as reducing levels of high frequency pitch. The unit 101 also reduces the sound and vibrations locally at the downstream apparatus 106 by 85%. The unit 101 has also produced the unexpected result of eliminating compressor 103 pulsations, which are typically observed in the art and otherwise lead to further irritation at the reverberating noise pollution. When the unit 101 is arranged in series between the compressor 103 and the downstream entity, there is no observable build-up of back-pressure on the compressor 103, nor any observable change to the rate or quality of air output exhibited at the downstream entity (apparatus 106, domestic fish pond or other receiving environment of oxygen). Accordingly, the unit 101 reduces the noise and vibrational pollution to the environment that is otherwise caused by the compressor 103 whilst maintaining aeration and obviating any equipment issues at the compressor 103.

[0039] It shall be understood that whilst the present embodiment utilises two grades of acoustic foam (first and second media 122 & 123), in alternative embodiments (described with reference to figures 2 through 4) either a single grade of foam may be used to fill the chamber 108, or three or more different grades. The embodiment of Figure 1 is the preferred arrangement, as it achieves greater damping of sound and vibrational pollution than when using a single grade of acoustic foam, but it is cheaper to produce and more readily manufactured / maintained than the model with three or more foams. That being said, the releasable attachment of the first and second encasing body sections (109 & 110) allows the user to open the unit 101 and access the contents within the elongate encasing body 108 for maintenance or exchange. In this regard, even if the unit 101 is sold with a single grade of foam, two grades or multiple grades, the user may readily remove / exchange the grades of foam to achieve the levels of noise damping required, for tuneable noise damping.

[0040] Whilst the releasable attachment of the first and second encasing body sections (109 & 110) is desirable, it shall be understood that the unit 101 would still function if it were irreversibly sealed, such as if it were welded. Accordingly, an alternative embodiment may not feature the releasable attachment of the first and second encasing body sections (109 & 110), and instead may see the elongate encasing body 108 of the unit 101 as a single piece of material, or still comprising the first and second encasing body sections (109 & 110) but that are irreversibly attached to one-another.

[0041] The upstream end (119) of the first encasing body section 109 and the downstream end (120) of the second encasing body section 110 are each dome ended in profile, thereby giving a capsule shaped profile to the elongate encasing body 108 of the unit 101. This design has been selected as it helps to optimise the acoustic damping of the incoming soundwaves into the chamber, assisting the first and second cancellation media (122 & 123) in their role of attenuating sound waves.

[0042] The first and second encasing body sections (109 & 110) each comprise rigid plastics or resin materials. Plastics or resins are utilised on account that such materials typically transmit vibrations that are imposed upon them less than metals, thereby further assisting the first and second cancellation media (122 & 123), and the elongate encasing body 108 as a whole, to reduce the vibrations that would otherwise be translated downstream. However, in alternative embodiments, the elongate encasing body 108 of the unit 101 may comprise metals, being made up of first and second encasing body sections (109 & 110) that comprise metals (such as steel). The elongate encasing body 108 shown has dimensions in the range of 200-300mm length and 50-150mm width, with an internal diameter between 40 and 140mm, and is generally cylindrical with dome ends. It will be understood that the cancellation media 121 utilised within the apparatus 101 are appropriately dimensioned so as to substantially fill, if not entirely fill, the cavity / space provided within the elongate encasing body 108 and that the apparatus 101 can be scaled to accommodate various applications.

Figure 2

[0043] Figure 2 illustrates the general structure of a second noise & vibration reduction unit 201 embodying the present invention. In particular, the internal components of the unit 201 and the way in which these are different to those of the first noise & vibration reduction unit 101 as previously noted.

[0044] The second noise & vibration reduction unit 201 comprises substantially identical features as previously noted for the first noise & vibration reduction unit 101, except for the nature of the noise cancellation medium that fills the internal volume of the elongate encasing body 108. In particular, the elongate encasing body 108 of the second noise & vibration reduction unit 201 is substantially filled with a single cancellation medium 202. The single cancellation medium 202 of the second noise & vibration reduction unit 201 comprises a single variety of open celled polyurethane acoustic foam. More particularly, the single cancellation medium 202 of the second noise & vibration reduction unit 201 comprises a single grade of acoustic foam.

[0045] As previously noted, greater levels of acoustic damping are achieved with higher grade Noise Reduction Coefficient (NRC) bearing acoustic foams, i.e. foams with a greater density. A foam presenting with a NRC ranging between 0.05 to 1.1 across 100Hz to 5000Hz and with a density between 10 and 100kg/m^3 is utilised in the present embodiment. More specifically, with a NRC ranging between; 0.1 and 0.2 across 100-200Hz; 0.2 to 0.4 across 200-400Hz; 0.4 to 0.7 across 400-1000Hz; 0.7 to 1.0 across 1000-4000Hz; and 1.0 to 1.1 across 4000-5000Hz. The preferred range of density of the medium 202 for utilisation in the present embodiment is within 75-95kg/m^3. Moreover, it is preferred to use a foam towards the upper end of each of these ranges as it must compensate for the lack of damping that would otherwise be achieved through utilisation of two different grades of foam arranged in layers (as in the first unit 101).

[0046] It shall be understood that, much the same as the first unit 101, the second unit 201 comprises first and second encasing body sections (203 & 204 respectively) that may either be releasably or permanently attached to one-another. In the releasable attachment variation, the user has the ability to open the elongate body 108 of the second unit 201 and exchange the foam found therein, either for maintenance or for alteration of the properties exhibited by the unit 201.

Figure 3

[0047] Figure 3 illustrates the general structure of a third noise & vibration reduction unit 301 embodying the present invention. In particular, the internal components of the unit 301 and the way in which these are different to those of the first and second noise & vibration reduction units 101 & 201 as previously noted.

[0048] The third noise & vibration reduction unit 301 comprises substantially identical features as previously noted for the first noise & vibration reduction unit 101, except for the nature of the noise cancellation medium that fills the internal volume of the elongate encasing body 108. In particular, the elongate encasing body 108 of the third noise & vibration reduction unit 301 is substantially filled with more than two forms of cancellation media. In the depicted embodiment of the third unit 301, first 302, second 303, third 304 and fourth 305 cancellation media are present. The first to fourth cancellation media 302-305 of the third noise & vibration reduction unit 301 each comprise a single variety of open celled polyurethane acoustic foam. More particularly, the first to fourth cancellation media 302-305 of the third noise & vibration reduction unit 301 each comprise a single grade of acoustic foam.

[0049] The highest grade of acoustic foam, presenting with the highest density or highest Noise Reduction Coefficient (NRC), is situated adjacent the air inlet adaptor 117, whilst the lowest grade acoustic foam, presenting with the lowest density or lowest NRC, is situated adjacent the air outlet adaptor 118.

[0050] The first through fourth cancellation media 302-305 each present with NRCs ranging between 0.05 to 1.1 across 100Hz to 5000Hz and with densities between 10 and 100kg/m^3. More specifically, with NRCs ranging between; 0.1 and 0.2 across 100-200Hz; 0.2 to 0.4 across 200-400Hz; 0.4 to 0.7 across 400-1000Hz; 0.7 to 1.0 across 1000-4000Hz; and 1.0 to 1.1 across 4000-5000Hz. The preferred range of density of the first through fourth media 302-305 for utilisation in the present embodiment is within 75-95kg/m^3. As noted, the first cancellation medium 302 presents with the highest density and NRC, preferably with density between 85-95kg/m^3 and average NRC across the 100-5000Hz range between 0.5 and 1.1. As noted, the last (fourth) cancellation medium 305 presents with the lowest density and NRC, preferably with density between 75-85kg/m^3 and an average NRC across the 100-5000Hz range between 0.05 and 0.5. The second and third media 303 & 304 present with densities or NRCs within the between the ranges of the first 302 and fourth 305 media.

[0051] In the embodiment shown in Figure 3, the first through fourth cancellation media 302-305 are arranged in layers, extending longitudinally, one on top of the other as a repeating unit, extending the length and internal volume of the elongate encasing body 108. Accordingly, the substantial volume, if not entire volume, of the elongate encasing body 108 is filled with the first though fourth media 302-305. Accordingly, air passing through the elongate encasing body 108 fluctuates from a high air pressure to a low air pressure several times in accordance with the multitude of layers. The result of passing the air through the elongate encasing body 108 of the third unit 301 (effectively as a cancellation chamber or silencer) is not complete soundproofing, but instead, significant nullification of sound and vibrations produced by the compressor 103.

[0052] It shall be understood that, much the same as the first unit 101, the third unit 301 comprises first and second encasing body sections (306 & 307 respectively) that may either be releasably or permanently attached to one-another. In the releasable attachment variation, the user has the ability to open the elongate body of the third unit 301 and exchange the foam found therein, either for maintenance or for alteration of the properties exhibited by the unit 301.

Figure 4

[0053] Figure 4 illustrates the general structure of a fourth noise & vibration reduction unit 401 embodying the present invention. In particular, the internal components of the unit 401 and the way in which these are different to the first. Second and third noise & vibration reduction units 101, 201 & 301 as previously noted.

[0054] The fourth noise & vibration reduction unit 401 comprises substantially identical features as previously noted for the first noise & vibration reduction unit 101, with exception to the arrangement of the noise cancellation media that fills the internal volume of the elongate encasing body 108. In particular, the elongate encasing body 108 of the fourth noise & vibration reduction unit 401 is substantially filled with two forms of cancellation media. In the depicted embodiment of the fourth unit 401, there are represented first and second cancellation media (402 & 403 respectively). The first and second cancellation media (402 & 403) of the fourth noise & vibration reduction unit 401 each comprise a single variety of open celled polyurethane foam. More particularly, the first and second cancellation media (402 & 403) of the fourth noise & vibration reduction unit 401 each comprise a single grade of acoustic foam.

[0055] The highest grade of acoustic foam, presenting with the highest density or highest Noise Reduction Coefficient (NRC), is situated adjacent the air inlet adaptor 117, whilst the lowest grade acoustic foam, presenting with the lowest density or lowest NRC, is situated adjacent the air outlet adaptor 118. The first and second cancellation media (402 & 403) each present with NRCs ranging between 0.05 to 1.1 across 100Hz to 5000Hz and with densities between 10 and 100kg/m^3. More specifically, with NRCs ranging between; 0.1 and 0.2 across 100-200Hz; 0.2 to 0.4 across 200-400Hz; 0.4 to 0.7 across 400-1000Hz; 0.7 to 1.0 across 1000-4000Hz; and 1.0 to 1.1 across 4000-5000Hz. The preferred range of density of the first and second media 402 & 403 for utilisation in the present embodiment is within 75-95kg/m^3. As noted, the first cancellation medium 402 presents with the highest density and NRC, preferably with density between 85-95kg/m^3 and average NRC across the 100-5000Hz range between 0.5 and 1.1. As noted, the second cancellation medium 403 presents with the lower density and NRC, preferably with density between 75-85kg/m^3 and an average NRC across the 100-5000Hz range between 0.05 and 0.5.

[0056] In the present embodiment, the first and second cancellation media 402 & 403 extend the entire length and internal volume of the elongate encasing body 108. Accordingly, the substantial volume, if not entire volume, of the elongate encasing body 108 is filled with the first and second media 402 & 403. However, unlike the first noise & vibration reduction unit 101, the fourth unit 401 only utilises a single layer of each foam 402 & 403 as opposed to repeated layers of the foam arranged on top of one another in series. Accordingly, air passing through the elongate encasing body 108 passes once from a high air pressure (high grade NRC) to a low air pressure (low grade NRC), resulting in the reduction of sound and vibrational disturbances produced by the compressor 103.

[0057] It is preferred to fill the encasing body 108 with alternating layers of the foams (as per the first unit 101) as it is believed that this achieves greater levels of acoustic and vibrational damping. However, it will be appreciated that the present embodiment provides an alternative unit 401 which would still lead to reduced levels of acoustic and vibrational disturbances caused by a compressor 103 in comparison to a compressor 103 that is used with no such unit 401.

[0058] It shall be understood that, much the same as the first unit 101, the fourth unit 401 comprises first and second encasing body sections (404 & 405 respectively) that may either be releasably or permanently attached to one-another. In the releasable attachment variation, the user has the ability to open the elongate body of the fourth unit 401 and exchange the foam found therein, either for maintenance or for alteration of the properties exhibited by the unit 401.

[0059] It shall also be understood that whilst the fourth unit 401 represents an embodiment where only two layers of foam are utilised (402 & 403) as a single layer, the same method of filling the unit 401 may be applied to the plurality of foam variant of unit 301. That is to say, the unit may alternatively comprise greater than two types of acoustic foam, such as three or more, but no repetition of the arrangement shall be observed, with the encasing body simply comprising one section of each variety of foam arranged on top of one-another.

Claims

1. A noise & vibration reduction unit (101) comprising:

   elongate encasing body means (108), having first (119) and second remote ends (120) and provided with air inlet means (117) and air outlet means (118);
   characterised in that
   said body means (108) comprises a rigid shell, defining an internal volume that is substantially filled by at least one cancellation medium (121).

2. The noise & vibration reduction unit of claim 1,

wherein the air inlet means (117) is situated adjacent the first end (119) of said body means (108) and the air outlet means (118) is situated adjacent the second end (120) of said body means (108).

3. The noise & vibration reduction unit of either claim 1 or claim 2, wherein the or each at least one cancellation medium (121) comprises an open cell polyurethane foam.

4. The noise & vibration reduction unit of any preceding claim, wherein the or each at least one cancellation medium (121) comprises an acoustic foam.

5. The noise & vibration reduction unit of any preceding claim, comprising a plurality of cancellation media (121) together extending from adjacent the first end (119) of the body means (108) to adjacent the second end (120) of the body means (108).

6. The noise & vibration reduction unit of claim 5, wherein the plurality of cancellation media (121) are arranged in layers, each layer extending transversely to a longitudinal axis of the elongate body means (108).

7. The noise & vibration reduction unit of claim 6, wherein each layer of cancellation medium (121) possesses a Noise Reduction Coefficient (NRC) different to that of each layer adjacent thereto.

8. The noise & vibration reduction unit of claim 7, wherein each layer of cancellation medium (121) possesses a Noise Reduction Coefficient (NRC) between 0.05 and 1.1 across a spectrum of 100-5000Hz.

9. The noise & vibration reduction unit of any one of claims 6 to 8, wherein each layer of cancellation medium (121) possesses a density different to that of each layer adjacent thereto.

10. The noise & vibration reduction unit any one of claims 6 to 9, wherein each layer of cancellation medium (121) has a density between 0.75 and 0.95kg/m^3.

11. The noise & vibration reduction unit of any one of claims 6 to 10, wherein the layers of cancellation media (121) are arranged sequentially from a high density to a low density.

12. The noise & vibration reduction unit of claim 11, wherein the layers of cancellation media (121) are arranged sequentially from a first layer (122) having a density between 0.85 and 0.95kg/m^3, through to a final layer (123) having a density between 0.75 and 0.85kg/m^3.

13. The noise & vibration reduction unit of any preceding claim, wherein the elongate encasing body means (108) comprises a first encasing body section (109) and a second encasing body section (110).

14. The noise & vibration reduction unit of claim 13, wherein the first and second encasing body sections (109 & 110) are releasably attached to one another.

15. The noise & vibration reduction unit of any preceding claim, wherein the elongate encasing body means (108) comprises either a rigid plastics material or a resin.

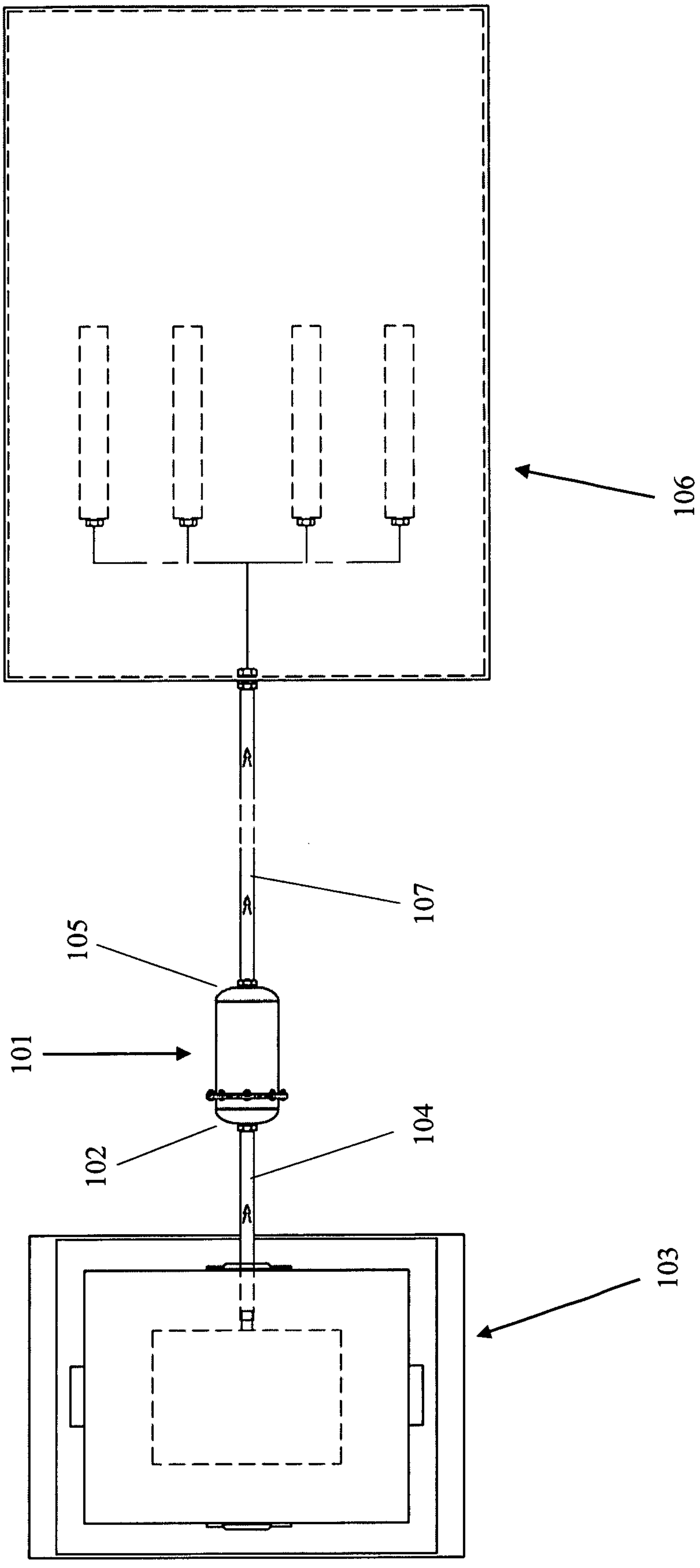

Figure 1a

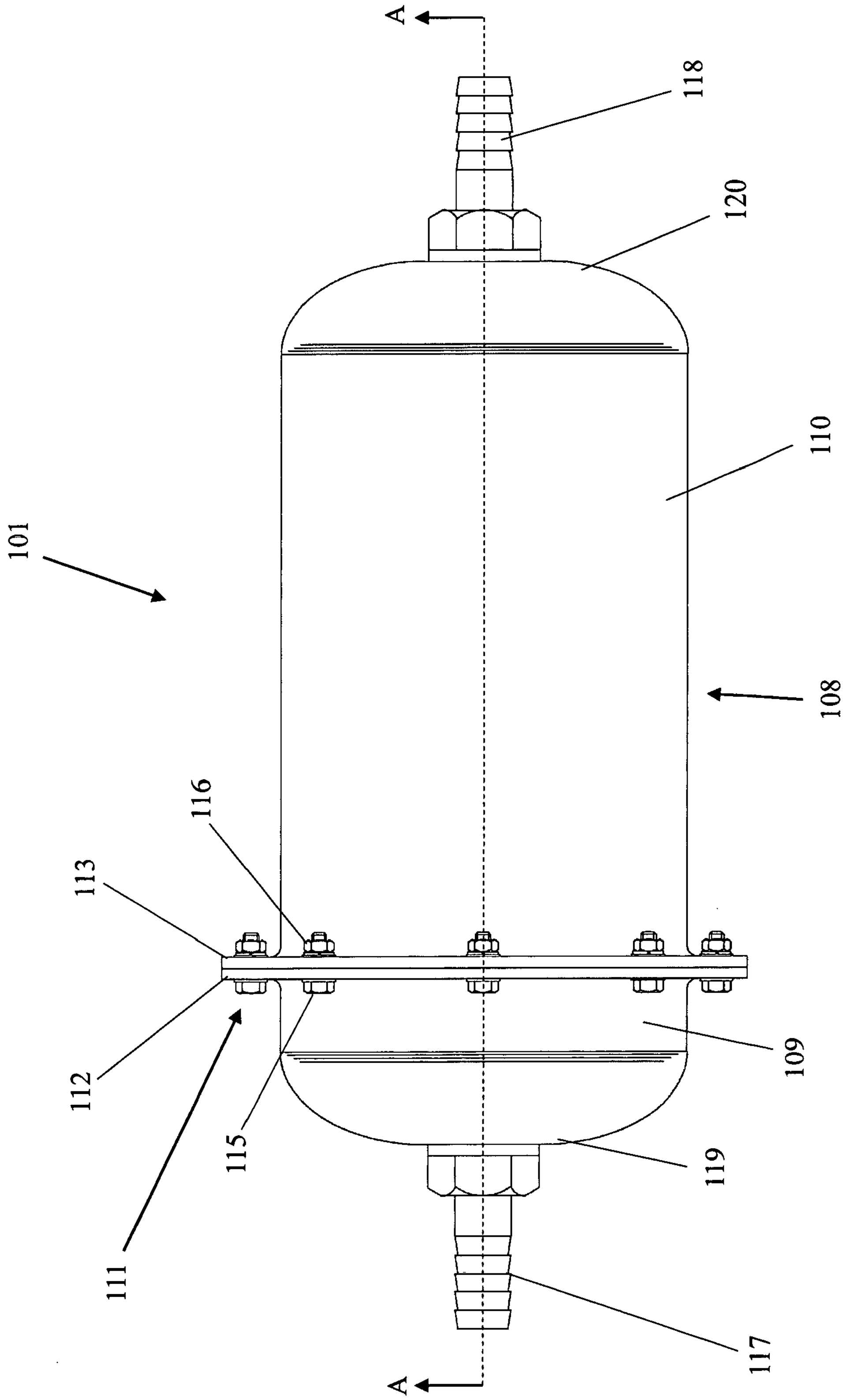

Figure 1b

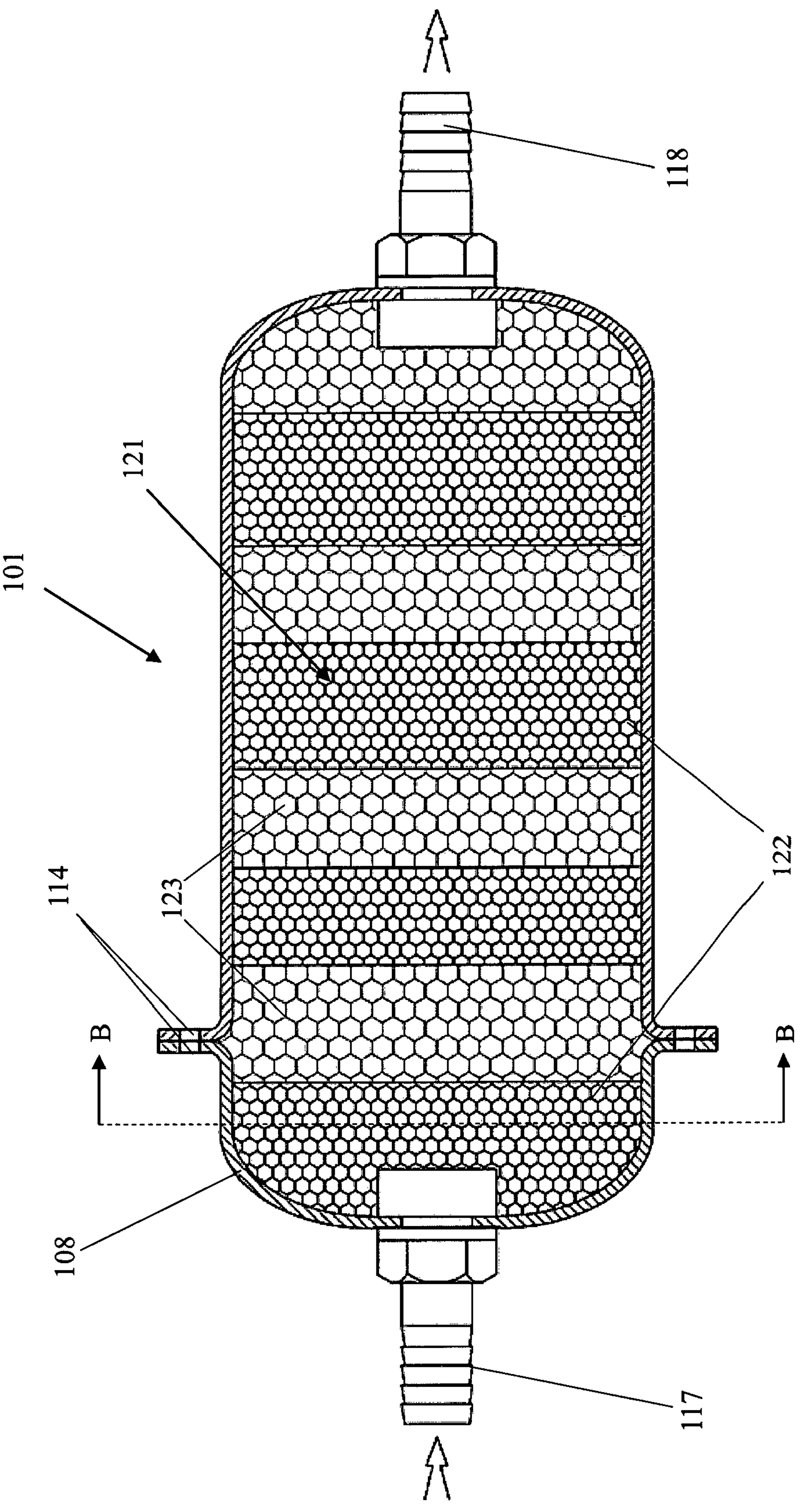

Figure 1c

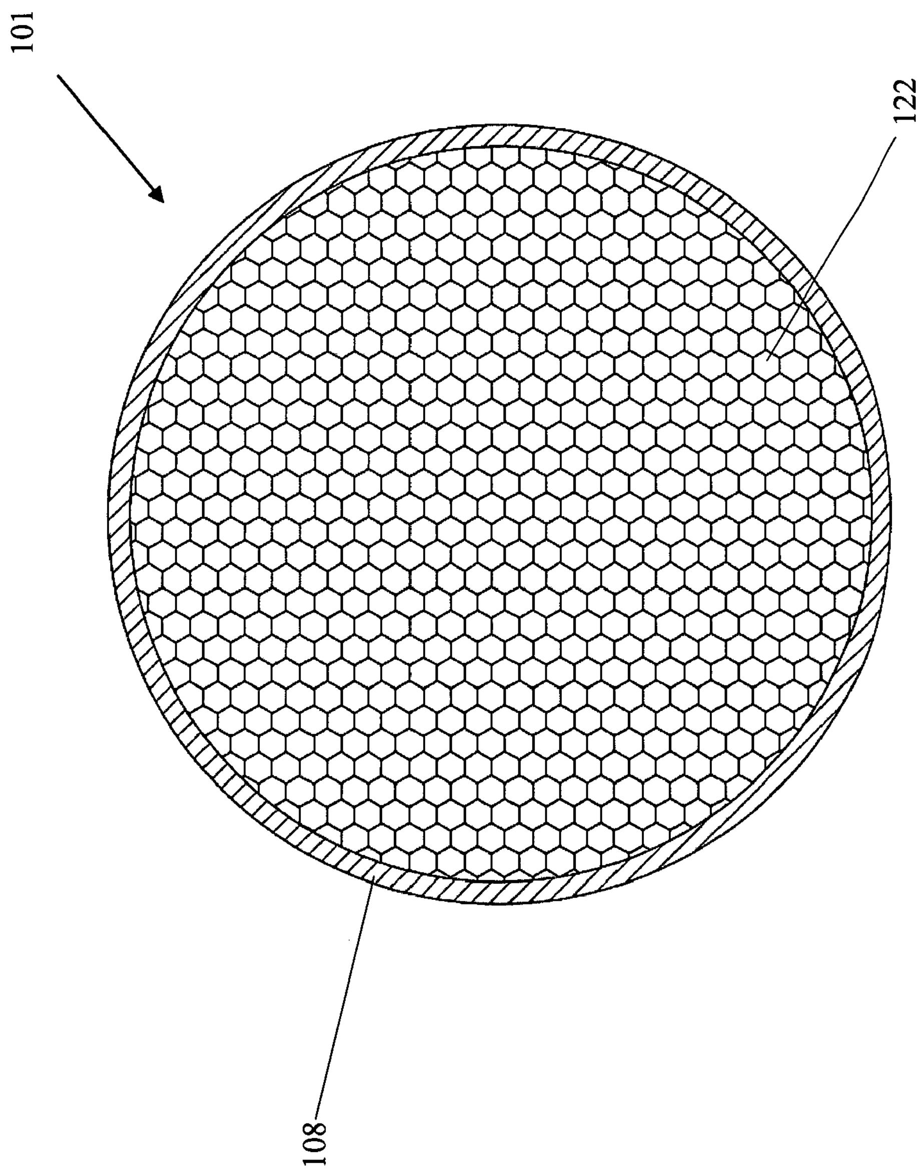

Figure 1d

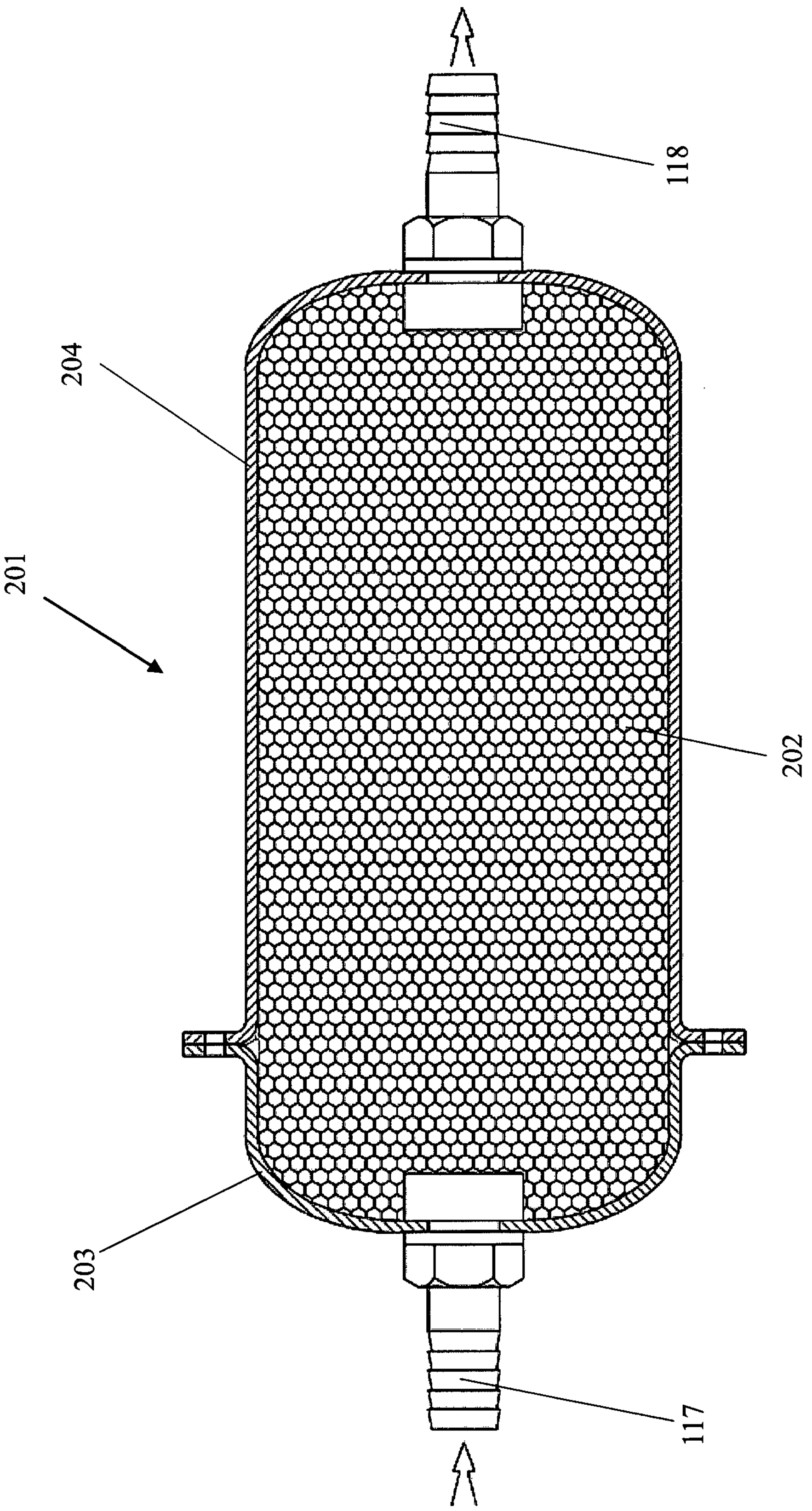

Figure 2

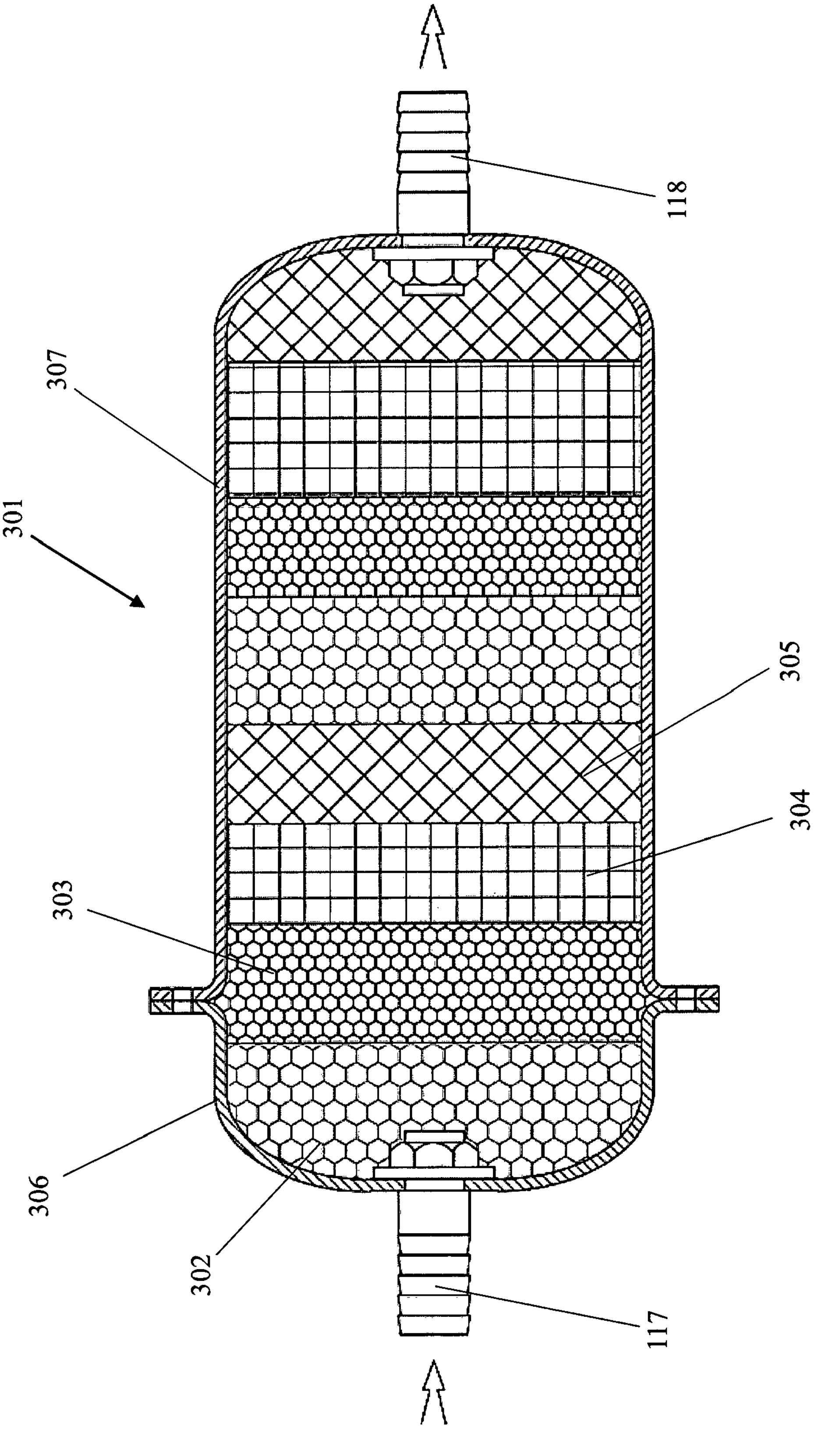

Figure 3

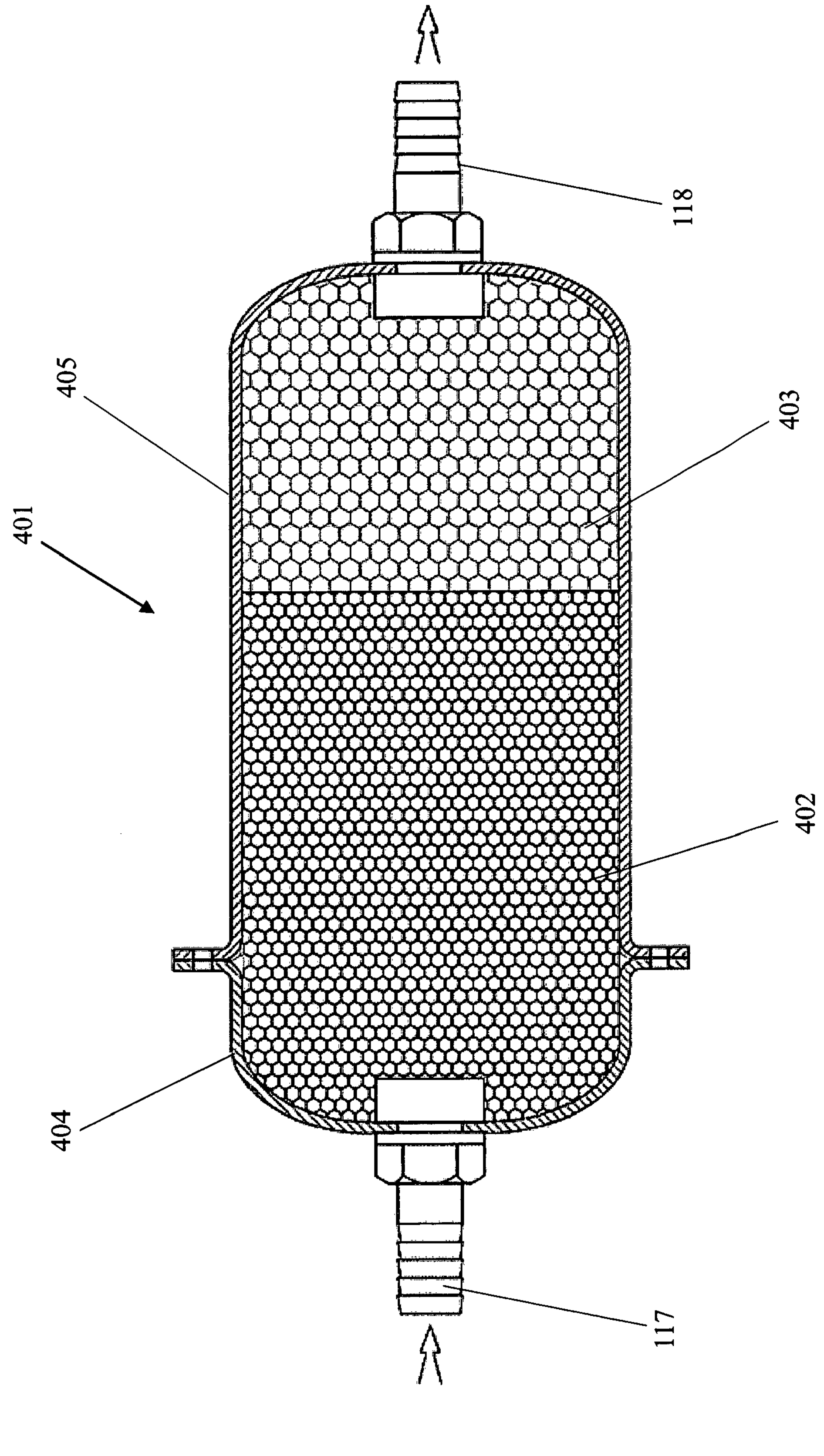

Figure 4

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EUROPEAN SEARCH REPORT

Application Number
EP 19 00 0203

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	10 July 2019	Olona Laglera, C

CATEGORY OF CITED DOCUMENTS

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