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(54) ATTENUATOR FOR AIR-CONDITIONING DUCT AND METHOD OF MANUFACTURING THE SAME

(57) The application refers to an attenuator (102) to be installed in an air-conditioning duct (300) according to one embodiment, which attenuator comprises a cylindrical frame (104), flow openings (114) in a direction of a mantle (106) of the frame and at least one adjusting plug (116). The frame is manufactured from a porous, sound-absorbing, flexible material so that the mantle of the installed attenuator presses against an inner surface (312) of the air-conditioning duct. The cross-sectional shape and dimensions of the at least one adjusting plug correspond to a corresponding flow opening (114) so that the at least one adjusting plug can be fitted into the corresponding flow opening in order to adjust the amount of air flow in the air-conditioning duct. The angle (PV) between a surface (PI) formed by a supply air end (108) of the attenuator and the mantle and an angle (TV) between a surface (PI) formed by an exhaust air end (110) of the attenuator and the mantle are sharp angles (PV, TV) achieving a narrowing (KA) of a middle part of the frame, where a diameter (VH) of a cross-section of the attenuator is smaller than diameters (PH) of the surfaces (PI) formed by the supply air end and exhaust air end (108, 1109) in order to improve a pressing of the mantle against the inner surface of the air-conditioning duct.

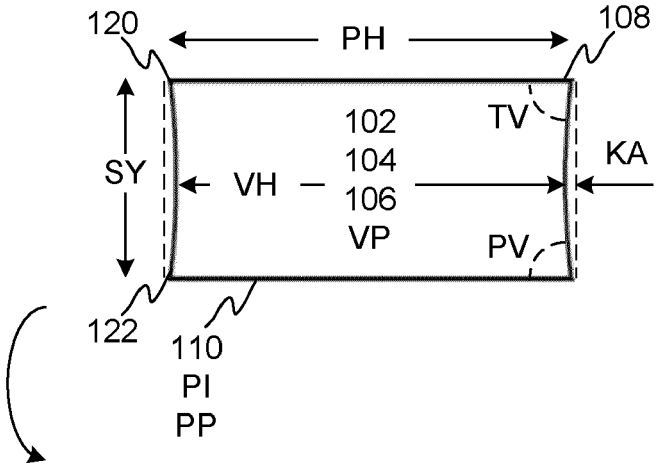

Fig. 1a

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Description

Technical field

[0001] The invention generally relates to an attenuator to be installed in an air-conditioning duct.

Background

[0002] One solution for adjusting the air flow speed and volume in a room's supply or exhaust air duct is a disc valve. The air flow is adjusted by turning the closing disc of the disc valve around its axle, whereby the flow gap (distance) between the closing disc and the valve frame increases or decreases in accordance with the turning direction of the closing disc.

[0003] A problem with a disc valve is that its sound attenuating properties are weak, its adjustment unprecise, when the distance between the closing disc and the valve frame is adjusted without measuring, and its adjustment is difficult, when the determining of the distance between the closing plate and the valve frame being a prerequisite for the desired air flow and corresponding thereto requires measuring with separate measuring means and a precise adjustment of the distance based on the measuring result.

[0004] One solution, which can be used also in connection with disc valves, is a cylindrical attenuator according to application publication EP 1098146 to be installed into circular air-conditioning ducts, meant for adjusting air flow, with the aid of the flow openings, which can be closed and opened with plugs, of which the amount of air passing through it is adjusted. A number of flow openings enabling a desired air flow is left open in the attenuator manufactured from a flexible and porous material, and the rest of the flow openings are closed with plugs before the attenuator is installed in the air-conditioning duct. Air flow through the attenuator installed in place thereafter occurs through the open flow openings.

[0005] Other attenuator solutions are presented in patent application publications WO 2004/023047 and JP 2008-303662.

Summary

[0006] One object of the invention is to solve prior art problems and implement an easily installable attenuator manufactured from a flexible material, which presses tightly against the inner surface of the air-conditioning duct comprising a threaded seam, with the aid of which attenuator the amount of air flow in the air-conditioning duct can be adjusted and the sound caused by the air flow can be attenuated in an efficient manner.

[0007] One object of the invention is accomplished by the attenuator and manufacturing method according to the independent claims.

[0008] Some embodiments of the invention comprise the attenuator and manufacturing method according to the independent claims.

[0009] One attenuator to be installed in an air-conditioning duct comprises a cylindrical frame, flow openings in a direction of a mantle of the frame, and at least one adjusting plug. The frame is manufactured from a porous, sound-absorbing, flexible material so that the mantle of the installed attenuator presses against an inner surface of the air-conditioning duct. The cross-sectional shape and dimensions of the at least one adjusting plug correspond to a corresponding flow opening so that the at least one adjusting plug can be fitted into the corresponding flow opening in order to adjust the amount of air flow in the air-conditioning duct. The angle between a surface formed by a supply air end of the attenuator and the mantle, and an angle between a surface formed by an exhaust air end of the attenuator and the mantle are sharp angles achieving a narrowing of a middle part of the frame, where a diameter of a cross-section of the attenuator is smaller than diameters of the surfaces formed by the supply air end and exhaust air end in order to improve a pressing of the mantle against the inner surface of the air-conditioning duct.

[0010] One manufacturing method, which is meant for manufacturing the above-mentioned attenuator, comprises at least following steps of installing manufacturing in a shape cutter and pressing, by the shape cutter, the manufacturing material with the aid of a mold into a shape of the attenuator so that the narrowing is formed in the middle part of the frame, where the diameter of the cross-section of the attenuator is smaller than the diameters of the surfaces formed by the supply air end and the exhaust air end.

Short description of the figures

[0011] The exemplary embodiments of the invention are presented in more detail with reference to the following figures:

- fig. 1a-1d show an attenuator formed from groat pressed foam without adjusting plugs and equipped with adjusting plugs, seen from the side, diagonally from above and from above
- fig. 2a-2d show an attenuator formed from a layer structure without adjusting plugs and equipped with adjusting plugs, seen from the side and diagonally from above
- fig. 3 shows a cross-sectional view of the operating principle of an attenuator manufactured from groat pressed foam installed in a threaded seam air-conditioning duct

Detailed description of the figures

[0012] Fig. 1a-1d show an attenuator 102 meant for adjusting and measuring air flow IL and attenuating the

sound caused by the air flow IL, which can be installed in a threaded seam air-conditioning duct (air-conditioning pipe) 300.

[0013] The attenuator 102 has a cylindrical frame 104, which is manufactured from porous, sound-absorbing, flexible material. The frame 104 has a mantle 106, which has a depth (height, length) SY and a surface area VP, and supply air and exhaust air ends 108, 110, the diameters of the surface PI of which are PH and the cross-sectional surface areas PP.

[0014] Due to the flexible manufacturing material, the mantle 106 of the frame 104 of the attenuator 102 installed in the duct 300 presses sufficiently tightly against the inner surface 312 of the duct 300, so that the attenuator 102 stays in place in the duct 300 and prevents an air flow IL between the mantle 106 and the inner surface 312, when the attenuator 102 to be installed is manufactured so that at least its diameter PH is larger than the diameter SH of the inner surface 312 of the duct 300.

[0015] The diameter PH of the attenuator 102 is e.g. 1-3 mm larger than the diameter SH of the inner surface 312 of the channel 300. The size of the diameter PH is 64-318 mm, for example 64, 81, 101, 126, 161, 201, 252 and 318 mm, but the attenuator 102 can also be manufactured in other dimensions, depending on the diameter SH of the duct 300. The depth SY of the attenuator 102 in turn is 25-75 mm, e.g. 25, 50 or 75 mm.

[0016] The attenuator 102 is installed in the duct 300 by pushing it from the open end of the duct 300, whereby the manufacturing material of the attenuator 102 expands and presses into place in the duct 300 against its inner surface 312. The attenuator 102 stays in place (fixed) in the channel 300 with the aid of friction without separate fasteners.

[0017] The frame 104 has flow openings (ducts) 114 in the direction (depth, height, length direction) of its mantle 106, the purpose of which openings is to allow air flow IL to flow through the attenuator 102 installed in the duct 300 in a controlled manner from the end 108 into the mantle 106 and from the end 110 out of the mantle 104. For example three, four, in accordance with the figures five, six or more openings 114 have been formed in the frame 104.

[0018] The openings 114 can be formed in the attenuator 102 in different shapes, e.g. in accordance with the figures with elliptical (oval) or circular shaped cross-sections. Alternatively, or additionally, openings 114 can be formed in the attenuator 102 in different sizes (dimensions), whereby their cross-sectional area AP varies. The openings 114 in the attenuator 102 have, in accordance to the figures, the same shape and size, or alternatively, the shape, size or both of at least one opening 114 differs from the other openings 114 in the attenuator 102. The length of the openings 114 corresponds to the depth SY of the attenuator 102.

[0019] The openings 114 are formed in the frame 104 at suitable distances from each other and their position in the frame 104 depends on their shape, size, number and possible shape and size differences of the openings 114. It is possible to place the openings 114 symmetrically and evenly in relation to the central axis KE passing through the central points KP of the ends 108, 110 of the frame 104, e.g. as in the figures.

[0020] The attenuator 102 additionally has at least one adjusting plug 116, each of which plugs 116 is meant to close one of the openings 114 of the frame 104 and to prevent the air flow IL from flowing through the attenuator 102 through the closed opening 114 in question. Naturally, each attached plug 116 can also be detached in order to open the opening 114. At least one plug 116 is additionally meant to guide the air flow IL to flow through the attenuator 102 via at least one opening 114 left open.

[0021] The shape and size (dimensions) of the cross-sectional surface area AP of each plug 116 correspond to the shape and size of the cross-sectional surface AP of the opening 114 meant for it, so that the plug 116 can be fitted in the opening 114 sufficiently tightly in order to close it, and if necessary, it can be detached in order to open the opening 114. The length of the at least one plug 116 corresponds to the depth SY of the attenuator 102 as well as of the openings 114.

[0022] It is possible to adjust the amount of air flow IL flowing through the attenuator 102 installed in the duct 300 to be smaller by closing a desired number of the openings 114, i.e. by fitting a plug 116 in each of the openings 114 to be closed, so that at least one of the openings 114 remains open, whereby the air flow IL is guided through the at least one opening 114 which remained open, with a cross-sectional surface shape size AP, from the side of the end 108 of the attenuator 102 to the side of the end 110. Correspondingly, it is possible to adjust the amount of air flow IL flowing through the attenuator 102 to be larger by keeping a required number of the openings 114 open, i.e. by removing the plug 116 from each of the openings 114 to be kept open.

[0023] The frame 104 can in addition to the openings 114 have at least one flow cut (not shown in the figures) in the direction of the mantle 106 shaped in the surface of the mantle 106, so that the shape and size of the flow opening achieved by each cut is determined by the inner surface 312 of the duct 300 and the surface (outer surface) of the mantle 106. The at least one cut is not meant to be closed, but it is meant to always be open and to allow the air flow IL to flow through the attenuator 102 installed in the duct 300 in a controlled manner between the surface of its mantle 106 and the inner surface 312 from the end 108 to the end 110. The at least one cut comprises e.g. one or two cuts.

[0024] The frame 104 has, in addition to the openings 114, a measuring coupling 118 in the direction of the depth direction of the mantle 106, penetrating the frame 104, into which measuring coupling a measuring pipe needed for measuring a pressure difference between the ends 108, 110 can be installed. The measuring coupling 118 can be closed with its own plug 119 in accordance with the figures.

[0025] The attenuator 102 is manufactured so that the angle TV between the surface PI formed by the end 108 of the frame 104, meant to be against incoming air flow IL, and the mantle 106, and the angle PV between the surface PI formed by the end 110, meant to be in the direction of the exiting air flow IL, and the mantle 106 are sharp, under 90 degree angles TV, PV, whereby a narrowing KA is formed in the frame 104 (mantle 106), in the middle part when seen in the depth direction.

[0026] Due to the narrowing KA, the diameter VH of the cross-sectional surface of the middle part is by the narrowest part of the frame 104, in the middle part in the depth direction of the attenuator 102, smaller than the diameters PH of the surfaces PI formed by the ends 108, 110, in order to improve the pressing of the mantle 106 against the inner surface 312 of the duct 300. The diameters PH of the surfaces PI of the ends 108, 110 are 2-3 mm larger than the narrowed diameter VH of the middle part of the frame 104, so that the attenuator 102 has the shape of a cylinder pressed at the middle. The diameters PH of the ends 108, 110 are 1-3 mm larger and the diameter VH of the narrowest point of the frame 104 is in turn 0-1 mm smaller than the diameter SH of the duct 300, into which the attenuator 102 is intended.

[0027] Due to the narrowing KA, the sharp supply and exhaust end edges 120, 122 formed by the angles TV, PV of the attenuator 102 push against the inner surface 312 of the duct 300 equipped with a threaded seam 324 and the inner surface 326 of the grooves formed by the threaded seams 324 on the inner surface 312 regardless of the manufacturer of the duct 300, so that the air flow IL cannot flow uncontrollably between the mantle 106 of the attenuator 102 and the inner surface 312 along the threaded seam 324 regardless of the manufacturer of the duct 300.

[0028] Due to the narrowing KA, the frame 104 of the attenuator 102 installed in the duct 300 retains its shape, so that the openings 114 are not compressed, simultaneously reducing their cross-sectional surface area AP and the amount of air flow IL flowing through.

[0029] The frame 104 of the attenuator 102 and each plug 116 are manufactured using as manufacturing material an open-cell groat pressed foam, in order to support their, and the especially the frame's 104, structure and improve the sound attenuation. The end 108 of the frame 104, i.e. surface PI, and the supply air end 126 toward the supply air of each plug 116 manufactured from groat pressed foam are in the supply air direction coated with a polyethylene plastic film 128, 130 in order to prevent flow through of an air flow IL outside the openings 114.

[0030] The attenuator 102 is manufactured using shape cutting (die cutting), where the manufacturing material to be used for manufacturing the attenuator 102 is installed in a shape cutter (cutting tool, die cutter) and the shape cutter is used to cut with the aid of a mold the manufacturing material in the shape of an attenuator 102 equipped with a sharp-edged 120, 122 frame 104 and plugs 116 which can be detached therefrom.

[0031] Due to the shape cutting, the dimensions of the attenuator 102 are as desired, in contrast to cutting occurring with the aid of a water jet, where the water jet bends so, that the cross-sectional surface area PP of one end 110 is larger than the other end 108.

[0032] Fig. 2a-2c show an attenuator 102 corresponding to the previous figures with regards to its manufacturing, shape, dimensions and function, which can be installed in a duct 300 equipped with a threaded seam 324, which attenuator differs from the others only with regards to its layered three-layer structure 232, 234, 236.

[0033] The three-layer structure of the frame 104 and each plug 116 of the attenuator 102 of the figures is manufactured from polyester fibre layers 232, 234 in the ends 108, 110 and a groat pressed foam layer 236 glued between them, so that the layer structure 232, 234, 236 of the frame 104 and each plug 116 is intended to improve the sound attenuation and reduce sound production cause by the air flow IL.

[0034] The thickness of the fibre layers 232, 234 is 10-25 mm, e.g. 10, 15, 20 or 25 mm, and the foam layer 236 is 20-50 mm, e.g. 20, 35 or 50 mm, in the three-layer structure 232, 234, 236.

[0035] Fig. 2d shows an attenuator 102 corresponding to the previous figures, which differs from the attenuators 102 of the previous figures only with regards to its two-layer structure 234, 236. The two-layer structure of the frame 104 and each plug 116 of the attenuator 102 of the figure is manufactured from a groat pressed foam layer 236 and a polyester fibre layer 234 glued together, to the end 110 of which a polyester fibre fabric 237 has been attached with heat processing to prevent the polyester fibre layer 234 from tearing due to the air flow IL of the attenuator 102.

[0036] The thickness of the foam layer 236 is e.g. 50-65 mm, e.g. 50, 55, 60 or 65 mm, and the fibre layer 234 is e.g. 10-25 mm, e.g. 10, 15, 20 or 25 mm, in the two-layer structure 234, 236.

[0037] In connection with the three-layer structure 232, 234, 236, a plastic film 128, 130 does not need to be used in the attenuator 102 in the ends 108, 126 of the frame 104 and each plug 116 on the supply air IL side, but in the two-layer structure 234, 236, a plastic film 128, 130 is used on top of the foam layer 236.

[0038] Fig. 3 shows the cross-section of a threaded seam duct 300 and a therein installed attenuator 102 manufactured completely from groat pressed foam. The installation of an attenuator 102 manufactured from a layer structure 232, 234, 236 and other attenuators 102 differing from the figure into a duct 300 and their function occur in a corresponding manner.

[0039] The air flow IL comes into the duct 300 installed in the structure 338, through openings 342 in a front grill (air, cover plate) 340 installed in front of it. In the attenuator 102 installed against the inner surface 312 of the duct 300, four openings 114 have been closed with plugs 116 and only the center opening 114 has been left open, along which the air flow IL can move through the atten-

uator 102 onward in the duct 300.

[0040] The mantle 106 of the frame 104 remains at its narrowest middle part about 0.5 mm apart from the duct 300 and starts to press against the inner surface 312 the harder, the closer we get to the ends 108, 110, whereby the sharp edges 120, 122 push while pressing against the threaded seam 324 against its inner surface 326, so that the air flow IL cannot push past the attenuator 102 along the threaded seam 324 between the mantle 106 and the inner surface 312.

[0041] Only some preferred embodiments of the invention are shown above. The principle according to the invention can naturally be varied within the protective scope defined by the claims, for example with regards to details and application areas of the implementation.

Claims

1. An attenuator (102) to be installed in an air-conditioning duct (300), comprising

a cylindrical frame (104),
flow openings (114) in a direction of a mantle (106) of the frame, and
at least one adjusting plug (116),
where the frame is manufactured from a porous, sound-absorbing, flexible material so that the mantle of the installed attenuator presses against an inner surface (312) of the air-conditioning duct,
where the cross-sectional shape and dimensions of the at least one adjusting plug correspond to a corresponding flow opening (114) so that the at least one adjusting plug can be fitted into the corresponding flow opening in order to adjust the amount of air flow in the air-conditioning duct,
characterized in that an angle (TV) between a surface (PI) formed by a supply air end (108) of the attenuator and the mantle, and an angle (PV) between a surface (PI) formed by an exhaust air end (110) of the attenuator and the mantle are sharp angles (TV, PV) achieving a narrowing (KA) of a middle part of the frame, where a diameter (VH) of a cross-section of the attenuator is smaller than diameters (PH) of the surfaces (PI) formed by the supply air end and exhaust air end in order to improve a pressing of the mantle against the inner surface of the air-conditioning duct.

2. The attenuator according to the previous claim, where the diameters of the supply and exhaust air ends (108, 110) of the attenuator are 2-3 mm larger than a diameter of the narrowing at the middle part of the attenuator so that the attenuator has a shape of a cylinder pressed in the middle.

3. The attenuator according to any of the previous claims, where a manufacturing material of the frame and the at least one adjusting plug comprises open-cell groat pressed foam in order to support a structure of the frame and improve sound attenuation.

4. The attenuator according to claim 3, which is manufactured completely from groat pressed foam so that the ends (108, 126) of the frame and the at least one adjusting plug are in a supply air direction coated with a polyethylene plastic film (128, 130) in order to prevent the flow through of air outside the flow openings.

5. The attenuator according to claim 3, which is manufactured from a three-layer structure (232, 234, 236) formed from polyester fibre layers (232, 234) and a groat pressed foam layer (236) between them so that the frame and the at least one adjusting plug are made from the three-layer structure in order to improve sound attenuation and reduce sound production.

6. The attenuator according to claim 3, which is manufactured from a two-layer structure (234, 236) formed from a polyester fibre layer (234) and a groat pressed foam layer (236) so that the frame and the at least one adjusting plug are made from the two-layer structure in order to improve sound attenuation and reduce sound production.

7. The attenuator according to claim 6, where the surfaces of the foam layer, away from the polyester fibre layer, of the supply air ends (108, 126) of the frame and the at least one adjusting plug are coated with a polyethylene plastic film (128, 130) in order to prevent the flow through of air outside the flow openings.

8. The attenuator according to claim 7, where the surfaces of the polyester fibre layer, away from the foam layer, of the exhaust air ends (110) of the frame and the at least one adjusting plug are coated with a polyester fibre fabric (237) in order to reinforce the polyester fibre layer.

9. The attenuator according to any of the previous claims, which comprises, in addition to the flow openings, a measuring coupling (118) in the direction of the mantle and penetrating the attenuator, into which a measuring pipe needed for measuring a pressure difference can be installed and which can be closed with a plug (119) fitted therein.

10. The attenuator according to any of the previous claims, where cross-sections of the flow openings and the at least one adjusting plug have an elliptical shape.

11. A manufacturing method for manufacturing an attenuator (102) according to any of the previous claims, comprising at least following steps of

installing manufacturing material in a shape cutter and
pressing, by the shape cutter, the manufacturing material with the aid of a mold into a shape of the attenuator so that the narrowing (KA) is formed in the middle part of the frame (104), where the diameter (VH) of the cross-section of the attenuator is smaller than the diameters (PH) of the surfaces (PI) formed by the supply air end (108) and exhaust air end (110).

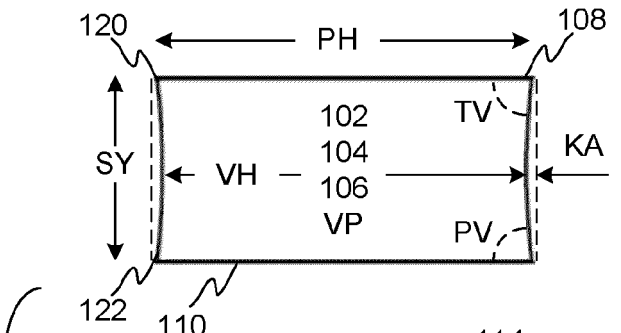

Fig. 1a

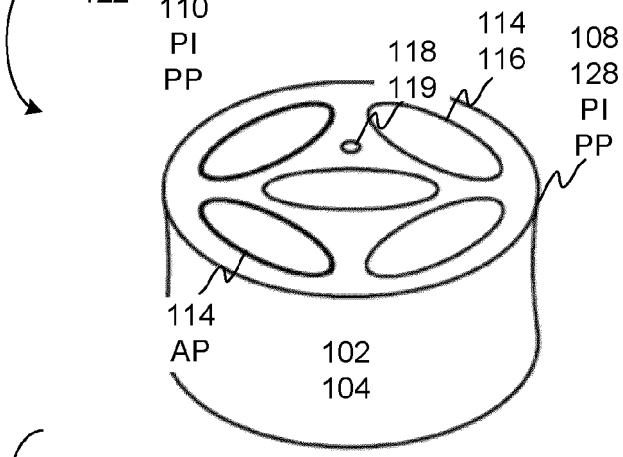

Fig. 1b

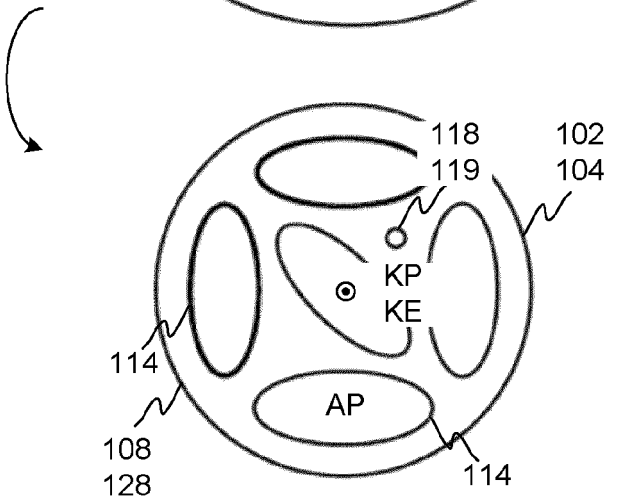

Fig. 1c

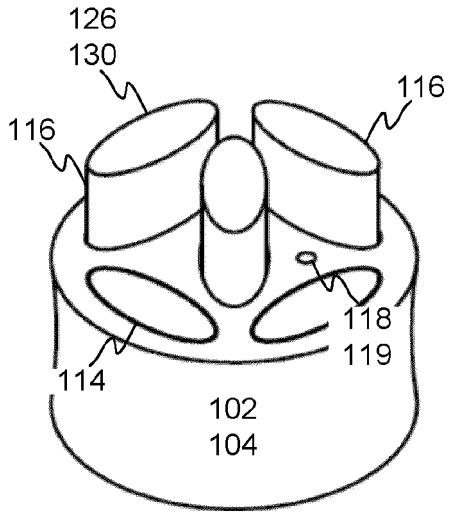

Fig. 1d

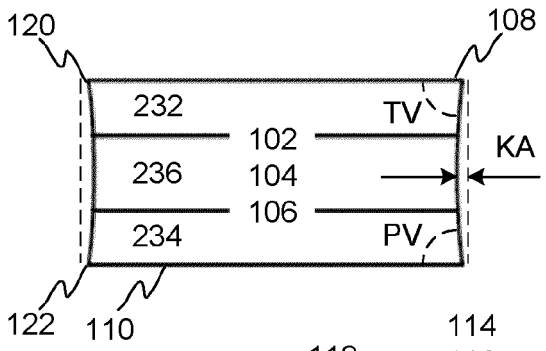

Fig. 2a

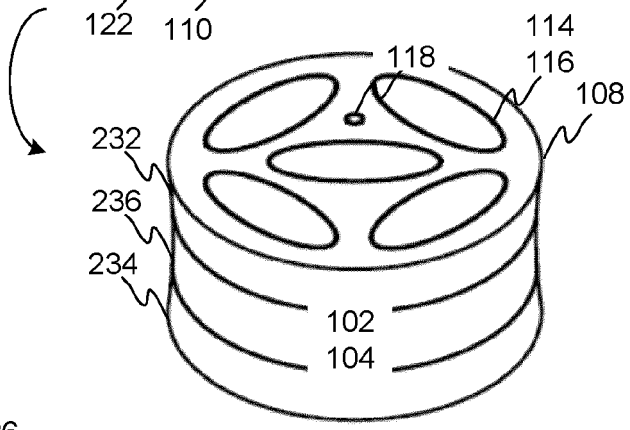

Fig. 2b

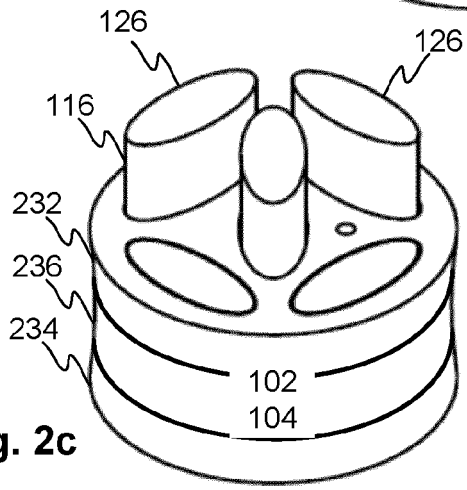

Fig. 2c

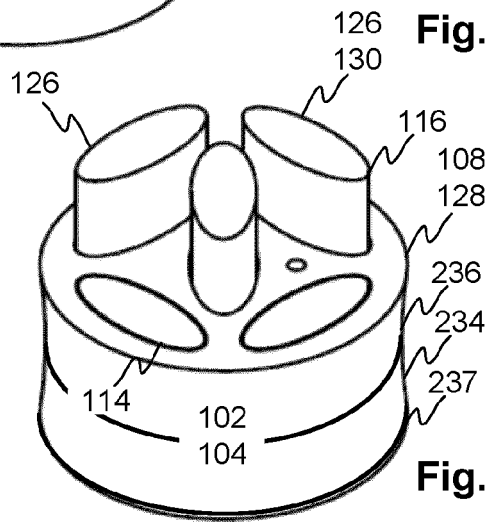

Fig. 2d

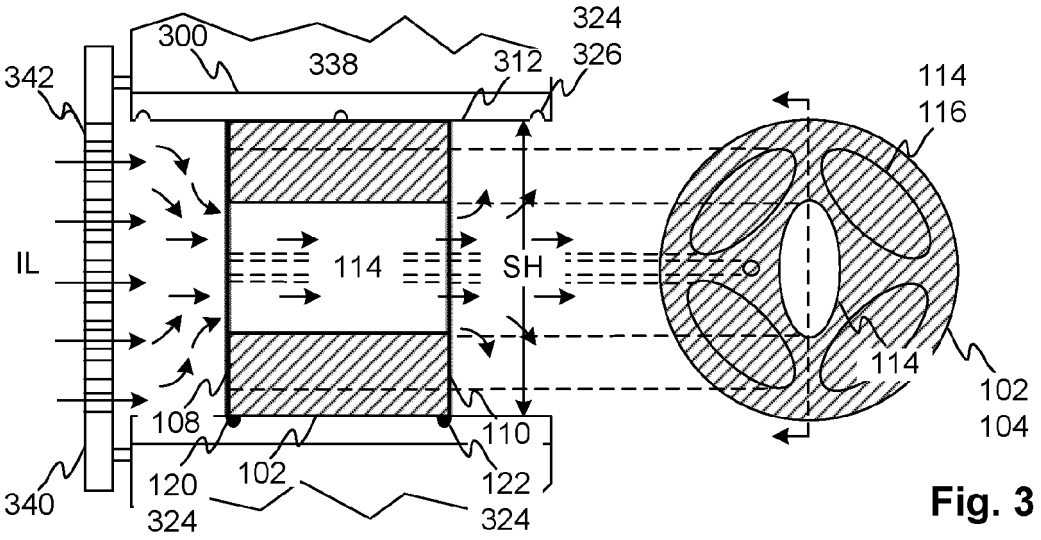

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 9396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC) F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 November 2022	Decking, Oliver

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 17 9396

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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