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(54) **Silencer of an intake system of an internal combustion engine and intake system**

(57) The present invention relates to a silencer (118) of an intake system (10) of an internal combustion engine (12), in particular a turbo engine, in particular of a motor vehicle, and an intake system (10). The silencer (118) comprises a housing (24). The housing (24) having at least one inlet (26) for combustion gas, in particular combustion air, having at least one outlet (28) for the combustion gas and having at least one flow path (32) for the combustion gas from the at least one inlet (26) to the at least one outlet (28). The silencer (118) comprises at least one muffling medium 36, which is in contact with the at least one flow path (32) at least partly inside the housing (24). The at least one muffling medium (36) has no detachable particles, which can be emitted at least in or toward the at least one flow path (32).

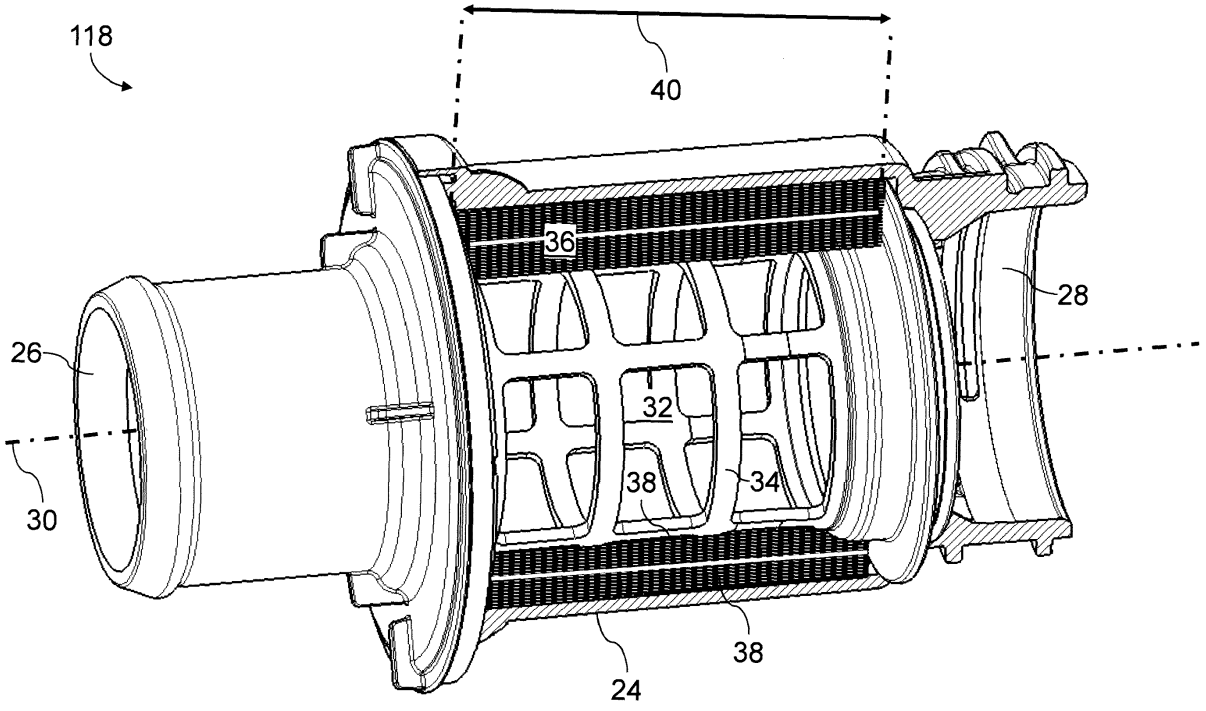

Fig. 2

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Description

Technical Field

[0001] The present invention relates to a silencer of an intake system of an internal combustion engine, in particular a turbo engine, in particular of a motor vehicle, comprising a housing, having at least one inlet for combustion gas, in particular combustion air, having at least one outlet for the combustion gas and having at least one flow path for the combustion gas from the at least one inlet to the at least one outlet, and the silencer comprising at least one muffling medium, which is in contact with the at least one flow path at least partly inside the housing.

[0002] Further the present invention relates to an intake system of an internal combustion engine, in particular a turbo engine, in particular of a motor vehicle, having at least one silencer comprising a housing, the housing having at least one inlet for combustion gas, in particular combustion air, having at least one outlet for the combustion gas and having at least one flow path for the combustion gas from the at least one inlet to the at least one outlet, and the silencer comprising at least one muffling medium, which is in contact with the at least one flow path at least partly inside the housing.

State of Technology

[0003] The DE 100 22 240 A1 discloses a filter noise absorber at the inlet side of a compressor comprising a supporting body, multiple muffler elements, which are realized as muffler blocks, and one filter frame, which is arranged at the circumference of the sound absorber. The filter frame is shaped as a perforated plate. Multiple through-flow passages are embedded in the muffler blocks.

[0004] It is an object of the invention to provide a silencer and an intake system of the above-mentioned kind, where the absorbing properties can be improved and/or a complexity, an effort and/or an expenditure can be reduced.

Disclosure of Invention

[0005] The object is achieved by the silencer in that, the at least one muffling medium has no detachable particles, which can be emitted at least in or toward the at least one flow path.

[0006] With known noise absorbers it became apparent that the muffler material used can emit particles, for example fibers. Such particles have to be filtered with help of a filter medium before the combustion gas enters a sensitive part of the internal combustion engine, in particular an injector, a combustion chamber or a compressor of a turbocharger, which is sensitive to dirt.

[0007] According to the invention, the at least one muffling medium, in particular the material of the at least one muffling medium, has no own particles, in particular fibers, which can loosen or be detached or emitted. The at least one muffling medium has no intrinsic emission of particles. The at least one muffling medium does not emit own particles to the combustion gas. There is no need for an additional filter or filtering system for such particles downstream the at least one muffling medium. Also, there is no need for any restraint system, in particular a mesh, for holding back particles. Thus, costs and effort can be reduced. The inventive silencer can be realized independent from a filter or a filter element. The silencer so can easier be optimized concerning its noise absorbing properties. Further, the silencer can be realized more flexible. Additionally, a loss of pressure caused by the silencer can be reduced.

[0008] Favorably, the silencer, in particular the at least one muffling medium, can stand high temperatures, in particular up to or more than 240 °C. Thus, the silencer can be used in hot areas of the internal combustion engine, in particular downstream of a compressor of a turbocharger, particularly upstream of a charge air cooler.

[0009] Particularly, the silencer, in particular the at least one muffling medium, can stand high pressures, in particular up to or more than 2.5 bar. Thus, the silencer can be used on a low-pressure side, in particular upstream of the compressor of the turbocharger, and/or a high-pressure side of the compressor in particular, in particular downstream of the compressor of the turbocharger.

[0010] Particularly, the silencer can be realized as a broadband silencer. Thus, the range of frequencies, which can be damped by the silencer, can be increased.

[0011] Favorably, the silencer can reduce noise in the frequency range between approximately 500 Hz and 10 kHz.

[0012] Advantageously, at least one silencer can be on a clean gas side, particularly a clean air side. Different to the silencers known from the state-of-the-art, according to the invention is no need for an additional filter of figure medium downstream of the inventive silencer. Favorably, at least one silencer can be arranged downstream of a filter for the combustion gas, in particular an air filter. So, a pollution of the silencer by particulate matter can be reduced. The at least one muffling medium itself does not pollute the combustion gas.

[0013] Favorably, the at least one muffling medium can be lint-free.

[0014] In particular, at least one muffling medium can consist of or contain a nonwoven, a fleece, a fabric, a textile or foam.

[0015] Particularly, at least one muffling medium can consist of or contain filter material, in particular for applicable for gas filtration, in particular air filtration. Filter material does not emit own particles. It has no intrinsic particle emission. Filter material can be lint-free. Thereby, the filter material used as muffling medium does not necessarily have the function of filtering the combustion gas. The combustion gas can solely flow along the filter material rather than flowing through it. A pressure loss so

can be further reduced.

[0016] The invention can be used with an intake system of a turbocharged internal combustion engine. Also, the invention can be used with an internal combustion engine without a turbocharger. The invention can also be used in a technical area beyond automotive engineering. In particular, the invention can be used with industrial engines.

[0017] The silencer can be used with an air boosting system providing in particular high frequency noise attenuation.

[0018] According to a favorable embodiment of the invention, at least one muffling medium can at least partly surround the at least one flow path. So, the combustion gas can flow along a surface of the muffling medium, which is facing toward the at least one flow path.

[0019] Particularly, a length of the at least one muffling medium along the at least one flow path can be between 60 mm and 120 mm.

[0020] According to a further favorable embodiment of the invention, at least one muffling medium can completely surround the at least one flow path, in particular the at least one muffling medium can be wrapped around the at least one flow path. So, the at least one flow path can be contained in a kind of casing realized by the at least one muffling medium. The at least one flow path can be surrounded by the at least one muffling medium. So, the acoustic insulation can be further improved.

[0021] Particularly, the shape of the at least one muffling medium can be cylindrical, conical or somehow or other bent or curved. A cross-section of the at least one muffling medium can be round, elliptical, oval, quadratic, rectangular, triangular or somehow different curved and/or angular.

[0022] Favorably, the at least one muffling medium can be hollow. Preferably, it can be tubular.

[0023] An inner diameter of the at least one muffling medium can define a flow cross-section of the at least one flow path. The inner diameter of the at least one muffling medium can be between approximately 30 mm and 150 mm.

[0024] The inner diameter of the at least one muffling medium can be adapted to a flow cross-section of the intake system upstream and/or downstream of the silencer. In this way, a more homogeneous flow of the combustion gas can be achieved.

[0025] An inlet of a compressor of a turbocharger usually can have a larger diameter than its outlet. If the silencer is arranged downstream of the compressor, the at least one muffling medium can have an inner diameter in particular between approximately 30 mm and 60 mm. If the silencer is arranged upstream of the compressor, the inner diameter can in particular be between approximately 40 mm and 120 mm.

[0026] According to a further favorable embodiment of the invention, the at least one muffling medium can be arranged outside of the at least one flow path of the combustion gas. The flow path does not cross the at least one muffling medium. So, the combustion gas does not need to flow through the muffling medium. Thus, a pressure loss can be further reduced. Further, a strain of the muffling medium can be reduced. Additionally, a risk can be reduced, that parts or particles of the at least one muffling medium, which are not detachable under normal operating conditions, can forcibly be entrained by the combustion gas.

[0027] According to a further favorable embodiment of the invention, at least one muffling medium can be arranged in at least one layer, preferable in multiple layers.

[0028] Particularly, multiple layers of the same muffling medium or different muffling media can be arranged. The layers of muffling medium can be different in pore size and/or permeability in particular.

[0029] At least one layer, in particular each layer, can have a thickness of between approximately 0.4 mm to 1 mm.

[0030] In particular, 2 to 12 layers of muffling medium can be arranged. With the number of layers, the frequency range in which the noise can be damped can be changed. Particularly, with an increasing number of layers, the damping of noise with lower frequencies can be improved. With a decreasing number of layers, the damping of noise with higher frequencies can be improved.

[0031] According to a further favorable embodiment of the invention, more than one muffling medium, in particular at least two different muffling media, can be used.

[0032] Particularly, at least two different muffling media can be arranged in at least two layers.

[0033] According to a further favorable embodiment of the invention, the at least one muffling medium can be arranged on at least one support part, in particular on a cylindrical or conical support part. The at least one support part can hold and/or support the at least one muffling medium.

[0034] Particularly, the forms and/or dimensions of the at least one muffling medium and the at least one support part can fit to one another.

[0035] Particularly, the shape of the at least one support part can be cylindrical, conical or somehow or other bent or curved. A cross-section of the at least one support part can be round, elliptical, oval, quadratic, rectangular, triangular or somehow different curved and/or angular.

[0036] Favorably, the at least one support part can be hollow. Preferably, it can be tubular.

[0037] Preferably, at least one muffling medium can be wrapped around at least one support part or vice versa.

[0038] In particular, at least one muffling medium can be fixed to at least one support part. So, the mechanical stability can be further improved. Alternatively, at least one muffling medium can be arranged loose on at least one support part.

[0039] Preferably, at least one support part can have a frame. The frame can preferably the wide-meshed. Thus, a coverage of the at least one muffling medium by the at least one support part can be reduced. So, a damp-

ing effect can be improved. Further, a flow resistance caused by the at least one support part can be reduced.

[0040] Preferably, the at least one support part can be arranged between the at least one muffling medium and the at least one flow path.

[0041] Preferably, at least one muffling medium can be wrapped with an insert, in particular a support part, which can finally be placed in the housing.

[0042] The object further is achieved by the intake system in that, the at least one muffling medium has no detachable particles, which can be emitted at least in or toward the at least one flow path.

[0043] The above-mentioned advantages and characteristic features of the inventive silencer apply analogously to the inventive intake system and its favorable embodiments and vice versa.

[0044] According to a favorable embodiment of the invention, at least one silencer can be arranged upstream and/or downstream of a compressor of a turbocharger.

[0045] Downstream of the compressor, the silencer can damp the noise generated by the flow of the charged combustion gas. Downstream of the compressor, noise with a wide frequency range, in particular higher and lower frequencies, can appear. With a broadband silencer, a wide frequency range can be damped.

[0046] Upstream of the compressor, the silencer can damp the noise generated by the flow of the combustion gas on the low pressure side.

Brief Description of Drawings

[0047] The present invention together with the above-mentioned and other objects and advantages may best be understood from the following detailed description of the embodiments, but not restricted to the embodiments, wherein is shown schematically

figure 1 an intake system of an turbocharged internal combustion engine of a motor vehicle comprising two silencers;

figure 2 a local section of one of the silencers of figure 1.

[0048] In the drawings, equal or similar elements are referred to by equal reference numerals. The drawings are merely schematic representations, not intended to portray specific parameters of the invention. Moreover, the drawings are intended to depict only typical embodiments of the invention and therefore should not be considered as limiting the scope of the invention.

Embodiment(s) of Invention

[0049] Figure 1 depicts an intake system 10 of a turbocharged internal combustion engine 12 of a motor vehicle.

[0050] The intake system 10 comprises an intake air duct 14 which leads to the engine 12. With the intake air duct 14 ambient air can be led to the engine 12 for combustion. In the intake air duct 14 an air filter 16, an upstream silencer 18, a compressor 20 of the turbocharger, a downstream silencer 118 and a charge air cooler 20 are arranged serial in flow direction 22 of the in-coming combustion air. In figure 1, the flow direction 22 of the combustion air is indicated by arrows.

[0051] The function of both silencers 18 and 118 is dampening operating noise, which can be generated for example by the flow of the combustion air and/or by the turbocharger. The silencers 18 and 118 are realized as broadband silencers each. The silencers 18 and 118 can reduce noise in the frequency range between approximately 500 Hz and 10 kHz each.

[0052] The silencers 18 and 118 are arranged downstream of the air filter 16 in a clean air side both. The upstream silencer 18 is arranged on a low-pressure side of the intake system 10. The downstream silencer 118 is arranged on a high-pressure side.

[0053] In the described exemplary embodiment, the upstream silencer 18 and the downstream silencer 118 in principle are equal in set-up and function. With other embodiments, the silencers 18 and 118 may be different. The silencers 18 and 118 are described in the following on the basis of the downstream silencer 118 shown in figure 2. Those parts of the upstream silencer 18 which are equal to those of the downstream silencer 118 have the same reference numbers.

[0054] The silencers 18 and 118 are comprising a cylindrical housing 24 each. The housing 24 is coaxial to an axis. The housing 24 has an inlet 26 and an outlet 28 for the combustion air. The inlet 26 and the outlet 28 are coaxial to an axis 30 of the housing 24 each. A flow path 32 for the combustion air extends from the inlet 26 to the outlet 28. The downstream silencer 118 and the upstream silencer 18 are arranged contrariwise relating to the flow direction 22 of the combustion air. The inlet 26 of the upstream silencer 18 equates to the outlet 28 of the downstream silencer 118 and vice versa.

[0055] The flow path 32 is surrounded by a cylindrical support tube 34. The support tube 34 is coaxial to the axis 30 of the housing 24. The support tube 34 has a wide-meshed frame. On its both ends, the support tube 34 is open.

[0056] Muffling medium 36 is wrapped in multiple layers 38 on a radial outer surface of the support tube 34. The support tube 34 holds and supports the layers 38 of muffling medium 36. The muffling medium 36 exemplary is fixed to the support tube 34. The shape of the muffling medium 36 is cylindrical. The muffling medium 36 is outside of the flow path 32 and surrounds it. The muffling medium 36 is in contact with the flow path 32 inside the housing 24. In operation of the intake system 10, the combustion air flows along a radial inner surface of the muffling medium 36, which is facing towards the flow path 32.

[0057] The layers 38 of the muffling medium 36 have a thickness of between approximately 4 mm to 5 mm

each. The silencers 18 and 118 have between 2 to 12 layers 38 of muffling medium 36. In figure 2 exemplary two of the layers 38 are shown. With the number of layers 38, the frequency range of noise which can be damped can be changed. With an increasing number of layers 38, the damping of noise with lower frequencies can be improved. With a decreasing number of layers 38, the damping of noise with higher frequencies can be improved. The number of layers 38 can be different for the upstream silencer 18 and the downstream silencer 118.

[0058] The multiple layers 38 are of the same muffling medium 36. Alternatively, different muffling media 36 can be arranged in different layers 38.

[0059] The muffling medium 36 exemplary consists of a nonwoven, a fleece, a fabric, a textile or a foam. Exemplary, the muffling medium 36 consists of filter material for air filtration. The muffling medium 36 has no detachable particles, which can be emitted toward the flow path 32. The muffling medium 36 has no own particles, for example fibers, which can loosen or can be detached or emitted. It has no intrinsic emission of particles. Thus, the muffling medium 36 cannot emit particles to the combustion gas. The muffling medium 36 is lint-free. The muffling medium 36 can stand high temperatures, in particular up to or more than 240 °C. The muffling medium 36 further can stand high pressures, for example up to or more than 2.5 bar.

[0060] An inlet of the compressor 20 of the turbocharger has a larger diameter than its outlet. Accordingly, the inlet 26, the outlet 28 and an inner diameter of the upstream silencer 18 and the downstream silencer 118 are dimensioned different. The radial inner diameter of the support tube 34 and the muffling medium 36 define a flow cross-section of the flow path 32 each.

[0061] The inner diameter of inlet 26, the muffling medium 36 and the support tube 34 of the downstream silencer 118 is adapted to the outlet of the compressor 20. They have an inner diameter exemplary between approximately 30 mm and 60 mm.

[0062] The inner diameter of the outlet 28, the muffling medium 36 and the support tube 34 of the upstream silencer 18 is adapted to the inner diameter of the inlet of the compressor 20. It is exemplary between approximately 40 mm and 120 mm.

[0063] An axial length 40 of the support tube 34 and the muffling medium 36 along the flow path 32 exemplary is between 60 mm and 120 mm.

[0064] During manufacturing of the silencers 18 and 118, the layers 38 of muffling medium 36 being wrapped on the support tube 34. The support tube 34 with the muffling medium 36 being placed in the housing 24. The silencers 18 and 118 then can be arranged in the intake air duct 14.

Claims

1. Silencer (18; 118) of an intake system (10) of an internal combustion engine (12), in particular a turbo engine, in particular of a motor vehicle, comprising a housing (24), having at least one inlet (26) for combustion gas, in particular combustion air, having at least one outlet (28) for the combustion gas and having at least one flow path (32) for the combustion gas from the at least one inlet (26) to the at least one outlet (28), and the silencer (18; 118) comprising at least one muffling medium 36, which is in contact with the at least one flow path (32) at least partly inside the housing (24), **characterized in that** the at least one muffling medium (36) has no detachable particles, which can be emitted at least in or toward the at least one flow path (32).

2. Silencer according to claim 1, **characterized in that** at least one muffling medium (36) at least partly surrounds the at least one flow path (32).

3. Silencer according to claim 1 or 2, **characterized in that** at least one muffling medium (36) completely surrounds the at least one flow path (32), in particular the at least one muffling medium (36) being wrapped around the at least one flow path (32).

4. Silencer according to one of the previous claims, **characterized in that** the at least one muffling medium (36) being arranged outside of the at least one flow path (32) of the combustion gas.

5. Silencer according to one of the previous claims, **characterized in that** at least one muffling medium (36) being arranged in at least one layer, preferable in multiple layers (38).

6. Silencer according to one of the previous claims, **characterized in that** more than one muffling medium (36), in particular at least two different muffling media, being used.

7. Silencer according to one of the previous claims, **characterized in that** the at least one muffling medium (36) being arranged on at least one support part, in particular on a cylindrical or conical support part (34).

8. Intake system (10) of an internal combustion engine (12), in particular a turbo engine, in particular of a motor vehicle, having at least one silencer (18; 118), in particular according to one of the previous claims, comprising a housing (24), the housing (24) having at least one inlet (26) for combustion gas, in particular combustion air, having at least one outlet (28) for the combustion gas and having at least one flow path (32) for the combustion gas from the at least one inlet (26) to the at least one outlet (28), and the silencer (18; 118) comprising at least one muffling medium (36), which is in contact with the at least one

flow path (32) at least partly inside the housing (24), **characterized in that** the at least one muffling medium (36) has no detachable particles, which can be emitted at least in or toward the at least one flow path (32).

9. Intake system according to claim 8, **characterized in that** at least one silencer (18; 118) being arranged upstream and/or downstream of a compressor (20) of a turbocharger.

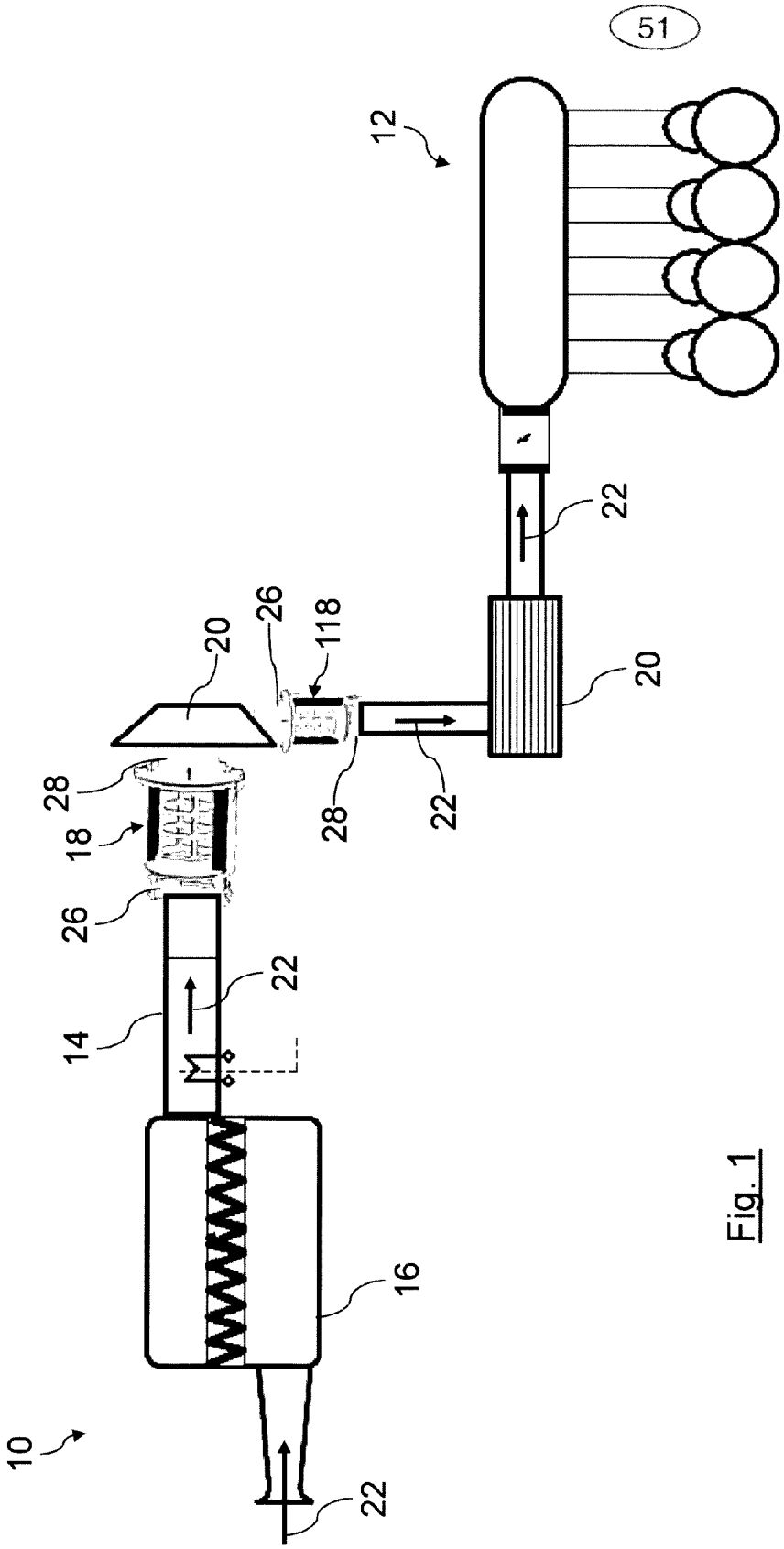

Fig. 1

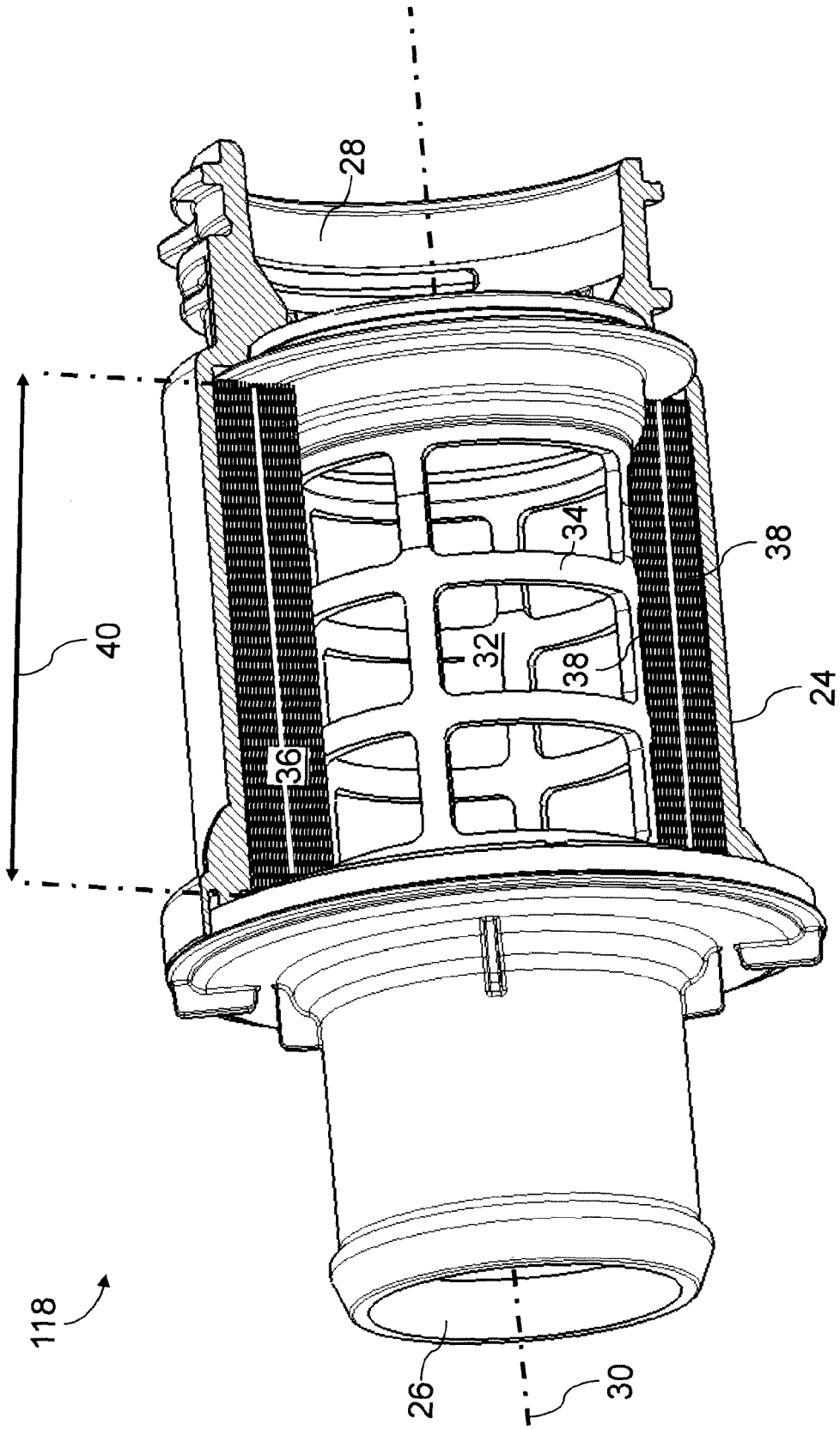

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 14 29 0259

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

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