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(54) Title: MULTIPLE FLOW PATH EXHAUST TREATMENT SYSTEM

(57) Abstract: A vehicle exhaust system for an engine having a plurality of combustion chambers includes a first emission treatment device, a second emission treatment device and a housing defining a first exhaust passageway in fluid communication with the combustion chambers and containing the first emission treatment device. A second parallel exhaust passageway is in fluid communication with the combustion chambers and contains the second emission treatment device. The first and second passageways share a common wall having a serpentine shape such that the cross-sectional area of the passageways varies along a direction of exhaust flow. The first emission treatment device is positioned at a location of increased cross-sectional area in the first passageway and the second emission treatment device is positioned at an axially offset location of increased cross-sectional area in the second passageway.



MULTIPLE FLOW PATH EXHAUST TREATMENT SYSTEM FIELD

[0001] The present disclosure generally relates to a system for treating exhaust gases. More particularly, an exhaust system having multiple parallel
5 flow paths is discussed.

BACKGROUND

[0002] To reduce the quantity of NO_x and particulate matter emitted to the atmosphere during internal combustion engine operation, a number of exhaust aftertreatment devices have been developed. A need for exhaust
10 aftertreatment systems particularly arises when diesel combustion processes are implemented. Typical aftertreatment systems for diesel engine exhaust may include one or more of a diesel particulate filter (DPF), a selective catalytic reduction (SCR) system, a hydrocarbon (HC) injector, and a diesel oxidation catalyst (DOC).

[0003] During engine operation, the DPF traps soot emitted by the engine and reduces the emission of particulate matter (PM). Over time, the DPF becomes loaded and begins to clog. Periodically, regeneration or oxidation of the trapped soot in the DPF is required for proper operation. To regenerate the
15 DPF, relatively high exhaust temperatures in combination with an ample amount of oxygen in the exhaust stream are needed to oxidize the soot trapped in the filter.

[0004] The DOC is typically used to generate heat useful for regenerating the soot loaded DPF. When hydrocarbons (HC) are sprayed over the DOC at or above a specific light-off temperature, the HC will oxidize. This
25 reaction is highly exothermic and the exhaust gases are heated during light-off. The heated exhaust gases are used to regenerate the DPF.

[0005] Known exhaust treatment devices have successfully operated in conjunction with relatively small displacement internal combustion engines for automotive use. However, other applications including diesel locomotives,
30 stationary power plants, marine vessels and others may be equipped with relatively large diesel compression engines having many large combustion chambers. The exhaust mass flow rate from the larger engines may be more

than ten times the maximum flow rate typically provided to the exhaust treatment device. While it may be possible to increase the size of the exhaust treatment device to account for the increased exhaust mass flow rate, the cost, weight and packaging concerns associated with this solution may be unacceptable.

- 5 Therefore, a need may exist in the art for an exhaust arrangement to reduce undesirable emissions from the exhaust output from a large diesel engine while minimally affecting the cost, weight, size and performance of the exhaust system.

SUMMARY

- 10 **[0006]** This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

- [0007]** A vehicle exhaust system for an engine having a plurality of combustion chambers includes a first emission treatment device, a second emission treatment device and a housing defining a first exhaust passageway in
15 fluid communication with the combustion chambers and containing the first emission treatment device. A second parallel exhaust passageway is in fluid communication with the combustion chambers and contains the second emission treatment device. The first and second passageways share a common wall having a serpentine shape such that the cross-sectional area of the
20 passageways varies along a direction of exhaust flow. The first emission treatment device is positioned at a location of increased cross-sectional area in the first passageway and the second emission treatment device is positioned at an axially offset location of increased cross-sectional area in the second passageway.

- 25 **[0008]** A vehicle exhaust system for an engine having a plurality of combustion chambers includes a housing, a first array of parallel positioned emission treatment devices and a second array of parallel positioned emission treatment devices. The first and second arrays are axially spaced apart from one another and positioned within the housing. A first exhaust passageway is in
30 fluid communication with the combustion chambers and contains the first array of emission treatment devices. A second and separate exhaust passageway is in fluid communication with the combustion chambers and contains the second

array of emission treatment devices. The first and second passageways extend parallel to one another within the housing. The first exhaust passageway includes a portion bypassing the second array of emission treatment devices and the second passageway includes a portion bypassing the first array of emission treatment devices.

[0009] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0010] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0011] Figure 1 is a schematic depicting an exhaust system having multiple flow paths; and

[0012] Figure 2 is a schematic depicting another exhaust system having multiple flow paths.

[0013] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

[0014] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0015] Referring initially to FIG. 1, an exhaust system 10 for an engine 12 is shown. The exhaust system 10 and engine 12 are mounted to a vehicle. The engine 12 generates torque to move the vehicle. As will be described in greater detail below, the exhaust system 10 receives exhaust from the engine 12 and treats the exhaust before it flows to the outside atmosphere (represented as "ATM" in FIG. 1).

[0016] The engine 12 includes a plurality of combustion chambers 14a, 14b, 14c. In the embodiment shown, engine 12 includes a first combustion chamber 14a, a second combustion chamber 14b, and a third combustion chamber 14c. However, it will be appreciated that engine 12 could include any

number of combustion chambers without departing from the scope of the present disclosure.

[0017] In one embodiment, engine 12 is a diesel engine; however, it will be appreciated that engine 12 could be of any suitable type without departing from the scope of the present disclosure. During operation, a fuel/air mixture is introduced into combustion chambers 14a, 14b, 14c, and the fuel/air mixture combusts, which drives a piston (not shown) to drive an output shaft. Rotation of the output shaft ultimately drives one or more wheels (not shown) to move the vehicle. Exhaust gas, soot, particulate and other materials (collectively referred to as "exhaust"), are products of the combustion within combustion chambers 14a, 14b, 14c. The exhaust flows through the exhaust system 10, which treats the exhaust before it flows to the outside atmosphere.

[0018] As shown in FIG. 1, the exhaust system 10 includes a plurality of exhaust treatment devices (ETD) 16a, 16b, 18a and 18b. It will be appreciated that the ETDs could include any suitable device operable for decreasing undesirable matter in the exhaust before the exhaust flows to the outside atmosphere. For instance, in FIG. 1, ETDs 16a and 16b include a diesel particulate filter (hereinafter "DPF"). ETDs 18a and 18b include selective catalytic reduction devices (hereinafter "SCR" device). DPFs 16a, 16b collect soot as the exhaust flows therethrough. SCRs 18a, 18b each include a catalyst operable to reduce other undesirable emissions. Other ETDs may include a diesel oxidation catalyst (hereinafter "DOC"), a reductant injector, a burner or the like.

[0019] Exhaust system 10 includes a first passageway 19 and a second passageway 20 extending parallel to one another. First passageway 19 includes an inlet 21 in communication with each of combustion chambers 14a, 14b, 14c. DPF 16a and SCR 18a are positioned in series within first passageway 19. Exhaust travelling through first passageway 19 passes through DPF 16a, SCR 18a and exits exhaust system 10 at an outlet 22.

[0020] In similar fashion, second passageway 20 includes an inlet 24 in communication with each of combustion chambers 14a, 14b, 14c. DPF 16b and SCR 18b are positioned in series within second passageway 20. Exhaust

travelling through second passageway 20 passes through DPF 16b, SCR 18b and escapes to atmosphere via an outlet 26.

[0021] It should be appreciated that exhaust provided from combustion chambers 14a, 14b and 14c is provided to both inlet 21 and inlet 24. The exhaust travels along the parallel paths at substantially the same flow rate. A substantially similar flow rate is achieved by matching the cross-sectional areas of DPF 16a and DPF 16b as well as matching the cross-sectional areas of SCR 18a and SCR 18b. Furthermore, not only does exhaust system 10 provide parallel passageways 19 and 20 having a substantially equivalent flow, but the maximum flow through each passageway is optimized by maximizing the cross-sectional area of each ETD while maintaining a relatively small cross-section for the overall exhaust system 10. These goals are achieved by defining a common wall 30 between first passageway 19 and second passageway 20 with a serpentine shape. Wall 30 includes a first end 32 positioned mid-way between a first outer wall 34 and a second outer wall 36. First passageway 19 is defined by first outer wall 34 and common wall 30. Second passageway 20 is defined by second outer wall 36 and common wall 30. Based on the position of first end 32, inlet 21 has a cross-sectional area substantially the same as inlet 24.

[0022] The serpentine shape of common wall 30 allows DPF 16a and DPF 16b to be positioned in an axially offset or staggered arrangement. By positioning the DPFs in this manner, the sum of the cross-sectional area of DPF 16a and the cross-sectional area of DPF 16b is greater than the cross-sectional area of exhaust system 10 as defined by first outer wall 34 and second outer wall 36 at the axial location of either DPF. Common wall 30 may extend toward first outer wall 34 and protrude into first passageway 19 to define a minimal cross-sectional area at a first zone 40. The smallest feasible cross-sectional area at first zone 40 may be determined by calculating or measuring the resistance to flow provided by DPF 16a or SCR 18a and assuring that the reduced area of first zone 40 does not restrict flow greater than any of the ETDs within first passageway 19. DPF 16b is axially positioned in an enlarged portion of second passageway 20 in line with zone 40.

[0023] At another point in the flow path, common wall 30 protrudes toward second outer wall 36 to define a minimum cross-sectional area at a second zone 42 of second passageway 20. The cross-sectional area of zones 40 and 42 are substantially the same. DPF 16a is positioned in an enlarged portion of first passageway 19 across from zone 42. SCR 18a and SCR 18b are also offset and staggered relative to one another such that the sum of the cross-sectional area of SCR 18a and the cross-sectional area of SCR 18b is greater than the cross-sectional area of exhaust system 10 at any one axial position.

[0024] FIG. 2 provides a schematic representation of another exhaust system identified at reference numeral 100. Exhaust system 100 includes a first housing 102 positioned in fluid communication with a second housing 104. Housing 102 includes an inlet 106 in communication with one or more combustion cylinders of an engine. Second housing 104 includes an outlet 108 in communication with the atmosphere. First housing 102 contains a plurality of diesel oxidation catalysts identified at reference numerals 110a-110i. Each DOC is coupled to a corresponding diesel particulate filter 112a-112i. Exhaust flows through housing 102 in a top-down direction as viewed in FIG. 2. As such, each of DOCs 110a-110i is positioned in parallel and includes an upstream end in communication with exhaust provided from the internal combustion engine. Exhaust entering each of the DOCs 110a-110i flows through the corresponding DPF 112a-112i. Each of DPFs 112a-112i includes an outlet or downstream end positioned in parallel with the other diesel particulate filter outlets. A collector 118 is in receipt of the exhaust that passes through each of DPFs 112a-112i.

[0025] An inlet 120 of second housing is in communication with collector 118. A plurality of SCRs 126a-126i are positioned within second housing 104. More particularly, SCR 126a, 126b and 126c define a first SCR array 128. SCRs 126d, 126e and 126f form a second SCR array identified at reference numeral 130. SCRs 126g, 126h and 126i form a third SCR array 132. First array 128, second array 130 and third array 132 are axially spaced apart from one another within second housing 104. As will be described, the SCR arrays are interconnected in parallel such that exhaust from collector 118 flows through three parallel passageways prior to rejoining at an end portion 136 of

second housing 104. Furthermore, the three SCRs within each SCR array are positioned in parallel with one another.

[0026] As supplied from collector 118, exhaust enters inlet 120 of second housing 104. A plate 140 is positioned within second housing 104 to direct exhaust from inlet 120 to one of three passageways. A first passageway 142 includes an aperture 143 extending through plate 140 to allow exhaust to travel through plate 140 into communication with upstream ends of SCRs 126a, 126b and 126c. Once this portion of the exhaust passes through the parallel SCRs of first array 128, the exhaust travels through a bypass portion or first tube 144 of first passageway 142. More particularly, an upstream end of first tube 144 and downstream ends of SCRs 126a, 126b, 126c are in communication with each other. The downstream of first tube 144 is in communication with end portion 136 and outlet 108.

[0027] A second passageway 150 provides exhaust gas from collector 118 to second array 130 via a bypass portion or second tube 152. Another bypass portion identified as a third tube 154 includes an upstream end in communication with the downstream ends of SCRs 128d, 128e and 128f. A downstream end of third tube 154 transfers this portion of the exhaust flow to outlet 108.

[0028] A third passageway 160 provides a path for exhaust travelling from collector 118 through third SCR array 132 and exiting at outlet 108. Third passageway 160 includes a bypass portion or fourth tube 162 having an inlet or upstream end passing through plate 140 and a downstream end positioned in fluid communication with upstream ends of SCRs 126g, 126h and 126i. The downstream ends of the SCRs within third SCR array 132 are in communication with outlet 108. Exhaust flowing through fourth tube 162 does not pass through any of the SCRs of first array 128 or second array 130. Similarly, exhaust flowing through first passageway 142 passes through only the SCRS of first SCR array 128 and bypasses the SCRs of second array 130 and third array 132. The parallel path of second passageway 150 provides exhaust only to the SCRs of second SCR array 130. It should be appreciated that through the use of exhaust treatment device arrays, compartmentalization and parallel pathways, a relatively

high flow exhaust system including multiple exhaust treatment devices may be provided in a minimal volume.

[0029] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be
5 exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be
varied in many ways. Such variations are not to be regarded as a departure
10 from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS

What is claimed is:

1. A vehicle exhaust system for an engine having a plurality of combustion chambers, comprising:
 - 5 a first emission treatment device;
 - a second emission treatment device; and
 - a housing including a first exhaust passageway in fluid communication with the combustion chambers and containing the first emission treatment device, the housing further including a second parallel exhaust passageway in fluid communication with the combustion chambers and containing the second emission treatment device, the first and second passageways sharing a common wall having a serpentine shape such that the cross-sectional area of the first and second exhaust passageways varies along a direction of exhaust flow, the first emission treatment device being positioned at a location of increased cross-sectional area in the first passageway and the second emission treatment device being positioned at an axially offset location of increased cross-sectional area in the second passageway.
2. The exhaust system of claim 1 wherein a sum of the cross-sectional area of the first emission treatment device and the cross-sectional area of the second emission treatment device is greater than a cross-sectional area of the housing at the first emission treatment device position.
3. The exhaust system of claim 1 wherein the cross-sectional area of the first and second emission treatment devices is substantially the same.
4. The exhaust system of claim 1 wherein the first and second emission treatment devices include diesel particulate filters.
5. The exhaust system of claim 1 further including a third emission treatment device positioned within the first passageway downstream of the first emission treatment device.

6. The exhaust system of claim 5 further including a fourth emission treatment device positioned within the second passageway downstream of the second emission treatment device.

5 7. The exhaust system of claim 6 wherein the cross-sectional area of the first and third emission treatment devices is substantially the same.

8. The exhaust system of claim 7 wherein the third and fourth emission treatment devices include selective catalytic reduction element.

10 9. A vehicle exhaust system for an engine having a plurality of combustion chambers, comprising:

a housing;

a first array of parallel positioned emission treatment devices;

15 a second array of parallel positioned emission treatment devices, the first and second arrays being axially spaced apart within the housing;

a first exhaust passageway in fluid communication with the combustion chambers and containing the first array of emission treatment devices; and

20 a second and separate exhaust passageway in fluid communication with the combustion chambers and containing the second array of emission treatment devices, the first and second passageways extending parallel to one another within the housing, wherein the first exhaust passageway includes a portion bypassing the second array of emission treatment devices and wherein the second passageway includes a portion bypassing the first array of emission treatment devices.

25

10. The exhaust system of claim 9 wherein the bypassing portion of the first passageway extends parallel to the second array.

30 11. The exhaust system of claim 10 wherein the bypassing portion of the second passageway extends parallel to the first array.

12. The exhaust system of claim 11 wherein an upstream end of the bypassing portion of the first passageway is positioned downstream of the first array.

5 13. The exhaust system of claim 12 wherein a downstream end of the bypassing portion of the second passageway is positioned upstream of the second array.

10 14. The exhaust system of claim 9 further including a third array of parallel positioned emission treatment devices axially spaced apart from the first and second arrays, and a third separate exhaust passageway in fluid communication with the combustion chambers and containing the third array of emission treatment devices, wherein the third passageway extends parallel to the first and second passageways and includes a portion bypassing the first and
15 second arrays.

15. The exhaust system of claim 14 wherein the bypassing portion of the third passageway extends parallel to the first and second arrays.

20 16. The exhaust system of claim 14 wherein ends of each of the first, second and third passageways are in communication with each other at an outlet of the housing.

25 17. The exhaust system of claim 16 wherein ends of each of the first, second and third passageways are in communication with each other at a collector portion of the housing in receipt of exhaust from the combustion chambers.

30 18. The exhaust system of claim 14 wherein each of the bypassing portions of the first, second and third passageways is positioned adjacent to two emission treatment devices.

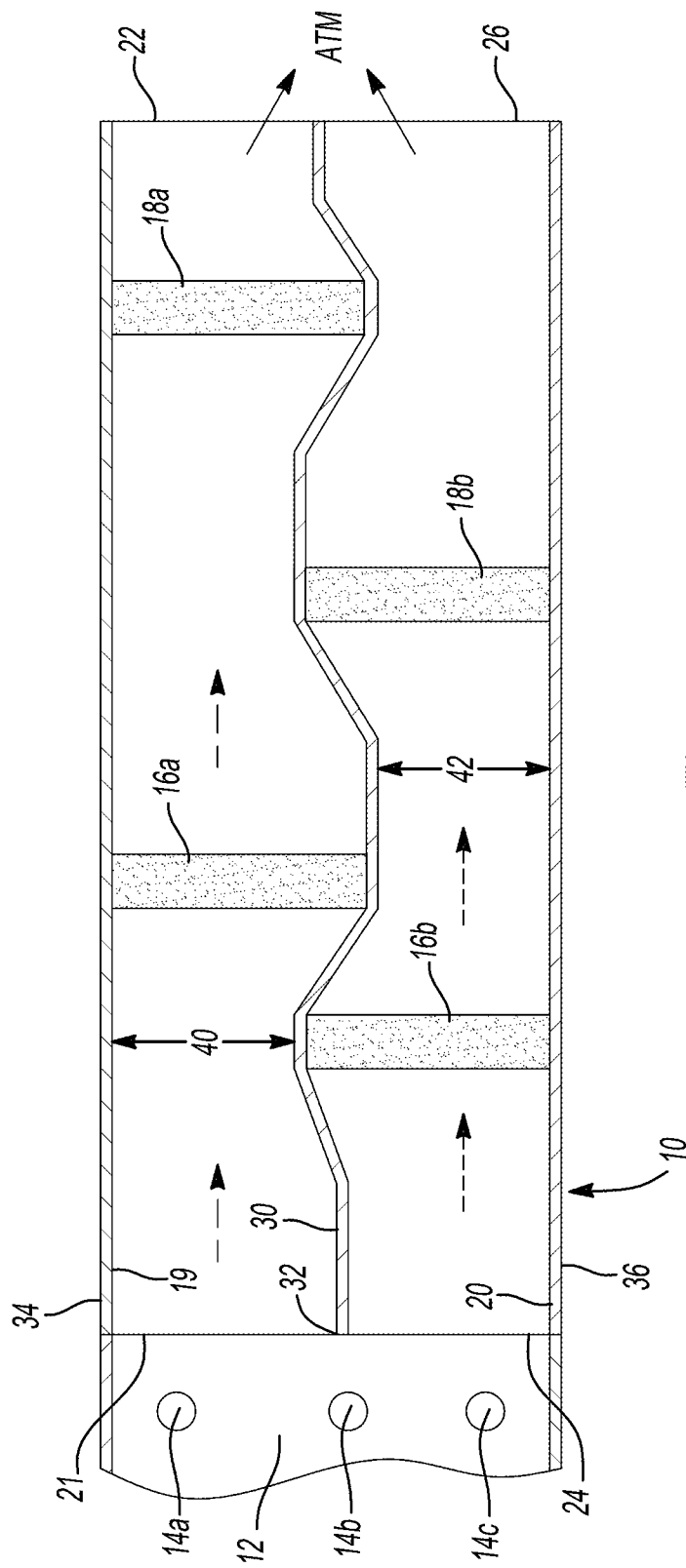


Fig-1

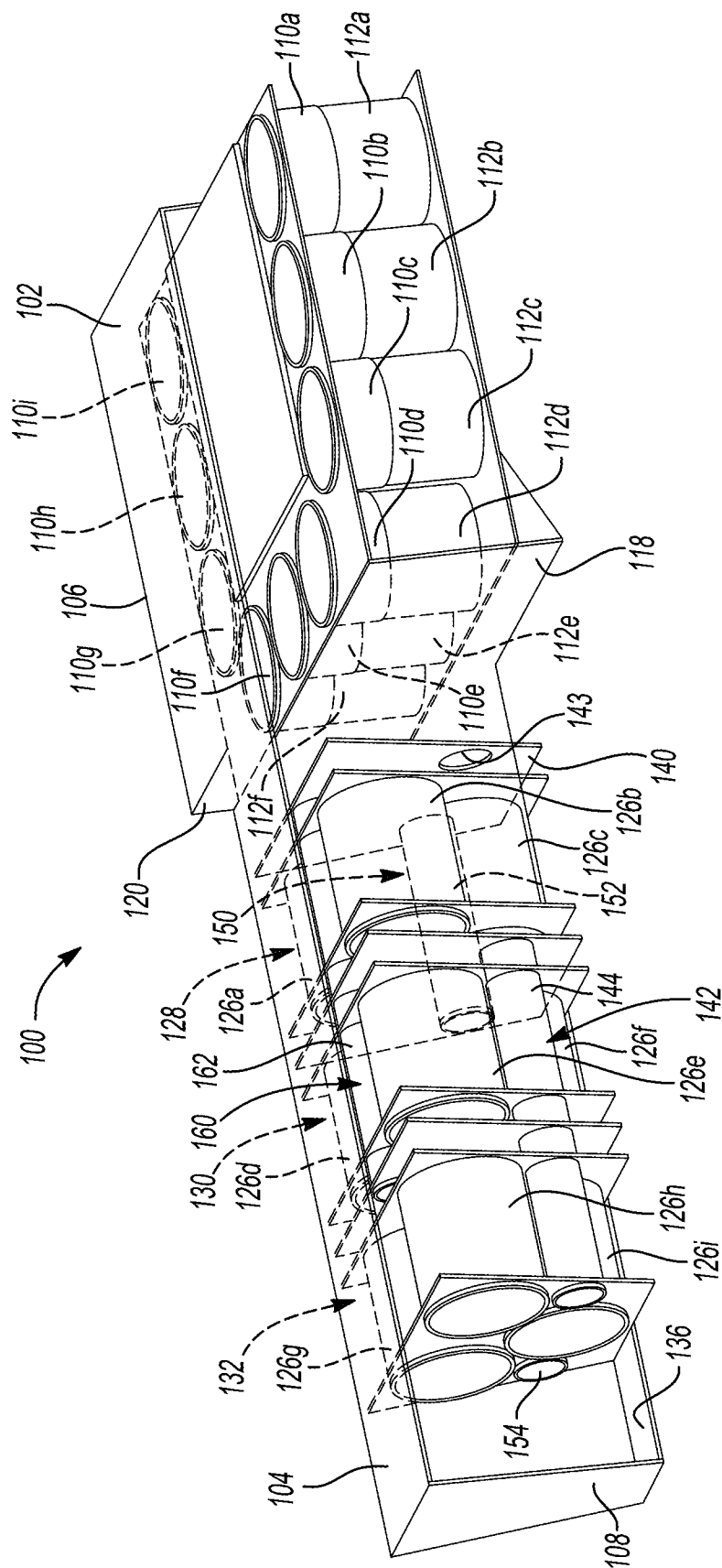


Fig-2