An engine exhaust aftertreatment system including a ring disposed in an exhaust conduit. The ring assists in the introduction and conversion of a reductant introduced by an injector.
FIG. 3
FIG. 4
RING REDUCTANT MIXER

TECHNICAL FIELD

[0001] The present disclosure relates to engine exhaust aftertreatment systems and more particularly to exhaust aftertreatment systems employing reductants for NOx reduction technologies.

BACKGROUND

[0002] A selective catalytic reduction (SCR) system may be included in an exhaust treatment or aftertreatment system for a power system to remove or reduce nitrous oxide (NOx) or NO emissions coming from the exhaust of an engine. SCR systems use reductants, such as urea, that are introduced into the exhaust stream.


SUMMARY

[0004] The present disclosure provides an engine exhaust aftertreatment system including an injector configured to introduce a reductant into an exhaust conduit and a ring disposed in the exhaust stream.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a diagrammatic view of a power system including an engine and an aftertreatment system with a mixer.

[0006] FIG. 2 is a front view of the mixer.

[0007] FIG. 3 is a front view of another embodiment of the mixer.

[0008] FIG. 4 is a front view of another embodiment of the mixer.

[0009] FIG. 5 is a front view of another embodiment of the mixer.

[0010] FIG. 6 is a front view of another embodiment of the mixer.

[0011] FIG. 7 is a diagrammatic view of a dual legged aftertreatment system incorporating the mixer.

DETAILED DESCRIPTION

[0012] As seen in FIG. 1, a power system 10 includes an engine 12 and an aftertreatment system 14 to treat an exhaust stream 16 produced by the engine 12. The engine 12 may include other features not shown, such as controllers, fuel systems, air systems, cooling systems, peripherals, drivetrain components, turbochargers, exhaust gas recirculation systems, etc.

[0013] The engine 12 may be any type of engine (internal combustion, gas, diesel, gaseous fuel, natural gas, propane, etc.), may be of any size, with any number of cylinders, and in any configuration (“V,” in-line, radial, etc.). The engine 12 may be used to power any machine or other device, including on-highway trucks or vehicles, off-highway trucks or machines, earth moving equipment, generators, aerospace applications, locomotive applications, marine applications, pumps, stationary equipment, or other engine powered applications.

[0014] The aftertreatment system 14 includes an exhaust conduit 18 and a Selective Catalytic Reduction (SCR) system 20. The SCR system 20 includes an SCR catalyst 22, mixing conduit 24, mixer 26, and reductant supply system 28.

[0015] The SCR catalyst 22 includes a catalyst material disposed on a substrate. The substrate may consist of cordierite, silicon carbide, other ceramic, or metal. The substrate may include a plurality of through going channels and may form a honeycomb structure.

[0016] The reductant supply system 28 may include a reductant 30, reductant source 32, pump 34, valve 36, reductant line 38, and injector 40. The reductant 30 drawn from the reductant source 32 via the pump 34 and delivery to the injector 40 is controlled via the valve 36. The flow of reductant 30 may also be controlled by operation of the pump 34.

[0017] The mixing conduit 24 is the section of the exhaust conduit 18 where the reductant 30 is introduced. The mixing conduit 24 includes an inner wall 25 and outer wall 27. The mixing conduit 24 is also defined by an inner width 29.

[0018] The reductant supply system 28 may also include a thermal management system to thaw frozen reductant 30, prevent reductant 30 from freezing, or preventing reductant 30 from overheating. Components of the reductant supply system 28 may also be insulated to prevent overheating of the reductant 30. The reductant supply system 28 may also include an air assist system for introducing compressed air to aid in the formation of small droplets in the reductant spray 44. The air assist system may also be used to purge the reductant lines 38 and other reductant supply system 28 components of reductant 30 when not in use.

[0019] The reductant 30 comes from a nozzle or injector tip 42 of the injector 40 to form a reductant spray 44 or is otherwise introduced into the exhaust stream 16 or SCR catalyst 22. The position of the injector tip 42 may be such to direct the reductant spray 44 directly down a centerline of the mixing conduit 24 and the mixer 26.

[0020] The aftertreatment system 14 may also include a diesel oxidation catalyst (DOC) 46, a diesel particulate filter (DPF) 48, and a clean-up catalyst 50. The DOC 46 and DPF 48 may be in the same canister, as shown, or separate. The SCR catalyst 22 and clean-up catalyst 50 may also be in the same canister, as shown, or separate.

[0021] The aftertreatment system 14 is configured to remove, collect, or convert undesired constituents from the exhaust stream 16. The DOC 46 oxidizes Carbon Monoxide (CO) and unburnt hydrocarbons (HC) into Carbon Dioxide (CO2). The DPF 48 collects particulate matter or soot. The SCR catalyst 22 is configured to reduce an amount of NOx in the exhaust stream 16 in the presence of the reductant 30.

[0022] A heat source 52 may also be included to remove the soot from the DPF 48, thermally manage the SCR catalyst 22, DOC 46, or clean-up catalyst 50, to remove sulfur from the SCR catalyst 22, or to remove deposits of reductant 30 that may have formed. The heat source 52 may embody a burner, hydrocarbon dosing system to create an exothermic reaction on the DOC 46, electric heating element, microwave device, or other heat source. The heat source 52 may also embody operating the engine 12 under conditions to generate elevated exhaust stream 16 temperatures. The heat source 52 may also embody a backpressure valve or another restriction in the exhaust to cause elevated exhaust stream 16 temperatures.

[0023] In the illustrated embodiment, the exhaust stream 16 exits the engine 12, passes by or through the heat source 52, passes through the DOC 46, DPF 48, then passes through the SCR system 20, and then passes through the clean-up catalyst 50 via the exhaust conduit 18.
Other exhaust treatment devices may also be located upstream, downstream, or within the SCR system 20. In the illustrated embodiment, the SCR system 20 is downstream of the DPF 48 and the DOC 46 is upstream of the DPF 48. The heat source 52 is upstream of the DOC 46. The clean-up catalyst 50 is downstream of the SCR system 20. In other embodiments, these devices may be arranged in a variety of orders and may be combined together. In one embodiment, the SCR catalyst 22 may be combined with the DPF 48 with the catalyst material deposited on the DPF 48.

While other reductants 30 are possible, urea is the most common source of reductant 30. Urea reductant 30 decomposes or hydrolyzes into ammonia (NH3) and is then adsorbed or otherwise stored in the SCR catalyst 22. The mixing conduit 24 may be long to aid in the mixing or even distribution of the reductant 30 into the exhaust stream 16 and provide dwell time for the urea reductant 30 to convert into NH3. The NH3 is consumed in the SCR Catalyst 22 through a reduction of NOx into Nitrogen gas (N2).

The clean-up catalyst 50 may embody an ammonia oxidation catalyst (AMOX). The clean-up catalyst 50 is configured to capture, store, oxidize, reduce, and/or convert NH3 that may slip past or breakthrough the SCR catalyst 22. The clean-up catalyst 50 may also be configured to capture, store, oxidize, reduce, and/or convert other constituents present.

Control and sensor systems may also be included to control the engine 12, heat source 52, reductant supply system 20, and other components in the power system 10 or its application.

The mixer 26 includes an encircling member or ring 54. The ring 54, as shown, is planar with a toroidal shape and a rectangular cross-section, like a washer. In other embodiments, the ring 54 may have a variety of other cross-sections, including circular.

The ring 54 includes a face surface 55, inner surface 56, and outer surface 57. The ring 54 is defined by a thickness 58 in the direction of flow of the exhaust stream 16, an inner diameter 60, outer diameter 61, and a width 62. The ring width 62 is the width of the member forming the ring 54 and is half the difference between the inner diameter 60 and outer diameter 61. The inner diameter 60 of the ring 54 defines a central opening 64.

Because the ring 54 may be planar, the surfaces of the ring may be constant through the thickness 58 and the same as the face surface 55. A traverse plane 65 passes through the center and across the mixing conduit 24. The traverse plane 65 includes the family of planes parallel to it. The traverse plane 65 may lie along the face surface 55 or may extend through another portion of the mixer 26. The traverse plane 65 may be perpendicular to the flow of exhaust 16, as shown. The traverse plane 65 may also be perpendicular to the inner wall 25 of the mixing conduit 24. In other embodiments, the traverse plane 65 could be disposed at a variety angles to the flow of exhaust 16 and inner wall 25.

While the ring 54 is described and shown as being toroidal and circular and as having a “diameter”, the ring 54 could also be rectangular, octagonal, triangular or any other shape. The shape of the ring 54 may follow the inner perimeter of mixing conduit 24 and may accordingly match at least a portion of the shape of the mixing conduit 24 where it is housed. The ring 54 may also have a different shape than the mixing conduit 24 and be sized to fit within the mixing conduit 24 (for example, the ring 54 may have a square shape that fits within a circular mixing conduit 24). The ring width 62 may or may not be constant. The outer shape of the ring 54 may also be different than the inner shape (for example, the outer shape may be circular while the inner shape and central opening 64 may be rectangular).

The mixer 26 may also include spacers 66 that separate the ring 54 from the inner wall 25 of the mixing conduit 24. The spacers 66 may also serve to mount the ring 54.

The separation between the outer surface 57 of the ring 54 and inner wall 25 defines a gap 68. The gap 68 may be ring shaped or have a different shape. The gap 68 may have a gap width 70. The gap width 70 may or may not be constant around the ring 54. In some embodiments no gap 68 may exist at some portions of the ring 54.

Provided below are some of the dimensional aspects of the mixer 26. These dimensional aspects may depend on a great number of variables that may vary between different power systems 10. For example, the proper mixer 26 dimensions may depend on exhaust flow 16 rates, mixing conduit 24 size, engine 12 duty cycle, engine 12 backpressure requirements, reductant spray 44 droplet sizes, reductant spray 44 velocity. In order to account for these variables, the dimensions below are defined in terms of ratios and ranges are provided.

The gap width 70 may be approximately 1/8 of an inch. In other embodiments, the gap width 70 may be between 1/16 and 1/8 of an inch. In yet other embodiments, the gap width may be between 3/32 and 1/8 of an inch.

The size of the gap width 70 may also be a function of the inner width 29. In one embodiment, the area of the gap 68 along the traverse plane 65 may be approximately 1.3% of the area of the mixing conduit along the traverse plane 65. In other embodiments, the area of the gap 68 along the traverse plane 65 may be between 0.5% and 5%, between 0.1% and 10%, or between 0.7% and 2% of the area of the mixing conduit along the traverse plane 65.

The ring width 62 may be approximately 2 inches. In other embodiments, the ring width 62 may be between 1 and 3 inches. In yet other embodiments, the ring width 62 may be between 0.5 and 5 inches.

The size of the ring width 62 may also be a function of the inner width 29. In one embodiment, the ring width 62 may be approximately 10% of the inner width 29. In other embodiments, the ring width 62 may be between 5% and 15% or between 2% and 25% of the inner width 29.

The gap width 70 and ring width 62 may also be selected to achieve a given size of the central opening 64 as a function of the inner width 29. In one embodiment the area of the central opening 64 along the traverse plane 65 may be approximately 62% of the area of the mixing conduit 24 along the traverse plane 65. In other embodiments, the area of the central opening 64 along the traverse plane 65 may be between 50% and 70%, between 40% and 80%, between 30% and 80%, or between 20% and 90% of the area of the mixing conduit 24 along the traverse plane 65.

The collection 54 may be constructed from sheet metal and therefore the thickness 58 may be relatively small, though it could be a variety of sizes. In one embodiment the thickness may be less than 1 (one) inch. In another embodiment the thickness may be less than 1/4 of an inch. The thickness may also be smaller than the ring width 62.

FIGS. 2-6 show various embodiments of the mixer 26 with a variety of features, as described below. The mixer 26 may include any combination of features described herein. FIG. 2 shows the ring 54 as a solid surface. FIG. 2 also shows...
that the spacers 66 may be formed by spot welds 72 that separate and mount or connect the ring 54 to the inner wall 25.

[0042] FIG. 3 shows the ring 54 may include one or more openings 73 through the face surface 55. The openings 73 may have a variety of locations on the ring 54 and may form a variety of patterns. FIG. 3 also shows that the spacers 66 may be formed by tabs 74 that extend from the outer surface 57 of the ring 54. A distal end of the tabs 74 may then be welded, inserted into, or otherwise connected to the mixing conduit 24 to separate and mount or connect the ring 54 to the inner wall 25 and form the gap 68.

[0043] FIG. 4 shows that the mixer 26 may include center structures 76 that extend into the central opening 64. These center structures 76 may extend from the inner surface 56 of the ring 54 or from another location or body. The central structures 76 may embody large members, small metal wires, or a mesh of wires.

[0044] FIG. 5 shows that baffles 78 may be added to the mixer 26. The baffles 78 include a baffle opening 80 and a deflector 82. The deflectors 82 are disposed at an angle less than ninety degrees to the exhaust stream 16 and thereby direct the exhaust stream 16 through the baffle openings 80 at an angle. The baffles 78 may be formed by bending a cutout 84 or stamping a scallop 86. FIG. 6 shows that deflectors 82 may also be formed off the spacers 66 or central structures 76.

[0045] FIG. 1 shows the location of the mixer 26 in the mixing conduit 24. The mixer 26 is disposed within the inner wall 25 at a mixer distance 88 from the injector tip 42. The mixer distance 88 may be such that the size of the exhaust stream 16 is approximated such that the exhaust opening 64 when the spray 44 reaches the ring 54.

[0046] FIG. 7 shows that the mixer 26 may be used in a dual leg aftertreatment system 90. The dual leg aftertreatment system 90 includes first and second SCR legs 91 and 92, receiving the exhaust stream 16 and reductant 30 from the reductant supply system 28.

[0047] The exhaust stream 16 from the mixing conduit 24 is split or divided in a dividing section 93 of the exhaust conduit 18. The dividing section 93 may be located at a dividing distance 94 downstream from the mixer 26. The dividing distance 94 may be longer than the mixer distance 88. In one embodiment, the dividing distance may be a function of the inner width 29. The dividing distance 94 may be approximately 1.2 times the inner width 29. In other embodiments, the dividing distance may be longer than the mixer distance 88, and the dividing distance may be a function of the inner width 29.

[0048] The dual leg aftertreatment system 90 may also include first and second entering legs 95 and 96, delivering the exhaust stream 16 to the reductant supply system 28. The exhaust stream 16 from the first and second entering leg 95 and 96 is split or divided in a combining section 97 of the exhaust conduit 18.

[0049] The first and second entering leg 95 and 96 may be shown as including the DPF 48 and DOC 46, but may not include either or may include other components. In other embodiment, the first and second entering leg 95 and 96 do not include the DPF 48. The first and second entering leg 95 and 96 are also shown as being disposed at right angles relative to the first and second SCR legs 91 and 92, but may be disposed at various other angles or may be arranged linearly. The dual leg aftertreatment system 90 may also be contained in a box structure with interior walls dividing the flow of the exhaust.

[0050] The mixer 26 components may be constructed from steel or any other of a variety of materials. The mixer 26 may also be coated with materials to assist in the conversion or hydrolysis of the reductant 30 into NH3.

INDUSTRIAL APPLICABILITY

[0051] The mixer 26 assists in evenly distributing or mixing the reductant 30 into the exhaust stream 16, promoting the conversion of the reductant 30 into NH3, and preventing the formation of deposits. The mixer 26 should also be cheap, small, and create minimal backpressure. These features, however, are often in conflict with one another. For instance, large and complex structures may be effective at evenly distributing the reductant 30 into the exhaust stream 16 and promoting the conversion of the reductant 30 into NH3 but are not cheap, take up too much space, and often create a large amount of backpressure.

[0052] Evenly distributing the reductant 30 into the exhaust stream 16 improves the efficiency of the SCR system 20 by evenly introducing NH3 to all channels of the SCR catalyst and therefore a greater amount of conversion can occur. Evenly distributing the reductant 30 into the exhaust stream 16 may also reduce the amount of reductant 30 that is needed to achieve that greater efficiency. Evenly distributing the reductant 30 into the exhaust stream 16 may also prevent introducing too much NH3 to some areas of the SCR catalyst that may cause NH3 slip.

[0053] Deposits may form when the reductant 30 is not quickly decomposed into NH3 and thick layers of reductant 30 collect. These layers may build as more and more reductant 30 is sprayed or collected, which may have a cooling effect that prevents decomposition into NH3. As a result, the reductant 30 sublimes into crystals or otherwise transforms into a solid composition to form the deposit. The deposit composition may consist of biuret (NH2CONHNHCONH2) or cyanuric acid ((NH4CO3) or another composition depending on temperatures and other conditions. These deposits may form in areas and on surfaces where the exhaust spray 44 impinges, settles, or lies stagnant.

[0054] These deposits may have negative impacts on the operation of the power system 10. The deposits may block flow of the exhaust stream 16, causing higher backpressure and reducing engine 12 and aftertreatment system 14 performance and efficiency. The deposits may also disrupt the flow and mixing of the reductant 30 into the exhaust stream 16, thereby reducing the decomposition into NH3 and reducing NOx reduction efficiency. The formation of the deposits also consumes reductant 30, making control of injection harder and potentially reducing NOx reduction efficiency. The deposits may also corrode and degrade components of the SCR system 20.

[0055] Limiting backpressure increases is also important. High backpressure can harm engine 12 performance. High backpressure may also lead to deposit formation and exhaust leaks.

[0056] The ring 54 may create limited backpressure while still achieving a high degree of mixing of the reductant 30 into the exhaust stream 16. The large size of the central opening 64 limits restrictions and also creates a tumbling of the exhaust stream 16 that is effective in mixing the reductant 30 into the exhaust stream 16. Many other mixer designs achieve mixing through swirling or creating high levels of turbulence. These mixers have structures that are complex and large and therefore tend to be expensive and cause backpressure. In contrast,
the tumbling achieved by the ring 54 has been found to be effective at mixing while also being cheap to produce and not causing as large an amount of backpressure as other mixers. The planar shape of the ring 54 facilitates its manufacture by cutting a simple sheet of material, which is cheap. More complex mixers require more complex cuts, bends, and welds which are expensive.

[0057] The gap 68 can be employed to allow flow-by of the exhaust stream 16, while still achieving the tumbling effect described above. This flow-by prevents the stagnant collecting of reductant 30 that would otherwise form deposits. The flow-by also helps to reduce backpressure. If the gap 68 were too large, the tumbling effect described above may be hampered as significant flow simply goes around the ring 54 instead of tumbling through the central opening 64. If the gap 68 were too small, the flow-by may not be enough to prevent deposits or achieve significant reductions in backpressure.

[0058] The gap 68 may be located along the periphery along the outer surface 57 of the ring 54 because that is where the reductant would collect. In some embodiments, the gap 68 may only be at the bottom of the ring 54, where the reductant 30 would otherwise collect.

[0059] The mixer distance 88 of the mixer 26 from the injector tip 42 may influence the formation of deposits and the mixing effectiveness. If the mixer distance 88 is too short, then the reductant spray 44 will be concentrated in a small volume because the spray 44 has not expanded. Accordingly, the reductant spray 44 may only pass through the very center of the central opening 64. Because the spray 44 would be concentrated in a small volume and only pass through the center of the central opening, the tumbling effect described above may not be effective and mixing of the reductant 30 into the exhaust stream 16 may not be to the degree desired. If the mixer distance 88 is too long, then the reductant spray 44 will have expanded to a larger volume and may impinge on the ring 54 or the inner wall 25 before converting to NH3. This impingement may cause deposits to form as described above.

[0060] The openings 73 may be employed to help reduce backpressure and may also reduce weight. The openings 73 may also be used to create flow-by and drain areas where reductant 30 collects, thereby preventing deposits.

[0061] The central structures 76 may help break up and atomize the reductant spray 44, thereby assisting in the conversion to NH3. The central structures 76 may also introduce turbulence into the exhaust stream 16 that may help in the conversion to NH3. The central structures 76 may not form deposits because they are in a region that has high flow rates and high temperatures. The central structures 76 may also add rigidity and structural strength to the mixer 26.

[0062] The baffles 78 may be employed to introduce a swirl, in addition to the tumble, into the exhaust stream 16 for additional mixing. In some embodiments, the baffles 78 may generate counter-rotating swirls. Like the openings 73, the baffles 78 may also help reduce backpressure and may also reduce weight. The baffles 78 may also be used to create flow-by and drain areas where reductant 30 collects, thereby preventing deposits.

[0063] The mixer 26 may also be suited for the dual leg aftertreatment system 90. Dual leg aftertreatment systems 90 are often used with larger engine systems. The dual leg aftertreatment systems 90 may allow for the use of smaller aftertreatment substrates. Because these substrates are often complex ceramic bodies they may be more economically produced in smaller sizes. The smaller sizes may also improve packaging options and improve flow distribution across the face of the substrates.

[0064] Because the mixer 26 introduces limited backpressure, it may uniformly combine exhaust stream 16 flows from the first and second entering legs 95 and 96. The tumbling created by the mixer 26 may also help divide the exhaust stream 16 flows into the first and second exiting legs 91 and 92. Mixers that depend heavily on swirling and turbulence may create a biased flow towards either of the first and second exiting legs 91 and 92.

[0065] The dividing distance 94 may influence the even division of the exhaust stream 16 flows into the first and second exiting legs 91 and 92 and prevent the formation deposits.

[0066] The dividing distance 94 may influence the even division of the exhaust stream 16 flows into the first and second exiting legs 91 and 92. If the dividing distance 94 is too short then the reductant 30 may not have time to convert into NH3 and the tumbling effect from the mixer 26 may be large. Poor conversion into NH3 before the dividing section 93 may cause deposits as the reductant impinges on the walls. The large tumbling may cause a bias towards one of the first and second exiting legs 91 and 92. If the dividing distance is too long it may lead to packaging challenges of the dual leg aftertreatment system 90 and may cause heat to be lost that is needed to activate the SCR catalyst 22 and prevent the formation of deposits.

[0067] While the mixer 26 is described above to aid in the introduction of a reductant into an exhaust stream, it is also contemplated that the mixer 26 could be used to aid in the introduction of any of a variety of substances in any of variety of flows. Although the embodiments of this disclosure as described herein may be incorporated without departing from the scope of the following claims, it will be apparent to those skilled in the art that various modifications and variations can be made. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosure. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. An engine exhaust aftertreatment system comprising: an injector configured to introduce a reductant into an exhaust conduit of an engine and a ring disposed in the exhaust conduit.
2. The engine exhaust aftertreatment system of claim 1 wherein the ring is disposed downstream of the injector and upstream of a selective catalytic reduction catalyst.
3. The engine exhaust aftertreatment system of claim 1 wherein the ring is planar.
4. The engine exhaust aftertreatment system of claim 1 wherein the ring is toroidal.
5. The engine exhaust aftertreatment system of claim 4 wherein the ring has a rectangular cross-section.
6. The engine exhaust aftertreatment system of claim 1 wherein the ring defines a central opening with an area along a traverse plane of the exhaust conduit that is between 50% and 70% the area of the traverse plane within the exhaust conduit.
7. The engine exhaust aftertreatment system of claim 1 wherein the ring defines a central opening with an area along a traverse plane of the exhaust conduit that is between 20% and 90% the area of the traverse plane within the exhaust conduit.
8. The engine exhaust aftertreatment system of claim 1 wherein the ring has a width that is between 2% and 25% of a width of the exhaust conduit.

9. The engine exhaust aftertreatment system of claim 1 wherein the ring defines a gap between an outer surface of the ring and an inner wall of the exhaust conduit.

10. The engine exhaust aftertreatment system of claim 9 wherein the gap extends around a perimeter of the ring.

11. The engine exhaust aftertreatment system of claim 10 wherein the gap is formed by spacers mounting the ring to the exhaust conduit.

12. The engine exhaust aftertreatment system of claim 9 wherein the gap has a width that is between \( \frac{1}{16} \) and \( \frac{1}{2} \) of an inch.

13. The engine exhaust aftertreatment system of claim 9 wherein the gap has an area along a traverse plane of the exhaust conduit that is between 0.5% and 5% the area of the traverse plane within the exhaust conduit.

14. The engine exhaust aftertreatment system of claim 1 wherein the injector directs a spray of reductant through a central opening in the ring.

15. The engine exhaust aftertreatment system of claim 14 wherein the ring is located at a distance from the injector so that the spray of reductant is not larger than the central opening when the spray reaches the ring.

16. The engine exhaust aftertreatment system of claim 1 wherein the exhaust conduit divides into 2 or more legs downstream of the ring.

17. The engine exhaust aftertreatment system of claim 16 wherein the exhaust conduit divides at a distance from the ring that is greater than a width of the exhaust conduit.

18. The engine exhaust aftertreatment system of claim 16 wherein 2 or more legs combine into the exhaust conduit upstream of the injector.

19. The engine exhaust aftertreatment system of claim 1 wherein the ring includes a plurality of openings.

20. The engine exhaust aftertreatment system of claim 1 wherein the ring includes a plurality of deflectors and central structures that extend into a central opening in the ring.

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