

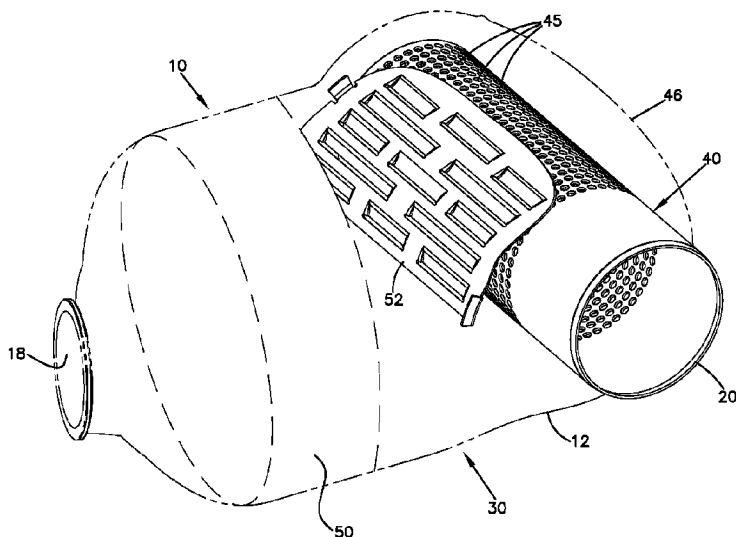


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(54) Titre : AGENCEMENT DE DOSAGE ET DE MELANGE DESTINE A ETRE UTILISE DANS LE TRAITEMENT
POSTCOMBUSTION DES GAZ D'ECHAPPEMENT

(54) Title: DOSING AND MIXING ARRANGEMENT FOR USE IN EXHAUST AFTERTREATMENT



(57) **Abrégé/Abstract:**

A method for causing exhaust gas flow to flow at least 270 degrees in a first direction about a perforated tube using a baffle plate having a main body with a plurality of flow-through openings and a plurality of louvers positioned adjacent to the flow-through openings. The method includes deflecting a first portion of the exhaust gas flow with the main body of the baffle plate. The method also includes allowing a second portion of the exhaust gas flow to flow through the flow-through openings of the baffle plate. The method also deflects the second portion of the exhaust gas flow at a downstream side of the main body with the louvers hereby causing the second portion of the exhaust gas flow to flow in the first direction about the perforated tube.

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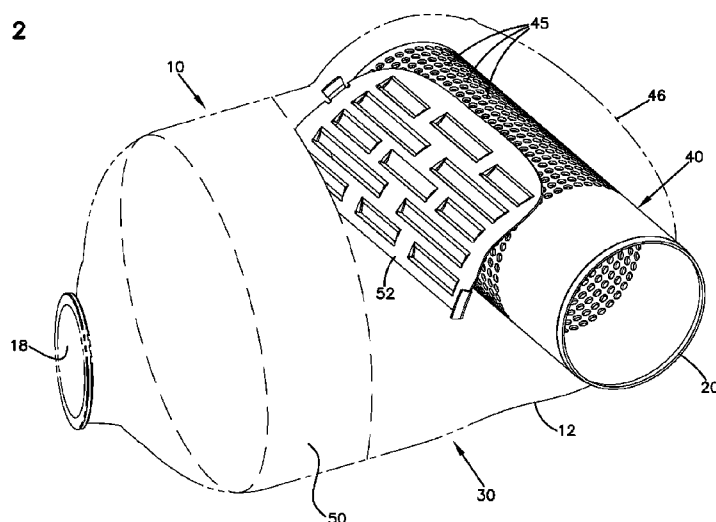
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FIG. 2



(57) Abstract: A method for causing exhaust gas flow to flow at least 270 degrees in a first direction about a perforated tube using a baffle plate having a main body with a plurality of flow-through openings and a plurality of louvers positioned adjacent to the flow-through openings. The method includes deflecting a first portion of the exhaust gas flow with the main body of the baffle plate. The method also includes allowing a second portion of the exhaust gas flow to flow through the flow-through openings of the baffle plate. The method also deflects the second portion of the exhaust gas flow at a downstream side of the main body with the louvers hereby causing the second portion of the exhaust gas flow to flow in the first direction about the perforated tube.

DOSING AND MIXING ARRANGEMENT FOR USE IN EXHAUST AFTERTREATMENT

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BACKGROUND

Vehicles equipped with internal combustion engines (e.g., diesel engines) typically include exhaust systems that have aftertreatment components such as selective catalytic reduction (SCR) catalyst devices, lean NO_x catalyst devices, or lean NO_x trap devices to reduce the amount of undesirable gases, such as nitrogen oxides (NO_x) in the exhaust. In order for these types of aftertreatment devices to work properly, a doser injects reactants, such as urea, ammonia, or hydrocarbons, into the exhaust gas. As the exhaust gas and reactants flow through the aftertreatment device, the exhaust gas and reactants convert the undesirable gases, such as NO_x, into more acceptable gases, such as nitrogen and water. However, the efficiency of the aftertreatment system depends upon how evenly the reactants are mixed with the exhaust gases. Therefore, there is a need for a flow device that provides a uniform mixture of exhaust gases and reactants.

SCR exhaust treatment devices focus on the reduction of nitrogen oxides. In SCR systems, a reductant (e.g., aqueous urea solution) is dosed into the exhaust stream. The reductant reacts with nitrogen oxides while passing through an SCR substrate to reduce the nitrogen oxides to nitrogen and water. When aqueous urea is used as a reductant, the aqueous urea is converted to ammonia which in turn reacts with the nitrogen oxides to convert the nitrogen oxides to nitrogen and water. Dosing, mixing and evaporation of aqueous urea solution can be challenging because the urea and by-products from the reaction of urea to ammonia can form deposits on the surfaces of the aftertreatment devices. Such deposits can accumulate over time and partially block or otherwise disturb effective exhaust flow through the aftertreatment device.

SUMMARY

An aspect of the present disclosure relates to a method for dosing and mixing exhaust gas in exhaust aftertreatment. Another aspect of the present disclosure relates to a dosing and mixing unit for use in exhaust aftertreatment.

- 5 More specifically, the present disclosure relates to a dosing and mixing unit including a baffle plate configured to direct exhaust gas flow to flow around a perforated mixing tube to effectively mix and dose exhaust gas within a relatively small area.

- An aspect of the disclosure includes a method for causing exhaust gas
- 10 flow to flow at least 270 degrees in a first direction about a perforated tube using a baffle plate. The baffle plate has a main body that defines a plurality of flow-through openings. The baffle plate also includes a plurality of louvers positioned adjacent to the flow-through openings. The main body of the baffle plate has an upstream side and a downstream side. The louvers are positioned at the
- 15 downstream side of the main body of the baffle plate. The downstream side of the main body of the baffle faces toward the perforated tube. The method includes deflecting a first portion of the exhaust gas flow with the upstream side of the main body of the baffle plate thereby causing the first portion of the exhaust flow to flow around an end of the main body of the baffle plate and around the perforated tube in
- 20 the first direction. The method also includes allowing a second portion of the exhaust gas flow to flow through the flow-through openings of the baffle plate from the upstream side of the main body to the downstream side of the main body. The method also involves deflecting the second portion of the exhaust gas flow at the downstream side of the main body with the louvers thereby causing the second
- 25 portion of the exhaust gas flow to flow in the first direction about the perforated tube.

- A variety of additional aspects will be set forth in the description that follows. These aspects can relate to individual features and to combinations of features. It is to be understood that both the foregoing general description and the
- 30 following detailed description are exemplary and explanatory only and are not restrictive of the broad concepts upon which the embodiments disclosed herein are based.

DRAWINGS

Figure 1 is a perspective view of a dosing and mixing unit having features that are examples of inventive aspects in accordance with the principles of the present disclosure;

5 Figure 2 is a side perspective view of the dosing and mixing unit of Figure 1 with interior components visible;

Figure 3 is a side view of the dosing and mixing unit of Figure 2;

Figure 4 shows exhaust gas flowing through the dosing and mixing unit of Figure 3;

10 Figure 5 is a top plan view of the exhaust gas flowing through the dosing and mixing unit of Figure 3;

Figure 6 is a perspective view of an example baffle curving partially around an example perforated tube suitable for use in the dosing and mixing unit of Figure 2;

15 Figure 7 is a perspective view showing a downstream side of the baffle of Figure 6;

Figure 8 is a side elevational view of the baffle of Figure 6;

Figure 9 is a cross-sectional view of the dosing and mixing unit of Figure 2 taken along the 9-9 line of Figure 3;

20 Figure 10 is a side view of the dosing and mixing unit of Figure 2 with a perforated plate disposed between the inlet and the treatment substrate;

Figure 11 is a front view of an example perforated suitable for use in the dosing and mixing unit of Figure 10; and

25 Figure 12 shows exhaust gas flowing through the dosing and mixing unit of Figure 10.

DETAILED DESCRIPTION

Reference will now be made in detail to the exemplary aspects of the present disclosure that are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer
30 to the same or like structure.

Figures 1-5 show a dosing and mixing unit 10 in accordance with the principles of the present disclosure. The dosing and mixing unit 10 includes a housing 12 having a housing body 30, an inlet 18, and an outlet 20. An exhaust

treatment substrate 50, a perforated tube 40, and a baffle 52 are disposed within the housing 12 (Figure 2). Exhaust gas G flows from the inlet 18, through the treatment substrate 50, through the baffle 52, and into the tube 40 (see Figure 4). The baffle 52 is configured to direct the exhaust gas G to flow in a direction d (see Figure 3) about the perforated tube 40 to enhance swirling within the tube 40. The tube 40 defines the outlet 20 of the unit 10.

As shown in Figure 3, the housing body 30 defines a central housing axis 32 between a first end 34 and a second opposite end 36. A length L of the main housing body 30 extends along the central housing axis 32 between the first and the second ends 34, 36 of the main housing body 30 (Figure 3). The inlet 18 is adjacent the first end 34 of the main housing body 30 and the outlet 20 is adjacent the second end 36 of the main housing body 30. The exhaust treatment substrate 50 is positioned within the main housing body 30 between the inlet 18 and the perforated tube 40. The main housing body 30 defines an interior volume V (see Figure 3) that extends between an exhaust treatment substrate 50 and the perforated tube 40. The interior volume V defines a transverse cross-sectional area A that is transverse relative to the central housing axis 32 (see Figure 9).

The perforated tube 40 is disposed towards the second end of the main housing body 30. In certain embodiments, the second end 36 of the main housing body 30 includes a curved portion 46 that curves partially around the perforated tube 40. As used herein, a “perforated tube” is a conduit having a plurality of side holes. The use of the term “perforated” is not dependent on the method(s) used to make the side holes (i.e., the holes can be made in any way and need not be formed by a stamping/perforation type process). The perforated tube 40 defines a tube axis 42 aligned at an angle θ relative to the central housing axis 32 (see Figure 5).

The baffle plate 52 is positioned within the interior volume V between the perforated tube 40 and the exhaust treatment substrate 50. In certain embodiments, the baffle plate 52 is separate from and not connected to the perforated tube 40. As shown in Figures 6-8, the baffle plate 52 includes a main plate body 54 having an upstream side 56 that faces toward the exhaust treatment substrate 50 and a downstream side 58 that faces toward the perforated tube 40 (also see Figure 3). In certain embodiments, the main body 54 of the baffle plate 52

extends only partially around the perforated tube 40. In certain embodiments, the main body 54 of the baffle plate 52 extends along less than fifty percent of a circumference of the perforated tube 40. In certain embodiments, the main body 54 of the baffle plate 52 extends along less than one-third of a circumference of the perforated tube 40. In certain embodiments, the main body 54 of the baffle plate 52 extends along less than one-quarter of a circumference of the perforated tube 40.

In certain embodiments, the main body 54 of the baffle plate 52 has a curvature defined by an arc having a radius centered on a centerline of the perforated tube 40. In some embodiments, the upstream side 56 of the main body 54 has a convex curvature and the downstream side 58 of the main body 54 has a concave curvature (see Figure 8). In some of these embodiments, the convex and concave curvatures curve partially around the perforated tube 40 (see Figure 3).

The main plate body 54 defines a plurality of flow-through openings 60 that extend through the main plate body 54 between the upstream and downstream sides 56, 58 of the main plate body 54. The openings 60 enable treated exhaust gas G to flow through the baffle 52 towards the tube 40 (see Figures 4 and 5). In certain embodiments, the perforated tube 40 defines circular openings 45 and the baffle plate 52 defines rectangular openings 60. In certain embodiments, the openings 45 of the perforated tube 40 are smaller in area than the openings 60 in the baffle plate 52.

In accordance with some aspects of the disclosure, the baffle plate 52 also includes one or more louvers 62 positioned adjacent to the flow-through openings 60 of the main plate body 54. In some implementations, the louvers 62 are disposed at the downstream side 58 of the plate body 54. In other implementations, one or more louvers 62 can be positioned at the upstream side 56 or at both the upstream and downstream sides 56, 58 of the plate body 54. In certain embodiments, the louvers 62 have base ends 63 that are integral/unitary with the main body 54 of the baffle plate 52. Free ends 65 of the louvers 62 extend laterally away from the main plate body 54. The louvers 62 direct the gas G passing through the openings 60 in a flow direction d (Figure 3) around the tube 40. The flow direction d generated by the louvers 62 encourages the swirling exhaust gas G to remain within the perforated tube 40 once the exhaust gas G has entered the perforated tube 40. Treated gas G also flows beneath the free edge 66 of the baffle

52 towards the curved portion 46 of the housing body 30, which further directs the gas G around the tube 40 in the flow direction d (see Figures 4 and 5).

In certain embodiments, an exhaust flow path extends 360 degrees about the circumference of the perforated tube 40, and the baffle plate 52 coincides with only a portion the flow path. In certain embodiments an exhaust flow path extends 360 degrees about the circumference of the perforated tube 40, and the baffle plate 52 coincides with less than one-third or less than one-quarter of the flow path. In certain embodiments, the main body 54 of the baffle plate 52 curves around only a portion of the circumference of the perforated tube 40. In certain embodiments, an exhaust flow path extends 360 degrees about the circumference of the perforated tube 40, the exhaust flow travels in a single rotational direction about the perforated tube 40 along the exhaust flow path, the baffle plate 52 coincides with only a first portion the exhaust flow path, and the louvers 62 encourage the flow in the single rotational direction within the first portion of the exhaust flow path and assist in preventing exhaust from exiting the perforated tube 40 along the first portion of the exhaust flow path. In certain embodiments, an exhaust flow path extends 360 degrees about the circumference of the perforated tube 40, the exhaust flow travels in a single rotational direction about the perforated tube 40 along the exhaust flow path, the baffle plate 52 coincides with only a first portion the exhaust flow path, the louvers 62 of the baffle plate 52 function as first swirl structures that encourage the flow in the single rotational direction within the first portion of the exhaust flow path, and a curved portion 46 of an outer housing 30 that curves along a portion of the perforated tube 40 and coincides with a second portion of the exhaust flow path functions as a second swirl structure that encourages the flow in the single rotational direction within the second portion of the exhaust flow path.

As shown in Figures 4 and 5, a first portion 80 of the exhaust gas G flowing through the housing 12 is directed though the open flow area A1 and then in the first rotational direction d around the perforated tube 40 (see Figures 4 and 5). The dosing and mixing unit 10 also is configured such that also a second portion 82 of the exhaust gas flow passes through the flow-through openings 60 and is deflected in the first rotation direction d about the perforated tube 40 by the louvers 62. In some implementations, the second portion 82 proceeds at least 180° in the first rotational direction d around the tube 40 before entering the tube 40 through the perforations. In certain implementations, the second portion 82 proceeds at least

270° in the first rotational direction d around the tube 40 before entering the tube 40 through the perforations. In one example embodiment, second portion 82 proceeds at least 360° in the first rotational direction d about the perforated tube 40 before entering the tube 40 through the perforations.

5 The main plate body 54 has a connected edge 64 that is connected to an interior of the main housing body 30. In some implementations, the main plate body 54 has a free edge 66 that extends across the interior volume V of the main housing body 30. In such implementations, the main plate body 54 is sized and shaped to coincide with only a portion of the transverse cross-sectional area A of the interior volume V such that an open flow area A1 (see Figure 9) is defined between
10 the free edge 66 and the interior of the main housing body 30. In some embodiments, the free edge 66 is generally parallel to the tube axis 42 (see Figure 9). In other embodiments, the free edge 66 and the tube axis 42 can be angled relative to one another.

15 In some implementations, a portion of the perforated tube 40 extends below the free edge 66 of the baffle plate 52 and overlaps the open flow area A1 (see Figure 9). In some implementations, between about 10% of the perforated tube 40 and about 50% of the perforated tube 40 overlaps the open flow area A1. In certain implementations, less than 40% of the perforated tube 40 overlaps the open flow
20 area A1. In certain implementations, less than 33% of the perforated tube 40 overlaps the open flow area A1. In certain implementations, no less than 20% of the perforated tube 40 overlaps the open flow area A1. In certain implementations, no less than 25% of the perforated tube 40 overlaps the open flow area A1.

 In other implementations, the main plate body 54 of the baffle 52
25 extends fully across the interior volume V of the main housing body 30. In such implementations, the main plate body 54 defines an aperture separate from the flow-through openings 60. The aperture extends over a significant portion of the surface area of the main plate body 54 to expose at least the portion of the cross-sectional area A located beneath the tube 40. In certain implementations, the aperture also
30 may extend across a portion of the tube 40. For example, in some implementations, the aperture extends over about 10% to about 60% of the main plate body 54. In certain implementations, the aperture extends over about 20% to about 50% of the

main plate body 54. In certain implementations, the aperture extends over no less than 30% and no more than 55% of the main plate body 54.

In still other implementations, first and second apertures can be defined in the main plate body 54 separate from the flow-through openings 60. The first aperture aligns with a portion of the perforated tube 40. The second aperture defines the open flow area (similar to open flow area A1 of Figure 9). In certain implementations, the second aperture does not overlap with the perforated tube 40. In certain implementations, the first aperture extends over no more than 20% of the main plate body 54 and the second aperture extends over no more than 30% of the main plate body 54.

In some implementations, the dosing and mixing unit 10 also can include a reactant dispenser 84 for dispensing reactant 86 within an interior of the perforated tube 40 such that the reactant 86 is mixed with the exhaust gas flow within the interior of the perforated tube 40 (see Figure 5). Examples of the reactant include, but are not limited to, ammonia, urea, or a hydrocarbon. In other embodiments, the reactant dispenser 84 may be positioned upstream from the perforated tube 40 or downstream from the perforated tube 40. The dispenser 84 can be aligned with the center axis 42 of the perforated tube 40 so as to generate a spray pattern concentric about the axis 42.

In some embodiments, a treatment substrate 99 is positioned downstream from the perforated tube 40 (see Figure 5). Example treatment substrates 99 suitable for use with the tube 40 include, but are not limited to, a lean NO_x catalyst substrate, a SCR substrate, a SCRF substrate (i.e., a SCR coating on a particulate filter), and a NO_x trap substrate. In some embodiments, the treatment substrate is an SCR substrate for treating NO_x and the reactant is selected from the group consisting of ammonia and urea.

A selective catalytic reduction (SCR) catalyst device is typically used in an exhaust system to remove undesirable gases such as nitrogen oxides (NO_x) from the vehicle's emissions. SCR's are capable of converting NO_x to nitrogen and oxygen in an oxygen rich environment with the assistance of reactants such as urea or ammonia, which are injected into the exhaust stream upstream of the SCR through the doser 84. In alternative embodiments, other aftertreatment devices such as lean NO_x catalyst devices or lean NO_x traps could be used in place of the SCR

catalyst device, and other reactants (e.g., hydrocarbons) can be dispensed by the doser.

A lean NO_x catalyst device is also capable of converting NO_x to nitrogen and oxygen. In contrast to SCR's, lean NO_x catalysts use hydrocarbons as
5 reducing agents/reactants for conversion of NO_x to nitrogen and oxygen. The hydrocarbon is injected into the exhaust stream upstream of the lean NO_x catalyst. At the lean NO_x catalyst, the NO_x reacts with the injected hydrocarbons with the assistance of a catalyst to reduce the NO_x to nitrogen and oxygen. While the exhaust treatment systems 400 and 500 will be described as including an SCR, it
10 will be understood that the scope of the present disclosure is not limited to an SCR as there are various catalyst devices that can be used in accordance with the principles of the present disclosure.

The lean NO_x traps use a material such as barium oxide to absorb NO_x during lean burn operating conditions. During fuel rich operations, the NO_x is
15 desorbed and converted to nitrogen and oxygen by reaction with hydrocarbons in the presence of catalysts (precious metals) within the traps.

In other implementations, the dosing and mixing unit 10 can be used to mix hydrocarbons with the exhaust to reactivate a diesel particulate filter (DPF). In such implementations, the reactant dispenser 84 injects hydrocarbons into the gas
20 flow within the perforated tube 40. The mixed gas leaves the tube 40 and is directed to a downstream diesel oxidation catalyst (DOC) at which the hydrocarbons ignite to heat the exhaust gas. The heated gas is then directed to the DPF to burn particulate clogging the filter.

As shown in Figures 10 and 11, some examples of the dosing and
25 mixing unit 10 also can include a perforated plate 105 positioned within the main housing body 30 of the dosing and mixing unit 10. In some embodiments, the perforated plate 105 is positioned between the inlet 18 and the exhaust treatment substrate 50. In some examples, the perforated plate 105 includes a flat plate body 107 having a plurality of apertures 109 to distribute the exhaust gas G within the
30 main housing body 30 before the gas reaches the exhaust treatment substrate 50 (Figure 12). In other examples, other types of flow distribution devices can be utilized. In still other examples, no devices are positioned between the inlet 18 and the exhaust treatment substrate 50.

In use of the dosing and mixing unit 10, exhaust enters the housing 12 of the dosing and mixing unit 10 through the inlet 18 into the main housing body 30. From the inlet 18, the exhaust flow G moves through the perforated plate 105 (if utilized), through the substrate 50, and into the interior volume V of the housing body 30 (see Figure 4). At the interior volume V, the first portion 80 of the exhaust gas G flows past the free edge 66 of the main body 54 of the baffle plate 52 and through the open area A1. Upon passing through the open area A1, the first portion 80 of the exhaust flow G is directed toward the curved portion 46 of the housing 12, which encourages the first portion 80 of the exhaust flow to flow in the first rotational direction d around a first side 41 (see Figure 3) of the perforated tube 40. In certain implementations, some of the gas flow G can initially deflect off the upstream side 56 of the main body 54 of the baffle plate 52 towards the free edge 66.

The second portion 82 of the exhaust gas flow G flows through the flow-through openings 60 of the baffle plate 52 from the upstream side 56 of the main body 54 to the downstream side 58 of the main body 56. The second portion 82 of the exhaust gas flow G is deflected at the downstream side 58 of the main body 54 with the louvers 62. This deflection causes the second portion 82 of the exhaust gas flow G to flow in the first rotational direction d around a second side 43 (see Figure 3) of the perforated tube 40. The first and second sides 41, 43 are opposite sides of the perforated tube 40. As shown in Figure 4, the exhaust gas (the combination of the first and second portions 80, 82) flows at least 270 degrees (preferably about 360 degrees) in the first direction d about the perforated tube 40.

The exhaust gas G swirling about the perforated tube 40 in the first rotational direction d enters the openings in the perforated tube 40 and continues to swirl in the first rotational direction d within the perforated tube 40. The reactant dispenser 84 (see FIG. 5) dispenses reactant 86 into the swirling exhaust flow within the perforated tube 40. The swirling of the exhaust gas causes the reactant 86 to be mixed with the exhaust gas within the perforated tube 40. The exhaust flow then exits the housing 12 through the outlet 18 defined by the perforated tube 40 and proceeds to the downstream exhaust treatment substrate 99 (see Figure 5). Mixing can continue as the exhaust gas flows from the perforated tube 40 to the substrate 99.

Various modifications and alterations of this disclosure will become apparent to those skilled in the art without departing from the scope and spirit of this

disclosure, and it should be understood that the scope of this disclosure is not to be unduly limited to the illustrative embodiments set forth herein.

WHAT IS CLAIMED IS:

1. A method for causing exhaust gas flow to flow at least 270 degrees in a first direction about a perforated tube using a baffle plate having a main body that defines a plurality of flow-through openings, the baffle plate also including a plurality of louvers positioned adjacent to the flow-through openings, the main body of the baffle plate having an upstream side and a downstream side, the louvers being positioned at the downstream side of the main body of the baffle plate and the downstream side of the main body of the baffle plate facing toward the perforated tube, the method comprising:

deflecting a first portion of the exhaust gas flow with the upstream side of the main body of the baffle plate thereby causing the first portion of the exhaust gas flow to flow through an open flow area defined at least partially by the baffle plate and around the perforated tube in the first direction;

allowing a second portion of the exhaust gas flow to flow through the flow-through openings of the baffle plate from the upstream side of the main body to the downstream side of the main body; and

deflecting the second portion of the exhaust gas flow at the downstream side of the main body with the louvers thereby causing the second portion of the exhaust gas flow to flow in the first direction about the perforated tube.

2. The method of claim 1, wherein the upstream side of the main body has a convex curvature and the downstream side of the main body has a concave curvature.

3. The method of claim 2, wherein the convex and concave curvatures curve partially around the perforated tube.

4. The method of claim 1, further comprising injecting a reactant within an interior of the perforated tube such that the reactant is mixed with the exhaust gas flow within the interior of the perforated tube.

5. The method of claim 4, further comprising reacting the reactant at a NO_x treatment substrate positioned downstream from the perforated tube.
6. The method of claim 5, wherein the NO_x treatment substrate is selected from the group consisting of a lean NO_x catalyst substrate, a SCR substrate, a SCRF substrate, and a NO_x trap substrate.
7. The method of claim 6, wherein the NO_x treatment substrate is an SCR substrate and the reactant is selected from the group consisting of ammonia and urea.
8. The method of claim 1, wherein the first portion of the exhaust gas flow is larger than the second portion of exhaust gas flow.
9. The method of claim 1, wherein the first portion of the exhaust gas flow flows around an end of the main body of the baffle plate when the first portion flows through the open flow area.
10. A dosing and mixing arrangement comprising:
 - a housing including a main housing body that defines a central housing axis, the main housing body having a length that extends along the central housing axis between first and second opposite ends of the main housing body, the housing also including an inlet adjacent the first end of the main housing body and an outlet adjacent the second end of the main housing body;
 - a perforated tube forming the outlet of the housing, the perforated tube defining a tube axis aligned at an angle relative to the central housing axis;
 - an exhaust treatment substrate disposed in the housing;
 - the main housing body defining an interior volume that extends between the exhaust treatment substrate and the perforated tube, the interior volume defining a transverse cross-sectional area that is transverse relative to the central housing axis;
 - a baffle plate positioned within the interior volume between the perforated tube and the inlet, the baffle plate having a main plate body having an upstream side that faces toward the inlet and a downstream side that faces toward the perforated tube, the main plate body defining a plurality of flow-through openings that extend

through the main plate body between the upstream and downstream sides of the main plate body, the baffle plate also including a plurality of louvers positioned adjacent to the flow-through openings at the downstream side of the main plate body, the main plate body having a connected edge that is connected to an interior of the main housing body and a free edge that extends across the interior volume of the main housing body, the main plate body being sized and shaped to coincide with only a portion of the transverse cross-sectional area of the interior volume such that an open flow area is defined between the free edge and the interior of the main housing body; and

wherein a first portion of exhaust gas flow through the housing is directed through the open flow area and then in a first rotational direction around the perforated tube, and wherein a second portion of the exhaust gas flow passes through the flow-through openings and is deflected in the first rotation direction about the perforated tube by the louvers.

11. The dosing and mixing arrangement of claim 10, wherein the main plate body has a first cross-dimension measured in a first orientation that is perpendicular with respect to the central housing axis and that is within a plane that includes the central housing axis and is perpendicular to the tube axis, wherein the transverse cross-sectional area of the interior volume of the main housing body has a second cross-dimension measured along the first orientation, and wherein the first cross-dimension is no more than 80 percent of the second cross-dimension.

12. The dosing and mixing arrangement of claim 10, further comprising an exhaust treatment substrate positioned within the main housing body, the baffle plate being positioned between the perforated tube and the exhaust treatment substrate.

13. The dosing and mixing arrangement of claim 10, wherein the open flow area is larger than a total area defined by the flow-through openings.

14. The dosing and mixing arrangement of claim 10, wherein at least 10% of the perforated tube overlaps with the open flow area.

15. The dosing and mixing arrangement of claim 10, wherein the free edge is parallel to the tube axis.
16. The dosing and mixing arrangement of claim 10, wherein the second end of the main housing body includes a curved portion that curves partially around the perforated tube.
17. The dosing and mixing arrangement of claim 10, further comprising a reactant dispenser for dispensing a reactant within an interior of the perforated tube such that the reactant is mixed with the exhaust gas flow within the interior of the perforated tube.
18. The dosing and mixing arrangement of claim 10, further comprising a NOx treatment substrate positioned downstream from the perforated tube, and a reactant dispenser for dispensing a reactant into the exhaust gas flow upstream from the NOx treatment substrate.
19. The dosing and mixing arrangement of claim 18, wherein the NOx treatment substrate is selected from the group consisting of a lean NOx catalyst substrate, a SCR substrate, a SCRF substrate, and a NOx trap substrate.
20. The dosing and mixing arrangement of claim 19, wherein the NOx treatment substrate is an SCR substrate and the reactant is selected from the group consisting of ammonia and urea.
21. The dosing and mixing arrangement of claim 10, wherein the upstream side of the main body has a convex curvature and the downstream side of the main body has a concave curvature, and wherein the convex and concave curvatures curve partially around the perforated tube.
22. The dosing and mixing arrangement of claim 10, wherein the baffle plate is configured to cause the exhaust gas flow to flow circumferentially in one direction around at least 270 degrees of an exterior of the perforated tube.

23. A dosing and mixing arrangement comprising:
- a mixing tube having an interior, an exterior, and at least a first portion defining a first plurality of apertures, the first portion surrounding a tube axis of the mixing tube;
 - a swirl structure including at least one plate curving partially around the tube axis of the mixing tube, the plate defining a plurality of baffles and a second plurality of apertures in between the baffles, the plate causing exhaust flow to move both around the plate and also through the second plurality of apertures and to swirl outside the exterior of the first portion of the mixing tube in one rotational direction along a flow path that extends at least 270 degrees around a central axis of mixing tube and into the interior of the mixing tube through the first plurality of apertures; and
 - a doser for dispensing a reactant into the exhaust.
24. The dosing and mixing arrangement of claim 23, wherein the swirl structure includes a housing at least partially surrounding the first portion of the mixing tube.
25. The dosing and mixing arrangement of claim 24, wherein the swirl structure includes at least one perforated plate having a third plurality of apertures, wherein the perforated plate is positioned within the housing and positioned between the inlet and the substrate.
26. The dosing and mixing arrangement of claim 25, wherein the perforated plate is positioned within the housing between an inlet of the housing and the first portion of the mixing tube.
27. The dosing and mixing arrangement of claim 23, wherein the plate is a curved plate.
28. The dosing and mixing arrangement of claim 23, wherein the plate is curved plate having a rounded end on one side.
29. The dosing and mixing arrangement of claim 23, wherein the plate is at least partially surrounding the exterior of the cylindrical mixing tube.

30. The dosing and mixing arrangement of claim 23, wherein each aperture of the second plurality of apertures is one of circle, square, or slot-shaped.
31. The dosing and mixing arrangement of claim 23, wherein an angle between the plate and each baffle of the plurality of baffles is an oblique angle.
32. The dosing and mixing arrangement of claim 31, wherein the angle between the plate and each baffle of the plurality of baffles is configured to direct exhaust to flow in one rotational direction along a flow path that extends at least 270 degrees around a central axis of the mixing tube.
33. The dosing and mixing arrangement of claim 23, wherein the plate is configured to cause the exhaust to flow circumferentially in one direction around at least 270 degrees of an exterior of the first portion of the mixing tube.
34. The dosing and mixing arrangement of claim 23, wherein the doser for dispensing a reactant into the exhaust interior of the mixing tube.
35. The dosing and mixing arrangement of claim 23, wherein the doser dispenses hydrocarbons into the exhaust to aid in heating the exhaust; and further comprising a downstream diesel particulate filter to be reactivated by the heated exhaust.
36. An exhaust arrangement for dosing and mixing a reactant into exhaust comprising:
a housing defining an inlet of the exhaust arrangement;
a substrate being positioned within the housing and defining a longitudinal axis;
a cylindrical mixing tube having an exterior, an interior, at least a portion of the cylindrical mixing tube defining a first plurality of apertures through the exterior of the cylindrical mixing tube, a first end being closed by the housing, and a second end extending out of the housing, the second end being an open end defining an outlet of the exhaust arrangement, the cylindrical mixing tube defining a central axis

extending from the first end to the second end that is generally perpendicular to the longitudinal axis;

a curved baffle plate defining a plurality of baffles and a second plurality of apertures in between the baffles, the curved baffle plate being positioned within the housing between at least a portion of the substrate and at least a portion of the cylindrical mixing tube, the curved baffle plate being coupled at a first end to an interior of the housing and including a second free end, the curved baffle plate at least partially surrounding the exterior of the cylindrical mixing tube, wherein each baffle of the plurality of baffles projects away from the curved main body and towards the cylindrical mixing tube such that exhaust flow is directed to swirl outside of the first portion of the cylindrical mixing tube and into the interior of the cylindrical mixing tube through the first plurality of apertures as the exhaust swirls in one rotational direction along a flow path that extends at least 270 degrees around a central axis of the cylindrical mixing tube;

the exhaust arrangement defining a flow-through region between the substrate and the cylindrical mixing tube that is unobstructed by the curved baffle plate and a deflection region disposed generally between the substrate and the baffle such that the plurality of baffles of the curved baffle plate are configured to deflect the exhaust flow both in a rotational direction around the exterior of the cylindrical mixing tube along a flow path that extends at least 270 degrees around the central axis and also through the first plurality of apertures of the cylindrical mixing tube;

a perforated plate having a third plurality of apertures, the perforated plate being positioned within the housing and positioned between the inlet and the substrate; and

a doser for dispensing a reactant into the exhaust into the interior of the cylindrical mixing tube, the doser being positioned inside the cylindrical mixing tube at the first end.

37. A dosing and mixing arrangement comprising:

a housing including a main housing body that defines a central housing axis, the main housing body having a length that extends along the central housing axis between first and second opposite ends of the main housing body, the housing also including an inlet adjacent the first end of the main housing body and an outlet adjacent the second end of the main housing body;

a perforated tube forming the outlet of the housing, the perforated tube defining a tube axis aligned at an angle relative to the central housing axis;

the main housing body defining an interior volume that extends between the inlet and the perforated tube, the interior volume defining a transverse cross-sectional area that is transverse relative to the central housing axis;

a baffle plate positioned within the interior volume between the perforated tube and the inlet, the baffle plate having a main plate body having a downstream side that faces toward the perforated tube and an upstream side, the main plate body defining a plurality of flow-through openings that extend through the main plate body between the upstream and downstream sides of the main plate body, the baffle plate also including a plurality of louvers positioned adjacent to the flow-through openings of the main plate body; and

wherein a first portion of exhaust gas flow through the housing is directed through the open flow area and then in a first rotational direction around the perforated tube, and wherein a second portion of the exhaust gas flow passes through the flow-through openings and is deflected in the first rotation direction about the perforated tube by the louvers.

38. The dosing and mixing arrangement of claim 37, further comprising an exhaust treatment substrate positioned within the main housing body, the baffle plate being positioned between the perforated tube and the exhaust treatment substrate.

39. The dosing and mixing arrangement of claim 37, wherein the open flow area is larger than a total area defined by the flow-through openings.

40. The dosing and mixing arrangement of claim 37, wherein at least 10% of the perforated tube overlaps with the open flow area.

41. The dosing and mixing arrangement of claim 37, wherein the free edge is parallel to the tube axis.

42. The dosing and mixing arrangement of claim 37, wherein the second end of the main housing body includes a curved portion that curves partially around the perforated tube.

43. The dosing and mixing arrangement of claim 37, further comprising a reactant dispenser for dispensing a reactant within an interior of the perforated tube such that the reactant is mixed with the exhaust gas flow within the interior of the perforated tube.
44. The dosing and mixing arrangement of claim 37, wherein the baffle plate is configured to cause the exhaust gas flow to flow circumferentially in one direction around at least 270 degrees of an exterior of the perforated tube.
45. The dosing and mixing arrangement of claim 37, wherein the baffle plate is curved.
46. The dosing and mixing arrangement of claim 37, wherein the perforated tube is cylindrical.
47. The dosing and mixing arrangement of claim 37, wherein the perforated tube has a first end being closed by the housing and a second end extending out of the housing.
48. The dosing and mixing arrangement of claim 47, wherein the second end is an open end defining the outlet of the housing.
49. The dosing and mixing arrangement of claim 47, further comprising an exhaust treatment substrate positioned within the main housing body, the exhaust treatment substrate defining a longitudinal axis, wherein the perforated tube defines a central axis extending from the first end to the second end that is generally perpendicular to the longitudinal axis.
50. The dosing and mixing arrangement of claim 37, further comprising a perforated plate defining a plurality of apertures therethrough, the perforated plate being positioned within the housing between the inlet and the baffle plate.

51. The dosing and mixing arrangement of claim 37, further comprising an injector for dispensing a reactant into the exhaust into the interior of the perforated tube.

52. The dosing and mixing arrangement of claim 51, wherein the injector is positioned inside the perforated tube at the first end.

53. A dosing and mixing arrangement comprising:
a housing defining an interior;
a mixing tube disposed within the interior of the housing, the mixing tube having an interior, an exterior, and at least a first portion defining a first plurality of apertures, the first portion surrounding a tube axis of the mixing tube, the tube axis extending between a closed end of the mixing tube and an open end of the mixing tube; and

a swirl structure including at least one plate curving partially around the tube axis of the mixing tube, the plate defining a plurality of baffles and a second plurality of apertures positioned adjacent to the baffles, the plate causing exhaust flow to move both around the plate and also through the second plurality of apertures and to swirl outside the exterior of the first portion of the mixing tube in one rotational direction along a flow path that extends at least 270 degrees around a central axis of the mixing tube and into the interior of the mixing tube through the first plurality of apertures.

54. The dosing and mixing arrangement of claim 53, wherein the closed end of the mixing tube is closed by the housing.

55. The dosing and mixing arrangement of claim 53, further comprising a doser mounted to the closed end of the mixing tube.

56. A dosing and mixing arrangement comprising:
a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the first and second ends, the main body also defining an interior accessible through an inlet;

an outlet pipe extending through the main body at a location adjacent the second end of the main body, the outlet pipe extending in a direction transverse to the longitudinal axis of the main body;

a mixing region disposed within the interior of the main body, the mixing region including a perforated conduit that extends transverse to the longitudinal axis of the main body, the mixing region also including a flow path extending around the perforated conduit and leading into the perforated conduit; and

a baffle arrangement disposed within the interior of the main body, the baffle arrangement including a curved baffle plate having at least a portion extending between the perforated conduit and the inlet, the baffle arrangement defining a first entrance to the flow path, the baffle arrangement also defining a second entrance to the flow path, the second entrance being spaced along the flow path from the first entrance.

57. The dosing and mixing arrangement of claim 56, wherein the first entrance is defined by a first aperture extending through the curved baffle plate and the second entrance is defined by a second aperture extending through the curved baffle plate.

58. The dosing and mixing arrangement of claim 57, wherein the baffle arrangement includes a first curved surface positioned at the first entrance and a second curved surface positioned at the second entrance.

59. The dosing and mixing arrangement of claim 58, wherein the first and second curved surfaces include louvers.

60. The dosing and mixing arrangement of claim 56, wherein the outlet pipe is coupled to the perforated conduit.

61. The dosing and mixing arrangement of claim 60, wherein the outlet pipe is a first section of a tube and the perforated conduit is a second section of the tube.

62. The dosing and mixing arrangement of 61, wherein the tube has a constant diameter along a length of the tube, the length of the tube extending transverse to the longitudinal axis of the main body.

63. The dosing and mixing arrangement of claim 56, wherein the perforated conduit has a constant diameter along a length of the perforated conduit, the length of the perforated conduit extending transverse to the longitudinal axis of the main body.
64. The dosing and mixing arrangement of claim 56, wherein the baffle arrangement includes a first curved surface positioned at the first entrance and a second curved surface positioned at the second entrance.
65. The dosing and mixing arrangement of claim 64, wherein both the first and second curved surfaces direct exhaust flow in a common direction along the flow path.
66. The dosing and mixing arrangement of claim 56, wherein the curved baffle plate extends partially along the perforated conduit, and wherein an open flow area is defined between the curved baffle plate and an opposing surface of the main body.
67. The dosing and mixing arrangement of claim 66, wherein the first entrance leads to a portion of the flow path extending between the curved baffle plate and the perforated conduit, and wherein the open flow area defines the second entrance.
68. The dosing and mixing arrangement of claim 56, further comprising a substrate disposed within the interior of the main body and along a flow path between the inlet and the perforated conduit.
69. The dosing and mixing arrangement of claim 56, further comprising a reactant dispenser location disposed at an end of the perforated conduit.
70. The dosing and mixing arrangement of claim 69, wherein the reactant dispenser location is aligned with a central longitudinal axis of the perforated conduit, the central longitudinal axis extending through the outlet pipe.

71. The dosing and mixing arrangement of claim 69, further comprising a reactant dispenser mounted at the reactant dispenser location.

72. The dosing and mixing arrangement of claim 56, wherein the inlet is disposed at the first end of the main body, wherein the longitudinal axis of the main body extends through the inlet.

73. A dosing and mixing arrangement for treating exhaust flow, the dosing and mixing arrangement comprising:

a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the first and second ends, the main body also defining an interior;

a conduit defining a passage that extends transverse to the longitudinal axis of the main body, the conduit defining a plurality of openings over a circumference of the conduit, the openings each extending between an exterior of the conduit and an interior of the conduit; and

a baffle arrangement disposed within the main body, the baffle arrangement including a first curved surface that directs a first portion of the exhaust flow in a first direction around the conduit beginning at a first side of the conduit, the baffle arrangement including a second curved surface that directs a second portion of the exhaust flow in the first direction around the conduit beginning at a second side of the conduit, the second side being spaced circumferentially along the conduit from the first side.

74. The dosing and mixing arrangement of claim 73, wherein the first curved surface and the second curved surface are both louvers.

75. The dosing and mixing arrangement of claim 73, wherein the first curved surface includes a curved baffle plate and the second curved surface includes a louver disposed at an opening defined in the curved baffle plate.

76. A dosing and mixing arrangement comprising:

a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the

first and second ends, the main body also defining an interior accessible through an inlet;

an outlet pipe extending through the main body at a location adjacent the second end of the main body, the outlet pipe extending in a direction transverse to the longitudinal axis of the main body;

a mixing region disposed within the interior of the main body, the mixing region including a perforated conduit that extends transverse to the longitudinal axis of the main body, the mixing region also including a flow path extending around the perforated conduit and leading into the perforated conduit; and

a baffle arrangement disposed within the interior of the main body, the baffle arrangement defining a first entrance to the flow path, the baffle arrangement also defining a second entrance to the flow path, the second entrance being spaced along the flow path from the first entrance, the baffle arrangement including a first curved surface positioned at the first entrance and a second curved surface positioned at the second entrance.

77. The dosing and mixing arrangement of claim 76, wherein both the first and second curved surfaces direct exhaust flow in a common direction along the flow path.

78. A dosing and mixing arrangement comprising:

a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the first and second ends, the main body also defining an interior accessible through an inlet;

an outlet pipe extending through the main body at a location adjacent the second end of the main body, the outlet pipe extending in a direction transverse to the longitudinal axis of the main body;

a mixing region disposed within the interior of the main body, the mixing region including a perforated conduit that extends transverse to the longitudinal axis of the main body, the mixing region also including a flow path extending around the perforated conduit and leading into the perforated conduit; and

a baffle arrangement disposed within the interior of the main body, the baffle arrangement defining a first entrance to the flow path, the baffle arrangement also

defining a second entrance to the flow path, the second entrance being spaced along the flow path from the first entrance, the baffle arrangement including a curved baffle plate extending partially along the perforated conduit;

wherein an open flow area is defined between the curved baffle plate and an opposing surface of the main body.

79. The dosing and mixing arrangement of claim 78, wherein the first entrance leads to a portion of the flow path extending between the curved baffle plate and the perforated conduit, and wherein the open flow area defines the second entrance.

80. A dosing and mixing arrangement comprising:

a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the first and second ends, the main body also defining an interior accessible through an inlet;

an outlet pipe extending through the main body at a location adjacent the second end of the main body, the outlet pipe extending in a direction transverse to the longitudinal axis of the main body;

a mixing region disposed within the interior of the main body, the mixing region including a perforated conduit that extends transverse to the longitudinal axis of the main body, the mixing region also including a flow path extending around the perforated conduit and leading into the perforated conduit;

a baffle arrangement disposed within the interior of the main body, the baffle arrangement including a curved baffle plate, the baffle arrangement defining a first entrance to the flow path, the baffle arrangement also defining a second entrance to the flow path, the second entrance being spaced along the flow path from the first entrance; and

a substrate disposed within the interior of the main body and along a flow path between the inlet and the perforated conduit.

81. A dosing and mixing arrangement comprising:

a main body extending along a length between first and second opposite ends of the main body, the main body defining a longitudinal axis extending between the first and second ends, the main body also defining an interior accessible through an

inlet disposed at the first end of the main body, wherein the longitudinal axis of the main body extends through the inlet;

an outlet pipe extending through the main body at a location adjacent the second end of the main body, the outlet pipe extending in a direction transverse to the longitudinal axis of the main body;

a mixing region disposed within the interior of the main body, the mixing region including a perforated conduit that extends transverse to the longitudinal axis of the main body, the mixing region also including a flow path extending around the perforated conduit and leading into the perforated conduit; and

a baffle arrangement disposed within the interior of the main body, the baffle arrangement including a curved baffle plate, the baffle arrangement defining a first entrance to the flow path, the baffle arrangement also defining a second entrance to the flow path, the second entrance being spaced along the flow path from the first entrance.

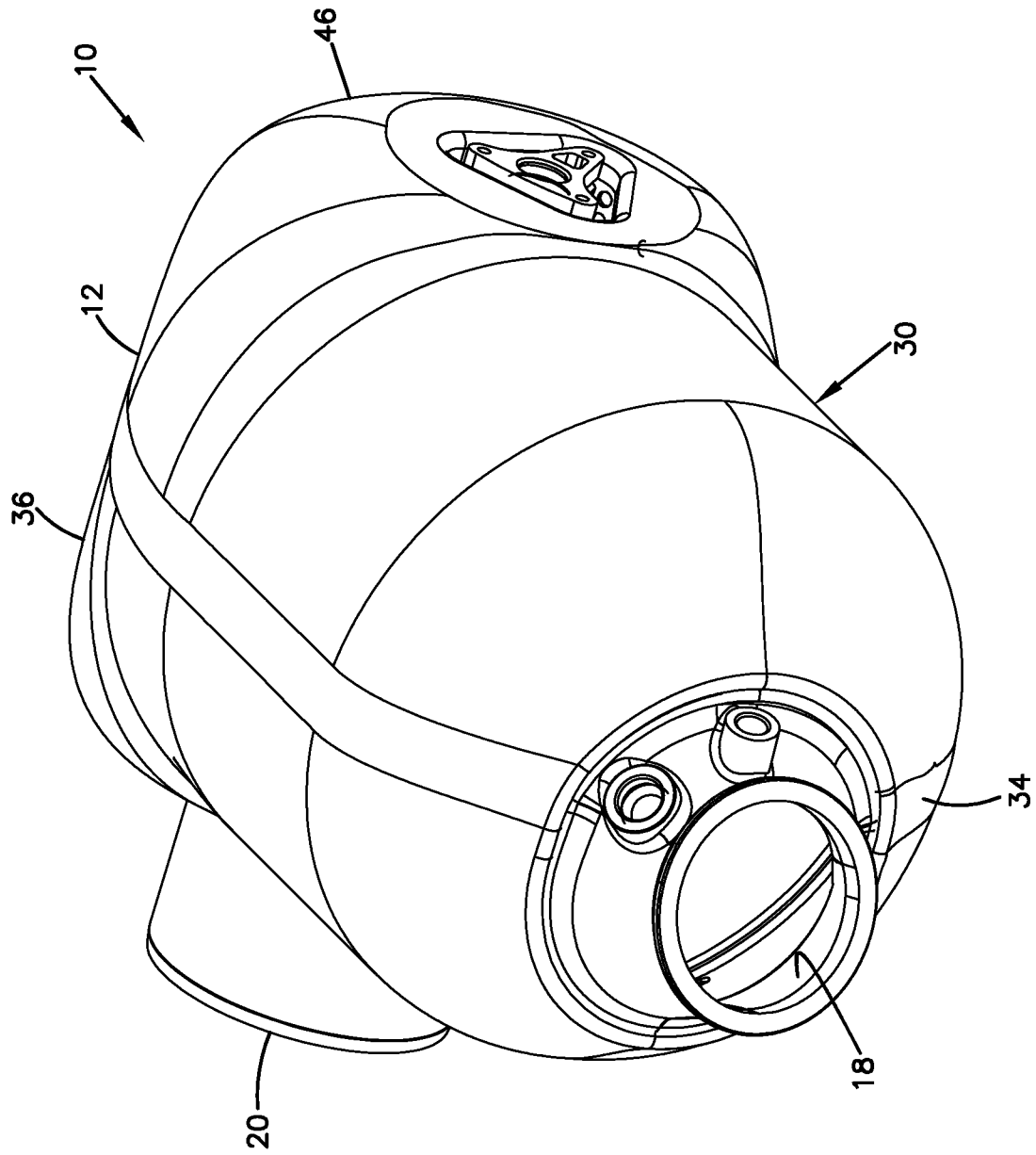


FIG. 1

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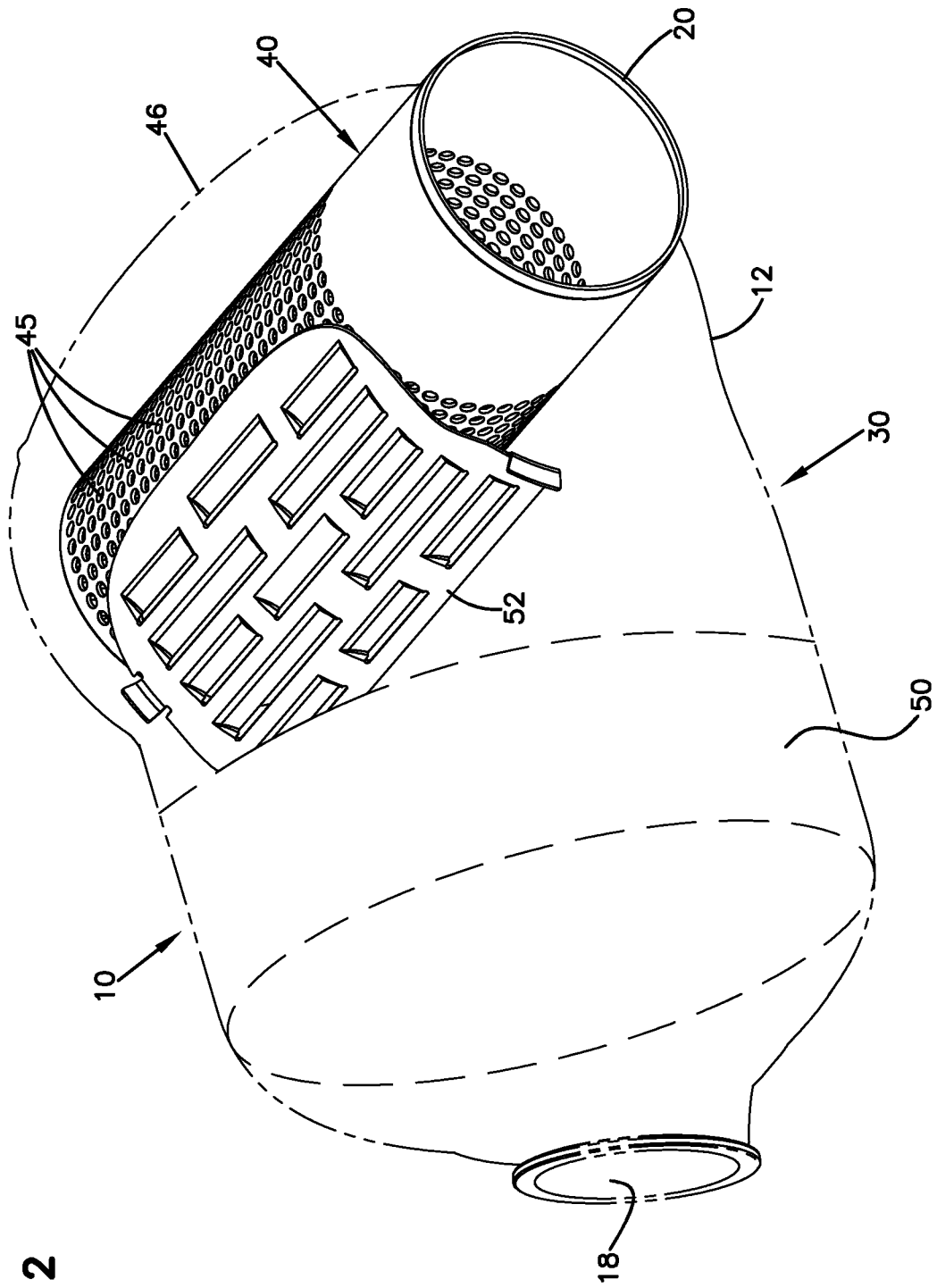


FIG. 2

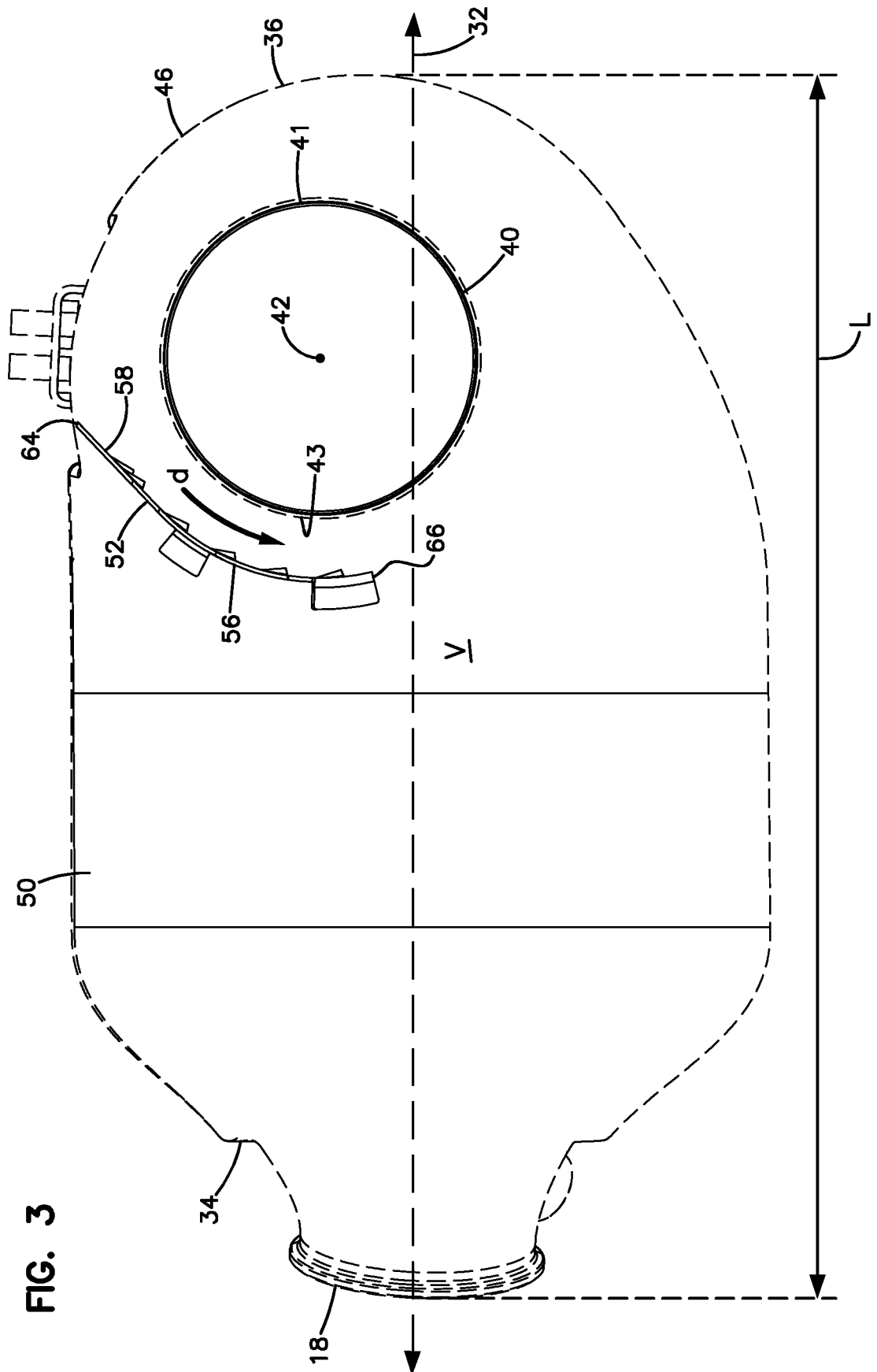


FIG. 3

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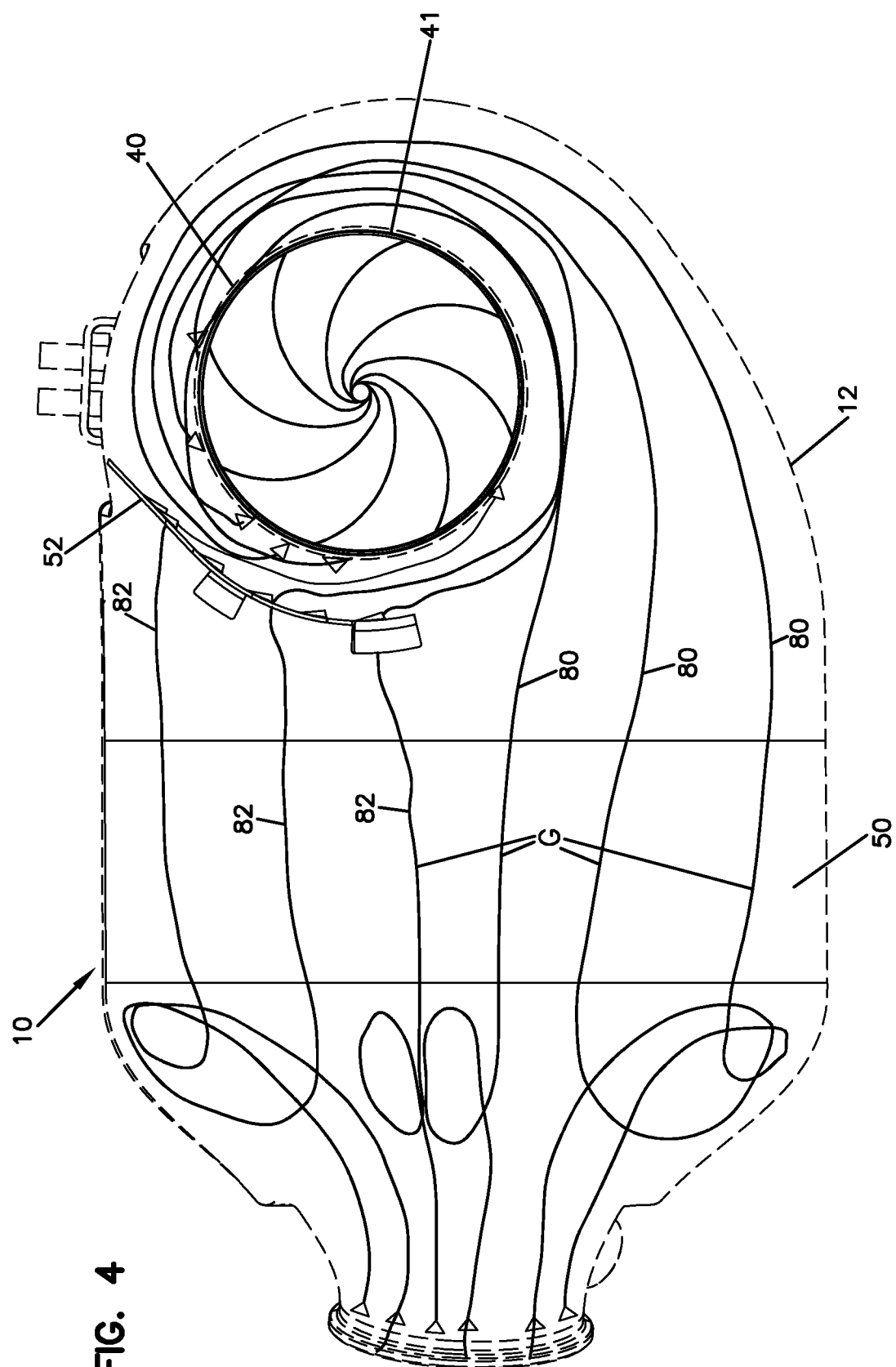


FIG. 4

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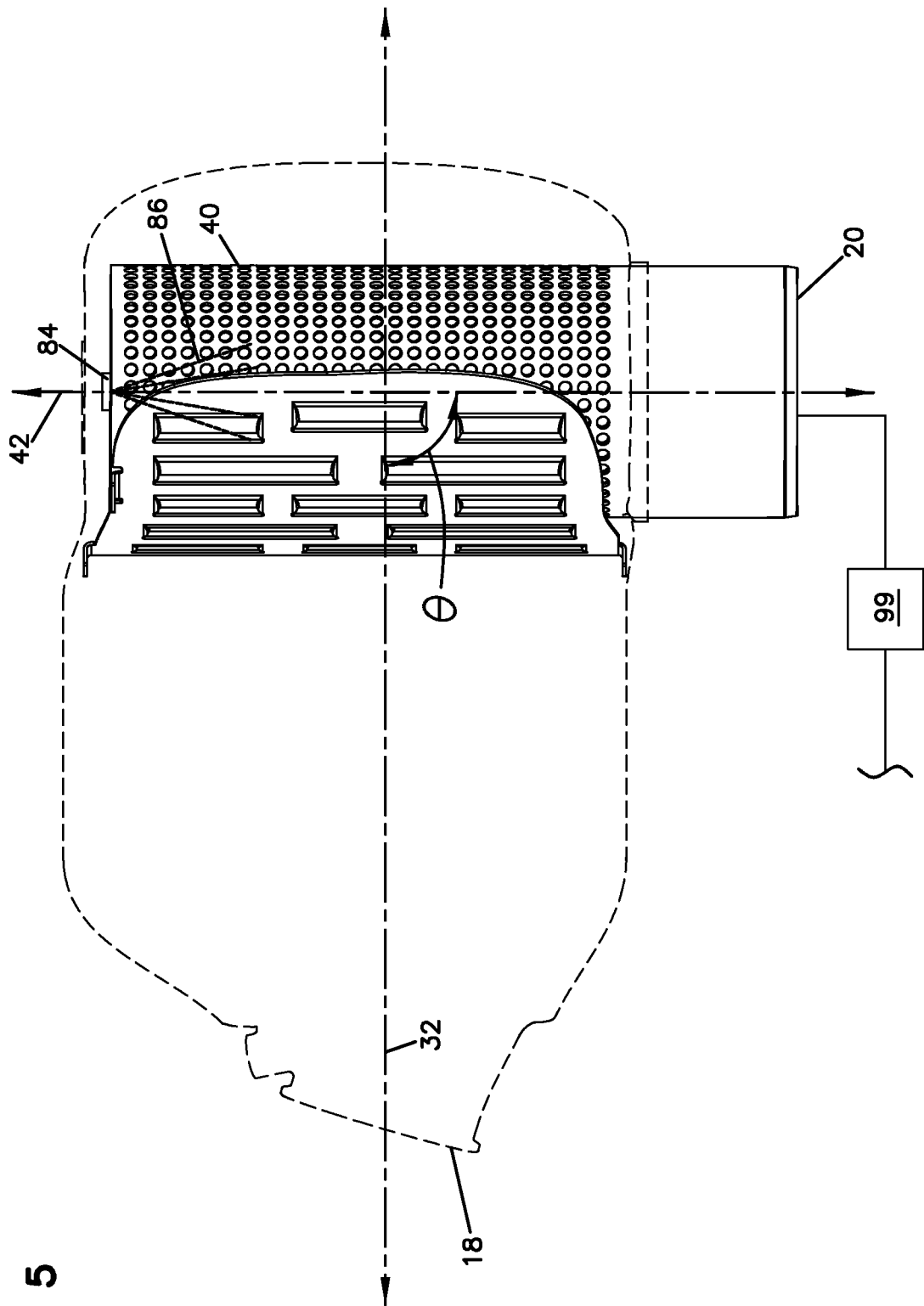


FIG. 5

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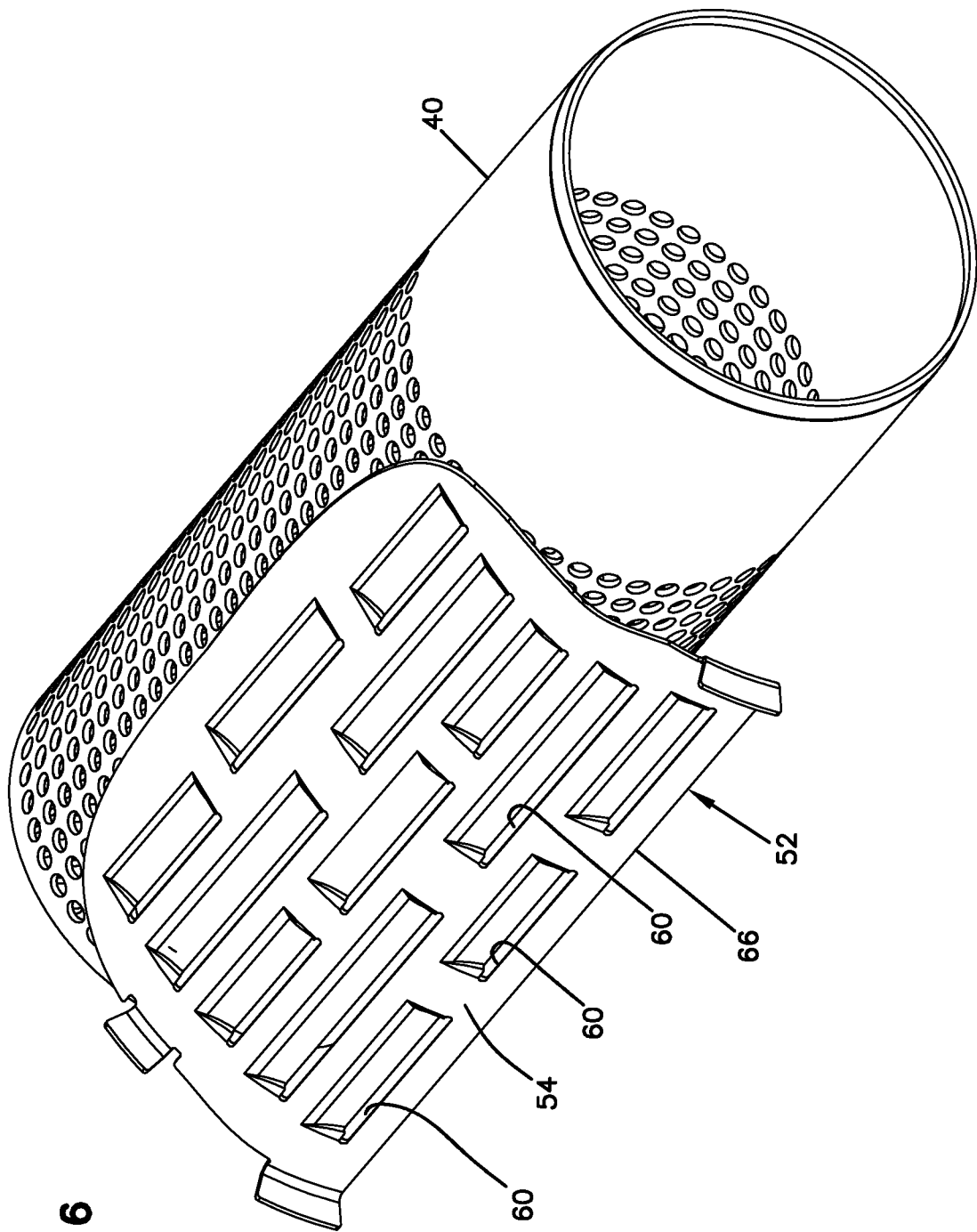


FIG. 6

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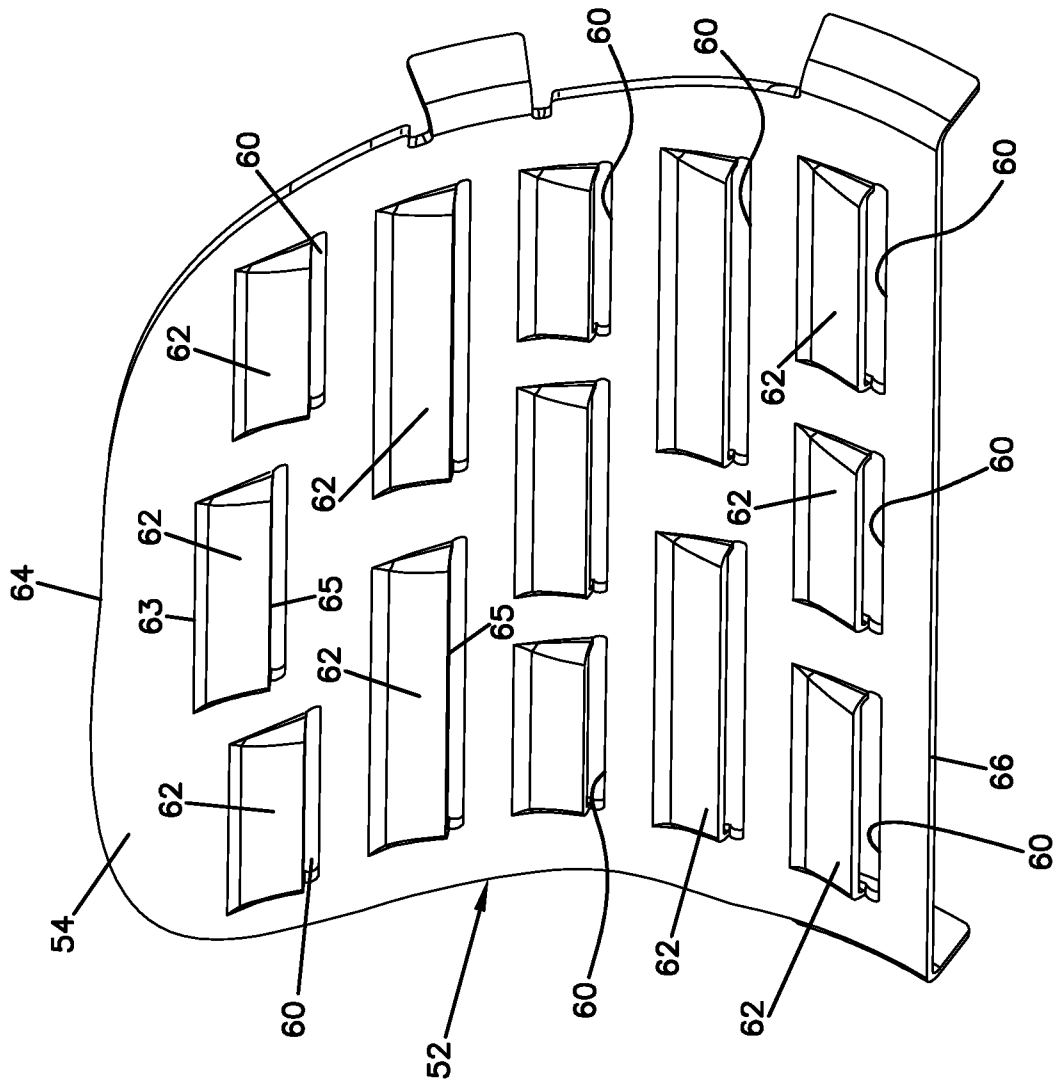
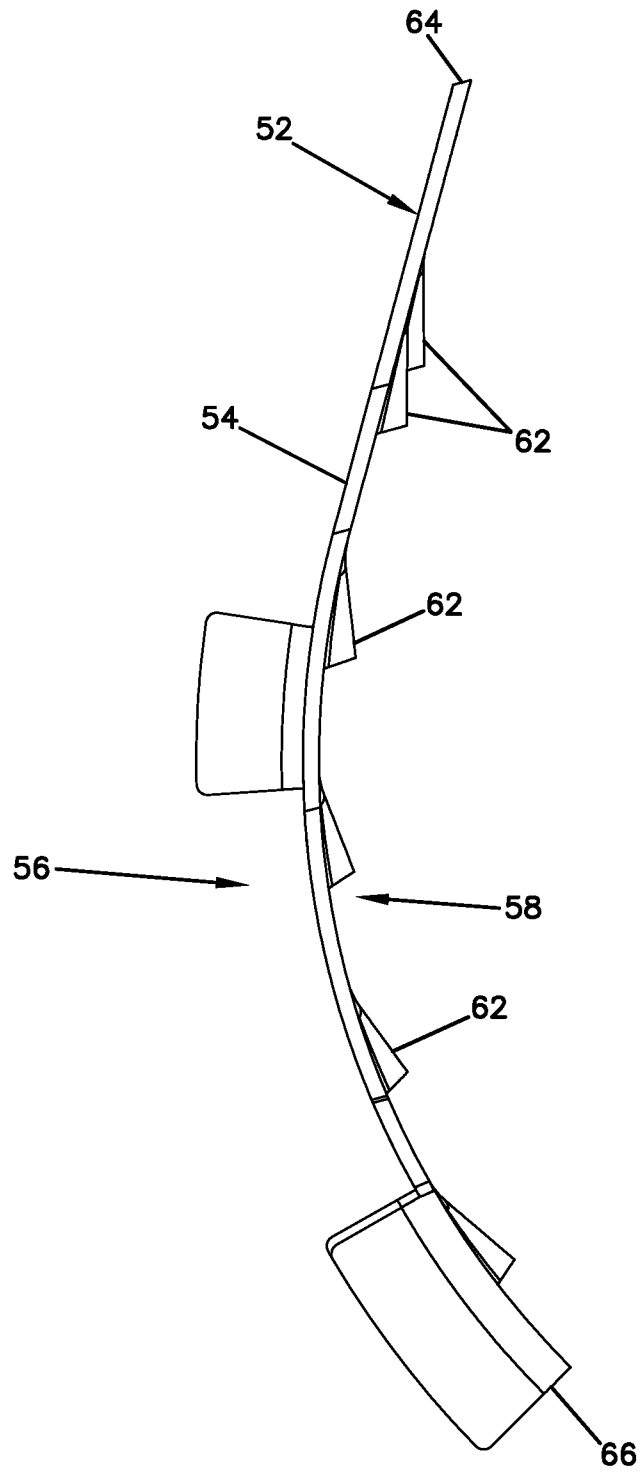
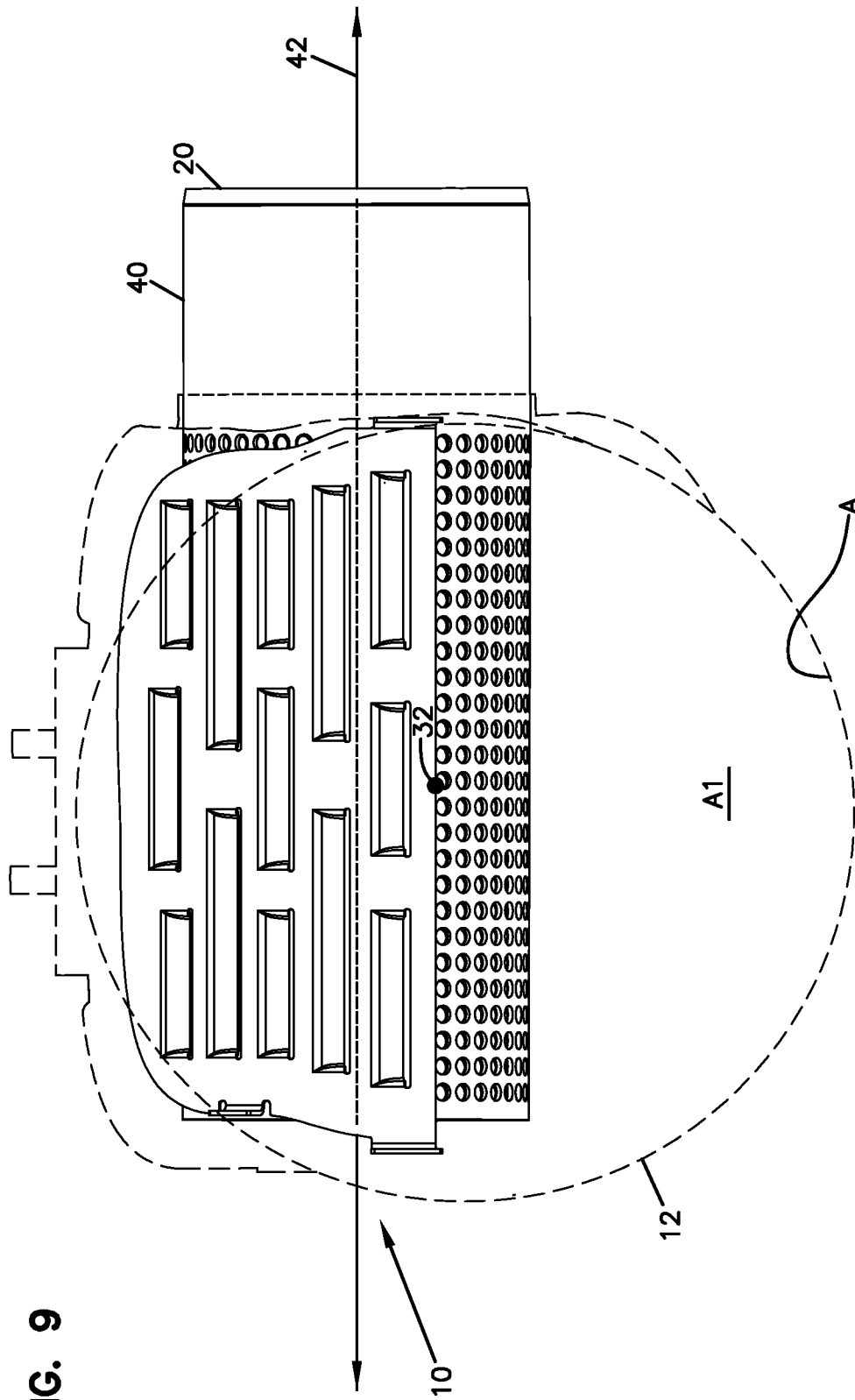


FIG. 7

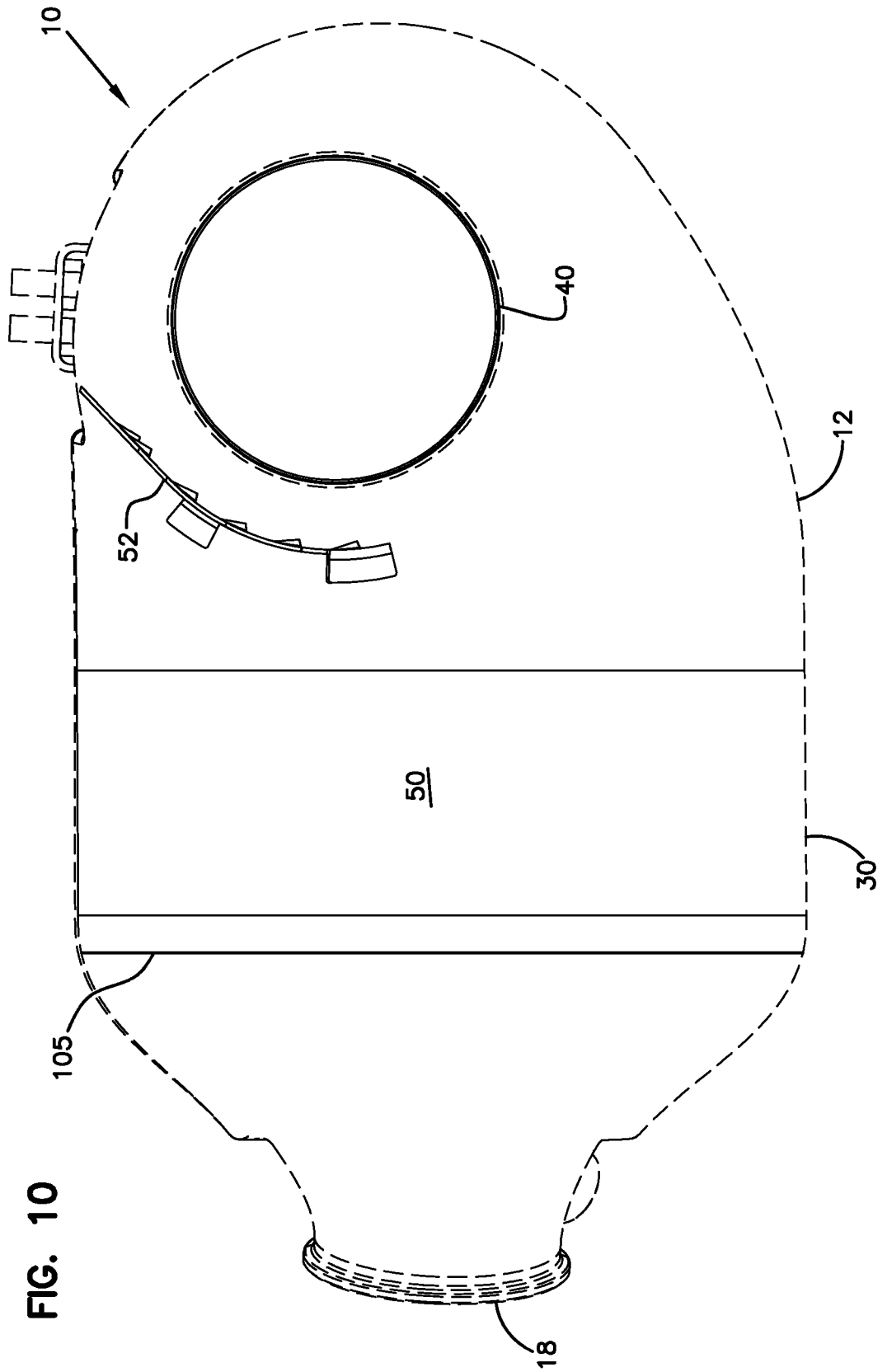
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FIG. 8

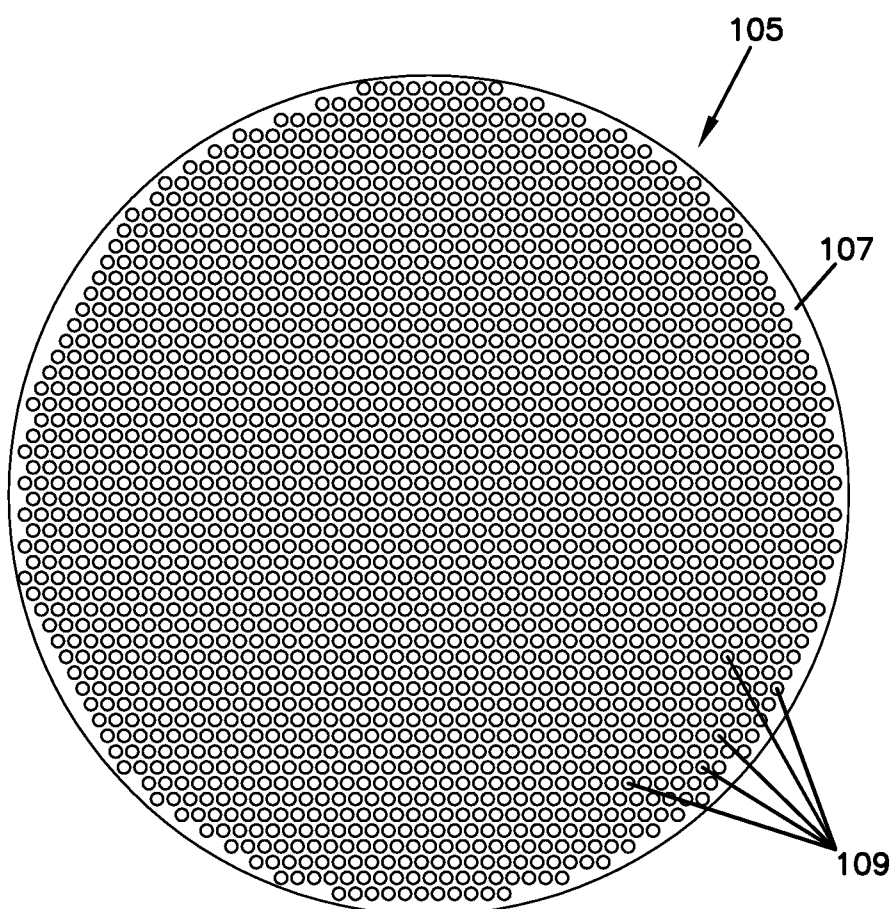
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FIG. 11

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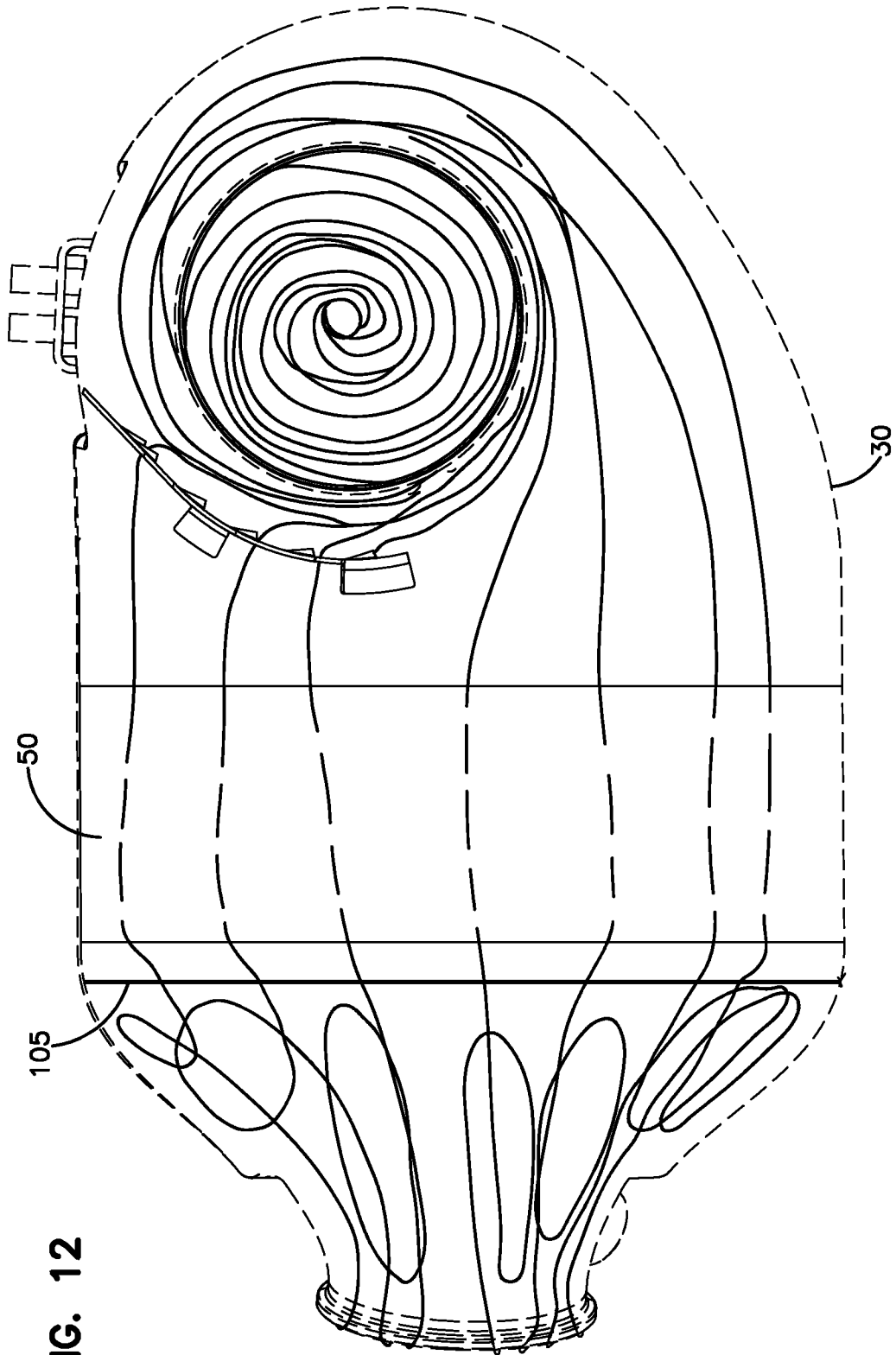


FIG. 12

