(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 June 2011 (03.06.2011)

PCT

(10) International Publication Number
WO 2011/066041 A1

(51) International Patent Classification:
B01D 50/00 (2006.01) ***F01N 3/20*** (2006.01) ***F01N 3/10*** (2006.01)

(21) International Application Number: PCT/US2010/051870

(22) International Filing Date: 7 October 2010 (07.10.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/264,956 30 November 2009 (30.11.2009) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title**: MOUNTING ASSEMBLIES FOR SUBSTRATES

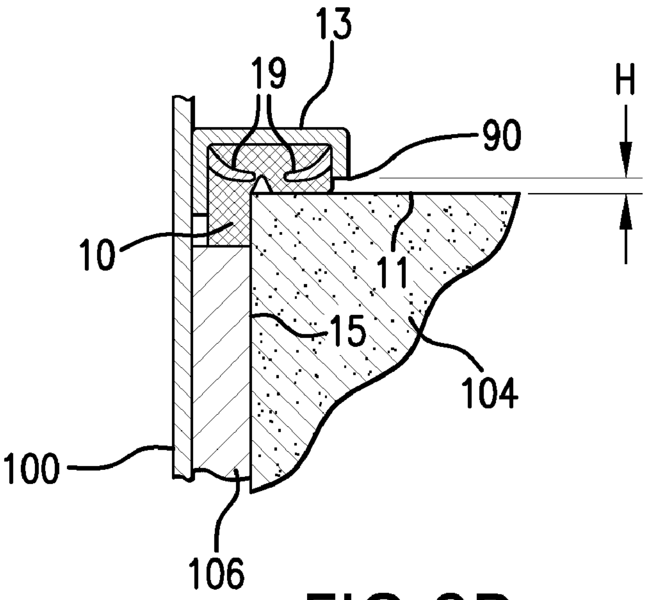


FIG.9B

(57) **Abstract**: Mounting assemblies for substrates (104) are disclosed which include an annular knitted wire mesh element (10,80) and a metallic annulus (13) which in accordance with certain aspects, has a cross-section which includes first, second, and third segments (41,42,43). During assembly, the third segment (43) can constrain the annular knitted wire mesh element (10,80) from extruding over the face (11) of the substrate (104) as the substrate (104) and the mounting assembly are pressed together. The first and third segments (41,43) can include tabs (19) for holding the wire mesh element (10,80) and the metallic annulus (13) together during shipping and handling. In accordance with other aspects, a mixer (200) for a gas and/or a liquid is attached to a metallic annulus (13,20) for an annular knitted wire mesh element (10,80).

WO 2011/066041 A1

MOUNTING ASSEMBLIES FOR SUBSTRATES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 USC §119(e) of U.S. Provisional Application No. 61/264,956 filed on November 30 2009, the contents of which in its entirety is hereby incorporated by reference.

FIELD

[0002] This disclosure relates to mounting assemblies for substrates such as the honeycomb ceramic substrates used in catalytic converters, and, in particular, to mounting assemblies in which an annular knitted wire mesh engages at least one of the ends of the substrate.

BACKGROUND

[0003] Commonly-assigned U.S. Patents Nos. 4,683,010, 6,286,840, 7,012,195, and 7,595,451, the contents of which in their entireties are incorporated herein by reference, disclose the use of annular elements composed of one or more knitted wire meshes as supports, seals, and/or isolators for substrates which operate at elevated temperatures, such as the ceramic substrates used in catalytic converters. FIG. 1 shows a representative embodiment for this use of knitted wire meshes. In this figure, reference number 12 is a catalytic converter, 104 is the converter's ceramic substrate, 98 is the container (can) for the substrate, 100 is the can's wall, 106 is a mat which surrounds the body of the substrate, and 10 is an L-shaped knitted wire mesh element which contacts a face 11 and the side wall 15 of the substrate and thus covers corner 17 between the substrate's face and its side wall.

[0004] In some cases, the wire mesh element can be simply sandwiched between the substrate 104 and wall 100, as in FIG. 1. In other cases, it is desirable to fix the position of the wire mesh element in the can. To address this need, in the past, the wire mesh element has been spot welded to an L-shaped metal annulus and the annulus has been welded to the wall of the can. FIG. 2 illustrates this approach where reference number 20 is the L-shaped metal annulus, 22 is a spot weld, 24 is the direction of gas flow through the catalytic converter, and, as in FIG. 1, 10 is the L-shaped knitted wire mesh element, 104 is the substrate, and 100 is the can's wall.

[0005] In practice, the system of FIG. 2 has suffered from a number of drawbacks. Beginning with the spot welding of the wire mesh to the L-shaped metal annulus, such welding produces hard spots in the wire mesh, i.e., areas of higher density, which can be problematic during installation as well during long term use since the hard spots can damage the substrate. The welds can also produce areas of higher thermal conductivity which can result in enhanced heat loss through wall 100 of can 98 which in some cases may cool the catalytic converter and thus compromise its efficiency. Also, in the case of particulate filters, e.g., diesel particulate filters, the extra heat loss associated with the welds may compromise the regeneration process, thus shortening the life of the filter and/or degrading vehicle performance through soot build up and its associated greater pressure drop. Furthermore, the presence of the welds may cause the external temperature of the can to rise above a specified maximum level during regeneration thus creating at least some risk of damage to nearby components of the vehicle, including possible ignition of those components.

[0006] The welding approach has the additional deficit that it cannot be used with wire meshes that have an oxidized surface, e.g., an oxidized surface produced by a heat treatment of the mesh or components thereof. As discussed in the above-referenced U.S. Patents Nos. 7,012,195 and 7,595,451, heat treatments can be highly beneficial in terms of improving the mechanical properties of a knitted wire mesh. Thus, the exclusion of heat-treated meshes severely limits the usefulness of the welding technique. The oxidation on a mesh can, of course, be removed, e.g., in the regions where the welding is to take place, but such removal requires additional process steps and thus increases costs, which is highly undesirable for cost sensitive, high volume products, such as automobile catalytic converters.

[0007] In addition to the foregoing problems, as discussed below, for the same product specification, the amount of knitted wire mesh needed when an L-shaped metal annulus is used is greater than the amount needed for the mounting assemblies of the present disclosure. Such additional mesh increases costs. Moreover, the L-shaped annulus approach can result in excess coverage of the face of the substrate as well as variability in the amount of coverage, both of which are undesirable.

[0008] In contrast to the system of FIG. 2, the substrate mounting assemblies disclosed herein do not require welding of the wire mesh and thus can be used with all types of knitted wire meshes, including those that have been heat treated. Likewise, the hardness and higher thermal conductivity issues associated with welding are avoided. In addition to these benefits, the mounting assemblies can use less knitted wire mesh and can result in finished products that exhibit lower levels of coverage of the substrate's face and lower variability in such coverage than products produced using the L-shaped annulus approach.

SUMMARY

[0009] In accordance with a first aspect, an assembly (12) is disclosed which includes:

(A) a substrate (104) having a first face (11), a second face, and a side wall (15) which extends between the two faces;

(B) a metallic container (98) which houses the substrate (104); and

(C) a mounting assembly which engages the periphery of the first face (11) of the substrate (104) and includes:

(i) an annular knitted wire mesh element (10) having a cross-section which includes first and second legs (61,62), the first leg (61) engaging the side wall (15) of the substrate (104) and the second leg (62) engaging the first face (11) of the substrate (104); and

(ii) a metallic annulus (13) having a cross-section which includes first, second, and third segments (41,42,43), the first and third segments (41,43) being parallel to the side wall (15) of the substrate (104) and the second segment (42) being parallel to the first face (11) of the substrate (104) and connecting the first and third segments (41,43);

wherein:

(a) the first segment (41) of the metallic annulus (13) is welded to the metallic container (98);

(b) the second segment (42) of the metallic annulus (13) engages the second leg (62) of the annular knitted wire mesh element (10) and is spaced above the first face (11) of the substrate (104) by the thickness of the second leg (62);

(c) the third segment (43) of the metallic annulus (13) engages the second leg (62) of the annular knitted wire mesh element (10) and has an end (90) which is spaced above the first face (11) of the substrate (104) by a distance which is greater than zero and less than the thickness of the second leg (62); and

(d) the height of the metallic annulus' first segment (41) is greater than the height of its third segment (43).

[0010] In accordance with a second aspect, an assembly method is disclosed which includes:

(A) providing a container (98), a substrate (104), and a mounting assembly for engaging the periphery of a face (11) of the substrate (104), the mounting assembly including an annular knitted wire mesh element (10,80) and a three-sided annulus (13);

(B) inserting the mounting assembly and the substrate (104) into the container (98) so that the periphery of the face (11) of the substrate (104) contacts the annular knitted wire mesh element (10,80); and

(C) pressing the substrate(104) and the mounting assembly together so as to compress at least the portion of the annular knitted wire mesh element (10,80) which contacts the periphery of the face (11) of the substrate (104);

wherein the three-sided annulus (13) constrains the annular knitted wire mesh element (10,80) from extruding over the face (11) of the substrate (104) during step (C).

[0011] In accordance with a third aspect, a mounting assembly for a substrate (104) is disclosed which includes:

(A) an annular knitted wire mesh element (10,80); and

(B) a metallic annulus (13) having a cross-section which includes first, second, and third segments (41,42,43), the first and third segments (41,43) being parallel to one another and the second segment (42) being orthogonal to and connecting the first and third segments (41,43);

wherein:

(i) the first, second, and third segments (41,42,43) engage the annular knitted wire mesh element (10,80); and

(ii) the first and third segments (41,43) include tabs (19) which restrict motion between the annular knitted wire mesh element (10,80) and the metallic annulus (13).

[0012] In accordance with a fourth aspect, a mounting assembly for a substrate (104) is disclosed which includes:

(A) an annular knitted wire mesh element (10,80);

(B) a metallic annulus (13,20) having a cross-section which comprises at least two segments which engage the annular knitted wire mesh element (10,80); and

(C) a mixing device (200) for a gas and/or a liquid attached to one of the at least two segments of the metallic annulus (13,20).

[0013] The reference numbers used in the above summaries of the various aspects of the disclosure are only for the convenience of the reader and are not intended to and should not be interpreted as limiting the scope of the invention. More generally, it is to be understood that both the foregoing general description and the following detailed description are merely exemplary of the invention and are intended to provide an overview or framework for understanding the nature and character of the invention.

[0014] Additional features and advantages of the invention are set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the invention as described herein. The accompanying drawings (which are not to scale) are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. It is to be understood that the various features of the invention disclosed in this specification and in the drawings can be used in any and all combinations. In this regard, it should be noted that not all dependent claims have been repeated for all independent claims, it being understood that the dependent claims (and all combinations thereof) are applicable to all independent claims even if not explicitly set forth in the original set of claims submitted herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a schematic, cross-sectional diagram illustrating a catalytic converter employing an L-shaped knitted wire mesh element.

[0016] FIG. 2 is a schematic, cross-sectional diagram illustrating an L-shaped knitted wire mesh element welded to an L-shaped metal annulus.

[0017] FIG. 3 is a photograph of a substrate mounting assembly of an embodiment of the present disclosure.

[0018] FIG. 4 is a photograph of a portion of the substrate mounting system of FIG. 3.

[0019] FIG. 5 is a plan view of a stamped metal strip that can be roll-formed and bent into a three-sided mesh-constraining annulus having holding tabs.

[0020] FIG. 6 is a cross-sectional view of the metal strip of FIG. 5 after roll forming.

[0021] FIG. 7 is a schematic, cross-sectional diagram showing a mounting assembly of the present disclosure in which an L-shaped knitted wire mesh element is held in a three-sided mesh-constraining annulus by holding tabs.

[0022] FIGS. 8A and 8B are schematic, cross-sectional diagrams illustrating the mounting of a substrate in a container using a mounting assembly of the present disclosure in which a knitted wire mesh element having a rectangular cross-section is held in a three-sided mesh-constraining annulus by holding tabs. FIG. 8A shows the substrate in position for installation and FIG. 8B shows it after installation.

[0023] FIGS. 9A and 9B are schematic, cross-sectional diagrams illustrating the mounting of a substrate in a container using a mounting assembly of the present disclosure in which an L-shaped knitted wire mesh element is held in a three-sided mesh-constraining annulus by holding tabs. FIG. 9A shows the substrate in position for installation and FIG. 9B shows it after installation.

[0024] FIG. 10 is a schematic diagram illustrating an embodiment of the present disclosure which includes a wire mesh element, a metal annulus, and a mixer associated with the metal annulus.

[0025] FIG. 11 is a schematic diagram showing an expanded view of a portion of FIG. 10.

[0026] FIG. 12 is a plan view of a stamped metal strip that can be used to form an embodiment of the metal annulus of FIGS. 10 and 11.

[0027] FIG. 13 is a plan view of an embodiment of the mixer of FIGS. 10 and 11.

[0028] The reference numbers used in the figures refer to the following:

- 10 L-shaped knitted wire mesh element (i.e., a knitted wire mesh element whose cross-section is L-shaped)
- 11 face of substrate
- 12 catalytic converter
- 13 three-sided mesh-constraining annulus
- 15 side wall of substrate

17	corner of substrate
19	holding tabs
20	L-shaped metal annulus
22	spot weld
24	direction of gas flow during use of substrate
30	metal strip
35	cutout for tab
41	first segment of wall of three-sided mesh-constraining annulus
42	second segment of wall of three-sided mesh-constraining annulus
43	third segment of wall of three-sided mesh-constraining annulus
50	substrate mounting assembly
61	first (radial) leg of L-shaped wire mesh element
62	second (axial) leg of L-shaped wire mesh element
70	gap in three-sided mesh-constraining annulus
80	knitted wire mesh element having a rectangular cross-section
90	end of third segment of wall of three-sided mesh-constraining annulus
98	container for substrate
100	container wall
104	substrate
106	mat for substrate
200	mixing device (mixer)
210	male protrusion
220	female aperture

DETAILED DESCRIPTION

[0029] FIGS. 3 and 4 are photographs of a substrate mounting assembly of an embodiment of the present disclosure. As shown therein, the assembly includes a three-sided mesh-constraining annulus 13 and, in this case, a knitted wire mesh element 10 having an L-shaped cross-section. Annulus 13 includes holding tabs 19 which engage the knitted wire mesh and hold it in place during shipment and handling, including handling during assembly of, for example, a catalytic converter.

[0030] The three-sided annulus can be made from a single piece of metal or can be assembled from multiple pieces. In either case, its annular shape will correspond to the shape of the perimeter of the substrate with which the mounting assembly will ultimately be used. As known in the art, common shapes for substrate perimeters (e.g., ceramic honeycomb substrates) include circular, oval, elliptical, and racetrack.

[0031] The three-sided annulus can be manufactured in various ways including by (1) stamping tabs in a strip of metal, (2) roll forming the strip to produce the desired three-sided structure, and (3) bending the structure so that its annular shape corresponds to that of the substrate. The ends of the roll-formed and bent strip can be welded together or a gap can be left between the ends (see, for example, reference number 70 in FIG. 4).

[0032] FIG. 5 shows a metal strip 30 prior to roll-forming in which cutouts 35, which ultimately become holding tabs 19, have been stamped into the strip. FIG. 6 shows the configuration of the strip after it has been roll formed into a three-sided channel. For purposes of illustration, in this figure, holding tabs 19 are shown in their inwardly bent condition. In practice, the holding tabs will normally be bent inward after the knitted wire mesh element has been inserted in the channel of the annulus so that the tabs engage the wire mesh during the bending process and hold it in place. The holding tabs of FIGS. 3-6 have a pointed configuration which can be helpful in engaging and holding the wire mesh. However, other tab configurations, e.g., square tabs, can be used if desired.

[0033] As can be seen in the cross-section of FIG. 6, the wall of the mesh-constraining annulus comprises three segments 41, 42, and 43 which, in this case, are of unequal lengths. In particular, first segment 41 is the longest of the segments and is used in welding the mounting assembly to the wall of the substrate's container, e.g., to wall 100 in FIG. 1. For a knitted wire mesh element which has an L-shaped cross-section consisting of a first leg (radial leg) and a second leg (axial leg), first segment 41 of annulus 13 will engage the first leg 61 of the element. Second segment 42 is the next longest segment of the annulus' cross-section and for an L-shaped wire mesh element, it engages the second leg 62 of the element. Finally, third segment 43 is the shortest of the three segments and it also engages the second leg 62 of an L-shaped wire mesh element. As discussed below, third segment 43 helps to constrain extrusion of the wire mesh onto the face of the substrate as the substrate is pressed into the mounting assembly during installation.

[0034] For some applications, wire mesh elements having a rectangular cross-section are used. In these cases, the mesh-constraining annulus is still three-sided, but the first and third sides can be of equal length, i.e., the annulus can have a symmetrical, as opposed to an asymmetrical, cross-section. FIGS. 8A and 8B show such an embodiment where the knitted wire mesh element having a rectangular cross-section is designated by the reference number 80. As in the case of a wire mesh element whose cross-section is L-shaped, first segment 41 of the annulus of these figures is used to weld the mounting assembly to the wall of the substrate's container and third segment 43 is used to constrain extrusion of the wire mesh onto the face of the substrate during installation. For this embodiment, the length of the second segment of the wall of the annulus will typically be greater than the length of the first and third segments.

[0035] As discussed above, the mounting assemblies of the present disclosure can use less knitted wire mesh and can achieve higher levels of product uniformity than the L-shaped metal annulus approach illustrated in FIG. 2. FIGS. 8A/8B and 9A/9B illustrate the manner in which these benefits can be achieved. In each of these figures, the A panel shows the configuration of the system at the point where the substrate first engages the knitted wire mesh element, while the B panel shows the configuration after the substrate has been fully installed.

[0036] Typically, the installation process for a mounting system which employs a knitted wire mesh involves compressing the mesh to a specified axial compressive force or, more particularly, a specified axial compressive pressure, e.g., a pressure on the order of 35 bar. Alternatively, the compression can be performed to a specified distance. The manner in which the specified force, pressure, or distance is achieved can vary with the application. For example, in a case where mounting assemblies are used at both ends of the substrate, the two assemblies can be pushed towards one another simultaneously and when the specified force, pressure, or distance is reached, the assemblies can be welded to the wall of the substrate's container, e.g., first segments 41 of the two assemblies can be simultaneously welded to the wall. Alternatively, again for the case of two mounting assemblies, one of the assemblies can be welded to the container's wall before force is applied, followed by welding of the other assembly once the specified force, pressure, or distance has been achieved. Similarly, when one mounting assembly is used, welding to the container wall typically takes place once the specified force, pressure, or distance has been reached. Normally, when one mounting assembly is used, it will be on the end of the substrate that will be downstream during use.

[0037] Irrespective of the specifics of the installation process, in all cases, the knitted wire mesh undergoes compression. This compression can be seen by comparing FIG. 8A (the pre-compression configuration) with FIG. 8B (the post-compression configuration). As shown in these figures, the axial height of knitted wire mesh element 80 has substantially decreased as a result of the application of the compressive force, e.g., the axial height can decrease from 6-8 millimeters to about 4 millimeters.

[0038] As a result of this compression, end 90 of third segment 43 of three-sided annulus 13 moves inward towards face 11 of substrate 104. This movement constrains knitted wire mesh 80 from moving outward (extruding) over the surface of face 11. This constraint, in turn, means that less wire mesh is needed to achieve the specified compressive pressure because the mesh substantially stays in place and generates a reactive force to the applied force, rather than extruding inward as the compressive force is applied and thus generating a smaller amount of reactive force for the same amount of wire mesh.

[0039] The constraining effect of third segment 43 also allows lower density wire meshes to be used. Lower density wire meshes comprise less metal and thus are less expensive. However, to achieve a specified amount of reactive force, a lower density mesh needs to be compressed more than a higher density mesh. Such greater compression increases the likelihood of extrusion and thus with the L-shaped metal annulus approach of FIG. 2, only relatively high density meshes can be used. In contrast, with the three-sided annulus of the present disclosure, lower density meshes can be used because the presence of third segment 43 substantially reduces extrusion onto the face of the substrate as the mesh is compressed. Quantitatively, reductions in mesh density of at least 10% can be achieved with the three-sided annulus, which represents a meaningful reduction in the cost of the mounting assembly, especially in high volume applications. As one example, in the case of mounting assemblies for catalytic converters, wire mesh densities prior to compression for the three-sided annulus approach of the present disclosure can be in the range of 0.8 to 1.2 grams per cubic centimeter while those required for the L-shaped annulus approach are consistently greater than 1.3 grams per cubic centimeter.

[0040] In addition to reducing the required amount of wire mesh and its density, the constraint provided by the three-sided annulus also can improve the performance and the part-to-part uniformity of the ultimate product, e.g., the catalytic converter. Performance can improve because the wire mesh which extrudes over the face of the substrate reduces the face's cross-sectional area which can compromise efficiency and increase backpressure. Uniformity can improve because in the absence of constraint, the lateral extrusion of the wire mesh is random and thus variations in the amounts and distributions of extruded material can be seen from part to part.

[0041] It should be noted that in the fully installed configuration (FIG. 8B), end 80 of segment 43 does not contact face 11 and thus does not constitute a hard spot which can damage the substrate either during installation or thereafter. The spacing H between end 80 and face 11 can, for example, be on the order of 0.5 millimeters.

[0042] As shown in FIGS. 9A and 9B, the same sequence of events takes place when the knitted wire mesh has an L-shaped cross-section. In particular, second (axial) leg 62 of the wire mesh element undergoes a substantially decrease in height from its pre-compression to its post-compression configuration (e.g., from 8.5 millimeters to 4.0 millimeters), but does not substantially extrude onto face 11 of substrate 104 because of the presence of third segment 43 of three-sided annulus 13.

[0043] The behavior of first (radial) leg 61 of the wire mesh during the compression depends somewhat on the application and, in particular, on the motion of mat 106 during the compression. In FIG. 9, mat 106 imposes a level of compression on leg 61 which leaves the leg longer than first segment 41 of three-sided annulus 13. However, in some cases, the level of compression applied to leg 61 by mat 106 can be greater so that the leg ends up having a length substantially equal to the length of segment 41. FIG. 7 illustrates such a case. This figure also illustrates the difference in axial heights of leg 62 and third segment 43 once the compression has been completed, i.e., segment 43 is shorter than leg 62 by H_1, where for a H_2 length of about 4.0 millimeter, $H_1 \cong 0.5$ millimeters.

[0044] Various materials can be used to form the three-sided annulus and the knitted wire mesh. In both cases, the materials need to be able to withstand the expected operating temperatures of the substrate, which are typically quite high. Thus, stainless steel materials are often required, although for some applications, other types of metals can be used. In the case of catalytic converters, the knitted wire mesh can, for example, be of the type disclosed in the above-reference U.S. Patent No. 7,595,451. In particular, the combination of an annealed soft wire and a precipitation-hardened hard wire, where the soft wire is a flat wire and the hard wire is a round wire has been found to work successfully in practice. The soft wire can, for example, be a type 309 or higher stainless steel and the hard wire can be a precipitation-hardened type A286 or higher stainless steel. The three-sided annulus can be formed from, for example, 409 or higher stainless steel.

[0045] More generally, the knitted wire mesh element can include two types of wire selected from the groups of round wires, flat wires, soft wires, and hard wire. The groups can be mixed in any desired manner. For example, a round wire (when used) can be hard or soft and a flat wire (when used) can be hard or soft. The use of two types of wire allows the wire mesh to have better sealing, support, and/or isolation properties than can be achieved with a single type of wire. The soft wire (when used) can be a wire that has been annealed after being knit to remove any mechanical hardening introduced into the wire during the knitting process. The hard wire (when used) can be mechanically hardened, but is preferably precipitation hardened by a heat treatment after knitting.

[0046] It is of course to be understood that the foregoing description of the types of materials that can be used for the knitted wire mesh element and the three-sided mesh-constraining annulus are merely exemplary and other materials besides those discussed above can be used if desired.

[0047] In some applications, the substrate can be coated with a catalyst whose operation requires the injection of a gas and/or a liquid (e.g., a urea solution) into the exhaust stream upstream of the substrate. For example, the catalyst can be of the selective catalytic reduction (SCR) type which promotes reduction of NOx in the exhaust gas. When a liquid and/or a gas is injected into an exhaust stream, it is often desirable to insert a mixing device upstream of the catalyst to provide a more uniform distribution of the liquid and/or the gas at the catalyst. See, for example, commonly-assigned PCT Patent Publication No. WO 2009/085641, the contents of which in its entirety is hereby incorporated by reference. As discussed in this PCT publication, the mixing device can, for example, be a wire mesh mixer, a helical mixer, a twisting mixer, or the like, and can be composed of a variety of materials capable of withstanding the conditions that prevail in an exhaust stream.

[0048] The mixing device (mixer) can be separately mounted in the exhaust stream as illustrated in the above-referenced PCT publication. Alternatively, in accordance with the present disclosure, the mixing device can be mounted to the metal annulus which carries the wire mesh element that serves as the substrate's support, seal, and/or isolator. FIGS. 10-13 illustrate such an embodiment, where the mixer is identified by reference number 200.

[0049] As shown in FIG 13, mixer 200 can include male protrusions 210, and as shown in FIG. 12, metal strip 30 can include a series of holes which form female apertures 220 when strip 30 is roll formed and bent into annulus 13. As shown in FIGS. 10 and 11, during assembly, male protrusions 210 mate with female apertures 220 to align mixer 200 with annulus 13. In some cases, the mating of protrusions 210 with apertures 220 may be sufficient to anchor the mixer to the annulus. In other cases, additional fastening may be desirable, e.g., the mixer and the annulus can be welded together either directly or by both elements being welded to the container wall for the substrate to fix their orientations. Although the use of protrusions and apertures is preferred, the mixer and the annulus can be attached to one another (e.g., welded to one another) without the use of such an alignment mechanism if desired.

[0050] Although shown as an asymmetric, three-sided annulus in FIGS. 10-12, a symmetric three-sided annulus of the type shown in FIGS. 8A and 8B can also be used as a mounting support for a mixer, as can an L-shaped metal annulus. Similarly, although an L-shaped knitted wire mesh element is used in FIGS. 10 and 11, a wire mesh element having a rectangular cross-section can also be used if desired, e.g., a wire mesh element of the type shown in FIGS. 8A and 8B. The mounting of the mixer to the metallic annulus can take place in advance of the installation of the annulus or while the annulus is being installed as described above.

[0051] A variety of modifications that do not depart from the scope and spirit of the invention will be evident to persons of ordinary skill in the art from the foregoing disclosure. For example, the above discussion has been in terms of substrates for catalytic converters and, in particular, for ceramic honeycomb substrates. The mounting systems disclosed herein can be used with other types of substrates which employ an annular knitted wire mesh to support, seal, and/or isolate an end of the substrate, including, without limitation, substrates that are used as filters to capture particulates, e.g., diesel particulates, and substrates having a sponge-like structure as opposed to a honeycomb structure. Also, although the mounting systems will typically be used with ceramic substrates, they can also be used with substrates made of other materials, e.g., metal substrates. The following claims are intended to cover the embodiments disclosed herein, as well as the foregoing and other modifications, variations, and equivalents of those embodiments.

What is claimed is:

1. An assembly comprising:

(A) a substrate having a first face, a second face, and a side wall which extends between the two faces;

(B) a metallic container which houses the substrate; and

(C) a mounting assembly which engages the periphery of the first face of the substrate comprising:

(i) an annular knitted wire mesh element having a cross-section which comprises first and second legs, the first leg engaging the side wall of the substrate and the second leg engaging the first face of the substrate; and

(ii) a metallic annulus having a cross-section which comprises first, second, and third segments, the first and third segments being parallel to the side wall of the substrate and the second segment being parallel to the first face of the substrate and connecting the first and third segments;

wherein:

(a) the first segment of the metallic annulus is welded to the metallic container;

(b) the second segment of the metallic annulus engages the second leg of the annular knitted wire mesh element and is spaced above the first face of the substrate by the thickness of the second leg;

(c) the third segment of the metallic annulus engages the second leg of the annular knitted wire mesh element and has an end which is spaced above the first face of the substrate by a distance which is greater than zero and less than the thickness of the second leg; and

(d) the height of the metallic annulus' first segment is greater than the height of its third segment.

2. The assembly of Claim 1 wherein the annular knitted wire mesh element comprises soft wires and hard wires.

3. The assembly of Claim 1 wherein the annular knitted wire mesh element comprises round wires and flat wires.

4. The assembly of Claim 1 wherein the annular knitted wire mesh element comprises flat, annealed, soft wires and round, precipitation-hardened, hard wires.

5. The assembly of Claim 1 wherein at least one of the segments of the metallic annulus comprises tabs which engage the annular knitted wire mesh element and restrict motion between that element and the metallic annulus.

6. The assembly of Claim 5 wherein the first and third segments comprise tabs.

7. The assembly of Claim 1 comprising a mounting assembly which engages the periphery of the second face of the substrate, the mounting assembly having the same composition and structure as the mounting assembly which engages the periphery of the first face of the substrate.

8. The assembly of Claim 1 wherein the substrate is a catalytic converter substrate.

9. The assembly of Claim 1 wherein the substrate is a particulate filter.

10. The assembly of Claim 1 wherein a mixing device for a gas and/or a liquid is attached to the second segment of the metallic annulus.

11. An assembly method comprising:

(A) providing a container, a substrate, and a mounting assembly for engaging the periphery of a face of the substrate, the mounting assembly comprising an annular knitted wire mesh element and a three-sided annulus;

(B) inserting the mounting assembly and the substrate into the container so that the periphery of the face of the substrate contacts the annular knitted wire mesh element; and

(C) pressing the substrate and the mounting assembly together so as to compress at least the portion of the annular knitted wire mesh element which contacts the periphery of the face of the substrate;

wherein the three-sided annulus constrains the annular knitted wire mesh element from extruding over the face of the substrate during step (C).

12. The method of Claim 11 wherein the three-sided annulus comprises tabs which engage the annular knitted wire mesh element and inhibit disengagement of that element from the three-sided annulus during step (B).

13. The method of Claim 11 wherein the substrate is a catalytic converter substrate.

14. The method of Claim 11 wherein the substrate is a particulate filter.

15. A mounting assembly for a substrate comprising:

(A) an annular knitted wire mesh element; and

(B) a metallic annulus having a cross-section which comprises first, second, and third segments, the first and third segments being parallel to one another and the second segment being orthogonal to and connecting the first and third segments;

wherein:

(i) the first, second, and third segments engage the annular knitted wire mesh element; and

(ii) the first and third segments comprise tabs which restrict motion between the annular knitted wire mesh element and the metallic annulus.

16. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element has a rectangular cross-section and the height of the metallic annulus' first and third segments are equal.

17. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element has an L-shaped cross-section and the height of the metallic annulus' first segment is greater than the height of its third segment

18. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element comprises soft wires and hard wires.

19. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element comprises round wires and flat wires.

20. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element comprises flat, annealed, soft wires and round, precipitation-hardened, hard wires.

21. The mounting assembly of Claim 15 wherein the annular knitted wire mesh element has a density in the range of 0.8 to 1.2 grams per cubic centimeter.

22. The mounting assembly of Claim 15 wherein a mixing device for a gas and/or a liquid is attached to the second segment of the metallic annulus.

23. A mounting assembly for a substrate comprising:

(A) an annular knitted wire mesh element;

(B) a metallic annulus having a cross-section which comprises at least two segments which engage the annular knitted wire mesh element; and

(C) a mixing device for a gas and/or a liquid attached to one of the at least two segments of the metallic annulus.

24. The mounting assembly of Claim 23 wherein:

(i) the metallic annulus comprises first, second, and third segments, the first and third segments being parallel to one another and the second segment being orthogonal to and connecting the first and third segments; and

(ii) the mixing device is attached to the second segment.

25. The mounting assembly of Claim 24 wherein the second segment comprises apertures and the mixing device comprises protrusions which mate with the apertures.

26. The mounting assembly of Claim 25 wherein the first and third segments comprise tabs which restrict motion between the annular knitted wire mesh element and the metallic annulus.

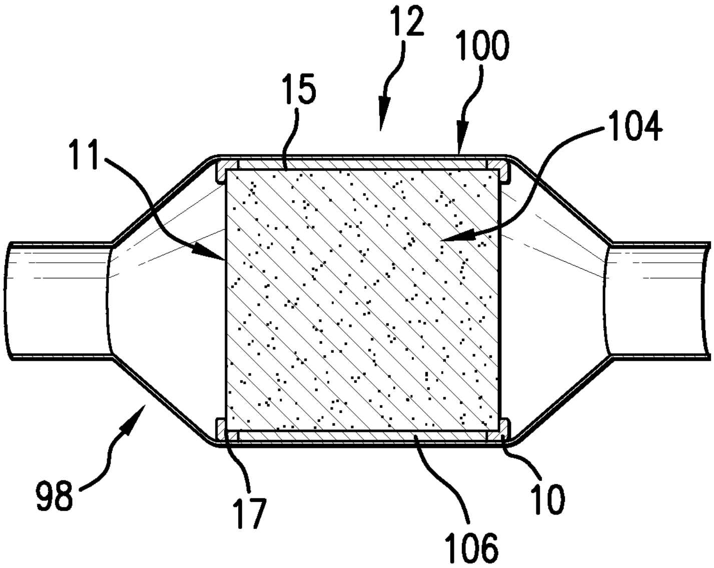


FIG.1 PRIOR ART

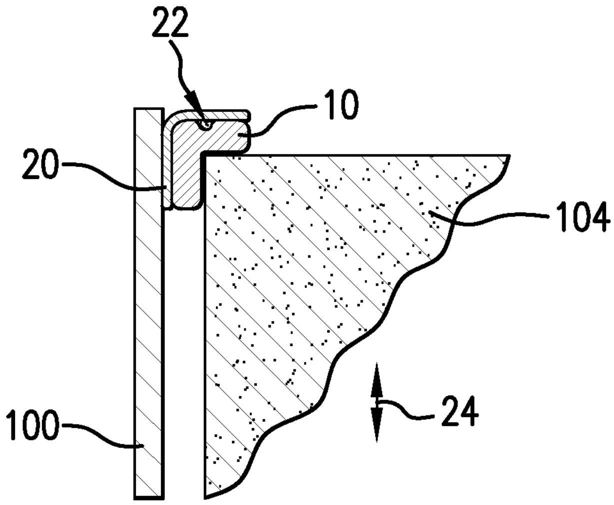


FIG.2 PRIOR ART

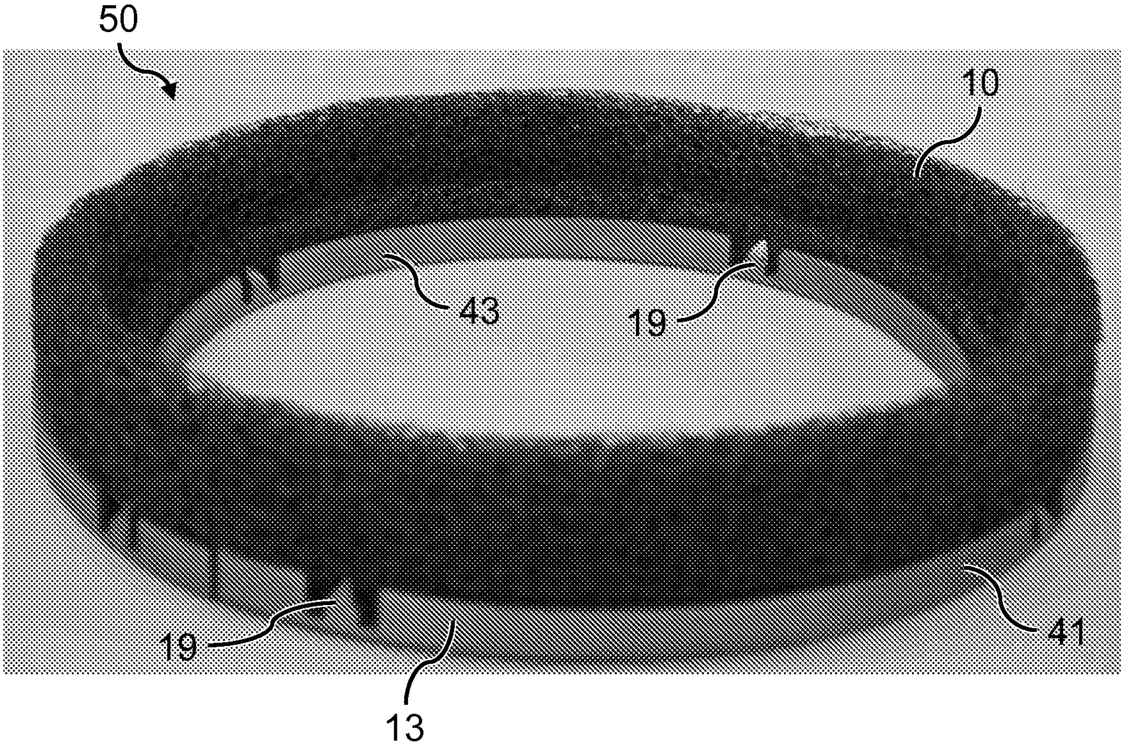


FIG.3

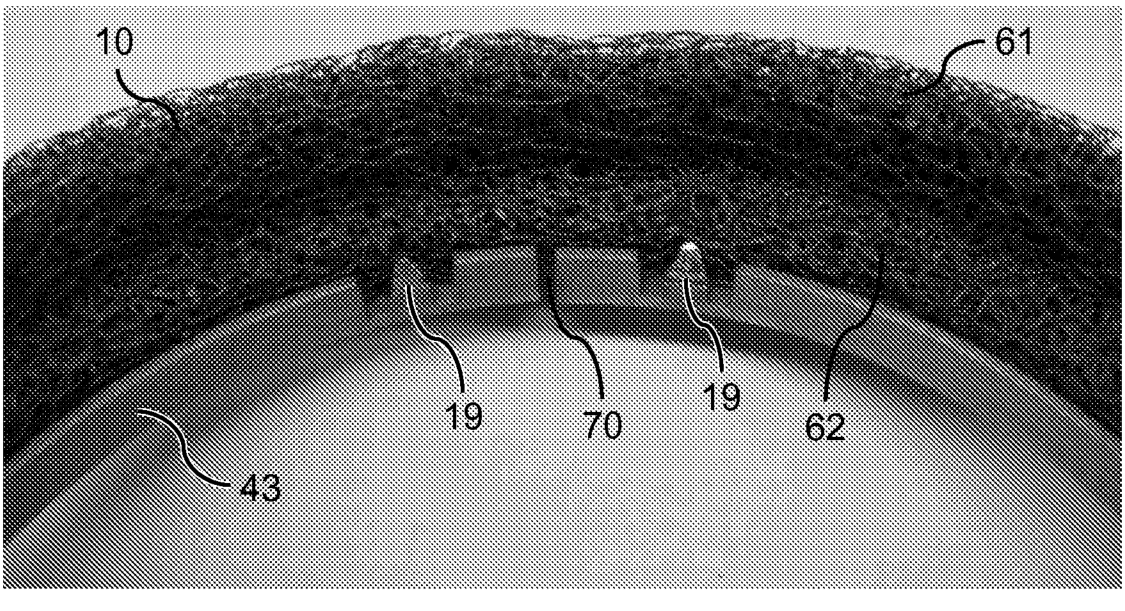


FIG.4

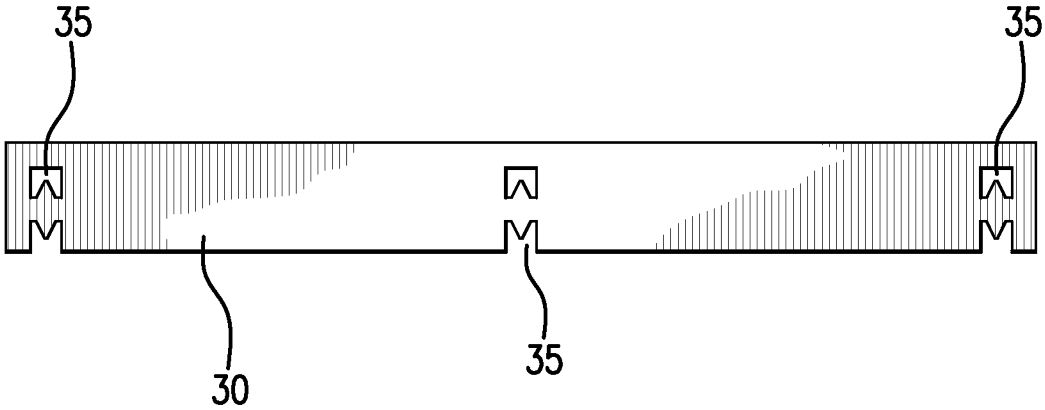


FIG.5

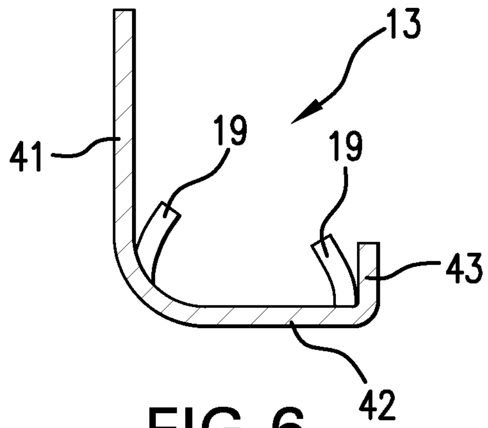


FIG.6

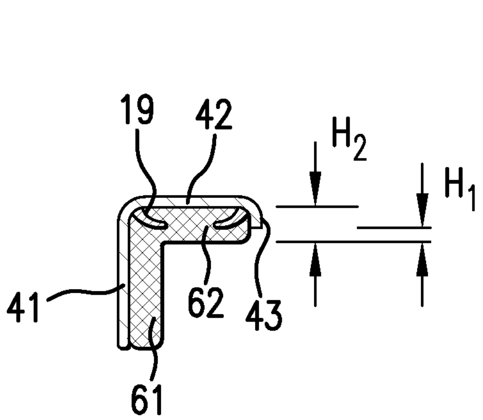


FIG.7

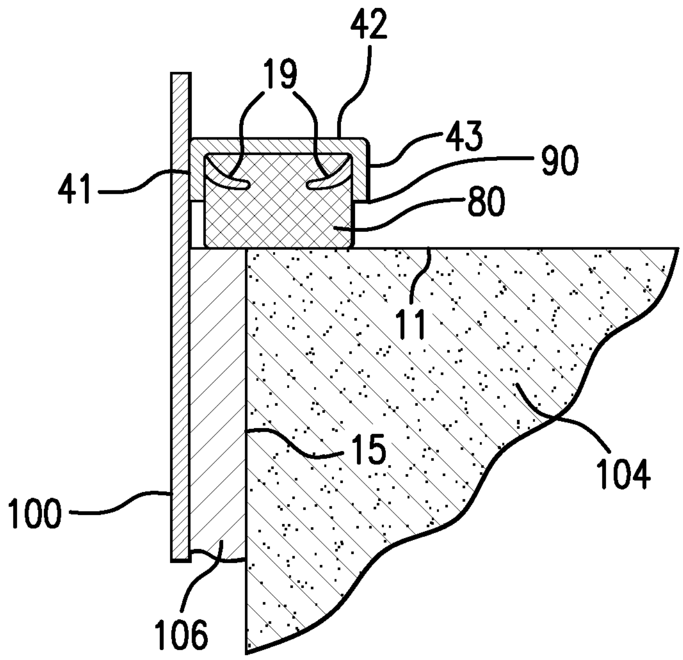


FIG.8A

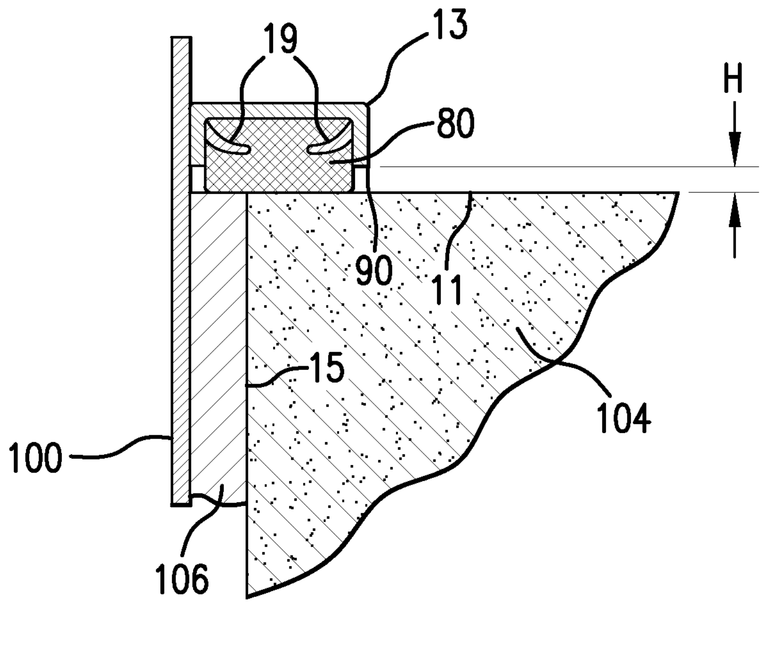
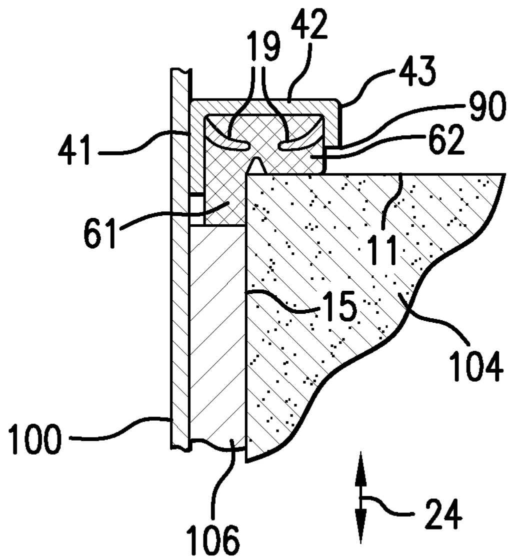


FIG.8B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61
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104
100
106
24

FIG.9A

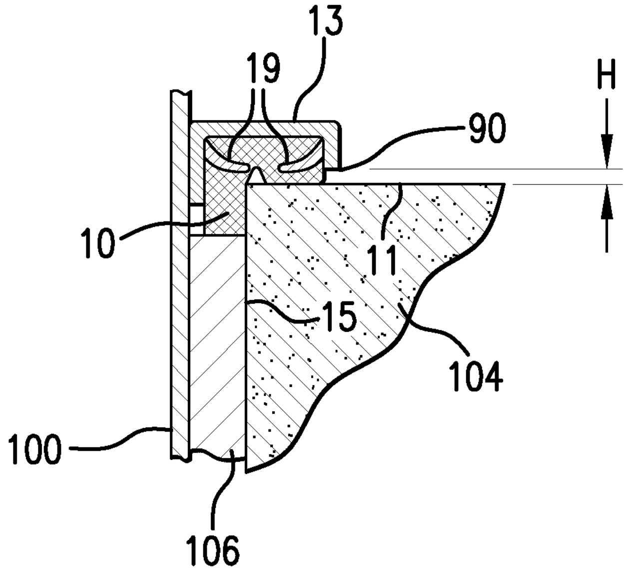
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FIG.9B

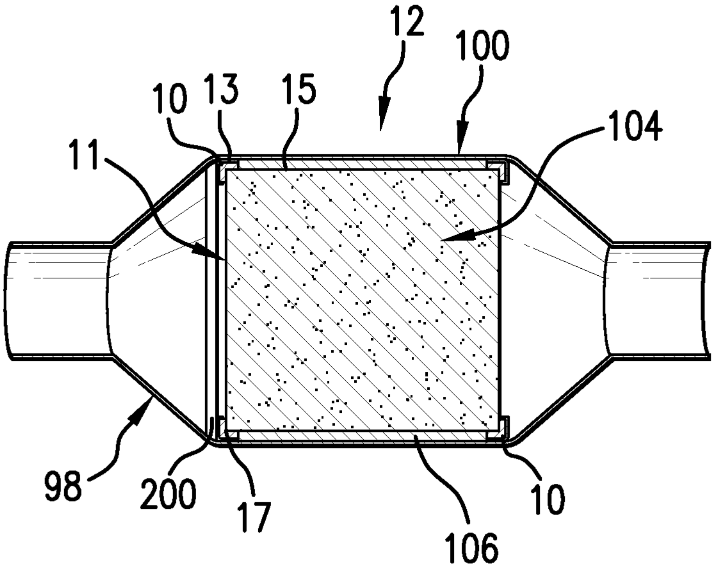
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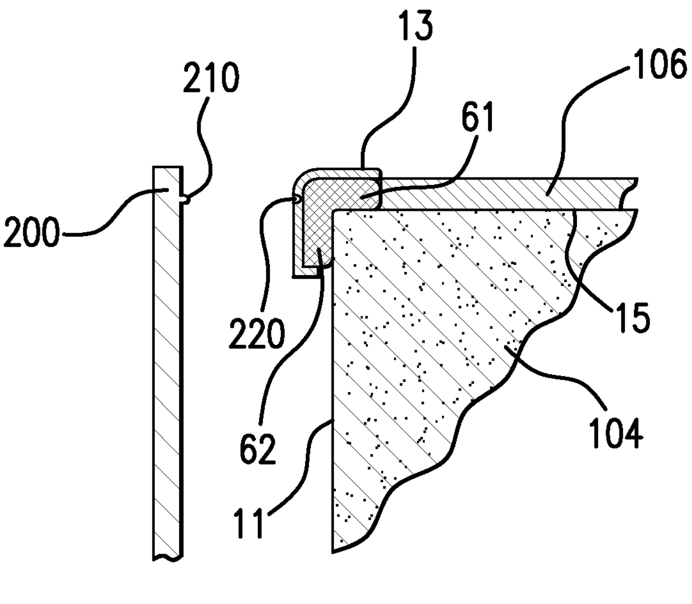
FIG.10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11

FIG.11

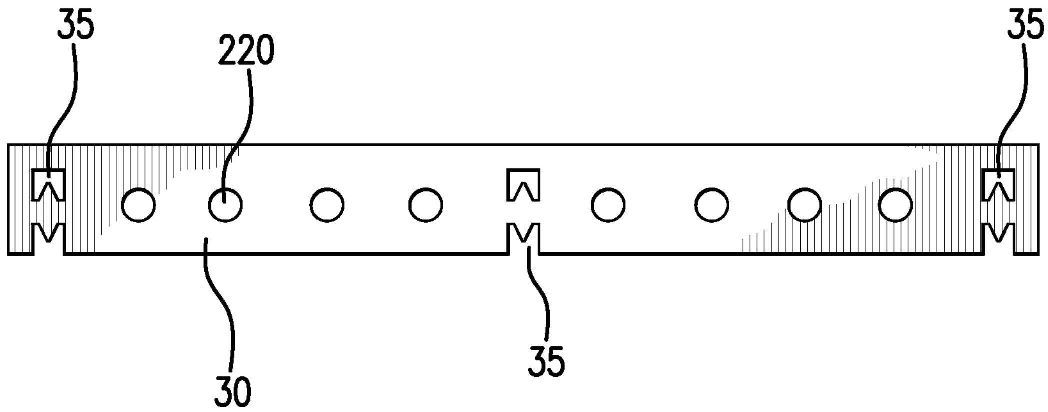

FIG.12

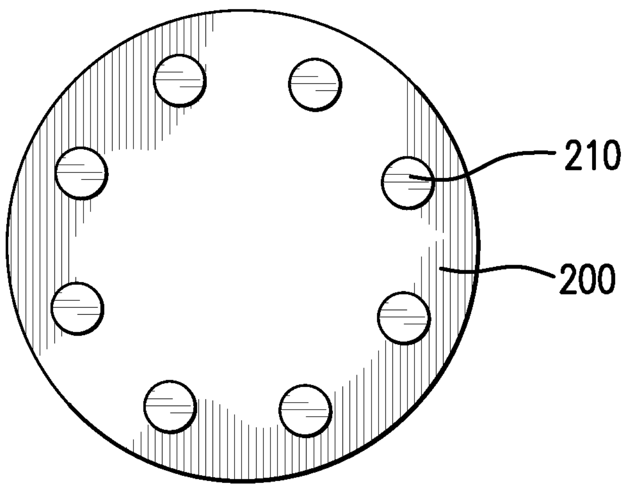

FIG.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/51870

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B01D 50/00; F01N 3/10; F01N 7/10 (2010.01)
USPC - 422/179; 60/302; 60/323
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B01D 50/00; F01N 3/10; F01N 7/10 (2010.01)
USPC - 422/179; 60/302; 60/323

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 60/299; 138/123; 174/117M; 277/650; 422/168,177,181
IPC(8) - B01D 53/34; F01N 3/28; F01N 7/00; F01N 7/02; F01N 7/18; H01B 7/08 (2010.01), patents, NPL - search term limited

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPTO - PubWEST; Google; Google Scholar. search terms on extra sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2006/0177359 A1 (Sinha et al.) 10 August 2006 (10.08.2006), para [0002], [0008], [0010], [0014], [0017], [0039], [0043], [0047], [0049], [0052], [0054]-[0056]; fig. 2-5; title	1, 7, 8, 11, 13 --- 2-6, 9, 10, 12, 14-26
Y	US 2006/0144614 A1 (Kircanski et al.) 06 July 2006 (06.07.2006), para [0017], [0019], [0026], [0031]	2-4, 18-20
Y	US 3,989,471 A (Nowack) 2 November 1976 (02.11.1976), fig. 2, 3; col 5 ln 22-35	5, 6, 12, 15-22
Y	Rajadurai et al. "Axial Mounting for Converters and Filters using Wiremesh Seals." Global Powertrain Congress 2006, page 90-96. 2006 (2006) [online] http://www.acsindustries.com/files/GPC_2.pdf] page 1, col 2 [downloaded from internet 2 December 2010	8, 14
Y	US 2009/0188246 A1 (Galligan) 30 July 2009 (30.07.2009), para [0050]	10, 22-26
Y	US 2007/0186546 A1 (Midgley et al.) 16 August 2007 (16.08.2007), para [0022]	21
A	Rajadurai et al., "Edge-Seal Mounting Support for Diesel Particulate Filters. Society of Automotive Engineers." 2005-01-3510, 2005 (2005) [online] http://www.acsindustries.com/files/sae%201.pdf [downloaded from internet 2 December 2010.]	1-26

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 December 2010 (02.12.2010)	14 DEC 2010

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Box B continued (search terms)

agitatate anneal annular aperture ash assembly axial can catalytic ceramic compress container converter density diesel dust edge end engage exhaust extend face filter filtrate flat flexible flow fluid force gas grasp hard hold hole honeycomb housing insert knit liquid mesh metal metalic mix mount particle particulate precipitation protrusion push rigid ring round screen seal soft steel stiff substrate support tab wire