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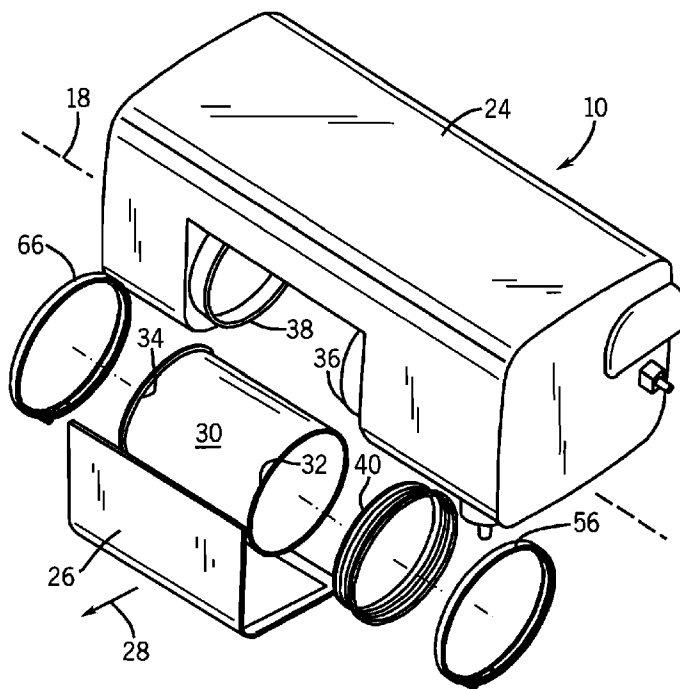
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(54) Title: SERVICEABLE EXHAUST AFTERTREATMENT ASSEMBLY AND METHOD



(57) Abstract: An exhaust aftertreatment assembly and method enables lateral removal of an aftertreatment component from between first and second assembly components for servicing.

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## SERVICEABLE EXHAUST AFTERTREATMENT ASSEMBLY AND METHOD

### BACKGROUND AND SUMMARY

5           **[0001]**       The invention relates to exhaust aftertreatment assemblies.

**[0002]**       Exhaust aftertreatment assemblies for internal combustion  
engines are experiencing increased demands for space efficiency and packaging of  
numerous aftertreatment components within small volumes, for example diesel  
particulate filters (DPF), diesel oxidation catalysts (DOC), selective catalytic  
10       reduction (SCR) components, hydrocarbon (HC) dosing components, urea injection  
components, and various catalytic and filter components. In some implementations, it  
is desirable or required to orient the assembly in a fore-aft direction along the vehicle  
axis, and it may be difficult, or impossible because of axial space/length constraints,  
to axially separate such components when needed for servicing or replacement.

15           **[0003]**       The present invention arose during continuing development  
efforts directed toward exhaust aftertreatment assemblies, including ease of servicing.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0004]**       Fig. 1 is a perspective view of an exhaust aftertreatment  
20       assembly in accordance with the invention.

**[0005]**       Fig. 2 is like Fig. 1 but shows several components in exploded  
perspective view.

**[0006]**       Fig. 3 is a sectional view of portion of Fig. 1.

**[0007]**       Fig. 4 is an enlarged sectional view of a portion of Fig. 3.

25           **[0008]**       Fig. 5 is like a portion of Fig. 4 and shows another embodiment.

### DETAILED DESCRIPTION

**[0009]**       Fig. 1 shows an exhaust aftertreatment assembly 10 for an  
internal combustion engine 12. The assembly has an inlet 14 for receiving

combustion exhaust from the engine, and has an outlet 16 for discharging the exhaust.

Within assembly 10 are various components as noted above, for example a diesel particulate filter (DPF), in the case of a diesel engine, a diesel oxidation catalyst (DOC), a selective catalytic reduction (SCR) component, and/or other filters or components depending upon the particular application. Various components may need servicing, e.g. cleaning or replacement. For example, a diesel particulate filter (DPF) may become filled with ash, and needs to be periodically removed for cleaning or replacement. In various vehicle applications, it is desired or necessary for the assembly 10 to be aligned along the fore-aft axis 18 of the vehicle. In such applications, there may not be sufficient room to axially remove one or both of the axial ends 20 or 22 of the assembly housing 24 to gain access to various of the components within the housing, to enable servicing.

**[0010]** Fig. 2 shows housing 24 of assembly 10 having a side door or panel 26 laterally opened or removed as shown at arrow 28 to permit access to components within housing 24, for example aftertreatment component 30, which may for example be a diesel particulate filter (DPF). Aftertreatment component 30 extends axially along axis 18 within housing 24 between first and second distally opposite axial ends 32 and 34 mounted in sealing relation to first and second assembly components 36 and 38 axially spaced by aftertreatment component 30 therebetween. For example, assembly component 36 may be a mounting post or the like providing a duct leading downstream to outlet 16. Assembly component 38 may be an upstream aftertreatment component such as a diesel oxidation catalyst (DOC). After opening or removal of door 26, aftertreatment component 30 is laterally removable from between the noted first and second assembly components 36 and 38, for servicing of aftertreatment component 30, e.g. for cleaning or replacement. Aftertreatment component 30 is removable from between first and second assembly components 36 and 38 without axially moving first assembly component 36 and without axially moving second assembly component 38, to be described. Aftertreatment component 30 is replaceable between the first and second assembly

components 36 and 38 and sealed to each of assembly components 36 and 38 without axially moving assembly component 36 and without axially moving assembly component 38, to be described.

[0011] A slip joint seal 40, Figs. 2-4, is provided at axial end 32 of  
5 aftertreatment component 30. The slip joint seal permits relative axial movement between aftertreatment component 30 and assembly component 36 while maintaining sealing therebetween such that exhaust may flow axially between aftertreatment component 30 and assembly component 36 without leakage at the junction thereof. Aftertreatment component 30 is axially spaced from assembly component 36 by an  
10 axial tolerance gap 42, Fig. 4, providing axial clearance between aftertreatment component 30 and assembly component 36 to permit lateral removal of aftertreatment component 30 as shown at arrow 28. Without axial tolerance gap 42, a tight snug fit between components 30 and 36 may impede lateral removal of component 30, particularly after thermal cycling (expansion and contraction), corrosion, dimensional  
15 variances, manufacturing tolerances, etc. Slip joint seal 40 spans axial gap 42 and preferably has at least one and further preferably two sliding seals 44, 46 slidably engaging one of the aftertreatment component 30 and assembly component 36, e.g. engaging component 30 in Figs. 3, 4, and axially slidable therealong in sealing relation. In another embodiment, seals 44, 46 are eliminated, and the sealing function  
20 is provided by a clamp, for example as shown in dashed line at 47, which is tightened after assembly to provide sealing engagement, e.g. at portion 48 of slip joint seal 40 against aftertreatment component 30 without seals 44, 46. In another embodiment, seals 44, 46 are provided in addition to clamp 47.

[0012] Slip joint seal 40 is an annular member and may include various  
25 annular shapes matching the shape of the noted aftertreatment component, e.g. cylindrical, oval, racetrack shaped, or other closed-loop shapes. Annular slip joint seal 40 has a first portion 48 circumscribing one of the aftertreatment component 30 and assembly component 36, e.g. portion 48 circumscribes component 30 along its outer shell or wall 30a, typically sheet metal, which in turn circumscribes outer

blanket 30b, typically vermiculite, which in turn circumscribes the diesel particulate filter material 30c, e.g. ceramic or cordierite. Annular slip joint seal 40 has a second portion 50 extending axially from first portion 48 toward the other of the aftertreatment component 30 and assembly component 36, e.g. toward component 36.

5 Second portion 50 circumscribes component 30 at the right end of outer shell wall 30a in Fig. 4 as the latter extends rightwardly beyond the diesel particulate filter material 30c and blanket 30b which may be retained by one or more retaining rings such as 30d, 30e. Second portion 50 has a first flange 52 axially facing component 36. Flange 52 is axially distally oppositely spaced from first portion 48 by second  
10 portion 50 therebetween. Flange 52 and second portion 50 circumscribe axial tolerance gap 42. Component 36, at its outer shell wall 36a, typically sheet metal, has a second flange 54 axially facing flange 52 and releasably clamped thereto in fixed sealing relation, e.g. by a V-band clamp 56. A gasket 57 may be provided between  
15 flanges 52 and 54, which gasket may circumscribe a retaining ring 36b extending from component 36.

[0013] Sliding seals 44, 46 are radially engaged between first portion 48 and outer wall 30a of component 30. Sliding seals 44, 46 are fixed to first portion 48 and are axially slidable along component 30 when first and second flanges 52 and 54 are clamped by clamp 56. First portion 48 includes one or more raised annular  
20 beads 58, 60 defining concave annular cavities 62, 64 around component 30. One or more sealing ropes, preferably wire mesh, provide the noted seals 44, 46 radially compressed in respective cavities 62, 64. Cavities 62, 64 preferably have a curved cross-sectional shape, preferably semi-circular, though other shapes may be used including rectangular, trapezoidal, and so on. Various materials may be used for  
25 sealing ropes 44, 46, including stainless steel, inconel wire mesh embedded with graphite, and other materials. Sealing ropes 44, 46 may have circular cross-sectional shapes, or other shapes such as rectangular, trapezoidal, and so on.

[0014] The system provides a method for sealing an exhaust aftertreatment component 30 in an exhaust aftertreatment assembly 10 for an internal

combustion engine. Exhaust flows axially, left to right in Figs. 2-4, from upstream to downstream through aftertreatment component 30 from axial end 34 to axial end 32. Downstream axial end 32 is at a lower pressure than upstream axial end 34. The sealing method includes providing the slip joint seal 40 at the lower pressure downstream axial end, to further ensure against leakage at the junction of components 30 and 36.

**[0015]** The system further provides a method for servicing an exhaust aftertreatment assembly. The method involves laterally removing aftertreatment component 30 from between assembly components 36 and 38, for servicing aftertreatment component 30. The method includes removing aftertreatment component 30 from between assembly components 36 and 38 without axially moving assembly component 36 and without axially moving assembly component 38. V-band clamps 56, 66 are loosened and slid axially past their respective flanges such as 52, 54, followed by axial sliding of slip joint seal 40 to allow clearance, followed by lateral removal of aftertreatment component 30 as shown at arrow 28. After cleaning or renewal or substitution with a new component, the aftertreatment component 30 is replaced between assembly components 36 and 38, followed by axial sliding of slip joint seal 40 into place around axial tolerance gap 42 and axial sliding of V-band clamps 56, 66 into place around respective flanges such as 52, 54, followed by tightening of the clamps. Door or panel 26 is then closed or moved back into a closed position on housing 24. This is all accomplished while housing 24 remains in place on the vehicle.

**[0016]** Fig. 5 shows another embodiment 70 of slip joint seal 40 of Fig. 4. Slip joint seal 70 is an annular member and may include various annular shapes matching the shape of the noted aftertreatment component, e.g. cylindrical, oval, racetrack shaped, or other closed-loop shapes. Annular slip joint seal 70 has a first portion 72 circumscribing one of the aftertreatment component 30 and assembly component 36, e.g. portion 72 circumscribes component 30 along its outer shell or wall 30a. Annular slip joint seal 70 has a second portion 74 extending axially from

first portion 72 toward the other of the aftertreatment component 30 and assembly component 36, e.g. toward component 36. Second portion 74 circumscribes component 30 at the right end of outer shell wall 30a of Fig. 4 as the latter extends rightwardly beyond the diesel particulate filter material 30c and blanket 30b which, as noted above, may be retained by one or more retaining rings such as 30d, 30e. Second portion 74 has a first flange 76 facing component 36. Flange 76 is axially distally oppositely spaced from first portion 72 by second portion 74 therebetween. Flange 76 and second portion 74 circumscribe axial tolerance gap 42 of Fig. 4. Component 36, at its outer shell wall 36a, has the noted second flange 54 axially facing flange 76 and releasably clamped thereto in fixed sealing relation, e.g. by the noted V-band clamp 56. The noted gasket 57 may be provided between flanges 76 and 54, which gasket may circumscribe the noted retaining ring 36b extending from component 36. One or more sliding seals such as 44, 46 may be provided in raised annular bead 78 defining concave annular cavity 80 around component 30. Clamp 47 may optionally be used, if desired, for tightening after assembly.

[0017] In the foregoing description, certain terms have been used for brevity, clearness, and understanding. No unnecessary limitations are to be implied therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed. The different configurations, method steps and systems described herein may be used alone or in combination with other configurations, method steps and systems. It is to be expected that various equivalents, alternatives and modifications are possible within the scope of the appended claims.

## CLAIMS

What is claimed is:

1. An exhaust aftertreatment assembly for an internal combustion engine, comprising an aftertreatment component extending axially along an axis between first and second distally opposite axial ends mounted in sealing relation to first and second assembly components axially spaced by said aftertreatment component therebetween, said aftertreatment component being laterally removable from between said first and second assembly components for servicing.
2. The exhaust aftertreatment assembly according to claim 1 wherein said aftertreatment component is removable from between said first and second assembly components without axially moving said first assembly component and without axially moving said second assembly component.
3. The exhaust aftertreatment assembly according to claim 1 wherein said aftertreatment component is replaceable between said first and second assembly components and sealed to each of said first and second assembly components without axially moving said first assembly component and without axially moving said second assembly component.
4. The exhaust aftertreatment assembly according to claim 1 comprising a slip joint seal at said first axial end of said aftertreatment component, said slip joint seal permitting relative axial movement between said aftertreatment component and said first assembly component while maintaining sealing therebetween such that exhaust may flow axially between said aftertreatment component and said first assembly component without leakage at the junction thereof.
5. The exhaust aftertreatment assembly according to claim 4 wherein said aftertreatment component is axially spaced from said first assembly

component by an axial tolerance gap providing axial clearance between said  
aftertreatment component and said first assembly component to permit said lateral  
5 removal of said aftertreatment component.

6. The exhaust aftertreatment assembly according to claim 5  
wherein said slip joint seal spans said axial tolerance gap and has at least one sliding  
seal slidably engaging one of said aftertreatment component and said first assembly  
component and axially slidable therealong in sealing relation.

7. The exhaust aftertreatment assembly according to claim 6  
wherein said slip joint seal is an annular member having a first portion circumscribing  
one of said aftertreatment component and said first assembly component, and having  
a second portion extending axially from said first portion toward the other of said  
5 aftertreatment component and said first assembly component, said second portion  
having a first flange axially facing said other of said aftertreatment component and  
said first assembly component, said first flange being axially distally oppositely  
spaced from said first portion by said second portion therebetween, said first flange  
and said second portion circumscribing said axial tolerance gap, said other of said  
10 aftertreatment component and said first assembly component having a second flange  
axially facing said first flange and releasably clamped thereto in fixed sealing relation  
by a clamp, said at least one sliding seal being radially engaged between said first  
portion and said one of said aftertreatment component and said first assembly  
component.

8. The exhaust aftertreatment assembly according to claim 7  
wherein said at least one sliding seal is fixed to said first portion and axially slidable  
along said one of said aftertreatment component and said first assembly component  
when said first and second flanges are clamped by said clamp.

9. The exhaust aftertreatment assembly according to claim 7 wherein said first portion comprises one or more raised annular beads defining one or more concave annular cavities around said one of said aftertreatment component and said first assembly component, and one or more sealing ropes radially compressed in  
5 respective said cavities.

10. The exhaust aftertreatment assembly according to claim 9 wherein said one or more concave annular cavities have a cross-sectional shape selected from the group consisting of semi-circular, curved, rectangular, trapezoidal.

11. The exhaust aftertreatment assembly according to claim 9 wherein the material of said one or more sealing ropes is selected from the group consisting of wire mesh, stainless steel, and inconel wire mesh embedded with graphite.

12. The exhaust aftertreatment assembly according to claim 1 wherein said aftertreatment component is a DPF, diesel particulate filter.

13. A method for sealing an aftertreatment component in an exhaust aftertreatment assembly for an internal combustion engine, comprising providing an aftertreatment component extending axially along an axis between first and second distally opposite axial ends, mounting said first and second axial ends to first and second assembly components axially spaced by said aftertreatment component  
5 therebetween, wherein exhaust flows axially from upstream to downstream through said aftertreatment component from said second axial end to said first axial end, said first axial end being at a lower pressure than said second axial end, providing a slip joint seal at said first axial end permitting relative axial movement between said  
10 aftertreatment component and said first assembly component while maintaining sealing therebetween such that exhaust may flow axially from said second axial end

of said aftertreatment component to said first assembly component without leakage at the junction thereof and with said slip joint seal being at said lower pressure axial end.

14. A method for servicing an aftertreatment component in an exhaust aftertreatment assembly for an internal combustion engine, said aftertreatment component extending axially along an axis between first and second distally opposite axial ends mounted in sealing relation to first and second assembly components axially spaced by said aftertreatment component therebetween, said  
5 method comprising laterally removing said aftertreatment component from between said first and second assembly components for servicing of said aftertreatment component.

15. The method according to claim 14 comprising laterally removing said aftertreatment component from between said first and second assembly components without axially moving said first assembly component and without axially moving said second assembly component.

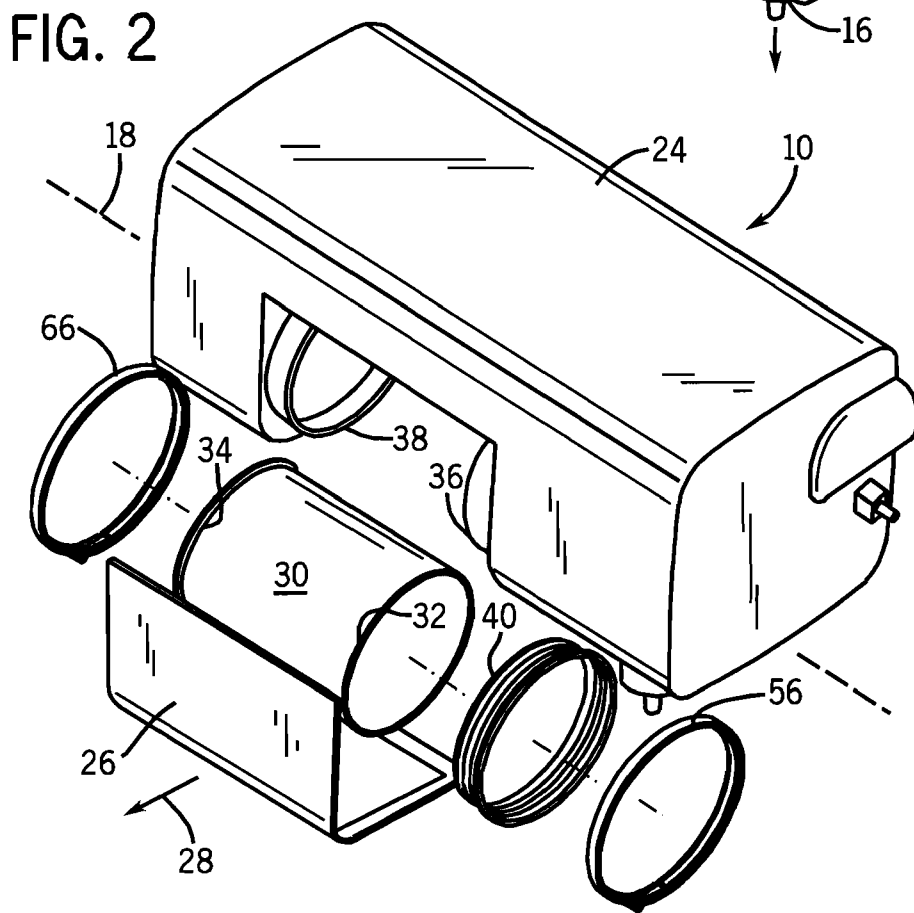
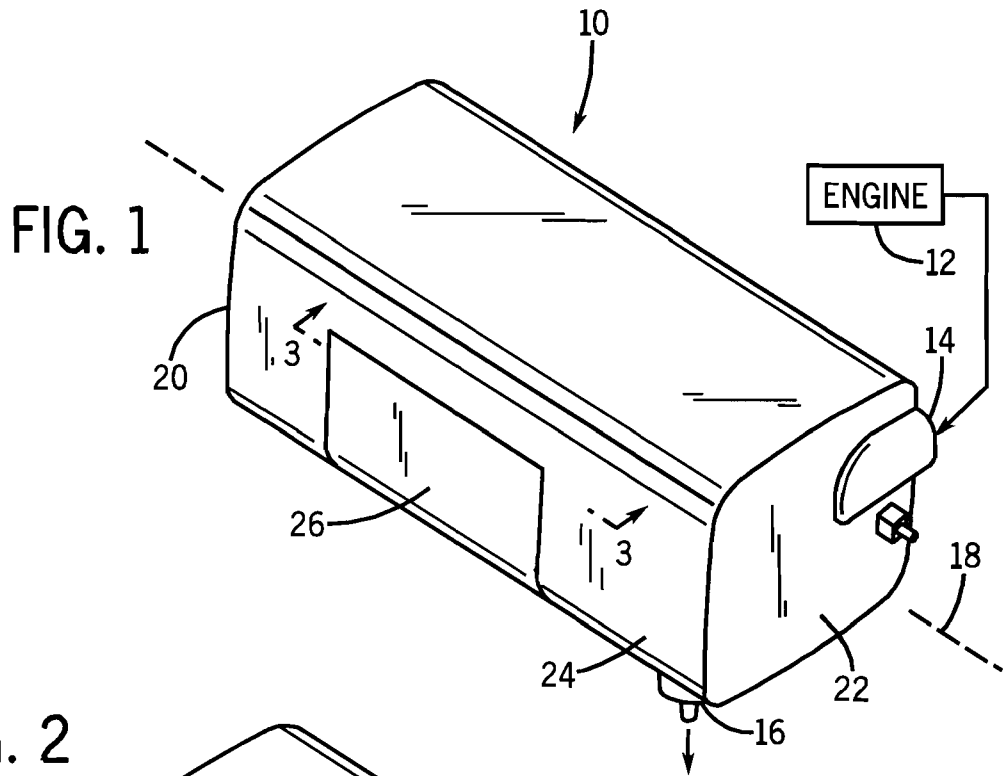
16. The method according to claim 14 comprising laterally replacing said aftertreatment component between said first and second assembly components and sealing said aftertreatment component to each of said first and second assembly components without axially moving said first assembly component and without  
5 axially moving said second assembly component.

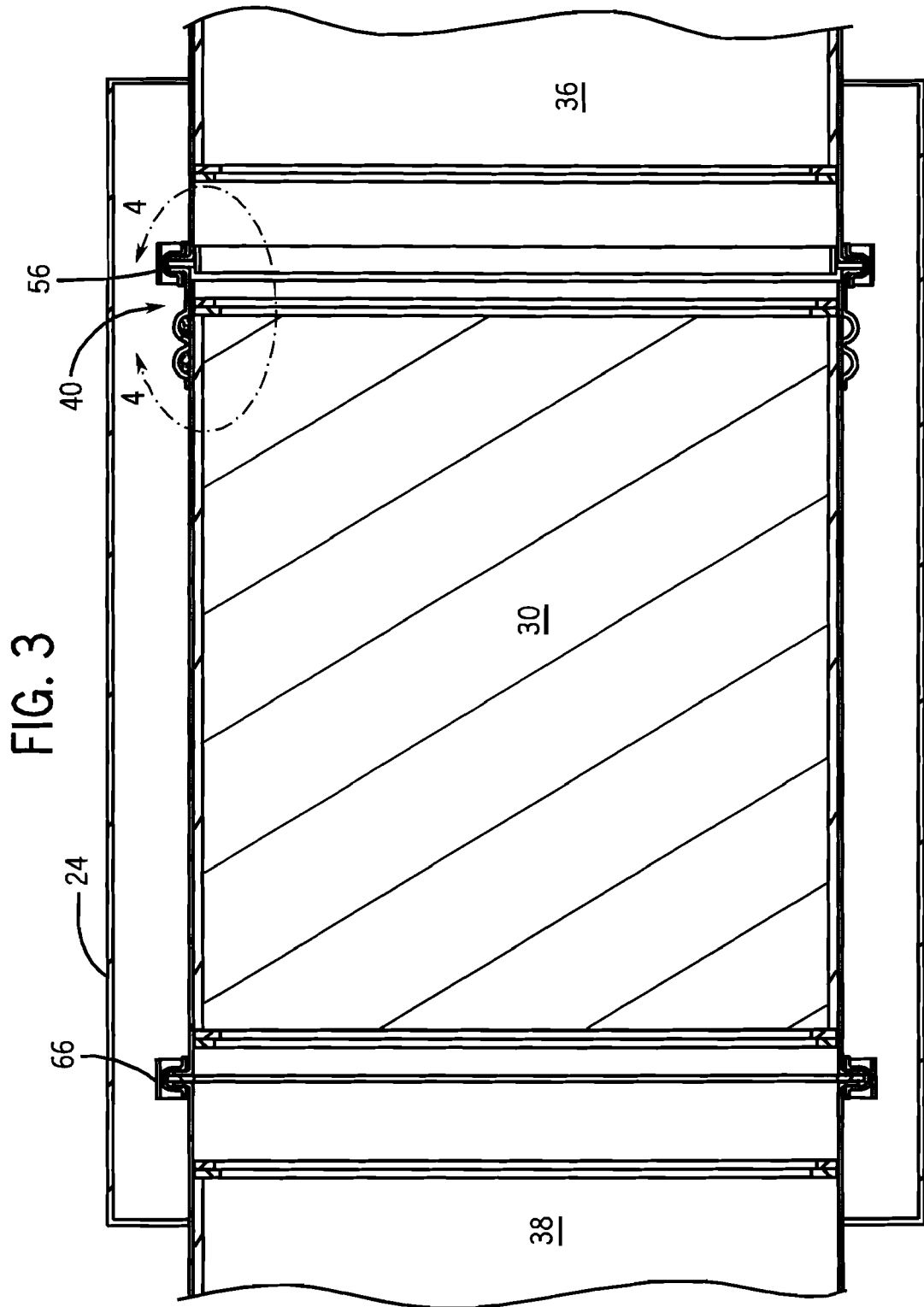
17. The method according to claim 14 comprising providing a slip joint seal at said first axial end of said aftertreatment component, and permitting via said slip joint seal relative axial movement between said aftertreatment component and said first assembly component while maintaining sealing therebetween such that  
5 exhaust may flow axially between said aftertreatment component and said first

assembly component without leakage at the junction thereof.

18. The method according to claim 17 comprising axially spacing said aftertreatment component from said first assembly component by an axial tolerance gap providing axial clearance between said aftertreatment component and said first assembly component to permit said lateral removal step of said aftertreatment component.

19. The method according to claim 18 comprising spanning said axial tolerance gap with said slip joint seal, and providing said slip joint seal with at least one sliding seal slidably engaging one of said aftertreatment component and said first assembly component and axially slidable therealong in sealing relation.





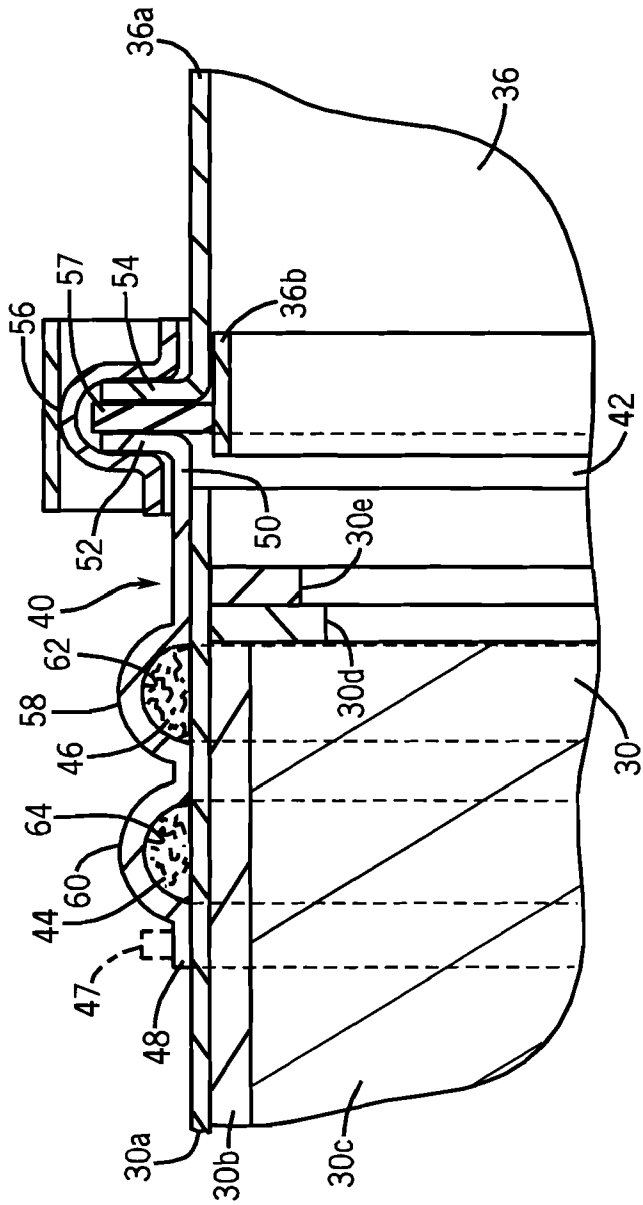


FIG. 4

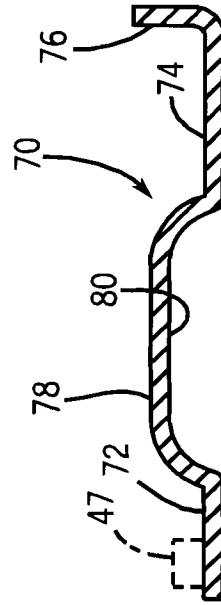


FIG. 5