ADAPTIVE VALVE FOR EXHAUST SYSTEM

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ABSTRACT
A vehicle exhaust system includes at least one adaptive valve that is associated with an exhaust component, and which is movable between open and closed positions. An anti-flutter component is associated with the adaptive valve to reduce fluttering movement of the adaptive valve caused by exhaust gas pulsations.
FIG. 3

FIG. 4
FIG. 5
ADAPTIVE VALVE FOR EXHAUST SYSTEM

RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/185,702, which was filed Jun. 10, 2009.

TECHNICAL FIELD

[0002] This invention generally relates to an adaptive valve as used in a vehicle exhaust system, and more specifically to an adaptive valve with an anti-flutter component.

BACKGROUND OF THE INVENTION

[0003] Exhaust systems often use adaptive valves to reduce noise during exhaust gas flow through an exhaust component. An adaptive valve is a self-regulating valve that adapts to different engine operating conditions through the effect of exhaust gas flow.

[0004] The adaptive valve includes a spring, which biases the valve toward a desired direction. When exhaust gas flow is sufficient to overcome the biasing force of the spring, valve movement is controlled by variations in exhaust gas flow. The adaptive valve functions differently depending on where the valve is located within the exhaust system. It is desirable to place an adaptive valve in a muffler, however, due to spring temperature limits, the valve springs are not considered a good match for most muffler applications.

[0005] Further, the adaptive valve can be susceptible to flutter due to exhaust gas pulsations impacting the valve, which causes the valve to open and close quickly and repeatedly. This fluttering action can cause premature wear and strain on the valves.

[0006] Finally, each exhaust component typically has several acoustic resonant modes. When the adaptive valve is mounted within the exhaust component, the valve is able to suppress many, but not all, of these resonant modes.

SUMMARY OF THE INVENTION

[0007] A vehicle exhaust system includes at least one adaptive valve that is associated with an exhaust component, and which is movable between open and closed positions. An anti-flutter component is associated with the adaptive valve to reduce fluttering movement of the adaptive valve caused by exhaust gas pulsations.

[0008] In one example, the exhaust component comprises an exhaust pipe. The adaptive valve is positioned within the exhaust pipe and is moveable from a closed position to an open position solely based on exhaust gas flow.

[0009] In one example, the anti-flutter component comprises a damper that is coupled to the adaptive valve. The damper can be mounted internal or external to the exhaust pipe.

[0010] In one example, the anti-flutter component comprises a second adaptive valve that operates independently of the first adaptive valve. One adaptive valve is positioned upstream of the exhaust component and the other adaptive valves is positioned downstream of the exhaust component. One of the adaptive valves provides broadband suppression and the other of the adaptive valves provides resonance suppression. The vehicle exhaust component could comprise a muffler, for example, and one adaptive valve could be positioned within an inlet pipe to the muffler and the other adaptive valve could be positioned within an outlet pipe to the muffler.

[0011] In another example, the anti-flutter component comprises a weighted mass that is coupled to the adaptive valve.

[0012] In another example, the anti-flutter component comprises first and second retainer members connected by a wire element. One of the first and second retainer members is rotatable relative to the other of the first and second retainer members and the wire element cooperates with the retainers to provide a damping effect.

[0013] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 shows a schematic view of an exhaust system that includes one example of an adaptive valve with an anti-flutter component in an internal configuration.

[0015] FIG. 2 shows another example of an exhaust component with an adaptive valve and anti-flutter component in an internal configuration.

[0016] FIG. 3 shows another schematic example of an adaptive valve in a first location in an exhaust system with a corresponding Sound Pressure Level vs. Engine Speed graph.

[0017] FIG. 4 shows another schematic example of an adaptive valve in a second location in an exhaust system with a corresponding Sound Pressure Level vs. Engine Speed graph.

[0018] FIG. 5 shows a combination of valves from FIGS. 3 and 4 with a corresponding Sound Pressure Level vs. Engine Speed graph.

[0019] FIG. 6 shows a prior art example of an exhaust component with a spring-loaded passive valve.

[0020] FIG. 7 shows another example of an exhaust component with an adaptive valve and anti-flutter component with the valve in a closed position.

[0021] FIG. 8 shows the valve of FIG. 7 in an open position.

[0022] FIG. 9 shows another example of an exhaust component with an adaptive valve and anti-flutter component.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0023] A vehicle exhaust system 10 is comprised of a plurality of exhaust components that direct exhaust gases from an engine 12 to a tailpipe 14. These exhaust components can comprise converters, mufflers, resonators, pipes, tubes, etc. as known. In the example shown in FIGS. 1 and 2, the exhaust system 10 includes an exhaust component 16 that comprises a tube that houses an adaptive valve 20. Additional exhaust components 24 can be located upstream of the exhaust component 16 and additional exhaust components 26 can be located downstream of the exhaust component 16 as known.

[0024] The exhaust component 16 provides a flow pathway 22 in which the adaptive valve 20 is positioned. The adaptive valve 20 comprises a disc-shaped valve body that is biased toward a closed position where the flow pathway 22 is substantially blocked. Typically, a resilient member such as a spring is used to bias the valve toward the closed position. When exhaust gas pressure is sufficient to overcome the biasing force, the adaptive valve 20 moves from the closed position toward an open position. When the exhaust gas pressure falls below the biasing force, the adaptive valve 20 will return
to the closed position. Thus, the adaptive valve 20 is a passive valve whose movement is solely controlled by variations exhaust gas flow pressure.

[0025] The adaptive valve 20 provides a system weight reduction because additional active control components are not required. Further, the adaptive valve 20 provides a broad range of noise reduction. However, the adaptive valve 20 can be susceptible to flutter due to exhaust gas pulsations impacting the valve 20, which causes the valve 20 to open and close quickly and repeatedly. This fluttering action can cause premature wear and strain on the valve.

[0026] The adaptive valve 20 includes at least one anti-flutter component 30 that is used to reduce this fluttering movement caused by exhaust gas pulsations. In one example, the anti-flutter component 30 comprises a damper 32 that is coupled to the adaptive valve 20. Any type of damper 32 can be used in the system, such as a linear, torsional, oil filled, friction based, integrated spring/force, etc. In the example shown in FIGS. 1-2, the damper 32 includes a cylinder 34 that is fixed to the exhaust component 16 and an extendible rod 36 that is coupled to the valve 20. The damper 32 can be tuned or set to provide a desired damping force on the valve 20 to reduce/dampen the opening and closing speed of the valve 20, which significantly reduces the effects of fluttering.

[0027] The damper 32 can be mounted external to the exhaust component 16 as shown in FIG. 1, or can be mounted internally as shown in FIG. 2. One benefit to locating the damper externally is that the damper 32 is not subjected to high exhaust temperatures; however, additional packaging space is required for the damper. The configuration shown in FIG. 2 does not require any additional packaging space.

[0028] In another example shown in FIGS. 3-5, a combination of adaptive valves are used to provide a wide range of noise reduction. In this example, first 40 and second 42 adaptive valves are used in combination with each other to provide broadband and resonance suppression. The first 40 and second 42 adaptive valves are positioned at different locations within the exhaust system 10 and operate independently of each other.

[0029] In this example, the exhaust system 10 includes an exhaust component 44, such as a muffler for example. The first adaptive valve 40 is positioned upstream of the exhaust component 44 in an inlet exhaust pipe 46 to provide broadband suppression as shown in FIG. 3. This broadband suppression is generally constant across a range of various engines speeds, such as from 750 rpm to 4500 rpm for example.

[0030] The second adaptive valve 42 is positioned downstream of the exhaust component 44 in an outlet exhaust pipe 48 to provide resonance suppression as shown in FIG. 4. The resonance suppression is significantly increased within the engine speed range of 1500-2500 rpm for example.

[0031] FIG. 5 shows the overall net effect of noise suppression when both of the first 40 and second 42 adaptive valves are utilized. This combination provides a widened range of noise suppression from engine speeds, such as from 750 rpm to 4500 rpm for example. Further, this combination has the potential for reducing the fluttering effect as described above. By combining multiple adaptive valves 20, i.e. two or more adaptive valves, into the exhaust system 10, the complex resonant nature of the overall exhaust system can be more effectively addressed. Also, the first adaptive valve 40, i.e. the upstream broadband suppression valve, can be adjusted to not flutter because this valve is not being relied upon for all noise suppression.

[0032] FIG. 6 shows a prior art configuration for an adaptive valve 50. In this configuration, the adaptive valve 50 includes a disc body 52 mounted within a pipe 54 that is biased toward the closed position by a spring 56. However, due to spring temperature limits, springs are not viewed as working well for most exhaust component applications.

[0033] In the example shown in FIGS. 7-8, the spring is replaced by a mass member 60 such that gravity can be used in place of the spring force. Also, a gravity activated device provides the benefit of generating a non-linear torsional moment M that is not easily accomplished with current spring configurations.

[0034] Further, the use of the mass member 60 in association with the adaptive valve 50 can serve as an anti-flutter component. The weighted end of the mass member 60 can reduce potential for fluttering movement as compared to traditional spring designs.

[0035] As shown, the mass member 60 is associated with an adaptive valve 62 to bias the valve 62 toward the closed position (FIG. 7) within a pipe 64. The mass member 60 exerts a mass force to hold the adaptive valve 62 in the closed position, and when exhaust gas flow force is sufficient to overcome the mass force, the adaptive valve 62 moves toward the open position (FIG. 8).

[0036] In the example shown, the mass member 60 comprises an elongated component 70 that is fixed to a valve body 72. An enlarged weighted mass 74 is fixed to a distal end 76 of the elongated component 70. It should be understood that this is just one example of a mass member configuration and that other types of mass member configurations could also be used. Further, the mass member can be located internally or externally of the pipe 64.

[0037] FIG. 9 shows another example of an anti-flutter component. In a traditional configuration such as that shown in FIG. 6, the spring 56 is mounted within the pipe 54 by spring retaining elements. In the example of FIG. 9, an anti-flutter assembly 80 includes first 82 and second 84 retainer members that are connected to each other with a wire element 86. These members can be comprised of spring retainers that were previously used for the spring 56; further, the wire element 86 can be used with or without the spring depending upon the application.

[0038] In the example shown, the first retainer member 82 comprises an outer spring retainer that rotates about a center axis A relative to the second retainer member 84, which comprises an inner spring retainer. The wire element 86 provides damping as well as spring characteristics. Any type of wire element can be utilized, including a wire rope, single wire element, and can use different types of wires and wire strand sizes. Further, the wire can be made from any type of material such as stainless steel, for example. Further, the wire element 86 can be attached to the first 82 and second 84 retainer members by any of various attachment interfaces. Examples include crimping, clamping, fastening, etc. Further, different methods of wire looking, bending, and twisting can be used to form the wire element 86.

[0039] One benefit is that the provided damping effects are accomplished with materials, such as stainless steel for example, which can withstand high temperatures while being simple to implement.
Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. A vehicle exhaust system comprising:
   at least one exhaust component;
   at least one adaptive valve associated with said at least one exhaust component, said at least one adaptive valve movable between open and closed positions within an exhaust gas flow path; and
   at least one anti-flutter component associated with said at least one adaptive valve to reduce fluttering movement of said at least one adaptive valve caused by exhaust gas pulsations.

2. The vehicle exhaust system according to claim 1 wherein said anti-flutter component comprises a damper that is coupled to said at least one adaptive valve.

3. The vehicle exhaust system according to claim 1 wherein said at least one adaptive valve comprises at least one first adaptive valve and wherein said anti-flutter component comprises a second adaptive valve that operates independently of said first adaptive valve.

4. The vehicle exhaust system according to claim 3 wherein one of said first and second adaptive valves is positioned upstream of said at least one exhaust component and the other of said first and second adaptive valves is positioned downstream of said at least one exhaust component.

5. The vehicle exhaust system according to claim 4 wherein said one of said first and second adaptive valves provides broadband suppression and said the other of said first and second adaptive valves provides resonance suppression.

6. The vehicle exhaust system according to claim 3 wherein said at least one exhaust component comprises a muffler and wherein said first adaptive valve is positioned within an inlet pipe to said muffler and said second adaptive valve is positioned within an outlet pipe to said muffler.

7. The vehicle exhaust system according to claim 1 wherein said anti-flutter component comprises a weighted mass that is coupled to said at least one adaptive valve.

8. The vehicle exhaust system according to claim 7 wherein said weighted mass biases said at least one adaptive valve to one of the closed position or open position.

9. The vehicle exhaust system according to claim 8 including an elongated body fixed to a valve body of said at least one adaptive valve, and wherein said weighted mass is fixed to a distal end of said elongated body.

10. The vehicle exhaust system according to claim 1 wherein said anti-flutter component comprises first and second retainer members connected by a wire element, wherein one of said first and said second retainer members is rotatable relative to the other of said first and said second retaining members.

11. The vehicle exhaust system according to claim 1 wherein said at least one exhaust component comprises a pipe that connects an upstream exhaust component to a downstream component.

12. The vehicle exhaust system according to claim 1 wherein movement of said at least one adaptive valve is solely controlled by exhaust gas flow.

13. A vehicle exhaust system comprising:
   at least one exhaust component;
   at least one adaptive valve associated with said at least one exhaust component, said at least one adaptive valve having a valve body that is movable between open and closed positions; and
   a mass member associated with said at least one valve to bias said at least one adaptive valve toward one of the open and closed positions.

14. The vehicle exhaust system according to claim 13 wherein said mass member exerts a mass force to hold said at least one adaptive valve in said closed position, and wherein when exhaust gas flow force is sufficient to overcome said mass force, said at least one adaptive valve moves toward said open position.

15. The vehicle exhaust system according to claim 13 wherein said mass member comprises an elongated component fixed to said valve body and an enlarged weighted mass fixed to a distal end of said elongated component.

16. A vehicle exhaust system comprising:
   at least one exhaust component;
   a first adaptive valve positioned upstream of said at least one exhaust component to provide a first type of noise suppression; and
   a second adaptive valve that operates independently of said first adaptive valve and is positioned downstream of said at least one exhaust component to provide a second type of noise suppression, said first and second adaptive valves each being movable between open and closed positions in response to exhaust gas flow.

17. The vehicle exhaust system according to claim 16 wherein one of said first and second types of noise suppression comprises broadband suppression and the other of said first and second types of noise suppression comprises resonance suppression.

18. The vehicle exhaust system according to claim 16 wherein said at least one exhaust component comprises a muffler and wherein said first adaptive valve is positioned within an inlet pipe to said muffler and said second adaptive valve is positioned within an outlet pipe to said muffler.

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