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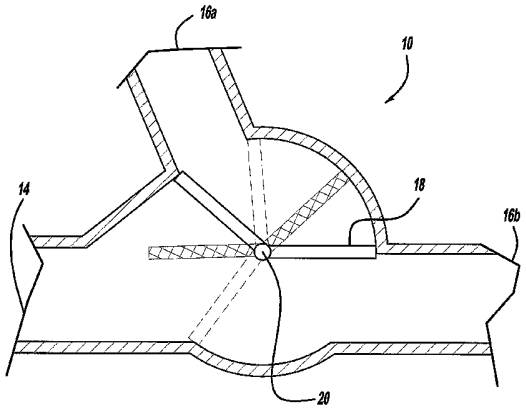
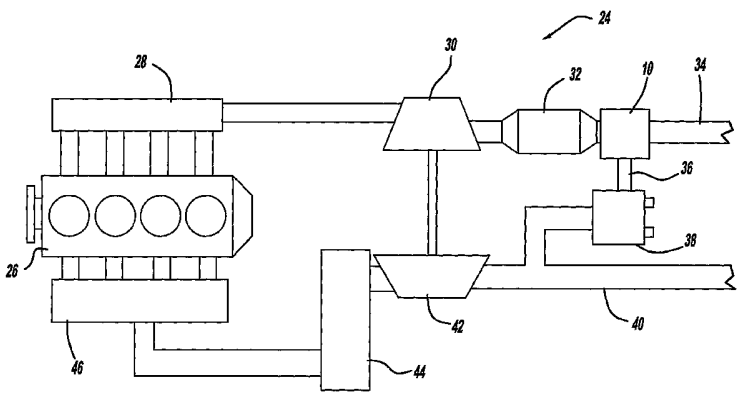
[Continued on next page]

(54) Title: EXHAUST THROTTLE-EGR VALVE MODULE FOR A DIESEL ENGINE





(57) Abstract: An exhaust gas module comprising of a housing, at least one inlet in the housing, a plurality of outlets in the housing, and a valve inside the housing, wherein exhaust gas passes through an EGR path when directed to a first outlet. A single actuator is used to control the valve. The primary valve directs the flow of exhaust gas with respect to the EGR path, and when the EGR path is substantially open, the actuator alters the position of the valve to close the exhaust path to increase the back pressure in the inlet and housing in order to increase the flow of exhaust gas through the EGR path.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

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EXHAUST THROTTLE-EGR VALVE MODULE FOR A DIESEL ENGINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/696,854, filed July 6, 2005 and U.S. Provisional Application No. 60/650,752, filed February 7, 2005.

FIELD OF THE INVENTION

The present invention relates to an exhaust gas module that directs exhaust gas to a plurality of outlets including at least one exhaust gas recirculation valve.

BACKGROUND OF THE INVENTION

Due to both federal and state regulations, motorized vehicles today are limited to the amount of emissions in which they can release during operation. One way of reducing the amount of emissions released by the vehicle is to include an exhaust gas recirculation (EGR) valve in the vehicle's exhaust system. The EGR valve redirects at least a portion of the exhaust gas from the exhaust gas manifold of the engine, so that the exhaust gas is recirculated into the intake manifold of the engine along with fresh air. The EGR valve is controlled by an actuator in order to control the amount of exhaust gas passing through the EGR valve. Furthermore, an exhaust gas throttle valve is placed in the vehicle's exhaust gas system which further controls the amount of exhaust gas that passes through an EGR path or through an exhaust pipe to exit the engine assembly. Thus, the EGR valve and the exhaust gas throttle both control the amount of exhaust gas returning to the intake side of the engine, but are separate components and are separately controlled.

Therefore, it would be desirable to develop a module which comprises both the EGR valve and the exhaust gas throttle valve, in which both the EGR valve and the exhaust gas throttle valve can be controlled by a single actuator. Due to being able to use a single actuator to control both the EGR valve and the exhaust gas throttle valve, the manufacturing process is more

efficient due to the reduction of the number of parts. Furthermore, the vehicle's exhaust system becomes more efficient due to having less connections and less parts in the exhaust system in which connections can become loose and cause leakage and pressure drops.

SUMMARY OF THE INVENTION

The present invention relates to an exhaust gas module comprising of a housing, at least one inlet in the housing, a plurality of outlets in the housing, an exhaust gas throttle inside the housing, an exhaust gas recirculation (EGR) valve inside the housing, wherein exhaust gas passes through the EGR valve when directed to a first outlet. A single actuator is used to control both the EGR valve and the exhaust gas throttle. Thus, the EGR valve is controlled by the actuator the majority of the time, and when the EGR valve is fully open, the actuator can alter the position of the exhaust gas throttle in order to increase the back pressure in the inlet and housing in order to increase the flow of exhaust gas through the EGR valve.

Furthermore, a method for controlling the amount of exhaust gas recirculation comprises the steps of the actuator receiving a signal from a control system, and the actuator altering the position of the EGR valve accordingly. Also included in the method for controlling the amount of exhaust gas recirculation includes all of the components described above, and the EGR valve being primarily controlled in order to control the amount of exhaust gas passing through the first outlet.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a perspective view of an exhaust throttle-exhaust gas recirculation module;

Figure 2 is a cross-sectional perspective view of a valve and a plurality of outlets in a preferred embodiment of the invention;

Figure 3 is a side cross-sectional view of the valve and plurality of outlets in an alternate embodiment of the invention;

Figure 4 is a schematic diagram of an exhaust gas recirculation system; and

Figure 5 is a block diagram of a method for controlling the flow of exhaust gas through a plurality of outlets using a single actuated valve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

Referring to Figures 1-3, an exhaust throttle-exhaust gas recirculation valve module (ETVM) is generally shown at 10. The ETVM 10 has a housing 12 with an inlet 14 and at least one outlet 16. In a preferred embodiment, the housing 12 has two outlets 16. The first outlet 16a is an exhaust gas recirculation (EGR) path and the second outlet 16b is an exhaust path. The housing 12 also contains valve 18 which is used to direct the flow of exhaust gas inside the housing 12 by being placed in different positions with respect to the EGR path 16a and the exhaust path 16b.

A single actuator 20 is used to control the valve 18. In a preferred embodiment, the actuator 20 is operably connected to an electric motor 22 so that the actuator 20 alters the position of the valve 18 in the desired position with respect to the EGR path 16a and the exhaust path 16b. The use of a single actuator 20 to control both the EGR path 16a and exhaust path 16b is beneficial because of the reduction in the number of parts needed to operate

the ETVM 10. For example, if the EGR path 16a and exhaust path 16b had separate actuators, there would be an additional actuator and an additional power source to operate the actuator in order to operate the ETVM 10. Thus, by using a single actuator 20 the manufacturing process is more efficient because less parts need to be produced and assembled.

In a preferred embodiment, the flow of the ETVM 10 is primarily controlled by the valve 18 being placed with respect to the EGR path 16a. Thus, as exhaust gas flows into the housing 12 through the inlet 14, the valve 18 as controlled by the actuator 20, directs the exhaust gas through either or both of the EGR path 16a and the EGR path 16b. When the valve 18 is positioned so that the EGR path is completely open, an amount of air flow passes through the EGR path 16a due to the back pressure in the housing 12 and inlet 14 created by the exhaust gas. However, to further increase the flow through the EGR path 16a, the actuator 20 closes the exhaust path 16b by repositioning the valve 18 to completely close the exhaust path 16b, which increases the back pressure in the housing 12 and inlet 14. This increase in back pressure causes a greater amount of exhaust gas flow through the EGR path 16a. Furthermore, the valve 18 is placed in any position where the valve 18 completely covers, partially covers, or does not cover the EGR path 16a and the exhaust path 16b, or any combination thereof, in order to obtain the desired amount of exhaust gas flowing through the EGR path 16a and the exhaust gas 16b.

Moreover, the valve 18 is positioned in order to fully close the EGR path 16a and partially or fully close the exhaust path 16b in order to raise the back pressure of the exhaust gas in the housing 12 and inlet 14. Raising the pressure of the exhaust gas in the housing 12 and inlet 14 is beneficial when the engine is being shut off or to raise the temperature of the exhaust gas in the system. As described above, the single actuator 20 is used to control the valve 18 in order to position the valve 18 with respect to the EGR path 16a and the exhaust path 16b. Raising the back pressure of the exhaust gas in this way is beneficial due to the increase in back pressure acting as an engine shut off. Thus, the increase in exhaust gas back pressure increases the

engine load which causes the engine to shut off. Furthermore, the raise in temperature of the exhaust gas is beneficial because the increased temperature acts as a catalyst to begin oxidation of the exhaust gas during low driving cycles.

In a preferred embodiment, the valve 18 is a disc that is angled with respect to the EGR path 16a and the exhaust path 16b. Thus, the valve 18 is operably connected to the actuator 20 and the valve rotates about the longitudinal axis of the housing 12 in order to block and expose the EGR path 16a and the exhaust path 16b as desired. The valve 18 has a semi-circle shape so that the valve 18 is capable of being placed as to completely block the EGR path 16a and the exhaust path 16b, completely open the EGR path 16a and the exhaust path 16b, partially open the EGR path 16a and exhaust path 16b, or any combination of the above positions. Furthermore, the valve 18 is angled in order to more efficiently direct the flow of exhaust gas to the desired location. Thus, the angle of the valve 18 is designed to reduce the amount of resistance applied to the exhaust gas from the valve 18.

Referring to Figure 3, in an alternate embodiment, the valve 18 rotates about a cross-sectional axis in order to close the EGR path 16a and exhaust path 16b as desired. Similar to the disc embodiment described above, the valve 18 is shaped as a flap so that the valve 18 is capable of being placed as to completely block the EGR path 16a and exhaust path 16b, completely open the EGR path 16a and exhaust path 16b, partially open the EGR path 16a and exhaust path 16b, or any combination of the above positions. In addition, the valve 18 is designed with an angle in order to reduce the amount of resistance applied to the exhaust gas by the valve 18.

Referring to Figures 1-4, an engine assembly including the ETVM 10 is generally shown at 24. An engine 26 has an exhaust gas manifold 28 where the exhaust gas from the engine is released, such that the exhaust gas passes through the exhaust gas manifold 28 to a turbine 30. The exhaust gas rotates the turbine 30. In a preferred embodiment, the exhaust gas then passes through a diesel particulate filter (DPF) 32 and into the ETVM 10. The inlet 14 of the housing 12 is directly connected to the outlet end of the DPF 32

in order to reduce the space occupied by the engine assembly 24. In addition, by having the direct connection between the ETVM 10 and the DPF 32 there is less leakage of exhaust gas due to the reduction in connection points, and which results in the prevention of a pressure drop of the exhaust gas, and simpler assembly due to the reduction in parts. In an alternate embodiment, the inlet end of the DPF 32 is directly connected to the EGR path 16a and exhaust path 16b, which is beneficial for the same reasons as described above.

No matter where the DPF 32 is located with respect to the ETVM 10, the exhaust gas that enters the ETVM 10 through the inlet 14 is directed to pass through one, both, or neither of the EGR path 16a and exhaust path 16b as described above. The exhaust gas that passes through the exhaust path 16b then flows through an exhaust pipe 34 and is discharged from the engine assembly 24. The exhaust gas that is directed through the EGR path 16a then passes through an EGR path 36 into an EGR cooler 38. After the exhaust gas has passed through the EGR cooler 38, the exhaust gas is combined with fresh air through an inlet 40. The mixture of exhaust gas and fresh air then enter a compressor 42 where the pressure of the air is increased. The compressor 42 is operably connected to the turbine 30, such that the exhaust gas that rotates turbine 30 causes the compressor 42 to rotate in order to increase the pressure of the mixture of exhaust gas and fresh air. Once the air has been compressed and exits the compressor 42, the air passes through a charge air cooler 44 in order to further reduce the temperature of the air. Then the air flows into an intake manifold 46 of the engine 26. In an alternate embodiment, the ETVM 10 is placed anywhere in the engine assembly 24 where it is beneficial to have an EGR valve and a control mechanism for altering the flow of exhaust gas controlled by a single actuator 20.

Referring to Figure 5, the method for controlling the amount of exhaust gas recirculation comprises the first step of the actuator 20 receiving a signal from a control system at decision box 48. In a preferred embodiment, the control system is an engine control unit (ECU) (not shown), and the ECU is

programmed to determine the desired valve 18 location and/or the air flow through the ETVM 10. In an alternate embodiment, the control unit is the actuator 20, which acts similar to the ECU described above in that the actuator 20 determines the desired location of the valve 18 and/or the air flow through the ETVM 10 and adjusts the valve accordingly. In either of the two embodiments described above, the ECU or the actuator 20 typically receives signals from position sensors (not shown) to determine the current location of the valve 18. However, in an alternate embodiment, a mass air flow sensor is used to determine the air flow through the ETVM 10 and the ECU or actuator 20 then determines the desired air flow and thus the valve 18 placement accordingly. Thus, any type of sensor is used so long as the adjustment to the ETVM 10 is determined to obtain the desired output from the ETVM 10.

After the actuator 20 has received a control signal, the actuator 20 alters the position of the valve 18 accordingly at decision box 50. Thus, depending on the amount of exhaust gas that is to be directly released from the engine assembly 24, the actuator 20 positions the valve 18 to direct exhaust gas through the EGR path 16a and the exhaust path 16b. Next, at decision box 52, it must be determined if the valve 18 is positioned such that the EGR path 16a is substantially open. If it is determined that the EGR path 16a is substantially open, then at decision box 54 the actuator 20 controls the valve 18 in order to further increase the amount of exhaust gas flowing through the EGR path 16a by closing the exhaust path 16b. However, if it is determined that the EGR path 16a is not substantially open, then at decision box 56 the actuator 20 continues to control the valve 18 in order to control the amount of exhaust gas flowing through the EGR path 16a and exhaust path 16b. After both decision box 54 and 56, the method for controlling the amount of exhaust gas recirculation returns to decision box 48 so that the actuator 20 receives a signal in order to further control valve 18.

In a preferred embodiment, it is determined if the EGR path 16a is substantially open prior to altering the valve 18 with respect to the exhaust path 16b because it is undesirable to increase the back pressure of the exhaust gas to increase the flow of exhaust gas through the EGR path 16a if

the EGR path 16a is not substantially open. Thus, if the EGR path 16a is not substantially open, the valve 18 is placed to open the EGR path 16a to increase the flow of exhaust gas through the EGR path 16a rather than increasing the back pressure. In a preferred embodiment, the valve 18 is placed so that the EGR path 16a is completely open prior to the valve 18 being placed with respect to the exhaust path 16b to alter the flow of exhaust gas through the EGR path 16a. However, it is within the scope of the invention to control the flow of exhaust gas through the EGR path 16a prior to the valve 18 completely opening the EGR path 16a.

The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system comprising the steps of:

providing a housing, wherein said housing has an inlet and at least one outlet;

providing an exhaust gas manifold of a vehicle directing exhaust gas into said inlet;

providing a valve inside said housing, wherein said valve is used to direct said exhaust gas to said at least one outlet;

providing a control unit that receives signals from at least one sensor, wherein said sensor determines vehicle conditions so that said control unit determines the position for said valve based upon said vehicle conditions; and

altering the position of said valve to control the flow of said exhaust gas through said at least one outlet, wherein said valve is inside said housing and said valve is controlled by a single actuator.

2. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 1, wherein said at least on outlet is a plurality of outlets, and a first outlet is an exhaust gas recirculation (EGR) path where said exhaust gas is recirculated and a second outlet is an exhaust path where said exhaust gas exits an exhaust gas system.

3. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 2, wherein the direction of said exhaust gas is primarily controlled by said valve with respect to said EGR path so that said EGR path is substantially open prior to said valve closing said exhaust path.

4. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 2 further comprising the step of altering the position of said valve in order to reduce the amount of said exhaust gas flowing through said second outlet in order to increase the backpressure of said exhaust gas in said inlet after said valve has substantially opened said EGR path, wherein the amount of said exhaust gas flowing through said EGR path is increased when compared to the amount of said exhaust gas flowing through said EGR path when said valve has substantially opened said EGR path prior to reducing the amount of said exhaust gas flowing through said second outlet.

5. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 1 further comprising the step of said exhaust gas passing through at least one filter, wherein said at least one filter is connected to at least one of said inlet and said outlet.

6. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 1, wherein said valve is a disc that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed, and said valve is angled with respect to said plurality of outlets in order to create a more aerodynamic surface for directing said exhaust gas to said plurality of outlets.

7. The method for controlling the amount of exhaust gas recirculation in an exhaust gas recirculation system of claim 1, wherein said valve is a two-plane flap that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed.

8. An exhaust gas module comprising:
a housing;

at least one inlet in said housing, wherein exhaust gas from an exhaust gas manifold of a vehicle enters said housing through said at least one inlet;

a plurality of outlets from said housing, wherein said exhaust gas exits said housing through said plurality of outlets;

a valve inside said housing, wherein said valve controls the amount of said exhaust gas that exits through said plurality of outlets; and

an actuator, wherein said actuator alters the position of said valve.

9. The exhaust gas module of claim 8, wherein said plurality of outlets has a first outlet that is an exhaust gas recirculation (EGR) path where said exhaust gas is recirculated, and a second outlet is an exhaust path where said exhaust gas exits an exhaust gas system.

10. The exhaust gas module of claim 9, wherein when said valve is positioned so that said EGR path is substantially open said valve is positioned to close said exhaust path in order to reduce the amount of said exhaust gas flowing through said exhaust path in order to increase a backpressure in said inlet, such that the amount of said exhaust gas flowing through said EGR path is increased

11. The exhaust gas module of claim 8, wherein said actuator is operable connected to an electric motor, such that said electric motor powers said actuator to control said exhaust gas throttle valve and said EGR valve.

12. The exhaust gas module of claim 8, wherein the direction of said exhaust gas is primarily controlled by said valve with respect to said EGR path so that said EGR path is substantially open prior to said valve closing said exhaust path.

13. The exhaust gas module of claim 8 further comprising at least one filter is connected to at least one of said inlet and said outlet, wherein said exhaust gas passes through said at least one filter.

14. The exhaust gas module of claim 8, wherein said valve is a disc that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed, and said valve is angled with respect to said plurality of outlets in order to create a more aerodynamic surface for directing said exhaust gas to said plurality of outlets.

15. The exhaust gas module of claim 8, wherein said valve is a two-plane flap that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed.

16. An exhaust gas module comprising:

a housing;

at least one inlet in said housing, wherein exhaust gas from an exhaust gas manifold of an engine system enters said housing through said at least one inlet;

a plurality of outlets from said housing so that said exhaust gas exits said housing through said plurality of outlets, wherein a first outlet is an exhaust gas recirculation (EGR) path where said exhaust gas is recirculated and a second outlet is an exhaust path where said exhaust gas exits an exhaust gas system;

a filter, wherein said filter is connected to at least one of said inlet and said outlet so that said exhaust gas passes through said filter;

a valve inside said housing, wherein said valve controls the amount of said exhaust gas that passes through said EGR path and said exhaust path, and said valve primarily controls flow of said exhaust gas with respect to said EGR path; and

an actuator, wherein said actuator controls said valve.

17. The exhaust gas module of claim 16, wherein said actuator is operably connected to an electric motor, such that said electric motor powers said actuator to control said exhaust gas throttle valve and said EGR valve.

18. The exhaust gas module of claim 16, wherein the direction of said exhaust gas is primarily controlled by said valve, such that when said EGR path is substantially open the position of said valve is altered in order to reduce the amount of said exhaust gas flowing through said exhaust path in order to increase a backpressure in said inlet so that the amount of said exhaust gas flowing through said EGR path is increased.

19. The exhaust gas module of claim 16, wherein said valve is a disc that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed, and said valve is angled with respect to said plurality of outlets in order to create a more aerodynamic surface for directing said exhaust gas to said plurality of outlets.

20. The exhaust gas module of claim 16, wherein said valve is a two-plane flap that is shaped so that said valve is capable of being positioned so that said plurality of outlets are fully open and fully closed.

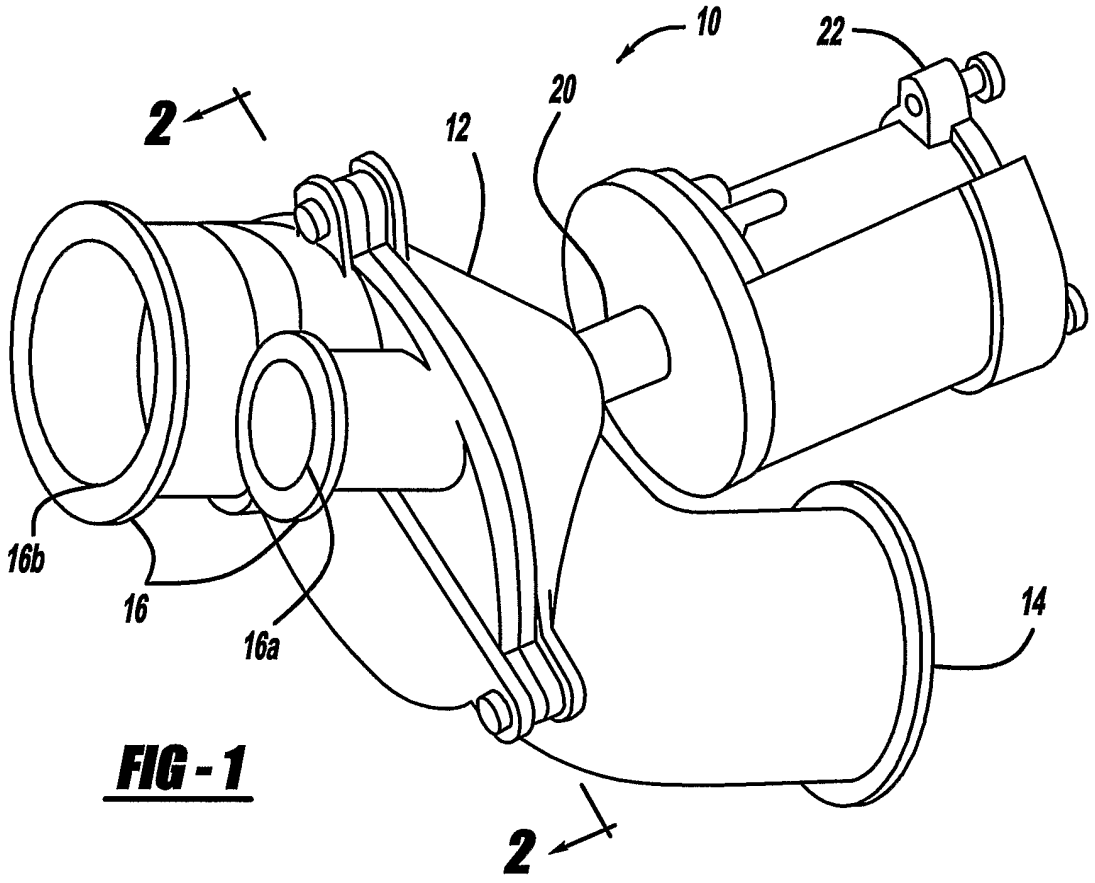


FIG - 1

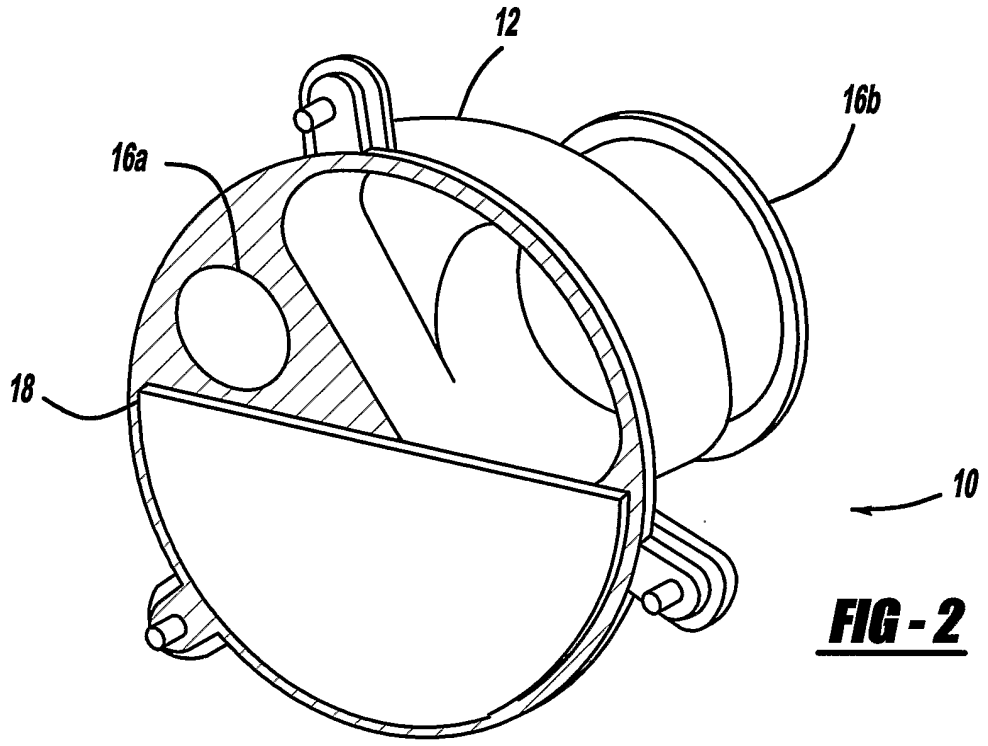


FIG - 2

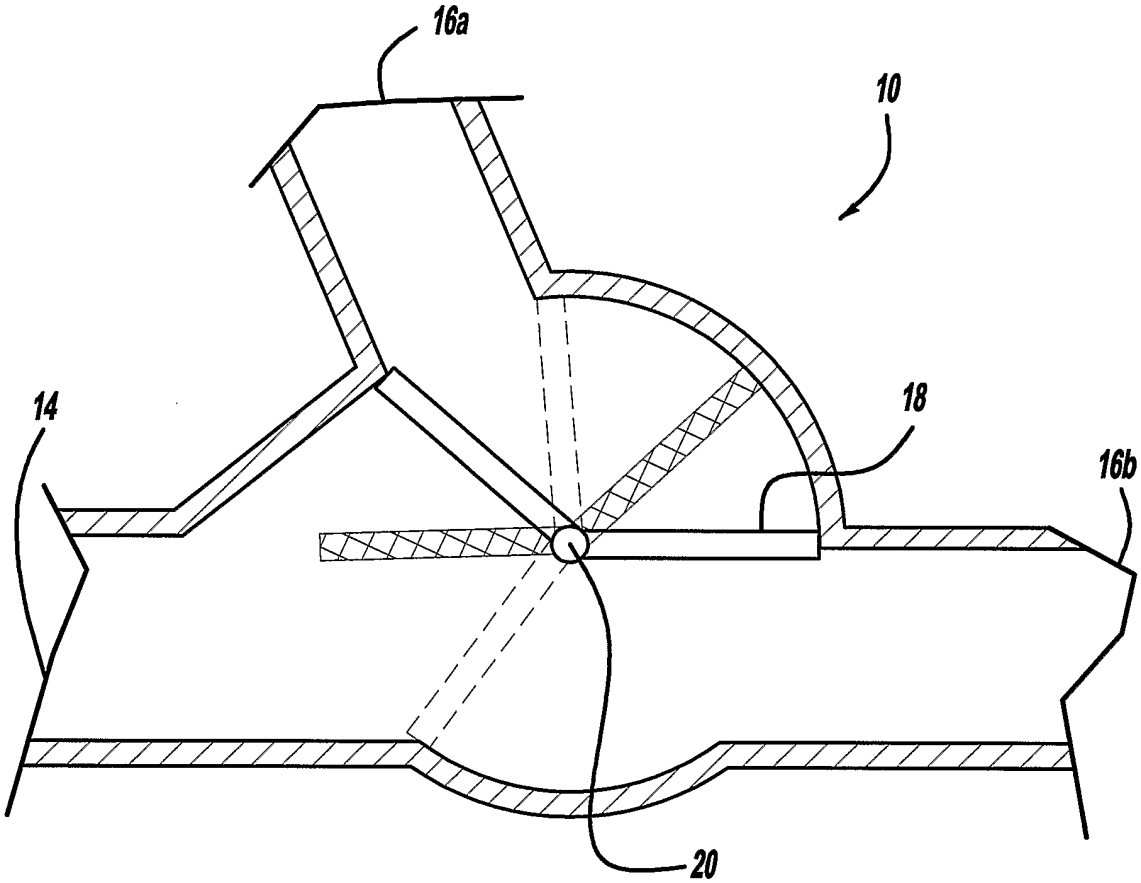


FIG - 3

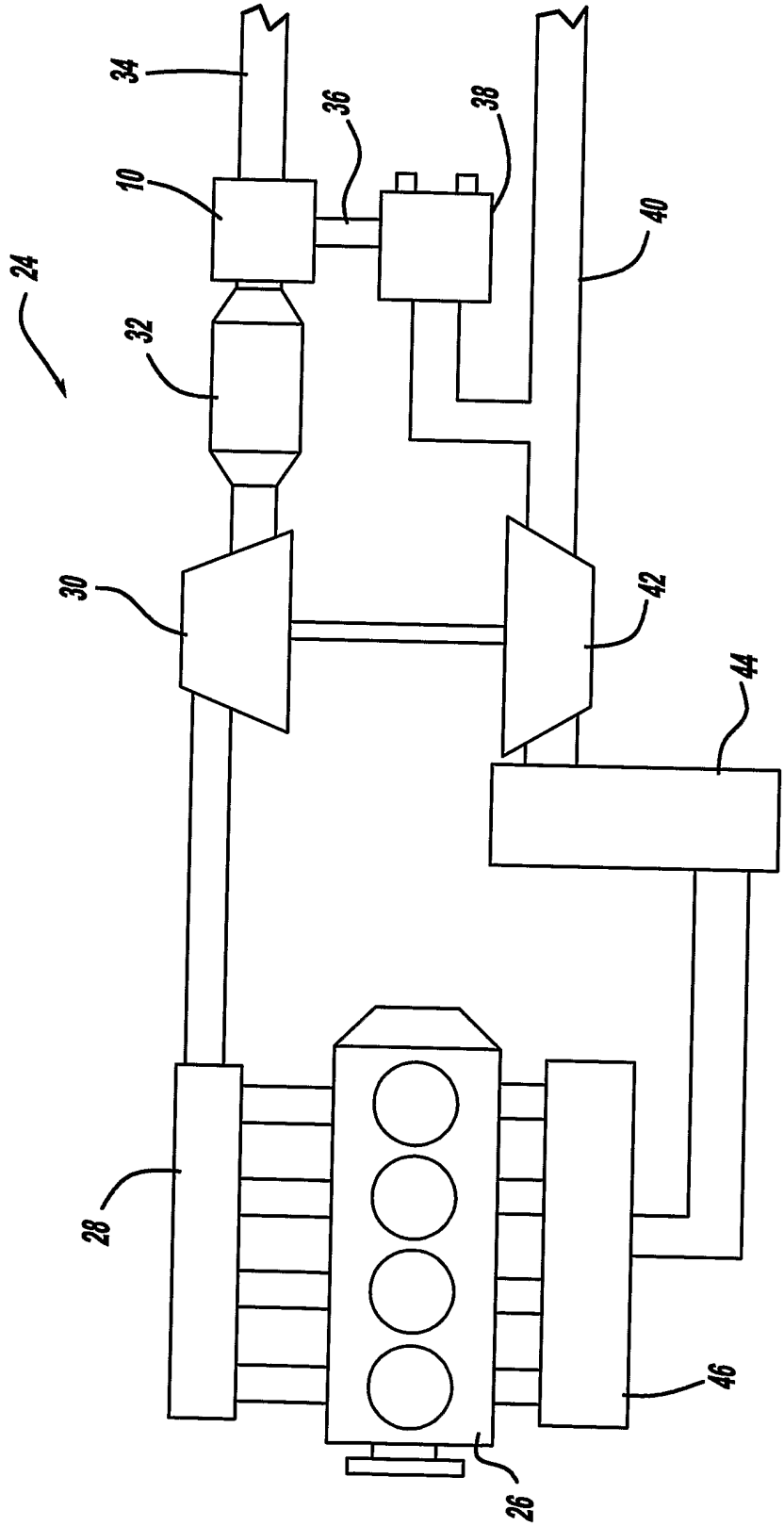
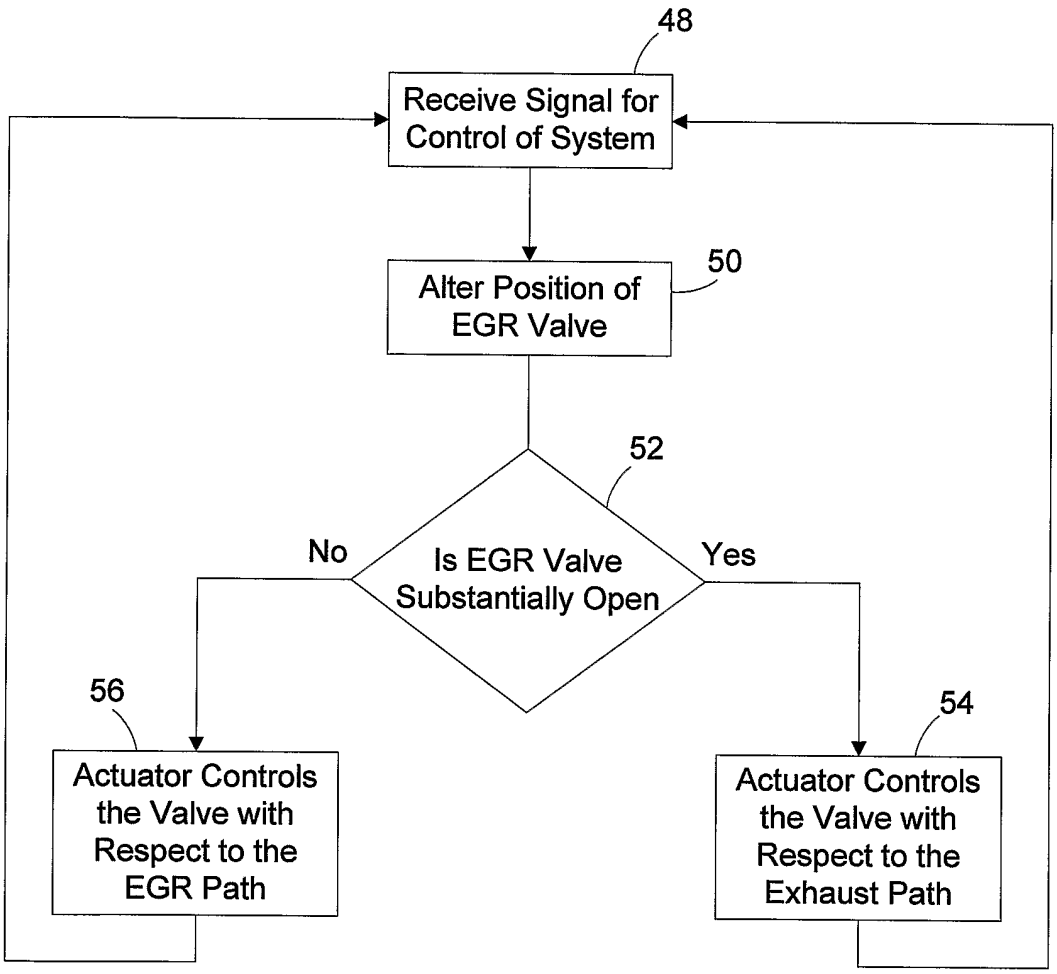


FIG-4

FIG - 5


48
Receive Signal for Control of System
Alter Position of EGR Valve
50
52
Is EGR Valve Substantially Open
No
Yes
56
Actuator Controls the Valve with Respect to the EGR Path
54
Actuator Controls the Valve with Respect to the Exhaust Path

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/004345

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02M25/07

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)
F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 00/42305 A (BORG-WARNER AUTOMOTIVE, INC) 20 July 2000 (2000-07-20) page 13, line 10 - page 14, line 17; figures 1,2a-c	1-4,6, 8-12,14 5,13, 16-19
Y A	EP 1 420 159 A (ISUZU MOTORS LIMITED) 19 May 2004 (2004-05-19) paragraphs [0025] - [0033]; figure 1	5,13, 16-19 1,2,8,9
X A	US 6 000 222 A (REGNIER ET AL) 14 December 1999 (1999-12-14) column 2, line 55 - column 4, line 21; figures 1,2	1-3, 8-10,12 11,16-18

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/004345

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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