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(54) Exhaust gas recirculating system for internal combustion engines

Abgasrückführungssystem für eine Brennkraftmaschine

Système de recirculation de gaz d'échappement pour un moteur à combustion interne

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Description

TECHNICAL FIELD

[0001] The present invention relates to an exhaust gas recirculating system according to the preamble of claim 1 for internal combustion engines, and in particular to an exhaust gas recirculating system that can reduce the emission of unburnt hydrocarbons (HC), nitrogen oxides (NOx) and soot (PM).

BACKGROUND OF THE INVENTION

[0002] It is known that NOx which is known as an undesirable content of the exhaust gas expelled from a combustion chamber of an engine can be reduced by recirculating part of the exhaust gas to the intake system and lowering the combustion temperature of the mixture in the combustion chamber. However, the composition of the exhaust gas from the combustion chamber varies depending on the temperature of the exhaust gas that is recirculated to the intake system (EGR). For instance, hot EGR has the advantage of reducing both HC and NOx, but has the disadvantage of increasing the emission of PM in medium to highly load operating ranges where the intake air temperature is high. On the other hand, cold EGR had the advantage or reducing both NOx and PM but the disadvantage of increasing HC.

[0003] To overcome this dilemma and reduce the emission of HC, NOx and PM over a wider engine operating range, Japanese patent laid-open publication No. 6-288306 proposes an exhaust gas recirculating system (EGR system) that comprises a passage including an intercooler (cooler passage) and a passage not including an intercooler (bypass passage) between an exhaust passage and an intake passage in a mutually parallel relationship, and a switching valve provided in a branch point of the two passages to selectively communicate one of the them depending on the operating condition of the engine.

[0004] However, according to this previous proposal, because the valve stem of the switching valve and the solenoid for actuating the valve stem are located so as to be directly exposed to the exhaust gas of high temperature, the movement of the valve stem could be impaired by deposition of PM thereon and it is difficult to ensure a high operation stability for other reasons.

[0005] Document FR 2 827 011 discloses an exhaust gas recirculating system according to the preamble of claim 1, wherein a cooler port valve member and a bypass port valve member are formed s6parately-of the valve stem.

[0006] Document DE 100 25.877 A1 discloses an exhaust gas recirculation system, wherein two separate valves are provided for opening and closing a cooler passage and a bypass passage, respectively, with the valve stem of the valve opening and closing the cooler passage being passed inside the valve stem of the valve opening and closing the bypass passage.

BRIEF SUMMARY OF THE INVENTION

[0007] In view of such problems of the prior art, a primary object of the present invention is to provide an EGR system which can selectively cool the EGR depending on the operating condition of the engine, and is provided with a switching valve having an improved operating stability.

[0008] A second object of the present invention is to provide an EGR system using a switching valve which is highly compact in design and durable in use.

[0009] According to the present invention, at least some of the objects can be accomplished by providing an exhaust gas recirculating system for internal combustion engines according to claim 1, comprising a cooler passage (13b) provided with an EGR cooler (14), a bypass passage (13a) extending in parallel with the cooler passage, a switching valve (15) provided in a branch point of the two passages for selectively communicating one of the two passages with an exhaust manifold (5), downstream ends of the cooler passage and bypass passage merging at another branch point and communicating with an intake manifold (4), wherein the switching valve comprises a valve body including an inlet port (26) communicating with the exhaust manifold, an actuator (16) provided in association with the valve body, a valve stem (32) including a first end formed with a poppet valve member (18), a second end connected to the actuator 16) and an intermediate portion slidably guided by a part (34) of the valve body, a cooler port valve seat (29b) provided in the valve body for cooperation with the poppet valve member and communicating with the cooler passage and a bypass port valve seat (29a) provided in the valve body for cooperation with the poppet valve member and communicating with the bypass passage, wherein the bypass port valve seat is located adjacent to the actuator and the cooler port valve seat is located remote from the actuator, with respect to the inlet port.

[0010] The cooler passage typically conducts EGR of high temperature during normal operation of the engine while the bypass passage conducts EGR of low temperature when warming up the engine. According to the present invention, because the bypass port valve seat is located adjacent to the actuator and the cooler port valve seat is located remote from the actuator, with respect to the inlet port, the thermal load on the actuator can be minimized. Also, because this arrangement allows the valve stem of the poppet valve member not to be exposed to the EGR of high temperature flowing into the cooler passage, the thermal load on the actuator and associated seal members can be minimized. These factors contribute to the improvement of the durability and operation stability of the switching valve. The actuator typically consists of a diaphragm actuator which may not be able to withstand excessive thermal load.

[0011] Typically, owing to the presence of the EGR cooler, the cooler passage presents a greater flow resistance to EGR than the bypass passage which may consist of a simple tube. Therefore, if the cooler port valve seat has a greater diameter than the bypass port valve seat, the flow rates of the two passages can be made even or distributed as desired for the given valve lift, and the flow control when switching over the two passages can be facilitated.

[0012] According to a preferred embodiment of the present invention, the poppet valve member comprises a cooler port valve member and a bypass port valve member which are separated from each other by a part from which material is removed or are joined to each other solely by a central piece having a substantially small diameter in a mutually separated relationship. Thereby, the resistance to the flow of EGR around the poppet valve member can be reduced and the inertia of the poppet valve member can be also reduced so that the responsiveness of the switching valve can be improved and the impact at the time of the valve member hitting the valve seat can be minimized.

[0013] According to a certain aspect of the present invention, the poppet valve member is actuated in such a manner that the inlet port communicates with the bypass passage when the engine is warming up and with the cooler passage after the engine is warmed up. Therefore, EGR is allowed to flow the bypass passage which is adjacent to the actuator and faces an exposed part of the valve stem only when the engine is warming up or when the exhaust temperature is relatively low and the cooler passage which is remote from the actuator and does not face an exposed part of the valve stem when the engine is warmed up and the exhaust temperature is relatively high. Therefore, the exposed part of the valve stem is exposed to the EGR only for a short period of time when the engine is warming up, and ceases to be in contact with the EGR once the engine is warmed up or during the normal operation of the engine. This prevents deposition of HC and PM on the valve stem, and reduces the thermal load on the internal components of the actuator and seal members that are typically included in the valve body for preventing the leakage of EGR. HC is produced mostly when the engine is warming up and the emission of HC reduces once the engine is warmed up. Therefore, deposition of HC on the EGR cooler can also be avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Now the present invention is described in the following with reference to the appended drawings, in which:

- Figure 1 is a diagram of an essential part of an engine embodying the present invention;
- Figure 2 is a perspective view of the EGR system mounted on the engine;
- Figure 3 is a vertical sectional view of the EGR valve; and
- Figure 4 is a vertical sectional view of the switching valve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Figure 1 is a simplified diagram of an essential part of a diesel engine incorporated with an EGR system embodying the present invention. This engine 1 comprises an intake port 2 and an exhaust port 3 that are connected to an intake manifold 4 and an exhaust manifold 5, respectively. The intake manifold 4 is further connected to an outlet 8 of a compressor of a turbocharger 7 which is in turn connected to an air cleaner 6. The exhaust manifold 5 is further connected to an inlet 9 of a turbine of the turbocharger 7.

[0016] The EGR system 10 comprises an EGR passage system 13 having an upstream end connected to the exhaust manifold 5 via a through hole 11 formed in the cylinder head and EGR pipes 12a and 12b connected to the through hole 11 and a downstream end connected to the intake manifold 4 via yet another EGR pipe 12c. As shown in Figure 2, the EGR passage system 13 extends along a lateral side of the engine 1 in parallel with the lengthwise direction of the cylinder bank.

[0017] An intermediate part of the EGR passage system 13 is provided with a cooler passage 13b including an EGR cooler 14 and a bypass passage 13a consisting of a simple passage that extend in a mutually parallel relationship. An upstream branch point of these two passage 13a and 13b is provided with a switch valve 15 for selectively communicating one of the two passages 13a and 13b at the upstream branch point.

[0018] The switch valve 15 is connected to a diaphragm actuator 16 of a per se known type controlled by a solenoid valve 17. The switch valve 15 comprises a poppet valve member 18 that changes position depending on the energized/deenergized state of a solenoid of the solenoid valve 17 so that the EGR forwarded from the exhaust manifold 5 flows into a selected one of the bypass passage 13a and cooler passage 13b.

[0019] Immediately downstream of the branch point at which the bypass passage 13a and cooler passage 13b merge together is provided with an EGR valve 19 for adjusting the amount of EGR supplied to the intake manifold 4. As shown in Figure 3, this EGR valve 19 comprises a poppet valve member 21 connected to a diaphragm actuator 20 of a per se known type controlled by a solenoid valve 22. By continuously varying the negative pressure supplied to a negative pressure chamber 20a of the diaphragm actuator 20 by performing a duty ratio control on a solenoid of the solenoid valve 22, the opening degree of the poppet member 21 connected to a diaphragm 20b of the diaphragm actuator 20 can be continuously varied so that the amount of EGR supplied to the intake manifold 4 via the EGR passage system 13 can be controlled accordingly.

[0020] The EGR system 10 is additionally provided with an ECU 23 including a microprocessor, memory and input/output circuits for controlling the operation of the switching valve 15 and EGR valve 19 via the solenoid valves 17 and 22 depending on the operating state of the engine 1. The ECU 23 receives data on the flow rate of the fresh air that flows into the engine 1 via the air cleaner 6 measured by a flow rate sensor 24 and the temperature of the cooling water that flows through the water jacket of the engine measured by a water temperature sensor 25, and controls the operation of the solenoid valves 17 and 22 associated with the switching valve 15 and EGR valve 19, respectively.

[0021] In the illustrated embodiment, when the temperature of the engine cooling water measured by the water temperature sensor 25 is below a prescribed value, the ECU 23 judges that the engine 1 is still cold and warming up, and switches the switching valve 15 so that the inlet port 26 communicates with the bypass passage 13a. When the temperature of the engine cooling water exceeds a prescribed value, the ECU 23 judges that the engine has already warmed up, and switches the switching valve 15 so that the inlet port 26 communicates with the cooler passage 13b.

[0022] The structure of the switching valve 15 is now described in the following with reference to Figure 4. An intermediate part of the switching valve 15 is provided with the inlet port 26 which communicates with the exhaust manifold 5 via the EGR pipe 12b. The chamber defining the inlet port 26 is provided with a bypass port 27 communicating with the bypass passage 13a in an upper part thereof and a cooler port 28 communicating with the cooler passage 13b in a lower part thereof. The bypass port 27 and cooler port 28 are provided with valve seats 29a and 29b, respectively, that are disposed above and below the inlet port 26 in a mutually coaxial relationship.

[0023] The switching valve 15 comprises a poppet valve member 18 as an essential element as mentioned above, and this poppet valve member 18 includes an upper valve member 30 for selectively closing the valve seat 29a of the bypass port 27 and a lower valve member 31 for selectively closing the valve seat 29b of the cooler port 28. The upper and lower valve members 30a and 31b are integrally formed in a lower part of a common valve stem 32 whose upper end is slidably guided by a slide guide 34 fitted with a seal member 33, and the upper end of the valve stem 32 is connected to the diaphragm actuator 16. The material of the part of the poppet valve member located between the upper and lower valve members 30a and 31b is removed by machining. This machined portion 35 not only reduces the resistance to the flow of EGR around the poppet valve member but also reduces the inertia mass of the poppet valve member so that the responsiveness of the valve is improved and the impact of the valve member as it hits the valve seat can be reduced.

[0024] In the illustrated embodiment, the upper and lower valve members 30a and 31b are integrally formed with the valve stem 32 as a one-piece member by forging and/or machining, but it is also possible to form this assembly by joining separate pieces. In such a case, instead of providing a machined portion 35, the upper and lower valve members 30a and 31b would be joined by a central piece having a substantially small diameter, which may or may not be a part of the valve stem, in a mutually spaced relationship.

[0025] The diaphragm actuator 16 for actuating the valve stem 32 of the switching valve 15 is of a per se known type, and defines a vacuum chamber 38 above a diaphragm 36 and an atmospheric chamber 37 below the diaphragm 36. A coil spring 39 resiliently urges the diaphragm 36 in the direction to expand the negative pressure chamber 37, and this actuates the valve stem 32 downwards. When the on/off solenoid valve 17 provided in a negative pressure passage 40 for selectively introducing the intake passage negative pressure at the upstream end of the turbocharger 7 into the negative pressure chamber 37 is opened, the valve stem 32 is actuated upward. Thereby, the inlet port 26 can be selectively communicated with one of the bypass port 27 and cooler port 28.

[0026] The EGR cooler 14 provided in the cooler passage 13b may comprise, for instance, a hollow cylindrical member having both ends closed and a plurality of runs of a heat dissipation tube extending inside the cylindrical member in parallel with the axial direction. Cooling water from the radiator is introduced into the cylindrical member from an axial end thereof, and the cooling water expelled from the opposite axial end of the cylindrical member flows into a cooling water jacket of the cylinder block of the engine 1 while the EGR is conducted through the heat dissipation tube. The outlet 43 of the cooling water is directly connected to the cylinder block of the engine 1 in the illustrated embodiment.

[0027] If EGR is continued to be supplied to the EGR cooler 14 when the engine is cold (warming up), because the combustion does not take place in a stable manner and the emission of HC is relatively large, the heat dissipation tube in the EGR cooler 14 may be clogged up by the HC causing a reduction in the cooling efficiency and the poppet valve member 21 of the EGR valve 19 may be seized up or get stuck to the valve seat causing a loss in the control of the flow rate of EGR. To avoid such problems, it is necessary to increase the cooling capacity of the EGR cooler 14 and to take a suitable measure to avoid the seizure of the EGR valve 19.

[0028] Based on this consideration, according to the present invention, EGR is allowed to flow through the bypass passage 13a and is not cooled when the engine is warming up and the HC emission is relatively large so that the clogging of the EGR cooler by HC can be avoided. Furthermore, because the combustion is prevented from becoming unstable owing to the controlled supply of the EGR, NOx can be reduced even further.

[0029] Meanwhile, the switching valve 15 through which EGR of high temperature flows when the engine is warm is required to be able to withstand a high thermal load, and present as little a flow resistance as possible. According to the present invention, it is when the engine is warming up and the EGR is therefore relatively low in temperature that the EGR passes through the bypass passage 13a. Furthermore, the time duration in which the EGR flows through the bypass passage 13a is relatively short. Therefore, in the illustrated embodiment, the bypass valve seat 29a and bypass passage 13a are disposed in the switching valve 15 so as to be adjacent to the seal member 33 and diaphragm 36. Thereby, the thermal load on the valve stem 32, seal member 33 and diaphragm 36 is relatively light.

[0030] On the other hand, the cooler passage 13b through which EGR of relatively high temperature passes when the engine is warm is disposed in the switching valve 15 remote in position from the seal member 33 and diaphragm 36. Furthermore, the valve stem 32 is disposed so as not to be exposed to the EGR. Therefore, the EGR valve would not be adversely affected by the transfer of heat.

[0031] The cooler passage 13b has a relatively high flow resistance owing to the presence of the EGR cooler 14, but the bypass passage 13a has a small flow resistance as it consists of a simple tube. Therefore, by selecting the diameters of the valve seats 29a and 29b indicated by A and B, respectively, in Figure 4 such that B (cooler side) > A (bypass side) for the given lift/flow rate property of the EGR valve regardless of when communicating the bypass passage 13a or when communicating the cooler passage 13b, the flow control by the EGR valve 19 can be simplified without increasing the valve lift of the switching valve 15. If desired, the overall flow resistances of the bypass passage 13a and cooler passage 13b can be made substantially equal to each other by suitably selecting the diameters of the two valve seats 29a and 29b.

[0032] Although the present invention has been described in terms of a preferred embodiment thereof, it is obvious to a person skilled in the art that various alterations and modifications are possible without departing from the scope of the present invention which is set forth in the appended claims. For instance, a diaphragm actuator was used for the switching valve in the illustrated embodiment, but it may also consist of actuators of other types such as a solenoid, electric motor and so on.

[0033] Provided is an EGR system which can selectively cool the EGR depending on the operating condition of the engine, and is provided with a switching valve having an improved operating stability. The switching valve comprises a valve stem 32 including a first end formed with a poppet valve member 18, a second end connected to a diaphragm actuator 16 and a slidably guided intermediate portion, a cooler port valve seat 29b communicating with the cooler passage and a bypass port valve seat 29a communicating with the bypass passage. The bypass port valve seat is located adjacent to the diaphragm actuator and the cooler port valve seat is located remote from the diaphragm actuator, with respect to an inlet port 26 communicating with the exhaust manifold.

Claims

1. An exhaust gas recirculating system for internal combustion engines, comprising a cooler passage (13b) provided with an EGR cooler (14), a bypass passage (13a) extending in parallel with the cooler passage, a switching valve (15) provided in a branch point of the two passages for selectively communicating one of the two passages with an exhaust manifold (5), downstream ends of the cooler passage and bypass passage merging at another branch point and communicating with an intake manifold (4), ,
   wherein the switching valve comprises a valve body including an inlet port (26) communicating with the exhaust manifold, an actuator (16) provided in association with the valve body, a valve stem (32) including a first end formed with a poppet valve member (18), a second end connected to the actuator (16) and an intermediate portion slidably guided by a part (34) of the valve body, a cooler port valve seat (29b) provided in the valve body for cooperation with the poppet valve member and communicating with the cooler passage and a bypass port valve seat (29a) provided in the valve body for cooperation with the poppet valve member (18) and communicating with the bypass passage (13a),
   the bypass port valve seat (29a) being located adjacent to the actuator (16) and the cooler port valve seat (29b) being located remote from the actuator (16), with respect to the inlet port,
   characterized in that the poppet valve member (18) comprises a cooler port valve member (31) and a bypass port valve member (30) which are integral with the valve stem (32).

2. The exhaust gas recirculating system for internal combustion engines according to claim 1, wherein the cooler port valve seat (29b) has a greater diameter than the bypass port valve seat (29a).

3. The exhaust gas recirculating system for internal combustion engines according to claim 1, wherein the cooler port valve member (31) and the bypass port valve member (30) are separated from each other by a part from which material is removed.

4. The exhaust gas recirculating system for internal combustion engines according to claim 1, wherein the cooler port valve member (31) and the bypass port valve member (30) are joined to each other solely by a central piece (35) having a substantially small diameter.

5. The exhaust gas recirculating system for internal

combustion engines according to claim 1, wherein the actuator (16) consists of a diaphragm actuator (16).

6. The exhaust gas recirculating system for internal combustion engines according to claim 1, wherein the poppet valve member (18) is actuated in such a manner that the inlet port (26) communicates with the bypass passage (13a) when the engine is warming up and with the cooler passage (13b) after the engine is warmed up.

Patentansprüche

1. Abgasrezirkulationssystem für Verbrennungsmotoren, umfassend einen Kühlerdurchgang (13b), der mit einem AGR-Kühler (14) versehen ist, einen Bypass-Durchgang (13a), der parallel zu dem Kühlerdurchgang verläuft, ein Schaltventil (15), das an einem Verzweigungspunkt der beiden Durchgänge vorgesehen ist, um selektiv einen der beiden Durchgänge mit einem Abgaskrümmer (5) zu verbinden, wobei stromabwärtige Enden des Kühlerdurchgangs und des Bypass-Durchgangs an einem weiteren Verzweigungspunkt zusammenlaufen und mit einem Einlasskrümmer (4) in Verbindung stehen,
wobei das Schaltventil einen Ventilkörper umfasst, umfassend einen Einlassanschluss (26), der mit dem Abgaskrümmer in Verbindung steht, einen Aktuator (16), der in Zuordnung zu dem Ventilkörper vorgesehen ist, einen Ventilschaft (32), umfassend ein erstes Ende, das mit einem Tellerventilelement (18) gebildet ist, ein zweites Ende, das mit dem Aktuator (16) verbunden ist, und einen mittleren Abschnitt, der durch einen Teil (34) des Ventilkörpers verschiebbar geführt ist, wobei ein Kühleranschluss-Ventilsitz (29b) in dem Ventilkörper für ein Zusammenwirken mit dem Tellerventilelement vorgesehen ist und mit dem Kühlerdurchgang in Verbindung steht, und ein Bypass-Anschluss-Ventilsitz (29a) in dem Ventilkörper für ein Zusammenwirken mit dem Tellerventilelement (18) vorgesehen ist und mit dem Bypass-Durchgang (13a) in Verbindung steht,
wobei, bezogen auf den Einlassanschluss, der Bypass-Anschluss-Ventilsitz (29a) neben dem Aktuator (16) angeordnet ist und der Kühleranschluss-Ventilsitz (29b) von dem Aktuator entfernt angeordnet ist,
dadurch gekennzeichnet, dass das Tellerventilelement (18) ein Kühleranschluss-Ventilelement (31) und ein Bypass-Anschluss-Ventilelement (30) umfasst, welche integral mit dem Ventilschaft (32) ausgebildet sind.

2. Abgasrezirkulationssystem für Verbrennungsmotoren nach Anspruch 1, wobei der Kühleranschluss-Ventilsitz (29b) einen größeren Durchmesser aufweist als der Bypass-Anschluss-Ventilsitz (29a).

3. Abgasrezirkulationssystem für Verbrennungsmotoren nach Anspruch 1, wobei das Kühleranschluss-Ventilelement (31) und das Bypass-Anschluss-Ventilelement (30) voneinander durch einen Teil getrennt sind, von dem Material entfernt ist.

4. Abgasrezirkulationssystem für Verbrennungsmotoren nach Anspruch 1, wobei das Kühleranschluss-Ventilelement (31) und das Bypass-Anschluss-Ventilelement (30) miteinander nur durch ein Mittelstück (35) verbunden sind, welches einen im Wesentlichen kleinen Durchmesser aufweist.

5. Abgasrezirkulationssystem für Verbrennungsmotoren nach Anspruch 1, wobei der Aktuator (16) aus einem Membranaktuator (16) besteht.

6. Abgasrezirkulationssystem für Verbrennungsmotoren nach Anspruch 1, wobei das Tellerventilelement (18) derart betätigt wird, dass der Einlassanschluss (26) mit dem Bypass-Durchgang (13a) in Verbindung steht, wenn der Motor aufgewärmt wird, und mit dem Kühlerdurchgang (13b), nachdem der Motor aufgewärmt ist.

Revendications

1. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne, comprenant un passage de refroidissement (13b) pourvu d'un dispositif de refroidissement EGR (14), un passage de dérivation (13a) s'étendant parallèlement au passage de refroidissement, une vanne de commutation (15) prévue en un point de branchement des deux passages pour mettre en communication, de manière sélective, l'un des deux passages avec un collecteur d'échappement (5), les extrémités aval du passage de refroidissement et du passage de dérivation se rencontrant en un autre point de branchement et communiquant avec un collecteur d'admission (4),
dans lequel la vanne de commutation comprend un corps de vanne comprenant un orifice d'entrée (26) communiquant avec le collecteur d'échappement, un actionneur (16) prévu en association avec le corps de vanne, une tige de soupape (32) comprenant une première extrémité comportant un élément de soupape champignon (18), une deuxième extrémité reliée à l'actionneur (16) et une partie intermédiaire guidée de manière coulissante par une partie (34) du corps de vanne, un siège de soupape d'orifice de refroidissement (29b) prévu dans le corps de vanne pour coopérer avec l'élément de soupape champignon et communiquant avec le passage de refroidissement et un siège de soupape d'orifice de dérivation (29a) prévu dans le corps de vanne pour

coopérer avec l'élément de soupape champignon (18) et communiquant avec le passage de dérivation (13a),
le siège de soupape d'orifice de dérivation (29a) étant situé adjacent à l'actionneur (16) et le siège de soupape d'orifice de refroidissement (29b) étant situé à distance de l'actionneur (16), par rapport à l'orifice d'entrée,
caractérisé en ce que l'élément de soupape champignon (18) comprend un élément de soupape d'orifice de refroidissement (31) et un élément de soupape d'orifice de dérivation (30) qui font partie intégrante de la tige de soupape (32).

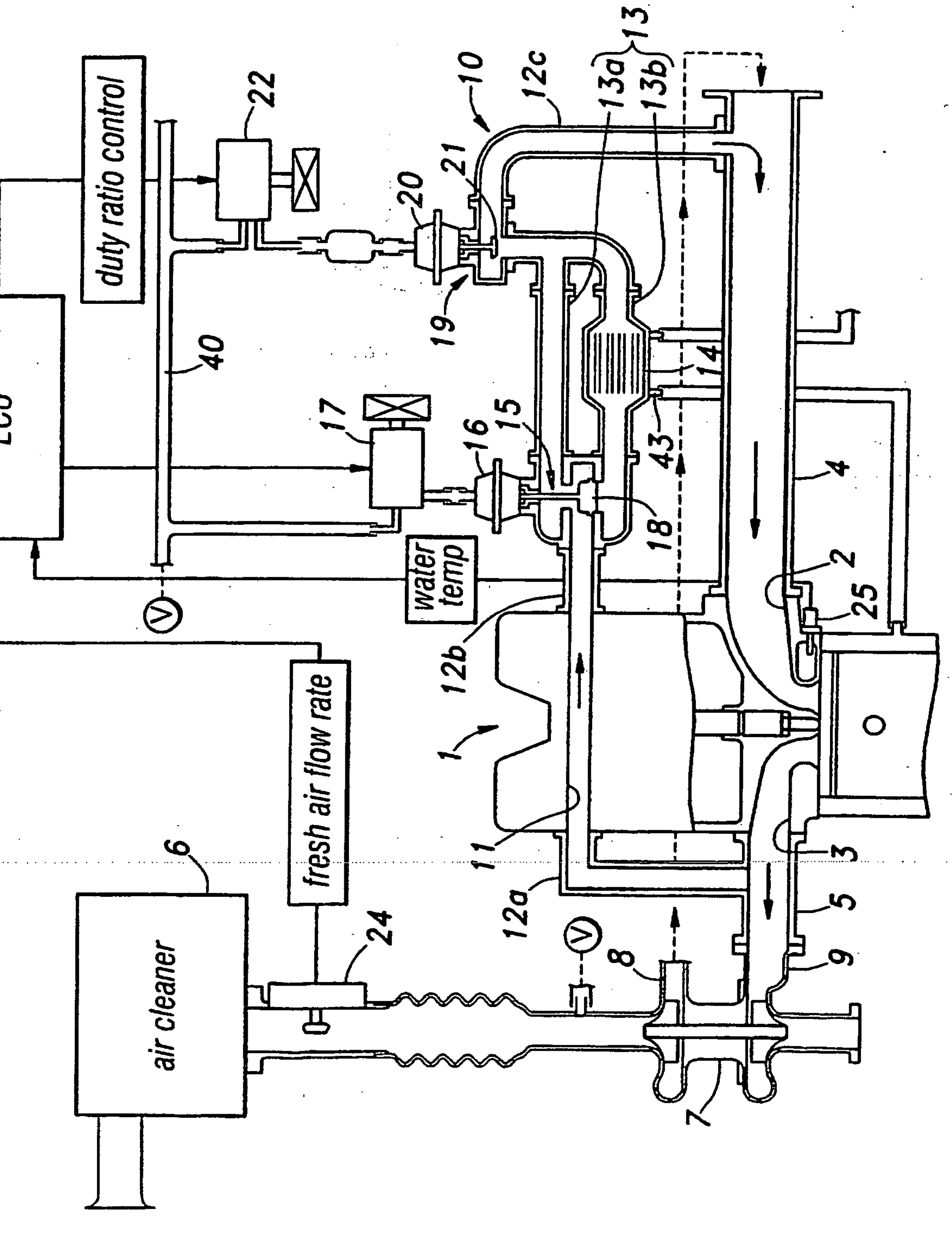
2. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel le siège de soupape d'orifice de refroidissement (29b) a un plus grand diamètre que le siège de soupape d'orifice de dérivation (29a).

3. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel l'élément de soupape d'orifice de refroidissement (31) et l'élément de soupape d'orifice de dérivation (30) sont séparés l'un de l'autre par une partie de laquelle de la matière est enlevée.

4. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel l'élément de soupape d'orifice de refroidissement (31) et l'élément de soupape d'orifice de dérivation (30) sont joints l'un à l'autre uniquement par une pièce centrale (35) ayant un diamètre sensiblement petit.

5. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel l'actionneur (16) consiste en un actionneur à membrane (16).

6. Système de recirculation de gaz d'échappement pour des moteurs à combustion interne selon la revendication 1, dans lequel l'élément de soupape champignon (18) est actionné de manière à ce que l'orifice d'entrée (26) communique avec le passage de dérivation (13a) lorsque le moteur chauffe et avec le passage de refroidissement (13b) lorsque le moteur est chaud.



air cleaner
fresh air flow rate
ECU
duty ratio control
water temp
23
22
40
17
16
15
19
20
21
10
12c
13a
13b
13
14
43
18
4
2
25
12b
1
11
3
5
9
12a
8
7
24
6

Fig. 1

Fig.2

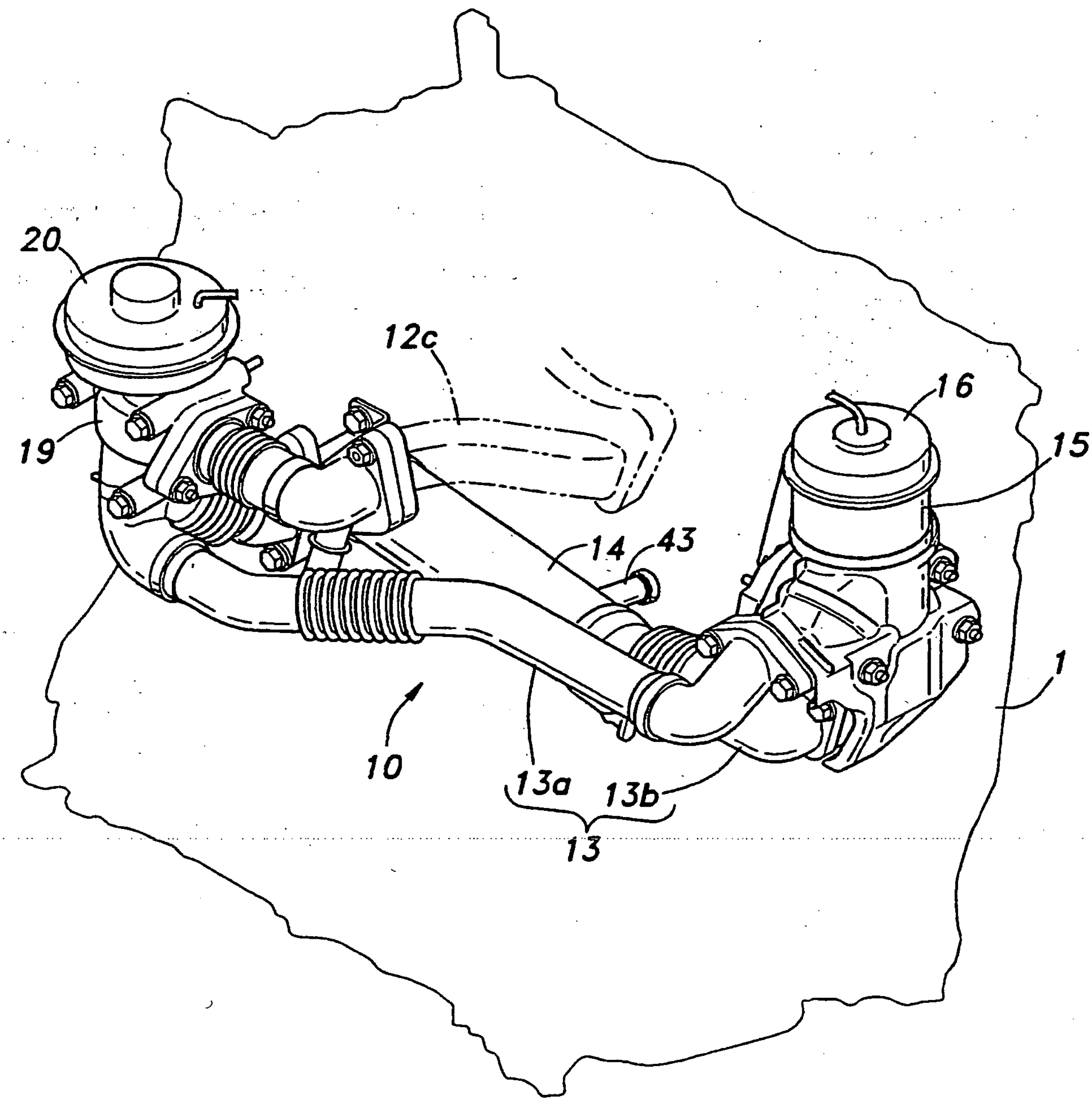


Fig.3

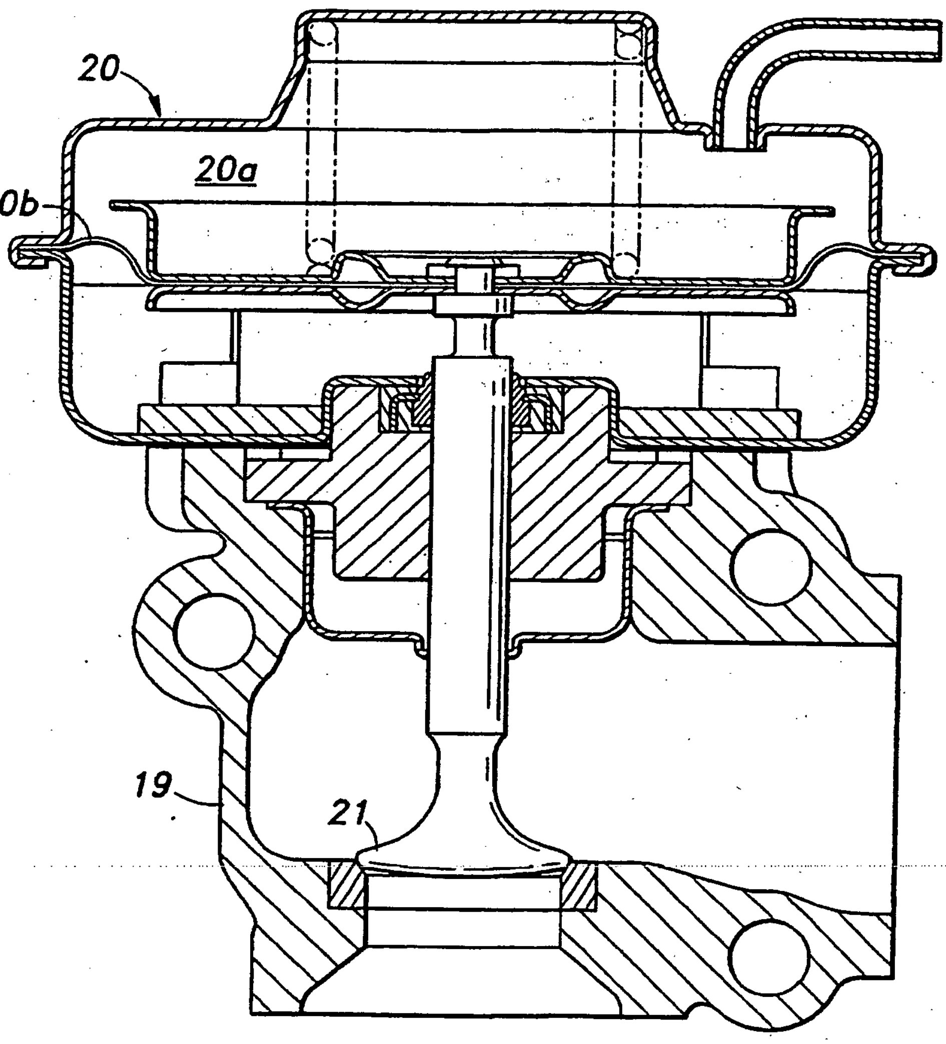
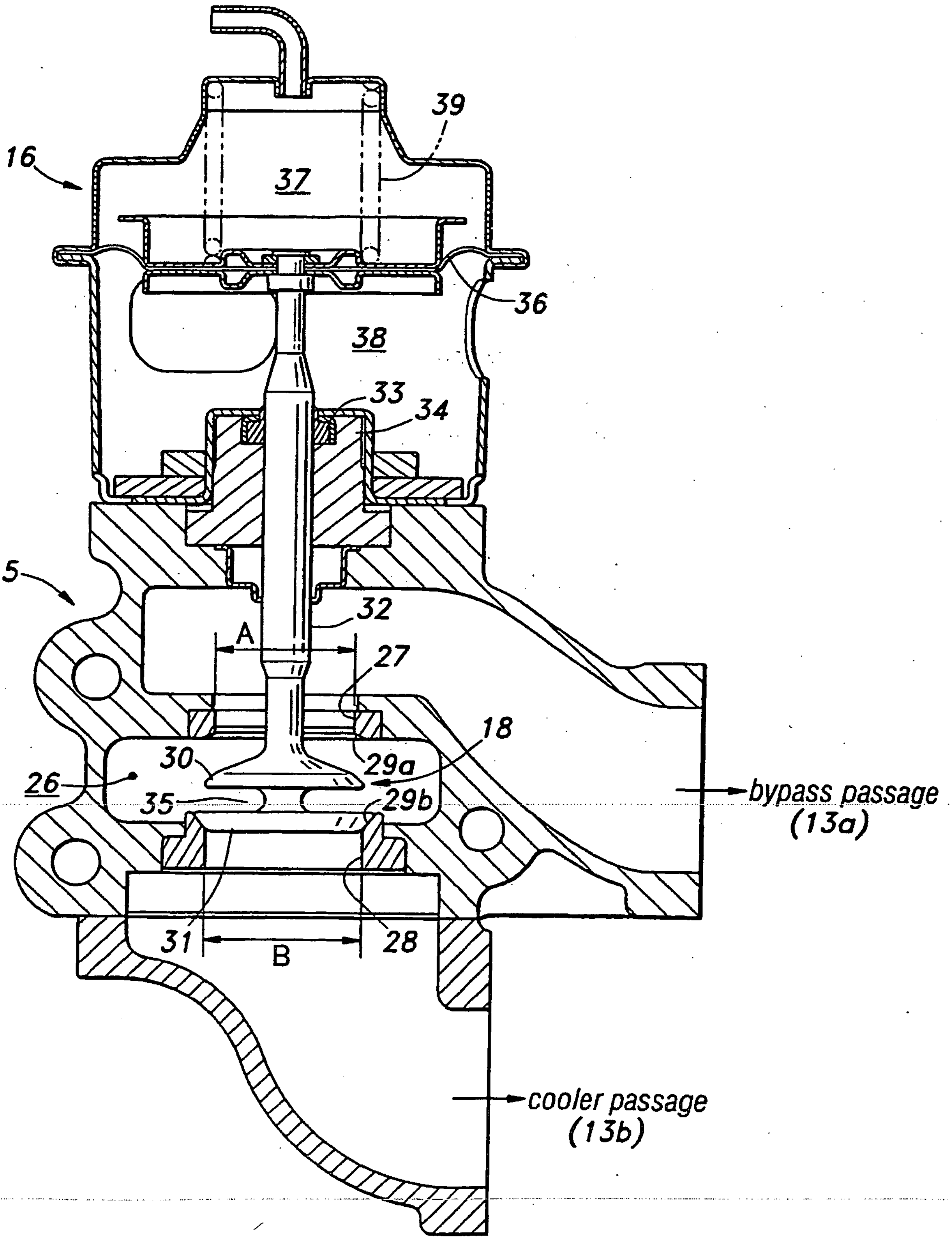


Fig.4


39
16
37
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38
33
34
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32
A
27
18
30
29a
26
35
29b
bypass passage
(13a)
31
B
28
cooler passage
(13b)