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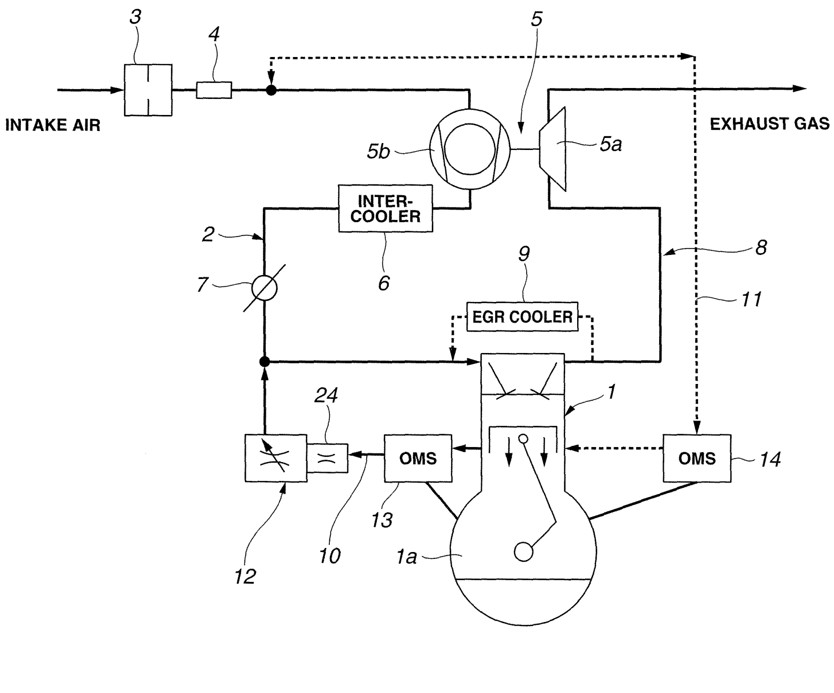
(54) **Crankcase ventilation system for engine**

(57) A crankcase ventilation system for a supercharged engine, includes a blowby gas recirculation passage for connecting a downstream section of an intake passage of the engine and a crankcase of the engine, the downstream section being located downstream of a throttle valve. A fresh air introduction passage is provided for connecting an upstream section of the intake passage and the crankcase, the upstream section being located upstream of the throttle valve. Additionally, a PCV valve is disposed in the blowby gas recirculation passage. In this crankcase ventilation system, fresh air is introduced from the downstream section of the intake passage into the crankcase through the blowby gas recirculation passage including the PCV valve or through a check valve disposed in parallel with the PCV valve when the boost pressure in the downstream section of the intake passage becomes positive.

FIG.1



EP 2 182 185 A1

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to a crankcase ventilation system for a turbocharged engine provided with a turbocharger or the like, and more particularly to a technique for improving a crankcase ventilation efficiency of a positive crankcase ventilation system (PCV system) constituting a part of a blowby gas treatment system.

[0002] A PCV system for a natural intake type or non-supercharged type engine is known as disclosed in Japanese Patent Provisional Publication No. 2007-16664. The PCV system includes a blowby gas recirculation passage for connecting an upstream section of an intake manifold as an intake passage and a crankcase, the upstream section being located upstream of a throttle valve. A fresh air introduction passage is provided for connecting an upstream section of the intake passage and the crankcase, the upstream section being located upstream of the throttle valve. Additionally, a PCV valve is provided in the blowby gas recirculation passage.

[0003] During a low load engine operation, a negative pressure prevails inside the engine under the action of the PCV valve, and therefore fresh air is introduced into the crankcase through the fresh air introduction passage connected to a rocker cover or the like. Simultaneously, blowby gas is mixed with fresh air within the crankcase and introduced through the PCV valve into the intake manifold at a position downstream of the throttle valve. During a high load engine operation, blowby gas inside the crankcase is discharged also through the fresh air introduction passage and introduced into the intake manifold at a position upstream of the throttle valve.

[0004] Such a configuration is basically common also in turbocharged engines each provided with, for example, a turbocharger. A PCV system for a supercharged engine is disclosed in Japanese Patent Provisional Publication No. 2003-184532.

SUMMARY OF THE INVENTION

[0005] In conventional crankcase ventilation systems for an engine, a boost pressure becomes high (i.e., approaches a positive pressure) during a high load engine operation as discussed above, and therefore the amount of blowby gas to be discharged through the PCV valve becomes smaller than that of blowby gas generated from the engine itself. This makes ventilation within the crankcase slow, so that engine oil within the crankcase is deteriorated with blowby gas.

[0006] Particularly in case of a supercharged engine, a boost pressure rises to become positive under the influence of a supercharged pressure also during a low engine load operation, thereby increasing an engine operation region where no fresh air is introduced into the crankcase, contrarily to natural intake type or non-supercharged engines. As a result, engine oil within the crankcase tends to be further undesirably deteriorated with blowby gas.

[0007] In view of the above problems, an object of the present invention is to provide an improved crankcase ventilation system for a supercharged engine, which can overcome drawbacks encountered in conventional crankcase ventilation systems.

[0008] Another object of the present invention is to provide an improved crankcase ventilation system for a supercharged engine, which can effectively suppress deterioration of engine oil within a crankcase.

[0009] A further object of the present invention is to provide an improved crankcase ventilation system for a supercharged engine, in which a crankcase ventilation efficiency is improved by securely introducing fresh air into a crankcase even when a boost pressure becomes positive.

[0010] According to the present invention, a crankcase ventilation system for a supercharged engine comprises a blowby gas recirculation passage for connecting a downstream section of an intake passage of the engine and a crankcase of the engine, the downstream section being located downstream of a throttle valve. A fresh air introduction passage is provided for connecting an upstream section of the intake passage and the crankcase, the upstream section being located upstream of the throttle valve. Additionally, a PCV valve is disposed in the blowby gas recirculation passage. In the crankcase ventilation system, fresh air is introduced from the downstream section of the intake passage into the crankcase when a boost pressure in the downstream section of the intake passage becomes positive. Accordingly, fresh air can be securely introduced into the crankcase even when the boost pressure in the intake passage downstream of the throttle valve becomes positive, thereby improving a crankcase ventilation efficiency thus suppressing the deterioration of engine oil within the crankcase.

[0011] Preferably, in the crankcase ventilation system, fresh air is introduced from the downstream section of the intake passage into the crankcase through the blowby gas recirculation passage including the PCV valve or through a check valve disposed in parallel with the PCV valve when the boost pressure in the downstream section of the intake passage becomes positive. In case of introduction of fresh air through the blowby gas recirculation passage, the fresh air introduction can be accomplished by using the existing blowby gas recirculation passage, which is advantageous from the viewpoint of simplification in structure. In case of introduction of fresh air through the check valve, the fresh air introduction can be accomplished through the check valve disposed separate from the PCV valve, which is advantageous because fresh air can be securely and stably introduced into the crankcase.

[0012] Preferably, in the crankcase ventilation system, the PCV valve includes a main body section for controlling flow of blowby gas to be fed from the crankcase to the downstream section of the intake passage in accordance with the boost pressure in the downstream section of the intake passage; and an orifice through which fresh air from the downstream of the intake passage is capable of flowing into the crankcase; and a device for maintaining the orifice to open even when the boost pressure in the downstream section of the intake passage becomes positive. Accordingly, a desired object can be attained merely by slightly improving an existing PCV valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is an explanatory view of a first embodiment of a crankcase ventilation system for a supercharged engine, according to the present invention, showing flow of blowby gas and fresh air during a low load engine operation;

Fig. 2 is an explanatory view similar to Fig. 1 but showing flow of blowby gas and fresh air during a high load engine operation;

Fig. 3 is an enlarged sectional view of a PCV valve used in the crankcase ventilation system of Figs. 1 and 2;

Fig. 4 is an enlarged perspective view of a valve member used in the PCV valve of Fig. 3;

Fig. 5 is a graph showing the relationship between gas flow rate of blowby gas and boost pressure in an intake system of the engine shown in Figs. 1 and 2;

Fig. 6 is an explanatory view of a second embodiment of the crankcase ventilation system for a supercharged engine, according to the present invention, showing flow of blowby gas and fresh air during a low load engine operation;

Fig. 7 is an explanatory view similar to Fig. 6 but showing flow of blowby gas and fresh air during a high load engine operation; and

Fig. 8 is an explanatory view of a third embodiment of the crankcase ventilation system for a supercharged engine, according to the present invention, showing flow of blowby gas and fresh air during a low load engine operation.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring now to Figs. 1 to 5 of the drawings, a first embodiment of a crankcase ventilation system for a supercharged engine according to the present invention is illustrated. Fig. 1 shows flow of blowby gas and fresh air during a low load engine operation of the engine 1; and Fig. 2 shows flow of blowby gas and fresh air during a high engine load operation of the engine 1.

[0015] In Fig. 1, a supercharged engine 1 is of the in-line multicylinder type having a plurality of cylinders though only one cylinder is conveniently shown in the figures. The engine 1 has an intake system including an intake passage 2 in which an air filter 3, an air flow meter 4, a compressor impeller 5b of a turbocharger 5 as a supercharger, an intercooler 6, and a throttle valve 7 are disposed in the order mentioned in a direction from an upstream side to a downstream side with respect to flow of intake air to be supplied to the engine 1. Additionally, the engine 1 has an exhaust system including an exhaust passage 8 in which a turbine impeller 5a is disposed. Exhaust gas from the engine 1 is discharged through the exhaust passage 8.

[0016] As known, intake air flows through the air filter 3 and the airflow meter 4 and then compressed or supercharged by the compressor impeller 5b of the turbocharger 5 which is driven by exhaust gas discharged from the engine 1. Thereafter, compressed intake air is cooled by the intercooler 6 located downstream of the compressor impeller 5b and then controlled in flow rate by the throttle valve 7, followed by being introduced into combustion chambers of the engine 1. A part of exhaust gas from the engine 1 is recirculated through an EGR cooler (cooler for exhaust gas) to the intake passage 2 of the intake system.

[0017] A blowby gas recirculation passage 10 is provided to connect a downstream section of the intake passage 2 and a crankcase or crank chamber 1a, the intake passage downstream section being located downstream of the throttle valve 7. Additionally, a fresh air introduction passage 11 is provided to connect an upstream section of the intake passage 2 and the crankcase 1a, the intake passage upstream section being located upstream of the throttle valve 7 and upstream of the compressor impeller 5b of the turbocharger 5 in this embodiment.

[0018] In the blowby gas recirculation passage 10, a PCV valve 12 and an oil mist separator (OMS) 13 are disposed in series with each other in such a manner that the PCV valve 12 is located at the side of the throttle valve 7. Additionally, another oil mist separator (ONS) 14 is disposed in the fresh air introduction passage 11. Further, the PCV valve 12 is provided with an orifice 24 (discussed in detail after) for introducing fresh air when boost pressure as intake air pressure in the intake passage 2 becomes positive, in addition to a main body section (no numeral) which inherently functions as a conventional PCV valve for controlling a flow rate of blowby gas to be fed to an intake passage (2) in accordance with a pressure in the intake passage. The main body section of the PCV valve 12 in this embodiment is adapted to control the flow rate of blowby gas to be fed from the crankcase to the downstream section of the intake passage 2 in accordance with the boost pressure in the downstream section of the intake passage 2. The orifice 24 is located in series with the main body section of the PCV valve 12 and positioned at the side of the oil mist separator 13. Both the oil mist separators 13, 14 are provided separate from the engine 1 and connected to the engine 1 by means of hose connection or the like; however, the oil mist separators may be formed integral with a rocker cover or cylinder head cover.

[0019] Fig. 3 shows the PCV valve 12 in detail, and

Fig. 4 shows a valve member 16 of the PCV valve 12. The PCV valve 12 includes a generally cylindrical and hollow valve body (casing or housing) 15 inside which the valve member 16 is slidably inserted. The valve body 15 is formed with a port 17 communicated with the intake passage 2 at a position downstream of the throttle valve 7, and an opposite port 18 communicated with the side of the crankcase 1a (or the oil mist separator 13). The valve member 16 is biased toward the port 18 by a compression coil spring 19 interposed between the valve member 16 and the valve body 15. As shown, the valve body 15 includes two sections 15a, 15b which are separable from each other in a longitudinal direction thereof and threadedly engaged with each other.

[0020] The valve body 15 is formed at its inner peripheral surface with a cylindrical throat section 20 in which the valve member 16 is slidably inserted. The throat section 20 is formed by an axially central section of the valve body 15 which central section is radially inwardly projected. The valve member 16 is such shaped as to be generally tapered in a direction of from the side of the port 18 to the side of the port 17 so that the diameter of the valve member 16 smoothly and gradually increases in a direction of from the side of the port 17 to the side of the port 18. The valve member 16 has a small diameter section (no numeral) which is larger in curvature in cross-section than a large diameter head section H, the small diameter head section being located at the side of the port 17 while the large diameter section being located at the side of the port 18. Accordingly, when the boost pressure in the intake passage 2 is negative, the valve member 16 pulled by the negative pressure slidingly displaces relative to the valve body 15 and takes its stationary state at a position at which the boost pressure and the biasing force of the compression coil spring 19 are balanced. In other words, a relative displacement between the throat section 20 and the valve member 16 is made according to the magnitude of the boost pressure. This continuously variably controls the degree of a valve opening formed between the throat section 20 and the valve member 16 and accordingly the flow rate of blowby gas flowing through the PCV valve. It is to be noted that the valve member 16 has a large diameter head section H (except for a flange section 21) is insertable in the port 18 formed in the section 15b to form a certain clearance which is defined between the peripheral surface of the large diameter head section H of the valve member 16 and the inner peripheral surface of the port 18. This clearance serves as the orifice 24.

[0021] As shown in Figs. 3 and 4, the large diameter head section H of the valve member 16 is located at the side of the port 18 of the valve body 15 and formed along its whole periphery with a large diameter flange section 21 which serves as a spring seat (spring receiver) for the compression coil spring 19 at the side of the valve member 16. As shown in Fig. 4, a plurality of cylindrical projections 22 are formed at the generally annular surface of the flange section 21 which annular surface faces an annular wall surface 23 of the valve body 15. The annular wall surface 23 is located around the port 18 of the valve body 15. The cylindrical projections 22 are located at equal intervals in a peripheral direction and project toward the annular wall surface 23 of the valve body 15 so as to be able to come into contact with the annular wall surface 23. Thus, the cylindrical projections 22 themselves function as a stopper for restricting the position of the valve member 16 in a direction of being biased by the compression coil spring 19. The flange section 21 is formed with a plurality of cutouts along the periphery thereof as clearly shown in Fig. 4.

[0022] Accordingly, even when the cylindrical projections 22 at the side of the valve member 16 is brought into contact with the annular wall surface 23 of the valve body 15, a certain clearance G corresponding to the height of each cylindrical projection 22 can be formed between the flange section 21 and the annular wall surface 23, the clearance G being communicated with the orifice 24. By this, even though the valve member 16 slidingly displaces to a position (the right-most position in Fig. 3) corresponding to the limit of its stroke under the biasing force of the compression coil spring 19 so that the cylindrical projections 22 of the flange section 21 are seated on the annular wall surface 23, a certain opening is ensured at the orifice 24 communicated with the clearance G in addition to ensuring a certain clearance at the throat section 20.

[0023] Fig. 5 shows the relationship between the boost pressure in the intake passage 2 at a position downstream of the throttle valve 7 (i.e., the downstream section of the intake passage) and the flow rates of blowby gas and the like. A curve A indicates an amount of blowby gas generated in the engine; a curve B indicates a gas flow rate characteristics of blowby gas and the like in the oil mist separator 13 disposed in the blowby gas recirculation passage 10; and a curve C indicates gas flow rate characteristics of blowby gas and the like in the oil mist separator 14 disposed in the fresh air introduction passage 11. In Fig. 5, a region where the boost pressure is negative corresponds to a low load engine operation in which engine load decreases as the magnitude of the negative pressure increases, while an opposite region where the boost pressure is positive corresponds to a high load engine operation in which engine load increases as the magnitude of the positive pressure increases.

[0024] In the blowby gas recirculation passage 10 shown in Fig. 1, the PCV valve 12 is disposed in series with the oil mist separator 13, and therefore a boost pressure - blowby gas flow rate characteristics of the PCV valve 12 provided with the orifice 24 is previously regulated to be generally equal to that indicated by the curve B in Fig. 5.

[0025] With the thus configured crankcase ventilation system, as shown in Figs. 1 and 5, during the low engine load operation of the engine 1, i.e., in a region P1 of Fig. 5, intake pressure or boost pressure prevailing in the intake passage 2 downstream of the throttle valve 7 is negative such that the magnitude of the negative pressure is larger. Consequently, the valve member 16 is pulled leftward under the action of the negative pressure in Fig. 3, so that the clearance (valve opening degree) between the inner peripheral surface of the throat section 20 and the peripheral surface of the valve member 16 becomes relatively small. Accordingly, in the region P1 of Fig. 5, the flow rate of blowby gas discharged or recirculated to the intake passage 2 becomes relatively low while the blowby gas generation amount itself is relatively small as compared with that in other regions.

[0026] In the region P1 of Fig. 5, the flow rate of blowby gas (indicated by the line B) discharged to the intake passage 2 through the oil mist separator 13 and the PCV valve 12 disposed in the blowby gas recirculation passage 10 is larger than the flow rate corresponding to the blowby gas generation amount (indicated by the line A), so that the difference between these flow rates corresponds to an amount of fresh air to be introduced into the crankcase 1a. Accordingly, as shown in Fig. 1, fresh air is introduced through the fresh air introduction passage 11 into the crankcase 1a thereby accomplishing ventilation of the crankcase 1a, together with discharge of blowby gas through the oil mist separator 13 and the PCV valve 12 disposed in the blowby gas recirculation passage 10.

[0027] Here, since fresh air to be introduced through the fresh air introduction passage 11 into the crankcase 1a passes through the oil mist separator 14, the flow rate characteristics in the oil mist separator 14 indicated by the curve C is inherently assumed to be "positive (+)" in the region P1 of Fig. 5; however, the flow rate characteristics indicated by the curve C is represented as "negative (-)" in the region P1 of Fig. 5 because the flow rate of blowby gas discharged through the fresh air introduction passage 11 to the intake passage 2 upstream of the throttle valve 2 is represented as "positive (+)" as discussed after.

[0028] Further, in a region P2 where engine load of the engine 1 becomes high, the boost pressure gradually approaches a positive pressure, and therefore the valve member 16 of the PCV valve 12 slidingly displaces rightward in Fig. 3, thereby increasing the valve opening degree at the throat section 20. As a result, as the generation amount of blowby gas indicated by the curve A increases, the flow rate of blowby gas (indicated by the curve B) discharged to the intake passage 2 through the oil mist separator 13 and the PCV valve 12 disposed in the blowby gas recirculation passage 10 and the amount of fresh air introduced through the fresh air introduction passage 11 increase.

[0029] In a state where the boost pressure unlimitedly approaches a positive pressure and immediately before development of the positive pressure, the flow rate (indicated by the curve B) of blowby gas discharged to the intake passage 2 through the oil mist separator 13 and the PCV valve 12 disposed in the blowby gas recirculation passage 10 is smaller than the blowby gas generation amount indicated by the curve A, decreasing the amount of fresh air introduced through the fresh air introduction passage 11 into the crankcase 1a. Thereafter, as shown in Fig. 2, blowby gas is discharged also through the fresh air introduction passage 11 into the intake passage 2 upstream of the throttle valve 7.

[0030] When the engine load of the engine 1 is further increased to establish a region P3 where the boost pressure in Fig. 5 is turned to a positive pressure under the influence of a supercharged or boost pressure by the turbocharger 5 shown in Fig. 1, the valve member 16 of the PCV valve 12 in Fig. 3 slidingly displaces rightward in Fig. 3 under the action of the biasing force of the compression coil spring 19 and upon receiving the boost pressure, the projections 22 of the valve member 16 are seated on the annular wall surface 23 of the valve body 15 as illustrated in Fig. 3. In this state, the valve opening degree at the throat section 20 becomes the largest while a valve opening degree corresponding to the orifice 24 is ensured at the side of the port 18.

[0031] After the boost pressure is turned to the positive pressure, i.e., after establishing the region P3 in Fig. 5, as the blowby gas generation amount increases, the flow rate (indicated by the curve C) of blowby gas discharged through the fresh air introduction passage 11 including the oil mist separator 14 to the intake passage 2 upstream of the throttle valve 7 abruptly increases, while the blowby gas flow rate in the PCV valve 12 and the oil mist separator 13 disposed in the blowby gas recirculation passage 10 is turned to the "negative (-)" side.

[0032] This turning of the gas flow rate at the side of the blowby gas recirculation passage 10 to the "negative (-)" side means that fresh air in the intake passage 2 downstream of the throttle valve 7 reversely flows to the crankcase 1a through the PCV valve 12 and the oil mist separator 13 thereby positively introducing fresh air into the side of the crankcase 1a. In other words, in the region P3 of Fig. 5, the flow rate (indicated by the curve C) of blowby gas discharged through the fresh air introduction passage 11 becomes larger than the blowby gas generation amount indicated by the curve A, so that the difference between these amounts or flow rates corresponds to an amount of fresh air to be introduced into the crankcase 1a through the blowby gas recirculation passage 10. That is, the PCV valve 12 positively allows fresh air to be introduced into the crankcase 1a through the orifice 24 and the clearance between the throat section 20 and the valve member 16.

[0033] Accordingly, as shown in Fig. 5, even in the region P3 established after the boost pressure is turned to the positive pressure, fresh air can be positively introduced into the crankcase 1a to accomplish a crankcase ventilation, thereby largely improving a ventilation efficiency of the crankcase 1a thus making it possible to suppress deterioration of engine oil by blowby gas.

[0034] While the function of the orifice 24 has been shown and described as being provided in the PCV valve 12 as shown in Fig. 3 in the first embodiment, it will be appreciated that the same effects as those of the first embodiment can be obtained by preparing a conventional and known PCV valve and an orifice member to be independent from each other, and by disposing the PCV valve and the orifice member in series with each other. It will be understood that the embodiment shown in Fig. 3 is preferable from the viewpoints of reducing the number of parts and simplifying the structure thereof.

[0035] Figs. 6 and 7 illustrate a second embodiment of the crankcase ventilation system according to the present invention, which is similar to the first embodiment and therefore the same reference numerals are assigned to the same parts and elements as those in the first embodiment shown in Figs. 1 and 2 for the purpose of simplicity of illustration. Fig. 6 shows flow of blowby gas and fresh air during a low load engine operation, and Fig. 7 shows flow of blowby gas and fresh air during a high load engine operation.

[0036] In the second embodiment, a conventional and known PCV valve 25 is used in place of the PCV valve 12 shown in Figs. 1, 2 and 3, in which a check valve 27 is disposed in parallel with the PCV valve 25. The conventional and known PCV valve 25 has a structure similar to that shown in Fig. 3 with the exception that a part for accomplishing the function of the orifice 24 does not exist.

[0037] Specifically, as shown in Fig. 6, the blowby gas recirculation passage 10 is branched off from or connected to the intake passage 2 downstream of the throttle valve 7, in which a bypass passage 26 is provided to be branched off from or connected at its one end to the intake passage 2 around a position at which the blowby gas recirculation passage 10 is connected to the intake passage 2. The other end of the bypass passage 26 is connected to the oil mist separator 13.

[0038] According to the second embodiment, during a low load engine operation as shown in Fig. 6, the boost pressure in the intake passage 2 becomes negative, and therefore the blowby gas recirculation passage 10 including the oil mist separator 13 and the PCV valve 25 accomplish its inherent function, while the bypass passage 26 including the check valve 27 accomplishes no function.

[0039] To the contrary, the engine load of the engine 1 is increased so that the boost pressure in the intake passage 2 becomes positive as shown in Fig. 7, the check valve 27 in the bypass passage 26 opens thereby allowing fresh air to flow through the bypass passage 26 like the orifice 24 in the PCV valve 12 shown in Fig. 3. As a result, the second embodiment crankcase ventilation system can accomplish the same function as the first embodiment crankcase ventilation system.

[0040] Fig. 8 illustrates a third embodiment of the crankcase ventilation system according to the present invention, similar to the second embodiment crankcase ventilation system. Fig. 8 shows flow of blowby gas and fresh air during a low load engine operation like Fig. 6.

[0041] In the third embodiment, as shown in Fig. 8, a bypass passage 26A similar to the bypass passage 26 in Fig. 6 and provided with the check valve 27 is directly connected at its end to the crankcase 1a of the engine 1 in place of being connected to the oil mist separator 13. It will be understood that the same function as the second embodiment is accomplished also in the third embodiment.

[0042] The entire contents of Japanese Patent Application No. 2008-282765, filed November 4, 2008, are incorporated herein by reference.

[0043] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above. Modifications and variations of the embodiments described above will occur to those skilled in the art, in light of the above teachings. The scope of the invention is defined with reference to the following claims.

Claims

1. A crankcase ventilation system for a supercharged engine, comprising:

a blowby gas recirculation passage for connecting a downstream section of an intake passage of the engine and a crankcase of the engine, the downstream section being located downstream of a throttle valve;
a fresh air introduction passage for connecting an upstream section of the intake passage and the crankcase, the upstream section being located upstream of the throttle valve; and
a PCV valve disposed in the blowby gas recirculation passage,
wherein fresh air is introduced from the downstream section of the intake passage into the crankcase when a boost pressure in the downstream section of the intake passage becomes positive.

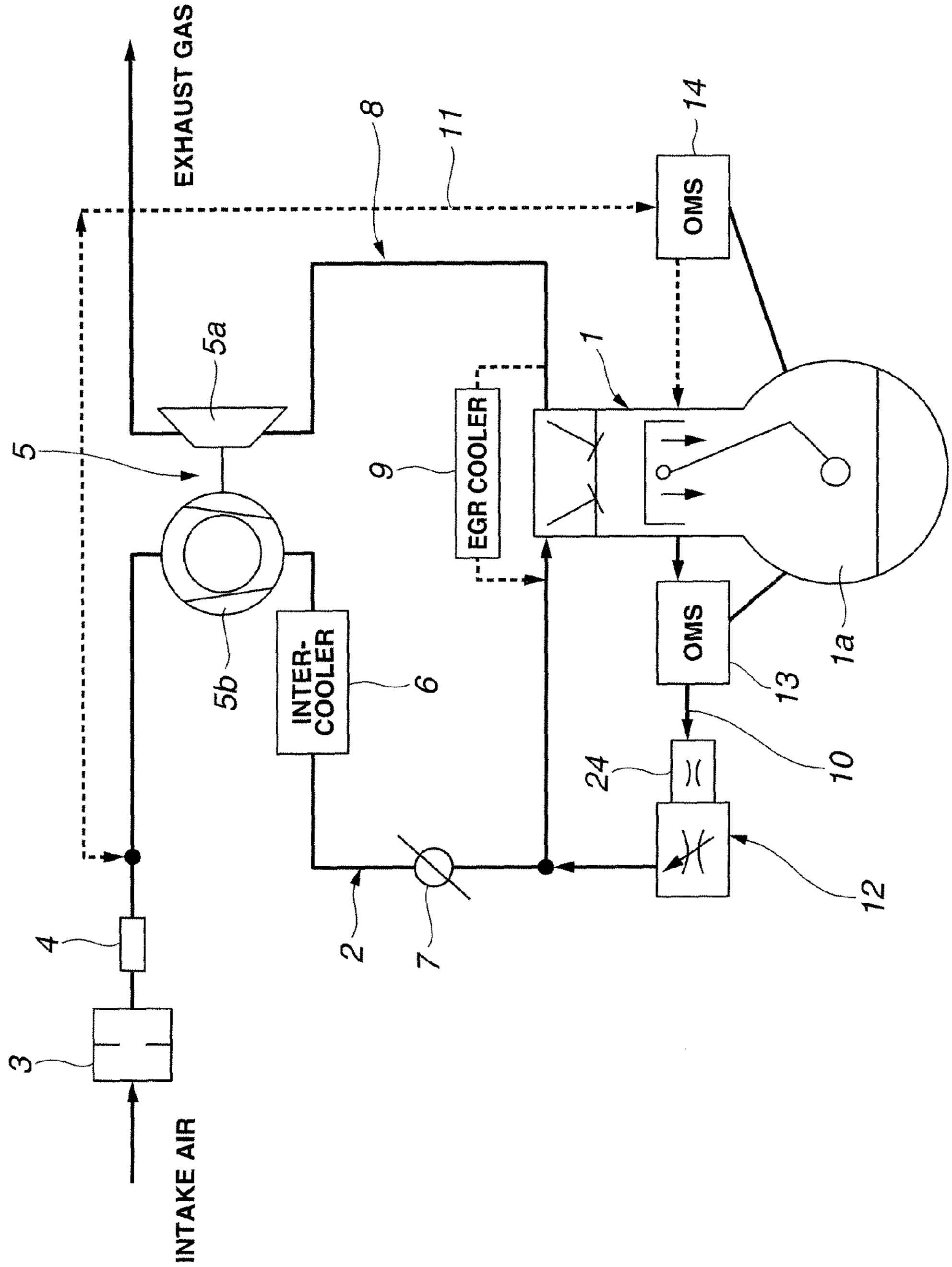
2. A crankcase ventilation system as claimed in Claim 1, wherein fresh air is introduced from the downstream section of the intake passage into the crankcase through the blowby gas recirculation passage including the PCV valve or through a check valve disposed in parallel with the PCV valve when the boost pressure in the downstream section of the intake passage becomes positive.

3. A crankcase ventilation system as claimed in Claim 2, wherein the PCV valve includes a main body section for controlling flow of blowby gas to be fed from the crankcase to the intake passage in accordance with the boost pressure in the downstream section of the intake passage; an orifice through which fresh air from the downstream of the intake passage is capable of flowing into the crankcase; and a device for maintaining the orifice to open even when the boost pressure in the downstream section of the intake passage becomes positive.

4. A crankcase ventilation system as claimed in Claim 2, wherein the check valve is disposed in a bypass passage through which the downstream section of the intake passage is communicated with the crankcase, the check valve being opened to flow fresh air from the downstream of the intake passage into the crankcase when the boost pressure in the downstream of the intake passage becomes positive.

5. A crankcase ventilation system as claimed in Claim 2, wherein the PCV valve includes a generally cylindrical casing having a first port communicated with the downstream section of the intake passage and a second port communicated with the crankcase; a valve member axially movably disposed in the casing and having a head section insertable in the second port to define an orifice, a flange section connected to the head section; a plurality of projections formed from the flange section and projecting toward an inner wall surface of the casing, the inner wall surface being located around the second port, each projection being capable of coming into contact with the inner wall surface to form a space between the flange section and the inner wall surface; and a compression coil spring located around the valve member and disposed between the casing and the valve member to bias the valve member in a direction to bring each projection into contact with the inner wall surface.

FIG.1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4
5
5a
5b
INTER-
COOLER
6
2
7
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EGR COOLER
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1a
OMS
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13
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24
12

FIG.2

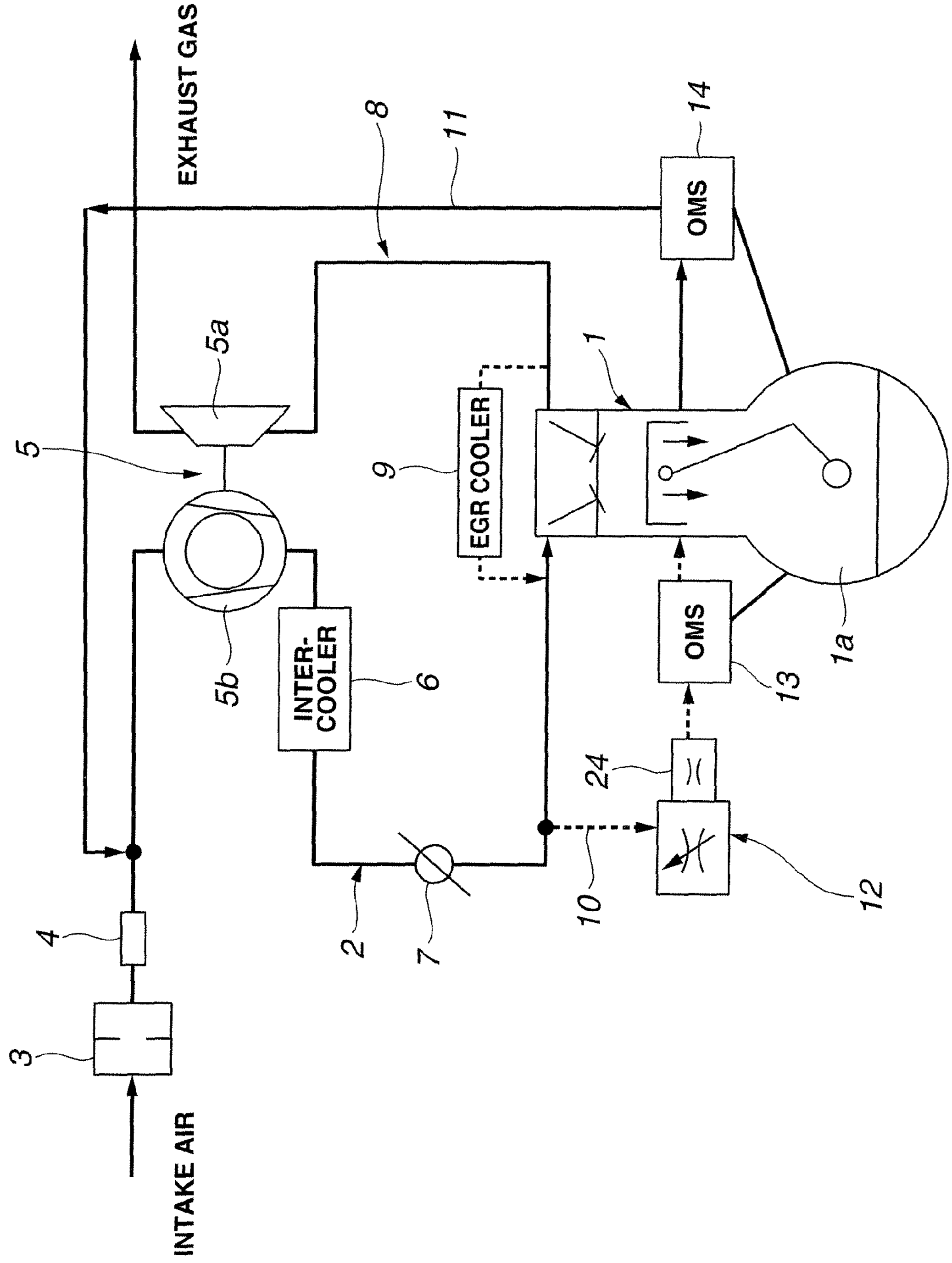
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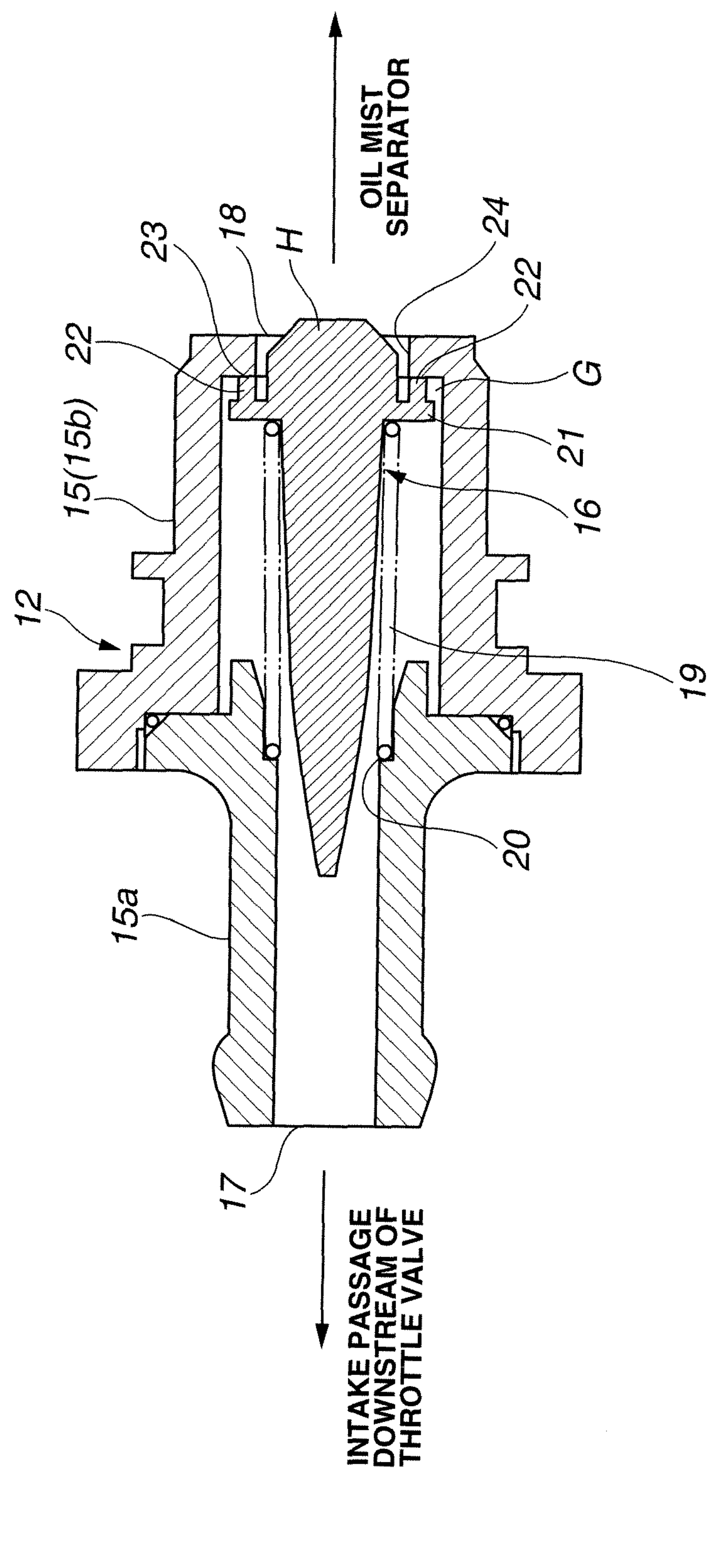
FIG.3


OIL MIST SEPARATOR
INTAKE PASSAGE DOWNSTREAM OF THROTTLE VALVE
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22
23
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H
24
22
G
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20
15a
17

FIG.4

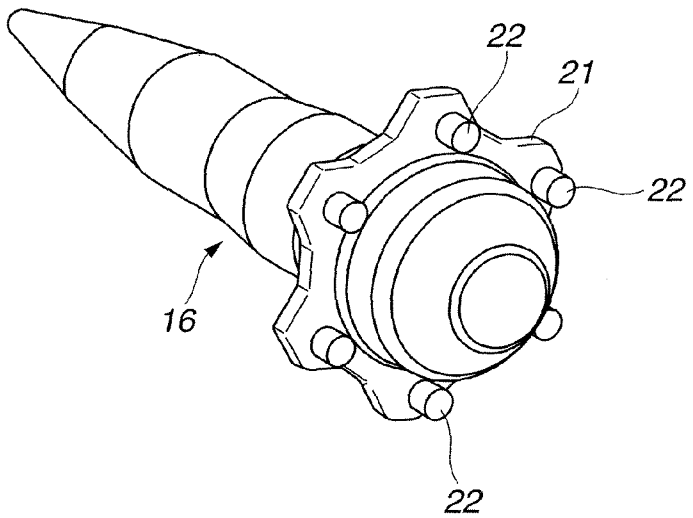


FIG.5

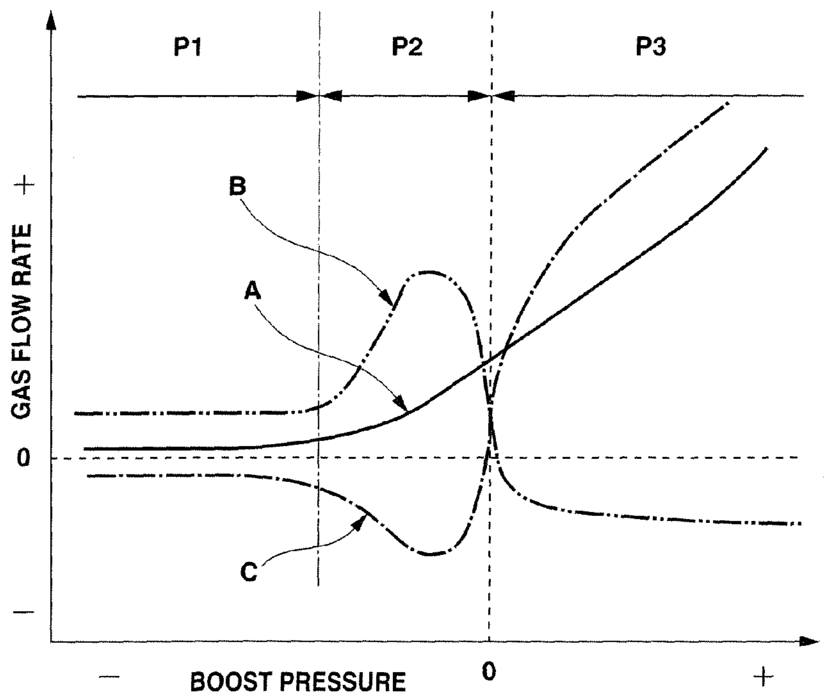
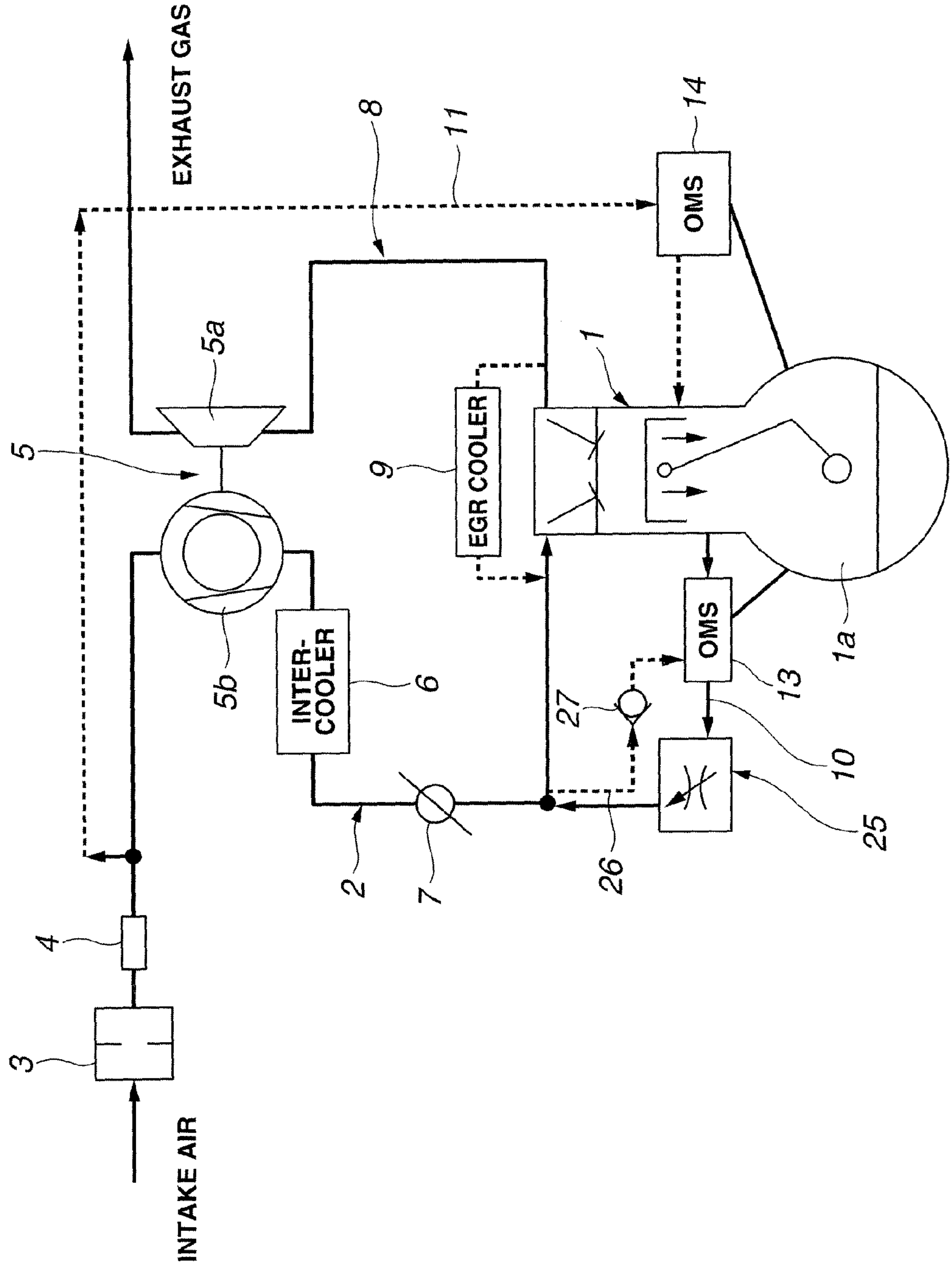


FIG.6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INTAKE AIR
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1
1a
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6
7
8
9
10
11
13
14
25
26
27

FIG.7

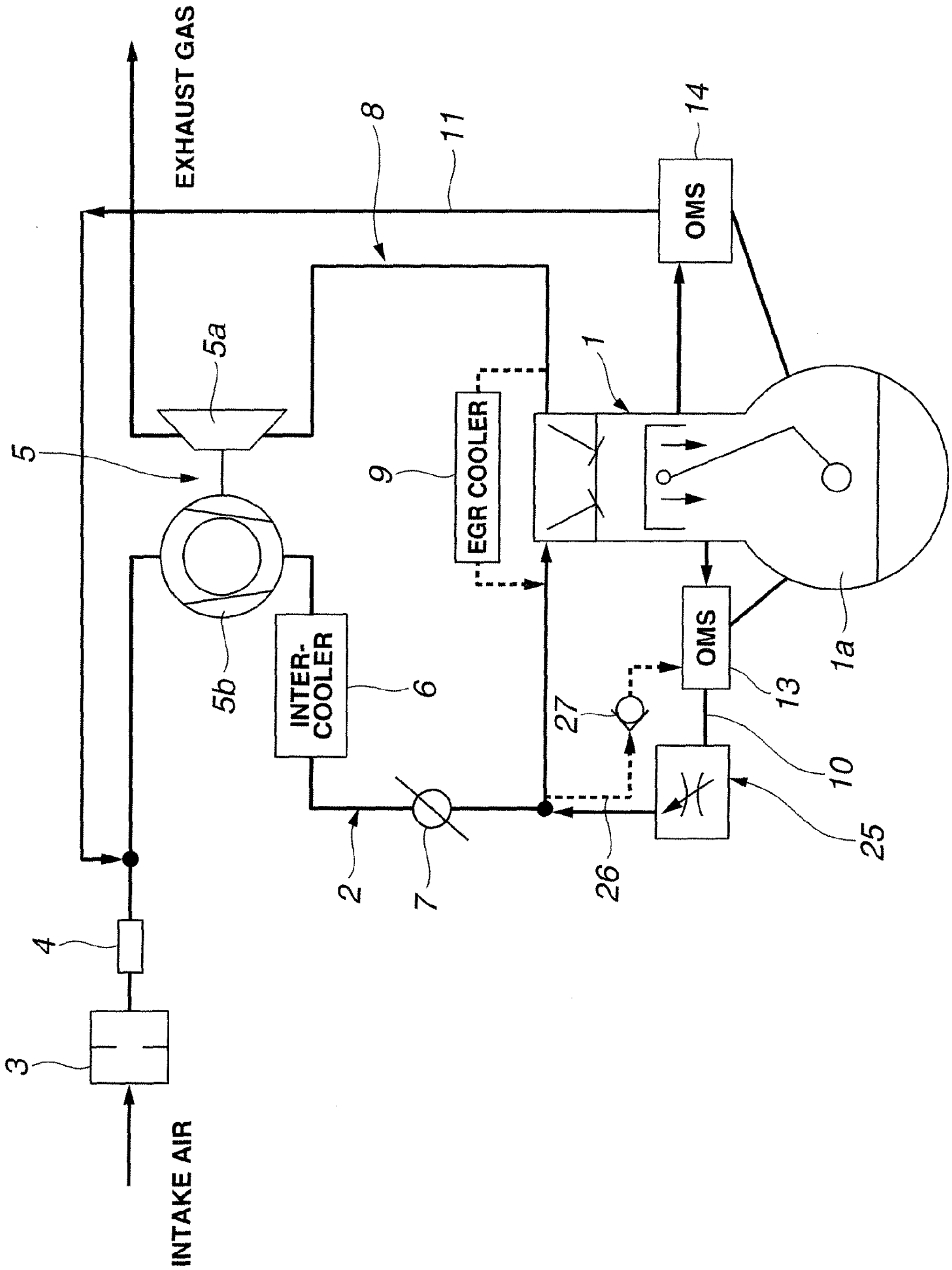
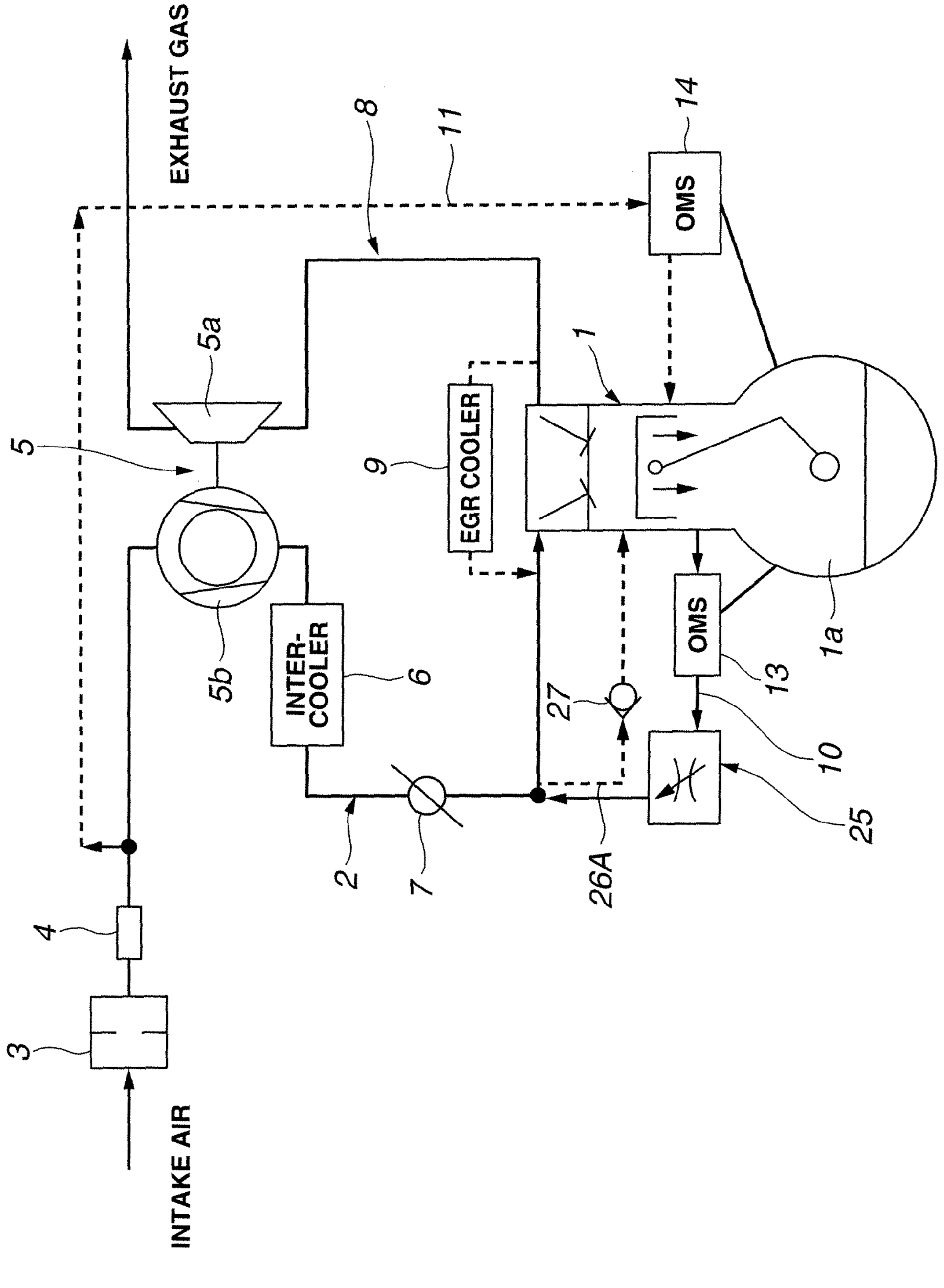

EXHAUST GAS
INTAKE AIR
INTER-COOLER
EGR COOLER
OMS
OMS
5a
5b
5
1
1a
2
3
4
6
7
8
9
10
11
13
14
25
26
27

FIG.8


EXHAUST GAS
INTAKE AIR
EGR COOLER
INTER-
COOLER
OMS
OMS
1
1a
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3
4
5
5a
5b
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14
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26A
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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 4401

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Place of search	Date of completion of the search	Examiner
Munich	28 January 2010	Vedoato, Luca

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