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(54) Exhaust gas recirculation device

Abgasrückführeinrichtung

Dispositif de recirculation de gaz d'échappement

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(56) References cited:
EP-A- 0 586 123
US-A- 4 373 496
US-A- 4 615 324
US-A- 5 333 456

Description

[0001] The present invention relates to an exhaust gas recirculation device in an internal combustion engine according to the preamble of claim 1.

[0002] As one of the methods for reducing the amount of NOx in the exhaust gas of an internal combustion engine, the exhaust gas recirculation system for recirculating a part of the exhaust gas into the intake air has been well known. The toughening of exhaust gas regulations in recent years, however, has made it necessary to increase the amount of recirculation of the exhaust gas. For this reason, various improvements have been made, such as the addition of a valve for adjusting the flow rate of the recirculated gas, that is, a throttle valve for restricting the flow of fresh air to the upstream side of the recirculated gas control valve (for example, refer to Japanese Unexamined Patent Publication (Kokai) No. 6-17711).

[0003] In such an improved exhaust gas recirculation device, however, there is the problem that, particularly in a transitional operating state such as a rapid acceleration shifting from an operating region in which the amount of the recirculated gas is large to an operating region in which the amount of the recirculated gas is small, even if the recirculated gas control valve operates with a good response, where the volume of the intake passage from the throttle valve to the intake valve of each cylinder is large, the actual shut off of the recirculated gas is delayed, so the amount of generation of smoke is increased.

[0004] As a countermeasure for this problem, it is possible to reduce the volume of the intake passage between the throttle valve and the intake valve of each cylinder explained above by arranging the two close in distance. However, as a result, the distance between the throttle valve and the recirculated gas control valve also becomes short, therefore the recirculated gas easily flows into a "backflow area" of the intake air generated on the downstream side of the throttle valve (region in which the intake air flows from the downstream side to the upstream side), the recirculated gas flows back to the throttle valve, the components contained in the recirculated gas adhere to the throttle valve, and therefore deposits build up.

[0005] When the deposits build up around the throttle valve, not only will the throttle valve no longer smoothly open and close in operation, but also the effective size of the valve opening with respect to the same amount of operation will change and therefore the relationship between the opening and closing positions of the throttle valve and the inflowing amount of the fresh air will change, the amount of fresh air with respect to the amount of fuel injection is reduced, smoke is increased, and the emission will become degraded. As is well known, in an internal combustion engine of a configuration which recirculates the blow-by gas containing the lubricant oil of the engine to the upstream side of the throttle valve and an internal combustion engine using a turbocharger for supercharging, if the oil component contained in the blow-by gas or the oil leaked from the turbocharger adhere to the recirculated gas inflowing port, carbon particles etc. in the recirculated gas will easily adhere to the recirculated gas inflowing port due to the oil and will form deposits there, therefore there also arises the problem that the passage area of the flow path of the recirculated gas inflowing port will be further reduced.

[0006] Further, in general, it is necessary to make the valve diameter of the recirculated gas control valve large, but in the conventional exhaust gas recirculation device as mentioned above, if the valve diameter of the recirculated gas control valve is enlarged and the flow rate of the recirculated gas is increased, there arises a problem that an actuator comprising a diaphragm or stepping motor or the like for opening or closing the recirculated gas control valve will be damaged due to the heat of the recirculated gas.

[0007] In order to prevent the damage of the actuator due to heat, in another related art, the inflowing port of the recirculated gas to the intake passage and the valve body of the recirculated gas control valve are provided at bottom portions of the intake pipe, the actuator is provided at an upper portion of the intake pipe, the two are connected by a long valve stem, and the valve stem is cooled by intake air (fresh air) of a relatively low temperature flowing through the intake passage so as prevent the heat of the recirculated gas received by the valve body from being directly transferred to the actuator as thereby preventing actuator damage (for example, refer to Japanese Unexamined Patent Publication (Kokai) No. 60-243359).

[0008] However, in the latter related art as well, usually the oil component contained in the blow-by gas flowing into the intake air at the upstream side from the recirculated gas inflowing port and the carbon particles contained in the recirculated gas will build up on the recirculated gas inflowing port to form deposits which will reduce the cross-sectional area of the flow path or adhere to the valve seat portion or valve body of the recirculated gas control valve and thereby cause them to stick and obstruct the operation of the control valve. Further, even if the blow-by gas inflowing port is not provided in the intake passage, where the turbocharger for the supercharging is provided at the upstream side of the intake passage, the oil leaking from the turbocharger will flow into the intake passage, so there is the possibility of occurrence of a similar problem.

[0009] A generic exhaust gas recirculation device is known from EP-A-0 586 123. According thereto, a throttle valve with a valve steam is provided in the middle of an intake pipe and adjusts an amount of intake air passing therethrough. A recirculated gas introduction passages refluxes part of an exhaust gas of an internal combustion engine into the intake pipe. A recirculated gas control valve is provided in the recirculated gas introduction passage and adjusts the amount of the recirculated gas passing through the passage. The recirculated gas introduction passage opens via a recirculated gas inflowing port in a forward flow area of the intake air. For that purpose a recirculated gas directing passage at the recirculated gas inflowing port is provided with an inclined surface which is positioned on an outside area of the intake pipe and inclined toward the downstream side of the intake pipe.

[0010] It is an object of the present invention to further develop an exhaust gas recirculation device according to the preamble of claim 1 such that a compact size can be achieved while a smooth flowing of the recirculated gas is guaranteed.

[0011] According to the invention, this object is achieved by an exhaust gas recirculation device having the features of the new claim 1.

[0012] Advantageous further developments are set out in the dependent claims.

[0013] According to the present invention, the exhaust gas recirculation device uses a new configuration to enable that the recirculated gas can be smoothly fed into the engine.

[0014] Further, an enhanced exhaust gas recirculation device is provided with which the deposits can be prevented from being adhered around the throttle valve due to the back flow of the recirculated gas.

[0015] With the exhaust gas recirculation device the recirculated gas can be smoothly fed into the engine without trouble such as deposits being produced near the recirculated gas inflowing port at which the recirculated gas control valve is provided and the inflowing port being clogged or the valve body sticking to the valve seat portion.

[0016] According to the exhaust gas recirculation device of the present invention, the recirculated gas inflowing port is opened in the forward flow area of the intake air flowing in the intake pipe from the upstream side to the downstream side at the downstream side part of the throttle valve provided in the intake pipe, therefore the recirculated gas flowing into the intake pipe from the recirculated gas inflowing port smoothly flows to the downstream side while riding the forward flow of the intake air so as to be fed into the engine again, so it is possible to avoid the recirculated gas flowing back in the intake pipe and reaching the throttle valve to cause the buildup of deposits.

[0017] Further, according to the exhaust gas recirculation device of the present invention, one end of a bent passage means is connected to an end of the recirculated gas introduction passage, the internal portion thereof is defined as the recirculated gas guide passage and, at the same time, the other end thereof is defined as the recirculated gas inflowing port and opened toward the downstream side at the forward flow area of the flow of the intake air in the intake pipe, therefore, regardless of the positions of disposition of the recirculated gas introduction passage and recirculated gas control valve, the recirculated gas inflowing port can be opened in the forward flow area of the flow of the intake air at the downstream side of the throttle valve and, at the same time, the recirculated gas is smoothly guided to the opening thereof and can be discharged toward the downstream side of the flow of the intake air. Accordingly, the recirculated gas does not enter into the back flow area but flows into the forward flow area and flows to the downstream side, therefore it is possible to reliably prevent deposits from building up at the throttle valve.

[0018] Also, in the present invention, taking note of the fact that the deposits produced in the intake pipe near the recirculated gas inflowing port where the recirculated gas control valve is provided are generated due to buildup of the mixture of the oil components in the blow-by gas or the oil leaking from the turbocharger and the carbon particles in the recirculated gas, a prevention wall for preventing the intrusion of the blow-by gas etc. as much as possible is formed at the upper portion of the intake passage at which the adhesion of the oil components in the blow-by gas is most difficult in the intake pipe and, at the same time, the valve seat portion of the recirculated gas control valve is provided in that prevention wall, thereby solving the problems possessed by the related art mentioned above.

[0019] More concretely, according to the exhaust gas recirculation device of the present invention, by providing the valve seat portion of the recirculated gas control valve at a position of the upper portion of the intake passage and, at the same time, providing the partition wall extending toward the downstream side so as to provide a space between the valve seat portion and the intake passage, the recirculated gas introduction port, which opens toward the downstream side when seen from the valve seat portion, is formed in the upper portion of the intake passage. By this, the recirculated gas passing through the valve gap of the valve seat portion passes through the recirculated gas introduction port and flows toward the downstream side where it merges with the intake air flowing in the intake passage and is taken into the engine to perform a purification action of the exhaust gas.

[0020] The object and features of the present invention will become clearer from the following description of the preferred embodiments given with reference to the attached drawings, in which

Fig. 1 is a front view, partially sectional, of the overall configuration of an exhaust gas recirculation device according to a first comparative example not claimed;

Fig. 2 is a sectional plan view of part of the exhaust gas recirculation device shown in Fig. 1;

Fig. 3 is a vertical sectional view of the constituent parts for explaining the mode of operation of the exhaust gas recirculation device shown in Fig. 1;

Fig. 4 is a lateral sectional side view taken along a line IV-IV in Fig. 3;

Fig. 5 is a partial vertical sectional view for explaining problems of the related art;

Fig. 6 is a partial vertical sectional view for explaining the mode of operation and effect of the first comparative example not claimed;

Fig. 7 is a plan view, partially sectional, of the overall configuration of the exhaust gas recirculation device according to a second comparative example not claimed;

Fig. 8 is a plan view, partially sectional, of the overall configuration of a conventional exhaust gas recirculation device given as an example of poor distribution of the intake air to the cylinders;

Fig. 9A is a sectional view schematically showing the configuration of the main parts of the conventional exhaust gas recirculation device shown in Fig. 8;

Fig. 9B is a graph of an exhaust gas recirculation rate of the conventional exhaust gas recirculation device shown in Fig. 8;

Fig. 10A is a sectional view schematically showing the configuration of the main parts of the second comparative example shown in Fig. 7;

Fig. 10B is a graph of the exhaust gas recirculation rate showing the effect of the second comparative example shown in Fig. 7;

Fig. 11 is a vertical sectional plan view showing the principal parts of an exhaust gas recirculation device according to a first embodiment of the present invention;

Fig. 12 is a vertical sectional front view taken along a line XII-XII in Fig. 11;

Fig. 13 is a lateral sectional side view taken along a line XIII-XIII in Fig. 12;

Fig. 14 is a vertical sectional front view of the principal parts showing a problem of the first comparative example;

Fig. 15 is a vertical sectional front view of the principal parts showing the effect of the first embodiment;

Fig. 16 is a vertical sectional plan view showing the principal parts of an exhaust gas recirculation device according to a second embodiment of the present invention;

Fig. 17 is a vertical sectional front view showing the principal parts of an exhaust gas recirculation device according to a third embodiment of the present invention;

Fig. 18 is a vertical sectional front view taken along a line XVIII-XVIII in Fig. 17;

Fig. 19 is a lateral sectional side view taken along a line XIX-XIX in Fig. 17;

Fig. 20 is a front view, partially sectional, of the configuration of the exhaust gas recirculation device according to a fourth embodiment of the present invention;

Fig. 21 is a plan view, partially sectional, of the exhaust gas recirculation device shown in Fig. 20;

Fig. 22 is a plan view, partially sectional, of the overall configuration of a conventional general exhaust gas recirculation device;

Fig. 23 is a front view, partially sectional, of the overall configuration of an exhaust gas recirculation device according to a further comparative example not claimed invention;

Fig. 24 is a vertical sectional view of the constituent parts for explaining the mode of operation of the exhaust gas recirculation device according to the comparative example;

Fig. 25 is a partial vertical sectional view for explaining the effect of the comparative example;

Fig. 26 is a front view, partially sectional, of the overall configuration of an exhaust gas recirculation device according to a further comparative example ;

Fig. 27 is a front view, partially sectional, of the overall configuration of an exhaust gas recirculation device according to a fifth embodiment of the present invention;

Fig. 28 is a partial vertical sectional front view of the overall configuration of an exhaust gas recirculation device according to a still further comparative example;

Fig. 29 is a partial vertical sectional plan view of the exhaust gas recirculation device shown in Fig. 28 as seen from the bottom;

Fig. 30 is a lateral sectional side view taken along a line XXX-XXX of Fig. 28;

Fig. 31 is a partial vertical sectional front view of the overall configuration of the conventional example;

Fig. 32 is a partial vertical sectional front view of the configuration of exhaust gas recirculation device according to a further comparative example;

Fig. 33 is a partial vertical sectional plan view of the exhaust gas recirculation device shown in Fig. 32 as seen from the bottom;

Fig. 34 is a partial vertical sectional front view of the configuration of the exhaust gas recirculation device according to a sixth embodiment; and

Fig. 35 is a partial vertical sectional plan view of the exhaust gas recirculation device shown in Fig. 34 as seen from the bottom.

[0021] Figure 1 and Fig. 2 show an example of an internal combustion engine 2 provided with an exhaust gas recirculation device 1 as a first comparative example not claimed. Figure 1 is a front view showing a cylinder block 9 of a multi-cylinder engine 2 from the front of a not illustrated crankshaft; while Fig. 2 is a plan view showing this from above. A throttle valve 3 of the engine 2 and a recirculated gas control valve 4 forming the principal element of the exhaust gas recirculation device 1 are successively attached at a predetermined interval in an intake pipe 5 in a direction (direction indicated by an arrow) in which the intake air, that is, an intaken fresh air (indicated as FA in the figure) flows. Needless to say the throttle valve 3 is provided as a variable opening valve at an appropriate position in the intake pipe 5 so as to adjust the flow rate of the intake air flowing in the intake pipe 5, while the recirculated gas control valve 4 is inserted as a variable opening valve at an appropriate position of the recirculated gas introduction passage 8 so as to adjust the flow rate of the recirculated gas (indicated as RG in the figure, with the gas exhausted to the outside being conversely indicated as EG) for taking out part of the exhaust gas from the exhaust manifold 6 side and refluxing the same into the intake air flowing in the intake pipe 5 at the intake manifold 7 side. The first embodiment is an example showing a case where the recirculated gas control valve 4 is directly attached to the pipe wall of the intake pipe 5.

[0022] On the other hand, a blow-by gas introduction passage 10 which introduces the blow-by gas (the blow-by gas is indicated as BG in the figure) accumulated in a crank case or cylinder head cover of the engine 2 into the intake pipe 5 for processing is opened in the pipe wall of the intake pipe 5 on the upstream side of the throttle valve 3.

[0023] In this case, when particularly viewing the flow of the intake air on the downstream side of the throttle valve 3, as shown in Fig. 3 and Fig. 4, in the part on the downstream side of the butterfly type throttle valve 3, a forward flow of the intake air flowing from the upstream side to the downstream side is formed in the part close to the pipe wall in the intake pipe 5 and, thereby, a low pressure part is formed at the center of the intake pipe immediately after the throttle valve 3. Therefore a phenomenon where part of the intake air flows back from the downstream side to the upstream side of the intake pipe 5 toward that low pressure part is observed. When the region in the intake pipe 5 in which the forward flow of the intake air exists is referred to as a "forward flow area" (shown by FF in the figure) and, at the same time, the region in which the back flow exists is referred to as a "back flow area" (shown by BF in the figure), the characteristic feature of the present invention basically resides in that the recirculated gas inflowing port 11 is opened in the forward flow area of the intake air.

[0024] It should be noted here that the shape of a curve B indicating the border of the forward flow area and the back flow area in the lateral cross sectional view is not a circular shape following the pipe wall of the intake pipe 5 in Fig. 4 indicating the lateral cross section of the intake pipe 5, but becomes a flat long oval shape due to the influence of the valve stem 12 of the throttle valve 3. For this reason, a phenomenon where the thickness of the forward flow area in the radial direction becomes the smallest at the part where the valve stem 12 intersects the pipe wall of the intake pipe 5 and becomes the largest at the part near a straight line R-R orthogonal to the valve stem 12 was found. Accordingly, one of the concrete characteristic features in the first embodiment resides in that, as shown in Fig. 3, the opening of the recirculated gas introduction passage 8, that is, the recirculated gas inflowing port 11, is provided particularly at the lower position of the pipe wall intersecting the straight line R-R in the forward flow area at the downstream side of the throttle valve 3. Where a throttle valve 3 of the butterfly type is used, the position suitable for providing the recirculated gas inflowing port 11 corresponds to the downstream side of the position where the throttle valve 3 opens earliest when it starts to open from the closed state.

[0025] The difference in the mode of operation and effect. between the conventional case and the first comparative example will be explained by a comparison of Fig. 5 and Fig. 6. Namely, the state of the flow of the recirculated gas when the recirculated gas flows into the back flow area of the intake air as in the conventional case while setting the recirculation rate of the exhaust gas at 20 percent is shown in Fig. 5 and, at the same time, the case of the first embodiment when the recirculated gas flows into the forward flow area under similar conditions is shown in Fig. 6.

[0026] In the case of the conventional example shown in Fig. 5, one reason for the recirculated gas inflowing port 11 often being opened in the back flow area of the intake air is that it is desired to make the length of the pipe in the piping the shortest. Concretely explaining this by Fig. 22 showing the related art, for example, in a four-cylinder internal combustion engine 2, the intake pipe 5 is extended in a right angle direction with respect to the direction of arrangement of the serially arranged four cylinders #1 to #4, but in order to make the distribution of the intake air to the combustion chambers 14 of the cylinders uniform, it is necessary to provide the valve stem 12 of the butterfly type throttle valve 3 parallel to the direction of arrangement of the cylinders.

[0027] On the other hand, the recirculated gas introduction passage 8 extending from one part of the exhaust manifold 6 to the intake pipe 5 side is guided to the opposite side of the cylinder block 9 at substantially the same height as that of the intake pipe 5, therefore due to the necessity of making the length of the passage 8 the shortest, the recirculated gas inflowing port 11 is provided in the plane containing the valve stem 12 of the throttle valve 3. However, on the downstream side of the throttle valve 3, near the valve stem 12, the thickness of the forward flow area of the intake air has become small as shown in Fig. 4, and the back flow area of the intake air extends to the considerably downstream side. Accordingly, as shown in Fig. 5, in the case of the conventional example where the recirculated gas inflowing port 11 is provided in the plane containing the valve stem 12, the inflowing port 11 will be opened in the back flow area of the intake air.

[0028] When the recirculated gas inflowing port 11 is opened in the back flow area of the intake air of the intake pipe 5 as in the conventional example shown in Fig. 5, the recirculated gas flowing from the inflowing port 11 into the intake pipe 5 reaches the throttle valve 3 while riding the flow flowing back from the downstream side of the intake pipe 5 toward the upstream side and build-up of deposits on the throttle valve 3 occurs, but if the recirculated gas inflowing port 11 is provided in the forward flow area of the intake air as in the first comparative example shown in Fig. 6, the inflowing recirculated gas flows to the downstream side from the inflowing port 11 while ridingthe forward flow of the intake air, so the build-up of deposits on the throttle valve 3 can be prevented. In the first comparative example, the inflowing port 11 is provided at the position where the thickness of the forward flow area becomes the largest, that is, the valve stem 15 of the poppet type recirculated gas control valve is provided on a straight line at right angles relative to the valve stem 12, therefore the best effect is obtained. As will be deduced from this fact, if the inflowing port 11 exists in the forward flow area of the intake air, substantially the same effect is obtained.

[0029] A second comparative example is shown in Fig. 7. If the recirculated gas inflowing port 11 is opened in the forward flow area of the intake air on the downstream side of the throttle valve 3 in this way, even if the recirculated gas control valve 4 is provided at the middle of the recirculated gas introduction passage 8 as exemplified in Fig. 7, a similar effect to that of the case of the first comparative example is obtained.

[0030] An undesirable conventional example is shown in Fig. 8. In this example, the valve stem 12 of the throttle valve 3 is provided in a direction at right angles with respect to the direction of arrangement of the cylinders #1 to #4 of the engine 2, therefore the distribution of the intake air to the cylinders is no longer uniformly carried out. If the recirculated gas inflowing port 11 is opened on the downstream side at the position where the valve stem 12 intersects with the pipe wall of the intake pipe 5, it will cause the flow of the recirculated gas into the back flow area of the intake air, therefore there arises the problem of buildup of deposits at the throttle valve 3. Contrary to this, in the second comparative example shown in Fig. 7, these problems are simultaneously solved by merely aligning the valve stem 12 of the throttle valve 3 in Fig. 8 in direction with the direction of arrangement of the cylinders.

[0031] The effect of the second comparative example will be explained in comparison with the poor example by Figs. 9A and 9B and Figs. 10A and 10B. Figure 9A shows a similar configuration to that shown in Fig. 8, in which the valve stem 12 of the butterfly type throttle valve 3 is arranged in the direction at right angles with respect to the direction of arrangement of the plurality of cylinders. Figure 10A compared with this shows a configuration similar to that shown in Fig. 7, in which the direction of arrangement of the plurality of cylinders and the direction of the valve stem 12 of the throttle valve 3 coincide. When the exhaust gas recirculation rate for each cylinder was measured under common conditions where the mean exhaust gas recirculation rate is 14.3 percent when the degree of opening of the throttle valve 3 is 100 percent, in the conventional system, a variation of 5 percent was confirmed as shown in Fig. 9B, but the variation could be suppressed to about 0.8 percent as shown in Fig. 10B.

[0032] Next, an explanation will be made of the first embodiment of the present invention. In this example, as shown in Fig. 11 to Fig. 13, so as to enable a different design from those of the first and second comparative examples, the characteristic feature resides in that the valve stem 15 of the recirculated gas control valve 4 is supported in parallel to the valve stem 12 of the throttle valve 3 and, at the same time, the position of the former is set at a position separate from the position of the latter by exactly the required distance, whereby the valve stem 15 and the valve seat 16 of the recirculated gas control valve 4 are offset at the outside of the pipe wall of the intake pipe 5. Then, in this case, a recirculated gas directing passage 17 is mounted on the pipe wall of the intake pipe 5, and the valve seat 16 is connected to the recirculated gas inflowing port 11. In the recirculated gas directing passage 17, an inclined surface (indicated as 18) is provided so as to enable the recirculated gas to easily ride on the forward flow of the intake air.

[0033] In the first embodiment, since the recirculated gas guide passage 18 having the inclined surface 18 inclined toward the forward flow area of the intake air was provided, even if the valve stem 12 of the throttle valve 3 and the valve stem 15 of the recirculated gas control valve are provided close to each other in the direction of the intake pipe 5, the back flow of the recirculated gas to the throttle valve 3 can be prevented. Further, if the partition flange 19 as shown in Fig. 12 and Fig. 13 is added and the opening position of the recirculated gas inflowing port 11 is shifted as much as possible from the throttle valve 3 to the downstream side, the flow rate of the forward flow of the intake air (mixture of the fresh air and blow-by gas) in the inflowing port 11 can be raised in comparison with a case where the partition flange 19 is not provided, therefore the recirculated gas can easily ride on the forward flow and the back flow of the recirculated gas to the throttle valve 3 can be further effectively hindered.

[0034] Further, since the recirculated gas directing passage 17 is provided with the inclined surface 18 inclined toward the downstream side of the intake pipe 5, the recirculated gas gradually smoothly flows out into the intake air flow and diffuses uniformly, therefore the distribution of the recirculated gas with respect to the cylinders is uniformly carried out, occurrence of a variation in the output of the different cylinders can be prevented, and the speed of the engine at the time of a low load operation becomes smoother than in the conventional case.

[0035] Further, in this embodiment, since the valve stem 12 of the throttle valve 3 and the valve stem 15 of the recirculated gas control valve 4 are arranged in parallel and the distance between the valve stems 12 and 15 in the direction of the intake pipe 5 is made small, it becomes possible to shorten the length of the intake pipe 5 near the throttle valve 3, and consequently the entire engine can be made smaller in size. By this, the response of acceleration is improved.

[0036] There is a slight difference in the mode of operation and effect between the first comparative example and the first embodiment due to the difference of the configurations. In the case of the first comparative example, if the exhaust gas recirculation rate is about 20 percent, as shown in Fig. 6, the recirculated gas flows to the downstream side while riding the forward flow of the intake air and does not flow back to the throttle valve 3, but if the recirculation rate exceeds a certain line of approximately 50 percent, a very large amount of recirculated gas is fed into the intake pipe 5, and therefore, as shown in Fig. 14, part of the recirculated gas sometimes still flows back and reaches the throttle valve 3. When the configuration shown in the first embodiment is used, however, due to the mode of operation of the partition flange 19, the inclined surface 18, etc., as shown in Fig. 15, the recirculated gas does not flow backhand reach the throttle valve 3 even in a state where the recirculation rate exceeds 50 percent.

[0037] Further, as a modification of the first embodiment, when the area of the flow path of the recirculated gas inflowing port 11 opened to the intake pipe 5 is made larger than the valve seat 16 of the recirculated gas control valve 4, and, for example, as in the second embodiment shown in Fig. 16, a fan-shaped gas inflowing port 20, the flow rate of the recirculated gas into the intake pipe 5 is lowered and, at the same time, the recirculated gas can flow into the flow of the intake air (mixture of the fresh air and blow-by gas) while being dispersed, therefore it becomes further easier for the recirculated gas having a lowered density to ride on the forward flow of the intake air, and the back flow to the throttle valve 3 can be prevented.

[0038] Further, in the third embodiment shown in Fig. 17 to Fig. 19, by providing the valve seat 16 of the recirculated gas control gas 4 and the recirculated gas inflowing port 11 above the throttle valve 4 corresponding to the direction of the opening and closing of the butterfly type throttle valve 3 with the parallel supported valve stem 12, the buildup of deposits due to not only the components contained in the recirculated gas, but also the lubricant oil particles of the engine contained in the blow-by gas can be prevented, whereby the inconvenience of reduction of the sectional area of the flow path of the valve seat 16 can be avoided.

[0039] The reason for this is that even if the lubricant oil particles etc. contained in the blow-by gas adhere to the inner surface of the intake pipe 5 to form an oil film, the oil film will flow downward due to gravity and therefore will not flow to near the recirculated gas control valve 4 provided above the throttle valve 3, so the formation of a deposit there due to the adhesion of the carbon particles etc. in the recirculated gas will not occur.

[0040] Note that, in the third embodiment, the position of the upper portion of the throttle valve 3 provided with the recirculated gas inflowing port 11 is downstream of the position at which the throttle valve 3 opens earliest when it starts to gradually open from the closed state. Accordingly, the recirculated gas flowing into the intake pipe 5 from the recirculated gas inflowing port 11 is mixed well with the intake air even if the degree of opening of the throttle valve 37 is small. Then, when the recirculated gas is shut off, the influence of the recirculated gas quickly disappears at the downstream side of the throttle valve 3, therefore the response with respect to the opening and closing of the recirculated gas control valve 4 becomes high. Also in this case, there is a large effect that the intrusion of the blow-by gas into the recirculated gas control valve 4 can be hindered by providing the recirculated gas directing passage 17 provided with the partition flange 19 and the inclined surface 18.

[0041] Further, if the directing passage 17 of the recirculated gas is mounted on the upper portion of the intake manifold 7 as part of the intake pipe 5 as in the fourth embodiment shown in Fig. 20 and Fig. 21, the throttle valve 3 can be made placed closer to the cylinder block 9 than that in the other embodiments, therefore, when the recirculated gas control valve 4 is opened for acceleration, the volume of the intake pipe 5 containing the intake manifold 7 on the downstream side from this is smaller than that of the case where the throttle valve 3 and the recirculated gas control valve 4 are provided at the more upstream position, therefore the amount of the recirculated gas remaining in the intake pipe 5 is small, and thus the acceleration response of the engine 2 becomes high and, at the same time, it becomes possible to make the exhaust gas recirculation device 1 compact in size.

[0042] The point that the recirculated gas directing passage 17 and the recirculated gas inflowing port 11 are provided in the intake manifold 7 for this purpose is different from the third embodiment, but substantially the same mode of operation and effect are obtained.

[0043] Both of the third embodiment and the fourth embodiment have the recirculated gas directing passage 17 provided with the inclined surface 18 as shown in Fig. 17 and Fig. 20, therefore, similar to the above embodiments, the distribution of the recirculated gas with respect to the cylinders of the engine becomes more uniform, the variation of output of the different cylinders becomes small, the speed becomes stable in the time of a low load operation, etc.

[0044] Next, a further comparative example with not claimed is shown in Fig. 23 to Fig. 25. A common characteristic feature of this comparative example with a further comparative example (Fig. 26) and fifth embodiment (Fig. 27) mentioned later resides in that an elbow-shaped bent pipe 24 is provided so as to be connected to the end of the recirculated gas introduction passage 8, the recirculated gas directing passage 17 is formed inside the bent pipe 24 and, at the same time, the opening of the other end of the bent pipe 24 is defined as the recirculated gas inflowing port 11 opening toward the downstream side of the intake pipe 5, whereby the recirculated gas inflowing port 11 of this bent pipe 24 is opened at a relatively downstream part of the flow of the intake air in the forward flow area of the intake air formed in the intake pipe 5.

[0045] Note that all of bent pipes 24 are shaped as elbows, but the pipes used as the bent recirculated gas guide passage in the present invention are not always formed by just elbow-shaped bent pipes 24 and be any bent pipes 24 so far as the bent recirculated gas directing passage 17 is formed and the recirculated gas flowing inside this is guided to the forward flow area at the relatively downstream side of the intake pipe 5 and, at the same time, they can discharge the recirculated gas toward the downstream side of the flow of the intake air in the opening of the other end. Therefore the bent pipe 24 should be generally read as a "bent passage means".

[0046] In the case of the above first comparative example (Fig. 1 to Fig. 4), if the recirculation rate of the exhaust gas is about 20 percent, the flow rate of the fresh air is high and the flow rate of the recirculated gas is low, therefore the recirculated gas flowing out of the recirculated gas inflowing port 11 opened in the forward flow area of the exhaust gas into the intake pipe 5 flows toward the downstream side while riding the forward flow of the fresh air in the intake pipe 5, so the recirculated gas does not flow into the back flow area of the intake air, but if the recirculation rate becomes high up to about 50 percent, as previously explained by using Fig. 14, the flow rate of the fresh air in the intake pipe 5 becomes low, but in contrast, the flow rate of the recirculated gas flowing out of the inflowing port 11 becomes high, therefore there is a case where the recirculated gas penetrates through the forward flow area of the fresh air and flows into the back flow area. In such a case, similar to the related art, the recirculated gas will flow back, although the amount thereof is small, and a deposit will sometimes be produced in the throttle valve 3, etc.

[0047] In the above first embodiment (refer to Fig. 11 to Fig. 13 and Fig. 15), a similar problem is solved by providing the recirculated gas directing passage 17 having the inclined surface 18, the partition flange 19, etc. but in the seventh embodiment, this problem is solved by providing the bent pipe 24 opened toward the downstream side of the flow of the intake air so as to be connected to the valve seat 16 of the recirculated gas control valve provided at the position where the recirculated gas introduction passage 8 penetrates through the pipe wall of the intake pipe 5 in the forward flow area of the fresh air in the intake pipe 5 and defining the opening of the end of the bent pipe 24 as the recirculated gas inflowing port 11 with respect to the intake pipe 5.

[0048] Accordingly, in the present comparative example, as shown in Fig. 24, the recirculated gas flowing in the introduction passage 8 passes the valve seat 16 of the recirculated gas control valve and is then guided by the smooth directing passage 17 formed inside the bent pipe 24 and changes in direction of flow, then is discharged to the direction of flow of the forward flow area of fresh air from the inflowing port 11 opened in the forward flow area of the fresh air, therefore even if the recirculated gas control valve 4 is provided close to the throttle valve 3 and even in a case where the valve stem 15 of the recirculated gas control valve 4 is located at the upstream side in the direction of the intake pipe 5 from the valve stem 12 of the throttle valve 3 as an extreme case, it becomes possible to open the inflowing port 11 in the forward flow area of the fresh air by using the bent pipe 24. Further, even in a case where the recirculation rate is as high as about 50 percent, as shown in Fig. 25, the recirculated gas is fed into the forward flow area of the fresh air (intake air) sufficiently downstream from the throttle valve 3 by the directing passage 17 of the bent pipe 24, and therefore the back flow of the recirculated gas to the throttle valve 3 is reliably hindered.

[0049] Figure 26 shows the further comparative example not claimed. In this example as well the bent pipe 24 is used at the end of the recirculated gas introduction passage 8. The different point of this resides in that the recirculated gas control valve 4 is not provided in the pipe wall of the intake pipe 5, but is provided in the middle of the recirculated gas introduction passage 8. Also in this case, in the mode of operation and effect the recirculated gas can be fed into the forward flow area of the fresh air in the intake pipe 5 sufficiently downstream from the throttle valve 3 by the bent pipe 24, therefore an adverse influence upon the throttle valve 3 due to the back flow of the recirculated gas can be prevented.

[0050] Figure 27 shows the fifth embodiment of the present invention. In the ninth embodiment, the valve stem 12 of the throttle valve 3 and the valve stem 15 of the recirculated gas control valve 4 have become parallel, therefore it is difficult to make the recirculated gas evenly flow into the flow of fresh air at the downstream side of the throttle valve 3 as it is, but by providing the bent pipe 24 so as to be connected to the downstream side of the valve seat 16 of the recirculated gas control valve 4 and opening the inflowing port 11 of the end of the recirculated gas directing passage 17 in the forward flow area of the fresh air sufficiently downstream from the throttle valve 3, it becomes possible to prevent the back flow of the recirculated gas to the direction of the throttle valve 3 and, at the same time, the recirculated gas can be evenly mixed into the fresh air. In this way, by providing the bent pipe 24 opened at the end of the recirculated gas introduction passage 8, there is an advantage that a large degree of freedom is obtained in the positional relationship between the throttle valve 3 and the recirculated gas control valve 4.

[0051] In the illustrated embodiments, the example of using a diaphragm actuator operating by the negative pressure so as to operate the throttle valve 3 and the recirculated gas control valve 4 (the negative pressure added is indicated as NP in the figure, while atmospheric pressure is indicated as AP) was shown, but needless to say other types of actuators, for example, a stepping motor, a piezoactuator, and a solenoid type actuator can be used as the actuator of these valves.

[0052] Before explaining the subsequent embodiments of the present invention, a further concrete explanation will be made of the configuration, mode of operation, and problems of the exhaust gas recirculation device in the latter related art simply explained in section on the related art by referring to Fig. 31. In Fig. 31, 101 is a multi-cylinder engine, and 102 indicates a conventional exhaust gas recirculation device mounted on this. Reference numeral 103 is an air cleaner, and 104 is an intake passage connected to this and formed in an intake pipe 105, an intake manifold 106, etc. Reference numeral 107 indicates an exhaust manifold of the engine 101. The exhaust gas recirculation device 102 is constituted by a recirculated gas introduction passage 108 which extracts part of the exhaust gas EG from the exhaust manifold 107 as the recirculated gas and feeds this to part of the intake passage 104 and a recirculated gas control valve 109 provided at the end of the passage 108.

[0053] The conventional recirculated gas control valve 109 comprises a valve seat 110 acting also as the recirculated gas inflowing port formed in the lower portion of the intake pipe 105, a valve body 111 of a frustoconical shape opening and closing this, a long rod-like valve stem 112 which is integrally formed with the valve body 111 and crosses the intake passage 104, and an actuator 113 driving the upper end of the valve stem 112. Further, the actuator 113 is provided with a diaphragm 114 engaged with the upper end of the valve stem 112 and a compression spring 116 placed in a negative pressure chamber 115 formed in the upper portion of the diaphragm 114.

[0054] Separate from the exhaust gas recirculation device 102, in order to guide and process the blow-by gas BG accumulated in the crank case and the cylinder head cover 117 of the engine 101, a blow-by gas introduction passage 118 connecting them is provided. The blow-by gas inflowing port 119 which is the outlet opening thereof is opened in the pipe wall of the intake pipe 105 at the 5 upstream side of the valve seat 110 of the recirculated gas control valve 109.

[0055] As is well known, in the conventional exhaust gas recirculation device shown in Fig. 31, when the negative pressure NP for control acts upon the negative pressure chamber 115 of the diaphragm actuator 113, the diaphragm 114 moves upward against the biasing force of the compression spring 116 and the valve body 111 opens the valve seat 110 via the valve stem 112. As a result, the recirculated gas, which is one part of the exhaust gas from the exhaust manifold 107, passes through the recirculated gas introduction passage 108, is mixed into the intake fresh air flowing in the intake passage 104 from the valve seat 110, is fed into the combustion chamber of the engine 101 where it enhances the state of combustion and is used for the purification of the exhaust gas.

[0056] Recently, the flow rate of the recirculated gas has been increased more and more, but the temperature of the valve seat 110 and valve body 111 becomes high due to flow of a large amount of recirculated gas. The heat causes deterioration of the diaphragm 114 of the actuator 113 or, if the actuator is a stepping motor or the like, damages the same, but in the conventional example of Fig. 31, a long valve stem 112 of the recirculated gas control valve 109 is provided so as to cross the intake passage 104 in which the intake air containing a large amount of low temperature fresh air flows, therefore even if the temperature of the valve seat 110 and the valve body 111 becomes high, the heat is scattered from the long valve stem 112 into the intake air, therefore the breakage of the diaphragm 114 etc. of the actuator 113 due to the heat can be prevented.

[0057] However, as in the conventional example of Fig. 31, when the valve seat 110 of the recirculated gas control valve 108, which is the opening at the end of the recirculated gas introduction passage 108, is provided in the lower portion of the intake passage 104, if blow-by gas containing a large oil component flows from the inflowing port 119 at the end of the blow-by gas introduction passage 118 which is ordinarily provided at the upstream side of the recirculated gas control valve 109, that oil component is separated and adhered to the wall surface of the intake passage 104 and, at the same time, coagulates and forms an oil film which flows downward under the influence of gravity to flow to near the valve seat 110 of the recirculated gas control valve 109. The valve seat 110, which is the opening of the end of the recirculated gas introduction passage 108, emits the recirculated gas, therefore there is the possibility as mentioned above that the carbon particles contained in this will be mixed with the oil component in the blow-by gas and build up near the valve seat 110 to form a deposit that reduces the sectional area of the flow path or that causes the valve body 111 to stick to the valve seat 110 to make the operation impossible.

[0058] As a means for solving this problem, the exhaust gas recirculation device of the next comparative example is shown in Fig. 28 to Fig. 30. Below, the configuration thereof will be explained in detail. For making the comparison easy, the same reference symbols will be used for constituent parts substantially the same as those of the conventional example mentioned above. Namely, 101 denotes a multi-cylinder engine, 103 an air cleaner, 104 an intake passage, 105 an intake pipe, 106 an intake manifold, 107 an exhaust manifold, 108 a recirculated gas introduction passage, 113 a diaphragm actuator, 114 a diaphragm, 115 a negative pressure chamber, 116 a compression spring, 117 a cylinder head cover, 118 a blow-by gas introduction passage, and 119 a blow-by gas inflowing port.

[0059] As apparent from the comparison with the conventional example of Fig. 31, the characteristic feature of the exhaust gas recirculation device 120 of Fig. 28 to Fig. 30 resides in the related configuration of the recirculated gas control valve 121 attached to the intake pipe 105 and the downstream side part thereof. This control valve 121 is constituted in a pipe part 122 which is provided so as to be inserted into the middle of the intake pipe 105 and forms part of the intake passage 104. One part 105a of the intake pipe 105 which is located on the downstream side of the pipe part 122 has a shape matched with the end surface of the control valve 121 including the pipe part 122. In the illustrated example, the part 105a of the intake pipe 105 is separately provided from the pipe part 122 of the control valve 121, but it is also possible to integrally form them from the first. Particularly, by providing the partition wall 123 with the intake passage 104, the intake air and blow-by gas flowing toward the downstream side are prevented from directly flowing into the recirculated gas control valve 121. Needless to say, it is possible for the partition wall 123 to be formed by part of the pipe part 122 so far as it does not hinder installation of the recirculated gas control valve 121.

[0060] Further, the recirculated gas control valve 121 is provided with a valve body 124 which is attached in a direction with its axial line intersecting the axial line of the pipe part 122 at right angles at the upper portion of the pipe part 122 and accordingly at the upper portion of the intake passage 104, an inlet 125 of the recirculated gas provided there, an annular valve seat 126 formed in the valve body 124, a valve body 127 of a frustoconical shape opening and closing this, and a recirculated gas introduction port 128 which is opened toward the downstream side so that, when the valve body 127 is separated from the valve seat 126, the recirculated gas flowing through the valve gap between them is guided to the intake passage 104 and flows into the intake flow.

[0061] 5 The valve stem 129 integrally formed with the valve body 127 is driven by the actuator 133 in the same way as that of the conventional example. By attaching the valve body 124 of the recirculated gas control valve 121 so as to intersect with the pipe part 122, the actuator 113 can 10 be located at a position close to the intake pipe 105, therefore it will be cooled together with the valve body 124 by the intake air of the relatively low temperature flowing in the intake pipe 105. Accordingly, when the actuator 113 is a diaphragm type, deterioration of the diaphragm 114 due to the heat of the recirculated gas transferred from the valve body 127 via the valve stem 129 can be prevented.

[0062] In the operating state of the exhaust gas recirculation device 120, by the feeding of the negative pressure from a not illustrated vacuum pump or the like to the negative pressure chamber 115 of the diaphragm actuator 113, the valve body 127 of the recirculated gas control valve 121 opens or closes the valve gap with the valve seat 126 and makes an appropriate amount of recirculated gas flow into the flow of the intake air flowing in the intake passage 104 toward the downstream side from the introduction port 128 when necessary.

[0063] The blow-by gas flowing from the blow-by gas inflowing port 119 opened at the upstream side from the recirculated gas control valve 121 is contained in the intake air, and therefore the oil component in the blow-by gas adheres to the inner wall surface of the intake pipe 105 and coagulates to form an oil film, but the oil film flows downward due to gravity. In addition, since the partition wall 123 is provided in the lower portion of the recirculated gas control valve 121 with the intake passage 104, even if there is no inflow of the recirculated gas, the blow-by gas will not slip around to near the valve seat 126. Accordingly, due to these two functions, the intrusion and adhesion of the oil component in the blow-by gas to the periphery of the valve seat 126 of the recirculated gas control valve 121 are reliably hindered. As a result, the trouble of the carbon particles contained in the recirculated gas flowing out of the control valve 121 to be mixed with the oil component in the blow-by gas and forming a deposit in the flow path which reduces the sectional area of the flow path or causes sticking of the valve body 127 and the valve seat 126 and thereby poor operation of the control valve 121 can be avoided.

[0064] Next, an explanation will be made of the exhaust gas recirculation device 130 of further comparative example illustrated in Fig. 32 and Fig. 33. The configuration of the recirculated gas control valve 121 as above is maintained as it is. Only the configuration of the downstream part thereof is changed. Accordingly, the same reference symbols or numerals are attached to parts common with the 10th embodiment such as the recirculated gas control valve 121 and overlapping explanations will be omitted. The present comparative example has an inclined recirculated gas inflowing passage 131 which not only is shaped so that the control valve 121 and the part 105b of the intake pipe 5 connected to the downstream side of the pipe part 122 thereof match with the upstream side in the connected end surface, but also is connected to the recirculated gas introduction port 128 of the control valve 121 on the upstream side and, at the same time, opens in the intake passage 104 on the downstream side. The opening of the inflowing passage 131 with respect to the intake passage 104, that is, the recirculated gas inflowing port 132, can smoothly combine the recirculated gas flowing while passing through the control valve 121 with the intake air in the intake passage 104.

[0065] Since the recirculated gas inflowing passage 131 inclined from the valve seat 126 of the recirculated gas control valve 121 toward the intake passage 104 is provided, the flow rate is lowered during the period when the recirculated gas passing through the valve gap between the valve body 127 and valve seat 126 of the control valve 121 flows in the inflowing passage 131, thus there are the advantages that the mixture with the intake air flowing in the intake passage 104 becomes better and the distribution of the recirculated gas with respect to cylinders becomes more uniform than that of the case of the preceding comparative example.

[0066] Figure 34 and Fig. 35 show the exhaust gas recirculation device 133 according to a sixth embodiment of the present invention. The characteristic feature of the sixth embodiment resides in that, while maintaining the substantive configuration of the exhaust gas recirculation device 130 of the above comparative example as it is, the pipe part 122 of the recirculated gas control valve 121 and the part 105a of the intake pipe 105 on the downstream side are combined so as to provide the recirculated gas inflowing member 134. Accordingly, in this case, part of the recirculated gas inflowing member 134 corresponds to the pipe part 122 in the above comparative example, therefore only the valve part excluding the pipe part 122 from the recirculated gas control valve 121 in the above comparative example is shown as the recirculated gas control valve 121' in the sixth embodiment. By providing the recirculated gas inflowing member 134, the number of parts and number of installation steps are reduced, therefore, in the sixth embodiment, the production costs can be reduced.

Claims

1. An exhaust gas recirculation device in an internal combustion engine provided with a throttle valve (3) having a valve stem (12), which is provided in the middle of an intake pipe (5) and adjusts an amount of intake air passing through the intake pipe (5) to be taken into a combustion chamber in a cylinder; a recirculated gas introduction passage (8) for refluxing part of an exhaust gas as recirculated gas into said intake pipe (5); a recirculated gas control valve (21) having a valve stem (15), provided in said recirculated gas introduction passage (8) and adjusting the amount of the recirculated gas passing through the passage and flowing into said intake pipe (5); and a recirculated gas inflowing port (11) opening in said intake pipe (5) so as to make the recirculated gas flow into said intake pipe (5) at an end of said recirculated gas introduction passage (8), wherein

   said recirculated gas inflowing port (11) is opened in a forward flow area of intake air flowing from the upstream to downstream side in said intake pipe (5) at the downstream side of said throttle valve (3), and wherein

   a recirculated gas directing passage (17) is provided for connecting said recirculated gas inflowing port (11) and a valve seat portion (16) of said recirculated gas control valve (21), and said recirculated gas directing passage (17) is provided with an inclined surface (18) which is positioned on the outside area of said intake pipe (5) and inclined toward the downstream side of said intake pipe (5),

   characterized in that

   said valve stem (12) of said throttle valve (3) and valve stem (15) of said recirculated gas control valve (21) are arranged in parallel and their distance in the direction of said intake pipe (5) is small.

2. An exhaust gas recirculation device according to claim 1,

   characterized in that

   a partition flange (19) is provided at an upstream side of intake air of said recirculated gas inflowing port (11) and hinders the flowing of the recirculated gas to the upstream side of said recirculated gas inflowing port (11) when it flows into said intake pipe (5).

3. An exhaust gas recirculation device according to claim 1 or 2,

   characterized in that

   a blow-by gas introduction passage (10) makes the blow-by gas generated in said engine flow into said intake pipe (5) on the upstream side of said throttle valve (3) and, at the same time, said recirculated gas inflowing port (11) is provided in the upper portion of said throttle valve (3).

4. An exhaust gas recirculation device according to any one of claims 1 to 3,

   characterized in that

   said throttle valve (3) is a butterfly type, and the valve stem (12) thereof is disposed in parallel to the direction of arrangement of a plurality of cylinders of said engine.

5. An exhaust gas recirculation device according to claim 4,

   characterized in that

   said recirculated gas inflowing port (11) is opened in the lower portion of said throttle valve (3) in the pipe wall of the intake pipe (5) on the downstream side of said butterfly type throttle valve (3).

6. An exhaust gas recirculation device according to claim 5,

   characterized in that

   said recirculated gas inflowing port (11) is opened in the upper portion of said throttle valve (3) in the pipe wall of the intake pipe (5) on the downstream side of said butterfly type throttle valve (3).

7. An exhaust gas recirculation device according to any one of claims 1 to 6, wherein said recirculated gas inflowing port (11) has a fan shape.

8. An exhaust gas recirculation device according to any of claims 1 to 7,

   characterized in that

   said recirculated gas inflowing passage (17) is inclined with respect to said intake pipe (5).

9. An exhaust gas recirculation device according to claim 8,
characterized in that
said recirculated gas inflowing passage (17) is integrally formed with said recirculated gas control valve (21).

10. An exhaust gas recirculation device according to any of claim 2,
characterized in that
both of said partition flange (19) and recirculated gas introduction passage (8) are provided in the upper portion of said intake pipe (5).

11. An exhaust gas recirculation device according to any one of claims 1 to 10,
characterized in that
said throttle valve (3) and recirculated gas control valve (21) are disposed in a common housing.

Patentansprüche

1. Abgasrückführeinrichtung in einem Verbrennungsmotor, ausgestattet mit einer Drosselklappe (3) mit einem Ventilschaft (12), der in der Mitte eines Ansaugrohres (5) angeordnet ist und eine Menge von durch das Ansaugrohr (5) strömende und zu einer Brennkammer in einem Zylinder zu leitende Ansaugluft regelt; Zuführleitung (8) für zurückgeführtes Gas zum Zurückführen eines Teils eines Abgases als zurückgeführtes Gas in das Ansaugrohr (5); Steuerventil (21) für zurückgeführtes Gas mit einem Ventilschaft (15), der in der Zuführleitung (8) für zurückgeführtes Gas angeordnet ist und die Menge des durch die Leitung und in das Ansaugrohr (5) strömenden zurückgeführten Gases regelt; und Zustromöffnung (11) für zurückgeführtes Gas, die sich in dem Ansaugrohr (5) öffnet, um das zurückgeführte Gas am Ende der Zuführleitung (8) für zurückgeführtes Gas in das Ansaugrohr (5) strömen zu lassen, wobei
die Zustromöffnung (11) für zurückgeführtes Gas in einem Vorwärtsstrombereich von Ansaugluft geöffnet wird, die auf der stromabwärts gelegenen Seite der Drosselklappe (3) von der stromaufwärts zur stromabwärts gelegenen Seite des Ansaugrohres (5) strömt, und wobei
eine Führungsleitung (17) für zurückgeführtes Gas bereitgestellt wird, um die Zustromöffnung (11) für zurückgeführtes Gas und einen Ventilsitzteil (16) des Steuerventils (21) für zurückgeführtes Gas zu verbinden, und wobei die Führungsleitung (17) für zurückgeführtes Gas mit einer geneigten Oberfläche (18) ausgestattet ist, die im Außenbereich des Ansaugrohrs (5) angeordnet und in Richtung der stromabwärts gelegenen Seite des Ansaugrohrs (5) geneigt ist,
dadurch gekennzeichnet, dass
der Ventilschaft (12) der Drosselklappe (3) und der Ventilschaft (15) des Steuerventils (21) für zurückgeführtes Gas parallel angeordnet sind und ihr Abstand in Richtung des Ansaugrohrs (5) gering ist.

2. Abgasrückführeinrichtung nach Anspruch 1,
dadurch gekennzeichnet, dass
ein Teilungsflansch (19) an einer stromaufwärts der Ansaugluft gelegenen Seite der Zustromöffnung (11) für zurückgeführtes Gas angeordnet ist und das Strömen des zurückgeführten Gases zur stromaufwärts gelegenen Seite der Zustromöffnung (11) für zurückgeführtes Gas verhindert, wenn es in das Ansaugrohr (5) strömt.

3. Abgasrückführeinrichtung nach Anspruch 1 oder 2,
dadurch gekennzeichnet, dass
eine Zuführleitung (10) für Durchblasgas das in dem Motor erzeugte Durchblasgas in das Ansaugrohr (5) an der stromaufwärts gelegenen Seite der Drosselklappe (3) strömen lässt und gleichzeitig die Zustromöffnung (11) für zurückgeführtes Gas im oberen Teil der Drosselklappe (3) angeordnet ist.

4. Abgasrückführeinrichtung nach einem beliebigen der Ansprüche 1 bis 3,
dadurch gekennzeichnet, dass
die Drosselklappe (3) vom Typ eines Klappenventils ausgeführt ist und sein Ventilschaft (12) parallel zur Anordnungsrichtung mehrerer Zylinder des Motors angeordnet ist.

5. Abgasrückführeinrichtung nach Anspruch 4,
dadurch gekennzeichnet, dass
die Zustromöffnung (11) für zurückgeführtes Gas im unteren Teil der Drosselklappe (3) in der Rohrwand des Ansaugrohrs (5) auf der stromabwärts gelegenen Seite der Drosselklappe (3) vom Typ eines Klappenventils geöffnet wird.

6. Abgasrückführeinrichtung nach Anspruch 5,
dadurch gekennzeichnet, dass
die Zustromöffnung (11) für zurückgeführtes Gas im oberen Teil der Drosselklappe (3) in der Rohrwand des Ansaugrohrs (5) an auf der stromabwärts gelegenen Seite der Drosselklappe (3) vom Typ eines Klappenventils geöffnet wird.

7. Abgasrückführeinrichtung nach einem beliebigen der Ansprüche 1 bis 6, wobei die Zustromöffnung (11) für zurückgeführtes Gas eine Fächerform hat.

8. Abgasrückführeinrichtung nach einem beliebigen der Ansprüche 1 bis 7,
dadurch gekennzeichnet, dass
die Zustromleitung (17) für zurückgeführtes Gas im

Verhältnis zum Ansaugrohr (5) geneigt ist.

9. Abgasrückführeinrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die Zustromleitung (17) für zurückgeführtes Gas in das Steuerventil (21) für zurückgeführtes Gas integriert ist.

10. Abgasrückführeinrichtung nach einem beliebigen der Ansprüche 2, **dadurch gekennzeichnet, dass** sowohl der Teilungsflansch (19) als auch die Zuführleitung (8) für zurückgeführtes Gas im oberen Teil des Ansaugrohrs (5) angeordnet sind.

11. Abgasrückführeinrichtung nach einem beliebigen der Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** die Drosselklappe (3) und das Steuerventil (21) für zurückgeführtes Gas in einem gemeinsamen Gehäuse angeordnet sind.

Revendications

1. Dispositif de remise en circulation de gaz d'échappement dans un moteur à combustion interne muni d'une soupape à papillon (3) ayant une tige de soupape (12), qui est disposée au centre d'une pipe d'admission (5) et ajuste une quantité d'air d'admission passant à travers la pipe d'admission (5) à amener dans une chambre de combustion d'un cylindre ; un passage d'introduction de gaz remis en circulation (8) pour refluer une partie des gaz d'échappement en tant que gaz remis en circulation dans ladite pipe d'admission (5) ; une valve de contrôle de gaz remis en circulation (21) ayant une tige de soupape (15), disposée dans ledit passage d'introduction de gaz remis en circulation (8) et ajustant la quantité du gaz remis en circulation passant à travers le passage et s'écoulant dans ladite pipe d'admission (5) ; et un port d'entrée de gaz remis en circulation (11) s'ouvrant dans ladite pipe d'admission (5) afin de permettre au gaz remis en circulation de s'écouler dans ladite pipe d'admission (5) à une extrémité dudit passage d'introduction de gaz remis en circulation (8), dans lequel

- ledit port d'entrée de gaz remis en circulation (11) est ouvert dans une zone d'écoulement avancé d'air d'admission s'écoulant du côté amont vers le côté aval dans ladite pipe d'admission (5) sur le côté aval de ladite soupape à papillon (3), et dans lequel

- un passage de direction de gaz remis en circulation (17) est fourni pour relier ledit port d'entrée de gaz remis en circulation (11) et une partie du siège de soupape (16) de ladite valve de contrôle de gaz remis en circulation (21), et ledit passage de direction de gaz remis en circulation (17) est doté d'une surface inclinée (18) qui est positionnée sur la zone extérieure de ladite pipe d'admission (5) et inclinée vers le côté aval de ladite pipe d'admission (5),

caractérisé en ce que

- lesdites tige de soupape (12) de ladite soupape à papillon (3) et tige de soupape (15) de ladite valve de contrôle de gaz remis en circulation (21) sont agencées en parallèle et leur distance dans la direction de ladite pipe d'admission (5) est réduite.

2. Dispositif de remise en circulation de gaz d'échappement selon la revendication 1, **caractérisé en ce que**

- une bride de séparation (19) est fournie sur un côté amont de l'air d'admission dudit port d'entrée de gaz remis en circulation (11) et empêche l'écoulement du gaz remis en circulation vers le côté amont dudit port d'entrée de gaz remis en circulation (11) lorsqu'il s'écoule dans ladite pipe d'admission (5).

3. Dispositif de remise en circulation de gaz d'échappement selon la revendication 1 ou 2, **caractérisé en ce que**

- un passage d'introduction de gaz de soufflage (10) permet au gaz de soufflage généré dans ledit moteur de s'écouler dans ladite pipe d'admission (5) sur le côté amont de ladite soupape à papillon (3) et, en même temps, ledit port d'entrée de gaz remis en circulation (11) est disposé dans la partie supérieure de ladite soupape à papillon (3).

4. Dispositif de remise en circulation de gaz d'échappement selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que**

- ladite soupape à papillon (3) est de type à oreilles, et la tige de soupape (12) de celle-ci est agencée parallèlement à la direction d'agencement d'une pluralité de cylindres dudit moteur.

5. Dispositif de remise en circulation de gaz d'échappement selon la revendication 4, **caractérisé en ce que**

- ledit port d'entrée de gaz remis en circulation

(11) est ouvert dans la partie inférieure de ladite soupape à papillon (3) dans la paroi de pipe de la pipe d'admission (5) sur le côté aval de ladite soupape à papillon de type à oreilles (3).

6. Dispositif de remise en circulation de gaz d'échappement selon la revendication 5,
caractérisé en ce que

- ledit port d'entrée de gaz remis en circulation (11) est ouvert dans la partie supérieure de ladite soupape à papillon (3) dans la paroi de pipe de la pipe d'admission (5) sur le côté aval de ladite soupape à papillon de type à oreilles (3).

7. Dispositif de remise en circulation de gaz d'échappement selon l'une quelconque des revendications 1 à 6, dans lequel ledit port d'entrée de gaz remis en circulation (11) a une forme en éventail.

8. Dispositif de remise en circulation de gaz d'échappement selon l'une quelconque des revendications 1 à 7,
caractérisé en ce que

- ledit passage d'arrivée de gaz remis en circulation (17) est incliné par rapport à ladite pipe d'admission (5).

9. Dispositif de remise en circulation de gaz d'échappement selon la revendication 8,
caractérisé en ce que

- ledit passage d'arrivée de gaz remis en circulation (17) est intégralement formé avec ladite valve de contrôle de gaz remis en circulation (21).

10. Dispositif de remise en circulation de gaz d'échappement selon la revendication 2,
caractérisé en ce que

- la bride de séparation (19) et le passage d'introduction de gaz remis en circulation (8) sont tous deux disposés dans la partie supérieure de ladite pipe d'admission (5).

11. Dispositif de remise en circulation de gaz d'échappement selon l'une quelconque des revendications 1 à 10,
caractérisé en ce que

- lesdites soupapes à papillon (3) et valve de contrôle de gaz remis en circulation (21) sont agencées dans un logement commun.

Fig.1

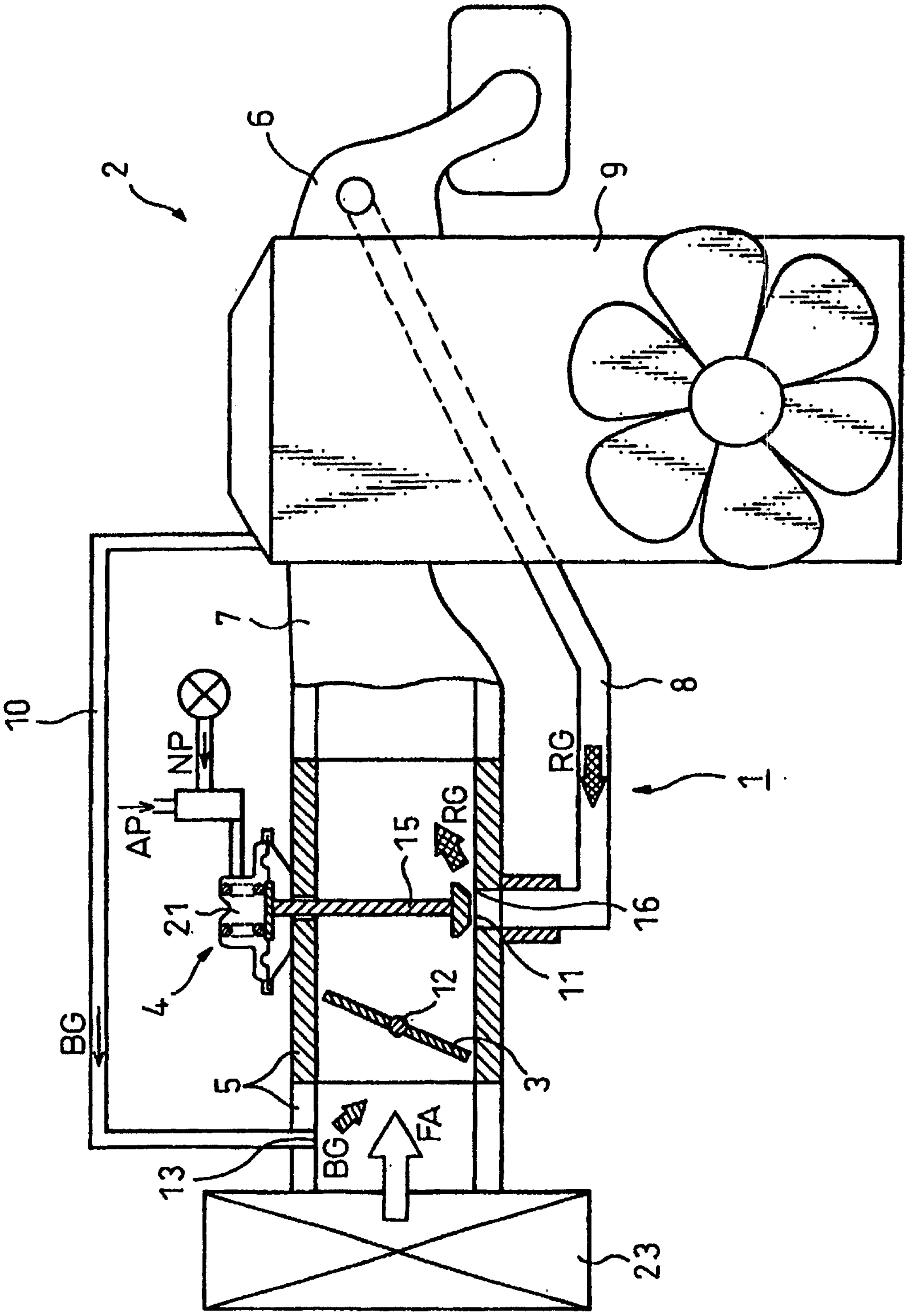


Fig. 2

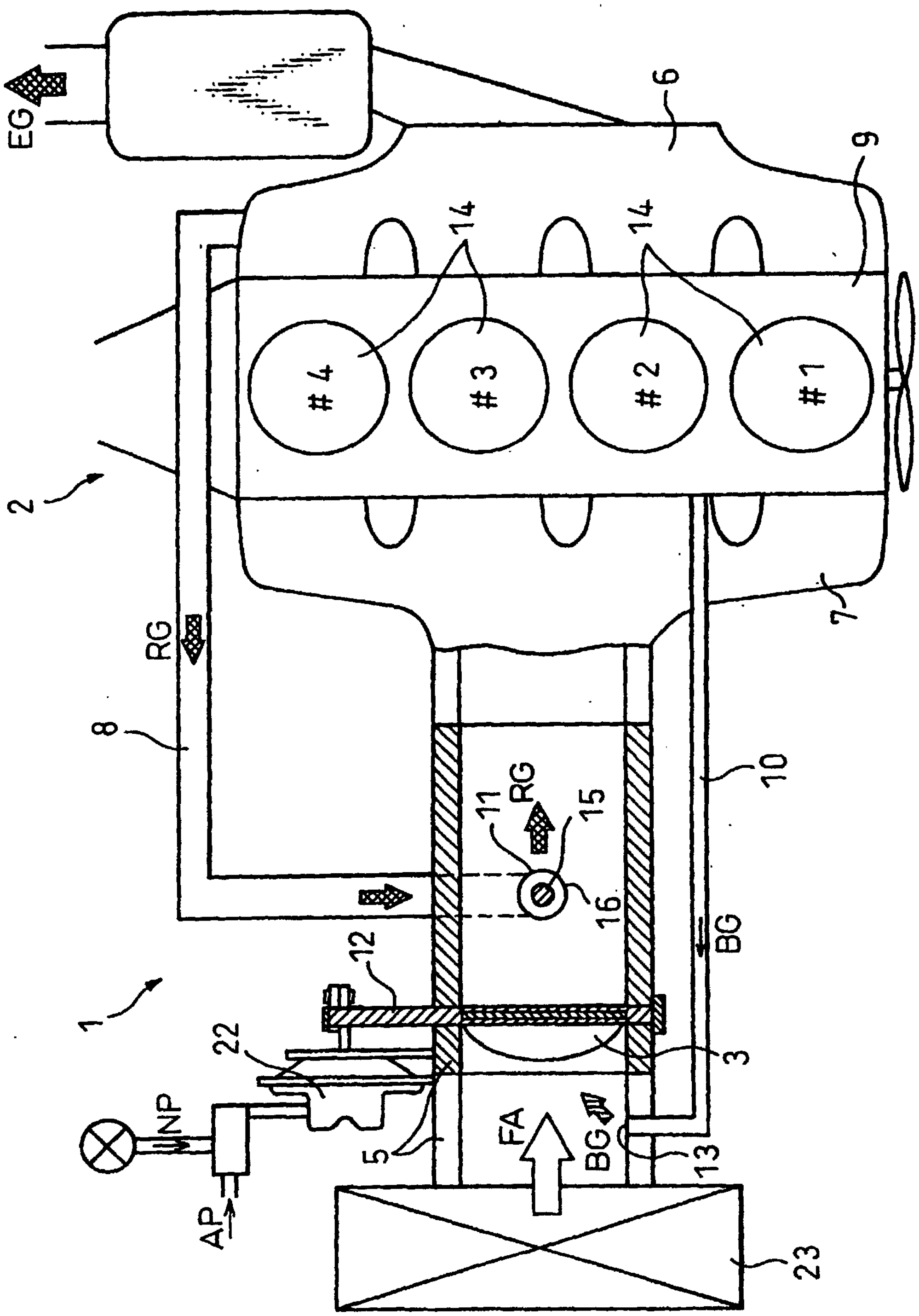


Fig. 3

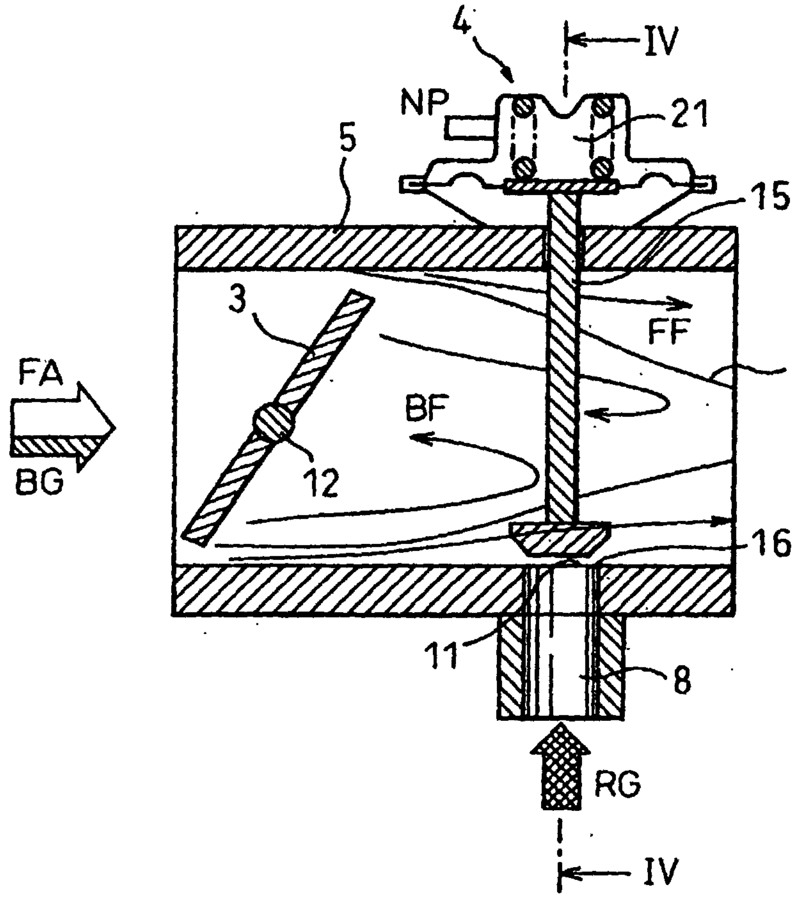


Fig. 4

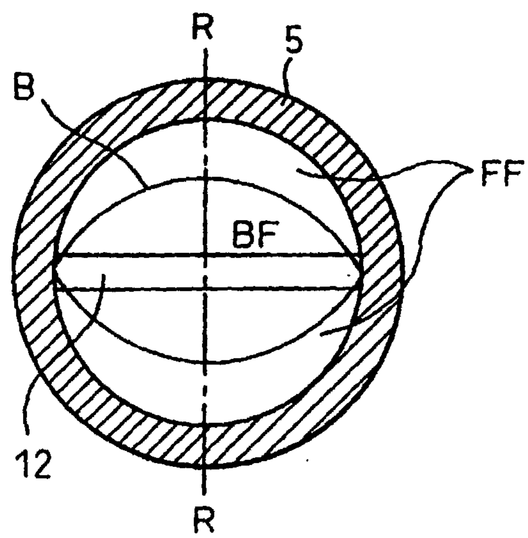


Fig.5
PRIOR ART

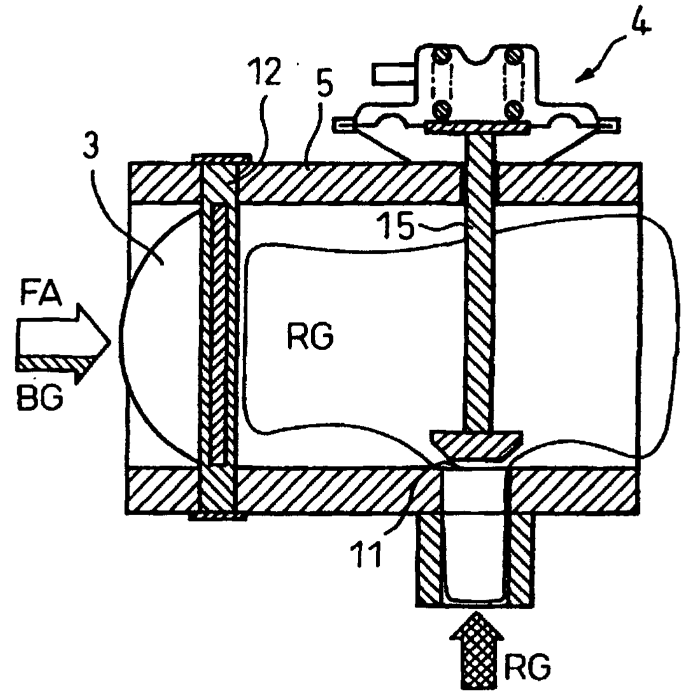


Fig.6

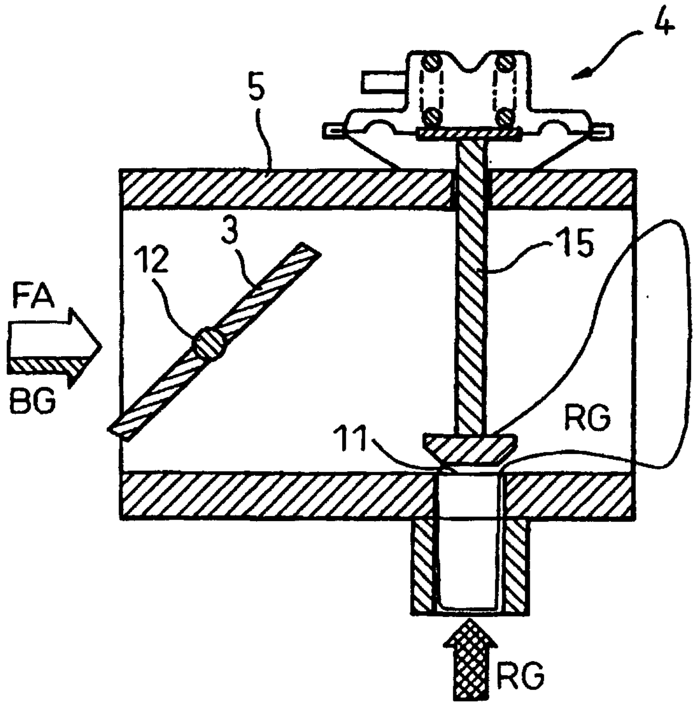
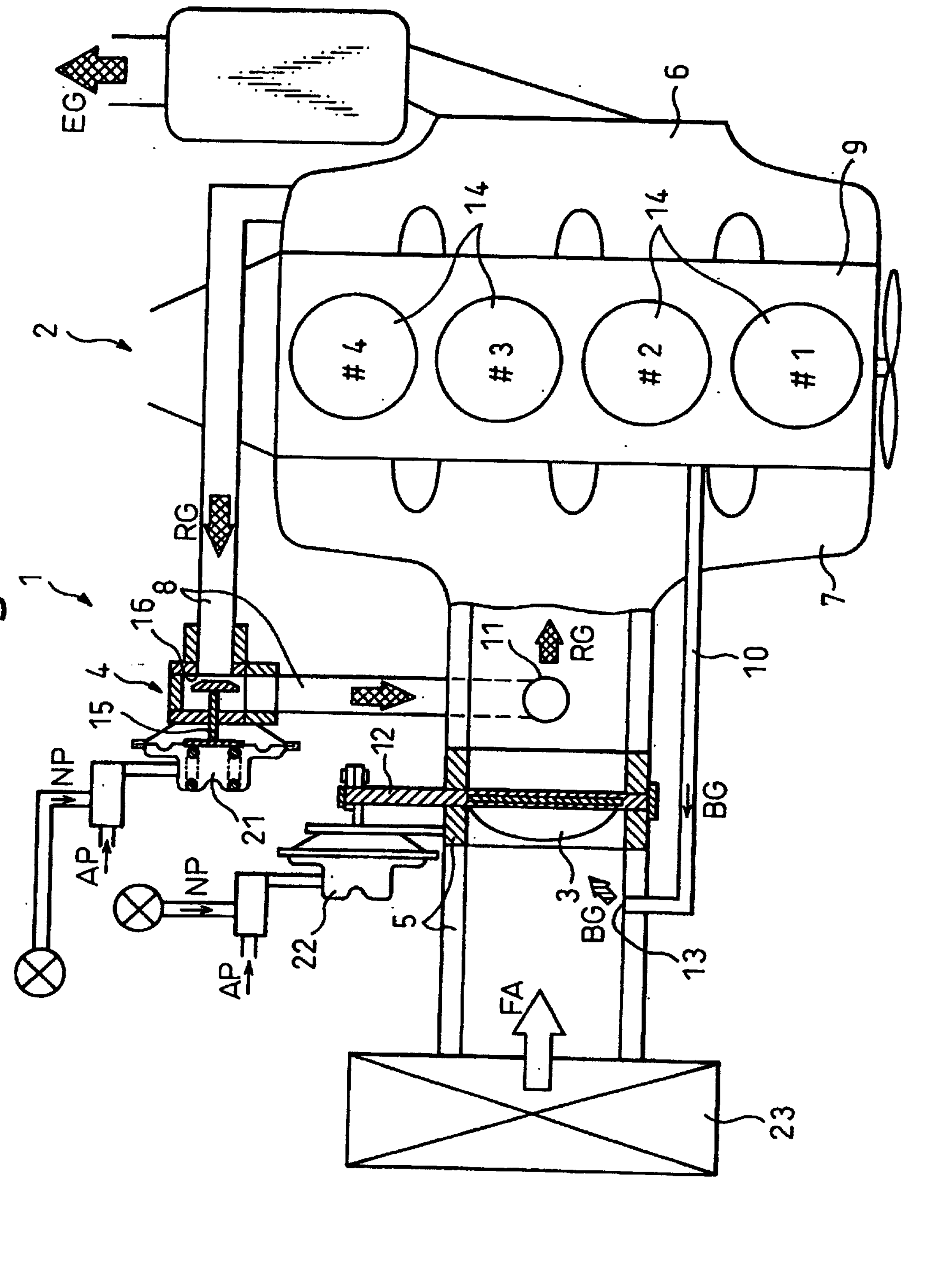


Fig.7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#4
#3
#2
#1
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RG
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BG
NP
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22
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23

Fig. 8
PRIOR ART

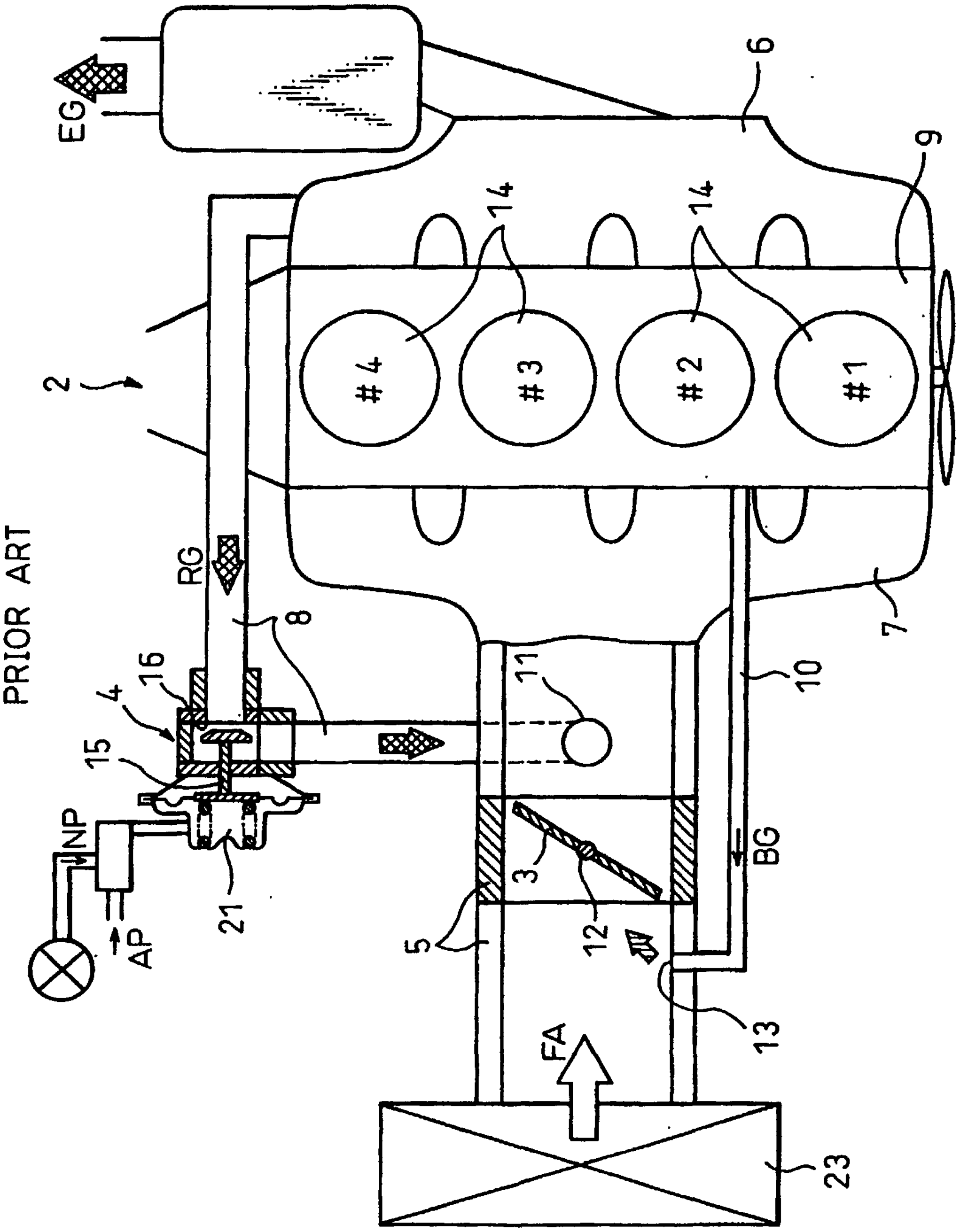


Fig.9A
PRIOR ART

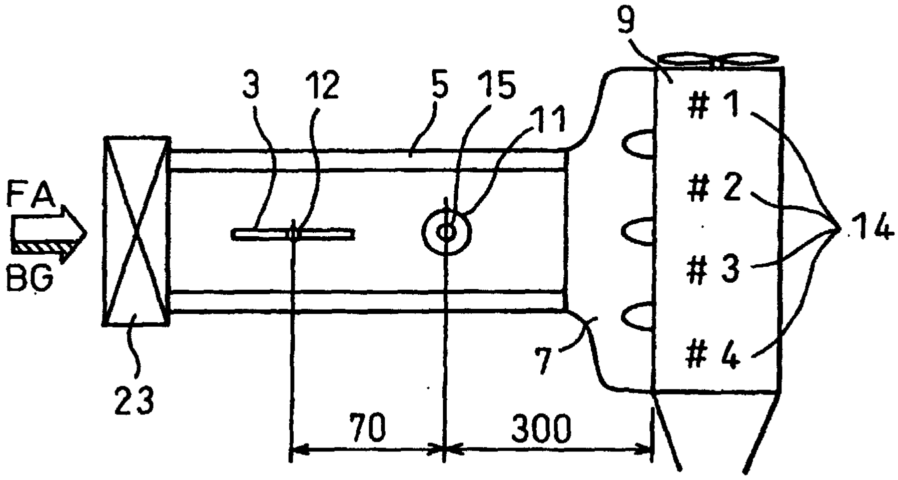


Fig.9B
PRIOR ART

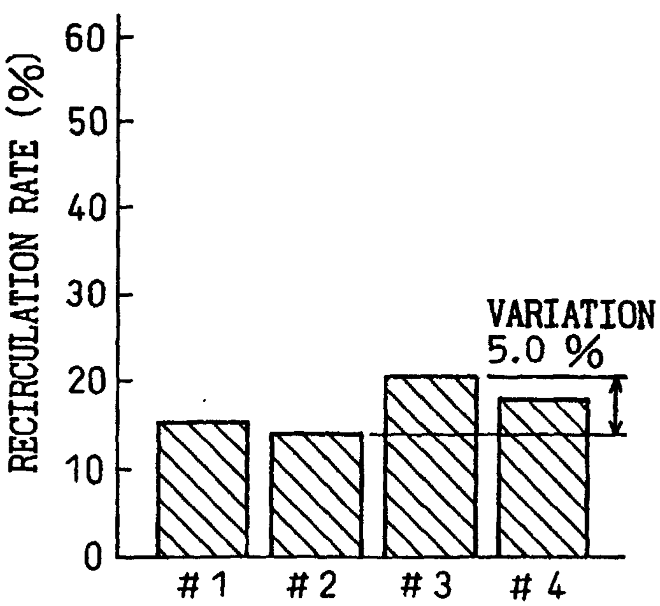


Fig. 10A

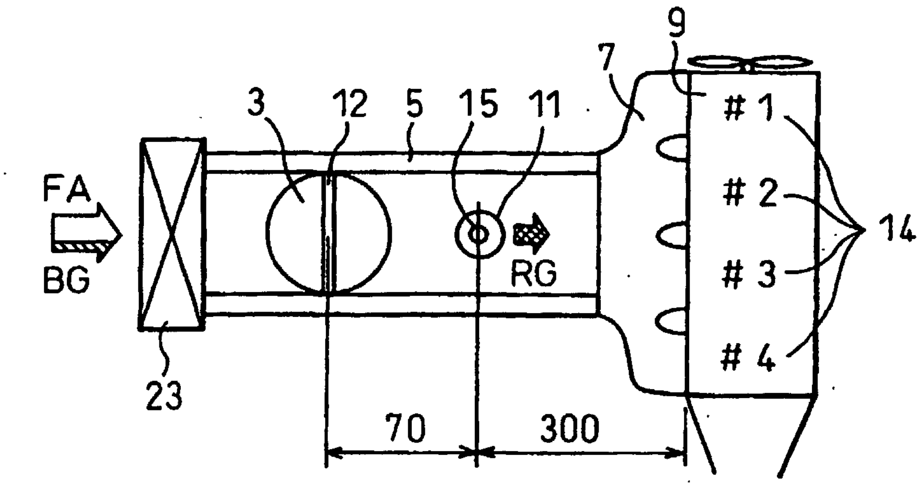


Fig. 10B

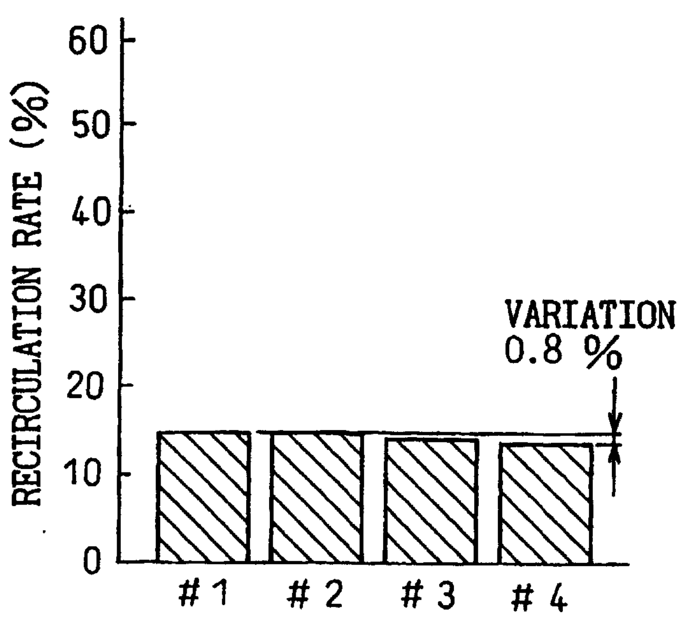
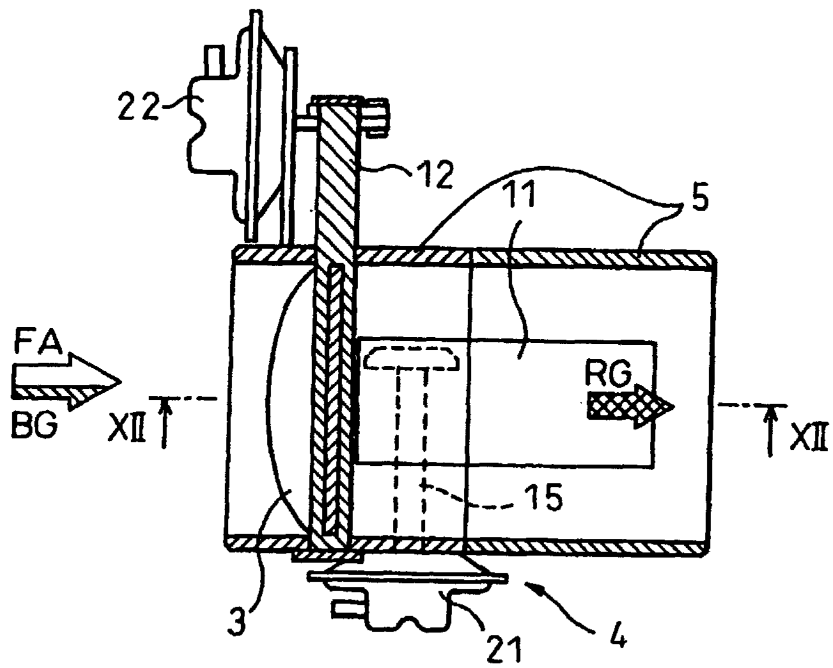


Fig. 11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XII
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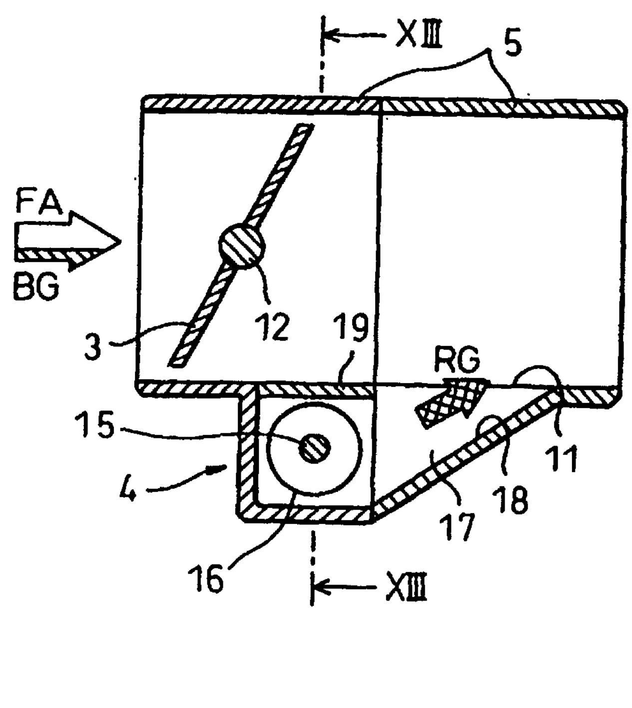
Fig. 12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16
17
18
11
XIII

Fig. 13

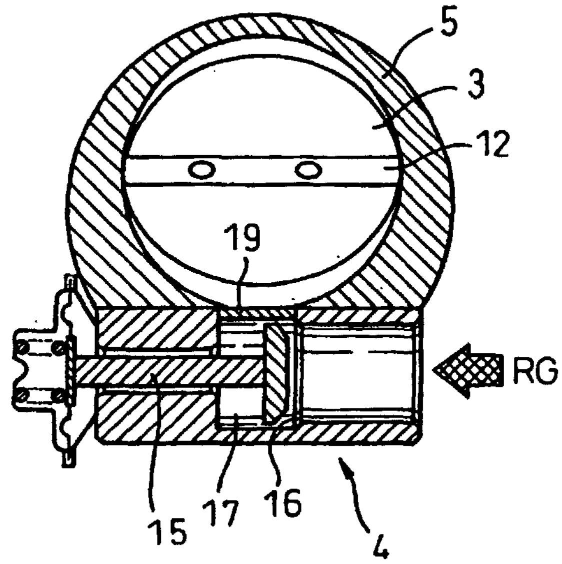


Fig. 14

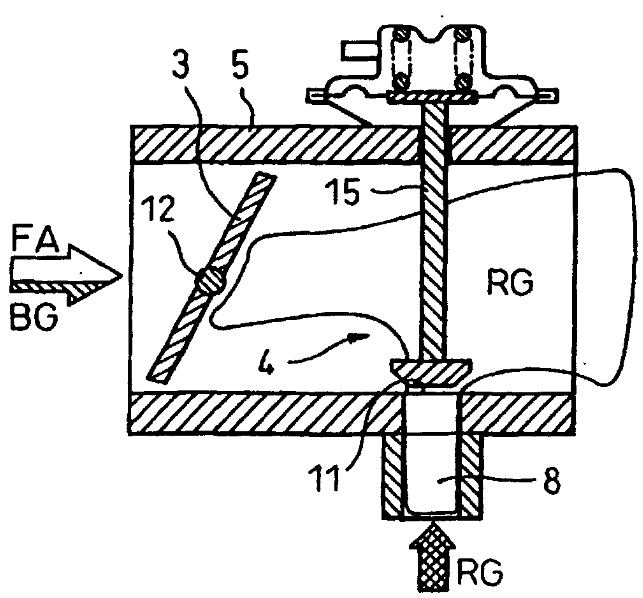


Fig.15

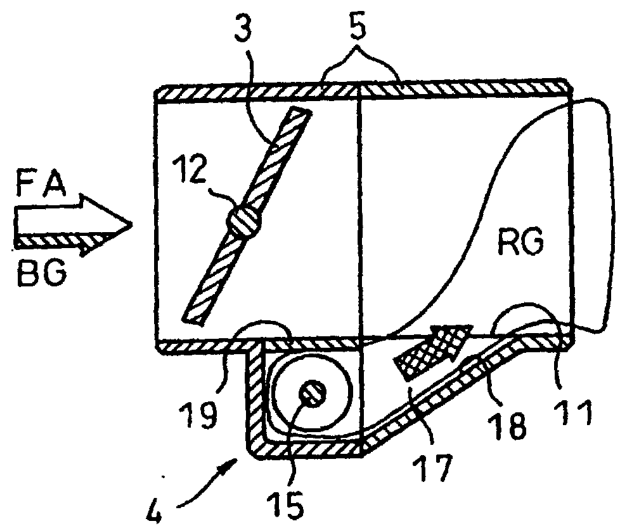


Fig.16

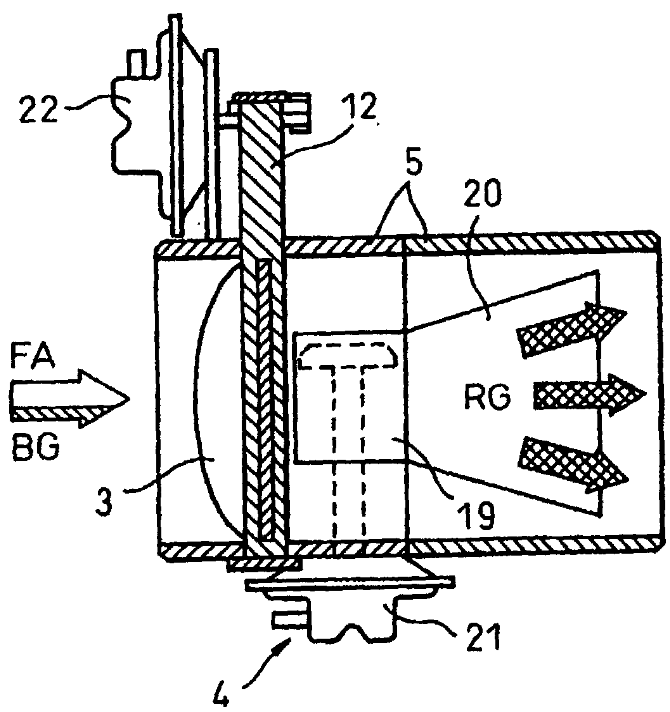
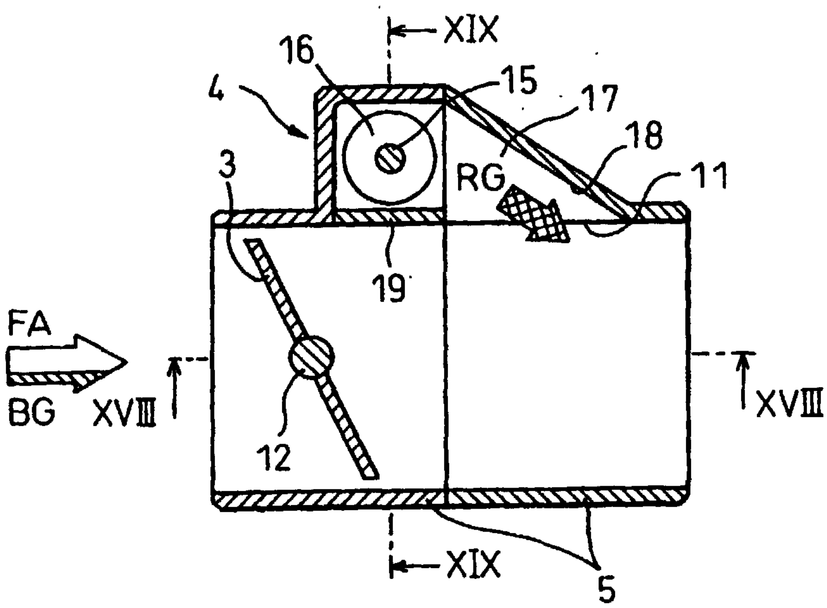


Fig. 17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XVIII
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XIX
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Fig. 18

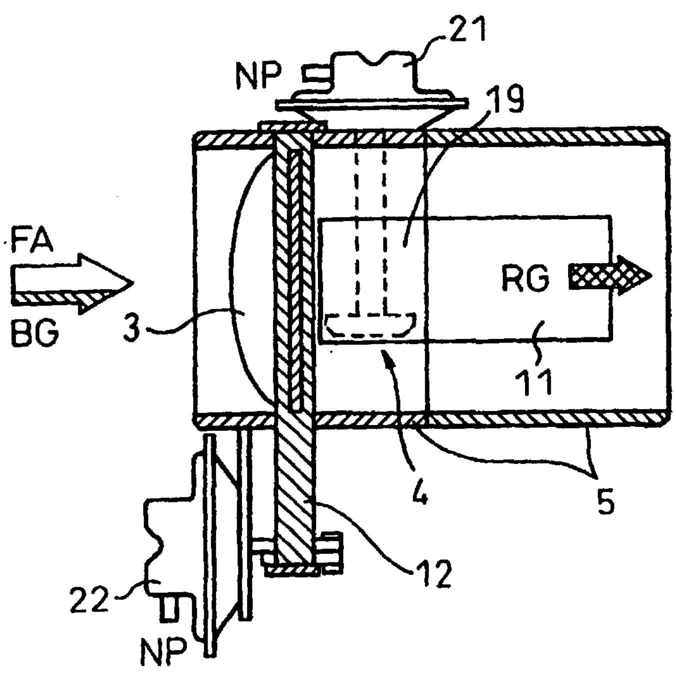
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Fig. 19

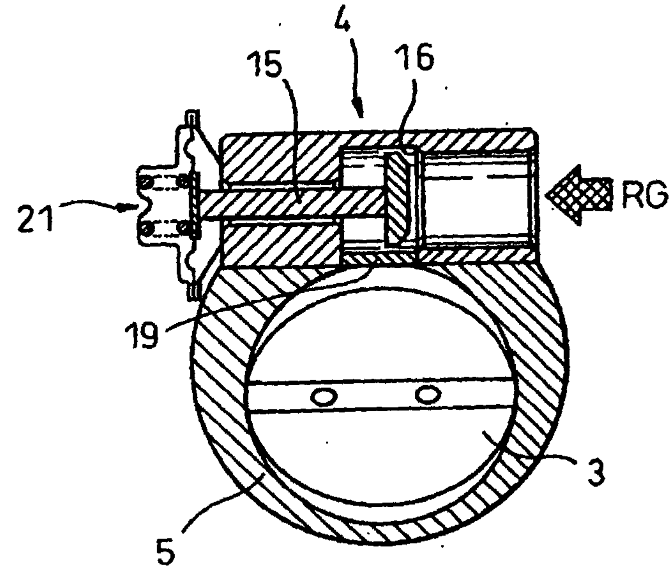

Fig. 20

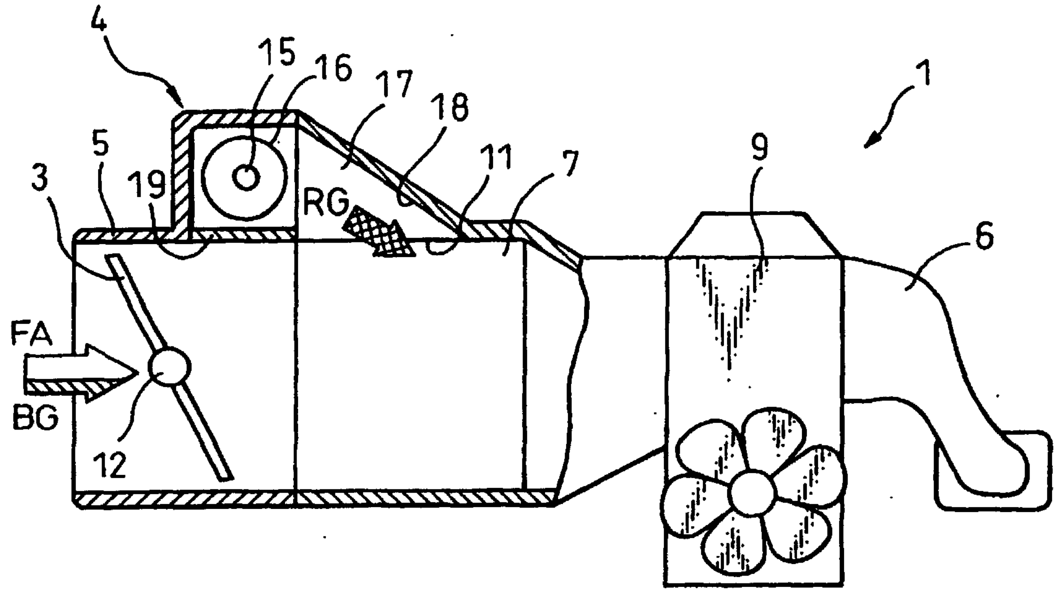
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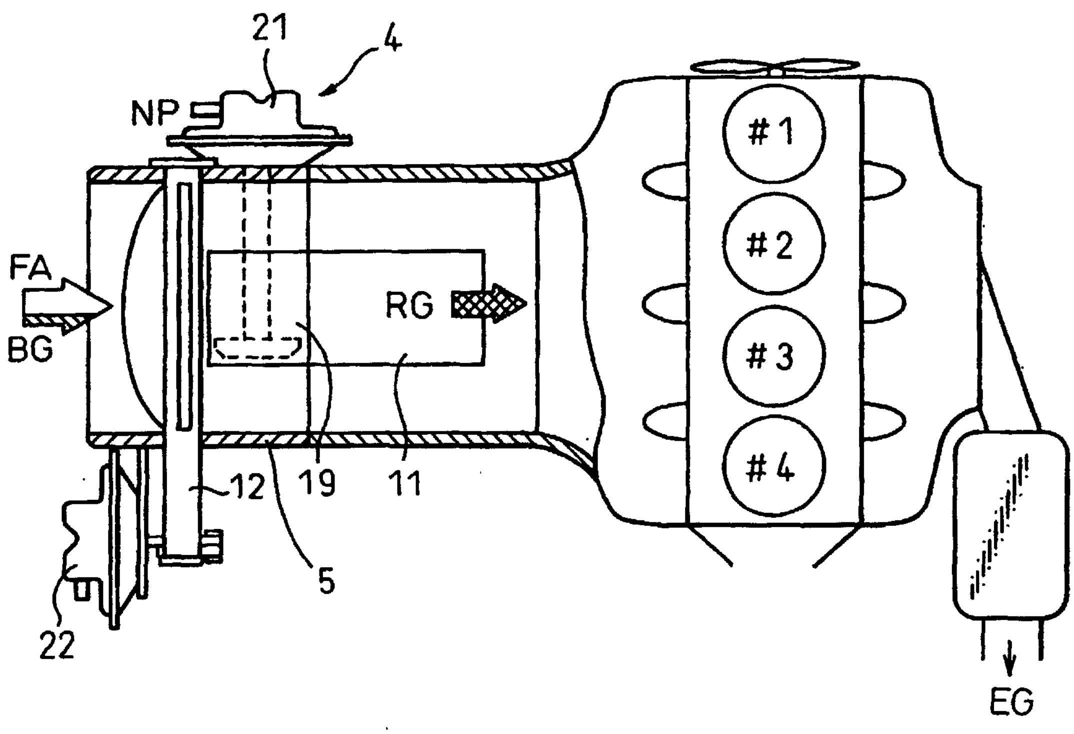
Fig. 21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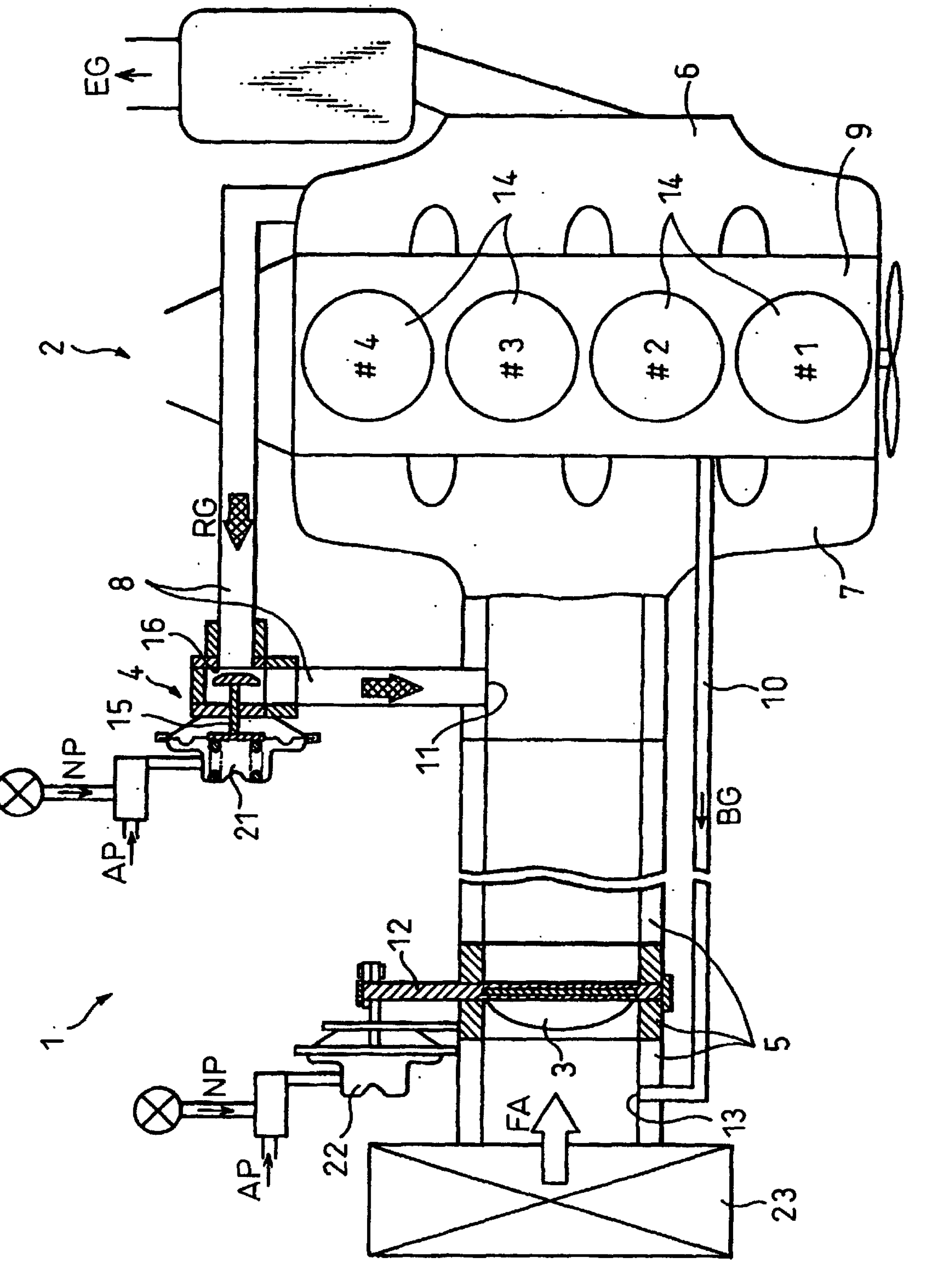


Fig. 22
PRIOR ART

Fig. 23

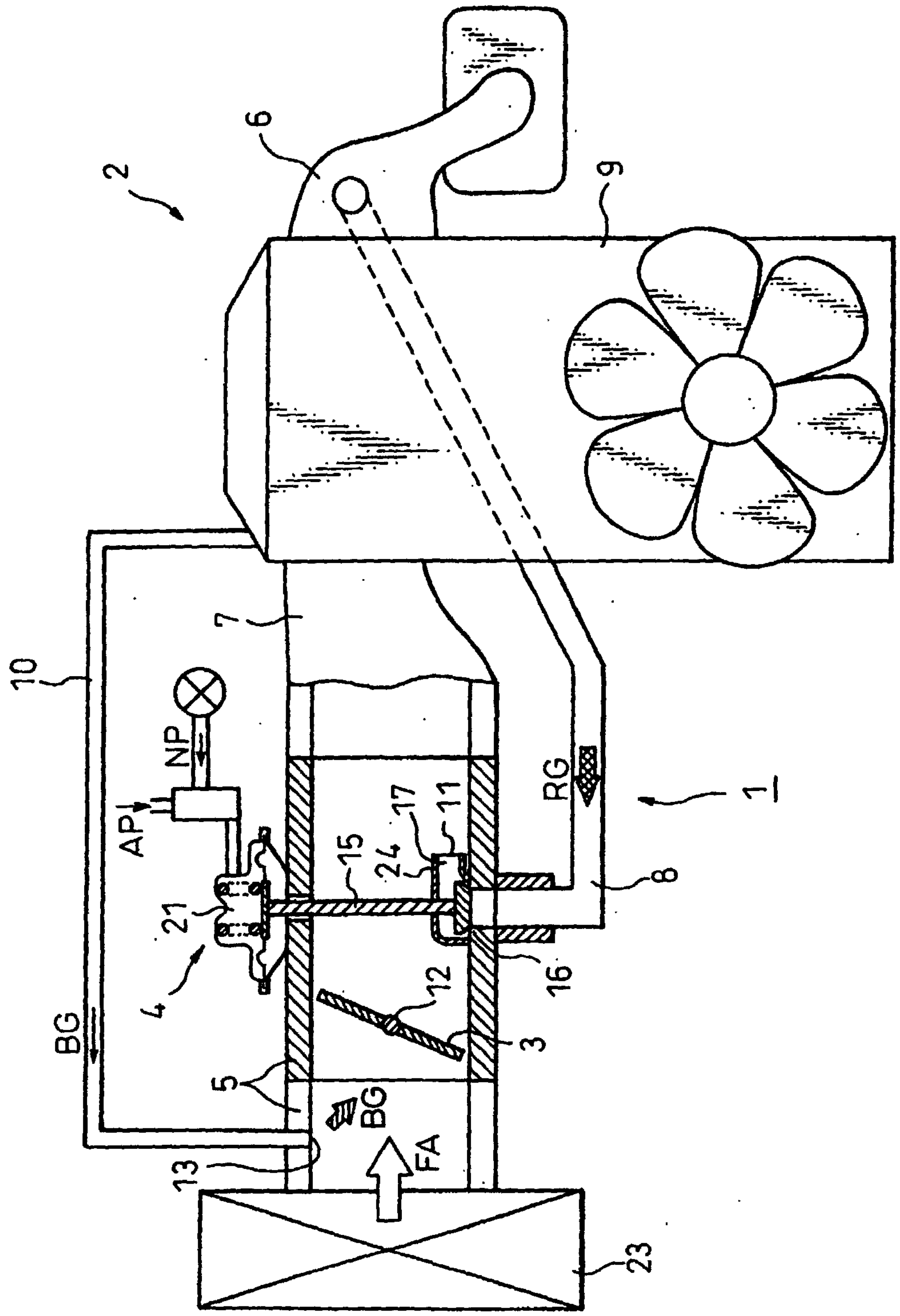


Fig. 24

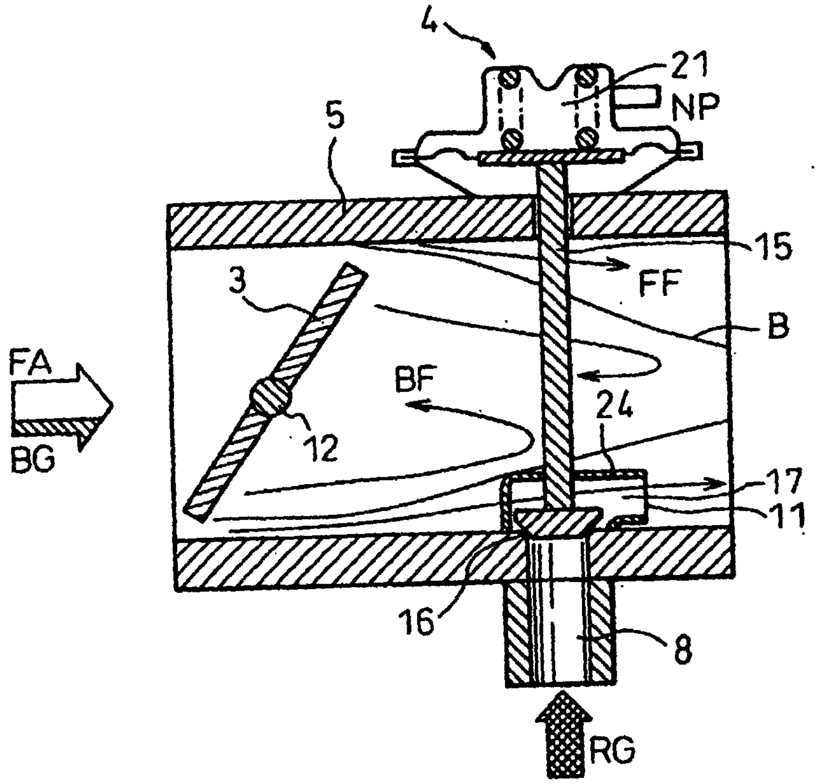
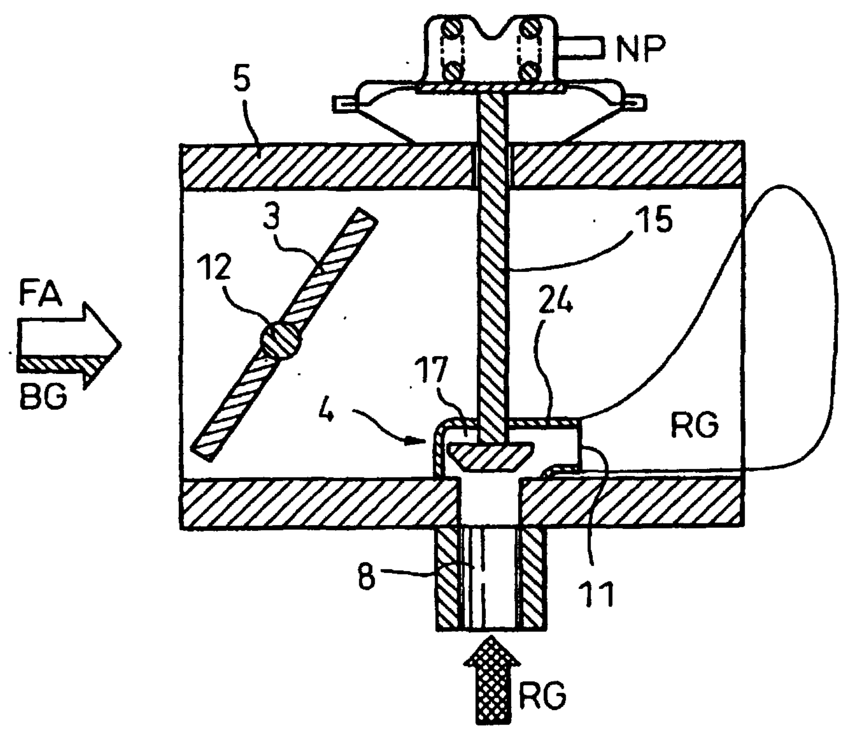


Fig. 25



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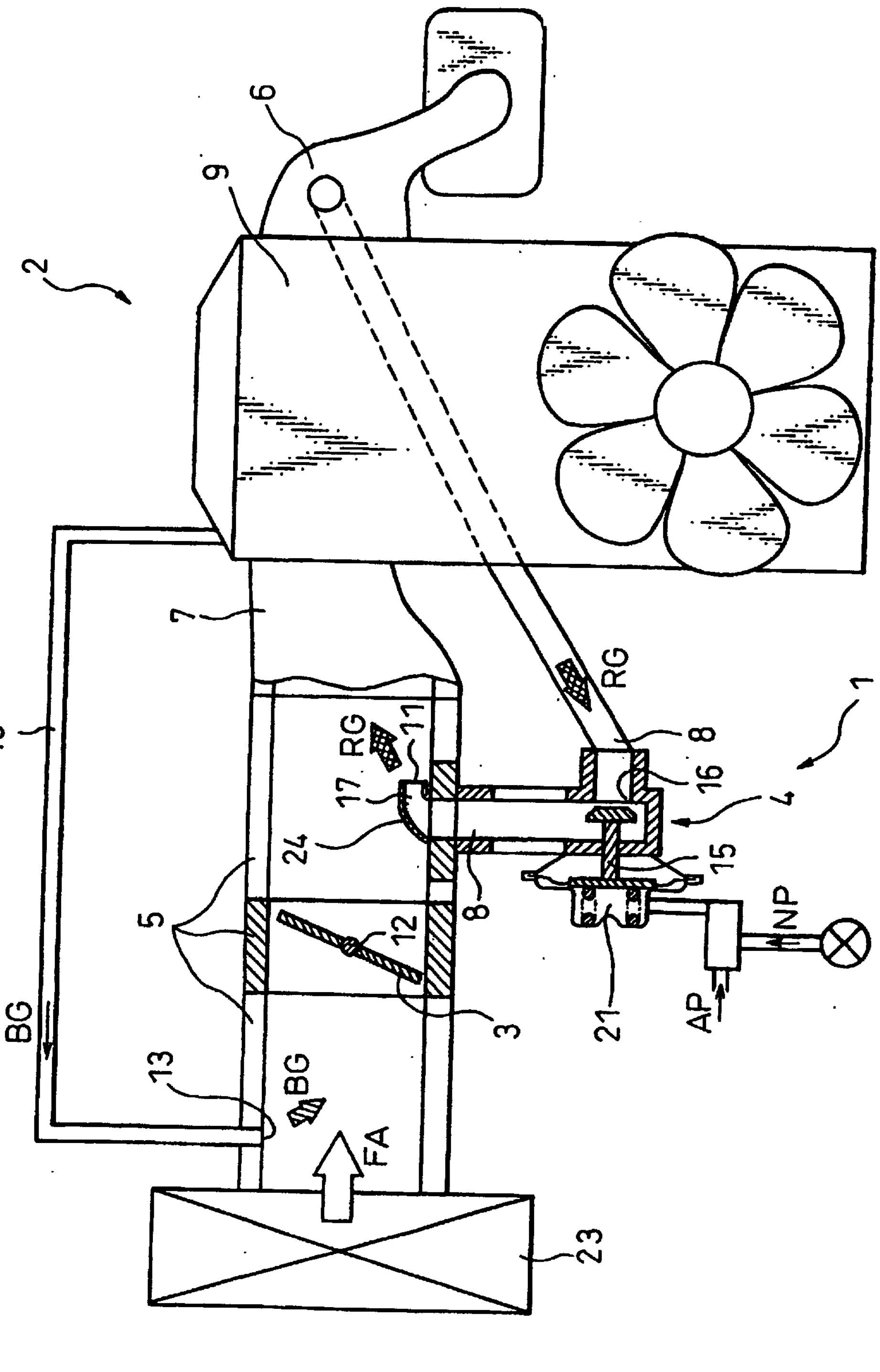

Fig. 27

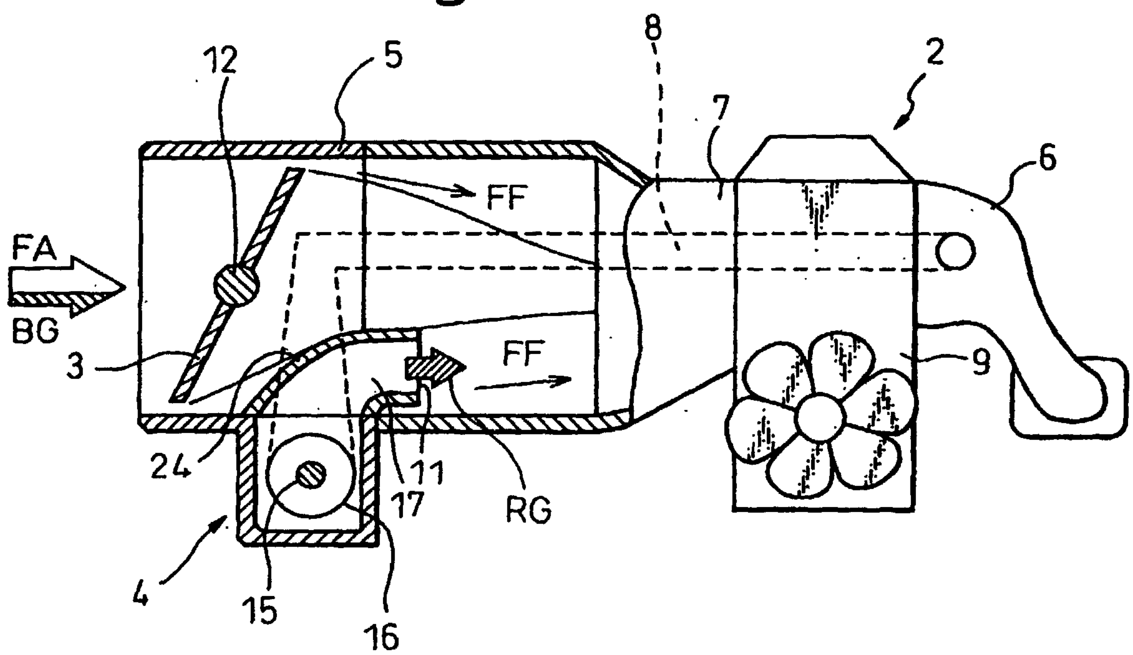

Fig. 28

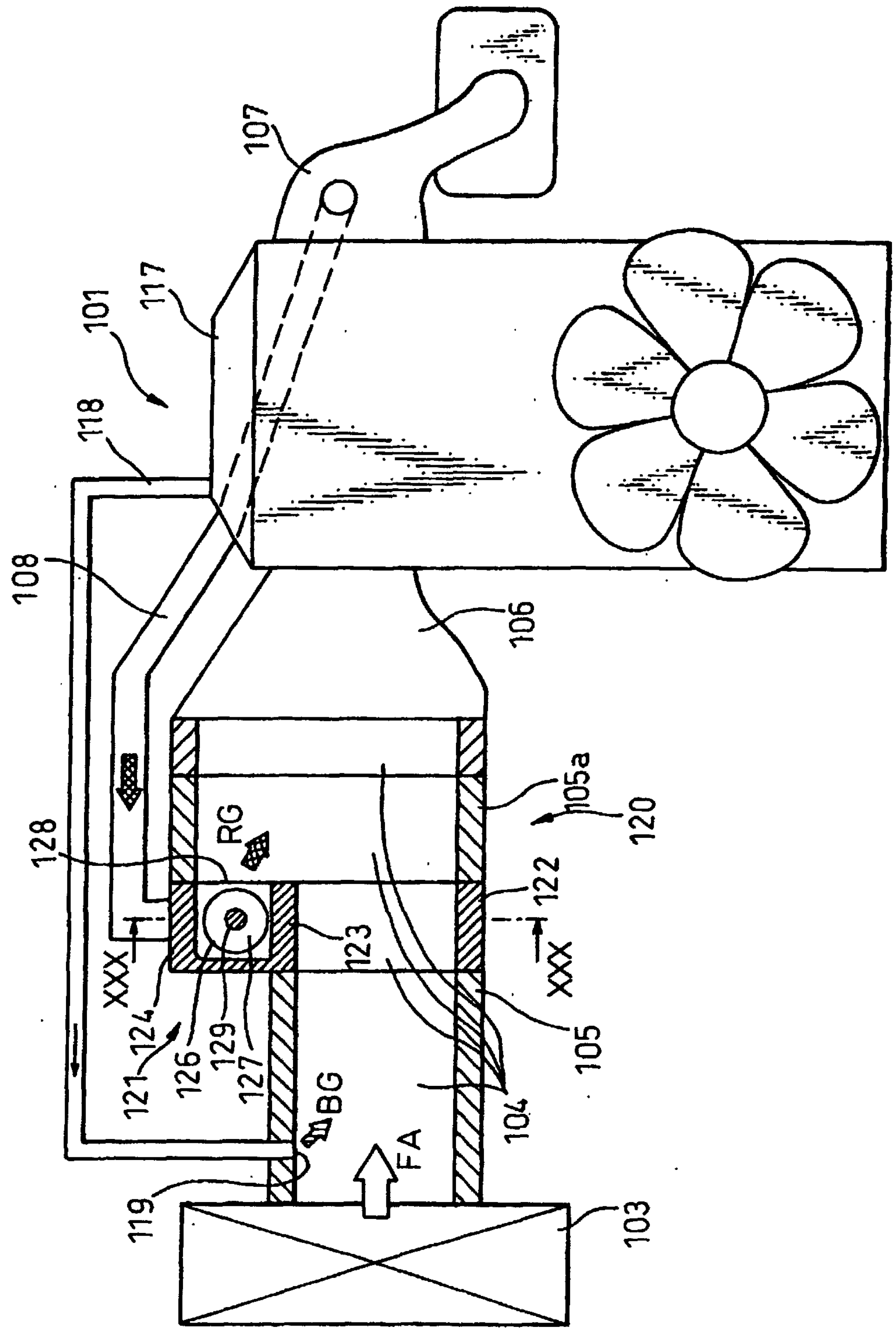
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Fig. 29

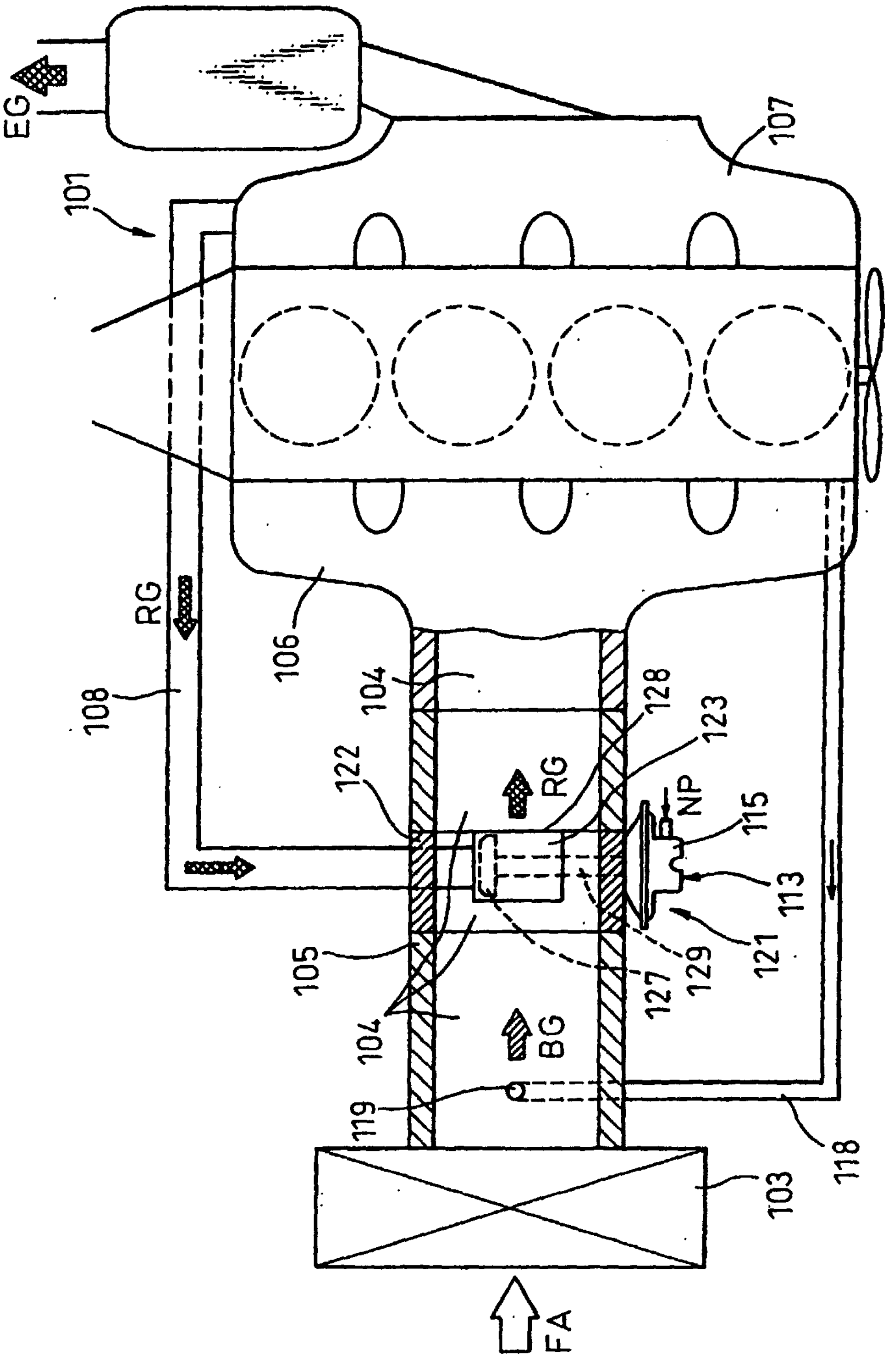
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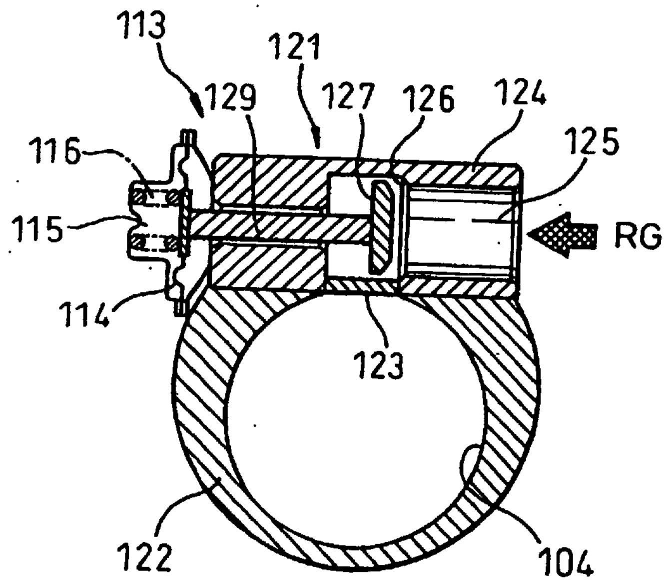
Fig. 30



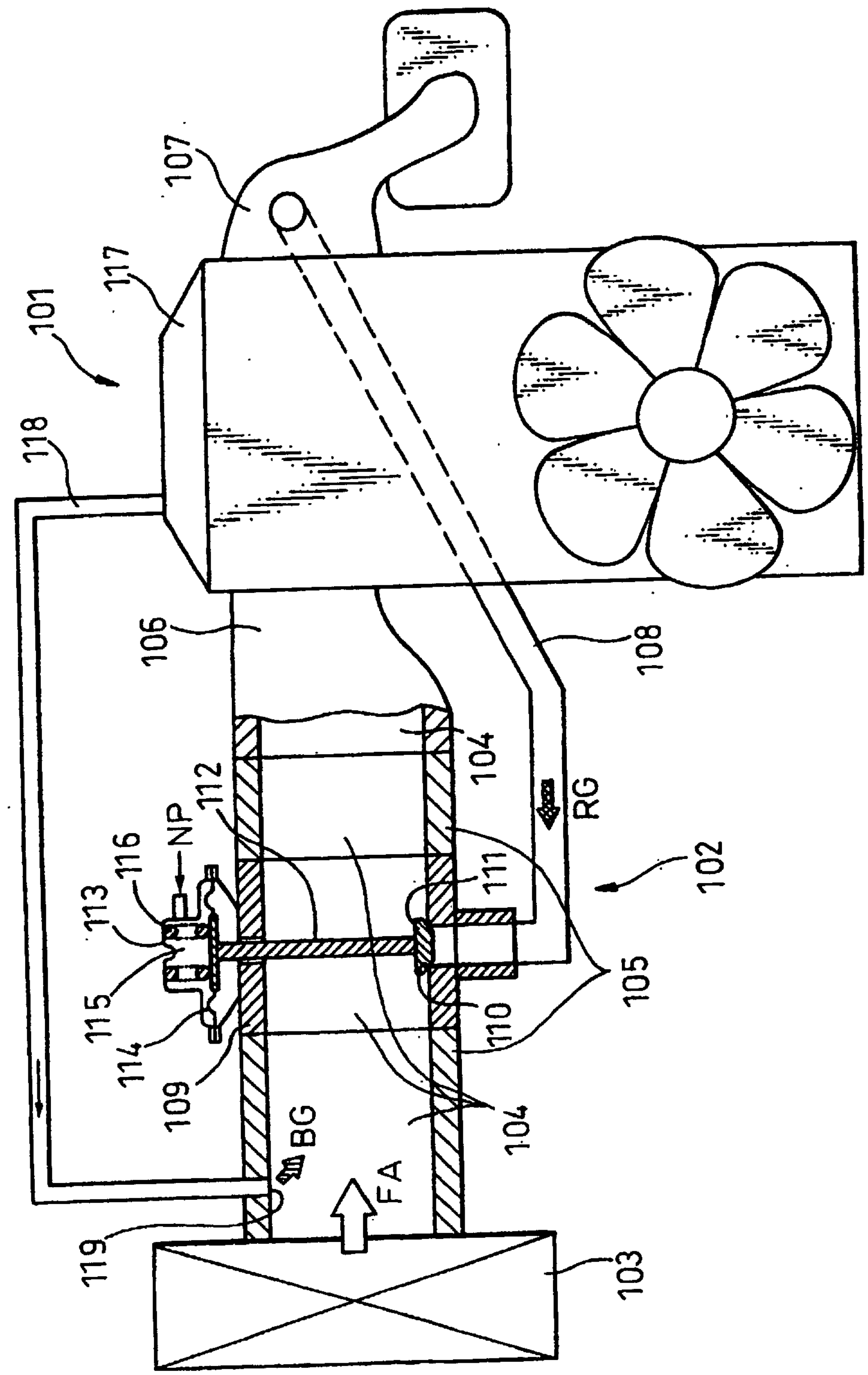


Fig. 31
PRIOR ART

Fig. 32

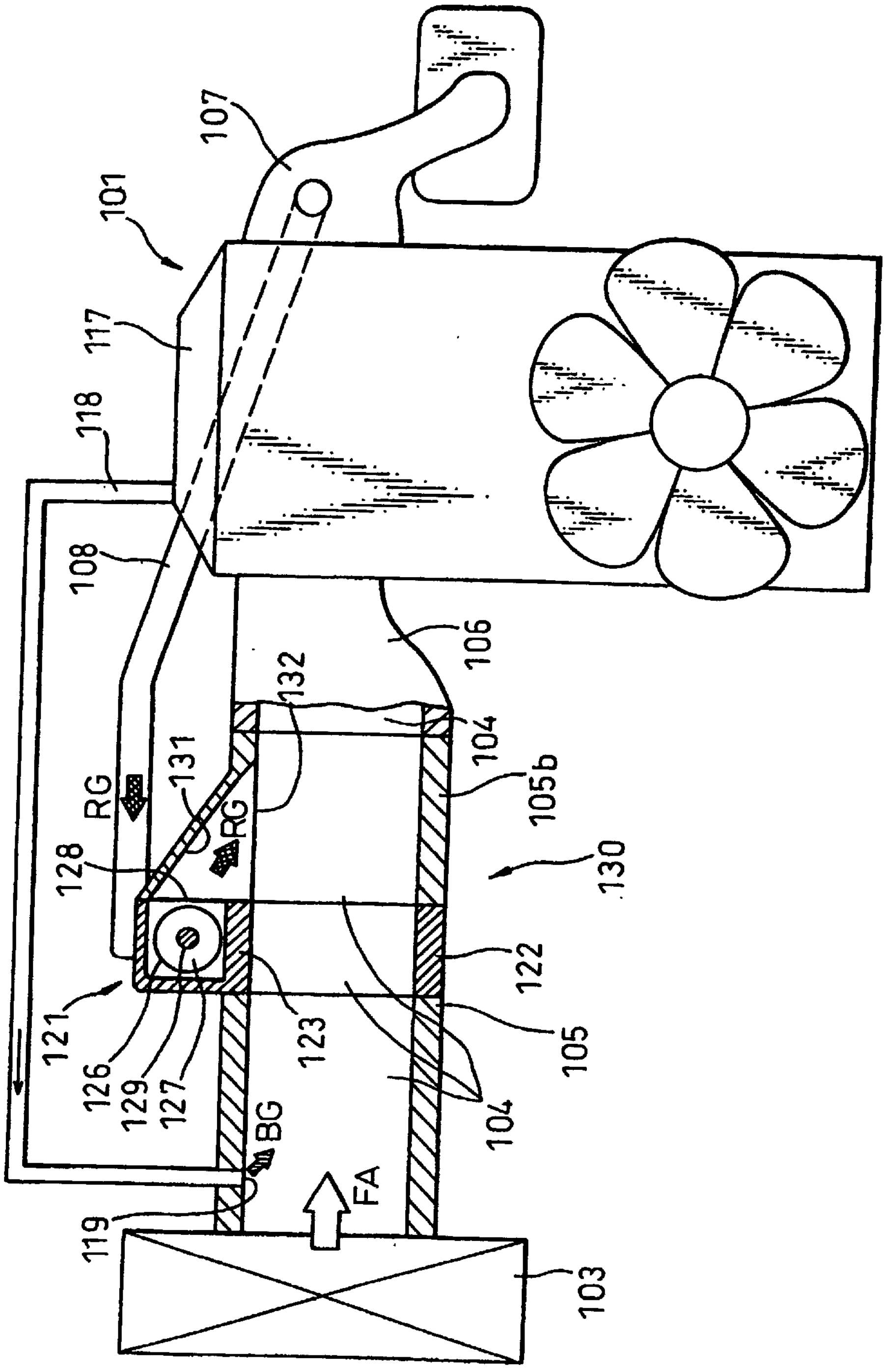

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Fig. 33

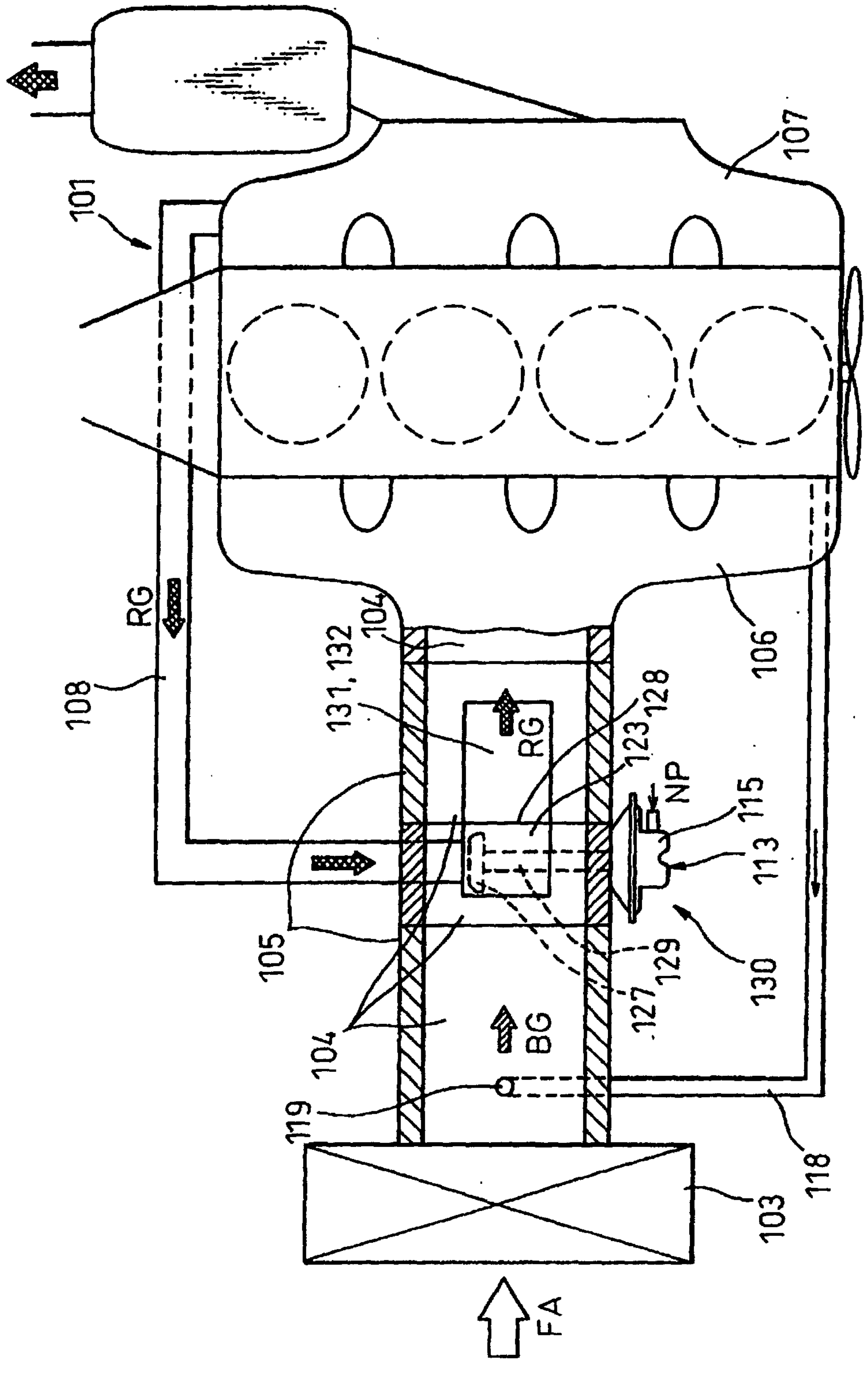
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Fig. 34

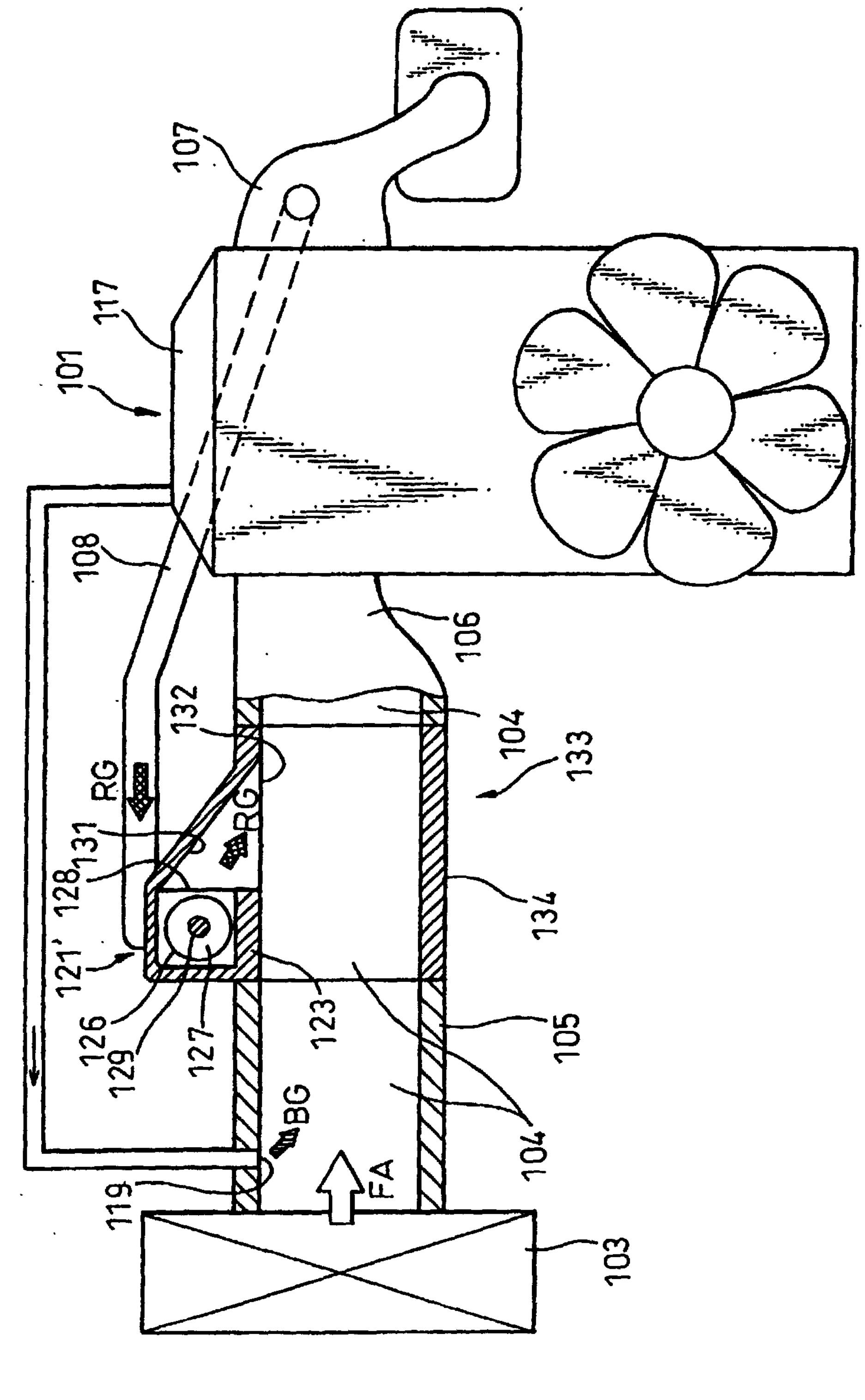
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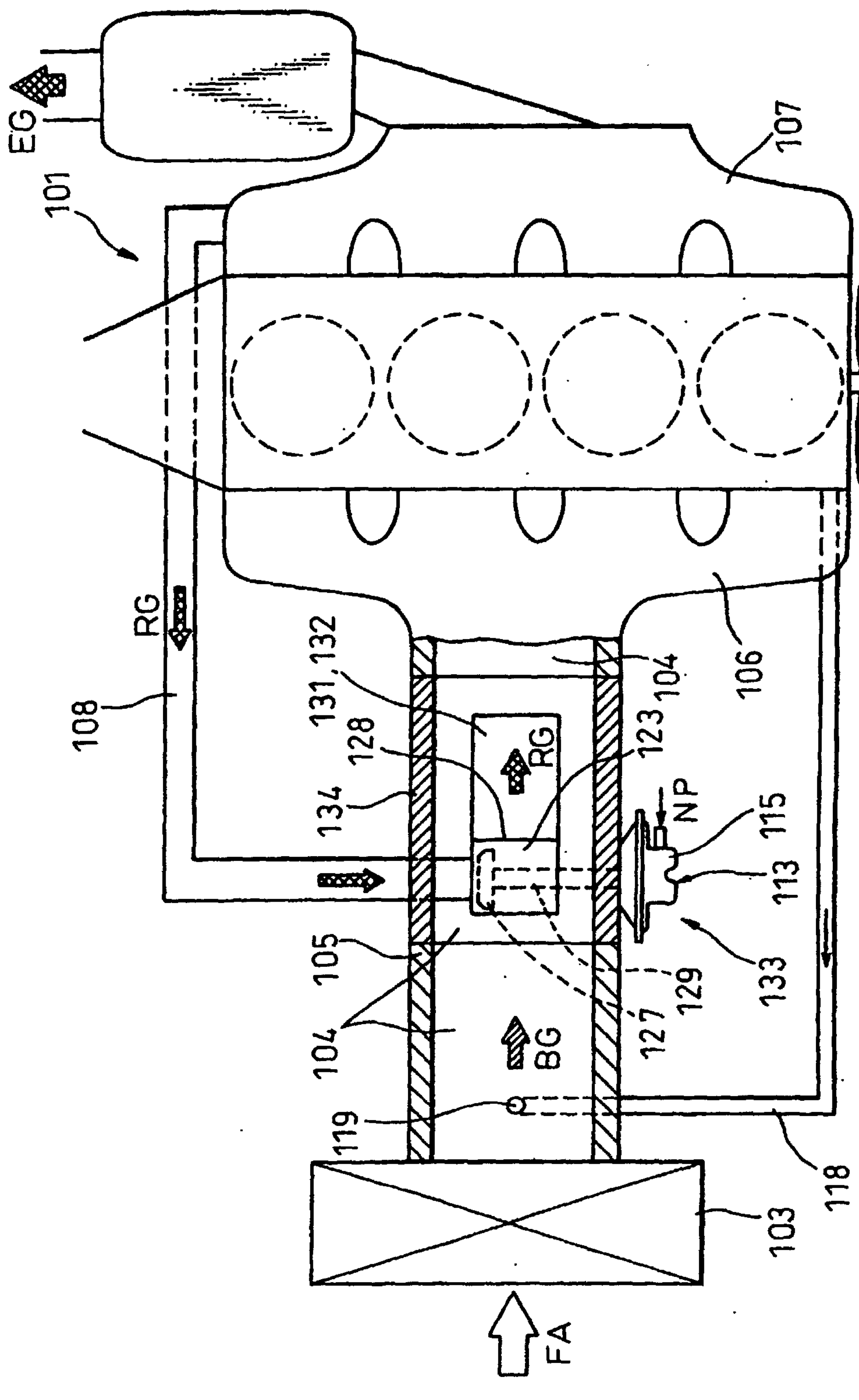
Fig. 35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