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(54) Variable geometry turbocharger

(57) A variable geometry turbocharger 1 includes a housing 201; and a link mechanism 202, provided in the housing 201, which controls the orientation of vanes 42 for controlling the flow of exhaust gas. The housing 201 includes a turbine-housing swirl chamber 5 for supplying

the exhaust gas to a turbine; and a link chamber 6 that houses the link mechanism 202. A communication hole 3, which provides communication between the turbine-housing swirl chamber 5 and the link chamber 6, is formed in the housing 201.

FIG. 1A

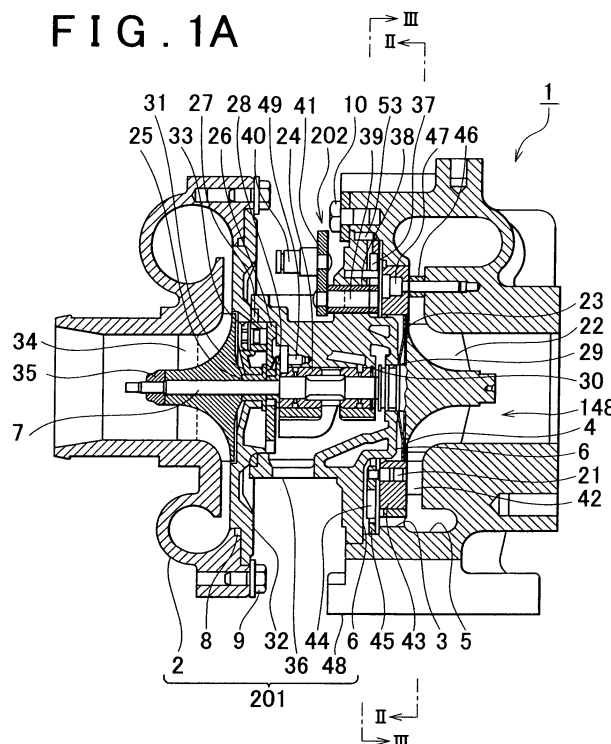
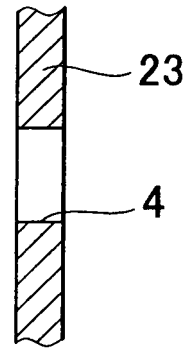


FIG. 1B



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a variable geometry turbocharger.

2. Description of the Related Art

[0002] Currently, variable geometry turbochargers (VG turbochargers) including a mechanism that can accurately control the amount of air supplied to an engine are mainly produced for diesel engines.

[0003] One type of such variable geometry turbochargers, variable nozzle turbochargers (VN turbochargers), which adjusts turbine speed by varying the orientation of the vanes, are known. Technologies related to such turbochargers are described in, for example, Japanese Patent Application Publication No. JP-A-11-229886, Japanese Patent Application Publication No. JP-A-2004-169703, and Japanese Utility Model Application Publication No. 07-25249.

[0004] Japanese Patent Application Publication No. JP-A-11-229886 describes providing a seal structure between the plate and the turbine housing in a diesel engine including a VN turbocharger.

[0005] Japanese Patent Application Publication No. JP-A-2004-169703 describes the structure where exhaust gas flows through a cavity when a movable wall moves.

[0006] Japanese Utility Model Application Publication No. 07-25249 describes the technology of providing a link chamber of a turbocharger with a variable nozzle, on the side opposite a bearing.

[0007] In the above-mentioned technologies, however, fuel, gas, and the like flow into the link chamber through a clearance formed around a pin for operating the nozzle, due to a difference in pressure between the turbine swirl chamber and the link chamber. This may raise a problem that the accumulated fuel and gas inhibits sliding of a unison ring, resulting in reduction in controllability.

SUMMARY OF THE INVENTION

[0008] The invention is made to solve the above-mentioned problem. It is, therefore, an object of the invention to provide a variable geometry turbocharger that can prevent fuel from flowing into a link chamber.

[0009] An aspect of the invention relates to a variable geometry turbocharger including a housing; and a link mechanism that drives the turbine vanes to control the flow of exhaust gas, and that is provided in the housing. The housing includes a turbine-housing swirl chamber for supplying the exhaust gas to a turbine; and a link chamber that houses the link mechanism. A communi-

cation hole, which provides communication between the turbine-housing swirl chamber and the link chamber, is formed in the housing.

[0010] In the thus configured variable geometry turbocharger, the presence of the communication hole reduces the difference in pressure between the turbine swirl chamber and the link chamber, and, therefore, the flow of fuel into the link chamber can be minimized. Also, because the high-temperature exhaust gas flows into the link chamber, any fuel present in the link chamber can be vaporized.

[0011] In the above-mentioned aspect, the communication hole may open into the lower portion of the turbine-housing swirl chamber. With this configuration, fuel flowing into the link chamber flows down to the turbine-housing swirl chamber through the communication hole. Accordingly, the accumulation of fuel in the link chamber can be prevented, and, therefore, formation of sludge in the link chamber can be prevented.

[0012] In the above-mentioned aspect, the communication hole may be positioned at the lowest portion of the variable geometry turbocharger when the variable geometry turbocharger is mounted in a vehicle. With this configuration, the communication hole can also serve as the discharge passage through which any deposits accumulated in the link chamber are returned to the turbine-housing swirl chamber.

[0013] In the above-mentioned aspect, an exhaust turbine chamber that houses the turbine may be formed in the housing, a shroud that separates the exhaust turbine chamber from the link chamber may be further provided, and scavenging holes, which provide communication between the exhaust turbine chamber and the link chamber, may be formed in the shroud. With this configuration, the high-temperature exhaust gas introduced through the communication hole can easily flow into the link chamber through the scavenging holes. Accordingly, the temperature in the link chamber can be increased, and, therefore, the deposit in the link chamber can be burned or peeled off.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The foregoing and further objects, features and advantages of the invention will become apparent from the following description of preferred embodiments with reference to the accompanying drawings, wherein the same or corresponding portions are denoted by the same reference numerals, and wherein:

FIG. 1A illustrates the cross sectional view of a variable geometry turbocharger in its entirety according to a first embodiment of the invention, and FIG. 1B illustrates the cross sectional view of a scavenging hole;
FIG. 2 illustrates the cross sectional view taken along line II-II in FIG. 1;
FIG. 3 illustrates the cross sectional view taken along

line III-III in FIG 1;
 FIG. 4 illustrates the cross sectional view taken along line IV-IV in FIG. 3;
 FIG. 5 illustrates the block diagram of a control system of the variable geometry turbocharger according to the first embodiment of the invention;
 FIG 6 illustrates the cross sectional view of a variable geometry turbocharger according to a second embodiment of the invention; and
 FIG. 7 illustrates the plan view of a variable geometry turbocharger according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0015] Hereafter, embodiments of the invention will be described in detail with reference to accompanying drawings. Note that, in the following embodiments, the same or corresponding portions will be denoted by the same reference numerals, and will be described only once.

[0016] Hereafter, a first embodiment of the invention will be described in detail. FIGS. 1A and 1B illustrate the cross sectional views of a variable geometry turbocharger according to the first embodiment. FIG. 1A illustrates the entirety of the variable geometry turbocharger. FIG. 1B illustrates the cross sectional view of a scavenging hole. As shown in FIG. 1, a variable geometry turbocharger 1 according to the first embodiment is a variable nozzle turbocharger, and includes a housing 201; a shaft 7 that is rotatably housed in the housing 201; a compressor wheel 34 and a turbine wheel assembly 22. The compressor wheel 34 and the turbine wheel assembly 22 are attached to the shaft 7.

[0017] The housing 201 is divided into a compressor housing 2, a center housing 36, and a turbine housing 48. The compressor housing 2 is attached to one side of the center housing 36, and the turbine housing 48 is attached to the other side of the center housing 36. The compressor housing 2 is configured such that air can be taken into the center portion and then discharged to the outside of the compressor housing 2. More specifically, air is introduced into the center portion of the compressor housing 2, the air is made to flow at an increasing speed toward the outside to be compressed by the turning compressor wheel 34, and the compressed air is introduced into an intake manifold (not shown).

[0018] The compressor wheel 34 is housed in the compressor housing 2. The compressor wheel 34 is fixed to the shaft 7 serving as a turbine shaft. The compressor wheel 34 turns along with the shaft 7. The compressor wheel 34 is fixed to the shaft 7 with a locknut 35. The compressor wheel 34 is provided with a plurality of vanes. When the compressor wheel 34 turns, the air is made to flow at an increasing speed, due to the centrifugal force, by the vanes and, the air is then compressed.

[0019] A thrust spacer 25 is provided adjacent to the compressor wheel 34. The thrust spacer 25 surrounds

the shaft 7. A back plate 32 is provided on the back-side of the compressor housing 2. The back plate 32 is attached to the compressor housing 2 with bolts 9. In addition, the thrust spacer 25 is fitted in the back plate 32. An O-ring 8 is provided between the back plate 32 and the compressor housing 2 to form a stronger gas-tight seal therebetween. A piston ring 31 is fitted around the thrust spacer 25.

[0020] The center housing 36 is provided at the center portion of the variable geometry turbocharger 1. The back plate 32 is fixed to the center housing 36 with a bolt 33. A seal ring 27 is provided between the back plate 32 and the center housing 36 to form a stronger gas-tight seal therebetween.

[0021] A thrust bearing 26 contacts the center housing 36. The thrust bearing 26 receives the load of the shaft 7 that is applied in the thrust direction. The thrust bearing 26 is lubricated with, for example, oil. A thrust collar 28 is provided on the inner side of the thrust bearing 26. The thrust collar 28 contacts the thrust spacer 25. The thrust collar 28 also contacts the step portion of the shaft 7.

[0022] A pin 49 is provided in the center housing 36. The center housing is provided with a bearing 24 that rotatably supports the shaft 7. The bearing 24 receives the load of the shaft that is applied in the radial direction.

[0023] A retainer ring 30 is fitted to the bearing 24. The retainer ring 30 is also fitted to the center housing 36.

[0024] The center housing 36 and the turbine housing 48 are provided with a link mechanism 202. The link mechanism 202 includes a unison ring 45 that is housed in a link chamber 6; a plurality of arms 44 that is provided on the inner side of the unison ring 45 and that contact the unison ring 45; a nozzle ring 43 that is provided adjacent to the turbine housing 48; and a main arm 37 that is connected to a pin 39 to drive the arms 44.

[0025] The link mechanism 202 controls the orientation of a plurality of vanes 42. When a pin 40 is turned by a predetermined angle, the turning movement is transmitted to the vanes 42, and the vanes 42 move and the orientation of the vanes 42 is changed. More specifically, the pin 40 is connected to an external crank 41, and the external crank 41 can pivot about a pin 39. A bushing 38 is provided around the pin 39. The bushing 38 is provided between the pin 39 and the center housing 36.

[0026] The pin 39 is connected to the main arm 37. When the pin 39 turns, the turning movement is transmitted to the main arm 37. The end portion of the main arm 37 on the inner side is fixed to the pin 39. The end portion of the main arm 37 on the outer side is fitted to the unison ring 45. Therefore, when the main arm 37 pivots about the pin 39, the pivoting movement is transmitted to the unison ring 45. The arms 44 are fitted in the inner surface of the unison ring 45. When the unison ring 45 turns, the turning movement is transmitted to the arms 44. The arms 44 can pivot about the respective pins 21. The pivoting movement of the arms 44 is transmitted to the pins 21. Because the pins 21 are connected to the respective vanes 42, the vanes 42 move along with the

pins 21 and the arms 44.

[0027] The nozzle ring 43 is fixed to the turbine housing 48 with cap screws 47. Vane spacers 46 are provided around the respective cap screws 47. The turbine wheel assembly 22 is attached to the end portion of the shaft 7. The turbine wheel assembly 22 is positioned in an exhaust turbine chamber 148.

[0028] A disk shroud 23 is provided between the turbine wheel assembly 22 and the link chamber 6. The disk shroud 23 enhances a gas-tightness of the exhaust turbine chamber 148. To enhance the gas-tightness, a piston ring 29 is fitted around the shaft 7. A plurality of scavenging holes 4 is formed in the disk shroud 23. The scavenging holes 4 provide communication between the link chamber 6 and the exhaust turbine chamber 148.

[0029] A turbine-housing swirl chamber 5 is provided in the turbine housing 48, and exhaust gas is supplied from the turbine-housing swirl chamber 5. The exhaust gas turns the turbine wheel assembly 22, and is then discharged from the exhaust turbine chamber 148. A communication hole 3, which provides communication between the turbine-housing swirl chamber 5 and the link chamber 6, is formed in the turbine housing 48. Due to the presence of the communication hole 3, the pressure in the turbine-housing swirl chamber 5 becomes substantially equal to the pressure in the link chamber 6. The turbine housing 48 is attached to the center housing 36 with a bolt 10.

[0030] As described so far, the variable geometry turbocharger 1 includes the turbine housing 48 that is a part of the housing 201 for supplying exhaust gas to the turbine wheel assembly 22; and the link mechanism 202 that is provided in the turbine housing 48 and the center housing 36, and that drives the vanes 42 for controlling the flow of the exhaust gas.

[0031] The turbine housing 48 and the center housing 36 have the turbine-housing swirl chamber 5 for supplying exhaust gas to the turbine wheel assembly 22; and the link chamber 6 that houses the link mechanism 202. The communication hole 3, which provides communication between the turbine-housing swirl chamber 5 and the link chamber 6, is formed in the turbine housing 48. The turbine housing 48 includes the exhaust turbine chamber 148 that houses the turbine wheel assembly 22. The exhaust turbine chamber 148 is separated from the link chamber 6 by the disk shroud 23. The scavenging holes 4, which provide communication between the exhaust turbine chamber 148 and the link chamber 6, are formed in the disk shroud 23.

[0032] FIG. 2 illustrates the cross sectional view taken along line II-II in FIG. 1. As shown in FIG. 2, the circular disk-shaped nozzle ring 43 is fitted in the inner side of the ring-shaped unison ring 45. The nozzle ring 43 is fixed to the turbine housing 48 with the cap screws 47. The vane spacers 46 are provided around the respective cap screws 47.

[0033] The unison ring 45 is slidable with respect to the nozzle ring 43. The main arm 37 and the arms 44 are

fitted in the respective concave portions formed in the inner surface of the unison ring 45. The arms 44 are connected to the respective vanes 42, and the vanes 42 can move to the positions indicated by the dashed lines. The flow volume and flow speed of the exhaust gas flowing from the turbine swirl chamber 5 to the exhaust turbine chamber 148 can be controlled by changing the orientation of the vanes 42.

[0034] FIG 3 illustrates the cross sectional view taken along line III-III in FIG. 1. As shown in FIG. 3, the main arm 37 and the arms 44 are fitted in the concave portions formed in the inner surface of the unison ring 45. The pin 39 passes through the nozzle ring 43, and is connected to the main arm 37. When the main arm 37 pivots about the pin 39, the unison ring 45 fitted to the main arm 37 turns. As the unison ring 45 turns, the arms 44 pivot about the respective pins 21. The pins 21 turn, and the turning movement of the pins 21 is transmitted to the vanes 42 in FIG. 2, causing the vanes 42 to move.

[0035] FIG. 4 illustrates the cross sectional view taken along line IV-IV in FIG. 3. As shown in FIG. 4, pins 52 are inserted in the nozzle ring 43, and rollers 51 are fitted to the upper portions of the respective pins 52. The rollers 51 guide the inner surface of the unison ring 45. Thus, the unison ring 45 can turn in the predetermined direction while being supported by the rollers 51.

[0036] FIG. 5 illustrates the block diagram of the control system of the variable geometry turbocharger according to the first embodiment. As shown in FIG. 5, the variable geometry turbocharger (variable nozzle turbocharger) 1 is controlled by a variable nozzle controller 200 and an engine control computer 300.

[0037] More specifically, the engine control computer 300 sets the opening amount of the variable nozzle based on the ON/OFF state of the ignition switch, the accelerator pedal operation amount, the engine speed, the ambient temperature, the ambient pressure, the supercharging pressure, the coolant temperature, and the like. The variable nozzle controller 200 receives the data concerning the set opening amount of the variable nozzle, and notifies the variable geometry turbocharger (variable nozzle turbocharger) 1 of the output of a DC motor for driving the nozzle based on the data. Then, the opening amount of the nozzle is set.

[0038] The information concerning the opening amount of the nozzle is fed back to the variable nozzle controller 200. Then, a motor status signal is transmitted from the variable nozzle controller 200 to the engine control computer 300.

[0039] In the variable geometry turbocharger 1, the flow speed and pressure of the exhaust gas supplied to the turbocharger are controlled by adjusting the orientation of the vanes 42, serving as the variable nozzle provided around the turbine wheel assembly 22, by using the motor. Thus, the balance between the backpressure and the supercharging pressure can be optimally controlled in accordance with the engine speed and the engine load.

[0040] The variable geometry turbocharger 1 includes the nozzle (vanes 42), the DC motor (not shown), the link mechanism 202 that connects the vanes 42 to the DC motor, and an opening amount sensor (not shown). The drive force generated by the DC motor is transmitted to the pin 40, the pin 39, the main arm 37, the unison ring 45, the arms 44 and the pins 21, in this order. The vanes 42 may be controlled in various methods. For example, when the engine is running at a low or medium speed, the increasing rate of the supercharging pressure and the supercharging pressure are increased by controlling the orientation of the vanes 42 such that the vanes 42 are closed to increase the flow speed of the exhaust gas. Accordingly, generation of soot can be suppressed, and the torque can be increased. In contrast to this, when the engine is running at a high speed, the orientation of the vanes 42 is controlled such that the vanes 42 are opened to decrease the pressure of the exhaust gas. Accordingly, the fuel efficiency and the output can be increased, and overspeed of the turbine wheel assembly 22 can be prevented. Also, while the exhaust gas is re-circulated, the orientation of the vanes 42 is controlled to stabilize the EGR control.

[0041] In the variable geometry turbocharger 1 according to the first embodiment, the flow of fuel through the clearance formed between the turbine housing 48 and the nozzle ring 43 is minimized. The fuel is injected into the exhaust gas at a position upstream of the turbine-housing swirl chamber 5, and used to burn the particulate matter accumulated in a DPNR (Diesel Particulate and NOx Reduction System) provided downstream of the exhaust turbine chamber 148. Because the communication hole 3, which provides communication between the turbine-housing swirl chamber 5 and the link chamber 6, is formed in the lower portion of the turbine housing 48, the difference in pressure between the turbine-housing swirl chamber 5 and the link chamber 6 is reduced. Any number of the communication holes 3 may be formed as appropriate.

[0042] The position and size of the communication hole 3 are set based on the area of the clearance formed between the nozzle ring 43 and the turbine housing 48. The communication hole 3 is formed in the portion of the surface of the turbine-housing swirl chamber 5, where the least amount of fuel adheres. The scavenging holes 4 are formed in the disk shroud 23, and the gas is made to flow to the back-side of the turbine from the turbine-housing swirl chamber 5 toward the link chamber 6. The number of the scavenging holes 4 may be, for example, three, and the scavenging holes 4 may be formed at intervals of, for example, 120 degrees. The temperature in the link chamber 6 can be increased by the gas flowing through the scavenging holes 4.

[0043] In the first embodiment, the deposit in the link chamber 6 can be burned or peeled off. To burn or peel off the deposit, the communication hole 3, which provides communication between the link chamber 6 and the turbine-housing swirl chamber 5, is formed. It is preferable

to form two or more communication holes 3, because the exhaust gas flows more efficiently, and does not stagnate easily. As described so far, in the variable geometry turbocharger 1 according to the first embodiment, the presence of the communication hole 3 and the scavenging holes 4 minimizes the difference in pressure between the turbine-housing swirl chamber 5 and the link chamber 6. Thus, the flow of fuel into the link chamber 6 is minimized. Furthermore, any fuel that flowed into the link chamber 6 would be vaporized by the high-temperature exhaust gas flowing into the link chamber 6 through the communication hole 3 and the scavenging holes 4.

[0044] The scavenging holes 4 are not necessarily formed. Only the communication hole 3 may be formed without forming the scavenging holes 4.

[0045] Hereafter, a second embodiment of the invention will be described in detail. FIG. 6 illustrates the cross sectional view of a variable geometry turbocharger according to the second embodiment. As shown in FIG. 6, in a variable geometry turbocharger 1 according to the second embodiment, the communication hole 3 opens into the lower portion of the turbine-housing swirl chamber 5. Namely, the communication hole 3 extends toward the lower portion of the turbine-housing swirl chamber 5. When the variable geometry turbocharger 1 is mounted in the vehicle, the communication hole 3 is positioned in the lowest portion, namely, the portion of the variable geometry turbocharger 1, which is closest to the ground surface.

[0046] In the thus configured variable geometry turbocharger 1 according to the second embodiment, the fuel flowing into the link chamber 6 flows down to the turbine-housing swirl chamber 5 through the communication hole 3. Accordingly, the fuel does not accumulate in the link chamber 6, and formation of sludge in the link chamber 6 can be minimized. Also, because the communication hole 3 is positioned in the lowest portion when the variable geometry turbocharger 1 is mounted in the vehicle, the communication hole 3 also serves as the discharge passage through which any deposit peeled off from the link chamber 6 is returned to the turbine-housing swirl chamber 5.

[0047] Hereafter, a third embodiment of the invention will be described in detail. FIG. 7 illustrates the plan view of a variable geometry turbocharger according to the third embodiment. As shown in FIG. 7, in a variable geometry turbocharger 1 according to the third embodiment, a discharge hole, through which the accumulated fuel is discharged to the inlet of the turbine, is formed in the lower portion of the turbine-housing swirl chamber 5. Thus, the flow of fuel from the turbine-housing swirl chamber 5 to the link chamber 6 is minimized. The discharge hole 149 is formed at an angle at which the dynamic pressure of the gas flow at the inlet portion of the turbine is not applied to the discharge hole 149.

[0048] While the invention has been described in detail with reference to the preferred embodiments, the embodiments may be modified in various manners. First,

the variable geometry turbocharger 1 according to the invention is mainly mounted in a vehicle provided with a diesel engine. However, the variable geometry turbocharger 1 according to the invention may be mounted in a vehicle provided with a gasoline engine or a rotary engine. Also, the invention may be applied to a hybrid vehicle using a diesel engine or a gasoline engine.

[0049] The embodiment of the invention that has been disclosed in the specification is to be considered in all respects as illustrative and not restrictive. The technical scope of the invention is defined by claims, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

[0050] A variable geometry turbocharger 1 includes a housing 201; and a link mechanism 202, provided in the housing 201, which controls the orientation of vanes 42 for controlling the flow of exhaust gas. The housing 201 includes a turbine-housing swirl chamber 5 for supplying the exhaust gas to a turbine; and a link chamber 6 that houses the link mechanism 202. A communication hole 3, which provides communication between the turbine-housing swirl chamber 5 and the link chamber 6, is formed in the housing 201.

vide communication between the exhaust turbine chamber and the link chamber, are formed in the shroud.

Claims

1. A variable geometry turbocharger including a housing, and a link mechanism, provided in the housing, which drives vanes for controlling a flow of exhaust gas, the housing including a turbine-housing swirl chamber for supplying the exhaust gas to a turbine and a link chamber that houses the link mechanism, **characterized in that** a communication hole, which provides communication between the turbine-housing swirl chamber and the link chamber, is formed in the housing.
2. The variable geometry turbocharger according to claim 1, wherein the communication hole is formed obliquely downward to open into a lower portion of the turbine-housing swirl chamber.
3. The variable geometry turbocharger according to claim 1 or 2, wherein the communication hole is positioned at a lowest portion of the turbine-housing swirl chamber when the variable geometry turbocharger is mounted in a vehicle.
4. The variable geometry turbocharger according to claims 1 to 3, wherein an exhaust turbine chamber that houses the turbine is formed in the housing, a shroud that separates the exhaust turbine chamber from the link chamber is further provided, and scavenging holes, which pro-

FIG. 1A

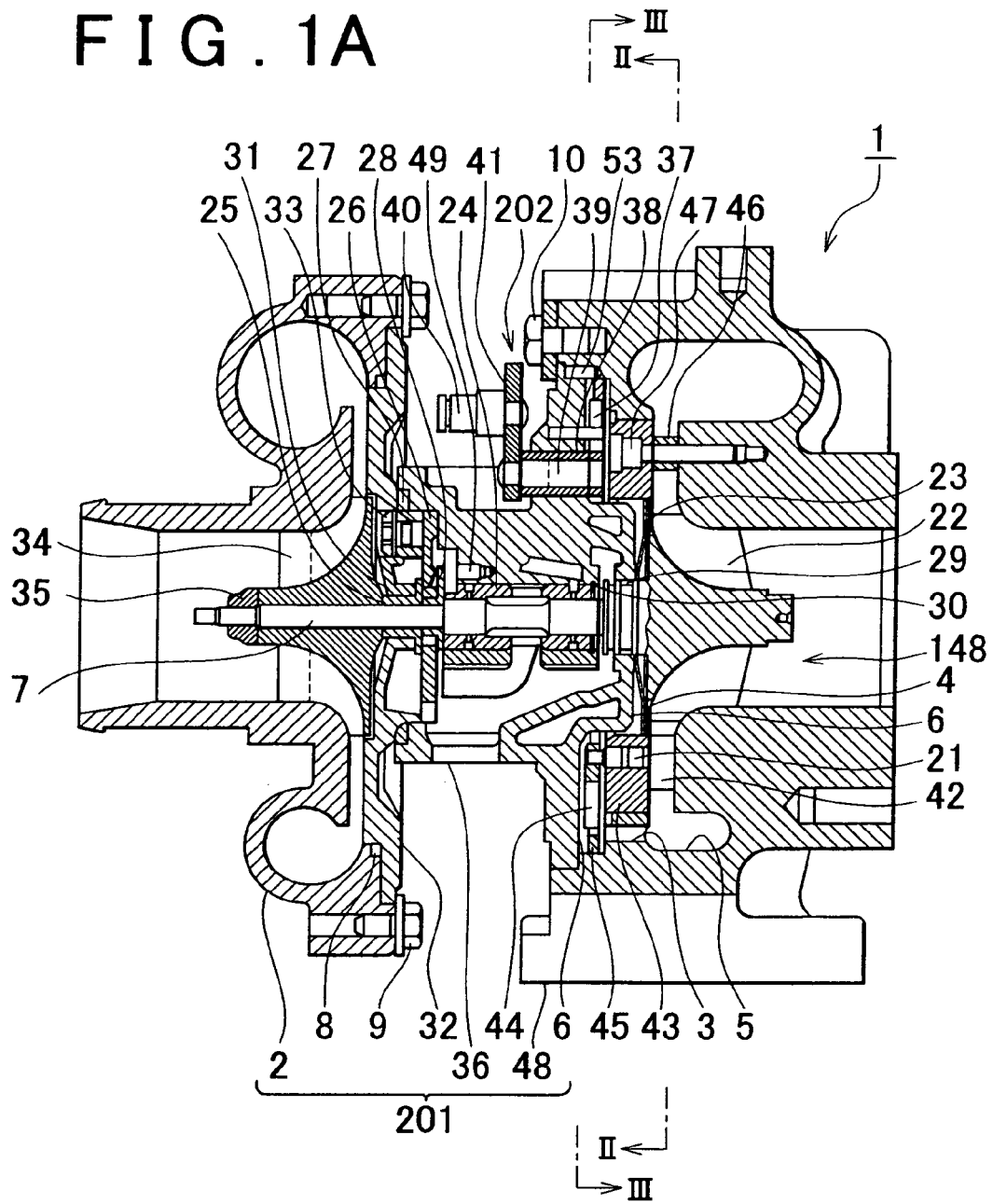


FIG. 1B

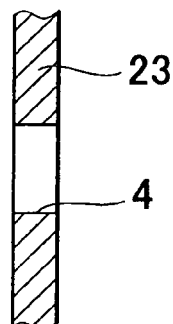


FIG. 2

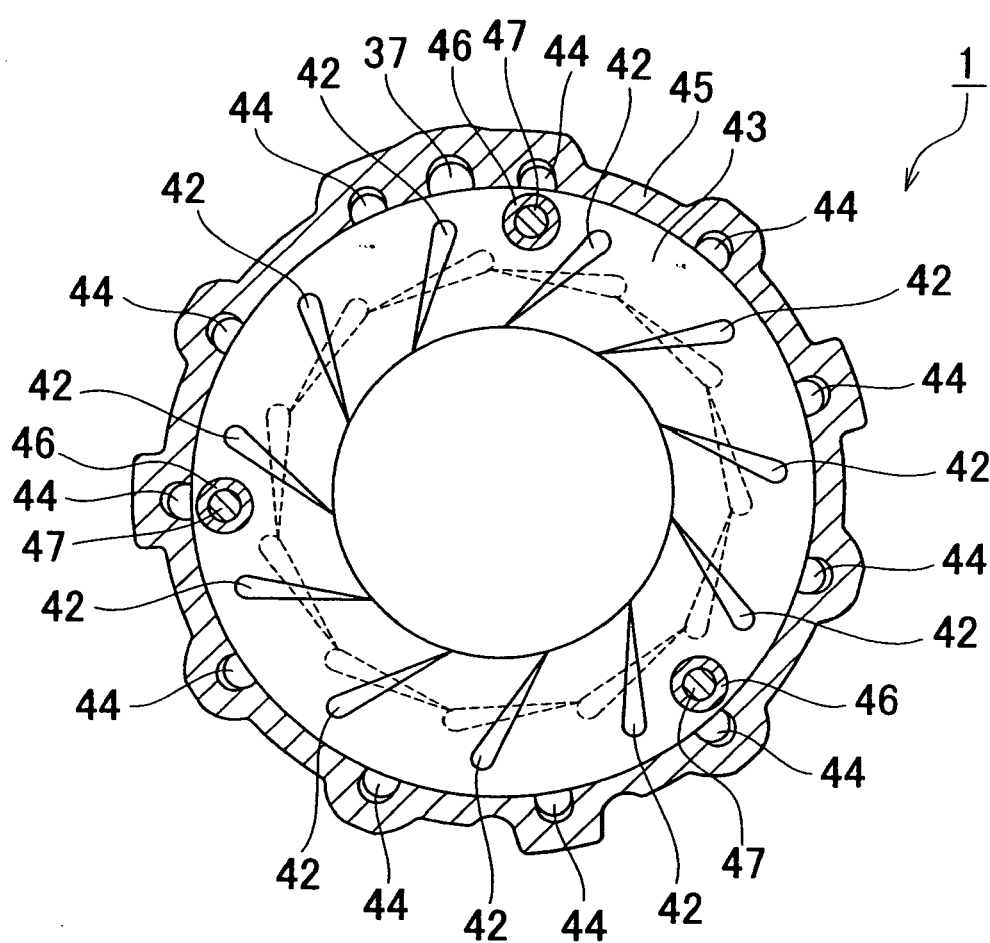


FIG. 3

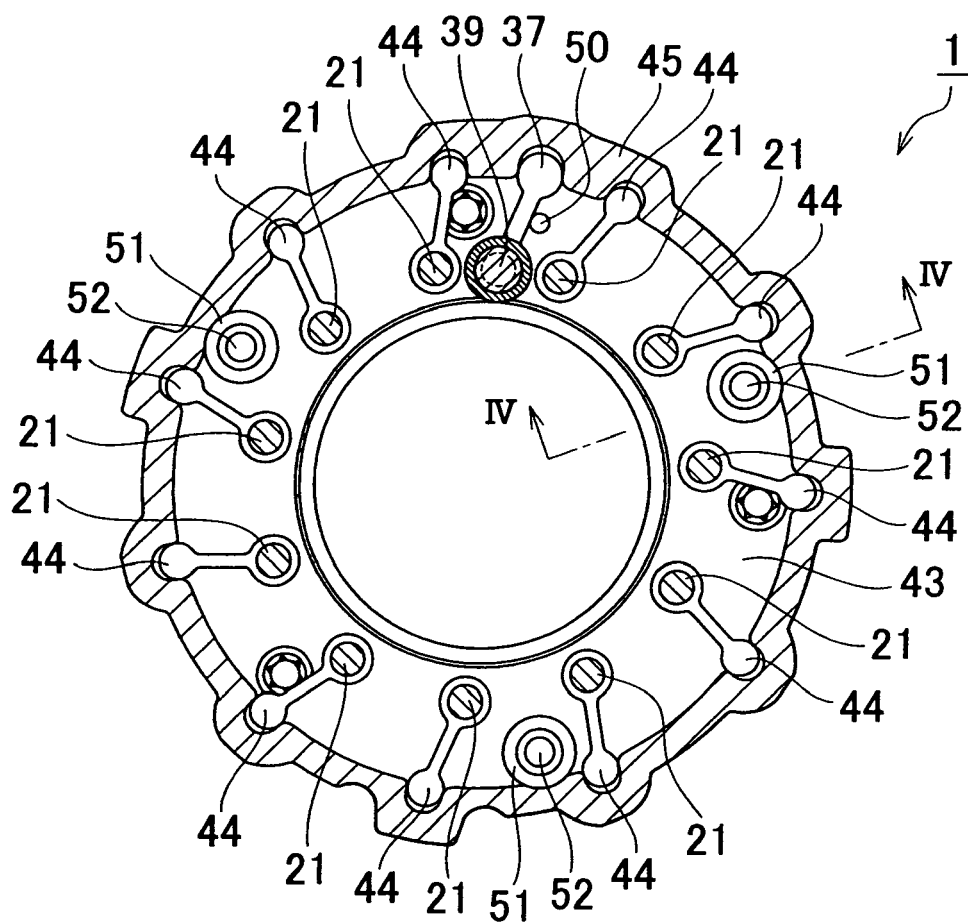


FIG. 4

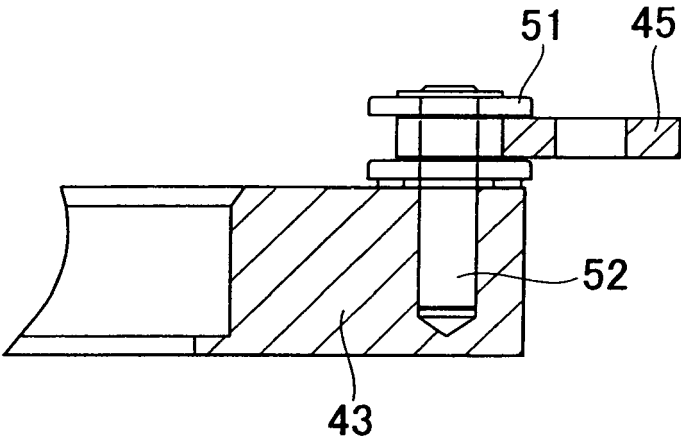


FIG. 5

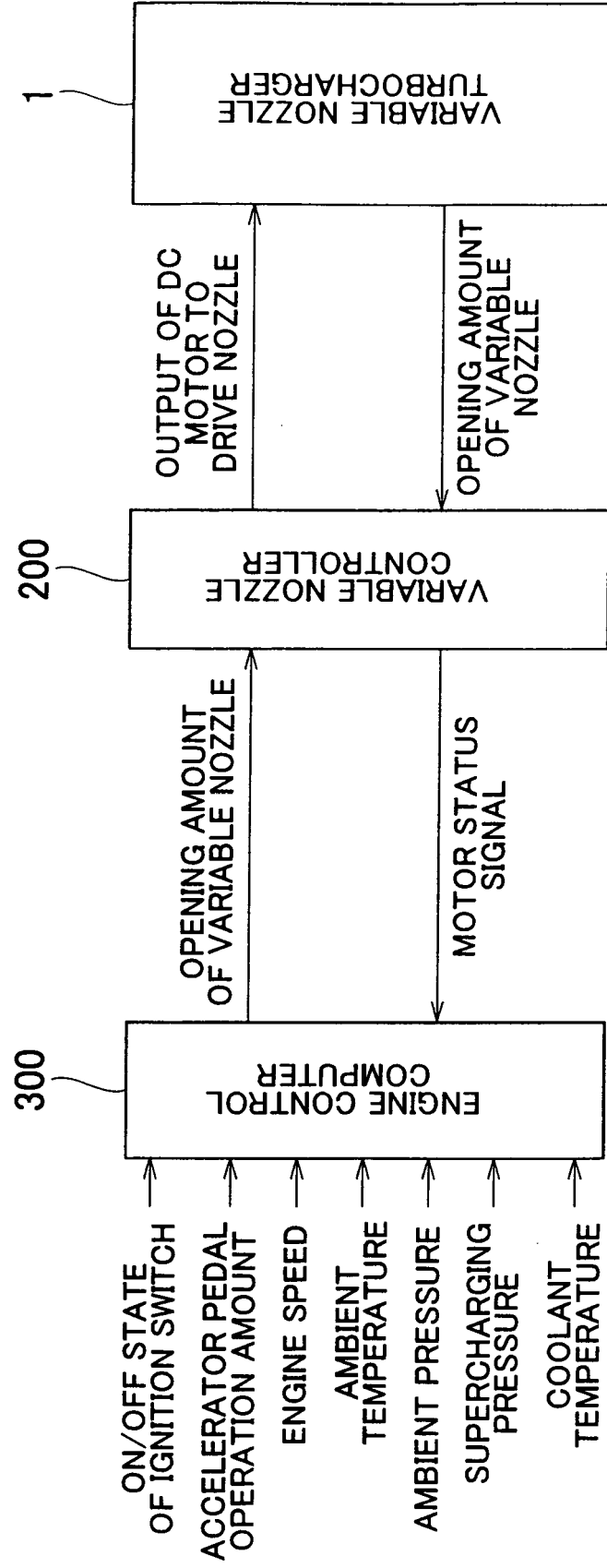


FIG. 6

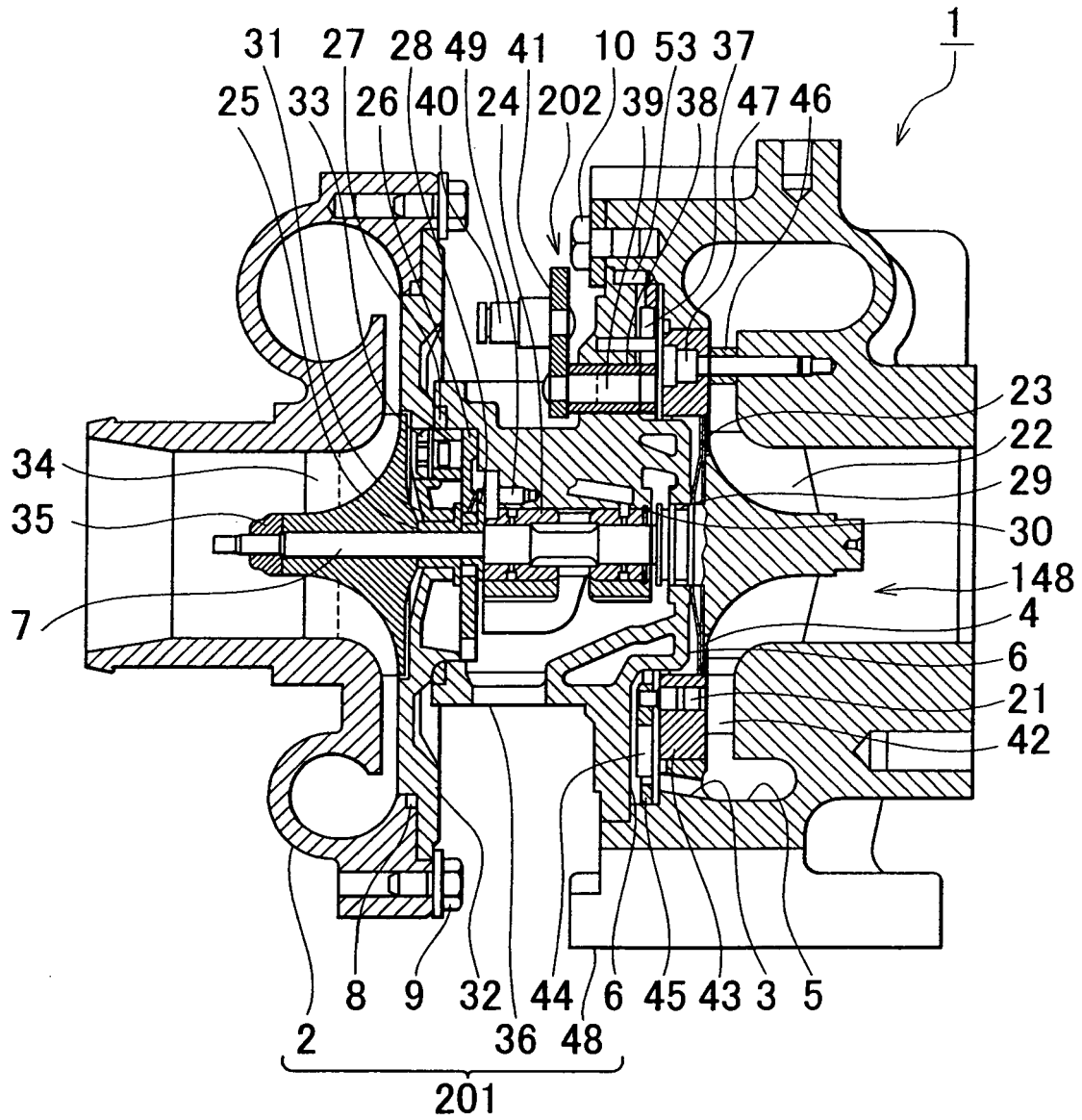


FIG. 7

