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(54) **GAS ENGINE SYSTEM**

(57) A gas engine system includes: a gas engine; an exhaust pipe extending over a plurality of cylinders of the gas engine in a bridging manner; a turbocharger disposed at a position that is away in an axial direction of a crank shaft of the gas engine from one end portion of the exhaust pipe; a catalyst converter that incorporates therein a catalyst that oxidizes uncombusted fuel gas in exhaust gas discharged from the gas engine; and a power generator disposed opposite to the turbocharger, with the gas engine being positioned between the power generator and the turbocharger. The catalyst converter is interposed in a passage extending from an exhaust gas outlet of the exhaust pipe to an exhaust gas inlet of the turbocharger, and is disposed above the power generator.

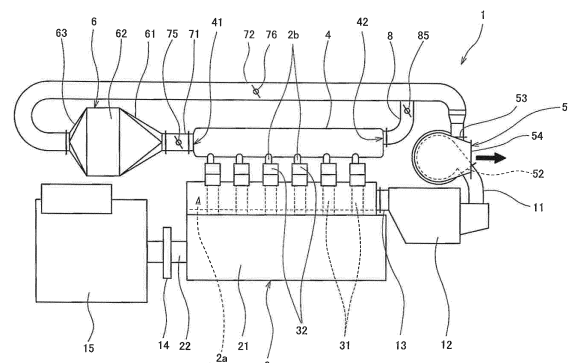


Fig. 1

Description

Technical Field

[0001] The present invention relates to a gas engine system including a gas engine and a turbocharger.

Background Art

[0002] Conventionally, there have been known gas engine systems that include: a gas engine that combusts fuel gas to drive, for example, a power generator; and a turbocharger that uses exhaust gas discharged from the gas engine as a driving source and feeds compressed air to the gas engine.

[0003] There are cases where such a gas engine system adopts a gas engine of a flame propagation type, which ignites an air-fuel mixture supplied into a combustion chamber by pilot light (e.g., by a spark generated by a spark plug or by self-ignition of pilot oil), the air-fuel mixture being a mixture of fuel gas and compressed air. In such a case, part of the fuel gas is left uncombusted near the wall surface of the combustion chamber, and the uncombusted fuel gas is discharged from the gas engine together with exhaust gas. For example, in a case where natural gas containing methane as a main component is used as the fuel gas, the uncombusted fuel gas in the exhaust gas contains a large amount of methane.

[0004] To address such a problem, Patent Literature 1 discloses oxidizing the uncombusted fuel gas in the exhaust gas by using a catalyst. The catalyst is set in an exhaust gas passage extending from the gas engine to the turbocharger. The temperature of the exhaust gas before it is expanded in the turbocharger is high. Accordingly, in the exhaust gas passage extending from the gas engine, if the catalyst is set upstream of the turbocharger, the uncombusted fuel gas can be oxidized by the catalyst more efficiently than in a case where the catalyst is set downstream of the turbocharger.

[0005] Patent Literature 2 discloses setting a catalyst in the exhaust gas passage extending from the gas engine to the turbocharger, the catalyst being used for SCR (selective catalytic reduction) in which nitrogen oxides (NO_x) are reduced by using methane as a reductant, although the catalyst set in the exhaust gas passage in Patent Literature 2 is not a catalyst that oxidizes the uncombusted fuel gas.

Citation List

Patent Literature

[0006]

PTL 1: Japanese Laid-Open Patent Application Publication No. H11-350942

PTL 2: Japanese Laid-Open Patent Application Publication No. 2001-107723

Summary of Invention

Technical Problem

[0007] However, Patent Literature 1 merely discloses a schematic configuration of the gas engine system in the form of a block diagram, and does not disclose what layout should be adopted. For example, if the gas engine and the turbocharger are connected by straight piping, and a catalyst converter incorporating a catalyst therein is interposed in the middle of the piping, the overall length of the gas engine system will be significantly great.

[0008] Meanwhile, Patent Literature 2 discloses a layout in which, in relation to the gas engine, a catalyst converter incorporating a catalyst therein is disposed in a direction orthogonal to the cylinder arrangement direction, and the turbocharger is disposed above a gap between the catalyst converter and the gas engine. However, as mentioned above, the catalyst incorporated in the catalyst converter of Patent Literature 2 is not a catalyst that oxidizes the uncombusted fuel gas, but a catalyst for SCR.

[0009] In view of the above, an object of the present invention is to provide a gas engine system that allows a catalyst converter for oxidizing uncombusted fuel gas in exhaust gas to be interposed in an exhaust gas passage extending from a gas engine to a turbocharger while allowing the turbocharger to be disposed adjacently to the gas engine.

Solution to Problem

[0010] In order to solve the above-described problems, a gas engine system according to the present invention includes: a gas engine including a crank shaft and a plurality of cylinders arranged in an axial direction of the crank shaft; an exhaust pipe extending over the plurality of cylinders in a bridging manner; a turbocharger disposed at a position that is away in the axial direction of the crank shaft from one end portion of the exhaust pipe; a catalyst converter that incorporates therein a catalyst that oxidizes uncombusted fuel gas in exhaust gas discharged from the gas engine; and a power generator disposed opposite to the turbocharger, with the gas engine being positioned between the power generator and the turbocharger, the power generator being coupled to the crank shaft. The catalyst converter is interposed in a passage extending from an exhaust gas outlet of the exhaust pipe to an exhaust gas inlet of the turbocharger, and is disposed above the power generator.

[0011] According to the above configuration, the power generator is disposed opposite to the turbocharger, with the gas engine being positioned between the power generator and the turbocharger. Therefore, particularly in a case where the exhaust gas outlet is provided at the other end portion of the exhaust pipe, the other end portion being positioned opposite to the aforementioned one end portion positioned at the turbocharger side, the catalyst

converter can be disposed by utilizing relatively useless space above the power generator.

[0012] The one end portion of the exhaust pipe at the turbocharger side may be provided with a bypass port. The gas engine system may further include: a first relay pipe that connects the exhaust gas outlet and the catalyst converter; a second relay pipe that connects the catalyst converter and the exhaust gas inlet of the turbocharger; a bypass pipe that extends from the bypass port of the exhaust pipe, and merges with the second relay pipe; a first bypass valve provided on the first relay pipe; and a second bypass valve provided on the second relay pipe and positioned upstream of a position where the bypass pipe merges with the second relay pipe. According to this configuration, replacement of the catalyst can be performed even while the gas engine system is operating.

[0013] The catalyst converter may include: a tubular casing accommodating a catalyst support; an upstream-side hood that expands toward the casing; and a downstream-side hood that narrows from the casing. The upstream-side hood may be provided with an injection mechanism that injects water, steam, or gas toward the catalyst support. This configuration makes it possible to lay out the catalyst support over a wide area. Moreover, by injecting the water, steam, or gas from the injection mechanism toward the catalyst support, excessive increase in the catalyst temperature can be suppressed; extraneous matter adhered to the surface of the catalyst support can be removed; or the catalyst can be activated at an early stage of the start of the gas engine.

[0014] The catalyst converter may incorporate therein an adsorbent positioned upstream of the catalyst, the adsorbent being capable of adsorbing a substance that causes degradation of performance of the catalyst. This configuration makes it possible to extend the life of the catalyst.

[0015] The catalyst converter may be provided with a temperature sensor for detecting a temperature of the catalyst converter. An oxidizing reaction of the uncombusted fuel gas, which is catalyzed by the catalyst, is highly sensitive to the concentration of the uncombusted fuel gas in the exhaust gas. Therefore, by providing the catalyst converter with the temperature sensor, abnormalities in the gas engine that cause increase in the concentration of the uncombusted fuel gas can be detected.

Advantageous Effects of Invention

[0016] The present invention makes it possible to allow the catalyst converter for oxidizing the uncombusted fuel gas in the exhaust gas to be interposed in the exhaust gas passage extending from the gas engine to the turbocharger while allowing the turbocharger to be disposed adjacently to the gas engine.

Brief Description of Drawings

[0017]

Fig. 1 shows a schematic configuration of a gas engine system according to one embodiment of the present invention.

Fig. 2A shows a view of the gas engine system of Fig. 1 as seen from a power generator side, and Fig. 2B shows a view of the gas engine system as seen from a turbocharger side.

Fig. 3 is a sectional view of part of a gas engine and an exhaust pipe included in the gas engine system of Fig. 1.

Fig. 4 is a longitudinal sectional view of a catalyst converter.

Fig. 5A is cross-sectional view of Fig. 4 taken along line VA-VA, and Fig. 5B is a cross-sectional view of Fig. 4 taken along line VB-VB.

Fig. 6 is a longitudinal sectional view of the catalyst converter according to a variation.

Description of Embodiments

[0018] Figs. 1 to 2B show a gas engine system 1 according to one embodiment of the present invention. The embodiment is intended for realizing a suitable layout for a 4-stroke gas engine.

[0019] Specifically, the gas engine system 1 includes: a 4-stroke gas engine 2, which combusts fuel gas; and a power generator 15 driven by the gas engine 2. The gas engine system 1 further includes: a turbocharger 5 disposed adjacently to the gas engine 2; and an air cooler 12 and a catalyst converter 6, which are provided between the gas engine 2 and the turbocharger 5.

[0020] The gas engine 2 includes: a crank shaft 22; and an engine frame 21, which accommodates large part of the crank shaft 22. An end portion of the crank shaft 22, the end portion projecting from the engine frame 21, is coupled to the power generator 15 via a flywheel 14. At the start of the gas engine 2, the flywheel 14 is driven by an unshown starter motor that is an air motor.

[0021] As shown in Fig. 3, a plurality of cylinders 31 are incorporated in the engine frame 21. In the present embodiment, the cylinders 31 are arranged in the axial direction of the crank shaft 22 in two rows. One row of cylinders 31 and the other row of cylinders 31 are inclined relative to the vertical direction at the same angle. When seen in the axial direction of the crank shaft 22, the angle between the cylinders 31 is an acute angle, and the cylinders 31 form a V shape. It should be noted that the one row of cylinders 31 and the other row of cylinders 31 may be inclined relative to the vertical direction at different angles from each other. Moreover, the angle between the cylinders 31 when seen in the axial direction of the crank shaft 22 may be the right angle such that the cylinders 31 form an L shape. Furthermore, the cylinders 31 may be arranged in a single row.

[0022] Each cylinder 31 forms a combustion chamber 30 together with a piston 33 disposed in the cylinder 31 and a corresponding one of cylinder heads 32. An intake port 3a and an exhaust port 3b are formed in each cylinder

head 32. The cylinder head 32 is also provided with intake valves 34 and exhaust valves 35. The intake valves 34 open/close the opening of the intake port 3a to the combustion chamber 30, and the exhaust valves 35 open/close the opening of the exhaust port 3b to the combustion chamber 30. The cylinder head 32 is further provided with a fuel valve 36, which injects the fuel gas into the intake port 3a. The fuel gas is, for example, natural gas containing methane as a main component.

[0023] Between the one row of cylinders 31 and the other row of cylinders 31, an intake chamber 2a is formed, which extends in the axial direction of the crank shaft 22 along all the cylinders 31 in a bridging manner. The intake ports 3a provided for the respective cylinders 31 are each connected to the intake chamber 2a by corresponding one of first connecting pipes 2c.

[0024] Immediately above the intake chamber 2a, an exhaust pipe 4 is disposed. The exhaust pipe 4 extends in the axial direction of the crank shaft 22 over all the cylinders 31 in a bridging manner. The exhaust ports 3b provided for the respective cylinders 31 are each connected to the exhaust pipe 4 by a corresponding one of second connecting pipes 2b.

[0025] Returning to Fig. 1, the turbocharger 5 is disposed at a position that is away in the axial direction of the crank shaft 22 from one end portion of the exhaust pipe 4, the one end portion being positioned opposite to the other end portion positioned at the power generator 15 side. In other words, the turbocharger 5 is disposed opposite to the power generator 15, with the gas engine 2 being positioned between the turbocharger 5 and the power generator 15.

[0026] Hereinafter, for the sake of convenience of the description, the axial direction of the crank shaft 22 is referred to as the forward-rearward direction (in particular, the turbocharger 5 side is referred to as the forward side, and the power generator 15 side is referred to as the rearward side), and the horizontal direction orthogonal to the forward-rearward direction is referred to as the right-left direction (in particular, the front side of the direction orthogonal to the plane of Fig. 1 is referred to as the right side, and the back side of the direction is referred to as the left side).

[0027] As shown in Fig. 1 and Fig. 2B, the turbocharger 5 includes: a compressor including an air inlet 51 and an air outlet 52; and a turbine including an exhaust gas inlet 53 and an exhaust gas outlet 54. In the present embodiment, the air inlet 51 is open to the left, and the air outlet 52 is open diagonally downward. Meanwhile, the exhaust gas inlet 53 is open upward (not in a direction toward the exhaust pipe 4), and the exhaust gas outlet 54 is open forward.

[0028] The air cooler 12 is disposed immediately below the turbocharger 5 and forward of the gas engine 2. The air outlet 52 of the turbocharger 5 is connected to the air cooler 12 by a first air supply pipe 11, and the air cooler 12 is connected to the intake chamber 2a by a second air supply pipe 13. The first air supply pipe 11 extends

diagonally downward and then smoothly bends diagonally sideways. The second air supply pipe 13 has a straight shape extending in the forward-rearward direction.

[0029] As shown in Fig. 1 and Fig. 2A, the catalyst converter 6 is disposed above the power generator 15. In other words, the catalyst converter 6 is disposed opposite to the turbocharger 5, with the exhaust pipe 4 being positioned between the catalyst converter 6 and the turbocharger 5. The catalyst converter 6 includes an inlet open forward and an outlet open rearward, and the catalyst converter 6 incorporates therein a catalyst that oxidizes uncombusted fuel gas in exhaust gas discharged from the gas engine 2.

[0030] The rear end portion of the exhaust pipe 4 is provided with an exhaust gas outlet 41, which is open rearward. The forward end portion of the exhaust pipe 4 is provided with a bypass port 42, which is open forward. The exhaust gas outlet 41 of the exhaust pipe 4 is connected to the inlet of the catalyst converter 6 by a first relay pipe 71, and the outlet of the catalyst converter 6 is connected to the exhaust gas inlet 53 of the turbocharger 5 by a second relay pipe 72. That is, the first relay pipe 71, the catalyst converter 6, and the second relay pipe 72 form a passage extending from the exhaust gas outlet 41 of the exhaust pipe 4 to the exhaust gas inlet 53 of the turbocharger 5. In other words, the catalyst converter 6 is interposed in the passage extending from the exhaust gas outlet 41 of the exhaust pipe 4 to the exhaust gas inlet 53 of the turbocharger 5.

[0031] The first relay pipe 71 has a straight shape extending in the forward-rearward direction. On the other hand, the second relay pipe 72 includes: a straight portion extending in the forward-rearward direction immediately above the catalyst converter 6 and the exhaust pipe 4; a 180-degree bent portion extending from the outlet of the catalyst converter 6 to the upstream end of the straight portion; and a 90-degree bent portion extending from the downstream end of the straight portion to the exhaust gas inlet 53 of the turbocharger 5. Although not illustrated, expandable and contractable members intended for absorbing thermal expansion may be incorporated at suitable positions in the first relay pipe 71 and the second relay pipe 72.

[0032] The bypass port 42 of the exhaust pipe 4 is connected to the second relay pipe 72 by a bypass pipe 8. The bypass pipe 8 bends from the bypass port 42 of the exhaust pipe 4 by 90 degrees, and merges with the straight portion of the second relay pipe 72.

[0033] Normally, the exhaust gas from the exhaust pipe 4 is led to the catalyst converter 6 through the first relay pipe 71. In a particular situation, the exhaust gas from the exhaust pipe 4 is led the second relay pipe 72 through the bypass pipe 8. The first relay pipe 71 is provided with a first bypass valve 75, and the second relay pipe 72 is provided with a second bypass valve 76. The second bypass valve 76 is positioned upstream of a position where the bypass pipe 8 merges with the second

relay pipe 72. The bypass pipe 8 is provided with a third bypass valve 85. Normally, the third bypass valve 85 is in a closed state, and the first bypass valve 75 and the second bypass valve 76 are in an open state. In a particular situation, the first bypass valve 75 and the second bypass valve 76 are closed, and the third bypass valve 85 is opened.

[0034] Next, the configuration of the catalyst converter 6 is described in detail with reference Fig. 4, Fig. 5A, and Fig. 5B.

[0035] The catalyst converter 6 includes: a tubular casing 62 accommodating catalyst supports 65 and extending in the forward-rearward direction; an upstream-side hood 61, which expands toward the casing 62; and a downstream-side hood 63, which narrows from the casing 62. In the present embodiment, the casing 62 has a rectangular sectional shape. However, as an alternative, the casing 62 may have a circular sectional shape, for example.

[0036] The interior of the casing 62 is divided into a plurality of small rooms by a lattice member 64. In each small room, a plurality of catalyst supports 65 are disposed such that they are stacked in the flow direction of the exhaust gas. Each of the catalyst supports 65 has, for example, a structure in which corrugated plates and flat plates are stacked alternately, and coating layers each containing a catalyst are formed on the surfaces of these plates. As one example, fine metal particles made of, for example, platinum or palladium can be used as the catalyst.

[0037] The upstream-side hood 61 is provided with an injection mechanism 9, which injects water, steam, or gas toward the catalyst supports 65. The injection mechanism 9 is formed by, for example, a main pipe 91 and a plurality of branch pipes 92. The main pipe 91 extends in the right-left direction above the upstream-side hood 61. The plurality of branch pipes 92 hang down from the main pipe 91 into the upstream-side hood 61. Each of the branch pipes 92 is provided with nozzles that are directed rearward and arranged at regular pitches. However, the injection mechanism 9 may be eliminated.

[0038] Desirably, the catalyst converter 6 is provided with a temperature sensor 67 for detecting the temperature of the catalyst converter 6. An oxidizing reaction of the uncombusted fuel gas, which is catalyzed by the catalyst, is highly sensitive to the concentration of the uncombusted fuel gas in the exhaust gas. Therefore, by providing the catalyst converter 6 with the temperature sensor 67, abnormalities in the gas engine 2 that cause increase in the concentration of the uncombusted fuel gas (e.g., fuel gas leakage from the fuel valves 36) can be detected.

[0039] As described above, in the gas engine system 1 according to the present embodiment, even if the turbocharger 5 is disposed adjacently to the gas engine 2, the route of the piping from the exhaust gas outlet 41 of the exhaust pipe 4 to the exhaust gas inlet 53 of the turbocharger 5 can be freely set depending on the directions

of the openings of the exhaust gas outlet 41 of the exhaust pipe 4 and the exhaust gas inlet 53 of the turbocharger 5. That is, whatever position the catalyst converter 6, which incorporates therein the catalyst that oxidizes the uncombusted fuel gas in the exhaust gas, is disposed at, the catalyst converter 6 can be connected to the exhaust gas outlet 41 of the exhaust pipe 4 and the exhaust gas inlet 53 of the turbocharger 5. In other words, the catalyst converter 6 can be interposed in the exhaust gas passage extending from the gas engine 2 to the turbocharger 5 while allowing the turbocharger 5 to be disposed adjacently to the gas engine 2.

[0040] Moreover, in the present embodiment, the rear end portion of the exhaust pipe is provided with the exhaust gas outlet 41, and the catalyst converter 6 is disposed rearward of the exhaust pipe 4. This makes it possible to connect the catalyst converter 6 and the exhaust gas outlet 41 by the shortest possible distance. Furthermore, the catalyst converter 6 is disposed above the power generator 15. That is, the catalyst converter 6 can be disposed by utilizing relatively useless space above the power generator 15.

[0041] The present embodiment includes the bypass pipe 8. Therefore, by closing the first bypass valve 75 and the second bypass valve 76 and opening the third bypass valve 85, replacement of the catalyst (in the present embodiment, the catalyst supports 65) can be performed even while the gas engine system 1 is operating. It should be noted that in the case of performing the replacement of the catalyst while the gas engine system 1 is in a stopped state, the bypass pipe 8 and the first and second bypass valves 75 and 76 may be eliminated.

[0042] In the present embodiment, the catalyst converter 6 is configured such that the catalyst converter 6 widens from both end portions thereof toward the central portion thereof. This makes it possible to lay out the catalyst supports 65 over a wide area. Consequently, pressure loss can be reduced. Since the upstream-side hood 61 of the catalyst converter 6 is provided with the injection mechanism 9, excessive increase in the catalyst temperature can be suppressed; extraneous matter adhered to the surface of the catalyst supports 65 can be removed; or the catalyst can be activated at an early stage of the start of the gas engine 2.

[0043] For example, when the concentration of the uncombusted fuel gas in the exhaust gas increases, abnormal oxidation may occur in the catalyst converter 6, causing the temperature of the catalyst to become excessively high. In order to suppress such excessive increase in the catalyst temperature, nitrogen, air, steam, water, or the like may be injected from the injection mechanism 9. Among them, the injection of the air may be performed by utilizing a pneumatic circuit to the starter motor, which is an air motor. In a case where the gas engine system 1 is installed together with a boiler, steam from the boiler may be led to the injection mechanism 9.

[0044] In order to physically remove the adhered ex-

traneous matter (e.g., fly ash) from the surface of the catalyst supports 65, air or water may be injected from the injection mechanism 9.

[0045] At the start of the gas engine 2, the temperature of the catalyst is low. Therefore, it is desirable to quickly increase the temperature of the catalyst so as to activate the catalyst at an early stage, thereby suppressing the discharge of the uncombusted fuel gas. In order to realize this, gas that is more reactive than the fuel gas may be injected from the injection mechanism 9. For example, in the case of using natural gas as the fuel gas, ethane or propane may be injected from the injection mechanism 9. Alternatively, oil or oxygen may be injected from the injection mechanism 9.

[0046] In the case of injecting water from the injection mechanism 9, the catalyst supports 65 can be washed with the water, and thus degradation of the catalyst performance can be prevented, because the exhaust gas and engine oil often contain substances that cause degradation of the catalyst performance, such as sulfur oxide, calcium, and zinc. It should be noted that, other than the injection of water from the injection mechanism 9, there are the following first to third methods for preventing degradation of the catalyst performance.

[0047] In the first method, the amount of fuel gas injected from the fuel valves 36 is increased to intentionally increase the concentration of the uncombusted fuel gas in the exhaust gas, thereby facilitating the oxidizing reaction in the catalyst converter 6 so as to increase the temperature of the catalyst converter 6. In this manner, substances adhered to the catalyst (e.g., S or SO₄) are removed by oxidation (gasification). In the second method, for a similar purpose to that of the first method, oxygen is injected from the injection mechanism 9, thereby facilitating the oxidizing reaction in the catalyst converter 6 so as to increase the temperature of the catalyst converter 6. In the third method, while the gas engine 2 is in a stopped state or while bypassing operation through the bypass pipe 8 is being performed, the catalyst supports 65 are removed from the catalyst converter 6 and immersed into water. As a result, if S or SO₄ is adhered to the catalyst, such substance can be dissolved into water as H₂SO₄.

[0048] In order to prevent degradation of the catalyst performance, for example, as shown in Fig. 6, the catalyst converter 6 may incorporate therein an adsorbent 66, which is capable of adsorbing substances that cause degradation of the catalyst performance. For example, in each of the small rooms divided by the lattice member 64, the adsorbent 66 may be disposed upstream of the catalyst supports 65. This configuration makes it possible to extend the life of the catalyst. Activated carbon, or an adsorbent containing calcium or manganese, may be used as the adsorbent 66 capable of adsorbing sulfur.

(Other Embodiments)

[0049] The present invention is not limited to the

above-described embodiment. Various modifications can be made without departing from the spirit of the present invention.

[0050] For example, the exhaust gas inlet 53 of the turbocharger 5 may be open in any direction. Similarly, the exhaust gas outlet 41 of the exhaust pipe 4 may be open in any direction.

Industrial Applicability

[0051] The gas engine system according to the present invention is useful for reducing uncombusted fuel gas, and applicable to various kinds of fuel gases.

Reference Signs List

[0052]

1	gas engine system
2	gas engine
22	crank shaft
31	cylinder
4	exhaust pipe
41	exhaust gas outlet
42	bypass port
5	turbocharger
53	exhaust gas inlet
6	catalyst converter
61	upstream-side hood
62	casing
63	downstream-side hood
65	catalyst support
66	adsorbent
67	temperature sensor
71, 72	relay pipe
75	first bypass valve
76	second bypass valve
8	bypass pipe
9	injection mechanism

Claims

1. A gas engine system comprising:

- a gas engine including a crank shaft and a plurality of cylinders arranged in an axial direction of the crank shaft;
- an exhaust pipe extending over the plurality of cylinders in a bridging manner;
- a turbocharger disposed at a position that is away in the axial direction of the crank shaft from one end portion of the exhaust pipe;
- a catalyst converter that incorporates therein a catalyst that oxidizes uncombusted fuel gas in exhaust gas discharged from the gas engine;
- and
- a power generator disposed opposite to the tur-

bocharger, with the gas engine being positioned between the power generator and the turbo-charger, the power generator being coupled to the crank shaft, wherein the catalyst converter is interposed in a passage extending from an exhaust gas outlet of the ex-haust pipe to an exhaust gas inlet of the turbo-charger, and is disposed above the power gen-erator.

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2. The gas engine system according to claim 1, wherein the one end portion of the exhaust pipe at the turbo-charger side is provided with a bypass port, and the gas engine system further comprises:

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a first relay pipe that connects the exhaust gas outlet and the catalyst converter;
a second relay pipe that connects the catalyst converter and the exhaust gas inlet of the tur-bocharger;
a bypass pipe that extends from the bypass port of the exhaust pipe, and merges with the second relay pipe;
a first bypass valve provided on the first relay pipe; and
a second bypass valve provided on the second relay pipe and positioned upstream of a position where the bypass pipe merges with the second relay pipe.

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3. The gas engine system according to claim 1 or 2, wherein the catalyst converter includes:

a tubular casing accommodating a catalyst sup-port;
an upstream-side hood that expands toward the casing; and
a downstream-side hood that narrows from the casing, and

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the upstream-side hood is provided with an injection mechanism that injects water, steam, or gas toward the catalyst support.

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4. The gas engine system according to any one of claims 1 to 3, wherein the catalyst converter incorporates therein an ad-sorbent positioned upstream of the catalyst, the ad-sorbent being capable of adsorbing a substance that causes degradation of performance of the catalyst.

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5. The gas engine system according to any one of claims 1 to 4, wherein the catalyst converter is provided with a temperature sensor for detecting a temperature of the catalyst converter.

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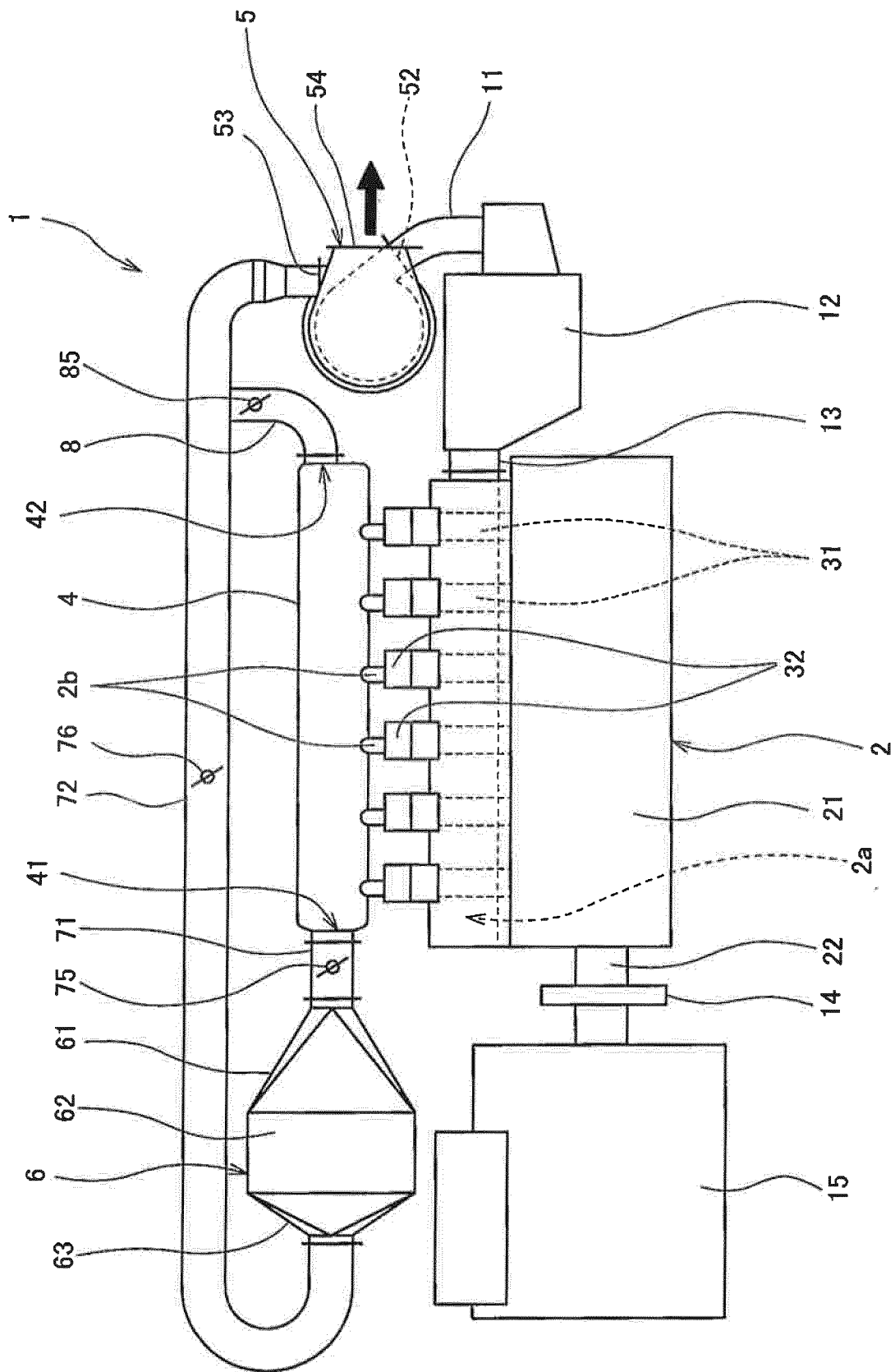


Fig. 1

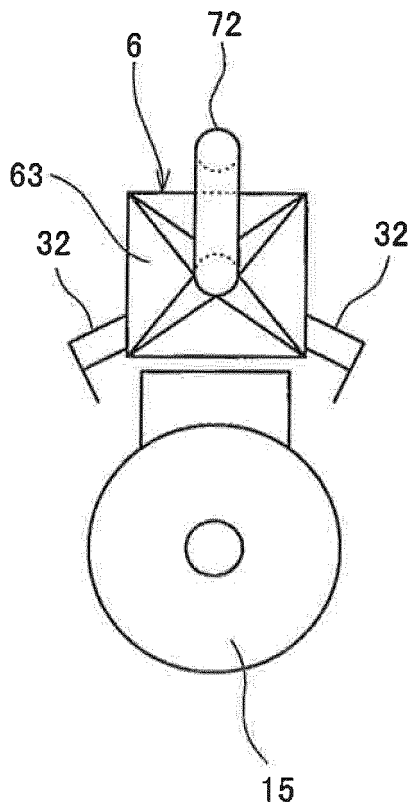


Fig. 2A

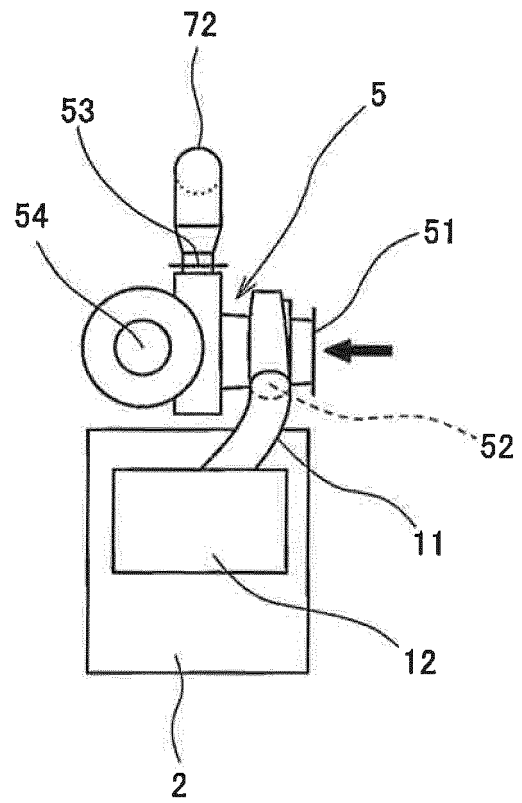


Fig. 2B

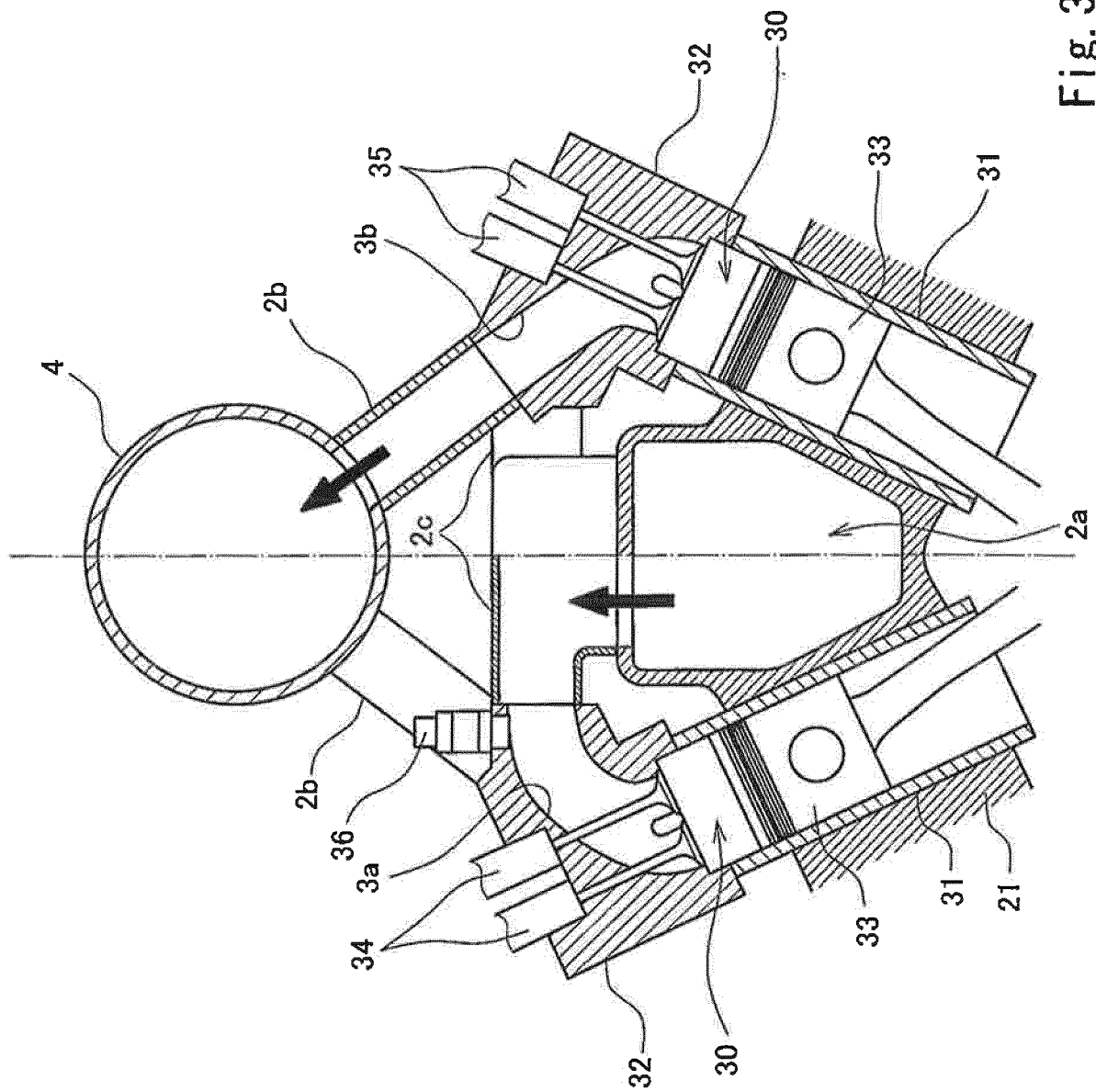


Fig. 3

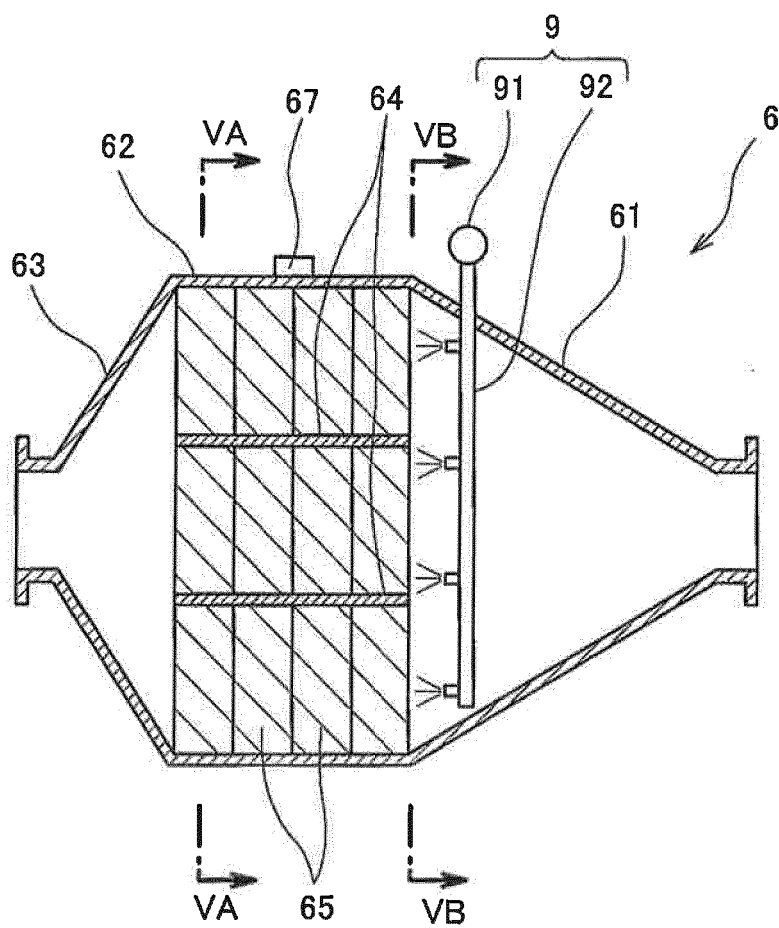


Fig. 4

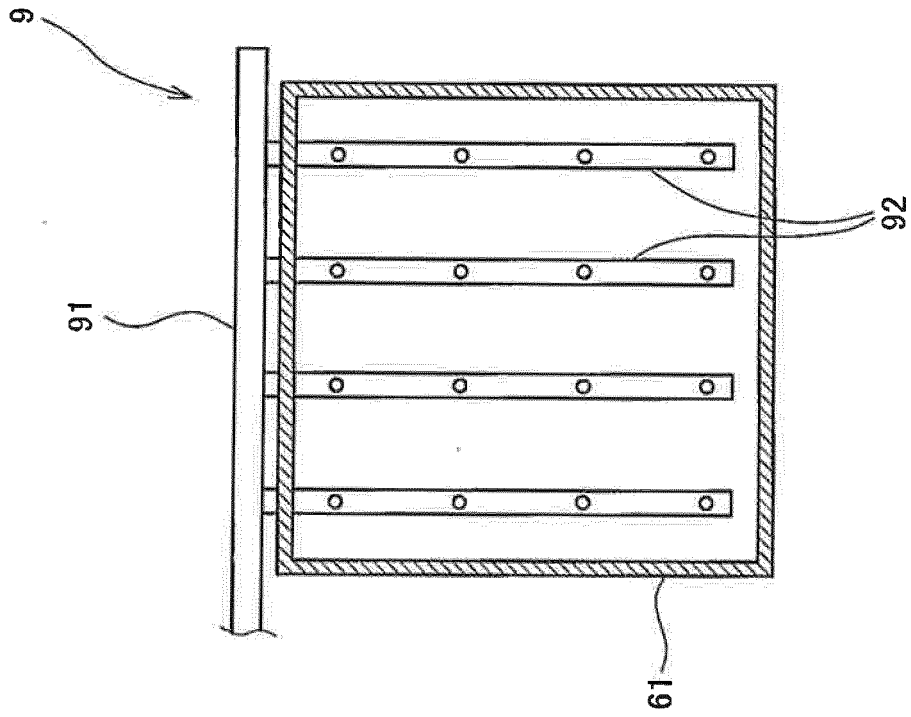


Fig. 5B

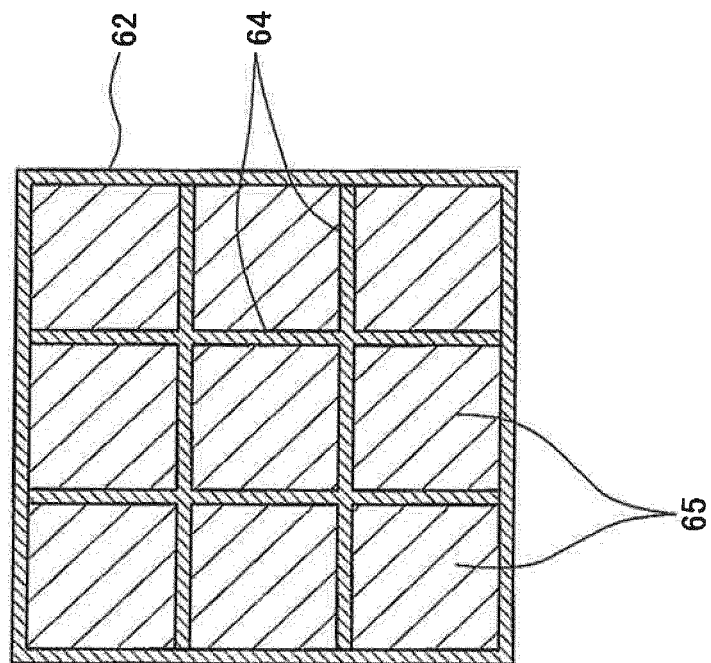


Fig. 5A

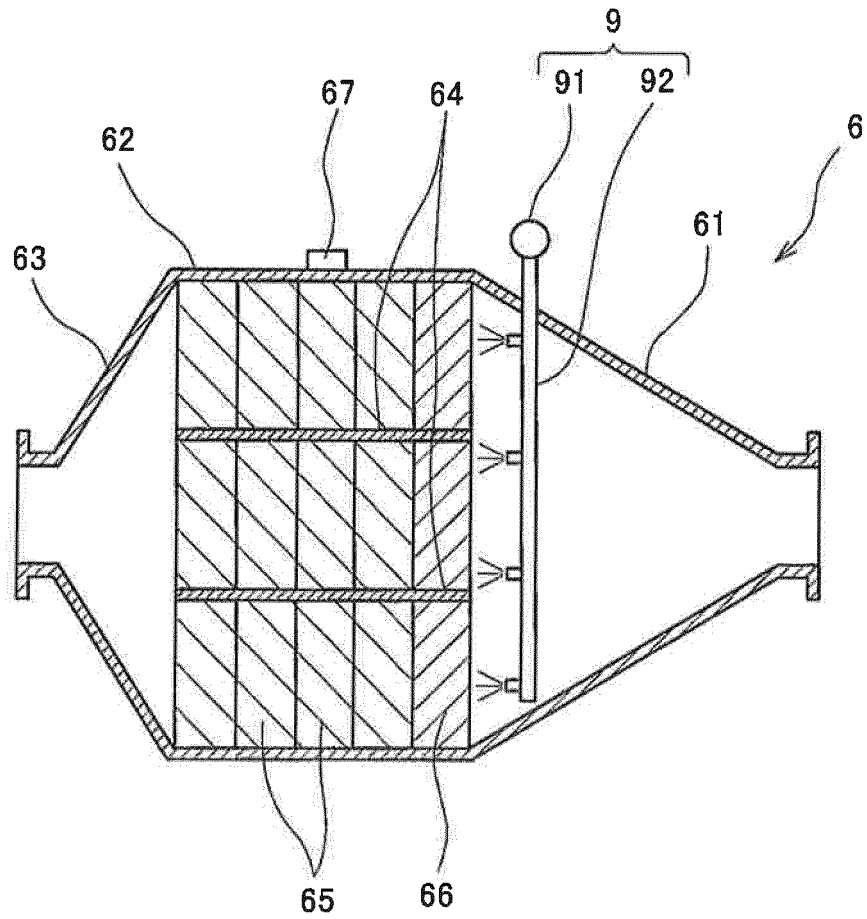


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/035540

A. CLASSIFICATION OF SUBJECT MATTER

F01N3/28(2006.01)i, F01N3/20(2006.01)i, F01N3/24(2006.01)i, F02B43/00
(2006.01)i, F02M21/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01N3/28, F01N3/20, F01N3/24, F02B43/00, F02M21/02

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-350942 A (Osaka Gas Co., Ltd.), 21 December 1999 (21.12.1999), entire text; all drawings (Family: none)	1-5
A	JP 2001-107723 A (Yanmar Diesel Engine Co., Ltd.), 17 April 2001 (17.04.2001), entire text; all drawings (Family: none)	1-5
A	JP 2016-138558 A (MAN Diesel & Turbo, Filial af Man Diesel & Turbo Se, Tyskland), 04 August 2016 (04.08.2016), entire text; all drawings (Family: none)	1-5

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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30 October 2017 (30.10.17)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H11350942 B [0006]
- JP 2001107723 A [0006]