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- **Nakahira, Toshio**
c/o Sakai-Rinkai Factory
Nishi-ku, Sakai-shi, Osaka (JP)
- **Sugimoto, Masahiko**
c/o Sakai-Rinkai Factory
Nishi-ku, Sakai-shi, Osaka (JP)
- **Inoue, Katsushi**
c/o Sakai-Rinkai Factory
Nishi-ku, Sakai-shi, Osaka (JP)

(71) Applicant: **Kubota Corporation**
Osaka-shi,
Osaka (JP)

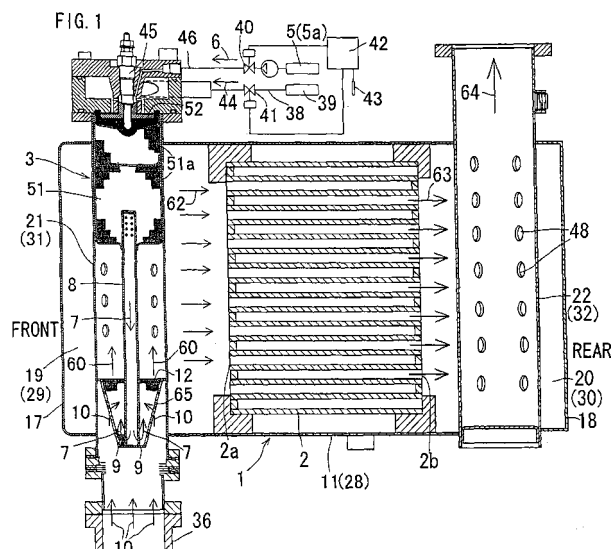
(72) Inventors:
• **Aketa, Masahiro**
c/o Sakai-Rinkai Factory
Nishi-ku, Sakai-shi, Osaka (JP)
• **Yamada, Shuichi**
c/o Sakai-Rinkai Factory
Nishi-ku, Sakai-shi, Osaka (JP)

(74) Representative: **Horton, Andrew Robert Grant et al**
BOWLES HORTON
Felden House
Dower Mews
High Street
Berkhamsted, Hertfordshire HP4 2BL (GB)

(54) **Exhaust device for a diesel engine**

(57) An exhaust device for a diesel engine supplies liquid fuel (6) from a supply source (5) of the liquid fuel (6) to a gas generator (3) which converts the liquid fuel (6) to flammable gas (7) and from which a flammable-gas supply passage (8) is conducted, the flammable-gas supply passage (8) having a flammable-gas outlet (9) communicated with an exhaust-gas route (1) upstream

of a diesel-particulate-filter (2), the flammable gas (7) flowed out of the flammable-gas outlet (9) being burnt in exhaust gas (10) to generate combustion heat which can burn fine particles of the exhaust gas (10) remaining at the filter (2). In this exhaust device for a diesel engine, a case (11) for containing the filter (2) accommodates at least part of the gas generator (3).



Description

[0001] The present invention relates to an exhaust device for a diesel engine and more particularly, concerns an exhaust device for a diesel engine adapted for compact construction.

[0002] In a known exhaust device for the diesel engine, that supplies liquid fuel from a source of liquid fuel to a gas generator, which converts the liquid fuel to flammable gas, a supply passage of the flammable gas extends from the gas generator, and has an outlet in communication with an exhaust-gas route upstream of a diesel-particulate-filter. The flammable gas from the flammable-gas outlet is made to burn in the exhaust gas, thereby generating combustion heat with which the fine particles of the exhaust gas remaining at the filter can be burnt.

An exhaust device of this type has an advantage that even when, for example at a light load, the exhaust gas temperature is comparatively low, the combustion heat of the flammable gas raises the temperature of the exhaust gas flowing into the filter, thereby burning the fine particles of the exhaust gas, facilitating recovery of the filter.

[0003] The general object of the invention is to provide an improved exhaust device of this general character. One object of the invention is to facilitate the provision of a compact exhaust device. Another, alternative or additional, object of the invention is to promote the efficient production and combustion of the flammable gas.

[0004] The invention is defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Fig. 1 is a vertical sectional side view of an exhaust device for a diesel engine, in accordance with a first embodiment of the present invention;

Fig. 2 shows essential portions of the exhaust device shown in Fig. 1. Fig. 2(A) is a vertical sectional side view of a gas generator. Fig. 2(B) is a plan view of a guide plate and Fig. 2(C) is a top view of a partition; Fig. 3 is a vertical sectional side view of an oxidation catalyst to be used for the exhaust device shown in Fig. 1 and its parts positioned in the vicinity thereof; Fig. 4 shows an exhaust device for a diesel engine, in accordance with a second embodiment of the present invention. Fig. 4(A) is a vertical sectional side view of a front portion and Fig. 4(B) is a sectional view taken along a line B-B in Fig. 4(A);

Fig. 5 shows an upstream oxidation-catalyst to be used for the exhaust device in Fig. 4. Fig. 5 (A) is a sectional view taken along a line V-V in Fig. 4 (A) and Fig. 5(B) corresponds to Fig. 5(A) of a modification;

Fig. 6 is an oxidation catalyst to be used for the exhaust device in Fig. 4. Fig. 6(A) is a sectional view taken along a line VI-VI of Fig. 4 (A) and Fig. 6(B)

corresponds to Fig. 6(A) of the modification; and Fig. 7 is a vertical sectional view of an exhaust device for a diesel engine, in accordance with a third embodiment of the present invention.

GENERAL EXPLANATION OF THE INVENTION

[0006] As exemplified in Fig. 1, an exhaust device for a diesel engine comprises a source 5 which supplies liquid fuel (denoted by the arrow 6) to a gas generator 3. The gas generator 3 converts the liquid fuel to flammable gas 7. There is a flammable-gas supply passage 8 extending out of the gas generator 3 and having an outlet 9 for the flammable gas denoted by the arrow 7. The flammable-gas outlet 9 communicates with an exhaust-gas route 1 upstream of a diesel particulate-filter 2. The flammable gas 7 which flows out of the flammable-gas outlet 9 is burnt in the exhaust gas denoted by the arrow 10 to generate combustion heat which can burn the fine particles of the exhaust gas residue at the filter 2. In this exhaust device for the diesel engine, a filter-containing case 11 which contains the filter 2 accommodates at least part of the gas generator 3.

[0007] It is feasible to make the exhaust device compact. As exemplified in Fig. 1, the filter-containing case 11 which contains the filter 2 accommodates at least part of the gas generator 3. Therefore, when compared with the case where the gas generator 3 is separated from the filter-containing case 11, the exhaust device can be made more compact.

[0008] It is also feasible to manufacture the exhaust device at a low cost. As illustrated in Fig. 1, the fuel from a fuel reservoir 5a of the diesel engine is used as the liquid fuel 6. When this liquid fuel 6 is mixed with air (denoted by the arrow 44), this air 44 may be the air from a supercharger 39. Accordingly, the fuel reservoir 5a and the diesel engine's supercharger 39 can serve as the fuel supply source and the air supply source of the gas generator 3, respectively, so that the exhaust device may be made at a low cost.

[0009] Gas may be very efficiently generated in a catalyst chamber. As exemplified in Fig. 2(A), a catalyst chamber 51 has an upper portion where a heat sink in the form of a thermally conductive plate 52 is disposed. There is formed a fuel-passing gap 53 along an upper surface of the plate 52. The gap 53 has a lateral opening to provide a fuel outlet 54 to the catalyst chamber 51. The catalytic combustion heat generated in the catalyst chamber 51 is conducted to the fuel-passage gap 53 through the plate 52. Thus the liquid fuel 6 and the air 44 are pre-heated within the fuel-passing gap 53 ahead of the catalyst chamber 51. This promotes the vaporization of the liquid fuel 6 and the feeding of a homogeneous mixture of air and fuel to the catalyst chamber 51, thereby enhancing the efficiency of gas generation in the catalyst chamber 51.

[0010] The thermally conductive plate may be heated at a low cost. As exemplified in Fig. 2(A), the catalytic

combustion heat generated in the catalyst chamber 51 is conducted through by way of the plate 52 to the fuel-passing gap 53. Consequently, while the catalytic combustion heat is being generated, it is unnecessary to heat the thermally conductive plate 52 by means of a glow plug 45 or the like.

[0011] It is possible to effect the commencement of gas generation promptly in several ways. As illustrated in Fig. 2(A), the liquid fuel 6 which flows out of the fuel outlet 54 impinges on a side 56a of a guide plate 56 and is guided by the guide plate 56 so as to approach an exothermic portion 45a of the glow plug 45. By making the glow plug 45 exothermic at the time of the commencement of gas generation before the catalytic combustion heat is generated in the catalyst chamber 51, without the catalytic combustion heat, the liquid fuel 6 is pre-heated ahead of the catalyst chamber 51. This accelerates the vaporization of the liquid fuel 6, introduces a homogeneous mixture of air and fuel into the catalyst chamber 51 and activates a catalyst 51a with heat from the glow plug 45, whereby to promote the prompt commencement of the gas generation.

[0012] Furthermore, as exemplified in Fig. 2(A), a flame-quenching material 57 occupies a space between the thermally conductive plate 52 and the guide plate 56. When the glow plug 45 is made exothermic, heat from the 45 is conducted through the flame-quenching material 57 to the heat conduction-plate 52 and the guide plate 56. Thus by making the glow plug 45 exothermic at the time of commencement of gas generation before the catalytic combustion heat is generated in the catalyst chamber 51, without the catalytic combustion heat, the liquid fuel 6 and the air 44 are pre-heated while they are passing through the fuel-passing gap 53 and the flame-quenching material 57 ahead of the catalyst chamber 51 and the liquid fuel 6 which flows out of the fuel-passing gap 53 is pre-heated while it is guided by the guide plate 56. This promotes the acceleration of the vaporization of the liquid fuel 6 and the introduction of homogeneous mixture of air and fuel to the catalyst chamber 51.

[0013] The gas may be highly efficiently generated in the catalyst chamber. As previously explained with reference to Fig. 2(A), the flame-quenching material 57 occupies the space between the plate 52 and the guide plate 56. While the catalyst is burning in the catalyst chamber 51, the catalytic combustion heat is conducted through the guide plate 56 and the flame-quenching material 57 to the plate 52. The liquid fuel 6 and the air 44 are pre-heated while they are passing through the fuel-passing gap 53 and the flame-quenching material 57 ahead of the catalyst chamber 51. This accelerates the vaporization of the liquid fuel 6 and the introduction of homogeneous mixture of air and fuel to the catalyst chamber 51, to improve the efficiency of gas generation in the catalyst chamber 51.

[0014] It is possible to inhibit damage to the gas generator by flame-combustion. Owing to the quenching function of the flame-quenching material 57, it inhibits

the occurrence of the flame-combustion between the thermally conductive plate 52 and the guide plate 56 and can prevent damage to the gas generator caused by the flame-combustion.

[0015] As exemplified in Fig. 2(A), the guide plate 56 has an under surface which is in contact with a catalyst 51a within the catalyst chamber 51. While the catalyst 51a is burning in the catalyst chamber 51, the catalytic combustion heat is efficiently conducted to the guide plate 56 as well as to the flame-quenching material 57 and the thermally conductive plate 52. Thus the liquid fuel 6 and the air 44 are efficiently pre-heated while they are passing through the flame-quenching material 57 and the fuel-passing gap 53 ahead of the catalyst chamber 51 to entail a high efficiency of the gas generation in the catalyst chamber 51.

[0016] Gas may be generated within the catalyst chamber with an increased efficiency. Since a catalyst component is supported on the flame-quenching material 57, part of the liquid fuel 6 undergoes catalytic combustion while the liquid fuel 6 is passing through the flame-quenching material 57 before the catalyst chamber 51 to produce heat with which the liquid fuel 6 is pre-heated. This promotes the the vaporization of the liquid fuel 6 and the introduction of a homogeneous mixture of air and fuel into the catalyst chamber 51, whereby to improve the efficiency of gas generation in the catalyst chamber 51.

[0017] As exemplified in Fig. 2(A), when the glow plug 45 is made exothermic, the heat of this glow plug 45 is conducted through the thermally conductive plate 52 to the fuel-passing gap 53. By making the glow plug 45 exothermic at the time of commencement of gas generation before the catalytic combustion occurs in the catalyst chamber 51, without the catalytic combustion heat, the liquid fuel 6 and the air 44 are pre-heated while they are passing through the fuel-passing gap 53 ahead of the catalyst chamber 51. This promotes the vaporization of the liquid fuel 6 and the introduction of a homogeneous mixture of air and fuel into the catalyst chamber 51, to promote prompt commencement of gas generation.

[0018] As exemplified in Fig. 1, an oxidation catalyst 12 for accelerating the combustion of the flammable gas 7 is disposed between the flammable-gas outlet 9 and an inlet 2a of the filter 2. Thus even if the exhaust gas 10 has a low temperature, it can still cause burning of the flammable gas 7.

[0019] As exemplified in Fig. 3, in order that the flammable gas 7 heated by the exothermic reaction within the gas generator 3 may flow from the flammable-gas outlet 9 to the oxidation catalyst 12, the oxidation catalyst 12 occupies a case 65 for accommodating the oxidation catalyst 12 and the flammable-gas outlet 9 opens into the oxidation catalyst 12. The case 65 has a side wall 66 provided with a plurality of exhaust gas inlets 67 and has an end part 68 provided with an exhaust gas outlet 69. Therefore, it is possible to reduce the inlet rate of the exhaust gas per unit area of each of the exhaust gas inlets 67 in accordance with the possible increase of the

total opening area of the exhaust gas inlets 67. Owing to this arrangement, even when the exhaust gas has a low temperature, the mixture of the flammable gas 7 and the exhaust gas 10 passes through the oxidation catalyst 12 while it retains sufficient heat to attain the activation temperature of the oxidation catalyst 12, so that the flammable gas 7 burns and the consequent increase in the temperature of the exhaust gas 10 causes the burning of the fine particles of the exhaust gas at the filter 12.

[0020] It is possible to alleviate the resistance the exhaust gas undergoes when it passes through the oxidation catalyst. As shown in Fig. 3, the exhaust gas inlets 67 are disposed in parallel with one another in the side 66 of the case 65 from a front end 70 of the case 65 to a rear end 68 thereof. Also, the case 65 tapers outwardly, the side wall 66 of the case 65 which accommodates the oxidation-catalyst progressively increasing in diameter from the front end 70 to the rear end 68 of the case 65. Accordingly, the cross-sectional area of the oxidation catalyst 12 increases towards the end 68 in compliance with the increasing rate of the exhaust gas and thereby the resistance that the exhaust gas 10 encounters when it passes through the oxidation catalyst 12 is reduced.

[0021] The oxidation catalyst 12 is preferably a catalyst which comprises a catalyst component supported on a metal substrate of a cubic mesh-structure. The quenching function of the substrate inhibits the flame-combustion within the oxidation catalyst 12, so as to reduce the damage that the oxidation catalyst experiences when it burns.

[0022] As exemplified in Fig. 1, the oxidation catalyst 12 and at least part of the gas generator 3 are arranged within the exhaust-gas inlet pipe 21 of the filter-containing case 11; this arrangement allows a more compact realization of the exhaust device.

[0023] As exemplified in Fig. 1, when an axial direction of the filter-containing case 11 is taken as a front to rear direction, the exhaust-gas inlet pipe 21 is inserted into an exhaust gas-inlet chamber 19 along a radial direction of the filter-containing case 11, and the oxidation catalyst 12 and at least part of the gas generator 3 are arranged in the afore-mentioned order within the exhaust-gas inlet pipe 21 from an upstream side. This arrangement can allow a decrease in the front-to-rear dimension of the filter-containing case 11.

[0024] As exemplified in Fig. 1, the exhaust-gas inlet pipe 21 is inserted into the exhaust gas inlet chamber 19 along the radial direction of the filter-containing case 11, and the oxidation catalyst 12 and at least part of the gas generator 3 are arranged within the exhaust-gas inlet pipe 21. The oxidation catalyst 12 is protected doubly by a wall of the filter-containing case 11 and a wall of the exhaust gas inlet pipe 21 as well as the at least part of the gas generator 3, thereby reducing the incidence of damage to the oxidation catalyst 12 and the gas generator 3.

[0025] As exemplified in Fig. 1, the exhaust-gas inlet pipe 21 is inserted into the exhaust-gas inlet chamber 19

along the radial direction of the filter-containing case 11 and the oxidation catalyst 12 is disposed within the exhaust gas inlet pipe 21. Thus the oxidation catalyst 12 is surrounded doubly by the wall of the exhaust-gas inlet pipe 21 and the wall of the filter-containing case 11 so that the heat of the oxidation catalyst 12 hardly escapes. For this reason, even the exhaust gas at a low temperature is sufficient to reach the activation temperature of the oxidation catalyst 12.

[0026] As exemplified in Fig. 1(A), the exhaust-gas inlet pipe 21 is inserted into the exhaust-gas inlet chamber 19 along the radial direction of the filter-containing case 11, and the oxidation catalyst 12 and at least part of the gas generator 3 are arranged in the mentioned order within the exhaust-gas inlet pipe 21 from the upstream side. Further, a flammable-gas supply passage 8 conducted out of the gas generator 3 is inserted into the oxidation catalyst 12. Therefore, the flammable-gas supply passage 8 is protected by the wall of the filter-containing case 11, the wall of the exhaust-gas inlet pipe 21 and the oxidation catalyst 12.

[0027] As illustrated in Fig. 1, since an exhaust muffler 28 is employed as the filter-containing case 11, there is no need to provide the filter-containing case 11 and the exhaust muffler 28 separately and thereby the exhaust device can be made more compact.

[0028] The gas generator 3 vaporizes the liquid fuel 6 to convert this liquid fuel 6 into the flammable gas 7. Thus, as compared with a reaction such as partial oxidation, there is less fluctuation of the component ratio of the flammable gas 7 and thereby the combustion heat of the flammable gas 7 can be stabilised.

[0029] The gas generator 3 partially oxidizes the liquid fuel 6 to convert the liquid fuel 6 into the flammable gas 7 containing carbon monoxide and hydrogen. Accordingly, the flammable gas 7 ignites at a relatively low temperature and therefore can be burnt even if the exhaust gas 10 has a low temperature.

[0030] As illustrated in Figs. 4 and 7, in order that the flammable gas 7, heated by the exothermic reaction within the gas generator 3, can flow from the flammable-gas outlet 9 to the upstream of the oxidation catalyst 12, an oxidation-passage 14 is formed within the exhaust-gas passage 13 upstream of the oxidation catalyst 12 to make the exhaust-gas passage 13 into a double-cylinder structure. The upstream oxidation-passage 14 accommodates an upstream oxidation catalyst 15, on an upstream side of which the flammable-gas outlet 9 of the gas generator 3 opens into the upstream oxidation-passage 14. Owing to this arrangement, the flammable gas at a high temperature is mixed with part of the exhaust gas 10 flowing into the upstream oxidation-passage 14, among the whole of the exhaust gas, shown by the arrows 10, 10 which passes through the exhaust-gas passage 13, and the mixture enters the upstream oxidation-catalyst 15. Therefore, even if the exhaust gas 10 has a low temperature, the mixture of the flammable gas 7 and the exhaust gas 10 flows into the upstream oxidation-catalyst

15 at a relatively high temperature sufficient to reach the activation temperature of the upstream oxidation-catalyst 15. Thus the flammable gas 7 is partly burnt by the upstream oxidation-catalyst 15. The combustion heat increases the temperature of the whole exhaust gas which flows into the oxidation catalyst 12 disposed downstream and enables the activation temperature of this oxidation catalyst 12 to be attained. Consequently, this oxidation catalyst 12 burns the residual flammable gas 7 to increase further the temperature of the whole exhaust gas. This exhaust gas 10 can then burn the fine particles of the exhaust gas at the filter 2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0031] Figs. 1 to 3 show an exhaust device for a diesel engine, in accordance with a first embodiment of the present invention. Figs. 4 to 6 show an exhaust device for a diesel engine, in accordance with a second embodiment of the present invention. Fig. 7 shows an exhaust device for a diesel engine, in accordance with a third embodiment of the present invention.

[0032] As shown in Fig. 1, liquid fuel 6 is supplied from a source 5 of the liquid fuel 6 to a gas generator 3, which converts the liquid fuel 6 into flammable gas 7. A supply passage 8 of the flammable gas 7 is conducted out of the gas generator 3. The supply passage 8 has a flammable-gas outlet 9 which communicates with an exhaust-gas route 1 upstream of a diesel-particulate-filter 2. The flammable gas 7 which flows out of the flammable-gas outlet 9 is burnt in exhaust gas 10 to generate combustion heat which in turn can burn fine particles of the exhaust gas 10 remaining at the filter 2. This exhaust device is connected to an exhaust-gas outlet 36 of an exhaust manifold for a diesel engine. The diesel-particulate-filter 2 is generally called as DPE and may have a ceramic honeycomb structure. An oxidation catalyst is supported on the diesel-particulate-filter 2. Alternatively, a NO_x-occlusion catalyst may be supported on the filter 2. A case 11 for containing the filter 2 accommodates part of the gas generator 3.

[0033] As shown in Fig. 1, the liquid fuel 6 is fuel from a fuel reservoir 5a of the diesel engine. The liquid fuel 6 is mixed with air 44 from a supercharger 39. For this purpose, a gap 53, through which the fuel passes, has an inlet side communicating with the fuel reservoir 5a of the diesel engine through a liquid-fuel supply passage 46 and with the supercharger 39 through an air-supply passage 38.

[0034] As illustrated in Fig. 1, the liquid-fuel supply passage 46 is provided with a liquid-fuel valve 40 and the air-supply passage 38 is provided with an air valve 41. Each of the valves 40 and 41 is associated with a back-pressure sensor 43 through a controller 42. If the filter 2 is clogged with fine particles of the exhaust gas, the back pressure increases. Then, based on the detection of this increase by the back-pressure sensor 43, the controller

42 opens the liquid-fuel valve 40 and the air valve 41 so as to supply the liquid fuel 6 and the air 44 to the gas generator 3. In the gas generator 3, the liquid fuel 6 is vaporized to convert the liquid fuel 6 into flammable gas 7. This flammable gas 7 is fed into the exhaust-gas route 1. A catalyst 51a within a catalyst chamber 51 is an oxidation catalyst, which partially oxidizes the liquid fuel 6 to generate oxidation heat that vaporizes the remaining liquid fuel 6. The catalyst 51a may be a catalyst which comprises a catalytic component, such as platinum, supported on a metal substrate of a cubic mesh-structure. In particular metal foam may be used for the substrate of the catalyst 51a. The metal foam is a metallic porous substance having the same cubic mesh-structure as a foamed resin, an example of which is a sponge, and is obtained by any suitable known method. For example, it may be obtained by using polyurethane foam of cubic mesh-framework as a base material; subjecting this base material to an electric-conduction treatment; then electroplating it; decomposing it by heat for removal; and leaving the metal cubic mesh-framework. As for the substrate of the catalyst 51a, alumina pellets or the like metal pellets may be used. The mixing ratio of the liquid fuel 6 to the air 44, namely air-fuel ratio (O/C) is set in range generally centred on 0.6, for example from 0.4 to 0.8.

[0035] Although, in this embodiment, the gas generator 3 vaporizes the liquid fuel 6 to convert it into the flammable gas 7, the gas generator 3 may partly oxidize the liquid fuel 6 to convert it into a flammable gas 7 containing carbon monoxide and hydrogen. In this case, a partial-oxidation catalyst in the chamber 51 is utilized instead of the previously mentioned oxidation catalyst. Such a partial-oxidation catalyst may comprise a catalytic component, such as palladium or rhodium, supported on a metal substrate of a cubic mesh-structure. Alternatively, alumina pellets or the like metal pellets may be employed. The mixing ratio of the liquid fuel 6 to the air 44, namely air-fuel ratio (O/C) may be set in a range about 1.3, for example from 1.0 to 1.6.

[0036] As shown in Fig. 2(A), the gas generator 3 is provided with a catalyst chamber 51. In order to accommodate a catalyst 51a within the catalyst chamber 51, this catalyst chamber 51 has an upper portion at which a thermally conductive plate 52 is disposed. Formed along an upper surface of this thermally conductive plate 52 is a fuel-passing gap 53, to which the liquid fuel 6 and the air 44 are supplied. This fuel-passing gap 53 has a side opening to provide a fuel outlet 54 to the catalyst chamber 51 so as to conduct the catalytic combustion heat generated within the catalyst chamber 51 through the thermally conductive plate 52 to the fuel-passing gap 53.

[0037] As shown in Fig. 2(A), the glow plug 45 has an exothermic portion 45a projected downwards from a mid portion of the thermally conductive plate 52. The metal guide plate 56 is arranged below the thermally conductive plate 52 and is downwardly inclined from a peripheral

portion 56a below the fuel outlet 54 to underneath the exothermic portion 45a of the glow plug 45, so that the liquid fuel 6 which flows from of the fuel outlet 54 impinges on the portion 56a of the guide plate 56 and approaches the exothermic portion 45a of the glow plug 45 through the guidance of the guide plate 56. A metal flame-quenching material 57 of a cubic mesh-structure occupies a space between the thermally conductive plate 52 and the guide plate 56. When the glow plug 45 generates heat, the heat generated by the glow plug 45 is conducted through the flame-quenching material 57 to the thermally conductive plate 52 and the guide plate 56. During the combustion of the catalyst 51a within the catalyst chamber 51, the catalytic combustion heat is conducted through the guide plate 56 and the flame-quenching material 57 to the thermally conductive plate 52. The glow plug 45 is associated with the controller 42 so as to generate heat for a predetermined period of time at the initial term of the gas generation. Metal foam is used for the flame-quenching material 57, but material made of stainless steel, and formed as 'wire-mesh', may be used.

[0038] As shown in Fig. 2(A), the guide plate 56 has an under-surface with which the catalyst 51a within the catalyst chamber 51 is brought into contact. A catalyst component is supported on the flame-quenching material 57. When the glow plug 45 generates heat, the heat generated by the glow plug 45 is conducted through the thermally conductive plate 52 to the fuel-passing gap 53. An oxidation-catalyst component is supported on the flame-quenching material 57. There is disposed below the guide plate 56 a partition 58, which divides the interior area of the catalyst chamber 51. As shown in Figs. 2(B) and 2(C), each of the guide plate 56 and the partition 58 is opened to provide a central aperture hole 56b and a central aperture 58b, respectively. Peripheral apertures 56c are regularly spaced around the central aperture 56b and a plurality apertures 58c are regularly spaced around the central aperture 58b. The apertures 56c and 58c of the guide plate 56 and the partition 58 are mutually staggered, when seen from above, so that the liquid fuel 6 flowed out of the fuel outlet 54 is prevented from flowing straight through both the apertures 56c and the apertures 58c in the mentioned order. Both the guide plate 56 and the partition 58 may be made of stainless steel.

[0039] As shown in Fig. 1, an oxidation catalyst 12 for accelerating the combustion of the flammable gas 7 is located between a flammable-gas outlet 9 and an inlet 2a of the filter 2. The oxidation catalyst 12 is composed as follows.

As shown in Fig. 3, in order that the flammable gas 7 heated by the exothermic reaction within the gas generator 3 can flow out of the flammable-gas outlet 9 to the oxidation catalyst 12, the oxidation catalyst 12 occupies the case 65 and the flammable-gas outlet 9 opens into the oxidation catalyst 12. The case 65 has a peripheral wall 66 provided with a plurality of exhaust-gas inlets 67 and has a rear 68 formed with an exhaust-gas outlet 69. There is a plurality of flammable-gas outlets 9, are ar-

ranged side by side along of the end part 8a of the supply passage 8. Exhaust-gas inlets 67 are disposed in the peripheral wall 66 of the oxidation-catalyst accommodating case 65.

[0040] As shown in Fig. 3, when the exhaust-gas inlets 67 are located side by side in the peripheral wall 66 from the front end 70 of the case 65 to the rear end 68 thereof. The peripheral wall 66 of the 65 has a diameter which progressively increases from the front 70 to the rear end 68. The case 65 resembles a cup in the form of a truncated cone.

[0041] As shown in Fig. 1, the case 11 is a cylindrical, with end walls 17 and 18. An axial direction of this case 11 is taken as a front-to-rear direction. A inlet side 2a of the filter 2 is regarded as the 'front' and an outlet side 2b is regarded as the 'rear'. Within the case 11 is disposed an exhaust-gas inlet chamber 19 in front of the filter 2 and an exhaust-gas outlet chamber 20 is arranged at the rear of the filter 2. The exhaust-gas inlet chamber 19 communicates with an exhaust-gas inlet pipe 21 and the exhaust-gas outlet chamber 20 communicates with an exhaust gas outlet pipe 22.

The exhaust-gas inlet pipe 21 is inserted into the exhaust-gas inlet chamber 19 along a radial direction of the filter-containing case 11. The oxidation catalyst 12 and part of the gas generator 3 are disposed from the upstream side of the exhaust gas into the exhaust-gas inlet pipe 21 in the mentioned order. The flammable-gas supply passage 8 from the gas generator 3 extends into the oxidation catalyst 12.

[0042] An exhaust muffler 28 is utilized as the filter-containing case 11. The exhaust-gas inlet chamber 19 is composed of a first expansion chamber 29 and the exhaust-gas outlet chamber 20 is constructed by a final expansion chamber 30. The exhaust-gas inlet pipe 21 is formed from an exhaust-gas lead-in pipe 31 of the first expansion chamber 29 and the exhaust-gas outlet pipe 22 is composed of an exhaust-gas lead-out pipe 32 of the final expansion chamber 30.

[0043] As shown in Fig. 2(A), when the gas generator 3 is supplied with the liquid fuel 6 and with the air 44, the liquid fuel 6 mixes with the air 44 within the fuel-passing gap 53. The liquid fuel 6 is converted into fine particles, which flow from the fuel-passing gap 53 through the flame-quenching material 57 into the catalyst chamber 51. Part of this liquid fuel 6 is oxidized (i.e. it undergoes catalytic combustion) within the catalyst chamber 51 to generate oxidation (combustion) heat by means of which the remaining liquid fuel 6 is vaporized to become high-temperature flammable gas 7. This high-temperature flammable gas 7, as shown in Fig. 2(A), is fed from the flammable-gas supply passage 8 into the oxidation catalyst 12. On the other hand, the exhaust gas 10 which passes through the exhaust-gas route 1 flows into the oxidation catalyst 12 and is mixed with the high-temperature flammable gas 7 and the mixture passes through the oxidation catalyst 12. The flammable gas 7 is oxidized (burnt) by the oxygen contained in the mixed exhaust

gas 10 to produce oxidation heat (combustion heat) which heats the mixed exhaust gas 10.

[0044] As shown in Fig. 1, the exhaust gas 10 flows out of the oxidation catalyst 12 as shown by arrows 60 and further flows out of the outlet holes 47 of the exhaust-gas lead-in pipe 31 into the first expansion chamber 29. Then, as shown by arrows 62, it enters the filter 2 from the inlets 2a and passes through the filter. The exhaust gas 10 that has passed through the filter 2 flows from the outlets 2b of the filter 2 into the final expansion chamber 30 as shown by arrows 63. Thereafter, the gas flows from the inlet holes 48 of the exhaust-gas lead-in pipe 32 into the exhaust-gas lead-in pipe 32 and flows out of the exhaust-gas lead-out pipe 32 as shown by an arrow 64.

[0045] The second embodiment as shown in Figs. 4 to 6 is different from the first embodiment as follows.

As shown in Fig. 4(A), the oxidation catalyst 12 is arranged outside the exhaust-gas inlet pipe 31, although it exists within the filter-containing case 11. In order that the flammable gas 7 heated by the exothermic reaction within the gas generator 3 from the flammable-gas outlet 9 may flow to the upstream side of the oxidation catalyst 12, an upstream oxidation-passage 14 is formed within the exhaust-gas passage 13 upstream of the oxidation catalyst 12 and is formed into a double-cylinder structure. The upstream oxidation-passage 14 accommodates an upstream oxidation-catalyst 15, on an upstream side of which the flammable-gas outlet 9 is opened toward the upstream oxidation-passage 14. The exhaust-gas passage 13 is the exhaust -gas inlet pipe 21.

[0046] The upstream oxidation-passage has a sectional area set as follows.

As shown in Fig. 4(B), the upstream oxidation-passage 14 of the exhaust-gas passage 13 of the double-cylinder structure has a sectional area set to a fraction (such as 1/4) of the sectional area of the whole exhaust-gas passage 13 including the upstream oxidation-passage 14. In order to ensure the oxidation-acceleration function of the upstream oxidation-catalyst 15, it is desirable to set the sectional area of the upstream oxidation- passage 14 of the exhaust-gas passage 13 of double-cylinder structure within a range of 1/4 to 1/2 of the total sectional area of the exhaust-gas passage 13 including the upstream oxidation passage 14.

[0047] The flammable-gas outlet and the upstream oxidation-passage are opened in the following direction.

As shown in Fig. 4(A), the flammable-gas lead-out pipe 8, oriented in the direction where the upstream oxidation-passage 14 is formed, has its terminal end 8a closed and has a peripheral wall near the terminal end 8a opened to provide the plurality of flammable-gas outlets 9 oriented radially of the upstream oxidation-passage 14. Further, the upstream oxidation-passage 14 has its terminal end 14a closed and has a peripheral wall near the terminal end 14a, opened to form a plurality of upstream oxidation-passage outlets 16 oriented radially of a passage 4 in front of the oxidation-catalyst inlet.

[0048] As shown in Fig. 4(A), the high-temperature

flammable gas 7 is fed from the flammable-gas supply passage 8 to the upstream oxidation-passage 14 within the exhaust-gas passage 13. On the other hand, part 10 of the exhaust gas (shown by the arrows 10) which passes through the exhaust-gas passage 13 flows into the upstream oxidation-passage 14 and is mixed with the high-temperature flammable gas 7 and the mixture passes through the upstream oxidation-catalyst 15. The flammable gas 7 is oxidized (burnt) by the oxygen contained in the mixed exhaust gas 10 to produce oxidation heat (combustion heat) which heats the mixed exhaust gas 10. The heated exhaust gas 10 flows out of the upstream oxidation-passage outlet 16; as shown by the arrows 35, and is mixed with the remaining exhaust gas 10 and 10 which did not flow into the upstream oxidation-passage 14. The mixture flows out of the outlet holes 47 and passes through the oxidation catalyst 12. The flammable gas 7 oxidized (burnt) by the upstream oxidation-catalyst 15 and remaining is oxidized (burnt) by the oxygen in the mixed exhaust gas 10 to produce oxidation (combustion) heat with which the mixed exhaust gas 10 is heated.

[0049] As shown in Fig. 5(A), the upstream oxidation catalyst 15 comprises a catalytic component supported on a substrate 25 formed by overlaying and winding a corrugated metal sheet 23 and a flat metal sheet 24. Each of the metal sheets 23 and 24 may be a stainless steel sheet having a thickness of 0.5 mm. Platinum may be used as the catalyst component. In the case where the upstream oxidation-catalyst 15 has such a structure, a relatively wide inter-catalyst passage 34 is formed and therefore even the upstream oxidation-passage 14 of a smaller diameter assures a sufficient sectional area of the inter-catalyst passage within the upstream oxidation-catalyst 15. Additionally, since the substrate itself 25 is resilient, it can be retained within the upstream oxidation-passage 14 without using any cushioning material.

As shown in Fig. 5(B), the upstream oxidation-catalyst 15 may comprises a catalytic component supported on a substrate 27 formed from a metal mesh 26. This metal mesh 26 may be made of stainless steel and is generally called as "wire-mesh". Platinum may be used as the catalytic component.

[0050] As shown in Fig. 6 (A), the oxidation catalyst 12 may comprise a catalytic component supported on a substrate 25 formed by overlaying and winding a corrugated metal sheet 23 and a flat metal sheet 24. Each of the metal sheets 23 and 24 may be a stainless steel sheet having a thickness of 0.5 mm. Platinum may be used as the catalyst component. In the case where the oxidation catalyst 12 has such a structure, a relatively wide inter-catalyst passage 34 is formed and therefore a sufficient sectional area of the inter-catalyst passage within the oxidation catalyst 12 is assured. Additionally, since the substrate 25 itself is resilient, it can be retained within the filter-containing case 11 without using any cushioning material.

As shown in Fig. 6(B), the catalyst may comprise a catalytic component supported on a substrate 27 formed

from a metal mesh 26. This metal mesh 26 may be made of stainless steel and is generally called as "wire-mesh". Platinum may be used as the catalyst component.

[0051] The second embodiment is the same as the first embodiment except for the variants described above.

[0052] The third embodiment shown in Fig. 7 is distinct from the first embodiment on the following point.

Alumina pellets may be used for the substrate of the catalyst 51a within the catalyst chamber 51. The oxidation catalyst 12 is accommodated between the upstream oxidation catalyst 15 and the catalyst chamber 51 of the gas generator 3 within the exhaust-gas inlet pipe 21 of the filter-containing case 11. The flammable-gas lead-out passage 8 extends through the oxidation catalyst 12. The third embodiment is the same as the second embodiment except for the other constructions and functions.

Claims

1. An exhaust device for a diesel engine, that supplies liquid fuel (6) from a source (5) of the liquid fuel (6) to a gas generator (3) which converts the liquid fuel (6) to flammable gas (7) and from which a flammable-gas supply passage (8) is conducted, the flammable-gas supply passage (8) having a flammable-gas outlet (9) in communication with an exhaust-gas route (1) upstream of a diesel-particulate-filter (2), flammable gas (7) which flows from the flammable-gas outlet (9) being burnt in exhaust gas (10) to generate combustion heat which can burn fine particles of the exhaust gas (10) remaining at the filter (2), a case (11) for containing the filter (2) accommodating at least part of the gas generator (3).
2. An exhaust device according to claim 1, and arranged to mix air from a supercharger (39) with fuel from a fuel reservoir (5a) of the diesel engine.
3. An exhaust device according to claim 1 or 2, wherein the gas generator (3) is provided with a catalyst chamber (51), a thermally conductive plate (52) is arranged at an upper portion of the catalyst chamber (51) and a fuel-passing gap (53) is formed along a surface of the thermally conductive plate (52), the fuel-passing gap (53) and having an opening to provide a fuel outlet (54) to the catalyst chamber (51), whereby catalytic combustion heat generated within the catalyst chamber (15) is conducted through the thermally conductive plate (52) to the fuel-passing gap (53).
4. An exhaust device according to claim 3, wherein the thermally conductive plate (52) has a mid portion from which an exothermic portion (45a) of a glow plug (45) projects downwards, and a guide (56) is arranged below the thermally conductive plate (52),

the guide (56) being downwardly inclined from a periphery (56a) underneath the fuel outlet (54) to below the exothermic portion (45a) of the glow plug (45), thereby to guide the fuel towards the exothermic portion (45a) of the glow plug (45).

5. An exhaust device according to claim 4, wherein a flame-quenching material (57) occupies a space between the thermally conductive plate (52) and the guide (56), whereby when the glow plug (45) generates heat, heat generated by the glow plug (45) is conducted through the flame-quenching material (57) to the thermally conductive plate (52) and the guide plate (56), and whereby during the catalytic combustion within the catalyst chamber (51), catalytic combustion heat is conducted through the guide (56) and the flame-quenching material (57) to the thermally conductive plate (52).
6. An exhaust device according to claim 5, wherein the guide (56) has a surface with which a catalyst (51a) within the catalyst chamber (51) is brought into contact.
7. An exhaust device according to claim 5 or claim 6, wherein a catalytic component is supported on the flame-quenching material (57).
8. An exhaust device according to any one of claims 4 to 7, wherein when the glow plug (45) generates heat, heat generated by the glow plug (45) is conducted through the thermally conductive plate (52) to the fuel-passing gap (53).
9. An exhaust device according to any one of claims 1 to 8, wherein an oxidation catalyst (12) for accelerating the combustion of the flammable gas (7) is disposed between the flammable-gas outlet (9) and an inlet (2a) of the filter (2).
10. An exhaust device according to claim 9, wherein in order that the flammable gas (7) heated by the exothermic reaction within the gas generator (3) from the flammable-gas outlet (9) can flow to the oxidation catalyst (12), the oxidation catalyst (12) occupies a case (65) and the flammable-gas outlet (9) opens into the oxidation catalyst (12), the case (65) having a peripheral wall (66) provided with a plurality of exhaust-gas inlets (67) and having an end portion (68) provided with an exhaust-gas outlet (69).
11. An exhaust device according to claim 10, wherein the exhaust-gas inlets (67) are disposed along the peripheral wall (66) from a front end (70) of the case (65) toward a rear end (68) thereof, and the cross-sectional area of the case (65) progressively increases from the front end (70) to the rear end (68).

12. An exhaust device according to any one of claims 9 to 11, wherein the oxidation catalyst (12) comprises a catalytic component supported on a metal mesh.
13. An exhaust device according to any one of claims 9 to 12, wherein the filter-containing case (11) is cylindrical, an exhaust-gas inlet chamber (19) being provided at a front end of the filter (2) and an exhaust-gas outlet chamber (20) being provided at a rear end of the filter (2) within the filter-containing case (11), an exhaust-gas inlet pipe (21) communicating with the exhaust-gas inlet chamber (19) and an exhaust-gas outlet pipe (22) communicating with the exhaust-gas outlet chamber (20), and the exhaust-gas inlet pipe (21) extends into the exhaust-gas inlet chamber (19) along a radial direction of the filter-containing case (11), within the exhaust-gas inlet pipe (21) the oxidation catalyst (12) and at least part of the gas generator (3) are arranged in the mentioned order from upstream side of the exhaust-gas inlet pipe, the flammable-gas supply passage (8) from the gas generator (3) being inserted into the oxidation catalyst (12).
14. An exhaust device according to claim 13, wherein an exhaust muffler (28) is disposed as the filter-containing case (11) and the exhaust-gas inlet chamber (19) is formed from a first expansion chamber (29), the exhaust-gas outlet chamber (20) being composed of a final expansion chamber (30), the exhaust-gas inlet pipe (21) being formed from an exhaust-gas lead-in pipe (31), and the exhaust-gas outlet pipe (22) being composed of an exhaust-gas lead-out pipe (32).
15. An exhaust according to any one of claims 1 to 14, wherein the gas generator (3) is disposed to vaporize the liquid fuel (6) to convert it into the flammable gas (7).
16. An exhaust device according to any one of claims 1 to 14, wherein the gas generator (3) is disposed to partly oxidizes the liquid fuel (6) to convert it into flammable gas (7) containing carbon monoxide and hydrogen.
17. An exhaust device according to claim 9, wherein in order that flammable gas (7) heated by the exothermic reaction within the gas generator (3) from the flammable-gas outlet (9) can flow to the upstream side of the oxidation catalyst (12), an upstream oxidation-passage (14) is formed upstream of the oxidation catalyst (12) within an exhaust-gas passage (13), which is formed into a double-cylinder structure, and an upstream oxidation-catalyst (15) is accommodated within the upstream oxidation-passage (14), the flammable-gas outlet (9) opening into the upstream oxidation-passage (14) on an upstream side of the upstream oxidation-catalyst (15).

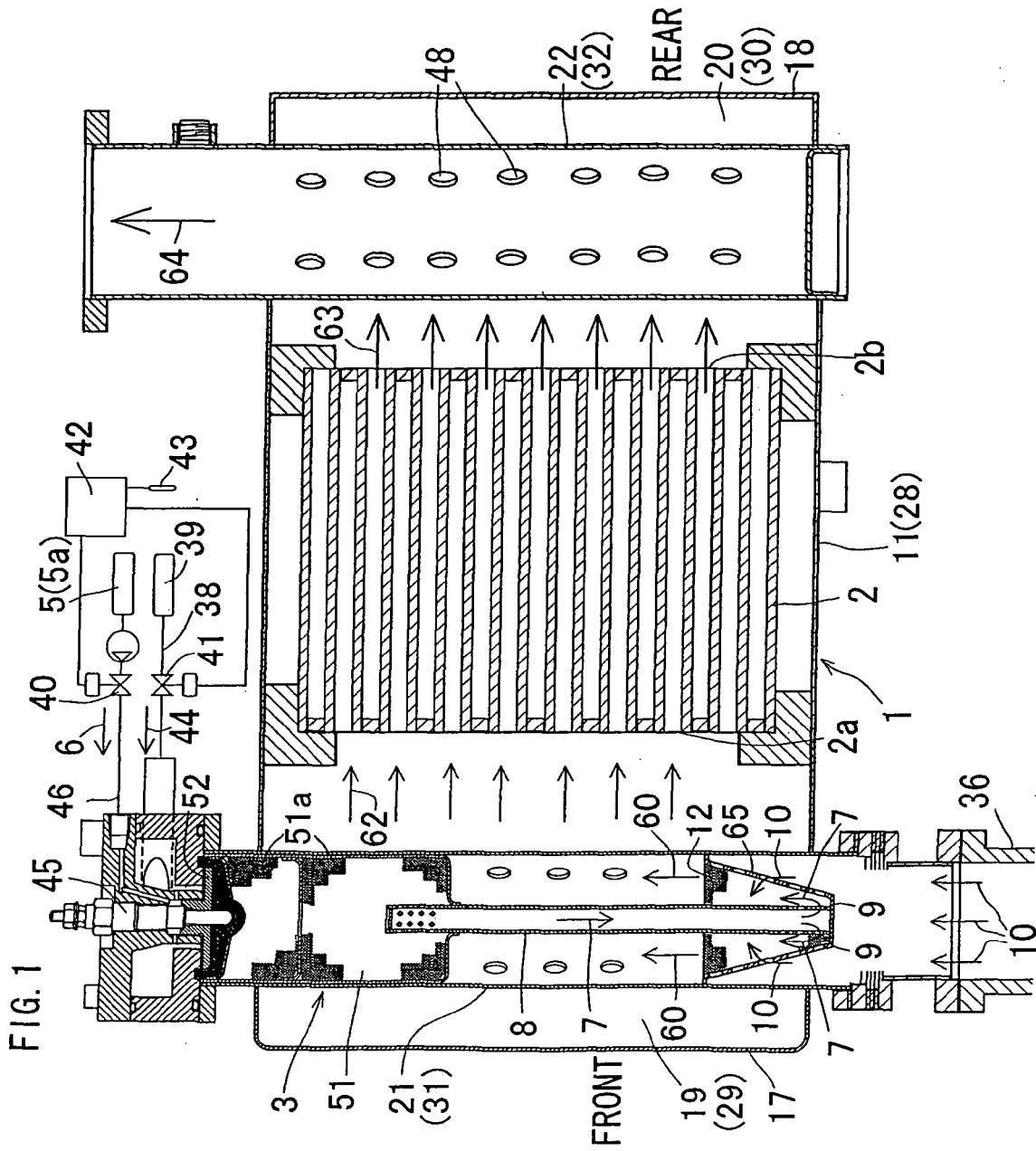


FIG. 2 (A)

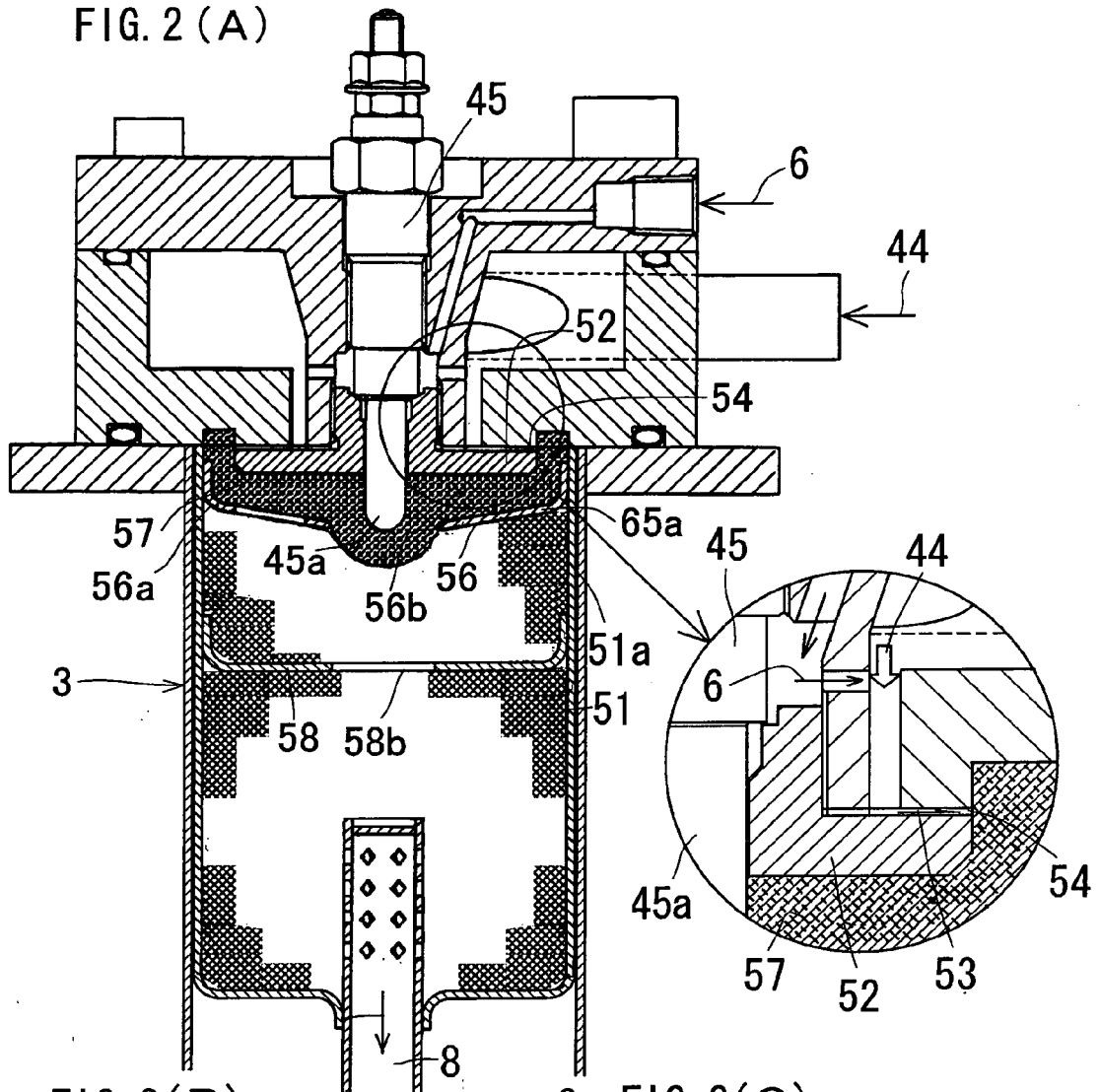


FIG. 2 (B)

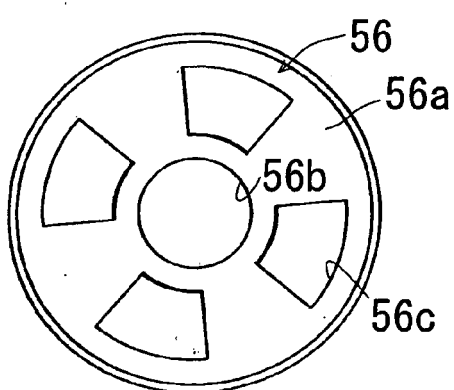
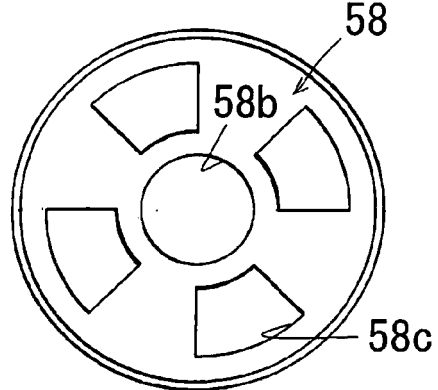
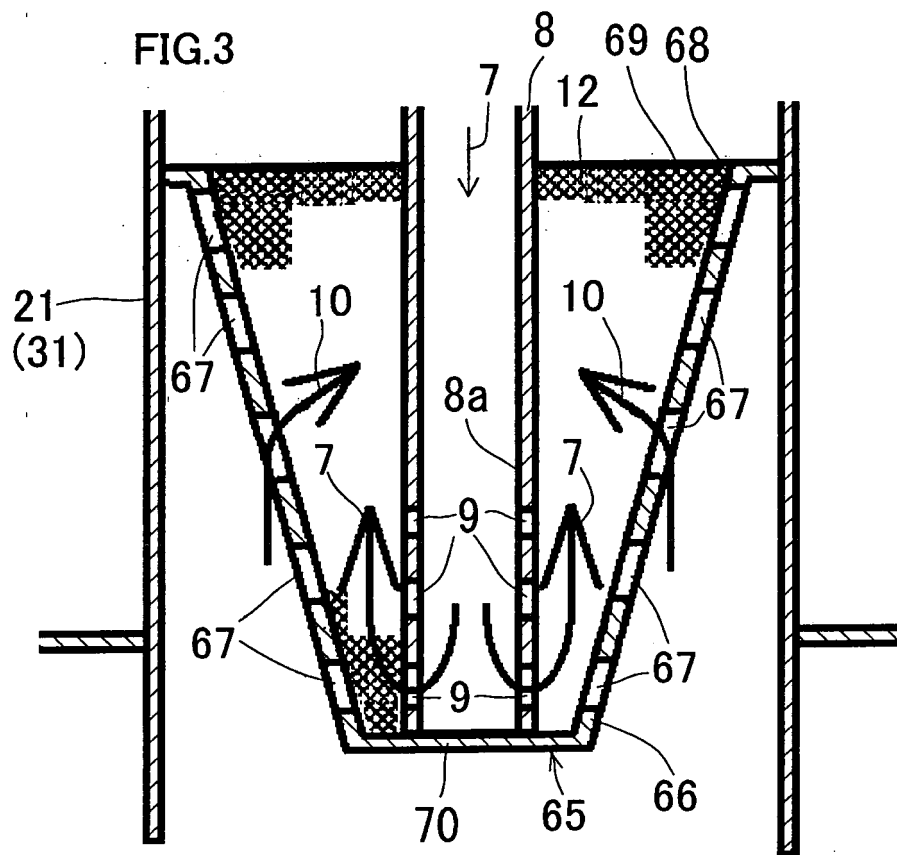


FIG. 2 (C)





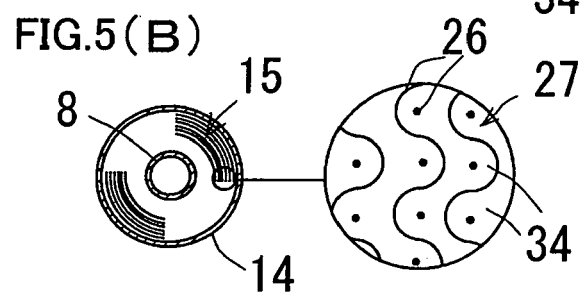
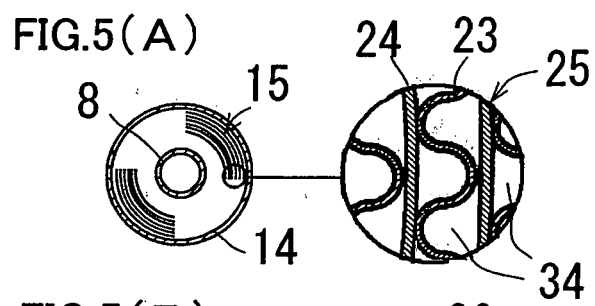


FIG.6(A)

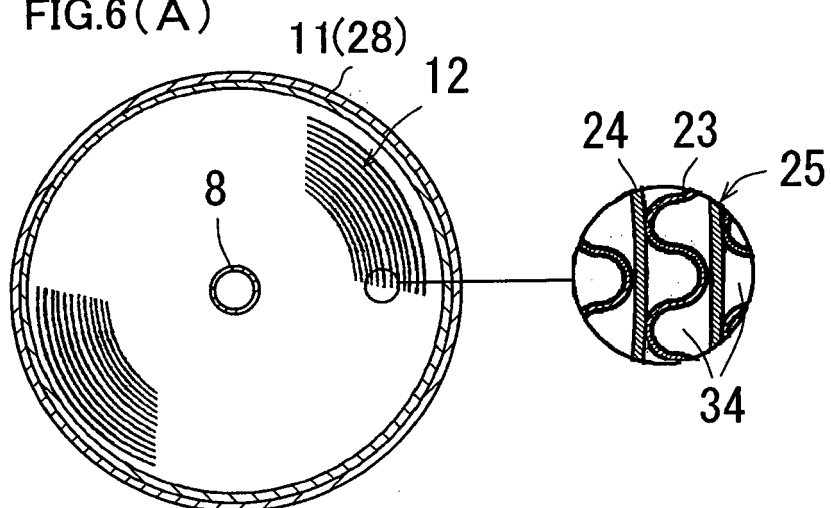
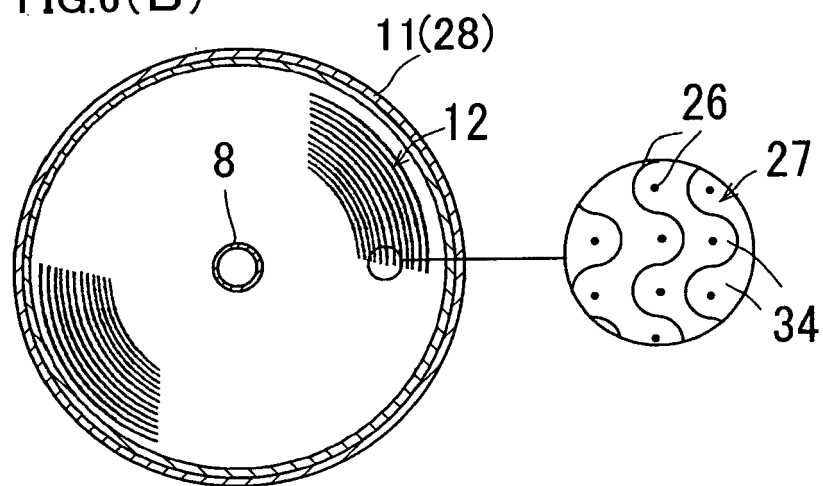
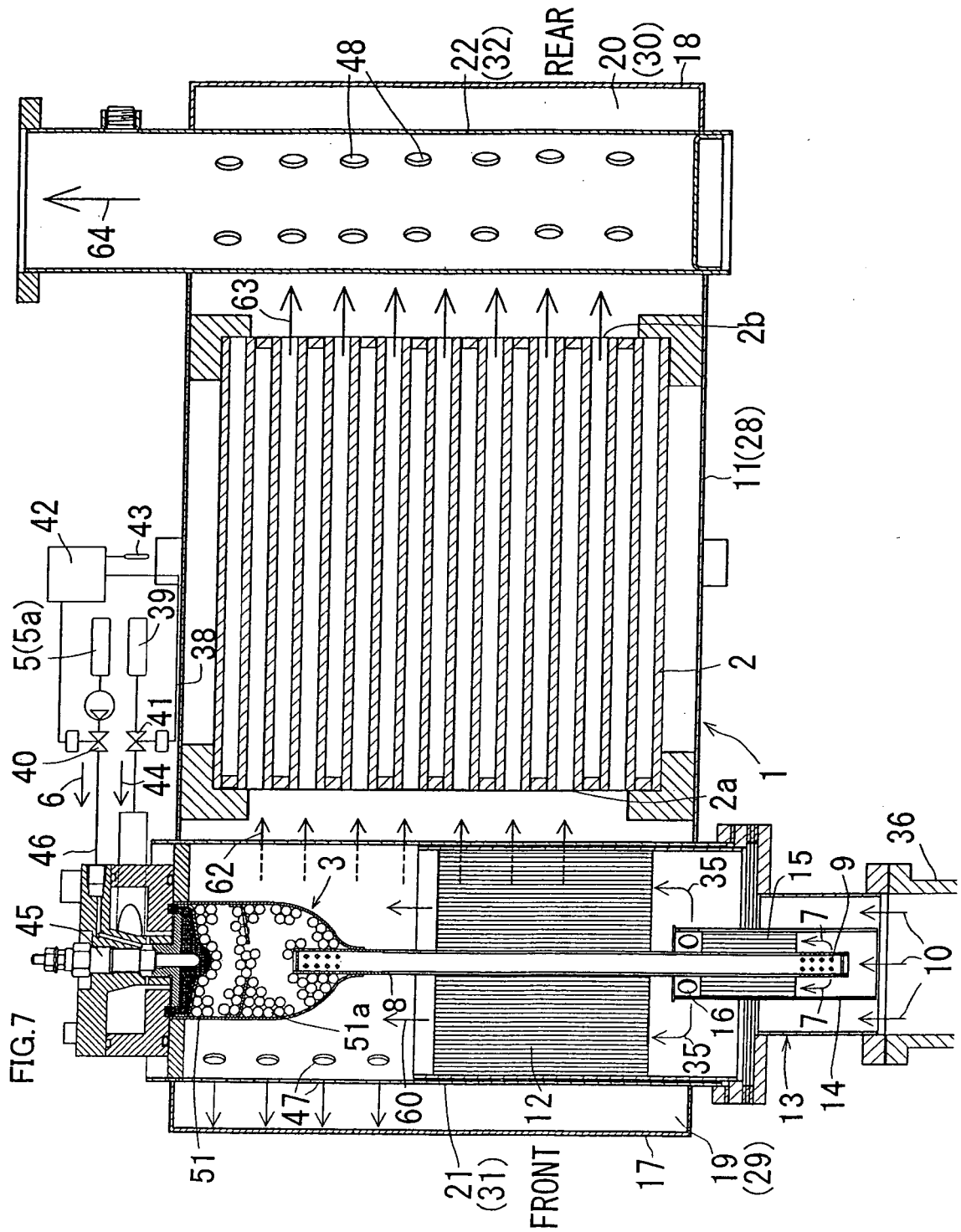


FIG.6(B)







European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 25 0776

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X	WO 2007/011113 A (KOREA INST OF MACHINERY AND MA [KR]; SIM SEONG HUN [KR]; JEONG SANG HY) 25 January 2007 (2007-01-25) * paragraphs [0048] - [0070] * * figures 2-7 *	1,15	INV. F01N3/025
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			F01N
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 July 2007	Examiner Ikas, Gerhard
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06-07-2007

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