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(71) Applicant: **RE-TEC Inc.**
Ohtsuki-shi, Yamanashi 401-0015 (JP)

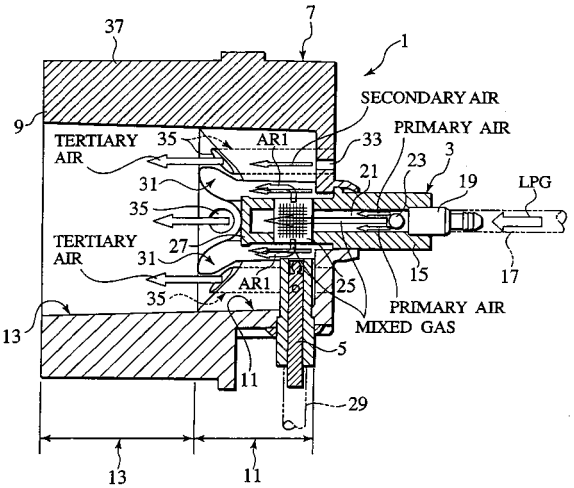
(72) Inventors:
- **KOKUO, Shinji**
  c/o MIKUNI CORP.
  Tokyo 101-0021 (JP)
- **IWAKI, Katsunori**
  c/o MIKUNI CORP.
  Tokyo 101-0021 (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) GAS COMBUSTION DEVICE

(57) A gas combustion device 1 has a combustor 7 for burning supplied combustion gas therein, an ejector 3 with a primary air hole for sucking a primary air due to ejector effect, and an ignitor 5 for igniting mixed gas injected from a wick 25 provided ahead of the ejector 3. The combustor 7 has a primary combustion chamber 11 for igniting and burning the mixed gas injected from the wick 25 therein, a secondary air hole 33 for supplying a secondary air to the gas burning after ignition, a secondary combustion chamber 13 for further burning the gas burnt in the primary combustion chamber 11 therein, and a tertiary air hole 35 for supplying a tertiary air to the gas burning in the secondary combustion chamber 13. Even when the amount of the primary air is increased, thereby improving ignitability of the mixed gas, since the secondary air is supplied to the gas after ignition in the primary combustion chamber 11, combustion performance of the gas is improved.

FIG.4



EP 1 617 140 A1

Description

Technical Field

[0001] The present invention relates to a gas combustion device for generating completely burnt hot air or warm air with high combustion efficiency using burning flame caused by, in particular, Liquefied Petroleum Gas (LPG) as a heat source.

Background Art

[0002] Conventionally, a gas combustion device contained in devices such as portable hair driers and heat guns has been known.

[0003] Referring to Figs. 1 to 3, in a gas combustion device 101 contained in a hair drier, a combustor 103 for burning gas is provided in a cylindrical casing 105 of the hair drier. The combustor 103 bums combustion gas supplied from a gas tank (not shown) in which fuel is stored. The air heated by the combustor 103 is emitted to the side of a vent by a fan (not shown) provided at the side of an inlet of the casing 105.

[0004] In Fig. 1, the gas tank not shown is connected to the combustor 103 through a gas passage 107. Due to flow speed of the combustion gas supplied to the combustor 103, the pressure in the gas passage 107 becomes negative relative to the outside pressure. An ejector 111 with a suction port 109 for sucking outside air from the outside of the gas passage 107 by utilizing a difference between the outside pressure and the pressure in the gas passage 107 is provided at and end of the gas passage 107.

[0005] In detail, as shown in Fig. 2, supplied LPG, for example, is injected from a nozzle 113 in the ejector 111 at high speed. Since the pressure in the gas passage 107 and the ejector 111 becomes negative due to the ejector effect generated by injection speed of the injected gas, outside air for mixing gas flows into from the suction port 109. As a result, mixed gas of the injected gas and air is generated.

[0006] The mixed gas is injected from a wick (wire mesh) 115 provided in the combustor 103 at the side of the inlet. A spark generated from an ignition plug (ignitor) 117 (refer to Fig. 3) by high voltage is blown to the wick 115 which injects the mixed gas, thereby igniting the mixed gas.

[0007] The combustor 103 is disposed between the fan and the vent of the casing 105. As shown in Fig. 3, the shape of a cross section perpendicular to the longitudinal direction of the combustor 103 is a non-circular cylindrical body in which the wick 115 is located at the center of the gas combustion device 101 and which has eight radial groove-like combustion chambers 119 in the shape of eight-divided star-like projections around the wick 115 (a first conventional example: Japanese Patent Application Laid-open Publication No. 2002-233416).

[0008] Since the ejector 111 is provided in the above-mentioned conventional gas combustion device 101 to supply the combustion gas to the combustor 103, outside air is automatically sucked from the suction port 109 due to the ejector effect generated by injection speed of the gas injected from the nozzle 113 in the ejector 111 at high speed. Thus, since the mixed gas of the gas and air is generated and injected from the surface of the wick 115, whereby complete combustion is promoted.

[0009] However, the ignition performance of the mixed gas and the combustion performance of the combustion gas after ignition are conflicting one another. That is, to improve the ignition performance of the gas, the ratio of the gas to air in the mixed gas needs to be increased, and however, when the mixed gas with high gas ratio is burnt, a large amount of incomplete combustion gas generates and the combustion performance is lowered. As a result, CO concentration is increased.

[0010] Conversely, to improve the combustion efficiency, when the amount of air is increased, thereby decreasing the ratio of gas in the mixed gas, the combustion performance is improved and however, it becomes difficult to set a fire, resulting in failure to burn.

[0011] Thus, to keep a certain level of ignitability, even when the size of the suction port 109 of the ejector 111 is made small to suppress the amount of sucked air, the ratio of air in the mixed gas is lowered compared to the mixed gas with good combustion efficiency for the above-mentioned reason and therefore, the problem occurs that air slightly lacks and CO concentration becomes high.

[0012] A conventional example 2: Japanese Patent Application Laid-open Publication No. 2002-249347 discloses that a combustor comprised of a primary combustion chamber for burning mixed gas injected from a wick and a secondary combustion chamber for supplying a secondary air from outside air to the gas burnt in the primary combustion chamber and firing the combustion gas is provided and that complete combustion of the combustion gas is promoted in the secondary combustion chamber.

[0013] However, also in the second conventional example, CO concentration is still high and there is a room for improvement. To solve the above-mentioned problem, the present invention intends to provide a gas combustion device capable of improving ignitability and combustion performance of gas and decreasing CO concentration.

Disclosure of the Invention

[0014] To achieve the above-mentioned object, a gas combustion device according to the present invention comprises a combustor for burning combustion gas supplied from a gas source, a gas passage for sending the gas supplied from the gas source to the combustor, an ejector with a primary air hole for sucking a primary air due to negative pressure generated by flow speed of the combustion gas supplied to the combustor in the gas

passage, an ignitor for igniting mixed gas injected from a wick provided ahead of the ejector, a primary combustion chamber provided in the combustor for igniting and burning the mixed gas injected from the wick therein, a secondary air hole provided in the combustor for supplying a secondary air to the gas burnt after ignition in the primary combustion chamber, a secondary combustion chamber for mixing the gas burnt in the primary combustion chamber with the secondary air sucked from the secondary air hole and further burning the mixed gas therein, and a tertiary air hole for supplying a tertiary air to the gas burnt in the secondary combustion chamber.

Brief Description of the Drawings

[0015]

Fig. 1 is a side view of a conventional gas combustion device.
Fig. 2 is a partial sectional view of an ejector in Fig. 1.
Fig. 3 is a front view of the gas combustion device viewed from the left side in Fig. 1.
Fig. 4 is a sectional view of a gas combustion device in accordance with an embodiment of the present invention taken along a line IV-IV in Fig. 6.
Fig. 5 is a side view of the gas combustion device in accordance with the embodiment of the present invention.
Fig. 6 is a front view of the gas combustion device viewed from the left side in Fig. 5.
Fig. 7 is a back view of the gas combustion device viewed from the right side in Fig. 5.

Best Mode for Carrying Out the Invention

[0016] An embodiment of the present invention will be described below with reference to figures.

[0017] With reference to Fig. 4, a gas combustion device 1 in accordance with this embodiment has an ejector 3 for generating mixed gas of LPG, for example, as combustion gas and air, an electrode 5 as an ignitor for igniting the mixed gas generated by the ejector 3 and a combustor 7 for burning the mixed gas ignited by the electrode 5 therein.

[0018] A chamber 9 of the combustor 7 made of aluminum (die-cast) is a substantially cylindrical body with circular right and left side faces in the longitudinal direction of the chamber 7 as shown in Figs. 6 and 7. The inside of the chamber 9 is comprised of a primary combustion chamber 11 located on the right side in Fig. 4 and a secondary combustion chamber 13 located ahead of the primary combustion chamber 11 (left side in Fig. 4). The ejector 3 is attached to the gas induction side in the rear of the primary combustion chamber 11 (right side in Fig. 4).

[0019] The ejector 3 is provided with a nozzle 19 for injecting gas supplied from a gas source such as a gas tank (not shown) for storing combustion gas such as LPG through a gas supply pipe 17 as a gas passage at the side of an inlet of a substantially cylindrical ejector body having a circular cross section.

[0020] A pin hole as an injection hole (not shown) having a bore diameter of ϕ 60 μm to ϕ 200 μm, for example, is provided at a front end of the nozzle 19. The injection hole is an orifice formed substantially in the center of a disc-like pin-hole disc (not shown) and LPG is thinly discharged at high speed close to sonic speed. A filter (not shown) for removing impurities and dusts which block the injection hole is provided in the nozzle 19. For example, a sintered metal with a pinhole having a diameter of 10 to 30 μm is used as the filter.

[0021] A mixer for mixing LPG with a primary air and introducing the mixed gas into the combustor 7 is provided in the ejector body 15 ahead of the nozzle 19 and a primary air hole 23 for sucking the primary air from the outside penetrates a side wall of the mixer 21. Accordingly, the pressure within the mixer 21 becomes negative due to the combustion gas discharged from the nozzle 19 at high speed, and the primary air is sucked and sent to a forward wick 25 as a gas combustion part while being mixed with the combustion gas. This is called as an ejector effect. By adjusting area of the primary air hole 23, the ratio of the primary air can be adjusted.

[0022] The wick 25 as a gas combustion part is a cylindrical SUS metal mesh of 50 to 150 mesh, for example, and is attached to the end ahead of the ejector body 15 by welding or the like substantially in the center of the right half of the primary combustion chamber 11 of the combustor 7 in Fig. 4. A wick holder 27 as a direct-advance suppression part is attached to the end ahead of the wick 25 by welding or the like. Since direct advance of the mixed gas discharged from the mixer 21 is suppressed by the wick holder 27, lateral discharge (in the direction shown by an arrow AR1 in Fig. 4) of the mixed gas is facilitated and the mixed gas of LPG and air is discharged from meshes of the wick 25. The flame after ignition is blue and substantially circular.

[0023] The electrode 5 is provided within the combustor 7 and ahead of the wick 25 and in the vicinity of the side face of the wick 25. High-tension electricity generated in a piezoelectric element for ignition (not shown) is input to the electrode 5 through an electric wire 29 and a spark is blown from the front end of the electrode 5 to the wick 25. The spark ignites the mixed gas discharged from the wick 25, thereby burning the gas.

[0024] Referring to Fig. 6, on an inner wall of the primary combustion chamber 11, a plurality of groove parts 31 extending in the forward-rearward direction are radially arranged around the wick 25. In Fig. 6, six groove parts 31 are formed.

[0025] A plurality of secondary air holes 33 for supplying a secondary air from outside air to the primary combustion chamber 11 are provided on a rear wall (right side wall in Fig. 4) of the primary combustion chamber 11. The plurality of secondary air holes 33 is disposed so that the secondary air is supplied at the position slightly

separated from the periphery of the wick 25. In other words, the holes are disposed so that the secondary air is supplied to the gas after ignition at the position where the air does not influence on the mixed gas just discharged from the wick 25, that is, the position other than an ignition point. The ignition point means the area where a spark generated by the electrode 5 can blow at the side of the electrode 5 in the periphery of the wick 25 as shown by an area surrounded by a dotted line in Fig. 6. In this embodiment, five secondary air holes 33 in total are provided so that the secondary air is supplied from the rear of the groove parts 31 except for the groove part 31 to which the electrode 5 is attached.

[0026] A plurality of tertiary air ducts 35 as tertiary air holes for supplying a tertiary air from outside air to the secondary combustion chamber 13 are provided in the wall of the primary combustion chamber 11 between adjacent groove parts 31. In this embodiment, six tertiary air ducts 35 in total are provided.

[0027] By adjusting area of the primary air hole 23 of the ejector 3, the ratio of the primary air can be adjusted. To improve ignitability of the mixed gas injected from the wick 25, in this embodiment, the area of the primary air hole 23 is configured so as to be an almost half of the area of the conventional primary air hole. For example, providing that the diameter of the conventional primary air hole is D, the diameter of the primary air hole 23 in this embodiment is 0.73D.

[0028] The diameter of five secondary air holes 33 is 0.4D and the diameter of six tertiary air ducts (tertiary air holes) 35 is D.

[0029] A plurality of fins 37 for heat exchange are provided in the outer periphery of the chamber 9. The fins 37 has the effect of emitting heat generated when the mixed gas is burnt in the chamber 9 and cooling the chamber 9, that is, performing heat exchange.

[0030] With the above-mentioned configuration, when LPG is supplied into the nozzle 19 of the ejector 3 through the gas supply pipe 17, LPG passes through the filter in the nozzle 19 and injected from the injection hole as the orifice to the mixer 21 at the speed close to sonic speed. As a result, the pressure within the mixer 21 becomes negative due to the ejector effect and the primary air necessary for combustion (corresponding to the air-fuel ratio) is sucked from the primary air hole 23 and flows into the mixer 21. And then, the flowed primary air and LPG are mixed to form the mixed gas and the mixed gas is injected into the forward wick 25.

[0031] In the mixer 21, in proportion to increase or decrease in LPG, the primary air necessary for combustion is automatically sucked. Furthermore, by making the diameter of the primary air hole 23 small to decrease the amount of the primary air, the mixed gas with good ignitability is injected to the forward wick 25.

[0032] Since the wick holder 27 is provided at the forward end face in the wick 25, the combustion gas (mixed gas) is mainly injected from the SUS metal mesh on the side face to the periphery.

[0033] Next, by supplying high voltage through the electric wire 29, a spark is generated from the electrode 5 in the combustor 7 and surely ignites the mixed gas with the suitable gas ratio emitted from the wick 25. Most of burning flame of the ignited gas spreads outwards in a circle pattern from the side face of the wick 25 and the length of the burning flame remains to be ten-odd mm from the wick 25. Warm air is transmitted along the inside of the primary combustion chamber 11 and eight groove parts 31 on the inner wall to the forward secondary combustion chamber 13.

[0034] At this time, although the mixed gas emitted from the wick 25 has good ignitability because of high gas ratio, CO concentration is increased, thereby lowering combustion performance. However, since the secondary air hole 33 is provided at the region other than the ignition point, the amount of air in the region other than the ignition point in the primary combustion chamber 11 and CO concentration is lowered. That is, since the secondary air is supplied to the combustion gas in the primary combustion chamber 11 after ignition, combustion efficiency of the gas in the primary combustion chamber 11 is improved, thereby improving combustion performance. Therefore, in the primary combustion chamber 11, the mixed gas discharged from the wick 25 is surely ignited, combustibility of the combustion gas after ignition is promoted and CO concentration is decreased.

[0035] Furthermore, since the tertiary air from outside air passes through the six tertiary air ducts (tertiary air holes) 35, the temperature at the wall part of the primary combustion chamber 11 is effectively decreased and the hot tertiary air that has passed through the tertiary air ducts 35 is introduced into the secondary combustion chamber 13. For this reason, combustion reaction of the gas in the secondary combustion chamber 13 is further promoted, thereby improving combustion performance. In other words, since the gas burnt in the primary combustion chamber 11 and the hot tertiary air are mixed, combustion reaction easily occurs and complete combustion is promoted. With such configuration, combustion performance is improved. As described above, the tertiary air has the effects of decreasing the temperature in the primary combustion chamber 11 and improving combustion performance in the secondary combustion chamber 13. It is preferred that the number of the tertiary air ducts 35 is eight to satisfy both of combustion performance and heat exchange.

[0036] As apparent from the above-mentioned matters, since most unburnt gas is burnt in the secondary combustion chamber 13 in the gas combustion device 1 in accordance with the embodiment of the present invention, flame is hard to go out of the chamber 9.

[0037] To validate performance of the present invention, when CO concentration in the gas combustion device of the second conventional example and the gas combustion device 1 of this embodiment was measured under the same condition, in the case of a first condition, CO concentration was 94 ppm in the second convention-

al example and 41 ppm in this embodiment. In the case of a second condition, CO concentration was 119 ppm in the second conventional example and 49 ppm in this embodiment.

[0038] Therefore, it was confirmed that CO concentration was decreased by supplying the tertiary air to the secondary combustion chamber 13 and the secondary air to the primary combustion chamber 11 in this embodiment. In the combustor of the second embodiment, although the tertiary air is supplied to the secondary combustion chamber 13 of the combustor 7 as in this embodiment, the secondary air is not supplied to the primary combustion chamber 11.

[0039] The present invention is not limited to the above-mentioned embodiments and can be carried out according to the other aspects. The gas combustion device 1 in accordance with this embodiment can be used as the gas combustion device such as a hair drier and a heat gun used for compression operation of a heat-shrinkable tube, drying, adhesion, fusing and soldering and the other gas combustion devices such as the other appliances.

Industrial Applicability

[0040] According to the present invention, even when ignitability of the mixed gas emitted from the wick is improved by decreasing the amount of the primary air, combustion efficiency of the combustion gas in the primary combustion chamber can be improved, thereby improving combustion performance. Furthermore, since the tertiary air is introduced into the secondary combustion chamber from the tertiary air holes, combustion performance is further improved, thereby improving combustion performance. Therefore, complete combustion is facilitated and CO concentration can be decreased.

[0041] Further, since the amount of the primary air can be decreased to increase the gas ratio by making the diameter of the primary air hole small, ignitability of the mixed gas discharged from the wick can be improved.

[0042] Furthermore, since the secondary air holes are provided at the positions other than the ignition point in the primary combustion chamber, the amount of air in the region other than the ignition point is increased without impairing ignitability of the ignition point in the primary combustion chamber, thereby improving combustibility of the gas as well as decreasing CO concentration.

Claims

1. A gas combustion device comprising:

a combustor for burning combustion gas supplied from a gas source;
a gas passage for sending the gas supplied from the gas source to the combustor;
an ejector with a primary air hole for sucking a primary air due to negative pressure generated by flow speed of the combustion gas supplied to the combustor in the gas passage;
an ignitor for igniting mixed gas injected from a wick provided ahead of the ejector;
a primary combustion chamber provided in the combustor for igniting and burning the mixed gas injected from the wick therein;
a secondary air hole provided in the combustor for supplying a secondary air to the gas burnt after ignition in the primary combustion chamber;
a secondary combustion chamber for mixing the gas burnt in the primary combustion chamber with the secondary air sucked from the secondary air hole and further burning the mixed gas therein; and
a tertiary air hole for supplying a tertiary air to the gas burnt in the secondary combustion chamber.

2. A gas combustion device of claim 1, wherein the diameter of the primary air hole is made small to improve ignitability of the mixed gas injected from the wick.

3. A gas combustion device of claim 1 or 2, wherein the secondary air hole is provided at the position other than an ignition point, at which the secondary air is supplied to the combustion gas.

FIG.1

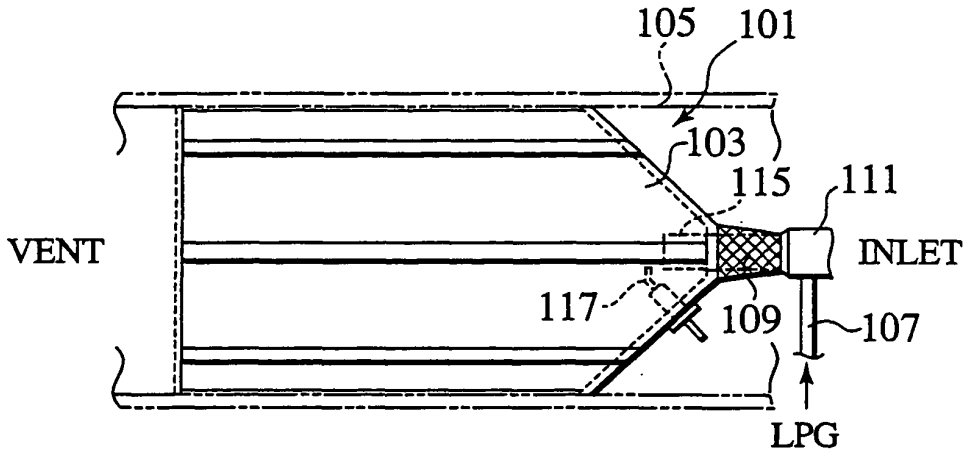


FIG.2

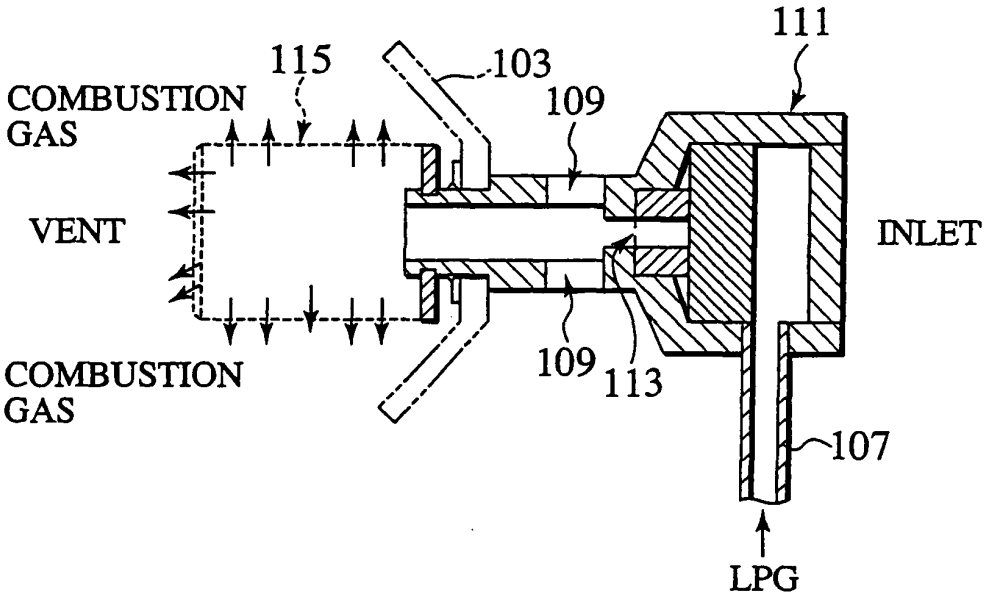


FIG.3

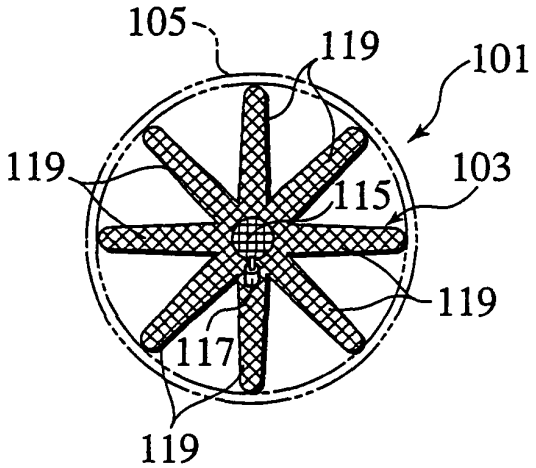


FIG.4

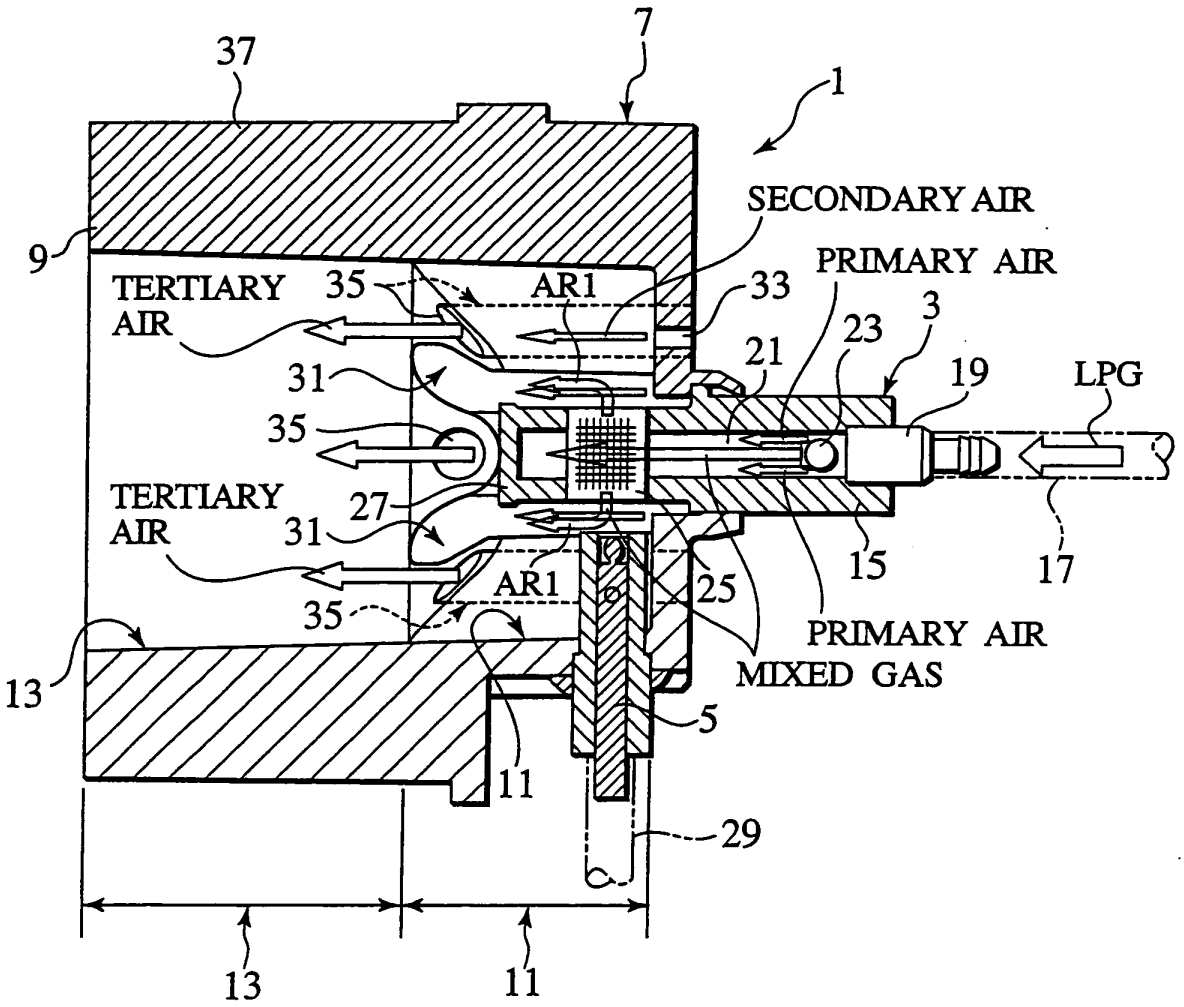

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FIG.5

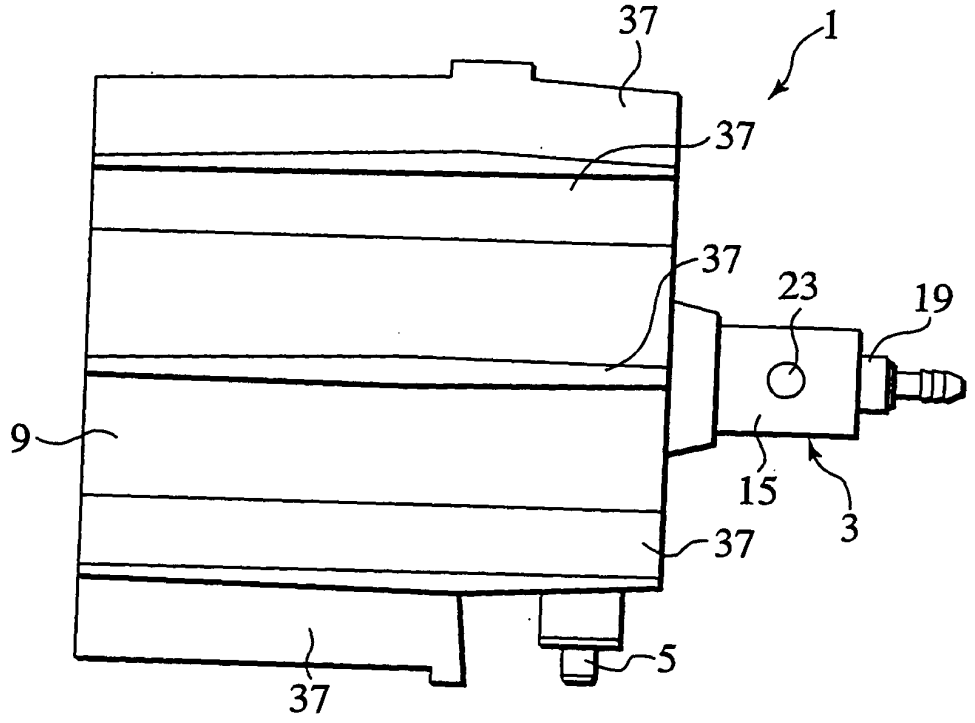
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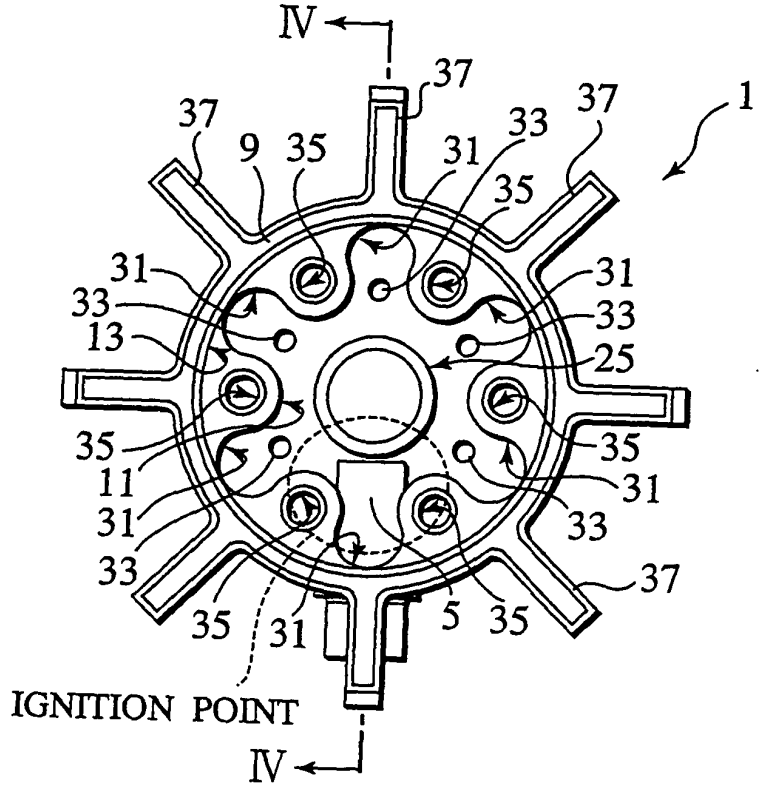
FIG.6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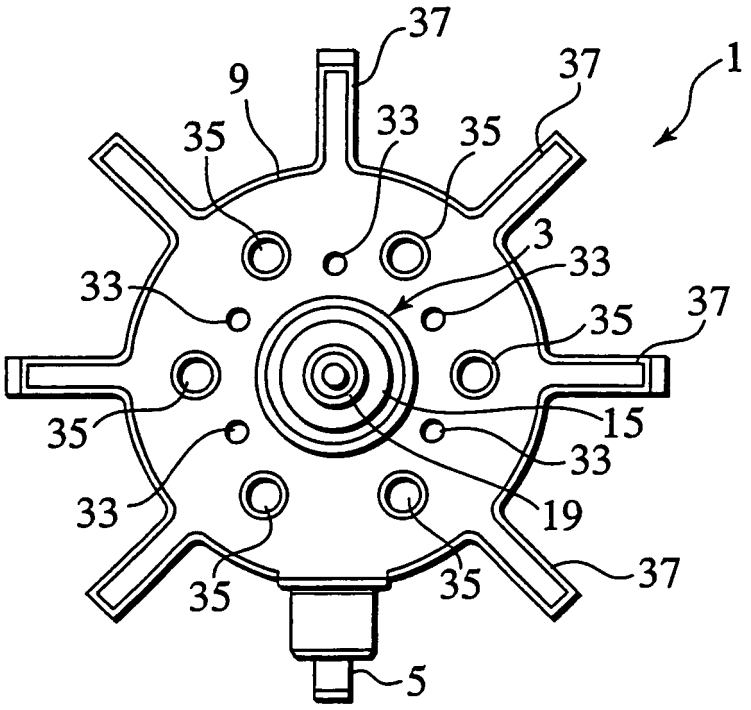
IGNITION POINT
IV

FIG.7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/002598

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F23D14/02, F23D14/28, A45D20/06

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)
Int.Cl[7] F23D14/02, F23D14/28, A45D20/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-2004
Kokai Jitsuyo Shinan Koho 1971-2004 Jitsuyo Shinan Toroku Koho 1996-2004

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.
Y	JP 2002-233416 A (RE-TEC INC.), 20 August, 2002 (20.08.02), Full text; Figs. 1 to 8 & WO 02/063990 A1	1-3
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 39342/1974(Laid-open No. 128141/1975) (Shoei Mfg. Co., Ltd.), 21 October, 1975 (21.10.75), Full text; Figs. 1 to 2 (Family: none)	1-3

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 June, 2004 (01.06.04)	22 June, 2004 (22.06.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/002598

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-342 A (Matsushita Electric Industrial Co., Ltd.), 09 January, 1996 (09.01.96), Full text; Figs. 1 to 8 (Family: none)	1-3
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 143013/1986(Laid-open No. 49138/1988) (Prince Industrial Development Co., Ltd.), 02 April, 1988 (02.04.88), Full text; Fig. 1 (Family: none)	1-3

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