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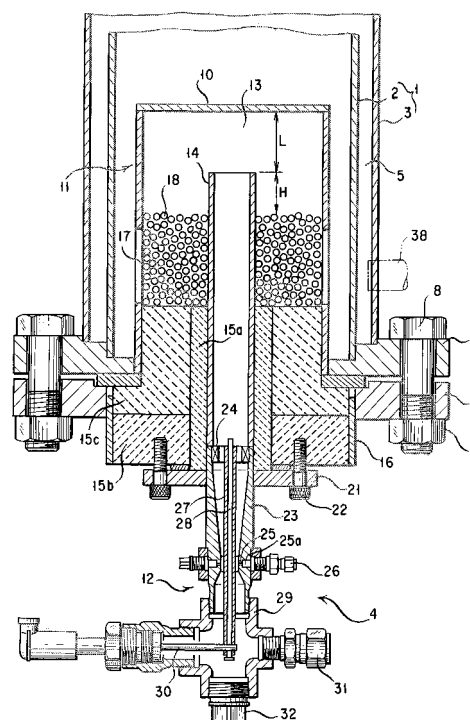
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(54) **COMBUSTOR**

(57) A combustor is proposed which is compact and eliminates generation of NOx and unburned combustible and is capable of stable combustion.

A combustor is accordingly provided which comprises a combustion section 11, a fuel supply section 12 coupled to the combustion section for supplying a fuel air mixture wherein the fuel supply section comprises a mixer of venturi tube type having a fuel supply port 25 on an inner peripheral surface of a throat part, a combustion air supply port 31 connected to a base end of the mixer of venturi tube type and an igniter made capable of generating a spark at an extremity of the mixer of venturi tube type and the combustion section comprises a frame 16 coupled to the boiler main body and a ceramic combustion tube 14 supported by the frame 16 via heat insulators 15a, 15b and 15c and having one end lying in communication with the extremity of the mixer of venturi tube type in the fuel supply section and the other end projecting into the boiler main body and wherein the ceramic combustion tube is made of a ceramic functioning as an oxidation catalyst.

FIG. 1



Description

Technical Field

[0001] The present invention relates to a combustor for obtaining a high-temperature gas, e. g., for a fuel reforming apparatus in a compact fuel cell system for family use.

Background Art

[0002] The combustion gas coming from a combustor of this type should desirably be free from pollutants, namely NO_x and unburned fuel and be also the least in the amount of residual oxygen by complete combustion.

[0003] Conventional combustors of this type are known to include (1) a combustor in which air is mixed with a fuel in a concentration within its explosion mixture limits and a resultant mixed gas of air and fuel is ignited by an igniting means such as electric spark to form a flame, followed by continued combustion of the mixed gas; (2) a combustor in which a preheated mixed gas made by mixing a fuel into preheated air is combusted by means of a combustion catalyst; (3) a combustor in which a heating tube in a primary combustor is always externally heated by an auxiliary combustor to more than an ignition temperature of a fuel and a mixed gas of fuel and air is brought into contact with the heated heating tube in the primary combustor to continue combustion; and (4) a combustor in which a mixed gas of a fuel and air is brought into contact with a tube heated to more than an ignition temperature of the fuel and thereby combusted and the combustion gas is U-turned at an end of the tube while heated to continue combustion (JP H10 - 26309 A).

[0004] Any of the conventional combustors mentioned above cannot serve satisfactorily as a boiler's combustor used for a fuel reforming apparatus in compact fuel cell systems for family use.

[0005] The reason is because the combustor used for an apparatus of this type needs to be compact and small in volume of its combustion chamber and requires its surrounding wall surface temperature to be of a 110 to 180°C, thus requiring a complete combustion with a reduced NO_x concentration, though under very adversely limited conditions for combustion.

[0006] In addition, the fuel chamber small in volume means that it is liable to undergo a pressure fluctuation. In the case of flame combustion, a fluctuation in pressure likely causes the fuel to temporarily stop flowing, the flame to disappear and the combustion to stop continuing, so that vapor is no longer coming out.

[0007] Consequently, the S / C (steam / carbon) ratio in the area of a reforming catalyst becomes lower than an optimum value so that carbon is generated, causing the fuel reforming apparatus on the whole to cease operating.

[0008] Furthermore, the compact fuel cell system for

family use calls for the use of both a gaseous fuel and a liquid fuel. While when it is started to operate, there is no choice but to use an auxiliary igniter, there must be adopted a method whereby the auxiliary igniter may thereafter be made unnecessary in a shortest possible time and moreover, even in the presence of a disturbance such as pressure fluctuation, the combustion is prevented from cessation.

Disclosure of the Invention

[0009] In view of the foregoing, it is an object of the present invention to provide a combustor which eliminates generation of NO_x and unburned combustible, as a pollutant, which is compact and which makes it possible to obtain a combustion gas stably even if there is a bit of disturbance.

[0010] There is provided in accordance with the present invention in a first aspect thereof a combustor which comprises a fuel air mixer of venturi tube type having an igniter and a ceramic combustion tube having an oxidation catalyzing function positioned downstream of the said fuel air mixer.

[0011] In a second aspect thereof, the present invention provides a combustor in the first aspect which further comprises a vortex generator disposed at an extremity of the fuel air mixer of venturi tube type such that the air fuel mixture becomes a vortex in the said combustion tube.

[0012] In a third aspect thereof, the present invention provides a combustor in the first or second aspect which further comprises a top closed cylindrical cover member with which a downstream extremity of the ceramic combustion tube is covered to form a combustion chamber around the extremity of the ceramic combustion tube, the cover member having a cylindrical base end portion formed with an outlet for the combustion gas.

[0013] In a fourth aspect thereof, the present invention provides a combustor in the third aspect in which the cover member has an outer peripheral surface having a radiation promoting paint applied thereto.

[0014] In a fifth aspect thereof the present invention provides a combustor in the third or fourth aspect in which an oxidation catalyst layer is interposed between the ceramic combustion tube and the base end portion of the cover member.

[0015] According to the first aspect of the invention, a combustor can be obtained that is suitable for use as a boiler's combustor for a fuel reforming apparatus in a compact fuel cell system for family use of which development is now in progress, that has a small combustion chamber and that is capable of combusting efficiently and stably.

[0016] According to the second aspect of the invention, a combustor can be obtained that is capable of combusting stably since an air fuel mixture is fully contacted by an oxidation catalyst.

[0017] According to the third aspect of the invention,

a combustion gas flowing out of the ceramic combustion tube is allowed to promote its combustion further in the combustion chamber constituted with the cover member.

[0018] According to the fourth aspect of the invention, radiant heat can be radiated from an outer surface of the cover member onto a portion to be heated, thereby to promote heating the latter.

[0019] According to the fifth aspect of the invention, a combustion gas flowing out through a through hole from the combustion chamber in the cover member is allowed to pass through the catalyst layer having an oxidation function; hence an unburned combustible which there may remain in the combustion gas after passed to combust through the ceramic combustion tube can completely be burned while passing through the catalyst layer.

Brief Description of the Drawings

[0020] In the Drawings:

Fig. 1 is a cross sectional view illustrating a combustor according to a first form of implementation of the present invention;

Fig. 2 is a cross sectional view illustrating a form of boiler in which the combustor as the first form of implementation of the invention; and

Fig. 3 is a cross sectional view illustrating a combustor according to a second form of implementation of the present invention and another form of boiler equipped therewith.

Best Modes for Carrying Out the Invention

[0021] An explanation is given of a first form of implementation of the present invention with reference to Figs. 1 and 2. Fig. 1 shows in a cross section the essential parts of a combustor of the present invention, and Fig. 2 shows in a cross section a form of boiler in which the combustor of the invention is used.

[0022] In Fig. 1, a boiler main body 1 comprises an inner cylinder 2 and an outer cylinder 3 coaxially arranged. Mounted at the lower end of the boiler main body 1 is a combustor 4 according to the present invention. A high temperature combustion gas generated by the combustor 4 is supplied into the inner cylinder 2 of the boiler main body 1 along its inner surface to heat the inner surface of the inner cylinder 2 whereby water (evaporating medium) supplied in a heating medium jacket 5 formed between the inner and outer cylinders 2 and 3 coaxially arranged to generate a high temperature steam. A boiler lower flange 6 is coupled integrally with the lower end of the boiler main body 1 to close the heating medium jacket 5 for the evaporating medium, and a combustor flange 7 integrally attached to an outer periphery of the combustor 4 is coupled to the boiler lower flange 6 by means of a bolt 8 and a nut 9 so that the combustor 4 is coupled to the lower end of the boiler main body 1 in the state that a cover member 10 lying at the uppermost of the com-

bustor 4 projects into the inner cylinder 2 of the boiler main body 1.

[0023] The combustor 4 comprises a combustion section 11 including a ceramic combustion tube 14 through which the combustion gas spurts and a fuel supply section 12 for supplying the combustion section 11 with a fuel air mixture, namely a mixture of a fuel and air.

The combustion section 11 comprises a cover member 10 defining a combustion chamber 13 in its inside at the uppermost of the combustion section 11, a ceramic combustion tube 14 disposed in an axial central area of the cover member 10 and opened at its top to the combustion section 11, heat insulators 15a, 15b and 15c composed of ceramic and disposed so as to surround outer lower sides of the ceramic combustion tube 14 and a frame 16 surrounding these heat insulators and securely connected to the combustor flange 7.

[0024] The cover member 10 which is in the form of a bell (or canister) is mounted so as to cover the heat insulators 15a, 15b and 15c and has its cylindrical base end portion formed with slit-like through holes 17 (an outlet for combustion gas) elongated vertically. And, the cover member 10 has in its side a catalyst layer 18 of small ceramic particles having an oxidizing function up to a height of the through holes 17. The upper end of the ceramic combustion tube 14 is spaced by a distance L (spacing) from the top inner surface of the cover member 10 in the combustion chamber 13 and has a given height H from the upper surface of the catalyst layer 18 such that a combustion gas flowing out of the ceramic combustion tube 14 passes through the combustion chamber 13 and the catalyst layer 18, then flowing through the through holes 17 into the inner cylinder 2 of the boiler main body 1.

[0025] The fuel supply section 12 is securely connected to the lower end of the combustion section 11 by means of a fitting flange 21 which is disposed at its upper end and fastened by bolts 22 via a packing to the lower end of the combustion section 11.

A mixer of venturi tube type 23 is fastened to the fitting flange 21 so as to pass therethrough. The exit portion of the mixer of venturi tube type 23 is concentric with the ceramic combustion tube 14 of the combustion section 11 and has an exit diameter substantially identical to the inner diameter of the ceramic combustion tube 14 and its exit end or extremity abutting on the lower end of the ceramic cylinder 14. And, a region of the abutment is provided with a vortex generator 24. The vortex generator 24 is configured so as to turn an air fuel mixture flow from the mixer of venturi tube type 23 circumferentially thereof, namely to generate a vortex such as flowing on and along the inner peripheral surface of the ceramic combustion tube 14.

[0026] The throat portion of the mixer of venturi tube type 23 is formed on its inner peripheral surface with a plurality of fuel ejection ports 25. The fuel ejection ports 25 are connected to a fuel supply port 26 via a fuel manifold 25a disposed in the throat portion of the mixer of

venturi tube type 23.

The mixer of venturi tube type 23 is provided along its axial center portion with an ignition rod guiding tube 27. The ignition rod guiding tube 27 has its upper end portion fastened to the center of the vortex generator 24 and its lower end portion projecting downwards of the mixer of venturi tube type 23. And, this ignition rod guiding tube 27 has an ignition rod 28 inserted therein so that its extremity protrudes from the ignition rod guiding tube 27.

[0027] The mixer of venturi tube type 23 has its base end portion connected to a cross tube joint 29 in which the lower end portion of the ignition rod guiding tube 27 is positioned. And, one of two joining ports orthogonal to an extension of the port in which the mixer of venturi tube type 23 joins into this tube joint 29 constitutes an igniting power supply rod joining port, in which an igniting power supply rod 30 is inserted so that its forward end is electrically connected to the ignition rod in the tube joint 29. Also, the other of the joining ports is connected to a port 31 for air supply for combustion. Further, a combustion monitoring port 32 is connected in a joining port on the extension of the port in which the mixer of venturi tube type 23 joins into the tube joint 29 to make the inside of the mixer of venturi tube 23 viewable.

[0028] Mention is made below of an operation of the combustor 4 for a boiler main body 1 as shown in Fig. 1.

[0029] Combustion air is supplied from the air supply port 31 in the fuel supply section 12 while a fuel supplied from the fuel supply port 26 is caused to spurt from the fuel ejection port 25 into the throat portion of the mixer of venturi tube type 23 whereby the air and fuel until they reach the exit of the mixer of venturi tube type 23 from that throat portion are mixed together into a fuel air mixture which then flows out of the exit of the mixer of venturi tube type 23 into the ceramic combustion tube 14. The fuel air mixture then flowing into the ceramic combustion tube 14 has, owing to the vortex generator 24, become a vortex flowing on and along the inner peripheral surface of the ceramic combustion tube 14. And, it is in this state that the igniting power supply rod 30 is energized to create a spark at the tip of the ignition rod 28, thereby igniting the fuel air mixture.

[0030] This commences combusting the fuel air mixture. And, after the ignition, though affected by the fuel air mixture proportion value, the combustion is allowed to continue if the ceramic combustion tube 14 is heated to more than a temperature at which it functions as an oxidation catalyst even if the sparking is ceased in two minutes or less.

[0031] In case a liquid fuel (e. g., kerosene) is used in the combustion, combustion air is supplied upon pre-heating to around 200 to 250°C, although the fuel per se is supplied at the normal temperature. In this form of implementation, a gaseous fuel can also be used.

[0032] Where the ignited fuel air mixture commences combusting, the combustion gas flows through the inside of the ceramic combustion tube 14 upwards along its inner peripheral wall. As a result, the ceramic combustion

tube 14 per se is heated up to more than a catalyst activation temperature. As a consequence, even if the ignition by the ignition rod 28 is ceased at the time the ceramic heat chamber 14 is heated up, bringing the fuel air mixture from the mixer of venturi tube type 23 into contact with the inner peripheral surface of the ceramic combustion tube 14 heated up to the catalyst activation temperature or more allows the oxidation reaction to be brought about immediately in the mixture, thus continuing the combustion.

[0033] Such combustion becomes stronger as the mixture runs downstream of the ceramic combustion tube 14, so that at the upper end of the ceramic combustion tube 14 most of the mixture is combusted. Note here that the state of combustion then is affected by the length of the ceramic combustion tube 14, from which the length of the ceramic combustion tube 14 is designed to be a length at which most of the mixture supplied from the fuel supply section 12 is combusted.

[0034] Since the fuel air mixture supplied into the ceramic heat chamber 14 has been mixed in a uniform concentration, the combustion reaction in the ceramic heat chamber 14 proceeds very rapidly. For example, a combustion speed of around 7/1000 second is shown when the fuel air mixture has a theoretical combustion temperature of around 1400 to 1600°C. For this sake, the ceramic combustion tube 14 should preferably be composed of a material having properties as stated below.

[0035] To wit, the conditions necessary for the ceramic combustion tube 14 having the oxidation function mentioned above are: (1) high in resistance to thermal shock, (2) low in catalyst activation temperature, (3) high in thermal emissivity, (4) high in mechanical strength at high temperatures, and (5) high in thermal conductivity.

[0036] Suitable as ceramics having such properties are SiC, Si₃N₄, ZrO₂ and one having 5 to 20 % of another metal oxide or oxides added to ZnO₂.

[0037] Non-oxide ceramics of Si such as SiC and Si₃N₄, though they have catalyst activation temperatures as relatively high as 640 to 645°C, can enough be used practically as they elsewhere meet the conditions mentioned above. While ZrO₂ simple exhibits a catalyst activation temperature of 465°C, ceramics having 5 % to 20 % of CoO, Cr₂O₃, MnO₂, La₂O₃, SnO₂, Y₂O₃, TbO₂ and MgO added thereto can have catalyst activation temperatures reduced to 330°C to 497°C (see "Catalytic Combustion by ZrO₂ compound oxide" read on the 9th Symposium on Catalytic Combustion (May 25, 1990)).

[0038] The reason for requirement for high resistance to thermal shock in (1) above is that rapid combustion speed is accompanied by large change in heat quantity which the ceramic combustion tube 14 must accept from its inside. To wit, large change in heat quantity which the ceramic combustion tube 14 receives means large temperature change of the ceramic combustion tube 14 itself. The thicker becomes the ceramic combustion tube 14, the larger becomes the temperature difference in the ceramic combustion tube 14, to an extent that the ceramic

combustion tube 14 may be broken by thermal shock. To prevent this, the requirement also arises for high thermal conductivity in the condition (5) above. Also, the requirement for high thermal conductivity is suitable for transfer of the heat received in the downstream side to the upstream side. Also, the requirement for high thermal emissivity in (3) exhibits analogous operations and effects.

[0039] The combustion gas generated in the ceramic combustion tube 14 flows through the extremity of the ceramic combustion tube 14 into the combustion chamber 13 where it turns downwards along the inner surface of the cover member 10 constituting the combustion chamber 13. The combustion gas then flows through the catalyst layer 18 and flows out into the inner cylinder 2 of the boiler main body 1 from the through holes 17.

[0040] The combustion gas then for combustion, if the flow path through which it flows is small in volume and surrounded by a cold wall surface, is insufficiently combusted to the extent that unburned combustible may remain in the combustion gas. In this combustion section 11, however, the combustion gas which flows from the ceramic combustion tube 14 into the combustion chamber 13 constituted by the cover member 10 and thereby formed with a large space continues to be fully combusted to a high temperature (1500 to 1700°C) whereby the unburned combustible is burned substantially completely.

[0041] And, the combustion gas in the combustion chamber 13 turns downwards along the inner surface of the cover member 10 constituting the combustion chamber 13. After passing through the catalyst layer 18, it flows through the through holes 17 into the inner cylinder 2 of the boiler main body 1, heating the inner surface of the inner cylinder 2. And, the combustion gas then by contacting ceramic small particles in the catalyst layer 18 has its unburned components completely burned. And, the presence of this catalyst layer 18 makes it possible to prevent the combustion from being ceased by a pressure fluctuation of the fuel and combustion air.

[0042] It is advantageous if the ceramic small particles having the oxidation function and making up the catalyst layer 18 are Si hollow particles.

[0043] Concerning the combustor 4 shown in the above mentioned form of implementation, to mention the sizes of the components in an example of the combustor for steam generation in a fuel cell system for family use, the ceramic combustion tube 14 has an inner diameter of 20 mm, a thickness of 2.5 mm and a length of 40 mm and the cover member 10 has an inner diameter of 50 mm and H and L as indicated in Fig. 1, sized of 10 mm and 15 mm, respectively.

[0044] The combustor has hereinbefore been shown in Fig. 1 and described, which is an example applied to the boiler main body 1 for steam generation in a fuel cell system for family use. Water filled in the heating medium jacket 5 of the boiler main body 1 is boiled to generate a steam which is guided out through a steam tube connect-

ed to an upper part of the heating medium jacket 5. In this case, in order for the cover member 10 to be used over a prolonged time period, the heat received from the high-temperature gas need to be transferred as much as possible towards the heating medium jacket 5. In this form of implementation, a radiation promoting paint, e. g., whose thermal emissivity is 92 % or more, may be applied over the outer peripheral surface of the cover member 10 made of steel so that the wall portion of the cover member 10 can be held at not more than 950°C if a combustion gas whose theoretical combustion temperature is 1600°C is generated in the combustion section 11. Thus, applying such a radiation promoting paint makes it possible for the cover member 10 to bear its services over a prolonged time period.

[0045] Fig. 2 shows a form of implementation of the boiler using the combustor 4 according to the present invention in the makeup in which a heat exchanger section 34 comprising a number of water pipes 33, 33, , is disposed above the combustion section 11 within the inner cylinder 2 of the boiler main body 1. Note here that an exhaust pipe 40 is connected to communicate with the inside of the inner cylinder 2.

A water retaining tank 35 is disposed above the heat exchanger 34, which has a water supply pipe 36 connected thereto. And, The water pipes 33 in the heat exchanger section 34 have their respective inlet ports 33a connected to the water retaining tank 35 and their respective outlet ports connected to communicate with an outlet chamber 37. The outlet chamber 37 constitutes a space formed between an upper part of a supporting plate 39 supporting the heat exchanger section 34 and a bottom part of the water retaining tank 35. The outlet chamber 37 serves to separate gas and liquid concurrently from both a gas liquid mixture in a vaporized state coming from the heating medium jacket 5 of the boiler main body 1 and a gas liquid mixture in a vaporized state coming from the outlet of the heat exchanger section 34. And, since the outlet chamber 37 is in communication via a conduit 38 with a lower part of the heating medium jacket 50, a separated liquid medium (hot water) is allowed to circulate, thus absorbing heat for vaporization. On the other hand, the gas liquid mixture in vaporized state from which the liquid is mostly removed by separation is moved up through a space between the inner cylinder 2 of the boiler main body 1 and an outer cylindrical portion of the water retaining tank 35 and is thereby separated into gas and liquid, with a separated vapor component taken out of a vapor outlet pipe 41 into the outside and with a separated hot water component collected in the water receiving tank 35.

[0046] In such a boiler configured as mentioned above, the heat of a combustion gas flowing in the inner cylinder 2 of the boiler main body 1 from the combustion section 11 of the combustor 4 directly can act on the inner surface of the inner cylinder 2 and further on the heating medium jacket 5 while being heat-exchanged in the heat exchange section 34 to preheat the water to be supplied

into the heating medium jacket 5. Thus, the heat of a combustion gas generated in the combustion section 11 can thus be utilized effectively.

[0047] In a modification (to be described later) of the form of implementation mentioned above, the cover member 10 to constitute the combustion chamber 13 can be omitted on adjusting the length of the ceramic combustion tube 14 where an air fuel mixture supplied from the mixer of venturi tube type 23 in the fuel supply section 12 can be burned with the resultant ceramic combustion tube 14 to an extent that there is little unburned combustible.

[0048] Also, if the cover member 10 is yet used, the catalyst layer 18 incorporated so as to block the through holes 17 may be eliminated if the burning is effected in the combustion chamber constituted by the cover member 10 to an extent that unburned combustible in the combustion gas can completely be burned.

[0049] While in the form of implementation mentioned above, a cover member 10 is shown disposed on the exit side of the ceramic combustion tube 14, such a cover member to constitute the combustion chamber 13 can be omitted on adjusting the length of the ceramic combustion tube 14 where an air fuel mixture supplied from the mixer of venturi tube type 23 in the fuel supply section 12 can be burned with the resultant ceramic combustion tube 14 to an extent that there is little unburned combustible. This modification is shown in Fig. 3 to constitute a second form of implementation of the invention. In the second form of implementation shown in Fig. 3, the ceramic combustion tube 14 is closed at its exit side with a thermal insulator 15d having a number of guide passages 19 therein for guiding a combustion gas radially outwards therefrom. The combustion gas guided circumferentially outwards of the thermal insulator 15d in the process of being discharged upwards acts to heat the inner cylinder 2 of the boiler main body 1 having a number of vertically descending water pipes 42 disposed circumferentially spaced apart in a spaced between the inner cylinder 2 and the outer cylinder 3 and to heat the respective outer walls of a number of water pipes 33 disposed centrally of the boiler main body 1.

[0050] In the second form of implementation shown in Fig. 3, note here that unlike in the first form of implementation shown in Fig. 1, a portion of the ceramic combustion tube 14 which is in an upper region of the combustion section 11 where the ceramic combustion tube 14 is not expectable to function as the oxidation catalyst is leaved out and substituted with a thermal insulator 15a forming a combustion passage whose inner diameter is identical to that of the ceramic combustion tube 14. Such a structure saves the cost of material of the ceramic combustion tube and is economically advantageous. Also, the structure can be used for heating a reformer and for heating at the time of starting a fuel cell utilizing a solid oxide.

Claims

1. A combustor **characterized in that** it comprises a fuel air mixer of venturi tube type having an igniter and a ceramic combustion tube having an oxidation catalyzing function positioned downstream of said fuel air mixer.
2. A combustor as set forth in claim 1, **characterized in that** it further comprises a vortex generator disposed at an extremity of said fuel air mixer of venturi tube type such that the air fuel mixture becomes a vortex in said ceramic combustion tube.
3. A combustor as set forth in claim 1 or claim 2, **characterized in that** it further comprises a top closed cylindrical cover member with which a downstream extremity of said ceramic combustion tube is covered to form a combustion chamber around the extremity of said ceramic combustion tube, said cover member having a cylindrical base end portion formed with an outlet for the combustion gas.
4. A combustor as set forth in claim 3, **characterized in that** said cover member has an outer peripheral surface having a radiation promoting paint applied thereto.
5. A combustor as set forth in claim 3 or claim 4, **characterized in that** an oxidation catalyst layer is interposed between said ceramic combustion tube and the base end portion of said cover member.

FIG. 1

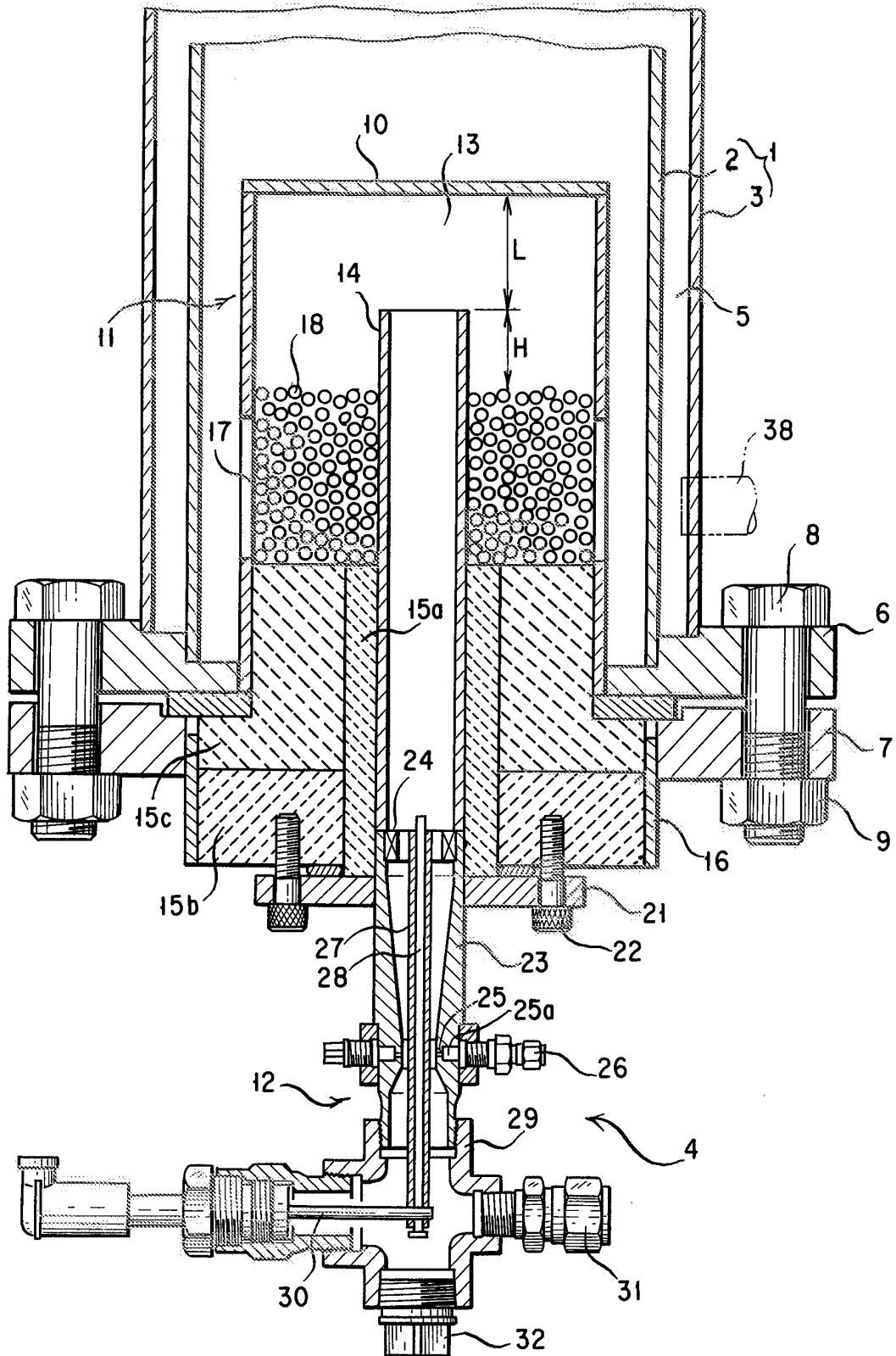


FIG. 2

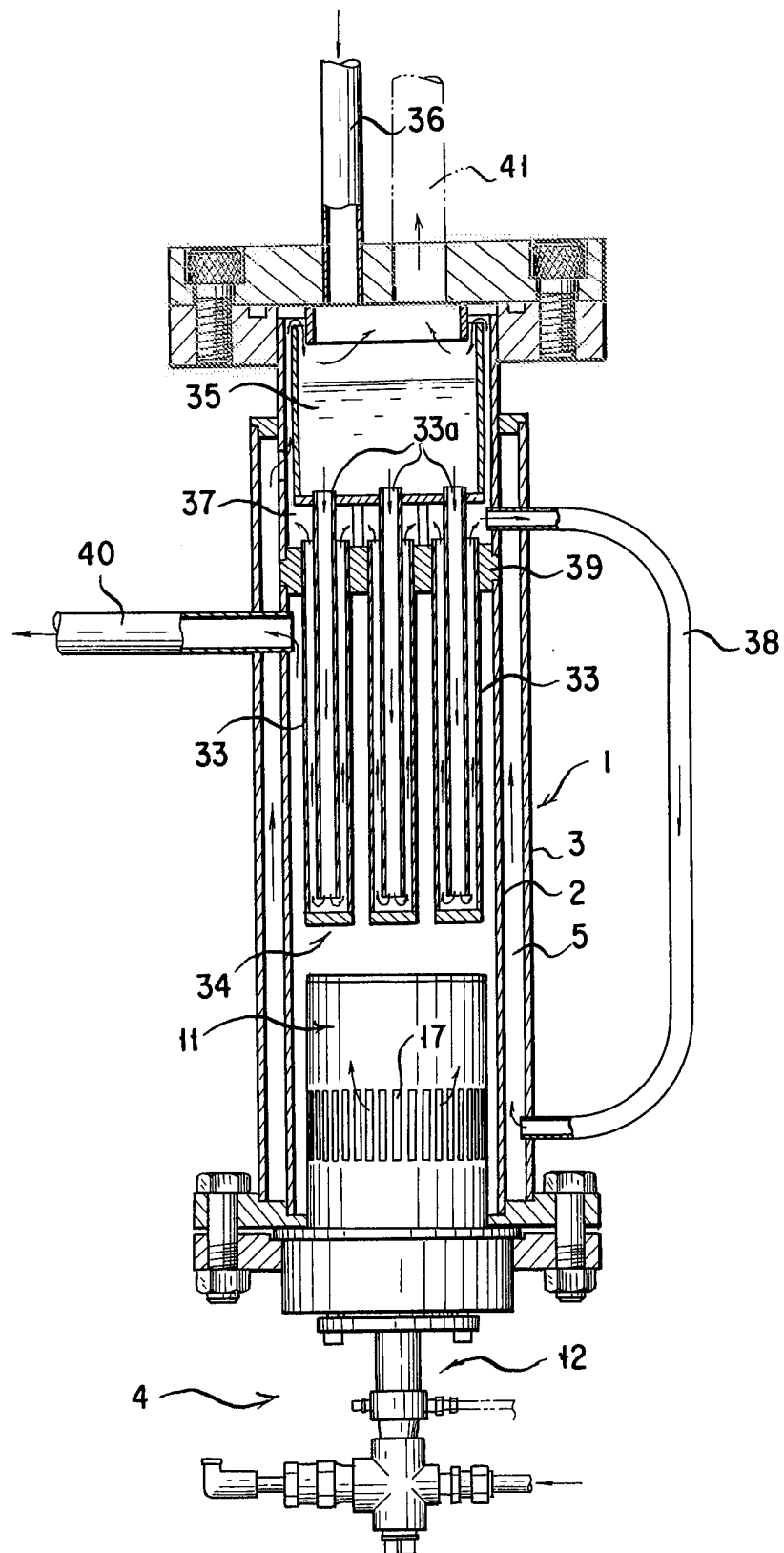
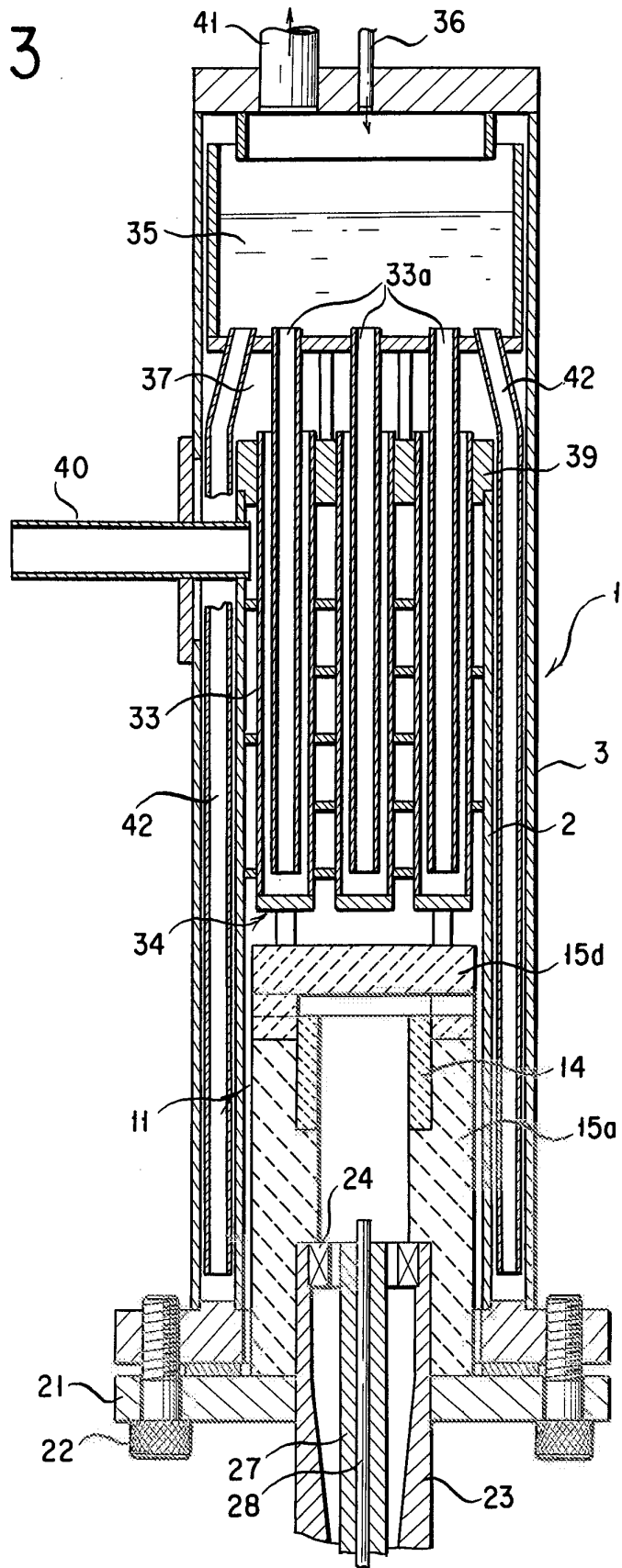


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/060565

A. CLASSIFICATION OF SUBJECT MATTER F23C3/00(2006.01)i, F23C13/00(2006.01)i, F23D11/40(2006.01)i, F23D14/18(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) F23C3/00, F23C13/00, F23D11/40, F23D14/18 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 1996-2007 Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007 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.
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Y	JP 2005-24181 A (Yamaichi Kinzoku Kabushiki Kaisha), 27 January, 2005 (27.01.05), Par. Nos. [0014] to [0015]; Figs. 1 to 3 (Family: none)	1-5
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 10 July, 2007 (10.07.07)		Date of mailing of the international search report 24 July, 2007 (24.07.07)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/060565

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