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D-81541 München (DE)(54) **PREMIXED GAS BURNING METHOD AND COMBUSTOR.**

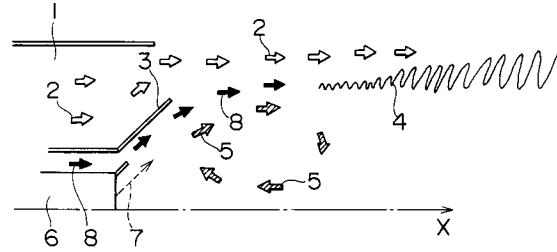
(57) This invention aims at eliminating from a fuel-air premixing nozzle-carrying combustor the inconveniences, such as variation of flame length which is ascribed to variation of combustion rate due to variation of fuel concentration in a premixed gas; and the occurrence of combustion vibration. The present

invention provides a combustion method in which a non-fuel-containing fluid (8) is supplied to a space between a premixed gas layer (2) formed by a premixed gas ejected from a premixing nozzle (1) and a high-temperature gas layer (5) formed by a part of a high temperature gas occurring due to the

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combustion of the premixed gas, which part of the high-temperature gas is circulated or reside in a downstream zone at an outlet portion of the premixing nozzle; and a combustor.

FIG. 1



Technical Field

This invention relates to a method for the combustion of a premixed gas in a combustor having a fuel-air premixing nozzle and useful for effecting low- NO_x combustion and a combustor therefor. This invention can be applied to such combustors as gas turbine combustors, boilers, and furnaces for use in chemical industry.

Background Art

Recently, in order to reduce the NO_x content of exhaust gas from gas turbine combustors and the like, there is commonly employed a combustion method in which fuel is premixed with combustion air and the resulting premixed gas is burned under lean combustion conditions. This method for the combustion of a premixed gas can eliminate areas having uneven fuel concentrations and also local areas burning at higher temperatures, resulting in a marked reduction in the amount of NO_x produced.

FIG. 3 illustrates a part of a burner based on the conventional method for the combustion of a premixed gas. In this figure, reference numeral 1 designates a premixing nozzle, 2 designates a premixed gas, 3 designates a flame holder, 4 designates a flame, 5 designates a circulating or staying hot gas, 6 designates a pilot nozzle, and 7 designates a pilot fuel.

The premixed gas 2 injected through the premixing nozzle 1 into the combustion chamber burns so as to go round the flame holder 3, thus forming downstream a circulating hot gas 5 serving for flame holding.

In this method for the combustion of a premixed gas, the combustion rate of the premixed gas (i.e., the velocity at which the flame advances into the unburned mixture) becomes higher as the temperature of the premixed gas is elevated and as the fuel concentration of the premixed gas is increased. In particular, the fuel concentration may cause marked variation in the resulting combustion rate. Such variation in combustion rate causes variation in flame length and may eventually lead to the development of combustive vibration.

Disclosure of the Invention

The present invention has been made for the purpose of solving the above-described problem and has for its object the provision of a method and combustor for the combustion of a premixed gas which can minimize the development of combustive vibration due to variation in the fuel concentration of the premixed gas.

In order to accomplish the above-described object, the present invention provides:

(1) a method for the combustion of a premixed gas in a combustor having a fuel-air premixing nozzle which comprises feeding a fluid containing no fuel between a premixed gas layer formed by injecting said premixed gas through said premixing nozzle and a hot gas layer formed from a portion of the hot gas resulting from the combustion of said premixed gas, the hot gas layer circulating or staying in a region downstream of the outlet of said premixing nozzle; and

(2) a combustor having a fuel-air premixing nozzle around a pilot nozzle which is characterized in that a means for feeding a fluid containing no fuel is provided between the outer periphery of the tip of said pilot nozzle and the outlet of said premixing nozzle.

By the above-described means, a neutral fluid is fed between the premixed gas layer and the hot gas, so that a flame is not propagated directly from the hot gas to the premixed gas. Instead, a mid-temperature gas is generated by the mixing and diffusion of the hot gas and the neutral fluid. Thereafter, the premixed gas is burned as a result of the mixing and diffusion of the mid-temperature gas and the premixed gas.

The mechanism by which the premixed gas is burned is such that the hot gas and the premixed gas intermingle with each other, during this process the premixed gas is heated by the heat transferred from the hot gas, and combustion is initiated when the combustion starting temperature is reached.

Thus, according to the present invention, the premixed gas is burned under mixing and diffusion rate control, as contrasted with an ordinary premixed flame in which combustion is effected by flame propagation. Consequently, it is possible to achieve combustion which is little affected by the fuel concentration of the premixed gas. As used herein, "diffusion" means that the hot gas and the premixed gas intermingle with each other, and "rate control" means the controlling of the rate of such diffusion. "Diffusion rate control" means the controlling of the rate at which the hot gas and the premixed gas intermingle with each other.

Moreover, since the hot gas and the neutral fluid are mixed to generate a mid-temperature gas which is then mixed with the premixed gas, the flame temperature in this mixing region is low and the production of NO_x in this region is minimized.

Furthermore, since the premixed gas is burned under diffusion rate control, the main flame is long, and heat generation or heat generation quotient can be spread in space, so that combustive vibration can be prevented. The reason why combustive vibration can be prevented is that the combustion pressure is reduced by dispersion of the heat gen-

eration and, moreover, the variation of flame length relative to the total flame length becomes smaller as a result of the prolongation of the flame.

As used herein, "heat generation quotient" means the per area combustion (dQ/dx) of fuel (Q) with respect to the axial distance (x) of a combustor.

Brief Description of the Drawings

FIG. 1 is a schematic diagram illustrating an exemplary burner to which the present invention has been applied;

FIG. 2 is a graphical representation of experimental data showing the effects of the present invention; and

FIG. 3 is a schematic diagram illustrating a burner based on the conventional method for the combustion of a premixed gas.

Best Mode for Carrying Out the Invention

FIG. 1 illustrates an exemplary burner for carrying out the method of the present invention. In this figure, the same elements as shown in FIG. 3 are designated by the same reference numerals and no detailed explanation thereof is given.

Referring to FIG. 1, a passage for feeding a neutral fluid 8 is formed between a premixing nozzle 1 and a pilot nozzle 6. The orifice for injecting the neutral fluid 8 into the combustion chamber is configured so as to cause the neutral fluid 8 to flow out along the inner wall surface of a flame holder 3. The neutral fluid 8 is a fluid containing no fuel and may comprise, for example, air, exhaust gas, steam or the like.

In the arrangement of FIG. 1, a neutral fluid is fed between a layer of a premixed gas 2 injected through the premixing nozzle 1 and a circulating hot gas 5, so that the premixed gas 2 injected through the premixing nozzle 1 does not come into direct contact with the hot gas 5. The neutral fluid 8 is first mixed with the hot gas 5 to generate a mid-temperature gas. Then, in a downward region, this mid-temperature gas is mixed with the premixed gas 2 to form a flame 4.

Thus, since the hot gas 5 does not come into direct contact with the premixed gas 2 fed through the premixing nozzle 1, it is unlikely that a flame is propagated directly from the hot gas 5 to the premixed gas 2 and ignites the premixed gas forcibly before the premixed gas diffuses sufficiently, as is the case with conventional burners. That is, the premixed gas 2 separated from the hot gas 5 by the neutral fluid 8 can be burned under diffusion rate control, so that a long main flame results. This means that the heat generation quotient can be spatially spread and small to prevent combustive

vibration.

FIG. 2 is a graph showing the states of combustive vibration when combustion was effected in a burner using air as the neutral fluid 8 according to the method of the present invention and in a conventional burner. In this graph, the ordinate shows the internal pressure fluctuation of the combustor which serves as a measure of combustive vibration, and the abscissa shows the proportion of the pilot fuel (i.e., the pilot fuel 7 for the formation of a diffusion flame) to the total fuel (i.e., the main fuel plus the pilot fuel). FIG. 2 indicates that, regardless of the proportion of the pilot fuel, the internal pressure fluctuation ratio is lower in the presence of a neutral fluid (the present invention) than in the absence of a neutral fluid (the prior art). That is, FIG. 2 indicates less combustive vibration in the presence of a neutral fluid, demonstrating the effects of the present invention.

The present invention is not limited to the burner design illustrated in FIG. 1, but comprehends all combustors involving the formation of a circulating flow wherein a neutral fluid is fed between the circulating flow and the premixed gas. For example, the present invention can be applied to combustors having various flame-holding plates and combustors forming a circulating flow or a stagnation point in a region having an abruptly expanded flow path.

Claims

1. A method for the combustion of a premixed gas in a combustor having a fuel-air premixing nozzle which comprises feeding a fluid containing no fuel between a premixed gas layer formed by injecting said premixed gas through said premixing nozzle and a hot gas layer formed from a portion of the hot gas resulting from the combustion of said premixed gas, the hot gas layer circulating or staying in a region downstream of the outlet of said premixing nozzle.
2. A combustor having a fuel-air premixing nozzle around a pilot nozzle which is characterized in that a means for feeding a fluid containing no fuel is provided between an outer periphery of a tip of said pilot nozzle and an outlet of said premixing nozzle.

FIG. 1

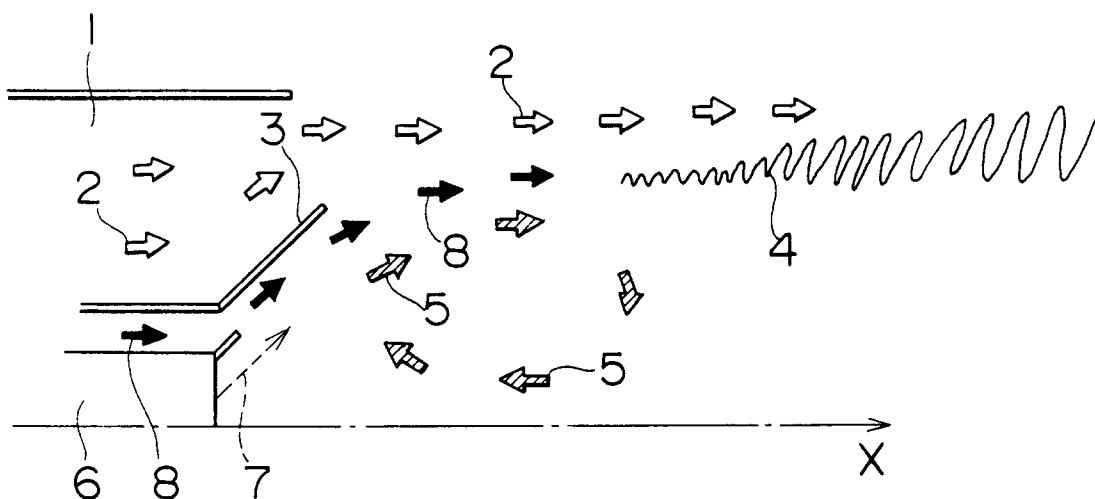


FIG. 3

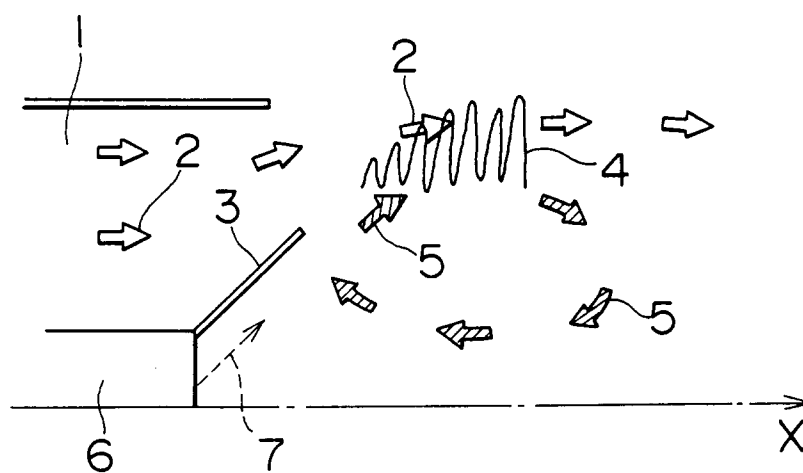
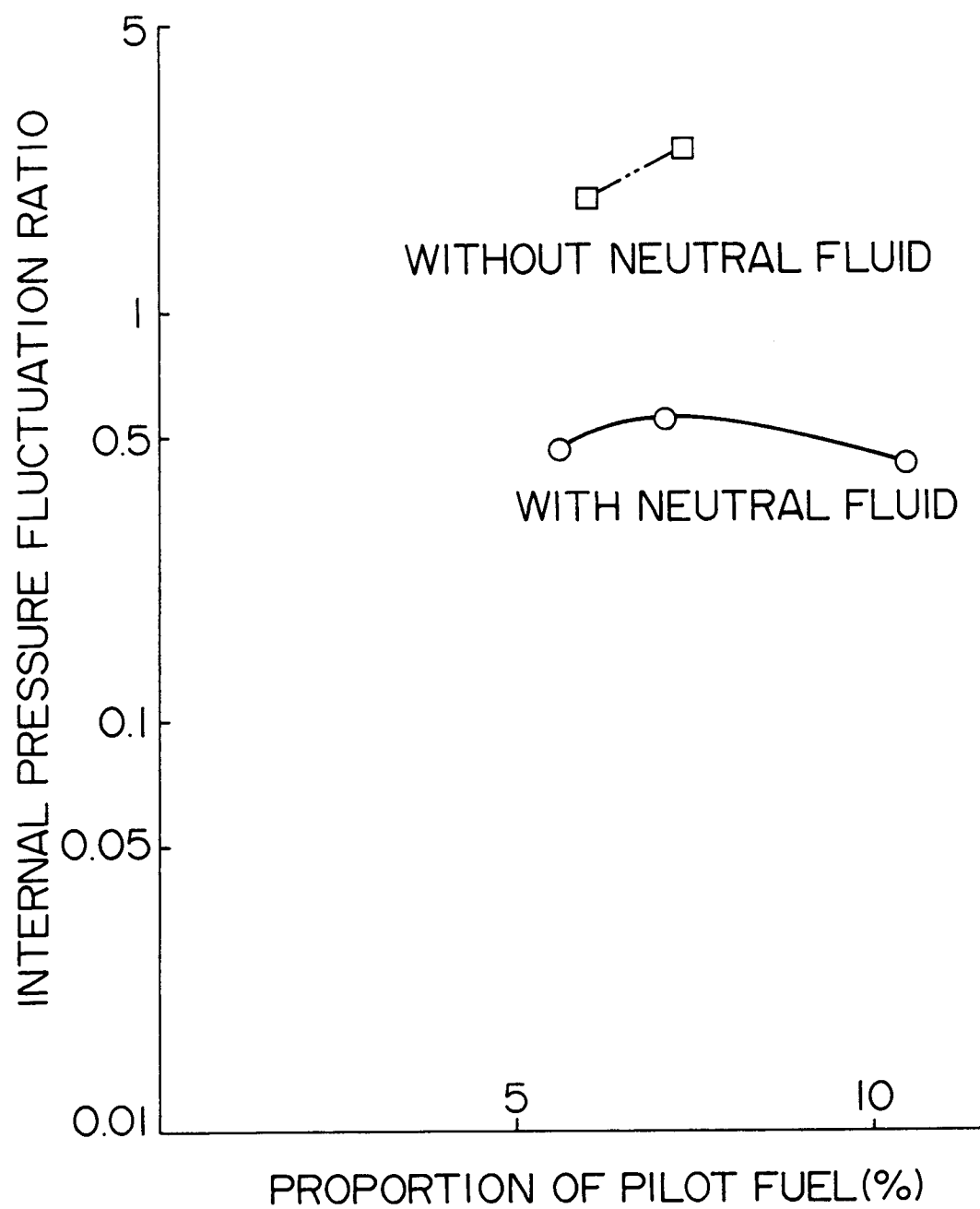


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP94/00363

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl ⁵ F23R3/32 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 ⁵ F23R3/30, F23R3/32, F23R3/18, F23R3/24 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1994 Kokai Jitsuyo Shinan KOho 1971 - 1994 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, A, 1-118023 (Hitachi, Ltd.), May 10, 1989 (10. 05. 89), Line 14, column 3 to line 15, column 4, (Family: none)	1-2
A	JP, B, 56-54537 (Rolls-Royce Ltd.), December 26, 1981 (26. 12. 81), Lines 25 to 34, column 2 & DE, A1, 2345282 & FR, A1, 2199059 & US, A, 3906718 & US, A, 3961475	1-2
A	JP, B, 53-13723 (Rolls-Royce Ltd.), May 12, 1978 (12. 05. 78), Lines 32 to 41, column 4 & DE, A1, 2412604 & FR, A1, 2222535 & CA, A1, 987918 & US, A, 3952503	1-2
Y	JP, B, 2-38851 (Hitachi, Ltd.), September 3, 1990 (03. 09. 90), Lines 19 to 27, column & EP, A1, 169431 & CA, A1, 1258379 & US, A, 4898001	1-2
☐ 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 document 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 April 22, 1994 (22. 04. 94)		Date of mailing of the international search report May 17, 1994 (17. 05. 94)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.