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(54) **COMBUSTOR FOR PULSATING COMBUSTION.**

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(73) Proprietor : **STICHTING IMPULS**
Op de Bies 17
NL-6333 BV Schimmert (NL)

Proprietor : **POSTMES, Johannes Gerardus**
Alphons Marie
Capucijnenstraat 73
NL-6211 RP Maastricht (NL)
Proprietor : **WILLEMS, Wilhelmus Paulus**
Op de Bies 17
NL-6333 BV Schimmert (NL)

(72) Inventor : **POSTMES, Johannes, Gerardus,**
Alphons, Marie
Capucijnenstraat 73
NL-6211 RP Maastricht (NL)
Inventor : **WILLEMS, Wilhelmus, Paulus**
Op de Bies 17
NL-6333 BV Schimmert (NL)

(74) Representative : **Prins, Hendrik Willem et al**
Octrooibureau Arnold & Siedsma
Sweelinckplein 1
Postbus 18558
NL-2502 EN The Hague (NL)

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Description

The present invention relates to a combustor for pulsating combustion, having a combustion chamber which at the inlet side is connected with a supply tube for combustion air and a supply tube for fuel and at the outlet side is provided with one or more exhaust tubes for the flue gasses, the volume of the combustion chamber being variable, the inlet tubes being arranged one into the other, thus defining an annular space between an outer tube and an inner tube, the annular space being bounded at the side facing the combustion chamber by a widening.

In a pulsating combustor, the combustion chamber and the in- and outlet tubes are dimensioned in such a way that they form a resonance tube which compares with the periodical inflammation of the inflammable mixture in the combustion chamber and the natural frequency of the gas masses in those tubes and the combustion chamber. As a consequence of the inertia of the flowing gasses in the outlet tube(s), a sub-pressure arises in the combustion chamber after the combustion, so that at the one hand fuel and air is sucked in and, at the other hand, hot flue-gasses flow back into the combustion chamber, thus igniting the newly sucked in inflammable mixture. Consequently a cyclic proces arises which pulsates with a frequency mainly depending on the dimensions of the combustion chamber and the in- and outlet tubes and on the fuel applied. Such devices are used for heating, drying, evaporation, inciting of gas-turbines and so on. They have the advantage of a high heat-transfer-rate, thus allowing a compact construction, whereas at the same time, with an excess-combustion-air coefficient of 1, a nearly complete combustion is obtained with almost no exhaust of CO and only very few NOx.

For a proper functioning of a pulscombustor it is necessary that the combustion chamber and the in- and outlet tubes are dimensioned in such a way that the desired resonance occurs.

From US-A-4 699 588 a combustor is known, in which the length of the combustion tube can be altered, whereby tuning is allowed.

It is a drawback of the known combustor that the moving parts of the combustor and/or those parts that are subjected to wear, e.g. an ignition device and optional valves for the supply of air and/or fuel, are difficult to be reached for maintenance and/or inspection.

It is an object of the present invention to provide a combustor for pulsating combustion, having a combustion chamber with a variable volume, from which combustor moving parts can be taken out all together in one movement.

According to the invention there is provided a combustor of the forsaied type, in which the widening is fixed on the inner tube and comprises a tube-

shaped part extending in axial direction, said tube-shaped part being provided with a collar which abuts against the inside of the outer tube, the widening thus constituting an axially movable wall of the combustion chamber, whereby at least the tube-shaped part or the collar is provided with openings for supplying the medium present in the annular space between the tubes into the combustion chamber,

the inner tube is movable in axial direction with respect to the outer tube, and

the inner tube, the widening with the tube-shaped part, and the collar are adapted to be taken out of the outer tube in one movement.

When the resonance of the combustor is adjusted by means of adjusting the combustor-head also the content of the fore-space between the tubes changes. This may influence the proportion of the air/fuel ratio in the combustion chamber. In regard with this, in the case of a preferable type of the invention, a disc which is provided with supply openings is axially movable in the space between both tubes. In this way it is possible to adjust the content of this space. (fore-chamber) By means of this adjustment it is possible to change the proportion of the air/fuel ratio, and so accomplish a combustion with the best efficiency. In the supply openings of the disc, back pressure valves may be fitted, in this way the pressure rise, occurring in the combustion chamber during the combustion, is limited in the fore-chamber as far as the disc. Likewise an axially movable disc provided with supply openings may be installed in the widening of the inner tube with the same function as the disc named above. This disc is attached to a adjustable rod in the inner tube and may equally be provided with back pressure valves. Moreover, this disc provides a regular distribution of the medium in the combustion chamber provided for by the inner tube. The spark plug or the filament can be installed on this disc whereby the wires for the electrical current supply can be lead through the inner tube.

The invention will further be elucidated with reference to the example represented in the drawing which shows a longitudinal section of a combustor according to the invention.

The combustor comprises a combustion chamber A being a part of the air supply tube B but divided from it by the combustor head C. In the air supply tube the air valve section E is located in such a way that there is a fore-chamber D between this section and the combustor head.

The combustor head C consists of the fuel supply tube 1 which is provided with a widening 2 at the side facing the combustion chamber. The widening has a radial outward situated collar 3. This collar may slide along the inner surface of the air supply tube B. In the wall of the widening 2 openings 4 for the supply of the combustion air from the fore-chamber D to the combustion chamber A are present.

In the widening 2 an axially movable disc 5 is supported by a support not shown in the drawing. This disc is fitted with supply openings 6 for the supply of the fuel. Furthermore, for the purpose of starting the combustion, a spark plug 14 is mounted on this disc. This plug is connected by wires with a power source not shown in the drawing. These wires may be led through tube 1. The air valve section E consists of a sleeve gland 7, a gasket 8, a gland 9, a distance piece 10, a gasket 11 and a disc 12 with the air valves 13.

The air valve section E may be fastened air tight to tube 1 by means of sleeve gland 7 and the gasket 8. The location of this fitting dictates the content of fore-chamber D. By means of gland 9 the distance piece 10 and the gasket 11, disc 12 may be fastened air tight to the air supply tube B. The location of this fitting dictates the content of the combustion chamber and also the total content of the resonance system. In this way it is possible to "tune in" the combustor from the outside, without the need to take constructive measures.

For repairs or inspection combustor head C together with disc 5, spark plug 14 and the valve section E may be taken out of the outer tube B as if it were one piece. The invention is not limited to the example described above. For example, it is possible to supply the fuel through the outer tube and the combustion air through the inner tube. Furthermore, instead of back pressure valves, the discs 5 and 12 may be equipped with an amount of narrow openings. When the combustion in the combustion chamber takes place, these openings deliver sufficient resistance to limit the pressure rise more or less to the front of these discs. By increasing the width of the openings an increasing portion of the flue gases of the preliminary combustion will be part of the new mixture. In this way it is possible to reduce the power output, but also to create a NOx reduction.

The supply openings in the wall of the widening may be made in the collar as well as anywhere in the outline of the widening.

The function of the spark plug or the filament is to start the combustion. When the temperature of the back flowing- or still in the combustion chamber located gases is high enough to ignite the inflammable mixture in this chamber, the power supply of the spark plug or filament might be shut off.

The described installation preferably works with gaseous or fluid fuels, but solid fuels (powder) also can be used. As an example: The content of a combustion chamber of 500 cm³ equals a power output of ~ 30 kWatt, whereas in a combustion chamber of Ø 40 x 300 cm ~ 10 MWatt can be generated.

The frequency of the combustion cycle mostly varies between 50 and 200 Hz.

Claims

1. Combustor for pulsating combustion, having a combustion chamber (A) which at the inlet side is connected with a supply tube (B) for combustion air and a supply tube (1) for fuel and at the outlet side is provided with one or more exhaust tubes for the flue gases, the volume of the combustion chamber (A) being variable, the inlet tubes (B, 1) being arranged one into the other, thus defining an annular space (D) between an outer tube (B) and an inner tube (1), the annular space (D) being bounded at the side facing the combustion chamber (A) by a widening (2),

characterized in that

the widening (2) is fixed on the inner tube (1) and comprises a tube-shaped part extending in axial direction, said tube-shaped part being provided with a collar (3) which abuts against the inside of the outer tube (B), the widening (2) thus constituting an axially movable wall of the combustion chamber (A), whereby at least the tube-shaped part or the collar (3) is provided with openings (4) for supplying the medium present in the annular space (D) between the tubes (1, B) into the combustion chamber (A),

the inner tube (1) is movable in axial direction with respect to the outer tube (B), and

the inner tube (1), the widening (2) with the tube-shaped part, and the collar (3) are adapted to be taken out of the outer tube (B) in one movement.

2. Combustor according to claim 1, **characterized in that** the volume of the annular space is independently variable by means of an axially movable disc between the inner and the outer tube.

3. Combustor according to claims 1 or 2, **characterized in that** in the tube-shaped part of the widening (2) an axially movable disc (5) is provided.

4. Combustor according to claim 3, **characterized in that** the disc (5) is provided with a spark plug (14) or a filament.

5. Combustor according to claim 4, **characterized in that** wires (15) for a power supply to the spark plug (14) or the filament are housed in the inner supply tube (1).

Patentansprüche

1. Brenner für pulsierende Verbrennung, mit einer Verbrennungskammer (A), die an ihrer Eingangs-

seite an ein Versorgungsrohr (B) für Verbrennungsluft und ein Zuführrohr (1) für Brennstoff und an der Ausgangsseite mit einem oder mehreren Auspuffrohren für die Abgase versehen ist, wobei das Volumen der Verbrennungskammer (A) variabel ist, und wobei die Eingangsrohre (B,1) ineinander angeordnet sind, wodurch zwischen dem äußeren Rohr (B) und dem inneren Rohr (1) ein ringförmiger Raum (D) definiert wird, der an der der Verbrennungskammer (A) zugewandten Seite durch eine Aufweitung (2) begrenzt ist;

dadurch **gekennzeichnet**, daß

die Aufweitung (2) am inneren Rohr (1) befestigt ist und einen rohrförmigen Teil aufweist, der sich in axialer Richtung erstreckt, wobei der rohrförmige Teil mit einem Kragen (3) versehen ist, der an der Innenseite des äußeren Rohres B anliegt, die Aufweitung (2) somit eine axial verschiebbare Wand der Verbrennungskammer (A) bildet, wobei wenigstens der rohrförmige Teil oder der Kragen (3) mit Öffnungen (4) versehen sind, um das Medium, welches im ringförmigen Raum (D) zwischen den Rohren (1;B) vorhanden ist, in die Verbrennungskammer (A) zu leiten;

das innere Rohr (1) in axialer Richtung mit Bezug auf das äußere Rohr (B) bewegbar ist; und das innerer Rohr (1), die Aufweitung (2) mit dem rohrförmigen Teil, und der Kragen (3) so ausgebildet sind, daß sie aus dem äußeren Rohr (B) in einer Bewegung herausgenommen werden können.

2. Brenner nach Anspruch 1, dadurch **gekennzeichnet**, daß das Volumen des ringförmigen Raumes durch eine axial verschiebbare Scheibe zwischen dem inneren und dem äußeren Rohr unabhängig variabel ist.

3. Brenner nach Anspruch 1 oder 2, dadurch **gekennzeichnet**, daß in dem rohrförmigen Teil der Aufweitung (2) eine axial verschiebbare Scheibe (5) vorgesehen ist.

4. Brenner nach Anspruch 3, dadurch **gekennzeichnet**, daß die Scheibe (5) mit einer Zündkerze (14) oder einem Heizfaden versehen ist.

5. Brenner nach Anspruch 4, dadurch **gekennzeichnet**, daß Drähte (15) für die Stromversorgung der Zündkerze (14) oder des Heizfaden im inneren Zuführrohr (1) aufgenommen sind.

Revendications

1. Brûleur à combustion pulsée, ayant une chambre de combustion (A), au côté entrée de laquelle est relié un tube d'alimentation (B), destiné à l'air de combustion, et un tube d'alimentation (1) pour le combustible, et au côté sortie de laquelle sont prévus un ou plusieurs tubes d'échappement, pour les gaz de combustion, le volume de la chambre de combustion (A) étant variable, les tubes d'entrée (B,1) étant agencés l'un à l'intérieur de l'autre, définissant ainsi un espace annulaire (D) entre un tube extérieur (B) et un tube intérieur (1), l'espace annulaire (D) étant relié au côté tourné vers la chambre de combustion (A), par un élargissement (2),

caractérisé en ce que

l'élargissement (2) est fixé sur le tube intérieur (1) et comprend une partie tubulaire, s'étendant en direction axiale, ladite partie tubulaire étant pourvue d'une collerette (3) venant buter contre l'intérieur du tube extérieur (B), l'élargissement (2) constituant ainsi une paroi, déplaçable axialement, de la chambre de combustion (A), de manière qu'au moins la partie tubulaire ou la collerette (3) soit pourvue d'ouvertures (4) destinées à l'alimentation du milieu présent dans l'espace annulaire (D), entre les tubes (1,B), dans la chambre de combustion (A),

le tube intérieur (1) est déplaçable en direction axiale par rapport au tube extérieur (B), et

le tube intérieur (1), l'élargissement (2) avec la partie tubulaire, et la collerette (3) sont adaptés pour être retirés du tube extérieur (B), en un seul mouvement.

2. Brûleur selon la revendication 1, caractérisé en ce que le volume de l'espace annulaire est variable, indépendamment, au moyen d'un disque déplaçable axialement entre les tubes intérieur et extérieur.

3. Brûleur selon la revendication 1 ou 2, caractérisé en ce qu'un disque (5), déplaçable axialement, est disposé dans la partie tubulaire de l'élargissement (2)

4. Brûleur selon la revendication 3, caractérisé en ce que le disque (5) est pourvu d'un allumeur par étincelle (14) ou d'un filament.

5. Brûleur selon la revendication 4, caractérisé en ce que des fils (15), destinés à une alimentation électrique de l'allumeur à étincelle (14), ou du filament sont logés dans le tube d'alimentation intérieur (1).

