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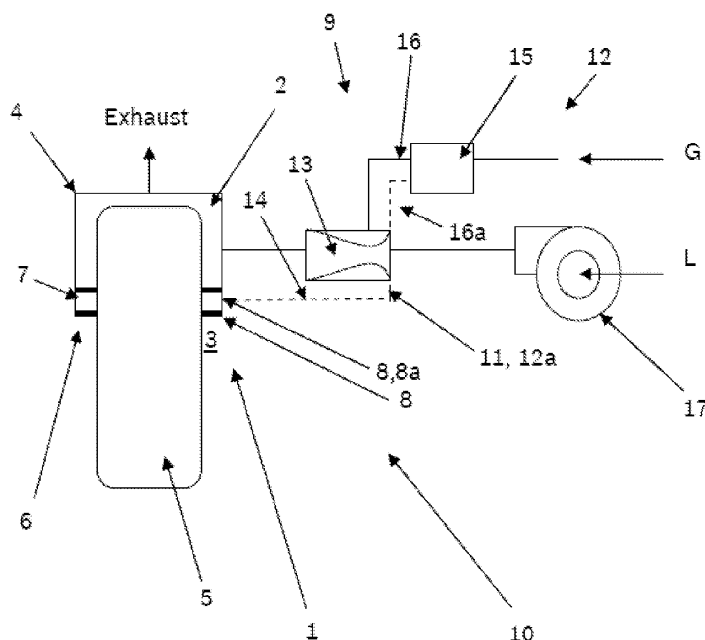
(54) **Method and apparatus for sealing a combustion chamber of a combustion system as well as a combustion system**

(57) The invention relates to a method and an apparatus (1) for sealing a combustion chamber (2) of a heat engine with external combustion comprising a Stirling engine (5), with respect to an environment (3), in particular for sealing a combustion chamber (2) between a premixing burner (4), the Stirling engine (5) and the environment (3). The invention further relates to a combustion system (10) with an apparatus (1) according to the invention. The seal is simply constructed and ensures a reliable seal.

The method is characterised in that an overpressure

with respect to a combustion chamber pressure is generated in a sealing zone. The apparatus (1) is characterised in that at a transition (6) to be sealed from the combustion chamber (2) to the environment (3), at least two sealing elements (8), which are spaced apart from one another and disposed one behind the other to form an intermediate chamber (7), are provided wherein the intermediate chamber (7) is connected fluidically to a cold medium supply. The combustion system (10) is characterised in that an apparatus (1) according to the invention is provided.

Figure



Description

[0001] The invention relates to a method for sealing a combustion chamber of a heat engine with external combustion comprising a Stirling engine, with respect to an environment, in particular for sealing a combustion chamber between a premixing burner, the Stirling engine and the environment.

[0002] In addition, the invention relates to an apparatus for sealing a combustion chamber of a heat engine with external combustion comprising a Stirling engine, with respect to an environment, in particular for sealing a combustion chamber between a premixing burner, the Stirling engine and the environment.

[0003] The invention further relates to a combustion system comprising a heat engine with external combustion such as a Stirling engine with a combustion chamber which is sealed with respect to an environment, in particular a combustion system with a sealed combustion chamber between a premixing burner, the Stirling engine and the environment.

[0004] Combustion systems with heat engines are generally known from the prior art. In this context, the heat engines usually configured as external combustion engines, e.g. free-piston Stirling engines are used for example, for micro-combined heat and power (CHP) applications. An external combustion engine can be operated with various heat sources. In such combustion systems it is necessary to seal the oscillating heat engine, more accurately the Stirling engine, with respect to a fixed gas burner which contains high-temperature combustion products. Known solutions use seals which have flutings in order to adapt the seal to the movements of the thermal engine. In order to prevent the seals from leaking, for example, due to holes or small cracks, as a result of the high temperatures prevailing there, these seals are cooled, preferably with water. Other seals have pressure means which keep the combustion zone at a lower static pressure level than the environment so that an under-pressure seal is achieved. In such cases, any leaks result in cold air from the environment being drawn into the burner and cooling the seal, rather than hot exhaust gases escaping and further damaging the seal. Such sealing systems are on the one hand very complex and expensive or cause negative effects in adjacent zones such as, for example, dilution of flue gases by clean air introduced through leaks, or difficulty in detecting leaks.

[0005] It is the object of the invention to provide a combustion system with a seal which is simply constructed and ensures a reliable seal.

[0006] According to a first aspect of the invention, there is provided a method for sealing a combustion chamber of a heat engine with external combustion comprising a Stirling engine, with respect to an environment, in particular for sealing a combustion chamber between a premixing burner, the Stirling engine and the environment, characterised in that an overpressure with respect to a combustion chamber pressure is generated in a sealing zone.

[0007] A second aspect of the present invention provides an apparatus for sealing a combustion chamber of a heat engine with external combustion comprising a Stirling engine, with respect to an environment, in particular for sealing a combustion chamber between a premixing burner, the Stirling engine and the environment, characterised in that at a transition to be sealed from the combustion chamber to the environment, at least two sealing elements, which are spaced apart from one another and disposed one behind the other to form an intermediate chamber, are provided wherein the intermediate chamber is connected fluidically to a cold medium supply.

[0008] A third aspect of the present invention provides a combustion system comprising a heat engine with external combustion such as a Stirling engine with a combustion chamber which is sealed with respect to an environment, in particular a combustion system with a sealed combustion chamber between a premixing burner, the Stirling engine and the environment, characterised in that at least one apparatus according to the second aspect of the invention is provided for sealing.

[0009] Advantageous further developments of the present invention can be deduced from the dependent claims.

[0010] In one embodiment of the method according to the invention, it is provided that the overpressure in the sealing zone is produced by an air supply from a combustion air fan or a gas-air mixer.

[0011] In another embodiment of the method according to the invention, it is provided that cold air exposed to overpressure is passed from the sealing zone into the combustion chamber and/or into the surroundings to provide a cooling flow through the seal.

[0012] In one embodiment of the apparatus according to the second aspect of the present invention, the at least two sealing elements may be arranged and joined in a single sealing device. This sealing device locates with the engine or burner at two distinct locations, which are spaced apart from one another and disposed one behind the other to form an intermediate chamber. The intermediate chamber is connected fluidically to a cold medium supply.

[0013] In a preferred embodiment of the present invention, it is provided that the intermediate chamber has a higher pressure than the combustion chamber by means of a pressure unit so that an overpressure prevails in the intermediate chamber.

[0014] In yet another exemplary embodiment of the present invention, it is provided that the sealing element assigned to the combustion chamber of the at least two sealing elements has at least one through opening for fluidic communication of the combustion chamber to the intermediate chamber.

[0015] In a preferred embodiment of the third aspect of the present invention, it is provided that the intermediate chamber of the apparatus is fluidically connected to the pressure side of a gas air mixture of a fuel supply of the combustion system.

[0016] Alternatively, it is provided that the intermediate chamber of the apparatus is fluidically connected to the pressure side (outlet) of the fan.

[0017] Yet another embodiment of the present invention provides that the gas-air mixer or fan is fluidically connected to the intermediate chamber for providing an overpressure in the intermediate chamber compared with the combustion chamber by means of at least one line.

[0018] Alternatively, it is provided that the fan is fluidically connected to the intermediate chamber of the apparatus.

[0019] Further embodiments can be envisaged which include a valve to distribute air between two burners. In this case it is provided that the intermediate chamber of the apparatus is fluidically connected to some point in the system (depending on the specific arrangement) which has a higher pressure than the combustion chamber.

[0020] The following advantages are achieved in particular with the method according to the invention, the apparatus according to the invention and the combustion system according to the invention:

Due to the two successively connected sealing elements, an intermediate chamber can be formed which is sealed by the first sealing element with respect to the environment and by the second sealing element with respect to a combustion chamber. The intermediate chamber is supplied by means of a cold medium supply, in particular a cold air supply. In this way, on the one hand an overpressure and on the other hand cooling for the intermediate chamber and therefore the seal can be achieved. In the event of a leak in one of the sealing elements, the cold medium escapes through the leakage opening with the result that the environment into which the cold medium flows is also cooled. By this means, damage due to rising temperature in the area of the leak is effectively prevented, at least up to a certain size of leak. If the cold medium supply is coupled to a fuel supply for the combustion chamber, in the event of a leak in the seals, the associated pressure drop can thus be kept lower than in the fuel supply so that the pressure in the intermediate chamber is kept above the pressure in the combustion chamber. In this way, no hot medium flows from the combustion chamber into the intermediate chamber, with the result that excessive damage to the sealing elements is effectively avoided. In addition, simple monitoring of the functionality of the sealing function is ensured by monitoring the intermediate chambers, for example, the pressure in the intermediate chamber or pressure drop across part of the line. In the event of a pressure drop, corresponding maintenance or service work can be initiated or the burner disabled and a fault indicator activated. Through openings can deliberately be provided in the sealing element to the

combustion chamber in order to achieve the cooling function described in connection with the leak.

[0021] The drawing shows an exemplary embodiment of the invention and shows:

schematically as a block diagram a section of a combustion system with the apparatus according to the invention.

[0022] The figures shows schematically as a block diagram a section of the combustion system 10 with the apparatus 1 according to the invention. The combustion system 10 comprises a Stirling engine 5, a combustion chamber 2 and an external environment 3. The combustion chamber 2 adjoins the Stirling engine 5. Both the combustion chamber 2 and the Stirling engine 5 are surrounded by the environment 3. In the area in which the combustion chamber 2, Stirling engine 5 and environment meet, a transition 6 is formed which needs to be sealed. The combustion system is operated such that a fuel, for example, a gas G and air L, via an air supply, are passed as fuel-air mixtures via a fuel supply 12 into the combustion chamber 2. Depending on the design of a burner having the combustion chamber 2, which is configured here as a premixing burner 4, air L and gas G are mixed in a gas-air mixer 12 before entering into the combustion chamber 2. For this purpose, an adjusting element 15, for example, a controllable gas valve, is provided in the fuel supply 12. From the gas valve the gas G is passed via corresponding line 16 into the gas-air mixer 12a. The line 16a is the reference pressure communication line (small hose) from the gas mixer air inlet to the gas valve.

[0023] The air L is passed via the air supply into the gas-air mixer 12a, for example, by means of a fan 17. The gas-air mixer 12a has a Venturi unit 11 through which the gas G and the air L flow. The Venturi unit 11 produces a region 13 having a lower pressure. The pressure is in this case dependent, inter alia, on the speed and the mass flow rate of the air flowing through the Venturi unit 11. The adjusting element 15 uses the pressure difference between incoming air pressure or the ambient air pressure and the lower pressure in the region produced by the Venturi unit 11 to regulate the gas supply. In this way, the mixture of air L and gas G is regulated by means of the pressure difference. The resulting gas-air mixture is then passed into the combustion chamber 2 and burnt by means of a flame or a plurality of flames. The heat thereby produced is passed via thermal radiation or thermal convection to the corresponding part of the Stirling engine 5.

[0024] The Venturi unit 11 and the pre-mixing burner 4 have a pressure loss compared with the inflowing air L which is associated with the gas volume flow through the Venturi unit 11 or the pre-mixing burner 4. In this way, the gas-air mixture in the combustion chamber 2 always has a lower static pressure during operation than the air

entering the Venturi unit 11.

[0025] In order to effectively seal the sealing zone or the transition 6 to be sealed, at least two sealing elements 8 which are spaced apart from one another, and disposed one behind the other to form an intermediate chamber 7 are provided at the transition 6 to be sealed from the combustion chamber 2 to the environment 3. The intermediate chamber 7 is fluidically connected to a cold medium supply 14. The cold medium supply 14 can be connected to any pressure unit 9 which provides a higher pressure than is present in the combustion chamber 2. In the exemplary embodiment according to this figure, the cold medium supply passes some of the cold air supplied to the Venturi unit 11 via a corresponding line into the intermediate chamber 7. The line is configured as a hose or the like. In this way, the intermediate chamber 7 has a higher static pressure than the environment 3 and the combustion chamber 2. If a leak occurs at the sealing elements 8, the cold air flows from the leak either into the combustion chamber 2 or into the environment 3. The associated pressure drop in the intermediate chamber 7 is smaller than the pressure loss due to the Venturi unit 11 and in the combustion chamber 2, at least as long as the leakage opening does not exceed a certain range. Thus, the pressure in the intermediate chamber 7 is always higher than in the combustion chamber 2. If the leak occurs at the sealing element 8a assigned to the combustion chamber 2, cold air flows into the combustion chamber 2 and thereby cools the sealing element 8a, with the result that further damage by heat from the combustion chamber 2 is avoided or at least reduced. This cooling function due to leakage can also be specifically used by integrating through openings in the sealing element 8a assigned to the combustion chamber 2, which execute the cooling function of the leak. The other sealing element 8 can, for example, be formed as a baffle. In addition, lines can be formed in the sealing elements 8 and/or around the sealing elements 8 through which the cold air can flow for cooling the sealing elements 8. Furthermore a constant flow of air can be provided through the intermediate chamber to the surroundings via an opening with an associated pressure drop in order to provide cooling to the seal at all times.

Claims

1. A method for sealing a combustion chamber (2) of a heat engine with external combustion comprising a Stirling engine (5), with respect to an environment (3), in particular for sealing a combustion chamber (2) between a premixing burner (4), the Stirling engine (5) and the environment (3), **characterised in that** an overpressure with respect to a combustion chamber pressure is generated in a sealing zone.
2. The method according to claim 1 or 2, **characterised in that** the overpressure in the sealing zone is pro-

duced by an air supply from a combustion air fan (17) or a gas-air mixer (11).

3. The method according to claim 1, **characterised in that** cold air exposed to overpressure is passed from the sealing zone into the combustion chamber (2) and/or into the surroundings to provide a cooling flow through the seal.
4. An apparatus (1) for sealing a combustion chamber (2) of a heat engine with external combustion comprising a Stirling engine (5), with respect to an environment (3), in particular for sealing a combustion chamber (2) between a premixing burner (4), the Stirling engine (5) and the environment (3), **characterised in that** at a transition (6) to be sealed from the combustion chamber (2) to the environment (3), at least two sealing elements (8), which are spaced apart from one another and disposed one behind the other to form an intermediate chamber (7), are provided wherein the intermediate chamber (7) is connected fluidically to a cold medium supply.
5. The apparatus (1) according to claim 4, **characterised in that** the intermediate chamber (7) has a higher pressure than the combustion chamber (2) by means of a pressure unit (9) so that an overpressure prevails in the intermediate space (7).
6. The apparatus (1) according to claim 4 or 5, **characterised in that** the sealing element (8a) assigned to the combustion chamber (8) of the at least two sealing elements (8) has at least one through opening for fluidic communication of the combustion chamber (2) to the intermediate chamber (7).
7. A combustion system (10) comprising a heat engine with external combustion such as a Stirling engine (5) with a combustion chamber (2) which is sealed with respect to an environment, in particular a combustion system (10) with a sealed combustion chamber (2) between a premixing burner (4), the Stirling engine (5) and the environment (3), **characterised in that** at least one apparatus (1) according to one of claims 4 to 6 is provided for sealing.
8. The combustion system (10) according to claim 7, **characterised in that** the intermediate chamber (7) of the apparatus (1) is fluidically connected to the pressure side of a gas air mixture (12a) of a fuel supply (12) of the combustion system (10).
9. The combustion system (10) according to claim 7 or 8, **characterised in that** the gas-air mixer (12a) is fluidically connected to the intermediate chamber (7) for providing an overpressure in the intermediate chamber (7) compared with the combustion chamber by means of at least one line (14).

10. The combustion system (10) according to claim 7, **characterised in that** the intermediate chamber (7) of the apparatus (1) is fluidically connected to the pressure side of a fan (17) of a combustion system (10). 5
11. The combustion system (10) according to claim 7 or 8, **characterised in that** the fan (17) is fluidically connected to the intermediate chamber (7) for providing an overpressure in the intermediate chamber (7) compared with the combustion chamber by means of at least one line (14). 10

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Figure

