PATENT SPECIFICATION (11) 1 589 329

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(21) Application No. 32363/77 (22) Filed 2 August 1977
(31) Convention Application No. 7608689
(32) Filed 5 August 1976 In
(33) Netherlands (NL)
(44) Complete Specification published 13 May 1981
(51) INT. CL.[3] F01B 29/10
(52) Index at Acceptance F1S 25
F1S 25

(54) HOT–GAS ENGINE

(71) We, N.V. PHILLIPS' GLOEILAMPENFABRIEKEN, a limited liability Company, organised and established under the laws of the Kingdom of the Netherlands, of Emmasingel 29, Eindhoven, the Netherlands, do hereby declare the invention for which we pray that a patent be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to a hot-gas engine comprising a metal housing, such as a cylinder or a regenerator housing, which envelops a chamber in which a pressurized working medium is contained during operation of the engine and which housing is provided on at least part of its inner side with a layer of a heat-insulating material.

A hot-gas engine of this kind is known form United Kingdom Specification 1,454,298.

In the known hot-gas enginer, at least the part of the cylinder which bounds the hot expansion space and at least the part of the regenerator housing in which the hot regenerator part is accommodated are each provided on the inner side with a layer of heat-insulating material, notably a (glass)ceramic material the relevant parts of the cylinder and the regenerator housing being cooled by forced cooling. The cylinder and the regenerator housing may thus be made of cheap materials.

The present invention has for its object to provide an improved hot-gas engine of the above kind which has an even cheaper and simpler construction.

In the hot-gas engine in accordance with the invention the heat-insulating layer consists of heat-insulating material in granular form contained in an annular space which is formed between the housing and a metal sleeve inside the housing.

Preferably, the heat-insulating material consists of grains of sand or grains of zirconium oxide. Both of these materials are cheap and require no further treatments, for example heat treatments, to make them suitable for use at the high operating temperatures of the engine. The metal sleeve can be manufactured simply and inexpensively.

The inner side of the normally cast housing does not require a surface treatment, such as milling, at the area where it contacts of heat-insulating material. Therefore, large dimensional tolerances in the casting are acceptable.

Since no heat treatment are required the assembly of the unit can be carried out quickly.

In preferred embodiment of the hot-gas engine in accordance with the invention the annular space communicates with a space in which a pressure prevails which is lower than the working medium pressure in the chamber.

Because the gas pressure in the layer of granular heat-insulating material is always lower than the working-medium pressure, the wall thickness of the metal sleeve may be small.

Preferably, the annular space communicates with the ambient atmosphere *via* a filter. This filter allows passage of air but does not allow passage of grains.

Alternatively, the annular space may communicate with the chamber *via* a non-return valve which opens in the direction of the chamber.

This advantageous if working medium, for example, hydrogen, diffuses through the metal sleeve and must not be lost.

The non-return valve opens if the working-medium pressure in the layer of grannular heat-insulating material exceeds the periodically varying working-medium pressure in the chamber. Working medium is then instantaneously returned from the layer of heat-insulating material to the chamber.

An embodiment of the invention will be described in detail hereinafter with reference to the accompanying diagrammtic drawing which is not to scale, and which is a longitudinal sectional view of a metal housing which is provided on its inner side of with a heat-insulating layer of sand.

The reference numeral 1 in the drawing denotes a metal housing which serves as a cylinder of a hot-gas engine and which is provided internally with a lining 2, on its lower portion a thin metal sleeve 3 and a metal cap 4 with a coller 4*a*. In the annular space 20 formed between the cylinder 1 and the sleeve 3 a layer of sand 5 is contained.

Around the cylinder 1 there is provided a cooling coil 6 through which a cooling medium can flow and which comprises a medium inlet 7 and a medium outlet 8.

At the lower end of the lining 2 a seal 9 is provided between the lining and the sleeve 3 and a seal 10 is provided between the lining 2 and the cylinder 1.

The chamber 11 constitutes the hot expansion space of the hot-gas engine during operation, a displacer (not shown) being reciprocable inside the chamber.

Heater pipes (not shown) may be connected to the upper end of the chamber 11 by way of a manifold.

In order to achieve a suitable sand seal with the cap 4, the construction of the cap is preferably such that the collar 4*a* is biased against the cylinder wall.

The cap 4 can be locked, if desired, by means of a ring.

The annular space 20, filled with sand 5, communicates, *via* a gap 21 between the lining 2 and the cylinder 1 with a duct 22 which opens into the ambient atmosphere. As a result, atmospheric pressure, being lower than the working medium pressure in the chamber 11, always prevails in the space 20, so that the wall of the metal sleeve 3 may be thin.

The duct 22 includes a filter 23.

If the working medium used is, for example, hydrogen, which tends to diffuse through the wall of the sleeve 3, and if the escaping hydrogen must not be lost, the gap 21 may be connected, *via* a duct 25 which includes a non-return valve 26, to the chamber 11. The duct 22 is then, of course, omitted or closed. The non-return valve 26 opens in the direction of the chamber 11. When the hydrogen pressure in the space 20 or the gap 21 exceeds the instantaneous cycle pressure in the chamber 11, the valve 26 opens and hydrogen flows back to the chamber 11.

WHAT WE CLAIM IS:-

1. A hot-gas engine comprising a metal housing which envelops a chamber in which a pressurized working medium is contained during operation of the engine and which housing is provided on at least part of its inner side with a layer of a heat-insulating material, wherein the heat-insulating layer consists of heat-insulating material in grannular from contained in an annular space which is formed between the housing and a metal sleeve inside the housing.

2. A hot-gas engine as claimed in Claim 1, wherein the heat-insulating material consists of grains of sand or Zro_2.

3. A hot-gas engine as claimed in Claim 1 or 2 wherein the annular space communicates with a space in which a pressure prevails which is lower than the working-medium pressure in the chamber.

4. A hot-gas engine as claimed in Claim 3, wherein the annular space communicates with the ambient atmosphere *via* a filter.

5. A hot-gas engine as claimed in Claim 1 or 2 wherein the annular space communicates with the chamber *via* a non-return valve which opens in the direction of the chamber.

6. A hot-gas engine substantially as herein described with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office by MULTIPLEX techniques ltd., St. Mary Cray, Kent. 1981. Published at the Patent Office, 25 Southampton Buildings, London WC2 1AY, from which copies may be obtained.

1589329 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*