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W. H. STIGTER

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HOT-GAS PISTON APPARATUS HAVING CYLINDER MEANS AND AXIALLY
ARRANGED PISTON BODIES, HEAT EXCHANGERS, AND
REGENERATOR THEREIN
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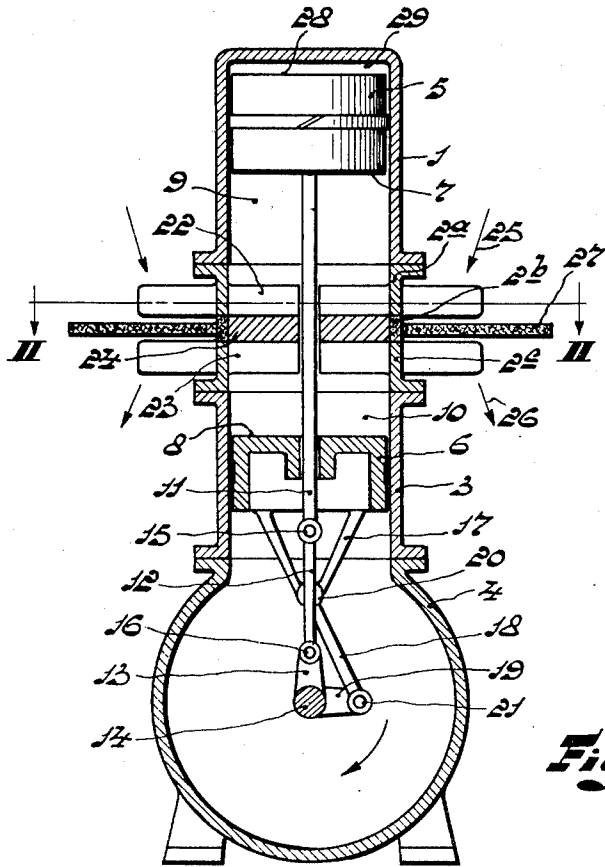


Fig. 1

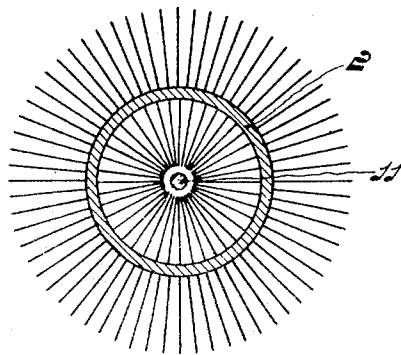


Fig. 2

INVENTOR.

WILLEM HENDRIK STIGTER

BY

Frank M. Vogel

AGENT

UNITED STATES PATENT OFFICE

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HOT-GAS PISTON APPARATUS HAVING CYLINDER MEANS AND AXIALLY ARRANGED PISTON BODIES, HEAT EXCHANGERS, AND REGENERATOR THEREIN

Willem Hendrik Stigter, Eindhoven, Netherlands,
assignor, by mesne assignments, to Hartford
National Bank and Trust Company, Hartford,
Conn., as trustee

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The present invention relates to hot-gas engines of the reciprocatory piston type.

In such hot-gas engines it is the practice to cause the volume of the caloric cycle or working medium present in the engine to vary by means of two piston-like bodies. One of these bodies, usually referred to as the displacer, is operative as such by means of both end surfaces thereof. On the other hand, the other piston-like body participates in the volume varying process only by means of the end thereof remote from the crank mechanism of the engine. The two chambers which contain the gaseous working medium which have the volume thereof varied to so participate in the caloric cycle, are in permanent communication with each other. This is accomplished, as a rule, by means of a communication space or communication canals that are grouped about the space in which the two piston-like bodies move. A disadvantage of this arrangement is that the clearance of such an engine is comparatively large and hence affects the output of the engine per unit of volume.

The present invention provides means operative to remove this difficulty as will be pointed out hereinafter.

In hot-gas piston apparatus (i. e. either hot-gas engines or refrigerating machines operating on the reverse hot-gas engine principle), constructed according to the invention, the volume of the caloric cycle or working medium present in the apparatus is varied by the adjacent end surfaces of two axially arranged piston-like bodies. Such construction then allows arranging the heat exchangers, and in some cases a regenerator, in the apparatus space between the two piston-like bodies. This in time results in that the clearance in such apparatus can be maintained small, while the flow losses are reduced to a minimum. The last optimum result is due to the fact that the course of the flow of gas is perfectly linear. In other words, neither any bends nor any auxiliary canals are traversed by the gas.

In accordance with a preferred embodiment of the invention, the piston-like body which is remote from the crank mechanism of the engine, has the end thereof most remote from said drive, vary the volume of an enclosure sealed from the surroundings. It is then possible to introduce a gas into this enclosure and to choose the compression ratio in this space to be such that the course of the torque or of a bearing load of the apparatus becomes more favorable.

In order that the invention may be clearly understood and readily carried into effect, it will

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now be described more fully with reference to the accompanying drawing, in which:

Figure 1 is a longitudinal section of a hot-gas piston apparatus constructed in accordance with the invention and, in this case, as a hot-gas engine; and

Figure 2 is a cross-sectional view of the heater of the apparatus shown in Figure 1 and taken on the line II—II thereof.

The engine according to the invention comprises an engine housing in turn comprising three sections 1, 2 and 3 of a cylinder mounted on a crankcase 4, all of which are assembled by means of flanges as shown. A piston-like body 5 is adapted to move in the section 1, while a piston-like body 6 is adapted to move in the section 3. The end surface 7 of the piston 5 and the end surface 8 of the piston 6 jointly influence the volume of the gas which participates in the caloric cycle of the engine. For this purpose, as is the practice in hot-gas engines, the movement of the piston-like body 5, which influences the volume of the hot space 9, reciprocates out of phase with respect to the reciprocation of the piston-like body 6, which varies the volume of the cold space 10. The out-of-phase relationship or phase difference may be of the order of 90°, for example. This phase difference is conventionally obtained by a crank mechanism which in this case comprises a piston rod 11 which is attached to piston body 5 and which extends through the piston body 6. The piston rod 11 is coupled by means of a connecting rod 12 to a crank 13 on a crankshaft 14. Numerals 15 and 16 designate pivot points in the connections between the piston rod 11 and connecting rod 12 on the one hand, and between connecting rod 12 and the crankshaft 14 on the other. The piston-like body 6 has a piston rod assembly 17 connected thereto, which is constructed so as to be double and in V-shape, as shown, and lies in front and at the back of the piston rod 11. The piston rod assembly 17 is coupled by means of a connecting rod 18 to a crank 19 on the crankshaft 14. The pivot points in this connection are designated 20 and 21. It is also possible that the piston 8 may be constructed as a trunk piston, the connecting rod 18 then engaging pivot points on the piston 6 itself.

The hot space 9 and the cold space 10 are in permanent communication via the heat exchangers 22 and 23 and the regenerator 24. The gas or working medium in the engine absorbs heat supplied to it via the heat exchanger 22. The heat to be applied in turn to the heat ex-

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changer 22 is diagrammatically indicated by the arrows 25. As may be seen in Figure 2, the heat exchanger 22 is assumed in this case to comprise a plurality of radial fins which are placed both on the inside and on the outside of the wall of the part 2 of the engine housing. Hence, on heat being supplied to the external fins, the part 2a of the engine housing is heated and transmits this heat to the fins on the inside of the housing. The working medium in the engine then absorbs heat therefrom.

The heat exchanger 23 is constructed in a similar manner but the fins lying in the housing part 2c withdraw heat from the working medium in the engine and transmit it through the wall of the housing to the fins on the outside of the housing, which are cooled in some suitable manner. This may be done, for example, by air flowing past the outer fins or by a cooling liquid. This causes heat to be dissipated on the outside of the engine, as is denoted diagrammatically by the arrows 26. The fins of the heat exchangers 22 and 23 that are external to the housing parts 2a and 2c are heat insulated from each other by a partition 21. In addition, precautions have to be taken to prevent heat supplied to the engine as indicated by the arrows 25, from flowing through the material of the wall of the housing part 2a to the heat exchanger 23. This may be effected, for example, by making the part 2b of the engine housing between the two heat exchangers of material of poor thermal conductivity, as indicated in Fig. 1. As a matter of course, the aforesaid detrimental heat flow may be prevented otherwise, for example, by the use of more complicated constructions of the heat exchangers.

In order to raise the output of the engine, a regenerator 24 is provided between the two heat exchangers 22 and 23. Such regenerator 24 may be made, for example, of very thin wire-like material.

If, as has been assumed, the apparatus operates as a hot-gas engine, the heat exchanger 22 is maintained at a temperature of 700° C., and the temperature of the heat exchanger 23 is maintained, for example, at 30° C. The crankshaft 14 of the engine consequently supplies mechanical energy. If in contradistinction to this, the apparatus is designed as a refrigerating machine operating on the reverse hot-gas engine principle, the heat exchanger 22 is maintained by the outside medium to be cooled at a temperature of say -20° C., and the heat withdrawn from the outside medium to be cooled is transmitted to the outside at a temperature of say +20° C. by the heat exchanger 23. In this case, the apparatus consequently supplies caloric energy (i. e. it supplies cold at the area of the heat exchanger 22). In this case, the crankshaft 14 must be actuated in some manner.

By causing the most remote end 28 of the piston 5 which is located remote from the crank mechanism of the apparatus, to move into the enclosed space 23 sealed from the surroundings, at a properly chosen compression of the gas contained in the said enclosed space, the course of the torque or of a bearing load in the operating apparatus may be made more favorable.

What I claim is:

1. A hot-gas piston apparatus comprising cylinder means, said cylinder means comprising a substantially imperforate wall section, two axially arranged piston bodies reciprocally confined by the inner periphery of said substantially im-

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perforate wall section therein, said piston bodies completely enclosing the volume of the working medium of the caloric cycle in said cylinder means by the adjacent end surfaces of said piston bodies and said inner periphery of said substantially imperforate wall section, and means for reciprocating said piston bodies out of phase in relation to each other whereby the volume of the working medium is varied during operation of the apparatus.

2. A hot-gas piston apparatus comprising cylinder means and two axially arranged piston bodies therein enclosing the volume of the working medium of the caloric cycle in said cylinder means by the adjacent end surfaces of said piston bodies, heat exchanger means and a regenerator enclosed in the space between said piston bodies, and means for reciprocating said piston bodies out of phase in relation to each other whereby the volume of the working medium is varied during operation of the apparatus.

3. A hot-gas piston apparatus comprising cylinder means, said cylinder means comprising a substantially imperforate wall section, two axially arranged piston bodies reciprocally confined by the inner periphery of said substantially imperforate wall section, therein, said piston bodies completely enclosing the volume of the working medium of the caloric cycle in said cylinder means by the adjacent end surfaces of said piston bodies and said inner periphery of said substantially imperforate wall section, means for reciprocating said piston bodies out of phase in relation to each other whereby the volume of the working medium is varied during operation of the apparatus, and said cylinder means comprising a closure member fixed at one end thereof, said closure member being positioned opposite the end surface of one of said piston bodies other than said adjacent end surface for enclosing a second volume whereby said second enclosed volume is varied upon reciprocation of said one of said piston bodies.

4. A hot-gas piston apparatus comprising cylinder means and two axially arranged piston bodies therein enclosing the volume of the working medium of the caloric cycle in said cylinder means by the adjacent end surfaces of said piston bodies, means for reciprocating said piston bodies out of phase in relation to each other whereby the volume of the working medium is varied during operation of the apparatus, heat exchanger means and a regenerator enclosed in the space between said piston bodies, and said cylinder means comprising a closure member fixed at one end thereof, said closure member being positioned opposite the end surface of one of said piston bodies other than said adjacent end surface for enclosing a second volume whereby said second enclosed volume is varied upon reciprocation of said one of said piston bodies.

WILLEM HENDRIK STIGTER.

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