

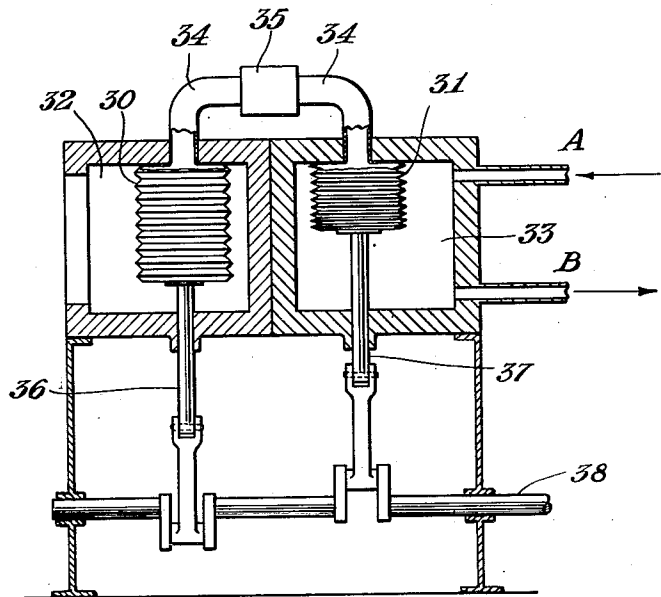
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HOT GAS ENGINE OF THE BELLOWS TYPE

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HOT GAS ENGINE OF THE BELLOWS TYPE

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This invention relates to hot-gas engines comprising two spaces, the volumes of which are varied with a phase difference and in which a thermodynamic cycle is performed during the operation of the engine. The term "hot-gas engines" is to be understood to include refrigerators and heat pumps operating according to the reversed hot-gas engine principle.

Hot-gas engines are, as a rule, constructed as reciprocating engines. The use of pistons usually involves the following difficulties. The working medium leaks away, in certain cases to a considerable extent, from the space on one side of the piston to the space on the other side of the piston. This leakage of working medium involves a material thermal loss. A further difficulty is that it is, as a rule, necessary to lubricate the pistons. This lubrication requires continuous supervision, since there is a risk that some lubricating oil may find its way into the regenerator, which considerably lessens the efficiency of the regenerator. A third difficulty is that the friction forces acting on the piston may attain a fairly high value. The aforesaid difficulties have a detrimental effect upon the power output of the engine. In certain cases it is possible to mitigate one of the said difficulties, but this, as a rule, results in the other difficulties being increased.

Furthermore, in the embodiments of hot-gas engines hitherto known, in which compression and expansion take place for the greater part in the working spaces of variable volumes and heating or cooling in a separate heater and cooler, the expansion and compression will, as a rule, not be isothermal but approximately adiabatic. This results in the working process being no longer reversible. Thus, for example, in a hot-gas reciprocating engine, the mean temperature of the medium is lower than it should be at the end of the expansion. In flowing through the heater, the medium ultimately assumes the temperature required. On compression, the temperature becomes, on the contrary, higher than it should be, so that the temperature must decrease during the passage of the medium through the cooler.

The object of the invention is to provide an improved hot-gas engine. According to the invention, a hot-gas engine comprising two spaces, the volumes of which are varied with a phase difference and in which a thermodynamic cycle is performed during operation of the engine, is characterized in that the wall of at least one of the spaces of variable volume is shaped in the

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form of bellows, the driving-gear of the engine and the bellows being mechanically connected such that movement of the driving gear is attended with an increase or a decrease in the volume of this space, the exchange of thermal energy being effected through the wall of the bellows. This ensures an approximately isothermal expansion or compression in these working spaces, so that an appreciable improvement in power output ensues. In this case this construction may dispense with the external heater and/or cooler.

A simple and compact construction of a hot-gas engine comprising bellows may be realised if two sets of bellows are arranged in line with each other, the adjacent terminal walls of these spaces being secured on either side of a partition having heat-insulating properties.

Since it is, as a rule, difficult for the rod mechanism with the use of which the bellows are varied in volume, to be taken through these bellows, it is preferable to vary the volumes of the spaces bounded by the bellows with the use of a driving rod mechanism which engages with the partition and which is connected to the driving gear of the engine externally of the bellows.

In one embodiment of the invention, a hot-gas engine in which at least three cycles are performed has in each case two bellows arranged in line with each other, the terminal walls of these bellows remote from each other being connected by way of a common rod system to the driving gear and the adjacent terminal walls having arranged between them a channel system which permits each space, bounded by a set of bellows, of each system to communicate with a space of another system. This embodiment allows of very short connection ducts between the spaces.

The aforesaid embodiments of the invention may be used with particular advantage for refrigerators.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying diagrammatic drawing, given by way of example, which shows one form of construction of a hot-gas engine according to the invention.

The figure shows a twin-cylinder hot-gas engine comprising bellows, the exchange of thermal energy between the working medium of the engine and the external means for the supply and dissipation of thermal energy being effected through the wall of the bellows.

The bellows of this engine, i. e. the heated

bellows 30 and the cooled bellows 31, are connected by connecting rods 36 and 37 respectively, to a drive shaft 38. The bellows indicated in this engine have a double function. Firstly, they serve to vary the volume of the working spaces and secondly they serve as a wall through which thermal energy is supplied to or withdrawn from the working medium taking part in the thermodynamic cycle. This affords the advantage that the working medium traversing the cycle is expanded and compressed substantially isothermally. The engine shown in this figure is intended for use as a refrigerator operating according to the reversed hot-gas engine principle. Space 32 about the bellows 30 serves as the refrigerator space, so that thermal energy is supplied from the space 32 through the wall of the bellows 30 to the working medium. Thermal energy is withdrawn through the wall of the bellows 31 from the working medium to space 33 about the bellows 31, with the use of a cooling medium, which flows into this space at A and leaves this space at B. The two working spaces, i. e. the working space in the bellows 30 and that in the bellows 31 communicate with each other through a duct 34 comprising a regenerator 35. Since the thermal energy is supplied and withdrawn through the walls of the bellows, the heater and the cooler may, in this case, be dispensed with.

It will be obvious that embodiments of the invention other than that described above fall within the scope of the invention and that many known constructions and arrangements adapted to be used in hot-gas reciprocating engines may be used or may be modified for use in a hot-gas engine according to the invention.

What we claim is:

1. A hot gas engine comprising means forming a cold working space of variable volume and adapted to receive a working gas, means forming a hot working space of variable volume and connected to said cold working space, one of said

means including a bellows-like member, means for heating the working gas within said hot space, means for cooling the gas within said cold space and means to vary the volume of the hot working space and cold working space in phase differences.

2. A hot gas engine comprising means forming a cold working space of variable volume and adapted to receive a working gas, means forming a hot working space of variable volume and connected to said cold working space, both of said means including a bellows-like member, means for heating through said bellows-like member, the gas within said cold space and means to vary the volume of the hot working space and cold working space in phase differences.

3. A hot gas engine comprising means forming a cold working space of variable volume and adapted to receive a working gas, means forming a hot working space of variable volume, a duct connecting said hot working space to said cold working space, both of said means including a bellows-like member, means for heating the working gas within said hot space, means for cooling the gas within said cold space, gear means connected to said bellows to vary the volume of the hot working space and cold working space in phase differences, and a regenerator in said duct.

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