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(54) **Method for converting heat into work.**

(57) The invention refers to a method for the conversion of the thermal energy of a fuel into mechanical energy, wherein the fuel is burnt, the gaseous combustion product is mixed with an inert gas, and the thus formed gas mixture is brought to expansion at essentially a constant pressure and a constant temperature. The inert gas may be the gas from a previous expansion.

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The invention refers to the conversion of the heat content of a fuel into mechanical work. According to the invention the fuel is burnt, the gaseous combustion product is mixed with an inert gas, and the resulting gas mixture is brought to expansion at essentially a constant pressure and a constant temperature.

The methods so far employed are based on the adiabatic expansion of a gas that is brought to a certain pressure and a certain temperature before the expansion. The thermal efficiency of this process is

$$\eta = \frac{T_1 - T_2}{T_1} \quad (1)$$

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where T_1 and T_2 denote the absolute temperatures before and after the expansion. The upper limits for the temperature and the pressure are set by the heat resistance of the material and the strength of the construction of the expansion vessel. The lower limits are set by the requirements that the pressure must be great enough to give a great enough force, and that the temperature must be high enough for the gas not to condense.

At the expansion under constant pressure and constant temperature, gas and heat are supplied in the course of the expansion. The thermal efficiency is then

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$$\eta = \frac{Q_1}{Q_1 + Q_2} \quad (2)$$

where Q_1 denotes the work produced during the expansion, and Q_2 denotes the heat content of the gas at the end of the expansion. The comparison with the adiabatic expansion is facilitated if one writes formula (2) in the form

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$$\eta = \frac{(Q_1 + Q_2) - Q_2}{Q_1 + Q_2} \quad (3)$$

The total heat supplied is represented by T_1 in (1), by $Q_1 + Q_2$ in (3). The net heat that remains in the gas after the expansion is represented by T_2 in (1), and by Q_2 in (3). The thermal efficiency of one expansion is, thus, the same in both cases.

The practical efficiency is determined by the recovery of the energy of the gas after the first expansion. When a gas expands at a constant pressure and a constant temperature, the state of the gas at the end of the expansion is the same as that during the expansion, only its mass has changed, it has increased. The gas functions, in principle, as a medium for the conversion of heat into work. It can be used in the same machine over and over again. The transfer of a gas to another gas of the same pressure and the same temperature at a constant pressure and a constant temperature, i.e. under expansion, requires no energy. But in order for the transfer to be rapid, one must create a pressure difference, either by compressing the gas to be transferred, whereupon the work of compression is recovered as work of expansion, or by expanding the receiving gas while yielding work of expansion that is then regained through the work of expansion of the gas received. In certain applications the heat content of the gas at the end of the adiabatic expansion cannot be utilized. It is then wasted, and the efficiency is low. According to the invention, this heat can be utilized to a great extent under almost all circumstances.

At the high temperature T_1 of the adiabatic expansion there are great losses of heat to the wall of the expansion chamber, and it is necessary to cool the wall. According to the invention, this heat can be used for warming the fuel and the combustion air, but the temperature is never higher than the wall material can endure.

According to the invention, the pressure and the temperature are selected each by itself or both together. The pressure is chosen so that it gives the required force, the temperature is chosen so that the amount of heat supplied during the expansion corresponds to the desired power, i.e. the velocity, the power being the product of the force and the velocity. Thus, the velocity is controlled by way of controlling the temperature. On the other hand, the acceleration is determined by the force, and, therefore, the pressure should be controlled together with the temperature for a rapid and smooth control of the velocity. The

pressure is controlled by means of the amount of inert gas supplied. The temperature is controlled by means of the amount of fuel and the corresponding amount of air supplied. In principle, the same control may be achieved at adiabatic expansion, namely by controlling the amounts of fuel and excess air. During acceleration, the force should be great at a small velocity, i.e. a high pressure and a low temperature. After
 5 the acceleration, a smaller force, i.e. a lower pressure, and a greater velocity, i.e. a higher temperature, are required. The choice of the amounts and the proportions of the gases supplied can be made by a computer according to a program made for each type of machine. In many applications, the choice of pressure and temperature may influence the over-all efficiency more than does the thermal efficiency.

Another advantage offered by the expansion at a constant pressure and a constant temperature, is that
 10 the volume change during the expansion can be chosen at will. At adiabatic expansion, the volume change is limited by the factors that limit the pressure and the temperature.

Finally should be mentioned another advantage of the lower temperature at the expansion at a constant temperature, as compared to the highest temperature at adiabatic expansion: since the temperature is lower, nitrogen oxides are formed in smaller amounts.

15 The invention can be applied to machines of various kinds, e.g. of the types of the piston engine and the turbine. In order to visualize the invention, a special form is shown here as an illustration. Therein lies, however, no implication that it should be a preferred form or even a practical form.

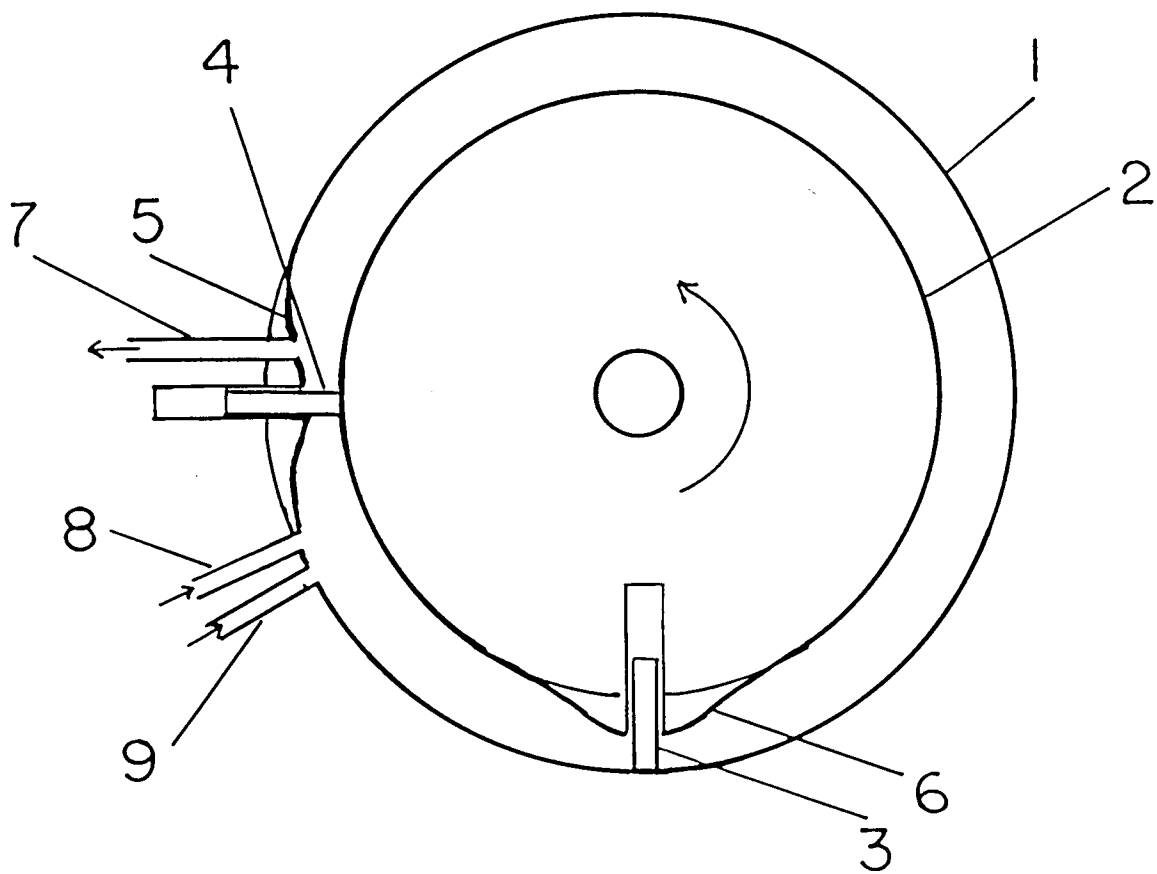
The machine shown in the Figure consists of a cylindrical stator 1 and a coaxial rotor 2. The rotor is fitted with a vane 3, that can be moved radially in a slit in the rotor. The stator is fitted with a disk 4 that can
 20 be moved radially in a slit in the stator. In order for the rotor vane to pass by the stator disk the vane is pressed into the rotor and the disk is pressed into the stator. For this purpose the stator is shaped with a sloped surface 5 upstreams of the disk against which the vane slides. Correspondingly, the rotor is shaped with a sloping surface 6 downstreams of the vane against which the disk slides. A hole is drilled through the sloping surface 5 of the stator through which the gas downstreams of the vane can be pressed out. A pipe
 25 7 is connected to this hole. The stator is also fitted with holes and pipes for the supply of fuel and air 8 and inert gas 9. Only one set of such holes and tubes are shown in the Figure, but in order to speed up the mixing of the gases one may provide several sets of holes and pipes 8 and 9 along the periphery of the stator.

A short time after the vane has passed the disk, the injection behind the vane of fuel and air and of gas
 30 from a previous expansion begins. It continues until the vane has travelled almost a revolution and has reached the exhaust hole 7. During the next revolution there is no injection, only exhaust of gas from the preceding revolution. The exhaust gas is transferred to a compressor of the same form as the motor in the Figure. During the exhaust the compressor sucks up this gas. During its next revolution the compressor compresses the gas to a pressure slightly higher than the working pressure on the motor. The third
 35 revolution of the motor is a repetition of the first revolution with injection of gas from the compressor through the hole 9. The work of compression in the compressor is recovered as work of expansion in the motor. The energy of the gas can be utilized almost completely in the motor.

In a further development of the invention two motors on the same shaft can act as compressors, one for the other, during the exhaust revolution.

40 Claims

1. Method for the conversion of the thermal energy of a fuel into mechanical energy, wherein a fuel, an oxidizing gas, and an inert gas are injected into an expansion chamber, continuously or intermittently, in
 45 such amounts and in such proportions that the gas mixture expands at essentially a constant temperature and a constant pressure at a desired force and at a desired amount of produced power.
2. Method according to claim 1, wherein the inert gas is the gas coming from a preceding expansion.
3. Method according to claim 1, wherein the pressure and the temperature are governed each by itself
 50 and both together, to a desired force and a desired velocity of expansion.



Figure



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EUROPEAN SEARCH REPORT

Application Number

EP 90 20 3271

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-1 165 404 (NESTOROVIC) * page 1, column 1, line 33 - line 35 * * page 2, column 1, line 25 - page 7, column 1, line 40; figures * ---	1	F02B75/02
A	FR-A-992 925 (DARCHE) * page 1, column 2, line 5 - line 22 * * page 1, column 2, line 32 - page 6, column 1, line 12; figures * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 4, no. 176 (M-45)(658) 5 December 1980 & JP-A-55 125 322 (ISAMU NEMOTO) 27 September 1980 * abstract * ---	1	
A	PATENT ABSTRACTS OF JAPAN (M-78)(3959) & JP-A-53 092 014 (MITSUBISHI JUKOGYO K.K) 8 December 1978 * abstract * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 4, no. 41 (M-5)(523) 29 March 1980 & JP-A-55 012 225 (MITSUBISHI JUKOGYO) 28 January 1980 * abstract * ---	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US-A-3 125 076 (MULLANEY) * the whole document * ---	1	F02B
A	US-A-4 552 106 (SPENCE) * the whole document * -----	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 JANUARY 1992	Examiner MOUTON J. M. M. P.
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