Nov. 14, 1972 J. K. PARMERLEE 3,702,746

ROTARY FREE PISTON GAS GENERATOR

Filed Nov. 1, 1971 2 Sheets-Sheet 1

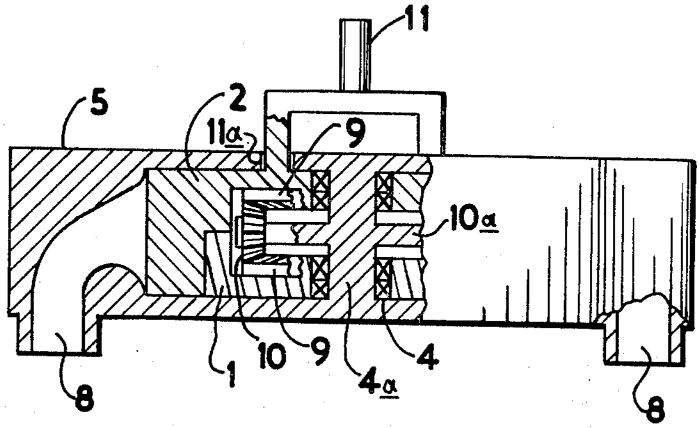

FIG. 1

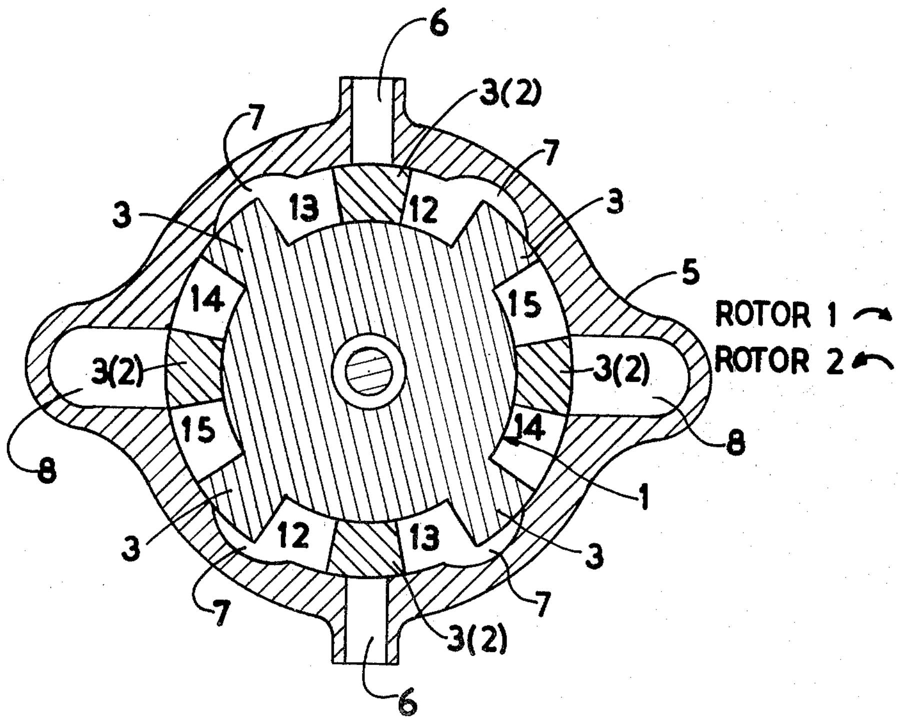

FIG. 2

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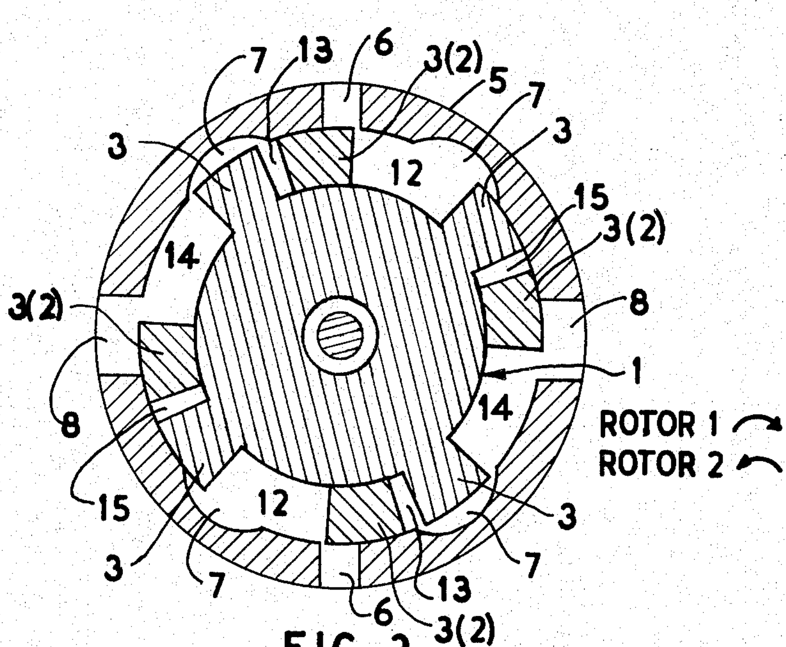
7
13
6
3(2)
5
7
3
12
15
3(2)
14
3(2)
8
1
14
ROTOR 1
ROTOR 2
8
15
12
3
7
3
7
13
6
3(2)

FIG. 3

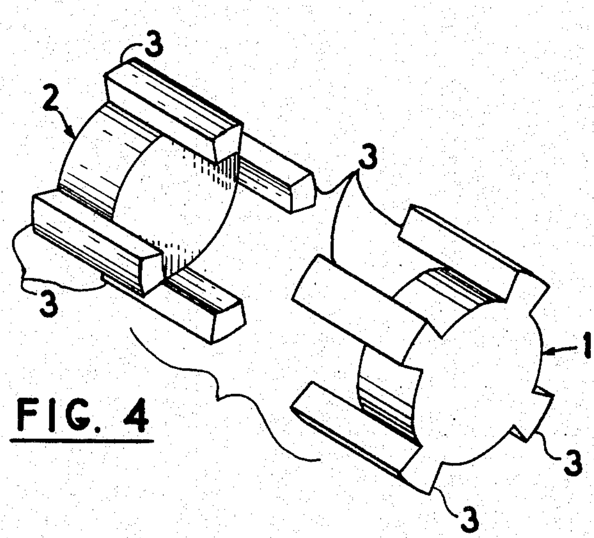
3
2
3
3
1
3
3

FIG. 4

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ROTARY FREE PISTON GAS GENERATOR

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U.S. Cl. 417—481 8 Claims

ABSTRACT OF THE DISCLOSURE

A gas generator having double acting free pistons, movably interconnected for opposing movement which achieves dimensional change of a combustion chamber, and operating in oscillating rotary rather than linear motion, for supplying high pressure and/or temperature gas either to processes requiring it or directly into a turbine, an engine, or other device to provide power for power stations or vehicles (such as automobiles, boats, aircraft, or motorcycles).

BACKGROUND OF THE INVENTION, AND ADVANTAGES OF THE PRESENT INVENTION

This invention is in the field of internal combustion engines to compress air, add heat to it by virtue of the combustible fuel, and supply this heated and compressed gas to a turbine for output mechanical power. Typical and other known prior art, in this field, while utilizing either two linear free pistons opposing each other for single-acting operation or a single double-acting free piston, suffers the disadvantage of extremely complex piston synchronizing mechanisms or extreme vibration.

In this present invention, the free pistons rotate about an axis, are opposing each other, and are double acting; and a set of inter-related internal meshing bevel gears provides the necessary synchronization between the rotors and the housing without employing bounce pistons and sophisticated pressure controls required to sustain linear single-acting free piston gas generators.

A gas generator according to the present concepts achieves good balance; for, because the rotors are opposing each other and their moments of inertia are equal, the unit is inherently balanced, quite in contrast to a linear double-acting free piston gas generator, which is inherently imbalanced.

Also, among the advantages of the present invention is the fact that the air/fuel ratio can be controlled to substantially eliminate all unburned hydrocarbon and carbon monoxide products of combustion; this is due to the concepts of the present invention which provide that the power output is through the gas and not the mechanical shaft rotation.

A further advantage provided by the present invention is control of gas temperature; that is, because there is no fixed stroke, the ignition temperature can be controlled by spark plug timing (in the case of spark ignition) or fuel selection (in the case of compression ignition) to reduce, to the lowest possible level, the nitrogen oxide content of the exhaust.

Accordingly, the inventive concepts achieve a virtual pollution-free power source, currently recognized as a particular advantage of a power source.

Other advantages, including also the possibility of using almost any type of combustible material as fuel, will be apparent from the more detailed description of the invention.

SUMMARY OF THE INVENTION

Concepts of the present invention provide a pair of rotors containing sector-shaped pistons, and these rotors oscillate in rotary fashion about a common axis. These

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rotors are effectively 180° out of phase, such that between their pistons, sequential functions of "intake, compression, bypass, compression, power, and exhaust" are attained and performed. A general attainment of this invention is, therefore, the provision of hot compressed gas suitable for powering a turbine, and attaining this without prior art disadvantages of vibration and complex external controls and "bounce" pistons normally associated with linear free piston gas generators.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, and the attendant advantages, features, and uses of the inventive concepts will become more apparent to those skilled in the art by the more detailed description which follows, considered along with the accompanying figures of drawing which illustrate, somewhat diagramatically, a preferred embodiment of the invention. In these drawings:

FIG. 1 is an elevational view, partly cut away and in section, of a gas generator according to the present inventive concepts;

FIG. 2 is a transverse cross-sectional view, with the two rotors shown in an intermediate relative position;

FIG. 3 is a transverse cross-sectional view similar to FIG. 2, but with the two rotors in another position relative to one another and to the features of the casing; and

FIG. 4 is an exploded pictorial view of the two rotor members.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings (first referring more particularly to FIGS. 1, 2, and 4), two rotors **1** and **2**, each shown as containing four integral piston vanes or sectors **3**, are each supported on a pair of bearings **4** suitably loaded and spaced to provide freedom of rotary oscillation yet maintaining positional accuracy, thereby providing the desirable running clearances with a minimum of frictional losses. These bearings **4** are supported on a central shaft **4***a* which is suitably attached or supported by the casing or housing **5**. The rotors **1** and **2** move in parallel, spaced planes.

The piston vanes or sectors **3** extend from the rotor member member (**1** or **2**) to which they are connected toward the other rotor member, in a common plane.

The housing **5** contains two intake ports **6**, four bypass recesses **7**, and two exhaust ports **8**, and surrounds the rotors **1** and **2**.

Internal to the rotors **1** and **2** is a set of bevel gears **9** and **10**, as follows: Bevel gears **9** are suitably attached to rotors **1** and **2**; and bevel gears **10**, which are idler gears located diametrically opposite one another, are allowed to pivot about their own axes, but such axes are fixed relative to the housing **5** by suitable attachment arms **10***a* to the central shaft **4***a* and housing **5**. The function of this gear set (**9**, **10**) is to provide the necessary synchronization of the rotors **1** and **2** relative to each other and to the ports **6**, **7**, and **8**, as discussed more fully below.

To facilitate starting, a shaft **11** is indicated as suitably attached to rotor **2** through suitable windows **11***a* in the housing **5**.

Operation

FIG. 2 is shown with both rotors **1** and **2** in an intermediate position. In the operation of the invention, let it be assumed that initially rotor **1** is rotating clockwise and rotor **2** counter-clockwise, and that a combustible mixture is present in all cavities **12**, **13**, **14**, and **15** which exist between adjacent sectors **3** of the two rotors **1** and **2**. Because of the above rotation, the cavities are undergoing the following changes: **13** and **15** are compressing, although **12** and **14** are expanding.

As cavities **12** continue to expand (Contrast FIG. 3 with FIG. 2), a suction will be formed so that as the pistons **3** on rotor **2** open the intake ports **6** (FIG. 3), a fresh charge will be drawn into cavities **12**.

Simultaneously, the following events are occuring in the other cavities:

(a) Cavities **13**: Compression of cavities **13** continues until the pistons **3** on rotor **1** open the bypass recesses or ports **7**, and a large portion of this compressed charge is transferred into cavities **14**, as shown in FIG. 3.

(b) Cavities **15**: Compression of cavities **15** continues until the charge ignites, forcing the rotors **1** and **2** to reverse their rotation.

(c) Cavities **14**: Having previously been ignited by a prior compression stroke, the pressure acts to drive the rotors **1** and **2** in the initially assumed direction. Expansion continues, and the pistons on rotor **2** open the exhaust ports **8** so that the gas is expelled through them.

After the above sequence of events, the processes reverse as follows:

(a) Cavities **12** interchange functions with those of cavities **13**.

(b) Cavities **14** interchange functions with those of cavities **15**.

It will be seen that the double-acting operativity is achieved by an explosion occurring at the operative end of a stroke in which the piston vanes **3** of one of the rotor members **1** or **2** are approaching the piston vanes **3** of the other of said rotor members **1** or **2** from one rotational direction, and by a subsequent explosion occurring at the operative end of the stroke in which the piston vanes of the said one of the rotor members are approaching the piston vanes of the said other rotor member from the opposite rotational direction. In the form shown in the drawings, chambers **15** provide the explosion chamber at one end of the stroke (FIG. 3 position); and at the other end of the stroke the chambers **14** provide the explosion chamber, it being noted that by that time the rotor member **2** will have moved clockwise sufficiently that (in contrast to FIG. 3) the outlet ports **8** will be then covered.

It will be noted that in the illustrative embodiment the bypass means **7** are not located symmetrically about the inner wall of the casing **5** relative to the region of movement of the rotor members **1** and **2**, nor uniformly spaced or symmetric with the overall body of the casing **5** even though the piston vanes **3** of both the rotor **1** and the rotor **2** are symmetrically balanced and symmetric about their own peripheries, being uniformly spaced therearound.

This spacing provides that a single stroke (e.g., FIG. 3) achieves a compression of a fuel charge for subsequent explosion, in size-decreasing chambers **15**, for the adjacent bypasses **7** are non-communicating with chambers **15**, even though the fuel charge in similarly size-decreasing chambers **13** is not being continued to be compressed but is being then bypassed to chambers **14** because the adjacent bypasseses **7** are in communication with the chambers **13**; and yet, nevertheless, on the opposite stroke of this double-acting gas generator, the respective bypasses **7**, respectively, in direct contrast, do provide and do not provide such bypass communication.

Thus, any one or like set of the bypasses **7** does not perform a bypass function during a stroke in a first direction yet does perform a bypass function during a stroke in the opposite direction, respectively achieving or permitting pre-explosion compression (chambers **15** in FIG. 3, and correspondingly chambers **14** in their position at the end of the stroke opposite that shown in FIG. 3), and compression bypass (chambers **12** in their position at the end of the stroke opposite that shown in FIG. 3, and correspondingly chambers **13** in FIG. 3).

(It will of course be understood that while the details thereof are not shown on the drawing, the intake fuel/air mixture is reecived from suitable carburetors and the exhaust is furnished to drive the processes, turbines, engines, and such other devices as may require this compressed gas.)

Modifications, and other details

Several operationl utilizations may be achieved by the present inventive concepts. For example, although this device as herein illustrated is primarily intended for coupling to a turbine and the total device thereby constituting an engine, it could also be used with any air motor device such as a piston motor, a vane motor, a gear motor, or the exhaust could be directed to a nozzle forming a high velocity jet engine.

The device shown is intended to be made of metals suitable for the several functions of the components involved; however, it could also use non-metals. In particular, the pistons and/or housing and/or end caps which are subject to the high temperature gas can be of suitable ceramic or surmet materials.

Other options include the fact that fuel injectors could be used rather than carburetors (by suitable linkage to the starting shaft, as would be known in the art). Moreover, although the device as shown is intended for compression ignition operation, spark or glow plugs might be utilized for starting and/or running.

It will be of course understood that the size, shape, and location of the inlet, bypass, and exhaust ports are depicted on the drawing by a schematic representation, in a nominal condition only; and their more specific final characteristic would be determined by a thermodynamic and aerodynamic analysis to achieve optimum efficiency with the other factors such as gas nature, temperatures, speeds, etc., this disclosure being of the basic concepts.

Although ports are herein shown for valving the air flow, this function could be produced by check, poppet, rotary or slide valves, with appropriate linkage to the starting shaft so that properly-timed actuation is attained.

The device is intended to use common automotive or aircraft fuels, however, because of the theoretically possible infinite compression ratio, virtually any combustible material can be used as a fuel.

While details of a starter have not been shown, it is intended that the starter shaft be coupled via a torsional spring to a rotationally oscillating motor with a controlled frequency, and with suitable release mechanisms, etc.

SUMMARY

From the foregoing description, considered with the accompanying drawings, it is thus seen that the present inventive concepts provide a new and useful gas generator device, having desired advantages and characteristics, including those pointed out and others which are inherent in the invention.

Modifications and variations, of the specific illustrative embodiment herein shown and described, may be effected without departing from the inventive concepts; accordingly, the invention is not limited to the particular form or arrangement of parts herein shown and described.

What is claimed is:

1. A gas generator, comprising:

a casing;

a pair of rotor members which are rotatable relative to one another and relatively to the case;

a casing provided with gas inlet means, gas outlet means, and gas bypass means;

the rotor members being rotatable about a common axis and in parallel spaced planes, but the rotor members having piston vanes extending respectively from one rotor member toward the other rotor member and in a common plane;

the rotor members being provided with relatively movable location-relating means which supportingly locate the rotor members at various positions thereof relative to one another and to the casing;

the piston vanes on the two rotor members being located thereon in such a manner as to provide between adjacent ones of them movable chamber means which are expandible and contractable as an incident to the relative movement of the two rotor members;

the gas bypass means being provided in such a manner as to provide that in any one direction of stroke, gas is bypassed from at least one of the chambers which is being made smaller to communicate that chamber with a chamber which is being made larger, but there is no such bypass from at least one other of the chambers which is concurrently being made smaller.

2. The invention as set forth in claim **1** in a combination in which the rotor members' location-relating means includes a gear means connected to each of said rotor members and an idler gear means mounted in a manner fixed with respect to the casing yet turnable on its own axis and operatively interengaging the gear means respectively connected to each of the said rotor members.

3. The invention as set forth in claim **1** in a combination in which the gas generator is double-acting by an explosion occurring at the operative end of a stroke in which the piston vanes on one of the rotor members are approaching the piston vanes of the other of said rotor members from one rotational direction, and by a subsequent explosion occurring at the operative end of the stroke in which the piston vanes of the said one of the rotor members are approaching the piston vanes of the said other rotor member from the opposite rotational direction.

4. The invention as set forth in claim **1** in a combination in which there are at least four of said piston vanes of each rotor member.

5. The invention as set forth in claim **3** in a combination in which the gas bypass means are located with respect to the casing and to the region of rotational movement therein of the said rotor members such that the bypass means is non-symmetric with respect to the region of rotational movement of the said rotor members, providing that during a stroke of the rotor members in one relative direction the bypass means will bypass gas from the chamber means existing on one side of an adjacent piston vane as that chamber is decreasing in size, but that during the subsequent stroke of the rotor members in the other relative direction the bypass means will not bypass gas from the chamber means existing on the other side of the said adjacent piston vane even though that chamber is then decreasing in size.

6. The invention as set forth in claim **5** in a combination in which there are at least four of the said piston vanes of each rotor member.

7. The invention as set forth in claim **5** in a combination in which each of the rotor means are symmetric and uniformly spaced circumferentially but the locations of the bypass means are not uniformly spaced around the inner wall of the casing.

8. The invention as set forth in claim **5** in a combination in which each of the rotor means are symmetrically balanced.

References Cited

UNITED STATES PATENTS

3,451,382	6/1969	Huff	123—18
1,737,082	11/1929	Gough	92—122

FOREIGN PATENTS

547,593	9/1929	Germany	123—18 R

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R. H. LAZARUS, Assistant Examiner

U.S. Cl. X.R.

418—180; 123—18 R; 92—122