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(54) HYPOCYCLOID ROTARY INTERNAL COMBUSTION ENGINE

(57) The invention relates to a hypocycloid rotary internal combustion engine which includes: a stator (Z) containing an internal lobed triangular, cavity (A, B, C) which defines an inner periphery (PI); and an internal rotor (D) which is configured to be driven in the internal cavity (A, B, C) and which is provided with (i) an outer continuous curvilinear periphery (PE) which is configured to slide along the inner periphery (PI) as the rotor (D) rotates in the stator (Z) and (ii) connection elements for connecting the internal rotor (D) to the crank (E) of a power output crankshaft. According to the invention, the inner periphery (PI) takes the form of a continuous curvilinear periphery, while the outer periphery (PE) is in permanent contact at a series of points with the inner periphery (PI) in order to define a portion of the internal cavity (A, B, C), the portion of the internal cavity (A, B, C) having a variable volume during the rotation of the rotor (D).

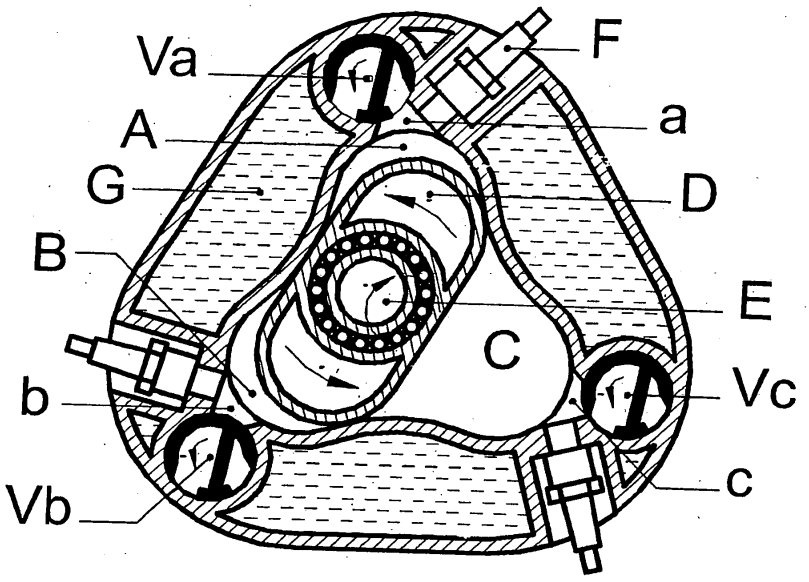

FIG. 9

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Description

Field of the Invention

[0001] The invention is comprised in the technical sector dedicated to internal heat combustion engines, more specifically those called explosion or spark ignition engines (SIE).

Background of the Invention

[0002] Conventional or reciprocating cylinder and piston-type heat engines, both explosion engines or gasoline spark ignition engines (SIE) and diesel or gas oil combustion ignition engines (CIE) are the most widely used heat engines in automotion and other fields.

[0003] The reciprocating rectilinear motion of the pistons in these engines is transformed into circular or rotating motion by means of the connecting rods and the crankshaft.

[0004] Pistons and connecting rods, as well as reciprocating motions making the balancing of the engine more difficult in order to prevent vibrations, are avoided with the present invention in which the rotor is directly coupled to a crankshaft.

[0005] Patent document DE 103 48 294 A1 describes a rotary engine similar to that of the invention but having different stator and rotor profiles and a different configuration for the distribution and feed system.

Description of the Invention

[0006] The present invention relates to a hypocycloid rotary heat engine of the type referred to as an explosion or spark ignition engine (SIE).

[0007] It comprises a curvilinear triangular shaped fixed body or stator with three chambers and planar covers, inside which chambers there is a rotor coupled to a crankshaft, the rotor maintaining permanent contact with the covers and with the profile of the stator in order to achieve tightness between these elements.

[0008] The rotor, twice as long as it is wide and with circular ends, is assembled in the crank pin of the crankshaft to which it transmits its circular orbital motion.

[0009] There is another small auxiliary chamber in the peripheral part of each of the chambers, referred to as a combustion or explosion chamber, where the sparkplug is included and which also communicates with the rotary valve.

[0010] The rotary valves, which perform the dual intake/exhaust function, are tubular, penetrating the air and fuel mixture at one of their ends when the intake stroke is carried out and the burned gases exiting at the other end after expansion to carry out the exhaust stroke.

[0011] The operating cycle of the engine has four strokes or phases: intake, compression, explosion-expansion and exhaust. The complete cycle is carried out in a single turn of the rotor corresponding to two turns of the crankshaft.

[0012] In the chambers, the pressure of the expansion resulting from the explosion of the mixture pushes the rotor and this makes the crankshaft rotate, thus transforming heat energy into mechanical energy.

[0013] The fuel to be used can be liquid or gas, in each case varying the fuel injection feed system to obtain suitable explosive mixtures.

[0014] This type of engine can be applied in different fields, such as automotion in general, generating energy and driving industrial and farm equipment.

[0015] The present invention thus has a series of advantages over the state of the art:

The rotating and at the same time circular orbital motion of the rotor is identical to that of a hypocycloid gear within the stator acting as a crown-wheel; obtaining as a favorable result that the angular and orbital velocities of the rotor are maintained constant for each rate of rotation of the crankshaft.

- The moment of inertia of the crankshaft with the coupled rotor does not vary in any of the positions which they adopt during the course of each revolution.
- With this configuration or architecture of the engine and the provided rotary valves, the static and dynamic balancing of the parts in motion is easily solved, obtaining-minimum vibrations at any rate of rotation.
- When carrying out the four-stroke cycle in each of the three chambers in a single turn of the rotor and two turns of the crankshaft, the engine can be compared to a reciprocating-type engine with three four-stroke cylinders, with the subsequent reduction in size, weight and number of parts.
- Upon having intake and exhaust valves compared to ports, the travel of the rotor in each stroke of the cycle is completely used, which improves the output.
- The profile type of the stator of the present invention makes it unnecessary to use slip segments for ensuring rotor-stator tightness.
- The ratio between the arm of the crankshaft and cubic capacity of the engine is greater in the present invention,

thus improving torque.

Brief Description of the Drawings

[0016] The sequence of Figures 1 to 8 shows a complete four-stroke or phase operating cycle corresponding to one turn of the rotor and to two turns of the crankshaft.

[0017] In order to know the position of the rotor in each figure one of its ends has been marked with a dot. The rotation of the rotor between one figure and the next is 45° and 90° for the crankshaft.

[0018] To better understand the operation, neither advances, overlaps or delays, nor early timing, have been taken into account in the figures with respect to the regulation or adjustment of the timing in opening and closing the valves, taking as reference only the top and bottom dead centers of the rotor in relation to each of the chambers.

[0019] The strokes or phases that each chamber is in are indicated below according to the order of the figures:

	Chamber A	Chamber B	Chamber C
Figure 1	Intake	Expansion	Compression
Figure 2	Intake	Exhaust	Explosion
Figure 3	Compression	Exhaust	Expansion
Figure4	Compression	Intake	Exhaust to be initiated
Figure 5	Expansion	Intake	Exhaust
Figure 6	Expansion	Compression	Intake to be initiated
Figure 7	Exhaust	Compression	Intake
Figure 8	Exhaust	Expansion	Compression to be initiated

[0020] Figure 9 shows a section view of an engine of the invention.

Description of a Preferred Embodiment of the Invention

[0021] In order to make an engine prototype, the stator, its closing covers, the rotor and the valves are to be made of alloy steel, similar to that which is used for cylinders in reciprocating engines, machining fine finishes in the surfaces in contact with the rotor and the valves.

[0022] A cut has been made at each of the ends of the rotor and such ends have been closed with straight segments to ensure the tightness with the stator to absorb the thermal expansions in the rotor; said cuts and segments have not been described in the drawings to simplify and improve the understanding thereof. The coupling with the crankshaft has been provided with bearings.

[0023] The crankshaft, also made of alloy steel suitable for these types of parts, must be constructed in at least two halves in order to be able to assemble the rotor. The driving force caused by the engine will be taken from one end of the crankshaft and the other end will move by means of gear-tooth belts and pulleys, the rotary valves, as well as the necessary auxiliary elements for adapting the chosen ignition and fuel injection systems on the market.

[0024] Lubrication can be carried out by means of an oil circulating pump with a crankcase.

[0025] An embodiment of the invention thus relates to a hypocycloid rotary internal combustion engine having:

a stator (Z) having an internal lobed triangular cavity (A, B, C) which defines an inner periphery (PI);
an internal rotor (D) configured to be driven in the internal cavity (A, B, C) by a combustion with a combustion agent and fuel mix, said rotor (D) having:

an outer continuous curvilinear periphery (PE) which is configured to slide along the inner periphery (PI) during the rotation of the rotor (D) in the stator (Z);
connection means for connecting the internal rotor (D) to a crank (E) of a power output crankshaft;

characterized in that:

the inner periphery (PI) takes the form of a continuous curvilinear periphery;
the outer periphery (PE) is in permanent contact at a plurality of points with the inner periphery (PI) in order to define a portion of the internal cavity (A, B, C), the portion of the internal cavity (A, B, C) having a variable volume during the rotation of the rotor (D).

[0026] The engine of the invention further comprises a combustion chamber (a, b, c):
in communication with each lobe of the internal cavity (A, B, C) through the inner periphery (PI); having:

intake means (Va, Vb, Vc) for taking in a reactant selected among:

a combustion agent; and
fuel and a combustion agent;
exhaust means (Va, Vb, Vc) for expelling exhaust gases produced in a combustion of the mixture.

[0027] The combustion chamber (a, b, c) is located in a vertex of the lobed triangular shape.
[0028] The exhaust means are formed by a rotary circular valve (Va, Vb, Vc) having: a circular intake segment (SA) having an intake arc (AA) for allowing a reactant to enter from an intake manifold into the combustion chamber (a, b, c); and a circular exhaust segment (SE) having an exhaust arc (AE) for allowing an exhaust gas outlet from the combustion chamber (a, b, c) to an exhaust manifold;
wherein:

the circular intake segment (SA) and the circular exhaust segment (SE) are separated by a partition (Vt);
the circular intake segment (AA) is larger than the circular exhaust segment (AE).

[0029] The engine further comprises:

an injector (Y) in each combustion chamber (a, b, c) for injecting fuel under pressure in each combustion chamber (a, b, c).

[0030] Any engine additionally comprises:

a sparkplug (F) in each combustion chamber (a, b, c) to cause the combustion of the mixture.

[0031] The stator further comprises a plurality of cooling lines (G) for circulating coolant fluid located between an inner wall (IW) rounding the inner periphery (PI) and an outer wall (OW) defining the outer contour of the engine.
[0032] The engine also comprises:

two planar closing covers in a first plane and in a second plane perpendicular to the crank (E) of the crankshaft.

Claims

1. A hypocycloid rotary internal combustion engine having:

a stator (Z) having an internal lobed triangular cavity (A, B, C) which defines an inner periphery (PI);
an internal rotor (D) configured to be driven in the internal cavity (A, B, C) by combustion with a combustion agent and fuel mix, said rotor (D) having:

an outer continuous curvilinear periphery (PE) which is configured to slide along the inner periphery (PI) during the rotation of the rotor (D) in the stator (Z);
connection means for connecting the internal rotor (D) to a crank (E) of a power output crankshaft;

characterized in that:

the inner periphery (PI) takes the form of a continuous curvilinear periphery;
the outer periphery (PE) is in permanent contact at a plurality of points with the inner periphery (PI) in order to define a portion of the internal cavity (A, B, C), the portion of the internal cavity (A, B, C) having a variable volume during the rotation of the rotor (D).

2. The engine of claim 1, further comprising a combustion chamber (a, b, c):

in communication with each lobe of the internal cavity (A, B, C) through the inner periphery (PI);
having:

intake means (Va, Vb, Vc) for taking in a reactant selected among:

a combustion agent; and
fuel and a combustion agent;

exhaust means (Va, Vb, Vc) for expelling exhaust gases produced in a combustion of the mixture.

3. The engine of claim 2, wherein the combustion chamber (a, b, c) is located in a vertex of the lobed triangular shape.

4. The engine of any of claims 2-3, wherein the intake means and the exhaust means are formed by a rotary circular valve (Va, Vb, Vc) having:

a circular intake segment (SA) having an intake arc (AA) for allowing a reactant to enter from an intake manifold into the combustion chamber (a, b, c); and
a circular exhaust segment (SE) having an exhaust arc (AE) for allowing an exhaust gas outlet from the combustion chamber (a, b, c) to an exhaust manifold;

wherein:

the circular intake segment (SA) and the circular exhaust segment (SE) are separated by a partition (Vt);
the circular intake segment (AA) is larger than the circular exhaust segment (AE).

5. The engine of any of claims 1-4, further comprising:

an injector (Y) in each combustion chamber (a, b, c) for injecting fuel under pressure in each combustion chamber (a, b, c).

6. The engine of any of claims 1-5, further comprising:

a sparkplug (F) in each combustion chamber (a, b, c) to cause the combustion of the mixture.

7. The engine of any of claims 1-6, wherein the stator further comprises a plurality of cooling lines (G) for circulating coolant fluid located between an inner wall (IW) rounding the inner periphery (PI) and an outer wall (OW) defining the outer contour of the engine.

8. The engine of any of claims 1-7, further comprising:

two planar closing covers in a first plane and a in a second plane perpendicular to the crank (E) of the crankshaft.

FIG. 1

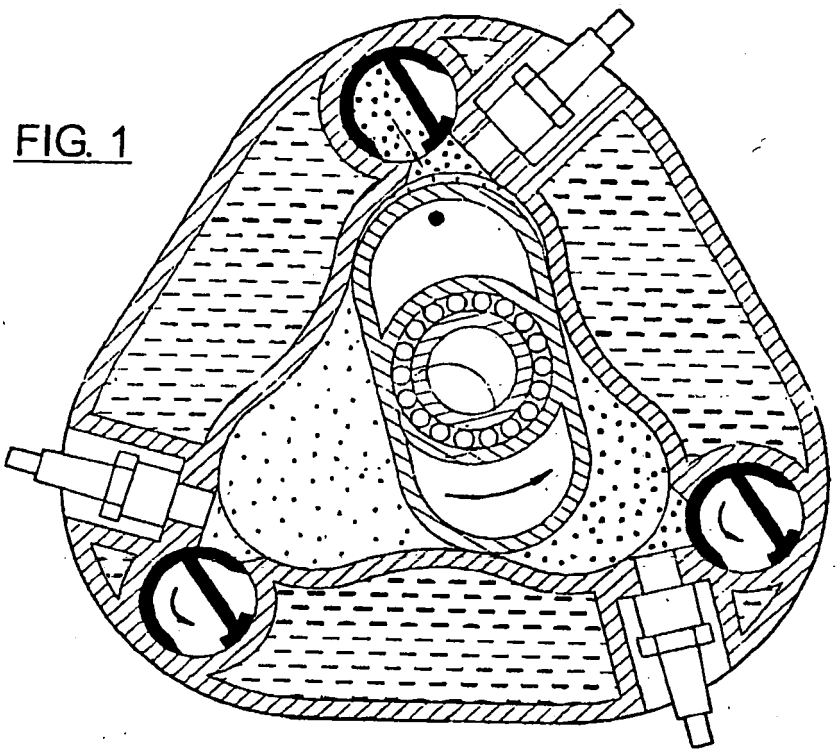


FIG. 2

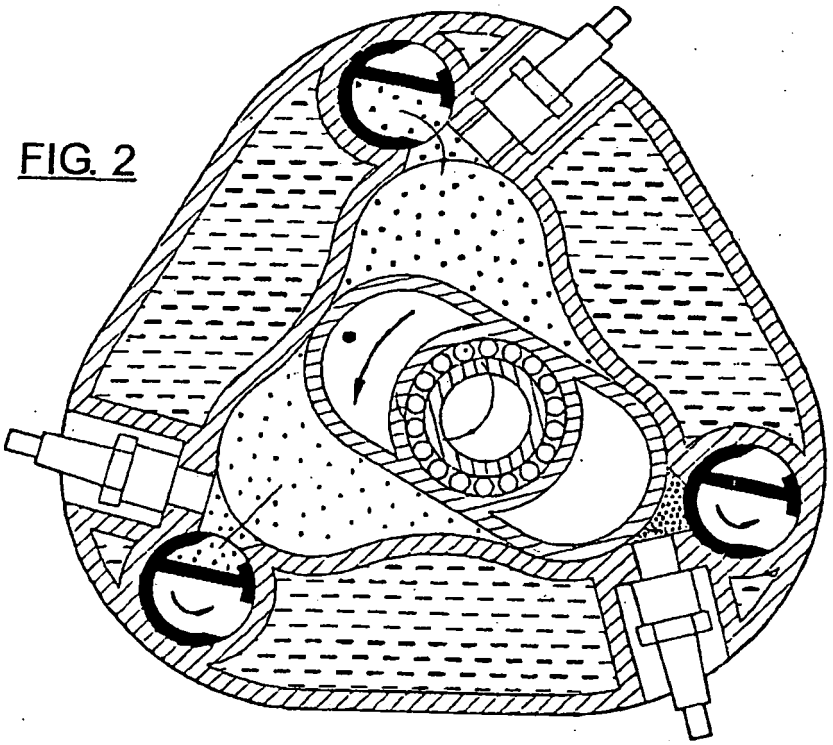


FIG. 3

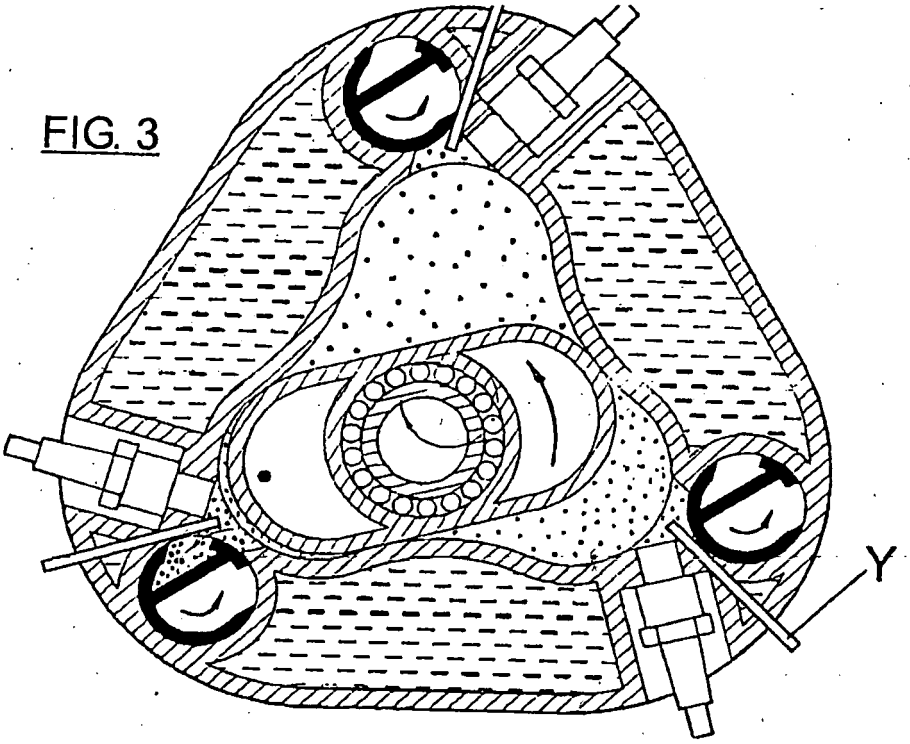


FIG. 4

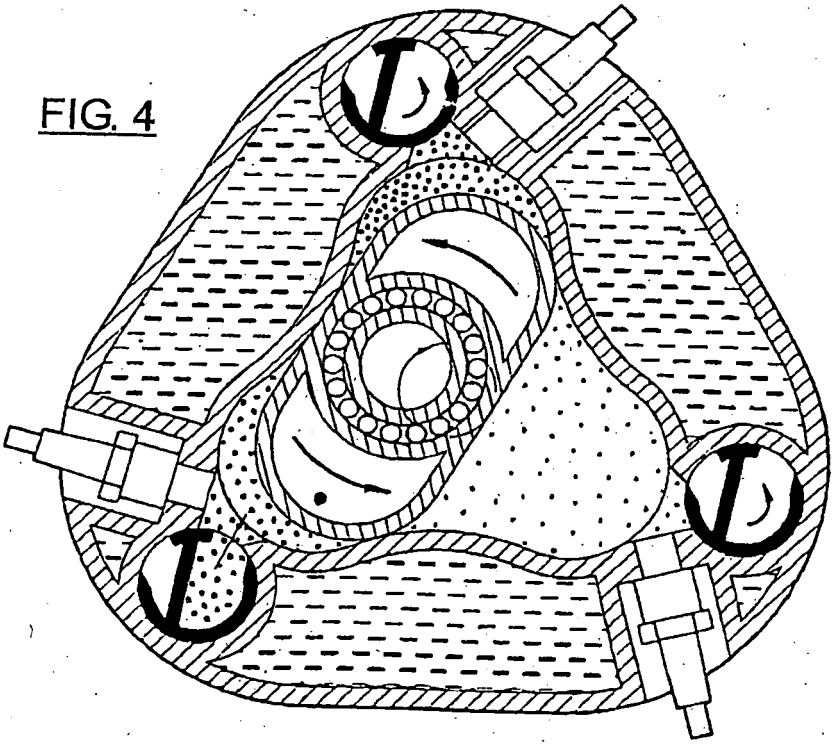
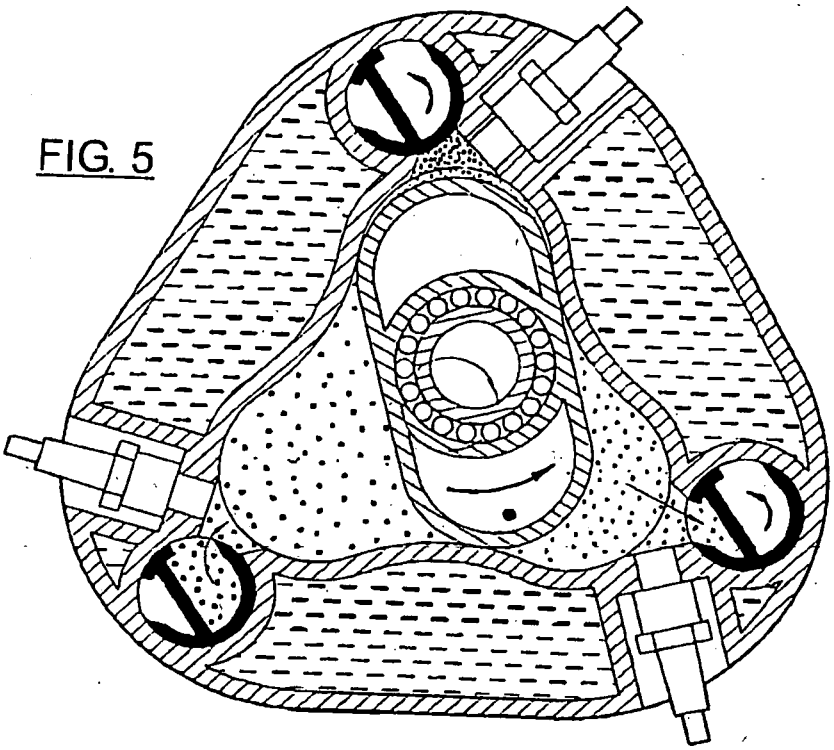


FIG. 5



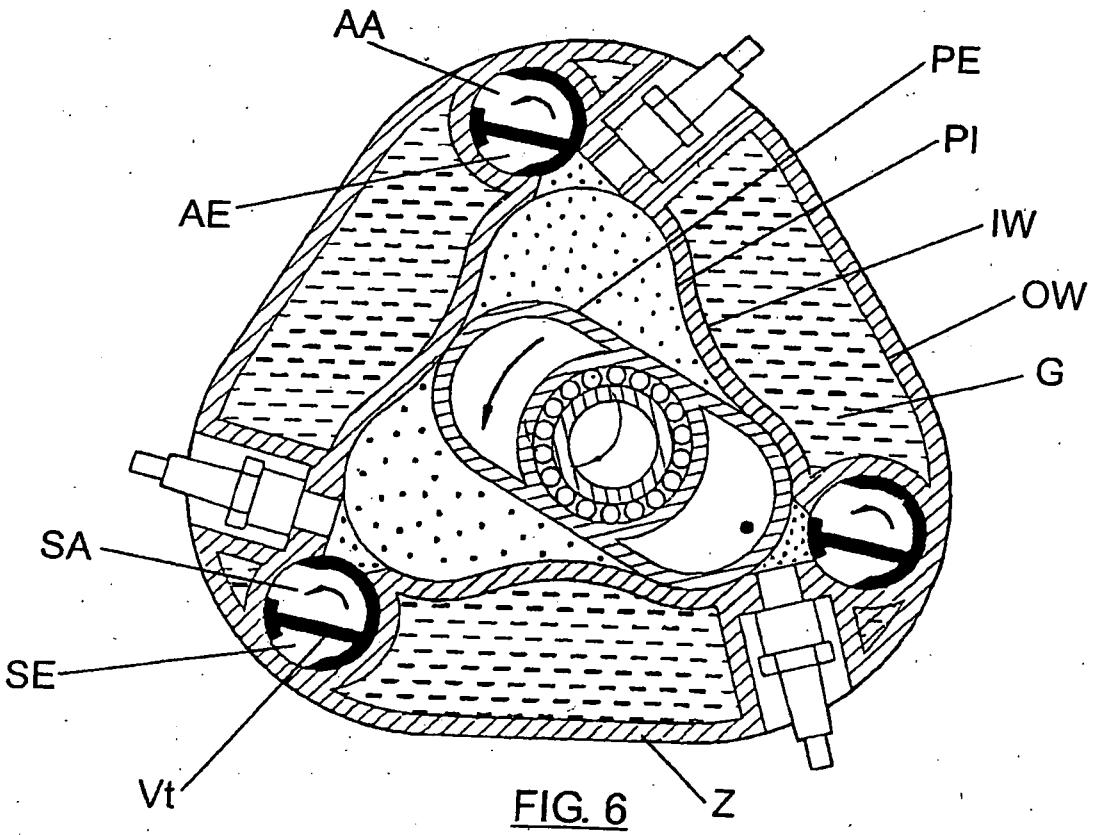


FIG. 6

FIG. 7

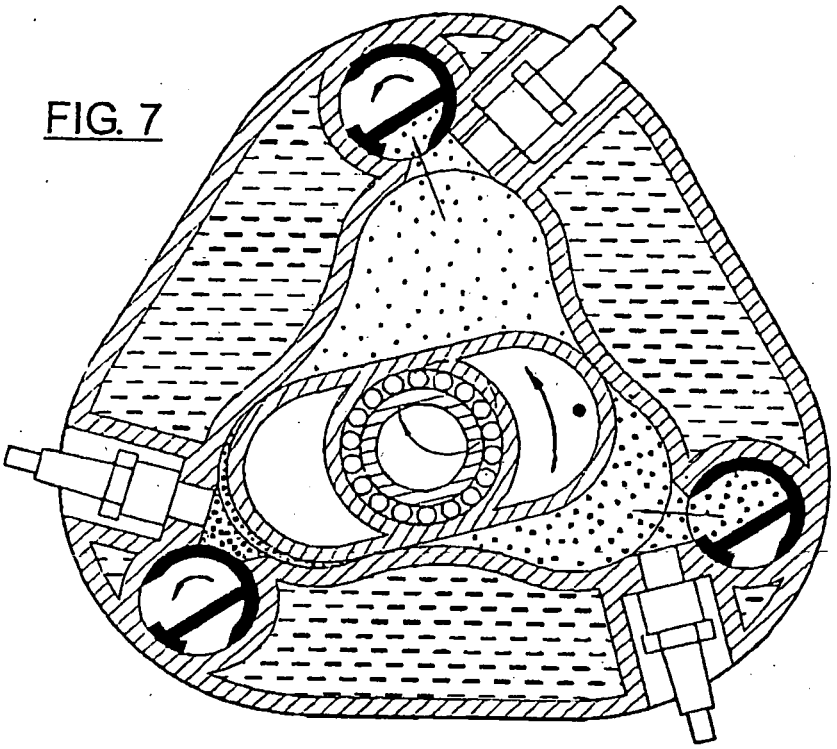
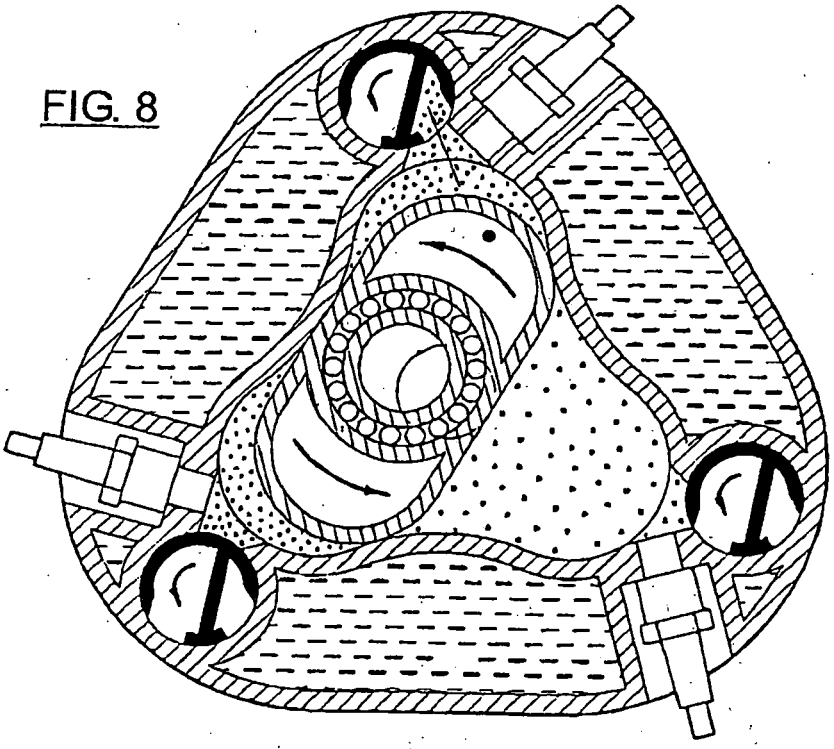


FIG. 8



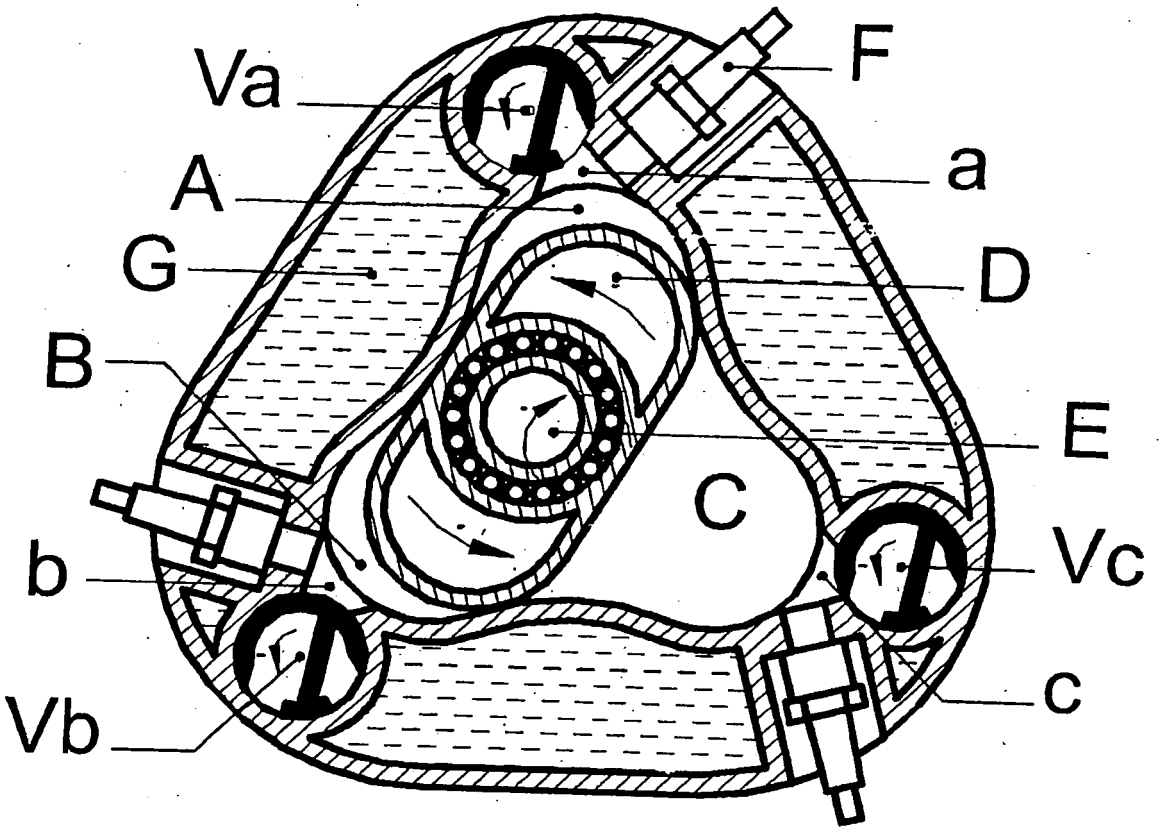


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ ES 2006/000649

A. CLASSIFICATION OF SUBJECT MATTER

F01C 1/10 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01C, F02B, F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CIBEPAT,EPODOC,WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 4209607 A1 (ECKERT ROLF) 13.08.1992, column3, line 3 - column 5, line 18; figures.	1-3,5-8 4
Y	US 2853980 A (ZIMMERMAN) 30.09.1958, column 3, lines 52-63; figures 2-4.	4
X A	US 3288121 A (LINDER RENE) 29.11.1966, column 11, line 29 - column 14, line 31; figures.	1-3,5-8 4
X A	GB 961872 A (GIRODIN MARIUS GEORGES HENRI) 24.06.1964, page 5, lines 1-124; figures.	1,5-8 2,3
X A	US 3246835 A (LINDER RENE) 19.04.1966, column 4, line 25 - column 5, line 15; figures.	1-3,5-8 4
A	JP 53105710 A (EBARA MFG) 14.09.1978, abstract; figures.	1,4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2007 (10.04.2007)	
Name and mailing address of the ISA/ O.E.P.M. Paseo de la Castellana, 75 28071 Madrid, España. Facsimile No. 34 91 3495304	Authorized officer J. Galán Mas Telephone No. +34 91 349 55 21

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/ ES 2006/000649

Patent document cited in the search report	Publication date	Patent family member(s)	Publication date
DE4209607 A	13.08.1992	NONE	----------
US2853980 A	30.09.1958	NONE	----------
US 3288121 A	29.11.1966	CH 385404 A GB 989588 A	15.12.1964 22.04.1965
GB 961872 A	24.06.1964	FR 1278136 A	08.12.1961
US3246835 A	19-04-1966	NONE	----------
JP53105710 A	14.09.1978	NONE	----------

Form PCT/ISA/210 (patent family annex) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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