(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 009 232 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
31.12.2008 Bulletin 2009/01

(21) Application number: **07730500.1**

(22) Date of filing: **20.03.2007**

(51) Int Cl.:
F01B 5/00 *(2006.01)*

(86) International application number:
PCT/ES2007/070060

(87) International publication number:
WO 2007/107617 (27.09.2007 Gazette 2007/39)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(30) Priority: **23.03.2006 ES 200600752**

(71) Applicant: **Ruiz Martinez, Francisco Javier**
07193 Palmanyola, Baleares (ES)

(72) Inventor: **Ruiz Martinez, Francisco Javier**
07193 Palmanyola, Baleares (ES)

(74) Representative: **Urizar Anasagasti, Jesus Maria**
Po de la Castellana, 72 - 1o
28046 Madrid (ES)

(54) HYBRID ROTARY ENGINE

(57) **Hybrid rotary engine** with tangential pistons that can operate, without distinction, as a two-stroke heat engine with spontaneous or controlled explosion or with compressed air, in which modification of the method of operation of the inlet valve (6) and the addition of a valve (4) in the cylinder head and another in the rear chamber (2), plus a fuel cut-off valve (3) and a distributor (5), in addition to the corresponding pneumatic system, make it possible for it to operate, without distinction, as conventional heat engine or by means of compressed gases, and the changeover from one type of operation to the other does not require any transition, the valves being able to operate pneumatically and/or electromechanically.

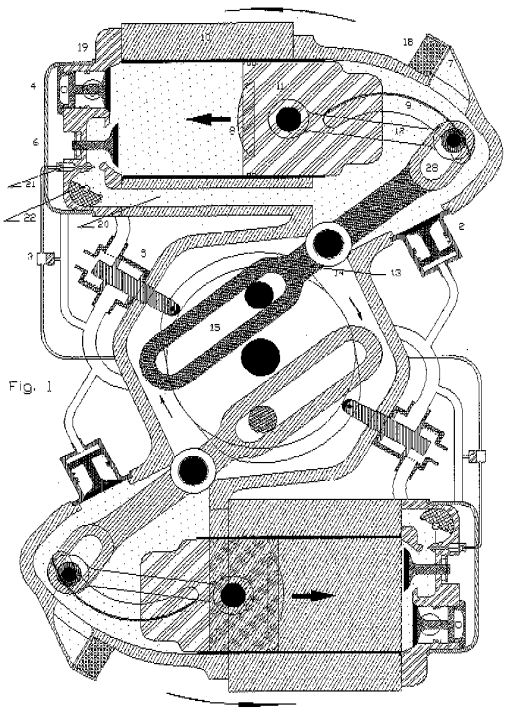


Fig. 1

EP 2 009 232 A1

Description

Object of the invention

[0001] The present specification refers to a rotary, two-stroke engine, with tangential cylinders incorporating a mechanism that enables it to work by means of compressed gas. In this way, some of or all the cylinders can work alternately as an internal combustion engine or by means of compressed gas. In addition, it includes other mechanisms that improve its performance.

Background to the invention

[0002] Rotary engines with tangential pistons, currently under development, are heat engines with cylinders placed tangentially to the axis of rotation. They are comprised of a block with cylinders, pistons and connecting rods, as well as other elements for their control and regulation The crankshaft is placed in the centre of the assemblage and the cylinders are arranging tangent to the axis of rotation. The pistons transmit movement to the crankshaft by means of a lever articulated in two arms which rotate on an intermediate shaft: the outer arm is joined to the piston by means of a connecting rod and the inner arm has a slot where the crankshaft pivot slides. This arrangement causes the length of the arm's lever to vary continuously due to the rotation of the crankshaft, thus modifying the relationship between both arms.

[0003] Also, since the block with all the elements, as well as the crankshaft, rotate (but in opposite directions), and they are joined by gears to a common shaft, considerable effort is required to move the whole unit during starting.

[0004] The present invention proposes to introduce a mechanism that allows this type of engine to operate with compressed gas. On the other hand, measures are proposed to improve the effort relationship between the arms of the articulated lever, and also to avoid the necessity to pull the block including all its elements during starting.

[0005] The invention is based on the development of the engine with tangential pistons: Patents P9200867, CA9400571, P200401019 and requested PCT/ES2005/070047.

Description of the invention

[0006] The working of this engine with two-stroke internal combustion, is as follows: on starting, the crankshaft, by means of the articulated lever and the connecting rod, moves the piston forwards, drawing air into the rear chamber through a one-way valve; this air becomes pressurized when the piston inverts its motion, And then it opens the admission valve, entering into the combustion chamber. When the piston changes direction again, this air, now inside the combustion chamber, is compressed and, with the addition of fuel, starts the heat cycle, with spark-ignition or compression-ignition.

[0007] The inlet valve, designed to operate as an internal combustion engine, in order to open and close, works by pressure differential, since it incorporates a spring in the closing direction, also it can be controlled electro-mechanically.

[0008] In order to work as a hybrid motor, (internal combustion-compressed gas) a mechanism, with several elements normally operated by compressed gas, although they can also be operated and/or controlled electro-mechanically, Ins been incorporated. This mechanism consists of an outer pressurized gas circuit, with a shutoff valve and a flow regulating valve, (worked by the accelerator for power control during operation with compressed gas); a rotary joint coupled to the forward rotation shaft where the gas enters the motor, and an internal circuit with a distribution valve, a valve to relieve the pressure in the cylinder's rear chamber, a valve to cut off the fuel to the engine, and a valve to allow the gas to enter and leave the expansion chamber. The distribution valve is controlled by a cam operated by the crankshaft and it has two functions: to open and close the gas valve to the expansion chamber at the right moment, and to allow the residual gas to be expelled, in order to avoid any resistance during the backward movement of the piston.

[0009] When the shutoff valve opens, the gas under pressure enters the engine by an rotary union, and it reaches the distribution valve, opens the valve which relieves the pressure in the cylinder's rear chamber, closes the fuel shut off valve, and opens the gas inlet valve to the cylinder. The distribution valve controls the gas flow which acts on the piston, and this transmits the energy to the crankshaft by means of the connecting rod and the articulated lever. When the shutoff valve for the compressed air is closed, the operation reverts to the previous condition, and no transition is necessary to change from one mode of operation to another.

[0010] A slot has been bored in the outer arm of the articulated lever, which modifies the union of the connecting rod with the lever. This slot is orientated such that, together with a lateral guide (the arc made by the ann makes sliding easier), it determines the support point of the connecting rod pivot, and means hat the arm of the lever increases as its moves away from the cylinder (expansion) and decreases during the return stroke (compression), thus improving the performance of the engine in both configurations.

[0011] The union of the crankcase and the crankshaft is by means of a differential; therefore, both elements can rotate at different speeds. It is proposed to connect the crankcase with its transmission gear by means of a one-way clutch; and this means that only the crankshaft operates during starting, thereby reducing the power needed. This mechanism allows maintenance operations to be carried out without any difficulty.

Description of the drawings

[0012] To complement the description, and in order to

understand the characteristics of the invention better, a set of drawings is attached to the present specification, as an integral part thereof, with an illustrative and non-limiting character, as follows:

Figure 1 shows a plan view of a two-cylinder hybrid rotary engine with tangential pistons.

Figure 2 shows a section of a two-cylinder hybrid rotary engine and the union gears of both shafts.

Figure 3 shows a scheme of the pneumatic system and the elements necessary for the operation of the engine with compressed air, arranged in both phases: Expansion and Backward Movement.

Figure 4 shows a diagram of the location of the mechanisms and the position of the valves during the operation as a heat engine, in four differentiated phases.

Figure 5 shows a plan view of a two-cylinder hybrid rotary engine with the position of the valves operated with compressed air during the expansion stage.

Figure 6 shows a plan view of a two-cylinder hybrid rotary engine with the position of the valves operated with compressed air during the piston's backward movement phase.

Figure 7 shows a plan view of a hybrid rotary engine with four cylinders, two equipped to operate as hybrids and two only as internal combustion, meaning that two cylinders could work by compressed air and two others with a heat cycle, or all four could work in this latter way.

Figure 8 shows the way the crankcase's shaft is connected to the differential and the crankshaft by means of two pinions.

Figure 9 shows a section of the rear chamber of the cylinder with the lateral guides that define the support point for the connecting rod shaft in the slot of the outer arm of the articulated lever.

Preferred embodiment of the invention

[0013] As can be observed in the attached figures, the preferred embodiment of a hybrid rotary engine, based on the tangential piston engine, is comprised of a crankcase, which contains the cylinders (10) where the pistons are located (11) that are joined by a connecting rod (12) to the outer arm of an articulated lever with two arms (13), which rotates around the pivot (14), and pulls the crankshaft pivot with its internal arm, that slides through the slot (15) also located in the arm, thus transforming the reciprocating motion of the piston to the rotary motion of the crankshaft.

[0014] The crankcase turns to the left and the crankshaft turns to the right, and both are joined to the exit shaft (16) by a gear train (17). A slot (28) has been bored in the outer articulated lever's arm and the crankcase has a lateral guide (9), which means that the union with the connecting rod is not at one fixed point but that the shaft slides through the slot, positioned by the lateral guide, thus varying the length of the lever arm according to the position of the piston.

[0015] The one-way valve (7) is situated in the cylinder's rear chamber and allows the air to enter into this area through a filter (18), where there is also the depressurization valve (2); the exhaust nozzle (8) is located inside the cylinder at the end of the combustion chamber. The compressed air inlet valve (4) is in the cylinder head (19), and the admission valve (6) is connected by means of a duct (20) with the cylinder's rear chamber. For engines with controlled ignition, the fuel injector (21) and a valve (22) that regulates the air flow are in this duct, at the inlet to the admission valve. The distribution valve (5) is coupled to the motor's crankcase, and this controls the inlet of compressed air to the cylinder, which is operated by a cam moved by the crankshaft, as well as the fuel shutoff valve (3). The rotary union (1) is coupled to the crankcase's forward shaft, at which point the pressurized gas enters, as well as the fuel feed. The clutch (24) that is in the rear shaft, joins the crankcase to the wheel crown (23) of the differential (17), which is connected by means of pinions (25 and 26) to the crankshaft (16). The whole unit rotates and is supported by the front bearing (27) and by the differential's housing.

[0016] A more extensive description than this one is not considered necessary so that any relevant expert can understand the scope of the invention and the advantages it implies.

[0017] The terms under which this description has been written will have to be taken in a broad unlimited sense.

Claims

1. **Hybrid rotary engine;** that consists of a two-stroke rotary engine with tangential pistons, which it is composed of a block that contains two or more cylinders arranged tangentially to the axis of rotation where the pistons move and that transmit the movement to the crankshaft by means of a lever articulated in two arms; an outer one joined to the piston by means of a connecting rod and another that has a slot where the crankshaft pivot slides. The block with all the components turns in one direction and the crankshaft in another, and both are joined to a common shaft by means of gears. Characterized because it is fitted with a pneumatic mechanism that allows it to work with compressed air. The air pressure circuit is controlled by a shutoff valve and a regulator operated by the accelerator that controls the power during operation with compressed air, which passes into the engine crankcase through a rotary joint via the forward rotary shaft, acting on a pressure relief valve that opens the cylinder's rear chamber, a valve that cuts the fuel to the motor, opens the air valve at the entrance to the expansion chamber and provides pressure to the distribution valve. The latter is con-

trolled by a cam worked by the crankshaft and it has two functions, to open and close the passage of air to the expansion chamber at the right moment, and allow the expulsion of the remaining air, thus avoiding any resistance during the backward movement of the piston. The inlet valve for the thermal cycle operates by pressure differential (and is slightly under load from a spring in the closing direction) and its operation is cancelled when the depressurization valve in the cylinder's rear chamber opens. Operation with compressed air can revert to conventional operation with a lack of air flow or due to closure of the shutoff valve.

2. **Hybrid rotary engine;** according to claim 1, **characterized** because a slot has been incorporated in the outer arm of the articulated lever that modifies the union of the connecting rod with the lever. The slot has an inclination that, in conjunction with a lateral guide, defines the support point of the connecting rod shaft, in such a way that the arm of the lever increases as it moves away from the cylinder and becomes smaller during compression, thus improving the performance of the engine in both configurations.

3. **Hybrid rotary engine;** according to claim 1, **characterized** because the link of the block shafts and the crankshaft carries out itself by means of an differential and, as a consequence, both components rotate at different speeds, with the relationship between them being adjusted as required, and the block's connection to its transmission gear is made by means of a mechanism that allows rotation between them only in one direction, which means that starting only acts on the crankshaft, thereby appreciably reducing the effort needed, and valve opening for operation with air is also reduced in the same way. This mechanism makes it easy to service and tune the engine.

4. **Hybrid rotary engine;** according to claims 1, 2 and 3, **characterized** because the control valves for operation with compressed air, and the inlet valve, are worked electro-mechanically.

Amended claims under Art. 19.1 PCT

1. Hybrid rotary engine; that consists of a balanced rotary engine with the cylinders tangential to the axis of rotation, which works as a two-stroke cycle, composed of a block and two or more cylinders (10), in which the pistons (11) move and operate the crankshaft by means of an articulated lever (13) with two arms, which rotate on a shaft (14); the block is comprised of a central isolated chamber, where the crankshaft and inner arms of the articulated levers are situated, and two or more chambers, (one for each cylinder) that conform to the rear part of the cylinders, where the outer arm of the articulated lever and the one-way air inlet valve (7) are situated, separated from the central chamber by the shaft where the articulated lever rotates. The piston is joined to the outer arm of the articulated lever by means of a connecting rod (12) and the crankshaft's pivot slides through a slot (15) bored in the lever's inner arm. When movement starts, the sliding of the crankshaft pivot through the inner arm's slot causes an oscillating motion in the articulated lever, which turns on its shaft, displacing the piston lineally; in its forward motion this causes air to be drawn into the rear of the cylinder through a one-way valve (7) and when it moves back, this air is compressed and injected into the combustion chamber through a duct (20) and an inlet valve (6) placed in the cylinder head that closes the forward part of the cylinder. The fuel injector for internal spontaneous combustion engines (diesel cycle) or the mixture mechanism, including gas flow regulation and the distributor, for spark ignition, are in the cylinder head. The cylinder is supplied with an exhaust nozzle (8) which allows the gases to escape when the piston reaches the ending of its rearward coursed but remains closed during the forward course by the piston itself and an incorporated skirt, specifically designed for this purpose.
The crankcase with all its constituent parts (cylinders, cylinder head, pistons, connecting rods and other mechanisms) turns in one direction and the crankshaft turns in another, and both are joined to a common shaft by means of gears. It is **characterized because** in the previously described engine, some modifications and mechanisms have been incorporated that improve its performance and mean that some or all of the cylinders can operate with compressed gases, which is the aim of this invention. Thus, the operation of the inlet valve (6), which works mechanically and is designed for operation as a thermal engine, has been modified in order to function through a pressure differential and/or by an electromechanical system, in order to control the cycle. In each of the cylinders designed to operate with this hybrid system, the following elements have been added: an overhead valve (4) that allows the entry of compressed gas into the cylinder with subsequent discharge of the residual gas; a valve (2) situated in the cylinder's rear chamber, that avoids the pressurization of this area, minimizing the resistance due to piston displacement; a valve (3) to cut off the fuel and a regulator valve (5), which controls the cycle of the entry of compressed gas to the expansion chamber and allows the exit of the trapped gas to the exterior, when the piston closes the exhaust nozzle. In addition, an external pneumatic system has been added with a shutoff valve to activate and deactivate the system, a regulator valve, connected to the ac-

celerator for controlling the power during operation with compressed gas and a rotary union (1), placed on the forward shaft, which allows the entry of the gas to the engine.

2. Hybrid rotary engine; according to claim 1, **characterized** because a slot (28) has been bored in the articulated lever's outer arm that modifies the support point of the connecting rod with this lever. This slot, because of its design and lateral guide (9), defines the support point of the connecting rod shaft, so that the arm of the lever increases as it moves away from the cylinder (expansion) and decreases during the return (compression), improving the performance of the engine so much if it works like a thermal engine or it is performed on by means of compressed gas..

3. Hybrid rotary engine; according to claims 1 and 2, **characterized** because the union of the crankcase (23) gear with its drive shaft is through a one-way clutch (24), in such a way that the crankcase is not pulled by the crankshaft's axle, but it is allowed to operate on it when it turns in the opposite direction.

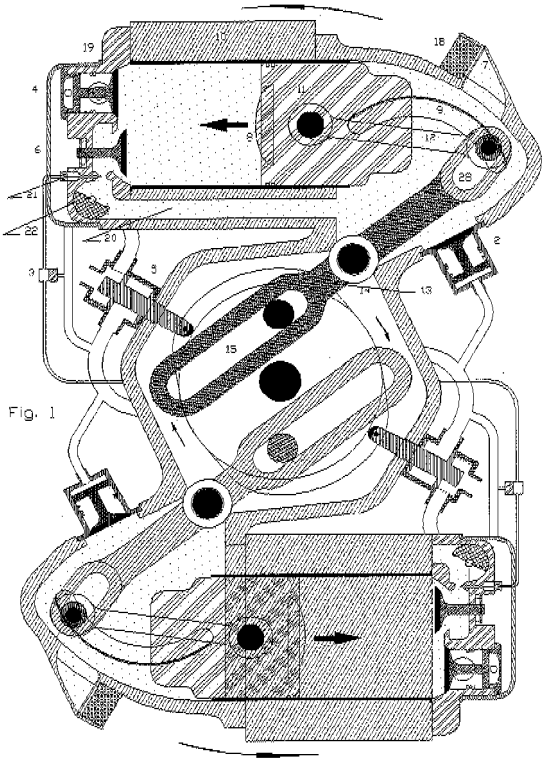


Fig. 1

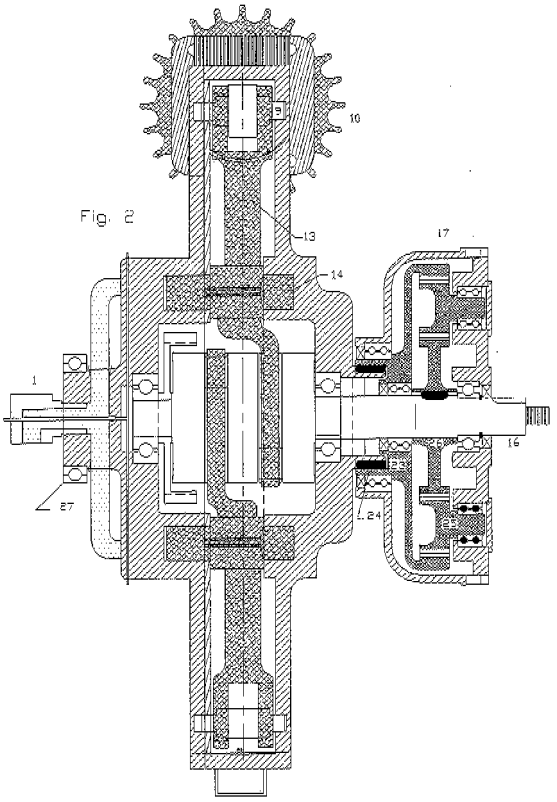


Fig. 2

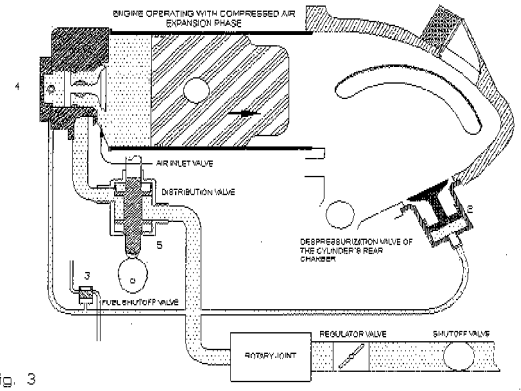
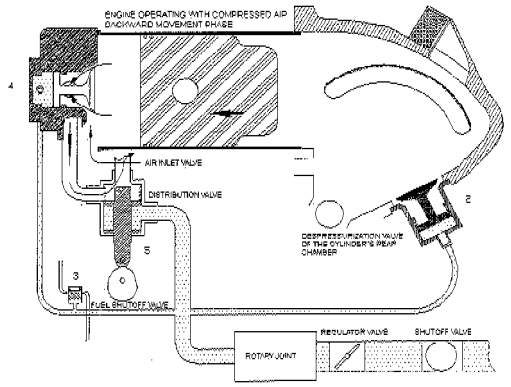

ENGINE OPERATING WITH COMPRESSED AIR EXPANSION PHASE
AIR INLET VALVE
DISTRIBUTION VALVE
DEPRESSURIZATION VALVE OF THE CYLINDER'S REAR CHAMBER
FUEL SHUTOFF VALVE
REGULATOR VALVE
SHUTOFF VALVE
ROTARY JOINT

Fig. 3


ENGINE OPERATING WITH COMPRESSED AIR BACKWARD MOVEMENT PHASE
AIR INLET VALVE
DISTRIBUTION VALVE
DEPRESSURIZATION VALVE OF THE CYLINDER'S REAR CHAMBER
FUEL SHUTOFF VALVE
REGULATOR VALVE
SHUTOFF VALVE
ROTARY JOINT

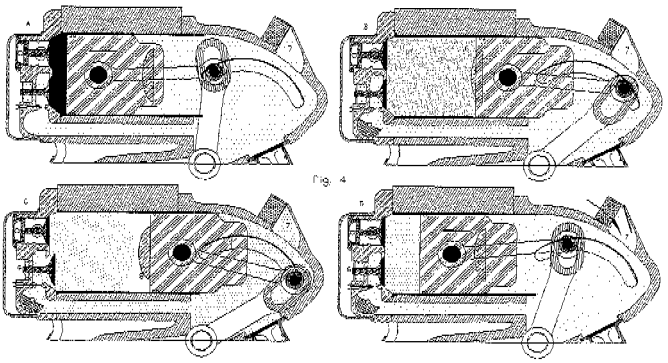


Fig. 4

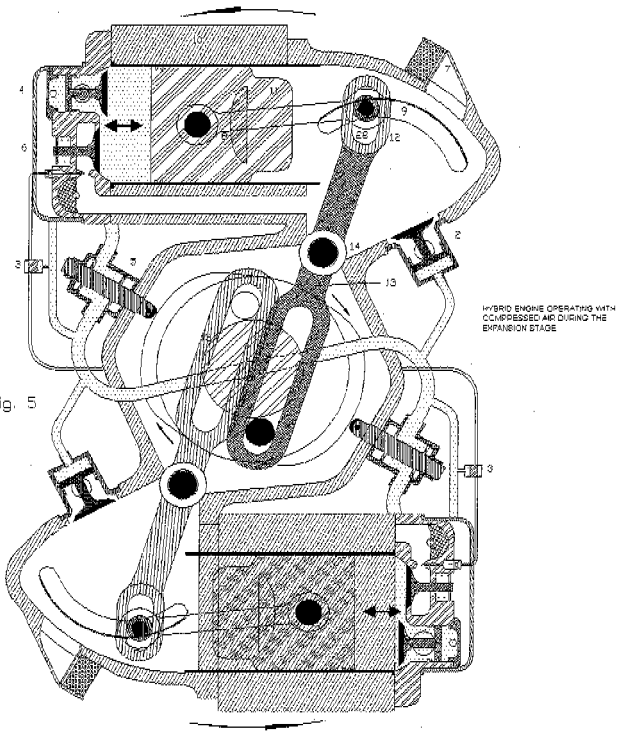

HYBRID ENGINE OPERATING WITH COMPRESSED AIR DURING THE EXPANSION STAGE

Fig. 5

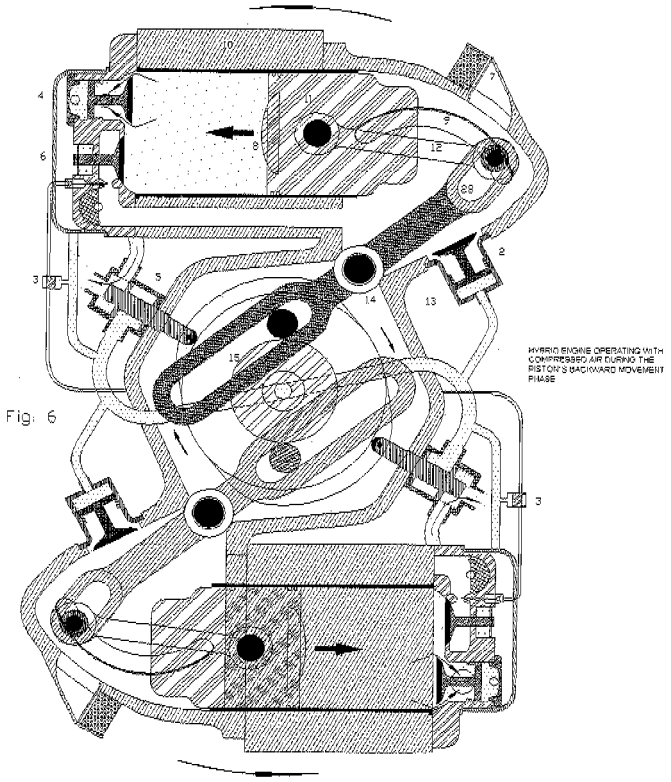

HYBRID ENGINE OPERATING WITH COMPRESSED AIR DURING THE PISTON'S BACKWARD MOVEMENT PHASE

Fig. 6

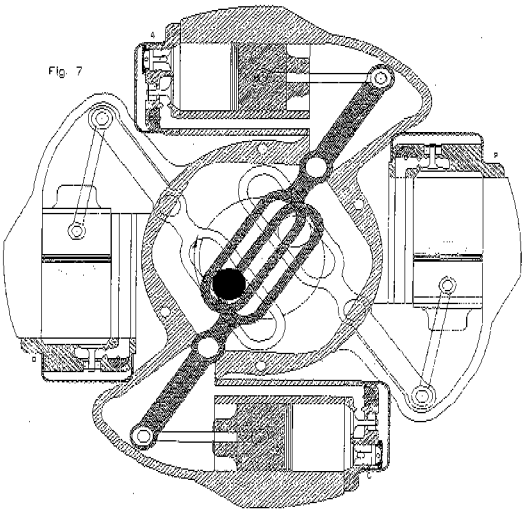


Fig. 7

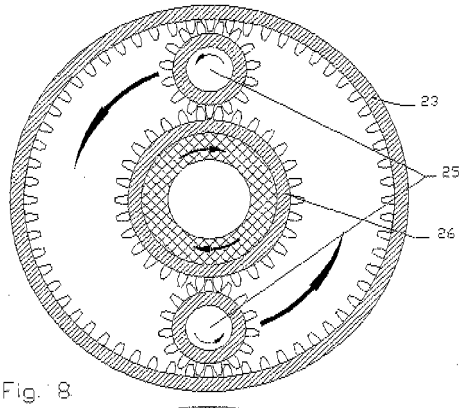
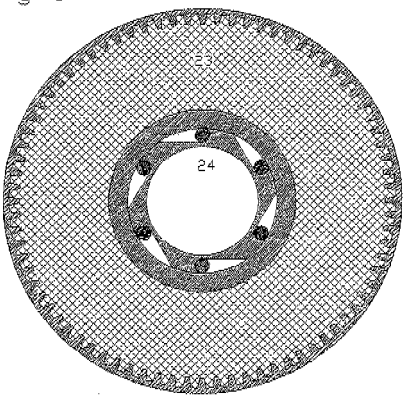


Fig. 8



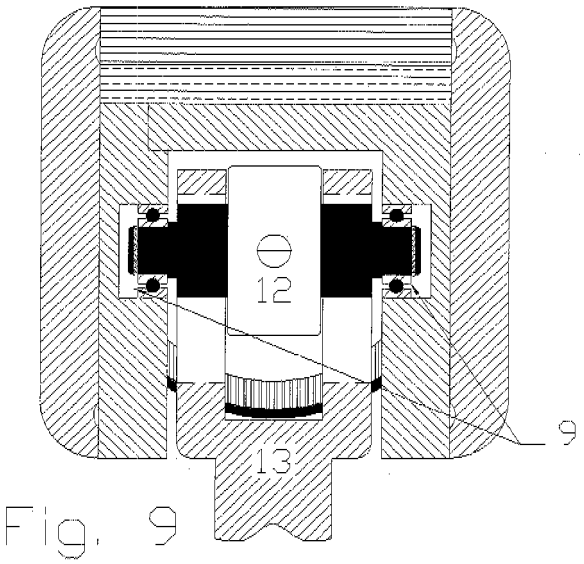


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ ES 2007/070060

A. CLASSIFICATION OF SUBJECT MATTER

F01B 5/00 (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)
F01B,F02B,F02M

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.
A	WO 2005106203 A1 (RUIZ MARTINEZ FRANCISCO JAVIER) 10.11.2005, the whole document.	1
A	GB 191204068 A (NEIGHBOUR ARTHUR GEORGE LLOYD) 13.02.1913, the whole document.	1,3
A	US 5992390 A (MOYER) 30.11.1999, column 4, line 10 - column 6, line 52; figure.	1
A	US 2005182553 A1 (MILLER et al.) 18.08.2005, paragraphs [52-53]; paragraphs [73-76]; figures.	1,4
A	JP 55046075 A (SHIMOOKA TADAO) 31.03.1980, abstract; figure.	1
A	US 1572541 A (LAWRENCE) 09.02.1926, the whole document.	1

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance.
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure use, exhibition, or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents , such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12.July.2007 (12.07.2007)	16/07/2007
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 2007)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/ ES 2007/070060

Patent document cited in the search report	Publication date	Patent family member(s)	Publication date
WO 2005106203 A	10.11.2005	AU 2005238671 A	10.11.2005
		ES 2261007 A	01.11.2006
		EP 1748152 A	31.01.2007
		EP 20050735159	21.04.2005
		CN 1950587 A	18.04.2007
GB 191204068 A	13.02.1913	NONE	
US 5992390 A	30.11.1999	US 5529549 A	25.06.1996
		US 5695430 A	09.12.1997
		US 5832885 A	10.11.1998
		US 5975052 A	02.11.1999
US 2005182553 A	18.08.2005	US 7050900 B	23.05.2006
		WO 2005079418 A	01.09.2005
		CA 2562743 A	01.09.2005
		US 2006052930 A	09.03.2006
		US 7177751 B	13.02.2007
		CN 1934573 A	21.03.2007
		US 2007113803 A	24.05.2007
JP 55046075 A	31.03.1980	NONE	
US 1572541 A	09.02.1926	NONE	

Form PCT/ISA/210 (patent family annex) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO P9200867 A **[0005]**
- CA 9400571 **[0005]**
- CA P200401019 **[0005]**
- ES 2005070047 W **[0005]**