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[Continued on next page]

(54) Title: A ROTARY POWER DEVICE

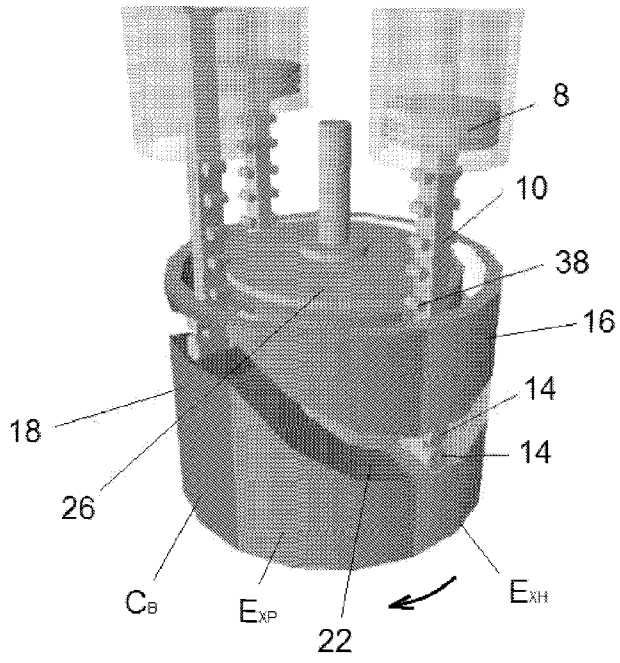


Figure 6

(57) Abstract: A rotary power device comprising a stationary block; at least one cylinder defining a cylinder axis formed in the block; a piston slideably supported in the cylinder; a cylindrical crankshaft arranged to rotate about a crankshaft axis which is parallel to the cylinder axis; and a connecting rod attached at a first end to the piston and coupled at a second end to the crankshaft by at least one piston bearing; wherein the crankshaft comprises a curved annular track defining first and second axially spaced bearing surfaces for engagement with the piston bearing.

WO 2012/168696 A3

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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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

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 104 049 C (GALLICE) 12 July 1899 (1899-07-12) page 2, column 2; figure 4	1-32,48
X	GB 02249 A A.D. 1915 (FASEY WILLIAM ROBERT; GALLEY GARNET THOMAS; TUFNELL GEORGE [GB]) 18 November 1915 (1915-11-18) page 2, line 22 - line 56; figures 4,5	1-32,48
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X	GB 190 150 A (MOTEURS EDOUARD LAAGE SA DES) 24 January 1924 (1924-01-24) page 2, line 50 - line 124; figure 3	1-32,48

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[X] Further documents are listed in the continuation of Box C.

[X] 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 application or patent 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 such 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
29 January 2013	05/02/2013

Name and mailing address of the ISA/	Authorized officer
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4

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

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 253 524 A (EGBERTUS VONK) 11 November 1926 (1926-11-11) page 1, line 33 - line 39; figure 3	1-32,48
X	US 4 022 167 A (KRISTIANSEN HAAKON HENRIK) 10 May 1977 (1977-05-10) column 4, line 39 - line 51; figure 6	1-32,48
X	US 4 996 953 A (BUCK ERIK S [US]) 5 March 1991 (1991-03-05) abstract column 11, line 7 - line 65; figures 5,7	1-32,48
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X	US 2003/188701 A1 (DANIEL CHRISTOPHER L [US]) 9 October 2003 (2003-10-09) paragraph [0049]; figure 4	1-32,48
X	US 2004/016412 A1 (HO PATRICK C [US]) 29 January 2004 (2004-01-29) paragraph [0031] - paragraph [0032]	1-32,48
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X	WO 2007/019452 A2 (CARLETON LIFE SUPPORT SYS INC [US]; RALEIGH TIMOTHY T [US]; MICHELSON) 15 February 2007 (2007-02-15) figure 7	1,33-40, 47,48
X	US 1 352 985 A (MURPHY PETER W) 14 September 1920 (1920-09-14) figure 1	1,33-38, 45,47,48
X	AU 696 914 B2 (WELLER BRUCE) 24 September 1998 (1998-09-24) figure 1	1,33-35, 38,42,44

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4

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/133452 A2 (THOMAS ENGINE COMPANY LLC [US]; GAISER RANDALL [US]; HOLD MICHAEL [AT]) 14 December 2006 (2006-12-14) figures 9,10	1,33-35, 38,43, 45,47,48

X	US 2 770 140 A (PALUMBO VINCENT E) 13 November 1956 (1956-11-13) figures 1,2	1,33-39, 42,43, 45,48

X	US 2 118 804 A (ANDERSEN GUNNAR E) 31 May 1938 (1938-05-31) figures 2,6	1,33-35, 38,39, 47,48

X	US 344 593 A (PEABODY) 29 June 1886 (1886-06-29) figures 2,3	1,33-35, 45,47

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2012/051221

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 2-48(partially)
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-32, 48

   Axial piston engine having a curved track, in particular the strokes resulting from the form of the curve

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2. claims: 1, 33-48

   Axial piston engine having a curved track, in particular the physical arrangement of bearings

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Continuation of Box II.2

Claims Nos.: 2-48(partially)

In the response to an informal request for clarification with regard to the first invention the applicant filed further information not present in the application as filed. This further information is still insufficient to make clear what has been invented. The basic idea of the application is apparently that each part of the whole cycle can be optimised as a group depending on the engine operation and the fuel to be used. Other than the one complete "group" described, however, there is insufficient indication for each of the parts alone as to how this part can be applied without the other parts, so that all that can be derived is a general optimisation wish, without concrete teaching. As a result of the terminology used, this general teaching becomes even more nebulous. The application talks of a 5-stroke cycle however has chosen not to show a simple indication of the strokes equivalent to fig 1, which shows the usual 4 strokes. 5 strokes in a single cycle is nonsense, since it will not return you back to the start of the cycle. The various statements that there are two different BDC's, yet three TDC's simply does not add up, for a cycle the number of TDC's and BDC's must be the same. The "stroke" which causes the most trouble is clearly the combustion event, which according to page 1 of the description should refer to the full travel of the piston from TDC to BDC, yet according to page 4 does not involve any movement at all, while on page 15 some undefined movement is indeed allowed after all. The applicant has argued in the above mentioned response that a slight movement of the piston during combustion can be deemed to be a stroke, but this does not tie up with the statement in the description that a stroke goes from TDC to BDC - i.e. from one change of direction to another, not from one change of gradient to another. In this case, the claims relating to the first invention cannot be searched exactly, rather a general overview can be given of various optimisation possibilities. A similar problem arises for the second invention, i.e. the claims relating to the structure of the bearing assembly. Particularly problematic is the description of the embodiment shown in fig 3, 6, 7 etc, which would seem to be the major embodiment. Strictly speaking the use of the term "crankshaft" is incorrect, since there is no crank, however from this term we understand the driven shaft which replaces the more usual crank. On, for example, page 9 there is reference to a first crankshaft portion and a second crankshaft portion, the one being on the piston side of the bearing assembly (i.e. the top 16 in fig 3) the other being opposite (i.e. the bottom 18 in fig 3). In the first portion there should be an annular slot, which means that the inner section of the first portion is not connected to the outer section. This is misleading. It would appear from fig 2, and would make technical sense, if the outer section of the upper bearing was in fact part of the second portion and the drawings have been understood in this way, even if no connection is shown in most figures. The problem starts to escalate when the claims are examined in the light of the embodiments, since none of the claims clearly directly describes either the arrangement of fig 3 or the very different arrangement of fig 4, rather, as was the case for the engine cycle, particular elements have been isolated without a clear link to other elements. In view of the fact that the terminology is

uncertain as the which part is which, the citations in the search report can only give a general guidance as to which claims are particularly relevant, so that the claims have not in fact been searched in their full scope since this full scope could not be unequivocally established.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2012/051221

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