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[Continued on next page]

(54) Title: FLOW RESTRICTING DEVICES IN PUMPS

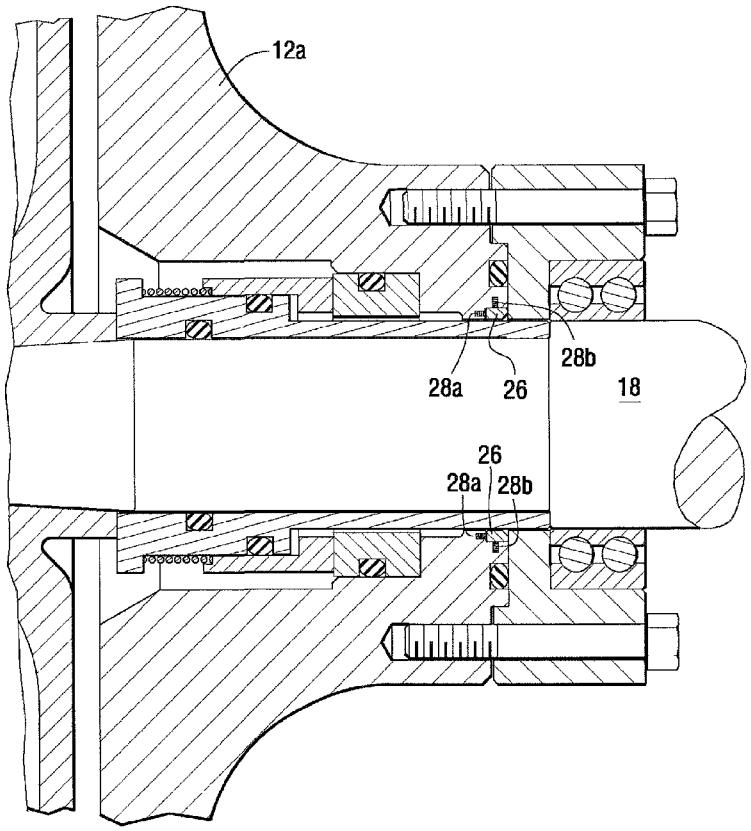


FIG. 2

(57) Abstract: Restriction of flow along a shaft by interposing a split ring in the annulus between the shaft and housing. When the ends of the split ring are separated, the effective diameter of the ring is increased and a clearance between the ID of the split ring and the shaft is maintained permitting flow. When the ends are released and allowed to come together the split ring closes the annular gap and restricts the flow. Also contemplated is the restriction of flow along a shaft by interposing an axially movable sleeve in the annulus between the shaft and housing. Flow through the annulus between the movable sleeve and the shaft is resisted by the clearance or features such as labyrinths, to thereby create a differential pressure from one end of the sleeve to the other.

WO 2008/030630 A3

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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INTERNATIONAL SEARCH REPORT

International application No.
PCT AJS07/61 130

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F04D** 29/10(2006.01)

USPC: 415/1 74.2;277/497,499
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)
U.S. : 415/174 2;277/497,499

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
x --- Y	US 5,988,649 A (VAN RYPER et al) 23 Nov 1999 (23.1 1. 199), whole document	1-5,1 1,15,16 ---------- 6-9, 12-14,30-34
X --- Y	US 3,472, 169 A (DYKE et al) 14 Oct. 1969 (14 10. 1969), whole document	17-21,24,36-38 ---------- 22,23,25-29,39,40
Y	US 4,105,040 A (CHESTER) 8 Aug. 1978 (08.08. 1978), whole document	6-9
Y	US 4,296,934 A (ATKIN) 27 Oct. 1981 (27 10.1987), whole document	12-14,30-34
Y	US 3,685,839 A (FREI) 22 Aug 1972 (22.08. 1972), whole document	22-23,39

☒ 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 application or patent 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 cifition or other special reason (as specified)

"O" document refemng 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 pubhshedafter 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

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category •	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,386,786 A (AGRAMA) 7 June 1983 (07.06. 1983), Figs. 2,3 and column 2, lines 49-60	25,26
A	US 3,574,473 A (GAFFAL) 13 Apr. 1971 (13.04. 1971)	1-40
A	US 6,358,000 B1 (VERONESI et al) 19 Mar. 2002 (19.03.2002), whole document	1-40

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/61 130

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.:
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:

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. Ill 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:
Please See Continuation 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 justify ing additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this intanational 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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/61 130

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In order for more than one species to be examined, the appropriate additional examination fees must be paid. The species are as follows:

The species of Figs. 2-4, related to a discontinuous ring member; and
The species of Figs. 6-8 related to a sliding sleeve member.

The claims are deemed to correspond to the species listed above in the following manner:

Claims 1-16,30 and 32-35 correlate to the species of Figs. 2-4; and
Claims 17-29,31 and 36-40 correlate to the species of Figs. 6-8

The following claim(s) are generic: none.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:
The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons: The species of Figs. 2-4 includes a special technical feature in the form of a discontinuous ring member being actuated between a first and second condition, while the species of Figs. 6-8 include a special technical feature in the form of a sleeve member that is displaceable between a first and second position.