



(51) International Patent Classification:

F04B 1/14 (2006.01) F16H 23/08 (2006.01)  
F04B 9/02 (2006.01) F04B 11/00 (2006.01)  
F04B 15/02 (2006.01) F04B 23/06 (2006.01)

(21) International Application Number:

PCT/US2017/013048

(22) International Filing Date:

11 January 2017 (11.01.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/277,363 11 January 2016 (11.01.2016) US  
62/423,008 16 November 2016 (16.11.2016) US  
62/429,446 2 December 2016 (02.12.2016) US

(71) Applicant: NATIONAL OILWELL VARCO, L.P.  
[US/US]; 7909 Parkwood Circle Drive, Houston, Texas  
77036 (US).

(72) Inventor: MARICA, Adrian; 7909 Parkwood Circle  
Drive, Houston, Texas 77036 (US).

(74) Agent: MOSCICKI, Matthew, R.; Conley Rose, P.C.,  
P.O. BOX 3267, Houston, Texas 77253-3267 (US).

(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,  
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN,  
KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA,  
MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG,  
NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS,  
RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY,  
TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN,  
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,  
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,  
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,  
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,  
LV, 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, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))

[Continued on next page]

(54) Title: DIRECT DRIVE PUMP ASSEMBLIES

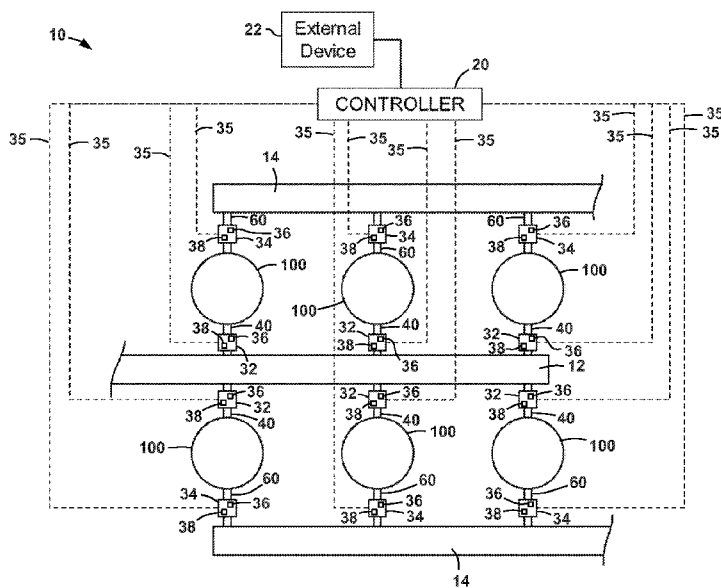


FIG. 1

(57) Abstract: Disclosed are embodiments of a pumping system with connectable and disconnectable pumping assemblies. The pumping assemblies between the power end and fluid end, wherein the transmission can include a cam assembly or a linkage or rocker assembly. The transmission can include an input shaft, and an offset collar including a throughbore extending at a non-zero angle relative to the input shaft axis. In addition, the transmission can include a linking member including a spherical member, a first shaft and a second shaft. The first shaft is received with the throughbore of the offset collar, and the spherical member is slidingly received within a seat. Further, the transmission includes a carriage assembly including a projection. The second shaft extends through the projection.

WO 2017/123656 A3

**(88) Date of publication of the international search report:**  
5 October 2017

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2017/013048

## 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. 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.

INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2017/013048

A. CLASSIFICATION OF SUBJECT MATTER  
 INV. F04B1/14 F04B9/02 F04B15/02 F16H23/08 F04B11/00  
 F04B23/06  
 ADD.  
 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)  
 F04B F16H

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 A	FR 911 137 A (BRANDT EDGAR ETS) 28 June 1946 (1946-06-28) page 1, lines 48-59 - page 2, lines 29-34; figure 1	1-3,5-7, 24-27 4,28
Y	----- US 2014/348677 A1 (MOELLER MANUEL [US] ET AL) 27 November 2014 (2014-11-27) paragraphs [0036] - [0039]; figure 1	1-7, 24-28
Y	----- EP 0 220 527 A1 (SCHAEFFLER WAELZLAGER KG [DE]) 6 May 1987 (1987-05-06) figure 1	1-7, 24-28
Y	----- FR 2 262 753 A1 (BEJEANNIN DESIRE [FR]) 26 September 1975 (1975-09-26) page 1, line 32 - page 2, line 32; figure 1	1-7, 24-28
	----- -/--	

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 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

8 August 2017

Date of mailing of the international search report

21/08/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040,  
 Fax: (+31-70) 340-3016

Authorized officer

Ziegler, Hans-Jürgen

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2017/013048

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 492 457 A (LEE W KEN [US]) 20 February 1996 (1996-02-20) figure 1	1-7, 24-28
A	----- DE 197 26 702 A1 (KAUFMANN RALF DR ING [DE]; NIX CHRISTOPH DIPL ING [DE]; REUL HELMUT PR) 7 January 1999 (1999-01-07) figures 3,4	1-7, 24-28
A	----- DE 721 098 C (NAAMLOOZE VENNOOTSCHAP HULSEMO) 2 June 1942 (1942-06-02) page 1, lines 1-17; figures 1,5,7	1-7, 24-28
X	----- US 5 846 056 A (DHINDSA JASBIR S [US] ET AL) 8 December 1998 (1998-12-08)	8
Y	column 4, line 36 - column 9, line 65; figures 1,2,5	9,29,30, 38
A		10-28, 31-37, 39-66
Y	----- DE 10 2014 212021 A1 (PUTZMEISTER SOLID PUMPS GMBH [DE]) 24 December 2015 (2015-12-24)	9
A	paragraph [0018]; figure 1	20
Y	----- DE 37 27 174 A1 (BOSCH GMBH ROBERT [DE]) 23 February 1989 (1989-02-23) column 2, line 46 - column 3, line 10; figure 2	9
Y	----- WO 2011/050585 A1 (BEIJING PURKINJE GENERAL INSTR [CN]; LU ZHENYU [CN]) 5 May 2011 (2011-05-05) abstract; figure 4	29,38
Y	----- US 2015/354329 A1 (PERRY LARRY [US] ET AL) 10 December 2015 (2015-12-10) paragraphs [0016] - [0023]; figure 2	29,30,38

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/013048

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 911137	A	28-06-1946	NONE
US 2014348677	A1	27-11-2014	CA 2846623 A1 04-04-2013 US 2014348677 A1 27-11-2014 WO 2013048792 A1 04-04-2013
EP 0220527	A1	06-05-1987	BR 8605082 A 21-07-1987 DE 3537245 A1 23-04-1987 EP 0220527 A1 06-05-1987
FR 2262753	A1	26-09-1975	NONE
US 5492457	A	20-02-1996	US 5492457 A 20-02-1996 WO 9731187 A1 28-08-1997
DE 19726702	A1	07-01-1999	AT 212422 T 15-02-2002 DE 19726702 A1 07-01-1999 DK 0991877 T3 06-05-2002 EP 0991877 A1 12-04-2000 ES 2168788 T3 16-06-2002 JP 2002505599 A 19-02-2002 PT 991877 E 31-07-2002 US 6354814 B1 12-03-2002 WO 9859187 A1 30-12-1998
DE 721098	C	02-06-1942	NONE
US 5846056	A	08-12-1998	NONE
DE 102014212021	A1	24-12-2015	DE 102014212021 A1 24-12-2015 EP 3158193 A1 26-04-2017 US 2017101986 A1 13-04-2017 WO 2015197486 A1 30-12-2015
DE 3727174	A1	23-02-1989	DE 3727174 A1 23-02-1989 JP 2577060 B2 29-01-1997 JP S6477767 A 23-03-1989 US 4887870 A 19-12-1989
WO 2011050585	A1	05-05-2011	CN 102052275 A 11-05-2011 WO 2011050585 A1 05-05-2011
US 2015354329	A1	10-12-2015	US 2015354329 A1 10-12-2015 WO 2015191692 A1 17-12-2015

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

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

1. claims: 1-7, 24-28

pump assembly having a swash type transmission for transforming a rotary motion into a reciprocating motion  
---

2. claims: 29-66

pump assembly and transmission therefor, having helical cam for transforming a rotary motion into a reciprocating motion  
---

3. claims: 8-23

system and method for pressure pulsation dampening  
---