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(71) Applicant (for all designated States except US): **PARKER HANNIFIN CORPORATION** [US/US]; 6035 Parkland Blvd., Cleveland, OH 44124 (US).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **ARANOVICH, Felix** [US/US]; 5339 Lunt Avenue, Skokie, IL 60077 (US).

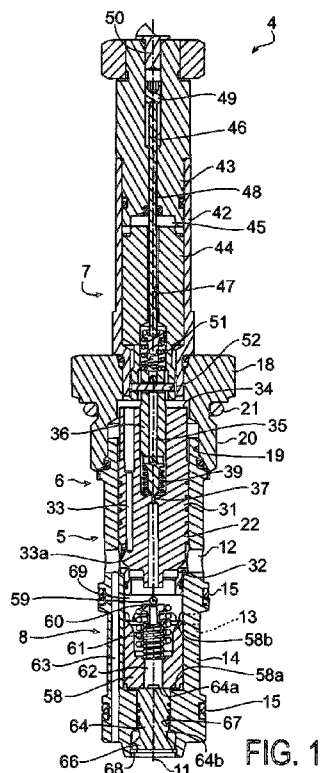
(74) Agents: **CLARK, Robert, J.** et al.; Parker-Hannifin Corporation, 6035 Parkland Blvd., Cleveland, OH 44124-4141 (US).

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[Continued on next page]

(54) Title: ELECTRO-PROPORTIONAL PILOT OPERATED POPPET VALVE WITH PRESSURE COMPENSATION



(57) Abstract: A normally closed, electrical solenoid actuated, pressure compensated, proportional, hydraulic flow control valve (4) includes a fluid flow control poppet valve (5), a pilot operator (6), a solenoid operator (7) and a pressure compensator (8). The poppet valve (5) includes a poppet (31) and a seat (32). The pilot operator (6) includes a pilot (36) and a pilot seat (37). The solenoid operator (7) includes a solenoid tube (42) and an armature (44). The pressure compensator (8) includes a pressure balanced pressure compensator spool (58), a smaller diameter differential pressure compensator control piston (64), and springs (61) that balance the forces on the compensator control piston (64). The compensator control piston (64) moves the compensator spool (58) to maintain a substantially constant pressure differential across the poppet valve (5). The valve (4) may be used in a variety of hydraulic systems. A similar normally opened valve (104) is also disclosed.



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

— *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))*

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/062976

A. CLASSIFICATION OF SUBJECT MATTER
INV. F15B11/05 F15B13/04 F15B13/02
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)
F15B

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 777 773 A (TOLBERT W) 11 December 1973 (1973-12-11) figures 1-5	1-18, 20-22
X	US 5 447 093 A (BUDZICH TADEUSZ [US]) 5 September 1995 (1995-09-05) figures 1-2	1-5, 10, 22
X	US 4 437 388 A (BUDZICH TADEUSZ [US]) 20 March 1984 (1984-03-20) figure 1	1-5, 10-12, 16-19, 22
X	US 3 444 689 A (BUDZICH TADEUSZ) 20 May 1969 (1969-05-20) figures 1-4	1-12, 16-18, 22



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

22 June 2012

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14/01/2013

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

Regaud, Christian

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/062976

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.:

1-22

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

Information on patent family members

International application No

PCT/US2011/062976

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3777773	A	11-12-1973	CA 944255 A1 26-03-1974 DE 2302845 A1 30-08-1973 FR 2173516 A5 05-10-1973 GB 1416263 A 03-12-1975 JP 48097120 A 11-12-1973 US 3777773 A 11-12-1973
US 5447093	A	05-09-1995	NONE
US 4437388	A	20-03-1984	NONE
US 3444689	A	20-05-1969	DE 1601773 A1 22-01-1970 GB 1190423 A 06-05-1970 US 3444689 A 20-05-1969

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-22

A pressure compensator comprising :

- a spool,
- a control piston,
- a variable fluid flow orifice defined by the spool.

2. claims: 23-25

A pressure compensator comprising :

- a cylindrical member,
- a leakage flow path within the member,
- a valve included in said cylindrical member which closes the leakage flow path.
