

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
14 November 2002 (14.11.2002)

PCT

(10) International Publication Number  
**WO 2002/089966 A3**

(51) International Patent Classification<sup>7</sup>: **B01F 13/00**,  
5/00, 5/06, B01J 19/00

18-20, 55129 Mainz (DE). **LÖWE, Holger** [DE/DE];  
Institut für Mikrotechnik Mainz GmbH, Carl-Zeiss-Strasse  
18-20, 55129 Mainz (DE). **HARDT, Steffen** [DE/DE];  
Institut für Mikrotechnik Mainz GmbH, Carl-Zeiss-Strasse  
18-20, 55129 Mainz (DE).

(21) International Application Number:  
PCT/US2002/014383

(22) International Filing Date: 6 May 2002 (06.05.2002)

(74) Common Representative: **UOP LLC**; John G. Tolomei,  
25 East Algonquin Road, Des Plaines, IL 60017-5017 (US).

(25) Filing Language: English

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,  
GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC,  
LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,  
MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,  
SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ,  
VN, YU, ZA, ZM, ZW.

(26) Publication Language: English

(30) Priority Data:  
09/850,439 7 May 2001 (07.05.2001) US  
09/850,470 7 May 2001 (07.05.2001) US

(71) Applicant (*for all designated States except US*): **UOP  
LLC** [US/US]; 25 East Algonquin Road, Des Plaines, IL  
60017-5017 (US).

(84) Designated States (*regional*): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),  
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR,  
GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent  
(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,  
NE, SN, TD, TG).

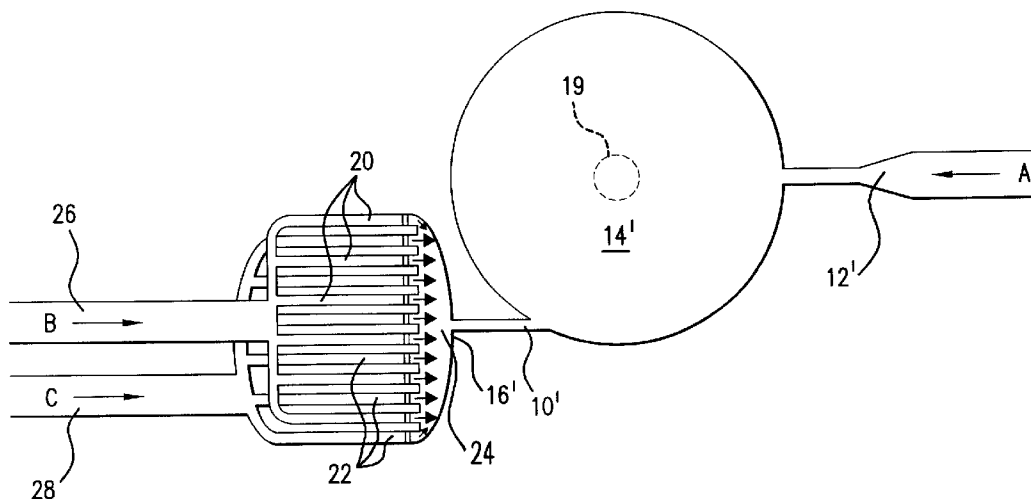
(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **VANDEN BUSS-  
CHE, Kurt, M.** [BE/US]; UOP LLC, 25 East Algonquin  
Road, Des Plaines, IL 60017-5017 (US). **ABDO, Suheil**  
[US/US]; UOP LLC, 25 East Algonquin Road, Des  
Plaines, IL 60017-5017 (US). **HESSEL, Volker** [DE/DE];  
Institut für Mikrotechnik Mainz GmbH, Carl-Zeiss-Strasse

Published:  
— with international search report

[Continued on next page]

(54) Title: APPARATUS FOR MIXING AND REACTING AT LEAST TWO FLUIDS



(57) Abstract: A novel apparatus for mixing and reacting at least two fluids is disclosed. Excellent mixing and superior pressure drop characteristics are achieved in a device comprising at least two supply channels to feed a mixing chamber and create a vortex. The alignment of the supply channels is such that fluids are introduced into the chamber at both tangential and radial directions. In the case of gas/liquid mixing, particularly advantageous is the injection of the liquid stream tangentially and the gas stream radially. Reaction of the fluids can take place within the mixing chamber or in a separate reactor in fluid communication with the mixing chamber outlet. The mixer/reactor apparatus is especially useful for reactions where rapid diffusion is critical.

WO 2002/089966 A3



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

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**(88) Date of publication of the international search report:**  
12 February 2004

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/02/14383

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B01F13/00 B01F5/00 B01F5/06 B01J19/00

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)

IPC 7 B01F B01J

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 909 865 A (COURTAULDS LDS) 7 November 1962 (1962-11-07) the whole document	1
A	SU 1 494 952 A (A.NEMCHIN ET AL.) 23 July 1989 (1989-07-23) the whole document	1
A	US 4 087 862 A (H.C.TSIEN) 2 May 1978 (1978-05-02) claim 1; figures 1-4	1,2
A	DE 197 48 481 A (INSTITUT FÜR MIKROTECHNIK MAINZ) 12 May 1999 (1999-05-12) claim 1; figures 2,3,5	10

 Further documents are listed in the continuation of box C. Patent family members are listed in 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 such documents, such combination being obvious to a person skilled in the art.

\* &amp; \* document member of the same patent family

Date of the actual completion of the international search

3 December 2003

Date of mailing of the international search report

17/12/2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Bertram, H

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CS 02/14383

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 909865	A	07-11-1962	NONE
SU 1494952	A	23-07-1989	SU 1494952 A1 23-07-1989
US 4087862	A	02-05-1978	NONE
DE 19748481	A	12-05-1999	DE 19748481 A1 12-05-1999