US009636913B2

(12) **United States Patent**
Clark

(10) **Patent No.: US 9,636,913 B2**
(45) **Date of Patent: May 2, 2017**

(54) **NOZZLE EJECTION TRAJECTORY DETECTION**

(75) Inventor: **Stephan R. Clark**, Albany, OR (US)

(73) Assignee: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/373,962**

(22) PCT Filed: **Apr. 9, 2012**

(86) PCT No.: **PCT/US2012/032816**

§ 371 (c)(1),
(2), (4) Date: **Jul. 23, 2014**

(87) PCT Pub. No.: **WO2013/154530**

PCT Pub. Date: **Oct. 17, 2013**

(65) **Prior Publication Data**

US 2014/0347420 A1 Nov. 27, 2014

(51) **Int. Cl.**

B41J 29/393	(2006.01)
B41J 2/125	(2006.01)
B41J 2/12	(2006.01)
B41J 2/21	(2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/125*** (2013.01); ***B41J 2/12*** (2013.01); ***B41J 2/2142*** (2013.01)

(58) **Field of Classification Search**
USPC 347/12, 14, 15, 19, 23
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,886,564	A	5/1975	Naylor et al.	
4,344,078	A	8/1982	Houston	
4,540,990	A	9/1985	Crean	
4,990,932	A	2/1991	Houston	
6,568,786	B2	5/2003	Sarmast et al.	
6,767,088	B2	7/2004	Sarmast	
7,963,627	B2 *	6/2011	Ito	B41J 2/0451 347/19
8,376,506	B2 *	2/2013	Shepherd	B41J 29/393 347/19
2002/0105629	A1	8/2002	Sandstrom et al.	
2005/0073544	A1	4/2005	Scofield	
2006/0192845	A1	8/2006	Cordingley et al.	
2007/0024658	A1	2/2007	Diol et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1509879	7/2004
CN	1532052	9/2004

(Continued)

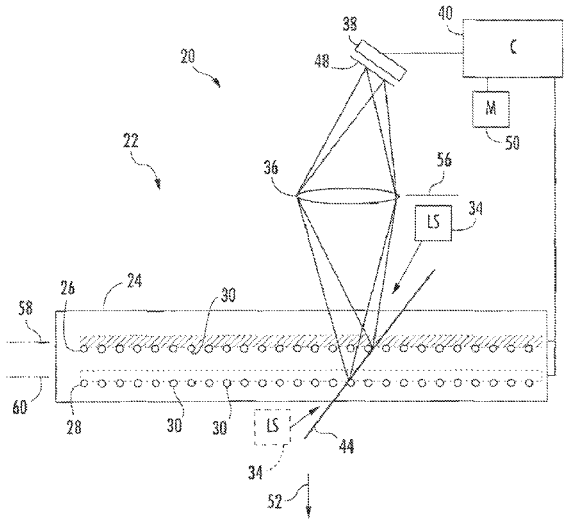
OTHER PUBLICATIONS

International Search Report. Date of mailing Aug. 13, 2013. International application No. PCT/US2012/032816.

(Continued)

Primary Examiner — Lam Nguyen
(74) *Attorney, Agent, or Firm* — Rathe Lindenbaum LLP

(57) **ABSTRACT**

Light redirected by liquid droplets ejected from nozzles (**30**) of a plurality of columns (**26**, **226**, **227**) of nozzles (**30**) is sensed to detect a vertical trajectory of the liquid droplets for each of the nozzles (**30**).

20 Claims, 7 Drawing Sheets