



- (51) **International Patent Classification:**
F03B 3/02 (2006.01) *F03B 11/00* (2006.01)
F03B 3/18 (2006.01) *F03B 15/04* (2006.01)
- (21) **International Application Number:** PCT/US2013/025085
- (22) **International Filing Date:** 7 February 2013 (07.02.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/602,812 24 February 2012 (24.02.2012) US
13/757,034 1 February 2013 (01.02.2013) US
- (71) **Applicant:** FLUID EQUIPMENT DEVELOPMENT COMPANY [US/US]; 800 Ternes Drive, Monroe, Michigan 48162 (US).
- (72) **Inventors:** KITZMILLER, Ryan; 5458 Brook Point Road, Toledo, Ohio 43611 (US). HUNT, Jason B.; 1222 Michigan Ave, Monroe, Michigan 48162 (US).
- (74) **Agents:** MIERZWA, Kevin et al.; Harness, Dickey & Pierce, P.L.C., P.O. Box 828, Bloomfield Hills, Michigan 48303 (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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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, 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,

[Continued on next page]

(54) **Title:** METHOD AND SYSTEM FOR TUNING A HYDRAULIC TURBINE USING SECONDARY INJECTION NOZZLES IN NOZZLE RING

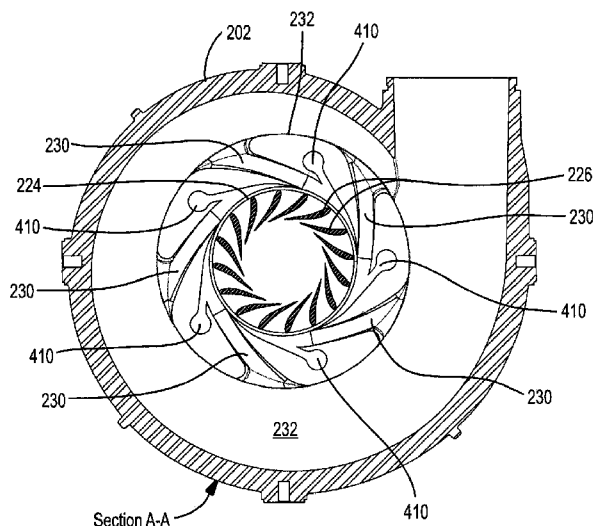


FIG. 4

(57) **Abstract:** A turbine and method of operating the same includes a housing having a volute and an outlet and an impeller rotatable coupled to the housing. The turbine includes a nozzle ring having a plurality of primary nozzles and a plurality of secondary nozzles. The plurality of primary nozzles and the plurality of secondary nozzles direct fluid toward the impeller. An auxiliary valve assembly selectively communicates fluid from the volute to the plurality of secondary nozzles. An actuator is coupled to the valve auxiliary assembly moving the auxiliary valve assembly from a first position communicating fluid from the volute into the secondary nozzles to a second position blocking flow of fluid to the secondary nozzles.



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

— *as to the applicant's entitlement to claim the priority of
the earlier application (Rule 4.17(iii))*

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*