



- (51) **International Patent Classification:**
H01L 33/06 (2010.01) *A01G 7/04* (2006.01)
- (21) **International Application Number:**
PCT/FI2012/050117
- (22) **International Filing Date:**
8 February 2012 (08.02.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
11158648.3 17 March 2011 (17.03.2011) EP
61/468,777 29 March 2011 (29.03.2011) US
- (71) **Applicant (for all designated States except US):**
VALOYA OY [FI/FI]; Lauttasaarentie 54 A 3. krs, FI-00200 Helsinki (FI).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** AIKALA, Lars [FI/FI]; Lammentie 80, FI-02520 Lapinkylä (FI). KIVIMÄKI, Ilkka [FI/FI]; Merikatu 41 A 11, FI-00150 Helsinki (FI).
- (74) **Agent:** SUINNO OY; PO Box 346, FI-00131 Helsinki (FI).

- (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, 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, 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, MD, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

— with amended claims and statement (Art. 19(1))

(54) **Title:** METHOD AND MEANS FOR ENHANCING GREENHOUSE LIGHTS

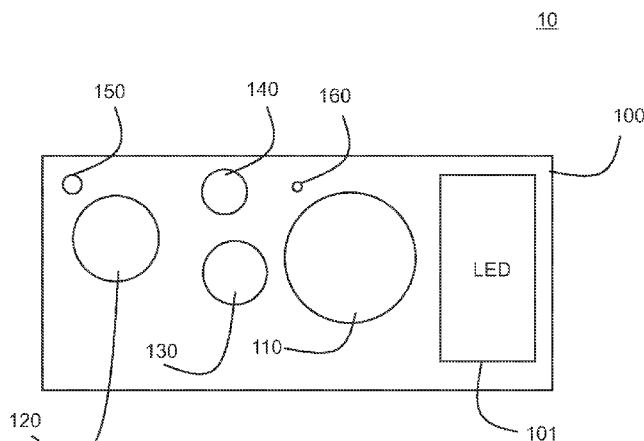


FIG 1B.

(57) **Abstract:** The invention relates to an illumination device with a semiconductor light emission solution that has a wavelength up conversion feature and is suited for plant cultivation in a greenhouse environment. The best mode of the invention is considered to be a light device with at least one blue LED (101) with wavelength up conversion binary alloy quantum dots (110, 120, 130, 140, 150, 160) made by colloidal methods that are arranged to produce an emission spectrum similar to photosynthetically active radiation (PAR) spectrum with the blue LEDs. The methods and arrangements of the invention allow more precise spectral tuning of the emission spectrum for lights used in plant cultivation. The invention therefore realises unexpected improvements in the photomorphogenetic control of plant growth, and further improvements in plant (310, 311) production. The invention is especially advantageous for greenhouses that already have legacy LED systems. These LED systems can often just be upgraded by adding the quantum dot array of the invention to arrive at the lighting solution of the invention.