(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 October 2014 (02.10.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/155352 A4

(51) International Patent Classification:
B22F 3/105 (2006.01)

(21) International Application Number:
PCT/IB2014/060261

(22) International Filing Date:
28 March 2014 (28.03.2014)

(25) Filing Language: Polish

(26) Publication Language: English

(30) Priority Data:
PL403344 28 March 2013 (28.03.2013) PL

(71) Applicant: **GENICORE SP. Z O.O.** [PL/PL]; Graniczna 101C, PL-05-510 Konstancin-Jeziorna (PL).

(72) Inventor: **ROSINSKI, Marcin**; Odkryta 35, PL-03-140 Warszawa (PL).

(74) Agent: **BURY, Marek**; PATPOL, Nowoursynowska 162J, PL-02-776 Warszawa (PL).

(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, IR, IS, JP, KE, KG, 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, SA, 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, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

— *with amended claims (Art. 19(1))*

(88) Date of publication of the international search report:
4 December 2014

Date of publication of the amended claims: 22 January 2015

(54) Title: A DEVICE AND A METHOD FOR CONSOLIDATION OF POWDER MATERIALS

(57) Abstract: The object of the invention is a device intended for powder materials consolidation, provided with an operating chamber, press connected to high-current discharge electrodes top and bottom, with arranged therebetween the sintered powder subjected to the pressure exerted by the press. To the top and bottom electrode there is connected a capacitive circuit with a power supply unit, closed by a high-current switch being a transistor switch. The object of the invention is also a method of powder materials consolidation in the device according to the invention, wherein the powder material is subjected to simultaneous operation of pressure in the range of 1-200 MPa and consolidation by electric current pulses with intensity of 1-80 kA, repeated with frequency from the range of 0.1 Hz to 100 Hz, generated by opening and closing the transistor switch.

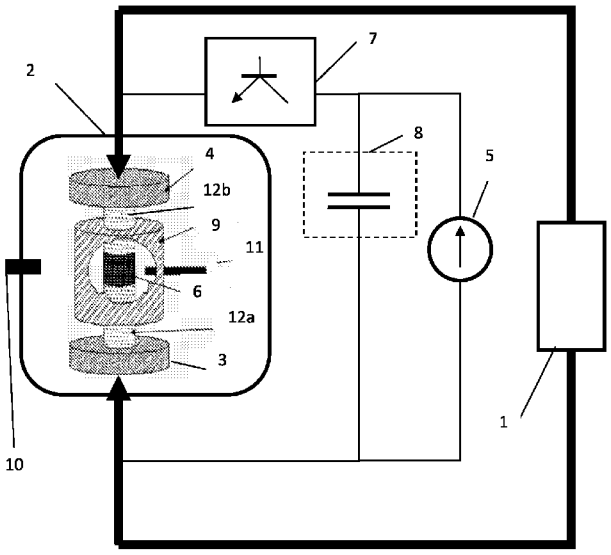

Fig.3

WO 2014/155352 A4

AMENDED CLAIMS
received by the International Bureau on 05 November 2014 (05.11.2014)

1. Device for powder materials consolidation, provided with operating chamber, press connected to the top electrode and the bottom electrode with accommodated in a die therebetween the consolidated powder to which the press exerts pressure, wherein to the top and bottom electrode there is connected a capacitive circuit with a power supply unit, and with a high-current switch for closing the capacitive circuit through the sample being sintered, characterized in that the high-current switch is a transistor switch (7).

2. Device according to the claim 1, characterized in that operating chamber (2) is vacuum sealed and is provided with a vacuum system for sintering in lowered ambient pressure, and the electrodes (3) and (4) are isolated from the operating chamber (2).

3 Device according to the claim 1 or 2, characterized in that operating chamber (2) is vacuum sealed and is further provided with gas dosage means for sintering in working gas.

4. Device for powder consolidation according to claim 1 or 2 or 3, characterized in that the transistor switch (7) comprises eight transistors connected in parallel.

5. Device for powder consolidation according to any of the claims 1 to 4, characterized in that the transistor switch (7) is adapted to forming rectangular pulses.

6. Device for powder consolidation according to claim 5,

characterized in that the transistor switch (7) is adapted both to supply energy to the sintered set in form of short pulses with the same high amplitude and to supply the same energy in cyclic oscillatory fading waveform of capacitor battery discharge, depending on the control signal waveform.

7. Device according to any of the claim from 1 to 6, characterized in that a transistor in the transistor switch (7) is connected to control circuit (60) comprising adjusted turn-on delay path (61) and adjusted turn-off delay path (62).

8. Device according to any of claims 1 to 7, characterized in that it is further provided with temperature measuring means (10, 11).

9. Device according to any of claims 1 to 8, characterized in that the capacitive circuit is a capacitor battery (6) with equivalent capacitance in the range of 50-1000 μF and maximal operating voltage of 15 kV.

10. Method of powder materials consolidation, wherein the sintered powder is located in a die between two electrodes connected to press exerting pressure thereon, wherein voltage is applied to the electrodes through a capacitive circuit with a power supply unit closed by a high-current switch, characterized in that the sintered powder is subjected to simultaneous operation of pressure in the range of 1-200 MPa and consolidation by pulses of electric current with intensity of 1-80 kA, repeated with frequency of 0.1 Hz to 100 Hz, generated by opening and closing a high-current switch, which is a transistor switch (7).

11. Method according to claim 10, characterized in that electric current pulses are generated by discharging a battery of capacitors in a capacitive circuit charged to the voltage of 0.5-15 kV.

12. Method according to claim 10 or 11, characterized in that the transistor switch is fed with a control signal disconnecting circuit of discharging the capacitor battery during the discharging and in that the moment of transistor turn-off is selected so that a rectangular capacitor battery discharging current pulse is obtained.

13. Method according to any of claims 10 to 12, characterized in that the consolidation is performed in temperature in the range of 0.5 to 0.8 of the melting temperature of the consolidated material or melting temperature of the consolidated material's matrix.

14. Method according to any of claims 10 to 13, characterized in that sintered powder is selected from a group of powder materials being metallic, ceramic, intermetallic and composites comprising a metallic matrix and dispersed non-metallic particles or mixtures of thereof.

15. Method according to claim 14, characterized in that powder material is selected from a group including in particular diamond, cubic boron nitride, Al_2O_3, SiC, Si_3N_4, WC, Ta, ZrO_2, TiC, TiN, and mixtures thereof, in a matrix of hard material selected from group including in particular sintered carbides or high thermal conductivity materials selected from a group

including in particular tungsten, molybdenum, aluminium, copper, and mixtures thereof.