



(51) International Patent Classification:

B22F 10/28 (2021.01) B33Y 30/00 (2015.01)
B22F 10/36 (2021.01)

(21) International Application Number:

PCT/US2023/067073

(22) International Filing Date:

16 May 2023 (16.05.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/342,615 16 May 2022 (16.05.2022) US

(71) Applicant: NUBURU, INC. [US/US]; 7442 Tucson Way
Suite 130, Centennial, CO 80112 (US).

(72) Inventors: PARICIO-MOREAU, Adam; 7672 Elmwood
St, Littleton, CO 80125 (US). FINUF, Mathew; 6809
Northstar Circle, Castle Rock, CO 80108 (US). BOESE,
Eric; 7442 Tucson Way Suite 130, Centennial, CO 80112
(US). FRITZ, Robert; 6562 South Ouray Way, Aurora, CO
80016 (US). FLETCHER, Dallen; 3842 Rawhide Circle,
Castle Rock, CO 80104 (US). ROBINSON, Ryan; 10111

Inverness Main Street, Unit 229, Englewood, CO 80112
(US). ZEDIKER, Mark S.; 1896 Via Los Pinon, Castle
Rock, CO 80104 (US).

(74) Agent: BELVIS, Glen P.; Belvis Law, LLC, P.O. Box
11317, Chicago, IL 60611 (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, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, 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, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, CV,
GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST,
SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,
RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ,

(54) Title: BLUE LASER METAL ADDITIVE MANUFACTURING SYSTEM

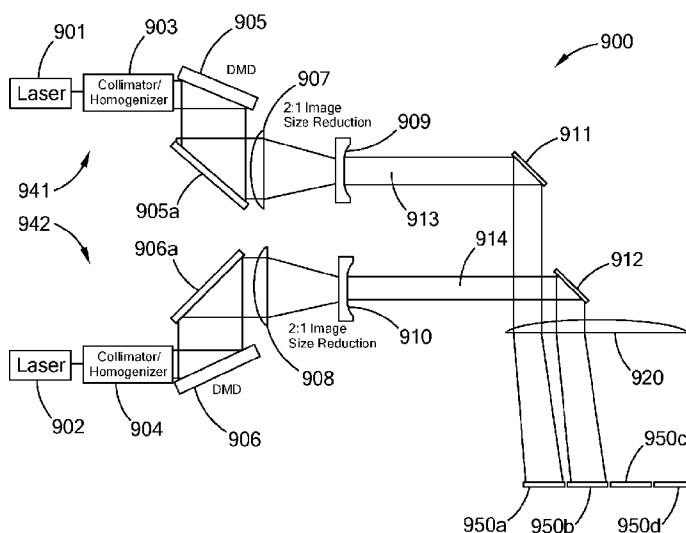


FIG. 9

(57) Abstract: A high-resolution additive manufacturing system based on a parallel printing method using a spatial light modulator. A method and system for additive manufacturing using a DMD in the laser beam path. The use of a pre-heat laser beam in combination with a build laser beam having a DMD along the build laser beam path.





DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT,
LU, LV, MC, ME, 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))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

29 February 2024 (29.02.2024)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/67073

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. B22F 10/28, B22F 10/36 (2023.01)

ADD. B33Y 30/00 (2023.01)

CPC - INV. B22F 10/28, B22F 10/36

ADD. B33Y 30/00

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2020/0094478 A1 (NUBURU, INC.) 26 March 2020 (26.03.2020) Fig 9, abstract, para [0022], [0031], [0050], [0064], [0078]	1-4, 17-21, 51
Y	WO 2020/154703 A1 (VOIT et al.) 30 July 2020 (30.07.2020) Fig 1F, 2A, 2B, 6A, abstract, para [003], [065], [079]	1-4, 17-21, 51

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent 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

"&" document member of the same patent family

Date of the actual completion of the international search

13 November 2023

Date of mailing of the international search report

JAN 09 2024

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents

P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Kari Rodriguez

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/67073

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 5-16, 22-32, 37-50, and 52-57
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-4, 17-21, and 51 drawn to an additive manufacturing system including details of a homogenizer.

Group II: Claims 33-36 drawn to an additive manufacturing system including details of an On-State and Off-State Mirror Configuration.

--see extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-4, 17-21, 51

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Continuation of Box No III -- Observations where unity of invention is lacking

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group I includes special technical features of details of a homogenizer, wherein the homogenizer is configured to shape and homogenize a laser beam into a titled spot on the DMD; the titled spot on the DMD defining an image having a pitch and a yaw; and, wherein, the pitch and the yaw of the image is within 12 degrees of an illumination cone angle for the DMD, not included in the other group.

Group II includes special technical features of details of an On-State mirror configuration and an Off-State mirror configuration for any given 2-D final image pattern; wherein the system is configured whereby in either the On-State mirror configurations or the Off-State mirror configurations, the DMD provides a heating laser beam along a heating laser beam path to create a heating image pattern on the surface, not included in the other group.

Common Technical Features:

The only technical features shared by Groups I-II that would otherwise unify the groups, are an additive manufacturing system for forming metal objects from metal powders, the system comprising: a laser source to provide a laser beam along a laser beam path; a digital micro-mirror device (DMD); optics to configure the laser beam and direct the laser beam path to a target location comprising a device for holding a surface layer of a metal powder; wherein the laser beam path optically associates the laser source to the DMD, the DMD to the optics, and the optics to the target location; whereby the laser beam is directed onto the DMD, wherein the DMD is configured to create a 2-D final pattern that is reflected from the DMD along the laser beam path to create a 2-D final image pattern on the surface; wherein the 2-D final pattern has a wavelength and a power density; and whereby the 2-D final image pattern is configured to weld the metal powder.

However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2020/0094478 A1 to NUBURU, INC. (hereinafter 'NUBURU').

NUBURU discloses an additive manufacturing system for forming metal objects from metal powders, the system comprising: a laser source to provide a laser beam along a laser beam path (para [0031], "...an additive manufacturing system for forming metal objects from metal powders, the system having : a laser source to provide a build laser beam along a build laser beam path.."); a digital micro-mirror device (DMD) (para [0031], "...a Digital Micro - Mirror Device (DMD) on the laser beam path.."); optics ("optical assembly") to configure the laser beam and direct the laser beam path to a target location comprising a device for holding a surface layer of a metal powder; wherein the laser beam path optically associates the laser source to the DMD, the DMD to the optics, and the optics to the target location; whereby the laser beam is directed onto the DMD, wherein the DMD is configured to create a 2-D final pattern that is reflected from the DMD along the laser beam path to create a 2-D final image pattern on the surface (para [0031], "...the build laser beam is directed into the DMD, the DMD creates a 2 - D image pattern that is reflected from the DMD along the laser beam path to an optical assembly; and , the optical assembly directing the laser beam to the metal powder, whereby the 2 - D image pattern is delivered to the metal powder.."); wherein the 2-D final pattern has a wavelength and a power density (para [0032], "...the laser beam has a wave length...the 2 - D image delivers a peak power density to the metal powder.."); and whereby the 2-D final image pattern is configured to weld the metal powder (para [0022], "...form an energy pattern on a powder metal layer that is fused to the layer below , by for example , using a conduction mode welding process..").

As the shared technical features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-II lack unity under PCT Rule 13.

Note: Claim 35 reads in part "The system of any of claims 33 to 35..." For purposes of this determination claim 35 is taken to read "The system of any of claims 33 to 34..."

Item 4. (continued) 5-16, 22-32, 37-50, and 52-57 have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention