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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 December 2024 (12.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/254588 A3

(51) International Patent Classification:
B29C 64/30 (2017.01) *B29C 64/40* (2017.01)
B33Y 80/00 (2015.01) *D01D 5/00* (2006.01)

(21) International Application Number:
PCT/US2024/033235

(22) International Filing Date:
10 June 2024 (10.06.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/507,065 08 June 2023 (08.06.2023) US

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(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.

WO 2024/254588 A3

(54) Title: CAPILLARY-EMBEDDED RAPID ADAPTABLE MULTISCALE BIOPRINTING FOR ENGINEERING LARGE VASCULARIZED TISSUES

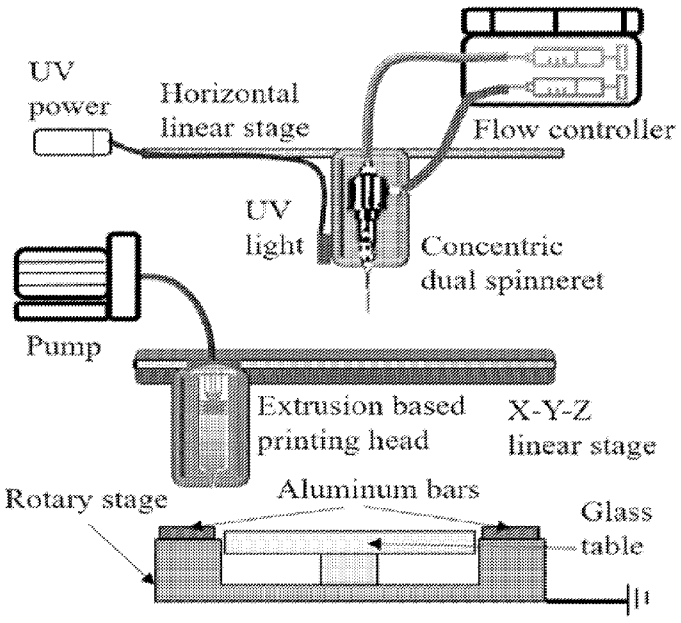

FIG. 2B

(57) Abstract: A capillary-incorporated bioprinting system for rapid engineering of vascularized tissues, the system comprising a three-dimensional printing head, wherein the three-dimensional printing head is configured on a three-axis linear stage; a spinneret, wherein the spinneret is configured on a horizontal linear stage and the spinneret is affixed above the three-dimensional printing head; a UV light source, wherein the UV light source is operatively coupled to the three-dimensional printing head and the spinneret, and adjacent to the spinneret; and a pair of parallel bars, wherein the pair of parallel bars are configured to collect a plurality of electrospun aligned microtubes.

[Continued on next page]

(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, 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))*

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

10 April 2025 (10.04.2025)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 24/33235

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. B29C 64/30 (2024.01)
ADD. B33Y 80/00, B29C 64/40, D01D 5/00 (2024.01)

CPC - INV. B29C 64/30
ADD. B33Y 80/00, B29C 64/40, D01D 5/0076

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.
A	SOORIYAARACHCHI, D., et al. "Hybrid Fabrication of Biomimetic Meniscus Scaffold by 3D Printing and Parallel Electrospinning." Procedia Manufacturing 34 (2019) 528-534 available, 18 July 2019 (18.07.2019) [online] <URL: https://www.sciencedirect.com/science/article/pii/S2351978919309461> <DOI: 10:1016/j.promfg.2019.06.216>	1-20
A	US 2009/0208577 A1 (XU et al.) 20 August 2009 (20.08.2009) Fig 1, abstract	1-20
A	US 2012/0058174 A1 (WEST et al.) 08 March 2012 (08.03.2012) abstract, para [0041], [0067], [0068]	1-20
A	US 2016/0288414 A1 (UNIVERSITY OF IOWA RESEARCH FOUNDATION) 06 October 2016 (06.10.2016) Fig 33, abstract, para [0047], [0155], [0256], [0380]	1-20
A	US 2017/0247430 A1 (UNIVERSITY OF SOUTH CAROLINA, et al.) 31 August 2017 (31.08.2017) abstract, para [0042], [0084], [0086], [0089], [0093], [0094]	1-20
A	EP 4 039 475 A1 (AJL OPHTHALMIC, S.A.) 10 August 2022 (10.08.2022) Fig 1, abstract	1-20

☐ 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	Date of mailing of the international search report
08 October 2024	NOV 01 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 Rodriquez Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 24/33235

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.:
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:
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.:
1-20

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.

International application No.

PCT/US 24/33235

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

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 1-20, directed to a capillary-incorporated bioprinting system or a method for engineering vascularized tissues including details of a pair of parallel bars, wherein the pair of parallel bars are configured to collect a plurality of electrospun aligned microtubes or microfibers.

Group II: Claims 21-25, directed to a bioprinting electrospinning hybrid printer including details of a parallel plate collector, wherein the parallel plate collector includes one or more plates with an adjustable distance and an adjustable angle.

The groups of inventions listed above 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 pair of parallel bars, wherein the pair of parallel bars are configured to collect a plurality of electrospun aligned microtubes or microfibers, not included in the other group.

Group II includes special technical features of details of a parallel plate collector, wherein the parallel plate collector includes one or more plates with an adjustable distance and an adjustable angle, not included in the other group.

Common Technical Features:

The only technical features shared by some of the Groups that would otherwise unify the groups, are a bioprinting electrospinning printer including parallel support features. However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2017/0247430 A1 to UNIVERSITY OF SOUTH CAROLINA, et al. (hereinafter 'U SOUTH CAROLINA').

U SOUTH CAROLINA discloses a bioprinting electrospinning printer including parallel support features (abstract, para [0042], “A novel biofabrication technique...3D printing..”, para [0086], “Reaction electrospinning is a new technique we have developed in our laboratory . It allows us to make collagen scaffolds with varying fiber diameters and varying size of voids and openness of the woven structure..”, para [0089], “Collagen hydrogels with a concentration of 10 to 20 mg / mL were placed on the parallel plates assembly..”).

Accordingly, the inventions listed as Groups I-II above lack unity of invention under PCT Rule 13 because they do not share a same or corresponding special technical feature providing contribution over prior art.