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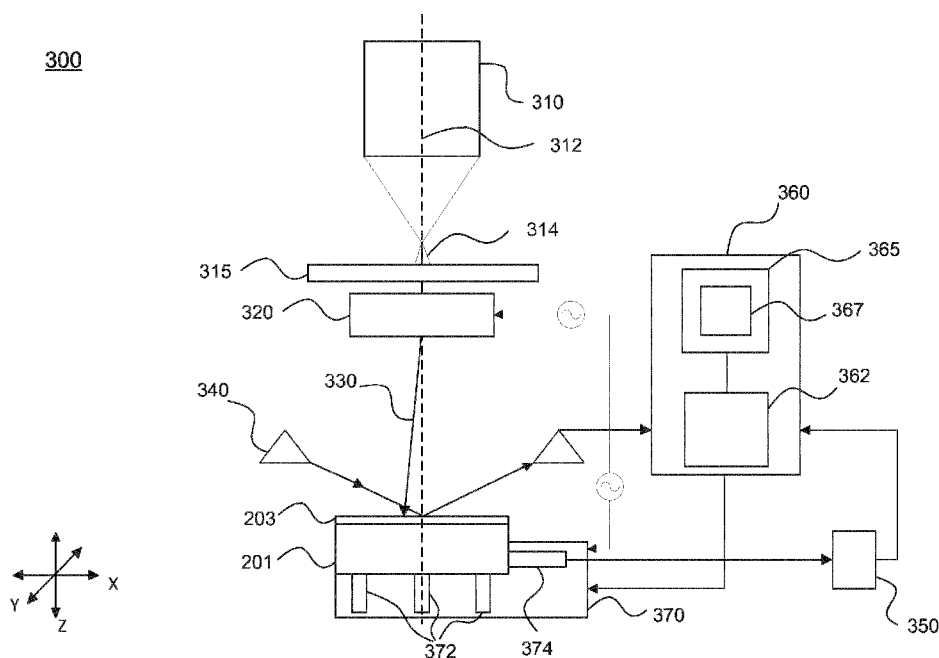
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(54) Title: SYSTEMS AND METHODS FOR FOCUSING CHARGED-PARTICLE BEAMS

**FIG. 3**

(57) **Abstract:** A charged-particle beam system (300) is disclosed. The charged-particle beam system comprises a stage (201) configured to hold a sample (203) and is movable in at least one of X-Y-Z axes. The charged-particle beam system further comprises a position sensing system (350, 340) to determine a lateral and vertical displacement of the stage, and a beam deflection controller (367) configured to apply a first signal to deflect a primary charged-particle beam (330) incident on the sample to at least partly compensate for the lateral displacement, and to apply a second signal to adjust a focus of the deflected charged-particle beam incident on the sample to at least partly compensate for the vertical displacement of the stage. The first and second signals may comprise an electrical signal having a high bandwidth in a range of 10 kHz to 50 kHz, and 50 kHz to 200 kHz, respectively. Further, a non-transitory computer readable medium is disclosed, comprising a set of instructions for causing an apparatus (300) to perform a method, the apparatus including a charged-





AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, 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.

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particle source (310) to generate a primary charged-particle beam (314,330), the method comprising determining a lateral displacement of a stage (201), wherein the stage is movable in at least one of X-Y axes; and instructing a controller (367) to apply a first signal to deflect the primary charged-particle beam incident on a sample (203) to at least partly compensate for the lateral displacement

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. H01J37/147 H01J37/20 H01J37/21 H01J37/28 ADD.		
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) H01J		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/048026 A1 (ISSHIKI FUMIO [JP] ET AL) 25 April 2002 (2002-04-25)	1,2,4,15
Y	abstract paragraphs [0023], [0064], [0073], [0085], [0095], [0159]; figures 24,25 -----	3
X	US 2013/342827 A1 (UMMETHALA UPENDRA [US] ET AL) 26 December 2013 (2013-12-26)	1,2,4,15
Y	abstract paragraphs [0037], [0101]; figures 1, 6G -----	3
Y	US 2013/016327 A1 (LOOIJIE ALEXIUS OTTO [NL] ET AL) 17 January 2013 (2013-01-17) abstract paragraphs [0048] - [0049]; figure 1 -----	3
☐ 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 "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 14 April 2020	Date of mailing of the international search report 26/06/2020	
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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 additional 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 an 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, 15

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 15

A charged-particle beam system comprising a stage configured to hold a sample and is movable in at least one of X-Y and Z axes; a position sensing system configured to determine a lateral and vertical displacement of the stage; and a controller configured to apply a first signal to deflect a primary charged-particle beam incident on the sample to at least partly compensate for the lateral displacement of the stage; and apply a second signal to adjust a focus of a deflected charged-particle beam incident on the sample to at least partly compensate for the vertical displacement of the stage (claim 1); wherein the first signal comprises an electrical signal affecting how the primary charged-particle beam is deflected in the at least one of X-Y axes (claim 2), wherein the electrical signal comprises a signal having a bandwidth in a range of 10 kHz to 50 kHz (claim 3).

2. claims: 5, 8

The system of claim 1, wherein the controller is further configured to dynamically adjust at least one of the first signal or the second signal during scanning of the primary charged-particle beam on the sample (claim 5); or the system of claim 1, wherein the vertical displacement corresponds to a difference between a current position of the stage and a target position of the stage in the Z-axis, and wherein the vertical displacement varies during scanning of the primary charged-particle beam on the sample to at least partly compensate for an angular rotation about at least one of X or Y axes (claim 8)

3. claims: 6, 7

The system of claim 1, wherein the controller is further configured to dynamically adjust at least one of the first signal or the second signal during scanning of the primary charged-particle beam on the sample.

4. claims: 9-14

The system of claim 1, further comprising a stage motion controller, wherein the stage motion controller comprises a plurality of motors configured to be independently controlled by a third signal.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/086459

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