

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing (day/month/year)		05 NOV 2018
Applicant's or agent's file reference 1304-0002		FOR FURTHER ACTION See paragraph 2 below
International application No. PCT/US 18/38956	International filing date (day/month/year) 22 June 2018 (22.06.2018)	Priority date (day/month/year) 30 June 2017 (30.06.2017)
International Patent Classification (IPC) or both national classification and IPC IPC(8) - B22F 3/105, B23K 15/00, B23K 15/02 (2018.01) CPC - B22F 2003/1057, B22F 3/105, B22F 3/1055		
Applicant ABLER, JEFFREY ALAN		

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion.
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application.

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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	Date of completion of this opinion 27 August 2018	Authorized officer Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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Box No. 1 Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
- the international application in the language in which it was filed.
 - a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
2. This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a)).
3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing:
- a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

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Box No. IV Lack of unity of invention

1. In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:
- paid additional fees.
- paid additional fees under protest and, where applicable, the protest fee.
- paid additional fees under protest but the applicable protest fee was not paid.
- not paid additional fees.

2. This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

complied with.

not complied with for the following reasons:

Group I: Claims 1-2, directed to a system for powder bed fusion additive manufacturing comprising: a platen having an additive manufacturing powder material spread thereon; a plurality of energy beams; an optical relay system comprising: fixed and moving optics that maintain focus of the plurality of energy beams at the surface of the additive manufacturing powder material; beam steering system that actively corrects the flight of the plurality of energy beams; a rotating polygon mirror that reflects the plurality of energy beams for fast scanning motion.

Group II: Claims 3-25, directed to a method for powder bed fusion additive manufacturing for the fabrication of three dimensional structures through a succession of multiple powder bed build layers utilizing a succession of parallel scans of a pattern of energy beams where the length and width of the beam pattern are more than 5 times the depth of the powder bed build layers and each build layer consists of a union of parallel channels of melted or sintered volume having lengths corresponding to the distances between structure surfaces as measured in the plane of the build layer in the direction of the scanning motion where the lengths of the channels are not necessarily limited to discrete values, and the combination of the scan speed and the power settings for the beams generate and maintain powder bed surface temperatures between the point of complete melting and the initiation of boiling for the fabrication material during the scan engagement.

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 requires a platen having an additive manufacturing powder material spread thereon; a plurality of energy beams; an optical relay system comprising: fixed and moving optics that maintain focus of the plurality of energy beams at the surface of the additive manufacturing powder material; beam steering system that actively corrects the flight of the plurality of energy beams; a rotating polygon mirror that reflects the plurality of energy beams for fast scanning motion, not required by group II.

Group II requires utilizing a succession of parallel scans of a pattern of energy beams where the length and width of the beam pattern are more than 5 times the depth of the powder bed build layers and each build layer consists of a union of parallel channels of melted or sintered volume having lengths corresponding to the distances between structure surfaces as measured in the plane of the build layer in the direction of the scanning motion where the lengths of the channels are not necessarily limited to discrete values, and the combination of the scan speed and the power settings for the beams generate and maintain powder bed surface temperatures between the point of complete melting and the initiation of boiling for the fabrication material during the scan engagement, not required by group I.

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4. Consequently, this opinion has been established in respect of the following parts of the international application:

all parts.

the parts relating to claims Nos. 1-2

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	None	YES
	Claims	1-2	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-2	NO
Industrial applicability (IA)	Claims	1-2	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-2 lack novelty under PCT Article 33(2) as being anticipated by US 2017/0021455 A1 to IPG PHOTONICS CORPORATION (hereinafter "IPG").

Regarding claim 1, IPG discloses a system for powder bed fusion additive manufacturing (Abstract, ...Systems and methods for multiple beam additive manufacturing use multiple beams of light...to expose layers of powder material...para[0044], ...as used herein, powder material refers to a material in the form of particles suitable for use in powder bed fusion additive manufacturing...) comprising: a platen having an additive manufacturing powder material spread thereon (para[0047], ...a processing surface 106 including the exposed layer of the powder bed 102...Figure 1, the flat processing surface 106 is the platen and the powder bed is the powder material spread thereon); a plurality of energy beams (Abstract, ...additive manufacturing use multiple beams of light (e.g., laser light)...para[0080], ...the energy from each of the exposures by the beams 431...); an optical relay system (para[0060], ...the optical head motion system 142 may include an X-Y motion stage configured to move the optical head in at least X and Y directions...) comprising: fixed and moving optics that maintain focus of the plurality of energy beams at the surface of the additive manufacturing powder material (Abstract, ...the light may be generated from selected light sources and coupled into an array of optical fibers having output ends arranged in an optical head in at least one line such that multiple beams are sequentially directed by the optical head to the same powder region providing multiple beam sequential exposures...The multiple sequential beams may be moved using various techniques...(if they can be moved, they can also be kept fixed)); beam steering system that actively corrects the flight of the plurality of energy beams (para[0059], ...multiple beams of light may be directed toward the processing surface 106, for example, by directing light sources (e.g., laser diodes) towards the processing surface 106, using other types of processing heads (e.g., similar to laser welding heads) directed toward the processing surface 106, and/or using mirrors or other optical components to direct light beams toward the processing surface 106...para[0070], ...the imaging optics may be moved to different positions to change the focus of the beams 231 relative to the processing surface 206 a-c...); a rotating polygon mirror that reflects the plurality of energy beams for fast scanning motion (para[0035], ...multiple beam laser additive manufacturing system including a polygon mirror for scanning multiple beams...Figure 19, the polygon mirror 1942 has arrows that indicate it can be rotated. The multiple beams 1931 from the optical head being directed from the mirror 1942 onto the powder bed 1902 shows that it is reflecting the beams...para[0105], ...the polygon mirror may be capable of scanning the beams at speeds of 50 m/s...) (see instant specification para[0069], ...this particular pattern and indicated intensity levels are appropriate for manufacturing with titanium at a scan speed of 34 m/s...); and post scan relay optics that provide planar focus of the plurality of energy beams at a predetermined portion of the additive manufacturing powder material (Abstract, ...the light may be generated from selected light sources and coupled into an array of optical fibers having output ends arranged in an optical head in at least one line such that multiple beams are sequentially directed by the optical head to the same powder region providing multiple beam sequential exposures...The multiple sequential beams may be moved using various techniques...para[0060], ...the optical head motion system 142 may include an X-Y motion stage configured to move the optical head in at least X and Y directions...Figure 1, the optical head is providing the light beams with planar focus onto the powder bed)); and control electronics that selectively control the motion of the optical system and the power modulation of the individual beams comprising the plurality of energy beams (para[0060], ...the optical head motion system 142 may include an X-Y motion stage configured to move the optical head in at least X and Y directions...para[0065], ...the control system 150 may include a CNC computer...and/or microcontroller circuitry. In one example, the CNC computer may read a build instruction file line by line to obtain the position data and control the position of the optical head 140. The CNC computer may send instructions to a microcontroller for controlling the light sources 130 while the optical head is in each position...para[0041], ...multiple beam sequential exposures with varying intensity over a powder region...para[0069], ...one or more of the light sources...is turned on for a defined time and power...).

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Box V(2): Citations and explanations

Regarding claim 2, IPG discloses a method of additive manufacturing (Abstract, ...Systems and methods for multiple beam additive manufacturing...) comprising: directing, by fixed and moving optical components a plurality of energy beams toward a beam steering system (Abstract, ...the light may be generated from selected sources and coupled into an array of optical fibers having output ends arranged in an optical head in at least one line such that multiple beams are sequentially directed by the optical head...The multiple sequential beams may be moved using various techniques (e.g., by moving the optical head)...para[0060], ...the optical head motion system 142 may include an X-Y motion stage configured to move the optical head in at least X and Y directions...(if it can be moved, it can also be kept fixed)), directing, by a beam steering system comprising optical components, the plurality of energy beams toward a rotating polygon mirror (Figure 19, the optical head 1940, that is able to be moved and contains the optical fibers, is directing the light beams 1931 towards the polygon mirror 1942, which has arrows that indicates that it can be rotated); reflecting in a scanning motion, by the rotating polygon mirror, the plurality of energy beams (Figure 19, the light beams 1931 are reflected off of the mirror 1942 onto the powder bed 1902...para[0105], ...additive manufacturing system 1900 may include a polygon mirror 1942 for scanning multiple beams 1931 according to any of the patterns described herein...); directing and focusing, by post scan relay optics, the reflected plurality of energy beams toward a platen having an additive manufacturing powder material spread thereon (para[0047], ...a processing surface 106 including the exposed layer of the powder bed 102...Figure 1, the flat processing surface 106 is the platen and the powder bed is the powder material spread thereon with the beams from the optical head being focused on certain regions of the powder bed...para[0121], ...an array of light sources may be arranged over a processing surface to direct or focus light beams on the processing surface to form a one or two dimensional array of beam spots...), wherein the reflected plurality of energy beams scan a region of the additive manufacturing powder material (Figure 19, the light beams 1931 are reflected off of the mirror 1942 onto the powder bed 1902...para[0105], ...additive manufacturing system 1900 may include a polygon mirror 1942 for scanning multiple beams 1931 according to any of the patterns described herein...) to selectively melt the additive manufacturing powder (para[0047], ...when forming a build layer in the exposed powder layer on the powder bed 102, an exposure by one or more of the light beams 131 melts the exposed powder material...para[0112], ...laser diode was used with a power of about 65 W...and scanning speeds...to melt various metal powders...); and controlling, by control electronics, power modulation of the individual beams comprising the plurality of energy beams in coordination with the scanning motion (para[0060], ...the optical head motion system 142 may include an X-Y motion stage configured to move the optical head in at least X and Y directions...para[0065], ...the control system 150 may include a CNC computer...and/or microcontroller circuitry. In one example, the CNC computer may read a build instruction file line by line to obtain the position data and control the position of the optical head 140. The CNC computer may send instructions to a microcontroller for controlling the light sources 130 while the optical head is in each position...para[0041], ...multiple beam sequential exposures with varying intensity over a powder region...para[0069], ...one or more of the light sources...is turned on for a defined time and power...) forming a build layer of a three dimensional structure and repeating the process on sequential build layers to form a three dimensional structure (Abstract, ...to expose layers of powder material in selected regions until the powder material fuses to form voxels, which form build layers of a three-dimensional structure...para[0009], ...a method is provided for multiple beam additive manufacturing of a three-dimensional structure formed by a plurality of build layers...).

Claims 1-2 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box IV(3): Lack of unity of invention

Common Technical Features:

Groups I-II share the technical features of powder bed fusion additive manufacturing for the fabrication of three dimensional structures through a succession of multiple powder bed build layers using scans of energy beams.

However, these shared technical features do not represent a contribution over prior art because the shared technical feature is being anticipated by US 2017/0021455 A1 to IPG PHOTONICS CORPORATION (hereinafter "IPG"). IPG discloses powder bed fusion additive manufacturing (Abstract, ...systems and methods for multiple beam additive manufacturing...to expose layers of powder material...para[0044], ...as used herein, powder materials refers to a material in the form of particles suitable for use in powder bed fusion additive manufacturing...) for the fabrication of three dimensional structures through a succession of multiple powder bed build layers using scans of energy beams (para[0047], ...when forming a build layer in the exposed powder layer on the powder bed 102, an exposure by one or more of the light beams 131 melts the exposed powder material...para[0112], ...laser diode was used with a power of about 65 W...and scanning speeds...to melt various metal powders...Abstract, ...to expose layers of powder material in selected regions until the powder material fuses to form voxels, which form build layers of a three-dimensional structure...para[0009], ...a method is provided for multiple beam additive manufacturing of a three-dimensional structure formed by a plurality of build layers...).

As the shared technical features were known in the art at the time of the invention, they cannot be considered common technical features that would otherwise unify the groups. Therefore, Groups I-II lack unity under PCT Rule 13.