IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: **7580**
Timothy E. Olson, *et al*.	Group Art Unit: **2884**
Serial No.: **16/986,014**	Examiner: **Faye, Mamadou**
Filed: **August 5, 2020**	Docket No.: **T17774US002 (222107-1970)**

For: **FOCUSED TOMOGRAPHY**

RESPONSE TO NON-FINAL OFFICE ACTION MAILED FEBRUARY 3, 2022

Mailstop: Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In regard to the outstanding non-final Office Action mailed on February 3, 2023, the following Response is submitted.

It is not believed that extensions of time or fees for net addition of claims are required beyond those that may otherwise be provided for in documents accompanying this paper. However, if additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including, but not limited to, fees for net addition of claims) are hereby authorized to be charged to our Deposit Account No. 20-0778.

LISTING OF CLAIMS

Please amend the above-identified application as follows. Language being added is identified with underlining ("___") and language being deleted is identified with strikethrough ("~~___~~") or double brackets ("[[ ]]"), as is applicable.

1. (Currently Amended) A focused tomography system comprising:

an x-ray transmitter that is configured to emit a radiation beam;

an x-ray detector that is configured to detect incident radiation from the radiation beam;

a plurality of collimators arranged between the x-ray transmitter and the x-ray detector, wherein each of the plurality of collimators are formed of a material that passes substantially 10% of incoming radiation, the plurality of collimators comprising at least an adaptive collimator;

~~an adaptive collimator device arranged between the x-ray transmitter and the x-ray detector, wherein the adaptive collimator device is formed of a material that passes substantially 10% of incoming radiation; and~~

wherein ~~a controller connected to the x-ray transmitter that is configured to cause the x-ray transmitter to emit~~ the adaptive collimator is configured to transmit the radiation beam at a first radiation dosage level when a path of the radiation beam intersects a region of interest of a subject and ~~cause the x-ray transmitter to emit~~ transmit the radiation beam at a second radiation dosage level when the path of the radiation beam does not intersect the region of interest of the subject, the second radiation dosage level being less than the first radiation dosage level and greater than 0[[,]]; and

~~wherein the~~ a controller connected to the focused tomography system that is ~~further~~ configured to perform 2-D computerized tomography reconstruction of an image within the region of interest at a first image quality level for the first radiation dosage level and an image outside the region of interest at a second image quality level for the second radiation dosage level, wherein the second image quality level is lower than the first image quality level and an image of

an entire slice is displayed at the first image quality level for the region of interest and the second image quality level for a region outside the region of interest.

2. (Currently Amended) The system of claim 1, wherein the adaptive collimator ~~device~~ provides a pair of sliding collimators that actuate to adjust a size of an opening between the sliding collimators to be adjustable laterally in size, wherein the adaptive collimator ~~device~~ is movable, via one or more motors, to position the opening at any lateral position within a scan field-of-view and to configure a size of the opening within a range from fully opened to fully closed during each rotation of the x-ray transmitter around the subject.

3. (Currently Amended) The system of claim 2, further comprising a pre-patient filter arranged between the x-ray transmitter and the adaptive collimator ~~device~~, wherein the pre-patient filter comprises a mechanical filter that is controllable by the controller to reduce the radiation dosage level and focus radiation from the x-ray transmitter on the region of interest.

4. (Currently Amended) The system of claim 1, wherein the adaptive collimator ~~device~~ is formed from aluminum, copper, or tungsten material.

5. (Currently Amended) The system of claim 1, wherein the adaptive collimator ~~device~~ comprises a pre-patient filter that focuses radiation from the x-ray transmitter on a region of interest.

6. (Original) The system of claim 1, wherein the an x-ray detector is configured to sample the radiation beam at a same rate within the region of interest and outside the region of interest.

7. (Currently Amended) The system of claim 1, wherein the ~~x-ray transmitter that~~ adaptive collimator is configured to smoothly transition between the first radiation dosage level and the second radiation dosage level.

8. (Original) The system of claim 1, wherein the second radiation dosage level does not exceed 10% of the first radiation dosage level.

9. (Previously Presented) The system of claim 1, wherein the controller is configured to use measurements of the second radiation dosage level outside of the region of interest to determine low frequency components of an image of the region of interest.

10. (Currently Amended) A focused tomography method comprising:

arranging ~~an adaptive collimator device~~ a plurality of collimators between an x-ray transmitter and an x-ray detector of a gantry for a computerized tomography scanner, wherein each of the plurality of collimators are formed of a material that passes substantially 10% of incoming radiation, the plurality of collimators comprising at least an adaptive collimator;

emitting a radiation beam at a first radiation dosage level when a path of the radiation beam intersects a region of interest and emitting the radiation beam at a second radiation dosage level when the path of the radiation beam does not intersect the region of interest, the second radiation dosage level being less than the first radiation dosage level and greater than 0;

detecting, via the x-ray detector, incident radiation from the radiation beam at the first radiation dosage level;

detecting, via the x-ray detector, incident radiation from the radiation beam at the second radiation dosage level;

performing 2-D computerized reconstruction, via a processor, of an image within the region of interest at a first image quality level for the first radiation dosage level and a region

outside the region of interest at a second image quality level for the second radiation dosage level, wherein the second image quality level is lower than the first image quality level; and

displaying an image of an entire slice at both the first image quality level for the region of interest and the second image quality level for a region outside the region of interest.

11. (Previously Presented) The method of claim 10, wherein high frequency components of the image are determined solely from the incident radiation at the first radiation dosage level whose path intersects the region of interest, wherein low frequency components of the image are determined from the incident radiation at the first radiation dosage level whose path intersects the region of interest and the incident radiation at the second radiation dosage level that does not intersect the region of interest.

12. (Currently Amended) The method of claim 10, wherein the adaptive collimator ~~device~~ provides a pair of sliding collimators, the method further comprising:

adjusting, via a controller of the computerized tomography scanner, a size of an opening between the sliding collimators in size in order to restrict a scan field-of-view to a region of interest; and

moving the adaptive collimator ~~device~~ to position the opening at any lateral position within the scan field-of-view.

13. (Currently Amended) The method of claim 12, further comprising arranging a pre-patient filter between the x-ray transmitter and the adaptive collimator ~~device~~, wherein the pre-patient filter comprises a mechanical filter that is controllable by the controller to reduce the radiation dosage level and focus a radiation beam from the x-ray transmitter on the region of interest.

14. (Currently Amended) The method of claim 12, wherein the adaptive collimator ~~device~~ comprises a pre-patient filter that focuses radiation from the x-ray transmitter on the region of interest.

15. (Original) The method of claim 12, wherein the size of the opening and/or a positioning of the opening is adjusted during each rotation of the x-ray transmitter around a subject.

16. (Original) The method of claim 10, further comprising selecting the region of interest before emitting a radiation beam.

17. (Original) The method of claim 10, further comprising sampling the radiation beam at a same rate within the region of interest and outside the region of interest.

18. (Cancelled)

19. (Original) The method of claim 10, further comprising smoothly transitioning between the first radiation dosage level and the second radiation dosage level.

20. (Original) The method of claim 10, wherein the second radiation dosage level does not exceed 10% of the first radiation dosage level.

REMARKS

This is a full and timely response to the outstanding non-final Office Action mailed February 3, 2023. Upon entry of this response, claims 1-17 and 19-20 are pending in the application, where claims 1-5, 7, 10, and 12-14 are currently amended. No new matter has been introduced with these amendments. Applicant respectfully requests reconsideration and allowance of all pending claims.

I. Interview

Applicant respectfully requests the Examiner to consider the amendments and arguments contained herein which are presented to place the application in condition for allowance and invites the Examiner to contact Applicant's representative to address any issues that can expedite examination.

II. Claims 1-9 Are Patentable under 35 U.S.C. §112(a) and §112(b)

On pages 4-6 of the Office Action, claims 1-9 have been rejected under 35 U.S.C. §112(a) as failing to comply with the written description requirement and 35 U.S.C. §112(b) as being indefinite. In particular, the Office Action objects to the term "adaptive collimator device." To address the Examiner's concerns and expedite examination, the claims have been amended to recite an "adaptive collimator." Withdrawal of the rejection is respectfully requested.

Additionally, on page 5 of the Office Action, claims 1-9 have been rejected under 35 U.S.C. §112(a) as failing to comply with the written description requirement. In particular, the Office Action indicates that there is no support in the specification for "cause the x-ray transmitter to emit the radiation beam at a first radiation dosage level when a path of the radiation beam intersects a region of interest of a subject and cause the x-ray transmitter to emit the radiation beam at a second radiation dosage level when the path of the radiation beam does not intersect the region of interest of the subject, the second radiation dosage level being less than the first radiation dosage level and greater than 0." Accordingly, to address the Examiner's concerns and expedite

examination, independent claim 1 has been rewritten to recite “wherein the adaptive collimator is configured to transmit the radiation beam at a first radiation dosage level when a path of the radiation beam intersects a region of interest of a subject and transmit the radiation beam at a second radiation dosage level when the path of the radiation beam does not intersect the region of interest of the subject, the second radiation dosage level being less than the first radiation dosage level and greater than 0.” Withdrawal of the rejection is respectfully requested.

III. Claims 1, 4, 7-10, and 20 Are Patentable under 35 U.S.C. §103 over *Raupach* and *Li*

On page 7 of the Office Action, claims 1, 4, 7-10, and 20 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* (U.S. Patent Pub. No. 2010/0091937) in view of *Li* (U.S. Patent Pub. No. 2010/0119033). Applicant respectfully requests that the rejections of claims 1, 4, 7-10, and 20 be withdrawn for at least the following reasons.

In reviewing the references cited in the Office Action, *Raupach* discloses an x-ray diaphragm system having two diaphragm devices 6, 7, with diaphragm device 6 being stated to be “a conventional beam shaping diaphragm 6 with diaphragm elements impermeable to x-rays.” *See* para. 0043. Thus, Applicant respectfully submits that *Raupach* fails to teach or suggest “wherein each of the plurality of collimators are formed of a material that passes substantially 10% of incoming radiation, the plurality of collimators comprising at least an adaptive collimator,” as required by claim 1. Similarly, *Li* does not remedy the deficiencies of the teachings of *Raupach*. For example, the system disclosed in *Li* discloses fully-attenuating collimators “that effectively block at least a first portion of the beam from reaching the object.” *See* para. 0013. As such, the combination of *Raupach* in view of *Li* fails to disclose “wherein each of the plurality of collimators are formed of a material that passes substantially 10% of incoming radiation, the plurality of collimators comprising at least an adaptive collimator,” as recited in claim 1.

Moreover, *Raupach* states “Due to the attenuated x-ray intensity of the x-rays used for the scanning of the region outside of the ROI, the noise of the corresponding projection data is

increased. Insofar as projection data that can be used for folding within the scope of the reconstruction exist for regions outside of the ROI, at least the ROI can be reconstructed without artifacts." *See* para. 0035. *Raupach* also refers repeatedly to interpolation, which is an artificial manipulation of the data to achieve eye pleasing, although possibly not correct images. *See* para. 0028 ("data being removed and replaced with interpolated data.") As such, the techniques of *Raupach* do not appear to contemplate that regions outside the ROI can be reconstructed without artifacts or at a high resolution. In contrast, the techniques of the present application allow for the viewing of a localized region of interest (ROI) and the area outside the ROI to also be viewable without utilizing artificial "look good" techniques. An example application where not only the ROI needs to be viewed, but the rest of the body at a lower dosage, is in Orthopedics. When a traumatic injury happens to one's bones, the body sometimes overcompensates and heterotopic ossification, or the creation of new and unwanted bones, occurs. This happens with hip replacements as well as simple elbow injuries. However, *Raupach* does not supply this information outside of the ROI, or a method to achieve it. As such, the below images demonstrate that the present application and the claimed subject matter can supply both of these goals with a net radiation reduction of 80-90%. Reconstruction from true measured data (without false manipulation) is achievable with the techniques of the claimed subject matter.

In the figures below, two cadaver images of a chest are illustrated. In image A, we see an image taken at 17 mGy. In image B, we see the same image but at 1.7 mGy. From image B, we can see the loss of detail on the spinal bones (as compared to image A). In image C (that is acquired using techniques of the claimed subject matter), we show the effect of combining the 17 mGy image in the ROI, with 1.7 mGy outside. The detail in the spinal record has been recovered in Image C.

Image A:

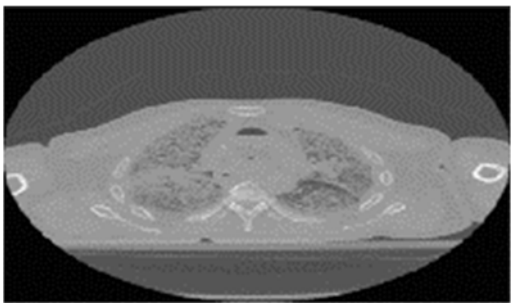


Image B:

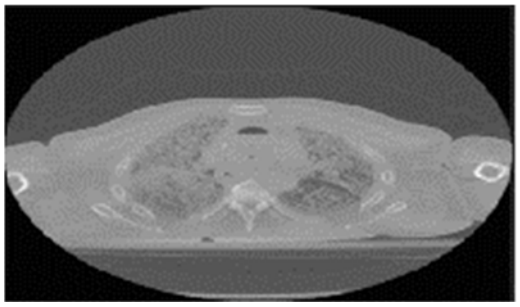
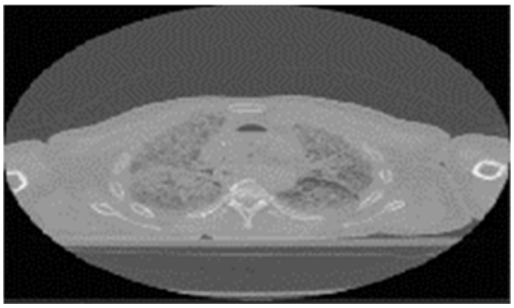
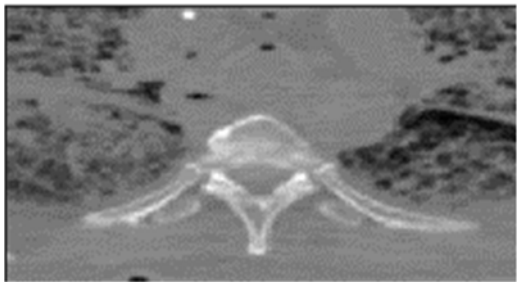


Image C:

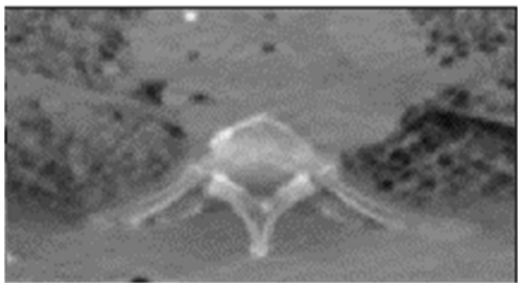


Next, closeups of the above cadaver images are provided below for images A-C. It its noted that the detail image from the 17 mGy image A is not present in the 1.7 mGy image B. Combining the ROI data from Image A with the non-ROI data of Image B, we see the spinal detail in image C with a dramatic reduction in radiation.

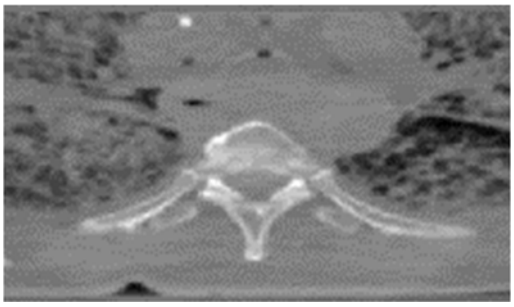
Closeup Image A:



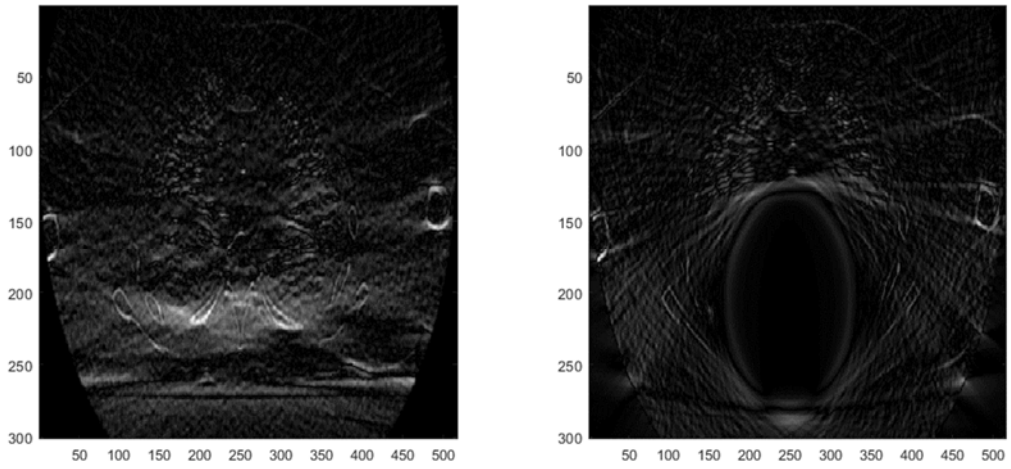
Closeup Image B:



Closeup Image C:

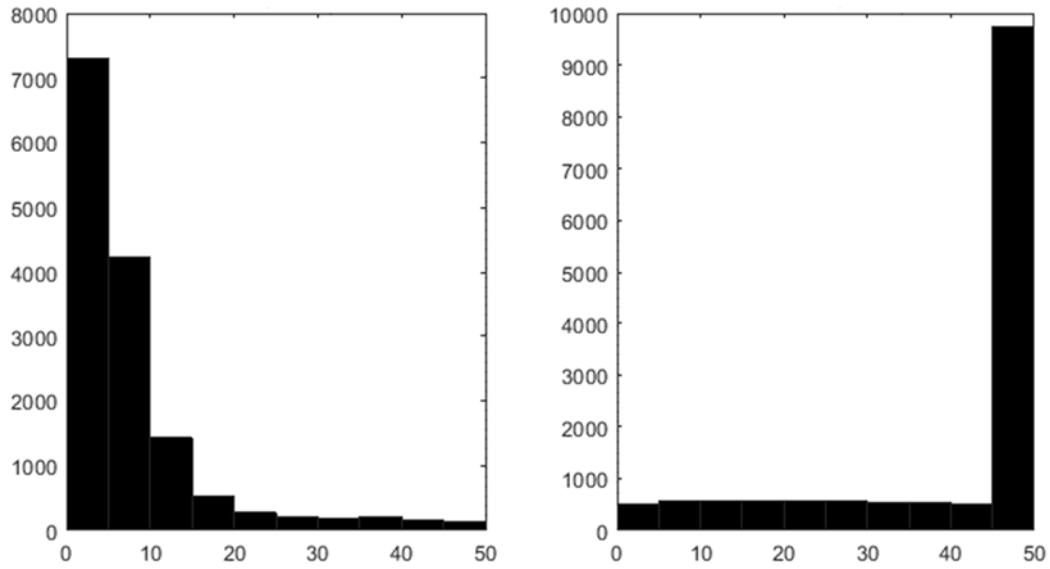


Correspondingly, the absolute differences between the 17 mGy Image A and the 1.7 mGy Image B is shown on the below left image, and the absolute difference between 17 mGy Image A and image D are shown on the below right image. Note that the errors on the spinal cord on the below left image are eliminated in the below right image, which was done in accordance with the claimed subject matter.

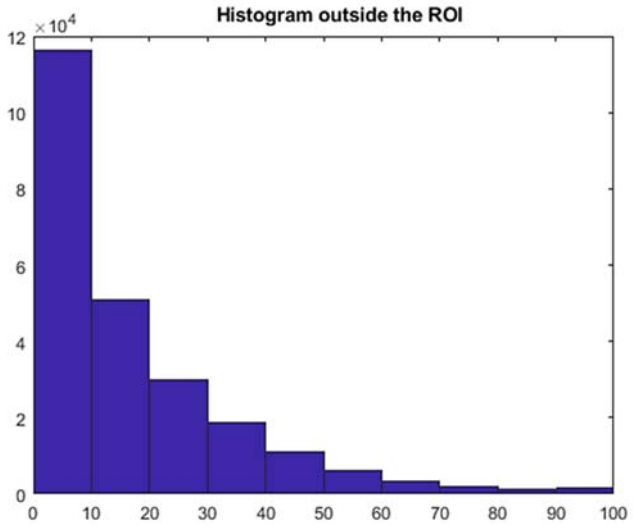


In the ROI, the mean error in the above image on the left is 94 Hounsfield Units, and the maximum error is 489 Hounsfield Units. In contrast, within the above image on the right, the mean error is 8 and the maximum error is 67 Hounsfield Units.

Next, histograms of the ROI errors are examined. In the histograms below, the x-values are Hounsfield units. For the histogram on the left (for techniques of the claimed subject matter), simple observation shows that 82% of the errors for images acquired using the claimed subject matter are below 10 Hounsfield units, or 10/1024=1% error. For the histogram on the right, analysis of the uncorrected tomography data shows that only 7% of the errors are below 10 Hounsfield Units, and 70 % of the errors are greater than 100, showing 70 % of the errors are above 10%. The large difference between these two histograms confirms the visual analysis for the images above.



The next figure analyzes the difference between Image B and Image C outside of the ROI. The question is how Image C (produced by techniques of the claimed subject matter) performs outside of the ROI. We see that 80% of the errors are below 30 Hounsfield units, or 3 % error, 70 % are below 20 Hounsfield units, or 2 % error, and 51% are below 10 Hounsfield units, or 1 % error. Thus, techniques in accordance with the claimed subject matter not only produce a very good image within the ROI, but a nearly identical lower dosage image outside of the ROI (which is not contemplated or disclosed by *Raupach*).



For at least the reasons provided above in the present response, claim 1 is patentable over the cited art. Insofar as claims 4 and 7-9 depend from claim 1 and recite additional features, the rejection of claims 1, 4, and 7-9 should be withdrawn. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Additionally, claim 10 shares allowable features with claim 1, and therefore, claim 10 is patentable over the cited art for similar reasons. Insofar as claim 20 depends from claim 10 and recites additional features, the rejection of claims 10 and 20 should be withdrawn.

IV. Claims 2, 12, and 15 Are Patentable under 35 U.S.C. §103 over *Raupach*, *Li*, and *Besson*

On page 9 of the Office Action, claims 2, 12, and 15 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Besson* (U.S. Patent Pub. No. 2004/0264626). As addressed above, Applicant respectfully submits that independent claims 1 and 10 are patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Besson* does not remedy the deficiencies of *Raupach* and *Li* in view of claims 1 and 10. Insofar as claims 2, 12, and 15 depend from claims 1 or 10, respectively, and recite additional features, Applicant respectfully submits that claims 2, 12, and 15 are patentable over the cited art of *Raupach*, *Li*, and *Besson*. Withdrawal of the rejection is respectfully requested.

V. Claims 3, 5, 6, 13, and 14 Are Patentable under 35 U.S.C. §103 over *Raupach*, *Li*, and *Deutsch*

On pages 10-12 of the Office Action, claims 3, 5, 6, 13, and 14 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Deutsch* (U.S. Patent Pub. No. 2013/0272504). As addressed above, Applicant respectfully submits that independent claims 1 and 10 are patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Deutsch* does not remedy the deficiencies of *Raupach* and *Li* in view of claims 1 and 10. Insofar as claims 3, 5, 6, 13, and 14 depend from claims 1 or 10, respectively, and recite additional features, Applicant respectfully submits that claims 3, 5, 6, 13, and 14 are

patentable over the cited art of *Raupach*, *Li*, and *Deutsch*. Withdrawal of the rejection is respectfully requested.

VI. Claim 11 Is Patentable under 35 U.S.C. §103 over *Raupach*, *Li*, and *Cao*

On page 13 of the Office Action, claim 11 has been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Cao* (U.S. Patent No. 10,628,974). As addressed above, Applicant respectfully submits that independent claim 10 is patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Cao* does not remedy the deficiencies of *Raupach* and *Li* in view of claim 10. Insofar as claim 11 depends from claim 10 and recites additional features, Applicant respectfully submits that claim 11 is patentable over the cited art of *Raupach*, *Li*, and *Cao*. Withdrawal of the rejection is respectfully requested.

VII. Claims 13 and 14 Are Patentable under 35 U.S.C. §103 over *Raupach , Li, Besson*, and *Deutsch*

On page 13 of the Office Action, claims 13 and 14 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Besson* and *Deutsch*. As addressed above, Applicant respectfully submits that independent claim 10 is patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Besson* and *Deutsch* do not remedy the deficiencies of *Raupach* and *Li* in view of claim 10. Insofar as claims 13 and 14 depend from claim 10 and recite additional features, Applicant respectfully submits that claims 13 and 14 are also patentable over the cited art of *Raupach*, *Li*, *Besson*, and *Deutsch*. Withdrawal of the rejection is respectfully requested.

VIII. Claims 16 and 19 Are Patentable under 35 U.S.C. §103 over *Raupach, Li,* and *Herold*

On page 14 of the Office Action, claims 16 and 19 have been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Herold* (U.S. Patent Pub. No. 2014/0177782). As addressed above, Applicant respectfully submits that independent

claim 10 is patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Herold* does not remedy the deficiencies of *Raupach* and *Li* in view of claim 10. Insofar as claims 16 and 19 depend from claim 10 and recite additional features, Applicant respectfully submits that claims 16 and 19 are patentable over the cited art of *Raupach*, *Li*, and *Herold*. Withdrawal of the rejection is respectfully requested.

IX. Claim 17 Is Patentable under 35 U.S.C. §103 over *Raupach, Li,* and *Helm*

On page 14 of the Office Action, claim 17 has been rejected under 35 U.S.C. §103 as allegedly being unpatentable over *Raupach* in view of *Li* and in further view of *Helm* (U.S. Patent Pub. No. 2012/0099697). As addressed above, Applicant respectfully submits that independent claim 10 is patentable over *Raupach* and *Li*. Further, Applicant respectfully submits that *Helm* does not remedy the deficiencies of *Raupach* and *Li* in view of claim 10. Insofar as claim 17 depends from claim 10 and recites additional features, Applicant respectfully submits that claim 17 is patentable over the cited art of *Raupach*, *Li*, and *Helm*.

CONCLUSION

Applicant respectfully requests that all outstanding rejections be withdrawn and that this application and presently pending claims be allowed to issue. Any statements in the Office Action that are not explicitly addressed herein are not intended to be admitted. In addition, any and all findings of inherency are traversed as not having been shown to be necessarily present. Furthermore, any and all findings of well-known art and official notice, or statements interpreted similarly, should not be considered well known since the Office Action does not include specific factual findings predicated on sound technical and scientific reasoning to support such conclusions. If the Examiner has any questions or comments regarding Applicant's response, the Examiner is encouraged to telephone Applicant's undersigned counsel.

Respectfully submitted,

By: /Charles W. Griggers/
Charles W. Griggers
Reg. No. 47,283

THOMAS | HORSTEMEYER, L.L.P.
Customer Number 24504
Tel. No. 770-933-9500