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Arnold

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(54) **MICROSCOPE WITH TUNABLE ACOUSTIC GRADIENT INDEX OF REFRACTION LENS ENABLING MULTIPLE FOCAL PLAN IMAGING**

USPC 359/385, 652
See application file for complete search history.

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CPC **G02B 21/025** (2013.01); **G02B 3/0087** (2013.01)

(58) **Field of Classification Search**
CPC G02B 3/0087; G02B 21/367; G02B 3/12; G02B 21/002; G02B 21/025

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0201123 A1* 8/2007 Saggau et al. 359/285
2012/0098949 A1* 4/2012 Knebel et al. 348/79

OTHER PUBLICATIONS

Nicolas Olivier et al., "Two-photon microscopy with simultaneous standard and extended depth of field using a tunable acoustic gradient-index lens", Optics Letters, vol. 34, No. 11, pp. 1684-1686, Jun. 1, 2009.*

* cited by examiner

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(57) **ABSTRACT**

An apparatus, system and method for microscopy. The apparatus, system and method includes a stage configured to receive an item; a tunable acoustic gradient index of refraction (TAG) lens having a first aspect positioned to image the received item, wherein the first aspect of the TAG lens is configured to have an optical power profile in accordance with an operational frequency of the TAG lens; one or more lenses configured to magnify an image of the received item at a viewing point; and at least one pulsed light source configured to illuminate the received item and to pulse at one or more points within the optical power profile of the TAG lens.

18 Claims, 30 Drawing Sheets

