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Klimov et al.

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(54) **HIGH-RESOLUTION PHOTONIC THERMOMETER ARTICLE**
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(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

8,508,370 B1 * 8/2013 El-Kady G08B 13/14 340/572.1

8,798,414 B2 8/2014 Quan et al.
(Continued)

OTHER PUBLICATIONS

Quan, et al., "Deterministic design of wavelength scale, ultra-high Q photonic crystal nanobeam cavities", Optics Express, 2011, p. 18529-18542, vol. 19 No. 19.

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(57) **ABSTRACT**

A high-resolution photonic thermometer article performs high-resolution thermometry and includes: a light source; a photonic thermometer with a waveguide and a photonic crystal cavity that stores light; a photodetector in communication with the photonic thermometer; a phase sensitive detector in communication with the photodetector and that: receives the photodetector signal from the photodetector; receives a reference frequency signal; and produces a lock signal from the photodetector signal, based on the reference frequency signal; a local oscillator in communication with the phase sensitive detector and that produces the reference frequency signal; and a servo controller in communication with the phase sensitive detector and local oscillator and that: receives the lock signal from the phase sensitive detector; receives the reference frequency signal from the local oscillator; and produces the control signal such that absorption power of the photonic crystal is maximized through wavelength control of the light source by the control signal.

19 Claims, 30 Drawing Sheets

