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(54) **HIGH EFFICIENCY PRODUCTION OF NANOFIBRILLATED CELLULOSE**

(71) Applicant: **University of Maine System Board of Trustees**, Bangor, ME (US)

(72) Inventors: **Michael A. Bilodeau**, Brewer, ME (US); **Mark A. Paradis**, Old Town, ME (US)

(73) Assignee: **University of Maine System Board of Trustees**, Bangor, ME (US)

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See application file for complete search history.

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Primary Examiner — Jose A Fortuna
(74) *Attorney, Agent, or Firm* — MacMillan, Sobanski & Todd, LLC

(57) **ABSTRACT**

A scalable, energy efficient process for preparing cellulose nanofibers employs treating the cellulosic material with a first mechanical refiner with plates having a configuration of blades separated by grooves, and subsequently treating the material with a second mechanical refiner with plates having a configuration of blades separated by grooves different than the first refiner. The plate configurations and treatment operations are selected such that the first refiner produces a first specific edge loading (SEL) that is greater than the SEL of the second refiner, by as much as 2-50 fold. An exemplary high first SEL may be in the range of 1.5 to 8 J/m. Paper products made with about 2% to about 30% cellulose nanofibers having a length from about 0.2 mm to about 0.5 mm, preferably from 0.2 mm to about 0.4 mm have improved properties.

12 Claims, 13 Drawing Sheets