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(12) **United States Patent**
Levine

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(54) **ROBUST WATERMARK METHOD AND APPARATUS FOR DIGITAL SIGNALS**

(75) Inventor: **Earl Levine, Palo Alto, CA (US)**

(73) Assignee: **Liquid Audio, Inc., Redwood City, CA (US)**

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(51) **Int. Cl.**⁷ **H04K 1/02; H04L 9/18; G06K 9/64**

(52) **U.S. Cl.** **380/205; 380/38; 380/37; 380/54; 713/176; 713/179; 382/284**

(58) **Field of Search** **713/176, 179; 380/37, 38, 51, 54, 55, 59, 205, 210, 212; 341/50, 55; 348/584; 382/284, 305**

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Primary Examiner—Gail Hayes

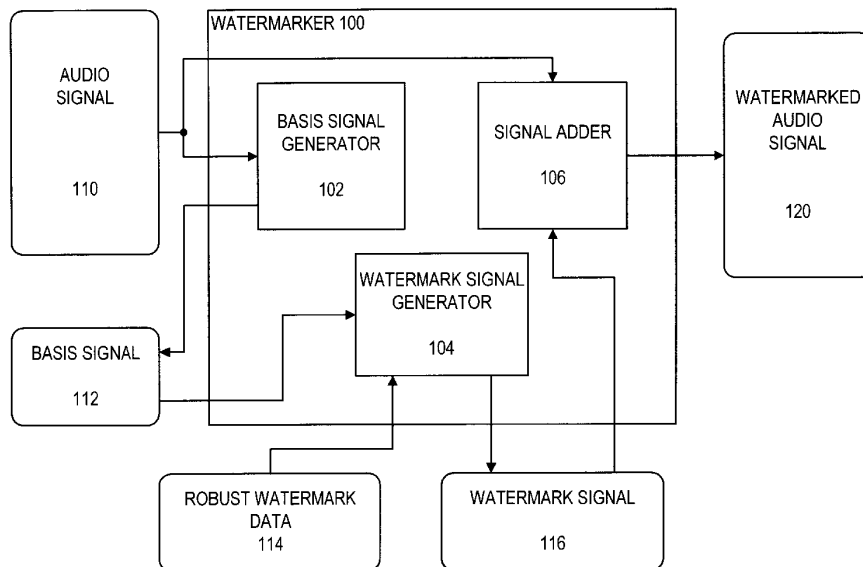
Assistant Examiner—Justin T. Darrow

(74) *Attorney, Agent, or Firm*—James D. Ivey

(57) **ABSTRACT**

Watermark data is encoded in a digitized signal by forming a noise threshold spectrum which represents a maximum amount of imperceptible noise, spread-spectrum chipping the noise threshold spectrum with a relatively endless stream of pseudo-random bits to form a basis signal, dividing the basis signal into segments, and filtering the segments to smooth segment boundaries. The data encoded in the watermark signal is precoded to make the watermark data inversion robust and is convolutional encoded to further increase the likelihood that the watermark data will subsequently be retrievable notwithstanding lossy processing of the watermarked signal.

57 Claims, 24 Drawing Sheets



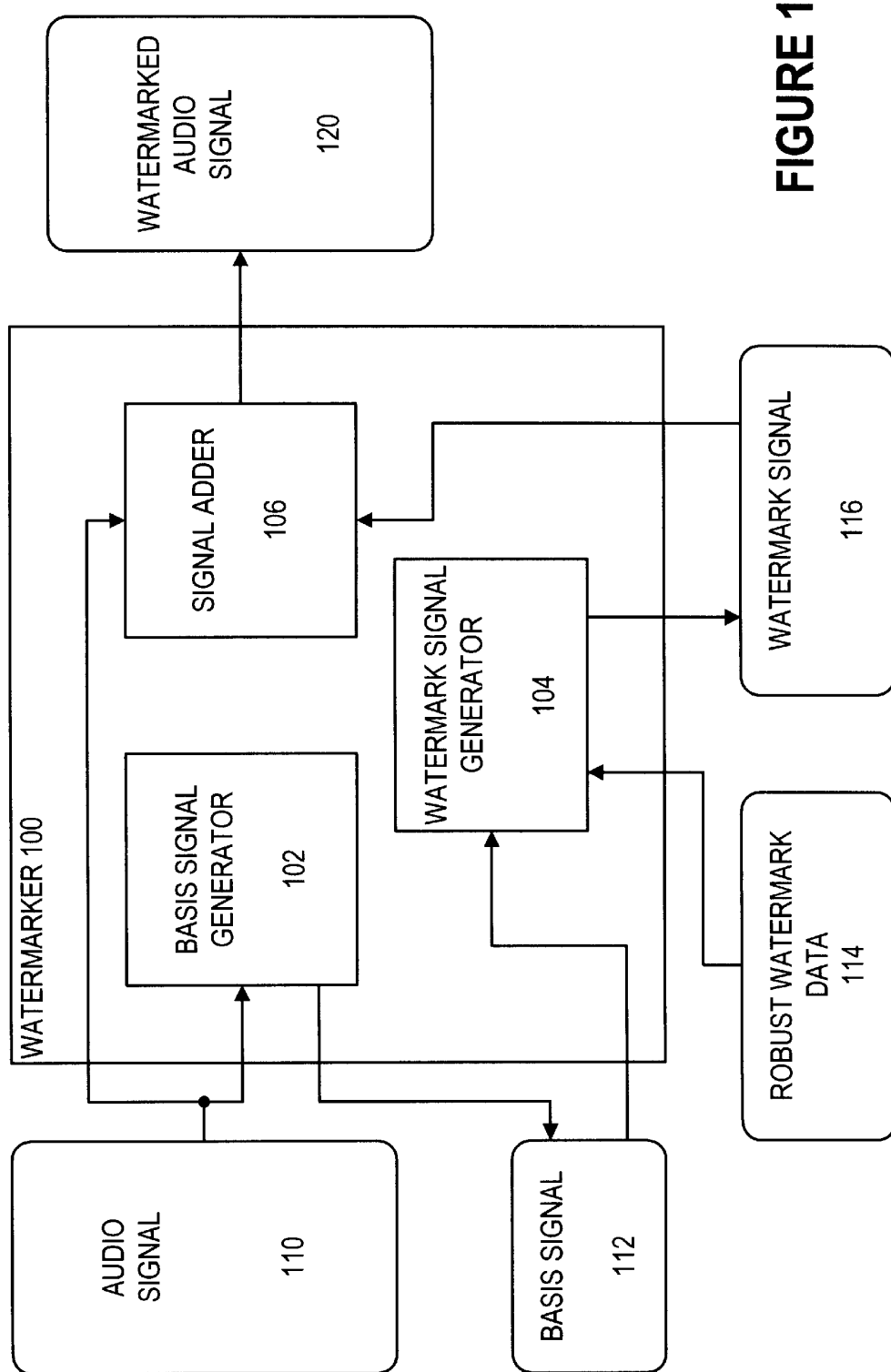


FIGURE 1

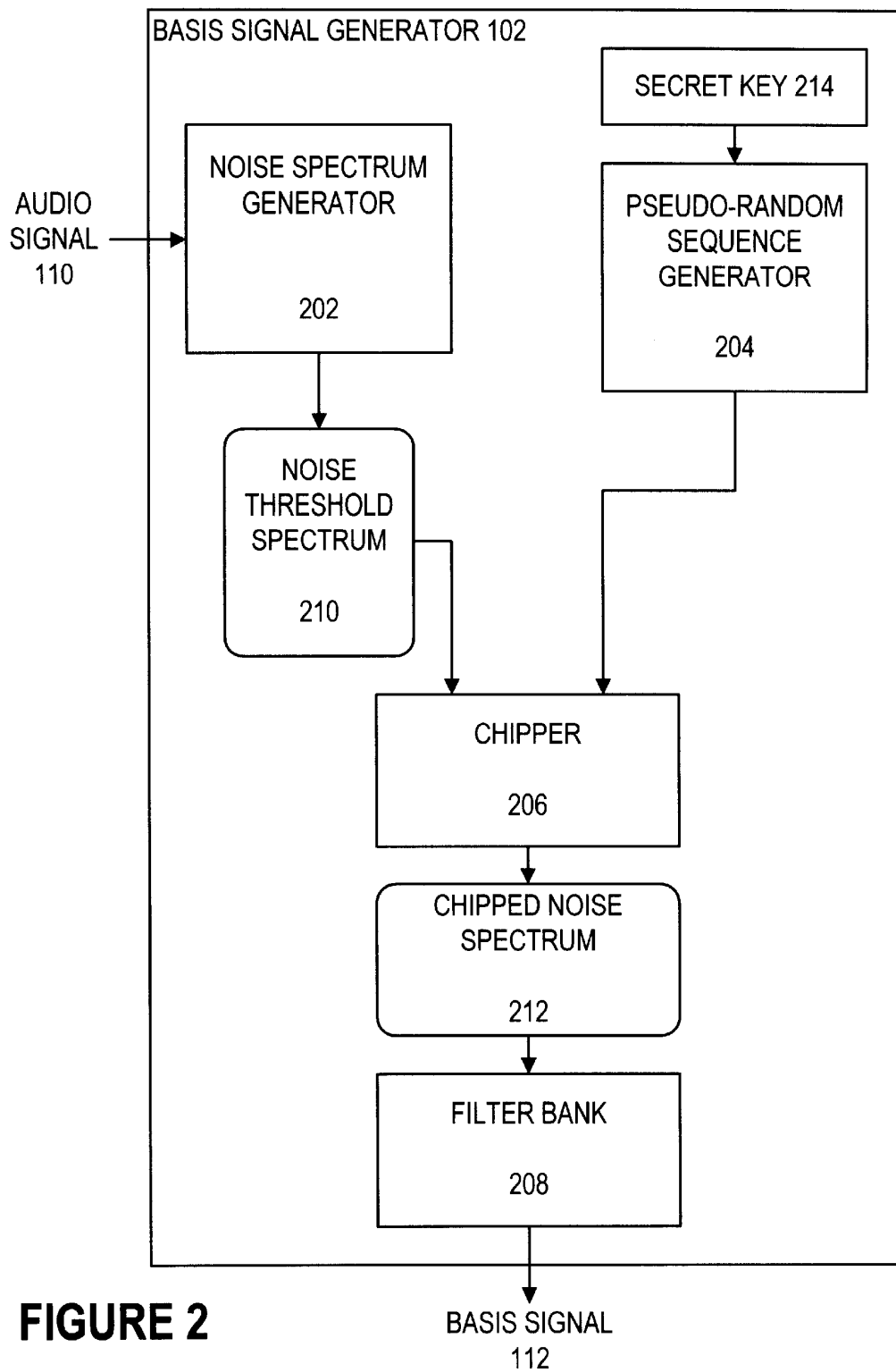


FIGURE 2

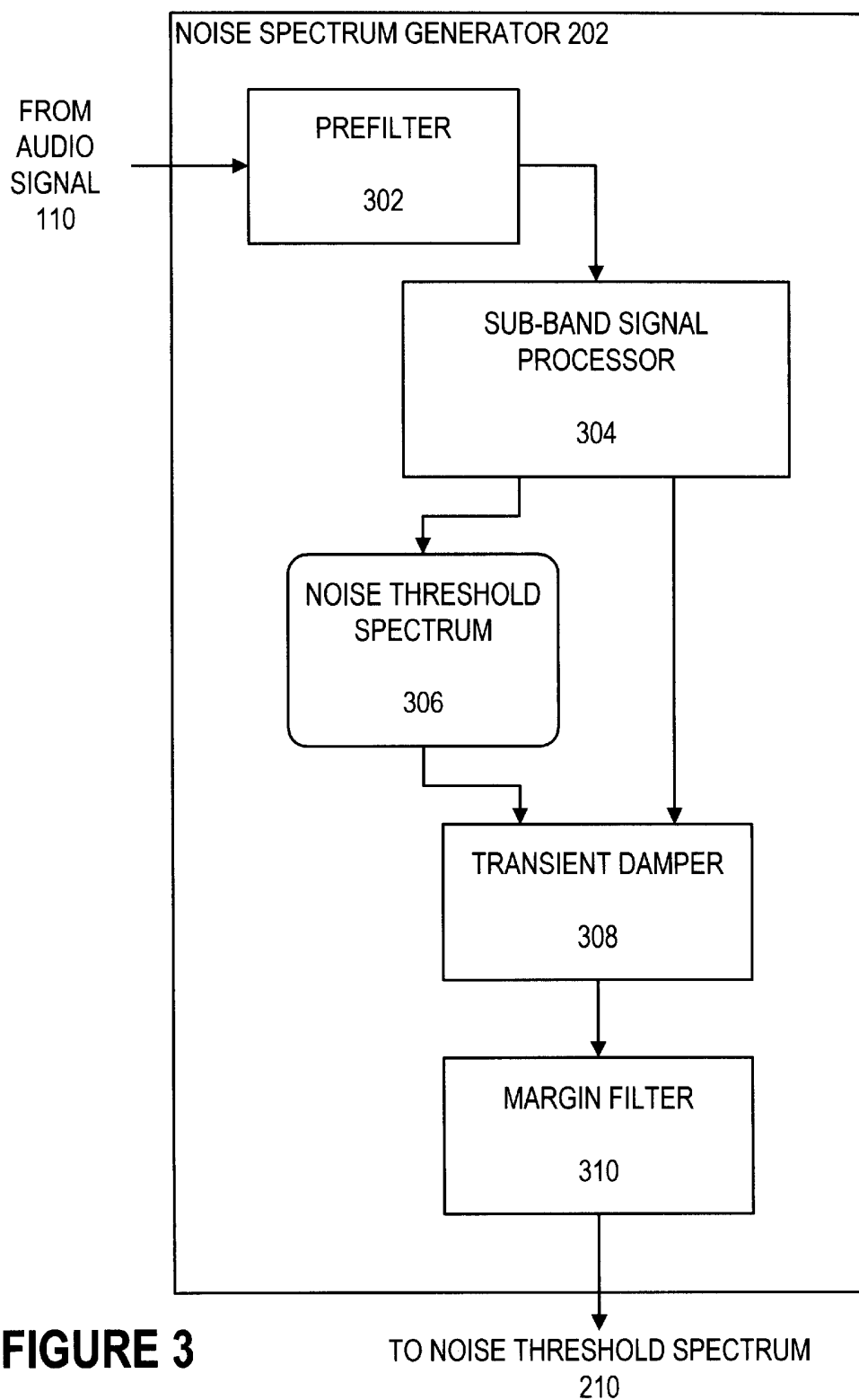


FIGURE 3

TO NOISE THRESHOLD SPECTRUM 210

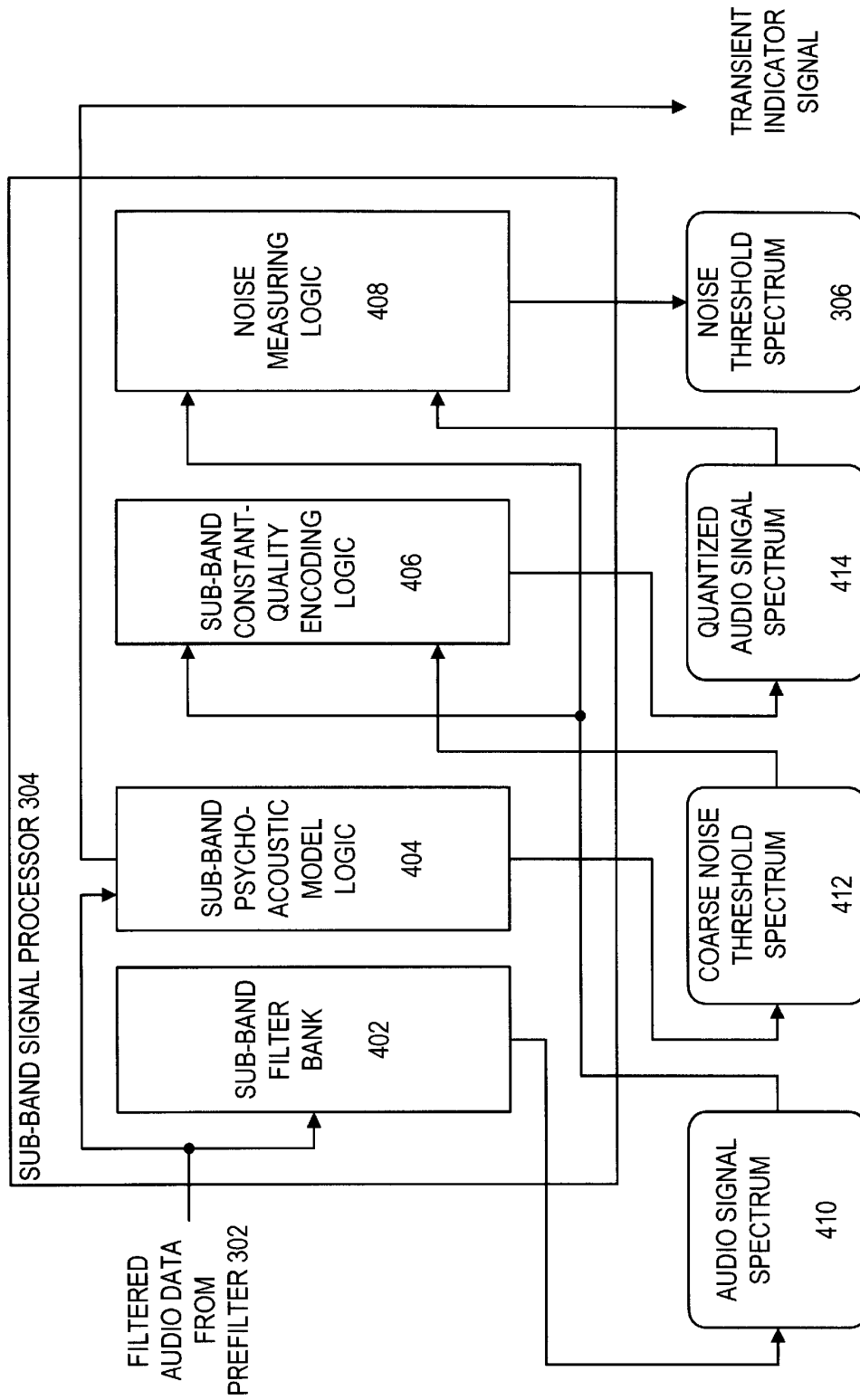


FIGURE 4

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