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Cooklev

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(54) **METHOD AND APPARATUS FOR WAVELET-BASED DIGITAL WATERMARKING**

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(52) U.S. Cl. **382/100**; 382/248
(58) Field of Search 382/100, 101, 382/118, 119, 120, 212, 232, 248, 249, 250, 276, 280, 284, 293, 296; 380/54, 210, 252, 287; 713/176

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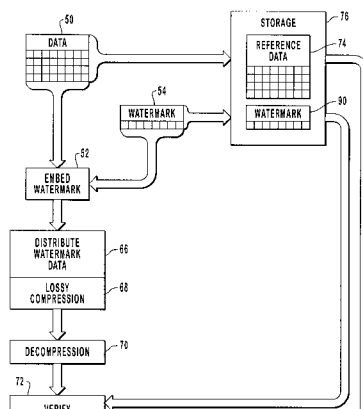* cited by examiner

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(57) **ABSTRACT**

The disclosed watermarking method utilizes a transform technique for inserting an imperceptible digital watermark into digital data that is strongly resistant to unauthorized detection and decoding. Methods for embedding a watermark that is sufficiently robust to lossy compression and other image processing operations such as rescaling are also provided. The watermarking principle is based on wavelet transforms where the coefficients of the filters have binary values, and are thus very attractive for practical realization. The wavelet filters utilize complimentary polynomials and implement non-regular wavelet transforms upon which the digital watermark is inserted. Following the inverse transformation process, the digital watermark is spread across multiple frequencies of the original digital data thereby reducing the impact of signal processing operations such as compression or other frequency filtering based operations. Additional embodiments employing complimentary matrix polynomials which are closely related to multifilter banks are also provided.
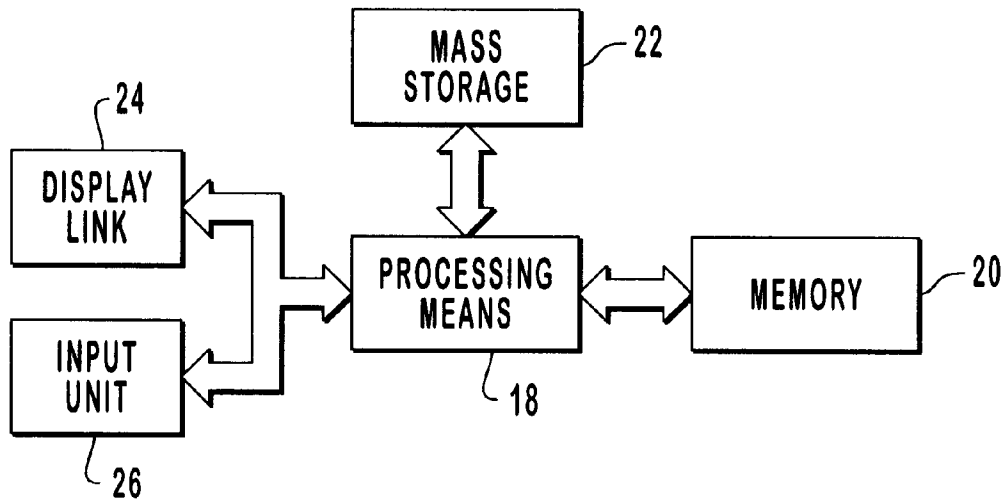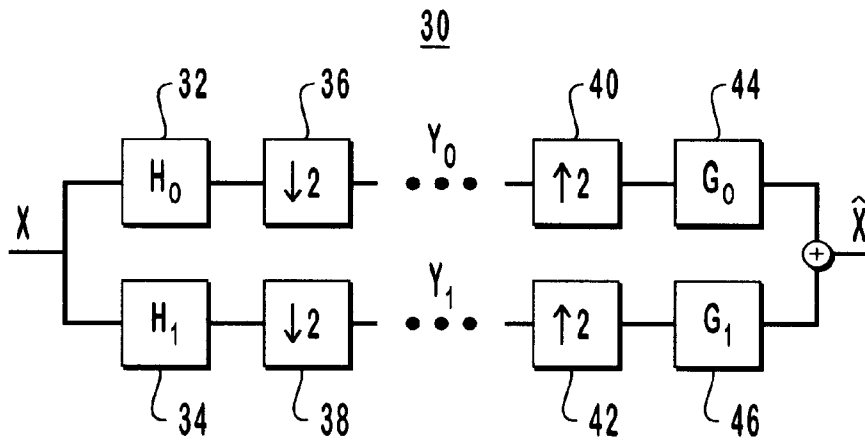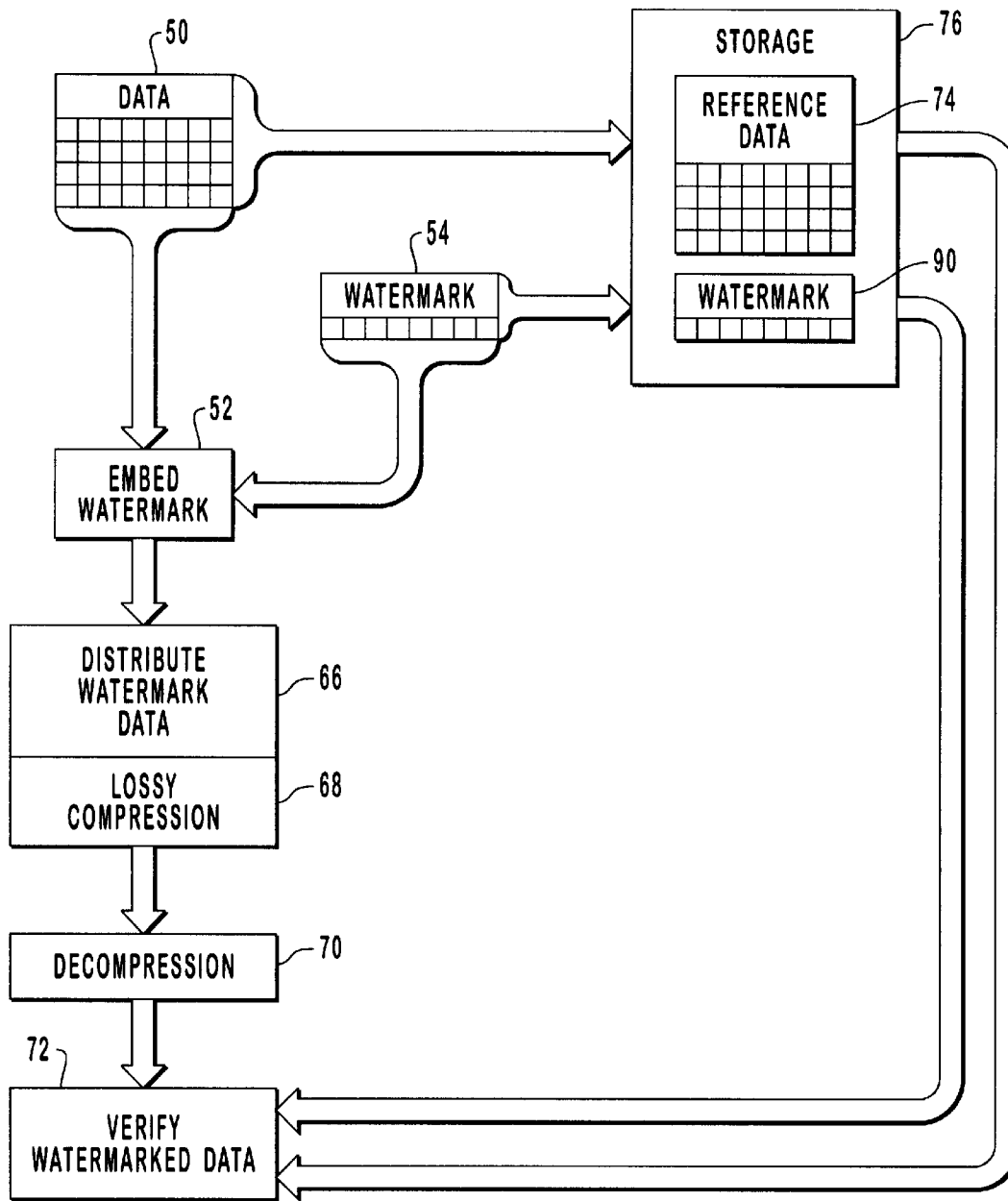
23 Claims, 6 Drawing Sheets

FIG. 1

FIG. 2

FIG. 3

EMBED WATERMARK —52

PARTITION DATA INTO BLOCKS —56

GENERATE SUBBAND TREE
(COMPLETE OR PRUNED) —58

PERFORM FORWARD WAVELET
TRANSFORM —60

INSERT WATERMARK INTO
WAVELET COEFFICIENTS —62

PERFORM INVERSE WAVELET
TRANSFORM —64

END

FIG. 4

VERIFY WATERMARK DATA — 72

PARTITION DATA INTO BLOCKS — 78

GENERATE SUBBAND TREE CONSISTENT WITH EMBEDDING SUBBAND TREE (COMPLETE OR PRUNED) — 80

PERFORM FORWARD WAVELET TRANSFORM OF DISTRIBUTED WATERMARKED DATA — 82

PERFORM FORWARD WAVELET TRANSFORM OF REFERENCE DATA — 84

COMPARE WAVELET COEFFICIENTS — 86

REFERENCE WATERMARK — 90

88 — COMPARE COEFFICIENT DIFFERENCES WITH REFERENCE WATERMARK

DIFFERENCE WITHIN VERIFICATION THRESHOLD ? — 92

NO

YES

WATERMARK DETECTED IN DISTRIBUTED WATERMARKED DATA — 94

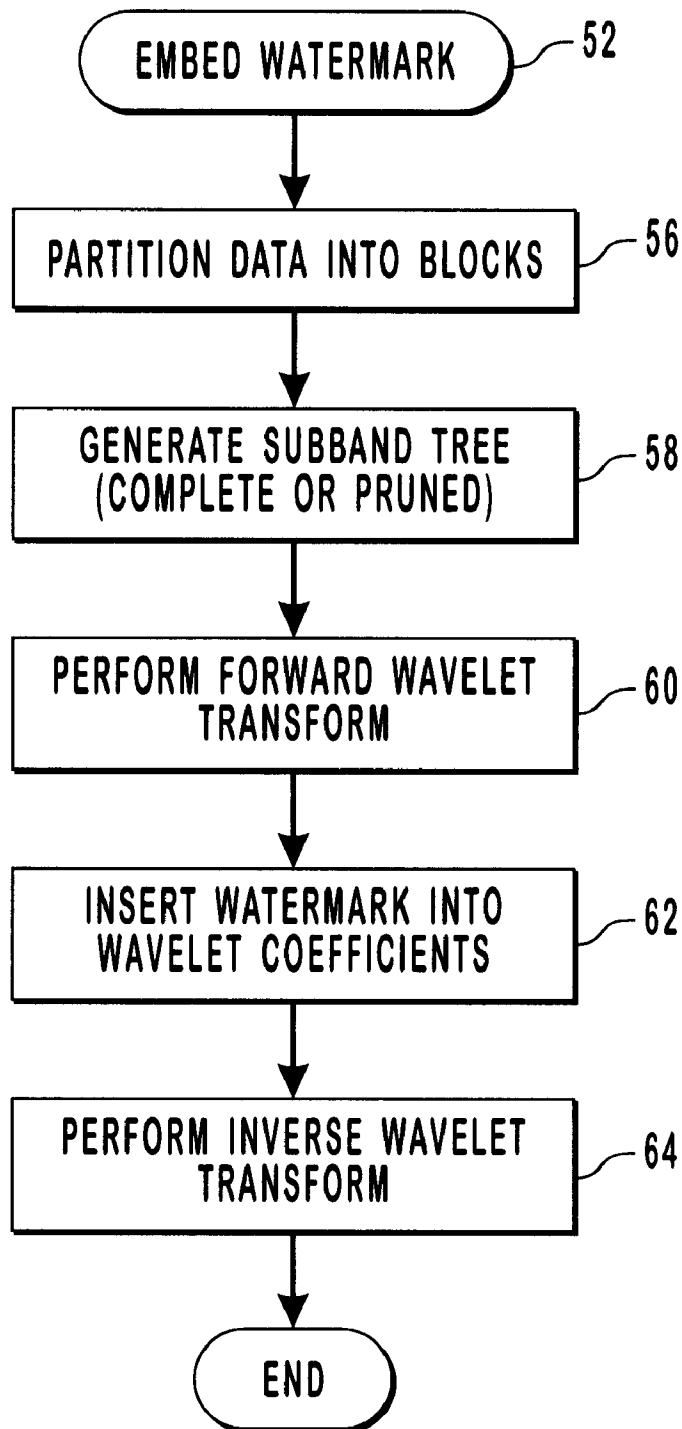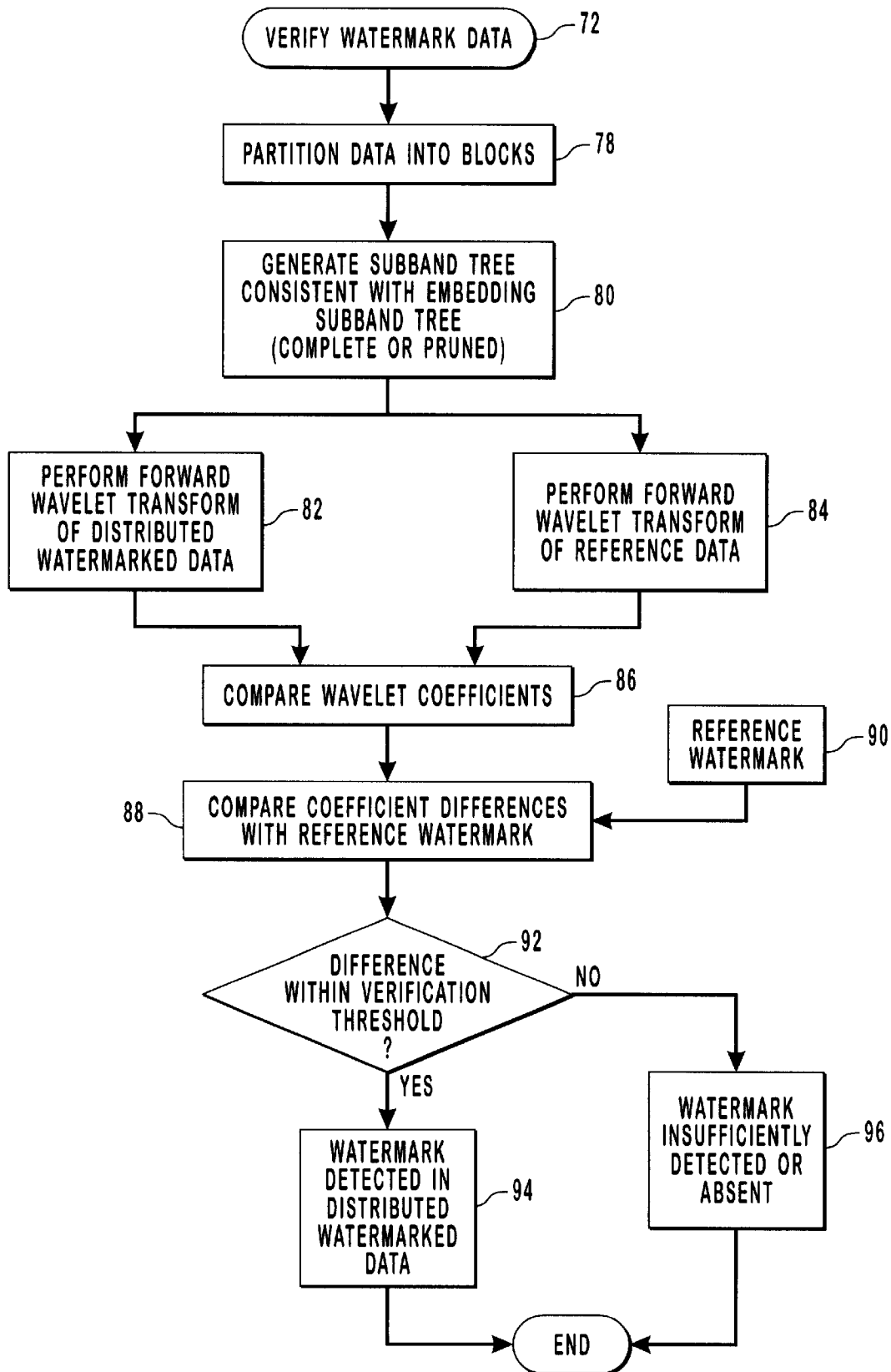WATERMARK INSUFFICIENTLY DETECTED OR ABSENT — 96

END

FIG. 5

DOCKET ALARM

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