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Jeričević et al.

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[54] ENERGY MINIMIZATION IN SURFACE MULTIPLE ATTENUATION

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[51] Int. Cl.⁶ **G01V 1/38**

[52] U.S. Cl. **367/24; 367/45; 367/24; 367/53**

[58] Field of Search **367/21, 24, 38, 367/45, 53**

[56] References Cited

U.S. PATENT DOCUMENTS

5,138,583	8/1992	Wason et al.	367/21
5,448,531	9/1995	Dragoset et al.	367/21
5,587,965	12/1996	Dragoset, Jr. et al.	367/24
5,719,821	2/1998	Sallas et al.	367/21
5,729,506	3/1998	Dragoset et al.	367/21

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Assistant Examiner—Anthony Jolly

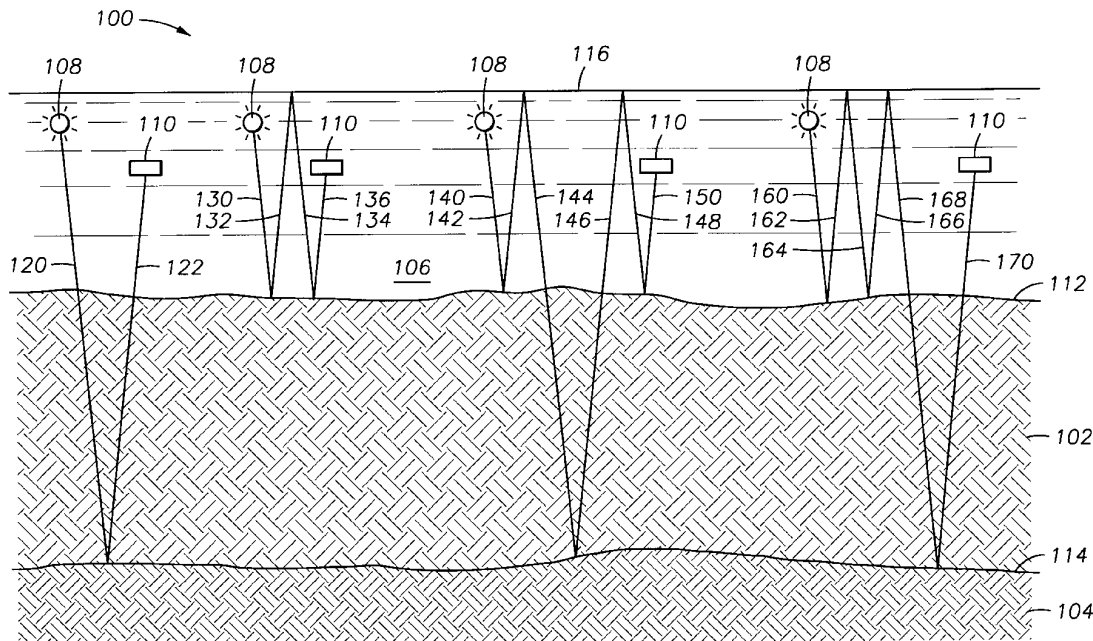
17 Claims, 4 Drawing Sheets

[57] ABSTRACT

A marine seismic signal is transformed from time domain into frequency domain and represented by matrix D. The marine data signal is truncated in time, transformed into the frequency domain and represented by matrix D_T . Eigenvalue decomposition $D_{T=SA}^{-1}$ of matrix D_T is computed. Matrix product D S is computed and saved in memory. Conjugate transpose $[D S]^*$ is computed and saved in memory. Matrix product $[D S]^*[D S]$ is computed and saved in memory. Matrix inverse S^{-1} is computed and saved in memory. Conjugate transpose $(S^{-1})^*$ is computed and saved in memory. Matrix product $S^{-1}(S^{-1})^*$ is computed and saved in memory. An initial estimate of the source wavelet w is made. Source wavelet w is optimized by iterating the steps of computing the diagonal matrix $[I-w^{-1}\Lambda]$, computing matrix inverse $[I-w^{-1}\Lambda]^{-1}$, computing conjugate transpose $[(I-w^{-1}\Lambda)^{-1}]^*$, retrieving matrix products $[D S]^*[D S]$ and $S^{-1}(S^{-1})^*$ from memory, and minimizing the total energy in trace of matrix product

$$S^{-1}(S^{-1})^*[(I-w^{-1}\Lambda)^{-1}]^*[D S][D S][I-w^{-1}\Lambda]^{-1}$$

Primary matrix P representing the wavefield free of surface multiples is computed by inserting computed value for w into the expression $[D S][I-w^{-1}\Lambda]^{-1}S^{-1}$. Primary matrix P is inverse transformed from frequency domain into time domain.



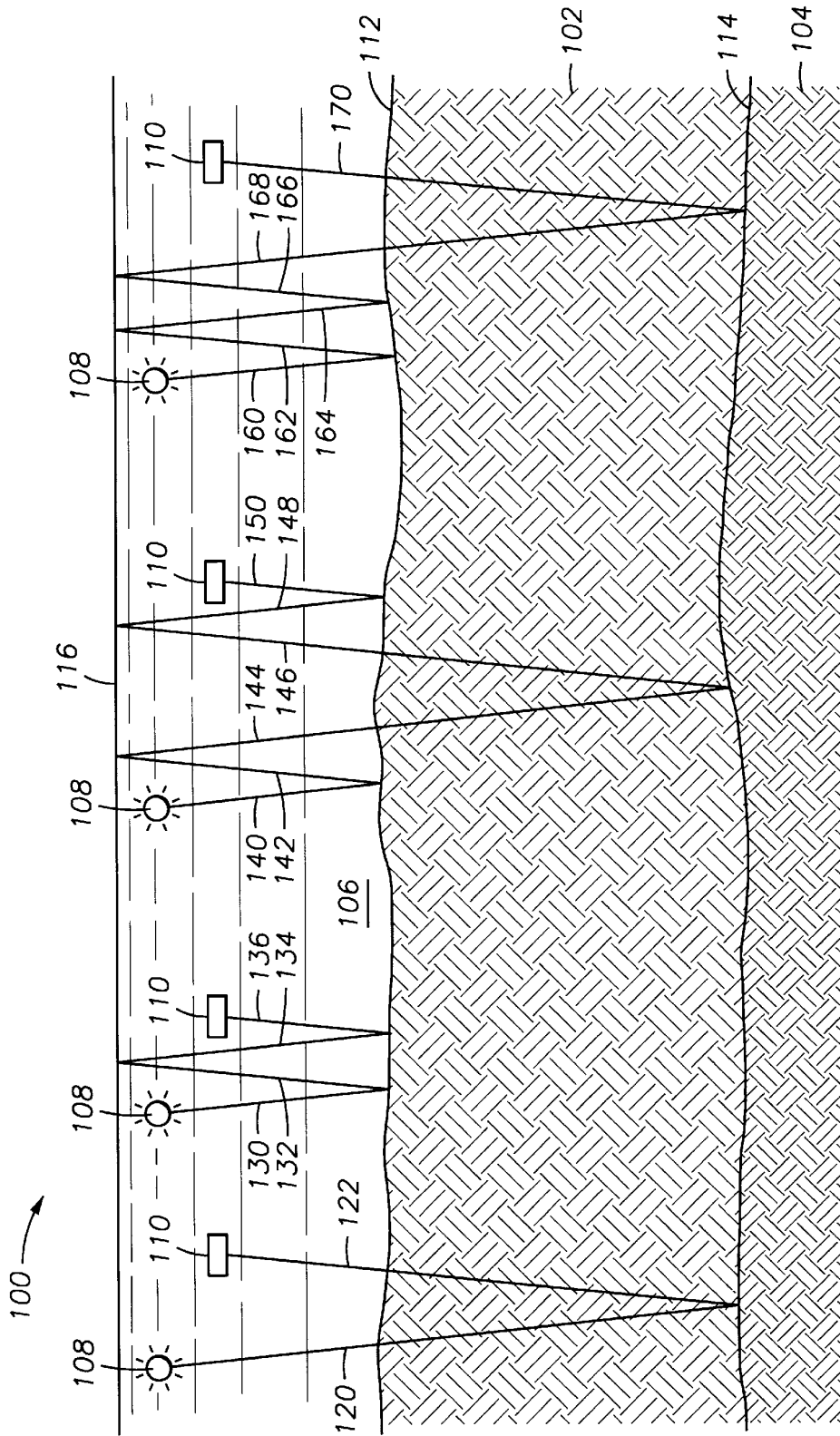


FIG. 1

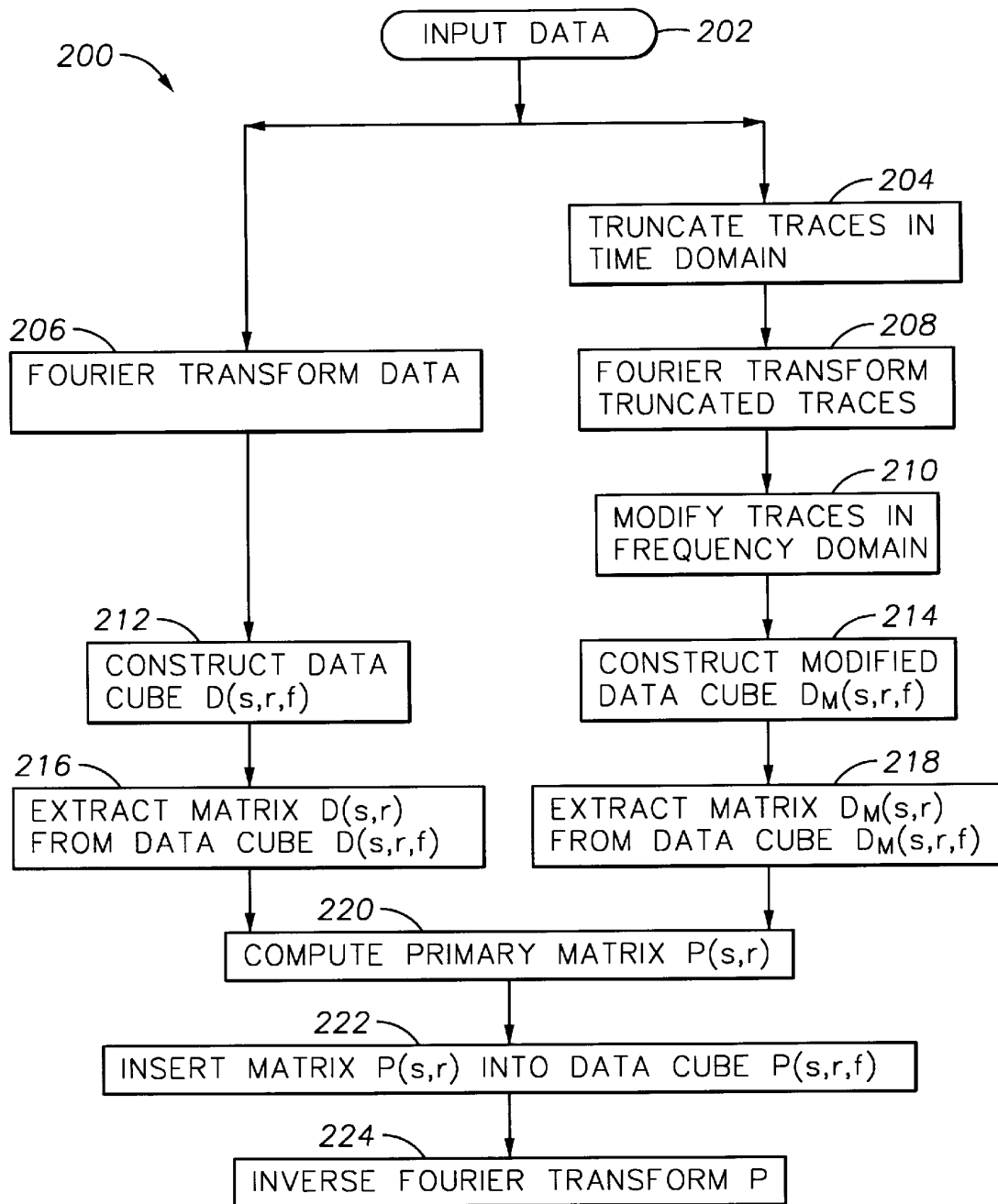


FIG. 2

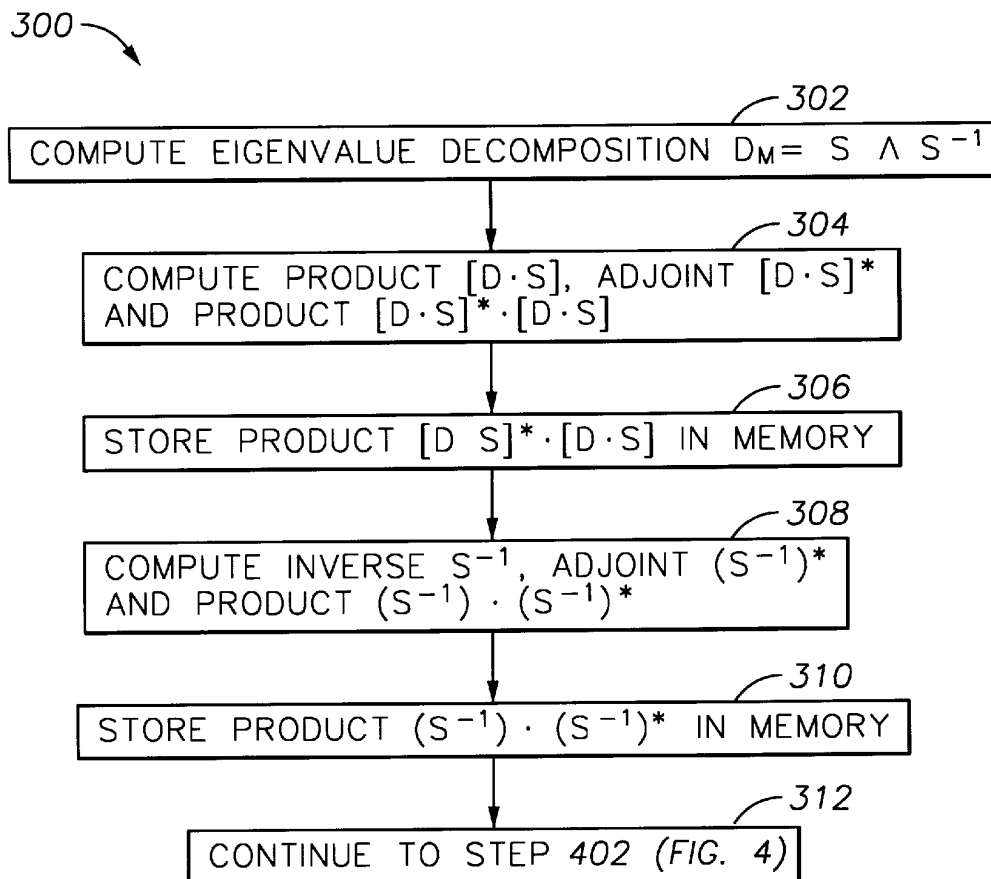


FIG. 3

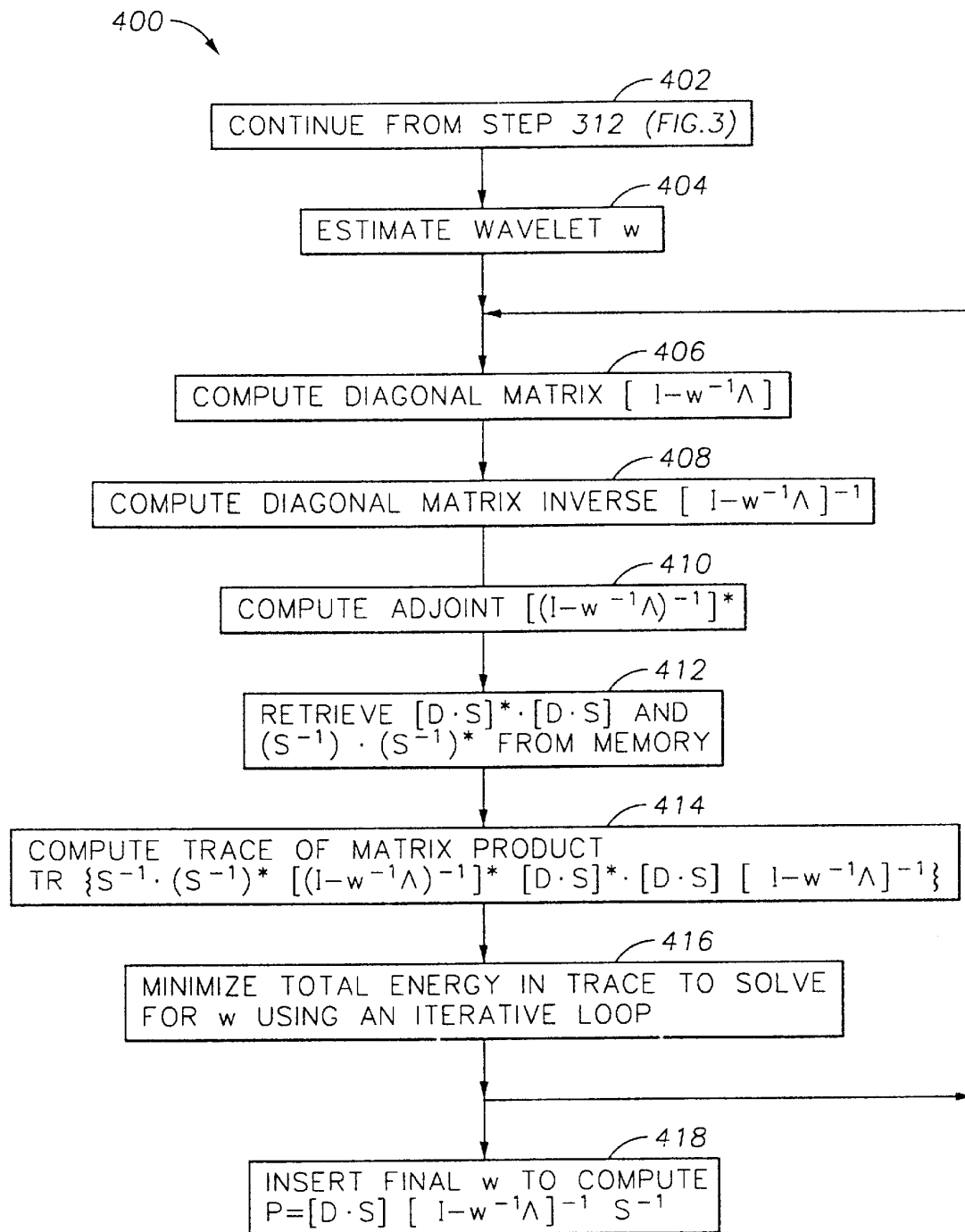


FIG. 4

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