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# United States Patent [19]

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Miller et al.

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[54] **METHOD AND APPARATUS FOR DYNAMIC SOUND OPTIMIZATION**

5,018,202 5/1991 Takahashi et al. .... 381/71

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[57] **ABSTRACT**

This invention comprises a system to compensate for the noise level inside a vehicle by measuring the music level and the noise level in the vehicle through the use of analog to digital conversion and adaptive digital filtering, including a sensing microphone in the vehicle cabin to measure both music and noise; preamplification and analog to digital (A/D) conversion of the microphone signal; A/D conversion of a stereo music signal; a pair of filters that use an adaptive algorithm such as the known Least Mean Squares (“LMS”) method to extract the noise from the total cabin sound; an estimation of the masking effect of the noise on the music; an adaptive correction of the music loudness and, optionally, equalization to overcome the masking effect; digital to analog (D/A) conversion of the corrected music signal; and transmission of the corrected music signal to the audio system.

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[51] Int. Cl.<sup>6</sup> ..... **H03G 3/24**

[52] U.S. Cl. .... **381/57; 381/108**

[58] Field of Search ..... 381/94, 98, 103, 71, 381/57, 107, 108

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

4,553,257	11/1985	Mori et al. ....	381/57
4,672,674	6/1987	Clough et al. ....	381/71
4,837,834	6/1989	Allie .....	381/71
4,868,881	9/1989	Zwicker et al. ....	381/57
4,965,834	10/1990	Miller .....	381/94

**29 Claims, 20 Drawing Sheets**

