United States Patent [19]

Hoshuyama

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[54] **BEAMFORMER USING COEFFICIENT RESTRAINED ADAPTIVE FILTERS FOR DETECTING INTERFERENCE SIGNALS**

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[21] Appl. No.: **523,059**

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[30] **Foreign Application Priority Data**

Sep. 1, 1994 [JP] Japan 6-208635

[51] **Int. Cl.^{6}** G01S 15/00

[52] **U.S. Cl.** 367/121; 367/901; 367/119; 367/905; 381/94

[58] **Field of Search** 367/12, 119, 121, 367/123, 129, 901, 905, 103; 128/661.01; 381/94

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[57] **ABSTRACT**

In an adaptive array beamformer, a spatial beamforming filter is connected to a sensor array for respectively filtering and summing array signals to produce a first filter output containing a target signal that arrives in a specified direction. First adaptive filters provide transversal-filtering the first filter output to produce a second filter output not containing the target signal, using a first error signal by restraining their tap weight coefficients. The array signals are further coupled to subtractors. Each subtractor detects a difference between the second filter output of the corresponding first adaptive filter and the corresponding sensor signal to derive the first error signal. Second adaptive filters provide transversal-filtering the first error signals of the subtractors to produce third filter outputs, using a second error signal, by restraining their tap weight coefficients. The third filter outputs are summed and subtracted from the first filter output to produce an output of the beamformer, which is supplied as the second error signal to the second adaptive filters
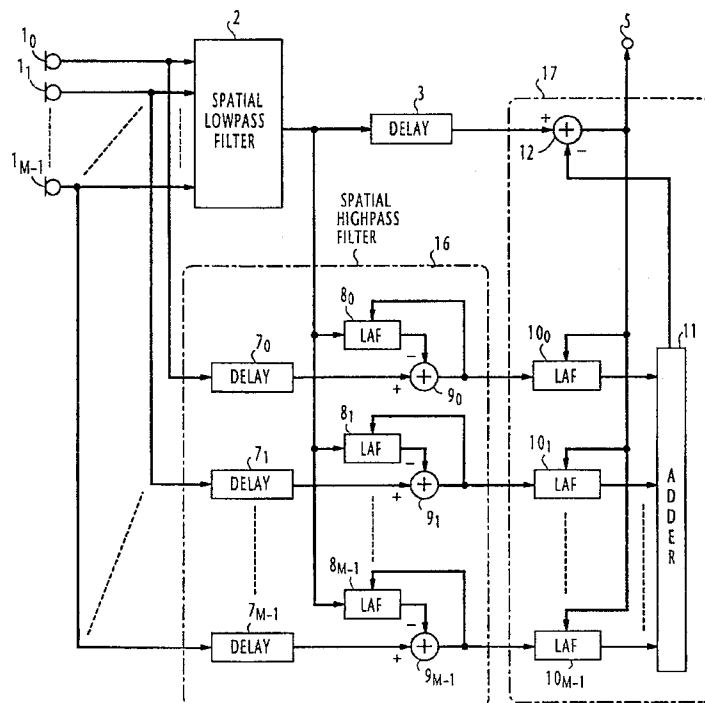
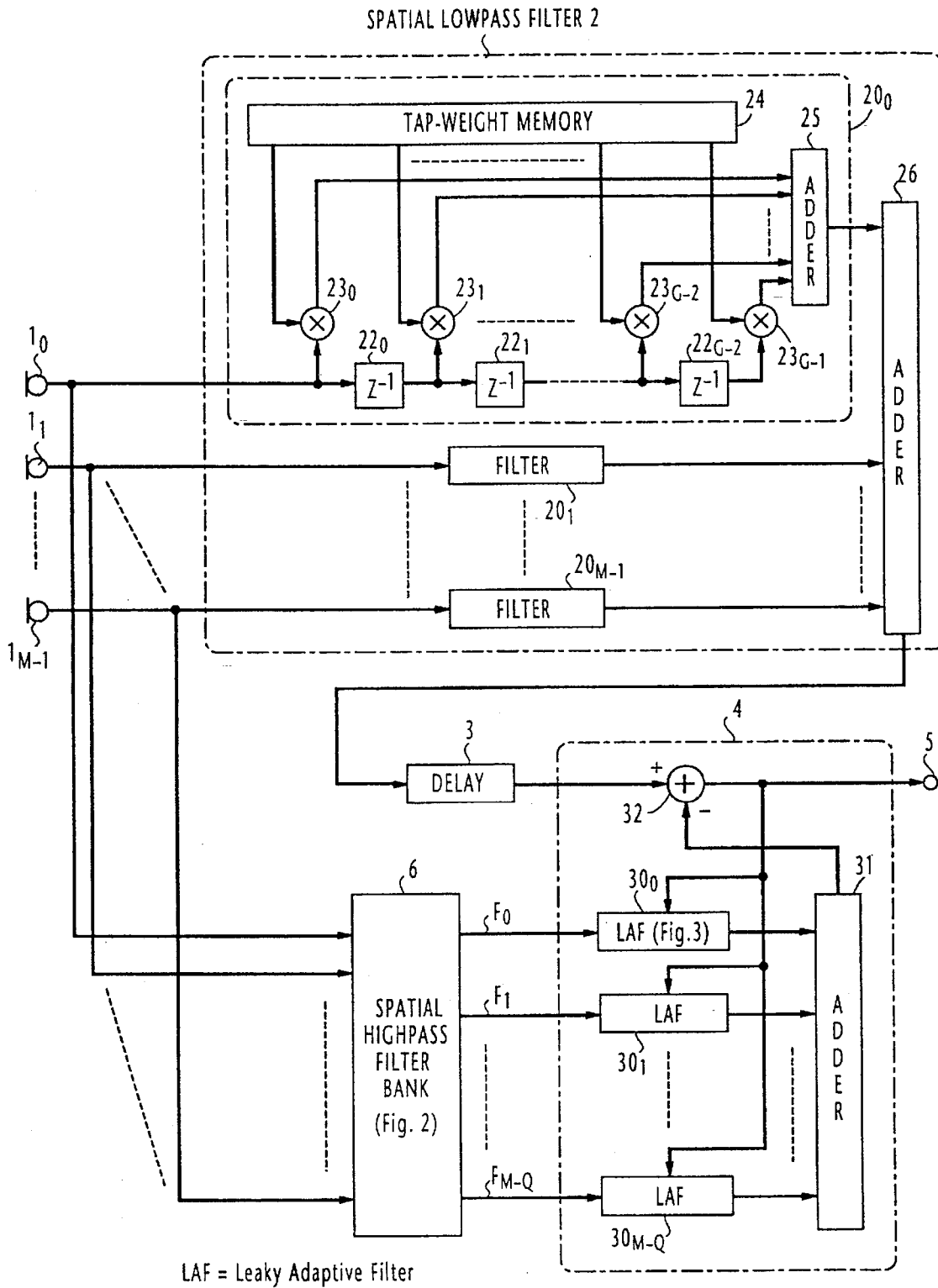**10 Claims, 11 Drawing Sheets**

FIG. 1
PRIOR ART

SPATIAL LOWPASS FILTER 2

TAP-WEIGHT MEMORY 24

25

20_0

ADDER

26

23_0 23_1 23_{G-2}

22_0 22_1 23_{G-1}

Z^{-1} Z^{-1} Z^{-1}

22_{G-2}

1_0

1_1

1_{M-1}

FILTER

20_1

FILTER

20_{M-1}

ADDER

3
DELAY

4

32

+
−

5

6
SPATIAL HIGHPASS FILTER BANK (Fig. 2)

F_0
F_1
F_{M-Q}

30_0
LAF (Fig.3)

30_1
LAF

30_{M-Q}
LAF

31
ADDER

LAF = Leaky Adaptive Filter

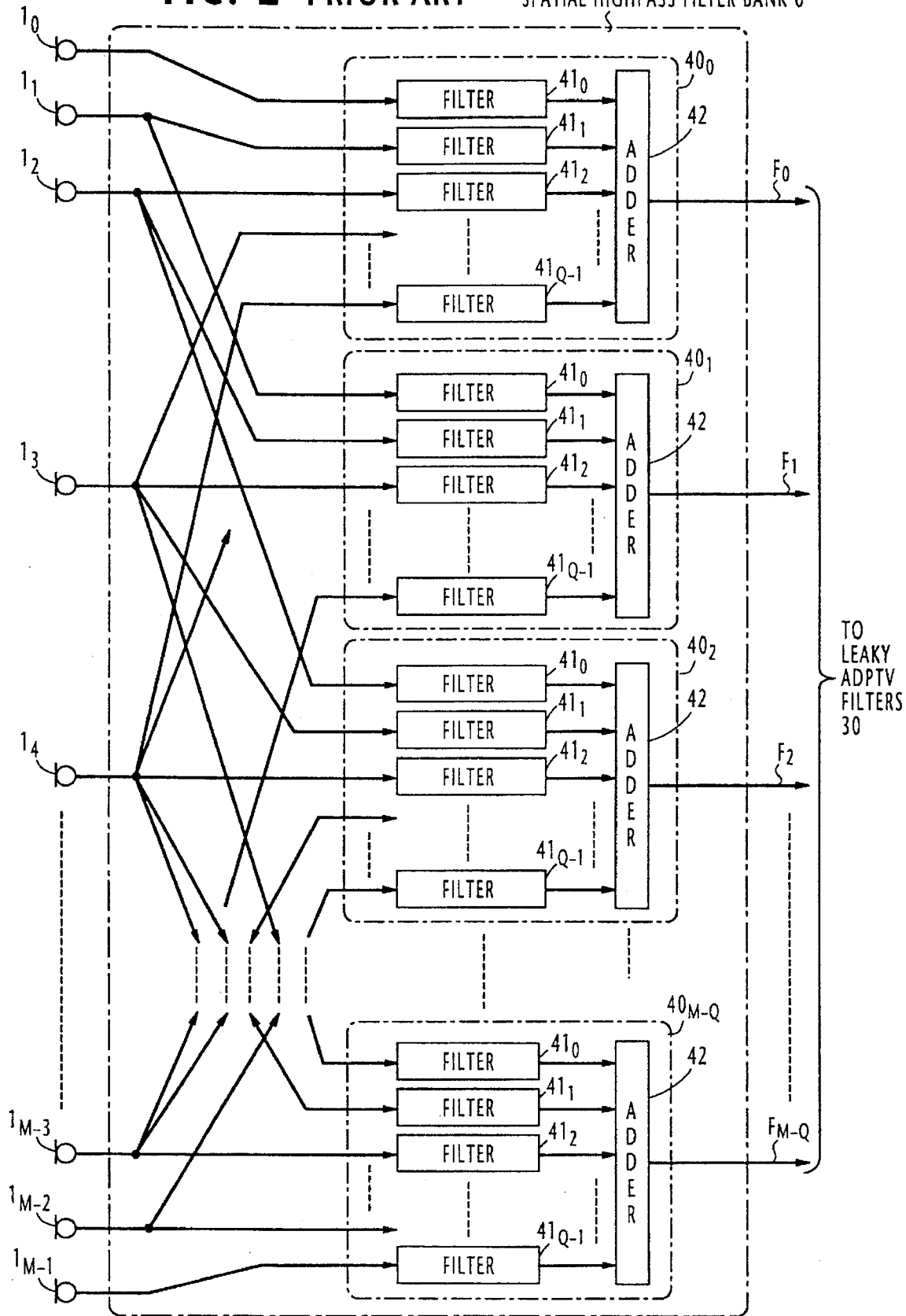**FIG. 2** PRIOR ART   SPATIAL HIGHPASS FILTER BANK 6
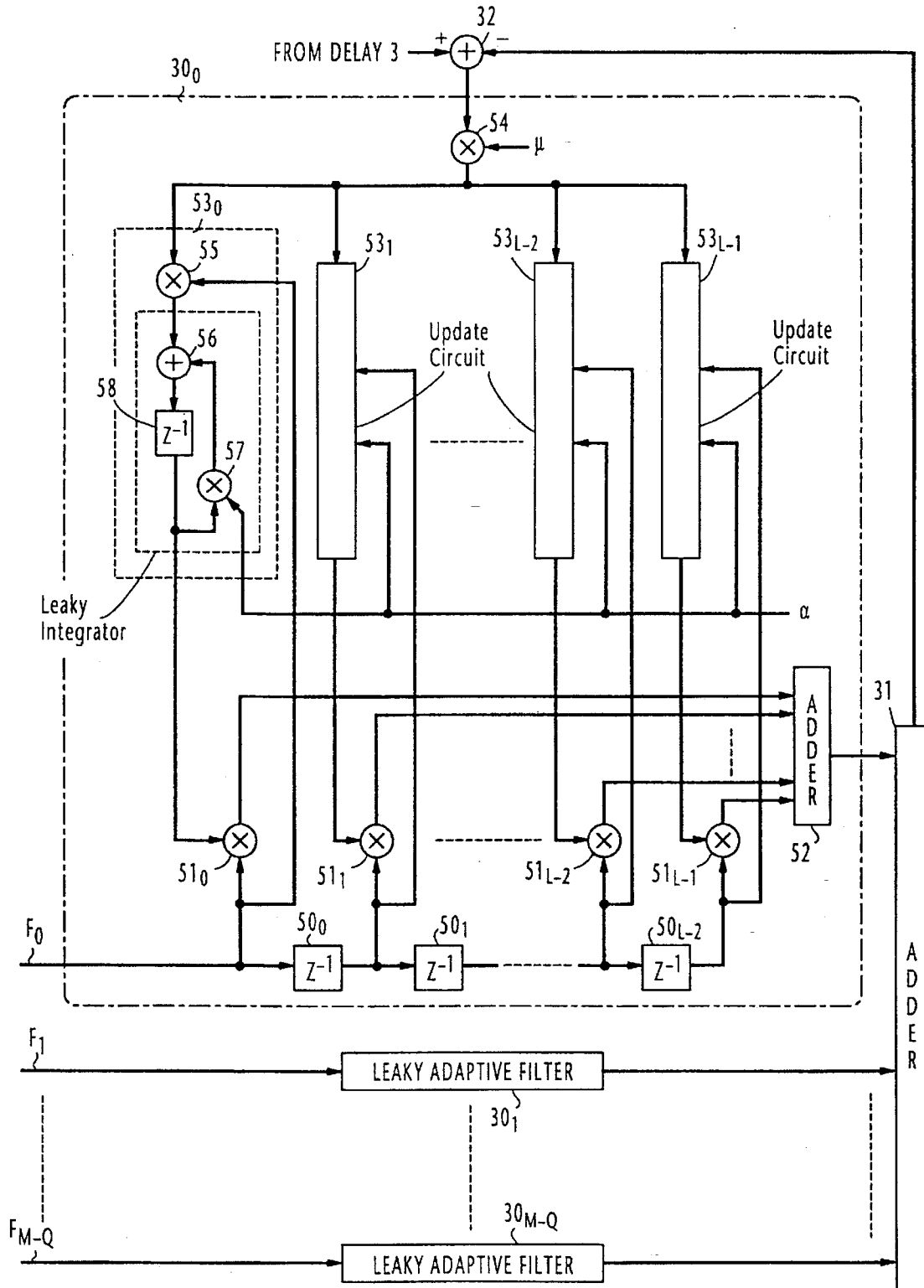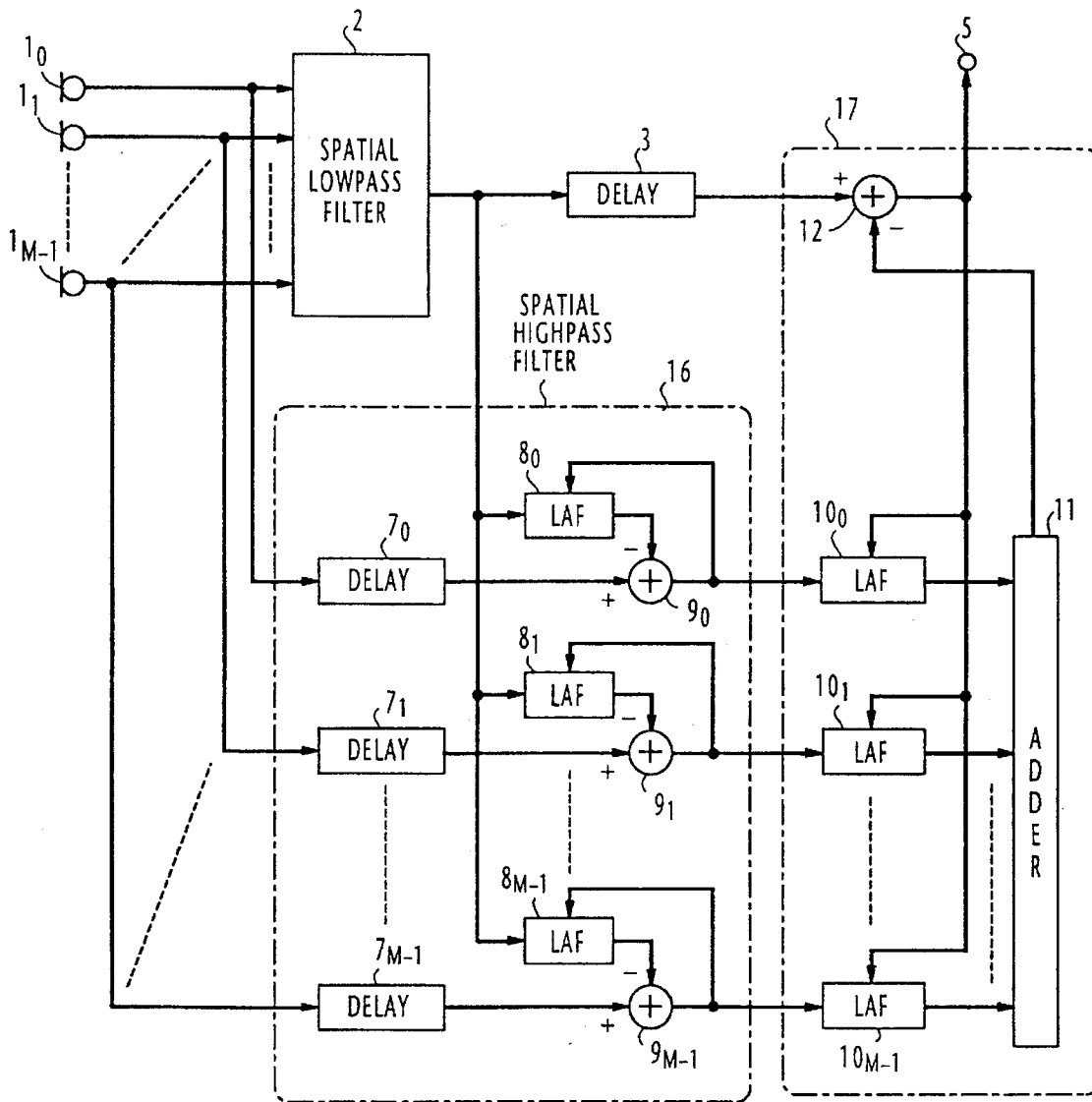
FIG. 3
PRIOR ART

FIG. 4

DOCKET ALARM

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