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**Higgins et al.**

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(54) **NOISE SUPPRESSION AND CHANNEL EQUALIZATION PREPROCESSOR FOR SPEECH AND SPEAKER RECOGNIZERS: METHOD AND APPARATUS**

(75) Inventors: **Alan Lawrence Higgins; Steven F. Boll; Jack E. Porter**, all of San Diego, CA (US)

(73) Assignee: **ITT Manufacturing Enterprises**, Wilmington, DE (US)

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(51) **Int. Cl.<sup>7</sup>** ..... **G10L 21/02**

(52) **U.S. Cl.** ..... **704/224; 704/228**

(58) **Field of Search** ..... **704/224, 228**

(56)           **References Cited**

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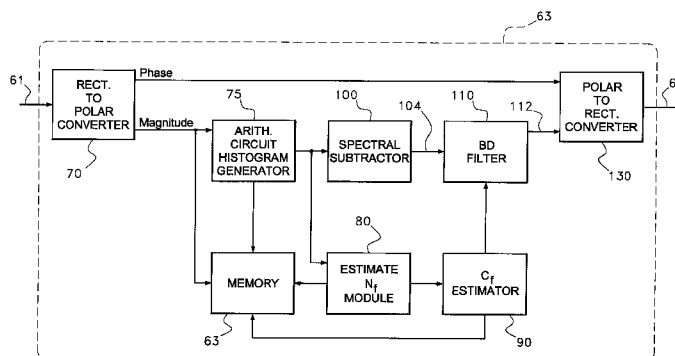
*Primary Examiner*—Tālvāldis I. Šmits

(74) *Attorney, Agent, or Firm*—Arthur L. Plevy; Duane, Morris & Hecksher

(57)           **ABSTRACT**

A method for performing noise suppression and channel equalization of a noisy voice signal comprising the steps of sampling the noisy voice signal at a predetermined sampling rate  $f_s$ ; segmenting the sampled voice signal into a plurality of frames having a predetermined number of samples per frame, over a predetermined temporal window; generating an N-point spectral sample representation of each of the sample signal frames; determining the magnitude of each of the N-point spectral samples and generating a histogram of the energy associated with each of the N-point spectral samples at a particular frequency; detecting a peak amplitude of the histogram which corresponds to a noise threshold  $N_f$  associated with the particular frequency; determining a channel frequency response  $C_f$  associated with the particular frequency by determining a geometric mean over all the spectral samples having magnitude exceeding the noise threshold  $N_f$ ; subtracting from each of the magnitudes of the N point spectral samples the noise threshold  $N_f$  to provide a noise suppressed sample sequence; applying blind deconvolution to the noise suppressed samples; transforming the deconvolved noise suppressed sampled sequence to a temporal representation; shifting the temporal sample sequence in time by a predetermined amount; and adding the time shifted temporal samples over a period corresponding to the predetermined temporal window to provide a suppressed noise voice signal.

**26 Claims, 5 Drawing Sheets**



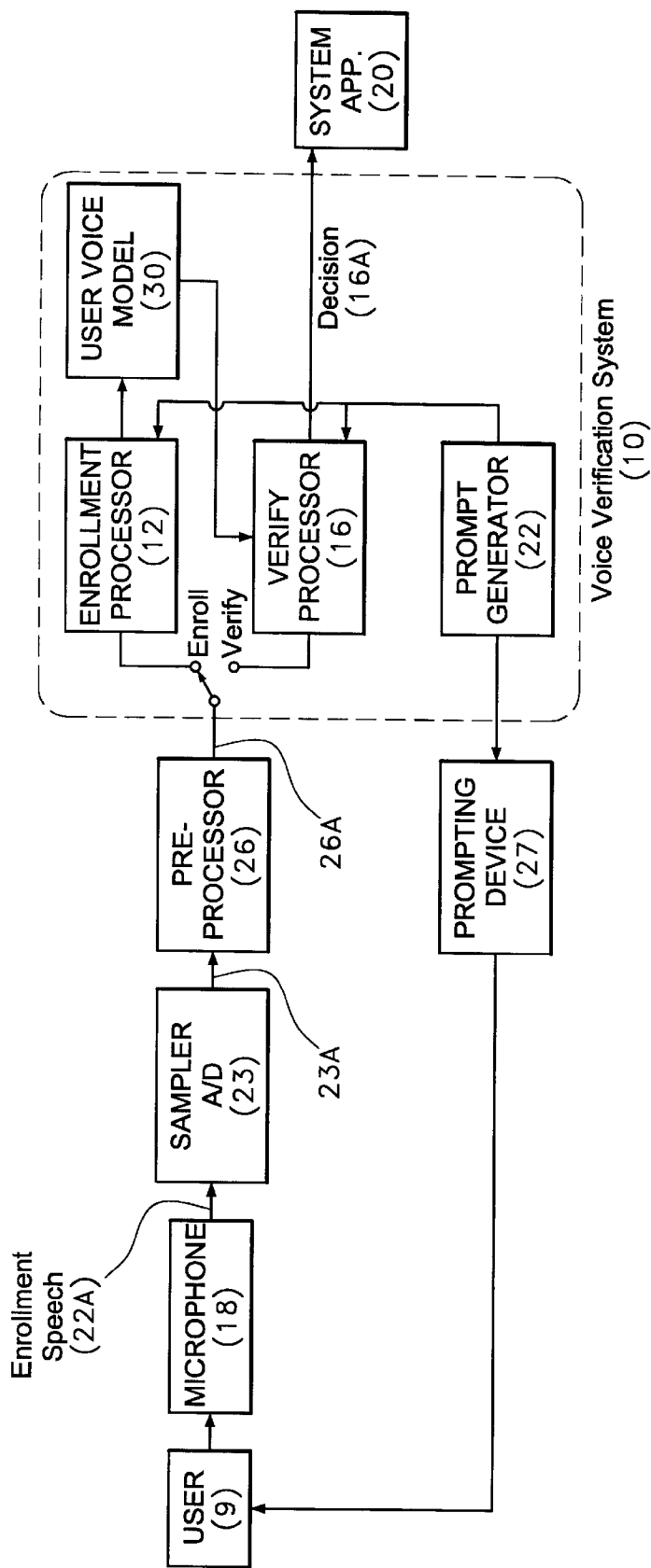


Fig. 1

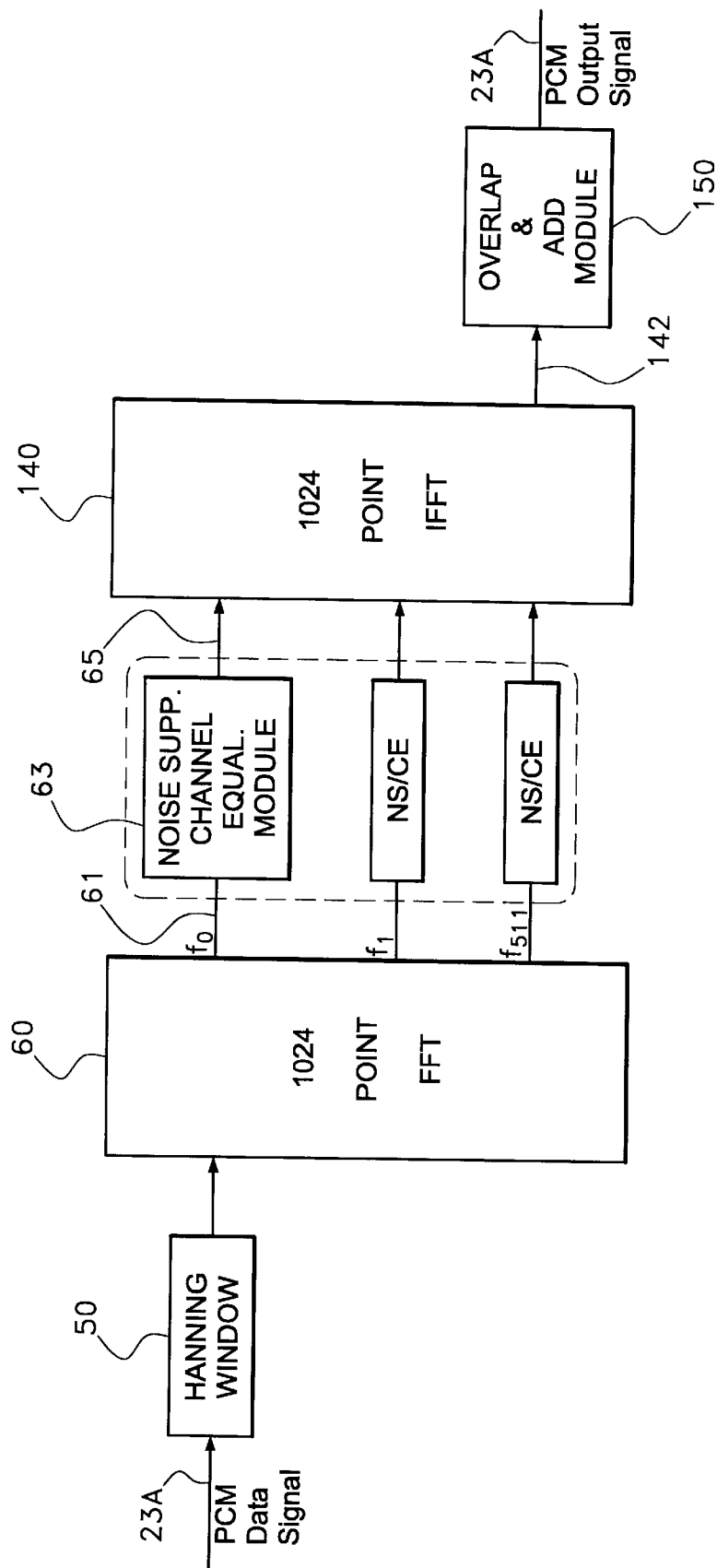


Fig. 2A

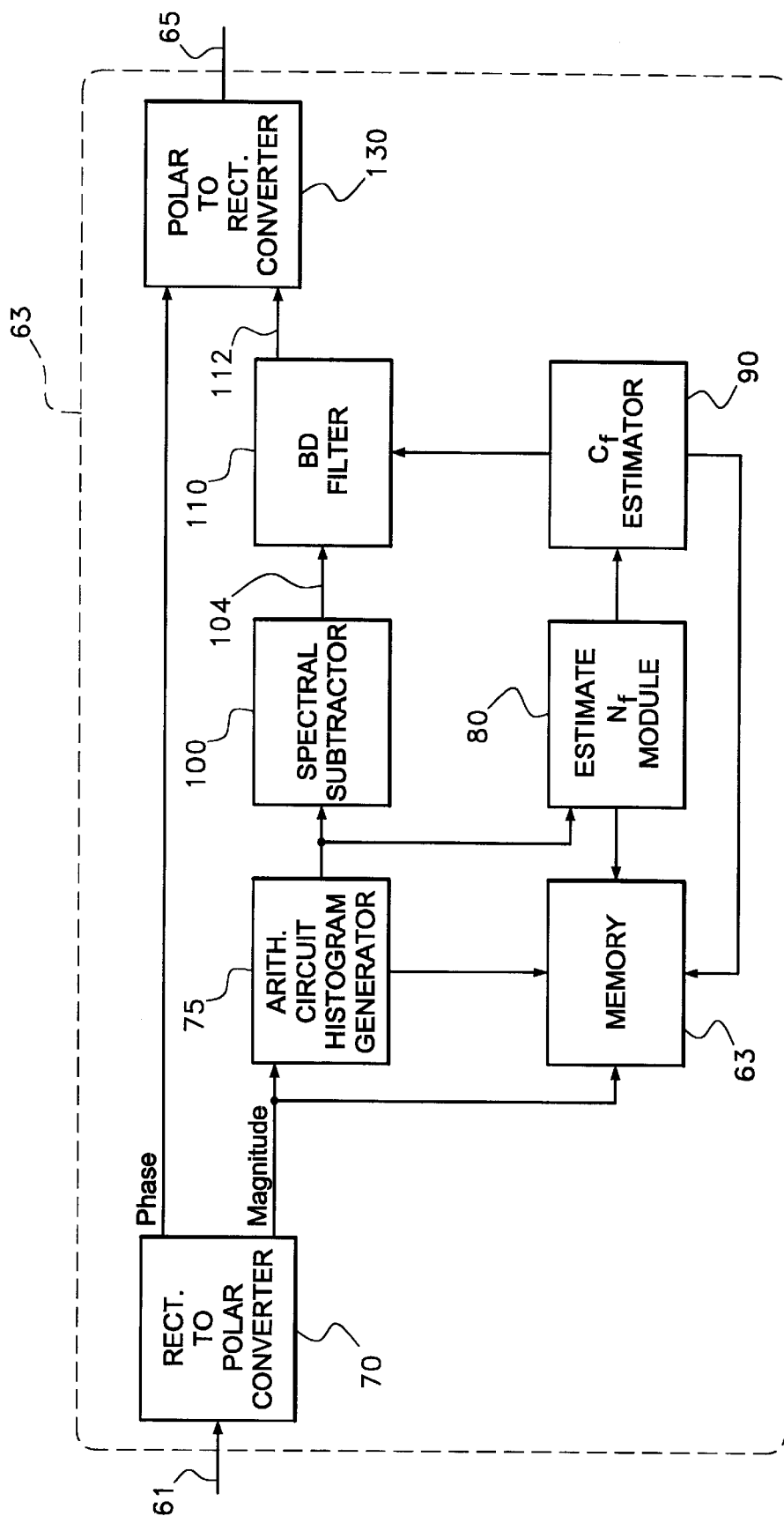


Fig. 2B

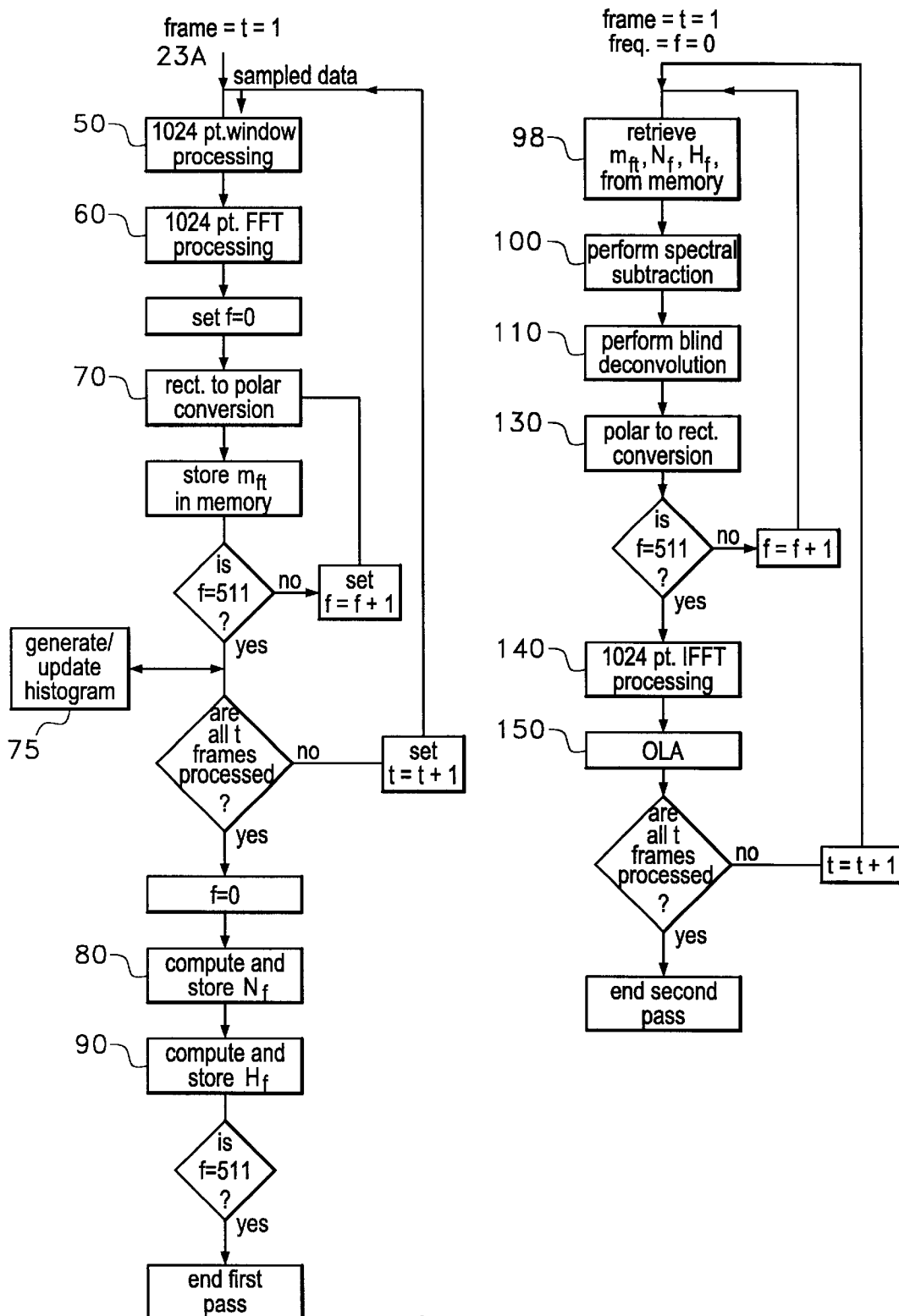


Fig. 3

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