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TITLE

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08/672899

PATENT APPLICATION

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SYMBOLS

- ✓ ..... Rejected
- = ... Allowed
- - (Through numberal) Canceled
- + ... Restricted
- N ..... Non-elected
- I ..... Interference
- A ..... Appeal
- O ..... Objected

Claim Final	Claim Original
	51
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367	121 123-126 119	12/18/97	DN
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381	92 94.1 94.2-94.4 94.7 26 122 155 111	7/13/98	DN
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SEARCH NOTES

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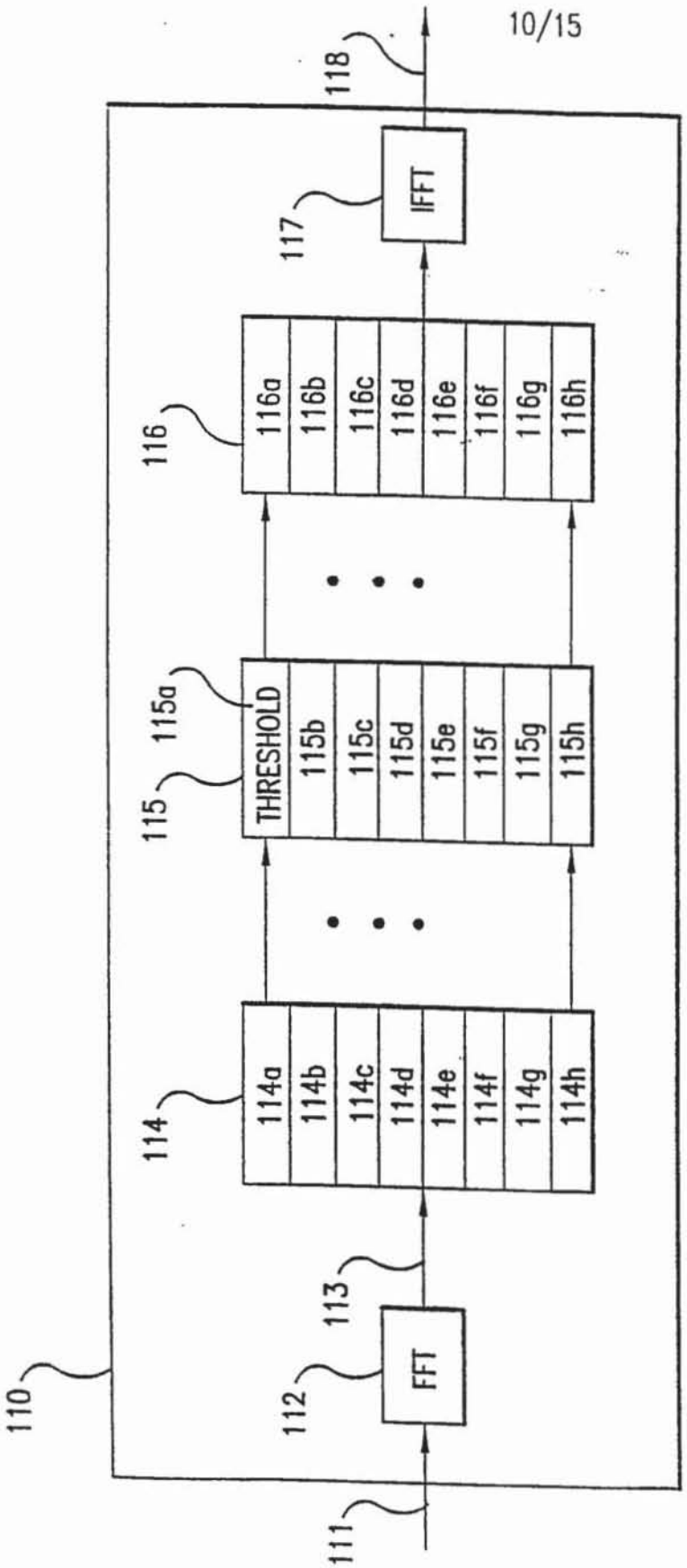

FIG.10

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APPLICANT

JOSEPH MARASH, HAIFA, ISRAEL.

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TITLE

SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

This is to certify that annexed hereto is a true copy from the records of the United States Patent and Trademark Office of the application which is identified above.

By authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

Date Certifying Officer

RTL898_1020-0007

PATENT APPLICATION SERIAL NO.

08/672899

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
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ATTORNEY DOCKET NO. 8797-003 Date June 27, 1996

Assistant Commissioner for Patents
Washington, D.C. 20231

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Sir: The following utility patent application is enclosed for filing:

Applicant(s): MARASH Executed on: unexecuted

Title of Invention: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

Pages of Specification 32 + ABSTRACT Sheets of Drawings 14

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Priority of application serial no. filed on in is claimed under 35 U.S.C. § 119.

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Respectfully submitted,

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SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANC[redacted]

BACKGROUND OF THE INVENTION

The present invention relates generally to signal processing, and more specifically to an adaptive signal processing system and method for reducing interference in a received signal.

There are many instances where it is desirable to have a sensor capable of receiving an information signal from a particular signal source where the environment includes sources of interference signals at locations different from that of the signal source. One such instance is the use of microphones to record a particular party's speech in a room where there are other parties speaking simultaneously, causing interference in the received signals.

If one knows the exact characteristics of the interference, one can use a fixed-weight filter to suppress it. But it is often difficult to predict the exact characteristics of the interference because they may vary according to changes in the interference sources, the background noise, acoustic environment, orientation of the sensor with respect to the signal source, the transmission paths from the signal source to the sensor, and many other factors. Therefore, in order to suppress such interference, an adaptive system that can change its own parameters in response to a changing environment is needed.

An adaptive filter is an adaptive system that can change its own filtering characteristics in order to produce a desired response. Typically, the filter weights defining the characteristics of an adaptive filter are continuously updated so that the difference between a signal representing a desired response and an output signal of the adaptive filter is minimized.

The use of adaptive filters for reducing interference in a received signal has been known in the art as adaptive noise cancelling. It is based on the idea of cancelling a noise component of a received signal from the direction of a signal source by sampling the noise independently of the source

signal and modifying the sampled noise to approximate the noise component in the received signal using an adaptive filter. For a seminal article on adaptive noise cancelling, see B. Widrow et al., Adaptive Noise Cancelling: Principles and Applications, Proc. IEEE 63:1692-1716, 1975.

A basic configuration for adaptive noise cancelling has a primary input received by a microphone directed to a desired signal source and a reference input received independently by another microphone directed to a noise source. The primary input contains both a source signal component originating from the signal source and a noise component originating from the noise source. The noise component is different from the reference input representing the noise source itself because the noise signal must travel from the noise source to the signal source in order to be included as the noise component.

The noise component, however, is likely to have some correlation with the reference input because both of them originate from the same noise source. Thus, a filter can be used to filter the reference input to generate a cancelling signal approximating the noise component. The adaptive filter does this dynamically by generating an output signal which is the difference between the primary input and the cancelling signal, and by adjusting its filter weights to minimize the mean-square value of the output signal. When the filter weights settle, the output signal effectively replicates the source signal substantially free of the noise component because the cancelling signal closely tracks the noise component.

Adaptive noise cancelling can be combined with beamforming, a known technique of using an array of sensors to improve reception of signals coming from a specific direction. A beamformer is a spatial filter that generates a single channel from multiple channels received through multiple sensors by filtering the individual multiple channels and combining them in such a way as to extract signals coming from a specific direction. Thus, a beamformer

can change the direction of receiving sensitivity without physically moving the array of sensors. For details on beamforming, see B.D. Van Veen and K.M. Buckley, Beamforming: A Versatile Approach to Spatial Filtering, IEEE ASSP Mag. 5(2), 4-24.

Since the beamformer can effectively be pointed in many directions without physically moving its sensors, the beamformer can be combined with adaptive noise cancelling to form an adaptive beamformer that can suppress specific directional interference rather than general background noise. The beamformer can provide the primary input by spatially filtering input signals from an array of sensors so that its output represents a signal received in the direction of a signal source. Similarly, the beamformer can provide the reference input by spatially filtering the sensor signals so that the output represents a signal received in the direction of interference sources. For a seminal article on adaptive beamformers, see L.J. Griffiths & C.W. Jim, An Alternative Approach to Linearly Constrained Adaptive Beamforming, IEEE Trans. Ant. Prop. AP-30:27-34, 1982.

One problem with a conventional adaptive beamformer is that its output characteristics change depending on input frequencies and sensor directions with respect to interference sources. This is due to the sensitivity of a beamformer to different input frequencies and sensor directions. A uniform output behavior of a system over all input frequencies of interest and over all sensor directions is clearly desirable in a directional microphone system where faithful reproduction of a sound signal is required regardless of where the microphones are located.

Another problem with adaptive beamforming is "signal leakage". Adaptive noise cancelling is based on an assumption that the reference input representing noise sources is uncorrelated with the source signal component in the primary input, meaning that the reference input should not contain the source signal. But this "signal free" reference input assumption is violated in any real

environment. Any mismatch in the microphones (amplitude or phase) or their related analog front end, any reverberation caused by the surroundings or a mechanical structure, and even any mechanical coupling in the physical microphone structure will likely cause "signal leakage" from the signal source into the reference input. If there is any correlation between the reference input and the source signal component in the primary input, the adaptation process by the adaptive filter causes cancellation of the source signal component, resulting in distortion and degradation in performance.

It is also important to confine the adaptation process to the case where there is at least some directional interference to be eliminated. Since nondirectional noise, such as wind noise or vibration noise induced by the mechanical structure of the system, is typically uncorrelated with the noise component of the received signal, the adaptive filter cannot generate a cancelling signal approximating the noise component.

Prior art suggests inhibiting the adaptation process of an adaptive filter when the signal-to-noise ratio (SNR) is high based on the observation that a strong source signal tends to leak into the reference input. For example, U.S. Pat. No. 4,956,867 describes the use of cross-correlation between two sensors to inhibit the adaptation process when the SNR is high.

But the prior art approach fails to consider the effect of directional interference because the SNR-based approach considers only nondirectional noise. Since nondirectional noise is not correlated to the noise component of the received signal, the adaptation process searches in vain for new filter weights, which often results in cancelling the source signal component of the received signal.

The prior art approach also fails to consider signal leakage when the source signal is of a narrow bandwidth. In a directional microphone application, the source signal often contains a narrow band signal, such as speech signal, with its power spectral density concentrated in a narrow frequency

range. When signal leakage occurs due to a strong narrow band signal, the prior art approach may not inhibit the adaptation process because the overall signal strength of such narrow band signal may not high enough. The source signal component of the received signal is cancelled as a result, and if the source signal is a speech signal, degradation in speech intelligibility occurs.

Therefore, there exists a need for an adaptive system that can suppress directional interference in a received signal with a uniform frequency behavior over a wide angular distribution of interference sources.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to suppress interference in a received signal using an adaptive filter for processing inputs from an array of sensors.

Another object of the invention is to limit the adaptation process of such adaptive filter to the case where there is at least some directional interference to be eliminated.

A further object of the invention is to control the adaptation process to prevent signal leakage for narrow band signals.

Another object is to produce an output with a uniform frequency behavior in all directions from the sensor array.

These and other objects are achieved in accordance with the present invention, which uses a system for processing digital data representing signals received from an array of sensors. The system includes a main channel matrix unit for generating a main channel representing signals received in the direction of a signal source where the main channel has a source signal component and an interference signal component. The system includes a reference channel matrix unit for generating at least one reference channel where each reference channel represents signals received in directions other than that of the signal source. The system uses adaptive filters for generating cancelling signals

approximating the interference signal component of the main channel and a difference unit for generating a digital output signal by subtracting the cancelling signals from the main channel. Each adaptive filter has weight updating means for finding new filter weights based on the output signal. The system includes weight constraining means for truncating the new filter weight values to predetermined threshold values when each of the new filter weight value exceeds the corresponding threshold value.

The system may further include at least one decolorizing filter for generating a flat-frequency reference channel. The system may further include inhibiting means for estimating the power of the main channel and the power of the reference channels and for generating an inhibit signal to the weight updating means based on normalized power difference between the main channel and the reference channels.

The system produces an output substantially free of directional interference with a uniform frequency behavior in all directions from the system.

The objects are also achieved in accordance with the present invention using a method, which can readily be implemented in a program controlling a commercially available DSP processor.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be more readily apparent from the following detailed description of the invention in which:

FIG. 1 is a block diagram of an overall system;

FIG. 2 is a block diagram of a sampling unit;

FIG. 3 is a block diagram of an alternative embodiment of a sampling unit;

FIG. 4 is a schematic depiction of tapped delay lines used in a main channel matrix and a reference matrix unit;

FIG. 5 is a schematic depiction of a main channel matrix unit;

FIG. 6 is a schematic depiction of a reference channel matrix unit;

FIG. 7 is a schematic depiction of a decolorizing filter;

FIG. 8 is a schematic depiction of an inhibiting unit based on directional interference;

FIG. 9 is a schematic depiction of a frequency-selective constraint adaptive filter;

FIG. 10 is a block diagram of a frequency-selective weight-constraint unit;

FIG. 11 is a flow chart depicting the operation of a program that can be used to implement the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a block diagram of a system in accordance with a preferred embodiment of the present invention. The system illustrated has a sensor array 1, a sampling unit 2, a main channel matrix unit 3, a reference channel matrix unit 4, a set of decolorizing filters 5, a set of frequency-selective constrained adaptive filters 6, a delay 7, a difference unit 8, an inhibiting unit 9, and an output D/A unit 10.

Sensor array 1, having individual sensors 1a-1d, receives signals from a signal source on-axis from the system and from interference sources located off-axis from the system. The sensor array is connected to sampling unit 2 for sampling the received signals, having individual sampling elements, 2a-2d, where each element is connected to the corresponding individual sensor to produce digital signals 11.

The outputs of sampling unit 2 are connected to main channel matrix unit 3 producing a main channel 12 representing signals received in the direction of a source. The main channel contains both a source signal component and an interference signal component.

The outputs of sampling unit 2 are also connected reference channel matrix unit 4, which generates reference channels 13 representing signals received from directions

other that of the signal source. Thus, the reference channels represent interference signals.

The reference channels are filtered through decolorizing filters 5, which generate flat-frequency reference channels 14 having a frequency spectrum whose magnitude is substantially flat over a frequency range of interest. Flat-frequency reference channels 14 are fed into the set of frequency-selective constraint adaptive filters 6, which generate cancelling signals 15.

In the mean time, main channel 12 is delayed through delay 7 so that it is synchronized with cancelling signals 15. Difference unit 8 then subtracts cancelling signals 15 from the delayed main channel to generate an digital output signal 16, which is converted by D/A unit 10 into analog form. Digital output signal 15 is fed back to the adaptive filters to update the filter weights of the adaptive filters.

Flat-frequency reference channels 14 are fed to inhibiting unit 9, which estimates the power of each flat-frequency reference channel as well as the power of the main channel and generates an inhibit signal 19 to prevent signal leakage.

FIG. 2 depicts a preferred embodiment of the sampling unit. A sensor array 21, having sensor elements 21a-21d, is connected to an analog front end 22, having amplifier elements 22a-22d, where each amplifier element is connected to the output of the corresponding sensor element. In a directional microphone application, each sensor can be either a directional or omnidirectional microphone. The analog front end amplifies the received analog sensor signals to match the input requirement of the sampling elements. The outputs from the analog front ends are connected to a set of delta-sigma A/D converters, 23, where each converter samples and digitizes the amplified analog signals. The delta-sigma sampling is a well-known A/D technique using both oversampling and digital filtering. For details on delta-sigma A/D sampling, see Crystal Semiconductor Corporation, Application Note: Delta-Sigma Techniques, 1989.

FIG. 3 shows an alternative embodiment of the sampling unit. A sensor array 31, having sensor elements 31a-31d, is connected to an amplifier 32, having amplifier elements 32a-32d, where each amplifier element amplifies the received signals from the corresponding sensor element. The outputs of the amplifier are connected to a sample & hold (S/H) unit 33 having sample & hold elements 33a-33d, where each S/H element samples the amplified analog signal from the corresponding amplifier element to produce a discrete signal. The outputs from the S/H unit are multiplexed into a single signal through a multiplexor 34. The output of the multiplexor is connected to a conventional A/D converter 35 to produce a digital signal.

FIG. 4 is a schematic depiction of tapped delay lines used in the main channel matrix unit and the reference channel matrix in accordance with a preferred embodiment of the present invention. The tapped delay line used here is defined as a nonrecursive digital filter, also known in the art as a transversal filter, a finite impulse response filter or an FIR filter. The illustrated embodiment has 4 tapped delay lines, 40a-40d. Each tapped delay line includes delay elements 41, multipliers 42 and adders 43. Digital signals, 44a-44d, are fed into the set of tapped delay lines 40a-40d. Delayed signals through delay elements 41 are multiplied by filter coefficients, F_{ij}, 45 and added to produce outputs, 46a-46d.

The n-th sample of an output from the i-th tapped delay line, $Y_i(n)$, can then be expressed as:

$Y_i(n) = \Sigma^k_{j=0} F_{i,j} X_i(n-j)$, where k is the length of the filter, and $X_i(n)$ is the n-th sample of an input to the i-th tapped delay line.

FIG. 5 depicts the main channel matrix unit for generating a main channel in accordance with a preferred embodiment of the present invention. The unit has tapped delay lines, 50a-50d, as an input section taking inputs 51a-51d from the sampling unit. Its output section includes multipliers, 52a-52d, where each multiplier is connected to

the corresponding tapped delay line and an adder 53, which sums all output signals from the multipliers. The unit generates a main channel 54, as a weighted sum of outputs from all multipliers. The filter weights 55a-55d can be any combination of fractions as long as their sum is 1. For example, if 4 microphones are used, the embodiment may use the filter weights of 1/4 in order to take into account of the contribution of each microphone.

The unit acts as a beamformer, a spatial filter which filters a signal coming in all directions to produce a signal coming in a specific direction without physically moving the sensor array. The coefficients of the tapped delay lines and the filter weights are set in such a way that the received signals are spatially filtered to maximize the sensitivity toward the signal source.

Since some interference signals find their way to reach the signal source due to many factors such as the reverberation of a room, main channel 54 representing the received signal in the direction of the signal source contains not only a source signal component, but also an interference signal component.

FIG. 6 depicts the reference channel matrix unit for generating reference matrix channels in accordance with a preferred embodiment of the present invention. It has tapped delay lines, 60a-60d, as an input section taking inputs 61a-61d from the sampling unit. The same tapped delay lines as that of FIG. 4 may be used, in which case the tapped delay lines may be shared by the main and reference channel matrix units.

Its output section includes multipliers, 62a-62d, 63a-63d, 64a-64d and adders 65a-65c, where each multiplier is connected to the corresponding tapped delay line and adder. The unit acts as a beamformer which generates the reference channels 66a-66c representing signals arriving off-axis from the signal source by obtaining the weighted differences of certain combinations of outputs from the tapped delay lines. The filter weight combinations can be any numbers as long as

their sum of filter weights for combining a given reference channel is 0. For example, the illustrated embodiment may use a filter weight combination, (W11, W12, W13, W14) = (0.25, 0.25, 0.25, -0.75), in order to combine signals 61a-61d to produce reference channel 66a.

The net effect is placing a null (low sensitivity) in the receiving gain of the beamformer toward the signal source. As a result, the reference channels represent interference signals in directions other than that of the signal source. In other words, the unit "steers" the input digital data to obtain interference signals without physically moving the sensor array.

FIG. 7 is a schematic depiction of the decolorizing filter in accordance with a preferred embodiment of the present invention. It is a tapped delay line including delay elements 71, multipliers 72 and adders 73. A reference channel 74 is fed into the tapped delay line. Delayed signals are multiplied by filter coefficients, F_i, 75 and added to produce an output 76. The filter coefficients are set in such a way that the filter amplifies the low-magnitude frequency components of an input signal to obtain an output signal having a substantially flat frequency spectrum.

As mentioned before in the background section, the output of a conventional adaptive beamformer suffers a non-uniform frequency behavior. This is because the reference channels do not have a flat frequency spectrum. The receiving sensitivity of a beamformer toward a particular angular direction is often described in terms of a gain curve. As mentioned before, the reference channel is obtained by placing a null in the gain curve (making the sensor array insensitive) in the direction of the signal source. The resulting gain curve has a lower gain for lower frequency signals than higher frequency signals. Since the reference channel is modified to generate a cancelling signal, a non-flat frequency spectrum of the reference channel is translated to a non-uniform frequency behavior in the system output.

The decolorizing filter is a fixed-coefficient filter which flattens the frequency spectrum of the reference channel (thus "decolorizing" the reference channel) by boosting the low frequency portion of the reference channel. By adding the decolorizing filters to all outputs of the reference channel matrix unit, a substantially flat frequency response in all directions is obtained.

The decolorizing filter in the illustrated embodiment uses a tapped delay line filter which is the same as a finite impulse response (FIR) filter, but other kinds of filters such as an infinite impulse response (IIR) filter can also be used for the decolorizing filter in an alternative embodiment.

FIG. 8 depicts schematically the inhibiting unit in accordance with a preferred embodiment of the present invention. It includes power estimation units 81, 82 which estimate the power of a main channel 83 and each reference channel 84, respectively. A sample power estimation unit 85 calculates the power of each sample. A multiplier 86 multiplies the power of each sample by a fraction, α, which is the reciprocal of the number of samples for a given averaging period to obtain an average sample power 87. An adder 88 adds the average sample power to the output of another multiplier 89 which multiplies a previously calculated main channel power average 90 by $(1-\alpha)$. A new main channel power average is obtained by (new sample power) $\times \alpha$ + (old power average) $\times (1-\alpha)$. For example, if a 100-sample average is used, $\alpha = 0.01$. The updated power average will be (new sample power) x 0.01 + (old power average) x 0.99. In this way, the updated power average will be available at each sampling instant rather than after an averaging period. Although the illustrated embodiment shows an on-the-fly estimation method of the power average, other kinds of power estimation methods can also be used in an alternative embodiment.

A multiplier 91 multiplies the main channel power 89 with a threshold 92 to obtain a normalized main channel power

average 93. An adder 94 subtracts reference channel power averages 95 from the normalized main channel power average 93 to produce a difference 96. If the difference is positive, a comparator 97 generates an inhibit signal 98. The inhibit signal is provided to the adaptive filters to stop the adaptation process to prevent signal leakage.

Although the illustrated embodiment normalizes the main channel power average, an alternative embodiment may normalize the reference channel power average instead of the main channel power average. For example, if the threshold 92 in the illustrated embodiment is 0.25, the same effect can be obtained in the alternative embodiment by normalizing each reference channel power average by multiplying it by 4.

This inhibition approach is different from the prior art SNR-based inhibition approach mentioned in the background section in that it detects the presence of significant directional interference which the prior art approach does not consider. As a result, the directional-interference-based inhibition approach stops the adaptation process when there is no significant directional interference to be eliminated, whereas the prior art approach does not.

For example, where there is a weak source signal (e.g. during speech intermission) and there is almost no directional interference except some uncorrelated noise (such as noise due to wind or mechanical vibrations on the sensor structure), the SNR-based approach would allow the adaptive filter to continue adapting due to the small SNR. The continued adaptation process is not desirable because there is very little directional interference to be eliminated in the first place, and the adaptation process searches in vain for new filter weights to eliminate the uncorrelated noise, which often results in cancelling the source signal component of the received signal.

By contrast, the directional-interference-based inhibition mechanism will inhibit the adaptation process in such a case because the strength of directional interference as reflected in the reference channel power average will be

smaller than the normalized main channel power average, producing a positive normalized power difference. The adaptive process is inhibited as a result until there is some directional interference to be eliminated.

FIG. 9 shows the frequency-selective constraint adaptive filter together with the difference unit in accordance with a preferred embodiment of the present invention. The frequency-selective constraint adaptive filter 101 includes a finite impulse response (FIR) filter 102, an LMS weight updating unit 103 and a frequency-selective weight-constraint unit 104. In an alternative embodiment, an infinite impulse response (IIR) filter can be used instead of the FIR filter.

A flat-frequency reference channel 105 passes through FIR filter 102 whose filter weights are adjusted to produce a cancelling signal 106 which closely approximates the actual interference signal component present in a main channel 107. In a preferred embodiment, the main channel is obtained from the main channel matrix unit after a delay in order to synchronize the main channel with the cancelling signal. In general, there is a delay between the main channel and the cancelling signal because the cancelling signal is obtained by processing reference channels through extra stages of delay, i.e., the decolorization filters and adaptive filters. In an alternative embodiment, the main channel directly from the main channel matrix unit may be used if the delay is not significant.

A difference unit 108 subtracts cancelling signal 106 from main channel 107 to generates an output signal 109. Adaptive filter 101 adjusts filter weights, W_1-W_n, to minimize the power of the output signal. When the filter weights settle, output signal 109 generates the source signal substantially free of the actual interference signal component because cancelling signal 106 closely tracks the interference signal component. Output signal 109 is sent to the output D/A unit to produce an analog output signal. Output signal 109 is also used to adjust the adaptive filter weights to further reduce the interference signal component.

There are many techniques to continuously update the values of the filter weights. The preferred embodiment uses the Least Mean-Square (LMS) algorithm which minimize the mean-square value of the difference between the main channel and the cancelling signal, but in an alternative embodiment, other algorithms such as Recursive Least Square (RLS) can also be used.

Under the LMS algorithm, the adaptive filter weights are updated according to the following:

$$W_p(n+1) = W_p(n) + 2 \mu r(n-p) e(n)$$

where n is a discrete time index; W_p is a p-th filter weight of the adaptive filter; e(n) is a difference signal between the main channel signal and the cancelling signal; r(n) is a reference channel; and μ is an adaptation constant that controls the speed of adaptation.

FIG. 10 depicts a preferred embodiment of the frequency-selective weight-constraint unit. The frequency-selective weight-control unit 110 includes a Fast Fourier Transform (FFT) unit 112, a set of frequency bins 114, a set of truncating units 115, a set of storage cells 116, and an Inverse Fast Fourier Transform (IFFT) unit 117, connected in series.

The FFT unit 112 receives adaptive filter weights 111 and performs the FFT of the filter weights 111 to obtain frequency representation values 113. The frequency representation values are then divided into a set of frequency bands and stored into the frequency bins 114a-114h. Each frequency bin stores the frequency representation values within a specific bandwidth assigned to each bin. The values represent the operation of the adaptive filter with respect to a specific frequency component of the source signal. Each of the truncating units 115a-115h compares the frequency representation values with a threshold assigned to each bin, and truncates the values if they exceeds the threshold. The truncated frequency representation values are temporarily stored in 116a-116h before the IFFT unit 117 converts them back to new filter weight values 118.

In addition to the inhibiting mechanism based on directional interference, the frequency-selective weight-constraint unit further controls the adaptation process based on the frequency spectrum of the received source signal. Once the adaptive filter starts working, the performance change in the output of the filter, better or worse, becomes drastic. Uncontrolled adaptation can quickly lead to a drastic performance degradation.

The weight-constraint mechanism is based on the observation that a large increase in the adaptive filter weight values hints signal leakage. If the adaptive filter works properly, there is no need for the filter to increase the filter weights to large values. But, if the filter is not working properly, the filter weights tend to grow to large values.

One way to curve the growth is to use a simple truncating mechanism to truncate the values of filter weights to predetermined threshold values. In this way, even if the overall signal power may be high enough to trigger the inhibition mechanism, the weight-constraint mechanism can still prevent the signal leakage.

For narrow band signals, such as a speech signal or a tonal signal, having their power spectral density concentrated in a narrow frequency range, signal leakage may not be manifested in a large growth of the filter weight values in the time domain. However, the filter weight values in the frequency domain will indicate some increase because they represent the operation of the adaptive filter in response to a specific frequency component of the source signal. The frequency-selective weight-constraint unit detects that condition by sensing a large increase in the frequency representation values of the filter weights. By truncating the frequency representation values in the narrow frequency band of interest and inverse-transforming them back to the time domain, the unit acts to prevent the signal leakage involving narrow band signals.

The system described herein may be implemented using commercially available digital signal processing (DSP) systems such as Analog Device 2100 series.

FIG. 11 shows a flow chart depicting the operation of a program for a DSP processor in accordance with a preferred embodiment of the present invention.

After the program starts at step 100, the program initializes registers and pointers as well as buffers (step 110). The program then waits for an interrupt from a sampling unit requesting for processing of samples received from the array of sensors (step 120). When the sampling unit sends an interrupt (step 131) that the samples are ready, the program reads the sample values (step 130) and stores the values (step 140). The program filters the stored values using a routine implementing a tapped delay line and stores the filtered input values (step 141).

The program then retrieves the filtered input values (step 151) and main channel matrix coefficients (step 152) to generate a main channel (step 150) by multiplying the two and to store the result (step 160).

The program retrieves the filtered input values (step 171) and reference channel matrix coefficients (step 172) to generate a reference channel (reference channel #1) by multiplying the two (step 170) and to store the result (step 180). Steps 170 and 180 are repeated to generate all other reference channels (step 190).

The program retrieves one of the reference channels (step 201) and decolorization filter coefficients for the corresponding reference channel (step 202) to generate a flat-frequency reference channel by multiplying the two (step 200) and stores the result (step 210). Steps 200 and 210 are repeated for all other reference channels (step 220).

The program retrieves one of the flat-frequency reference channels (step 231) and adaptive filter coefficients (step 232) to generate cancelling signal (step 230) by multiplying the two and to store the result (step

240). Steps 230 and 240 are repeated for all other reference channels to generate more cancelling signals (step 250).

The program retrieves cancelling signals (steps 262-263) to subtract them from the main channel (retrieved at step 261) to cancel the interference signal component in the main channel (step 260). The output is send to a D/A unit to reproduce the signal without interference in analog form (step 264). The output is also stored (step 270).

The program calculates the power of a reference channel sample (step 281) and retrieves an old reference channel power average (step 282). The program multiplies the sample power by α and the old power average by $(1-\alpha)$, and sums them (step 280), and stores the result as a new power average (step 290). This process is repeated for all other reference channels (step 300) and the total sum of power averages of all reference channels is stored (step 310).

The program multiplies the power of a main channel sample (retrieved at step 321) by α and an old main channel power average (retrieved at step 322) by $(1-\alpha)$, sums them (step 320) and stores them as a new main channel power average (step 330).

The program then multiplies the main channel power with a threshold to obtain a normalized main channel power average (step 340). The program subtracts the total reference channel power average (retrieved at step 341) from the normalized main channel power average to produce a difference (step 350). If the difference is positive, the program goes back to step 120 where it simply waits for another samples.

If the difference is negative, the program enters a weight-updating routine. The program calculates a new filter weight by adding [2 x adaptation constant x reference channel sample (retrieved at step 361) x output (retrieved at step 362)] to an old filter weight (retrieved at step 363) to update the weight (step 360) and stores the result (step 370).

The program performs the FFT of the new filter weights to obtain their frequency representation (step 380). The

frequency representation values are divided into several frequency bands and stored into a set of frequency bins (step 390). The frequency representation values in each bin are compared with a threshold associated with each frequency bin (step 400). If the values exceed the threshold, the values are truncated to the threshold (step 410). The program performs the IFFT to convert the truncated frequency representation values back to filter weight values (step 420) and stores them (step 430). The program repeats the weight-updating routine, steps 360-430, for all other reference channels and associated adaptive filters (step 440). The program then goes back to step 120 to wait for an interrupt for a new round of processing samples (step 450).

While the invention has been described with reference to preferred embodiments, it is not limited to those embodiments. It will be appreciated by those of ordinary skill in the art that modifications can be made to the structure and form of the invention without departing from its spirit and scope which is defined in the following claims.

WHAT IS CLAIMED IS:

1. An adaptive system for processing digital input data representing signals containing a source signal from a signal source on-axis relative to an array of sensors as well as interference signals from interference sources located off-axis from the signal source and for producing digital output data representing the source signal with reduced interference signals relative to the source signal, comprising:

a main channel matrix unit for generating a main channel from the digital input data, the main channel representing signals received in the direction of the signal source and having a source signal component and an interference signal component;

a reference channel matrix unit for generating at least one reference channel from the digital input data, each reference channel representing signals received in directions other than that of the signal source;

at least one adaptive filter having adaptive filter weights, connected to receive signals from the reference channel matrix unit, for generating a cancelling signal approximating the interference signal component of the main channel;

a difference unit, connected to receive signals from the main channel matrix unit and said at least one adaptive filter, for generating the digital output data by subtracting the cancelling signal from the main channel;

said at least one adaptive filter also being connected to receive the digital output data and including weight updating means for finding new filter weight values of said at least one adaptive filter such that the difference between the main channel and the cancelling signal is minimized; and

weight constraining means for truncating said new filter weight values to predetermined threshold values when each of the new filter weight values exceeds the corresponding threshold value.

2. The system of claim 1, further comprising at least one decolorizing filter for filtering said at least one reference channel so that it has a frequency spectrum whose magnitude is substantially flat over a predetermined frequency range.

3. The system of claim 1, further comprising inhibiting means, connected to receive signals from the main channel matrix unit and the reference channel matrix unit, for estimating the power of the main channel and the power of said at least one reference channel and for generating an inhibit signal to said weight updating means when a normalized power difference between the main channel and said at least one reference channel is positive.

4. The system of claim 1 wherein the sensors are microphones.

5. An adaptive system for processing digital input data representing signals containing a source signal from a signal source on-axis relative to an array of sensors as well as interference signals from interference sources located off-axis from the signal source and for producing digital output data representing the source signal with reduced interference signals relative to the source signal, comprising:

a main channel matrix unit for generating a main channel from the digital input data, the main channel representing signals received in the direction of the signal source and having a source signal component and an interference signal component;

a reference channel matrix unit for generating at least one reference channel from the digital input data, each reference channel representing signals received in directions other than that of the signal source;

at least one adaptive filter having adaptive filter weights, connected to receive signals from the reference channel matrix unit, for generating a cancelling signal

approximating the interference signal component of the main channel;

a difference unit, connected to receive signals from the main channel matrix unit and said at least one adaptive filter, for generating digital output data by subtracting the cancelling signal from the main channel;

said at least one adaptive filter also being connected to receive the digital output data and including weight updating means for finding new filter weight values of said at least one adaptive filter such that the difference between the main channel and the cancelling signal is minimized; and

weight constraining means for converting the new filter weight values to frequency representation values, truncating the frequency representation values to predetermined threshold values, and converting them back to adaptive filter weights.

6. The system of claim 5, further comprising at least one decolorizing filter for filtering said at least one reference channel so that it has a frequency spectrum whose magnitude is substantially flat over a predetermined frequency range.

7. The system of claim 5, further comprising inhibiting means, connected to receive signals from the main channel matrix unit and the reference channel matrix unit, for estimating the power of the main channel and the power of said at least one reference channel and for generating an inhibit signal to said weight updating means when a normalized power difference between the main channel and said at least one reference channel is positive.

8. The system of claim 5 wherein the sensors are microphones.

9. An adaptive system for receiving a source signal from a signal source on-axis relative to the system as well as interference signals from interference sources located off-axis from the signal source and for producing an output

signal with reduced interference signals relative to the source signal, comprising:

a sensor array of spatially distributed sensors, each for receiving such source and interference signals;

a sampling unit, connected to receive signals from the sensor array, for converting such signals to digital form;

a main channel matrix unit, connected to receive signals from the sampling unit, for generating a main channel representing signals received in the direction of the signal source, the main channel having a source signal component and an interference signal component;

a reference channel matrix unit, connected to receive signals from the sampling unit, for generating at least one reference channel, each reference channel representing signals received in directions other than that of the signal source;

at least one adaptive filter having adaptive filter weights, connected to receive signals from the reference channel matrix unit, for generating a cancelling signal approximating the interference signal component of the main channel;

a difference unit, connected to receive signals from the main channel matrix unit and said at least one adaptive filter, for subtracting the cancelling signal from the main channel to generate a digital output signal;

an output digital-to-analog converter for converting said digital output signal to analog form;

said at least one adaptive filter also being connected to receive the digital output signal of the difference unit and including weight updating means for finding new filter weight values of said at least one adaptive filter such that the difference between the main channel and the cancelling signal is minimized; and

weight constraining means for truncating said new filter weight values to predetermined threshold values when each of the new filter weight value exceeds the corresponding threshold value.

10. The system of claim 9, further comprising at least one decolorizing filter for filtering said at least one reference channel so that it has a frequency spectrum whose magnitude is substantially flat over a predetermined frequency range.

11. The system of claim 9, further comprising inhibiting means, connected to receive signals from the main channel matrix unit and the reference channel matrix unit, for estimating the power of the main channel and the power of said at least one reference channel and for generating an inhibit signal to said weight updating means when a normalized power difference between the main channel and said at least one reference channel is positive.

12. The system of claim 9, further comprising delay means for delaying the main channel so that the main channel is synchronized with the cancelling signal before the difference unit subtracts the cancelling signal from the main channel.

13. The system of claim 9 wherein the sensors are microphones.

14. The system of claim 13 wherein the microphones are omnidirectional microphones.

15. The system of claim 13 wherein the microphones are unidirectional microphones.

16. The system of claim 9 wherein the main channel matrix unit includes beamforming means for spatially filtering signals from the sampling unit to exhibit the highest sensitivity toward the signal source.

17. The system of claim 9 wherein the reference channel matrix unit includes beamforming means for spatially filtering signals from the sampling unit to exhibit the lowest sensitivity toward the signal source.

18. The system of claim 9 wherein said at least one adaptive filter comprises a finite-impulse-response filter for generating the cancelling signal.

19. The system of claim 9 wherein said at least one adaptive filter comprises an infinite-impulse-response filter for generating the cancelling signal.

20. The system of claim 9 wherein the weight updating means uses the least-mean-square algorithm where the mean-square value of the difference between the main channel and the cancelling signal is minimized.

21. An adaptive system for receiving a source signal from a signal source on-axis relative to the system as well as interference signals from interference sources located off-axis from the signal source and for producing an output signal with reduced interference signals relative to the source signal, comprising:

a sensor array of spatially distributed sensors, each for receiving such source and interference signals;

a sampling unit, connected to receive signals from the sensor array, for converting such signals to digital form;

a main channel matrix unit, connected to receive signals from the sampling unit, for generating a main channel representing signals received in the direction of the signal source, the main channel having a source signal component and an interference signal component;

a reference channel matrix unit, connected to receive signals from the sampling unit, for generating at least one reference channel, each reference channel representing signals received in directions other than that of the signal source;

at least one adaptive filter having adaptive filter weights, connected to receive signals from the reference channel matrix unit, for generating a cancelling signal approximating the interference signal component of the main channel;

a difference unit, connected to receive signals from the main channel matrix unit and said at least one adaptive filter, for subtracting the cancelling signal from the main channel to generate a digital output signal;

an output digital-to-analog converter for converting the digital output signal to analog form;

said at least one adaptive filter also being connected to receive the digital output signal of the difference unit and including weight updating means for finding new filter weight values of said at least one adaptive filter such that the difference between the main channel and the cancelling signal is minimized; and

weight constraining means for constraining the operation of the adaptive filter by converting the new filter weight values to frequency representation values, truncating the frequency representation values to predetermined threshold values, and converting them back to adaptive filter weights.

22. The system of claim 21 wherein the weight constraining means comprises:

a Fast Fourier Transform unit for generating frequency representation values of the new filter weight values;

a set of frequency bins, each frequency bin for storing the frequency representation values for a frequency band assigned to each frequency bin;

a set of truncating means, each connected to the corresponding frequency bin, for truncating the frequency representation values stored in each frequency bin to a predetermined threshold value if the frequency representation values exceed the threshold value associated with each frequency bin; and

an Inverse Fast Fourier Transform unit, connected to the set of truncating means, for converting values from the set of truncating means back to adaptive filter weights.

23. The system of claim 21, further comprising at least one decolorizing filter for filtering said at least one reference channel so that it has a frequency spectrum whose magnitude is substantially flat over a predetermined frequency range.

24. The system of claim 21, further comprising inhibiting means, connected to receive signals from the main channel matrix unit and the reference channel matrix unit,

for estimating the power of the main channel and the power of said at least one reference channel and for generating an inhibit signal to said weight updating means when a normalized power difference between the main channel and said at least one reference channel is positive.

25. The system of claim 21 wherein the sensors are microphones.

26. The system of claim 21 wherein the main channel matrix unit includes beamforming means for spatially filtering signals from the sampling unit to exhibit the highest sensitivity toward the signal source.

27. The system of claim 21 wherein the reference channel matrix unit includes beamforming means for spatially filtering signals from the sampling unit to exhibit the lowest sensitivity toward the signal source.

28. The system of claim 21 wherein the weight updating means uses the least-mean-square algorithm where the mean-square value of the difference between the main channel and the cancelling signal is minimized.

29. A method for processing digital input data representing signals containing a source signal from a signal source on-axis from an array of sensors as well as interference signals from interference sources located off-axis from the signal source and for producing digital output data representing the source signal with reduced interference signals relative to the source signal, comprising the steps of:

generating a main channel from the digital input data, the main channel representing signals received in the direction of the signal source and having a source signal component and an interference signal component;

generating at least one reference channel from the digital input data, each reference channel representing signals received in directions other than that of the signal source;

filtering said at least one reference channel using filter weight values to generate a cancelling signal approximating the interference signal component in the main channel;

generating the digital output data by subtracting the cancelling signal from the main channel;

deriving new filter weight values so that the difference between the main channel and the cancelling signal is minimized; and

truncating the new filter weight values to predetermined threshold values when each of the new filter weight values exceeds the corresponding threshold value.

30. The method of claim 29, further comprising the step of filtering said at least one reference channel so that it has a substantially flat frequency spectrum.

31. The method of claim 29, further comprising the step of inhibiting the generation of the cancelling signal when a normalized power difference between the main channel and said at least one reference channel is positive.

32. A method for processing digital input data representing signals containing a source signal from a signal source on-axis from an array of sensors as well as interference signals from interference sources located off-axis from the signal source and for producing digital output data representing the source signal with reduced interference signals relative to the source signal, comprising the steps of:

generating a main channel from the digital input data, the main channel representing signals received in the direction of the signal source and having a source signal component and an interference signal component;

generating at least one reference channel from the digital input data, each reference channel representing signals received in directions other than that of the signal source;

filtering said at least one reference channel using filter weight values to generate a cancelling signal approximating the interference signal component in the main channel;

generating the digital output data by subtracting the cancelling signal from the main channel;

deriving new filter weight values so that the difference between the main channel and the cancelling signal is minimized; and

constraining the new filter weight values by converting the new filter weight values to frequency representation values, truncating the frequency representation values to predetermined threshold values, and converting them back to filter weight values.

33. The method of claim 32 wherein constraining the new filter weight values comprises:

generating frequency representation values of the new filter weight values;

divide the frequency representation values into a plurality of frequency bins;

truncating the frequency representation values in each frequency bin if they exceed a predetermined threshold value associated with each frequency bin; and

converting the frequency representation values back to filter weight values.

34. The method of claim 33 wherein generating the frequency representation is done by using the Fast Fourier Transform, and converting back is done by using the Inverse Fast Fourier Transform.

35. The method of claim 32, further comprising the step of filtering said at least one reference channel so that it has a substantially flat frequency spectrum.

36. The method of claim 32, further comprising the step of inhibiting the generation of the cancelling signal when a normalized power difference between the main channel and said at least one reference channel is positive.

37. A method for receiving a source signal from a signal source as well as interference signals from interference sources and for producing an output signal with reduced interference signals relative to the source signal, comprising the steps of:

receiving analog signals from a sensor array of spatially distributed sensors;

sampling the analog signals to convert them to digital form;

generating a main channel representing signals received in the direction of the signal source, the main channel having a source signal component and an interference signal component;

generating at least one reference channel, each reference channel representing signals received in directions other than that of the signal source;

filtering said at least one reference channel using filter weight values to generate a cancelling signal approximating the interference signal component in the main channel;

generating a digital output signal by subtracting the cancelling signal from the main channel;

converting the digital output signal to analog form;

deriving new filter weight values so that the difference between the main channel and the cancelling signal is minimized; and

truncating the new filter weight values to predetermined threshold values when each of the new filter weight values exceeds the corresponding threshold value.

38. The method of claim 37, further comprising the step of filtering said at least one reference channel so that it has a substantially flat frequency spectrum.

39. The method of claim 37, further comprising the step of inhibiting the generation of the cancelling signal when a normalized power difference between the main channel and said at least one reference channel is positive.

40. A method for receiving a source signal from a signal source as well as interference signals from interference sources and for producing an output signal with reduced interference signals relative to the source signal, comprising the steps of:

receiving analog signals from a sensor array of spatially distributed sensors;

sampling the analog signals to convert them to digital form;

generating a main channel representing signals received in the direction of the signal source, the main channel having a source signal component and an interference signal component;

generating at least one reference channel, each reference channel representing signals received in directions other than that of the signal source;

filtering said at least one reference channel using filter weight values to generate a cancelling signal approximating the interference signal component in the main channel;

generating a digital output signal by subtracting the cancelling signal from the main channel;

converting the digital output signal to analog form;

deriving new filter weight values so that the difference between the main channel and the cancelling signal is minimized; and

constraining the new filter weight values by converting the new filter weight values to frequency representation values, truncating the frequency representation values to predetermined threshold values, and converting them back to filter weight values.

41. The method of claim 40 wherein constraining the new filter weight values comprises:

generating frequency representation values of the new filter weight values;

divide the frequency representation values into a plurality of frequency bins;

truncating the frequency representation values in each frequency bin if they exceed a predetermined threshold value associated with each frequency bin; and

converting the frequency representation values back to filter weight values.

42. The method of claim 41 wherein generating frequency representation values is done by using the Fast Fourier Transform, and converting them back to filter weight values is done by using the Inverse Fast Fourier Transform.

43. The method of claim 40, further comprising the step of filtering said least one reference channel so that it has a substantially flat frequency spectrum.

44. The method of claim 40, further comprising the step of inhibiting the generation of the cancelling signal when a normalized power difference between the main channel and said at least one reference channel is positive.

ABSTRACT OF THE DISCLOSURE

An adaptive system and method for reducing interference in a signal received from an array of sensors. Adaptive filters are used to generate cancelling signals that closely approximate the interference present in the received signal. The adaptive filter weights are converted into the frequency domain where the frequency representation values in a selected frequency range are truncated to avoid signal leakage involving narrow band signals. Decolorizing filters are used to produce the cancelling signals having a flat frequency spectrum. Normalized power difference is used limit the operation of the adaptive filters to the case where there is some directional interference to be eliminated.

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below at 201 et seq. underneath my name.

I believe I am the original, first and sole inventor if only one name is listed at 201 below, or an original, first and joint inventor if plural names are listed at 201 et seq. below, of the subject matter which is claimed and for which a patent is sought on the invention entitled

SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

and for which a patent application:
☒ is attached hereto.
☐ was filed in the United States on _____ as Application Serial No. _____ *(for declaration not accompanying application)*
with amendment(s) filed on _____ *(if applicable)*
☐ was filed as PCT international application Serial No. _____ on _____ and was amended under PCT Article 19 on _____ *(if applicable)*

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION			
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES ☐ NO ☐
			YES ☐ NO ☐

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

APPLICATION NUMBER	FILING DATE

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NO.	FILING DATE	STATUS		
		PATENTED	PENDING	ABANDONED

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202	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
203	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
204	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
205	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
206	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE

ASSIGNMENT

WHEREAS, I, **Joseph Marash,**

ASSIGNOR, citizen of Israel

residing at 1A Shimkin Street, Haifa 34750, Israel

is the inventor of the invention in **SYSTEM AND METHOD FOR ADAPTIVE INTEFERENCE CANCELLING** for which I have executed an application for a

Patent of the United States

☐ which is executed on ☐ even date herewith or ☐ _____ (date)
☐ which is identified by Pennie & Edmonds docket no.
☒ which was filed on June 27, 1996

and WHEREAS, **Lamar Signal Processing Ltd.**, having a place of business at P.O. Box 7752, Haifa 31077, Israel, ASSIGNEE, is desirous of obtaining the entire right, title and interest in, to and under the said invention and the said application:

NOW, THEREFORE, in consideration of the sum of One Dollar ($1.00) to us in hand paid, and other good and valuable consideration, the receipt of which is hereby acknowledged, I, the said ASSIGNOR, have sold, assigned, transferred and set over, and by these presents do hereby sell, assign, transfer and set over, unto the said ASSIGNEE, its successors, legal representatives and assigns, the entire right, title and interest in, to and under the said invention, and the said United States application and all divisions, renewals and continuations thereof, and all Patents of the United States which may be granted thereon and all reissues and extensions thereof; and all applications for industrial property protection, including, without limitation, all applications for patents, utility models, and designs which may hereafter be filed for said invention in any country or countries foreign to the United States, together with the right to file such applications and the right to claim for the same the priority rights derived from said United States application under the Patent Laws of the United States, the International Convention for the Protection of Industrial Property, or any other international agreement or the domestic laws of the country in which any such application is filed, as may be applicable; and all forms of industrial property protection, including, without limitation, patents, utility models, inventors' certificates and designs which may be granted for said invention in any country or countries foreign to the United States and all extensions, renewals and reissues thereof;

AND I HEREBY authorize and request the Commissioner of Patents and Trademarks of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents or other evidence or forms of industrial property protection on applications as aforesaid, to issue the same to the said ASSIGNEE, its successors, legal representatives and assigns, in accordance with the terms of this instrument.

AND I HEREBY covenant and agree that I have full right to convey the entire interest herein assigned, and that I have not executed, and will not execute, any agreement in conflict herewith.

AND I HEREBY further covenant and agree that I will communicate to the said ASSIGNEE, its successors, legal representatives and assigns, any facts known to us respecting said invention, and testify in any legal proceeding, sign all lawful papers, execute all divisional, continuing, reissue and foreign applications, make all rightful oaths, and generally do everything possible to aid the said ASSIGNEE, its successors, legal representatives and assigns, to obtain and enforce proper protection for said invention in all countries.

IN TESTIMONY WHEREOF, I hereunto set my hand and seal the day and year set opposite my signature.

Date July 19, 1996, 1996 Joseph Marash L.S.
Joseph Marash

On this 19th day of July, 1996, before me, a witness, personally appeared, Joseph Marash to me known and known to me to be the person of that name, who signed and sealed the foregoing instrument, and he acknowledged the same to be his free act and deed.

Louise E. Roberts, Witness.

LOUISE E. ROBERTS
NOTARY PUBLIC, State of New York
No. 41-4874552
Qualified in Queens County
Commission Expires November 24, 1996

PENY3-501542.1

RTL898_1020-0045

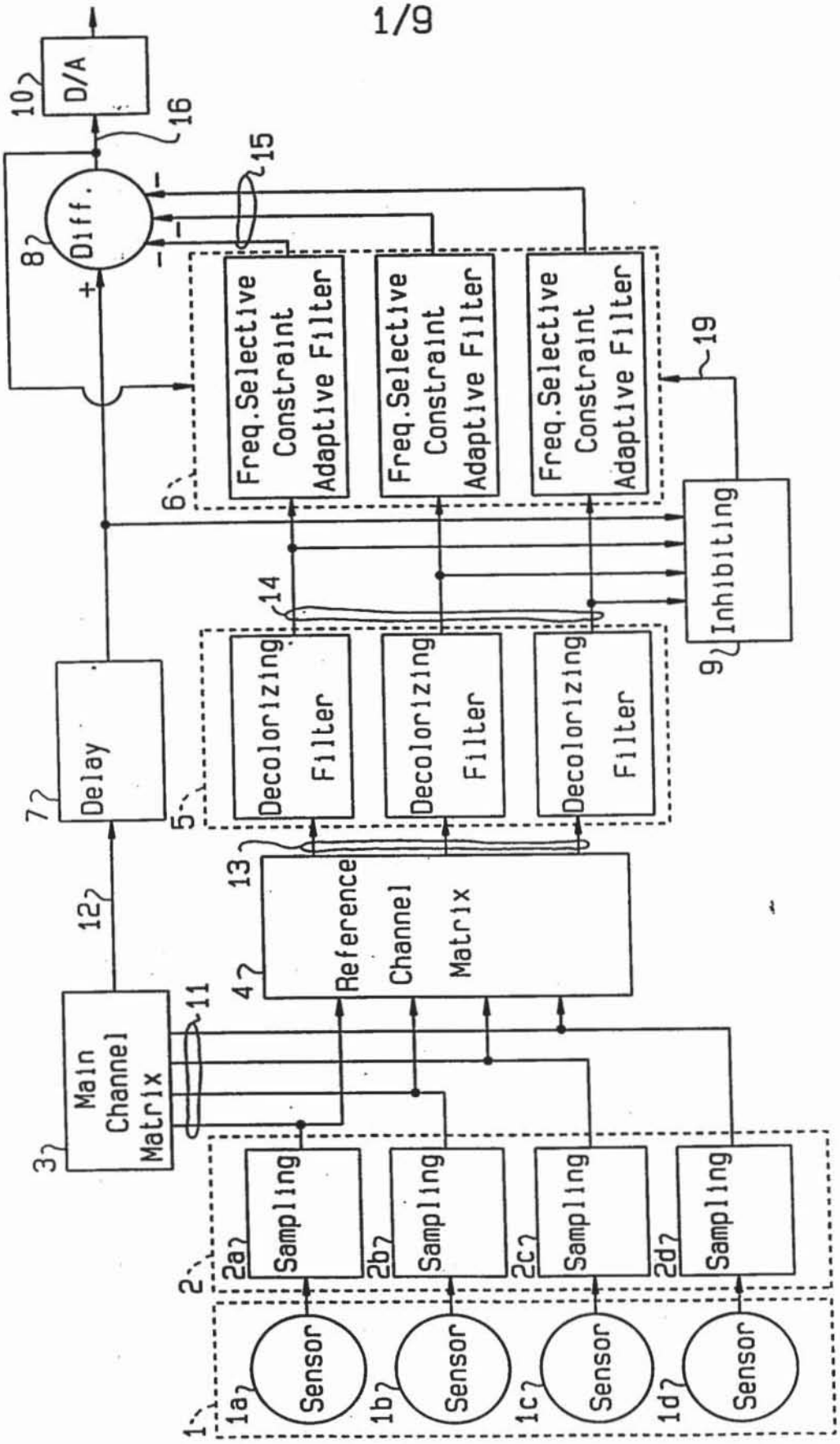
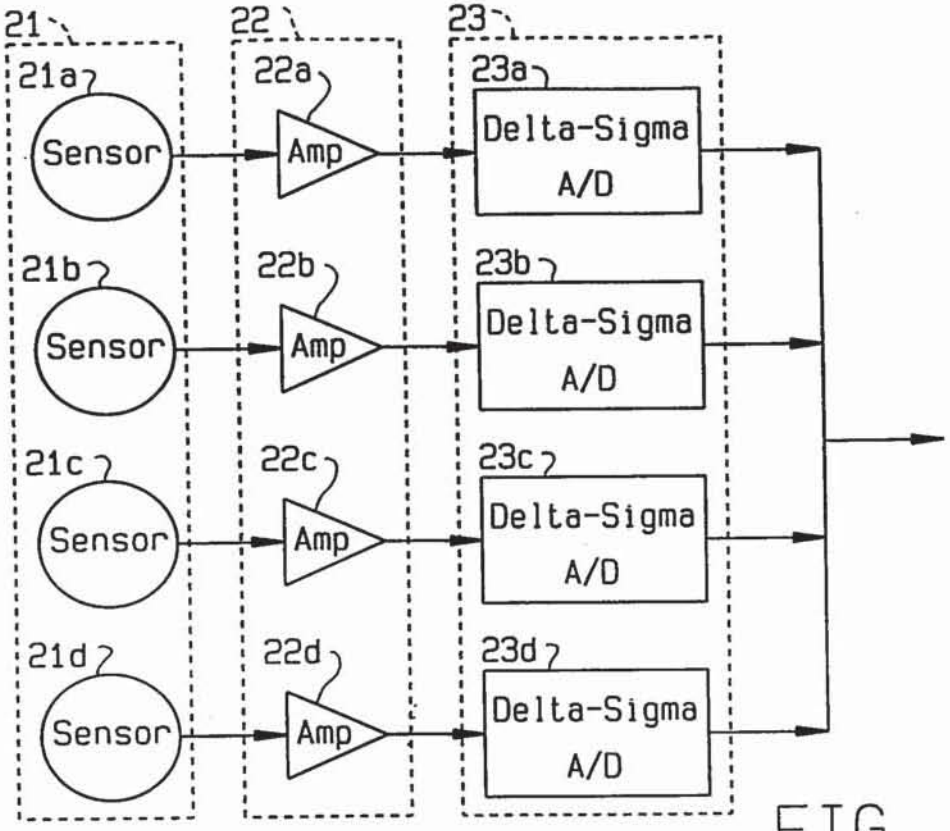

1
1a
Sensor
1b
Sensor
1c
Sensor
1d
Sensor
2
2a
Sampling
2b
Sampling
2c
Sampling
2d
Sampling
3
Main Channel Matrix
4
Reference Channel Matrix
5
Decolorizing Filter
Decolorizing Filter
Decolorizing Filter
6
Freq.Selective Constraint Adaptive Filter
Freq.Selective Constraint Adaptive Filter
Freq.Selective Constraint Adaptive Filter
7
Delay
8
Diff.
9
Inhibiting
10
D/A
11
12
13
14
15
16
19

FIG. 1

15 [illegible]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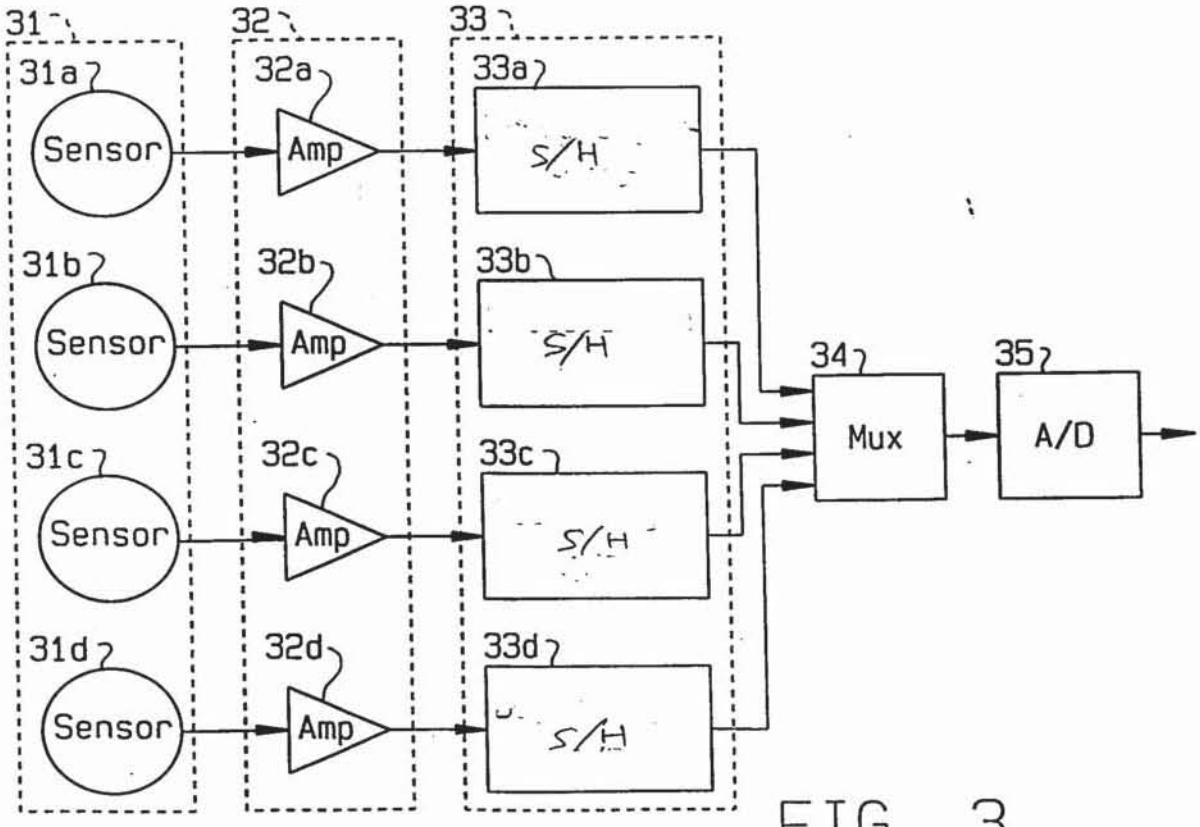
22
23
21a
22a
23a
Sensor
Amp
Delta-Sigma
A/D
21b
22b
23b
Sensor
Amp
Delta-Sigma
A/D
21c
22c
23c
Sensor
Amp
Delta-Sigma
A/D
21d
22d
23d
Sensor
Amp
Delta-Sigma
A/D

FIG. 2


31
32
33
31a
32a
33a
Sensor
Amp
S/H
31b
32b
33b
Sensor
Amp
S/H
34
35
Mux
A/D
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32c
33c
Sensor
Amp
S/H
31d
32d
33d
Sensor
Amp
S/H

FIG. 3

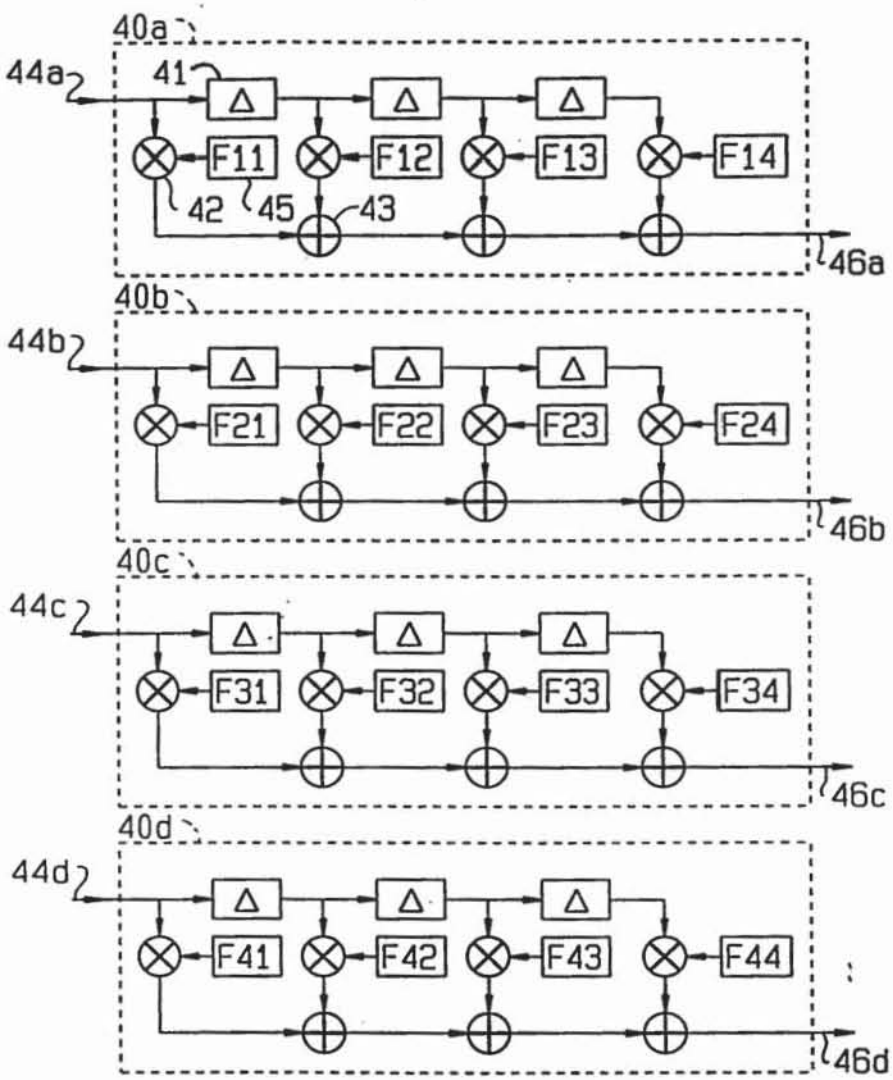
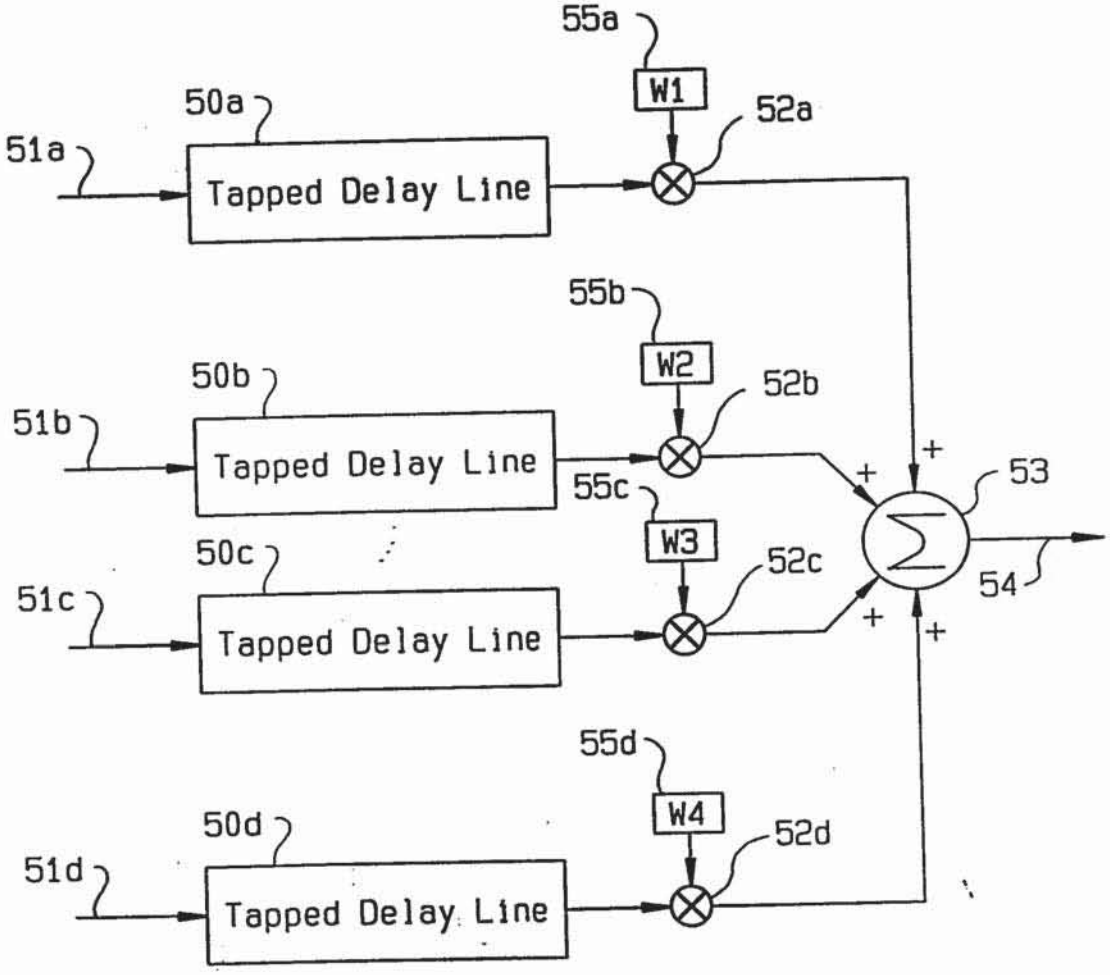

40a
44a
41
Δ
Δ
Δ
F11
F12
F13
F14
42
45
43
46a
40b
44b
F21
F22
F23
F24
46b
40c
44c
F31
F32
F33
F34
46c
40d
44d
F41
F42
F43
F44
46d

FIG. 4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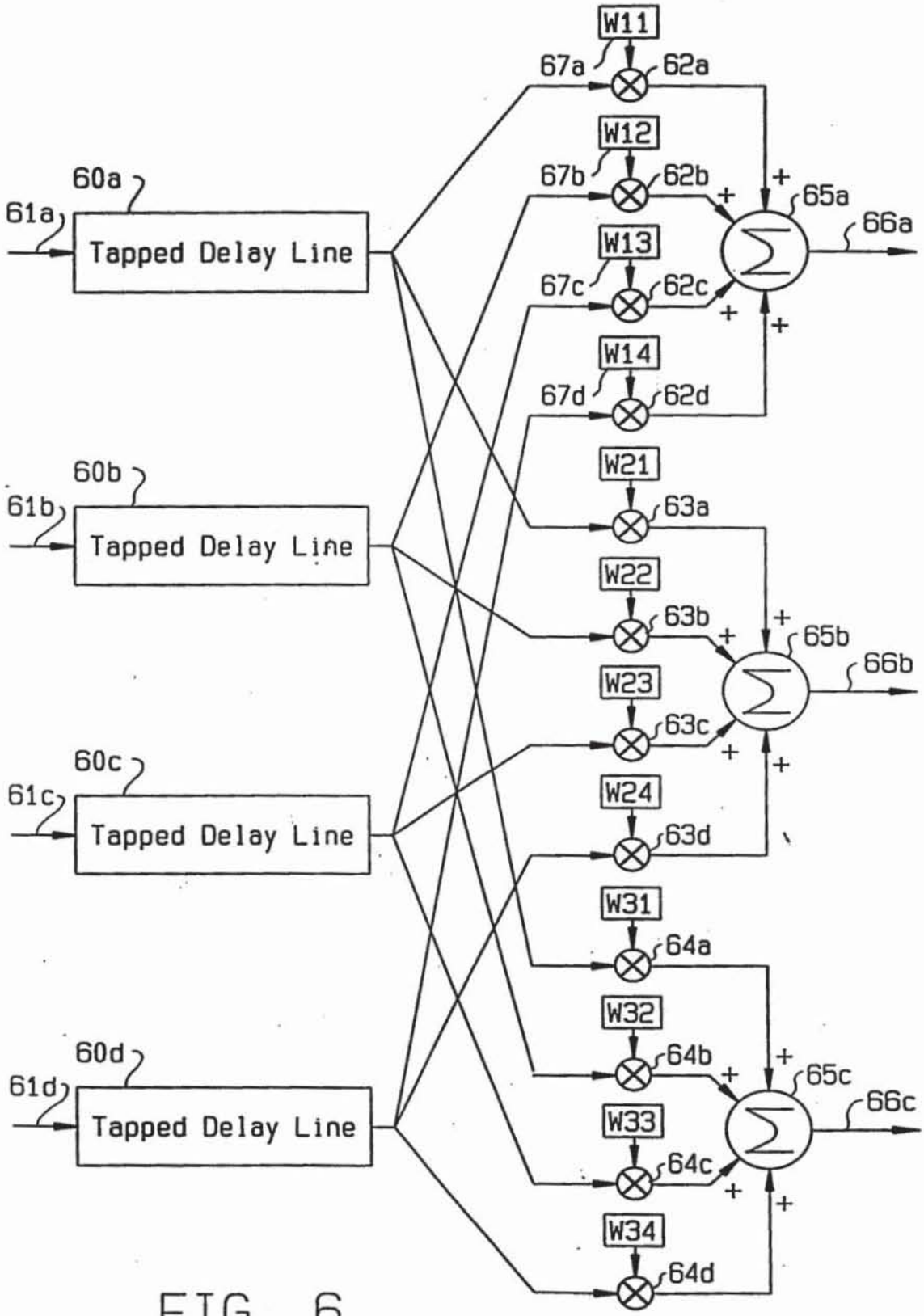
W1
52a
50a
51a
Tapped Delay Line
55b
W2
52b
50b
51b
Tapped Delay Line
55c
W3
52c
50c
51c
Tapped Delay Line
53
54
55d
W4
52d
50d
51d
Tapped Delay Line
+
+
+
+

FIG. 5


W11
67a
62a
W12
67b
62b
60a
61a
Tapped Delay Line
65a
66a
W13
67c
62c
W14
67d
62d
W21
63a
60b
61b
Tapped Delay Line
W22
63b
65b
66b
W23
63c
60c
61c
Tapped Delay Line
W24
63d
W31
64a
W32
64b
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61d
Tapped Delay Line
W33
64c
W34
64d

FIG. 6

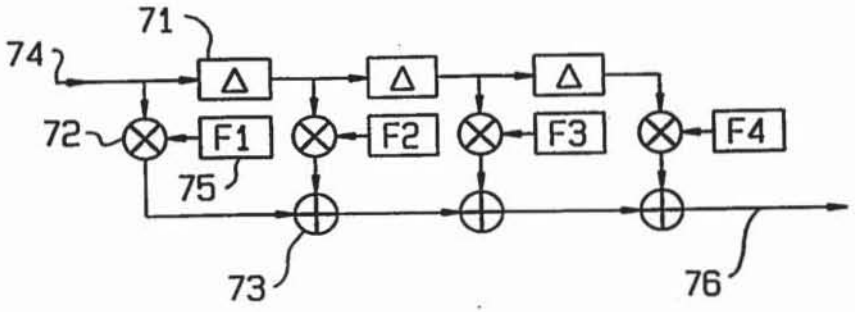
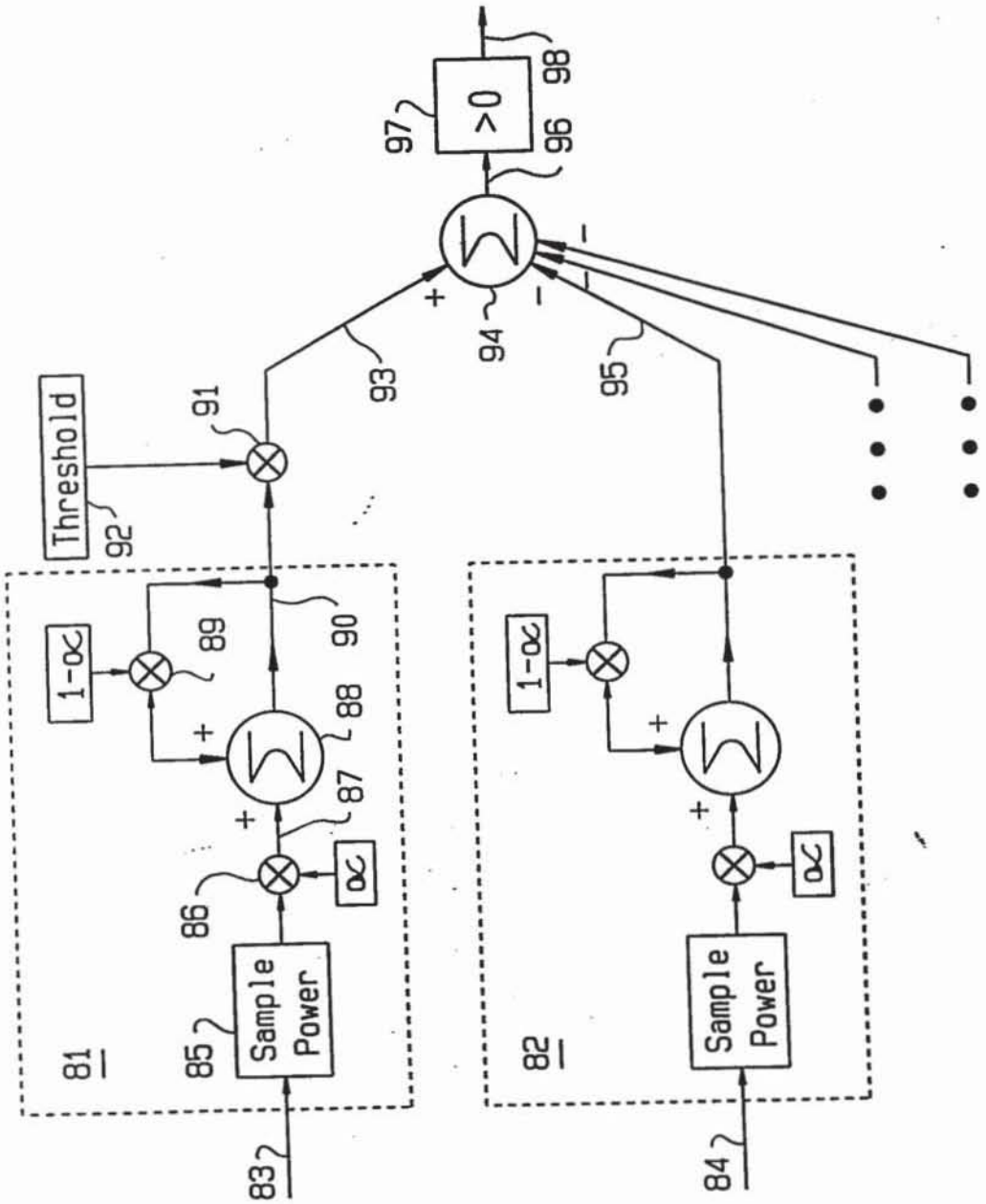


FIG. 7


81
82
Sample Power
Sample Power
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1-α
α
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Threshold
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83
84
85
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94
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96
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+
+
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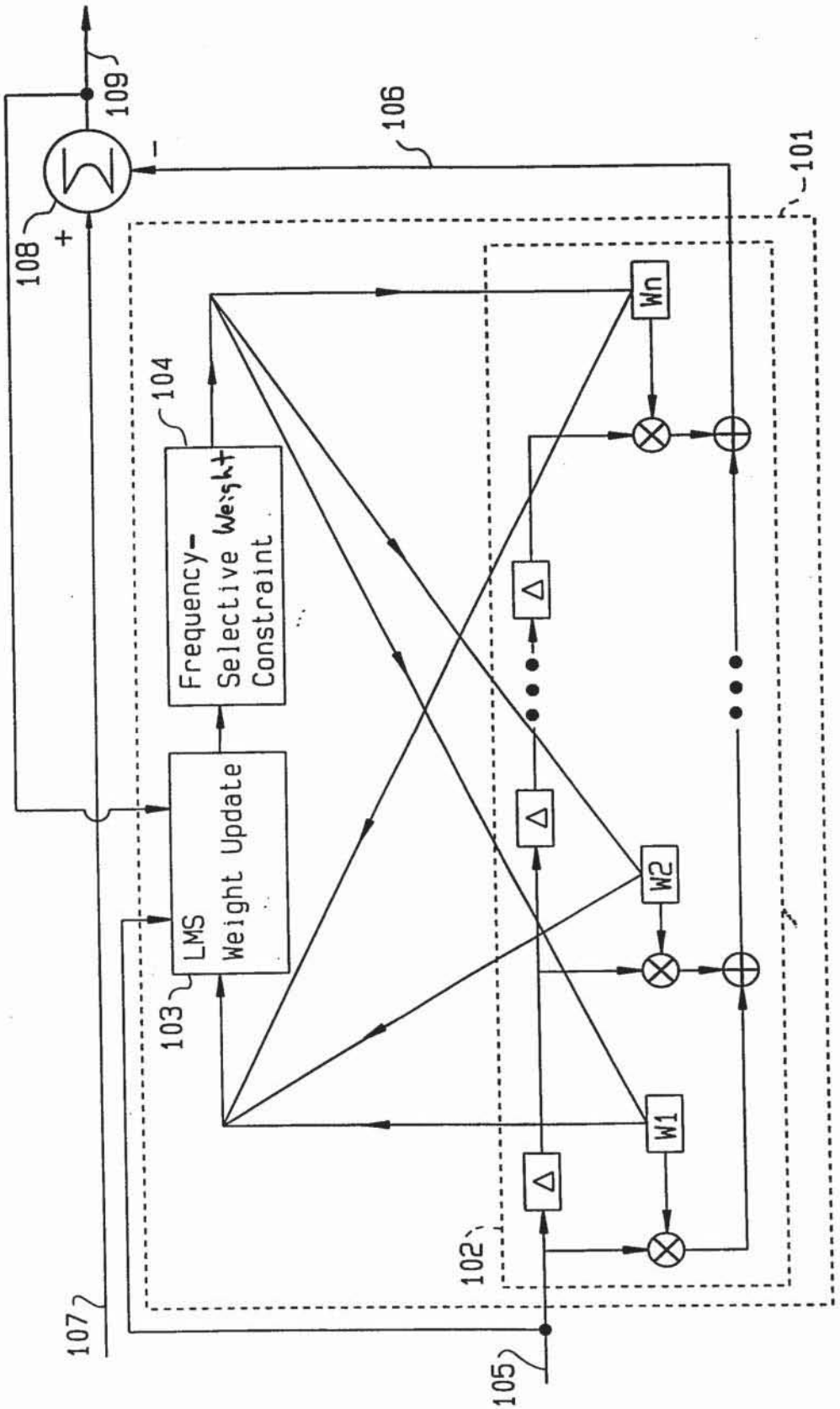
+
−
−

FIG. 8


109
106
101
108
+
-
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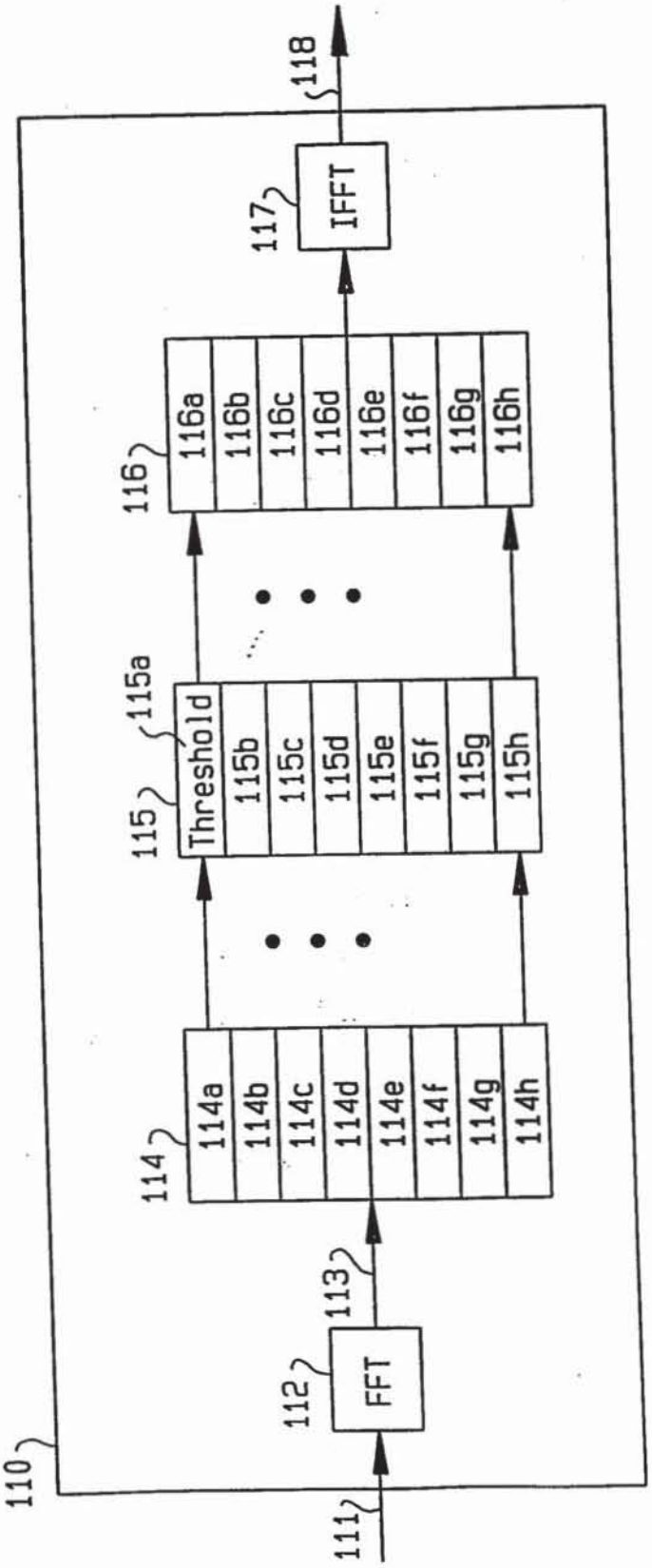
Selective Weight
Constraint
LMS
Weight Update
103
Wn
W2
W1
102
107
105

FIG. 9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111
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FFT
113
114
114a
114b
114c
114d
114e
114f
114g
114h
115
Threshold
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115c
115d
115e
115f
115g
115h
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116g
116h
117
IFFT
118

FIG. 10

381/92

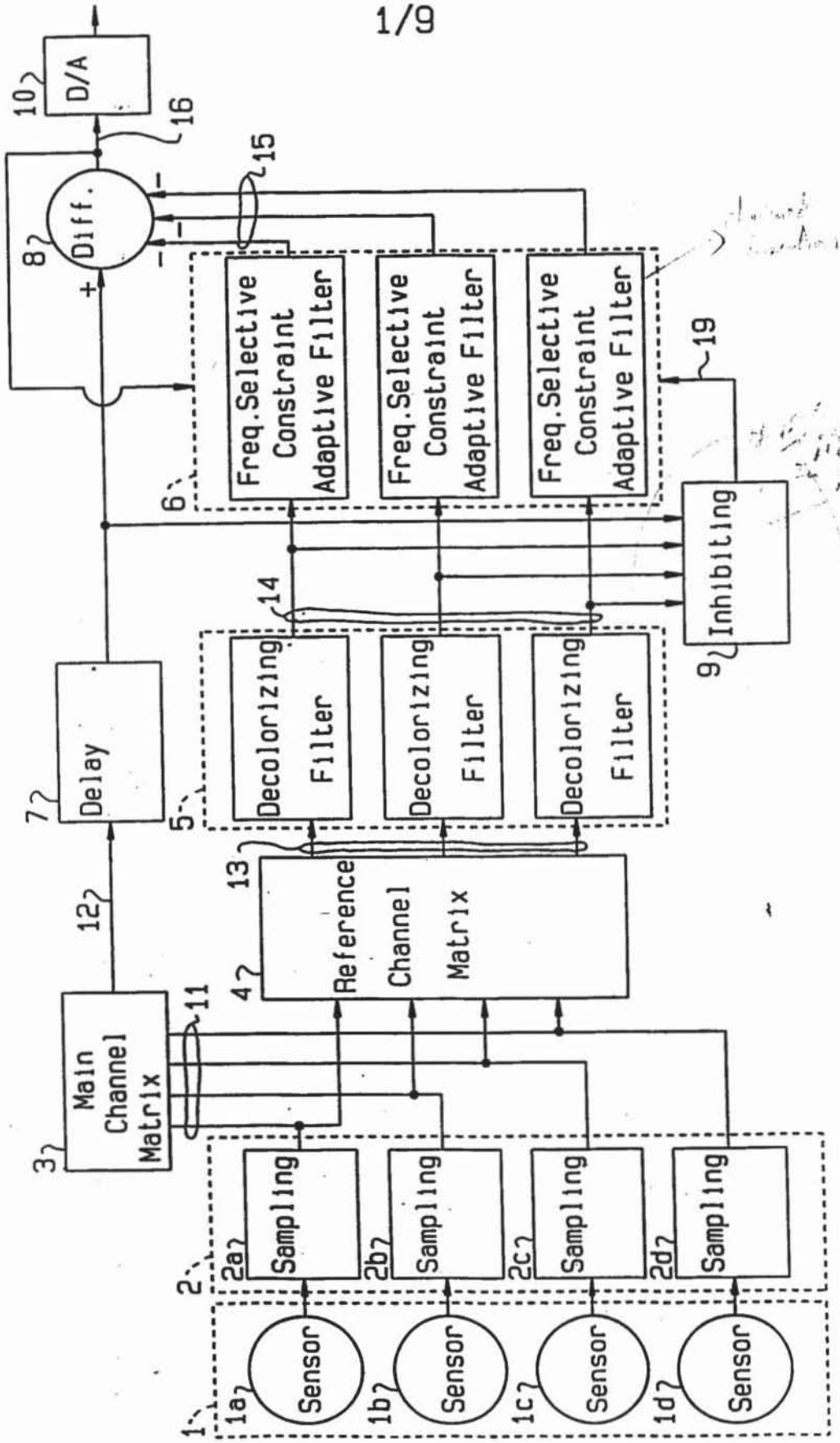


FIG. 1

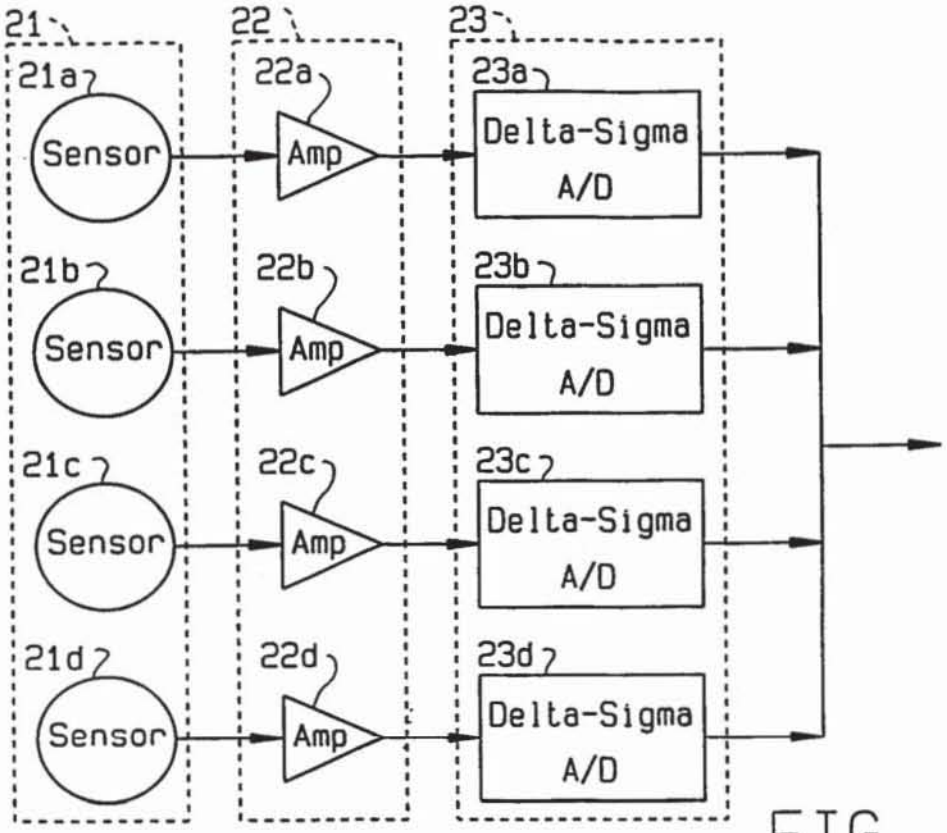


FIG. 2

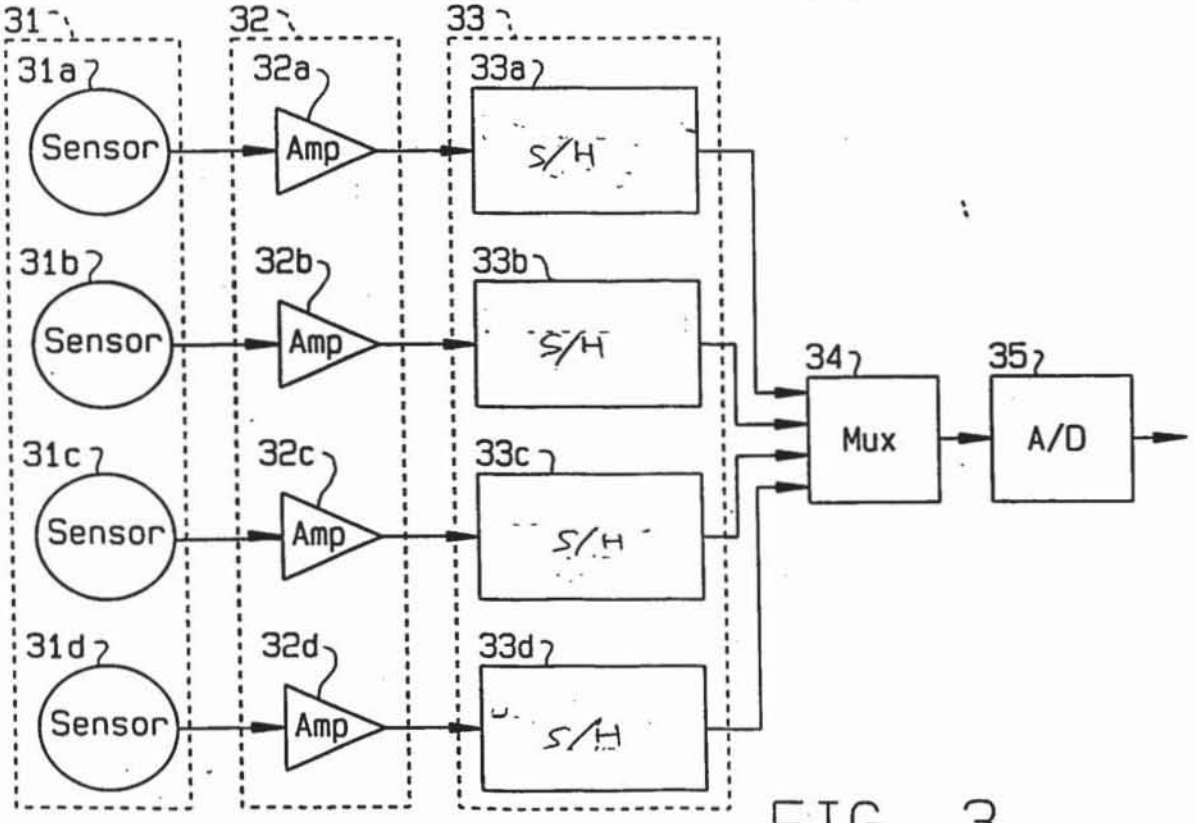


FIG. 3

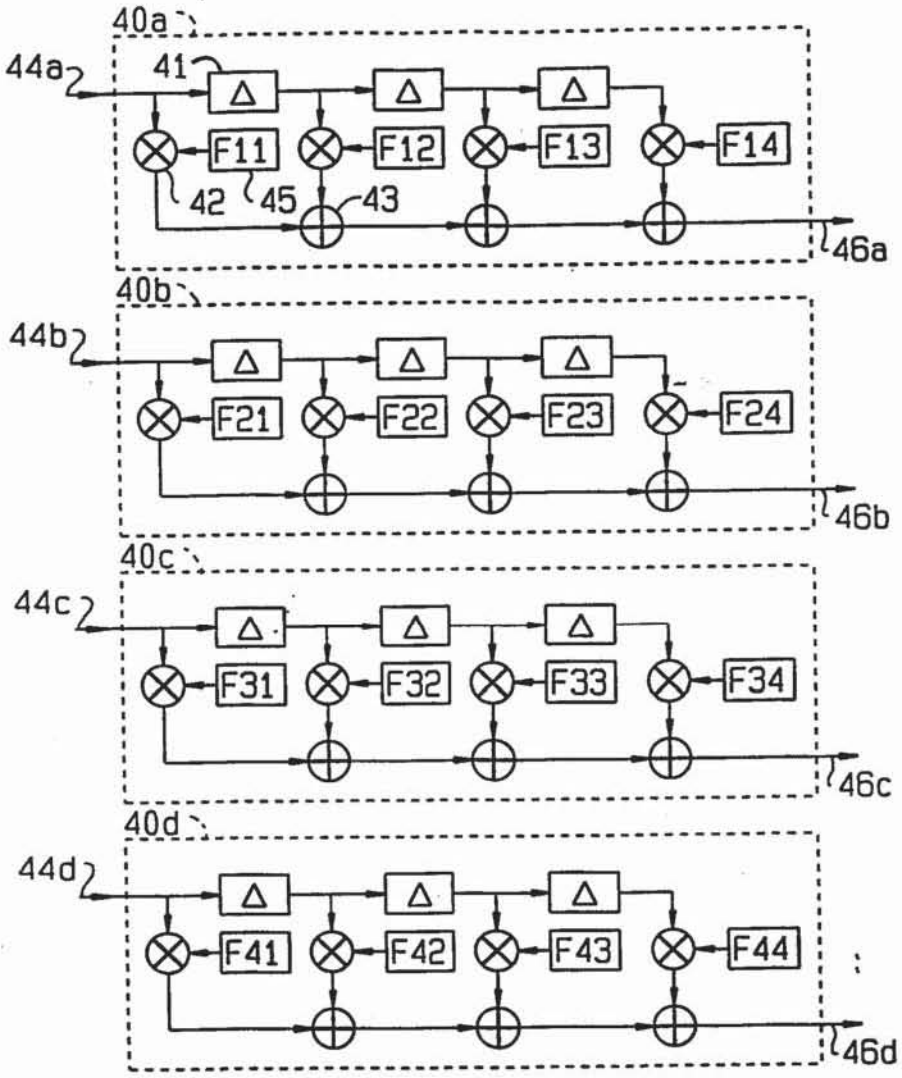


FIG. 4

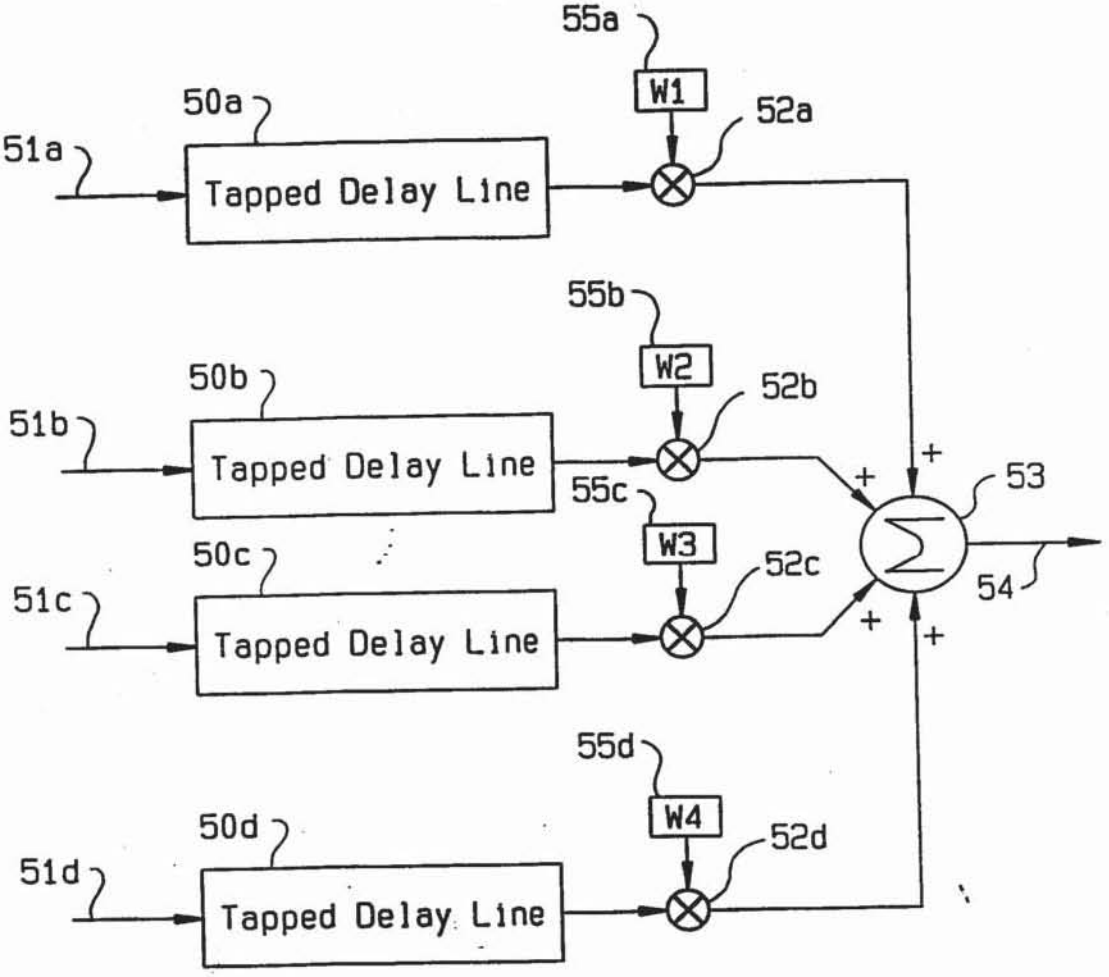
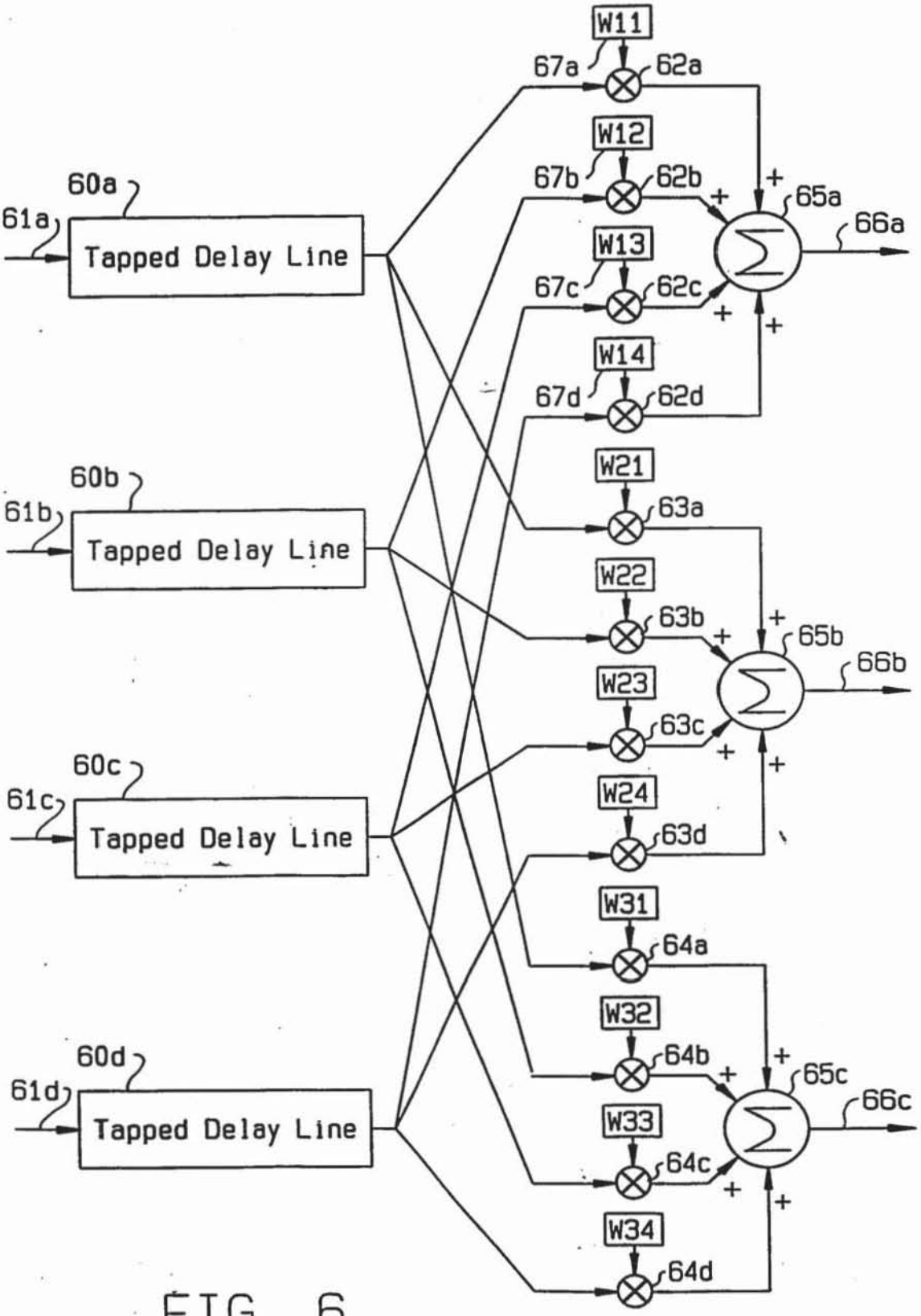


FIG. 5


W11
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63b
65b
66b
W23
63c
60c
61c
Tapped Delay Line
W24
63d
W31
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65c
66c
W33
64c
W34
64d

FIG. 6

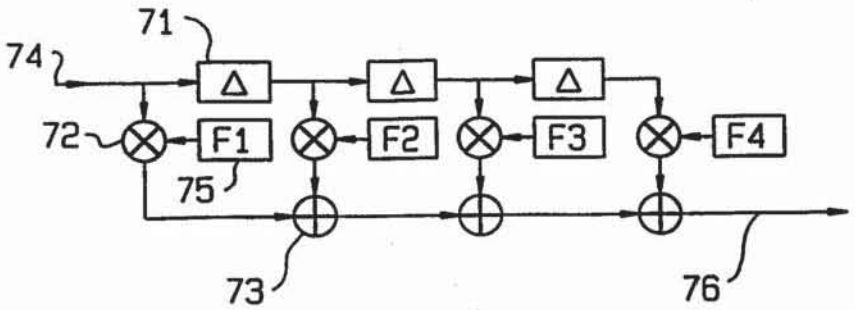

FIG. 7

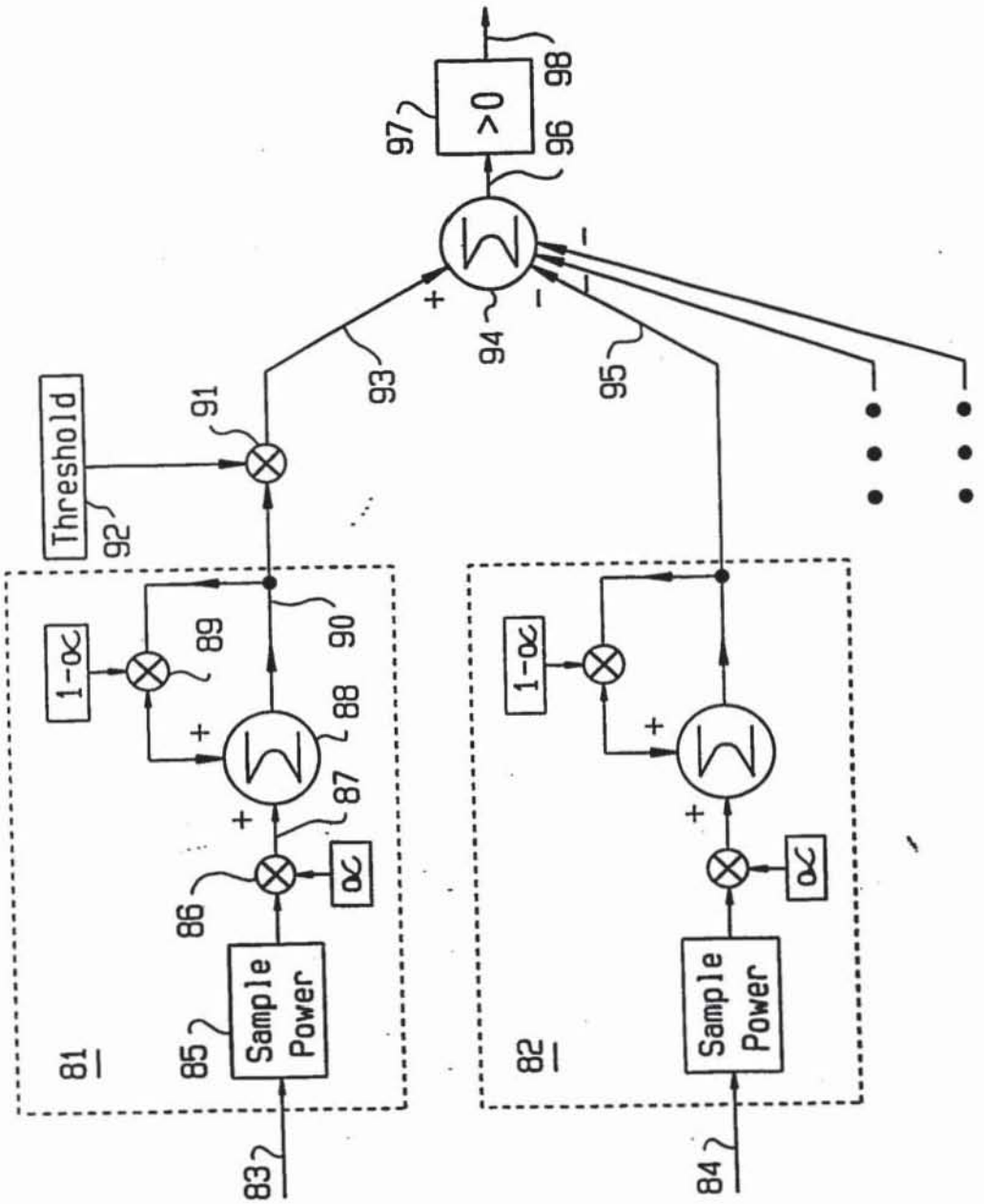

FIG. 8

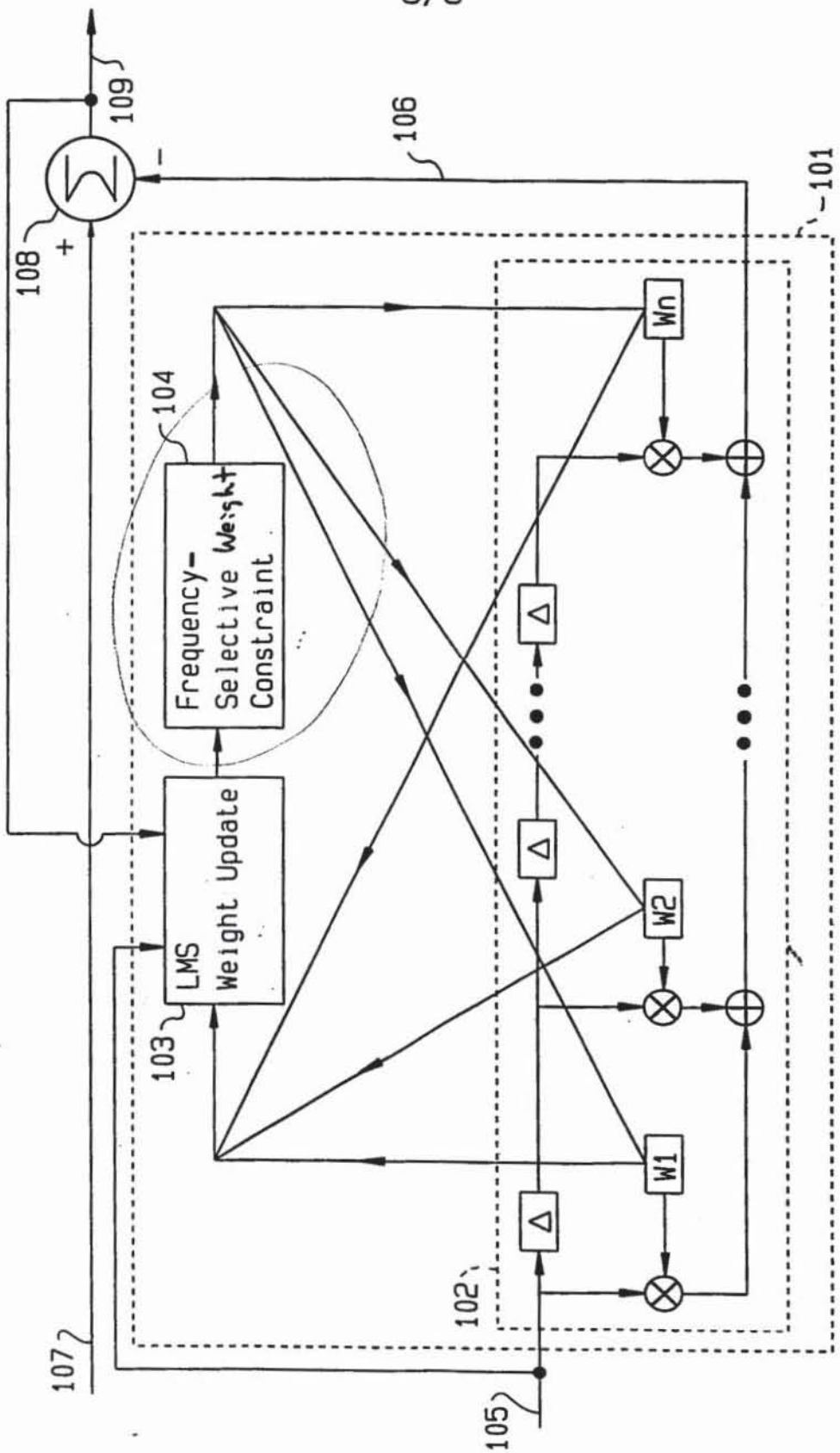

FIG. 9

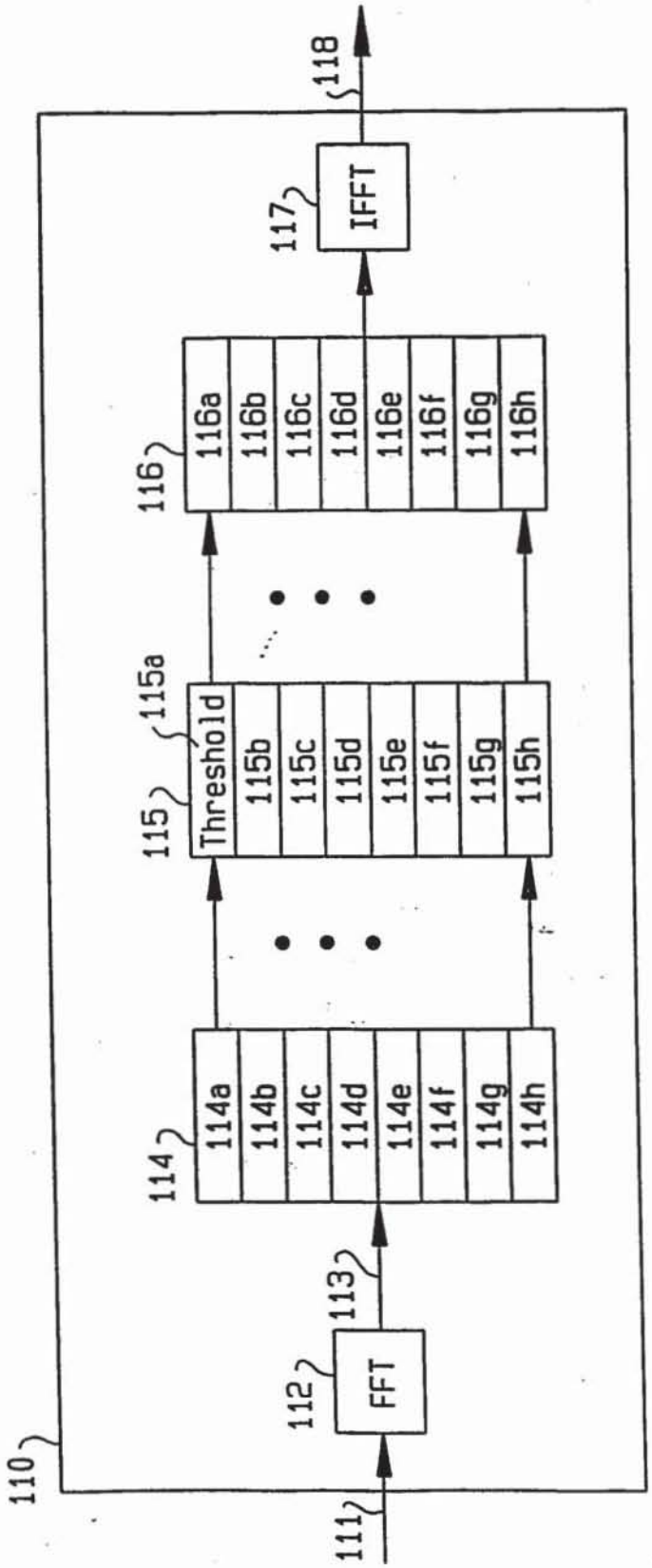

FIG. 10

#2

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
08/672,899	06/28/96	MARASH J	8797-003

0242/0816

PENNIE AND EDMONDS
1155 AVENUE OF THE AMERICAS
NEW YORK NY 10036-2711

0000

DATE MAILED: 08/16/96

NOTICE TO FILE MISSING PARTS OF APPLICATION
FILING DATE GRANTED

An Application Number and Filing Date have been assigned to this application. However, the items indicated below are missing. The required items and fees identified below must be timely submitted **ALONG WITH THE PAYMENT OF A SURCHARGE** for items 1 and 3-6 only of $ 130 for large entities or $ 65 for small entities who have filed a verified statement claiming such status. The surcharge is set forth in 37 CFR 1.16(e).

If all required items on this form are filed within the period set below, the total amount owed by applicant as a ☒ large entity, ☐ small entity (verified statement filed), is $ 130.

Applicant is given **ONE MONTH FROM THE DATE OF THIS LETTER, OR TWO MONTHS FROM THE FILING DATE** of this application, **WHICHEVER IS LATER,** within which to file all required items and pay any fees required above to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

1. ☐ The statutory basic filing fee is: ☐ missing ☐ insufficient. Applicant as a ☐ large entity ☐ small entity, must submit $_____ to complete the basic filing fee.

2. ☐ Additional claim fees of $_____ as a ☐ large entity, ☐ small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

3. ☐ The oath or declaration:
   ☐ is missing.
   ☐ does not cover items omitted at time of execution.

   An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date is required.

4. ☐ The oath or declaration does not identify the application to which it applies. An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

5. ☒ The signature(s) to the oath or declaration is/are: ☒ missing; ☐ by a person other than the inventor or a person qualified under 37 CFR 1.42, 1.43, or 1.47. A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

6. ☐ The signature of the following joint inventor(s) is missing from the oath or declaration:

   _____ An oath or declaration listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.

7. ☐ The application was filed in a language other than English. Applicant must file a verified English translation of the application and a fee of $_____ under 37 CFR 1.17(k), unless this fee has already been paid.

8. ☐ A $_____ processing fee is required since your check was returned without payment. (37 CFR 1.21(m)).

9. ☐ Your filing receipt was mailed in error because your check was returned without payment.

10. ☐ The application does not comply with the Sequence Rules. See attached Notice to Comply with Sequence Rules 37 CFR 1.821-1.825.

11. ☐ Other.

Direct the response and any questions about this notice to, Attention: Application Processing Division, Special Processing and Correspondence Branch (703) 308-1202.

A copy of this notice MUST be returned with the response.

RTL898_1020-0064

FORM PTO-1533 (REV. 11-95) OFFICE COPY

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#3

In re: ☒ Application of: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

☐ Patent of:

☒ Serial No.: 08/672,899
☐ Patent No.:

Group Art Unit:

☒ Filed: June 27, 1996
☐ Issued:

Examiner:

For: JOSEPH MARASH

Attorney Docket No.: 8797-0003

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
[37 CFR 1.9(f) and 1.27(c)] - Small Business Concern

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

I hereby declare that I am

☐ the owner of the small business concern identified below:
☒ an official of the small business concern empowered to act in behalf of the concern identified below:

Name of concern Lamar Signal Processing Ltd.
Address of concern P.O. Box 7752, Haifa 31077, Israel

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the person employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern and/or there is an obligation under contract or law by the inventor(s) to convey rights to the small business concern with regard to the invention, entitled by inventor(s) described in

☐ the specification filed herewith
☒ application filed
☐ patent no. issued

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below and no

rights to the invention are [illegible] by any person, other than the inventor [illegible] could not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

FULL NAME____________________
ADDRESS____________________

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME____________________
ADDRESS____________________

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME____________________
ADDRESS____________________

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME____________________
ADDRESS____________________

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. [37 CFR 1.28 (b)]

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, and patent issuing thereon, or any patent to which this verified statement is directed.

Send correspondence to:	PENNIE & EDMONDS 1155 Avenue of the Americas New York, N.Y. 10036-2711	Direct Telephone calls to: PENNIE & EDMONDS (212) 790-9090

Name of person signing Joseph Marash
Title of person other than owner General Manager
Address of person signing P.O. Box 7752
Haifa 31077, Israel
Signature Joseph Koal Date July 19 1996

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

PENY3-494745.1

Loc-0360 A/N
8-13-96

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: MARASH, Joseph

Serial No.: 08/672,899 — Group Art Unit: To be assigned

Filed: June 27, 1995 — Examiner: To be assigned

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING — Attorney Docket No.: 8797-003

REQUEST TO ESTABLISH SMALL ENTITY STATUS AND FOR A REFUND

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

A filing fee in excess of the required fee has been paid in connection with the subject patent application. In particular, a fee of $1,668.00 has been paid. An Assignment of the invention described in this application to Lamar Signal Processing Ltd, a corporation having a principal place of business at P.O. Box 7752, Haifa 31077, Israel is being concurrently submitted for recordation. A copy of this Assignment is enclosed herewith.

Lamar Signal Processing Ltd., having fewer than 500 employees, qualifies as a small entity under 37 CFR §§ 1.9(d), (f) and 1.27(c) and, therefore, a fee of only $834.00 is required. Enclosed herewith is a Verified Statement pursuant to 37 CFR § 1.27(c) claiming small entity status for Lamar Signal Processing Ltd., the assignee of the subject application, as a small business concern pursuant to 37 CFR §§ 1.9(d) and (f).

EXPRESS MAIL CERTIFICATION

"Express Mail" label No. EM 325 964 508 US Date of Deposit August 16, 1996. I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

MICHAEL VIGUIE
(Type or print name of person mailing paper or fee)

(Signature of person mailing paper or fee)

PENY3-510396.1

RTL898_1020-0067

Since this Verified Statement is being filed within two months of the date on which the full filing fee for the subject application was timely paid, it is believed that a refund of half the filing fee paid is due pursuant to 37 CFR §§ 1.26 and 1.28. Please refund the excess by depositing $834.00 to Deposit Account No. 16-1150. A duplicate copy of this sheet is attached.

Respectfully submitted,

Date: August 16, 1996

Barry D. Rein 22,411 (Reg. No.)

PENNIE & EDMONDS
1155 Avenue of the Americas
New York, New York 10036-2711
(212) 790-9090

Enclosures

#3

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
08/672,899	06/28/96	MARASH J	8797-003

0242/0816

PENNIE AND EDMONDS
1155 AVENUE OF THE AMERICAS
NEW YORK NY 10036-2711

0000

DATE MAILED: 08/16/96

NOTICE TO FILE MISSING PARTS OF APPLICATION
FILING DATE GRANTED

An Application Number and Filing Date have been assigned to this application. However, the items indicated below are missing. The required items and fees identified below must be timely submitted **ALONG WITH THE PAYMENT OF A SURCHARGE** for items 1 and 3-6 only of $ 130 for large entities or $ 65 for small entities who have filed a verified statement claiming such status. The surcharge is set forth in 37 CFR 1.16(e).

If all required items on this form are filed within the period set below, the total amount owed by applicant as a ☑ large entity, ☐ small entity (verified statement filed), is $ 130.

Applicant is given **ONE MONTH FROM THE DATE OF THIS LETTER, OR TWO MONTHS FROM THE FILING DATE** of this application, **WHICHEVER IS LATER,** within which to file all required items and pay any fees required above to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

1. ☐ The statutory basic filing fee is: ☐ missing ☐ insufficient. Applicant as a ☐ large entity ☐ small entity, must submit $_____ to complete the basic filing fee.

2. ☐ Additional claim fees of $_____ as a ☐ large entity, ☐ small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

3. ☐ The oath or declaration:
   ☐ is missing.
   ☐ does not cover items omitted at time of execution.

   An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date is required.

4. ☐ The oath or declaration does not identify the application to which it applies. An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

5. ☑ The signature(s) to the oath or declaration is/are: ☑ missing; ☐ by a person other than the inventor or a person qualified under 37 CFR 1.42, 1.43, or 1.47. A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

6. ☐ The signature of the following joint inventor(s) is missing from the oath or declaration:

   _____ An oath or declaration listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.

7. ☐ The application was filed in a language other than English. Applicant must file a verified English translation of the application and a fee of $_____ under 37 CFR 1.17(k), unless this fee has already been paid.

8. ☐ A $_____ processing fee is required since your check was returned without payment. (37 CFR 1.21(m)).

9. ☐ Your filing receipt was mailed in error because your check was returned without payment.

10. ☐ The application does not comply with the Sequence Rules. See attached Notice to Comply with Sequence Rules 37 CFR 1.821-1.825.

11. ☐ Other.

Direct the response and any questions about this notice to, Attention: Application Processing Division, Special Processing and Correspondence Branch (703) 308-1202.

A copy of this notice MUST be returned with the response.

03CO #1

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: MARASH, Joseph

Serial No.: 08/672,899 — Group Art Unit: To Be Assigned

Filed: June 27, 1996 — Examiner: To Be Assigned

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING — Attorney Docket No.: 8797-003

RESPONSE TO NOTICE TO FILE MISSING PARTS OF APPLICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Submitted herewith in response to the Notice to File Missing Parts of Application Filing Date Granted, mailed August 16, 1996, a copy of which is attached, is an executed Declaration and Power of Attorney in compliance with 37 CFR § 1.63.

Applicant submitted a Verified Statement Claiming Small Entity Status on August 16, 1996. Therefore, a fee of $65.00 (Small Entity) is believed to be due with this filing. Please charge the required fee to Pennie & Edmonds deposit account No. 16-1150. A copy of this sheet is enclosed.

Respectfully submitted,

Date September 12, 1996

Barry D. Reinl — 22,411 (Reg. No.)

PENNIE & EDMONDS
1155 Avenue of the Americas
New York, New York 10036-2711
(212) 790-9090

Enclosures

EXPRESS MAIL CERTIFICATION

"Express Mail" label No. EM 325 958 428 US Date of Deposit September 12, 1996.
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

MICHAEL VIGUIE
(Type or print name of person mailing paper or fee)

(Signature of person mailing paper or fee)

PENY3-518373.1

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below at 201 et seq. underneath my name.

I believe I am the original, first and sole inventor if only one name is listed at 201 below, or an original, first and joint inventor if plural names are listed at 201 et seq. below, of the subject matter which is claimed and for which a patent is sought on the invention entitled

SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

and for which a patent application:
☐ is attached hereto.
☒ was filed in the United States on June 27, 1996 as Application Serial No. 08/672,899 *(for declaration not accompanying application)*
with amendment(s) filed on _____ *(if applicable)*
☐ was filed as PCT international application Serial No. _____ on _____ and was amended under PCT Article 19 on _____ *(if applicable)*

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION			
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES ☐ NO ☐
			YES ☐ NO ☐

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

APPLICATION NUMBER	FILING DATE

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NO.	FILING DATE	STATUS		
		PATENTED	PENDING	ABANDONED

POWER OF ATTORNEY: As a named inventor, I hereby appoint S. Leslie Misrock (Reg. No. 18872), Harry C. Jones, III (Reg. No. 20280), Berj A. Terzian (Reg. No. 20060), Gerald J. Flintoft (Reg. No. 20823), David Weild, III (Reg. No. 21094), Jonathan A. Marshall (Reg. No. 24614), Barry D. Rein (Reg. No. 22411), Stanton T. Lawrence, III (Reg. No. 25736), Isaac Jarkovsky (Reg. No. 22713), Joseph V. Colaianni (Reg. No. 20019), Charles E. McKenney (Reg. No. 22795), Philip T. Shannon (Reg. No. 24278), Francis E. Morris (Reg. No. 24615), Charles E. Miller (Reg. No. 24576), Gidon D. Stern (Reg. No. 27469), John J. Lauter, Jr. (Reg. No. 27814), Brian M. Poissant (Reg. No. 28462), Brian D. Coggio (Reg. No. 27624), Rory J. Radding (Reg. No. 28749), Stephen J. Harbulak (Reg. No. 29166), Donald J. Goodell (Reg. No. 19766), James N. Palik (Reg. No. 25510), Thomas E. Friebel (Reg. No. 29258), Laura A. Coruzzi (Reg. No. 30742), Jennifer Gordon (Reg. No. 30753), Jon R. Stark (Reg. No. 30111), Allan A. Fanucci (Reg. No. 30256), Geraldine F. Baldwin (Reg. No. 31232), Victor N. Balancia (Reg. No. 31231), Albert P. Halluin (Reg. No. 25227), Samuel B. Abrams (Reg. No. 30605), Steven I. Wallach (Reg. No. 35402), and Marcia H. Sundeen (Reg. No. 30893), all of Pennie & Edmonds, whose addresses are 1155 Avenue of the Americas, New York, New York 10036, 1667 K Street N.W., Washington, DC 20006 and 2730 Sand Hill Road, Menlo Park, CA 94025, and each of them, my attorneys, to prosecute this application, and to transact all business in the Patent and Trademark Office connected therewith.

SEND CORRESPONDENCE TO:	PENNIE & EDMONDS 1155 AVENUE OF THE AMERICAS NEW YORK, N.Y. 10036-2711	DIRECT TELEPHONE CALLS TO: PENNIE & EDMONDS DOCKETING (212) 790-2803

201	FULL NAME OF INVENTOR	LAST NAME MARASH	FIRST NAME JOSEPH	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY HAIFA	STATE OR FOREIGN COUNTRY ISRAEL	COUNTRY OF CITIZENSHIP ISRAEL	
	POST OFFICE ADDRESS	STREET P.O. Box 7752	CITY HAIFA	STATE OR COUNTRY ISRAEL	ZIP CODE 31077
202	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
203	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
204	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
205	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE
206	FULL NAME OF INVENTOR	LAST NAME	FIRST NAME	MIDDLE NAME	
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP	
	POST OFFICE ADDRESS	STREET	CITY	STATE OR COUNTRY	ZIP CODE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 Josph Marash	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE July 15 1996	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE

RTL898_1020-0072

Express Mail No.: EM 325 959 967 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Marash	:	
Serial No.: 08/672,899	:	
Filed: 06/27/96	:	Group Art Unit: 2500
For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING	:	Examiner: To be assigned
Attorney Docket No.: 8797-0003	:	Pennie & Edmonds 1155 Avenue of the Americas New York, New York 10036

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.56

Assistant Commissioner for Patents
Washington, D.C. 20231

S I R:

In accordance with the continuing duty of disclosure imposed by 37 C.F.R. § 1.56 to inform the Patent Office of all references coming to the attention of Applicant or attorney or agent for Applicant which are or may be material to the patentability of any claim of the subject application, Attorney for Applicant hereby directs the Examiner's attention to the references listed on the attached revised form PTO 1449. Pursuant to 37 C.F.R. § 1.98(d), the Examiner is directed to application Serial No. 08/672,899 for copies of the references cited herein.

Identification of the listed references is not to be construed an admission of Applicant or Attorney for Applicant that such references are available as "prior art" against the subject application. Consequently, Applicant respectfully declines to use form PTO-1449, since this form identifies all of the references cited therein as "Prior Art." As

an alternative, Applicant submitsherewith a "revised form PTO 1449" entitled "List of References Cited" instead of "List of Prior Art Cited."

Applicant respectfully requeststhat the Examiner review the foregoing references and that the references be made of record in the file history of the application.

Pursuant to 37 C.F.R. § 1.97(b), since this information disclosure statement is being filed before the mailing date of a first Office action on the merits, no fee is due in connection herewith. However, should the Patent Office determine otherwise, please charge the required fee to Pennie & Edmonds deposit account no. 16-1150; a duplicate of this sheet is enclosed.

Respectfully submitted,

Date: January 3, 1997

22,411
Barry D. Rein (Reg. No.)

PENNIE & EDMONDS
1155 Avenue of the Americas
New York, New York 10036-2711
(212) 790-9090

LIST OF REFERENCES CITED BY APPLICANT (Use several sheets if necessary)	ATTY. DOCKET NO. 8797-0003-999	SERIAL NO. 08/672,899
	APPLICANT Marash	
	FILING DATE June 27, 1996	GROUP 2502

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	4,956,867	9/11/90	Zurek et al.			
DN	AB	4,811,404	3/7/89	Vilmur et al.			
DN	AC	4,658,426	4/14/87	Chabries et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO

OTHER REFERENCES (*Including Author, Title, Date, Pertinent Pages, Etc.*)

DN	AD	Widrow et al., Adapative Noise Cancelling: Principles and Applications, Proc. IEEE 63:1692-1716, 1975.
DN	AE	Van Veen and Buckley, Beamforming: A Versatile Approach to Spatial Filtering, IEEE ASSP Mag. 5(2), 4-24, 1988.
DN	AF	Griffiths and Jim, An Alternative Approach to Linearly Constrained Adaptive Beamforming, IEEE Trans. Ant. Prop. AP-30:27-34, 1982.

EXAMINER	DATE CONSIDERED
D. NGUYEN	1/2/98

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with **MPEP 609**; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/672,899	06/27/96	MARASH	J 8797-003

LM61/0112

PENNIE AND EDMONDS
1155 AVENUE OF THE AMERICAS
NEW YORK NY 10036-2711

EXAMINER	
NGUYEN, D	
ART UNIT	**PAPER NUMBER**
2743	6

DATE MAILED: 01/12/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

RTL898_1020-0076

Office Action Summary	Application No. 08/672,899	Applicant(s) MARASH
	Examiner Duc Nguyen	Group Art Unit 2743

☐ Responsive to communication(s) filed on _____.

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-44* is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☒ Claim(s) *1-28* is/are allowed.

☒ Claim(s) *29-44* is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 5

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 29-30 and 37-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshuyama.

Consider claims 29 and 37. Hoshuyama teaches an adaptive array beamformer using coefficient restrained adaptive filters for detecting interference signals comprises the steps of generating a main channel (e.g., output of filter 2); generating a reference channel (e.g., output of filter 16); filtering the reference channel by adaptive filter (17) to generate a canceling signal (e.g., output signal from adder 11); generating the digital output data (5) by subtracting the canceling signal from the main channel; deriving new filter weight values so that the difference between the main channel and the canceling signal is minimized (column 5 line 50 to column 6 line 38, minimizes the error input of the leaky adaptive filter); truncating the new filter weight values to predetermined threshold values when each

of the new filter weight values exceeds the corresponding threshold value (threshold θ)(column 6 line 48 to column 7 line 33). It would have been obvious to one skilled in the art at the time the invention was made to utilize the coefficient update circuit in the second embodiment which comprises restraining means into the coefficient update circuit of the first embodiment in order to prevent the coefficients from increasing indefinitely. As to claim 37, the steps of sampling the analog signals to convert them to digital form and converting the digital output signal to analog form were well-known to one skilled in the art by placing analog to digital converter at the output of microphones (1) and digital to analog converter at the output of subtractor (12).

Consider claims 30 and 38. The step of filtering the reference channel so that it has a substantially flat frequency spectrum is met by filters (16).

3. Claims 32-35 and 40-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshuyama in view of Chabries.

Consider claims 32-34 and 40-42. Hoshuyama teaches an adaptive array beamformer using coefficient restrained adaptive filters for detecting interference signals comprises the steps of generating a main channel (e.g., output of filter 2); generating

a reference channel (e.g., output of filter 16); filtering the reference channel by adaptive filter (17) to generate a canceling signal (e.g., output signal from adder 11); generating the digital output data (5) by subtracting the canceling signal from the main channel; deriving new filter weight values so that the difference between the main channel and the canceling signal is minimized (column 5 line 50 to column 6 line 38, minimizes the error input of the leaky adaptive filter); truncating the new filter weight values to predetermined threshold values when each of the new filter weight values exceeds the corresponding threshold value (threshold θ) (column 6 line 48 to column 7 line 33). It would have been obvious to one skilled in the art at the time the invention was made to utilize the coefficient update circuit in the second embodiment which comprises restraining means into the coefficient update circuit of the first embodiment in order to prevent the coefficients from increasing indefinitely. Hoshuyama does not explicitly teach the step of converting the new filter weight values to frequency representation values, and converting them back to filter weight values. Chabries, on the other hand, teaches a method and apparatus for suppressing noise comprise the step of converting filter weight values to frequency representation values and converting them back to filter weight values (see figures 5-8,

column 2 line 53 to column 3 line 8). It would have been obvious to one skilled in the art at the time the invention was made to utilize Chabries' Frequency-Domain Algorithm instead of using Time-Domain Algorithm due to the fact that time domain filters have a response time on the order of 200-300ms which is quite long as compared to the dynamics of speech which is in the range of 20-40ms, as the result, in time domain filtering background noises which appear in higher frequency components are not effectively filtered. As to claim 40, the steps of sampling the analog signals to convert them to digital form and converting the digital output signal to analog form were well-known to one skilled in the art by placing analog to digital converter at the output of microphones (1) and digital to analog converter at the output of subtractor (12).

Consider claims 35 and 43. The step of filtering the reference channel so that it has a substantially flat frequency spectrum is met by filters (16).

4. Claims 31 and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshuyama in view of Zurek et al.

Consider claims 31 and 39. Hoshuyama does not explicitly teach the step of inhibiting the generation of the canceling signal when a normalized power difference between the main

channel and the at least one reference channel. Zurek et al., on the other hand, teach the step of inhibiting the generation of the canceling signal when a normalized power difference between the main channel and the at least one reference channel is positive (i.e., the signal-to-noise ratio of the main channel and the reference channel is high) (column 4 lines 31-60, column 5 lines 31-42). It would have been obvious to one skilled in the art at the time the invention was made to adapt the teachings of Zurek et al. in order to prevent degradation of the target signal when it dominates the beamformer input.

5. Claims 36 and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hoshuyama in view of Chabries as applied to claims 32 and 40 above, and further in view of Zurek et al.

Consider claims 36 and 44. Hoshuyama in view of Chabries do not explicitly teach the step of inhibiting the generation of the canceling signal when a normalized power difference between the main channel and the at least one reference channel. Zurek et al., on the other hand, teach the step of inhibiting the generation of the canceling signal when a normalized power difference between the main channel and the at least one reference channel is positive (i.e., the signal-to-noise ratio of the main channel and the reference channel is high) (column 4

lines 31-60, column 5 lines 31-42). It would have been obvious to one skilled in the art at the time the invention was made to adapt the teachings of Zurek et al. in order to prevent degradation of the target signal when it dominates the beamformer input.

6. Claims 1-28 are allowed.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Duc Nguyen whose telephone number is (703) 308-7527.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mr. Kuntz, can be reached on (703) 305-4708.

Duc Nguyen
12/30/97

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to:

(703) 308-9051, (for formal communications intended for entry)

Or:

(703) 305-9508, (for informal or draft communications, please label "PROPOSED" or "DRAFT")

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington. VA., Sixth Floor (Receptionist).

CURTIS A. KUNTZ
SUPERVISORY PATENT EXAMINER
GROUP 2700

Notice of References Cited

Application No.	Applicant(s)		
08/672,899	MARASH		
Examiner		Group Art Unit	Page 1 of 1
Duc Nguyen		2743	

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
	A	5,627,799	5/6/97	Hoshuyama	381	92
	B	4,658,426	4/14/87	Chabries et al.	381	94.3
x	C	4,802,227	1/31/89	Elko et al.	381	92
x	D	5,416,847	5/16/95	Boze	381	94.3
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

*		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	U		
	V		
	W		
	X		

* A copy of this reference is not being furnished with this Office action.
(See Manual of Patent Examining Procedure, Section 707.05(a).)

Form PTO 948 (Rev. 10-94) U.S. DEPARTMENT OF COMMERCE - Patent and Trademark Office Application No. 672899

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

PTO Draftpersons review all originally filed drawings regardless of whether they are designated as formal or informal. Additionally, patent Examiners will review the drawings for compliance with the regulations. Direct telephone inquiries concerning this review to the Drawing Review Branch, 703-305-8404.

The drawings filed (insert date) 6/27/96, are
A. ___ not objected to by the Draftsperson under 37 CFR 1.84 or 1.152.
B. X objected to by the Draftsperson under 37 CFR 1.84 or 1.152 as indicated below. The Examiner will require submission of new, corrected drawings when necessary. Corrected drawings must be submitted according to the instructions on the back of this Notice.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings: Black ink. Color.
   - ___ Not black solid lines. Fig(s)_____
   - ___ Color drawings are not acceptable until petition is granted. Fig(s) _____
2. PHOTOGRAPHS. 37 CFR 1.84(b)
   - ___ Photographs are not acceptable until petition is granted. Fig(s) _____
   - ___ Photographs not properly mounted (must use brystol board or photographic double-weight paper). Fig(s)_____
   - ___ Poor quality (half-tone). Fig(s)_____
3. GRAPHIC FORMS. 37 CFR 1.84 (d)
   - ___ Chemical or mathematical formula not labeled as separate figure. Fig(s)_____
   - ___ Group of waveforms not presented as a single figure, using common vertical axis with time extending along horizontal axis. Fig(s)_____
   - ___ Individuals waveform not identified with a separate letter designation adjacent to the vertical axis. Fig(s)_____
4. TYPE OF PAPER. 37 CFR 1.84(c)
   - ___ Paper not flexible, strong, white, smooth, nonshiny, and durable. Sheet(s)_____
   - ___ Erasures, alterations, overwritings, interlineations, cracks, creases, and folds copy machine marks not accepted. Fig(s) _____
   - ___ Mylar, velum paper is not acceptable (too thin). Fig(s) _____
5. SIZE OF PAPER. 37 CFR 1.84(f): Acceptable sizes:
   - 21.6 cm. by 35.6 cm. (8 1/2 by 14 inches)
   - 21.6 cm. by 33.1 cm. (8 1/2 by 13 inches)
   - 21.6 cm. by 27.9 cm. (8 1/2 by 11 inches)
   - 21.0 cm. by 29.7 cm. (DIN size A4)
   - ___ All drawing sheets not the same size. Sheet(s)_____
   - ___ Drawing sheet not an acceptable size. Sheet(s) _____
6. MARGINS. 37 CFR 1.84(g): Acceptable margins:

Paper size			
21.6 cm. X 35.6 cm. (8 1/2 X 14 inches)	21.6 cm X 33.1 cm. (8 1/2 X 13 inches)	21.6 cm. X 27.9 cm. (8 1/2 X 11 inches)	21.0 cm. X 29.7 cm. (DIN Size A4)
T 5.1 cm. (2")	2.5 cm. (1")	2.5 cm. (1")	2.5cm.
L .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	2.5 cm.
R .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.5 cm.
B .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.0 cm.

Margins do not conform to chart above.
Sheet(s)_____
___Top (T) ___ Left (L) ___Right (R) ___Bottom (B)

7. VIEWS. 37 CFR 1.84(h)
   REMINDER: Specification may require revision to correspond to drawing changes.
   - ___ All views not grouped together. Fig(s)_____
   - ___ Views connected by projection lines or lead lines. Fig(s)_____
   - Partial views. 37 CFR 1.84(h) 2
   - ___ View and enlarged view not labled separatly or properly. Fig(s)_____
   - Sectional views. 37 CFR 1.84 (h) 3
   - ___ Hatching not indicated for sectional portions of an object. Fig(s)_____
   - ___ Cross section not drawn same as view with parts in cross section with regularly spaced parallel oblique strokes. Fig(s)_____
8. ARRANGEMENT OF VIEWS. 37 CFR 1.84(i)
   - ___ Words do not appear on a horizontal, left-to-right fashion when page is either upright or turned so that the top becomes the right side, except for graphs. Fig(s)_____
9. SCALE. 37 CFR 1.84(k)
   - ___ Scale not large enough to show mechanism with crowding when drawing is reduced in size to two-thirds in reproduction. Fig(s)_____
   - ___ Indication such as "actual size" or scale 1/2" not permitted. Fig(s)_____
10. CHARACTER OF LINES, NUMBERS, & LETTERS. 37 CFR 1.84(l)
    - A Lines, numbers & letters not uniformly thick and well defined, clean, durable, and black (except for color drawings). Fig(s) 1/A - 11/E
11. SHADING. 37 CFR 1.84(m)
    - ___ Solid black shading areas not permitted. Fig(s)_____
    - ___ Shade lines, pale, rough and blurred. Fig(s)_____
12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.84(p)
    - ___ Numbers and reference characters not plain and legible. 37 CFR 1.84(p)(l) Fig(s)_____
    - ___ Numbers and reference characters not oriented in same direction as the view. 37 CFR 1.84(p)(l) Fig(s)_____
    - ___ English alphabet not used. 37 CFR 1.84(p)(2) Fig(s)_____
    - ✓ Numbers, letters, and reference characters do not measure at least .32 cm. (1/8 inch) in height. 37 CFR(p)(3) Fig(s)_____
13. LEAD LINES. 37 CFR 1.84(q)
    - ___ Lead lines cross each other. Fig(s)_____
    - ___ Lead lines missing. Fig(s)_____
14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.84(t)
    - ___ Sheets not numbered consecutively, and in Arabic numerals, beginning with number 1. Sheet(s)_____
15. NUMBER OF VIEWS. 37 CFR 1.84(u)
    - ___ Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s)_____
    - ___ View numbers not preceded by the abbreviation Fig. Fig(s)_____
16. CORRECTIONS. 37 CFR 1.84(w)
    - ___ Corrections not made from prior PTO-948. Fig(s)_____
17. DESIGN DRAWING. 37 CFR 1.152
    - ___ Surface shading shown not appropriate. Fig(s)_____
    - ___ Solid black shading not used for color contrast. Fig(s)_____

COMMENTS:

ATTACHMENT TO PAPER NO. 6 REVIEWER _____ DATE 11/24/96

RTL898_1020-0086
PTO Copy

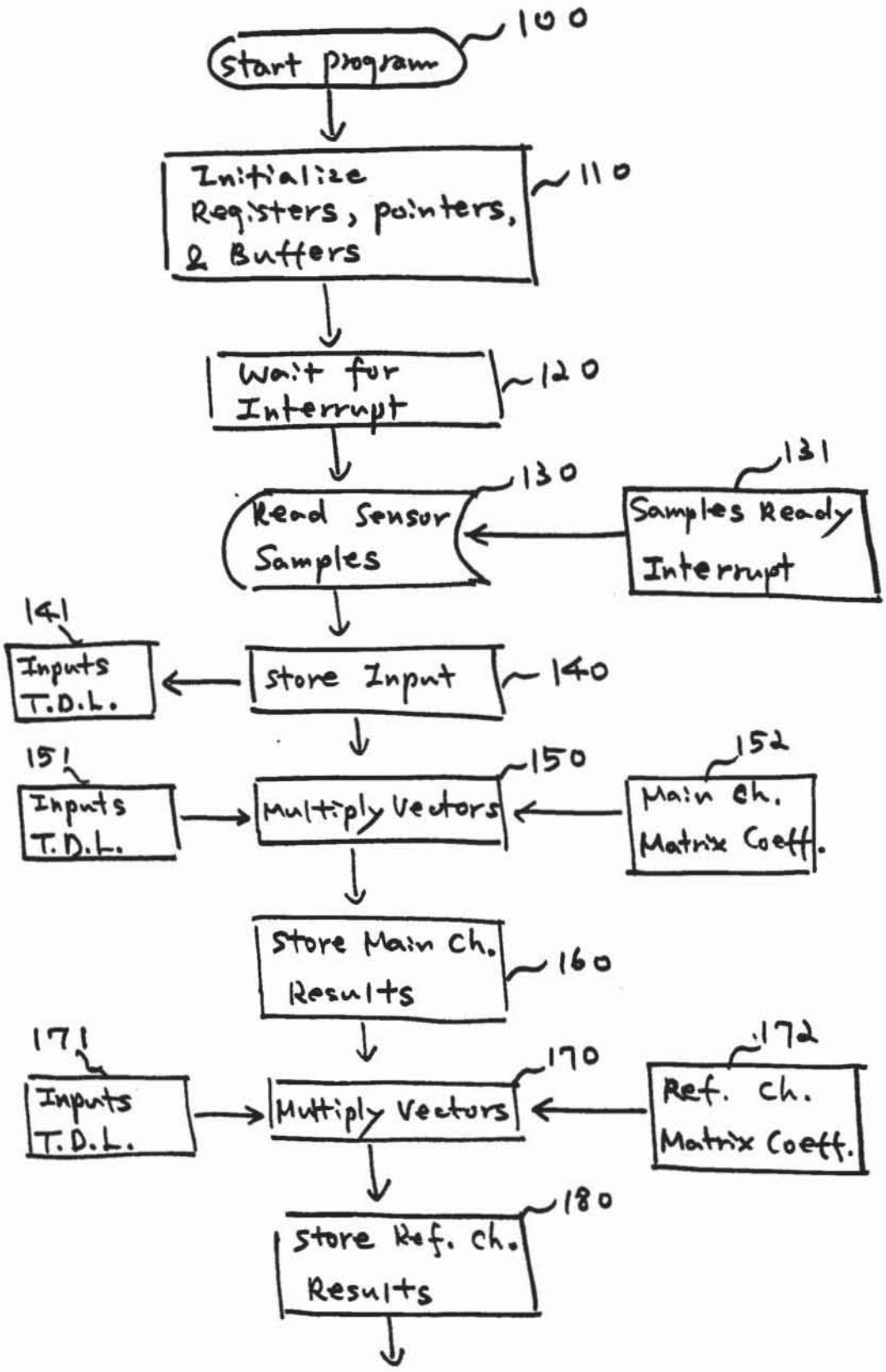
100
Start program
110
Initialize Registers, pointers, & Buffers
120
Wait for Interrupt
130
Read Sensor Samples
131
Samples Ready Interrupt
140
Store Input
141
Inputs T.D.L.
150
Multiply Vectors
151
Inputs T.D.L.
152
Main Ch. Matrix Coeff.
160
Store Main Ch. Results
170
Multiply Vectors
171
Inputs T.D.L.
172
Ref. Ch. Matrix Coeff.
180
Store Ref. Ch. Results

FIG. 11A

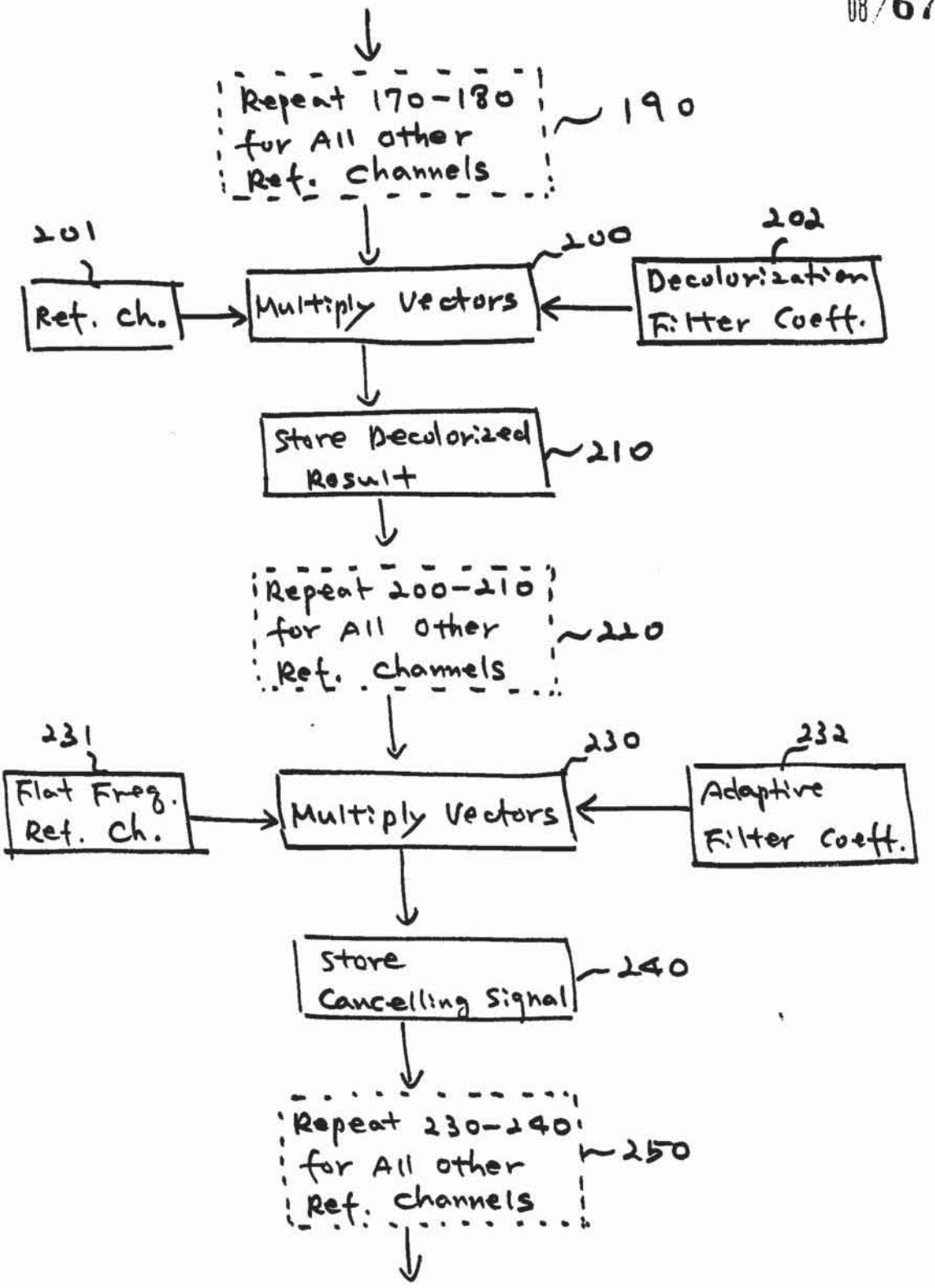

FIG. 11B (continued)

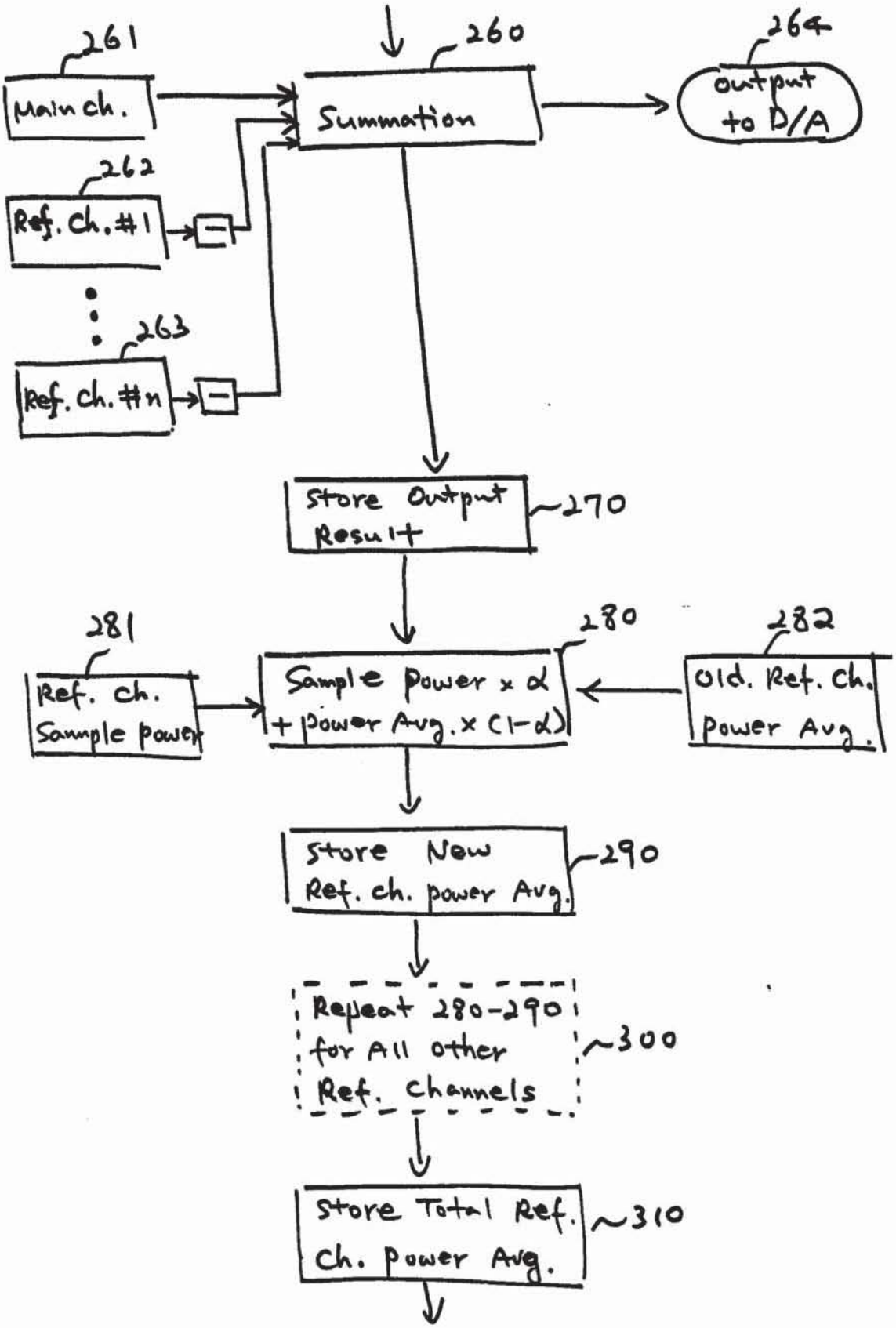

FIG. 11C (continued)

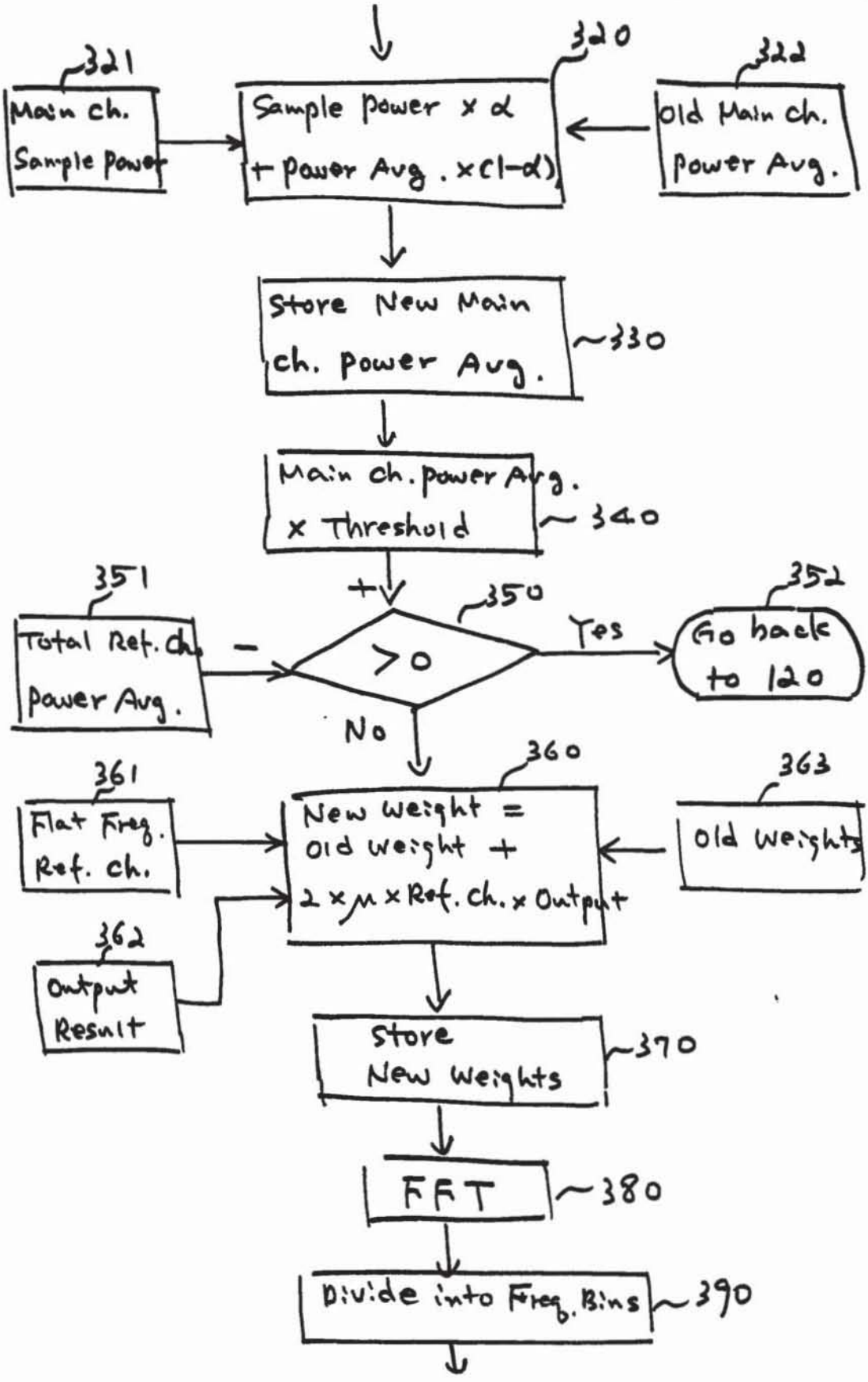

FIG. 11D (continued)

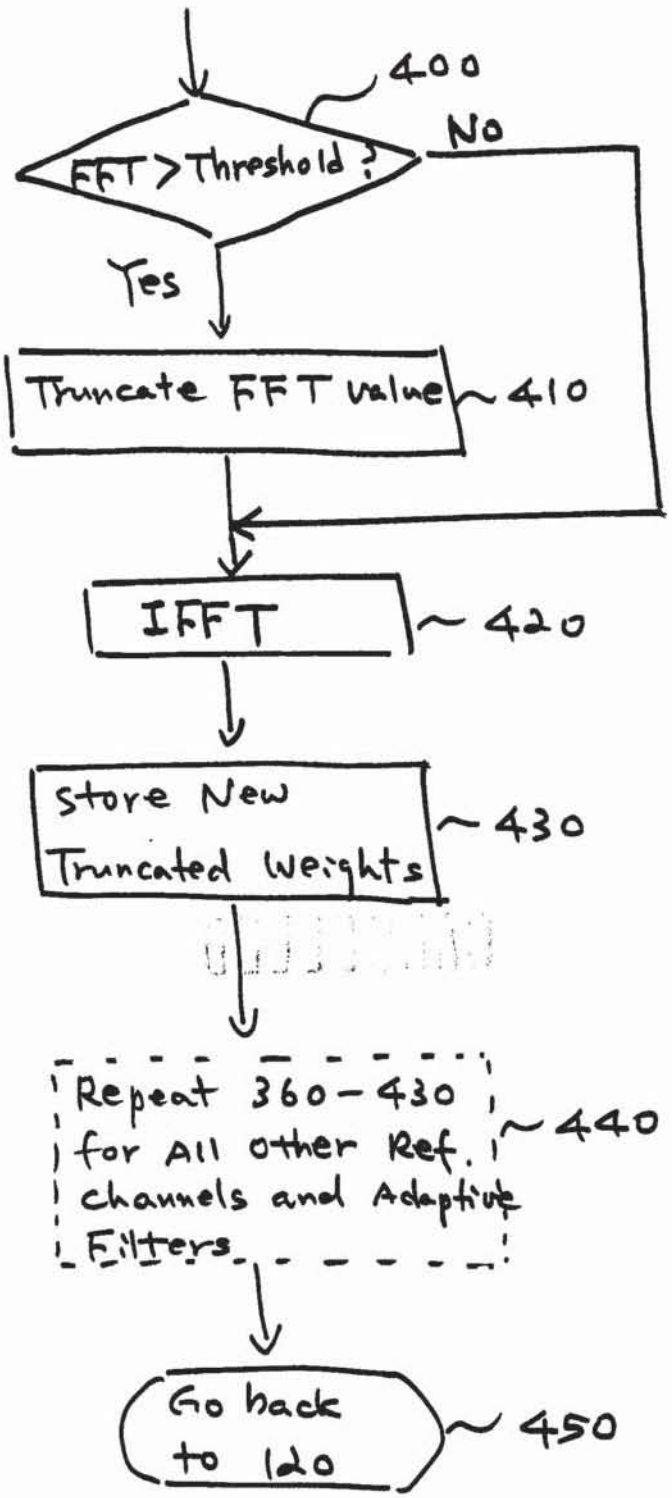

FIG. 11E (Continued)

GP 2743

Express Mail No.: EM 490 490 460 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

MARASH, Joseph

Serial No.: 08/672,899 Group Art Unit: 2743

Filed: June 27, 1996 Examiner: Nguyen, D.

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING Attorney Docket No.: 8797-0003

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Pursuant to Applicant's duty of disclosure under 37 C.F.R. § 1.56, Applicant encloses copies of references for the Examiner's review and consideration. These references are listed on the enclosed PTO Form 1449, and were discovered by applicant not more than three months prior to the filing of this Supplemental Information Disclosure Statement.

It is respectfully requested that these references be made of record in this application by the Examiner's completion and return of the attached PTO Form 1449.

This Information Disclosure Statement is submitted under 37 C.F.R. § 1.97(c), after a First Office Action, but before a Final Office Action or a Notice of Allowance. It is estimated that no fee is due for this Information Disclosure Statement; however, the required fee for the accompanying petition and certification under 37 C.F.R. 1.97(c), estimated to be $240.00, is submitted concurrently with that document. Please charge the required fee, if any, for this Information Disclosure Statement to Pennie & Edmonds LLP Deposit Account No. 16-1150. A copy of this sheet is attached for accounting purposes.

This Supplemental Information Disclosure Statement should not be deemed a response to the Office Action dated January 12, 1998, a response to which is intended to be filed in due course.

Respectfully submitted,

Chung K. Ko P-42,753

Date April 10, 1998

for Barry Rein 22,411

Barry D. Rein (Reg. No.)

PENNIE & EDMONDS LLP
1155 Avenue of the Americas
New York, New York 10036-2711

(212) 790-9090

Express Mail No.: EM 490 490 460 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

MARASH, Joseph

Serial No.: 08/672,899

Group Art Unit: 2743

Filed: June 27, 1996

Examiner: Nguyen, D.

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

Attorney Docket No.: 8797-0003

PETITION UNDER 37 C.F.R. § 1.97(c) AND CERTIFICATION UNDER 37 C.F.R. § 1.97 (e)(2)

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicant hereby petitions under 37 C.F.R. § 1.97(c) for the consideration of the attached Supplemental Information Disclosure Statement, which is being submitted prior to the receipt of a Final Office Action for the above-identified application.

Applicant's attorneys hereby certify pursuant to 37 C.F.R. § 1.97(e)(2) that the references in the Information Disclosure Statement filed concurrently herewith were discovered by applicant not more than three months prior to the filing of the attached Supplemental Information Disclosure Statement.

Applicant respectfully requests that this petition be granted, and that the Information Disclosure Statement be considered.

The fee required for the filing of this petition is estimated to be $240.00. Please charge the required fee to Pennie & Edmonds LLP Deposit Account No. 16-1150. A copy of this sheet is attached for accounting purposes.

Respectfully submitted,

Date April 10, 1998

chung K. Ko P-42,753
for Barry Rein 22,411
Barry D. Rein (Reg. No.)

PENNIE & EDMONDS LLP
1155 Avenue of the Americas
New York, New York 10036-2711

(212) 790-9090

ATTY. DOCKET NO.	APPLICATION NO.
8797-0003-999	08/672,899
APPLICANT	
MARASH, Joseph	
FILING DATE	GROUP
June 27, 1996	2743

LIST OF REFERENCES CITED BY APPLICANT

(Use several sheets if necessary)

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	4,589,137	5/13/86	Miller			
DN	AB	4,628,529	12/9/86	Borth et al.			
DN	AC	4,653,102	3/24/87	Hansen			
DN	AD	4,731,850	3/15/88	Levitt et al.			
DN	AE	4,769,847	9/6/88	Taguchi			
DN	AF	4,932,063	6/5/90	Nakamura			
DN	AG	4,965,834	10/23/90	Miller			
DN	AH	5,192,918	5/9/93	Sugiyama			
DN	AI	5,241,692	8/31/93	Harrison et al.			
DN	AJ	5,319,736	6/7/94	Hunt			
DN	AK	5,353,376	10/4/94	Oh et al.			
DN	AL	5,381,473	6/10/95	Andrea et al.			
DN	AM	5,412,735	5/2/95	Engebretson et al.			
DN	AN	5,473,701	12/5/95	Cezanne et al.			
DN	AO	5,473,702	12/5/95	Yoshida et al.			
DN	AP	5,515,378	5/7/96	Roy, III et al.			
DN	AQ	5,524,057	6/4/96	Akiho et al.			
DN	AR	5,592,490	1/7/97	Barratt et al.			
DN	AS	5,625,880	4/29/97	Goldburg et al.			
DN	AT	5,642,353	6/24/97	Roy, III et al.			
DN	AU	5,644,641	7/1/97	Ikeda			
DN	AV	5,668,747	9/16/97	Obashi			
DN	AW	5,673,325	9/30/97	Andrea et al.			

DV	AX	5,689,572	11/18/97	Ohki et al.			
DV	AY	5,727,933	3/10/98	Ikeda			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
DV	AZ	EP B 0,411,360		DE FR GB IT SE				
DV	BA	WO-A-97/23068		CN JP KR EP				
	BB							
	BC							
	BD							

OTHER REFERENCES (*Including Author, Title, Date, Pertinent Pages, Etc.*)

	BE	
	BF	
	BG	

EXAMINER	DATE CONSIDERED
D. Nguyen	7/13/98

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with **MPEP 609**; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

GAU 2743

#8
S Cutter
4-17-98

Express Mail No.: EM 490 490 495 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

MARASH, Joseph

Serial No.: 08/672,899 Group Art Unit: 2743

Filed: June 27, 1996 Examiner: Nguyen, D.

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING Attorney Docket No.: 8797-0003

SECOND SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Pursuant to Applicant's continuing duty of disclosure under 37 C.F.R. § 1.56, Applicant encloses copies of references for the Examiner's review and consideration. These references are listed on the enclosed PTO Form 1449, and were cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Second Supplemental Information Disclosure Statement.

It is respectfully requested that these references be made of record in this application by the Examiner's completion and return of the attached PTO Form 1449.

This Information Disclosure Statement is submitted under 37 C.F.R. § 1.97(c), after a First Office Action, but before a Final Office Action or Notice of Allowance. It is estimated that no fee is due for this Information Disclosure Statement; however, the required fee for the accompanying petition and certification under 37 C.F.R. 1.97(c), estimated to be $240.00, is submitted concurrently with that document. Please charge the required fee, if any, for this Information Disclosure Statement to Pennie

& Edmonds LLP Deposit Account No. 16-1150. A copy of this sheet is attached for accounting purposes.

This Second Supplemental Information Disclosure Statement should not be deemed a response to the Office Action dated January 12, 1998, a response to which is intended to be filed in due course.

Date April 14, 1998

Chung K. Ko P-42,753
for Barry Rein 22,411
Barry D. Rein (Reg. No.)

PENNIE & EDMONDS LLP
1155 Avenue of the Americas
New York, New York 10036-2711

(212) 790-9090

Express Mail No.: EM 490 490 495 US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

MARASH, Joseph

Serial No.: 08/672,899

Group Art Unit: 2743

Filed: June 27, 1996

Examiner: Nguyen, D.

For: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

Attorney Docket No.: 8797-0003

PETITION UNDER 37 C.F.R. § 1.97(c) AND CERTIFICATION UNDER 37 C.F.R. § 1.97 (e)(1)

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicant hereby petitions under 37 C.F.R. § 1.97(c) for the consideration of the attached Second Supplemental Information Disclosure Statement, which is being submitted prior to the receipt of a Final Office Action for the above-identified application.

Applicant's attorneys hereby certify pursuant to 37 C.F.R. § 1.97(e)(1) that the references in the Information Disclosure Statement filed concurrently herewith were cited in a communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this Second Supplemental Information Disclosure Statement. In particular, the listed references were cited in an International Search Report mailed January 15, 1998, for a corresponding international application filed under the Patent Cooperation Treaty.

Applicant respectfully requests that this petition be granted, and that the Information Disclosure Statement be considered.

The fee required for the filing of this petition is estimated to be $240.00. Please charge the required fee to Pennie & Edmonds LLP Deposit Account No. 16-1150. A copy of this sheet is attached for accounting purposes.

Respectfully submitted,

Chung K. Ko P-42,753
for Barry Rein

Date April 14, 1998

Barry D. Rein 22,411
(Reg. No.)

PENNIE & EDMONDS LLP
1155 Avenue of the Americas
New York, New York 10036-2711

(212) 790-9090

LIST OF REFERENCES CITED BY APPLICANT

(Use several sheets if necessary)

ATTY. DOCKET NO.	SERIAL NO.
8797-0003-999	08/672,899
APPLICANT	
MARASH, Joseph	
FILING DATE	**GROUP**
June 27, 1996	2743

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	5,416,845	5/16/95	Shen			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
DN	AB	EP 0 483 845 A2	published 05/06/92	DE FR GB NL				

OTHER REFERENCES (*Including Author, Title, Date, Pertinent Pages, Etc.*)

EXAMINER	DATE CONSIDERED
D. Nguyen	7/13/98

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with **MPEP 609**; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PATENT
670025-7002.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Joseph Marash
Appln. Serial No.	:	08/672,899
Filed	:	June 27, 1996
For	:	**SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING**

745 Fifth Avenue
New York, New York 10151

EXPRESS MAIL
Mailing Label Number EH067270485US
Date of Deposit May 21, 1998
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

HOWARD CUTLER
(Typed or printed name of person mailing paper or fee)

Howard Cutler
(Signature of person mailing paper or fee)

POWER OF ATTORNEY BY ASSIGNEE OF ENTIRE INTEREST AND REVOCATION OF PRIOR POWERS

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

LAMAR SIGNAL PROCESSING, LTD., as owner of the entire right, title and interest in, to and under the above-identified patent application, hereby revokes all powers of attorney previously given and appoints the following attorneys, with full power of association, revocation and appointment, to prosecute and transact all business in the Patent and Trademark Office in connection therewith, including to receive the Letters Patent:

PATENT
670025-7002.1

Thomas J. Kowalski Reg. No. 32,147

I. Marc Asperas Reg. No. 37,274

Please send all correspondence relating to the above patent application to:

Thomas J. Kowalski, Esq.
FROMMER LAWRENCE & HAUG LLP
745 Fifth Avenue
New York, New York 10151

(212) 588-0800 - Telephone
(212) 588-0500 - Telefax

Pursuant to 37 C.F.R. §3.73, the undersigned signatory (whose titled is supplied below) states that he is empowered to act on behalf of the assignee identified above, and has reviewed all the documents in the chain of title of the patent application and, to the best of undersigned's knowledge and belief, title is in the assignee, and certifies that LAMAR SIGNAL PROCESSING, LTD. is the assignee of the entire right, title and interest in, to and under the patent application, by virtue of an assignment from the inventor to LAMAR SIGNAL PROCESSING, LTD. recorded in the United States Patent and Trademark Office.

The undersigned hereby declares that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements

may jeopardize the validity of the application or any patent issuing thereon.

LAMAR SIGNAL PROCESSING, LTD.

By: Joseph Mark
Title: President

Date: 5/21/98

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NEW YORK NY 10151-0010

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ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, DC 20231

L 670025-7002.1

RTL898_1020-0106

Serial No. 08/672,899 File No. 6700S-7002.1 By TKR/s

Title In the Matter of the Application of JOSEPH HARASH.

The following due _____ in the U.S. Patent Office, was received in the Patent Office

- ☐ Affidavit ☐ Declaration
- ☐ Amendment
- ☐ Preliminary Amendment
- ☐ Amendment After Final Rejection
- ☐ Request for Extension of Time
- ☐ Provisional Patent Application
- ☐ Application for Patent, including ___ Pages Specification ___ Claims
- ☐ Declaration ☐ Oath ☐ Power
- ☐ Request for Filing Continuation or Divisional Application ___ sheets, in duplicate
- ☐ File Wrapper Continuation Patent Application _____ sheets, in duplicate
- ☐ PCT Request _____ sheets, including
- ☐ Transmittal Letter to the US/RO
- ☐ Assignment ☐ Recordation Cover Sheet
- ☐ Express Mail Mailing Certificate (separate sheet)
- ☐ Check No. _____ for $ _____
- ☐ Deposit Account Order Form
- ☐ Drawing ___ Sheet(s)
- ☐ Information Disclosure Statement
- ☐ PTO Form 1449,
- ☐ Issue Fee Transmittal
- ☐ Brief ☐ Letter
- ☐ Application for TM Registration Including _____ Specimens
- ☐ Status Request ☐ Notice of Appeal
- ☐ Petition ☐ Response
- ☐ Priority Document
- ☐ Small Entity Declaration
- ☒ POWER OF ATTORNEY BY ASSIGNEE OF ENTIRE INTEREST AND REVOCATION OF PRIOR POWERS

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EH067127048US 5/21/98

RTL898_1020-0107

PATENT
670025-7002.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Joseph Marash
Appln. Serial No.	:	08/672,899
Filed	:	June 27, 1996
For	:	SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

745 Fifth Avenue
New York, New York 10151

EXPRESS MAIL
Mailing Label Number EH067270485US
Date of Deposit May 27, 1998
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

HOWARD CUTLER
(Typed or printed name of person mailing paper or fee)

Howard Cutler
(Signature of person mailing paper or fee)

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Assistant Commissioner for Patents
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PATENT
670025-7002.1

Thomas J. Kowalski Reg. No. 32,147

I. Marc Asperas Reg. No. 37,274

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New York, New York 10151

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(212) 588-0500 - Telefax

Pursuant to 37 C.F.R. §3.73, the undersigned signatory (whose titled is supplied below) states that he is empowered to act on behalf of the assignee identified above, and has reviewed all the documents in the chain of title of the patent application and, to the best of undersigned's knowledge and belief, title is in the assignee, and certifies that LAMAR SIGNAL PROCESSING, LTD. is the assignee of the entire right, title and interest in, to and under the patent application, by virtue of an assignment from the inventor to LAMAR SIGNAL PROCESSING, LTD. recorded in the United States Patent and Trademark Office.

The undersigned hereby declares that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements

may jeopardize the validity of the application or any patent issuing thereon.

LAMAR SIGNAL PROCESSING, LTD.

By: Joseph Mark
Title: President

Date: 5/21/91

9/2/Prin Art Statement

PATENT
670025-7002.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Joseph Marash
U.S. Serial No.	:	08/672,899
Filing Date	:	June 27, 1996
Examiner	:	D. Nguyen
Art Unit	:	2743
Title of Invention	:	**SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING**

745 Fifth Avenue
New York, NY 10151
May 29, 1998

INFORMATION DISCLOSURE STATEMENT

Hon. Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

Sir:

The Examiner's attention is respectfully directed to the following documents:

1. U.S. Patent No. 4,589,137 dated May 13, 1986;
2. U.S. Patent No. 4,628,529 dated December 9, 1986;
3. U.S. Patent No. 4,653,102 dated March 24, 1987;
4. U.S. Patent No. 4,658,426 dated April 14, 1987;
5. U.S. Patent No. 4,731,850 dated March 15, 1988;
6. U.S. Patent No. 4,769,847 dated September 6, 1988;
7. U.S. Patent No. 4,802,227 dated January 31, 1989;
8. U.S. Patent No. 4,811,404 dated March 7, 1989;

9. U.S. Patent No. 4,932,063 dated June 5, 1990;

10. U.S. Patent No. 4,956,867 dated September 11, 1990;

11. U.S. Patent No. 5,192,918 dated March 9, 1993;

12. U.S. Patent No. 4,965,834 dated October 23, 1990;

13. U.S. Patent No. 5,241,692 dated August 31, 1993;

14. U.S. Patent No. 5,412,735 dated May 2, 1995;

15. U.S. Patent No. 5,416,847 dated May 16, 1995;

16. U.S. Patent No. 5,473,701 dated December 5, 1995;

17. U.S. Patent No. 5,473,702 dated December 5, 1995;

18. U.S. Patent No. 5,524,057 dated June 4, 1996;

19. U.S. Patent No. 5,627,799 dated May 6, 1997;

20. U.S. Patent No. 5,644,641 dated July 1, 1997;

21. U.S. Patent No. 5,673,325 dated September 30, 1997;

22. U.S. Patent No. 5,381,473 dated January 10, 1995;

23. U.S. Patent No. 5,689,572 dated November 18, 1997;

24. U.S. Patent No. 5,727,073 dated March 10, 1998;

25. U.S. Patent No. 5,353,376 dated October 4, 1994;

26. U.S. Patent No. 5,319,736 dated June 7, 1994;

27. European Patent No. 0411360 B1 dated February 6, 1991;

28. U.S. Patent No. 5,668,747 dated September 16, 1997;

29. International Patent No. WO 97/23068 dated June 26, 1997;

30. U.S. Patent No. 4,363,007 dated December 7, 1982;

31. U.S. Patent No. 4,409,435 dated October 11, 1983;

32. U.S. Patent No. 4,442,546 dated April 10, 1984;

33. U.S. Patent No. 4,495,643 dated January 22, 1985;

34. U.S. Patent No. 4,517,415 dated May 14, 1985;

35. U.S. Patent No. 4,622,692 dated November 11, 1986;

36. U.S. Patent No. 4,750,207 dated June 7, 1988;

37. U.S. Patent No. 5,432,859 dated July 11, 1995;

38. U.S. Patent No. 5,485,515 dated January 16, 1996;

39. U.S. Patent No. 5,524,056 dated June 4, 1996;

40. U.S. Patent No. 5,701,344 dated December 23, 1997;

41. U.S. Patent No. 5,592,181 dated January 7, 1997;

42. U.S. Patent No. 5,335,011 dated August 2, 1994;

43. U.S. Patent No. 5,075,694 dated December 24, 1991;

44. International Patent No. WO 88/09512 dated December 1, 1988;

45. U.S. Patent No. 4,910,718 dated March 20, 1990;

46. International Patent No. WO 94/16517 dated July 21, 1994;

47. U.S. Patent No. 4,559,642 dated December 17, 1985;

48. U.S. Patent No. 4,581,758 dated April 8, 1986;

49. U.S. Patent No. 4,653,606 dated March 31, 1987;

50. U.S. Patent No. 4,696,043 dated September 22, 1987;

51. U.S. Patent No. 4,741,038 dated April 26, 1988;

52. U.S. Patent No. 4,910,719 dated March 20, 1990;

53. U.S. Patent No. 5,086,415 dated February 4, 1992;

54. U.S. Patent No. 5,208,864 dated May 4, 1993;

55. U.S. Patent No. 5,511,128 dated April 23, 1996;

56. U.S. Patent No. 5,581,620 dated December 3, 1996;

57. U.S. Patent No. 5,615,175 dated March 25, 1997;

58. U.S. Patent No. 5,625,697 dated April 29, 1997;

59. U.S. Patent No. 5,657,393 dated August 12, 1997;

60. U.S. Patent No. 5,664,021 dated September 2, 1997;

61. U.S. Patent No. 5,715,319 dated February 3, 1998;

62. U.S. Patent No. 4,459,851 dated July 17, 1984;

63. European Patent No. 0059745 B1 dated September 15, 1982;

64. British Patent No. 2,239,971 B dated July 17, 1991;

65. U.S. Patent No. 5,642,353 dated June 24, 1997;

66. U.S. Patent No. 5,625,880 dated April 29, 1997;

67. U.S. Patent No. 5,592,490 dated January 7, 1997;

68. U.S. Patent No. 5,546,090 dated August 13, 1996;

69. U.S. Patent No. 5,515,378 dated May 7, 1996;

70. Japanese Patent No. 4-16900 dated January 21, 1992;

71. Japanese Patent No. 1-149695 dated June 12, 1989;

72. U.S. Patent No. 4,937,871 dated June 26, 1990;

73. U.S. Patent No. 4,239,936 dated December 16, 1980;

74. U.S. Patent No. 4,718,096 dated January 5, 1988;

75. U.S. Patent No. 5,142,585 dated August 25, 1992;

76. U.S. Patent No. 5,208,864 dated May 4, 1993;

77. U.S. Patent No. 5,212,764 dated May 18, 1993;

78. U.S. Patent No. 5,313,555 dated May 17, 1994;

79. U.S. Patent No. 5,416,887 dated May 16, 1995;

80. European Appln. No. 88908903.3 dated April 16, 1997.

90. "Beamforming, a versatile approach to spacial filtering," IEEE ASSN Magazine, April 1988, Vol. 5, No. 2, pp.4-24.

91. Sewald et al., "Application of...Beamforming to Reject Turbulence Noise in Airducts," 1996 IEEE International Conference on Acoustics, Speech and Signal Processing Proceedings (ICASSP), May 7-16, 1996, Vol. 5, No. CONF-21, May 7, 1996, IEEE pp. 2734-37.

92. European Patent Number 0724415 dated 11/20/96.

93. European Patent Number 0483845 dated 1/13/93.

94. European Patent Number 0721251 dated 7/10/96.

95. U.S. Patent No. 5,416,845 dated 5/16/95.

A copy of all of the foregoing documents is enclosed.

The Examiner is respectfully requested to consider and make of record, the documents cited herein.

It is hereby certified pursuant to 37 C.F.R. §1.97(c) and (e) to the best of the underigned's knowledge and belief that the documents cited herein (some were cited by a foreign patent office, others from other sources) were called to the undersigned's and thus Applicant's and Applicant's assignees attention within three (3) months of the date of this paper. Thus, no fee should be due for consideration and making of record the documents cited herein.

Entry of this Information Disclosure Statement and an early examination on the merits are respectfully solicited.

PATENT
670025-7002.1

This Information Disclosure Statement is not a representation that any of the cited documents are considered pertinent, or that any of the cited documents are indeed prior art. Rather, this paper merely discloses documents cited to the undersigned (and thus to the Applicant and Applicant's assignee) for the Examiner's convenience and to make them of record. The cited documents are not believed to impact upon patentability. Note particularly those documents whose 102(e) dates do not predate the instant application's filing date. It is requested, however, that the Examiner consider each of the cited documents and make them of record.

Please charge any additional fees or credit any overpayment therein to Deposit Account No. 50-0320.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicants

Date: May 29, 1998

By _____
Thomas J. Kowalski
Reg. No. 32,147
I. Marc Asperas
Reg. No. 37,274
Tel. (212) 588-0800

IMA/ep
Encs.

j:\pearce\andrea\7002-1.ids

Based on Form PTO-1449 (3/90)	ATTORNEY DOCKET NO. 670025-7002.1	SERIAL NO. 08/672,899
LIST OF REFERENCES CITED BY APPLICANTS (Use several sheets if necessary)	APPLICANT: JOSEPH MARASH	
	FILING DATE: June 27, 1996	GROUP

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	4,589,137	5/13/86	Miller			
DN	AB	4,628,529	12/9/86	Borth et al.			
DN	AC	4,653,102	3/24/87	Hansen			
DN	AD	4,658,426	4/14/87	Chabries et al.			
DN	AE	4,731,850	3/15/88	Levitt et al.			
DN	AF	4,769,847	9/6/88	Taguchi			
DN	AG	4,802,227	1/31/89	Elko et al.			
DN	AH	4,811,404	3/7/89	Vilmur et al.			
DN	AI	4,932,063	6/5/90	Nakamura			
DN	AJ	4,956,867	9/11/90	Zarek et al.			
DN	AK	5,192,918	3/9/93	Sugiyama			
DN	AL	4,965,834	10/23/90	Miller			
DN	AM	5,241,692	8/31/93	Harrison et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
							YES	NO
DN	AN	0411360 B1	2/6/91	EPO				
DN	AO	WO 97/23068	6/26/97	WIPO				
DN	AP	WO 88/09512	12/1/88	WIPO				
DN	AQ	WO 94/16517	7/21/94	WIPO				
DN	AR	0059745 B1	9/15/82	EPO				
DN	AS	2,239,971 B	7/17/91	Great Britain				

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

DN	AT		"Beamforming, a versatile approach to spacial filtering," IEEE ASSN Magazine, April 1988, Vol. 5, No. 2, pp.4-24.
			1

EXAMINER	D. Nguyen	DATE CONSIDERED	7/13/98

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

USCOMM-DC 80-3995

Based on Form PTO-1449 (3/90)	ATTORNEY DOCKET NO. 670025-7002.1	SERIAL NO. 08/672,899
LIST OF REFERENCES CITED BY APPLICANTS (Use several sheets if necessary)	APPLICANT: JOSEPH MARASH	
	FILING DATE: June 27, 1996	GROUP

U.S. PATENT DOCUMENTS

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DN	AA	5,412,735	5/2/95	Engebretson et al.			
DN	AB	5,416,847	5/16/95	Boze			
DN	AC	5,473,701	12/5/95	Cezanne et al.			
DN	AD	5,473,702	12/5/95	Yoshida et al.			
DN	AE	5,524,057	6/4/96	Akiho et al.			
DN	AF	5,627,799	5/6/97	Hoshuyama			
DN	AG	5,644,641	7/1/97	Ikeda			
DN	AH	5,673,325	9/30/97	Andrea et al.			
DN	AI	5,381,473	1/10/95	Andrea et al.			
DN	AJ	5,689,572	11/18/97	Ohki et al.			
DN	AK	5,727,073	3/10/98	Ikeda			
DN	AL	5,353,376	10/4/94	Oh et al.			
DN	AM	5,319,736	6/7/94	Hunt			
DN	AN	5,668,747	9/16/97	Ohashi			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
DN	AO	4-16900	1/21/92	Japan				
DN	AP	1-149695	6/12/89	Japan				
DN	AQ	88908903.3	4/16/97	EPO				
	AR							
	AS							

OTHER REEFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

DN	AT		Sewald et al., "Application of...Beamforming to Reject Turbulence Noise in Airducts," 1996 IEEE International Conference on Acoustics, Speech and Signal Processing Proceedings (ICASSP), May 7-16, 1996, Vol. 5, No. CONF-21, May 7, 1996, IEEE pp. 2734-37.

EXAMINER	D. Nguyen	DATE CONSIDERED	7/13/98

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

USCOMM-DC 80-3995

RTL898_1020-0118

Based on Form PTO-1449 (3/90)	ATTORNEY DOCKET NO. 670025-7002.1	SERIAL NO. 08/672,899
LIST OF REFERENCES CITED BY APPLICANTS (Use several sheets if necessary)	APPLICANT: JOSEPH MARASH	
	FILING DATE: June 27, 1996	GROUP

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	4,363,007	12/7/82	Haramoto et al.			
DN	AB	4,409,435	10/11/83	Ono			
DN	AC	4,442,546	4/10/84	Ishigaki			
DN	AD	4,495,643	1/22/85	Orban			
DN	AE	4,517,415	5/14/85	Laurence			
DN	AF	4,622,692	11/11/86	Cole			
DN	AG	4,750,207	6/7/88	Gebert et al.			
DN	AH	5,432,859	7/11/95	Yang et al.			
DN	AI	5,485,515	1/16/96	Allen et al.			
DN	AJ	5,524,056	6/4/96	Killion et al.			
DN	AK	5,701,344	12/23/97	Wakui			
DN	AL	5,592,181	1/7/97	Cai et al.			
DN	AM	5,335,011	8/2/94	Addeo et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
DN	AN	0724415	11/20/96	EPO				
DN	AO	0483845	1/13/93	EPO				
DN	AP	0721251	7/10/96	EPO				
	AQ							
	AR							
	AS							

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	AT		

EXAMINER	DATE CONSIDERED
D. Nguyen	7/13/98

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

USCOMM-DC 80-3995

Based on Form PTO-1449 (3/90)	ATTORNEY DOCKET NO. 670025-7002.1	SERIAL NO. 08/672,899
LIST OF REFERENCES CITED BY APPLICANTS (Use several sheets if necessary)	APPLICANT: JOSEPH MARASH	
	FILING DATE: June 27, 1996	GROUP

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	5,075,694	12/24/91	Donnangelo et al.			
DN	AB	4,910,718	3/20/90	Horn			
DN	AC	4,559,642	12/17/85	Miyaji et al.			
DN	AD	4,581,758	4/8/86	Coker et al.			
DN	AE	4,653,606	3/31/87	Flanagan			
DN	AF	4,696,043	9/22/87	Iwahara et al.			
DN	AG	4,741,038	4/26/88	Elko et al.			
DN	AH	4,910,719	3/20/90	Thubert			
DN	AI	5,086,415	2/4/92	Takahashi et al.			
DN	AJ	5,208,864	5/4/93	Kaneda			
DN	AK	5,511,128	4/23/96	Lindemann			
DN	AL	5,581,620	12/3/96	Brandstein et al.			
DN	AM	5,615,175	3/25/97	Cater et al.			
DN	AN	5,625,697	4/29/97	Bowen et al.			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION	
							YES	NO
	AO							
	AP							
	AQ							
	AR							
	AS							

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	AT		

EXAMINER	DATE CONSIDERED
D. Nguyen	7/13/98

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

USCOMM-DC 80-3995

Based on Form PTO-1449 (3/90)	ATTORNEY DOCKET NO. 670025-7002.1	SERIAL NO. 08/672.899
LIST OF REFERENCES CITED BY APPLICANTS (Use several sheets if necessary)	APPLICANT: JOSEPH MARASH	
	FILING DATE: June 27, 1996	GROUP

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
DN	AA	5,657,393	8/12/97	Crow			
DN	AB	5,664,021	9/2/97	Chu et al.			
DN	AC	5,715,319	2/3/98	Chu			
DN	AD	4,459,851	7/17/84	Crostack			
DN	AE	5,642,353	6/24/97	Roy, III et al.			
DN	AF	5,625,880	4/29/97	Goldburg et al.			
DN	AG	5,592,490	1/7/97	Barratt et al.			
DN	AH	5,546,090	8/13/96	Roy III et al.			
DN	AI	5,515,378	5/7/96	Roy, III et al.			
DN	AJ	4,937,871	6/26/90	Hattori			
DN	AK	4,239,936	12/16/80	Sakoe			
DN	AL	4,718,096	1/5/88	Meisel			
DN	AM	5,142,585	8/25/92	Taylor			
DN	AN	5,208,864	5/4/93	Kaneda			
DN	AO	5,212,764	5/18/93	Ariyoshi			
DN	AP	5,313,555	5/17/94	Kamiya			
DN	AQ	5,416,887	5/16/95	Shimada			
DN	AR	5,416,845	5/16/95	Shen			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO
	AS							

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

	AT		

EXAMINER	D. Nguyen	DATE CONSIDERED	7/13/98

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

USCOMM-DC 80-3995

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/672899	06/27/96	MARASH	8797-003

EXAMINER	
NGUYEN, DUC	
ART UNIT	PAPER NUMBER
2743	10

DATE MAILED: 06/11/98

PENNIE AND EDMONDS
1155 AVENUE OF THE AMERICAS
NEW YORK NY 10036-2711

This is in response to the Power of Attorney filed 05/21/98.

☑ 1. The Power of Attorney to you in this application **has been revoked** by the applicant. Future correspondence will be mailed to the new address of record. 37 CFR 1.33.

☐ 2. The Power of Attorney to you in this application **has been revoked** by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record. (37 CFR 1.33).

☐ 3. The withdrawal as attorney in this application **has been accepted**. Future correspondence will be mailed to the new address of record. 37 CFR 1.33.

Kirk Watson 7033064139
This is a communication from the
Patent and Trademark Office

☒ 4. The Power of Attorney in this application **is accepted**. Correspondence in this application will be mailed to the below-noted address as provided by 37 CFR 1.33.

☐ 5. The Power of Attorney in this application **is not accepted** for the reason(s) checked below:

- ☐ a. The Power of Attorney is from an assignee and the Certificate required by 37 CFR 3.73 (b) has not been received.
- ☐ b. The person signing for the assignee has omitted their empowerment to sign on behalf of the assignee.
- ☐ c. The inventor(s) is without authority to appoint attorneys since the assignee has intervened as provided by 37 CFR 3.71.
- ☐ d. The signature of _____, a co-inventor in this application, has been omitted. The Power of Attorney will be entered upon receipt of confirmation signed by said co-inventor.
- ☐ e. The person(s) appointed in the Power of Attorney is not registered to practice before the U. S. Patent & Trademark Office.
- ☐ f. The revocation is not signed by the applicant, the assignee of the entire interest, or **one** particular principal attorney having the authority to revoke.

THOMAS J KOWALSKI ESQ
FROMMER LAWRENCE & HAUG LLP
745 FIFTH AVENUE
NEW YORK NY 10151

Kirk Watson
This is a communication from the
Patent and Trademark Office

RTL898 1020-0122

216-$200.00

PATENT
670025-7002.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Joseph Marash
U.S. Serial No.	:	08/672,899
Filing Date	:	June 27, 1996
Examiner	:	D. Nguyen
Art Unit	:	2743
For	:	**SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING**

Received
JUN 0 1 1998
Group 2700

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98 JUN -8 AM 11:47
GROUP 2700

745 Fifth Avenue
New York, NY 10151
May 29, 1998

AMENDMENT AND CHANGE OF ADDRESS

Hon. Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Responsive to the Office Action which issued on January 12, 1998, please amend the above-referenced application as follows:

06/03/1998 DFLOYD 00000012 08672899
01 FC:216 200.00 OP

TWO MONTH EXTENSION GRANTED
By Direction
Primary Examiner
Clerk, Group 260 Date 6/18/98

IN THE CLAIMS:

Please cancel claims 29-44 without prejudice, admission, or any intention of creating any estoppel as to equivalents.

REMARKS

Applicant acknowledges with appreciation the indication that claims 1-28 are allowed. To expedite this application to allowance, claims 29-44 are canceled without prejudice, admission, or any intention of creating any estoppel as to equivalents.

A copy of the duly executed Power-of-Attorney in favor of the undersigned, which was filed by Express Mail on May 21, 1998, is enclosed with this Amendment for the Examiner's convenience. An Information Disclosure Statement is also enclosed.

A two-month extension of the period for response under 37 C.F.R. Sections 1.136(a) and 1.17(a) is respectfully requested. A check for $200.00 in payment of the fee for the extension is enclosed. Please charge any additional fees or credit any overpayment to Deposit Account No. 50-0320.

Early allowance is earnestly solicited. If any issue remains as an impediment to allowance, an interview is respectfully requested and the Examiner is respectfully

invited to contact the undersigned by telephone to arrange a mutually convenient time and manner therefor.

As a change of address, please direct all future communications to Thomas J. Kowalski at the address and telephone and facsimile numbers below.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP

Attorneys for Applicant

By /I Marc Asperas/

Thomas J. Kowalski
Reg. No. 32,147
I. Marc Asperas
Reg. No. 37,274
FROMMER LAWRENCE & HAUG LLP
745 Fifth Avenue
New York, New York 10151
Tel: (212) 588-0800
Fax: (212) 588-0500

PATENT
670025-7002.1

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Applicant	:	Joseph Marash
Appln. Serial No.	:	08/672,899
Filed	:	June 27, 1996
For	:	SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

745 Fifth Avenue
New York, New York 10151

EXPRESS MAIL
Mailing Label Number EH067270485US
Date of Deposit May 21, 1998
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231,

HOWARD CUTLER
(Typed or printed name of person mailing paper or fee)

Howard Cutler
(Signature of person mailing paper or fee)

POWER OF ATTORNEY BY ASSIGNEE OF ENTIRE INTEREST AND REVOCATION OF PRIOR POWERS

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

LAMAR SIGNAL PROCESSING, LTD., as owner of the entire right, title and interest in, to and under the above-identified patent application, hereby revokes all powers of attorney previously given and appoints the following attorneys, with full power of association, revocation and appointment, to prosecute and transact all business in the Patent and Trademark Office in connection therewith, including to receive the Letters Patent:

PATENT
670025-7002.1

Thomas J. Kowalski Reg. No. 32,147

I. Marc Asperas Reg. No. 37,274

Please send all correspondence relating to the above patent application to:

Thomas J. Kowalski, Esq.
FROMMER LAWRENCE & HAUG LLP
745 Fifth Avenue
New York, New York 10151

(212) 588-0800 - Telephone
(212) 588-0500 - Telefax

Pursuant to 37 C.F.R. §3.73, the undersigned signatory (whose titled is supplied below) states that he is empowered to act on behalf of the assignee identified above, and has reviewed all the documents in the chain of title of the patent application and, to the best of undersigned's knowledge and belief, title is in the assignee, and certifies that LAMAR SIGNAL PROCESSING, LTD. is the assignee of the entire right, title and interest in, to and under the patent application, by virtue of an assignment from the inventor to LAMAR SIGNAL PROCESSING, LTD. recorded in the United States Patent and Trademark Office.

The undersigned hereby declares that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements

may jeopardize the validity of the application or any patent issuing thereon.

LAMAR SIGNAL PROCESSING, LTD.

By: Joseph Mark
Title: President

Date: 5/21/98

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, DC 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/672,899	06/27/96	MARASH J	8797-003

LM61/0721

THOMAS J KOWALSKI ESQ
FROMMER LAWRENCE & HAUG LLP
745 FIFTH AVENUE
NEW YORK NY 10151

EXAMINER	
NGUYEN, D	

ART UNIT	PAPER NUMBER
2743	12

DATE MAILED: 07/21/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

PTO-90C (REV. 2/95)

1-File Copy

RTL898_1020-0129

Notice of Allowability

Application No.	Applicant(s)
08/672,899	MARASH
Examiner	**Group Art Unit**
Duc Nguyen	2743

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance and Issue Fee Due or other appropriate communication will be mailed in due course.

☒ This communication is responsive to *Amendment filed 6/1/98*.

☒ The allowed claim(s) is/are *1-28*.

☐ The drawings filed on _____ are acceptable.

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE **THREE MONTHS** FROM THE "DATE MAILED" of this Office action. Failure to timely comply will result in ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.

☒ Applicant MUST submit NEW FORMAL DRAWINGS

☐ because the originally filed drawings were declared by applicant to be informal.

☒ including changes required by the Notice of Draftsperson's Patent Drawing Review, PTO-948, attached hereto or to Paper No. *6*.

☐ including changes required by the proposed drawing correction filed on _____, which has been approved by the examiner.

☐ including changes required by the attached Examiner's Amendment/Comment.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the reverse side of the drawings. The drawings should be filed as a separate paper with a transmittal lettter addressed to the Official Draftsperson.

☐ Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Any response to this letter should include, in the upper right hand corner, the APPLICATION NUMBER (SERIES CODE/SERIAL NUMBER). If applicant has received a Notice of Allowance and Issue Fee Due, the ISSUE BATCH NUMBER and DATE of the NOTICE OF ALLOWANCE should also be included.

Attachment(s)

☐ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). *7,8,12*

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

☐ Interview Summary, PTO-413

☐ Examiner's Amendment/Comment

☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material

☒ Examiner's Statement of Reasons for Allowance

CURTIS A. KUNTZ
SUPERVISORY PATENT EXAMINER
GROUP 2700

1. Claims 1-28 are allowed.

2. The following is an examiner's statement of reasons for allowance: the prior art of record (Hoshuyama, Chabries et al., Elko et al. and Boze) fails to teach or suggest an adaptive system for active interference cancellation comprising a sensor array of spatially distributed sensors; a sampling unit; a main channel matrix unit; a reference channel matrix unit; an adaptive filter; a difference unit; and weight constraining means. The prior art of record does not explicitly teach, either individually or in combination, a main channel matrix unit for generating a main channel from the digital input data, the main channel having both a source signal component and an interference signal component; and a reference channel matrix unit for generating at least one reference channel, each reference channel representing signals received in directions other than that of the signal source, as substantially described and connected in independent claims 1, 5, 9, 21.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Duc Nguyen whose telephone number is (703) 308-7527.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mr. Kuntz, can be reached on (703) 305-4708.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to:

(703) 308-9051, (for formal communications intended for entry)

Or:

(703) 305-9508, (for informal or draft communications, please label "PROPOSED" or "DRAFT")

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington. VA., Sixth Floor (Receptionist).

Duc Nguyen

7/13/98

CURTIS A. KUNTZ
SUPERVISORY PATENT EXAMINER
GROUP 2700

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

LM61/0721

THOMAS J KOWALSKI ESQ
FROMMER LAWRENCE & HAUG LLP
745 FIFTH AVENUE
NEW YORK NY 10151

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT	DATE MAILED
08/672,899	06/27/96	028	NGUYEN, D	2743 07/21/98

First Named Applicant	MARASH, JOSEPH

TITLE OF INVENTION: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2 3797-003	381-092.000	G86	UTILITY	YES	$660.00	10/21/98

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the Patent and Trademark Office of the change in status, or
B. If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

A. Pay FEE DUE shown above, or

B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

II. Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give application number and batch number.
Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PATENT AND TRADEMARK OFFICE COPY

PTOL-85 (REV. 10-96) Approved for use through 06/30/99. (0651-0033)

*U.S. GPO: 1998-437-639/80023

RTL898_1020-0133

PART B—ISSUE FEE TRANSMITTAL

Complete and mail this form together with ap[illegible] fees, to: **Box ISSUE FEE**
Assistant Commissioner for Patents
Washington, D.C. 20231

242 - 660.00
561 - 30.00

LSB

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Issue Fee Receipt, the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

THOMAS J KOWALSKI ESQ
FROMMER LAWRENCE & HAUG LLP
745 FIFTH AVENUE
NEW YORK NY 10151

RECEIVED
JUL 23 1998
Publishing Division
13

Note: The certificate of mailing below can only be used for domestic mailings of the Issue Fee Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

Certificate of Mailing

I hereby certify that this Issue Fee Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above on the date indicated below.

Thomas J. Kowalski, Reg. No. 32,147 (Depositor's name)
Thomas J. Kowalski (Signature)
23 July 98 (Date)

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
08/672,899	06/27/96	028	NGUYEN, D	2743	07/21/98

First Named Applicant	MARASH,	JOSEPH

TITLE OF INVENTION: SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
6700025-7002 ~~2-8797-003~~	381-092.000	G86	UTILITY	YES	$660.00	10/21/98

1. Change of correspondence address or indication of " Fee Address" (37 CFR 1.363). Use of PTO form(s) and Customer Number are recommended, but not required.

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47) attached.

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Frommer, Lawrence & Haug, LLP
2 Thomas J. Kowalski
3 I. Marc Asperas

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)
PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropiate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a subsititue for filing an assignment.

(A) NAME OF ASSIGNEE: Lamar Signal Processing Ltd., (a wholly owned subsidiary of Andrea Electronics Corporation)

(B) RESIDENCE: (CITY & STATE OR COUNTRY) Haifa, Isreal

Please check the appropriate assignee category indicated below (will not be printed on the patent)

☐ Individual ☒ corporation or other private group entity ☐ government

4a. The following fees are enclosed (make check payable to Commissioner of Patents and Trademarks):

☒ Issue Fee
☒ Advance Order - # of Copies 10 @ 3.00ea = $30.00
Total = $690.00

4b. The following fees or deficiency in these fees should be charged to:

DEPOSIT ACCOUNT NUMBER _____
(ENCLOSE AN EXTRA COPY OF THIS FORM) Please charge any deficiency to Deposit Account No. 50-032.

☐ Issue Fee
☐ Advance Order - # of Copies _____

The COMMISSIONER OF PATENTS AND TRADEMARKS IS requested to apply the Issue Fee to the application identified above.

(Authorized Signature) Thomas J. Kowalski, Reg. No. 32,147 (Date) 23 July 98

NOTE; The Issue Fee will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

08/18/1998 CASHBY 00000098 08672899
01 FC:242 660.00 OP
02 FC:561 30.00 OP

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending on the needs of the individual case. Any comments on the amount of time required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND FEES AND THIS FORM TO: Box Issue Fee, Assistant Commissioner for Patents, Washington D.C. 20231

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMIT THIS FORM WITH FEE

RTL898_1020-0134

#13

PATENT
670025-7002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Joseph Marash
Serial No.	:	08/672,899
Filed	:	June 27, 1996
For	:	SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING
Examiner	:	D. Nguyen
Art Unit	:	2743
Batch No.	:	G86

745 Fifth Avenue
New York, New York 10151
Tel. (212) 588-0800

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to:
Assistant Commissioner for Patents
Washington, D.C. 20231, on July 23, 1998

I. Marc Asperas, Reg. No. 37,274
Name of Applicant, Assignee or Registered Representative

Signature

July 23, 1998
Date of Signature

FILING OF FORMAL DRAWINGS

Box Issue Fee
Assistant Commissioner for Patents
Washington, D.C. 20231

Attn: Official Draftsman

Sir:

In accordance with the requirement cited in the Notice of Allowability (PTOL-37, Paper No. 13), Applicant files herewith 15 sheets of formal drawings (Figs. 1-11E) to be made of

record in the present application in place of the original drawings, which incorporate the corrections noted in form PTO-948 attached to Paper No. 6.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicant

By: /Marc Asperas/

I. Marc Asperas
Reg. No. 37,274
Tel. (212) 588-0800

ANDREA.7\7002.DWG

5825898

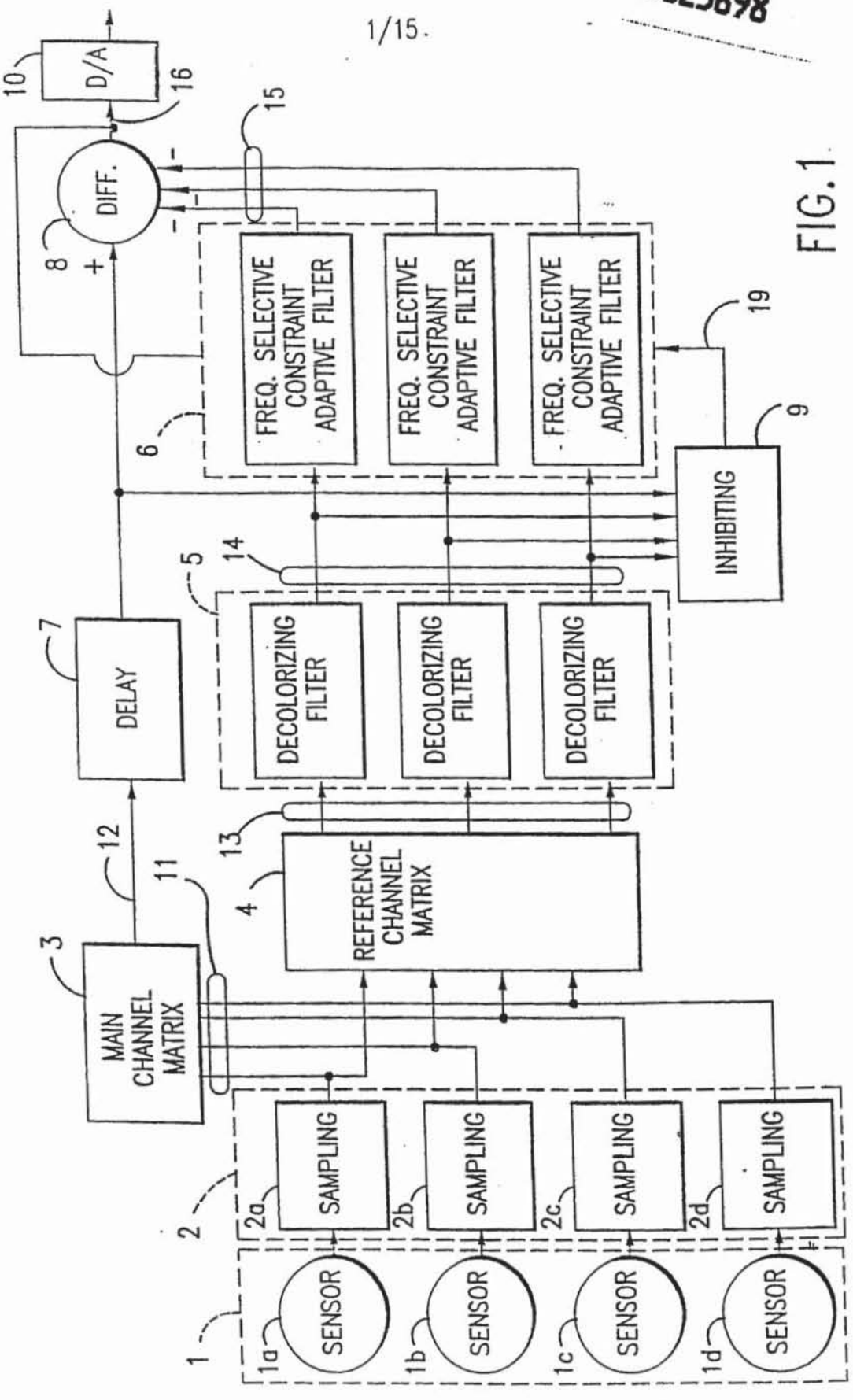


FIG. 1.

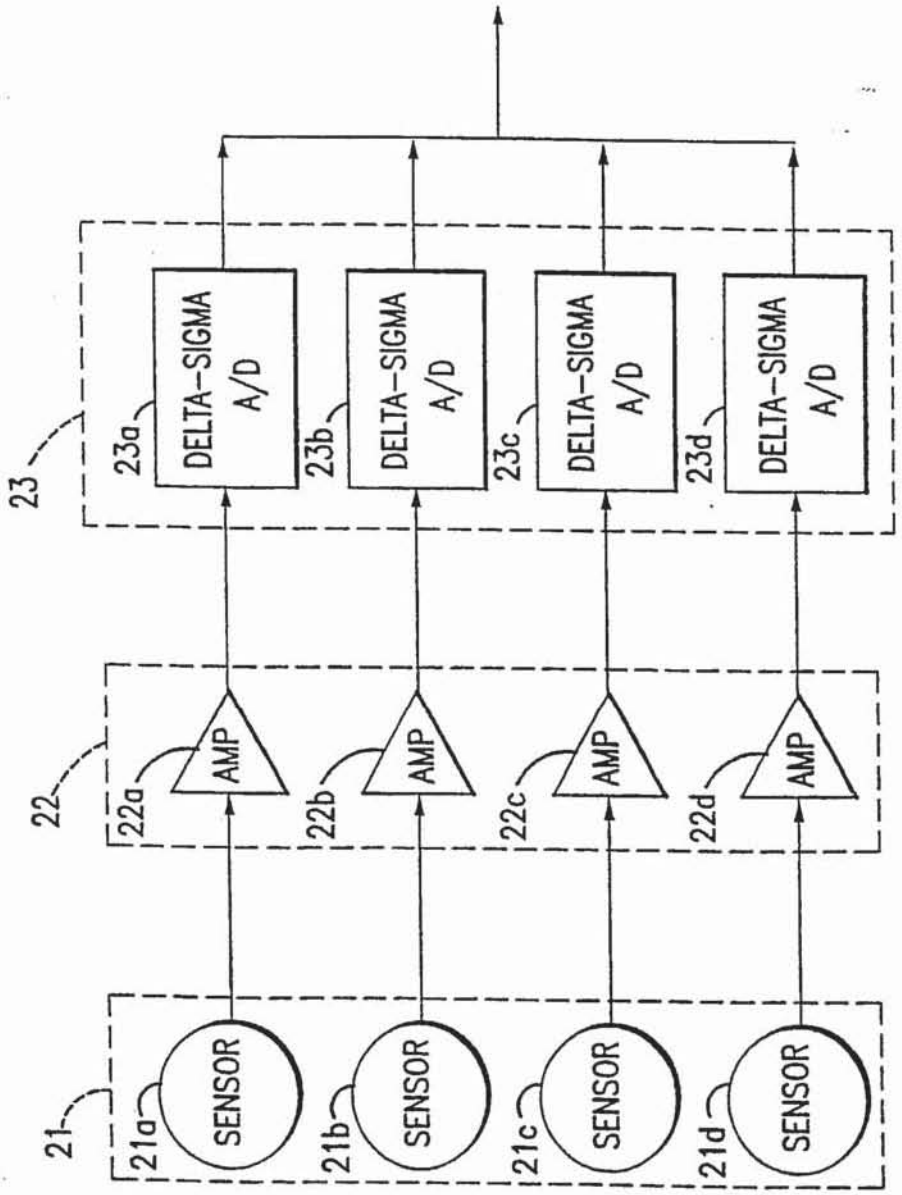


FIG.2

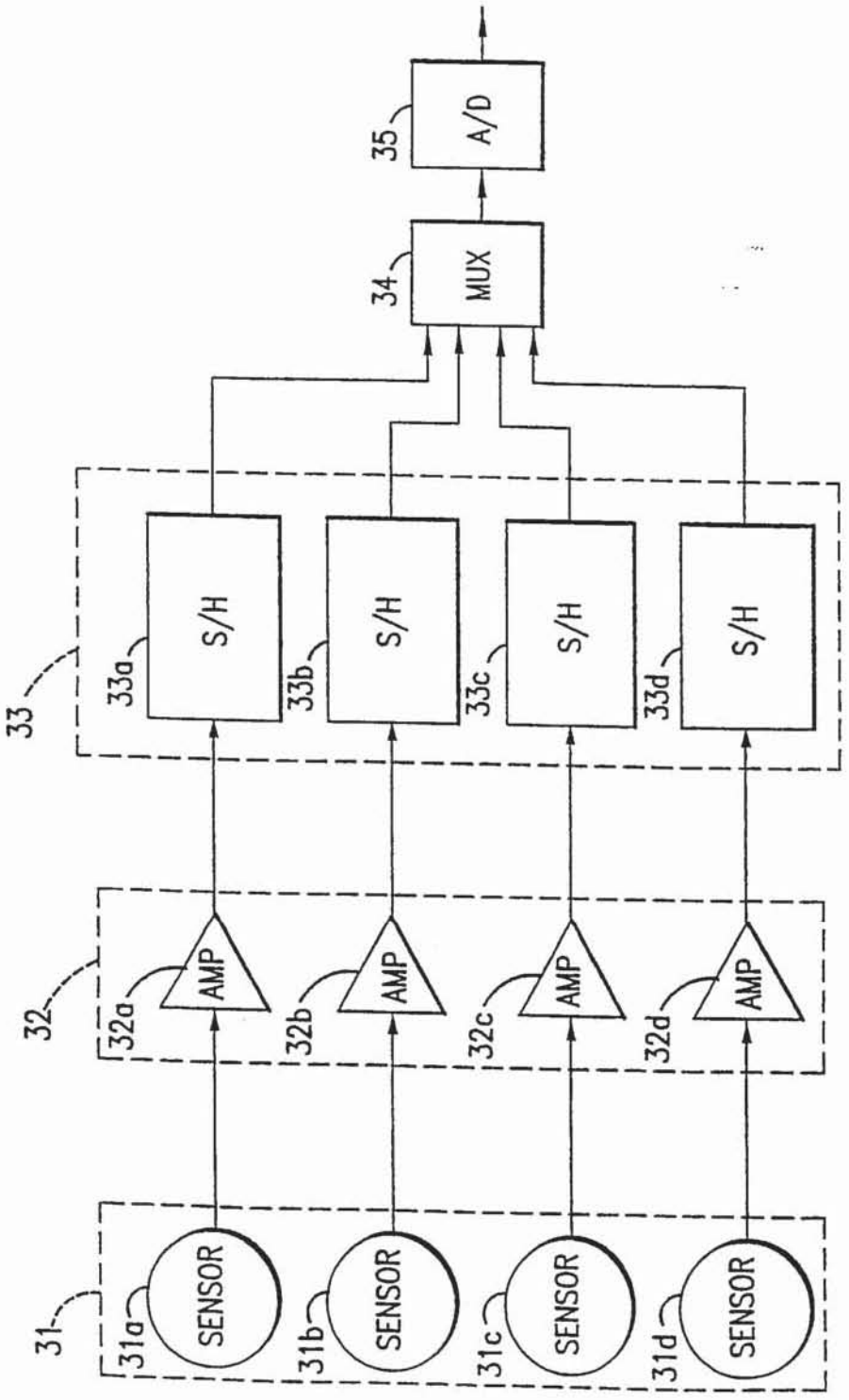


FIG.3

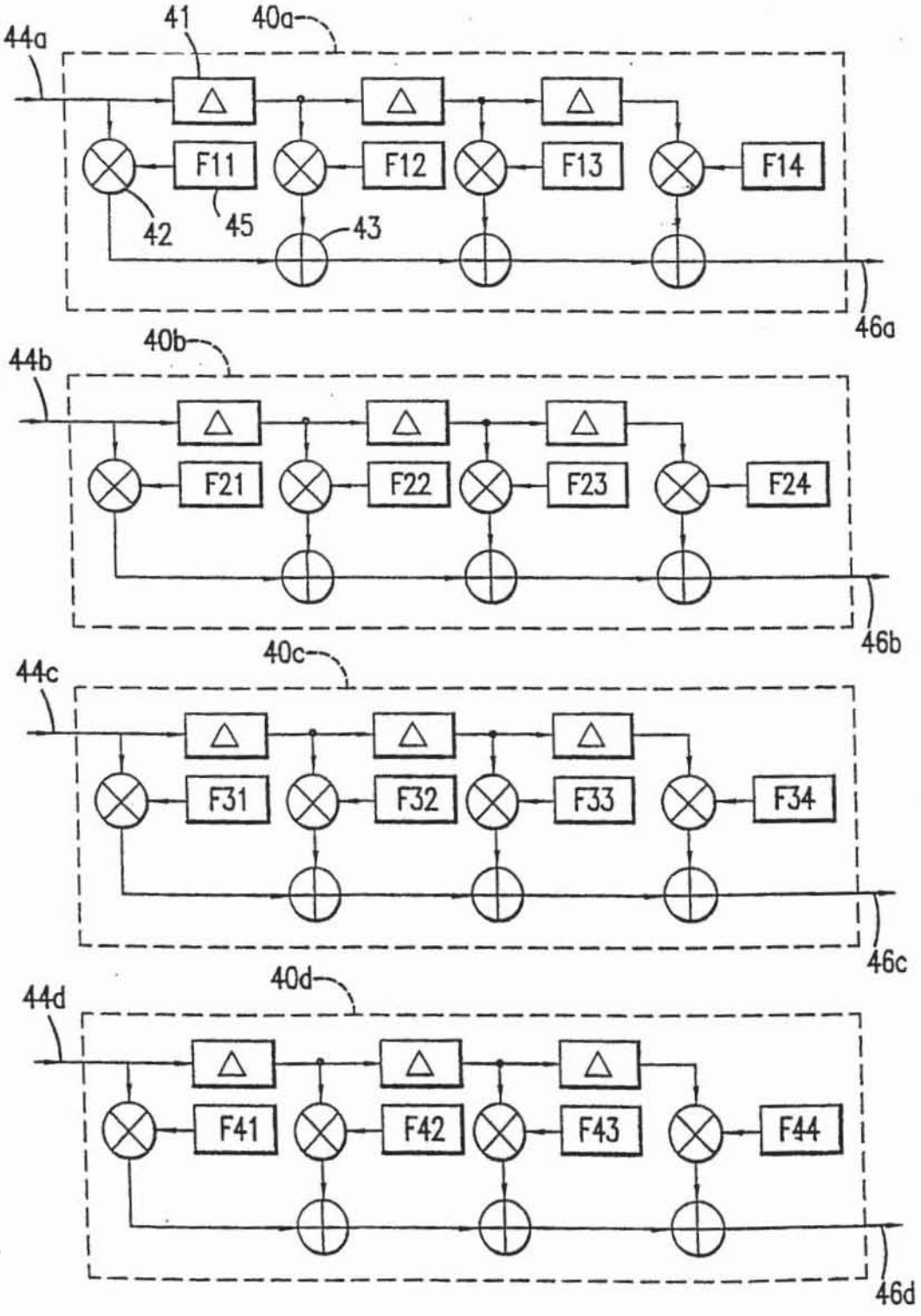


FIG.4

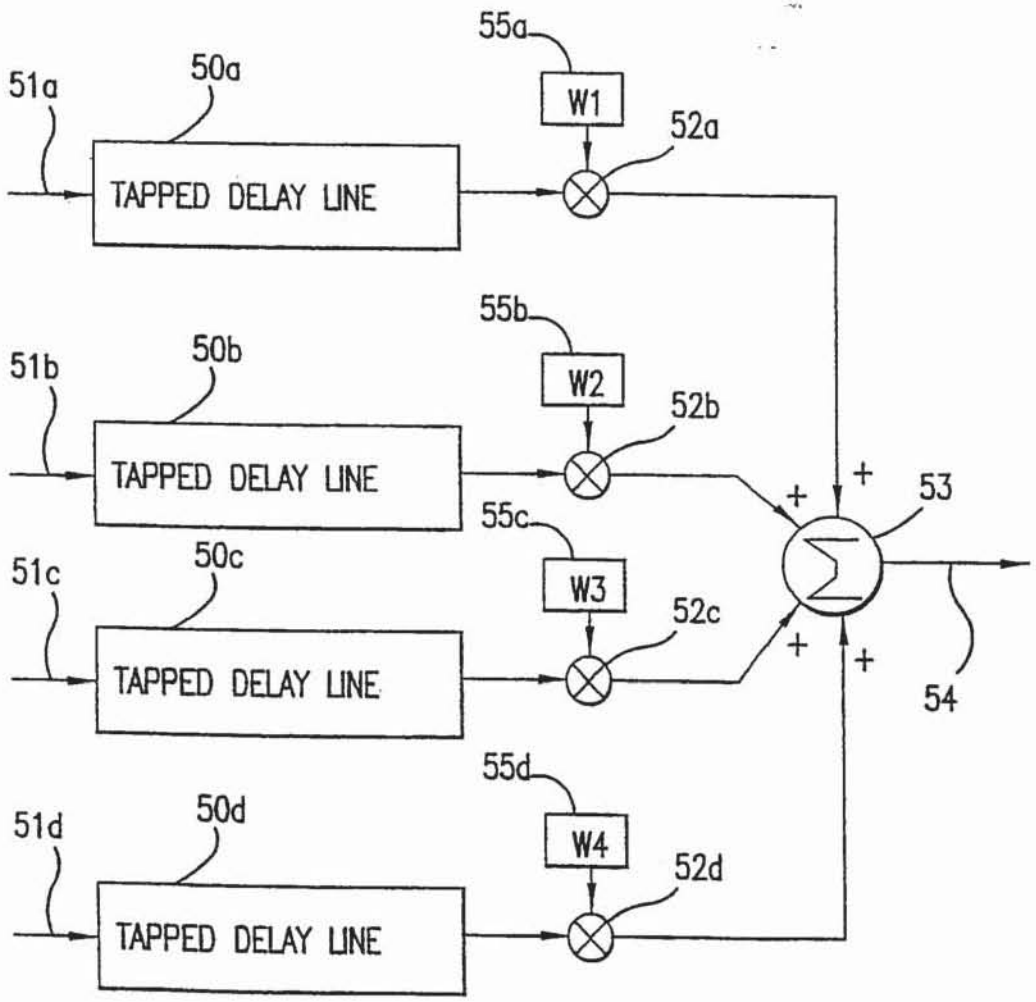


FIG.5

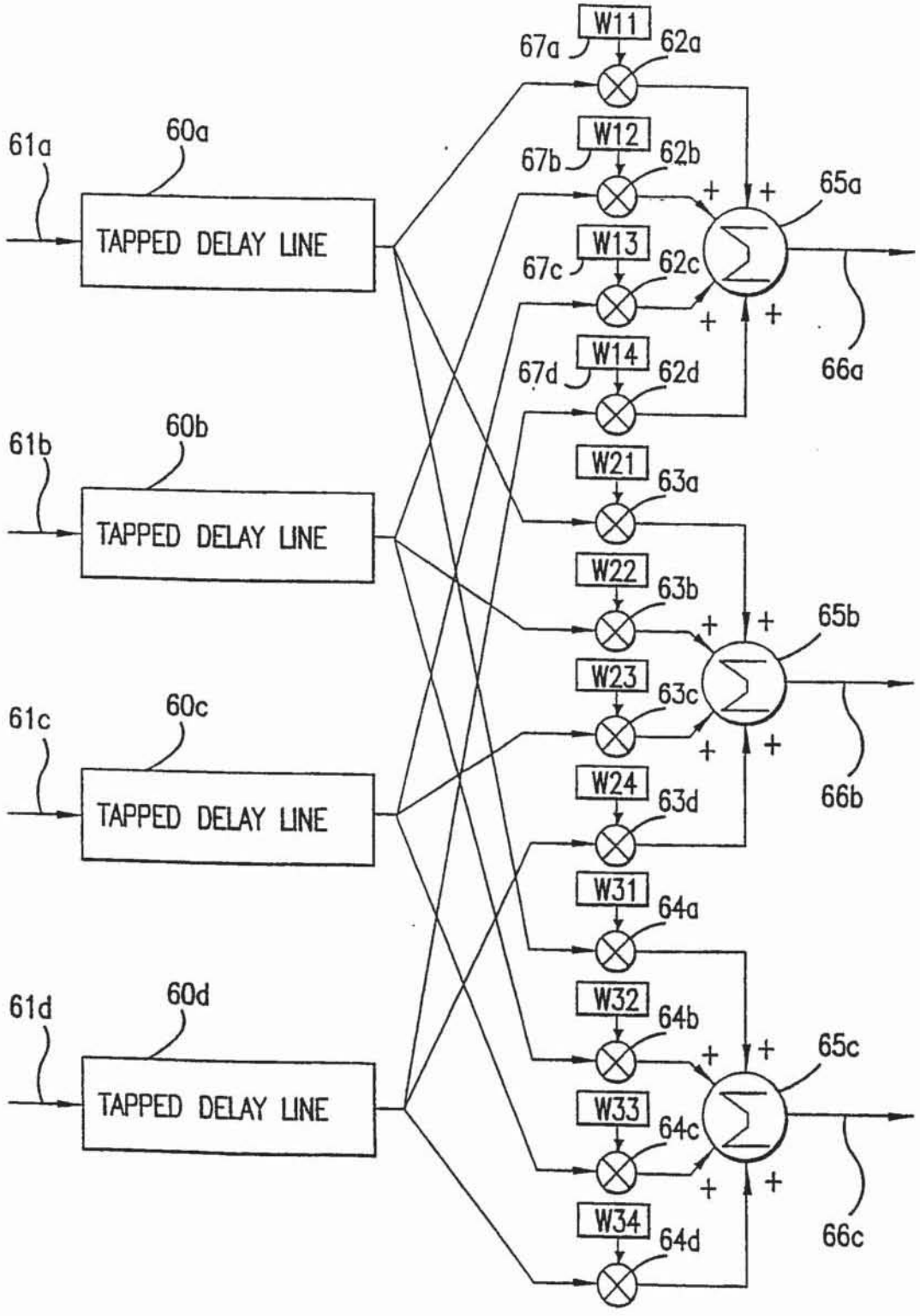


FIG.6

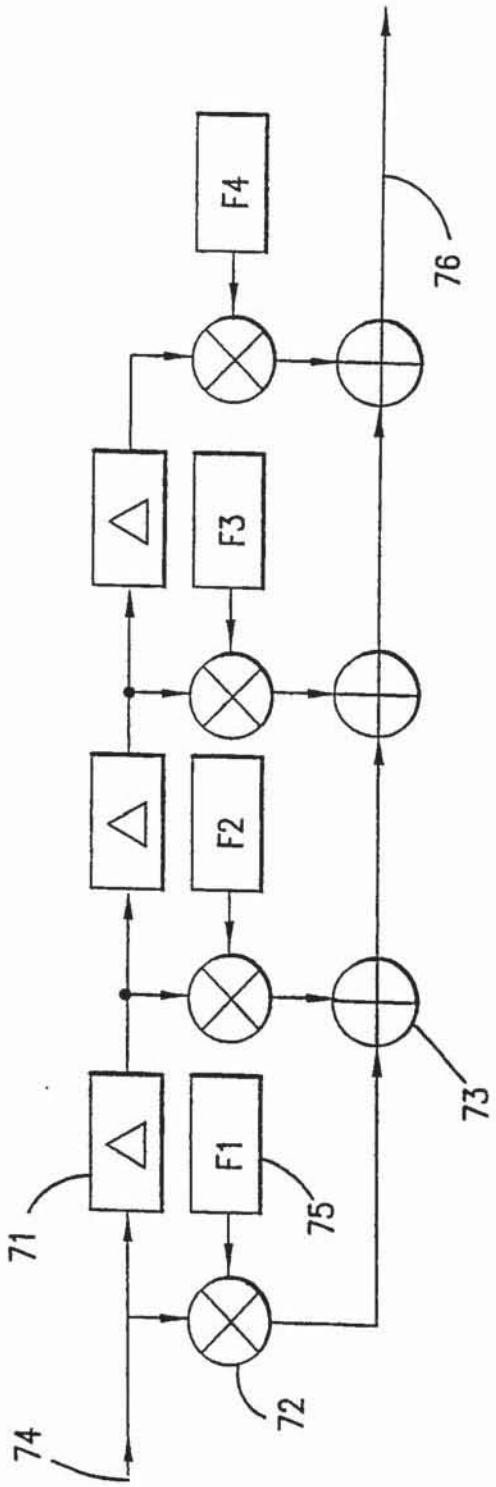


FIG.7

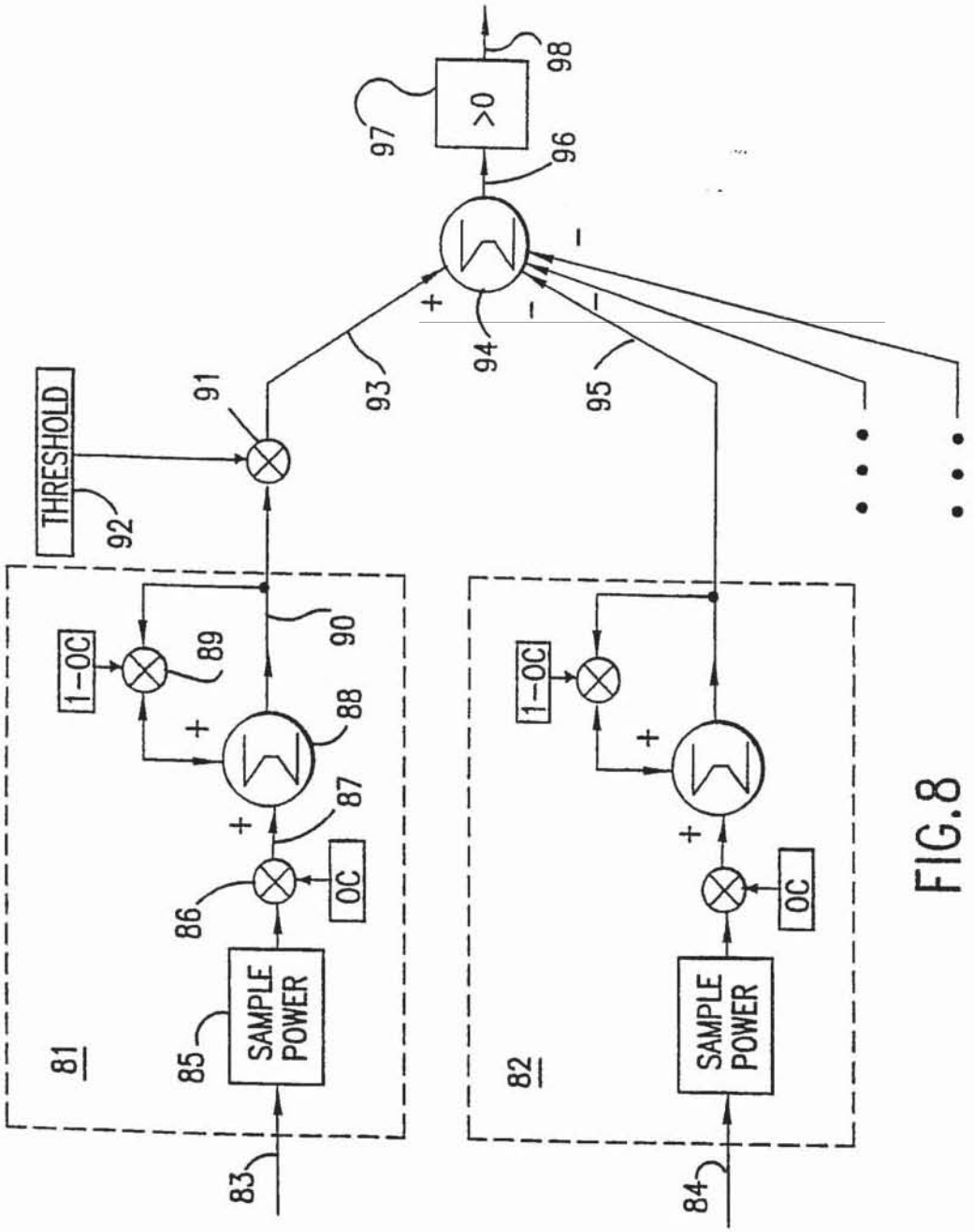


FIG.8

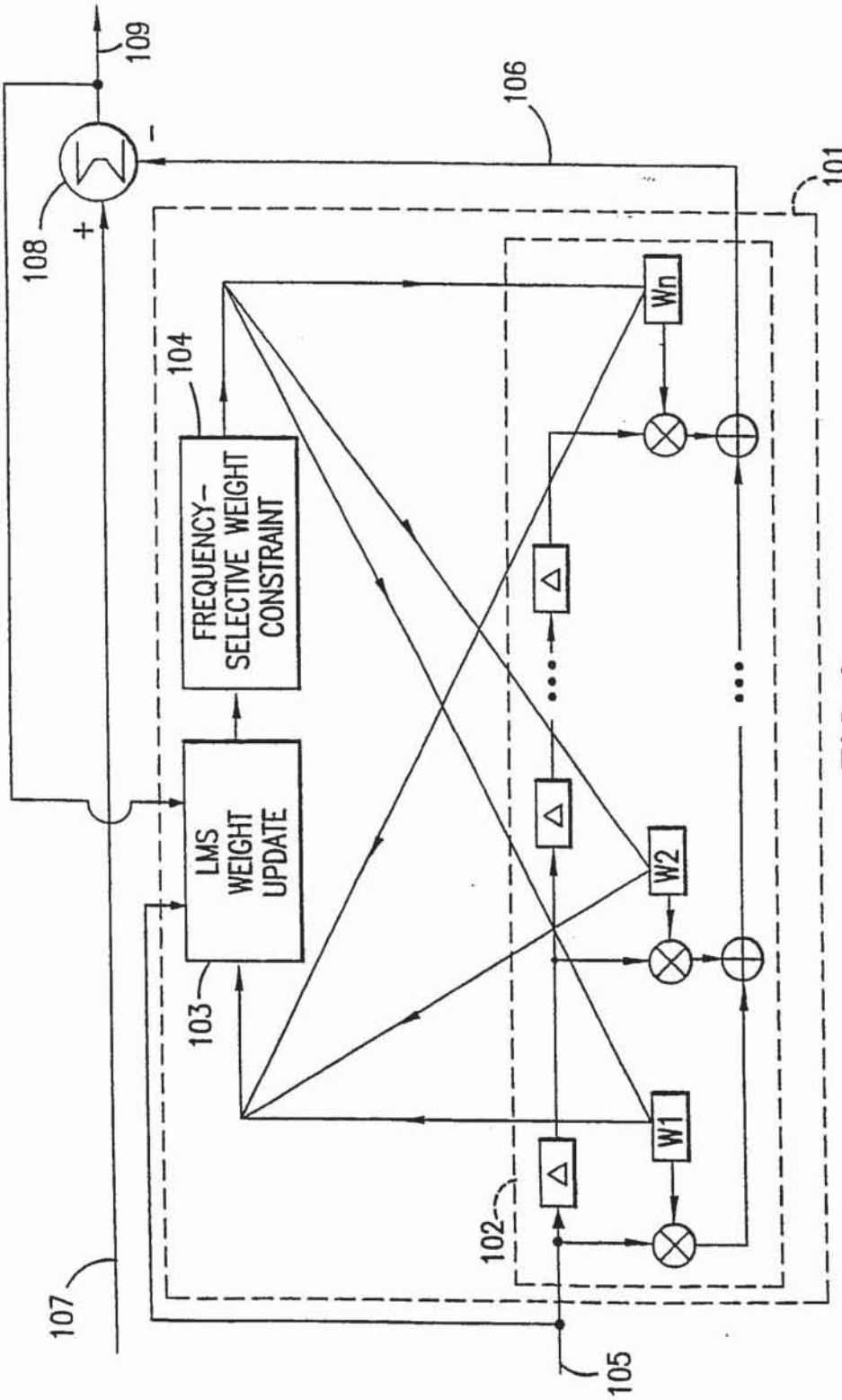


FIG.9

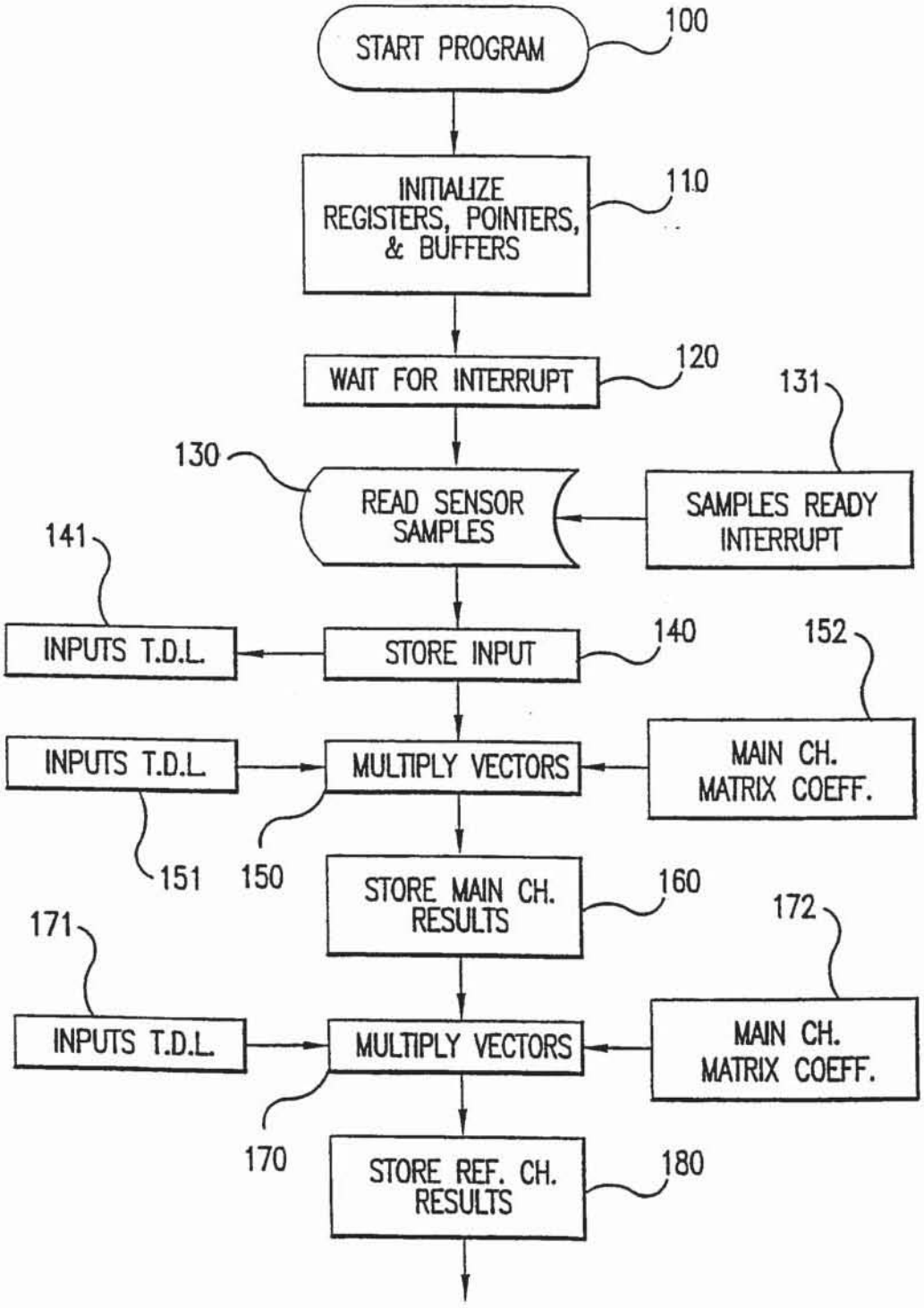


FIG.11A

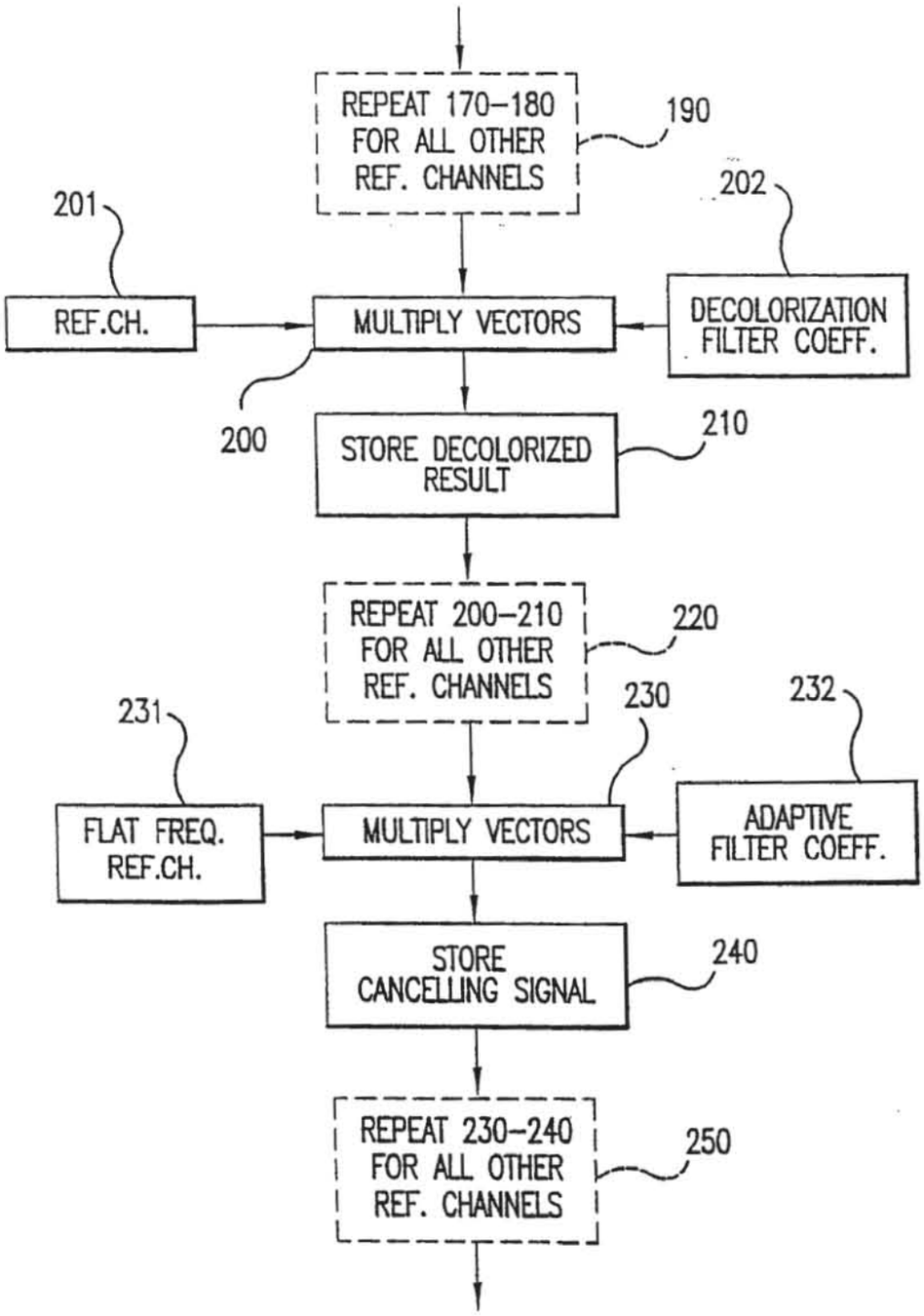


FIG.11B

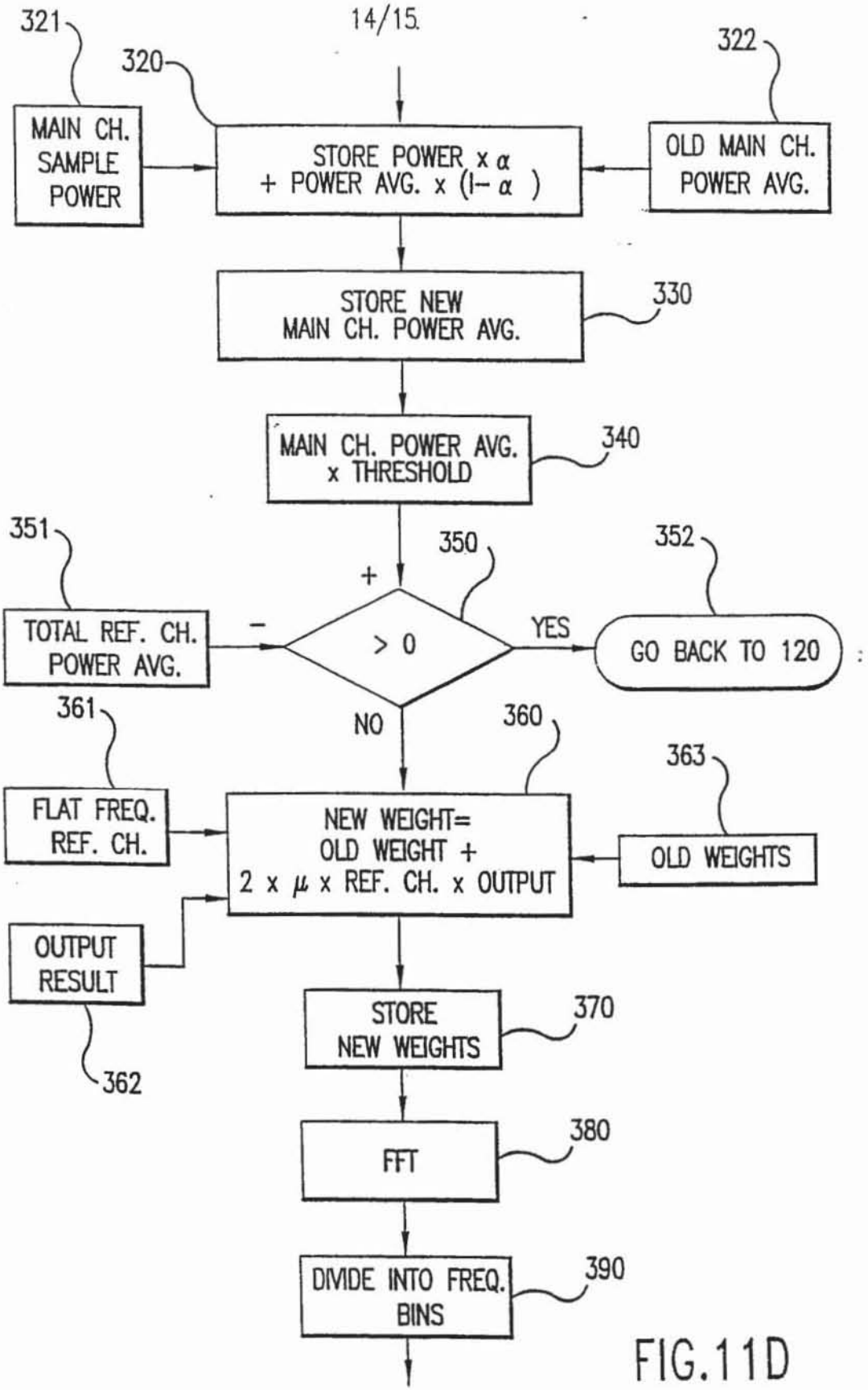


FIG.11D

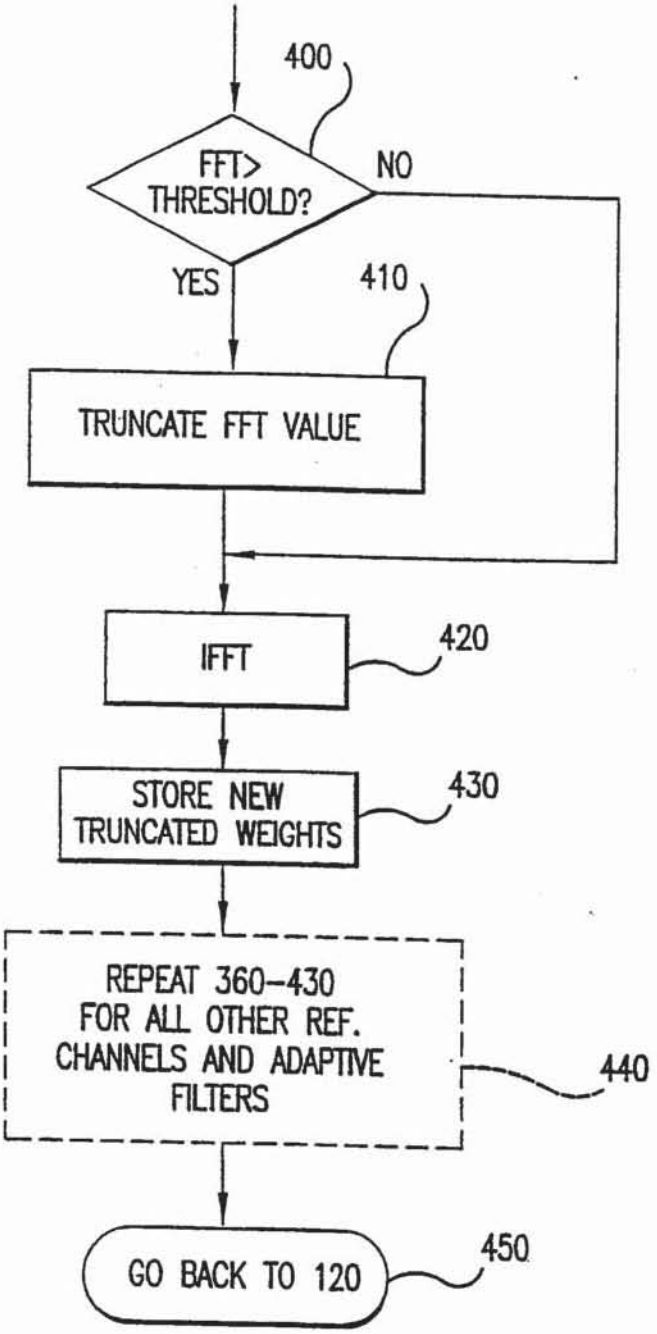


FIG.11E

PTO UTILITY GRANT
Paper Number 14

The United States of America

The Commissioner of Patents and Trademarks

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America for the term set forth below, subject to the payment of maintenance fees as provided by law.

If this application was filed prior to June 8, 1995, the term of this patent is the longer of seventeen years from the date of grant of this patent or twenty years from the earliest effective U.S. filing date of the application, subject to any statutory extension.

If this application was filed on or after June 8, 1995, the term of this patent is twenty years from the U.S. filing date, subject to an statutory extension. If the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121 or 365(c), the term of the patent is twenty years from the date on which the earliest application was filed, subject to any statutory extension.

Bruce Lehman
Commissioner of Patents and Trademarks

Arnitra Manley
Attest

Form PTO-1584 (Rev. 2/97)

PATENT
43086.00.7002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Joseph Marash et al.
U.S. Patent No.	:	5,825,898
Issued	:	October 20, 1998
Serial No.	:	08/672,899
For	:	SYSTEM AND METHOD FOR ADAPTIVE INTERFERENCE CANCELLING
Filed	:	June 27, 1996
Examiner	:	NGUYEN, DUC MINH
Art Unit	:	2743
Confirmation No.	:	6383

1633 Broadway, 47th Floor,
New York, NY 10019

FILED VIA EFS-WEB
ON January 27, 2014

REQUEST FOR CERTIFICATE OF CORRECTION

Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

It is requested that a Certificate of Correction be issued in the above-entitled patent in accordance with the accompanying form PTO 1050. Please make the following changes:

ON THE FACE OF THE PATENT:

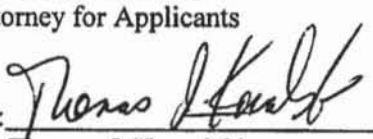
Left column, field (73), Assignee, replace the text "**Lamar Signal Processing, Yokneam, Israel**" with "**Andrea Electronics Corporation, Melville, New York**".

REMARKS

The requested changes do not constitute new matter and this application does not require re-examination. A completed Form PTO 1050 is enclosed.

Since the error to be corrected is due to Applicants' error, a charge of $100.00 is believed to be due. The Commissioner is authorized to charge any additional fees for this paper or credit any overpayment to Deposit Account No. No. 22-0259.

Respectfully submitted,
VEDDER PRICE P.C.
Attorney for Applicants

By: 

Thomas J. Kowalski
Reg. No. 32,147
Deborah L. Lu, Ph.D.
Reg. No. 50,940
Tel. No. (212) 407-7700
Fax No. (212) 407-7799

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO.	:	5,825,898
APPLICATION NO.	:	08/672,899
ISSUE DATE	:	October 20, 1998
INVENTOR(S)	:	Joseph Marash, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

ON THE FACE OF THE PATENT

(73) Assignee: ~~Lamar Signal Processing, Yokneam, Israel~~ Andrea Electronics Corporation, Melville, New York

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Vedder Price P.C.
1633 Broadway, 47th Floor
New York, New York 10019

NEWYORK/#335387.1

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

3-19-2014

Patent No: 5,825,898
Serial Number: 08/672,899
Inventor(s): Joseph Marash, et. al.
Issued: October 20,1998

Request for Certificate of Correction

Consideration has been given your request for the issuance of a certificate of correction for the above-identified patent under the provisions of Rule(s) 1.322or 1.323.

Assignees' names and addresses (assignment data) printed in a patent, are based *solely* on information supplied in the appropriate space for identifying the assignment data, i.e., item 3 of the Issue Fee Transmittal Form PTOL-85B. Granting of a request under 37 CFR 3.81(b) is required to correct applicant's error providing ***incorrect or erroneous*** assignment data, *before* issuance of a Certificate of Correction, under 37 CFR 1.323 *(see Manual of Patent Examining Procedures (M.P.E.P) Chp.1400, sect. 1481).* This procedure is required *at any time after the issue fee is paid*, including after issuance of the patent.

In view of the foregoing, your request is hereby denied.

A request to correct the Assignee under 37 CFR 3.81(b) should include:

A. **the processing fee set forth in 37 CFR 1.17(i) (currently $130);**
B. a statement that the failure to include the correct assignee name on the PTOL-85B was inadvertent; and
C. a copy of the Notice of Recordation of Assignment Document, reflecting the reel and frame number where the assignment(s) is recorded and/or reflecting proof of *the date* the assignment was submitted for recordation.

In the Request, Applicant(s) may request that the file be forwarded to Certificates of Correction Branch, for issuance of a Certificate of Correction, if the Request is granted.

Any request under 37 CFR 3.81(b) should be directed to the following address or facsimile number:

By mail: Mail Stop PETITIONS
Commissioner for Patents
Post Office Box 1450
Alexandria, VA 22313-1450

By hand: Customer Service Window
Mail Stop Petitions
Randolph Building
401 Dulany Street
Alexandria, VA 22314

By fax: (703) 872-9306
ATTN: Office of Petitions

If a fee (currently $100) was previously submitted for consideration of a Request for Certificate of Correction, under CFR 1.323, to correct assignment data, no additional fee is required.

Eva James
Certificate of Correction Branch
571-272-3422

Vedder Price P.C.
1633 Broadway, 47th floor
New York, NY

1. 5,416,844, May 16, 1995, Apparatus for reducing noise in space applicable to vehicle passenger compartment; Yoshiharu Nakaji, et al., **381/71.4, 71.9** :IMAGE AVAILABLE:

2. 4,956,867, Sep. 11, 1990, Adaptive beamforming for noise reduction; Patrick M. Zurek, et al., **381/94.7, 71.11** :IMAGE AVAILABLE:

3. 4,491,701, Jan. 1, 1985, Adaptive filter including a far end energy discriminator; Donald L. Duttweiler, et al., 364/724.19; 379/410; **381/101** :IMAGE AVAILABLE:

```
=> s l7 and 364/clas
         56137 364/CLAS
L9           9 L7 AND 364/CLAS

=> d 1-9
```

1. 5,703,904, Dec. 30, 1997, Impulse noise effect reduction; Ehud Langberg, 375/232; **364/724.19** :IMAGE AVAILABLE:

2. 5,638,311, Jun. 10, 1997, Filter **coefficient** estimation apparatus; Kensaku Fujii, et al., **364/724.19** :IMAGE AVAILABLE:

3. 5,553,014, Sep. 3, 1996, Adaptive finite impulse response filtering method and apparatus; Phillip L. De Leon, II, et al., **364/724.19** :IMAGE AVAILABLE:

4. 5,390,364, Feb. 14, 1995, Least-mean squares adaptive digital filter havings variable size loop bandwidth; Mark A. Webster, et al., 455/506; **364/724.2**; 375/232; 455/307 :IMAGE AVAILABLE:

5. 5,136,531, Aug. 4, 1992, Method and apparatus for detecting a wideband tone; Shawn McCaslin, **364/724.09, 724.19** :IMAGE AVAILABLE:

6. 4,754,419, Jun. 28, 1988, Adaptive digital filter; Yoshihiro Iwata, **364/724.19** :IMAGE AVAILABLE:

7. 4,591,669, May 27, 1986, Adaptive filter update gain normalization; Donald L. Duttweiler, et al., 370/291; 333/166; **364/724.16, 724.19** :IMAGE AVAILABLE:

8. 4,491,701, Jan. 1, 1985, Adaptive filter including a far end energy discriminator; Donald L. Duttweiler, et al., **364/724.19**; 379/410; 381/101 :IMAGE AVAILABLE:

9. 3,992,616, Nov. 16, 1976, Receiver equalizer apparatus; William F. Acker, **364/724.2**; 333/18; 375/232 :IMAGE AVAILABLE:

```
=> d his

     (FILE 'USPAT' ENTERED AT 20:12:13 ON 31 DEC 1997)
L1           0 S 4658426/PN AND THRESHOLD#
L2           1 S 4956867/PN AND INHIBIT?
L3        1419 S ADAPTIVE FILTER# OR ADAPTIVE DIGITAL FILTER# (P) (INHIBI
T?)
L4         616 S L3 (P) (COEFFICIENT# OR FILTER WEIGHT#)
L5          10 S L4 AND (BEAMFORMER#)
L6          43 S (ADAPTIVE FILTER# OR ADAPTIVE DIGITAL FILTER#) (P) (INHI
```

BIT
L7 39 S L6 A[redacted](COEFFICIENT# OR WEIGHT#)
L8 3 S L7 AND 381/CLAS
L9 9 S L7 AND 364/CLAS

1. 5,416,844, May 16, 1995, Apparatus for reducing noise in space applicable to vehicle passenger compartment; Yoshiharu Nakaji, et al., **381/71.4, 71.9** :IMAGE AVAILABLE:

2. 4,956,867, Sep. 11, 1990, Adaptive beamforming for noise reduction; Patrick M. Zurek, et al., **381/94.7, 71.11** :IMAGE AVAILABLE:

3. 4,491,701, Jan. 1, 1985, Adaptive filter including a far end energy discriminator; Donald L. Duttweiler, et al., 364/724.19; 379/410; **381/101** :IMAGE AVAILABLE:

=> d his

```
     (FILE 'USPAT' ENTERED AT 14:40:05 ON 30 DEC 1997)
L1             1 S 5627799/PN AND THRESHOLD#
L2            94 S INHIBIT? (P) (ADF OR ADAPTIVE DIGITAL FILTER# OR ADAPTIV
E F
L3             3 S L2 AND 381/CLAS
```

1. 5,623,318, Apr. 22, 1997, Ghost cancelling method and apparatus using canonical signed digit codes; Myeong-hwan Lee, 348/614 :IMAGE AVAILABLE:

2. 5,553,623, Sep. 10, 1996, Method for calibrating a system for recording and playing back ECG signals; Dennis E. Ochs, 600/523, 524 :IMAGE AVAILABLE:

3. 5,503,159, Apr. 2, 1996, Method for enhancement of late potentials measurements; David L. Burton, 600/516 :IMAGE AVAILABLE:

4. 5,423,325, Jun. 13, 1995, Methods for enhancement of HRV and late potentials measurements; David L. Burton, 600/515 :IMAGE AVAILABLE:

5. 5,422,912, Jun. 6, 1995, Adaptive weak signal identification system; Jason Asser, et al., 375/350, 351 :IMAGE AVAILABLE:

6. 5,416,847, May 16, 1995, Multi-band, digital audio noise filter; Steven E. Boze, 381/94.3, 98 :IMAGE AVAILABLE:

7. 5,406,955, Apr. 18, 1995, ECG recorder and playback unit; J. Daren Bledsoe, et al., 600/524 :IMAGE AVAILABLE:

8. 5,347,586, Sep. 13, 1994, Adaptive system for controlling noise generated by or emanating from a primary noise source; Peter D. Hill, et al., 381/71.8, 71.3 :IMAGE AVAILABLE:

9. 5,276,516, Jan. 4, 1994, Ghost canceling apparatus utilizing forward and reverse fourier transform processing; Richard G. Bramley, 348/614 :IMAGE AVAILABLE:

10. 5,235,646, Aug. 10, 1993, Method and apparatus for creating de-correlated audio output signals and audio recordings made thereby; Martin D. Wilde, et al., 381/17, 97 :IMAGE AVAILABLE:

11. 5,161,017, Nov. 3, 1992, Ghost cancellation circuit; Takashi Sato, 348/614, 607 :IMAGE AVAILABLE:

12. 5,121,433, Jun. 9, 1992, Apparatus and method for controlling the magnitude spectrum of acoustically combined signals; Gary S. Kendall, et al., 381/1, 17, 97 :IMAGE AVAILABLE:

13. 5,117,418, May 26, 1992, Frequency domain adaptive echo canceller for full-duplex data transmission; Donald L. Chaffee, et al., 370/289, 210, 290; 379/406, 411 :IMAGE AVAILABLE:

=> d his

(FILE 'USPAT' ENTERED AT 10:09:39 ON 30 DEC 1997)

L1 22 S (FREQUENC###) (8A) (FILTER WEIGHT# OR FILTER COEFFICTION #)

L2 1 S (FFT OR FAST FOURIER TRANSFORM OR IFFT OR INVERSE# FAST FOU

L3 24 S (FFT OR FAST FOURIER TRANSFORM OR IFFT OR INVERSE# FAST FOU

L4 381 S (FREQUENC###) (8A) (FILTER WEIGHT# OR FILTER COEFFICIENT #)

L5 13 S L3 AND L4

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1995

Application or Docket Number: 672899

CLAIMS AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA
BASIC FEE		
TOTAL CLAIMS	44 minus 20 =	* 24
INDEPENDENT CLAIMS	8 minus 3 =	* 5
MULTIPLE DEPENDENT CLAIM PRESENT		

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY RATE	SMALL ENTITY FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
	375.00	OR		750.00
x$11=	264	OR	x$22=	528
x39=	195	OR	x78=	390
+125=		OR	+250=	
TOTAL	834	OR	TOTAL	1668

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x39=		OR	x78=	
+125=		OR	+250=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x39=		OR	x78=	
+125=		OR	+250=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				

SMALL ENTITY RATE	SMALL ENTITY ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY ADDITIONAL FEE
x$11=		OR	x$22=	
x39=		OR	x78=	
+125=		OR	+250=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

RTL898_1020-0161

Form PTO 1130
(REV 2/94)

PACE DATA ENTRY CODING SHEET

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

1ST EXAMINER K. Nelson — DATE 8/8/96
2ND EXAMINER Paul — DATE 7-26-96

APPLICATION NUMBER	TYPE APPL	FILING DATE (MONTH DAY YEAR)	SPECIAL HANDLING	GROUP ART UNIT	CLASS	SHEETS OF DRAWING
08/672899	1	06 27 96	Ø	2502	333	14

TOTAL CLAIMS	INDEPENDENT CLAIMS	SMALL ENTITY?	FILING FEE	FOREIGN LICENSE	ATTORNEY DOCKET NUMBER
44	8	2	877	Y	8797-ØØ3

CONTINUITY DATA

CONT CODE	STATUS CODE	PARENT APPLICATION SERIAL NUMBER	PCT APPLICATION SERIAL NUMBER	PARENT PATENT NUMBER	PARENT FILING DATE (MONTH DAY YEAR)
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		

PCT/FOREIGN APPLICATION DATA

FOREIGN PRIORITY CLAIMED	COUNTRY CODE	PCT/FOREIGN APPLICATION SERIAL NUMBER	FOREIGN FILING DATE (MONTH DAY YEAR)

☆ U.S. GPO: 1995-401-429

RTL898_1020-0162

U.S.GOVERNMENT PRINTING OF 1997 [illegible]

PATENT NUMBER	ORIGINAL CLASSIFICATION	
	CLASS	SUBCLASS
	381	92

APPLICATION SERIAL NUMBER	CROSS REFERENCE(S)				
08/672,899	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)			
APPLICANT'S NAME (PLEASE PRINT)	381	94.1	94.2	94.7	
MARASH	367	121	119		
IF REISSUE, ORIGINAL PATENT NUMBER					

INTERNATIONAL CLASSIFICATION					
H	0	4	R		3/00
					/
					/
					/

GROUP ART UNIT	ASSISTANT EXAMINER (PLEASE STAMP OR PRINT FULL NAME)
2743	DUC NGUYEN
	PRIMARY EXAMINER (PLEASE STAMP OR PRINT FULL NAME)
	CURTIS A. KUNTZ
	SUPERVISORY PATENT EXAMINER
	GROUP 2700

PTO 270
(REV. 5-91)

ISSUE CLASSIFICATION SLIP

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE