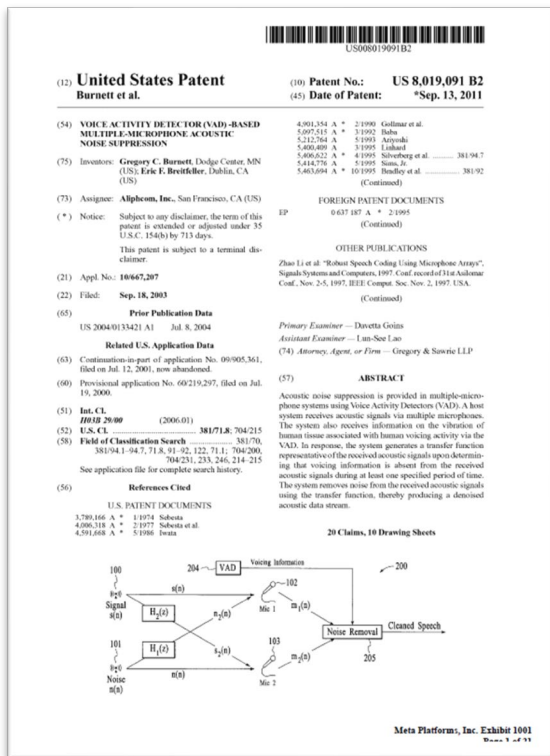


*Before The Patent Trial And Appeal Board*  
Oral Hearing  
September 20, 2024

**Jawbone's Presentation**

IPR2023-01127: U.S. 8,019,091

# U.S. Patent 8,019,091



Ex. 1001

## The '091 Patent:

- Filed: Sept. 18, 2003
- Issued: Sept. 13, 2011
- 20 claims
- Independent claims 1, 11, and 18

# Claim 11

## Claim 11

11. A system for removing acoustic noise from the acoustic signals, comprising:

a receiver that receives at least two acoustic signals via at least two acoustic microphones positioned in a plurality of locations;

at least one sensor that receives human tissue vibration information associated with human voicing activity of a user;

a processor coupled among the receiver and the at least one sensor that generates a plurality of transfer functions, wherein the plurality of transfer functions includes a first transfer function representative of a ratio of energy of acoustic signals received using at least two different acoustic microphones of the at least two acoustic microphones, wherein the first transfer function is generated in response to a determination that voicing activity is absent from the acoustic signals for a period of time, wherein the plurality of transfer functions includes a second transfer function representative of the acoustic signals, wherein the second transfer function is generated in response to a determination that voicing activity is present in the acoustic signals for the period of time, wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce the denoised acoustic data stream.

At least one sensor that receives human tissue vibration information associated with human voicing activity

Ex. 1001, cl. 11

# GROUND 1: Meta's Combinations

## Ikeda + Puthuff Combinations

A POSITA would have immediately recognized that one could combine the teachings of Ikeda and Puthuff and use Puthuff's vibration sensor either (a) in place of, or (b) in addition to, Ikeda's VAD (e.g., the signal-to-noise power ratio estimator and optionally the step size output circuit) so that Ikeda's system could more accurately determine periods when voicing activity is absent or present. (Ex. 1002 ¶88.) Each of the two proposed combinations are addressed below.

Petition, 32

# First Ikeda/Puthuff Combination

## Ikeda's Invention

It is therefore an object of the present invention to provide a noise canceler capable of achieving a sufficient noise canceling ability and reducing signal distortion even when adequate learning sections cannot be indicated from the outside.

Ex. 1003, 3:57-61

signal accurately. The noise canceler therefore insures rapid convergence and allows a minimum of signal distortion to occur without resorting to a command customarily input from the outside for commanding the learning operation of filters. These advantages are derived from a unique configuration in which a relation in size between a desired signal, which is an interference signal for an adaptive filter used to estimate the noise signal of the main signal from the estimated signal-to-noise power ratio of the main signal, and the noise signal to be canceled is determined. This relation is used to control a step size to be fed to the adaptive filter.

Ikeda discloses that one way to control when  $W1(z)$  is calculated is by determining from “outside,” e.g., using a sensor other than the physical microphones, whether  $S(z)$  is absent.

Ex. 1003, 9:14-24

Pet., 21; Ex. 1002, ¶ 70.

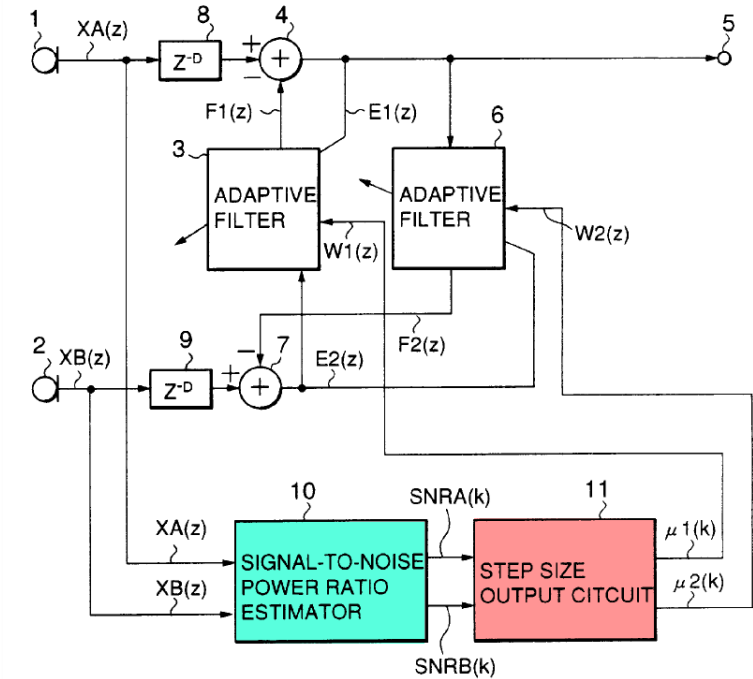
# First Ikeda/Puthuff Combination

## Ikeda's Invention

filters. These advantages are derived from a unique configuration in which a relation in size between a desired signal, which is an interference signal for an adaptive filter used to estimate the noise signal of the main signal from the estimated signal-to-noise power ratio of the main signal, and the noise signal to be canceled is determined. This relation is used to control a step size to be fed to the adaptive filter. This is also true with an adaptive filter for estimating the desired signal of the reference signal from the estimated signal-to-noise power ratio of the reference signal; the noise signal is an interference signal while the desired signal is a signal to be canceled.

Ex. 1003, 9:18-27

Dr. Stern: "That's the invention."



Ex. 1003, Fig. 1

Ex. 2004, 27:2-3.

# GROUND 1: Meta's Combinations

## First Ikeda + Puthuff Combination

19 Q. Okay. So let's talk about the  
20 first one, in place of.

21 A. Um-hum.

22 Q. So in your combination that  
23 you're proposing here, you would take  
24 Puthuff's accelerometer number 30 from  
25 Figure 1 of Puthuff and put that in place  
2 of boxes 10 and 11 of Ikeda; is that  
3 right?

4 A. That's correct.

Ex. 2004, 34:19-35:4

3 Q. You would need to make more  
4 alterations to Ikeda, is that right,  
5 rather than just dropping in the  
6 accelerometer?

8 THE WITNESS: No, the way it is  
9 right now, boxes 10 and 11 are there,  
10 they take inputs from microphones A  
11 and B, XA and XB, and control the  
12 adaptation of the adaptive filters.

13 The sensor for Puthuff would do  
14 exactly the same thing. You replace  
15 boxes 10 and 11, eliminate the inputs  
16 from XA and XB, at least in the  
17 replacement mode, and then have the  
18 signal, the voice activity detector  
19 signal go to the adaptive filter in  
20 exactly the same way the figure  
21 specifies. So no additional  
22 modifications, just a straight up  
23 replacement.

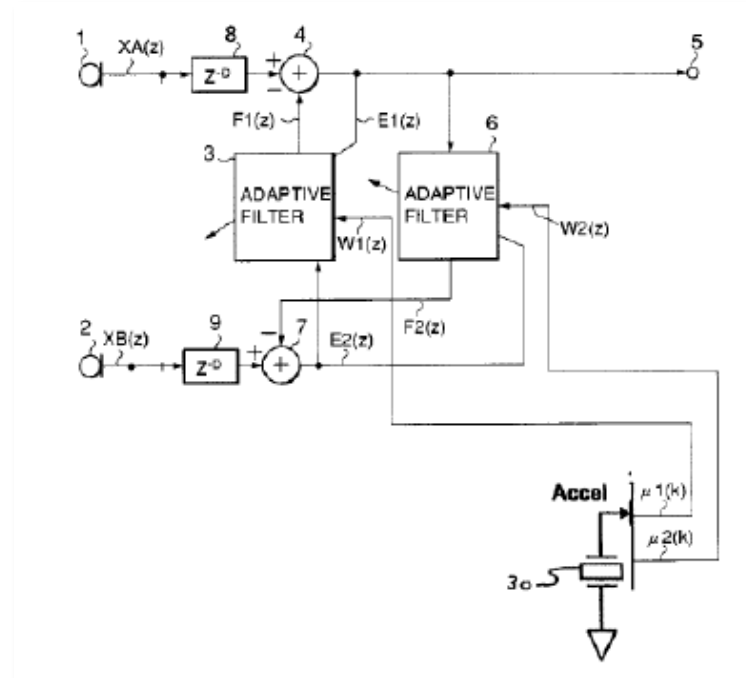
Ex. 2004, 36:3-23

# GROUND 1: Meta's Combinations

## First Ikeda + Puthuff Combination

19 Q. Okay. So let's talk about the  
20 first one, in place of.  
21 A. Um-hum.  
22 Q. So in your combination that  
23 you're proposing here, you would take  
24 Puthuff's accelerometer number 30 from  
25 Figure 1 of Puthuff and put that in place  
2 of boxes 10 and 11 of Ikeda; is that  
3 right?  
4 A. That's correct.

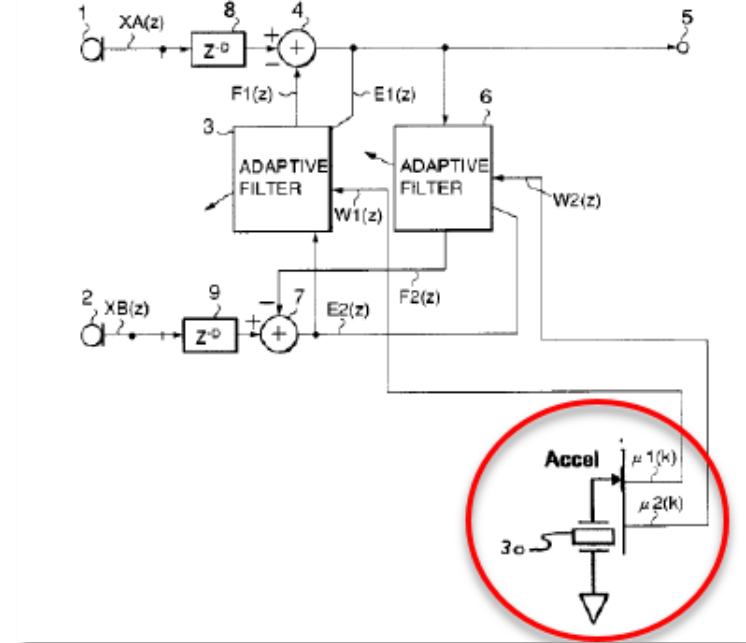
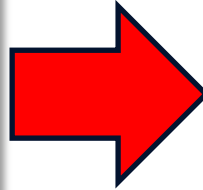
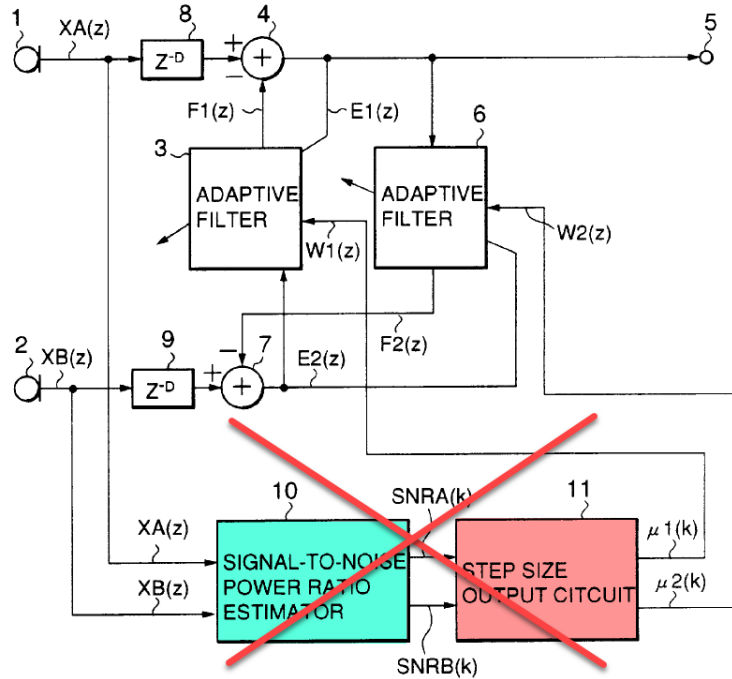
Ex. 2004, 34:19-35:4



Ex. 2002, ¶ 64

# GROUND 1: Meta's Combinations

## First Ikeda + Puthuff Combination



# First Ikeda/Puthuff Combination

## No Motivation

However, it is, in many cases, difficult to command the adaptive filters to perform learning from the outside in accordance with the level of the desired signal and that of the noise signal, depending on the situation in which the noise canceler is located. With the conventional noise canceler, a sufficient noise canceling ability and a sufficient distortion correction characteristic are not achievable unless adequate learning sections are indicated to each adaptive filter for the learning purpose.

Ex. 1003, 3:46-55

Puthuff sensor would be a command from the outside. Moreover, Puthuff's sensor would, just like the outside sensor in Ikeda, be unable to command the filters to "perform learning . . . in accordance with the level of the desired signal and that of the noise signal." Instead, Puthuff's sensor could only command the filters based on vibrations, not on signal levels. In other words, Puthuff's sensor has no way to determine that the vibrations it senses indicate intelligible speech in the acoustic signals or that the level of the desired signal exceeds the level of the noise signal.

Ex. 2002, ¶ 69

# First Ikeda/Puthuff Combination

## Teaching Away

14 Q. But I think we agree Ikeda's  
15 invention, just looking at Ikeda itself,  
16 what Ikeda purports to invent is a system  
17 that doesn't need a command from the  
18 outside; is that right?

19 A. Yes, that's indeed the objective,  
20 as you pointed out, and it accomplishes  
21 that objective and that's a system that  
22 provides useful functionality in some  
23 circumstances but not in all  
24 circumstances.

Ex. 2004, 27:14-24

# Ground 1 “Motivations”

## Petitioner’s Offered Motivations

1. Ikeda and Puthuff address the same problem
2. Puthuff reduces false triggering
3. Puthuff discloses use of accelerometer to detect voice activity
4. Accelerometers were known
5. Puthuff discloses that vibration sensor is useful for dual microphone systems

Petition, 32-34

# Ground 1 “Motivations”

## Not “same problem”

A noise canceler of the present invention includes a signal-to-noise power ratio estimator to which a main signal and a reference signal are input. The estimator 10 estimates the signal-to-noise power ratio of the main signal from the mean power of a desired signal contained in the main signal and a mean power of a noise signal also contained in the main signal. In addition, the estimator estimates the signal-to-noise power ratio of the reference signal from the mean power of a desired signal contained in the reference signal and the mean power of a noise signal also contained in the reference signal. An adaptive filter for estimating the noise

Ex. 1003, Abstract

A pickup system (10) utilizes both sound pressure disturbances sensed by a microphone (20) and bone conduction sensed by a vibration sensor (30) such as an accelerometer, velocity sensor or displacement sensor to pick up and faithfully transmit a talker's voice despite acoustically noisy ambient environments. The system senses the microphone signal amplitude and adjusts the gain of associated amplification circuitry (23, 26) to effectively and smoothly fade in the microphone signal and fade out the vibration sensor signal as ambient noise increases. The pickup system (10) may be part of a stand alone ear level communication transmitter worn behind the talker's ear, or it may be implemented in a telephone system or other communication systems.

Ex. 1004, Abstract

# Ground 1 “Motivations”

## “false triggering”

An additional advantage of the invention is its particular suitability to voice-activated applications, as the bone conduction expedient improves system immunity to false triggering due to noisy environments. The invention realizes power conservation advantages by for example turning off a radio transmitter in the absence of the user's voice.

Ex. 1004, 6:6-10

Ikeda's system. Therefore, combining Puthuff's (or Alcivar's) teachings with Ikeda's system would reduce false triggering, because the input signal already represents a cleaner signal with effectively reduced noise. A POSITA would have

Ex. 1021, ¶ 17

# Ground 1 “Motivations”

## “Dual Microphones”

The invention finds utility in numerous voice pickup applications, including but not limited to ear level pickups, telephony and dual microphone directional pickup systems.

Ex. 1004, 6:21-23

94. Fifth, Puthuff expressly teaches that its vibration sensor is useful for “dual microphone” systems. (*Id.*, 6:11-23.) Thus, a person of ordinary skill in the art would have been motivated to combine Puthuff’s teachings with Ikeda’s dual microphone system, and would have had a reasonable expectation of success in doing so.

Ex. 1002, ¶ 94  
POR, 24; Surreply, 14

# GROUND 1: Meta's Combinations

## Second Ikeda + Puthuff Combination

15 Q. Sure. For the second  
16 combination, you propose taking Puthuff's  
17 circuit as shown in Figure 1 and dropping  
18 it into Ikeda Figure 1 essentially where  
19 the letters XA and Z appear, basically  
20 where that's pointing; is that right?  
21 A. Looks like as described, we  
22 replace the PD microphone channel. The  
23 output would be used as the output of the  
24 microphone 20. So yeah, the PD microphone  
25 would be replaced by the signal XA from  
2 the first microphone in the Ikeda  
3 reference and then everything would  
4 proceed as before.

Ex. 2004, 37:15-38:4

12 Q. The entire body of Puthuff Figure  
13 1 minus the PD microphone would be  
14 incorporated into Figure 1 of Ikeda; do I  
15 now have it right?  
16 MS. WANG: Objection, form.  
17 THE WITNESS: Yes, that's  
18 correct.

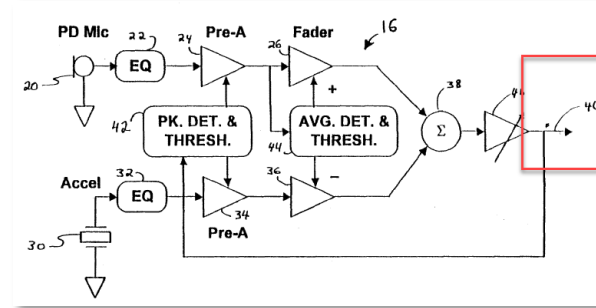
Ex. 2004, 38:12-18

# GROUND 1: Meta's Combinations

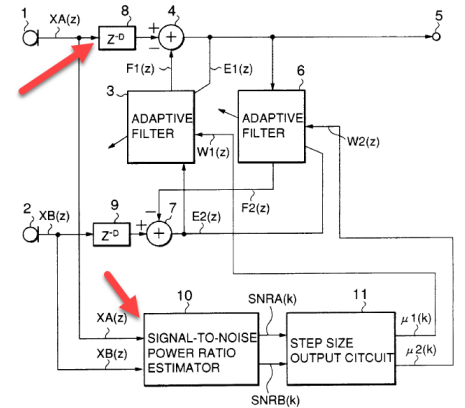
## Second Ikeda + Puthuff Combination

20 Q. So then what we'd have on the  
21 Ikeda side is we would have the signal 40  
22 coming into box 8 and then also box 10,  
23 the signal-to-noise power ratio estimator;  
24 right?  
25 A. The output of -- yes, that would  
2 be correct.

Ex. 1004, 38:20-39:2

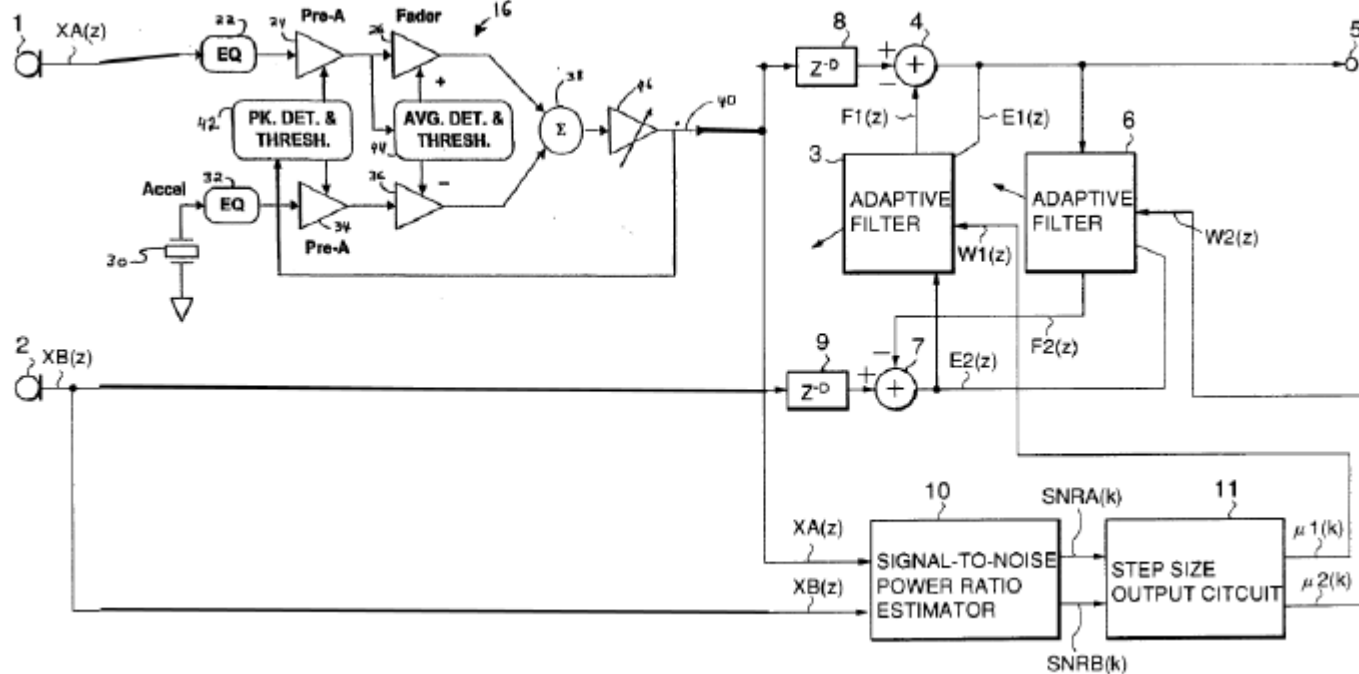


Ex. 1004, Fig. 1



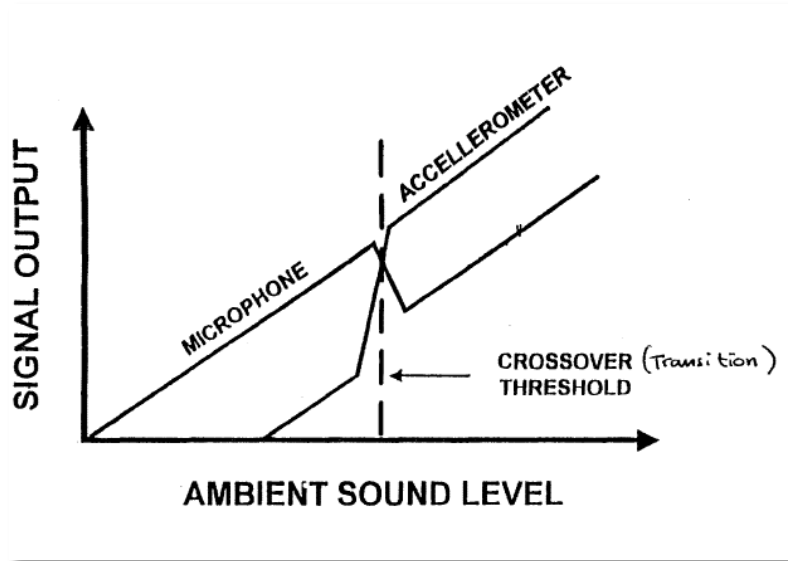
Ex. 1003, Fig. 1

## Second Ikeda + Puthuff Combination



# GROUND 1: Meta's Combinations

## Second Ikeda + Puthuff Combination



Ex. 1004, Fig. 2  
POR, 27-29

$$XA(z) = GA(z)N(z) + HA(z)S(z)$$

Eq. (10)

$$XB(z) = GB(z)N(z) + HB(z)S(z)$$

Eq. (11)

$$W1(z) = GA(z)/GB(z)$$

Eq. (14)

$$W2(z) = HB(z)/HA(z)$$

Eq. (15)

then, there hold:

$$E1(z) = S(z)$$

Eq. (16)

$$E2(z) = N(z)$$

Eq. (17)

Ex. 1003, 5:35-61

# “in response to a determination...”

## Claim 11

11. A system for removing acoustic noise from the acoustic signals, comprising:

a receiver that receives at least two acoustic signals via at least two acoustic microphones positioned in a plurality of locations;

at least one sensor that receives human tissue vibration information associated with human voicing activity of a user;

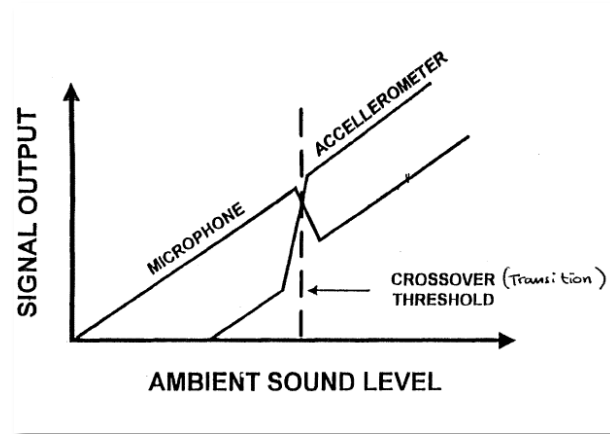
a processor coupled among the receiver and the at least one sensor that generates a plurality of transfer functions, wherein the plurality of transfer functions includes a first transfer function representative of a ratio of energy of acoustic signals received using at least two different acoustic microphones of the at least two acoustic microphones, wherein the first transfer function is generated in response to a determination that voicing activity is absent from the acoustic signals for a period of time, wherein the plurality of transfer functions includes a second transfer function representative of the acoustic signals, wherein the second transfer function is generated in response to a determination that voicing activity is present in the acoustic signals for the period of time, wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce the denoised acoustic data stream.

phones, wherein the first transfer function is generated in response to a determination that voicing activity is absent from the acoustic signals for a period of time,

signals, wherein the second transfer function is generated in response to a determination that voicing activity is present in the acoustic signals for the period of time,

Ex. 1001, cl. 11  
POR, 30-31

# “in response to a determination...”



Ex. 1004, Fig. 2  
POR, 30-31

Yet another advantage of the invention derives from the use of the two modalities of sound transfer--namely, air pressure waves and bone conduction.

Ex. 1004, 6:11-12  
POR, 30-31; Surreply 20.

# “generating a voice activity detection...”

## Claim 1

What we claim is:

1. A method for removing noise from acoustic signals, comprising:

receiving at least two acoustic signals using at least two acoustic microphones positioned in a plurality of locations;

receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user;

generating a voice activity detection (VAD) signal using the voice activity signal;

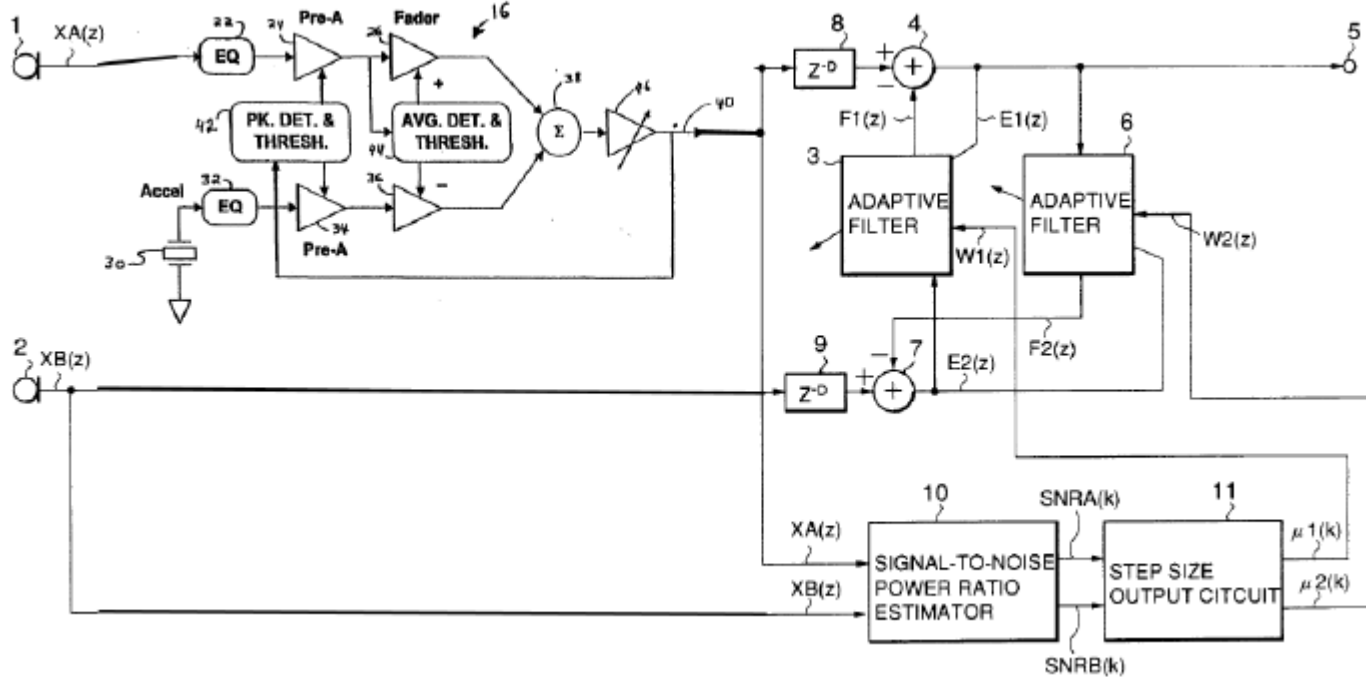
generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function; and

removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

Ex. 1001, cl. 1

receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user;  
generating a voice activity detection (VAD) signal using the voice activity signal;

# “generating a voice activity detection...”

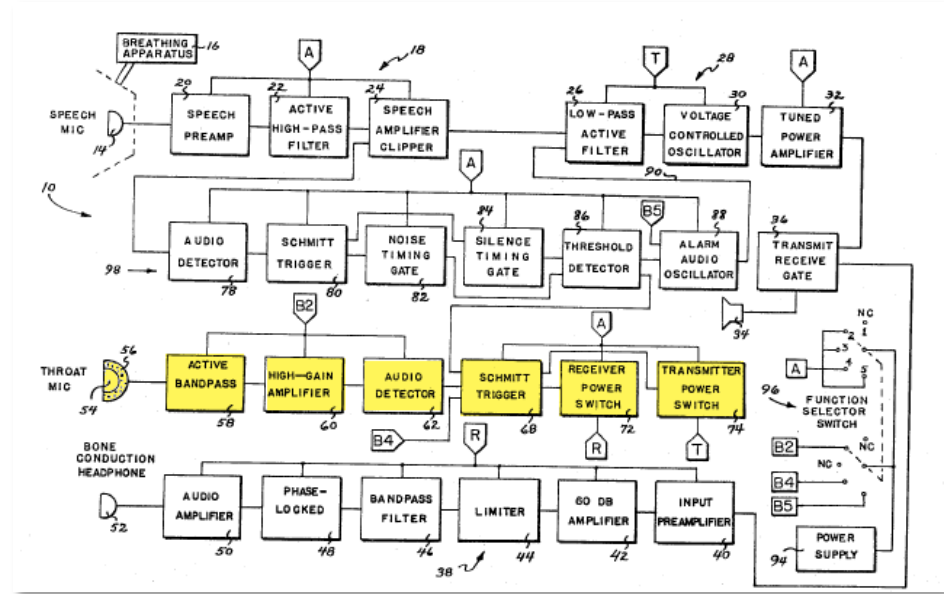


# GROUND 2: Ikeda + Alcivar

## Combination

7 Q. So your proposal is to replace  
8 boxes 10 and 11 of Figure 1 of Ikeda with  
9 components 54, 56, 58, 60, 62 and 68 of  
10 Figure 1 of Alcivar?  
11 A. Yes, that's correct.  
14 THE WITNESS: I'm sorry. Also  
15 possibly boxes 72 and 74. I need to  
16 determine what 72 and 74 actually do.

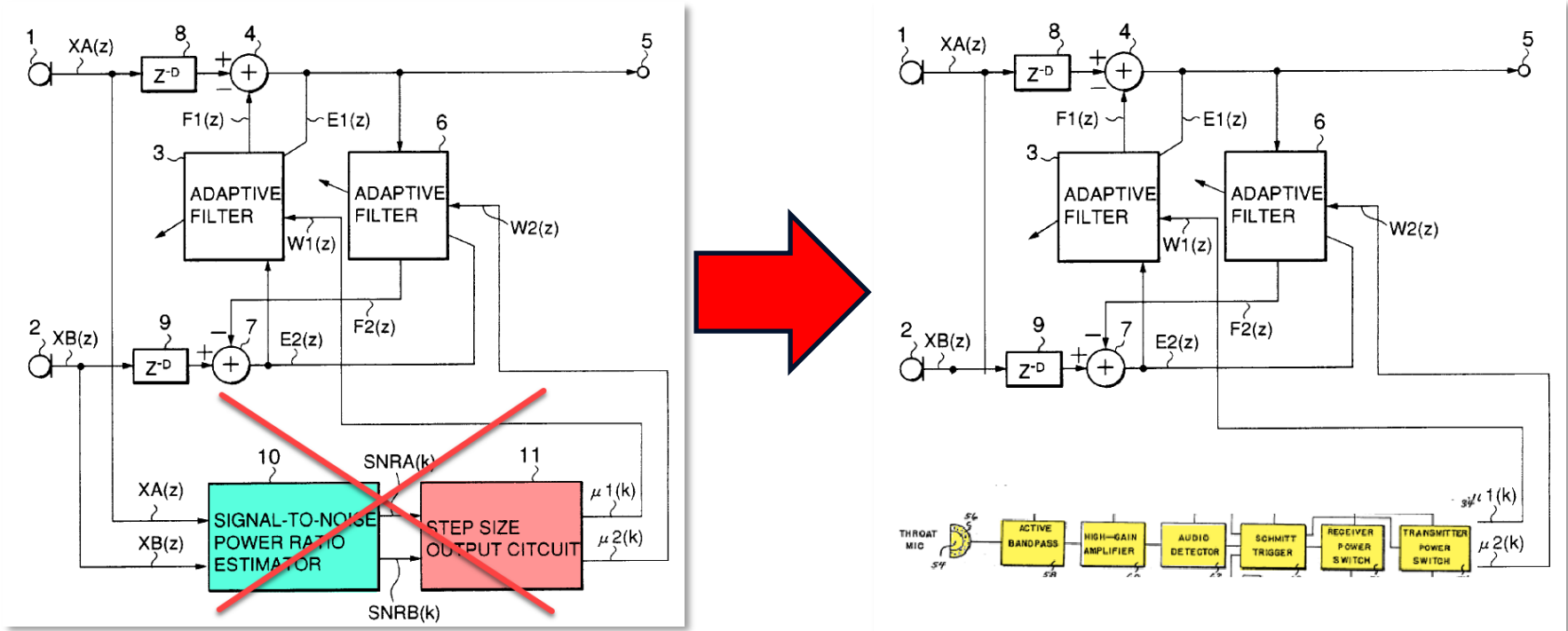
Ex. 2004, 48:7-16



Ex. 1005, Fig. 1

# GROUND 2: Ikeda + Alcivar

## Ikeda + Alcivar Combination



# GROUND 2: Ikeda + Alcivar

## No Motivation

7 Q. So your proposal is to replace  
8 boxes 10 and 11 of Figure 1 of Ikeda with  
9 components 54, 56, 58, 60, 62 and 68 of  
10 Figure 1 of Alcivar?  
11 A. Yes, that's correct.  
12 THE WITNESS: I'm sorry. Also  
13 possibly boxes 72 and 74. I need to  
14 determine what 72 and 74 actually do.

Ex. 2004, 48:7-16

ily performed in the water. The throat microphone 54  
is isolated from waterborne noises by a layer of sound  
absorbing material 56. Preferably the sound absorbing  
material 56 comprises a layer of 3/16 inch mark cellular  
rubber or neoprene of the type normally used to  
construct wet diving suits. If the diver wears a diving

Ex. 1005, 5:21-26

10 Q. So when we are adding the means  
11 disclosed by Alcivar, now we have a throat  
12 microphone that's in physical contact with  
13 the user's throat; correct?  
14 A. That's correct.

15 Q. And that would be connected by a  
16 wire of some sort to the rest of the Ikeda  
17 system; is that right?

\* \* \*

21 Q. Well, at the time of the  
22 invention, what would it be?  
23 A. At the time of the invention it  
24 probably would have been a wire.

Ex. 2004, 50:10-24

# GROUND 2: Ikeda + Alcivar

## No Motivation

15 Q. And in your mind, what's the --  
16 what would someone use your Ikeda/Alcivar  
17 combination for?  
18 MS. WANG: Objection, asked and  
19 answered.  
20 THE WITNESS: For speaking into  
21 microphones in noisy environments and  
22 having the noise removed.

Ex. 2004, 51:15-22

24 Q. What's the noisy environment  
25 you're thinking of?  
2 A. It could be a noisy restaurant,  
3 it could be just stepping inside, it could  
4 be inside a train station, there is an  
5 airport, just talking to a cell phone on  
6 the street. There's many, many, many use  
7 cases.

Ex. 2004, 51:24-52:7

## Alcivar

in such a communications system. However, it is not possible to use the output of the speech microphone 14 for VOX purposes, since it contains breathing noises which would activate the transmitter 28 every time the diver inhales or exhales. Furthermore, it is not possible

Ex. 1005, 4:46-49

# GROUND 2: Ikeda + Alcivar

## No Motivation

### Ikeda

The present invention relates to a noise canceler and, more particularly, to a noise canceler for canceling, by use of an adaptive filter, a background noise signal introduced into a speech signal input via a microphone, a handset or the like.

Ex. 1003, 1:3-8

an output terminal 5. A desired signal  $S(z)$  spoken by a speaker (signal source) is input to the main signal microphone 1 adjoining the speaker's mouth by way of a path having an acoustic transfer characteristic  $HA(z)$ ;  $z$  is expressed as:

Ex. 1003, 1:46-50

an acoustic transfer characteristic  $GA(z)$ . At the same time, the noise  $N(z)$  is input to a reference signal microphone 2 remote from the speaker by way of a path having an acoustic transfer characteristic  $GB(z)$ . The adaptive filter 3 estimates,

Ex. 1003, 1:56-59

# Ground 2 “Motivations”

## Petitioner’s Offered Motivations

1. Ikeda and Alcivar address the same problem
2. Alcivar is cheaper, simpler
3. Alcivar would improve the accuracy of Ikeda’s system
4. Vibration sensors were known

Petition, 50-51