

American GNC Corp.

May 28, 2025 IPR Hearing

Nintendo v. American GNC, IPR2024-00667

U.S. Patent No. 6,508,122



(12) **United States Patent**
McCall et al.

(10) Patent No.: **US 6,671,648 B2**
(45) Date of Patent: ***Dec. 30, 2003**

(54) MICRO INERTIAL MEASUREMENT UNIT

(56) References Cited

(75) Inventors: Hiram McCall, C
Ching-Fang Lin,

(73) Assignee: American GNC C
Valley, CA (US)

(*) Notice: Subject to any disc
patent is extended
U.S.C. 154(b) by s

This patent is sub
claimer.

(21) Appl. No.: **10/017,310**

(22) Filed: **Oct. 22, 2001**

(65) **Prior Publication**

US 2002/0065626 A1 May 30, 2002

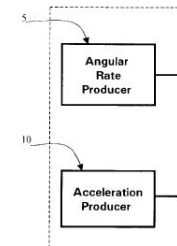
Related U.S. Appli

(62) Division of application No. 09/4
2000.

(51) **Int. Cl.** **G01P 9/04**

(52) **U.S. Cl.** **73/504.12; 73/488; 702/147**

(58) **Field of Search** **702/142, 145, 1**



(12) **United States Patent**
McCall et al.

(10) Patent No.: **US 6,508,122 B1**
(45) Date of Patent: ***Jan. 21, 2003**

(54) **MICROELECTROMECHANICAL SYSTEM
FOR MEASURING ANGULAR RATE**

(75) Inventors: Hiram McCall, Simi Valley, CA (US);
Ching-Fang Lin, Simi Valley, CA (US)

(73) Assignee: American GNC Corporation, Simi
Valley, CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **09/662,438**

(22) Filed: **Sep. 15, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/154,700, filed on Sep. 16,
1999.

(51) **Int. Cl.** **G01P 9/04**

(52) **U.S. Cl.** **73/504.12; 73/488; 702/147**

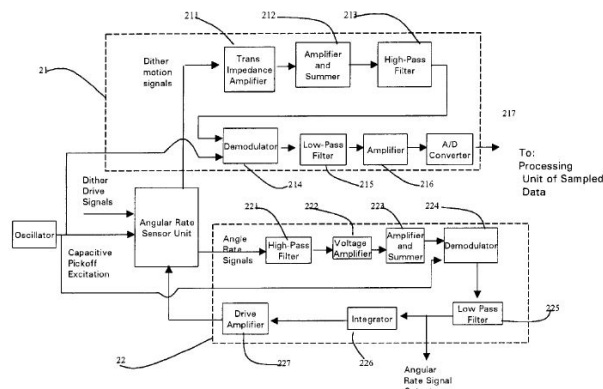
(58) **Field of Search** **73/504.14, 504.15, 504.16, 504.04; 702/145,
147; 700/1, 73, 302, 303, 304; 701/1**

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,131,749 A * 7/1992 Varnham 356/350

16 Claims, 6 Drawing Sheets



American GNC Corp.

Founded by Dr. Ching-Fang Lin in 1986

79 Patents

in inertial sensors, GNSS, and MEMS technology

Many Products

including coremicro™ Inertial Measurement Unit



EX2002



details of inventive work

7. ... When I arrived, the company was investigating **how to build a commercially and technically viable gyroscope from silicon MEMS technology**, as well as an Inertial Measurement Unit (IMU) that would incorporate and utilize such MEMS gyroscope technology. This was seen as a significant technical challenge at the time, in large part due to the difficulties presented by the existing micromechanical sensor designs.



Hiram McCall

Response at 2-3, 32-34; Sur-Reply at 5, 11, 20-22; EX2023 at ¶¶3, 5-20; EX2019 at ¶¶41-48, 81-84

details of inventive work

13. Very early in the invention and design process, **I determined that accurate and reliable electronic control of the dither drive loop would require, and should utilize, digital signal processing.** I was not aware of others having used DSP elements in this application, but expected from my prior digital RF signal processing design experience that this would provide a good solution.



Hiram McCall

Response at 2-3, 32-34; Sur-Reply at 5, 11, 20-22; EX2023 at ¶¶3, 5-20; EX2019 at ¶¶41-48, 81-84

details of inventive work

10. ... We found that doing so was critical to overcoming the problems discussed below—**making the dither motion control loop the crucial place to apply the advanced control and digital signal processing electronics of the inventions.** ... 9:51-54 (claim 1: “...a digital signal processing system analyzing said digital low frequency inertial element displacement signals and feeding back said dither driver signals to said angular rate sensor unit.”). See, e.g., '648 Patent, at 17:29-36 (“**The performance of the dither drive signals is critical for the whole performance of a MEMS angular rate producer.**”)



Hiram McCall

Response at 2-3, 32-34; Sur-Reply at 5, 11, 20-22; EX2023 at ¶¶3, 5-20; EX2019 at ¶¶41-48, 81-84

inventive work was not obvious

84. Again, based on my own understanding of the state of the art at the time, I agree with Mr. McCall that his digital signal processing experience (gained for instance in working on the F-14 and the AMRAAM missile, see EX2023, ¶¶5-6) was **unusual and beyond ordinary skill in the MEMS sensor art at the time**. In my opinion, **an ordinary artisan would not have been motivated to take the inventive step that Mr. McCall did**. See, e.g., EX2023, ¶¶6-14. A person of merely ordinary skill would not have been motivated to undertake the complicated application of digital signal processing in, for example, a MEMS angular rate sensor control loop of the time.



Professor Larson

Response at 2-3, 32-34; Sur-Reply at 5, 11, 20-22; EX2023 at ¶¶3, 5-20; EX2019 at ¶¶41-48, 81-84

inventive work was not obvious

11. **In the capacitive MEMS gyroscopes available at the time of the invention, there were significant unaddressed problems.** For example, mechanical crosstalk was a major issue. Also, low materials quality caused differences from one device to another even in the same design, often requiring individual tuning and calibration to counteract. And of course, the small signal size relative to the many sources of noise made it **nearly impossible to obtain a suitably accurate measurement of angular rate with the analog loop control systems that were being used.** *See, e.g., '648 Patent, at 17:19-28; '122 Patent at 2:1-4.*



Hiram McCall

Response at 2-3, 32-34; Sur-Reply at 5, 11, 20-22; EX2023 at ¶¶3, 5-20; EX2019 at ¶¶41-48, 81-84

Claim 1 ('122 Patent)

1. A microelectromechanical system (MEMS) for measuring angular rate of a carrier, comprising:
 - an angular rate sensor unit receiving dither driver signals, **capacitive pickoff excitation signals** and a displacement restoring signal and outputting angle rate signals in response to motion of said carrier and dither motion signals;
 - a central circuitry receiving said angle rate signals in response to said motion of said carrier and said dither motion signals and outputting angular rate signals and **digital low frequency inertial element displacement signals**; and
 - a **digital signal processing system analyzing** said digital low frequency inertial element displacement signals and feeding back said dither driver signals to said angular rate sensor unit.

EX1001 at claim 1

alleged combinations



alleged combinations

1. A microelectromechanical system (MEMS) for measuring angular rate of a carrier, comprising:

an angular rate sensor unit receiving dither driver signals, **capacitive pickoff excitation signals** and a displacement signal in response to motion of said carrier and dither driver signals in response to motion of said carrier and dither driver signals;
Fujiyoshi + Kumar + Slater + Ristic

a central circuitry receiving said angle rate signals in response to said motion of said carrier and said dither motion signals and outputting angular rate signals and **digital low frequency inertial element displacement signals**; and

a **digital signal processing system analyzing** said digital signals and feeding back said dither driver signals to said angular rate sensor unit.
Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

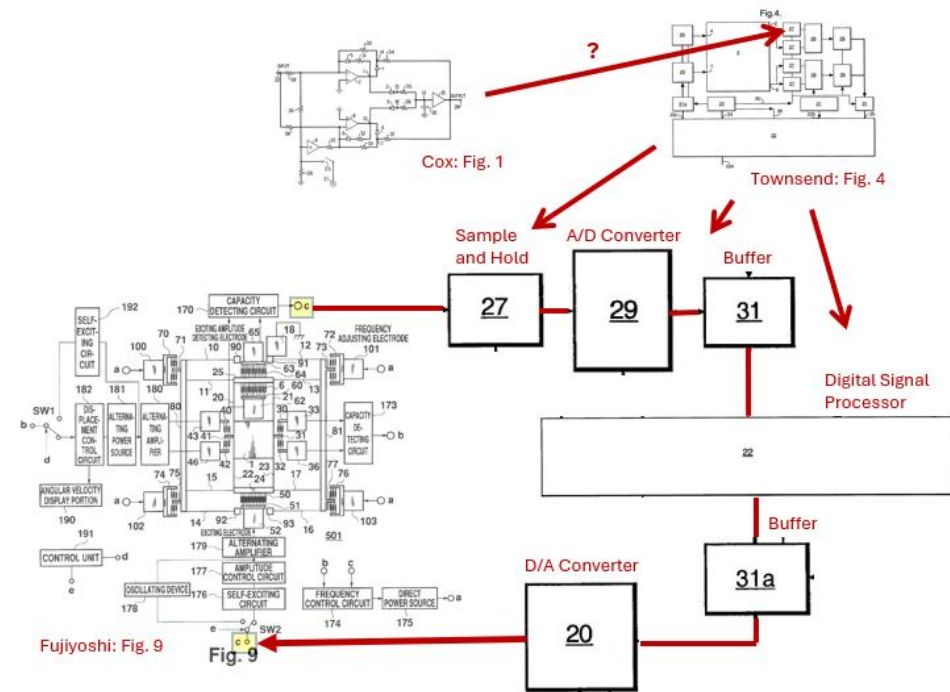
Response at 17, 24-35, 36-40; Sur-Reply at 1-2, 10-16

no motivation to combine

Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

“Professor Young does not cite to any teaching of *Fujiyoshi* to support this opinion, and no disclosure of the reference does so in my opinion. He also does not draw the extent to which he is proposing an ordinary engineer would modify *Fujiyoshi*’s control loop, as **to do so would illustrate how unlikely it would be for a person of ordinary skill to be motivated to add this complicated circuitry in place of a wire.**” EX2019 at ¶¶63-65.



Response at 17, 28-32, 36-40; Sur-Reply at 1-2, 10-16; EX2019 at ¶¶49-50, 62-68, 81-84; EX2020 at 45:20-46:22

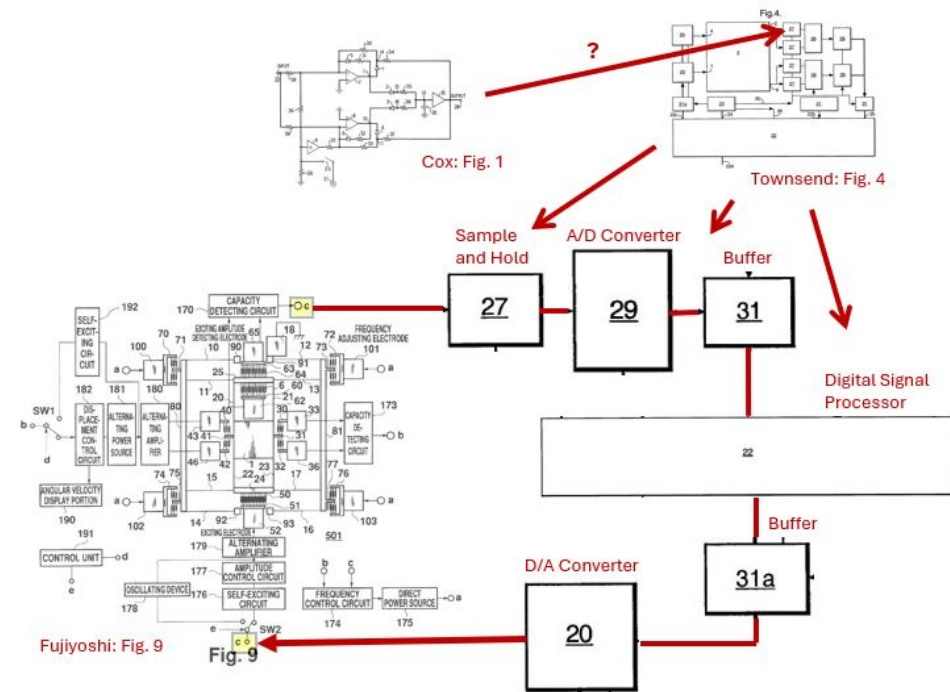
no motivation to combine

Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

Why do all this?!?

Fujiyoshi says it **already achieves benefits with its analog approach**. EX1003, 6:35-52 (“sensor resolution can be improved”), 8:23-48 (“linearity, sensibility, frequency characteristic, temperature characteristic, and the like ... can be improved.”); see *also* EX2019 at ¶¶67.



Response at 28-32, 36-39; Sur-Reply at 10-15; EX2019 at ¶¶49-50, 62-68

no motivation to combine

Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

Claims require a specific use of DSP:

“digital signal processing system **analyzing** said **digital low frequency inertial element displacement signals**” in a dither control loop. EX1001 (claim 1)

Townsend does not teach or suggest this use of DSP.

Response at 28-32; Sur-Reply at 15-16; EX2019, ¶¶67

Even if combined, Nintendo does not even cite from *Townsend* what the DSP would be used to analyze.

22

EX1004, 5 (“digital processing unit 22”), Fig. 2

Response at 28-32, 36-39; Sur-Reply at 10-15; EX2019 at ¶¶49-50, 62-68

no motivation to combine

Concern about “noise” applies to every electrical circuit and is not a specific motivation to combine everything with everything.

Q. Well, I guess what I'm getting at is noise, in some form, is going to be a problem in every MEMS application. It's always an issue; right?

A. I think in all electrical systems -- I mean, **all electrical systems, just to be fair, right, you always have noise** like you said. ...

...

A. I think as an engineer, right -- electrical engineer, you know, **working on electronic circuitry**, I have to look at the noise; right? I cannot ignore the noise.

...

Q. Right. Well, I mean, among those motivations, though, would you agree with me that the -- the sort of mention of noise is a little bit overbroad?

A. **If I only focus on noise, maybe it's overbroad**; right? ...



Dr. Young

EX2020 at 56:6-57:8, 60:2-64:23; EX1002 at ¶164 (“to decrease noise”), ¶ 186 (“noise”)

specific use of DSP was not obvious

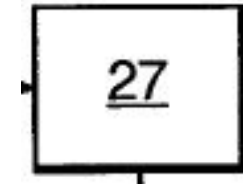
Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

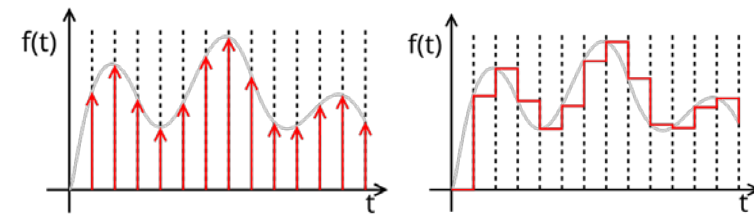
Claims require a specific use of DSP on specific signals:
“digital signal processing system **analyzing** said **digital low frequency inertial element displacement signals**” in a dither control loop. EX1001 (claim 1).

Townsend sample and hold devices do not filter or decrease signal frequency.

Response at 24-28; Sur-Reply at 3-4, 12-13



EX1004, 13 (“sample and hold devices 27”), Fig. 4



Sur-Reply at 3

Response at 24-28; Sur-Reply at 3-4, 12-14; EX2019 at ¶¶49-50, 62-68, 81-84

specific use of DSP was not obvious

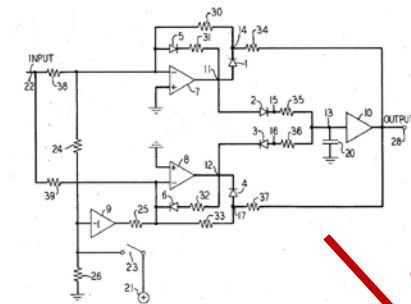
Fujiyoshi + Townsend + Cox + Irwin

Fujiyoshi + Townsend

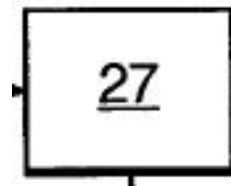
Nintendo provides no motivation, explanation, or support for concept of **redesigning** an unspecified *Townsend* sample and hold circuit to be a filter using *Cox* somehow.

See Reply at 9 (“include a resistive element”)

Nintendo’s suggestion of need for “an anti-aliasing filter for *Townsend*’s analog-to-digital converter circuitry” is a **problem created by the combination with *Townsend***, not a problem with *Fujiyoshi*. *Id.*



EX1006, Fig. 1



EX1004, 13 (“sample and hold devices 27”), Fig. 4

Response at 26-28; Sur-Reply at 2-4, 10-14; EX2019 at ¶¶49-50, 62-68, 81-84

specific use of DSP was not obvious

66. I do not agree that a person of ordinary skill would have found this very complex modification to *Fujiyoshi's* wire "c" to be obvious, and I do not agree they would have been motivated to make that change. My opinion does not change if I assume that the person of ordinary skill was aware of *Townsend*.

67. **The *Townsend* reference does not disclose any specific benefit that would have been deemed applicable to the complete analog feedback loop taught in *Fujiyoshi*.** ... True or not, *Fujiyoshi* taught a person of ordinary skill that its analog feedback loop would solve known problems in the art. There is simply no suggestion to look at other solutions.



Professor Larson

Response at 17, 24-35, 36-40; Sur-Reply at 1-2, 10-16; EX2019 at ¶¶49-50, 62-68, 81-84

specific use of DSP was not obvious

81. The declaration testimony of Hiram McCall, dated January 6, 2024, further confirms my understanding that **it would not have been obvious to a person of ordinary skill to insert a digital signal processing system into the control loop of a sensor like those discussed in the references** identified by Nintendo or Professor Young. In my understanding, confirmed by Mr. McCall, ordinary engineers at the time did not have his experience both with MEMS inertial sensors, and with digital signal processing techniques. *See, e.g., EX2023, ¶¶5-6, 13-14.*



Professor Larson

Response at 17, 24-35, 36-40; Sur-Reply at 1-2, 10-16; EX2019 at ¶¶49-50, 62-68, 81-84

specific use of DSP was not obvious

“... I said that we start the project maybe **around 2003** to 200[4] time frame. **Last about two years.**”

“Q. ... Just to be clear, **that ASIC that you described that you designed and built, that included some digital signal processing**; right?

A: They had some digital components in there, but been number of years. I don't remember exactly what's inside that chip.”

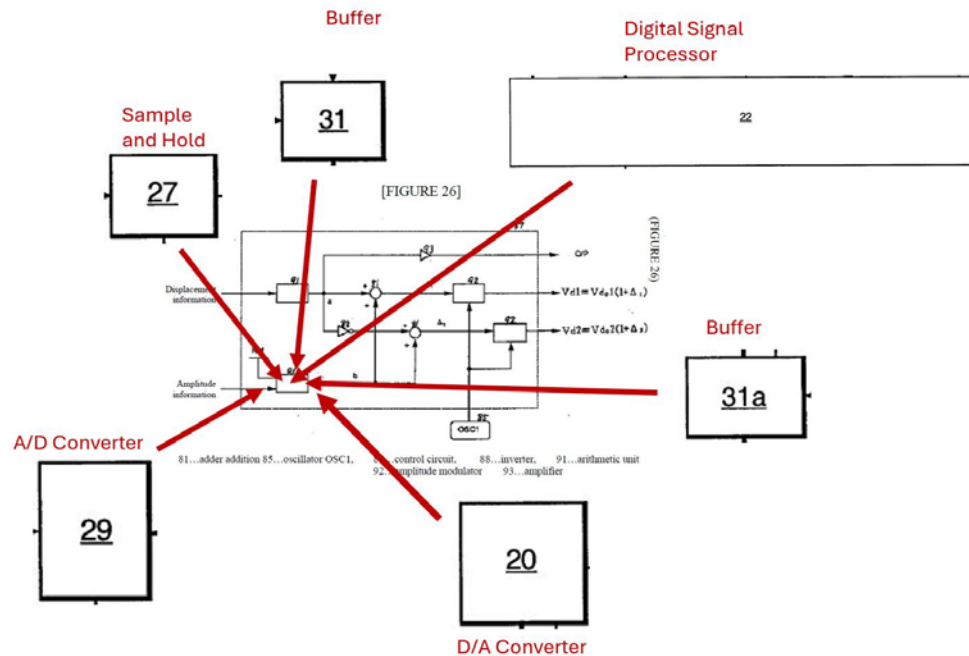


Dr. Young

EX2020 at 77:7-81:13; *see also id.* at 66:22-70:3, 31:24-36:2; EX2021

alleged combinations

Mitamura + Townsend



“Professor Young does not cite to any teaching of *Mitamura* to support this opinion, and no disclosure of the reference does so in my opinion. As with *Fujiyoshi*, he also does not draw the extent to which he is proposing an ordinary engineer would modify *Mitamura*’s control loop, as **to do so would illustrate how unlikely it would be for a person of ordinary skill to be motivated to add this complicated [] digital circuitry to the analog loop discussed in *Mitamura*.**” EX2019 at ¶¶70-72.

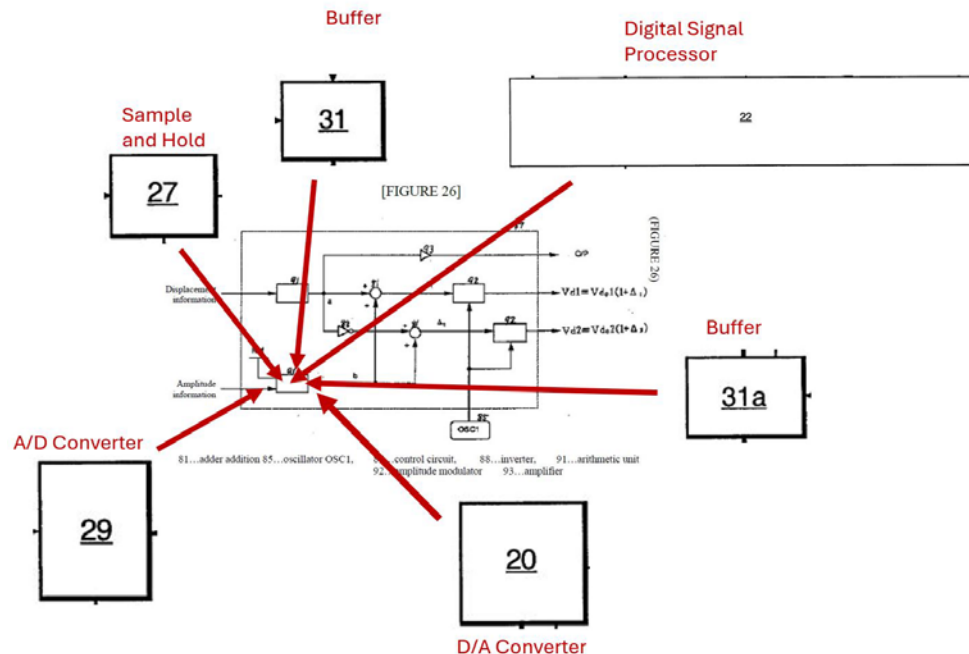
Response at 40-50; Sur-Reply at 6-7, 16-20; EX2019 at ¶¶49-50, 69-75, 81-84

no motivation to combine

Mitamura + Townsend

Again, why do all this?!?

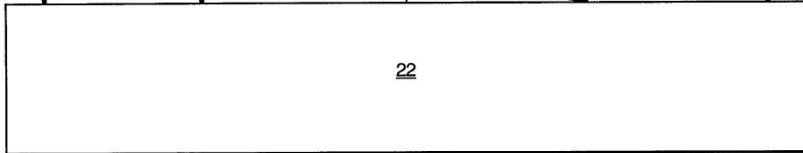
Mitamura says it **already achieves benefits with its analog approach**. EX1010, Abstract (“not susceptible to the effects of noise acceleration and other types of noise and achieves high sensitivity and high precision”); see also EX2019 at ¶¶74.



Response at 40-50; Sur-Reply at 6-7, 16-20; EX2019 at ¶¶49-50, 69-75, 81-84

no motivation to combine

Mitamura + Townsend



EX1004, 5 (“digital processing unit 22”), Fig. 2

Claims require a specific use of DSP:

“digital signal processing system **analyzing** said **digital low frequency inertial element displacement signals**” in a dither control loop. EX1001 (claim 1)

Townsend does not teach or suggest this use of DSP.

Response at 44-48; Sur-Reply at 19-20; EX2019, ¶74

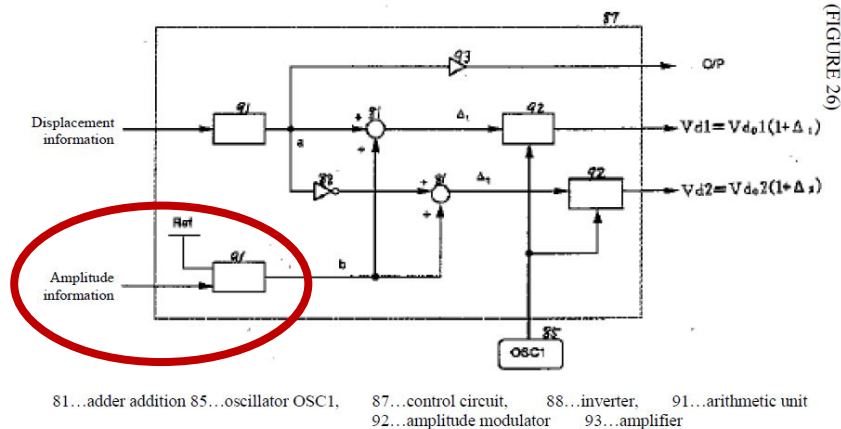
Even if combined, Nintendo does not even cite from *Townsend* what the DSP would be used to analyze.

Response at 40-50; Sur-Reply at 6-7, 16-20; EX2019 at ¶¶49-50, 69-75, 81-84

specific use of DSP was not obvious

Mitamura + Townsend

[FIGURE 26]



“arithmetic unit” 91 is a simple threshold comparison circuit. EX1009, [0046], Fig. 26 (“Ref”); EX2019 at ¶71 (“This function could be performed by a simple analog circuit, such as a subtractor”).

As with *Fujiyoshi*’s node/wire “c” there is no basis for the sheer amount of additional logic Nintendo piles onto this simple analog function in service of trying to invalidate the claims with hindsight. EX2019 at ¶¶49-50, 69-75, 81.

Response at 40-50; Sur-Reply at 6-7, 16-20; EX2019 at ¶¶49-50, 69-75, 81-84

specific use of DSP was not obvious

73. I do not agree that a person of ordinary skill would have found this very complex modification to or after *Mitamura's* arithmetic unit 91 to be obvious, and I do not agree they would have been motivated to make that change. Compared to the simple analog circuit that *Mitamura* discusses for its arithmetic unit, an implementation involving analog-to-digital converters, a digital signal processor, and digital-to-analog converters would be much more complex, and **changing *Mitamura* to use such a system would involve significant design and engineering work.** My opinion does not change if I assume that the person of ordinary skill was aware of *Townsend*.



Professor Larson

Response at 40-50; Sur-Reply at 6-7, 16-20; EX2019 at ¶¶49-50, 69-75, 81-84

considerations of non-obviousness



American GNC's coremicro IMU product

“My circuit designs that led to the '122 and '648 Patents, including the digital signal processing elements of those designs, were **successfully implemented in American GNC's coremicro IMU product**”

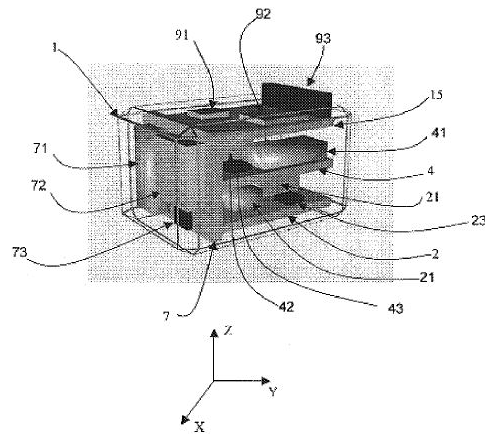


Figure 17

IPR2024-00668, EX1001, Fig. 17



Image of coremicro IMU. See, e.g., EX2002 at 2

EX2023, ¶¶15-20

“AGNC produced the world’s first MEMS rate integrating gyroscope in 1999, setting the stage for continued development of its coremicro® IMU product series”

EX2002 at 2

Response at 2-4, 33-34; Sur-Reply at 8-9, 20-22

American GNC's coremicro IMU product

Inventor McCall worked on the patents and the coremicro IMU together.

EX2024, 16 (“MEMS Provisional patent” and “MEMS Micro IMU Development”)

The coremicro IMU includes the angular rate sensor of the '122 Patent.

EX1001 at 2:31-34 (“the present invention enables the core micro IMU”), 2:43-47, 9:39-54 (claim 1)

American GNC is entitled to a presumption of nexus, because the coremicro IMU product **“is** the invention disclosed and claimed.”

Demaco Corp. v. F. Von Langsdorff Licensing Ltd., 851 F.2d 1387, 1392 (Fed. Cir. 1988);
Polaris Indus., Inc. v. Arctic Cat, Inc., 882 F.3d 1056, 1072 (Fed. Cir. 2018)

Response at 2-4, 33-34; Sur-Reply at 8-9, 20-22

the inventions were successful

20. My circuit designs that led to the '122 and '648 Patents, including the digital signal processing elements of those designs, were successfully implemented in American GNC's coremicro IMU product. I understand that **this product was commercially successful for American GNC** as well.



Hiram McCall

Response at 2-4, 33; Sur-Reply at 8-9, 20-21; EX2023 at ¶¶19-20; EX2019 at ¶48

the inventions were successful

American GNC succeeded before NASA JPL and Draper Labs.

22. For example, **NASA Jet Propulsion Laboratories** attempted to develop a navigation-grade silicon MEMS device, but I understand that it was not robust enough to survive the required environmental testing. Similarly, **Draper Labs** had funding from DARPA to develop such a sensor, but I understand that it did not achieve navigation-grade performance.

JPL - PH II Fengs proposal
substituted with fig 1 and on page 14

4. Business related contacts.

Neil Barber of Draper Labs for MEMS data.

- b) Preparation for a trip to camp Pendleton CDNU on 3/17.
- c) Discussion for tracker Ball Kalman Filter for JPL trip on 4/2
- d) Discussion for Army demonstration on PC 104



Hiram McCall

EX2005 at 3; EX2024 at 1, 4

Response at 2-3, 33-34; Sur-Reply at 8-9, 20-22; EX2023, ¶¶5-23; EX1048, 18:8-15, 18:23-19:11

the inventions were successful

48. ... American GNC was **successful at developing and commercializing a rate-integrating sensor** based on the techniques claimed and patented in the '122 Patent. I understand that American GNC credited their application of signal processing expertise for much of the success of this innovation.

78. ... **I understand that American GNC also received patents, recognition, and citations for its work in MEMS motion sensors.**

83. ... An ordinary engineer 25 years ago would only find digitization, and the application of digital signal processing to MEMS sensor control loops, to be obvious *in hindsight*—that is, *only after* being shown by American GNC how to make a successful application of DSP technology to the control of a MEMS sensor.



Professor Larson

Response at 2-3, 33-34; Sur-Reply at 8-9, 20-22; EX2019 at ¶¶44, 47-49, 78, 81-84; EX1046, 27:3-15

the inventions were cited and licensed

Q. Okay. "From 2015 to the present **Hiram has supported the successful licensing of AGNC patents** (including but not limited to those patents with him as the inventor) **in the areas of silicon MEMS inertial rate sensors and critical interfacing circuits.**" Do you see that?

A. Yes. This is an accurate statement.

EX1048 at 37:18-38:16



Hiram McCall

Response at 3-4, 33; Sur-Reply at 8, 20-22; EX2023 at ¶¶19-20, 21-23; EX2019 at ¶¶48, 78

RPI and Motion for Discovery



RPI and Motion for Discovery

Issue needn't be reached if claims upheld.

Recent Director guidance supports discovery in this proceeding.

Semiconductor Components Industries, LLC v. Greenthread, LLC, IPR2023-01242, Decision on Director Review, Paper 94 (P.T.A.B. April 24, 2025).

Requested discovery is narrowly tailored and appropriate.

Samsung Electronics Co., Ltd. v. Netlist, Inc., IPR2022-00615, 2023 WL 9787488 at *4 (P.T.A.B. Feb. 3, 2023).

The RPI statute applies to STMicro entities, who were “served with a complaint alleging infringement of the patent” here.

35 U.S.C § 315(b).

Response at 61-64; Sur-Reply at 23-25; Paper 41

Thank You

