

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NINTENDO CO., LTD., and
NINTENDO OF AMERICA INC.,
Petitioners,

v.

AMERICAN GNC CORPORATION,
Patent Owner

IPR2024-00667 & -00668
U.S. Patent Nos. 6,508,122 & 6,671,648

**DECLARATION OF HIRAM MCCALL IN SUPPORT OF
PATENT OWNER'S PRELIMINARY RESPONSES**

I, Hiram McCall, declare as follows:

INTRODUCTION

1. My name is Hiram McCall. I am a co-inventor on U.S. Patent No. 6,508,122 (“the ’122 Patent”) and U.S. Patent No. 6,671,648 (“the ’648 Patent”). I am a Systems Engineer with over 45 years of experience designing sensors and control electronics, including at American GNC from 1999 to 2003. I have a Masters degree in Electrical Engineering from Georgia Institute of Technology. I am also a named inventor on twenty-one additional patents, and continue to work on new innovations in MEMS motion sensor technology.

2. I have been asked to provide factual information about the process of invention that led to the filing of what became the ’122 Patent and the ’648 Patent, as well as the accompanying design and prototyping of American GNC’s rate-integrating MEMS gyroscope and MEMS Inertial Measurement Unit product that incorporated those inventions. *See, e.g.*, ’122 Patent, Figure 4; ’648 Patent, Figures 17-19.

3. I understand that Nintendo has challenged the ’122 Patent and the ’648 Patent, claiming that they were obvious at the time based on combinations of other references. I do not believe that my substantial inventive work leading to the filing of the patents was obvious to an ordinary engineer in the field at the time. In truth,

I find this suggestion somewhat insulting. And it is contrary to the commercial and technical success, as well as the recognition by the U.S. Patent Office and industry, that I understand American GNC has received for the inventions. But I understand that I am not being asked for my personal or expert opinion on this matter. Instead, I confine my testimony to the factual context of the inventive work.

4. I have personal knowledge of the facts set forth in this declaration, and, if called upon to do so, I would testify competently thereto. I am not being compensated for my work in preparing this declaration, and I do not have any financial stake in the outcome of these *inter partes* review proceedings.

BACKGROUND OF INVENTIVE WORK AT AMERICAN GNC

5. Prior to coming to work with American GNC as an engineer, I had experience working in digital signal processing in radio frequency (RF) applications. For example, for the transmitter on the F-14 AWG 9 Radar, and the AIM 120 (AMRAAM) Radar transmitter Pulse Repetition Rate Generator.

6. I believe that my level of experience in digital signal processing techniques was out of the ordinary for engineers working in MEMS sensors at the time. I also believe that it was this experience that enabled me to find and apply solutions to problems with those sensors that had eluded others working in the field at the time.

7. At the time I arrived there, American GNC was already known for its

expertise in guidance and navigation systems. The company's Founder and my co-inventor, Dr. Ching-Fang Lin, had already written multiple books and many academic articles about guidance, navigation, and control systems. *See, e.g.*, EX2003, EX2004. 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 micro-mechanical sensor designs.

8. In particular, navigation and guidance products in Aerospace and in other vehicular applications require high precision and stability, which were not available from existing MEMS sensor mechanical designs. To my knowledge, at the time of the invention of the '122 Patent, no one had successfully deployed a small accurate silicon MEMS gyroscope in an aircraft or vehicular navigation product. The micro-mechanical gyro sensors available at the time simply did not work well enough to meet the demands of a real vehicular navigation product.

9. By the late 1990s, silicon MEMS based accelerometers were available and had been used in commercial products, such as automotive airbag sensors. *See, e.g.*, '122 Patent at 1:42-44. A silicon MEMS based accelerometer is a fairly simple, passive device. For example, in automotive airbag sensors, the device is simply

calibrated to trigger when deceleration passes a certain high threshold. Designing commercial products with MEMS acceleration sensors was still a relatively new endeavor with real challenges to overcome, but the primary achievement reflected in the '122 and '648 Patents and related products related to the rate-integrating silicon MEMS gyroscope and its incorporation into a complete IMU.

10. A gyroscope is generally a much more complicated device than an accelerometer. A MEMS gyroscope is an active device, which requires feedback from precisely designed control loops in order to operate. *See, e.g.,* '122 Patent at 7:21-25. For example, a capacitive MEMS gyroscope measures and detects changes in the Coriolis force, due to motion of a tuned, oscillating mass. *See, e.g., id.* at 5:6-34. That oscillation, at a particular resonator frequency, must be precisely maintained. *Id.* 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. *See, e.g., id.* at Abstract, 1:18-21 (“signal processing to obtain a highly accurate, sensitive, stable angular rate measurement of the carrier under dynamic environments”), 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.”).

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.

12. As part of my work for American GNC, as well as from my knowledge of the field at the time, I was familiar with these problems and technical challenges to the successful application of MEMS gyroscopes in viable inertial navigation products. For instance, I was aware that the existing MEMS gyroscope designs did not have sufficient stability and performance to meet what would have been the requirements of an IMU for an aircraft or missile system.

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.

14. For example, I understood that using digital signal processing to integrate the analog measurements of angular rate would be effective to reduce the signal-to-noise ratio and improve accuracy. In addition to the use of digital control of processes affecting resonator performance, digital control of the analog portion of the electronics was found to offer substantial improvement in the performance of the tiny analog signals present in the device. This is a critical issue to improving signal to noise ratio of a tiny MEMS device.

INVENTIVE WORK AT AMERICAN GNC

15. At American GNC, I kept an inventor's logbook, and also prepared detailed weekly status reports, to record our progress and track my activities. For example, my log book beginning on February 6, 1999 reflects work on designing, prototyping, and testing the MEMS micro Inertial Measurement Unit (IMU) product. EX2005 (excerpts).

16. For example, the weekly status report for the week ending February 26, 1999 indicates that: "The design of the dither sensing and drive circuitry is underway." EX2024 at AGNC_NIN0001775. Dither sensing circuitry was complete the week of March 5, 1999. *Id.* at AGNC_NIN0001776. During the week of March 19, 1999, a "specification and top level SW design of the high speed

processing for the accel and gyro data has been completed.” *Id.* at AGNC_NIN0001780. The report for the week ending May 21, 1999 indicated that the drive circuitry schematic would be complete in the next week. *Id.* at AGNC_NIN0001787. During the week of June 4, 1999, driver and phase locked loop (PLL) circuit “is been prepared.” *Id.* at AGNC_NIN0001791.

17. This is consistent with my recollection of circuit design work that I did during the Spring of 1999, leading into testing of working prototypes beginning in the Summer of 1999. For example, the weekly status report for the week ending July 2, 1999 indicates that a working prototype IMU was being tested by June. The report indicates that early tests of the gyro control provided excellent results, with initial drift of “less than .1 deg.hr.” EX2024 at AGNC_NIN0001793.

18. As reflected in my logbook and status reports, my work on the design of the control circuitry and the micro IMU device occupied substantially all of my time for the first half of 1999, and continuing on as the design was tested and improved. This work also led to and included the preparation and filing of the provisional patent application and patent applications that became the issued ’122 and ’648 Patents.

19. My logbook and weekly status reports also reflect contacts and conversations with American GNC customers interested in the IMU products being developed. Some of these entities, and the defense programs they were evaluating

the technology for, were and remain confidential. Broadly, however, the American GNC customers receiving updates during the development of the micro IMU product included the United States Air Force, the United States Army Armament Research, Development and Engineering Center, NASA Jet Propulsion Labs, several universities (for example the USC Robotics Lab), Lockheed Martin, and others.

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 core micro IMU product. I understand that this product was commercially successful for American GNC as well. At this time there had been interest in commercial applications such as UAVs, automobile, and low cost aircraft displays, but due to the lack of existing suitable designs, tiny more accurate devices had not found their way into cell phones, toy drones, or games.

WORK BY OTHERS AT THE TIME

21. As part of my work for American GNC, I became aware of work by others on MEMS sensors that were targeted toward guidance and navigation applications. I believe that none of these companies achieved success at designing and implementing a navigation-grade device prior to American GNC's patents and prototypes.

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.

23. I also understand that Analog Devices was also working on silicon MEMS technology in the late 1990s and early 2000s. For example, inventor John Geen at Analog Devices was awarded multiple subsequent patents that cite to, and copy aspects of, the American GNC '122 Patent. *See, e.g.*, U.S. Patent No. 6,767,758; U.S. Patent App. Pub. Nos. 2004/0211258, 20040211257, 2004/0211256.

SUBSTITUTION OF MEMS SENSORS FOR CONVENTIONAL

24. I understand that it has been suggested by Nintendo that it would have been obvious for an ordinary engineer to replace the accelerometer and gyroscope elements in a conventional system, such as one using a ring laser gyroscope, with MEMS acceleration and rate sensors. I wholeheartedly disagree with this position.

25. In 1999 and since then, the specifics of the required control system electronics for a gyroscope or an IMU design are dependent on the sensor technology type. Changing one sensor technology for another is not less work than designing from scratch with a MEMS sensor. As my own work discussed above showed, it required substantial expertise, design, and experimentation to produce the American GNC coremicro IMU product.

CONCLUSION

26. This declaration and the statements herein are made to the best of my knowledge and understanding, based on the material available to me at the time. All statements made on my knowledge herein are true and all statements made on my belief are believed to be true.

Executed this 6th day of January, 2025.

By: Hiram McCall
Hiram McCall