

Greetings to the Japan Audio Society Introduction to Knowles Corporation

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ABSTRACT

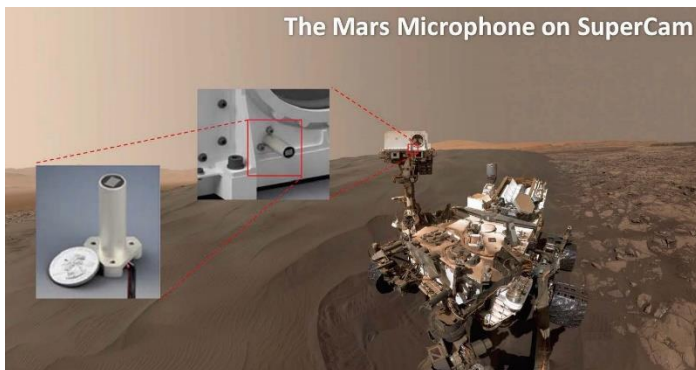
Knowles Corporation is a global provider of advanced micro balanced armature drivers, MEMS microphones, and audio processors for hearing aids, music earphones including TWS (True Wireless System), mobile phones, smart speakers, and many other products using acoustics for communication, monitoring, or control. We will introduce our company and some of the key areas in which we work today. Then we will describe in more detail one important area where Knowles is making significant investments: Balanced armature drivers for earphones including TWS. We will also share our work to support using balanced armatures with Active Noise Cancellation (ANC) since both are becoming more popular in TWS earphones. We thank the JAS for the opportunity to join and look forward to learning from and contributing to the knowledge shared by members.

1. Introduction

Knowles Electronics Japan K. K. is pleased to announce that we joined Japan Audio Society as a corporate member in April 2020. As a pioneer of Balanced Armature and MEMS microphones, the company has been supplying devices for audio products. With the rapid growth of true wireless earphones (TWS), the company's key technologies, which enable miniaturization and power savings while maintaining sound quality, are now receiving even more attention. We hope to contribute to the spread of High-Reso audio from the standpoint of a component supplier through interaction with our members.

2. History and Products

Mr. Hugh Knowles founded the company in 1946. He is most famous for developing the micro

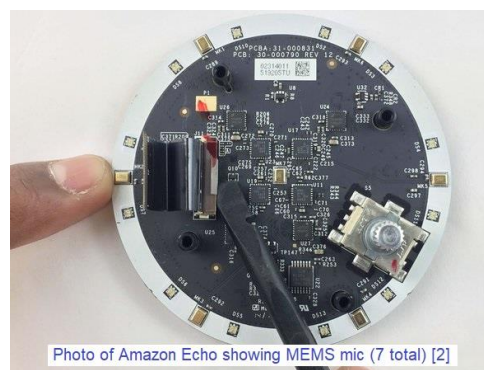


balanced armature microphone and speaker in 1954. These devices, along with transistors and miniature batteries, allowed hearing aids to be small enough to wear on the face. Previous hearing aids were in a box that one clipped to their pocket or belt. Knowles Corp. is also known for

providing the microphones used in the headsets for the Apollo astronauts. When Neil Armstrong spoke from the moon, it was through the Knowles microphone. (Another Knowles microphone will be part of the Mars 2020 mission launching this summer.) [1]

Another major contribution to acoustics by Knowles is the introduction of the MEMS microphone in 2002. Today Knowles is the largest supplier of MEMS microphones, shipping several billion units annually. Though MEMS microphones were originally used exclusively in mobile phones, today increasing numbers are used in headphones, smart speakers, and other IoT devices with voice control. Knowles continues to introduce new microphone models designed to give optimum performance for each of these markets.

Whereas originally one microphone was used in a mobile phone or headset, today several microphones are often used in the same device. For example, a smart speaker uses up to seven microphones, a mobile phone three or four, and a TWS earphone with ANC uses four or six. This is one reason for the rapid increase in MEMS microphone demand.



More recently Knowles also introduced the SmartMic, a MEMS microphone with DSP chip included. This allows the microphone itself to listen for a wake word and turn on the device's main processor when invoked. Since the power consumption of the microphone is much less than the main processor, the smart mic helps reduce power consumption when idling. Knowles also introduced a line of audio DSPs which can be used to provide voice commands in devices such as white goods, thermostats, etc.

3. Balanced Armature Operating Principle

As the name implies, moving coil speakers have a stationary magnet and a coil that is attached to the moving diaphragm. The moving coil speaker performance is influenced by the mass of both the diaphragm and the coil.

In a balanced armature, both the coil and magnet are stationary. The audio signal in the coil induces a corresponding magnetic field in a reed, which is between two magnets and allowed to move. The moving reed is attached to the diaphragm. Because the coil is not part of the moving components, its mass does not affect the performance of the driver. The coil can be wound with more turns and be as large as physically practical for the overall size of the driver. Balanced armatures can be made smaller and are more efficient in small sizes than moving coil speakers. This is the reason they were originally designed for hearing aids and why their adoption is increasing in TWS earphones. The impedance of balanced armature coils can also

be made much higher than for moving coil speakers. High impedance coils are often used together with Class D drive.



4. Balanced Armatures for Earphones

Beginning in the 1980's audio engineers began using hearing aid balanced armature drivers to create in-ear monitors for musicians. Balanced armatures were chosen because of the precision with which they reproduced sound and because they provided more passive isolation than moving coil speakers. As in-ear monitors became more popular with musicians, and later with audiophiles, Knowles developed balanced armatures specifically for music. Because they are so small, multiple drivers can be used in a single earphone. This led to the development of specialized drivers (woofer, midrange, tweeter) for increased performance, just as with loudspeakers. Today many companies make earphones with multiple balanced armature drivers. Because of their small size, balanced armature drivers

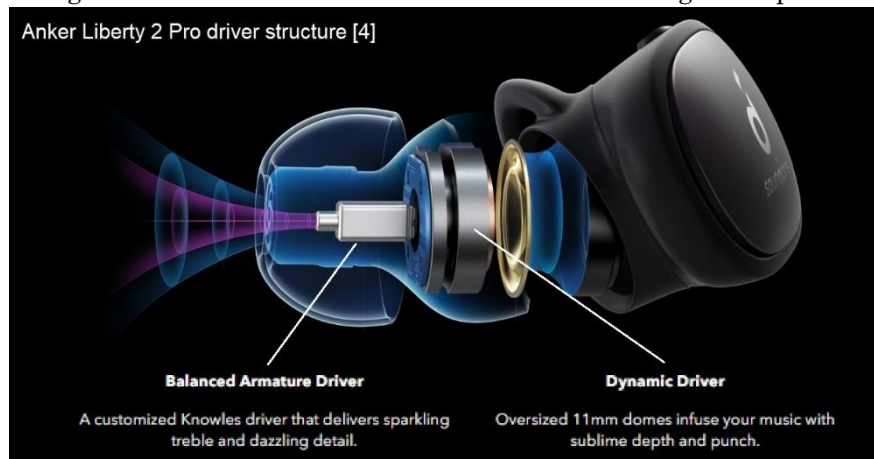
are increasingly used in TWS earphones as well. For example, the Amazon Echo Buds uses a 2-way balanced armature woofer-tweeter combination. [3]



5. Hybrid Drivers

An increasingly popular option in earphones is the hybrid driver combining a moving coil speaker and balanced armature driver. There are multiple reasons for this. One is to deliver premium sound while retaining the familiar bass characteristic of a moving coil speaker. This is the approach taken by Anker in the Liberty 2 Pro TWS earphone.

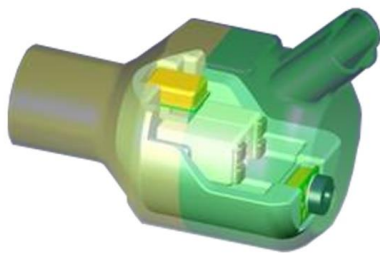
Another reason is to provide premium sound and ANC in a smaller size. ANC requires a speaker that is very responsive in the bass region. To provide the necessary bass while



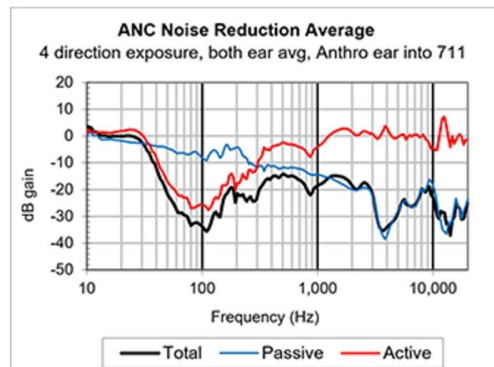
retaining pleasing treble performance requires a larger speaker. By designing the moving coil speaker to concentrate on the bass performance and using a tiny balanced armature tweeter, first-in-class ANC combined with premium sound can be achieved in a smaller package. Sony took this approach in the WI-1000X. [5][6]

6. ANC with Balanced Armatures

In a hybrid earphone, the moving coil speaker is responsible for producing the ANC anti-noise signal. Therefore, developing an ANC system in a hybrid earphone is very similar to an earphone with only a moving coil speaker. ANC can also be implemented with a balanced armature driver provided certain guiding principles are followed. Because there is increasing interest in developing ANC for compact TWS earphones using balanced armatures, Knowles has made considerable effort to gain a deep understanding of what is required. This knowledge is available to companies wishing to create balanced armature earphones with ANC. [7]



Knowles-developed ANC test earpiece with twin BA model RAB and two SiSonic MEMS mics. [7]



7. Conclusion

Knowles is continuously making advances in the design and efficient manufacturing of miniature acoustic transducers. We look forward to sharing our expertise and advancing the state of the art in audio design together with other JAS member companies.

Citations

- [1] [The Mars Microphone onboard Supercam for the Mars 2020 rover](#), pg. 18
- [2] [Amazon Echo LED/Microphone Board Replacement](#)
- [3] <https://www.amazon.com/Echo-Buds/dp/B07F6VM1S3>
- [4] <https://www.soundcore.com/products/variant/liberty-2-pro/A3909011>
- [5] [1000X Series Developer Interview](#)
- [6] <https://www.sony.jp/headphone/products/WI-1000X/>
- [7] [Earphones with Noise Cancellation: Balanced Armatures Support ANC While Delivering Premium Sound](#)

Author profile

Andrew Bellavia: Since joining Knowles in 2012, Bellavia has been involved in the development of in-ears ranging from traditional audio brands like AKG to the latest hearables from companies such as Amazon. Andrew is also an advocate for protecting one's hearing, and for the role technology can play in addressing hearing loss. When not in the office he can usually be found running the roads near his home, and until recently around the world, often photographing as he goes.

Hiroshi Suzuki: Suzuki has been promoting and supporting Knowles audio products to its customers in Japan since joining Knowles as country manager. Prior to Knowles, Suzuki worked as an independent consultant to support Japan entry of high-tech companies. Suzuki also worked at various high-tech companies such as Synaptic and Motorola Mobility as Japan county manager. He spends most of the time outdoor in weekends.