

Filed on behalf of Luxottica of America Inc. and Meta Platforms, Inc.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LUXOTTICA OF AMERICA INC.
AND
META PLATFORMS, INC.,

Petitioners

v.

SOLOS TECHNOLOGY LIMITED,

Patent Owner

Case IPR2026-00413
U.S. Patent No. 11,871,174

**DECLARATION OF MICHAEL T. JOHNSON, PH.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,871,174**

Luxottica et al. v. Solos IPR2026-00413 Petitioners' Ex. 1003
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(i)	[1.pre] “A method to provide audio signals to a user from an eyewear device, comprising;”	46
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(iii)	[1.b] “concentrating the audio signals for delivery to the user’s ear”	49
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	(iii)	[14.b] “at least one speaker, the at least one speaker to generate audio signals, the at least one speaker is contained within the volume”	155
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	2. Claim 6	169
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	3. Claims 7 and 8	170
	(i) 7. “The method of claim 6, wherein the portion is forward of the chamber.”	170
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4.	Claim 9	172
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(ii)	25. “The apparatus of claim 24, the portion absorbs vibrational energy.”	177
(iii)	26. “The apparatus of claim 25, wherein the portion is forward of the chamber.”	177

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I, Michael T. Johnson, Ph.D., declare as follows:

I. INTRODUCTION

1. I have been retained as an expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”) regarding U.S. Patent No. 11,871,174 (“the ’174 patent”) (EX1001).¹ I have been asked to analyze the scope and content of the ’174 patent relative to the state of the art at the time of the earliest application to which the ’174 patent claims priority. My analysis relates to claims 1-28 (“the challenged claims”) of the ’174 patent. I have also been retained to provide analysis regarding what a person of ordinary skill in the art (“POSITA”) would have understood at the time of the earliest application underlying the ’174 patent.

2. This declaration summarizes the opinions I have formed to date. I reserve the right to modify or amend my opinions, if necessary, based on further review and analysis of information that I receive subsequent to the filing of this declaration, including in response to positions taken by Solos Technology Limited (“Solos”) or its experts that I have not yet seen, such as any secondary considerations evidence that Solos or its expert may consider and present.

¹ In this declaration, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the ’174 patent.

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3. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study and analysis, the substance of my opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or in any litigation involving the '174 patent.

II. BACKGROUND AND QUALIFICATIONS

4. My experience and qualifications are summarized in my curriculum vitae ("CV"), a copy of which is provided as Exhibit 1004.

5. My educational background includes undergraduate degrees in both Computer Science Engineering and Electrical Engineering from LeTourneau University in Longview, Texas, in 1989 and 1990, respectively, and a Master's degree in Electrical Engineering from the University of Texas at San Antonio in 1994. I earned a Ph.D. from Purdue University in West Lafayette, Indiana, in 2000, with a doctoral dissertation focused on speech processing and automatic speech recognition. Prior to receiving my Ph.D., I worked in industry as a design engineer and engineering manager for more than 5 years, primarily in the telecommunications industry. My industry experience included work as a design and hardware engineer

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and engineering manager on telecommunications, networking, videoconferencing, and embedded-microprocessor products, including responsibility for new-product design and development.

6. I am currently a Full Professor in the Department of Electrical and Computer Engineering at the University of Kentucky (UK) in Lexington, Kentucky. I also currently serve as the Associate Dean for Undergraduate Education and Student Success in the Stanley and Karen Pigman College of Engineering at the UK, a role I have held since July 2023.

7. I previously served as the Electrical and Computer Engineering Department Chair from 2016 to 2023.

8. Prior to my faculty role at UK, I was a faculty member at Marquette University in Milwaukee, WI from 2000 to 2016, during which time I also spent two separate sabbatical years as a Visiting Professor at Tsinghua University in Beijing, China.

9. My research focuses on speech, audio, acoustics, and signal processing. My work includes speech recognition and enhancement, natural language processing, bioacoustics, microphone array processing, signal enhancement, pattern recognition, and machine learning. I have authored or co-authored approximately 50

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journal papers and more than 150 refereed publications and presentations, including publications concerning audio and speech processing, speech enhancement, acoustic-to-articulatory inversion, bioacoustic signal analysis, microphone-array and multichannel signal processing, speaker recognition, and acoustic classification. Through this work, I have developed substantial experience with the generation, capture, analysis, enhancement, and interpretation of acoustic signals, including signals produced by speakers or other sound sources and received by listeners, sensors, or audio-processing systems. I have received multiple research grant awards for my work in these areas, including from the National Science Foundation and the National Institutes of Health.

10. As a faculty member, I regularly teach both undergraduate and graduate courses in electrical and computer engineering, primarily in the areas of computers, signal processing, machine learning, speech processing, and audio/acoustic signal processing. These courses include graduate-level speech and signal-processing courses that address acoustic signal generation, propagation, spectral analysis, filtering, enhancement, and the behavior of acoustic devices and systems. These topics are directly relevant to the acoustic principles at issue in this proceeding,

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including speaker-generated audio signals, acoustic chambers and ports, sound concentration and directionality, and delivery of audio signals to a listener.

11. My professional service also reflects my work in acoustic, audio, and signal-processing fields. I am an active member of the Institute of Electrical and Electronics Engineers (IEEE), the IEEE Signal Processing Society, the Acoustical Society of America (ASA), and the Electrical and Computer Engineering Department Heads Association (ECEDHA). I served as a member of the IEEE Signal Processing Society Speech and Language Technical Committee from 2014 to 2017, and regularly serve as a reviewer for journals, conferences, and workshops in the area of speech and signal processing, including IEEE Transactions on Acoustics, Speech, and Signal Processing, IEEE Transactions on Signal Processing, the Journal of the Acoustical Society of America, Speech Communication, the International Conference on Acoustics, Speech, and Signal Processing, the IEEE Workshop on Automatic Speech Recognition, and Interspeech. I have reviewed funding proposals for a number of public and private agencies and foundations, including for multiple programs and directorates at the National Science Foundation. In addition to these manuscript and grant proposal reviewing activities, I also currently serve as Area Editor for the journal Speech Communication in the area of speech enhancement.

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12. During my academic career, I have been honored to receive a number of awards for my teaching and research work. Notable awards have included the College of Engineering Researcher of the Year at Marquette University in 2007, Milwaukee Young Engineer of the Year in 2006, and Electrical and Computer Engineering Eta Kappa Nu Teacher of the Year in 2005 and 2014. In 2008, my work applying speech recognition technology to animal vocalizations was featured in the Milwaukee Journal-Sentinel series “Groundbreaking Thinkers in Wisconsin.”

13. A detailed record of my professional qualifications, including a list of publications, awards, and professional activities, is set forth in my CV, submitted as EX1004.

III. MATERIALS REVIEWED

14. The opinions contained in this declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding systems and processes for providing user audio.

15. In forming my opinions expressed in this Declaration, I reviewed the following materials:

EX1001	U.S. Patent No. 11,871,174 to Villalpando <i>et al.</i> (“the ’174 patent”)
EX1002	Excerpts from Prosecution History of the ’174 patent

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EX1004	Curriculum Vitae of Michael T. Johnson, Ph.D.
EX1005	English Translation of Matsunari from EX1013
EX1006	U.S. Patent Application Publication No. 2014/0268016 to Chow <i>et al.</i> (“Chow”)
EX1007	English Translation of Ono from EX1014
EX1008	U.S. Patent No. 6,301,367 to Boyden <i>et al.</i> (“Boyden”)
EX1009	English Translation of Higuchi from EX1015
EX1010	U.S. Patent No. 7,306,332 to Chen <i>et al.</i> (“Chen”)
EX1011	U.S. Patent App. Publ’n No. 2003/0002703 to Ma (“Ma”)
EX1013	Declaration of John Andrews for Translation of Japanese Unexamined Patent Application Publication No. JP2016039632A to Matsunari (“Matsunari”)
EX1014	Declaration of John Andrews for Translation of Japanese Unexamined Patent Application Publication No. JPH02104200A to Ono (“Ono”)
EX1015	Declaration of John Andrews for Translation of Japanese Unexamined Patent Application Publication No. JPS5681814A to Higuchi (“Higuchi”)
EX1017	International Patent Application Publication No. 2020/161545 to Villalpando <i>et al.</i>
EX1018	Japanese Patent Publication No. 7295253B2 to Villalpando <i>et al.</i>
EX1019	Leo L. Beranek & Tim J. Mellow, <i>Acoustics: Sound Fields and Transducers</i> , Academic Press (2012), Chapter 10 (“Beranek”)

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EX1020	Harry F. Olson, <i>Music, Physics and Engineering</i> , Dover Publications, 2d ed. (1967), Chapters 4 and 9 (“Olson”)
EX1021	Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens & James V. Sanders, <i>Fundamentals of Acoustics</i> , John Wiley & Sons, 4th ed. (2000), Chapters 1, 4, and 6-7 (“Kinsler”)
EX1023	Jack Katz, <i>Handbook of Clinical Audiology</i> , Wolters Kluwer, 7th ed. (2015), Chapters 4 and 38-39 (“Katz”)
EX1024	Harvey Dillon, <i>Hearing Aids</i> , Boomerang Press, 2nd ed. (2012), Chapter 5 (“Dillon”)
EX1025	A. N. Thiele, “Loudspeakers in Vented Boxes, Part I,” <i>Journal of the Audio Engineering Society</i> , vol. 19, no. 5 (1971) (“Thiele Part I”)
EX1026	A. N. Thiele, “Loudspeakers in Vented Boxes, Part II,” <i>Journal of the Audio Engineering Society</i> , vol. 19, no. 6 (1971) (“Thiele Part II”)
EX1027	W. E. Kock & F. K. Harvey, “Refracting Sound Waves,” <i>Journal of the Acoustical Society of America</i> , vol. 21, no. 5 (1949) (“Kock & Harvey”)
EX1028	Allan D. Pierce, <i>Acoustics: An Introduction to Its Physical Principles and Applications</i> , McGraw-Hill (1981), Chapter 3 (“Pierce”)
EX1029	Philip M. Morse & K. Uno Ingard, <i>Theoretical Acoustics</i> , McGraw-Hill (1968), Chapters 6 and 8 (“Morse & Ingard”)
EX1030	Jean-François Allard & Noureddine Atalla, <i>Propagation of Sound in Porous Media</i> , John Wiley & Sons, 2nd ed. (2009), Chapters 2-4 (“Allard & Atalla”)

I also considered any other documents and materials I refer to in this declaration.

16. My opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a POSITA would have understood the state of the art, the prior art, and the claims and the specification of the '174 patent at the time of the alleged invention, which I discuss below.

17. I have been asked to consider that the time of the alleged invention of the '174 patent was no later than December 12, 2018, which corresponds to the filing date of the earliest application associated with the '174 patent.

18. Based on my experience and expertise, it is my opinion that certain references disclose or would have suggested to a POSITA all the features recited in the challenged claims of the '174 patent, as I discuss in detail below.

IV. PERSON OF ORDINARY SKILL IN THE ART

19. I understand that in determining the level of ordinary skill in the art, several factors are considered. Those factors may include: (i) the type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) the rapidity with which innovations are made; (iv) the sophistication of the technology; and (v) the educational level of active workers in the field. A POSITA must have the capability

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of understanding the scientific and engineering principles applicable to the pertinent art.

20. I am familiar with the level of ordinary skill in the art regarding the '174 patent as of around December 12, 2018. Considering the '174 patent, the technology, the educational level and experience of workers in the field relating to the patent, and problems and solutions in that field, and drawing on my own experience, I believe a person of ordinary skill in the art at the time of the alleged invention (around December 12, 2018) would have had at least a bachelor's degree in mechanical engineering, manufacturing engineering, mechatronics, electrical engineering with coursework in mechanical engineering, manufacturing engineering, or mechatronics, or a similar technical degree, such as one related to acoustic design. A POSITA would have also had at least two years of experience in eyewear design, consumer-electronics design, and/or acoustic design. Work experience could substitute for formal education and additional formal education could substitute for work experience.

21. My opinions in this declaration regarding the '174 patent and the prior art (including the state of the art) are from the perspective of one of ordinary skill in

the art as I defined above, during the relevant timeframe (e.g., the time of the alleged invention), which I discussed above as being around December 12, 2018.

22. I can make this assessment because, before and around December 12, 2018, I was familiar with the design and implementation of audio and acoustic signal-processing systems, speech- and audio-processing systems, microphone arrays, digital signal-processing systems, signal enhancement, filtering, pattern recognition, machine learning, and related signal-processing techniques. Through my teaching, research, publications, and work with students and engineers, I was familiar with what engineers and researchers in these fields would have known and been able to implement at that time. Based on my education and experience in electrical engineering, engineering design, audio, and acoustics, I had at least the level of ordinary skill described above by the relevant time.

23. As discussed below, it is my opinion that claims 1-28 of the '174 patent are rendered obvious in view of the prior art discussed below. It is also my opinion that reasonable variations in the precise formulation of the level of ordinary skill in the art would not materially alter the opinions I express below.

V. UNDERSTANDING OF RELEVANT LEGAL PRINCIPLES

24. I understand that statutory and judicially created standards must be considered in determining whether a patent claim is unpatentable. I am not an attorney and, consequently, will offer no opinion on the law itself. My understanding of the pertinent law is described in this section and is the result of explanations provided by counsel. I have applied this understanding in my analysis.

25. I understand that a patent claim is unpatentable if it would have been obvious in view of the prior art. I further understand that, for purposes of the '174 patent, obviousness is assessed from the perspective of a person of ordinary skill in the art before the effective filing date of the claimed invention. I have been asked to assume that December 12, 2018 is the relevant effective filing date for the challenged claims. I have not been asked to determine whether that date is appropriate.

26. In analyzing obviousness in light of the prior art I have been informed that it is important to understand the scope of the claims, the level of skill in the relevant art, the scope and content of the prior art, the differences between the prior art and the claims, and any objective indicia of non-obviousness (also called secondary considerations).

27. I have been informed that a patent claim is unpatentable for obviousness if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious, before the effective filing date of the claimed invention, to a person of ordinary skill in the art. I have been informed that obviousness may be based on one reference or a combination of references. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

28. I understand that a reference is analogous art if it either (1) is from the same field of endeavor as the claimed invention, or (2) is reasonably pertinent to a particular problem with which the inventor was involved. A reference outside the same field of endeavor may therefore still qualify as analogous art if it is reasonably pertinent to the problem addressed by the claimed invention.

29. To assess the differences between prior art and the claimed subject matter, it is my understanding that the law requires the claimed invention to be considered as a whole. This “as a whole” assessment considers whether, from the perspective of a POSITA at the relevant time and without hindsight, the prior art and

knowledge in the field would have provided a reason to select and combine the relevant teachings in the claimed manner, with a reasonable expectation of success.

30. It is my understanding that something is “inherent in,” and therefore taught by, the prior art, if it necessarily flows from the explicit disclosure of the prior art. I understand that the fact that a certain result or characteristic may be present in the prior art is not sufficient to establish inherency. However, if the result or characteristic is necessarily present based upon the explicit disclosure in the prior art, it is inherent in the prior art and is therefore disclosed.

31. I have been informed that when a patented invention is a combination of known elements, the Patent Trial and Appeal Board must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in a field or present in the marketplace, and the background knowledge possessed by a POSITA.

32. I have been informed that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of the claimed subject matter. I understand that several of these rationales are: (1) combining prior art elements according to known methods to yield predictable

results; (2) simple substitution of one known element for another to obtain predictable results; (3) use of a known technique to improve a similar device (method or product) in the same way; (4) applying a known technique to a known device (method or product) ready for improvement to yield predictable results; (5) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; (6) and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

33. I have been informed that in order to prove that a claimed invention is not patentable for obviousness, a petitioner must (1) identify the differences between the claim and particular disclosures in the prior art references, singly or in combination, (2) specifically explain how the prior art references could have been combined in order to arrive at the subject matter of the claimed invention, and (3) specifically explain why a person of ordinary skill in the art would have had reasons to so combine the prior art references.

VI. TECHNICAL BACKGROUND

34. Below, I present a brief overview of certain aspects of eyewear-mounted and other head-worn directional audio systems at the time of the alleged

invention of the '174 patent. These concepts reflect the state of the art that a POSITA would have known and understood at that time. I rely on and incorporate (even if not expressly mentioned below) the following disclosures and opinions to support my opinions in this declaration, including those opinions relating to how the prior art teaches or would have suggested the challenged claims of the '174 patent and how and why a POSITA would have been motivated to consider and combine the disclosures and suggestions from that prior art, as I explain in more detail in the obviousness analysis that follows.

35. The prior-art references and technical background discussed in this section provide factual support for my opinions regarding the state of the art as of the earliest claimed priority date of the '174 patent. They also provide support for my opinions regarding why a POSITA would have been motivated to use, modify, and combine the teachings of the prior-art references discussed below, and why a POSITA would have had a reasonable expectation of success in doing so. The references identified in this section are exemplary in nature and are not intended to limit the scope of the state of the art.

A. Eyewear-Mounted Audio Systems

36. Integrating speakers and audio electronics into head-worn form factors, including eyewear (eyeglasses and sunglasses), headsets, hearing aids, headbands, and hats, is standard engineering practice that dates back decades, long before the time of the alleged invention. Eyeglass hearing aids integrating the hearing aid into, or coupling it to, the eyeglass frame are documented in clinical texts such as J. Katz, *Handbook of Clinical Audiology*, 2015 (EX1023) (see, e.g., p. 742, 749), and general acoustics of sound in enclosures is documented in established articles and texts such as L. Beranek, T. Mellow, *Acoustics: Sound Fields and Transducers*, 2012 (EX1019) (see, e.g., pp. 5, 12). Examples of head-worn audio devices in the prior art include:

- Higuchi, 1981 (EX1009), 1 (“an auxiliary device for hearing aids”);
- Ono, 1990, (EX1007), 1 (“a hearing aid that does not use earphones”);
- Boyden, 2001 (EX1008), Abstract (“[a]coustic modules adapted to be worn on the head of a wearer . . . modules are situated on opposite sides of the wearer’s head”), 11:55-12:7 (“adapted to be fastened to a pair of eyeglasses”), FIG. 20;

- Chen, 2007 (EX1010), 1:28-31 (“sunglasses that provide music playing and cell phone capabilities”);
- Chow, 2014 (EX1006), Abstract (“[a]udio eyewear includes a front frame and at least one side frame member secured to the front frame for engaging a user’s ear.”), *see also* [0038]-[0039]; and
- Matsunari, 2016 (EX1005), [0014]-[0019] (“eyeglass-type hearing aid [] attached to [] eyeglasses”).

37. Well before 2018, integration of audio capabilities into ordinary eyewear was already a recognized consumer-product trend. *See, e.g.*, EX1010 (Chen), 1:28-31 (“as demonstrated by sunglasses that provide music playing and cell phone capabilities, consumer interest is growing in augmented eyewear”).

38. A recurring design objective in head-worn audio systems has been to deliver desired audio to the wearer’s ear without occluding the ear canal. Blocking the ear canal cuts the wearer off from ambient sound, which is uncomfortable and in many settings unsafe. The ’174 patent identifies these design objectives, criticizing in-ear earphones as “occlusive” devices that “obstruct[] the ear canal” and stating that “sharp directivity for personal listening of audio” is desirable. EX1001, 1:55-65. Many references similarly criticize conventional in-ear earphones and over-ear

headphones as uncomfortable, environment-blocking, inconvenient, or unreliable. *See, e.g.*, EX1008 (Boyden), 1:32-40 (“uncomfortable to use for long periods of time . . . can block or attenuate environmental sounds causing the wearer to lose contact with the surroundings”); EX1005 (Matsunari), [0006] (“inconvenient for elderly users to use”); EX1007 (Ono), 1 (“discomfort of inserting earphones into their ear canals . . . they experience inconvenience as a result”); EX1006 (Chow), [0004] (“bulky, cumbersome or unreliable”). Occluding the ear canal can also produce an “occlusion effect,” which alters the perception of self-generated sound. *See, e.g.*, H. Dillon, *Hearing Aids*, 2012 (EX1024) (see, e.g., pp. 16, 18); *see also* EX1023 (Katz) (see, e.g., p. 69).

39. There are a number of established approaches for addressing this issue and delivering sound to the ear while leaving the ear canal unobstructed. These approaches include housing the speaker in a cavity or chamber within an eyewear temple and venting sound toward the ear through one or more holes (*see, e.g.*, EX1005 (Matsunari), [0054]-[0055]; EX1019 (Beranek), 5), orienting the speaker’s audio port to face downward and rearward toward the ear (*see, e.g.*, EX1006 (Chow), [0007], [0038]-[0039]), using reflector-based acoustic structures to focus sound toward the user (*see, e.g.*, EX1007 (Ono), 1-3; EX1019 (Beranek), 31; EX1021

(Kinsler), 199-200; EX1027 (Kock & Harvey), 2, 7-8), employing wearable acoustic modules with vented enclosures attached to eyeglasses (*see, e.g.*, EX1008 (Boyden), 11:55-12:7, FIG. 20), and using eyewear-mounted ear-covering structures to direct sound while excluding ambient noise (*see, e.g.*, EX1009 (Higuchi), 1-2). In my opinion, by 2018, a POSITA would have been familiar with these approaches and would have known how to combine and adapt them in eyewear-mounted audio design.

B. Acoustic Chambers for Sound Concentration

40. The '174 patent utilizes several structural acoustic concepts: a chamber that surrounds the audio-signal-generating speaker, a port in the chamber through which audio signals are transmitted, and a structure that concentrates audio signals toward the user's ear. EX1001, claims 1, 14; *see also id.*, 20:5-10, 24:46-51, FIG. 20. Each of these concepts was well-understood in the acoustic engineering art before the relevant date of the '174 patent.

41. A loudspeaker is often mounted within an enclosure to confine the acoustic radiation from the rear surface of the transducer so that it does not destructively combine with the out-of-phase radiation from the front surface. *See, e.g.*, EX1019 (Beranek), 5, 12; EX1021 (Kinsler), 200; EX1008 (Boyden), 1:55-62.

Without such an enclosure, “there is a significant reduction of net radiated intensity, especially in the low frequency audio ranges.” EX1008 (Boyden), 1:65-67.

42. For wearable speakers and other small-form-factor designs, the requirement of an enclosure creates a recognized acoustic challenge: the enclosure’s small volume causes its acoustic stiffness to dominate the speaker’s behavior, and the resulting resonance frequency is high, producing a poor low-frequency response. EX1008 (Boyden), 2:1-5; EX1019 (Beranek). This is the relationship known in the literature as the Thiele-Small theory. *See* A. N. Thiele, “Loudspeakers in Vented Boxes,” 1971 (EX1025 (see, e.g., pp. 1, 3-5), EX1026 (see, e.g., pp. 1-2, 11)). A POSITA designing a small wearable speaker enclosure would have been familiar with this constraint and with the established design techniques used to manage it, including selection of enclosure materials and surface treatments, internal damping materials, and venting strategies.

43. Within an enclosure, an opening or port positioned in a wall of the enclosure was a known means of venting sound from the enclosure interior into the external environment, including toward a target listener. Matsunari, for example, discloses this arrangement in the eyewear-hearing-aid context: speaker 8 is housed within cavity 37 inside the temple, and “multiple holes are formed extending from

the cavity 37 toward the ear,” such that the sound is output “directly towards the ear through the multiple holes 38, thereby reducing sound leakage.” EX1005 (Matsunari), [0054]-[0055]. The same chamber/port principle appears in Boyden’s wearable acoustic modules, which use enclosure walls together with one or more openings (an acoustic outlet port and an acoustic vent port) to confine and direct the speaker’s sound output toward the listener. EX1008 (Boyden), 4:59-67.

44. A curved reflective surface, in particular a parabolic surface of revolution, can be used to concentrate or collimate acoustic energy. *See, e.g.*, EX1019 (Beranek), 31; EX1020 (Olson), 25-28; EX1021 (Kinsler), 199-200. Acoustic transducers such as loudspeakers have multi-directional, frequency-dependent power output characterized by a beam pattern. *See, e.g.*, EX1021, 194, 199-200. A transducer positioned at the focal point of a parabolic reflector produces a reflected wavefront that is approximately planar and propagates parallel to the reflector axis, concentrating the source’s multi-directional acoustic energy into a directed beam. The same principle underlies optical, microwave, and other wave-physics contexts and was a standard tool in acoustic engineering before 2018. *See, e.g.*, EX1027 (Kock & Harvey), 2, 7-8.

45. This principle is often applied to hearing aid design. For example, Ono explains that its hearing aid “employs a structure comprising a first reflector having a parabolic surface of revolution” with “a sound generating device positioned at the focal point of the first reflector,” so that the sound is “reflected by the first reflector as parallel sound waves toward the second reflector” and “focused into a sound beam” that reaches the user “locally.” EX1007 (Ono), 1-3. Ono’s structure “utilizes the principle of an acoustic lens using a parabolic surface of revolution to radiate sound waves in a specific direction.” *Id.*, 3. The acoustic lens principle Ono references is a long-standing core concept from the acoustic literature. *See, e.g.*, W. Kock, F. Harvey, “Refracting Sound Waves,” 1949 (EX1027), 2, 7-8, 11; EX1019 (Beranek), 31. A POSITA would have understood that Ono’s parabolic-reflector approach was not unique to hearing aids and could be implemented within other small acoustic chambers, including chambers housed in an eyewear temple of the kind disclosed in Matsunari (EX1005) (cavity 37 within temple 32) or Chow (EX1006) (cavity 20 within side frame member 14), because the reflector geometry is independent of the enclosure’s placement on the device.

46. Ma further confirms that, in the hearing-aid and earphone art, using a reflective structure to enhance and focus speaker output toward a listener was a

known design principle before 2018. EX1011 (Ma), [0002] (disclosing “an earphone with a reflection disk to enhance the quality of sound received”), [0007], [0017].

C. Acoustic Properties of Materials

47. Several challenged claims concern material behavior, but they address distinct energy pathways. Claims 5, 15, and 24 compare acoustic reflectivity at surfaces encountered by airborne sound; claims 16 and 20 address absorption of acoustic energy; and claims 6 and 25 address absorption of vibrational energy in a portion of the eyewear structure. The '174 patent itself distinguishes airborne acoustic signals generated by a moving speaker surface from mechanical vibration imparted to a chamber wall and transmitted through the eyewear structure. EX1001, 21:12-21, 23:32-24:14. A POSITA therefore would not have treated acoustic energy and mechanical vibrational energy as interchangeable, even though a material or layered structure may be selected to attenuate both through different physical mechanisms.

48. When a sound wave traveling in one medium encounters a boundary with a second medium having different properties, the incident acoustic energy is divided three ways: part of the energy is reflected back into the first medium, part is absorbed and dissipated as heat within the boundary material, and the remainder is

transmitted through and radiated into the second medium. This energy balance is a foundational principle of acoustics, and characterizing an acoustic boundary by the fraction of incident energy it reflects versus the fraction it absorbs or transmits was standard practice before 2018. *See, e.g.*, EX1021 (Kinsler), 165-166; A. Pierce, *Acoustics: An Introduction to Its Physical Principles and Applications*, 1981 (EX1028), 148-149, 153, 176; EX1019 (Beranek), 12.

49. At a given boundary, the degree to which that boundary reflects energy is governed by the mismatch in acoustic impedance across the boundary. *See, e.g.*, P. Morse, K. Ingard, *Theoretical Acoustics*, 1968 (EX1029), 283-284; *see also* EX1028 (Pierce), 149; EX1021 (Kinsler), 167. The acoustic impedance presented at a boundary depends on the properties of the media and is frequency dependent. For example, rigid materials are highly reflective, thick porous and fibrous materials such as foams and heavy cloth are highly absorbing, and thin air-transmitting surfaces such as micro-perforated materials or light open-weave cloth are acoustically transparent. *See, e.g.*, J.-F. Allard, N. Atalla, *Propagation of Sound in Porous Media*, 2009 (EX1030), 36-41, 55; *see also* EX1008 (Boyden), 2:57-61, 4:36-42. Thus a rigid, high-impedance surface can be used to reflect sound and can have a high acoustic reflectivity, whereas a surface constructed of thick lossy

material can be used to absorb sound and a surface constructed of thin acoustically transparent material will transmit sound with minimal reflection or absorption. *See, e.g.*, EX1021 (Kinsler), 167, 176. Consistent with these principles, Boyden teaches that the walls of its acoustic modules may be made from “a substantially acoustically inert material, that is, non-radiative and absorbing.” EX1008 (Boyden), 5:54-56. These properties are also frequency dependent; for example, Boyden explains that it is easier to damp high frequencies than lower frequencies in its acoustic enclosures. *Id.*, 5:45-53.

50. The use of materials with selected acoustic properties was common practice to control unwanted resonance and stray sound within enclosures. For example, sound-absorbing material was known to reduce resonance peaks and increase damping, while hard enclosure boundaries produce reflected waves. *See, e.g.*, EX1019 (Beranek), 4, 8, 12; EX1021 (Kinsler), 200. This also relates to another well-known material property—dispersion, the scattering or diffusion of incident sound by a surface’s shape or texture—which was another mechanism, along with absorption, that could serve as a means of breaking up and redistributing reflected acoustic energy. EX1029 (Morse & Ingard).

51. In my opinion, by 2018, the material-selection concepts relevant to these claims were well understood. A rigid or otherwise acoustically reflective chamber-facing boundary could be used to return airborne sound toward an intended output path, while a porous, fibrous, or otherwise acoustically lossy material could be used to absorb unwanted acoustic energy. EX1019, 10, 12-14. A vibration-damping layer or treatment mechanically coupled to a wall could deform with the wall and dissipate structural vibration. EX1021, 18-19, 24-27, 30-31, 115-116; EX1008, 5:36-67. A particular material or construction can provide more than one of these benefits, but acoustic absorption and mechanical damping are not the same property. A POSITA would have selected both the material and its location according to the energy pathway and function to be controlled.

52. In my opinion, by 2018, each of the claimed technical concepts, such as an eyewear-mounted speaker housed in a chamber, an acoustic port in a wall of that chamber, the use of reflective/curved acoustic structures to concentrate sound toward a target listener, and the use of acoustic properties of materials, for example, was thoroughly developed and well-understood in the acoustic engineering art.

53. Thus, the '174 patent does not claim any new speaker type or any new acoustic technique. Rather, it claims the use of well-known directional-audio design

features—a chamber, a sound-concentrating structure, an acoustic port, and material/coating selections, optionally with an external sound cover—in an eyewear form factor. As I explain in the analysis that follows, each of those features, taken individually, was already disclosed in the hearing-aid and wearable-audio art before the earliest priority date of the '174 patent.

VII. THE '174 PATENT

A. Overview

54. The '174 patent is directed to a broad concept for delivering personal directional audio from eyewear. EX1001, 1:40-44 (“The invention relates generally to eyewear devices, and more particularly to apparatuses, methods, and systems for providing audio signals to a user through an eyewear device.”). At the claim level, the patent centers on a speaker-based acoustic chamber within the eyewear that generates audio, concentrates that audio toward the user’s ear, and emits it through an acoustic port in a wall of the chamber. *Id.*, Abstract, claims 1, 14.

55. The specification itself devotes much of its discussion to modular eyewear architectures, including interchangeable temples, temple insert modules (“TIMs”), associated electronics packages, and related accessory hardware. *See id.*, 4:4-19:58. In column 19, the specification turns to the directional-audio embodiments relevant to the challenged claims. *Id.*, 19:59-21:21. When it does

address the claimed audio arrangement, the patent describes a speaker mounted in a chamber, an acoustic port through which sound is emitted toward the user's ear, and curved or parabolic chamber surfaces that may help direct sound. *Id.*

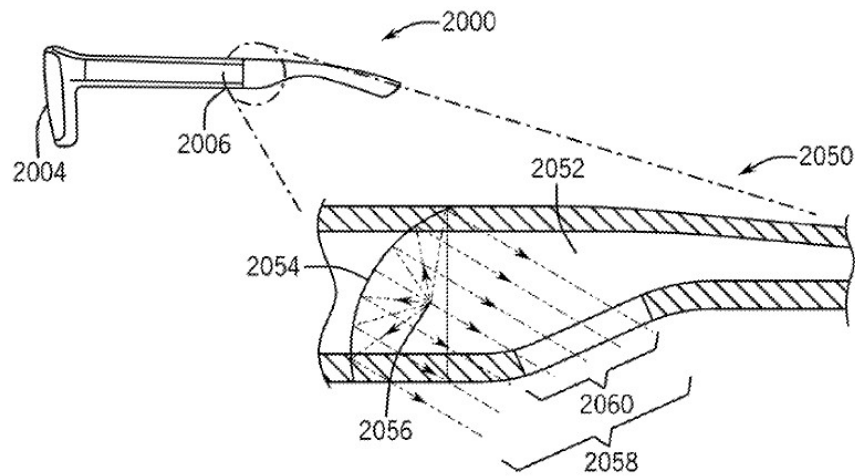


FIG. 20

Id., FIG. 20.

56. Consistent with those structures, the '174 patent's specification describes the chamber arrangement as directing acoustic signals toward the user's ear to provide a "personal listening experience" while "minimizing the acoustic signals ... that are audible to other people proximate to the user." *Id.*, 20:5-10. The specification adds that personal-projection micro-speaker ("PPMS") systems "are designed and intended to concentrate and to project acoustic signals ... in the direction of the user's ear and to attenuate acoustic energy and vibration in other

directions in order to provide a comfortable and personal listening experience to the user.” *Id.*, 24:46-51. The specification also describes temple insert modules that are “releasably coupleable” with an eyewear temple and that can house different electronic configurations. *Id.*, 6:6-7:10, 7:63-8:36.

B. Prosecution History

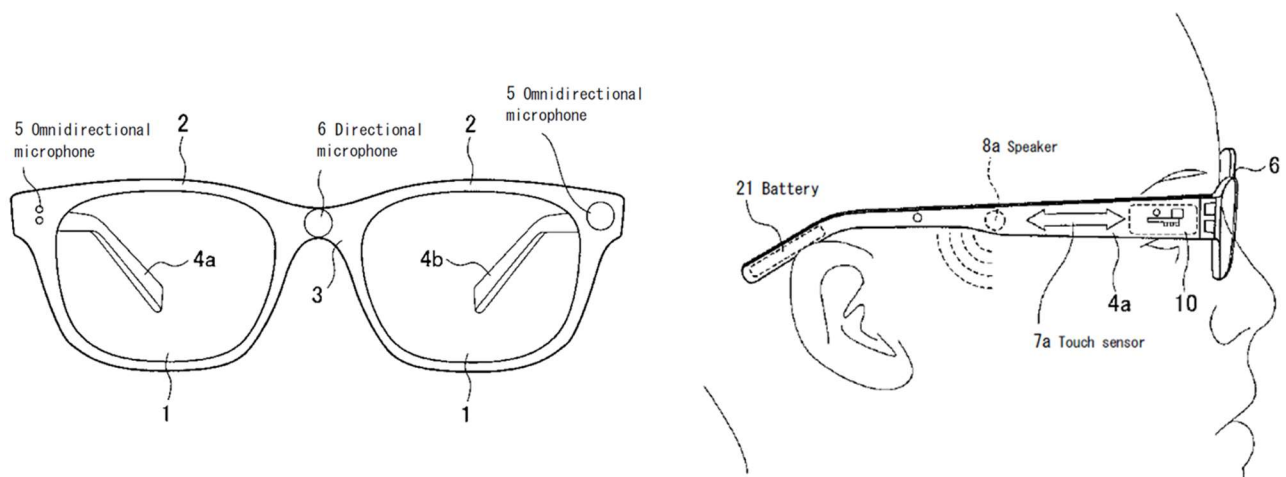
57. I understand that during prosecution the Examiner twice rejected claims as obvious based on Huang (International Patent Application Publication No. 2020/206775 at EX1002, 284-316), either alone or in combination with other references. EX1002, 224-230, 275-280. I further understand that, in response, Applicant argued Huang was not a proper prior-art reference. *Id.*, 190-208, 251-263. The Examiner subsequently indicated that the claims were allowable. *Id.*, 83-87, 160-165. The ’174 patent issued on January 9, 2024. EX1001, Cover.

VIII. OVERVIEW OF THE PRIOR ART

A. Matsunari (EX1005)

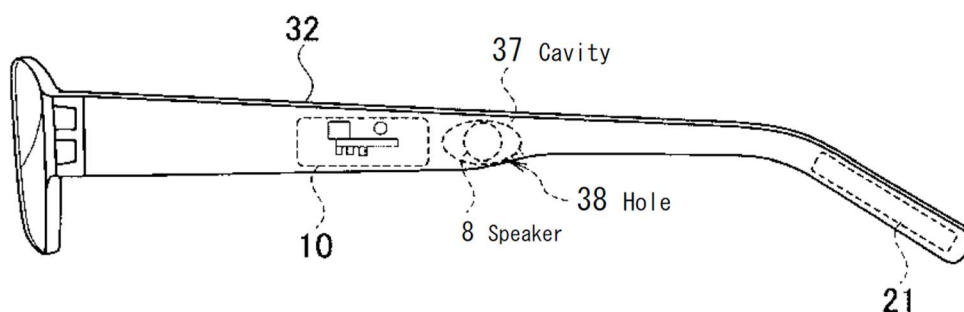
58. Japanese Unexamined Patent Application Publication No. JP2016039632A (“Matsunari”) published on March 22, 2016, from Japanese Application No. JP2015148402A, filed July 28, 2015, and claiming priority to August 5, 2014. EX1005, Cover.

59. Matsunari describes an eyeglass-type hearing aid designed to be “easy to operate” and to help the wearer hear “the voice of the person they are looking at.” *Id.*, [0008]. Matsunari’s eyeglasses include speakers 8a and 8b located on the right and left frames, respectively, with an amplifier that “amplify[ies] [the] audio signals from the microphone control unit 11 and output[s] it to the speaker 8a located on the right frame and the speaker 8b located on the left frame,” and “the amplified sound is output to speakers 8a and 8b, and the sound is then output from speakers 8a and 8b towards the ear canal.” *Id.*, [0017], [0019], [0022], [0033]; *see also id.*, [0027] (“Consequently, people with hearing impairments and the elderly can hear the voices of those who are speaking.”).



Id., FIG. 1(a) (left), FIG. 1(b) (right).

60. Embodiment 6 is an adaptation of the first embodiment described above. Matsunari explains that Embodiment 6 “has the same configuration as the eyeglass-type hearing aid according to Embodiment 1,” but “further includes a cavity 37 that surrounds the speaker 8 within the temple 32.” *Id.*, [0054]. In Embodiment 6, the speaker is placed in the temple and surrounded by “cavity 37,” which is described as a “space designed to optimally output sound” from the speaker. *Id.*, [0054]. Matsunari further explains that “multiple holes are formed extending from the cavity 37 toward the ear,” so that “the sound from the cavity 37 is output directly towards the ear through the multiple holes 38, thereby reducing sound leakage.” *Id.*, [0054]-[0055]. Matsunari further states that “because sound energy is not dispersed, even quiet sounds can be easily heard, resulting in energy savings.” *Id.*, [0055].



Id., FIG. 10.

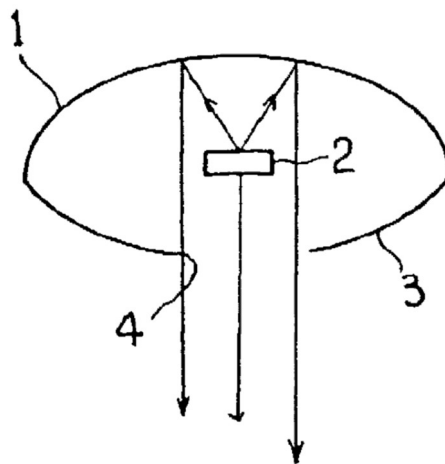
B. Ono (EX1007)

61. Japanese Patent Application Publication No. JPH02104200A (“Ono”) published on April 17, 1990, from an application filed October 13, 1988. EX1007, Cover.

62. Ono describes a hearing aid that uses parabolic reflectors to project sound in a “specific direction” without requiring earphones. *Id.*, 3 (“[T]he present invention employs a structure that utilizes the principle of an acoustic lens using a parabolic surface of revolution to radiate sound waves in a specific direction.”). Ono’s structure includes “a reflector having a parabolic surface of revolution and a sound generating device positioned at the focal point of the reflector,” together with “a second reflector positioned opposite the first reflector with their peripheries touching, having a parabolic surface of revolution and an opening in its central part.” *Id.*, 1 (claims 1-2). Ono describes at least two relevant embodiments of this structure.

63. ***First embodiment*** (FIG. 1). In the first embodiment, the first reflector is “formed in a dish shape having a parabolic surface of revolution,” and a “sound generating device (speaker) 2” is “positioned at the focal point of this first reflector.” *Id.*, 2. Sound generated by the speaker “is reflected by the first reflector as parallel sound waves toward the second reflector,” and “[m]ost of these sound waves are

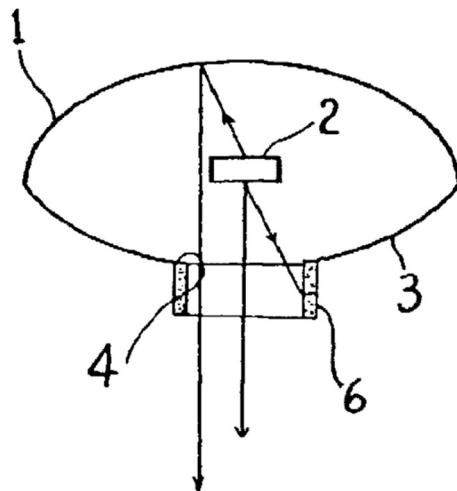
emitted from the opening of the second reflector towards the user,” where they are “focused into a sound beam” that “reach[es] the user positioned opposite the opening 4 locally,” delivering amplified sound only to the limited area around the user. *Id.*, 2-3. Ono explains that “if the user is positioned in the direction of the sound wave radiation, amplified sound can be sent to a specific space around the user, and it can be used as a hearing aid that does not require earphones.” *Id.*, 3. Because the focused sound beam is delivered only to the limited area around the user, sound is reduced in other areas, “thus avoiding disturbing other[s].” *Id.*, 2.



EX1007, FIG. 1.

64. **Second Embodiment** (‘Embodiment 3’) (FIG. 3). Ono’s Embodiment 3 builds on the same basic arrangement shown in Embodiment 1. Like Embodiment 1, it includes the first reflector 1, the speaker 2, the second reflector 3, and the central

opening 4. Ono discloses that, in Embodiment 3, a “short cylindrical sound-absorbing material 6 is provided around the opening of the second reflector, extending downwards.” *Id.*, 2-3; *see also id.*, 1 (claim 4) (“a short cylindrical sound-absorbing material extending downward is provided around the opening of the second reflector”). With sound-absorbing material 6 in place, “sound waves that are scattered and not traveling in a straight line are absorbed from the opening 4, and only sound waves traveling in a straight line are emitted from the opening 4, thereby concentrating the sound waves that have been amplified to a specific range.” *Id.* The sound-absorbing material 6 thus absorbs off-axis scattered sound, thereby further concentrating the soundwaves emitted from the chamber.



Id., FIG. 3.

C. Boyden (EX1008)

65. U.S. Patent No. 6,301,367 (“Boyden”) issued on October 9, 2001, from an application filed June 11, 1998. EX1008, Cover.

66. Boyden discloses “[a]coustic modules adapted to be worn on the head of a wearer, such as with a headband, or fastened to a hat or eyeglasses.” *Id.*, Abstract. Boyden explains that “[a] pair of enclosures or acoustic modules 12 and 14 are provided” that are “positioned on opposite sides of the wearer’s head 16, and each is situated in close proximity to one of the wearer’s ears.” *Id.*, 4:59-63. In one embodiment, acoustic modules 240 are disposed on the temples of eyeglasses 232.

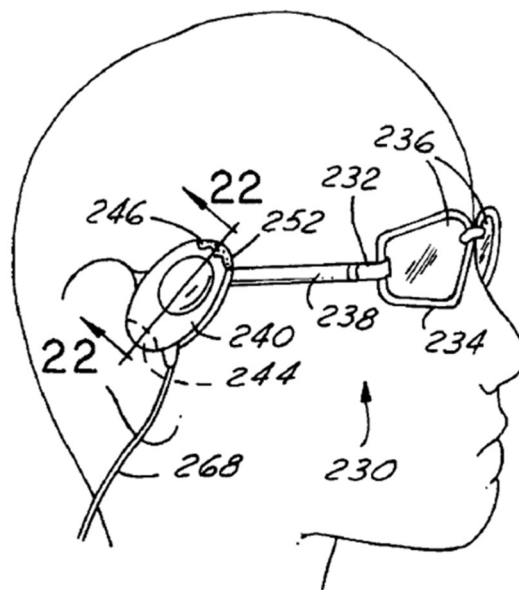


FIG. 20

Id., FIG. 20.

67. Boyden recognizes in small wearable speaker enclosures “[i]n general, the volume of the enclosure will be quite small and its acoustic stiffness will dominate the speaker behavior,” resulting in “a high resonance frequency and consequently a poor low frequency response.” *Id.*, 2:1-5.

68. To address the small-enclosure issues identified in paragraph 67, Boyden teaches several related construction and material options. Boyden preferably seals the transducer into a wall or structural member between chambers. EX1008, 5:1-8. Boyden also teaches acoustically transparent or mildly absorbing fill, acoustic damping material used to suppress undesired enclosure resonance, substantially acoustically inert walls that are non-radiative and absorbing, and coated surfaces or liners selected to provide desired acoustic properties. *Id.*, 5:36-67. A POSITA would have understood that a transducer mechanically fixed to an enclosure wall can excite that wall through reaction forces from the moving diaphragm and through fluctuating pressure within the enclosure. Boyden further states that physical contact between the module-housing walls or contact pads and the wearer’s temples promotes direct coupling of low audio frequencies to the wearer’s head. *Id.*, 10:16-24. This structure-to-head coupling occurs through mechanical motion of the contacting module structure. The resulting wall motion is structural vibration that

can propagate into adjoining housing portions and can reradiate sound. A vibration-damping treatment selected from Boyden's damping, wall, coating, and liner options and mechanically coupled to the wall or housing would deform with that structure and dissipate part of the cyclic strain energy, reducing the vibration amplitude. EX1021, 24-27, 30-31, 115-116. My opinions below do not assume that every acoustically absorbing material necessarily provides the same degree of mechanical damping; they concern a POSITA's reasoned selection and placement of a damping treatment for that function.

69. Boyden's eyeglass-mounted embodiment uses the same acoustic construction and materials. Boyden explains that "[t]he acoustic module 240 is similar to the acoustic modules 62 and 64 discussed above in construction, materials, operation and performance." *Id.*, 12:5-7.

D. Chow (EX1006)

70. U.S. Patent Application Publication No. 2014/0268016 ("Chow") published on September 18, 2014, from an application filed February 14, 2014. EX1006, Cover.

71. Chow criticizes traditional earphones, headphones, and bone-conducting speakers as "bulky, cumbersome or unreliable," and identifies a need for

“earphones that overcome or minimize the above-referenced problem.” *Id.*, [0004]-[0005]. Chow then discloses audio eyewear having “a front frame and at least one side frame member secured to the front frame for engaging a user’s ear,” with speakers in the side frame members “oriented to direct an audio port of the speaker face downwardly at an angle away from at least one side frame member, thereby directing sound downwardly and rearwardly into the user’s ear.” *Id.*, Abstract.

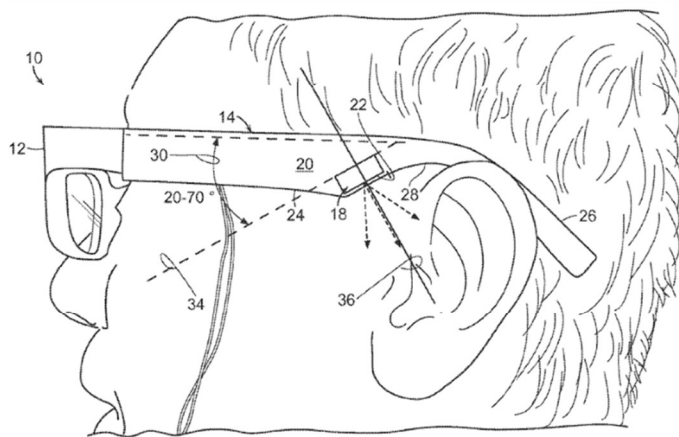


FIG. 2



FIG. 7

Id., FIGs. 2, 7; *see also id.*, FIGs. 3-6.

72. Beyond that temple-speaker arrangement, Chow describes attaching a sound-channel member to the side frame to further direct sound toward the ear. In one embodiment, Chow discloses a “sound tube 60” that is “attached to the at least

one of side frame members 14, 16 for directing sound from a speaker ... in side frame member 14, 16 into the user's ear," with an "outlet opening facing the user's ear for directing the sound from the speaker to the user's ear or into the ear canal." *Id.*, [0041]. In another embodiment, Chow discloses a "sound deflecting surface 66 [that] extends from an outer surface of the at least one side frame member 64 and over a portion of the user's ear for channeling sound from a speaker ... into the user's ear while also allowing ambient sound to be heard." *Id.*, [0042]. Chow further discloses that "[t]he sound channel members, whether a sound tube or a sound deflecting surface[,] are, in one embodiment, removably attached by magnetic or mechanical attachment fittings, and can be attached to both right and left side frame members for directing sound to both ears." *Id.*

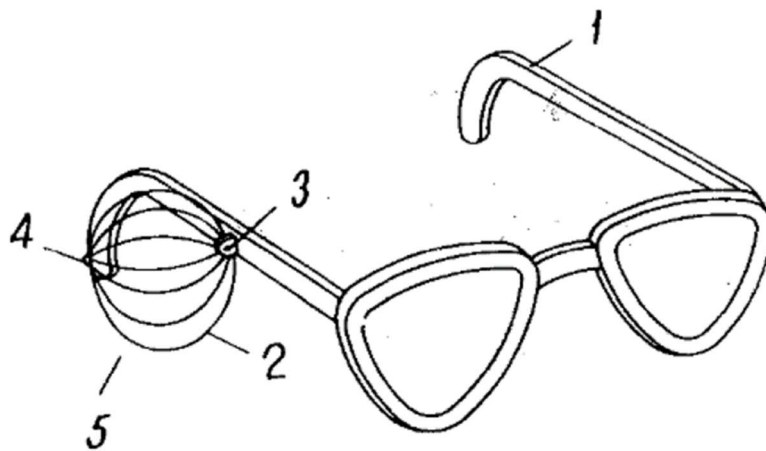
E. Higuchi (EX1009)

73. Japanese Patent Application Publication No. JPS5681814A ("Higuchi") published on July 4, 1981, from an application filed December 6, 1979. EX1009, Cover.

74. Higuchi describes "[a]n auxiliary device for hearing aids comprising multiple arc-shaped segments that cover the ears, rotatably attached to an eyeglass frame." *Id.*, 1 (claim 1). The stated objective is "to provide an auxiliary device for

hearing aids that blocks external noise when using hearing aids, earphones, etc., and makes it easier to hear sounds from the hearing aids, earphones, etc.” *Id.*, 1.

75. Higuchi explains that “1 is the eyeglass frame, and 2 is an arc-shaped segment that is rotatably mounted around pivot points 3 and 4 located near the earpieces of the eyeglass frame 1,” and that “[s]everal segments 2 are combined to form a hood 5 that covers the ears.” *Id.*, 1. In use, “[w]hen hearing aids, earphones, etc. are in use, segment 2 is opened ... to cover the ear and block out external noise,” while “when hearing aids, earphones, etc. are not in use, segment 2 is folded ... to prevent it from getting in the way.” *Id.*, 2.



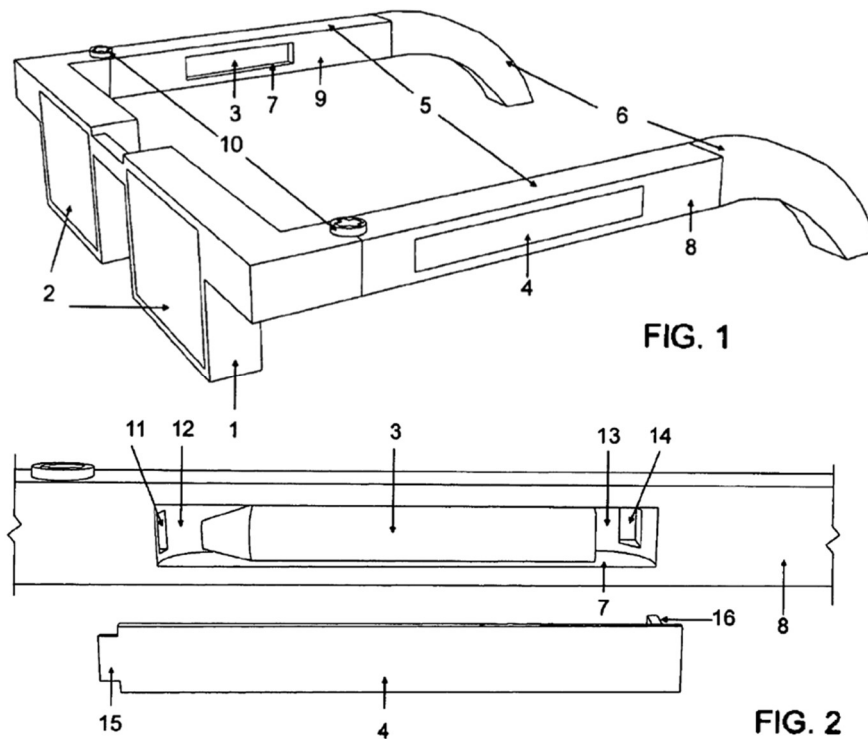
Id., FIG. 1.

F. Chen (EX1010)

76. U.S. Patent No. 7,306,332 (“Chen”) issued on December 11, 2007, from an application filed November 14, 2005. EX1010, Cover.

77. Chen discloses an eyewear temple assembly designed to host removable, functional cartridges in concealed temple compartments. Chen explains that its temple assembly “is comprised of a temple, removable cartridge, cartridge compartment that can accommodate and conceal one or multiple said cartridge(s), and temple tip attached to a temple in a permanent or detachable manner.” *Id.*, 2:60-63. The cartridge itself “comprises of materials and components, including electronic or non-electronic or any combination thereof, which will provide functions.” *Id.*, 2:63-65. The cartridge compartment “can be within the temple, within the temple tip, or be comprised of sub-compartments within the temple and temple tip.” *Id.*, 2:65-3:1.

78. Chen identifies a market motivation for modular, functional eyewear, noting that “as demonstrated by sunglasses that provide music playing and cell phone capabilities, consumer interest is growing in augmented eyewear, which offers functionalities that go beyond the obvious features.” *Id.*, 1:28-31. Chen further explains that “eyewear parts should be easily disassembled and reassembled” so that the user can conveniently modify and enhance existing eyewear capabilities. *Id.*, 1:35-38.



Id., FIGs. 1-2.

79. Chen explains that its modular architecture “allows the addition of diverse functions to eyewear through the installment of cartridge(s) comprised of different, unique capabilities.” *Id.*, 4:22-24. Chen also identifies practical service and replacement benefits: “the present invention offers a means to quickly, cost effectively, and conveniently add functionalities to eyewear via the application of modular, functional cartridge(s) that fit into properly sized compartments. For instance, rather than replacing an entire temple, a user can just remove the old cartridge and install a new one.” *Id.*, 4:14-18. Chen summarizes that its invention

provides “the flexibility to add functionalities ... to eyewear in an integrated and concealed manner.” *Id.*, 2:43-45.

G. Analogous Art

80. Matsunari, Chow, Ono, Boyden, Higuchi, and Chen are in the same field as the '174 patent because they concern head-worn systems providing user audio. They also are reasonably pertinent to problems addressed by the '174 patent, including providing personal audio without blocking the ear. Accordingly, in my opinion, these prior-art references are analogous art to the '174 patent.

IX. CLAIM CONSTRUCTION

81. I understand that when considering the meaning of patent claims, one must consider the language of the claims, the specification, and the prosecution history of the patent. I also understand that claim terms are typically given their ordinary and customary meanings as would have been understood by a POSITA at the relevant time for the patent. For the '174 patent, as I explained above in Section IV, the relevant time that I have been asked to consider is around December 12, 2018. For purposes of my opinions in this declaration, I have been asked to consider the challenged claims under their plain and ordinary meanings based on a review of the intrinsic evidence as understood by a POSITA at the time of the alleged

invention, and I have applied such understandings in my analysis of the '174 patent and the prior art.

82. I understand that a patent and its prosecution history are considered “intrinsic evidence” and are the most important sources for interpreting claim language in a patent. I also understand that in reading the claim, I must not import limitations from the specification into the claim terms; in other words, I must not narrow the scope of the claim terms by implicitly adding disclosed limitations that have no express basis in the claims. The prosecution history of related patents and applications can also be relevant.

83. I understand that sources extrinsic to a patent and its prosecution history (such as dictionary definitions and technical publications) may also be used to help interpret the claim language, but that such extrinsic sources cannot be used to contradict the unambiguous meaning of the claim language that is evident from the intrinsic evidence.

84. I have applied the plain and ordinary meaning of “concentrate” and “concentrating” as those terms would have been understood by a POSITA in view of the '174 patent. In my opinion, the specification uses these terms functionally to describe directing emission of audio signals toward the user’s ear. The terms do not

require any particular chamber geometry, a generally parallel column of sound waves, or any particular number of reflectors. The dependent claims separately recite narrower structural features, including chamber shapes that contribute to concentrating in claims 2-4 and 18, a curved chamber inner surface around the speaker in claim 17, and external sound-cover features in claims 10 and 19. I have applied that understanding in the analyses below.

X. THE PRIOR ART TEACHES AND/OR SUGGESTS ALL RECITED FEATURES OF CLAIMS 1-28 OF THE '174 PATENT

85. In my opinion, a POSITA would have found claims 1-28 obvious based on the prior-art combinations set forth below, which use various combinations of Matsunari, Chow, Ono, Boyden, Higuchi, and Chen.²

A. Ground 1: Matsunari in View of Ono Teaches and/or Suggests Claims 1-4, 11-12, 14, 17-18, and 22

1. Claim 1

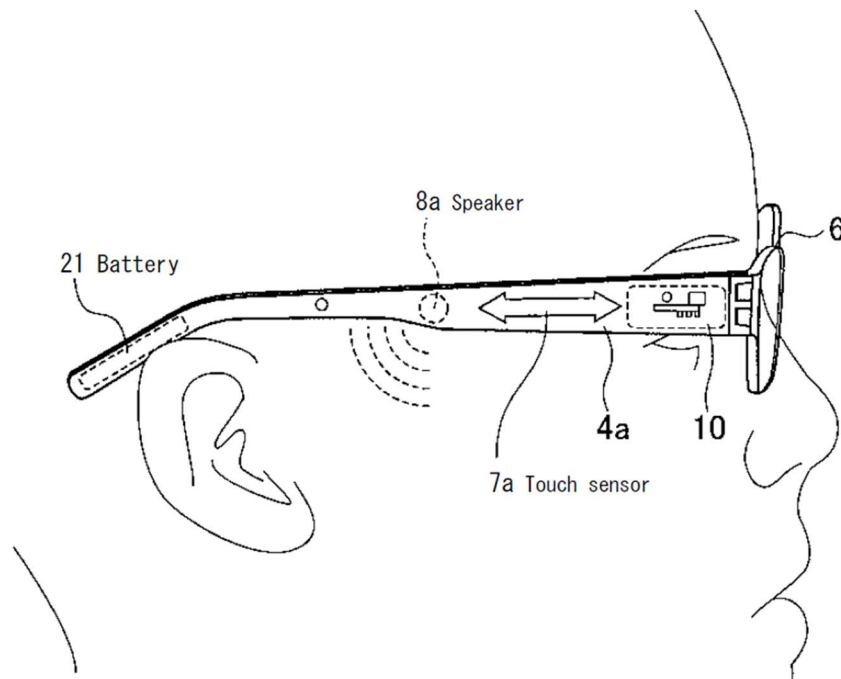
(i) [1.pre] “A method to provide audio signals to a user

² In this Section (Section X), I sometimes refer to exhibits other than the prior-art references identified for a particular ground. Those additional exhibits provide background regarding the state of the art and help explain how a POSITA would have understood and applied the disclosures of the identified prior-art references; I do not rely on those additional exhibits to supply a claim limitation missing from the identified prior-art references.

from an eyewear device, comprising;”

86. I understand that [1.pre] is the preamble of claim 1. I have been asked to assume that this preamble is limiting. Under that assumption, it is my opinion that Matsunari teaches preamble [1.pre].

87. Matsunari discloses “an eyeglass-type hearing aid that is easy to operate and allows the user to easily hear the voice of the person they are looking at.” EX1005, Abstract; *see also id.*, [0008], [0023], [0027] (“[T]he microphone control unit 11 turns on the directional microphone 6 based on the ON signal from the sensor control unit 13 and outputs the audio signal to the speakers 8a and 8b. Consequently, people with hearing impairments and the elderly can hear the voices of those who are speaking with a simple operation.”), [0033] (“The amplified sound is output to speakers 8a and 8b, and the sound is then output from speakers 8a and 8b towards the ear canal.”), claim 1.



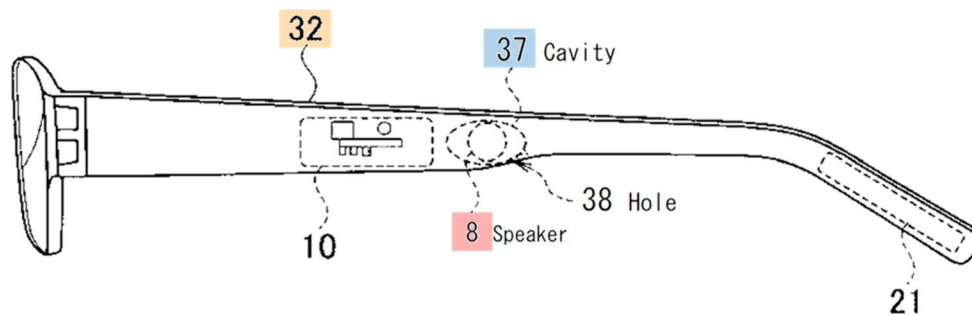
Id., FIG. 1(b); *see also id.*, FIGs. 10-11.

(ii) [1.a] “generating audio signals within a chamber, the chamber is a part of a volume of the eyewear device;”

88. It is my opinion that Matsunari discloses this limitation.

89. Matsunari’s Embodiment 1 discloses that “speaker 8a is located approximately in the center of the right frame 4a” and “speaker 8b is located approximately in the center of the left frame 4b.” EX1005, [0017], [0019]. Amplifier 12 outputs audio signals to speakers 8a and 8b, and the amplified sound is then output from speakers 8a and 8b toward the ear canal. *Id.*, [0022], [0027], [0033].

90. According to Matsunari, “Embodiment 6 has the same configuration as the eyeglass-type hearing aid according to Embodiment 1,” but “further includes a cavity 37 that surrounds the speaker 8 within the temple 32,” and that “[t]he cavity 37 is a space designed to optimally output sound from the speaker 8.” *Id.*, [0054]. As a result, speaker 8 generates sound within cavity 37 in Embodiment 6. Such features, including temple 32 (orange), cavity 37 (blue), and speaker 8 (red), are shown in FIG. 10.



Id., FIG. 10 (annotated).

91. As illustrated, temple 32 is part of the eyewear device; temple 32 also defines a chamber in the form of cavity 37 within the volume of the eyewear device. Further, cavity 37 surrounds speaker 8 such that it is the chamber in which the audio signals are generated.

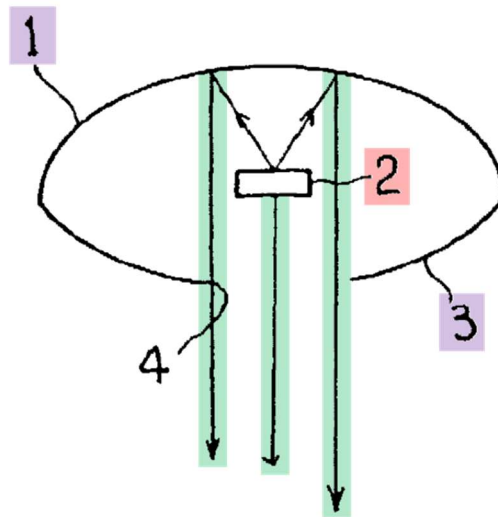
(iii) [1.b] “concentrating the audio signals for delivery to the user’s ear”

92. In my opinion, the Matsunari-Ono combination teaches or would have suggested this limitation to a POSITA.

93. Matsunari explains that cavity 37 is “a space designed to optimally output sound from the speaker 8,” and that sound from speaker 8 is output through cavity 37 and holes 38 directly toward the ear. EX1005, [0054]-[0055]. Matsunari additionally explains that this arrangement reduces “sound leakage,” and that, because sound energy is not dispersed, even quiet sounds can be easily heard. *Id.*, [0055]. As a result, Matsunari discloses a speaker-in-cavity arrangement that directs sound toward the wearer’s ear while reducing dispersion and leakage.

94. Ono explains that its hearing aid “utilizes the principle of an acoustic lens using a parabolic surface of revolution to radiate sound waves in a specific direction.” EX1007, 3. Ono discloses a first reflector “formed in a dish shape having a parabolic surface of revolution,” with a “sound generating device (speaker) 2” “positioned at the focal point of this first reflector,” and a second reflector also having a parabolic surface of revolution and positioned opposite the first reflector. *Id.*, 2. Sound generated by the speaker “is reflected by the first reflector as parallel sound waves toward the second reflector,” and “[m]ost of these sound waves are

emitted from the opening of the second reflector towards the user.” *Id.* Figure 1 illustrates those radiated sound waves (green).



EX1007, FIG. 1 (annotated); *see also id.*, FIGs. 2-5.

95. Ono discloses that “if the user is positioned in the direction of the sound wave radiation, amplified sound can be sent to a specific space around the user, and it can be used as a hearing aid that does not require earphones.” EX1007, 3. Ono thus expressly discloses the known acoustic principle that a sound-generating device used with Ono’s shaped, reflective structure can concentrate sound from a speaker through an opening toward a target listener. *See also* Ma (EX1011), [0002] (disclosing “an earphone with a reflection disk to enhance the quality of sound received”), [0007], [0017].

96. A POSITA would have been motivated, with a reasonable expectation of success, to configure Matsunari's existing speaker-in-cavity arrangement using Ono's parabolic acoustic-reflector geometry and speaker positioning relative to that geometry for several reasons:

a. Combination Rationale

97. In my opinion, Matsunari and Ono are directed to the same field (e.g., hearing aids), and to the same general objective as the '174 patent: improving audibility for the user without requiring conventional in-ear earphones.

98. Matsunari describes "an eyeglass-type hearing aid." EX1005, [0001], [0014]. Ono relates to "a hearing aid device, and more particularly, to a hearing aid that does not use earphones." EX1007, 1.

99. Matsunari provides that prior eyeglass-type hearing aids which require users to "put the earphones in their ears each time they want to hear sound" are inconvenient. EX1005, [0006]. Matsunari thus seeks "to provide eyeglass-type hearing aids that are easy to operate and allow the user to easily hear the voice of the person they are looking at." *Id.*, [0008]. Ono discusses the same general problem when discussing a hearing aid that "does not require earphones" and directs amplified sound to the user through a focused acoustic structure. EX1007, 1-3.

100. The '174 patent describes design objectives that match those of Matsunari and Ono. According to the '174 patent, conventional in-ear earphones and earbuds are “occlusive,” can “obstruct[] the ear canal,” and can interfere with hearing ambient sounds; the '174 patent further states that “sharp directivity for personal listening of audio” is desirable, and criticizes bone-conduction approaches for having “low transmission efficiencies” and delivering lower sound energy to the user. EX1001, 1:55-65. When discussing the directional-audio embodiments, the '174 patent states the chambered speaker arrangement directs acoustic signals toward the user’s ear to provide a “personal listening experience” while “minimizing” sound audible to nearby others, and is designed to “concentrate and to project” acoustic signals toward the ear while attenuating acoustic energy in other directions. *Id.*, 20:5-10, 24:46-51. Such objectives are consistent with Matsunari’s use of a temple cavity and ear-facing holes for directing sound toward the ear while reducing leakage (EX1005, [0054]-[0055]), and Ono’s use of parabolic reflector geometry for focusing sound toward a user without earphones (EX1007, 2-3).

101. A POSITA looking to implement or further improve Matsunari’s stated objective would have looked to known acoustic structures, including those used in

the field of hearing aids. Ono describes such known structures and shares many of the same acoustic goals as Matsunari.

102. In my opinion, as I explain in detail below, a POSITA would have been motivated to combine the teachings of Matsunari and Ono by configuring Matsunari's existing speaker-in-cavity arrangement to include Ono's parabolic acoustic-reflector geometry and positioning the speaker relative to that geometry, including at or near focal position as Ono teaches, so that sound generated by the speaker would be focused through Matsunari's ear-facing holes toward the user.

103. *First*, Ono's parabolic reflector arrangement was a known technique for improving the same type of directional-audio performance Matsunari already sought—directing sound toward the user through an ear-facing output while reducing dispersion. Matsunari discloses cavity 37 surrounding speaker 8, with holes 38 extending from cavity 37 toward the ear, and explains that this arrangement is “designed to optimally output sound from the speaker 8,” reduces “sound leakage,” and allows even quiet sounds to be easily heard. EX1005, [0054]-[0055]. Ono discloses using parabolic acoustic-reflector geometry, with the sound-generating device positioned relative to the reflector's focal point, to focus generated sound through an opening toward the listener. EX1007, 2-3. In my opinion, a POSITA

would have recognized Ono's parabolic reflector arrangement as a known way to enhance the directional output Matsunari already sought.

104. *Second*, applying Ono's reflector geometry and associated speaker positioning to Matsunari's speaker-in-cavity arrangement would have furthered Matsunari's express goals of reducing sound leakage, improving audibility, and saving energy.

105. Matsunari explains that, "because sound energy is not dispersed [in its cavity embodiment], even quiet sounds can be easily heard, resulting in energy savings." EX1005, [0055]. Ono likewise explains that its reflector structure creates a "focused . . . sound beam," which "deliver[s] amplified sound only to the area around the user." EX1007, 2. In my opinion, configuring Matsunari's cavity to focus more of the speaker's acoustic energy toward the wearer's ear would predictably improve perceived loudness and intelligibility of the sound at the ear while reducing off-axis leakage and wasted acoustic output.

106. *Third*, once a POSITA started from Matsunari's temple cavity and ear-facing holes and sought a more focused output toward the user's ear, Ono's parabolic reflector geometry and associated speaker positioning would have been an obvious candidate. Matsunari already provided the relevant eyewear environment, including

a speaker housed in a temple cavity and holes extending from the cavity toward the ear. EX1005, [0054]-[0055]. Ono provided a known acoustic concentration approach for directing speaker output through an opening toward a listener. EX1007, 2-3. In my opinion, the available design approaches for directing speaker output from a small chamber through an ear-facing opening—such as changing the chamber shape, reflector shape, speaker position, and output-path geometry—were finite and predictable.

107. ***Fourth***, configuring Matsunari's cavity to include Ono's parabolic reflective surface, with Matsunari's speaker positioned relative to that surface to concentrate sound toward the ear-facing holes, would have been a routine optimization of result-effective acoustic parameters. Those parameters include reflector curve/shape, speaker/reflector positioning, and the geometry of the sound-output path. A POSITA would have understood that adjusting those parameters would predictably affect the degree to which sound from the speaker is concentrated toward the wearer's ear. Accordingly, in my opinion, applying Ono's parabolic reflector geometry and associated speaker positioning to Matsunari's speaker-in-cavity arrangement would have been a routine and predictable way to achieve the already-identified result of concentrating sound toward the wearer's ear.

108. Matsunari and Ono confirm these motivations. Matsunari provides that its cavity and holes direct sound toward the ear and reduce “sound leakage.” EX1005, [0055]. Ono details the same concentrated-audio objective: using Ono’s reflector arrangement, “a parallel sound wave” is produced that “reach[es] the user positioned opposite the opening 4 locally,” while “sound in other areas” is decreased “thus avoiding disturbing other[s].” EX1007, 2. Additionally, Ono’s optional sound-absorbing material confirms Ono’s concentrated-audio objective because Ono explains that such material may absorb scattered sound near the opening so that only straight-traveling sound is emitted. EX1007, 3. In my opinion, a POSITA would have recognized that configuring Matsunari’s existing speaker-in-cavity arrangement to include Ono’s parabolic reflective geometry and associated speaker positioning would further Matsunari’s stated goal of directing sound toward the wearer’s ear while reducing leakage of sound to non-users and bystanders.

109. This is also true for efficiency and audibility. According to Matsunari, “because sound energy is not dispersed [in its cavity embodiment], even quiet sounds can be easily heard, resulting in energy savings.” EX1005, [0055]. Ono similarly explains that its reflector structure creates a “focused . . . sound beam,” which “deliver[s] amplified sound only to the area around the user.” EX1007, 2.

110. Applying Ono's parabolic reflective geometry and associated speaker positioning to Matsunari's existing speaker-in-cavity arrangement would have been a straightforward adaptation of known acoustic design principles to improve Matsunari's expressly identified cavity function, with predictable results. Matsunari already describes cavity 37 as a space designed to optimally output sound from speaker 8 through holes 38 toward the ear. EX1005, [0054]-[0055]. A POSITA would have understood that configuring that cavity to direct a greater portion of the speaker's acoustic energy toward the wearer's ear would predictably improve perceived loudness and intelligibility at the ear while reducing off-axis leakage and wasted acoustic output, thereby furthering Matsunari's leakage-reduction, audibility, and energy-savings objectives.

111. In my opinion, the combination would not require incorporating Ono's entire hearing-aid structure into Matsunari's temple. Nor would the combination have required an ideally collimated sound field; a POSITA would have understood how to select the reflector curvature, speaker position, and output-path geometry within Matsunari's temple cavity to direct more of the speaker's acoustic energy toward the ear-facing holes. Rather, in my opinion, the relevant teaching is Ono's parabolic acoustic-reflector geometry and speaker positioning relative to that

geometry, including positioning the sound-generating device relative to the reflector's focal point to focus sound through an opening toward a listener. EX1007, 1-3. A POSITA would have applied that teaching to Matsunari's existing speaker-in-cavity arrangement by configuring the acoustic chamber region within Matsunari's temple cavity to include a curved/parabolic reflective surface, positioning Matsunari's speaker relative to that surface, and aligning the focused output with Matsunari's ear-facing holes. That combination would retain Matsunari's eyewear form factor, temple placement, and ear-facing sound-output path, while using Ono's reflector geometry for its established concentrating function.

112. In my opinion, a POSITA would have had a reasonable expectation of success in combining Matsunari with Ono, and the result of the combination would have been predictable.

113. This combination would have involved combining familiar elements according to known methods to improve a similar device in the same field, in response to known design needs, with no more than predictable results. Matsunari already disclosed eyewear having a speaker/cavity/hole arrangement for directing sound toward the ear, and Ono disclosed parabolic acoustic-reflector geometry with the sound-generating device positioned relative to that geometry to focus sound

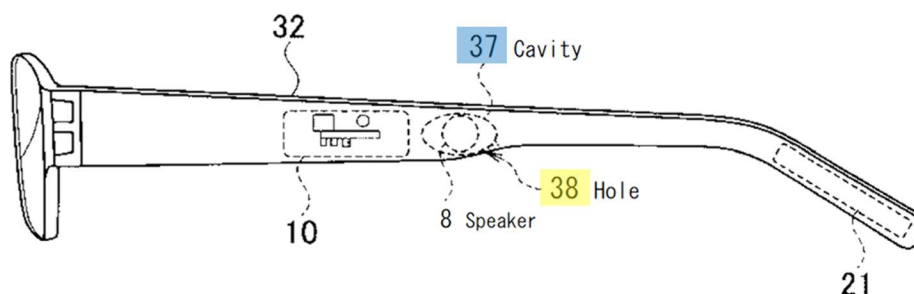
through an opening toward a listener. A POSITA therefore would have had a reasonable expectation of success in applying Ono's parabolic reflector geometry and speaker-positioning teachings to Matsunari's temple cavity and ear-facing output path. The result would have been a straightforward adaptation of a known acoustic focusing technique to the eyewear environment Matsunari already provides, directing more sound toward the wearer's ear while reducing off-axis leakage and wasted acoustic energy.

114. The use of parabolic reflectors to concentrate and direct sound was a mature acoustic technique before the priority date of the '174 patent. Ono itself was published in 1990, nearly three decades before the earliest claimed priority date of the '174 patent. Ma (EX1011) further confirms that the principle of using a reflective structure to enhance speaker output was known and applied in the hearing-aid and earphone art. EX1011, [0002], [0007], [0017]. Use of a parabolic reflector structure in an eyewear temple cavity was a straightforward application of known acoustic design principles, not a burdensome undertaking.

- (iv) **[1.c] “transmitting the audio signals to the user’s ear, the audio signals are transmitted through a port in the chamber.”**

115. In my opinion, the Matsunari-Ono combination teaches or would have suggested this limitation to a POSITA.

116. Matsunari expressly discloses transmitting sound from the cavity to the user's ear through openings in the cavity. For example, Matsunari describes that "multiple holes 38 are formed extending from the cavity 37 and toward the ear," and that "the sound from the cavity 37 is output directly towards the ear through the multiple holes 38, thereby reducing sound leakage." EX1005, [0054]-[0055]. In my opinion, holes 38 (yellow) are ports in cavity 37 (blue) through which the sound/audio signals are transmitted toward the user's ear.



Id., Fig. 10 (annotated).

117. The Matsunari-Ono combination would preserve Matsunari's holes as the ear-facing output openings from the cavity. Ono's parabolic reflective geometry and speaker-positioning teachings would be applied to direct and concentrate the sound generated by the speaker toward those openings. As a result, the resulting

chamber would transmit the generated audio signals through the cavity ports toward the user's ear.

2. Claim 2

(i) 2. “The method of claim 1, wherein a shape of the chamber contributes to the concentrating.”

118. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 2 and would have rendered claim 2 obvious.

119. Ono describes an acoustic-reflector chamber arrangement including “a first reflector having a parabolic surface of revolution” and a second reflector with an opening. EX1007, 2. According to Ono, when this structure is used, sound from the speaker positioned relative to the first reflector is reflected toward the second reflector, most of the sound is emitted through the opening toward the user, and the structure “utilizes the principle of an acoustic lens using a parabolic surface of revolution to radiate sound waves in a specific direction.” *Id.*, 3; *see also id.*, FIGs. 1-5. As a result, the chamber's shape in Ono—including its parabolic reflector geometry—contributes to concentrating the audio signals for delivery to the user.

FIG. 1
*Longitudinal
section and side
view*

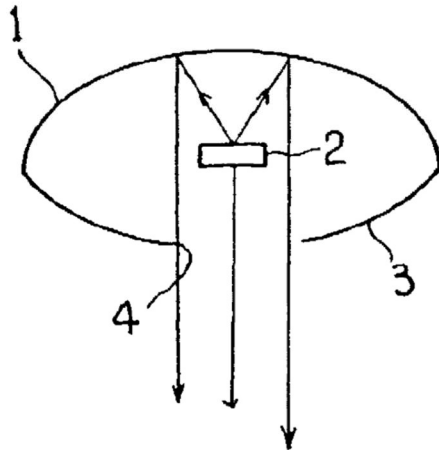
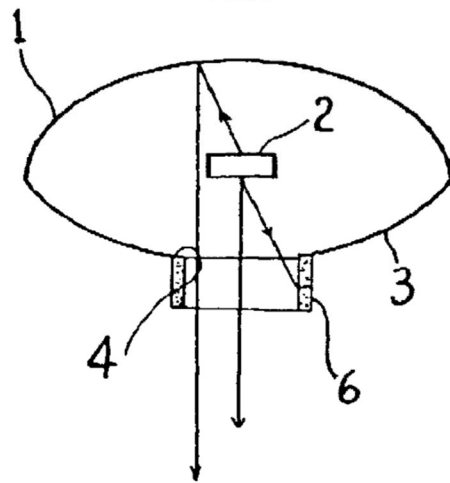


FIG. 3
*Longitudinal
section and side
view*



Id., FIGs. 1 (left), 3 (right).

120. Thus, it is my opinion that, in the Matsunari-Ono combination, a POSITA would have been motivated to configure Matsunari's chamber-facing boundary (cavity-facing boundary) to include Ono's parabolic reflective geometry, with the speaker positioned relative to that geometry, yielding a chamber whose shape contributes to the concentrating of the audio signals.

3. Claim 3

- (i) 3. "The method of claim 2, wherein the shape provides a curved surface to a speaker, and the speaker is used in the generating."

121. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitations of claim 3 and would have rendered claim 3 obvious.

122. Ono describes a first reflector “formed in a dish shape having a parabolic surface of revolution,” having a “sound generating device (speaker) 2” positioned at the focal point of that reflector. EX1007, 2; *see also id.*, FIGs. 1-5. Ono also describes a second reflector, also having a parabolic surface of revolution, positioned opposite the first reflector. *Id.*, 2. As a result, the chamber’s shape in Ono provides curved reflector surfaces to the speaker, and the speaker is used in generating the sound that is reflected and directed toward the user.

123. Thus, in the Matsunari-Ono combination, a POSITA would have been motivated to configure Matsunari’s cavity/chamber to include Ono’s parabolic reflective geometry, with Matsunari’s speaker positioned relative to that geometry, and would have yielded a chamber whose shape provides a curved surface to a speaker, with the speaker being used in the generating of the audio signals.

4. Claim 4

- (i) 4. “The method of claim 2, wherein the shape is generally parabolic.”**

124. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 4 and would have rendered claim 4 obvious.

125. As I explained for claims 2 and 3, Ono discloses a dish-shaped reflector having “a parabolic surface of revolution” and explains that its structure uses that parabolic geometry to radiate sound in a specific direction. EX1007, 1-3. A POSITA would have been motivated to configure the chamber-facing boundary of Matsunari’s cavity with that geometry for the reasons I explained above. The resulting chamber shape in the Matsunari-Ono combination would therefore have been generally parabolic.

5. Claim 11

(i) 11. “The method of claim 1, wherein a speaker is used in the generating.”

126. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 11 and would have rendered claim 11 obvious.

127. As I explained for claim 3, Matsunari discloses speakers 8a and 8b located in the eyeglass frames that generate and output audio signals toward the ear canal. EX1005, [0017], [0019], [0022], [0027], [0033].

6. Claim 12

(i) 12. “The method of claim 11, wherein the speaker is located within a temple of the eyewear device.”

128. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 12 and would have rendered claim 12 obvious.

129. As I explained for limitation [1.a], Matsunari expressly discloses that speaker 8 is located within temple 32 of the eyewear device, specifically within cavity 37 that is formed within temple 32. EX1005, [0054]. In the Matsunari-Ono combination, the speaker would remain located within Matsunari’s temple cavity, while Ono’s parabolic reflective geometry and speaker-positioning teachings would be applied to that speaker-in-cavity arrangement to focus sound toward Matsunari’s ear-facing holes. Thus, the speaker in the resulting combination would be located within a temple of the eyewear device.

7. Claim 14

130. For substantially the same reasons I explained for claim 1, a POSITA would have been motivated, with a reasonable expectation of success, to configure Matsunari’s existing speaker-in-cavity arrangement using Ono’s parabolic acoustic-reflector geometry and speaker-positioning teachings, and the resulting Matsunari-

Ono combination teaches or would have suggested the limitations of claim 14 and would have rendered claim 14 obvious.

(i) [14.pre] “An apparatus to provide audio signals to a user from an eyewear device, comprising:”

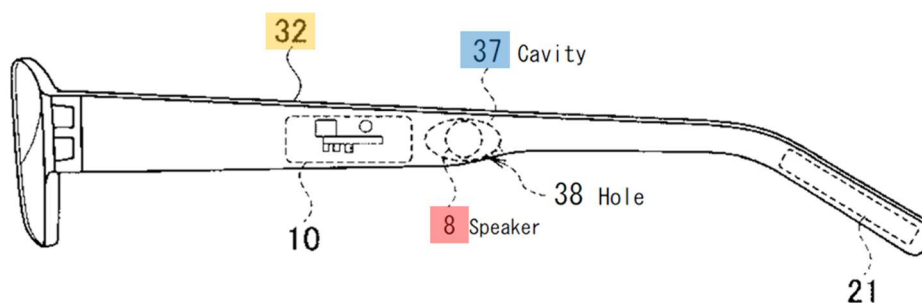
131. I understand that [14.pre] is the preamble of claim 14. I have been asked to assume that this preamble is limiting. Under that assumption, Matsunari discloses preamble [14.pre] for the same reasons as I explained for preamble [1.pre]. *See* Section X.A.1(i). In particular, Matsunari discloses an eyeglass-type hearing aid with speakers located in the eyeglass frames that output audio signals to those speakers. EX1005, Abstract, [0014]-[0019], claim 1.

(ii) [14.a] “a chamber, the chamber is defined by an interior surface, the chamber is a part of a volume of the eyewear device, the chamber further comprising:”

132. In my opinion, Matsunari discloses limitation [14.a] for the reasons I explained for limitation [1.a]. *See* Section X.A.1(ii).

133. As I explained for limitation [1.a], Matsunari discloses a chamber in the form of cavity 37, which surrounds speaker 8 and is formed within temple 32 of the eyeglass-type hearing aid. EX1005, [0054]. Because temple 32 is part of Matsunari’s eyewear device, cavity 37 is part of a volume of the eyewear device.

134. A POSITA would have understood that cavity 37 is bounded by the inner walls of temple 32, and that those walls provide an interior surface of the chamber surrounding speaker 8. Matsunari's Figure 10 illustrates this arrangement, showing cavity 37 (blue) surrounding speaker 8 (red) within temple 32 (orange). EX1005, FIG. 10.



Id., FIG. 10 (annotated).

(iii) [14.b] “at least one speaker, the at least one speaker to generate audio signals, the at least one speaker is contained within the volume”

135. It is my opinion that Matsunari teaches this limitation to a POSITA for the reasons I explained for limitation [1.a] and [14.a]. *See* Sections X.A.1(ii), X.A.7(ii). In particular, Matsunari discloses cavity 37 within temple 32 of the eyeglass-type hearing aid, and speaker 8 is located within that cavity. EX1005, [0054]. Matsunari also explains that audio signals are provided to the speakers and that sound is output from the speakers toward the user's ears. EX1005, [0022],

[0027], [0033], [0054]-[0055]. Thus, speaker 8 is at least one speaker that generates audio signals and is contained within the volume of the eyewear device, including within temple 32 and cavity 37.

- (iv) **[14.c] “an acoustic port, the acoustic port is positioned in a wall of the chamber to concentrate emission of the audio signals from the chamber in a direction of the user’s ear when the user wears the eyewear device;”**

136. It is my opinion that the Matsunari-Ono combination teaches or would have suggested this limitation for the reasons I explained for limitations [1.b]-[1.c]. *See* Sections X.A.1(iii)-(iv).

137. As I discussed for limitation [1.c], Matsunari discloses holes 38 extending from cavity 37 toward the user’s ear. *See* Section X.A.1(iv). Matsunari provides that sound from cavity 37 is output directly toward the ear through holes 38, reducing sound leakage. EX1005, [0054]-[0055]. In my opinion, one or more of holes 38 are an acoustic port positioned in a wall of cavity 37, because the holes provide the ear-facing openings through which sound exits the chamber toward the wearer’s ear.

138. As I discussed for limitation [1.b], Ono teaches using parabolic acoustic-reflector geometry and speaker positioning relative to that geometry to

focus sound toward a listener. *See* Section X.A.1(iii). Ono explains that its reflector arrangement produces sound waves “focused into a sound beam” that reach the user “locally” through an opening, with reduced sound in other areas. EX1007, 2-3. A POSITA would have been motivated to apply Ono’s teachings to Matsunari’s speaker-in-cavity arrangement to configure the chamber region to focus the generated sound toward Matsunari’s ear-facing holes 38.

139. In the resulting Matsunari-Ono combination, Matsunari’s holes 38 would remain the acoustic ports positioned in the wall of cavity 37 and along the ear-facing output path, and Ono’s parabolic reflective geometry and speaker-positioning teachings would cause the generated sound to be focused toward those ports. As a result, the reflective chamber surface and wall-port arrangement would operate together to concentrate emission from the chamber in the direction of the user’s ear.

(v) **[14.d] “an outer surface, the outer surface is exterior to the inner surface.”**

140. It is my opinion that the Matsunari-Ono combination teaches or would have suggested this limitation to a POSITA.

141. As I discussed for limitation [14.a], Matsunari discloses cavity 37 formed within temple 32, and cavity 37 is bounded by the inner walls of temple 32.

See Section X.A.7(ii); EX1005, [0054]. Those chamber-facing wall surfaces define the chamber and provide the interior surface discussed for limitation [14.a].

142. In my opinion, the physical temple wall defining cavity 37 also has an opposite outer surface that is exterior to the chamber-facing interior surface, as illustrated in Matsunari's Figure 10. That same physical surface is both an outer surface of the temple and an outer surface of the wall structure defining the chamber. This follows from the structure Matsunari discloses: cavity 37 is formed within temple 32 and surrounds speaker 8, so the chamber is defined by physical wall surfaces rather than by an abstract boundary. EX1005, [0054], FIG. 10; *see also* EX1007, FIG.1.

143. The same inner/outer surface relationship would be present in the Matsunari-Ono combination. As I discussed for limitation [1.b], the combination retains Matsunari's eyewear form factor and temple cavity while configuring the acoustic chamber region within the temple cavity using Ono's parabolic reflective geometry and speaker-positioning teachings. *See* Section X.A.1(iii). Applying Ono's teachings within the chamber region would not eliminate or replace the surrounding temple wall. The combination therefore would retain the same physical outer surface identified above—both as an outer surface of the temple and as an outer

surface of the wall structure defining the chamber—and that surface would remain exterior to the chamber-facing inner surface.

8. Claim 17

- (i) 17. “The apparatus of claim 14, wherein the inner surface forms a curved shape around the at least one speaker.”**

144. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 17 and would have rendered claim 17 obvious, for the reasons I discussed for claim 3, limitation [1.b], and limitations [14.a]-[14.b]. *See* Sections X.A.3, X.A.1(iii), X.A.7(ii)-(iii).

145. As I discussed for limitations [14.a]-[14.b], Matsunari discloses cavity 37 within temple 32, with speaker 8 contained in that cavity. EX1005, [0054]. As I discussed for claim 3 and limitation [1.b], Ono teaches parabolic acoustic-reflector geometry in which curved reflective surfaces are positioned relative to a sound-generating device/speaker to focus sound toward a user. EX1007, 2-3.

146. Specifically, Ono discloses a first reflector “formed in a dish shape having a parabolic surface of revolution,” with “sound generating device (speaker) 2” positioned at the focal point of that reflector. EX1007, 2. Ono also discloses a second reflector, also having a parabolic surface of revolution, positioned opposite

the first reflector. *Id.* These parabolic sound-reflecting surfaces form an inner surface arranged around the speaker for focusing sound generated by the speaker.

147. In the Matsunari-Ono combination, a POSITA would have been motivated to configure Matsunari's cavity to include Ono's parabolic reflective geometry, with Matsunari's speaker positioned relative to that geometry. The resulting chamber would therefore include an inner surface forming a curved shape around the speaker.

9. Claim 18

(i) 18. "The apparatus of claim 17, wherein the curved shape is generally parabolic."

148. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 18 and would have rendered claim 18 obvious, for reasons I explained for claims 4 and 17. *See* Sections X.A.4, X.A.8.

149. As I explained for claim 4, Ono discloses reflector surfaces having "a parabolic surface of revolution," and further explains that its reflector structure "utilizes the principle of an acoustic lens using a parabolic surface of revolution." EX1007, 1-3. As I explained for claim 17, in the Matsunari-Ono combination, a POSITA would have been motivated to configure Matsunari's cavity to include Ono's parabolic reflective geometry, with Matsunari's speaker positioned relative to

that geometry. The resulting chamber would therefore include an inner surface forming a generally parabolic shape around the speaker.

10. Claim 22

(i) 22. “The apparatus of claim 14, wherein the chamber is located within a temple of the eyewear device.”

150. In my opinion, the Matsunari-Ono combination teaches or would have suggested the additional limitation of claim 22 and would have rendered claim 22 obvious, for the reasons I explained for limitations [1.a] and [14.a]. *See* Sections X.A.1(ii), X.A.7(ii).

151. As I explained for limitation [14.a], Matsunari discloses a chamber in the form of cavity 37, which surrounds speaker 8 and is formed within temple 32 of the eyeglass-type hearing aid. EX1005, [0054]. Thus, Matsunari expressly discloses a chamber located within a temple of the eyewear device.

152. In the Matsunari-Ono combination, Matsunari’s eyewear form factor and temple cavity would be retained, while the acoustic chamber region within Matsunari’s temple cavity would be configured using Ono’s parabolic reflective geometry and speaker-positioning teachings. *See* Section X.A.1(iii). Because the chamber region remains within Matsunari’s temple 32, the resulting chamber would be located within a temple of the eyewear device.

B. Ground 2: Matsunari in View of Ono and Boyden Teaches and/or Suggests Claims 5-9, 15-16, and 24-28

1. Claim 5

- (i) 5. “The method of claim 1, wherein an inner surface of the chamber has a first acoustic reflectivity and at least a portion of the eyewear device has a second acoustic reflectivity, the first acoustic reflectivity is greater than the second acoustic reflectivity.”**

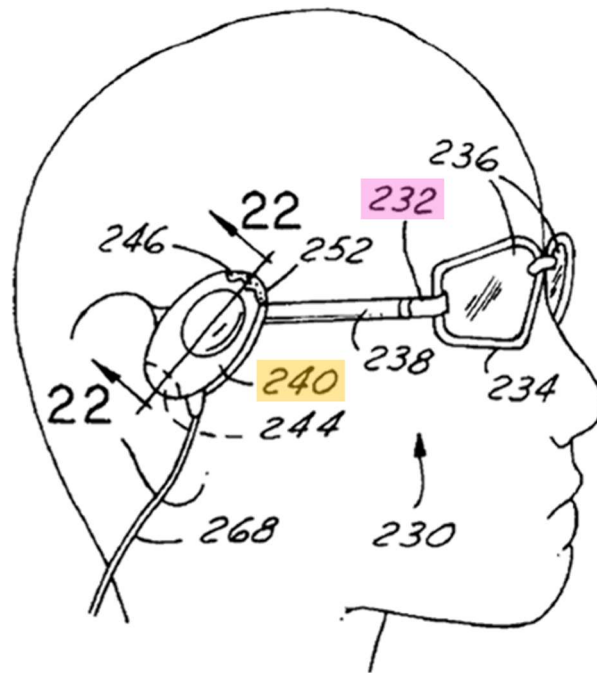
153. Claim 5 depends from claim 1 and recites “wherein an inner surface of the chamber has a first acoustic reflectivity and at least a portion of the eyewear device has a second acoustic reflectivity, the first acoustic reflectivity is greater than the second acoustic reflectivity.” Claim 5 thus adds a difference in acoustic reflectivity between the chamber’s inner surface and another portion of the eyewear device. Boyden provides the relevant materials and surface-treatment teachings, and a POSITA would have been motivated to apply those teachings to the Matsunari-Ono combination.

154. Thus, it is my opinion that the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitations of claim 5 and would have rendered claim 5 obvious.

155. As I explained for claims 1-4 in Sections X.A.1-4, the Matsunari-Ono combination results in an eyewear chamber that generates, concentrates, and directs

sound toward the user's ear. Matsunari discloses outputting sound directly toward the ear through cavity 37 and holes 38 while reducing sound leakage and avoiding dispersion of acoustic energy. EX1005, [0054]-[0055]. Ono discloses parabolic acoustic-reflector geometry for doing so: parabolic reflectors 1 and 3 reflect sound from speaker 2, focus the sound into a beam, and emit the sound through opening 4 toward the user. EX1007, 2-3.

156. Boyden describes “[a]coustic modules adapted to be worn on the head of a wearer, such as with . . . eyeglasses.” EX1008, Abstract. Boyden also describes that “[a] pair of enclosures or acoustic modules 12 and 14” are “positioned on opposite sides of the wearer’s head 16” and “situated in close proximity to one of the wearer’s ears.” *Id.*, 4:59-63. In one embodiment, acoustic modules 240 (orange) are disposed on the temples of eyeglasses 232 (pink), as depicted in FIG. 20.



Id., FIG. 20 (annotated).

157. According to Boyden, small wearable speaker enclosures present an acoustic problem because “the volume of the enclosure will be quite small” and the enclosure’s “acoustic stiffness will dominate speaker behavior,” resulting in “a high resonance frequency and consequently a poor low frequency response.” *Id.*, 2:1-5.

158. For addressing acoustic performance in wearable speaker modules, Boyden teaches that the modules may be hollow, filled with acoustically transparent material, or filled or partially filled with acoustic damping material to “suppress undesired resonance within the enclosure.” *Id.*, 5:36-50. Boyden further teaches that the walls of its speaker modules “are preferably made from a substantially

acoustically inert material, that is, non-radiative and absorbing,” and identifies as suitable materials “[h]eavy gauge woven impregnated fabrics, most conventional plastic materials, and carbon fiber composites.” *Id.*, 5:54-62. Boyden also teaches that “[t]he walls and interiors of the modules are preferably designed to provide the best acoustical properties, and this could include a plurality of structural rib members, coated surfaces, or liners made from more acoustically efficient materials.” *Id.*, 5:63-67.

159. Boyden’s eyeglass embodiment uses the same type of acoustic material and construction: Boyden explains that the acoustic module attached to the eyeglass temple is similar to the previously described acoustic modules in “construction, materials, operation and performance.” *Id.*, 12:5-7.

160. Boyden is from the same field of endeavor as Matsunari, Ono, and the ’174 patent. Boyden describes “portable entertainment and personal communication and information systems, particularly wearable audio systems,” *id.*, 1:14-16, and expressly contemplates acoustic modules mounted to eyeglasses. *Id.*, Abstract, 11:55-12:7, FIG. 20. The ’174 patent, Matsunari, and Ono all operate in the same field of head-worn personal audio. EX1001, 1:40-44; EX1005, [0001], [0014]; EX1007, 1.

161. Boyden is reasonably pertinent to a particular problem the inventors of the '174 patent were focused on, including providing high-quality directional personal audio to a user without occluding the ear. Boyden criticizes conventional earphones and headphones because they are “often uncomfortable to use for long periods of time” and “can block or attenuate environmental sounds causing the wearer to lose contact with the surroundings.” EX1008, 1:33-42. Boyden’s objectives including “provid[ing] a non-occluding wearable audio system,” *id.*, 2:15-16, and “a wearable audio system which does not require the speakers to be contacting, positioned in, or covering the wearer’s ears.” *Id.*, 2:18-20. The '174 patent also identifies those design objectives, criticizing in-ear earphones as “occlusive” devices that “obstruct[] the ear canal” and can interfere with hearing ambient sounds. EX1001, 1:55-59.

162. Boyden is directed to the kind of acoustic-enclosure design problem that Matsunari’s cavity and Ono’s reflector-defined chamber address: how to control acoustic energy within a small wearable speaker enclosure so that desired sound is delivered to the listener while undesired vibration, leakage, and resonance are suppressed. EX1008, 2:1-5, 5:36-67; EX1005, [0054]-[0055]; EX1007, 2-3.

a. Combination Rationale

163. In my opinion, a POSITA would have been motivated, with a reasonable expectation of success, to combine the Matsunari-Ono combination with Boyden's material and surface-treatment teachings. In particular, a POSITA would have been motivated to implement Ono's parabolic reflective geometry with an acoustically efficient, sound-reflecting chamber-facing surface, while applying Boyden's non-radiative and absorbing/damping materials to at least another portion of the eyewear device, such as surrounding temple housing or wall material.

164. Boyden's teachings advance the same acoustic objectives reflected in Matsunari and Ono. Matsunari seeks to direct sound from cavity 37 toward the ear while reducing "sound leakage" and avoiding dispersion of acoustic energy. EX1005, [0054]-[0055]. Ono focuses sound through an opening toward the user. EX1007, 2-3. Boyden likewise teaches selecting module wall and interior materials "to provide the best acoustical properties" in small wearable speaker enclosures, including through "coated surfaces" and "liners made from more acoustically efficient materials." EX1008, 5:54-67.

165. Boyden's material-selection guidance would have been relevant to the Matsunari-Ono eyewear chamber for two related but distinct reasons. First, Boyden's non-radiative and acoustically absorbing wall materials and surface

treatments provide a way to lower acoustic reflectivity and reduce unwanted airborne sound outside the intended chamber-to-port path. Second, Boyden's damping, coating, liner, and wall-construction teachings provide options from which a POSITA could select a vibration-damping treatment mechanically coupled to a wall or surrounding housing portion excited by the speaker. EX1008, 5:1-8, 5:36-67. The Matsunari-Ono combination includes the same basic design context: a speaker located within a small temple chamber whose useful output is directed toward the wearer's ear. EX1005, [0054]-[0055]; EX1007, 2-3.

166. In the Matsunari-Ono-Boyden combination, the higher-reflectivity inner surface would be the exposed chamber-facing surface that implements Ono's parabolic reflector geometry. Whether that geometry is formed directly in the wall of Matsunari's cavity or by a reflector insert or liner that itself defines part of the chamber, the chamber-facing face is the surface encountered by the speaker-generated sound. Ono teaches that sound is reflected by its reflector surfaces, focused into a sound beam, and emitted through the opening toward the user. EX1007, 2-3. The material boundary at that exposed face supplies the reflection, while the reflector geometry determines the direction of the reflected sound. The resulting chamber-facing surface therefore has the claimed first acoustic reflectivity.

167. For the second, lower-reflectivity portion, a POSITA would have been motivated to select another eyewear portion, such as the surrounding temple housing or wall, and formed or treated it with a substantially acoustically inert, non-radiative, and absorbing material such as Boyden's. EX1008, 5:54-67. That portion would reflect less incident acoustic energy than Ono's sound-reflecting chamber-facing surface and would reduce unwanted acoustic reradiation outside the intended output path.

168. A POSITA would have had a reasonable expectation of success in making these material selections. Boyden discloses these material and surface-treatment options for wearable speaker modules and applies similar construction, materials, operation, and performance to an eyeglass-mounted acoustic module. EX1008, 5:54-67, 12:5-7. Applying Boyden's known material selections to the Matsunari-Ono eyewear chamber would have been a straightforward use of known acoustic design principles to improve a small wearable speaker enclosure, with predictable results.

2. Claim 6

- (i) 6. "The method of claim 5, the portion absorbs vibrational energy."**

169. It is my opinion that the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitation of claim 6 and would have rendered claim 6 obvious.

170. The '174 patent characterizes vibration damping as minimizing speaker-induced mechanical vibration imparted to the chamber wall and attenuating its transmission through the eyewear. EX1001, 21:12-21, 23:32-24:14. In the Matsunari-Ono-Boyden combination, the relevant portion is the lower-reflectivity chamber-wall or adjoining temple-housing portion identified for claim 5. *See* ¶167.

171. That portion forms or adjoins the wall defining Matsunari's speaker-containing cavity 37. EX1005, [0054], FIG.10. A POSITA would have understood that speaker reaction forces and cavity-pressure fluctuations load and excite the wall or housing portion, allowing vibration to propagate into the adjoining temple structure. For example, Kinsler identifies loudspeaker diaphragms as oscillators and explains that dissipative frictional forces and mechanical resistance damp oscillation by dissipating power; it likewise explains that damping of a vibrating membrane arises from internal friction and forces associated with sound radiation. EX1021, 18-19, 24-27, 30-31, 115-116. Consistently, Boyden preferably seals its transducer into a module wall and teaches damping material to suppress enclosure resonance,

together with non-radiative, absorbing walls and coated surfaces or liners. EX1008, 5:1-8, 5:36-67. Boyden also recognizes direct low-frequency coupling through module walls or pads contacting the wearer's temples, confirming that structure-borne coupling through the module housing was a known transmission path. *Id.*, 10:16-24.

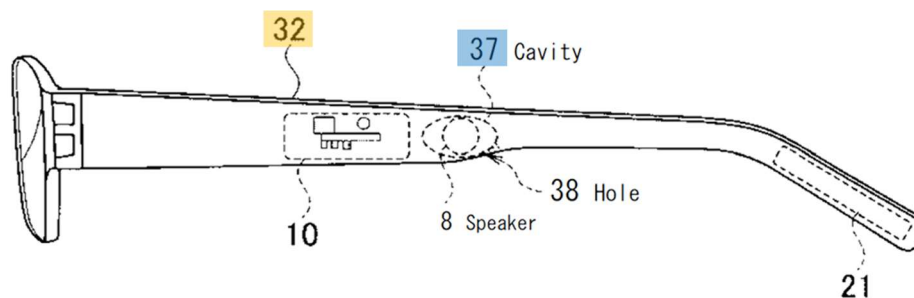
172. A POSITA therefore would have selected from Boyden's disclosed material, coating, and liner options a vibration-damping treatment mechanically coupled to that wall or housing portion, with a reasonable expectation of success. The treatment would deform with the structure and dissipate part of its cyclic strain energy, reducing transmission through the temple and unwanted reradiation as sound while preserving Ono's reflective inner surface. Beranek separately confirms the predictable enclosure-level effect of added absorption: reduced resonance peaks and an increased damping constant. EX1019, 10, 12-14. The treated portion would thus absorb vibrational energy, as claim 6 requires.

3. Claims 7 and 8

- (i) 7. "The method of claim 6, wherein the portion is forward of the chamber."**
- (ii) 8. "The method of claim 6, wherein the portion is rear of the chamber."**

173. In my opinion, the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitations of claims 7 and 8 and would have rendered claims 7 and 8 obvious.

174. As I explained in Section X.B.2 for claim 6, in the Matsunari-Ono-Boyden combination, the identified lower-reflectivity, vibration-absorbing portion of the eyewear device includes surrounding temple housing or wall material outside the chamber. According to Matsunari, cavity 37 surrounding speaker 8 is located within temple 32. EX1005, [0054]; *see also id.*, FIG. 10 (showing temple 32 (orange) includes a portion forward of cavity 37 (blue) and a portion rear of cavity 37).



Id., FIG. 10 (annotated). Such forward and rear temple portions are parts of the same surrounding temple housing outside the chamber in the Matsunari-Ono-Boyden combination.

175. The temple portions forward and rear of cavity 37 are each contiguous structural paths extending from the speaker chamber. A POSITA would have

recognized that speaker-induced wall vibration could enter either path. For the reasons explained in ¶¶165-172, the POSITA would have applied the selected absorbing material to the forward portion (as required by claim 7) and the rear portion (as required by claim 8), so that the material would deform with the surrounding temple structure and dissipate speaker-induced mechanical energy before it was transmitted along the eyewear. EX1008, 5:1-8, 5:36-67.

176. Accordingly, in my opinion, the Chow-Ono-Boyden combination would have rendered claims 7 and 8 obvious: for claim 7, the relevant vibration-absorbing portion would be forward of the chamber; for claim 8, the relevant vibration-absorbing portion would be rear of the chamber.

4. Claim 9

(i) 9. “The method of claim 6, wherein the portion is an outer surface of the chamber.”

177. In my opinion, the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitation of claim 9 and would have rendered claim 9 obvious.

178. As I explained for claims 5 and 6, the Matsunari-Ono-Boyden chamber would retain a higher-reflectivity chamber-facing surface for directing useful airborne sound, while another portion would be selected for lower acoustic

reflectivity and for mechanical-vibration damping. *See* Sections X.B.1-2. Claim 9 further specifies the location of that vibration-absorbing portion: an outer surface of the chamber.

179. As I also explained for limitation [14.d], the chamber wall has a chamber-facing inner surface and an outer surface exterior to that inner surface. *See* Section X.A.7(v). Boyden teaches using acoustically inert, non-radiative, and absorbing materials for speaker-module walls. EX1008, 5:54-56. Boyden also discloses using acoustic damping material to “suppress undesired resonance within the enclosure,” and teaches that the “walls and interiors of the modules” may be designed with different materials and surface treatments to provide “the best acoustical properties.” *Id.*, 5:36-50, 5:63-67. Boyden’s eyeglass-mounted acoustic module uses the same type of construction and materials. *Id.*, 12:5-7.

180. A POSITA would have been motivated to apply the damping treatment selected for claim 6 to the chamber wall’s outer surface while leaving Ono’s chamber-facing reflective surface exposed. Because the outer surface is mechanically coupled to the chamber wall, the treatment would deform with the wall and dissipate part of its cyclic strain energy before vibration propagated into the surrounding temple. The outer-side placement would also avoid covering the inner

reflector that directs useful sound toward the chamber port and would reduce acoustic reradiation from the wall. EX1007, 2-3; EX1008, 5:1-8, 5:36-67. The outer surface would therefore be the lower-reflectivity portion that absorbs vibrational energy, as claims 5, 6, and 9 require.

5. Claim 15

- (i) 15. “The apparatus of claim 14, wherein the interior surface has a larger acoustic reflectivity than an acoustic reflectivity of the outer surface.”**

181. In my opinion, the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitation of claim 15 and would have rendered claim 15 obvious, for the reasons I explained for claims 5 and 9. *See* Sections X.B.1, X.B.4.

182. The acoustic-reflectivity comparison for claim 15 follows from the functions assigned to the two surfaces. The chamber-facing interior surface would retain Ono’s reflecting boundary and would return useful airborne acoustic energy toward the port. The exterior or outer surface would be formed or treated with a non-radiative and acoustically absorbing material such as Boyden’s and therefore would have lower acoustic reflectivity. EX1007, 2-3; EX1008, 5:54-67. The mechanical-damping function discussed for claims 6 and 9 is compatible with this arrangement,

but it is a separate reason for selecting and locating the outer-side treatment rather than the basis for the acoustic-reflectivity comparison.

6. Claim 16

- (i) 16. “The apparatus of claim 15, wherein the outer surface is coated with a material that absorbs acoustic energy.”**

183. It is also my opinion that the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitation of claim 16 and would have rendered claim 16 obvious.

184. Claim 16 concerns absorption of acoustic energy, not merely damping of structural vibration. As explained for claims 9 and 15, the Matsunari-Ono-Boyden combination would include a chamber wall having a higher-reflectivity chamber-facing inner surface and an outer surface exterior to that inner surface. *See* Sections X.B.4-5. The inner surface would preserve and redirect useful airborne sound toward the port, while the outer surface would be available for an acoustically lossy coating outside the intended chamber-to-port path.

185. Boyden teaches substantially acoustically inert, non-radiative, and absorbing wall materials and identifies coated surfaces as an available way to obtain desired acoustic properties in module walls and interiors. EX1008, 5:54-67. At an acoustic boundary, incident energy is divided among reflected, absorbed, and

transmitted components. *See* Section VI.C. Thus, the portion of speaker-generated acoustic energy not reflected by the chamber-facing surface can be transmitted into or through the wall structure. A POSITA would have been motivated to select an acoustically lossy Boyden-type coating for the opposite surface to absorb part of that transmitted energy and reduce its outward reradiation.

186. Applying that coating to the outer surface would have been a routine and predictable fabrication choice. It would leave the chamber-facing reflector exposed, avoid occupying useful chamber volume or interfering with the port, and permit the coating to be applied before final assembly. Boyden applies related construction and materials to an eyeglass-mounted acoustic module. EX1008, 12:5-7. The resulting outer surface would be coated with a material that absorbs acoustic energy, as claim 16 requires.

7. Claims 24-28

- (i) 24. “The apparatus of claim 14, wherein an inner surface of the chamber has a first acoustic reflectivity and at least a portion of the eyewear device has a second acoustic reflectivity, the first acoustic reflectivity is greater than the second acoustic reflectivity.”**
- (ii) 25. “The apparatus of claim 24, the portion absorbs vibrational energy.”**
- (iii) 26. “The apparatus of claim 25, wherein the portion is**

forward of the chamber.”

- (iv) 27. “The apparatus of claim 25, wherein the portion is rear of the chamber.”**
- (v) 28. “The apparatus of claim 25, wherein the portion is an outer surface of the chamber.”**

187. Claims 24-28 are the apparatus counterparts to method claims 5-9. It is my opinion that the Matsunari-Ono-Boyden combination teaches or would have suggested the additional limitations of claims 24-28 and would have rendered claims 24-28 obvious, for the reasons I explained for claims 5-9, respectively. *See* Sections X.B.1-4.

C. Ground 3: Matsunari in View of Ono and Chow Teaches and/or Suggests Claims 10 and 19

1. Claim 10

- (i) 10. “The method of claim 1, wherein an external sound cover contributes to the concentrating, the external sound cover is attached to the eyewear device.”**

188. Claim 10 depends from claim 1 and recites “wherein an external sound cover contributes to the concentrating, the external sound cover is attached to the eyewear device.” Claim 10 thus adds an external structure attached to the eyewear device that helps guide or concentrate audio signals toward the user’s ear. In my opinion, Chow provides the relevant external sound-cover teaching, and a POSITA

would have been motivated to apply that teaching to the Matsunari-Ono combination for the reasons I explain below.

189. It is my opinion that the Matsunari-Ono-Chow combination teaches or would have suggested the additional limitations of claim 10 and would have rendered claim 10 obvious.

190. As I explained for claim 1 in Section X.A.1, the Matsunari-Ono combination provides an eyewear-mounted chamber arrangement that generates, concentrates, and directs sound toward the user's ear. Matsunari outputs sound directly toward the ear through cavity 37 and holes 38 while reducing sound leakage and avoiding dispersion of acoustic energy. EX1005, [0054]-[0055]. Ono's parabolic acoustic-reflector geometry and speaker-positioning teachings would further focus the generated sound toward that ear-facing output path. EX1007, 2-3.

191. Chow discloses "audio eyewear" having a front frame and side frame members, with a speaker mounted in a side frame member to direct sound into the user's ear. EX1006, Abstract, [0007], [0038].

192. Chow further discloses, in the embodiment shown in FIG. 7, an external sound-channel member in the form of sound-deflecting surface 66 (orange). Chow explains that sound-deflecting surface 66 "extends from an outer surface of the at

least one side frame member 64 and over a portion of the user's ear for channeling sound from a speaker...into the user's ear while also allowing ambient sound to be heard." EX1006, [0042].



FIG. 7

Id., FIG. 7 (annotated). Chow also teaches that such sound-channel members, including the sound-deflecting surface, can be attached to the eyewear side frame members, including by removable magnetic or mechanical attachment fittings. *Id.*, [0041]-[0042].

193. Chow is also reasonably pertinent to a particular problem the inventors of the '174 patent were focused on, including providing directional personal audio

to a user without occluding the ear. Chow criticizes traditional earphones and bone-conducting speakers as “bulky, cumbersome or unreliable,” EX1006, [0004], and discloses directing sound to the user’s ear from an eyewear-mounted speaker while still allowing ambient sound to be heard. *Id.*, [0041]-[0042]. That objective directly aligns with the ’174 patent’s stated goal of “sharp directivity for personal listening of audio” without occlusive earphones. EX1001, 1:55-59.

194. Chow is directed to an external sound-channel structure for an eyewear-mounted speaker, which is the same type of structure addressed by the ’174 patent’s external-sound-cover limitation. EX1006, [0041]-[0042], FIGs. 5-7.

a. Combination Rationale

195. In my opinion, a POSITA would have been motivated to attach an external sound-channel member like Chow’s, such as sound-deflecting surface 66, to the eyewear in the Matsunari-Ono-Chow combination to further guide sound emitted from Matsunari’s ear-facing holes 38 toward the wearer’s ear while maintaining an open-ear arrangement.

196. That modification would have advanced the same ear-directed audio objectives reflected in the references. Matsunari seeks to output sound from cavity 37 toward the user’s ear through holes 38 while reducing sound leakage and avoiding

dispersion of acoustic energy. EX1005, [0054]-[0055]. Ono's parabolic acoustic-reflector geometry and speaker-positioning teachings would further focus the generated sound toward that ear-facing output path. EX1007, 2-3. Chow likewise teaches an eyewear-mounted sound-channel structure that channels sound from a speaker into the user's ear while still allowing ambient sound to be heard. EX1006, [0041]-[0042]. A POSITA would have recognized such an external sound-channel member as a known and suitable way to further guide the sound emitted from the Matsunari-Ono chamber ports toward the user's ear.

197. Chow's teaching would have been straightforward to apply because Chow expressly discloses attaching its sound-channel structure to eyewear side frame members. *Id.*, [0042]. The Matsunari-Ono combination already retains Matsunari's eyewear form factor, including a temple cavity, speaker, and ear-facing holes. EX1005, [0054]. Attaching an external sound-channel member like Chow's to the eyewear side frame or temple region therefore would have been a predictable application of Chow's own eyewear-mounted sound-channel teaching to the Matsunari-Ono eyewear arrangement.

198. Such an external sound-channel member also preserves the non-occlusive nature of the Matsunari-Ono arrangement. Chow explains that sound-

deflecting surface 66 channels sound into the user's ear "while also allowing ambient sound to be heard." EX1006, [0042]. That feature is consistent with Matsunari's objective of avoiding inconvenient in-ear earphones and Ono's hearing-aid structure that "does not require earphones." EX1005, [0006]-[0008]; EX1007, 1.

199. In my opinion, a POSITA would have had a reasonable expectation of success in applying Chow's external sound-channel teachings to the Matsunari-Ono eyewear arrangement. Chow's sound-channel member is an external eyewear attachment designed for ear-directed audio delivery, and adding such a structure would not require changing the internal speaker/cavity operation of the Matsunari-Ono combination. Instead, the external sound-channel member would be positioned downstream of the chamber output to help channel sound emitted from the ear-facing holes toward the user's ear. EX1006, [0042].

200. Chow's disclosure that its sound-channel members can be "removably attached by magnetic or mechanical attachment fittings" further supports the straightforwardness of the modification. *Id.*, [0042]. A POSITA would have understood that Chow's external sound-channel member would be attached to eyewear using known mechanical or magnetic attachment techniques without materially altering the internal chamber structure.

201. As a result, in the Matsunari-Ono-Chow combination, an external sound-channel member like Chow's, such as sound-deflecting surface 66, would provide an external sound cover attached to the eyewear device that contributes to concentrating the audio signals for delivery to the user's ear.

2. Claim 19

- (i) [19.pre] "The apparatus of claim 14, further comprising:"**
- (ii) [19.a] "an external sound cover, the external sound cover has an inner surface and an outer surface, the external sound cover is configured to attach to the eyewear device, wherein in operation, the audio signals emitted from the acoustic port reflect off of the inner surface toward the user's ear."**

202. In my opinion, the Matsunari-Ono-Chow combination teaches or would have suggested the additional limitations of claim 19 and would have rendered claim 19 obvious.

203. As I explained for limitation [14.c], in the Matsunari-Ono combination, Matsunari's holes 38 remain the acoustic ports positioned in the wall of cavity 37, and sound is emitted through those ports toward the user's ear. *See* Section X.A.7(iv). As I explained for claim 10, Chow discloses an external sound cover, including sound-deflecting surface 66, configured to attach to an eyewear device. *See* Section X.C.1. Chow explains that sound-deflecting surface 66 "extends from

an outer surface of the at least one side frame member 64 and over a portion of the user's ear for channeling sound from a speaker ... into the user's ear while also allowing ambient sound to be heard." EX1006, [0042]. Chow further discloses that such sound channel members can be "removably attached by magnetic or mechanical attachment fittings" to the side frame members. *Id.*

204. As shown in Chow's FIG. 7, the ear-facing sound-deflecting surface 66 (orange) provides the cover's inner surface because it is the side positioned to receive and channel sound toward the user's ear. The opposite side of that structure provides the cover's outer surface.



FIG. 7

Id., FIG. 7 (annotated).

205. Chow describes surface 66 as a “sound-deflecting surface” that channels sound from the eyewear speaker toward the user’s ear. EX1006, [0042]. Those are Chow’s descriptions of the surface and its function. In the combination, the acoustic mechanism relied on for claim 19 is reflection: a POSITA would have been motivated to position and configure the ear-facing inner surface of Chow’s attached surface so that audio signals emitted from Matsunari’s acoustic ports impinge on and reflect off that inner surface toward the user’s ear. As discussed above, reflection is an ordinary response of acoustic energy incident on a material boundary. *See* ¶¶48-49. This arrangement would further the same ear-directed audio-delivery objectives I discussed for claim 10.

206. As a result, in my opinion, the attached sound-deflecting member in the Matsunari-Ono-Chow combination would provide an external sound cover having an inner surface and an outer surface, configured to attach to the eyewear device, with audio signals emitted from the acoustic port reflecting off the inner surface toward the user’s ear.

207. [Intentionally omitted to preserve paragraph numbering.]

208. [Intentionally omitted to preserve paragraph numbering.]

209. [Intentionally omitted to preserve paragraph numbering.]

210. [Intentionally omitted to preserve paragraph numbering.]

211. [Intentionally omitted to preserve paragraph numbering.]

D. Ground 4: Matsunari in View of Ono, Chow and Boyden Teaches and/or Suggests Claim 20

1. Claim 20

- (i) 20. “The apparatus of claim 19, wherein a first material used for the inner surface provides substantially for reflection of the audio signals and a second material used for the outer surface provides substantially for absorption of acoustic energy.”**

212. Claim 20 depends from claim 19 and recites “wherein a first material used for the inner surface provides substantially for reflection of the audio signals and a second material used for the outer surface provides substantially for absorption of acoustic energy.” Claim 20 adds a two-material arrangement for the inner and outer surfaces of the external sound cover addressed for claim 19. In my opinion, Boyden discloses the pertinent material and surface-treatment teachings, and a POSITA would have applied those teachings to the Matsunari-Ono-Chow external cover.

213. It is therefore my opinion that the Matsunari-Ono-Chow-Boyden combination teaches or would have suggested the additional limitations of claim 20 and would have rendered claim 20 obvious.

214. As I explained for claim 19, the Matsunari-Ono-Chow combination includes an external sound cover attached to the eyewear and positioned so that sound emitted from the acoustic port encounters the cover's ear-facing surface and is redirected toward the user's ear. *See* Section X.C.2. Chow calls surface 66 a "sound-deflecting surface" that extends over part of the ear to channel sound into the ear. EX1006, [0042]. Because the cover performs that function through interaction with its exposed ear-facing boundary, the material forming that boundary provides the reflection or deflection of the incident audio signals; the cover's shape and position determine the direction in which the reflected sound travels. That existing material is the claimed first material used for the inner surface. The opposite side of the cover provides its outer surface.

215. Boyden teaches material and surface-treatment selections for wearable acoustic modules. Boyden states that the module walls are preferably made from "a substantially acoustically inert material, that is, non-radiative and absorbing." EX1008, 5:54-56. Boyden further teaches that the module "walls and interiors" may

include “coated surfaces, or liners made from more acoustically efficient materials” to provide “the best acoustical properties.” *Id.*, 5:63-67. Boyden also applies the same construction and materials to an acoustic module fastened to eyeglasses. *Id.*, 11:55-12:7.

216. In my opinion, Boyden is in the same field as Matsunari, Ono, and Chow for the reasons I explained in Section X.B. Boyden describes wearable audio systems, including acoustic modules attached to eyeglasses. EX1008, Abstract, 11:55-12:7, FIG. 20. Boyden is also reasonably pertinent to the problem of providing audio from a wearable or eyewear-mounted device without occluding the user’s ear. *Id.*, 1:32-40, 2:14-20.

a. Combination Rationale

217. A POSITA would have been motivated to preserve Chow’s existing ear-facing material and surface, rather than cover that surface with an absorber, and to add an absorbing material such as Boyden’s only at the outward-facing side. The second material would be applied as a coating or laminate, or the outward-facing portion would be formed as an outer layer of that material, so that the exposed face of the added material forms the cover’s outer surface. Boyden teaches non-radiative and absorbing wall materials and identifies coated surfaces and liners as available

techniques for obtaining desired acoustic properties. EX1008, 5:54-67. This arrangement uses the two materials for different functions without changing the cover's geometry, attachment, or ear-facing reflecting boundary.

218. The placement is function-driven. When speaker-generated sound encounters the ear-facing inner surface, a substantial portion is reflected or deflected toward the ear, while some energy can be absorbed by or transmitted into the cover. *See* Section VI.C. An acoustically lossy outer layer or coating would absorb part of the energy transmitted into the cover and reduce outward reradiation from the opposite side. Placing that material on the inner face instead would attenuate the same useful incident sound that Chow intends to redirect toward the ear. Any reduction in structural vibration of the cover would be an additional mechanical benefit, not the acoustic-energy absorption on which I rely for claim 20. The arrangement is also consistent with Boyden's broader objective of reducing radiation beyond the wearer's immediate environment. EX1008, 6:18-23.

219. A POSITA would have had a reasonable expectation of success. Applying an acoustic coating or laminate to one side of a molded or otherwise formed cover was a routine fabrication technique, and the outer-side treatment would not alter the location or contour of the sound-deflecting inner surface. Boyden

teaches absorbing wall materials, coated surfaces, and liners in wearable modules and applies related construction and materials to an eyeglass-mounted module. EX1008, 5:54-67, 11:55-12:7. A POSITA therefore would have expected the preserved inner surface to continue channeling useful sound toward the ear while the distinct outer material absorbed transmitted acoustic energy.

220. As a result, in my opinion, the Matsunari-Ono-Chow-Boyden combination would have yielded an external sound cover in which a first material used for the inner surface provides substantially for reflection of the audio signals and a second material used for the outer surface provides substantially for absorption of acoustic energy, as recited in claim 20.

E. Ground 5: Matsunari in View of Ono, Chow and Higuchi Teaches and/or Suggests Claim 21

1. Claim 21

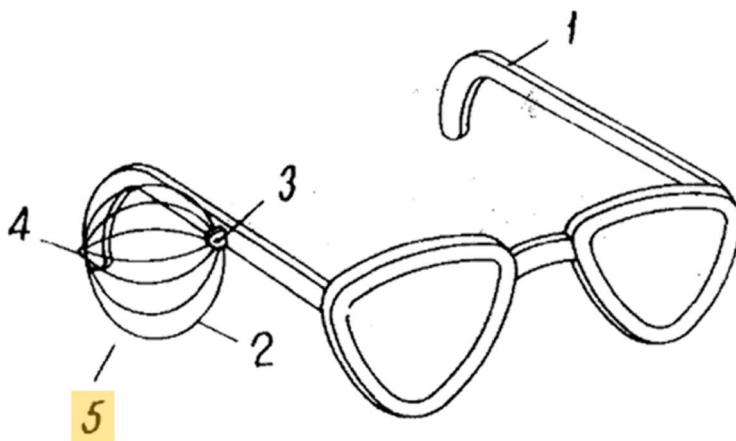
- (i) 21. “The apparatus of claim 19, wherein a shape of the external sound cover is concave towards the user’s ear.”**

221. In my opinion, the Matsunari-Ono-Chow-Higuchi combination teaches or would have suggested that limitation and would have rendered claim 21 obvious.

222. As I explained for claims 10 and 19, Chow discloses an external sound cover in the form of an external sound-channel member, including sound-deflecting

surface 66, attached to eyewear for directing sound toward the user's ear. *See* Sections X.C.1-2. Thus, the Matsunari-Ono-Chow combination provides the external sound cover required by claim 19.

223. Higuchi describes “[a]n auxiliary device for hearing aids comprising multiple arc-shaped segments that cover the ears, rotatably attached to an eyeglass frame.” EX1009, 1 (claim 1). According to Higuchi, “several segments 2 are combined to form a hood 5 (orange) that covers the ears,” with the segments “rotatably mounted around pivot points 3 and 4” located near the earpieces of the eyeglass frame. EX1009, 1. FIG. 1 illustrates Higuchi’s ear-covering hood mounted to the eyeglass frame.



Id., FIG. 1 (annotated).

224. Higuchi explains that, when hearing aids or earphones are in use, the arc-shaped segments are opened to cover the ear, making it “easier to hear sounds

from the hearing aids, earphones, etc.” EX1009, 1-2. The arc-shaped, ear-covering hood disclosed in Higuchi presents a concave shape toward the user’s ear. *Id.*, FIG. 1.

225. Higuchi is in the same field as the other references. Higuchi is titled “Auxiliary Device for Hearing Aids” and describes a device that attaches to an eyeglass frame to assist users of hearing aids and earphones. EX1009, 1. Matsunari and Ono are also directed to hearing-aid devices, and Chow is directed to audio eyewear. EX1005, [0001]; EX1007, 1; EX1006, Title, Abstract.

226. Higuchi is also reasonably pertinent to a problem the ’174 patent’s external-sound-cover limitations address, including providing an eyeglass-mounted, ear-facing structure shaped to help the user hear desired sound. Higuchi’s stated objective is to “make[] it easier to hear sounds from the hearing aids, earphones, etc.” EX1009, 1.

a. Combination Rationale

227. In my opinion, a POSITA implementing an external sound-channel member like Chow’s in the Matsunari-Ono-Chow combination would have been motivated to use Higuchi’s eyeglass-mounted, concave geometry to further channel

or redirect sound inward toward the user's ear, rather than allowing sound to disperse outward.

228. That modification would have been consistent with Chow's disclosed purpose. Chow teaches a sound-deflecting surface that channels sound from an eyewear speaker into the user's ear. EX1006, [0042]. Higuchi provides a known eyeglass-mounted, arc-shaped geometry positioned around the ear to make it easier for the user to hear sound from hearing aids or earphones. EX1009, 1-2. A POSITA would have recognized Higuchi's concave, ear-facing geometry as a suitable shape for such an external sound cover because that geometry would help direct sound inward toward the ear.

229. The modification also would have been straightforward to implement. Higuchi expressly mounts its arc-shaped, ear-covering hood to an eyeglass frame, with pivot points near the earpieces. EX1009, 1, FIG. 1. The Matsunari-Ono-Chow combination already includes eyewear carrying an external sound-channel structure, so shaping that external sound cover using Higuchi's eyeglass-mounted concave geometry would have been a predictable application of Higuchi's teaching to an eyewear-mounted sound-directing structure.

230. In my opinion, a POSITA would have had a reasonable expectation of success in implementing the external sound cover of the Matsunari-Ono-Chow combination with Higuchi's concave, arc-shaped, eyeglass-mounted geometry. Higuchi's geometry is a straightforward physical shape for an eyeglass-mounted ear-facing structure, and using such a shape for Chow's external sound cover would not require changing the internal speaker, chamber, or acoustic-port operation of the Matsunari-Ono combination.

231. As a result, in the Matsunari-Ono-Chow-Higuchi combination, it is my opinion that a POSITA would have been motivated to provide an external sound-channel member like Chow's, including a sound-deflecting surface, with a shape concave toward the user's ear in view of Higuchi's eyeglass-mounted arc-shaped hood geometry.

F. Ground 6: Matsunari in View of Ono, and Chen Teaches and/or Suggests Claims 13 and 23

1. Claim 13

- (i) 13. "The method of claim 11, wherein the speaker is located within a temple insert module of the eyewear device."**

232. Claim 13 depends from claim 11 and recites "wherein the speaker is located within a temple insert module of the eyewear device." Claim 13 adds the

requirement that the speaker be located within a module inserted into or housed by the eyewear temple. In my opinion, Chen provides the relevant teaching of a removable cartridge/module housed within an eyewear temple, and a POSITA would have been motivated to apply that teaching to the Matsunari-Ono combination.

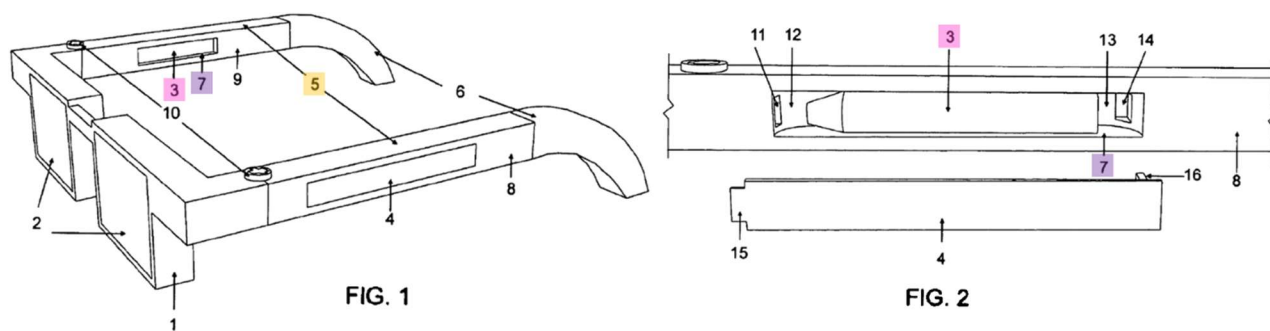
233. It is therefore my opinion that the Matsunari-Ono-Chen combination teaches or would have suggested the additional limitation of claim 13 and would have rendered claim 13 obvious.

234. As I explained for limitation [1.a] and claim 12, in the Matsunari-Ono combination, Matsunari's temple-mounted speaker-in-cavity arrangement is retained, while Ono's parabolic reflective geometry and speaker-positioning teachings are applied to concentrate generated sound toward Matsunari's ear-facing holes. *See* Sections X.A.1(ii), X.A.6.

235. Chen discloses an eyewear temple assembly that includes a removable cartridge housed in a cartridge compartment within the temple. EX1010, Abstract, 2:55-65, FIGs. 1-2. Chen explains that the temple assembly includes "a temple, removable cartridge, cartridge compartment that can accommodate and conceal one

or multiple said cartridge(s), and temple tip attached to a temple in a permanent or detachable manner.” *Id.*, 2:60-63.

236. Chen further explains that “[t]he removable cartridge comprises of materials and components, including electronic or non-electronic or any combination thereof, which will provide functions.” EX1010, 2:63-65. Chen also discloses that the cartridge compartment “can be within the temple, within the temple tip, or be comprised of sub-compartments within the temple and temple tip.” *Id.*, 2:65-3:1. Figures 1-2 show cartridge 3 (pink) positioned within temple 5 (orange) and secured within cartridge compartment 7 (purple).



Id., FIGs. 1-2 (both annotated).

237. Chen explains that this modular cartridge architecture “allows the addition of diverse functions to eyewear through the installment of cartridge(s) comprised of different, unique capabilities.” EX1010, 4:22-24. Chen also recognizes consumer interest in eyewear with electronic functionalities, including “music

playing and cell phone capabilities,” *id.*, 1:28-31, and explains that the cartridge arrangement allows a user to remove an old cartridge and install a new one rather than replacing the entire temple, *id.*, 4:14-18. *See also id.*, 2:43-45 (“the flexibility to add functionalities . . . to eyewear in an integrated and concealed manner”).

238. Chen is from the same field of endeavor. Chen is titled “Eyewear Temple Assembly” and is directed to eyewear temples with compartments for housing removable functional modules. EX1010, Title, Abstract. Matsunari and Ono are directed to head-worn hearing aids, including an eyewear-type hearing aid in Matsunari, and the ’174 patent addresses eyewear devices that provide audio to a user. EX1005, [0001], [0014]; EX1007, 1; EX1001, 1:40-44.

239. Chen is also reasonably pertinent to a problem the inventors of the ’174 patent were focused on, including modular eyewear-design. Chen identifies interest in eyewear with additional electronic functionality, including “music playing and cell phone capabilities,” and teaches removable cartridges for adding, replacing, and modifying eyewear functionality. EX1010, 1:28-39, 4:14-24. The ’174 patent identifies that general design objective in describing temple insert modules (“TIMs”) that are removably couplable to an eyewear temple and that house electronics packages. EX1001, 5:6-6:7, 7:64-8:42.

240. Chen is directed to the same type of removable, temple-housed modular structure that claim 13 addresses. EX1010, 2:55-3:8, FIGs. 1-2.

a. Combination Rationale

241. In my opinion, a POSITA would have been motivated to implement the temple-mounted speaker/audio components of the Matsunari-Ono combination in a removable temple cartridge/module like Chen's, so that the audio hardware could be inserted into, removed from, replaced, upgraded, or serviced as a unit within the eyewear temple.

242. Chen expressly teaches the benefits of that type of modular architecture. Chen explains that, "rather than replacing an entire temple, a user can just remove the old cartridge and install a new one," providing a "quickly, cost effectively, and conveniently" serviceable arrangement. EX1010, 4:14-18. A POSITA implementing audio hardware in an eyewear temple would have recognized that speaker/audio components are the type of functional eyewear components that would benefit from that modular arrangement.

243. Chen also expressly contemplates cartridges containing functional components, including electronic components. *Id.*, 2:63-65. Chen further identifies consumer interest in eyewear having electronic functions such as "music playing and

cell phone capabilities.” *Id.*, 1:28-31. Those disclosures would have made Chen’s cartridge/module architecture a natural fit for housing the speaker and associated audio components of the Matsunari-Ono eyewear arrangement.

244. Applying Chen’s cartridge/module teaching would not have required changing the acoustic operation relied on for claim 1. The Matsunari-Ono arrangement would retain the speaker’s positioning relative to the chamber/reflective geometry and the ear-facing output path discussed above; Chen’s cartridge/module would provide a removable temple-mounted housing for the audio components, not change the chamber’s sound-generating, concentrating, or port-output functions.

245. In my opinion, a POSITA would have had a reasonable expectation of success in applying Chen’s removable cartridge/module architecture to the Matsunari-Ono eyewear audio arrangement. The combination would use Chen’s cartridge for its intended purpose—housing functional components in a concealed temple compartment—while retaining the Matsunari-Ono speaker, chamber, and ear-facing output path for generating and concentrating sound toward the user’s ear. *Id.*, 2:55-65, 4:14-24.

246. The modification also would have been mechanically straightforward and predictable. Chen discloses a removable cartridge sized to fit within a temple compartment, and the Matsunari-Ono combination already places the relevant speaker/audio arrangement within the eyewear temple. *Id.*, 2:55-65; EX1005, [0054]. A POSITA would have viewed placing the speaker/audio components in such a cartridge as a routine application of Chen's modular eyewear architecture.

247. Because Chen's removable cartridge is a modular cartridge housed within a cartridge compartment of the eyewear temple, it corresponds to a temple insert module. EX1010, 2:55-3:1, claim 1, FIGs. 1-2. In the Matsunari-Ono-Chen combination, locating Matsunari's speaker within a removable temple cartridge/module like Chen's, while maintaining the speaker's relationship to the chamber and ear-facing output path, would have yielded a speaker located within a temple insert module of the eyewear device.

2. Claim 23

- (i) 23. "The apparatus of claim 14, wherein the chamber is located within a temple insert module of the eyewear device."**

248. In my opinion, the Matsunari-Ono-Chen combination teaches or would have suggested the additional limitation of claim 23 and would have rendered claim

23 obvious, for the reasons I explained for claim 13 and for the chamber limitations of claim 14. *See* Sections X.F.1, X.A.7(ii)-(iv).

249. Claim 23 requires the chamber, rather than merely the speaker, to be located within a temple insert module. As I explained for claim 14, the Matsunari-Ono combination includes Matsunari's cavity 37 surrounding the speaker, with the reflector geometry positioned to concentrate sound toward Matsunari's ear-facing holes. EX1005, [0054]-[0055]; EX1007, 2-3. As I explained for claim 13, Chen discloses a removable cartridge or module housed within a cartridge compartment in the eyewear temple.

250. More specifically, in the Matsunari-Ono-Chen combination, the removable cartridge shell—rather than the fixed temple compartment—would itself define the chamber. A POSITA would form Matsunari's cavity in the cartridge shell around the speaker and reflector, with holes corresponding to Matsunari's holes extending through the cartridge's ear-facing wall. When the cartridge was installed, those holes would register with Chen's interior-lateral opening. EX1005, [0054]-[0055]; EX1010, 5:38-6:4. The speaker, chamber-defining shell, reflector, and acoustic port would therefore be contained together in the cartridge/module.

251. Chen's disclosed retention structures would maintain that arrangement after installation and replacement. In Chen's first embodiment, the compartment lid and cartridge restraints secure the cartridge; in Chen's second embodiment, cartridge tabs engage corresponding slots in the temple and temple-tip sub-compartments. EX1010, 6:5-51, 8:55-9:8. A POSITA would use those type of structures to fix the cartridge's position and maintain registration between the cartridge holes and the wearer-side opening. Keeping the speaker, chamber, reflector, and port in one replaceable acoustic subassembly would preserve the relative geometry on which Matsunari's optimized output and Ono's concentration depend, while furthering Chen's modular replacement and serviceability objective. EX1007, 2-3; EX1010, 4:6-21.

252. A POSITA would have had a reasonable expectation of success because Chen permits self-contained cartridges of different sizes and shapes, containing electronic or non-electronic functional components, within a temple compartment. EX1010, 2:54-3:8, 5:38-6:4. The modification would use Chen's cartridge architecture for its intended modular function while retaining the Matsunari-Ono acoustic relationships. The resulting chamber itself would be located within Chen's removable temple insert module, as recited in claim 23.

**G. Ground 7A: Chow in View of Ono Teaches and/or Suggests
Claims 1-4, 10-12, 14, 17-19, and 22**

253. In my opinion, Chow in view of Ono's parabolic acoustic-reflector teaching³ renders claims 1-4, 10-12, 14, 17-19, and 22 obvious. This portion of my analysis addresses a reflector-geometry implementation of the Chow-Ono combination. In that implementation, Chow's speaker, cavity 20, lower transition surface 28, and audio openings would be retained, while cavity 20 would be configured to include a chamber-defining reflector structure having Ono's generally parabolic geometry around the speaker. A POSITA could have provided that geometry by shaping a chamber-facing portion of the cavity wall or by placing a reflector insert or liner within the cavity. The speaker would be positioned and oriented relative to that reflector structure, consistent with Ono's teaching, so that

³ Although the analysis below is organized as Grounds 7A, 7B, and 7C for clarity and ease of reference, those grounds present alternative or complementary implementations of the same Chow-Ono combination. Ono teaches multiple mechanisms for concentrating sound. For the reasons explained below, a POSITA would have been motivated to incorporate those mechanisms individually or together.

sound generated by the speaker would be reflected toward and through Chow's audio openings. This implementation would preserve Chow's eyewear platform and ear-facing output path while using Ono's known reflector geometry for its established sound-concentrating function. EX1006, [0039], FIGs. 3-4; EX1007, 1-3.

1. Claim 1

(i) [1.pre] "A method to provide audio signals to a user from an eyewear device, comprising;"

254. I understand that [1.pre] is the preamble of claim 1. I have been asked to assume that the preamble is limiting. Under that assumption, it is my opinion that Chow teaches preamble [1.pre].

255. Chow "provide[s] a method of hearing audio signals including . . . providing audio eyewear 10 having a front frame 12 and at least one side frame member 14, 16 secured to front frame 12 for engaging a user's ear." EX1006, [0043]; *see also id.* [0007], [0010], [0038], [0040], [0042]. Chow also discloses speaker 18 that "is oriented such that the audio port 22 of speaker 18, faces downwardly rearwardly at an angle 30 away from the at least one side frame member 14, for directing sound downwardly rearwardly into the user's ear generally along a vertical plane." *Id.*, [0043]; *see also* Abstract, [0022].

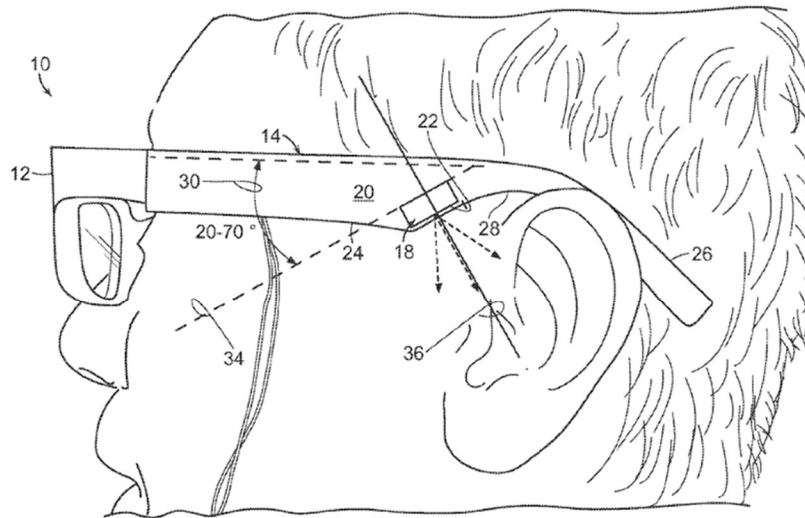


FIG. 2

Id., FIG. 2; *see also id.*, FIGs. 1A-1C, 7.

- (ii) **[1.a] “generating audio signals within a chamber, the chamber is a part of a volume of the eyewear device;”**

256. In my opinion, Chow discloses this limitation.

257. Chow discloses a chamber within the volume of an eyewear device and discloses a speaker positioned within that chamber. For example, Chow provides a “speaker assembly within an audio chamber defined by the left side frame member,” and explains that “[s]peaker 18 can be positioned within cavity 20 formed within the at least one side frame member 14.” EX1006, [0018], [0039]. Chow shows these features, including speaker 18 (red) and cavity 20 (blue), in Figures 3-4:

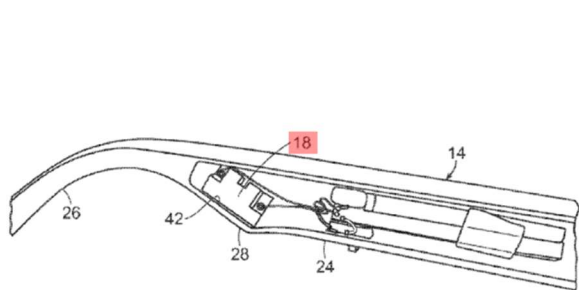


FIG. 3
(excerpt)

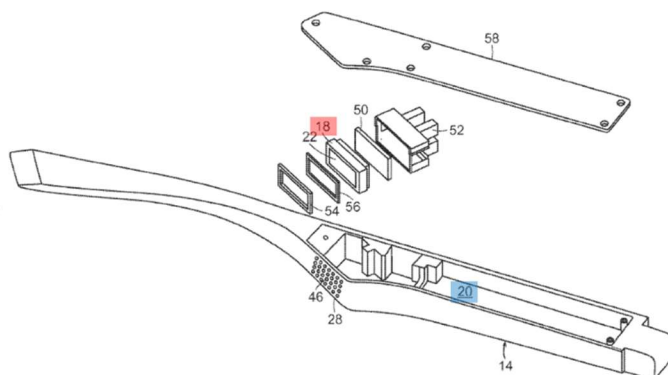


FIG. 4

Id., FIGs. 3 (excerpt), 4. Chow's audio chamber/cavity 20 is part of a volume of the eyewear device because it is "formed within" the side frame member of the eyewear.

Id., [0039]; *see also* FIG. 2 (depicting cavity 20).

258. Chow also explains that audio signals are generated within that chamber. For example, Chow discloses that the "side frame members have speakers therein" and that the sound emanating from the speakers is directed "downwardly and rearwardly into the user's ear." *Id.*, Abstract; *see also id.*, [0043] ("Speaker 18, for example, is oriented such that audio port 22 of speaker 18, faces downwardly rearwardly at an angle 30 away from the at least one side frame member 14, for directing sound downwardly rearwardly into the user's ear"), [0022], [0038]-[0040].

(iii) [1.b] "concentrating the audio signals for delivery to the user's ear"

259. For this limitation, it is my opinion that Chow in view of Ono renders obvious limitation [1.b]. The combination applies Ono's parabolic reflector /

speaker concentration teachings to Chow's eyewear. As discussed below, the result is that the audio signals are concentrated for delivery to the user's ear as recited in [1.b].

260. In my opinion, the combination of Chow and Ono's parabolic-reflector geometry and associated speaker-positioning teachings teaches or would have suggested this limitation to a POSITA.

261. Chow discloses that "an audio port of the speaker face[s] downwardly . . . thereby directing sound downwardly and rearwardly into the users [sic] ear." EX1006, Abstract; *see also id.*, [0043] ("audio port 22 of speaker 18[] faces downwardly rearwardly . . . for directing sound downwardly rearwardly into the user's ear"), [0039]-[0040], FIG.2. Chow also identifies privacy and avoiding disturbance to others as objectives of its eyewear audio system. *Id.*, [0004].

262. As I explained for limitation [1.b] in Ground 1 and in the following combination rationale, Ono teaches a parabolic acoustic-reflector 1 that redirects sound impinging on its reflective surface toward opening 4 and, in turn, toward a user's ear. *See* Section X.A.1(iii). According to Ono, because of the parabolic reflector 1, sound waves are "focused into a sound beam," reach the user "locally,"

and are delivered “only to the area around the user,” while sound in other areas is reduced. EX1007, 2-3.

263. The ’174 patent describes the same kind of arrangement. It discloses an acoustic chamber whose inner surface is configured with a generally parabolic shape, and explains that sound waves directed toward that surface are reflected and concentrated out the audio port in the direction of the user’s ear canal. EX1001, 21:36-38, 30:53-56 (limitation [14.c]), FIGs. 17, 20-21. The combination of Chow and Ono provides that same arrangement in Chow’s eyewear: a chamber whose inner surface is generally parabolic and which reflects the sound generated by a speaker out Chow’s audio openings toward the wearer’s ear.

a. Combination Rationale

264. In my opinion, a POSITA would have been motivated to apply Ono’s sound concentration mechanisms, and in particular Ono’s parabolic chamber / speaker mechanism, to Chow, so that sound generated by a speaker is reflected toward Chow’s audio openings and the user’s ear.

265. ***First***, the combination would have furthered Chow’s express objective of private listening without disturbing others. Chow identifies a desire for “privacy” and “peace and quiet for others,” while recognizing that conventional approaches

could be bulky, cumbersome, or unreliable. EX1006, [0004]. Ono teaches that a speaker positioned relative to a parabolic reflective surface produces sound that is directed through the output opening toward the user locally, delivering sound only to the area around the user while decreasing sound in other areas and thus avoiding disturbing others. EX1007, 2. A POSITA would have recognized that applying Ono's sound concentration teachings would have predictably directed more of the emitted sound toward the wearer and reduced off-axis leakage to bystanders.

266. *Second*, the combination would have improved directionality and audibility at the ear. Chow already houses speaker 18 within cavity 20 and directs sound through audio openings 46 toward the user's ear. EX1006, Abstract, [0039], [0043], FIGs. 3-4. Ono's parabolic reflective speaker chamber directs parallel sound toward an output opening and, in turn, toward the listener, which concentrates the sound and improves directionality and audibility. EX1007, 2, FIGs. 1-2. A POSITA would have recognized the application of Ono's sound concentration teachings to Chow's eyewear would have resulted in the same improvements to directionality and audibility described in Ono itself. In my opinion, a POSITA would have recognized that concentrating the generated sound toward the openings would improve perceived loudness and intelligibility at the wearer's ear.

267. **Third**, Chow and Ono address the same general class of non-occluding personal-audio/hearing-aid devices that deliver sound to a user without requiring in-ear earphones. Chow explains that users of its disclosed device “do not have to hold a speaker or device in place” and do not have “electronics behind the[] ear, or earbuds blocking their ear.” EX1006, [0013]. Ono similarly explains that its focused-output hearing aid “does not require earphones.” EX1007, 2-3. In my opinion, that shared open-ear objective would have led a POSITA to view Ono’s teaching of a compact parabolic sound-concentration arrangement as a logical improvement to a similar non-occluding device like Chow’s eyewear.

268. **Fourth**, applying Ono’s sound-concentration teachings would have involved routine optimization of known acoustic design parameters. Examples include the reflector curvature and speaker/reflector positioning. Because these sound-concentration mechanisms in Ono were known, a POSITA would have expected these specific design choices to improve sound delivery to the wearer’s ear. *See* Ex.1007, 1-3.

269. In my opinion, implementing this reflector-geometry arrangement in Chow’s eyewear would have been within the ordinary skill of a POSITA. Chow discloses that speaker 18 is mounted against inner side 42 of lower transition surface

28 with sealing arrangement 48, and that mask 52, gasket 54, and sticky gasket 56 position and seal speaker 18 relative to audio openings 46. EX1006, [0039], FIG. 4. A POSITA would have understood that Ono's generally parabolic reflector geometry could be implemented either by configuring a chamber-facing portion of Chow's existing cavity wall with the desired geometry or by placing a reflector insert or liner within cavity 20. In either approach, selecting the reflector curvature, positioning and orienting the speaker relative to that geometry, and aligning the reflected output with Chow's audio openings would have involved routine mechanical and acoustic design choices. Those alternatives would have retained the speaker, cavity, lower transition surface, audio openings, eyewear form factor, and ear-facing output path while predictably directing sound toward the wearer's ear. EX1007, 1-3.

270. In my opinion, Chow's "beam-forming" disclosure supports the combination's rationale. Chow identifies beam forming as a known method for achieving "privacy or peace and quiet for others" while acknowledging that "multi-speaker" beam forming approaches may be "bulky, cumbersome, or unreliable." EX1006, [0004]. Ono uses another approach: a compact, single-speaker parabolic reflector arrangement that focuses sound through an opening toward a limited

listening area, not a bulky multi-speaker beam-forming array. EX1007, 1-3. A POSITA therefore would not have understood Chow's criticism of multi-speaker beam forming to discourage use of Ono's focusing geometry to achieve the same privacy-oriented objective in a compact wearable form.

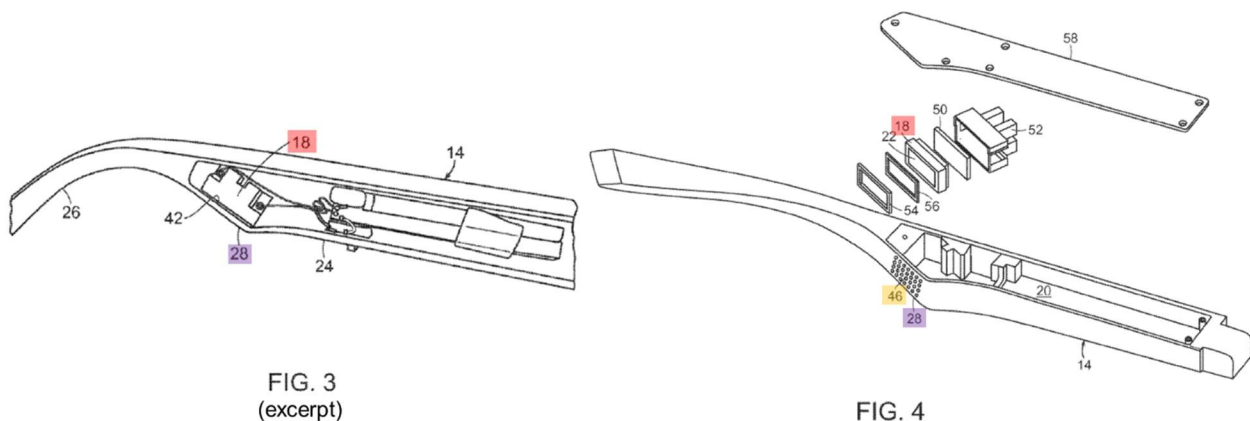
271. In my opinion, a POSITA would have had a reasonable expectation of success in combining Chow and Ono, and the result would have been predictable. Chow discloses a temple-mounted speaker positioned within a cavity with ear-facing audio openings. EX1006, Abstract, [0039]-[0040], FIGs. 2-4. Ono discloses how parabolic reflective geometry directs sound impinging on it through an output opening toward a listener. EX1007, 2, FIGs. 1-2. The application of Ono's sound concentration teachings to Chow's eyewear would have used known acoustic-reflection principles for their intended purpose and would have predictably directed sound toward Chow's audio openings and the wearer's ear. A POSITA would have been able to design curvature and reflectivity of the surface using routine acoustic design, and would have expected the resulting arrangement to direct more of the generated sound toward the wearer's ear.

272. In the resulting combination of Chow and Ono, Chow's eyewear form factor, temple placement, and general ear-facing output direction through audio openings would be retained.

(iv) [1.c] “transmitting the audio signals to the user’s ear, the audio signals are transmitted through a port in the chamber.”

273. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

274. Chow discloses that speaker 18 is “positioned within cavity 20 formed within the at least one side frame member 14” and is “mounted against inner 42 side of lower transition surface 28.” EX1006, [0039]. Chow describes “lower transition surface 28” as “defin[ing] audio openings 46 for allowing sound from speaker 18 to pass through.” *Id.*, [0039]. Figures 3-4 of Chow illustrate these features, including speaker 18 (red), lower transition surface 28 (purple), and openings 46 (orange):



Id., FIGs. 3 (excerpt), 4. Chow also discloses that speaker 18 is oriented so that audio port 22 faces downwardly and rearwardly “for directing sound downwardly rearwardly into the user’s ear.” *Id.*, [0043]; *see also id.*, Abstract, [0038]-[0040]. In my opinion, Chow therefore discloses transmitting sound generated within the side-frame speaker cavity through ear-facing port/openings toward the user’s ear.

275. As I explained above for [1.c] in Ground 1 and in this ground’s combination rationale, Ono also discloses emitting focused sound through an opening toward the user. *See* Sections X.A.1(iv), X.G.1(iii)(a). In particular, Ono discloses opening 4 in the second reflector, through which focused sound waves are emitted toward the user. EX1007, 2-3.

276. In the combination of Chow and Ono, Chow’s ear-facing port/openings and output path are retained. Sound generated by a speaker is reflected toward Chow’s audio openings. EX1007, 2, FIGs. 1-2. As a result, the combination would transmit the audio signals through a port/opening in the chamber toward the user’s ear.

2. Claim 2

- (i) 2. “The method of claim 1, wherein a shape of the chamber contributes to the concentrating.”**

277. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 2 and would have rendered claim 2 obvious.

278. As I explained for claim 2 in Ground 1, Ono discloses that chamber/reflector shape, including parabolic reflector geometry, contributes to concentrating sound for delivery to the user. *See* Section X.A.2 (citing EX1007, 2-3, FIGs. 1-5).

279. In the combination of Chow and Ono, as I explained for limitation [1.b], a POSITA would have been motivated to configure the chamber-facing inner surface with a generally parabolic geometry that curves around a speaker. The resultant audio would be directed toward Chow's output ports. As a result, the shape of the resulting chamber would contribute to concentrating the audio signals for delivery to the user's ear, as recited in claim 2.

3. Claim 3

(i) 3. "The method of claim 2, wherein the shape provides a curved surface to a speaker, and the speaker is used in the generating."

280. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 3 and would have rendered claim 3 obvious.

281. As I explained for claim 3 in Ground 1, Ono discloses a parabolic reflector 1 in which the geometry of the acoustic reflector structure provides curved reflector surfaces relative to speaker 2, and the speaker 2 is used to generate sound that is reflected and directed toward the user. *See* Section X.A.3 (citing EX1007, 2, FIGs. 1-5).

282. In the combination of Chow and Ono, as I explained for claim 2, a POSITA would have been motivated to configure the chamber-facing inner surface with a generally parabolic geometry that curves around a speaker, which is used to generate the audio signals. The resulting chamber would therefore have a shape that provides a curved surface to the speaker, with the speaker being used in the generating, as recited in claim 3.

4. Claim 4

(i) 4. “The method of claim 2, wherein the shape is generally parabolic.”

283. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 4 and would have rendered claim 4 obvious.

284. As I explained for claim 4 in Ground 1, Ono discloses acoustic reflector geometry having a generally parabolic shape; specifically, Ono discloses

reflectors having “a parabolic surface of revolution” and explains that its reflector structure “utilizes the principle of an acoustic lens using a parabolic surface of revolution.” *See* Section X.A.4 (citing EX1007, 1-3).

285. In the combination of Chow and Ono, as I explained for claim 2, a POSITA would have been motivated to configure the chamber-facing inner surface with a generally parabolic geometry, as Ono discloses. The resulting chamber would therefore have a generally parabolic shape, as recited in claim 4.

5. Claim 10

- (i) 10. “The method of claim 1, wherein an external sound cover contributes to the concentrating, the external sound cover is attached to the eyewear device.”**

286. In my opinion, combination of Chow and Ono teaches or would have suggested the additional limitation of claim 10 and would have rendered claim 10 obvious.

287. As I explained for claim 10 in Ground 3, Chow discloses the additional external sound-cover structure recited in claim 10. *See* Section X.C.1 (citing EX1006, Abstract, [0007], [0038], [0042], FIG. 7).

288. In the combination of Chow and Ono, a POSITA would have been motivated to use Chow’s external sound-channel member to further guide and

concentrate sound emitted from Chow's ear-facing port/openings toward the wearer's ear, while maintaining an open-ear arrangement. That use would have complemented the directional-audio arrangement in the combination of Chow and Ono because Chow already directs sound toward the ear through its ear-facing port/openings, and the parabolic reflective geometry of the combination directs the generated sound toward that output path.

289. As a result, in my opinion, a POSITA would have been motivated to include an external sound cover attached to the eyewear device that contributes to concentrating the audio signals for delivery to the user's ear as disclosed in Chow, as recited in claim 10.

6. Claim 11

(i) 11. "The method of claim 1, wherein a speaker is used in the generating."

290. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 11 and would have rendered claim 11 obvious.

291. The Chow-Ono combination teaches or would have suggested the additional limitations of claim 11 and would have rendered claim 11 obvious, for the reasons I explained for limitation [1.a] in this ground. *See* Section X.G.1(ii). Chow

discloses speaker 18 positioned within cavity 20 and oriented to direct sound toward the user's ear. EX1006, [0039], [0043]. Ono similarly discloses the use of a speaker within a cavity to direct audio signals toward the user's ear. EX1007, 1-3. A POSITA would have been motivated to configure the combination implementation so that the speaker in the speaker/cavity arrangement is used in the generating.

7. Claim 12

(i) 12. “The method of claim 11, wherein the speaker is located within a temple of the eyewear device.”

292. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 12 and would have rendered claim 12 obvious. *See* Section X.G.1(ii).

293. Chow discloses that speaker 18 is “positioned within cavity 20 formed within the at least one side frame member 14,” which is part of the temple/side-frame structure of the eyewear device. EX1006, [0039]; *see also id.*, FIGs. 1-4. In the combination of Chow and Ono, a POSITA would have been motivated to configure the combination implementation so that the speaker would likewise be located within the combination's temple. Chow's eyewear form factor, side-frame cavity, and temple-located speaker would be retained in the combination. Thus, the

combination teaches or would have suggested the speaker located within a temple of the eyewear device, as recited in claim 12.

8. Claim 14

(i) [14.pre] “An apparatus to provide audio signals to a user from an eyewear device, comprising:”

294. I understand that [14.pre] is the preamble of claim 14. I have been asked to assume that the preamble is limiting. Under that assumption, it is my opinion that Chow teaches preamble [14.pre].

295. As I explained for [1.pre] in this ground, Chow discloses the recited apparatus. *See* Section X.G.1(i). Specifically, Chow describes “[a]udio eyewear” with side frame members and explains that speakers in the frame members “direct[] sound downwardly and rearwardly into the user’s ear.” EX1006, Abstract; *see also id.*, Title, [0038], [0043].

(ii) [14.a] “a chamber, the chamber is defined by an interior surface, the chamber is a part of a volume of the eyewear device, the chamber further comprising:”

296. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

297. As I explained for [1.a] in this ground, Chow discloses a chamber/cavity within the volume of an eyewear device. *See* Section X.G.1(ii). For example,

Chow describes a “speaker assembly within an audio chamber defined by the left side frame member,” and explains that “[s]peaker 18 can be positioned within cavity 20 formed within the at least one side frame member.” EX1006, [0018], [0039]; *see also id.*, FIG. 4. These disclosures confirm that cavity 20 is the chamber volume defined by the side-frame structure. Since cavity 20 is formed within Chow’s side frame member, it is part of the eyewear device’s volume and is defined by the surrounding interior surfaces of that frame member. *Id.*, [0039]; *see also id.*, FIG. 2 (depicting cavity 20).

298. In the reflector-geometry implementation, Chow’s cavity 20 would remain within side frame member 14 and therefore within the volume of the eyewear device. If Ono’s generally parabolic geometry were formed in a chamber-facing portion of Chow’s cavity wall, that chamber-facing wall surface would provide the recited interior surface. If the geometry were provided by a chamber-defining reflector insert or liner within cavity 20, the chamber-facing surface of that structure would provide the recited interior surface. In either implementation, the resulting acoustic chamber would remain part of the eyewear volume and would be defined by an interior surface, as recited in limitation [14.a]. EX1006, [0018], [0039], FIG. 4; EX1007, 1-3.

(iii) [14.b] “at least one speaker, the at least one speaker to generate audio signals, the at least one speaker is contained within the volume”

299. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

300. As explained for [1.a] and [14.a], Chow discloses speaker 18 positioned within cavity 20 formed within side frame member 14. *See* Sections X.G.1(ii), X.G.8(ii); *see* EX1006, [0039]. Because cavity 20 is formed within Chow’s side frame member, the speaker is contained within the volume of the eyewear device. Chow further discloses that sound from speaker 18 passes through audio openings 46 and is directed toward the user’s ear. EX1006, [0039], [0043]; *see also id.*, Abstract, [0038]-[0040].

301. Chow further discloses that speaker 18 generates sound that passes through audio openings 46 and is directed toward the user’s ear through Chow’s ear-facing output path. EX1006, [0039], [0043]; *see also id.*, Abstract, [0038]-[0040].

302. Thus, Chow discloses at least one speaker, speaker 18, that generates the audio signals and is contained within the volume of the eyewear device, as recited in limitation [14.b]. Ono similarly discloses a speaker contained within a chamber. EX1007, 1-3. In the combination, a POSITA would have been motivated to

configure the speaker so that it would still be within a chamber, and the chamber so that it would be part of the volume of the eyewear, as explained in limitation [14.b]. As such, in the combination, the speaker would be used to generate audio signals and would be contained within the volume.

- (iv) **[14.c] “an acoustic port, the acoustic port is positioned in a wall of the chamber to concentrate emission of the audio signals from the chamber in a direction of the user’s ear when the user wears the eyewear device;”**

303. For this limitation, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA. For the reasons I explained for [14.c] in Ground 1 (Section X.A.7(iv)), the acoustic port in a combination like Chow-Ono would concentrate emission of audio signals from the chamber through the audio openings, which are positioned in a wall of the chamber to direct sound toward the user’s ear.

304. As I explained for [1.b]-[1.c] in this ground, Chow discloses an ear-facing output path from its side-frame speaker cavity. *See* Sections X.G.1(iii)-(iv). Chow explains that lower transition surface 28 “defines audio openings 46 for allowing sound from speaker 18 to pass through.” EX1006, [0039]; *see also id.*, FIGs. 3-4. Chow also discloses that sound is directed through openings 46 “into the

user's ear." *Id.*, [0043]; *see also id.*, Abstract. In my opinion, these disclosures teach audio openings/ports positioned in a wall of the chamber/ cavity for transmitting sound toward the user's ear when the eyewear device is worn.

305. In the reflector-geometry implementation, Chow's audio openings would remain in lower transition surface 28, which forms part of the wall defining the output from cavity 20. Ono's generally parabolic reflector geometry and the speaker's positioning relative to that geometry would direct generated sound toward and through those openings. The openings would therefore remain positioned in a wall of the chamber along Chow's downward-and-rearward ear-facing output path, while the chamber-facing reflective surface would concentrate the generated sound toward those openings. As a result, the chamber surface and wall-port arrangement would operate together to concentrate emission of the audio signals from the chamber in the direction of the user's ear when the eyewear device is worn. *See* EX1006, [0039], [0043], FIGs. 2-4; EX1007, 2-3.

(v) [14.d] "an outer surface, the outer surface is exterior to the inner surface."

306. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

307. As I explained for limitation [14.a], Chow discloses cavity 20 within side frame member 14, with the cavity bounded by chamber-facing interior surfaces of the side-frame structure. *See* Section X.G.8(ii); EX1006, [0018], [0039], FIGs. 3-4. The physical wall of side frame member 14 that defines cavity 20 also has a surface on the opposite side that is exterior to the chamber-facing interior surface, as shown in Chow's Figures 3 and 4. That same physical surface is both an outer surface of the side-frame or temple structure and an outer surface of the wall structure defining the chamber. If Ono's generally parabolic reflector geometry is implemented by shaping a chamber-facing portion of Chow's cavity wall, that inner-surface/outer-surface relationship would remain unchanged. If the reflector geometry is instead provided by a chamber-defining reflector insert or liner within cavity 20, the chamber-facing side of that structure would provide at least part of the chamber's inner surface, and the opposite side of that structure would provide an outer surface exterior to the inner surface. Accordingly, the Chow-Ono combination would include an outer surface exterior to the chamber's inner surface.

9. Claim 17

- (i) 17. "The apparatus of claim 14, wherein the inner surface forms a curved shape around the at least one speaker."**

308. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 17 and would have rendered claim 17 obvious.

309. As I explained for claim 17 in Ground 1, Ono provides parabolic acoustic-reflector 1 with curved inner reflector surfaces arranged around speaker 2. *See* Section X.A.8(i); *see* EX1007, 2-3, FIGs. 1-5.

310. As I explained for limitations [14.a] and [14.b] and in this ground's combination rationale, a POSITA would have configured a chamber-defining reflector structure within Chow's cavity 20 with Ono's curved, generally parabolic geometry around the speaker, whether by shaping a chamber-facing portion of the cavity wall or by using a reflector insert or liner. The speaker would be positioned relative to that geometry so that generated sound was reflected toward Chow's audio openings. The resulting chamber-facing inner surface would therefore form a curved shape around the speaker, as recited in claim 17.

10. Claim 18

(i) 18. "The apparatus of claim 17, wherein the curved shape is generally parabolic."

311. In my opinion, the combination of Chow in view of Ono teaches or would have suggested the additional limitation of claim 18 and would have rendered

claim 18 obvious, for the reasons I explained for claims 4 and 17. *See* Sections X.G.4, X.G.9.

312. As I explained for claim 4, Ono discloses acoustic reflector surfaces having a “parabolic surface of revolution.” EX1007, 1-2. In the Chow-Ono reflector-geometry implementation, whether the chamber-defining geometry were formed in the cavity wall or supplied by a reflector insert or liner, the curved chamber-facing inner surface around the speaker would have Ono’s generally parabolic geometry. The combination would therefore teach or suggest the additional limitation of claim 18.

11. Claim 19

- (i) [19.pre] “The apparatus of claim 14, further comprising:”**
- (ii) [19.a] “an external sound cover, the external sound cover has an inner surface and an outer surface, the external sound cover is configured to attach to the eyewear device, wherein in operation, the audio signals emitted from the acoustic port reflect off of the inner surface toward the user’s ear.”**

313. In my opinion, the combination of Chow in view of Ono teaches or would have suggested the additional limitation of claim 19 and would have rendered claim 19 obvious.

314. As I explained for [14.c] in this ground, the combination of Chow in view of Ono includes Chow's ear-facing acoustic port/openings positioned to emit sound from the chamber/cavity toward the user's ear. *See* Section X.G.8(iv).

315. As I explained for claim 10 in this ground and claim 19 in Ground 3, a POSITA would have been motivated to use Chow's external sound-channel member to further guide sound emitted from Chow-Ono's ear-facing port/openings toward the user's ear. *See* Sections X.G.5, X.C.2. Chow discloses that the sound-channel member may include sound-deflecting surface 66, which extends from the side frame member and over a portion of the ear to channel sound from the speaker into the user's ear. EX1006, [0042], FIG. 7.



FIG. 7

Id., FIG. 7 (annotated).

316. In my opinion, Chow's sound-deflecting surface provides an ear-facing inner surface and an opposite outer surface of the external sound cover. The sound-channel member is also configured to attach to the eyewear device. EX1006, [0042], FIG. 7.

317. Sound emitted through the combination's ear-facing acoustic port/openings would encounter the inner surface of the external sound cover and be reflected toward the user's ear. As a result, the Chow-Ono combination teaches or would have suggested the external sound cover recited in claim 19.

12. Claim 22

(i) 22. "The apparatus of claim 14, wherein the chamber is located within a temple of the eyewear device."

318. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 22 and would have rendered claim 22 obvious, for the reasons explained for [1.a] and [14.a]. *See* Sections X.G.1(ii), X.G.8(ii). Chow discloses that speaker 18 is positioned within cavity 20 "formed within the at least one side frame member 14." EX1006, [0039]. A POSITA would have understood Chow's side frame member to be the temple portion of the eyewear device. Thus, Chow discloses the chamber/cavity located within a temple of the

eyewear device, as recited in claim 22. This configuration would not change in the combination and when incorporating Ono's reflector-geometry teachings.

**H. Ground 7B: Chow in View of Ono Teaches and/or Suggests
Claims 1, 10-12, 14, 19, and 22**

319. In my opinion, Chow in view of Ono's sound-absorbing-material teaching renders claims 1, 10-12, 14, 19, and 22 obvious. This portion of my analysis addresses an implementation in which Chow's speaker, cavity 20, lower transition surface 28, and audio openings would be retained, while Ono's sound-absorbing material is provided around Chow's audio openings. As Ono teaches, the material would absorb scattered or off-axis sound while permitting the desired straight-traveling, ear-directed sound to pass through the openings. The material would thereby narrow the angular distribution of the emitted sound and concentrate the output toward the wearer's ear. EX1006, [0039], [0043], FIG. 4; EX1007, 3.

1. Claim 1

**(i) [1.pre] "A method to provide audio signals to a user
from an eyewear device, comprising;"**

320. I understand that [1.pre] is the preamble of claim 1. I have been asked to assume that the preamble is limiting. Under that assumption, it is my opinion that Chow teaches preamble [1.pre]. *See* my opinion in Ground 7A (Section X.G.1(i)).

(ii) [1.a] "generating audio signals within a chamber, the

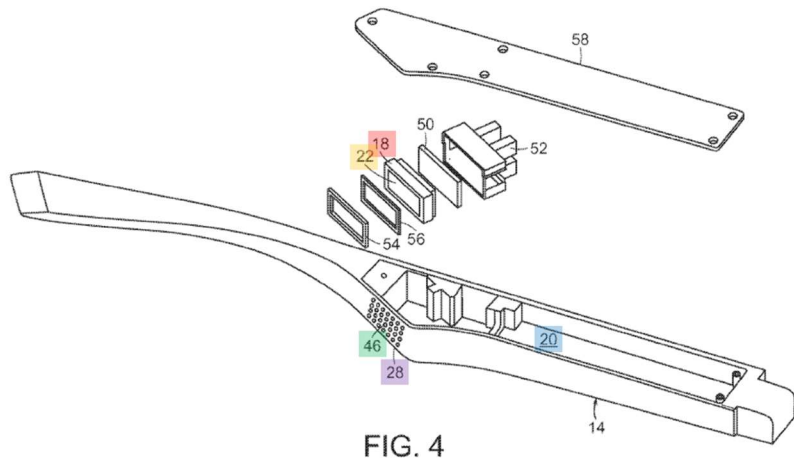
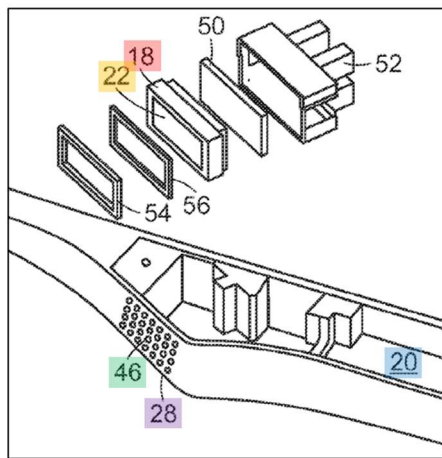
chamber is a part of a volume of the eyewear device;”

321. In my opinion, Chow discloses this limitation. *See* my opinion in Ground 7A (Section X.G.1(ii)).

(iii) [1.b] “concentrating the audio signals for delivery to the user’s ear”

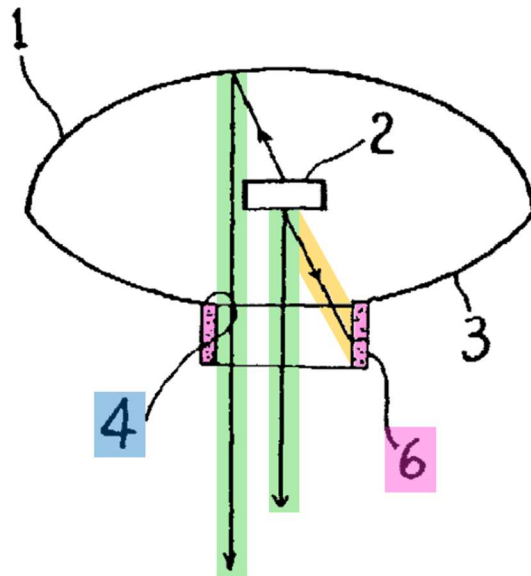
322. For this limitation, it is my opinion that Chow in view of Ono’s sound-absorbing-material teaching renders obvious limitation [1.b]. In the combination, a POSITA would have been motivated to apply Ono’s sound-absorbing material at Chow’s audio openings such that it absorbs scattered, off-axis sound so that only straight-traveling, on-axis sound is emitted. EX1007, 3. As a result, the audio signals are concentrated for delivery to the user’s ear as recited in [1.b].

323. Chow discloses that speaker 18 (red) is mounted against an inner side of lower transition surface 28 (purple) in cavity 20 (blue), and that “lower transition surface 28 defines audio openings 46 [green] for allowing sound from speaker 18 to pass through.” EX1006, [0039]. Chow further discloses that audio port 22 (orange) of speaker 18 “faces downwardly rearwardly at an angle . . . for directing sound downwardly rearwardly into the user’s ear.” *Id.*, [0043]; *see also id.*, Abstract; FIGs. 3-4.



EX1006, FIG. 4 (excerpted, left), 4 (annotated, right).

324. In Ono's FIG. 3, "[a] short cylindrical sound-absorbing material 6 is provided around the opening of the second reflector, extending downward." EX1007, 3. With sound-absorbing material 6 (pink) in place around the output opening (blue), "sound waves that are scattered [orange] and not traveling in a straight line are absorbed from the opening 4, and only sound waves traveling in a straight line [green] are emitted from the opening 4, thereby concentrating the sound waves that have been amplified to a specific range." *Id.* The sound-absorbing material 6 thus concentrates the audio signals, absorbing off-axis scattered sound while permitting only the straight-traveling, on-axis sound to be emitted.



EX1007, FIG. 3 (annotated).

325. The '174 patent describes the same general objective of attenuating acoustic energy in undesired directions while preserving sound directed toward the user's ear. It explains that the disclosed systems are designed to concentrate and to project acoustic signals in the direction of the user's ear and to attenuate acoustic energy in other directions. EX1001, 24:46-49. It further discloses a multilayered chamber wall in which an inner layer having a high degree of acoustic reflectivity enhances sound concentration, emission, and projection of acoustic signals to a user's ear, while an outer layer is made from a material selected to absorb and attenuate acoustic energy. *Id.*, FIG. 23. The combination applies the same approach at Chow's audio openings, where Ono's sound-absorbing material absorbs the off-

axis component of the emitted sound while the on-axis, ear-directed sound is emitted.

a. Combination Rationale

326. A POSITA would have been motivated and found it beneficial to combine Chow with Ono's sound-absorbing-material teaching. The result would be an eyewear-based audio system in which sound-absorbing material concentrates the sound at the audio ports and thereby directs the emitted audio signals toward the wearer's ear.

327. ***First***, the combination would have furthered Chow's express design objectives. Chow identifies privacy and not disturbing others as design objectives of its eyewear audio system, EX1006, [0003]-[0004], and Ono's sound-absorbing material 6 expressly absorbs scattered sound so that "only sound waves traveling in a straight line are emitted," "thereby concentrating the sound waves that have been amplified to a specific range," EX1007, 3. Providing Ono's material-based sound concentration mechanism at Chow's audio openings would have predictably concentrated the audio output more narrowly toward the wearer's ear, reducing off-axis acoustic leakage to bystanders and thereby advancing Chow's privacy objective.

328. **Second**, the combination would have improved the directionality of the emitted sound and reduced off-axis leakage. Chow's audio openings already direct sound toward the user's ear. EX1006, [0039], [0043]. Applying Ono's sound-absorbing material would have concentrated the sound toward the user. EX1007, 3. A POSITA would have expected that attenuating the off-axis component in this way would predictably narrow the angular distribution of the emitted sound, increasing the proportion of the emitted sound directed toward the wearer's ear and reducing the sound radiated in other directions, where it would be audible to bystanders.

329. **Third**, as explained in Ground 7A, Chow and Ono address the same general class of non-occluding personal-audio/hearing-aid devices that deliver sound to a user without requiring earphones. Both Chow and Ono tout that their designs do not require earphones / earbuds. EX1006, [0013]; EX1007, 2-3. This shared objective would have led a POSITA to view Ono's sound-absorbing-material concentration teachings as logical improvements to a similar non-occluding device like Chow's eyewear.

330. **Fourth**, sound-absorbing materials were familiar and well-established acoustic engineering elements at the relevant time. Applying a sound-absorbing material at a sound-output opening to filter out off-axis acoustic energy and

concentrate on-axis emission was a routine application of known acoustic-design principles, and Ono expressly applies that principle in the head-worn audio context. EX1007, 3. Implementing of the sound-absorbing material would have involved routine selection of the material's size and placement around Chow's audio openings.

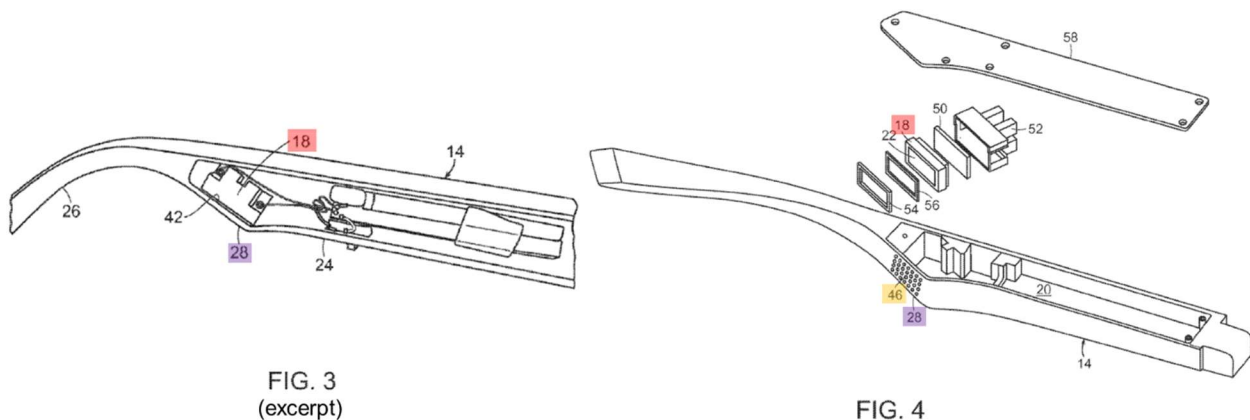
331. In my opinion, a POSITA would have had a reasonable expectation of success in combining Chow with Ono's sound-absorbing-material concentration mechanism, and the result of the combination would have been predictable. Sound-absorbing materials operate passively, by absorbing incident acoustic energy that strikes them. Placing sound-absorbing material of the kind disclosed in Ono at Chow's audio openings would predictably concentrate the on-axis output toward the user's ear as disclosed in Ono. EX1006, [0039], [0043]; EX1007, 3. The combination would require only minor changes to Chow's eyewear—the addition of passive sound-absorbing material at the openings.

332. [Intentionally omitted to preserve paragraph numbering.]

- (iv) **[1.c] “transmitting the audio signals to the user's ear, the audio signals are transmitted through a port in the chamber.”**

333. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

334. Chow discloses transmitting sound generated by speaker 18 within cavity 20 through ear-facing output openings/ports toward the user's ear. Chow specifically discloses audio openings 46 (orange) in lower transition surface 28 (purple) that allow sound from speaker 18 (red) to pass through, and audio port 22 oriented to direct sound downwardly and rearwardly into the user's ear. EX1006, [0039], [0043].



Id., FIGs. 3 (excerpt), 4 (annotated). In the combination, a POSITA would have been motivated to apply Ono's sound-absorbing material at Chow's audio openings, the same chamber output openings/ports through which the audio signals are transmitted. That material would absorb scattered or off-axis sound while allowing ear-directed sound to pass through. As a result, in my opinion, the combination

would transmit the audio signals to the user's ear through a port in the chamber, as recited in limitation [1.c].

2. Claim 10

- (i) **10. “The method of claim 1, wherein an external sound cover contributes to the concentrating, the external sound cover is attached to the eyewear device.”**

335. In my opinion, combination of Chow and Ono teaches or would have suggested the additional limitation of claim 10 and would have rendered claim 10 obvious.

336. As I explained for claim 10 in Ground 3, Chow discloses the additional external sound-cover structure recited in claim 10. *See* Section X.C.1 (citing EX1006, Abstract, [0007], [0038], [0042], FIG. 7).

337. In the combination, a POSITA would have been motivated to use Chow's external sound-channel member to further guide and concentrate sound emitted from Chow's ear-facing output openings toward the wearer's ear. That use would have complemented this combination because Chow already directs sound toward the user's ear through its ear-facing output path, and Ono's sound-absorbing material would further concentrate emitted sound from Chow's audio openings by absorbing scattered or off-axis sound.

338. As a result, in my opinion, a POSITA would have been motivated to include an external sound cover attached to the combination's eyewear device that contributes to concentrating the audio signals for delivery to the user's ear, as recited in claim 10.

3. Claim 11

(i) 11. "The method of claim 1, wherein a speaker is used in the generating."

339. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 11 and would have rendered claim 11 obvious, for the reasons I explained for limitation [1.a] in this ground. *See* Section X.H.1(ii).

340. Chow discloses speaker 18 positioned within cavity 20 formed within side frame member 14. EX1006, [0018], [0039]. Chow further discloses that speaker 18 generates sound that is transmitted through audio openings 46 and audio port 22 toward the user's ear. *Id.*, [0039], [0043]. A POSITA would have been motivated to configure the combination implementation so that the speaker in the speaker/cavity arrangement is used in the generating.

4. Claim 12

(i) 12. "The method of claim 11, wherein the speaker is located within a temple of the eyewear device."

341. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 12 and would have rendered claim 12 obvious, for the reasons I explained for limitation [1.a] in this ground. See Section X.H.1(ii).

342. Chow discloses that speaker 18 is positioned within cavity 20 “formed within the at least one side frame member 14.” EX1006, [0039]. Side frame member 14 is part of the temple structure of Chow’s eyewear device. As a result, Chow discloses speaker 18 located within a temple of the eyewear device. In the combination of Chow and Ono, a POSITA would have been motivated to configure the combination implementation so that the speaker likewise located within the combination’s temple.

5. Claim 14

(i) [14.pre] “An apparatus to provide audio signals to a user from an eyewear device, comprising:”

343. I understand that [14.pre] is the preamble of claim 14. I have been asked to assume that the preamble is limiting. Under that assumption, it is my opinion that Chow teaches preamble [14.pre]. See my opinion in Ground 7A (Section X.G.8(i)).

(ii) [14.a] “a chamber, the chamber is defined by an interior surface, the chamber is a part of a volume of the eyewear device, the chamber further comprising:”

344. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

345. As I explained for [1.a] in this ground, Chow discloses a chamber/cavity within the volume of an eyewear device, defined by the surrounding interior surfaces of the side frame member. EX1006, [0018], [0039], FIG. 4. A POSITA would have been motivated to apply Ono's sound-absorbing material 6 at Chow's audio openings, while Chow's side-frame cavity/chamber would be retained. As a result, the resulting chamber would remain defined by an interior surface and would remain part of the volume of the eyewear device, as recited in limitation [14.a].

(iii) [14.b] “at least one speaker, the at least one speaker to generate audio signals, the at least one speaker is contained within the volume”

346. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

347. Chow discloses speaker 18 positioned within cavity 20 formed within side frame member 14, so the speaker is contained within the volume of the eyewear device, and that speaker 18 generates sound that passes through audio openings 46 toward the user's ear. EX1006, [0039], [0043]; *see also id.*, Abstract, [0038]-[0040]. In the combination, a POSITA would have been motivated to apply Ono's sound-

absorbing material 6 at Chow's audio openings 46, while Chow's side-frame speaker/ cavity arrangement would be retained. As a result, the combination would include at least one speaker contained within the eyewear volume and used to generate audio signals, as recited in limitation [14.b].

- (iv) **[14.c] “an acoustic port, the acoustic port is positioned in a wall of the chamber to concentrate emission of the audio signals from the chamber in a direction of the user's ear when the user wears the eyewear device;”**

348. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

349. As I explained for limitations [1.b] and [1.c], Chow discloses audio openings 46 in lower transition surface 28 that allow sound from speaker 18, located within cavity 20, to pass out of the cavity toward the user's ear. EX1006, [0039], [0043].

350. In my opinion, those audio openings are acoustic port/openings associated with the output from Chow's chamber/cavity. Chow further discloses that audio port 22 faces downwardly and rearwardly to direct sound into the user's ear. *Id.*, [0043]. Thus, Chow's audio openings 46 and associated ear-facing output path transmit sound from the chamber/cavity in the direction of the user's ear when the

eyewear device is worn. Ono teaches placing sound-absorbing material 6 around an acoustic opening so that scattered or off-axis sound is absorbed and only straight-traveling sound is emitted, thereby concentrating the amplified sound to a specific range. EX1007, 3.

351. In the combination of Chow and Ono, a POSITA would have been motivated to apply Ono's sound-absorbing material at Chow's audio openings in lower transition surface 28, as discussed in the combination rationale for this ground. That material would absorb scattered or off-axis sound near the output openings while allowing the desired ear-directed sound to pass through. As a result, in my opinion, the combination would include acoustic port/openings positioned in the surface defining the output from Chow's chamber/cavity to concentrate emission of the audio signals from the chamber toward the user's ear when the eyewear device is worn, as recited in limitation [14.c].

(v) [14.d] “an outer surface, the outer surface is exterior to the inner surface.”

352. In my opinion, the combination of Chow and Ono teaches or would have suggested this limitation to a POSITA.

353. As I explained for [14.a], Chow discloses a chamber/cavity within the eyewear volume defined by surrounding interior surfaces of the side frame member;

a physical wall defining that cavity has a chamber-facing inner surface and an opposite outer surface exterior to it. EX1006, [0018], [0039], FIG. 4. Ono's sound-absorbing material would be applied around Chow's audio openings 46, while Chow's side-frame cavity/chamber structure would be retained. As a result, as I explained for [14.d] in Ground 7A the combination's chamber would continue to have an outer surface exterior to the inner/interior surface that defines the chamber.

6. Claim 19

- (i) [19.pre] “The apparatus of claim 14, further comprising:”**
- (ii) [19.a] “an external sound cover, the external sound cover has an inner surface and an outer surface, the external sound cover is configured to attach to the eyewear device, wherein in operation, the audio signals emitted from the acoustic port reflect off of the inner surface toward the user's ear.”**

354. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 19 and would have rendered claim 19 obvious.

355. As I explained for [14.c] in this ground, the combination of Chow and Ono includes Chow's ear-facing acoustic port/openings positioned to emit sound from the chamber/cavity toward the user's ear. As I explained for claim 10 in this ground and claim 19 in Ground 3 (Section X.C.2), a POSITA would have been

motivated to use Chow's external sound-channel member to further guide sound emitted from Chow-Ono's ear-facing port/openings toward the user's ear.

356. Chow discloses that the sound-channel member may include sound-deflecting surface 66, which extends from the side frame member and over a portion of the ear to channel sound from the speaker into the user's ear. EX1006, [0042], FIG. 7.



FIG. 7

Id., FIG. 7 (annotated).

357. In my opinion, Chow's sound-deflecting surface provides an ear-facing inner surface and an opposite outer surface of the external sound cover, and the sound-channel member is configured to attach to the eyewear device. EX1006,

[0042], FIG. 7. Sound/audio signals emitted from the combination's acoustic port/openings would encounter the ear-facing inner surface of the external sound cover and would be reflected or deflected toward the user's ear. As a result, the Chow-Ono combination teaches or would have suggested the external sound cover recited in claim 19.

7. Claim 22

- (i) 22. “The apparatus of claim 14, wherein the chamber is located within a temple of the eyewear device.”**

358. In my opinion, the combination of Chow and Ono teaches or would have suggested the additional limitation of claim 22 and would have rendered claim 22 obvious, for the reasons explained for [1.a] and [14.a]. *See* Sections X.H.1(ii), X.H.5(ii). Chow discloses that speaker 18 is positioned within cavity 20 “formed within the at least one side frame member 14.” EX1006, [0039]. A POSITA would have understood Chow's side frame member to be the temple portion of the eyewear device. Thus, Chow discloses the chamber/cavity located within a temple of the eyewear device. This configuration would not change in the combination and when incorporating Ono's sound-absorbing-material teachings.

I. Ground 7C: Chow in View of Ono Teaches and/or Suggests Claims 1-4, 10-12, 14, 17-19, and 22

359. This ground combines the two implementations I described in Grounds 7A and 7B. As in Ground 7A, Ono's parabolic acoustic-reflector teachings would have been applied to Chow's existing chamber. And as in Ground 7B, Ono's sound-absorbing-material teachings would have been applied to the audio openings. Together, as taught by Ono, these mechanisms would have concentrated the sound emitted to the user.

360. For the reasons I explained in the preceding portions of this analysis, a POSITA would have been motivated to implement both Ono's parabolic reflector geometry and Ono's sound-absorbing material in Chow's eyewear. Each implementation would have advanced Chow's objectives of delivering sound privately toward the wearer's ear while reducing sound radiated toward bystanders. Each would also have improved directionality and audibility at the ear, and each would have used known acoustic components or techniques in the same general class of non-occluding personal-audio devices. Implementing the reflector geometry would have involved routine selection of reflector curvature and speaker position and orientation relative to the reflector. Implementing the sound-absorbing material would have involved routine selection of the material's size and placement around Chow's existing audio openings. When used together, the mechanisms would have

been complementary: the reflector geometry would direct acoustic output toward the openings, and the sound-absorbing material would attenuate residual off-axis output at the openings. Each implementation would retain Chow's eyewear form factor, temple cavity, and ear-facing output path. A POSITA therefore would have had a reasonable expectation of success, and the resulting concentration of sound toward the wearer's ear would have been predictable. *See, supra*, Sections X.G.1(iii)(a), X.H.1(iii)(a); *see also* EX1006, [0039], [0043], FIGs. 3-4; EX1007, 2-3.

**1. Claims 1, 10-12, 14, 19, and 22
(for the Reasons Explained in Grounds 7A & 7B)**

361. For the reasons I explained for each of these claims and their limitations in Grounds 7A and 7B, the combination of Chow and Ono teaches or would have suggested every limitation of claims 1, 10-12, 14, 19, and 22, and would have rendered those claims obvious. Each such limitation was shown under both Ground 7A, in which the parabolic chamber curves around a speaker, and Ground 7B, in which sound-absorbing material is applied at Chow's openings, and this combination includes both arrangements. *See supra*, Sections X.G.1, X.G.5-8, X.G.11-12, X.H.1-7.

362. With respect to the concentrating limitations [1.b] and [14.c], each of the three implementations discussed above would concentrate the generated audio

signals toward the user's ear. In the reflector-geometry implementation, the generally parabolic chamber-facing surface and associated speaker positioning would direct generated sound toward and through Chow's audio openings. In the sound-absorbing-material implementation, the material around those openings would attenuate scattered or off-axis sound while permitting the desired ear-directed sound to pass through. In the combined implementation, both mechanisms would operate together. In every implementation, audio openings would remain in lower transition surface 28, a wall defining the output from cavity 20, and would remain positioned along Chow's downward-and-rearward ear-facing output path. *See, supra*, Sections X.G.1(iii), X.G.8(iv), X.H.1(iii), X.H.5(iv).

**2. Claims 2-4, 17, and 18
(for the Reasons Explained in Ground 7A)**

363. For the reasons I explained for each of these claims in Ground 7A, the combination of Chow and Ono teaches or would have suggested the additional limitations of claims 2, 3, 4, 17, and 18, and would have rendered those claims obvious. These claims recite the shape of the chamber or of the inner surface, namely a curved or generally parabolic shape around the speaker, which is provided by Ono's chamber/speaker-based concentration mechanism as I explained for claims

2, 3, 4, 17, and 18 in Ground 7A. Adding Ono's sound-absorbing material concentration mechanism does not alter that showing.

J. Ground 8: Chow in View of Ono and Boyden Teaches and/or Suggests Claims 5-9, 15-16, 20, and 24-28

364. In Grounds 7A, 7B, and 7C, I explained how Chow (EX1006) in view of Ono (EX1007) renders obvious independent claims 1 and 14 and certain of their dependent claims, including that the resulting combination concentrates the generated audio signals in the direction of the user's ear. Ono discloses concentrating through more than one teaching: the parabolic reflector / speaker chamber (Ground 7A), the sound-absorbing material (Ground 7B), or both together (Ground 7C). I refer to the combinations of Chow and Ono described in Grounds 7A, 7B, and 7C, collectively, as the "Chow-Ono Combinations," and to any one of them individually as a "Chow-Ono Combination." Each claim addressed in Grounds 8, 9, and 10 ultimately depends from independent claim 1 or 14. Claim 13 depends through claim 11, and claims 20 and 21 depend through claim 19; the remaining claims follow their stated dependency chains from claim 1 or 14. I have explained that claims 1, 11, 14, and 19 are rendered obvious under each Chow-Ono Combination. The additional teachings I apply in these grounds, namely Boyden's material and surface-treatment selections (Ground 8), Chen's temple-insert-module housing (Ground 9), and

Higuchi's concave over-ear cover (Ground 10), concern aspects of the eyewear that are independent of the particular Ono teaching by which each Chow-Ono Combination concentrates sound. In each of Grounds 8, 9, and 10, I add the additional reference to each of the Chow-Ono Combinations, and I refer to the resulting combinations as the "Chow-Ono-Boyden," "Chow-Ono-Chen," and "Chow-Ono-Higuchi" combinations, respectively; a reference to "each Chow-Ono-Boyden combination" (or each Chow-Ono-Chen or Chow-Ono-Higuchi combination) therefore means that added reference applied to each of the three Chow-Ono Combinations. My opinions in these grounds apply to each of the Chow-Ono Combinations, and I state them once rather than repeating the same analysis separately for Grounds 7A, 7B, and 7C.

365. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C render obvious claims 5-9, 15-16, and 24-28 because those implementations include Ono's generally parabolic reflector geometry and a chamber-facing sound-reflecting surface. It is also my opinion that each Chow-Ono-Boyden combination—whether based on Ground 7A, 7B, or 7C—renders claim 20 obvious because claim 20 concerns material selections for Chow's external sound

cover and does not depend on the particular Ono mechanism used to concentrate sound within the chamber or at its output.

1. Claim 5

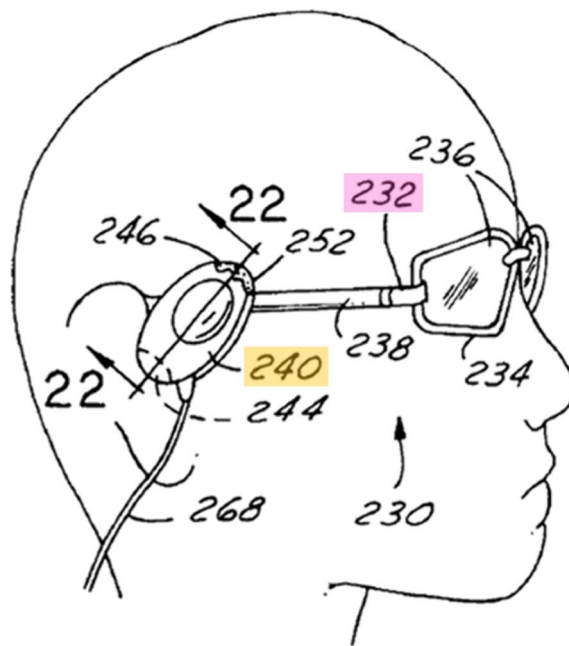
- (i) 5. “The method of claim 1, wherein an inner surface of the chamber has a first acoustic reflectivity and at least a portion of the eyewear device has a second acoustic reflectivity, the first acoustic reflectivity is greater than the second acoustic reflectivity.”**

366. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitations of claim 5 and would have rendered claim 5 obvious.

367. As I explained for claim 1 in Grounds 7A and 7C, each of those Chow-Ono Combinations provides an eyewear chamber that generates, concentrates, and directs sound toward the user’s ear. In those combinations, the chamber-facing inner surface defining Chow’s cavity 20 is configured with a generally parabolic geometry that reflects sound toward Chow’s ear-facing port/output path, providing an inner sound-reflecting surface.

368. As I explained for claim 5 in Ground 2, Boyden discloses material and surface-treatment selections for small wearable speaker modules to provide desired acoustic properties. Boyden substantially acoustically inert, non-radiative, and absorbing wall materials, and also teaches interiors to provide “the best acoustical

properties,” including through “coated surfaces” or “liners made from more acoustically efficient materials.” EX1008, 5:54-67. Boyden applies related construction and materials to an eyeglass-mounted acoustic module. EX1008, 12:5-7. Boyden’s Figure 20 illustrates acoustic modules 240 (orange) disposed on the temples of eyeglasses 232 (pink).



Id., FIG. 20 (annotated).

a. Combination Rationale

369. In my opinion, a POSITA would have been motivated to apply Boyden’s material-selection and surface-treatment teachings to the Chow-Ono eyewear chamber while preserving the Ono-derived reflecting surface. In the

Ground 7A and 7C implementations, Ono's generally parabolic geometry would be formed directly in a chamber-facing portion of Chow's cavity wall or would be supplied by a chamber-defining reflector insert or liner within cavity 20. In either case, the exposed chamber-facing face performs Ono's reflecting function and would be retained. A non-radiative and acoustically absorbing material such as Boyden's would be used for another chamber-wall or surrounding side-frame portion so that the other portion reflected less incident acoustic energy and reduced unwanted acoustic reradiation. *See* EX1006, [0039]-[0043]; EX1007, 2-3; EX1008, 2:1-5, 5:36-67.

370. The material roles would remain distinct. The Ono-derived chamber-facing boundary would have comparatively high acoustic reflectivity because it reflects speaker-generated sound toward Chow's ear-facing port or output path. The other portion would use non-radiative and acoustically absorbing material such as Boyden's and therefore would have lower acoustic reflectivity. EX1008, 5:54-67. If the reflector is an insert or liner, its exposed chamber-facing face itself defines the inner surface; no separate absorbing layer is placed over that face.

371. That arrangement would have yielded an inner chamber surface having a first acoustic reflectivity greater than the second acoustic reflectivity of at least

another portion of the eyewear device, as claim 5 requires. A POSITA would have had a reasonable expectation of success because Boyden expressly discloses these material and surface-treatment options for wearable speaker modules and applies related construction and materials to an eyeglass-mounted acoustic module. *Id.*, 5:54-67, 12:5-7.

2. Claim 6

(i) 6. “The method of claim 5, the portion absorbs vibrational energy.”

372. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitation of claim 6 and would have rendered claim 6 obvious.

373. The structural-vibration principles and supporting literature explained in ¶¶170-172 apply equally here. Chow mounts its speaker within cavity 20 and against the inner side of lower transition surface 28. EX1006, [0039]. A POSITA would have understood that speaker reaction forces transmitted through that mount and cavity-pressure fluctuations would load and excite the cavity wall and adjoining side-frame or reflector structure. Those loads could produce mechanical vibration that propagates through the eyewear and reradiates as sound. Boyden’s recognition of direct low-frequency coupling through module walls or pads contacting the

wearer's temples confirms the relevant structure-borne transmission path, while Boyden's damping material, wall construction, coated surfaces, and liners provide known options for controlling that behavior. EX1008, 5:1-8, 5:36-67, 10:16-24.

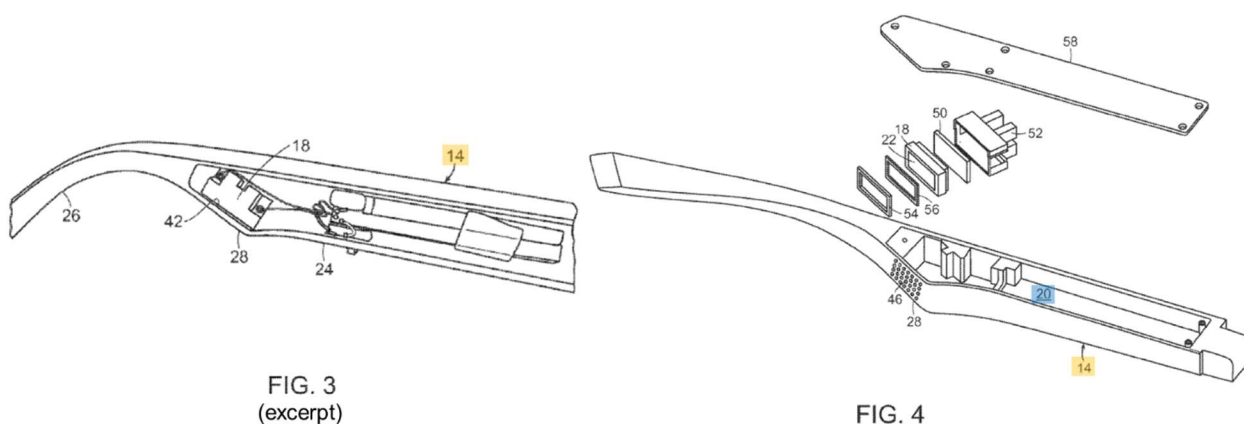
374. A POSITA therefore would have selected from Boyden's disclosed material, coating, and liner options a vibration-damping treatment for the lower-reflectivity side-frame, temple, wall, or reflector portion identified for claim 5. Mechanically coupled to that portion, the treatment would deform with the structure and dissipate a part of its cyclic strain energy, reducing vibration amplitude and transmission while preserving the Ono-derived reflective inner surface. The resulting lower-reflectivity portion would absorb speaker-induced vibrational energy, as claim 6 requires.

3. Claims 7 and 8

- (i) 7. "The method of claim 6, wherein the portion is forward of the chamber."**
- (ii) 8. "The method of claim 6, wherein the portion is rear of the chamber."**

375. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitations of claims 7 and 8 and would have rendered claims 7 and 8 obvious.

376. Chow's "[s]peaker 18 can be positioned within cavity 20 formed within the at least one side frame member 14." EX1006, [0039]. Figures 3-4 of Chow illustrate that side frame member 14 (orange) includes a portion forward and a portion rear of cavity 20 (blue):



Id., FIGs. 3 (excerpt), 4 (annotated).

377. The side-frame portions forward and rear of cavity 20 are each contiguous structural paths extending away from the speaker enclosure. A POSITA would have recognized that speaker-induced mechanical vibration could propagate through either path. For the reasons explained for claims 5 and 6 in this ground and claims 7 and 8 in Ground 2, the POSITA would have used the selected absorbing material in the forward portion (as required by claim 7) and the rearward portion (as required by claim 8) so that cyclic structural motion would be dissipated rather than transmitted along the eyewear. *See* Sections X.J.1-2, X.B.3.

378. Accordingly, in my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C would have rendered claims 7 and 8 obvious: for claim 7, the relevant vibration-absorbing portion would be forward of the chamber; for claim 8, the relevant vibration-absorbing portion would be rear of the chamber.

4. Claim 9

(i) 9. “The method of claim 6, wherein the portion is an outer surface of the chamber.”

379. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitation of claim 9 and would have rendered claim 9 obvious.

380. As explained for claim 9 in Ground 2 and claim 5 in this ground, the Ono-derived chamber-facing surface would be preserved as the higher-reflectivity inner surface, while the applicable outer surface would be formed or treated with the selected Boyden-type material. *See* Sections X.B.4, X.J.1. The outer-side treatment provides the location for mechanical-vibration damping without covering the surface that reflects useful sound toward Chow’s port or output path.

381. Each relevant Chow-Ono implementation includes an outer surface exterior to the chamber-facing inner surface. If Ono’s reflector geometry is formed in Chow’s cavity wall, the opposite side of that physical wall is the outer surface. If

the reflector is a chamber-defining insert or liner, the opposite or back face of that structure is an outer surface exterior to its chamber-facing face. In either implementation, the outer surface is mechanically coupled to the chamber-defining structure and therefore can receive speaker-induced wall or liner vibration. A POSITA would have been motivated, with a reasonable expectation of success, to apply the vibration-damping treatment selected for claim 6 to that surface, where it would deform with the structure and dissipate part of its cyclic strain energy while preserving the inner reflector and reducing unwanted acoustic reradiation. EX1008, 5:1-8, 5:36-67. The lower-reflectivity, vibration-absorbing portion identified for claims 5 and 6 would thus be an outer surface of the chamber, as claim 9 requires.

5. Claim 15

- (i) 15. “The apparatus of claim 14, wherein the interior surface has a larger acoustic reflectivity than an acoustic reflectivity of the outer surface.”**

382. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitation of claim 15 and would have rendered claim 15 obvious. The acoustic-reflectivity comparison follows from the surfaces’ respective acoustic functions. The chamber-facing interior surface would be the Ono-derived reflecting boundary and would return useful airborne sound toward Chow’s ear-facing output path. *See* Sections X.J.1, X.J.4. The outer

surface would use a non-radiative and acoustically absorbing material such as Boyden's and therefore would have lower acoustic reflectivity. *See* EX1007, 2-3; EX1008, 5:54-67.

6. Claim 16

- (i) 16. "The apparatus of claim 15, wherein the outer surface is coated with a material that absorbs acoustic energy."**

383. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitation of claim 16 and would have rendered claim 16 obvious.

384. For claim 16, I rely on the Ground 7A and 7C implementation in which the reflector is provided as a chamber-defining insert or liner within Chow's cavity 20. *See* Sections X.G.1, X.I, X.J.4. The liner's chamber-facing face is the higher-reflectivity inner surface, and the liner's opposite or back face is an outer surface exterior to that inner surface. Boyden teaches non-radiative and absorbing wall materials, acoustic damping material, and "coated surfaces" or liners for achieving desired acoustic properties. EX1008, 5:37-50, 5:54-67. Boyden also cautions that enclosure fill should not significantly load the transducer diaphragm. *Id.*, 5:37-50.

385. A POSITA would have applied an acoustically lossy Boyden-type coating to the liner's opposite or back face. Airborne acoustic energy incident on the

chamber-facing face is divided among reflected, absorbed, and transmitted components; the portion not reflected toward the port can be transmitted into or through the liner. *See* Section VI.C. The coating on the back face would absorb part of that transmitted acoustic energy and reduce outward reradiation, while leaving the reflective face exposed and avoiding cavity fill that could occupy useful volume, load the diaphragm, or obstruct Chow's output path. EX1008, 5:37-50, 5:54-67. Applying the coating before installing the liner would have been a routine fabrication step. The resulting back face would be an outer surface coated with material that absorbs acoustic energy, as claim 16 requires.

7. Claim 20

- (i) 20. "The apparatus of claim 19, wherein a first material used for the inner surface provides substantially for reflection of the audio signals and a second material used for the outer surface provides substantially for absorption of acoustic energy."**

386. In my opinion, each Chow-Ono-Boyden combination teaches or would have suggested the additional limitation of claim 20 and would have rendered claim 20 obvious.

387. As I explained for claim 19 in Grounds 7A-7C, each Chow-Ono combination retains an external sound cover with an exposed ear-facing inner surface that reflects or deflects audio toward the user's ear and an opposite outer

surface. *See* Sections X.G.11, X.H.6, X.I.1. The material forming the existing ear-facing boundary is the first material because that boundary provides the reflection or deflection; the cover's geometry and placement determine the direction of the reflected sound. The particular Ono mechanism used inside the chamber or at its output does not alter those external-cover surfaces.

388. The outer-material construction explained for Ground 4 therefore applies to each Chow-Ono combination. *See* Section X.D.1. A POSITA would have been motivated to preserve Chow's existing ear-facing material and add an absorbing material such as Boyden's at the outward-facing side, by coating or laminating that side or by forming the outward-facing portion as an outer layer, so that the exposed face of the second material forms the cover's outer surface. EX1006, [0042]; EX1008, 5:54-67, 11:55-12:7. The inner material would continue reflecting useful sound toward the ear, while the second material would absorb acoustic energy transmitted into the cover and reduce outward reradiation. This placement is independent of whether the associated Chow-Ono chamber uses Ono's reflector geometry, sound-absorbing material, or both.

389. Accordingly, each Chow-Ono-Boyden combination would have yielded a first material used for the inner surface that provides substantially for

reflection of the audio signals and a second material used for the outer surface that provides substantially for absorption of acoustic energy, as recited in claim 20.

8. Claims 24-28

- (i) 24. “The apparatus of claim 14, wherein an inner surface of the chamber has a first acoustic reflectivity and at least a portion of the eyewear device has a second acoustic reflectivity, the first acoustic reflectivity is greater than the second acoustic reflectivity.”**
- (ii) 25. “The apparatus of claim 24, the portion absorbs vibrational energy.”**
- (iii) 26. “The apparatus of claim 25, wherein the portion is forward of the chamber.”**
- (iv) 27. “The apparatus of claim 25, wherein the portion is rear of the chamber.”**
- (v) 28. “The apparatus of claim 25, wherein the portion is an outer surface of the chamber.”**

390. In my opinion, the Chow-Ono-Boyden combinations based on Grounds 7A and 7C teach or would have suggested the additional limitations of claims 24-28 and would have rendered claims 24-28 obvious, for the reasons explained for claims 5-9. *See* Sections X.J.1-X.J.4.

391. Claims 24-28 recite apparatus limitations corresponding to the method limitations of claims 5-9. For the reasons explained for those claims, each relevant Chow-Ono-Boyden apparatus would include an Ono-derived chamber-facing inner

surface having greater acoustic reflectivity than another Boyden-treated portion; the latter portion would be deliberately selected and arranged to dissipate speaker-induced mechanical vibration; and that portion could be located forward of the chamber, rear of the chamber, or at an outer surface of the chamber. *See* Sections X.J.1-4. Thus, the apparatus would include the distinct acoustic-reflectivity and structural-vibration functions required by claims 24-28.

K. Ground 9: Chow in View of Ono, and Chen Teaches and/or Suggests Claims 13 and 23

392. As I explained at the outset of Ground 8, the “Chow-Ono Combinations” are the combinations of Chow (EX1006) and Ono (EX1007) described in Grounds 7A, 7B, and 7C, each of which, in my opinion, renders the relevant claims obvious. In this ground, Chen (EX1010) is added to each of the Chow-Ono Combinations, and I refer to the results as the “Chow-Ono-Chen” combinations.

393. It is my opinion that each Chow-Ono-Chen combination renders obvious claims 13 and 23.

1. Claim 13

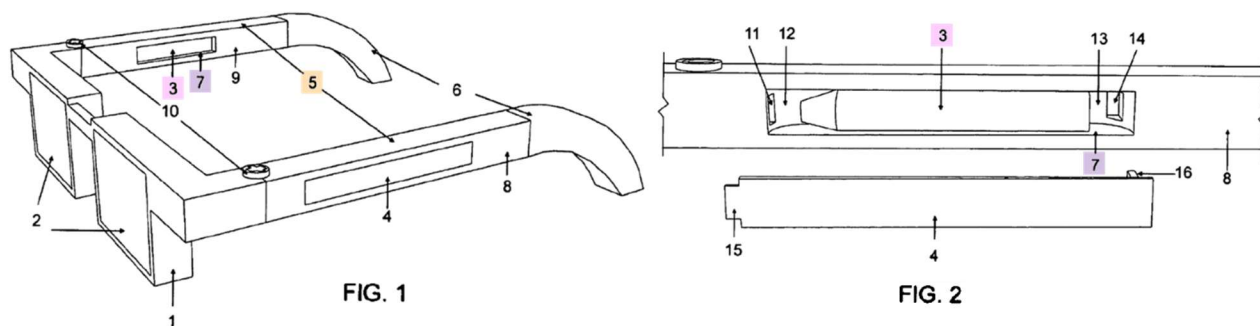
- (i) 13. “The method of claim 11, wherein the speaker is located within a temple insert module of the eyewear device.”**

394. In my opinion, each Chow-Ono-Chen combination teaches or would have suggested the additional limitation of claim 13 and would have rendered claim 13 obvious.

395. As I explained for limitation [1.a] and claim 12 in Grounds 7A-7C, each Chow-Ono Combination retains Chow's speaker 18 within cavity 20 formed in side frame member 14, which is part of the eyewear temple. The particular Ono sound-concentration teaching used in the combination—parabolic reflector geometry, sound-absorbing material around the audio openings, or both—does not alter the speaker's location within the temple or its relationship to Chow's cavity and ear-facing output path.

396. As I explained for claim 13 in Ground 6, Chen discloses an eyewear temple assembly that includes a removable cartridge or module housed in a cartridge compartment of the temple. *See* Section X.F.1; *see also* EX1010, Abstract, 2:55-65, FIGs. 1-2. Chen further teaches that the removable cartridge may include electronic or non-electronic components, and that the cartridge architecture can provide modular eyewear functions, including electronic functions such as music playing or cell-phone capabilities. EX1010, 1:28-31, 2:63-65, 4:14-24. Figures 1 and 2 of Chen

illustrate cartridge 3 (pink) positioned within temple 5 (orange) and secured within cartridge compartment 7 (purple).



Id., FIGs. 1-2 (both annotated).

a. Combination Rationale

397. In my opinion, a POSITA would have been motivated to house the temple-mounted speaker/audio assembly of each Chow-Ono Combination within Chen's removable temple cartridge/module architecture. Doing so would have allowed the audio hardware to be installed, removed, replaced, upgraded, or serviced as a unit within the eyewear temple, consistent with Chen's teaching that a user can remove an old cartridge and install a new one rather than replacing the entire temple. EX1010, 4:14-18.

398. A POSITA would have recognized Chen's cartridge architecture as suitable for each Chow-Ono Combination's audio assembly because Chen expressly contemplates cartridges containing electronic components and eyewear functions,

including music-playing functionality. *Id.*, 1:28-31, 2:63-65. The Chow-Ono speaker and associated audio components are the type of temple-mounted functional hardware that a POSITA would have understood could be housed in Chen's removable cartridge/module.

399. This modification would have preserved each Chow-Ono Combination's relevant acoustic relationships. The speaker would remain located within the temple, and the speaker/cavity/output-path arrangement would still direct sound toward the user's ear. Chen's cartridge/module would provide a removable temple housing for that audio assembly; it would not require changing the speaker's function or its acoustic relationship with the chamber and ear-facing output path.

400. In my opinion, a POSITA would have had a reasonable expectation of success. The combination applies Chen's known removable cartridge/compartment architecture for eyewear temples to the known temple-mounted speaker/audio assembly of Chow and Ono. Chen expressly teaches temple cartridges containing electronic components, and a POSITA would have expected such a modular implementation to function predictably. *Id.*, 2:55-65, 4:14-24.

401. Because Chen's cartridge/module is inserted into and housed by the temple, it would be a temple insert module. As a result, in each Chow-Ono-Chen

combination, the speaker of each Chow-Ono Combination would be located within a temple insert module of the eyewear device, as recited in claim 13.

2. Claim 23

- (i) 23. “The apparatus of claim 14, wherein the chamber is located within a temple insert module of the eyewear device.”**

402. In my opinion, each Chow-Ono-Chen combination teaches or would have suggested the additional limitation of claim 23 and would have rendered claim 23 obvious.

403. As I explained for claim 22 in Grounds 7A-7C, each Chow-Ono combination includes a chamber within the eyewear temple, and as I explained for claim 13 above, a POSITA would have been motivated to implement the temple-mounted audio assembly in Chen’s removable cartridge/module architecture. *See* Sections X.G.12, X.H.7, X.I.1, X.K.1. In that implementation, the cartridge shell—not the fixed side-frame recess—would define the cavity. The cartridge would carry speaker, the cavity-defining walls, lower transition surface, audio openings, and whichever Ono reflector or absorber is used in the particular combination. EX1006, [0039], FIGs. 3-4. The audio openings would register with Chen’s wearer-side opening, while Chen’s compartment lid and restraints or its alternative cartridge tabs

and matching slots would secure the cartridge and maintain that alignment. EX1010, 5:38-6:4, 6:5-51, 8:55-9:8.

404. Keeping the complete acoustic subassembly in the cartridge would preserve the fixed relationship among the speaker, cavity walls, lower transition surface, audio openings, and sound-concentration structure, and therefore would preserve Chow's ear-facing output path. At the same time, the arrangement would provide Chen's disclosed benefit of replacing or servicing the functional cartridge without replacing the entire temple. EX1010, 4:6-21 A POSITA would have expected that mechanically retained, registered cartridge to operate predictably. The cartridge/module would therefore provide a temple insert module in which the chamber itself is located, as recited in claim 23.

L. Ground 10: Chow in View of Ono, and Higuchi Teaches and/or Suggests Claim 21

405. As I explained at the outset of Ground 8, the "Chow-Ono Combinations" are the combinations of Chow (EX1006) and Ono (EX1007) described in Grounds 7A, 7B, and 7C, each of which, in my opinion, renders the relevant claims obvious. In this ground, Higuchi (EX1009) is added to each of the Chow-Ono Combinations, and I refer to the results as the "Chow-Ono-Higuchi"

combinations. It is my opinion that each Chow-Ono-Higuchi combination renders obvious claim 21.

1. Claim 21

- (i) 21. “The apparatus of claim 19, wherein a shape of the external sound cover is concave towards the user's ear.”**

406. In my opinion, each Chow-Ono-Higuchi combination teaches or would have suggested the additional limitation of claim 21 and would have rendered claim 21 obvious.

407. As I explained for claims 10 and 19 in Grounds 7A-7C, Chow discloses an external sound cover in the form of an external sound-channel member that attaches to eyewear and includes a sound-deflecting surface for channeling sound toward the user's ear. *See* Sections X.G.5, X.G.11, X.H.2, X.H.6, X.I.1.

408. As I explained for claim 21 in Ground 5, Higuchi discloses an eyeglass-mounted hood formed from “multiple arc-shaped segments” that covers the ear and helps the user hear sounds from hearing aids or earphones. *See* Section X.E.1. Higuchi's arc-shaped, over-ear hood presents a concave shape toward the user's ear.

a. Combination Rationale

409. In my opinion, a POSITA would have been motivated to use Higuchi's eyeglass-mounted, concave over-ear geometry with Chow's external sound-channel

member in each Chow-Ono combination. That geometry would have directed or channeled sound emitted from Chow's ear-facing port/openings inward toward the user's ear, rather than allowing the sound to disperse outward. That would have been consistent with Chow's sound-channeling function and with each Chow-Ono combination's concentrating of sound toward Chow's ear-facing output path. EX1006, [0042]; EX1007, 2-3.

410. A POSITA would also have recognized Higuchi as a suitable reference because Higuchi expressly teaches an ear-covering sound-directing structure mounted to an eyeglass frame. EX1009, 1, FIG. 1. The Chow-Ono combination already uses eyewear-mounted audio components, including an external sound-channel member, so applying Higuchi's concave, arc-shaped geometry to that external cover would have been a straightforward use of a known eyeglass-mounted sound-directing structure.

411. In my opinion, a POSITA would have had a reasonable expectation of success. Higuchi's arc-shaped hood is a simple mechanical geometry mounted to eyeglasses, and incorporating that concave over-ear shape into Chow's external sound-channel member would not have required changing each Chow-Ono combination's speaker, chamber, acoustic port, or ear-facing output path. The

resulting structure would predictably direct/channel sound inward toward the user's ear.

XI. SECONDARY CONSIDERATIONS

412. I have not been provided with, and am not presently aware of, evidence of secondary considerations that would alter the opinions expressed in this declaration.

413. In particular, I am not presently aware of evidence of long-felt but unresolved need, unexpected results, skepticism, industry praise, copying, or other secondary considerations that would support a conclusion of non-obviousness of the challenged claims. If Solos identifies or presents such evidence, I reserve the right to evaluate that evidence and respond to it.

Declaration of Michael T. Johnson, Ph.D.
U.S. Patent No. 11,871,174

XII. CONCLUSION

414. I 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 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.

Dated: 8 / 14 / 2026 By: Michael T. Johnson /

Michael T. Johnson, Ph.D.