

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

META PLATFORMS, INC.,
Petitioner

v.

MULLEN INDUSTRIES LLC,
Patent Owner.

Case IPR2025-00743
U.S. Patent No. 11,947,716 B2
Issue Date: April 2, 2024

Title: WIRELESS DEVICES WITH FLEXIBLE MONITORS AND
KEYBOARDS

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,947,716 B2**

Table of Contents

	Page
I. MANDATORY NOTICES UNDER §42.8(A)(1)	1
A. Real Party-In-Interest under §42.8.(b)(1).....	1
B. Related Matters under §42.8(b)(2)	1
C. Lead and Back-Up Counsel under §42.8(b)(3)	1
D. Service Information	2
II. FEE PAYMENT	2
III. REQUIREMENTS UNDER §§ 42.104 AND 42.108 AND CONSIDERATIONS UNDER §§ 314(A) AND 325(D).....	3
A. Grounds for Standing	3
B. Identification of Challenge and Statement of Precise Relief Requested	3
C. Considerations Under §§ 314(a) and 325(d).....	3
IV. OVERVIEW OF THE PATENT.....	4
A. Level of Ordinary Skill	4
B. Specification Overview	4
V. CLAIM CONSTRUCTION	5
VI. THE CHALLENGED CLAIMS ARE UNPATENTABLE.....	6
A. Overview of Grounds	6
B. Prior Art Status of Relied-Upon References	11
A. Ground 1: Claims Are Obvious Over Ronzani in View of Horton and Ohshima	12
1. Independent Claim 16: “[a] head-mounted device comprising:” (16[pre])	12
(a) “a head-mounted power source;” (Claim 16[a])	15
(b) “a head-mounted manual input;” (Claim 16[b]).....	16
(c) “a head-mounted processor;” (Claim 16[c]).....	19

Table of Contents
(continued)

	Page
(d) “a head-mounted movement sensor;” (Claim 16[d])	24
(e) “a top-of-the-head mounting structure;” (Claim 16[e]) and “a behind-the-head mounting structure;” (Claim 16[f])	30
(f) “a head-mounted display operable to cover at least a portion of at least one eye of a wearer of said head-mounted device, wherein a first virtual object is operable to be displayed on said head-mounted display and controlled with manual input and a second virtual object is operable to be displayed on said head mounted display and controlled autonomously by said processor; and” (Claim 16[g])	33
(g) “a head-mounted camera, wherein information from said head-mounted camera is operable to be displayed on said head-mounted display simultaneously with said first virtual object and said second virtual object.” (Claim 16[h])	43
2. Claim 18: “The apparatus of claim 16, wherein:” (Claim 18[pre]).....	48
(a) “said head-mounted camera is pointed in a field-of-vision of said wearer and operable to capture said information, wherein said information comprises a portion of said wearer’s actual world environment; and” (Claim 18[a])	49
(b) “said display is operable to display said information comprising said portion of said wearer’s actual world environment captured by said camera simultaneously with said first virtual object and said second virtual object.” (Claim 18[b])	50
B. Ground 2: Claims 1 and 8 Are Obvious Over Ronzani in view of Horton, Natoli, and Peli.	51

Table of Contents
(continued)

	Page
1. Independent Claim 1: “An apparatus comprising:” (Claim 1[pre])	51
(a) “a head-wearable device comprising at least one housing, said at least one housing comprising:” (Claim 1[a])	51
(b) “a speaker” (Claim 1[b]).....	52
(c) “a microphone; and” (Claim 1[c]).....	56
(d) “a movement sensor, wherein said movement sensor comprises an accelerometer;” (Claim 1[d])	58
(e) “a manual input operably coupled to said head- wearable device;” (Claim 1[e]).....	59
(f) “wherein said head-wearable device further comprises:” (Claim 1[f]).....	60
(1) “a display operable to cover at least a portion of at least one eye of a wearer of said head-wearable device, wherein said display is operable to display a virtual object and to allow said wearer of said head- wearable device to view, simultaneously with said virtual object, a portion of said wearer’s actual world environment; and” (Claim 1[f][1]).....	60
(2) “a camera pointed in a field-of-vision of said wearer and operable to capture an image of said portion of said wearer’s actual world environment;” (Claim 1[f][2]).....	68
(g) “wherein said display is operable to display said image of said wearer’s actual world environment taken by said camera simultaneously with said virtual object.” (Claim 1[g])	76

Table of Contents
(continued)

	Page
2. Claim 8: “The apparatus of claim 1, wherein said display comprises: a first display covering at least a portion of a first eye of said wearer; and a second display covering at least a portion of a second eye of said wearer.” (Claim 8[pre]).....	77
VII. CONCLUSION.....	78
CERTIFICATE OF SERVICE	80

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

List of Exhibits

Exhibit No.	Description of Document
1001	U.S. Patent No. 11,947,716 B2 to Jeffrey David Mullen (filed Jan. 13, 2023, issued Apr. 2, 2024) (“ 716 ” or “ 716 patent ”)
1002	Declaration of Jeremy Cooperstock, Ph.D. (“ Cooperstock ”)
1003	U.S. Patent App. Pub. No. 2002/0163486 A1 to Peter A. Ronzani et al. (filed May 16, 1997; published Nov. 7, 2002) (“ Ronzani ”)
1004	U.S. Patent No. 5,615,132 to Mike A. Horton et al., “Method and Apparatus for Determining Position and Orientation of a Movable Object Using Accelerometers” (filed Jan. 21, 1994; issued Mar. 25, 1997) (“ Horton ”)
1005	U.S. Patent No. 6,951,515 B2 to Toshikazu Ohshima et al., “Game Apparatus for Mixed Reality Space, Image Processing Method Thereof, and Program Storage Medium” (filed Feb. 17, 2000; issued Oct. 4, 2005) (“ Ohshima ”)
1006	U.S. Patent No. 6,611,618 B1 to Eliezer Peli, “Wide-Band Image Enhancement” (filed Jan. 22, 1999; issued Aug. 26, 2003) (“ Peli ”)
1007	U.S. Patent No. 6,388,657 B1 to Anthony James Francis Natoli, “Virtual Reality Keyboard System and Method” (filed Dec. 31, 1998; issued May 14, 2002) (“ Natoli ”)
1008	Proof of Service of Complaint

I. MANDATORY NOTICES UNDER §42.8(A)(1)

A. Real Party-In-Interest under §42.8.(b)(1)

Meta Platforms, Inc. is the real party-in-interest to this IPR petition.

B. Related Matters under §42.8(b)(2)

The '716 patent is the subject of pending litigation involving Petitioner: *Mullen Industries LLC v. Meta Platforms, Inc.*, Case No. 1:24-cv-00354-DAE (W.D. Tex.). Petitioner was served on April 5, 2024. (EX1008, p.003.)

Petitioner is filing IPR petitions against twelve related patents asserted by Patent Owner in the pending litigation involving Petitioner:

U.S. Patent No.	IPR Case
8,585,476 B2	IPR2025-00737
9,744,448 B2	IPR2025-00738
10,179,277 B2	IPR2025-00739
10,828,559 B2	IPR2025-00740
10,967,270 B2	IPR2025-00702
11,033,821 B2	IPR2025-00703
11,376,493 B2	IPR2025-00741
11,904,243 B2	IPR2025-00742
11,947,716 B2	IPR2025-00743
12,019,791 B2	IPR2025-00744
9,662,582 B2	IPR2025-00745
10,974,151 B2	IPR2025-00746

C. Lead and Back-Up Counsel under §42.8(b)(3)

Petitioner provides the following designation of counsel.

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

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D. Service Information

This Petition is being served by Federal Express to the attorney of record for the '716 patent, 32733 - JEFFREY D. MULLEN, 2212 Hassinger Lane, Glenshaw, PA 15116. Petitioner consents to electronic service at the addresses provided above for lead and back-up counsel.

II. FEE PAYMENT

Petitioner requests review of four claims, with a \$51,875 payment.

**III. REQUIREMENTS UNDER §§ 42.104 AND 42.108 AND
CONSIDERATIONS UNDER §§ 314(A) AND 325(D)**

A. Grounds for Standing

Petitioner certifies that the '716 patent is available for IPR and that Petitioner is not barred or otherwise estopped.

B. Identification of Challenge and Statement of Precise Relief Requested

Petitioner requests IPR institution based on:

Ground	Claims	Basis for Challenge under §103
1	16 and 18	Ronzani in view of Horton and Ohshima
2	1 and 8	Ronzani in view of Horton, Natoli, and Peli

Submitted herewith is the expert declaration of Jeremy Cooperstock, Ph.D. (EX1002) (“Cooperstock”). (EX1002, ¶¶1-18, Appendix A.)

C. Considerations Under §§ 314(a) and 325(d)

§314(a): The *General Plastic* factors are inapplicable as this is the first and only IPR petition filed regarding the '716 patent.

The *Fintiv* factors do not support discretionary denial under §314(a). The pending litigation against Petitioner is in early stages. Trial is scheduled for October 5, 2026. Petitioner’s motion to transfer venue is pending, which if granted would likely move trial even later. Petitioner intends to move to stay the litigation pending

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

resolution of the IPRs. If IPR is instituted, Petitioner will not pursue in litigation any invalidity defense that was or could have been raised in IPR.

§325(d): No §325(d) issue is raised here. No relied-upon reference was cited during prosecution. Ronzani is a continuation-in-part of cited U.S. Patent No. 5,815,126, but both grounds raise obviousness combinations that were not cited and are not cumulative of any presented combinations.

Petitioner reserves the right to address and respond to any assertions that Patent Owner may raise regarding discretionary factors.

IV. OVERVIEW OF THE PATENT

A. Level of Ordinary Skill

A person of ordinary skill (“POSITA”) would have possessed a bachelor’s degree in electrical engineering, computer science, or similar field, with two years combined experience in designing and/or developing computer systems/software involving interactive graphical virtual and/or augmented reality. A person could also have qualified as a person of ordinary skill in the art with some combination of (1) more formal education (such as a master’s of science degree) and less technical experience, or (2) less formal education and more technical or professional experience. (Cooperstock, ¶¶21-25.)

B. Specification Overview

The ’716 patent “relates to improved portable devices” and “portable devices

with enlarged, and improved, display and input components.” (’716, 1:30-32.) The patent purports to provide “[a]n improved portable device ... that includes both a flexible display screen and a flexible keyboard.” (’716, 1:53-54.) According to the patent, “[a] number of systems and methods for displaying information to a user of a portable device is also provided. For example, virtual bifocals are provided in head-mounted systems such that a user can work in a virtual world (e.g., check email from an email server or surf the internet on a browser) while working in an actual world (e.g., while walking to work in the morning).” (’716, 2:31-38.)

The patent further contemplates a head-mounted camera to capture still or video images. (’716, 14:53-15:3.) An infrared camera could be used to capture an image that is displayed: “For example, infrared and night vision cameras can be utilized. The information received from these cameras can be displayed on the display screen.” (’716, 14:57-60.)

V. CLAIM CONSTRUCTION

Petitioner does not believe express claim construction is necessary at this time. The prior art renders the challenged claims obvious under any reasonable construction.

VI. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Overview of Grounds

The challenged claims attempt to lay claim to head-mounted displays with physical components and “virtual” display features that were well-known before the ’716 patent.

Both grounds rely on Ronzani (EX1003), which discloses most of the elements of the challenged claims. Ronzani describes head-mounted display (“HMD”) embodiments strikingly similar to those claimed by the ’716 patent. Ronzani teaches “head mounted displays” comprising display elements, “computer system,” “manually adjustable controls,” “user interface,” and other components “for numerous applications including commercial, industrial and entertainment purposes.” (Ronzani, ¶¶0005-0016.) Ronzani proceeds to describe numerous exemplary embodiments of a head-mounted display device as illustrated throughout Ronzani’s written description and figures. (Ronzani, ¶¶0017-0281, Figs. 1-70.) Ronzani explains that “the particular head and/or body mounted display systems embodying the invention [are] shown by way of illustration only” and “[t]he principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.” (Ronzani, ¶0017.)

Ronzani also teaches the applicability of head-mounted displays to a wide variety of applications, including “simulation such as virtual imaging[.]”

“entertainment purposes,” and other uses.¹ (Ronzani, ¶¶0002, 0005 (“The present invention relates generally to systems and methods for mounting display and electronic systems on the human body for numerous applications including commercial, industrial and entertainment purposes.”).) Consistent with these teachings, Ronzani describes that its system may use “a virtual keyboard using motion sensitive gloves” and “a virtual reality data glove.” (Ronzani, ¶¶0007, 0170.)

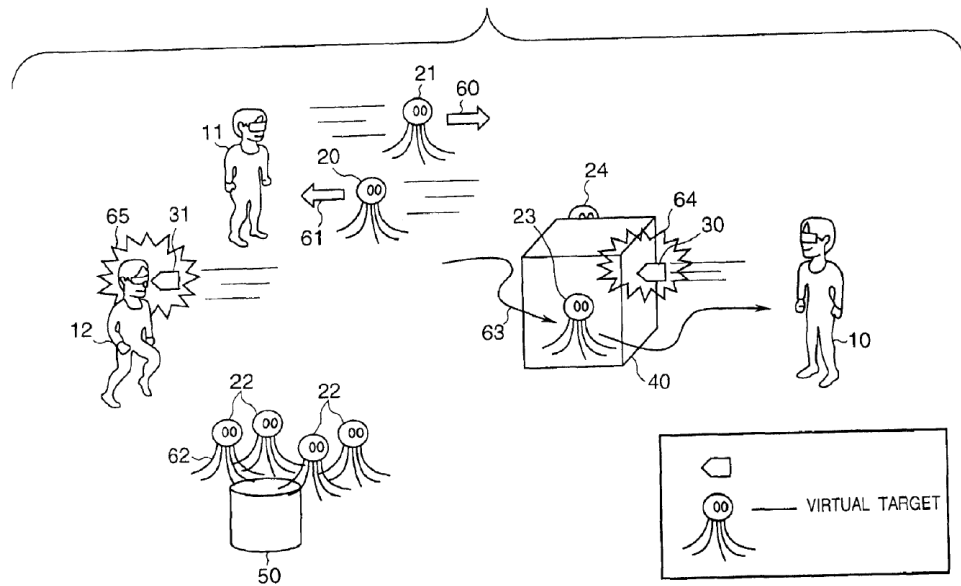
Both grounds rely on combination with **Horton** (EX1004). (Cooperstock, ¶¶55-58.) Horton discloses and renders obvious claim elements that recite a head-mounted “**movement sensor**” that may comprise an “**accelerometer**,” namely Claim 16[d] (“**a head-mounted movement sensor**”) and Claim 1[d] (“**a movement sensor, wherein said movement sensor comprises an accelerometer**”). As noted previously, Ronzani discloses HMD devices for use in various applications such as virtual simulations and entertainment. Horton explains the need to accurately determine the user’s position and orientation in virtual reality or other simulated environments. (Horton, 1:13-22.) To address that stated need, Horton teaches the use of accelerometers to track movement. Horton specifically teaches that the accelerometers can be placed on an HMD to track movement of the user’s head.

¹ All underlining added to quoted material unless noted.

(Horton, 2:16-21, 3:41-62 (“the tracking invention could be implemented on an HMD and two data gloves to track head and hand movement of a user”).)

Ground 1 further relies on **Ohshima** (**EX1005**), which describes a head-mounted mixed-reality game that displays “virtual” objects. (Cooperstock, ¶¶60-66.) Specifically, Ohshima teaches the “**first virtual object . . . controlled with manual input**” and “**second virtual object . . . controlled autonomously**” of Claims 16 and 18. Ohshima describes a game system including an HMD with a camera that displays images of the real world along with “virtual” objects in a “mixed reality” environment. (Ohshima, 1:8-14, 6:19-54, 7:17-38.) Specifically, Ohshima describes a mixed reality game where the player can use a simulated “gun” controller to shoot virtual “bullets” at virtual “spacemen” (also called “targets”). Figure 1 of Ohshima illustrates the overall game environment including spacemen/targets **20-24** and virtual bullet **30**.

FIG. 1



(Ohshima, Fig. 1.)

Disclosing the “**first virtual object**” being “**controlled with manual input**” per claim 16[g], Ohshima describes that when the user points the gun-shaped controller **1004** and performs an “action of a trigger” or “shooting action,” a virtual “bullet” is fired in the direction indicated by the user. (Ohshima, 5:64-67, 6:57-63.)

Disclosing the “**second virtual object**” being controlled “**autonomously**” by a processor per Claim 16[g], each virtual spaceman/target is controlled autonomously by the system with behavior that appears to the user “as if it had its own will and objective” and “as if a virtual object (target) decided its own movement pattern” without user control. (Ohshima, 5:57-59, 6:1-8, 8:18-29, 11:18-30.)

Ground 2 relies on combination with **Peli** (**EX1006**), which describes a head-mounted display with infrared camera that captures and displays an image, much

like the '716 patent. (Cooperstock, ¶¶68-71.) Peli discloses and renders obvious the features of Claim 1[f]-[g] regarding a head-wearable device with a **“display is operable to display a virtual object and to allow said wearer of said head-wearable device to view, simultaneously with said virtual object, a portion of said wearer’s actual world environment”** and **“wherein said display is operable to display said image of said wearer’s actual world environment taken by said camera simultaneously with said virtual object.”** Like the '716 patent, Peli describes the use of head-mounted cameras to capture an image of a real-world scene in the user’s field of view and provide that image in a head-mounted display. Peli teaches multiple applications for enhancing a person’s view of the real-world environment, including by capturing an image of the scene in front of the user and displaying the image on a transparent “see-through” head-mounted display, enabling the user to simultaneously see both the actual world environment and the displayed image. (*E.g.*, Peli, 9:23-55, 13:43-14:4, Figs. 4, 5, 13.) Similar to the '716 patent’s disclosure of capturing and displaying an image using an infrared camera ('716, 14:57-60), Peli teaches using a head-mounted infrared camera to capture an image that is displayed on the head-mounted display: “an infrared camera 70 obtains an infrared image of a natural scene, and a display module 72 displays the image on a screen, preferably spectacle mounted or mounted to move with the movement of the patient’s head, disposed in front of at least one of the patient’s eyes.” (Peli, 14:24-

49.)

Finally, Ground 2 further relies on Natoli (EX1007) which teaches the claimed “**virtual object**” of claim 1[f]-[g] in the form of a virtual keyboard. Ronzani discloses that a “virtual keyboard” with a virtual reality glove may be used with a head-mounted display but does not describe details of the virtual keyboard. (Ronzani, ¶¶0007, 0010.) Natoli naturally builds upon Ronzani’s disclosure, teaching and motivating functionality for displaying on a semi-transparent head-mounted display a “VR keyboard” simulating a physical keyboard that overlays the wearer’s view of the real world environment, which can be controlled with a motion-sensitive VR glove. (Natoli, 2:34-48.)

B. Prior Art Status of Relied-Upon References

Pre-AIA law applies to the challenged claims, and each reference cited in the grounds qualifies as prior art to the ’716 patent. Ronzani, Horton, Peli, and Natoli qualify as prior art under § 102(b) because they were published and/or issued more than one year before the priority date.² Ohshima qualifies as prior art under § 102(e)

² The ’716 patent claims priority to a provisional application (no. 60/603,481) filed August 20, 2004. For purposes of this Petition, Petitioner has assumed a priority date of August 20, 2004. Petitioner at this time expresses no opinion on whether the patent is actually entitled to the benefit of the provisional application filing date.

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

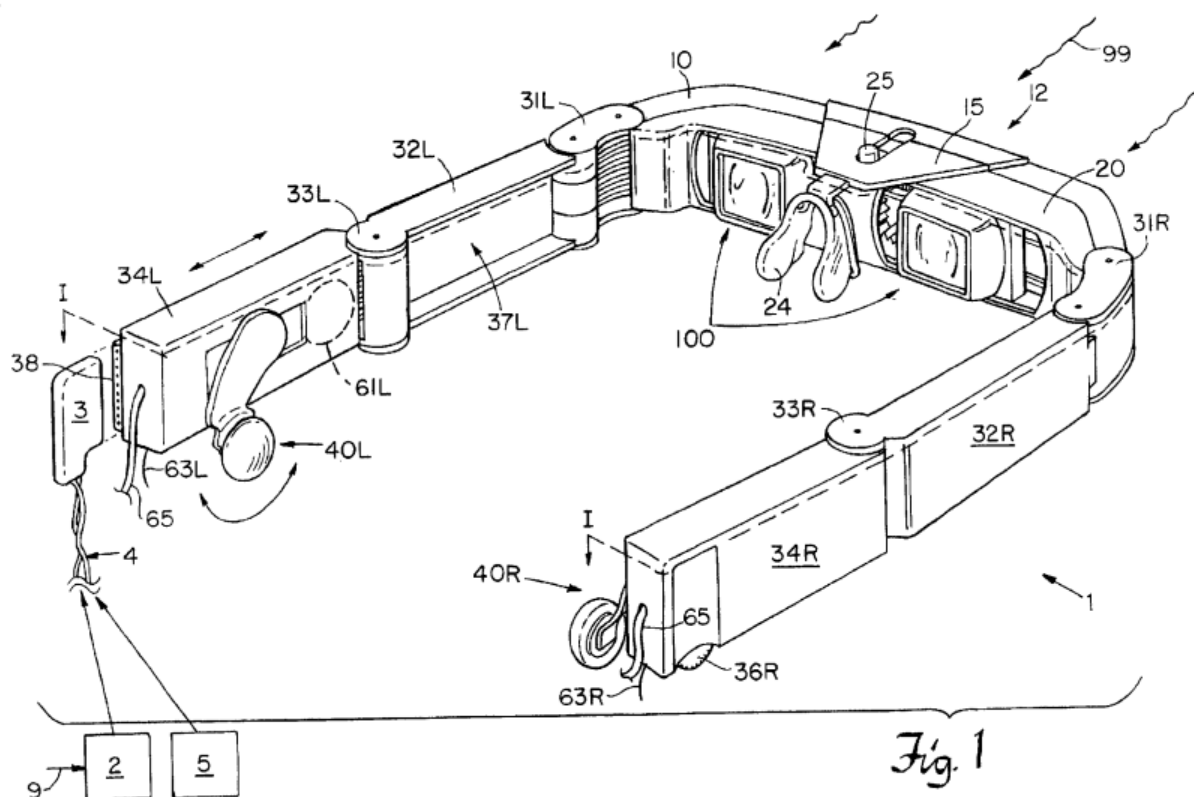
(and § 102(a)) because it was filed on February 17, 2000, four years before the earliest claimed priority date.

A. Ground 1: Claims Are Obvious Over Ronzani in View of Horton and Ohshima

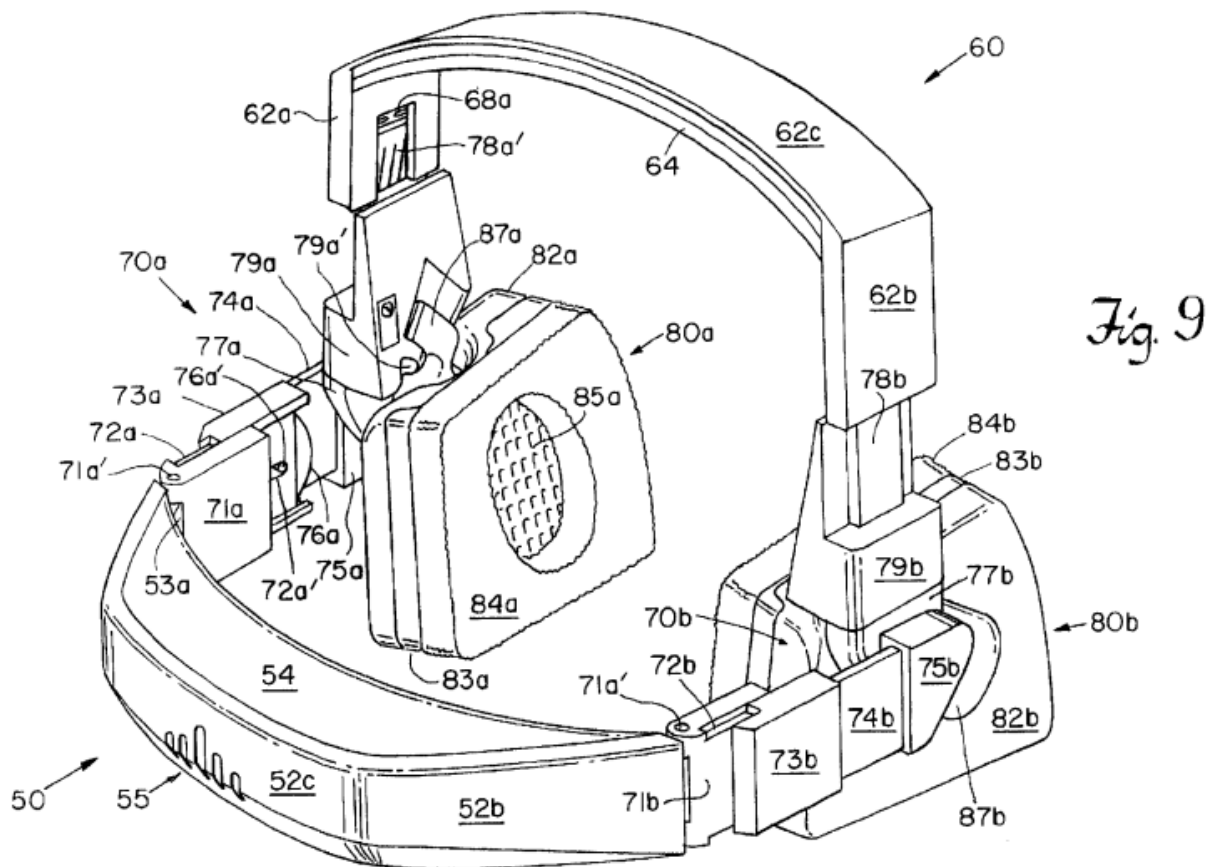
1. Independent Claim 16: “[a] head-mounted device comprising:” (16[pre])

Assuming the preamble provides a claim limitation, Ronzani discloses “a **head-mounted device**” as explained further below. (Cooperstock, ¶¶76-82; Ronzani, ¶¶0005-0016.) Figures 1 and 9 illustrate embodiments:

This issue is not relevant here because all the prior art references relied upon predate August 20, 2004. In the event entitlement to the provisional filing date or another earlier priority date may later become relevant, Petitioner reserves the right to respond at that time.



(Ronzani, Fig. 1.)



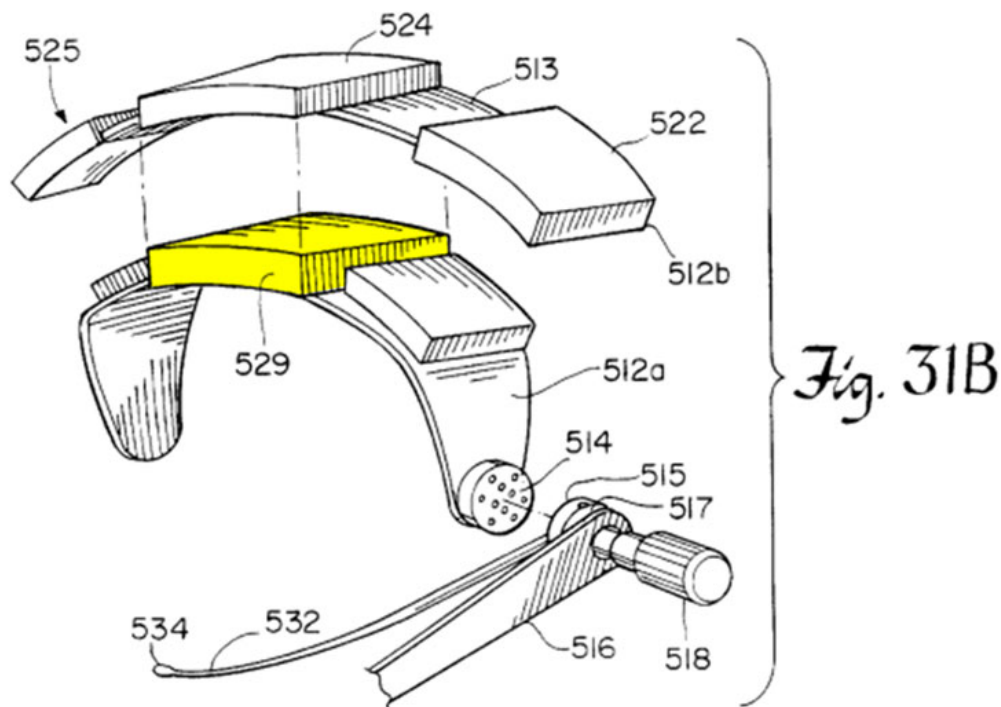
(Ronzani, Fig. 9.)

This Petition cites various embodiments of Ronzani's head-mounted device, but Ronzani teaches, and a POSITA would have found it obvious, to combine the components from these embodiments in a head-mounted display device like those in Figures 1 and 9. (Ronzani, ¶¶0005-0016, 0017; Cooperstock, ¶¶76-79.) Ronzani explains, for example, that “the particular head and/or body mounted display systems embodying the invention [are] shown by way of illustration only” and “[t]he principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.” (Ronzani, ¶0017.)

The obviously combined components are discussed further below where applicable for each element. “Combining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness.” *Boston Scientific Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009).

(a) “a head-mounted power source;” (Claim 16[a])

Ronzani discloses “a head-mounted power source” in a “self-contained” head-mounted device with internal “power supply” such as battery module **529**. (Ronzani, ¶¶0094, 0148, Figs. 1, 31B, Cooperstock, ¶¶80-81.)



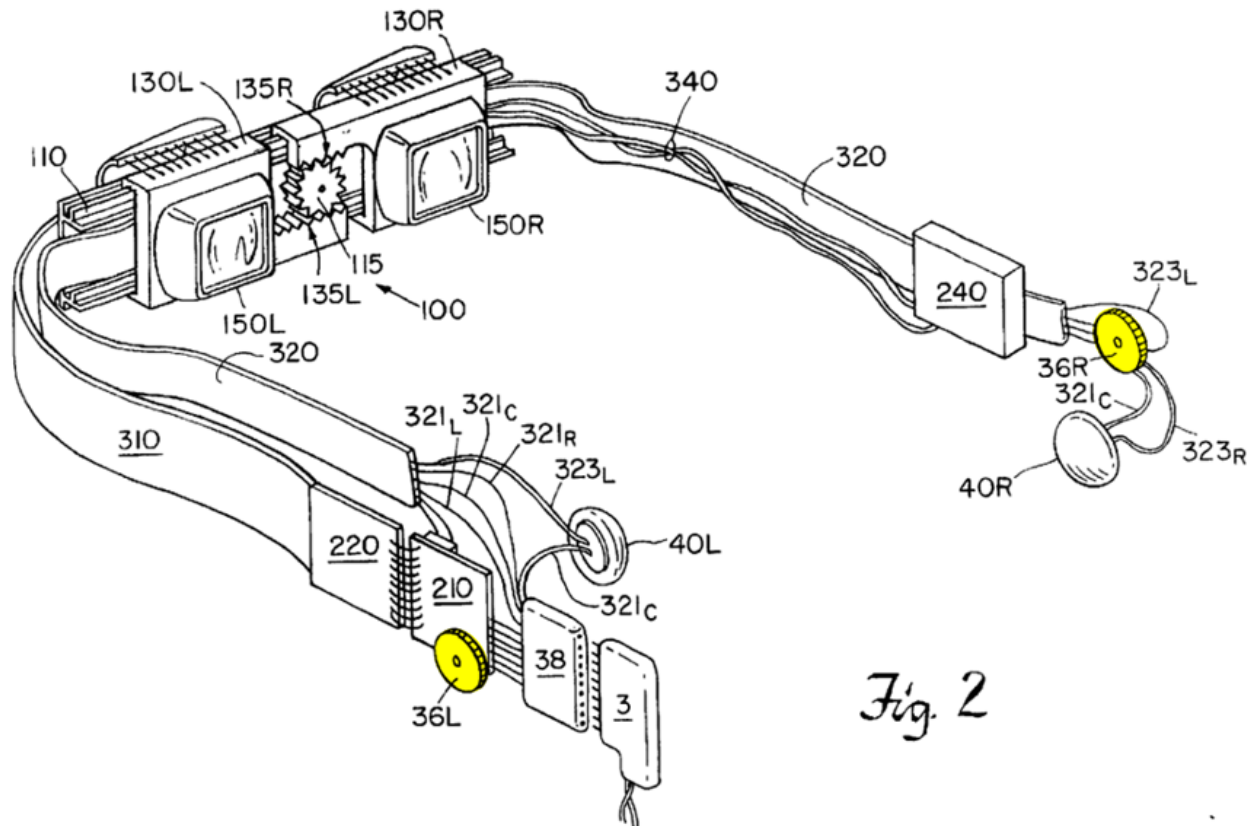
(Ronzani, Fig. 31B (highlighting added).)

Ronzani also renders obvious incorporating a head-mounted power source (such as the “integrated” power source of the Figure 1 embodiment or a battery

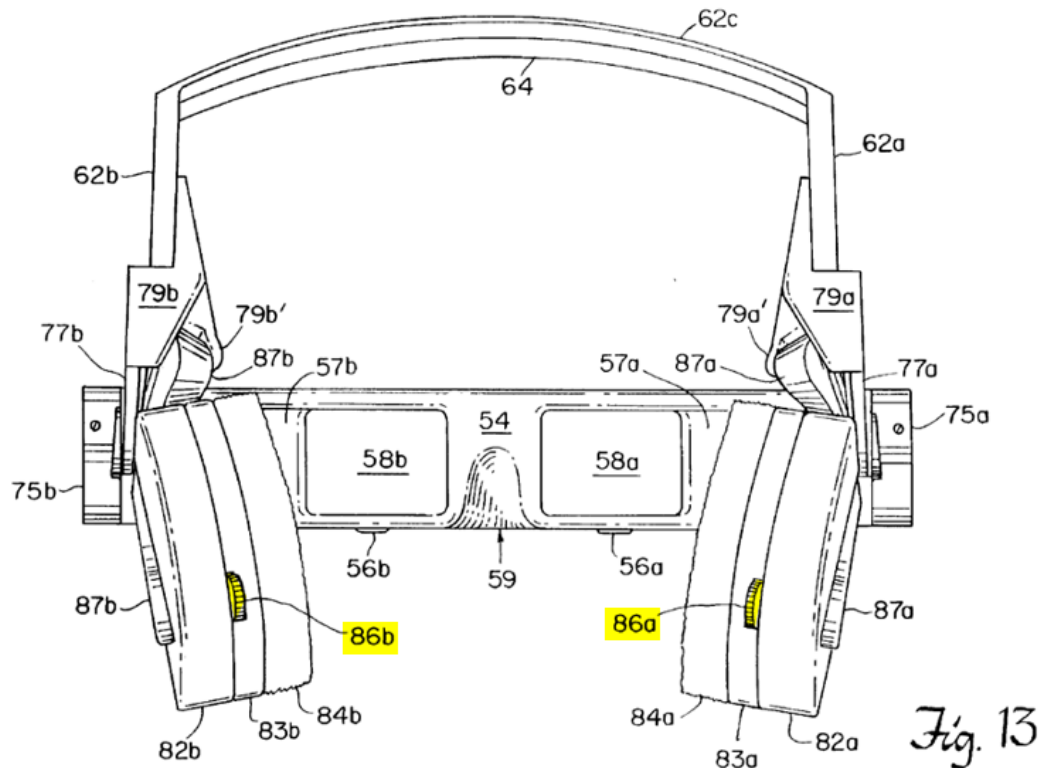
module mounted in a headband as shown in Figure 31B) for the natural convenience and benefits of a “self-contained” head-mounted display requiring “no physical connection” to an external power supply. (Ronzani, ¶0094.) A POSITA would have understood that a self-contained power supply would conveniently enable use of the device in any location, regardless of the availability of an external power source such as an electrical outlet, and by not requiring an external wire to connect to an external power source such as an electrical outlet that would potentially be cumbersome and interfere with the user’s movements. This teaching would also apply naturally to Ronzani’s Figure 9 embodiment and other embodiments. (Cooperstock, ¶82.) A self-contained power source is also consistent with Ohshima’s disclosed HMD, discussed further below, which is not described as requiring any connection to an external power source. *Boston Scientific*, 554 F.3d at 991.

(b) “a head-mounted manual input;” (Claim 16[b])

Ronzani discloses its head-mounted device comprises “**a head-mounted manual input**” in “manually adjustable controls” such as audio and video knobs. (Ronzani, ¶¶0009, 0097, 0099, 0129, Figs. 2, 13; Cooperstock, ¶¶83-86.)



(Ronzani, Fig. 2 (highlighting added), ¶0097 (“volume control **36R**” and “contrast control **36L**”).)



(Ronzani, Fig. 13 (highlighting added), ¶0129 (control knobs **86a** and **86b**).)

Ronzani also renders obvious incorporating head-mounted controls into each embodiment of a head-mounted display for usability and convenience in adjusting display and/or audio volume. It would have been obvious to include these types of manually adjustable control inputs, such as display contrast and/or speaker volume controls, in each embodiment of the head-mounted display device that includes a display and/or speaker for the obvious benefit of the user being able to easily and conveniently control the display contrast (for example, to account for different contrast levels of displayed content and different daytime or nighttime lighting conditions affecting visibility) and speaker volume (for example, to account for

different volume levels of played audio and different surrounding noise levels affecting audibility). (Cooperstock, ¶87.) *Boston Scientific*, 554 F.3d at 991.

(c) “a head-mounted processor;” (Claim 16[c])

Ronzani discloses that its head-mounted device comprises “a head-mounted processor” such as a CPU. (Ronzani, ¶¶0009, 0148, 0154-0155, 0169, Figs. 31B, 33, 34A, 35; Cooperstock, ¶¶88-93.) Ronzani teaches that its head-mounted device generally may contain a head-mounted “computer system,” which a person of ordinary skill in the art would have understood to contain a processor. (Ronzani, ¶0007.) Ronzani also teaches specific examples of a head-mounted system including a CPU. For example, Ronzani’s Figure 33 embodiment contains a CPU inside its headband **512**. (Ronzani, ¶0154 (“The CPU and video drive circuitry are fabricated as an integral part of the head band **512**”).)

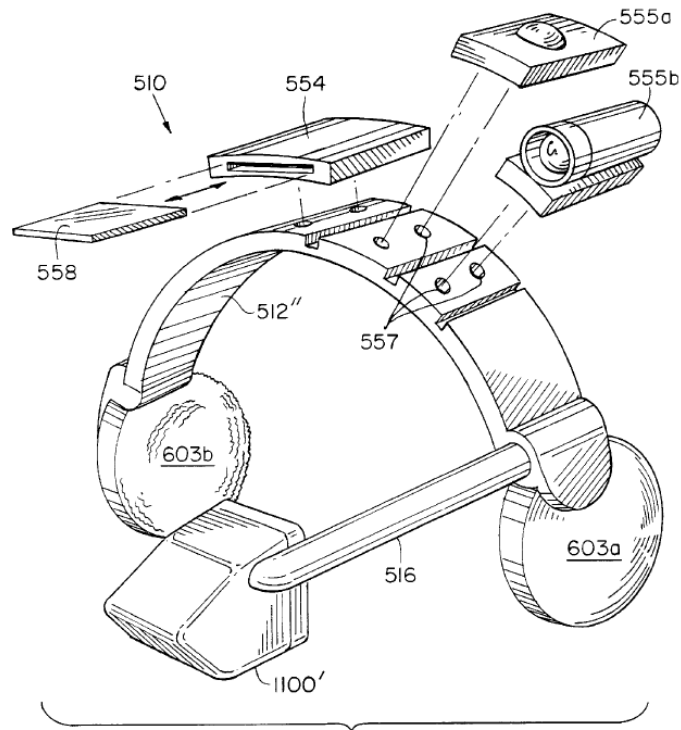
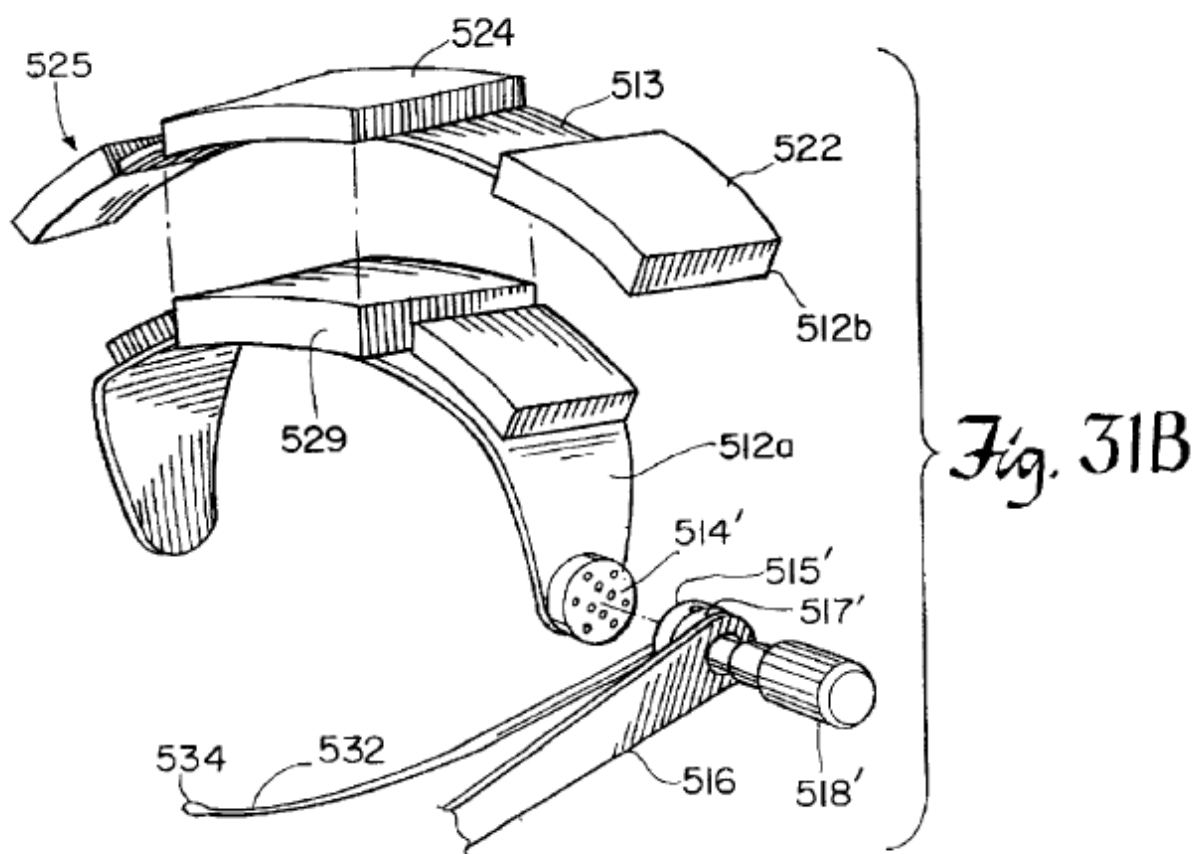


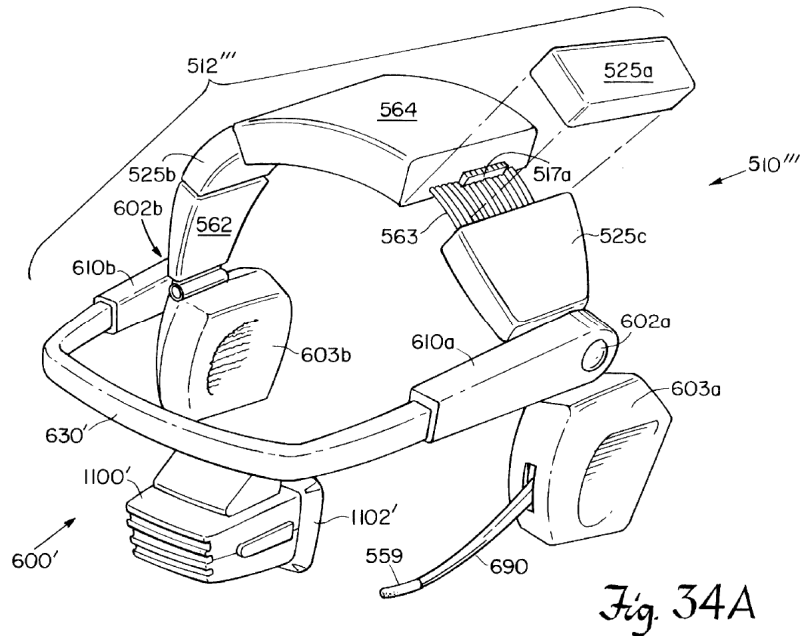
Fig. 33

(Ronzani, Fig. 33.)

Ronzani similarly describes other head-mounted device embodiments containing a CPU inside the headband, as shown in Figures 31B and 34A.



(Ronzani, Fig. 31B, ¶0146 (“The computing assembly **512b** includes a CPU . . .”).)



(Ronzani, Fig. 34A, ¶0155 (“The head band **512'''** includes a CPU, a disk drive **564** and expansion modules **525a**, **525b**, **525c** all interconnected together by a flexible bus **563**.”).)

Ronzani also illustrates in Figure 35 a functional block diagram for a head-mounted computer architecture that includes a CPU and may also include additional microprocessors in expansion modules:

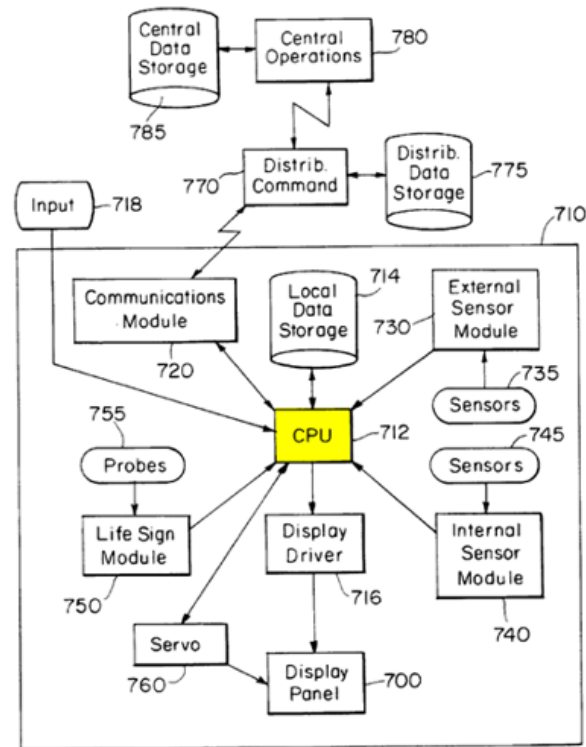


Fig. 35

(Ronzani, Fig. 35 (highlighting added), ¶0169.)

Ronzani also renders obvious incorporating a CPU into a head-mounted display for the advantages of self-contained processing capability. A POSITA have found it obvious that a head-mounted display device, including those in the Figure 1 and Figure 9 embodiments, would include a head-mounted processor for the natural convenience and benefits that the device includes capability to process input/output, communications, video/image processing, and other processing as may be needed. A POSITA would have understood that implementing a processor in the head-mounted device would make the device more convenient for the user than requiring a connection to an external device or component containing a processor,

enabling use of a self-contained device in any location without requiring wiring to an external processing system that could be cumbersome and interfere with the user's movements. (Cooperstock, ¶¶94.) *Boston Scientific*, 554 F.3d at 991.

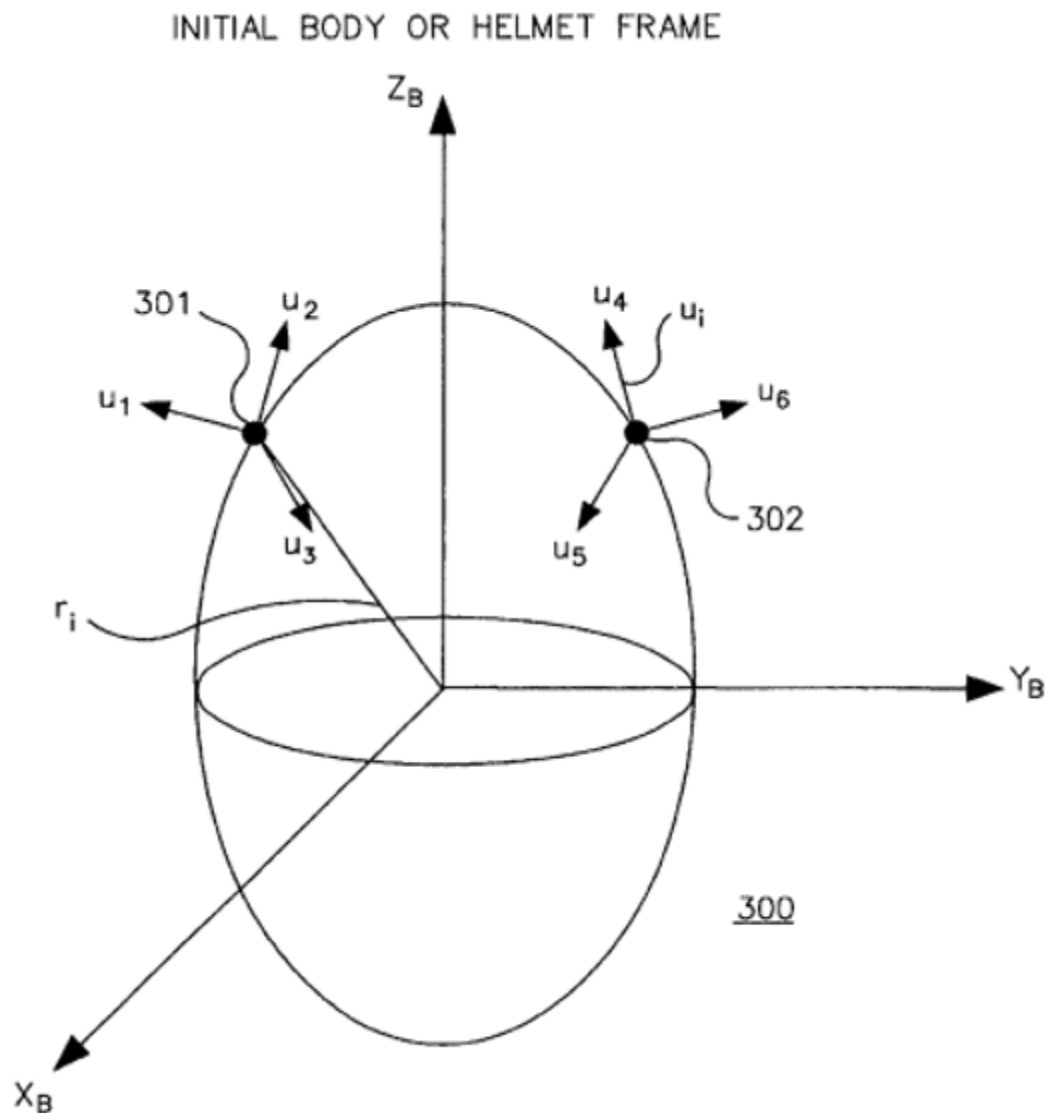
(d) “a head-mounted movement sensor;” (Claim 16[d])

Ronzani with Horton discloses and renders obvious the head-mounted device comprising “a head-mounted movement sensor.”

Ronzani contemplates numerous applications for its head-mounted displays, including “virtual reality,” simulations, and entertainment though does not provide full details of implementations for those applications. (Ronzani, ¶¶0002, 0005, 0011, 0170; Cooperstock, ¶¶95-96.) Horton, which also discloses systems such as head-mounted displays for “virtual” reality and “simulation” applications, further discloses and motivates incorporating into a head-mounted device a **movement sensor** comprising accelerometers to track the user's head movements in “virtual” reality and “simulation” applications. (Horton, 1:13-22, 2:16-35, 3:41-62, 5:7-15.) Horton explains the need for accurate determination of the user's position and orientation for use in virtual reality or other simulated environments created by computer. (Horton, 1:13-22.) To address that stated need, Horton teaches the use of accelerometers to determine and track position and orientation. Horton teaches that accelerometers can be positioned to track a head-mounted display unit. (Horton, 2:16-35 (system “uses accelerometers to measure acceleration” of “a moveable

object (e.g., a head-mounted display unit, or a wristband/data glove)).) The accelerometers disclose a “**movement sensor**” to sense “movement,” such as on a head-mounted display (HMD): “For example, the tracking invention could be implemented on an HMD and two data gloves to track head and hand movement of a user.” (Horton, 3:41-62.)

Horton’s Figure 2 depicts movement sensors (**301-302**) mounted on a head-mounted display (**300**):



(Horton, Fig. 2)

Rationale and Motivation to Combine (Ronzani and Horton). It would have been obvious to combine Horton's movement-tracking accelerometers with Ronzani's head-mounted display disclosures, predictably rendering obvious Ronzani's head-mounted device that included one or more accelerometers to sense movement ("head-mounted movement sensor"). (Cooperstock, ¶102.)

Ronzani and Horton are analogous references to the '716 patent in the field of portable user-worn devices including head-mounted displays for virtual-reality and pertinent to the problems the '716 patent addresses. (Cooperstock, ¶103; '716, 1:30-32, 2:9-18, 2:32-43; Ronzani, ¶¶0002, 0005, 0170; Horton, 2:15-35.)

A POSITA would have been motivated to make the combination. As discussed above, Ronzani contemplates head-mounted “virtual reality” and “simulation” applications. (Ronzani, ¶¶0002, 0005, 0170.) Horton teaches that virtual reality systems “must continuously determine with a high degree of accuracy the position and orientation of a user (or part of the user e.g., head or hand) relative to a ‘virtual world’ or simulated environment in which the user operates.” (Horton, 1:13-22.) To address this need, Horton teaches motion-sensing accelerometers that are suitably integrated into a body-worn moveable object such as “a head-mounted display unit” to sense motion. (Horton, 2:16-29.) Horton provides express motivations to combine its accelerometers into head-mounted display units (or other body-worn units) because they are both (1) “easily integrated” into electronic systems, and (2) easily attached to a human user without interfering with body movements. (Horton, 2:29-35 (“Accelerometers are easily integrated into electronic componentry (e.g., using silicon chip technology). Thus, the tracking system of the present invention can be embodied in a small, lightweight unit that is easily attached to a human user without significant interference to natural body movements.”).)

In view of these teachings, a POSITA would have appreciated that implementing Horton's accelerometer motion sensing functionality in a head-mounted display device of Ronzani would increase the available functionality and utility of the device, making it useful for a wider variety of applications for which it may be useful to track motion sensing of the head-mounted device (or the user's head). For example, implementing the functionality would make Ronzani's head-mounted device suitable for virtual reality and/or augmented reality applications that require tracking of the user's head or headset, in addition to other applications that do not require such tracking. In other words, it would have been obvious to implement Horton's functionality as a beneficial and useful available feature in Ronzani's device even if not every application of Ronzani's device would necessarily make use of that functionality. This type of design consideration is and was standard and common in product and technology design in the relevant field, where not every application will use every available feature of a device. (Cooperstock, ¶105.)

Furthermore, a POSITA would have appreciated the natural harmony between Horton's teaching and motivation that its "[a]ccelerometers are easily integrated into electronic componentry (e.g., using silicon chip technology)" (Horton, 2:29-35) and Ronzani's teachings to implement a head-mounted display device with a head-

mounted computer system including a CPU and other electronic componentry, as discussed previously for claim 16[c]. (*E.g.*, Ronzani, ¶¶0007, 0148, 0154-0155, 0169, Figs. 31B, 33, 34A, 35.) Ronzani also explicitly contemplates that its head-mounted computer system including CPU can receive and process data from “sensors” via “sensor modules,” which would naturally encompass motion sensors such as accelerometers. (Ronzani, ¶¶0166-0169 (“The sensor modules **730**, **740**, **750** receive data from associated detectors and format the data for transmission over the bus **513** to the CPU **712**.”).) These teachings would be understood to apply as potential implementations for Ronzani’s various embodiments, including the Figure 1 and Figure 9 embodiments. Ronzani also describes that the head-mounted computer system may include multiple “expansion modules” to accommodate additional components, which can communicate with the CPU over a bus. (Ronzani, ¶0148.) (Cooperstock, ¶106.)

The combination would have involved the use of a known technique (accelerometers to sense motion in a head-mounted display device for virtual reality applications) to improve a similar device (Ronzani’s head-mounted display device for use in virtual reality applications) in the same way. Moreover, because the details of implementing virtual reality applications are not a focus of Ronzani, a person of ordinary skill in the art, seeking to implement and adapt Ronzani’s teachings for virtual reality applications, naturally would have turned to Horton for its

complementary applicable teachings and motivations. (Cooperstock, ¶107.)

A POSITA would have had a reasonable expectation that the combination would have been successful. Horton teaches that its “[a]ccelerometers are easily integrated into electronic componentry (e.g., using silicon chip technology)” (Horton, 2:29-35) and Ronzani similarly contemplates implanting sensor modules and expansion modules in its head-mounted computer system as noted previously (Ronzani, ¶¶0148, 0166-0169). (Cooperstock, ¶108.)

- (e) **“a top-of-the-head mounting structure;” (Claim 16[e]) and “a behind-the-head mounting structure;” (Claim 16[f])**

Ronzani discloses that its head-mounted device includes **“a top-of-the-head mounting structure”** and **“a behind-the-head mounting structure”** consistent with the ’716 patent’s disclosure. (’716, 8:57-65, Fig. 9; Cooperstock, ¶¶109-110.) Figure 9 of the ’716 patent illustrates top-of-the-head and behind-the-head mounting components **(911-912)**:

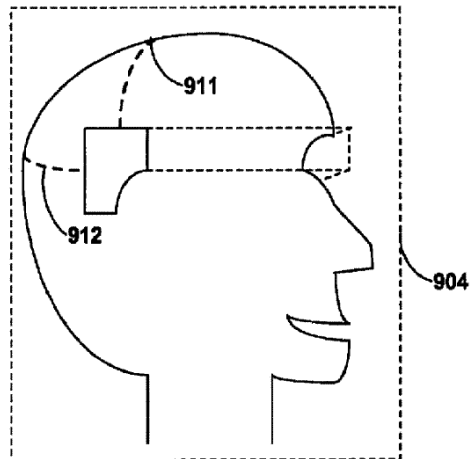


FIG. 9

('716, Fig. 9.)

For example, Ronzani's embodiments include over-the-head and back-of-the-head mountings. (Ronzani, ¶¶0009, 0122, Figs. 46C, 49.)

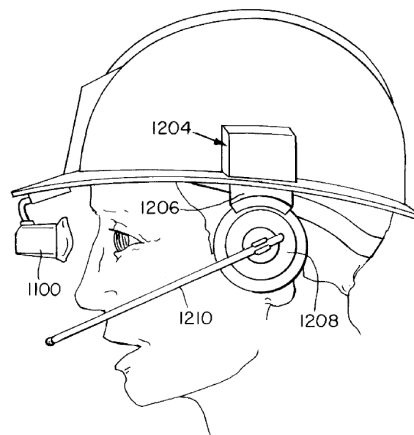


Fig. 46C

(Ronzani, Fig. 46C.)

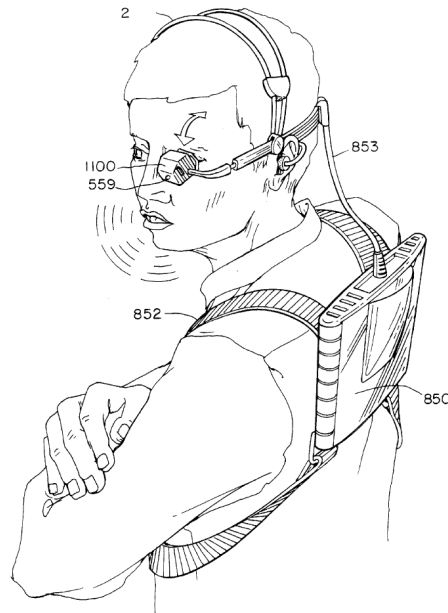


Fig. 49

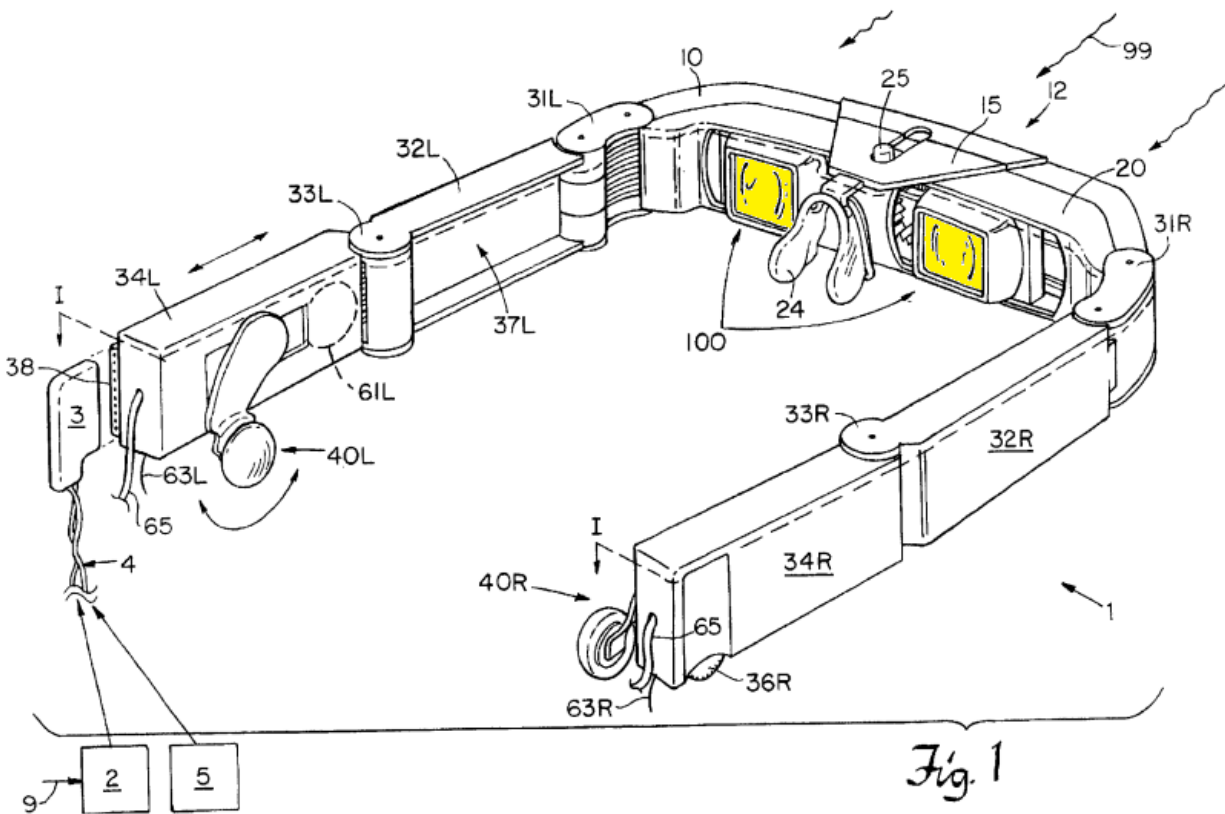
(Ronzani, Fig. 49.)

Ronzani further teaches general applicability of bands above and/or behind the head to position controls and distribute component weight evenly, rendering obvious head-top and behind-head mountings for its head-mounted displays. (Ronzani, ¶0009 (“Positioning of the electronics and controls within the arms or bands permits a more desirable distribution of weight evenly about the sides or top of the user’s head.”).) In view of Ronzani’s teachings, a POSITA would have understood that it would be obvious to use bands extending both “above” and “behind” the head of the user for the purpose of providing “a more desirable distribution of weight evenly about the sides or top of the user’s head” based on the electronics and controls to be positioned within the bands for a given implementation. (Ronzani, ¶0009.) The embodiments shown in Figures 46C and

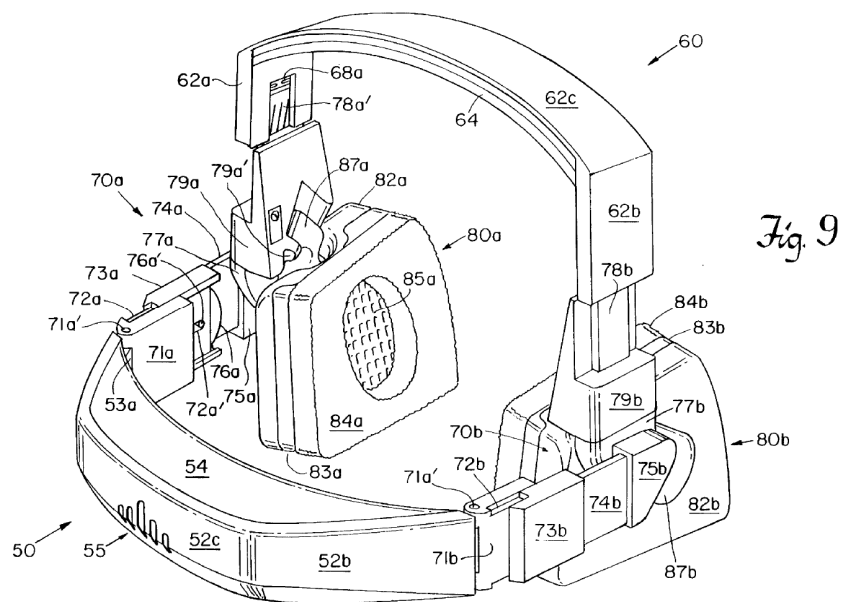
49 would have been understood to provide example illustrations of configurations using both top-of-the-head and behind-the-head mounting structures. In view of these teachings and motivations, a POSITA would have found it obvious to include both top-of-the-head and behind-the-head mounting components, including to add a behind-the-head mounting band to any of the embodiments such as those shown in Figures 1 and 9, as an obvious implementation design choice to help securely position the product on the user's head and to help distribute weight evenly around the user's head for the various components contained in the headband in each implementation, which could be located in either the over-the-top and/or behind-the-head mounting structures. (Cooperstock, ¶¶113-115.) *Boston Scientific*, 554 F.3d at 991.

- (f) **“a head-mounted display operable to cover at least a portion of at least one eye of a wearer of said head-mounted device, wherein a first virtual object is operable to be displayed on said head-mounted display and controlled with manual input and a second virtual object is operable to be displayed on said head mounted display and controlled autonomously by said processor; and” (Claim 16[g])**

Due to its length, this element is addressed in parts. First, **Ronzani** discloses **“a head-mounted display operable to cover at least a portion of at least one eye of a wearer of said head-mounted device”** with various displays covering one or both eyes. (Ronzani, ¶¶0092, 0119, 0129, Figs. 1, 9, 13.)



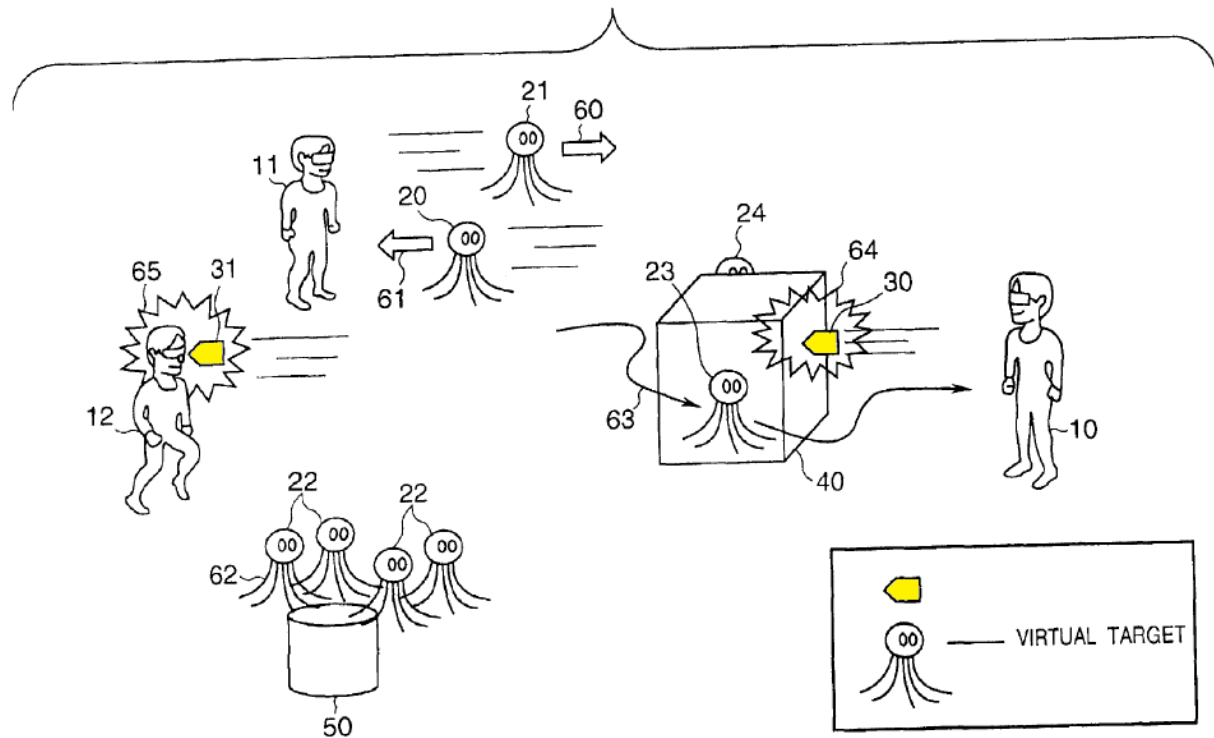
(Ronzani, Fig. 1 (highlighting added).)



(Ronzani, Fig. 9.)

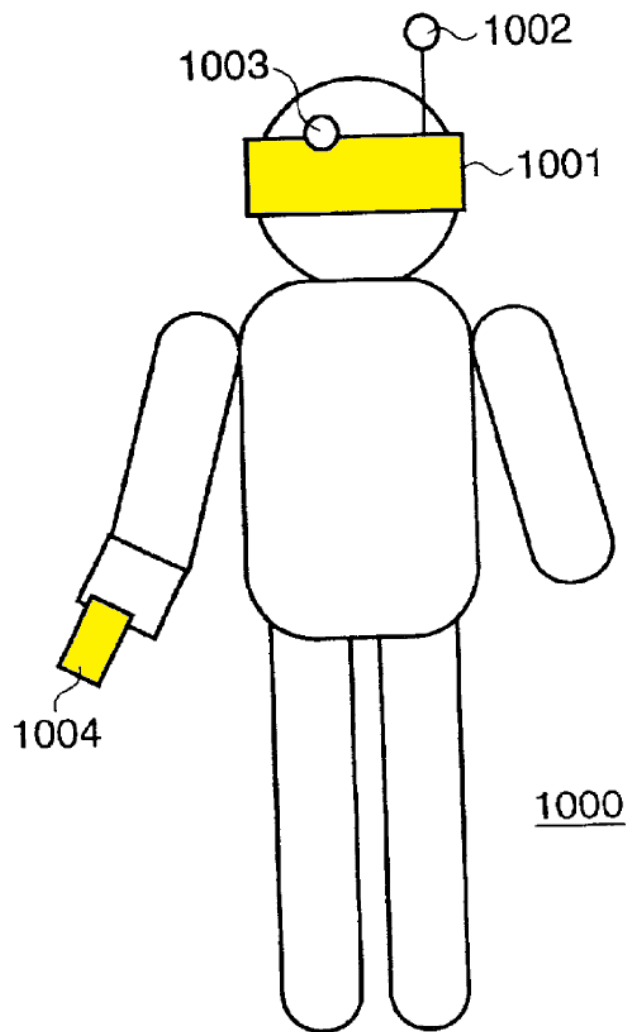
Ronzani with Ohshima further discloses and renders obvious “**wherein a first virtual object is operable to be displayed on said head-mounted display and controlled with manual input and a second virtual object is operable to be displayed on said head mounted display and controlled autonomously by said processor.**” Ohshima discloses displaying virtual objects of an augmented reality video game, such as “spacemen” and “virtual bullets.” Specifically, Ohshima discloses a “virtual bullet” (“**a first virtual object**”) is both “**displayed on said head-mounted display**” and “**controlled with manual input**” (controlled with the user’s manual input using a gun-shaped controller). (Ohshima, 7:17-38 (describing how “virtual bullet” is displayed and manually controlled by user: an image generation unit “generates virtual images such as targets, bullets, and the like,” a “mixed image” is generated including the virtual images, and the “mixed image whose matching is adjusted is output to the HMD **101** and is presented to the player”)), 6:45-47.) (Cooperstock, ¶¶123-126.)

FIG. 1



(Ohshima, Fig. 1 (highlighting added).)

Ohshima describes a player wearing an HMD (**1001**) with a gun-shaped controller (**1004**):

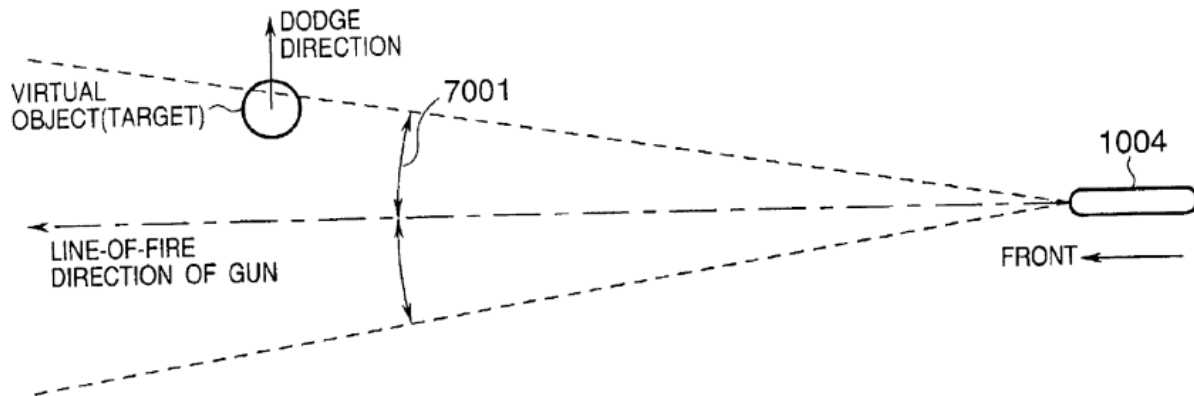


(Ohshima, Fig. 4 (highlighting added), 6:45-47.)

Ohshima's "virtual bullet" is "controlled with manual input" including (1) being "fired" by the player's "trigger" action using controller **1004**, and (2) the user's positioning of controller **1004** manually controls the bullet's line-of-fire direction.

(Ohshima, 6:57-63, 9:2-8; Cooperstock, ¶¶127-129.)

FIG. 9



(Ohshima, Fig. 9.)

Ohshima further discloses that **“a second virtual object is operable to be displayed on said head mounted display and controlled autonomously by said processor.”** For example, Ohshima describes that a “spaceman” (also called a “target”) (a **“second virtual object”**) is both **“displayed on said head-mounted display”** and **“controlled autonomously by said processor.”** Ohshima describes displaying on the head-mounted display a virtual object including one or more “spaceman” (or “target”) objects such as items **20, 21, 22, 23, and 24** in Figure 1 (reproduced above). (Ohshima, 7:17-38 (image generation unit “generates virtual images such as targets, bullets, and the like” and imagery is “presented to the player”), Fig. 1; Cooperstock, ¶130.) Each spaceman/target virtual object is **“controlled autonomously”** by the processor operating the game, based on pre-stored information and instructions in memory, without the user manual controlling

it. (Ohshima, 6:1-8 (“each virtual object makes unique movements or actions”), 11:18-30 (each virtual object target “decided its own movement pattern” and “can act with a given objective as if it had its own will”), 8:18-29 (programming for targets); Cooperstock, ¶131.)

Rationale and Motivation to Combine (Ronzani-Horton and Ohshima).

It would have been obvious to a POSITA to combine Ohshima’s virtual reality game using a head-mounted display (with virtual objects and gun-shaped controller) with Ronzani’s head-mounted display (including under the proposed combination of Ronzani and Horton), predictably resulting in Ronzani’s head-mounted display where **a first virtual object is operable to be displayed on said head-mounted display and controlled with manual input and a second virtual object is operable to be displayed on said head mounted display and controlled autonomously by the processor** (e.g., CPU) in Ronzani’s head-mounted device, as claimed. (Cooperstock, ¶¶133, 138 (“processor” implementation obvious).)

Like Ronzani, Ohshima is an analogous reference to the ’716 patent. Ohshima is also in the field of portable user-worn devices, specifically including head-mounted display devices that can be used for applications displaying “virtual” objects. (Ohshima, 1:8-13 (describing the “invention” as relating to a game which “allows a player to play a game in a mixed reality space which includes both real and virtual objects”), 6:34-36 (describing that “the player joins the game wearing a

head-mounted display device (to be abbreviated as an HMD hereinafter)).)

Moreover, Ohshima would have been reasonably pertinent to problems facing the '716 patent inventor, including components and features to include in head-mounted display devices for various applications including applications generating and displaying virtual components. (Cooperstock, ¶134.)

A POSITA would have been motivated to make the combination. As discussed above, Ronzani contemplates that its head-mounted display device can be used for applications involving “simulation” and “virtual” components, including “virtual reality,” as well as “entertainment purposes” and other applications. (Ronzani, ¶¶0002, 0005, 0170.) Ronzani also specifically contemplates the use of a “virtual reality data glove.” (Ronzani, ¶0170.) However, Ronzani does not focus on the details of the “virtual reality” and/or “entertainment” applications for which its head-mounted display device may be used and does not detail an application where the “virtual reality” glove would be used. When considering virtual reality and/or entertainment applications to be implemented using the head-mounted display device of Ronzani, as well as a hand-mounted “virtual” input device, a POSITA naturally would have looked to Ohshima’s teachings including its game with “virtual” objects and hand-mounted gun-shaped controller. Further motivating Ronzani’s desired applicability to “entertainment” applications, Ohshima teaches that its game is particularly “fun”—entertaining—for the user in multiple ways.

Ohshima specifically teaches and motivates one entertainment advantage that a **virtual object** (spaceman/target) acting **autonomously** outside the control of the user, as per claim 16[g], is a beneficial advance over the prior art because “the player experiences an illusion as if the virtual object had its own will, thus making the game more fun to play.” (Ohshima, 2:33-38; *see also id.*, 11:22-26 (“Such game allows the player to feel as if the player himself or herself existed in the mixed reality space and targets as virtual images acted by sensing the presence of the player and other real objects, thus making the game more fun to play.”).) Serving Ronzani’s desired goal of “entertainment,” Ohshima teaches and motivates that the autonomy of the virtual object makes the game more entertaining: “by determining the action of the virtual object (target) based on information other than the position or posture of the player, the game becomes more entertaining to the players.” (Ohshima, 11:66-12:2.) Ohshima also teaches and motivates another entertainment advantage that the functionality of another **virtual object** (virtual bullet) **being controlled with manual input** (via the gun-shaped controller **1004**) “has a gun shape to make the game more fun to play for the player, but is an input device serving as a user interface in practice.” (Ohshima, 6:57-59. (Cooperstock, ¶135.)

The combination would have involved the use of a known technique (Ohshima’s game application including hand-mounted gun-shaped controller) to improve a similar device (Ronzani’s head-mounted display device including hand-

mounted input for use in virtual reality and entertainment applications) in the same way. Moreover, because the details of implementing virtual reality applications are not a focus of Ronzani, a POSITA, seeking to implement and adapt Ronzani's teachings for virtual reality and entertainment applications, naturally would have turned to Ohshima for its complementary applicable teachings and motivations. (Cooperstock, ¶136.)

A POSITA would have had a reasonable expectation that the combination would have been successful. Ronzani already discloses ample system capability including a head-mounted computer system with CPU and related components as well as sensor modules and expansion modules connected to the CPU (*e.g.*, Ronzani, ¶¶0148, 0166-0169), invoking a flexible architecture designed to be expanded and modified for desired applications, and therefore it would have been considered relatively straightforward to implement the Ohshima game application and hand-mounted gun-shaped controller in connection with Ronzani's platform. (Cooperstock, ¶137.)

A POSITA would have further understood and found it obvious that when Ohshima's virtual game was implemented in combination with Ronzani's system, the activity of the virtual "spaceman" (or "target") objects would be **controlled autonomously** by the same head-mounted "**processor**" (CPU) disclosed in Ronzani as I discussed previously for Claim 16[c], executing instructions based on pre-stored

memory information to define the behavior and actions of these virtual objects. Given that Ronzani's head-mounted device already includes a CPU and related system components as noted previously, when the Ohshima game was implemented on Ronzani's platform it would have been obvious to use same processor to control the activity of the computer-controlled spacemen. (Cooperstock, ¶138.)

- (g) **“a head-mounted camera, wherein information from said head-mounted camera is operable to be displayed on said head-mounted display simultaneously with said first virtual object and said second virtual object.”**
(Claim 16[h])

Ronzani in view of **Ohshima** discloses and renders obvious this element. Ronzani teaches its head-mounted display including a **“head-mounted camera”** pointed forward in the same direction the user faces:

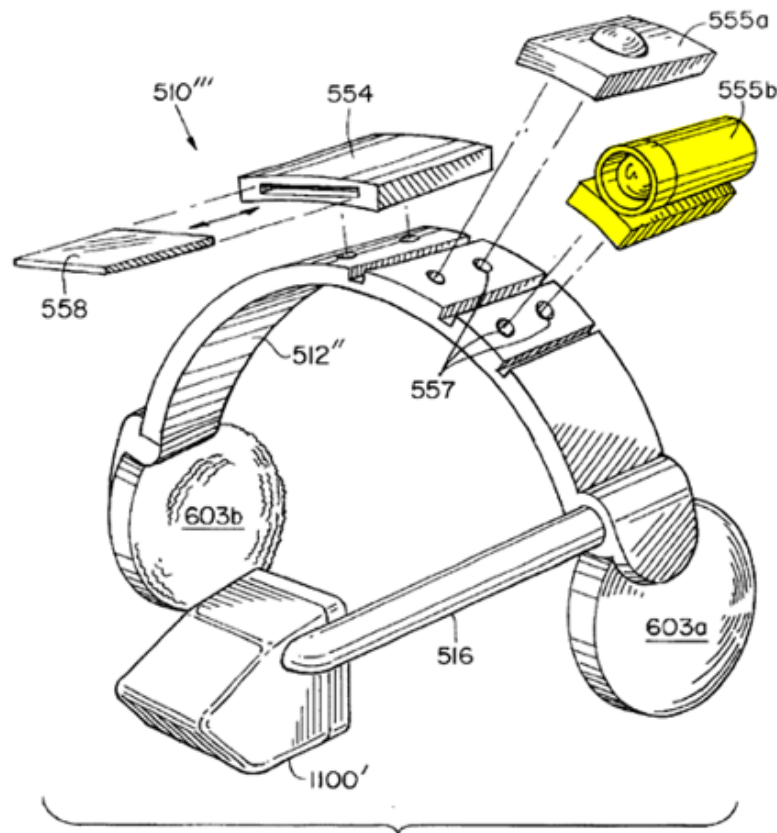


Fig. 33

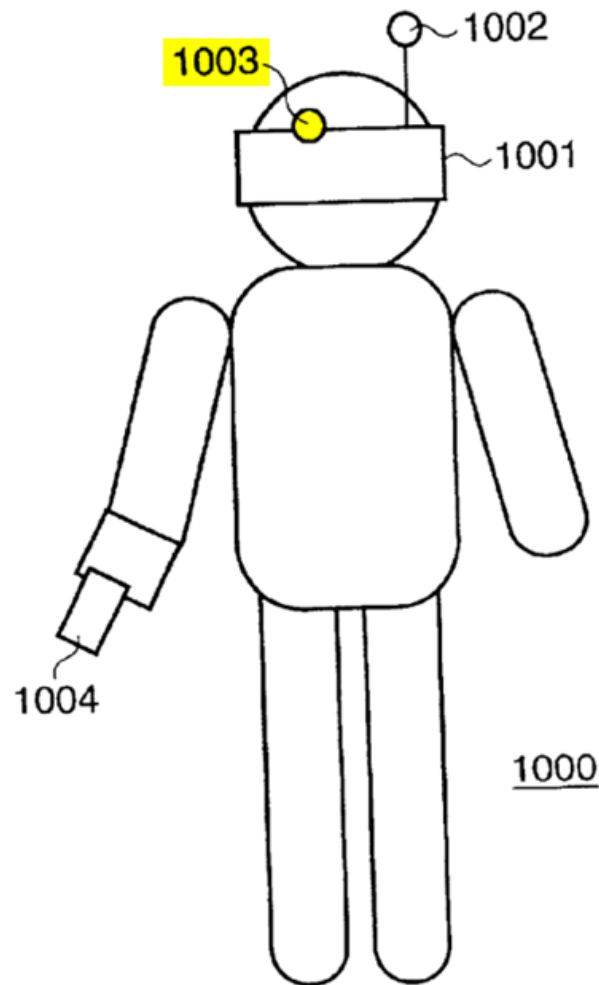
(Ronzani, Fig. 33 (highlighting added), ¶0154.)

A POSITA would have found it obvious to implement a similar head-mounted camera in Ronzani's embodiments such as the Figures 1 and 9 embodiments. (Cooperstock, ¶142.) For example, Ronzani's Figure 1 embodiment may display video from "any device that can transmit a video signal," which would be understood to obviously include a head-mounted video camera. (Cooperstock, ¶142; Ronzani, ¶0093.) Similarly, Ronzani's Figure 9 embodiment encompasses "video and audio connections" that obviously could be implemented using Ronzani's disclosed head-mounted camera to capture video, which could be positioned for example on top of

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

the headband as Figure 33 illustrates. (Cooperstock, ¶142; Ronzani, ¶0128.) *Boston Scientific*, 554 F.3d at 991.

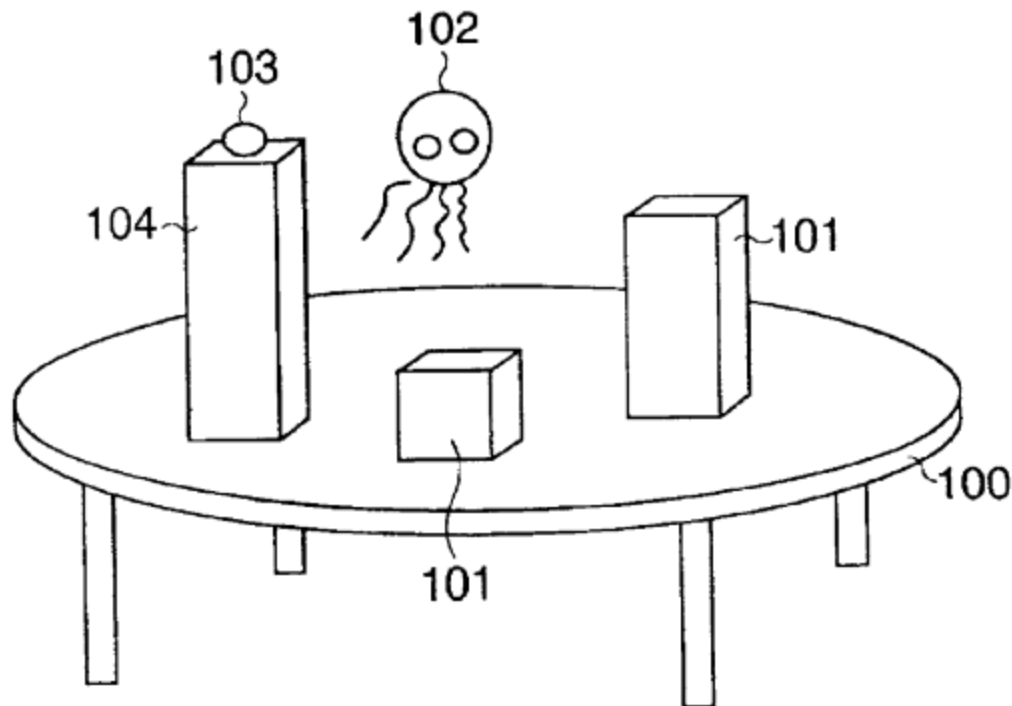
Ohshima also discloses that its HMD includes a “**head-mounted camera**,” specifically a video camera fixed to it that captures an image in front of the user. (Ohshima, 6:45-49.)



(Ohshima, Fig. 4 (highlighting added).)

Ohshima further discloses and renders obvious that “**information from said head-mounted camera is operable to be displayed on said head-mounted**

display simultaneously with said first virtual object and said second virtual object.” Specifically, Ohshima’s head-mounted camera together with display provides “a video see-through HMD” with a “mixed reality space” where the user sees a video representation of the real world overlaid by “virtual object” images such as one or more “bullets” (“**first virtual object**”) and spacemen/targets (“**second virtual object**”). (Ohshima, 6:52-56, 2:13-17, 7:17-38; Cooperstock, ¶¶145-146.) The system **simultaneously** displays the real-world and virtual imagery, such as illustrated in Figure 2 with real-world table **100**, “real objects” **101** and **104**, and “virtual object” spaceman/target **102**:



(Ohshima, Fig. 2, 6:12-38.) (Cooperstock, ¶¶147-148.) A POSITA would have understood that the “mixed image” would **simultaneously display** (1) portions of

the “real image” of the real-world scene in front of the user captured by the camera (e.g., “real objects that appear in the game” such as real objects **101** and **104**), and (2) the virtual objects such as bullets and targets (spacemen), such as virtual object **102** and any virtual bullet fired at it. (Cooperstock, ¶149.) This understanding is reinforced by Ohshima’s alternative “optical see-through HMD” embodiment, where the user sees the real world through a transparent display along with displayed virtual objects rather than seeing a video representation of the real world. (Ohshima, 2:7-9, 11:34-37, 6:52-56; Cooperstock, ¶150.)

Rationale and Motivation to Combine (Ronzani-Horton and Ohshima).

It would have been obvious to a POSITA to modify Ronzani’s teachings in view of Ohshima’s teachings of a “mixed reality” configuration that displays virtual objects alongside information captured by the head-mounted camera (including under the proposed combination of Ronzani and Horton), predictably resulting in “**a head-mounted camera, wherein information from said head-mounted camera is operable to be displayed on said head-mounted display simultaneously with said first virtual object and said second virtual object.**” The motivation to combine Ronzani and Ohshima for Claim 16[g] applies equally here. (Cooperstock, ¶151.) Ronzani discloses a head-mounted display with head-mounted camera and motivates virtual reality and entertainment applications, but does not provide details on uses of the head-mounted camera or virtual reality/entertainment applications,

naturally motivating a POSITA to consider Ohshima's complementary teachings and find it obvious to implement Ohshima's "mixed reality" game as a "fun" and "entertaining" application, as explained for Claim 16[g]. (Cooperstock, ¶151.)

A POSITA would have had a reasonable expectation of success in view of Ohshima's teaching how to implement mixed-reality combining "real" and "virtual" object imagery using a head-mounted camera (Ohshima, 7:4-38), especially considering Ronzani's teachings of CPU and associated components as well as control circuitry to handle a video source that can be a CCD camera and provides video to the head-mounted display. (Ronzani, ¶¶0148, 0150, 0154, 0162, 0166-0169, 0250.) (Cooperstock, ¶152.)

The combination would use a known technique (Ohshima's head-mounted camera providing real-world imagery alongside virtual objects in "mixed reality") to improve a similar device (Ronzani's head-mounted display including Horton's movement sensor). (Cooperstock, ¶153.)

2. Claim 18: "The apparatus of claim 16, wherein:" (Claim 18[pre])

Ronzani in view of **Horton** and **Ohshima** discloses and renders obvious the apparatus of claim 16 as explained previously.

- (a) **“said head-mounted camera is pointed in a field-of-vision of said wearer and operable to capture said information, wherein said information comprises a portion of said wearer’s actual world environment; and”**
(Claim 18[a])

Ronzani and **Ohshima** disclose and render obvious that **“said head-mounted camera is pointed in a field-of-vision of said wearer and operable to capture said information, wherein said information comprises a portion of said wearer’s actual world environment.”** As explained previously for Claim 16[h], Ronzani discloses a head-mounted camera that is pointed forward in the same direction the user faces, such as in Figure 33 depicting camera **555b** mounted on the user’s head facing forward. (Ronzani, Fig. 33, ¶0154.) As explained for Claim 16[h], it would have been obvious to implement a similar forward-facing head-mounted camera in Ronzani’s other embodiments such as the Figure 1 and Figure 9 embodiments. The same reasoning applies here. (Cooperstock, ¶157.) Ohshima also discloses that its HMD includes a video camera fixed to it that captures an image “in front of” the player. (Ohshima, 6:45-49, Fig. 4.)

A POSITA would have understood that when a given individual wears the head-mounted unit with video camera pointing straight ahead and the user is looking ahead, the camera would be **pointed in a field-of-vision of the wearer** because it would be pointed in the area of view visible by that wearer. (Cooperstock, ¶¶160-161.)

Furthermore, in the obvious combination of Ronzani and Oshima discussed previously for Claim 16[h], a POSITA would have understood and found it obvious the camera would be **operable to capture information comprising a portion of the wearer's actual world environment**, as discussed for Claim 16[h].
(Cooperstock, ¶162.)

- (b) **“said display is operable to display said information comprising said portion of said wearer's actual world environment captured by said camera simultaneously with said first virtual object and said second virtual object.” (Claim 18[b])**

Ronzani in view of Ohshima discloses and renders obvious that **“said display is operable to display said information comprising said portion of said wearer's actual world environment captured by said camera simultaneously with said first virtual object and said second virtual object.”** As explained previously for Claim 16[h], in the obvious combination of Ronzani and Ohshima, Ohshima discloses and renders obvious that the video see-through head-mounted display device displays information comprising the portion of the wearer's actual world environment captured by the camera (such as, for example, displaying imagery of real-world objects table **100**, objects **101**, and object **104**) simultaneously with the first virtual object (virtual bullet) and second virtual object (target/spaceman). (Cooperstock, ¶164.)

B. Ground 2: Claims 1 and 8 Are Obvious Over Ronzani in view of Horton, Natoli, and Peli.

1. Independent Claim 1: “An apparatus comprising:” (Claim 1[pre])

Ronzani discloses a head-wearable apparatus as explained below.

(a) “a head-wearable device comprising at least one housing, said at least one housing comprising:” (Claim 1[a])

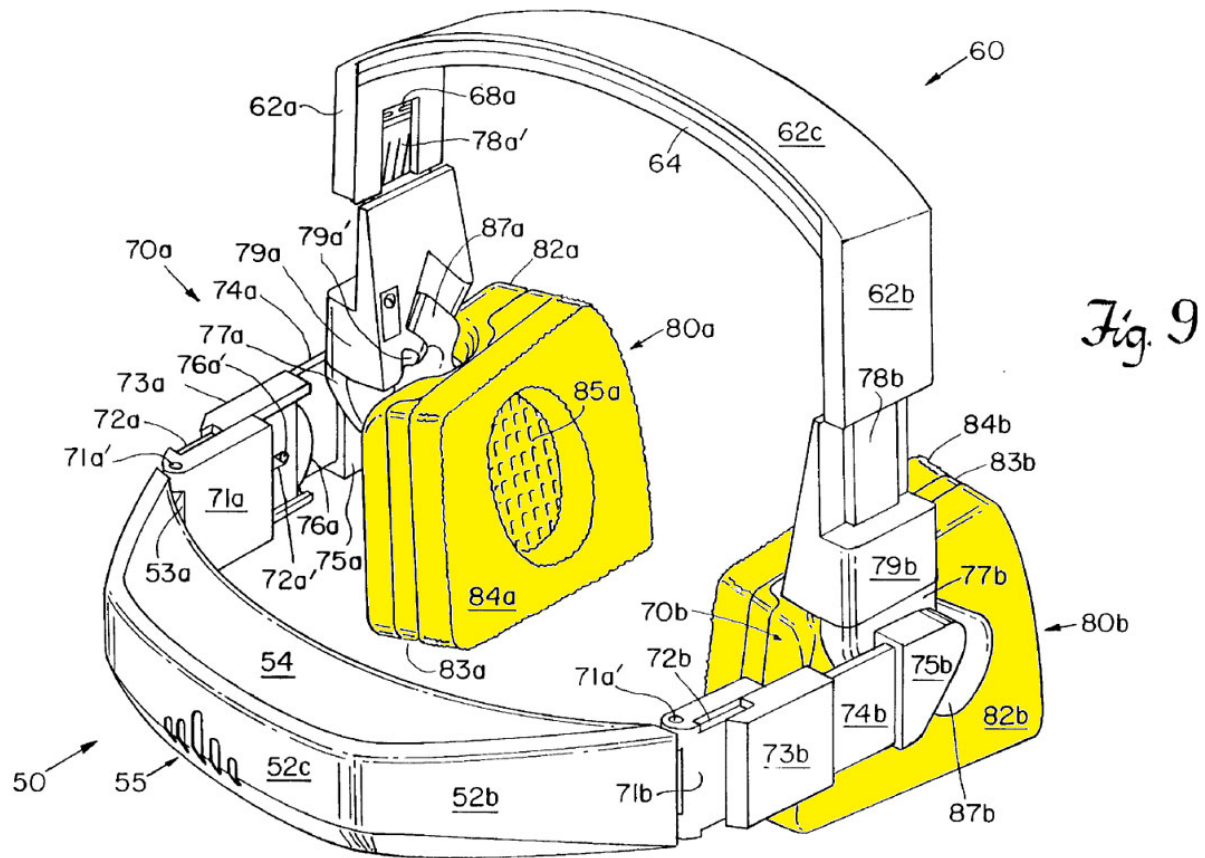
Ronzani discloses multiple “head-wearable device” embodiments comprising “at least one housing,” such as one or more housing components containing display(s), camera, CPU, speakers, and microphone as discussed further below for each element. Ronzani teaches multiple embodiments of head-mounted display devices that each include **at least one housing** to accommodate various components. Ronzani’s head-mounted display may be “constructed of plastic or some other light-weight housing material.” (Ronzani, ¶¶0092, 0117, Fig. 1; Cooperstock, ¶167.)

As explained for Claim 16[pre] previously, Ronzani’s Summary of the Invention section teaches “head mounted displays” comprising various components “for numerous applications including commercial, industrial and entertainment purposes.” (Ronzani, ¶¶0005-0016.) The same discussion from Claim 16[pre] applies to claim 1 regarding Ronzani’s teachings of multiple embodiments, including those in Figures 1 and 9, and motivations why a POSITA would have

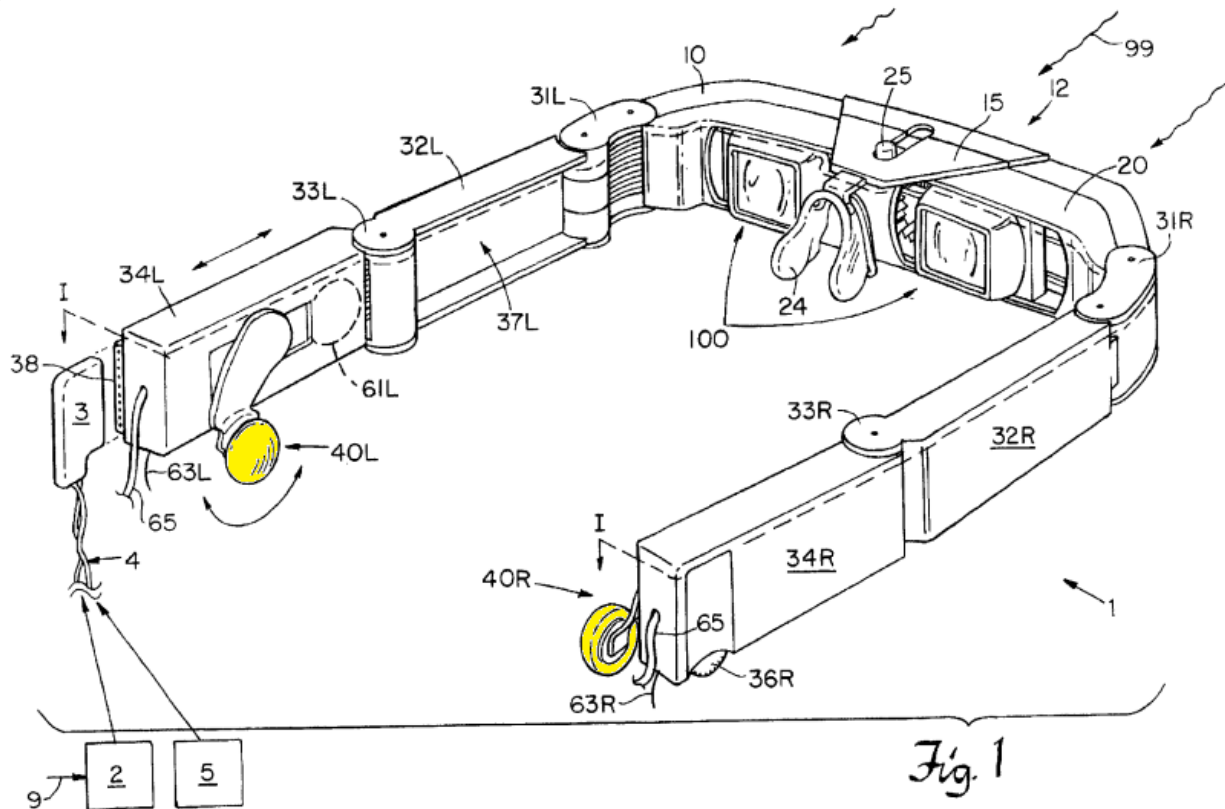
found it obvious to implement the disclosed components and features of Ronzani's embodiments in each head-mounted display. (Cooperstock, ¶168.) *Boston Scientific*, 554 F.3d at 991.

(b) “a speaker” (Claim 1[b])

Ronzani discloses “a speaker” in the at least one housing of the head-wearable device. Ronzani's head-mounted displays may include an “audio system” with speakers such as earphones/headphones to provide an audio signal. (Ronzani, ¶¶0013, 0093, 0096-0097, 0118, 0154; Cooperstock, ¶¶169-170.) Ronzani discloses a housing containing each speaker, such as plastic surrounding earphone/headphone “speaker assembly” components:



(Ronzani, Fig. 9 (highlighting added), ¶0118 (“speaker assembly” items **80a-80b**).)



(Ronzani, Fig. 1 (highlighting added), ¶¶0096-0097 (earphones **40L-40R**).)

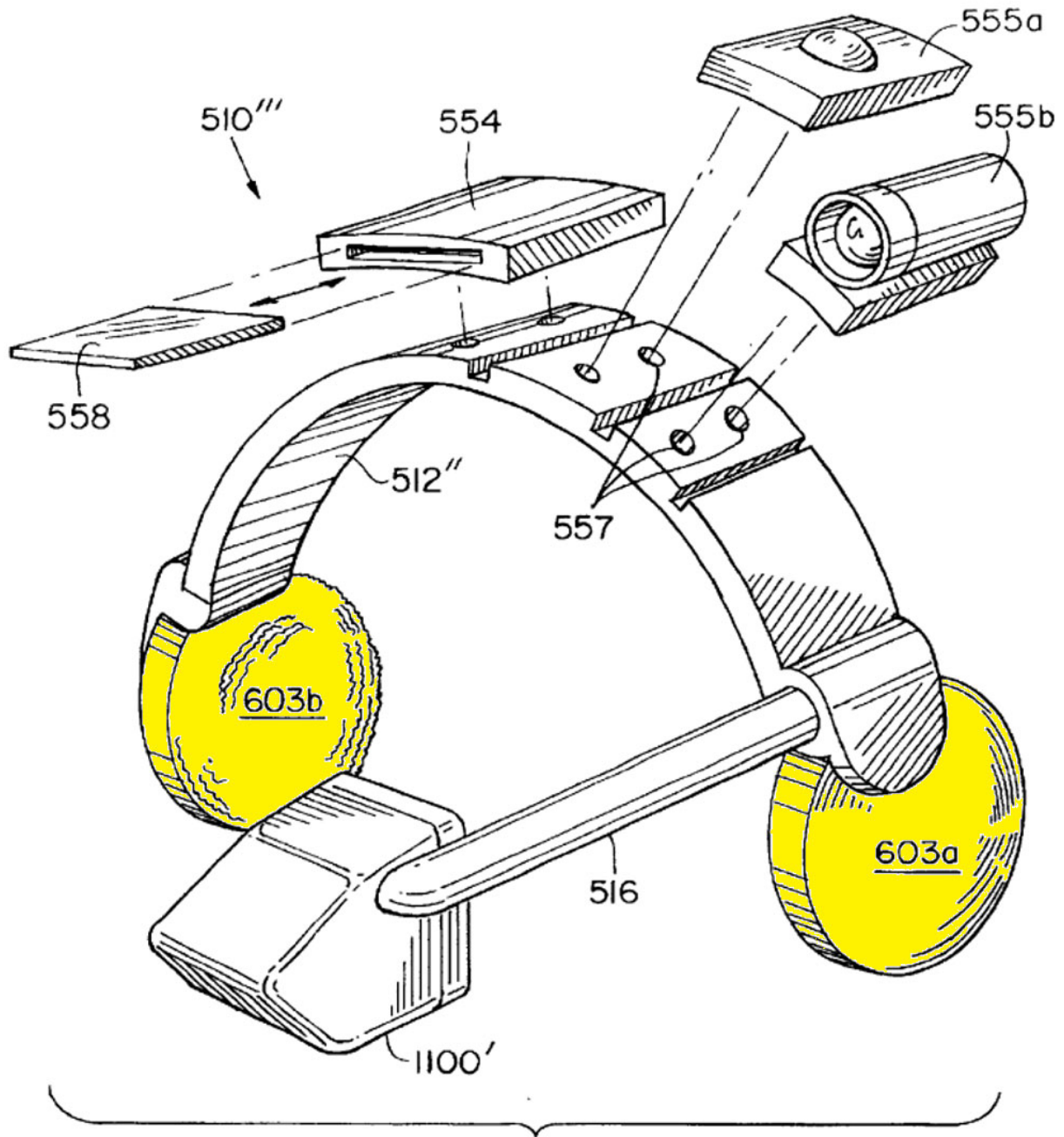


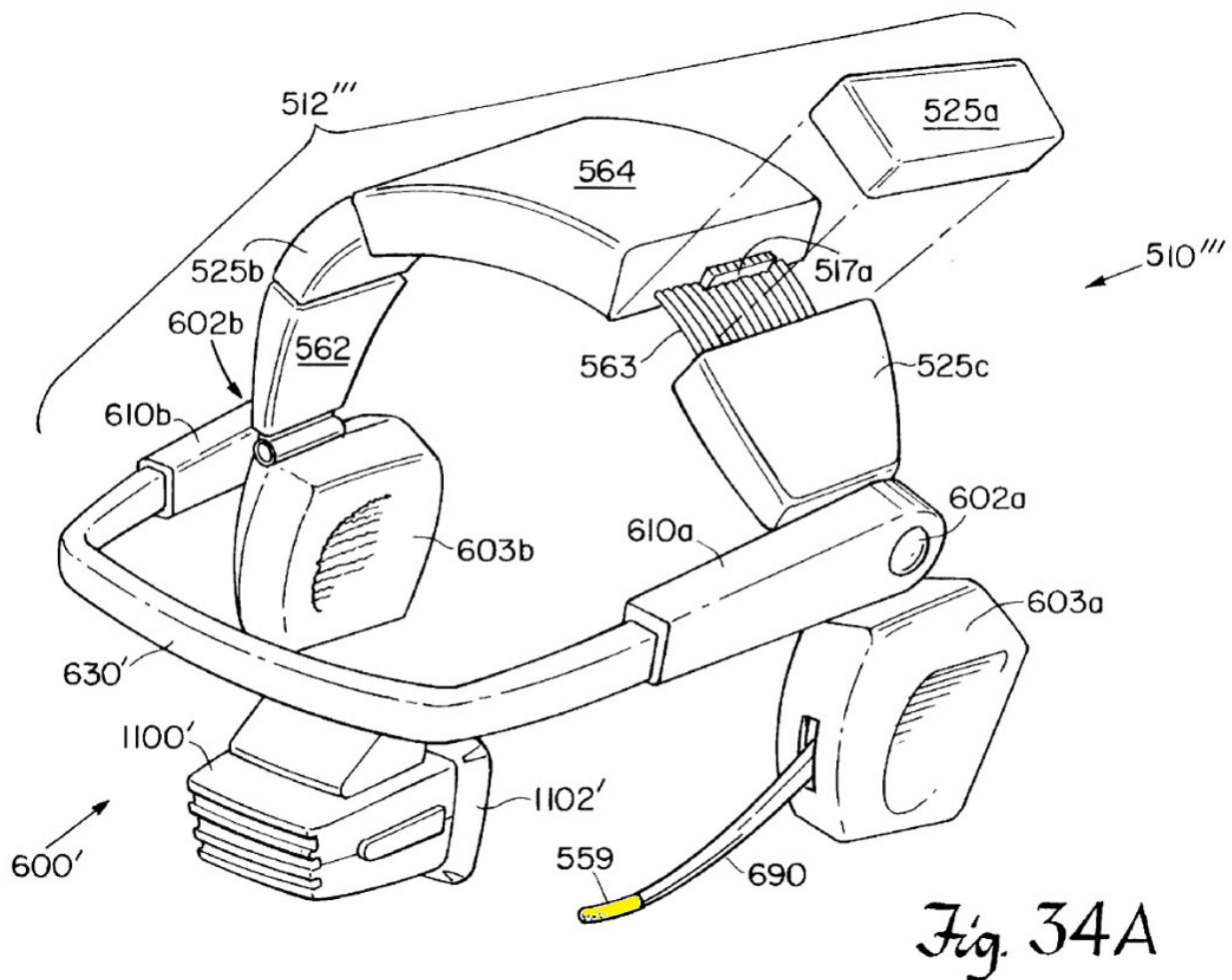
Fig. 33

(Ronzani, Fig. 33 (highlighting added), ¶0154 (headphones **603a-603b**).)

A POSITA would have found it obvious to include a speaker in at least one housing of the head-mounted apparatus, such as those discussed above in the Figure 1, Figure 9, and other embodiments, for the obvious benefit of enabling playing audio to the wearer for applications that involve audio (for example, entertainment and/or virtual reality games or other applications that play sounds to the user and/or permit the user to communicate through a microphone and headphones/earphones). (Cooperstock, ¶179.) Ronzani teaches, for example, that its head-mounted system may include a communication module for transmitting and receiving audio signals. (Ronzani, ¶0165.) A POSITA would have understood from Ronzani’s teachings of audio-related components and features that incorporating speakers in a housing connected to the head-mounted display device would have been an obvious design choice. (Cooperstock, ¶179.) *Boston Scientific*, 554 F.3d at 991.

(c) “a microphone; and” (Claim 1[c])

Ronzani discloses “a microphone” in the at least one housing of the head-wearable device. For example, Ronzani discloses that the head-wearable device can include a microphone attached to one of the earphones, as illustrated in Figure 34A (microphone **559**).



(Ronzani, Fig. 34A (highlighting added) (microphone **559**), ¶0156.) A POSITA also would have understood and found it obvious to house the microphone itself (including sound-receiving diaphragm and other sensitive components) within a protective housing rather than having the sensitive diaphragm and other components directly exposed, consistent with Ronzani's depiction of the smooth surface of microphone **559** in Figure 34A. (Cooperstock, ¶180.)

In view of Ronzani's teachings, a POSITA would have understood that that a microphone contained in a housing would be obvious to include in a head-mounted device (including, *e.g.*, Ronzani's Figures 1 and 9 embodiments) for multiple purposes, including enabling voice-activated commands and enabling communication by voice such as in telephone communications. (Cooperstock, ¶¶181-184.) Ronzani teaches multiple uses for a microphone in the head-mounted device, including audio communication by the wearer and voice-activated commands. (Ronzani, ¶¶0007, 0170, 0165.) As further explained previously for Claim 1[b], a person of ordinary skill in the art also would have found it obvious to include a microphone along with a speaker in at least one housing of the head-mounted apparatus, such as the microphone embodiment disclosures discussed above, for the obvious benefit of enabling the wearer of the device to communicate and/or issue voice-activated commands in applications that involve audio. (Cooperstock, ¶184.) *Boston Scientific*, 554 F.3d at 991.

(d) “a movement sensor, wherein said movement sensor comprises an accelerometer;” (Claim 1[d])

Ronzani in view of **Horton** discloses and renders obvious that the head-wearable device comprises in its at least one housing “**a movement sensor, wherein said movement sensor comprises an accelerometer**” for the same reasons these references disclose and render obvious that the head-mounted device includes “**a head-mounted movement sensor**” that comprises one or more accelerometers as

explained previously for Claim 16[d]. (Cooperstock, ¶185.) Horton discloses and renders obvious that its one or more accelerators would be contained in a **housing** to protect its sensitive internal circuitry, such as being “embodied in a small, lightweight unit that is easily attached” and optionally “integrated into electronic componentry.” (Horton, 2:16-35; Cooperstock, ¶185.)

(e) **“a manual input operably coupled to said head-wearable device;” (Claim 1[e])**

Ronzani discloses and renders obvious **“a manual input operably coupled to said head-wearable device”** for the same reasons as Ronzani discloses and renders obvious **“a head-mounted manual input”** as described above for Claim 16[b]. Each disclosed head-mounted manual input, including for the Figure 1 and 9 embodiments, is operably coupled to the head-wearable device—physically connected to it and operable to impose control (*e.g.*, controlling speaker volume or display contrast). (Ronzani, ¶0097, Fig. 2 (volume control **36R** and contrast control **36L**), ¶0129, Fig. 13 (control knobs **86a** and **86b** for display contrast and speaker volume).) Furthermore, in embodiments including head-mounted speaker(s) per Claim 1[b], such as headphones/earphones, it would have been obvious to include a head-mounted manual volume control as disclosed in Ronzani and discussed for Claim 16[b]. (Cooperstock, ¶186.)

(f) “wherein said head-wearable device further comprises:”
(Claim 1[f])

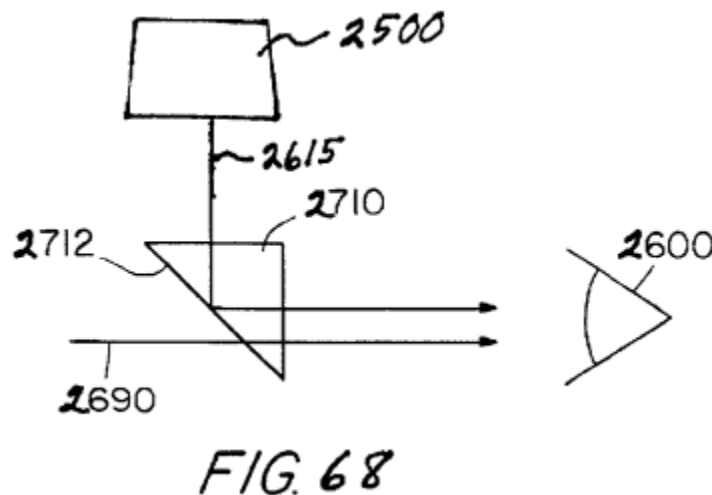
(1) “a display operable to cover at least a portion of at least one eye of a wearer of said head-wearable device, wherein said display is operable to display a virtual object and to allow said wearer of said head-wearable device to view, simultaneously with said virtual object, a portion of said wearer’s actual world environment; and” (Claim 1[f][1])

Ronzani in view of Natoli discloses and renders obvious that the head-wearable device further includes “a display operable to cover at least a portion of at least one eye of a wearer of said head-wearable device, wherein said display is operable to display a virtual object and to allow said wearer of said head-wearable device to view, simultaneously with said virtual object, a portion of said wearer’s actual world environment.”

Both “video see-through” and “optical see-through” HMD displays were well-known in the prior art. Generally, an “optical see-through” HMD permits the wearer to see the actual world environment through a transparent or semi-transparent display screen, and imagery (such as virtual objects) can be displayed overlaying the real-world environment. Generally, a “video see-through” HMD displays a video representation of a real-world scene. (Cooperstock, ¶190.)

Ronzani teaches optical see-through (also called “direct view display”) embodiments with “transparent” or “partially transmissive” displays covering one or both eyes, where an image is overlaid onto the display and the wearer can also

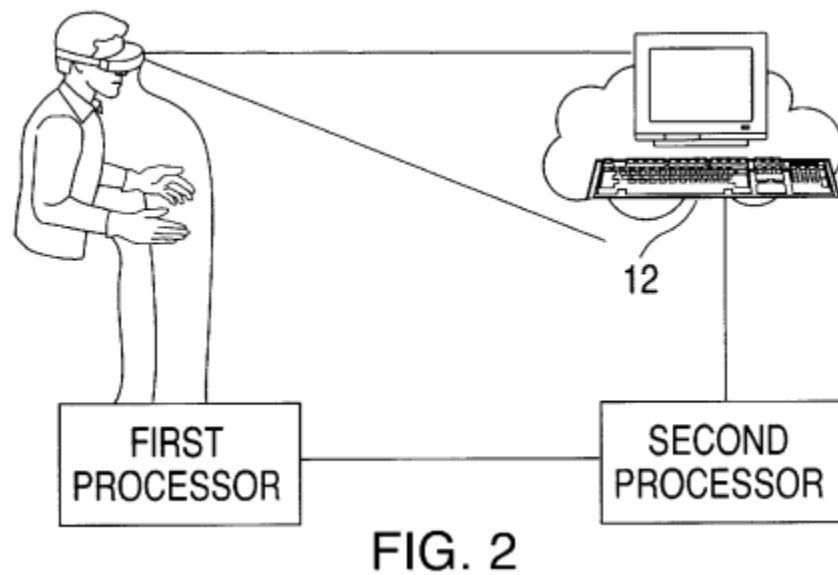
see the actual world environment through the display. (Ronzani, ¶0011, 0211, 0275-0276, 0279-0280, Figs. 47A-47D, 65-70.) Ronzani further teaches overlaying an image on the optical see-through display where “the image created by the display device **2500** appears to the viewer to float in the viewer’s field of vision.” (Ronzani, ¶0280.) Ronzani illustrates this in Figure 68 showing incoming light (**2690**) seen by the human eye (**2600**) along with an image (**2615**) from a display device (**2500**).



(Ronzani, Fig. 68.)

Ronzani in view of Natoli renders obvious the display of a “**virtual object**” on the transparent see-through display. Ronzani teaches that a user interface for its head-mounted display device can be “a virtual keyboard using motion sensitive gloves.” (Ronzani, ¶0007.) Ronzani further teaches that an input device can be “a virtual reality glove.” (Ronzani, ¶0170.) Ronzani does not expressly describe the functionality of the “virtual keyboard ” and “virtual reality data glove.” A POSITA

would have understood that one obvious way to implement these features would be to display an image of a virtual keyboard on Ronzani's head-mounted display, with which the user could interact by using one or two motion-sensitive gloves. (Cooperstock, ¶200.) This functionality is described, for example, in Natoli. Natoli discloses the display of a virtual keyboard—a “**virtual object**” as claimed—on a semi-transparent head-mounted display. Natoli teaches a system for displaying on a head-mounted display a “virtual keyboard” simulating a physical keyboard, which can be controlled with a motion-sensitive glove. (Natoli, 2:34-48.) The virtual keyboard can be displayed in a head-mounted display, which may be a semi-transparent head-mounted display so the user “may view the actual physical environment through” the display while also seeing “a VR representation of a keyboard” on the display. (Natoli, 5:28-41.) The user may operate VR gloves to manipulate the VR keyboard. (Natoli, 6:64-7:15.) Natoli's Figure 2 illustrates the user wearing a headset and viewing the VR keyboard (item **12**).



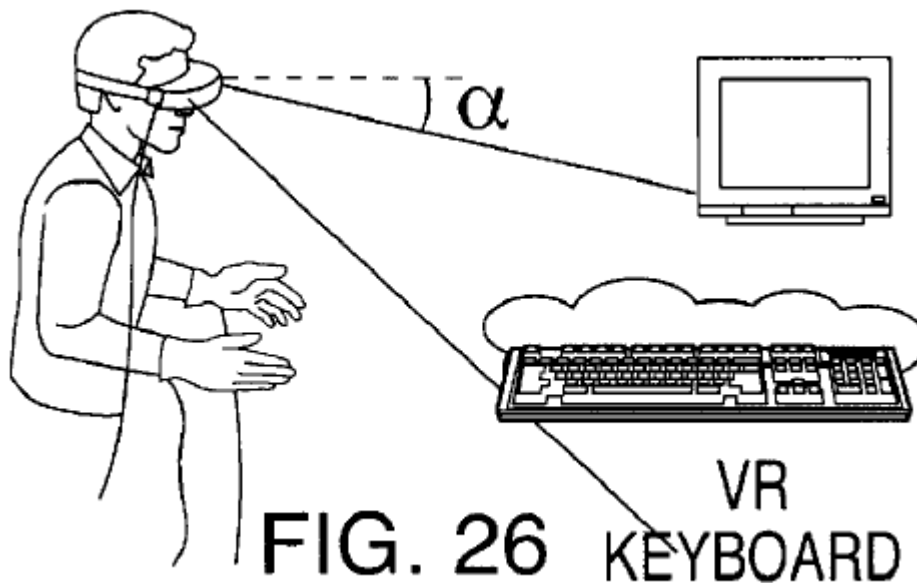
(Natoli, Fig. 2, 6:64-7:15.) Natoli describes how the VR keyboard may be “superimposed in the view of the user” so the user has the perception of viewing the virtual keyboard as if it were present in front of the user:

FIG. 2 illustrates the VR keyboard system and method of FIG. 1 in use by a user, with the user operating the VR gloves, connected to the first processor, to manipulate the VR keyboard in the view of the user. The display may be an actual display device connected to the second processor and/or may be a VR representation of at display screen. The VR keyboard may be superimposed in the view of the user to appear in the region of space near or in front of the display, so that the user has the perception of viewing the VR keyboard as an actual keyboard for operation with the display displaying screens such as a GUI for operating the application program. In addition, the VR keyboard system and method may generate the VR display to also be superimposed over the actual display, so that the VR display may complement the actual

display and the operation of the application program displayed on the actual display.

(Natoli, 6:64-7:15.)

Natoli's Figure 26 also illustrates a VR keyboard displayed to the user of a VR headset:



(Natoli, Fig. 26, 12:64-67.)

Rationale and Motivation to Combine (Ronzani-Horton and Natoli). It would have been obvious to a POSITA to combine Natoli's teachings of displaying a virtual keyboard on a semi-transparent head-mounted display with Ronzani's head-mounted camera and display disclosures (including under the proposed combination with Horton), predictably incorporating Natoli's virtual keyboard into Ronzani's head-mounted display device to provide "a display operable to cover at least a

portion of at least one eye of a wearer of said head-wearable device, wherein said display is operable to display a virtual object and to allow said wearer of said head-wearable device to view, simultaneously with said virtual object, a portion of said wearer's actual world environment.” (Cooperstock, ¶206.)

Like the other references, Natoli is an analogous reference to the '716 patent with teachings in the field of virtual reality and techniques for user inputs, including with head-mounted displays, and reasonably pertinent to the same problems. (Natoli, Abstract, 1:9-13, 2:34-37.) (Cooperstock, ¶¶207-208.) The '716 patent similarly “relates to portable devices with enlarged, and improved, display and input components.” ('716, 1:30-32.)

A POSITA would have been motivated to combine the teachings of Ronzani and Natoli. As discussed above, Ronzani contemplates “a virtual keyboard using motion sensitive gloves” and/or a “virtual reality data glove” with a head-mounted display but does not detail how to implement those features. (Ronzani, ¶¶0007, 0170.) A POSITA would have looked for teachings of virtual keyboards and/or virtual reality, naturally leading to Natoli's teaching of a “virtual reality keyboard” displayed in a head-mounted display and manipulated with one or two “VR gloves.” (Natoli, Abstract, 2:34-48, 5:28-52, 6:64-7:15, Figs. 1, 2.) (Cooperstock, ¶209.)

A POSITA also would have appreciated Natoli's specific applicability to a see-through HMD display that is **operable to display a virtual object and to allow**

said wearer of said head-wearable device to view, simultaneously with said virtual object, a portion of said wearer's actual world environment. Natoli contemplates semi-transparent HMD display technology where the user “may view the actual physical environment through the LCD” (Natoli, 5:37-41) in addition to the displayed virtual keyboard, complementing Ronzani's teachings of transparent and semi-transparent direct-view HMD displays as discussed previously. Natoli also specifically teaches that the VR keyboard may be “superimposed in the view of the user,” and may be superimposed “over the actual display,” consistent with a display overlaid on an optical see-through HMD. (Natoli, 7:2-12.) Ronzani likewise teaches that each image “created” by the head-mounted display system and presented on a transparent display “appears to float in the viewer's field of vision,” which would be understood to apply to the creation of a virtual object such as Natoli's virtual keyboard that is displayed on the transparent screen. (Ronzani, ¶0280.) (Cooperstock, ¶210.)

A POSITA would have further been motivated to apply Natoli's teachings to provide an improved user interface. (Cooperstock, ¶211.) Natoli describes that existing systems with physical keyboards and other physical input devices imposed size requirements that interfere with the desire for “smaller, portable” devices and also “have heretofore been primarily hardware-based, and so are susceptib[l]e to wear, damage, and theft.” (Natoli, 1:47-63.) Some virtual reality applications

existed but were perceived to “not provide the versatility of hardware-based, actual and physical keyboards and/or keypads” for purposes of user “commands and control signals.” (Natoli, 2:27-31.) Natoli addresses those perceived deficiencies with user input techniques with “a system and method for providing a virtual reality keyboard addresses solves numerous difficulties of input devices and provides many diverse advantages in use and applications.” (Natoli, 2:34-37.) These teachings would have motivated a POSITA to consider Natoli’s teachings in conjunction with the head-mounted display device teachings of Ronzani, which likewise contemplate user input devices and techniques that could be improved by reference to Natoli. (Cooperstock, ¶211.)

The combination would have involved the use of a known technique (Natoli’s teachings for a virtual keyboard displayed on a head-mounted display) to improve a similar device (Ronzani’s head-mounted display device as modified to implement Horton’s motion detector) in the same way. (Cooperstock, ¶212.)

A POSITA would have had a reasonable expectation that the combination would have been successful. Ronzani already discloses ample system capability including a head-mounted computer system with CPU and related components as well as sensor modules and expansion modules connected to the CPU (*e.g.*, Ronzani, ¶¶0148, 0166-0169), invoking a flexible architecture designed to be expanded and modified for desired applications, and therefore it would have been considered

relatively straightforward to implement Natoli's teachings in connection with Ronzani's platform. (Cooperstock, ¶213.)

- (2) **“a camera pointed in a field-of-vision of said wearer and operable to capture an image of said portion of said wearer's actual world environment;” (Claim 1[f][2])**

Ronzani in view of Peli discloses and renders obvious “a camera pointed in a field-of-vision of said wearer and operable to capture an image of said portion of said wearer's actual world environment.”

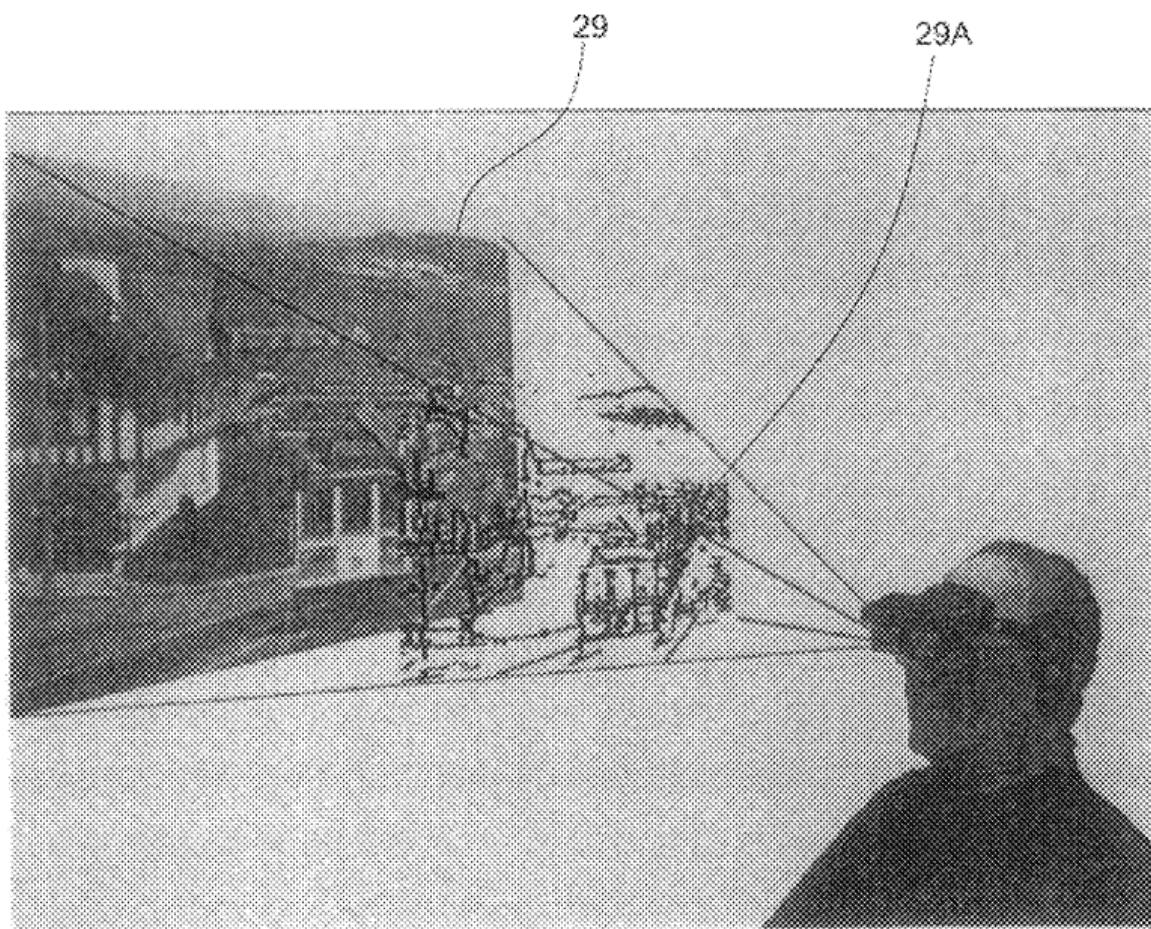
Ronzani discloses and renders obvious a head-mounted display device with a camera pointed in a field-of-vision of the wearer and operable to capture an image of a portion of the wearer's actual world environment, as discussed previously for Claim 16[h] and Claim 18, such as camera **555b** in Figure 33. Those discussions are hereby incorporated by reference. However, Ronzani does not further describe potential applications for the head-mounted camera.

Peli teaches the use of head-mounted cameras to capture an image of a real-world scene in the user's field of view and provide that image in a head-mounted display, disclosing “a camera pointed in a field-of-vision of said wearer and operable to capture an image of said portion of said wearer's actual world environment.” Specifically, Peli describes an embodiment that employs a head-mounted “infrared camera” that captures an “infrared image of a natural scene” and **“displays a bright image of a natural scene”** on a head-mounted display. (Peli, 14:24-

49.) Peli's Summary of the Invention describes capturing an infrared image for display onto a "see-through" visual screen in front of the wearer's eyes. (Peli, 4:42-49.) Describing the detailed embodiment using the infrared image, Peli further explains that the infrared image may be displayed to the wearer: "an infrared camera 70 obtains an infrared image of a natural scene, and a display module 72 displays the image on a screen." (Peli, 14:24-49.) Peli's teaching is strikingly similar to the '716 patent's disclosure: "Multiple types of cameras can be utilized. For example, infrared and night vision cameras can be utilized. The information received from these cameras can be displayed on the display screen." ('716, 14:57-60.) (Cooperstock, ¶218.) Peli describes that the infrared image captured by the infrared camera may be displayed either by itself or together with a "contour image" (labeled a "cartoon image"), on a screen in front of at least one of the wearer's eyes. (Peli, 14:24-49, Fig. 14.)

While this passage of Peli does not expressly describe that the head-mounted display screen is a transparent see-through display, elsewhere Peli provides that disclosure. Specifically, Peli's Summary of the Invention explains that its night vision enhancement embodiment using an infrared image projects a display onto a "see-through" visual screen. (Peli, 4:42-49.) This understanding is reinforced by Peli's description of multiple other embodiments of head-mounted displays that employ transparent screens through which the wearer can see the actual world. For

example, referencing Figure 5, Peli describes a standard “see-through head-mounted display” as known in the art, which displays images on “two partially transparent screens positioned in the front of the observer’s eyes.” (Peli, 9:33-47.) (Cooperstock, ¶221.) Figure 5 illustrates a user wearing an exemplary see-through head-mounted display:



(Peli, Fig. 5.)

A person of ordinary skill in the art thus would have understood and found it obvious that the display in the Figure 14 infrared camera embodiment likewise

would be a see-through display as known in the art and described earlier in Peli. (Peli, 4:42-49, 9:33-47.) Peli also describes with reference to Figure 14 that instead of a head-mounted display, an image could alternatively be displayed on an automobile windshield, which of course would be a transparent surface as well. (Peli, 14:54-58 (discussing “projecting the contours of objects in an image of the natural scene, obtained for example by an infrared camera, onto the windshield of the automobile.”).) A person of ordinary skill in the art would have understood that the see-through head-mounted display used in the Figure 14 embodiment would enable the wearer to see the natural scene through the display while also displaying an enhanced image based on the same visible natural scene, given that the display is “see-through” and transparent. (Cooperstock, ¶222.)

Rationale and Motivation to Combine (Ronzani-Horton-Natoli and Peli).

It would have been obvious to a POSITA to combine Peli’s teachings of a head-mounted camera to capture an image of the actual world environment and display it on a transparent see-through head-mounted display with Ronzani’s head-mounted camera and display disclosures (including under the proposed combination with Horton and Natoli). The combination would have involved the straightforward incorporation of Peli’s image-enhancement teachings into Ronzani’s head-mounted display device and would have predictably resulted in Ronzani’s head-mounted display with a head-mounted “**camera pointed in a field-of-vision of said wearer**

and operable to capture an image of said portion of said wearer’s actual world environment” visible by the wearer of Ronzani’s head-mounted device, as claimed, and further resulting in the display being **“operable to display said image of said wearer’s actual world environment taken by said camera simultaneously with said virtual object”** as discussed further for Claim 1[g] below.

Like the other references, Peli is an analogous reference to the ’716 patent. Peli provides teachings in the field of portable user-worn devices, including head-mounted display devices with camera and image display capabilities and including proposed improvements to image visibility for various applications. (Peli, 2:43-47 (Summary of the Invention describing that Peli’s image-improvement disclosures “can be integrated in a wearable real-time image enhancement apparatus, such as a head mounted display (‘HMD’) display unit”), 9:23-55, Figs. 4-5, 14:24-49, Fig. 14 (describing head-mounted display embodiments).) (Cooperstock, ¶225.) The ’716 patent similarly states that its disclosure relates to improved display components for portable devices: “this invention relates to portable devices with enlarged, and improved, display and input components.” (’716, 1:30-32.)

Moreover, Peli would have been reasonably pertinent to problems facing the ’716 patent inventor, including components and features to include in head-mounted display devices for various applications, including capturing images using a camera. Echoing Peli’s teachings of implementing multiple different types of cameras,

including infrared cameras for night-vision enhancement, the later-filed '716 patent contemplates that “[m]ultiple types of cameras can be utilized” in a head-mounted device, including “infrared and night vision cameras” ('716, 14:57-59.) (Cooperstock, ¶226.)

A POSITA would have been motivated to make the combination. As discussed above, Ronzani contemplates that its head-mounted display device can be used for applications involving “simulation” and “virtual” components, including “virtual reality,” as well as “entertainment purposes” and other applications. (Ronzani, ¶¶0002, 0005, 0170.) Ronzani specifically contemplates implementing a head-mounted camera with a head-mounted display but does not detail applications to use that camera. (Ronzani, ¶0154.) Ronzani also describes embodiments with an “infrared” detector and providing “night vision” capability in its head-mounted display device, though does not expressly describe an infrared camera and does not provide details of how the night vision enhancement would work. (Ronzani, ¶¶0154, 0181, 0192, 0197, 0202.) Complementing Ronzani’s disclosures and picking up where Ronzani leaves off, Peli specifically teaches useful applications of a head-mounted camera to capture an image of the wearer’s actual world environment for the purpose of enhancing the wearer’s visibility of the real-world environment, which may be an infrared camera to create a “bright” image for vision enhancement. (Peli, 3:44-48, 14:24-49.) (Cooperstock, ¶227.)

When considering applications to be implemented using the head-mounted display device of Ronzani, a person of ordinary skill in the art naturally would have looked to Peli's teachings of enhancing the imagery viewable and displayed in a head-mounted display device. Peli expressly motivates application of its teachings to head-mounted display devices such as those disclosed in Ronzani, including commercially available HMD products such as the Sony Glasstron and Virtual IO i-Glasses. (Peli, 9:29-47.) Peli thus teaches that its disclosure would be well-suited as an addition to existing head-mounted display products, such as those described in Ronzani that could be "adapted" to implement Peli's teachings. (Cooperstock, ¶228.)

A POSITA would have further been motivated to apply Peli's teachings to improve visibility for low-light conditions and for individuals with impaired vision. A POSITA would have understood that the quality of vision through an optical see-through head-mounted display (such as taught in Ronzani) depends, in part, on the quantity/quality of light present in the environment and the quality of vision of the human wearer of the device. (Cooperstock, ¶229.) Peli teaches techniques that would help improve the usability of Ronzani's head-mounted display devices for low-light conditions and for individuals who suffer from visual impairment. Peli specifically teaches that its infrared camera display enhancement may have various useful applications: "Such a night vision device advantageously enhances night

mobility of patients who suffer from a loss of night vision and visual field loss. In addition to being useful for patients having night blindness, an infrared night vision device according to the invention can have a variety of other useful applications.” (Peli, 14:50-55.) For example, the infrared display technique “displays a bright image of a natural scene” and therefore is well-suited “during periods of low ambient light intensity . . .” (Peli, 14:25-26, 14:62-63.) A POSITA would have understood these enhancements would be suitable to implement with Ronzani’s head-mounted display devices to facilitate visibility of the real-world environment for users who have limited vision under low light conditions. (Cooperstock, ¶229.)

The combination would have involved the use of a known technique (Peli’s teachings for improved visibility of a real-world scene using an HMD) to improve a similar device (Ronzani’s head-mounted display device) in the same way. Moreover, because the details of applications for using head-mounted cameras are not a focus of Ronzani, a person of ordinary skill in the art, seeking to implement and adapt Ronzani’s teachings for head-mounted cameras, naturally would have turned to Peli for its complementary applicable teachings and motivations. (Cooperstock, ¶230.)

A person of ordinary skill in the art would have had a reasonable expectation that the combination would have been successful. Ronzani already discloses ample system capability including a head-mounted computer system with CPU and related

components as well as sensor modules and expansion modules connected to the CPU (e.g., Ronzani, ¶¶0148, 0166-0169), invoking a flexible architecture designed to be expanded and modified for desired applications, and therefore it would have been considered relatively straightforward to implement Peli's teachings in connection with Ronzani's platform. As Peli describes, its techniques may be adapted for use in standard existing HMDs such as commercially available devices. (Peli, 9:39-46.) (Cooperstock, ¶231.)

- (g) **“wherein said display is operable to display said image of said wearer's actual world environment taken by said camera simultaneously with said virtual object.” (Claim 1[g])**

Ronzani in view of **Natoli** and **Peli** discloses and renders obvious that the head-mounted display is **“operable to display said image of said wearer's actual world environment taken by said camera simultaneously with said virtual object.”**

As described above for Claim 1[f][2], Peli describes that “an infrared camera 70 obtains an infrared image of a natural scene, and a display module 72 displays the image on a screen,” disclosing that the display is **“operable to display said image of said wearer's actual world environment taken by said camera.”** (Peli, 14:24-49.)

Ronzani and Natoli further disclose and render obvious capability to simultaneously display a **“virtual object”** (virtual keyboard) on the head-mounted

display incorporating Peli's infrared image enhancement. The same teachings and motivations discussed for Claim 1[f][2] apply equally here. A POSITA would have understood and found it obvious that the capability for the Ronzani-Natoli head-mounted device to display the virtual keyboard on its transparent or semi-transparent screen would be maintained after the obvious addition of Peli's infrared image technique to enhance visibility for vision-impaired individuals and/or low light conditions. The same VR keyboard functionality would persist when the system was adapted to implement Peli's teachings. The resulting transparent head-mounted display with Peli's infrared image enhancement and Natoli's VR keyboard would thus be **"operable to display said image of said wearer's actual world environment taken by said camera simultaneously with said virtual object."** (Cooperstock, ¶234.) The rationales and motivations to combine these references regarding Claim 1[f] apply equally here and are incorporated by reference. (Cooperstock, ¶235.)

2. **Claim 8: "The apparatus of claim 1, wherein said display comprises: a first display covering at least a portion of a first eye of said wearer; and a second display covering at least a portion of a second eye of said wearer." (Claim 8[pre])**

Ronzani and **Peli** disclose and render obvious that the display comprises a first display and second display as recited in claim 8.

Ronzani and Peli each disclose and render obvious that the "display" of Claim 1 includes **"a first display covering at least a portion of a first eye of said wearer"**

Petition for *Inter Partes* Review of
U.S. Patent No. 11,947,716 B2

and “a second display covering at least a portion of a second eye of said wearer.”

For example, the displays in each of Ronzani’s embodiments depicted in Figures 1, 9, and 67 in the obvious combinations of Claim 1 each include two display units—one covering at least a portion of the wearer’s left eye, and one covering at least a portion of the wearer’s right eye—as discussed previously and shown in each figure. (Ronzani, Figs. 1, 9, 67.) (Cooperstock, ¶237.)

Peli likewise teaches and renders obvious the use of a see-through head-mounted display with two partially transparent screens, one for each eye, as discussed for Claim 1[f][2]. (*E.g.*, Peli, 9:33-37 (“two partially transparent screens positioned in the front of the observer’s eyes, known in the art as a see-through head-mounted display”), Fig. 5, 14:35-39.) (Cooperstock, ¶238.)

VII. CONCLUSION

Petitioner respectfully requests IPR institution.

Dated: April 4, 2025

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), I certify that this petition complies with the type-volume limits of 37 C.F.R. § 42.24(a)(1)(i) because it contains 11,330 words, according to the word-processing system used to prepare this petition, excluding the parts of this petition that are exempted by 37 C.F.R. § 42.24(a) (including the table of contents, a table of authorities, mandatory notices, a certificate of service or this certificate word count, appendix of exhibits, and claim listings).

DATED: April 4, 2025

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CERTIFICATE OF SERVICE

I hereby certify, pursuant to 37 C.F.R. Sections 42.6 and 42.105, that a complete copy of the attached **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,947,716 B2**, including all exhibits (**Nos. 1001-1008**) and related documents, are being served via Federal Express on the 4th day of April, 2025, the same day as the filing of the above-identified document in the United States Patent and Trademark Office/Patent Trial and Appeal Board, upon Patent Owner by serving the correspondence address of record with the USPTO as follows:

32733 - JEFFREY D. MULLEN
2212 Hassinger Lane
Glenshaw, PA 15116
UNITED STATES

And, via Federal Express upon counsel of record for Patent Owner in the litigation pending before the U.S. District Court for the Western District of Texas entitled *Mullen Industries LLC v. Meta Platforms, Inc.*, Case No. 1:24-cv-00354-DAE (W.D. Tex.) as follows:

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DATED: April 4, 2025

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