UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CORETRONIC CORPORATION and
OPTOMA CORPORATION,

Petitioners,

v.

MAXELL, LTD.,

Patent Owner

IPR2025-00941

PETITION FOR INTER PARTES REVIEW

OF U.S. PATENT NO. 7,159,988

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I. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

A. Parties-in-Interest

The Petitioners are Coretronic Corporation ("Coretronic") and Optoma Corporation ("Optoma") (collectively, "Petitioners"). Coretronic, Optoma, and Optoma Technology, Inc. ("Optoma USA") are real parties in interest.

B. Related Matters

Patent Owner Maxell, Ltd. ("Maxell") has asserted U.S. Patent No. 7,159,988 ("the '988 Patent") against Petitioners in *Maxell, Ltd. v. Coretronic Corp. et al.*, Case No. 5:24-cv-00088 (E.D. Tex.). That case is currently pending.

Petitioners are not aware of any other related matters.

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II. GROUNDS FOR STANDING

Petitioners certify that the '988 Patent is available for *inter partes* review and that Petitioners are not barred or estopped from requesting *inter partes* review challenging the patent claims on the grounds identified in this Petition.

III. REQUESTED RELIEF

Petitioners request that the Board review the accompanying prior art and analysis, institute a trial for an *inter partes* review of claims 1, 7, and 8 of the '988 Patent ("the Challenged Claims"), and cancel those claims as unpatentable.

IV. REASONS FOR THE REQUESTED RELIEF

The Challenged Claims of the '988 Patent would have been anticipated by the prior art or obvious to a person of ordinary skill in the art ("POSITA") as of their priority date and are therefore unpatentable. The claims of the '988 Patent recite nothing more than an obvious combination of optical and mechanical elements that had been known and used by POSITAs for many years prior to the filing of the '988 Patent.

This Petition's showing that the cited art renders the Challenged Claims unpatentable is fully supported by the Declaration of Dr. Jose Sasian (EX1004), a Professor of Optical Sciences for over 20 years at the University of Arizona and an expert in the relevant field. EX1004, ¶9. Professor Sasian is familiar with the state of the art before the '988 Patent was filed, and fully agrees with and supports the showing herein that the claims at issue merely recite long-known optical and mechanical elements arranged in an obvious fashion. EX1004, ¶¶47-259.

Accordingly, the Board should institute trial and cancel the Challenged Claims.

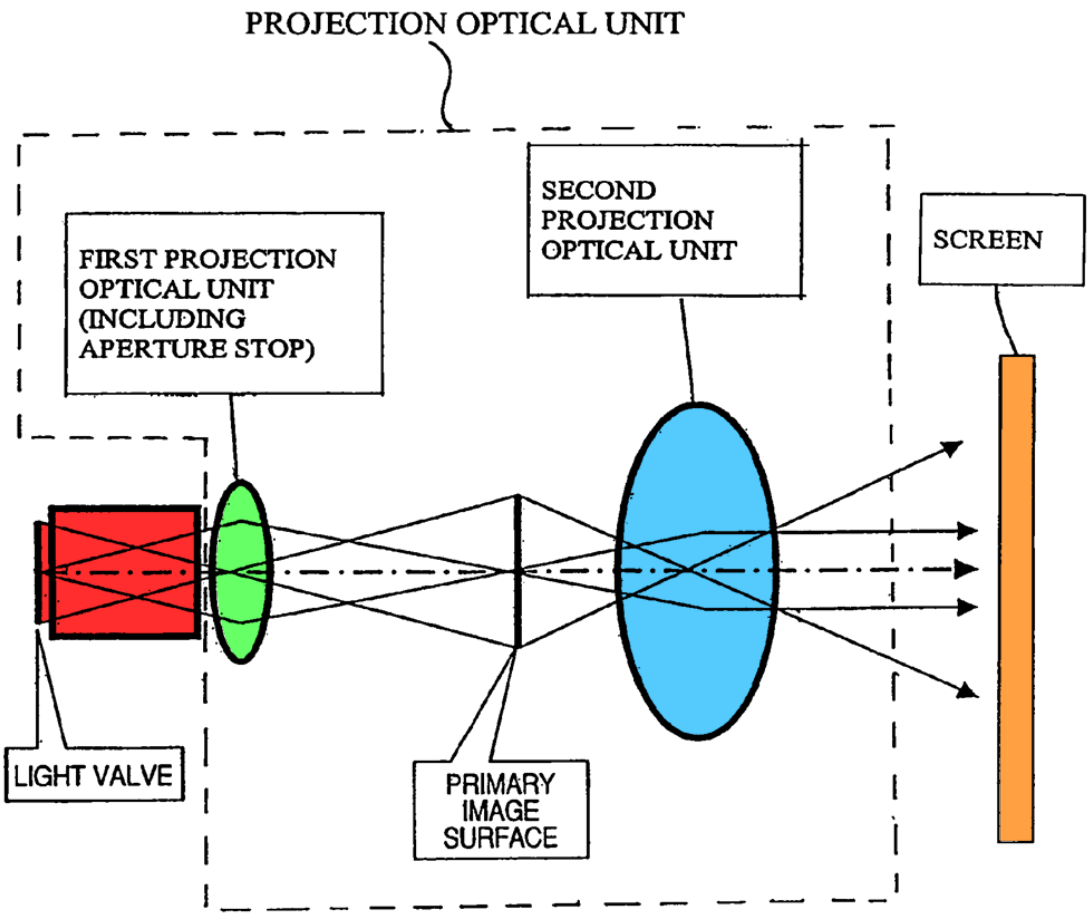
A. '988 Patent Summary

The '988 Patent describes a projection optical unit. EX1001, 2:40-3:4; EX1004, ¶56. The described projection optical unit includes an image display element, a first projection optical unit, a second projection optical unit, and a screen. The first projection optical unit is disposed between the image display element and the second projection optical unit. The second projection optical unit is disposed between the first projection optical unit and the screen. The first projection optical unit is configured to form a first enlarged image by enlarging an image displayed by the image display element with a magnification M1. The second projection optical unit is configured to enlarge the first enlarged image onto the screen with a magnification M2. The magnification M1 is smaller than the magnification M2 and

the first projection optical unit includes an aperture stop that defines an F-value of the entire projection optical unit. *Id*.

The '988 Patent's FIG. 1, reproduced and annotated below, depicts a configuration diagram of the claimed projection optical unit.

FIG. 1

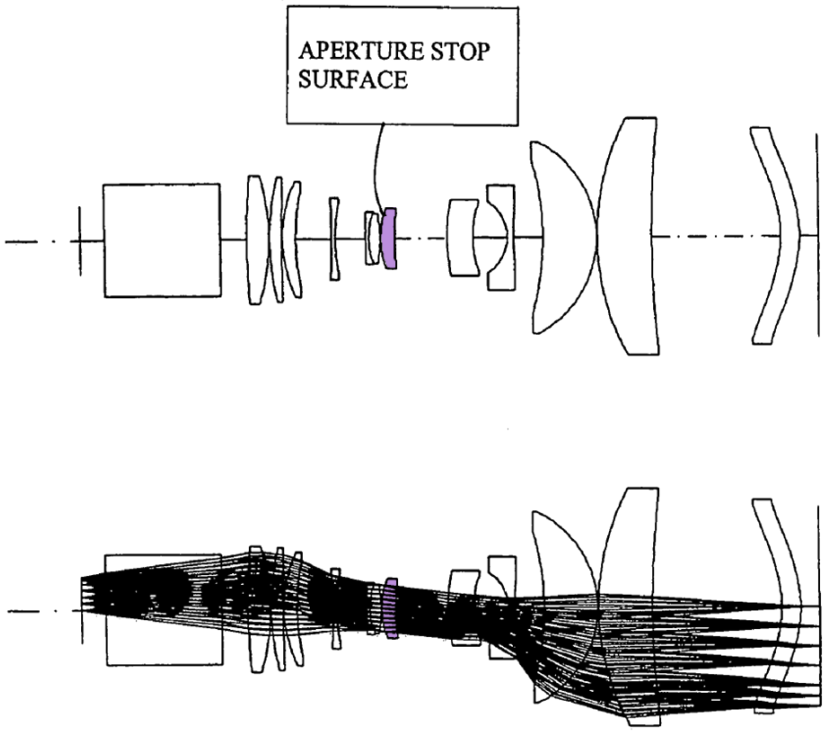


As shown, the claimed invention includes an image display element (red), a first projection optical unit (green), a second projection optical unit (blue), and a screen (orange). EX1001, 7:4-23. The first projection optical unit (green) and the second

projection option unit (blue) are each composed of lens groups. *Id.* One of those lens groups (the first projection optical unit) forms a first enlarged image; the other lens group (the second projection optical unit) forms a second enlarged image by further enlarging the first enlarged image. *Id.* The second projection optical unit has positive refractive power. *Id*.

The ’988 Patent further discloses and claims the first projection optical unit includes an aperture stop that defines an F-value of the entire unit. *Id.,* abstract, 26:46-27:3; EX1004, ¶59. This aperture stop is shown in purple in the annotated version of FIG. 3 below:

FIG. 3



The ’988 Patent states that “F2 (divergence angle of light rays)[,] that is the F-value of the second lens group[,] equals a value obtained by dividing F1, the F-value of the first lens group, by the magnification M1 of the first enlarged image. That is to say, F2=F1/M1.” EX1001, 2:63-67; EX1004, ¶60.

The ’988 Patent also discloses and claims that the first enlarged image has a magnification M1 and the second enlarged image has a magnification M2, where M2>M1. EX1001, abstract; EX1004, ¶61. The ’988 Patent includes an example where M1 is 3× and M2 is 27×, such that M2 is greater than M1. EX1001, 7:26-30; EX1004, ¶61.

B. Prosecution History

The ’988 Patent issued on January 9, 2007, from U.S. Patent Application Serial No. 10/921,938, filed August 20, 2004. EX1004, ¶62. The patent claims priority to Japanese Application No. 2003-398395, filed on November 28, 2003. EX1002; EX1004, ¶62. A restriction requirement was mailed on April 17, 2006. Following applicants’ response, an Ex Parte Quayle Action was mailed on June 6, 2006, in which the elected claims (including claims 1, 7, and 8 of the ’988 Patent) were allowed but the drawings were objected to. A Notice of Allowance was mailed on August 29, 2006. EX1002 at page 28-33; EX1004, ¶62.

C. Priority Date

All the references cited in the instant Petition qualify as prior art based on the assumed priority date of November 28, 2003, which is the filing date of the Japanese application to which the '988 Patent claims priority.

D. Challenged Claims

Claims 1, 7, and 8 of the '988 Patent are challenged.

V. CLAIM CONSTRUCTION

Terms not expressly construed in the discussion below have been given their plain and ordinary meaning to a POSITA, consistent with the claim construction standards set forth under *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). EX1004, ¶39.

VI. STATUTORY GROUNDS FOR CHALLENGES

Ground #1: Claims 1 and 7 of the '988 Patent are anticipated under pre-AIA 35 U.S.C. § 102 by, or obvious under pre-AIA 35 U.S.C. § 103 over, U.S. Patent No. 5,357,289A ("Konno"; EX1005).

Ground #2: Claim 8 of the '988 Patent is obvious under pre-AIA 35 U.S.C. § 103 over Konno in view of U.S. Patent No. 3,963,337A ("Lundberg"; EX1006).

Ground #3: Claims 1 and 7 of the '988 Patent are obvious under pre-AIA 35 U.S.C. § 103 over U.S. Patent No. 5,302,983A ("Sato"; EX1007) in view of U.S. Patent Application Publication No. 2002/0067467A1 ("Dorval"; EX1008) and U.S. Patent No. 6,028,715A ("Takamoto"; EX1009).

Ground #4: Claim 8 of the '988 Patent is obvious under pre-AIA 35 U.S.C. § 103 over Sato in view of Dorval, Takamoto, and U.S. Patent Application Publication No. 2002/0044263A1 ("Takeuchi"; EX1010).

Ground #5: Claims 1 and 7 of the '988 Patent are obvious under pre-AIA 35 U.S.C. § 103 over U.S. Patent No. 5,422,691A ("Ninomiya"; EX1011) in view of Dorval.

Ground #6: Claim 8 of '988 Patent are obvious under pre-AIA 35 U.S.C. § 103 over Ninomiya in view of Dorval and Takeuchi.

Ground #7: Claims 1, 7, and 8 of the '988 Patent are obvious under pre-AIA 35 U.S.C. § 103 over U.S. Patent No. 6,808,271B1 ("Kurematsu"; EX1012) in view of Dorval and Takamoto.

VII. LEVEL OF ORDINARY SKILL IN THE ART

As of November 28, 2003, a POSITA would have had a Ph.D. in electrical engineering, physics, optical sciences, optical engineering, or a related scientific or engineering field, and at least one to two years of work or research experience in optical engineering, optical design, or a related field. EX1004, ¶44. Alternatively, a POSITA could have had a Bachelor's degree in one of the foregoing areas and at least three to four years of work or research experience in optical engineering, optical design, optoelectronics, or a related field. *Id.*

VIII. CLAIMS 1, 7, and 8 ARE UNPATENTABLE

A. Ground 1: Claims 1 and 7 are invalid under pre-AIA 35 U.S.C. § 102 as anticipated by, or § 103 obvious over, Konno.

1. Overview of Konno

a) Qualification as Prior Art

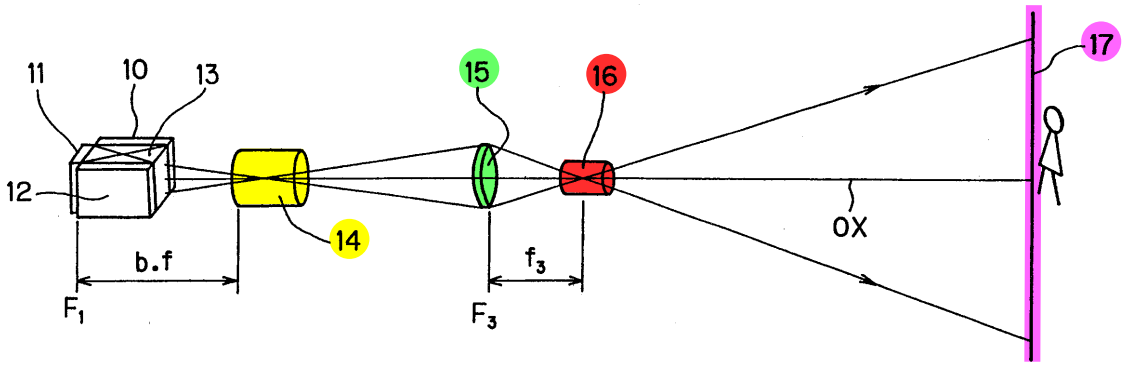
Konno was filed as U.S. Patent Application Serial No. 08/180,705 on January 13, 1994, and issued as U.S. Patent No. 5,357,289 on October 18, 1994. EX1004, ¶64; EX1005. Accordingly, Konno qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was patented more than one year before the earliest U.S. filing date of the '988 Patent, *i.e.*, August 20, 2004. *See* EX1001. Konno was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

b) General Overview

Konno discloses a projector lens system for an image projector. EX1005, title; EX1004, ¶65. This lens system includes a first lens group, a second lens group, and a third lens group for projecting an image onto a screen as a magnified image. EX1005, abstract; EX 1004, ¶65.

Fig. 3 of Konno, reproduced and colorized below, shows the overall arrangement of a projector in accordance with Konno's invention. EX1005, 6:46-56; EX1004, ¶66. Konno discloses the projector includes a first lens group 14 (yellow), a second lens group 15 (green), a third lens group 16 (red), and a screen 17 (pink). EX1005; 3:22-44; *Id*.

Fig. 3



Konno explains that "[e]ach of the lights reflected from the image forming devices is incident to the tri-color separation and composition system 13 to compose a composite optical image beam, and the composite image beam is focused as a optical image on the second lens group 15 through the first lens group 14. The optical image on the second lens group 15 is projected on the screen 17 as a predetermined magnified picture through the third lens group 16." EX1005; 3:53-61; EX1004, ¶67.

2. Element-by-Element Invalidity Analysis

a) Independent Claim 1

[1.0] A projection optical unit…, comprising;

The term "projection optical unit" is a means-plus-function term and so should be interpreted as covering the corresponding structure described in the specification and equivalents thereof. The specification of '988 Patent describes the structure for

a "projection optical unit" as constituting one or more lens group having a positive refractive power. EX1004, ¶¶41-42. More specifically, the specification states that

> In the present invention, the projection optical unit for providing an enlarged projection of the images displayed by image display elements is divided into two lens groups. One of the lens groups constitutes a first projection optical unit that forms a first enlarged image, and the other lens group constitutes a second projection optical unit that forms a second enlarged image…the second projection optical unit having positive refractive power.

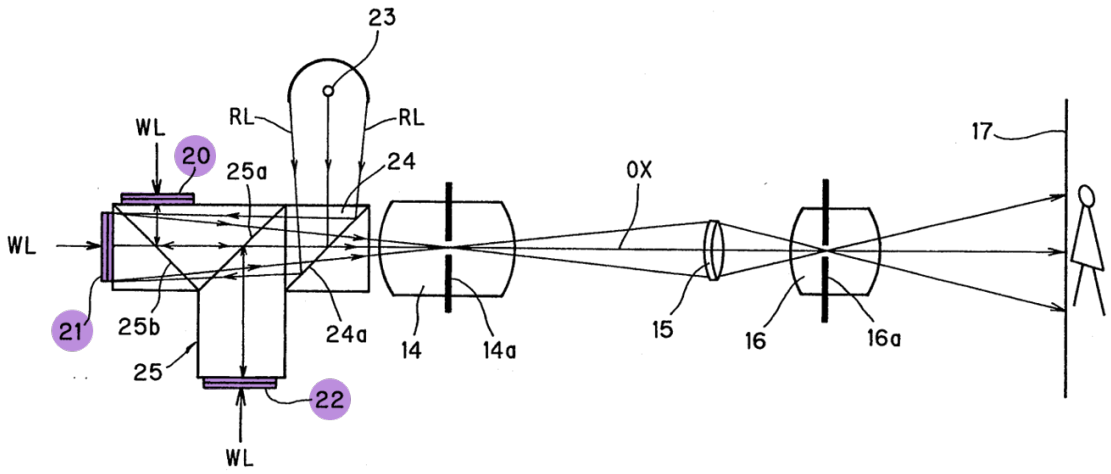
EX1001, 7:8-14.

Konno similarly discloses "projection optical units" composed of one or more lens groups have a positive refractive power. EX1004, ¶¶96-98. More specifically, as described above, Konno's Fig. 3 shows a projector that includes a first lens group 14 (yellow), a second lens group 15 (green), a third lens group 16 (red), and a screen 17 (pink). EX1005; 3:22-44; EX1004, ¶66.

Konno further teaches that "[t]he present invention relates to improvements of an image projector and more particularly to an image projector capable of displaying a high definition image in spite of a short projection length." EX1005, 1:10-13. Additionally, "[a] more specific object of the present invention is to provide an image projector ***for projecting a magnified*** tri-color composite ***optical image on a screen***." *Id.,* 2:33-35 (emphasis added).

Referring to Fig. 4, which has been reproduced and colorized for clarity below, Konno states that "***the light modulators 20, 21 and 22 are employed as image forming devices*** in the embodiment of the present invention, but it is possible to employ such devices as ***liquid crystal panels*** which can modulate the light." EX1005, 3:22-30 (emphasis added). It is well known in the art that liquid crystal panels, such as those disclosed by Konno, are image display elements. EX1004, ¶98.

Fig. 4



Konno therefore discloses "an image display element." EX1004, ¶98.

Accordingly, to the extent the preamble of claim 1 is deemed a limitation, Konno discloses this limitation, *i.e.*, element [1.0]. *Id*.

[1.1] a first projection optical unit…; and

The construction of the term "projection optical unit" is discussed above. *See* Section VIII.A.2.a.[1.0].

Konno teaches "FIG. 3 is an explanatory view showing a basic structure of an image projector according to the present invention, in which the numeral…14 [indicates] a first lens group having a back-focal length 'b.f.' defined as a distance between a front surface of the first lens group and an object focal point 'F1'," EX1005, 3:22-30. Because Konno discloses that "the composite image beam is focused as a optical image on the second lens group 15 through the first lens group 14" and "the first lens group 14 [provides] a magnification of ×2,", Konno teaches that the first lens group has a positive refractive power. *Id.,* 3:56-58, 4:1-4; EX1004, ¶100. The "first lens group 14" shown in Konno's Fig. 3 above therefore corresponds to the "first projection optical unit." EX1004, ¶100.

Konno therefore discloses this limitation, *i.e.*, element [1.1]. EX1004, ¶¶99-100.

[1.2] a second projection optical unit…;

The construction of the term "projection optical unit" is discussed above. *See* Section VIII.A.2.a.[1.0].

Konno teaches that "FIG. 3 is an explanatory view showing a basic structure of an image projector according to the present invention, in which the numeral…16 [indicates] a third lens group having an object focal point 'F3' and a focal length 'f3' for projecting a magnified image on a screen 17." EX1005, 3:22-33. Further "[t]he optical image on the second lens group 15 is projected on the screen 17 as a

predetermined magnified picture through the third lens group 16," *i.e.*, the third lens group has a positive refractive power. *Id.,* 3:58-61; EX1004, ¶102. The "third lens group 16" shown in Konno's Fig. 3 above therefore corresponds to the "second projection optical unit." EX1004, ¶102.

Konno therefore discloses this limitation, *i.e.*, element [1.2]. EX1004, ¶¶101-102.

[1.3] wherein the first enlarged image…,

As an initial matter, the term "***the*** image display element side" is ambiguous and indefinite because the first optical projection unit and the second projection optical unit both form an image and the claim does not identify which of those two images is "the image" for purposes of identifying where "the image display side" is located in the projector. EX1004, ¶43.

In the on-going district court litigation involving the '988 Patent, Maxell has argued to the court that this term should mean "a side after the image display element and before the second projection optical unit." *See Maxell, Ltd. v. Coretronic Corp.*, Case No. (EDTX), Dkt. No. 89. Without waiving any indefiniteness position for purposes of related litigation, Petitioner will use Maxell's proposed construction for purposes of this analysis.

Konno teaches that "[e]ach of the lights reflected from the image forming devices is incident to the tri-color separation and composition system 13 compose a

composite optical image beam, and ***the composite image beam is focused as a optical image on the second lens group 15 through the first lens group 14***." EX1005, 3:53-58 (emphasis added). Konno's Fig. 3 above shows that second lens group 15, where the first enlarged image is formed, is positioned between the first lens group and the second lens group. EX1004, ¶104. Consequently, the first enlarged image is formed at the image display element side of the first lens group. *Id*. This is also consistent with the '988 Patent's specification. *Id*.

Konno therefore discloses this limitation, *i.e.*, element [1.3]. EX1004, ¶¶103-104.

[1.4] a magnification M1…, and

Konno teaches "the composite optical image beam is focused on the second lens group 15 through the first lens group 14 as an optical image with a magnification of ×2" EX1005, 4:1-4. Konno further teaches "[t]he optical image on the second lens group 15 is projected on the screen 17 as a predetermined magnified picture through the third lens group 16." *Id.,* 3:58-61. This, the first magnification M1 is equal to 2. EX1004, ¶106. Although Konno does not expressly disclose a numerical value for the second magnification M2, Konno's Fig. 3 shows that the picture on screen 17 is larger than the optical image on the second lens group 15, meaning that it has been magnified. *Id.* Moreover, a POSITA would also have recognized that the magnification of the "third lens group" of Konno must be greater than the

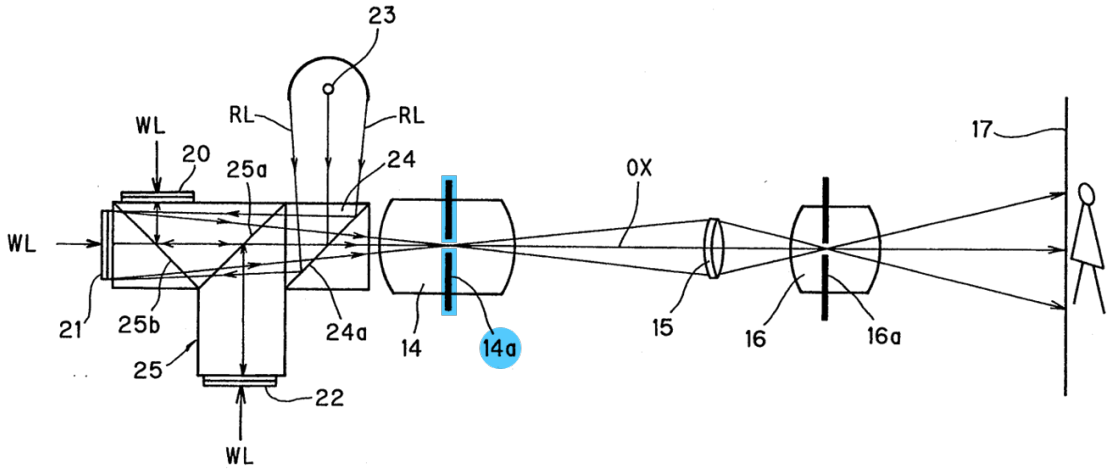
magnification of the "first lens group" in order to project an image onto the screen that is multiple times the size of the image on the display element. *Id.* This is shown in Konno's Fig. 3, where the picture on screen 17 is more than two times larger than the optical image on second lens group 15 and the ratio of the distance from lens group 16 to screen 17 to the distance from lens group 15 to lens group 16 shows the magnification of lens group 16 is larger than 2 (magnification M1) . *Id.*

Konno therefore discloses this limitation, *i.e.,* element [1.4]. EX1004, ¶¶105-106.

[1.5] said first projection optical unit….

Konno's Figure 4 is reproduced and colorized for clarity below:

Fig. 4



Konno discloses that "14a [is] an iris of the first lens group for controlling the light quantity". EX1005, 5:15-24. A POSITA would have understood that an "iris" is an aperture stop, *i.e.*, an opening that controls the quantity of light passing through

the lens group. EX1004, ¶108. A POSITA would also have understood that the ratio of the focal length of the lens to the diameter of the opening in the aperture stop defines an F-value, and "iris 14a" of "first lens group 14" defines an F-value of the entire projection optical unit. *Id.*, ¶¶108-110.

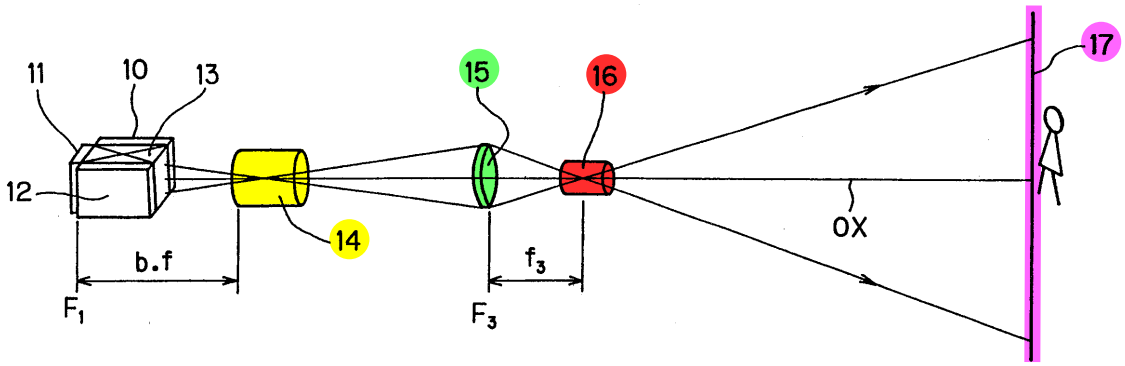
Konno therefore discloses this limitation, *i.e.,* element [1.5]. EX1004, ¶¶107-110.

b) Independent Claim 7

[7.0] A projection image display apparatus, comprising;

Konno's Figure 3 is reproduced and colorized for clarity below:

Fig.3



As described above, Konno discloses "an image projector capable of displaying a high definition image in spite of a short projection length." EX1005, 1:10-13.

Accordingly, to the extent the preamble of claim 7 is deemed a limitation, Konno discloses this limitation, *i.e.*, element [7.0]. EX1004, ¶¶111-112.

[7.1] an image display element; and

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.0]. EX1004, ¶¶113-114.

[7.2] a projection optical unit…,

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.0]. EX1004, ¶115.

[7.3] wherein said projection optical unit includes…,

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.1]-[1.2]. EX1004, ¶¶116-117.

[7.4] said first projection optical unit…, and

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.1]. EX1004, ¶118.

[7.5] said second projection optical unit…;

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.2]. EX1004, ¶119.

[7.6] wherein the first enlarged image…,

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.3]. EX1004, ¶120.

[7.7] a magnification M1…, and

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.4]. EX1004, ¶121.

[7.8] said first projection optical unit includes….

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[1.5]. EX1004, ¶122.

B. Ground 2: Claim 8 are invalid under pre-AIA 35 U.S.C. § 103 as obvious over Konno and further in view of Lundberg.

1. Overview of Lundberg

a) Qualification as Prior Art

Lundberg was filed as U.S. Patent Application Serial No. 05/576,365 on May 12, 1975, and issued as U.S. Patent No. 3,963,337 on June 15, 1976. EX1004, ¶68; EX1006. Accordingly, Lundberg qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was patented more than one year before the earliest U.S. filing date of the ’988 Patent. *Id.* Lundberg was neither cited nor considered by the Examiner during prosecution of the ’988 Patent. EX1002.

b) General Overview

Lundberg discloses a still projector. EX1006, title; EX1004, ¶69. This projector includes a compensation device acting in vertical direction compensating for the so-called Keystone-effect. EX1006, 1:7-12; EX 1004, ¶70.

Figs. 4 and 5 of Lundberg, reproduced below, show the ray paths through a still projector with a compensation device in accordance with Lundberg’s invention. EX1006, 4:25-63. The optical axis of this projector is adjustable to compensate for the Keystone effect and have the projected image eccentric to the screen. *Id.*

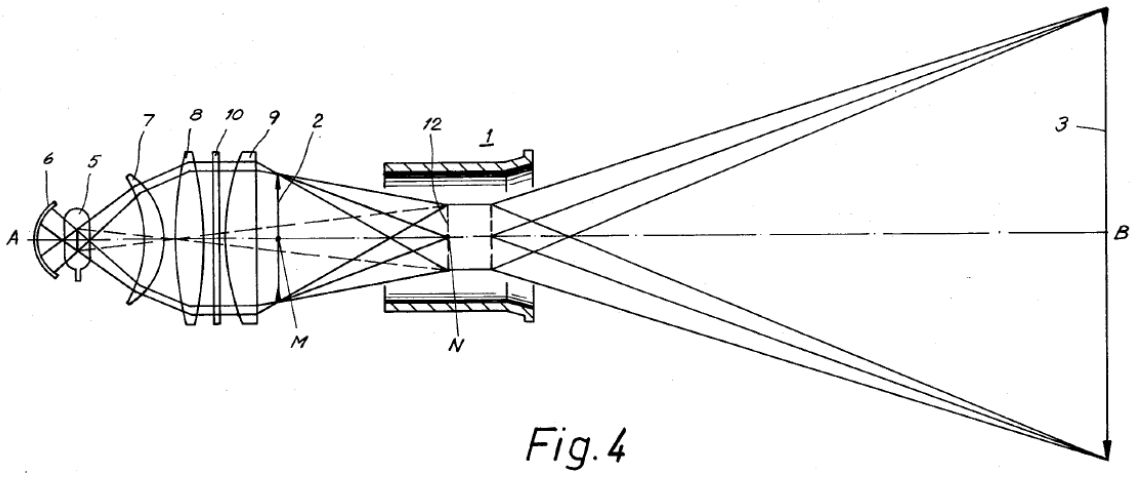


Fig. 4

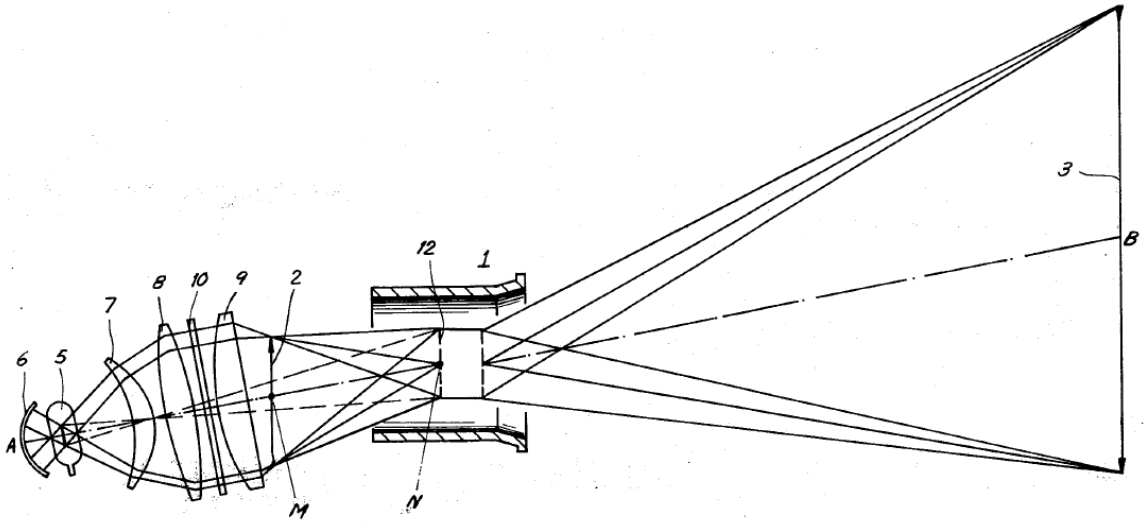


Fig. 5

Lundberg explains that "[w]hen the lens 1 is displaced in parallel to compensate for the Keystone-effect from the normal case shown in FIG. 4 to a position deviating from the normal case, FIG. 5, the lighting means 5-10, coupled to the lens 1, automatically will turn so that the ray path always is centered on the exit pupil of the lens 1, located in the rear nodal plane 12." *Id*.

2. Motivation to Combine Lundberg with Konno

A POSITA would have been motivated to combine the teachings of Lundberg with the teachings of Konno—and would have had a reasonable expectation of success in making that combination—for a number of reasons. *See* EX1004, ¶¶124-126.

Both references are directed to optical systems that project light from an image-generating device onto a screen via one or more groups of lenses. EX1004, ¶125; *see, e.g.*, EX1005, abstract; EX1006, abstract. Both references are therefore in the same field of endeavor and so a POSITA would naturally have looked to both when working in this area. EX1004, ¶125; *see also In re Wood*, 599 F.2d 1032, 1036 (CCPA 1979) ("In resolving the question of obviousness under 35 U.S.C. § 103, we presume full knowledge by the inventor of all the prior art in the field of his endeavor."). A POSITA would also have understood that the teachings of Konno are compatible and operable in combination with the teachings of Lundberg. EX1004, ¶125.

Moreover, a POSITA would have recognized that Lundberg describes the benefits of having an adjustable optical axis in the vertical direction in a projector. EX1004, ¶126. Lundberg explains that "[w]hen the lens 1 is displaced in parallel to compensate for the Keystone-effect from the normal case shown in FIG. 4 to a position deviating from the normal case, FIG. 5, the lighting means 5-10, coupled to

the lens 1, automatically will turn so that the ray path always is centered on the exit pupil of the lens 1, located in the rear nodal plane 12." EX1006, 4:25-63; EX1004, ¶126. A POSITA would therefore have been motivated to combine Lundberg's disclosures with those of Konno so as to achieve these benefits. EX1004, ¶126. Indeed, such a combination would have been a matter of common sense to a POSITA. *Id*.

3. Element-by-Element Invalidity Analysis

a) Dependent Claim 8

[8.0] The projection image display apparatus according to claim 7,

This element is disclosed by Konno, as described above in Section VIII.A.2.a.[7.0]-[7.8]. EX1004, ¶¶111-122.

[8.1] wherein an optical-axis center….

Lundberg teaches that "[t]he angular deviation γ, FIG. 3, amounts in practice usually to about 10° but may, in exceptional cases, be about 15°. In order not to unnecessarily render the still projector expensive and increase its dimensions, the compensation possibilities should preferably be limited to an angle about ±15° from the normal situation. The increases in cost and dimensions are then moderate." EX1006, 4:18-24; EX1004, ¶128. Further, Lundberg discloses "[w]hen the lens 1 is displaced in parallel to compensate for the Keystone-effect from the normal case shown in FIG. 4 to a position deviating from the normal case, FIG. 5, the lighting

means 5-10, coupled to the lens 1, automatically will turn so that the ray path always is centered on the exit pupil of the lens 1, located in the rear nodal plane 12." EX1006, 4:25-63; EX1004, ¶128.

Lundberg therefore discloses element [8.1]. EX1004, ¶¶127-128. And it would have been obvious to a POSITA to combine this disclosure with the teachings of Konno for at least the reasons described above. *See Id.,* ¶¶124-126.

C. Ground 3: Claims 1 and 7 are invalid under pre-AIA 35 U.S.C. § 103 as obvious over Sato in view of Dorval and Takamoto.

1. Overview of Prior Art

a) Sato

1) Qualification as Prior Art

Sato was filed as U.S. Application Serial No. 07/988,974 on December 10, 1992, and issued as U.S. Patent No. 5,302,983 on April 12, 1994. EX1004, ¶72; EX1007. Accordingly, Sato qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was patented more than one year before the earliest U.S. filing date of the '988 Patent. *Id.* Sato was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

2) General Overview

Sato discloses a projecting apparatus. EX1007, abstract; EX1004, ¶73. This apparatus includes a first projecting system for projecting an object to form an

intermediate image, and a second projecting system for projecting the intermediate image formed by the first projecting system onto a screen in an enlarged fashion. *Id*.

Fig. 1 of Sato, reproduced and colorized for clarity below, shows the overall arrangement of Sato's projecting apparatus. EX1007, 6:46-56; EX1004, ¶74. This apparatus includes an indicator 13 (yellow), an auxiliary projecting lens 17 (green), a projecting lens 14 (red), and a projection screen 12 (pink). Image Ao (brown) is projected through auxiliary projecting lens 17 to form a first projection image A1 (blue), which is then further projected by projecting lens 14 to form screen projection image A2 (purple). *Id.*

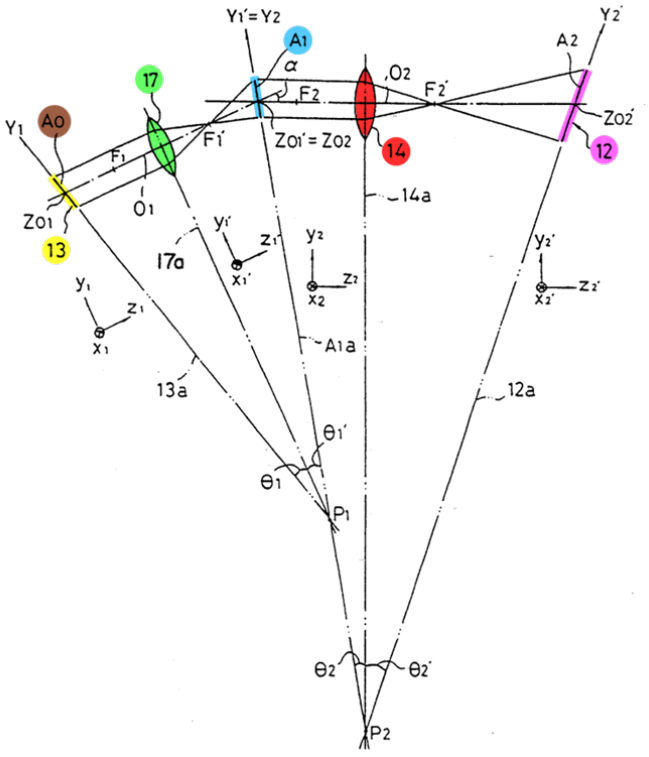


Fig. 1

More specifically, referring to Fig. 1 above, Sato explains that:

> [The] projector…has a first optical system which projects an indication image Ao of an indicator 13 (object to be projected)…through an auxiliary projecting lens 17 to form a first projection image (intermediate projection image) A1, and a second optical system which projects the first image A1 onto a projection plane, such as a projection screen 12 from an inclined direction through a projecting lens 14 to form a screen projection image A2.

EX1007, 6:46-56; EX1004, ¶75.

b) Dorval

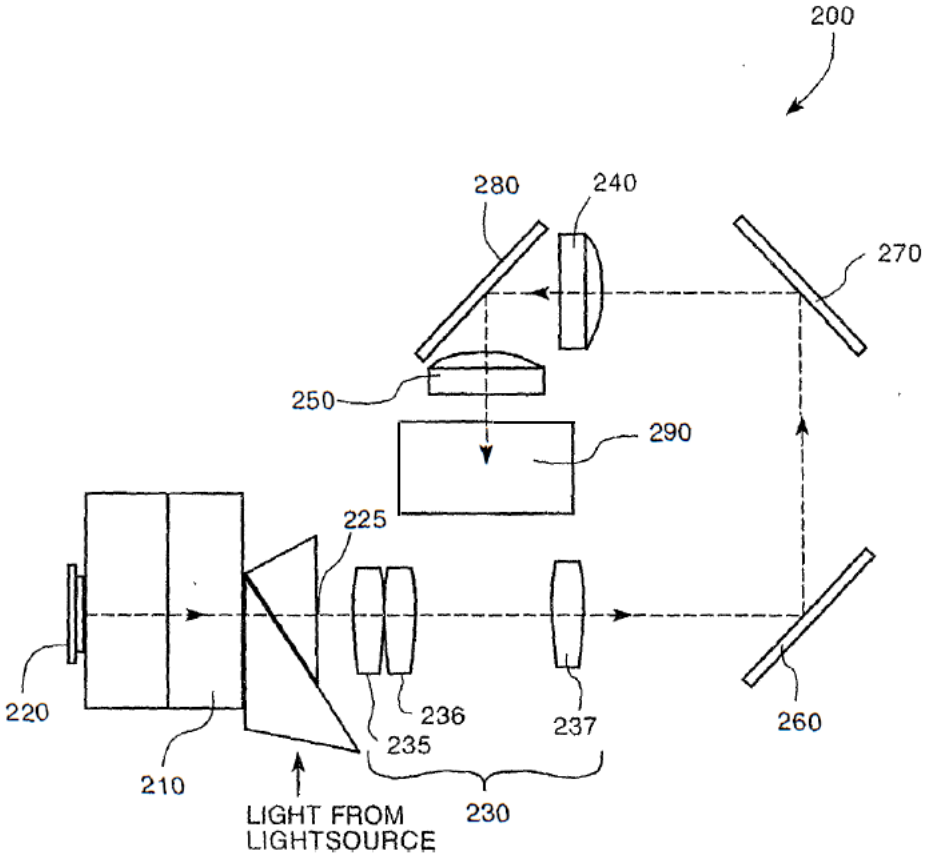
1) Qualification as Prior Art

Dorval was filed as U.S. Patent Application Serial No. 09/948,060 on September 6, 2001, and published as U.S. Patent Application Publication No. 2002/0067467 on June 6, 2002. EX1004, ¶76; EX1008. Accordingly, Dorval qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was published more than one year before the earliest U.S. filing date of the ’988 Patent. Dorval was neither cited nor considered by the Examiner during prosecution of the ’988 Patent. EX1002.

2) General Overview

Dorval discloses a three-dimensional display that produces volume-filling imagery. EX1008, [0002]-[0003]; EX1004, ¶77. Figure 2B of Dorval, reproduced

below, depicts a top-down view of a projection engine in accordance with Dorval's invention:



Dorval explains that "[t]he intermediate image, having 3.8× magnification, is formed between two field lenses, 240 and 250, which are also doublet lenses." EX1008, [0039]. Dorval also discloses that "[t]he projection system is designed to be highly compact so as to fit within a very limited space within casing 140 and dome 195, while at the same time providing the desired image magnification (i.e., about 20×) and resolution." EX1008, [0037]; EX1004, ¶78.

c) Takamoto

1) Qualification as Prior Art

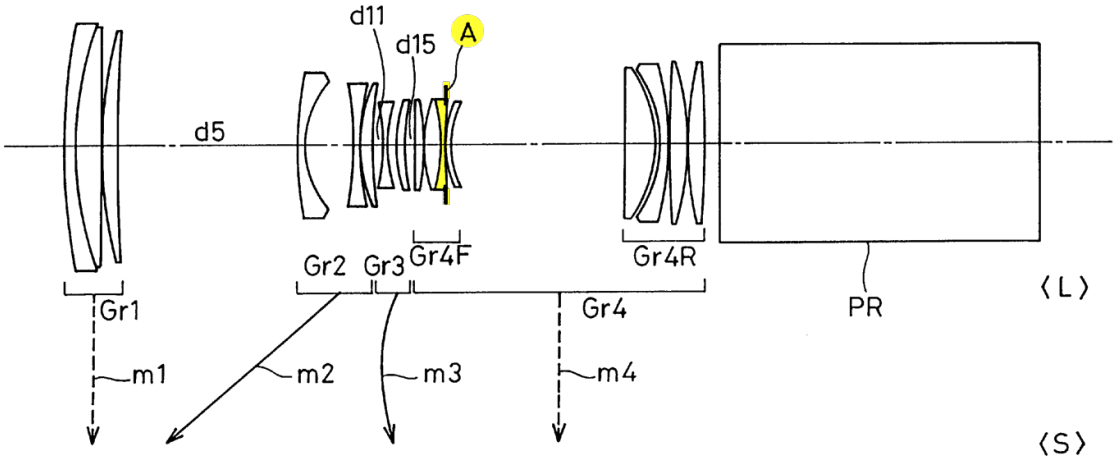
Takamoto was filed as U.S. Patent Application Serial No. 08/978,239 on November 25, 1997, and issued as U.S. Patent No. 6,028,715 on February 22, 2000. EX1004, ¶79; EX1009. Accordingly, Takamoto qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was patented more than one year before the earliest U.S. filing date of the '988 Patent. Takamoto was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

2) General Overview

Takamoto discloses a variable magnification optical system. EX1009, title; EX1004, ¶80. More particularly, Takamoto discloses "a variable magnification optical system suitable for use as a projection optical system in a projection apparatus (for example, a liquid crystal projector for projecting an image from a display device such as a liquid crystal panel onto a screen)." EX1009, 1:7-11; EX1004; ¶80.

FIG. 2 of Takamoto, reproduced and colorized for clarity below, depicts the lens arrangement in one embodiment of Takamoto's invention:

FIG. 2



Describing the components of the device depicted in FIG. 2, Takamoto explains that:

> [T]he variable magnification optical system is constituted as a four-unit zoom lens system consisting of, from the enlargement (projection) side, a first lens unit Gr1 having a positive optical power…and that is a fourth lens unit Gr4 having a positive optical power and kept in a fixed position during zooming.

EX1009, 4:44-51; EX1004, ¶81.

Takamoto also discloses an aperture stop A (yellow) within the fourth lens unit Gr4: "[i]n the first embodiment, the front lens unit Gr4F of the fourth lens unit Gr4 is composed of, from the enlargement side…an aperture stop A." EX1009, 5:25-30; EX1004, ¶82.

2. Motivation to Combine Sato with Dorval and Takamoto

A POSITA would have been motivated to combine the teachings of Sato with the teachings of both Dorval and Takamoto—and would have had a reasonable expectation of success in making such a combination—for a number of reasons. *See* EX1004, ¶¶130-135.

All three references are directed to optical systems that project an enlarged image onto a screen via one or more groups of lenses. EX1004, ¶132; *see, e.g.*, EX1007, abstract; EX1008, abstract, [0008]; EX1009, abstract. All three references are therefore in the same field of endeavor and so a POSITA would naturally have looked to them when working in this area. EX1004, ¶132; *see also In re Wood*, 599 F.2d at 1036. A POSITA would also have understood that the teachings of Sato are compatible and operable in combination with the teachings of Dorval and Takamoto. EX1004, ¶132.

A POSITA would have recognized that Dorval's volumetric display system would advantageously provide smaller, more compact solutions for projecting an enlarged image onto a screen. EX1004, ¶133. Dorval explains that "[t]he projection system is designed to…provid[e] the desired image magnification (i.e., about 20×) and resolution." EX1008, [0037]. A POSITA would therefore have been motivated to combine Dorval's teachings with those of Sato to produce a compact projection system capable of projecting an enlarged image. EX1004, ¶133.

A POSITA would also have recognized that Takamoto describes the benefit of having an aperture stop in at least one group of lenses. EX1004, ¶134. Takamoto explains that "[i]t is preferable…to dispose an aperture stop A within the front lens unit Gr4F…." EX1009, 9:11-33. This is because, with such an aperture stop, "it is possible to keep the reduction-side F-number constant during magnification adjustment." *Id*. Moreover, a POSITA would have recognized that of having an aperture stop in the first group of lenses would have enable that group of lenses to define the F-value of the entire system. EX1004, ¶134. Thus, a POSITA would have been motivated to combine Takamoto's teachings with those of Sato to obtain the benefits taught by Takamoto. *Id.*

It would also have been obvious to a POSITA to include an aperture stop in the first projection optical unit in order to control the illumination. EX1004, ¶135.

3. Element-by-Element Invalidity Analysis

a) Independent Claim 1

[1.0] A projection optical unit…comprising;

Sato's FIG. 1 is reproduced and colorized for clarity below:

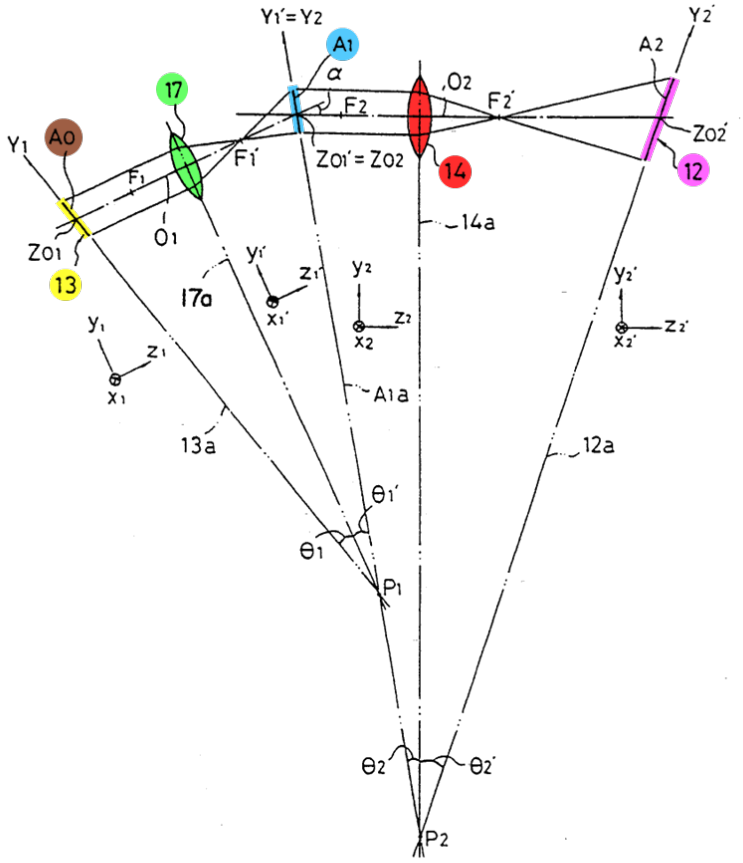


Fig. 1

Sato teaches that "[t]he present invention…relates to an apparatus ***for enlarging and projecting an image of an object, such as liquid crystal panel,*** Braun tube, original picture film, or a testpiece." EX1007, 1:12-15 (emphasis added). It is well known in the art that a liquid crystal panel, such as that disclosed by Sato, is an image display element. EX1004, ¶137. Sato therefore discloses "an image display element." EX1004, ¶¶136-137.

Accordingly, to the extent the preamble of claim 1 is deemed a limitation, Sato discloses this limitation, *i.e.*, element [1.0]. *Id*.

[1.1] a first projection optical unit…; and

Sato discloses that the projecting apparatus includes a first projection optical unit for forming a first image. EX1004, ¶¶138-141. As discussed above, Sato teaches "a first optical system which projects an indication image Ao of an indicator 13 (object to be projected), such as a liquid crystal display panel or the like through an auxiliary projecting lens 17 to form a first projection image (intermediate projection image) A1." EX1007, 6:46-58.

The "auxiliary projecting lens 17" shown in Sato's Fig. 1 above corresponds to the claimed "first projection optical unit." EX1004, ¶139. Sato discloses that this first projection optical unit has a positive refractive power. *Id*. More specifically, Sato teaches "[t]he auxiliary projecting lens 17 [] is made of a convex lens." EX1007, 9:14-18. It is well known by a POSITA that a convex lens has positive refractive power. EX1004, ¶139.

Sato teaches that:

> In case of a rectangular indication image Ao, as shown in FIG. 2a, the first projection image A1 is distorted into a trapezoidal shape, as shown in FIG. 2b. …The screen projection image A1 shown in FIG. 2c ***has magnifications slightly different from each other in the X and Y directions***, with respect to the indication image Ao. ***Namely, the image is slightly extended in the longitudinal direction (Y direction)***.

EX1007, 8:47-59 (emphasis added).

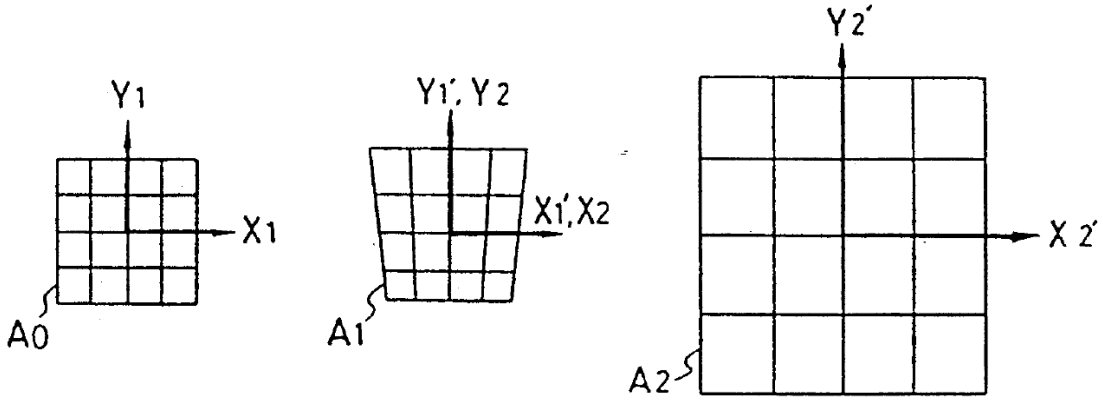


FIG. 2a FIG. 2b FIG. 2c

While Sato discloses that the first projection optical unit forms a first image A1 that is larger than the original image Ao in at least the longitudinal direction, Sato does not expressly disclose the extent of that magnification. EX1004, ¶141. Nevertheless, to the extent necessary, Dorval discloses that such a first image will be an enlarged, *i.e.*, magnified, image compared to the original. *Id*. More specifically, Dorval discloses that the image formed by the first lens group between field lenses 240 and 250 has a 3.8× magnification. EX1008, [0039]; EX1004, ¶142.

Sato, either alone or in combination with Dorval, therefore discloses element [1.1]. EX1004, ¶¶138-143.

[1.2] a second projection optical unit…;

Sato teaches that

> [The] projector shown in FIG. 1…has a first optical system which projects an indication image Ao of an indicator 13 (object to be

> projected)…and ***a second optical system which projects the first image A1 onto a projection plane***, such as a projection screen 12 from an inclined direction ***through a projecting lens 14 to form a screen projection image A2***.

EX1007, 6:46-58 (emphasis added).

Sato discloses that image A2 is "an enlarged screen projection image" which has been magnified by the same amount in both the X and Y directions. EX1007, 8:59-64. The "projecting lens 14" shown in Fig. 1 of Sato above therefore corresponds to the "second projection optical unit." EX1004, ¶145. As can be seen from Sato's Figs. 2(b) and Fig. 2(c), projection lens 14 further magnifies the image cast by the auxiliary projecting lens 17 to provide a further enlarged image on the screen. *Id*.

Because the shape of the projecting lens 14 is the same as the auxiliary projecting lens 17, a POSITA would have recognized that projection lens 14 is also a convex lens. EX1994, ¶146. Projection lens 14 therefore has a positive refractive power. *Id.*

Accordingly, Sato discloses this claim limitation, *i.e.*, element [1.2]. EX1004, ¶¶144-146.

[1.3] wherein the first enlarged image…,

Sato teaches that "it is possible to provide a first image forming plane…which forms a real image between the auxiliary projecting lens 17 and the projecting lens

14." EX1007; 10:42-52. Moreover, Sato's Fig. 1 above shows that intermediate image A1 is formed after the first projection optical unit and before the second projection optical unit. EX1004, ¶148.

Sato therefore discloses this claim limitation, *i.e.*, element [1.3]. EX1004, ¶¶147-148.

[1.4] a magnification M1…, and

Sato, either alone or in combination with Dorval, discloses forming a first enlarged image A1. *See* Section VIII.C.3.a.[1.1].

Sato also discloses forming a second enlarged image A2. S*ee* Section VIII.C.3.a.[1.3]. A POSITA would have understood from Figs. 2(a)-2(c) of Sato that the magnification M1 of the first enlarged image A1 is smaller than the magnification M2 of the second enlarged image A2. EX1004, ¶150.

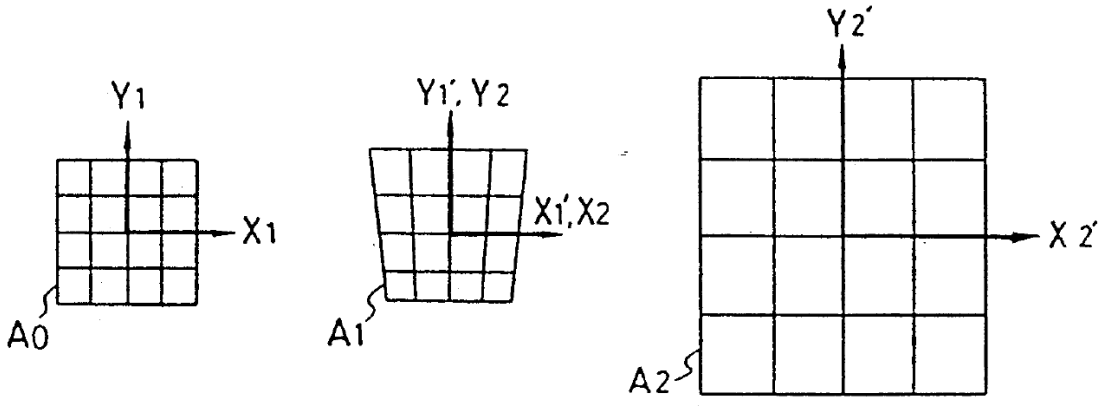


FIG. 2a FIG. 2b FIG. 2c

Moreover, to the extent necessary, Dorval discloses that "[t]he intermediate image, having 3.8× magnification is formed between two field lenses, 240 and 250," EX1008, [0039]. Dorval further discloses that "[t]he projection system is designed to be highly compact…while at the same time providing the desired image magnification (*i.e.*, about 20×) and resolution." *Id.,* [0037]. The 3.8× magnification of Dorval corresponds to magnification M1 and the 5.3× (i.e., 20×/3.8×) magnification of Dorval corresponds to magnification M2. EX1004, ¶151.

A POSITA would therefore have been motivated to combine Dorval with Sato to obtain a smaller, more compact projector capable of providing a first enlarged image and then further magnifying that image to obtain a second enlarged image larger than the first. EX1004, ¶152.

Sato, either alone or in combination with Dorval, therefore discloses this claim limitation, *i.e.*, element [1.4]. EX1004, ¶¶149-152.

[1.5] said first projection optical unit….

Takamoto teaches that "[i]t is preferable…to dispose an aperture stop A within the front lens unit Gr4F of the fourth lens unit Gr4 and substantially at the position of the front focal point of the rear lens unit Gr4R of the fourth lens unit Gr4." EX1009, 9:11-33; EX1004, ¶154. Takamoto further teaches that

> Such [an] arrangement of an aperture stop A makes it possible to realize an optical system that is telecentric toward the reduction side. …In addition, since the front lens unit Gr4F, in which the aperture stop A is

> disposed, of the fourth lens unit Gr4 is kept in a fixed position during magnification adjustment, it is possible to keep the reduction-side f-number constant during magnification adjustment.

Id.

Takamoto therefore discloses this claim limitation, *i.e.*, element [1.5]. EX1004, ¶¶153-155. And, as discussed above, a POSITA would have been motivated to combine Takamoto with Sato and, to the extent necessary, Dorval. *See* Section VIII.C.2. EX1004, ¶156.

b) Independent Claim 7

[7.0] A projection image display apparatus, comprising;

As described above, Sato teaches that "[t]he present invention relates to a projector and more precisely it relates to an apparatus for enlarging and projecting an image of an object, such as liquid crystal panel, Braun tube, original picture film, or a testpiece." EX1007, 1:12-15; EX1004, ¶158.

Thus, to the extent the preamble of claim 7 is deemed a limitation, Sato discloses this claim limitation, *i.e.*, element [7.0]. EX1004, ¶¶157-158.

[7.1] an image display element; and

This element is disclosed by Sato, as described above in Section VIII.C.3.a. EX1004, ¶¶159-160.

[7.2] a projection optical unit…,

This element is disclosed by Sato, as described above in Section VIII.C.3.a. EX1004, ¶161.

[7.3] wherein said projection optical unit…,

This element is disclosed by Sato, as described above in Section VIII.C.3.a. EX1004, ¶162.

[7.4] said first projection optical unit…, and

This element is disclosed by Sato or the combination of Sato and Dorval, as described above in Section VIII.C.3.a. EX1004, ¶163.

[7.5] said second projection optical unit…;

This element is disclosed by Sato, as described above in Section VIII.C.3.a. EX1004, ¶164.

[7.6] wherein the first enlarged image…,

This element is disclosed by Sato, as described above in Section VIII.C.3.a. EX1004, ¶165.

[7.7] a magnification M1…, and

This element is disclosed by Sato or the combination of Sato and Dorval, as described above in Section VIII.C.3.a. EX1004, ¶166.

[7.8] said first projection optical unit includes….

This element is disclosed by combining Takamoto with Sato and, to the extent necessary, Dorval, as described above in Section VIII.C.3.a. EX1004, ¶167.

D. Ground 4: Claim 8 is invalid under pre-AIA 35 U.S.C. § 103 as obvious over Sato in view of Dorval and Takamoto, and Further in View of Takeuchi

1. Takeuchi

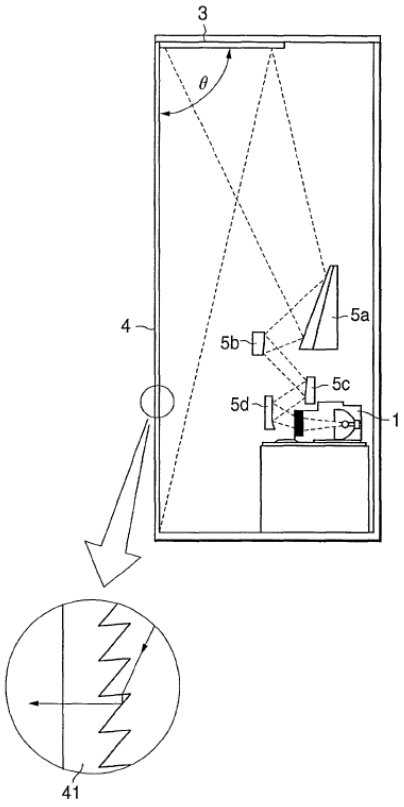
a) Qualification as Prior Art

Takeuchi was filed as U.S. Application Serial No. 09/974,966 on October 12, 2001, and published as U.S. Patent Application Serial No. Publication No. 2002/0044263A1 on April 18, 2002. EX1004, ¶83; EX1010. Accordingly, Takeuchi qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was published more than one year before the earliest U.S. filing date of the '988 Patent. *Id.* Takeuchi was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

b) General Overview

Takeuchi discloses "a rear projection television or rear projection display device and a projecting method thereof and, particularly, to a rear projection display device for enlarging and projecting an image on an image display element onto a projection screen." EX1010, [0002]; EX1004, ¶84.

Takeuchi's Fig. 4, reproduced below, depicts a rear projection television according to an embodiment of Takeuchi's invention:



Takeuchi discloses "[a]n object of the present invention is to provide a rear projection television having a size, which is reduced by removing a skirt portion thereof and reducing a depth length thereof, and a projection method for use in the rear projection television." EX1010, [0016]; EX1004, ¶86.

2. Motivation to Combine Takeuchi with Sato, Dorval, and Takamoto

A POSITA would have been motivated to combine Takeuchi with the combined system of Sato, Dorval, Takamoto, and would have had a reasonable expectation of success in making that combination. EX1004, ¶170. All four references are in the same field of endeavor and a POSITA would naturally have looked to them in their work. *Id*.; *see also In re Wood*, 599 F.2d at 1036. As Takeuchi

explains, there are significant benefits to making the optical axis center of the projection optical unit eccentric with respect to a center of the screen. *See* EX1010, [0028]; EX1004, ¶171. For example, Takeuchi discloses that by having the center of the focused image in a different position than the optical axis, and by having the optical axis of the light beam slated to the screen, the distance between the screen and the optical axis can be reduced, which in turn, permits the projection system to be made more compact. *Id.* A POSITA would therefore have been motivated to combine Takeuchi's teachings with those of Sato, Dorval, and Takamoto. *Id.*

3. Element-by-Element Analysis

a) Dependent Claim 8

[8.0] The projection image display apparatus according to claim 7,

This element is disclosed by the combination of Sato and Takamoto, and, to the extent necessary, Dorval, as described above in Section VIII.C.3.b.[7.0]-[7.8]. EX1004, ¶¶158-167.

[8.1] wherein an optical-axis center….

Takeuchi discloses that "the present projection method is featured by that a center of the focused image is different in position from the optical axis of the focusing optical system." EX1010, [0028]; EX1004, ¶172. Takeuchi therefore discloses this claim limitation, *i.e.*, element [8.1]. EX1004, ¶172. And, as discussed

above, a POSITA would have been motivated to combine Takeuchi with Sato and Takamoto and, to the extent necessary, Dorval. *See* Section VIII.D.2. EX1004, ¶173.

E. Ground 5: Claims 1 and 7 are invalid under pre-AIA 35 U.S.C. § 103 as obvious over Ninomiya in view of Dorval.

1. Overview of Prior Art

a) Ninomiya

1) Qualification as Prior Art

Ninomiya was filed as PCT Application No. PCT/JP92/00307 on March 13, 1991, entered the national stage in the United States as U.S. Patent Application Serial No. 07/949,243 on November 13, 1992, and issued as U.S. Patent No. 5,422,691 on June 6, 1995. EX1004, ¶87; EX1011. Accordingly, Ninomiya qualifies as prior art under 35 U.S.C. § 102(b) (pre-AIA) because it was published more than one year before the earliest U.S. filing date of the '988 Patent. *Id.* Ninomiya was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

2) General Overview

Ninomiya discloses a projection type displaying apparatus. EX1011, title; EX1004, ¶88. This apparatus includes a first projecting optical means that produces an intermediate image, and a second projecting optical means that projects the intermediate image on a screen. EX1011, 4:35-49; EX1004, ¶88.

FIG. 22 of Ninomiya, reproduced and colorized for clarity below, shows the overall arrangement of an oblique projection type optical system in accordance with

Ninomiya's invention. EX1011, 10:41-54; EX1004, ¶89. This system includes: a light bulb 86 (pink); a first projection optical system that includes a first lens 80, a second lens 81, a third lens 82, and a fourth lens 83 (green); an intermediate image plane 88 (yellow); a second projection optical system 85 (red); a screen 7 (blue); and an aperture stop 84 (orange). *Id.*

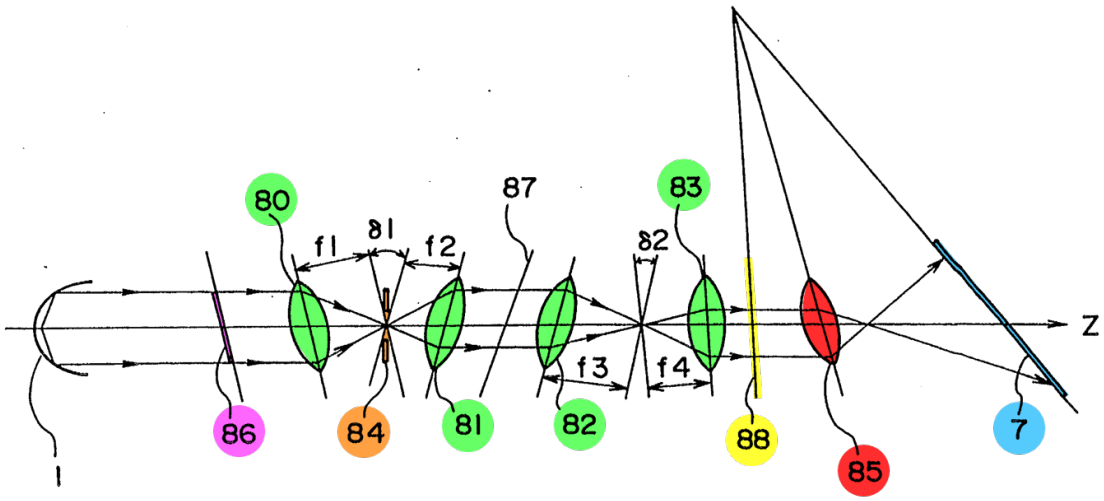


FIG. 22

Ninomiya explains that "[i]n FIG. 22, the optical axis of a first lens 80 of a first projection optical system, the optical axis of a second lens 81 thereof, the optical axis of a third lens 82 thereof, the optical axis of a fourth lens 83 thereof, the optical axis of an aperture stop mechanism 84, the optical axis of a second projection optical system 85, the normal of a light bulb 86, and the normal of a screen 7 are placed on the same plane. In the figure, reference numeral 87 is a first intermediate image

plane. Reference numeral 88 is a second intermediate image plane." EX1011, 10:45-54; EX1004, ¶90.

b) Dorval

1) Qualification as Prior Art

See Section VIII.C.1.b.(1).

2) General Overview

See Section VIII.C.1.b.(2).

2. Motivation to Combine Ninomiya with Dorval.

A POSITA would have been motivated to combine the teachings of Ninomiya with the teachings of Dorval —and would have had a reasonable expectation of success in making that combination—for a number of reasons. *See* EX1004, ¶¶175-177.

Both references are directed to optical systems that project an enlarged image onto a screen via at least two groups of lenses. EX1004, ¶175; *see, e.g.*, EX1011, abstract, 14:31-34; EX1008, abstract, [0008]. Both references are therefore in the same field of endeavor and so a POSITA would naturally have looked to them when working in this area. *See In re Wood*, 599 F.2d at 1036. A POSITA would also have understood that the teachings of Ninomiya are compatible and operable in combination with the teachings of Dorval. EX1004, ¶175.

A POSITA would have recognized that Dorval's volumetric display system would advantageously provide smaller, more compact solutions for projecting an

enlarged image onto a screen. EX1004, ¶176. Dorval explains that "[t]he projection system is designed to…provid[e] the desired image magnification (i.e., about 20×) and resolution." EX1008, [0037]. A POSITA would therefore have been motivated to combine Dorval's teachings with those of Ninomiya to produce a compact projection system capable of projecting an enlarged image. EX1004, ¶176.

3. Element-by-Element Invalidity Analysis

a) Independent Claim 1

[1.0] A projection optical unit…, comprising;

Ninomiya's FIG. 22 is annotated below:

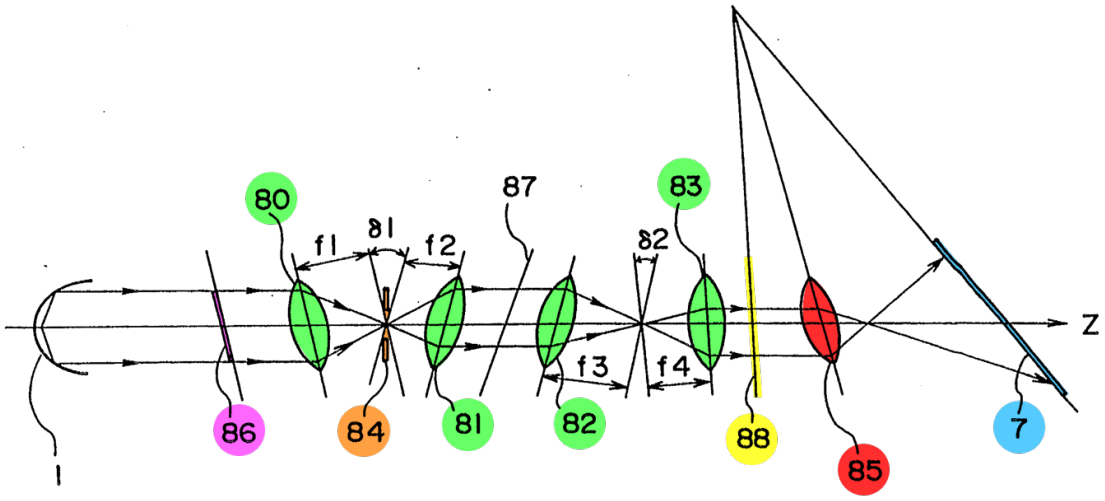


FIG. 22

Ninomiya discloses "a projection type displaying apparatus for displaying video images, computer images, and so forth, [including] a projection type displaying apparatus for obliquely projecting these images from the rear of a screen

with a liquid crystal light bulb or the like." EX1011, 1:6-12. Ninomiya teaches that "when ***an image formed by a liquid crystal*** or the like is projected by using the above-mentioned lighting unit, ***an enlarged projection image*** with an even brightness can be obtained." *Id.*, 14:31-34 (emphasis added). It is well known in the art that a liquid crystal panel, such as that disclosed by Ninomiya, is an image display element. EX1004, ¶179.

Accordingly, to the extent the preamble of claim 1 is deemed a limitation, Ninomiya discloses this limitation, *i.e.*, element [1.0]. *Id.*, ¶¶178-179

[1.1] a first projection optical unit…; and

Ninomiya discloses a projection optical unit having a first projection optical unit that forms a first image. EX1004, ¶¶180-186.

Ninomiya teaches that "[t]he first lens 80 of the first projection optical system and the second lens 81 thereof are inclined by an angle δ1 to each other. …[And] the third lens 82 of the first projection optical system and the fourth lens 83 thereof are inclined by an angle δ2 each other." EX1011, 10:62-11:5. Ninomiya further teaches that

> An image on the light bulb 86 passes through the first lens 80 of the first projection optical system, the second lens 81 thereof, and the aperture stop mechanism with the shape as shown in FIG. 23 (A). Thus, an image with a trapezoidal distortion is formed on the first intermediate image plane 87. Thereafter, the first intermediate image

> passes through the third lens 82 of the first projection optical system and the fourth lens 83 thereof. Thus, a second intermediate image with a trapezoidal distortion is formed on the second intermediate image plane 88.

EX1011,11:17-27.

The "first projection optical system" disclosed by Ninomiya – which includes "a first lens 80, a second lens 81, a third lens 82, and a fourth lens 83" as shown in FIG. 22 reproduced above – corresponds to the first projection optical unit. EX1004, ¶182. Consequently, Ninomiya's second intermediate image (which is formed on the second intermediate image plane 88) corresponds to the "first image" of the claims. *Id.*

Moreover, as shown in FIG. 22 reproduced above, each of the first, second, third, and fourth lenses is a convex lens, and a POSITA would know that a convex lens has a positive refractive power. EX1004, ¶¶183-184.

While Ninomiya does disclose that the first projection optical unit forms a first image, Ninomiya does not expressly disclose that this image is enlarged relative to the original image. EX1004, ¶186. Nevertheless, to the extent necessary, Dorval discloses that such a first image is an enlarged image, *i.e.*, "[t]he intermediate image[] having 3.8× magnification is formed between two field lenses, 240 and 250." EX1008, [0039]; EX1004, ¶186.

Ninomiya, either alone or in combination with Dorval, therefore discloses this claim limitation, *i.e.*, element [1.1]. EX1004, ¶180-187.

[1.2] a second projection optical unit…;

Ninomiya teaches that "the second intermediate image passes through the second projection optical system 85. Thus, an image without a trapezoidal distortion is formed on the screen 7." EX1011, 11:28-31. Further, Ninomiya discloses "when an image formed by a liquid crystal or the like is projected by using the above-mentioned lighting unit, ***an enlarged projection image*** with an even brightness can be obtained." EX1011, 14:31-34 (emphasis added). The second projection optical unit corresponds to "the second projection optical system 85" shown in Fig. 22 of Ninomiya above. EX1004, ¶189.

As obvious from Fig. 22, the image formed on the screen 7 is larger than the second intermediate image formed on the second intermediate image plane 88, thus Ninomiya discloses or inherently discloses the feature of forming a second enlarged image by further enlarging the intermediate image. EX1004, ¶190.

Ninomiya inherently discloses said second projection optical unit having positive refractive power. EX1004, ¶191. As would have recognized by a POSITA, Ninomiya's Fig. 22 shows that the fifth lens (the second projection optical system 85) is a convex lens, and a POSITA would have recognized that a convex lens has positive refractive power. *Id*.

Ninomiya therefore discloses this claim limitation, *i.e.*, element [1.2]. EX1004, ¶¶188-191.

[1.3] wherein the first enlarged image…,

Ninomiya discloses that "second intermediate image with a trapezoidal distortion is formed on the second intermediate image plane 88. Next, the second intermediate image passes through the second projection optical system 85." EX1011; 11:25-29. Ninomiya's Fig. 22 above also shows that the second intermediate image plane where the second intermediate image is formed is in between the first projection optical system and the second projection optical system. EX1004, ¶194.

Ninomiya therefore discloses this claim limitation, *i.e.*, element [1.3]. EX1004, ¶¶192-194.

[1.4] a magnification M1…, and

Ninomiya, either alone or in combination with Dorval, discloses forming a first enlarged image. *See* Section VIII.E.3.a.[1.1]. Ninomiya also discloses forming a second enlarged image. *See* Section VIII.E.3.a.[1.2].

While Ninomiya does not expressly discloses that the magnification M1 of the first enlarged image is smaller than the magnification M2 of the second enlarged image, Dorval discloses "[an] intermediate image, having 3.8× magnification is formed between two field lenses, 240 and 250." EX1008, [0039]. Dorval also

discloses that "[t]he projection system is designed to be highly compact so as to fit within a very limited space within casing 140 and dome 195, while at the same time providing the desired image magnification (i.e., about 20×) and resolution." *Id.,* [0037]. The 3.8× magnification disclosed by Dorval corresponds to magnification M1 and the approximately 5.3× magnification of Dorval (*i.e.*, 20×/3.8×) corresponds to magnification M2. EX1004, ¶196. And, as discussed above, a POSITA would have been motivated to combine Dorval with Ninomiya. *Id.*; *see also* Section VIII.E.2.

The combination of Ninomiya and Dorval therefore discloses this claim limitation, *i.e.*, element [1.4]. EX1004, ¶¶195-196.

[1.5] said first projection optical unit….

As shown in Ninomiya's FIG. 22, Ninomiya's projector includes an aperture stop mechanism. EX1004, ¶198. Moreover, Ninomiya discloses that "[an] aperture stop mechanism is disposed at the position where the focal plane of the first lens 80 and the focal plane of the second lens 81 are intersected on the axis Z." EX1011, 10:68-11:3. Ninomiya also discloses that "the aperture stop mechanism stops vertical rays of light with a low resolution which are radiated from the light source 1 shown in FIG. 22." *Id.,* 11:36-39; EX1004, ¶198. Because the aperture stop mechanism affects the amount of lights passing through, a POSITA would have

recognized that the aperture stop mechanism of Ninomiya defines the F-value of the entire projection optical unit. EX1004, ¶189.

Ninomiya therefore discloses this claim limitation, *i.e.*, element [1.5]. EX1004, ¶¶197-199.

b) Independent Claim 7

[7.0] A projection image display apparatus, comprising;

As discussed above, Ninomiya teaches "a projection type displaying apparatus for displaying video images, computer images, and so forth [including] a projection type displaying apparatus for obliquely projecting these images from the rear of a screen with a liquid crystal light bulb or the like." EX1011, 1:6-12; EX1004, ¶201.

Ninomiya therefore discloses this claim limitation, *i.e.*, element [7.0]. EX1004, ¶¶200-201.

[7.1] an image display element; and

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶¶202-203.

[7.2] a projection optical unit for projecting…,

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶204.

[7.3] wherein said projection optical unit…,

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶205.

[7.4] said first projection optical unit…, and

This element is disclosed by the combination of Ninomiya and Dorval, as described above in Section VIII.E.3.a. EX1004, ¶206.

[7.5] said second projection optical unit…;

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶207.

[7.6] wherein the first enlarged image…,

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶208.

[7.7] a magnification M1 of the first enlarged image…, and

This element is disclosed by the combination of Ninomiya and Dorval, as described above in Section VIII.E.3.a. EX1004, ¶209.

[7.8] said first projection optical unit includes….

This element is disclosed by Ninomiya, as described above in Section VIII.E.3.a. EX1004, ¶210.

F. Ground 6: Claim 8 is invalid under pre-35 U.S.C. § 103 as obvious over Ninomiya in view of Dorval, and further in view of Takeuchi

1. Takeuchi

a) Qualification as Prior Art

See Section VIII.D.1.a.

b) General Overview

See Section VIII.D.1.b.

2. Motivation to Combine Takeuchi with Ninomiya and Dorval

A POSITA would have been motivated to further combine Takeuchi with the combined system of Ninomiya and Dorval and would have had a reasonable expectation of success in making the combination. EX1004, ¶213. All references are in the same field of endeavor and a POSITA would naturally have looked to them in their work. EX1004, ¶213. As Takeuchi explains, there are significant benefits to make the optical axis center of the projection optical unit eccentric with respect to a center of the screen. *See* EX1010, [0028]; EX1004, ¶213; *see also* Section VIII.D.2.

A POSITA would thus have been motivated to combine Takeuchi's teachings with those of Ninomiya and Dorval and would have recognized that combining those teachings would have produced predictable and operable results. *Id.*

3. Element-by-Element Analysis

a) Dependent Claim 8

[8.0] The projection image display apparatus according to claim 7,

This element is disclosed by the combination of Ninomiya and Dorval as described above in Section VIII.E.3.b.[7.0]-[7.8]. EX1004, ¶¶200-210.

[8.1] wherein an optical-axis center….

This element is disclosed by Takeuchi, as described above in Section VIII.D.3.a. EX1004, ¶214. And, as discussed above, a POSITA would have been motivated to combine Takeuchi with Ninomiya and Dorval. *See* Section VIII.E.2.

G. Ground 7: Claims 1, 7, and 8 are invalid under pre-AIA 35 U.S.C. § 103 as obvious over Kurematsu in view of Dorval and Takamoto.

a) Kurematsu

1) Qualification as Prior Art

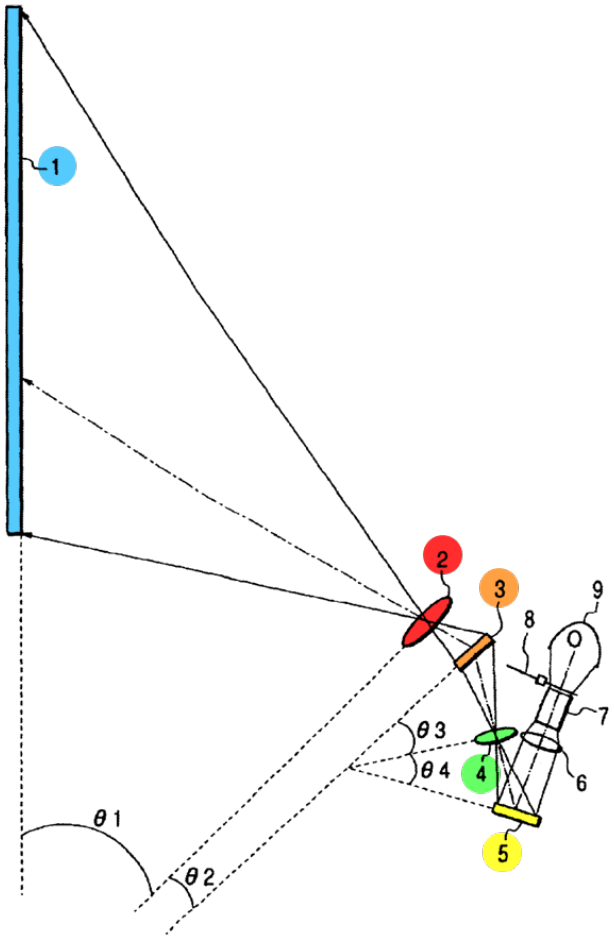
Kurematsu was filed as U.S. Patent Application Serial No. 09/680,770 on October 6, 2000, and issued as U.S. Patent No. 6,808,271B1 on October 26, 2004. EX1004, ¶91; EX1012. Accordingly, Kurematsu qualifies as prior art under 35 U.S.C. § 102(e) (pre-AIA) because it was filed before the earliest priority date of the '988 Patent, *i.e.,* November 28, 2003, and later issued as a patent. *Id.* Kurematsu was neither cited nor considered by the Examiner during prosecution of the '988 Patent. EX1002.

2) General Overview

Krematsu discloses a projection type display apparatus that includes a first projection optical system for projecting light from an original picture and forming an intermediate image, and a second projection optical system for projecting the intermediate image onto a surface. EX1012*,* abstract; EX1004, ¶92.

FIG. 1 of Krematsu, reproduced and colorized for clarity below, shows a thin type rear projection display apparatus in accordance with Krematsu's invention. EX1012, 3:11-36. This apparatus includes a DMD display device 5 (yellow), a first projection optical system 4 (green), a transmission type diffracting optical element 3 (orange) for an intermediate projected image to be formed on, a second projection optical system 2 (red), and a screen 1 (blue). *Id*.

FIG. 1



Kurematsu explains that "[o]nly the display reflected light from the DMD display device 5 passes through the auxiliary projection lens 4, and by the imaging action of this auxiliary projection lens 4, the intermediate projected image thereof is formed on the transmission type diffracting optical element 3." EX1012, 3:37-41; EX1004, ¶94. In addition, "the intermediate image is enlarged and projected onto the screen by the main projection lens 2." *Id.,* 4:9-11; EX1004, ¶94.

b) Dorval

1) Qualification as Prior Art

See Section VIII.C.1.b.(1).

2) General Overview

See Section VIII.C.1.b.(2).

c) Takamoto

1) Qualification as Prior Art

See Section VIII.C.1.c.(1).

2) General Overview

See Section VIII.C.1.c.(2).

2. Motivation to Combine Kurematsu with Dorval and Takamoto

A POSITA would have been motivated to combine the teachings of Kurematsu with the teachings of Dorval and Takamoto—and would have had a reasonable expectation of success in making that combination—for a number of reasons. *See* EX1004, ¶¶217-220.

All three references are directed to optical systems that project an enlarged image onto a screen via one or more groups of lenses. EX1004, ¶217; *see, e.g.*, EX1012, abstract, 4:9-11; EX1008, abstract, [0008]; EX1009, abstract. Accordingly, the references are in the same field of endeavor and so a POSITA would naturally have looked to both when working in this area. EX1004, ¶217; *see also In re Wood*,

599 F.2d at 1036. A POSITA would also have understood that the teachings of Kurematsu are compatible and operable in combination with the teachings of Dorval and Takamoto. EX1004, ¶217.

A POSITA would have recognized that Dorval's volumetric display system would advantageously provide smaller, more compact solutions for projecting an enlarged image onto a screen. EX1004, ¶218; *see also* Section VIII.C.1. A POSITA would therefore have been motivated to combine Dorval's teachings with those of Kurematsu to produce a compact projection system capable of projecting an enlarged image. *Id*.

Additionally, a POSITA would have recognized that Takamoto describes the benefit of having an aperture stop in the first projection optical unit, *viz.*, to enable the first projection optical unit to define the F-value of the entire system. EX1004, ¶219. EX1004, ¶219. A POSITA would have been motivated to take advantage of that benefit by adding Takamoto's aperture stop to Kurematsu's apparatus. *Id.*

A POSITA would thus have been motivated to combine the teachings of Kurematsu with those of Dorval and Takamoto and would have recognized that combining those teachings would have produced predictable and operable results. EX1004, ¶220.

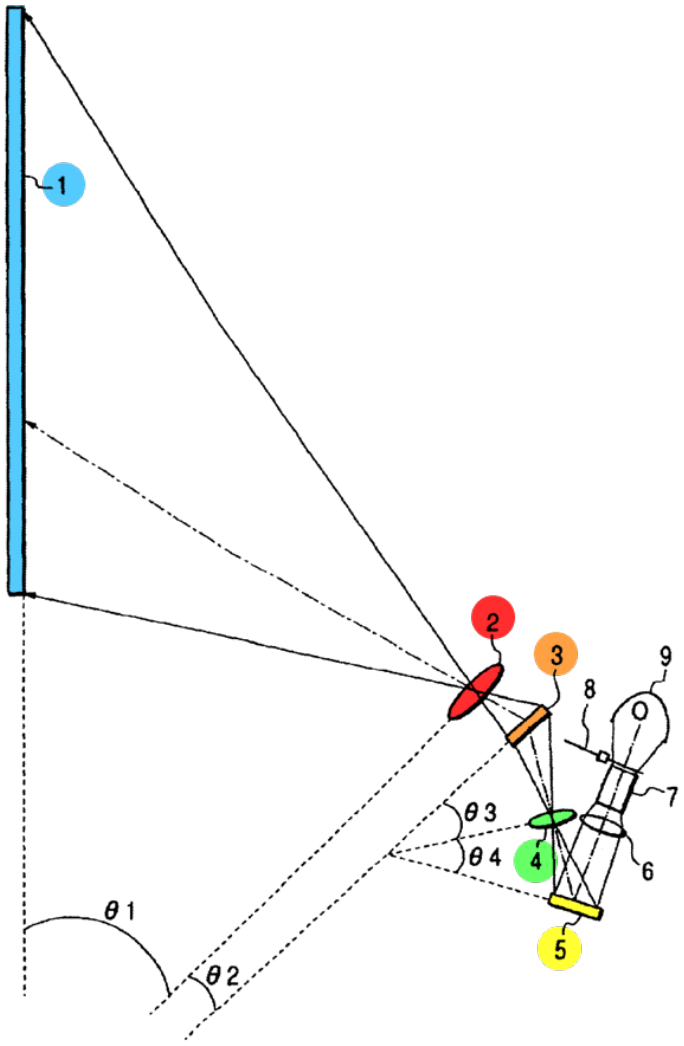
3. Element-by-Element Invalidity Analysis

a) Independent Claim 1

[1.0] A projection optical unit…, comprising;

Kurematsu's FIG. 1 is reproduced and colorized for clarity below:

FIG. 1



Kurematsu teaches that "light from the ***DMD display device 5*** passes through the auxiliary projection lens 4, and by the imaging action of this auxiliary projection lens 4, the intermediate projected image thereof is formed on the transmission type

diffracting optical element 3." EX1012, 3:37-41 (emphasis added). It is well known and recognized that the DMD disclosed by Kurematsu is an image display element. EX1004, ¶222.

Kurematsu discloses that the "projection type display apparatus for obliquely projecting an original image onto a screen includes a first projection optical system for projecting light from an original picture and forming an intermediate image having trapezoid distortion caused therein [and] a second projection optical system for obliquely projecting the light from the intermediate image onto a surface for projection." EX1012, abstract. Kurematsu further discloses "the intermediate image is enlarged and projected onto the screen by the main projection lens 2 [red]." *Id.,* 4:9-11.

Accordingly, to the extent the preamble of claim 1 is deemed a limitation, Kurematsu discloses this claim limitation, *i.e.*, element [1.0]. EX1004, ¶¶221-223.

[1.1] a first projection optical unit…; and

Kurematsu discloses "FIG. 1 generally shows a basic optical system for a thin type rear projection display apparatus according to an embodiment of the present invention. In FIG. 1…***reference numeral 4 denotes an auxiliary projection lens (a first projection optical system)***." EX1012, 3:11-24 (emphasis added). Kurematsu further discloses "the display reflected light from the DMD display device 5 passes through the auxiliary projection lens 4, and by the imaging action of this auxiliary

projection lens 4, the intermediate projected image thereof is formed on the transmission type diffracting optical element 3." EX1012, 3:37-41.

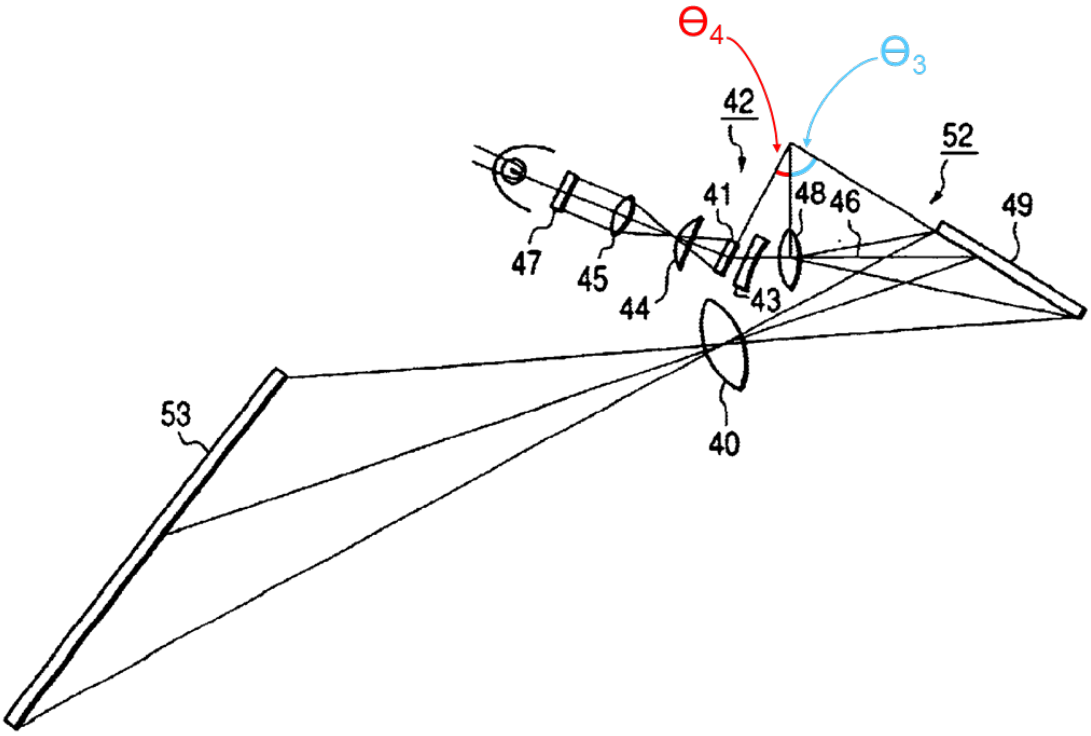
The "first projection optical system 4" shown in Kurematsu's FIG. 1 above corresponds to the first projection optical unit. EX1004, ¶226. Kurematsu discloses that this first projection optical unit has a positive refractive power. *Id*. More specifically, Kurematsu's FIG. 1 shows that the auxiliary projection lens is a convex lens. It is well known by a POSITA that a convex lens has positive refractive power. *Id*.

In addition, to the extent necessary, Takamoto can be combined with Kurematsu to teach an auxiliary projection lens 4 having a positive refractive power. *Id*. More specifically, Takamoto discloses "[i]n all of the [] embodiments, the variable magnification optical system is constituted as a four-unit zoom lens system consisting of, from the enlargement (projection) side, a first lens unit Gr1 having a positive optical power…[and] ***a fourth lens unit Gr4 having a positive optical power***." EX1009, 4:44-51 (emphasis added). The motivation to combine Takamoto and Kurematsu is discussed above.

Further, if tilt angles θ_3 and θ_4 from FIG. 1 of Kurematsu are applied to FIG. 6, as shown in the annotated reproduction of FIG. 6 below, θ_3 is larger than θ_4. EX1004; ¶227. Since θ_3 is shown to be larger than θ_4, a POSITA would understand that auxiliary projection lens 4 is enlarging. *Id.* This is confirmed by the fact that

reflecting mirror 49—where the intermediate image is formed—is larger than display 41, meaning the intermediate image (*i.e.*, the first image) has been enlarged relative to the original. *Id*.

FIG. 6 PRIOR ART



Additionally, to the extent necessary, Dorval can also be combined with Kurematsu to teach that the first image is an enlarged image. EX1004; ¶228. In particular, as noted above, Dorval discloses an "intermediate image, having 3.8× magnification is formed between two field lenses, 240 and 250." EX1008, [0039]. The motivation to combine Dorval and Kurematsu is discussed above.

Kurematsu, either alone or in combination with Takamoto or Dorval or both Takamoto and Dorval, discloses this limitation, *i.e.*, element [1.1]. EX1004, ¶¶224-228.

[1.2] a second projection optical unit…;

Kurematsu teaches that "FIG. 1 generally shows a basic optical system for a thin type rear projection display apparatus [in which] ***reference numeral 2 denotes a main projection lens (a second projection optical system)***." EX1012, 3:11-24 (emphasis added). Kurematsu further discloses that "the intermediate image [formed by the first projection optical system] is enlarged and projected onto the screen by the main projection lens 2." EX1012, 4:9-11. The "second projection optical system 2" shown in FIG. 1 of Kurematsu above corresponds to the second projection optical unit. EX1004, ¶231.

Kurematsu discloses the second projection optical unit has a positive refractive power because FIG. 1 shows that the main projection lens 2 is a convex lens. EX1004, ¶232. It is well known by a POSITA that a convex lens has positive refractive power. *Id*. Moreover, a POSITA would have understood from FIG. 1 and from the working principle of the projector, that the main projection lens 2 must have a positive refractive power and, necessarily, a larger magnifying power than the auxiliary projection lens in order to achieve the intended function of projecting an enlarged image. *Id*.

In addition, to the extent necessary, Takamoto can be combined with Kurematsu to teach that main projection lens 2 should have a positive refractive power. EX1004, ¶233. More specifically, Takamoto discloses "[i]n all of the [] embodiments, the variable magnification optical system is constituted as a four-unit zoom lens system consisting of, from the enlargement (projection) side, ***a first lens unit Gr1 having a positive optical power***…[and] a fourth lens unit Gr4 having a positive optical power." EX1009, 4:44-51 (emphasis added). The motivation to combine Takamoto and Kurematsu is discussed above.

Kurematsu, alone or in combination with Takamoto, therefore discloses this claim limitation, *i.e.*, element [1.2]. EX1004, ¶¶230-233.

[1.3] wherein the first enlarged image…,

Kurematsu teaches that "the intermediate projected image thereof is formed on the transmission type diffracting optical element 3." EX1012; 3:39-41. FIG. 1 above also shows that the transmission type diffracting optical element where the intermediate image is formed is in between the first projection optical system and the second projection optical system. EX1004, ¶235. This is also consistent with the specification of the '988 patent. *Id.*

Kurematsu therefore discloses this limitation, *i.e.*, element [1.3]. EX1004, ¶¶234-235.

[1.4] a magnification M1…, and

As described above, Kurematsu, alone or in combination with Dorval, discloses forming a first enlarged image. *See* Section VIII.G.3.a.[1.1]. Kurematsu also discloses forming a second enlarged image. *See* Section VIII.G.3.a.[1.2]. Further, a POSITA would have understood from FIG. 1 and the intended function of Kurematsu's projector that magnification M2 is larger than magnification M1. EX1004, ¶237.

Additionally, to the extent necessary, Dorval discloses this arrangement. More specifically, Dorval discloses that "[t]he intermediate image, having 3.8× magnification is formed between two field lenses, 240 and 250," and that "[t]he projection system is designed to…provid[e] the desired image magnification (*i.e.*, about 20×) and resolution." *Id.,* [0039]; [0037]. The 3.8× magnification of Dorval corresponds to magnification M1 and the 5.3× magnification (*i.e.,* 20×/3.8×) of Dorval corresponds to magnification M2. EX1004, ¶238. The motivation to combine Kurematsu and Dorval is discussed above.

Kurematsu, either alone or in combination with Dorval, therefore discloses this limitation, *i.e.*, element [1.4]. EX1004, ¶¶236-239.

[1.5] said first projection optical unit includes….

The relevant disclosure of Takamoto is described above. *See*, Section VIII.C.3.a.[1.5], It would have been obvious for a POSITA to place an aperture stop

at the auxiliary projection lens to control the amount of light, and therefore to control the F-value of the entire projection optical unit. EX1004, ¶¶240-243.

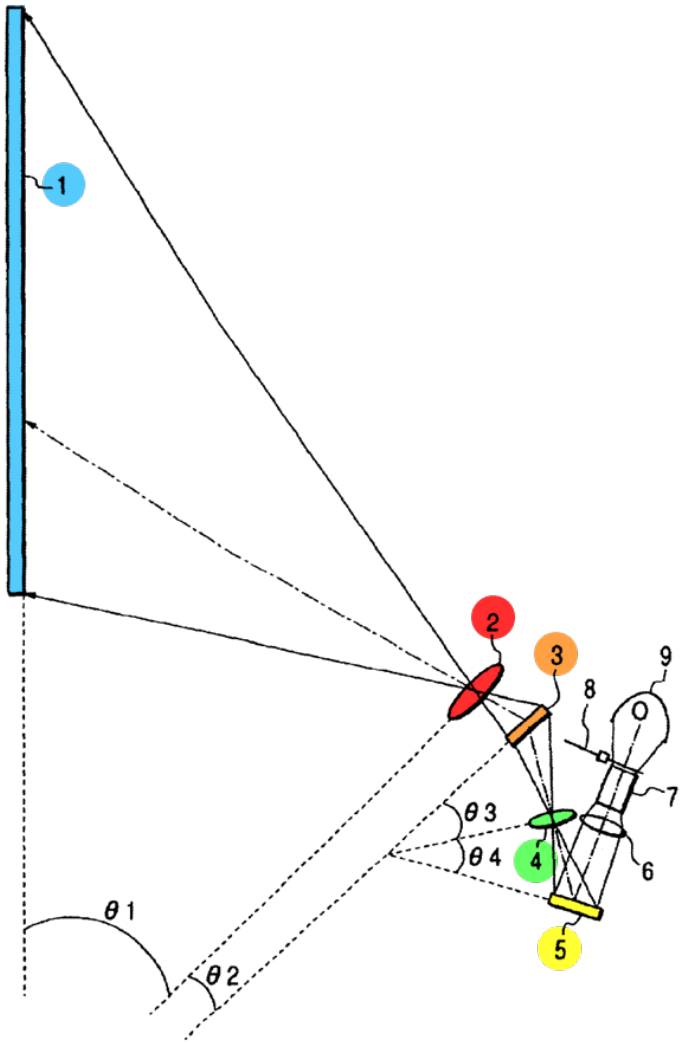
Takamoto therefore discloses this claim limitation, *i.e.*, element [1.5]. *Id.*

b) Independent Claim 7

[7.0] A projection image display apparatus, comprising;

Kurematsu's FIG. 1 is reproduced and colorized for clarity below:

FIG. 1



Kurematsu teaches "a projection type display apparatus [that] includes a first projection optical system for projecting light from an original picture and forming an intermediate image…[and] a second projection optical system for obliquely projecting the light from the intermediate image onto a surface for projection." EX1012, abstract.

Accordingly, to the extent the preamble of claim 7 is deemed a limitation, Kurematsu discloses this claim limitation, *i.e.*, element [7.0]. EX1004, ¶¶244-245.

[7.1] an image display element; and

This element is disclosed by Kurematsu, as described above in Section VIII.G.3.a. EX1004, ¶¶246-247.

[7.2] a projection optical unit…,

This element is disclosed by Kurematsu, as described above in Section VIII.G.3.a. EX1004, ¶248.

[7.3] wherein said projection optical unit includes…,

This element is disclosed by Kurematsu, as described above in Section VIII.G.3.a. EX1004, ¶249.

[7.4] said first projection optical unit…, and

This element is disclosed by Kurematsu, alone or in combination with Dorval or Takamoto or both Takamoto and Dorval, as described above in Section VIII.G.3.a. EX1004, ¶250.

[7.5] said second projection optical unit…;

This element is disclosed by Kurematsu, as described above in Section VIII.G.3.a. EX1004, ¶251.

[7.6] wherein the first enlarged image is formed …,

This element is disclosed by Kurematsu, as described above in Section VIII.G.3.a. EX1004, ¶252.

[7.7] a magnification M1 of the first enlarged image…, and

This element is disclosed by Kurematsu, alone or in combination with Dorval, as described in Section VIII.G.3.a. EX1004, ¶253.

[7.8] said first projection optical unit includes….

This element is disclosed by the combination of Kurematsu and Takamoto, as described in Section VIII.G.3.a. EX1004, ¶254.

c) Dependent Claim 8

[8.0] The projection image display apparatus according to claim 7,

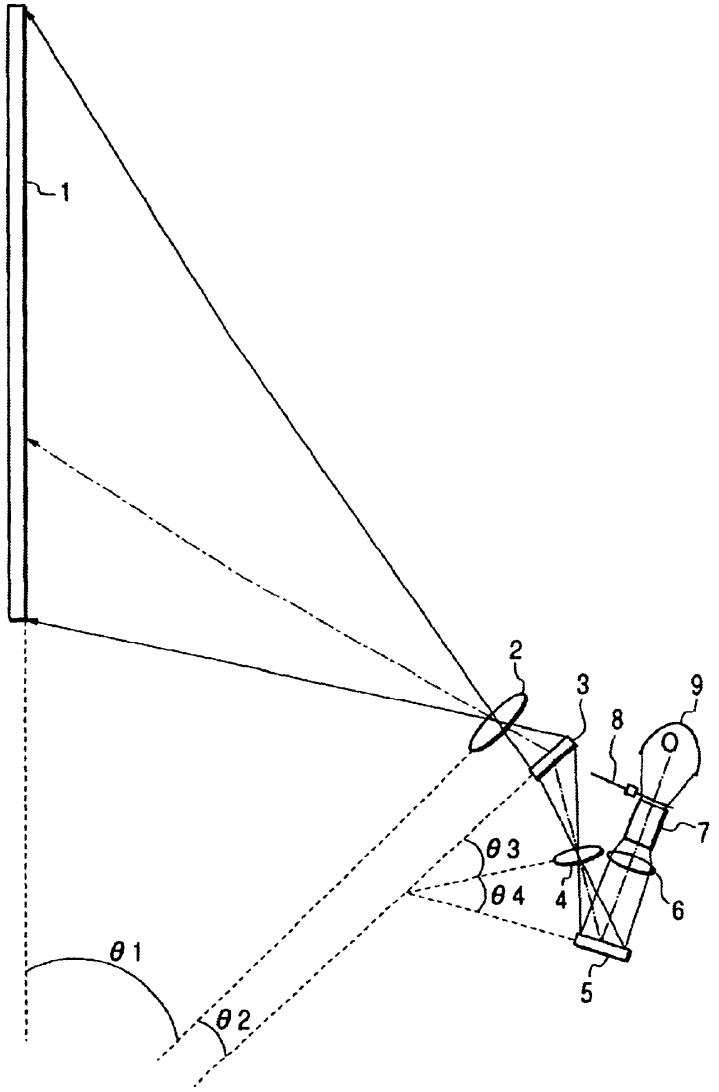
This element is disclosed by the combination of Kurematsu and Takamoto, and, optionally, Dorval, as described above in Section VIII.F.3.b.[7.0]-[7.8]. EX1004, ¶¶244-254.

[8.1] wherein an optical-axis center….

Kurematsu teaches that "the screen 1 and the light deflecting element 3 are installed while being tilted with each other relative to the optical axis of the main

projection lens 2, and the tilt angles θ2 and θ1 thereof are also set in conformity to the Sheimpflug rule." EX10012, 4:14-18. Further, Kurematsu's Fig. 1, reproduced below, shows that the optical axis (dotted line) is eccentric with respect to the center of the screen. EX1004, ¶256.

FIG. 1



Kurematsu therefore discloses this claim limitation, *i.e.*, element [8.1]. EX1004, ¶¶255-256.

IX. SECONDARY CONSIDERATIONS

Petitioners are not aware of any secondary considerations that would make claims 1, 7, and 8 of the ’988 Patent nonobvious over the prior art discussed herein. EX1004, ¶¶258-259. Regardless, any possible secondary considerations would not overcome the above-cited prior art, which clearly demonstrates that the subject matter of claims 1, 7, and 8 of the ’988 Patent would have been obvious to a POSITA as of November 28, 2003. *Id.*

X. CONCLUSION

For the reasons above, Petitioners ask that the Patent Office order an *inter partes* review trial and cancel the Challenged Claims as unpatentable.

Respectfully submitted,

Date: May 6, 2025

/Donald R. McPhail/
Donald R. McPhail
Counsel for Petitioners
Registration No. 35,811

CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned attorney for the Petitioners declares that this Petition, excluding the table of contents, mandatory notices, certificate of service, and appended claim listing, has 11,508 words according to the word count tool in Microsoft Word™.

/Donald R. McPhail/
Donald R. McPhail
Counsel for Petitioners
Registration No. 35,811

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF SERVICE

The undersigned certifies, in accordance with 37 C.F.R. §§ 42.105 and 42.6, that service was made on the Patent Owner as detailed below.

Date of service May 6, 2025

Manner of service Electronic Mail and UPS Mail Service

Documents served Petition for *Inter Partes* Review, including Exhibits and Power of Attorney

Served upon:

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Date: May 6, 2025

Respectfully Submitted,

/Donald R. McPhail/
Donald R. McPhail
Counsel for Petitioners
Registration No. 35,811

APPENDIX A – CLAIM LISTING

U.S. Patent No. 7,159,988

Claim or Element #	Claim Language
Claim 1	
[1.0]	A projection optical unit for enlarged projection of an image displayed by an image display element, comprising:
[1.1]	a first projection optical unit for forming a first enlarged image, said first projection optical unit having positive refractive power; and
[1.2]	a second projection optical unit positioned at an enlarged image side of said first projection optical unit in order to form a second enlarged image by further enlarging the first enlarged image obtained by said first projection optical unit, said second projection optical unit having positive refractive power;
[1.3]	wherein the first enlarged image is formed at the image display element side, rather than at said second projection optical unit,
[1.4]	a magnification M1 of the first enlarged image is smaller than a magnification M2 of the second enlarged image, and
[1.5]	said first projection optical unit includes an aperture stop that defines an F-value of said entire projection optical unit.

Claim 7	
[7.0]	A projection image display apparatus, comprising:
[7.1]	an image display element; and
[7.2]	a projection optical unit for projecting, in an enlarged form and onto a projection screen, an image displayed by said image display element, wherein said projection optical unit includes
[7.3]	a first projection optical unit and a second projection optical unit, both arranged on an optical path ranging from said image display element to the screen,
[7.4]	said first projection optical unit being adapted to form a first enlarged image and having positive refractive power, and
[7.5]	said second projection optical unit being positioned at an enlarged image side of said first projection optical unit, being adapted to form a second enlarged image by further enlarging the first enlarged image obtained by said first projection optical unit, and having positive refractive power;
[7.6]	wherein the first enlarged image is formed at the image display element side, rather than at said second projection optical unit,

[7.7]	a magnification M1 of the first enlarged image is smaller than a magnification M2 of the second enlarged image, and
[7.8]	said first projection optical unit includes an aperture stop that defines an F-value of said entire projection optical unit.
Claim 8	
[8.0]	The projection image display apparatus according to claim 7,
[8.1]	wherein an optical-axis center of said projection optical unit is made eccentric with respect to a center of the screen.